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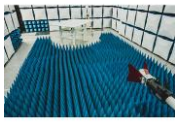

MEASUREMENT REPORT
FCC PART 15.407 / ISED RSS-247 UNII 802.11a/n/ac

Applicant Name:
Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:
6/30/2022-10/20/2022
Test Site/Location:
Element Materials Technology Morgan Hill, CA, USA
Test Report Serial No.:
1C2206300045-03.BCG

FCC ID:	**BCGA2825**
IC:	**579C-A2825**
APPLICANT:	**Apple Inc.**

Application Type:	Certification
Model/HVIN:	A2825
EUT Type:	Smart Speaker
Frequency Range:	5180 – 5825MHz
Modulation Type:	OFDM
FCC Classification:	Unlicensed National Information Infrastructure (UNII)
FCC Rule Part(s):	Part 15 Subpart E (15.407)
ISED Specification:	RSS-247 Issue 2
Test Procedure(s):	ANSI C63.10-2013, KDB 789033 D02 v02r01

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013 and KDB 789033 D02 v02r01. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RJ Ortanez
Executive Vice President

ACCREDITED
CERT #2041.02

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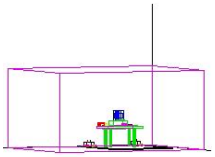
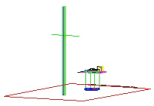


MEASUREMENT REPORT



UNII Band	Channel Bandwidth (MHz)	Mode	Tx Frequency (MHz)	Conducted Power	
				Max. Power (mW)	Max Power (dBm)
1	20	802.11a/n	5180 - 5240	43.15	16.35
2A		802.11a/n	5260 - 5320	43.85	16.42
2C		802.11a/n	5500 - 5720	44.57	16.49
3		802.11a/n	5745 - 5825	31.48	14.98
1	80	802.11ac	5210	6.24	7.95
3		802.11ac	5775	6.12	7.87

FCC EUT Overview (Low Data Rate)

UNII Band	Channel Bandwidth (MHz)	Mode	Tx Frequency (MHz)	Conducted Power	
				Max. Power (mW)	Max Power (dBm)
1	20	802.11a/n	5180 - 5240	22.18	13.46
2A		802.11a/n	5260 - 5320	43.85	16.42
2C		802.11a/n	5500 - 5720	44.57	16.49
3		802.11a/n	5745 - 5825	31.48	14.98
1	80	802.11ac	5210	6.24	7.95
3		802.11ac	5775	6.12	7.87

ISED EUT Overview (Low Data Rate)

UNII Band	Channel Bandwidth (MHz)	Mode	Tx Frequency (MHz)	Conducted Power	
				Max. Power (mW)	Max Power (dBm)
1	20	802.11n	5180 - 5240	28.18	14.50
2A		802.11n	5260 - 5320	27.86	14.45
2C		802.11n	5500 - 5720	28.18	14.50
3		802.11n	5745 - 5825	27.61	14.41
1	80	802.11ac	5210	6.18	7.91
3		802.11ac	5775	5.96	7.75

FCC EUT Overview (High Data Rate)

UNII Band	Channel Bandwidth (MHz)	Mode	Tx Frequency (MHz)	Conducted Power	
				Max. Power (mW)	Max Power (dBm)
1	20	802.11n	5180 - 5240	22.08	13.44
2A		802.11n	5260 - 5320	27.86	14.45
2C		802.11n	5500 - 5720	28.18	14.50
3		802.11n	5745 - 5825	27.61	14.41
1	80	802.11ac	5210	6.18	7.91
3		802.11ac	5775	5.96	7.75

ISED EUT Overview (High Data Rate)

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 Element Materials Technology Morgan Hill Test Location

These measurement tests were conducted at the Element Materials Technology Morgan Hill facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at Element Materials Technology located in Morgan Hill, CA 95037, U.S.A.

- Element Materials Technology Morgan Hill is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- Element Washington DC LLC TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- Element Materials Technology Morgan Hill facility is a registered (22831) test laboratory with the site description on file with ISED.

- Element Materials Technology Morgan Hill is a Recognized U.S. Certification Assessment Body (CAB # US0110) for ISED Canada as designated by NIST under the U.S. and Canada Mutual Recognition Agreements (MRAs).

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Smart Speaker FCC ID: BCGA2825** and **IC: 579C-A2825**. The test data contained in this report pertains only to the emissions due to the EUT's UNII transmitter.

Test Device Serial No.: KC6NJW0211, HG37PD75JJ, GY9YGK3GVM, NPWWYNHGTV

2.2 Device Capabilities

This device contains the following capabilities:

802.11b/g/n WLAN, 802.11a/n/ac UNII Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8), UWB, 802.15.4

Band 1		Band 2A		Band 2C		Band 3	
Ch.	**Frequency (MHz)**	**Ch.**	**Frequency (MHz)**	**Ch.**	**Frequency (MHz)**	**Ch.**	**Frequency (MHz)**
36	5180	52	5260	100	5500	149	5745
:	:	:	:	:	:	:	:
42	5210	56	5280	116	5580	157	5785
:	:	:	:	:	:	:	:
48	5240	64	5320	144	5720	165	5825

Table 2-1. 802.11a / 802.11n (20MHz) Frequency / Channel Operations

Band 1		Band 3	
Ch.	**Frequency (MHz)**	**Ch.**	**Frequency (MHz)**
42	5210	155	5775

Table 2-2. 802.11ac (80MHz BW) Frequency / Channel Operations

Notes:

1. 5GHz NII operation is possible in 20MHz and 80MHz channel bandwidths. The maximum achievable duty cycles for all modes were determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz, and detector = peak per the guidance of Section B)2)b) KDB 789033 D02 v02r01 and ANSI C63.10-2013. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

Measured Duty Cycles		
802.11 Mode/Band		**Duty Cycle [%]**
5GHz	a	98.5
	n (HT20 Low Rate)	98.7
	n (HT20 High Rate)	74.0
	ac (HT80 Low Rate)	97.3
	ac (HT80 High Rate)	52.6

Table 2-3. Measured Duty Cycles

Data Rate(s) Tested: 6, 9, 12, 18, 24, 36, 48, 54Mbps (802.11a)

6.5/7.2, 13/14.4, 19.5/21.7, 26/28.9, 39/43.3, 52/57.8, 58.5/65, 65/72.2 (n – 20MHz)

29.3/32.5, 58.5/65, 87.8/97.5, 117/130, 175.5/195, 234/260, 263.3/292.5, 292.5/325, 351/390, 390/433.3 (ac – 80MHz BW)

2. This device supports simultaneous transmission operations, which allows for multiple transmitters to transmit simultaneously on the same antenna. The table below shows the configuration possible.

Simultaneous Tx Config	Bluetooth	UNII
	BDR, EDR, LE1M/2M, HDR4/8	802.11a/n/ac
Config 1	✓	✓

Table 2-4. Simultaneous Transmission Configurations

✓= Support; × = NOT Support

2.3 Antenna Description

Following antenna gains provided by manufacturer were used for the testing.

Frequency [GHz]	Antenna Gain (dBi)
5.150 – 5.250	5.1
5.250 – 5.350	5.8
5.470 – 5.725	4.3
5.725 – 5.850	3.8

Table 2-5. Highest Antenna Gain

2.4 Test Support Equipment

1	Apple Macbook	Model:	A2289	S/N:	C02DV7VGMD6T
	w/ AD/DC Adapter	Model:	A2164	S/N:	N/A
2	USB-C Cable	Model:	N/A	S/N:	N/A
3	Gordo Cable	Model:	N/A	S/N:	10282A

Table 2-6. Test Support Equipment List

2.5 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013 and KDB 789033 D02 v02r01. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for AC line conducted emissions test setups, 3.3 for radiated emissions test setups, and 7.2, 7.3, 7.4, and 7.5 for antenna port conducted emissions test setups.

For emissions from 1GHz – 18GHz, low, mid, and high channels were tested with highest power and worst case configuration. The emissions below 1GHz and above 18GHz were tested with the highest transmitting power and the worst case channel.

The EUT was manipulated through two orthogonal planes of X-orientation (flatbed) and Y-orientation (landscape) during the testing. Only the worst case emissions were reported in this test report.

For AC line conducted and radiated test below 1GHz, following configuration were investigated reported.

- EUT powered by AC Power Cable

All possible simultaneous transmission configurations have been investigated and the worst case config has been reported.

Description	Bluetooth	UNII
Channel	78	40
Operating Frequency (MHz)	2480	5200
Mode/Modulation	GFSK - ePA	MCS0

Table 2-7. Worst Case Simultaneous Transmission Configuration

The data rates have been classified into two different groups; low data rate and high data rate. Both groups of data rate have been investigated and only the worst case data rate per group is reported. The worst case data rate for each group per mode are as follows:

- 802.11a:
  - Low Data Rate: 6Mbps
- 802.11n HT20:
  - Low Data Rate: MCS0 (SISO)
  - High Data Rate: MCS7 (SISO)
- 802.11ac VHT80:
  - Low Data Rate: MCS0
  - High Data Rate: MCS7

2.6 Software and Firmware

The test was conducted with firmware version 20J373 installed on the EUT.

2.7 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 789033 D02 v02r01 were used in the measurement of the EUT**.**

Deviation from measurement procedure……..…….....None

3.2 AC Line Conducted Emissions

The line-conducted facility is located inside a 7m x 3.66m x 2.7m shielded enclosure. The shielded enclosure is manufactured by AP Americas. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-6. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50µH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. The external power line filter is EPCOS 2X60A Power Line Filter (100dB Attenuation, 14kHz-18GHz) and the two EPCOs 2X48A filters (100dB Minimum Insertion Loss, 14kHz - 10GHz). These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference ground plane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions is used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

Line conducted emissions test results are shown in Section 7.8. Automated test software was used to perform the AC line conducted emissions testing. Automated measurement software utilized is Rohde & Schwarz EMC32, Version 10.50.40.

3.3 Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. An 80cm tall test table made of Styrodur is placed on top of the turn table. For measurements above 1GHz, an additional Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

Per KDB 414788, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30MHz if characterized so that the measurements correspond to those obtained at an open-field test site. To determine test site equivalency, a reference sample transmitting at 149kHz was measured on an open field test site (asphalt with no ground plane) and then measured in the 3m semi-anechoic chamber. A calibrated 60cm loop antenna was used while the reference device was rotated through the X, Y and Z axis in order to capture the worst case level. A maximum deviation of 2.77dB at 149kHz was measured when comparing the 3 meter semi-anechoic chamber to the open field site.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33 depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through two orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

3.4 Environmental Conditions

The temperature is controlled within range of 15ºC to 35ºC. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

- The antennas of the EUT are **permanently attached.**
- There are no provisions for connection to an external antenna.

Conclusion:

The EUT complies with the requirement of §15.203.

5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.23-2012. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
Conducted Bench Top Measurements	1.77
Line Conducted Disturbance	2.70
Radiated Disturbance (<30MHz)	4.38
Radiated Disturbance (30MHz - 1GHz)	4.75
Radiated Disturbance (1 - 18GHz)	5.20
Radiated Disturbance (>18GHz)	4.72

6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial #
Agilent	N9020A	MXA Signal Analyzer	4/26/2022	Annual	4/26/2023	MY56470202
Keysight Technologies	N9030A	PXA Signal Analyzer	6/10/2022	Annual	6/10/2023	MY49430244
Anritsu	MA2411B	Pulse Power Sensor	11/30/2021	Annual	11/30/2022	1726261
Anritsu	MA2411B	Pulse Power Sensor	5/19/2022	Annual	5/19/2023	1911106
Anritsu	ML2495A	Power Meter	12/6/2021	Annual	12/6/2022	1039008
Anritsu	ML2496A	Power Meter	11/29/2021	Annual	11/29/2022	1840005
ETS-Lindgren	3117	Double Ridged Guide Horn Antenna (1-18 GHz)	5/24/2022	Annual	5/24/2023	240049
ETS-Lindgren	3142E	Biconilog Antenna - (30MHz-6GHz)	10/21/2021	Annual	10/21/2022	121034
Rohde & Schwarz	HFH-2Z2	9kHz - 30MHz Loop Antenna	4/13/2022	Annual	4/13/2023	100546
Rohde & Schwarz	ENV216	Two-Line V-Network	1/14/2022	Annual	1/14/2023	101364
Rohde & Schwarz	FSVA3044	Signal Analyzer 44GHz	5/12/2022	Annual	5/12/2023	101098
Rohde & Schwarz	FSV40	Signal Analyzer 40GHz	3/4/2022	Annual	3/4/2023	101619
Rohde & Schwarz	FSW43	Signal and Spectrum Analyzer 2Hz to 43GHz	5/19/2022	Annual	5/19/2023	104093
Rohde & Schwarz	FSW67	Signal and Spectrum Analyzer (2Hz-67GHz)	4/21/2022	Annual	4/21/2023	101366
Rohde & Schwarz	TS-PR18	Pre Amplifier 1-18GHz	1/6/2022	Annual	1/6/2023	101639
Rohde & Schwarz	TS-PR1	Preamplifier - Antenna System; 30MHz - 1GHz	4/18/2022	Annual	4/18/2023	102081
Rohde & Schwarz	180-442A-KF	Horn (Small)	1/19/2022	Annual	1/19/2023	T058701-2
Rohde & Schwarz	TS-PR1840	Pre Amplifier 18-40GHz	4/18/2022	Annual	4/18/2023	100050

Table 6-1. Test Equipment List

Note:

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.
FCC ID: BCGA2825
IC: 579C-A2825
FCC Classification: Unlicensed National Information Infrastructure (UNII)

FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.407	RSS-Gen [6.7]	26dB Bandwidth	N/A	CONDUCTED	N/A	Section 7.2
15.407(e)	RSS-Gen [6.7]	6dB Bandwidth	>500kHz(5725-5850MHz)		PASS	Section 7.3
2.1049	RSS-Gen [6.7]	Occupied Bandwidth	N/A		PASS	Section 7.2, Section 7.3
15.407 (a.1.iv), (a.2), (a.3)	RSS-247 [6.2]	Maximum Conducted Output Power	Maximum conducted powers must meet the limits detailed in 15.407 (a) (RSS-247 [6.2])		PASS	Section 7.4
15.407 (a.1.iv), (a.2), (a.3)	RSS-247 [6.2]	Maximum Power Spectral Density	Maximum power spectral density must meet the limits detailed in 15.407 (a) (RSS-247 [6.2])		PASS	Section 7.5
15.407(h)	RSS-247 [6.3]	Dynamic Frequency Selection	See DFS Test Report	RADIATED	PASS	See DFS Test Report (1C2206300045-02.BCG)
15.407(b.1), (2), (3), (4)	RSS-247 [6.2]	Undesirable Emissions	Undesirable emissions must meet the limits detailed in 15.407(b) (RSS-247 [6.2])		PASS	Section 7.6
15.205, 15.407(b.1), (4), (5), (6)	RSS-Gen [8.9]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209 (RSS-Gen [8.9])		PASS	Section 7.6, 7.7
15.207	RSS-Gen [8.8]	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 (RSS-Gen [8.8]) limits	LINE CONDUCTED	PASS	Section 7.8

Table 7-1. Summary of Test Results

Notes:

1) All channels, modes, and modulations/data rates were investigated among all UNII bands. The test results shown in the following sections represent the worst case emissions.
2) The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
3) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.
4) For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is Element "UNII Automation," Version 7.0.
5) For radiated band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is Element "Chamber Automation," Version 1.3.2.
6) Per RSS-247 Section 6.2.3, transmission on channels which overlap the 5600-5650 MHz is prohibited. This device operates under these frequencies only under the control of a certified master device and does not support active scanning on these channels. This device does not transmit any beacons or initiate any transmissions in UNII Bands 2A or 2C.

