Keysight Technologies
N5531X Measuring Receiver

Specifications
Addendum

KEYSIGHT
TECHNOLOGIES

Notices

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Manual Part Number

N5531-90006

Edition

Edition 1, August 2019
Published in USA

Published by:

Keysight Technologies, Inc.
1400 Fountaingrove Parkway
Santa Rosa, CA 95403

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1 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 of the PXA-B Specifications Guide, the following conditions must be met for the analyzer to meet the specifications included in this document.

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.

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-RTS	Real-Time Wideband I/Q Data Streaming	Yet to be qualified in the production line
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; $P_{distortion}$ (D) = Power of the harmonic distortion (P_{H2}+ P_{H3} + ...+ 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. InfoBW 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	$\frac{N + D}{S + N + D}$	**$(P_{total} - P_{signal})^{1/2} / (P_{total})^{1/2} \times 100\%$**
THD	$\frac{D}{S}$	**$(P_{distortion})^{1/2} / (P_{signal})^{1/2} \times 100\%$** where THD is the total harmonic distortion
SINAD	$\frac{S + N + D}{N + D}$	**$20 \times \log10\ [1/(P_{distortion})]^{1/2} = 20 \times \log10\ [(P_{total})^{1/2} / (P_{total} - P_{signal})^{1/2}]$** where SINAD is Signal-to-Noise-And-Distortion ratio
SNR	$\frac{S + N + D}{N}$	**$P_{signal} / P_{noise} \sim (P_{signal} + P_{noise} + P_{distortion}) / P_{noise}$** 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 *Option 503*	3.6 GHz	RF/μW frequency option
Option 508	8.4 GHz	RF/μW frequency option
Option 513	13.6 GHz	RF/μW frequency option
Option 526	26.5 GHz	RF/μW frequency option
Option 544	44 GHz	mmW frequency option
Option 550	50 GHz	mmW frequency option
Minimum Frequency AC Coupled[a] DC Coupled	 10 MHz 2 Hz	 In practice, limited by the need to keep modulation sidebands from folding, and by the interference from LO feedthrough.
Maximum Information Bandwidth (Info BW)[b]		
Standard *B25*	25 MHz	
Option B40	40 MHz	
Option B85	85 MHz	
Option B1X	160 MHz	
Option B2X	255 MHz	
Option B5X	510 MHz	Not compatible with *Option 107*

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.

Frequency Modulation (FM)

Additional conditions required to meet specifications:

- Peak FM Deviation ≥ 200 Hz
- ß ≥ 0.2 or FM Deviation ≥ 200 Hz whichever is greater, and ß ≤ 2000 or FM Deviation ≤ 1 MHz whichever is smaller where, ß is modulation index and defined as (FM IF Deviation)/(FM Rate)
- Info Bandwidth (BW): ≤ 8 MHz for center frequency (f_c) between 100 kHz and 3.6 GHz, ≤ 3.5 MHz for f_c > 3.6 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 kHz ≤ f_c < 3.6 GHz		10 Hz to 400 kHz	
3.6 GHz ≤ f_c < 50 GHz		10 Hz to 200 kHz	
Peak FM Deviations [a]			
100 kHz < f_c < 50 GHz		1 MHz maximum	
FM Deviation Accuracy[b]			
Frequency Range	β		
100 kHz to 3.6 GHz	≥ 0.2, ≤ 100	±(0.35% of reading + 0.2% x rate)	
	>100	±0.8% of reading	
3.6 to 8.4 GHz	≥ 0.2, ≤ 100	±(0.7% of reading + 0.2% x rate)	
	>100	±2.0% of reading	
8.4 to 17.1 GHz	≥ 0.2, ≤ 100	±(0.7% of reading + 0.3% x rate)	
	>100	±2.5.% of reading	
17.1 to 34.5 GHz	≥ 0.2, ≤ 100	±(0.8% of reading + 0.3% x rate)	
	>100	±3.0% of reading	
34.5 to 50 GHz	≥ 0.2, ≤ 100	±(1.4% of reading + 0.5% x rate)	
	>100	±4.0% of reading	

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 × (f_c – 100 kHz).

Description	Specification	Supplemental Information
Modulation Distortion Floor		See "Modulation Distortion" on page 17.
AM Rejection (50 Hz to 3 kHz BW)[a]		
Frequency Range	Max peak deviation	
100 kHz to 3.6 GHz	2.8 Hz	
3.6 to13.6 GHz	9.6 Hz	
13.6 to 17.1 GHz	9.9 Hz	
17.1 to 26.5 GHz	10.8 Hz	
26.5 to 34.5 GHz	11.5 Hz	
34.5 to 50 GHZ	13.5 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.

Description	Specification	Supplemental Information
Residual FM (50 Hz to 3 kHz BW)[a][b] RF Frequency		
100 kHz to 3.6 GHz	< 1.2 Hz (rms)	
3.6 to 8.4 GHz	< 3.9 Hz (rms)	
8.4 to 13.6 GHz	< 4.2Hz (rms)	
13.6 to 17.1 GHz	< 4.4 Hz (rms)	
17.1 to 26.5 GHz	< 4.9 Hz (rms)	
26.5 to 34.5 GHz	< 5.7 Hz (rms)	
34.5 to 50 GHz	< 6.7 Hz (rms)	
Detectors		Available: +peak, –peak, ±peak/2, peak hold, rms
Auto Carrier Frequency Triggering	Free run, Video, RF Burst, External	

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) ≤ 1MHz
- IF BW: 15 times of AM rate (when AM rate ≤ 50 kHz) or 10 times of AM rate (when 50 kHz < AM rate ≤ 100 kHz)
- 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 kHz ≤ f_c < 50 GHz	10 Hz to 100 kHz	

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 IF BW < 2 × (f_c – 100 kHz).

