Keysight X-Series Signal Analyzers

This manual provides documentation for the following Analyzer:

N9032B PXA Signal Analyzer

KEYSIGHT

MEASUREMENT APPLICATION SPECIFICATIONS GUIDE

Notices

Trademark Acknowledgments

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A **WARNING** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Where to Find the Latest Information

Documentation is updated periodically. For the latest information about these products, including instrument software upgrades, application information, and product information, browse to one of the following URLs, according to the name of your product:

https://www.keysight.com/find/n9032b

To receive the latest updates by email, subscribe to Keysight Email Updates at the following URL:

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Periodically, Keysight releases software updates to fix known defects and incorporate product enhancements. To search for software updates for your product, go to the Keysight Technical Support website at:

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Keysight X-Series Signal Analyzer
N9032B

Measurement Application Specifications Guide

1 Definitions and Requirements

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

NOTE

For comprehensive specifications that describe the performance of parameters covered by the product warranty and apply to temperature ranges 0 to 55 °C, unless otherwise noted refer to the N9032B PXA X-Series Signal Analyzer, Multi-touch Data Sheet.

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 analyzer will meet its specifications when:

- It is within its calibration cycle.
- Under auto couple control, except that Auto Sweep Time Rules = Accy
- For signal frequencies < 10 MHz, DC coupling applied.
- Analyzer is used in environment that falls within allowed operating range; and has been in that environment at least 2 hours before being turned on.
- Analyzer has been turned on at least 30 minutes with AutoAlign 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. Note that factory default is with the AutoAlign set to Light, which (compared to Normal) allows wider temperature changes before causing Alignments to run automatically. The benefit is that Alignments interrupt less frequently. The user can change AutoAlign to Normal if desired, and this setting will persist after power cycle or PRESET. 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. In practice, the impact of such choices is primarily on Absolute Amplitude Accuracy. If temperature changes are small, the impact of Light vs Normal is negligible. Also, the user may invoke Align All at any time, to get the best possible accuracy.

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.

2 Power Suite Measurements

This chapter contains specifications for the Power Suite measurement application.

Power Suite Measurements

Power Suite Measurements

Description	Specifications	Supplemental Information
Channel Power		
Amplitude Accuracy		Absolute Amplitude Accuracy[a] + Power Bandwidth Accuracy[bc]
Case: Radio Std = 3GPP 5G NR		
Absolute Power Accuracy (20 to 30°C, Attenuation = 10 dB)	±0.74 dB	±0.20 dB (95th percentile)

a. Refer to "Absolute Amplitude Accuracy" in the N9032B PXA X-Series Signal Analyzer, Multi-touch Data Sheet
b. Refer to "Frequency and Time" in the N9032B PXA X-Series Signal Analyzer, Multi-touch Data Sheet
c. Expressed in dB.

Description	Specifications	Supplemental Information
Occupied Bandwidth		
Frequency Accuracy		±(Span/1000) (nominal)

Power Suite Measurements

Description		Specifications	Supplemental Information
Adjacent Channel Power			
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]
Case: Radio Std = 3GPP 5G NR			
Minimum power at RF Input			–36 dBm (nominal)
ACPR Accuracy			Meas Method ≠ RBW
Radio	**Offset Freq**		Channel Bandwidth 100 MHz
MS	Adjacent	±0.29 dB	At ACPR range of –33 to –27 dBc with optimum mixer level
BTS	Adjacent	±1.48 dB	At ACPR range of –48 to –42 dBc with optimum mixer level
BTS	Alternate	±0.30 dB	At ACPR range of –48 to –42 dBc with optimum mixer level

a. The effect of scale fidelity on the ratio of two powers is called the relative scale fidelity. The scale fidelity specified in the Amplitude section is an absolute scale fidelity with –35 dBm at the input mixer as the reference point. The relative scale fidelity is nominally only 0.01 dB larger than the absolute scale fidelity.
b. Refer to the Amplitude Accuracy and Range section in the N9032B PXA X-Series Signal Analyzer, Multi-touch Data Sheet
c. Refer to the Frequency and Time section in the N9032B PXA X-Series Signal Analyzer, Multi-touch Data Sheet.
d. Expressed in decibels in the N9032B PXA X-Series Signal Analyzer, Multi-touch Data Sheet.

Power Suite Measurements

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	Power above threshold Power within burst width	
Results	Output power, average Output power, single burst Maximum power Minimum power within burst Burst width	

Description	Specifications	Supplemental Information
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)	

Power Suite Measurements

Description	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Case: Radio Std = 3GPP 5G NR		
Dynamic Range[a], relative (RBW=1 MHz)		
10 MHz to 3.6 GHz (Band 0[b])		91.9 dB (nominal)
3.5 GHz to 8.4 GHz (Band 1[b])		92.8 dB (nominal)
Sensitivity[c], (RBW=1 MHz)		
10 MHz to 3.6 GHz (Band 0[b])		–87.5 dBm (typical)
3.5 GHz to 8.4 GHz (Band 1[b])		–89.5 dBm (typical)
Accuracy		Attenuation = 10 dB
10 MHz to 3.6 GHz (Band 0[b])		±0.20 dB (95th percentile)
3.5 to 8.4 GHz (Band 1[b])		±0.64 dB (95th percentile)
8.3 to 13.6 GHz (Band 2[b])		±0.69 dB (95th percentile)
13.5 to 17.1 GHz (Band 3[b])		±0.80 dB (95th percentile)
17 to 26.5 GHz (Band 4[b])		±0.96 dB (95th percentile)

a. The dynamic range is specified at 50 MHz offset from center frequency with mixer level of 1 dB compression point, which will degrade accuracy 1 dB.
b. Refer to the Frequency and Time section in the N9032B PXA X-Series Signal Analyzer, Multi-touch Data Sheet.
c. 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.

Power Suite Measurements

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Case: Radio Std = 3GPP 5G NR		
Dynamic Range		
Channel Bandwidth: 100 MHz		
10 MHz to 3.6 GHz (Band 0[a])[b]	84.4 dB	88.5 dB (typical)
3.5 GHz to 8.4 GHz (Band 1[a])[c]	82.7 dB	87.4 dB (typical)
Sensitivity		
10 MHz to 3.6 GHz (Band 0[a])	-94.5 dBm	-97.5 dBm (typical)
3.5 GHz to 8.4 GHz (Band 1[a])	-95.5 dBm	-99.5 dBm (typical)
Accuracy		
Relative		
10 MHz to 3.6 GHz (Band 0[a])	±0.20 dB	
3.5 GHz to 8.4 GHz (Band 1[a])	±0.64 dB	
Absolute		
10 MHz to 3.6 GHz (Band 0[a])	±0.73 dB	±0.34 dB (95th percentile)
3.5 GHz to 8.4 GHz (Band 1[a])	±1.88 dB	±1.03 dB (95th percentile)

a. Refer to the Frequency and Time section in the N9032B PXA X-Series Signal Analyzer, Multi-touch Data Sheet.
b. This dynamic range specification applies for the optimum mixer level, which is -8 dBm for channel bandwidths of 100 MHz (band 0).
c. This dynamic range specification applies for the optimum mixer level, which is -10 dBm for channel bandwidths of 100 MHz (band 1).

3 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[a]		20 to 30°C, Atten = 10 dB
10 MHz to 3.6 GHz (Band 0)	±0.74 dB	±0.20 dB (95th Percentile)
3.5 to 8.4 GHz (Band 1)	±1.89 dB	±0.64 dB (95th Percentile)
Measurement Floor		In a 100 MHz bandwidth
10 MHz to 3.6 GHz (Band 0)		-67.7 dBm (typical)
3.5 to 8.4 GHz (Band 1)		-69.7 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
Power Statistics CCDF		
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.

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

Description	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Dynamic Range[a], (RBW = 1 MHz)		
10 MHz to 3.6 GHz (Band 0)		91.9 dB (nominal)
3.5 to 8.4 GHz (Band 1)		92.8 dB (nominal)
Sensitivity[b], (RBW = 1 MHz)		
10 MHz to 3.6 GHz (Band 0)	–84.5 dBm	–87.5 dBm (typical)
3.5 to 8.4 GHz (Band 1)	–85.5 dBm	–89.5 dBm (typical)
Accuracy		(Attenuation = 10 dB)
10 MHz to 3.6 GHz (Band 0)		±0.20 dB (95th Percentile)
3.5 to 8.4 GHz		±0.64 dB (95th Percentile)
8.3 to 13.6 GHz		±0.69 dB (95th Percentile)
13.5 to 17.1 GHz		±0.80 dB (95th Percentile)
17 to 26.5 GHz		±0.96 dB (95th Percentile)

a. The dynamic range is specified at 50 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 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.

