Tonal

REVISED TEST REPORT TO 110825-16

Apollo Board, Model: 500-0806
Trainer, Model: T2

Tested to The Following Standards:

FCC Part 15 Subpart E Section(s)

15.207 & 15.407
(NII 5250 – 5350 MHz)

Report No.: 110825-16A

Date of issue: February 17, 2025

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

Test Certificate # 803.01

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Administrative Information

Test Report Information

REPORT PREPARED FOR:

Tonal
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Representative: Lars Gilstrom
Customer Reference Number: PO3317

REPORT PREPARED BY:

Lisa Bevington
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 110825

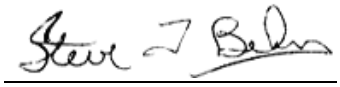
DATE OF EQUIPMENT RECEIPT: October 7, 2024
DATE(S) OF TESTING: October 7-9, 2024
January 7, 13 & 15, 2025

Revision History

Original: Testing of Testing of Apollo Board, Model: 500-0806 and Trainer, Model: T2 to FCC Part 15 Subpart E Section(s) 15.207 & 15.407 (NII 5250 – 5350 MHz).
Revision A: To replace correct plot to page 55 from page 61.

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the equipment provided by the client, tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.



Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
110 North Olinda Place
Brea, CA 92823

CKC Laboratories, Inc.
1120 Fulton Place
Fremont, CA 94539

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.20

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Canada	Japan
Canyon Park, Bothell, WA	US0103	US1024	3082C	A-0136
Brea, CA	US0103	US1024	3082D	A-0136
Fremont, CA	US0103	US1024	3082B	A-0136
Mariposa, CA	US0103	US1024	3082A	A-0136

*CKC's list of NIST designated countries can be found at: https://standards.gov/cabs/designations.html

Summary of Results

Standard / Specification: FCC Part 15 Subpart E - 15.407 (NII 5250-5350 MHz)

Test Procedure	Description	Modifications	Results
15.215	Occupied Bandwidth	NA	NA2
15.407(a)	Output Power	NA	Pass
15.407(a)	Power Spectral Density	NA	Pass
15.407(b)	Radiated Emissions & Band Edge	MOD1	Pass
15.407(g)	Frequency Stability	NA	NA1
15.207	AC Conducted Emissions	NA	NA2

NA = Not Applicable
NA1 = In accordance with KDB 789033, this test is not required.
NA2 = Not applicable for PCII, only relevant sections were tested/recalculate.

ISO/IEC 17025 Decision Rule
The equipment sample utilized for testing is selected by the manufacturer. The declaration of pass or fail herein is a binary statement for simple acceptance rule (ILAC G8) based upon assessment to the specification(s) listed above, without consideration of measurement uncertainties. For performance related tests, equipment was monitored for specified criteria identified in that section of testing.

Modifications During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions
Modification 1 (MOD1) = Reduce RF output power to 12dBm in the software for 802.11n HT40 Chain 0 Added a ferrite (Wurth: 742 712 21) on lower resistor wire Green Resistor

Modifications listed above must be incorporated into all production units.

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
Test Condition #1 Evaluation for PCII, with MIMO enabled. Conducted power and Conducted PSD were calculated from original testing. Radiated emissions were re-measured. The unit is mounted to a floor standing rack as to simulate typical wall mounted setup. One weight line is extended to the floor. Camera is on. WiFi transmitting continuously with modulation type as listed with pattern of 0s and 1s at power level 14dBm. Worst case tested: 802.11a 18Mbit/s 802.11n HT20 MSC2 802,11n HT40 MSC0 802.11ac VHT20 MSC2 802.11ac VHT40 MSC0 802.11ac VHT80 MSC1

Equipment Under Test (EUT)

During testing, numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration A

***Equipment Under Test* (* = EUT):**

Device Name	Manufacturer	Model #	S/N
Apollo Board	Tonal System	500-0806	080600030001263

Support Devices:

Device Name	Manufacturer	Model #	S/N
MCB Board	Tonal Systems	500-0131	500-0131_rev003_00001286_20240909_17
Laptop	Dell	XPS	22E00911
AC/DC Adapter for Laptop	Dell	DA130PM130	CN-06TTY6-48661-4CO-27M7-A00

Configuration 1

***Equipment Under Test* (* = EUT):**

Device Name	Manufacturer	Model #	S/N
Trainer	Tonal System	T2	4000055

Support Devices:

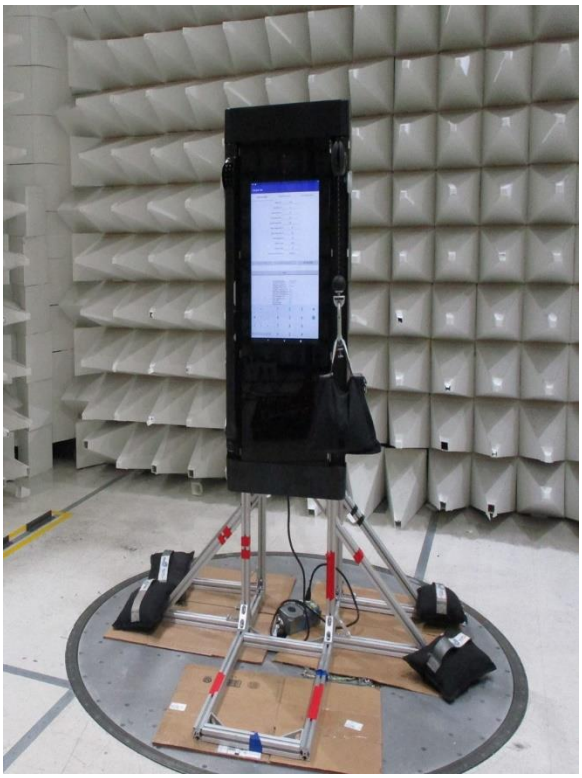
Device Name	Manufacturer	Model #	S/N
Laptop	Dell	XPS	22E00911
AC/DC Adapter for Laptop	Dell	DA130PM130	CN-06TTY6-48661-4CO-27M7-A00

General Product Information:

Description of EUT
Exercise Trainer

Product Information	Manufacturer-Provided Details
Operating Frequencies Tested:	5260MHz-5320MHz
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	802.11
Maximum Duty Cycle:	100%
Modulation Type(s):	802.11a (BPSK, QPSK, 16QAM, 64QAM) 802.11n HT20 (BPSK, QPSK, 16QAM, 64QAM) 802.11n HT40 (BPSK, QPSK, 16QAM, 64QAM) 802.11ac VHT20 (BPSK, QPSK, 16QAM,64QAM, 256QAM) 802.11ac VHT40 (BPSK, QPSK, 16QAM,64QAM, 256QAM) 802.11ac VHT80 (BPSK, QPSK, 16QAM,64QAM, 256QAM)
Number of TX Chains:	2 Note: The manufacturer declared MIMO is Enabled
Beamforming Type:	NA
Antenna Type(s) and Gain:	External/4.66dBi
Antenna Connection Type:	External Connector
Nominal Input Voltage:	12VDC
Firmware / Software Version(s):	QRCT (Qualcomm Radio Control Toolkit) Version 4.1
Firmware / Software Description:	Using C-Prompt and QRCT application to control all modulation types and frequencies to continuously transmit or receive as intended
Firmware / Software Setting(s):	NA
Tune-up or Adjustment(s):	NA
Declared Operation Use Case:	☐ Indoor Access Point ☐ Outdoor Access Point ☒ Indoor Client ☐ Outdoor Client ☐ Outdoor Fixed Equipment
The validity of results is dependent on the stated product details, the accuracy of which the manufacturer assumes full responsibility.	

EUT and Accessory Photo(s)



EUT

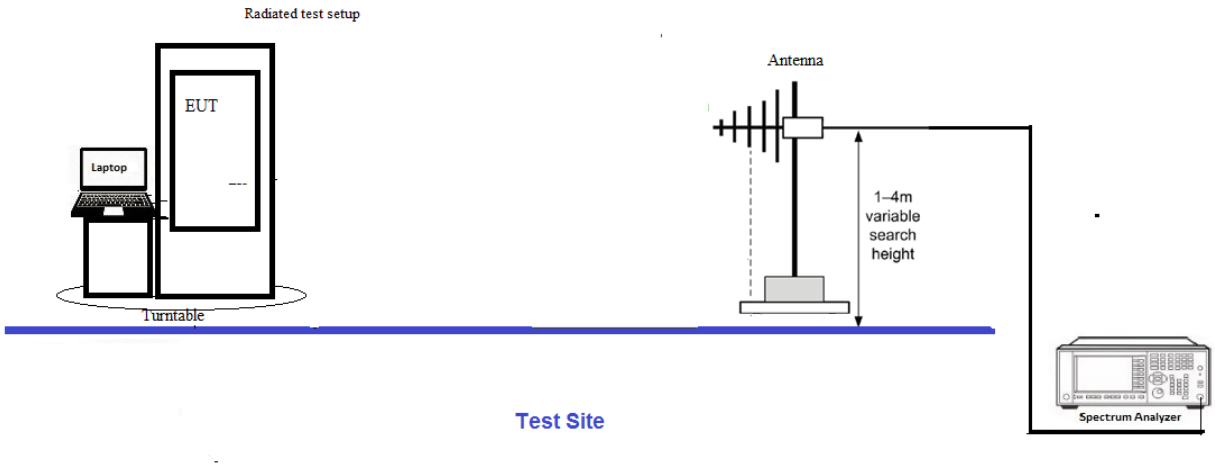
Support Equipment Photo(s)

Laptop

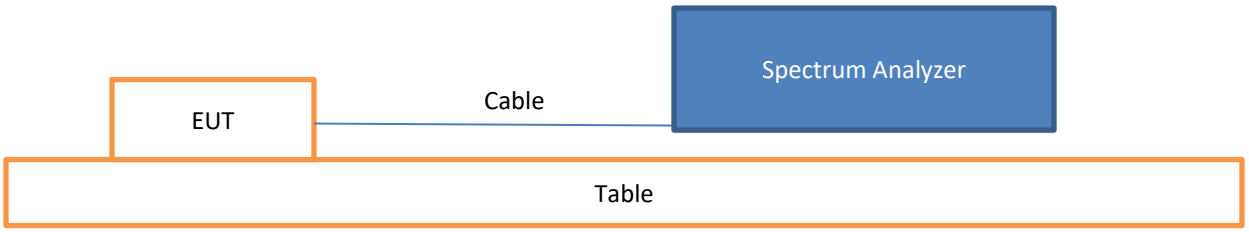
Block Diagram of Test Setup(s)

Configuration#	Setup Description of Block Diagram
1	Radiated Measurement: The Antenna is set up at 3meter distance from the EUT according to ANSI C63.10 2020. The EUT is set up and operated as intended.
A	Conducted Measurement: The EUT is placed non-conducted table. It is operated as intended. It is connected straight to a Spectrum Analyzer.

Radiated Method Setup



Conducted Method Setup



FCC Part 15 Subpart E

15.407(a) Output Power

Test Setup/Conditions			
Test Location:	Brea Lab Bench	Test Engineer:	Hieu Song Nguyenpham E. Wong
Test Method:	ANSI C63.10 (2020), KDB 789033 662911 D01 Multiple Transmitter Output v02r01	Test Date(s):	10/07-09/2024
Configuration:	A		
Test Setup:	The EUT is placed non-conducted table. It is operated as intended. It is connected straight to a Spectrum Analyzer.		

Environmental Conditions			
Temperature (ºC)	21.2-23.7	Relative Humidity (%):	39-45

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
03013	Cable	Astrolab	32022-2-2909K-36TC	1/9/2024	1/9/2026
P07365	Attenuator	Weinschel	54A-10	5/26/2023	5/26/2025
03471	Spectrum Analyzer	Agilent	E4440A	2/23/2024	2/23/2026

Test Data Summary - Voltage Variations					
Frequency (MHz)	**Modulation / Ant Port**	**$V_{Minimum}$ (dBm)**	**$V_{Nominal}$ (dBm)**	**$V_{Maximum}$ (dBm)**	**Max Deviation from $V_{Nominal}$ (dB)**
5260	802.11a/1	15.87	15.90	15.90	0.03
5300	802.11a/1	15.67	15.68	15.69	0.02
5320	802.11a/1	15.39	15.40	15.41	0.01

Test performed using operational mode with the highest output power, representing worst case.

Parameter Definitions:

Measurements performed at input voltage Vnominal ± 15%.

Parameter	Value
$V_{Nominal}$:	12VDC
$V_{Minimum}$:	10.2VDC
$V_{Maximum}$:	13.8VDC

Test Data Summary - RF Conducted Measurement-Chain 0							
Measurement Option: AVGSA-1							
Frequency (MHz)	**Modulation**	**Ant. Type / Gain (dBi)**	**RF Conducted (dBm)**		**EIRP (dBm)**		**Results**
			Measured	**Limit**	**Calculated**	**Limit**	
5260	802.11a	External/4.66	12.45	≤24	17.11	≤30	Pass
5300	802.11a	External/4.66	12.17	≤24	16.83	≤30	Pass
5320	802.11a	External/4.66	12.01	≤24	16.67	≤30	Pass
5260	802.11n HT20	External/4.66	12.32	≤24	16.98	≤30	Pass
5300	802.11n HT20	External/4.66	11.96	≤24	16.62	≤30	Pass
5320	802.11n HT20	External/4.66	11.88	≤24	16.54	≤30	Pass
5260	802.11ac 20MHz	External/4.66	12.30	≤24	16.96	≤30	Pass
5300	802.11ac 20MHz	External/4.66	11.97	≤24	16.63	≤30	Pass
5320	802.11ac 20MHz	External/4.66	11.91	≤24	16.57	≤30	Pass
5270	802.11n HT40	External/4.66	12.23	≤24	16.89	≤30	Pass
5310	802.11n HT40	External/4.66	11.96	≤24	16.62	≤30	Pass
5270	802.11ac 40MHz	External/4.66	12.29	≤24	16.95	≤30	Pass
5310	802.11ac 40MHz	External/4.66	11.94	≤24	16.6	≤30	Pass
5290	802.11ac 80MHz	External/4.66	11.81	≤24	16.47	≤30	Pass

Test Data Summary - RF Conducted Measurement-Chain 1							
Measurement Option: AVGSA-1							
Frequency (MHz)	**Modulation**	**Ant. Type / Gain (dBi)**	**RF Conducted (dBm)**		**EIRP (dBm)**		**Results**
			Measured	**Limit**	**Calculated**	**Limit**	
5260	802.11a	External/4.66	13.29	≤24	17.95	≤30	Pass
5300	802.11a	External/4.66	13.12	≤24	17.78	≤30	Pass
5320	802.11a	External/4.66	12.73	≤24	17.39	≤30	Pass
5260	802.11n HT20	External/4.66	13.13	≤24	17.79	≤30	Pass
5300	802.11n HT20	External/4.66	12.93	≤24	17.59	≤30	Pass
5320	802.11n HT20	External/4.66	12.61	≤24	17.27	≤30	Pass
5260	802.11ac 20MHz	External/4.66	13.01	≤24	17.67	≤30	Pass
5300	802.11ac 20MHz	External/4.66	13.03	≤24	17.69	≤30	Pass
5320	802.11ac 20MHz	External/4.66	12.43	≤24	17.09	≤30	Pass
5270	802.11n HT40	External/4.66	13.01	≤24	17.67	≤30	Pass
5310	802.11n HT40	External/4.66	12.71	≤24	17.37	≤30	Pass
5270	802.11ac 40MHz	External/4.66	13.03	≤24	17.69	≤30	Pass
5310	802.11ac 40MHz	External/4.66	12.77	≤24	17.43	≤30	Pass
5290	802.11ac 80MHz	External/4.66	12.46	≤24	17.12	≤30	Pass

Test Data Summary - RF Conducted Measurement (MIMO Total Power)										
Measurement Option: AVGSA-1										
Frequency (MHz)	**Modulation**	**Cond Power (dBm)**		**EIRP (dBm)**		**Total RF Conducted (dBm)**		**Total EIRP (dBm)**		**Results**
		Ch0	**Ch1**	**Ch0**	**Ch1**	**Measured**	**Limit**	**Calculated**	**Limit**	
5260	802.11a	12.45	13.29	17.11	17.95	**15.90**	≤24	20.56	≤30	Pass
5300	802.11a	12.17	13.12	16.83	17.78	15.68	≤24	20.34	≤30	Pass
5320	802.11a	12.01	12.73	16.67	17.39	15.40	≤24	20.06	≤30	Pass
5260	802.11n HT20	12.32	13.13	16.98	17.79	15.75	≤24	20.41	≤30	Pass
5300	802.11n HT20	11.96	12.93	16.62	17.59	15.48	≤24	20.14	≤30	Pass
5320	802.11n HT20	11.88	12.61	16.54	17.27	15.27	≤24	19.93	≤30	Pass
5260	802.11ac 20MHz	12.3	13.01	16.96	17.67	15.68	≤24	20.34	≤30	Pass
5300	802.11ac 20MHz	11.97	13.03	16.63	17.69	15.54	≤24	20.20	≤30	Pass
5320	802.11ac 20MHz	11.91	12.43	16.57	17.09	15.19	≤24	19.85	≤30	Pass
5270	802.11n HT40	12.23	13.01	16.89	17.67	15.65	≤24	20.31	≤30	Pass
5310	802.11n HT40	11.96	12.71	16.62	17.37	15.36	≤24	20.02	≤30	Pass
5270	802.11ac 40MHz	12.29	13.03	16.95	17.69	15.69	≤24	20.35	≤30	Pass
5310	802.11ac 40MHz	11.94	12.77	16.6	17.43	15.39	≤24	20.05	≤30	Pass
5290	802.11ac 80MHz	11.81	12.46	16.47	17.12	15.16	≤24	19.82	≤30	Pass

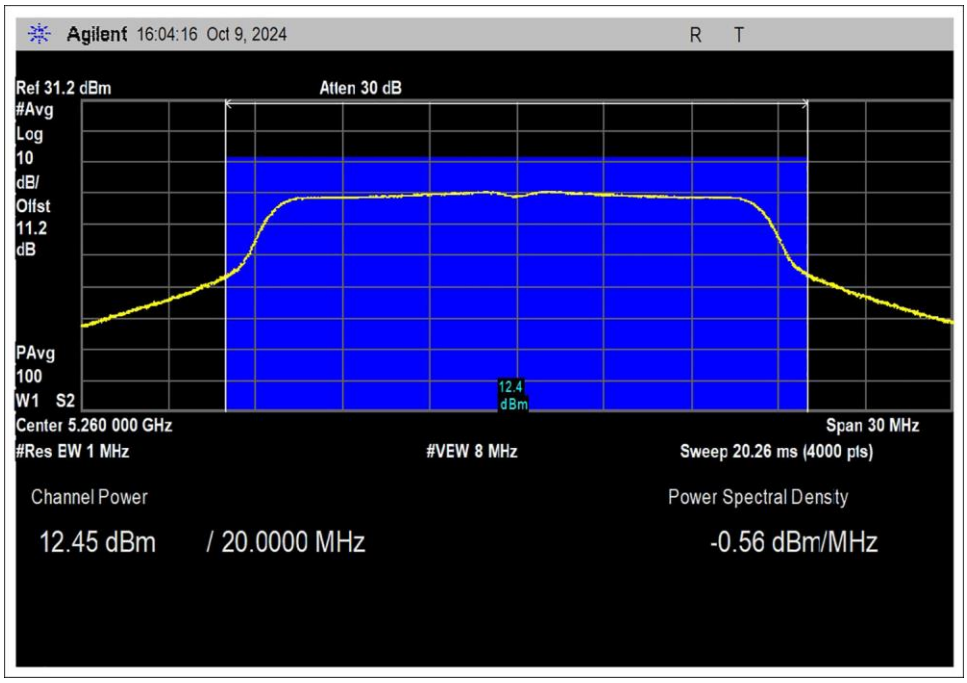
Antenna gain =4.66dBi
Ch0=Chain0
Ch1=Chain1

662911 D01 Multiple Transmitter Output v02r01 E 1) In-Band Power Measurements The measure-and-sum technique shall be used for measuring in-band transmit power of a device. Total power is the sum of the conducted power levels measured at the various output ports

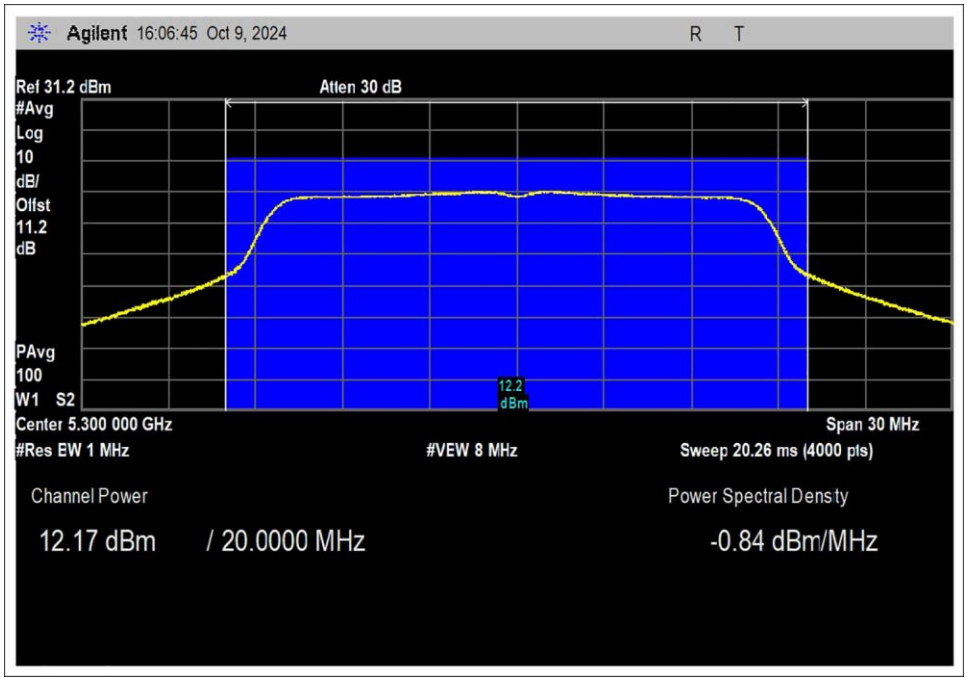
EIRP is calculated as RF conducted power (dBm) + antenna gain (dBi)

Plot(s)