7.2 26dB & 99% Bandwidth Measurement – 802.11a/n/ac

§2.1049; §15.407; RSS-Gen [6.7]

Test Overview and Limit

The bandwidth at 26dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating at its maximum duty cycle, at its maximum power control level, as defined in ANSI C63.10-2013 and KDB 789033 D02 v02r01, and at the appropriate frequencies. The spectrum analyzer's bandwidth measurement function is configured to measure the 26dB bandwidth.

The 26dB bandwidth is used to determine the conducted power limits.

Test Procedure Used

ANSI C63.10-2013 – Section 12.4
KDB 789033 D02 v02r01 – Section C

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability was used to perform the 26dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 26. The automatic bandwidth measurement function also has the capability of simultaneously measuring the 99% occupied bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = approximately 1% of the emission bandwidth
3. VBW $\geq$ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-1. Test Instrument & Measurement Setup

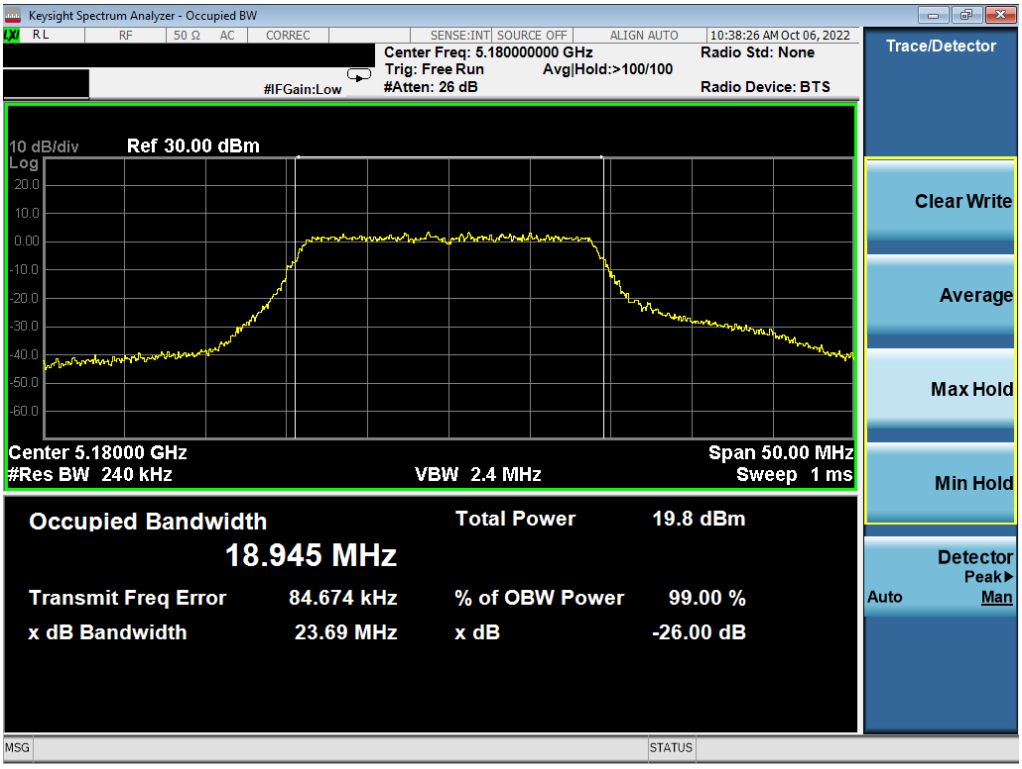
Test Notes

1. All modes were investigated and only the worst case is reported.

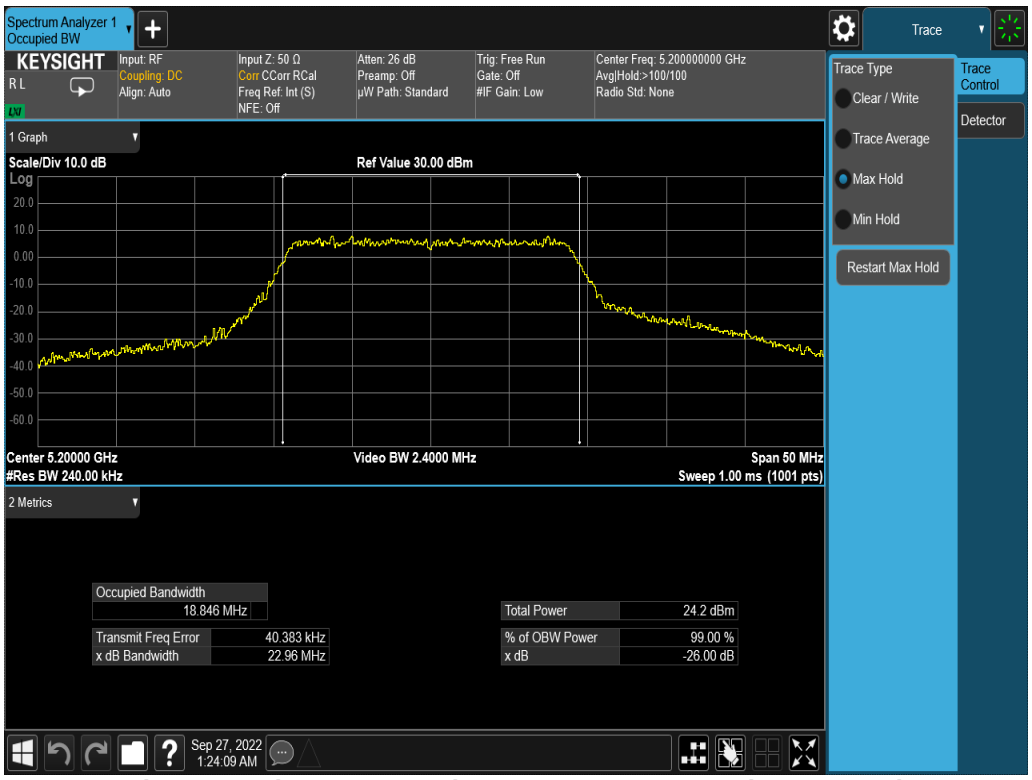
26dB & 99% Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Measured 99% Occupied Bandwidth [MHz]	Measured 26dB Bandwidth [MHz]
Band 1	5180	36	n (20MHz)	6.5/7.2 (MCS0)	18.945	23.690
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	18.846	22.960
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	18.885	23.020
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	75.653	85.510
Band 2A	5260	52	n (20MHz)	6.5/7.2 (MCS0)	19.295	23.580
	5280	56	n (20MHz)	6.5/7.2 (MCS0)	19.173	23.720
	5320	64	n (20MHz)	6.5/7.2 (MCS0)	19.248	23.310
Band 2C	5500	100	n (20MHz)	6.5/7.2 (MCS0)	19.277	23.820
	5580	116	n (20MHz)	6.5/7.2 (MCS0)	19.041	23.770
	5720	144	n (20MHz)	6.5/7.2 (MCS0)	19.232	24.340

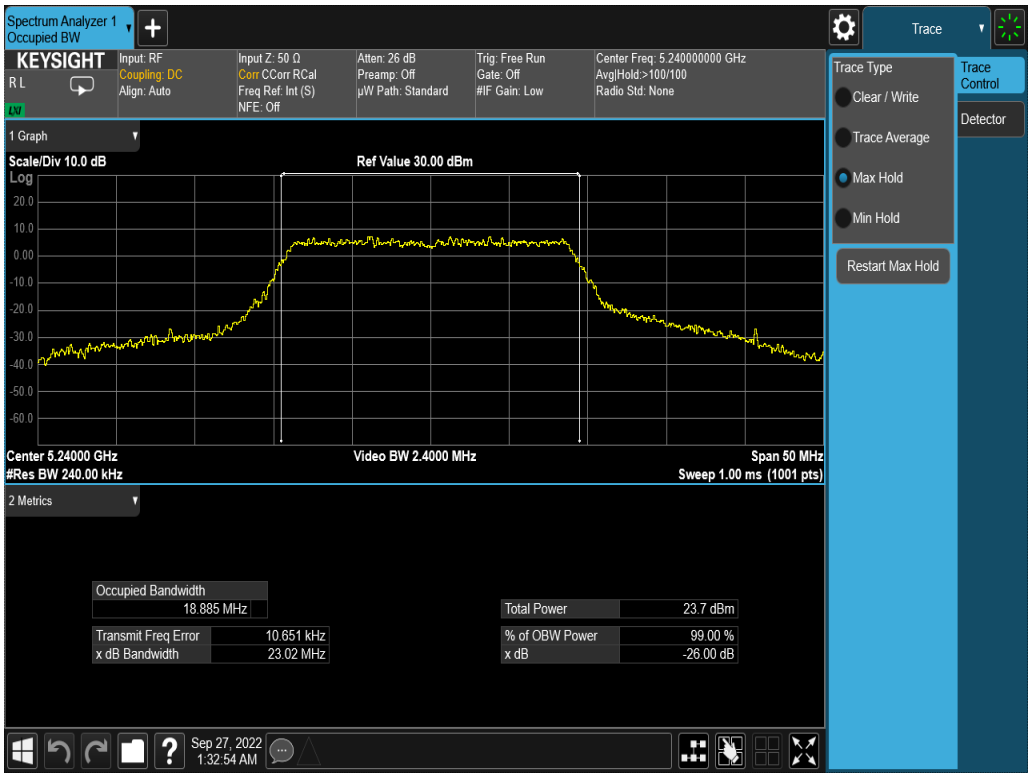
Table 7-2. Conducted Bandwidth Measurements



Plot 7-1. 26dB BW & 99% (20MHz BW 802.11n – Ch. 36, MCS0)

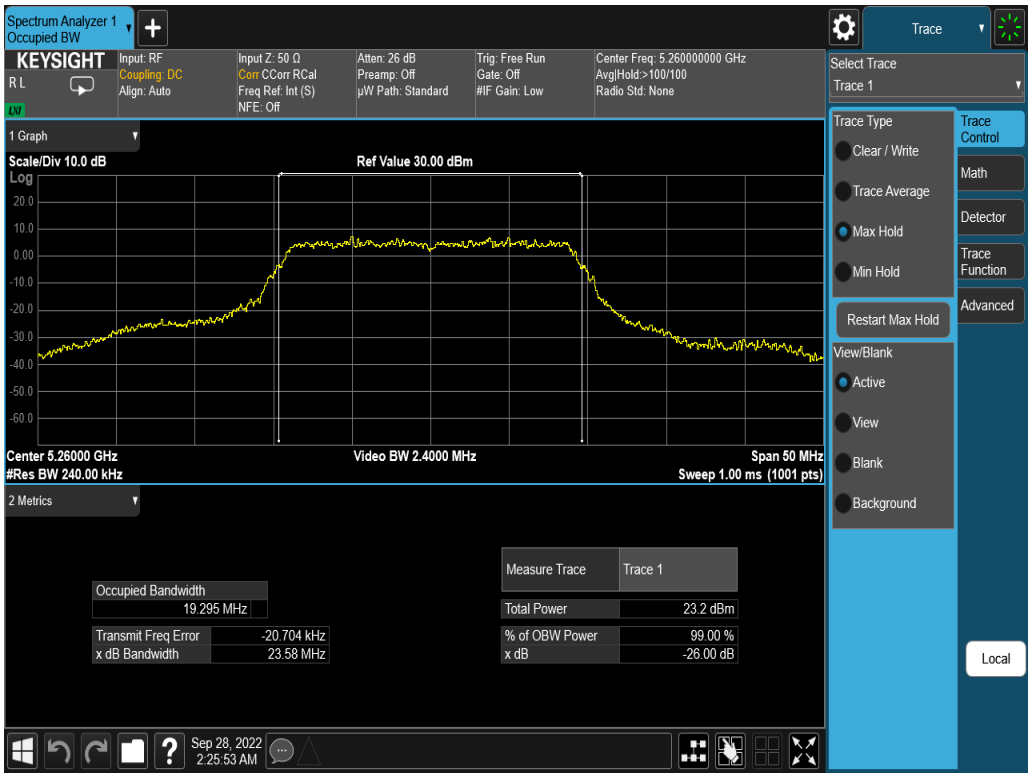


Plot 7-2. 26dB BW & 99% (20MHz BW 802.11n – Ch. 40, MCS0)

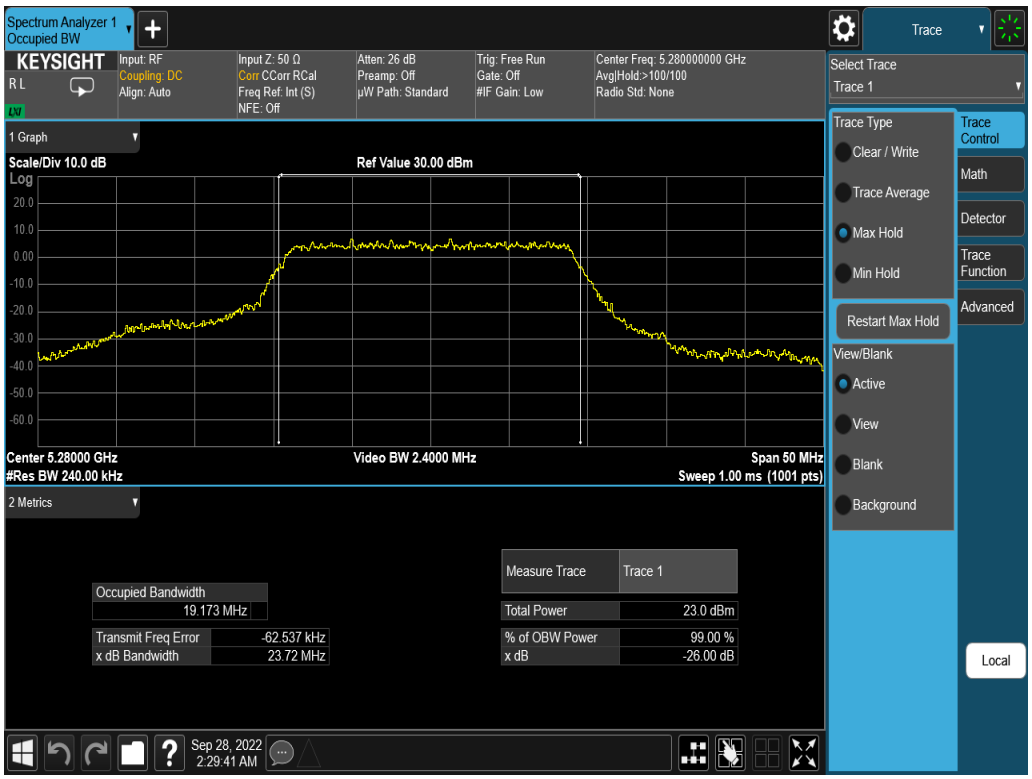


Plot 7-3. 26dB BW & 99% (20MHz BW 802.11n – Ch. 48, MCS0)