Description		Specification	Supplemental Information
AM Depth Range		1 to 99%	Capable of measuring AM depth range of 0 to 100%.
AM Depth Accuracy[a]			
Frequency Range	Depths		
100 kHz to 3.6 GHz	1 to 99%	±(0.1% of reading + 0.07%)	
3.6 to 13.6 GHz	5 to 99%	±(0.1% of reading + 0.10%)	
13.6 to 17.1 GHz	5 to 99%	±(0.1% of reading + 0.12%)	
17.1 to 26.5 GHz	5 to 99%	±(0.15% of reading + 0.12%)	
26.4 to 34.5 GHz	5 to 99%	±(0.15% of reading + 0.16%)	
34.5 to 50 GHz	5 to 99%	±(0.15% of reading + 0.35%)	

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.

Description	Specification	Supplemental Information
Flatness[a]		
Frequency Range		
100 kHz to 3.6 GHz	±0.25% of reading	
3.6 to 8.4 GHz	±0.65% of reading	
8.4 to 17.1 GHz	±0.65% of reading	
17.1 to 26.5 GHz	±0.80% of reading	
26.5 to 34.5 GHz	±0.90% of reading	
34.5 to 50 GHz	±0.90% of reading	10 Hz ≤ AM rate ≤10 kHz
Modulation Distortion Floor		See “Modulation Distortion” on page 17.

a. Flatness is the relative variation in indicated AM depth versus rate for a constant carrier frequency and depth.

Description	Specification	Supplemental Information
FM Rejection (50 Hz to 3 kHz BW)[a]		
Frequency Range		
100 kHz to 34.5 GHz	0.04%	
34.5 to 50.0 GHz	0.08%	
Residual AM (300 Hz to 3 kHz BW)[b]		
Frequency Range		
100 kHz to 3.6GHz	0.01% (rms)	
3.6 to 34.5 GHz	0.04% (rms)	
34.5 to 50.0 GHz	0.06% (rms)	
Detectors		Available: +peak, –peak, ±peak/2, peak hold, rms
Auto Carrier Frequency Triggering	Free run, Video, RF Burst, External	

a. 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= 300 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.
b. 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 = 300 Hz, LPF = 3 kHz, channel BW = 6 kHz.

Phase Modulation (PM)

Additional conditions required to meet specifications:

- Info BW (IF BW) ≤ 3.5 MHz
- HPF = 50 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		
100 kHz ≤ f_c < 50 GHz	200 Hz to 100 kHz	
Peak Phase Deviation[a]		
100 kHz ≤ f_c < 50 GHz	0.2 to 25,000 radians[b]	

a. The fc and IF BW must be chosen to satisfy IF BW < 2x(fc - 100 kHz).
b. 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) = [IF BW/(2 x modulation rate in Hz)] - 1.

Description	Specification	Supplemental Information
PM Accuracy		
Frequency range		
100 kHz to 3.6 GHz	±(0.1% of reading + 2 mrad)	
3.6 to 13.6 GHz	±(0.1% of reading + 3 mrad)	
13.6 to 17.1GHz	±(0.1% of reading + 4 mrad)	
17.1 to 26.5 GHz	±(0.1% of reading + 6 mrad)	
26.5 to 34.5 GHz	±(0.1% of reading + 9 mrad)	
34.5 to 50 GHz	±(0.1% of reading + 10 mrad)	
Modulation Distortion Floor		See "Modulation Distortion" on page 17.

Description	Specification	Supplemental Information
AM Rejection (50 Hz to 3 kHz BW)[a]		
100 kHz to 3.6 GHz	0.0030 rad	
3.6 to 8.4 GHz	0.0054 rad	
8.4 to 13.6 GHz	0.0081 rad	
13.6 to 17.1GHz	0.0105 rad	
17.1 to 26.5 GHz	0.0159 rad	
26.5 to 34.5 GHz	0.0199 rad	
34.5 to 50 GHz	0.0286 rad	
Residual PM (50 Hz to 3 kHz BW)[bc]		
Frequency range		
100 kHz to 3.6 GHz	< 0.0017 rad (rms)	
3.6 to 8.4 GHz	< 0.0032 rad (rms)	
8.4 to 13.6 GHz	< 0.0048 rad (rms)	
13.6 to 17.1GHz	< 0.0060 rad (rms)	
17.1 to 26.5 GHz	< 0.0091 rad (rms)	
26.5 to 34.5 GHz	< 0.0117 rad (rms)	
34.5 to 50 GHz	< 0.0165 rad (rms)	
Detectors		Available: +peak, –peak, ±peak/2, peak hold, rms
Auto Carrier Frequency Triggering	Free run, Video, RF Burst, External	

a. 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.

b. 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.