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**
10 MHz to 3.6 GHz (Band 0)	±0.15 dB	±0.22 dB	±0.29 dB	–33 to –27 dBc with opt ML(–18, –17, –15 dBm)
3.5 GHz to 8.4 GHz (Band 1)	±0.48 dB	±0.69 dB	±0.90 dB	–33 to –27 dBc with opt ML(–20, –19, –17 dBm)
Adjacent Offset, BTS[b]				
10 MHz to 3.6 GHz (Band 0)	±0.69 dB	±1.07 dB	±1.48 dB	–48 to –42 dBc with opt ML(–14, –12, –11 dBm)
3.5 GHz to 8.4 GHz (Band 1)	±1.19 dB	±1.80 dB	±2.44 dB	–48 to –42 dBc with opt ML(–16, –15, –13 dBm)
Alternate Offset, BTS				
10 MHz to 3.6 GHz (Band 0)	±0.17 dB	±0.24 dB	±0.30 dB	–48 to –42 dBc with opt ML(–1, 1, 4 dBm)
3.5 GHz to 8.4 GHz (Band 1)	±0.56 dB	±0.78 dB	±1.01 dB	–48 to –42 dBc with opt ML(0, 6, 7 dBm)

a. Measurement bandwidths for mobile stations are 19.095, 48.615 and 98.31 MHz for channel bandwidths of 20, 50 and 100 MHz respectively.
b. 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.

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		
10 MHz to 3.6 GHz (Band 0)[a]	82.1 dB	86.1 dB (typical)
3.5 GHz to 8.4 GHz (Band 1)[b]	80.4 dB	85.1 dB (typical)
Channel Bandwidth: 50 MHz		
10 MHz to 3.6 GHz (Band 0)[a]	83.4 dB	87.5 dB (typical)
3.5 GHz to 8.4 GHz (Band 1)[b]	81.7 dB	86.4 dB (typical)
Channel Bandwidth: 100 MHz		
10 MHz to 3.6 GHz (Band 0)[a]	84.4 dB	88.5 dB (typical)
3.5 GHz to 8.4 GHz (Band 1)[b]	82.7 dB	87.4 dB (typical)
Sensitivity		
10 MHz to 3.6 GHz (Band 0)	–94.5 dBm	–97.5 dBm (typical)
3.5 GHz to 8.4 GHz (Band 1)	–95.5 dBm	–99.5 dBm (typical)
Accuracy		
Relative		
10 MHz to 3.6 GHz (Band 0)	±0.20 dB	
3.5 GHz to 8.4 GHz (Band 1)	±0.64 dB	
Absolute (20 to 30°C)		
10 MHz to 3.6 GHz (Band 0)	±0.73 dB	±0.34 dB (95th Percentile)
3.5 GHz to 8.4 GHz (Band 1)	±1.88 dB	±1.03 dB (95th Percentile)

a. This dynamic range specification applies for the optimum mixer level, which are -10, -9 and -8 dBm for channel bandwidths of 20, 50 and 100 MHz (band 0) respectively.
b. This dynamic range specification applies for the optimum mixer level, which are -13, -11 and -10 dBm for channel bandwidths of 20, 50 and 100 MHz (band 1) respectively.

Description	Specifications	Supplemental Information
Modulation Analysis		
EVM floor		Channel Bandwidth: 100 MHz
Frequency		
2 GHz		0.16% (nominal)
4.5 GHz		0.23% (nominal)
Frequency Error		
Lock range		±2.5 × subcarrier spacing = 75 kHz for default 30 kHz subcarrier spacing[a] (nominal)
Accuracy		±1 Hz + tfa[b] (nominal)

a. The specification applies when Extended Freq Range = On.
b. tfa = transmitter frequency × frequency reference accuracy.

Frequency Ranges

Frequency Range: FR1					
NR Operating Band	**Uplink (UL) Operating Band** BS Receive UE Transmit		**Downlink (DL) Operating Band** BS Transmit UE Receive		Duplex Mode
	$F_{UL\_low} - F_{UL\_high}$	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

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

Frequency Range: FR2					
NR Operating Band	**Uplink (UL) Operating Band** BS Receive UE Transmit		**Downlink (DL) Operating Band** BS Transmit UE Receive		Duplex Mode
	$F_{UL\_low} - F_{UL\_high}$	Total BW (MHz)	$F_{DL\_low} - F_{DL\_high}$	Total BW (MHz)	
n257	26500–29500 MHz	3000	26500–29500 MHz	3000	TDD
n258	24250–27500 MHz	3260	24250–27500 MHz	3260	TDD
n260	37000–40000 MHz	3000	37000–40000 MHz	3000	TDD

4 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.

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[1]		+30 dBm to –70 dBm
Absolute Power Accuracy[2] (20 to 30°C, Atten = 10 dB)		±21 dB (95th percentile)
Measurement floor		–70 dBm (nominal)

1. 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.
2. 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.

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 Δf1avg min Δf2max (kHz) total Δf2max > Δf2max lower limit (%) min of min Δf2avg / max Δf1avg pseudo frequency deviation (Δf1 and Δf2)
RF input level range[1]		+30 dBm to –70 dBm
Deviation range		±250 kHz (nominal)
Deviation resolution		100 Hz (nominal)
Measurement Accuracy[2]		±100 Hz + tfa[3] (nominal)

1. 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.
2. 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 ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
3. tfa = transmitter frequency × frequency reference accuracy.

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, BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
RF input level range[1]		+30 dBm to –70 dBm
Measurement range		Nominal channel freq ± 100 kHz (nominal)
Measurement Accuracy[2]		±100 Hz + tfa[3] (nominal)

1. 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.
2. 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 ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
3. tfa = transmitter frequency × 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, BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
RF input level range[1]		+30 dBm to –70 dBm
Measurement range		±100 kHz (nominal)
Measurement Accuracy[2]		±100 Hz + tfa[3] (nominal)

1. 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.

2. 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 ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
3. tfa = transmitter frequency × 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, BS0F, BS55
Synchronization		None
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Measurement Accuracy[1]		Dominated by the variance of measurements[2]

1. The accuracy is for absolute power measured at 2.0 MHz offset and other offsets (offset = K MHz, K = 3,...,78).
2. 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 ±0.21 dB.

Low Energy 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 LE.RF-PHY.TS/0.7d2.6.2.1.
Packet Type		Reference type
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[1]		+30 dBm to –70 dBm
Absolute Power Accuracy[2] (20 to 30°C, Atten = 10 dB)		±0.21 dB (95th percentile)
Measurement floor		–70 dBm (nominal)

1. 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.
2. 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.

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		BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Supported measurements		Min/max Δf1avg min Δf2max (kHz) total Δf2max > Δf2max lower limit (%) min of min Δf2avg / max Δf1avg pseudo frequency deviation (Δf1 and Δf2)
RF input level range[1]		+30 dBm to –70 dBm
Deviation range		±250 kHz (nominal)
Deviation resolution		100 Hz (nominal)
Measurement Accuracy[2]		±100 Hz + tfa[3] (nominal)

1. 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.
2. 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 ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
3. tfa = transmitter frequency × frequency reference accuracy.

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, BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
RF input level range[1]		+30 dBm to –70 dBm
Measurement range		Nominal channel freq ± 100 kHz (nominal)
Measurement Accuracy[2]		±100 Hz + tfa[3] (nominal)

1. 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.
2. 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 ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
3. tfa = transmitter frequency × frequency reference accuracy.

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, BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
RF input level range[1]		+30 dBm to –70 dBm
Measurement range		±100 kHz (nominal)
Measurement Accuracy[2]		±100 Hz + tfa[3] (nominal)

1. 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.
2. 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 ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
3. tfa = transmitter frequency × 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, BS0F, BS55
Synchronization		None
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Measurement Accuracy[1]		Dominated by the variance of measurements[2]

1. The accuracy is for absolute power measured at 2.0 MHz offset and other offsets (offset =2 MHz × K, K = 2,...,39).
2. 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 ±0.21 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[1]		+30 dBm to –70 dBm
Absolute Power Accuracy[2] (20 to 30°C, Atten = 10 dB)		±0.21 dB (95th percentile)
Measurement floor		–70 dBm (nominal)

1. 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.
2. 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.