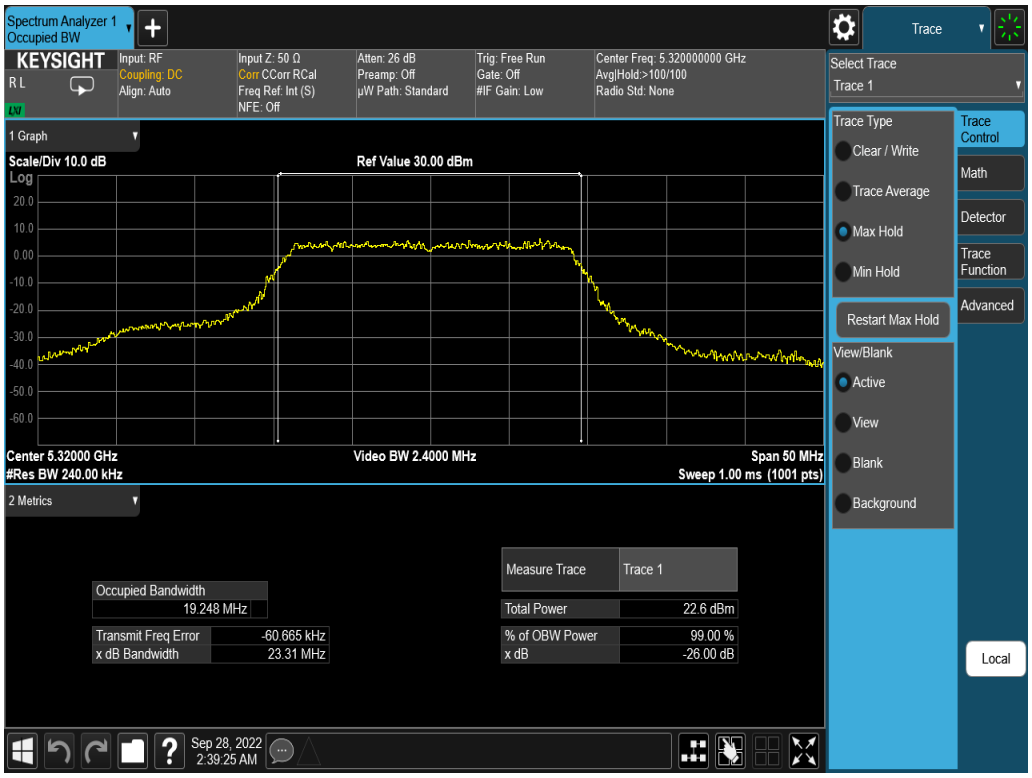
Plot 7-4. 26dB BW & 99% (80MHz BW 802.11ac – Ch. 42, MCS0)



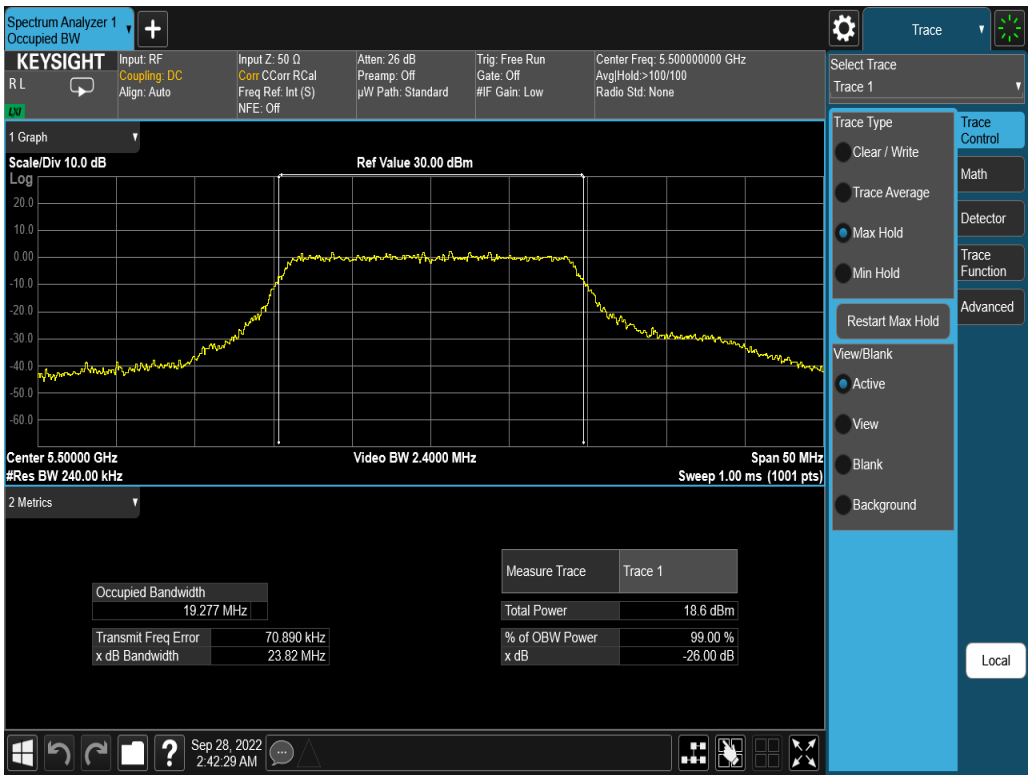
Plot 7-5. 26dB BW & 99% (20MHz BW 802.11n – Ch. 52, MCS0)



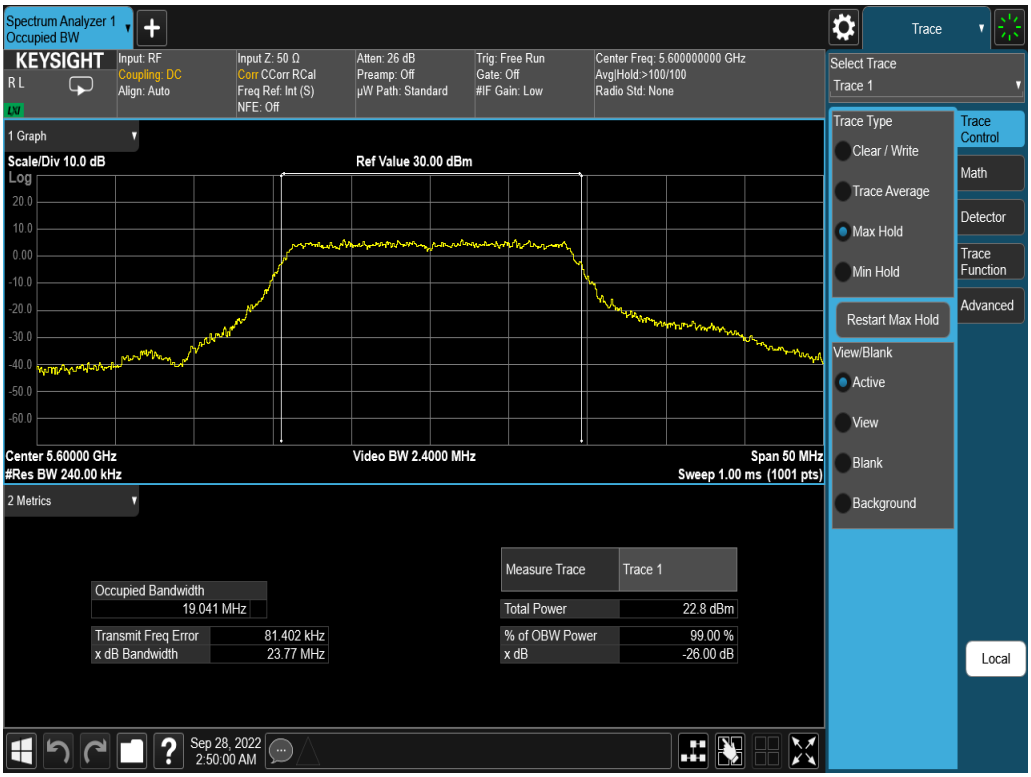
Plot 7-6. 26dB BW & 99% (20MHz BW 802.11n – Ch. 56, MCS0)



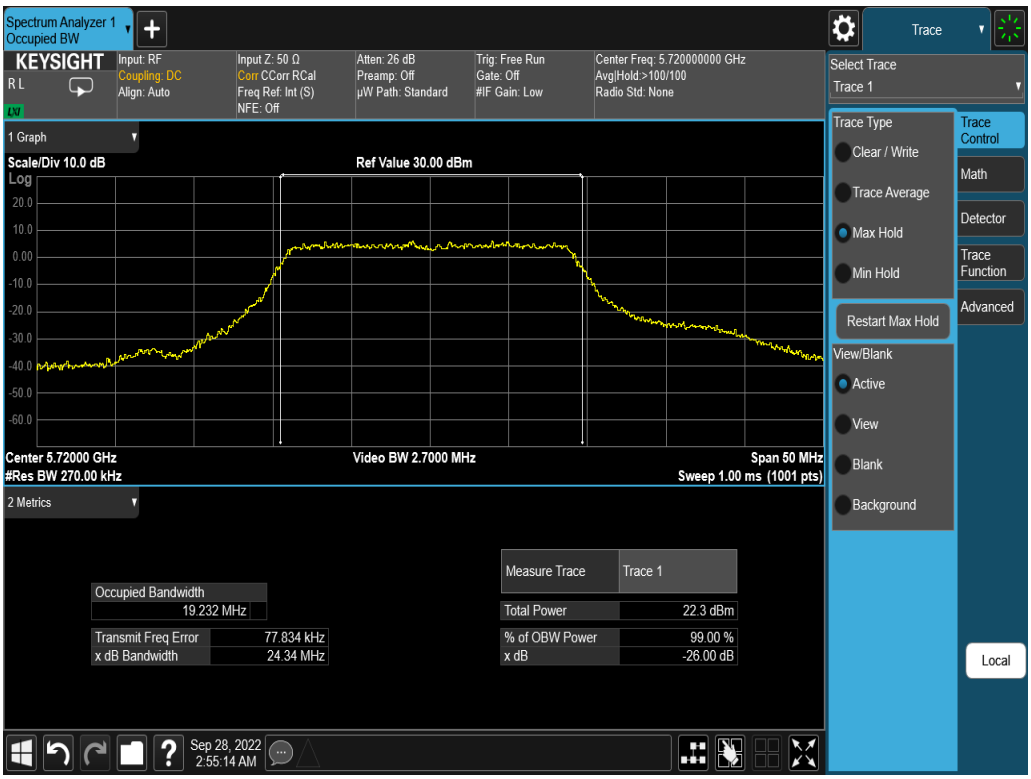
Plot 7-7. 26dB BW & 99% (20MHz BW 802.11n – Ch. 58, MCS0)



Plot 7-8. 26dB BW & 99% (20MHz BW 802.11n – Ch. 100, MCS0)



Plot 7-9. 26dB BW & 99% (20MHz BW 802.11n – Ch. 116, MCS0)



Plot 7-10. 26dB BW & 99% (20MHz BW 802.11n – Ch. 144, MCS0)

7.3 6dB & 99% Bandwidth Measurement – 802.11a/n/ac

§2.1049; §15.407 (e); RSS-Gen [6.7]

Test Overview and Limit

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating at its maximum duty cycle, at its maximum power control level, as defined in ANSI C63.10-2013 and KDB 789033 D02 v02r01, and at the appropriate frequencies. The spectrum analyzer's bandwidth measurement function is configured to measure the 6dB bandwidth.

In the 5.725 – 5.850GHz band, the 6dB bandwidth must be ≥ 500 kHz.

Test Procedure Used

ANSI C63.10-2013 – Section 6.9.2
KDB 789033 D02 v02r01 – Section C

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The automatic bandwidth measurement function also has the capability of simultaneously measuring the 99% occupied bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 100 kHz
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-2. Test Instrument & Measurement Setup

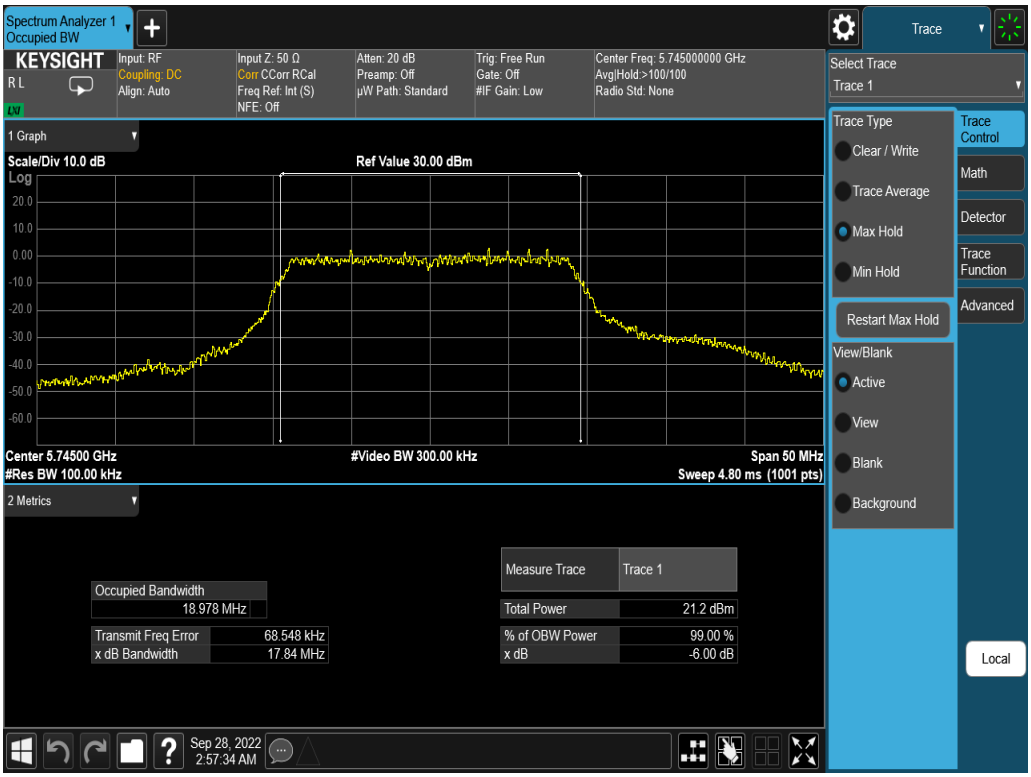
Test Notes

1. All modes were investigated and only the worst case is reported.

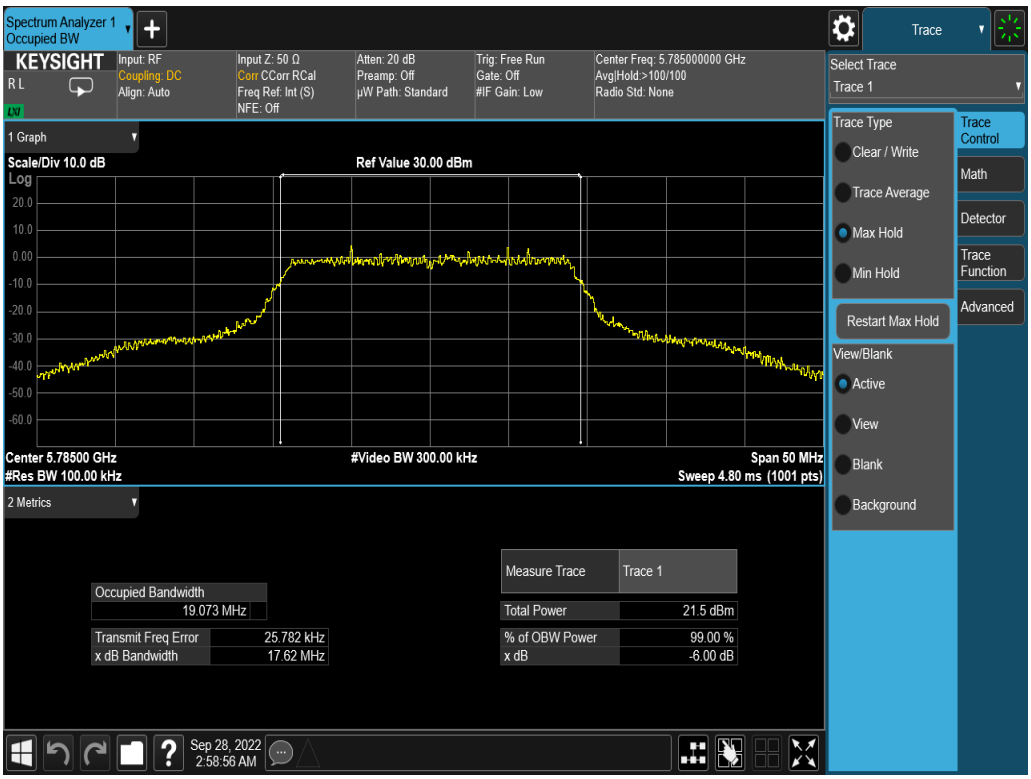
6dB & 99% Bandwidth Measurements

Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Measured 99% Occupied Bandwidth [MHz]	Measured 6dB Bandwidth [MHz]	Minimum 6dB Bandwidth [MHz]	Pass / Fail
5745	149	n (20MHz)	6.5/7.2 (MCS0)	18.978	17.840	0.50	Pass
5785	157	n (20MHz)	6.5/7.2 (MCS0)	19.073	17.620	0.50	Pass
5825	165	n (20MHz)	6.5/7.2 (MCS0)	19.110	17.650	0.50	Pass
5775	155	ac (80MHz)	29.3/32.5 (MCS0)	75.398	71.460	0.50	Pass