c. 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

Description	Specification	Supplemental Information
Frequency Range (for demodulated signals)		
FM		
100 kHz ≤ f_c < 13.6 GHz	10 Hz to 400 kHz	
3.6 GHz ≤ f_c < 50 GHz	10 Hz to 200 kHz	
AM		
100 kHz ≤ f_c < 50 GHz	10 Hz to 100 kHz	
PM		
100 kHz ≤ f_c < 50 GHz	200 Hz to 100 kHz	
Modulation Rate Accuracy[a]		
FM Rate Accuracy		
100 kHz ≤ f_c ≤ 3.6 GHz		
0.2 ≤ β < 1	±(0.01% of reading) + rfa	
1 ≤ β < 3	±(0.007% of reading) + rfa	
3 ≤ β < 10	±(0.003% of reading) + rfa	
10 ≤ β < 100	±(0.01% of reading) + rfa	
β ≥ 100	±(0.002% of reading) + rfa	
3.6 GHz ≤ f_c ≤ 13.6 GHz		
0.2 ≤ ß<100	±(0.03% of reading) + rfa	
β ≥ 100	±(0.004% of reading) + rfa	
13.6 GHz ≤ f_c ≤ 26.5 GHz		
0.2 ≤ ß<100	±(0.03% of reading) + rfa	
β ≥ 100	±(0.005% of reading) + rfa	
26.5 GHz ≤ f_c ≤ 34.5 GHz		
0.2 ≤ ß<100	±(0.03% of reading) + rfa	
β ≥ 100	±(0.006% of reading) + rfa	
34.5 GHz ≤ f_c ≤ 50 GHz		
0.2 ≤ ß<100	±(0.05% of reading) + rfa	

Description	Specification	Supplemental Information
$\beta \geq 100$	±(0.01% of reading) + rfa	
AM Rate Accuracy		
Rate range	1 to 100 kHz	
100 kHz ≤ f_c ≤ 3.6 GHz	±((3 ppm of reading) x 100%/(AM Depth)) + rfa	
3.6 GHz ≤ f_c ≤ 17.1 GHz	±((6 ppm of reading) x 100%/(AM Depth)) + rfa	
17.1 GHz ≤ f_c ≤ 34.5 GHz	±((8 ppm of reading) x 100%/(AM Depth)) + rfa	
34.5 GHz ≤ f_c ≤ 50 GHz	±((18 ppm of reading) x 100%/(AM Depth)) + rfa	AM Depth ≥2%
PM Rate Accuracy		
100 kHz ≤ f_c ≤ 3.6 GHz		
Rate ≤ 500 Hz	±(0.01 Hz/PM Deviation) + rfa	
Rate ≤ 50 kHz	±(0.08 Hz/PM Deviation) + rfa	
3.6 GHz ≤ f_c ≤ 8.4 GHz		
Rate ≤ 500 Hz	±(0.02 Hz/PM Deviation) + rfa	
Rate ≤ 50 kHz	±(0.10 Hz/PM Deviation) + rfa	
8.4 GHz ≤ f_c ≤ 13.6 GHz		
Rate ≤ 500 Hz	±(0.03 Hz/PM Deviation) + rfa	
Rate ≤ 50 kHz	±(0.15 Hz/PM Deviation + rfa)	
13.6 GHz ≤ f_c ≤ 17.1 GHz		
Rate ≤ 500 Hz	±(0.03 Hz/PM Deviation) + rfa	
Rate ≤ 50 kHz	±(0.20 Hz/PM Deviation) + rfa	
17.1 GHz ≤ f_c ≤ 26.5 GHz		
Rate ≤ 500 Hz	±(0.05 Hz/PM Deviation) + rfa	
Rate ≤ 50 kHz	±(0.28 Hz/PM Deviation) + rfa	
26.5 GHz ≤ f_c ≤ 34.5 GHz		
Rate ≤ 500 Hz	±(0.07 Hz/PM Deviation) + rfa	
Rate ≤ 50 kHz	±(0.35 Hz/PM Deviation) + rfa	
34.6 GHz ≤ f_c ≤ 50 GHz		
Rate ≤ 500 Hz	±(0.10 Hz/PM Deviation) + rfa	
Rate ≤ 50 kHz	±(0.50 Hz/PM Deviation) + rfa	

Description	Specification	Supplemental Information
Displayed Resolution	1 mHz	
Measurement Rate		2 readings/second

a. rfa = Modulation Rate × Frequency reference accuracy.

Modulation Distortion[1]

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		(Rate: 1 to 10 kHz, **β**: 0.2 to 100)
Distortion	±(2% of reading +DistResidual)	
AM		(Rate: 1 to 10 kHz, depth: 5 to 90%)
Distortion	±(1% of reading +DistResidual)	
PM		(Rate: 1 to 10 kHz, deviation: 0.2 to 100)
Distortion	±(2% of reading +DistResidual)	
Sensitivity		
Modulation		See "Post-Demod Distortion Residual" below for minimum modulation levels.

1. The PXA-based measuring receiver measures distortion plus noise as per the standard method of distortion analyzers (accepted by the Institute of High Fidelity and others, refer to "Standard Methods of Measurement For Audio Amplifiers", The Institute of High Fidelity, Inc., New York (1978), p. 9). The distortion analyzer method is simple and adequate for most situations. When using this method, it is important to understand that the measurement result is not "total harmonic distortion" except under the condition that the distortion is not too excessive but that it does predominate over any other signal impurities.

