
X-Series Signal Analyzer

N9030B PXA Signal Analyzer

This document contains N9030B signal analyzer specifications and supplemental information.

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1 PXA Signal Analyzer

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

Definitions and Requirements

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

Definitions

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

Conditions Required to Meet Specifications

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

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

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

Certification

Keysight Technologies certifies that this product met its published specifications at the time of shipment from the factory. Keysight Technologies further certifies that its calibration measurements are traceable to the International System of Units (SI) via national metrology institutes (www.keysight.com/find/NMI) that are signatories to the CIPM Mutual Recognition Arrangement.

Frequency and Time

| Description | Specifications | | Supplemental Information |
|--------------------------|-------------------------|------------|--------------------------|
| Frequency Range | | | |
| Maximum Frequency | | | |
| <i>Option 503</i> | 3.6 GHz | | |
| <i>Option 508</i> | 8.4 GHz | | |
| <i>Option 513</i> | 13.6 GHz | | |
| <i>Option 526</i> | 26.5 GHz | | |
| <i>Option 544</i> | 44 GHz | | |
| <i>Option 550</i> | 50 GHz | | |
| Preamp <i>Option P03</i> | 3.6 GHz | | |
| Preamp <i>Option P08</i> | 8.4 GHz | | |
| Preamp <i>Option P13</i> | 13.6 GHz | | |
| Preamp <i>Option P26</i> | 26.5 GHz | | |
| Preamp <i>Option P44</i> | 44 GHz | | |
| Preamp <i>Option P50</i> | 50 GHz | | |
| Minimum Frequency | | | |
| Preamp | AC Coupled ^a | DC Coupled | |
| Off | 10 MHz | 2 Hz | |
| On | 10 MHz | 9 kHz | |

PXA Signal Analyzer
Frequency and Time

| Description | Specifications | | Supplemental Information |
|----------------------------------|----------------------|-------------------------------|---|
| Band | Harmonic Mixing Mode | LO Multiple (N ^b) | Band Overlaps ^c |
| 0 (2 Hz to 3.6 GHz) ^d | 1– | 1 | <i>Options 503, 508, 513, 526, 544, 550</i> |
| 1 (3.5 to 8.4 GHz) | 1– | 1 | <i>Options 508, 513, 526, 544, 550</i> |
| 2 (8.3 to 13.6 GHz) | 1– | 2 | <i>Options 513, 526, 544, 550</i> |
| 3 (13.5 to 17.1 GHz) | 2– | 2 | <i>Options 526, 544, 550</i> |
| 4 (17.0 to 26.5 GHz) | 2– | 4 | <i>Options 526, 544, 550</i> |
| 5 (26.4 to 34.5 GHz) | 2– | 4 | <i>Options 544, 550</i> |
| 6 (34.4 to 50 GHz) | 4– | 8 | <i>Options 544, 550</i> |

- AC Coupled only applicable to frequency *Options 503, 508, 513, and 526*.
- N is the LO multiplication factor. For negative mixing modes (as indicated by the “–” in the “Harmonic Mixing Mode” column), the desired 1st LO harmonic is higher than the tuned frequency by the 1st IF.
- In the band overlap regions, for example, 3.5 to 3.6 GHz, the analyzer may use either band for measurements, in this example Band 0 or Band 1. The analyzer gives preference to the band with the better overall specifications (which is the lower numbered band for all frequencies below 26 GHz), but will choose the other band if doing so is necessary to achieve a sweep having minimum band crossings. For example, with CF = 3.58 GHz, with a span of 40 MHz or less, the analyzer uses Band 0, because the stop frequency is 3.6 GHz or less, allowing a span without band crossings in the preferred band. If the span is between 40 and 160 MHz, the analyzer uses Band 1, because the start frequency is above 3.5 GHz, allowing the sweep to be done without a band crossing in Band 1, though the stop frequency is above 3.6 GHz, preventing a Band 0 sweep without band crossing. With a span greater than 160 MHz, a band crossing will be required: the analyzer sweeps up to 3.6 GHz in Band 0; then executes a band crossing and continues the sweep in Band 1.
Specifications are given separately for each band in the band overlap regions. One of these specifications is for the preferred band, and one for the alternate band. Continuing with the example from the previous paragraph (3.58 GHz), the preferred band is band 0 (indicated as frequencies under 3.6 GHz) and the alternate band is band 1 (3.5 to 8.4 GHz). The specifications for the preferred band are warranted. The specifications for the alternate band are not warranted in the band overlap region, but performance is nominally the same as those warranted specifications in the rest of the band. Again, in this example, consider a signal at 3.58 GHz. If the sweep has been configured so that the signal at 3.58 GHz is measured in Band 1, the analysis behavior is nominally as stated in the Band 1 specification line (3.5 to 8.4 GHz) but is not warranted. If warranted performance is necessary for this signal, the sweep should be reconfigured so that analysis occurs in Band 0. Another way to express this situation in this example Band 0/Band 1 crossing is this: The specifications given in the “Specifications” column which are described as “3.5 to 8.4 GHz” represent nominal performance from 3.5 to 3.6 GHz, and warranted performance from 3.6 to 8.4 GHz.
- Band 0 is extendable (set “Extend Low Band” to On) to 3.7 GHz instead of 3.6 GHz in instruments with frequency *Option 508, 513 or 526*.

PXA Signal Analyzer
Frequency and Time

| Description | Specifications | Supplemental Information |
|---|---|---|
| Precision Frequency Reference (Option EP1) | | |
| Accuracy | $\pm[(\text{time since last adjustment} \times \text{aging rate}) + \text{temperature stability} + \text{calibration accuracy}]^a$ ^b | |
| Temperature Stability | | |
| 20 to 30°C | $\pm 1.5 \times 10^{-8}$ | Nominally linear ^c |
| Full temperature range | $\pm 5 \times 10^{-8}$ | |
| Aging Rate | | $\pm 5 \times 10^{-10}/\text{day}$ (nominal) |
| Total Aging | | |
| 1 Year | $\pm 1 \times 10^{-7}$ | |
| 2 Years | $\pm 1.5 \times 10^{-7}$ | |
| Settability | $\pm 2 \times 10^{-9}$ | |
| Warm-up and Retrace ^d | | Nominal |
| 300 s after turn on | | $\pm 1 \times 10^{-7}$ of final frequency |
| 900 s after turn on | | $\pm 1 \times 10^{-8}$ of final frequency |
| Achievable Initial Calibration Accuracy ^e | $\pm 4 \times 10^{-8}$ | |
| Standby power to reference oscillator | | Not supplied |
| Residual FM (Center Frequency = 1 GHz 10 Hz RBW, 10 Hz VBW) | | $\leq 0.25 \text{ Hz} \times N^f$ p-p in 20 ms (nominal) |

- Calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz. If the adjustment procedure is followed, the calibration accuracy is given by the specification "Achievable Initial Calibration Accuracy."
- The specification applies after the analyzer has been powered on for four hours.
- Narrow temperature range performance is nominally linear with temperature. For example, for $25 \pm 3^\circ \text{C}$, the stability would be only three-fifths as large as the warranted $25 \pm 5^\circ \text{C}$, thus $\pm 0.9 \times 10^{-8}$.
- Standby mode does not apply power to the oscillator. Therefore warm-up applies every time the power is turned on. The warm-up reference is one hour after turning the power on. Retracing also occurs every time warm-up occurs. The effect of retracing is included within the "Achievable Initial Calibration Accuracy" term of the Accuracy equation.

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Frequency and Time

- e. The achievable calibration accuracy at the beginning of the calibration cycle includes these effects:
- 1) Temperature difference between the calibration environment and the use environment
 - 2) Orientation relative to the gravitation field changing between the calibration environment and the use environment
 - 3) Retrace effects in both the calibration environment and the use environment due to turning the instrument power off.
 - 4) Settability
- f. N is the LO multiplication factor.

| Description | Specifications | Supplemental Information |
|---|---|---|
| Precision Frequency Reference (Option EP0) | | |
| Accuracy | $\pm[(\text{time since last adjustment} \times \text{aging rate}) + \text{temperature stability} + \text{calibration accuracy}]^{\text{a,b}}$ | |
| Temperature Stability | | |
| Full temperature range | $\pm 4.5 \times 10^{-9}$ | |
| Aging Rate | | $\pm 2.5 \times 10^{-10}/\text{day}$ (nominal) |
| Total Aging | | |
| 1 Year | $\pm 3 \times 10^{-8}$ | |
| Settability | $\pm 4 \times 10^{-11}$ | |
| Warm-up and Retrace ^c | | Nominal |
| 300 s after turn on | | $\pm 1 \times 10^{-7}$ of final frequency |
| 600 s after turn on | | $\pm 1 \times 10^{-8}$ of final frequency |
| Achievable Initial Calibration Accuracy ^d | $\pm 3.1 \times 10^{-8}$ | |
| Standby power | | Standby power is supplied to both the CPU and the frequency reference oscillator. |
| Residual FM (Center Frequency = 1 GHz 10 Hz RBW, 10 Hz VBW) | | $\leq 0.25 \text{ Hz} \times N^{\text{e}}$ p-p in 20 ms (nominal) |

- a. Calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz. If the adjustment procedure is followed, the calibration accuracy is given by the specification "Achievable Initial Calibration Accuracy."
- b. The specification applies after the analyzer has been powered on for four hours.

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- c. Standby mode applies power to the oscillator. Therefore warm-up and retrace only apply if the power connection is lost and restored. The warm-up reference is one hour after turning the power on. The effect of retracing is included within the "Achievable Initial Calibration Accuracy" term of the Accuracy equation.
- d. The achievable calibration accuracy at the beginning of the calibration cycle includes these effects:
 - 1) Temperature difference between the calibration environment and the use environment
 - 2) Orientation relative to the gravitation field changing between the calibration environment and the use environment
 - 3) Retrace effects in both the calibration environment and the use environment due to turning the instrument power off.
 - 4) Settability
- e. N is the LO multiplication factor.

| Description | Specifications | Supplemental Information |
|-----------------------------------|--|-----------------------------------|
| Frequency Readout Accuracy | $\pm(\text{marker freq} \times \text{freq ref accy} + 0.10\% \times \text{span} + 5\% \times \text{RBW}^a + 2 \text{ Hz} + 0.5 \times \text{horizontal resolution}^b)$ | Single detector only ^c |
| Example for EMC ^d | | $\pm 0.0032\%$ (nominal) |

- a. The warranted performance is only the sum of all errors under autocoupled conditions. Under non-autocoupled conditions, the frequency readout accuracy will nominally meet the specification equation, except for conditions in which the RBW term dominates, as explained in examples below. The nominal RBW contribution to frequency readout accuracy is 2% of RBW for RBWs from 1 Hz to 390 kHz, 4% of RBW from 430 kHz through 3 MHz (the widest autocoupled RBW), and 30% of RBW for the (manually selected) 4, 5, 6 and 8 MHz RBWs.
First example: a 120 MHz span, with autocoupled RBW. The autocoupled ratio of span to RBW is 106:1, so the RBW selected is 1.1 MHz. The $5\% \times \text{RBW}$ term contributes only 55 kHz to the total frequency readout accuracy, compared to 120 kHz for the $0.10\% \times \text{span}$ term, for a total of 175 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 20 kHz of error (0.10%) 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 1001 sweep points, the horizontal resolution is $\text{span}/1000$. 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 $\text{span}/500$ for the factory preset case. When the RBW is autocoupled and there are 1001 sweep points, that exception occurs only for spans > 750 MHz.
- c. Specifications apply to traces in most cases, but there are exceptions. Specifications always apply to the peak detector. Specifications apply when only one detector is in use and all active traces are set to Clear Write. Specifications also apply when only one detector is in use in all active traces and the "Restart" key has been pressed since any change from the use of multiple detectors to a single detector. In other cases, such as when multiple simultaneous detectors are in use, additional errors of 0.5, 1.0 or 1.5 sweep points will occur in some detectors, depending on the combination of detectors in use.

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Frequency and Time

- d. In most cases, the frequency readout accuracy of the analyzer can be exceptionally good. As an example, Keysight has characterized the accuracy of a span commonly used for Electro-Magnetic Compatibility (EMC) testing using a source frequency locked to the analyzer. Ideally, this sweep would include EMC bands C and D and thus sweep from 30 to 1000 MHz. Ideally, the analysis bandwidth would be 120 kHz at –6 dB, and the spacing of the points would be half of this (60 kHz). With a start frequency of 30 MHz and a stop frequency of 1000.2 MHz and a total of 16168 points, the spacing of points is ideal. The detector used was the Peak detector. The accuracy of frequency readout of all the points tested in this span was with $\pm 0.0032\%$ of the span. A perfect analyzer with this many points would have an accuracy of $\pm 0.0031\%$ of span. Thus, even with this large number of display points, the errors in excess of the bucket quantization limitation were negligible.

| Description | Specifications | Supplemental Information |
|--------------------------------------|---|--------------------------|
| Frequency Counter^a | | See note ^b |
| Count Accuracy | $\pm(\text{marker freq} \times \text{freq ref accy.} + 0.100 \text{ Hz})$ | |
| Delta Count Accuracy | $\pm(\text{delta freq.} \times \text{freq ref accy.} + 0.141 \text{ Hz})$ | |
| Resolution | 0.001 Hz | |

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

| Description | Specifications | Supplemental Information |
|-----------------------|--|--------------------------|
| Frequency Span | | |
| Range | | |
| Option 503 | 0 Hz, 10 Hz to 3.6 GHz | |
| Option 508 | 0 Hz, 10 Hz to 8.4 GHz | |
| Option 513 | 0 Hz, 10 Hz to 13.6 GHz | |
| Option 526 | 0 Hz, 10 Hz to 26.5 GHz | |
| Option 544 | 0 Hz, 10 Hz to 44 GHz | |
| Option 550 | 0 Hz, 10 Hz to 50 GHz | |
| Resolution | 2 Hz | |
| Span Accuracy | | |
| Swept | $\pm(0.1\% \times \text{span} + \text{horizontal resolution}^a)$ | |
| FFT | $\pm(0.1\% \times \text{span} + \text{horizontal resolution}^a)$ | |

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- a. Horizontal resolution is due to the marker reading out one of the sweep 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 1001 sweep points, the horizontal resolution is $\text{span}/1000$. 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 $\text{span}/500$ for the factory preset case. When the RBW is auto coupled and there are 1001 sweep points, that exception occurs only for spans >750 MHz.

| Description | Specifications | Supplemental Information |
|--|--|--|
| Sweep Time and Trigger | | |
| Sweep Time Range Span = 0 Hz Span ≥ 10 Hz | 1 μs to 6000 s 1 ms to 4000 s | |
| Sweep Time Accuracy Span ≥ 10 Hz, swept Span ≥ 10 Hz, FFT Span = 0 Hz | | $\pm 0.01\%$ (nominal) $\pm 40\%$ (nominal) $\pm 0.01\%$ (nominal) |
| Sweep Trigger | Free Run, Line, Video, External 1, External 2, RF Burst, Periodic Timer | |
| Delayed Trigger ^a | | |
| Range | | |
| Span ≥ 10 Hz | -150 ms to 500 ms | |
| Span = 0 Hz | -10 s to +500 ms ^b | |
| Resolution | 0.1 μs | |

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

b. Prior to A.19.28 software, zero span trigger delay was limited to -150 ms to 500 ms.

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| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Triggers | | Additional information on some of the triggers and gate sources |
| Video | | Independent of Display Scaling and Reference Level |
| Minimum settable level | –170 dBm | Useful range limited by noise |
| Maximum usable level | | Highest allowed mixer level ^a + 2 dB (nominal) |
| Detector and Sweep Type relationships | | |
| Sweep Type = Swept | | |
| Detector = Normal, Peak, Sample or Negative Peak | | Triggers on the signal before detection, which is similar to the displayed signal |
| Detector = Average | | Triggers on the signal before detection, but with a single-pole filter added to give similar smoothing to that of the average detector |
| Sweep Type = FFT | | Triggers on the signal envelope in a bandwidth wider than the FFT width |
| RF Burst | | |
| Level Range | | –40 to –10 dBm plus attenuation (nominal) ^b |
| Level Accuracy ^c | | |
| Absolute | | ±2 dB + Absolute Amplitude Accuracy (nominal) |
| Relative | | ±2 dB (nominal) |
| Bandwidth (–10 dB) | | |
| Most cases ^d | | >80 MHz (nominal) |
| Start Freq < 300 MHz, RF Burst Level Type = Absolute | | |
| Sweep Type = Swept | | 16 MHz (nominal) |
| Sweep Type = FFT | | |
| FFT Width > 25 MHz; | | >80 MHz (nominal) |
| FFT Width 8 to 25 MHz; | | 30 MHz (nominal) |
| FFT Width < 8 MHz | | 16 MHz (nominal) |
| Frequency Limitations | | If the start or center frequency is too close to zero, LO feedthrough can degrade or prevent triggering. How close is too close depends on the bandwidth listed above. |

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| Description | Specifications | Supplemental Information |
|--------------------------|--|---|
| External Triggers | | See “Trigger Inputs” on page 91 |
| TV Triggers | | Triggers on the leading edge of the selected sync pulse of standardized TV signals. |
| Amplitude Requirements | | –65 dBm minimum video carrier power at the input mixer, nominal |
| Compatible Standards | NTSC-M, NTSC-Japan, NTSC-4.43, PAL-M, PAL-N, PAL-N Combination, PAL-B/-D/-G/-H/-I. PAL-60, SECAM-L | |
| Field Selection | Entire Frame, Field One, Field Two | |
| Line Selection | 1 to 525, or 1 to 625, standard dependent | |

- The highest allowed mixer level depends on the IF Gain. It is nominally –10 dBm for Preamp Off and IF Gain = Low.
- Noise will limit trigger level range at high frequencies, such as above 15 GHz.
- With positive slope trigger. Trigger level with negative slope is nominally 1 to 4 dB lower than positive slope.
- Include RF Burst Level Type = Relative.

PXA Signal Analyzer
Frequency and Time

| Description | Specifications | Supplemental Information |
|--|--|--|
| Gated Sweep | | |
| Gate Methods | Gated LO Gated Video Gated FFT | |
| Span Range | Any span | |
| Gate Delay Range | 0 to 100.0 s | |
| Gate Delay Settability | 4 digits, ≥ 100 ns | |
| Gate Delay Jitter | | 33.3 ns p-p (nominal) |
| Gate Length Range (Except Method = FFT) | 1 μ s to 5.0 s | Gate length for the FFT method is fixed at 1.83/RBW, with nominally 2% tolerance. |
| Gated FFT and Gated Video Frequency and Amplitude Errors | | Nominally no additional error for gated measurements when the Gate Delay is greater than the MIN FAST setting |
| Gated LO Frequency Errors | | |
| Gate ≥ 10 μ s | | Nominally no additional error when the Gate Delay is greater than the MIN FAST setting |
| $1.0 \mu\text{s} \leq \text{Gate} < 10 \mu\text{s}$ | | Nominal error given by $100 \text{ ns} \times N \times (\text{Span}/\text{ST}) \times \sqrt{(\text{SpanPosition} \times \text{ST} / \text{GateLength})}$; see footnote ^a |
| Gated LO Amplitude Errors | | Nominally no additional error when the Gate Delay is greater than the MIN FAST setting |
| Phase Noise Effects | | Gated LO method overrides the loop configuration to force single loop in place of dual loop. |
| Gate Sources | External 1 External 2 Line RF Burst Periodic | Pos or neg edge triggered |

a. ST is sweep time; SpanPosition is the location of the on-screen signal, 0 being the left edge of the screen and 1 being the right edge. N is the harmonic mixing number.

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Number of Frequency Sweep Points (buckets) | | |
| Factory preset | 1001 | |
| Range | 1 to 100,001 | Zero and non-zero spans |

PXA Signal Analyzer
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| Description | Specifications | Supplemental Information |
|---|---|----------------------------------|
| Resolution Bandwidth (RBW) | | |
| Range (–3.01 dB bandwidth) Standard | 1 Hz to 10 MHz ^a Bandwidths above 3 MHz are 4, 5, 6, 8, and 10 MHz. ^a Bandwidths 1 Hz to 3 MHz are spaced at 10% spacing using the E24 series (24 per decade): 1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1 in each decade. | |
| With <i>Option B85</i> and <i>Option RBE</i> ^b | 10, 15, 20, 25, 30, 40, 50, 60, and 70 MHz, in Spectrum Analyzer mode and zero span. | |
| With <i>Option B1X</i> and <i>Option RBE</i> ^b | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 100, and 133 MHz, in Spectrum Analyzer mode and zero span. | |
| With <i>Option B2X</i> or <i>B5X</i> and <i>Option RBE</i> ^b | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 100, 133, 150, 200, and 212 MHz, in Spectrum Analyzer mode and zero span. | |
| Power bandwidth accuracy ^c | | |
| RBW Range CF Range | | |
| 1 Hz to 100 kHz | All | ±0.5% (0.022 dB) |
| 110 kHz to 1.0 MHz | < 3.6 GHz | ±1.0% (0.044 dB) |
| 1.1 to 2.0 MHz | < 3.6 GHz | ±0.07 dB (nominal) |
| 2.2 to 3 MHz | < 3.6 GHz | 0 to –0.2 dB (nominal) |
| 4 to 10 MHz ^a | < 3.6 GHz | 0 to –0.4 dB (nominal) |
| Noise BW to RBW ratio ^d | | 1.056 ±2% (nominal) |
| Accuracy (–3.01 dB bandwidth) ^e | | |
| 1 Hz to 1.3 MHz RBW | | ±2% (nominal) |
| 1.5 MHz to 3 MHz RBW CF ≤ 3.6 GHz CF > 3.6 GHz | | ±7% (nominal) ±8% (nominal) |
| 4 MHz to 10 MHz RBW ^a CF ≤ 3.6 GHz CF > 3.6 GHz | | ±15% (nominal) ±20% (nominal) |
| Selectivity (–60 dB/–3 dB) | | 4.1:1 (nominal) |

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- a. The 10 MHz RBW setting is only available on analyzers with instrument software version \geq A.30.05 and which also have option FS1 installed. Otherwise, the maximum RBW setting is 8 MHz.
- b. Option RBE enables wider bandwidth filters in zero span in the Signal Analyzer mode. Available detectors are Peak+ and Average. VBW filtering is disabled. Minimum sweep time is the greater of 200 μ S or 200ns/pt. The filter shape is approximately square. Support for Average detector was first added in SW Version A.23.05.
- c. The noise marker, band power marker, channel power and ACP all compute their results using the power bandwidth of the RBW used for the measurement. Power bandwidth accuracy is the power uncertainty in the results of these measurements due only to bandwidth-related errors. (The analyzer knows this power bandwidth for each RBW with greater accuracy than the RBW width itself, and can therefore achieve lower errors.) The warranted specifications shown apply to the Gaussian RBW filters used in swept and zero span analysis. There are four different kinds of filters used in the spectrum analyzer: Swept Gaussian, Swept Flattop, FFT Gaussian and FFT Flattop. While the warranted performance only applies to the swept Gaussian filters, because only they are kept under statistical process control, the other filters nominally have the same performance.
- d. The ratio of the noise bandwidth (also known as the power bandwidth) to the RBW has the nominal value and tolerance shown. The RBW can also be annotated by its noise bandwidth instead of this 3 dB bandwidth. The accuracy of this annotated value is similar to that shown in the power bandwidth accuracy specification.
- e. Resolution Bandwidth Accuracy can be observed at slower sweep times than auto-coupled conditions. Normal sweep rates cause the shape of the RBW filter displayed on the analyzer screen to widen by nominally 6%. This widening declines to 0.6% nominal when the Swp Time Rules key is set to Accuracy instead of Normal. The true bandwidth, which determines the response to impulsive signals and noise-like signals, is not affected by the sweep rate.

| Description | Specification | Supplemental information |
|---------------------------------------|---------------|--------------------------|
| Analysis Bandwidth^a | | |
| Standard | 25 MHz | |
| With <i>Option B40</i> | 40 MHz | |
| With <i>Option B85</i> | 85 MHz | |
| With <i>Option B1X</i> | 160 MHz | |
| With <i>Option B2X</i> | 255 MHz | |
| With <i>Option B5X</i> | 510 MHz | |

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

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| Description | Specifications | Supplemental Information | |
|-----------------------------------|----------------|--|-----------------------------|
| Preselector Bandwidth | | Relevant to many options, such as B1X Wide IF Bandwidth, in Bands 1 and higher. Nominal. | |
| Mean Bandwidth at CF ^a | | Freq option ≤ 526 | Freq option > 526 |
| 5 GHz | | 58 MHz | 46 MHz |
| 10 GHz | | 57 MHz | 52 MHz |
| 15 GHz | | 59 MHz | 53 MHz |
| 20 GHz | | 64 MHz | 55 MHz |
| 25 GHz | | 74 MHz | 56 MHz |
| 35 GHz | | | 62 MHz |
| 44 GHz | | | 70 MHz |
| Standard Deviation | | 9% | 7% |
| –3 dB Bandwidth | | –7.5% relative to –4 dB bandwidth, nominal | |

- a. The preselector can have a significant passband ripple. To avoid ambiguous results, the –4 dB bandwidth is characterized.

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

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

Amplitude Accuracy and Range

| Description | Specifications | Supplemental Information |
|--|--|--------------------------|
| Measurement Range | | |
| Preamp Off | Displayed Average Noise Level to +30 dBm | |
| Preamp On | | |
| RF (<i>Option 503</i>) | Displayed Average Noise Level to +30 dBm | |
| μ W (<i>Options 508, 513, 526</i>) | Displayed Average Noise Level to +24 dBm | |
| mmW (<i>Options 544, 550</i>) | Displayed Average Noise Level to +20 dBm | |
| Input Attenuation Range | 0 to 70 dB, in 2 dB steps | |

| Description | Specifications | Supplemental Information |
|---|-----------------|---|
| Maximum Safe Input Level | | Applies with or without preamp (<i>Options P03, P08, P13, P26, P44, P50</i>) |
| Average Total Power | +30 dBm (1 W) | |
| Peak Pulse Power ($\leq 10 \mu$ s pulse width, $\leq 1\%$ duty cycle, input attenuation ≥ 30 dB) | +50 dBm (100 W) | |
| DC voltage | | |
| DC Coupled | ± 0.2 Vdc | |
| AC Coupled | ± 100 Vdc | |

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

PXA Signal Analyzer
Amplitude Accuracy and Range

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

Frequency Response

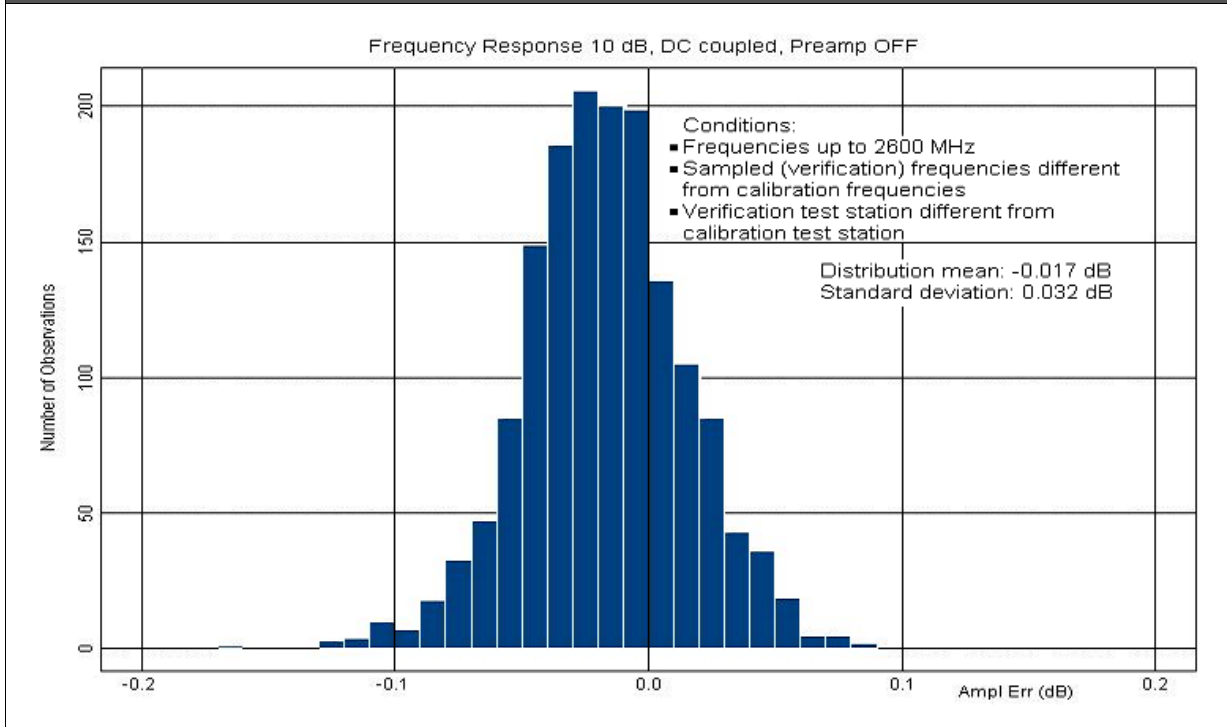
| Description | | | Specifications | | Supplemental Information |
|---|---|---|-------------------|-------------------|---|
| Frequency Response (Maximum error relative to reference condition (50 MHz) Mechanical attenuator only ^b Swept operation ^c Attenuation 10 dB) | | | | | Refer to the footnote for Band Overlaps on page 21 . Freq <i>Option 526</i> only: Modes above 18 GHz ^a |
| Option 544, or 550 (mmW) | | | | | |
| Option 503, 508, 513, or 526 (RF/μW) | | | 20 to 30°C | Full range | 95th Percentile ($\approx 2\sigma$) |
| | ↓ | ↓ | | | |
| 3 Hz to 10 MHz | x | x | ±0.46 dB | ±0.54 dB | |
| 10 to 20 MHz ^d | x | | ±0.35 dB | ±0.44 dB | |
| 10 to 20 MHz | | x | ±0.46 dB | ±0.54 dB | |
| 20 to 50 MHz ^d | x | | ±0.35 dB | ±0.44 dB | ±0.16 dB |
| 20 to 50 MHz | | x | ±0.35 dB | ±0.44 dB | ±0.19 dB |
| 50 MHz to 3.6 GHz | x | | ±0.35 dB | ±0.44 dB | ±0.16 dB |
| 50 MHz to 3.6 GHz | | x | ±0.35 dB | ±0.47 dB | ±0.15 dB |
| 3.6 to 3.7 GHz (Band 0) | x | | | | See note ^e |
| 3.5 to 5.2 GHz ^{fg} | x | | ±1.5 dB | ±2.5 dB | ±0.54 dB |
| 3.5 to 5.2 GHz ^{fg} | | x | ±1.7 dB | ±3.5 dB | ±0.70 dB |
| 5.2 to 8.4 GHz ^{fg} | x | | ±1.5 dB | ±2.5 dB | ±0.54 dB |
| 5.2 to 8.4 GHz ^{fg} | | x | ±1.5 dB | ±2.5 dB | ±0.57 dB |
| 8.3 to 13.6 GHz ^{fg} | x | | ±2.0 dB | ±2.7 dB | ±0.56 dB |
| 8.3 to 13.6 GHz ^{fg} | | x | ±2.0 dB | ±2.5 dB | ±0.54 dB |
| 13.5 to 16 GHz (with <i>Option EPO</i>) ^{fg} | x | | ±2.0 dB | ±2.7 dB | ±0.55 dB |
| 16 to 17 GHz (with <i>Option EPO</i>) ^{fg} | x | | ±2.0 dB | ±3.0 dB | ±0.81 dB |
| 13.5 to 17.1 GHz (without <i>Option EPO</i>) ^{fg} | x | | ±2.0 dB | ±2.7 dB | ±0.62 dB |

PXA Signal Analyzer
Amplitude Accuracy and Range

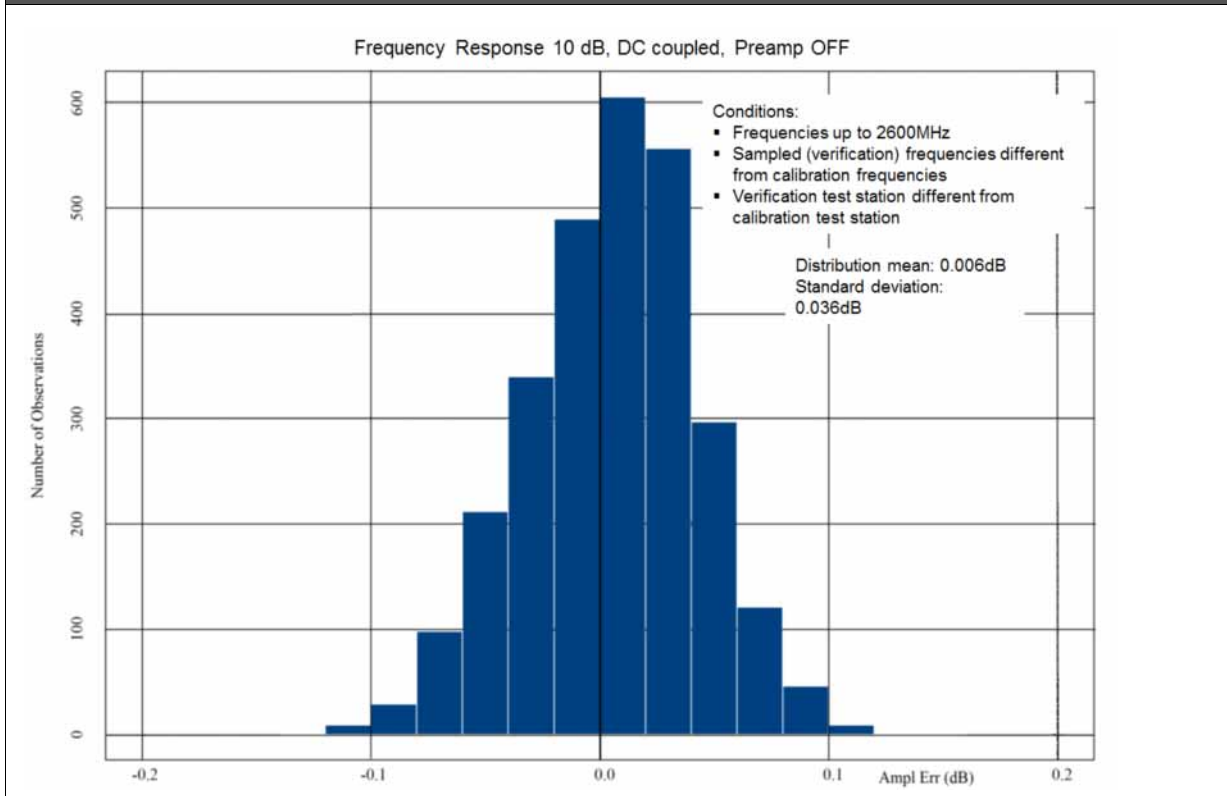
| Description | | | Specifications | | Supplemental Information |
|-----------------------------------|---|---|----------------|---------|--------------------------|
| 13.5 to 17.1 GHz ^{fg} | | x | ±2.0 dB | ±2.7 dB | ±0.64 dB |
| Frequency Response (cont.) | | | | | |
| 17.0 to 22 GHz ^{fg} | x | | ±2.0 dB | ±2.7 dB | ±0.65 dB |
| 17.0 to 22 GHz ^{fg} | | x | ±2.0 dB | ±2.8 dB | ±0.72 dB |
| 22.0 to 26.5 GHz ^{fg} | x | | ±2.5 dB | ±3.7 dB | ±0.82 dB |
| 22.0 to 26.5 GHz ^{fg} | | x | ±2.5 dB | ±3.5 dB | ±0.71 dB |
| 26.4 to 34.5 GHz ^{fg} | | x | ±2.5 dB | ±3.5 dB | ±1.00 dB |
| 34.4 to 50 GHz ^{fg} | | x | ±3.2 dB | ±4.9 dB | ±1.37 dB |

- Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option* 526 that do not also have input connector *Option* C35 will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. The effect of these modes with this connector are included within these specifications.
- See the Electronic Attenuator (*Option* EA3) chapter for Frequency Response using the electronic attenuator.
- For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.
- Specifications apply with DC coupling at all frequencies. With AC coupling, specifications apply at frequencies of 50 MHz and higher. Statistical observations at 10 MHz and lower show that most instruments meet the specification, but a few percent of instruments can be expected to have errors that, while within the specified limits, are closer to those limits than the measurement uncertainty guardband, and thus are not warranted. The AC coupling effect at 20 to 50 MHz is negligible, but not warranted.
- Band 0 is extendable (set “Extend Low Band” to On) to 3.7 GHz instead of 3.6 GHz in instruments with frequency option 508, 513 or 526. Subject to these conditions, statistical observations show that performance nominally fits within the same range within the 3.6 to 3.7 GHz frequencies as within the next lower specified frequency range, but is not warranted.
- Specifications for frequencies >3.5 GHz apply for sweep rates ≤100 MHz/ms.
- Preselector centering applied when preselector is not bypassed. Refer to Option MPB – Microwave Preselector Bypass chapter for performance affected by bypassing the preselector.

Nominal Frequency Response Band 0 without *Option EPO* [Plot]



Nominal Frequency Response Band 0 with *Option EPO* [Plot]



PXA Signal Analyzer
Amplitude Accuracy and Range

| Description | | | Specifications | Supplemental Information | | |
|--|-------------------------------|--------------------|------------------------------|--|---|----------------------------------|
| IF Frequency Response^a (Demodulation and FFT response relative to the center frequency) | | | | Freq <i>Option 526</i> only: Modes above 18 GHz ^b | | |
| Center Freq (GHz) | Span^c (MHz) | Preselector | Max Error^d | Midwidth Error (95th Percentile) | Slope (dB/MHz) (95th Percentile) | RMS^e (nominal) |
| < 3.6 | ≤10 | | ±0.20 dB | ±0.12 dB | ±0.10 | 0.02 dB |
| ≥ 3.6, ≤ 26.5 | ≤10 | On | | | | 0.23 dB |
| ≥ 3.6, ≤ 26.5 | ≤10 | Off ^f | ±0.25 dB | ±0.12 dB | ±0.10 | 0.02 dB |
| ≥ 26.5, ≤ 50 | ≤10 | On | | | | 0.12 dB |
| > 26.5, ≤ 50 | ≤10 | Off ^f | ±0.30 dB | ±0.12 dB | ±0.10 | 0.024 dB |

- The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF passband effects.
- Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- This column applies to the instantaneous analysis bandwidth in use. In the Spectrum Analyzer Mode, this would be the FFT width.
- The maximum error at an offset (f) from the center of the FFT width is given by the expression $\pm [\text{Midwidth Error} + (f \times \text{Slope})]$, but never exceeds ±Max Error. Here the Midwidth Error is the error at the center frequency for a given FFT span. Usually, the span is no larger than the FFT width in which case the center of the FFT width is the center frequency of the analyzer. When using the Spectrum Analyzer mode with an analyzer span is wider than the FFT width, the span is made up of multiple concatenated FFT results, and thus has multiple centers of FFT widths; in this case the f in the equation is the offset from the nearest center. Performance is nominally three times better at most center frequencies.
- The “rms” nominal performance is the standard deviation of the response relative to the center frequency, integrated across the span. This performance measure was observed at a center frequency in each harmonic mixing band, which is representative of all center frequencies; it is not the worst case frequency.
- Option MPB* is installed and enabled.

PXA Signal Analyzer
Amplitude Accuracy and Range

| Description | | | Specifications | Supplemental Information | | | |
|------------------------------|-----------------------|--------------------|----------------|---|--------------------------------------|-----------------------------------|--------------------------------------|
| IF Phase Linearity | | | | Deviation from mean phase linearity Freq <i>Option 526</i> only: Modes above 18 GHz ^a Without <i>Option EPO</i> With <i>Option EPO</i> | | | |
| Center Freq (GHz) | Span (MHz) | Preselector | | Peak-to-peak (nominal) | RMS (nominal)^b | Peak-to-peak (nominal) | RMS (nominal)^b |
| ≥ 0.02, < 3.6 | ≤10 | n/a | | 0.06° | 0.012° | 0.17° | 0.037° |
| ≥ 3.6 | ≤10 | Off ^c | | 0.10° | 0.022° | 0.31° | 0.067° |
| ≥ 3.6 | ≤10 | On | | 0.11° | 0.024° | 0.83° | 0.170° |

- Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- The listed performance is the standard deviation of the phase deviation relative to the mean phase deviation from a linear phase condition, where the rms is computed across the span shown and over the range of center frequencies shown.
- Option MPB is installed and enabled.

PXA Signal Analyzer
Amplitude Accuracy and Range

| Description | Specifications | Supplemental Information |
|--|--|---------------------------------|
| Absolute Amplitude Accuracy | | |
| At 50 MHz ^a 20 to 30°C Full temperature range | ± 0.24 dB ± 0.28 dB | ± 0.13 dB (95th percentile) |
| At all frequencies ^a 20 to 30°C Full temperature range | $\pm(0.24 \text{ dB} + \text{frequency response})$ $\pm(0.28 \text{ dB} + \text{frequency response})$ | |
| 95th Percentile Absolute Amplitude Accuracy ^b (Wide range of signal levels, RBWs, RLs, etc., 0.01 to 3.6 GHz, Atten = 10 dB) | | ± 0.19 dB |
| Amplitude Reference Accuracy | | ± 0.05 dB (nominal) |
| Preamp On ^c (P03, P08, P13, P26, P44, P50) | $\pm(0.36 \text{ dB} + \text{frequency response})$ | |



- a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: $1 \text{ Hz} \leq \text{RBW} \leq 1 \text{ MHz}$; Input signal -10 to -50 dBm (details below); Input attenuation 10 dB; span < 5 MHz (nominal additional error for span ≥ 5 MHz is 0.02 dB); all settings auto-coupled except Swp Time Rules = Accuracy; combinations of low signal level and wide RBW use $\text{VBW} \leq 30 \text{ kHz}$ to reduce noise. When using FFT sweeps, the signal must be at the center frequency.
- This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.
- The only difference between signals within the range above -50 dBm and those signals below that level is the scale fidelity. Our specifications and experience show no difference between signals above and below this level. The only reason our Absolute Amplitude Uncertainty specification does not go below this level is that noise detracts from our ability to verify the performance at all levels with acceptable test times and yields. So the performance is not warranted at lower levels, but we fully expect it to be the same.

PXA Signal Analyzer
Amplitude Accuracy and Range

- b. Absolute Amplitude Accuracy for a wide range of signal and measurement settings, covers the 95th percentile proportion with 95% confidence. Here are the details of what is covered and how the computation is made: The wide range of conditions of RBW, signal level, VBW, reference level and display scale are discussed in footnote a. There are 44 quasi-random combinations used, tested at a 50 MHz signal frequency. We compute the 95th percentile proportion with 95% confidence for this set observed over a statistically significant number of instruments. Also, the frequency response relative to the 50 MHz response is characterized by varying the signal across a large number of quasi-random verification frequencies that are chosen to not correspond with the frequency response adjustment frequencies. We again compute the 95th percentile proportion with 95% confidence for this set observed over a statistically significant number of instruments. We also compute the 95th percentile accuracy of tracing the calibration of the 50 MHz absolute amplitude accuracy to a national standards organization. We also compute the 95th percentile accuracy of tracing the calibration of the relative frequency response to a national standards organization. We take the root-sum-square of these four independent Gaussian parameters. To that rss we add the environmental effects of temperature variations across the 20 to 30°C range. These computations and measurements are made with the mechanical attenuator only in circuit, set to the reference state of 10 dB.
- A similar process is used for computing the result when using the electronic attenuator under a wide range of settings: all even settings from 4 through 24 dB inclusive, with the mechanical attenuator set to 10 dB. The 95th percentile result was 0.21 dB.
- c. Same settings as footnote a, except that the signal level at the preamp input is –40 to –80 dBm. Total power at preamp (dBm) = total power at input (dBm) minus input attenuation (dB). This specification applies for signal frequencies above 100 kHz.

| Description | Specifications | Supplemental Information |
|--|--|---|
| Input Attenuation Switching Uncertainty (Relative to 10 dB (reference setting) 50 MHz (reference frequency), preamp off Attenuation 12 to 40 dB Attenuation 2 to 8 dB, or > 40 dB Attenuation 0 dB Attenuation > 2 dB, preamp off 3 Hz to 3.6 GHz 3.5 to 8.4 GHz 8.3 to 13.6 GHz 13.5 to 26.5 GHz 26.5 to 50.0 GHz | ±0.14 dB ±0.18 dB | Refer to the footnote for Band Overlaps on page 21 ±0.04 dB (typical) ±0.06 dB (typical) ±0.05 dB (nominal) ±0.3 dB (nominal) ±0.5 dB (nominal) ±0.7 dB (nominal) ±0.7 dB (nominal) ±1.0 dB (nominal) |

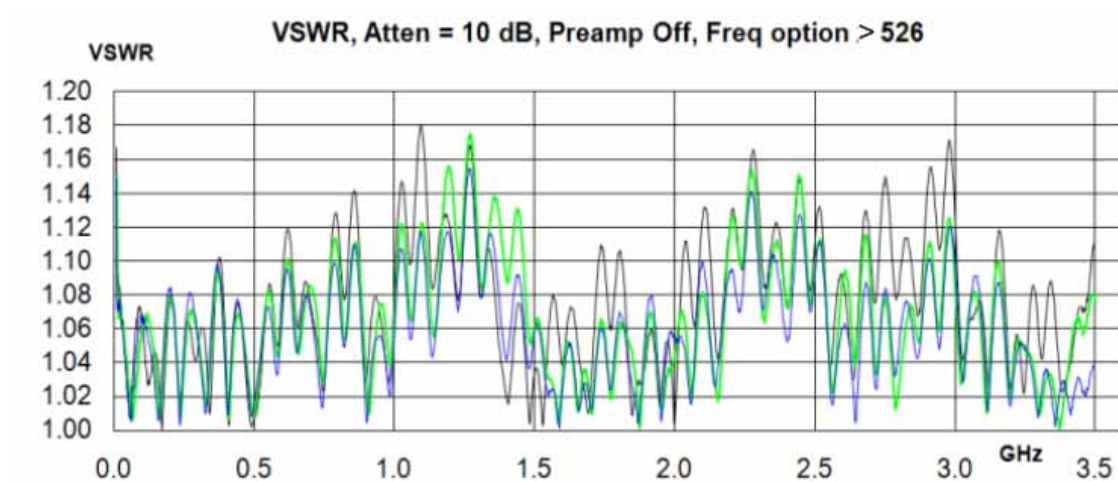
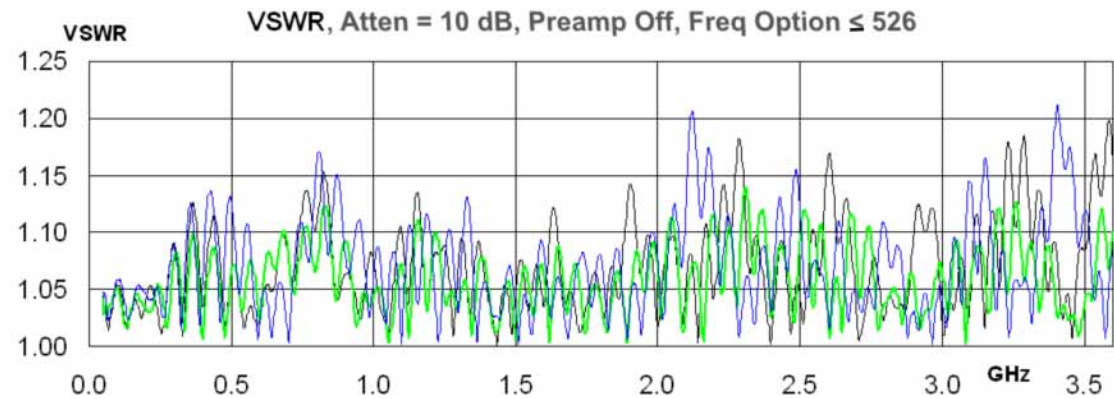
PXA Signal Analyzer
Amplitude Accuracy and Range

| Description | Specifications | | Supplemental Information |
|--|---|---|--|
| RF Input VSWR | | | |
| (at tuned frequency, DC coupled) | | | |
| <i>mmW (Option 544, or 550)</i> | | | |
| RF/ μ W (Option 503, 508, 513, or 526) | | | |
| |  |  | |
| 10 dB atten, 50 MHz (ref condition) | x | | 1.07:1 (nominal) |
| 10 dB atten, 50 MHz (ref condition) | | x | 1.09:1 (nominal) |
| 0 dB atten, 0.01 to 3.6 GHz | x | x | < 2.2:1 (nominal) |
| | | | 95th Percentile^a |
| Band 0 (0.01 to 3.6 GHz, 10 dB atten) | x | | 1.139 |
| Band 0 (0.01 to 3.6 GHz, 10 dB atten) | | x | 1.134 |
| Band 1 (3.5 to 8.4 GHz, 10 dB atten) | x | | 1.290 |
| Band 1 (3.5 to 8.4 GHz, 10 dB atten) | | x | 1.152 |
| Band 2 (8.3 to 13.6 GHz, 10 dB atten) | x | | 1.388 |
| Band 2 (8.3 to 13.6 GHz, 10 dB atten) | | x | 1.178 |
| Band 3 (13.5 to 17.1 GHz, 10 dB atten) | x | | 1.41 |
| Band 3 (13.5 to 17.1 GHz, 10 dB atten) | | x | 1.212 |
| Band 4 (17.0 to 26.5 GHz, 10 dB atten) | x | | 1.48 |
| Band 4 (17.0 to 26.5 GHz, 10 dB atten) | | x | 1.331 |
| Band 5 (26.4 to 34.5 GHz, 10 dB atten) | | x | 1.373 |
| Band 6 (34.4 to 50 GHz, 10 dB atten) | | x | 1.389 |
| Nominal VSWR vs. Freq, 10 dB | | | See plots following |
| Atten > 10 dB | | | Similar to atten = 10 dB |
| RF Calibrator (e.g. 50 MHz) is On | | | Open input |
| Alignments running | | | Open input for some, unless "All but RF" is selected |
| Preselector centering | | | Open input |

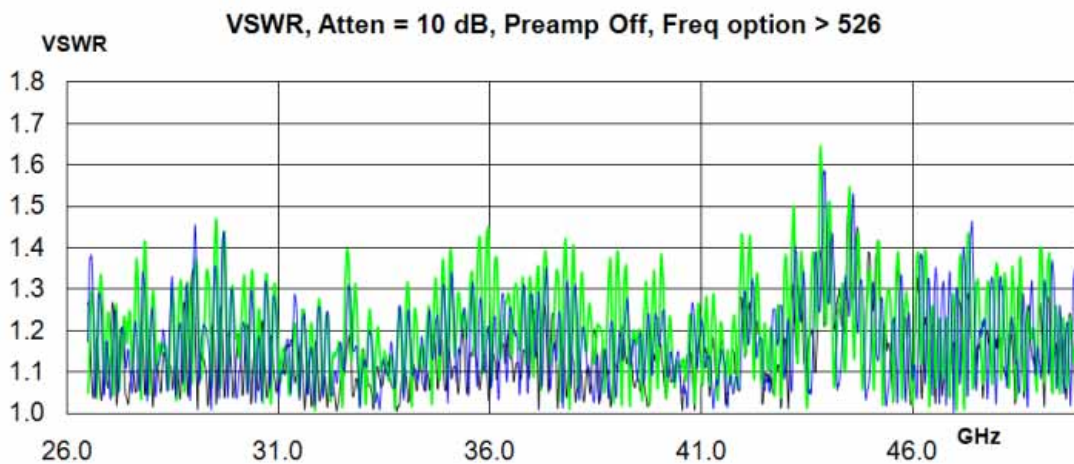
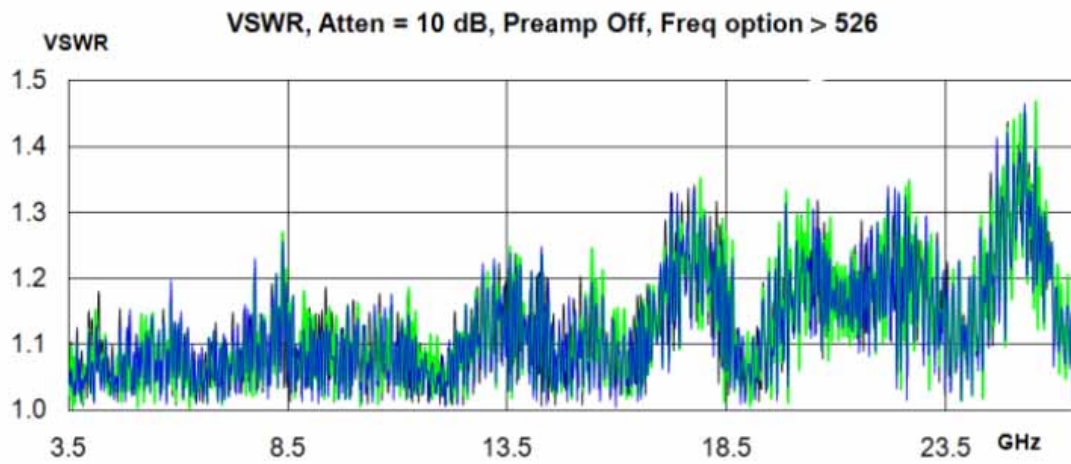
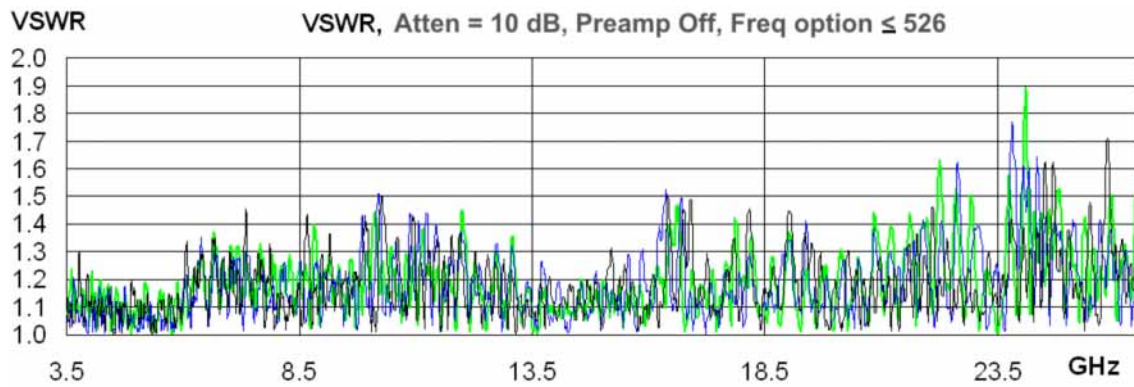
PXA Signal Analyzer
Amplitude Accuracy and Range

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

Nominal VSWR Low Band [Plot]



Nominal VSWR, above 3.5 GHz [Plot]



PXA Signal Analyzer
Amplitude Accuracy and Range

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| Resolution Bandwidth Switching Uncertainty | | Relative to reference BW of 30 kHz, verified in low band ^a |
| 1.0 Hz to 1.5 MHz RBW | ± 0.03 dB | |
| 1.6 MHz to 2.7 MHz RBW | ± 0.05 dB | |
| 3.0 MHz RBW | ± 0.10 dB | |
| Manually selected wide RBWs: 4, 5, 6, 8, 10 MHz ^b | ± 0.30 dB | |

- a. RBW switching uncertainty is verified at 50 MHz. It is consistent for all measurements made without the preselector, thus in Band 0 and also in higher bands with the Preselector Bypass option. In preselected bands, the slope of the preselector passband can interact with the RBW shape to make an apparent additional RBW switching uncertainty of nominally ± 0.05 dB/MHz times the RBW.
- b. The 10 MHz RBW setting is only available on analyzers with instrument software version \geq A.30.05 and which also have option FS1 installed. Otherwise, the maximum RBW setting is 8 MHz.

| Description | Specifications | Supplemental Information |
|------------------------|---|--------------------------|
| Reference Level | | |
| Range | | |
| Log Units | -170 to +30 dBm, in 0.01 dB steps | |
| Linear Units | 707 pV to 7.07 V, with 0.01 dB resolution (0.11%) | |
| Accuracy | 0 dB ^a | |

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

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

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

PXA Signal Analyzer
Amplitude Accuracy and Range

| Description | Specifications | Supplemental Information |
|---|--|--|
| Display Scale Fidelity^{ab} Absolute Log-Linear Fidelity (Relative to the reference condition: –25 dBm input through 10 dB attenuation, thus –35 dBm at the input mixer) Input mixer level^c –18 dBm ≤ ML ≤ –10 dBm ML < –18 dBm Relative Fidelity ^d Sum of the following terms: high level term instability term slope term prefilter term | Linearity ±0.10 dB ±0.07 dB | Typical ±0.04 dB ±0.02 dB Applies for mixer level ^c range from –10 to –80 dBm, mechanical attenuator only, preamp off, and dither on. Nominal Up to ±0.015 dB ^e 0.0019 dBrms ^f From equation ^g Up to ±0.005 dB ^h |

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

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

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

- b. The scale fidelity is warranted with ADC dither set to Medium. Dither increases the noise level by nominally only 0.28 dB for the most sensitive case (preamp Off, best DANL frequencies). With dither Off, scale fidelity for low level signals, around –60 dBm or lower, will nominally degrade by 0.2 dB. Dither High will give exceptional linear relative scale fidelity, but increase DANL by 0.63 dB instead of 0.28 dB.
- c. Mixer level = Input Level – Input Attenuation
- d. The relative fidelity is the error in the measured difference between two signal levels. It is so small in many cases that it cannot be verified without being dominated by measurement uncertainty of the verification. Because of this verification difficulty, this specification gives nominal performance, based on numbers that are as conservatively determined as those used in warranted specifications. We will consider one example of the use of the error equation to compute the nominal performance.

Example: the accuracy of the relative level of a sideband around –60 dBm, with a carrier at –5 dBm, using attenuation = 10 dB, RBW = 3 kHz, evaluated with swept analysis. The high level term is evaluated with P1 = –15 dBm and P2 = –70 dBm at the mixer. This gives a maximum error within ±0.008 dB. The instability term is ±0.0019 dB if the measurement is completed within a minute. The slope term evaluates to ±0.022 dB. The prefilter term applies and evaluates to the limit of ±0.005 dB. The sum of all these terms is ±0.037 dB.

PXA Signal Analyzer
Amplitude Accuracy and Range

- e. Errors at high mixer levels will nominally be well within the range of $\pm 0.015 \text{ dB} \times \{\exp[(P1 - Pref)/(8.69 \text{ dB})] - \exp[(P2 - Pref)/(8.69 \text{ dB})]\}$ (exp is the natural exponent function, e^x). In this expression, P1 and P2 are the powers of the two signals, in decibel units, whose relative power is being measured. Pref is -10 dBm (-10 dBm is the highest power for which linearity is specified). All these levels are referred to the mixer level.
- f. The stability of the analyzer gain can be an error term of importance when no settings have changed. These have been studied carefully in the PXA. One source of instability is the variation in analyzer response with time when fully warmed up in a stable lab environment. This has been observed to be well modeled as a random walk process, where the difference in two measurements spaced by time t is given by $a \times \sqrt{t}$, where a is 0.0019 dBrms per root minute. The other source of instability is updated alignments from running full or partial alignments in the background or invoking an alignment. Invoked alignments (Align Now, All) have a standard deviation of 0.0018 dB , and performing these will restart the random walk behavior. Partial alignments (Auto Align set to "Partial") have a standard deviation that is, coincidentally, also 0.0018 dBrms , and only occurs once every ten minutes. The standard deviation from full background alignment (Auto Align set to "Normal") is 0.015 dBrms ; with these alignments on, there is no additional random walk behavior. (Keysight recommends setting alignments (Auto Align) to Normal in order to make the best measurements over long periods of time or in environments without very high temperature stability. For short term measurements in highly stable environments, setting alignments to Partial can give the best stability. Setting Alignments to Off is not recommended where stability matters.)
- g. Slope error will nominally be well within the range of $\pm 0.0004 \times (P1 - P2)$. P1 and P2 are defined in footnote e.
- h. A small additional error is possible. In FFT sweeps, this error is possible for spans under 4.01 kHz . For non-FFT measurements, it is possible for RBWs of 3.9 kHz or less. The error is well within the range of $\pm 0.0021 \times (P1 - P2)$ subject to a maximum of $\pm 0.005 \text{ dB}$. (The maximum dominates for all but very small differences.) P1 and P2 are defined in footnote e.

| Description | Specifications | Supplemental Information |
|----------------------------|--|---|
| Available Detectors | Normal, Peak, Sample, Negative Peak, Average | Average detector works on RMS, Voltage and Logarithmic scales |

Dynamic Range

Gain Compression

| Description | Specifications | | Supplemental Information |
|---|--------------------------------------|-------------------|---------------------------------------|
| 1 dB Gain Compression Point (Two-tone)^{abc} | Maximum power at mixer ^d | | |
| | 20 to 30°C | Full range | |
| 20 to 40 MHz | −3 dBm | −4 dBm | 0 dBm (typical) |
| 40 to 200 MHz | +1 dBm | −1 dBm | +3 dBm (typical) |
| 200 MHz to 3.6 GHz | +3 dBm | +2 dBm | +5 dBm (typical) |
| 3.6 to 16 GHz | +1 dBm | 0 dBm | +4 dBm (typical) |
| 16 to 26.5 GHz | −1 dBm | −3 dBm | +2 dBm (typical) |
| 26.5 to 50 GHz | | | 0 dBm (nominal) |
| Clipping (ADC Over-range) | | | |
| Any signal offset | −10 dBm | | Low frequency exceptions ^e |
| Signal offset > 5 times IF prefilter bandwidth and IF Gain set to Low | | | +12 dBm (nominal) |
| IF Prefilter Bandwidth | | | |
| Zero Span or Swept^f, RBW = | Sweep Type = FFT, FFT Width = | | −3 dB Bandwidth (nominal) |
| ≤ 3.9 kHz | < 4.01 kHz | | 8.9 kHz |
| 4.3 to 27 kHz | < 28.81 kHz | | 79 kHz |
| 30 to 160 kHz | < 167.4 kHz | | 303 kHz |
| 180 to 390 kHz | < 411.9 kHz | | 966 kHz |
| 430 kHz to 10 MHz ^g | < 7.99 MHz | | 10.9 MHz |

- Large signals, even at frequencies not shown on the screen, can cause the analyzer to incorrectly measure on-screen signals because of two-tone gain compression. This specification tells how large an interfering signal must be in order to cause a 1 dB change in an on-screen signal.
- Specified at 1 kHz RBW with 100 kHz tone spacing. The compression point will nominally equal the specification for tone spacing greater than 5 times the prefilter bandwidth. At smaller spacings, ADC clipping may occur at a level lower than the 1 dB compression point.

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- c. Reference level and off-screen performance: The reference level (RL) behavior differs from some earlier analyzers in a way that makes this analyzer more flexible. In other analyzers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in these analyzers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in this signal analyzer, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, the analyzer can make measurements largely independent of the setting of the RL without compromising accuracy. Because the RL becomes a display function, not a measurement function, a marker can read out results that are off-screen, either above or below, without any change in accuracy. The only exception to the independence of RL and the way in which the measurement is performed is in the input attenuation setting: When the input attenuation is set to auto, the rules for the determination of the input attenuation include dependence on the reference level. Because the input attenuation setting controls the tradeoff between large signal behaviors (third-order intermodulation, compression, and display scale fidelity) and small signal effects (noise), the measurement results can change with RL changes when the input attenuation is set to auto.
- d. Mixer power level (dBm) = input power (dBm) – input attenuation (dB).
- e. The ADC clipping level declines at low frequencies (below 50 MHz) when the LO feedthrough (the signal that appears at 0 Hz) is within 5 times the prefilter bandwidth (see table) and must be handled by the ADC. For example, with a 300 kHz RBW and prefilter bandwidth at 966 kHz, the clipping level reduces for signal frequencies below 4.83 MHz. For signal frequencies below 2.5 times the prefilter bandwidth, there will be additional reduction due to the presence of the image signal (the signal that appears at the negative of the input signal frequency) at the ADC.
- f. This table applies without *Option FS1* or *FS2*, fast sweep. With *Option FS1* or *FS2*, this table applies for sweep rates that are manually chosen to be the same as or slower than "traditional" sweep rates, instead of the much faster sweep rates, such as autocoupled sweep rates, available with *FS1* or *FS2*. Sweep rate is defined to be span divided by sweep time. If the sweep rate is ≤ 1.1 times RBW-squared, the table applies. Otherwise, compute an "effective RBW" = Span / (SweepTime \times RBW). To determine the IF Prefilter Bandwidth, look up this effective RBW in the table instead of the actual RBW. For example, for RBW = 3 kHz, Span = 300 kHz, and Sweep time = 42 ms, we compute that Sweep Rate = 7.1 MHz/s, while RBW-squared is 9 MHz/s. So the Sweep Rate is < 1.1 times RBW-squared and the table applies; row 1 shows the IF Prefilter Bandwidth is nominally 8.9 kHz. If the sweep time is 1 ms, then the effective RBW computes to 100 kHz. This would result in an IF Prefilter Bandwidth from the third row, nominally 303 kHz.
- g. The 10 MHz RBW setting is only available on analyzers with instrument software version $\geq A.30.05$ and which also have option FS1 installed. Otherwise, the maximum RBW setting is 8 MHz.

Displayed Average Noise Level

| Description | | | | Specifications | | Supplemental Information |
|--|---|---|---|---|----------|---|
| DANL without Noise Floor Extension and without Option EP0^a | | | | Input terminated Sample or Average detector Averaging type = Log 0 dB input attenuation IF Gain = High 1 Hz Resolution Bandwidth | | Refer to the footnote for Band Overlaps on page 21 . |
| mmW with no signal path options ^b | | | | | | |
| mmW with one or more signal path options ^c | | | | | | |
| RF/ μ W without Option EP0 | | | | | | |
| | ↓ | ↓ | ↓ | 20 to 30°C Full range | | Typical |
| 3 to 10 Hz | x | x | x | | | –100 dBm (nominal) |
| 10 to 100 Hz | x | x | x | | | –125 dBm (nominal) |
| 100 Hz to 1 kHz | x | x | x | | | –130 dBm (nominal) |
| 1 to 9 kHz | x | x | x | | | –145 dBm (nominal) |
| 9 to 100 kHz | x | x | x | –146 dBm | –146 dBm | –151 dBm |
| 100 kHz to 1 MHz | x | x | x | –150 dBm | –150 dBm | –156 dBm |
| 1 to 10 MHz ^d | x | x | x | –155 dBm | –152 dBm | –158 dBm |
| 10 MHz to 1.2 GHz | x | x | x | –154 dBm | –152 dBm | –155 dBm |
| 1.2 to 2.1 GHz | x | x | x | –153 dBm | –152 dBm | –155 dBm |
| 2.1 to 3 GHz | x | x | x | –151 dBm | –150 dBm | –153 dBm |
| 3.0 to 3.6 GHz | x | x | x | –151 dBm | –149 dBm | –153 dBm |
| 3.5 to 4.2 GHz | x | | | –147 dBm | –146 dBm | –150 dBm |
| 3.5 to 4.2 GHz | | x | | –143 dBm | –141 dBm | –147 dBm |
| 3.5 to 4.2 GHz | | | x | –145 dBm | –143 dBm | –148 dBm |
| 4.2 to 8.4 GHz | x | | | –150 dBm | –148 dBm | –152 dBm |
| 4.2 to 6.6 GHz | | x | | –144 dBm | –142 dBm | –148 dBm |
| 4.2 to 6.6 GHz | | | x | –146 dBm | –144 dBm | –149 dBm |
| 6.6 to 8.4 GHz | | x | | –147 dBm | –145 dBm | –149 dBm |
| 6.6 to 8.4 GHz | | | x | –149 dBm | –147 dBm | –151 dBm |
| 8.3 to 13.6 GHz | x | | | –149 dBm | –147 dBm | –151 dBm |
| 8.3 to 13.6 GHz | | x | | –147 dBm | –145 dBm | –149 dBm |

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| Description | | | | Specifications | | Supplemental Information |
|---|---|---|---|----------------|----------|--------------------------|
| 8.3 to 13.6 GHz | | | x | –149 dBm | –147 dBm | –151 dBm |
| 13.5 to 16.9 GHz | x | | | –145 dBm | –143 dBm | –147 dBm |
| 13.5 to 14 GHz | | x | | –143 dBm | –141 dBm | –146 dBm |
| 13.5 to 14 GHz | | | x | –145 dBm | –143 dBm | –148 dBm |
| 14 to 17 GHz | | x | | –145 dBm | –143 dBm | –148 dBm |
| 14 to 17 GHz | | | x | –147 dBm | –145 dBm | –150 dBm |
| 16.9 to 20 GHz | x | | | –143 dBm | –140 dBm | –145 dBm |
| 17.0 to 22.5 GHz | | x | | –141 dBm | –139 dBm | –146 dBm |
| 17.0 to 22.5 GHz | | | x | –145 dBm | –143 dBm | –148 dBm |
| 20.0 to 26.5 GHz | x | | | –137 dBm | –135 dBm | –140 dBm |
| 22.5 to 26.5 GHz | | x | | –139 dBm | –137 dBm | –143 dBm |
| 22.5 to 26.5 GHz | | | x | –142 dBm | –140 dBm | –145 dBm |
| 26.4 to 30 GHz | | x | | –138 dBm | –136 dBm | –142 dBm |
| 26.4 to 30 GHz | | | x | –141 dBm | –139 dBm | –145 dBm |
| 30 to 34 GHz | | x | | –138 dBm | –135 dBm | –142 dBm |
| 30 to 34 GHz | | | x | –141 dBm | –138 dBm | –144 dBm |
| 33.9 to 37 GHz | | x | | –134 dBm | –131 dBm | –139 dBm |
| 33.9 to 37 GHz | | | x | –137 dBm | –133 dBm | –142 dBm |
| 37 to 40 GHz | | x | | –132 dBm | –129 dBm | –138 dBm |
| 37 to 40 GHz | | | x | –136 dBm | –133 dBm | –141 dBm |
| 40 to 49 GHz | | x | | –130 dBm | –126 dBm | –135 dBm |
| 40 to 46 GHz | | | x | –136 dBm | –132 dBm | –140 dBm |
| 46 to 49 GHz | | | x | –133 dBm | –129 dBm | –138 dBm |
| 49 to 50 GHz | | x | | –128 dBm | –124 dBm | –133 dBm |
| 49 to 50 GHz | | | x | –133 dBm | –129 dBm | –137 dBm |
| Additional DANL, IF Gain = Low ^e | x | x | x | | | –164.5 dBm (nominal) |

- DANL for zero span and swept is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the noise figure does not depend on RBW and 1 kHz measurements are faster.
- Specifications marked with an x in this column apply to analyzers with mmW frequency options (*Option 544 or 550*) and none of the following options that affect the signal path: *MPB, LNP, B85, B1X, B2X, or B5X*.
- Specifications marked with an x in this column apply to analyzers with mmW frequency options (*Option 544 or 550*) and one or more of the following options that affect the signal path: *MPB, LNP, B85, B1X*.

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- d. DANL below 10 MHz is affected by phase noise around the LO feedthrough signal. Specifications apply with the best setting of the Phase Noise Optimization control, which is to choose the "Best Close-in ϕ Noise" for frequencies below about 150 kHz, and "Best Wide Offset ϕ Noise" for frequencies above about 150 kHz.
- e. Setting the IF Gain to Low is often desirable in order to allow higher power into the mixer without overload, better compression and better third-order intermodulation. When the Swept IF Gain is set to Low, either by auto coupling or manual coupling, there is noise added above that specified in this table for the IF Gain = High case. That excess noise appears as an additional noise at the input mixer. This level has sub-decibel dependence on center frequency. To find the total displayed average noise at the mixer for Swept IF Gain = Low, sum the powers of the DANL for IF Gain = High with this additional DANL. To do that summation, compute $\text{DANL}_{\text{total}} = 10 \times \log(10(\text{DANL}_{\text{high}}/10) + 10(\text{AdditionalDANL} / 10))$. In FFT sweeps, the same behavior occurs, except that FFT IF Gain can be set to autorange, where it varies with the input signal level, in addition to forced High and Low settings.

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| Description | | | Specifications | | Supplemental Information |
|--|---|---|---|-------------------|---|
| DANL without Noise Floor Extension, with Option EPO^a | | | Input terminated Sample or Average detector Averaging type = Log 0 dB input attenuation IF Gain = High 1 Hz Resolution Bandwidth | | Refer to the footnote for Band Overlaps on page 21 . |
| mmW with Option EPO | | | | | |
| RF/ μ W with Option EPO | | | | | |
| |  |  | 20 to 30°C | Full range | Typical |
| 3 to 10 Hz | x | | | | –100 dBm (nominal) |
| 10 to 100 Hz | x | | | | –125 dBm (nominal) |
| 100 Hz to 1 kHz | x | | | | –130 dBm (nominal) |
| 1 to 9 kHz | x | | | | –137 dBm (nominal) |
| 3 to 10 Hz | | x | | | –95 dBm (nominal) |
| 10 to 100 Hz | | x | | | –114 dBm (nominal) |
| 100 Hz to 1 kHz | | x | | | –128 dBm (nominal) |
| 1 to 9 kHz | | x | | | –136 dBm (nominal) |
| 9 to 100 kHz | | x | –143 dBm | –143 dBm | –144 dBm |
| 100 kHz to 1 MHz | | x | –150 dBm | –150 dBm | –153 dBm |
| 1 to 10 MHz ^b | | x | –155 dBm | –152 dBm | –156 dBm |
| 10 MHz to 1.2 GHz | | x | –154 dBm | –152 dBm | –155 dBm |
| 1.2 to 2.1 GHz | | x | –152 dBm | –151 dBm | –153 dBm |
| 2.1 to 3 GHz | | x | –151 dBm | –150 dBm | –152 dBm |
| 3.0 to 3.6 GHz | | x | –150 dBm | –149 dBm | –151 dBm |
| 9 to 100 kHz | x | | –141 dBm | –141 dBm | –145 dBm |
| 100 kHz to 1 MHz | x | | –150 dBm | –150 dBm | –154 dBm |
| 1 to 10 MHz ^c | x | | –155 dBm | –152 dBm | –156 dBm |
| 10 MHz to 1.2 GHz | x | | –154 dBm | –153 dBm | –155 dBm |
| 1.2 to 2.1 GHz | x | | –152 dBm | –151 dBm | –153 dBm |
| 2.1 to 3 GHz | x | | –151 dBm | –149 dBm | –152 dBm |
| 3.0 to 3.6 GHz | x | | –150 dBm | –148 dBm | –151 dBm |
| 3.5 to 4.2 GHz | x | | –147 dBm | –146 dBm | –150 dBm |
| 3.5 to 4.2 GHz | | x | –143 dBm | –141 dBm | –147 dBm |

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| Description | | | Specifications | | Supplemental Information |
|---|---|---|----------------|----------|--------------------------|
| 4.2 to 8.4 GHz | x | | -150 dBm | -148 dBm | -152 dBm |
| 4.2 to 6.6 GHz | | x | -144 dBm | -142 dBm | -148 dBm |
| 6.6 to 8.4 GHz | | x | -147 dBm | -145 dBm | -148 dBm |
| 8.3 to 13.6 GHz | | x | -147 dBm | -145 dBm | -148 dBm |
| 8.3 to 13.6 GHz | x | | -147 dBm | -146 dBm | -149 dBm |
| 13.5 to 16.9 GHz | x | | -145 dBm | -143 dBm | -147 dBm |
| 13.5 to 14 GHz | | x | -143 dBm | -141 dBm | -146 dBm |
| 14 to 17 GHz | | x | -145 dBm | -143 dBm | -148 dBm |
| 17 to 22.5 GHz | | x | -141 dBm | -139 dBm | -145 dBm |
| 16.9 to 20 GHz | x | | -143 dBm | -140 dBm | -145 dBm |
| 20.0 to 26.5 GHz | x | | -135 dBm | -133 dBm | -138 dBm |
| 22.5 to 26.5 GHz | | x | -139 dBm | -137 dBm | -142 dBm |
| 26.4 to 30 GHz | | x | -138 dBm | -136 dBm | -142 dBm |
| 30 to 34 GHz | | x | -138 dBm | -135 dBm | -142 dBm |
| 33.9 to 37 GHz | | x | -134 dBm | -131 dBm | -139 dBm |
| 37 to 40 GHz | | x | -132 dBm | -129 dBm | -138 dBm |
| 40 to 49 GHz | | x | -130 dBm | -126 dBm | -134 dBm |
| 49 to 50 GHz | | x | -128 dBm | -124 dBm | -133 dBm |
| Additional DANL, IF Gain = Low ^d | x | x | | | -164.5 dBm (nominal) |

- DANL for zero span and swept is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the noise figure does not depend on RBW and 1 kHz measurements are faster.
- DANL below 10 MHz is affected by phase noise around the LO feedthrough signal. Specifications apply with the best setting of the Phase Noise Optimization control, which is to choose the "Best Close-in ϕ Noise" for frequencies below about 150 kHz, and "Best Wide Offset ϕ Noise" for frequencies above about 150 kHz.
- DANL below 10 MHz is affected by phase noise around the LO feedthrough signal. Specifications apply with the best setting of the Phase Noise Optimization control, which is to choose the "Best Close-in ϕ Noise" for frequencies below about 150 kHz, and "Best Wide Offset ϕ Noise" for frequencies above about 150 kHz.
- Setting the IF Gain to Low is often desirable in order to allow higher power into the mixer without overload, better compression and better third-order intermodulation. When the Swept IF Gain is set to Low, either by auto coupling or manual coupling, there is noise added above that specified in this table for the IF Gain = High case. That excess noise appears as an additional noise at the input mixer. This level has sub-decibel dependence on center frequency. To find the total displayed average noise at the mixer for Swept IF Gain = Low, sum the powers of the DANL for IF Gain = High with this additional DANL. To do that summation, compute $\text{DANL}_{\text{total}} = 10 \times \log(10(\text{DANL}_{\text{high}}/10) + 10(\text{AdditionalDANL} / 10))$. In FFT sweeps, the same behavior occurs, except that FFT IF Gain can be set to autorange, where it varies with the input signal level, in addition to forced High and Low settings.

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| Description | | | Specifications | Supplemental Information | |
|---|---|---|----------------|---|------------------------------|
| Displayed Average Noise Level with Noise Floor Extension Improvement^a | | | | | |
| mmW with no signal path options ^b | | | | | |
| mmW with one or more signal path options ^c | | | | 95th Percentile ($\approx 2\sigma$)^d | |
| RF/ μ W (Option 503, 508, 513, or 526) | | | | Preamp Off | Preamp On^e |
| | ↓ | ↓ | ↓ | | |
| Band 0, $f > 20$ MHz ^f | x | | | 9 dB | 10 dB |
| Band 0, $f > 20$ MHz ^f | | x | | 10 dB | 9 dB |
| Band 0, $f > 20$ MHz ^f | | | x | 10 dB | 9 dB |
| Band 1 | x | | | 10 dB | 9 dB |
| Band 1 | | x | | 9 dB | 9 dB |
| Band 1 | | | x | 10 dB | 9 dB |
| Band 2 | x | | | 10 dB | 10 dB |
| Band 2 | | x | | 9 dB | 8 dB |
| Band 2 | | | x | 9 dB | 8 dB |
| Band 3 | x | | | 9 dB | 9 dB |
| Band 3 | | x | | 9 dB | 8 dB |
| Band 3 | | | x | 10 dB | 8 dB |
| Band 4 | x | | | 10 dB | 8 dB |
| Band 4 | | x | | 10 dB | 9 dB |
| Band 4 | | | x | 11 dB | 9 dB |
| Band 5 | | x | | 11 dB | 8 dB |
| Band 5 | | | x | 12 dB | 9 dB |
| Band 6 | | x | | 11 dB | 7 dB |
| Band 6 | | | x | 12 dB | 8 dB |
| Improvement for CW Signals^g | | | | 3.5 dB (nominal) | |
| Improvement, Pulsed-RF Signals^h | | | | 10.8 dB (nominal) | |
| Improvement, Noise-Like Signals | | | | 9.1 dB (nominal) | |

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- a. This statement on the improvement in DANL is based on the statistical observations of the error in the effective noise floor after NFE is applied. That effective noise floor can be a negative or a positive power at any frequency. These 95th percentile values are based on the absolute value of that effective remainder noise power.
- b. Specifications marked with an x in this column apply to analyzers with mmW frequency options (*Option 544 or 550*) and none of the following options that affect the signal path: MPB, LNP, B85, B1X, B2X or B5X.
- c. Specifications marked with an x in this column apply to analyzers with mmW frequency options (*Option 544 or 550*) and one or more of the following options that affect the signal path: MPB, LNP, B85, B1X, B2X or B5X.
- d. Unlike other 95th percentiles, these table values do not include delta environment effects. NFE is aligned in the factory at room temperature. For best performance, in an environment that is different from room temperature, such as an equipment rack with other instruments, we recommend running the "Characterize Noise Floor" operation after the first time the analyzer has been installed in the environment, and given an hour to stabilize.
- e. DANL of the preamp is specified with a 50 Ω source impedance. Like all amplifiers, the noise varies with the source impedance. When NFE compensates for the noise with an ideal source impedance, the variation in the remaining noise level with the actual source impedance is greatly multiplied in a decibel sense.
- f. NFE does not apply to the low frequency sensitivity. At frequencies below about 0.5 MHz, the sensitivity is dominated by phase noise surrounding the LO feedthrough. The NFE is not designed to improve that performance. At frequencies between 0.5 and 20 MHz the NFE effectiveness increases from nearly none to near its maximum.
- g. Improvement in the uncertainty of measurement due to amplitude errors and variance of the results is modestly improved by using NFE. The nominal improvement shown was evaluated for a 2 dB error with 250 traces averaged. For extreme numbers of averages, the result will be as shown in the "Improvement for Noise-like Signals" and DANL sections of this table.
- h. Pulsed-RF signals are usually measured with peak detection. Often, they are also measured with many "max hold" traces. When the measurement time in each display point is long compared to the reciprocal of the RBW, or the number of traces max held is large, considerable variance reduction occurs in each measurement point. When the variance reduction is large, NFE can be quite effective; when it is small, NFE has low effectiveness. For example, in Band 0 with 100 pulses per trace element, in order to keep the error within ± 3 dB error 95% of the time, the signal can be 10.8 dB lower with NFE than without NFE.

| Description | | | | Specifications | Supplemental Information | |
|---|---|---|---|----------------|---|------------------------------|
| Displayed Average Noise Level with Noise Floor Extension^a | | | | | 95th Percentile ($\approx 2\sigma$)^b | |
| mmW with no signal path options ^b | | | | | | |
| mmW with one or more signal path options ^c | | | | | | |
| RF/ μ W (Option 503, 508, 513, or 526) | | | | | | |
| | ↓ | ↓ | ↓ | | Preamp Off | Preamp On^c |
| Band 0, $f > 20$ MHz ^f | x | x | x | | –163 dBm | –174 dBm |
| Band 1 | x | | | | –162 dBm | –174 dBm |
| Band 1 | | x | | | –159 dBm | –172 dBm |
| Band 1 | | | x | | –160 dBm | –172 dBm |
| Band 2 | x | | | | –162 dBm | –173 dBm |
| Band 2 | | x | | | –159 dBm | –172 dBm |
| Band 2 | | | x | | –161 dBm | –173 dBm |
| Band 3 | x | | | | –156 dBm | –172 dBm |
| Band 3 | | x | | | –159 dBm | –173 dBm |
| Band 3 | | | x | | –161 dBm | –174 dBm |
| Band 4 | x | | | | –150 dBm | –166 dBm |
| Band 4 | | x | | | –154 dBm | –169 dBm |
| Band 4 | | | x | | –158 dBm | –171 dBm |
| Band 5 | | x | | | –153 dBm | –167 dBm |
| Band 5 | | | x | | –157 dBm | –168 dBm |
| Band 6 | | x | | | –144 dBm | –158 dBm |
| Band 6 | | | x | | –149 dBm | –161 dBm |

- a. DANL with NFE is unlike DANL without NFE. It is based on the statistical observations of the error in the effective noise floor after NFE is applied. That effective noise floor can be a negative or a positive power at any frequency. These 95th percentile values are based on the absolute value of that effective remainder noise power.
- b. Unlike other 95th percentiles, these table values do not include delta environment effects. NFE is aligned in the factory at room temperature. For best performance, in an environment that is different from room temperature, such as an equipment rack with other instruments, we recommend running the "Characterize Noise Floor" operation after the first time the analyzer has been installed in the environment, and given an hour to stabilize.

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- c. NFE performance can give results below theoretical levels of noise in a termination resistor at room temperature, about -174 dBm/Hz. this is intentional and usually desirable. NFE is not designed to report the noise at the input of the analyzer; it reports how much more noise is at the input of the analyzer than was present in its alignment. And its alignment includes the noise of a termination at room temperature. So it can often see the added noise below the theoretical noise. Furthermore, DANL is defined with log averaging in a 1 Hz RBW, which is about 2.3 dB lower than the noise density (power averaged) in a 1 Hz noise bandwidth.

Spurious Responses

| Description | | Specifications | | | Supplemental Information | |
|--|-----------------|--------------------------|----------------------|---------|---|----------------------------|
| Spurious Responses: Residual and Image (see Band Overlaps on page 21) | | | | | Preamp Off ^a <i>Option EPO</i> effects ^b | |
| Residual Responses ^c 200 kHz to 8.4 GHz (swept) Zero span or FFT or other frequencies | | –100 dBm | | | –100 dBm (nominal) | |
| Image Responses | | | | | | |
| Tuned Freq (f) | Excitation Freq | Mixer Level ^d | Response | | Response (typical) | |
| | | | RF/ μ W | mmW | RF/ μ W | mmW |
| 10 MHz to 26.5 GHz | f+45 MHz | –10 dBm | –80 dBc | –80 dBc | –118 dBc –105 dBc (EPO) | –118 dBc –117 dBc (EPO) |
| 10 MHz to 3.6 GHz | f+10245 MHz | –10 dBm | –80 dBc | –80 dBc | –112 dBc –106 dBc (EPO) | –112 dBc –104 dBc (EPO) |
| 10 MHz to 3.6 GHz | f+645 MHz | –10 dBm | –80 dBc | –80 dBc | –101 dBc | –101 dBc |
| 3.5 to 13.6 GHz | f+645 MHz | –10 dBm | –78 dBc ^e | –80 dBc | –87 dBc | –102 dBc |
| 13.5 to 17.1 GHz | f+645 MHz | –10 dBm | –74 dBc | –80 dBc | –84 dBc | –102 dBc |
| 17.0 to 22 GHz | f+645 MHz | –10 dBm | –70 dBc | –80 dBc | –82 dBc | –100 dBc |
| 22 to 26.5 GHz | f+645 MHz | –10 dBm | –68 dBc | –70 dBc | –79 dBc –75 dBc (EPO) | –97 dBc –90 dBc (EPO) |
| 26.5 to 50 GHz | f+45 MHz | –30 dBm | | | | –90 dBc (nominal) |
| 26.5 to 34.5 GHz | f+645 MHz | –30 dBm | | –70 dBc | | –94 dBc |
| 34.4 to 42 GHz | f+645 MHz | –30 dBm | | –59 dBc | | –79 dBc –76 dBc (EPO) |
| 42 to 50 GHz | f+645 MHz | –30 dBm | | | | –75 dBc (nominal) |

- The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation + Preamp Gain
- Where the presence of *Option EPO* affects the performance, it is noted with "(EPO)" text.
- Input terminated, 0 dB input attenuation.
- Mixer Level = Input Level – Input Attenuation.

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- e. We also support the following additional spurious responses specifications from 8 to 12 GHz at 20 to 30° C. Image responses are warranted to be better than –82 dBc, with 95th percentile performance of –88.3 dBc. LO-related spurious responses are warranted to be better than –83 dBc at 1 to 10 MHz offsets from the carrier, with phase noise optimization set to Best Wide-Offset.

| Description | Specifications | | Supplemental Information |
|---|--------------------------------|--|--|
| Spurious Responses: Other | Mixer Level^a | Response | Response (typical) |
| First RF Order ^b (f ≥ 10 MHz from carrier) | | | |
| Carrier Frequency ≤ 26.5 GHz | –10 dBm | –80 dBc + 20 × log(N ^c) | Includes IF feedthrough, LO harmonic mixing responses |
| Carrier Frequency > 26.5 GHz | –30 dBm | | –90 dBc (nominal) |
| Higher RF Order ^d (f ≥ 10 MHz from carrier) | | | |
| Carrier Frequency ≤ 26.5 GHz | –40 dBm | –80 dBc + 20 × log(N ^c) | Includes higher order mixer responses |
| Carrier Frequency > 26.5 GHz ^e | –30 dBm | | –90 dBc (nominal) |
| LO-Related Spurious Responses (Offset from carrier 200 Hz to 10 MHz) | –10 dBm | –68 dBc ^f + 20 × log(N ^c) | –72 dBc + 20 × log(N ^c) (typical) |
| Close-in Sidebands Spurious Response (LO Related, offset < 200 MHz) | | | –73 dBc ^e + 20 × log(N ^c) (nominal) |

- a. Mixer Level = Input Level – Input Attenuation.
b. With first RF order spurious products, the indicated frequency will change at the same rate as the input, with higher order, the indicated frequency will change at a rate faster than the input.
c. N is the LO multiplication factor.
d. RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
e. Nominally –40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.
f. We also support the following additional spurious responses specifications from 8 to 12 GHz at 20 to 30° C. Image responses are warranted to be better than –82 dBc, with 95th percentile performance of –88.3 dBc. LO-related spurious responses are warranted to be better than –83 dBc at 1 to 10 MHz offsets from the carrier, with phase noise optimization set to Best Wide-Offset.

Second Harmonic Distortion

| Description | | | Specifications | | | Supplemental Information | |
|--------------------------------------|---|---|--------------------------|------------|-------------------|--------------------------|-----------------------------|
| Second Harmonic Distortion | | | | | | | |
| mmW (Option 544, or 550) | | | | | | | |
| RF/μW (Option 503, 508, 513, or 526) | | | | | | | |
| | ↓ | ↓ | Mixer Level ^a | Distortion | SHI ^{bc} | Distortion (nominal) | SHI ^{bc} (nominal) |
| Source Frequency | | | | | | | |
| 0 to 100 MHz | x | x | –15 dBm | –57 dBc | +42 dBm | | |
| 0.1 to 1.8 GHz ^d | x | x | –15 dBm | –60 dBc | +45 dBm | | |
| 1.75 ^d to 3 GHz | x | | –15 dBm | –77 dBc | +62 dBm | | |
| 1.75 to 3 GHz | | x | –15 dBm | –72 dBc | +57 dBm | | |
| 3 to 6.5 GHz | x | x | –15 dBm | –77 dBc | +62 dBm | | |
| 6.5 to 10 GHz | x | x | –15 dBm | –70 dBc | +55 dBm | | |
| 10 to 13.25 GHz | x | x | –15 dBm | –62 dBc | +47 dBm | | |
| 13.2 to 25 GHz | | x | –15 dBm | | | –65 dBc | +50 dBm |

a. Mixer level = Input Level – Input Attenuation

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

c. Performance >3.6 GHz improves greatly with *Option LNP* enabled. See **Option LNP – Low Noise Path Specifications on page 225**.

d. These frequencies are half of the band edge frequencies. See **Band Overlaps on page 21**.