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[1]		+30 dBm to –70 dBm
RMS DEVM		
Range	0 to 12%	
Floor		0.23%(nominal)
Accuracy[2]	1.2%	

1. 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.
2. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:
error = sqrt(EVMUUT2 + EVMsa2) – EVMUUT, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent

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(ωi) for all packets (carrier frequency stability), worst case frequency error for all blocks (ωo), ($\omega o + \omega i$) for all blocks
RF input level range[1]		+30 dBm to –70 dBm
Carrier Frequency Stability and Frequency Error[2]		±100 Hz + tfa[3] (nominal)

1. 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.
2. 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 ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
3. tfa = transmitter frequency × frequency reference accuracy.

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[1]		
Offset Freq = 1 MHz to 1.5 MHz		Dominated by ambiguity of the measurement standards[2]
Offset Freq = other offsets (2 MHz to 78 MHz)		Dominated by the variance of measurements[3]

1. 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.
2. The measurement standards call for averaging the signal across 3.5 µs 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 µs 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.
3. 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 ±0.21 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 MHz, k = 0,...,78 (RF channels used by Bluetooth)
Bluetooth Low Energy System	2.400 to 2.4835 GHz (ISM radio band)	f = 2402 + k×2 MHz, k = 0,...,39 (RF channels used by Bluetooth)

5 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.

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)	±0.74 dB	±0.20 dB (95th Percentile)
Measurement floor		–77.7 dBm (typical) 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)	±1.89 dB	±0.64dB (95th Percentile)
Measurement floor		–79.7 dBm (typical) 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, Atten = 10 dB)	±0.72 dB	±0.20 dB (95th Percentile)
Measurement floor		–94.7 dBm (typical) in a 200 kHz 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
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.

Description	Specifications	Supplemental Information
Power Statistics CCDF		LTE/LTEA/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
Occupied Bandwidth		
Minimum carrier power at RF Input		–30 dBm (nominal)
Frequency accuracy	±10 kHz	RBW = 30 kHz, Number of Points = 1001, Span = 10 MHz

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

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

Description	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Dynamic Range[a], relative (RBW = 1 MHz)		91.8 dB (nominal)
Sensitivity[b], absolute (RBW=1 MHz)	–84.5 dBm	–87.5 dBm (typical)
Accuracy		Attenuation = 10 dB
Frequency Range		
10 MHz to 3.6 GHz (Band 0)		±0.20 dB (95th percentile)
3.5 GHz to 8.4 GHz (Band 1)		±0.64 dB (95th percentile)
8.3 GHz to 13.6 GHz (Band 2)		±0.69 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.

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)		92.8 dB (nominal)
Sensitivity[b], absolute (RBW=1 MHz)	–85.5 dBm	–89.5 dBm (typical)
Accuracy		Attenuation = 10 dB
Frequency Range		
10 MHz to 3.6 GHz (Band 0)		±0.20 dB (95th percentile)
3.5 GHz to 8.4 GHz (Band 1)		±0.64 dB (95th percentile)
8.3 GHz to 13.6 GHz (Band 2)		±0.69 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.

Description	Specifications			Supplemental Information
Adjacent Channel Power				Single Carrier
Minimum power at RF input				–36 dBm (nominal)
Accuracy	**Channel Bandwidth**			
	5 MHz	**10 MHz**	**20 MHz**	**ACPR Range for Specification**
Adjacent Offset, MS[a]	±0.09 dB	±0.12 dB	±0.15 dB	–33 to –27 dBc with opt ML (-23, -22, -19 dBm)
Adjacent Offset, BTS[b]	±0.35 dB	±0.48 dB	±0.66 dB	–48 to –42 dBc with opt ML (-17, -16, -14 dBm)
Alternate Offset, BTS[b]	±0.11 dB	±0.14 dB	±0.17 dB	–48 to –42 dBc with opt ML (-6, -5, -2 dBm)

a. Measurement bandwidths for mobile stations are 4.5, 9 and 18 MHz for channel bandwidths of 5, 10 and 20 MHz respectively.
b. 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.

Description		Specifications			Supplemental Information
Adjacent Channel Power					C-V2X
					Frequency Range: 5855 to 5925 MHz
Minimum power at RF input					–36 dBm (nominal)
Accuracy		Channel Bandwidth			
Radio	**Offset**	**5 MHz**	**10 MHz**	**20 MHz**	**ACPR Range for Specification**
MS[a]	Adjacent	±0.28 dB	±0.37 dB	±0.48 dB	–33 to –27 dBc with opt ML (-24, -23, -21 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.

Description		Specifications	Supplemental Information
Adjacent Channel Power			NB-IoT Stand-alone
Minimum power at RF input			–36 dBm (nominal)
Accuracy			
Radio	**Offset**		**ACPR Range for Specification**
MS[a]	200 kHz	±0.02 dB	–23 to –17 dBc with opt ML (-26 dBm)
MS[a]	2.5 MHz	±0.13 dB	–40 to –34 dBc with opt ML (-21 dBm)
BTS[b]	300 kHz	±0.05 dB	–43 to –37 dBc with opt ML (-26 dBm)
BTS[b]	500 kHz	±0.07 dB	–53 to –47 dBc with opt ML (-16 dBm)

a. Measurement bandwidth for mobile stations is 180 kHz.
b. Measurement bandwidth for base transceiver stations is 180 kHz.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Offset from CF = (channel bandwidth + measurement bandwidth) / 2; measurement bandwidth = 100 kHz
Dynamic Range[ab]		
Channel Bandwidth		
5 MHz	80.0 dB	84.0 dB (typical)
10 MHz	81.0 dB	85.1 dB (typical)
20 MHz	82.0 dB	86.2 dB (typical)
Sensitivity [c]	-94.5 dBm	-97.5 dBm (typical)
Accuracy		
Relative[d]	±0.14 dB	
Absolute, 20 to 30°C	±0.73 dB	±0.34 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. 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.
b. This dynamic range specification applies for the optimum mixer level, which are -12, -11 and -10 dBm for channel bandwidths of 5, 10 and 20 MHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

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[ab]		
Channel Bandwidth		
5 MHz	78.4 dB	83.0 dB (typical)
10 MHz	79.4 dB	84.0 dB (typical)
20 MHz	80.4 dB	85.0 dB (typical)
Sensitivity[c]	–95.5 dBm	–99.5 dBm (typical)
Accuracy		
Relative[d]	±0.38dB	
Absolute, 20 to 30°C	±1.88 dB	±1.03 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. 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.
b. This dynamic range specification applies for the optimum mixer level, which are -15, -14 and -13 dBm for channel bandwidths of 5, 10 and 20 MHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		NB-IoT: Stand-alone Offset from CF = (channel bandwidth + measurement bandwidth) / 2 = 115 kHz Measurement bandwidth = 100 kHz
Dynamic Range[ab]	74.0 dB	78.3 dB (typical)
Sensitivity[c]	–99.7 dBm	–102.7 dBm (typical)
Accuracy		
Relative[d]	±0.05 dB	
Absolute, 20 to 30°C	±0.73 dB	±0.34 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. 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 -16 dBm.
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 in an operating band.
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.

Description	Specifications	Supplemental Information
Modulation Analysis		
EVM for Downlink (OFDMA) Floor[a]		
Signal Bandwidth		
5 MHz	0.21%	
10 MHz	0.21%	
20 MHz	0.29%	
EVM Accuracy for Downlink (OFDMA)[b]		
(EVM range: 0 to 8%)		±0.3% (nominal)
EVM for Uplink (SC-FDMA) Floor[a]		
Signal Bandwidth		
5 MHz	0.21%	
10 MHz	0.21%	
20 MHz	0.29%	
Frequency Error		
Lock range		±2.5 × subcarrier spacing = 37.5 kHz for default 15 kHz subcarrier spacing (nominal)
Accuracy		±1 Hz + tfa[c] (nominal)
Time Offset[d]		
Absolute frame offset accuracy	±20 ns	
Relative frame offset accuracy		±5 ns (nominal)
MIMO RS timing accuracy		±5 ns (nominal)

a. Overall EVM and Data EVM using 3GPP standard-defined calculation. Phase Noise Optimization set to Best Close-in.
b. The accuracy specification applies when EVM is less than 1% and no boost applies for resource elements.
c. tfa = transmitter frequency x frequency reference accuracy.
d. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$error = [sqrt(EVM_{UUT}^2 + EVM_{sa}^2)] - EVM_{UUT}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.