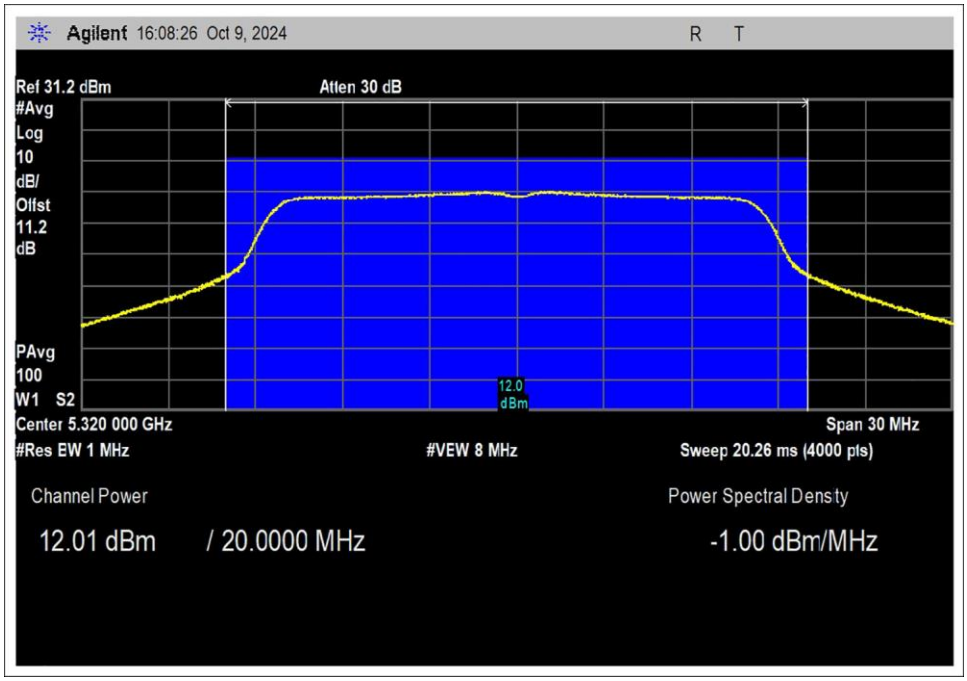
Chain 0



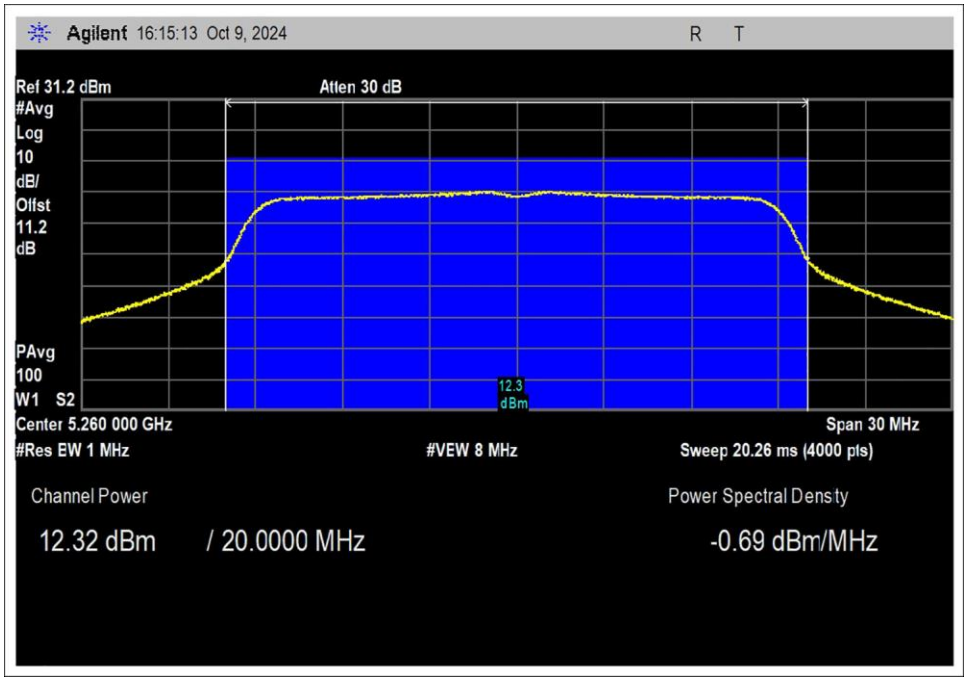
OFDM, Low Channel



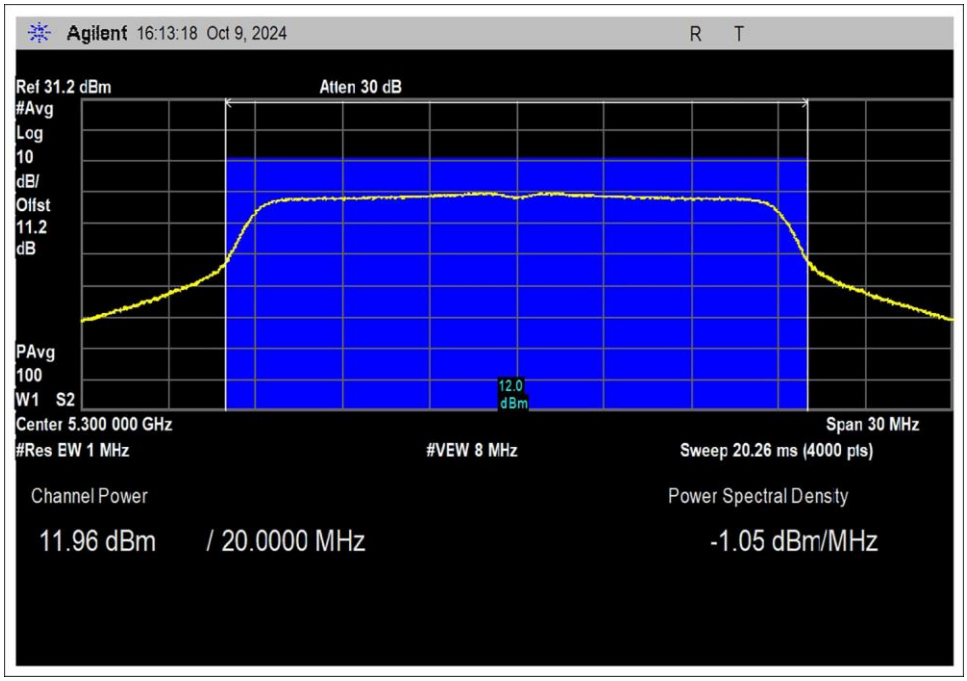
OFDM, Middle Channel



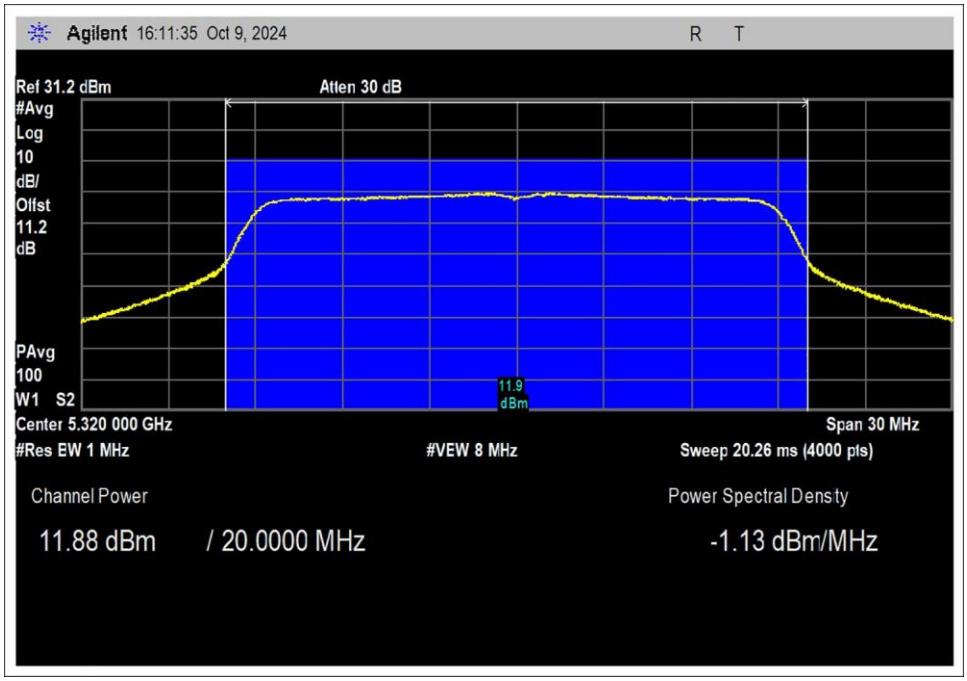
OFDM, High Channel



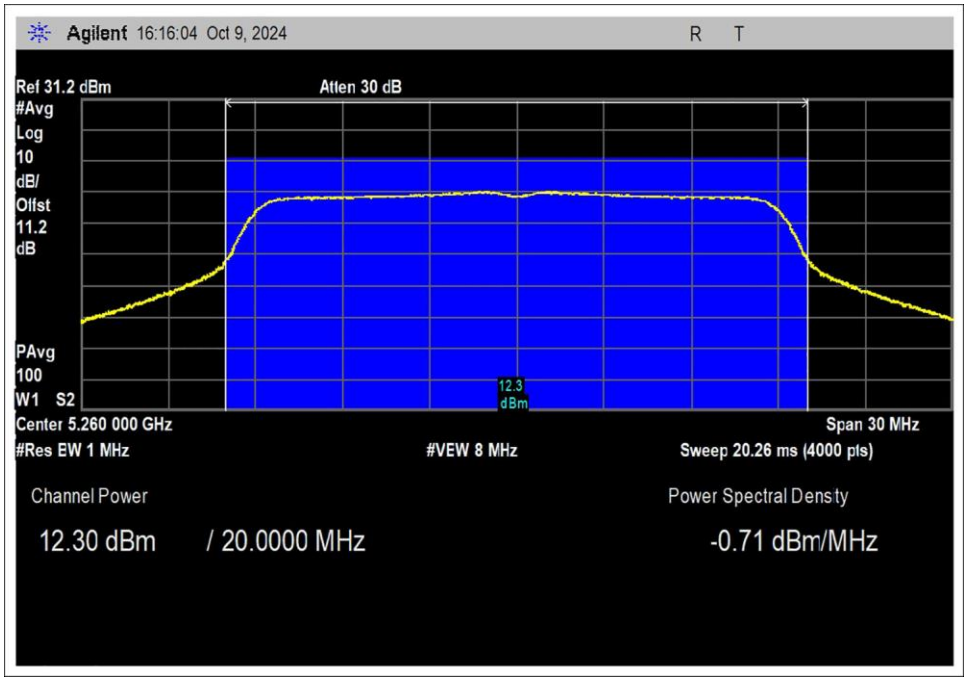
802.11n HT20, Low Channel



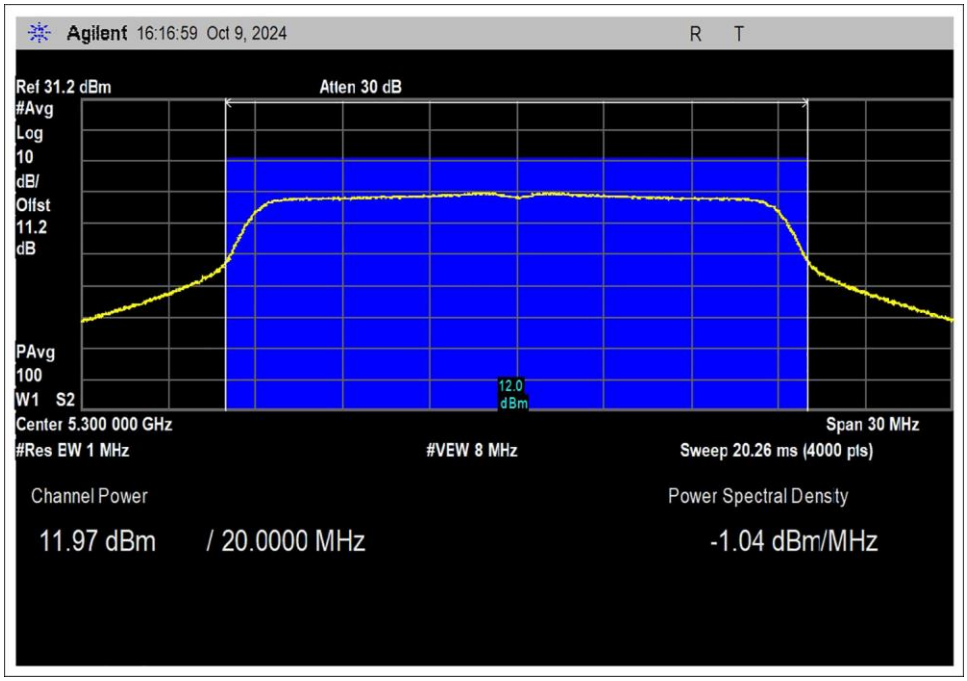
802.11n HT20, Middle Channel



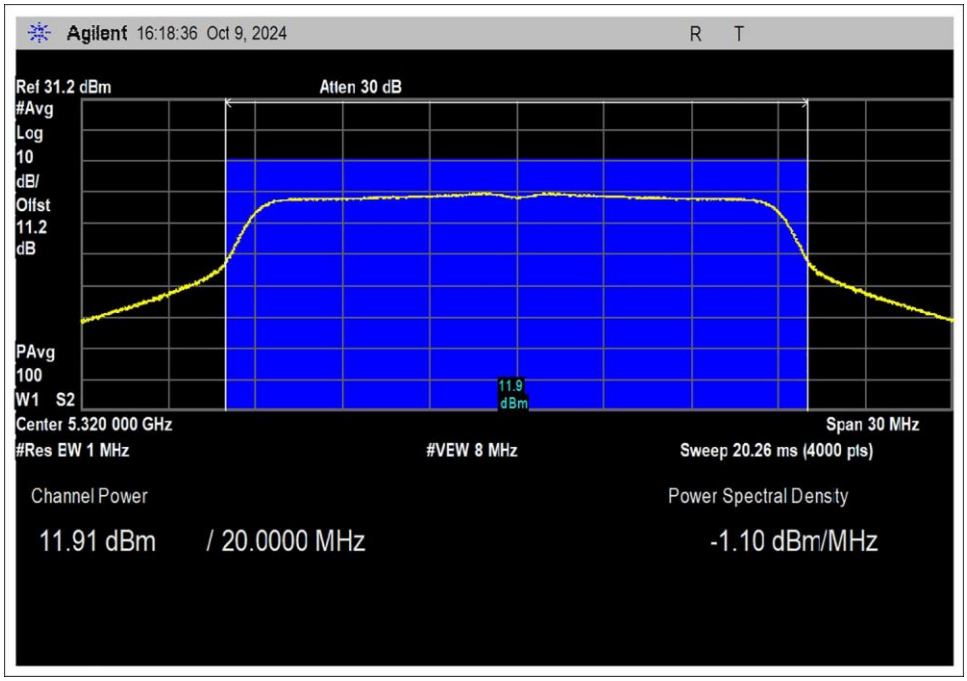
802.11n HT20, High Channel



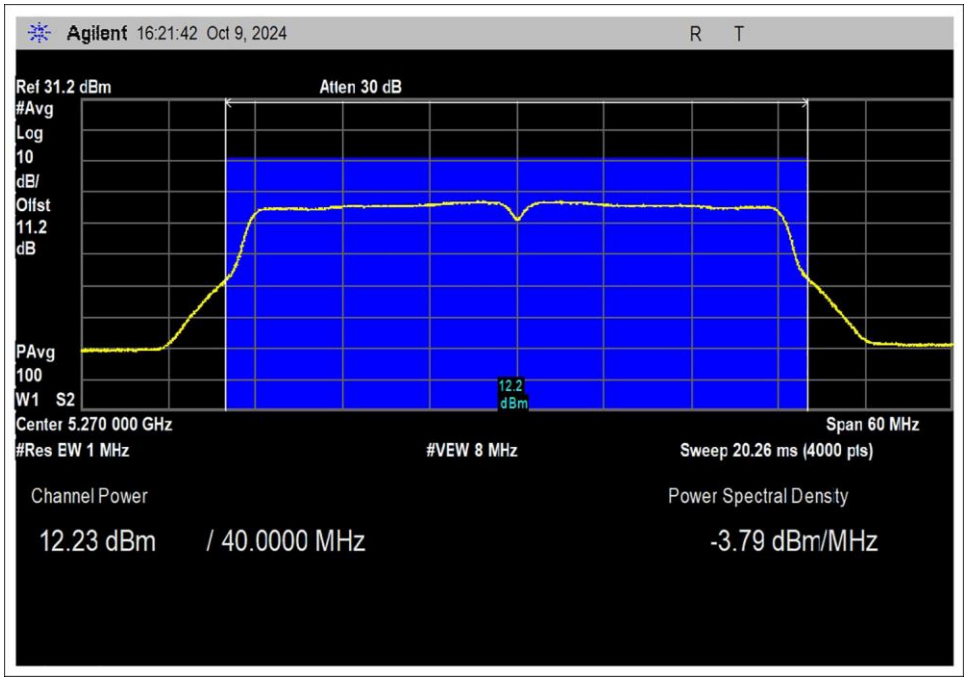
802.11ac 20MHz, Low Channel



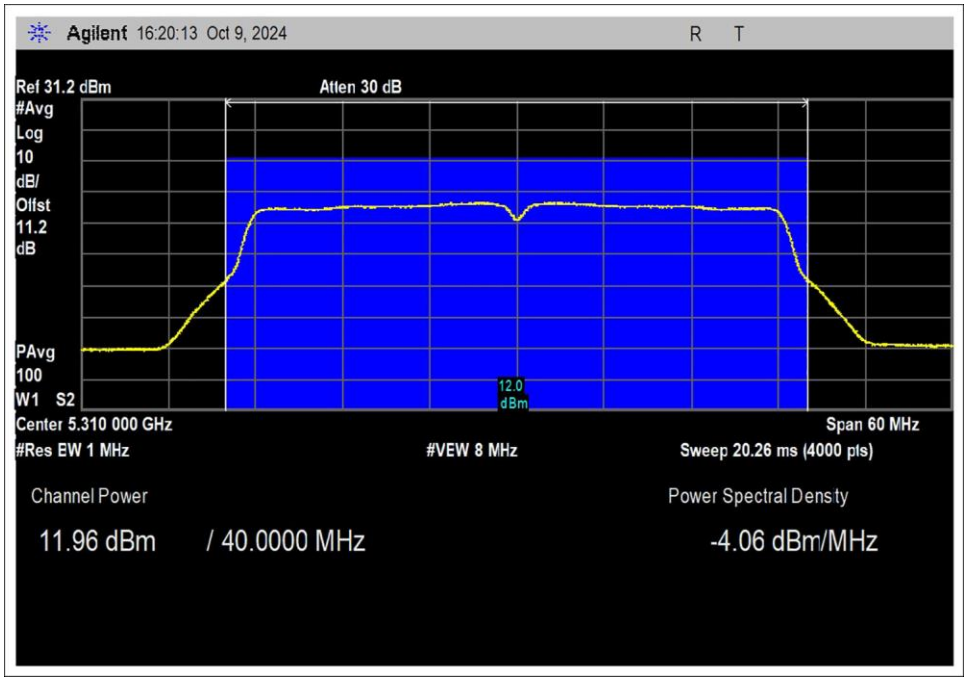
802.11ac 20MHz, Middle Channel



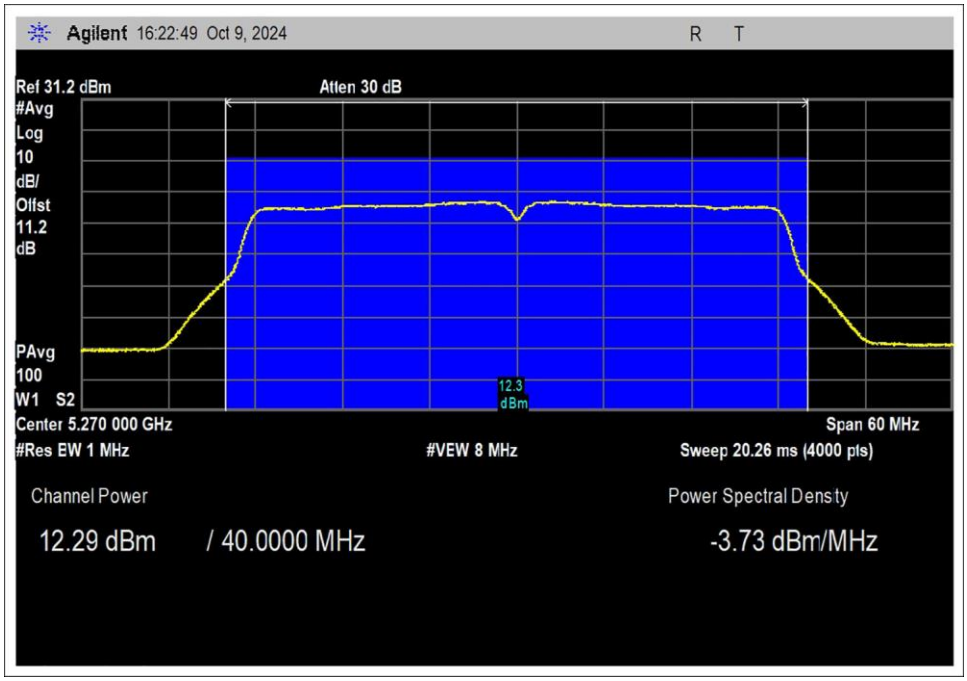
802.11ac 20MHz, High Channel



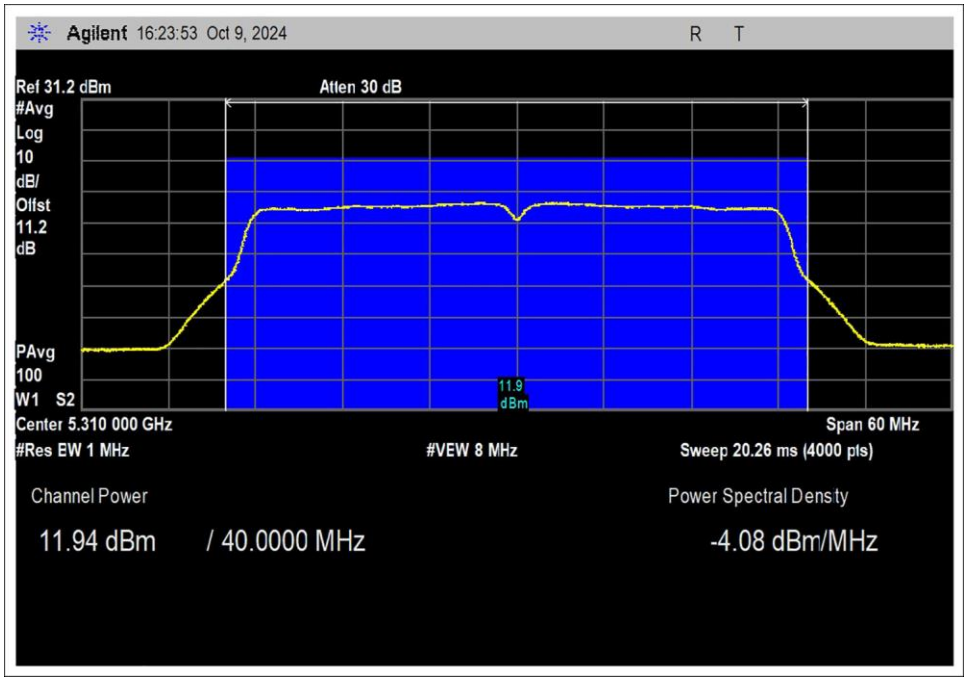
802.11n HT40, Low Channel



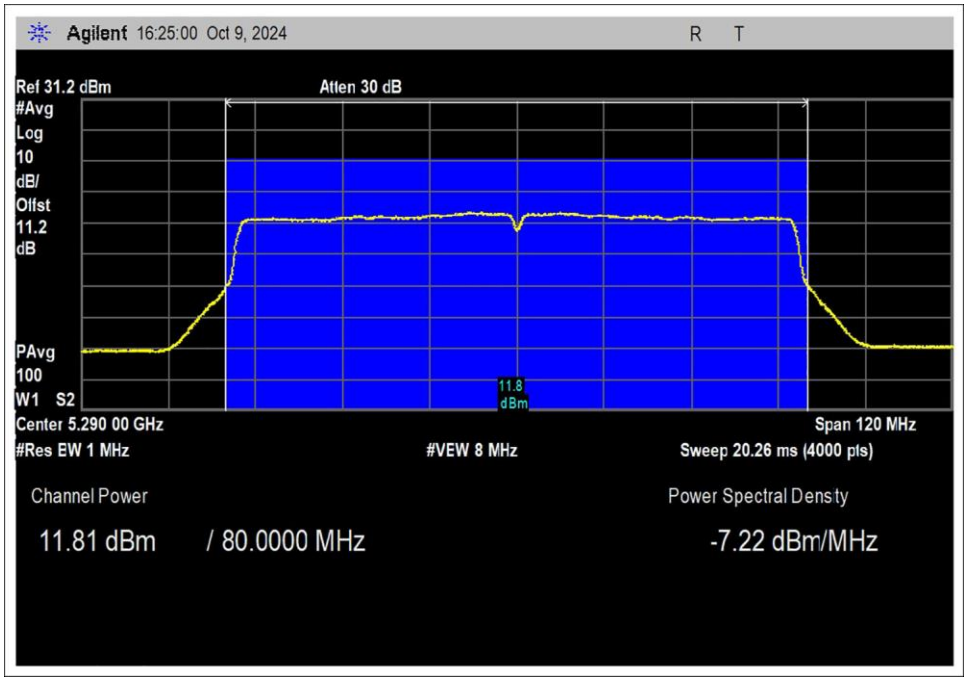
802.11n HT40, High Channel



802.11ac 40MHz, Low Channel

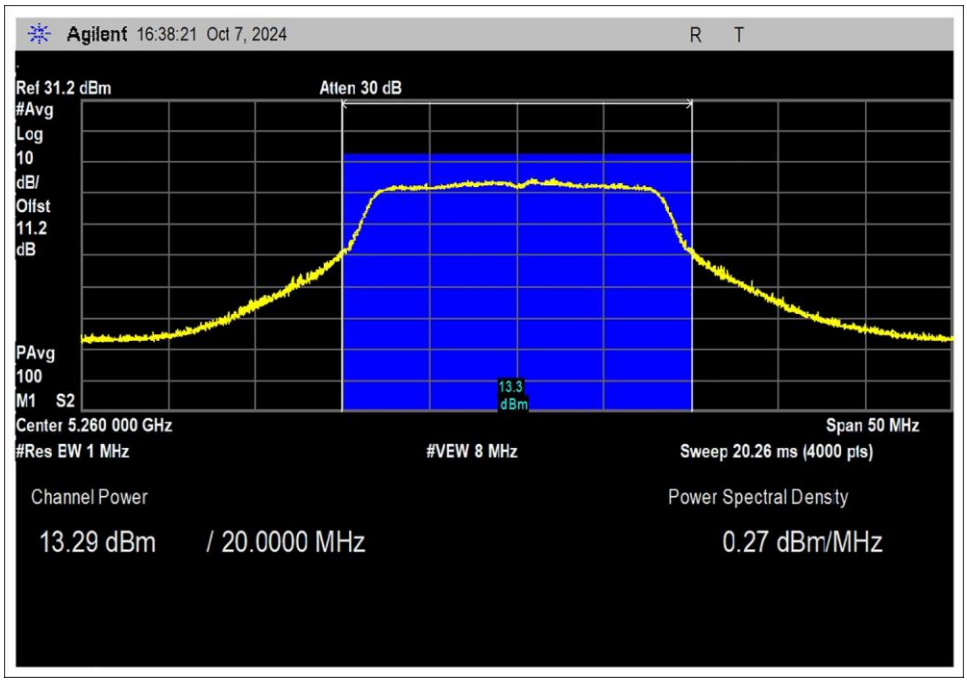


802.11ac 40MHz, High Channel

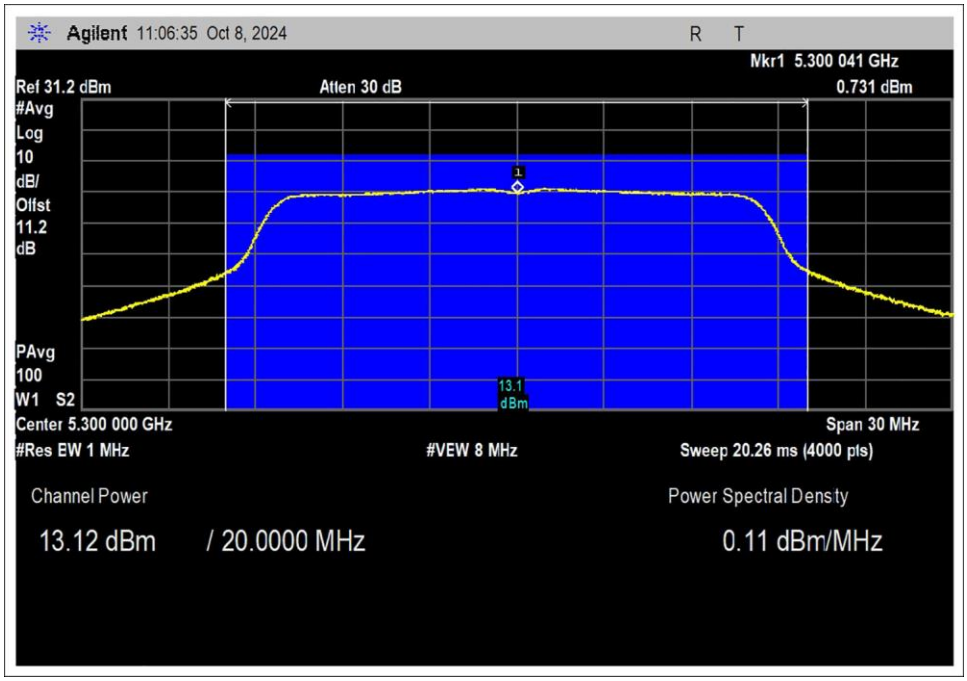


802.11ac 80MHz

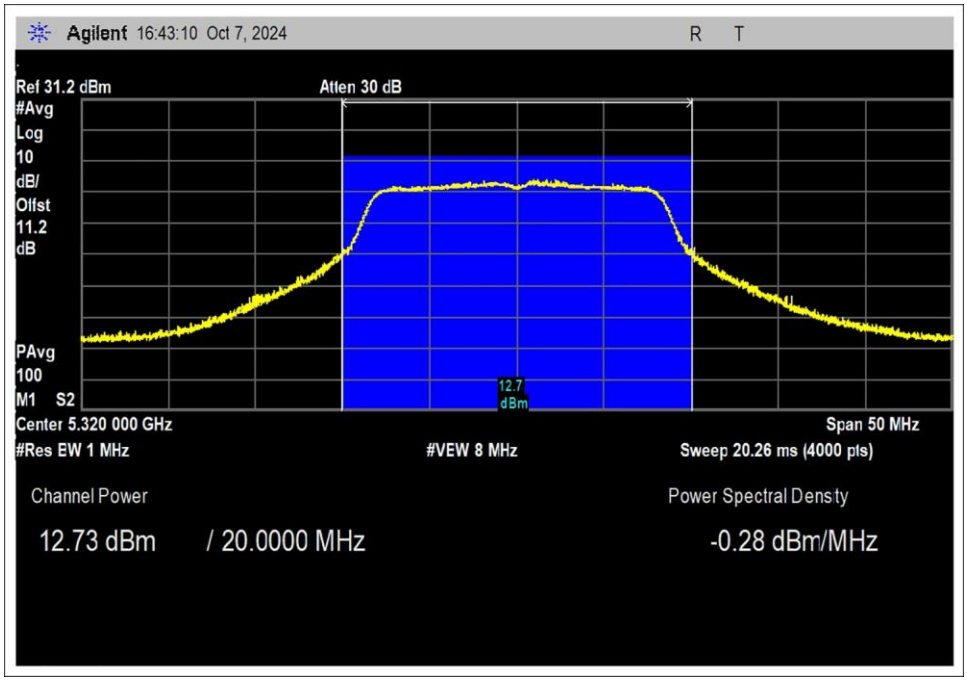
Chain 1



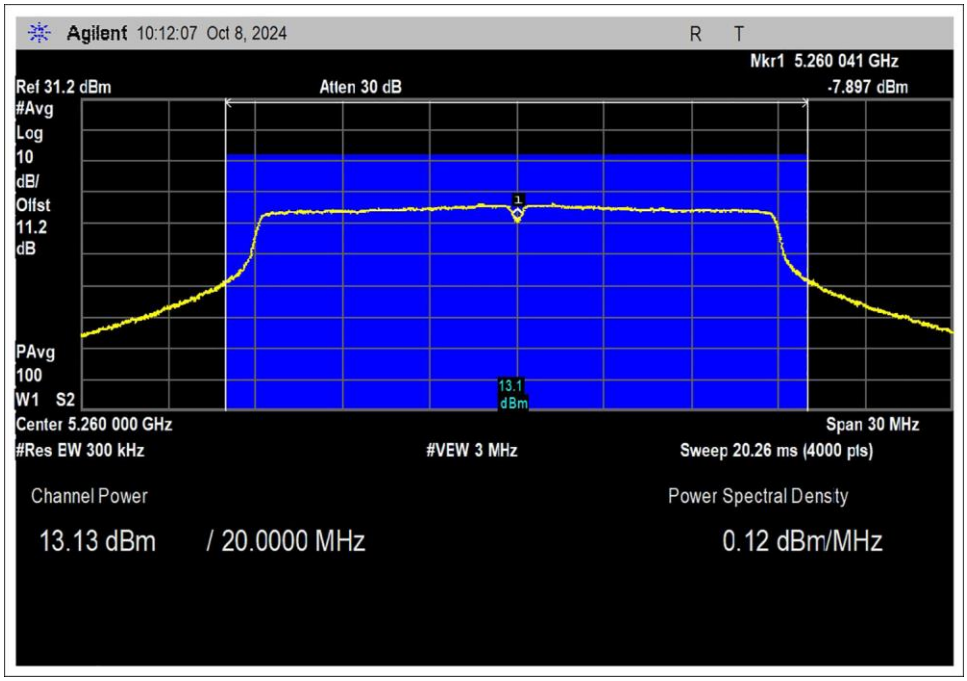
OFDM, Low Channel



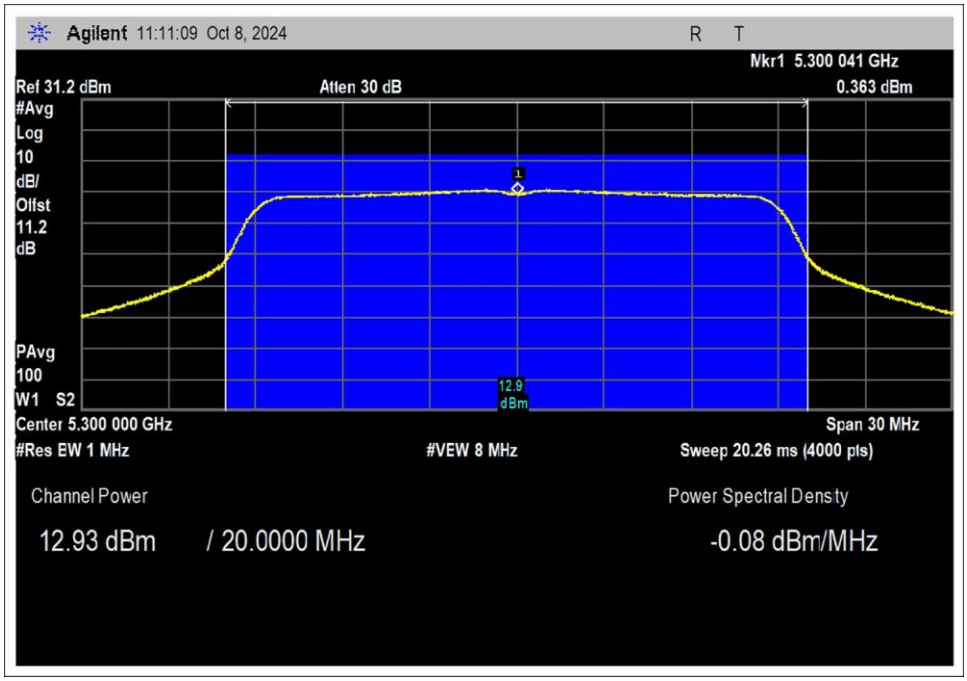
OFDM, Middle Channel



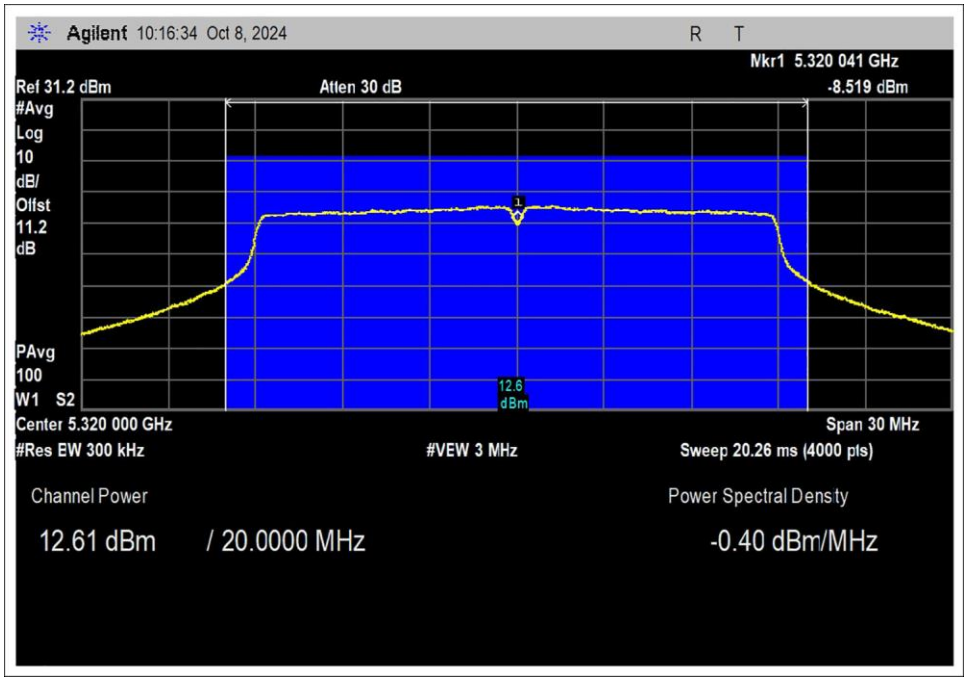
OFDM, High Channel



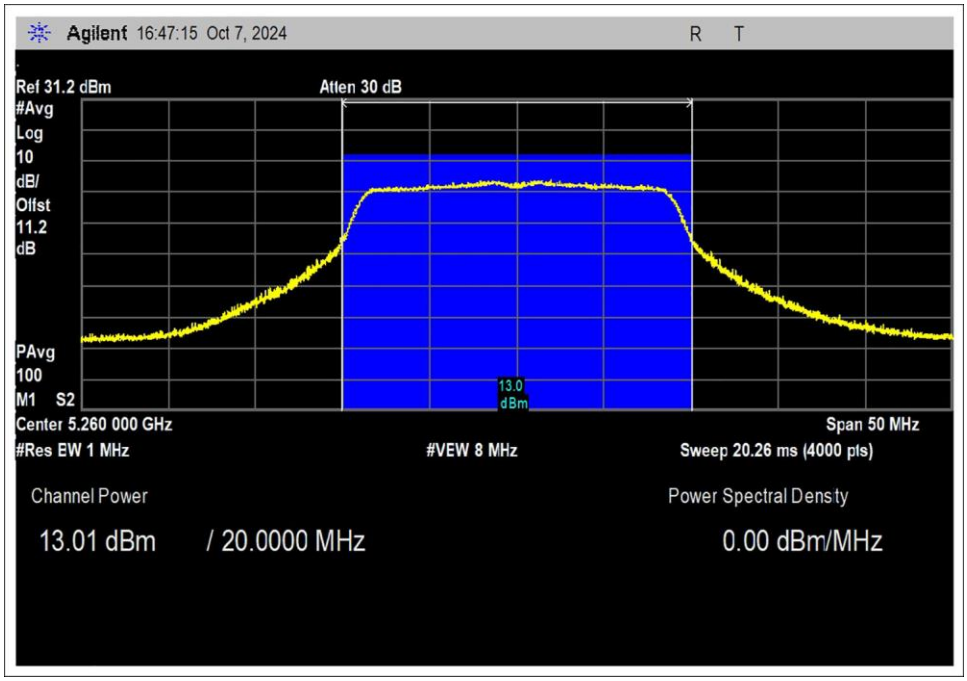
802.11n HT20, Low Channel



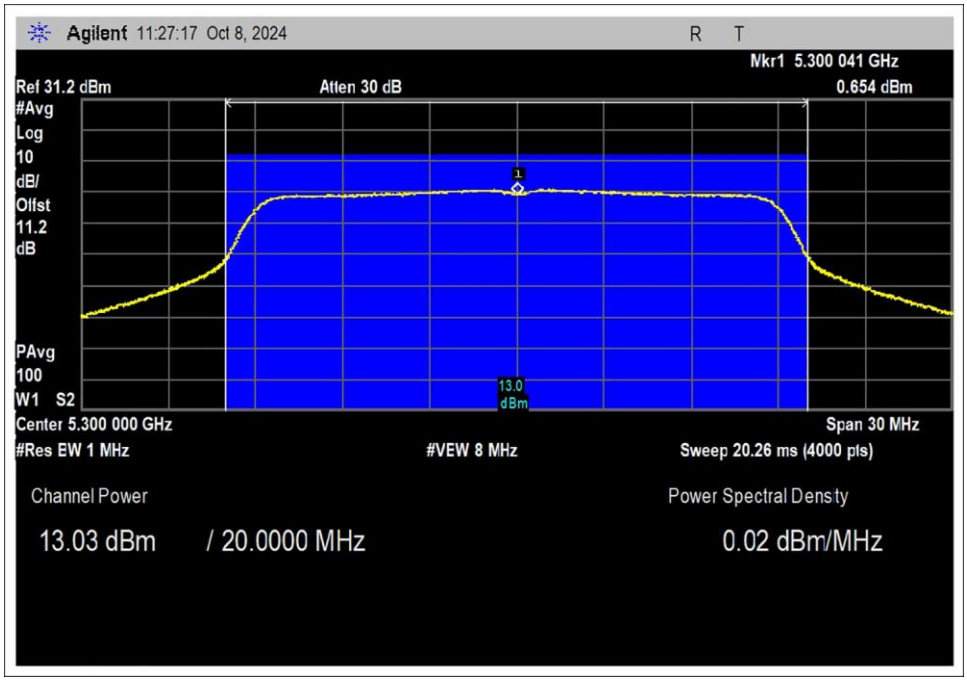
802.11n HT20, Middle Channel



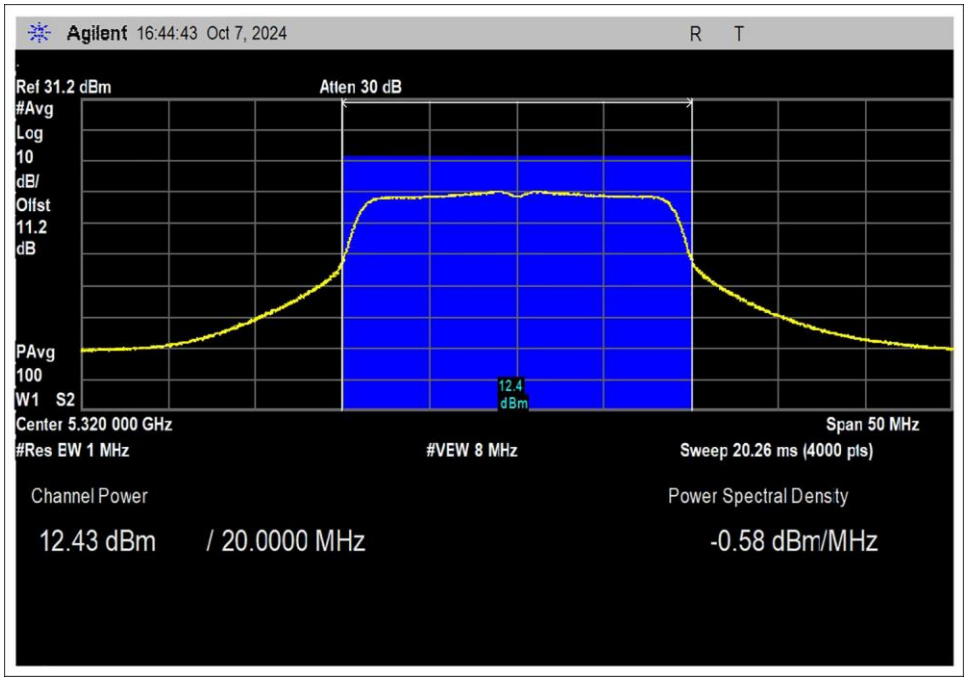
802.11n HT20, High Channel



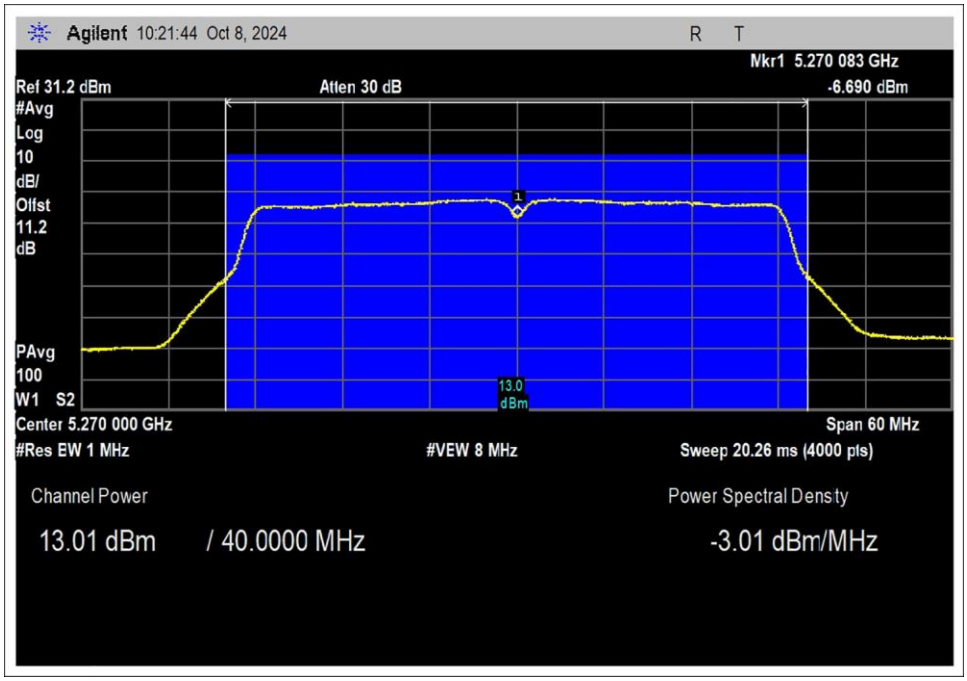
802.11ac 20MHz, Low Channel



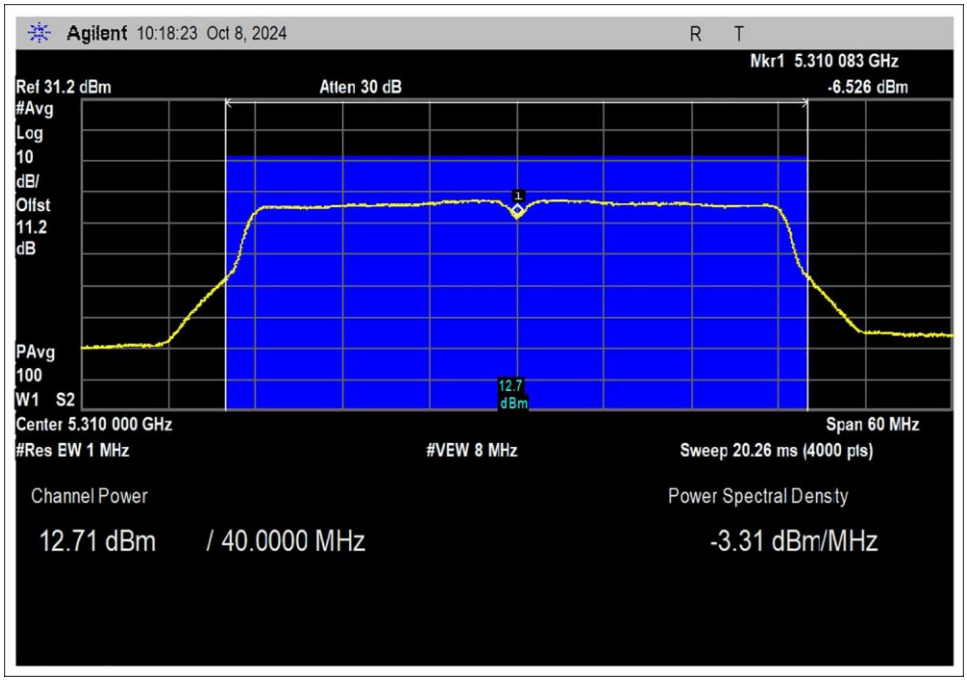
802.11ac 20MHz, Middle Channel



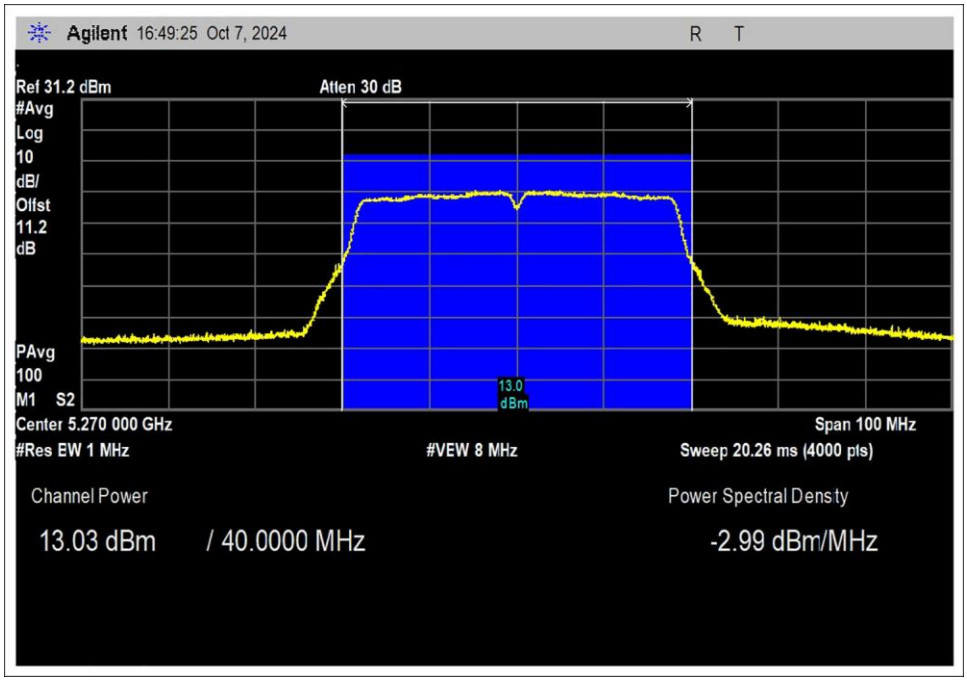
802.11ac 20MHz, High Channel



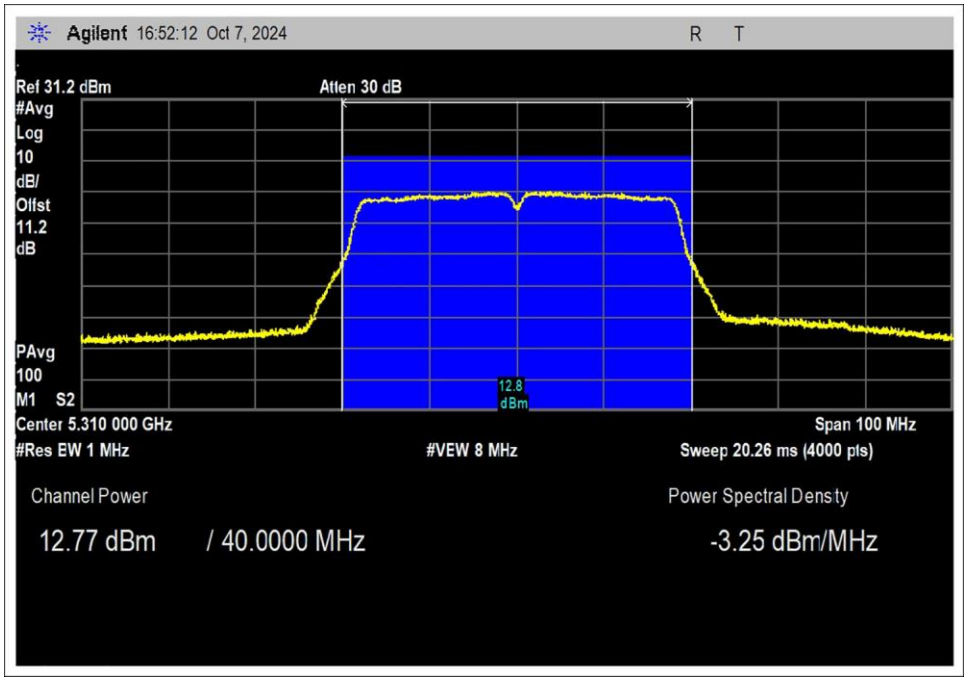
802.11n HT40, Low Channel



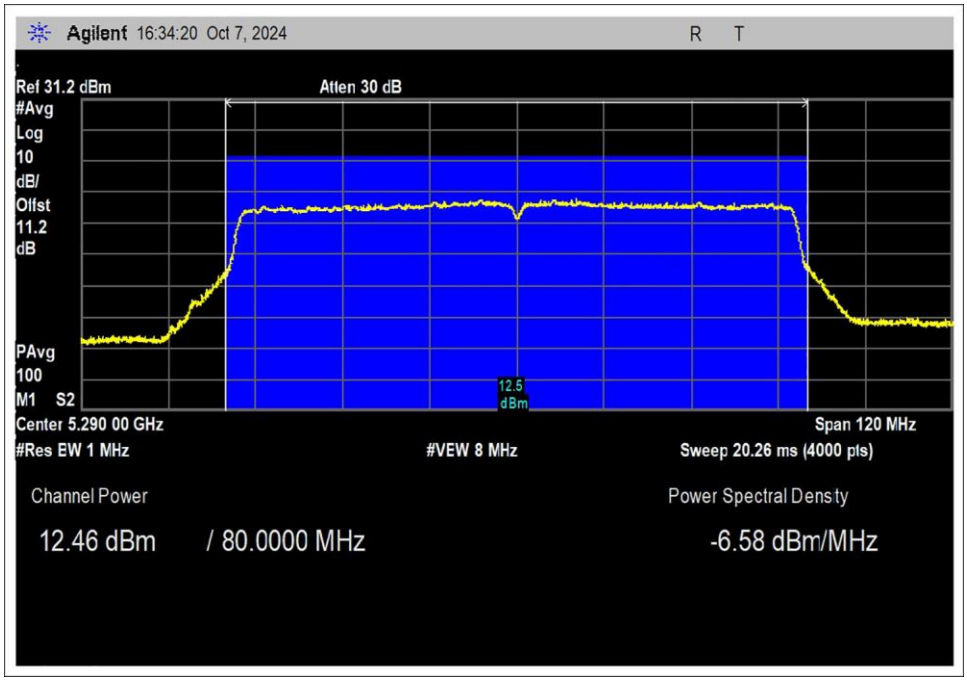
802.11n HT40, High Channel



802.11ac 40MHz, Low Channel

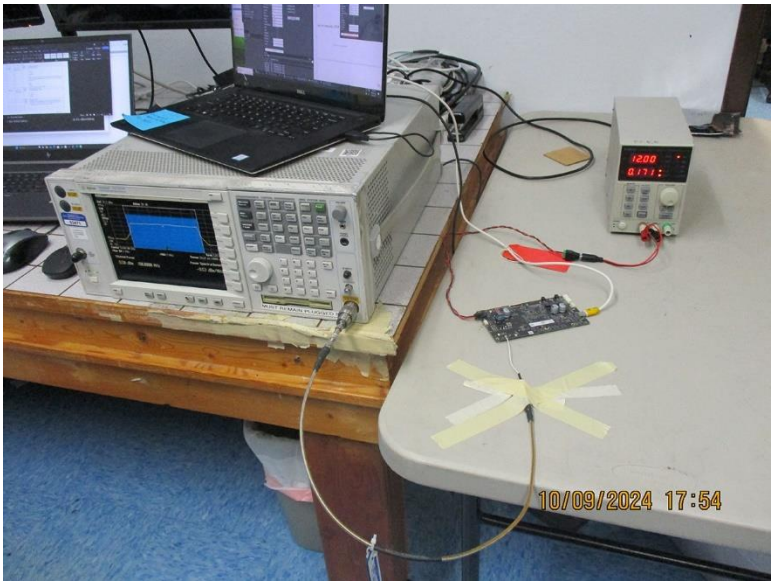


802.11ac 40MHz, High Channel



802.11ac 80MHz

Test Setup Photo(s)



Overall Test Setup

Test Setup, Closeup View

15.407(a) Power Spectral Density

Test Setup/Conditions – RF Conducted Measurement			
Test Location:	Fremont Lab Bench	Test Engineer:	Hieu Song Nguyenpham E. Wong
Test Method:	ANSI C63.10 (2020), KDB 789033	Test Date(s):	10/07-09/2024
Configuration:	A		
Test Setup:	The EUT is placed non-conducted table. It is operated as intended. It is connected straight to a Spectrum Analyzer.		

Environmental Conditions			
Temperature (ºC)	21.2-23.7	Relative Humidity (%):	39-45

Test Equipment – RF Conducted Measurement					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
03013	Cable	Astrolab	32022-2-2909K-36TC	1/9/2024	1/9/2026
P07365	Attenuator	Weinschel	54A-10	5/26/2023	5/26/2025
03471	Spectrum Analyzer	Agilent	E4440A	2/23/2024	2/23/2026

Test Data Summary - RF Conducted Measurement-Chain 0