Description	Specification	Supplemental Information
Post-Demod Distortion Residual		
FM		
Distortion (SINAD)[a]		
100 kHz ≤ f_c ≤ 3.6 GHz		
IF BW < 3.5 MHz	$0.8\%/\beta^{1/2} + 0.1\%$	
IF BW ≥ 3.5 MHz		
$\beta \le 1$	$2.0\%/\beta^{1/2} + 0.1\%$	
$1 < \beta \le 10$	$1.0\%/\beta^{1/2} + 0.1\%$	
$10 < \beta$	$0.8\%/\beta^{1/2} + 0.1\%$	
3.6 GHz ≤ f_c ≤ 8.4 GHz	$1.8\%/\beta^{1/2} + 0.25\%$	
8.4 GHz ≤ f_c ≤ 17.1 GHz	$2.0\%/\beta^{1/2} + 0.3\%$	
17.1 GHz ≤ f_c ≤ 26.5 GHz	$2.2\%/\beta^{1/2} + 0.3\%$	
26.5 GHz ≤ f_c ≤ 34.5 GHz	$2.5\%/\beta^{1/2} + 0.4\%$	
34.5 GHz ≤ f_c ≤ 50 GHz	$3.5\%/\beta^{1/2} + 0.5\%$	
AM		
Distortion (SINAD)[a]		
100 kHz ≤ f_c ≤ 3.6 GHz	0.1% x (100%/(AM Depth))+ 0.02%	
3.6 GHz ≤ f_c ≤ 8.4 GHz	0.35% x (100%/(AM Depth))+ 0.05%	
8.4 GHz ≤ f_c ≤ 17.1 GHz	0.4% x (100%/(AM Depth))+ 0.05%	
17.1 GHz ≤ f_c ≤ 26.5 GHz	0.45% x (100%/(AM Depth))+ 0.05%	
26.5 GHz ≤ f_c ≤ 34.5 GHz	0.55% x (100%/(AM Depth))+ 0.1%	
34.5 GHz ≤ f_c ≤ 50 GHz	0.65% x (100%/(AM Depth))+ 0.2%	
PM		
Distortion (SINAD)[a]		
100 kHz ≤ f_c ≤ 3.6 GHz	0.6%/(PM Deviation)+ 0.01%	
3.6 GHz ≤ f_c ≤ 8.4 GHz	1.0%/(PM Deviation)+ 0.01%	
8.4 GHz ≤ f_c ≤ 13.6 GHz	1.5%/(PM Deviation)+ 0.01%	
13.6 GHz ≤ f_c ≤ 17.1 GHz	1.8%/(PM Deviation)+ 0.01%	
17.1 GHz ≤ f_c ≤ 26.5 GHz	3.0%/(PM Deviation)+ 0.01%	

Description	Specification	Supplemental Information
26.5 GHz ≤ f_c ≤ 34.5 GHz	4.0%/(PM Deviation)+ 0.01%	
34.5 GHz ≤ f_c ≤ 50 GHz	6.0%/(PM Deviation)+ 0.01%	

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

Modulation SINAD

Description	Specification	Supplemental Information
Display Range	0.00 to 80 dB	
Displayed Resolution	0.001 dB	
Accuracy[a]	±1 dB of reading	Defaulted display in dB. It can be converted into linear term using % = (1-10^(A dB/20)) x 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 18.

Modulation Filters

Description	Specification	Supplemental Information
Filter Flatness[ab]		Nominal
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 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 (nom).
b. 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 kHz ≤ f_c < 3.6 GHz	0.4 mV_{rms} (–55 dBm)	
3.6 GHz ≤ f_c < 26.5 GHz	1.3 mV_{rms} (–45 dBm)	
26.5 GHz ≤ f_c < 50 GHz	4.0 mV_{rms} (–35 dBm)	
Maximum Resolution	0.001 Hz	
Accuracy[c]	±(readout freq. × rfa+0.100 Hz)	Internal ref. See notes[d][e]
Accuracy (For f_c < 100 MHz)	±(readout freq. × rfa+0.002 Hz)[f]	±(readout freq. × rfa+0.001 Hz) (99th percentile, or ~2.576σ).
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.

a. 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.
b. Instrument condition: RBW ≤ 1 kHz
c. 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.
d. Verified at 1 GHz with RBW = 1 kHz, gate time = 0.1 s (autocoupled), SNR = 50 dB.
e. While the first term scales obviously with frequency, the second term also scales (weakly) with frequency; the nominal standard deviation of the measurement is 0.003Hz per GHz of fc for RBW = 1,000Hz, gate time = 0.1s. 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.
f. For the special case of F_c <100 MHz, RBW = 300 Hz, and gate time = 0.5 s, the second term is <0.002 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 Input[1]

Description	Specification	Supplemental Information
Frequency Range		
AC Coupled	20 Hz to 250 kHz	
DC Coupled		5 Hz to 250 kHz (nominal)
Input Impedance		100 kΩ (nominal)
Maximum Safe Input Level		
AC Coupled	7 Vrms, or 20 Vdc	
DC Coupled	7 Vrms, or 0 Vdc	

Audio Frequency Counter [1]

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	±(0.02 Hz + f × Internal Reference Accuracy)[b]	
$f \geq 1$ kHz	±3 counts of the first 6 significant digits ± f × (Internal Reference Accuracy)[b]	
Resolution	0.01 Hz (8 digits)	
Sensitivity	≤ 5 mV	Nominally applies to "DC Coupled".

a. This specification is for the "AC Coupled" audio signal path and nominally applies to the "DC Coupled" path. 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.

b. Refer to the Frequency Reference section in the PXA base specifications.

1. PXA Option 107 is required.

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 to 250 kHz BW)	0.01% to 100% (–80 to 0 dB)	
Accuracy		Verified in dB; can be converted into linear term in % using formula of % = (10^(A dB/20)-1) x 100%
20 Hz to 20 kHz	± 1 dB of reading	
20 to 80 kHz[a]	± 2 dB of reading	
Residual Noise and Distortion	< 0.3% (–50.4 dB)	
Total Noise		–73.2 dB characteristic performance
Total Distortion		–74.8 dB characteristic performance

a. Verification is performed for the audio frequency up to 80 kHz due to the technical limitation of test equipment used.