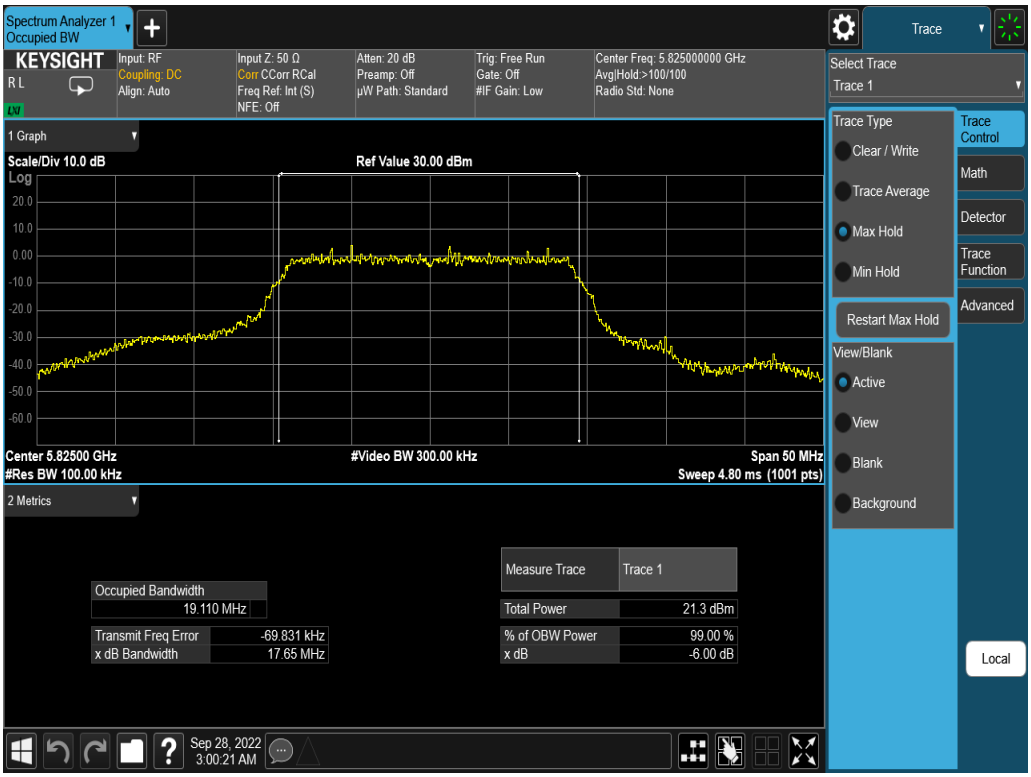
Table 7-3. Conducted Bandwidth Measurements



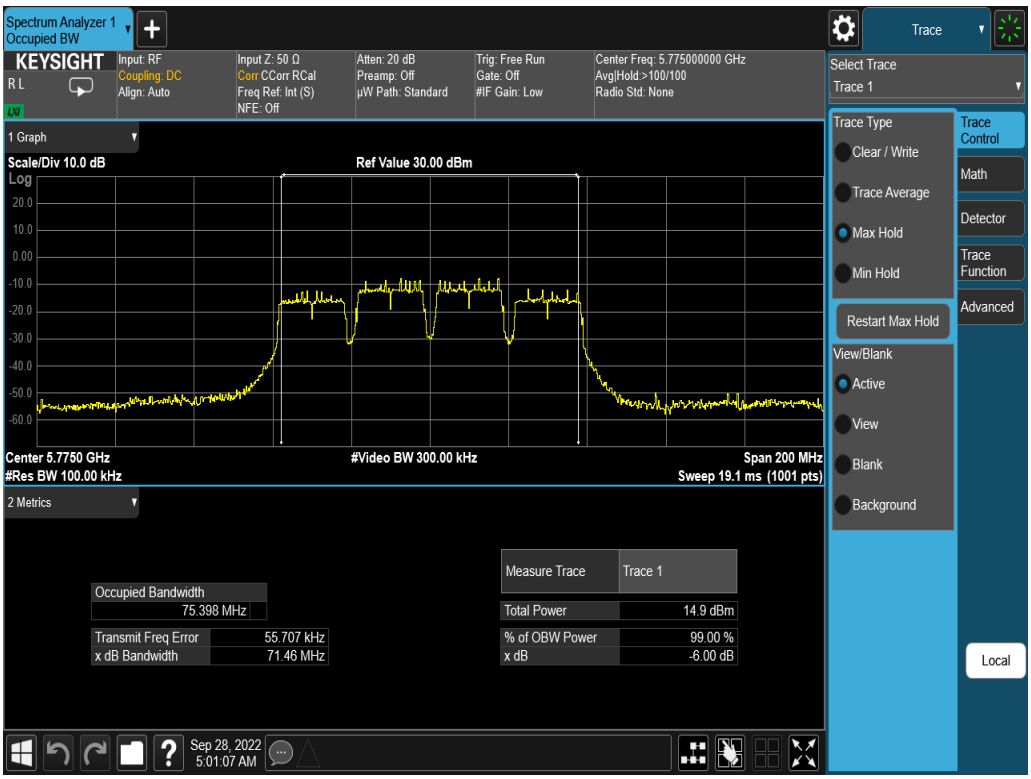
Plot 7-11. 6dB BW & 99% OBW (20MHz BW 802.11n – Ch. 149, MCS0)



Plot 7-12. 6dB BW & 99% OBW (20MHz BW 802.11n – Ch. 157, MCS0)



Plot 7-13. 6dB BW & 99% OBW (20MHz BW 802.11n – Ch. 165, MCS0)



Plot 7-14. 6dB BW & 99% OBW (80MHz BW 802.11ac – Ch. 155, MCS0)

7.4 Conducted Output Power and Max EIRP Measurement – 802.11a/n/ac

§15.407(a.1.iv) §15.407(a.2) §15.407(a.3); RSS-247 [6.2]

Test Overview and Limits

A transmitter antenna terminal of the EUT is connected to the input of an RF pulse power sensor. Measurement is made using a broadband average power meter while the EUT is operating at its maximum duty cycle, at its maximum power control level, as defined in ANSI C63.10-2013 and KDB 789033 D02 v02r01, and at the appropriate frequencies. B is the 99% OBW per ISED RSS-247 and 26dB BW is per FCC 15.407.

In the 5.15 – 5.25GHz band, the maximum permissible conducted output power is 250mW (23.98dBm). The maximum e.i.r.p. shall not exceed the lesser of 200 mW or 10 + 10 log$_{10}$B, dBm.

In the 5.25 – 5.35GHz band, the maximum permissible conducted output power is the lesser of 250mW (23.98dBm) or 11 dBm + 10log$_{10}$(26dB BW) = 11 dBm + 10log$_{10}$(19.17) = 23.83dBm. The maximum e.i.r.p. shall not exceed the lesser of 1.0 W or 17 + 10 log$_{10}$B, dBm.

In the 5.47 – 5.725GHz band, the maximum permissible conducted output power is the lesser of 250mW (23.98dBm) or 11 dBm + 10log$_{10}$(26dB BW) = 11 dBm + 10log$_{10}$(19.04) = 23.80dBm. The maximum e.i.r.p. shall not exceed the lesser of 1.0 W or 17 + 10 log$_{10}$B, dBm.

In the 5.725 – 5.850GHz band, the maximum permissible conducted output power is 1W (30dBm). The maximum e.i.r.p. is 36 dBm.

Test Procedure Used

ANSI C63.10-2013 – Section 12.3.3.2 Method PM-G
KDB 789033 D02 v02r01 – Section E)3)b) Method PM-G

Test Settings

Average power measurements were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The power meter implemented triggering and gating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter. The trace was averaged over 100 traces to obtain the final measured average power.

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-3. Test Instrument & Measurement Setup

Test Notes

1. Per RSS-247 Section 6.2.3, transmission on channels which overlap the 5600-5650 MHz is prohibited. This device operates under these frequencies only under the control of a certified master device and does not support active scanning on these channels. This device does not transmit any beacons or initiate any transmissions in UNII Bands 2A or 2C.

7.4.1 FCC Conducted Output Power Measurements

Freq [MHz]	Channel	Detector	Conducted Powers [dBm]			Conducted Power Limit [dBm]	Conducted Power Margin [dB]
			802.11a	802.11n (MCS0)	802.11n (MCS7)		
5180	36	AVG	12.90	12.92	12.87	23.98	-11.06
5200	40	AVG	16.22	16.26	14.50	23.98	-7.72
5240	48	AVG	16.31	16.35	14.42	23.98	-7.63
5260	52	AVG	16.41	16.42	14.34	23.98	-7.56
5280	56	AVG	16.22	16.26	14.45	23.98	-7.72
5300	60	AVG	15.98	16.00	14.42	23.98	-7.98
5320	64	AVG	10.41	10.44	10.31	23.98	-13.54
5500	100	AVG	11.42	11.42	11.49	23.98	-12.49
5520	104	AVG	14.77	14.79	14.44	23.98	-9.19
5540	108	AVG	16.41	16.43	14.40	23.98	-7.55
5580	116	AVG	16.48	16.49	14.50	23.98	-7.49
5600	120	AVG	15.90	15.99	14.44	23.98	-7.99
5620	124	AVG	15.75	15.78	14.38	23.98	-8.20
5640	128	AVG	15.80	15.83	14.40	23.98	-8.15
5660	132	AVG	15.88	15.94	14.46	23.98	-8.04
5680	136	AVG	14.46	14.50	14.42	23.98	-9.48
5700	140	AVG	7.78	7.81	7.92	23.98	-16.06
5720	144	AVG	14.99	15.00	14.42	23.98	-8.98
5745	149	AVG	14.80	14.82	14.36	30.00	-15.18
5785	157	AVG	14.80	14.79	14.38	30.00	-15.20
5825	165	AVG	14.90	14.98	14.41	30.00	-15.02

Table 7-4. FCC 20MHz BW (UNII) Maximum Conducted Output Power

Freq [MHz]	Channel	Detector	Conducted Powers [dBm]		Conducted Power Limit [dBm]	Conducted Power Margin [dB]
			802.11ac (MCS0)	802.11ac (MCS7)		
5210	42	AVG	7.95	7.91	23.98	-16.03
5775	155	AVG	7.87	7.75	30.00	-22.13

Table 7-5. FCC 80MHz BW (UNII) Maximum Conducted Output Power

7.4.2 ISED Conducted Output Power Measurements

Freq [MHz]	Channel	Detector	Conducted Powers [dBm]			Conducted Power Limit [dBm]	Conducted Power Margin [dB]	Ant. Gain [dBi]	Max e.i.r.p. [dBm]	Max e.i.r.p. Limit [dBm]	e.i.r.p. Margin [dB]
			802.11a	802.11n (MCS0)	802.11n (MCS7)						
5180	36	AVG	12.90	12.92	12.87	-	-	5.10	18.02	23.01	-4.99
5200	40	AVG	13.41	13.46	13.44	-	-	5.10	18.56	23.01	-4.45
5240	48	AVG	13.35	13.39	13.30	-	-	5.10	18.49	23.01	-4.52
5260	52	AVG	16.41	16.42	14.34	23.98	-7.56	5.80	22.22	30.00	-7.78
5280	56	AVG	16.22	16.26	14.45	23.98	-7.72	5.80	22.06	30.00	-7.94
5300	60	AVG	15.98	16.00	14.42	23.98	-7.98	5.80	21.80	30.00	-8.20
5320	64	AVG	10.41	10.44	10.31	23.98	-13.54	5.80	16.24	30.00	-13.76
5500	100	AVG	11.42	11.42	11.49	23.98	-12.49	4.30	15.79	30.00	-14.21
5520	104	AVG	14.77	14.79	14.44	23.98	-9.19	4.30	19.09	30.00	-10.91
5540	108	AVG	16.41	16.43	14.40	23.98	-7.55	4.30	20.73	30.00	-9.27
5580	116	AVG	16.48	16.49	14.50	23.98	-7.49	4.30	20.79	30.00	-9.21
5600	120	AVG	15.90	15.99	14.44	23.98	-7.99	4.30	20.29	30.00	-9.71
5620	124	AVG	15.75	15.78	14.38	23.98	-8.20	4.30	20.08	30.00	-9.92
5640	128	AVG	15.80	15.83	14.40	23.98	-8.15	4.30	20.13	30.00	-9.87
5660	132	AVG	15.88	15.94	14.46	23.98	-8.04	4.30	20.24	30.00	-9.76
5680	136	AVG	14.46	14.50	14.42	23.98	-9.48	4.30	18.80	30.00	-11.20
5700	140	AVG	7.78	7.81	7.92	23.98	-16.06	4.30	12.22	30.00	-17.78
5720	144	AVG	14.99	15.00	14.42	23.98	-8.98	4.30	19.30	30.00	-10.70
5745	149	AVG	14.80	14.82	14.36	30.00	-15.18	3.80	18.62	-	-
5785	157	AVG	14.80	14.79	14.38	30.00	-15.20	3.80	18.60	-	-
5825	165	AVG	14.90	14.98	14.41	30.00	-15.02	3.80	18.78	-	-

Table 7-6. ISED 20MHz BW (UNII) Maximum Conducted Output Power and Max EIRP

Freq [MHz]	Channel	Detector	Conducted Powers [dBm]		Conducted Power Limit [dBm]	Conducted Power Margin [dB]	Ant. Gain [dBi]	Max e.i.r.p. [dBm]	Max e.i.r.p. Limit [dBm]	e.i.r.p. Margin [dB]
			802.11ac (MCS0)	802.11ac (MCS7)						
5210	42	AVG	7.95	7.91	23.98	-16.03	5.10	13.05	23.01	-9.96
5775	155	AVG	7.87	7.75	30.00	-22.13	3.80	11.67	-	-

Table 7-7. ISED 80MHz BW (UNII) Maximum Conducted Output Power and Max EIRP

Sample e.i.r.p. Calculation:

At 5180MHz in 802.11n MCS7 (20MHz BW) mode, the average conducted power was calculated to be 12.87 dBm with antenna gain of 5.10 dBi.

e.i.r.p. (dBm) = Conducted Power (dBm) + Ant gain (dBi)

12.87 dBm + 5.10 dBi = 17.97 dBm

7.5 Maximum Power Spectral Density – 802.11a/n/ac

§15.407(a.1.iv) §15.407(a.2) §15.407(a.3); RSS-247 [6.2]

Test Overview and Limit

The spectrum analyzer was connected to the antenna terminal while the EUT was operating at its maximum duty cycle, at its maximum power control level, as defined in ANSI C63.10-2013 and KDB 789033 D02 v02r01, and at the appropriate frequencies. Method SA-1, as defined in ANSI C63.10-2013 and KDB 789033 D02 v02r01, was used to measure the power spectral density.