Description	Specifications	Supplemental Information
C-V2X Modulation Analysis		Frequency Range: 5855 MHz to 5925 MHz
(Signal level within on range step of overload)		
OSTP/RSTP		
Absolute accuracy[a]		±0.21 dB (nominal)
EVM Floor[b]		
Signal Bandwidth		
10 MHz		-54.0 dB (nominal)
20 MHz		-54.4 dB (nominal)
Frequency Error		
Lock rang		±2.5 × subcarrier spacing = 37.5 kHz for default 15 kHz subcarrier spacing (nominal)
Accuracy		±1 Hz + tfa[c] (nominal)
Time Offset[d]		
Absolute frame offset accuracy	±20 ns	
Relative frame offset accuracy		±5 ns (nominal)
MIMO RS timing accuracy		±5 ns (nominal)

a. The accuracy specification applies when EVM is less than 1% and no boost applies for the reference signal.
b. Overall EVM and Data EVM using 3GPP standard-defined calculation. Phase Noise Optimization set to o Balance Noise and Spurs [offset < 600 kHz].
c. tfa = transmitter frequency × frequency reference accuracy.
d. The accuracy specification applies when EVM is less than 1% and no boost applies for resource elements.

Description	Specifications	Supplemental Information
NB-IoT Modulation Analysis (Signal level within on range step of overload)		**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 Floor for Downlink[a]		-58.0 dB (nominal)
EVM Floor for Uplink		
3/6/12 subcarrier signal with 15 kHz subcarrier spacing		-66 dB (nominal)
1 subcarrier signal with 15 kHz subcarrier spacing		-80.9 dB (nominal)
3.75 kHz subcarrier spacing		-83.1 dB (nominal)

a. Overall EVM and Data EVM using 3GPP standard-defined calculation. Phase Noise Optimization set to Balance Noise and Spurs [offset<600 kHz]

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:
Dynamic Range = Dynamic Range for 5 MHz – 10*log10(Info BW/5.0e6)

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:
Dynamic Range = Dynamic Range for 5 MHz – 10*log10(Info BW/5.0e6)

In-Band Frequency Range

C-V2X Operating Band	
E-UTRA band 47, TDD	5855 to 5925 MHz

NB-IoT Operating Band	
E-UTRA bands, FDD, 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 to798 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	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 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

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	3400 to 3600 MHz
44	703 to 803 MHz

6 Noise Figure Measurement Application

This chapter contains specifications for the N9069EM0E Noise Figure Measurement Application.

General Specifications

Description	Specifications		Supplemental Information
Noise Figure			Uncertainty Calculator[a]
<10 MHz			See note[b]
10 MHz to 26.5 GHz and 26.5 to 55 GHz[c]			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.

Description	Specifications	Supplemental Information
Gain		
Instrument Uncertainty[a]		DUT Gain Range = –20 to +40 dB
<10 MHz		See note[b]
10 MHz to 3.6 GHz	±0.07 dB	
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.

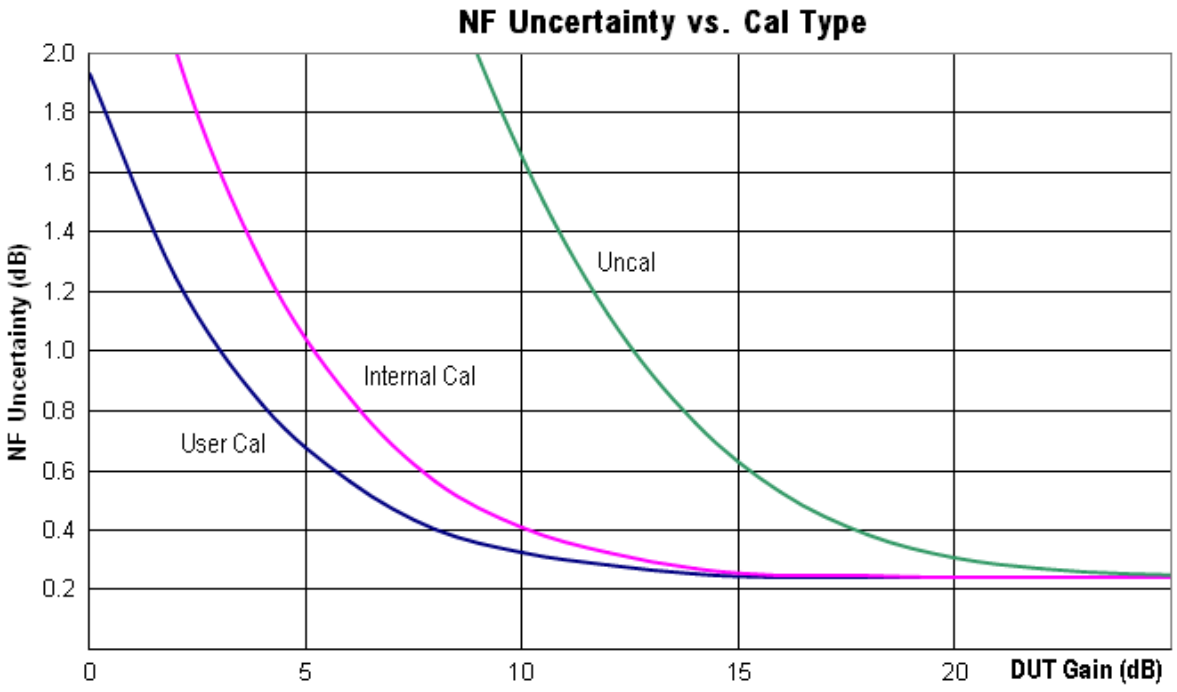
Description	Specifications	Supplemental Information
Noise Figure Uncertainty Calculator[a]		
Instrument Noise Figure Uncertainty	See the Noise Figure table earlier in this chapter	
Instrument Gain Uncertainty	See the Gain table earlier in this chapter	
Instrument Noise Figure		See graphs of "Nominal 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]		Refer to "Displayed Average Noise Level (DANL) in the N9032B Data Sheet.

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.

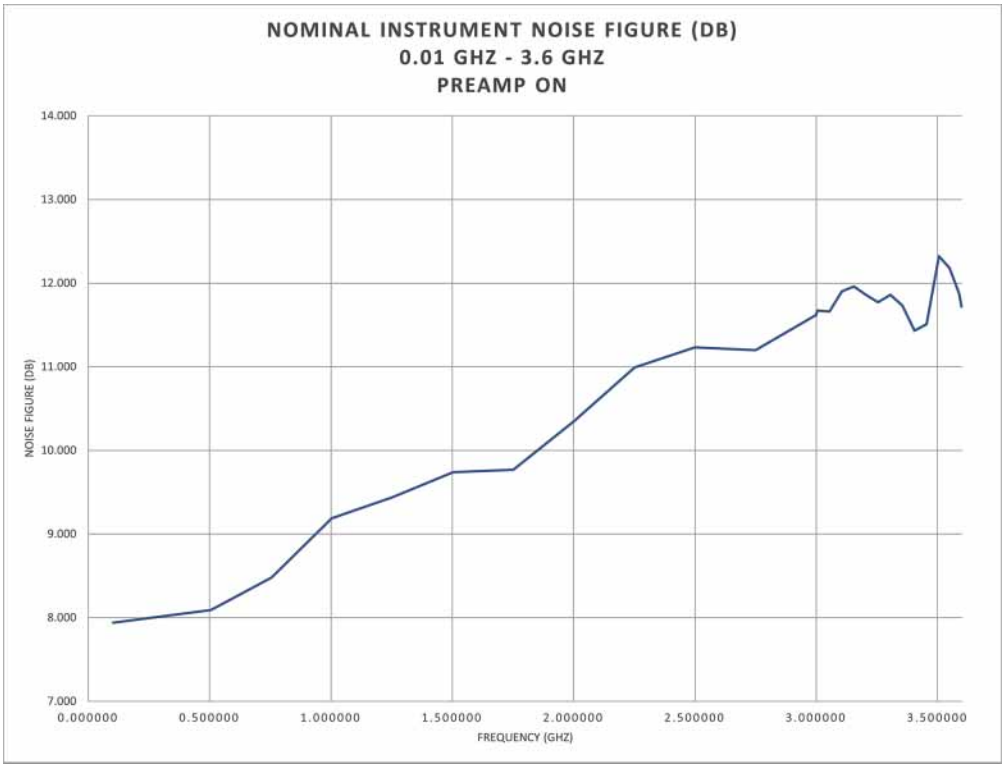
Description	Supplemental Information
Uncertainty versus Calibration Options	
User Calibration	Best uncertainties; Noise Figure Uncertainty Calculator applies
Uncalibrated	Worst uncertainties; noise of the analyzer input acts as a second stage noise on the DUT
Internal Calibration	Good uncertainties without 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.