Third Order Intermodulation

| Description | Specifications | | Supplemental Information |
|--|----------------|------------------------------|--|
| Third Order Intermodulation (Tone separation > 5 times IF Prefilter Bandwidth ^a Sweep rate reduced ^b Verification conditions ^c) mmW Option 544, or 550 RF/μW Option 503, 508, 513, or 526 | | | Refer to the footnote for Band Overlaps on page 21 . Refer to footnote ^d for the "Extrapolated Distortion". |
| | ↓ | ↓ | |
| 20 to 30°C | | Intercept^e | Intercept (typical) |
| 10 to 150 MHz | x | x | +13 dBm |
| 150 to 600 MHz ^f | x | x | +17 dBm |
| 600 MHz to 1.1 GHz | x | x | +19 dBm |
| 1.1 to 3.6 GHz ^g | x | x | +19.5 dBm |
| 3.5 to 8.4 GHz | x | | +17 dBm |
| 3.6 to 3.7 GHz (Band 0) | x | | See note ^h |
| 3.5 to 8.4 GHz | | x | +16 dBm |
| 8.3 to 13.6 GHz | x | | +17 dBm |
| 8.3 to 13.6 GHz | | x | +16 dBm |
| 13.5 to 17.1 GHz | x | | +15 dBm |
| 13.5 to 17.1 GHz | | x | +13 dBm |
| 17.0 to 26.5 GHz ⁱ | x | | +16 dBm |
| 17.0 to 26.5 GHz ^j | | x | +13 dBm |
| 26.4 to 34.5 GHz | | x | +13 dBm |
| 34.4 to 50 GHz ^g | | x | +10 dBm |
| Full temperature range | | | |
| 10 to 150 MHz | x | x | +12 dBm |
| 150 to 600 MHz ^j | x | x | +16 dBm |

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| Description | | | Specifications | Supplemental Information |
|---|---|---|----------------|--------------------------|
| 600 MHz to 1.1 GHz | x | x | +17 dBm | |
| 1.1 to 3.6 GHz ^k | x | x | +17.5 dBm | |
| Third Order Intermodulation Full temperature Range (cont.) | | | | |
| 3.5 to 8.4 GHz | x | | +14 dBm | |
| 3.5 to 8.4 GHz | | x | +13 dBm | |
| 8.3 to 13.6 GHz | x | | +14 dBm | |
| 8.3 to 13.6 GHz | | x | +13 dBm | |
| 13.5 to 17.1 GHz | x | | +13 dBm | |
| 13.5 to 17.1 GHz | | x | +10 dBm | |
| 17.0 to 26.5 GHz ⁱ | x | | +14 dBm | |
| 17.0 to 26.5 GHz ^j | | x | +10 dBm | |
| 26.4 to 36.5 GHz | | x | +9 dBm | |
| 34.4 to 50 GHz ^l | | x | +6 dBm | |

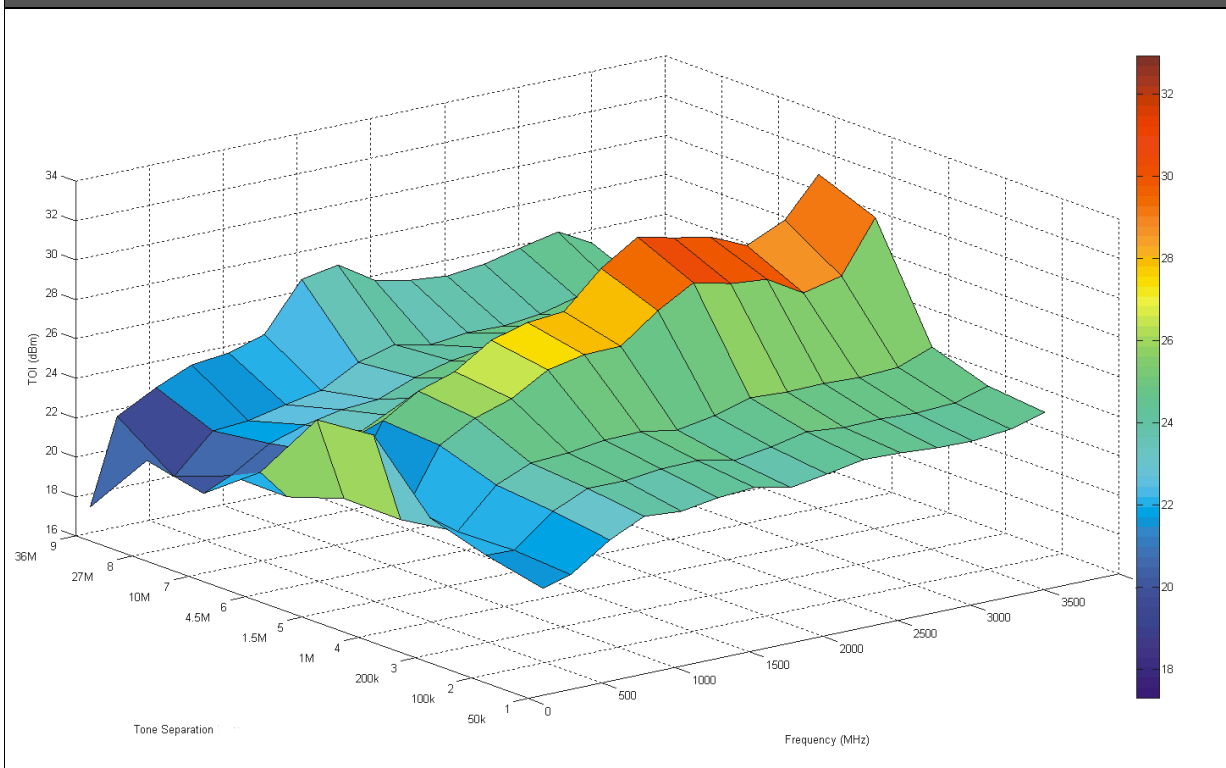
- See the IF Prefilter Bandwidth table in the Gain Compression specifications on [page 48](#). When the tone separation condition is met, the effect on TOI of the setting of IF Gain is negligible. TOI is verified with IF Gain set to its best case condition, which is IF Gain = Low.
- Autocoupled sweep rates using Option FS1 or FS2 are often too fast for excellent TOI performance. A sweep rate of $1.0 \times \text{RBW}^2$ is often suitable for best TOI performance, because of how it affects the IF Prefilter settings Foot-note ^a links to the details.
- TOI is verified with two tones, each at -16 dBm (10 MHz to 26.5 GHz) and -20 dBm (26.5 GHz to 50 GHz) at the mixer, spaced by 100 kHz.
- Traditionally, the distortion components from two tones, each at -30 dBm, were given as specifications. When spectrum analyzers were not as good as they are now, these distortion products were easily measured. As spectrum analyzers improved, the measurement began to be made at higher levels and extrapolated to the industry-standard -30 dBm test level. This extrapolation was justified by excellent conformance with the third-order model, wherein distortion in dBc was given by twice the difference between the test tone level and the intercept, both given in dBm units. In PXA, we no longer make that extrapolation in this Specifications Guide. One reason we don't extrapolate is that the model does not work as well as it had with higher levels of distortion in older and less capable analyzers, so that the computation is misleading; distortions at low test levels will be modestly higher than predicted from the formula. The second reason is that the distortion components are so small as to be unmeasurable, and thus highly irrelevant, in many cases. Please note the curvature of the third-order intermodulation line in the 1 GHz graph that follows, which is representative of performance below 3.6 GHz.
- Intercept = TOI = third order intercept. The TOI is given by the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc.
- For *Option EP0*:

| | | |
|----------------|---------|-------------------|
| 150 to 300 MHz | +16 dBm | +19 dBm (typical) |
| 300 to 600 MHz | +17 dBm | +19 dBm (typical) |

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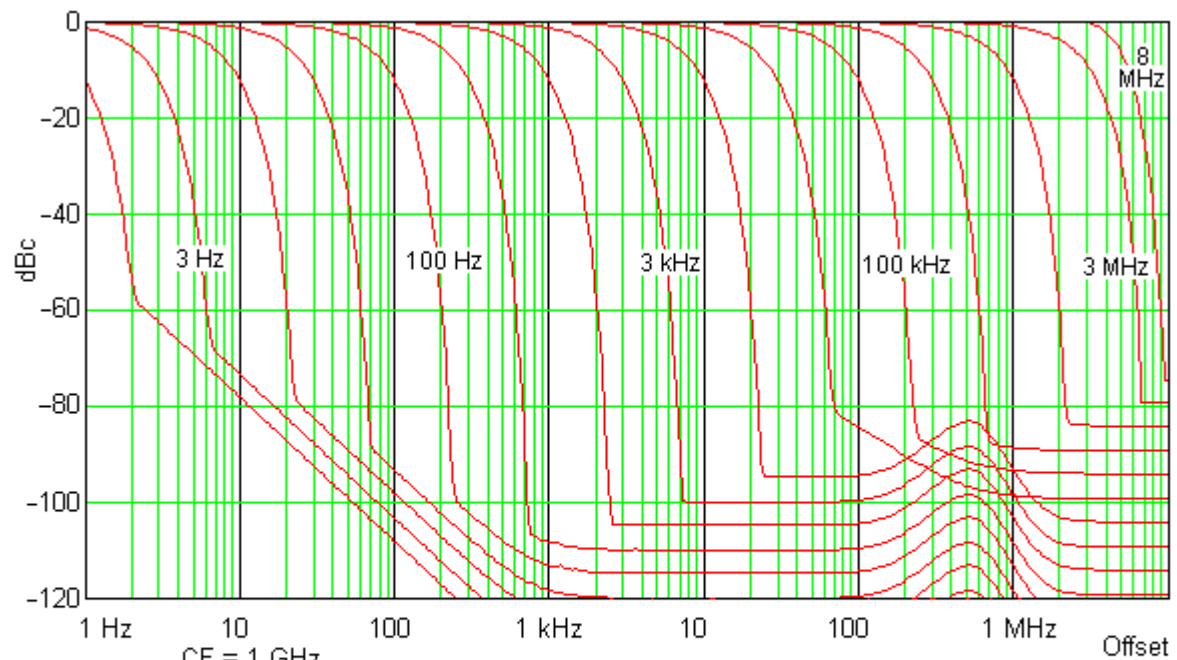
- g. For mmW PXA with *Option EP0*:
 34.4 to 50 GHz +10 dBm +13 dBm (typical)
 For mmW PXA with *Option MPB*:
 34.4 to 50 GHz +10 dBm +15 dBm (typical)
 For mmW PXA without *Option MPB*:
 34.4 to 50 GHz +9 dBm +15 dBm (typical)
- h. Band 0 is extendable (set "Extend Low Band" to On) to 3.7 GHz instead of 3.6 GHz in instruments with frequency option 508, 513 or 526. Subject to these conditions, statistical observations show that performance nominally fits within the same range within the 3.6 to 3.7 GHz frequencies as within the next lower specified frequency range, but is not warranted.
- i. Intercept performance is nominally 3 dB better in this band in those analyzers which have either *Option LNP* or *Option MPB* installed, or both, when these options are not in use.
- j. For *Option EP0*:
 150 to 300 MHz +15 dBm
 300 to 600 MHz +17 dBm
- k. For mmW PXA with *Option EP0*:
 1.1 to 1.5 GHz +18 dBm
 1.5 to 3.6 GHz +19 dBm
- l. For mmW PXA with *Option MPB*:
 34.4 to 50 GHz +6 dBm
 For mmW PXA without *Option MPB*:
 34.4 to 50 GHz +5 dBm

Nominal TOI vs. Input Frequency and Tone Separation [Plot] ^a



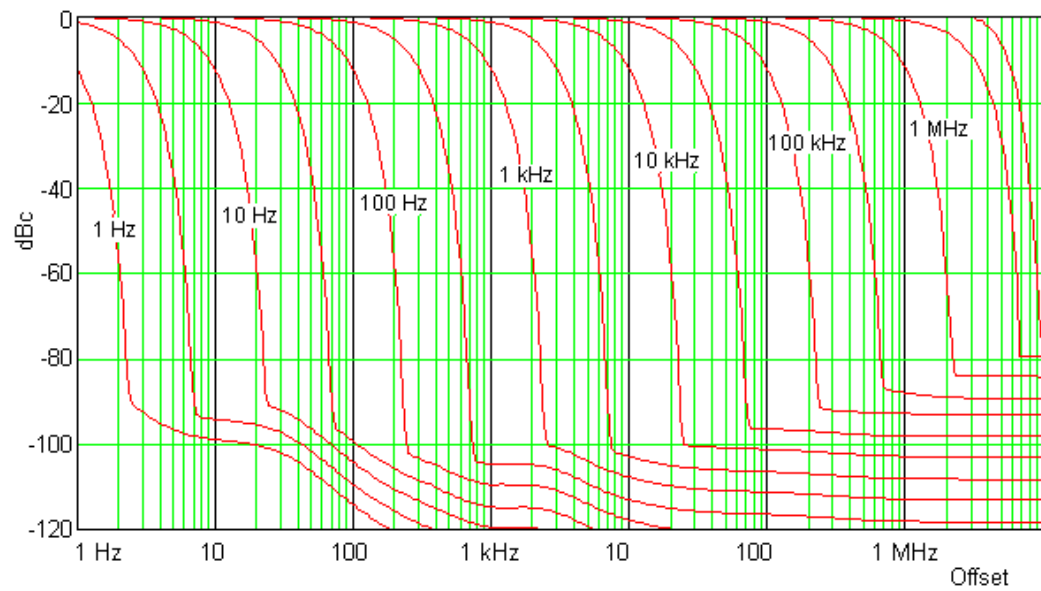
a. This plot is not applicable to *Option EP0*.

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



a. This plot is not applicable to *Option EP0*.

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



CF = 1 GHz
Mixer Level = -10 dBm
Conditions: Only 2 per decade of the 24/decade RBWs are shown
RBWs 100 kHz and below are shown with phase noise optimized close-in
RBWs 300 kHz and above are shown with phase noise optimized wide offset
Average Type = Log

a. This plot is only applicable to *Option EPO*.

Phase Noise

| Description | Specifications | | Supplemental Information |
|--|-------------------|-------------------|-----------------------------------|
| Phase Noise with Option EP1 (Center Frequency = 1 GHz ^a Best-case Optimization ^b Internal Reference ^c) | | | Noise Sidebands |
| Offset Frequency | 20 to 30°C | Full range | |
| 10 Hz | | | –80 dBc/Hz (nominal) ^d |
| 100 Hz | –94 dBc/Hz | –92 dBc/Hz | –100 dBc/Hz (typical) |
| 1 kHz | –121 dBc/Hz | –118 dBc/Hz | –125 dBc/Hz (typical) |
| 10 kHz | –129 dBc/Hz | –128 dBc/Hz | –132 dBc/Hz (typical) |
| 30 kHz | –130 dBc/Hz | –129 dBc/Hz | –132 dBc/Hz (typical) |
| 100 kHz | –129 dBc/Hz | –128 dBc/Hz | –131 dBc/Hz (typical) |
| 1 MHz ^e | –145 dBc/Hz | –144 dBc/Hz | –146 dBc/Hz (typical) |
| 10 MHz ^e | –155 dBc/Hz | –154 dBc/Hz | –158 dBc/Hz (typical) |

- The nominal performance of the phase noise at center frequencies different than the one at which the specifications apply (1 GHz) depends on the center frequency, band and the offset. For low offset frequencies, offsets well under 100 Hz, the phase noise increases by $20 \times \log[(f + 0.3225)/1.3225]$. For mid-offset frequencies such as 50 kHz, phase noise trends as $20 \times \log[(f + 5.1225)/6.1225]$, and also varies chaotically an additional nominally ± 2 dB versus the center frequency. For wide offset frequencies, offsets above about 500 kHz, phase noise increases as $20 \times \log(N)$. N is the LO Multiple as shown on [page 21](#); f is in GHz units in all these relationships; all increases are in units of decibels.
- Noise sidebands for lower offset frequencies, for example, 10 kHz, apply with the phase noise optimization (PhNoise Opt) set to Best Close-in ϕ Noise. Noise sidebands for higher offset frequencies, for example, 1 MHz, as shown apply with the phase noise optimization set to Best Wide-offset ϕ Noise.
- Specifications are given with the internal frequency reference. The phase noise at offsets below 100 Hz is impacted or dominated by noise from the reference. Thus, performance with external references will not follow the curves and specifications. When using an external reference with superior phase noise, we recommend setting the external reference phase-locked-loop bandwidth to wide (60 Hz), to take advantage of that superior performance. When using an external reference with inferior phase noise performance, we recommend setting that bandwidth to narrow (15 Hz). In these relationships, inferior and superior phase noise are with respect to –134 dBc/Hz at 30 Hz offset from a 10 MHz reference. Because most reference sources have phase noise behavior that falls off at a rate of 30 dB/decade, this is usually equivalent to –120 dBc/Hz at 10 Hz offset. For more information, see Phase Noise Effects, Ext Ref vs. Loop BW [Plot] on [page 74](#).
- Nominal phase noise was –75 dBc/Hz for instruments produced before approximately September 1, 2012.

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- e. Analyzer-contributed phase noise at the low levels of this offset requires advanced verification techniques because broadband noise would otherwise cause excessive measurement error. Keysight uses a high level low phase noise CW test signal and sets the input attenuator so that the mixer level will be well above the normal top-of-screen level (-10 dBm) but still well below the 1 dB compression level. This improves dynamic range (carrier to broadband noise ratio) at the expense of amplitude uncertainty due to compression of the phase noise sidebands of the analyzer. (If the mixer level were increased to the "1 dB Gain Compression Point," the compression of a single sideband is specified to be 1 dB or lower. At lower levels, the compression falls off rapidly. The compression of phase noise sidebands is substantially less than the compression of a single-sideband test signal, further reducing the uncertainty of this technique.) Keysight also measures the broadband noise of the analyzer without the CW signal and subtracts its power from the measured phase noise power. The same techniques of overdrive and noise subtraction can be used in measuring a DUT, of course.

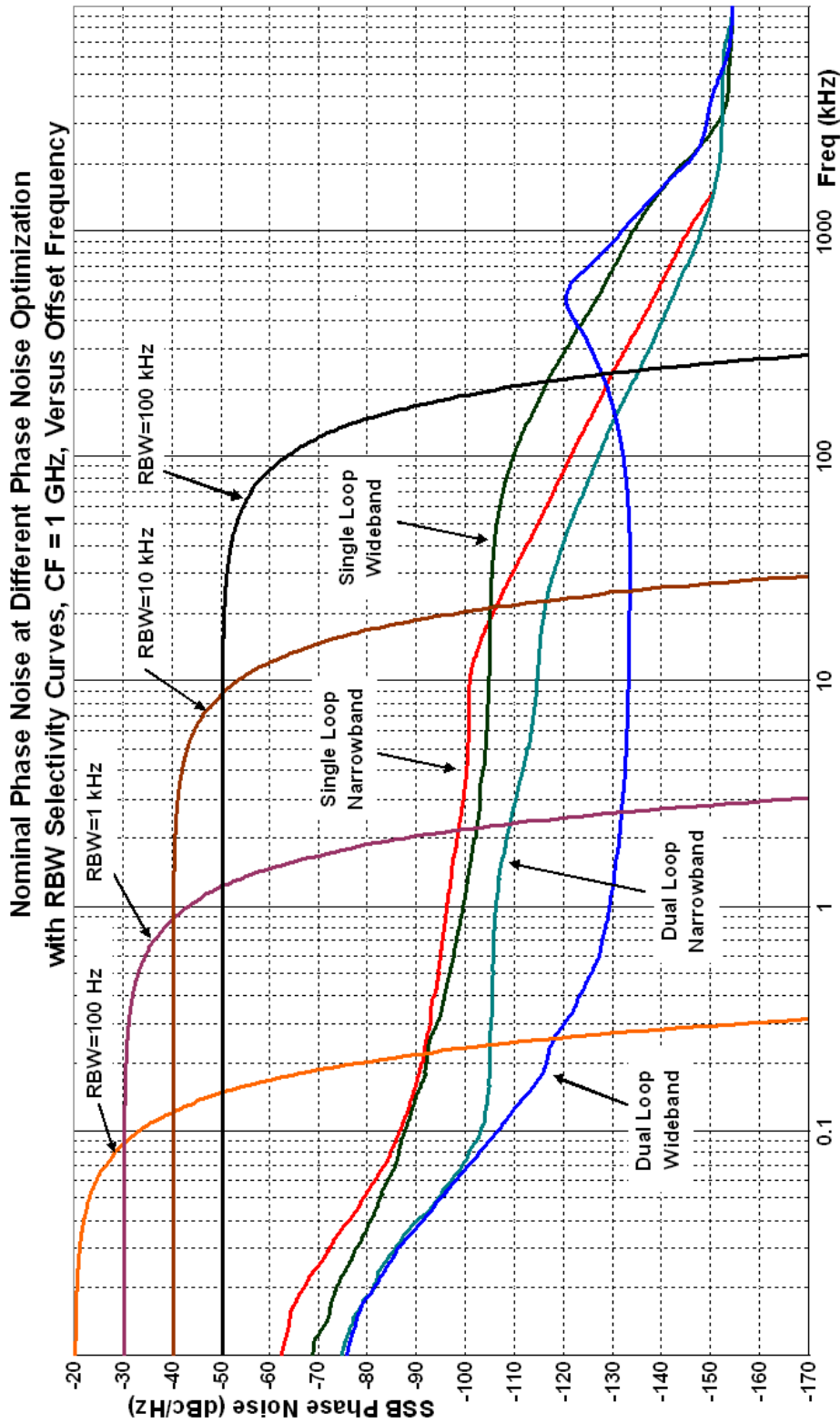
| Description | Specifications | | Supplemental Information |
|---|-----------------------|-------------------|-----------------------------------|
| Phase Noise with Option EPO (Center Frequency = 1 GHz ^b Best-case Optimization ^c Internal Reference ^d) | | | Noise Sidebands ^a |
| Offset Frequency | 20 to 30°C | Full range | |
| 10 Hz | | | |
| Wide Ref Loop BW | See note ^e | | -95 dBc/Hz (typical) ^e |
| Narrow Ref Loop BW | | | -88 dBc/Hz (nominal) |
| 100 Hz | -107 dBc/Hz | -107 dBc/Hz | -112 dBc/Hz (typical) |
| 1 kHz | -125 dBc/Hz | -124 dBc/Hz | -129 dBc/Hz (typical) |
| 10 kHz | -134 dBc/Hz | -132 dBc/Hz | -136 dBc/Hz (typical) |
| 100 kHz | -139 dBc/Hz | -138 dBc/Hz | -141 dBc/Hz (typical) |
| 1 MHz ^e | -145 dBc/Hz | -144 dBc/Hz | -146 dBc/Hz (typical) |
| 10 MHz | -155 dBc/Hz | -154 dBc/Hz | -157 dBc/Hz (typical) |

- a. Noise sidebands around a signal are dominantly phase noise sidebands. With the extremely low phase noise of the PXA, AM sidebands are non-negligible contributors. These specifications apply to the sum of the AM and PM sidebands.
- b. The nominal performance of the phase noise at center frequencies different than the one at which the specifications apply (1 GHz) depends on the center frequency, band and the offset. For low offset frequencies, offsets well under 100 Hz, the phase noise increases by $20 \times \log[(f + 0.3225)/1.3225]$, where f is the larger of 0.5 and the center frequency in GHz units. For mid-offset frequencies such as 50 kHz, phase noise trends as $20 \times \log[(f + 5.1225)/6.1225]$, where f is the larger of 1.0 and the carrier frequency in GHz units. For wide offset frequencies, offsets above about 500 kHz, phase noise increases as $20 \times \log(N)$. N is the LO Multiple as shown on [page 21](#).

PXA Signal Analyzer Dynamic Range

- c. Noise sidebands for lower offset frequencies, for example, 10 kHz, apply with phase noise optimization (PNO) set to Balance Noise and Spurs. In some frequency settings of the analyzer, a spurious response 60 to 180 MHz offset from the carrier may be present unless the phase locked loop behavior is changed in a way that increases the phase noise. This tradeoff is controlled such that the spurs are better than -70 dBc, at the expense of up to 7 dB increase in phase noise within ± 1 octave of 1 MHz offset for those settings where this spurious is likely to be visible. To eliminate this phase noise degradation in exchange for the aforementioned spurs, Best Close-in Noise should be used. When the setting is changed to Best Spurs, the maximum spurious response is held to -90 dBc, but the phase noise at all center frequencies is degraded by up to approximately 12 dB from the best possible setting, mostly within ± 1 octave of an offset of 400 kHz from the carrier. Noise sidebands for higher offset frequencies, for example, 1 MHz, apply with the phase noise optimization set to Best Wide-Offset Noise.
- d. Specifications are given with the internal frequency reference. The phase noise at offsets below 100 Hz is impacted or dominated by noise from the reference. Thus, performance with external references will not follow the curves and specifications. When using an external reference with superior phase noise, we recommend setting the external reference phase-locked-loop bandwidth to wide (60 Hz), to take advantage of that superior performance. When using an external reference with inferior phase noise performance, we recommend setting that bandwidth to narrow (15 Hz). In these relationships, inferior and superior phase noise are with respect to -134 dBc/Hz at 30 Hz offset from a 10 MHz reference. Because most reference sources have phase noise behavior that falls off at a rate of 30 dB/decade, this is usually equivalent to -120 dBc/Hz at 10 Hz offset. For more information, see Phase Noise Effects, Ext Ref vs. Loop BW [Plot] on [page 74](#).
- e. Keysight measures 100% of the signal analyzers for phase noise at 10 Hz offset from a 1 GHz carrier in the factory production process. This measurement requires a signal of exceptionally low phase noise that is characterized with specialized processes. It is impractical for field and customer use. Because field verification is impractical, Keysight only gives a typical result. More than 80% of prototype instruments met this "typical" specification; the factory test line limit is set commensurate with an on-going 80% yield to this typical. Like all typical specifications, there is no guardbanding for measurement uncertainty. The factory test line limit is consistent with a warranted specification of -90 dBc/Hz.

Nominal Phase Noise of Different LO Optimizations without *Option EPO* [Plot]

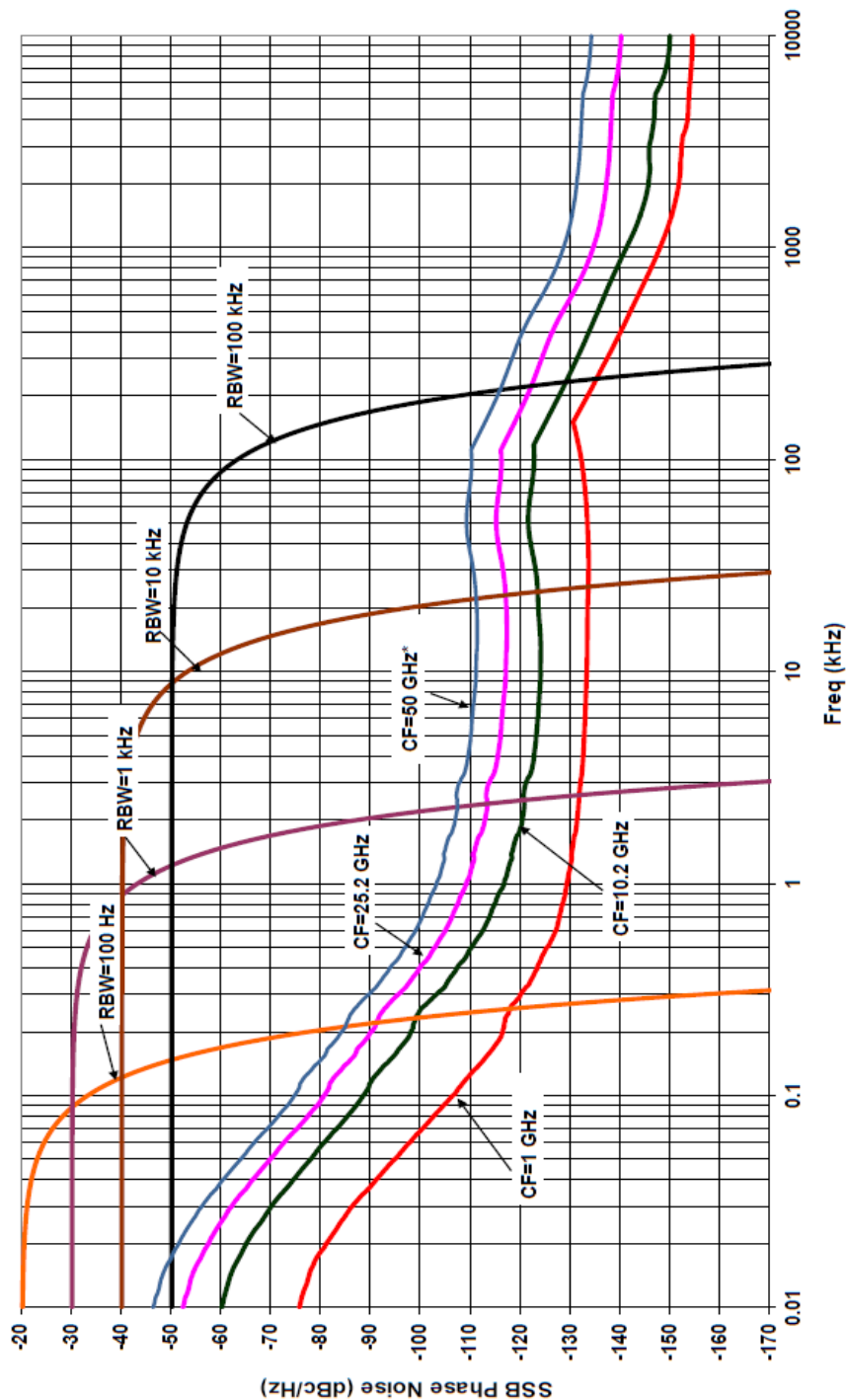


| Sweep Type | Span | Best Close-in ϕ Noise [offset < 140 kHz] | | Best Wide-offset ϕ Noise [offset > 160 kHz] | |
|------------|------------------------|--|--|---|--|
| | | Dual Loop Wideband | | Dual Loop Narrowband | |
| FFT | All | | | | |
| Swept | ≤ 10 MHz | | | | |
| | > 10 to ≤ 100 MHz | Single Loop Narrowband | | | |
| Swept | > 100 MHz | | | | |
| | | | | Single Loop Wideband | |

Relationship between user interface
settings and loop configuration

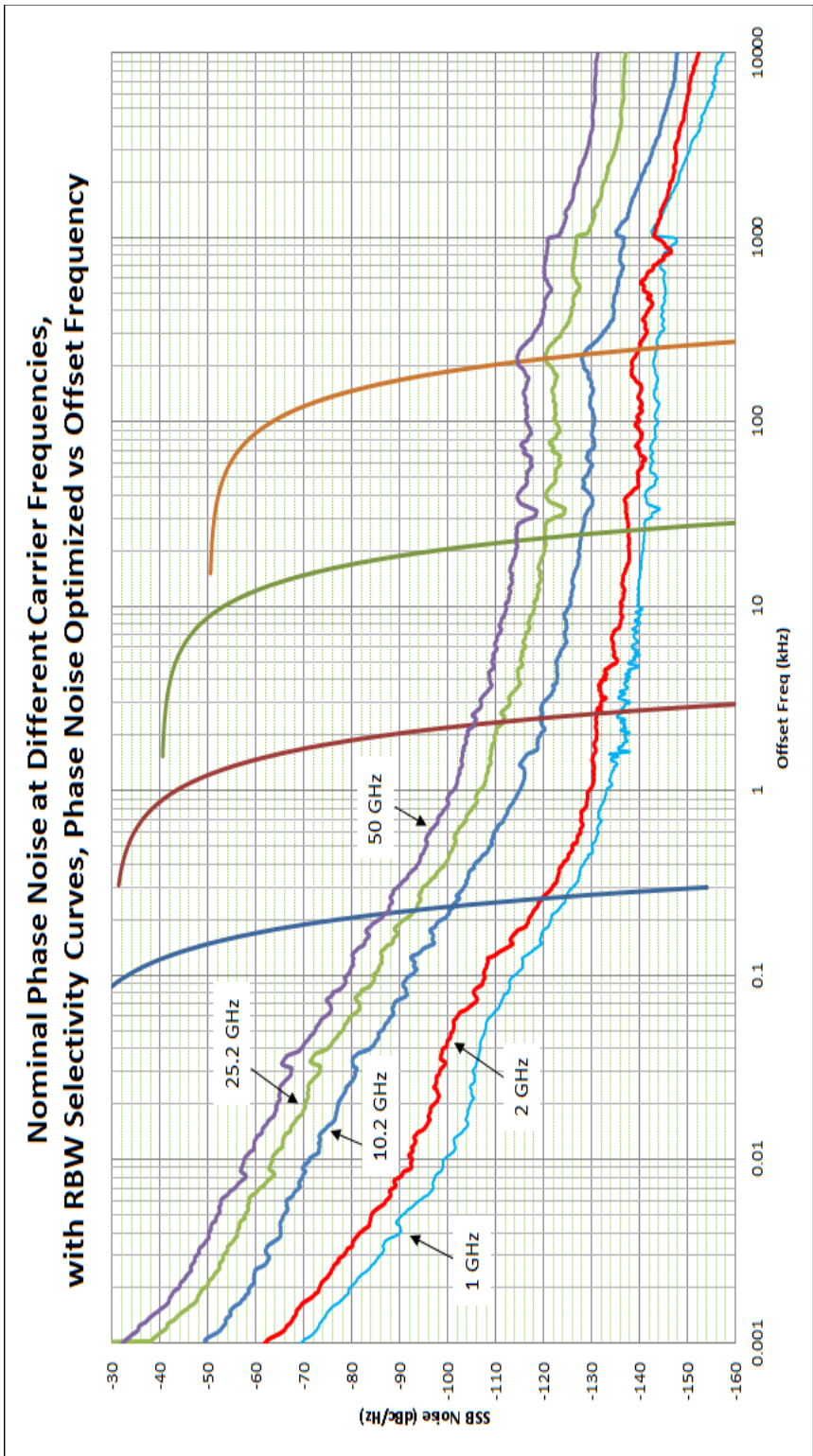
Nominal Phase Noise at Different Center Frequencies without *Option EPO* [Plot]

Nominal Phase Noise at Different Center Frequencies
with RBW Selectivity Curves, Optimized Phase Noise, Versus Offset Frequency



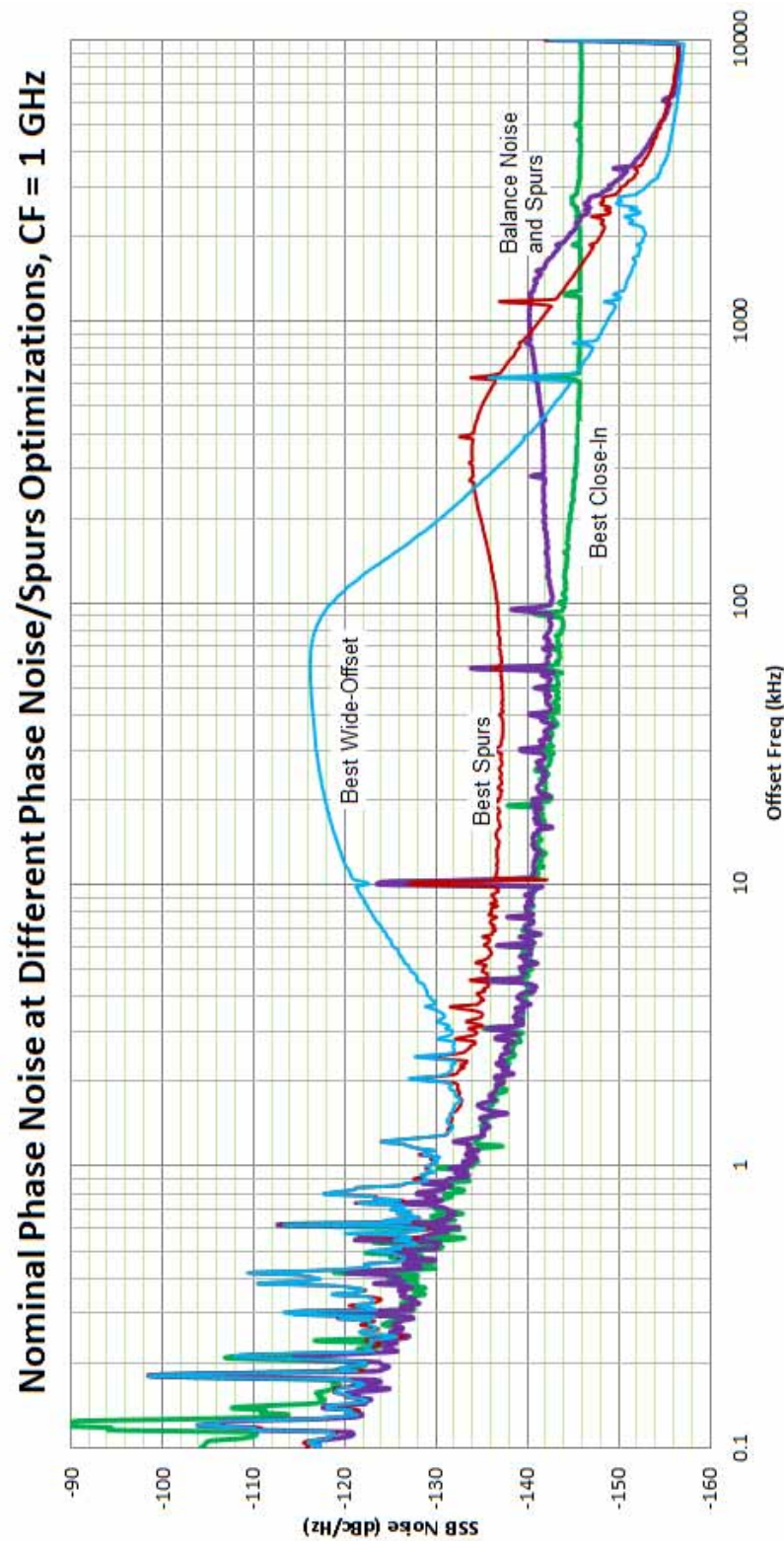
* Unlike other curves, which are measured results from the measurement of excellent sources, the CF = 50 GHz curve is the predicted, not observed, phase noise, computed from the 25.2 GHz observation. See the footnotes in the Frequency Stability section for the details of phase noise performance versus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

Nominal Phase Noise at Different Carrier Frequencies, Phase Noise Optimized vs Offset Frequency with *Option EP0*
[Plot]



* Unlike 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 Different Phase Noise/Spurs Optimization with *Option EPO* [Plot]

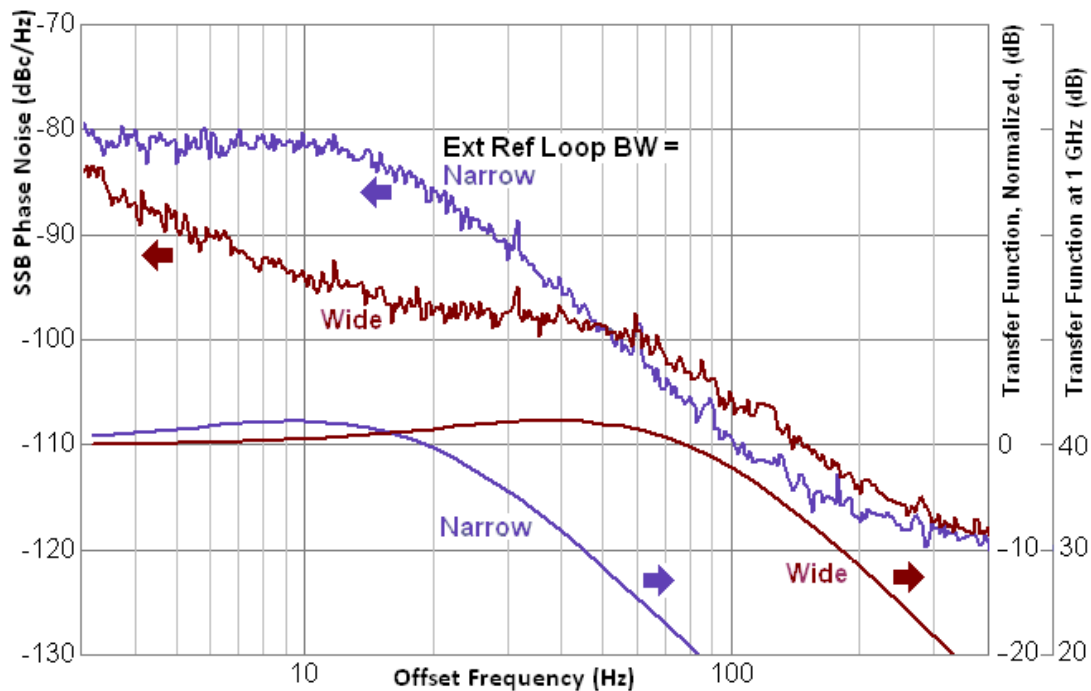


Phase Noise Effects, Ext Ref vs. Loop BW without *Option EPO* [Plot]

The effect of the Ext Ref Loop BW control (Narrow and Wide) is shown in this graphic. When set to Wide, the noise from the internal circuitry is reduced, but noise in the external reference is subject to being impressed on the LO through the transfer function shown in the smooth curve labeled "Wide." For an excellent reference, this can give lower overall noise. When the Narrow selection is made, the internal noise effect is higher, but external reference noise above 20 Hz is rejected.

The noise curves were measured at 1 GHz center frequency with an excellent reference and excellent RF signal, and is thus a conservative estimate of the residual noise of the PXA circuitry. At that center frequency, the transfer function curves approach 40 dB gain to phase noise at low offset frequencies for a 10 MHz external reference. (This 40 dB is computed as $20 \times \log_{10} 10 \wedge (f_C/f_{REF})$). The measured noise curves will scale with frequency the same way.)

Example: Consider an external reference at 10 MHz with phase noise of -135 dBc/Hz at 20 Hz offset. If the Narrow setting is chosen, the analyzer noise density will be -86 dBc/Hz at 20 Hz offset, the gain to the reference will be 40 dB, giving -95 dBc/Hz contribution. Add these together on a power scale as $10 \times \log_{10} (10^{(-86/10)} + 10^{(-95/10)}) = -85.5$ dBc/Hz. If Wide is chosen, the analyzer noise density will be -97 dBc/Hz at 20 Hz offset, the gain to the reference will be 42 dB, giving -93 dBc/Hz contribution. Add those together on a power scale as $10 \times \log_{10} (10^{(-97/10)} + 10^{(-93/10)}) = -91.5$ dBc/Hz. "Wide" will give a 6 dB superior result to the Narrow selection.



Power Suite Measurements

The specifications for this section apply only to instruments with Frequency *Option 508, 513, or 526*. For instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different between instruments with the higher frequency options. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specification in this chapter.

| Description | Specifications | Supplemental Information |
|--|---|---|
| Channel Power Amplitude Accuracy Case: Radio Std = 3GPP W-CDMA, or IS-95 Absolute Power Accuracy (20 to 30°C, Attenuation = 10 dB) | ± 0.61 dB | Absolute Amplitude Accuracy ^a + Power Bandwidth Accuracy ^{bc} ± 0.19 dB (95th percentile) |

- a. See **“Absolute Amplitude Accuracy”** on page 40.
- b. See **“Frequency and Time”** on page 20.
- c. Expressed in dB.

| Description | Specifications | Supplemental Information |
|---|----------------|-----------------------------------|
| Occupied Bandwidth Frequency Accuracy | | $\pm(\text{Span}/1000)$ (nominal) |

| Description | | Specifications | Supplemental Information |
|--|--------------------|----------------|---|
| Adjacent Channel Power (ACP) | | | |
| Case: Radio Std = None | | | |
| Accuracy of ACP Ratio (dBc) | | | Display Scale Fidelity ^a |
| Accuracy of ACP Absolute Power (dBm or dBm/Hz) | | | Absolute Amplitude Accuracy ^b + Power Bandwidth Accuracy ^{cd} |
| Accuracy of Carrier Power (dBm), or Carrier Power PSD (dBm/Hz) | | | Absolute Amplitude Accuracy ^b + Power Bandwidth Accuracy ^{cd} |
| Passband Width ^e | | −3 dB | |
| Case: Radio Std = 3GPP W-CDMA | | | (ACPR; ACLR) ^f |
| Minimum power at RF Input | | | −36 dBm (nominal) |
| ACPR Accuracy ^g | | | RRC weighted, 3.84 MHz noise bandwidth, method ≠ RBW |
| Radio | Offset Freq | | |
| MS (UE) | 5 MHz | ±0.09 dB | At ACPR range of −30 to −36 dBc with optimum mixer level ^h |
| MS (UE) | 10 MHz | ±0.09 dB | At ACPR range of −40 to −46 dBc with optimum mixer level ⁱ |
| BTS | 5 MHz | ±0.25 dB | At ACPR range of −42 to −48 dBc with optimum mixer level ^j |
| BTS | 10 MHz | ±0.18 dB | At ACPR range of −47 to −53 dBc with optimum mixer level ⁱ |
| BTS | 5 MHz | ±0.10 dB | At −48 dBc non-coherent ACPR ^k |
| <i>Option EPO</i> | | | |
| Radio | Offset Freq | | |
| MS (UE) | 5 MHz | ±0.09 dB | At ACPR range of −30 to −36 dBc with optimum mixer level ^h |
| MS (UE) | 10 MHz | ±0.11 dB | At ACPR range of −40 to −46 dBc with optimum mixer level ⁱ |
| BTS | 5 MHz | ±0.28 dB | At ACPR range of −42 to −48 dBc with optimum mixer level ^j |
| BTS | 10 MHz | ±0.25 dB | At ACPR range of −47 to −53 dBc with optimum mixer level ⁱ |
| BTS | 5 MHz | ±0.12 dB | At −48 dBc non-coherent ACPR ^k |

| Description | | | Specifications | Supplemental Information | | |
|---------------------------------------|--------------------|---------------|----------------|--|---|---|
| Adjacent Channel Power (cont.) | | | | | | |
| Dynamic Range | | | | RRC weighted, 3.84 MHz noise bandwidth | | |
| Noise Correction^l | Offset Freq | Method | | ACLR (typical)^m | ACLR (EPO) (typical)^m | Optimum MLⁿ (nominal) |
| Off | 5 MHz | Filtered IBW | | –81.5 dB | –80 dB | –8 dBm |
| Off | 5 MHz | Fast | | –81 dB | –80 dB | –8 dBm |
| Off | 10 MHz | Filtered IBW | | –87 dB | –86 dB | –4 dBm |
| On | 5 MHz | Filtered IBW | | –82.5 dB | –81.5 dB | –8 dBm |
| On | 10 MHz | Filtered IBW | | –88.0 dB | –87 dB | –4 dBm |
| RRC Weighting Accuracy ^o | | | | | | |
| White noise in Adjacent Channel | | | | 0.00 dB nominal | | |
| TOI-induced spectrum | | | | 0.001 dB nominal | | |
| rms CW error | | | | 0.012 dB nominal | | |

- 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.
- See Amplitude Accuracy and Range section.
- See Frequency and Time section.
- Expressed in decibels.
- 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 $x - 0.572 \times \text{RBW}$.
- 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.
- 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 $-37 \text{ dBm} - (\text{ACPR}/3)$, where the ACPR is given in (negative) decibels.

- h. To meet this specified accuracy when measuring mobile station (MS) or user equipment (UE) within 3 dB of the required -33 dBc ACPR, the mixer level (ML) must be optimized for accuracy. This optimum mixer level is -22 dBm, so the input attenuation must be set as close as possible to the average input power $-(-22$ dBm). For example, if the average input power is -6 dBm, set the attenuation to 16 dB. This specification applies for the normal 3.5 dB peak-to-average ratio of a single code. Note that, if the mixer level is set to optimize dynamic range instead of accuracy, accuracy errors are nominally doubled.
- i. ACPR accuracy at 10 MHz offset is warranted when the input attenuator is set to give an average mixer level of -14 dBm.
- j. In order to meet this specified accuracy, the mixer level must be optimized for accuracy when measuring node B Base Transmission Station (BTS) within 3 dB of the required -45 dBc ACPR. This optimum mixer level is -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 10 dB peak-to-average ratio (at 0.01% probability) for Test Model 1. Note that, if the mixer level is set to optimize dynamic range instead of accuracy, accuracy errors are nominally doubled.
- k. Accuracy can be excellent even at low ACPR levels assuming that the user sets the mixer level to optimize the dynamic range, and assuming that the analyzer and UUT distortions are incoherent. When the errors from the UUT and the analyzer are incoherent, optimizing dynamic range is equivalent to minimizing the contribution of analyzer noise and distortion to accuracy, though the higher mixer level increases the display scale fidelity errors. This incoherent addition case is commonly used in the industry and can be useful for comparison of analysis equipment, but this incoherent addition model is rarely justified. This derived accuracy specification is based on a mixer level of -14 dBm.
- l. The dynamic range shown with Noise Correction = Off applies with Noise Floor Extension On. (Noise Correction is the process within the measurement of making a calibration of the noise floor at the exact analyzer settings used for the measurement. Noise Floor Extension is the factory calibration of the noise floor.)
- m. Keysight measures 100% of the signal analyzers for dynamic range in the factory production process. This measurement requires a near-ideal signal, which is impractical for field and customer use. Because field verification is impractical, Keysight only gives a typical result. More than 80% of prototype instruments met this "typical" specification; the factory test line limit is set commensurate with an on-going 80% yield to this typical. The ACPR dynamic range is verified only at 2 GHz, where Keysight has the near-perfect signal available. The dynamic range is specified for the optimum mixer drive level, which is different in different instruments and different conditions. The test signal is a 1 DPCH signal.
The ACPR dynamic range is the observed range. This typical specification includes no measurement uncertainty.
- n. ML is Mixer Level, which is defined to be the input signal level minus attenuation.
- o. 3GPP requires the use of a root-raised-cosine filter in evaluating the ACLR of a device. The accuracy of the pass-band shape of the filter is not specified in standards, nor is any method of evaluating that accuracy. This footnote discusses the performance of the filter in this instrument. The effect of the RRC filter and the effect of the RBW used in the measurement interact. The analyzer compensates the shape of the RRC filter to accommodate the RBW filter. The effectiveness of this compensation is summarized in three ways:
 - White noise in Adj Ch: The compensated RRC filter nominally has no errors if the adjacent channel has a spectrum that is flat across its width.
 - TOI-induced spectrum: If the spectrum is due to third-order intermodulation, it has a distinctive shape. The computed errors of the compensated filter are -0.001 dB for the 100 kHz RBW used for UE testing with the IBW method. It is 0.000 dB for the 27 kHz RBW filter used for BTS testing with the Filtered IBW method. The worst error for RBWs between 27 and 390 kHz is 0.05 dB for a 330 kHz RBW filter.
 - rms CW error: This error is a measure of the error in measuring a CW-like spurious component. It is evaluated by computing the root of the mean of the square of the power error across all frequencies within the adjacent channel. The computed rms error of the compensated filter is 0.012 dB for the 100 kHz RBW used for UE testing with the IBW method. It is 0.000 dB for the 27 kHz RBW filter used for BTS testing. The worst error for RBWs between 27 kHz and 470 kHz is 0.057 dB for a 430 kHz RBW filter.

| Description | | | Specifications | Supplemental Information | |
|---|--------|--------------------|----------------|--|--------------------|
| Multi-Carrier Adjacent Channel Power | | | | | |
| Case: Radio Std = 3GPP W-CDMA | | | | RRC weighted, 3.84 MHz noise bandwidth, Noise Correction (NC) on | |
| ACPR Accuracy (4 carriers) | | | | | |
| Radio | Offset | Coher ^a | | UUT ACPR Range | MLOpt ^b |
| BTS | 5 MHz | no | ±0.09 dB | −42 to −48 dB | −15 dBm |
| BTS | 5 MHz | no (Option EPO) | ±0.10 dB | −42 to −48 dB | −15 dBm |

- 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 multi-carrier amplifiers built with compensations and predistortions that mostly eliminate coherent third-order effects in the amplifier.
- b. Optimum mixer level (MLOpt). The mixer level is given by the average power of the sum of the four carriers minus the input attenuation.

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Power Statistics CCDF Histogram Resolution ^a | 0.01 dB | |

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

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

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

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Spurious Emissions | | Table-driven spurious signals; search across regions |
| Case: Radio Std = 3GPP W-CDMA | | |
| Dynamic Range ^a , relative (RBW=1 MHz) (1 to 3.6 GHz) | 88.8 dB | 91.8 dB (typical) |
| Dynamic Range ^a , relative (RBW=1 MHz) (1 to 3.6 GHz) (<i>Option EPO</i>) | 86.9 dB | 89.9 dB (typical) |
| Sensitivity ^b , absolute (RBW=1 MHz) (1 to 3.6 GHz) | −88.5 dBm | −91.5 dBm (typical) |
| Sensitivity ^b , absolute (RBW=1 MHz) (1 to 3.6 GHz) (<i>Option EPO</i>) | −86.5 dBm | −89.5 dBm (typical) |
| Accuracy | | Attenuation = 10 dB |
| 20 Hz to 3.6 GHz | | ±0.19 dB (95th percentile) |
| 3.5 to 8.4 GHz | | ±1.09 dB (95th percentile) |
| 3.5 to 8.4 GHz (<i>Option EPO</i>) | | ±1.15 dB (95th percentile) |
| 8.3 to 13.6 GHz | | ±1.48 dB (95th percentile) |
| 8.3 to 13.6 GHz (<i>Option EPO</i>) | | ±1.52 dB (95th percentile) |

- a. The dynamic range is specified at 12.5 MHz offset from center frequency with mixer level of 1 dB compression point, which will degrade accuracy 1 dB.

- b. The sensitivity is specified at far offset from carrier, where phase noise does not contribute. You can derive the dynamic range at far offset from 1 dB compression mixer level and sensitivity.

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Spectrum Emission Mask | | Table-driven spurious signals; measurement near carriers |
| Case: Radio Std = cdma2000 | | |
| Dynamic Range, relative (750 kHz offset ^{ab}) | 85.0 dB | 89.3 dB (typical) |
| Dynamic Range, relative (750 kHz offset ^{ab}) (<i>Option EPO</i>) | 83.3 dB | 87.3 dB (typical) |
| Sensitivity, absolute (750 kHz offset ^c) | −103.7 dBm | −106.7 dBm (typical) |
| Sensitivity, absolute (750 kHz offset ^c) (<i>Option EPO</i>) | −101.7 dBm | −104.7 dBm (typical) |
| Accuracy (750 kHz offset) | | |
| Relative ^d | ±0.06 dB | |
| Absolute ^e (20 to 30°C) | ±0.62 dB | ±0.21 dB (95th percentile ≈ 2σ) |
| Case: Radio Std = 3GPP W-CDMA | | |
| Dynamic Range, relative (2.515 MHz offset ^{ad}) | 86.9 dB | 91.8 dB (typical) |
| Dynamic Range, relative (2.515 MHz offset ^{ad}) (<i>Option EPO</i>) | 85.0 dB | 89.6 dB (typical) |
| Sensitivity, absolute (2.515 MHz offset ^c) | −103.7 dBm | −106.7 dBm (typical) |
| Sensitivity, absolute (2.515 MHz offset ^c) (<i>Option EPO</i>) | −101.7 dBm | −104.7 dBm (typical) |
| Accuracy (2.515 MHz offset) | | |
| Relative ^d | ±0.08 dB | |
| Absolute ^e (20 to 30°C) | ±0.62 dB | ±0.21 dB (95th percentile) |

PXA Signal Analyzer
Power Suite Measurements

- a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 30 kHz RBW.
- b. This dynamic range specification applies for the optimum mixer level, which is about –18 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 30 kHz RBW, at a center frequency of 2 GHz.
- d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.
- e. The absolute accuracy of SEM measurement is the same as the absolute accuracy of the spectrum analyzer. See **“Absolute Amplitude Accuracy” on page 40** for more information. The numbers shown are for 0 to 3.6 GHz, with attenuation set to 10 dB.

Options

The following options and applications affect instrument specifications.

| | |
|----------------------|--|
| <i>Option 503:</i> | Frequency range, 2 Hz to 3.6 GHz |
| <i>Option 508:</i> | Frequency range, 2 Hz to 8.4 GHz |
| <i>Option 513:</i> | Frequency range, 2 Hz to 13.6 GHz |
| <i>Option 526:</i> | Frequency range, 2 Hz to 26.5 GHz |
| <i>Option 544:</i> | Frequency range, 2 Hz to 44 GHz |
| <i>Option 550:</i> | Frequency range, 2 Hz to 50 GHz |
| <i>Option ALV:</i> | Auxiliary Log Video output |
| <i>Option B1X:</i> | Analysis bandwidth, 160 |
| <i>Standard B25:</i> | Analysis bandwidth, 25 MHz |
| <i>Option B40:</i> | Analysis bandwidth, 40 MHz |
| <i>Option B85:</i> | Analysis bandwidth, 85 MHz |
| <i>Option B2X:</i> | Analysis bandwidth, 255 MHz |
| <i>Option B5X:</i> | Analysis bandwidth, 510 MHz |
| <i>Option BBA:</i> | BBIQ inputs, analog |
| <i>Option C35:</i> | APC 3.5 mm connector (for Freq <i>Option 526</i> only) |
| <i>Option CR3:</i> | Connector Rear, second IF Out |
| <i>Option CRP:</i> | Connector Rear, arbitrary IF Out |
| <i>Option EA3:</i> | Electronic attenuator, 3.6 GHz |
| <i>Option EMC:</i> | Precompliance EMC Features |
| <i>Option EP0:</i> | Enhanced Phase noise, DDS LO |
| <i>Option ESC:</i> | External source control |
| <i>Option EXM:</i> | External mixing |
| <i>Option LNP:</i> | Low Noise Path |
| <i>Option MPB:</i> | Preselector bypass |
| <i>Standard NFE:</i> | Noise floor extension, instrument alignment |
| <i>Option P03:</i> | Preamplifier, 3.6 GHz |
| <i>Option P08:</i> | Preamplifier, 8.4 GHz |
| <i>Option P13:</i> | Preamplifier, 13.6 GHz |
| <i>Option P26:</i> | Preamplifier, 26.5 GHz |

PXA Signal Analyzer
Options

| | |
|--------------------|---|
| <i>Option P44:</i> | Preamplifier, 44 GHz |
| <i>Option P50:</i> | Preamplifier, 50 GHz |
| <i>Option RT1:</i> | Real-Time analysis up to 160 MHz, basic detection |
| <i>Option RT2:</i> | Real-Time analysis up to 160 MHz, optimum detection |
| <i>Option RTS:</i> | Real-Time wideband I/Q data streaming |
| <i>Option YAS:</i> | Y-Axis Screen Video output |
| <i>Option YAV:</i> | Y-Axis Video output |
| N9054EM0E: | Flexible Digital Demodulation measurement application |
| N9054EM1E: | Custom OFDM measurement application |
| N9063EM0E: | Analog Demodulation measurement application |
| N9067EM0E: | Pulse measurement application |
| N9068EM0E: | Phase Noise measurement application |
| N9069EM0E: | Noise Figure measurement application |
| N9071EM0E: | GSM/EDGE/EDGE Evolution measurement application |
| N9073EM0E: | W-CDMA/HSPA/HSPA+ measurement application |
| N9077EM0E: | WLAN measurement application |
| N9080EM0E: | LTE-Advanced FDD measurement application |
| N9081EM0E: | Bluetooth Measurement application |
| N9082EM0E: | LTE-Advanced TDD measurement application |
| N9083EM0E: | MSR measurement application |
| N9084EM0E: | Short Range Communications measurement application |
| N9085EM0E: | 5G NR measurement application |
| N9092EM0E: | Avionics measurement application |

| Description | Specifications | Supplemental Information |
|------------------------------|------------------------------|--|
| Environment Indoor | | |
| Temperature Range | | |
| Operating | | |
| Altitude ≤ 2,300 m | 0 to 55°C | |
| Altitude = 4,600 m | 0 to 47°C | |
| Derating ^a | | |
| Storage | −40 to +70°C | |
| Altitude | 4,600 m (approx 15,000 feet) | |
| Humidity | | |
| Relative humidity | | 95% relative humidity, non-condensing at 40°C, decreasing linearly to 50% relative humidity at 55°C. |

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

PXA Signal Analyzer
General

| Description | Specification | Supplemental Information |
|--|---------------|--|
| Acoustic Noise Ambient Temperature $< 40^{\circ}\text{C}$ $\geq 40^{\circ}\text{C}$ | | <p>Values given are per ISO 7779 standard in the "Operator Sitting" position</p> <p>Nominally under 55 dBA Sound Pressure. 55 dBA is generally considered suitable for use in quiet office environments.</p> <p>Nominally under 65 dBA Sound Pressure. 65 dBA is generally considered suitable for use in noisy office environments. (The fan speed, and thus the noise level, increases with increasing ambient temperature.)</p> |

| Description | Specification | Supplemental Information |
|--|---|--|
| Power Requirements Low Range Voltage Frequency High Range Voltage Frequency Power Consumption, On Power Consumption, Standby Typical instrument configuration Base PXA instrument <i>B85/B1X/B2X/B5X</i> Adding <i>Option B85/B1X</i> to base instrument Adding <i>Option BBA</i> to base instrument | 100 /120 V 50/60/400 Hz 220 /240 V 50/60 Hz 630 W 45 W | $\pm 10\%$ operating range $\pm 10\%$ operating range Maximum Standby power is not supplied to the frequency reference oscillator but to the CPU. Power (nominal) 330 W +45 W +46 W |

PXA Signal Analyzer
General

| Description | Supplemental Information |
|---|-----------------------------|
| Measurement Speed^a | Nominal |
| Local measurement and display update rate ^{bc} | 10 ms (100/s) |
| Remote measurement and LAN transfer rate ^{bc} | 10 ms (100/s) |
| Marker Peak Search | 2.5 ms |
| Center Frequency Tune and Transfer (Band 0) | 43 ms |
| Center Frequency Tune and Transfer (Bands 1-4) | 69 ms |
| Measurement/Mode Switching | 40 ms |
| W-CDMA ACLR measurement time | See page 76 |

- Sweep Points = 101.
- Factory preset, fixed center frequency, RBW = 1 MHz, 10 MHz < span ≤ 600 MHz, stop frequency ≤ 3.6 GHz, Auto Align Off.
- Phase Noise Optimization set to Fast Tuning, Display Off, 32 bit integer format, markers Off, single sweep, measured with IBM compatible PC with 2.99 GHz Pentium® 4 with 2 GB RAM running Windows® XP, Keysight I/O Libraries Suite Version 14.1, one meter GPIB cable, National Instruments PCI-GPIB Card and NI-488.2 DLL.

| Description | Specifications | Supplemental Information |
|----------------------------|----------------|-------------------------------------|
| Display^a | | |
| Resolution | 1280 × 800 | Capacitive multi-touch screen |
| Size | | 269 mm (10.6 in) diagonal (nominal) |

- The LCD display is manufactured using high precision technology. However, if a static image is displayed for a lengthy period of time (~2 hours) you might encounter "image sticking" that may last for approximately 2 seconds. This is normal and does not affect the measurement integrity of the product in any way.

| Description | Specifications | Supplemental Information |
|---------------------|----------------|--|
| Data Storage | | |
| Internal Total | | Removable solid state drive (≥ 160 GB) |
| Internal User | | ≥ 9 GB available on separate partition for user data |

PXA Signal Analyzer
General

| Description | Specifications | Supplemental Information |
|---------------------------|------------------|--|
| Weight | | Weight without options |
| Net | | 22 kg (48 lbs) (nominal) |
| Shipping | | 34 kg (75 lbs) (nominal) |
| Cabinet Dimensions | | Cabinet dimensions exclude front and rear protrusions. |
| Height | 177 mm (7.0 in) | |
| Width | 426 mm (16.8 in) | |
| Length | 556 mm (21.9 in) | |

Inputs/Outputs

Front Panel

| Description | Specifications | Supplemental Information |
|-------------------|----------------|--|
| RF Input | | |
| Connector | | |
| Standard | Type-N female | Frequency <i>Option 503, 508, 513, and 526</i> |
| | 2.4 mm male | Frequency <i>Option 544, and 550</i> |
| <i>Option C35</i> | 3.5 mm male | Frequency <i>Option 526 only</i> |
| Impedance | | 50 Ω (nominal) |

| Description | Specifications | Supplemental Information |
|--------------------|----------------|--|
| Probe Power | | |
| Voltage/Current | | +15 Vdc, $\pm 7\%$ at 0 to 150 mA (nominal) |
| | | –12.6 Vdc, $\pm 10\%$ at 0 to 150 mA (nominal) |
| | | GND |

| Description | Specifications | Supplemental Information |
|-------------------------------------|-----------------------|--------------------------|
| USB Ports | | |
| Host (3 ports) | | Compliant with USB 2.0 |
| Connector | USB Type “A” (female) | |
| Output Current | | |
| Port marked with Lightning Bolt | | 1.2 A (nominal) |
| Port not marked with Lightning Bolt | 0.5 A | |

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

Rear Panel

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

| Description | Specifications | Supplemental Information |
|---|--|--|
| Ext Ref In | | |
| Connector | BNC female | Note: Analyzer noise sidebands and spurious response performance may be affected by the quality of the external reference used. See footnote in the Phase Noise specifications within the Dynamic Range section on page 67 . |
| Impedance | | 50 Ω (nominal) |
| Input Amplitude Range sine wave square wave | | –5 to +10 dBm (nominal) 0.2 to 1.5 V peak-to-peak (nominal) |
| Input Frequency | | 1 to 50 MHz (nominal) (selectable to 1 Hz resolution) |
| Lock range | $\pm 2 \times 10^{-6}$ of ideal external reference input frequency | |

| Description | Specifications | Supplemental Information |
|-------------|----------------|--------------------------|
| Sync | | |
| Connector | BNC female | Reserved for future use |

PXA Signal Analyzer
Inputs/Outputs

| Description | Specifications | Supplemental Information |
|--|----------------------------------|--|
| Trigger Inputs (Trigger 1 In, Trigger 2 In) Connector Impedance Trigger Level Range | BNC female –5 to +5 V | Either trigger source may be selected 10 k Ω (nominal) 1.5 V (TTL) factory preset |

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| Trigger Outputs (Trigger 1 Out, Trigger 2 Out) Connector Impedance Level | BNC female 50 Ω (nominal) 0 to 5 V (CMOS) | |

| Description | Specifications | Supplemental Information |
|---|-------------------|---|
| Monitor Output 1 VGA compatible Connector Format Monitor Output 2 Mini DisplayPort | 15-pin mini D-SUB | XGA (60 Hz vertical sync rates, non-interlaced) Analog RGB |

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Analog Out Connector Impedance | BNC female | 50 Ω (nominal) |

| Description | Specifications | Supplemental Information |
|--|--|--------------------------|
| Noise Source Drive +28 V (Pulsed) Connector Output voltage on Output voltage off | BNC female 28.0 \pm 0.1 V <1.0 V | 60 mA maximum current |

PXA Signal Analyzer
Inputs/Outputs

| Description | Specs | Supplemental Information |
|--------------------------------|-------|---|
| SNS Series Noise Source | | For use with Keysight/Agilent Technologies SNS Series noise sources |

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

| Description | Specifications | Supplemental Information |
|------------------------|-----------------------|--------------------------|
| USB Ports | | |
| Host, Super Speed | | 2 ports |
| Compatibility | USB 3.0 | |
| Connector | USB Type "A" (female) | |
| Output Current | 0.9 A | |
| Host, stacked with LAN | | 1 port |
| Compatibility | USB 2.0 | |
| Connector | USB Type "A" (female) | |
| Output Current | 0.5 A | |
| Device | | 1 port |
| Compatibility | USB 3.0 | |
| Connector | USB Type "B" (female) | |

| Description | Specifications | Supplemental Information |
|-----------------------|------------------------|---|
| GPIB Interface | | |
| Connector | IEEE-488 bus connector | |
| GPIB Codes | | SH1, AH1, T6, SR1, RL1, PP0, DC1, C1, C2, C3 and C28, DT1, L4, C0 |
| Mode | | Controller or device |

| Description | Specifications | Supplemental Information |
|-----------------------------|-----------------|--------------------------|
| LAN TCP/IP Interface | RJ45 Ethertwist | 1000BaseT |

Regulatory Information

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

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

This product is intended for indoor use.



The CE mark is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). This product complies with all relevant directives.



The UK conformity mark is a UK government owned mark. Products showing this mark comply with all applicable UK regulations.

ccr.keysight@keysight.com

The Keysight email address is required by EU directives applicable to our product.



The RCM mark is a registered trademark of the Australian Communications and Media Authority.



South Korean Certification (KC) mark. It includes the marking's identifier code.

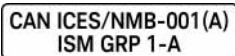
CAN ICES/NMB-001(A)

Canada EMC label.

Interference-Causing Equipment Standard for industrial, scientific and medical (ISM) equipment. Matériel industriel, scientifique et médical (ISM)

ISM 1-A

This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPR 11, Clause 5)



ICES/ISM Label.

This is a space saver label that combines two markings – CAN ICES and ISM



CE/ICES/ISM Label.

This is a space saver label that combines three markings – CE, CAN ICES, and ISM.



The CSA mark is a registered trademark of the CSA International.



The crossed-out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation. Please refer to www.keysight.com/go/takeback to understand your trade-in options with Keysight, in addition to product takeback instructions.



China Restricted Substance Product Label. The EPUP (environmental protection use period) number in the center indicates the time period during which no hazardous or toxic substances or elements are expected to leak or deteriorate during normal use and generally reflects the expected useful life of the product.



Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.

EMC: Complies with the essential requirements of the European EMC Directive and the UK Electromagnetic Compatibility Regulations 2016 as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):

- IEC/EN 61326-1
- CISPR 11, Group 1, Class A
- AS/NZS CISPR 11
- ICES/NMB-001

This ISM device complies with Canadian ICES-001.

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

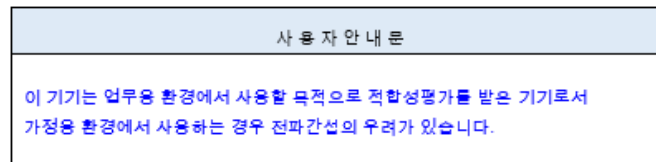
NOTE

This is a sensitive measurement apparatus by design and may have some performance loss (up to 25 dBm above the Spurious Responses, Residual specification of -100 dBm) when exposed to ambient continuous electromagnetic phenomenon in the range of 80 MHz -2.7 GHz when tested per IEC 61000-4-3.

South Korean Class A EMC declaration:

This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference.

This EMC statement applies to the equipment only for use in business environment.



※ 사용자 안내문은 "업무용 방송통신기자재"에만 적용한다.

SAFETY: Complies with the essential requirements of the European Low Voltage Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):

- IEC/EN 61010-1
- Canada: CSA C22.2 No. 61010-1
- USA: UL std no. 61010-1

Acoustic statement: (European Machinery Directive)

Acoustic noise emission

LpA <70 dB

Operator position

Normal operation mode per ISO 7779

To find a current **Declaration of Conformity** for a specific Keysight product, go to: <http://www.keysight.com/go/conformity>

2 I/Q Analyzer

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

Specifications Affected by I/Q Analyzer

| Specification Name | Information |
|--|---|
| Number of Frequency Display Trace Points (buckets) | Does not apply. |
| Resolution Bandwidth | See “Frequency” on page 99 in this chapter. |
| Video Bandwidth | Not available. |
| Clipping-to-Noise Dynamic Range | See “Clipping-to-Noise Dynamic Range” on page 100 in this chapter. |
| Resolution Bandwidth Switching Uncertainty | Not specified because it is negligible. |
| Available Detectors | Does not apply. |
| Spurious Responses | The “Spurious Responses” on page 59 of core specifications still apply. Additional bandwidth-option-dependent spurious responses are given in the Analysis Bandwidth chapter for any optional bandwidths in use. |
| IF Amplitude Flatness | See “IF Frequency Response” on page 38 of the core specifications for the 10 MHz bandwidth. Specifications for wider bandwidths are given in the Analysis Bandwidth chapter for any optional bandwidths in use. |
| IF Phase Linearity | See “IF Phase Linearity” on page 39 of the core specifications for the 10 MHz bandwidth. Specifications for wider bandwidths are given in the Analysis Bandwidth chapter for any optional bandwidths in use. |
| Data Acquisition | See “Data Acquisition” on page 101 in this chapter for the 10 MHz bandwidth. Specifications for wider bandwidths are given in the Analysis Bandwidth chapter for any optional bandwidths in use. |

Frequency

| Description | Specifications | Supplemental Information |
|--|---|--------------------------|
| Frequency Span | | |
| Standard instrument | 10 Hz to 10 MHz | |
| Standard <i>B25</i> | 10 Hz to 25 MHz | |
| <i>Option B40</i> | 10 Hz to 40 MHz | |
| <i>Option B85</i> | 10 Hz to 85 MHz | |
| <i>Option B1X</i> | 10 Hz to 160 MHz | |
| <i>Option B2X</i> | 10 Hz to 255 MHz | |
| <i>Option B5X</i> | 10 Hz to 510 MHz | |
| Resolution Bandwidth (Spectrum Measurement) Range | | |
| Overall | 100 MHz to 3 MHz | |
| Span = 1 MHz | 50 Hz to 1 MHz | |
| Span = 10 kHz | 1 Hz to 10 kHz | |
| Span = 100 Hz | 100 MHz to 100 Hz | |
| Window Shapes | Flat Top, Uniform, Hanning, Hamming, Gaussian, Blackman, Blackman-Harris, Kaiser Bessel (K-B 70 dB, K-B 90 dB & K-B 110 dB) | |
| Analysis Bandwidth (Span) (Waveform Measurement) | | |
| Standard <i>B25</i> | 10 Hz to 25 MHz | |
| <i>Option B40</i> | 10 Hz to 40 MHz | |
| <i>Option B85</i> | 10 Hz to 85 MHz | |
| <i>Option B1X</i> | 10 Hz to 160 MHz | |
| <i>Option B2X</i> | 10 Hz to 255 MHz | |
| <i>Option B5X</i> | 10 Hz to 510 MHz | |

Clipping-to-Noise Dynamic Range

| Description | Specifications | Supplemental Information |
|--|---|--|
| Clipping-to-Noise Dynamic Range^a | | Excluding residuals and spurious responses |
| Clipping Level at Mixer | | Center frequency ≥ 20 MHz |
| IF Gain = Low | –10 dBm | –8 dBm (nominal) |
| IF Gain = High | –20 dBm | –17.5 dBm (nominal) |
| Noise Density at Mixer at center frequency ^b | $(\text{DANL}^c + \text{IFGainEffect}^d) + 2.25$ dB ^e | Example ^f |

- This specification is defined to be the ratio of the clipping level (also known as “ADC Over Range”) to the noise density. In decibel units, it can be defined as $\text{clipping_level [dBm]} - \text{noise_density [dBm/Hz]}$; the result has units of dBFS/Hz (fs is “full scale”).
- The noise density depends on the input frequency. It is lowest for a broad range of input frequencies near the center frequency, and these specifications apply there. The noise density can increase toward the edges of the span. The effect is nominally well under 1 dB.
- The primary determining element in the noise density is the **“DANL without Noise Floor Extension and without Option EP0” on page 50**.
- DANL is specified with the IF Gain set to High, which is the best case for DANL but not for Clipping-to-noise dynamic range. The core specifications **“DANL without Noise Floor Extension and without Option EP0” on page 50**, gives a line entry on the excess noise added by using IF Gain = Low, and a footnote explaining how to combine the IF Gain noise with the DANL.
- DANL is specified for log averaging, not power averaging, and thus is 2.51 dB lower than the true noise density. It is also specified in the narrowest RBW, 1 Hz, which has a noise bandwidth slightly wider than 1 Hz. These two effects together add up to 2.25 B.
- As an example computation, consider this: For the case where $\text{DANL} = -151$ dBm in 1 Hz, IF Gain is set to low, and the “Additional DANL” is -160 dBm, the total noise density computes to -148.2 dBm/Hz and the Clipping-to-noise ratio for a -10 dBm clipping level is -138.2 dBFS/Hz.

Data Acquisition

| Description | Specifications | Supplemental Information |
|---|---|---|
| Time Record Length Analysis Tool IQ Analyzer Advanced Tools Length (IQ sample pairs) | 8,000,000 IQ sample pairs Data Packing 32-bit 64-bit 536 MSa (2^{29} Sa) 268 MSa (2^{28} Sa) | Waveform measurement ^a 89600 VSA software or Fast Capture ^b 2 GB total memory |
| Maximum IQ Capture Time (89600 VSA and Fast Capture) 10 MHz IFBW | Data Packing 32-bit 64-bit 42.94 s 21.47 s | Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs) ^c |
| Sample Rate (IQ Pairs) | $1.25 \times \text{IFBW}$ | |
| ADC Resolution | 16 bits | |

- This can also be accessed with the remote programming command of "read:wav0?".
- This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
- For example, using 32-bit data packing at 10 MHz IF bandwidth (IFBW) the Maximum Capture Time is calculated using the formula: "Max Capture Time = $(2^{29}) / (10 \text{ MHz} \times 1.25)$ ".

3 Option B25 – 25 MHz Analysis Bandwidth

This chapter contains specifications for the standard *Option B25* 25 MHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 25 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 25 MHz, whether by Auto selection (depending on Span) or manually.

| Specification Name | Information |
|--|---|
| IF Frequency Response | See specifications in this chapter. |
| IF Phase Linearity | See specifications in this chapter. |
| Spurious and Residual Responses | The “Spurious Responses” on page 59 still apply. Further, bandwidth-option-dependent spurious responses are contained within this chapter. |
| Displayed Average Noise Level, Third-Order Intermodulation and Phase Noise | The performance of the analyzer will degrade by an unspecified extent when using this bandwidth option. This extent is not substantial enough to justify statistical process control. |

Other Analysis Bandwidth Specifications

| Description | | | | Specifi- cations | Supplemental Information |
|---|-------------------------------------|--------------------------------|----------------|---------------------|-----------------------------|
| IF Spurious Response^a | | | | | Preamp Off ^b |
| IF Second Harmonic | | | | | |
| Apparent Freq | Excitation Freq | Mixer Level^c | IF Gain | | |
| Any on-screen f | $(f + f_c + 22.5 \text{ MHz})/2$ | -15 dBm | Low | | -54 dBc (nominal) |
| | | -25 dBm | High | | -54 dBc (nominal) |
| IF Conversion Image | | | | | |
| Apparent Freq | Excitation Freq | Mixer Level^c | IF Gain | | |
| Any on-screen f | $2 \times f_c - f + 45 \text{ MHz}$ | -10 dBm | Low | | -70 dBc (nominal) |
| | | -20 dBm | High | | -70 dBc (nominal) |

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

Option B25 – 25 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | | Specifications | Supplemental Information | | |
|--|-------------------------|------------------|------------------------|---|----------------------------------|----------------------------|
| IF Frequency Response^a (Demodulation and FFT response relative to the center frequency) | | | | Freq <i>Option 526</i> only Modes above 18 GHz ^b | | |
| Center Freq (GHz) | Span ^c (MHz) | Preselector | Max Error ^d | Midwidth Error (95th Percentile) | Slope (dB/MHz) (95th Percentile) | RMS ^e (nominal) |
| ≥ 0.02, ≤ 3.6 | 10 to ≤ 25 | n/a | ±0.30 dB | ±0.12 dB | ±0.10 | 0.05 dB |
| 3.6 to 26.5 | 10 to ≤ 25 ^f | On | | | | 0.50 dB |
| 3.6 to 26.5 | 10 to ≤ 25 | Off ^g | ±0.40 dB | ±0.12 dB | ±0.10 | 0.04 dB |
| 26.5 to 50 | 10 to ≤ 25 ^f | On | | | | 0.31 dB |
| 26.5 to 50 | 10 to ≤ 25 | Off ^g | ±0.40 dB | | | 0.02 dB |

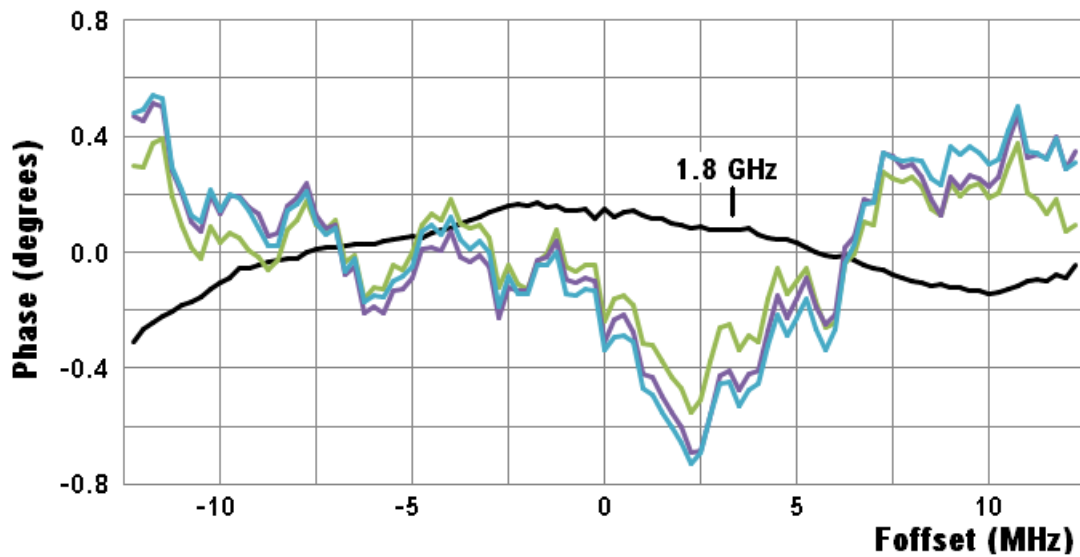
- The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF passband effects.
- Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- This column applies to the instantaneous analysis bandwidth in use. In the Spectrum analyzer Mode, this would be the FFT width. For Span <10 MHz. see **“IF Frequency Response” on page 38**.
- The maximum error at an offset (f) from the center of the FFT width is given by the expression ± [Midwidth Error + (f × Slope)], but never exceeds ±Max Error. Here the Midwidth Error is the error at the center frequency for the given FFT span. Usually, the span is no larger than the FFT width in which case the center of the FFT width is the center frequency of the analyzer. In the Spectrum Analyzer mode, when the analyzer span is wider than the FFT width, the span is made up of multiple concatenated FFT results, and thus has multiple centers of FFT widths so the f in the equation is the offset from the nearest center. These specifications include the effect of RF frequency response as well as IF frequency response at the worst case center frequency. Performance is nominally three times better at most center frequencies.
- The “RMS” nominal performance is the standard deviation of the response relative to the center frequency, integrated across the span. This performance measure was observed at a center frequency in each harmonic mixing band, which is representative of all center frequencies; it is not the worst case frequency.
- For information on the preselector which affects the passband for frequencies above 3.6 GHz when *Option MPB* is not in use, see **“Preselector Bandwidth” on page 32**.
- Option MPB is installed and enabled.

Option B25 - 25 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | | Specifications | Supplemental Information | | | |
|---------------------------|------------|------------------|----------------|--|----------------------------|------------------------|----------------------------|
| IF Phase Linearity | | | | Deviation from mean phase linearity For Freq <i>Option 526</i> only: Modes above 18 GHz | | | |
| Center Freq (GHz) | Span (MHz) | Preselector | | Peak-to-peak (nominal) | RMS (nominal) ^a | Peak-to-peak (nominal) | RMS (nominal) ^a |
| | | | | Without <i>Option EPO</i> | | With <i>Option EPO</i> | |
| ≥ 0.02, ≤ 3.6 | 25 | n/a | | 0.48° | 0.12° | 0.47° | 0.12° |
| > 3.6 | 25 | Off ^b | | 0.85° | 0.20° | 1.1° | 0.28° |

- a. The listed performance is the standard deviation of the phase deviation relative to the mean phase deviation from a linear phase condition, where the RMS is computed across the span shown.
- b. Option MPB is installed and enabled.

Nominal Phase Linearity [Plot]^a



The phase characteristics of analysis frequencies below 3.6 GHz are similar to the 1.8 GHz graph shown. For analysis above 3.6 GHz, the curves shown are representative. They were measured between 5 and 25 GHz. The phase linearity of the analyzer does not depend on the frequency option.

- a. This graph is not applicable to *Option EPO*.

Option B25 - 25 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specification | Supplemental Information |
|---|---------------|---|
| Full Scale (ADC Clipping)^a | | |
| Default settings, signal at CF (IF Gain = Low) | | |
| Band 0 | | –8 dBm mixer level ^b (nominal) |
| Band 1 through 4 | | –7 dBm mixer level ^b (nominal) |
| High Gain setting, signal at CF (IF Gain = High) | | |
| Band 0 | | –18 dBm mixer level ^b (nominal), subject to gain limitations ^c |
| Band 1 through 6 | | –17 dBm mixer level ^b (nominal), subject to gain limitations ^c |
| Effect of signal frequency \neq CF | | up to ± 3 dB (nominal) |

- This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
- Mixer level is signal level minus input attenuation.
- The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.

Data Acquisition

| Description | Specifications | | Supplemental Information |
|--|------------------------------|------------------------------|--|
| Time Record Length | | | |
| Analysis Tool | | | |
| IQ Analyzer | 8,000,000 IQ sample pairs | | Waveform measurement ^a |
| Advanced Tools | Data Packing | | 89600 VSA software or Fast Capture ^b |
| | 32-bit | 64-bit | |
| Length (IQ sample pairs) | 536 MSa (2 ²⁹ Sa) | 268 MSa (2 ²⁸ Sa) | 2 GB total memory |
| Maximum IQ Capture Time | Data Packing | | |
| (89600 VSA and Fast Capture ^b) | 32-bit | 64-bit | Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs) ^c |
| 10 MHz IFBW | 42.94 s | 21.47 s | |
| 25 MHz IFBW | 17.17 s | 8.58 s | |
| Sample Rate (IQ Pairs) | 1.25 × IFBW | | |
| ADC Resolution | 16 bits | | |

- This can also be accessed with the remote programming command of "read:wav0?".
- This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
- For example, using 32-bit data packing at 10 MHz IF bandwidth (IFBW) the Maximum Capture Time is calculated using the formula: "Max Capture Time = $(2^{29}) / (10 \text{ MHz} \times 1.25)$ ".

Option B25 - 25 MHz Analysis Bandwidth
Data Acquisition

4 Option B40 – 40 MHz Analysis Bandwidth

This chapter contains specifications for the *Option B40* 40 MHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 40 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 40 MHz, whether by Auto selection (depending on Span) or manually.

| Specification Name | Information |
|---|--|
| IF Frequency Response | See specifications in this chapter. |
| IF Phase Linearity | See specifications in this chapter. |
| Spurious Responses | There are three effects of the use of Option B40 on spurious responses. Most of the warranted elements of the “Spurious Responses” on page 59 still apply without changes, but the revised-version of the table on page 59 , modified to reflect the effect of Option B40, is shown in its place in this chapter. The image responses part of that table have the same warranted limits, but apply at different frequencies as shown in the table. The "higher order RF spurs" line is slightly degraded. Also, spurious-free dynamic range specifications are given in this chapter, as well as IF Residuals. |
| Displayed Average Noise Level | See specifications in this chapter. |
| Third-Order Intermodulation | This bandwidth option can create additional TOI products to those that are created by other instrument circuitry. These products do not behave with typical analog third-order behavior, and thus cannot be specified in the same manner. Nominal performance statements are given in this chapter, but they cannot be expected to decrease as the cube of the voltage level of the signals. |
| Phase Noise | The performance of the analyzer will degrade by an unspecified extent when using wideband analysis. This extent is not substantial enough to justify statistical process control. |
| Absolute Amplitude Accuracy | Nominally 0.5 dB degradation from base instrument absolute amplitude accuracy. (Refer to Absolute Amplitude Accuracy on page 40.) |
| Frequency Range Over Which Specifications Apply | Specifications on this bandwidth only apply with center frequencies of 30 MHz and higher. |

Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| SFDR (Spurious-Free Dynamic Range) Signal Frequency within ± 12 MHz of center Signal Frequency anywhere within analysis BW Spurious response within ± 18 MHz of center Response anywhere within analysis BW | | Test conditions ^a –80 dBc (nominal) –79 dBc (nominal) –77 dBc (nominal) |

a. Signal level is –6 dB relative to full scale at the center frequency. See the Full Scale table.

Option B40 – 40 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | Specifications | | Supplemental Information | | |
|---|-----------------|--------------------------|----------|-------------------------------|----------------------------|---------------|
| Spurious Responses: Residual and Image^a (see Band Overlaps on page 21) | | | | Preamplifier Off ^b | | |
| Residual Responses ^c | | | | –100 dBm (nominal) | | |
| Image Responses | | | | | | |
| Tuned Freq (f) | Excitation Freq | Mixer Level ^d | Response | Response (nominal) | Option EP0 RF/μW (nominal) | mmW (nominal) |
| 10 MHz to 3.6 GHz | f+10100 MHz | –10 dBm | –80 dBc | –120 dBc | | –123 dBc |
| 10 MHz to 3.6 GHz | f+500 MHz | –10 dBm | –80 dBc | –100 dBc | | –101 dBc |
| 3.5 to 13.6 GHz | f+500 MHz | –10 dBm | –78 dBc | –101 dBc | –86 dBc | –101 dBc |
| 13.5 to 17.1 GHz | f+500 MHz | –10 dBm | –74 dBc | –99 dBc | –85 dBc | –101 dBc |
| 17.0 to 22 GHz | f+500 MHz | –10 dBm | –70 dBc | –99 dBc | –81 dBc | –99 dBc |
| 22 to 26.5 GHz | f+500 MHz | –10 dBm | –68 dBc | –96 dBc | –78 dBc | –94 dBc |
| 26.5 to 34.5 GHz | f+500 MHz | –30 dBm | –60 dBc | –94 dBc | | –94 dBc |
| 34.4 to 44 GHz | f+500 MHz | –30 dBm | –57 dBc | –91 dBc | | –84 dBc |
| 44 to 50 GHz | f+500 MHz | –30 dBm | | –82 dBc | | –73 dBc |

a. Preselector enabled for frequencies >3.6 GHz.

b. The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation – Preamp Gain

c. Input terminated, 0 dB input attenuation.

d. Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than –12 dBm if necessary to avoid ADC overload.

Option B40 – 40 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specifications | | Supplemental Information | | |
|---|--------------------------------|---|---|--|----------------------|
| Spurious Responses: Other^a (see Band Overlaps on page 21) | Mixer Level^b | Response | Response (nominal) | Option EPO RF/μW (nominal) | mmW (nominal) |
| First RF Order ^c (f \geq 10 MHz from carrier) | | | | | |
| Carrier Frequency \leq 26.5 GHz | -10 dBm | $-80 \text{ dBc} + 20 \times \log(N^d)$ | -126 dBc | -97 dBc | -95 dBc |
| Carrier Frequency $>$ 26.5 GHz | -30 dBm | | -101 dBc | | -94 dBc |
| Higher RF Order ^e (f \geq 10 MHz from carrier) | | | | | |
| Carrier Frequency \leq 26.5 GHz | -40 dBm | $-78 \text{ dBc} + 20 \times \log(N^d)$ | -103 dBc | -103 dBc | -97 dBc |
| Carrier Frequency $>$ 26.5 GHz | -30 dBm | | -100 dBc | | -95 dBc |
| LO-Related Spurious Response (Offset from carrier 200 Hz to 10 MHz) | -10 dBm | $-68 \text{ dBc} + 20 \times \log(N^d)$ | | | |
| Close-in Sidebands Spurious Response (LO Related, offset $<$ 200 Hz) | | | $-73 \text{ dBc}^f + 20 \times \log(N^d)$ | | |

- Preselector enabled for frequencies $>$ 3.6 GHz.
- Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than -12 dBm if necessary to avoid ADC overload.
- With first RF order spurious products, the indicated frequency will change at the same rate as the input, with higher order, the indicated frequency will change at a rate faster than the input.
- N is the LO multiplication factor.
- RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
- Nominally -40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.

| Description | Specification | Supplemental Information |
|---|---------------|--|
| IF Residual Responses | | Relative to full scale; see the Full Scale table for details |
| Band 0 | | -112 dBFS (nominal) |
| Band 1, Preselector Bypassed (Option MPB) | | -110 dBFS (nominal) |

Option B40 – 40 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | | Specifications | Supplemental Information | |
|--|-------------------|--------------------|----------------|--|----------------------------------|
| IF Frequency Response^a | | | | Relative to center frequency Freq <i>Option 526</i> only: Modes above 18 GHz ^b | |
| Center Freq (GHz) | Span (MHz) | Preselector | | Typical | RMS (nominal)^c |
| ≥ 0.03, < 3.6 | ≤40 | n/a | ±0.4 dB | ±0.25 dB | 0.05 dB ^d |
| ≥ 3.6, ≤ 8.4 | ≤40 | Off ^e | ±0.4 dB | ±0.16 dB | 0.05 dB |
| > 8.4, ≤ 26.5 | ≤40 | Off ^e | ±0.7 dB | ±0.20 dB | 0.05 dB |
| ≥ 26.5, ≤ 34.4 | ≤40 | Off ^e | ±0.8 dB | ±0.25 dB | 0.1 dB |
| ≥ 34.4, ≤ 50 | ≤40 | Off ^e | ±1.0 dB | ±0.35 dB | 0.1 dB |
| ≥ 3.6, ≤ 50 | ≤40 | On | | See footnote ^f | |

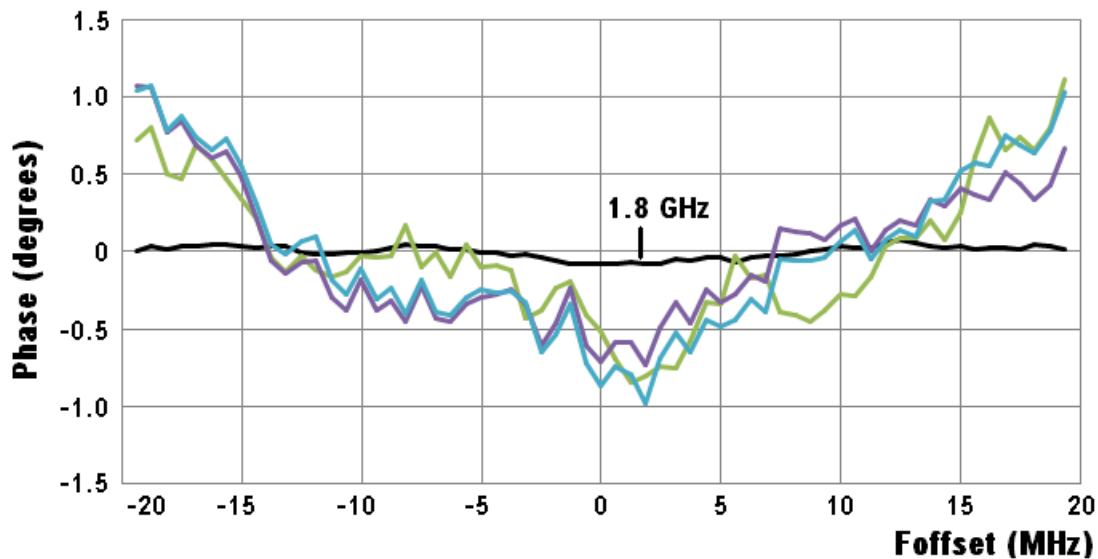
- The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF passband effects.
- Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- The listed performance is the rms of the amplitude deviation from the mean amplitude response of a span/CF combination. 50% of the combinations of prototype instruments, center frequencies and spans had performance better than the listed values.
- For *Option EPO*, the nominal RMS value is 0.07 dB.
- Option MPB* is installed and enabled.
- The passband shape will be greatly affected by the preselector. See “**Preselector Bandwidth**” on page 32.

Option B40 – 40 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | | Specifications | Supplemental Information | | | |
|---------------------------|-------------------|--------------------|----------------|---|----------------------------------|-------------------------------|----------------------------------|
| IF Phase Linearity | | | | Deviation from mean phase linearity Freq <i>Option 526</i> only: Modes above 18 GHz ^a | | | |
| | | | | Without <i>Option EPO</i> | | With <i>Option EPO</i> | |
| Center Freq (GHz) | Span (MHz) | Preselector | | Peak-to-peak (nominal) | RMS (nominal)^b | Peak-to-peak (nominal) | RMS (nominal)^c |
| ≥ 0.02, < 3.6 | 40 | n/a | | 0.16° | 0.041° | 0.5° | 0.12° |
| ≥ 3.6, ≤ 50 | 40 | Off ^d | | 1.5° | 0.35° | 1.24° | 0.32° |

- a. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- b. The listed performance is the standard deviation of the phase deviation relative to the mean phase deviation from a linear phase condition, where the RMS is computed across the span shown.
- c. The listed performance is the standard deviation of the phase deviation relative to the mean phase deviation from a linear phase condition, where the RMS is computed across the span shown.
- d. Option MPB is installed and enabled.

Nominal Phase Linearity [Plot]^a



The phase characteristics of analysis frequencies below 3.6 GHz are similar to the 1.8 GHz graph shown. For analysis above 3.6 GHz, the curves shown are representative. They were measured between 5 and 25 GHz. The phase linearity of the analyzer does not depend on the frequency option.

- a. This plot is not applicable to *Option EPO*.

Option B40 – 40 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specification | Supplemental Information | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|--|--|-------------------|---|------------------|--------|--------|--------|--------|----------|--------|--------|--|---------|---------|---------|---------|---------|--------|---------|---------|--------|---------|---------|--|---------|
| Full Scale (ADC Clipping) ^a Default settings, signal at CF (IF Gain = Low; IF Gain Offset = 0 dB) Band 0 Band 1 through 4 Band 5 through 6 High Gain setting, signal at CF (IF Gain = High; IF Gain Offset = 0 dB) Band 0 Band 1 through 2 Band 3 through 4 Band 5 through 6 IF Gain Offset ≠ 0 dB, signal at CF Effect of signal frequency ≠ CF | | Mixer Level (nominal) ^b <table><thead><tr><th><i>Option EP1</i></th><th><i>Option EP0</i> RF/μW (nominal)</th><th>mmW (nominal)</th></tr></thead><tbody><tr><td>−8 dBm</td><td>−7 dBm</td><td>−8 dBm</td></tr><tr><td>−7 dBm</td><td>−5.5 dBm</td><td>−7 dBm</td></tr><tr><td>−7 dBm</td><td></td><td>−11 dBm</td></tr></tbody></table> Mixer level ^b (nominal), subject to gain limitations ^c <table><tbody><tr><td>−18 dBm</td><td>−13 dBm</td><td>−13 dBm</td></tr><tr><td>−17 dBm</td><td>−9 dBm</td><td>−17 dBm</td></tr><tr><td>−17 dBm</td><td>−4 dBm</td><td>−16 dBm</td></tr><tr><td>−17 dBm</td><td></td><td>−15 dBm</td></tr></tbody></table> See formula ^d , subject to gain limitations ^c up to ±4 dB (nominal) | | | <i>Option EP1</i> | <i>Option EP0</i> RF/μW (nominal) | mmW (nominal) | −8 dBm | −7 dBm | −8 dBm | −7 dBm | −5.5 dBm | −7 dBm | −7 dBm | | −11 dBm | −18 dBm | −13 dBm | −13 dBm | −17 dBm | −9 dBm | −17 dBm | −17 dBm | −4 dBm | −16 dBm | −17 dBm | | −15 dBm |
| <i>Option EP1</i> | <i>Option EP0</i> RF/μW (nominal) | mmW (nominal) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| −8 dBm | −7 dBm | −8 dBm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| −7 dBm | −5.5 dBm | −7 dBm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| −7 dBm | | −11 dBm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| −18 dBm | −13 dBm | −13 dBm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| −17 dBm | −9 dBm | −17 dBm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| −17 dBm | −4 dBm | −16 dBm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| −17 dBm | | −15 dBm | | | | | | | | | | | | | | | | | | | | | | | | | | |

- This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
- Mixer level is signal level minus input attenuation.
- The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
- The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

| Description | Specification | Supplemental Information |
|--|---------------|--------------------------|
| EVM (EVM measurement floor for an 802.11g OFDM signal, MCS7, using 89600 VSA software equalization on channel estimation sequence and data, pilot tracking on) | | |
| 2.4 GHz | | 0.25% (nominal) |
| 5.8 GHz with Option MPB | | 0.35% (nominal) |

Option B40 – 40 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Third Order Intermodulation Distortion | | Two tones of equal level 1 MHz tone separation Each tone –13 dB relative to full scale (ADC clipping) IF Gain = High IF Gain Offset = 0 dB Preselector Bypassed ^a (Option MPB) in Bands 1 through 6 |
| Band 0 | | –85 dBc (nominal) |
| Band 1 - 2 | | –84 dBc (nominal) |
| Band 3 - 4 | | –83 dBc (nominal) |
| Band 5 | | –84 dBc (nominal) |
| Band 6 | | –79 dBc (nominal) |

a. When using the preselector, performance is similar

| Description | Specifications | | Supplemental Information |
|---|-------------------------------|----------------------------------|--|
| Noise Density with Preselector Bypass (Option MPB) | | | 0 dB attenuation; Preselector bypassed above Band 0; center of IF bandwidth ^a |
| Band | Freq (GHz)^b | IF Gain^c = Low | IF Gain = High |
| 0 | 1.80 | –144 dBm/Hz | –144 dBm/Hz |
| 1 | 5.95 | –140 dBm/Hz | –140 dBm/Hz |
| 2 | 10.95 | –141 dBm/Hz | –141 dBm/Hz |
| 3 | 15.30 | –135 dBm/Hz | –135 dBm/Hz |
| 4 | 21.75 | –133 dBm/Hz | –133 dBm/Hz |
| 5 | 30.45 | –130 dBm/Hz | –130 dBm/Hz |
| 6 | 42.20 | –130 dBm/Hz | –130 dBm/Hz |

- The noise level in the IF will change for frequencies away from the center of the IF. Usually, the IF part of the total noise will get worse by nominally up to 3 dB as the edge of the IF bandwidth is approached.
- Specifications apply at the center of each band. IF Noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
- IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain. High IF gain gives better noise levels to such a small extent that the warranted specifications do not change. High gain gives a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

Option B40 – 40 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | Specifications | Supplemental Information |
|---|-------------------------------|----------------|---|
| Noise Density without Option MPB | | | 0 dB attenuation; center of IF bandwidth ^a , IF Gain = Low |
| Band | Freq (GHz)^b | | Nominal |
| 0 | 1.80 | –144 dBm/Hz | |
| 1 | 5.95 | | –148 dBm/Hz |
| 2 | 10.95 | | –150 dBm/Hz |
| 3 | 15.30 | | –145 dBm/Hz |
| 4 | 21.75 | | –144 dBm/Hz |

- a. The noise level in the IF will change for frequencies away from the center of the IF. Usually, the IF part of the total noise will get worse by nominally up to 3 dB as the edge of the IF bandwidth is approached.
- b. Specifications apply at the center of each band. IF Noise dominates the system noise, therefore the noise density will not change substantially with center frequency.

| Description | | Specification | Supplemental Information |
|------------------------------|--|---------------|---|
| Signal to Noise Ratio | | | Ratio of clipping level ^a to noise level |
| Example: 1.8 GHz | | | 136 dBc/Hz, IF Gain = Low, IF Gain Offset = 0 dB |

- a. For the clipping level, see the table above, "Full Scale." Note that the clipping level is not a warranted specification, and has particularly high uncertainty at high microwave frequencies.