In the 5.15 – 5.25GHz, 5.25 – 5.35GHz, 5.47 – 5.725GHz bands, the maximum permissible power spectral density is 11dBm/MHz.

In the 5.15 – 5.25GHz band, the e.i.r.p. spectral density shall not exceed 10 dBm in any 1 MHz band.

In the 5.725 – 5.850GHz band, the maximum permissible power spectral density is 30dBm/500kHz.

Test Procedure Used

ANSI C63.10-2013 – Section 12.3.2.2
KDB 789033 D02 v02r01 – Section F

Test Settings

1. Analyzer was set to the center frequency of the UNII channel under investigation
2. Span was set to encompass the entire emission bandwidth of the signal
3. RBW = 1MHz
4. VBW = 3MHz
5. Number of sweep points ≥ 2 x (span/RBW)
6. Sweep time = auto
7. Detector = power averaging (RMS)
8. Trigger was set to free run for all modes
9. Trace was averaged over 100 sweeps
10. The peak search function of the spectrum analyzer was used to find the peak of the spectrum.

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-4. Test Instrument & Measurement Setup

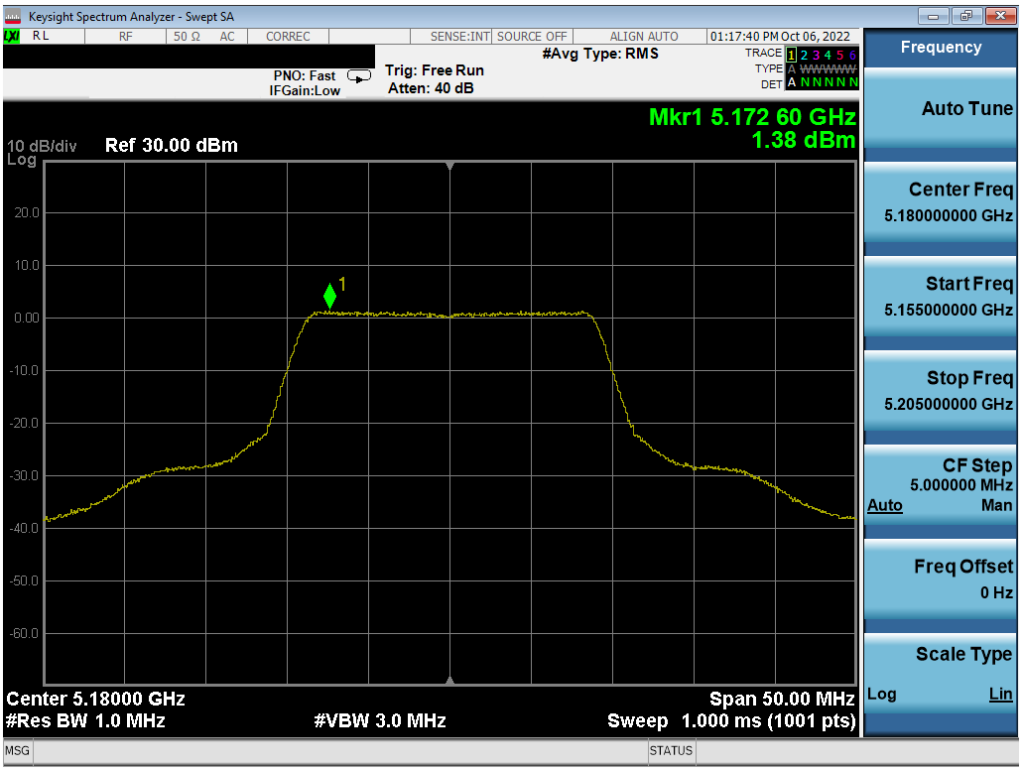
Test Notes

1. All modes were investigated and only the worst case is reported.

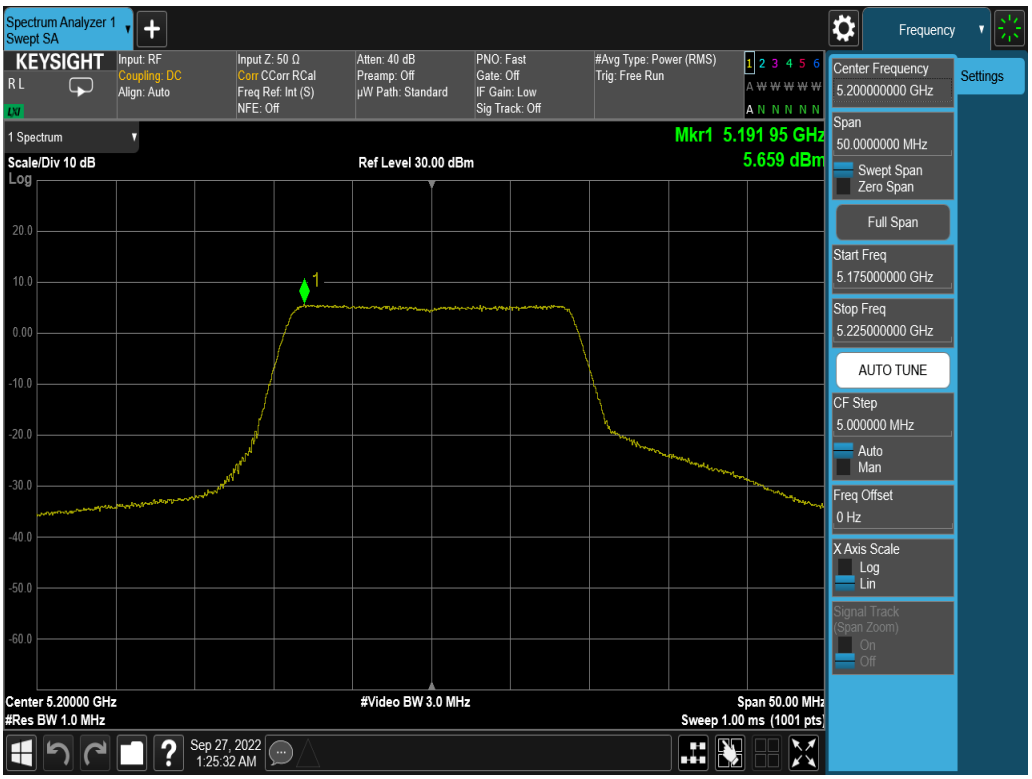
7.5.1 Power Spectral Density Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Measured Power Density [dBm/MHz]	Max Power Density [dBm/MHz]	Margin [dB]
Band 1	5180	36	n (20MHz)	6.5/7.2 (MCS0)	1.380	11.0	-9.62
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	5.659	11.0	-5.34
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	5.231	11.0	-5.77
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	-8.014	11.0	-19.01
Band 2A	5260	52	n (20MHz)	6.5/7.2 (MCS0)	3.782	11.0	-7.22
	5280	56	n (20MHz)	6.5/7.2 (MCS0)	3.755	11.0	-7.25
	5320	64	n (20MHz)	6.5/7.2 (MCS0)	3.655	11.0	-7.35
Band 2C	5500	100	n (20MHz)	6.5/7.2 (MCS0)	-0.265	11.0	-11.27
	5580	116	n (20MHz)	6.5/7.2 (MCS0)	3.704	11.0	-7.30
	5720	144	n (20MHz)	6.5/7.2 (MCS0)	2.682	11.0	-8.32

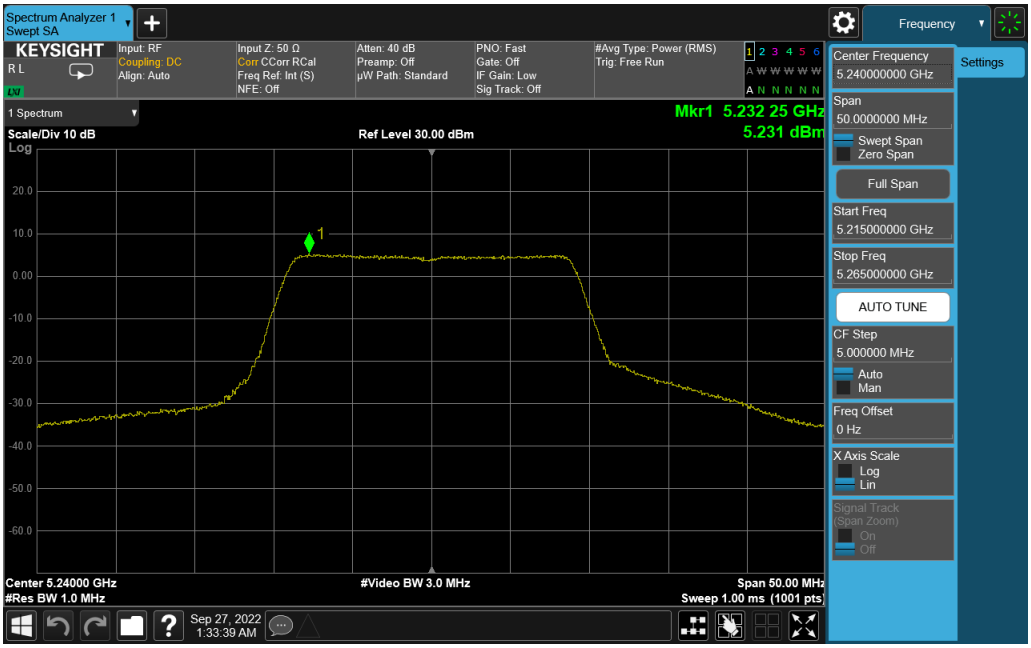
Table 7-8. Bands 1, 2A, 2C Power Spectral Density Measurements



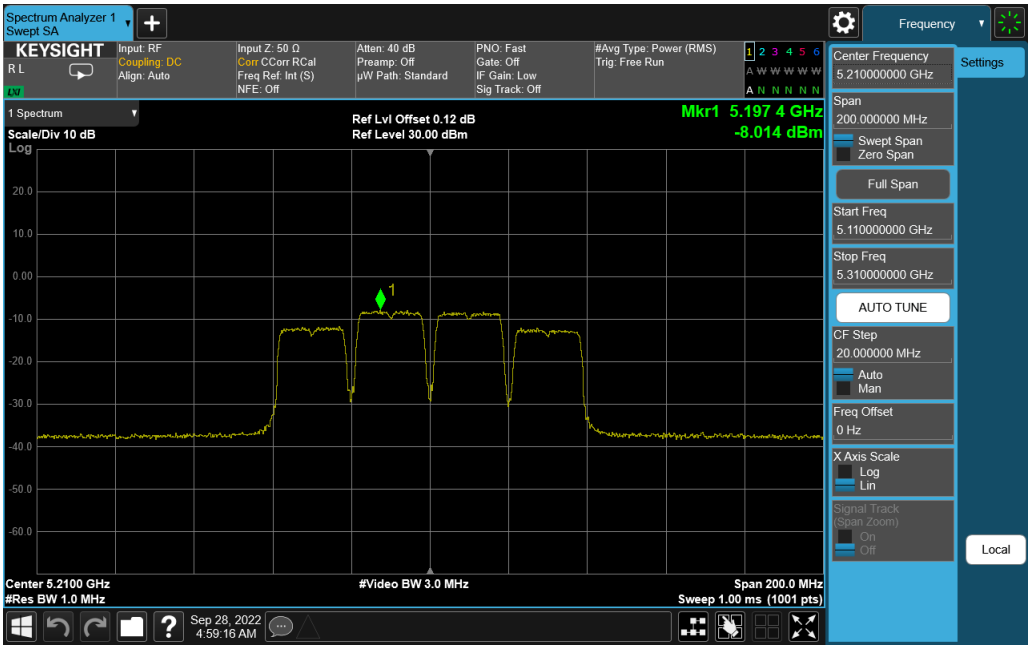
Plot 7-15. PSD (20MHz BW 802.11n – Ch. 36, MCS0)



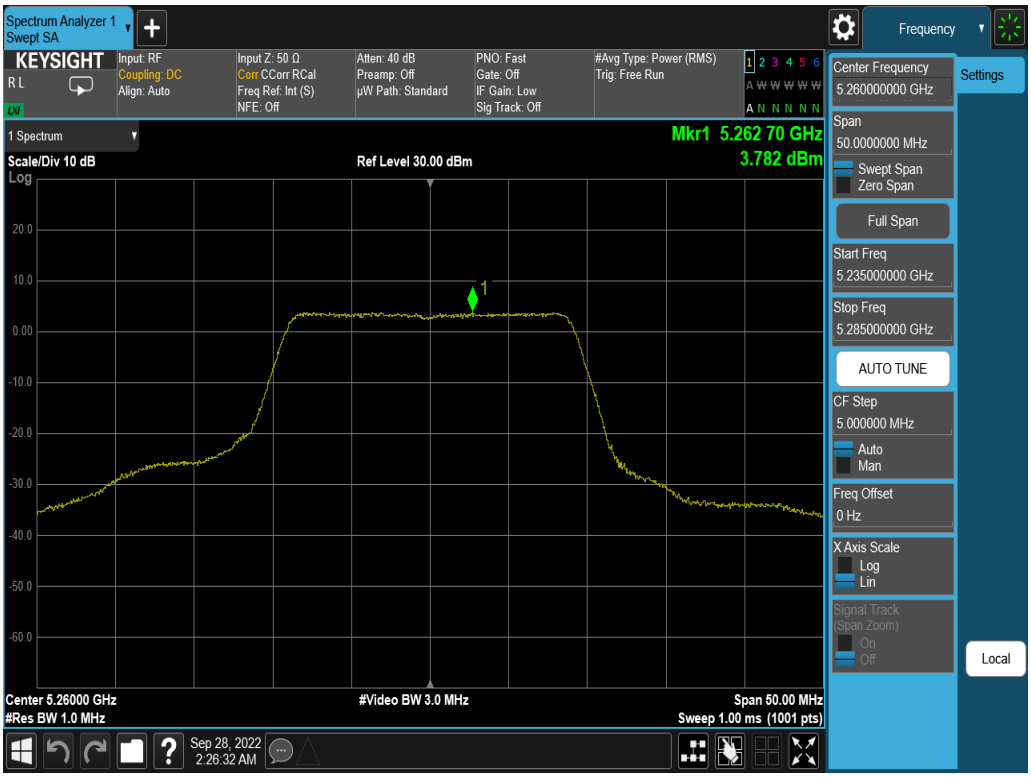
Plot 7-16. PSD (20MHz BW 802.11n – Ch. 40, MCS0)