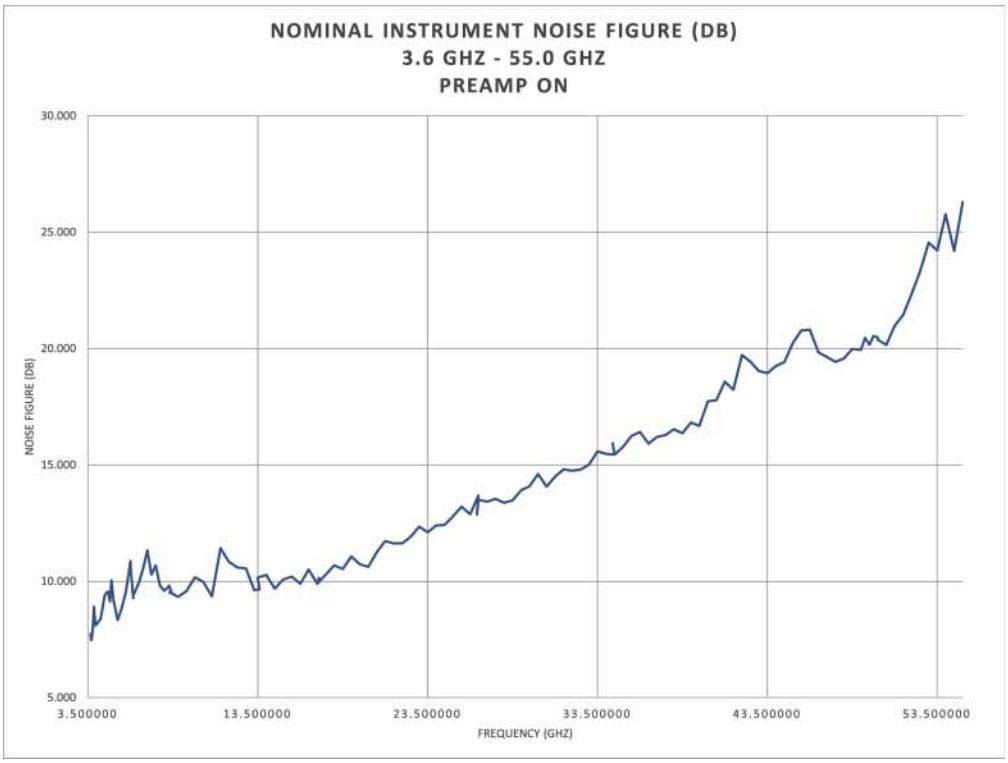
Nominal Noise Figure Uncertainty versus Calibration Used

Assumptions for DUT: NF = 3 dB, Input VSWR = Output VSWR = 1.5:1
Assumptions for Noise Source: Keysight 346B; Uncertainty = 0.20 dB, ENR = 15 dB; VSWR = 1.15
Assumptions for Spectrum Analyzer: PXA operating at 1 GHz. Instrument Uncertainty for NF = 0.03 dB, Instrument Uncertainty for Gain = 0.07 dB, Instrument NF = 10 dB, VSWR = 1.5.

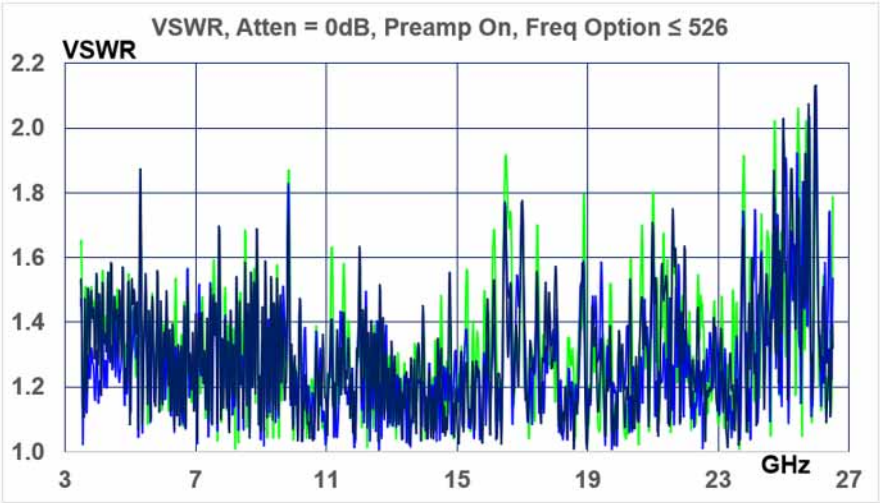


Nominal Instrument Noise Figure

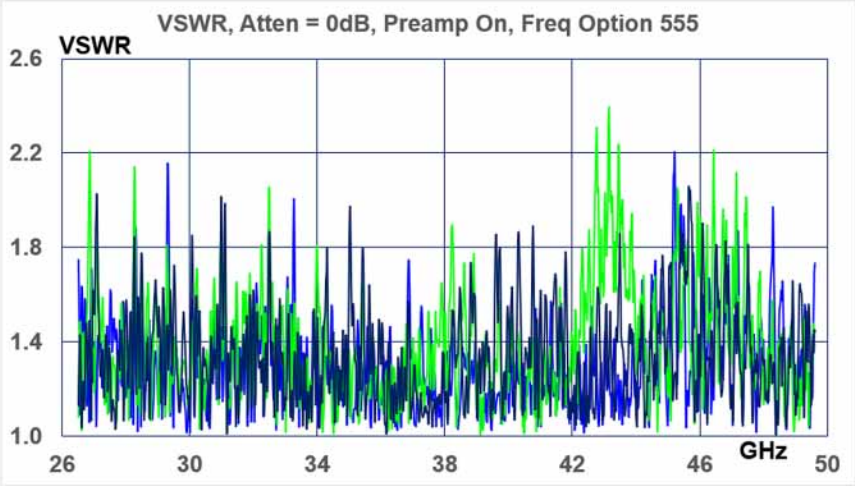


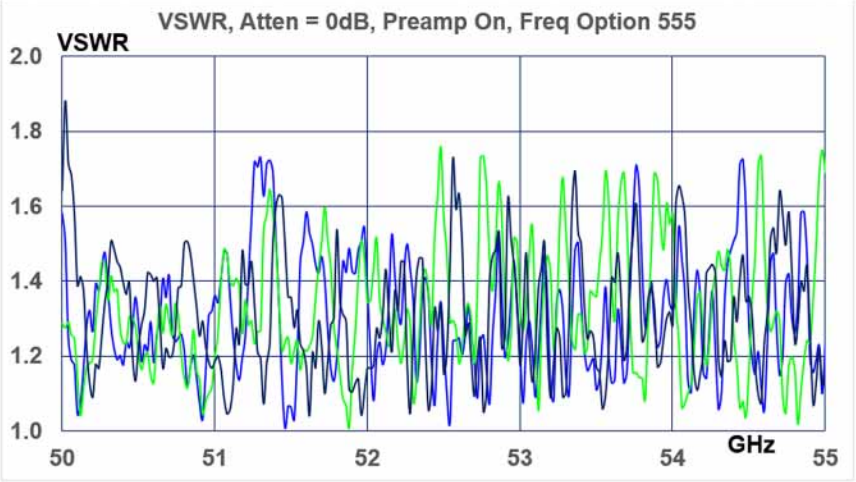


Nominal Instrument Input VSWR, DC Coupled without *Option EP0* [Plot]



Nominal Instrument Input VSWR, DC Coupled without *Option EP0* [Plot]





7 Vector Modulation Analysis Application

This chapter contains specifications for the N9054C Vector Modulation Analysis Measurement Application.

Additional Definitions and Requirements

This application supports the following:

PSK formats: BPSK, QPSK, Offset QPSK, Shaped OQPSK, DQPSK, π/4 DQPSK, 8-PSK, π/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.