Measurement Option: AVGSA-1

Frequency (MHz)	Modulation	Ant. Type / Gain (dBi)	Measured (dBm/MHz)	Limit (dBm/MHz)	Results
5260	802.11a	External/4.66	-0.56	≤11	Pass
5300	802.11a	External/4.66	-0.84	≤11	Pass
5320	802.11a	External/4.66	-1.00	≤11	Pass
5260	802.11n HT20	External/4.66	-0.69	≤11	Pass
5300	802.11n HT20	External/4.66	-1.05	≤11	Pass
5320	802.11n HT20	External/4.66	-1.13	≤11	Pass
5260	802.11ac 20MHz	External/4.66	-0.71	≤11	Pass
5300	802.11ac 20MHz	External/4.66	-1.04	≤11	Pass
5320	802.11ac 20MHz	External/4.66	-1.10	≤11	Pass
5270	802.11n HT40	External/4.66	-3.79	≤11	Pass
5310	802.11n HT40	External/4.66	-4.06	≤11	Pass
5270	802.11ac 40MHz	External/4.66	-3.73	≤11	Pass
5310	802.11ac 40MHz	External/4.66	-4.08	≤11	Pass
5290	802.11ac 80MHz	External/4.66	-7.22	≤11	Pass

Test Data Summary - RF Conducted Measurement-Chain 1					
Measurement Option: AVGSA-1					
Frequency (MHz)	**Modulation**	**Ant. Type / Gain (dBi)**	**Measured (dBm/MHz)**	**Limit (dBm/MHz)**	**Results**
5260	802.11a	External/4.66	0.27	≤11	Pass
5300	802.11a	External/4.66	0.11	≤11	Pass
5320	802.11a	External/4.66	-0.28	≤11	Pass
5260	802.11n HT20	External/4.66	0.12	≤11	Pass
5300	802.11n HT20	External/4.66	-0.08	≤11	Pass
5320	802.11n HT20	External/4.66	-0.40	≤11	Pass
5260	802.11ac 20MHz	External/4.66	0.00	≤11	Pass
5300	802.11ac 20MHz	External/4.66	0.02	≤11	Pass
5320	802.11ac 20MHz	External/4.66	-0.58	≤11	Pass
5270	802.11n HT40	External/4.66	-3.01	≤11	Pass
5310	802.11n HT40	External/4.66	-3.31	≤11	Pass
5270	802.11ac 40MHz	External/4.66	-2.99	≤11	Pass
5310	802.11ac 40MHz	External/4.66	-3.25	≤11	Pass
5290	802.11ac 80MHz	External/4.66	-6.58	≤11	Pass

The limit is calculated in accordance with 15.407(a)(2):

$Limit = 11 - Roundup(G - 6)$

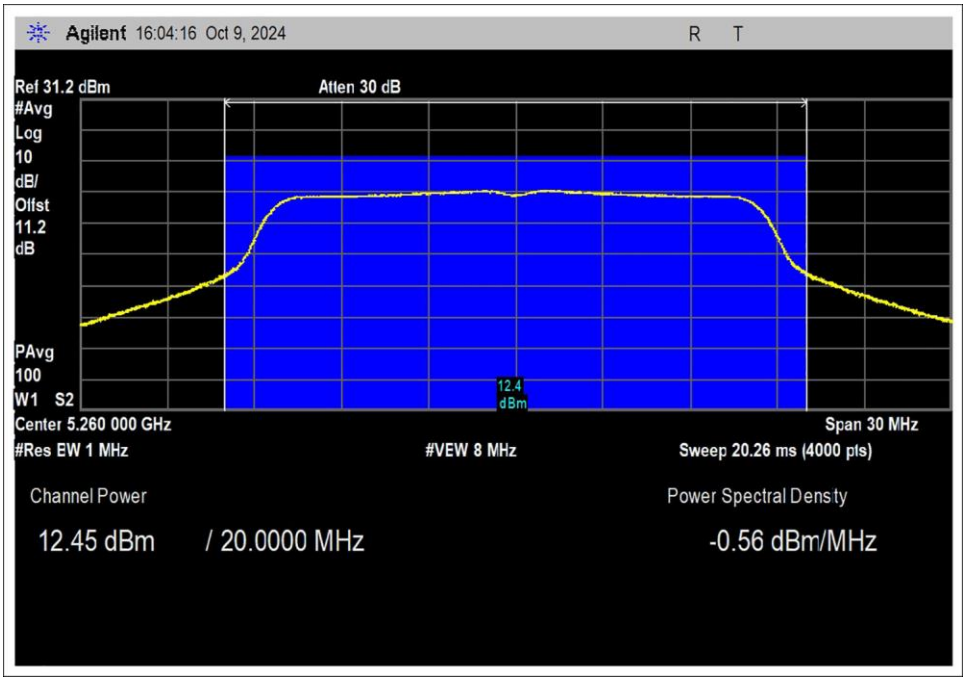
Test Data Summary - RF Conducted Measurement- MIMO Total PSD						
Measurement Method: AVGPSD-1						
Frequency (MHz)	**Modulation**	**Measured (dBm/MHz)**		**Measured Total (dBm/MHz)**	**Limit (dBm/MHz)**	**Results**
		Ch0	Ch1			
5260	802.11a	**-0.56**	**0.27**	2.89	**≤11**	Pass
5300	802.11a	-0.84	0.11	2.67	≤11	Pass
5320	802.11a	-1	-0.28	2.39	≤11	Pass
5260	802.11n HT20	-0.69	0.12	2.74	≤11	Pass
5300	802.11n HT20	-1.05	-0.08	2.47	≤11	Pass
5320	802.11n HT20	-1.13	-0.4	2.26	≤11	Pass
5260	802.11ac 20MHz	-0.71	0	2.67	≤11	Pass
5300	802.11ac 20MHz	-1.04	0.02	2.53	≤11	Pass
5320	802.11ac 20MHz	-1.1	-0.58	2.18	≤11	Pass
5270	802.11n HT40	-3.79	-3.01	-0.37	≤11	Pass
5310	802.11n HT40	-4.06	-3.31	-0.66	≤11	Pass
5270	802.11ac 40MHz	-3.73	-2.99	-0.33	≤11	Pass
5310	802.11ac 40MHz	-4.08	-3.25	-0.63	≤11	Pass
5290	802.11ac 80MHz	-7.22	-6.58	-3.88	≤11	Pass

Ch0=Chain0
Ch1=Chain1

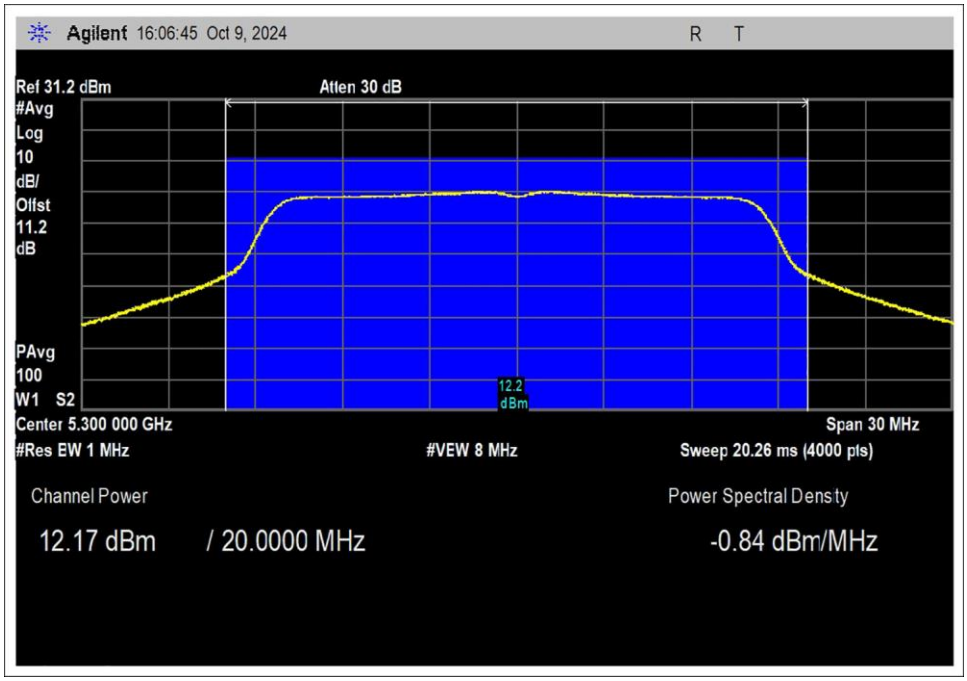
662911 D01 Multiple Transmitter Output v02r01 E 2 b) Measure and sum spectral maxima across the outputs.