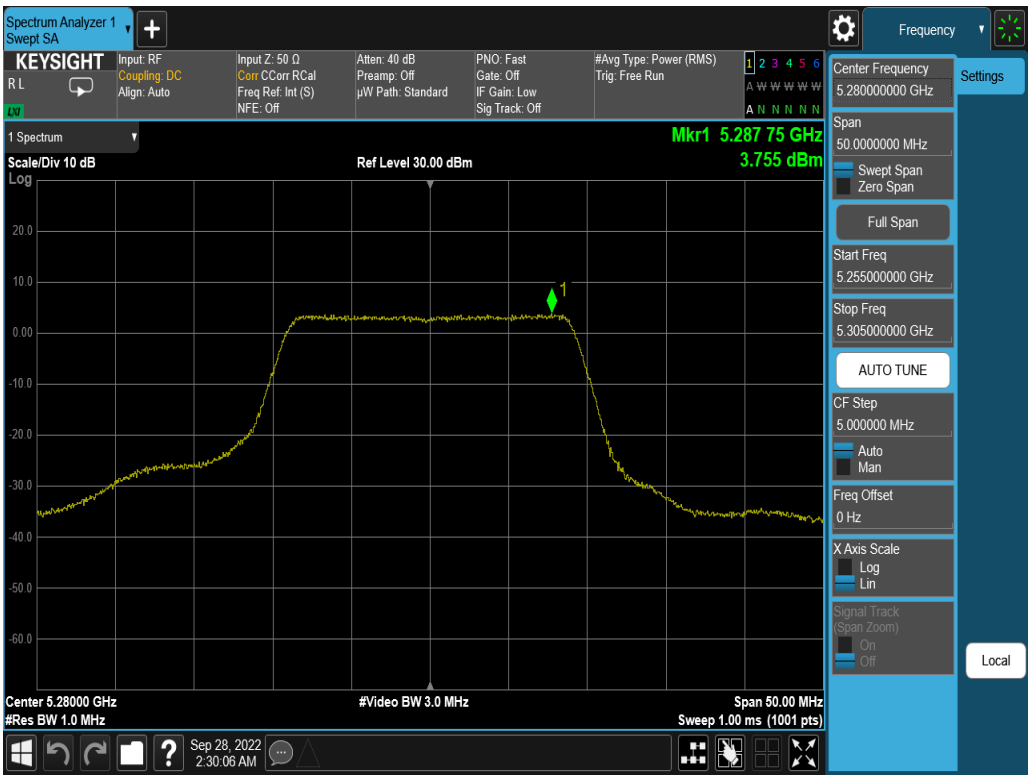
Plot 7-17. PSD (20MHz BW 802.11n – Ch. 48, MCS0)



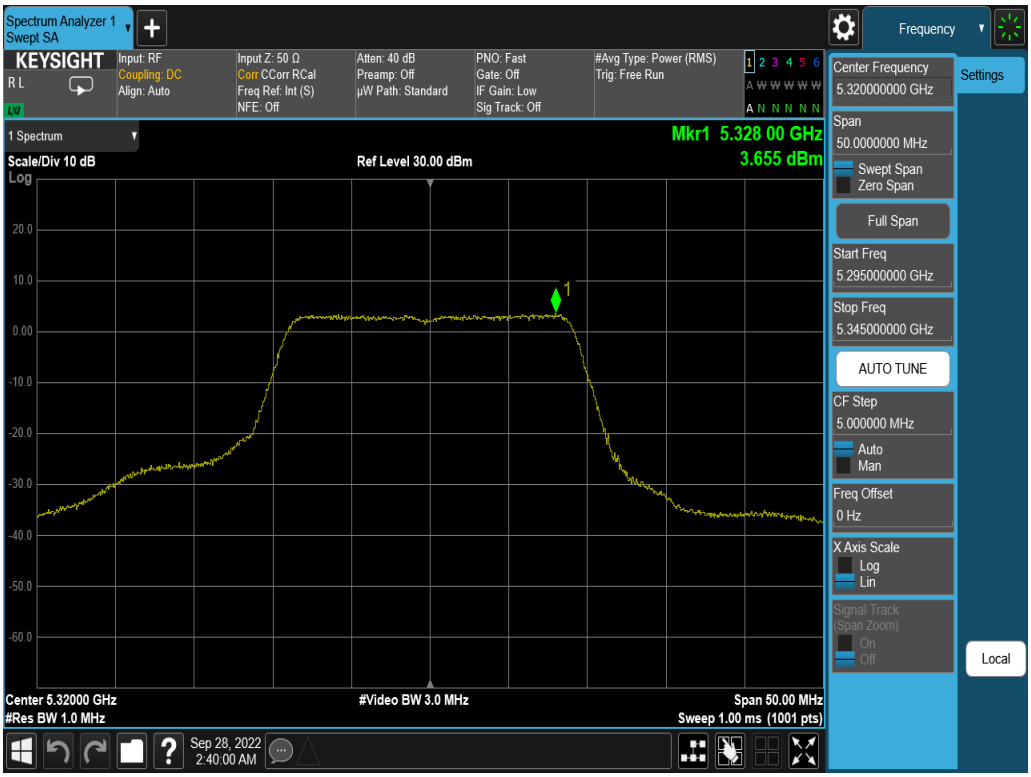
Plot 7-18. PSD (80MHz BW 802.11ac – Ch. 42, MCS0)



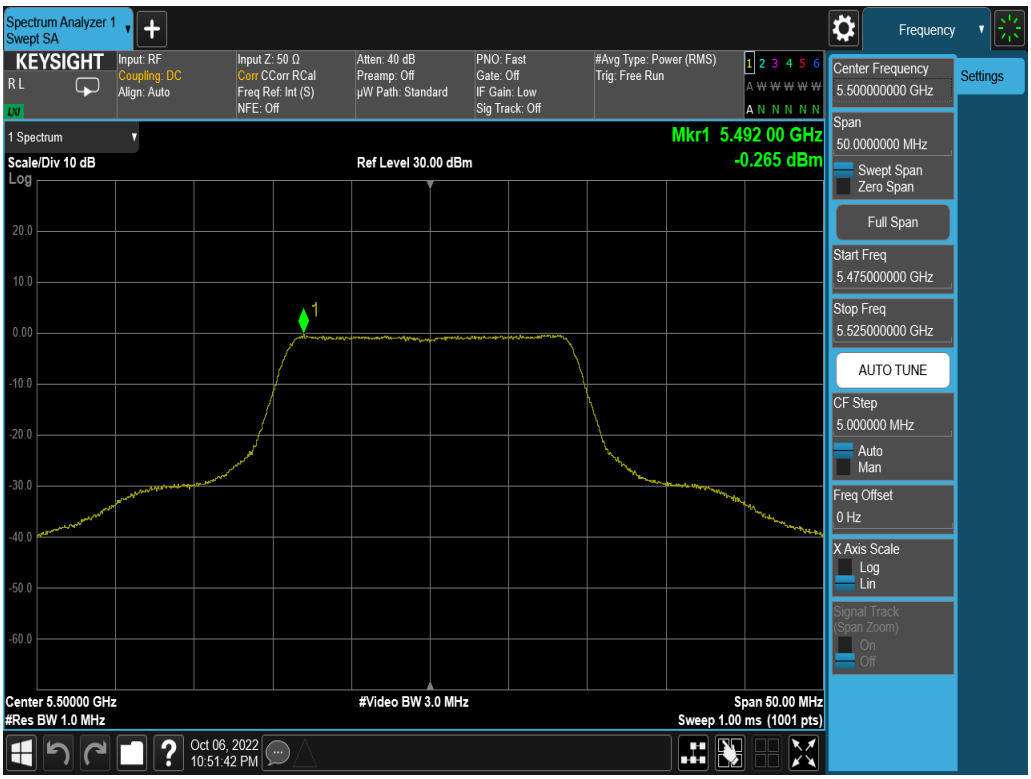
Plot 7-19. PSD (20MHz BW 802.11n – Ch. 52, MCS0)



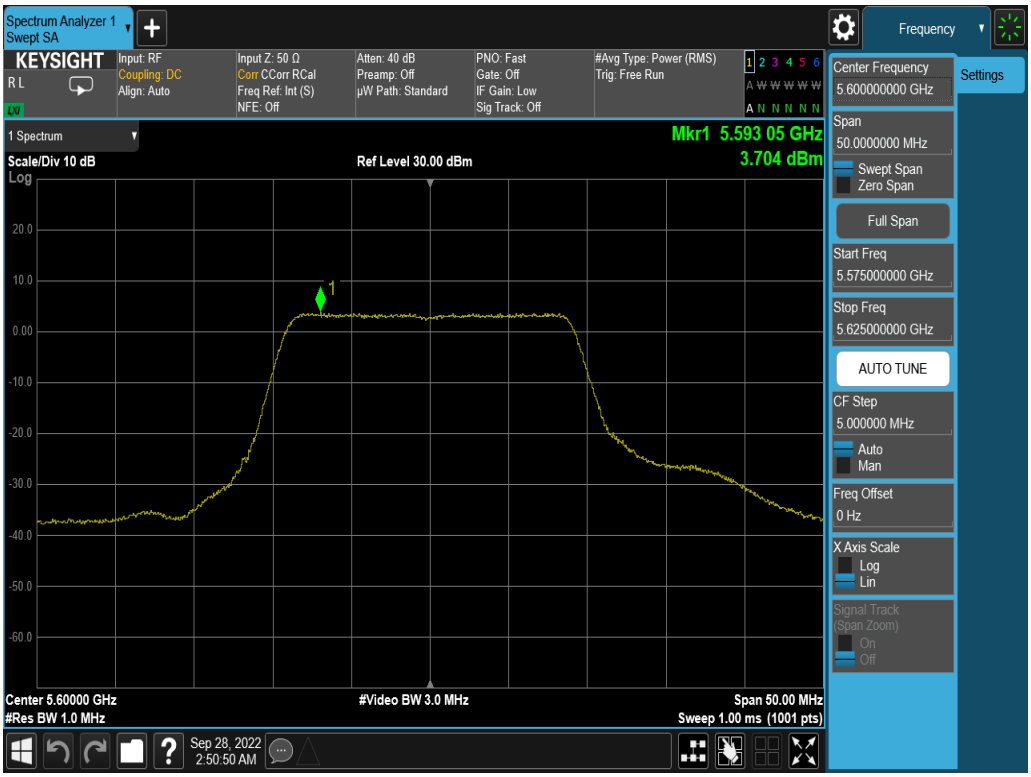
Plot 7-20. PSD (20MHz BW 802.11n – Ch. 56, MCS0)



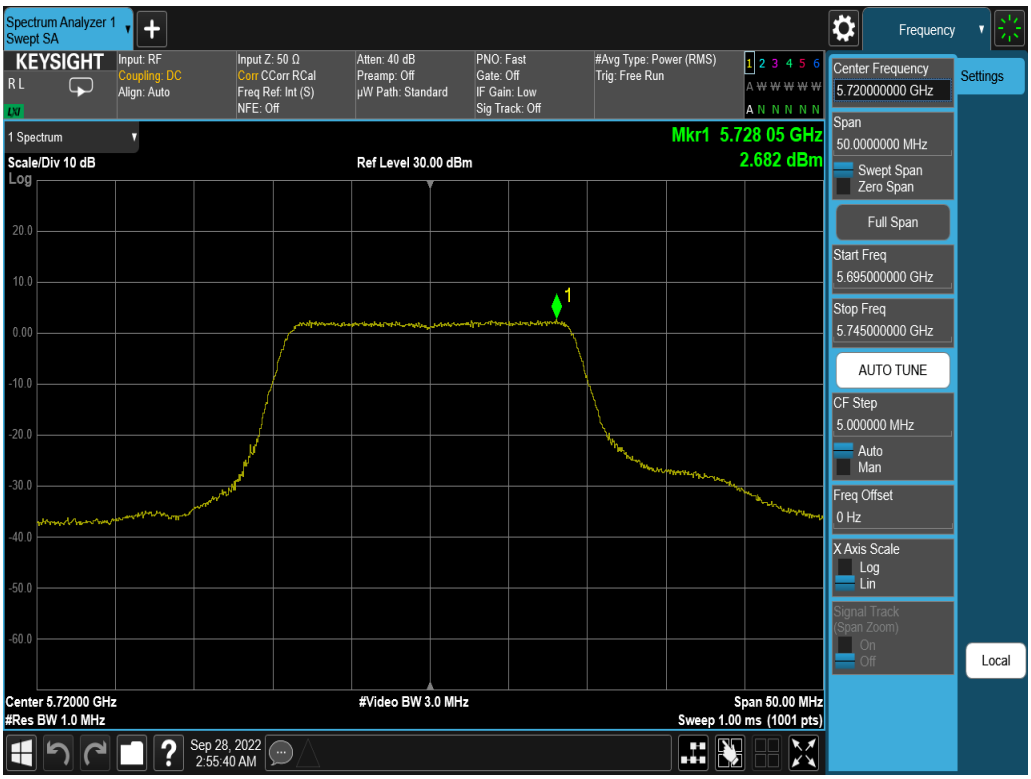
Plot 7-21. PSD (20MHz BW 802.11n – Ch. 64, MCS0)



Plot 7-22. PSD (20MHz BW 802.11n – Ch. 100, MCS0)



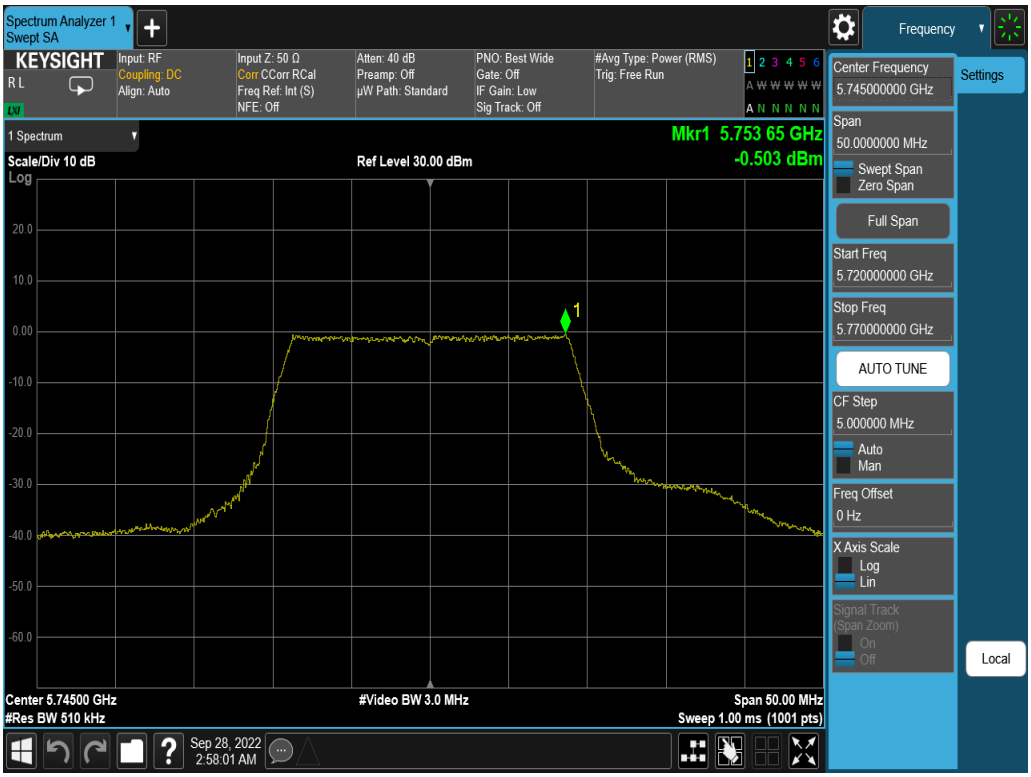
Plot 7-23. PSD (20MHz BW 802.11n – Ch. 116, MCS0)