Frequency and Time

Description	Specifications		Supplemental Information
Frequency Range			
Maximum Frequency			
Option 508	8.4 GHz		
Option 513	13.6 GHz		
Option 526	26.5 GHz		
Preamp *Option P08*	8.4 GHz		
Preamp *Option P13*	13.6 GHz		
Preamp *Option P26*	26.5 GHz		
Minimum Frequency	DC Coupled	AC Coupled	
PA off, LNA off	2 Hz	10 MHz	
PA on	9 kHz	10 MHz	
LNA on	20 MHz	20 MHz	

Measurements

Description	Specifications	Supplemental Information
Modulation Analysis		
Residual EVM		Modulation formats include BPSK, QPSK, DQPSK, π/4 DQPSK, 8-PSK, π/8 D8PSK, D8PSK, 16/32/64/128/256/512/1024-QAM; Center Frequency = 1 GHz; Transmit filter is RRC with ? = 0.35; Result length set to at least 150 symbols, or 3 × Number of ideal constellation states; Average number = 10. Equalizer On
Symbol Rate[a]		
1 MSa/s		0.50% (nominal)
10 MSa/s		0.50% (nominal)
25 MSa/s		0.60% (nominal)
100 MSa/s		0.90% (nominal)
Residual EVM for MSK		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. Equalizer On
Symbol Rate[a]		
10 MSa/s		0.60% (nominal)
80 MSa/s		1.60% (nominal)
Residual EVM for VSB		Modulation formats include 8-VSB and 16-VSB; Transmit filter is RRC with ? = 0.115; Center Frequency < 3.6 GHz; Result length = 800; Average number = 10.
Symbol Rate[a]		
10.762 MHz		1.50% (SNR 36 dB) (nominal)

a. Supportable symbol rate is dependent on the analyzer hardware bandwidth option.

8 WLAN Measurement Application

This chapter contains specifications for the N9077EM0E/EM1E/EM2E 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.

Measurements

Description	Specifications	Supplemental Information
Channel Power		Radio standard is: 802.11ah 1M/2M/4M/8M/16M
Minimum power at RF Input		–50 dBm
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	
Absolute Power Accuracy[a] (20 to 30°C) for 802.11ah 1M/2M/4M/8M/16M	±0.72 dB	±0.20 dB (95th percentile)
Measurement floor		Typical
802.11ah 1M		– 92.7 dBm
802.11ah 2M		– 89.7 dBm
802.11ah 4M		– 86.7 dBm
802.11ah 8M		– 83.7 dBm
802.11ah 16M		– 80.6 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.

Description	Specifications	Supplemental Information
Channel Power		Radio standard is: 802.11af 6M/7M/8M
Minimum power at RF Input		–50 dBm
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	±0.72 dB	±0.20 dB (95th percentile)
Measurement floor		Typical
802.11af 6M		– 84.9 dBm
802.11af 7M		– 84.2 dBm
802.11af 8M		– 83.7 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.

Description	Specifications		Supplemental Information	
Channel Power 20 MHz Integration BW			Radio standard is: 802.11ax (20 MHz) 2.4 GHz band and 5/6 GHz band	
Minimum power at RF Input			–50 dBm	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Absolute Power Accuracy[a] (20 to 30°C)	±0.72 dB	±1.87 dB	±0.20 dB (95th percentile)	±0.64 dB (95th percentile)
Measurement floor			–74.7 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 20 MHz Integration BW			Radio standards are: 802.11a/g/j/p (OFDM) 802.11g (DSSS-OFDM) 802.11n (20 MHz) 802.11ac (20 MHz), 5 GHz band	
Minimum power at RF Input			–50 dBm	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Absolute Power Accuracy[a] (20 to 30°C)	±0.72 dB	±1.87 dB	±0.20 dB (95th percentile)	±0.64 dB (95th percentile)
Measurement floor			–74.7 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 22 MHz Integration BW		Radio standard is: 802.11b/g (DSSS/CCK/PBCC)
Minimum power at RF Input		–50 dBm
Absolute Power Accuracy[a] (20 to 30°C)	±0.72 dB	±0.20 dB (95th percentile)
Measurement floor		–74.3 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.

Description	Specifications		Supplemental Information	
Channel Power 40 MHz Integration BW			Radio standards are: 802.11n (40 MHz) 802.11ac (40 MHz), 5 GHz band	
Minimum power at RF Input			–50 dBm	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Absolute Power Accuracy[a] (20 to 30°C)	±0.72 dB	±1.87 dB	±0.20 dB (95th percentile)	±0.64 dB (95th percentile)
Measurement floor			–71.7 dBm (typical)	–73.7 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: 802.11ax (40 MHz) 2.4 GHz band and 5/6 GHz band	
Minimum power at RF Input			–50 dBm	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Absolute Power Accuracy[a] (20 to 30°C)	±0.72 dB	±1.87 dB	±0.20 dB (95th percentile)	±0.64 dB (95th percentile)
Measurement floor			–71.7 dBm (typical)	–73.7 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			Radio standard is: 802.11ax (80 MHz) 2.4 GHz band and 5/6 GHz band	
Minimum power at RF Input			–50 dBm	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Absolute Power Accuracy[a] (20 to 30°C)	±0.72 dB	±1.87 dB	±0.20 dB (95th percentile)	±0.64 dB (95th percentile)
Measurement floor			–68.7 dBm (typical)	–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 80 MHz Integration BW		Radio standard is: 802.11ac (80 MHz) 5.0 GHz Band
Minimum power at RF Input		–50 dBm (nominal)
Absolute Power Accuracy[a] (20 to 30°C)	±1.87 dB	±0.64 dB (95th percentile)
Measurement floor		–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		Radio standard is: 802.11ac (160 MHz) 5.0 GHz Band
Minimum power at RF Input		–50 dBm
Absolute Power Accuracy[a] (20 to 30°C)	±1.87 dB	±0.64 dB (95th percentile)
Measurement floor		–67.6 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			Radio standard is: 802.11ax (160 MHz) 2.4 GHz band and 5/6 GHz band	
Minimum power at RF Input			–50 dBm	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Absolute Power Accuracy[a] (20 to 30°C)	±0.72 dB	±1.87 dB	±0.20 dB (95th percentile)	±0.64 dB (95th percentile)
Measurement floor			–65.6 dBm (typical)	–67.6 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 320 MHz Integration BW			Radio standard is: 802.11be (320 MHz) 2.4 GHz band and 5/6 GHz band	
Minimum power at RF Input			–50 dBm	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Absolute Power Accuracy[a] (20 to 30°C)	±0.72 dB	±1.87 dB	±0.20 dB (95th percentile)	±0.64 dB (95th percentile)
Measurement floor			–62.6 dBm (typical)	–64.6 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
Power Statistics CCDF		Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11/b/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.

Description	Specifications	Supplemental Information
Occupied Bandwidth		Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11/b/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
Minimum power at RF Input		–30 dBm (nominal)
Frequency accuracy	±25 kHz	RBW = 100 kHz Number of Points = 1001 Span = 25 MHz

Description	Specifications	Supplemental Information
Occupied Bandwidth		Radio standards are: 802.11ah 1M/2M/4M/8M/16M
Minimum power at RF Input		–30 dBm (nominal)
Frequency accuracy	±20 kHz	RBW = 10 kHz Number of Points = 1001 Span = 20 MHz

Description	Specifications	Supplemental Information
Power vs. Time		Radio standard is: 802.11/b/g (DSSS/CCK/PBCC)
		Center Frequency in 2.4 GHz Band
Measurement results type		Min, Max, Mean
Average Type	0.01 dB	Off, RMS, Log
Measurement Time		Up to 88 ms
Dynamic Range		64.0 dB (nominal)
Dynamic Range (*Option EP0*)		62.0 dB (nominal)