Plot(s)

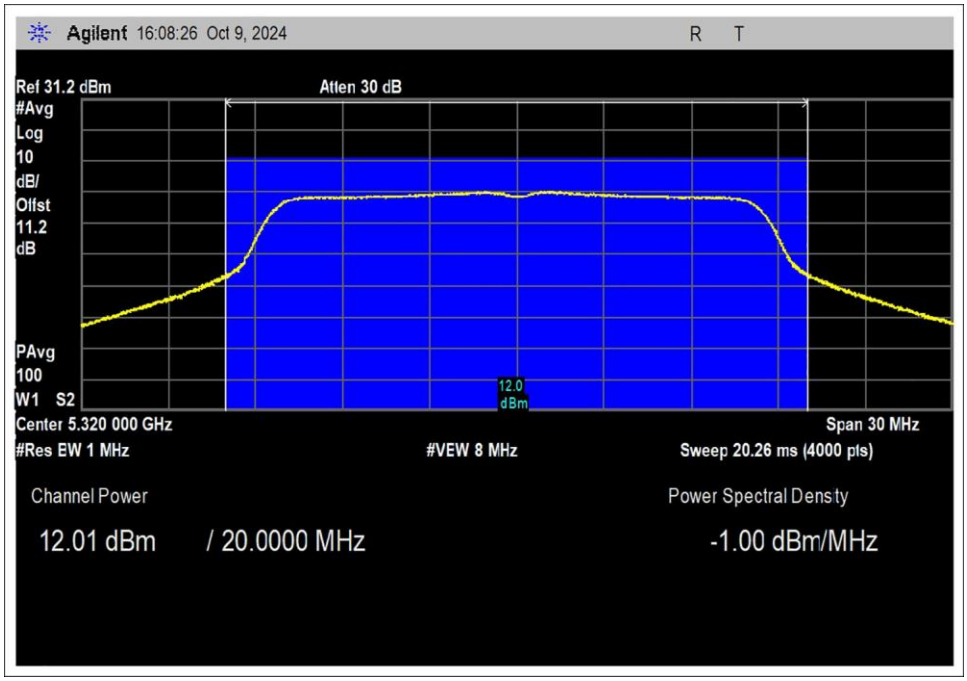
Chain 0



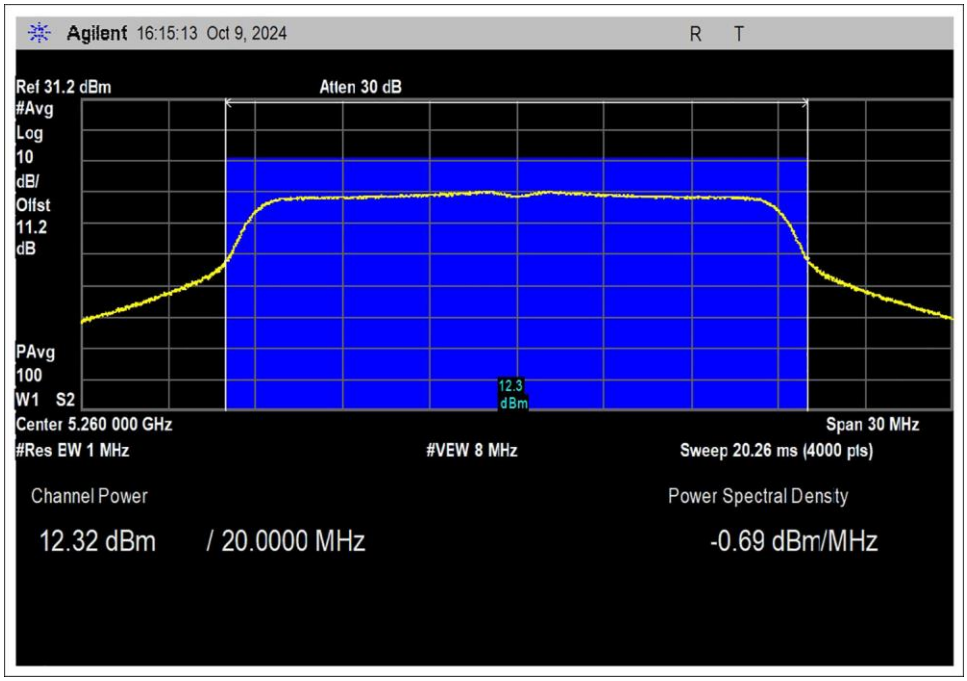
OFDM, Low Channel



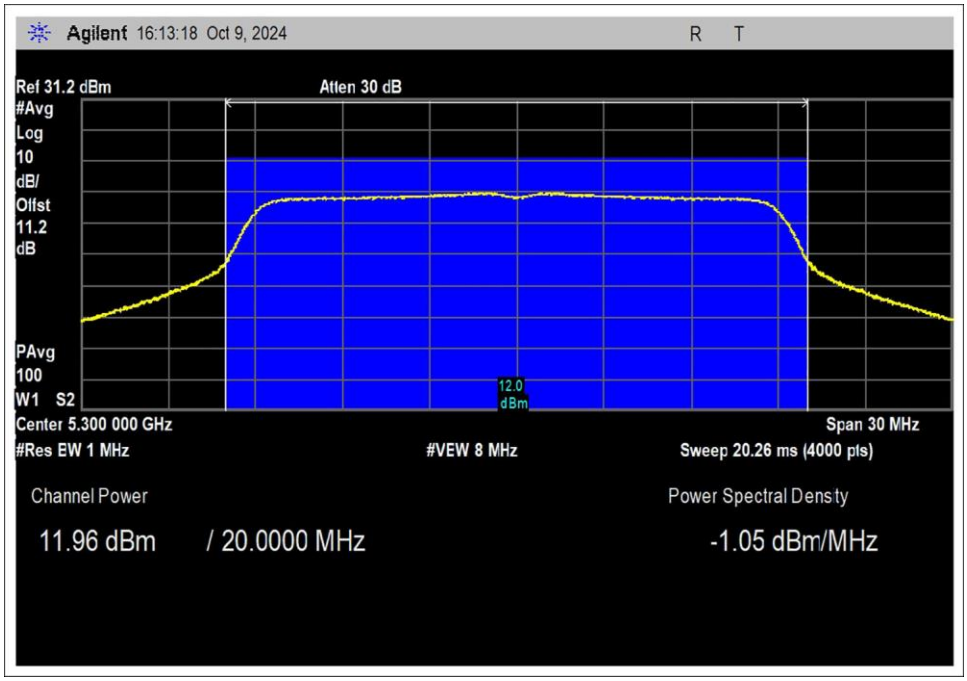
OFDM, Middle Channel



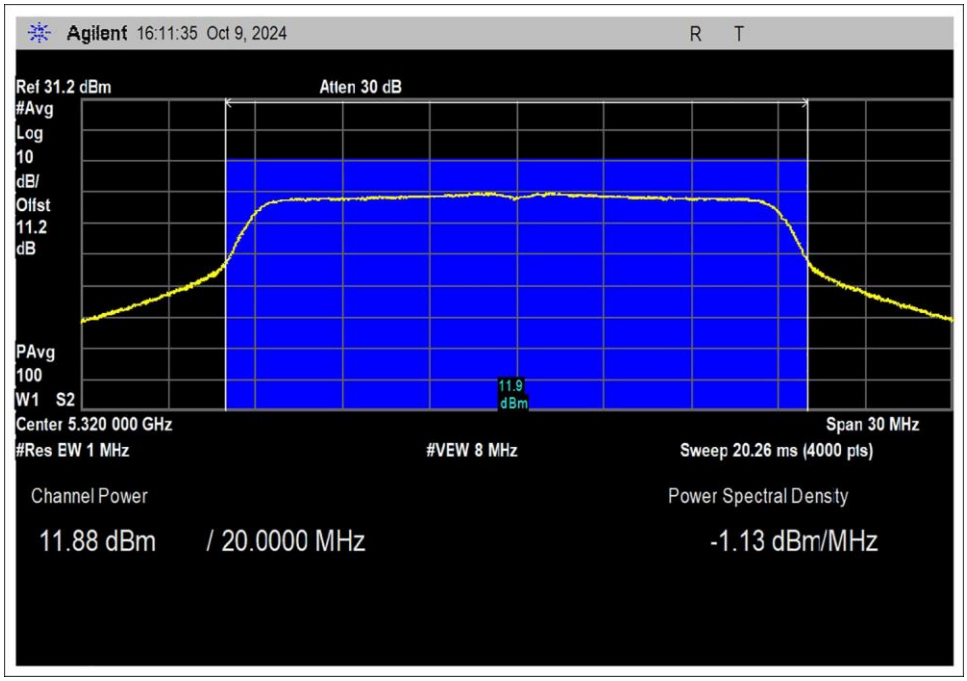
OFDM, High Channel



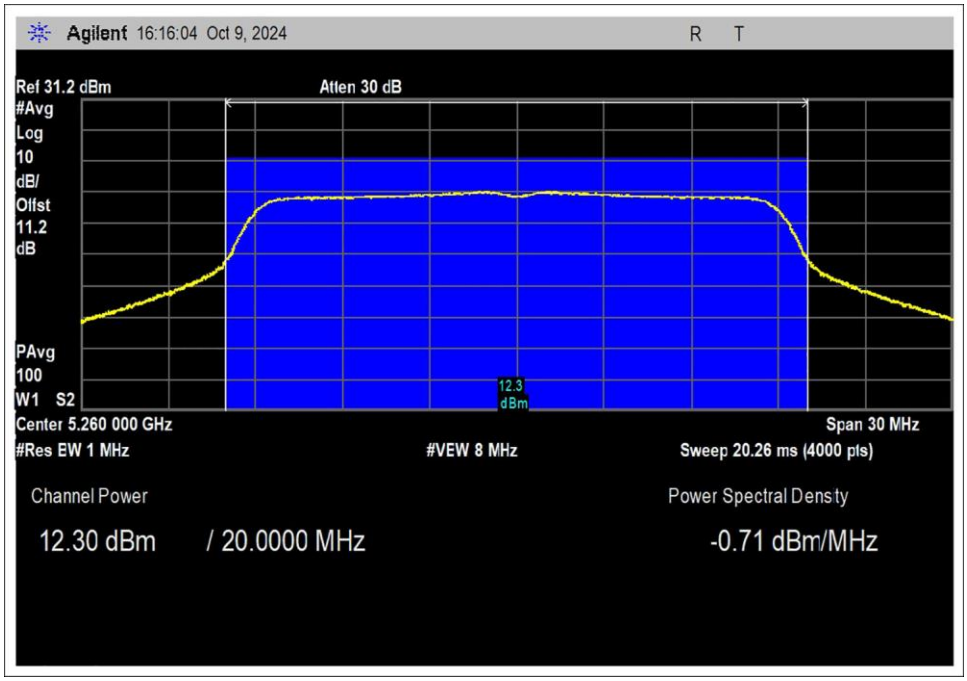
802.11n HT20, Low Channel



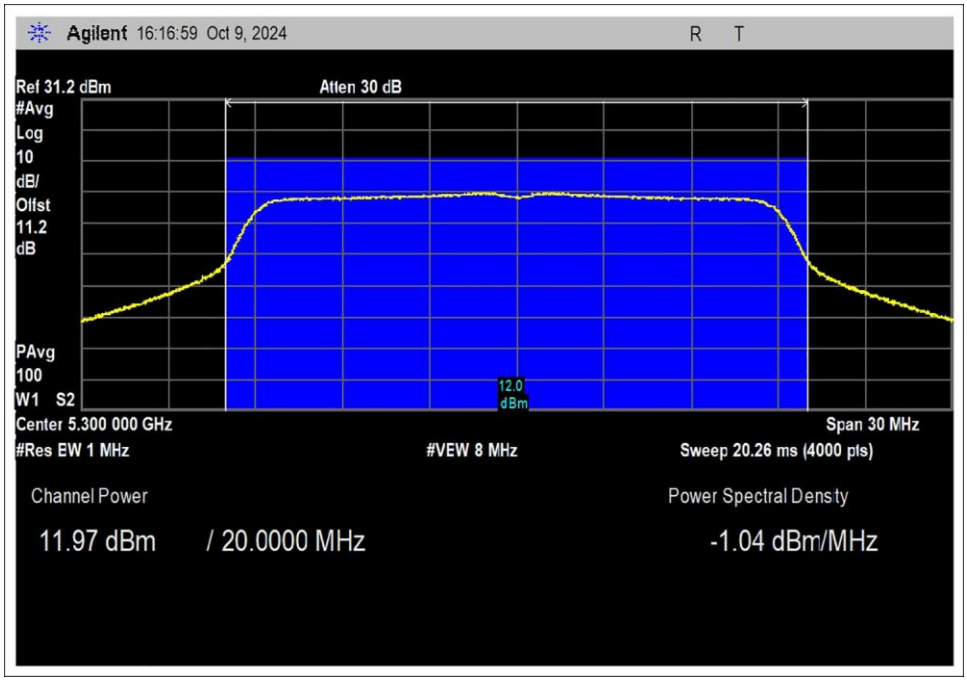
802.11n HT20, Middle Channel



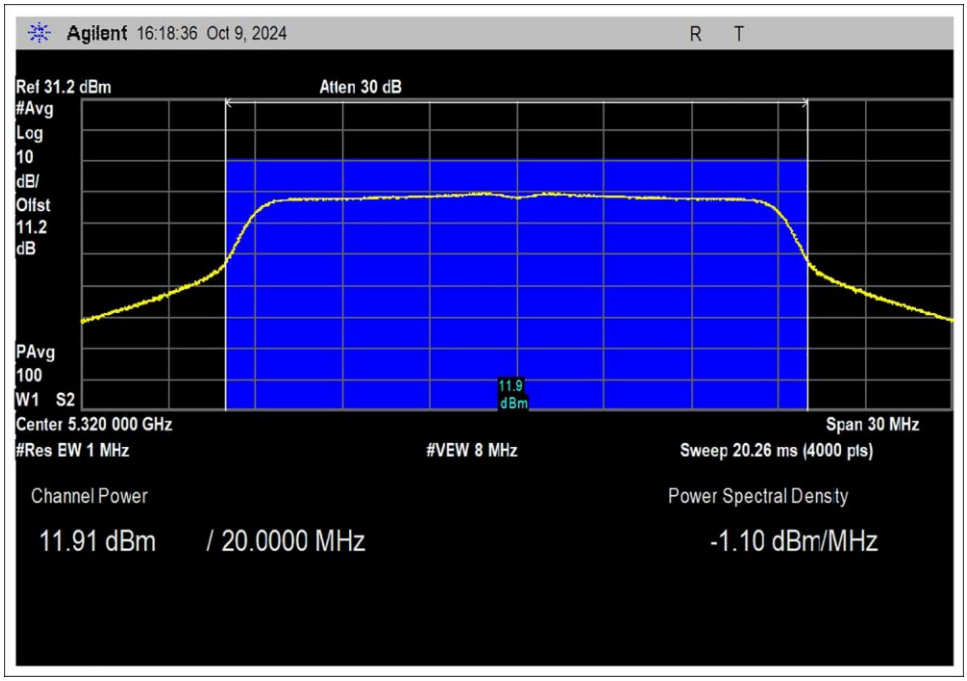
802.11n HT20, High Channel



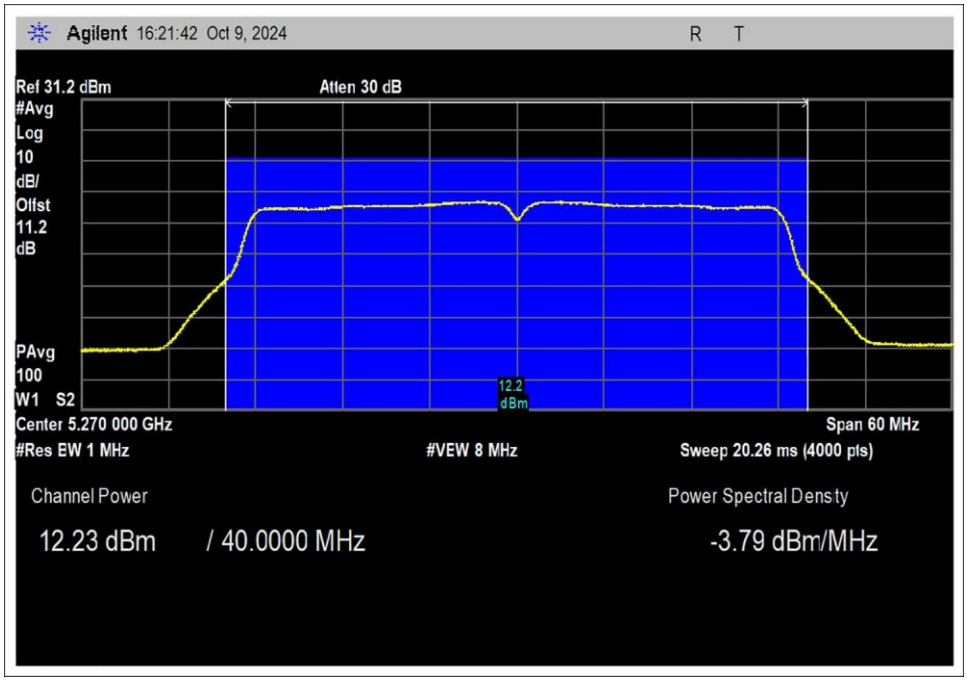
802.11ac 20MHz, Low Channel



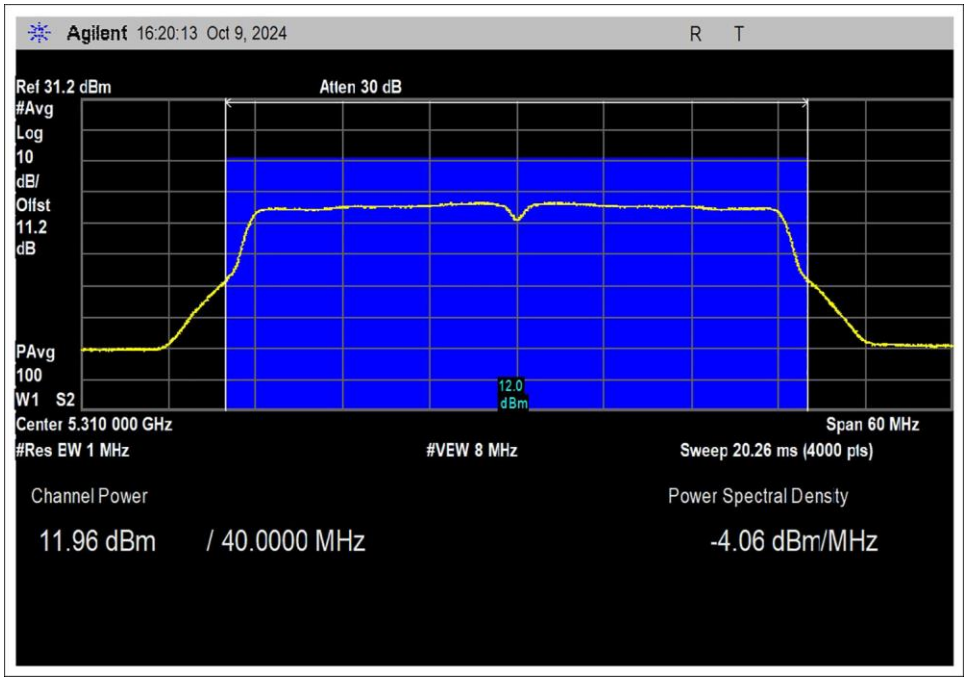
802.11ac 20MHz, Middle Channel



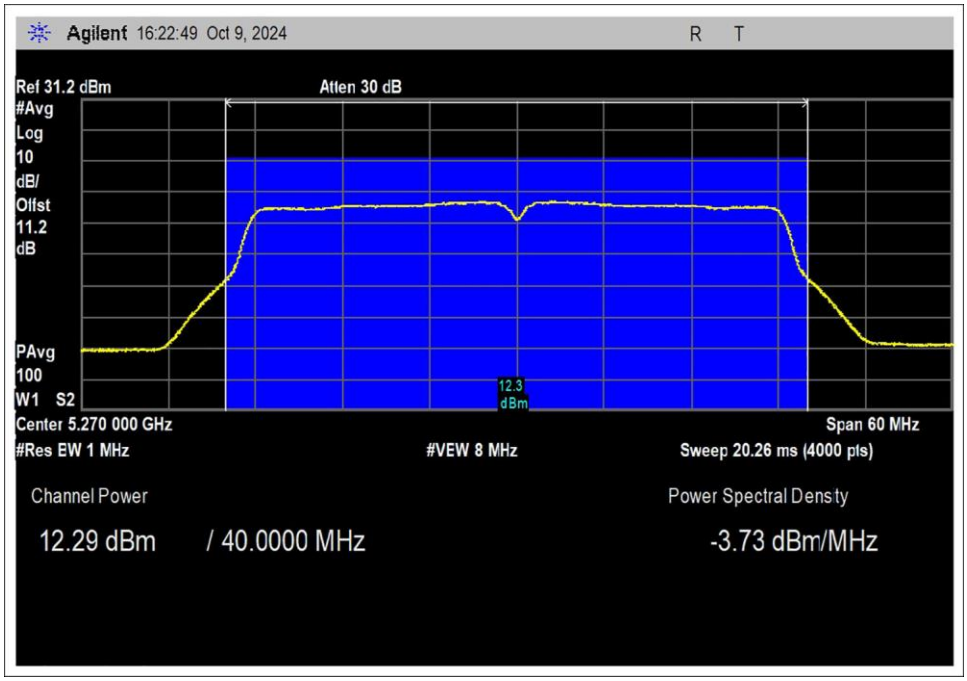
802.11ac 20MHz, High Channel



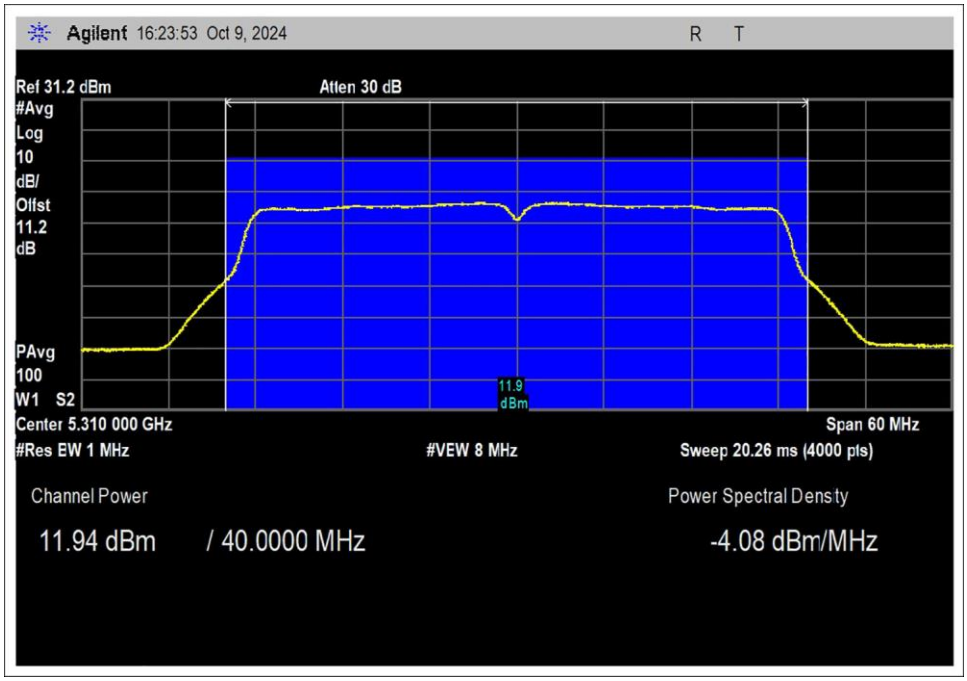
802.11n HT40, Low Channel



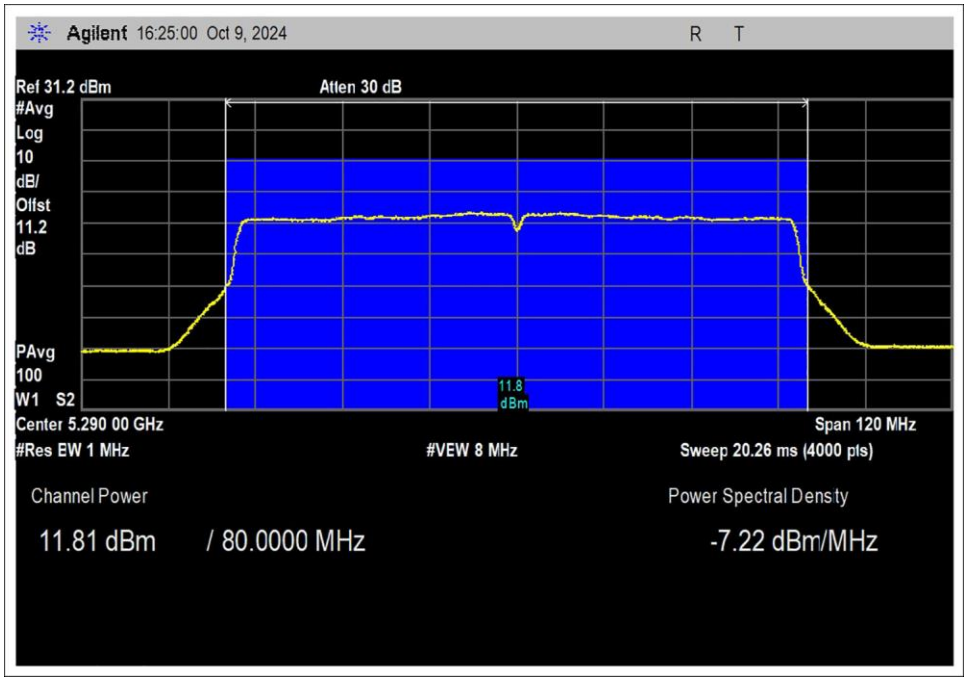
802.11n HT40, High Channel



802.11ac 40MHz, Low Channel

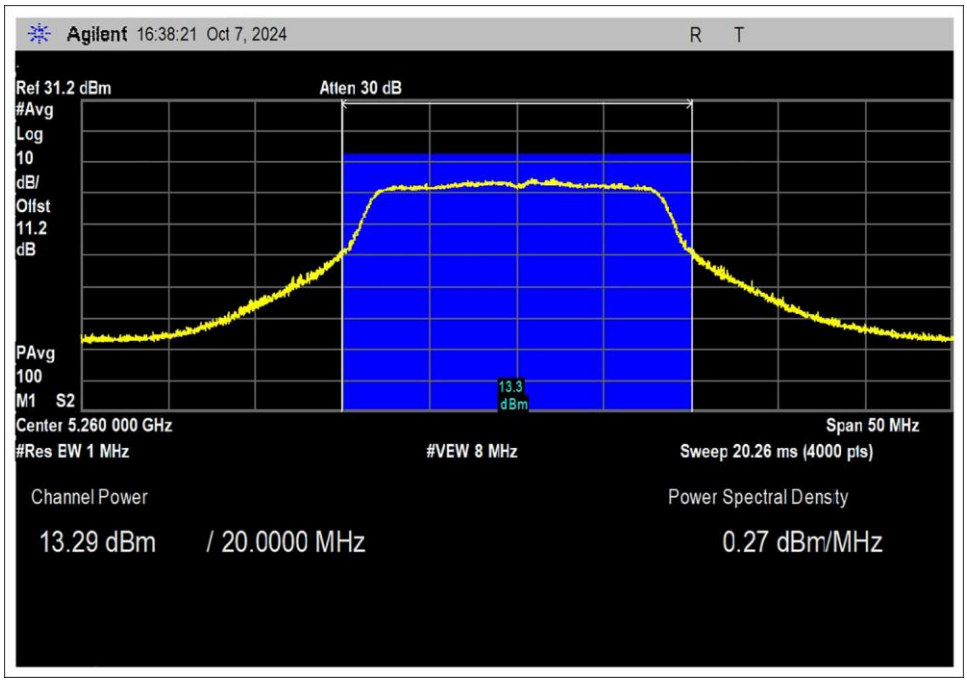


802.11ac 40MHz, High Channel

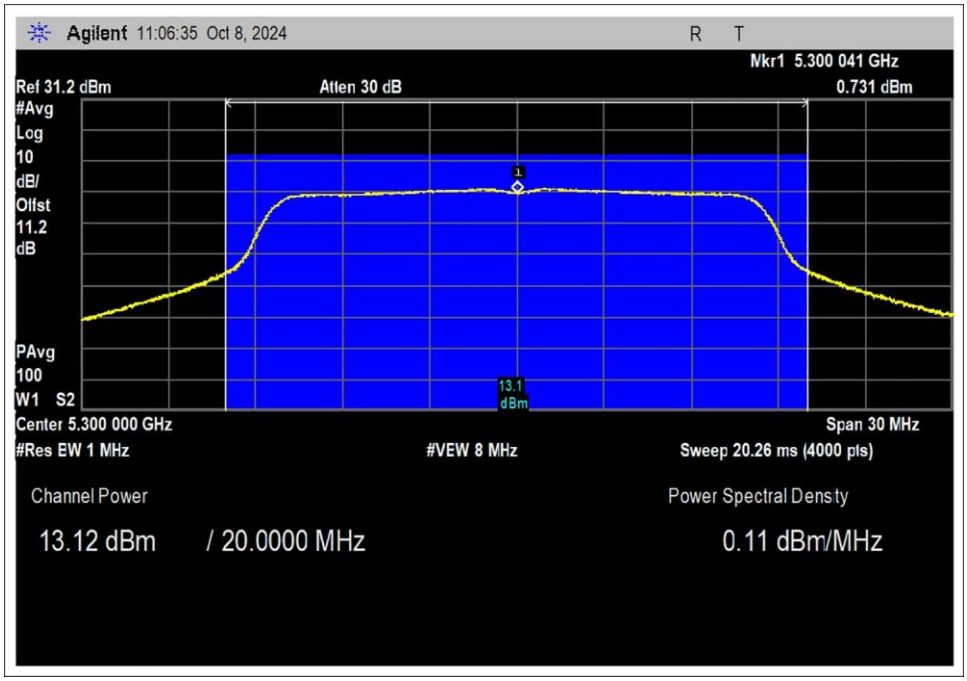