Data Acquisition

| Description | Specifications | | Supplemental Information |
|--------------------------------|---------------------------|------------------------|--|
| Time Record Length | | | |
| IQ Analyzer | 8,000,000 IQ sample pairs | | Waveform measurement ^a |
| Advanced Tools | Data Packing | | 89600 VSA software or Fast Capture ^b |
| | 32-bit | 64-bit | |
| Length (IQ sample pairs) | 536 MSa (2^{29} Sa) | 268 MSa (2^{28} Sa) | 2 GB total memory |
| Maximum IQ Capture Time | Data Packing | | |
| (89600 VSA and Fast Capture) | 32-bit | 64-bit | Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs) ^c |
| 10 MHz IFBW | 42.94 s | 21.47 s | |
| 25 MHz IFBW | 17.17 s | 8.58 s | |
| 40 MHz IFBW | 10.73 s | 5.36 s | |
| Sample Rate (IQ Pairs) | $1.25 \times \text{IFBW}$ | | |
| ADC Resolution | 12 bits | | |

- This can also be accessed with the remote programming command of "read:wav0?".
- This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
- For example, using 32-bit data packing at 10 MHz IF bandwidth (IFBW) the Maximum Capture Time is calculated using the formula: "Max Capture Time = (2^{29})/(10 MHz \times 1.25)".

Option B40 - 40 MHz Analysis Bandwidth
Data Acquisition

5 Option B85/B1X – 85/160 MHz Analysis Bandwidth

This chapter contains specifications for the *Option B85/B1X*, 85 or 160 MHz Analysis Bandwidth, and are unique to this IF Path.

This option is not available with *Option EP0*.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 85/160 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 85/160 MHz, whether by Auto selection (depending on Span) or manually.

| Specification Name | Information |
|---|--|
| IF Frequency Response | See specifications in this chapter. |
| IF Phase Linearity | See specifications in this chapter. |
| Spurious Responses | There are three effects of the use of Option B85/B1X on spurious responses. Most of the warranted elements of the "Spurious Responses" on page 59 still apply without changes, but the revised-for-85/160-MHz table is shown in its place in this chapter. The image responses part of that table have the same warranted limits, but apply at different frequencies as shown in the table. The "higher order RF spurs" line is slightly degraded. Also, spurious-free dynamic range specifications are given in this chapter, as well as IF Residuals. |
| Displayed Average Noise Level | See specifications in this chapter. |
| Third-Order Intermodulation | This bandwidth option can create additional TOI products to those that are created by other instrument circuitry. These products do not behave with typical analog third-order behavior, and thus cannot be specified in the same manner. Nominal performance statements are given in this chapter, but they cannot be expected to decrease as the cube of the voltage level of the signals. |
| Phase Noise | The performance of the analyzer will degrade by an unspecified extent when using wideband analysis. This extent is not substantial enough to justify statistical process control. |
| Absolute Amplitude Accuracy | Nominally 0.5 dB degradation from base instrument absolute amplitude accuracy. (Refer to Absolute Amplitude Accuracy on page 40.) |
| Frequency Range Over Which Specifications Apply | Specifications on this bandwidth only apply with center frequencies of 100 MHz and higher. |

Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|---|----------------|------------------------------|
| SFDR (Spurious-Free Dynamic Range) | | Test conditions ^a |
| Signal Frequency within ± 12 MHz of center | | -75 dBc (nominal) |
| Signal Frequency anywhere within analysis BW | | |
| Spurious response within ± 63 MHz of center | | -74 dBc (nominal) |
| Response anywhere within analysis BW | | -72 dBc (nominal) |

a. Signal level is -6 dB relative to full scale at the center frequency. See the Full Scale table.

| Description | Specifications | Supplemental Information |
|---|------------------------|--------------------------------|
| Spurious Responses: Residual and Image^a (see Band Overlaps on page 21) | | Preamplifier Off ^b |
| Residual Responses ^c | | -100 dBm (nominal) |
| Image Responses | | |
| Tuned Freq (f) | Excitation Freq | Mixer Level^d |
| | | Response |
| 10 MHz to 3.6 GHz | f+10200 MHz | -10 dBm |
| | | -80 dBc |
| 10 MHz to 3.6 GHz | f+600 MHz | -10 dBm |
| | | -80 dBc |
| 3.5 to 13.6 GHz | f+600 MHz | -10 dBm |
| | | -78 dBc |
| 13.5 to 17.1 GHz | f+600 MHz | -10 dBm |
| | | -74 dBc |
| 17.0 to 22 GHz | f+600 MHz | -10 dBm |
| | | -70 dBc |
| 22 to 26.5 GHz | f+600 MHz | -10 dBm |
| | | -68 dBc |
| 26.5 to 34.5 GHz | f+600 MHz | -30 dBm |
| | | -60 dBc |
| 34.4 to 44 GHz | f+600 MHz | -30 dBm |
| | | -57 dBc |
| 44 to 50 GHz | f+600 MHz | -30 dBm |
| | | -80 dBc (nominal) |

a. Preselector enabled for frequencies >3.6 GHz.

b. The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level - Input Attenuation - Preamp Gain

c. Input terminated, 0 dB input attenuation.

d. Mixer Level = Input Level - Input Attenuation. Verify with mixer levels no higher than -12 dBm if necessary to avoid ADC overload.

Option B85/B1X - 85/160 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specifications | | Supplemental Information |
|--|--------------------------------|--|--|
| Spurious Responses: Other^a (see Band Overlaps on page 21) | | | Preamplifier Off ^b |
| | Mixer Level^c | Response | |
| First RF Order ^d (f ≥ 10 MHz from carrier) | | | |
| Carrier Frequency ≤ 26.5 GHz | -10 dBm | -80 dBc + 20 × log(N ^e) | -120 dBc (nominal) |
| Carrier Frequency > 26.5 GHz | 30 dBm | | -101 dBc (nominal) |
| Higher RF Order ^f (f ≥ 10 MHz from carrier) | | | |
| Carrier Frequency ≤ 26.5 GHz | -40 dBm | -78 dBc + 20 × log(N ^e) | -103 dBc (nominal) |
| Carrier Frequency > 26.5 GHz | -30 dBm | | -100 dBc (nominal) |
| LO-Related Spurious Response (Offset from carrier 200 Hz to 10 MHz) | -10 dBm | -68 dBc ^g + 20 × log(N ^e) | |
| Close-in Sidebands Spurious Responses (LO Related, offset <200Hz) | | | -73 dBc ^g + 20 × log(N ^e) (nominal) |

- Preselector enabled for frequencies >3.6 GHz.
- The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation – Preamp Gain
- Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than -12 dBm if necessary to avoid ADC overload.
- With first RF order spurious products, the indicated frequency will change at the same rate as the input, with higher order, the indicated frequency will change at a rate faster than the input.
- N is the LO multiplication factor.
- RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
- Nominally -40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| IF Residual Responses | | Relative to full scale; see the Full Scale table for details. |
| Band 0 | | -110 dBFS (nominal) |
| Band 1, Preselector Bypassed (<i>Option MPB</i>) | | -108 dBFS (nominal) |

Option B85/B1X - 85/160 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | | Specifications | Supplemental Information | |
|--|-------------------|--------------------|----------------|--|----------------------------------|
| IF Frequency Response^a | | | | Relative to center frequency Freq <i>Option 526</i> only: Modes above 18 GHz ^b | |
| Center Freq (GHz) | Span (MHz) | Preselector | | Typical | RMS (nominal)^c |
| ≥ 0.1, < 3.6 | ≤85 | n/a | ±0.6 dB | ±0.17 dB | 0.05 dB |
| ≥ 0.1, < 3.6 | ≤140 | n/a | ±0.6 dB | ±0.25 dB | 0.05 dB |
| ≥ 0.1, < 3.6 | ≤160 | n/a | | ±0.2 dB (nominal) | 0.07 dB |
| > 3.6, ≤ 8.4 | ≤85 | Off ^d | ±0.73 dB | ±0.2 dB | 0.05 dB |
| ≥ 3.6, ≤ 8.4 | ≤140 | Off ^d | ±0.8 dB | ±0.35 dB | 0.05 dB |
| ≥ 3.6, ≤ 8.4 | ≤160 | Off ^d | | ±0.3 dB (nominal) | 0.07 dB |
| > 8.4, ≤ 26.5 | ≤85 | Off ^d | ±1.1 dB | ±0.50 dB | 0.1 dB |
| > 8.4, ≤ 26.5 | ≤140 | Off ^d | ±1.30 dB | ±0.75 dB | 0.1 dB |
| > 8.4, ≤ 26.5 | ≤160 | Off ^d | | ±0.5 dB (nominal) | 0.12 dB |
| ≥ 26.5, ≤ 50 | ≤85 | Off ^d | ±1.20 dB | ±0.45 dB | 0.12 dB |
| > 26.5, 50 | ≤140 | Off ^d | ±1.40 dB | ±0.65 dB | 0.12 dB |
| > 3.6 | | On | | See note ^e | |

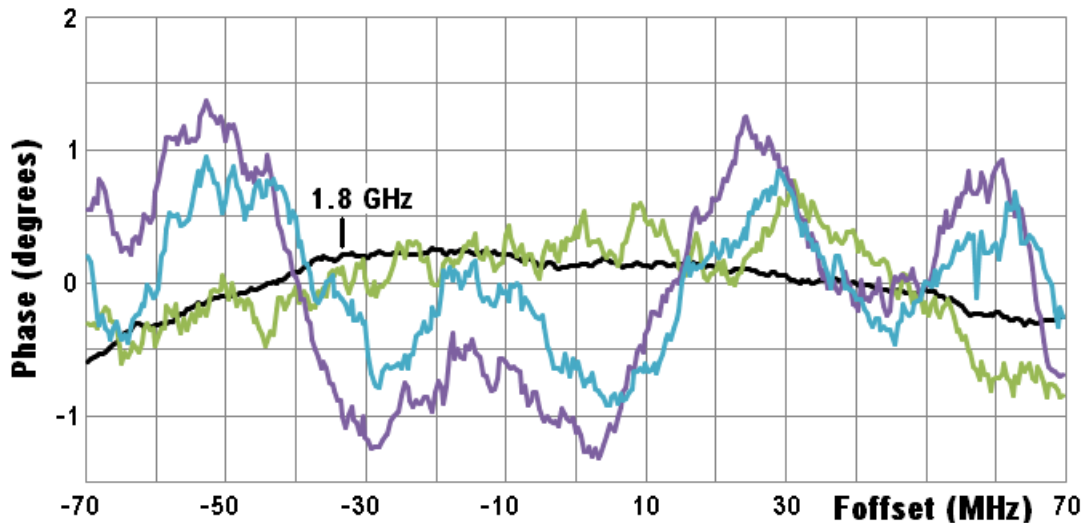
- The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF pass-band effects.
- Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- The listed performance is the rms of the amplitude deviation from the mean amplitude response of a span/CF combination. 50% of the combinations of prototype instruments, center frequencies and spans had performance better than the listed values.
- Option MPB is installed and enabled.
- The passband shape will be greatly affected by the preselector. See **“Preselector Bandwidth” on page 32**.

Option B85/B1X - 85/160 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | | Specifications | Supplemental Information | |
|---------------------------|-------------------|--------------------|----------------|---|----------------------------------|
| IF Phase Linearity | | | | Deviation from mean phase linearity Freq <i>Option 526</i> only: Modes above 18 GHz ^a | |
| Center Freq (GHz) | Span (MHz) | Preselector | | Peak-to-peak (nominal) | RMS (nominal)^b |
| ≥ 0.03, < 3.6 | ≤140 | n/a | | 0.9° | 0.20° |
| | ≤160 | n/a | | 1.7° | 0.42° |
| ≥ 3.6, ≤ 50 | ≤140 | Off ^c | | 1.6° | 0.39° |
| | ≤160 | Off ^c | | 2.8° | 0.64° |

- Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to -0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- The listed performance is the rms of the phase deviation relative to the mean phase deviation from a linear phase condition, where the rms is computed across the span shown.
- Option MPB is installed and enabled.

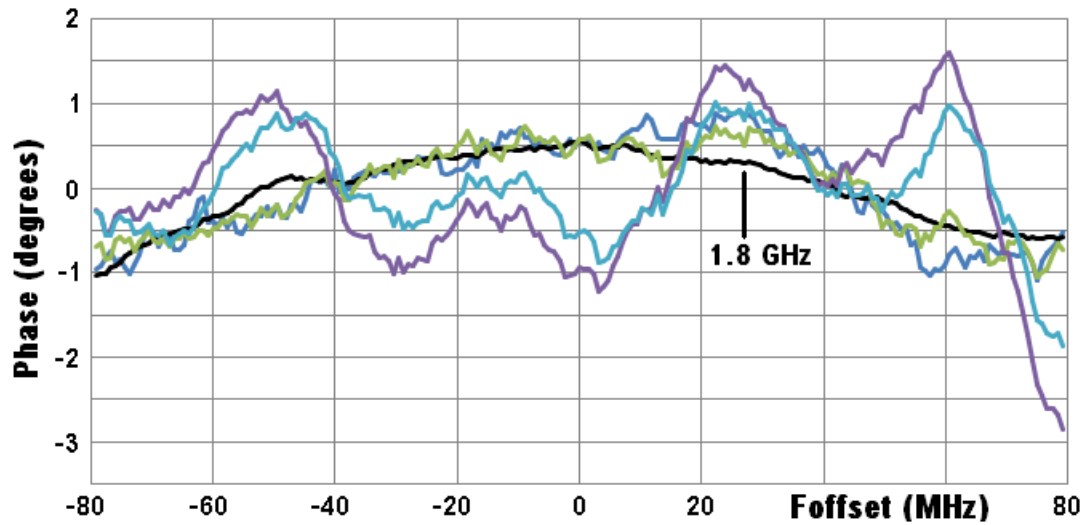
Nominal IF Phase Linearity [Plot] 140 MHz IF Path^a



The phase characteristics of analysis frequencies below 3.6 GHz are similar to the 1.8 GHz graph shown. For analysis above 3.6 GHz, the curves shown are representative. They were measured between 5 and 25 GHz. The phase linearity of the analyzer does not depend on the frequency option.

- This plot is not applicable to *Option EP0*.

Nominal IF Phase Linearity [Plot] 160 MHz IF Path^a



The phase characteristics of analysis frequencies below 3.6 GHz are similar to the 1.8 GHz graph shown. For analysis above 3.6 GHz, the curves shown are representative. They were measured between 5 and 25 GHz. The phase linearity of the analyzer does not depend on the frequency option.

a. This plot is not applicable to *Option EP0*.

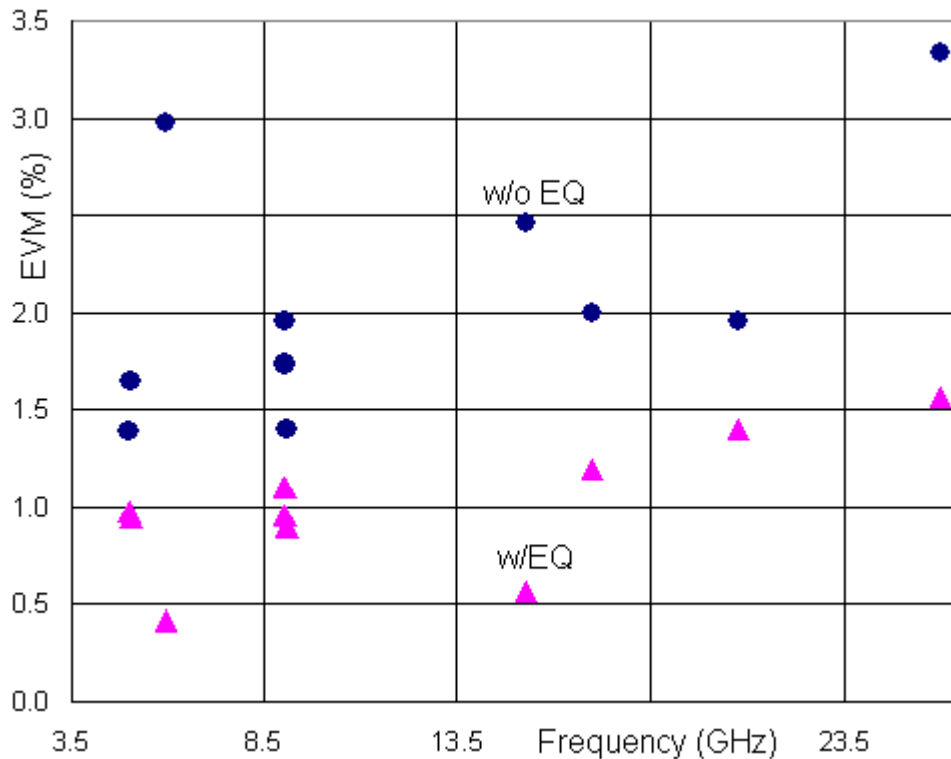
Option B85/B1X - 85/160 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specification | Supplemental Information |
|--|---------------|--|
| Full Scale (ADC Clipping)^a Default settings, signal at CF (IF Gain = Low; IF Gain Offset = 0 dB) Band 0 Band 1 through 6 High Gain setting, signal at CF (IF Gain = High; IF Gain Offset = 0 dB) Band 0 Band 1 through 6 IF Gain Offset \neq 0 dB, signal at CF Effect of signal frequency \neq CF | | -8 dBm mixer level ^b (nominal) -7 dBm mixer level ^b (nominal) -18 dBm mixer level ^b (nominal), subject to gain limitations ^c -17 dBm mixer level ^b (nominal), subject to gain limitations ^c See formula ^d , subject to gain limitations ^c up to ± 3 dB (nominal) |

- This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
- Mixer level is signal level minus input attenuation.
- The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
- The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Option B85/B1X - 85/160 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specification | Supplemental Information |
|---|---------------|--|
| EVM measurement floor Case 1: 62.5 Msymbol/s, 16QAM signal, RRC filter alpha of 0.2, non-equalized, with approximately 75 MHz occupied bandwidth Band 0, 1.8 GHz ^b Band 1, 5.95 GHz ^b Case 2: 104.167 Msymbol/s, 16QAM signal, RRC filter alpha of 0.35, with approximately 140 MHz occupied bandwidth | | Customized settings required ^a , Preselector Bypassed (Option MPB) 0.8% (nominal) 1.1% (nominal) See graph. Observations on one instrument shown for Bands 1 through 4, with and without equalization. ^c |



- EVM is evaluated using 89600 vector signal analysis (VSA) software. This software selects input attenuation and preamplification indirectly. The selection usually optimizes signal-to-noise ratio, not EVM, biasing the results toward 0 dB input attenuation. With low input attenuation, the VSWR effects at the input across a 140 MHz bandwidth will dominate the EVM. Thus, very exacting setting of the Input Range control relative to the input signal level is required to get the best EVM and avoid the low attenuation problems. Recommended settings are these: For input signal levels between 0 and -14 dBm, use Input Range +4 dBm; for input signal levels between -14 and -24 dBm, use Input Range -2 dBm.
- The test frequency used was in the middle the band, and is representative of all of that band.
- This graph is not applicable to *Option EPO*.

Option B85/B1X - 85/160 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Third Order Intermodulation Distortion | | Two tones of equal level 1 MHz tone separation Each tone –15 dB relative to full scale (ADC clipping) IF Gain = High IF Gain Offset = 0 dB Preselector Bypassed ^a (Option MPB) in Bands 1 through 4 |
| Band 0 | | –79 dBc (nominal) |
| Band 1- 4 | | –78 dBc (nominal) |

a. When using the preselector, performance is similar

| Description | Specifications | | Supplemental Information |
|---|-------------------------------|----------------------------------|--|
| Noise Density with Preselector Bypass (Option MPB) | | | 0 dB attenuation; Preselector bypassed above Band 0; center of IF bandwidth ^a |
| Band | Freq (GHz)^b | IF Gain^c = Low | IF Gain = High |
| 0 | 1.80 | –149 dBm/Hz | –151 dBm/Hz |
| 1 | 5.95 | –145 dBm/Hz | –146 dBm/Hz |
| 2 | 10.95 | –144 dBm/Hz | –145 dBm/Hz |
| 3 | 15.30 | –139 dBm/Hz | –139 dBm/Hz |
| 4 | 21.75 | –136 dBm/Hz | –136 dBm/Hz |
| 5 | 30 | –130 dBm/Hz | –130 dBm/Hz |
| 6 | 42.20 | –130 dBm/Hz | –130 dBm/Hz |

- The noise level in the IF will change for frequencies away from the center of the IF. Usually, the IF part of the total noise will get worse by nominally up to 3 dB as the edge of the IF bandwidth is approached.
- Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
- IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain, giving better noise levels but a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

Option B85/B1X - 85/160 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | Specifications | Supplemental Information |
|---|-------------------------------|----------------|---|
| Noise Density without Option MPB | | | 0 dB attenuation; center of IF bandwidth ^a |
| Band | Freq (GHz)^b | | Nominal |
| 0 | 1.80 | -149 dBm/Hz | |
| 1 | 5.95 | | -147 dBm/Hz |
| 2 | 10.95 | | -146 dBm/Hz |
| 3 | 15.30 | | -141 dBm/Hz |
| 4 | 21.75 | | -138 dBm/Hz |

- The noise level in the IF will change for frequencies away from the center of the IF. Usually, the IF part of the total noise will get worse by nominally up to 3 dB as the edge of the IF bandwidth is approached.
- Specifications apply at the center of each band. IF Noise dominates the system noise, therefore the noise density will not change substantially with center frequency.

| Description | | Specification | Supplemental Information |
|------------------------------|--|---------------|--|
| Signal to Noise Ratio | | | Ratio of clipping level ^a to noise level ^b |
| Example: 1.8 GHz | | | 143 dB nominal, log averaged, 1 Hz RBW, IF Gain = Low, IF Gain Offset = 0 dB |

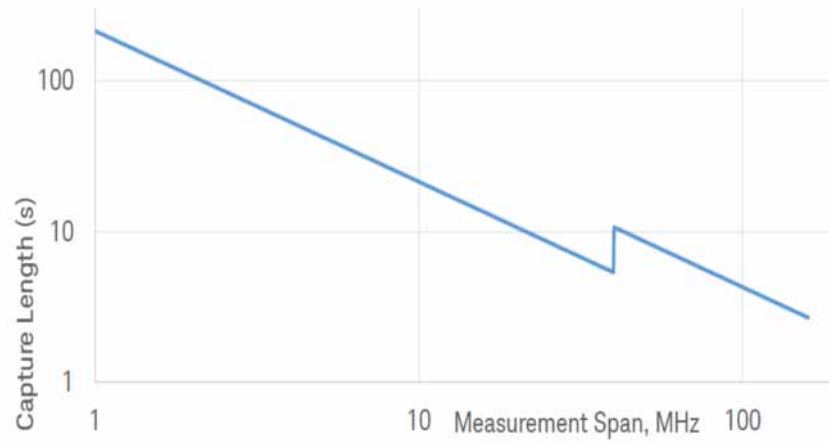
- For the clipping level, see the table above, "Full Scale." Note that the clipping level is not a warranted specification, and has particularly high uncertainty at high microwave frequencies.
- The noise level is specified in the table above, "Displayed Average Noise Level." Please consider these details and additional information: DANL is, by Keysight and industry practice, specified with log averaging, which reduces the measured noise level by 2.51 dB. It is specified for a 1 Hz resolution bandwidth, which will nominally have a noise bandwidth of 1.056 Hz. Therefore, the noise density is 2.27 dB above the DANL. Please note that the signal-to-noise ratio can be further improved by using negative settings of IF Gain Offset.

Data Acquisition

| Description | Specifications | | | | Supplemental Information |
|--------------------------------|-------------------------------|------------|------------------------------|------------|--|
| Time Record Length | | | | | |
| IQ Analyzer | 8,000,000 IQ sample pairs | | | | Waveform measurement ^a |
| Advanced Tools | | | | | 89600 VSA software or Fast Capture ^b |
| | Data Packing | | | | |
| Length (IQ sample pairs) | 32-bit | | 64-bit | | |
| Standard | 536 MSa (2 ²⁹ Sa) | | 268 MSa (2 ²⁸ Sa) | | 2 GB total memory ^c |
| <i>Option DP4</i> | 1073 MSa (2 ³⁰ Sa) | | 536 MSa (2 ²⁹ Sa) | | 4 GB total memory |
| Maximum IQ Capture Time | Data Packing | | | | |
| (89600 VSA and Fast Capture) | 32-bit | | 64-bit | | Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs) ^d |
| | Standard | <i>DP4</i> | Standard | <i>DP4</i> | |
| 10 MHz IFBW | 42.94 s | 85.89 s | 21.47 s | 42.94 s | |
| 25 MHz IFBW | 17.17 s | 34.35 s | 8.58 s | 17.17 s | |
| 40 MHz IFBW | 10.73 s | 21.47 s | 5.36 s | 10.73 s | |
| 85 MHz IFBW | 5.05 s | 10.10 s | 2.53 s | 5.05 s | |
| 160 MHz IFBW | 2.68 s | 5.36 s | 1.34 s | 2.68 s | |
| Sample Rate (IQ Pairs) | 1.25 × IFBW | | | | |
| ADC Resolution | 14 bits | | | | |

- This can also be accessed with the remote programming command of "read:wav()?".
- This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
- For instruments without *Option DP4*, instruments that shipped with S/N prefix <MY5608.
- For example, using 32-bit data packing with *Option DP4* at 10 MHz IF bandwidth (IFBW), the Maximum Capture Time is calculated using the formula: "Max Capture Time = (2^{30})/(10 MHz \times 1.25)".

Capture Length versus Span, with Auto Bit Packing



Option B85/B1X - 85/160 MHz Analysis Bandwidth
Data Acquisition

6 Option B2X – 255 MHz Analysis Bandwidth

This chapter contains specifications for the *Option B2X* 255 MHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 255 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 255 MHz, whether by Auto selection (depending on Span) or manually.

| Specification Name | Information |
|---|---|
| IF Frequency Response | See specifications in this chapter. |
| IF Phase Linearity | See specifications in this chapter. |
| Spurious Responses | There are three effects of the use of Option B2X on spurious responses. Most of the warranted elements of the "Spurious Responses" on page 59 still apply without changes, modified to reflect the effect of Option B2X, is shown in its place in this chapter. The image responses part of that table have the same warranted limits, but apply at different frequencies as shown in the table. The "higher order RF spurs" line is slightly degraded. Also, spurious-free dynamic range specifications are given in this chapter, as well as IF Residuals. |
| Displayed Average Noise Level | See specifications in this chapter. |
| Third-Order Intermodulation | This bandwidth option can create additional TOI products to those that are created by other instrument circuitry. These products do not behave with typical analog third-order behavior, and thus cannot be specified in the same manner. Nominal performance statements are given in this chapter, but they cannot be expected to decrease as the cube of the voltage level of the signals. |
| Phase Noise | The performance of the analyzer will degrade by an unspecified extent when using wideband analysis. This extent is not substantial enough to justify statistical process control. |
| Absolute Amplitude Accuracy | Nominally 0.5 dB (for Band 0 through Band 3) or 0.8 dB (for Band 4) degradation from base instrument absolute amplitude accuracy. (Refer to "Absolute Amplitude Accuracy" on page 40.) |
| Frequency Range Over Which Specifications Apply | Specifications on this bandwidth only apply with center frequencies of 400 MHz and higher. |

Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| SFDR (Spurious-Free Dynamic Range) Anywhere within the analysis BW | | Test conditions ^a –78 dBc (nominal) |

a. Signal level is –6 dB relative to full scale at the center frequency. Verified in the full IF bandwidth.

Option B2X – 255 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | Specifications | | Supplemental Information | |
|---|-----------------|--------------------------|----------|---|----------|
| Spurious Responses: Residual and Image^a | | | | Preamp Off ^b ; Verification conditions ^c | |
| Residual Responses ^d | | | | –95 dBm (nominal) | |
| Image Responses | | | | | |
| Tuned Freq (f) | Excitation Freq | Mixer Level ^e | Response | Response (nominal) | |
| | | | | RF/ μ W | mmW |
| 10 MHz to 3.6 GHz | f+11100 MHz | –10 dBm | –80 dBc | –128 dBc | –123 dBc |
| 10 MHz to 3.6 GHz | f+1500 MHz | –10 dBm | –73 dBc | –94 dBc | –96 dBc |
| 3.6 to 13.6 GHz | f+1500 MHz | –10 dBm | –78 dBc | –95 dBc | –104 dBc |
| 13.6 to 17.1 GHz | f+1500 MHz | –10 dBm | –74 dBc | –95 dBc | –106 dBc |
| 17.1 to 22 GHz | f+1500 MHz | –10 dBm | –70 dBc | –88 dBc | –106 dBc |
| 22 to 26.5 GHz | f+1500 MHz | –10 dBm | –66 dBc | –85 dBc | –100 dBc |
| 26.5 to 34.5 GHz | f+1500 MHz | –30 dBm | –60 dBc | | –100 dBc |
| 34.5 to 42 GHz | f+1500 MHz | –30 dBm | –57 dBc | | –82 dBc |
| 42 to 50 GHz | f+1500 MHz | –30 dBm | | | –78 dBc |

- Preselector enabled for frequencies >3.6 GHz.
- The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation – Preamp Gain
- Verified in the full IF width.
- Input terminated, 0 dB input attenuation.
- Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than –12 dBm if necessary to avoid ADC overload.

Option B2X – 255 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specifications | | Supplemental Information | |
|---|--------------------------------|---|---|------------|
| Spurious Responses: Other^a | | | Preamp Off ^b ; Verification conditions ^c | |
| | Mixer Level^d | Response | Response (nominal) | |
| | | | RF/μW | mmW |
| First RF Order ^e (f \geq 10 MHz from carrier) | | | | |
| Carrier Frequency \leq 26.5 GHz | -10 dBm | $-80 \text{ dBc} + 20 \times \log(N^f)$ | -111 dBc | -107 dBc |
| Carrier Frequency $>$ 26.5 GHz | -10 dBm | | | -94 dBc |
| Higher RF Order ^g (f \geq 10 MHz from carrier) | | | | |
| Carrier Frequency \leq 26.5 GHz | -40 dBm | $-78 \text{ dBc} + 20 \times \log(N^f)$ | -97 dBc | -96 dBc |
| Carrier Frequency $>$ 26.5 GHz | -40 dBm | | | -94 dBc |
| LO-Related Spurious Response (Offset from carrier 200 Hz to 10 MHz) | -10 dBm | $-68 \text{ dBc}^h + 20 \times \log(N^f)$ | | |
| Close-in Sidebands Spurious Responses (LO Related, offset $<$ 200 Hz) | | | $-73 \text{ dBc}^h + 20 \times \log(N^f)$ (nominal) | |

- Preselector enabled for frequencies $>$ 3.6 GHz.
- The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation – Preamp Gain
- Verified in the full IF width.
- Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than -12 dBm if necessary to avoid ADC overload.
- With first RF order spurious products, the indicated frequency will change at the same rate as the input, with higher order, the indicated frequency will change at a rate faster than the input.
- N is the LO multiplication factor.
- RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
- Nominally -40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.

Option B2X – 255 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|---------------------------------------|----------------|---|
| IF Residual Responses | | Relative to full scale; see the Full Scale table for details. |
| Band 0 | | –110 dBFS (nominal) |
| Band 1, Preselector Bypassed (MPB on) | | –108 dBFS (nominal) |

| Description | Specifications | Supplemental Information |
|--|----------------------------------|---|
| IF Frequency Response^a | | Modes above 18 GHz ^b Test conditions ^c |
| Center Freq (GHz) | Span (MHz) | Preselector |
| Typical | RMS (nominal)^d | |
| ≥ 0.4, < 3.6 | ≤255 | n/a |
| ±0.75 dB | ±0.3 dB | 0.1 dB |
| > 3.6, ≤ 8.4 | ≤255 | Off ^e |
| ±0.85 dB | ±0.34 dB | 0.1 dB |
| > 8.4, ≤ 26.5 | ≤255 | Off ^e |
| ±0.6 dB (nominal) | ±0.2 dB | 0.2 dB |
| > 26.5 | ≤255 | Off ^e |
| ±0.8 dB (nominal) | 0.2 dB | |
| > 3.6, ≤ 50 | ≤255 | On |
| See footnote ^f | | |

- The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF pass-band effects.
- Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- Verified in the full IF bandwidth.
- The listed performance is the rms of the amplitude deviation from the mean amplitude response of a span/CF combination. 50% of the combinations of prototype instruments, center frequencies and spans had performance better than the listed values.
- Standard *Option MPB* is enabled.
- The passband shape will be greatly affected by the preselector. See [Preselector Bandwidth on page 32](#).

Option B2X – 255 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | | Specifications | Supplemental Information | |
|------------------------------|-----------------------|--------------------|----------------|---|----------------------------------|
| IF Phase Linearity | | | | Deviation from mean phase linearity Freq <i>Option 526</i> only: Modes above 18 GHz ^a | |
| Center Freq (GHz) | Span (MHz) | Preselector | | Peak-to-peak (nominal) | RMS (nominal)^b |
| ≥ 0.03, < 3.6 | ≤255 | n/a | | 3° | 0.6° |
| ≥ 3.6, ≤ 26.5 | ≤255 | Off ^c | | 2° | 0.5° |
| ≥ 26.5 | ≤255 | Off ^c | | 4° | 0.8° |

- Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- The listed performance is the rms of the phase deviation relative to the mean phase deviation from a linear phase condition, where the rms is computed across the span shown.
- Standard *Option MPB* is enabled.

Option B2X – 255 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specification | Supplemental Information |
|---|---------------|--|
| Full Scale (ADC Clipping) with <i>Option EP0</i>^a | | |
| Default settings, signal at CF | | |
| (IF Gain = Low; IF Gain Offset = 0 dB) | | Mixer level^b (nominal) |
| | | RF/μW mmW |
| Band 0 | | 3 dBm2 dBm |
| Band 1 through 2 | | 4 dBm3 dBm |
| Band 3 through 4 | | 1 dBm0 dBm |
| Band 5 through 6 | | –11 dBm |
| High Gain setting, signal at CF | | Mixer level ^b (nominal), subject to gain limitations ^c |
| (IF Gain = High; IF Gain Offset = 0 dB) | | |
| Band 0 | | –4 dBm–3 dBm |
| Band 1 through 2 | | 2.5 dBm–6 dBm |
| Band 3 through 4 | | 1 dBm–9 dBm |
| Band 5 through 6 | | –11 dBm |
| IF Gain Offset ≠ 0 dB, signal at CF | | See formula ^d , subject to gain limitations ^c |
| Effect of signal frequency ≠ CF | | up to ±4 dB (nominal) |

- This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
- Mixer level is signal level minus input attenuation.
- The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
- The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Option B2X – 255 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specification | Supplemental Information |
|--|---------------|---|
| Full Scale (ADC Clipping) - Full Bypass Path^a | | |
| Default settings, signal at CF (IF Gain = Low; IF Gain Offset = 0 dB) | | Mixer level^b (nominal) RF/μW mmW |
| Band 0 | | N/A |
| Band 1 through 2 | | 3 dBm |
| Band 3 through 4 | | 2 dBm |
| Band 5 through 6 | | N/A |
| High Gain setting, signal at CF (IF Gain = High; IF Gain Offset = 0 dB) | | Mixer level ^b (nominal), subject to gain limitations ^c |
| Band 0 | | N/A |
| Band 1 through 2 | | −6 dBm |
| Band 3 through 4 | | −6 dBm |
| Band 5 through 6 | | N/A |
| IF Gain Offset \neq 0 dB, signal at CF | | See formula ^d , subject to gain limitations ^c |
| Effect of signal frequency \neq CF | | up to ± 4 dB (nominal) |

- This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
- Mixer level is signal level minus input attenuation.
- The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
- The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Option B2X - 255 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Third Order Intermodulation Distortion^{ab} | | Two tones of equal level 1 MHz tone separation Each tone -23 dB relative to full scale (ADC clipping) IF Gain = High IF Gain Offset = 0 dB Preselector Bypassed (MPB on) in Bands 1 through 6 |
| Band 0 | | -85 dBc (nominal) |
| Band 1 through 4 | | -85 dBc (nominal) |
| Band 5 through 6 | | -80 dBc (nominal) |

- a. Most applications of this wideband IF will have their dynamic range limited by the noise of the IF. In cases where TOI is relevant, wide-band IFs usually have distortion products that, unlike mixers and traditional signal analyzer signal paths, behave chaotically with drive level, so that reducing the mixer level does not reduce the distortion products. In this IF, distortion performance variation with drive level behaves surprisingly much like traditional signal paths. The distortion contributions for wideband signals such as OFDM signals is best estimated from the TOI products at total CW signal power levels near the average total OFDM power level. This power level must be well below the clipping level to prevent clipping distortion in the IF. So a test level of two tones each at -23 dB is useful for estimating the contribution of TOI to a typical measurement of a wide-band OFDM signal, which will usually be quite far below the IF noise contribution.
- b. Intercept = TOI = third order intercept. The TOI equivalent can be determined from the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The mixer tone level can be calculated using the information in the Full Scale table in this chapter.

| Description | | Specifications | | Supplemental Information |
|--|-------------------------------|----------------------------------|-----------------------|---|
| Noise Density with Preselector Bypass | | | | 0 dB attenuation; Preselector bypassed (MPB on) above Band 0; center of IF bandwidth ^a |
| Band | Freq (GHz)^b | IF Gain^c = Low | IF Gain = High | |
| 0 | 1.80 | -144 dBm/Hz | -145 dBm/Hz | |
| 1 | 6.00 | -141 dBm/Hz | -141 dBm/Hz | |
| 2 | 10.80 | -140 dBm/Hz | -140 dBm/Hz | |
| 3 | 15.15 | -137 dBm/Hz | -137 dBm/Hz | |
| 4 | 21.80 | -135 dBm/Hz | -135 dBm/Hz | |
| 5 | 30.50 | -130 dBm/Hz | -130 dBm/Hz | |
| 6 | 42.25 | -130 dBm/Hz | -130 dBm/Hz | |

- a. The noise level in the IF will change for frequencies away from the center of the IF. The IF part of the total noise is nominally 2.5 dB worse at the worst frequency in the IF bandwidth. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.
- b. Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.

Option B2X - 255 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

- c. IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain, giving better noise levels but a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

| Description | | Specifications | | Supplemental Information | | |
|----------------------------------|-------------------------|----------------------|-----------------|---|---------------|-------------|
| Noise Density - Full Bypass Path | | Option 503, 513, 526 | Option 544, 550 | 0 dB attenuation; Preselector bypassed (MPB on) above Band 0; center of IF bandwidth ^a | | |
| Band | Freq (GHz) ^b | | | IF Gain ^c = Low | IF Gain= High | |
| 1 | 6.00 | | X | | −146 dBm/Hz | −152 dBm/Hz |
| 1 | 6.00 | | | X | −148 dBm/Hz | −155 dBm/Hz |
| 2 | 10.80 | | X | | −146 dBm/Hz | −152 dBm/Hz |
| 2 | 10.80 | | | X | −147 dBm/Hz | −155 dBm/Hz |
| 3 | 15.15 | | X | | −146 dBm/Hz | −149 dBm/Hz |
| 3 | 15.15 | | | X | −148 dBm/Hz | −155 dBm/Hz |
| 4 | 21.80 | | X | | −147 dBm/Hz | −150 dBm/Hz |
| 4 | 21.80 | | | X | −148 dBm/Hz | −153 dBm/Hz |
| 5 | 30.50 | | | X | −148 dBm/Hz | −153 dBm/Hz |
| 6 | 42.25 | | | X | −147 dBm/Hz | −149 dBm/Hz |

- a. The noise level in the IF will change for frequencies away from the center of the IF. The IF part of the total noise is nominally 2.5 dB worse at the worst frequency in the IF bandwidth. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.
- b. Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
- c. IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain, giving better noise levels but a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

| Description | Specification | Supplemental Information |
|--|---------------|--|
| Signal to Noise Ratio Example: 1.8 GHz | | Ratio of clipping level ^a to noise level ^b 148 dB nominal, log averaged, 1 Hz RBW, IF Gain = Low, IF Gain Offset = 0 dB |

- a. For the clipping level, see the table above, "Full Scale." Note that the clipping level is not a warranted specification, and has particularly high uncertainty at high microwave frequencies.

Option B2X - 255 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

- b. The noise level is specified in the table above, "Displayed Average Noise Level." Please consider these details and additional information: DANL is, by Keysight and industry practice, specified with log averaging, which reduces the measured noise level by 2.51 dB. It is specified for a 1 Hz resolution bandwidth, which will nominally have a noise bandwidth of 1.056 Hz. Therefore, the noise density in dBm/Hz units is 2.27 dB above the DANL in dBm (1 Hz RBW) units. Please note that the signal-to-noise ratio can be further improved by using negative settings of IF Gain Offset.

Data Acquisition

| Description | Specifications | | | | Supplemental Information |
|--------------------------------|---|------------|------------------------|------------|--|
| Time Record Length | | | | | |
| IQ Analyzer | 8,000,000 IQ sample pairs | | | | Waveform measurement ^a |
| Advanced Tools | | | | | 89600 VSA software or Fast Capture ^b |
| | Data Packing | | | | |
| Length (IQ sample pairs) | 32-bit | | 64-bit | | |
| Standard | 536 MSa (2^{29} Sa) | | 268 MSa (2^{28} Sa) | | 2 GB total memory ^c |
| <i>Option DP4</i> | 1073 MSa (2^{30} Sa) | | 536 MSa (2^{29} Sa) | | 4 GB total memory |
| Maximum IQ Capture Time | Data Packing | | | | |
| (89600 VSA and Fast Capture) | 32-bit | | 64-bit | | Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs) ^d |
| | Standard | <i>DP4</i> | Standard | <i>DP4</i> | |
| 10 MHz IFBW | 42.94 s | 85.89 s | 21.47 s | 42.94 s | |
| 25 MHz IFBW | 17.17 s | 34.35s | 8.58 s | 17.17 s | |
| 40 MHz IFBW | 10.73 s | 21.47 s | 5.36 s | 10.73 s | |
| 240 MHz IFBW | 1.78 s | 3.57 s | 0.89 s | 1.78 s | |
| 255 MHz IFBW | 1.78 s | 3.57 s | 0.89 s | 1.78 s | |
| Sample Rate (IQ Pairs) | Minimum of $(1.25 \times \text{IFBW}, 300 \text{ MSa/s})$ | | | | |
| ADC Resolution | 14 bits | | | | |

- This can also be accessed with the remote programming command of "read:wav0?".
- This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
- For instruments without *Option DP4*, instruments that shipped with S/N prefix <MY5608.
- For example, using 32-bit data packing with *Option DP4* at 10 MHz IF bandwidth (IFBW), the Maximum Capture Time is calculated using the formula: "Max Capture Time = $(2^{30})/(10 \text{ MHz} \times 1.25)$ ".

Option B2X – 255 MHz Analysis Bandwidth
Data Acquisition

7 Option B5X – 510 MHz Analysis Bandwidth

This chapter contains specifications for the *Option B5X* 510 MHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 510 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 510 MHz, whether by Auto selection (depending on Span) or manually.

| Specification Name | Information |
|---|--|
| IF Frequency Response | See specifications in this chapter. |
| IF Phase Linearity | See specifications in this chapter. |
| Spurious Responses | There are three effects of the use of Option B5X on spurious responses. Most of the warranted elements of the "Spurious Responses" on page 59 still apply without changes, but the revised version of the table on page 45, modified to reflect the effect of Option B5X, is shown in its place in this chapter. The image responses part of that table have the same warranted limits, but apply at different frequencies as shown in the table. The "higher order RF spurs" line is slightly degraded. Also, spurious-free dynamic range specifications are given in this chapter, as well as IF Residuals. |
| Displayed Average Noise Level | See specifications in this chapter. |
| Third-Order Intermodulation | This bandwidth option can create additional TOI products to those that are created by other instrument circuitry. These products do not behave with typical analog third-order behavior, and thus cannot be specified in the same manner. Nominal performance statements are given in this chapter, but they cannot be expected to decrease as the cube of the voltage level of the signals. |
| Phase Noise | The performance of the analyzer will degrade by an unspecified extent when using wideband analysis. This extent is not substantial enough to justify statistical process control. |
| Absolute Amplitude Accuracy | Nominally 0.5 dB (for Band 0 through Band 3) or 0.8 dB (for Band 4) degradation from base instrument absolute amplitude accuracy. (Refer to Absolute Amplitude Accuracy on page 40.) |
| Frequency Range Over Which Specifications Apply | Specifications on this bandwidth only apply with center frequencies of 600 MHz and higher. |

Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| SFDR (Spurious-Free Dynamic Range) Anywhere within the analysis bandwidth | | Test conditions ^a -78 dBc (nominal) |

a. Signal level is -6 dB relative to full scale at the center frequency. Verified in the full IF width.

Option B5X – 510 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | Specifications | | Supplemental Information | |
|---|-----------------|--------------------------|----------|--|----------|
| Spurious Responses: Residual and Image^a | | | | Preamp Off ^b , Verification conditions ^c | |
| Residual Responses ^d | | | | –100 dBm (nominal) | |
| Image Responses | | | | | |
| Tuned Freq (f) | Excitation Freq | Mixer Level ^e | Response | Response (nominal) | |
| | | | | RF/ μ W | mmW |
| 10 MHz to 3.6 GHz | f+11354 MHz | –10 dBm | –80 dBc | –105 dBc | –106 dBc |
| 10 MHz to 3.6 GHz | f+1754 MHz | –10 dBm | –80 dBc | –105 dBc | –104 dBc |
| 3.6 to 13.6 GHz | f+1754 MHz | –10 dBm | –78 dBc | –96 dBc | –100 dBc |
| 13.6 to 17.1 GHz | f+1754 MHz | –10 dBm | –74 dBc | –94 dBc | –101 dBc |
| 17.1 to 22 GHz | f+1754 MHz | –10 dBm | –70 dBc | –88 dBc | –98 dBc |
| 22 to 26.5 GHz | f+1754 MHz | –10 dBm | –66 dBc | –85 dBc | –96 dBc |
| 26.5 to 34.5 GHz | f+1754 MHz | –30 dBm | –70 dBc | | –79 dBc |
| 34.5 to 42 GHz | f+1754 MHz | –30 dBm | –61 dBc | | –73 dBc |
| 42 to 50 GHz | f+1754 MHz | –30 dBm | | | –72 dBc |

- Preselector enabled for frequencies >3.6 GHz.
- The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation – Preamp Gain
- Verified in the full IF width.
- Input terminated, 0 dB input attenuation.
- Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than –12 dBm if necessary to avoid ADC overload.

Option B5X - 510 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|--|--------------------------------|---|
| Spurious Responses: Other^a | | Preamp Off ^b , Verification conditions ^c |
| | Mixer Level^d | Response |
| | | Response (nominal) RF/μW mmW |
| First RF Order ^e (f \geq 10 MHz from carrier) | | |
| Carrier Frequency \leq 26.5 GHz | -10 dBm | $-80 \text{ dBc} + 20 \times \log(N^f)$ |
| Carrier Frequency $>$ 26.5 GHz | -30 dBm | |
| Higher RF Order ^g (f \geq 10 MHz from carrier) | | |
| Carrier Frequency \leq 26.5 GHz | -40 dBm | See footnote ^h |
| Carrier Frequency $>$ 26.5 GHz | -30 dBm | See footnote ^h |
| LO-Related Spurious Response (Offset from carrier 200 Hz to 10 MHz) | -10 dBm | $-68 \text{ dBc}^i + 20 \times \log(N^f)$ |
| Close-in Sidebands Spurious Responses (LO Related, offset $<$ 200 Hz) | | $-73 \text{ dBc}^i + 20 \times \log(N^f)$ |

- Preselector enabled for frequencies $>$ 3.6 GHz.
- The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation – Preamp Gain
- Verified in the full IF width.
- Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than -12 dBm if necessary to avoid ADC overload.
- With first RF order spurious products, the indicated frequency will change at the same rate as the input, with higher order, the indicated frequency will change at a rate faster than the input.
- N is the LO multiplication factor.
- RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
- At the designated test conditions this spur is nominally below the noise floor and cannot be measured.
- Nominally -40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.

| Description | Specifications | Supplemental Information |
|---------------------------------------|----------------|---|
| IF Residual Responses | | Relative to full scale; see the Full Scale table for details. |
| Band 0 | | -104 dBFS (nominal) |
| Band 1, Preselector Bypassed (MPB on) | | -103 dBFS (nominal) |

Option B5X - 510 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | | Specifications | Supplemental Information | |
|--|-------------------|--------------------|----------------|---|----------------------------------|
| IF Frequency Response^a | | | | Modes above 18 GHz ^b Test conditions ^c | |
| Center Freq (GHz) | Span (MHz) | Preselector | | Typical | RMS (nominal)^d |
| ≥ 0.6, < 3.6 | ≤ 500 | n/a | ±1.0 dB | ±0.41 dB | 0.06 dB |
| ≥ 0.6, < 3.6 | ≤ 510 | n/a | | See note ^e | 0.06 dB |
| ≥ 3.6, ≤ 8.4 | ≤ 500 | Off ^f | ±1.25 dB | ±0.42 dB | 0.3 dB |
| ≥ 3.6, ≤ 8.4 | ≤ 510 | Off ^f | | ±0.3 dB (nominal) ^e | |
| ≥ 8.4, ≤ 26.5 | ≤ 510 | Off ^f | | ±0.8 dB (nominal) | |
| ≥ 26.5 | ≤ 510 | Off ^f | | | ±1.0 dB |
| ≥ 3.6, ≤ 26.5 | ≤ 510 | On | | See note ^g | |

- The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF pass-band effects.
- Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to -0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- Verified in the full IF bandwidth.
- The listed performance is the rms of the amplitude deviation from the mean amplitude response of a span/CF combination. 50% of the combinations of prototype instruments, center frequencies and spans had performance better than the listed values.
- IF flatness nominally degrades by 15% in the 510 MHz span setting relative to the 500 MHz span.
- Standard *Option MPB* is enabled.
- The passband shape will be greatly affected by the preselector. See **"Preselector Bandwidth" on page 32**.

Option B5X - 510 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | | Specifications | Supplemental Information | |
|---------------------------|-------------------|--------------------|----------------|---|----------------------------------|
| IF Phase Linearity | | | | Deviation from mean phase linearity Freq <i>Option 526</i> only: Modes above 18 GHz ^a | |
| Center Freq (GHz) | Span (MHz) | Preselector | | Peak-to-peak (nominal) | RMS (nominal)^b |
| ≥ 0.04, < 3.6 | ≤510 | n/a | | 5° | 1.0° |
| ≥ 3.6, < 26.5 | ≤510 | Off ^c | | 6° | 1.4° |
| ≥ 26.5 | ≤510 | Off ^c | | 7° | 1.6° |

- Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to -0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
- The listed performance is the rms of the phase deviation relative to the mean phase deviation from a linear phase condition, where the rms is computed across the span shown.
- Standard *Option MPB* is enabled.

Option B5X - 510 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specification | Supplemental Information |
|--|---------------|--|
| Full Scale (ADC Clipping) with Option EPO^a | | |
| Default settings, signal at CF (IF Gain = Low; IF Gain Offset = 0 dB) | | Mixer level ^b (nominal) |
| | | RF/μW mmW |
| Band 0 | | +2 dBm 2 dBm |
| Band 1 through 2 | | +3 dBm 3 dBm |
| Band 3 through 4 | | +1 dBm 0 dBm |
| Band 5 through 6 | | -11 dBm |
| High Gain setting, signal at CF (IF Gain = High; IF Gain Offset = 0 dB) | | Mixer level ^b (nominal), subject to gain limitations ^c |
| | | RF/mW mmW |
| Band 0 | | -3.5 dBm -3 dBm |
| Band 1 through 2 | | -1 dBm -9 dBm |
| Band 3 through 4 | | +1 dBm -13 dBm |
| Band 5 through 6 | | -11 dBm |
| IF Gain Offset \neq 0 dB, signal at CF | | See formula ^d , subject to gain limitations ^c |
| Effect of signal frequency \neq CF | | up to ± 4 dB (nominal) |

- This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
- Mixer level is signal level minus input attenuation.
- The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
- The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Option B5X - 510 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specification | Supplemental Information |
|---|---------------|--|
| Full Scale (ADC Clipping) - Full Bypass Path^a | | |
| Default settings, signal at CF | | |
| (IF Gain = Low; IF Gain Offset = 0 dB) | | Mixer level^b (nominal) |
| | | RF/μW mmW |
| Band 0 | | N/A |
| Band 1 through 2 | | 3 dBm |
| Band 3 through 4 | | 2 dBm |
| Band 5 through 6 | | N/A |
| High Gain setting, signal at CF | | Mixer level ^b (nominal), subject to gain limitations ^c |
| (IF Gain = High; IF Gain Offset = 0 dB) | | |
| Band 0 | | N/A |
| Band 1 through 2 | | −7 dBm |
| Band 3 through 4 | | −9 dBm |
| Band 5 through 6 | | N/A |
| IF Gain Offset \neq 0 dB, signal at CF | | See formula ^d , subject to gain limitations ^c |
| Effect of signal frequency \neq CF | | up to ± 4 dB (nominal) |

- This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
- Mixer level is signal level minus input attenuation.
- The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
- The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Option B5X - 510 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Third Order Intermodulation Distortion^{ab} | | Two tones of equal level 1 MHz tone separation Each tone -23 dB relative to full scale (ADC clipping) IF Gain = High IF Gain Offset = 0 dB Preselector Bypassed (MPB on) in Bands 1 through 6 |
| Band 0 | | -85 dBc (nominal) |
| Band 1 through 2 | | -82 dBc (nominal) |
| Band 3 through 4 | | -80 dBc (nominal) |
| Band 5 through 6 | | -79 dBc (nominal) |

- a. Most applications of this wideband IF will have their dynamic range limited by the noise of the IF. In cases where TOI is relevant, wide-band IFs usually have distortion products that, unlike mixers and traditional signal analyzer signal paths, behave chaotically with drive level, so that reducing the mixer level does not reduce the distortion products. In this IF, distortion performance variation with drive level behaves surprisingly much like traditional signal paths. The distortion contributions for wideband signals such as OFDM signals is best estimated from the TOI products at total CW signal power levels near the average total OFDM power level. This power level must be well below the clipping level to prevent clipping distortion in the IF. So a test level of two tones each at -23 dB is useful for estimating the contribution of TOI to a typical measurement of a wide-band OFDM signal, which will usually be quite far below the IF noise contribution.
- b. Intercept = TOI = third order intercept. The TOI equivalent can be determined from the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The mixer tone level can be calculated using the information in the Full Scale table in this chapter.

Option B5X - 510 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | Specifications | | Supplemental Information |
|--|-------------------------------|----------------------------------|-----------------------|---|
| Noise Density with Preselector Bypass | | | | 0 dB attenuation; Preselector bypassed (MPB on) above Band 0; center of IF bandwidth ^a |
| Band | Freq (GHz)^b | IF Gain^c = Low | IF Gain = High | |
| 0 | 1.80 | -144 dBm/Hz | -145 dBm/Hz | |
| 1 | 6.0 | -140 dBm/Hz | -142 dBm/Hz | |
| 2 | 10.80 | -140 dBm/Hz | -141 dBm/Hz | |
| 3 | 15.15 | -137 dBm/Hz | -137 dBm/Hz | |
| 4 | 21.80 | -135 dBm/Hz | -135 dBm/Hz | |
| 5 | 30.5 | -130 dBm/Hz | -130 dBm/Hz | |
| 6 | 42.25 | -130 dBm/Hz | -130 dBm/Hz | |

- The noise level in the IF will change for frequencies away from the center of the IF. The IF part of the total noise varies significantly and nonmonotonically with IF frequency. At the worst IF frequency, which is at one edge of the bandwidth, it is nominally 5 dB higher. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.
- Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
- IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain, giving better noise levels but a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

Option B5X - 510 MHz Analysis Bandwidth
Other Analysis Bandwidth Specifications

| Description | | Specifications | | Supplemental Information | | |
|----------------------------------|-------------------------|----------------------|-----------------|---|---------------|-------------|
| Noise Density - Full Bypass Path | | Option 503, 513, 526 | | 0 dB attenuation; Preselector bypassed (MPB on) above Band 0; center of IF bandwidth ^a | | |
| | | | Option 544, 550 | Nominal | | |
| Band | Freq (GHz) ^b | | | IF Gain ^c = Low | IF Gain= High | |
| 1 | 6.00 | | X | | −146 dBm/Hz | −153 dBm/Hz |
| 1 | 6.00 | | | X | −147 dBm/Hz | −155 dBm/Hz |
| 2 | 10.80 | | X | | −146 dBm/Hz | −152 dBm/Hz |
| 2 | 10.80 | | | X | −147 dBm/Hz | −154 dBm/Hz |
| 3 | 15.15 | | X | | −147 dBm/Hz | −151 dBm/Hz |
| 3 | 15.15 | | | X | −148 dBm/Hz | −155 dBm/Hz |
| 4 | 21.80 | | X | | −146 dBm/Hz | −151 dBm/Hz |
| 4 | 21.80 | | | X | −147 dBm/Hz | −153 dBm/Hz |
| 5 | 30.50 | | | X | −147 dBm/Hz | −152 dBm/Hz |
| 6 | 42.25 | | | X | −146 dBm/Hz | −150 dBm/Hz |

- The noise level in the IF will change for frequencies away from the center of the IF. The IF part of the total noise is nominally 2.5 dB worse at the worst frequency in the IF bandwidth. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.
- Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
- IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain, giving better noise levels but a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

| Description | Specification | Supplemental Information |
|------------------------------|---------------|--|
| Signal to Noise Ratio | | Ratio of clipping level ^a to noise level ^b |
| Example: 1.8 GHz | | 148 dB nominal, log averaged, 1 Hz RBW, IF Gain = Low, IF Gain Offset = 0 dB |

- For the clipping level, see the table above, "Full Scale." Note that the clipping level is not a warranted specification, and has particularly high uncertainty at high microwave frequencies.
- The noise level is specified in the table above, "Displayed Average Noise Level." Please consider these details and additional information: DANL is, by Keysight and industry practice, specified with log averaging, which reduces the measured noise level by 2.51 dB. It is specified for a 1 Hz resolution bandwidth, which will nominally have a noise bandwidth of 1.056 Hz. Therefore, the noise density in dBm/Hz units is 2.27 dB above the DANL in dBm (1 Hz RBW). Please note that the signal-to-noise ratio can be further improved by using negative settings of IF Gain Offset.

Data Acquisition

| Description | Specifications | | | | Supplemental Information |
|--|-------------------------------------|------------|--------------------------------|---------------|--|
| Time Record Length | | | | | |
| IQ Analyzer | 8,000,000 IQ sample pairs | | | | Waveform measurement ^a |
| Advanced Tools | | | | | 89600 VSA software or Fast Capture ^b |
| | Data Packing | | | | |
| Length (IQ sample pairs) | 32-bit | | | 64-bit | |
| Standard | | | | | |
| IFBW ≤255.176 MHz | 536 MSa (2 ²⁹ Sa) | | 268 MSa (2 ²⁸ Sa) | | 2 GB total memory ^c |
| IFBW >255.176 MHz | 1,073 MSa (2 ³⁰ Sa) | | 536 MSa (2 ²⁹ Sa) | | 4 GB total memory ^c |
| <i>Option DP4</i> | | | | | |
| IFBW ≤255.176 MHz | 1,073 MSa (2 ³⁰ Sa) | | 536 MSa (2 ²⁹ Sa) | | 4 GB total memory |
| IFBW >255.176 MHz | 2,147 MSa (2 ³¹ Sa) | | 1,073 MSa (2 ³⁰ Sa) | | 8 GB total memory |
| Maximum IQ Capture Time | Data Packing | | | | |
| (89600 VSA and Fast Capture ^b) | 32-bit | | | 64-bit | |
| | Standard | <i>DP4</i> | Standard | <i>DP4</i> | Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs) ^d |
| 10 MHz IFBW | 42.94 s | 85.88 s | 21.47 s | 42.94 s | |
| 25 MHz IFBW | 17.17 s | 34.34 s | 8.58 s | 17.17 s | |
| 40 MHz IFBW | 10.73 s | 21.46 s | 5.36 s | 10.73 s | |
| 240 MHz IFBW | 1.78 s | 3.56 s | 0.89 s | 1.78 s | |
| 255 MHz IFBW | 1.78 s | 3.56 s | 0.89 s | 1.78 s | |
| 256 MHz IFBW | 3.35 s | 6.70 s | 1.67 s | 3.35 s | |
| 480 MHz IFBW | 1.78 s | 3.56 s | 0.89 s | 1.78 s | |
| 510 MHz IFBW | 1.78 s | 3.56 s | 0.89 s | 1.78 s | |
| Sample Rate (IQ Pairs) | | | | | |
| IFBW ≤255.176 MHz | Minimum of (1.25 × IFBW, 300 MSa/s) | | | | |
| IFBW >255.176 MHz | Minimum of (1.25 × IFBW, 600 MSa/s) | | | | |
| ADC Resolution | 14 bits | | | | |

- This can also be accessed with the remote programming command of "read:wav0?".
- This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
- For instruments without *Option DP4*, instruments that shipped with S/N prefix <MY5608.
- For example, using 32-bit data packing at 10 MHz IF bandwidth (IFBW) the Maximum Capture Time is calculated using the formula: "Max Capture Time = (2²⁹)/(10 MHz × 1.25)".

Option B5X - 510 MHz Analysis Bandwidth
Data Acquisition

8 Option FBP – Full Bypass Path

This chapter contains specifications for *Option FBP*, Full Bypass Path.

Full Bypass Path provides another signal path configuration in addition to the Standard path, Microwave Preselector Bypass, and Low Noise Path Enable.

Full Bypass Path allows better sensitivity through the signal path used above 3.6 GHz start frequency. When Full Bypass Path is enabled, BOTH the Preselector and the Low Band Switch are bypassed. With both these assemblies bypassed, there is less loss in the signal path improving instrument sensitivity.

Specifications Affected by Full Bypass Path

| Specification Name | Information |
|--|--|
| Displayed Average Noise Level | See specifications in this chapter. |
| IF Frequency Response and IF Phase Linearity | Not warranted, but nominally the same as “ IF Frequency Response ” on page 38 and “ IF Phase Linearity ” on page 39. Also see the associated "Analysis Bandwidth" chapter for any optional bandwidths. Note: Since <i>Option FBP</i> turns off the preselector, under the Preselector heading, use the values associated with the OFF notation. |
| Frequency Response | See specifications in this chapter. |
| VSWR | The magnitude of the mismatch over the range of frequencies will be very similar between FBP and non-FBP operation, but the details, such as the frequencies of the peaks and valleys, will shift. |
| Additional Spurious Responses | In addition to the “ Spurious Responses ” on page 59 of the core specifications, “ Additional Spurious Responses ” on page 169 of this chapter also apply. |
| Maximum Safe Input Levels | See specifications in this chapter. |

Other Specifications Affected by Full Bypass Path

| Description | Specifications | Supplemental Information |
|----------------------------------|--------------------|---|
| Maximum Safe Input Levels | | Limiter and Preselector are not in the signal path. |
| Average Total Power | | |
| Option 508, 513, 526 | +26 dBm (398.1 mW) | |
| Option 544 , 550 | +20 dBm (100 mW) | |
| DC Voltage | ±0.2 Vdc | |

| Description | Specifications | | Supplemental Information |
|--|----------------|---|---|
| Frequency Response (Maximum error relative to reference condition (50 MHz) Swept operation ^a Attenuation 10 dB) | | | Refer to the footnote for Band Overlaps on page 21 . |
| Option 544, or 550 (mmW) | | | |
| Option 508, 513, or 526 (RF/μW) | | | |
| | ↓ | ↓ | |
| | ▼ | ▼ | |
| 3.5 GHz to 8.4 GHz | x | x | 20 to 30°C Full range 95th Percentile (≈2σ) ±0.90 dB ±1.45 dB ±0.72 dB |
| 8.3 GHz to 13.6 GHz | x | x | ±1.01 dB ±1.57 dB ±0.83 dB |
| 13.5 GHz to 16.0 GHz | x | | ±1.26 dB ±1.91 dB ±0.92 dB |
| 16.0 GHz to 17.1 GHz | x | | ±1.33 dB ±3.04 dB ±1.19 dB |
| 13.5 GHz to 17.1 GHz | | x | ±1.26 dB ±1.91 dB ±0.88 dB |
| 17.0 GHz to 22.0 GHz | x | | ±1.29 dB ±2.01 dB ±0.94 dB |
| 17.0 GHz to 22.0 GHz | | x | ±1.29 dB ±2.30 dB ±1.06 dB |
| 22.0 GHz to 26.5 GHz | x | | ±1.49 dB ±2.37 dB ±1.11 dB |
| 22.0 GHz to 26.5 GHz | | x | ±1.49 dB ±2.37 dB ±1.15 dB |
| 26.4 GHz to 34.5 GHz | | x | ±1.63 dB ±2.60 dB ±1.40 dB |
| 34.4 GHz to 50.0 GHz | | x | ±3.00 dB ±3.95 dB ±2.31 dB |

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

Option FBP – Full Bypass Path
Other Specifications Affected by Full Bypass Path

| Description | | | Specifications | | Supplemental Information |
|--|---|---|-------------------|-------------------|--------------------------|
| Displayed Average Noise Level (DANL) Response | | | | | |
| <i>Option 544, or 550 (mmW)</i> | | | | | |
| <i>Option 508, 513, or 526 (RF/μW)</i> | | | | | |
| | | | 20 to 30°C | Full range | Nominal |
| | ↓ | ↓ | | | |
| 3.5 GHz to 13.6 GHz | x | | –152 dBm | –151 dBm | –156 dBm |
| 3.5 GHz to 13.6 GHz | | x | –154 dBm | –153 dBm | –158 dBm |
| 13.5 GHz to 17.1 GHz | x | | –150 dBm | –149 dBm | –153 dBm |
| 13.5 GHz to 17.1 GHz | | x | –153 dBm | –152 dBm | –156 dBm |
| 17.0 GHz to 22.5 GHz | x | | –149 dBm | –148 dBm | –153 dBm |
| 17.0 GHz to 22.5 GHz | | x | –152 dBm | –151 dBm | –155 dBm |
| 22.5 GHz to 26.5 GHz | x | | –147 dBm | –146 dBm | –151 dBm |
| 22.5 GHz to 26.5 GHz | | x | –151 dBm | –150 dBm | –153 dBm |
| 26.4 GHz to 34.0 GHz | | x | –151 dBm | –149 dBm | –153 dBm |
| 33.9 GHz to 46.0 GHz | | x | –147 dBm | –145 dBm | –151 dBm |
| 46.0 GHz to 50.0 GHz | | x | –145 dBm | –143 dBm | –149 dBm |

Option FBP – Full Bypass Path
Other Specifications Affected by Full Bypass Path

| Description | Specifications | Supplemental Information |
|--|----------------------------|---|
| Additional Spurious Responses^a | | |
| Tuned Frequency (f) | Excitation | |
| Image Response | | |
| 3.5 to 50 GHz | $f + fIF^b$ | 0 dBc (nominal), High Band Image Suppression is lost with Option FBP. |
| LO Harmonic and Subharmonic Responses | | |
| 3.5 to 8.4 GHz | $N(f + fIF) \pm fIF^b$ | –10 dBc (nominal), N = 2, 3 |
| 8.3 to 26.5 GHz | $[N(f + fIF)/2] \pm fIF^b$ | –10 dBc (nominal), N = 1, 3, 4 |
| 26.4 to 34.5 GHz | $[N(f + fIF)/2] \pm fIF^b$ | –10 dBc (nominal), N = 1, 2, 3, 5, 6, 7 |
| 34.4 to 50 GHz | $[N(f + fIF)/2] \pm fIF^b$ | –10 dBc (nominal), N = 1, 2, 3, 5, 6, 7, 9, 10 |
| Second Harmonic Response | | |
| 3.5 to 13.6 GHz | $f/2$ | –72 dBc (nominal) for –40 dBm mixer level |
| 13.5 to 34.5 GHz | $f/2$ | –68 dBc (nominal) for –40 dBm mixer level |
| 34.4 to 50 GHz | $f/2$ | –68 dBc (nominal) for –40 dBm mixer level |
| IF Feedthrough Response | | |
| 3.5 to 13.6 GHz | fIF^b | –100 dBc (nominal) |
| 13.5 to 50 GHz | fIF^b | –90 dBc (nominal) |

- a. Dominant spurious responses are described here. Generally, other *Option FBP*-specific spurious responses will be substantially lower than those listed here, but may exceed core specifications.
- b. $fIF = 322.5$ MHz except $fIF = 250$ MHz with *Option B40* and $fIF = 300$ MHz with *Option B85*, or *B1X* as well as $fIF = 750$ MHz with *Option B2X* and 877.1484375 MHz with *Option B5X*.

Option FBP - Full Bypass Path
Other Specifications Affected by Full Bypass Path

9 Option ALV – Log Video Out

This chapter contains specifications for Option ALV, Log Video Out.

Specifications Affected by Log Video Out

No other analyzer specifications are affected by the presence or use of this option. New specifications are given in the following pages.

Other Log Video Out Specifications

Aux IF Out Port

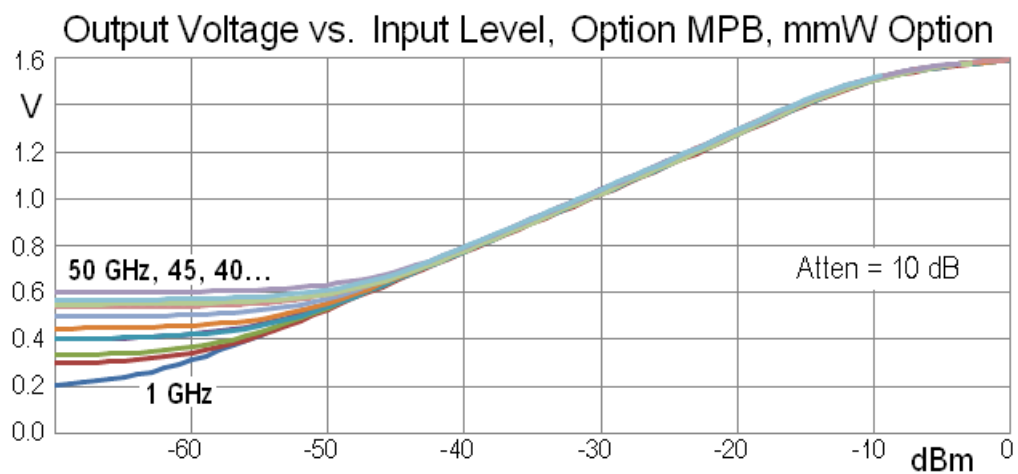
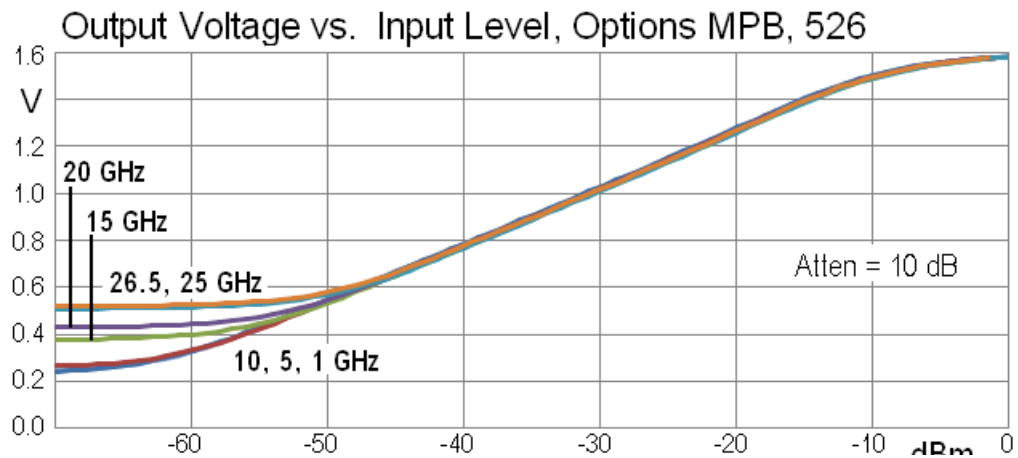
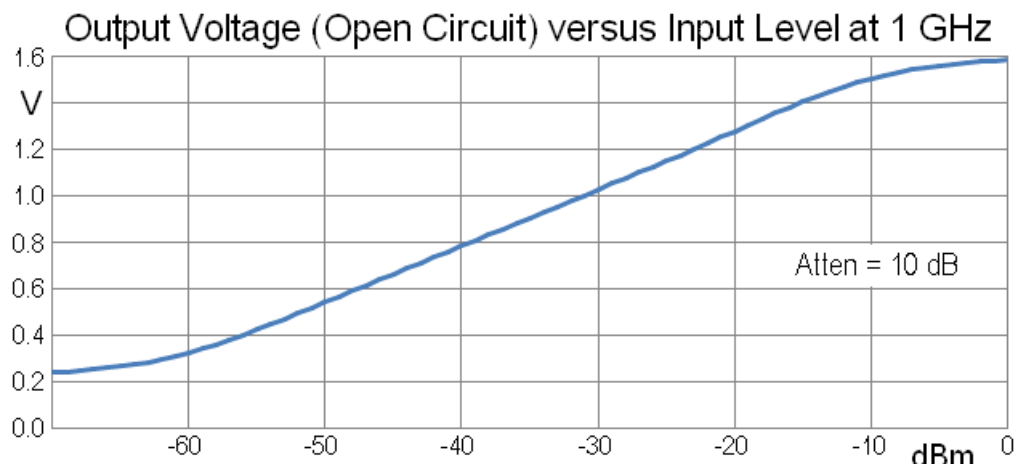
| Description | Specifications | Supplemental Information |
|-------------|----------------|---------------------------|
| Connector | SMA female | Shared with other options |
| Impedance | | 50 Ω (nominal) |

Fast Log Video Output

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Fast Log Video Output (Preselector bypassed <i>(Option MPB)</i> for Bands 1-4, Preamp Off) | | |
| Output voltage | | Open-circuit voltages shown |
| Maximum | | 1.6 V at -10 dBm ^a (nominal) |
| Slope | | 25 \pm 1 mV/dB (nominal) |
| Log Fidelity | | |
| Range | | 49 dB (nominal) with input frequency at 1 GHz ^b |
| Accuracy within Range | | \pm 1.0 dB (nominal) |
| Rise Time | | 15 ns (nominal) |
| Fall Time | | |
| Bands 1–4 with <i>Option MPB</i> | | 40 ns (nominal) |
| Other Cases | | Depends on bandwidth ^c |

- The signal level which gives an output corresponding to the high end of the log fidelity range, nominally -10 dBm at the mixer, has a band and frequency dependence that is the same as that given in the “Conversion Gain” entry in the specifications for **“Second IF Out” on page 195**.
- Refer to the next page for details.
- The bandwidth will be the same as for the **“Second IF Out” on page 195**. The bandwidth effects will dominate the fall time in high band with preselection.

Nominal Output Voltage (Open Circuit) versus Input Level [Plot]



10 Option BBA – Analog Baseband IQ (BBIQ) Inputs

This chapter contains specifications for the *Option BBA* (Baseband IQ) hardware. *Option BBA* is only compatible with *Options 503, 508, 513, and 526*.

Frequency and Time

| Description | Specifications | Supplemental Information |
|-----------------------------------|-----------------------------|--|
| Frequency Range | | |
| I only, Q only | DC to 40 MHz | Tuning range ^a |
| I + jQ | -40 MHz to 40 MHz | Baseband range |
| Frequency Span^b | | Dependent on base instrument IF BW options |
| I only, Q only | | |
| With <i>Option B25</i> (standard) | 10 Hz to 25 MHz | |
| With <i>Option B40</i> | 10 Hz to 40 MHz | |
| I + jQ | | |
| With <i>Option B25</i> (standard) | 10 Hz to 50 MHz | |
| With <i>Option B40</i> | 10 Hz to 80 MHz | |
| 2-channel with 89600 VSA | | |
| Standard Instrument | 10 Hz to 10 MHz per channel | |
| With <i>Option B25</i> (standard) | | |
| Zoom, complex data | 10 Hz to 25 MHz per channel | |
| Baseband | 10 Hz to 20 MHz per channel | |
| With <i>Option B40</i> | | |
| Zoom, complex data | 10 Hz to 40 MHz per channel | |
| Baseband | 10 Hz to 20 MHz per channel | |
| Frequency Resolution | 1 Hz | |

- a. Closest approach of center frequency to edge frequency is limited to one-half of span.
b. Standard base instrument provides 0 Hz to 25 MHz span range. For >25 MHz spans, *Option B40* (40 MHz) is required.

Amplitude Accuracy and Range

| Description | Specifications | Supplemental Information |
|---|---------------------|--|
| Input Ranges | | 50 Ω source power setting for full-scale sinusoid |
| Full-Scale Peak Voltage | | |
| 50 Ω Input Impedance | 1 V Peak | 10 dBm |
| | 0.5 V Peak | 4 dBm |
| | 0.250 V Peak | -2 dBm |
| | 0.125 V Peak | -8 dBm |
| 1 M Ω Input Impedance ^a | 1 V Peak | 4 dBm |
| | 0.5 V Peak | -2 dBm |
| | 0.250 V Peak | -8 dBm |
| | 0.125 V Peak | -14 dBm |
| Maximum Common Mode Input Range | | |
| 50 Ω Input Impedance | -3 V to +3 V | ± 6.75 V (Keysight 1130A probe) |
| 1 M Ω Input Impedance | -3 V to +3 V | ± 30 V (Keysight 1161A probe) |
| Maximum Safe Input Voltage | ± 4 V (DC + AC) | |

a. Underterminated – no external termination used on input.

| Description | Specifications | Supplemental Information |
|--|----------------|--------------------------|
| Absolute Amplitude Accuracy^a | | |
| 250 kHz Reference Frequency, All Ranges | | ± 0.07 dB (nominal) |

a. Measured at -6 dB relative to maximum for each range.

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Frequency Response | | ± 0.25 dB (nominal) |
| (Relative to 250 kHz, 50 Ω and 1 M Ω Inputs, 0 to 40 MHz) | | |

Option BBA – Analog Baseband IQ (BBIQ) Inputs
Amplitude Accuracy and Range

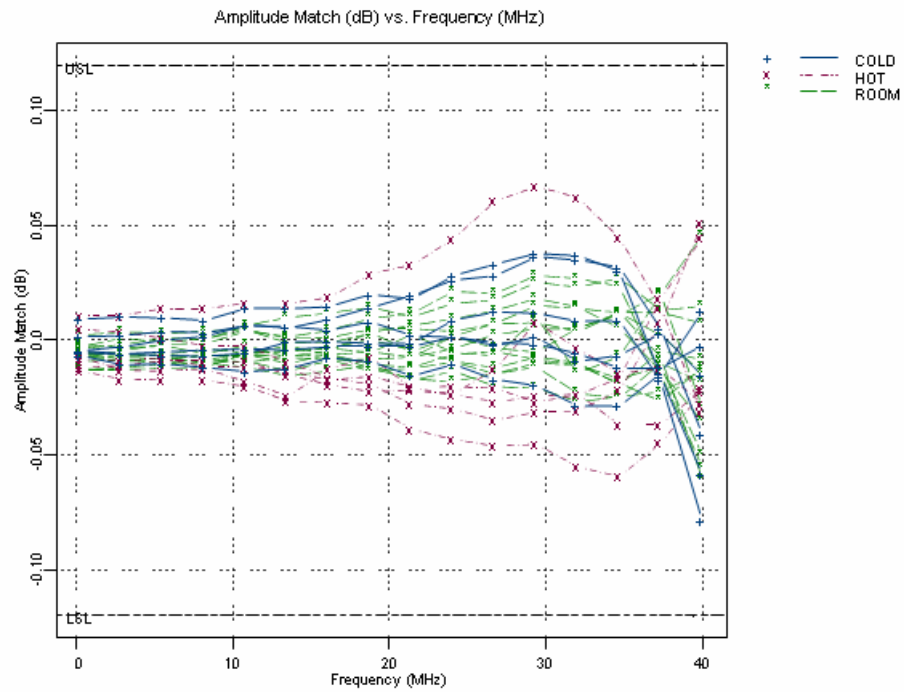
| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Amplitude Linearity^a (All ranges) 0 to –45 dB relative to Full Scale More than 45 dB below Full Scale | | ±0.10 dB (nominal) ±0.20 dB (nominal) |

a. With dither turned on.

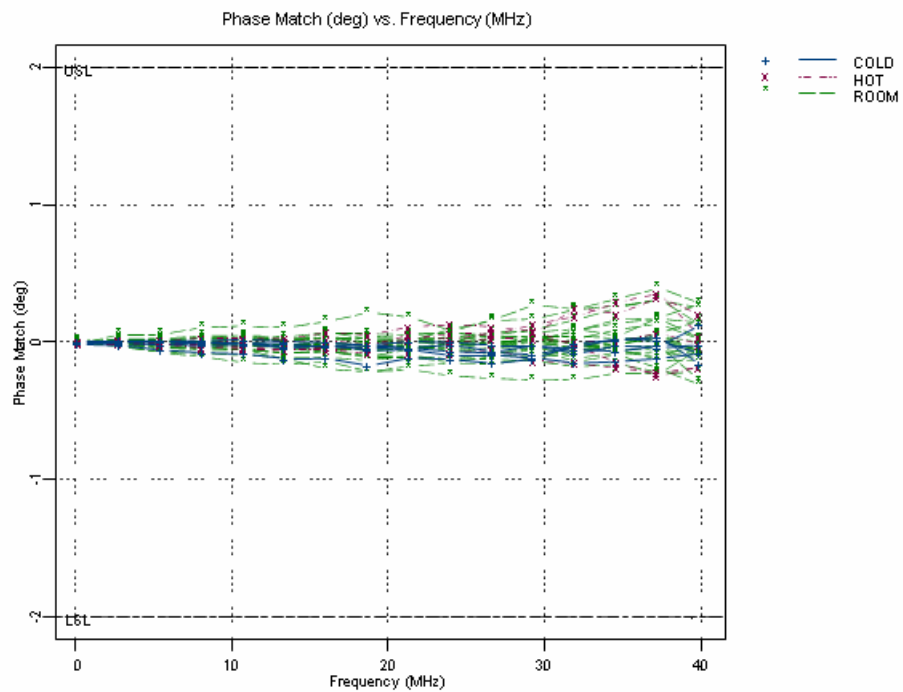
| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Channel Match Amplitude Match 0 to 10 MHz >10 MHz to 25 MHz >25 MHz to 40 MHz Phase Match 0 to 10 MHz >10 MHz to 25 MHz >25 MHz to 40 MHz | | All Ranges, 50 Ω and 1 M Ω Inputs, Single Ended input mode selected 95th Percentile (=2σ) ±0.04 dB ±0.06 dB ±0.10 dB All Ranges, 50 Ω and 1 M Ω Inputs, Single Ended input mode selected 95th Percentile (=2σ) ±0.08° ±0.18° ±0.32° |

Option BBA - Analog Baseband IQ (BBIQ) Inputs
Amplitude Accuracy and Range

Nominal Channel Match, 50 Ω Input, Single-Ended input mode, 0.25V Range [Plot]



Nominal Phase Match, 50 Ω Input, Single-Ended input mode, 0.25V Range [Plot]



Option BBA - Analog Baseband IQ (BBIQ) Inputs
Amplitude Accuracy and Range

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Crosstalk (50 Ω and 1 M Ω Inputs) | | <-70 dB (nominal) |

| Description | Specifications | Supplemental Information |
|--|----------------|--------------------------|
| Common Mode Rejection (50 Ω Input, 0 to 40 MHz) | | <-50 dB (nominal) |

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Phase Noise (1 MHz to 40 MHz) Offset 1 kHz Offset 10 kHz Offset 100 kHz Offsets >100 kHz | | -132 dBc/Hz (nominal) -136 dBc/Hz (nominal) -142 dBc/Hz (nominal) -142 dBc/Hz (nominal) |

Dynamic Range

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Displayed Average Noise Level^a (Single Ended input selected I only, or Q only 1 kHz RBW, normalized to 1 Hz Voltage averaging applied No DC offset applied) | | Nominal |
| 50 Ω Input Impedance Selected | | Input terminated in 50 Ω >2 MHz to 40 MHz |
| 1 V Peak | | -137 dBm (32 nV/ $\sqrt{\text{Hz}}$) |
| 0.5 V Peak | | -141 dBm (20 nV/ $\sqrt{\text{Hz}}$) |
| 0.25 V Peak | | -144 dBm (14 nV/ $\sqrt{\text{Hz}}$) |
| 0.125 V Peak | | -146 dBm (11 nV/ $\sqrt{\text{Hz}}$) |
| 1 M Ω Input Impedance Selected | | Input terminated in 1 M Ω >2 MHz to 40 MHz |
| 1 V Peak | | -136 dBm (35 nV/ $\sqrt{\text{Hz}}$) |
| 0.5 V Peak | | -139 dBm (25 nV/ $\sqrt{\text{Hz}}$) |
| 0.25 V Peak | | -142 dBm (18 nV/ $\sqrt{\text{Hz}}$) |
| 0.125 V Peak | | -144 dBm (14 nV/ $\sqrt{\text{Hz}}$) |

a. DANL (Displayed Average Noise Level) is the average noise level over the stated frequency range.

Option BBA - Analog Baseband IQ (BBIQ) Inputs
Dynamic Range

| Description | Specifications | Supplemental Information |
|--|----------------|--------------------------|
| Signal to Noise Ratio (50 Ω Input Impedance Selected, 1 V scale) | | 147 dBFS/Hz (nominal) |

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Residual Responses (0 Hz to 40 MHz) | | -90 dBm (nominal) |

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Spurious Responses^a (f > 1 kHz from carrier) | | -70 dBc (nominal) |
| Second Harmonic Distortion^a | | -70 dBc (nominal) |
| Third Order Intermodulation Distortion^b | | -70 dBFS (nominal) |

a. Measured relative to 0 dBm carrier

b. Measured with two tones, each at half of full scale, spaced by 100 kHz.

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Residual DC (IQ) offset (After Auto-Zero) | | -54 dBFS (nominal) |

Application Specifications

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Supported X-Series Measurement Applications N9073C-1FP/2FP/3FP W-CDMA/HSPA/HSPA+ N9080C-1FP LTE-FDD N9082C-1FP LTE-TDD | | Refer to the corresponding measurement application chapter for performance information with <i>Option BBA</i> enabled. |

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Residual EVM – X-Series Measurement Applications N9073C W-CDMA Composite EVM floor | | 1.5% (nominal) |

Option BBA - Analog Baseband IQ (BBIQ) Inputs

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Residual EVM – 89600 VSA Software Applications 89600 <i>Option BHD</i> : 3GPP LTE (10 MHz Bandwidth) DL UL 89600 <i>Option B7U</i> : 3GPP W-CDMA (5 MHz Bandwidth) | | ≤−48 dB (0.4%) (nominal) ≤−46 dB (0.5%) (nominal) ≤1.5% EVM (nominal) |

Measurements

| Description | Specifications | Supplemental Information |
|---|---|--|
| Complex Spectrum Measurement | | |
| Resolution BW Range | 100 MHz to 3 MHz | |
| Pre-FFT Filter BW Range (Type: Gaussian, Flat BW Control: Auto, Manual) | | |
| Standard <i>B25</i> | 10 Hz to 50 MHz | |
| Option <i>B40</i> | 10 Hz to 80 MHz | |
| FFT Window | Flat Top (high amplitude accuracy); Uniform; Hanning; Hamming; Gaussian; Blackman; Blackman-Harris; Kaiser-Bessel 70, 90, 110 | |
| Averaging | | |
| Avg Number | 1 to 20,001 | |
| Avg Mode | Exponential, Repeat | |
| Avg Type | Power Avg (RMS), Log-Power Avg (Video), Voltage Avg, Maximum, Minimum | |
| Y-axis Display | | |
| Dynamic Range | 10 divisions × scale/div | |
| Log scale/div Range | 0.1 to 20 dB | |
| Log scale/div Increment | 0.01 dB | |
| Voltage scale/div Range | 1 nV to 20 V | |
| Controls | Ref Value, Range, Scale/Div, Ref Position, and Auto Scaling | Allows expanded views of portions of the trace data |
| Range Selection | Auto, Manual | Refer to “ Input Ranges ” on page 177 |
| I Range and Q Range | 1 V peak, 0.5 V peak, 0.25 V peak, or 0.125 V peak | |

Option BBA - Analog Baseband IQ (BBIQ) Inputs
Measurements

| Description | Specifications | Supplemental Information |
|---|---|--|
| Complex Spectrum Measurement (cont.) | | |
| Markers | Normal, Delta, Band Power, Noise | |
| Measurement Resolution | | |
| Displayed (manual) | 0.01 dB | |
| Remote Query | 0.001 dB | |
| Trigger | | Refer to “Trigger Inputs” on page 91. |
| Source | Free Run External 1 External 2 | |
| Baseband I/Q Source | I/Q Mag I (Demodulated) Q (Demodulated) Input I Input Q Aux Channel Center Frequency | |
| Baseband IQ Trigger Setup | Trigger level, Trigger slope, and Trigger delay | |
| Aux Channel I/Q mag Trigger Setup | Trigger level, Trigger slope, Trigger delay, Trigger center frequency, and Trigger BW | |
| General Trigger Setup | Auto trigger, Trigger holdoff | |

Option BBA – Analog Baseband IQ (BBIQ) Inputs
Measurements

| Description | Specifications | Supplemental Information |
|--------------------------------|---|--|
| IQ Waveform Measurement | | |
| Time Record Length | | Refer to “ Capture Length vs. Span, 2-channel with 89600 VSA, I+jQ Mode [Plot] ” on page 191. |
| Information Bandwidth | | |
| Standard <i>B25</i> | 10 Hz to 50 MHz | |
| Option <i>B40</i> | 10 Hz to 80 MHz | |
| Averaging | | |
| Avg Number | 1 to 20,001 | |
| Avg Mode | Exponential, Repeat | |
| Avg Type | Power Avg (RMS), Log-power Avg (Video), Voltage Avg | |
| Displays | RF Envelope, I/Q Waveform | |
| Y-axis Display | | |
| Dynamic Range | 10 divisions × scale/div | |
| Log scale/div Range | 0.1 to 20 dB | |
| Log scale/div Increment | 0.01 dB | |
| Voltage scale/div Range | 1 nV to 20 V | |
| Controls | Scale/Div, Ref Value, and Ref Position | Allows expanded views of portions of the trace data. |
| X-axis Display | | |
| Range | 10 divisions x scale/div | Allows expanded views of portions of the trace data. |
| Controls | Scale/Div, Ref Value, and Ref Position | |
| Markers | Normal, Delta, Band Power, Noise | |
| Measurement Resolution | | |
| Displayed | 0.01 dB | |
| Remote query | 0.001 dB | |
| Trigger | | Refer to “ Trigger Inputs ” on page 91. |

Option BBA - Analog Baseband IQ (BBIQ) Inputs
Measurements

| Description | Specifications | Supplemental Information |
|---|---|--|
| IQ Waveform Measurement (cont.) | | |
| Trigger Source | External 1 External 2 I/Q Mag I, Q, Input I, Input Q Aux channel I/Q mag | Refer to “Trigger Inputs” on page 91. |
| Trigger Slope | Positive, Negative | |
| Trigger Delay | On, Off | |
| Range | | |
| External-1/2 | –150 ms to 500 ms | |
| I/Q Mag, I, Q, Input I, Input Q, Aux channel I/Q mag | –2.5 s to 10.0 s | |
| General Trigger Setup | Auto trigger, Trigger holdoff | |
| Auto Trigger | On, Off | |
| Time Interval Range | | |
| | | |
| Trigger Holdoff | On, Off | 1 ms to 100 s (nominal) Triggers immediately if no trigger occurs before the set time interval. |
| Range | 0 to 500 ms | |
| Resolution | 100 ns | |
| Baseband I/Q Source | I/Q Mag I (Demodulated) Q (Demodulated) Input I, Input Q, Aux Channel Center Frequency | |
| Baseband I/Q Trigger Setup | Trigger level, Trigger slope, and Trigger delay | |
| Aux Channel I/Q mag Trigger Setup | Trigger level, Trigger slope, Trigger delay, Trigger center frequency, and Trigger BW | |
| Aux Channel I/Q mag Trigger | | |
| Trigger Center Frequency | | |
| Standard B25 | –25 MHz to 25 MHz | |
| Option B40 | –40 MHz to 40 MHz | |

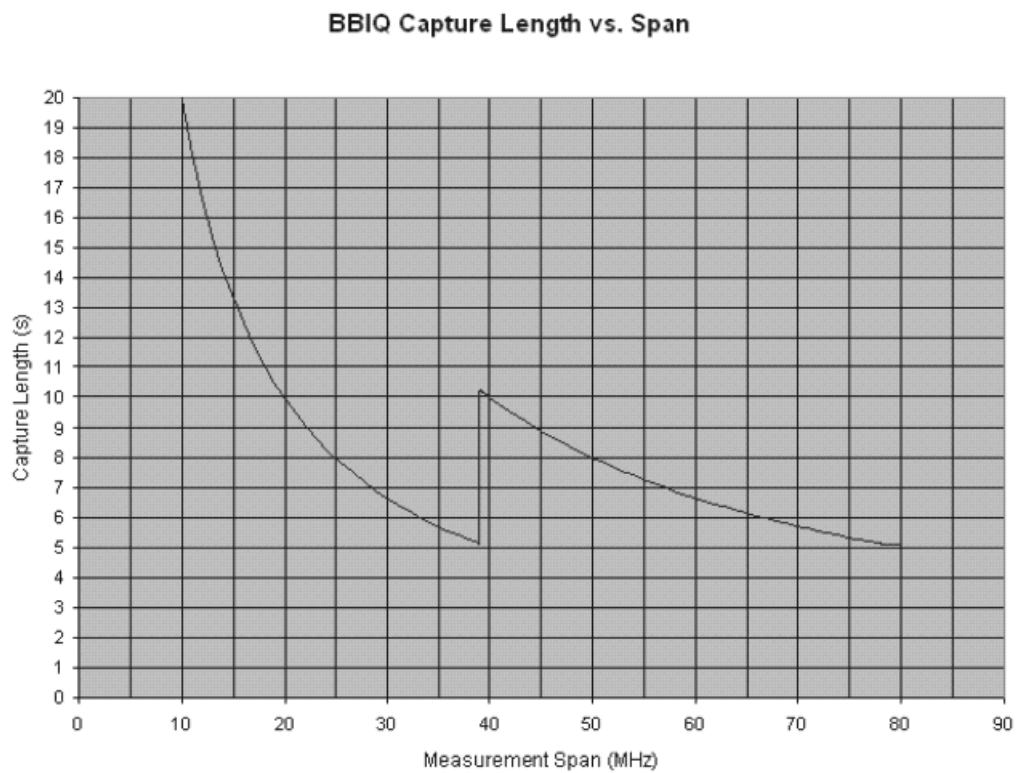
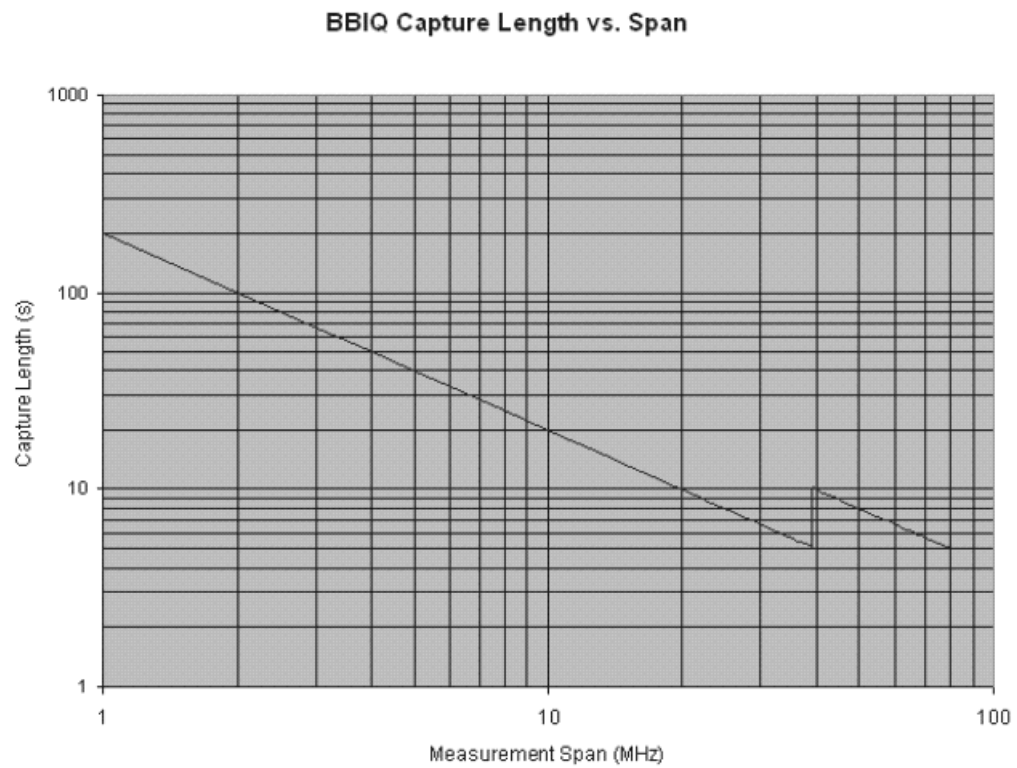
Option BBA - Analog Baseband IQ (BBIQ) Inputs
Measurements

| Description | Specifications | Supplemental Information |
|---|-----------------|--------------------------|
| IQ Wave form Measurement (cont.) | | |
| Trigger BW | | |
| Standard <i>B25</i> | 10 Hz to 50 MHz | |
| Option <i>B40</i> | 10 Hz to 80 MHz | |

General

| Description | Specifications | Supplemental Information |
|------------------------------|----------------|-------------------------------------|
| Capture Depth | 512 MSa | Sampling rate 50 MSa/s to 100 MSa/s |
| | 256 MSa | Sampling rate < 50 MSa/s |
| Capture Record Length | | |
| Sample Rate 100 MSa/s | 5 s | 80 MHz bandwidth with I+jQ |
| Sample Rate 50 MSa/s | 5 s | 40 MHz bandwidth with I+jQ |
| Sample Rate 25 MSa/s | 10 s | 20 MHz bandwidth with I+jQ |
| Sample Rate 12.5 MSa/s | 20 s | 10 MHz bandwidth with I+jQ |

Capture Length vs. Span, 2-channel with 89600 VSA, I+jQ Mode [Plot]



Inputs/Outputs

| Description | Specifications | Supplemental Information |
|--|---|--|
| Connectors (I, Q, I, Q, and Cal Out) | BNC female | See Frequency and Amplitude sections for Baseband Input details |
| Cal Out | | |
| Signal | AC coupled square wave | |
| Frequency | Selectable between 1 kHz or 250 kHz (fixed) | |
| Input Impedance (4 connectors: I, I and Q, Q) | | 50 Ω or 1 M Ω (nominal) selectable |
| Probes Supported | Keysight InfiniiMax series: | Probe connectivity kits such as E2668A, E2669A or E2675A are needed. For more details, please refer to the Keysight probe configuration guides: 5968-7141EN and 5989-6162EN. |
| Active Probe | 1130A, 1131A, 1132A, 1134A | |
| Passive Probe | 1161A | |
| Input Return Loss | | |
| (50 Ω Impedance Selected) | | |
| 0 to 10 MHz | | -35 dB (nominal) |
| 10 to 40 MHz | | -30 dB (nominal) |
| Input Capacitance | | 12 pF (nominal) |
| (1 M Ω Input Impedance) | | |

11 Option CR3 – Connector Rear, 2nd IF Output

This chapter contains specifications for *Option CR3*, Connector Rear, 2nd IF Output.