Description	Specifications	Supplemental Information
Spurious Emission		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 802.11be (320 MHz) 2.4 GHz band and 5/6 GHz band
Dynamic Range[a] (RBW= 1 MHz)		
Center Frequency		
2.4 GHz		91.9 dB (nominal)
5.0 GHz		92.8 dB (nominal)
Sensitivity[b] (RBW= 1 MHz)		
Center Frequency		
2.4 GHz	-84.5 dBm	-87.5 dBm (typical)
5.0 GHz	-85.5 dBm	-89.5 dBm (typical)
Accuracy		Attenuation=10dB
Frequency Range		
10 MHz to 3.6 GHz (Band 0)		±0.20 dB (95th percentile)
3.5 GHz to 8.4 GHz (Band 1)		±0.64 dB (95th percentile)
8.3 GHz to 13.6 GHz (Band 2)		±0.69 dB (95th percentile)

a. The dynamic range is specified at 50.0 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
Spurious Emission		Radio standard is: 802.11af 6M/7M/8M
Dynamic Range[a] (RBW =100 kHz)		104.6 dB (nominal)
Sensitivity[b] (RBW =100 kHz)	–98.5 dBm	–102.5 dBm (typical)
Accuracy		
Frequency Range		
10 MHz to 3.6 GHz (Band 0)		±0.20 dB (95th percentile)
3.5 GHz to 8.4 GHz (Band 1)		±0.64 dB (95th percentile)
8.3 GHz to 13.6 GHz (Band 2)		±0.69 dB (95th percentile)

a. The dynamic range is specified at 15.0 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
Spurious Emission		Radio standard is: 802.11ah 1M/2M/4M/8M/16M
Dynamic Range[a] (RBW =100 kHz)		
802.11ah 1M		109.0 dB (nominal)
802.11ah 2M		112.0 dB (nominal)
802.11ah 4M		114.4 dB (nominal)
802.11ah 8M		114.7 dB (nominal)
802.11ah 16M		114.7 dB (nominal)
Sensitivity[b], absolute (RBW =100 kHz)	–100.0 dBm	–102.3 dBm (typical)
Accuracy		
Frequency Range		
10 MHz to 3.6 GHz (Band 0)		±0.20 dB (95th percentile)
3.5 GHz to 8.4 GHz (Band 1)		±0.64 dB (95th percentile)
8.3 GHz to 13.6 GHz (Band 2)		±0.69 dB (95th percentile)

a. The dynamic range is specified at 2.5 MHz, 5 MHz, 10 MHz, 20 MHz, and 40 MHz offset from center frequency for 1M/2M/4M/8M/16MHz 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.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Radio standard is: 802.11ah
Minimum power at RF Input		-50 dBm
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	
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	
Dynamic Range[ab]		
802.11ah 1M	88.8 dB	93.5 dB (typical)
802.11ah 2M	91.2 dB	95.8 dB (typical)
802.11ah 4M	92.3 dB	97.0 dB (typical)
802.11ah 8M	93.3 dB	98.2 dB (typical)
802.11ah 16M	94.4 dB	99.3 dB (typical)
Sensitivity[c]	–108.5 dBm	–112.5 (typical) dBm
Relative Accuracy[d]		
802.11ah 1M	±0.06 dB	
802.11ah 2M	±0.07 dB	
802.11ah 4M	±0.08 dB	
802.11ah 8M	±0.11 dB	
802.11ah 16M	±0.13 dB	
Absolute Accuracy (20 to 30°C) for 802.11ah 1M/2M/4M/8M/16M	±0.73 dB	±0.34 dB (typical)

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 10 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which are -16, -15, -14, -13 and -12 dBm for channel bandwidths of 1, 2, 4, 8 and 16 MHz respectively.
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 10 kHz RBW, at a center frequency in an operating band.
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.

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	
Offset		
802.11af 6M	3.150 MHz	
802.11af 7M	3.675 MHz	
802.11af 8M	4.200 MHz	
Dynamic Range[ab]		
802.11af 6M	76.7 dB	82.6 dB (typical)
802.11af 7M	76.9 dB	83.0 dB (typical)
802.11af 8M	77.1 dB	83.2 dB (typical)
Sensitivity[c]	–98.5 dBm	–102.5 dBm (typical)
Relative Accuracy[d]		
802.11af 6M	±0.08 dB	
802.11af 7M	±0.09 dB	
802.11af 8M	±0.10 dB	
Absolute Accuracy (20 to 30°C) for 802.11af 6M/7M/8M	±0.73 dB	±0.34 dB (95th percentile)

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 10 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which are -20, -19 and -19 dBm for channel bandwidths of 6, 7 and 8 MHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (18 MHz Transmission BW 11.0 MHz offset)			Radio standards are: 802.11a/g/j/p (OFDM) 802.11g (DSSS-OFDM) or 802.11n (20 MHz) 802.11ac (20 MHz) 5 GHz Band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Dynamic Range[ab]	82.1 dB	80.1 dB	86.6 dB (typical)	85.0 dB (typical)
Sensitivity[c]	–94.5 dBm	–95.5 dBm	–97.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.14 dB	±0.39 dB		
Absolute (20 to 30°C)	±0.73 dB	±1.88 dB	±0.34 dB (95th percentile)	±1.03 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which are -10 and -13 dBm for center frequency 2.4 and 5 GHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (19.5 MHz Transmission BW 10.25 MHz offset)			Radio standard is: 802.11ax (20 MHz) Center Frequency in 2.4 GHz and 5/6 GHz band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Dynamic Range[ab]	82.1 dB	80.1 dB	86.6 dB (typical)	85.0 dB (typical)
Sensitivity[c]	–94.5 dBm	–95.5 dBm	–97.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.14 dB	±0.38 dB		
Absolute (20 to 30°C)	±0.73 dB	±1.88 dB	±0.34 dB (95th percentile)	±1.03 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which are -10 and -13 dBm for center frequency 2.4 and 5/6 GHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications	Supplemental Information
Spectrum Emission Mask (22 MHz Transmission BW 11.0 MHz offset)		Radio standard is: 802.11b/g (DSSS/CCK/PBCC)
Dynamic Range[ab]	82.2 dB	86.8 dB (typical)
Sensitivity[c]	–94.5 dBm	–97.5 dBm (typical)
Accuracy		
Relative[d]	±0.14 dB	
Absolute (20 to 30°C)	±0.73 dB	±0.34 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which is -10 dBm.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (38 MHz Transmission BW 21.0 MHz offset)			Radio standard is: 802.11n (40 MHz) or 802.11ac (40 MHz) 5.0 GHz Band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Dynamic Range[ab]	83.1 dB	81.1 dB	87.6 dB (typical)	86.0 dB (typical)
Sensitivity[c]	–94.5 dBm	–95.5 dBm	–97.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.16 dB	±0.48 dB		
Absolute (20 to 30°C)	±0.73 dB	±1.88 dB	±0.34 dB (95th percentile)	±1.03 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which are -9 and -12 dBm for center frequency 2.4 and 5 GHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (39.0 MHz Transmission BW 20.5 MHz offset)			Radio standard is: 802.11ax (40 MHz) Center Frequency in 2.4 GHz and 5/6 GHz band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Dynamic Range[ab]	83.1 dB	81.1 dB	87.6 dB (typical)	86.0 dB (typical)
Sensitivity[c]	–94.5 dBm	–95.5 dBm	–97.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.16 dB	±0.48 dB		
Absolute (20 to 30°C)	±0.73 dB	±1.88 dB	±0.34 dB (95th percentile)	±1.03 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which are -9 and -12 dBm for center frequency 2.4 and 5/6 GHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications	Supplemental Information
Spectrum Emission Mask (78 MHz Transmission BW 41.0 MHz offset)		Radio standard is: 802.11ac (80 MHz) 5.0 GHz Band
Dynamic Range[ab]	82.1 dB	87.0 dB (typical)
Sensitivity[c]	–95.5 dBm	–99.5 dBm (typical)
Accuracy		
Relative[d]	±0.60 dB	
Absolute (20 to 30°C)	±1.88 dB	±1.03 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which is -11 dBm.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (79.0 MHz Transmission BW 40.5 MHz offset)			Radio standard is: 802.11ax (80 MHz) Center Frequency in 2.4 GHz and 5/6 GHz band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Dynamic Range[ab]	84.1 dB	82.1 dB	88.5 dB (typical)	87.0 dB (typical)
Sensitivity[c]	–94.5 dBm	–95.5 dBm	–97.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.19 dB	±0.60 dB		
Absolute (20 to 30°C)	±0.73 dB	±1.88 dB	±0.34 dB (95th percentile)	±1.03 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which are -8 and -11 dBm for center frequency 2.4 and 5/6 GHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications	Supplemental Information
Spectrum Emission Mask (158 MHz Transmission BW 81.0 MHz offset)		Radio standard is: 802.11ac (160 MHz) 5.0 GHz Band
Dynamic Range[ab]	83.1 dB	88.0 dB (typical)
Sensitivity[c]	–95.5 dBm	–99.5 dBm (typical)
Accuracy		
Relative[d]	±0.76 dB	
Absolute (20 to 30°C)	±1.88 dB	±1.03 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which is -10 dBm.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (159.0 MHz Transmission BW 80.5 MHz offset)			Radio standard is: 802.11ax (160 MHz) Center Frequency in 2.4 GHz and 5/6 GHz band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Dynamic Range[ab]	85.1 dB	83.1 dB	89.5 dB (typical)	88.0 dB (typical)
Sensitivity[c]	–94.5 dBm	–95.5 dBm	–97.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.23 dB	±0.76 dB		
Absolute (20 to 30°C)	±0.73 dB	±1.88 dB	±0.34 dB (95th percentile)	±1.03 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which are -7 and -10 dBm for center frequency 2.4 and 5/6 GHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (319.0 MHz Transmission BW 160.5 MHz offset)			Radio standard is: 802.11be (320 MHz) Center Frequency in 2.4 GHz and 5/6 GHz band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5/6 GHz**	**2.4 GHz**	**5/6 GHz**
Dynamic Range[ab]	86.1 dB	84.1 dB	90.4 dB (typical)	89.0 dB (typical)
Sensitivity[c]	–94.5 dBm	–95.5 dBm	–97.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.28 dB	±0.96 dB		
Absolute (20 to 30°C)	±0.73 dB	±1.88 dB	±0.34 dB (95th percentile)	±1.03 dB (95th percentile)