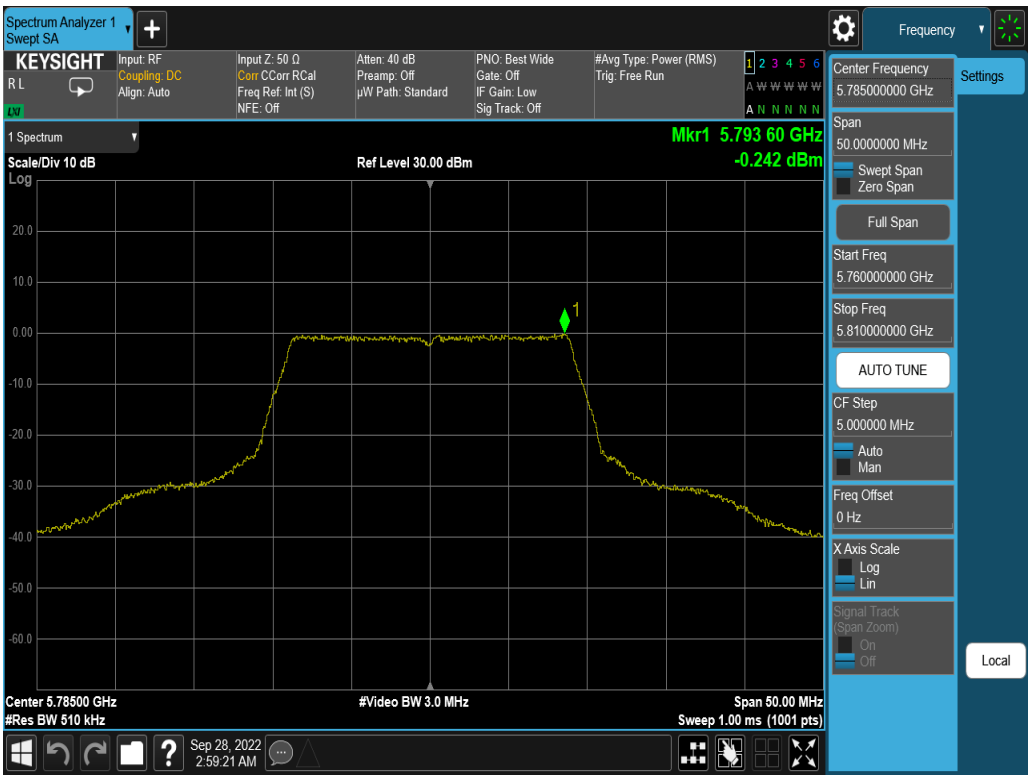
Plot 7-24. PSD (20MHz BW 802.11n – Ch. 144, MCS0)

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Measured Power Density [dBm/500kHz]	Max Permissible Power Density [dBm/500kHz]	Margin [dB]
Band 3	5745	149	n (20MHz)	6.5/7.2 (MCS0)	-0.503	30.0	-30.50
	5785	157	n (20MHz)	6.5/7.2 (MCS0)	-0.242	30.0	-30.24
	5825	165	n (20MHz)	6.5/7.2 (MCS0)	-0.135	30.0	-30.14
	5775	155	ac (80MHz)	29.3/32.5 (MCS0)	-9.947	30.0	-39.95

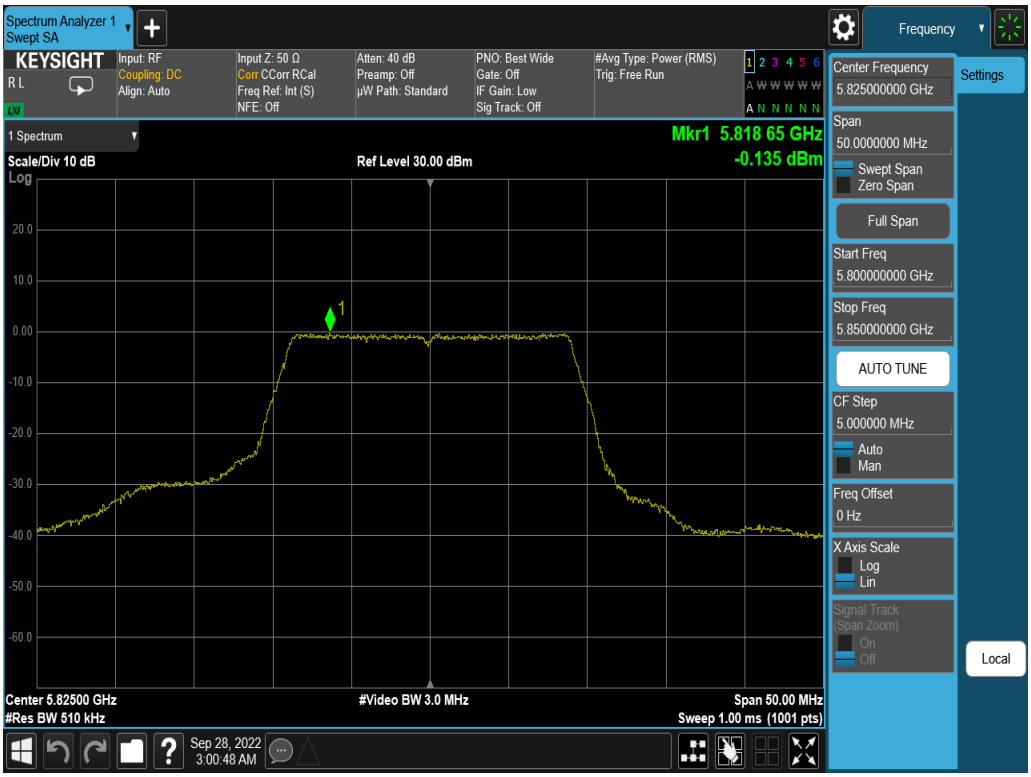
Table 7-9. Band 3 Power Spectral Density Measurements



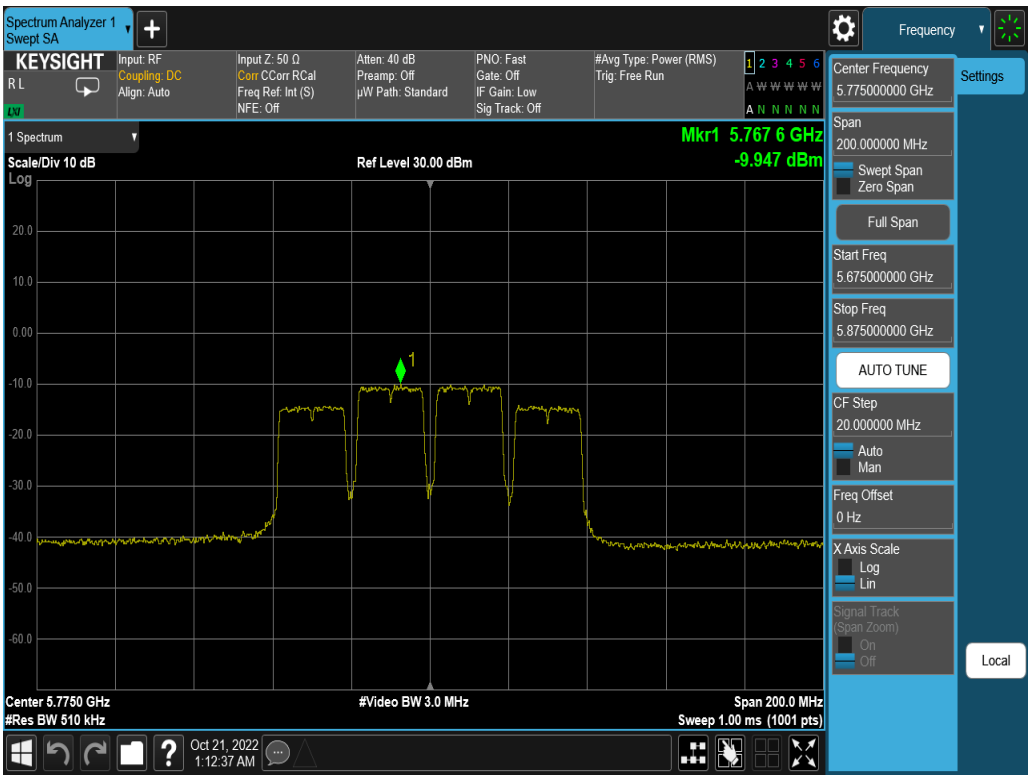
Plot 7-25. PSD (20MHz BW 802.11n – Ch. 149, MCS0)



Plot 7-26. PSD (20MHz BW 802.11n – Ch. 157, MCS0)



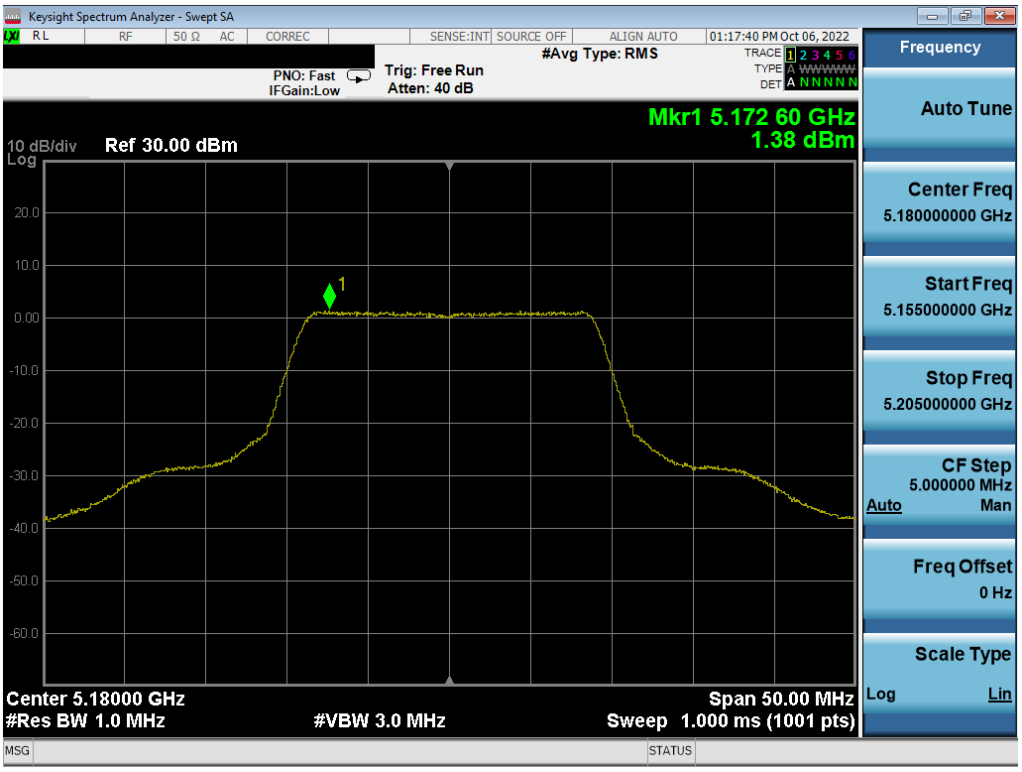
Plot 7-27. PSD (20MHz BW 802.11n – Ch. 165, MCS0)



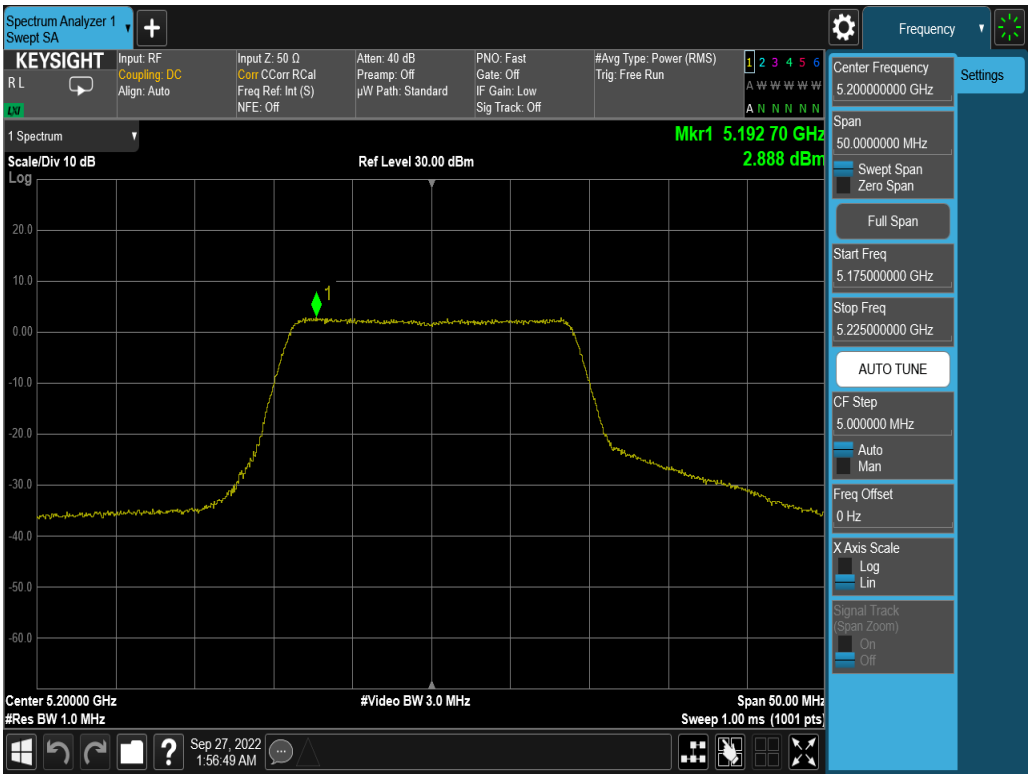
Plot 7-28. PSD (80MHz BW 802.11ac – Ch. 155, MCS0)

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Measured Power Density [dBm/MHz]	Antenna Gain [dBi]	e.i.r.p. Power Density [dBm/MHz]	ISED Max e.i.r.p. Power Density [dBm/MHz]	Margin [dB]
Band 1	5180	36	n (20MHz)	6.5/7.2 (MCS0)	1.380	5.10	6.48	10.0	-3.52
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	2.888	5.10	7.99	10.0	-2.01
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	2.375	5.10	7.48	10.0	-2.53
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	-8.014	5.10	-2.91	10.0	-12.91