Specifications Affected by Connector Rear, 2nd IF Output

No other analyzer specifications are affected by the presence or use of this option. New specifications are given in the following page.

Other Connector Rear, 2nd IF Output Specifications

Aux IF Out Port

| Description | Specifications | Supplemental Information |
|-------------|----------------|---------------------------|
| Connector | SMA female | Shared with other options |
| Impedance | | 50 Ω (nominal) |

Second IF Out

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Second IF Out | | |
| Output Center Frequency | | |
| SA Mode | | 322.5 MHz |
| I/Q Analyzer Mode | | |
| IF Path ≤ 25 MHz | | 322.5 MHz |
| IF Path 40 MHz | | 250 MHz |
| IF Path 160 MHz | | 300 MHz |
| IF Path 255 MHz | | 750 MHz |
| IF Path 510 MHz | | 877.1484375 MHz |
| Conversion Gain at 2nd IF output center frequency | | 1 dB (nominal) ^a |
| Bandwidth (–6 dB) | | |
| Low band | | |
| IF Path ≤ 160 MHz | | Up to 160 MHz (nominal) ^b |
| IF Path 255 MHz | | 250 MHz nominal |
| IF Path 510 MHz | | 510 MHz nominal |
| High band | | |
| With preselector | | Depends on RF center frequency ^c |
| Range | | |
| Preselector bypassed | | 100–800 MHz ± 3 dB nominal ^d |
| External mixing | | 100–1200 MHz ± 6 dB nominal ^e |
| Residual Output Signals | | –94 dBm or lower (nominal) |

a. “Conversion Gain” is defined from RF input to IF Output with 0 dB mechanical attenuation and the electronic attenuator off. The nominal performance applies in zero span.

Option CR3 - Connector Rear, 2nd IF Output
Other Connector Rear, 2nd IF Output Specifications

- b. The passband width at -3 dB nominally extends from IF frequencies of 230 to 370 MHz. The passband width is thus maximum and symmetric when using 300 MHz as the IF output center frequency. When the IF path in use is centered at a frequency different from 300 MHz, the passband will be asymmetric.
- c. The YIG-tuned preselector bandwidth nominally varies from 55 MHz for a center frequencies of 3.6 GHz through 57 MHz at 15 GHz to 75 MHz at 26.5 GHz. The preselector effect will dominate the passband width.
- d. The passband width at -6 dB nominally extends from 100 to 800 MHz. Thus, the maximum width is not centered around the IF output center frequency. Expandable to 900 MHz with Corrections.
- e. The passband width at -6 dB nominally extends from 100 to 800 MHz. Thus, the maximum width is not centered around the IF output center frequency. Expandable to 900 MHz with Corrections.

12 Option CRP – Connector Rear, Arbitrary IF Output

This chapter contains specifications for *Option CRP*, Connector Rear, Arbitrary IF Output.

Specifications Affected by Connector Rear, Arbitrary IF Output

No other analyzer specifications are affected by the presence or use of this option. New specifications are given in the following page.

Other Connector Rear, Arbitrary IF Output Specifications

Aux IF Out Port

| Description | Specifications | Supplemental Information |
|-------------|----------------|---------------------------|
| Connector | SMA female | Shared with other options |
| Impedance | | 50 Ω (nominal) |

Arbitrary IF Out

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Arbitrary IF Out^a | | |
| IF Output Center Frequency | | |
| Range | 10 to 75 MHz | |
| Resolution | 0.5 MHz | |
| Conversion Gain at the RF Center Frequency | | –1 to +4 dB (nominal) plus RF frequency response ^b |
| Bandwidth | | |
| Highpass corner frequency | | 5 MHz (nominal) at –3 dB |
| Lowpass corner frequency | | 120 MHz (nominal) at –3 dB |
| Output at 70 MHz center | | |
| Low band; also, high band with preselector bypassed | | 100 MHz (nominal) ^c |
| Preselected bands | | Depends on RF center frequency ^d |
| Lower output frequencies | | Subject to folding ^e |
| Phase Noise | | Added noise above analyzer noise ^f |
| Residual Output Signals | | –88 dBm or lower (nominal) ^g |

- Only accessible when 10 MHz, 25 MHz or 40 MHz IF path is enabled.
- “Conversion Gain” is defined from RF input to IF Output with 0 dB mechanical attenuation and the electronic attenuator off. The nominal performance applies with zero span.
- The bandwidth shown is in non-preselected bands. The combination with preselection (see footnote d) will reduce the bandwidth.
- See **“Preselector Bandwidth” on page 32.**
- As the output center frequency declines, the lower edge of the passband will fold around zero hertz. This phenomenon is most severe for output frequencies around and below 20 MHz. For more information on frequency folding, refer to *X-Series Spectrum Analyzer User's and Programmer's Reference*.
- The added phase noise in the conversion process of generating this IF is nominally –88, –106, and –130 dBc/Hz at offsets of 10, 100, and 1000 kHz respectively.
- Measured from 1 MHz to 150 MHz.

Option CRP - Connector Rear, Arbitrary IF Output
Other Connector Rear, Arbitrary IF Output Specifications

13 Option EA3 – Electronic Attenuator, 3.6 GHz

This chapter contains specifications for the *Option EA3* Electronic Attenuator, 3.6 GHz.

Specifications Affected by Electronic Attenuator

| Specification Name | Information |
|--|--|
| Frequency Range | See “Range (Frequency and Attenuation)” on page 203. |
| 1 dB Gain Compression Point | See “Distortions and Noise” on page 204. |
| Displayed Average Noise Level | See “Distortions and Noise” on page 204. |
| Frequency Response | See “Frequency Response” on page 205. |
| Attenuator Switching Uncertainty | The recommended operation of the electronic attenuator is with the reference setting (10 dB) of the mechanical attenuator. In this operating condition, the Attenuator Switching Uncertainty specification of the mechanical attenuator in the core specifications does not apply, and any switching uncertainty of the electronic attenuator is included within the “Electronic Attenuator Switching Uncertainty” on page 207. |
| Absolute Amplitude Accuracy, | See “Absolute Amplitude Accuracy” on page 206. |
| Second Harmonic Distortion | See “Distortions and Noise” on page 204. |
| Third Order Intermodulation Distortion | See “Distortions and Noise” on page 204. |

Other Electronic Attenuator Specifications

| Description | Specifications | Supplemental Information |
|--|------------------------|---|
| Range (Frequency and Attenuation) | | |
| Frequency Range | 2 Hz to 3.6 GHz | |
| Attenuation Range | | |
| Electronic Attenuator Range | 0 to 24 dB, 1 dB steps | |
| Calibrated Range | 0 to 24 dB, 2 dB steps | Electronic attenuator is calibrated with 10 dB mechanical attenuation |
| Full Attenuation Range | 0 to 94 dB, 1 dB steps | Sum of electronic and mechanical attenuation |

Option EA3 – Electronic Attenuator, 3.6 GHz
Other Electronic Attenuator Specifications

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Distortions and Noise | | When using the electronic attenuator, the mechanical attenuator is also in-circuit. The full mechanical attenuator range is available ^a . |
| 1 dB Gain Compression Point | | The 1 dB compression point will be nominally higher with the electronic attenuator “Enabled” than with it not Enabled by the loss, ^b except with high settings of electronic attenuation ^c . |
| Displayed Average Noise Level | | Instrument Displayed Average Noise Level will nominally be worse with the electronic attenuator “Enabled” than with it not Enabled by the loss ^b . |
| Second Harmonic Distortion | | Instrument Second Harmonic Distortion will nominally be better in terms of the second harmonic intercept (SHI) with the electronic attenuator “Enabled” than with it not Enabled by the loss ^b . |
| Third-order Intermodulation Distortion | | Instrument TOI will nominally be better with the electronic attenuator “Enabled” than with it not Enabled by the loss ^b except for the combination of high attenuation setting and high signal frequency ^d . |

- The electronic attenuator is calibrated for its frequency response only with the mechanical attenuator set to its preferred setting of 10 dB.
- The loss of the electronic attenuator is nominally given by its attenuation plus its excess loss. That excess loss is nominally 2 dB from 0 – 500 MHz and increases by nominally another 1 dB/GHz for frequencies above 500 MHz.
- An additional compression mechanism is present at high electronic attenuator settings. The mechanism gives nominally 1 dB compression at +20 dBm at the internal electronic attenuator input. The compression threshold at the RF input is higher than that at the internal electronic attenuator input by the mechanical attenuation. The mechanism has negligible effect for electronic attenuations of 0 through 14 dB.
- The TOI performance improvement due to electronic attenuator loss is limited at high frequencies, such that the TOI reaches a limit of nominally +45 dBm at 3.6 GHz, with the preferred mechanical attenuator setting of 10 dB, and the maximum electronic attenuation of 24 dB. The TOI will change in direct proportion to changes in mechanical attenuation.

Option EA3 – Electronic Attenuator, 3.6 GHz
Other Electronic Attenuator Specifications

| Description | Specifications | | Supplemental Information |
|--|-------------------|-------------------|---|
| Frequency Response (Maximum error relative to reference condition (50 MHz)) Attenuation = 4 to 24 dB, even steps 3 Hz to 50 MHz 50 MHz to 3.6 GHz Attenuation = 0, 1, 2 and odd steps, 3 to 23 dB 10 MHz to 3.6 GHz | 20 to 30°C | Full Range | Mech atten set to default/calibrated setting of 10 dB. 95th Percentile ($\approx 2\sigma$) ±0.30 dB ±0.20 dB ±0.30 dB |

Option EA3 – Electronic Attenuator, 3.6 GHz
Other Electronic Attenuator Specifications

| Description | Specifications | Supplemental Information |
|---|--|--|
| Absolute Amplitude Accuracy At 50 MHz ^a 20 to 30°C Full temperature range At all frequencies ^a 20 to 30°C Full temperature range 95th Percentile Absolute Amplitude Accuracy ^b (Wide range of signal levels, RBWs, RLs, etc., 0.01 to 3.6 GHz) | ± 0.24 dB ± 0.32 dB $\pm(0.24 \text{ dB} + \text{frequency response})$ $\pm(0.32 \text{ dB} + \text{frequency response})$ | ± 0.13 dB (95th percentile) ± 0.21 dB |

- a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: $1 \text{ Hz} \leq \text{RBW} \leq 1 \text{ MHz}$; Input signal -10 to -50 dBm; Input attenuation 10 dB; all settings auto-coupled except Swp Time Rules = Accuracy; combinations of low signal level and wide RBW use $\text{VBW} \leq 30 \text{ kHz}$ to reduce noise. When using FFT sweeps, the signal must be at the center frequency. This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.
- b. Absolute Amplitude Accuracy for a wide range of signal and measurement settings, covers the 95th percentile proportion with 95% confidence. Here are the details of what is covered and how the computation is made: The wide range of conditions of RBW, signal level, VBW, reference level and display scale are discussed in footnote a. There are 44 quasi-random combinations used, tested at a 50 MHz signal frequency. We compute the 95th percentile proportion with 95% confidence for this set observed over a statistically significant number of instruments. Also, the frequency response relative to the 50 MHz response is characterized by varying the signal across a large number of quasi-random verification frequencies that are chosen to not correspond with the frequency response adjustment frequencies. We again compute the 95th percentile proportion with 95% confidence for this set observed over a statistically significant number of instruments. We also compute the 95th percentile accuracy of tracing the calibration of the 50 MHz absolute amplitude accuracy to a national standards organization. We also compute the 95th percentile accuracy of tracing the calibration of the relative frequency response to a national standards organization. We take the root-sum-square of these four independent Gaussian parameters. To that rss we add the environmental effects of temperature variations across the 20 to 30°C range. These computations and measurements are made with the mechanical attenuator, set to the reference state of 10 dB, the electronic attenuator set to all even settings from 4 through 24 dB inclusive.

Option EA3 – Electronic Attenuator, 3.6 GHz
Other Electronic Attenuator Specifications

| Description | Specifications | Supplemental Information |
|---|-----------------------|--------------------------|
| Electronic Attenuator Switching Uncertainty (Error relative to reference condition: 50 MHz, 10 dB mechanical attenuation, 10 dB electronic attenuation) Attenuation = 0 dB 50 MHz Attenuation = 1 to 24 dB 50 MHz | See note ^a | ±0.04 dB (nominal) |

- a. The specification is ± 0.16 dB; typically 0.04 dB. Note that this small relative uncertainty does not apply in estimating absolute amplitude accuracy, because it is included within the absolute amplitude accuracy for measurements done with the electronic attenuator. (Measurements made without the electronic attenuator are treated differently; the absolute amplitude accuracy specification for those measurements does not include attenuator switching uncertainty.)

Option EA3 - Electronic Attenuator, 3.6 GHz
Other Electronic Attenuator Specifications

14 Option EMC – Precompliance EMI Features

This chapter contains specifications for the *Option EMC* precompliance EMI features.

Frequency

| Description | Specifications | Supplemental information |
|-----------------------------------|---|--|
| Frequency Range | | 10 Hz to 3.6, 7, 13.6, 26.5, 44, or 50 GHz depending on the frequency option. |
| EMI Resolution Bandwidths | | See “CISPR Preset Settings” on page 211 and “MIL-STD 461D/E/F Frequency Ranges and Bandwidths” on page 211 for CISPR and MIL-STD frequency ranges. |
| CISPR | | Available when the EMC Standard is CISPR. |
| 200 Hz, 9 kHz, 120 kHz, 1 MHz | | As specified in CISPR 16-1-1, –6 dB bandwidths, subject to masks |
| Non-CISPR bandwidths | 10, 30, 100, 300 Hz, 1, 3, 30, 300 kHz, 3, 10 MHz | –6 dB bandwidths |
| MIL STD | | Available when the EMC Standard is MIL |
| 10, 100 Hz, 1, 10, 100 kHz, 1 MHz | | As specified in MIL-STD-461, –6 dB bandwidths |
| Non-MIL STD bandwidths | 30, 300 Hz, 3, 30, 300 kHz, 3, 10 MHz | –6 dB bandwidths |

Table 14-1 CISPR Preset Settings

| CISPR Band | Frequency Range | CISPR RBW | Data Points |
|------------|-------------------|-----------|-------------|
| Band A | 9 to 150 kHz | 200 Hz | 1413 |
| Band B | 150 kHz to 30 MHz | 9 kHz | 6637 |
| Band C | 30 to 300 MHz | 120 kHz | 4503 |
| Band D | 300 MHz to 1 GHz | 120 kHz | 11671 |
| Band C/D | 30 MHz to 1 GHz | 120 kHz | 16171 |
| Band E | 1 to 18 GHz | 1 MHz | 34001 |

Table 14-2 MIL-STD 461D/E/F Frequency Ranges and Bandwidths

| Frequency Range | 6 dB Bandwidth | Minimum Measurement Time |
|-------------------|----------------|--------------------------|
| 30 Hz to 1 kHz | 10 Hz | 0.015 s/Hz |
| 1 kHz to 10 kHz | 100 Hz | 0.15 s/kHz |
| 10 kHz to 150 kHz | 1 kHz | 0.015 s/kHz |
| 150 kHz to 30 MHz | 10 kHz | 1.5 s/MHz |
| 30 MHz to 1 GHz | 100 kHz | 0.15 s/MHz |
| Above 1 GHz | 1 MHz | 15 s/GHz |

Amplitude

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| EMI Average Detector | | Used for CISPR-compliant average measurements and, with 1 MHz RBW, for frequencies above 1 GHz |
| Default Average Type | | All filtering is done on the linear (voltage) scale even when the display scale is log. |
| Quasi-Peak Detector | | Used with CISPR-compliant RBWs, for frequencies ≤ 1 GHz |
| Absolute Amplitude Accuracy for reference spectral intensities | | As specified in CISPR 16-1-1 |
| Relative amplitude accuracy versus pulse repetition rate | | As specified in CISPR 16-1-1 |
| Quasi-Peak to average response ratio | | As specified in CISPR 16-1-1 |
| Dynamic range | | |
| Pulse repetition rates ≥ 20 Hz | | As specified in CISPR 16-1-1 |
| Pulse repetition rates ≤ 10 Hz | | Does not meet CISPR standards in some cases with DC pulse excitation. |
| RMS Average Detector | | As specified in CISPR 16-1-1 |

15 Option ESC – External Source Control

This chapter contains specifications for the *Option ESC*, External Source Control.

General Specifications

| Description | Specification | Supplemental Information |
|---|---------------------|--|
| Frequency Range | | |
| SA Operating range | | |
| N9030B-503 | 2 Hz to 3.6 GHz | |
| N9030B-508 | 2 Hz to 8.4 GHz | |
| N9030B-513 | 2 Hz to 13.6 GHz | |
| N9030B-526 | 2 Hz to 26.5 GHz | |
| N9030B-544 | 2 Hz to 44 GHz | |
| N9030B-550 | 2 Hz to 50 GHz | |
| Source Operating range | | |
| N5171B-501 | 9 kHz to 1 GHz | |
| N5171B/72B/81B/82B-503 | 9 kHz to 3 GHz | |
| N5171B/72B/81B/82B-506 | 9 kHz to 6 GHz | |
| N5161A/N5162A/N5181A/N5182A-503 | 100 kHz to 3 GHz | |
| N5161A/N5162A/N5181A/N5182A-506 | 100 kHz to 6 GHz | |
| N5183A-520 | 100 kHz to 20 GHz | |
| N5183A-532 | 100 kHz to 31.8 GHz | |
| N5183A-540 | 100 kHz to 40 GHz | |
| N5173B/N5183B-513 | 9 kHz to 13 GHz | |
| N5173B/N5183B-520 | 9 kHz to 20 GHz | |
| N5173B/N5183B-532 | 9 kHz to 31.8 GHz | |
| N5173B/N5183B-540 | 9 kHz to 40 GHz | |
| E8257C/E8257D-520 | 250 kHz to 20 GHz | |
| E8257D-532 | 250 kHz to 31.8 GHz | |
| E8257N-340 | 250 kHz to 40 GHz | |
| E8257C/E8257D-540 | 250 kHz to 40 GHz | |
| E8257D/E8257N-550 | 250 kHz to 50 GHz | |
| E8257D-567 | 250 kHz to 67 GHz | |
| E8267C/E8267D-520 | 250 kHz to 20 GHz | |
| E8267D-532 | 250 kHz to 31.8 GHz | |
| E8267D-544 | 250 kHz to 44 GHz | |
| Span Limitations | | |
| Span limitations due to source range | | Limited by the source and SA operating range |
| Offset Sweep | | |
| Sweep offset setting range | | Limited by the source and SA operating range |
| Sweep offset setting resolution | 1 Hz | |
| Harmonic Sweep | | |
| Harmonic sweep setting range ^a | | |
| Multiplier numerator | | N = 1 to 1000 |
| Multiplier denominator | | N = 1 to 1000 |

Option ESC - External Source Control
General Specifications

| Description | Specification | Supplemental Information |
|-------------------------------------|---------------|--------------------------|
| Sweep Direction ^b | | Normal, Reversed |

- Limited by the frequency range of the source to be controlled.
- The analyzer always sweeps in a positive direction, but the source may be configured to sweep in the opposite direction. This can be useful for analyzing negative mixing products in a mixer under test, for example.

| Description | Specification | Supplemental Information |
|--|---------------|--|
| Dynamic Range (10 MHz to 3 GHz, Input terminated, sample detector, average type = log, 20 to 30°C) | | Dynamic Range = −10 dBm − DANL − 10×log(RBW) ^a |
| SA span | SA RBW | |
| 1 MHz | 2 kHz | 108.0 dB |
| 10 MHz | 6.8 kHz | 102.7 dB |
| 100 MHz | 20 kHz | 98.0 dB |
| 1000 MHz | 68 kHz | 92.7 dB |
| Amplitude Accuracy | | Multiple contributors ^b Linearity ^c Source and Analyzer Flatness ^d YTF Instability ^e VSWR effects ^f |

- The dynamic range is given by this computation: $-10 \text{ dBm} - \text{DANL} - 10 \times \log(\text{RBW})$ where DANL is the displayed average noise level specification, normalized to 1 Hz RBW, and the RBW used in the measurement is in hertz units. The dynamic range can be increased by reducing the RBW at the expense of increased sweep time.
- The following footnotes discuss the biggest contributors to amplitude accuracy.
- One amplitude accuracy contributor is the linearity with which amplitude levels are detected by the analyzer. This is called "scale fidelity" by most spectrum analyzer users, and "dynamic amplitude accuracy" by most network analyzer users. This small term is documented in the Amplitude section of the Specifications Guide. It is negligibly small in most cases.
- The amplitude accuracy versus frequency in the source and the analyzer can contribute to amplitude errors. This error source is eliminated when using normalization in low band (0 to 3.6 GHz). In high band the gain instability of the YIG-tuned prefilter in the analyzer keeps normalization errors nominally in the 0.25 to 0.5 dB range.
- In the worst case, the center frequency of the YIG-tuned prefilter can vary enough to cause very substantial errors, much higher than the nominal 0.25 to 0.5 dB nominal errors discussed in the previous footnote. In this case, or as a matter of good practice, the prefilter should be centered. See the user's manual for instructions on centering the preselector.
- VSWR interaction effects, caused by RF reflections due to mismatches in impedance, are usually the dominant error source. These reflections can be minimized by using 10 dB or more attenuation in the analyzer, and using well-matched attenuators in the measurement configuration.

Option ESC - External Source Control
General Specifications

| Description | Specification | Supplemental Information |
|--------------------------|---------------|-----------------------------------|
| Power Sweep Range | | Limited by source amplitude range |

| Description | Specification | Supplemental Information | | |
|---|---------------|-------------------------------------|---------------|-------------------|
| Measurement Time (RBW setting of the SA determined by the default for Option ESC) | | Nominal ^a | | |
| | | RF MXG (N5181A/N5182A) ^b | | |
| <i>Option 503, 508, 513, 526, 544, 550</i> | | Band 0 | Band 1 | |
| 201 Sweep points (default setting) | | 450 ms | 1.1 s | |
| 601 Sweep points | | 1.1 s | 3.7 s | |
| | | μW MXG (N5183A) ^b | | |
| <i>Option 503, 508, 513, 526</i> | | Band 0 | Band 1 | >Band1 |
| 201 Sweep points (default setting) | | 450 ms | 1.1 s | 2.4 s |
| 601 Sweep points | | 1.1 s | 3.3 s | 6.9 s |
| <i>Option 544, 550</i> | | | | |
| 201 Sweep points (default setting) | | 450 ms | 6.5 s | 6.5 s |
| 601 Sweep points | | 1.1 s | 19 s | 19 s |
| | | PSG (E8257D)/(E8267D) ^c | | |
| <i>Option 503, 508, 513, 526</i> | | Band 0 | Band 1 | >Band 1 |
| 201 Sweep points (default setting) | | 2.2 s | 2.2 s | 2.5 s |
| 601 Sweep points | | 6.3 s | 6.1 s | 7.1 s |
| | | PSG (E8257D)/(E8267D) ^c | | |
| <i>Option 544, 550</i> | | Band 0 | Band 1 | >Band 1 |
| 201 Sweep points (default setting) | | 2.2 s | 6.6 s | 6.6 s |
| 601 Sweep points | | 6.0 s | 20 s | 19.1 s |

a. These measurement times were observed with a span of 100 MHz, RBW of 20 kHz, and the point triggering method being set to Ext Trigger1. The measurement times will not change significantly with span when the RBW is automatically selected. If the RBW is decreased, the sweep time increase would be approximately 23.8 times Npoints/RBW.

b. Based on MXG firmware version A.01.80 and *Option UNZ* installed.

c. Based on PSG firmware version C.06.15 and *Option UNZ* installed.

Option ESC - External Source Control
General Specifications

| Description | Specification | Supplemental Information |
|---|---------------|--|
| Supported External Sources^a | | |
| Agilent/Keysight EXG | | N5171B/72B/73B |
| Agilent/Keysight MXG | | N5161A/62A N5181A/82A/83A N5181B/82B/83B |
| Agilent/Keysight PSG | | E8257C/67C E8257D/67D E8257N |
| IO interface connection between EXG/MXG and SA between PSG and SA | | LAN, GPIB, or USB LAN or GPIB |

a. Firmware revision A.19.50 or later is required for the signal analyzer.

Option ESC - External Source Control
General Specifications

16 Option EXM – External Mixing

This chapter contains specifications for the *Option EXM* External Mixing.

Specifications Affected by External mixing

| Specification Name | Information |
|--|--|
| RF-Related Specifications, such as TOI, DANL, SHI, Amplitude Accuracy, and so forth. | Specifications do not apply; some related specifications are contained in IF Input in this chapter |
| IF-Related Specifications, such as RBW range, RBW accuracy, RBW switching uncertainty, and so forth. | Specifications unchanged, except IF Frequency Response - see specifications in this chapter. |
| New specifications: IF Input Mixer Bias LO Output | See specifications in this chapter. |

Other External Mixing Specifications

| Description | Specifications | Supplemental Information |
|----------------------------------|--|--|
| Connection Port EXT MIXER | | |
| Connector | SMA, female | |
| Impedance | | 50 Ω (nominal) at IF and LO frequencies |
| Functions | Triplexed for Mixer Bias, IF Input and LO output | |

| Description | Specifications | Supplemental Information |
|---------------------------|----------------|------------------------------------|
| Mixer Bias | | |
| Bias Current ^a | | Short circuit current ^b |
| Range | ± 10 mA | |
| Resolution | 10 μ A | |
| Output impedance | | 477 Ω (nominal) |
| Voltage Clamp | | ± 3.7 V (nominal) |

- a. The mixer bias circuit has a Norton equivalent, characterized by its short circuit current and its impedance. It is also clamped to a voltage range less than the Thevenin voltage capability.
- b. The actual port current is often less than the short circuit current, due to the diode voltage drop of many mixers.

Option EXM - External Mixing
Other External Mixing Specifications

| Description | Specifications | | Supplemental Information |
|--|-------------------|-------------------|-------------------------------|
| IF Input | | | |
| Maximum Safe Level | +7 dBm | | |
| Center Frequency | | | |
| IF BW \leq 25 MHz | 322.5 MHz | | includes swept |
| 40 MHz IF path | 250.0 MHz | | |
| 85 through 160 MHz paths | 300.0 MHz | | |
| 255 MHz IF path | 750.0 MHz | | |
| 510 MHz IF path | 877.1484375 MHz | | |
| Bandwidth | | | Supports all optional IFs |
| ADC Clipping Level ^a | | | |
| Without <i>Option EP0</i> | | | -14.5 \pm 1.5 dBm (nominal) |
| With <i>Option EP0</i> | | | |
| 25, 255, or 510 MHz IF paths | | | -15 dBm (nominal) |
| 40 MHz IF path | | | -20 dBm (nominal) |
| 1 dB Gain | | | -2 dBm (nominal) |
| Compression ^a | | | |
| Gain Accuracy ^b | 20 to 30°C | Full Range | |
| IF BW \leq 25 MHz | \pm 1.2 dB | \pm 2.5 dB | |
| Wider IF BW | | | \pm 1.2 dB (nominal) |
| IF Frequency Response | | | RMS (nominal) |
| CF | Width | | |
| 322.5 MHz | \pm 5 MHz | | 0.05 dB |
| 322.5 MHz | \pm 12.5 MHz | | 0.07 dB |
| 250 MHz | \pm 20 MHz | | 0.15 dB |
| 300 MHz | \pm 80 MHz | | 0.5 dB |
| 750 MHz | \pm 127.5 MHz | | 0.12 dB |
| 877.1484375 MHz | \pm 255 MHz | | 0.15 dB |
| Noise Figure (322.5 MHz, swept operation) | | | 9 dB (nominal) |
| VSWR | | | 1.3:1 (nominal) |

Option EXM - External Mixing
Other External Mixing Specifications

- a. These specifications apply at the IF input port. The on-screen and mixer-input levels scale with the conversion loss and corrections values.
- b. The amplitude accuracy of a measurement includes this term and the accuracy with which the settings of corrections model the loss of the external mixer.

| Description | Specifications | | Supplemental Information |
|--|-------------------|-------------------|--------------------------|
| LO Output | | | |
| Frequency Range | 3.75 to 14.1 GHz | | |
| Output Power ^a | 20 to 30°C | Full Range | |
| 3.75 to 7.0 GHz ^b | +15.0 to 18.0 dBm | +14.5 to 18.5 dBm | |
| 7.0 to 8.72 GHz ^b | +15.0 to 18.0 dBm | +13.5 to 18.8 dBm | |
| 7.8 to 14.1 GHz ^c | +14.0 to 18.5 dBm | Not specified | |
| Second Harmonic | | | -20 dB (nominal) |
| Fundamental Feedthrough and Undesired Harmonics ^c | | | -15 dB (nominal) |
| VSWR | | | <2.2:1 (nominal) |

- a. The LO output port power is compatible with Agilent/Keysight M1970 and 11970 Series mixers except for the 11970K. The power is specified at the connector. Cable loss will affect the power available at the mixer. With non-Agilent/Keysight mixer units, supplied loss calibration data may be valid only at a specified LO power that may differ from the power available at the mixer. In such cases, additional uncertainties apply.
- b. LO Doubler = Off settings.
- c. LO Doubler = On setting. Fundamental frequency = 3.9 to 7.0 GHz.

Option EXM - External Mixing
Other External Mixing Specifications

17 Option LNP – Low Noise Path Specifications

This chapter contains specifications for the *Option LNP*, Low Noise Path.

Specifications Affected by Low Noise Path

The low noise path is in use when all the following are true:

- The LNP option is licensed
- The setting of the Microwave Path is "Low Noise Path Enabled"
- The start frequency is at least 3.5 GHz and the stop frequency is above 3.6 GHz
- The preamp is either not licensed, or set to Off, or set to "Low Band"

| Specification Name | Information |
|--------------------------------------|---|
| Displayed Average Noise Level (DANL) | See specifications in this chapter |
| Compression | Little change in dynamic range ^a |
| VSWR | The magnitude will be very similar between LNP and non-LNP operation, but the details, such as the frequencies of the peaks and valleys, will shift. |
| Frequency Response | See specifications in this chapter. The specifications are very similar to the normal path. But the details of the response can be quite different, with the frequencies of the peaks and valleys shifting between LNP and non-LNP operation. That means that any relative measurements between, for example, a large signal measured without LNP, and a small signal measured with LNP, could be subject to relative frequency response errors as large as the sum of the individual errors. |
| Second Harmonic Distortion | See specifications in this chapter ^b |
| Third-Order Intermodulation | Little change in dynamic range ^a |
| Other Input Related Spurious | See "Spurious Responses" on page 59 of the core specifications. This performance with LNP is not warranted, but is nominally the same as non-LNP performance. |

- a. The low noise path, when in use, does not substantially change the compression-to-noise dynamic range or the TOI-to-noise dynamic range because it mostly just reduces losses in the signal path in front of all significant noise, TOI and compression-affecting circuits. In other words, the compression threshold and the third-order intercept both decrease, and to the same extent as that to which the DANL decreases.
- b. Unlike the case for TOI and compression, the low noise path does provide a substantial improvement in the second-harmonic performance. The low noise path bypasses electronic switching elements that otherwise dominate harmonic distortion, including second harmonic distortion.

Displayed Average Noise Level

| Description | | | Specifications | | Supplemental Information |
|---|---|---|---|-------------------|--|
| Displayed Average Noise Level (DANL)^a (without Noise Floor Extension) | | | Input terminated, Sample or Average detector Averaging type = Log 0 dB input attenuation IF Gain = High 1 Hz Resolution Bandwidth | | Refer to the footnote for “Band Overlaps” on page 21. |
| mmW (<i>Option 544, or 550</i>) | | | | | |
| RF/μW (<i>Option 508, 513, or 526</i>) | | | | | |
| | | | 20 to 30°C | Full range | Typical |
| | | ↓ | | | |
| | | ↓ | | | |
| 3.5 to 4.2 GHz | x | | –153 dBm | –152 dBm | –155 dBm |
| 3.5 to 4.2 GHz | | x | –150 dBm | –148 dBm | –153 dBm |
| 4.2 to 8.4 GHz | x | | –155 dBm | –153 dBm | –156 dBm |
| 4.2 to 6.6 GHz | | x | –152 dBm | –150 dBm | –154 dBm |
| 6.6 to 8.4 GHz (without <i>Option EPO</i>) | | x | –154 dBm | –152 dBm | –154 dBm |
| 6.6 to 8.4 GHz (with <i>Option EPO</i>) | | x | –153 dBm | –152 dBm | –154 dBm |
| 8.3 to 13.6 GHz | x | | –155 dBm | –153 dBm | –156 dBm |
| 8.3 to 13.6 GHz | | x | –153 dBm | –151 dBm | –154 dBm |
| 13.5 to 16.9 GHz | x | | –152 dBm | –150 dBm | –154 dBm |
| 13.5 to 14 GHz | | x | –150 dBm | –148 dBm | –152 dBm |
| 14 to 17 GHz | | x | –151 dBm | –149 dBm | –153 dBm |
| 16.9 to 20.0 GHz | x | | –151 dBm | –149 dBm | –153 dBm |
| 17.0 to 22.5 GHz | | x | –149 dBm | –147 dBm | –150 dBm |
| 20.0 to 26.5 GHz | x | | –150 dBm | –148 dBm | –152 dBm |
| 22.5 to 26.5 GHz | | x | –146 dBm | –145 dBm | –149 dBm |
| 26.4 to 30 GHz | | x | –146 dBm | –144 dBm | –149 dBm |
| 30 to 34 GHz | | x | –146 dBm | –143dBm | –148 dBm |
| 33.9 to 37 GHz | | x | –141 dBm | –139 dBm | –146 dBm |
| 37 to 46 GHz | | x | –140 dBm | –136 dBm | –142 dBm |
| 46 to 50 GHz | | x | –138 dBm | –134 dBm | –140 dBm |

Option LNP - Low Noise Path Specifications
Displayed Average Noise Level

- 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 noise figure does not depend on RBW and 1 kHz measurements are faster. 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.

| Description | Specifications | Supplemental Information | |
|---|----------------|---|--|
| DANL with Noise Floor Extension Improvement^a | | 95th Percentile ($\approx 2\sigma$) | |
| | | Freq Option ≤ 526 | Freq Option > 526 |
| Band 1 | | 10 dB | 10 dB |
| Band 2 | | 10 dB | 9 dB |
| Band 3 | | 10 dB | 10 dB |
| Band 4 | | 10 dB | 11 dB |
| Band 5 | | N/A | 11 dB |
| Band 6 | | N/A | 11 dB |
| DANL with Noise Floor Extensions^b (18 to 30°C) | | 95th Percentile ($\approx 2\sigma$) | |
| | | Freq Option ≤ 526 | Freq Option > 526 |
| Band 1 | | -166 dBm | -164 dBm |
| Band 2 | | -167 dBm | -164 dBm |
| Band 3 | | -164 dBm | -164 dBm |
| Band 4 | | -162 dBm | -161 dBm |
| Band 5 | | N/A | -161 dBm |
| Band 6 | | N/A | -152 dBm |

- a. This statement on the improvement in DANL is based on the statistical observations of the error in the effective noise floor after NFE is applied. That effective noise floor can be a negative or a positive power at any frequency. These 95th percentile values are based on the absolute value of that effective remainder noise power.
- b. DANL with NFE is unlike DANL without NFE. It is based on the statistical observations of the error in the effective noise floor after NFE is applied. That effective noise floor can be a negative or a positive power at any frequency. These 95th percentile values are based on the absolute value of that effective remainder noise power.

Option LNP - Low Noise Path Specifications
Displayed Average Noise Level

| Description | | | Specifications | | Supplemental Information |
|---|---|---|-------------------|-------------------|---|
| Frequency Response (Maximum error relative to reference condition (50 MHz) Swept operation ^a , Attenuation 10 dB) | | | | | Refer to the footnote for “Band Overlaps” on page 21 . Freq <i>Option 526</i> only: Modes above 18 GHz ^b |
| <i>mmW (Option 544, or 550)</i> | | | | | |
| <i>RF/μW (Option 508, 513, or 526)</i> | | | 20 to 30°C | Full range | 95th Percentile (≈2σ) |
| | | | | | |
| | ↓ | ↓ | | | |
| 3.5 to 5.2 GHz | x | | ±1.5 dB | ±2.5 dB | ±0.71 dB |
| 3.5 to 5.2 GHz | | x | ±1.9dB | ±3.7 dB | ±0.81 dB |
| 5.2 to 8.4 GHz | x | | ±1.5 dB | ±2.5 dB | ±0.71 dB |
| 5.2 to 8.4 GHz | | x | ±1.5 dB | ±2.5 dB | ±0.62 dB |
| 8.3 to 13.6 GHz | x | | ±2.0 dB | ±2.7 dB | ±0.65 dB |
| 8.3 to 13.6 GHz | | x | ±2.0 dB | ±2.7 dB | ±0.61 dB |
| 13.5 to 17.1 GHz | x | | ±2.0 dB | ±2.7 dB | ±0.62 dB |
| 13.5 to 16 GHz (with <i>Option EPO</i>) | x | | ±2.0 dB | ±2.7 dB | ±0.67 dB |
| 16 to 17.1 GHz (with <i>Option EPO</i>) | x | | ±2.0 dB | ±2.9 dB | ±0.87 dB |
| 13.5 to 17.1 GHz | | x | ±2.0 dB | ±2.7 dB | ±0.68 dB |
| 17.0 to 22.0 GHz | x | | ±2.0 dB | ±2.7 dB | ±0.77 dB |
| 17.0 to 22.0 GHz | | x | ±2.0 dB | ±2.7 dB | ±0.72 dB |
| 22.0 to 26.5 GHz | x | | ±2.5 dB | ±3.7 dB | ±1.03 dB |
| 22.0 to 26.5 GHz | | x | ±2.5 dB | ±3.7 dB | ±0.71 dB |
| 26.4 to 34.5 GHz | | x | ±2.3 dB | ±3.5 dB | ±0.95 dB |
| 34.4 to 50 GHz | | x | ±3.2 dB | ±5.0 dB | ±1.35 dB |

- a. For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.
- b. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. The effect of these modes with this connector are included within these specifications.

Second Harmonic Distortion

| Description | Specifications | | | Supplemental Information | |
|-----------------------------------|--------------------------------|-------------------|------------------------|-----------------------------|----------------------------------|
| Second Harmonic Distortion | Mixer Level^a | Distortion | SHI^b | Distortion (nominal) | SHI^b (nominal) |
| Source Frequency | | | | | |
| 1.75 to 2.5 GHz | -15 dBm | -95 dBc | +80 dBm | | |
| 2.5 to 4 GHz | | | | | |
| Freq option ≤526 | -15 dBm | -101 dBc | +86 dBm | | |
| Freq option >526 | -15 dBm | -99 dBc | +84 dBm | | |
| 4 to 5 GHz | | | | | |
| Freq option ≤526 | -15 dBm | -105 dBc | +90 dBm | | |
| Freq option >526 | -15 dBm | -99 dBc | +84 dBm | | |
| 5 to 13.25 GHz | -15 dBm | -105 dBc | +90 dBm | | |
| 13.25 to 25 GHz | -15 dBm | | | -105 dBc | +90 dBm |

a. Mixer level = Input Level – Input Attenuation

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

18 Option MPB – Microwave Preselector Bypass

This chapter contains specifications for the *Option MPB*, Microwave Preselector Bypass.

NOTE

The preselector eliminates image frequencies and unwanted signals outside the preselector passband. Using option MPB to bypass the preselector will improve measurement repeatability and amplitude accuracy, since the preselector can drift over time. With the preselector bypassed, the measurement speed will be improved and attenuator cycles reduced, because Preselector Centering is no longer required before making a measurement. The reduction in attenuator cycles will extend the life of the mechanical attenuators in the instrument.

Specifications Affected by Microwave Preselector Bypass

| Specification Name | Information |
|---|---|
| Displayed Average Noise Level with Preamp OFF | MPB path Displayed Average Noise Levels are nominally 3 dB better compared to Preamp OFF levels. |
| Displayed Average Noise Level with Preamp ON | Preamp/MPB path Displayed Average Noise Levels are nominally 4 dB worse compared with Preamp ON levels. |
| IF Frequency Response and IF Phase Linearity | See "Frequency Response" on page 35 and "IF Frequency Response" on page 38 for the standard 10 MHz analysis bandwidth; also, see the associated "Analysis Bandwidth" chapter for any optional bandwidths. |
| Frequency Response | See specifications in this chapter. |
| VSWR | The magnitude of the mismatch over the range of frequencies will be very similar between MPB and non-MPB operation, but the details, such as the frequencies of the peaks and valleys, will shift. |
| Additional Spurious Responses | In addition to the "Spurious Responses" on page 59 of the core specifications, "Additional Spurious Responses" on page 234 of this chapter also apply. |

Other Microwave Preselector Bypass Specifications

| Description | | Specifications | | Supplemental Information |
|--|---|----------------|------------|---|
| Frequency Response (Maximum error relative to reference condition (50 MHz) Swept operation ^a , Attenuation 10 dB) | | | | Refer to the footnote for Band Overlaps on page 21 . Freq <i>Option 526</i> only: Modes above 18 GHz ^b |
| <div> <div><i>mmW (Option 544, or 550)</i></div> <div>RF/μW (<i>Option 508, 513, or 526</i>)</div> </div> | | 20 to 30°C | Full range | |
| | ↓ | | | 95th Percentile (≈2σ) |
| 3.5 to 8.4 GHz | x | ±0.9 dB | ±1.5 dB | ±0.42 dB |
| 3.5 to 8.4 GHz | x | ±0.9 dB | ±1.5 dB | ±0.44 dB |
| 8.3 to 13.6 GHz | x | ±1.0 dB | ±2.0 dB | ±0.50 dB |
| 8.3 to 13.6 GHz | x | ±1.0 dB | ±2.0 dB | ±0.43 dB |
| 13.5 to 17.1 GHz | x | ±1.3 dB | ±2.0 dB | ±0.50 dB |
| 13.5 to 16 GHz (with <i>Option EP0</i>) | x | ±1.3 dB | ±2.0 dB | ±0.56 dB |
| 16 to 17.1 GHz (with <i>Option EP0</i>) | x | ±1.5 dB | ±3.1 dB | ±0.83 dB |
| 13.5 to 17.1 GHz | x | ±1.3 dB | ±2.0 dB | ±0.58 dB |
| 17.0 to 22.0 GHz | x | ±1.3 dB | ±2.0 dB | ±0.59 dB |
| 17.0 to 22.0 GHz | x | ±1.3 dB | ±2.3 dB | ±0.69 dB |
| 22.0 to 26.5 GHz | x | ±2.0 dB | ±2.8 dB | ±0.69 dB |
| 22.0 to 26.5 GHz | x | ±1.5 dB | ±2.4 dB | ±0.63 dB |
| 26.4 to 34.5 GHz | x | ±1.7 dB | ±2.6 dB | ±0.83 dB |
| 34.4 to 50 GHz | x | ±3.1 dB | ±4.8 dB | ±1.35 dB |

- a. For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.
- b. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. The effect of these modes with this connector are included within these specifications.

Option MPB – Microwave Preselector Bypass
Other Microwave Preselector Bypass Specifications

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| Additional Spurious Responses^a | | |
| Tuned Frequency (f) Excitation | | |
| Image Response | | |
| 3.5 to 50 GHz $f + fIF^b$ | | 0 dBc (nominal); High Band Image Suppression is lost with Option MPB. |
| LO Harmonic and Subharmonic Responses | | |
| 3.5 to 8.4 GHz $N(f + fIF) \pm fIF^b$ | | -10 dBc (nominal), N = 2, 3 |
| 8.3 to 26.5 GHz $[N(f + fIF)/2] \pm fIF^b$ | | -10 dBc (nominal), N = 1, 3, 4 |
| 26.4 to 34.5 GHz $[N(f + fIF)/4] \pm fIF^b$ | | -10 dBc (nominal), N = 1, 2, 3, 5, 6, 7 |
| 34.4 to 50 GHz $[N(f + fIF)/8] \pm fIF^b$ | | -10 dBc (nominal), N = 1, 2, 3, 5, 6, 7, 9, 10 |
| Second Harmonic Response | | |
| 3.5 to 13.6 GHz $f/2$ | | -72 dBc (nominal) for -40 dBm mixer level |
| 13.5 to 34.5 GHz $f/2$ | | -68 dBc (nominal) for -40 dBm mixer level |
| 34.4 to 50 GHz $f/2$ | | -68 dBc (nominal) for -40 dBm mixer level |
| IF Feedthrough Response | | |
| 3.5 to 13.6 GHz fIF^b | | -100 dBc (nominal) |
| 13.5 to 50 GHz fIF^b | | -90 dBc (nominal) |

- a. Dominate spurious responses are described here. Generally, other *Option MPB*-specific spurious responses will be substantially lower than those listed here, but may exceed core specifications.
- b. $fIF = 322.5$ MHz except $fIF = 250$ MHz with *Option B40* and $fIF = 300$ MHz with *Option B85*, or *B1X* as well as $fIF = 750$ MHz with *Option B2X* and 877.1484375 MHz with *Option B5X*.

19 Options P03, P08, P13, P26, P44 and P50 – Preamplifiers

This chapter contains specifications for the PXA Signal Analyzer *Options P03, P08, P13, P26, and P50* preamplifiers.

Specifications Affected by Preamp

| Specification Name | Information |
|--|---|
| Nominal Dynamic Range vs. Offset Frequency vs. RBW | The graphic from the core specifications does not apply with Preamp On. |
| Measurement Range | The measurement range depends on displayed average noise level (DANL). See “Amplitude Accuracy and Range” on page 33 . |
| Gain Compression | See specifications in this chapter. |
| DANL with NFE Off | See specifications in this chapter. |
| DANL with NFE (Noise Floor Extension) | See “Displayed Average Noise Level with Noise Floor Extension Improvement” on page 55 of the core specifications. |
| Frequency Response | See specifications in this chapter. |
| Absolute Amplitude Accuracy | See “Absolute Amplitude Accuracy” on page 40 of the core specifications. |
| RF Input VSWR | See plot in this chapter. |
| Display Scale Fidelity | See Display Scale Fidelity on page 46 of the core specifications. Then, adjust the mixer levels given downward by the preamp gain given in this chapter. |
| Second Harmonic Distortion | See specifications in this chapter. |
| Third Order Intermodulation Distortion | See specifications in this chapter. |
| Other Input Related Spurious | See “Spurious Responses” on page 59 of the core specifications. Preamp performance is not warranted but is nominally the same as non-preamp performance. |
| Dynamic Range | See plot in this chapter. |
| Gain | See “Preamp” specifications in this chapter. |
| Noise Figure | See “Preamp” specifications in this chapter. |

Other Preamp Specifications

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Preamp (Options P03, P08, P13, P26, P44 and P50) ^a Gain 100 kHz to 3.6 GHz 3.6 to 26.5 GHz 26.5 to 50 GHz Noise figure 100 kHz to 3.6 GHz 3.6 to 8.4 GHz 8.4 to 13.6 GHz 13.6 to 50 GHz | | Maximum^b +20 dB (nominal) +35 dB (nominal) +40 dB (nominal) 8 to 12 dB (proportional to frequency) (nominal) Note on DC coupling ^c 9 dB (nominal) 10 dB (nominal) Noise Figure is DANL + 176.24 dB (nominal) ^d |

- The preamp follows the input attenuator, AC/DC coupling switch, and precedes the input mixer. In low-band, it follows the 3.6 GHz low-pass filter. In high-band, it precedes the preselector.
- Preamp Gain directly affects distortion and noise performance, but it also affects the range of levels that are free of final IF overload. The user interface has a designed relationship between input attenuation and reference level to prevent on-screen signal levels from causing final IF overloads. That design is based on the maximum preamp gains shown. Actual preamp gains are modestly lower, by up to nominally 5 dB for frequencies from 100 kHz to 3.6 GHz, and by up to nominally 10 dB for frequencies from 3.6 to 50 GHz.
- The effect of AC coupling is negligible for frequencies above 40 MHz. Below 40 MHz, DC coupling is recommended for the best measurements. The instrument NF nominally degrades by 0.2 dB at 30 MHz and 1 dB at 10 MHz with AC coupling.

- Nominally, the noise figure of the spectrum analyzer is given by

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

where, D is the DANL (displayed average noise level) specification (Refer to [page 239](#) for DANL with Preamp),

K is kTB (–173.98 dBm in a 1 Hz bandwidth at 290 K),

L is 2.51 dB (the effect of log averaging used in DANL verifications)

N is 0.24 dB (the ratio of the noise bandwidth of the RBW filter with which DANL is specified to an ideal noise bandwidth)

B is ten times the base-10 logarithm of the RBW (in hertz) in which the DANL is specified. B is 0 dB for the 1 Hz RBW.

The actual NF will vary from the nominal due to frequency response errors.

Options P03, P08, P13, P26, P44 and P50 – Preamplifiers
Other Preamp Specifications

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| 1 dB Gain Compression Point (Two-tone)^a (Preamp On (Options P03, P08, P13, P26, P44 or P50)) Maximum power at the preamp ^b for 1 dB gain compression) 10 MHz to 3.6 GHz 3.6 to 26.5 GHz Tone spacing 100 kHz to 20 MHz Tone spacing > 70 MHz Freq Option ≤ 526 Freq Option > 526 26.5 to 50 GHz | | –14 dBm (nominal) –28 dBm (nominal) –10 dBm (nominal) –20 dBm (nominal) –30 dBm (nominal) |

a. Large signals, even at frequencies not shown on the screen, can cause the analyzer to mismeasure on-screen signals because of two-tone gain compression. This specification tells how large an interfering signal must be in order to cause a 1 dB change in an on-screen signal.

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

Options P03, P08, P13, P26, P44 and P50 - Preamplifiers
Other Preamp Specifications

| Description | | Specifications | | Supplemental Information |
|---|---|---|-------------------|--|
| Displayed Average Noise Level (DANL) (without Noise Floor Extension)^a | | Input terminated Sample or Average detector Averaging type = Log 0 dB input attenuation IF Gain = High 1 Hz Resolution Bandwidth | | Refer to the footnote for Band Overlaps on page 21. |
| mmW with no signal path options ^b | | | | |
| mmW with one or more signal path options ^c | | | | |
| mmW with <i>Option EP0</i> | | | | |
| RF/ μ W (<i>Option 503, 508, 513, or 526</i>) | | | | |
| <i>Option P03, P08, P13, P26, P44 or P50</i> | | 20 to 30°C | Full range | Typical |
| | ↓ | ↓ | ↓ | ↓ |
| 100 to 200 kHz | x | x | x | -152 dBm |
| 200 to 500 kHz | x | x | x | -155 dBm |
| 500 kHz to 1 MHz ^d | x | x | x | -157 dBm |
| 1 to 10 MHz ^d | x | x | x | -161 dBm |
| 10 MHz to 2.1 GHz | x | | | -165 dBm |
| 10 MHz to 2.1 GHz | | x | | -164 dBm |
| 10 MHz to 2.1 GHz | | | x | -164 dBm |
| 2.1 to 3.6 GHz | x | | x | -163 dBm |
| 2.1 to 3.6 GHz | | x | | -162 dBm |
| <i>Option P08, P13, P26, P44 or P50</i> | | | | |
| 3.5 to 8.4 GHz | x | | | -164 dBm |
| 3.5 to 8.4 GHz | | x | | -160 dBm |
| 3.5 to 8.4 GHz | | | x | -161 dBm |
| <i>Option P13, P26, P44 or P50</i> | | | | |
| 8.3 to 13.6 GHz | x | | | -163 dBm |
| 8.3 to 13.6 GHz | | x | | -161 dBm |
| 8.3 to 13.6 GHz | | | x | -161 dBm |

Options P03, P08, P13, P26, P44 and P50 - Preamplifiers
Other Preamp Specifications

| Description | | | | | Specifications | | Supplemental Information |
|---|---|---|---|---|----------------|----------|--------------------------|
| Displayed Average Noise Level (DANL) without Noise Floor Extension (cont.) | | | | | | | |
| <i>Option P26, P44 or P50</i> | | | | | | | |
| 13.5 to 16.9 GHz | x | | | | -161 dBm | -159 dBm | -162 dBm |
| 13.5 to 17.1 GHz | | x | x | | -161 dBm | -159 dBm | -163 dBm |
| 13.5 to 17.1 GHz | | | | x | -162 dBm | -160 dBm | -164 dBm |
| 16.9 to 20.0 GHz | x | | | | -159 dBm | -157 dBm | -161 dBm |
| 17 to 20 GHz | | x | | | -160 dBm | -157 dBm | -162 dBm |
| 17.0 to 20.0 GHz | | | x | | -160 dBm | -157 dBm | -163 dBm |
| 17.0 to 20.0 GHz | | | | x | -161 dBm | -159 dBm | -163 dBm |
| 20.0 to 26.5 GHz | x | | | | -155 dBm | -153 dBm | -157 dBm |
| 20 to 26.5 GHz | | x | | | -158 dBm | -156 dBm | -160 dBm |
| 20.0 to 26.5 GHz | | | x | | -158 dBm | -156 dBm | -161 dBm |
| 20.0 to 26.5 GHz | | | | x | -159 dBm | -156 dBm | -161 dBm |
| <i>Option P44 or P50</i> | | | | | | | |
| 26.4 to 30 GHz | | x | x | | -157 dBm | -155 dBm | -159 dBm |
| 26.4 to 30 GHz | | | | x | -158 dBm | -155 dBm | -160 dBm |
| 30 to 34 GHz | | x | | | -155 dBm | -153 dBm | -157 dBm |
| 30 to 34 GHz | | | x | | -155 dBm | -153 dBm | -158 dBm |
| 30 to 34 GHz | | | | x | -156 dBm | -153 dBm | -159 dBm |
| 33.9 to 37 GHz | | x | x | | -153 dBm | -150 dBm | -157 dBm |
| 33.9 to 37 GHz | | | | x | -154 dBm | -150 dBm | -157 dBm |
| 37 to 40 GHz | | x | | | -152 dBm | -147 dBm | -155 dBm |
| 37 to 40 GHz | | | x | | -152 dBm | -147 dBm | -156 dBm |
| 37 to 40 GHz | | | | x | -153 dBm | -149 dBm | -157 dBm |
| 40 to 43 GHz | | x | | | -149 dBm | -145 dBm | -153 dBm |
| 40 to 43 GHz | | | x | | -149 dBm | -145 dBm | -154 dBm |
| 40 to 43 GHz | | | | x | -151 dBm | -147 dBm | -155 dBm |

Options P03, P08, P13, P26, P44 and P50 - Preamplifiers
Other Preamp Specifications

| Description | | | | | Specifications | | Supplemental Information |
|---|--|---|---|---|----------------|----------|--------------------------|
| Displayed Average Noise Level (DANL) without Noise Floor Extension (cont.) | | | | | | | |
| <i>Option P44 or P50</i> | | | | | | | |
| 43 to 44 GHz | | x | x | | -149 dBm | -145 dBm | -154 dBm |
| 43 to 44 GHz | | | | x | -150 dBm | -147 dBm | -155 dBm |
| <i>Option P50</i> | | | | | | | |
| 44 to 46 GHz | | x | x | | -149 dBm | -145 dBm | -154 dBm |
| 44 to 46 GHz | | | | x | -150 dBm | -147 dBm | -155 dBm |
| 46 to 50 GHz | | x | x | | -146 dBm | -142 dBm | -150 dBm |
| 46 to 50 GHz | | | | x | -150 dBm | -144 dBm | -153 dBm |

- DANL for zero span and swept is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the noise figure does not depend on RBW and 1 kHz measurements are faster.
- Specifications marked with an x in this column apply to analyzers with mmW frequency options (*Option 544 or 550*) and none of the following options that affect the signal path: MPB, LNP, B85 or B1X.
- Specifications marked with an x in this column apply to analyzers with mmW frequency options (*Option 544 or 550*) and one or more of the following options that affect the signal path: MPB, LNP, B85, B1X, B2X or B5X.
- Specifications apply only when the Phase Noise Optimization control is set to "Best Wide-offset Phase Noise."

Options P03, P08, P13, P26, P44 and P50 - Preamplifiers
Other Preamp Specifications

| Description | | Specifications | | Supplemental Information |
|---|---|-------------------|-------------------|--|
| Frequency Response – Preamp On | | | | Refer to the footnote for Band Overlaps on page 21 . Freq option 526 only: Modes above 18 GHz ^a |
| <i>(Options P03, P08, P13, P26, P44, P50)</i> | | | | |
| (Maximum error relative to reference condition (50 MHz, with 10 dB attenuation); Input attenuation 0 dB Swept operation ^{b)}) | | | | |
| <i>mmW (Option 544, or 550)</i> | | | | |
| RF/ μ W (Option 503, 508, 513, or 526) | | | | |
| | | 20 to 30°C | Full range | 95th Percentile ($\approx 2\sigma$) |
| | | | | |
| 9 to 100 kHz ^c | x | | | ± 0.38 dB ^d |
| 9 to 100 kHz ^c | | | | ± 0.40 dB ^d |
| 100 kHz to 50 MHz ^c | x | ± 0.68 dB | ± 0.75 dB | ± 0.34 dB |
| 100 kHz to 50 MHz ^c | x | ± 0.68 dB | ± 0.80 dB | ± 0.34 dB |
| 50 MHz to 3.6 GHz ^c | x | ± 0.55 dB | ± 0.80 dB | ± 0.30 dB |
| 50 MHz to 3.6 GHz ^c | x | ± 0.60 dB | ± 0.90 dB | ± 0.31 dB |
| 3.5 to 5.2 GHz ^{ef} | x | ± 2.0 dB | ± 2.7 dB | ± 0.69 dB |
| 3.5 to 5.2 GHz ^{ef} | x | ± 2.0 dB | ± 3.8 dB | ± 0.81 dB |
| 5.2 to 8.4 GHz ^{ef} | x | ± 2.0 dB | ± 2.7 dB | ± 0.67 dB |
| 5.2 to 8.4 GHz ^{ef} | x | ± 2.0 dB | ± 2.7 dB | ± 0.70 dB |
| 8.3 to 13.6 GHz ^{ef} | x | ± 2.3 dB | ± 2.9 dB | ± 0.71 dB |
| 8.3 to 13.6 GHz ^{ef} | x | ± 2.3 dB | ± 2.9 dB | ± 0.79 dB |
| 13.5 to 17.1 GHz ^{ef} | x | ± 2.5 dB | ± 3.3 dB | ± 0.95 dB |
| 13.5 to 16 GHz ^{ef} (with Option EP0) | x | ± 2.5 dB | ± 3.3 dB | ± 0.80 dB |
| 16 to 17.1 GHz ^{ef} (with Option EP0) | x | ± 2.5 dB | ± 3.3 dB | ± 1.01 dB |

Options P03, P08, P13, P26, P44 and P50 – Preamplifiers
Other Preamp Specifications

| Description | | | Specifications | | Supplemental Information |
|---|---|---|----------------|---------|--------------------------|
| 13.5 to 17.1 GHz ^{ef} | | x | ±2.5 dB | ±3.3 dB | ±0.88 dB |
| Frequency Response - Preamp On (cont.) | | | | | |
| 17.0 to 22.0 GHz ^{ef} | x | | ±3.0 dB | ±3.7 dB | ±1.41 dB |
| 17.0 to 22.0 GHz ^{ef} | | x | ±3.0 dB | ±3.7 dB | ±1.07 dB |
| 22.0 to 26.5 GHz ^{ef} | x | | ±3.5 dB | ±4.5 dB | ±1.61 dB |
| 22.0 to 26.5 GHz ^{ef} | | x | ±3.5 dB | ±4.5 dB | ±1.03 dB |
| 26.4 to 34.5 GHz ^{ef} | | x | ±3.0 dB | ±4.5 dB | ±1.35 dB |
| 34.4 to 50 GHz ^{ef} | | x | ±4.1 dB | ±6.0 dB | ±1.69 dB |

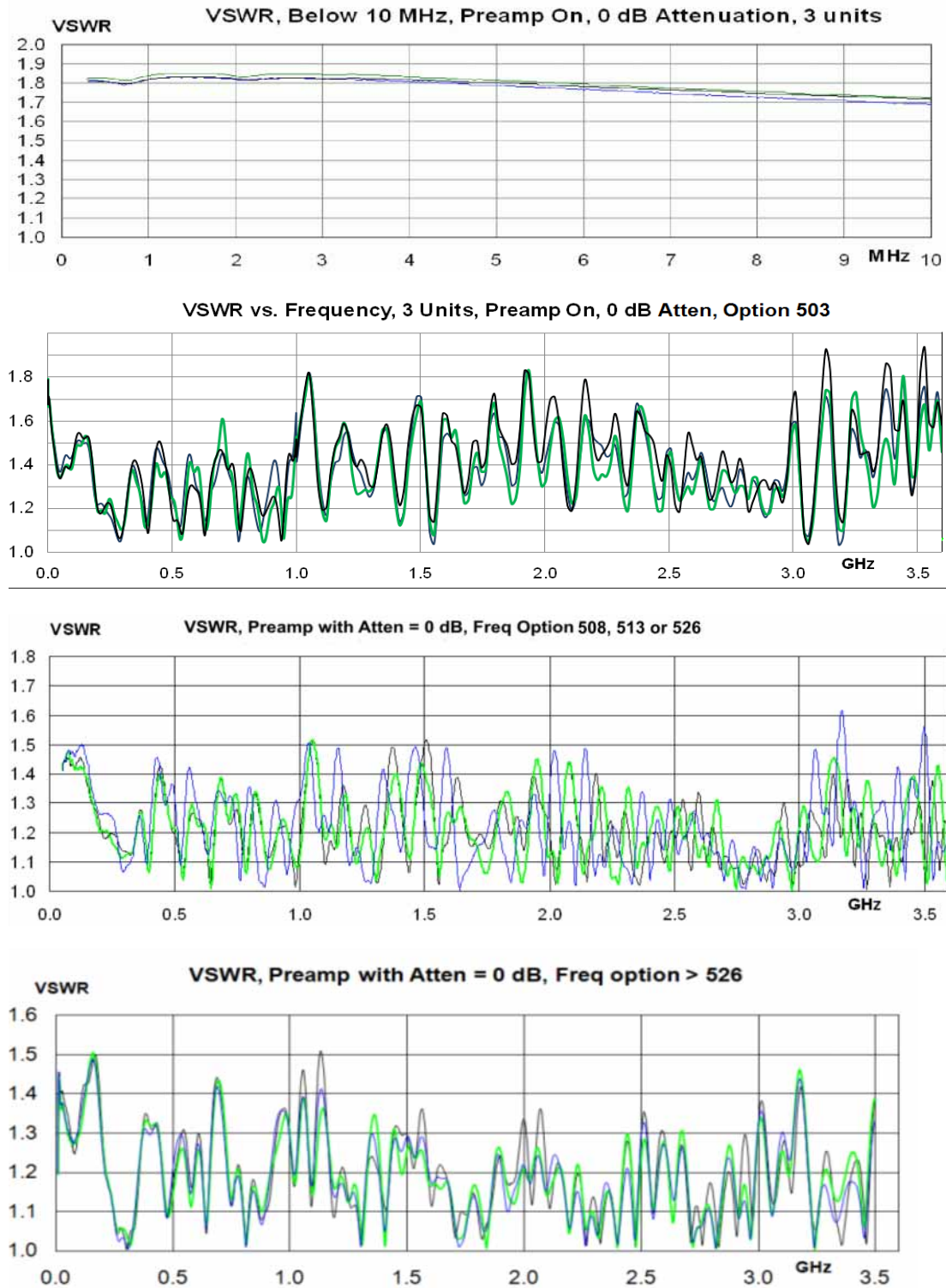
- Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. The effect of these modes with this connector are included within these specifications.
- For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.
- Electronic attenuator (Option EA3) may not be used with preamp on.
- All instruments are tested against a suitable test line limit in factory production but not in field calibration.
- Specifications for frequencies >3.5 GHz apply for sweep rates < 100 MHz/ms.
- Preselector centering applied when preselector is not bypassed. Refer to Option MPB – Microwave Preselector Bypass chapter for performance affected by bypassing the preselector.

Options P03, P08, P13, P26, P44 and P50 - Preamplifiers
Other Preamp Specifications

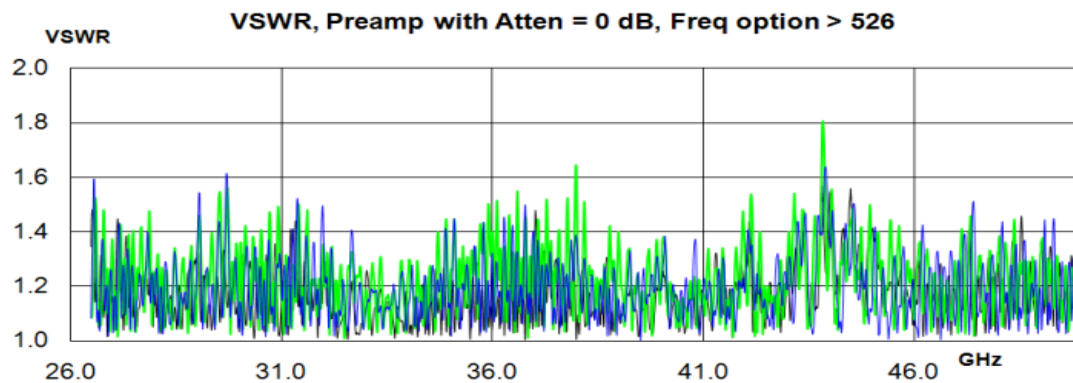
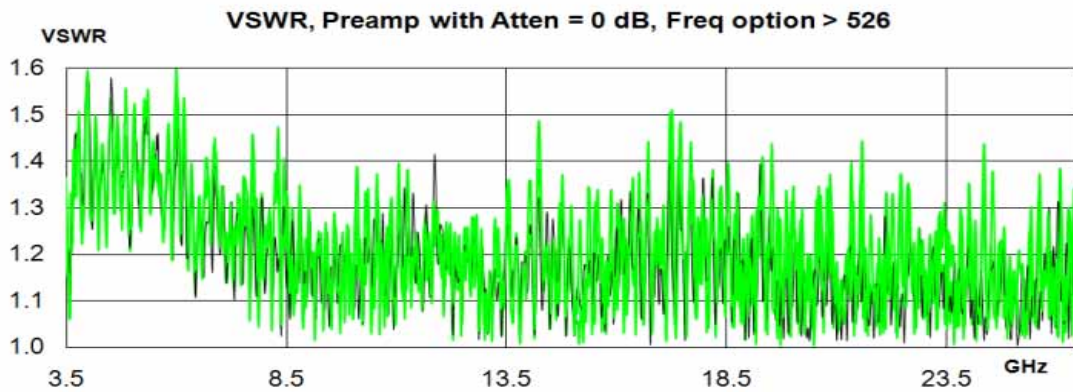
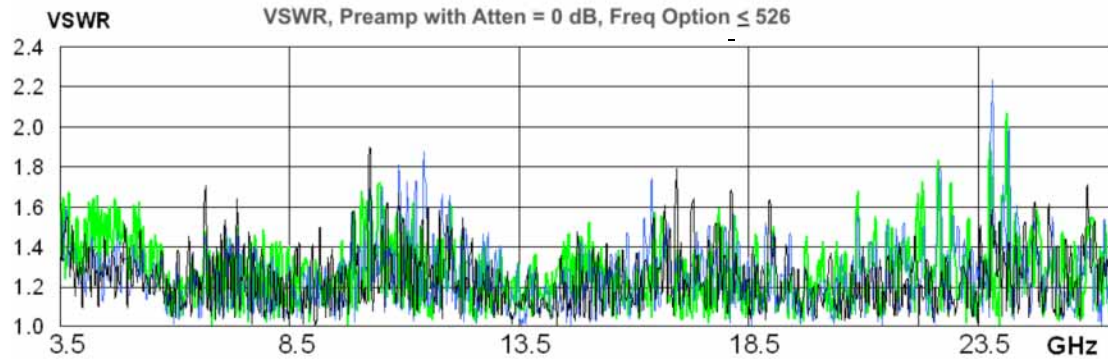
| Description | Specifications | | | Supplemental Information | |
|--|----------------|---|------|------------------------------------|-------|
| RF Input VSWR (at tuned frequency, DC coupled) | | | | DC coupled, 0 dB atten | |
| Option 544, or 550 (mmW) | | | | 95th Percentile^a | |
| Option 508, 513, or 526 (RF/μW) | | | | | |
| Option 503 (RF) | | | | | |
| | ↓ | ↓ | | | |
| Band 0 (0.01 to 3.6 GHz) | x | | 1.71 | | |
| Band 0 (0.01 to 3.6 GHz) | | x | 1.68 | | |
| Band 0 (0.01 to 3.6 GHz) | | | x | | 1.393 |
| Band 1 (3.5 to 8.4 GHz) | | x | | | 1.54 |
| Band 1 (3.5 to 8.4 GHz) | | | x | | 1.50 |
| Band 2 (8.3 to 13.6 GHz) | | x | | | 1.57 |
| Band 2 (8.3 to 13.6 GHz) | | | x | | 1.352 |
| Band 3 (13.5 to 17.1 GHz) | | x | | | 1.48 |
| Band 3 (13.5 to 17.1 GHz) | | | x | | 1.330 |
| Band 4 (17.0 to 26.5 GHz) | | x | | | 1.54 |
| Band 4 (17.0 to 26.5 GHz) | | | x | | 1.339 |
| Band 5 (26.4 to 34.5 GHz) | | | x | | 1.41 |
| Band 6 (34.4 to 50 GHz) | | | x | | 1.42 |
| Nominal VSWR vs. Freq, 0 dB | | | | See plots following | |

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

Nominal VSWR — Preamp On, Low Band [Plot]



Nominal VSWR — Preamp On, Above 3.5 GHz [Plot]



Options P03, P08, P13, P26, P44 and P50 – Preamplifiers
Other Preamp Specifications

| Description | Specifications | Supplemental Information | | |
|-----------------------------------|----------------|---------------------------------|-----------------------------|----------------------------------|
| Second Harmonic Distortion | | Preamp Level^a | Distortion (nominal) | SHI^b (nominal) |
| Source Frequency | | | | |
| 10 MHz to 1.8 GHz | | –45 dBm | –78 dBc | +33 dBm |
| 1.8 to 13.25 GHz | | –50 dBm | –60 dBc | +10 dBm |
| 13.26 to 25 GHz | | –50 dBm | –50 dBc | 0 dBm |

a. Preamp Level = Input Level – Input Attenuation.

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

| Description | Specifications | Supplemental Information | | |
|--|----------------|---------------------------------|-----------------------------|----------------------------------|
| Third Order Intermodulation Distortion | | | | |
| (Tone separation 5 times IF Prefilter Bandwidth ^a Sweep type not set to FFT) | | | | |
| | | Preamp Level^b | Distortion (nominal) | TOI^c (nominal) |
| 10 MHz to 500 MHz | | –45 dBm | –98 dBc | +4 dBm |
| 500 MHz to 3.6 GHz | | –45 dBm | –99 dBc | +4.5 dBm |
| 3.6 to 26.5 GHz | | –50 dBm | –70 dBc | –15 dBm |

a. See the IF Prefilter Bandwidth table in the specifications for **“Gain Compression” on page 48**. When the tone separation condition is met, the effect on TOI of the setting of IF Gain is negligible.

b. Preamp Level = Input Level – Input Attenuation.

c. TOI = third order intercept. The TOI is given by the preamplifier input tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc.

Options P03, P08, P13, P26, P44 and P50 - Preamplifiers
Other Preamp Specifications

20 Options RT1, RT2 – Real-time Spectrum Analyzer (RTSA)

This chapter contains specifications for the PXA Signal Analyzer Options RT1, real-time analysis, basic detection, and RT2, real-time analysis, optimum detection.

Real-time Spectrum Analyzer Performance

| Description | Specs & Nominals | | Supplemental Information |
|---|------------------|----------------|--|
| General Frequency Domain Characteristics | | | |
| Maximum real-time analysis bandwidth (<i>Option RT1</i> or <i>RT2</i>) | | | Determined by analysis BW option |
| With <i>Option B5X</i> | 509.47 MHz | | |
| With <i>Option B2X</i> | 255 MHz | | |
| With <i>Option B1X</i> | 160 MHz | | |
| With <i>Option B85</i> | 85 MHz | | |
| Minimum signal duration with 100% probability of intercept (POI) at full amplitude accuracy | Opt RT2 | Opt RT1 | Maximum span: Default window is Kaiser; Viewable on screen |
| With <i>Option B2X, B5X</i> | | | |
| Spans ≤ 85 MHz | 3.7 μs | 17.17 μs | |
| Spans > 85 MHz | 3.51 μs | 17.17 μs | |
| With <i>Option B1X</i> | | | |
| Span = 85 MHz | 3.7 μs | 3.7 μs | |
| Span > 85 MHz | 3.57 μs | 17.3 μs | |
| With <i>Option B85</i> | 3.7 μs | 3.7 μs | |
| Supported Detectors | | | Peak, Negative Peak, Sample, Average |
| Number of Traces | 6 | | Clear Write, Max Hold, Min Hold |
| Resolution Bandwidths (Window type = Kaiser) | | | 6 RBWs available for each window type, Nominal Span: RBW ratio for windows. Instruments with B1X: Flattop = 7 to 213, Gaussian, Blackman-Harris = 13 to 418, Kaiser = 13 to 418, Hanning = 17 to 551 Instruments with B5X (Span >255MHz) Flattop = 54 to 426, Gaussian, Blackman-Harris = 104 to 836, Kaiser = 104 to 368, Hanning = 138 to 1102 |

Options RT1, RT2 - Real-time Spectrum Analyzer (RTSA)
Real-time Spectrum Analyzer Performance

| Description | Specs & Nominals | | Supplemental Information |
|---|--|-----------------------|---|
| General Frequency Domain Characteristics (cont.) | | | |
| Span | Min RBW | Max RBW | |
| 100 Hz | 240 MHz | 7.67 Hz | |
| 255 MHz | 574 kHz | 18.6 MHz ^a | |
| 509.47 MHz | 574 kHz | 4.59 MHz | |
| Window types | Hanning, Blackman-Harris, Rectangular, Flattop, Kaiser, Gaussian | | |
| Maximum Sample Rate | | | Complex |
| With Option B5X | 600 MSa | | |
| With Option B2X | 300 MSa | | |
| With Option B1X | 200 MSa | | |
| With Option B85 | 106 MSa | | |
| FFT Rate | 292,969/s | | Nominal value for maximum sample rate. For all spans greater than 300 kHz. |
| Supported Triggers | | | Level, Level with Time Qualified (TQT), Line, External, RF Burst, Frame, Frequency Mask (FMT), FMT with TQT |
| Number of Markers | 12 | | |
| Supported Markers | | | Normal, Delta, Noise, Band Power |
| Amplitude resolution | 0.01 dB | | |
| Frequency points ^b | 821 | | |
| With Option B2X | 871 | | |
| With Option B5X | 1,742 | | |
| Minimum acquisition time | 104 μ s ^c | | Value for maximum sample rate |

- This maximum RBW value applies to all window types. Option RT1 has a maximum RBW of 10 MHz with early instrument SW.
- Points are not fixed and vary with span.
- For spectrogram only. For Density view: 30 ms. For Density & spectrogram: 90 ms.

Options RT1, RT2 - Real-time Spectrum Analyzer (RTSA)
Real-time Spectrum Analyzer Performance

| Description | Specs & Nominals | Supplemental Information |
|--|---|--|
| Density View | | |
| Probability range | 0-100% | |
| Minimum Span | 100 Hz | 0.001% steps |
| Maximum Span | | 160 MHz in real-time. Stitched density supports full frequency of instrument |
| Persistence duration | 10 s | |
| Color palettes | Cool, Warm, Grayscale, Radar, Fire, Frost | |
| Spectrogram View | | |
| Maximum number of acquisitions stored | 10,000 | 5,000 with power vs. time combination view |
| Maximum number of acquisitions stored with <i>Option DP4</i> | 50,000 | |
| Dynamic range covered by colors | 200 dB | |

| Description | Specs & Nominals | Supplemental Information |
|---|------------------|---|
| Power vs. Time | | |
| Supported Detectors | | Peak, Negative Peak, Sample, Average |
| Supported Triggers | | Level, Level with Time Qualified (TQT), Line, External, RF Burst, Frame, Frequency Mask (FMT), FMT with TQT |
| Number of Markers | 12 | |
| Maximum Time Viewable | 40 s | |
| Minimum Time Viewable | 215 μ s | |
| Minimum detectable signal For <i>Option RT2</i> only; Available with "Multi-view". | | Signal must have >60 dB Signal-to-Mask (StM) to maintain 100% POI. Does not include analog front-end effects. |
| With <i>Option B2X, B5X</i> | 3.33 ns | |
| With <i>Option B1X</i> | 5 ns | |
| With <i>Option B85</i> | 11.42 ns | |

Options RT1, RT2 - Real-time Spectrum Analyzer (RTSA)
Real-time Spectrum Analyzer Performance

| Description | Specs & Nominals | | | | | Supplemental Information |
|--|--|------------|-----------|-----------|------------|--|
| Frequency Mask Trigger (FMT) | | | | | | |
| Trigger Views | Density, Spectrogram, Normal | | | | | |
| Trigger resolution | 0.5 dB | | | | | |
| Trigger conditions | Enter, Leave, Inside, Outside, Enter->Leave, Leave->Enter, TQT | | | | | |
| Minimum TQT Duration @ 160 MHz span (or BW) | 5.12 μ s | | | | | The minimum TQT duration is inversely proportional to the span (or BW) |
| Minimum detectable signal duration with >60 dB Signal-to Mask (StM) | | | | | | Does not include analog front-end effects. For <i>Option RT2</i> only |
| With <i>Option B2X, B5X</i> | 3.33 ns | | | | | |
| With <i>Option B1X</i> | 5 ns | | | | | |
| With <i>Option B85</i> | 11.42 ns | | | | | |
| Minimum signal duration (in μ s) for 100% probability of FMT triggering with various RBW | | | | | | RBW 1 through 6 can be selected under Bandwidth [BW] Manual. |
| <i>Option RT1</i> | Span (MHz) | | | | | |
| | 160 | 120 | 80 | 40 | 20 | |
| RBW 6 | 17.23 | 17.27 | 17.41 | 17.72 | 18.44 | |
| RBW 5 | 17.39 | 17.49 | 17.73 | 18.36 | 19.72 | |
| RBW 4 | 17.71 | 17.91 | 18.37 | 19.64 | 22.28 | |
| RBW 3 | 18.35 | 18.77 | 19.65 | 22.20 | 27.40 | |
| RBW 2 | 19.63 | 20.47 | 22.21 | 27.32 | 37.64 | |
| RBW 1 | 22.19 | 23.89 | 27.33 | 37.56 | 58.12 | |
| <i>Option RT2</i> | Span (MHz) | | | | | |
| | 509.47 | | | | 255 | |
| RBW 6 | n/a ^a | | | | 3.62 | |
| RBW 4 | 3.837 | | | | 3.837 | |

Options RT1, RT2 - Real-time Spectrum Analyzer (RTSA)
Real-time Spectrum Analyzer Performance

| Description | Specs & Nominals | | | | | Supplemental Information |
|--|------------------|------------|-----------|-----------|-----------|---|
| Frequency Mask Trigger (FMT) (cont.) | | | | | | For 1024-point Blackmann-Harris window. |
| Minimum signal duration (in μ s) for 100% probability of FMT triggering with various StM | | | | | | |
| <i>Option RT1</i> | Span (MHz) | | | | | |
| | 160 | 120 | 80 | 40 | 20 | |
| 0 dB offset | 22.19 | 23.89 | 13.65 | 22.88 | 44.36 | |
| 6 dB offset | 17.08 | 17.07 | 3.48 | 4.66 | 8.36 | |
| 12 dB offset | 16.10 | 15.77 | 1.76 | 2.22 | 4.00 | |
| 20 dB offset | 15.23 | 14.61 | 0.71 | 0.88 | 1.64 | |
| 40 dB offset | 13.87 | 12.79 | 0.08 | 0.10 | 0.24 | |
| 60 dB offset | 13.03 | 11.67 | 0.01 | 0.02 | 0.04 | |
| <i>Option RT2</i> | Span (MHz) | | | | | |
| | 160 | 120 | 80 | 40 | 20 | |
| 0 dB offset | 8.53 | 10.23 | 13.65 | 23.88 | 44.36 | |
| 6 dB offset | 3.42 | 3.42 | 3.48 | 4.66 | 8.36 | |
| 12 dB offset | 2.44 | 2.12 | 1.76 | 2.22 | 4.00 | |
| 20 dB offset | 1.58 | 1.04 | 0.71 | 0.88 | 1.64 | |
| 40 dB offset | 0.325 | 0.120 | 0.080 | 0.100 | 0.240 | |
| 60 dB offset | 0.035 | 0.013 | 0.010 | 0.020 | 0.040 | |

a. Only 4 RBWs are available for spans >255 MHz.

21 Option YAV – Y-Axis Video Output

This chapter contains specifications for *Option YAV* Y-Axis Video Output.

Specifications Affected by Y-Axis Video Output

No other analyzer specifications are affected by the presence or use of this option. New specifications are given in the following pages.

Other Y-Axis Video Output Specifications

General Port Specifications

| Description | Specifications | Supplemental Information |
|-------------|----------------|---------------------------|
| Connector | BNC female | Shared with other options |
| Impedance | | 50Ω (nominal) |

Screen Video

| Description | Specifications | Supplemental Information |
|--|--|--|
| Operating Conditions | | |
| Display Scale Types | All (Log and Lin) | “Lin” is linear in voltage |
| Log Scales | All (0.1 to 20 dB/div) | |
| Modes | Spectrum Analyzer only | |
| FFT & Sweep | Select sweep type = Swept. | |
| Gating | Gating must be off. | |
| Output Signal | | Replication of the RF Input Signal envelope, as scaled by the display settings |
| Differences between display effects and video output | | |
| Detector = Peak, Negative, Sample, or Normal | The output signal represents the input envelope excluding display detection | |
| Average Detector | The effect of average detection in smoothing the displayed trace is approximated by the application of a low-pass filter | Nominal bandwidth: $LPFBW = \frac{Npoints - 1}{SweepTime \cdot \pi}$ |
| EMI Detectors | The output will not be useful. | |
| Trace Averaging | Trace averaging affects the displayed signal but does not affect the video output | |
| Amplitude Range | | Range of represented signals |
| Minimum | Bottom of screen | |
| Maximum | Top of Screen + Overrange | |
| Overrange | | Smaller of 2 dB or 1 division, (nominal) |

Option YAV – Y-Axis Video Output
Other Y-Axis Video Output Specifications

| Description | Specifications | Supplemental Information |
|--|---|--|
| Output Scaling^a | 0 to 1.0 V open circuit, representing bottom to top of screen | |
| Offset | | ±1% of full scale (nominal) |
| Gain accuracy | | ±1% of output voltage (nominal) |
| Delay (RF Input to Analog Out) | | BaseDelay ^b + RBWDelay ^c + 0.159/VBW |

- a. The errors in the output can be described as offset and gain errors. An offset error is a constant error, expressed as a fraction of the full-scale output voltage. The gain error is proportional to the output voltage. Here's an example. The reference level is –10 dBm, the scale is log, and the scale is 5 dB/division. Therefore, the top of the display is –10 dBm, and the bottom is –60 dBm. Ideally, a –60 dBm signal gives 0 V at the output, and –10 dBm at the input gives 1 V at the output. The maximum error with a –60 dBm input signal is the offset error, ±1% of full scale, or ±10 mV; the gain accuracy does not apply because the output is nominally at 0 V. If the input signal is –20 dBm, the nominal output is 0.8 V. In this case, there is an offset error (±10 mV) plus a gain error (±1% of 0.8 V, or ±8 mV), for a total error of ±18 mV.
- b. With *Option FS1* or *Option FS2*, 114 μs; otherwise, 71.7 μs.
- c. With RBW > 100 kHz and either *Option FS1* or *Option FS2*, 5.52/RBW; otherwise 2.56/RBW.

Continuity and Compatibility

| Description | Specifications | Supplemental Information |
|---|------------------------------|---|
| Continuity and Compatibility | | |
| Output Tracks Video Level | | |
| During sweep | | Except band breaks in swept spans |
| Zero span | Yes | |
| FFT spans | No | |
| Swept spans | | |
| ≤2.5 MHz | Yes | |
| >2.5, ≤10 MHz | | Sweep segmentation interruptions ^a |
| >10, ≤100 MHz | Yes | |
| >100 MHz | | Band crossing interruptions possible |
| Between sweeps | See supplemental information | Before sweep interruption ^b Alignments ^c Auto Align = Partial ^{de} |
| External trigger, no trigger ^e | Yes | |
| HP 8566/7/8 Compatibility ^f | | Recorder output labeled “Video” |
| Continuous output | | Alignment differences ^g Band crossing ^h FFTs ⁱ |
| Output impedance | | Two variants ^j |
| Gain calibration | | LL and UR not supported ^k |
| RF Signal to Video Output Delay | | See footnote ^l |

- In these spans, the sweep is segmented into sub-spans, with interruptions between these subspans. These can be prevented by setting the Phase Noise Optimize key to Fast Tuning.
- There is an interruption in the tracking of the video output before each sweep. During this interruption, the video output holds instead of tracks for a time period given by approximately 1.8/RBW.
- There is an interruption in the tracking of the video output during alignments. During this interruption, the video output holds instead of tracking the envelope of the RF input signal. Alignments may be set to prevent their interrupting video output tracking by setting Auto Align to Off.
- Setting Auto Align to Off usually results in a warning message soon thereafter. Setting Auto Align to Partial results in many fewer and shorter alignment interruptions, and maintains alignments for a longer interval.
- If video output interruptions for Partial alignments are unacceptable, setting the analyzer to External Trigger without a trigger present can prevent these from occurring, but will prevent there being any on-screen updating. Video output is always active even if the analyzer is not sweeping.

Option YAV – Y-Axis Video Output
Other Y-Axis Video Output Specifications

- f. This section of specifications shows compatibility of the Screen Video function with HP 8566-Series analyzers. Compatibility with ESA and PSA analyzers is similar in most respects.
- g. The HP 8566-series analyzer(s) did not have alignments and interruptions that interrupted video outputs, as discussed above.
- h. The location of the boundaries between harmonic mixing bands is different between the HP 8566-series analyzer(s) and this analyzer. Also, this analyzer uses segmented sweeps for spans between 2.5 and 10 MHz.
- i. The HP 8566-series analyzer(s) did not have FFT sweeps. This analyzer compatibility is improved if the sweep type is set to Manual and Swept.
- j. Early HP 8566-series analyzer(s) had a 140Ω output impedance; later ones had 190Ω . The specification was $<475\Omega$. The Analog Out port has a 50Ω impedance.
- k. The HP 8566-series analyzer(s) had LL (lower left) and UR (upper right) controls that could be used to calibrate the levels from the video output circuit. These controls are not available in this option.
- l. The delay between the RF input and video output shown in **Delay on page 258** is much higher than the delay in the HP 8566-series analyzer(s). The latter has a delay of approximately $0.554/\text{RBW} + 0.159/\text{VBW}$.

Log Video Output

| Description | Specifications | Supplemental Information |
|--|----------------------------|--|
| Amplitude Range (terminated with 50Ω) Maximum Scale factor | | 1.0 V (nominal) for signal envelope of – 10 dBm at the mixer Output changes 1 V for every 192.66 dB change in signal envelope |
| Bandwidth | Set by RBW | |
| Operating Conditions | Select Sweep Type = Swept. | |

Linear Video (AM Demod) Output

| Description | Specifications | Supplemental Information |
|---|----------------------------|---|
| Amplitude Range (terminated with 50Ω) Maximum Minimum Scale factor | | 1.0 V (nominal) for signal envelope at the reference level 0 V If carrier level is set to half the reference level in volts, the scale factor is 200%/V |
| Bandwidth | Set by RBW | |
| Operating Conditions | Select Sweep Type = Swept. | |

22 5G NR Measurement Application

This chapter contains specifications for the N9085EM0E 5G NR (New Radio) measurement application.

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 range documented in the In-band Frequency Range of each application.

Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|----------------------------|
| Channel Power | | |
| Minimum power at RF Input | | –50 dBm (nominal) |
| Absolute power accuracy | | 20 to 30°C, Atten = 10 dB |
| 10 MHz to 3.5 GHz (Band 0) | ±0.63 dB | ±0.19 dB (95th Percentile) |
| 3.5 to 8.4 GHz (Band 1) | ±1.78 dB | ±0.73 dB (95th Percentile) |
| 26.4 to 34.5 GHz (Band 5) (<i>Option 544/550</i>) ^a | ±2.78 dB | ±1.16 dB (95th Percentile) |
| 34.4 to 50 GHz (Band 6) (<i>Option 544/550</i>) ^b | ±3.48 dB | ±1.53 dB (95th Percentile) |
| Measurement Floor | | In a 100 MHz bandwidth |
| 3 Hz to 3.6 GHz (Band 0) (<i>Option EP1</i>) | | –70.7 dBm (typical) |
| 3 Hz to 3.6 GHz (Band 0) (<i>Option EP0</i>) | | –68.7 dBm (typical) |
| 3.6 to 8.4 GHz (Band 1) (<i>Option 508/513/526</i>) | | –69.7 dBm (typical) |
| 3.6 to 8.4 GHz (Band 1) (<i>Option 544/550</i>) | | –65.7 dBm (typical) |
| 26.4 to 30 GHz (Band 5) (<i>Option 544/550</i>) ^a | | –59.7 dBm (typical) |
| 37 to 40 GHz (Band 6) (<i>Option 544/550</i>) ^b | | –55.7 dBm (typical) |

a. Covers NR Operating Band n257 and n258.

b. Covers NR Operating Band n260.

5G NR Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Spurious Emissions | | Table-driven spurious signals; search across regions |
| Dynamic Range ^a , relative (RBW = 1 MHz) | | |
| 10 MHz to 3.6 GHz (Band 0) | 86.2 dB | 89.2 dB (typical) |
| 3.6 to 8.4 GHz (Band 1) | 84.9 dB | 88.7 dB (typical) |
| 8.3 to 13.6 GHz (Band 2) | 82.1 dB | 85.2 dB (typical) |
| 13.5 to 17.1 GHz (Band 3) | 78.3 dB | 83.3 dB (typical) |
| 17 to 26.5 GHz (Band4) | 71.4 dB | 76.4 dB (typical) |
| 26.4 to 34.5 GHz (Band 5) (<i>Option 544/550</i>) | 70.4 dB | 76.4 dB (typical) |
| 34.4 to 50 GHz (Band 6) (<i>Option 544/550</i>) | 63.5 dB | 72.4 dB (typical) |
| Sensitivity ^b , absolute (RBW = 1 MHz) | | |
| 10 MHz to 3.6 GHz (Band 0) | –85.5 dBm | –88.5 dBm (typical) |
| 3.6 to 8.4 GHz (Band 1) | –85.5 dBm | –89.5 dBm (typical) |
| 8.3 to 13.6 GHz (Band 2) | –82.5 dBm | –85.5 dBm (typical) |
| 13.5 to 17.1 GHz (Band 3) | –78.5 dBm | –83.5 dBm (typical) |
| 17 to 26.5 GHz (Band4) | –74.5 dBm | –79.5 dBm (typical) |
| 26.4 to 34.5 GHz (Band 5) (<i>Option 544/550</i>) | –73.5 dBm | –79.5 dBm (typical) |
| 34.4 to 50 GHz (Band 6) (<i>Option 544/550</i>) | –66.5 dBm | –75.5 dBm (typical) |
| Accuracy | | (Attenuation = 10 dB) |
| Frequency Range | | |
| 10 MHz to 3.6 GHz (Band 0) | | ±0.19 dB (95th Percentile) |
| 3.6 to 8.4 GHz (Band 1) | | ±0.62 dB (95th Percentile) |
| 8.3 to 13.6 GHz (Band 2) | | ±0.60 dB (95th Percentile) |
| 13.5 to 17.1 GHz (Band 3) | | ±0.71 dB (95th Percentile) |
| 17 to 26.5 GHz (Band4) | | ±0.81 dB (95th Percentile) |
| 26.4 to 34.5 GHz (Band 5) (<i>Option 544/550</i>) | | ±1.41 dB (95th Percentile) |
| 34.4 to 50 GHz (Band 6) (<i>Option 544/550</i>) | | ±2.07 dB (95th Percentile) |

- a. The dynamic range is specified at 12.5 MHz offset from the center frequency with the mixer level at a 1 dB compression point. This will degrade the accuracy by 1 dB if the carrier and spurious emissions are within the same band.
- b. The sensitivity is specified at the far offset from the carrier, where the phase noise does not contribute. You can derive the dynamic range at the far offset from the 1 dB compression mixer level and the sensitivity.