802.11ac 80MHz

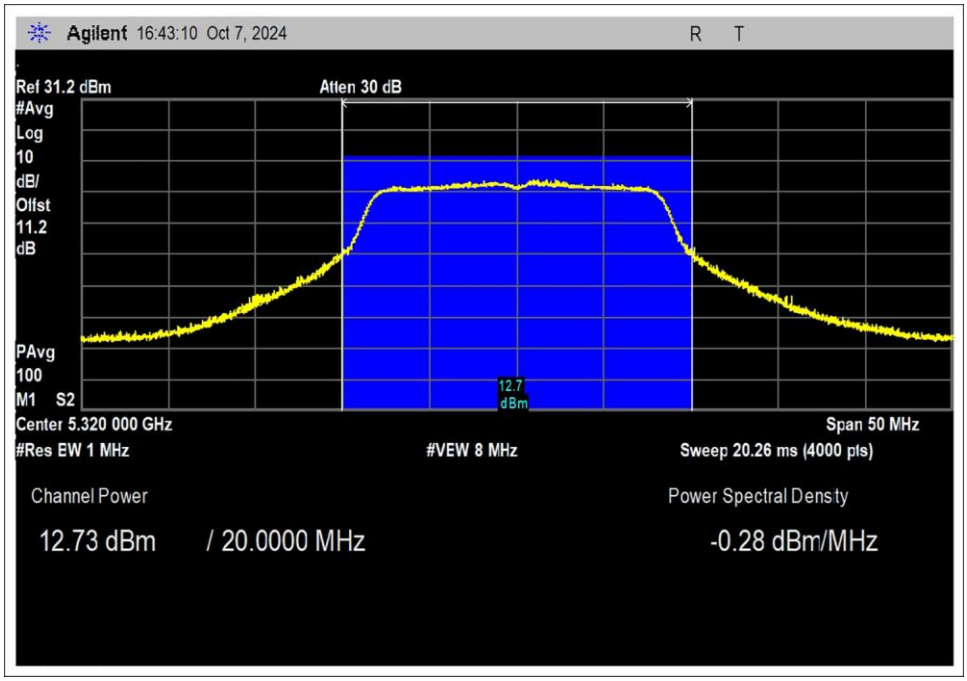
Chain 1



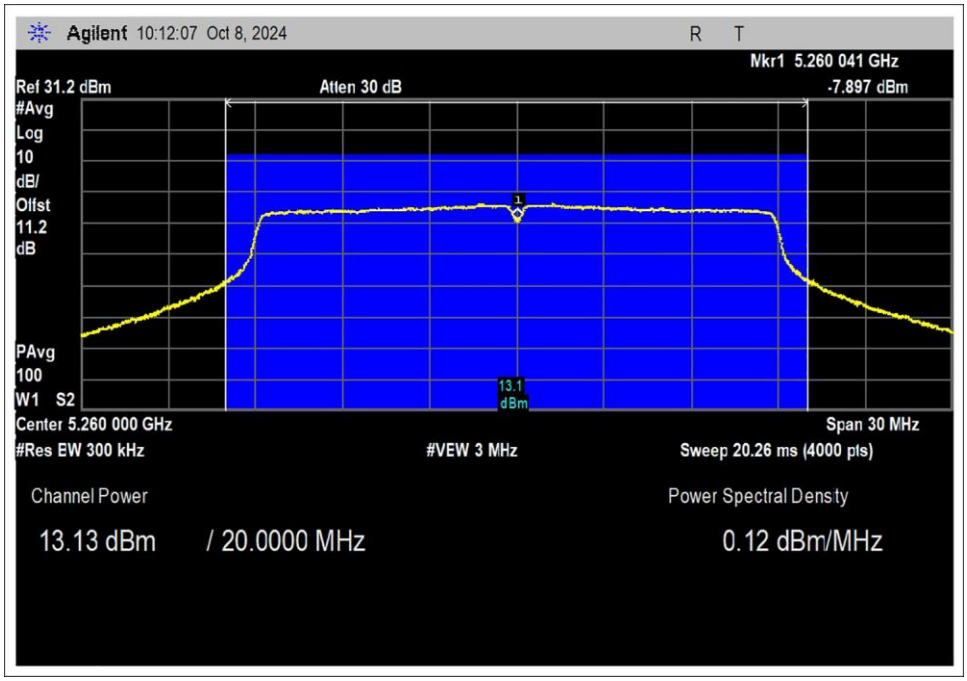
OFDM, Low Channel



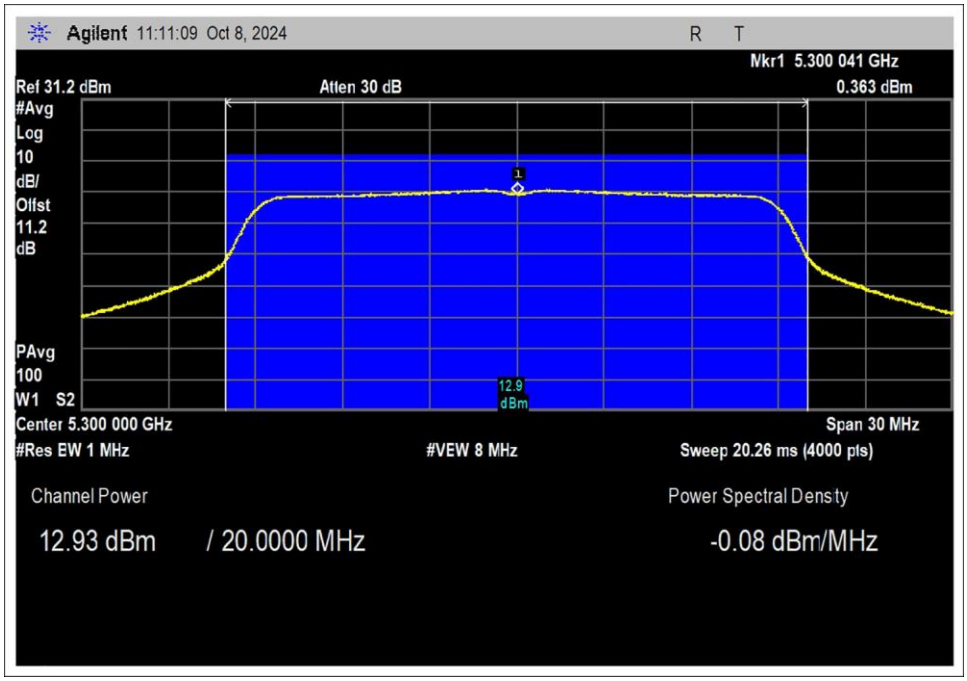
OFDM, Middle Channel



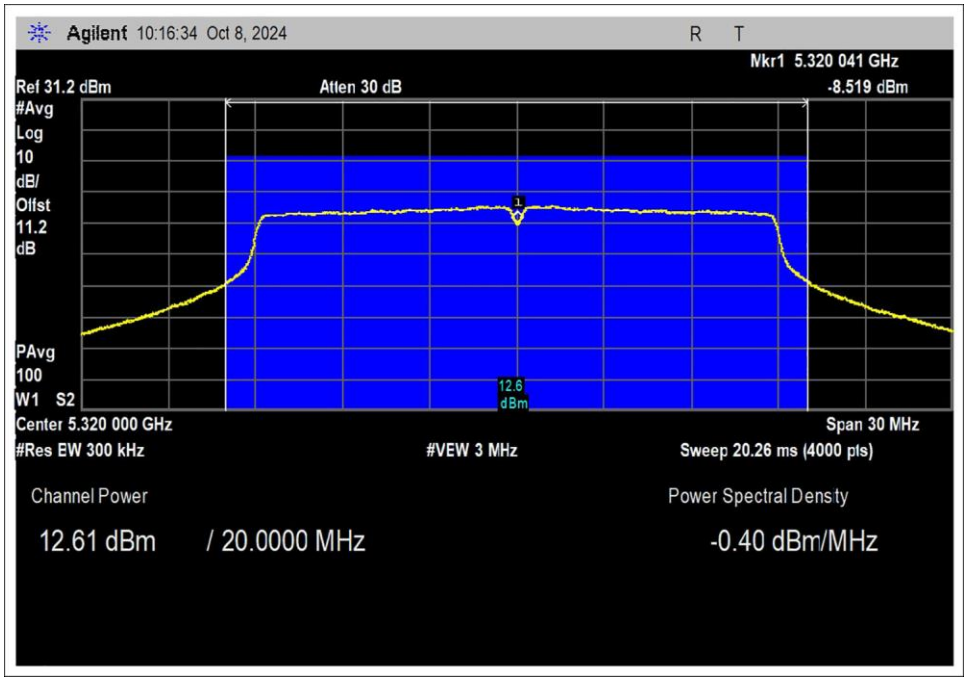
OFDM, High Channel



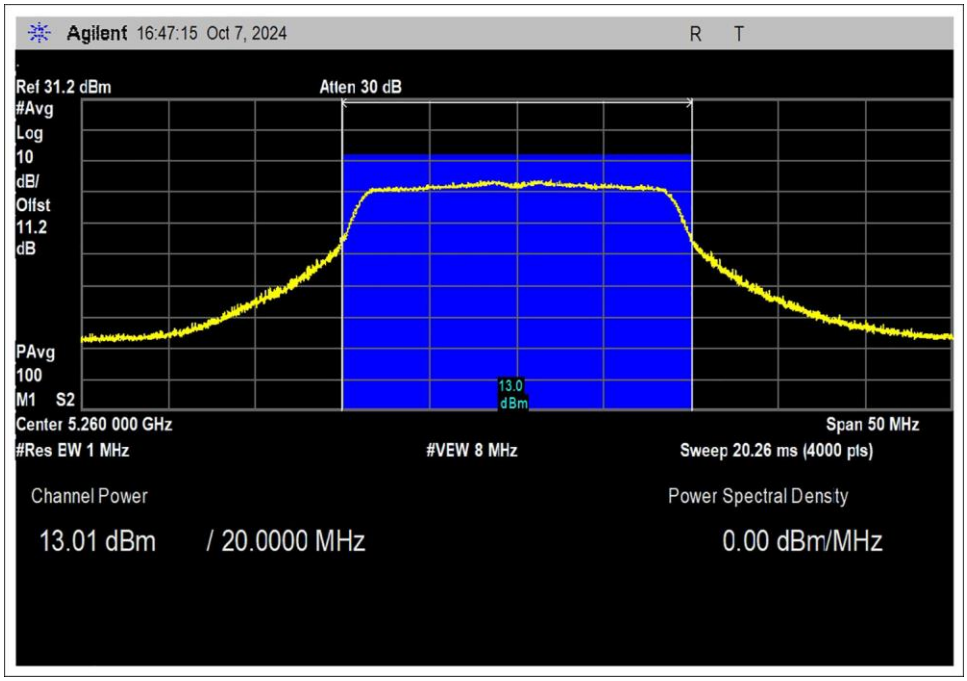
802.11n HT20, Low Channel



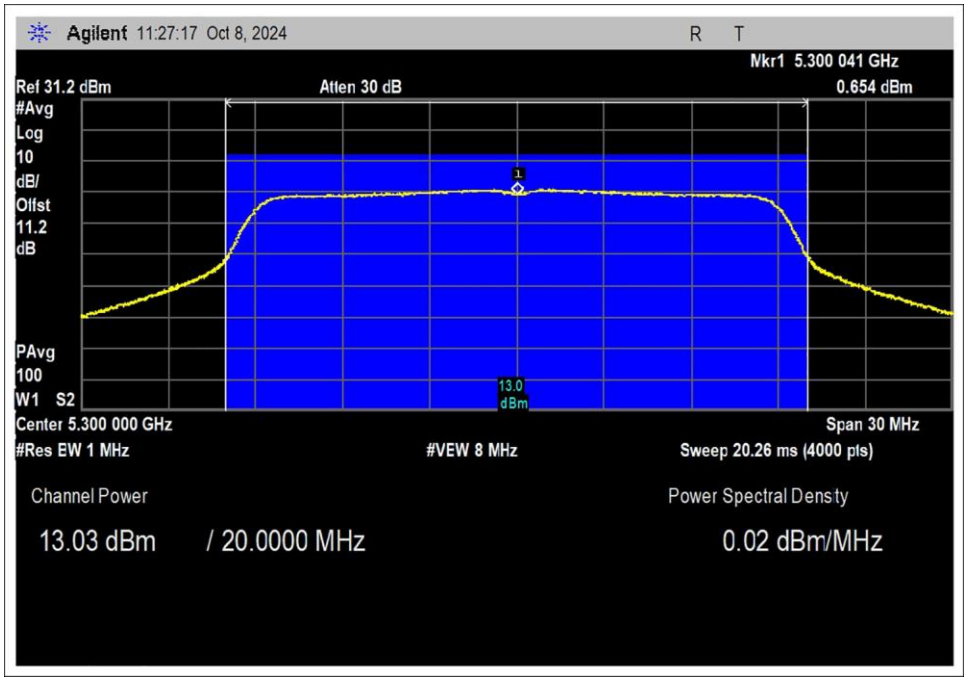
802.11n HT20, Middle Channel



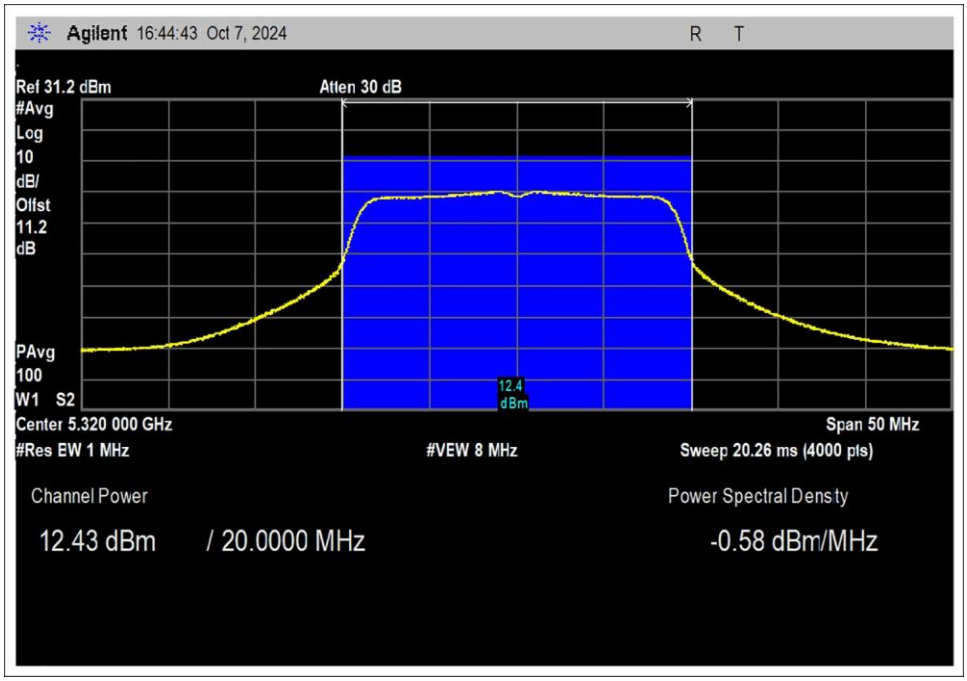
802.11n HT20, High Channel



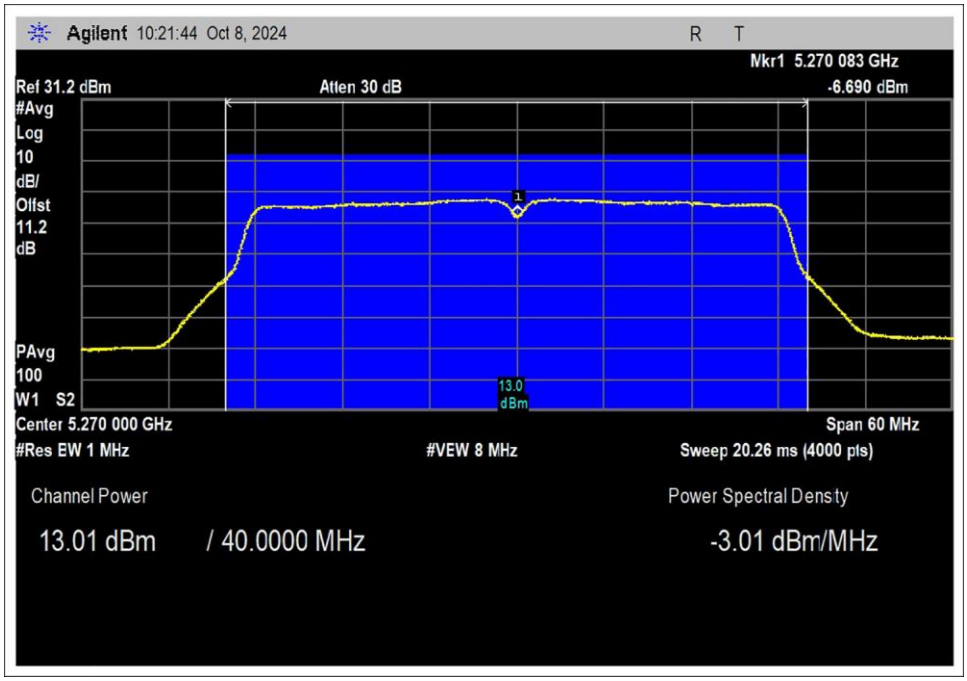
802.11ac 20MHz, Low Channel



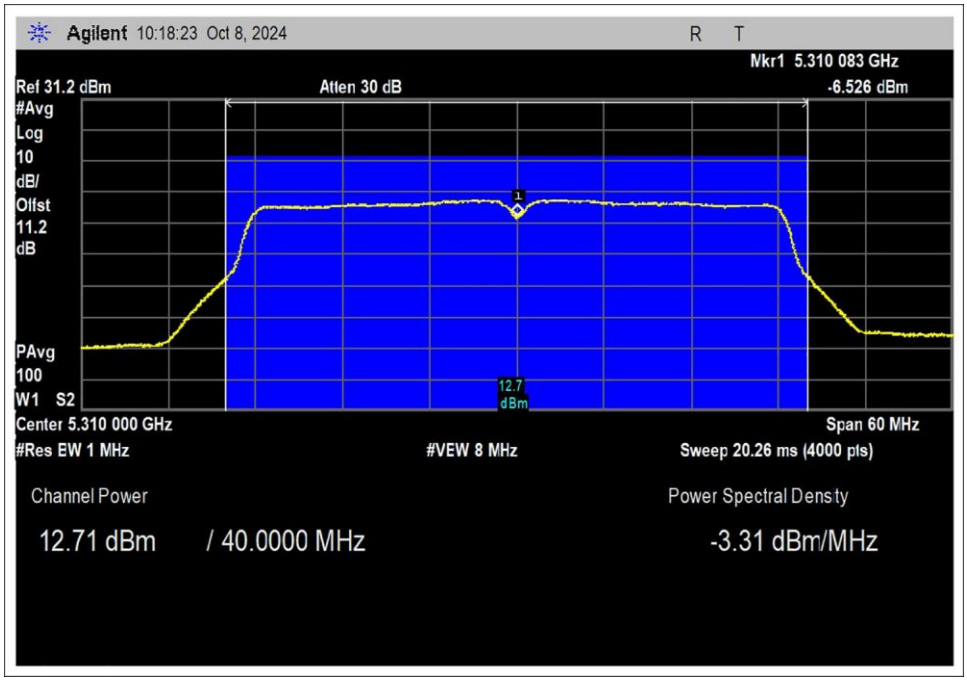
802.11ac 20MHz, Middle Channel



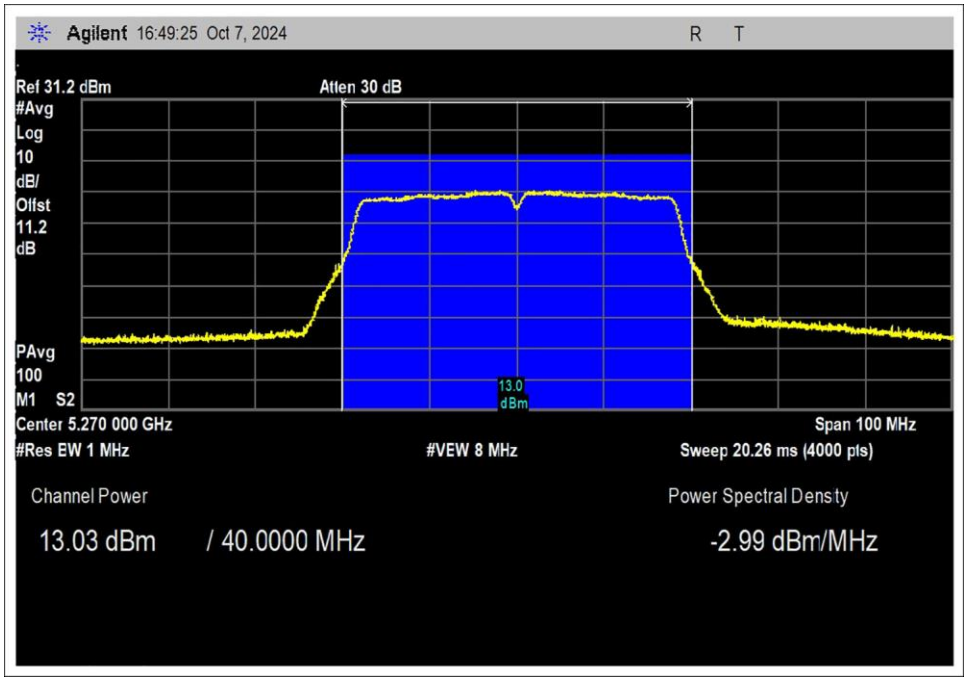
802.11ac 20MHz, High Channel



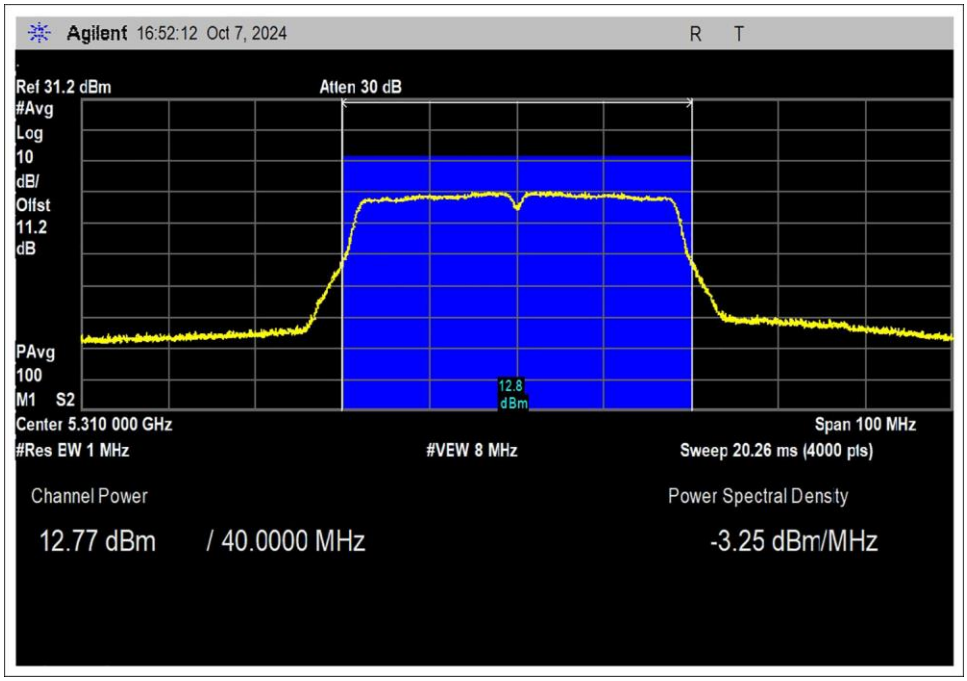
802.11n HT40, Low Channel



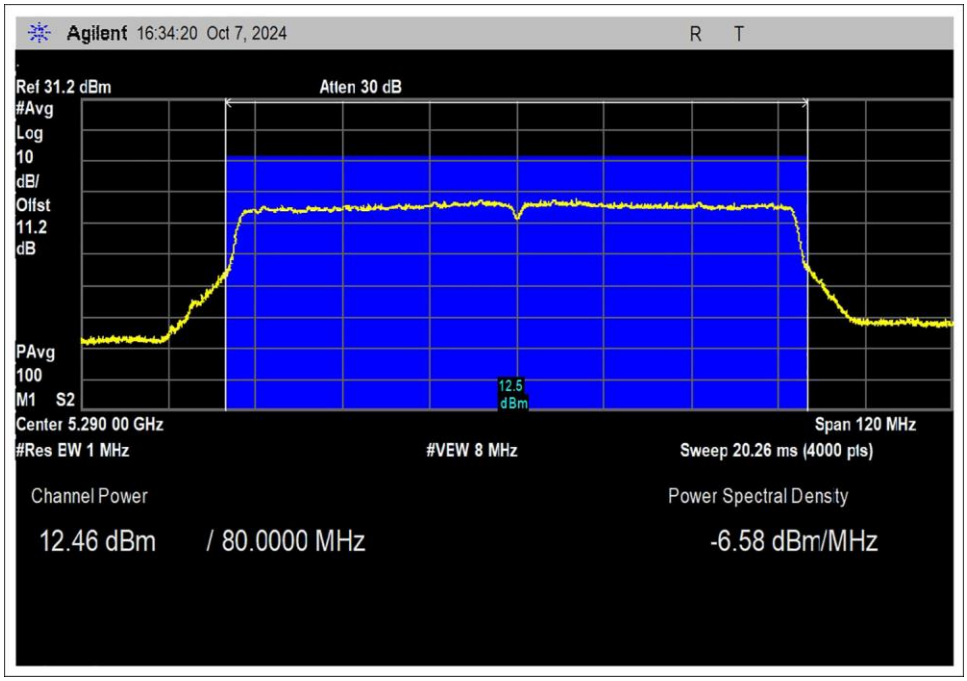
802.11n HT40, High Channel



802.11ac 40MHz, Low Channel

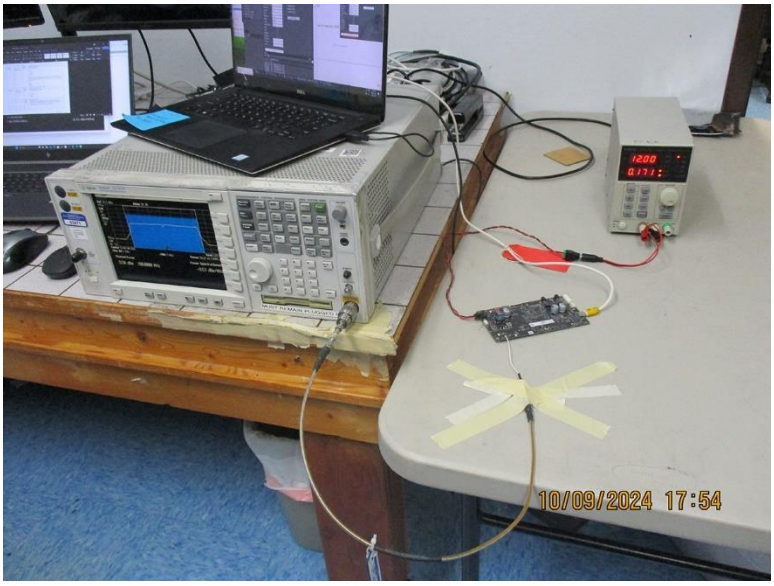


802.11ac 40MHz, High Channel



802.11ac 80MHz

Test Setup Photo(s)