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 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which are -6 and -9 dBm for center frequency 2.4 and 5/6 GHz respectively.
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 100 kHz RBW, at a center frequency in an operating band.
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.

Description	Specifications	Supplemental Information
64QAM EVM (RF Input Level = –10 dBm, Optimize EVM, 20 to 30°C)		Radio standard are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz) 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
		Center Freq
		2.4 GHz (nominal) / **5.0 GHz (nominal)**
EVM		
Floor[ab]		–57.0 dB / –55.8 dB
Accuracy		±0.30% / ±0.30%
(EVM Range: 0 to 8.0%)		
Frequency Error		
Range		±100 kHz / ±100 kHz
Accuracy		±10 Hz + tfa[c]

a. The EVM Floor specification applies when Phase Noise Optimization is set to Best Wide-offset ? Noise [offset > 800 kHz].
b. The EVM Floor specification applies when uW Path Control is set to Full Bypass Enable (Option FBP enabled) for center frequencies above 3.6 GHz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information	
64QAM EVM (RF Input Level = –10 dBm, Optimize EVM, 20 to 30°C)		Radio standard are: 802.11n (40 MHz) or 802.11ac (40 MHz) 5.0 GHz Band 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[ab]		–56.3 dB	–53.0 dB
Accuracy		±0.30%	±0.30%
(EVM Range: 0 to 8.0%)			
Frequency Error			
Range		±100 kHz	±100 kHz
Accuracy		±10 Hz + tfa[c]	

a. The EVM Floor specification applies when Phase Noise Optimization is set to Best Wide-offset ? Noise [offset > 800 kHz].
b. The EVM Floor specification applies when uW Path Control is set to Full Bypass Enable (Option FBP enabled) for center frequencies above 3.6 GHz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
64QAM EVM (RF Input Level = –10 dBm, Optimize EVM, 20 to 30°C)		Radio standard are: 802.11ac (80 MHz) 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[ab]		–51.5 dB (nominal)
Accuracy		±0.30% (nominal)
(EVM Range: 0 to 8.0%)		
Frequency Error		
Range		±100 kHz (nominal)
Accuracy		±10 Hz + tfa[c] (nominal)

a. The EVM Floor specification applies when Phase Noise Optimization is set to Best Wide-offset ? Noise [offset > 800 kHz].
b. The EVM Floor specification applies when uW Path Control is set to Full Bypass Enable (Option FBP enabled) for center frequencies above 3.6 GHz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
64QAM EVM (RF Input Level = –10 dBm, Optimize EVM, 20 to 30°C)		Radio standard are: 802.11ac (160 MHz) 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[ab]		–49.7 dB (nominal)
Accuracy		±0.30% (nominal)
(EVM Range: 0 to 8.0%)		
Frequency Error		
Range		±100 kHz (nominal)
Accuracy		±10 Hz + tfa[c] (nominal)

a. The EVM Floor specification applies when Phase Noise Optimization is set to Best Wide-offset ? Noise [offset > 800 kHz].
b. The EVM Floor specification applies when uW Path Control is set to Full Bypass Enable (Option FBP enabled) for center frequencies above 3.6 GHz.
c. tfa = transmitter frequency × frequency reference accuracy.

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		Radio standard are: 802.11ah 1M/2M/4M/8M/16M
EVM floor[a]		**Nominal**
802.11ah 1M		-68.3 dB
802.11ah 2M		-66.7 dB
802.11ah 4M		-64.6 dB
802.11ah 8M		-63.4 dB
802.11ah 16M		-61.6 dB
EVM Floor Accuracy		
(EVM Range: 0 to 8.0%)		±0.30%
for 802.11ah 1M/2M/4M/8M/16M		
Frequency Error		
Range		±100 kHz (nominal)
for 802.11ah 1M/2M/4M/8M/16M		
Accuracy		±10 Hz + tfa[b] (nominal)
for 802.11ah 1M/2M/4M/8M/16M		

a. The EVM Floor specification applies when Phase Noise Optimization is set to Best Wide-offset ? Noise [offset > 800 kHz]
b. tfa = transmitter frequency × frequency reference accuracy.

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		Radio standard are: 802.11af 6M/7M/8M
EVM floor[a]		**Nominal**
802.11af 6M		-49.7 dB
802.11af 7M		-49.7 dB
802.11af 8M		-49.4 dB
EVM Accuracy		±0.3%
(EVM Range: 0 to 8.0%)		
for 802.11af 6M/7M/8M		
Frequency Error		
Range		±20 kHz (nominal)
for 802.11af 6M/7M/8M		
Accuracy		±10 Hz + tfa[b] (nominal)
for 802.11af 6M/7M/8M		

a. The EVM Floor specification applies when Phase Noise Optimization is set to Best Wide-offset ? Noise [offset > 800 kHz]
b. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information	
1024QAM EVM (RF Input Level = –10 dBm, Optimize EVM, 20 to 30°C)		Radio standard are: 802.11ax in 2.4 G 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	
		Center Freq	
		2.4 GHz (nominal)	**5.0 GHz (nominal)**
EVM floor			
802.11ax 20 M[ab]		–58.0 dB	–55.6 dB
802.11ax 40 M		–56.3 dB	–53.0 dB
802.11ax 80 M		–54.1 dB	–51.5 dB
802.11ax 160 M		–50.8 dB	–49.7 dB
Accuracy			
(EVM Range: 0 to 8.0%)			
Frequency Error			
Range		±100 kHz	
Accuracy		±10 Hz + tfa[c]	

a. The EVM Floor specification applies when Phase Noise Optimization is set to Best Wide-offset ? Noise [offset > 800 kHz].
b. The EVM Floor specification applies when uW Path Control is set to Full Bypass Enable (Option FBP enabled) for center frequencies above 3.6 GHz.
c. tfa = transmitter frequency × frequency reference accuracy.

In-Band Frequency Range for Warranted Specifications

Spectrum Range	Supplemental Information
2.4 GHz Band	Channel center frequency = 2407 MHz + 5 × k MHz, k = 1,...,13
5.0 GHz Band	Channel center frequency = 5000 MHz + 5 × k MHz, k = 0, 1, 2, ..., 200
6.0 GHz Band	Channel center frequency = 5940 MHz + 5 × k MHz, k = 1, ..., 253
700 MHz ~ 1 GHz	Channel center frequency = Channel starting frequency + 0.5 MHz × Channel center frequency Index[a]
54 ~ 780 MHz	Channel center frequency = Channel starting frequency + nch (MHz) × Channel number multiplier[b] nch = 0, 1, 2, ...,100

a. Channel center frequency, Channel starting frequency and Channel Center Frequency Index are given by the operating class (Annex E) in IEEE P802.11ah ™/D2.1.
b. Channel starting frequency, Channel number multiplier are given by the operating class (Annex E) in IEEE P802.11ac™/D1.05.

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