5G NR Measurement Application
Measurements

| Description | Specifications | | | Supplemental Information |
|--|--------------------------|---------------|----------------|---|
| Adjacent Channel Power | | | | Single Carrier |
| Minimum power at RF input | | | | –36 dBm (nominal) |
| Accuracy | Channel Bandwidth | | | |
| Adjacent Offset, MS ^a | 20 MHz | 50 MHz | 100 MHz | ACPR Range for Specification |
| Band 0 | ±0.13 dB | ±0.19 dB | ±0.25 dB | –33 to –27 dBc with opt ML(–20, –17, –15 dBm ^b) |
| Band 1 | ±0.49 dB | ±0.70 dB | ±0.92 dB | –33 to –27 dBc with opt ML(–18, –16, –15 dBm ^b) |
| Band 5 (<i>Option 544/550</i>) | | ±0.91 dB | ±1.18 dB | –20 to –14 dBc with opt ML(–20, –19, –17 dBm ^b) |
| Band 6 (<i>Option 544/550</i>) | | ±1.37 dB | ±1.80 dB | –19 to –13 dBc with opt ML(–19, –17, –15 dBm ^b) |
| Adjacent Offset, BTS ^c | | | | |
| Band 0 | ±0.68 dB | ±1.09 dB | ±1.54 dB | –48 to –42 dBc with opt ML(–15, –13, –11 dBm ^b) |
| Band 1 | ±1.28 dB | ±1.94 dB | ±2.63 dB | –48 to –42 dBc with opt ML(–14, –13, –11 dBm ^b) |
| Band 5 (<i>Option 544/550</i>) | | ±1.36 dB | ±1.81 dB | –31 to –25 dBc with opt ML(–18, –16, –14 dBm ^b) |
| Band 6 (<i>Option 544/550</i>) | | ±2.30 dB | ±3.09 dB | –29 to –23 dBc with opt ML(–16, –14, –13 dBm ^b) |
| Alternate Offset, BTS ^c | | | | |
| Band 0 | ±0.14 dB | ±0.21 dB | ±0.26 dB | –48 to –42 dBc with opt ML(–4, –1, +3 dBm ^b) |
| Band 1 | ±0.59 dB | ±0.91 dB | ±1.04 dB | –48 to –42 dBc with opt ML(+2, +6, +6 dBm ^b) |
| Band 5 (<i>Option 544/550</i>) | | ±1.08 dB | ±1.39 dB | –31 to –25 dBc with opt ML(–4, –2, +2 dBm ^b) |
| Band 6 (<i>Option 544/550</i>) | | ±1.51 dB | ±1.95 dB | –29 to –23 dBc with opt ML(–1, +2, +4 dBm ^b) |
| Dynamic Range | | | | Noise Correction On, Noise Floor Extension Off |
| Channel Bandwidth:100 MHz | | | | Dynamic Range (nominal) Optimum Mixer Level (nominal) |
| Band 1 (<i>Option EP1</i>) | | | | 78.7 dB –1.37 dBm |
| Band 1 (<i>Option EP0</i>) | | | | 78.3 dB 0.13 dBm |
| Band 5, Band 6 (<i>Option 544/550</i>) | | | | 54.5 dB |

- Measurement bandwidths for mobile stations are 19.095, 48.615 and 98.31 MHz for channel bandwidths of 20, 50 and 100 MHz respectively.
- The optimum mixer levels for each channel bandwidths of 20, 50 and 100 MHz respectively.
- Measurement bandwidths for base transceiver stations are 19.08, 48.6 and 98.28 MHz for channel bandwidths of 20, 50 and 100 MHz respectively.

5G NR Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--------------------------------------|----------------|---|
| Spectrum Emission Mask | | Offset from CF = (channel bandwidth + measurement bandwidth) / 2; measurement bandwidth = 1.0 MHz |
| Dynamic Range | | |
| Channel Bandwidth: 20MHz | | |
| Band 0 (<i>Option EP1</i>) | 82.5 dB | 88.2 dB (typical) |
| Band 0 (<i>Option EP0</i>) | 81.5 dB | 86.2 dB (typical) |
| Band 1 (<i>Option 508/513/526</i>) | 79.7 dB | 85.4 dB (typical) |
| Band 1 (<i>Option 544/550</i>) | 75.0 dB | 82.4 dB (typical) |
| Band 5 (<i>Option 544/550</i>) | 68.4 dB | 76.3 dB (typical) |
| Band 6 (<i>Option 544/550</i>) | 61.8 dB | 71.8 dB (typical) |
| Channel Bandwidth: 50 MHz | | |
| Band 0 (<i>Option EP1</i>) | 83.5 dB | 89.0 dB (typical) |
| Band 0 (<i>Option EP0</i>) | 83.0 dB | 87.5 dB (typical) |
| Band 1 (<i>Option 508/513/526</i>) | 81.0 dB | 86.4 dB (typical) |
| Band 1 (<i>Option 544/550</i>) | 76.4 dB | 84.3 dB (typical) |
| Band 5 (<i>Option 544/550</i>) | 69.8 dB | 77.3 dB (typical) |
| Band 6 (<i>Option 544/550</i>) | 63.1 dB | 73.0 dB (typical) |
| Channel Bandwidth: 100 MHz | | |
| Band 0 (<i>Option EP1</i>) | 84.5 dB | 90.0 dB (typical) |
| Band 0 (<i>Option EP0</i>) | 84.0 dB | 87.9 dB (typical) |
| Band 1 (<i>Option 508/513/526</i>) | 81.0 dB | 87.4 dB (typical) |
| Band 1 (<i>Option 544/550</i>) | 77.4 dB | 85.3 dB (typical) |
| Band 5 (<i>Option 544/550</i>) | 70.8 dB | 78.3 dB (typical) |
| Band 6 (<i>Option 508/513/526</i>) | 66.1 dB | 76.3 dB (typical) |
| Band 6 (<i>Option 544/550</i>) | 64.1 dB | 74.0 dB (typical) |
| Sensitivity | | |
| Band 0 (<i>Option EP1</i>) | -96.5 dBm | -100.5 dBm (typical) |
| Band 0 (<i>Option EP0</i>) | -95.5 dBm | -98.5 dBm (typical) |
| Band 1 (<i>Option 508/513/526</i>) | -95.5 dBm | -99.5 dBm (typical) |
| Band 1 (<i>Option 544/550</i>) | -89.5 dBm | -95.5 dBm (typical) |

5G NR Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|----------------------------------|----------------|----------------------------|
| Band 5 (<i>Option 544/550</i>) | –83.5 dBm | –89.5 dBm (typical) |
| Band 6 (<i>Option 544/550</i>) | –76.5 dBm | –85.5 dBm (typical) |
| Accuracy | | |
| Relative | | |
| Band 0 | ±0.16 dB | |
| Band 1 | ±0.65 dB | |
| Band 5 (<i>Option 544/550</i>) | ±0.87 dB | |
| Band 6 (<i>Option 544/550</i>) | ±1.20 dB | |
| Absolute | | |
| Band 0 | ±0.62 dB | ±0.21 dB (95th Percentile) |
| Band 1 | ±1.17 dB | ±0.56 dB (95th Percentile) |
| Band 5 (<i>Option 544/550</i>) | ±2.27 dB | ±1.01 dB (95th Percentile) |
| Band 6 (<i>Option 544/550</i>) | ±3.47 dB | ±1.38 dB (95th Percentile) |

| Description | Specifications | Supplemental Information |
|------------------------------|----------------------|--------------------------|
| Power Statistics CCDF | | |
| Histogram Resolution | 0.01 dB ^a | |

- 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.

| Description | Specifications | Supplemental Information |
|---------------------------|----------------|---|
| Occupied Bandwidth | | |
| Minimum power at RF Input | | –30 dBm (nominal) |
| Frequency Accuracy | ± 200 kHz | RBW = 30 kHz, Number of Points = 1001, Span = 200 MHz |

5G NR Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|----------------------------|----------------|--|
| Modulation Analysis | | |
| EVM for Downlink floor | | |
| Channel Bandwidth: 20 MHz | | |
| Option EP1 | | |
| Band 0 (2 GHz) | | 0.17% (nominal) |
| Option EP0 | | |
| Band 0 (2 GHz) | | 0.16% (nominal) |
| Channel Bandwidth: 100 MHz | | |
| Option EP1 | | |
| Band 1 (5 GHz) | | 0.28% (nominal) |
| Band 5 (28 GHz) | | 0.71% (nominal) |
| Band 6 (39 GHz) | | 1.31% (nominal) |
| Option EP0 | | |
| Band 1 (5 GHz) | | 0.27% (nominal) |
| Band 5 (28 GHz) | | 0.67% (nominal) |
| Band 6 (39 GHz) | | 0.99% (nominal) |
| Frequency Error | | |
| Lock range | | $\pm 2.5 \times \text{subcarrier spacing} = 75 \text{ kHz}$ for default 30 kHz subcarrier spacing ^a (nominal) |
| Accuracy | | $\pm 1 \text{ Hz} + \text{tfa}^b$ (nominal) |

a. The specification applies when Extended Freq Range = On.

b. tfa = transmitter frequency \times frequency reference accuracy.

Frequency Ranges

| Frequency Range: FR1 | | | | | |
|----------------------|--|----------------|--|----------------|-------------|
| NR Operating Band | Uplink (UL) Operating Band | | Downlink (DL) Operating Band | | Duplex Mode |
| | BS Receive | | BS Transmit | | |
| | UE Transmit | | UE Receive | | |
| | F _{UL_low} – F _{UL_high} | Total BW (MHz) | F _{DL_low} – F _{DL_high} | Total BW (MHz) | |
| n1 | 1920 -1980 MHz | 60 | 2110 -2170 MHz | 60 | FDD |
| n2 | 1850 - 1910 MHz | 60 | 1930 - 1990 MHz | 60 | FDD |
| n3 | 1710 - 1785 MHz | 75 | 1805 - 1880 MHz | 75 | FDD |
| n5 | 824 - 849 MHz | 25 | 869 - 894 MHz | 25 | FDD |
| n7 | 2500 - 2570 MHz | 70 | 2620 - 2690 MHz | 70 | FDD |
| n8 | 880 - 915 MHz | 35 | 925 - 960 MHz | 35 | FDD |
| n20 | 832 - 862 MHz | 30 | 791- 821 MHz | 30 | FDD |
| n28 | 703 - 748 MHz | 45 | 758 - 803 MHz | 45 | FDD |
| n38 | 2570 -2620 MHz | 50 | 2570 -2620 MHz | 50 | TDD |
| n41 | 2496 -2690 MHz | 194 | 2496 -2690 MHz | 194 | TDD |
| n50 | 1432 -1517 MHz | 85 | 1432 -1517 MHz | 85 | TDD |
| n51 | 1427 -1432 MHz | 5 | 1427 -1432 MHz | 5 | TDD |
| n66 | 1710 -1780 MHz | 70 | 2110 -2200 MHz | 90 | FDD |
| n70 | 1695 -1710 MHz | 15 | 1995 -2020 MHz | 25 | FDD |
| n71 | 663 - 698 MHz | 35 | 617 - 652 MHz | 35 | FDD |
| n74 | 1427 -1470 MHz | 43 | 1475 -1518 MHz | 43 | FDD |
| n75 | N/A | | 1432 -1517 MHz | 85 | SDL |
| n76 | N/A | | 1427 -1432 MHz | 5 | SDL |
| n78 | 3300 -3800 MHz | 500 | 3300 - 3800 MHz | 500 | TDD |
| n77 | 3300 - 4200 MHz | 900 | 3300 - 4200 MHz | 900 | TDD |
| n79 | 4400 -5000 MHz | 600 | 4400 - 5000 MHz | 600 | TDD |
| n80 | 1710 -1785 MHz | 75 | N/A | | SUL |
| n81 | 880 -915 MHz | 35 | N/A | | SUL |
| n82 | 832 -862 MHz | 30 | N/A | | SUL |

5G NR Measurement Application
Frequency Ranges

| Frequency Range: FR1 | | | | |
|----------------------|------------------------------|----------------|------------------------------|----------------|
| NR Operating Band | Uplink (UL) Operating Band | | Downlink (DL) Operating Band | |
| | BS Receive | | BS Transmit | |
| | UE Transmit | | UE Receive | |
| | $F_{UL_low} - F_{UL_high}$ | Total BW (MHz) | $F_{DL_low} - F_{DL_high}$ | Total BW (MHz) |
| n83 | 703 -748 MHz | 45 | N/A | |
| n84 | 1920 -1980 MHz | 60 | N/A | |
| | | | | Duplex Mode |
| | | | | SUL |
| | | | | SUL |

| Frequency Range: FR2 | | | | |
|----------------------|------------------------------|----------------|------------------------------|----------------|
| NR Operating Band | Uplink (UL) Operating Band | | Downlink (DL) Operating Band | |
| | BS Receive | | BS Transmit | |
| | UE Transmit | | UE Receive | |
| | $F_{UL_low} - F_{UL_high}$ | Total BW (MHz) | $F_{DL_low} - F_{DL_high}$ | Total BW (MHz) |
| n257 | 26500-29500 MHz | 3000 | 26500-29500 MHz | 3000 |
| n258 | 24250-27500 MHz | 3260 | 24250-27500 MHz | 3260 |
| n260 | 37000-40000 MHz | 3000 | 37000-40000 MHz | 3000 |
| | | | | Duplex Mode |
| | | | | TDD |
| | | | | TDD |
| | | | | TDD |

5G NR Measurement Application Frequency Ranges

23 Analog Demodulation Measurement Application

This chapter contains specifications for the N9063EM0E Analog Demodulation Measurement Application.

Additional Definitions and Requirements

The warranted specifications shown apply to Band 0-6 operations, unless otherwise noted, for all analyzers. The application functions, with nominal (non-warranted) performance, at any frequency within the frequency range set by the analyzer frequency options (see table). In practice, the lowest and highest frequency of operation may be further limited by AC coupling; by "folding" near 0 Hz; by DC feedthrough; and by Channel BW needed. Phase noise and residual FM generally increase in higher bands.

Warranted specifications shown apply when Channel BW ≤ 40 MHz, unless otherwise noted. (Channel BW is an important user-settable control.) The application functions, with nominal (non-warranted) performance, at any Channel BW up to the analyzer's bandwidth options (see table). The Channel BW required for a measurement depends on: the type of modulation (AM, FM, PM); the rate of modulation; the modulation depth or deviation; and the spectral contents (e.g. harmonics) of the modulating tone. Many specifications require that the Channel BW control is optimized: neither too narrow nor too wide.

Specifications for frequencies above 3.6 GHz apply when the signal path is set to Preselector Bypassed (*Option MPB* enabled).

Many warranted specifications (rate, distortion) apply only in the case of a single, sinusoidal modulating tone without excessive harmonics, non-harmonics, spurs, or noise. Harmonics, which are included in most distortion results, are counted up to the 10th harmonic of the dominant tone, or as limited by SINAD BW or post-demod filters. Note that SINAD will include Carrier Frequency Error (the "DC term") in FM by default; it can be eliminated with a HPF or Auto Carrier Frequency feature.

Warranted specifications apply to results of the software application; the hardware demodulator driving the Analog Out line is described separately.

Warranted specifications apply over an operating temperature range of 20 to 30°C; and mixer level -24 to -18 dBm (mixer level = Input power level – Attenuation). Additional conditions are listed at the beginning of the FM, AM, and PM sections, in specification tables, or in footnotes.

See **"Definitions of terms used in this chapter" on page 272.**

Definitions of terms used in this chapter

Let P_{signal} (S) = Power of the signal; P_{noise} (N) = Power of the noise; $P_{\text{distortion}}$ (D) = Power of the harmonic distortion ($P_{H2} + P_{H3} + \dots + P_{Hi}$ where Hi is the i^{th} harmonic up to $i=10$);
 P_{total} = Total power of the signal, noise and distortion components.

| Term | Short Hand | Definition |
|------------|---------------------------|---|
| Distortion | $\frac{N + D}{S + N + D}$ | $(P_{\text{total}} - P_{\text{signal}})^{1/2} / (P_{\text{total}})^{1/2} \times 100\%$ |
| THD | $\frac{D}{S}$ | $(P_{\text{distortion}})^{1/2} / (P_{\text{signal}})^{1/2} \times 100\%$ where THD is the total harmonic distortion |
| SINAD | $\frac{S + N + D}{N + D}$ | $20 \times \log_{10} [1/(P_{\text{distortion}})]^{1/2} = 20 \times \log_{10} [(P_{\text{total}})^{1/2} / (P_{\text{total}} - P_{\text{signal}})^{1/2}]$ where SINAD is Signal-to-Noise-And-Distortion ratio |
| SNR | $\frac{S + N + D}{N}$ | $P_{\text{signal}} / P_{\text{noise}} \sim (P_{\text{signal}} + P_{\text{noise}} + P_{\text{distortion}}) / P_{\text{noise}}$ where SNR is the Signal-to-Noise Ratio. The approximation is per the implementations defined with the HP/Agilent/Keysight 8903A. |

NOTE

P_{noise} must be limited to the bandwidth of the applied filters.
The harmonic sequence is limited to the 10th harmonic unless otherwise indicated.
 P_{noise} includes all spectral energy that is not near harmonic frequencies, such as spurious signals, power line interference, etc.

RF Carrier Frequency and Bandwidth

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Carrier Frequency | | |
| Maximum Frequency | | |
| <i>Option 503</i> | 3.6 GHz | RF/ μ W frequency option |
| <i>Option 508</i> | 8.4 GHz | RF/ μ W frequency option |
| <i>Option 513</i> | 13.6 GHz | RF/ μ W frequency option |
| <i>Option 526</i> | 26.5 GHz | RF/ μ W frequency option |
| <i>Option 544</i> | 44 GHz | mmW frequency option |
| <i>Option 550</i> | 50 GHz | mmW frequency option |
| Minimum Frequency | | |
| AC Coupled ^a | 10 MHz | In practice, limited by the need to keep modulation sidebands from folding, and by the interference from LO feedthrough. |
| DC Coupled | 2 Hz | |
| Maximum Information Bandwidth (Info BW)^b | | |
| Standard <i>B25</i> | 25 MHz | |
| <i>Option B40</i> | 40 MHz | |
| <i>Option B85</i> | 85 MHz | |
| <i>Option B1X</i> | 160 MHz | |
| <i>Option B2X</i> | 255 MHz | |
| <i>Option B5X</i> | 510 MHz | |
| Capture Memory | 3.6 MSa | Each sample is an I/Q pair. |
| (<i>Sample Rate</i> \times <i>Acq Time</i>) | | See note ^c |

- a. AC Coupled is only applicable to frequency *Options 503, 508, 513, and 526*.
- b. The maximum Info BW indicates the maximum operational BW, which depends on the analysis BW option equipped with the analyzer. However, the demodulation specifications only apply to the Channel BW indicated in the following sections.
- c. Sample rate is set indirectly by the user, with the Span and Channel BW controls (viewed in RF Spectrum). The Info BW (also called Demodulation BW) is based on the larger of the two; specifically, Info BW = max [Span, Channel BW]. The sample interval is $1/(1.25 \times \text{Info BW})$; e.g. if Info BW = 200 kHz, then sample interval is 4 μ s. The sample rate is $1.25 \times \text{Info BW}$, or $1.25 \times \text{max} [\text{Span}, \text{Channel BW}]$. These values are approximate, to estimate memory usage. Exact values can be queried via SCPI while the application is running. Acq Time (acquisition time) is set by the largest of 4 controls:
Acq Time = max[2.0 / (RF RBW), 2.0 / (AF RBW), 2.2 \times Demod Wfm Sweep Time, Demod Time]

Post-Demodulation

| Description | Specifications | Supplemental Information |
|-------------------------------------|---------------------------------------|---|
| Maximum Audio Frequency Span | | 1/2 × Channel BW |
| Filters | | |
| High Pass | 20 Hz | 2-Pole Butterworth |
| | 50 Hz | 2-Pole Butterworth |
| | 300 Hz | 2-Pole Butterworth |
| | 400 Hz | 10-Pole Butterworth; used to attenuate sub-audible signaling tones |
| Low Pass | 300 Hz | 5-Pole Butterworth |
| | 3 kHz | 5-Pole Butterworth |
| | 15 kHz | 5-Pole Butterworth |
| | 30 kHz | 3-Pole Butterworth |
| | 80 kHz | 3-Pole Butterworth |
| | 300 kHz | 3-Pole Butterworth |
| | 100 kHz (>20 kHz Bessel) ^a | 9-Pole Bessel; provides linear phase response to reduce distortion of square-wave modulation, such as FSK or BPSK |
| Band Pass | Manual | Manually tuned by user, range 300 Hz to 20 MHz; 5-Pole Butterworth; for use with high modulation rates |
| | CCITT | ITU-T O.41, or ITU-T P.53; known as "psophometric" |
| | A-Weighted | ANSI IEC rev 179 |
| | C-Weighted | Roughly equivalent to 50 Hz HPF with 10 kHz LPF |
| | C-Message | IEEE 743, or BSTM 41004; similar in shape to CCITT, sometimes called "psophometric" |
| | CCIR-1k Weighted ^a | ITU-R 468, CCIR 468-2 Weighted, or DIN 45 405 |
| | CCIR-2k Weighted ^a | ITU 468 ARM or CCIR/ARM (Average Responding Meter), commonly referred to as "Dolby" filter |
| | CCIR Unweighted | ITU-R 468 Unweighted ^a |

Analog Demodulation Measurement Application
Post-Demodulation

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Maximum Audio Frequency Span (cont.) | | |
| De-emphasis (FM only) | 25 μ s | Equivalent to 1-pole LPF at 6366 Hz |
| | 50 μ s | Equivalent to 1-pole LPF at 3183 Hz; broadcast FM for most of world |
| | 75 μ s | Equivalent to 1-pole LPF at 2122 Hz; broadcast FM for U.S. |
| | 750 μ s | Equivalent to 1-pole LPF at 212 Hz; 2-way mobile FM radio. |
| SINAD Notch ^b | | Tuned automatically by application to highest AF response, for use in SINAD, SNR, and Distortion calculations; complies with TI-603 and ITU-O.132; stop bandwidth is $\pm 13\%$ of tone frequency. |
| Signaling Notch ^b | | FM only; manually tuned by user, range 50 to 300 Hz; used to eliminate CTCSS or CDCSS signaling tone; complies with TIA-603 and ITU-O.132; stop bandwidth is $\pm 13\%$ of tone frequency. |

- a. ITU standards specify that CCIR-1k Weighted and CCIR Unweighted filters use Quasi-Peak-Detection (QPD). However, the implementation in N9063B is based on true-RMS detection, scaled to respond as QPD. The approximation is valid when measuring amplitude of Gaussian noise, or SINAD of a single continuous sine tone (e.g. 1 kHz), with harmonics, combined with Gaussian noise. The results may not be consistent with QPD if the input signal is bursty, clicky, or impulsive; or contains non-harmonically related tones (multi-tone, intermods, spurs) above the noise level. Use the AF Spectrum trace to validate these assumptions. Consider using Agilent/Keysight U8903A Audio Analyzer if true QPD is required.
- b. The Signaling Notch filter does not visibly affect the AF Spectrum trace.

Frequency Modulation

Conditions required to meet specification

- Peak deviation¹: ≥ 10 Hz
- Modulation index (β : Deviation/Rate) and Deviation:
 $\beta \geq 0.001$ or Deviation ≥ 10 Hz, whichever is larger,
 $\beta \leq 20000$, Deviation ≤ 16 MHz, whichever is smaller
 Minimum Deviation
 50 Hz @ Rate 10 Hz
 20 Hz @ Rate 20 Hz
 Maximum Deviation
 10 MHz @ Rate 200 kHz/500 kHz
 5 MHz @ Rate 1 MHz
- Channel BW: 390 Hz to 40 MHz
- Rate: 10 Hz to 1 MHz
- SINAD bandwidth: (Channel BW) / 2
- Single tone - sinusoid modulation
- Center Frequency (CF): ≥ 100 kHz (Band 0), Band 1 to 6

| Description | Specifications | Supplemental Information |
|--------------------------------------|-------------------------|--------------------------|
| FM Measurement Range | | |
| Modulation Rate Range ^{abc} | 1 Hz to (max info BW)/2 | |
| Peak Deviation Range ^{abc} | < (max info BW)/2 | |

- a. $((\text{Modulation Rate}) + (\text{Peak Deviation})) < (\text{max Info BW})/2$
- b. The measurement range is also limited by max capture memory. Specifically, $\text{SamplingRate} \times \text{AcqTime} < 3.6 \text{ MSa}$, where $\text{SamplingRate} = 1.25 \times \text{Info BW}$. For example, if the modulation rate is 1 Hz, then the period of the waveform is 1 second. Suppose $\text{AcqTime} = 72$ seconds, then the max SamplingRate is 50 kHz, which leads to 40 kHz max Info BW. Under such condition, the peak deviation should be less than 20 kHz.
- c. Max info BW: See **“Maximum Information Bandwidth (Info BW)” on page 273**.

1. Peak deviation, modulation index ("beta"), and modulation rate are related by Peak-Deviation = ModIndex \times Rate. Each of these has an allowable range, but all conditions must be satisfied at the same time. For example, PeakDeviation = 800 kHz at Rate = 20 Hz is not allowed, since ModIndex = PeakDeviation/Rate would be 40000, but ModIndex is limited to 20000. In addition, 2nd harmonics must be contained in Channel BW. For FM, an approximate rule-of-thumb is $5 \times \text{Rate} < \text{Channel BW}$.

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|--|--|--------------------------|
| FM Deviation Accuracy^{abc} | | |
| Band 0 | $\pm (1.0 \times 10^{-7} \times \text{Deviation}^{0.75} + 0.002) \times (\text{Deviation} + \text{Rate}) \text{ [Hz]}$ | |
| Band 1 0.01 ≤ ModIndex @ 2 kHz ≤ Rate 100 ≤ Deviation + Rate @ Rate ≤ 20 Hz | $\pm (2.0 \times 10^{-7} \times \text{Deviation}^{0.75} + 0.002) \times (\text{Deviation} + \text{Rate}) \text{ [Hz]}$ | |
| Band 2 0.005 ≤ ModIndex @ 1 MHz = Rate 200 ≤ Deviation + Rate @ Rate ≤ 50 Hz | $\pm (1.5 \times 10^{-7} \times \text{Deviation}^{0.75} + 0.002) \times (\text{Deviation} + \text{Rate}) \text{ [Hz]}$ | |
| Band 3 0.01 ≤ ModIndex @ 500 kHz ≤ Rate 150 ≤ Deviation + Rate @ Rate ≤ 50 Hz | $\pm (2.5 \times 10^{-7} \times \text{Deviation}^{0.75} + 0.002) \times (\text{Deviation} + \text{Rate}) \text{ [Hz]}$ | |
| Band 4 0.02 ≤ ModIndex @ 100 kHz ≤ Rate 150 ≤ Deviation + Rate @ Rate ≤ 100 Hz | $\pm (4.0 \times 10^{-7} \times \text{Deviation}^{0.75} + 0.003) \times (\text{Deviation} + \text{Rate}) \text{ [Hz]}$ | |
| Band 5 0.02 ≤ ModIndex @ 100 kHz ≤ Rate 150 ≤ Deviation + Rate @ Rate ≤ 100 Hz | $\pm (5.0 \times 10^{-7} \times \text{Deviation}^{0.75} + 0.003) \times (\text{Deviation} + \text{Rate}) \text{ [Hz]}$ | |
| Band 6 0.05 ≤ ModIndex @ 20 kHz ≤ Rate 150 ≤ Deviation + Rate @ Rate ≤ 100 Hz | $\pm (1.5 \times 10^{-6} \times \text{Deviation}^{0.75} + 0.003) \times (\text{Deviation} + \text{Rate}) \text{ [Hz]}$ | |

- This specification applies to the result labeled "(Pk-Pk)/2".
- For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
- Deviation is a frequency peak deviation in Hz, and Rate is a modulation rate in Hz.

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| FM Rate Accuracy^a | | |
| <i>Option EP1</i> | | |
| Band 0 | | |
| Rate ≤ 2 kHz | $\pm (0.005 / \text{Deviation of Reading}) + \text{rfa}$ or $\pm(0.00001 \text{ of Rate}) + \text{rfa}$, whichever is larger [Hz] | |
| 2 kHz < Rate, $0.01 \leq \text{ModIndex}$ | $\pm \left(\frac{4.0 \times 10^{-8}}{\text{ModIndex}} + 1.0 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa}$ [Hz] | |
| Band 1 | | |
| Rate ≤ 2 kHz | $\pm (0.01 / \text{Deviation of Reading}) + \text{rfa}$ or $\pm(0.00001 \text{ of Rate}) + \text{rfa}$, whichever is larger [Hz] | |
| 2 kHz < Rate, $0.02 \leq \text{ModIndex}$ | $\pm \left(\frac{6.0 \times 10^{-8}}{\text{ModIndex}} + 8.0 \times 10^{-8} \right) \times \text{Rate}^{1.5} + \text{rfa}$ [Hz] $\text{ModIndex} \leq 20$ $\pm (3.5 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa}$ [Hz] $20 < \text{ModIndex}$ | |
| Band 2 | | |
| Rate ≤ 2 kHz | $\pm (0.015 / \text{Deviation of Reading}) + \text{rfa}$ or $\pm(0.00001 \text{ of Rate}) + \text{rfa}$, whichever is larger [Hz] | |
| 2 kHz < Rate, $0.02 \leq \text{ModIndex}$ | $\pm \left(\frac{5.0 \times 10^{-8}}{\text{ModIndex}} + 1.2 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa}$ [Hz] | |
| Band 3 | | |
| Rate ≤ 2 kHz | $\pm (0.018 / \text{Deviation of Reading}) + \text{rfa}$ or $\pm(0.00001 \text{ of Rate}) + \text{rfa}$, whichever is larger [Hz] | |
| 2 kHz < Rate, $0.02 \leq \text{ModIndex}$ | $\pm \left(\frac{8.0 \times 10^{-8}}{\text{ModIndex}} + 8.0 \times 10^{-8} \right) \times \text{Rate}^{1.5} + \text{rfa}$ [Hz] $\text{ModIndex} \leq 20$ $\pm (3.5 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa}$ [Hz] $20 < \text{ModIndex}$ | |
| Band 4 | | |
| Rate ≤ 2 kHz, $20 \text{ Hz} \leq \text{Deviation}$ | $\pm (0.025 / \text{Deviation of Reading}) + \text{rfa}$ or $\pm(0.00002 \text{ of Rate}) + \text{rfa}$, whichever is larger [Hz] | |
| 2 kHz < Rate, $0.05 \leq \text{ModIndex}$ | $\pm \left(\frac{1.0 \times 10^{-7}}{\text{ModIndex}} + 1.5 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa}$ [Hz] $\text{ModIndex} \leq 20$ $\pm (6.0 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa}$ [Hz] $20 < \text{ModIndex}$ | |

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|---|---|--------------------------|
| Band 5 | | |
| Rate \leq 2 kHz, 20 Hz \leq Deviation | $\pm (0.035 / \text{Deviation of Reading}) + \text{rfa}$ or $\pm(0.00002 \text{ of Rate}) + \text{rfa}$, whichever is larger [Hz] | |
| 2 kHz < Rate, 0.05 \leq ModIndex | $\pm \left(\frac{1.0 \times 10^{-7}}{\text{ModIndex}} + 1.5 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa [Hz]} \quad \text{ModIndex} \leq 20$ $\pm (6.0 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa [Hz]} \quad 20 < \text{ModIndex}$ | |
| Band 6 | | |
| Rate \leq 2 kHz, 20 Hz \leq Deviation | $\pm (0.045 / \text{Deviation of Reading}) + \text{rfa}$ or $\pm(0.000055 \text{ of Rate}) + \text{rfa}$, whichever is larger [Hz] | |
| 2 kHz < Rate, 0.2 \leq ModIndex | $\pm \left(\frac{2.0 \times 10^{-7}}{\text{ModIndex}} + 4.0 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa [Hz]} \quad \text{ModIndex} \leq 20$ $\pm (1.6 \times 10^{-7} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa [Hz]} \quad 20 < \text{ModIndex}$ | |

a. rfa = Modulation Rate \times Frequency reference accuracy.

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|-------------------------------------|---|--------------------------|
| FM Rate Accuracy^a | | |
| <i>Option EPO</i> | | |
| Band 0 | | |
| Rate ≤ 2 kHz | ± (0.002 / Deviation of Reading) + rfa or ±(0.000005 of Rate) + rfa, whichever is larger | |
| 2 kHz < Rate, 0.01 ≤ ModIndex | $\pm \left(\frac{2.0 \times 10^{-8}}{\text{ModIndex}} + 3.0 \times 10^{-8} \right) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad \text{ModIndex} \leq 20$ $\pm (1.5 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad 20 < \text{ModIndex}$ | |
| Band 1 | | |
| Rate < 2 kHz | ± (0.003 / Deviation of Reading) + rfa or ±(0.00001 of Rate) + rfa, whichever is larger | |
| 2 kHz ≤ Rate, 0.02 ≤ ModIndex | $\pm \left(\frac{5.0 \times 10^{-8}}{\text{ModIndex}} + 8.0 \times 10^{-8} \right) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad \text{ModIndex} \leq 20$ $\pm (3.5 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad 20 < \text{ModIndex}$ | |
| Band 2 | | |
| Rate < 2 kHz | ± (0.007 / Deviation of Reading) + rfa or ±(0.000008 of Rate) + rfa, whichever is larger | |
| 2 kHz ≤ Rate, 0.02 ≤ ModIndex | $\pm \left(\frac{6.0 \times 10^{-8}}{\text{ModIndex}} + 8.0 \times 10^{-8} \right) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad \text{ModIndex} \leq 100$ $\pm (2.5 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad 100 < \text{ModIndex}$ | |
| Band 3 | | |
| Rate < 2 kHz | ± (0.007 / Deviation of Reading) + rfa or ±(0.00001 of Rate) + rfa, whichever is larger | |
| 2 kHz ≤ Rate, 0.02 ≤ ModIndex | $\pm \left(\frac{8.0 \times 10^{-8}}{\text{ModIndex}} + 1.0 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad \text{ModIndex} \leq 100$ $\pm (3.0 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad 100 < \text{ModIndex}$ | |
| Band 4 | | |
| Rate < 2 kHz | ± (0.01 / Deviation of Reading) + rfa or ±(0.000015 of Rate) + rfa, whichever is larger | |
| 2 kHz ≤ Rate, 0.05 ≤ ModIndex | $\pm \left(\frac{1.5 \times 10^{-7}}{\text{ModIndex}} + 1.5 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad \text{ModIndex} \leq 100$ $\pm (5.0 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad 100 < \text{ModIndex}$ | |
| Band 5 | | |
| Rate < 2 kHz | ± (0.015 / Deviation of Reading) + rfa or ±(0.00002 of Rate) + rfa, whichever is larger | |
| 2 kHz ≤ Rate, 0.05 ≤ ModIndex | $\pm \left(\frac{1.7 \times 10^{-7}}{\text{ModIndex}} + 1.7 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad \text{ModIndex} \leq 100$ $\pm (5.5 \times 10^{-8} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad 100 < \text{ModIndex}$ | |

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|---|---|--------------------------|
| Band 6 Rate < 2 kHz Deviation ≥ 20 @ Rate ≥ 1 kHz 2 kHz ≤ Rate, 0.1 ≤ ModIndex | $\pm (0.02 / \text{Deviation of Reading}) + \text{rfa}$ or $\pm(0.00006 \text{ of Rate}) + \text{rfa}$, whichever is larger $\pm \left(\frac{3 \times 10^{-7}}{\text{ModIndex}} + 3.2 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad \text{ModIndex} \leq 20$ $\pm (1.7 \times 10^{-7} \times \text{ModIndex}^{1/4}) \times \text{Rate}^{1.5} + \text{rfa} [\text{Hz}] \quad 20 < \text{ModIndex}$ | |

a. rfa = Modulation Rate × Frequency reference accuracy.

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|---|---|--------------------------|
| Carrier Frequency Error^{ab} | | |
| Band 0 | $\pm (3.0 \times 10^{-6} \times \text{Deviation} + 5 \times 10^{-5} \times \text{Rate}) + \text{rfa}$ | |
| Band 1 | $\pm (6.0 \times 10^{-6} \times \text{Deviation} + 6 \times 10^{-5} \times \text{Rate}) + \text{rfa}$ | |
| Band 2 | $\pm (6.0 \times 10^{-6} \times \text{Deviation} + 6 \times 10^{-5} \times \text{Rate}) + \text{rfa}$ | |
| Band 3 | $\pm (6.0 \times 10^{-6} \times \text{Deviation} + 6 \times 10^{-5} \times \text{Rate}) + \text{rfa}$ | |
| Band 4 | $\pm (1.0 \times 10^{-5} \times \text{Deviation} + 8 \times 10^{-5} \times \text{Rate}) + \text{rfa}$ | |
| Band 5 | $\pm (1.2 \times 10^{-5} \times \text{Deviation} + 1.2 \times 10^{-4} \times \text{Rate}) + \text{rfa}$ | |
| Band 6 | $\pm (2.0 \times 10^{-5} \times \text{Deviation} + 2 \times 10^{-4} \times \text{Rate}) + \text{rfa}$ | |

a. tfa = transmitter frequency \times frequency reference accuracy.

b. Deviation is a frequency peak deviation in Hz, and Rate is a modulation rate in Hz.

Frequency Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| Post-Demod Distortion Residual^a | | |
| Distortion (SINAD) ^b [%] | | |
| Band 0 Rate ≤ 2 kHz | $80 / \text{Deviation} + 0.00004 \times \text{Deviation}^{1/2} + 0.08$ | |
| 2 kHz < Rate, $0.01 \leq \text{ModIndex}$ | $0.0007 \times \text{Rate}^{1/2} / \text{ModIndex} + 0.0015 \times \text{Rate}^{1/2} + 0.000005 \times \text{Deviation}^{1/2}$ | |
| Band 1 Rate ≤ 2 kHz | $110 / \text{Deviation} + 0.00008 \times \text{Deviation}^{1/2} + 0.08$ | |
| 2 kHz < Rate, $0.01 \leq \text{ModIndex}$ | $0.0015 \times \text{Rate}^{1/2} / \text{ModIndex} + 0.0015 \times \text{Rate}^{1/2} + 0.0001 \times \text{Deviation}^{1/2}$ | |
| Band 2 Rate ≤ 2 kHz | $160 / \text{Deviation} + 0.00008 \times \text{Deviation}^{1/2} + 0.08$ | |
| 2 kHz < Rate, $0.01 \leq \text{ModIndex}$ | $0.0018 \times \text{Rate}^{1/2} / \text{ModIndex} + 0.0015 \times \text{Rate}^{1/2} + 0.0001 \times \text{Deviation}^{1/2}$ | |
| Band 3 Rate ≤ 2 kHz | $200 / \text{Deviation} + 0.00008 \times \text{Deviation}^{1/2} + 0.08$ | |
| 2 kHz < Rate, $0.01 \leq \text{ModIndex}$ | $0.0025 \times \text{Rate}^{1/2} / \text{ModIndex} + 0.002 \times \text{Rate}^{1/2} + 0.0001 \times \text{Deviation}^{1/2}$ | |
| Band 4 Rate ≤ 2 kHz | $300 / \text{Deviation} + 0.00015 \times \text{Deviation}^{1/2} + 0.1$ | |
| 2 kHz < Rate, $0.01 \leq \text{ModIndex}$ | $0.0035 \times \text{Rate}^{1/2} / \text{ModIndex} + 0.0025 \times \text{Rate}^{1/2} + 0.00015 \times \text{Deviation}^{1/2}$ | |
| Band 5 Rate ≤ 2 kHz | $400 / \text{Deviation} + 0.0002 \times \text{Deviation}^{1/2} + 0.1$ | |
| 2 kHz < Rate, $0.01 \leq \text{ModIndex}$ | $0.0045 \times \text{Rate}^{1/2} / \text{ModIndex} + 0.0025 \times \text{Rate}^{1/2} + 0.00018 \times \text{Deviation}^{1/2}$ | |
| Band 6 Rate ≤ 2 kHz | $700 / \text{Deviation} + 0.0006 \times \text{Deviation}^{1/2} + 0.16$ | |
| 2 kHz < Rate, $0.2 \leq \text{ModIndex}$ | $0.007 \times \text{Rate}^{1/2} / \text{ModIndex} + 0.004 \times \text{Rate}^{1/2} + 0.0006 \times \text{Deviation}^{1/2}$ | |

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|----------------------------|---|--------------------------|
| THD [%] | | |
| Band 0 | | |
| Rate \leq 100 kHz | | |
| 0.01 \leq ModIndex | $0.35 / \text{ModIndex}^{1/2}$ | |
| 100 kHz < Rate | | |
| 0.01 \leq ModIndex < 0.1 | $0.0001 / \text{ModIndex} \times \text{Rate}^{1/2}$ | |
| 0.1 \leq ModIndex < 10 | $0.001 \times \text{Rate}^{1/2}$ | |
| 10 \leq ModIndex | $0.003 / \text{ModIndex}^{1/2} \times \text{Rate}^{1/2}$ | |
| Band 1 | | |
| Rate \leq 20 kHz | | |
| 0.01 \leq ModIndex | $0.4 / \text{ModIndex}^{1/2}$ | |
| 20 kHz < Rate | | |
| 0.01 \leq ModIndex < 0.1 | $0.00015 / \text{ModIndex} \times \text{Rate}^{1/2}$ | |
| 0.1 \leq ModIndex < 5 | $0.0015 \times \text{Rate}^{1/2}$ | |
| 5 \leq ModIndex | $0.0035 / \text{ModIndex}^{1/2} \times \text{Rate}^{1/2}$ | |
| Band 2, 3 | | |
| Rate \leq 20 kHz | | |
| 0.01 \leq ModIndex | $0.5 / \text{ModIndex}^{1/2}$ | |
| 20 kHz < Rate | | |
| 0.01 \leq ModIndex < 0.2 | $0.0003 / \text{ModIndex} \times \text{Rate}^{1/2}$ | |
| 0.2 \leq ModIndex < 5 | $0.0015 \times \text{Rate}^{1/2}$ | |
| 5 \leq ModIndex | $0.0035 / \text{ModIndex}^{1/2} \times \text{Rate}^{1/2}$ | |
| Band 4 | | |
| Rate \leq 50 kHz | | |
| 0.01 \leq ModIndex | $0.5 / \text{ModIndex}^{1/2}$ | |
| 50 kHz < Rate | | |
| 0.01 \leq ModIndex < 0.2 | $0.0003 / \text{ModIndex} \times \text{Rate}^{1/2}$ | |
| 0.2 \leq ModIndex < 5 | $0.0015 \times \text{Rate}^{1/2}$ | |
| 5 \leq ModIndex | $0.0035 / \text{ModIndex}^{1/2} \times \text{Rate}^{1/2}$ | |
| Band 5 | | |
| Rate \leq 50 kHz | | |
| 0.01 \leq ModIndex | $0.6 / \text{ModIndex}^{1/2}$ | |
| 50 kHz < Rate | | |
| 0.02 \leq ModIndex < 0.2 | $0.0003 / \text{ModIndex} \times \text{Rate}^{1/2}$ | |
| 0.2 \leq ModIndex < 5 | $0.0015 \times \text{Rate}^{1/2}$ | |
| 5 \leq ModIndex | $0.0035 / \text{ModIndex}^{1/2} \times \text{Rate}^{1/2}$ | |

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| Band 6 Rate ≤ 10 kHz $0.05 \leq \text{ModIndex}$ 10 kHz < Rate $0.05 \leq \text{ModIndex} < 1$ $1 \leq \text{ModIndex} < 10$ $10 \leq \text{ModIndex}$ | $0.8 / \text{ModIndex}^{1/2}$ $0.0003 / \text{ModIndex} \times \text{Rate}^{1/2}$ $0.002 \times \text{Rate}^{1/2}$ $0.005 / \text{ModIndex}^{1/2} \times \text{Rate}^{1/2}$ | |

- For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
- SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.

| Description | Specifications | Supplemental Information |
|---------------------------------------|---|---|
| Post-Demod Distortion Accuracy | | |
| Distortion (SINAD) ^a | $\pm(0.02 \times \text{Reading} + \text{DistResidual})$ | |
| THD | $\pm(0.02 \times \text{Reading} + \text{THDResidual})$ | 2 nd and 3 rd harmonics |

- SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.

Analog Demodulation Measurement Application

| Description | Specifications | Supplemental Information |
|---|-------------------------|--------------------------|
| Post-Demod Distortion Residual (Audio) | | |
| Distortion (SINAD) ^{ab} [%] | | Audio Filter |
| 200 Hz ≤ Deviation ≤ 100 kHz | | LPF = 3 kHz |
| Band 0 | | |
| Rate = 400Hz | 35 / Deviation + 0.04 | HPF = 50 Hz |
| Rate = 1 kHz | 35 / Deviation + 0.02 | HPF = 300 Hz |
| Band 1 | | |
| Rate = 400Hz | 60 / Deviation + 0.04 | HPF = 50 Hz |
| Rate = 1 kHz | 60 / Deviation + 0.02 | HPF = 300 Hz |
| Band 2 | | |
| Rate = 400Hz | 100 / Deviation + 0.04 | HPF = 50 Hz |
| Rate = 1 kHz | 100 / Deviation + 0.015 | HPF = 300 Hz |
| Band 3 | | |
| Rate = 400Hz | 120 / Deviation + 0.05 | HPF = 50 Hz |
| Rate = 1 kHz | 120 / Deviation + 0.02 | HPF = 300 Hz |
| Band 4 | | |
| Rate = 400Hz | 180 / Deviation + 0.05 | HPF = 50 Hz |
| Rate = 1 kHz | 180 / Deviation + 0.02 | HPF = 300 Hz |
| Band 5 | | |
| Rate = 400Hz | 250 / Deviation + 0.05 | HPF = 50 Hz |
| Rate = 1 kHz | 250 / Deviation + 0.015 | HPF = 300 Hz |
| Band 6 | | |
| Rate = 400Hz | 400 / Deviation + 0.05 | HPF = 50 Hz |
| Rate = 1 kHz | 400 / Deviation + 0.015 | HPF = 300 Hz |

- For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
- SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|--|--|-----------------------------|
| THD [%] ^a 200 Hz ≤ Deviation ≤ 100 kHz | | Audio Filter LPF = 3 kHz |
| Band 0 Rate = 400Hz Rate = 1 kHz | $1 / (10 \times \text{ModIndex}^{1/4})$ $1 / (20 \times \text{ModIndex}^{1/4})$ | HPF = 50 Hz HPF = 300 Hz |
| Band 1 Rate = 400Hz Rate = 1 kHz | $1 / (10 \times \text{ModIndex}^{1/4})$ $1 / (15 \times \text{ModIndex}^{1/4})$ | HPF = 50 Hz HPF = 300 Hz |
| Band 2 Rate = 400Hz Rate = 1 kHz | $1 / (10 \times \text{ModIndex}^{1/4})$ $1 / (15 \times \text{ModIndex}^{1/4})$ | HPF = 50 Hz HPF = 300 Hz |
| Band 3 Rate = 400Hz Rate = 1 kHz | $1 / (10 \times \text{ModIndex}^{1/4})$ $1 / (12 \times \text{ModIndex}^{1/2})$ | HPF = 50 Hz HPF = 300 Hz |
| Band 4 Rate = 400Hz Rate = 1 kHz | $1 / (8 \times \text{ModIndex}^{1/4})$ $1 / (12 \times \text{ModIndex}^{1/2})$ | HPF = 50 Hz HPF = 300 Hz |
| Band 5 Rate = 400Hz Rate = 1 kHz | $1 / (7 \times \text{ModIndex}^{1/4})$ $1 / (10 \times \text{ModIndex}^{1/2})$ | HPF = 50 Hz HPF = 300 Hz |
| Band 6 Rate = 400Hz Rate = 1 kHz | $1 / (3 \times \text{ModIndex}^{1/2})$ $1 / (5 \times \text{ModIndex}^{1/2})$ | HPF = 50 Hz HPF = 300 Hz |

- a. For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.

Analog Demodulation Measurement Application
Frequency Modulation

| Description | Specifications | Supplemental Information |
|---------------------------------|----------------|--------------------------|
| AM Rejection^a | | |
| <i>Option EP1/EPO</i> | | |
| Band 0 | 0.6 Hz (peak) | |
| Band 1 | 1.0 Hz (peak) | |
| Band 2 | 1.4 Hz (peak) | |
| Band 3 | 1.7 Hz (peak) | |
| Band 4 | 2.6 Hz (peak) | |
| Band 5 | 3.3 Hz (peak) | |
| Band 6 | 5.3 Hz (peak) | |
| Residual FM^b | | |
| <i>Option EP1/EPO</i> | | |
| Band 0 | 0.4 Hz (rms) | |
| Band 1 | 0.6 Hz (rms) | |
| Band 2 | 0.9 Hz (rms) | |
| Band 3 | 1.1 Hz (rms) | |
| Band 4 | 1.7 Hz (rms) | |
| Band 5 | 2.2 Hz (rms) | |
| Band 6 | 3.3 Hz (rms) | |

- AM rejection describes the instrument's FM reading for an input that is strongly AMed (with no FM); this specification includes contributions from residual FM. AM signal (Rate = 1 kHz, Depth = 50%), HPF=50 Hz, LPF = 3 kHz, Channel BW = 15 kHz.
- Residual FM describes the instrument's FM reading for an input that has no FM and no AM; this specification includes contributions from FM deviation accuracy. HPF = 50 Hz, LPF = 3 kHz, Channel BW = 15 kHz.

Amplitude Modulation

Conditions required to meet specification

- Depth: 1% to 99%
- Depth + Power ratio of Distortion + Power ratio of Noise < 100%
- Channel BW: Rate × 5
- Rate: 10 Hz to 1 MHz
- SINAD bandwidth: (Channel BW) / 2
- Single tone - sinusoid modulation
- Center Frequency (CF): ≥ 100 kHz (Band 0), Band 1 to 6

| Description | Specifications | Supplemental Information |
|------------------------------------|-------------------------|--------------------------|
| AM Measurement Range | | |
| Modulation Rate Range ^a | 1 Hz to (max info BW)/2 | |
| Peak Depth Range | 0% to 100% | |

a. Max info BW: See **“Maximum Information Bandwidth (Info BW)”** on page 273.

| Description | Specifications | Supplemental Information |
|--|---|--------------------------|
| AM Depth Accuracy^{ab}[%] | | |
| Band 0, Depth ≥ 2% | $\pm 0.001 \times \text{reading} \quad \text{Rate} \leq 10\text{kHz}$ $\pm 0.00001 \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} \times \text{reading} \quad 10\text{kHz} < \text{Rate}$ | |
| Band 1, Band 2 Depth ≥ 5% | $\pm 0.001 \times \text{reading} \quad \text{Rate} \leq 10\text{kHz}$ $\pm 0.00001 \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} \times \text{reading} \quad 10\text{kHz} < \text{Rate}$ | |
| Band 3, Depth ≥ 5% | $\pm 0.001 \times \text{reading} \quad \text{Rate} \leq 5\text{kHz}$ $\pm 0.00001 \times \sqrt{\frac{2 \times \text{Rate}[\text{Hz}]}{1\text{Hz}}} \times \text{reading} \quad 5\text{kHz} < \text{Rate}$ | |
| Band 4, Depth ≥ 5% | $\pm 0.001 \times \text{reading} \quad \text{Rate} \leq 5\text{kHz}$ $\pm (0.00001 \times \sqrt{\frac{3 \times \text{Rate}[\text{Hz}]}{1\text{Hz}}} - 0.00022) \times \text{reading} \quad 5\text{kHz} < \text{Rate}$ | |
| Band 5, Depth ≥ 5% | $\pm 0.0012 \times \text{reading} \quad \text{Rate} \leq 5\text{kHz}$ $\pm (0.000012 \times \sqrt{\frac{3 \times \text{Rate}[\text{Hz}]}{1\text{Hz}}} - 0.00027) \times \text{reading} \quad 5\text{kHz} < \text{Rate}$ | |

Analog Demodulation Measurement Application
Amplitude Modulation

| Description | Specifications | Supplemental Information |
|-----------------------------|--|--------------------------|
| Band 6, Depth $\geq 5\%$ | $\pm 0.0025 \times \text{reading} \quad \text{Rate} \leq 5\text{kHz}$ $\pm (0.00000012 \times \frac{\text{Rate}[\text{Hz}]}{1\text{Hz}} + 0.0025) \times \text{reading} \quad 5\text{kHz} < \text{Rate}$ | |

- a. This specification applies to the result labeled "(Pk-Pk)/2".
b. Reading is a measured AM depth in %.

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| Flatness^{ab} (Depth $\geq 5\%$) | | |
| Band 0 | $\pm (0.00004 \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} \times \text{reading})$ | |
| Band 1 | $\pm (0.00008 \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} \times \text{reading})$ | |
| Band 2 Rate ≤ 500 Hz 500 Hz < Rate | $\pm 0.01 \times \text{reading}$ $\pm (0.00025 \times (\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}})^{0.6} \times \text{reading})$ | |
| Band 3 Rate ≤ 500 Hz 500 Hz < Rate | $\pm 0.015 \times \text{reading}$ $\pm (0.0002 \times (\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}})^{0.64} \times \text{reading})$ | |
| Band 4 Rate ≤ 500 Hz 500 Hz < Rate | $\pm 0.035 \times \text{reading}$ $\pm (0.0015 \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} \times \text{reading})$ | |
| Band 5 Rate ≤ 1 kHz 1 kHz < Rate | $\pm 0.05 \times \text{reading}$ $\pm (0.0015 \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} \times \text{reading})$ | |
| Band 6 Rate ≤ 1 kHz 1 kHz < Rate | $\pm 0.12 \times \text{reading}$ $\pm (0.004 \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} \times \text{reading})$ | |

- a. Flatness is the relative variation in indicated AM depth versus rate for a constant carrier frequency and depth.
b. Reading is a measured AM depth in %.

Analog Demodulation Measurement Application
Amplitude Modulation

| Description | Specifications | Supplemental Information |
|---|---|--------------------------|
| AM Rate Accuracy^a[Hz] | | |
| Band 0 Rate < 100Hz 100Hz ≤ Rate < 1kHz 1kHz ≤ Rate | $\pm (4.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ $\pm (4.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}) + \text{rfa}$ $\pm (5.0 \times 10^{-9} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |
| Band 1, Depth ≥ 5% Rate < 100Hz 100Hz ≤ Rate < 1kHz 1kHz ≤ Rate | $\pm (7.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ $\pm (7.0 \times 10^{-7} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}) + \text{rfa}$ $\pm (1.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |
| Band 2, Depth ≥ 2% Rate < 50Hz 50Hz ≤ Rate < 1kHz 1kHz ≤ Rate | $\pm (1.2 \times 10^{-7} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ $\pm (6 \times 10^{-6} \times \frac{100\%}{\text{Depth}\%} \times \sqrt{\text{Rate}}) + \text{rfa}$ $\pm (6.0 \times 10^{-9} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |
| Band 3, Depth ≥ 5% Rate < 50Hz 50Hz ≤ Rate < 1kHz 1kHz ≤ Rate | $\pm (2.0 \times 10^{-7} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ $\pm (1.0 \times 10^{-5} \times \frac{100\%}{\text{Depth}\%} \times \sqrt{\text{Rate}}) + \text{rfa}$ $\pm (1.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |
| Band 4, Depth ≥ 5% Rate < 50Hz 50Hz ≤ Rate ≤ 1kHz 1kHz < Rate | $\pm (4.0 \times 10^{-7} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ $\pm (2.0 \times 10^{-5} \times \frac{100\%}{\text{Depth}\%} \times \sqrt{\text{Rate}}) + \text{rfa}$ $\pm (1.5 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |
| Band 5, Depth ≥ 5% Rate < 50Hz 50Hz ≤ Rate < 1kHz 1kHz ≤ Rate | $\pm (8.0 \times 10^{-7} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ $\pm (4.0 \times 10^{-5} \times \frac{100\%}{\text{Depth}\%} \times \sqrt{\text{Rate}}) + \text{rfa}$ $\pm (1.6 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |
| Band 6, Depth ≥ 20% Rate < 50Hz 50Hz ≤ Rate < 1kHz 1kHz ≤ Rate | $\pm (1.4 \times 10^{-6} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ $\pm (7.0 \times 10^{-5} \times \frac{100\%}{\text{Depth}\%} \times \sqrt{\text{Rate}}) + \text{rfa}$ $\pm (5.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |

a. rfa = Modulation Rate × Frequency reference accuracy.

Amplitude Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| Post-Demod Distortion Residual | | |
| Distortion (SINAD) ^{ab} | | |
| Band 0, | $= 0.0002 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 \text{ [%]}$ | |
| Band 1 | $= 0.0004 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 \text{ [%]}$ | |
| Band 2, 100 Hz ≤ Rate | $= 0.0003 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 \text{ [%]}$ | |
| Band 3, 100 Hz ≤ Rate | $= 0.0004 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 \text{ [%]}$ | |
| Band 4, Band 5, 100 Hz ≤ Rate ≤ 500 kHz, 1% ≤ Depth ≤ 99% 500 kHz < Rate, 2% ≤ Depth ≤ 99% | $= 0.0007 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 \text{ [%]}$ | |
| Band 6, 100 ≤ Rate ≤ 50 kHz, 1% ≤ Depth ≤ 99% 50 kHz < Rate ≤ 200 kHz, 2% ≤ Depth ≤ 99% 200 kHz < Rate ≤ 1 MHz, 5% ≤ Depth ≤ 99% | $= 0.0025 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.05 \text{ [%]}$ | |

- a. SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.
b. Depth is AM depth in %. Rate is a modulation rate in Hz.

| Description | Specifications | Supplemental Information |
|---------------------------------------|---|--------------------------|
| Post-Demod Distortion Residual | | |
| THD ^{ab} | | |
| Band 0 | $= 0.00003 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 \text{ [%]}$ | |
| Band 1 | $= 0.00007 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 \text{ [%]}$ | |

Analog Demodulation Measurement Application
Amplitude Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| Band 2, 100 Hz ≤ Rate | $= 0.00004 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 [\%]$ | |
| Band 3, 100 Hz ≤ Rate | $= 0.00006 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 [\%]$ | |
| Band 4 100 Hz ≤ Rate ≤ 500 kHz, 1% ≤ Depth ≤ 99% 500 kHz < Rate ≤ 1 MHz, 2% ≤ Depth ≤ 99% | $= 0.00009 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 [\%]$ | |
| Band 5 100 Hz ≤ Rate ≤ 500 kHz, 1% ≤ Depth ≤ 99% 500 kHz < Rate ≤ 1 MHz, 2% ≤ Depth ≤ 99% | $= 0.0001 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 [\%]$ | |
| Band 6 100 Hz ≤ Rate ≤ 50 kHz, 1% ≤ Depth ≤ 99% 50 kHz < Rate ≤ 200 kHz, 2% ≤ Depth ≤ 99% 200 kHz < Rate ≤ 1 MHz, 5% ≤ Depth ≤ 99% | $= 0.00035 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.04 [\%]$ | |

- a. SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.
b. Depth is AM depth in %. Rate is a modulation rate in Hz.

| Description | Specifications | Supplemental Information |
|---------------------------------------|---|---|
| Post-Demod Distortion Accuracy | | |
| Distortion (SINAD) ^a | $\pm(0.01 \times \text{Reading} + \text{DistResidual})$ | |
| THD | $\pm(0.01 \times \text{Reading} + \text{THDResidual})$ | 2 nd and 3 rd harmonics |

- a. SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.

Analog Demodulation Measurement Application
Amplitude Modulation

| Description | Specifications | Supplemental Information |
|--|---|---|
| Post-Demod Distortion Residual (Audio) Distortion (SINAD) ^{ab} [%] $1\% \leq \text{Depth} \leq 90\%$ Band 0 Rate = 400Hz Rate = 1 kHz Band 1 Rate = 400Hz Rate = 1 kHz Band 2 Rate = 400Hz Rate = 1 kHz Band 3 Rate = 400Hz Rate = 1 kHz Band 4 Rate = 400Hz Rate = 1 kHz Band 5 Rate = 400Hz Rate = 1 kHz Band 6 Rate = 400Hz Rate = 1 kHz | $0.0026 \times (100\% / \text{Depth}\%) \text{ or } 0.02, \text{ whichever is larger}$ $0.0038 \times (100\% / \text{Depth}\%) \text{ or } 0.02, \text{ whichever is larger}$ $0.0046 \times (100\% / \text{Depth}\%) \text{ or } 0.02, \text{ whichever is larger}$ $0.0068 \times (100\% / \text{Depth}\%) \text{ or } 0.02, \text{ whichever is larger}$ $0.003 \times (100\% / \text{Depth}\%) \text{ or } 0.02, \text{ whichever is larger}$ $0.0045 \times (100\% / \text{Depth}\%) \text{ or } 0.02, \text{ whichever is larger}$ $0.005 \times (100\% / \text{Depth}\%) \text{ or } 0.02, \text{ whichever is larger}$ $0.007 \times (100\% / \text{Depth}\%) \text{ or } 0.03, \text{ whichever is larger}$ $0.0075 \times (100\% / \text{Depth}\%) \text{ or } 0.03, \text{ whichever is larger}$ $0.011 \times (100\% / \text{Depth}\%) \text{ or } 0.04, \text{ whichever is larger}$ $0.0085 \times (100\% / \text{Depth}\%) \text{ or } 0.035, \text{ whichever is larger}$ $0.012 \times (100\% / \text{Depth}\%) \text{ or } 0.04, \text{ whichever is larger}$ $0.026 \times (100\% / \text{Depth}\%) \text{ or } 0.08, \text{ whichever is larger}$ $0.038 \times (100\% / \text{Depth}\%) \text{ or } 0.095, \text{ whichever is larger}$ | Audio Filter LPF = 3 kHz HPF = 50 Hz HPF = 300 Hz HPF = 50 Hz HPF = 300 Hz HPF = 50 Hz HPF = 300 Hz HPF = 50 Hz HPF = 300 Hz HPF = 50 Hz HPF = 300 Hz HPF = 50 Hz HPF = 300 Hz |

a. SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.

b. Depth is AM depth in %. Rate is a modulation rate in Hz.

Analog Demodulation Measurement Application
Amplitude Modulation

| Description | Specifications | Supplemental Information |
|---|--|-----------------------------|
| THD [%] ^{ab} 1% ≤ Depth ≤ 90% | | Audio Filter LPF = 3 kHz |
| Band 0 Rate = 400Hz Rate = 1 kHz | 0.0005 × (100% / Depth%) or 0.02, whichever is larger 0.0006 × (100% / Depth%) or 0.02, whichever is larger | HPF = 50 Hz HPF = 300 Hz |
| Band 1 Rate = 400Hz Rate = 1 kHz | 0.0008 × (100% / Depth%) or 0.01, whichever is larger 0.0012 × (100% / Depth%) or 0.01, whichever is larger | HPF = 50 Hz HPF = 300 Hz |
| Band 2 Rate = 400Hz Rate = 1 kHz | 0.0005 × (100% / Depth%) or 0.01, whichever is larger 0.0007 × (100% / Depth%) or 0.015, whichever is larger | HPF = 50 Hz HPF = 300 Hz |
| Band 3 Rate = 400Hz Rate = 1 kHz | 0.0007 × (100% / Depth%) or 0.02, whichever is larger 0.001 × (100% / Depth%) or 0.03, whichever is larger | HPF = 50 Hz HPF = 300 Hz |
| Band 4 Rate = 400Hz Rate = 1 kHz | 0.0013 × (100% / Depth%) or 0.025, whichever is larger 0.0017 × (100% / Depth%) or 0.035, whichever is larger | HPF = 50 Hz HPF = 300 Hz |
| Band 5 Rate = 400Hz Rate = 1 kHz | 0.0013 × (100% / Depth%) or 0.025, whichever is larger 0.0018 × (100% / Depth%) or 0.04, whichever is larger | HPF = 50 Hz HPF = 300 Hz |
| Band 6 Rate = 400Hz Rate = 1 kHz | 0.0045 × (100% / Depth%) or 0.07, whichever is larger 0.0065 × (100% / Depth%) or 0.055, whichever is larger | HPF = 50 Hz HPF = 300 Hz |

- a. SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.
b. Depth is AM depth in %. Rate is a modulation rate in Hz.

Analog Demodulation Measurement Application
Amplitude Modulation

| Description | Specifications | Supplemental Information |
|---------------------------------|----------------|--------------------------|
| FM Rejection^a | | |
| <i>Option EP1/EPO</i> | | |
| Band 0 | 0.05% (peak) | |
| Band 1 | 0.1% (peak) | |
| Band 2 | 0.1% (peak) | |
| Band 3 | 0.1% (peak) | |
| Band 4 | 0.11% (peak) | |
| Band 5 | 0.11% (peak) | |
| Band 6 | 0.16% (peak) | |
| FM Rejection^b | | |
| <i>Option EPO</i> | | |
| Band 0 | 0.025% (rms) | |
| Band 1 | 0.025% (rms) | |
| Residual AM^c | | |
| <i>Option EP1/EPO</i> | | |
| Band 0 | 0.005% (rms) | |
| Band 1 | 0.01% (rms) | |
| Band 2 | 0.01% (rms) | |
| Band 3 | 0.01% (rms) | |
| Band 4 | 0.02% (rms) | |
| Band 5 | 0.02% (rms) | |
| Band 6 | 0.05% (rms) | |
| Residual AM^d | | |
| <i>Option FBP</i> | | |
| Band 0 | 0.01% (rms) | |
| Band 1 | 0.01% (rms) | |
| Band 2 | 0.01% (rms) | |
| Band 3 | 0.01% (rms) | |
| Band 4 | 0.01% (rms) | |
| Band 5 | 0.01% (rms) | |
| Band 6 | 0.02% (rms) | |

Analog Demodulation Measurement Application
Amplitude Modulation

- a. FM rejection describes the instrument's AM reading for an input that is strongly FMed (with no AM); this specification includes contributions from residual AM. FM signal (Rate = 1 kHz, Deviation = 50 kHz), HPF= 50 Hz, LPF = 3 kHz, Channel BW = 420 kHz.
- b. FM rejection describes the instrument's AM reading for an input that is strongly FMed (with no AM); this specification includes contributions from residual AM. FM signal (Rate = 1 kHz, Deviation = 50 kHz), HPF= 50 Hz, LPF = 3 kHz, Channel BW = 12 MHz.
- c. Residual AM describes the instrument's AM reading for an input that has no AM and no FM; this specification includes contributions from AM depth accuracy. HPF = 50 Hz, LPF = 3 kHz, Channel BW = 6 kHz.
- d. Residual AM describes the instrument's AM reading for an input that has no AM and no FM; this specification includes contributions from AM depth accuracy. HPF = 30 Hz, LPF = 23 kHz, Channel BW = 46 kHz. Option FBP is required except Band 0.

Phase Modulation

Conditions required to meet specification

- Peak deviation¹: 0.01 to 25000 rad
 - Minimum Deviation
 - 0.2 rad @Rate 50 Hz
 - 0.1 rad @Rate 100 Hz
 - 0.05 rad @Rate 200 Hz
 - 0.02 rad @Rate 500 Hz
 - Maximum Deviation
 - 10000 rad @Rate 1 kHz
 - 5000 rad @Rate 2 kHz
 - ...
 - 20 rad @Rate 500 kHz
 - 5 rad @Rate 1 MHz
- Channel BW: ≤ 40 MHz
- HPF = 20 Hz always on (unless otherwise stated)
- Single tone - sinusoid modulation
- Rate: 50 Hz to 1 MHz
- SINAD bandwidth: (Channel BW)/2
- Center Frequency (CF): ≥ 100 kHz (Band 0), Band 1 to 6

| Description | Specifications | Supplemental Information |
|--------------------------------------|--|--------------------------|
| PM Measurement Range | | |
| Modulation Rate Range ^{abc} | 1 Hz to (max info BW)/2 | |
| Peak Deviation Range ^{abc} | $< (\text{max info BW}) / (2 \times (\text{Modulation Rate}))$ | |

- a. $(1 + \text{Peak Deviation}) < (\text{max info BW}) / (2 \times (\text{Modulation Rate}))$.
- b. The measurement range is also limited by max capture memory. Specifically, $\text{SamplingRate} \times \text{AcqTime} < 3.6 \text{ MSa}$, where $\text{SamplingRate} = 1.25 \times \text{Info BW}$.
- c. Max info BW: See **“Maximum Information Bandwidth (Info BW)” on page 273**.

1. PeakDeviation (for phase, in rads) and Rate are jointly limited to fit within the Channel BW. For PM, an approximate rule-of-thumb is $2 \times [\text{PeakDeviation} + 1] \times \text{Rate} < \text{Channel BW}$, such that most of the sideband energy is within the Channel BW.

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|---|---|--------------------------|
| PM Deviation Accuracy^{ab}[rad] | | |
| <i>Option EP1</i> | | |
| Band 0 100 Hz ≤ Rate ≤ 100 kHz | ± (0.001 × Deviation ^{1/4} + 0.001) or 1.0 × 10 ⁵ × Rate ⁻⁴ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 8.0 \times 10^{-6} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 1, Band 2 100 Hz ≤ Rate ≤ 100 kHz | ± (0.002 × Deviation ^{1/4} + 0.001) or 1.0 × 10 ⁵ × Rate ⁻⁴ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 3 Deviation ≥ 0.02 100 Hz ≤ Rate ≤ 100 kHz | ± (0.002 × Deviation ^{1/4} + 0.001) or 1.0 × 10 ⁵ × Rate ⁻⁴ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 4 Deviation ≥ 0.02 100 Hz ≤ Rate ≤ 100 kHz | ± (0.0025 × Deviation ^{1/4} + 0.0025) or 1.0 × 10 ⁵ × Rate ⁻⁴ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 5 Deviation ≥ 0.05 100 Hz ≤ Rate ≤ 100 kHz | ± (0.0025 × Deviation ^{1/4} + 0.0025) or 1.0 × 10 ⁵ × Rate ⁻⁴ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 6 Deviation ≥ 0.05 100 Hz ≤ Rate ≤ 100 kHz | ± (0.006 × Deviation ^{1/4} + 0.004) or 1.0 × 10 ⁵ × Rate ⁻⁴ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.5 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| <i>Option EPO</i> | | |
| Band 0 100 Hz ≤ Rate ≤ 100 kHz | $\pm (0.001 \times \text{Deviation}^{1/4} + 0.001)$ or $1.0 \times 10^5 \times \text{Rate}^{-4}$ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 6.0 \times 10^{-6} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 1, Band 2 100 Hz ≤ Rate ≤ 100 kHz | $\pm (0.002 \times \text{Deviation}^{1/4} + 0.001)$ or $1.0 \times 10^5 \times \text{Rate}^{-4}$ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 3 Deviation ≥ 0.02 100 Hz ≤ Rate ≤ 100 kHz | $\pm (0.002 \times \text{Deviation}^{1/4} + 0.001)$ or $1.0 \times 10^5 \times \text{Rate}^{-4}$ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 4 Deviation ≥ 0.02 100 Hz ≤ Rate ≤ 100 kHz | $\pm (0.0025 \times \text{Deviation}^{1/4} + 0.001)$ or $1.0 \times 10^5 \times \text{Rate}^{-4}$ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 5 Deviation ≥ 0.05 100 Hz ≤ Rate ≤ 100 kHz | $\pm (0.0025 \times \text{Deviation}^{1/4} + 0.001)$ or $1.0 \times 10^5 \times \text{Rate}^{-4}$ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |
| Band 6 Deviation ≥ 0.05 100 Hz ≤ Rate ≤ 100 kHz | $\pm (0.006 \times \text{Deviation}^{1/4} + 0.001)$ or $1.0 \times 10^5 \times \text{Rate}^{-4}$ of Deviation, whichever is larger | |
| 100 kHz < Rate | $\pm 1.5 \times 10^{-5} \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{1/2} \times \text{Deviation}^{1/4}$ | |

- This specification applies to the result labeled "(Pk-Pk)/2".
- For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| PM Rate Accuracy^{abc}[Hz] <i>Option EP1</i> Band 0 0.02 rad ≤ Deviation Band 1 0.05 rad ≤ Deviation Band 2 0.05 rad ≤ Deviation Band 3 0.05 rad ≤ Deviation Band 4 0.1 rad ≤ Deviation Band 5 0.2 rad ≤ Deviation Band 6 0.2 rad ≤ Deviation | $\pm \left(0.001 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.0018 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.0025 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.003 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.006 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.008 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.015 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger | |

- a. rfa = Modulation Rate × Frequency reference accuracy.
 b. For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
 c. Deviation is a peak deviation in radians. Rate is a modulation rate in Hz.

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|--|---|--------------------------|
| PM Rate Accuracy^{abc}[Hz] <i>Option EPO</i> Band 0 0.02 rad ≤ Deviation Band 1 0.05 rad ≤ Deviation Band 2 0.05 rad ≤ Deviation Band 3 0.05 rad ≤ Deviation Band 4 0.05 rad ≤ Deviation Band 5 0.1 rad ≤ Deviation Band 6 0.2 rad ≤ Deviation | $\pm \left(0.0002 \times \frac{\text{Rate}^{1/2}}{\text{Deviation}} \right) + \text{rfa}$ or 1 mHz whichever is larger $\pm \left(0.0006 \times \frac{\text{Rate}^{1/2}}{\text{Deviation}} \right) + \text{rfa}$ or 1 mHz whichever is larger $\pm \left(0.0006 \times \frac{\text{Rate}^{1/2}}{\text{Deviation}} \right) + \text{rfa}$ or 1 mHz whichever is larger $\pm \left(0.0007 \times \frac{\text{Rate}^{1/2}}{\text{Deviation}} \right) + \text{rfa}$ or 1 mHz whichever is larger $\pm \left(0.0012 \times \frac{\text{Rate}^{1/2}}{\text{Deviation}} \right) + \text{rfa}$ or 1 mHz whichever is larger $\pm \left(0.0015 \times \frac{\text{Rate}^{1/2}}{\text{Deviation}} \right) + \text{rfa}$ or 1 mHz whichever is larger $\pm \left(0.0035 \times \frac{\text{Rate}^{1/2}}{\text{Deviation}} \right) + \text{rfa}$ or 1 mHz whichever is larger | |

- a. rfa = Modulation Rate × Frequency reference accuracy.
 b. For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
 c. Deviation is a peak deviation in radians. Rate is a modulation rate in Hz.

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| Carrier Frequency Error^{ab}[Hz] | | |
| <i>Option EP1</i> | | |
| Band 0 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 2 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.004) + \text{tfa}$ | |
| Band 1 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 4 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.006) + \text{tfa}$ | |
| Band 2 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 6 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.01) + \text{tfa}$ | |
| Band 3 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 7 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.012) + \text{tfa}$ | |
| Band 4 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 1 \times 10^{-5}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.02) + \text{tfa}$ | |
| Band 5 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 1.5 \times 10^{-5}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.025) + \text{tfa}$ | |
| Band 6 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 2 \times 10^{-5}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.035) + \text{tfa}$ | |
| <i>Option EPO</i> | | |
| Band 0 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 4 \times 10^{-7}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.0005) + \text{tfa}$ | |
| Band 1 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 1 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.002) + \text{tfa}$ | |
| Band 2 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 1.5 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.003) + \text{tfa}$ | |
| Band 3 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 2 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.003) + \text{tfa}$ | |

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| Band 4 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 3 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.005 + \text{tfa})$ | |
| Band 5 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 3 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.007 + \text{tfa})$ | |
| Band 6 Rate ≤ 1 kHz 1 kHz < Rate | $\pm (8 \times 10^{-6} \times \text{Deviation} + 5 \times 10^{-6}) \times \text{Rate} + \text{tfa}$ $\pm (15 / \text{Rate} \times \text{Deviation} + 0.01 + \text{tfa})$ | |

- a. tfa = transmitter frequency \times frequency reference accuracy.
b. Deviation is a peak deviation in radians, and Rate is a modulation rate in Hz.

Phase Modulation

| Description | Specifications | Supplemental Information |
|---|----------------------------|--------------------------|
| Post-Demod Distortion Residual^a | | |
| Distortion (SINAD) ^{bc} | | |
| <i>Option EP1</i> | | |
| Band 0 | | |
| Rate ≤ 100 kHz | 0.4 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 0.8 / Deviation + 0.01[%] | |
| Band 1 | | |
| Rate ≤ 100 kHz | 0.75 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 1.1 / Deviation + 0.01[%] | |
| Band 2 | | |
| Rate ≤ 100 kHz | 0.4 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 1.3 / Deviation + 0.01[%] | |
| Band 3 | | |
| Rate ≤ 100 kHz | 1.6 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 1.6 / Deviation + 0.01[%] | |
| Band 4 | | |
| Rate ≤ 100 kHz | 3.0 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 2.5 / Deviation + 0.01[%] | |
| Band 5 | | |
| Rate ≤ 100 kHz | 3.5 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 3.0 / Deviation + 0.01[%] | |
| Band 6 | | |
| Rate ≤ 100 kHz | 5.0 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 5.5 / Deviation + 0.01[%] | |
| <i>Option EP0</i> | | |
| Band 0 | | |
| Rate ≤ 100 kHz | 0.15 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 0.8 / Deviation + 0.01[%] | |
| Band 1 | | |
| Rate ≤ 100 kHz | 0.4 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 0.9 / Deviation + 0.01[%] | |
| Band 2 | | |
| Rate ≤ 100 kHz | 0.5 / Deviation + 0.01[%] | |
| 100 kHz < Rate, Deviation < 100 rad | 0.9 / Deviation + 0.01[%] | |

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|--|---|--------------------------|
| Band 3 Rate ≤ 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.55 / Deviation + 0.01[%] 1.1 / Deviation + 0.01[%] | |
| Band 4 Rate ≤ 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.8 / Deviation + 0.01[%] 1.5 / Deviation + 0.01[%] | |
| Band 5 Rate ≤ 100 kHz 100 kHz < Rate, Deviation < 100 rad | 1.0 / Deviation + 0.01[%] 1.6 / Deviation + 0.01[%] | |
| Band 6 Rate ≤ 20 kHz 100 kHz < Rate, Deviation < 100 rad | 1.5 / Deviation + 0.01[%] 4.0 / Deviation + 0.01[%] | |

- For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
- Deviation is a peak deviation in radians. Rate is a modulation rate in Hz.
- SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.

Analog Demodulation Measurement Application

Phase Modulation

| Description | Specifications | Supplemental Information |
|--|---|--------------------------|
| Post-Demod Distortion Residual^a | | |
| THD ^b | | |
| <i>Option EP1</i> | | |
| Band 0 Rate ≤ 100 kHz 100 kHz < Rate | $0.1 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.8 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.3 [%], whichever is smaller | |
| Band 1 Rate ≤ 100 kHz 100 kHz < Rate | $0.15 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.8 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.3 [%], whichever is smaller | |
| Band 2 Rate ≤ 50 kHz and 0.02 ≤ Deviation 50 kHz < Rate and 0.02 ≤ Deviation | $0.15 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.8 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.4 [%], whichever is smaller | |
| Band 3 Rate ≤ 50 kHz and 0.02 ≤ Deviation 50 kHz < Rate and 0.02 ≤ Deviation | $0.2 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.8 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.4 [%], whichever is smaller | |
| Band 4 Rate ≤ 100 kHz and 0.05 ≤ Deviation 100 kHz < Rate and 0.05 ≤ Deviation | $0.2 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.9 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.4 [%], whichever is smaller | |
| Band 5 Rate ≤ 100 kHz and 0.05 ≤ Deviation 100 kHz < Rate and 0.05 ≤ Deviation | $0.3 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.8 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.4 [%], whichever is smaller | |
| Band 6 Rate ≤ 100 kHz and 0.1 ≤ Deviation 100 kHz < Rate and 0.1 ≤ Deviation | $0.3 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.9 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.4 [%], whichever is smaller | |
| <i>Option EP0</i> | | |
| Band 0 Rate ≤ 100 kHz 100 kHz < Rate | $0.1 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.8 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.3 [%], whichever is smaller | |
| Band 1 Rate ≤ 100 kHz 100 kHz < Rate and 0.02 ≤ Deviation | $0.2 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.8 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.3 [%], whichever is smaller | |
| Band 2 Rate ≤ 100 kHz 100 kHz < Rate | $0.2 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.8 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.3 [%], whichever is smaller | |
| Band 3 Rate ≤ 100 kHz 100 kHz < Rate | $0.2 \times \text{Deviation}^{1/2} + 0.005 \text{ [\%]}$ $0.9 / \text{Deviation} + 0.005 \text{ [\%]}$ or 0.4 [%], whichever is smaller | |

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| Band 4 Rate ≤ 100 kHz 100 kHz < Rate and $0.02 \leq \text{Deviation}$ | $0.2 \times \text{Deviation}^{1/2} + 0.005$ [%] $0.9 / \text{Deviation} + 0.005$ [%] or 0.4 [%], whichever is smaller | |
| Band 5 Rate ≤ 100 kHz 100 kHz < Rate and $0.02 \leq \text{Deviation}$ | $0.3 \times \text{Deviation}^{1/2} + 0.005$ [%] $0.8 / \text{Deviation} + 0.005$ [%] or 0.4 [%], whichever is smaller | |
| Band 6 Rate ≤ 100 kHz and $0.02 \leq \text{Deviation}$ 100 kHz < Rate and $0.05 \leq \text{Deviation}$ | $0.3 \times \text{Deviation}^{1/2} + 0.005$ [%] $0.9 / \text{Deviation} + 0.005$ [%] or 0.4 [%], whichever is smaller | |

- For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
- Deviation is a peak deviation in radians. Rate is a modulation rate in Hz

| Description | Specifications | Supplemental Information |
|--|---|---|
| Post-Demod Distortion Accuracy (Rate: 100 Hz to 10 MHz, Deviation: 0.01 to 10000) | | |
| Distortion (SINAD) ^a | $\pm(0.02 \times \text{Reading} + \text{DistResidual})$ | |
| THD | $\pm(0.02 \times \text{Reading} + \text{THDResidual})$ | 2 nd and 3 rd harmonics |

- SINAD [dB] can be derived by $20 \times \log_{10}(1 / \text{Distortion})$.

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|--|---|-----------------------------|
| THD [%] ^{ab} 1 rad ≤ Deviation ≤ 100 rad | | Audio Filter LPF = 3 kHz |
| Band 0 Rate = 400Hz Rate = 1 kHz | $1 / (50 \times \text{Deviation}^{1/2}) + 0.005$ $1 / (100 \times \text{Deviation}^{1/2}) + 0.003$ | HPF = 50 Hz HPF = 300 Hz |
| Band 1 Rate = 400Hz Rate = 1 kHz | $1 / (50 \times \text{Deviation}^{1/2}) + 0.006$ $1 / (80 \times \text{Deviation}^{1/2}) + 0.003$ | HPF = 50 Hz HPF = 300 Hz |
| Band 2 Rate = 400Hz Rate = 1 kHz | $1 / (40 \times \text{Deviation}^{1/2}) + 0.005$ $1 / (60 \times \text{Deviation}^{1/2}) + 0.002$ | HPF = 50 Hz HPF = 300 Hz |
| Band 3 Rate = 400Hz Rate = 1 kHz | $1 / (25 \times \text{Deviation}^{1/2}) + 0.005$ $1 / (50 \times \text{Deviation}^{1/2}) + 0.002$ | HPF = 50 Hz HPF = 300 Hz |
| Band 4 Rate = 400Hz Rate = 1 kHz | $1 / (20 \times \text{Deviation}^{1/2}) + 0.003$ $1 / (35 \times \text{Deviation}^{1/2}) + 0.002$ | HPF = 50 Hz HPF = 300 Hz |
| Band 5 Rate = 400Hz Rate = 1 kHz | $1 / (16 \times \text{Deviation}^{1/2}) + 0.002$ $1 / (26 \times \text{Deviation}^{1/2})$ | HPF = 50 Hz HPF = 300 Hz |
| Band 6 Rate = 400Hz Rate = 1 kHz | $1 / (10 \times \text{Deviation}^{1/2})$ $1 / (12 \times \text{Deviation}^{1/2})$ | HPF = 50 Hz HPF = 300 Hz |

- For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
- Deviation is a peak deviation in radians. Rate is a modulation rate in Hz.

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|---------------------------------|------------------|--------------------------|
| AM Rejection^a | | |
| <i>Option EP1</i> | | |
| Band 0 | 2.4 mrad (peak) | |
| Band 1 | 4.0 mrad (peak) | |
| Band 2 | 6.4 mrad (peak) | |
| Band 3 | 8.0 mrad (peak) | |
| Band 4 | 12.4 mrad (peak) | |
| Band 5 | 16.2 mrad (peak) | |
| Band 6 | 23.4 mrad (peak) | |
| <i>Option EP0</i> | | |
| Band 0 | 0.4 mrad (peak) | |
| Band 1 | 1.0 mrad (peak) | |
| Band 2 | 1.6 mrad (peak) | |
| Band 3 | 2.0 mrad (peak) | |
| Band 4 | 3.1 mrad (peak) | |
| Band 5 | 4.0 mrad (peak) | |
| Band 6 | 5.6 mrad (peak) | |

- a. AM rejection describes the instrument's PM reading for an input that is strongly AMed (with no PM); this specification includes contributions from residual PM. AM signal (Rate = 1 kHz, Depth = 50%), HPF=50 Hz, LPF = 3 kHz, Channel BW = 15 kHz.

Analog Demodulation Measurement Application
Phase Modulation

| Description | Specifications | Supplemental Information |
|--------------------------------|-----------------|--------------------------|
| Residual PM^a | | |
| <i>Option EP1</i> | | |
| Band 0 | 1.4 mrad (rms) | |
| Band 1 | 2.5 mrad (rms) | |
| Band 2 | 3.9 mrad (rms) | |
| Band 3 | 4.9 mrad (rms) | |
| Band 4 | 7.5 mrad (rms) | |
| Band 5 | 9.8 mrad (rms) | |
| Band 6 | 14.1 mrad (rms) | |
| <i>Option EP0</i> | | |
| Band 0 | 0.3 mrad (rms) | |
| Band 1 | 0.7 mrad (rms) | |
| Band 2 | 1.1 mrad (rms) | |
| Band 3 | 1.3 mrad (rms) | |
| Band 4 | 2.0 mrad (rms) | |
| Band 5 | 2.6 mrad (rms) | |
| Band 6 | 3.7 mrad (rms) | |

- a. Residual PM describes the instrument's PM reading for an input that has no PM and no AM; this specification includes contributions from PM deviation accuracy. HPF = 50 Hz, LPF = 3 kHz, Channel BW = 15 kHz.

Analog Out

The "Analog Out" connector (BNC) is located at the analyzer's rear panel. It is a multi-purpose output, whose function depends on options and operating mode (active application). When the N9063C Analog Demod application is active, this output carries a voltage waveform reconstructed by a real-time hardware demodulator (designed to drive the "Demod to Speaker" function for listening). The processing path and algorithms for this output are entirely separate from those of the N9063C application itself; the Analog Out waveform is not necessarily identical the application's Demod Waveform.

Condition of "Open Circuit" is assumed for all voltage terms such as "Output range".

| Description | Specifications | Supplemental Information |
|----------------------|----------------|---|
| Bandwidth | | ≤ 8 MHz |
| Output impedance | | 50 Ω (nominal) |
| Output range | | –1V to +1 V (Nominal) |
| AM scaling | | |
| AM scaling factor | | 5 mV/%AM (nominal) |
| AM scaling tolerance | | $\pm 10\%$ (nominal) |
| AM offset | | 0 V corresponds to carrier power as measured at setup ^a |
| FM scaling | | |
| FM scaling factor | | 2 V/Channel BW (nominal), where Channel BW is settable by the user |
| FM scaling tolerance | | $\pm 10\%$ (nominal) |
| FM scale adjust | | User-settable factor, range from 0.5 to 10, default =1, applied to above FM scaling. |
| FM offset | | |
| HPF off | | 0 V corresponds to SA tuned frequency, and Carrier Frequency Errors (constant frequency offset) are included (DC coupled) |
| HPF on | | 0 V corresponds to the mean of the waveform |
| PM scaling | | |
| PM scaling factor | | (1/ π) V/rad (nominal) |
| PM scaling tolerance | | $\pm 10\%$ (nominal) |
| PM offset | | 0 V corresponds to mean phase |

Analog Demodulation Measurement Application

Analog Out

- a. For AM, the reference “unmodulated” carrier level is determined by a single “invisible” power measurement, of 2 ms duration, taken at setup. “Setup” occurs whenever a core parameter is changed, such as Center Frequency, modulation type, Demod Time, etc. Ideally, the RF input signal should be un-modulated at this time. However, if the AM modulating (audio) waveform is evenly periodic in 2 ms (i.e. multiples of 500 Hz, such as 1 kHz), the reference power measurement can be made with modulation applied. Likewise, if the AM modulating period is very short compared to 2ms (e.g. >5000 Hz), the reference power measurement error will be small.

FM Stereo/Radio Data System (RDS) Measurements¹

| Description | Specifications | Supplemental Information |
|---|--|---|
| FM Stereo Modulation Analysis Measurements | | |
| MPX view | RF Spectrum, AF Spectrum, Demod Waveform, FM Deviation (Hz) (Peak +, Peak-, (Pk-Pk)/2, RMS), Carrier Power (dBm), Carrier Frequency Error (Hz), SINAD (dB), Distortion (% or dB) | MPX consists of FM signal multiplexing with the mono signal (L+R), stereo signal (L-R), pilot signal (at 19 kHz) and optional RDS signal (at 57 kHz). <ul style="list-style-type: none"> – SINAD MPX BW, default 53 kHz, range from 1 kHz to 58 kHz. – Reference Deviation, default 75 kHz, range from 15 kHz to 150 kHz. |
| Mono (L+R) / Stereo (L-R) view | Demod Waveform, AF Spectrum, Carrier Power (dBm), Carrier Frequency Error (Hz), Modulation Rate | Mono Signal is Left + Right Stereo Signal is Left – Right |
| Left / Right view | Demod Waveform, AF Spectrum, Carrier Power (dBm), Carrier Frequency Error (Hz), Modulation Rate, SINAD (dB), Distortion (% or dB), THD (% or dB) | Post-demod settings: <ul style="list-style-type: none"> – Highpass filter: 20, 50, or 300 Hz – Lowpass filter: 300 Hz, 3, 15, 80, or 300 kHz – Bandpass filter: A-Weighted, CCITT – De-Emphasis: 25, 50, 75 and 750 μs |
| RDS / RBDS Decoding Results view | BLER basic tuning and switching information, radio text, program item number and slow labeling codes, clock time and date | BLER Block Count default 1E+8, range from 1 to 1E+16 |
| Numeric Result view | MPX, Mono, Stereo, Left, Right, Pilot and RDS with FM Deviation result (Hz) of Peak+, (Pk-Pk)/2, RMS, Modulation Rate (Hz), SINAD (% or dB), THD (% or dB), Left to Right (dB), Mono to Stereo (dB), RF Carrier Power (dBm), RF Carrier Frequency Error (Hz), 38 kHz Carrier Phase Error (deg) | |

1. Requires *Option N9063C-3FP*, which in turn requires that the instrument also has *Option N9063C-2FP* installed and licensed.

Analog Demodulation Measurement Application
 FM Stereo/Radio Data System (RDS) Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| FM Stereo Modulation Analysis Measurements | | FM Stereo with 67.5 kHz audio deviation at 1 kHz modulation rate plus 6.75 kHz pilot deviation. |
| SINAD | | |
| A-Weighted filter | | 69 dB (nominal) |
| CCITT filter | | 71 dB (nominal) |
| Left to Right Ratio | | |
| A-Weighted filter | | 72 dB (nominal) |
| CCITT filter | | 76 dB (nominal) |

24 Avionics Measurement Application

This chapter contains specifications for the N9092EM0E Avionics Measurement X-Series multi-touch application, with the N9030B PXA or the N5531X MMR-X system.

The N9092EM0E application can measure and verify signals from a signal generator or transmitter, of the following types, used for avionics navigation:

- VOR (VHF Omnidirectional Range), used to determine compass bearing (azimuth) relative to a ground transmitter.
- ILS (Instrument Landing System), used to help aircraft approach the runway for landing.
- Marker-Beacon (with Outer, Middle, and Inner markers), used to indicate aircraft distance from end of runway, on approach.
- ADF (Automatic Direction Finder), used to determine compass bearing (azimuth) relative to a ground transmitter, for aircraft equipped with a directional antenna.

Signal generators are used to imitate these RF signals as if coming from an airport, so that the plane-based RF receivers can be tested while on the ground. The N9092EM0E application is used to verify the signal quality from these signal generators.

VOR Algorithms

The N9092EM0E application includes 3 algorithms to measure the accuracy of the critical VOR-bearing (azimuth) result:

- a. Standard - based on the FFT algorithm from NBS/NIST, described in their Tech Note 1069, April 1985, by Larsen, Vecchia, and Sugar. It can be said to have the highest accuracy, but is the most sensitive to variations in signal parameters.
- b. Adaptive - similar to (a) with very high accuracy, but modified to be more tolerant of signal parameter variations.
- c. Phase - uses step-wise AM- and FM-demodulation with phase detection after tone recovery. It has the best tolerance to signal variations, but only moderate accuracy.

The N9092EM0E application defaults to Adaptive and all VOR specifications in this chapter (including ranges of signal parameters) are based on Adaptive.

Additional Definitions and Requirements

The following conditions and limitations, in addition to those at the beginning of this chapter, must be met for all specifications of all measurements to apply.

Additional constraints may be found in the "Supplemental Information" column for specific specifications.

NOTE

Most measurements 'function' and are usable, although unspecified, for some ranges outside of these conditions.

- The power level to the PXA's first mixer should be -15 dBm +/- 5 dB. The application will adjust the PXA input attenuation automatically to achieve this level.

Very high signal levels may require external attenuation, both to avoid damage and to achieve quality measurements.

The user may optimize Attenuator level manually, and may apply the Preamp, however specifications may be degraded.

- The frequency of RF carrier must be within 500 ppm of the N9092EM0E's measurement frequency. At 110 MHz, this is approximately 50 kHz.

Signal generators using analog or open-loop tuning, with high 'drift', or having excessive residual FM (phase noise) cannot be reliably measured.

Signal generators with synthesized tuning will often have a 10 MHz Reference input or output; this Reference should be shared with the PXA, if allowed.

The signal of interest, and all sideband energy, must fall within the analyzer's measurement bandwidth (~75 kHz for VOR, otherwise ~11 kHz) centered on the tuning frequency.

- **The** N9030B PXA (*Options 503, 508, 513, or 526*) is defaulted to AC coupling (i.e. use a DC-block) at their input connector. Signals at 10 MHz and below will be attenuated when using default AC coupling. To avoid the signal attenuation for the low frequency signals, it is recommended for the user to manually switch to DC coupling.

- Modulation must conform to ICAO technical specifications for each aviation signal type, *and* meet conditions described in this document.

Multiple tones must maintain an exact integer multiple relationship to 30 Hz; i.e. for VOR, $9,960 = 30 \times 332$; for ILS, $90 = 30 \times 3$, and $150 = 30 \times 5$.

COM or IDENT tones (if enabled) are based on single-tone CW sine wave AM modulation, without voice, pulse, or Morse code modulation, in the range of 1,000-1,020 Hz.

- THD (Total Harmonic Distortion) measurements are based on the 2nd, 3rd, 4th, and 5th harmonics of the fundamental tones.

- Mismatch errors (includes output match of the signal generator under test) are excluded from the specifications, so they must be controlled as needed with attenuators (“pads”) or isolators.
- Total AM modulation from all tones must be <95% AM.
- No error conditions detected by the PXA.
- Additional constraints as noted.

Disclaimer:

For safety and liability reasons, the PXA-based avionic measurement application is NOT intended to be used to verify navigation signals from airports, nor serve as an operational or functional element of an aircraft in flight.

RF Input

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| General, RF Input | | |
| RF Input Frequency Range ^a | 10 to 335 MHz | 190 kHz to 3 GHz (nominal) |
| RF Frequency Accuracy | | |
| Internal Time Base | | As per PXA's timebase. Typically between ± 0.07 and ± 0.1 ppm/year |
| External Frequency Reference | | As per user-supplied reference specifications |
| RF input power range (for best accuracy) | | –15 to +10 dBm (nominal) |
| Usable RF input power range | | –50 to +30 dBm (nominal) |
| Power accuracy | | ± 0.8 dB (nominal) (at the front panel connector; external losses, including those due to N5532A/B or U5532C sensors in the RF path, can be compensated for entering Ext RF Attenuation under AMPTD menu) |

- a. See cautions under "Additional conditions" on [page 318](#) regarding attenuation at <10MHz due to AC coupling.