Audio SINAD [1]

Description	Specification	Supplemental Information
Display Range (20 Hz to 250 kHz BW)	0.00 to 80 dB	
Display Resolution	0.001 dB	
Accuracy		
20 Hz to 20 kHz	± 1 dB of reading	Verified in dB; can be converted into linear term in % using formula of % = (10^(A dB/20)-1) x 100%
20 to 80 kHz[a]	± 2 dB of reading	

1. PXA Option 107 is required. All specifications in the tables are for "AC Coupled" but also nominally applies to "DC Coupled".

Description	Specification	Supplemental Information
Residual Noise and Distortion	50.4 dB	
Total Noise		73.2 dB characteristic performance
Total Distortion		74.8 dB characteristic performance

a. Verification is performed for the audio frequency up to 80 kHz due to the technical limitation of test equipment used.

Audio Filters[1]

Description	Specification	Supplemental Information
Filter Flatness[a]		Nominal
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 μW) to +30 dBm (1 W).

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 ≤ f_c ≤ 10 MHz	±0.287	–	–	–	±0.146	–	–	–
10 MHz < f_c ≤ 30 MHz	±0.287	±0.287	–	–	±0.146	±0.146	–	–
30 MHz < f_c ≤ 2 GHz	±0.287	±0.287	±0.287	±0.265	±0.146	±0.146	±0.146	±0.135
2 GHz < f_c ≤ 4.2 GHz	±0.302	±0.302	±0.302	±0.279	±0.146	±0.154	±0.146	±0.142
4.2 GHz < f_c ≤ 18 GHz	–	±0.466	±0.468	±0.342	–	±0.240	±0.241	±0.175
18 GHz < f_c ≤ 26.5 GHz	–	–	±0.386	±0.332	–	–	±0.198	±0.170
26.5 GHz < f_c ≤ 50 GHz	–	–	–	±0.363	–	–	–	±0.186

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. The resulting calculation yields ±0.190 to ±0.297 dB when measuring a +10 dBm signal and ignoring DUT mismatch. Assuming 1.5:1 DUT SWR, the calculation would return a typical accuracy of ±0.213 to ±0.387 dB (depending on the frequency range and power under test). Absolute and relative accuracy specifications do not include mismatch uncertainty.

Description	Specification				Supplemental Information			
					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 ≤ f_c ≤ 10 MHz	±0.222	–	–	–	±0.113	–	–	–
10 MHz < f_c ≤ 30 MHz	±0.222	±0.222	–	–	±0.113	±0.113	–	–
30 MHz < f_c ≤ 2 GHz	±0.222	±0.222	±0.222	±0.191	±0.113	±0.113	±0.113	±0.097
2 GHz < f_c ≤ 4.2 GHz	±0.222	±0.242	±0.242	±0.211	±0.113	±0.123	±0.123	±0.107
4.2 GHz < f_c ≤ 18 GHz	–	±0.432	±0.433	±0.291	–	±0.222	±0.223	±0.148
18 GHz < f_c ≤ 26.5 GHz	–	–	±0.342	±0.279	–	–	±0.175	±0.142
26.5 GHz < f_c ≤ 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 ≤ f_c ≤ 10 MHz	±0.220	–	–	–	±0.112	–	–	–
10 MHz < f_c ≤ 30 MHz	±0.220	±0.219	–	–	±0.112	±0.111	–	–
30 MHz < f_c ≤ 2 GHz	±0.220	±0.219	±0.220	±0.189	±0.112	±0.111	±0.112	±0.097
2 GHz < f_c ≤ 4.2 GHz	±0.240	±0.219	±0.240	±0.209	±0.122	±0.122	±0.122	±0.106
4.2 GHz < f_c ≤ 18 GHz	–	±0.240	±0.432	±0.289	–	±0.122	±0.222	±0.148
18 GHz < f_c ≤ 26.5 GHz	–	–	±0.341	±0.277	–	–	±0.174	±0.141
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	–	–	±0.117	±0.117	–	–
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

Description	Specification	Supplemental Information
RF Power Resolution		
Display resolution	0.001 dB	

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)	
2 GHz to 18 GHz	< 1.28:1 (ρ = 0.123)	
18 GHz to 26.5 GHz	< 1.40:1 (ρ = 0.167)	
U5532C Option 550 N5532A/B Option 550		
30 MHz to 2 GHz	< 1.10:1 (ρ = 0.048)	
2 GHz to 18 GHz	< 1.28:1 (ρ = 0.123)	
18 GHz to 26.5 GHz	< 1.40:1 (ρ = 0.167)	
26.5 GHz to 33 GHz	< 1.55:1 (ρ = 0.216)	
33 GHz to 40 GHz	< 1.70:1 (ρ = 0.259)	
40 GHz to 50 GHz	< 1.75:1 (ρ = 0.272)	

Description	Specification	Supplemental Information
Zero Set and Measurement Noise[a]		
U5532C *Options 504*, *518*, *526*, and *550* N5532A/B *Options 504*, *518*, *526*, and *550*	± 500 nW ± 680 nW	
Zero Drift of Sensors		
U5532C *Options 504*, *518*, *526*, and *550* N5532A/B *Options 504*, *518*, *526*, and *550*	< 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 μW) to +30 dBm (1 W)	One range for power sensors
Response Time (0 to 99% of reading)		150 ms × 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)