Overall Test Setup

Test Setup, Closeup View

15.407(b) Radiated Emissions & Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc • 110 N. Olinda Place • Brea, CA • 714 993 6112		
Customer:	**Tonal**		
Specification:	**15.407(b) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**110825**	Date:	1/15/2025
Test Type:	**Radiated Scan**	Time:	09:24:20
Tested By:	E. Wong	Sequence#:	22
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Test Condition #1

Tx Freq:
802.11a: 5300MHz
802.11ac20: 5300MHz
802.11ac40: 5270MHz
802.11ac80: 5290MHz

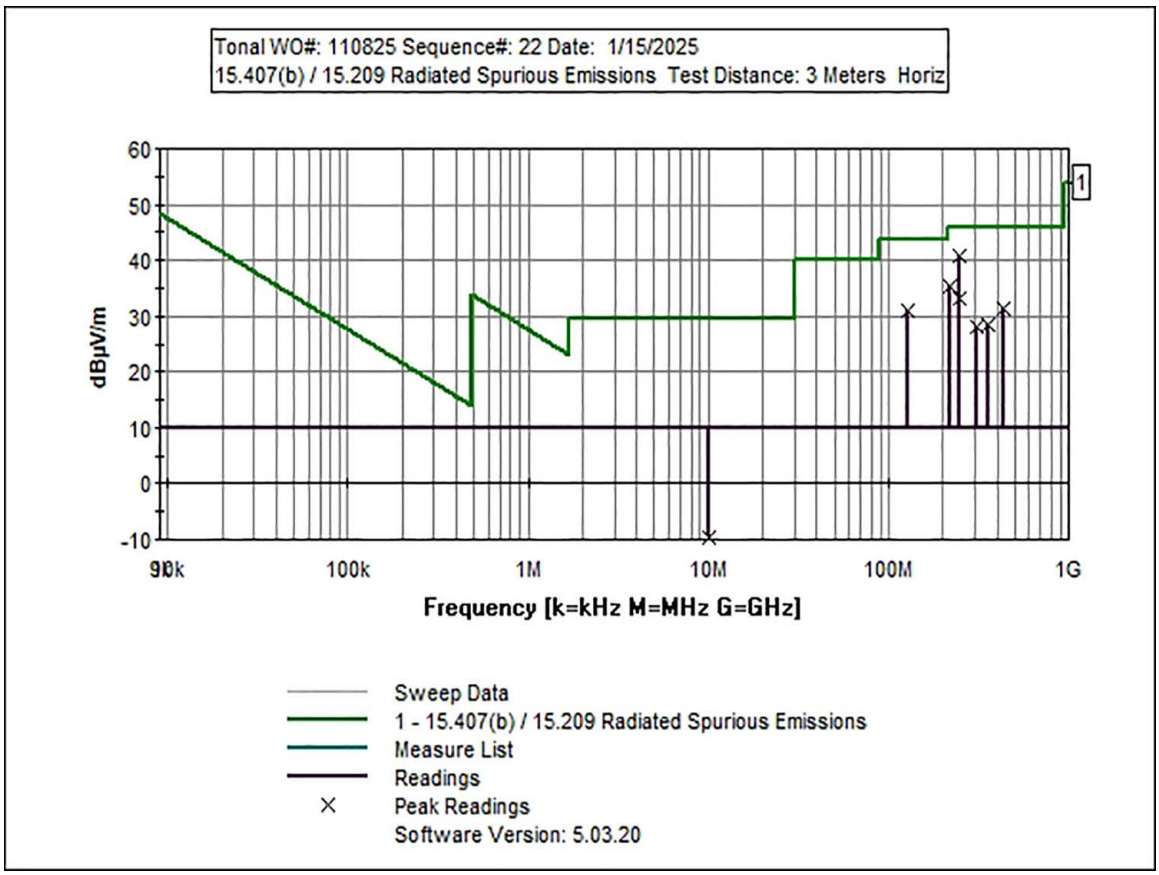
Frequency range of measurement = 9 kHz- 1 GHz.
9 kH -150 kHz;RBW=200 Hz,VBW=600 Hz;
150 kHz-30 MHz;RBW=9 kHz,VBW=27 kHz;
30 MHz-1000 MHz;RBW=120 kHz,VBW=360 kHz,

Worst case emission, no spurious emission found recorded data represent noise floor level or non-intentional emission of the device.

Test Environment Conditions:
Temperature: 20°C
Humidity: 34%
Pressure: 100kPa

Modification 1 (MOD1) was in place during testing:
Reduce RF output power to 12dBm in the software for 802.11n HT40 Chain 0.
Added a ferrite (Wurth: 742 712 21) on lower resistor wire. Green Resistor

Site D
ANSI C63.10-2020



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03834	Spectrum Analyzer	E4448A	5/6/2024	5/6/2026
T2	AN03628	Biconilog Antenna	CBL6111C	5/16/2024	5/16/2026
T3	ANP01911	Cable-Amplitude +15C to +45C (dB)	RG214/U	1/4/2024	1/4/2026
T4	ANP04382	Cable	LDF-50	6/4/2024	6/4/2026
T5	AN00010	Preamp	8447D	1/2/2024	1/2/2026
T6	ANP06985	Cable	Sucoflex 104A	9/12/2024	9/12/2026
T7	AN00314	Loop Antenna	6502	5/3/2024	5/3/2026

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2 T6	T3 T7	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	245.970M	45.9	+0.0 -26.5	+17.9 +0.2	+1.5 +0.0	+1.6	+0.0	40.6	46.0	-5.4	Horiz
2	220.020M	42.6	+0.0 -26.6	+16.5 +0.1	+1.4 +0.0	+1.5	+0.0	35.5	46.0	-10.5	Horiz
3	127.130M	42.4	+0.0 -27.0	+13.4 +0.1	+1.0 +0.0	+1.1	+0.0	31.0	43.5	-12.5	Vert
4	245.700M	38.3	+0.0 -26.5	+17.9 +0.2	+1.5 +0.0	+1.6	+0.0	33.0	46.0	-13.0	Vert
5	434.700M	31.6	+0.0 -27.6	+22.8 +0.2	+2.0 +0.0	+2.2	+0.0	31.2	46.0	-14.8	Vert
6	360.000M	30.3	+0.0 -27.0	+21.4 +0.2	+1.8 +0.0	+1.9	+0.0	28.6	46.0	-17.4	Horiz
7	312.000M	31.9	+0.0 -26.6	+19.0 +0.2	+1.7 +0.0	+1.8	+0.0	28.0	46.0	-18.0	Horiz
8	9.986M	21.2	+0.0 +0.0	+0.0 +0.0	+0.3 +8.7	+0.2	-40.0	-9.6	29.5	-39.1	Paral

Test Location:	CKC Laboratories, Inc • 110 N. Olinda Place • Brea, CA • 714 993 6112		
Customer:	**Tonal**		
Specification:	**15.407(b)(2) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**110825**	Date:	1/13/2025
Test Type:	**Radiated Scan**	Time:	14:12:42
Tested By:	E. Wong	Sequence#:	12
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Test condition #1

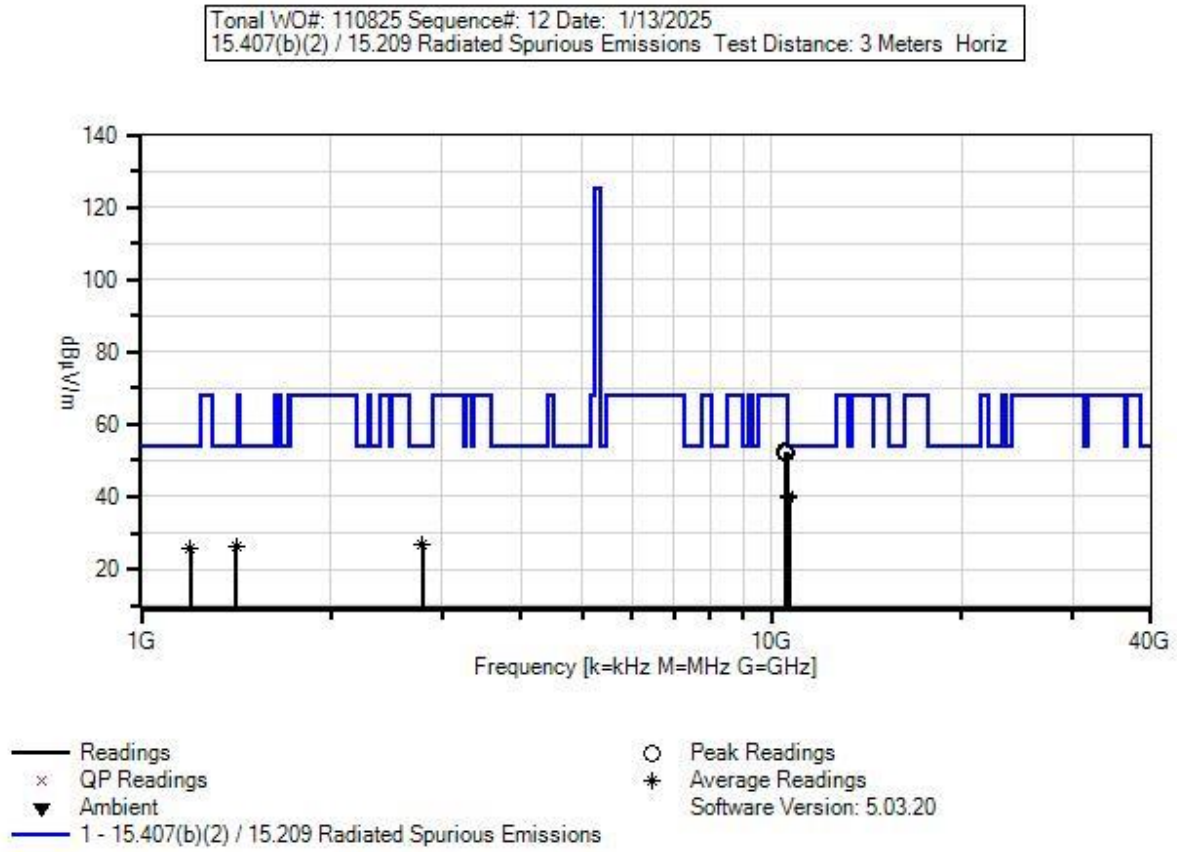
Frequency range of measurement = 1GHz- 40GHz.
1000 MHz- 40 000 MHz;RBW=1MHz,VBW=3 MHz.

Worst case emission, no spurious emission found recorded data represent noise floor level.

Test Environment Conditions:
Temperature: 20°C
Humidity: 34%
Pressure: 100kPa

Modification 1 (MOD1) was in place during testing:
Reduce RF output power to 12dBm in the software for 802.11n HT40 Chain 0.
Added a ferrite (Wurth: 742 712 21) on lower resistor wire. Green Resistor

Site D
ANSI C63.10-2020



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03834	Spectrum Analyzer	E4448A	5/6/2024	5/6/2026
T2	AN01646	Horn Antenna	3115	3/8/2024	3/8/2026
T3	ANP07660	Cable	32022-29094K-29094K-24TC	7/20/2024	7/20/2026
T4	AN00787	Preamp	83017A	6/27/2023	6/27/2025
T5	ANP04382	Cable	LDF-50	6/4/2024	6/4/2026
T6	ANP08191	Cable	ANDL1-PNMNM-50	11/11/2024	11/11/2026
T7	AN02755	High Pass Filter	11SH10-6000/T18000-O/O	2/23/2024	2/23/2026
	AN03367	Horn Antenna	62-GH-62-25.	8/10/2023	8/10/2025
	ANP08087	Cable	32022-29094K-29094K-120TC	12/1/2023	12/1/2025
	ANP08088	Cable	32022-29094K-29094K-120TC	12/1/2023	12/1/2025
	AN01413	Horn Antenna	84125-80008	10/15/2024	10/15/2026
	AN03158A	Horn Antenna	GH-28-25	7/17/2023	7/17/2025

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2 T6	T3 T7	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	10640.000 M Ave	18.3	+0.0 +13.5	+38.3 +7.6	+1.0 +0.4	-39.1	+0.0	40.0	54.0 802.11a_H	-14.0	Horiz
2	10640.000 M Ave	18.3	+0.0 +13.5	+38.3 +7.6	+1.0 +0.4	-39.1	+0.0	40.0	54.0 802.11ac20_H	-14.0	Horiz
^	10640.000 M	31.9	+0.0 +13.5	+38.3 +7.6	+1.0 +0.4	-39.1	+0.0	53.6	54.0 802.11a_H	-0.4	Horiz
^	10640.000 M	30.4	+0.0 +13.5	+38.3 +7.6	+1.0 +0.4	-39.1	+0.0	52.1	54.0 802.11ac20_H	-1.9	Horiz
5	10601.330 M Ave	18.2	+0.0 +13.5	+38.2 +7.5	+0.9 +0.4	-39.1	+0.0	39.6	54.0 802.11ac20_M	-14.4	Horiz
^	10601.330 M	31.4	+0.0 +13.5	+38.2 +7.5	+0.9 +0.4	-39.1	+0.0	52.8	54.0 802.11ac20_M	-1.2	Horiz
7	10620.000 M Ave	17.9	+0.0 +13.5	+38.3 +7.5	+1.0 +0.4	-39.1	+0.0	39.5	54.0 802.11ac40_H	-14.5	Horiz
^	10620.000 M	31.3	+0.0 +13.5	+38.3 +7.5	+1.0 +0.4	-39.1	+0.0	52.9	54.0 802.11ac40_H	-1.1	Horiz
9	10600.000 M Ave	18.2	+0.0 +13.5	+38.2 +7.5	+0.9 +0.3	-39.1	+0.0	39.5	54.0 802.11a_M	-14.5	Horiz
^	10600.000 M	31.6	+0.0 +13.5	+38.2 +7.5	+0.9 +0.3	-39.1	+0.0	52.9	54.0 802.11a_M	-1.1	Horiz
11	10520.000 M	31.3	+0.0 +13.4	+38.2 +7.5	+0.9 +0.4	-39.1	+0.0	52.6	68.2 802.11ac20_L	-15.6	Horiz
12	10580.000 M	30.9	+0.0 +13.5	+38.2 +7.5	+0.9 +0.3	-39.1	+0.0	52.2	68.2 802.11ac80_M	-16.0	Horiz
13	10540.000 M	30.9	+0.0 +13.4	+38.2 +7.5	+0.9 +0.4	-39.1	+0.0	52.2	68.2 802.11ac40_L	-16.0	Horiz
14	10520.000 M	30.7	+0.0 +13.4	+38.2 +7.5	+0.9 +0.4	-39.1	+0.0	52.0	68.2 802.11a_L	-16.2	Horiz

15	2790.500M	27.5	+0.0	+28.9	+0.4	-39.8	+0.0	26.6	54.0	-27.4	Horiz
	Ave		+5.9	+3.7	+0.0				802.11a_L		
^	2790.500M	49.4	+0.0	+28.9	+0.4	-39.8	+0.0	48.5	54.0	-5.5	Horiz
			+5.9	+3.7	+0.0				802.11a_L		
17	1417.000M	33.8	+0.0	+25.4	+0.3	-40.0	+0.0	26.1	54.0	-27.9	Horiz
	Ave		+4.1	+2.5	+0.0				802.11a_L		
^	1417.000M	51.6	+0.0	+25.4	+0.3	-40.0	+0.0	43.9	54.0	-10.1	Horiz
			+4.1	+2.5	+0.0				802.11a_L		
19	1198.750M	34.7	+0.0	+25.1	+0.3	-40.5	+0.0	25.7	54.0	-28.3	Horiz
	Ave		+3.8	+2.3	+0.0				802.11a_H		
^	1198.750M	57.1	+0.0	+25.1	+0.3	-40.5	+0.0	48.1	54.0	-5.9	Horiz
			+3.8	+2.3	+0.0				802.11a_H		

Band Edge

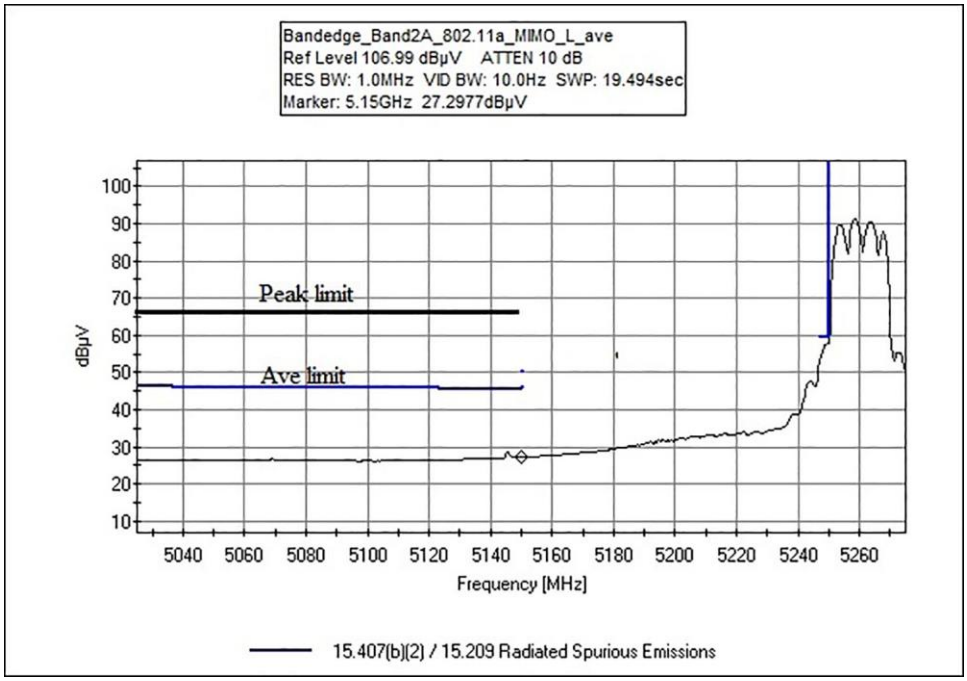
Band Edge Summary							
Frequency (MHz)	Modulation	Ant. Type / Gain (dBi)	Average (dBuV/m @3m)		Peak (dBuV/m @3m)		Results
			Measured	Limit	Measured	Limit	
5150*	802.11a 18Mbps	Ext 4.66	35.7	≤54	49.4	≤ 68.2, 74	Pass
5350*	802.11a 18Mbps	Ext 4.66	44.6	≤54	60.3	≤ 68.2, 74	Pass
5150*	802.11n HT20 MCS2	Ext 4.66	35.3	≤54	48.4	≤ 68.2, 74	Pass
5350*	802.11n HT20 MCS2	Ext 4.66	45.2	≤54	62.3	≤ 68.2, 74	Pass
5150*	802.11ac 20MHz MCS2	Ext 4.66	35.5	≤54	47.9	≤ 68.2, 74	Pass
5350*	802.11ac 20MHz MCS2	Ext 4.66	43.9	≤54	57.9	≤ 68.2, 74	Pass
5150*	802.11n HT40 MCS0	Ext 4.66	36.0	≤54	60.0	≤ 68.2, 74	Pass
5350*	802.11n HT40 MCS0	Ext 4.66	49.8	≤54	64.9	≤ 68.2, 74	Pass
5150*	802.11ac 40MHz MCS0	Ext 4.66	35.8	≤54	60.1	≤ 68.2, 74	Pass
5350*	802.11ac 40MHzMCS0	Ext 4.66	49.5	≤54	65.3	≤ 68.2, 74	Pass
5150*	802.11ac 80MHz MCS1	Ext 4.66	34.8	≤54	49.2	≤ 68.2, 74	Pass
5350*	802.11ac 80MHz MCS1	Ext 4.66	48.2	≤54	65.2	≤ 68.2, 74	Pass

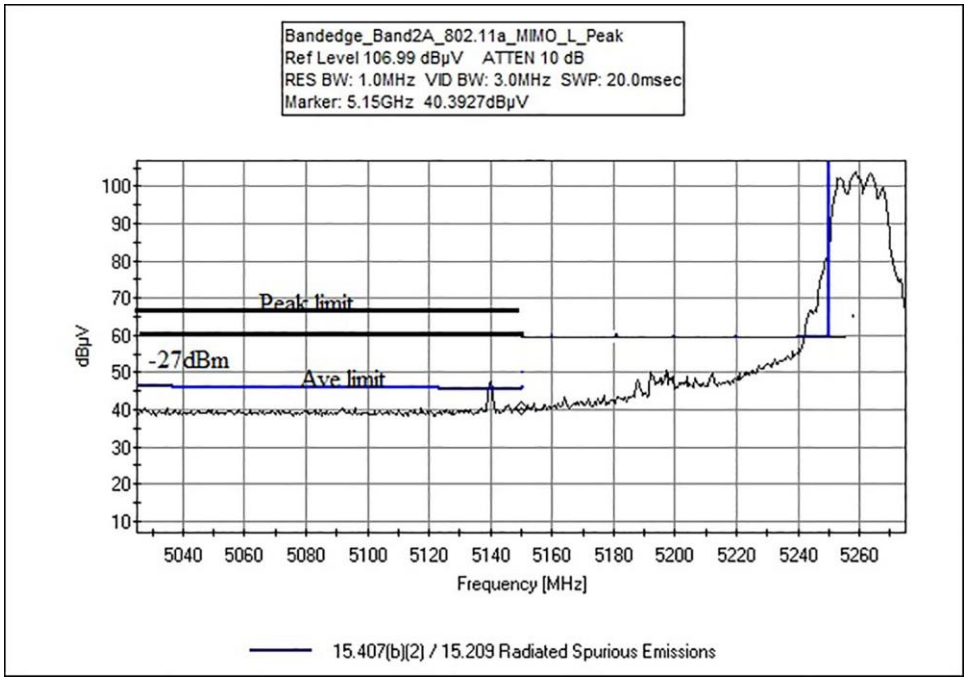
*Restricted band edge

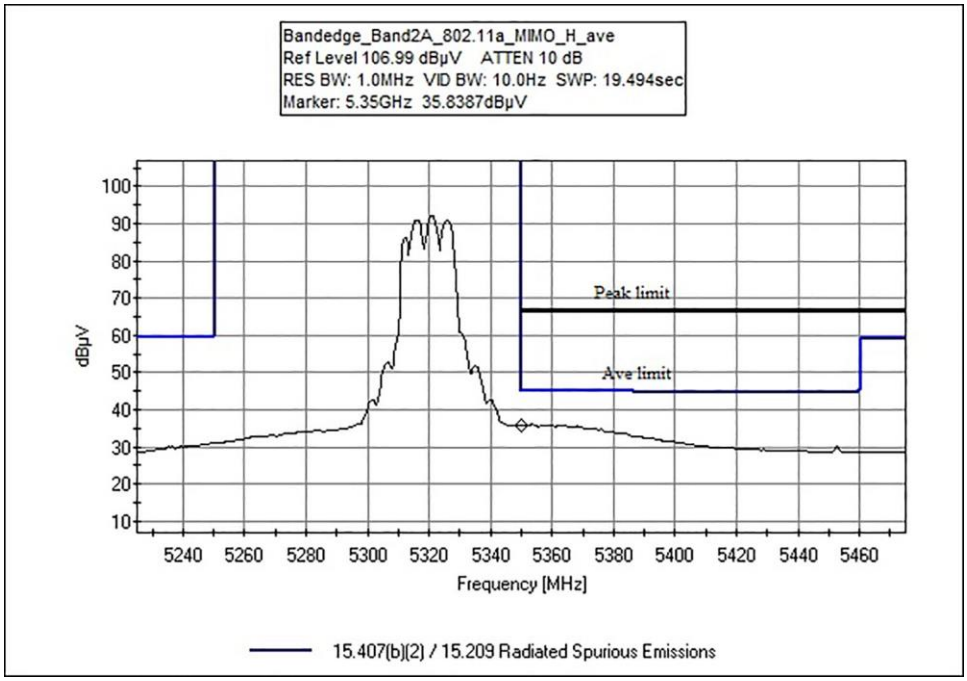
15.407(b)(2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
-27dBm/MHz = 68.2dBuV/m@3m

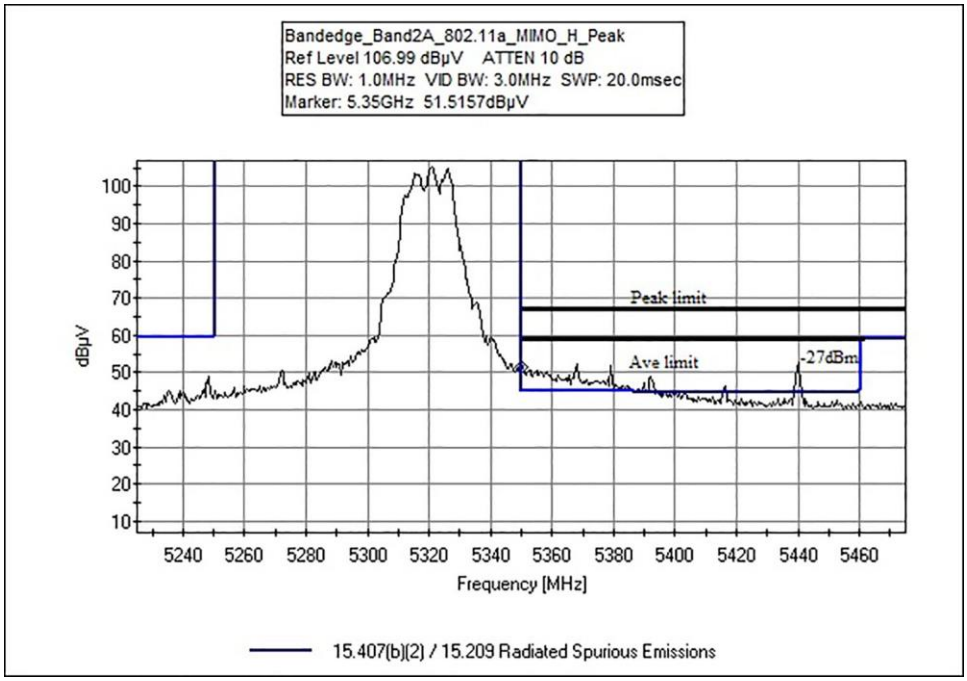
Band Edge Plots

802.11a






Bandedge_Band2A_802.11a_MIMO_H_ave
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 19.494sec
Marker: 5.35GHz 35.8387dBµV
dBµV
Peak limit
Ave limit
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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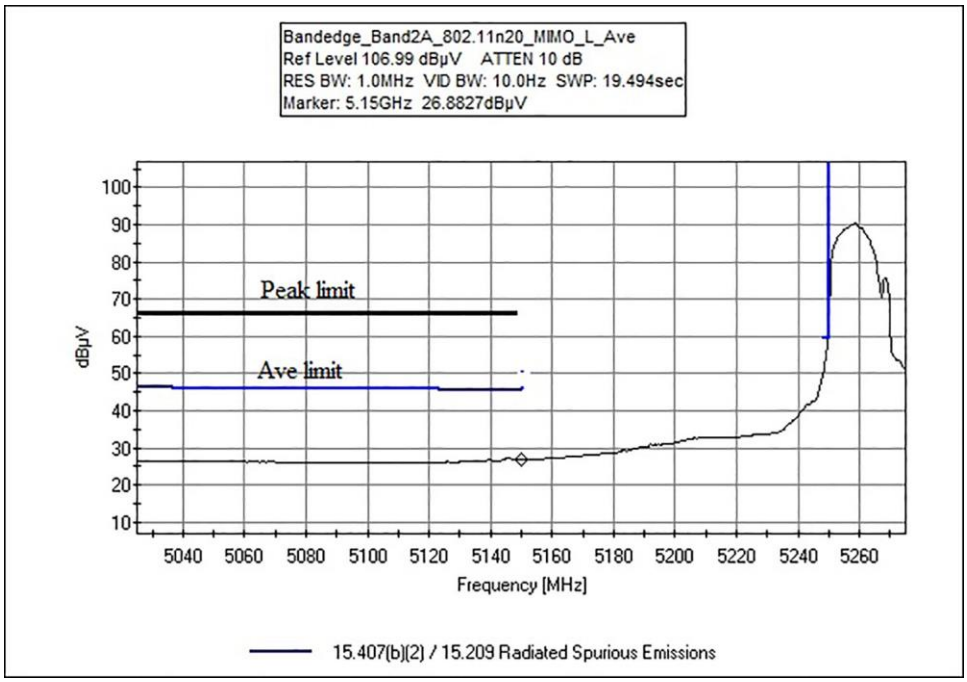
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.35GHz 51.5157dBµV
dBµV
Peak limit
Ave limit
-27dBm
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions

802.11n20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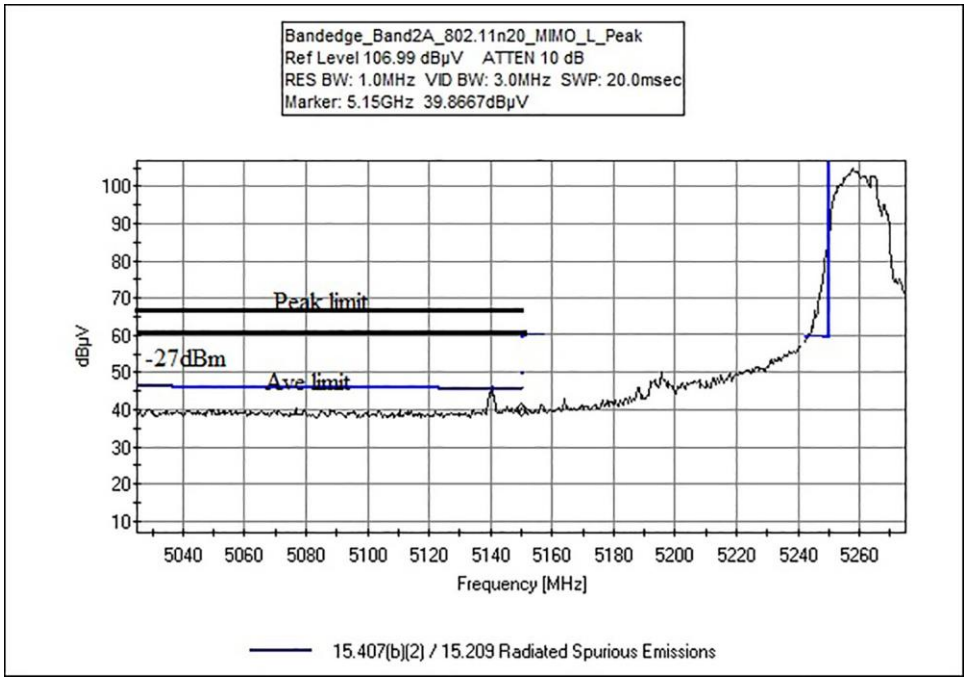
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 19.494sec
Marker: 5.15GHz 26.8827dBµV
Peak limit
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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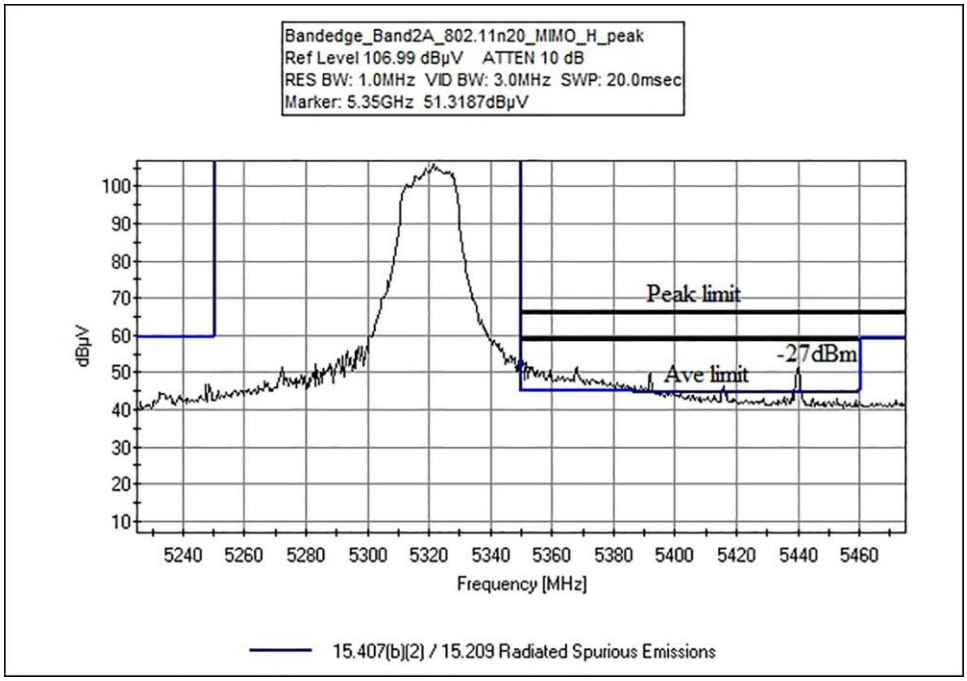
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.15GHz 39.8667dBµV
Peak limit
-27dBm
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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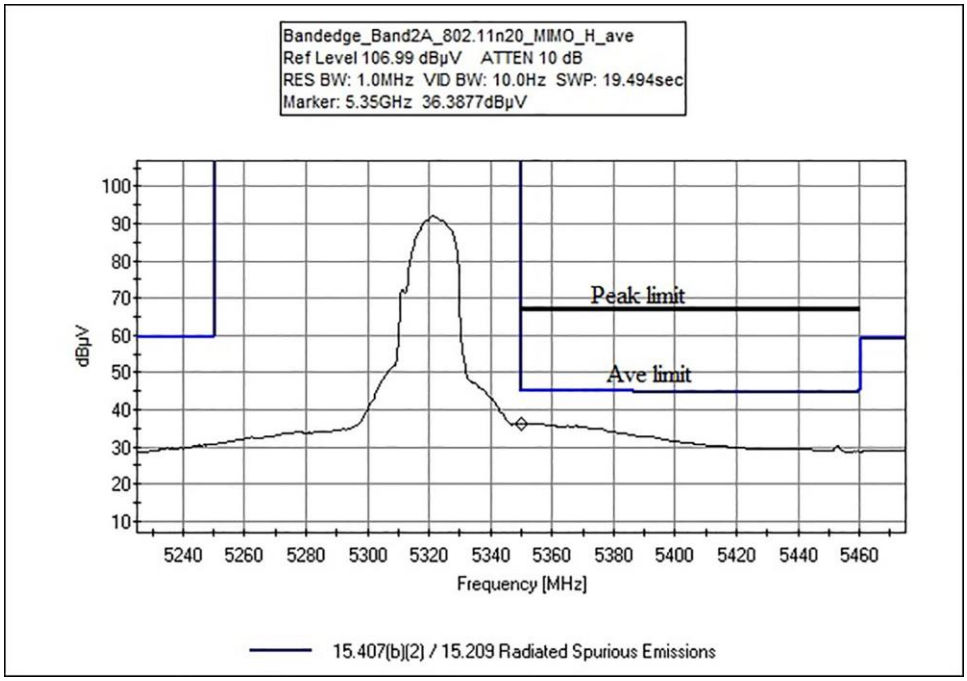
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.35GHz 51.3187dBµV
dBµV
Peak limit
-27dBm
Ave limit
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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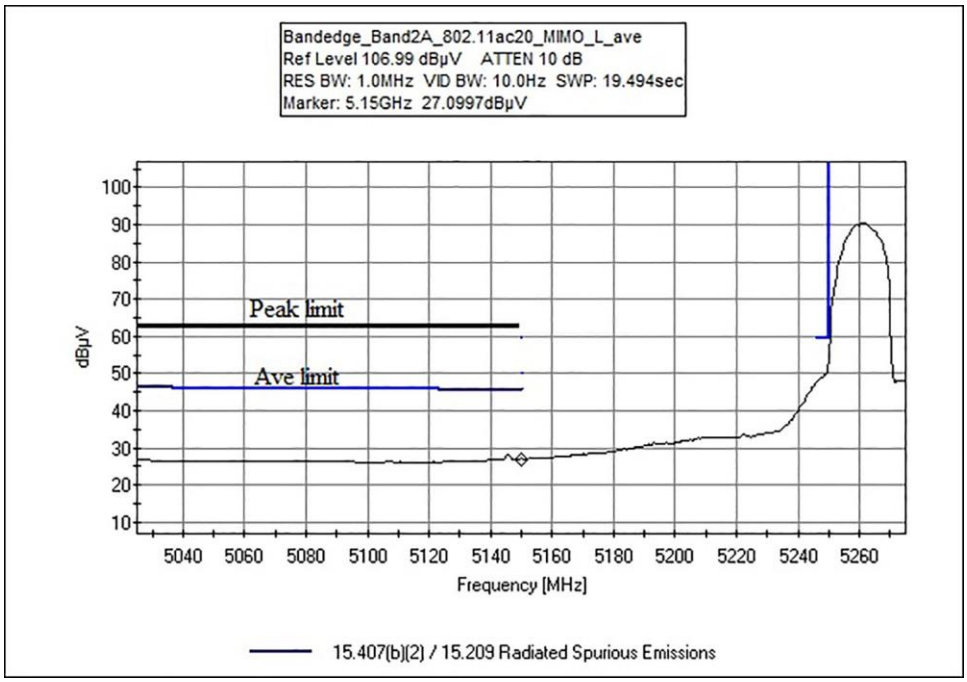
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 19.494sec
Marker: 5.35GHz 36.3877dBµV
dBµV
Peak limit
Ave limit
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions

802.11ac20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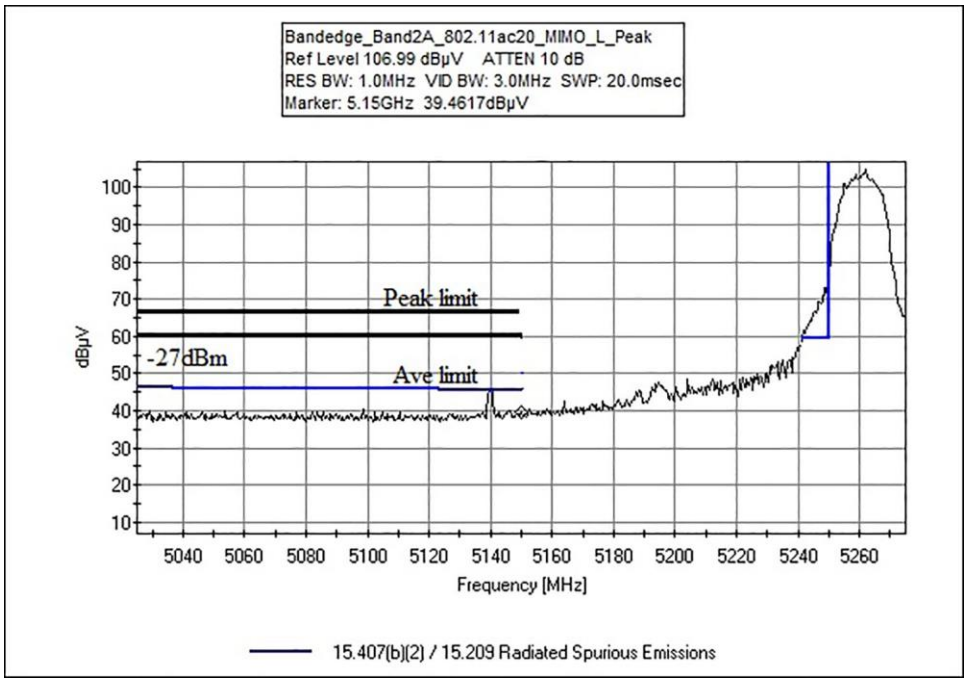
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 19.494sec
Marker: 5.15GHz 27.0997dBµV
dBµV
Peak limit
Ave limit
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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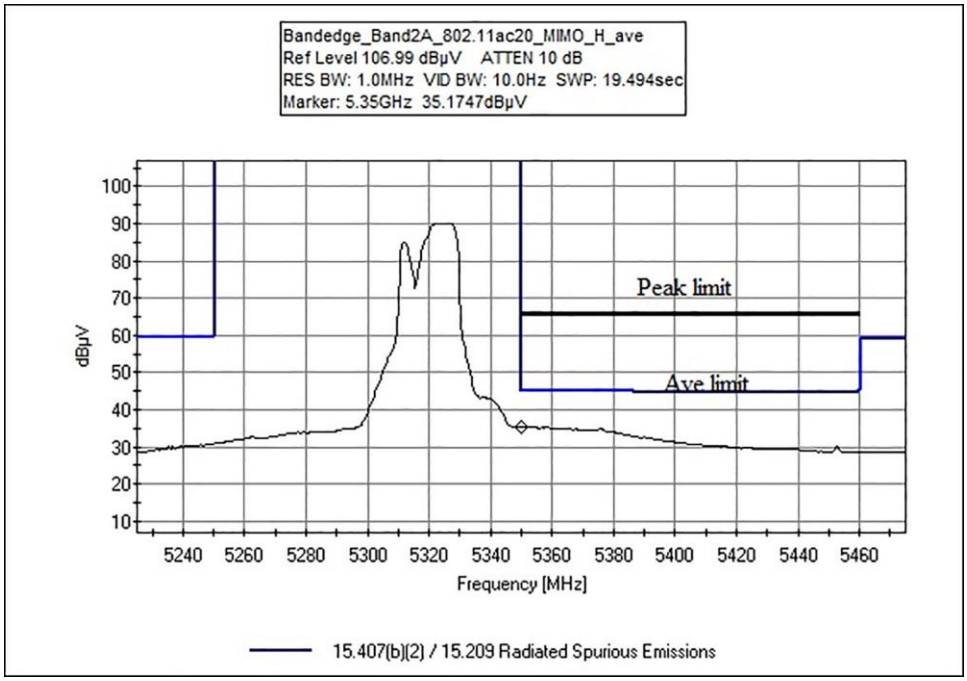
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.15GHz 39.4617dBµV
dBµV
Peak limit
-27dBm
Ave limit
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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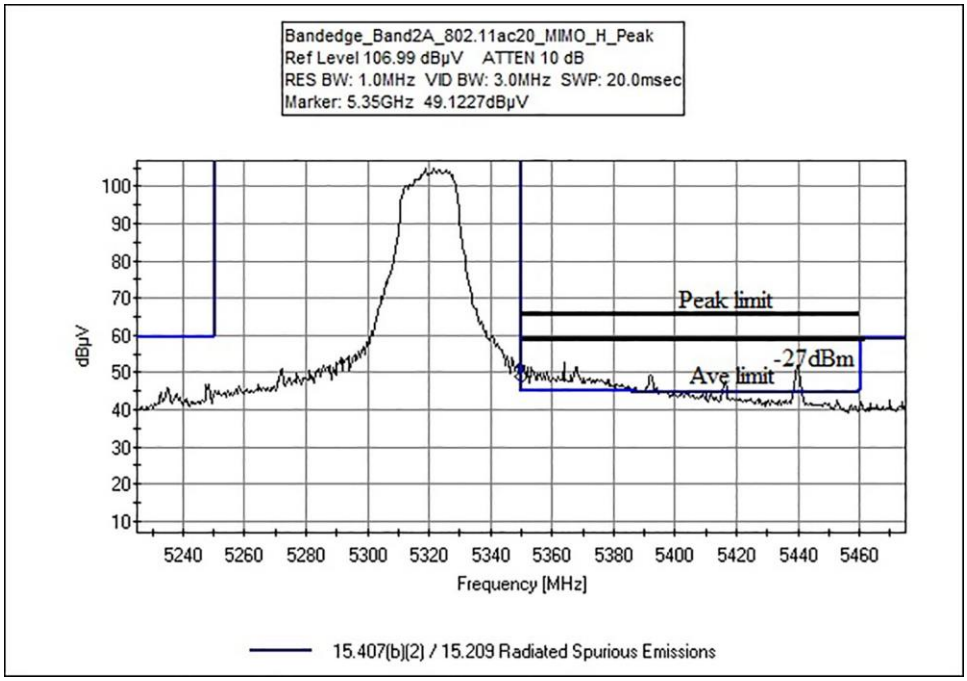
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 19.494sec
Marker: 5.35GHz 35.1747dBµV
Peak limit
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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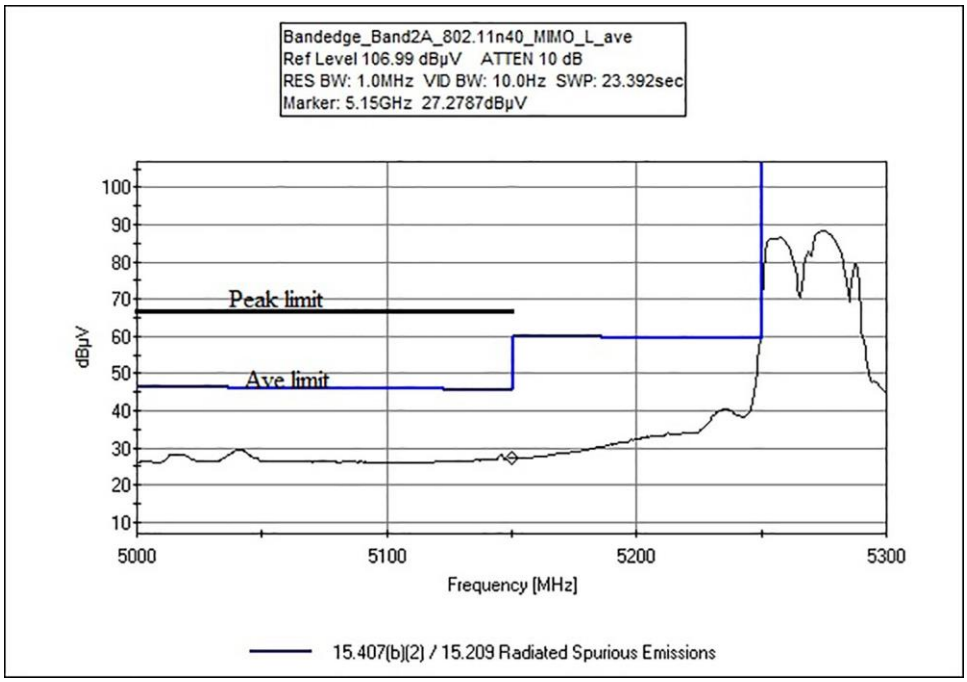
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.35GHz 49.1227dBµV
Peak limit
-27dBm
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions

802.11n40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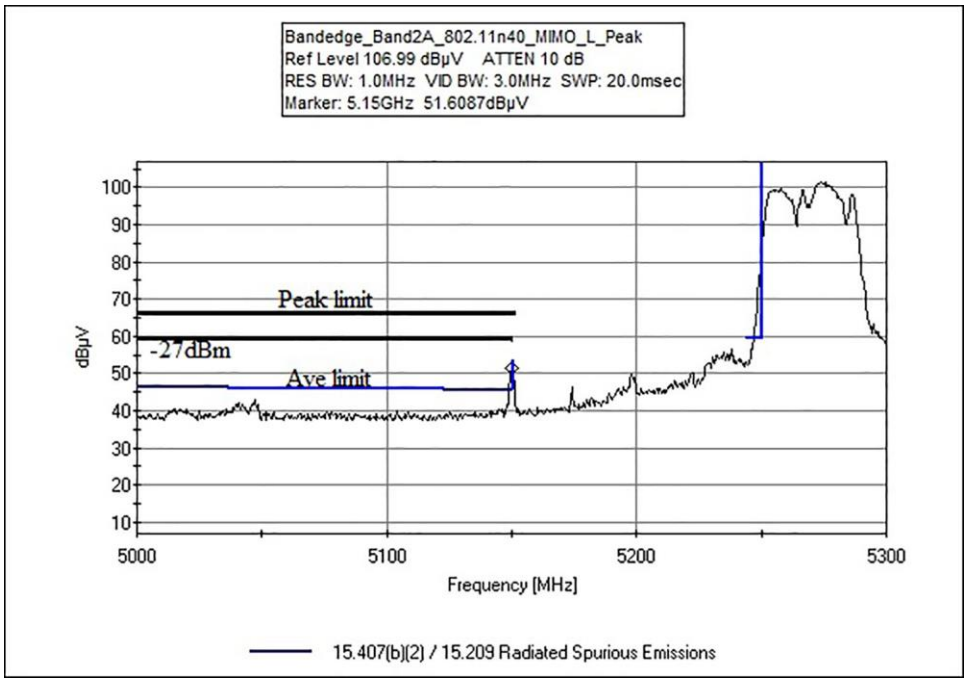
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 23.392sec
Marker: 5.15GHz 27.2787dBµV
Peak limit
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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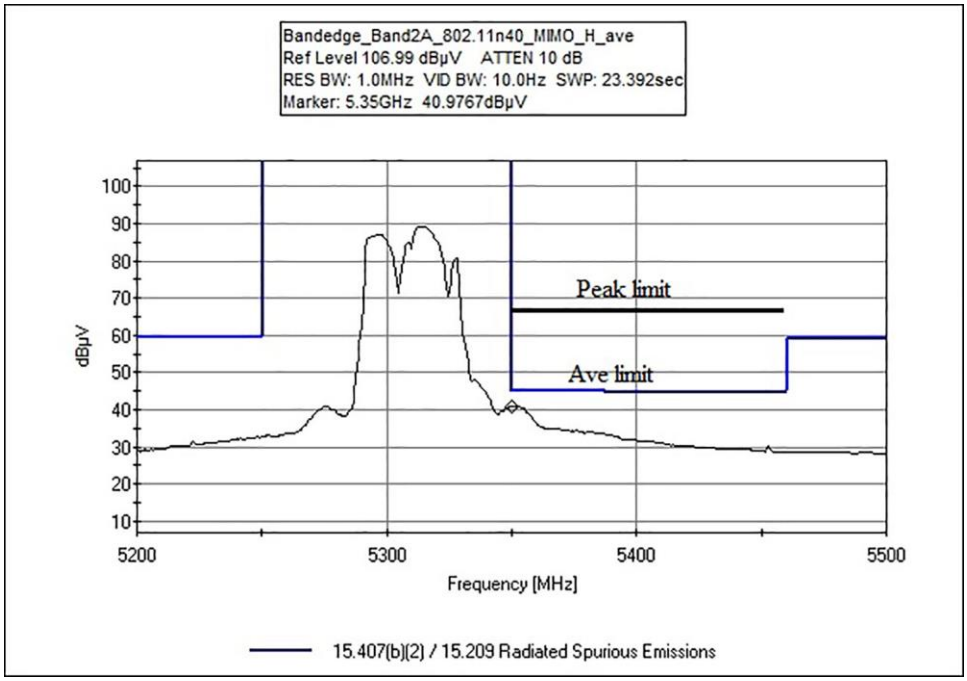
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.15GHz 51.6087dBµV
Peak limit
-27dBm
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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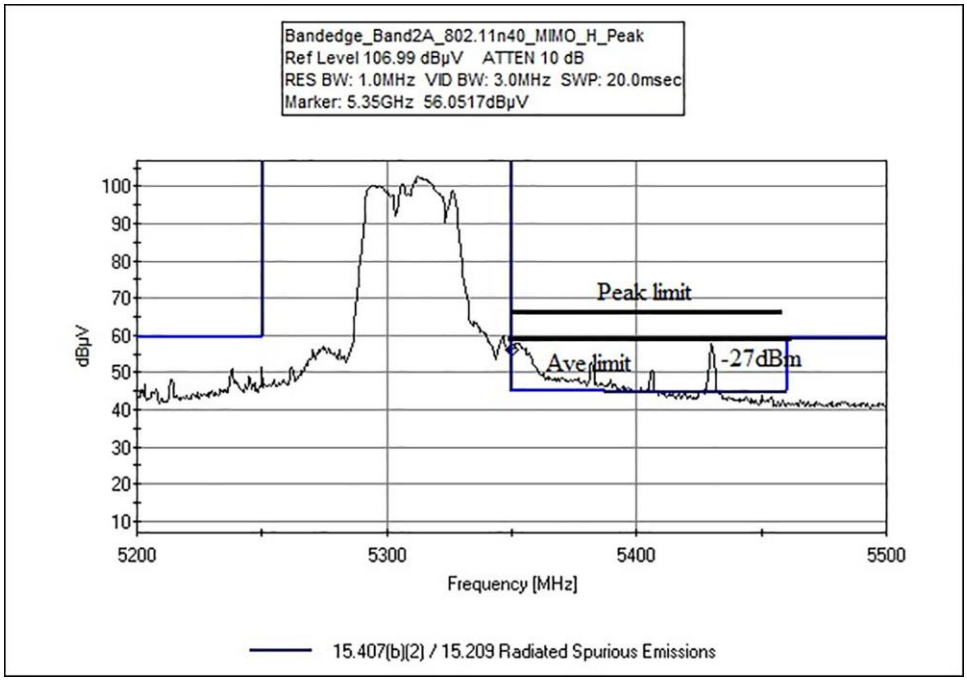
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 23.392sec
Marker: 5.35GHz 40.9767dBµV
dBµV
Peak limit
Ave limit
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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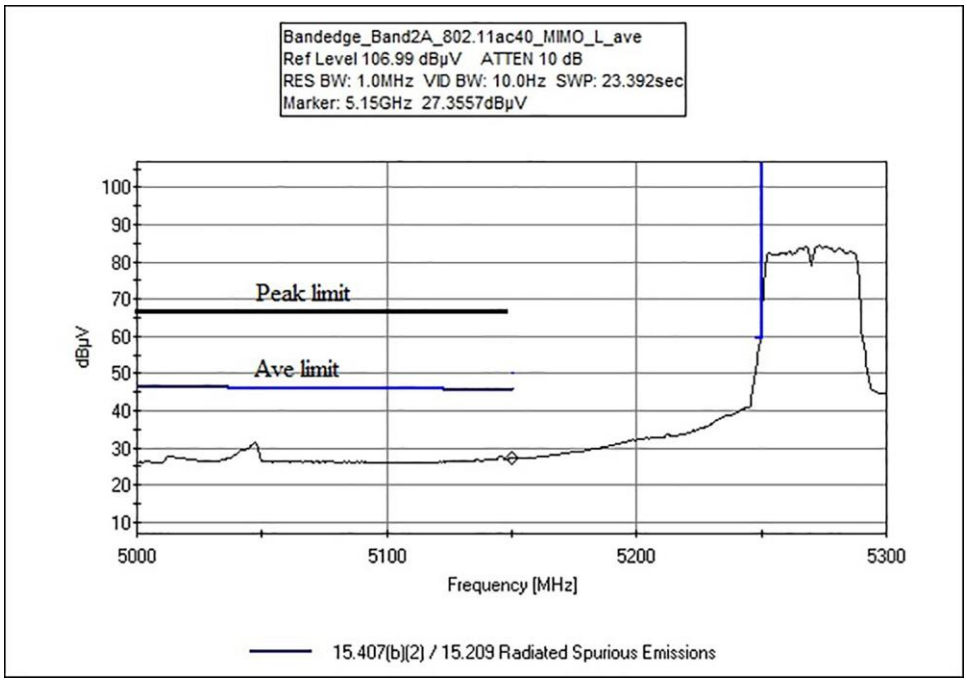
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.35GHz 56.0517dBµV
dBµV
Peak limit
Ave limit
-27dBm
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions

802.11ac40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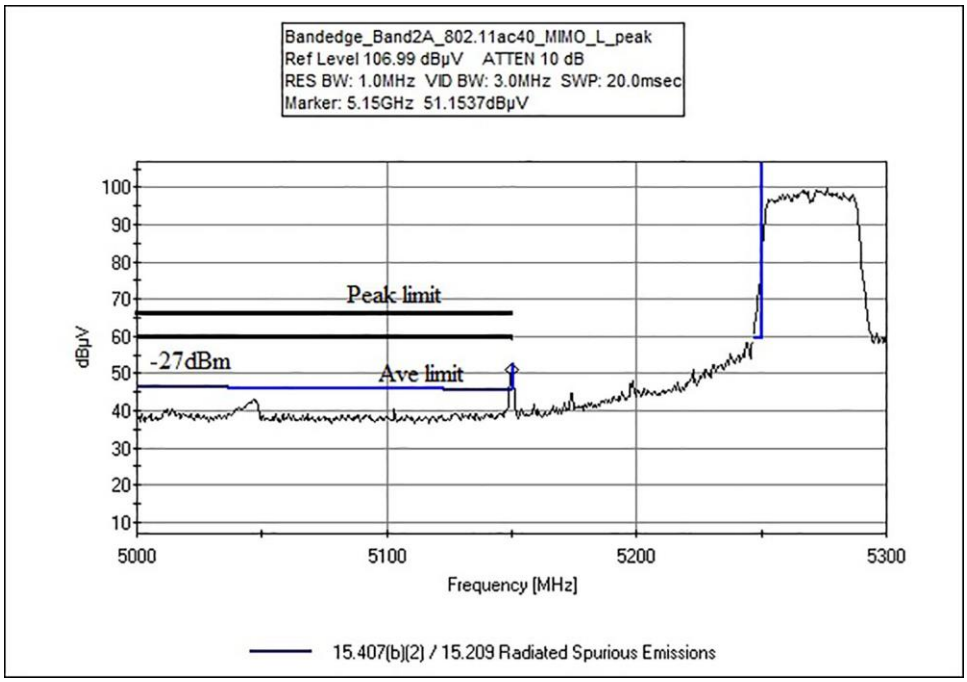
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 23.392sec
Marker: 5.15GHz 27.3557dBµV
Peak limit
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions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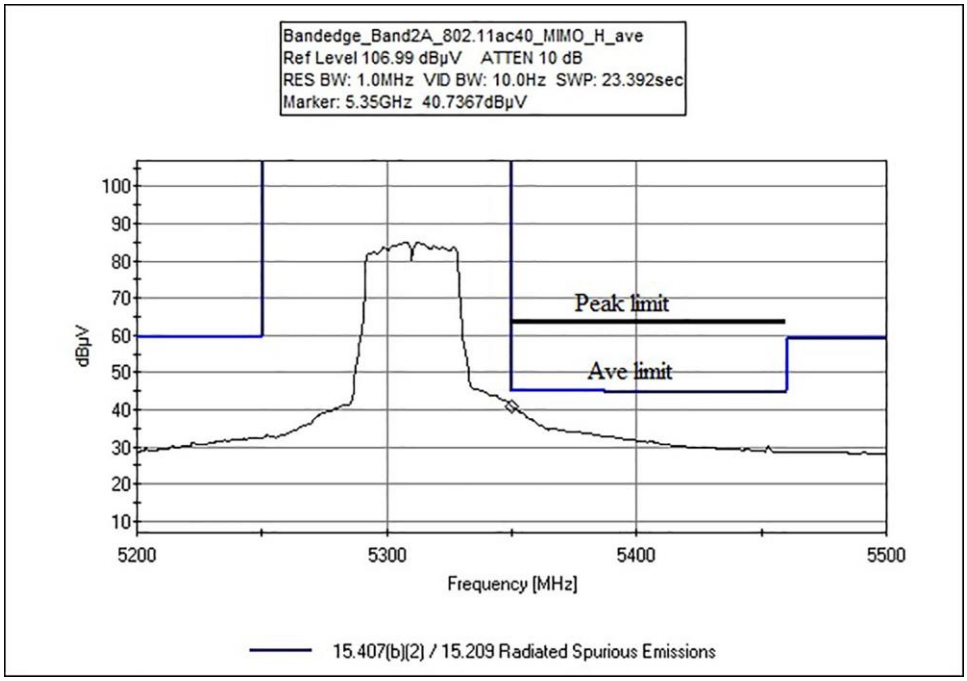
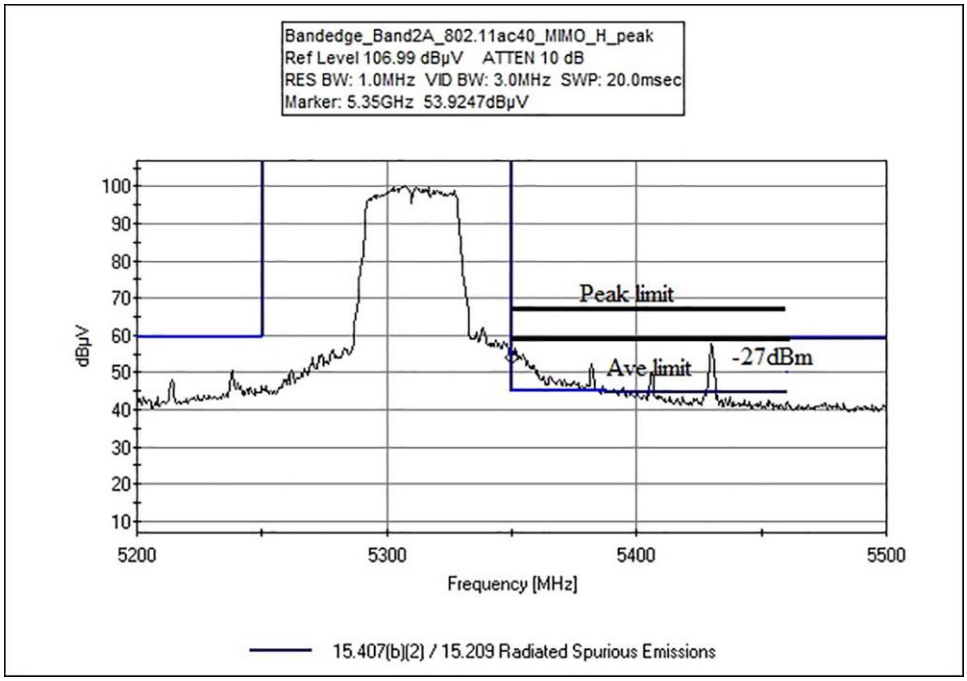
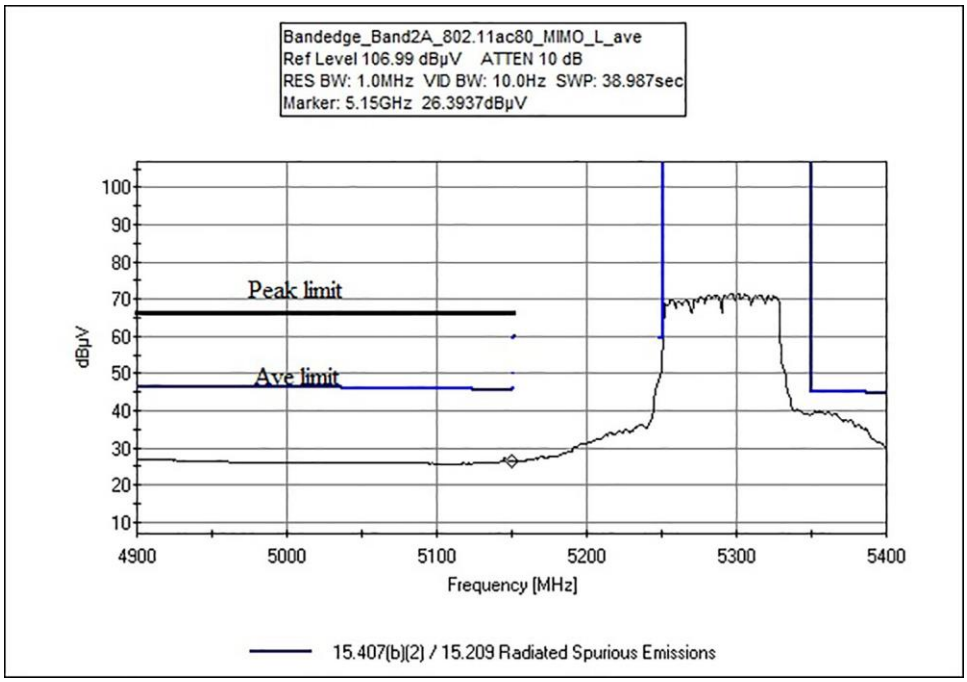
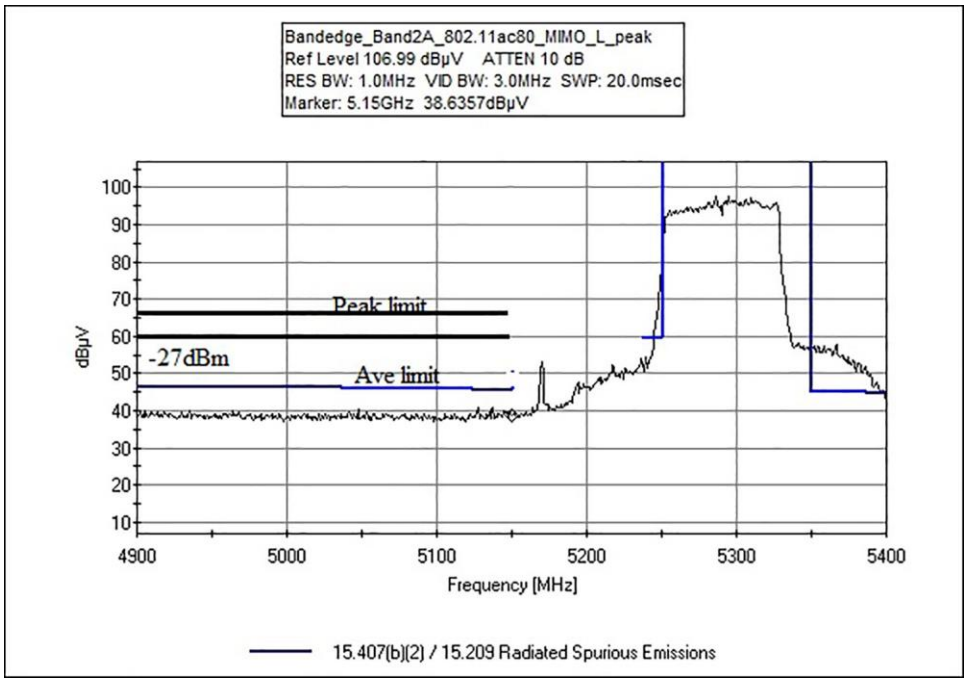
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.15GHz 51.1537dBµV
Peak limit
-27dBm
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions

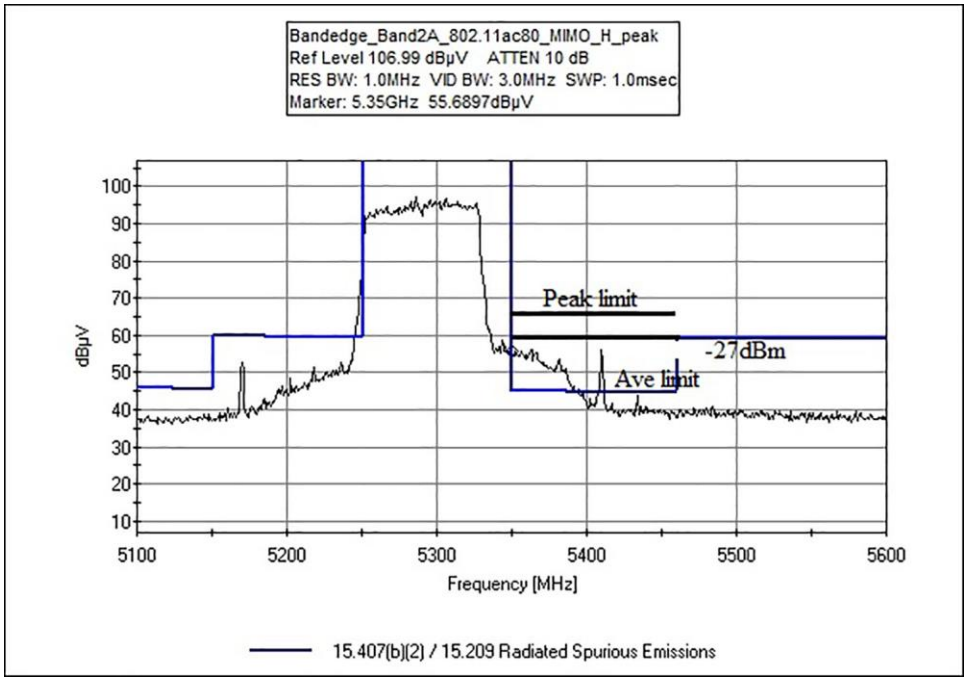

Bandedge_Band2A_802.11ac40_MIMO_H_ave
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 23.392sec
Marker: 5.35GHz 40.7367dBµV
dBµV
Peak limit
Ave limit
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions


Bandedge_Band2A_802.11ac40_MIMO_H_peak
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.35GHz 53.9247dBµV
dBµV
Peak limit
Ave limit
-27dBm
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions

802.11ac80


Bandedge_Band2A_802.11ac80_MIMO_L_ave
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 10.0Hz SWP: 38.987sec
Marker: 5.15GHz 26.3937dBµV
Peak limit
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions


Bandedge_Band2A_802.11ac80_MIMO_L_peak
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 20.0msec
Marker: 5.15GHz 38.6357dBµV
Peak limit
-27dBm
Ave limit
dBµV
Frequency [MHz]
15.407(b)(2) / 15.209 Radiated Spurious Emissions


Bandedge_Band2A_802.11ac80_MIMO_H_peak
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 3.0MHz SWP: 1.0msec
Marker: 5.35GHz 55.6897dBµV
dBµV
100
90
80
70
60
50
40
30
20
10
5100
5200
5300
5400
5500
5600
Frequency [MHz]
Peak limit
-27dBm
Ave limit
15.407(b)(2) / 15.209 Radiated Spurious Emissions

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc • 110 N. Olinda Place • Brea, CA • 714 993 6112		
Customer:	**Tonal**		
Specification:	**15.407(b)(2) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**110825**	Date:	1/7/2025
Test Type:	**Radiated Scan**	Time:	14:08:07
Tested By:	E. Wong	Sequence#:	2
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Test Condition #1

Frequency range of measurement = Band Edge
RBW=1MHz,VBW=3 MHz.

Test Environment Conditions:
Temperature: 20°C
Humidity: 34%
Pressure: 100kPa

Modification 1 (MOD1) was in place during testing:
Reduce RF output power to 12dBm in the software for 802.11n HT40 Chain 0.
Added a ferrite (Wurth: 742 712 21) on lower resistor wire. Green Resistor

Site D
ANSI C63.10-2020

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03834	Spectrum Analyzer	E4448A	5/6/2024	5/6/2026
T2	AN01646	Horn Antenna	3115	3/8/2024	3/8/2026
T3	ANP07660	Cable	32022-29094K-29094K-24TC	7/20/2024	7/20/2026
T4	AN00787	Preamp	83017A	6/27/2023	6/27/2025
T5	ANP04382	Cable	LDF-50	6/4/2024	6/4/2026
T6	ANP08191	Cable	ANDL1-PNMNM-50	11/11/2024	11/11/2026

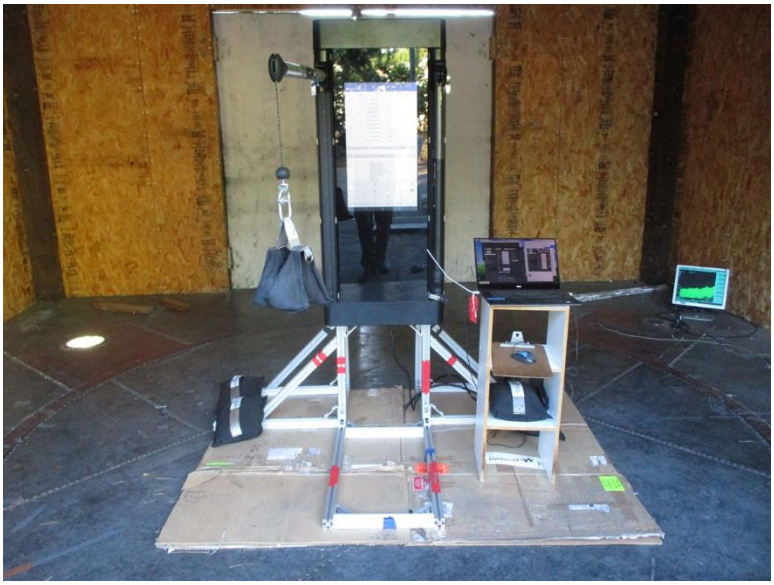
Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2 T6	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	5350.000M Ave	39.4	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	48.2	54.0 802.11ac80_Bandedge_H	-5.8	Horiz
2	5350.000M Ave	35.8	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	44.6	54.0 802.11a_Bandedge_H	-9.4	Horiz
^	5350.000M	56.5	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	65.3	54.0 802.11ac40_Bandedge_H	+11.3	Horiz
^	5350.000M	56.4	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	65.2	54.0 802.11ac80_Bandedge_H	+11.2	Horiz
^	5350.000M	56.1	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	64.9	54.0 802.11n40_Bandedge_H	+10.9	Horiz
^	5350.000M	53.5	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	62.3	54.0 802.11n20_Bandedge_H	+8.3	Horiz
^	5350.000M	51.5	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	60.3	54.0 802.11a_Bandedge_H	+6.3	Horiz
^	5350.000M	49.1	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	57.9	54.0 802.11ac20_Bandedge_H	+3.9	Horiz
^	5350.000M	41.0	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	49.8	54.0 802.11n40_Bandedge_H	-4.2	Horiz
^	5350.000M	40.7	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	49.5	54.0 802.11ac40_Bandedge_H	-4.5	Horiz
^	5350.000M	36.4	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	45.2	54.0 802.11n20_Bandedge_H	-8.8	Horiz
^	5350.000M	35.1	+0.0 +8.7	+34.0 +5.0	+0.6	-39.5	+0.0	43.9	54.0 802.11ac20_Bandedge_H	-10.1	Horiz
13	5410.417M Ave	30.8	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	39.9	54.0 802.11ac80	-14.1	Horiz
^	5410.417M	56.1	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	65.2	54.0 802.11ac80	+11.2	Horiz

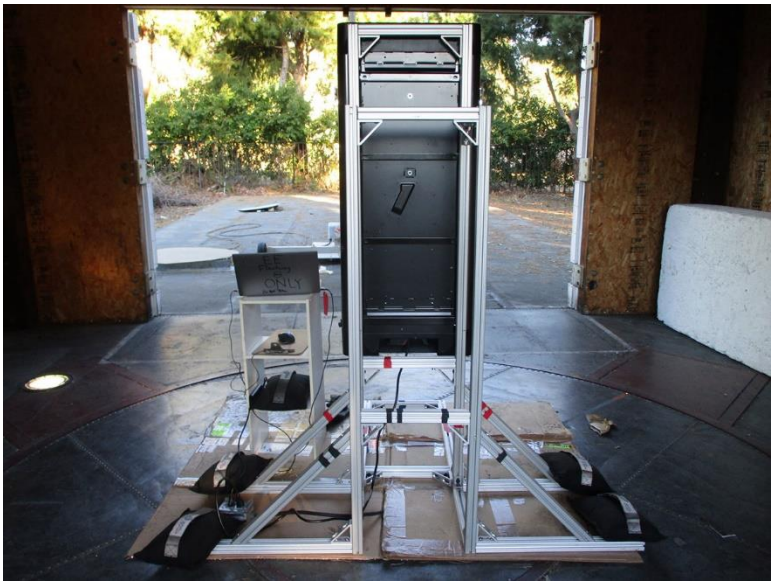
15	5430.000M Ave	30.6	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	39.7	54.0 802.11ac40	-14.3	Horiz
^	5430.000M	56.8	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	65.9	54.0 802.11ac40	+11.9	Horiz
17	5429.500M Ave	29.5	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	38.6	54.0 802.11n40	-15.4	Horiz
^	5429.500M	56.8	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	65.9	54.0 802.11n40	+11.9	Horiz
19	5440.000M Ave	29.3	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	38.4	54.0 802.11n20	-15.6	Horiz
20	5440.000M Ave	29.2	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	38.3	54.0 802.11ac20	-15.7	Horiz
^	5440.000M	52.6	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	61.7	54.0 802.11n20	+7.7	Horiz
^	5440.000M	52.2	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	61.3	54.0 802.11ac20	+7.3	Horiz
23	5440.833M Ave	28.2	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	37.3	54.0 802.11a	-16.7	Horiz
^	5440.833M	45.8	+0.0 +8.8	+34.1 +5.0	+0.6	-39.4	+0.0	54.9	54.0 802.11a	+0.9	Horiz
25	5150.000M Ave	27.6	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	36.0	54.0 802.11n40_Bandedge_L	-18.0	Horiz
26	5150.000M Ave	27.4	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	35.8	54.0 802.11ac40_Bandedge_L	-18.2	Horiz
27	5150.000M Ave	27.3	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	35.7	54.0 802.11a_Bandedge_L	-18.3	Horiz
28	5150.000M Ave	27.1	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	35.5	54.0 802.11ac20_Bandedge_L	-18.5	Horiz
29	5150.000M Ave	26.9	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	35.3	54.0 802.11n20_Bandedge_L	-18.7	Horiz
30	5140.000M Ave	26.7	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	35.1	54.0 802.11a	-18.9	Horiz
^	5140.000M	46.5	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	54.9	54.0 802.11a	+0.9	Horiz

32	5150.000M Ave	26.4	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	34.8	54.0	-19.2	802.11ac80_Bandedge_L	Horiz
^	5150.000M	51.7	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	60.1	54.0	+6.1	802.11ac40_Bandedge_L	Horiz
^	5150.000M	51.6	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	60.0	54.0	+6.0	802.11n40_Bandedge_L	Horiz
^	5150.000M	41.0	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	49.4	54.0	-4.6	802.11a_Bandedge_L	Horiz
^	5150.000M	40.8	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	49.2	54.0	-4.8	802.11ac80_Bandedge_L	Horiz
^	5150.000M	40.0	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	48.4	54.0	-5.6	802.11n20_Bandedge_L	Horiz
^	5150.000M	39.5	+0.0 +8.6	+33.7 +5.0	+0.6	-39.5	+0.0	47.9	54.0	-6.1	802.11ac20_Bandedge_L	Horiz
39	5534.500M Ave	37.7	+0.0 +8.9	+34.0 +5.0	+0.6	-39.4	+0.0	46.8	68.2	-21.4	802.11n40	Horiz
^	5534.500M	49.8	+0.0 +8.9	+34.0 +5.0	+0.6	-39.4	+0.0	58.9	68.2	-9.3	802.11n40	Horiz
41	5532.833M Ave	36.1	+0.0 +8.9	+34.0 +5.0	+0.6	-39.4	+0.0	45.2	68.2	-23.0	802.11ac40	Horiz
^	5532.833M	47.2	+0.0 +8.9	+34.0 +5.0	+0.6	-39.4	+0.0	56.3	68.2	-11.9	802.11ac40	Horiz

Test Setup Photo(s)



Below 1GHz, View 1



Below 1GHz, View 2

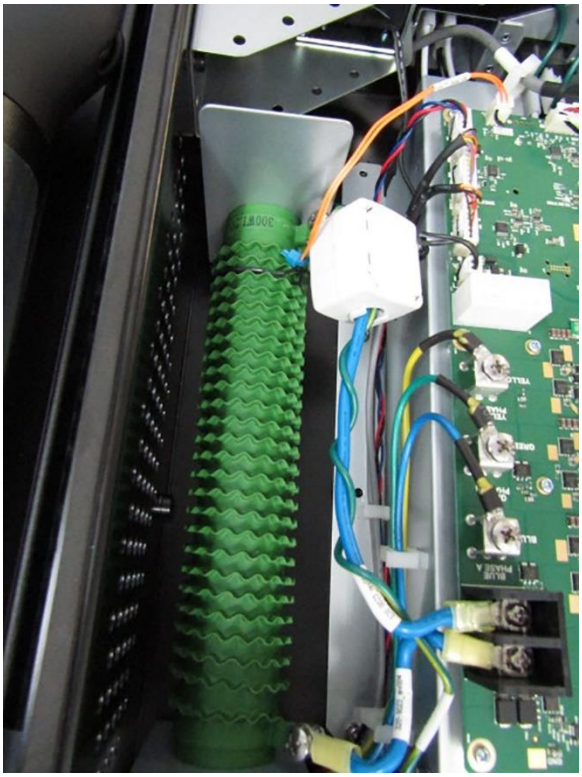
Above 1GHz, View 1

Above 1GHz, View 2

APPENDIX A: MODIFICATIONS MADE DURING TESTING

Modification 1 (MOD1)
Reduce RF output power to 12dBm in the software for 802.11n HT40 Chain 0
Added a ferrite (Wurth: 742 712 21) on lower resistor wire
Green Resistor

Test Setup Photo(s)



Supplemental Information

Measurement Uncertainty

Uncertainty Value	Parameter
5.77 dB	Radiated Emissions
0.673 dB	RF Conducted Measurements
5.77 x 10^{-10}	Frequency Deviation
0.00005 s	Time Deviation
3.18 dB	Mains Conducted Emissions

Uncertainties reported are worst case for all CKC Laboratories' sites and represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2. Compliance is deemed to occur provided measurements are below the specified limits.

Emissions Test Details

TESTING PARAMETERS

Unless otherwise indicated, the following configuration parameters are used for equipment setup: The cables were routed consistent with the typical application by varying the configuration of the test sample. Interface cables were connected to the available ports of the test unit. The effect of varying the position of the cables was investigated to find the configuration that produced maximum emissions. Cables were of the type and length specified in the individual requirements. The length of cable that produced maximum emissions was selected.

The equipment under test (EUT) was set up in a manner that represented its normal use, as shown in the setup photographs. Any special conditions required for the EUT to operate normally are identified in the comments that accompany the emissions tables.

The emissions data was taken with a spectrum analyzer or receiver. Incorporating the applicable correction factors for distance, antenna, cable loss and amplifier gain, the data was reduced as shown in the table below. The corrected data was then compared to the applicable emission limits. Preliminary and final measurements were taken in order to ensure that all emissions from the EUT were found and maximized.

CORRECTION FACTORS

The basic spectrum analyzer reading was converted using correction factors as shown in the highest emissions readings in the tables. For radiated emissions in dBµV/m, the spectrum analyzer reading in dBµV was corrected by using the following formula. This reading was then compared to the applicable specification limit. Individual measurements were compared with the displayed limit value in the margin column. The margin was calculated based on subtracting the limit value from the corrected measurement value; a positive margin represents a measurement exceeding the limit, while a negative margin represents a measurement less than the limit.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB/m)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dBµV/m)

TEST INSTRUMENTATION AND ANALYZER SETTINGS

The test instrumentation and equipment listed were used to collect the emissions data. A spectrum analyzer or receiver was used for all measurements. Unless otherwise specified, the following table shows the measuring equipment bandwidth settings that were used in designated frequency bands. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	9 kHz	150 kHz	200 Hz
RADIATED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	30 MHz	1000 MHz	120 kHz
RADIATED EMISSIONS	1000 MHz	>1 GHz	1 MHz

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

The notes that accompany the measurements contained in the emissions tables indicate the type of detector function used to obtain the given readings. Unless otherwise noted, all readings were made in the "positive peak" detector mode. Whenever a "quasi-peak" or "average" reading was recorded, the measurement was annotated with a "QP" or an "Ave" on the appropriate rows of the data sheets. In cases where quasi-peak or average limits were employed and data exists for multiple measurement types for the same frequency then the peak measurement was retained in the report for reference, however the numbering for the affected row was removed and an arrow or caret ("^") was placed in the far left-hand column indicating that the row above takes precedence for comparison to the limit. The following paragraphs describe in more detail the detector functions and when they were used to obtain the emissions data.

Peak

In this mode, the spectrum analyzer or receiver recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature called "peak hold," the measurement device had the ability to measure intermittent or low duty cycle transient emission peak levels. In this mode the measuring device made a slow scan across the frequency band selected and measured the peak emission value found at each frequency across the band.

Quasi-Peak

Quasi-peak measurements were taken using the quasi-peak detector when the true peak values exceeded or were within 2 dB of a quasi-peak specification limit. Additional QP measurements may have been taken at the discretion of the operator.

Average

Average measurements were taken using the average detector when the true peak values exceeded or were within 2 dB of an average specification limit. Additional average measurements may have been taken at the discretion of the operator. If the specification or test procedure requires trace averaging, then the averaging was performed using 100 samples or as required by the specification. All other average measurements are performed using video bandwidth averaging. To make these measurements, the test engineer reduces the video bandwidth on the measuring device until the modulation of the signal is filtered out. At this point, the measuring device is set into the linear mode and the scan time is reduced.

End of Report