Avionics Measurement Application
RF Input

| Description | Specifications | Supplemental Information |
|--|---|---|
| VOR (VHF Omnidirectional Range), RF Input | | |
| RF Input Frequency Range | 108 to 118 MHz | |
| VOR bearing | | Angle, azimuth, or phase. |
| Range | 0 to 360° | |
| Accuracy ^a | ± 0.025° | 30 Hz and 9,960 Hz tones at 10% to 40% AM depth each. |
| Resolution | 0.001° | |
| Frequency of tones (30 Hz, 1,020 Hz, and 9,960 Hz) | | |
| Range | | ±0.2% of nominal tone value (nominal) |
| Accuracy ^a | ± 0.01 Hz | At 10% to 40% AM depth |
| AM depth of tones (30 Hz, 1,020 Hz, and 9,960 Hz) | | |
| Range | | 0 to 40% AM depth (nominal) |
| Accuracy (for 30 Hz and 1,020 Hz tones) ^a | ± 0.1% of AM, or ±0.5% of reading, whichever is greater | At 10% to 40% AM 30 Hz, and 1% to 35% AM for 1,020 Hz |
| Accuracy (for 9,960 Hz tone) ^a | ± 0.3% AM | At 10% to 35% AM depth |
| Distortion of tones (30 Hz, 1,020 Hz, and 9,960 Hz) | | Frequency within 2% of nominal, 10% to 30% AM per tone and < 90% AM total |
| Range | | < 10% THD |
| Accuracy ^a | | ± 0.4% THD (nominal) |
| FM deviation (0-to-peak) of 9,960 Hz subcarrier | | |
| Peak FM deviation | | 480 Hz (nominal) |
| FM deviation range | | 400 to 700 Hz (nominal) |
| Accuracy ^a | ± 1 Hz | At 10% to 40% AM depth |
| Combined AM modulation of 30 and 9,960 Hz tones | | Indicator is simply the sum of the underlying AM% measurements |

a. Tone frequency must be within ±500 ppm of the nominal tone frequency, FM deviation at 480 Hz ±25 Hz.

Avionics Measurement Application
RF Input

| Description | Specifications | Supplemental Information |
|---|---|---|
| ILS (Instrument Landing System) - Localizer (LOC) and Glide-Slope (GS), RF Input | | |
| RF Input Frequency Range | 108.0 to 335.0 MHz | |
| DDM ^a (Difference in Depth of Modulation, between 90 to 150 Hz) | | SDM (total modulation) from 0% to 80% |
| Range | | 0 to 0.40000 DDM (nominal) |
| Accuracy ^b | ± 0.0001 or ±0.004 of reading, whichever is greater (≤ ±10%DDM) ±0.002 of reading + 0.0002 (> ±10%DDM) | SDM = 40% AM (LOC) or 80% AM (GS) |
| SDM (Sum of Depth of Modulation) | | |
| Range | | |
| LOC | | 0% to 40% (nominal) |
| GS | | 0% to 80% (nominal) |
| Accuracy ^b | ± 0.1% AM or ± 0.5% of reading, whichever is greater | LOC: 1% to 40%, GS: 1% to 80% |
| Frequency of tones (90, 150, and 1,020 Hz) | | |
| Range | | ± 2% of reading (nominal) |
| Accuracy ^b | ± 0.01 Hz | > 10% AM each tone |
| AM depth of tones (90, 150, and 1,020 Hz) | | Frequency within 2% of nominal, 10% to 30% AM per tone and < 90% AM total |
| Range | | 0% to 80% AM (each tone) (nominal) |
| Accuracy ^b | ± 0.1% AM or ± 0.5% of reading, whichever is greater | 1% to 80% AM (90, 150Hz), and 1% to 20% (1,020Hz) |
| Distortion of tones | | 10% to 40% each tone, < 80% AM total |
| Range | | < 10% THD |
| Accuracy ^b | | ± 0.4% THD (nominal) |
| Phase angle between 90 Hz and 150 Hz | | Ratio of 90 Hz and 150 Hz tones must be exactly 3:5 |
| Range | | -60° to +60°, or 0° to +120° |
| Uncertainty ^b | | ± 0.2° (nominal), at 0° to +120° At 1% to 80% AM depth both tones |

a. "DDM" is unitless, and related to equivalent AM% by a factor of 100.

b. Tone frequency must be within ±500 ppm of the nominal tone frequency.

Avionics Measurement Application
RF Input

| Description | Specifications | Supplemental Information |
|------------------------------------|---|---|
| Markers - Beacons, RF input | | |
| Frequency of tones | | Tone at 400, 1,300, or 3,000 Hz (only 1 tone at a time) |
| Range | | $\pm 5\%$ of nominal tone value |
| Accuracy | ± 0.1 Hz | for 2% to 99% AM |
| Amplitude modulation (measured) | | |
| Range | | 2% to 99% AM (nominal) |
| Accuracy | $\pm 0.1\%$ AM, or $\pm 0.7\%$ of reading, whichever is greater | $\pm 0.1\%$ AM, or $\pm 0.5\%$ of reading, whichever is greater (nominal) |
| Distortion of tones | | 10% to 99% AM |
| Range | | $< 10\%$ THD |
| Accuracy | | $\pm 0.4\%$ THD (nominal) |

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| ADF (Automatic Direction Finder), RF input | | |
| Frequency of tones | | Tones at 50, 100, 1,020, 5,000 Hz; Continuous sine, no Morse, no Voice |
| Range | | $\pm 5\%$ of nominal tone value |
| Accuracy | | $\pm 0.2\%$ of reading (nominal); At $> 10\%$ AM |
| Amplitude modulation (measured) | | |
| Range | | 0 to 90% AM (nominal) |
| Accuracy | | $\pm 0.1\%$ AM, or $\pm 0.5\%$ of reading, whichever is greater (nominal) |
| Distortion of tones | | 10% to 95% AM |
| Range | | $< 10\%$ THD (nominal) |
| Accuracy | | $\pm 0.4\%$ THD (nominal) |

Audio Input

Requires Option N9030B *Option 107* Audio input and digitizer.

| Description | Specifications | Supplemental Information |
|-----------------------------|----------------|--|
| General, Audio input | | |
| Audio input voltage level | | |
| Range | 0 to 3 Vrms | |
| Extended Range | 0 to 10 Vrms | By use of external high-impedance voltage attenuator, with display correction factor |
| Accuracy | | ± 1 mVrms, or < 1% of reading, whichever is greater (nominal) |
| Frequency range | | 5 Hz to 250 kHz nominal (DC coupled) |
| Input impedance | | 100 k Ω (nominal) |

Avionics Measurement Application
Audio Input

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| VOR (VHF Omnidirectional Range), Audio Input | | |
| VOR bearing ^a | | Angle, azimuth, or phase. |
| Range | 0 to 360° | |
| Accuracy ^b | ± 0.025° | At >100 mVrms; 30 Hz and 9,960 Hz tones within 100 ppm of nominal freq; FM deviation at 480 Hz ± 2 Hz; 1,000-1,020 Hz Com/Ident Off. |
| Resolution | 0.001° | |
| Frequency of tones | | Tones at 30, 1,020, and 9,960 Hz |
| Range | | ±0.2% of nominal tone value (nominal) |
| Accuracy (for 30 Hz and 1,020 Hz tones) | | ± (0.005% of reading + 0.005 Hz), nominal; At > 100 mVrms, no modulation on 1,000 Hz |
| Accuracy (for 9,960 Hz tone) | | ± 0.06 Hz (nominal); At > 100 mVrms, < 700 Hz of sine FM |
| Amplitude of tones | | Tones at 30, 1,020, and 9,960 Hz |
| Range | | 0.1 to 3 Vrms total |
| Accuracy (for 30 Hz and 1,020 Hz tones) | | ± 0.1% Vrms, or ± 0.5% of reading, whichever is greater (nominal) |
| Accuracy (for 9,960 Hz tone) | | ± 1% of reading (nominal); within ± 10 Hz of 9,960 Hz center frequency; at 30% AM |
| Distortion of tones | | Tones at 30, 1,000-1,020, and 9,960 Hz; FM on 9,960 Hz tone is < 700 Hz |
| Range | | < 10% THD |
| Accuracy (for 30 Hz and 1,020 Hz tones) | | ± 0.1%, or ± 5% of reading, whichever is greater (nominal) |
| Accuracy (for 9,960 Hz tone) | | ± 0.2%, or ± 8% of reading, whichever is greater (nominal) |
| FM deviation (0-to-peak) of 9,960 Hz subcarrier | | |
| Peak FM deviation | | 480 Hz (nominal) |
| FM deviation range | | 400 to 700 Hz (nominal) |
| Accuracy | | ± 2 Hz with 30 Hz sine FM |

a. VOR bearing specifications apply to a default "Adaptive" algorithm.

b. 95th percentile.

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| ILS (Instrument Landing System) - Localizer (LOC) and Glide-Slope (GS), Audio Input | | All specifications apply to both GS and LOC unless noted otherwise |
| Amplitude of tones | | Tones at 90, 150, 1,020 Hz (nominal) |
| Range | | 0.1 to 3 Vrms total (nominal) |
| Accuracy | | ± 0.01 Vrms, or $\pm 0.5\%$ of reading, whichever is greater (nominal) |
| Frequency of tones | | Tones at 90, 150, 1,020 Hz (nominal) |
| Range | | $\pm 2\%$ of nominal tone value (nominal) |
| Accuracy | | $\pm 0.005\%$ of reading (nominal) |
| Distortion of tones | | Tones at 90, 150, 1,020 Hz |
| Range | | $< 10\%$ THD |
| Accuracy (for 30 Hz and 1,020 Hz tones) | | $\pm 0.1\%$, or $\pm 5\%$ of reading, whichever is greater (nominal); at > 100 mVrms |
| DDM ^a (Difference in Depth of Modulation, between 90 to 150 Hz) | | Audio DDM is "scaled" on the basis that SDM (total modulation) is 40% for LOC and 80% for GS |
| Range | | 0 to 0.40000 DDM (nominal) |
| Accuracy | | ± 0.0001 , or ± 0.004 of reading, whichever is greater (nominal); Com/Ident Off |
| Phase angle between 90 Hz and 150 Hz | | 90 Hz and 150 Hz tones must be exact integer multiples of 30 Hz |
| Range | | -60° to $+60^\circ$, or 0° to $+120^\circ$ |
| Uncertainty | | $\pm 0.2^\circ$ (nominal) |

a. "DDM" is unitless, and related to equivalent AM% by a factor of 100.

Avionics Measurement Application
Audio Input

| Description | Specifications | Supplemental Information |
|---------------------------------------|----------------|---|
| Markers - Beacons, Audio input | | |
| Frequency of tones | | Tone at 400, 1,300, or 3,000 Hz (only 1 tone at a time) |
| Range | | $\pm 2\%$ of nominal tone value (nominal) |
| Accuracy | | $\pm 0.005\%$ of reading (nominal); at >100 mVrms |
| Amplitude of tones | | |
| Range | | 0.1 to 3 Vrms; range can be extended by use of external high-impedance voltage attenuator |
| Accuracy | | ± 0.01 Vrms, or $\pm 0.5\%$ of reading, whichever is greater (nominal) |
| Distortion of tones | | |
| Range | | $< 10\%$ THD |
| Accuracy | | $\pm 0.1\%$, or $\pm 5\%$ of reading, whichever is greater (nominal) |

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| ADF (Automatic Direction Finder), Audio input | | |
| Frequency of tones | | Tones at 50, 1,000/1,020, 5,000 Hz; one tone at a time, sine |
| Range | | $\pm 2\%$ of nominal tone value (nominal) |
| Accuracy | | $\pm (0.005\% \text{ of reading} + 0.005 \text{ Hz})$ nominal; at >100 mVrms |
| Amplitude of tones | | |
| Range | | 100 mVrms to 3 Vrms |
| Accuracy | | ± 0.01 mVrms, or $\pm 0.5\%$ of reading, whichever is greater (nominal) |
| Distortion of tones | | 10% to 95% AM |
| Range | | $< 10\%$ THD |
| Accuracy | | $\pm 0.1\%$, or $\pm 5\%$ of reading, whichever is greater (nominal) |

25 Bluetooth Measurement Application

This chapter contains specifications for N9081EM0E-2FP Bluetooth measurement application. Three standards, Bluetooth 2.1-basic rate, Bluetooth 2.1-EDR and Bluetooth 2.1-low energy are supported.

Three power classes, class 1, class 2 and class 3 are supported. Specifications for the three standards above are provided separately.

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 range documented in In-Band Frequency Range.

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

The specifications for this chapter apply only to instruments with Frequency *Option 508, 513 or 526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different between instruments with the higher frequency options. 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.

Basic Rate Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Output Power | | This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.3. |
| Packet Type | | DH1, DH3, DH5, HV3 |
| Payload | | PRBS9, BS00, BSFF, BS0F, BS55 |
| Synchronization | | RF Burst or Preamble |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| Supported measurements | | Average power, peak power |
| Range ^a | | +30 dBm to -70 dBm |
| Absolute Power Accuracy ^b (20 to 30°C, Atten = 10 dB) | | ±0.20 dB(95th percentile) |
| Measurement floor | | -70 dBm (nominal) |

- a. When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- b. 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.

Bluetooth Measurement Application
Basic Rate Measurements

| Description | Specifications | Supplemental Information |
|-----------------------------------|----------------|---|
| Modulation Characteristics | | This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.9. |
| Packet Type | | DH1, DH3, DH5, HV3 |
| Payload | | BS0F, BS55 |
| Synchronization | | Preamble |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| Supported measurements | | Min/max $\Delta f1_{avg}$ min $\Delta f2_{max}$ (kHz) total $\Delta f2_{max} > \Delta f2_{max}$ lower limit (%) min of min $\Delta f2_{avg}$ / max $\Delta f1_{avg}$ pseudo frequency deviation ($\Delta f1$ and $\Delta f2$) |
| RF input level range ^a | | +30 dBm to -70 dBm |
| Deviation range | | ± 250 kHz (nominal) |
| Deviation resolution | | 100 Hz (nominal) |
| Measurement Accuracy ^b | | ± 100 Hz + tfa ^c (nominal) |

- When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of $\pm(2.402 \text{ GHz} \times 1 \text{ ppm}) \text{ Hz} \pm 100 \text{ Hz} = \pm 2402 \text{ Hz} \pm 100 \text{ Hz} = \pm 2502 \text{ Hz}$.
- tfa = transmitter frequency \times frequency reference accuracy.

Bluetooth Measurement Application
Basic Rate Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| Initial Carrier Frequency Tolerance | | This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.10. |
| Packet Type | | DH1, DH3, DH5, HV3 |
| Payload | | PRBS9, BS00, BSFF, BSOF, BS55 |
| Synchronization | | Preamble |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| RF input level range ^a | | +30 dBm to -70 dBm |
| Measurement range | | Nominal channel freq \pm 100 kHz (nominal) |
| Measurement Accuracy ^b | | ± 100 Hz + tfa ^c (nominal) |

- a. When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of $\pm(2.402 \text{ GHz} \times 1 \text{ ppm}) \text{ Hz} \pm 100 \text{ Hz} = \pm 2402 \text{ Hz} \pm 100 \text{ Hz} = \pm 2502 \text{ Hz}$.
- c. tfa = transmitter frequency \times frequency reference accuracy.

| Description | Specifications | Supplemental Information |
|-----------------------------------|----------------|---|
| Carrier Frequency Drift | | This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.11. |
| Packet Type | | DH1, DH3, DH5, HV3 |
| Payload | | PRBS9, BS00, BSFF, BSOF, BS55 |
| Synchronization | | Preamble |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| RF input level range ^a | | +30 dBm to -70 dBm |
| Measurement range | | ± 100 kHz (nominal) |
| Measurement Accuracy ^b | | ± 100 Hz + tfa ^c (nominal) |

- a. When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.

Bluetooth Measurement Application
Basic Rate Measurements

- b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of $\pm(2.402 \text{ GHz} \times 1 \text{ ppm}) \text{ Hz} \pm 100 \text{ Hz} = \pm 2402 \text{ Hz} \pm 100 \text{ Hz} = \pm 2502 \text{ Hz}$.
- c. $tfa = \text{transmitter frequency} \times \text{frequency reference accuracy}$.

| Description | Specifications | Supplemental Information |
|-----------------------------------|----------------|---|
| Adjacent Channel Power | | This measurement is an Adjacent Channel Power measurement and is in conformance with Bluetooth RF test specification 2.1.E.0.5.1.8. |
| Packet Type | | DH1, DH3, DH5, HV3 |
| Payload | | PRBS9, BS00, BSFF, BSOF, BS55 |
| Synchronization | | None |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| Measurement Accuracy ^a | | Dominated by the variance of measurements ^b |

- a. The accuracy is for absolute power measured at 2.0 MHz offset and other offsets (offset = K MHz, K = 3,...,78).
- b. The measurement at these offsets is usually the measurement of noise-like signals and therefore has considerable variance. For example, with 100 ms sweeping time, the standard deviation of the measurement is about 0.5 dB. In comparison, the computed uncertainties of the measurement for the case with CW interference is only $\pm 0.20 \text{ dB}$.

Low Energy Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Output Power Packet Type Payload Synchronization Trigger Supported measurements Range ^a Absolute Power Accuracy ^b (20 to 30°C, Atten = 10 dB) Measurement floor | | This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.1. Reference type PRBS9, BS00, BSFF, BS0F, BS55 RF Burst or Preamble External, RF Burst, Periodic Timer, Free Run, Video Average Power, Peak Power +30 dBm to -70 dBm ±0.20 dB(95th percentile) -70 dBm (nominal) |

- When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- 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.

Bluetooth Measurement Application
Low Energy Measurements

| Description | Specifications | Supplemental Information |
|-----------------------------------|----------------|---|
| Modulation Characteristics | | This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.3. |
| Packet Type | | Reference type |
| Payload | | BSOF, BS55 |
| Synchronization | | Preamble |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| Supported measurements | | Min/max $\Delta f1_{avg}$ min $\Delta f2_{max}$ (kHz) total $\Delta f2_{max} > \Delta f2_{max}$ lower limit (%) min of min $\Delta f2_{avg}$ / max $\Delta f1_{avg}$ pseudo frequency deviation ($\Delta f1$ and $\Delta f2$) |
| RF input level range ^a | | +30 dBm to -70 dBm |
| Deviation range | | ± 250 kHz (nominal) |
| Deviation resolution | | 100 Hz (nominal) |
| Measurement Accuracy ^b | | ± 100 Hz + tfa ^c (nominal) |

- When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of $\pm(2.402 \text{ GHz} \times 1 \text{ ppm}) \text{ Hz} \pm 100 \text{ Hz} = \pm 2402 \text{ Hz} \pm 100 \text{ Hz} = \pm 2502 \text{ Hz}$.
- tfa = transmitter frequency \times frequency reference accuracy.

Bluetooth Measurement Application
Low Energy Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Initial Carrier Frequency Tolerance | | This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.4. |
| Packet Type | | Reference type |
| Payload | | PRBS9, BS00, BSFF, BSOF, BS55 |
| Synchronization | | Preamble |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| RF input level range ^a | | +30 dBm to -70 dBm |
| Measurement range | | Nominal channel freq \pm 100 kHz (nominal) |
| Measurement Accuracy ^b | | ± 100 Hz + tfa ^c (nominal) |

- a. When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of $\pm(2.402 \text{ GHz} \times 1 \text{ ppm}) \text{ Hz} \pm 100 \text{ Hz} = \pm 2402 \text{ Hz} \pm 100 \text{ Hz} = \pm 2502 \text{ Hz}$.
- c. tfa = transmitter frequency \times frequency reference accuracy.

Bluetooth Measurement Application
Low Energy Measurements

| Description | Specifications | Supplemental Information |
|-----------------------------------|----------------|--|
| Carrier Frequency Drift | | This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.4. |
| Packet Type | | Reference type |
| Payload | | PRBS9, BS00, BSFF, BSOF, BS55 |
| Synchronization | | Preamble |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| RF input level range ^a | | +30 dBm to -70 dBm |
| Measurement range | | ±100 kHz (nominal) |
| Measurement Accuracy ^b | | ±100 Hz + tfa ^c (nominal) |

- a. When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of $\pm(2.402 \text{ GHz} \times 1 \text{ ppm}) \text{ Hz} \pm 100 \text{ Hz} = \pm 2402 \text{ Hz} \pm 100 \text{ Hz} = \pm 2502 \text{ Hz}$.
- c. tfa = transmitter frequency \times frequency reference accuracy.

| Description | Specifications | Supplemental Information |
|-----------------------------------|----------------|---|
| LE In-band Emission | | This measurement is an LE in-band emission measurement and is in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.2. |
| Packet Type | | Reference type |
| Payload | | PRBS9, BS00, BSFF, BSOF, BS55 |
| Synchronization | | None |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| Measurement Accuracy ^a | | Dominated by the variance of measurements ^b |

- a. The accuracy is for absolute power measured at 2.0 MHz offset and other offsets (offset = 2 MHz \times K, K = 2,...,39).
- b. The measurement at these offsets is usually the measurement of noise-like signals and therefore has considerable variance. For example, with 100 ms sweeping time, the standard deviation of the measurement is about 0.5 dB. In comparison, the computed uncertainties of the measurement for the case with CW interference is only $\pm 0.20 \text{ dB}$.

Enhanced Data Rate (EDR) Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| EDR Relative Transmit Power | | This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.12. |
| Packet Type | | 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5 |
| Payload | | PRBS9, BS00, BSFF, BS55 |
| Synchronization | | DPSK synchronization sequence |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| Supported measurements | | Power in GFSK header, power in PSK payload, relative power between GFSK header and PSK payload |
| Range ^a | | +30 dBm to -70 dBm |
| Absolute Power Accuracy ^b (20 to 30°C, Atten = 10 dB) | | ±0.20 dB (95th percentile) |
| Measurement floor | | -70 dBm (nominal) |

- When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- 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.

Bluetooth Measurement Application
Enhanced Data Rate (EDR) Measurements

| Description | Specifications | Supplemental Information |
|-----------------------------------|----------------|---|
| EDR Modulation Accuracy | | This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification 2.1.E.0.5.1.13 |
| Packet Type | | 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5 |
| Payload | | PRBS9, BS00, BSFF, BS55 |
| Synchronization | | DPSK synchronization sequence |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| Supported measurements | | rms DEVM peak DEVM, 99% DEVM |
| RF input level range ^a | | +30 dBm to -70 dBm |
| RMS DEVM | | |
| Range | 0 to 12% | |
| Floor | 1.5% | |
| Accuracy ^b | 1.2% | |

- a. When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- 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:

$$\text{error} = \sqrt{\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2} - \text{EVM}_{\text{UUT}}$$
where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent

Bluetooth Measurement Application
Enhanced Data Rate (EDR) Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| EDR Carrier Frequency Stability | | This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification 2.1.E.0.5.1.13 |
| Packet Type | | 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5 |
| Payload | | PRBS9, BS00, BSFF, BS55 |
| Synchronization | | DPSK synchronization sequence |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| Supported measurements | | Worst case initial frequency error(ω_i) for all packets (carrier frequency stability), worst case frequency error for all blocks (ω_o), ($\omega_o + \omega_i$) for all blocks |
| RF input level range ^a | | +30 dBm to -70 dBm |
| Carrier Frequency Stability and Frequency Error ^b | | $\pm 100 \text{ Hz} + \text{tfa}^c$ (nominal) |

- When the input signal level is lower than -40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
- Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of $\pm(2.402 \text{ GHz} \times 1 \text{ ppm}) \text{ Hz} \pm 100 \text{ Hz} = \pm 2402 \text{ Hz} \pm 100 \text{ Hz} = \pm 2502 \text{ Hz}$.
- tfa = transmitter frequency \times frequency reference accuracy.

Bluetooth Measurement Application
Enhanced Data Rate (EDR) Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| EDR In-band Spurious Emissions | | This measurement is an EDR in-band spur emissions and is in conformance with Bluetooth RF test specification 2.1.E.0.5.1.15. |
| Packet Type | | 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5 |
| Payload | | PRBS9, BS00, BSFF, BS55 |
| Synchronization | | DPSK synchronization sequence |
| Trigger | | External, RF Burst, Periodic Timer, Free Run, Video |
| Measurement Accuracy ^a | | |
| Offset Freq = 1 MHz to 1.5 MHz | | Dominated by ambiguity of the measurement standards ^b |
| Offset Freq = other offsets (2 MHz to 78 MHz) | | Dominated by the variance of measurements ^c |

- For offsets from 1 MHz to 1.5 MHz, the accuracy is the relative accuracy which is the adjacent channel power (1 MHz to 1.5 MHz offset) relative to the reference channel power (main channel). For other offsets (offset = K MHz, K= 2,...,78), the accuracy is the power accuracy of the absolute alternative channel power.
- The measurement standards call for averaging the signal across 3.5 μ s apertures and reporting the highest result. For common impulsive power at these offsets, this gives a variation of result with the time location of that interference that is 0.8 dB peak-to-peak and changes with a scallop shape with a 3.5 μ s period. Uncertainties in the accuracy of measuring CW-like relative power at these offsets are nominally only ± 0.03 dB, but observed variations of the measurement algorithm used with impulsive interference are similar to the scalloping error.
- The measurement at these offsets is usually the measurement of noise-like signals and therefore has considerable variance. For example, with a 1.5 ms packet length, the standard deviation of the measurement of the peak of ten bursts is about 0.6 dB. In comparison, the computed uncertainties of the measurement for the case with CW interference is only ± 0.20 dB.

In-Band Frequency Range

| Description | Specifications | Supplemental Information |
|---|--------------------------------------|---|
| Bluetooth Basic Rate and Enhanced Data Rate (EDR) System | 2.400 to 2.4835 GHz (ISM radio band) | $f = 2402 + k \text{ MHz}$, $k = 0, \dots, 78$ (RF channels used by Bluetooth) |
| Bluetooth Low Energy System | 2.400 to 2.4835 GHz (ISM radio band) | $f = 2402 + k \times 2 \text{ MHz}$, $k = 0, \dots, 39$ (RF channels used by Bluetooth) |

26 GSM/EDGE Measurement Application

This chapter contains specifications for the N9071EM0E GSM/EDGE/EDGE Evolution Measurement Application. For EDGE Evolution (EGPRS2) including Normal Burst (16QAM/32QAM) and High Symbol Rate (HSR) Burst, *Option 3FP* is required.

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 range documented in In-Band Frequency Range.

The specifications for this chapter apply only to instruments with Frequency *Option 508, 513 or 526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different between instruments with the higher frequency options. 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.

Measurements

| Description | Specifications | Supplemental Information |
|--|---------------------------------------|--|
| EDGE Error Vector Magnitude (EVM) | | <p>$3\pi/8$ shifted 8PSK modulation, $3\pi/4$ shifted QPSK, $\pi/4$ shifted 16QAM, $-\pi/4$ shifted 32QAM modulation in NSR/HSR with pulse shaping filter.</p> <p>Specifications based on 200 bursts</p> <p>+24 to -45 dBm (nominal)</p> |
| Carrier Power Range at RF Input | | |
| EVM ^a , rms | | |
| Operating range | | 0 to 20% (nominal) |
| Floor (NSR/HSR Narrow/HSR Wide) (all modulation formats) | 0.6% | 0.4% (nominal) |
| Floor (Baseband IQ Input) | | 0.5% (nominal) |
| Accuracy ^b (EVM range 1% to 10% (NSR 8PSK) EVM range 1% to 6% (NSR 16QAM/32QAM) EVM range 1% to 8% (HSR QPSK) EVM range 1% to 5% (HSR 16QAM/32QAM)) | ±0.5% | |
| Frequency error ^a | | |
| Initial frequency error range | | ±80 kHz (nominal) |
| Accuracy | ±5 Hz ^c + tfa ^d | |
| IQ Origin Offset | | |
| DUT Maximum Offset | | -15 dBc (nominal) |
| Maximum Analyzer Noise Floor | | -50 dBc (nominal) |
| Trigger to T0 Time Offset (Relative accuracy ^e) | | ±5.0 ns (nominal) |

- EVM and frequency error specifications apply when the Burst Sync is set to Training Sequence.
- The definition of accuracy for the purposes of this specification is how closely the result meets the expected result. That expected result is 0.975 times the actual RMS EVM of the signal, per 3GPP TS 45.005, annex G.
- This term includes an error due to the software algorithm. The accuracy specification applies when EVM is less than 1.5%.
- tfa = transmitter frequency × frequency reference accuracy
- The accuracy specification applies when the Burst Sync is set to Training Sequence, and Trigger is set to External Trigger.

GSM/EDGE Measurement Application

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Power vs. Time <i>and</i> EDGE Power vs. Time | | GMSK modulation (GSM) $3\pi/8$ shifted 8PSK modulation, $3\pi/4$ shifted QPSK, $\pi/4$ shifted 16QAM, $-\pi/4$ shifted 32QAM modulation in NSR/HSR (EDGE) |
| Minimum carrier power at RF Input for GSM and EDGE | | Measures mean transmitted RF carrier power during the useful part of the burst (GSM method) and the power vs. time ramping. 510 kHz RBW −35 dBm (nominal) |
| Absolute power accuracy for in-band signal (excluding mismatch error) ^a | | −0.11 ±0.19 dB (95th percentile) |
| Power Ramp Relative Accuracy | | Referenced to mean transmitted power |
| Accuracy | ±0.11 dB | |
| Measurement floor | −95 dBm | |
| Measurement floor (<i>Option EP0</i>) | −94 dBm | |

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

GSM/EDGE Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|---------------------------------------|---|
| Phase and Frequency Error | | GMSK modulation (GSM) |
| | | Specifications based on 3GPP essential conformance requirements, and 200 bursts |
| Carrier power range at RF Input | | +27 to –45 dBm (nominal) |
| Phase error ^a , rms | | |
| Floor | 0.5° | |
| Floor (Baseband IQ Input) | | 0.3° (nominal) |
| Accuracy | ±0.3° | Phase error range 1° to 6° |
| Frequency error ^a | | |
| Initial frequency error range | | ±80 kHz (nominal) |
| Accuracy | ±5 Hz ^b + tfa ^c | |
| I/Q Origin Offset | | |
| DUT Maximum Offset | | –15 dBc (nominal) |
| Analyzer Noise Floor | | –50 dBc (nominal) |
| Trigger to T0 time offset (Relative accuracy ^d) | | ±5.0 ns (nominal) |

- Phase error and frequency error specifications apply when the Burst Sync is set to Training Sequence.
- This term includes an error due to the software algorithm. The accuracy specification applies when RMS phase error is less than 1°.
- tfa = transmitter frequency × frequency reference accuracy
- The accuracy specification applies when the Burst Sync is set to Training Sequence, and Trigger is set to External Trigger.

GSM/EDGE Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| Output RF Spectrum (ORFS) <i>and</i> EDGE Output RF Spectrum | | GMSK modulation (GSM) $3\pi/8$ shifted 8PSK modulation, $3\pi/4$ shifted QPSK, $\pi/4$ shifted 16QAM, $-\pi/4$ shifted 32QAM modulation in NSR/HSR (EDGE) |
| Minimum carrier power at RF Input | | -20 dBm (nominal) ^a |
| ORFS Relative RF Power Uncertainty ^b Due to modulation | | |
| Offsets ≤ 1.2 MHz | ± 0.09 dB | |
| Offsets ≥ 1.8 MHz | ± 0.11 dB | |
| Due to switching ^c | | ± 0.09 dB (nominal) |
| ORFS Absolute RF Power Accuracy ^d | | ± 0.19 dB (95th percentile) |

- a. For maximum dynamic range, the recommended minimum power is -10 dBm.
- b. 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.
- c. 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, Keysight 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.
- d. The absolute power accuracy depends on the setting of the input attenuator as well as the signal-to-noise ratio. For high input levels, the use of the electronic attenuator and "Adjust Atten for Min Clip" will result in high signal-to-noise ratios and Electronic 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, "high levels" would nominally be levels above +1.7 dBm and -1.3 dBm, respectively.

GSM/EDGE Measurement Application
Measurements

| Description | Specifications | | | Supplemental Information | | |
|---|-----------------------|--|--------------------------------------|--|--|--|
| ORFS and EDGE ORFS (continued) | | | | | | |
| Dynamic Range, Spectrum due to modulation ^a | | | | 5-pole sync-tuned filters ^b Methods: Direct Time ^c and FFT ^d | | |
| Analyzers with <i>Option EP1</i> | | | | | | |
| Offset Frequency | GSM (GMSK) | EDGE (NSR 8PSK & Narrow QPSK) | EDGE (others)^e | GSM (GMSK) (typical) | EDGE (NSR 8PSK & Narrow QPSK) (typical) | EDGE (others)^e (typical) |
| 100 kHz ^f | 66.9 dB | 66.8 dB | 66.8 dB | | | |
| 200 kHz ^f | 74.8 dB | 74.6 dB | 74.2 dB | | | |
| 250 kHz ^f | 77.3 dB | 77.0 dB | 76.3 dB | | | |
| 400 kHz ^f | 82.0 dB | 81.2 dB | 79.6 dB | | | |
| 600 kHz | 85.3 dB | 83.6 dB | 81.2 dB | 87.7 dB | 86.1 dB | 83.8 dB |
| 1.2 MHz | 88.0 dB | 85.2 dB | 82.0 dB | 90.5 dB | 87.8 dB | 84.7 dB |
| 1.8 MHz ^g | 90.2 dB | 88.5 dB | 86.0 dB | 92.8 dB | 91.1 dB | 88.8 dB |
| 6.0 MHz ^g | 92.3 dB | 89.7 dB | 86.7 dB | 95.3 dB | 92.7 dB | 89.6 dB |
| Dynamic Range, Spectrum due to switching ^a | GSM (GMSK) | EDGE (NSR 8PSK & Narrow QPSK) | EDGE (others)^e | 5-pole sync-tuned filters ^h | | |
| Analyzers with <i>Option EP1</i> | | | | | | |
| Offset Frequency | | | | | | |
| 400 kHz | | 79.4 dB | 78.7 dB | | | |
| 600 kHz | | 81.8 dB | 80.6 dB | | | |
| 1.2 MHz | | 83.4 dB | 81.8 dB | | | |
| 1.8 MHz | | 91.9 dB | 90.7 dB | | | |

- a. Maximum dynamic range requires RF input power above –2 dBm for offsets of 1.2 MHz and below for GSM, and above –5 dBm for EDGE. For offsets of 1.8 MHz and above, the required RF input power for maximum dynamic range is +8 dBm for GSM signals and +5 dBm for EDGE signals.

GSM/EDGE Measurement Application Measurements

- b. 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 faster, but has lower dynamic range than the direct time method.
- c. 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 below, 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.
- d. The FFT method uses an exact 5-pole sync-tuned RBW filter, implemented in software.
- e. EDGE (others) means NSR 16/32QAM and HSR all formats (QPSK/16QAM/32QAM).
- f. 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.
- g. Offsets of 1.8 MHz and higher use 100 kHz analysis bandwidths.
- h. 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.

GSM/EDGE Measurement Application
Measurements

| Description | Specifications | | | Supplemental Information | | |
|---|-----------------------|--|--------------------------------------|--|--|--|
| ORFS and EDGE ORFS (continued) | | | | | | |
| Dynamic Range, Spectrum due to modulation ^a | | | | 5-pole sync-tuned filters ^b Methods: Direct Time ^c and FFT ^d | | |
| Analyzers with <i>Option EPO</i> | | | | | | |
| Offset Frequency | GSM (GMSK) | EDGE (NSR 8PSK & Narrow QPSK) | EDGE (others)^e | GSM (GMSK) (typical) | EDGE (NSR 8PSK & Narrow QPSK) (typical) | EDGE (others)^e (typical) |
| 100 kHz ^f | 71.4 dB | 71.3 dB | 71.1 dB | | | |
| 200 kHz ^f | 74.3 dB | 74.1 dB | 73.7 dB | | | |
| 250 kHz ^f | 75.2 dB | 75.0 dB | 74.4 dB | | | |
| 400 kHz ^f | 77.1 dB | 76.7 dB | 76.0 dB | | | |
| 600 kHz | 82.4 dB | 81.2 dB | 79.4 dB | 85.5 dB | 84.0 dB | 81.8 dB |
| 1.2 MHz | 86.7 dB | 84.1 dB | 81.0 dB | 88.5 dB | 86.0 dB | 82.9 dB |
| | | | | GSM (GMSK) (nominal) | EDGE (NSR 8PSK & Narrow QPSK) (nominal) | EDGE (others) (nominal) |
| 1.8 MHz ^g | 87.4 dB | 86.2 dB | 84.3 dB | 89.7 dB | 88.4 dB | 86.4 dB |
| 6.0 MHz ^g | 90.4 dB | 88.2 dB | 85.5 dB | 92.7 dB | 90.4 dB | 87.6 dB |
| Dynamic Range, Spectrum due to switching ^a | GSM (GMSK) | EDGE (NSR 8PSK & Narrow QPSK) | EDGE (others)^e | 5-pole sync-tuned filters ^h | | |
| Analyzers with <i>Option EPO</i> | | | | | | |
| Offset Frequency | | | | | | |
| 400 kHz | | 74.9 dB | 74.6 dB | | | |
| 600 kHz | | 79.5 dB | 78.6 dB | | | |
| 1.2 MHz | | 82.3 dB | 80.7 dB | | | |
| 1.8 MHz | | 89.6 dB | 88.7 dB | | | |

GSM/EDGE Measurement Application Measurements

- a. Maximum dynamic range requires RF input power above -2 dBm for offsets of 1.2 MHz and below for GSM, and above -5 dBm for EDGE. For offsets of 1.8 MHz and above, the required RF input power for maximum dynamic range is $+8$ dBm for GSM signals and $+5$ dBm for EDGE signals.
- b. 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 faster, but has lower dynamic range than the direct time method.
- c. 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 below, 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.
- d. The FFT method uses an exact 5-pole sync-tuned RBW filter, implemented in software.
- e. EDGE (others) means NSR 16/32QAM and HSR all formats (QPSK/16QAM/32QAM).
- f. 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.
- g. Offsets of 1.8 MHz and higher use 100 kHz analysis bandwidths.
- h. 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.

Frequency Ranges

| Description | Uplink | Downlink |
|---------------------------------|--------------------|--------------------|
| In-Band Frequency Ranges | | |
| P-GSM 900 | 890 to 915 MHz | 935 to 960 MHz |
| E-GSM 900 | 880 to 915 MHz | 925 to 960 MHz |
| R-GSM 900 | 876 to 915 MHz | 921 to 960 MHz |
| DCS1800 | 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 |
| 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 | 777 to 792 MHz | 747 to 762 MHz |
| T-GSM810 | 806 to 821 MHz | 851 to 866 MHz |

27 LTE/LTE-A Measurement Application

This chapter contains specifications for the N9080EM0E LTE/LTE-Advanced FDD measurement application and for the N9082EM0E LTE/LTE-Advanced TDD measurement application.

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 range documented in In-Band Frequency Range.

The specifications apply to the single carrier case only, unless otherwise stated.

The specifications for this chapter apply only to instruments with Frequency *Option 508*, *513* or *526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different between instruments with the higher frequency options. 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.

Supported Air Interface Features

| Description | Specifications | Supplemental Information |
|----------------------------------|--|---|
| 3GPP Standards Supported | 36.211 V10.7.0 (March 2013) 36.212 V10.7.0 (December 2012) 36.213 V10.9.0 (March 2013) 36.214 V10.12.0 (March 2013) 36.141 V11.4.0 (March 2013) 36.521-1 V10.5.0 (March 2013) | |
| Signal Structure | FDD Frame Structure Type 1 TDD Frame Structure Type 2 Special subframe configurations 0-9 | N9080C only N9082C only N9082C only |
| Signal Direction | Uplink and Downlink UL/DL configurations 0-6 | N9082C only |
| Signal Bandwidth | 1.4 MHz (6 RB), 3 MHz (15 RB), 5 MHz (25 RB), 10 MHz (50 RB), 15 MHz (75 RB), 20 MHz (100 RB) | |
| Modulation Formats and Sequences | BPSK; BPSK with I & Q CDM; QPSK; 16QAM; 64QAM; PRS; CAZAC (Zadoff-Chu) | |
| Component Carrier | 1, 2, 3, 4, or 5 | |
| Physical Channels | | |
| Downlink | PBCH, PCFICH, PHICH, PDCCH, PDSCH, PMCH | |
| Uplink | PUCCH, PUSCH, PRACH | |
| Physical Signals | | |
| Downlink | P-SS, S-SS, C-RS, P-PS (positioning), MBSFN-RS, CSI-RS | |
| Uplink | PUCCH-DMRS, PUSCH-DMRS, S-RS (sounding) | |

Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Channel Power | | |
| Minimum power at RF input | | –50 dBm (nominal) |
| Absolute power accuracy ^a (20 to 30°C, Atten = 10 dB) | ±0.63 dB | ±0.19 dB (95th Percentile) |
| Measurement floor | | –80.7 dBm (nominal) in a 10 MHz bandwidth |
| Measurement floor (<i>Option EPO</i>) | | –78.7 dBm (nominal) in a 10 MHz bandwidth |

- 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 the measurement floor contribution is negligible.

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| Channel Power | | NB-IoT |
| Minimum power at RF input | | –50 dBm (nominal) |
| Absolute power accuracy ^a (20 to 30°C) | ±0.63 dB | ±0.19 dB (95th Percentile) |
| Measurement floor | | –97.7 dBm (nominal) in a 10 MHz bandwidth |
| Measurement floor (<i>Option EPO</i>) | | –95.7 dBm (nominal) in a 10 MHz bandwidth |

- 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 the measurement floor contribution is negligible.

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Channel Power | | C-V2X |
| | | Frequency Range: 5855 to 5925 MHz |
| Minimum power at RF input | | –50 dBm (nominal) |
| Absolute power accuracy ^a (20 to 30°C, Atten = 10 dB) | ±1.78 dB | ±0.41 dB (95th Percentile) |
| Absolute power accuracy (<i>Option EPO</i>) ^a (20 to 30°C, Atten = 10 dB) | ±1.78 dB | ±0.56 dB (95th Percentile) |
| Measurement floor | | –80.7 dBm (nominal) in a 10 MHz bandwidth |
| Measurement floor (<i>Option EPO</i>) | | –78.7 dBm (nominal) in a 10 MHz bandwidth |

LTE/LTE-A Measurement Application
Measurements

- 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 the measurement floor contribution is negligible.

| Description | Specifications | Supplemental Information |
|------------------------------|----------------------|--------------------------|
| Power Statistics CCDF | | NB-IoT |
| Histogram Resolution | 0.01 dB ^a | |

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

| Description | Specifications | Supplemental Information |
|-----------------------------------|----------------|--|
| Power Statistics CCDF | | C-V2X Frequency Range: 5855 to 5925 MHz |
| Histogram Resolution ^a | 0.01 dB | |

- 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.

LTE/LTE-A Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|------------------------------|----------------|--|
| Transmit On/Off Power | | This table applies only to the N9082C measurement application. |
| Burst Type | | Traffic, DwPTS, UpPTS, SRS, PRACH |
| Transmit power | | Min, Max, Mean, Off |
| Dynamic Range ^a | | 124.5 dB (nominal) |
| Average type | | Off, RMS, Log |
| Measurement time | | Up to 20 slots |
| Trigger source | | External 1, External 2, Periodic, RF Burst, IF Envelope |

- a. This dynamic range expression is for the case of Information BW = 5 MHz; for other Info BW, the dynamic range can be derived. The equation is:

$$\text{Dynamic Range} = \text{Dynamic Range for 5 MHz} - 10 \cdot \log_{10}(\text{Info BW}/5.0\text{e6})$$

| Description | Specifications | Supplemental Information |
|------------------------------|----------------|---|
| Transmit On/Off Power | | C-V2X |
| | | Frequency Range: 5855 to 5925 MHz |
| Transmit power | | Min, Max, Mean, Off |
| Dynamic Range ^a | | 124.5 dB (nominal) |
| Average type | | Off, RMS, Log |
| Measurement time | | Up to 20 slots |
| Trigger source | | External 1, External 2, Periodic, RF Burst, IF Envelope |

- a. This dynamic range expression is for the case of Information BW = 5 MHz; for other Info BW, the dynamic range can be derived. The equation is:

$$\text{Dynamic Range} = \text{Dynamic Range for 5 MHz} - 10 \cdot \log_{10}(\text{Info BW}/5.0\text{e6})$$

LTE/LTE-A Measurement Application
Measurements

| Description | | Specifications | | | Supplemental Information | |
|-------------------------------|------------------------|--------------------------|---------------|---------------|---|--------------------------------------|
| Adjacent Channel Power | | | | | Single Carrier | |
| Minimum power at RF input | | | | | –36 dBm (nominal) | |
| Accuracy | | Channel Bandwidth | | | ACPR Range for Specification | |
| Radio | Offset | 5 MHz | 10 MHz | 20 MHz | | |
| MS | Adjacent ^a | ±0.08 dB | ±0.10 dB | ±0.13 dB | –33 to –27 dBc with opt ML ^b | |
| BTS | Adjacent ^c | ±0.32 dB | ±0.44 dB | ±0.61 dB | –48 to –42 dBc with opt ML ^d | |
| BTS | Alternate ^c | ±0.09 dB | ±0.12 dB | ±0.18 dB | –48 to –42 dBc with opt ML ^e | |
| Accuracy (Option EPO) | | Channel Bandwidth | | | ACPR Range for Specification | |
| Radio | Offset | 5 MHz | 10 MHz | 20 MHz | | |
| MS | Adjacent ^a | ±0.09 dB | ±0.10 dB | ±0.14 dB | –33 to –27 dBc with opt ML ^b | |
| BTS | Adjacent ^c | ±0.37 dB | ±0.49 dB | ±0.69 dB | –48 to –42 dBc with opt ML ^d | |
| BTS | Alternate ^c | ±0.10 dB | ±0.13 dB | ±0.19 dB | –48 to –42 dBc with opt ML ^e | |
| Dynamic Range E-UTRA | | | | | Test conditions ^f | |
| Offset | Channel BW | | | | Dynamic Range (nominal) | Optimum Mixer Level (nominal) |
| Adjacent | 5 MHz | | | | 83.5 dB | –8.5 dBm |
| Adjacent | 10 MHz | | | | 82.1 dB | –8.3 dBm |
| Alternate | 5 MHz | | | | 86.7 dB | –8.5 dBm |
| Alternate | 10 MHz | | | | 83.7 dB | –8.3 dBm |
| Dynamic Range UTRA | | | | | Test conditions ^f | |
| Offset | Channel BW | | | | Dynamic Range (nominal) | Optimum Mixer Level (nominal) |
| 2.5 MHz | 5 MHz | | | | 86.2 dB | –8.5 dBm |
| 2.5 MHz | 10 MHz | | | | 84.2 dB | –8.3 dBm |
| 7.5 MHz | 5 MHz | | | | 87.3 dB | –8.7 dBm |
| 7.5 MHz | 10 MHz | | | | 87.0 dB | –8.4 dBm |

- a. Measurement bandwidths for mobile stations are 4.5, 9.0 and 18.0 MHz for channel bandwidths of 5, 10 and 20 MHz respectively.
- b. The optimum mixer levels (ML) are –25, –22 and –21 dBm for channel bandwidths of 5, 10 and 20 MHz respectively.

LTE/LTE-A Measurement Application
Measurements

- c. Measurement bandwidths for base transceiver stations are 4.515, 9.015 and 18.015 MHz for channel bandwidths of 5, 10 and 20 MHz respectively.
- d. The optimum mixer levels (ML) are –19, –17 and –16 dBm for channel bandwidths of 5, 10 and 20 MHz respectively.
- e. The optimum mixer level (ML) is –8 dBm.
- f. E-TM1.1 and E-TM1.2 used for test. Noise Correction set to On.

| Description | | | Specifications | Supplemental Information | |
|-------------------------------|---------------|-------------------|----------------|---|--------------------------------------|
| Adjacent Channel Power | | | | NB-IoT Stand-alone | |
| Minimum power at RF input | | | | –36 dBm (nominal) | |
| Accuracy | | | | ACPR Range for Specification | |
| Radio | Offset | | | | |
| MS | 200 kHz | | ±0.02 dB | –23 to –17 dBc with opt ML ^a | |
| MS | 2.5 MHz | | ±0.13 dB | –40 to –34 dBc with opt ML ^b | |
| BTS | 300 kHz | | ±0.05 dB | –43 to –37 dBc with opt ML ^c | |
| BTS | 500 kHz | | ±0.16 dB | –53 to –47 dBc with opt ML ^d | |
| Accuracy (Option EP0) | | | | ACPR Range for Specification | |
| Radio | Offset | | | | |
| MS | 200 kHz | | ±0.02 dB | –23 to –17 dBc with opt ML ^a | |
| MS | 2.5 MHz | | ±0.13 dB | –40 to –34 dBc with opt ML ^b | |
| BTS | 300 kHz | | ±0.05 dB | –43 to –37 dBc with opt ML ^c | |
| BTS | 500 kHz | | ±0.18 dB | –53 to –47 dBc with opt ML ^d | |
| Dynamic Range | | | | Test conditions ^e | |
| Radio | Offset | Channel BW | | Dynamic Range (nominal) | Optimum Mixer Level (nominal) |
| MS | 200 kHz | 180 kHz | | 78.0 dB | –8.4 dBm |
| MS | 2.5 MHz | 3.84 MHz | | 74.0 dB | –8.4 dBm |
| BTS | 300 kHz | 180 kHz | | 78.0 dB | –8.4 dBm |
| BTS | 500 kHz | 180 kHz | | 82.0 dB | –8.4 dBm |

- a. The optimum mixer levels (ML) is –25 dBm.
- b. The optimum mixer levels (ML) is –20 dBm.
- c. The optimum mixer levels (ML) is –20 dBm.
- d. The optimum mixer levels (ML) is –24 dBm.
- e. Noise Correction set to On.

LTE/LTE-A Measurement Application
Measurements

| Description | | Specifications | | | Supplemental Information |
|-------------------------------|-----------------------|-------------------|---------------|---------------|---|
| Adjacent Channel Power | | | | | C-V2X Frequency Range: 5855 to 5925 MHz –36 dBm (nominal) |
| Minimum power at RF input | | | | | |
| Accuracy | | Channel Bandwidth | | | |
| Radio | Offset | 5 MHz | 10 MHz | 20 MHz | ACPR Range for Specification |
| MS | Adjacent ^a | ±0.28 dB | ±0.36 dB | ±0.47 dB | –33 to –27 dBc with opt ML ^b |
| Accuracy (Option EPO) | | Channel Bandwidth | | | |
| Radio | Offset | 5 MHz | 10 MHz | 20 MHz | ACPR Range for Specification |
| MS | Adjacent ^a | ±0.29 dB | ±0.37 dB | ±0.48 dB | –33 to –27 dBc with opt ML ^c |
| Dynamic Range E-UTRA | | | | | Test conditions ^c |
| Offset | Channel BW | | | | Dynamic Range (nominal) Optimum Mixer Level (nominal) |
| Adjacent | 5 MHz | | | | 83.5 dB –8.5 dBm |
| Adjacent | 10 MHz | | | | 82.1 dB –8.3 dBm |
| Alternate | 5 MHz | | | | 86.7 dB –8.5 dBm |
| Alternate | 10 MHz | | | | 83.7 dB –8.3 dBm |
| Dynamic Range UTRA | | | | | Test conditions ^c |
| Offset | Channel BW | | | | Dynamic Range (nominal) Optimum Mixer Level (nominal) |
| 2.5 MHz | 5 MHz | | | | 86.2 dB –8.5 dBm |
| 2.5 MHz | 10 MHz | | | | 84.2 dB –8.3 dBm |
| 7.5 MHz | 5 MHz | | | | 87.3 dB –8.7 dBm |
| 7.5 MHz | 10 MHz | | | | 87.0 dB –8.4 dBm |

- a. Measurement bandwidths for mobile stations are 4.5, 9.0 and 18.0 MHz for channel bandwidths of 5, 10 and 20 MHz respectively.
- b. The optimum mixer levels (ML) are –25, –22 and –21 dBm for channel bandwidths of 5, 10 and 20 MHz respectively.
- c. Noise Correction set to On.

LTE/LTE-A Measurement Application
Measurements

| Description | Specification | Supplemental Information |
|--|--------------------------|---|
| Occupied Bandwidth Minimum carrier power at RF Input Frequency accuracy | ± 10 kHz | –30 dBm (nominal) RBW = 30 kHz, Number of Points = 1001, Span = 10 MHz |

| Description | Specification | Supplemental Information |
|--|--------------------------|--|
| Occupied Bandwidth Minimum carrier power at RF Input Frequency accuracy | ± 400 Hz | NB-IoT –30 dBm (nominal) RBW = 10 kHz, Number of Points = 1001, Span = 400 kHz |

| Description | Specification | Supplemental Information |
|--|--------------------------|---|
| Occupied Bandwidth Minimum carrier power at RF Input Frequency accuracy | ± 10 kHz | C-V2X Frequency Range: 5855 to 5925 MHz –30 dBm (nominal) RBW = 30 kHz, Number of Points = 1001, Span = 10 MHz |

LTE/LTE-A Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|-------------------------------------|----------------|---|
| Spectrum Emission Mask | | Offset from CF = (channel bandwidth + measurement bandwidth) / 2; measurement bandwidth = 100 kHz |
| Dynamic Range | | |
| Channel Bandwidth | | |
| 5 MHz | 80.7 dB | 85.7 dB (typical) |
| 10 MHz | 79.7 dB | 84.1 dB (typical) |
| 20 MHz | 82.7 dB | 87.8 dB (typical) |
| Dynamic Range (<i>Option EPO</i>) | | |
| Channel Bandwidth | | |
| 5 MHz | 79.6 dB | 83.6 dB (typical) |
| 10 MHz | 78.8 dB | 82.2 dB (typical) |
| 20 MHz | 81.7 dB | 85.8 dB (typical) |
| Sensitivity | −96.5 dBm | −100.5 dBm (typical) |
| Sensitivity (<i>Option EPO</i>) | −95.5 dBm | −98.5 dBm (typical) |
| Accuracy | | |
| Relative | ±0.11 dB | |
| Absolute, 20 to 30°C | ±0.62 dB | ±0.21 dB (95th percentile) |

| Description | Specifications | Supplemental Information |
|-------------------------------------|----------------|--|
| Spectrum Emission Mask | | NB-IoT: Stand-alone Offset from CF = (channel bandwidth + measurement bandwidth) / 2 = 115 kHz Channel bandwidth = 200 kHz Measurement bandwidth = 30 kHz |
| Dynamic Range | 68.9 dB | 72.3 dB (typical) |
| Dynamic Range (<i>Option EPO</i>) | 73.5 dB | 79.2 dB (typical) |
| Sensitivity | −101.7 dBm | −105.7 dBm (typical) |
| Sensitivity (<i>Option EPO</i>) | −100.7 dBm | −103.7 dBm (typical) |
| Accuracy | | |
| Relative | ±0.05 dB | |
| Absolute, 20 to 30°C | ±0.62 dB | ±0.20 dB (95th percentile) |

LTE/LTE-A Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| Spectrum Emission Mask | | C-V2X Frequency Range: 5855 to 5925 MHz Offset from CF = (channel bandwidth + measurement bandwidth) / 2; measurement bandwidth = 100 kHz |
| Dynamic Range | | |
| Channel Bandwidth | | |
| 5 MHz | 80.7 dB | 85.7 dB (typical) |
| 10 MHz | 79.7 dB | 84.1 dB (typical) |
| 20 MHz | 82.7 dB | 87.8 dB (typical) |
| Dynamic Range (<i>Option EP0</i>) | | |
| Channel Bandwidth | | |
| 5 MHz | 79.6 dB | 83.6 dB (typical) |
| 10 MHz | 78.8 dB | 82.2 dB (typical) |
| 20 MHz | 81.7 dB | 85.8 dB (typical) |
| Sensitivity | −96.5 dBm | −100.5 dBm (typical) |
| Sensitivity <i>Option EP0</i>) | −95.5 dBm | −98.5 dBm (typical) |
| Accuracy | | |
| Relative | ±0.38dB | |
| Absolute, 20 to 30°C (<i>Option EP0</i>) | ±1.77 dB | ±0.42 dB (95th percentile) |
| Absolute, 20 to 30°C | ±1.77 dB | ±0.56 dB (95th percentile) |

LTE/LTE-A Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Spurious Emissions | | Table-driven spurious signals; search across regions |
| Dynamic Range ^a , relative (RBW = 1 MHz) | 87.4 dB | 91.1 dB (typical) |
| Dynamic Range ^a , relative (RBW = 1 MHz) (<i>Option EPO</i>) | 86.2 dB | 89.2 dB (typical) |
| Sensitivity ^b , absolute (RBW=1 MHz) | −86.5 dBm | −90.5 dBm (typical) |
| Sensitivity ^b , absolute (RBW=1 MHz) (<i>Option EPO</i>) | −85.5 dBm | −88.5 dBm (typical) |
| Accuracy (Attenuation = 10 dB) | | |
| Frequency Range | | |
| 20 Hz to 3.6 GHz | | ±0.19 dB (95th percentile) |
| 3.5 to 8.4 GHz | | ±1.09 dB (95th percentile) |
| 3.5 to 8.4 GHz (<i>Option EPO</i>) | | ±1.15 dB (95th percentile) |
| 8.3 to 13.6 GHz | | ±1.48 dB (95th percentile) |
| 8.3 to 13.6 GHz (<i>Option EPO</i>) | | ±1.52 dB (95th percentile) |

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

LTE/LTE-A Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Spurious Emissions | | C-V2X Frequency Range: 5855 to 5925 MHz Table-driven spurious signals; search across regions |
| Dynamic Range ^a , relative (RBW = 1 MHz) | 87.3 dB | 91.1 dB (typical) |
| Dynamic Range ^a , relative (RBW = 1 MHz) (<i>Option EP0</i>) | 86.2 dB | 89.2 dB (typical) |
| Sensitivity ^b , absolute (RBW=1 MHz) | −86.5 dBm | −90.5 dBm (typical) |
| Sensitivity ^b , absolute (RBW=1 MHz) (<i>Option EP0</i>) | −85.5 dBm | −88.5 dBm (typical) |
| Accuracy | | Attenuation = 10 dB |
| Frequency Range | | |
| 20 Hz to 3.6 GHz | | ±0.19 dB (95th percentile) |
| 3.5 to 8.4 GHz | | ±1.09 dB (95th percentile) |
| 3.5 to 8.4 GHz (<i>Option EP0</i>) | | ±1.15 dB (95th percentile) |
| 8.3 to 13.6 GHz | | ±1.48 dB (95th percentile) |
| 8.3 to 13.6 GHz (<i>Option EP0</i>) | | ±1.52 dB (95th percentile) |

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

LTE/LTE-A Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|------------------|-----------------------------------|
| Modulation Analysis | | % and dB expressions ^a |
| (Signal level within one range step of overload) | | |
| OSTP/RSTP | | |
| Absolute accuracy ^b | | ±0.21 dB (nominal) |
| EVM for Downlink (OFDMA) Floor ^c | | |
| Signal Bandwidth | | |
| 5 MHz | 0.34% (–49.3 dB) | 0.28% (–51.2 dB) (nominal) |
| 10 MHz | 0.35% (–49.1 dB) | 0.31% (–50.3 dB) (nominal) |
| 20 MHz ^d | 0.39% (–48.1 dB) | 0.34% (–49.5 dB) (nominal) |
| EVM for Downlink (OFDMA) Floor (<i>Option EPO</i>) ^c | | |
| Signal Bandwidth | | |
| 5 MHz | 0.17% (–55.3 dB) | |
| 10 MHz | 0.17% (–55.3 dB) | |
| 20 MHz ^d | 0.23% (–52.7 dB) | |
| EVM Accuracy for Downlink (OFDMA) | | |
| (EVM range: 0 to 8%) ^e | | ±0.3% (nominal) |
| EVM for Uplink (SC-FDMA) Floor ^c | | |
| Signal Bandwidth | | |
| 5 MHz | 0.31% (–50.1 dB) | 0.21% (–53.5 dB) (nominal) |
| 10 MHz | 0.32% (–49.8 dB) | 0.21% (–53.5 dB) (nominal) |
| 20 MHz ^e | 0.35% (–49.1 dB) | 0.22% (–53.2 dB) (nominal) |
| EVM for Uplink (SC-FDMA) Floor ^c (<i>Option EPO</i>) | | |
| Signal Bandwidth | | |
| 5 MHz | 0.17% (–55.3 dB) | |
| 10 MHz | 0.17% (–55.3 dB) | |
| 20 MHz ^e | 0.23% (–52.7 dB) | |

LTE/LTE-A Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--------------------------------|---------------------|---|
| Frequency Error | | |
| Lock range | | $\pm 2.5 \times \text{subcarrier spacing} = 37.5 \text{ kHz}$ for default 15 kHz subcarrier spacing (nominal) |
| Accuracy | | $\pm 1 \text{ Hz} + \text{tfa}^f$ (nominal) |
| Time Offset ^g | | |
| Absolute frame offset accuracy | $\pm 20 \text{ ns}$ | |
| Relative frame offset accuracy | | $\pm 5 \text{ ns}$ (nominal) |
| MIMO RS timing accuracy | | $\pm 5 \text{ ns}$ (nominal) |

- In these specifications, those values with % units are the specifications, while those with decibel units, in parentheses, are conversions from the percentage units to decibels for reader convenience.
- The accuracy specification applies when EVM is less than 1% and no boost applies for the reference signal.
- Overall EVM and Data EVM using 3GPP standard-defined calculation. Phase Noise Optimization set to Best Close-in (<140 kHz) (*Option EPO*: Best Close-in (<600 kHz)).
- The accuracy specification applies when EVM is less than 1% and no boost applies for resource elements
- 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:

$$\text{error} = [\text{sqrt}(\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2)] - \text{EVM}_{\text{UUT}}$$
 where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
- tfa = transmitter frequency \times frequency reference accuracy.
- The accuracy specification applies when EVM is less than 1% and no boost applies for resource elements

LTE/LTE-A Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| NB-IoT Modulation Analysis (Signal level within one range step of overload) | | % and dB expressions ^a Channel bandwidth: 200 kHz Downlink: Operation Modes: Inband, guard-band, stand-alone Uplink: Operation Modes: Stand-alone Subcarrier spacing: 3.75 kHz, 15 kHz Number of subcarriers: 1, 3, 6, 12 Modulation types: BPSK, QPSK |
| EVM for Downlink Floor ^b | | 0.37% (–48.6 dB) (nominal) |
| EVM for Uplink Floor ^b | | |
| 3/6/12 subcarrier signal with 15 kHz subcarrier spacing | | 0.15% (–56.5 dB) (nominal) |
| 1 subcarrier signal with 15 kHz subcarrier spacing | | 0.035% (–69.1 dB) (nominal) |
| 3.75 kHz subcarrier spacing | | 0.035% (–69.1 dB) (nominal) |

- a. In these specifications, those values with % units are the specifications, while those with decibel units, in parentheses, are conversions from the percentage units to decibels for reader convenience.
- b. Overall EVM and Data EVM using 3GPP standard-defined calculation. Phase Noise Optimization set to Best Close-in (<140 kHz).

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| C-V2X Modulation Analysis (Signal level within one range step of overload) | | % and dB expressions ^a Frequency Range: 5855 to 5925 MHz |
| OSTP/RSTP | | |
| Absolute accuracy ^b | | ±0.21 dB (nominal) |
| EVM Floor ^c | | |
| Signal Bandwidth | | |
| 5 MHz | | 0.31% (–50.1 dB) (nominal) |
| 10 MHz | | 0.32% (–49.8 dB) (nominal) |
| 20 MHz ^d | | 0.35% (–49.1 dB) (nominal) |
| EVM Floor ^c (<i>Option EP0</i>) | | |
| Signal Bandwidth | | |
| 5 MHz | | 0.17% (–55.3 dB) |
| 10 MHz | | 0.17% (–55.3 dB) |
| 20 MHz ^d | | 0.23% (–52.7 dB) |
| Frequency Error | | |
| Lock range | | ±2.5 × subcarrier spacing = 37.5 kHz for default 15 kHz subcarrier spacing (nominal) |
| Accuracy | | ±1 Hz + tfa ^e (nominal) |
| Time Offset ^f | | |
| Absolute frame offset accuracy | ±20 ns | |
| Relative frame offset accuracy | | ±5 ns (nominal) |
| MIMO RS timing accuracy | | ±5 ns (nominal) |

- In these specifications, those values with % units are the specifications, while those with decibel units, in parentheses, are conversions from the percentage units to decibels for reader convenience.
- The accuracy specification applies when EVM is less than 1% and no boost applies for the reference signal.
- Overall EVM and Data EVM using 3GPP standard-defined calculation. Phase Noise Optimization set to Best Close-in (<600 kHz).
- 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:

$$\text{error} = [\text{sqrt}(\text{EVMUUT}^2 + \text{EVMsa}^2)] - \text{EVMUUT}$$
 where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent.

LTE/LTE-A Measurement Application Measurements

- e. $tfa = \text{transmitter frequency} \times \text{frequency reference accuracy}$.
- f. The accuracy specification applies when EVM is less than 1% and no boost applies for resource elements

In-Band Frequency Range

| C-V2X Operating Band | |
|----------------------|------------------|
| E-UTRA band 47, TDD | 5855 to 5925 MHz |

| NB-IoT Operating Band | |
|---|-----------------------------|
| E-UTRA bands, TDD, 1, 2, 3, 4, 5, 8, 11, 12, 13, 14, 17, 18, 19, 20, 25, 26, 28, 31 | See LTE FDD operating bands |

| LTE FDD Operating Band | Uplink | Downlink |
|--------------------------|----------------------|----------------------|
| 1 | 1920 to 1980 MHz | 2110 to 2170 MHz |
| 2 | 1850 to 1910 MHz | 1930 to 1990 MHz |
| 3 | 1710 to 1785 MHz | 1805 to 1880 MHz |
| 4 | 1710 to 1755 MHz | 2110 to 2155 MHz |
| 5 | 824 to 849 MHz | 869 to 894 MHz |
| 6 | 830 to 840 MHz | 875 to 885 MHz |
| 7 | 2500 to 2570 MHz | 2620 to 2690 MHz |
| 8 | 880 to 915 MHz | 925 to 960 MHz |
| 9 | 1749.9 to 1784.9 MHz | 1844.9 to 1879.9 MHz |
| 10 | 1710 to 1770 MHz | 2110 to 2170 MHz |
| 11 | 1427.9 to 1452.9 MHz | 1475.9 to 1500.9 MHz |
| 12 | 698 to 716 MHz | 728 to 746 MHz |
| 13 | 777 to 787 MHz | 746 to 756 MHz |
| 14 | 788 to 798 MHz | 758 to 768 MHz |
| 17 | 704 to 716 MHz | 734 to 746 MHz |
| 18 | 815 to 830 MHz | 860 to 875 MHz |
| 19 | 830 to 845 MHz | 875 to 890 MHz |
| 20 | 832 to 862 MHz | 791 to 821 MHz |
| 21 | 1447.9 to 1462.9 MHz | 1495.9 to 1510.9 MHz |
| 22 See note ^a | 3410 to 3490 MHz | 3510 to 3590 MHz |
| 23 | 2000 to 2020 MHz | 2180 to 2200 MHz |
| 24 | 1626.5 to 1660.5 MHz | 1525 to 1559 MHz |
| 25 | 1850 to 1915 MHz | 1930 to 1995 MHz |

LTE/LTE-A Measurement Application
In-Band Frequency Range

| LTE FDD Operating Band | Uplink | Downlink |
|------------------------|--------------------|--------------------|
| 26 | 814 to 849 MHz | 859 to 894 MHz |
| 27 | 807 to 824 MHz | 852 to 869 MHz |
| 28 | 703 to 748 MHz | 758 to 803 MHz |
| 29 | N/A | 717 to 728 MHz |
| 30 | 2305 to 2315 MHz | 2350 to 2360 MHz |
| 31 | 452.5 to 457.5 MHz | 462.5 to 467.5 MHz |
| 32 | N/A | 1452 to 1496 MHz |

- a. ACP measurements and SEM for operating Band 22 and 42 require measurement of some spectral energy above the 3.6 GHz maximum for Band 0 in earlier firmware versions. These measurements can be made with the combination of recent firmware, version A.16.13 or later, and calibration of the analyzer in analyzer RF Band 0 extended to 3.7 GHz instead of the 3.6 GHz supported by earlier versions of the firmware. The calibration extension occurs in production of instruments with Frequency *Option 508, 513 or 526* and serial number is equal with or greater than the following: US54490126, MY54490690, or SG54490127; older analyzers with these frequency options and recent firmware can have their Band 0 coverage extended in service centers upon request. With the combination of recent firmware and extended Band 0 range, the performance in the region above 3.6 GHz is nominally similar to that just below 3.6 GHz but not warranted.

| LTE TDD Operating Band | Uplink/Downlink |
|--------------------------|------------------|
| 33 | 1900 to 1920 MHz |
| 34 | 2010 to 2025 MHz |
| 35 | 1850 to 1910 MHz |
| 36 | 1930 to 1990 MHz |
| 37 | 1910 to 1930 MHz |
| 38 | 2570 to 2620 MHz |
| 39 | 1880 to 1920 MHz |
| 40 | 2300 to 2400 MHz |
| 41 | 2496 to 2690 MHz |
| 42 See note ^a | 3400 to 3600 MHz |
| 44 | 703 to 803 MHz |

LTE/LTE-A Measurement Application
In-Band Frequency Range

- a. ACP measurements and SEM for operating Band 22 and 42 require measurement of some spectral energy above the 3.6 GHz maximum for Band 0 in earlier firmware versions. These measurements can be made with the combination of recent firmware, version A.16.13 or later, and calibration of the analyzer in analyzer RF Band 0 extended to 3.7 GHz instead of the 3.6 GHz supported by earlier versions of the firmware. The calibration extension occurs in production of instruments with Frequency *Option 508, 513 or 526* and serial number is equal with or greater than the following: US54490126, MY54490690, or SG54490127; older analyzers with these frequency options and recent firmware can have their Band 0 coverage extended in service centers upon request.

With the combination of recent firmware and extended Band 0 range, the performance in the region above 3.6 GHz is nominally similar to that just below 3.6 GHz but not warranted.

LTE/LTE-A Measurement Application
In-Band Frequency Range

28 Measuring Receiver

This chapter contains specifications for the N5531X measuring receiver system comprised of:

- N9030B PXA signal analyzer (NOT the N9030A model);
- N9091EM0E Measuring Receiver application software and;
- U5532C USB sensor module (any option); or alternatively,
- Power meter (models N1913A, N1914A, N1911A or N1912A recommended, or E4416A, E4417A, E4418B, E4419B), and the N5532B/A Sensor Module. When used with the N1911A or N1912A power meter, an adapter (N5532B-019) is required.

Additional Definitions and Requirements

This chapter contains specifications and supplemental information for the N5531X measuring receiver "one-box" configuration (comprised of an N9030B PXA signal analyzer with the N9091EM0E and a U5532C USB sensor module), or alternatively, the N5531X measuring receiver system (comprised of a N9030B PXA signal analyzer with the N9091EM0E, a P-Series (N1911A, N1912A), an EPM-Series (N1913A, N1914A), or a legacy EPM/EPM-P Series (E4416A, E4417A, E4418B, E4419B)¹ power meter, and an N5532B/A sensor module).

Available for the N9030B PXA with all frequency options.

In addition to the required general conditions stated on page 16, the following conditions must be met for the analyzer to meet the specifications included in this chapter.

N9030B PXA Conditions Required to Meet Specifications

- Accuracy Mode set to "High" when performing Tuned RF Level (TRFL)
- Fast Mode set to "Off" when performing modulation measurements.
- At least 2 hours of storage or operation at the operating temperature of 20 to 30 °C.
- The N9030B PXA 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, or
 - Any time the ambient temperature changes more than 3 °C, or
 - After the analyzer has been at operating temperature at least 2 hours.
- For analog modulation measurements, a direct connection between the N9030B PXA and the device under test (DUT) is required to achieve the best performance and meet the specifications for all test frequencies.
- Warranted analog modulation analysis specifications apply to mixer level –24 to –18 dBm (mixer level = Input power level – Attenuation).
- Additional conditions are listed at the beginning of the FM, AM, and PM sections, in specification tables, or in footnotes.

1. For the discontinued legacy EPM/EPM-P Series (E4416A, E4417A, E4418B, E4419B) power meters to work with the N5531X measuring receiver system, a USB-to-GPIB converter, or a LAN/GPIB gateway is required.

Measuring Receiver
Additional Definitions and Requirements

PXA options that are NOT supported or conditionally supported by the N5531X:

| Option Number | Description | Note |
|---------------|-----------------------------|--|
| N9030B-B5X | Analysis bandwidth, 510 MHz | Only supported in the PXA without Option N9030B-107 (Audio input and digitizer) as it competes slot with Option N9030B-107 |
| N9030B-BBA | I/Q Baseband Inputs, Analog | Competes slot with Option N9030B-107 (Audio input and digitizer); yet to be qualified in the production line |

Definitions of terms used in this chapter

Let P_{signal} (S) = Power of the signal; P_{noise} (N) = Power of the noise; $P_{\text{distortion}}$ (D) = Power of the harmonic distortion ($P_{H2} + P_{H3} + \dots + P_{Hi}$ where Hi is the i^{th} harmonic up to $i=10$);

P_{total} = Total power of the signal, noise and distortion components.

| Term | Short Hand | Definition |
|---------------------------------|---------------------------|---|
| Information bandwidth (Info BW) | IF BW | Also called demodulation bandwidth or channel bandwidth. It is one of the determinants of the capacity of a given communication channel. The wider the Info BW, the greater amount of information carried by the modulated signal can be analyzed. Info BW is typically 1.25 times sample rate. Noise passes through only this bandwidth in demodulation if no post-process filter is applied. The maximum Info BW depends on the analysis BW option equipped with the analyzer. However, the demodulation specifications only apply to the Channel BW indicated in the following sections. |
| Distortion | $\frac{N + D}{S + N + D}$ | $(P_{\text{total}} - P_{\text{signal}})^{1/2} / (P_{\text{total}})^{1/2} \times 100\%$ |
| THD | $\frac{D}{S}$ | $(P_{\text{distortion}})^{1/2} / (P_{\text{signal}})^{1/2} \times 100\%$ where THD is the total harmonic distortion |
| SINAD | $\frac{S + N + D}{N + D}$ | $20 \times \log_{10} [1/(P_{\text{distortion}})]^{1/2} = 20 \times \log_{10} [(P_{\text{total}})^{1/2} / (P_{\text{total}} - P_{\text{signal}})^{1/2}]$ where SINAD is Signal-to-Noise-And-Distortion ratio |
| SNR | $\frac{S + N + D}{N}$ | $P_{\text{signal}} / P_{\text{noise}} \sim (P_{\text{signal}} + P_{\text{noise}} + P_{\text{distortion}}) / P_{\text{noise}}$ where SNR is the Signal-to-Noise Ratio. The approximation is per the implementations defined with the Keysight 8903A. |

NOTE

P_{noise} must be limited to the bandwidth of the applied filters.

The harmonic sequence is limited to the 10th harmonic unless otherwise indicated.

P_{noise} includes all spectral energy that is not near harmonic frequencies, such as spurious signals, power line interference, etc.

RF Carrier Frequency and Bandwidth

| Description | Specifications | Supplemental Information |
|--|----------------------|--|
| Carrier Frequency | | |
| Maximum Frequency | | |
| <i>Option 503</i> | 3.6 GHz | RF/ μ W frequency option |
| <i>Option 508</i> | 8.4 GHz | RF/ μ W frequency option |
| <i>Option 513</i> | 13.6 GHz | RF/ μ W frequency option |
| <i>Option 526</i> | 26.5 GHz | RF/ μ W frequency option |
| <i>Option 544</i> | 44 GHz | mmW frequency option |
| <i>Option 550</i> | 50 GHz | mmW frequency option |
| Minimum Frequency | | |
| AC Coupled ^a | 10 MHz | In practice, limited by the need to keep modulation sidebands from folding, and by the interference from LO feedthrough. |
| DC Coupled | 2 Hz | |
| Maximum Information Bandwidth (Info BW)^b | | |
| Standard <i>B25</i> | 25 MHz | |
| <i>Option B40</i> | 40 MHz | |
| <i>Option B85</i> | 85 MHz | |
| <i>Option B1X</i> | 160 MHz | |
| <i>Option B2X</i> | 255 MHz ^c | |
| <i>Option B5X</i> | 510 MHz ^c | Not compatible with <i>Option 107</i> |

a. AC Coupled is only applicable to frequency *Options 503, 508, 513, and 526*.

b. The maximum Info BW indicates the maximum operational BW, which depends on the analysis BW option equipped with the analyzer. However, the demodulation specifications only apply to the IF BW indicated in the AM, FM, and PM sections.

c. Under the "Measuring Receiver" mode, limited to 160 MHz maximum.

Frequency Modulation (FM)

Additional conditions required to meet specifications:

- Peak FM Deviation ≥ 10 Hz
- β (modulation index) = (FM Deviation)/(FM Rate). The maximum β is 20,000; and it is 50 for rate > 100 kHz, 20 for rate > 200 kHz, and 5 for rate > 500 kHz. The minimum β is 0.001; and it is 1 for rate < 50 Hz, and 5 for rate < 20 Hz
- Info Bandwidth (BW): ≤ 40 MHz for center frequency (f_c) up to 50 GHz
- SINAD BW: (IF BW/2)
- Single tone: sinusoid modulation

| Description | Specification | Supplemental Information |
|---|--|--------------------------|
| Input Power Range | –24 to +30 dBm | |
| FM Rate Range^a | | |
| $100 \text{ kHz} \leq f_c \leq 50 \text{ GHz}$ | 10 Hz to 1 MHz | |
| Peak FM Deviations^a | | |
| $100 \text{ kHz} < f_c < 50 \text{ GHz}$ | 16 MHz maximum | |
| FM Deviation Accuracy ^b | | |
| RF Frequency Range | | |
| 100 kHz to 3.6 GHz | $\pm(1.0 \times 10^{-7} \times \text{Dev}^{0.75} + 0.002) \times (\text{Dev} + \text{Rate})$ | |
| 3.6 to 8.4 GHz 2 kHz \leq Rate, $0.01 \leq \beta$ Rate ≤ 20 Hz, $100 \leq \text{Dev} + \text{Rate}$ | $\pm(2.0 \times 10^{-7} \times \text{Dev}^{0.75} + 0.002) \times (\text{Dev} + \text{Rate})$ | |
| 8.4 to 13.6 GHz 1 MHz = Rate, $0.005 \leq \beta$ Rate ≤ 50 Hz, $200 \leq \text{Dev} + \text{Rate}$ | $\pm(1.5 \times 10^{-7} \times \text{Dev}^{0.75} + 0.002) \times (\text{Dev} + \text{Rate})$ | |
| 13.6 to 17.1 GHz 500 kHz \leq Rate, $0.01 \leq \beta$ Rate ≤ 50 Hz, $150 \leq \text{Dev} + \text{Rate}$ | $\pm(2.5 \times 10^{-7} \times \text{Dev}^{0.75} + 0.002) \times (\text{Dev} + \text{Rate})$ | |
| 17.1 to 26.5 GHz 100 kHz \leq Rate, $0.02 \leq \beta$ Rate ≤ 100 Hz, $150 \leq \text{Dev} + \text{Rate}$ | $\pm(4.0 \times 10^{-7} \times \text{Dev}^{0.75} + 0.003) \times (\text{Dev} + \text{Rate})$ | |
| 26.5 to 34.5 GHz 100 kHz \leq Rate, $0.02 \leq \beta$, Rate ≤ 100 Hz, $150 \leq \text{Dev} + \text{Rate}$ | $\pm(5.0 \times 10^{-7} \times \text{Dev}^{0.75} + 0.003) \times (\text{Dev} + \text{Rate})$ | |
| 34.5 to 50 GHz 20 kHz \leq Rate, $0.05 \leq \beta$ Rate ≤ 100 Hz, $150 \leq \text{Dev} + \text{Rate}$ | $\pm(1.5 \times 10^{-6} \times \text{Dev}^{0.75} + 0.003) \times (\text{Dev} + \text{Rate})$ | |

Measuring Receiver
Frequency Modulation (FM)

- a. The modulation rates and the peak deviations that the system is capable of measuring are governed by the instrument's Information Bandwidth (IF BW) setting which depends on the PXA's analysis bandwidth hardware). Their relationship is described by the equation: Peak deviation (in Hz) = (IF BW)/2 – modulation rate.
- b. When the carrier frequency f_c is less than 10 MHz, to avoid the image signal that appears in the IF corresponding to the negative of the signal frequency, the f_c and IF BW must be chosen to satisfy $IF\ BW < 2 \times (f_c - 100\text{ kHz})$. In the FM deviation accuracy specifications, the FM deviation (Dev) and the FM rate (Rate) are both in Hz.

| Description | Specification | Supplemental Information |
|---|--------------------|---|
| Modulation Distortion Floor | | See "Modulation Distortion" on page 400. |
| AM Rejection (50 Hz to 3 kHz BW)^a | | |
| Frequency Range | Max peak deviation | |
| 100 kHz to 3.6 GHz | 0.6 Hz | |
| 3.6 GHz to 8.4 GHz | 1.0 Hz | |
| 8.4 to 13.6 GHz | 1.4 Hz | |
| 13.6 to 17.1 GHz | 1.7 Hz | |
| 17.1 to 26.5 GHz | 2.6 Hz | |
| 26.5 to 34.5 GHz | 3.3 Hz | |
| 34.5 to 50 GHz | 5.3 Hz | |

- a. AM rejection (also known as "incidental FM" due to AM) describes the instrument's FM reading for an input that is strongly AMed (with no FM); this specification includes contributions from residual FM. AM signal (Rate = 1 kHz, Depth = 50%), HPF=50 Hz, LPF = 3 kHz, Channel BW = 15 kHz. Conditions that would constrain FM deviation or beta near zero, or constrain the rate of modulation, do not apply to Incidental FM.

Measuring Receiver
Frequency Modulation (FM)

| Description | Specification | Supplemental Information |
|--|--|---|
| Residual FM (50 Hz to 3 kHz BW)^{ab} RF Frequency 100 kHz to 3.6 GHz 3.6 to 8.4 GHz 8.4 to 13.6 GHz 13.6 to 17.1 GHz 17.1 to 26.5 GHz 26.5 to 34.5 GHz 34.5 to 50 GHz Detectors Auto Carrier Frequency Triggering | < 0.4 Hz (rms) < 0.6 Hz (rms) < 0.9 Hz (rms) < 1.1 Hz (rms) < 1.7 Hz (rms) < 2.2 Hz (rms) < 3.3 Hz (rms) Free run, Video, RF Burst, External | Available: +peak, –peak, ±peak/2, peak hold, rms |

- a. The Residual FM specification is a warranted traceable worst-case figure for the entire band. For most instruments, at most frequencies, the actual residual FM performance is usually much better (lower). When testing the Residual FM of a DUT, the measurement result is the combined noise of the DUT and the measuring receiver. If the FM noise of the DUT and the measuring receiver are uncorrelated (normally the case), then these two contributors can only add to each other in a RSS (Root-Sum-Squared) manner. Therefore, we can say with high confidence that the FM noise of the DUT is no greater than the Residual FM indicated by the measuring receiver.
- b. Residual FM describes the instrument's FM reading for an input that has no FM and no AM; this specification includes contributions from FM deviation accuracy. HPF = 50 Hz, LPF = 3 kHz, Channel BW = 15 kHz. Conditions that would constrain FM deviation or beta near zero, or constrain the rate of modulation, do not apply to residual FM.

Amplitude Modulation (AM)

Additional conditions required to meet specifications:

- Info BW (IF BW) ≤ 40 MHz for center frequency (f_c) up to 50 GHz
- IF BW: 5 times of AM rate
- SINAD BW: (IF BW)/2
- Single tone: sinusoid modulation

| Description | Specification | Supplemental Information |
|---|----------------|--------------------------|
| Input Power Range | –24 to +30 dBm | |
| AM Rate Range^a $100\text{ kHz} \leq f_c < 50\text{ GHz}$ | 10 Hz to 1 MHz | |

a. When the carrier frequency f_c is less than 10 MHz, to avoid the image signal that appears in the intermediate frequency corresponding to the negative of the signal frequency, the f_c and IF BW must be chosen to satisfy $\text{IF BW} < 2 \times (f_c - 100\text{ kHz})$.

Measuring Receiver
Amplitude Modulation (AM)

| Description | Specification | Supplemental Information |
|---------------------------------------|--|---|
| AM Depth Range | 1 to 99% (Depth + Power ratio of Distortion + Power ratio of Noise < 100%) | Capable of measuring AM depth range of 0 to 100%. |
| AM Depth Accuracy^{ab} | | |
| RF Frequency Range | | |
| 100 kHz to 3.6 GHz Depth 2 to 99% | | |
| Rate ≤ 10 kHz 10 kHz < Rate | $\pm 0.001 \times \text{reading}$ $\pm 0.00001 \times (\text{Rate}/1 \text{ Hz})^{0.5} \times \text{reading}$ | |
| 3.6 to 13.6 GHz Depth 5 to 99% | | |
| Rate ≤ 10 kHz 10 kHz < Rate | $\pm 0.001 \times \text{reading}$ $\pm 0.00001 \times (\text{Rate}/1 \text{ Hz})^{0.5} \times \text{reading}$ | |
| 13.6 to 17.1 GHz Depth 5 to 99% | | |
| Rate ≤ 5 kHz 5 kHz < Rate | $\pm 0.001 \times \text{reading}$ $\pm 0.00001 \times (2 \times \text{Rate}/1 \text{ Hz})^{0.5} \times \text{reading}$ | |
| 17.1 to 26.5 GHz Depth 5 to 99% | | |
| Rate ≤ 5 kHz 5 kHz < Rate | $\pm 0.001 \times \text{reading}$ $\pm (0.00001 \times (3 \times \text{Rate}/1 \text{ Hz})^{0.5} - 2.2 \times 10^{-4}) \times \text{reading}$ | |
| 26.5 to 34.5 GHz Depth 5 to 99% | | |
| Rate ≤ 5 kHz 5 kHz < Rate | $\pm 0.0012 \times \text{reading}$ $\pm (0.000012 \times (3 \times \text{Rate}/1 \text{ Hz})^{0.5} - 2.7 \times 10^{-4}) \times \text{reading}$ | |
| 34.5 to 50 GHz Depth 5 to 99% | | |
| Rate ≤ 5 kHz 5 kHz < Rate | $\pm 0.0025 \times \text{reading}$ $\pm (1.2 \times 10^{-7} \times (\text{Rate}/1 \text{ Hz}) + 2.5 \times 10^{-3}) \times \text{reading}$ | |

- a. For peak measurement only: AM accuracy may be affected by distortion generated by the measuring receiver. In the worst case this distortion can decrease accuracy by 0.1% of reading for each 0.1% of distortion.
- b. Reading is a measured AM depth in %.

Measuring Receiver
Amplitude Modulation (AM)

| Description | Specification | Supplemental Information |
|---|--|--|
| Flatness^{ab} 5% ≤ Depth Frequency Range | | |
| 100 kHz to 3.6 GHz | $\pm (0.00004 \times \sqrt{\frac{\text{Rate[Hz]}}{1\text{Hz}}} \times \text{reading})$ | |
| 3.6 to 8.4 GHz | $\pm (0.00008 \times \sqrt{\frac{\text{Rate[Hz]}}{1\text{Hz}}} \times \text{reading})$ | |
| 8.4 to 13.6 GHz | | |
| Rate ≤ 500 Hz | $\pm 0.01 \times \text{reading}$ | |
| 500 Hz < Rate | $\pm (0.00025 \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{0.6} \times \text{reading})$ | |
| 13.6 to 17.1 GHz | | |
| Rate ≤ 500 Hz | $\pm 0.015 \times \text{reading}$ | |
| 500 Hz < Rate | $\pm (0.0002 \times \left(\frac{\text{Rate[Hz]}}{1\text{Hz}}\right)^{0.64} \times \text{reading})$ | |
| 17.1 to 26.5 GHz | | |
| Rate ≤ 500 Hz | $\pm 0.035 \times \text{reading}$ | |
| 500 Hz < Rate | $\pm (0.0015 \times \sqrt{\frac{\text{Rate[Hz]}}{1\text{Hz}}} \times \text{reading})$ | |
| 26.5 to 34.5 GHz | | |
| Rate ≤ 1 kHz | $\pm 0.05 \times \text{reading}$ | |
| 1 kHz < Rate | $\pm (0.0015 \times \sqrt{\frac{\text{Rate[Hz]}}{1\text{Hz}}} \times \text{reading})$ | |
| 34.5 to 50 GHz | | |
| Rate ≤ 1 kHz | $\pm 0.12 \times \text{reading}$ | |
| 1 kHz < Rate | $\pm (0.004 \times \sqrt{\frac{\text{Rate[Hz]}}{1\text{Hz}}} \times \text{reading})$ | |
| Modulation Distortion Floor | | See “Modulation Distortion” on page 400. |

- a. Flatness is the relative variation in indicated AM depth versus rate for a constant carrier frequency and depth.
 b. Reading is a measured AM depth in %.

Measuring Receiver
Amplitude Modulation (AM)

| Description | Specification | Supplemental Information |
|---|-------------------------------------|---|
| FM Rejection (50 Hz to 3 kHz BW)^a | | |
| Frequency Range | | |
| 100 kHz to 3.6 GHz | 0.05% (peak) | |
| 3.6 to 17.1 GHz | 0.1% (peak) | |
| 17.1 to 34.5 GHz | 0.11% (peak) | |
| FM Rejection (rms)^b | | |
| <i>Option EPO</i> | | |
| 100 kHz to 8.4 GHz | 0.025% (rms) | |
| Residual AM (50 Hz to 3 kHz BW)^c | | |
| Frequency Range | | |
| 100 kHz to 3.6 GHz | 0.005% (rms) | |
| 3.6 to 17.1 GHz | 0.01% (rms) | |
| 17.1 to 34.5 GHz | 0.02% (rms) | |
| 34.5 to 50.0 GHz | 0.05% (rms) | |
| Residual AM (30 Hz to 23 kHz BW)^d | | |
| Frequency Range | | |
| 100 kHz to 34.5 GHz | 0.01% (rms) | |
| 34.5 to 50.0 GHz | 0.02% (rms) | |
| Detectors | | Available: +peak, -peak, \pm peak/2, peak hold, rms |
| Auto Carrier Frequency Triggering | Free run, Video, RF Burst, External | |

- FM rejection (also known as "incidental AM" due to FM/PM) describes the instrument's AM reading for an input that is strongly FMed (with no AM); this specification includes contributions from residual AM. FM signal (Rate = 1 kHz, Deviation = 50 kHz), HPF = 50 Hz, LPF = 3 kHz, Channel BW = 420 kHz. Conditions that would constrain AM depth, or constrain the rate of modulation, do not apply to incidental AM.
- FM rejection (also known as "incidental AM" due to FM/PM) describes the instrument's AM reading for an input that is strongly FMed (with no AM); this specification includes contributions from residual AM. FM signal (Rate = 1 kHz, Deviation = 50 kHz), HPF = 50 Hz, LPF = 3 kHz, Channel BW = 12 MHz. Conditions that would constrain AM depth, or constrain the rate of modulation, do not apply to incidental AM.
- Residual AM describes instruments AM reading for an input that has no AM and no FM; this specification includes contribution from AM depth accuracy. HPF = 50 Hz, LPF = 3 kHz, channel BW = 6 kHz.
- Residual AM describes instruments AM reading for an input that has no AM and no FM; this specification includes contribution from AM depth accuracy. HPF = 30 Hz, LPF = 23 kHz, channel BW = 46 kHz. Option FBP is required except Band 0.

Phase Modulation (PM)

Additional conditions required to meet specifications:

- Info BW (IF BW) \leq 40 MHz for center frequency (f_c) up to 50 GHz
- HPF = 20 Hz is always On (unless otherwise stated)
- SINAD BW = (IF BW)/2 - Single

tone: sinusoid modulation

| Description | Specification | Supplemental Information |
|---|--|--------------------------|
| Input Power Range | –24 to +30 dBm | |
| PM Rate Range ^a $100\text{ kHz} \leq f_c < 50\text{ GHz}$ | 50 Hz to 1 MHz | |
| Peak Phase Deviation ^b $100\text{ kHz} \leq f_c < 50\text{ GHz}$ | 0.01 to 25,000 radians ^c | |

- a. Below 500 Hz PM rate, set the HPF to "None" to meet the PM deviation accuracy specifications.
- b. The f_c and IF BW must be chosen to satisfy $\text{IF BW} < 2 \times (f_c - 100\text{ kHz})$.
- c. The maximum peak deviation that the instrument is capable of measuring depends on the IF BW setting and the modulation rate of the signal-under-test. The relationship is described by the equation:
Max peak deviation (in radians) = $[\text{IF BW} / (2 \times \text{modulation rate in Hz})] - 1$.

Measuring Receiver
Phase Modulation (PM)

| Description | Specification | Supplemental Information |
|--|--|--------------------------|
| PM Deviation Accuracy^a | | |
| RF Frequency range | | |
| Option EP1 | | |
| 100 kHz to 3.6 GHz | | |
| 0.01 ≤ Dev | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.001 \times \text{reading}^{0.25} + 0.001, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 8.0 \times 10^{-6} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| 3.6 to 13.6 GHz | | |
| 0.01 ≤ Dev | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.002 \times \text{reading}^{0.25} + 0.001, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| 13.6 to 17.1GHz | | |
| 0.02 ≤ Dev | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.002 \times \text{reading}^{0.25} + 0.001, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| 17.1 to 26.5 GHz | | |
| 0.02 ≤ Dev | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.0025 \times \text{reading}^{0.25} + 0.0025, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| 26.5 to 34.5 GHz | | |
| 0.05 ≤ Dev | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.0025 \times \text{reading}^{0.25} + 0.0025, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate, | $\pm 1.0 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| 34.5 to 50 GHz | | |
| 0.05 ≤ Dev | | |

Measuring Receiver
Phase Modulation (PM)

| Description | Specification | Supplemental Information |
|--|---|--------------------------|
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.006 \times \text{reading}^{0.25} + 0.004, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 1.5 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| PM Deviation Accuracy^a | | |
| RF Frequency range | | |
| <i>Option EPO</i> | | |
| 100 kHz to 3.6 GHz | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.001 \times \text{reading}^{0.25} + 0.001, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 6.0 \times 10^{-6} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| 3.6 to 13.6 GHz | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.002 \times \text{reading}^{0.25} + 0.001, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| 13.6 to 17.1GHz | | |
| 0.02 ≤ Dev | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.002 \times \text{reading}^{0.25} + 0.001, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| 17.1 to 26.5 GHz | | |
| 0.02 ≤ Dev | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.0025 \times \text{reading}^{0.25} + 0.001, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |
| 26.5 to 34.5 GHz | | |
| 0.05 ≤ Dev | | |
| 100 Hz ≤ Rate ≤ 100 kHz | $\pm \text{Max} \{0.0025 \times \text{reading}^{0.25} + 0.001, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ | |
| 100 kHz < Rate | $\pm 1.0 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | |

Measuring Receiver
Phase Modulation (PM)

| Description | Specification | Supplemental Information |
|---|--|---|
| 34.5 to 50 GHz 0.05 ≤ Dev 100 Hz ≤ Rate ≤ 100 kHz 100 kHz < Rate Modulation Distortion Floor | $\pm \text{Max} \{0.006 \times \text{reading}^{0.25} + 0.001, 1.0 \times 10^5 \times \text{Rate}^{-4} \times \text{reading}\}$ $\pm 1.5 \times 10^{-5} \times \text{Rate}^{0.5} \times \text{reading}^{0.25}$ | See “Modulation Distortion” on page 400. |

- a. The function of $\text{Max} \{x, y\}$ means whichever is greater between x and y. The deviation reading is in radian, and rate is in Hz.