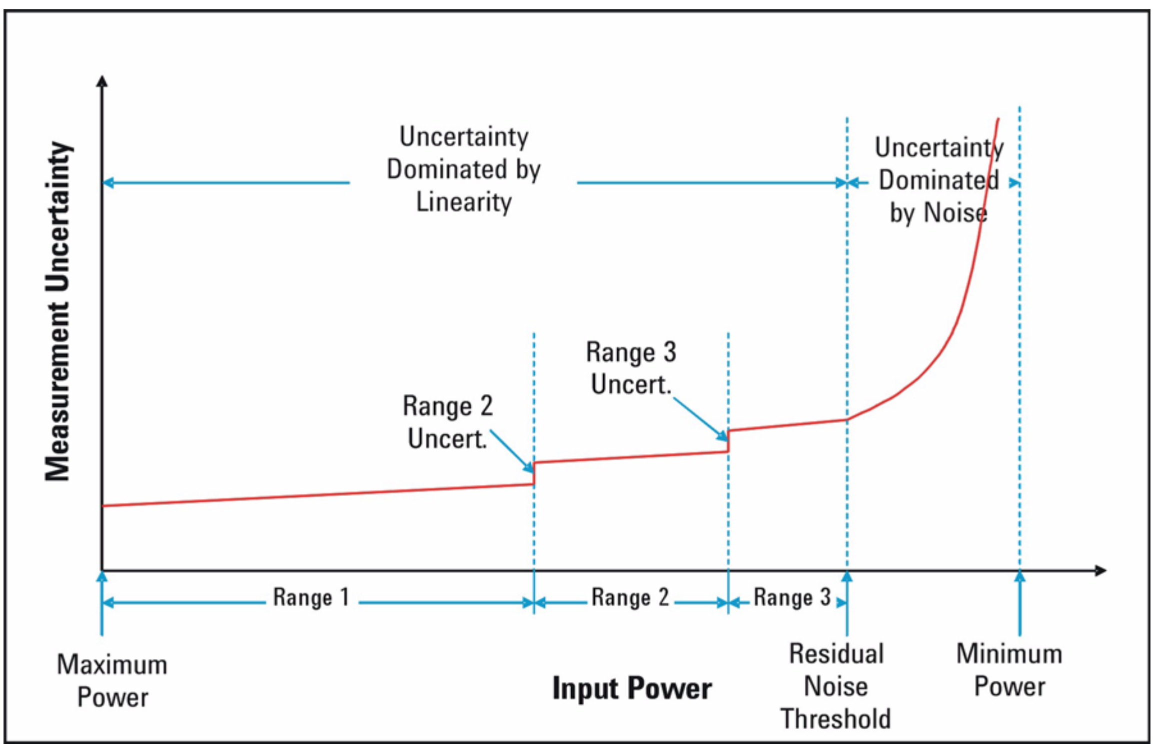
Description	Specification	Supplemental Information
Power Output		Power output is traceable to the U.S. National Institute of Standards and Technology (NIST) and National Physical Laboratories (NPL), UK.
N1911A/N1912A	1.00 mW (0.0 dBm). Factory set to ±0.4%	
N1913A/N1914A	1.00 mW (0.0 dBm). Factory set to ±0.4%	
E4416A/E4417A	1.00 mW (0.0 dBm). Factory set to ±0.4%	
E4418B/E4419B	1.00 mW (0.0 dBm). Factory set to ±0.4%	
Accuracy		25 ± 10°C
N1911A/N1912A	±0.4% for two years	
N1913A/N1914A	±0.4% for two years	
E4416A/E4417A	±0.6% for two years	
E4418B/E4419B	±0.6% for two years	
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”.

Measurement Uncertainty vs. Input Power Relationship



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:
±(0.15 dB + 0.1 dB/MHz of span) to a max of ±0.40 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.

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] **Frequency Range**	75 Hz IFBW[b]	10 Hz IFBW [c]	
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

a. 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 × log (IFBW/75 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.

b. With 75 Hz IFBW setting selected, the measurement automatically switches the IFBW to the 30 Hz setting for SNR values <10 dB.

c. With 10 Hz IFBW setting selected, the measurement automatically switches the IFBW to the 1 Hz setting for SNR values <10 dB.

d. The frequency option determines the maximum frequency the PXA can reach.

Description	Specification		Supplemental Information
Minimum Power (dBm)[a] **Frequency Range**	75 Hz IFBW[b]	10 Hz IFBW [c]	
Option 544/550[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	–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	Band1
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

a. 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 × log (IFBW/75 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.

b. With 75 Hz IFBW setting selected, the measurement automatically switches the IFBW to the 30 Hz set-ting for SNR values <10 dB.

c. With 10 Hz IFBW setting selected, the measurement automatically switches the IFBW to the 1 Hz setting for SNR values <10 dB.

d. The frequency option determines the maximum frequency the PXA can reach.

Description	Specification	Supplemental Information
Linearity	±(0.009 dB + 0.005 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	±(0.015 dB + 0.005 dB/10 dB step [a]) [c] [d] (nom.)	
Minimum power to residual noise threshold	±(cumulative error[e] + 0.0012 × (Input Power – Residual Noise Threshold Power)^2)	
Residual Noise Threshold Power (dBm)	Residual Noise Threshold Power = Minimum Power +30 dB	
Range 2 Uncertainty[f]	±0.031 dB	
Range 3 Uncertainty[g]	±0.031 dB	

a. "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 ±(0.009 + 2× (0.005)) or ±0.019 dB.
b. 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.
c. 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".
d. This includes the linearity accuracy.
e. 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 ±(0.015 dB + 0.005 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 $\pm(0.015 + \lceil 99/10 \rceil \times 0.005$ dB), or ±0.065 dB, where $\lceil x \rceil$ is a ceiling function that means the smallest integer not less than x.
f. 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.
g. 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.