Measuring Receiver
Phase Modulation (PM)

| Description | Specification | Supplemental Information |
|---|------------------|--------------------------|
| AM Rejection (50 Hz to 3 kHz BW)^a | | |
| <i>Option EP1</i> | | |
| 100 kHz to 3.6 GHz | 2.4 mrad (peak) | |
| 3.6 to 8.4 GHz | 4.0 mrad (peak) | |
| 8.4 to 13.6 GHz | 6.4 mrad (peak) | |
| 13.6 to 17.1 GHz | 8.0 mrad (peak) | |
| 17.1 to 26.5 GHz | 12.4 mrad (peak) | |
| 26.5 to 34.5 GHz | 16.2 mrad (peak) | |
| 34.5 to 50 GHz | 23.4 mrad (peak) | |
| <i>Option EPO</i> | | |
| 100 kHz to 3.6 GHz | 0.4 mrad (peak) | |
| 3.6 to 8.4 GHz | 1.0 mrad (peak) | |
| 8.4 to 13.6 GHz | 1.6 mrad (peak) | |
| 13.6 to 17.1 GHz | 2.0 mrad (peak) | |
| 17.1 to 26.5 GHz | 3.1 mrad (peak) | |
| 26.5 to 34.5 GHz | 4.0 mrad (peak) | |
| 34.5 to 50 GHz | 5.6 mrad (peak) | |
| Residual PM (50 Hz to 3 kHz BW)^{bc} | | |
| <i>Option EP1</i> | | |
| 100 kHz to 3.6 GHz | 1.4 mrad (rms) | |
| 3.6 to 8.4 GHz | 2.5 mrad (rms) | |
| 8.4 to 13.6 GHz | 3.9 mrad (rms) | |
| 13.6 to 17.1GHz | 4.9 mrad (rms) | |
| 17.1 to 26.5 GHz | 7.5 mrad (rms) | |
| 26.5 to 34.5 GHz | 9.8 mrad (rms) | |
| 34.5 to 50 GHz | 14.1 mrad (rms) | |
| <i>Option EPO</i> | | |
| 100 kHz to 3.6 GHz | 0.3 mrad (rms) | |
| 3.6 to 8.4 GHz | 0.7 mrad (rms) | |
| 8.4 to 13.6 GHz | 1.1 mrad (rms) | |

Measuring Receiver
Phase Modulation (PM)

| Description | Specification | Supplemental Information |
|--|-------------------------------------|---|
| 13.6 to 17.1GHz | 1.3 mrad (rms) | |
| 17.1 to 26.5 GHz | 2.0 mrad (rms) | |
| 26.5 to 34.5 GHz | 2.6 mrad (rms) | |
| 34.5 to 50 GHz | 3.7 mrad (rms) | |
| Detectors | | Available: +peak, -peak, \pm peak/2, peak hold, rms |
| Auto Carrier Frequency Triggering | Free run, Video, RF Burst, External | |

- AM rejection (also known as "incidental PM" due to AM) describes the instrument's PM reading for an input that is strongly AMed (with no PM); this specification includes contributions from residual PM. AM signal (Rate = 1 kHz, Depth = 50%), HPF=50 Hz, LPF = 3 kHz, Channel BW = 15 kHz. Conditions that would constrain PM deviation or beta near zero, or constrain the rate of modulation, do not apply to incidental PM.
- The Residual PM specification is a warranted traceable worst-case figure for the entire band. For most instruments, at most frequencies, the actual residual PM performance is usually much better (lower). When testing the Residual PM of a DUT, the measurement result is the combined noise of the DUT and the measuring receiver. If the phase noise of the DUT and measuring receiver are uncorrelated (normally the case), then these two contributors can only add to each other in a RSS (Root-Sum-Squared) manner. Therefore, we can say with high confidence that the phase noise of the DUT is no greater than the Residual PM indicated by the measuring receiver.
- Residual PM describes the instrument's PM reading for an input that has no PM and no AM; this specification includes contributions from PM deviation accuracy. HPF = 50 Hz, LPF = 3 kHz, IF BW = 15 kHz. Conditions that would constrain PM deviation or beta near zero, or constrain the rate of modulation, do not apply to residual PM.

Modulation Rate

FM Rate: 10 Hz to 1 MHz

AM Rate: 10 Hz to 1 MHz

PM Rate: 50 Hz to 1 MHz

| Description | Specification | Supplemental Information |
|---|---|--------------------------|
| FM Rate Accuracy^a [Hz] | | |
| <i>Option EP1</i> | | |
| 100 kHz to 3.6 GHz Rate ≤ 2 kHz | ±(0.005 / Deviation) x Rate + rfa or ±0.00001 x Rate + rfa, whichever is larger | |
| 2 kHz < Rate, 0.01 ≤ β | $\pm \left(\frac{4.0 \times 10^{-8}}{\beta} + 1.0 \times 10^{-7} \right) \times Rate^{1.5} + rfa$ | |
| 3.6 to 8.4 GHz Rate ≤ 2 kHz | ±(0.01 / Deviation) x Rate + rfa or ±0.00001 x Rate + rfa, whichever is larger | |
| 2 kHz < Rate, 0.02 ≤ β | $\pm \left(\frac{6.0 \times 10^{-8}}{\beta} + 8.0 \times 10^{-8} \right) \times Rate^{1.5} + rfa$ $\pm (3.5 \times 10^{-8} \times \beta^{1/4}) \times Rate^{1.5} + rfa$ | β ≤ 20 20 < β |
| 8.4 to 13.6 GHz Rate ≤ 2 kHz | ±(0.015 / Deviation) x Rate + rfa or ±0.00001 x Rate + rfa, whichever is larger | |
| 2 kHz < Rate, 0.02 ≤ β | $\pm \left(\frac{5.0 \times 10^{-8}}{\beta} + 1.2 \times 10^{-7} \right) \times Rate^{1.5} + rfa$ | |
| 13.6 to 17.1GHz Rate ≤ 2 kHz | ±(0.018 / Deviation) x Rate + rfa or ±0.00001 x Rate + rfa, whichever is larger | |
| 2 kHz < Rate, 0.02 ≤ β | $\pm \left(\frac{8.0 \times 10^{-8}}{\beta} + 8.0 \times 10^{-8} \right) \times Rate^{1.5} + rfa$ $\pm (3.5 \times 10^{-8} \times \beta^{1/4}) \times Rate^{1.5} + rfa$ | β ≤ 20 20 < β |
| 17.1 to 26.5 GHz Rate ≤ 2 kHz, 20 Hz ≤ Deviation | ±(0.025 / Deviation) x Rate + rfa or ±0.00002 x Rate + rfa, whichever is larger | |
| 2 kHz < Rate, 0.05 ≤ β | $\pm \left(\frac{1.0 \times 10^{-7}}{\beta} + 1.5 \times 10^{-7} \right) \times Rate^{1.5} + rfa$ $\pm (6.0 \times 10^{-8} \times \beta^{1/4}) \times Rate^{1.5} + rfa$ | β ≤ 20 20 < β |
| 26.5 to 34.5 GHz Rate ≤ 2 kHz, 20 Hz ≤ Deviation | ±(0.035 / Deviation) x Rate + rfa or ±0.00002 x Rate + rfa, whichever is larger | |
| 2 kHz < Rate, 0.05 ≤ β | $\pm \left(\frac{1.0 \times 10^{-7}}{\beta} + 1.5 \times 10^{-7} \right) \times Rate^{1.5} + rfa$ $\pm (6.0 \times 10^{-8} \times \beta^{1/4}) \times Rate^{1.5} + rfa$ | β ≤ 20 20 < β |

Measuring Receiver
Modulation Rate

| Description | Specification | Supplemental Information |
|---|---|--------------------------|
| 34.5 to 50 GHz Rate ≤ 2 kHz, 20 Hz ≤ Deviation | ±(0.045 / Deviation) x Rate + rfa or ±0.000055 x Rate + rfa, whichever is larger | |
| 2 kHz < Rate, 0.2 ≤ β | $\pm \left(\frac{2.0 \times 10^{-7}}{\beta} + 4.0 \times 10^{-7} \right) \times Rate^{1.5} + rfa \quad \beta \leq 20$ $\pm (1.6 \times 10^{-7} \times \beta^{1/4}) \times Rate^{1.5} + rfa \quad 20 < \beta$ | |

a. rfa = Modulation Rate × Frequency reference accuracy. Deviation is a frequency peak deviation in Hz, and Rate is a modulation rate in Hz.

| Description | Specification | Supplemental Information |
|---|---|--------------------------|
| FM Rate Accuracy^a[Hz] | | |
| <i>Option EP0</i> | | |
| 100 kHz to 3.6 GHz Rate ≤ 2 kHz | ±(0.002 / Deviation) x Rate + rfa or ±0.000005 x Rate + rfa, whichever is larger | |
| 2 kHz < Rate, 0.01 ≤ β | $\pm \left(\frac{2.0 \times 10^{-8}}{\beta} + 3.0 \times 10^{-8} \right) \times Rate^{1.5} + rfa \quad \beta \leq 20$ $\pm (1.5 \times 10^{-8} \times \beta^{1/4}) \times Rate^{1.5} + rfa \quad 20 < \beta$ | |
| 3.6 to 8.4 GHz Rate < 2 kHz | ±(0.003 / Deviation) x Rate + rfa or ±0.00001 x Rate + rfa, whichever is larger | |
| 2 kHz ≤ Rate, 0.02 ≤ β | $\pm \left(\frac{5.0 \times 10^{-8}}{\beta} + 8.0 \times 10^{-8} \right) \times Rate^{1.5} + rfa \quad \beta \leq 20$ $\pm (3.5 \times 10^{-8} \times \beta^{1/4}) \times Rate^{1.5} + rfa \quad 20 < \beta$ | |
| 8.4 to 13.6 GHz Rate < 2 kHz | ±(0.007 / Deviation) x Rate + rfa or ±0.000008 x Rate + rfa, whichever is larger | |
| 2 kHz ≤ Rate, 0.02 ≤ β | $\pm \left(\frac{6.0 \times 10^{-8}}{\beta} + 8.0 \times 10^{-8} \right) \times Rate^{1.5} + rfa \quad \beta \leq 100$ $\pm (2.5 \times 10^{-8} \times \beta^{1/4}) \times Rate^{1.5} + rfa \quad 100 < \beta$ | |
| 13.6 to 17.1GHz Rate < 2 kHz | ±(0.007 / Deviation) x Rate + rfa or ±0.00001 x Rate + rfa, whichever is larger | |
| 2 kHz ≤ Rate, 0.02 ≤ β | $\pm \left(\frac{8.0 \times 10^{-8}}{\beta} + 1.0 \times 10^{-7} \right) \times Rate^{1.5} + rfa \quad \beta \leq 100$ $\pm (3.0 \times 10^{-8} \times \beta^{1/4}) \times Rate^{1.5} + rfa \quad 100 < \beta$ | |
| 17.1 to 26.5 GHz Rate < 2 kHz | ±(0.01 / Deviation) x Rate + rfa or ±0.000015 x Rate + rfa, whichever is larger | |
| 2 kHz ≤ Rate, 0.05 ≤ β | $\pm \left(\frac{1.5 \times 10^{-7}}{\beta} + 1.5 \times 10^{-7} \right) \times Rate^{1.5} + rfa \quad \beta \leq 100$ $\pm (5.0 \times 10^{-8} \times \beta^{1/4}) \times Rate^{1.5} + rfa \quad 100 < \beta$ | |

Measuring Receiver
Modulation Rate

| Description | Specification | Supplemental Information |
|--|--|--------------------------|
| 26.5 to 34.5 GHz Rate < 2 kHz, | $\pm(0.015 / \text{Deviation}) \times \text{Rate} + \text{rfa}$ or $\pm 0.00002 \times \text{Rate} + \text{rfa}$, whichever is larger | |
| 2 kHz \leq Rate, $0.05 \leq \beta$ | $\pm \left(\frac{1.7 \times 10^{-7}}{\beta} + 1.7 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa}$ $\beta \leq 100$ $\pm (5.5 \times 10^{-8} \times \beta^{1/4}) \times \text{Rate}^{1.5} + \text{rfa}$ $100 < \beta$ | |
| 34.5 to 50 GHz Rate < 2 kHz 20 \leq Deviation @ 1kHz \leq Rate | $\pm(0.02 / \text{Deviation}) \times \text{Rate} + \text{rfa}$ or $\pm 0.00006 \times \text{Rate} + \text{rfa}$, whichever is larger | |
| 2 kHz \leq Rate, $0.1 \leq \beta$ | $\pm \left(\frac{3 \times 10^{-7}}{\beta} + 3.2 \times 10^{-7} \right) \times \text{Rate}^{1.5} + \text{rfa}$ $\beta \leq 20$ $\pm (1.7 \times 10^{-7} \times \beta^{1/4}) \times \text{Rate}^{1.5} + \text{rfa}$ $20 < \beta$ | |

- a. rfa = Modulation Rate \times Frequency reference accuracy. Deviation is a frequency peak deviation in Hz, and Rate is a modulation rate in Hz.

| Description | Specifications | Supplemental Information |
|---|--|--------------------------|
| AM Rate Accuracy^a[Hz] | | |
| 100 kHz to 3.6 GHz | | |
| Rate < 100Hz | $\pm (4.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |
| 100Hz \leq Rate < 1kHz | $\pm (4.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}) + \text{rfa}$ | |
| 1kHz \leq Rate | $\pm (5.0 \times 10^{-9} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |
| 3.6 GHz to 8.4 GHz 5% \leq Depth | | |
| Rate < 100Hz | $\pm (7.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |
| 100Hz \leq Rate < 1kHz | $\pm (7.0 \times 10^{-7} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}) + \text{rfa}$ | |
| 1kHz \leq Rate | $\pm (1.0 \times 10^{-8} \times \frac{100\%}{\text{Depth}\%} \times \text{Rate}^{1.5}) + \text{rfa}$ | |

Measuring Receiver
Modulation Rate

| Description | Specifications | Supplemental Information |
|--------------------------------------|--|--------------------------|
| 8.4 GHz to 13.6 GHz 5% ≤ Depth | | |
| Rate < 100Hz | $\pm (1.2 \times 10^{-7} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |
| 100Hz ≤ Rate < 1kHz | $\pm (6 \times 10^{-6} \times \frac{100\%}{Depth\%} \times \sqrt{Rate}) + rfa$ | |
| 1kHz ≤ Rate | $\pm (6.0 \times 10^{-9} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |
| 13.6 GHz to 17.1 GHz 5% ≤ Depth | | |
| Rate < 50Hz | $\pm (2.0 \times 10^{-7} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |
| 50Hz ≤ Rate < 1kHz | $\pm (1.0 \times 10^{-5} \times \frac{100\%}{Depth\%} \times \sqrt{Rate}) + rfa$ | |
| 1kHz ≤ Rate | $\pm (1.0 \times 10^{-8} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |
| 17.1 GHz to 26.5 GHz 5% ≤ Depth | | |
| Rate < 50Hz | $\pm (4.0 \times 10^{-7} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |
| 50Hz ≤ Rate ≤ 1kHz | $\pm (2.0 \times 10^{-5} \times \frac{100\%}{Depth\%} \times \sqrt{Rate}) + rfa$ | |
| 1kHz < Rate | $\pm (1.5 \times 10^{-8} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |
| 26.5 GHz ≤ to 34.5 GHz 5% ≤ Depth | | |
| Rate < 50Hz | $\pm (8.0 \times 10^{-7} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |
| 50Hz ≤ Rate < 1kHz | $\pm (4.0 \times 10^{-5} \times \frac{100\%}{Depth\%} \times \sqrt{Rate}) + rfa$ | |
| 1kHz < Rate | $\pm (1.6 \times 10^{-8} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |

Measuring Receiver
Modulation Rate

| Description | Specifications | Supplemental Information |
|-------------------------------------|--|--------------------------|
| 34.5 GHz to 50.0 GHz 20% ≤ Depth | | |
| Rate < 50Hz | $\pm (1.4 \times 10^{-6} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |
| 50Hz ≤ Rate < 1kHz | $\pm (7.0 \times 10^{-5} \times \frac{100\%}{Depth\%} \times \sqrt{Rate}) + rfa$ | |
| 1kHz ≤ Rate | $\pm (5.0 \times 10^{-8} \times \frac{100\%}{Depth\%} \times Rate^{1.5}) + rfa$ | |

a. rfa = Modulation Rate × Frequency reference accuracy.

Measuring Receiver
Modulation Rate

| Description | Specifications | Supplemental Information |
|--|--|--------------------------|
| PM Rate Accuracy^a[Hz] <i>Option EP1</i> 100 kHz to 3.6 GHz 0.02 rad ≤ Deviation 3.6 GHz to 8.4 GHz 0.05 rad ≤ Deviation 8.4 GHz to 13.6 GHz 0.05 rad ≤ Deviation 13.6 GHz to 17.1 GHz 0.05 rad ≤ Deviation 17.1 GHz to 26.5 GHz 0.1 rad ≤ Deviation 26.5 GHz to 34.5 GHz 0.2 rad ≤ Deviation 34.6 GHz to 50 GHz 0.2 rad ≤ Deviation | $\pm \left(0.001 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.0018 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.0025 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.003 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.006 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.008 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger $\pm \left(0.015 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1mHz whichever is larger | |

a. rfa = Modulation Rate × Frequency reference accuracy.

Measuring Receiver
Modulation Rate

| Description | Specifications | Supplemental Information |
|--|--|--------------------------|
| PM Rate Accuracy^a[Hz] <i>Option EPO</i> 100 kHz to 3.6 GHz 0.02 rad ≤ Deviation 3.6 GHz to 8.4 GHz 0.05 rad ≤ Deviation 8.4 GHz to 13.6 GHz 0.05 rad ≤ Deviation 13.6 GHz to 17.1 GHz 0.05 rad ≤ Deviation 17.1 GHz to 26.5 GHz 0.1 rad ≤ Deviation 26.5 GHz to 34.5 GHz 0.2 rad ≤ Deviation 34.6 GHz to 50 GHz 0.2 rad ≤ Deviation | $\pm \left(0.0002 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1 mHz whichever is larger $\pm \left(0.0006 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1 mHz whichever is larger $\pm \left(0.0006 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1 mHz whichever is larger $\pm \left(0.0007 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1 mHz whichever is larger $\pm \left(0.0012 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1 mHz whichever is larger $\pm \left(0.0015 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1 mHz whichever is larger $\pm \left(0.0035 \times \frac{Rate^{1/2}}{Deviation} \right) + rfa$ or 1 mHz whichever is larger | |

a. rfa = Modulation Rate × Frequency reference accuracy.

| Description | Specifications | Supplemental Information |
|-----------------------------|----------------|--------------------------|
| Displayed Resolution | 1 mHz | |
| Measurement Rate | | 2 readings/second |

Modulation Distortion

| Description | Specification | Supplemental Information |
|---|---|---|
| Display Range | 0.01% to 100% (-80 to 0 dB) | |
| Displayed Resolution | 0.001% (0.001 dB) | |
| Post-Demod Distortion Measurement Accuracy | | |
| FM | | |
| Distortion | $\pm(0.02 \times \text{reading} + \text{DistResidual})$ | |
| THD | $\pm(0.02 \times \text{reading} + \text{THDResidual})$ | |
| AM | | |
| Distortion | $\pm(0.01 \times \text{reading} + \text{DistResidual})$ | |
| THD | $\pm(0.02 \times \text{reading} + \text{THDResidual})$ | |
| PM | | |
| Distortion | $\pm(0.02 \times \text{reading} + \text{DistResidual})$ | (Rate: 100 Hz to 1 MHz, deviation: 0.01 to 10000) |
| THD | $\pm(0.02 \times \text{reading} + \text{THDResidual})$ | |
| Sensitivity | | |
| Modulation | | See "Post-Demod Distortion Residual" below for minimum modulation levels. |

| Description | Specification | Supplemental Information |
|---------------------------------------|--|--------------------------|
| Post-Demod Distortion Residual | | |
| FM | | |
| Distortion (SINAD) ² [%] | | |
| 100 kHz to 3.6 GHz | | |
| Rate ≤ 2 kHz | $80 / \text{Deviation} + 0.00004 \times \text{Deviation}^{1/2} + 0.08$ | |
| 2 kHz < Rate, $0.01 \leq \beta$ | $0.0007 \times \text{Rate}^{1/2} / \beta + 0.0015 \times \text{Rate}^{1/2} + 0.000005 \times \text{Deviation}^{1/2}$ | |
| 3.6 GHz to 8.4 GHz | | |
| Rate ≤ 2 kHz | $110 / \text{Deviation} + 0.00008 \times \text{Deviation}^{1/2} + 0.08$ | |
| 2 kHz < Rate, $0.01 \leq \beta$ | $0.0015 \times \text{Rate}^{1/2} / \beta + 0.0015 \times \text{Rate}^{1/2} + 0.0001 \times \text{Deviation}^{1/2}$ | |
| 8.4 GHz to 13.6 GHz | | |
| Rate ≤ 2 kHz | $160 / \text{Deviation} + 0.00008 \times \text{Deviation}^{1/2} + 0.08$ | |
| 2 kHz < Rate, $0.01 \leq \beta$ | $0.0018 \times \text{Rate}^{1/2} / \beta + 0.0015 \times \text{Rate}^{1/2} + 0.0001 \times \text{Deviation}^{1/2}$ | |
| 13.6 GHz to 17.1 GHz | | |
| Rate ≤ 2 kHz | $200 / \text{Deviation} + 0.00008 \times \text{Deviation}^{1/2} + 0.08$ | |
| 2 kHz < Rate, $0.01 \leq \beta$ | $0.0025 \times \text{Rate}^{1/2} / \beta + 0.002 \times \text{Rate}^{1/2} + 0.0001 \times \text{Deviation}^{1/2}$ | |
| 17.1 GHz to 26.5 GHz | | |
| Rate ≤ 2 kHz | $300 / \text{Deviation} + 0.00015 \times \text{Deviation}^{1/2} + 0.1$ | |
| 2 kHz < Rate, $0.01 \leq \beta$ | $0.0035 \times \text{Rate}^{1/2} / \beta + 0.0025 \times \text{Rate}^{1/2} + 0.00015 \times \text{Deviation}^{1/2}$ | |
| 26.5 GHz to 34.5 GHz | | |
| Rate ≤ 2 kHz | $400 / \text{Deviation} + 0.0002 \times \text{Deviation}^{1/2} + 0.1$ | |
| 2 kHz < Rate, $0.01 \leq \beta$ | $0.0045 \times \text{Rate}^{1/2} / \beta + 0.0025 \times \text{Rate}^{1/2} + 0.00018 \times \text{Deviation}^{1/2}$ | |
| 34.5 GHz to 50 GHz | | |
| Rate ≤ 2 kHz | $700 / \text{Deviation} + 0.0006 \times \text{Deviation}^{1/2} + 0.16$ | |
| 2 kHz < Rate, $0.2 \leq \beta$ | $0.007 \times \text{Rate}^{1/2} / \beta + 0.004 \times \text{Rate}^{1/2} + 0.0006 \times \text{Deviation}^{1/2}$ | |

| Description | Specification | Supplemental Information |
|--|---|--------------------------|
| AM | | |
| Distortion (SINAD) ^a | | |
| 100 kHz to 3.6 GHz | $= 0.0002 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 [\%]$ | |
| 3.6 GHz to 8.4 GHz | $= 0.0004 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 [\%]$ | |
| 8.4 GHz to 13.6 GHz | $= 0.0003 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 [\%]$ | |
| 13.6 GHz to 17.1 GHz | $= 0.0004 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 [\%]$ | |
| 17.1 GHz to 34.5 GHz 100 Hz ≤ Rate ≤ 500 kHz, 1% ≤ Depth ≤ 99% 500 kHz < Rate, 2% ≤ Depth ≤ 99% | $= 0.0007 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 [\%]$ | |
| 34.5 GHz to 50 GHz 100 ≤ Rate ≤ 50 kHz, 1% ≤ Depth ≤ 99% 50 kHz < Rate ≤ 200 kHz, 2% ≤ Depth ≤ 99% 200 kHz < Rate ≤ 1 MHz, 5% ≤ Depth ≤ 99% | $= 0.0025 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.05 [\%]$ | |
| PM | | |
| Distortion (SINAD) ^a | | |
| <i>Option EP1</i> | | |
| 100 kHz to 3.6 GHz Rate ≤ 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.4 / Deviation + 0.01[%] 0.8 / Deviation + 0.01[%] | |
| 3.6 GHz to 8.4 GHz Rate ≤ 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.75 / Deviation + 0.01[%] 1.1 / Deviation + 0.01[%] | |
| 8.4 GHz to 13.6 GHz Rate ≤ 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.4 / Deviation + 0.01[%] 1.3 / Deviation + 0.01[%] | |
| 13.6 GHz to 17.1 GHz Rate ≤ 100 kHz 100 kHz < Rate, Deviation < 100 rad | 1.6 / Deviation + 0.01[%] 1.6 / Deviation + 0.01[%] | |
| 17.1 GHz to 26.5 GHz Rate ≤ 100 kHz 100 kHz < Rate, Deviation < 100 rad | 3.0 / Deviation + 0.01[%] 2.5 / Deviation + 0.01[%] | |

Measuring Receiver
Modulation Distortion

| Description | Specification | Supplemental Information |
|--|---|--------------------------|
| 26.5 GHz to 34.5 GHz Rate \leq 100 kHz 100 kHz < Rate, Deviation < 100 rad | 3.5 / Deviation + 0.01[%] 3.0 / Deviation + 0.01[%] | |
| 34.5 GHz to 50 GHz Rate \leq 100 kHz 100 kHz < Rate, Deviation < 100 rad | 5.0 / Deviation + 0.01[%] 5.5 / Deviation + 0.01[%] | |
| PM | | |
| Distortion (SINAD) ^a | | |
| <i>Option EPO</i> | | |
| 100 kHz to 3.6 GHz Rate \leq 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.15 / Deviation + 0.01[%] 0.8 / Deviation + 0.01[%] | |
| 3.6 GHz to 8.4 GHz Rate \leq 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.4 / Deviation + 0.01[%] 0.9 / Deviation + 0.01[%] | |
| 8.4 GHz to 13.6 GHz Rate \leq 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.5 / Deviation + 0.01[%] 0.9 / Deviation + 0.01[%] | |
| 13.6 GHz to 17.1 GHz Rate \leq 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.55 / Deviation + 0.01[%] 1.1 / Deviation + 0.01[%] | |
| 17.1 GHz to 26.5 GHz Rate \leq 100 kHz 100 kHz < Rate, Deviation < 100 rad | 0.8 / Deviation + 0.01[%] 1.5 / Deviation + 0.01[%] | |
| 26.5 GHz to 34.5 GHz Rate \leq 100 kHz 100 kHz < Rate, Deviation < 100 rad | 1.0 / Deviation + 0.01[%] 1.6 / Deviation + 0.01[%] | |
| 34.5 GHz to 50 GHz Rate \leq 100 kHz 100 kHz < Rate, Deviation < 100 rad | 1.5 / Deviation + 0.01[%] 4.0 / Deviation + 0.01[%] | |

a. SINAD [dB] can be derived by $20 \times \log_{10}(1/\text{Distortion})$.

| Description | Specification | Supplemental Information |
|--|---|--------------------------|
| Post-Demod Distortion Residual | | |
| FM | | |
| THD[%] | | |
| 100 kHz to 3.6 GHz | | |
| Rate \leq 100 kHz, $0.01 \leq \beta$ | $0.35 / \beta^{1/2}$ | |
| 100 kHz < Rate | $0.0001 / \beta \times \text{Rate}^{1/2}$ | |
| 0.01 $\leq \beta$ < 0.1 | $0.001 \times \text{Rate}^{1/2}$ | |
| 0.1 $\leq \beta$ < 10 | $0.003 / \beta^{1/2} \times \text{Rate}^{1/2}$ | |
| 10 $\leq \beta$ | | |
| 3.6 GHz to 8.4 GHz | | |
| Rate \leq 20 kHz, $0.01 \leq \beta$ | $0.4 / \beta^{1/2}$ | |
| 20 kHz < Rate | $0.00015 / \beta \times \text{Rate}^{1/2}$ | |
| 0.01 $\leq \beta$ < 0.1 | $0.0015 \times \text{Rate}^{1/2}$ | |
| 0.1 $\leq \beta$ < 5 | $0.0035 / \beta^{1/2} \times \text{Rate}^{1/2}$ | |
| 5 $\leq \beta$ | | |
| 8.4 GHz to 17.1 GHz | | |
| Rate \leq 20 kHz, $0.01 \leq \beta$ | $0.5 / \beta^{1/2}$ | |
| 20 kHz < Rate | $0.0003 / \beta \times \text{Rate}^{1/2}$ | |
| 0.01 $\leq \beta$ < 0.2 | $0.0015 \times \text{Rate}^{1/2}$ | |
| 0.2 $\leq \beta$ < 5 | $0.0035 / \beta^{1/2} \times \text{Rate}^{1/2}$ | |
| 5 $\leq \beta$ | | |
| 17.1 GHz to 26.5 GHz | | |
| Rate \leq 50 kHz, $0.01 \leq \beta$ | $0.5 / \beta^{1/2}$ | |
| 50 kHz < Rate | $0.0003 / \beta \times \text{Rate}^{1/2}$ | |
| 0.01 $\leq \beta$ < 0.2 | $0.0015 \times \text{Rate}^{1/2}$ | |
| 0.2 $\leq \beta$ < 5 | $0.0035 / \beta^{1/2} \times \text{Rate}^{1/2}$ | |
| 5 $\leq \beta$ | | |
| 26.5 GHz to 34.5 GHz | | |
| Rate \leq 50 kHz, $0.01 \leq \beta$ | $0.6 / \beta^{1/2}$ | |
| 50 kHz < Rate | $0.0003 / \beta \times \text{Rate}^{1/2}$ | |
| 0.02 $\leq \beta$ < 0.2 | $0.0015 \times \text{Rate}^{1/2}$ | |
| 0.2 $\leq \beta$ < 5 | $0.0035 / \beta^{1/2} \times \text{Rate}^{1/2}$ | |
| 5 $\leq \beta$ | | |
| 34.5 GHz to 50 GHz | | |
| Rate \leq 10 kHz, $0.05 \leq \beta$ | $0.8 / \beta^{1/2}$ | |

Measuring Receiver
Modulation Distortion

| Description | Specification | Supplemental Information |
|---|---|--------------------------|
| <p>10 kHz < Rate $0.05 \leq \beta < 1$ $1 \leq \beta < 10$ $10 \leq \beta$</p> <p>AM</p> <p>THD</p> | <p>$0.0003 / \beta \times \text{Rate}^{1/2}$ $0.002 \times \text{Rate}^{1/2}$ $0.005 / \beta^{1/2} \times \text{Rate}^{1/2}$</p> | |
| 100 kHz to 3.6 GHz | $= 0.00003 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 [\%]$ | |
| 3.6 GHz to 8.4 GHz | $= 0.00007 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 [\%]$ | |
| 8.4 GHz to 13.6 GHz 100 Hz ≤ Rate | $= 0.00004 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.01 [\%]$ | |
| 13.6 GHz to 17.1 GHz 100 Hz ≤ Rate | $= 0.00006 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 [\%]$ | |
| 17.1 GHz to 26.5 GHz 100 Hz ≤ Rate ≤ 500 kHz, 1% ≤ Depth ≤ 99% 500 kHz < Rate, 2% ≤ Depth ≤ 99% | $= 0.00009 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 [\%]$ | |
| 26.5 GHz to 34.5 GHz 100 Hz ≤ Rate ≤ 500 kHz, 1% ≤ Depth ≤ 99% 500 kHz < Rate, 2% ≤ Depth ≤ 99% | $= 0.0001 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.02 [\%]$ | |
| 34.5 GHz to 50 GHz 100 Hz ≤ Rate ≤ 50 kHz, 1% ≤ Depth ≤ 99% 50 kHz < Rate ≤ 200 kHz, 2% ≤ Depth ≤ 99% 200 kHz < Rate, 5% ≤ Depth ≤ 99% | $= 0.00035 \times \left(\frac{100\%}{\text{Depth}\%} \right) \times \sqrt{\frac{\text{Rate}[\text{Hz}]}{1\text{Hz}}} + 0.04 [\%]$ | |
| PM | | |
| THD | | |
| <i>Option EP1</i> | | |
| 100 kHz to 3.6 GHz Rate ≤ 100 kHz 100 kHz < Rate | <p>$0.1 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.8 / \text{Deviation} + 0.005[\%]$ or $0.3[\%]$ whichever is smaller</p> | |
| 3.6 GHz to 8.4 GHz Rate ≤ 100 kHz 100 kHz < Rate | <p>$0.15 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.8 / \text{Deviation} + 0.005[\%]$ or $0.3[\%]$ whichever is smaller</p> | |

Measuring Receiver
Modulation Distortion

| Description | Specification | Supplemental Information |
|--|---|--------------------------|
| 8.4 GHz to 13.6 GHz Rate \leq 50 kHz and $0.02 \leq$ Deviation 50 kHz < Rate, and $0.02 \leq$ Deviation | $0.15 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.8 / \text{Deviation} + 0.005[\%]$ or $0.4[\%]$ whichever is smaller | |
| 13.6 GHz to 17.1 GHz Rate \leq 50 kHz and $0.02 \leq$ Deviation 50 kHz < Rate, and $0.02 \leq$ Deviation | $0.2 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.8 / \text{Deviation} + 0.005[\%]$ or $0.4[\%]$ whichever is smaller | |
| 17.1 GHz to 26.5 GHz Rate \leq 100 kHz and $0.05 \leq$ Deviation 100 kHz < Rate, and $0.05 \leq$ Deviation | $0.2 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.9 / \text{Deviation} + 0.005[\%]$ or $0.4[\%]$ whichever is smaller | |
| 26.5 GHz to 34.5 GHz Rate \leq 100 kHz and $0.05 \leq$ Deviation 100 kHz < Rate, and $0.05 \leq$ Deviation | $0.3 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.8 / \text{Deviation} + 0.005[\%]$ or $0.4[\%]$ whichever is smaller | |
| 34.5 GHz to 50 GHz Rate \leq 100 kHz and $0.1 \leq$ Deviation 100 kHz < Rate, and $0.1 \leq$ Deviation | $0.3 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.9 / \text{Deviation} + 0.005[\%]$ or $0.4[\%]$ whichever is smaller | |
| PM | | |
| THD | | |
| <i>Option EPO</i> | | |
| 100 kHz to 3.6 GHz Rate \leq 100 kHz 100 kHz < Rate | $0.1 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.8 / \text{Deviation} + 0.005[\%]$ or $0.3[\%]$ whichever is smaller | |
| 3.6 GHz to 8.4 GHz Rate \leq 100 kHz 100 kHz < Rate, $0.02 \leq$ Deviation | $0.2 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.8 / \text{Deviation} + 0.005[\%]$ or $0.3[\%]$ whichever is smaller | |
| 8.4 GHz to 13.6 GHz Rate \leq 100 kHz 100 kHz < Rate | $0.2 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.8 / \text{Deviation} + 0.005[\%]$ or $0.3[\%]$ whichever is smaller | |
| 13.6 GHz to 17.1 GHz Rate \leq 100 kHz 100 kHz < Rate | $0.2 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.9 / \text{Deviation} + 0.005[\%]$ or $0.4[\%]$ whichever is smaller | |

Measuring Receiver
Modulation Distortion

| Description | Specification | Supplemental Information |
|---|--|--------------------------|
| 17.1 GHz to 26.5 GHz Rate \leq 100 kHz 100 kHz < Rate, $0.02 \leq$ Deviation | $0.2 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.9 / \text{Deviation} + 0.005[\%]$ or $0.4[\%]$ whichever is smaller | |
| 26.5 GHz to 34.5 GHz Rate \leq 100 kHz 100 kHz < Rate, $0.02 \leq$ Deviation | $0.3 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.8 / \text{Deviation} + 0.005[\%]$ or $0.4[\%]$ whichever is smaller | |
| 34.5 GHz to 50 GHz Rate \leq 100 kHz, $0.02 \leq$ Deviation 100 kHz < Rate, $0.05 \leq$ Deviation | $0.3 \times \text{Deviation}^{1/2} + 0.005[\%]$ $0.9 / \text{Deviation} + 0.005[\%]$ or $0.4[\%]$ whichever is smaller | |

Modulation SINAD

| Description | Specification | Supplemental Information |
|-----------------------------|---------------|--|
| Display Range | 0.00 to 80 dB | |
| Displayed Resolution | 0.001 dB | |
| Accuracy^a | ≤ 1 dB | Defaulted display in dB. It can be converted into linear term using % = $(1 - 10^{-(A \text{ dB}/20)}) \times 100\%$. |

- a. Measured distortion must be greater than 3% for the accuracy specification to apply. For distortions less than 3%, the noise floor of the analyzer will begin to affect the accuracy of the measurement.

| Description | Specification | Supplemental Information |
|--------------------------------|---------------|---|
| Post-Demod Distortion Residual | | Refer to “Post-Demod Distortion Residual” on page 401. |

Modulation Filters

| Description | Specification | Supplemental Information |
|--|---|---|
| Filter Flatness^{ab} | | Nominal |
| 20 Hz High-Pass Filter | | -3 dB at 20 Hz; Type: 2-pole Butterworth |
| 50 Hz High-Pass Filter | ±1% flatness at > 175 Hz | -3 dB at 50 Hz; Type: 2-pole Butterworth |
| 300 Hz High-Pass Filter | ±1% flatness at > 950 Hz | -3 dB at 300 Hz; Type: 2-pole Butterworth |
| 400 Hz High-Pass Filter | ±1% flatness at > 550 Hz | -3 dB at 400 Hz; Type: 10-pole Butterworth |
| 3 kHz Low-Pass Filter | ±1% flatness at < 1.5 kHz | -3 dB at 3 kHz; Type: 5-pole Butterworth, |
| 15 kHz Low-Pass Filter | ±1% flatness at < 9 kHz | -3 dB at 15 kHz; Type: 5-pole Butterworth, |
| 30 kHz Low-Pass Filter | ±1% flatness at < 13.5 kHz | -3 dB at 30 kHz; Type: 3-pole Butterworth |
| 80 kHz Low-Pass Filter | ±1% flatness at < 38.5 kHz | -3 dB at 80 kHz; Type: 3-pole Butterworth |
| 300 kHz Low-Pass Filter | ±1% flatness at < 285 kHz | -3 dB at 300 kHz; Type: 3-pole Butterworth, |
| De-Emphasis Filters | 25 μ s, 50 μ s, 75 μ s, and 750 μ s | De-emphasis filters are single-pole, low-pass filters with nominal -3 dB frequencies of: 6,366 Hz for 25 μ s, 3,183 Hz for 50 μ s, 2,122 Hz for 75 μ s, and 212 Hz for 750 μ s. |
| Deviation from Ideal De-Emphasis Filter | < 0.4 dB, or < 3° | Applicable to 25 μ s, 50 μ s, and 75 μ s filters. With 3 kHz Low-Pass filter and IFBW Mode set to "minimal". |

- All filters asymptotically approach -6 dB per octave or -20 dB per decade, times number of poles, in the stop-band (nom).
- The specified frequency for which the filter passband response stays <1% flatness is a 'worst case' based on a very high IFBW of 500 kHz. As IFBW is reduced, this frequency moves closer to the -3 dB cutoff frequency; i.e. the 1% flatness range applies to more of the pass-band, and the filter shape becomes closer to ideal.

RF Frequency Counter

| Description | Specification | Supplemental Information |
|---|--|--|
| Range^a | 100 kHz to 50 GHz | |
| Sensitivity^b | | In “Auto” mode |
| $100 \text{ kHz} \leq f_c < 3.6 \text{ GHz}$ | $0.4 \text{ mV}_{\text{rms}} (-55 \text{ dBm})$ | |
| $3.6 \text{ GHz} \leq f_c < 26.5 \text{ GHz}$ | $1.3 \text{ mV}_{\text{rms}} (-45 \text{ dBm})$ | |
| $26.5 \text{ GHz} \leq f_c < 50 \text{ GHz}$ | $4.0 \text{ mV}_{\text{rms}} (-35 \text{ dBm})$ | |
| Maximum Resolution | 0.001 Hz | |
| Accuracy^c | $\pm(\text{readout freq.} \times \text{rfa} + 0.100 \text{ Hz})$ | Internal ref. See notes ^{de} |
| Accuracy (For $f_c < 100 \text{ MHz}$) | $\pm(\text{readout freq.} \times \text{rfa} + 0.002 \text{ Hz})^f$ | $\pm(\text{readout freq.} \times \text{rfa} + 0.001 \text{ Hz})$ (99th percentile, or $\sim 2.576\sigma$). |
| Modes | | Frequency and Frequency Error (manual tuning) |
| Sensitivity in Manual Tuning Mode | | Using manual ranging and changing RBW settings, sensitivity can be increased to approximately –100 dBm. |

- When the U5532C or N5532A/B sensor module is used for the measurement, the frequency range may be limited by the sensor module's maximum frequency.
- Instrument condition: $\text{RBW} \leq 1 \text{ kHz}$
- The first term is the reference frequency accuracy (rfa) of the internal timebase within the PXA, scaled by input frequency. This term normally dominates. If locked to an external timebase reference, then specs of this user-supplied clock apply. The second term (0.1 Hz) reflects measurement noise; it will increase with phase noise (of signal input), poor S/N ratios, wider analyzer RBWs, and higher frequencies.
- Verified at 1 GHz with $\text{RBW} = 1 \text{ kHz}$, gate time = 0.1 s (autocoupled), $\text{SNR} = 50 \text{ dB}$.
- While the first term scales obviously with frequency, the second term also scales (weakly) with frequency; the nominal standard deviation of the measurement is 0.003 Hz per GHz of f_c for $\text{RBW} = 1,000 \text{ Hz}$, gate time = 0.1 s. This term is insignificant except for the case where analyzer (and source) is locked to excellent external same time base, and the source has low phase noise. It can be reduced by narrow RBW, longer gate times, and averaging, but at some frequencies not necessarily below 0.003 Hz.
- For the special case of $F_c < 100 \text{ MHz}$, $\text{RBW} = 300 \text{ Hz}$, and gate time = 0.5 s, the second term is $< 0.002 \text{ Hz}$ (3-sigma). The 0.002 Hz term includes noisiness as well as mean errors that occur at some frequencies, and thus cannot necessarily be reduced with averaging.

Audio Input¹

| Description | Specification | Supplemental Information |
|---------------------------------|-------------------|---------------------------|
| Frequency Range | | |
| AC Coupled | 20 Hz to 250 kHz | |
| DC Coupled | | 5 Hz to 250 kHz (nominal) |
| Input Impedance | | 100 k Ω (nominal) |
| Maximum Safe Input Level | | |
| AC Coupled | 7 Vrms, or 20 Vdc | |
| DC Coupled | 7 Vrms, or 0 Vdc | |

Audio Frequency Counter¹

| Description | Specification | Supplemental Information |
|-----------------------------|---|------------------------------------|
| Frequency Range | | |
| AC Coupled | 20 Hz to 250 kHz | |
| DC Coupled | | 5 Hz to 250 kHz (nominal) |
| Accuracy^a | | |
| f < 1 kHz | $\pm(0.02 \text{ Hz} + f \times \text{Internal Reference Accuracy})^b$ | |
| f \geq 1 kHz | ± 3 counts of the first 6 significant digits $\pm f \times (\text{Internal Reference Accuracy})^b$ | |
| Resolution | 0.01 Hz (8 digits) | |
| Sensitivity | $\leq 5 \text{ mV}$ | Nominally applies to "DC Coupled". |

- Follow this procedure to verify this specification:
Set an input audio signal at 100 mV. Set the PXA as follows: (1) Auto Level, (2) Auto IF BW, (3) LP is greater than the audio frequency, (4) HP=300 Hz or less than the audio frequency, (5) Average = 5 Repeat.
- Refer to the Frequency Reference section in the PXA base specifications.

1. PXA Option 107 is required. All specifications in this section are for the "AC Coupled" audio signal path and nominally apply to the "DC Coupled" path, unless otherwise stated.

Audio AC Level ¹

| Description | Specification | Supplemental Information |
|--------------------------------|----------------------|---------------------------|
| Frequency Range | | |
| AC Coupled | 20 Hz to 250 kHz | |
| DC Coupled | | 5 Hz to 250 kHz (nominal) |
| Measurement Level Range | 100 mV rms to 3V rms | |
| Accuracy | 1% of reading | |
| Detector Mode | | RMS |

Audio Distortion ¹

| Description | Specification | Supplemental Information |
|--|--|--|
| Display Range (20 Hz^a to 250 kHz BW) | 0.01% to 100% (–80 to 0 dB) | |
| Accuracy^b | | Nominal |
| AC Coupled | ± 1 dB of reading (20 Hz to 20 kHz) ± 2 dB of reading (20 to 80 kHz) ^c | ± 0.3 dB of reading (20 Hz to 200 kHz) |
| DC Coupled | | ± 0.7 dB of reading (5 to 20 Hz) ± 0.3 dB of reading (20 Hz to 200 kHz) |
| Residual Noise and Distortion | < 0.3% (–50.4 dB) | < 0.063% (–64 dB) (nominal) |
| Total Noise | | –73.2 dB characteristic performance |
| Total Distortion | | –74.8 dB characteristic performance |

a. Starts from 5 Hz for "DC Coupled".

b. Verified in dB; can be converted into linear term in % using formula of % = $(1 - 10^{-(A \text{ dB}/20)}) \times 100\%$.

c. Verification is performed for the audio frequency up to 80 kHz due to the technical limitation of test equipment used.

1. PXA Option 107 is required. All specifications in the tables are for "AC Coupled" but also nominally applies to "DC Coupled" unless otherwise specified.

Audio SINAD ¹

| Description | Specification | Supplemental Information |
|--|--|------------------------------------|
| Display Range (20 Hz^a to 250 kHz BW) | 0.00 to 80 dB | Nominal |
| Display Resolution | 0.001 dB | |
| Accuracy | | |
| AC Coupled | ± 1 dB of reading (20 Hz to 20 kHz) ± 2 dB of reading (20 to 80 kHz) ^b | |
| DC Coupled | | |
| Residual Noise and Distortion | 50.4 dB | 64 dB (nominal) |
| Total Noise | | 73.2 dB characteristic performance |
| Total Distortion | | 74.8 dB characteristic performance |

a. Starts from 5 Hz for "DC Coupled".

b. Verification is performed for the audio frequency up to 80 kHz due to the technical limitation of test equipment used.

1. PXA Option 107 is required. All specifications in the tables are for "AC Coupled" but also nominally applies to "DC Coupled" unless otherwise specified.

Audio Filters¹

| Description | Specification | Supplemental Information |
|---|--|---|
| Filter Flatness^a | | Nominal |
| 20 Hz High-Pass Filter | | -3 dB at 20 Hz (nominal); Type: 2-pole Butterworth |
| 50 Hz High-Pass Filter | < ±1% at >175 Hz | -3 dB at 50 Hz (nominal); Type: 2-pole Butterworth |
| 300 Hz High-Pass Filter | < ±1% at >950 Hz | -3 dB at 300 Hz (nominal); Type: 2-pole Butterworth |
| 400 Hz High-Pass Filter | < ±1% at >550 Hz | -3 dB at 400 Hz (nominal); Type: 10-pole Butterworth |
| 3 kHz Low-Pass Filter | < ±1% at <1.5 kHz | -3 dB at 3.030 kHz (nominal); Type: 5-pole Butterworth |
| 15 kHz Low-Pass Filter | < ±1% at <9 kHz | -3 dB at 15.030 kHz (nominal); Type: 5-pole Butterworth |
| 30 kHz Low-Pass Filter | < ±1% at <13.5 kHz | -3 dB at 30.000 kHz (nominal); Type: 3-pole Butterworth |
| 80 kHz Low-Pass Filter | < ±1% at <38.5 kHz | -3 dB at 80.000 kHz (nominal); Type: 3-pole Butterworth |
| > 300 kHz Low-Pass Filter | < ±1% at <285 kHz | -3 dB at 300 kHz (nominal); Type: 3-pole Butterworth |
| CCITT Weighting Filter Deviation from the Ideal CCITT filter Response | CCITT Recommendation P53 ±0.2 dB at 800 Hz ±1.0 dB, 300 Hz to 3 kHz ±2.0 dB, 50 to 300 Hz and 3 to 3.5 kHz ±3.0 dB, 3.5 to 5 kHz | |
| De-Emphasis Filters | 25 μs, 50 μs, 75 μs, and 750 μs | De-emphasis filters are single-pole, low-pass filters with nominal -3 dB frequencies of: 6,366 Hz for 25 μs, 3,183 Hz for 50 μs, 2,122 Hz for 75 μs, and 212 Hz for 750 μs. |
| Deviation from Ideal De-Emphasis Filter | < 0.4 dB, or < 3° | Applicable to 25 μs, 50 μs, and 75 μs filters. With 3 kHz Low-Pass filter and IFBW Mode set to “minimal”. |

- a. All filters asymptotically approach -6 dB per octave or -20 dB per decade, times number of poles, in the stop-band (nominal).

1. PXA Option 107 is required.

RF Power^{1 2}

The Keysight N5531X measuring receiver with the U5532C USB sensor modules, or with the N5532A/B sensor modules performs RF power measurements from –10 dBm (100 μ W) to +30 dBm (1 W).

-
1. The N5531X measuring receiver supports Keysight U5532C USB sensor modules, or the combination of N5532B/A sensor modules and a variety of power meters including Keysight EPM Series (N1913A, N1914A), P-Series (N1911A, N1912A), and legacy Agilent EPM/EPM-P (E4416A, E4417A, E4418B, and E4419B). A LAN/GPIB gateway may be required if the legacy EPM/EPM-P Series power meter (E441xA/B) is used. For latest specification updates refer to N1911A/N1912A, N1913A/N1914A, E4416A/17A and E4418B/19B power meter User's Guides.
 2. The N5531X RF Power Accuracy is derived from the Keysight power meter accuracy. The parameters listed in this section are components used to calculate the RF Power Accuracy. Application Note 1449-3 (P/N 5988-9215EN) does an excellent job of explaining how the components are combined to derive an overall accuracy number. Absolute and relative accuracy specifications do not include mismatch uncertainty.

Measuring Receiver
RF Power

| Description | Specification | | | | Supplemental Information | | | |
|--------------------------------|------------------------------|-------------|---------------|-------------|------------------------------|-------------|---------------|-------------|
| RF Power Accuracy (dB) | | | | | Typicals | | | |
| Power Meter Range 1 | Sensor module options | | | | Sensor module options | | | |
| +20 to +30 dBm | #504 | #518 | #526 | #550 | #504 | #518 | #526 | #550 |
| 100 kHz $\leq f_c \leq$ 10 MHz | ± 0.287 | – | – | – | ± 0.146 | – | – | – |
| 10 MHz $< f_c \leq$ 30 MHz | ± 0.287 | ± 0.287 | $\pm 0.287^a$ | – | ± 0.146 | ± 0.146 | $\pm 0.146^a$ | – |
| 30 MHz $< f_c \leq$ 2 GHz | ± 0.287 | ± 0.287 | ± 0.287 | ± 0.265 | ± 0.146 | ± 0.146 | ± 0.146 | ± 0.135 |
| 2 GHz $< f_c \leq$ 4.2 GHz | ± 0.302 | ± 0.302 | ± 0.302 | ± 0.279 | ± 0.146 | ± 0.154 | ± 0.146 | ± 0.142 |
| 4.2 GHz $< f_c \leq$ 18 GHz | – | ± 0.466 | ± 0.468 | ± 0.342 | – | ± 0.240 | ± 0.241 | ± 0.175 |
| 18 GHz $< f_c \leq$ 26.5 GHz | – | – | ± 0.386 | ± 0.332 | – | – | ± 0.198 | ± 0.170 |
| 26.5 GHz $< f_c \leq$ 50 GHz | – | – | – | ± 0.363 | – | – | – | ± 0.186 |
| Power Meter Range 2 | Sensor module options | | | | Typicals | | | |
| 0 to $< +20$ dBm | #504 | #518 | #526 | #550 | #504 | #518 | #526 | #550 |
| 100 kHz $\leq f_c \leq$ 10 MHz | ± 0.222 | – | – | – | ± 0.113 | – | – | – |
| 10 MHz $< f_c \leq$ 30 MHz | ± 0.222 | ± 0.222 | $\pm 0.222^a$ | – | ± 0.113 | ± 0.113 | $\pm 0.113^a$ | – |
| 30 MHz $< f_c \leq$ 2 GHz | ± 0.222 | ± 0.222 | ± 0.222 | ± 0.191 | ± 0.113 | ± 0.113 | ± 0.113 | ± 0.097 |
| 2 GHz $< f_c \leq$ 4.2 GHz | ± 0.222 | ± 0.242 | ± 0.242 | ± 0.211 | ± 0.113 | ± 0.123 | ± 0.123 | ± 0.107 |
| 4.2 GHz $< f_c \leq$ 18 GHz | – | ± 0.432 | ± 0.433 | ± 0.291 | – | ± 0.222 | ± 0.223 | ± 0.148 |
| 18 GHz $< f_c \leq$ 26.5 GHz | – | – | ± 0.342 | ± 0.279 | – | – | ± 0.175 | ± 0.142 |
| 26.5 GHz $< f_c \leq$ 50 GHz | – | – | – | ± 0.316 | – | – | – | ± 0.161 |
| Power Meter Range 3 | Sensor module options | | | | Sensor module options | | | |
| –5 to < 0 dBm | #504 | #518 | #526 | #550 | #504 | #518 | #526 | #550 |
| 100 kHz $\leq f_c \leq$ 10 MHz | ± 0.220 | – | – | – | ± 0.112 | – | – | – |
| 10 MHz $< f_c \leq$ 30 MHz | ± 0.220 | ± 0.219 | $\pm 0.220^a$ | – | ± 0.112 | ± 0.111 | $\pm 0.112^a$ | – |
| 30 MHz $< f_c \leq$ 2 GHz | ± 0.220 | ± 0.219 | ± 0.220 | ± 0.189 | ± 0.112 | ± 0.111 | ± 0.112 | ± 0.097 |
| 2 GHz $< f_c \leq$ 4.2 GHz | ± 0.240 | ± 0.219 | ± 0.240 | ± 0.209 | ± 0.122 | ± 0.122 | ± 0.122 | ± 0.106 |
| 4.2 GHz $< f_c \leq$ 18 GHz | – | ± 0.240 | ± 0.432 | ± 0.289 | – | ± 0.122 | ± 0.222 | ± 0.148 |
| 18 GHz $< f_c \leq$ 26.5 GHz | – | – | ± 0.341 | ± 0.277 | – | – | ± 0.174 | ± 0.141 |

Measuring Receiver
RF Power

| Description | Specification | | | | Supplemental Information | | | |
|----------------------------|------------------------------|--------|---------------------|--------|------------------------------|--------|---------------------|--------|
| 26.5 GHz < f_c ≤ 50 GHz | – | – | – | ±0.315 | – | – | – | ±0.161 |
| Power Meter Range 4 | Sensor module options | | | | Sensor module options | | | |
| –10 to < –5 dBm | #504 | #518 | #526 | #550 | #504 | #518 | #526 | #550 |
| 100 kHz ≤ f_c ≤ 10 MHz | ±0.229 | – | – | – | ±0.117 | – | – | – |
| 10 MHz < f_c ≤ 30 MHz | ±0.229 | ±0.229 | ±0.229 ^a | – | ±0.117 | ±0.117 | ±0.117 ^a | – |
| 30 MHz < f_c ≤ 2 GHz | ±0.229 | ±0.229 | ±0.229 | ±0.200 | ±0.117 | ±0.117 | ±0.117 | ±0.102 |
| 2 GHz < f_c ≤ 4.2 GHz | ±0.249 | ±0.249 | ±0.249 | ±0.219 | ±0.127 | ±0.127 | ±0.127 | ±0.111 |
| 4.2 GHz < f_c ≤ 18 GHz | – | ±0.435 | ±0.437 | ±0.296 | – | ±0.224 | ±0.225 | ±0.151 |
| 18 GHz < f_c ≤ 26.5 GHz | – | – | ±0.347 | ±0.285 | – | – | ±0.178 | ±0.145 |
| 26.5 GHz < f_c ≤ 50 GHz | – | – | – | ±0.321 | – | – | – | ±0.164 |
| RF Power Resolution | | | | | | | | |
| Display resolution | 0.001 dB | | | | | | | |

a. For U5532C only.

| Description | Specification | Supplemental Information |
|--|----------------------------|--------------------------|
| Instrumentation Accuracy | | |
| Logarithmic | ±0.02 dB | |
| Linear | ±0.5% | |
| Input SWR | | |
| U5532C Option 504 N5532A/B Option 504 | | |
| 100 kHz to 2 GHz | < 1.10:1 (ρ = 0.048) | |
| 2 GHz to 4.2 GHz | < 1.28:1 (ρ = 0.123) | |
| U5532C Option 518 N5532A/B Option 518 | | |
| 10 MHz to 2 GHz | < 1.10:1 (ρ = 0.048) | |
| 2 GHz to 18 GHz | < 1.28:1 (ρ = 0.123) | |
| U5532C Option 526 N5532A/B Option 526 | | |
| 10 MHz to 30 MHz | < 1.10:1 (ρ = 0.048) | For U5532C-526 only |
| 30 MHz to 2 GHz | < 1.10:1 (ρ = 0.048) | |

Measuring Receiver
RF Power

| Description | Specification | Supplemental Information |
|--|-----------------------------|--------------------------|
| 2 GHz to 18 GHz | < 1.28:1 ($\rho = 0.123$) | |
| 18 GHz to 26.5 GHz | < 1.40:1 ($\rho = 0.167$) | |
| U5532C Option 550 N5532A/B Option 550 | | |
| 30 MHz to 2 GHz | < 1.10:1 ($\rho = 0.048$) | |
| 2 GHz to 18 GHz | < 1.28:1 ($\rho = 0.123$) | |
| 18 GHz to 26.5 GHz | < 1.40:1 ($\rho = 0.167$) | |
| 26.5 GHz to 33 GHz | < 1.55:1 ($\rho = 0.216$) | |
| 33 GHz to 40 GHz | < 1.70:1 ($\rho = 0.259$) | |
| 40 GHz to 50 GHz | < 1.75:1 ($\rho = 0.272$) | |

Measuring Receiver RF Power

| Description | Specification | Supplemental Information |
|---|--|---|
| Zero Set and Measurement Noise^a U5532C <i>Options 504, 518, 526, and 550</i> N5532A/B <i>Options 504, 518, 526, and 550</i> | ± 500 nW ± 680 nW | |
| Zero Drift of Sensors U5532C <i>Options 504, 518, 526, and 550</i> N5532A/B <i>Options 504, 518, 526, and 550</i> | < 70 nW < 100 nW | (1 hour, at constant temperature after 24 hour warm-up) |
| RF Power Ranges of N5531X with U5532C or N5532A/B Sensor Modules | –20 dBm (10 μ W) to +30 dBm (1 W) | One range for power sensors |
| Response Time (0 to 99% of reading) | | 150 ms \times number of averages (nominal) |
| Displayed Units | dBm, Watts, Volts, dBmV, or dBuV | |

- a. Since Zero Set and Measurement Noise cannot be separated, the two components are combined as one error term.

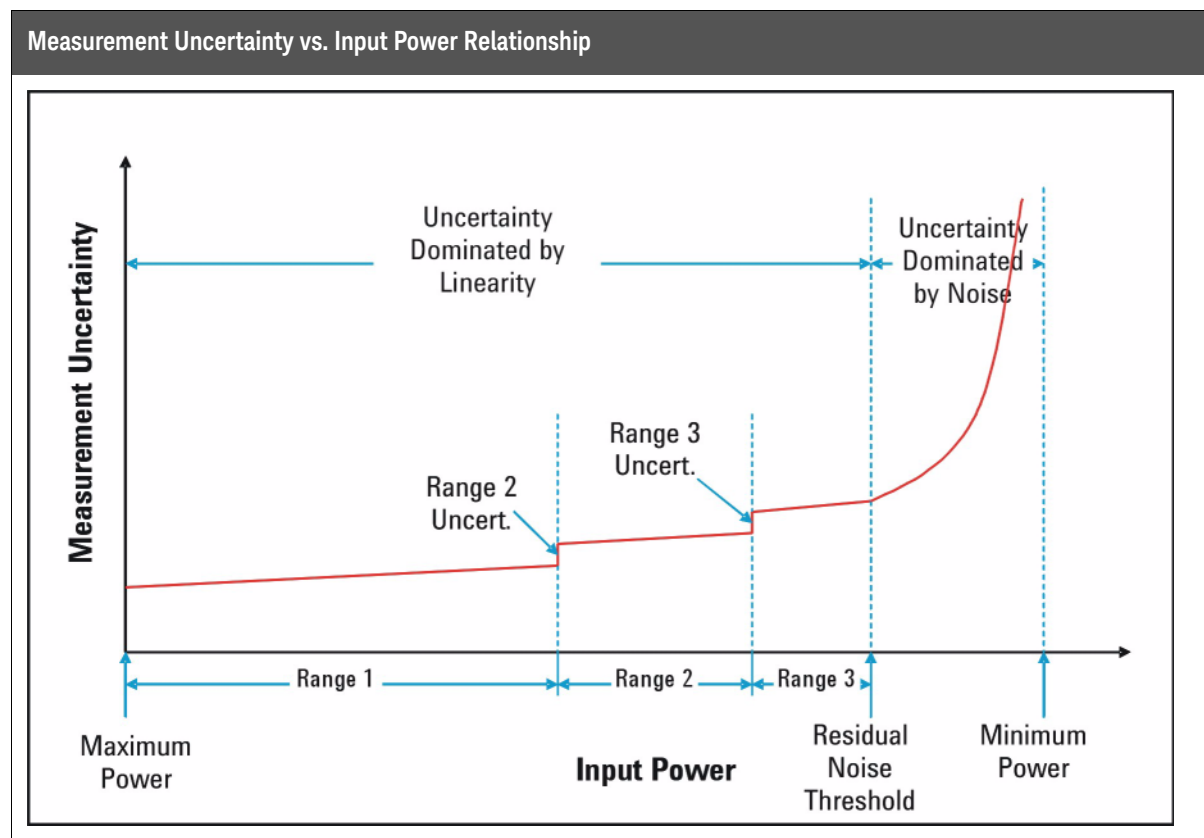
Power Reference (P-Series, EPM and EPM-P Series Specifications)

| Description | Specification | Supplemental Information |
|------------------------------|--|---|
| Power Output | | Power output is traceable to the U.S. National Institute of Standards and Technology (NIST) and National Physical Laboratories (NPL), UK. |
| N1911A/N1912A | 1.00 mW (0.0 dBm). Factory set to $\pm 0.4\%$ | |
| N1913A/N1914A | 1.00 mW (0.0 dBm). Factory set to $\pm 0.4\%$ | |
| E4416A/E4417A | 1.00 mW (0.0 dBm). Factory set to $\pm 0.4\%$ | |
| E4418B/E4419B | 1.00 mW (0.0 dBm). Factory set to $\pm 0.4\%$ | |
| Accuracy | | |
| N1911A/N1912A | $\pm 0.4\%$ for two years, $25 \pm 10^\circ\text{C}$ | |
| N1913A/N1914A | $\pm 0.4\%$ for two years, $25 \pm 10^\circ\text{C}$ | |
| E4416A/E4417A | $\pm 0.6\%$ for two years, $25 \pm 10^\circ\text{C}$ | |
| E4418B/E4419B | $\pm 0.6\%$ for two years, $25 \pm 10^\circ\text{C}$ | |
| Frequency | | 50 MHz (nominal) |
| SWR | | |
| N1911A/N1912A | | < 1.05:1 (typical) |
| N1913A/N1914A | | < 1.05:1 (typical) |
| E4416A/E4417A | | < 1.06:1 (nominal) |
| E4418B/E4419B | | < 1.05:1 (nominal) |
| Front Panel Connector | | Type N (f), 50 Ω |

Tuned RF Level Specification Nomenclature

The tuned RF level measurement uncertainty is represented primarily by two regions. For high signal-to-noise (S/N) measurements, the uncertainty is dominated by the linearity of the measuring receiver. For low S/N measurements, the measurement uncertainty is dominated by the noise of the measuring receiver being added to the measured signal. The input power level at which the uncertainty switches from linearity dominated to noise dominated is labeled as “Residual Noise Threshold.” The minimum power level is defined as the noise floor of the measuring receiver system.

Additionally, there are 2 range-to-range change uncertainties known as “Range 2 Uncertainty” and “Range 3 Uncertainty”, respectively. Range 2 Uncertainty occurs when the measuring receiver switches from Range 1 to Range 2, and Range 3 Uncertainty from Range 2 to Range 3. They are additive uncertainties applied to all measurements whose input powers across “Range Switch Level”.



Tuned RF Level (TRFL)

Additional Definitions and Requirements

PXA Option MPB (Microwave pre-selector bypass) is required to perform “Tuned RF Level” measurements above 3.6 GHz

PXA Option P03, P08, P13, P26, P44, or P50 (Preamplifier, depending on the maximum frequency of the PXA) is required to achieve the Minimum Power specified in this section.

These specifications are valid when the measuring receiver input is a CW tone and operating temperature is within the range of 20 to 30 °C. Measurement accuracy mode needs to be set to “High”. The measurements need to be complete within a time period of 20 minutes after setting the Reference Level.

Absolute and relative accuracy specifications do not include mismatch uncertainty.

Specifications in the following tables apply when measuring stable frequency sources, and where the source and measuring receiver share a common frequency reference.

NOTE

For sources with frequency instability greater than 100 kHz, use the Tuned RF Level with Tracking measurement. When using the Tuned RF Level with Tracking measurement, the following additional amplitude error must be applied due to FFT frequency response as the signal drifts within the Tracking Range:

$\pm(0.15 \text{ dB} + 0.1 \text{ dB/MHz of span})$ to a max of $\pm 0.40 \text{ dB}$, where span is equivalent to the Tracking Range setting in the measurement.

The Tuned RF Level with Tracking measurement upper frequency limit = 3.6 GHz.

Minimum power = $10 \times \log[\text{Integrated BW}/(75 \text{ Hz} \times 1.06)]$, relative to the specified 75 Hz minimum power level.

Measuring Receiver
Tuned RF Level (TRFL)

| Description | Specification | | Supplemental Information |
|--|-------------------------|-------------------------|--------------------------|
| Power Range | | | |
| Maximum power | | | |
| Preamp off | +30 dBm | | |
| Preamp on | | | |
| Option N9030B-503 | +30 dBm | | |
| Option N9030B-508/513/526 | +24 dBm | | |
| Option N9030B-544/550 | +20 dBm | | |
| Minimum power (dBm)^a | 75 Hz IFBW ^b | 10 Hz IFBW ^c | |
| Frequency Range | | | |
| Option 503/508/513/526 ^d | | | |
| 100 to 200 kHz | −123.0 | −137.8 | Band 0 |
| 200 to 500 kHz | −126.0 | −140.8 | Band 0 |
| 500 kHz to 1 MHz | −130.0 | −144.8 | Band 0 |
| 1 to 10 MHz | −132.0 | −146.8 | Band 0 |
| 10 MHz to 2.1 GHz | −136.0 | −150.8 | Band 0 |
| 2.1 to 3.6 GHz | −134.0 | −148.8 | Band 0 |
| 3.5 to 8.4 GHz | −130.2 | −145.0 | Band 1 |
| 8.3 to 13.6 GHz | −129.2 | −144.0 | Band 2 |
| 13.5 to 16.9 GHz | −123.2 | −138.0 | Band 3 |
| 16.9 to 20 GHz | −121.2 | −136.0 | Band 4 |
| 20 to 26.5 GHz | −106.7 | −121.5 | Band 4 |

- Preamplifier option (N9030B-Pxx) is automatically turned "On" to achieve the Minimum Power. In addition to 75 Hz and 10 Hz IFBW listed here, the N5531X also offers 30 kHz and 200 kHz IFBW settings for less stable signal generator calibration. With 30 kHz and 200 kHz IF bandwidths (IFBW), TRFL minimum power level will be degraded by a factor of $10 \times \log(\text{IFBW}/75 \text{ Hz})$, relative to the specified 75 Hz minimum power level. This will result in a degradation of 26 dB for the 30 kHz IF bandwidth and 34 dB for the 200 kHz IF bandwidth.
- With 75 Hz IFBW setting selected, the measurement automatically switches the IFBW to the 30 Hz setting for SNR values <10 dB.
- With 10 Hz IFBW setting selected, the measurement automatically switches the IFBW to the 1 Hz setting for SNR values <10 dB.
- The frequency option determines the maximum frequency the PXA can reach.

Measuring Receiver
Tuned RF Level (TRFL)

| Description | Specification | | Supplemental Information |
|--|-------------------------|-------------------------|--------------------------|
| Minimum Power (dBm)^a Frequency Range | 75 Hz IFBW ^b | 10 Hz IFBW ^c | |
| <i>Option 544/550^d</i> | | | |
| 100 to 200 kHz | –123.0 | –137.8 | Band 0 |
| 200 to 500 kHz | –126.0 | –140.8 | Band 0 |
| 500 kHz to 1 MHz | –128.0 | –142.8 | Band 0 |
| 1 to 10 MHz | –132.0 | –146.8 | Band 0 |
| 10 MHz to 2.1 GHz | –135.0 | –149.8 | Band 0 |
| 2.1 to 3.6 GHz | –134.0 | –148.8 | Band 0 |
| 3.5 to 8.4 GHz | –126.2 | –141.0 | Band 1 |
| 8.3 to 13.6 GHz | –126.2 | –141.0 | Band 2 |
| 13.5 to 17.1 GHz | –125.2 | –140.0 | Band 3 |
| 17 to 20 GHz | –124.2 | –139.0 | Band 4 |
| 20 to 26.5 GHz | –117.7 | –132.5 | Band 4 |
| 26.4 to 30 GHz | –113.7 | –128.5 | Band 5 |
| 30 to 34 GHz | –111.7 | –126.5 | Band 5 |
| 33.9 to 37 GHz | –109.7 | –124.5 | Band 6 |
| 37 to 40 GHz | –99.7 | –114.5 | Band 6 |
| 40 to 44 GHz | –97.7 | –112.5 | Band 6 |
| 44 to 46 GHz | –96.7 | –111.5 | Band 6 |
| 46 to 50 GHz | –95.7 | –110.5 | Band 6 |

- Preamplifier option (N9030B-Pxx) is automatically turned "On" to achieve the Minimum power. In addition to 75 Hz and 10 Hz IFBW listed here, the N5531X also offers 30 kHz and 200 kHz IFBW settings for less stable signal generator calibration. With 30 kHz and 200 kHz IF bandwidths (IFBW), TRFL minimum power level will be degraded by a factor of $10 \times \log(\text{IFBW}/75 \text{ Hz})$, relative to the specified 75 Hz minimum power level. This will result in a degradation of 26 dB for the 30 kHz IF bandwidth and 34 dB for the 200 kHz IF bandwidth.
- With 75 Hz IFBW setting selected, the measurement automatically switches the IFBW to the 30 Hz setting for SNR values <10 dB.
- With 10 Hz IFBW setting selected, the measurement automatically switches the IFBW to the 1 Hz setting for SNR values <10 dB.
- The frequency option determines the maximum frequency the PXA can reach.

Measuring Receiver
Tuned RF Level (TRFL)

| Description | Specification | Supplemental Information |
|--|---|--|
| Linearity | $\pm(0.009 \text{ dB} + 0.005 \text{ dB/10 dB step}^a)$ | Refer to Relative Fidelity in the PXA base specifications for special circumstances. |
| Relative Measurement Accuracy | | |
| Residual noise threshold ^b to Max power | $\pm(0.015 \text{ dB} + 0.005 \text{ dB/10 dB step}^a)^c^d \text{ (nom.)}$ | |
| Minimum power to residual noise threshold | $\pm(\text{cumulative error}^e + 0.0012 \times (\text{Input Power} - \text{Residual Noise Threshold Power})^2)$ | |
| Residual Noise Threshold Power (dBm) | Residual Noise Threshold Power = Minimum Power +30 dB | |
| Range 2 Uncertainty^f | $\pm 0.031 \text{ dB}$ | |
| Range 3 Uncertainty^g | $\pm 0.031 \text{ dB}$ | |

- "Step" in this specification refers to the difference between relative measurements, such as might be experienced by stepping a stepped attenuator. Therefore, this accuracy is computed by adding the uncertainty for each full or partial 10 dB step to the other uncertainty term. For example, if the two levels whose relative level is to be determined differ by 15 dB, consider that to be a difference of two 10 dB steps. The accuracy specification would be $\pm(0.009 + 2 \times (0.005))$ or $\pm 0.019 \text{ dB}$.
- The residual noise threshold power is the power level at which the signal-to-noise ratio (SNR) becomes the dominant contributor to the measurement uncertainty. See the "Tuned RF Level Specification Nomenclature" section.
- Immediately following the system alignments, the measurement is made by manually setting frequency to that of the signal-under-test, "Accuracy" mode to "High", and "Measure Control" to "Single".
- This includes the linearity accuracy.
- In relative accuracy of TRFL measurements, the "cumulative error" is the error incurred when stepping from a higher power level to the Residual Noise Threshold Power level. The formula to calculate the cumulative error is $\pm(0.015 \text{ dB} + 0.005 \text{ dB/10 dB step})$. For example, assume the higher level starting power is 0 dBm and the calculated Residual Noise Threshold Power is -99 dBm. The cumulative error would be $\pm(0.015 + \lceil 99/10 \rceil \times 0.005 \text{ dB})$, or $\pm 0.065 \text{ dB}$, where $\lceil x \rceil$ is a ceiling function that means the smallest integer not less than x.
- Add this specification when the Measuring Receiver enters the "Range 2" state. Range 2 is entered when the "Range 1" signal-to-noise ratio (SNR) falls between 50 and 28 dB. The SNR value is tuning band dependent. A prompt of "Range 2" in the PXA display will indicate that the Measuring Receiver is in Range 2.
- Add this specification in addition to "Range 2 Uncertainty" when the Measuring Receiver software enters the "Range 3" state. Range 3 is entered when the "Range 2" SNR falls between 50 and 28 dB. The SNR value is tuning band dependent. A prompt of "Range 3" in the PXA display will indicate that the Measuring Receiver is in Range 3.

Measuring Receiver
Tuned RF Level (TRFL)

| Description | Specification | Supplemental Information |
|---|---|--------------------------|
| Absolute Measurement Accuracy | | |
| +20 dBm to Max Power | $\pm(\text{Power Meter Range 1 Uncert} + 0.005 \text{ dB/10 dB Step})$ | |
| Residual Noise Threshold power to +20 dBm | $\pm(\text{Power Meter Range 2-4 Uncert} + 0.005 \text{ dB/10 dB Step})$ | |
| Minimum Power to Residual Noise Threshold power | $\pm(\text{cumulative error}^a + 0.0012 \times (\text{Input Power} - \text{Residual Noise Threshold Power})^2)$ | |
| Residual Noise Threshold Power (dBm) | Residual Noise Threshold Power = Minimum Power + 30 dB | |
| Range 2 Uncertainty^b | $\pm 0.031 \text{ dB}$ | |
| Range 3 Uncertainty^c | $\pm 0.031 \text{ dB}$ | |

- a. In absolute accuracy of TRFL measurements, the “cumulative error” is the error incurred when stepping from a higher power level to the Residual Noise Threshold power level. See [page 421](#) for a graphic. In order to calculate the cumulative error, you must determine the Residual Noise Threshold power and determine the Power Meter Range Uncertainty. The formula to calculate the cumulative error is: $\pm(\text{power meter range uncertainty} + 0.005 \text{ dB/10 dB step})$.

For example: the power sensor is option 504, starting power is 0 dBm and power will be stepped to –120 dBm. Therefore, the Power Meter Range Uncertainty is $\pm 0.222 \text{ dB}$ from the table on [page 427](#). Assume a 26.5 GHz PXA (Option N9030B-526) is used, the IFBW is set to 75 Hz to gain measurement speed, and the measurement frequency is 2 GHz. The Residual Noise Threshold Power is calculated by adding 30 dB to the Minimum Power specification shown on [page 423](#). That is, Residual Noise Threshold Power = –136 dBm + 30 dB = –106 dBm using the formula on this page. The cumulative error is then $\pm(0.222 \text{ dB} + \lceil 106/10 \rceil \times 0.005 \text{ dB})$, or $\pm 0.277 \text{ dB}$, where $\lceil x \rceil$ is a ceiling function that means the smallest integer not less than x. That is 11 in this example. It should be noted that even though the power level was stepped 120 dB (twelve 10 dB steps), the Residual Noise Threshold occurred at –106 dBm (eleven 10 dB steps).

- b. Add this specification when the Measuring Receiver enters the “Range 2” state. Range 2 is entered when the “Range 1” signal-to-noise ratio (SNR) falls between 50 and 28 dB. The SNR value is tuning band dependent. A prompt of “Range 2” in the PXA display will indicate that the Measuring Receiver is in Range 2.
- c. Add this specification in addition to “Range 2 Uncertainty” when the Measuring Receiver software enters the “Range 3” state. Range 3 is entered when the “Range 2” SNR falls between 50 and 28 dB. The SNR value is tuning band dependent. A prompt of “Range 3” in the PXA display will indicate that the Measuring Receiver is in Range 3. In the example mentioned in footnote a., since the measurements step through both Range 2 and Range 3, the range uncertainties need to be taken into account. Therefore, the total absolute power measurement uncertainty in this example can be calculated as $\pm(0.222 \text{ dB} + \lceil 106/10 \rceil \times 0.005 \text{ dB} + 0.031 \text{ dB} + 0.031 \text{ dB} + 0.0012 \times (120 - 106)^2 \text{ dB}) = \pm 0.574 \text{ dB}$.

Measuring Receiver
Tuned RF Level (TRFL)

| Description | Specification | | | | Supplemental Information | | | |
|--------------------------------|------------------------------|-------------|---------------|-------------|------------------------------|-------------|---------------|-------------|
| RF Power Accuracy (dB) | | | | | Typicals | | | |
| Power Meter Range 1 | Sensor module options | | | | Sensor module options | | | |
| +20 to +30 dBm | #504 | #518 | #526 | #550 | #504 | #518 | #526 | #550 |
| 100 kHz $\leq f_c \leq$ 10 MHz | ± 0.287 | — | — | — | ± 0.146 | — | — | — |
| 10 MHz $< f_c \leq$ 30 MHz | ± 0.287 | ± 0.287 | $\pm 0.287^a$ | — | ± 0.146 | ± 0.146 | $\pm 0.146^a$ | — |
| 30 MHz $< f_c \leq$ 2 GHz | ± 0.287 | ± 0.287 | ± 0.287 | ± 0.265 | ± 0.146 | ± 0.146 | ± 0.146 | ± 0.135 |
| 2 GHz $< f_c \leq$ 4.2 GHz | ± 0.302 | ± 0.302 | ± 0.302 | ± 0.279 | ± 0.146 | ± 0.154 | ± 0.146 | ± 0.142 |
| 4.2 GHz $< f_c \leq$ 18 GHz | — | ± 0.466 | ± 0.468 | ± 0.342 | — | ± 0.240 | ± 0.241 | ± 0.175 |
| 18 GHz $< f_c \leq$ 26.5 GHz | — | — | ± 0.386 | ± 0.332 | — | — | ± 0.198 | ± 0.170 |
| 26.5 GHz $< f_c \leq$ 50 GHz | — | — | — | ± 0.363 | — | — | — | ± 0.186 |
| | | | | | Typicals | | | |
| Power Meter Range 2 | Sensor module options | | | | Sensor module options | | | |
| 0 to $< +20$ dBm | #504 | #518 | #526 | #550 | #504 | #518 | #526 | #550 |
| 100 kHz $\leq f_c \leq$ 10 MHz | ± 0.222 | — | — | — | ± 0.113 | — | — | — |
| 10 MHz $< f_c \leq$ 30 MHz | ± 0.222 | ± 0.222 | $\pm 0.222^a$ | — | ± 0.113 | ± 0.113 | $\pm 0.113^a$ | — |
| 30 MHz $< f_c \leq$ 2 GHz | ± 0.222 | ± 0.222 | ± 0.222 | ± 0.191 | ± 0.113 | ± 0.113 | ± 0.113 | ± 0.097 |
| 2 GHz $< f_c \leq$ 4.2 GHz | ± 0.222 | ± 0.242 | ± 0.242 | ± 0.211 | ± 0.113 | ± 0.123 | ± 0.123 | ± 0.107 |
| 4.2 GHz $< f_c \leq$ 18 GHz | — | ± 0.432 | ± 0.433 | ± 0.291 | — | ± 0.222 | ± 0.223 | ± 0.148 |
| 18 GHz $< f_c \leq$ 26.5 GHz | — | — | ± 0.342 | ± 0.279 | — | — | ± 0.175 | ± 0.142 |
| 26.5 GHz $< f_c \leq$ 50 GHz | — | — | — | ± 0.316 | — | — | — | ± 0.161 |
| | | | | | | | | |
| Power Meter Range 3 | Sensor module options | | | | Sensor module options | | | |
| -5 to < 0 dBm | #504 | #518 | #526 | #550 | #504 | #518 | #526 | #550 |
| 100 kHz $\leq f_c \leq$ 10 MHz | ± 0.220 | — | — | — | ± 0.112 | — | — | — |
| 10 MHz $< f_c \leq$ 30 MHz | ± 0.220 | ± 0.219 | $\pm 0.220^a$ | — | ± 0.112 | ± 0.111 | $\pm 0.112^a$ | — |
| 30 MHz $< f_c \leq$ 2 GHz | ± 0.220 | ± 0.219 | ± 0.220 | ± 0.189 | ± 0.112 | ± 0.111 | ± 0.112 | ± 0.097 |
| 2 GHz $< f_c \leq$ 4.2 GHz | ± 0.240 | ± 0.219 | ± 0.240 | ± 0.209 | ± 0.122 | ± 0.122 | ± 0.122 | ± 0.106 |
| 4.2 GHz $< f_c \leq$ 18 GHz | — | ± 0.240 | ± 0.432 | ± 0.289 | — | ± 0.122 | ± 0.222 | ± 0.148 |
| 18 GHz $< f_c \leq$ 26.5 GHz | — | — | ± 0.341 | ± 0.277 | — | — | ± 0.174 | ± 0.141 |

Measuring Receiver
Tuned RF Level (TRFL)

| Description | Specification | | | | Supplemental Information | | | |
|----------------------------|------------------------------|--------|---------------------|--------|------------------------------|--------|---------------------|--------|
| 26.5 GHz < f_c ≤ 50 GHz | — | — | — | ±0.315 | — | — | — | ±0.161 |
| Power Meter Range 4 | Sensor module options | | | | Sensor module options | | | |
| –10 to < –5 dBm | #504 | #518 | #526 | #550 | #504 | #518 | #526 | #550 |
| 100 kHz ≤ f_c ≤ 10 MHz | ±0.229 | — | — | — | ±0.117 | — | — | — |
| 10 MHz < f_c ≤ 30 MHz | ±0.229 | ±0.229 | ±0.229 ^a | — | ±0.117 | ±0.117 | ±0.117 ^a | — |
| 30 MHz < f_c ≤ 2 GHz | ±0.229 | ±0.229 | ±0.229 | ±0.200 | ±0.117 | ±0.117 | ±0.117 | ±0.102 |
| 2 GHz < f_c ≤ 4.2 GHz | ±0.249 | ±0.249 | ±0.249 | ±0.219 | ±0.127 | ±0.127 | ±0.127 | ±0.111 |
| 4.2 GHz < f_c ≤ 18 GHz | — | ±0.435 | ±0.437 | ±0.296 | — | ±0.224 | ±0.225 | ±0.151 |
| 18 GHz < f_c ≤ 26.5 GHz | — | — | ±0.347 | ±0.285 | — | — | ±0.178 | ±0.145 |
| 26.5 GHz < f_c ≤ 50 GHz | — | — | — | ±0.321 | — | — | — | ±0.164 |
| RF Power Resolution | | | | | | | | |
| Display resolution | 0.001 dB | | | | | | | |

a. For U5532C only.

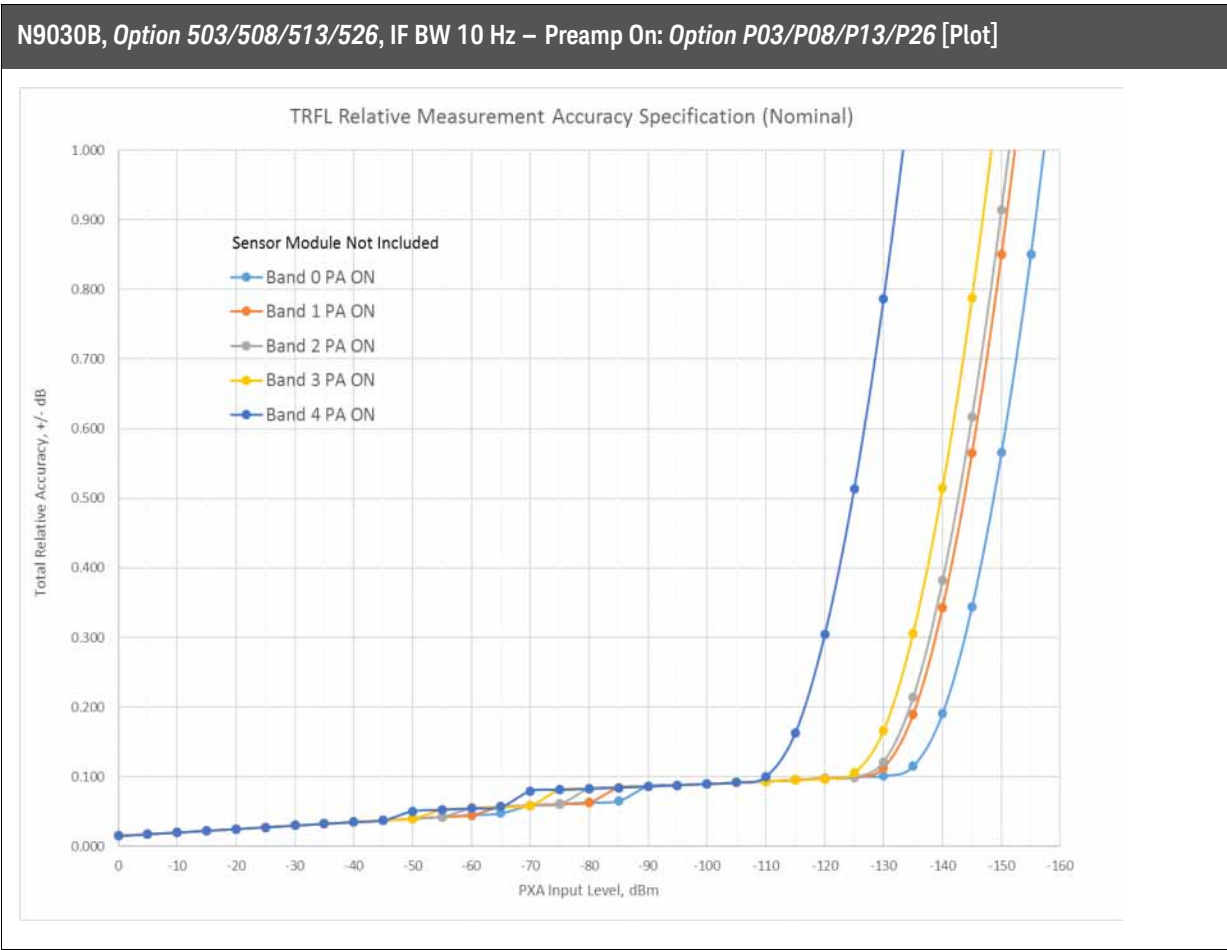
Information about Residuals

- As the DANL (displayed average noise level) of a signal/spectrum analyzer becomes very low, it can reveal “residuals”. These occur at discrete frequencies and arise from the various clocks and other components of the local oscillators. This is true for ALL modern signal/spectrum analyzers. The residuals specification for the PXA Series is –100 dBm. Please take this information into consideration when you measure the TRFL level below –100 dBm. A user may apply a 50 ohm terminator to the PXA “RF input” connector and switch to the “spectrum analyzer” mode to verify the PXA residuals.
- The power meter and early vintage of the sensor module (N5532) combination may generate a residual of around –100 dBm or lower at frequency of 50 MHz and its harmonics. Please take this information into consideration when you use the N5532 to measure the TRFL level below –100 dBm at 50 MHz and its second or third harmonic.

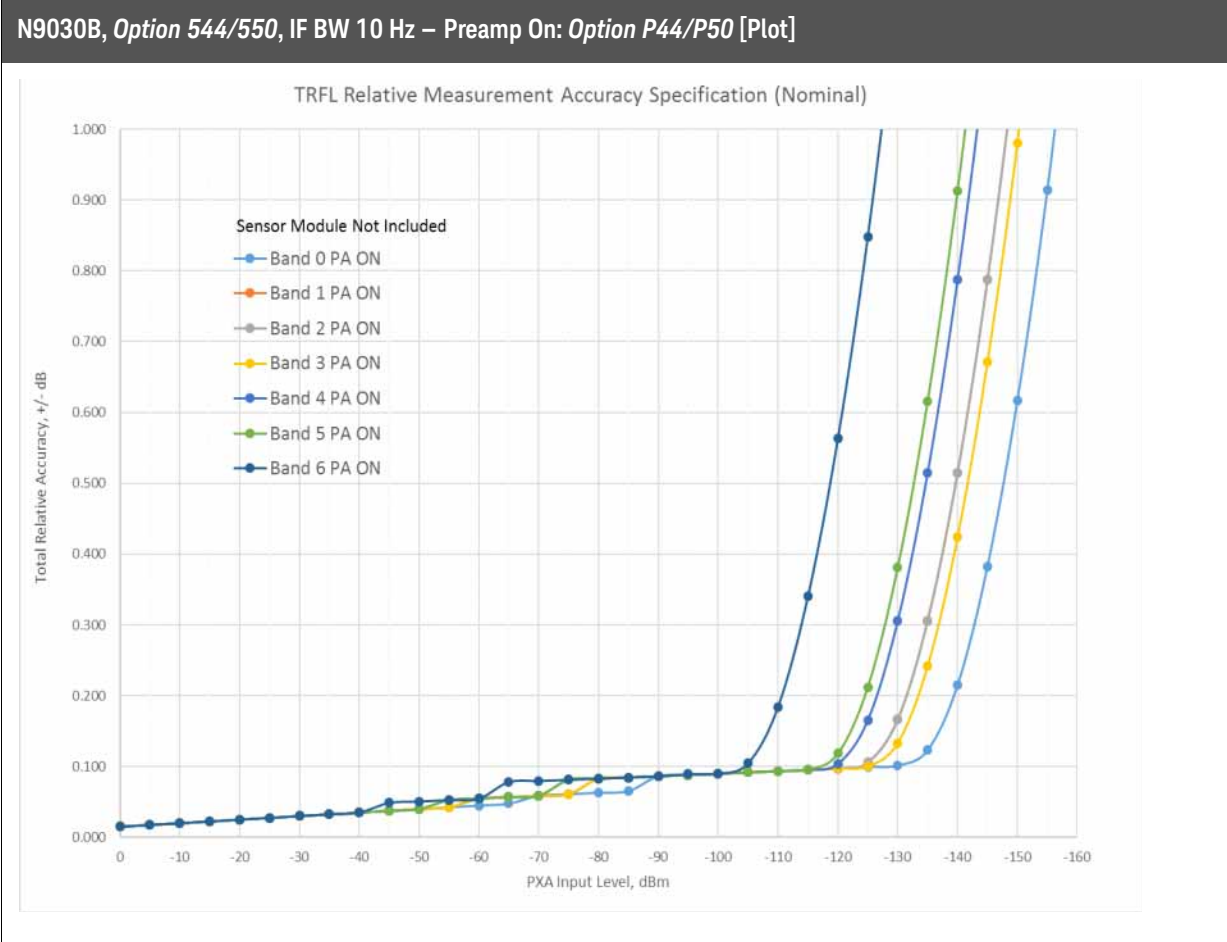
| Description | Specification | Supplemental Information |
|---------------------------------------|--|----------------------------|
| Operating Frequency Range | | |
| <i>Option 503/508/513/526/544/550</i> | 100 kHz to 3.6 GHz | |
| <i>Option 508/513/526/544/550</i> | 3.6 to 8.4 GHz | Requires <i>Option MPB</i> |
| <i>Option 513/526/544/550</i> | 8.4 to 13.6 GHz | Requires <i>Option MPB</i> |
| <i>Option 526/544/550</i> | 13.6 to 26.5 GHz | Requires <i>Option MPB</i> |
| <i>Option 544/550</i> | 26.5 to 44 GHz | Requires <i>Option MPB</i> |
| <i>Option 550</i> | 44 to 50 GHz | Requires <i>Option MPB</i> |
| Displayed Units | | |
| Absolute | dBm, Watts, Volts, dBmV, or dBuV | |
| Relative | Percent or dB | |
| Displayed Resolution | 6 digits in watts or 5 digits in volts mode 0.001 dB in dBm or dB (relative) mode | |
| Input SWR | See “RF Power” on page 415. | |

Measuring Receiver
Graphical TRFL Measurement Accuracy (Nominal)

Graphical TRFL Measurement Accuracy (Nominal)



Measuring Receiver
Graphical TRFL Measurement Accuracy (Nominal)



Measuring Receiver
Graphical TRFL Measurement Accuracy (Nominal)

29 Multi-Standard Radio Measurement Application

This chapter contains specifications for the N9083EM0E Multi-Standard Radio (MSR) measurement application. The measurements for GSM/EDGE, W-CDMA and LTE FDD and NB-IoT also require N9071EM0E-1FP, N9073EM0E-1FP, N9080C-1FP and N9080EM0E-3FP respectively.

Additional Definitions and Requirements

The specifications apply in the frequency range documented in In-Band Frequency Range of each application.

The specifications for this chapter apply only to instruments with Frequency *Option 503, 508, 513 or 526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|-----------------------------------|
| Channel Power Minimum power at RF Input 95th percentile Absolute power accuracy (20 to 30°C, Atten = 10 dB) | | –50 dBm (nominal) ±0.19 dB |

| Description | Specifications | Supplemental Information |
|--|----------------------|--------------------------|
| Power Statistics CCDF Histogram Resolution | 0.01 dB ^a | |

- 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.

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Occupied Bandwidth Minimum power at RF Input Frequency Accuracy | | –30 dBm (nominal) ± (Span / 1000) (nominal) |

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Spurious Emissions Accuracy (Attenuation = 10 dB) Frequency Range 20 Hz to 3.6 GHz 3.5 to 8.4 GHz 3.5 to 8.4 GHz (<i>Option EP0</i>) 8.3 to 13.6 GHz 8.3 to 13.6 GHz (<i>Option EP0</i>) | | Table-driven spurious signals; search across regions ±0.19 dB (95th percentile) ±1.08 dB (95th percentile) ±1.15 dB (95th percentile) ±1.48 dB (95th percentile) ±1.52 dB (95th percentile) |

Multi-Standard Radio Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| Conformance EVM^a | | |
| GSM/EDGE^b | | |
| EVM, rms - floor (EDGE) | | 0.6% (nominal) |
| Phase error, rms - floor (GSM) | | 0.5° (nominal) |
| W-CDMA^c | | |
| Composite EVM floor | | 1.5% (nominal) |
| LTE FDD^d | | |
| EVM floor for downlink (OFDMA) | | % and dB expression ^e |
| Signal bandwidths | | |
| 5 MHz | | 0.44% (-47.1 dB) (nominal) |
| 10 MHz | | 0.36% (-48.8 dB) (nominal) |
| 20 MHz | | 0.38% (-48.4 dB) (nominal) |
| EVM floor for downlink (OFDMA) (<i>Option EPO</i>) | | % and dB expression ^e |
| Signal bandwidths | | |
| 5 MHz | | 0.38% (-48.4 dB) (nominal) |
| 10 MHz | | 0.25% (-52.0 dB) (nominal) |
| 20 MHz | | 0.28% (-51.0 dB) (nominal) |
| NB-IoT | | % and dB expression ^e Channel bandwidth 200 kHz |
| EVM floor for downlink | | 0.78% (-42.1 dB) (nominal) |

- The signal level is within one range step of overload. The specification for floor do not include signal-to-noise impact which may decrease by increasing the number of carriers. The noise floor can be estimated by $DANL + 2.51 + 10 \times \log_{10}(\text{MeasBW})$, where DANL is the Display Averaged Noise Level specification in dBm and MeasBW is the measurement bandwidth at the receiver in Hz.
- Specifications apply when the carrier spacing is 600 kHz and the carrier power of each adjacent channel does not exceed the carrier power of the channel tested for EVM.
- Specifications apply when the carrier spacing is 5 MHz and the carrier power of each adjacent channel does not exceed the carrier power of the channel tested for EVM.
- Specifications apply when the carrier spacing is the same as the signal bandwidth and the carrier power of each adjacent channel does not exceed the carrier power of the channel tested for EVM.
- In LTE FDD specifications, those values with % units are the specifications, while those with decibel units, in parentheses, are conversion from the percentage units to decibels for reader convenience.

In-Band Frequency Range

Refer to the tables of In-Band Frequency Range in GSM/EDGE on [page 352](#), W-CDMA on [page 475](#), and LTE-A on [page 371](#).

30 Noise Figure Measurement Application

This chapter contains specifications for the N9069EM0E Noise Figure Measurement Application.

General Specifications

| Description | Specifications | | Supplemental Information |
|---|--------------------------|---|---|
| Noise Figure <10 MHz 10 MHz to 26.5 GHz and 26.5 to 50 GHz ^c | | | Uncertainty Calculator ^a See note ^b Internal and External preamplification recommended ^d |
| Noise Source ENR | Measurement Range | Instrument Uncertainty^e | |
| 4 to 6.5 dB | 0 to 20 dB | ±0.02 dB | |
| 12 to 17 dB | 0 to 30 dB | ±0.025 dB | |
| 20 to 22 dB | 0 to 35 dB | ±0.03 dB | |

- a. The figures given in the table are for the uncertainty added by the X-Series Signal Analyzer instrument only. To compute the total uncertainty for your noise figure measurement, you need to take into account other factors including: DUT NF, Gain and Match, Instrument NF, Gain Uncertainty and Match; Noise source ENR uncertainty and Match. The computations can be performed with the uncertainty calculator included with the Noise Figure Measurement Personality. Go to **Mode Setup** then select **Uncertainty Calculator**. Similar calculators are also available on the Keysight web site; go to <http://www.keysight.com/find/nfu>.
- b. Uncertainty performance of the instrument is nominally the same in this frequency range as in the higher frequency range. However, performance is not warranted in this range. There is a paucity of available noise sources in this range, and the analyzer has poorer noise figure, leading to higher uncertainties as computed by the uncertainty calculator.
- c. At the highest frequencies, especially above 40 GHz, the only Agilent/Keysight supra-26-GHz noise source, the 346CK01, often will not have enough ENR to allow for the calibration operation. Operation with "Internal Cal" is almost as accurate as with normal calibration, so the inability to use normal calibration does not greatly impact usefulness. Also, if the DUT has high gain, calibration has little effect on accuracy. In those rare cases when normal calibration is required, the Noisecom NC5000 and the NoiseWave NW346V do have adequate ENR for calibration.
- d. The NF uncertainty calculator can be used to compute the uncertainty. For most DUTs of normal gain, the uncertainty will be quite high without preamplification.
- e. "Instrument Uncertainty" is defined for noise figure analysis as uncertainty due to relative amplitude uncertainties encountered in the analyzer when making the measurements required for a noise figure computation. The relative amplitude uncertainty depends on, but is not identical to, the relative display scale fidelity, also known as incremental log fidelity. The uncertainty of the analyzer is multiplied within the computation by an amount that depends on the Y factor to give the total uncertainty of the noise figure or gain measurement. See Keysight App Note 57-2, literature number 5952-3706E for details on the use of this specification. Jitter (amplitude variations) will also affect the accuracy of results. The standard deviation of the measured result decreases by a factor of the square root of the Resolution Bandwidth used and by the square root of the number of averages. This application uses the 4 MHz Resolution Bandwidth as default because this is the widest bandwidth with uncompromised accuracy.

Noise Figure Measurement Application
General Specifications

| Description | Specifications | Supplemental Information |
|-------------------------------------|----------------|--|
| Gain | | |
| Instrument Uncertainty ^a | | DUT Gain Range = –20 to +40 dB |
| <10 MHz | ±0.07 dB | See note ^b |
| 10 MHz to 3.6 GHz | | |
| 3.6 GHz to 26.5 GHz | | ±0.11 dB additional ^c 95th percentile, 5 minutes after calibration |
| 26.5 to 50 GHz | | Nominally the same performance as for 3.6 to 26.5 GHz. Also, see footnote c . |

- a. “Instrument Uncertainty” is defined for gain measurements as uncertainty due to relative amplitude uncertainties encountered in the analyzer when making the measurements required for the gain computation. See Keysight App Note 57-2, literature number 5952-3706E for details on the use of this specification. Jitter (amplitude variations) will also affect the accuracy of results. The standard deviation of the measured result decreases by a factor of the square root of the Resolution Bandwidth used and by the square root of the number of averages. This application uses the 4 MHz Resolution Bandwidth as default since this is the widest bandwidth with uncompromised accuracy. Under difficult conditions (low Y factors), the instrument uncertainty for gain in high band can dominate the NF uncertainty as well as causing errors in the measurement of gain. These effects can be predicted with the uncertainty calculator.
- b. Uncertainty performance of the instrument is nominally the same in this frequency range as in the higher frequency range. However, performance is not warranted in this range. There is a paucity of available noise sources in this range, and the analyzer has poorer noise figure, leading to higher uncertainties as computed by the uncertainty calculator.
- c. For frequencies above 3.6 GHz, the analyzer uses a YIG-tuned filter (YTF) as a preselector, which adds uncertainty to the gain. When the Y factor is small, such as with low gain DUTs, this uncertainty can be greatly multiplied and dominate the uncertainty in NF (as the user can compute with the Uncertainty Calculator), as well as impacting gain directly. When the Y factor is large, the effect of IU of Gain on the NF becomes negligible. When the Y-factor is small, the non-YTF mechanism that causes Instrument Uncertainty for Gain is the same as the one that causes IU for NF with low ENR. Therefore, we would recommend the following practice: When using the Uncertainty Calculator for noise figure measurements above 3.6 GHz, fill in the IU for Gain parameter with the sum of the IU for NF for 4 – 6.5 dB ENR sources and the shown “additional” IU for gain for this frequency range. When estimating the IU for Gain for the purposes of a gain measurement for frequencies above 3.6 GHz, use the sum of IU for Gain in the 0.01 to 3.6 GHz range and the “additional” IU shown. You will find, when using the Uncertainty Calculator, that the IU for Gain is only important when the input noise of the spectrum analyzer is significant compared to the output noise of the DUT. That means that the best devices, those with high enough gain, will have comparable uncertainties for frequencies below and above 3.6 GHz. The additional uncertainty shown is that observed to be met in 95% of the frequency/instrument combinations tested with 95% confidence. It applies within five minutes of a calibration. It is not warranted.

Noise Figure Measurement Application
General Specifications

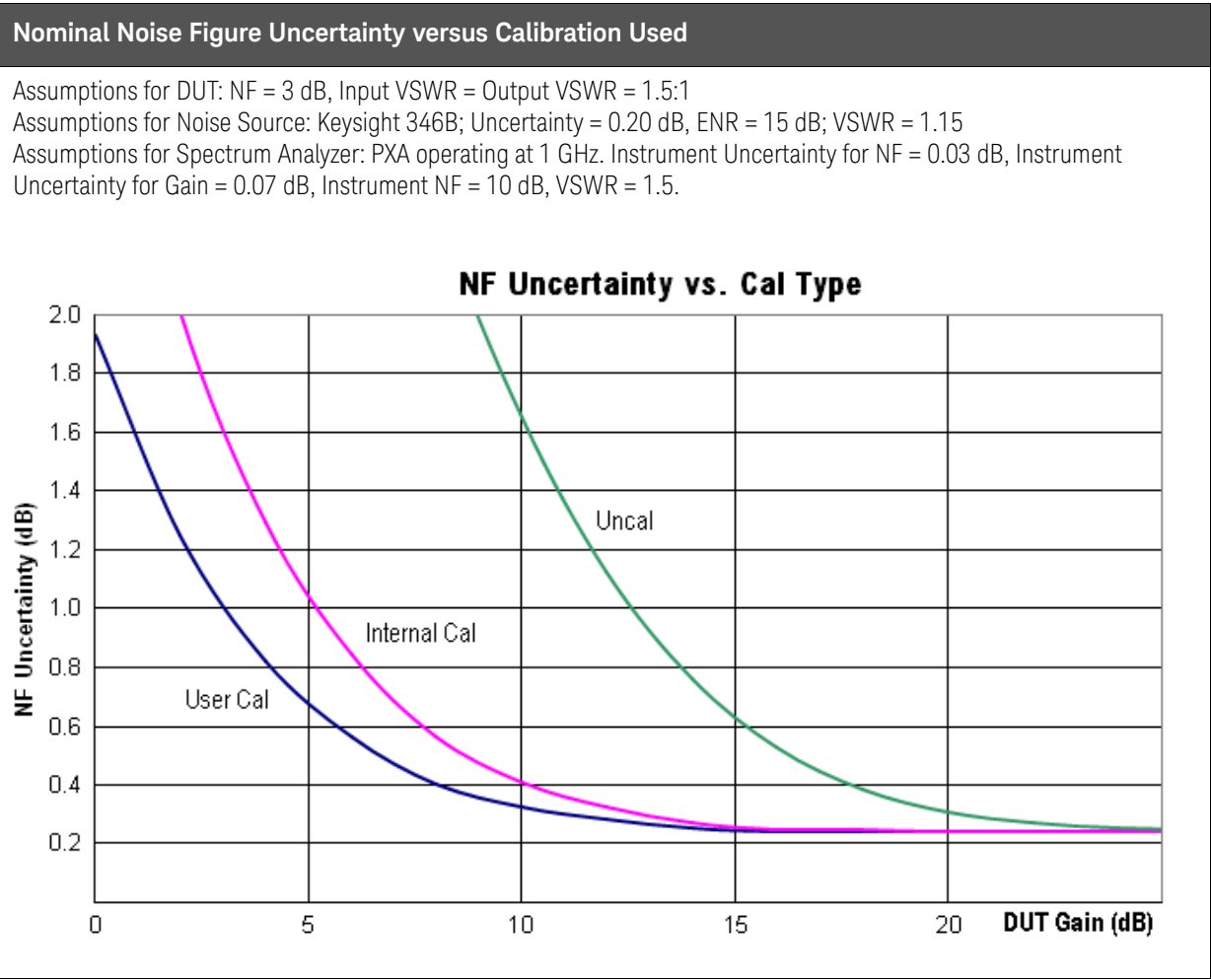
| Description | Specifications | Supplemental Information |
|--|--|---|
| Noise Figure Uncertainty Calculator^a | | |
| Instrument Noise Figure Uncertainty | See the Noise Figure table earlier in this chapter | |
| Instrument Gain Uncertainty | See the Gain table earlier in this chapter | |
| Instrument Noise Figure | | See graphs of "Nominal Instrument Noise Figure"; Noise Figure is DANL + 176.24 dB (nominal) ^b Note on DC coupling ^{cd} |
| Instrument Input Match | | See graphs: Nominal VSWR Note on DC coupling ^c |
| NFE Improvement/Internal Cal ^e | | See "Displayed Average Noise Level with Noise Floor Extension Improvement" on page 55. |

- a. The Noise Figure Uncertainty Calculator requires the parameters shown in order to calculate the total uncertainty of a Noise Figure measurement.
- b. Nominally, the noise figure of the spectrum analyzer is given by

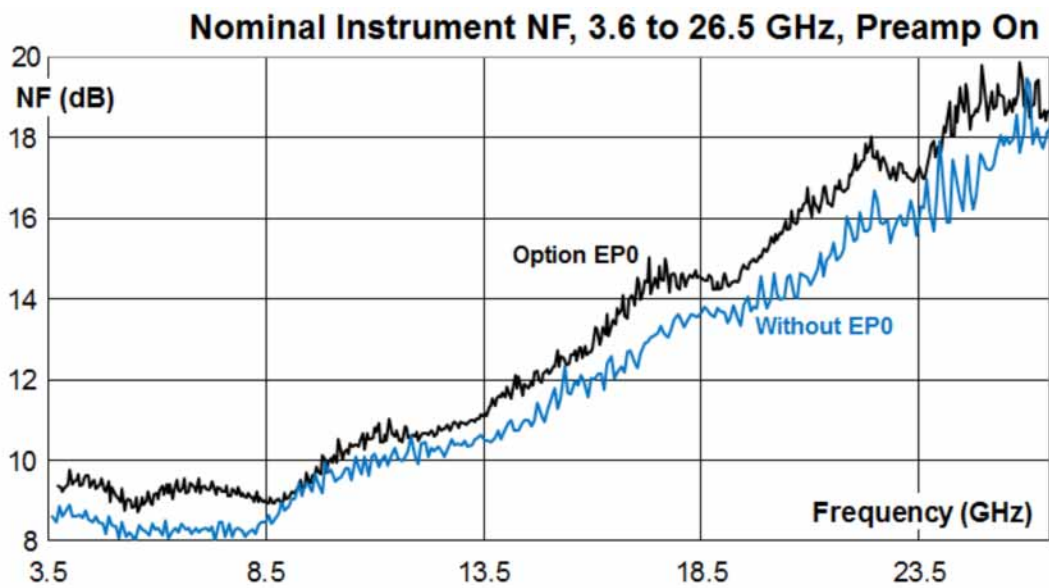
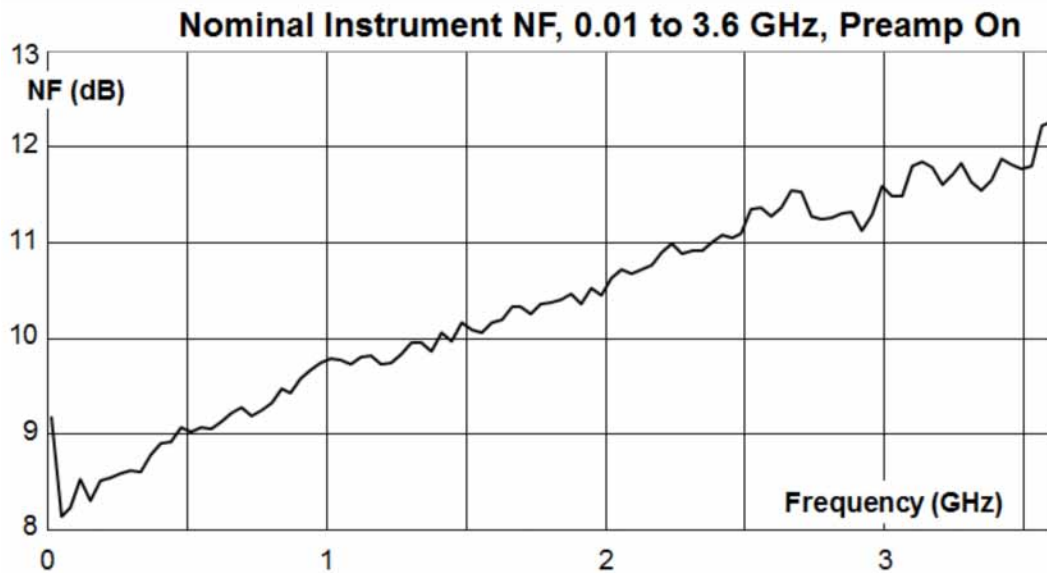
$$NF = D - (K - L + N + B)$$
 where D is the DANL (displayed average noise level) specification,
 K is kTB (−173.98 dBm in a 1 Hz bandwidth at 290 K)
 L is 2.51 dB (the effect of log averaging used in DANL verifications)
 N is 0.24 dB (the ratio of the noise bandwidth of the RBW filter with which DANL is specified to an ideal noise bandwidth)
 B is ten times the base-10 logarithm of the RBW (in hertz) in which the DANL is specified. B is 0 dB for the 1 Hz RBW.
 The actual NF will vary from the nominal due to frequency response errors.
- c. The effect of AC coupling is negligible for frequencies above 40 MHz. Below 40 MHz, DC coupling is recommended for the best measurements.
- d. The instrument NF nominally degrades by 0.2 dB at 30 MHz and 1 dB at 10 MHz with AC coupling.
- e. Analyzers with NFE (Noise Floor Extension) use that capability in the Noise Figure Measurement Application to allow "Internal Cal" instead of user calibration. With internal calibration, the measurement is much better than an uncalibrated measurement but not as good as with user calibration. Calibration reduces the effect of the analyzer noise on the total measured NF. With user calibration, the extent of this reduction is computed in the uncertainty calculator, and will be on the order of 16 dB. With internal calibration, the extent of reduction of the effective noise level varies with operating frequency, its statistics are given on the indicated page. It is usually about half as effective as User Calibration, and much more convenient. For those measurement situations where the output noise of the DUT is 10 dB or more above the instrument input noise, the errors due to using an internal calibration instead of a user calibration are negligible.

Noise Figure Measurement Application
General Specifications

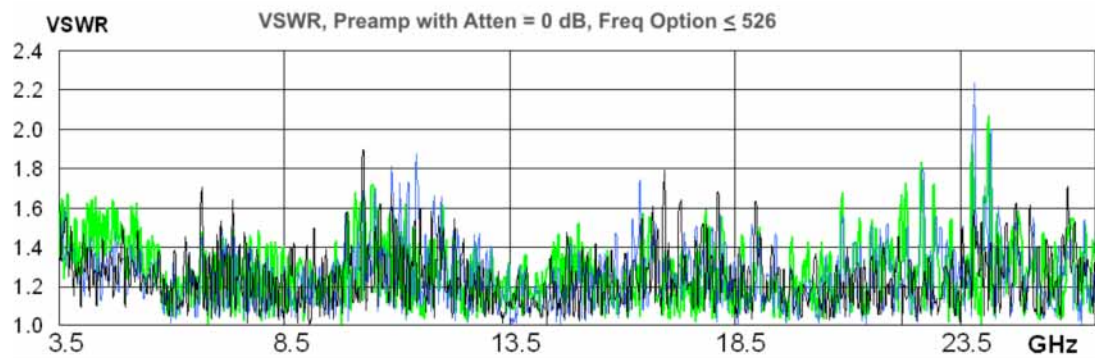
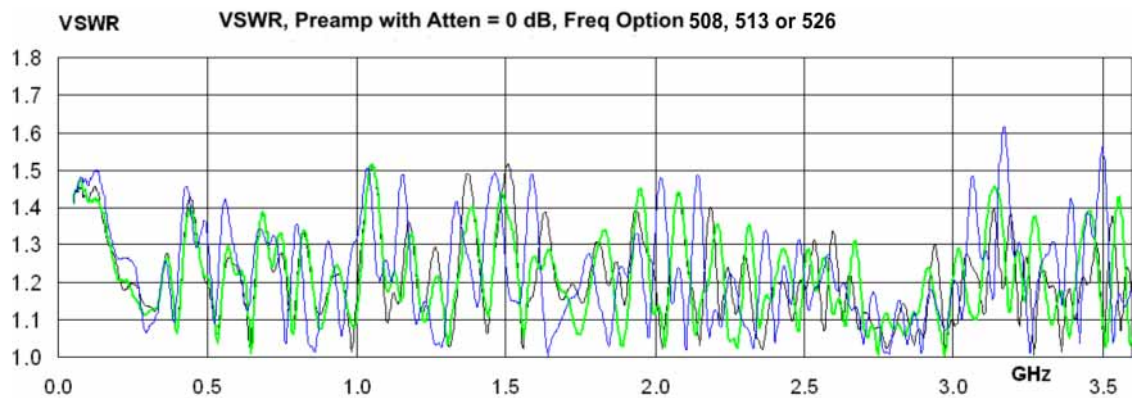
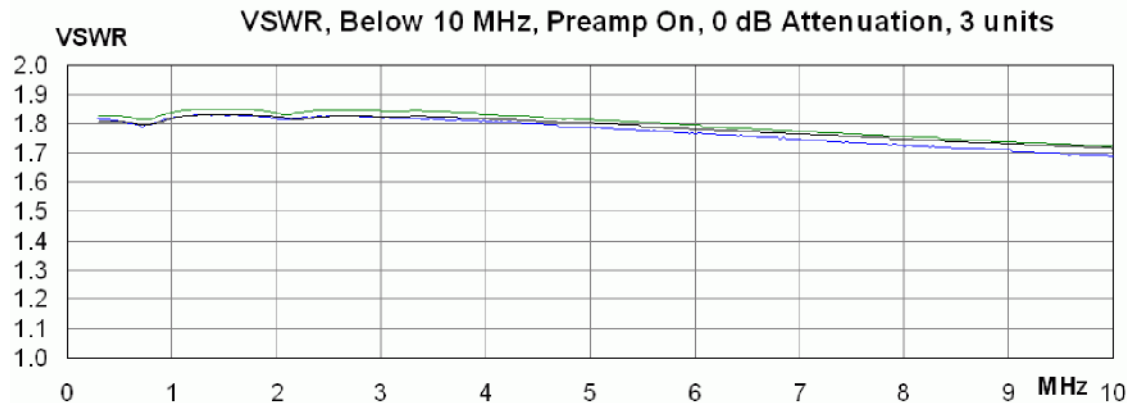
| Description | Supplemental Information |
|---|---|
| Uncertainty versus Calibration Options | |
| User Calibration | Best uncertainties; Noise Figure Uncertainty Calculator applies |
| Uncalibrated | Worst uncertainties; noise of the analyzer input acts as a second stage noise on the DUT |
| Internal Calibration | Good uncertainties without the need of reconnecting the DUT and running a calibration. The uncertainty of the analyzer input noise model adds a second-stage noise power to the DUT that can be positive or negative. See the figure for example uncertainties. |



Nominal Instrument Noise Figure

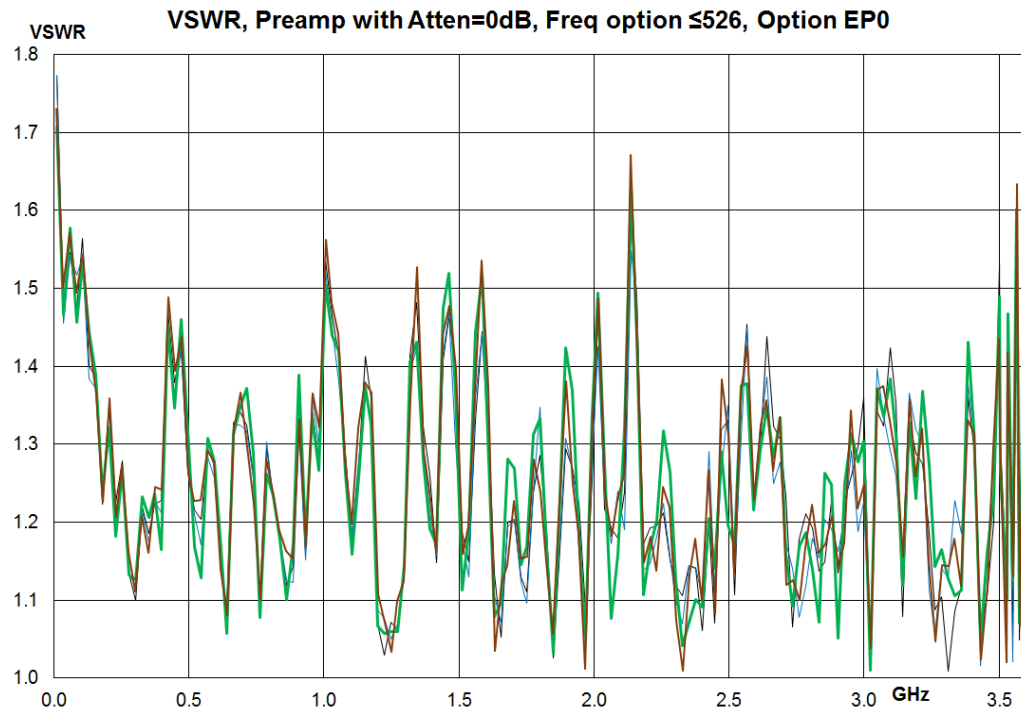


Nominal Instrument Input VSWR, DC Coupled without *Option EP0* [Plot]

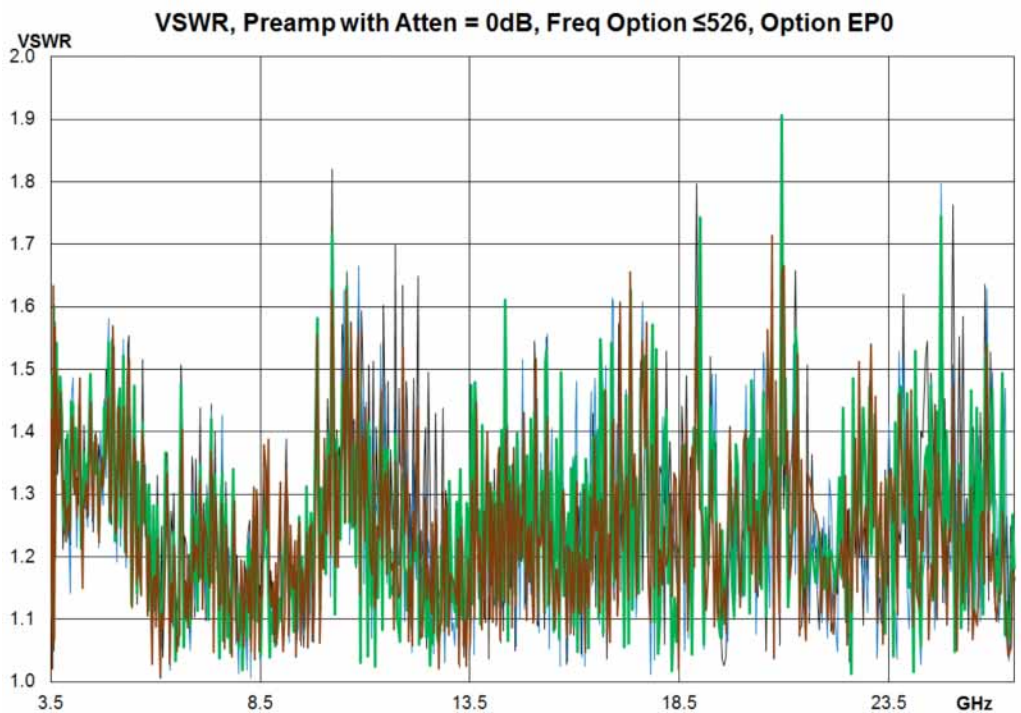


Noise Figure Measurement Application
General Specifications

Nominal VSWR – Preamp On Low Band with *Option EP0* [Plot]



Nominal VSWR – Preamp, Above 3.5 GHz with *Option EP0* [Plot]



31 Phase Noise Measurement Application

This chapter contains specifications for the N9068EM0E Phase Noise measurement application.

General Specifications

| Description | Specifications | Supplemental Information |
|----------------------------------|----------------|--------------------------|
| Maximum Carrier Frequency | | |
| <i>Option 503</i> | 3.6 GHz | |
| <i>Option 508</i> | 8.4 GHz | |
| <i>Option 513</i> | 13.6 GHz | |
| <i>Option 526</i> | 26.5 GHz | |
| <i>Option 544</i> | 44 GHz | |
| <i>Option 550</i> | 50 GHz | |

| Description | Specifications | Supplemental Information |
|------------------------------------|---|--------------------------|
| Measurement Characteristics | | |
| Measurements | Log plot, RMS noise, RMS jitter, Residual FM, Spot frequency | |

Phase Noise Measurement Application
General Specifications

| Description | Specifications | Supplemental Information |
|---|--|---|
| Measurement Accuracy Phase Noise Density Accuracy ^{ab} Offset < 1 MHz Offset ≥ 1 MHz Non-overdrive case ^c With Overdrive RMS Markers | ±0.26 dB ±0.16 dB | ±0.39 dB (nominal) See equation ^d |

- 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.
- Offset frequency errors also add amplitude errors. See the Offset frequency section, below.
- The phase noise density accuracy for the non-overdrive case is derived from warranted analyzer specifications. It applies whenever there is no overdrive. Overdrive occurs only for offsets of 1 MHz and greater, with signal input power greater than -10 dBm, and controls set to allow overdrive. The controls allow overdrive if the electronic attenuator option is licensed, Enable Elect Atten is set to On, Pre-Adjust for Min Clip is set to either Elect Atten Only or Elect-Mech Atten, and the carrier frequency plus offset frequency is <3.6 GHz.
The controls also allow overdrive if (in the Meas Setup > Advanced menu) the Overdrive with Mech Atten is enabled. With the mechanical attenuator only, the overdrive feature can be used with carriers in the high band path (>3.6 GHz). To prevent overdrive in all cases, set the overdrive with Mech Atten to disabled and the Enable Elect Atten to Off.
- The accuracy of an RMS marker such as "RMS degrees" is a fraction of the readout. That fraction, in percent, depends on the phase noise accuracy, in dB, and is given by $100 \times (10^{\text{PhaseNoiseDensityAccuracy} / 20} - 1)$. For example, with +0.30 dB phase noise accuracy, and with a marker reading out 10 degrees RMS, the accuracy of the marker would be +3.5% of 10 degrees, or +0.35 degrees.

Phase Noise Measurement Application
General Specifications

| Description | Specifications | Supplemental Information |
|---|--|--|
| Offset Frequency Range (Log Plot) Range (Spot Frequency) Accuracy Offset < 1 MHz Offset ≥ 1 MHz | 1 Hz to $(f_{\text{opt}} - f_{\text{CF}})$ 10 Hz up to $(f_{\text{opt}} - f_{\text{CF}})$ | f_{opt} : Maximum frequency determined by option ^a f_{CF} : Carrier frequency of signal under test Negligible error (nominal) $\pm(0.5\% \text{ of offset} + \text{marker resolution})$ (nominal) 0.5% of offset is equivalent to 0.0072 octave ^b |

- a. For example, f_{opt} is 3.6 GHz for *Option 503*.
b. 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.

| Description | Specifications | Supplemental Information |
|--|----------------|------------------------------|
| Amplitude Repeatability (No Smoothing, all offsets, default settings, including averages = 10) | | <1 dB (nominal) ^a |

- a. Standard deviation. The repeatability can be improved with the use of smoothing and increasing the number of averages.

Nominal Phase Noise at Different Center Frequencies

See the plot of core spectrum analyzer Nominal Phase Noise on [page 71](#).

32 Pulse Measurement Software

This chapter contains specifications for the N9067EM0E Pulse measurement software.

Pulse Measurement Accuracy

| Description | Specifications | Supplemental Information |
|-----------------------------|----------------|--|
| Amplitude and Timing | | Nominal |
| Top Level ^a | | ±0.2 dB + Absolute Amplitude Accuracy (CW) ±0.2 dB + Absolute Amplitude Accuracy + IF Frequency Response (Chirp) |
| On Level ^a | | ±0.1 dB + Absolute Amplitude Accuracy (CW) ±0.1 dB + Absolute Amplitude Accuracy + IF Frequency Response (Chirp) |
| Mean Level ^a | | ±0.1 dB + Absolute Amplitude Accuracy (CW) ±0.1 dB + Absolute Amplitude Accuracy + IF Frequency Response (Chirp) |
| Peak Level ^a | | ±0.2 dB + Absolute Amplitude Accuracy (CW) ±0.2 dB + Absolute Amplitude Accuracy + IF Frequency Response (Chirp) |
| Width ^a | | ±1/Sample Rate |
| PRI ^a | | ±1/Sample Rate |

a. SNR ≥30 dB, Pulse Width ≥100/IF Bandwidth.

Frequency and Phase

| Description | Specifications | Supplemental Information | |
|--|--|--|----------|
| Frequency Error RMS^a | | | |
| | Unmodulated pulsed signal^b | Chirp (linear chirp signal)^c | |
| | 20 to 30°C | Nominal | Nominal |
| CF 2 GHz | | | |
| <i>Option B2X</i> | ±100 kHz | ±55 kHz | ±70 kHz |
| <i>Option B5X^d</i> | ±260 kHz | ±160 kHz | ±160 kHz |
| CF 10 GHz ^e | | | |
| <i>Option B2X</i> | ±160 kHz | ±85 kHz | ±85 kHz |
| <i>Option B5X^d</i> | ±410 kHz | ±240 kHz | ±250 kHz |
| CF 20 GHz ^f | | | |
| <i>Option B2X</i> | ±300 kHz | ±150 kHz | ±140 kHz |
| <i>Option B5X^d</i> | ±820 kHz | ±430 kHz | ±400 kHz |
| Frequency Pulse to Pulse Difference^g | | | |
| CF 2 GHz | | | |
| <i>Option B2X</i> | ±200 kHz | ±65 kHz | ±80 kHz |
| <i>Option B5X^d</i> | ±550 kHz | ±190kHz | ±210 kHz |
| CF 10 GHz ^e | | | |
| <i>Option B2X</i> | ±350 kHz | ±100 kHz | ±120 kHz |
| <i>Option B5X^d</i> | ±850 kHz | ±280 kHz | ±320 kHz |
| CF 20 GHz ^f | | | |
| <i>Option B2X</i> | ±660 kHz | ±200 kHz | ±210 kHz |
| <i>Option B5X^d</i> | ±1800 kHz | ±520 kHz | ±580 kHz |
| Phase Pulse to Pulse Difference | | | |
| CF 2 GHz | | | |
| <i>Option B2X</i> | ±0.45° | ±0.2° | ±0.25° |
| <i>Option B5X^d</i> | ±0.6° | ±0.25° | ±0.3° |

Pulse Measurement Software
Frequency and Phase

| Description | Specifications | Supplemental Information | |
|-------------------------|----------------|--------------------------|-------|
| CF 10 GHz ^e | | | |
| Option B2X | ±0.95° | ±0.45° | ±0.5° |
| Option B5X ^d | ±1.0° | ±0.4° | ±0.5° |
| CF 20 GHz ^f | | | |
| Option B2X | ±1.6° | ±0.7° | ±0.8° |
| Option B5X ^d | ±1.9° | ±0.8° | ±0.9° |

- a. Frequency/Phase Analysis setup:
Width = 50%
- b. Atten = 0 dB, IF Gain = Auto.
Signal condition:
Pulse on Power = -10 dBm
Pulse Width ≥ 100/IF Bandwidth
Modulation Setup:
FM Filter Bandwidth = 20%
- c. Atten = 0 dB, IF Gain = Auto.
Signal condition
Pulse on power = -10 dBm
Pulse Width ≥ 1000/IF Bandwidth
Chirp Deviation ≤ 80% of IF Bandwidth
Modulation setup
FM Filter Bandwidth = 20%.
- d. Requires *Option EPO*.
- e. *Option LNP* reduces losses that occur before noise-setting and compressive stages. As a result, the sensitivity improves by about 6 dB, but the maximum signal handling ability falls by the same amount.
- f. Footnote d applies except to the extent of 8 dB.
- g. Pulse to Pulse Analysis setup:
Reference Time = Center
Offset = 0.0 s
Window Length = 0.0 s

33 Short Range Communications Measurement Application

This chapter contains specifications for the N9084EM0E Short Range Communications Measurement Application, which has two major measurement applications:

- ZigBee (IEEE 802.15.4)
- Z-Wave (ITU-T G.9959)

ZigBee (IEEE 802.15.4) Measurement Application

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| EVM (Modulation Accuracy) ZigBee O-QPSK (2450 MHz) ZigBee BPSK (868/950 MHz) ZigBee BPSK (915 MHz) | | 0.25% Offset EVM (nominal) 0.50% (nominal) 0.50% (nominal) |
| Frequency Error Range ZigBee O-QPSK (2450 MHz) ZigBee BPSK (868/950 MHz) ZigBee BPSK (915 MHz) | | ±80 ppm (nominal) ±50 ppm (nominal) ±80 ppm (nominal) |
| Accuracy ZigBee O-QPSK (2450 MHz) ZigBee BPSK (868/950 MHz) ZigBee BPSK (915 MHz) | | ± 1 Hz+tfa ^a (nominal) ± 1 Hz+tfa ^a (nominal) ± 1 Hz+tfa ^a (nominal) |

a. tfa = transmitter frequency × frequency reference accuracy.

Z-Wave (ITU-T G.9959) Measurement Application

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| FSK Error Z-Wave R1 FSK (9.6 kbps) Z-Wave R2 FSK (40 kbps) Z-Wave R3 FSK (100 kbps) | | 0.58% (nominal) 0.78% (nominal) 0.80% (nominal) |
| Frequency Error Range Z-Wave R1 FSK (9.6 kbps) Z-Wave R2 FSK (40 kbps) Z-Wave R3 FSK (100 kbps) | | ±60 ppm (nominal) ±60 ppm (nominal) ±60 ppm (nominal) |
| Accuracy Z-Wave R1 FSK (9.6 kbps) Z-Wave R2 FSK (40 kbps) Z-Wave R3 FSK (100 kbps) | | ± 50 Hz+tfa ^a (nominal) ± 50 Hz+tfa ^a (nominal) ± 50 Hz+tfa ^a (nominal) |

a. tfa = transmitter frequency × frequency reference accuracy.

34 Vector Modulation Analysis Application

This chapter contains specifications for the N9054C Vector Modulation Analysis Measurement Application. Model numbers of the Vector Modulation Analyzer Mode are N9054EM0E (Flexible Digital Demod) and N9054EM1E (Custom OFDM).

This application supports the following:

PSK formats: BPSK, QPSK, Offset QPSK, Shaped OQPSK, DQPSK, $\pi/4$ DQPSK, 8-PSK, $\pi/8$ D8PSK, D8PSK;

QAM formats: 16/32/64/128/256/512/1024-QAM;

FSK formats: 2/4/8/16-FSK;

MSK formats: MSK Type 1, MSK Type 2;

ASK formats: 2-ASK;

APSK formats: 16/32 APSK;

VSB formats: 8/16-VSB;

Other formats: CPM (FM), EDGE.

The following measurements are supported in this application:

- Digital Demod
- Monitor Spectrum
- IQ Waveform
- Custom OFDM
- Channel Power
- Occupied BW
- Power Stat CCDF
- Adjacent Channel Power
- Spectrum Emission Mask
- Spurious Emissions

Frequency

| Description | Specifications | Supplemental Information |
|--------------|----------------|--|
| Range | | See “Frequency Range” on page 20. |

Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Modulation Analysis Maximum Demodulation BW 40 MHz (Standard) 1 GHz (<i>Option H1G</i>) Residual EVM Symbol Rate ^a 1 MSa/s 10 MSa/s 25 MSa/s 100 MSa/s Residual EVM for MSK Symbol Rate ^a 10 MSa/s 80 MSa/s | | Modulation formats include BPSK, QPSK, DQPSK, $\pi/4$ DQPSK, 8-PSK, $\pi/8$ D8PSK, D8PSK, 16/32/64/128/256/512/1024-QAM; Center Frequency = 1 GHz; Transmit filter is RRC with $\alpha = 0.35$; Result length set to at least 150 symbols, or $3 \times$ Number of ideal constellation states; Average number = 10. 0.50% (nominal) 0.50% (nominal) 0.70% (nominal) 1.00% (nominal) Modulation formats include MSK Type 1 and MSK Type 2; Center Frequency = 1 GHz; Transmit filter is Gaussian with BT = 0.3; Result length set to 150 symbols; Average number = 10. 0.50% (nominal) 1.40% (nominal) |

Vector Modulation Analysis Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Residual EVM for VSB Symbol Rate ^a 10.762 MHz | | Modulation formats include 8-VSB and 16-VSB; Transmit filter is RRC with $\alpha = 0.115$; Center Frequency < 3.6 GHz; Result length = 800; Average number = 10. 1.50% (SNR 36 dB) (nominal) |

a. Supportable symbol rate is dependent on the analyzer hardware bandwidth option.

35 W-CDMA Measurement Application

This chapter contains specifications for the N9073EM0E W-CDMA/HSPA/HSPA+ measurement application. It contains N9073EM0E -1FP W-CDMA, N9073EM0E -2FP HSPA and N9073EM0E -3FP HSPA+ measurement applications.

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 range documented in In-Band Frequency Range.

The specifications for this chapter apply only to instruments with Frequency *Option 508, 513 or 526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different between instruments with the higher frequency options. 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

| 3GPP Standard Sections Sub-Clause Measurement Name | | 3GPP Required Test Instrument Tolerance (as of 2009-12) | Instrument Tolerance Interval ^{abc} | Supplemental Information |
|---|---|--|--|---------------------------------------|
| 6.2.1 | Maximum Output Power (Channel Power) | ±0.7 dB (95%) | ±0.19 dB (95%) | Excluding timebase error |
| 6.2.2 | CPICH Power Accuracy (Code Domain) | ±0.8 dB (95%) | ±0.20 dB (95%) | |
| 6.3 | Frequency Error (Modulation Accuracy) | ±12 Hz (95%) | ±5 Hz (100%) | |
| 6.4.2 | Power Control Steps ^d (Code Domain) | | | |
| | 1 dB step | ±0.1 dB (95%) | ±0.03 dB (100%) | |
| | Ten 1 dB steps | ±0.1 dB (95%) | ±0.03 dB (100%) | |
| 6.4.3 | Power Dynamic Range | ±1.1 dB (95%) | ±0.14 dB (100%) | |
| 6.4.4 | Total Power Dynamic Range ^d (Code Domain) | ±0.3 dB (95%) | ±0.06 dB (100%) | Absolute peak ^e |
| 6.5.1 | Occupied Bandwidth | ±100 kHz (95%) | ±10 kHz (100%) | |
| 6.5.2.1 | Spectrum Emission Mask | ±1.5 dB (95%) | ±0.21 dB (95%) | |
| 6.5.2.2 | ACLR | | | |
| | 5 MHz offset | ±0.8 dB (95%) | ±0.28 dB (100%) | |
| | 10 MHz offset | ±0.8 dB (95%) | ±0.25 dB (100%) | |
| 6.5.3 | Spurious Emissions | | | |
| | f ≤ 2.2 GHz | ±1.5 dB (95%) | ±0.19 dB (95%) | |
| | 2.2 GHz < f ≤ 4 GHz | ±2.0 dB (95%) | ±1.09 dB (95%) | |
| | 4 GHz < f | ±4.0 dB (95%) | ±1.48 dB (95%) | |
| 6.7.1 | EVM (Modulation Accuracy) | ±2.5% (95%) | ±0.5% (100%) | EVM in the range of 12.5% to 22.5% |
| 6.7.2 | Peak Code Domain Error (Modulation accuracy) | ±1.0 dB (95%) | ±1.0 dB (100%) | |
| 6.7.3 | Time alignment error in Tx Diversity (Modulation Accuracy) | ±26 ns (95%) [= 0.1 T _c] | ±1.25 ns (100%) | |

- 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.

W-CDMA Measurement Application
Conformance with 3GPP TS 25.141 Base Station Requirements

- 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. These measurements are obtained by utilizing the code domain power function or general instrument capability. The tolerance limits given represent instrument capabilities.
- e. 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 Keysight's interpretation of the current standards and is subject to change.

Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|--------------------------|
| Channel Power | | |
| Minimum power at RF Input | | –50 dBm (nominal) |
| Absolute power accuracy ^a (20 to 30°C, Atten = 10 dB) | ±0.61 dB | |
| 95th percentile Absolute power accuracy (20 to 30°C, Atten = 10 dB) | | ±0.19 dB |
| Measurement floor | | –85.8 dBm (nominal) |
| Measurement floor (<i>Option EP0</i>) | | –83.8 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.

W-CDMA Measurement Application
Measurements

| Description | | Specifications | Supplemental Information |
|--|--------------------|----------------|---|
| Adjacent Channel Power (ACPR; ACLR) | | | |
| Single Carrier | | | |
| Minimum power at RF Input | | | –36 dBm (nominal) |
| ACPR Accuracy ^{ab} | | | RRC weighted, 3.84 MHz noise bandwidth, method = IBW or Fast ^c |
| Radio | Offset Freq | | |
| MS (UE) | 5 MHz | ±0.09 dB | At ACPR range of –30 to –36 dBc with optimum mixer level ^d |
| MS (UE) | 10 MHz | ±0.09 dB | At ACPR range of –40 to –46 dBc with optimum mixer level ^e |
| BTS | 5 MHz | ±0.25 dB | At ACPR range of –42 to –48 dBc with optimum mixer level ^f |
| BTS | 10 MHz | ±0.18 dB | At ACPR range of –47 to –53 dBc with optimum mixer level ^e |
| BTS | 5 MHz | ±0.10 dB | At –48 dBc non-coherent ACPR ^g |
| <i>Option EPO</i> | | | |
| Radio | Offset Freq | | |
| MS (UE) | 5 MHz | ±0.09 dB | At ACPR range of –30 to –36 dBc with optimum mixer level ^d |
| MS (UE) | 10 MHz | ±0.11 dB | At ACPR range of –40 to –46 dBc with optimum mixer level ^e |
| BTS | 5 MHz | ±0.28 dB | At ACPR range of –42 to –48 dBc with optimum mixer level ^f |
| BTS | 10 MHz | ±0.25 dB | At ACPR range of –47 to –53 dBc with optimum mixer level ^e |
| BTS | 5 MHz | ±0.12 dB | At –48 dBc non-coherent ACPR ^g |

W-CDMA Measurement Application
Measurements

| Description | | | | Specifications | Supplemental Information | | |
|---|-------------|--------------|--|----------------|--|------------------------------|-----------------------------------|
| Adjacent Channel Power (cont.) (ACPR; ACLR) | | | | | | | |
| Dynamic Range | | | | | RRC weighted, 3.84 MHz noise bandwidth | | |
| Noise Correction ^h | Offset Freq | Method | | | Typical ⁱ Dynamic Range | (EPO) (typical) ⁱ | Optimum ML (nominal) |
| off | 5 MHz | Filtered IBW | | | −81.5 dB | −80 dB | −8 dBm |
| off | 5 MHz | Fast | | | −81.0 dB | −80 dB | −8 dBm |
| off | 10 MHz | Filtered IBW | | | −87.0 dB | −86 dB | −4 dBm |
| on | 5 MHz | Filtered IBW | | | −82.5 dB | −81.5 dB | −8 dBm |
| on | 5 MHz | Filtered IBW | | | −88 dB (note ^j) | | −8 dBm |
| on | 10 MHz | Filtered IBW | | | −88.0 dB | −87 dB | −4 dBm |
| RRC Weighting Accuracy ^k | | | | | | | |
| White noise in Adjacent Channel | | | | | 0.00 dB (nominal) | | |
| TOI-induced spectrum | | | | | 0.001 dB (nominal) | | |
| rms CW error | | | | | 0.012 dB (nominal) | | |
| Multiple Carriers | | | | | RRC weighted, 3.84 MHz noise bandwidth. All specifications apply for 5 MHz offset. | | |
| Two Carriers | | | | | | | |
| ACPR Dynamic Range | | | | | −83 dB, NC on (nominal) | | |
| ACPR Accuracy | | | | | ±0.20 dB (nominal) | | |
| Four Carriers | | | | | Dynamic range (nominal) | | Optimum ML ^l (nominal) |
| ACPR Dynamic Range | | | | | | | |
| Noise Correction (NC) and NFE off | | | | | −69 dB | −8 dBm | |
| Noise Correction (NC) on | | | | | −79 dB | −12 dBm | |
| ACPR Accuracy, BTS, Incoherent TOI ^m | | | | | UUT ACPR Range | | |
| Noise Correction (NC) off ⁿ | | | | ±0.18 dB | −42 to −48 dB | | −12 dBm |
| Noise Correction (NC) off ⁿ (Option EPO) | | | | ±0.23 dB | | | |
| Noise Correction (NC) on | | | | ±0.09 dB | −42 to −48 dB | | −15 dBm |

W-CDMA Measurement Application Measurements

- a. 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 $-37 \text{ dBm} - (\text{ACPR}/3)$, where the ACPR is given in (negative) decibels.
- b. Accuracy is specified without NC or NFE. NC or NFE will make the accuracy even better.
- c. The Fast method has a slight decrease in accuracy in only one case: for BTS measurements at 5 MHz offset, the accuracy degrades by $\pm 0.01 \text{ dB}$ relative to the accuracy shown in this table.
- d. To meet this specified accuracy when measuring mobile station (MS) or user equipment (UE) within 3 dB of the required -33 dBc ACPR, the mixer level (ML) must be optimized for accuracy. This optimum mixer level is -22 dBm , so the input attenuation must be set as close as possible to the average input power $- (-22 \text{ dBm})$. For example, if the average input power is -6 dBm , set the attenuation to 16 dB. This specification applies for the normal 3.5 dB peak-to-average ratio of a single code. Note that if the mixer level is set to optimize dynamic range instead of accuracy, accuracy errors are nominally doubled.
- e. ACPR accuracy at 10 MHz offset is warranted when the input attenuator is set to give an average mixer level of -14 dBm .
- f. 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 so the input attenuation must be set as close as possible to the average input power $- (-18 \text{ dBm})$. For example, if the average input power is -4 dBm , set the attenuation to 14 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.
- g. Accuracy can be excellent even at low ACPR levels assuming that the user sets the mixer level to optimize the dynamic range, and assuming that the analyzer and UUT distortions are incoherent. When the errors from the UUT and the analyzer are incoherent, optimizing dynamic range is equivalent to minimizing the contribution of analyzer noise and distortion to accuracy, though the higher mixer level increases the display scale fidelity errors. This incoherent addition case is commonly used in the industry and can be useful for comparison of analysis equipment, but this incoherent addition model is rarely justified. This derived accuracy specification is based on a mixer level of -14 dBm .
- h. The dynamic range shown with Noise Correction = Off applies with Noise Floor Extension On. (Noise Correction is the process within the measurement of making a calibration of the noise floor at the exact analyzer settings used for the measurement. Noise Floor Extension is the factory calibration of the noise floor.)
- i. Keysight measures 100% of the signal analyzers for dynamic range in the factory production process. This measurement requires a near-ideal signal, which is impractical for field and customer use. Because field verification is impractical, Keysight only gives a typical result. More than 80% of prototype instruments met this "typical" specification; the factory test line limit is set commensurate with an on-going 80% yield to this typical. The ACPR dynamic range is verified only at 2 GHz, where Keysight has the near-perfect signal available. The dynamic range is specified for the optimum mixer drive level, which is different in different instruments and different conditions. The test signal is a 1 DPCH signal. The ACPR dynamic range is the observed range. This typical specification includes no measurement uncertainty.
- j. All three early production units hand-measured had performance better than 88 dB with a test signal even better than the "near-ideal" one used for statistical process control in production mentioned in the footnoteⁱ above. Therefore, this value can be considered "Nominal," not "Typical," by the definitions used within this document. These observations were done near 2 GHz, because that is a common W-CDMA operation region. It is also a region in which the analyzer third-order dynamic range is near its best.

W-CDMA Measurement Application Measurements

- k. 3GPP requires the use of a root-raised-cosine filter in evaluating the ACLR of a device. The accuracy of the pass-band 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 with the IBW method and also used for all testing with the Fast method, and 0.000 dB for the 30 kHz RBW filter used for BTS testing with the IBW method. 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 with the IBW method and also used for all testing with the Fast method, 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.
- l. Optimum mixer level (MLOpt). The mixer level is given by the average power of the sum of the four carriers minus the input attenuation.
- m. Incoherent TOI means that the specified accuracy only applies when the distortions of the device under test are not coherent with the third-order distortion of the analyzer. Incoherence is often the case with advanced multicarrier amplifiers built with compensations and predistortions that mostly eliminate coherent third-order affects in the amplifier.
- n. Accuracy is specified without NFE. With NFE, the accuracy will be closer to that with NC, and the optimum mixer level will be close to that for NC.

| Description | Specifications | Supplemental Information |
|------------------------------|----------------------|--------------------------|
| Power Statistics CCDF | | |
| Histogram Resolution | 0.01 dB ^a | |

- 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.

W-CDMA Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---------------------------|----------------|--|
| Occupied Bandwidth | | |
| Minimum power at RF Input | | –30 dBm (nominal) |
| Frequency Accuracy | ±10 kHz | RBW = 30 kHz, Number of Points = 1001, span = 10 MHz |

| Description | Specifications | Supplemental Information |
|--|----------------|----------------------------|
| Spectrum Emission Mask | | |
| Dynamic Range, relative (2.515 MHz offset ^{ab}) | 86.9 dB | 91.8 dB (typical) |
| Dynamic Range, relative (<i>Option EPO</i>) (2.515 MHz offset ^{ab}) | 85.0 dB | 89.6 dB (typical) |
| Sensitivity, absolute (2.515 MHz offset ^c) | –103.7 dBm | –106.7 dBm (typical) |
| Sensitivity, absolute (<i>Option EPO</i>) (2.515 MHz offset ^c) | –101.7 dBm | –104.7 dBm (typical) |
| Accuracy (2.515 MHz offset) | | |
| Relative ^d | ±0.08 dB | |
| Absolute ^e (20 to 30°C) | ±0.62 dB | ±0.21 dB (95th percentile) |

- 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.
- 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.
- 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.
- 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.
- The absolute accuracy of SEM measurement is the same as the absolute accuracy of the spectrum analyzer. See **“Absolute Amplitude Accuracy” on page 40** for more information. The numbers shown are for 0 to 3.6 GHz, with attenuation set to 10 dB.

W-CDMA Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Spurious Emissions | | Table-driven spurious signals; search across regions |
| Dynamic Range ^a , relative (RBW=1 MHz) | 88.8 dB | 91.8 dB (typical) |
| Dynamic Range ^a , relative (RBW=1 MHz) (Option EP0) | 86.9 dB | 89.9 dB (typical) |
| Sensitivity ^b , absolute (RBW=1 MHz) | −88.5 dBm | −91.5 dBm (typical) |
| Sensitivity ^b , absolute (RBW=1 MHz) (Option EP0) | −86.5 dBm | −89.5 dBm (typical) |
| Accuracy (Attenuation = 10 dB) | | |
| Frequency Range | | |
| 20 Hz to 3.6 GHz | | ±0.19 dB (95th percentile) |
| 3.5 to 8.4 GHz | | ±1.09 dB (95th percentile) |
| 3.5 to 8.4 GHz (<i>Option EP0</i>) | | ±1.15 dB (95th percentile) |
| 8.3 to 13.6 GHz | | ±1.48 dB (95th percentile) |
| 8.3 to 13.6 GHz (<i>Option EP0</i>) | | ±1.52 dB (95th percentile) |

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

W-CDMA Measurement Application

[illegible]

- a. ML (mixer level) is RF input power minus attenuation.
- b. Code Domain Power Absolute accuracy is calculated as sum of 95% Confidence Absolute Amplitude Accuracy and Code Domain relative accuracy at Code Power level.

W-CDMA Measurement Application

| Description | Specifications | Supplemental Information |
|---|--|---|
| QPSK EVM | | |
| ($-25 \text{ dBm} \leq \text{ML}^{\text{a}} \leq -15 \text{ dBm}$ 20 to 30°C) | | RF input power and attenuation are set to meet the Mixer Level range. |
| EVM | | |
| Range | | 0 to 25% (nominal) |
| Floor | 1.5% | |
| Accuracy ^b | $\pm 1.0\%$ | |
| I/Q origin offset | | |
| DUT Maximum Offset | | -10 dBc (nominal) |
| Analyzer Noise Floor | | -50 dBc (nominal) |
| Frequency error | | |
| Range | | $\pm 30 \text{ kHz}$ (nominal) ^c |
| Accuracy | $\pm 5 \text{ Hz} + \text{tfa}^{\text{d}}$ | |

- a. ML (mixer level) is RF input power minus attenuation.
- b. The accuracy specification applies when the EVM to be measured is well above the measurement floor and successfully synchronized to the signal. 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.
- c. This specifies a synchronization range with CPICH for CPICH only signal.
- d. $\text{tfa} = \text{transmitter frequency} \times \text{frequency reference accuracy}$

W-CDMA Measurement Application

| Description | Specifications | Supplemental Information |
|--|--------------------------|---|
| Modulation Accuracy (Composite EVM) | | |
| (BTS Measurements −25 dBm ≤ ML ^a ≤ −15 dBm 20 to 30°C) Composite EVM | | RF input power and attenuation are set to meet the Mixer Level range. |
| Range | 0 to 25% | |
| Floor | 1.5% | |
| Floor (with <i>Option BBA</i>) | | 1.5% (nominal) |
| Accuracy ^b | | |
| Overall | ±1.0% ^c | |
| Limited circumstances (12.5% ≤ EVM ≤ 22.5%, No 16QAM nor 64QAM codes) | ±0.5% | |
| Peak Code Domain Error | | |
| Accuracy | ±1.0 dB | |
| I/Q Origin Offset | | |
| DUT Maximum Offset | | −10 dBc (nominal) |
| Analyzer Noise Floor | | −50 dBc (nominal) |
| Frequency Error | | |
| Range | | ±3 kHz (nominal) ^d |
| Accuracy | ±5 Hz + tfa ^e | |
| Time offset | | |
| Absolute frame offset accuracy | ±20 ns | |
| Relative frame offset accuracy | | ±5.0 ns (nominal) |
| Relative offset accuracy (for STTD diff mode) ^f | ±1.25 ns | |

- a. ML (mixer level) is RF input power minus attenuation.
- b. For 16 QAM or 64 QAM modulation, the relative code domain error (RCDE) must be better than -16 dB and -22 dB respectively.

W-CDMA Measurement Application Measurements

- c. 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%.
- d. This specifies a synchronization range with CPICH for CPICH only signal.
- e. $\text{tfa} = \text{transmitter frequency} \times \text{frequency reference accuracy}$
- f. 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 ± 0.1 chips.

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

In-Band Frequency Range

| Operating Band | UL Frequencies UE transmit, Node B receive | DL Frequencies UE receive, Node B transmit |
|----------------|--|--|
| I | 1920 to 1980 MHz | 2110 to 2170 MHz |
| II | 1850 to 1910 MHz | 1930 to 1990 MHz |
| III | 1710 to 1785 MHz | 1805 to 1880 MHz |
| IV | 1710 to 1755 MHz | 2110 to 2155 MHz |
| V | 824 to 849 MHz | 869 to 894 MHz |
| VI | 830 to 840 MHz | 875 to 885 MHz |
| VII | 2500 to 2570 MHz | 2620 to 2690 MHz |
| VIII | 880 to 915 MHz | 925 to 960 MHz |
| IX | 1749.9 to 1784.9 MHz | 1844.9 to 1879.9 MHz |
| X | 1710 to 1770 MHz | 2110 to 2170 MHz |
| XI | 1427.9 to 1452.9 MHz | 1475.9 to 1500.9 MHz |
| XII | 698 to 716 MHz | 728 to 746 MHz |
| XIII | 777 to 787 MHz | 746 to 756 MHz |
| XIV | 788 to 798 MHz | 758 to 768 MHz |

W-CDMA Measurement Application
In-Band Frequency Range

36 WLAN Measurement Application

This chapter contains specifications for the N9077EM0E/EM1E WLAN measurement application.

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 the variations.

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

Different IEEE radio standard requires relative minimum hardware bandwidth for OFDM analysis:

802.11a/b/g/p, 11n (20 MHz), 11ac (20 MHz) or 11ax (20 MHz) require N9030B-B25 or above.

802.11n (40 MHz), 11ac (40 MHz) or 11ax (40 MHz) require N9030B-B40 or above.

802.11ac (80 MHz) or 11ax (80 MHz) require N9030B-B85 or above.

802.11ac (160 MHz) or 11ax (160 MHz) require N9030B-B1X.

802.11ah 1M/2M/4M/8M/16M requires N9030B-B25 or above.

802.11af 6M/7M/8M requires N9030A-B25 or above.

Measurements

| Description | Specifications | | Supplemental Information | |
|---|--------------------|----------------|--|----------------------------|
| Channel Power 20 MHz Integration BW | | | Radio standards are: 802.11a/g/j/p (OFDM) or 802.11g (DSSS-OFDM) or 802.11n (20 MHz) or 802.11ac (20 MHz), 5 GHz band 802.11ax (20 MHz) 2.4 GHz band and 5 GHz band | |
| Minimum power at RF Input | | | –50 dBm (nominal) | |
| | Center Freq | | Center Freq | |
| | 2.4 GHz | 5.0 GHz | 2.4 GHz | 5.0 GHz |
| Absolute Power Accuracy ^a (20 to 30°C) | ±0.63 dB | ±1.78 dB | ±0.19 dB (95th percentile) | ±0.41 dB (95th percentile) |
| Absolute Power Accuracy ^a (Option EP0) (20 to 30°C) | ±0.63 dB | ±1.78 dB | ±0.19 dB (95th percentile) | ±0.56 dB (95th percentile) |
| Measurement floor | | | –78.7 dBm (typical) | –76.7 dBm (typical) |
| Measurement floor (Option EP0) | | | –76.7 dBm (typical) | –76.7 dBm (typical) |

- 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 the measurement floor contribution is negligible.

| Description | Specifications | | Supplemental Information | |
|---|--------------------|----------------|---|----------------------------|
| Channel Power 40 MHz Integration BW | | | Radio standard is: 802.11n (40 MHz) or 802.11ac (40 MHz), 5 GHz band 802.11ax (40 MHz) 2.4 GHz band and 5 GHz band | |
| Minimum power at RF Input | | | –50 dBm (nominal) | |
| | Center Freq | | Center Freq | |
| | 2.4 GHz | 5.0 GHz | 2.4 GHz | 5.0 GHz |
| Absolute Power Accuracy ^a (20 to 30°C) | ±0.63 dB | ±1.78 dB | ±0.19 dB (95th percentile) | ±0.41 dB (95th percentile) |
| Absolute Power Accuracy ^a (Option EP0) (20 to 30°C) | ±0.63 dB | ±1.78 dB | ±0.19 dB (95th percentile) | ±0.56 dB (95th percentile) |
| Measurement floor | | | –75.7 dBm (typical) | –73.7 dBm (typical) |
| Measurement floor (Option EP0) | | | –73.7 dBm (typical) | –73.7 dBm (typical) |

WLAN Measurement Application Measurements

- 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 the measurement floor contribution is negligible.

| Description | Specifications | Supplemental Information |
|--|---|---|
| Channel Power 22 MHz Integration BW Minimum power at RF Input Absolute Power Accuracy ^a (20 to 30°C) Measurement floor Measurement floor (<i>Option EPO</i>) | ± 0.63 dB | Radio standard is: 802.11b/g (DSSS/CCK/PBCC) Center Frequency in 2.4 GHz Band -50 dBm (nominal) ± 0.19 dB (95th percentile) -78.3 dBm (typical) -76.3 dBm (typical) |

- 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 the measurement floor contribution is negligible.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Channel Power 80 MHz Integration BW Minimum power at RF Input Absolute Power Accuracy ^a (20 to 30°C) Measurement floor | | Radio standard is: 802.11ax (80 MHz) Center Frequency in 2.4 GHz Band –50 dBm (nominal) –72.7 dBm (typical) |

- 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 the measurement floor contribution is negligible.

| Description | Specifications | Supplemental Information |
|---|--------------------------------------|---|
| Channel Power 80 MHz Integration BW Minimum power at RF Input Absolute Power Accuracy ^a (20 to 30°C) Absolute Power Accuracy ^a (<i>Option EP0</i>) (20 to 30°C) Measurement floor | ±1.78 dB ±1.78 dB | Radio standard are: 802.11ac (80 MHz) or 802.11ax (80 MHz) Center Frequency in 5.0 GHz Band –50 dBm (nominal) ±0.41 dB (95th percentile) ±0.56 dB (95th percentile) –70.7 dBm (typical) |

- 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 the measurement floor contribution is negligible.

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Channel Power 160 MHz Integration BW Minimum power at RF Input Absolute Power Accuracy ^a (20 to 30°C) Measurement floor | | Radio standard is: 802.11ax (160 MHz) Center Frequency in 2.4 GHz Band –50 dBm (nominal) –67.7 dBm (typical) |

- 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 the measurement floor contribution is negligible.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|--|---|
| Channel Power 160 MHz Integration BW Minimum power at RF Input Absolute Power Accuracy ^a (20 to 30°C) Absolute Power Accuracy ^a (<i>Option EP0</i>) (20 to 30°C) Measurement floor | ±1.78 dB ±1.78 dB | Radio standard are: 802.11ac (160 MHz) or 802.11ax (160 MHz) Center Frequency in 5.0 GHz Band –50 dBm (nominal) ±0.41 dB (95th percentile) ±0.56 dB (95th percentile) –67.7 dBm (typical) |

- 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 the measurement floor contribution is negligible.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Channel Power | | Radio standard is: 802.11af 6M/7M/8M |
| Minimum power @ RF Input | | –50 dBm (nominal) |
| Integration BW | | |
| 802.11af 6M | 6 MHz | |
| 802.11af 7M | 7 MHz | |
| 802.11af 8M | 8 MHz | |
| Absolute Power Accuracy ^a (20 to 30°C) for 802.11af 6M/7M/8M | ±0.63 dB | ±0.19 dB (95th percentile) |
| Measurement floor | | Typical |
| 802.11af 6M | | – 83.96 dBm |
| 802.11af 7M | | – 83.29 dBm |
| 802.11af 8M | | – 82.71 dBm |

- 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 the measurement floor contribution is negligible.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|--------------------------------|
| Channel Power | | Radio standard is: 802.11ah |
| Integration BW | | |
| 802.11ah 1M | 1 MHz | |
| 802.11ah 2M | 2 MHz | |
| 802.11ah 4M | 4 MHz | |
| 802.11ah 8M | 8 MHz | |
| 802.11ah 16M | 16 MHz | |
| Minimum power @ RF Input 802.11ah 1M/2M/4M/8M/16M | | – 50 dBm (nominal) |
| Absolute Power Accuracy ^a (20 to 30°C) for 802.11ah 1M/2M/4M/8M/16M | ±0.63 dB | ±0.19 dB (95th percentile) |
| Measurement floor | | Typical |
| 802.11ah 1M | | – 91.74 dBm |
| 802.11ah 2M | | – 88.73 dBm |
| 802.11ah 4M | | – 85.72 dBm |
| 802.11ah 8M | | – 82.71 dBm |
| 802.11ah 16M | | – 79.70 dBm |
| Measurement floor (<i>Option EPO</i>) | | |
| 802.11ah 1M | | – 89.74 dBm |
| 802.11ah 2M | | – 86.73 dBm |
| 802.11ah 4M | | – 83.72 dBm |
| 802.11ah 8M | | – 80.71 dBm |
| 802.11ah 16M | | – 77.70 dBm |

- 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 the measurement floor contribution is negligible.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|------------------------------|----------------------|---|
| Power Statistics CCDF | | Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11b/g (DSSS/CCK/PBCC), 802.11n (20 MHz), 802.11n (40 MHz), 802.11ac (20 MHz), or 802.11ax (20 MHz) 802.11ac (40 MHz), or 802.11ax (40 MHz) 802.11ac (80 MHz) or 802.11ac (160 MHz) Center Frequency in 2.4 GHz Band or 5.0 GHz Band |
| Minimum power at RF Input | | -50 dBm (nominal) |
| Histogram Resolution | 0.01 dB ^a | |

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

| Description | Specifications | Supplemental Information |
|------------------------------|----------------------|---|
| Power Statistics CCDF | | Radio standards are: 802.11af 6M/7M/8M |
| Minimum power at RF Input | | -50 dBm (nominal) |
| Histogram Resolution | 0.01 dB ^a | |

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

| Description | Specifications | Supplemental Information |
|------------------------------|----------------------|--|
| Power Statistics CCDF | | Radio standards are: 802.11ah 1M/2M/4M/8M/16M |
| Minimum power at RF Input | | -50 dBm (nominal) |
| Histogram Resolution | 0.01 dB ^a | |

- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|-------------------------------------|--|
| Occupied Bandwidth Minimum power at RF Input Frequency accuracy | ±25 kHz | Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11b/g (DSSS/CCK/PBCC), 802.11n (20 MHz), 802.11n (40 MHz), 802.11ac (20 MHz), 802.11ac (40 MHz), 802.11ac (80 MHz), or 802.11ax (80 MHz) 802.11ac (160 MHz) or 802.11ax (160 MHz) Center Frequency in 2.4 GHz Band or 5.0 GHz Band -30 dBm (nominal) RBW = 100 kHz Number of Points = 1001 Span = 25 MHz |

| Description | Specifications | Supplemental Information |
|--|-------------------------------------|---|
| Occupied Bandwidth Minimum power at RF Input Frequency accuracy | ±20 kHz | Radio standards are: 802.11ah 1M/2M/4M/8M/16M -30 dBm (nominal) RBW = 10 kHz Number of Points = 1001 Span = 20 MHz |

| Description | Specifications | Supplemental Information |
|---|-------------------------------------|---|
| Power vs. Time Measurement results type Average Type Measurement Time Dynamic Range Dynamic Range (<i>Option EP0</i>) | 0.01 dB | Radio standard is: 802.11b/g (DSSS/CCK/PBCC) Center Frequency in 2.4 GHz Band Min, Max, Mean Off, RMS, Log Up to 88 ms 64.0 dB (nominal) 62.0 dB (nominal) |

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| Spectrum Emission Mask (18 MHz Transmission BW RBW = 100 kHz 11.0 MHz offset) | | Radio standards are: 802.11a/g/j/p (OFDM) 802.11g (DSSS-OFDM) or 802.11n (20 MHz) Center Frequency in 2.4 GHz Band |
| Dynamic Range, relative ^{ab} | 83.7 dB | 87.2 dB (typical) |
| Dynamic Range, relative ^{ab} (<i>Option EP0</i>) | 81.9 dB | 85.3 dB (typical) |
| Sensitivity, absolute ^c | -98.5 dBm | -101.5 dBm (typical) |
| Sensitivity, absolute ^c (<i>Option EP0</i>) | -96.5 dBm | -99.5 dBm (typical) |
| Accuracy | | |
| Relative ^d | ±0.11 dB | |
| Absolute (20 to 30°C) | ±0.62 dB | ±0.21 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about -14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 2.412 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Spectrum Emission Mask (18 MHz Transmission BW RBW = 100 kHz 11.0 MHz offset) | | Radio standards are: 802.11a/g (OFDM), 802.11n (20 MHz) or 802.11ac (20 MHz) Center Frequency in 5.0 GHz Band |
| Dynamic Range, relative ^{ab} | 79.0 dB | 85.3 dB (typical) |
| Dynamic Range, relative ^{ab} (Option EP0) | 79.8 dB | 85.3 dB (typical) |
| Sensitivity, absolute ^c | -95.5 dBm | -99.5 dBm (typical) |
| Sensitivity, absolute ^c (Option EP0) | -95.5 dBm | -99.5 dBm (typical) |
| Accuracy | | |
| Relative ^d | ±0.11 dB | |
| Absolute (20 to 30°C) | ±1.77 dB | ±0.42 dB (95th percentile) |
| Absolute (Option EP0) (20 to 30°C) | ±1.77 dB | ±0.56 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about -14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 5.18 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | | Supplemental Information | |
|--|---------------------------------------|--------------------------|----------------------------|----------------------------|
| Spectrum Emission Mask (19.5 MHz Transmission BW RBW = 100 kHz 10.25 MHz offset) | Center Freq | | Center Freq | |
| | 2.4 GHz | 5.0 GHz | 2.4 GHz | 5.0 GHz |
| | Dynamic Range, relative ^{ab} | 83.7 dB 79.0 dB | 87.2 dB (typical) | 85.3 dB (typical) |
| | Sensitivity, absolute ^c | -98.5 dBm -95.5 dBm | -100.5 dBm (typical) | -99.5 dBm (typical) |
| | Accuracy | | | |
| | Relative ^d | ±0.11 dB ±0.39 dB | | |
| Absolute (20 to 30°C) | ±0.62 dB | ±1.77 dB | ±0.21 dB (95th percentile) | ±0.42 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about -14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 2.412 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Spectrum Emission Mask (22 MHz Transmission BW RBW = 100 kHz 11.0 MHz offset) | | Radio standard is: 802.11b/g (DSSS/CCK/PBCC) Center Frequency in 2.4 GHz Band |
| Dynamic Range, relative ^{ab} | 83.7 dB | 87.2 dB (typical) |
| Dynamic Range, relative ^{ab} (<i>Option EP0</i>) | 82.0 dB | 85.3 dB (typical) |
| Sensitivity, absolute ^c | –98.5 dBm | –101.5 dBm (typical) |
| Sensitivity, absolute ^c (<i>Option EP0</i>) | –96.5 dBm | –99.5 dBm (typical) |
| Accuracy | | |
| Relative ^d | ±0.11 dB | |
| Absolute (20 to 30°C) | ±0.62 dB | ±0.21 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 2.412 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | | Supplemental Information | |
|---|---|--------------------------|----------------------------|----------------------------|
| Spectrum Emission Mask (38 MHz Transmission BW RBW = 100 kHz 21.0 MHz offset) | Center Freq | | Center Freq | |
| | 2.4 GHz | 5.0 GHz | 2.4 GHz | 5.0 GHz |
| | Dynamic Range, relative ^{ab} | 84.0 dB 80.1 dB | 87.3 dB (typical) | 85.4 dB (typical) |
| | Dynamic Range, relative ^{ab} (<i>Option EP0</i>) | 82.2 dB 80.5 dB | 85.3 dB (typical) | 85.4 dB (typical) |
| | Sensitivity, absolute ^c | -98.5 dBm -95.5 dBm | -99.5 dBm (typical) | -99.5 dBm (typical) |
| | Sensitivity, absolute ^c (<i>Option EP0</i>) | -98.5 dBm -95.5 dBm | -99.5 dBm (typical) | -99.5 dBm (typical) |
| | Accuracy | | | |
| | Relative ^d | ±0.13 dB ±0.48 dB | | |
| | Relative ^d (<i>Option EP0</i>) | ±0.13 dB ±0.48 dB | | |
| | Absolute (20 to 30°C) | ±0.62 dB ±1.77 dB | ±0.21 dB (95th percentile) | ±0.42 dB (95th percentile) |
| | Absolute (<i>Option EP0</i>) (20 to 30°C) | ±0.62 dB ±1.77 dB | ±0.21 dB (95th percentile) | ±0.56 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about -14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 2.412 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | | Supplemental Information | |
|---|---------------------------------------|--------------------------|----------------------------|----------------------------|
| Spectrum Emission Mask (39.0 MHz Transmission BW RBW = 100 kHz 20.5 MHz offset) | Center Freq | | Center Freq | |
| | 2.4 GHz | 5.0 GHz | 2.4 GHz | 5.0 GHz |
| | Dynamic Range, relative ^{ab} | 84.0 dB 80.1 dB | 87.3 dB (typical) | 85.4 dB (typical) |
| | Sensitivity, absolute ^c | -98.5 dBm -95.5 dBm | -101.5 dBm (typical) | -99.5 dBm (typical) |
| | Accuracy | | | |
| | Relative ^d | ±0.13 dB ±0.48 dB | | |
| Absolute (20 to 30°C) | ±0.62 dB | ±1.77 dB | ±0.21 dB (95th percentile) | ±0.42 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about -14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 2.412 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Spectrum Emission Mask (78 MHz Transmission BW RBW = 100 kHz 41.0 MHz offset) | | Radio standard is: 802.11ac (80 MHz) Center Frequency in 5.0 GHz Band |
| Dynamic Range, relative ^{ab} | 80.7 dB | 85.4 dB (typical) |
| Dynamic Range, relative ^{ab} (<i>Option EP0</i>) | 80.9 dB | 85.4 dB (typical) |
| Sensitivity, absolute ^c | −95.5 dBm | −99.5 dBm (typical) |
| Sensitivity, absolute ^c (<i>Option EP0</i>) | −95.5 dBm | −99.5 dBm (typical) |
| Accuracy | | |
| Relative ^d | ±0.60 dB | |
| Absolute (20 to 30°C) | ±1.77 dB | ±0.42 dB (95th percentile) |
| Absolute (<i>Option EP0</i>) (20 to 30°C) | ±1.77 dB | ±0.56 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about −14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 2.412 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | | Supplemental Information | |
|---|---------------------------------------|--------------------------|----------------------------|----------------------------|
| Spectrum Emission Mask (79.0 MHz Transmission BW RBW = 100 kHz 40.5 MHz offset) | Center Freq | | Center Freq | |
| | 2.4 GHz | 5.0 GHz | 2.4 GHz | 5.0 GHz |
| | Dynamic Range, relative ^{ab} | 84.2 dB 80.7 dB | 87.4 dB (typical) | 85.4 dB (typical) |
| | Sensitivity, absolute ^c | -98.5 dBm -95.5 dBm | -101.5 dBm (typical) | -99.5 dBm (typical) |
| | Accuracy | | | |
| | Relative ^d | ±0.15 dB ±0.60 dB | | |
| Absolute (20 to 30°C) | ±0.63 dB | ±1.77 dB | ±0.22 dB (95th percentile) | ±0.42 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about -14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 2.412 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Spectrum Emission Mask (158 MHz Transmission BW RBW = 100 kHz 81.0 MHz offset) | | Radio standard is: 802.11ac (160 MHz) Center Frequency in 5.0 GHz Band |
| Dynamic Range, relative ^{ab} | 81.0 dB | 85.4 dB (typical) |
| Dynamic Range, relative ^{ab} (<i>Option EP0</i>) | 81.2 dB | 85.4 dB (typical) |
| Sensitivity, absolute ^c | –95.5 dBm | –99.5 dBm (typical) |
| Sensitivity, absolute ^c (<i>Option EP0</i>) | –95.5 dBm | –99.5 dBm (typical) |
| Accuracy | | |
| Relative ^d | ±0.75 dB | |
| Absolute (20 to 30°C) | ±1.77 dB | ±0.42 dB (95th percentile) |
| Absolute (<i>Option EP0</i>) (20 to 30°C) | ±1.77 dB | ±0.56 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 2.412 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | | Supplemental Information | |
|--|---------------------------------------|--------------------------|----------------------------|----------------------------|
| Spectrum Emission Mask (159.0 MHz Transmission BW RBW = 100 kHz 80.5 MHz offset) | Center Freq | | Center Freq | |
| | 2.4 GHz | 5.0 GHz | 2.4 GHz | 5.0 GHz |
| | Dynamic Range, relative ^{ab} | 84.3 dB 81.0 dB | 87.4 dB (typical) | 85.4 dB (typical) |
| | Sensitivity, absolute ^c | -98.5 dBm -95.5 dBm | -101.5 dBm (typical) | -99.5 dBm (typical) |
| | Accuracy | | | |
| | Relative ^d | ±0.18 dB ±0.75 dB | | |
| Absolute (20 to 30°C) | ±0.63 dB | ±1.77 dB | ±0.22 dB (95th percentile) | ±0.42 dB (95th percentile) |

- 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 100 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about -14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 100 kHz RBW, at a center frequency of 2.412 GHz.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|---|
| Spectrum Emission Mask | | Radio standard is: 802.11af 6M/7M/8M |
| Transmission BW | | |
| 802.11af 6M | 5.70 MHz | |
| 802.11af 7M | 6.65 MHz | |
| 802.11af 8M | 7.60 MHz | |
| RBW for 802.11af 6M/7M/8M | 100 kHz | |
| Offset | | |
| 802.11af 6M | 3.15 MHz | |
| 802.11af 7M | 3.675 MHz | |
| 802.11af 8M | 4.2 MHz | |
| Relative Dynamic Range ^{ab} | | Typical |
| 802.11af 6M | 82.3 dB | 86.7 dB |
| 802.11af 7M | 82.5 dB | 86.8 dB |
| 802.11af 8M | 82.7 dB | 86.9 dB |
| Absolute Sensitivity ^c | −98.5 dB | −101.5 dB |
| Relative Accuracy ^d (20 to 30°C) | | |
| 802.11af 6M | ±0.08 dB | |
| 802.11af 7M | ±0.09 dB | |
| 802.11af 8M | ±0.09 dB | |
| Absolute Accuracy (20 to 30°C) for 802.11af 6M/7M/8M | ±0.62 dB | ±0.21 dB (typical) |

- 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 10 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about −14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 10 kHz RBW.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------------|
| Spectrum Emission Mask | | Radio standard is: 802.11ah |
| Transmission BW | | |
| 802.11ah 1M | 0.9 MHz | |
| 802.11ah 2M | 1.8 MHz | |
| 802.11ah 4M | 3.8 MHz | |
| 802.11ah 8M | 7.8 MHz | |
| 802.11ah 16M | 15.8 MHz | |
| RBW for 802.11ah 1M/2M/4M/8M/16M | 10 kHz | |
| Offset | | |
| 802.11ah 1M | 0.6 MHz | |
| 802.11ah 2M | 1.1 MHz | |
| 802.11ah 4M | 2.1 MHz | |
| 802.11ah 8M | 4.1 MHz | |
| 802.11ah 16M | 8.1 MHz | |
| Relative Dynamic Range ^{ab} | | Typical |
| 802.11ah 1M | 87.6 dB | 93.8 dB |
| 802.11ah 2M | 89.9 dB | 95.8 dB |
| 802.11ah 4M | 91.6 dB | 96.5 dB |
| 802.11ah 8M | 92.8 dB | 96.9 dB |
| 802.11ah 16M | 93.5 dB | 97.2 dB |
| Relative Dynamic Range ^{ab} (Option EP0) | | Typical |
| 802.11ah 1M | 86.5 dB | 92.1 dB |
| 802.11ah 2M | 88.9 dB | 93.9 dB |
| 802.11ah 4M | 90.3 dB | 94.6 dB |
| 802.11ah 8M | 91.2 dB | 95.0 dB |
| 802.11ah 16M | 91.8 dB | 95.2 dB |
| Absolute Sensitivity ^c | −108.5 dB | −111.5 dB |
| Absolute Sensitivity ^c (Option EP0) | −106.5 dB | −109.5 dB |

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--------------------------|
| Relative Accuracy ^d (20 to 30°C) | | |
| 802.11ah 1M | ±0.06 dB | |
| 802.11ah 2M | ±0.07 dB | |
| 802.11ah 4M | ±0.08 dB | |
| 802.11ah 8M | ±0.09 dB | |
| 802.11ah 16M | ±0.10 dB | |
| Relative Accuracy ^d (Option EP0) (20 to 30°C) | | |
| 802.11ah 1M | ±0.08 dB | |
| 802.11ah 2M | ±0.08 dB | |
| 802.11ah 4M | ±0.09 dB | |
| 802.11ah 8M | ±0.10 dB | |
| 802.11ah 16M | ±0.11 dB | |
| Absolute Accuracy (20 to 30°C) for 802.11ah 1M/2M/4M/8M/16M | ±0.62 dB | ±0.21 dB (typical) |

- 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 10 kHz RBW.
- This dynamic range specification applies for the optimum mixer level, which is about -14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
- 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 10 kHz RBW.
- 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.

WLAN Measurement Application
Measurements

| Description | Specifications | | Supplemental Information | |
|---|---|-----------|--|---------------------|
| Spurious Emission (ML = 3 dBm, 0 to 55° C RBW = 100 kHz) | | | Radio standards are: 802.11a/g/j/p (OFDM), 802.11b/g (DSSS/CCK/PBCC), 802.11g (DSSS-OFDM), 802.11n (20 MHz), 802.11n (40 MHz), 802.11ac (20 MHz) 5.0 GHz Band, 802.11ac (40 MHz) 5.0 GHz Band, 802.11ac (80 MHz) 5.0 GHz Band or 802.11ac (160 MHz) 5.0 GHz Band 802.11ax (20 MHz) in 2.4 GHz and 5 GHz Band 802.11ax (40 MHz) in 2.4 GHz and 5 GHz Band 802.11ax (80 MHz) in 2.4 GHz and 5 GHz Band 802.11ax (160 MHz) in 2.4 GHz and 5 GHz Band | |
| | Center Freq 2.4 GHz 5.0 GHz | | Center Freq 2.4 GHz 5.0 GHz | |
| Dynamic Range ^a , relative (RBW= 1 MHz) | 88.8 dB | 84.9 dB | 91.8 dB (typical) | 88.7 dB (typical) |
| Dynamic Range ^a , relative (<i>Option EP0</i>) (RBW= 1 MHz) | 87.3 dB | 84.9 dB | 90.3 dB (typical) | 88.7 dB (typical) |
| Sensitivity ^b , absolute (RBW= 1 MHz) | -88.5 dBm | -85.5 dBm | -91.5 dBm (typical) | -89.5 dBm (typical) |
| Sensitivity ^b , absolute (<i>Option EP0</i>) (RBW= 1 MHz) | -86.5 dBm | -85.5 dBm | -89.5 dBm (typical) | -89.5 dBm (typical) |
| Accuracy, absolute | | | (95th percentile) | (95th percentile) |
| 20 Hz to 3.6 GHz | | | ±0.19 dB | ±0.19 dB |
| 3.5 to 8.4 GHz | | | ±1.08 dB | ±1.08 dB |
| 3.5 to 8.4 GHz (<i>Option EP0</i>) | | | ±1.15 dB | ±1.15 dB |
| 8.3 to 13.6 GHz | | | ±1.48 dB | ±1.48 dB |
| 8.3 to 13.6 GHz (<i>Option EP0</i>) | | | ±1.52 dB | ±1.52 dB |

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

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| Spurious Emission (ML = 3 dBm, 0 to 55° C RBW = 100 kHz) | | Radio standard is: 802.11af 6M/7M/8M |
| Dynamic Range ^a , relative | 88.8 dB | 91.8 dB (typical) |
| Sensitivity ^b , absolute | −88.5 dBm | −91.5 dBm (typical) |
| Accuracy, absolute | | |
| 20 Hz to 3.6 GHz | | ±0.19 dB (95th percentile) |
| 3.5 to 8.4 GHz | | ±1.08 dB (95th percentile) |
| 8.3 to 13.6 GHz | | ±1.48 dB (95th percentile) |

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

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| Spurious Emission (ML = 3 dBm, 0 to 55° C RBW = 10 kHz) | | Radio standard is: 802.11ah 1M/2M/4M/8M/16M |
| Dynamic Range ^a , relative | 88.8 dB | 91.8 dB (typical) |
| Dynamic Range ^a , relative (<i>Option EP0</i>) | 87.3 dB | 90.3 dB (typical) |
| Sensitivity ^b , absolute | −88.5 dBm | −91.5 dBm (typical) |
| Sensitivity ^b , absolute (<i>Option EP0</i>) | −86.5 dBm | −89.5 dBm (typical) |
| Accuracy, absolute | | |
| 20 Hz to 3.6 GHz | | ±0.19 dB (95th percentile) |
| 3.5 to 8.4 GHz | | ±1.08 dB (95th percentile) |
| 3.5 to 8.4 GHz (<i>Option EP0</i>) | | ±1.15 dB (95th percentile) |
| 8.3 to 13.6 GHz | | ±1.48 dB (95th percentile) |
| 8.3 to 13.6 GHz (<i>Option EP0</i>) | | ±1.52 dB (95th percentile) |

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

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information | |
|---|----------------|---|---------------------------|
| 64QAM EVM (RF Input Level = -10 dBm, Attenuation = 10 dB, 20 to 30°C) | | Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz) ^a or 802.11ac (20 MHz) 5.0 GHz Band Code Rate: 3/4 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing Off | |
| | | <p style="text-align: center;">Center Freq</p> <p style="text-align: center;">2.4 GHz (nominal) 5.0 GHz (nominal)</p> | |
| EVM | | | |
| Floor ^{bcd} | | -53.0 dB (0.23%) | -50.7 dB (0.29%) |
| Floor ^{bcd e} (<i>Option EPO</i>) | | -59.6 dB (0.11%) | -56.6 dB (0.15%) |
| Accuracy ^f (EVM Range: 0 to 8.0%) | | ±0.30% | ±0.30% |
| Frequency Error | | | |
| Range | | ±100 kHz | ±100 kHz |
| Accuracy | | ±10 Hz + tfa ^g | ±10 Hz + tfa ^g |

- a. Requires *Option B25, B40, B85, B1X, B2X* or *B5X* (IF bandwidth above 10 MHz).
- b. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
- c. The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>160 kHz)
- d. The EVM Floor specification applies when the signal path is set to the μ W Preselector Bypass (*Option MPB* enabled) for center frequencies above 3.6 GHz.
- e. *Option EPO* is not available with *Option B85* or *B1X*.
- 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:

$$\text{error} = [\text{sqrt}(\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2)] - \text{EVM}_{\text{UUT}}$$
where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
- g. tfa = transmitter frequency × frequency reference accuracy.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information | |
|---|----------------|---|---------------------------|
| 64QAM EVM (RF Input Level = -10 dBm, Attenuation = 10 dB, 20 to 30°C) | | Radio standard is: 802.11n (40 MHz) or 802.11ac (40MHz) 5.0 GHz Band ^a Code Rate: 3/4 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing Off | |
| | | Center Freq | |
| | | 2.4 GHz (nominal) | 5.0 GHz (nominal) |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| EVM | | | |
| Floor ^{bcd} | | -50.0 dB (0.32%) | -48.0 dB (0.40%) |
| Floor ^{bcd} <i>(Option EP0)</i> | | -57.4 dB (0.14%) | -54.4 dB (0.19%) |
| Accuracy ^f | | ±0.30% | ±0.30% |
| (EVM Range:0 to 8.0%) | | | |
| Frequency Error | | | |
| Range | | ±100 kHz | ±100 kHz |
| Accuracy | | ±10 Hz + tfa ^g | ±10 Hz + tfa ^g |

- a. Requires *Option B40, B85, B1X, B2X, or B5X* and *Option MPB* for center frequencies above 3.6 GHz.
- b. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
- c. The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>160 kHz)
- d. The EVM Floor specification applies when the signal path is set to μ W Preselector Bypass (*Option MPB* enabled) for center frequencies above 3.6 GHz.
- e. *Option EP0* is not available with *Option B85* or *B1X*.
- 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:

$$\text{error} = [\text{sqrt}(\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2)] - \text{EVM}_{\text{UUT}}$$
where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
- g. tfa = transmitter frequency \times frequency reference accuracy.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|---|
| 64QAM EVM (RF Input Level = -10 dBm, Attenuation = 10 dB, 20 to 30°C) | | Radio standards is: 802.11ac (80 MHz), Center Frequency in 5.0 GHz Band Code Rate: 3/4 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing Off |
| EVM | | |
| Floor ^{abcd} | | -47.0 dB (0.45%) |
| Floor ^{abde} (<i>Option EP0</i>) | | -51.9 dB (0.26%) |
| Accuracy ^f (EVM Range:0 to 8.0%) | | ±0.30% (nominal) |
| Frequency Error | | |
| Range | | ±100 kHz (nominal) |
| Accuracy | | ±10 Hz + tfa ^g (nominal) |

- In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
- The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>140 kHz)
- The EVM Floor specification applies when *Option B85, B1X, B2X, or B5X* is available.
- The EVM Floor specification applies when μ W Path Control is set to μ W Preselector Bypass.
- Option EP0* is not available with *Option B85 or B1X*.
- 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:

$$\text{error} = [\text{sqrt}(\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2)] - \text{EVM}_{\text{UUT}}$$
where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
- tfa = transmitter frequency \times frequency reference accuracy.

WLAN Measurement Application
Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| 64QAM EVM (RF Input Level = -10 dBm, Attenuation = 10 dB, 20 to 30°C) | | Radio standards is: 802.11ac (160 MHz), Center Frequency in 5.0 GHz Band Code Rate: 3/4 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing Off |
| EVM | | |
| Floor ^{abcd} | | -46.0 dB (0.50%) |
| Floor ^{abde} (<i>Option EPO</i>) | | -49.1 dB (0.35%) |
| Accuracy ^f (EVM Range: 0 to 8.0%) | | ±0.30% (nominal) |
| Frequency Error | | |
| Range | | ±100 kHz (nominal) |
| Accuracy | | ±10 Hz + tfa ^g (nominal) |

- a. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
- b. The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>140 kHz)
- c. The EVM Floor specification applies when *Option B1X*, *B2X*, or *B5X* is available.
- d. The EVM Floor specification applies when μ W Path Control is set to μ W Preselector Bypass.
- e. *Option EPO* is not available with *Option B1X*.
- 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:

$$\text{error} = [\text{sqrt}(\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2)] - \text{EVM}_{\text{UUT}}$$
where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
- g. tfa = transmitter frequency \times frequency reference accuracy.

WLAN Measurement Application

Measurements

| Description | Specifications | Supplemental Information |
|---|----------------|--|
| 256QAM EVM RF Input Level = -10 dBm, Optimize EVM, Code Rate: 3/4 EQ training: Channel Est Seq Only Track Phase: On Track Amp: Off Track Timing: Off EVM floor ^{ab} 802.11af 6M 802.11af 7M 802.11af 8M EVM floor (<i>Option EPO</i>) 802.11af 6M 802.11af 7M 802.11af 8M EVM Accuracy ^c (EVM Range:0 to 8.0%) for 802.11af 6M/7M/8 Frequency Error Range for 802.11af 6M/7M/8M Accuracy for 802.11af 6M/7M/8M | | Radio standard is: 802.11af 6M/7M/8M Nominal -48.2 dB (0.39%) -48.2 dB (0.39%) -48.2 dB (0.39%) -48.9 dB (0.36%) -48.9 dB (0.36%) -48.9 dB (0.36%) ±0.3% ±20 kHz (nominal) ±10 Hz + tfa ^d (nominal) |

- In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
- The EVM Floor Specifications applies when Phase Noise Optimization is set to Wide-offset (>160 kHz).
- 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:

$$\text{error} = [\text{sqrt}(\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2)] - \text{EVM}_{\text{UUT}}$$
 where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
- $\text{tfa} = \text{transmitter frequency} \times \text{frequency reference accuracy}$.

WLAN Measurement Application

Measurements

[illegible]

- a. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
- b. The EVM Floor Specifications applies when Phase Noise Optimization is set to Wide-offset (>160 kHz).

WLAN Measurement Application
Measurements

- c. 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:

$$\text{error} = [\text{sqrt}(\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2)] - \text{EVM}_{\text{UUT}}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.

- d. tfa = transmitter frequency \times frequency reference accuracy.

| Description | Specifications | Supplemental Information | |
|--|----------------|---|--------------------------|
| 1024QAM EVM | | Radio standard is: 802.11ax in 2.4 GHz and 5.0 GHz Band MCS: 11 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing On Freq Sync: Preamble, Pilot & Data | |
| (RF Input Level = -10 dBm, Optimize EVM ^a , 20 to 30°C) | | Center Freq | |
| EVM floor | | 2.4 GHz (nominal) | 5.0 GHz (nominal) |
| 802.11ax 20 MHz ^{bc} | | -55.5 dB (0.17%) ^d | -53.4 dB (0.21%) |
| 802.11ax 40 MHz | | -55.4 dB (0.17%) | -53.0 dB (0.22%) |
| 802.11ax 80 MHz | | -51.7 dB (0.26%) | -50.5 dB (0.30%) |
| 802.11ax 160 MHz | | -47.5 dB (0.42%) | -47.0 dB (0.45%) |
| Accuracy ^e (EVM Range:0 to 8.0%) | | | |
| Frequency Error | | | |
| Range | | ± 100 kHz | |
| Accuracy | | ± 10 Hz + tfa^f | |

- a. The EVM Specifications are based on EVM optimization.
b. Phase Noise Optimization left at its default setting (Best Wide-offset Φ Noise >160 kHz).
c. The EVM Floor specification applies when the signal path is set to μ W Preselector Bypass (*Option MPB* enabled) for center frequencies above 3.6 GHz.
d. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
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:

$$\text{error} = [\text{sqrt}(\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2)] - \text{EVM}_{\text{UUT}}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.

WLAN Measurement Application Measurements

f. $tfa = \text{transmitter frequency} \times \text{frequency reference accuracy}$.

| Description | Specifications | Supplemental Information |
|--|----------------|--|
| CCK 11Mbps (RF Input Level = -10 dBm, Attenuation = 10 dB, 20 to 30°C) EVM Floor ^{ab} (EQ Off) Floor(EQ7 On) Accuracy ^c EVM Range: 0 to 2.0% EVM Range: 2 to 20.0% Frequency Error Range Accuracy | | Radio standard is: 802.11/b/g (DSSS/CCK/PBCC) Center Frequency in 2.4 GHz Band Reference Filter: Gaussian -41.9 dB (0.80%) (nominal) -54.0 dB (0.20%) (nominal) ±0.90% (nominal) ±0.40% (nominal) ±100 kHz (nominal) ±10 Hz + tfa^d (nominal) |

- In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
- The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>140 kHz)
- 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:

$$\text{error} = [\text{sqrt}(\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2)] - \text{EVM}_{\text{UUT}}$$
where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
- $tfa = \text{transmitter frequency} \times \text{frequency reference accuracy}$.

In-Band Frequency Range for Warranted Specifications

| Description | Spectrum Range | Supplemental Information |
|---|-----------------|--|
| Radio standard is 802.11b/g (DSSS/CCK/PBCC) | 2.4 GHz Band | Channel center frequency = $2407 \text{ MHz} + 5 \times k \text{ MHz}$, $k = 1, \dots, 13$ |
| Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz), 802.11n (40 MHz) 802.11ac (20 MHz), or 802.11ac (40 MHz), | 2.4 GHz Band | Channel center frequency = $2407 \text{ MHz} + 5 \times k \text{ MHz}$, $k = 1, \dots, 13$ |
| Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz) or 802.11n (40 MHz), 802.11ac (20 MHz) or 802.11ac (40 MHz), 802.11ac (80 MHz) or 802.11ac (160 MHz) | 5.0 GHz Band | Channel center frequency = $5000 \text{ MHz} + 5 \times k \text{ MHz}$, $k = 0, 1, 2, \dots, 200$ |
| Radio standards are: 802.11 ah 1M/2M/4M/8M/16M | 700 MHz ~ 1 GHz | Channel center frequency = Channel starting frequency + $0.5 \text{ MHz} \times$ Channel center frequency Index ^a |
| Radio standards are: 802.11af 6M/7M/8M | 54 ~ 780 MHz | Channel center frequency = Channel starting frequency + $nch \text{ (MHz)} \times$ Channel number multiplier ^b $nch = 0, 1, 2, \dots, 100$ |

- Channel center frequency, Channel starting frequency and Channel Center Frequency Index are given by the operating class (Annex E) in IEEE P802.11ahTM/D2.1.
- Channel starting frequency, Channel number multiplier are given by the operating class (Annex E) in IEEE P802.11acTM/D1.05.