Description	Specification	Supplemental Information
Absolute Measurement Accuracy		
+20 dBm to Max Power	±(Power Meter Range 1 Uncert + 0.005 dB/10 dB Step)	
Residual Noise Threshold power to +20 dBm	±(Power Meter Range 2-4 Uncert + 0.005 dB/10 dB Step)	
Minimum Power to Residual Noise Threshold power	±(cumulative error[a] + 0.0012×(Input Power – Residual Noise Threshold Power)^2)	
Residual Noise Threshold Power (dBm)	Residual Noise Threshold Power = Minimum Power + 30 dB	
Range 2 Uncertainty[b]	±0.031 dB	
Range 3 Uncertainty[c]	±0.031 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 32 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: ±(power meter range uncertainty + 0.005 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 ±0.190 dB from the table on page 34.
The Residual Noise Threshold Power is –106 dBm. This is calculated as follows: See Minimum Power specification on page 35. Assume no preamp is installed, and that the measurement frequency is 10 MHz to 3 GHz. The Residual Noise Threshold Power is –136 + 30 dB = –106 dBm using the formula on page 37.
The cumulative error is then ±(0.190 dB + $\lceil 106/10 \rceil \times$ 0.005 dB), or ±0.245 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.

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 ≤ f_c ≤ 10 MHz	±0.287	–	–	–	±0.146	–	–	–
10 MHz < f_c ≤ 30 MHz	±0.287	±0.287	–	–	±0.146	±0.146	–	–
30 MHz < f_c ≤ 2 GHz	±0.287	±0.287	±0.287	±0.265	±0.146	±0.146	±0.146	±0.135
2 GHz < f_c ≤ 4.2 GHz	±0.302	±0.302	±0.302	±0.279	±0.146	±0.154	±0.146	±0.142
4.2 GHz < f_c ≤ 18 GHz	–	±0.466	±0.468	±0.342	–	±0.240	±0.241	±0.175
18 GHz < f_c ≤ 26.5 GHz	–	–	±0.386	±0.332	–	–	±0.198	±0.170
26.5 GHz < f_c ≤ 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 ≤ f_c ≤ 10 MHz	±0.222	–	–	–	±0.113	–	–	–
10 MHz < f_c ≤ 30 MHz	±0.222	±0.222	–	–	±0.113	±0.113	–	–
30 MHz < f_c ≤ 2 GHz	±0.222	±0.222	±0.222	±0.191	±0.113	±0.113	±0.113	±0.097
2 GHz < f_c ≤ 4.2 GHz	±0.222	±0.242	±0.242	±0.211	±0.113	±0.123	±0.123	±0.107
4.2 GHz < f_c ≤ 18 GHz	–	±0.432	±0.433	±0.291	–	±0.222	±0.223	±0.148
18 GHz < f_c ≤ 26.5 GHz	–	–	±0.342	±0.279	–	–	±0.175	±0.142
26.5 GHz < f_c ≤ 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 ≤ f_c ≤ 10 MHz	±0.220	–	–	–	±0.112	–	–	–
10 MHz < f_c ≤ 30 MHz	±0.220	±0.219	–	–	±0.112	±0.111	–	–
30 MHz < f_c ≤ 2 GHz	±0.220	±0.219	±0.220	±0.189	±0.112	±0.111	±0.112	±0.097
2 GHz < f_c ≤ 4.2 GHz	±0.240	±0.219	±0.240	±0.209	±0.122	±0.122	±0.122	±0.106
4.2 GHz < f_c ≤ 18 GHz	–	±0.240	±0.432	±0.289	–	±0.122	±0.222	±0.148
18 GHz < f_c ≤ 26.5 GHz	–	–	±0.341	±0.277	–	–	±0.174	±0.141

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	–	–	±0.117	±0.117	–	–
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							

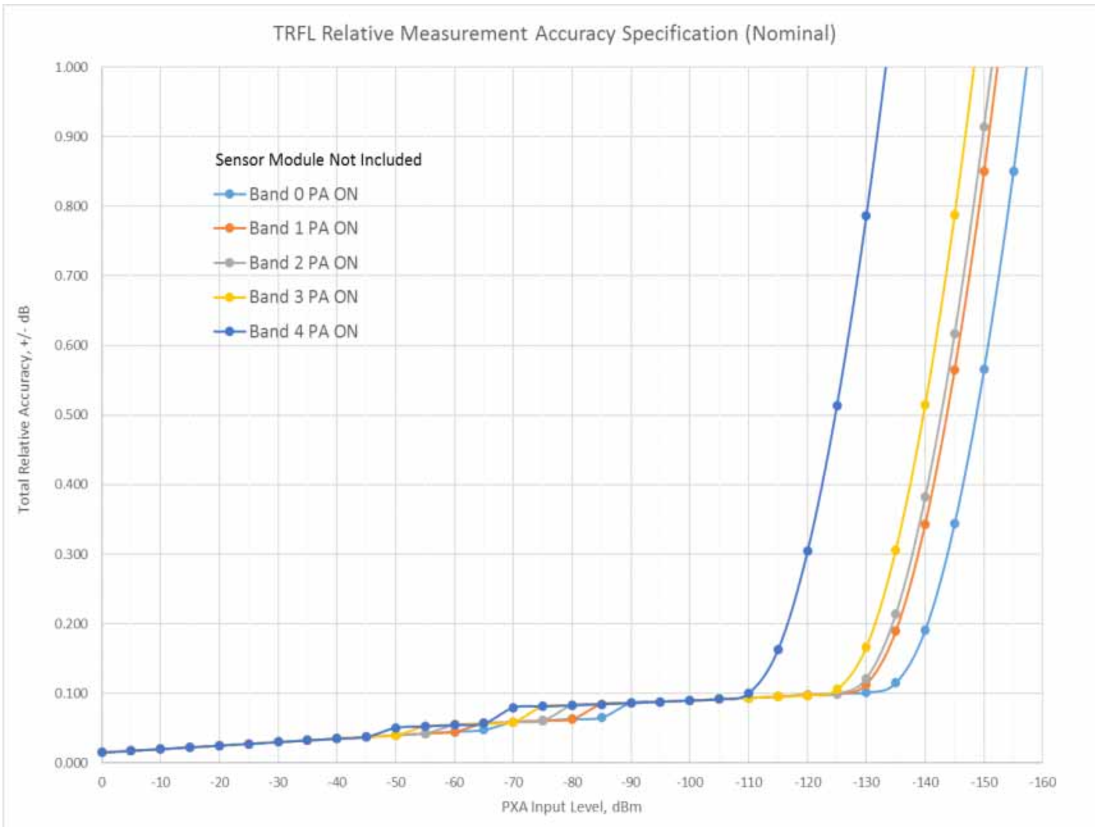
Information about Residuals

- 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 sensor module (N5532A/B) 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 N5532A/B to measure the TRFL level below –100 dBm at 50 MHz and its second or third harmonic.

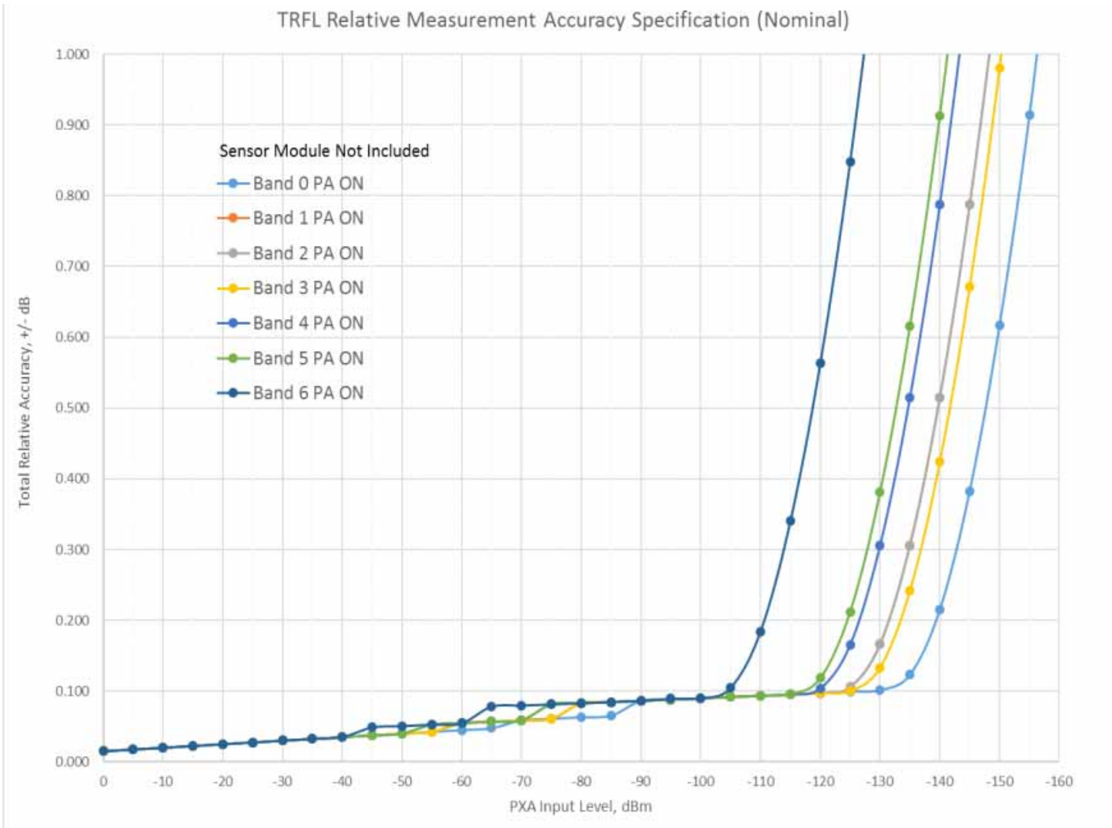
Description	Specification	Supplemental Information
Operating Frequency Range		
Option 503/508/513/526/544/550	100 kHz to 3.6 GHz	
Option 508/513/526/544/550	3.6 to 8.4 GHz	Requires *Option MPB*
Option 513/526/544/550	8.4 to 13.6 GHz	Requires *Option MPB*
Option 526/544/550	13.6 to 26.5 GHz	Requires *Option MPB*
Option 544/550	26.5 to 44 GHz	Requires *Option MPB*
Option 550	44 to 50 GHz	Requires *Option MPB*
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 27.	

Graphical TRFL Measurement Accuracy (Nominal)

N9030B, Option 503/508/513/526, IF BW 10 GHz– Preamp On: Option P03/P08/*P13/26* [Plot]



N9030B, Option 544/550, IF BW 10 GHz– Preamp On: Option P44 [Plot]



KEYSIGHT TECHNOLOGIES

Edition 1, August 2019

N5531-90006

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