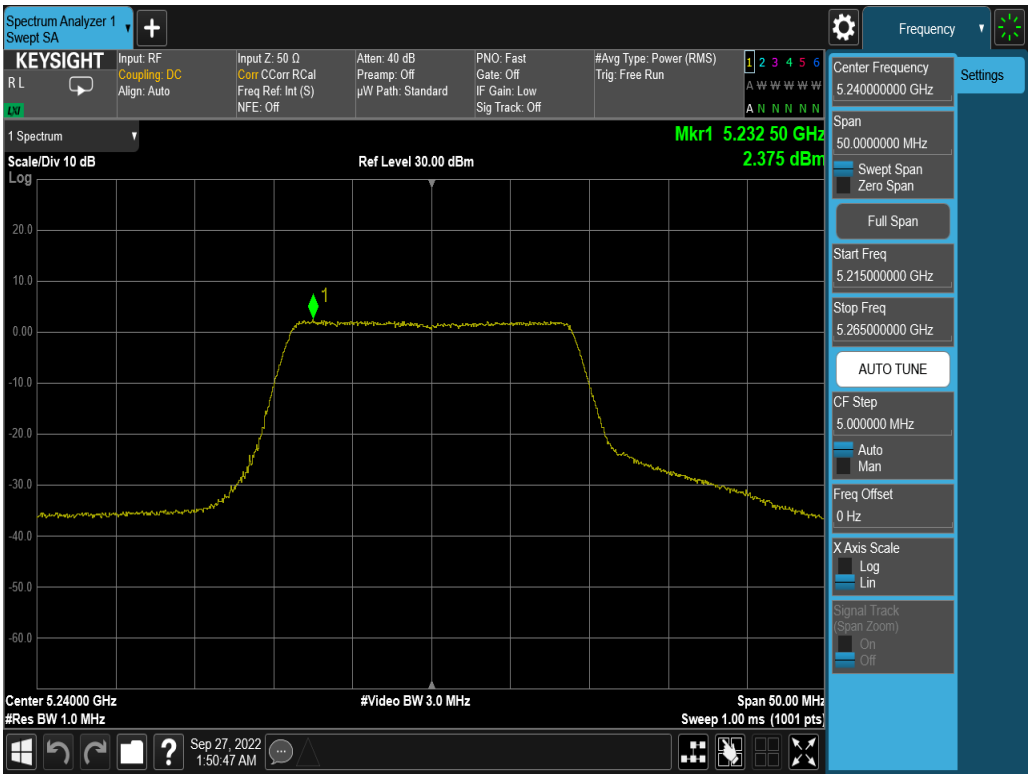
Table 7-10. ISED Band 1 e.i.r.p. Power Spectral Density Measurements



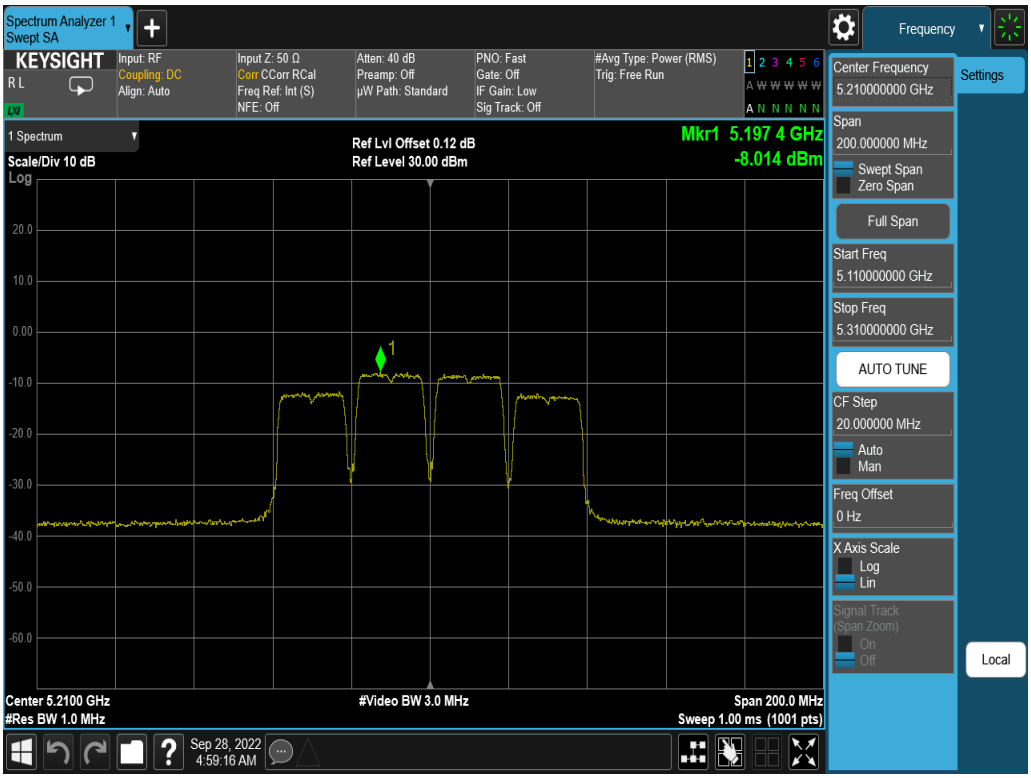
Plot 7-29. ISED PSD (20MHz BW 11n – Ch.36, MCS0)



Plot 7-30. ISED PSD (20MHz BW 11n – Ch.40, MCS0)



Plot 7-31. ISED PSD (20MHz BW 11n – Ch.48, MCS0)



Plot 7-32. ISED PSD (80MHz BW 11ac – Ch.42, MCS0)

Sample e.i.r.p Power Spectral Density Calculation:

At 5180MHz in 802.11n (20MHz BW) mode, the average power density was measured to be 1.38 dBm with antenna gain of 5.10 dBi.

e.i.r.p. Power Spectral Density(dBm) = Power Spectral Density (dBm) + Ant gain (dBi)

1.38 dBm + 5.10 dBi = 6.48 dBm

7.6 Radiated Spurious Emissions – Above 1GHz

§15.407(b) §15.205 §15.209; RSS-Gen [8.9]

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at its maximum duty cycle, at its maximum power control level, as defined in ANSI C63.10-2013 and KDB 789033 D02 v02r01, and at the appropriate frequencies. All channels, modes (e.g. 802.11a, 802.11n, (20MHz BW), and 802.11ac, (80MHz), and modulations/data rates were investigated among all UNII bands. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

For transmitters operating in the 5.15-5.25 GHz and 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of −27 dBm/MHz.

For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an EIRP of −27 dBm/MHz.

For transmitters operating in the 5.725-5.85 GHz band: All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 7 of RSS-Gen (8.10) must not exceed the limits shown in Table 7-11 per Section 15.209 and RSS-Gen (8.9).

Frequency	Field Strength [µV/m]	Measured Distance [Meters]
Above 960.0 MHz	500	3

Table 7-11. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Sections 12.7.7.2, 12.7.6, 12.7.5
KDB 789033 D02 v02r01 – Section G

Test Settings

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = power average (RMS)
5. Number of measurement points = 1001 (Number of points must be ≥ 2 x span/RBW)
6. Averaging type = power (RMS)
7. Sweep time = auto couple
8. Trace was averaged over 100 sweeps

Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

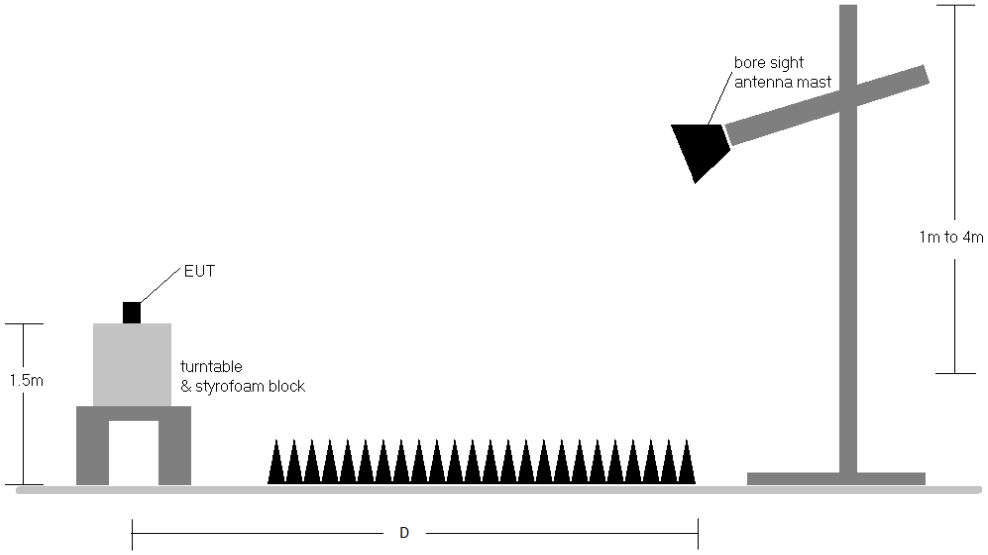


Figure 7-5. Test Instrument & Measurement Setup

Test Notes

1. All emissions that lie in the restricted bands (denoted by a * next to the frequency) specified in §15.205 and Section 8.10 of RSS-Gen are below the limit shown in Table 7-11.
2. All spurious emissions lying in restricted bands specified in §15.205 and Section 8.10 of RSS-Gen are below the limit shown in Table 7-11. All spurious emissions that do not lie in a restricted band are subject to a peak limit of -27dBm/MHz. At a distance of 3 meters, the field strength limit in dBμV/m can be determined by adding a "conversion" factor of 95.2dB to the EIRP limit of -27dBm/MHz to obtain the limit for out of band spurious emissions of 68.2dBμV/m.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through two orthogonal planes.
4. This unit was tested while powered by an AC power source.
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas.
6. D is the measurement test distance and emissions 1-18GHz were measured at a 3 meters test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.
7. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. Any emissions found to be within 20dB of the limit are fully investigated and the results are shown in this section.
8. All data rates were investigated and only the worse case is reported
9. The unit was tested with all possible modes and only the highest emission is reported.
10. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

Sample Calculations

Determining Spurious Emissions Levels

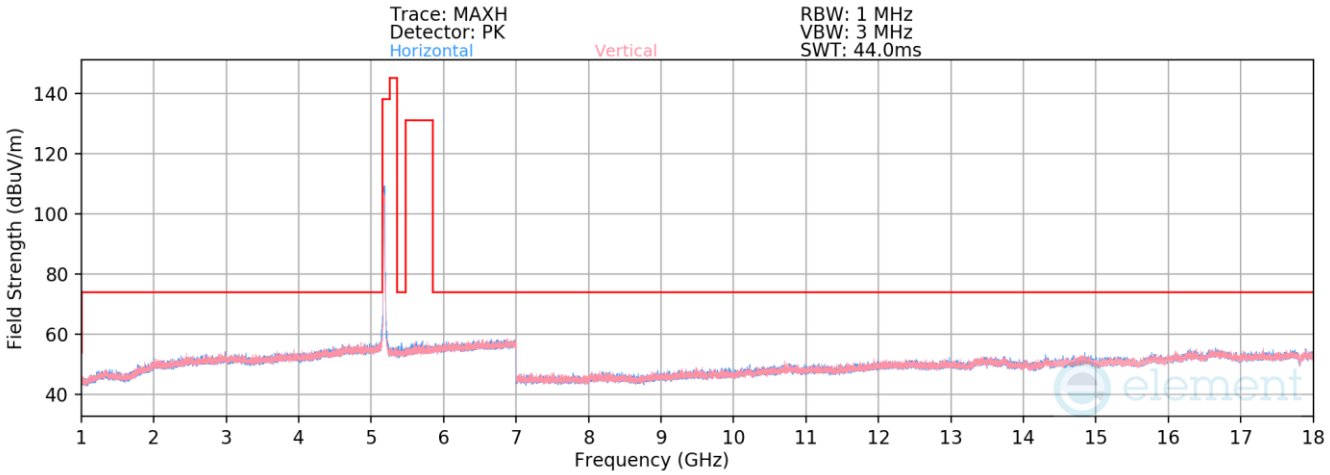
- Field Strength Level [dBμV/m] = Analyzer Level [dBm] + 107 + AFCL [dB/m]
- AFCL [dB/m] = Antenna Factor [dB/m] + Cable Loss [dB] – Preamplifier Gain [dB]
- Margin [dB] = Field Strength Level [dBμV/m] – Limit [dBμV/m]

Radiated Band Edge Measurement Offset

- The amplitude offset shown in the radiated restricted band edge plots in Section 7.6 was calculated using the formula:

  Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain

7.6.1 Radiated Spurious Emissions

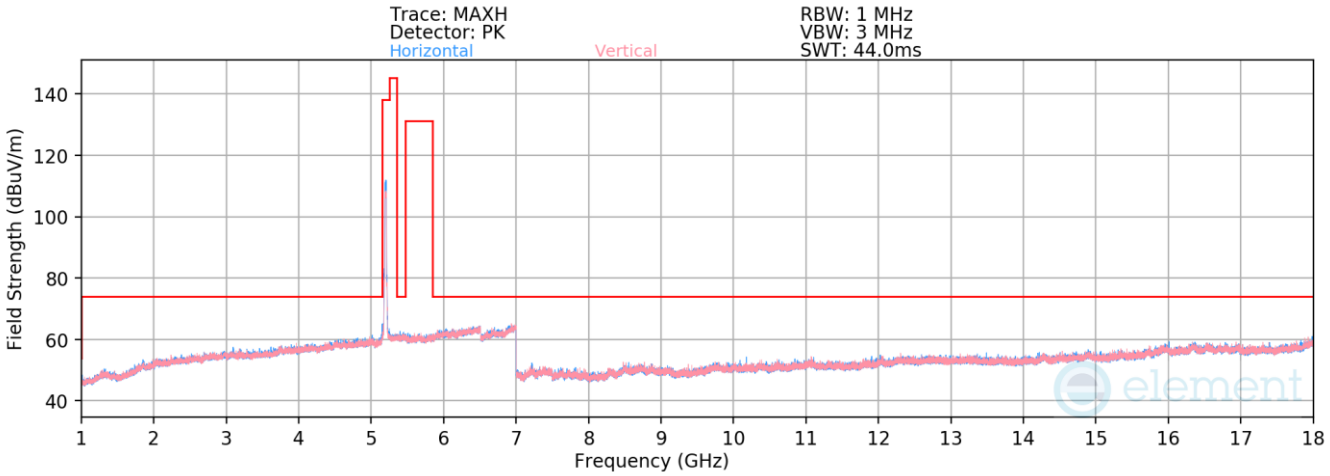


Plot 7-33. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 36)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5180MHz
Channel:	36

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4145.00	Average	-	-	-	-90.25	12.86	29.61	53.98	-24.37
*	4145.00	Peak	-	-	-	-79.08	12.86	40.78	73.98	-33.20
*	5149.00	Average	H	329	188	-70.83	14.78	50.95	53.98	-3.03
*	5149.00	Peak	H	329	188	-58.16	14.78	63.62	73.98	-10.36
*	5420.00	Average	H	255	189	-76.59	15.16	45.57	53.98	-8.41
*	5420.00	Peak	H	255	189	-64.71	15.16	57.45	73.98	-16.53
	10360.00	Peak	-	-	-	-78.23	11.82	40.59	68.20	-27.61
*	15540.00	Average	-	-	-	-89.85	16.04	33.19	53.98	-20.79
*	15540.00	Peak	-	-	-	-78.56	16.04	44.48	73.98	-29.50

Table 7-12. Radiated Spurious Emissions Measurements

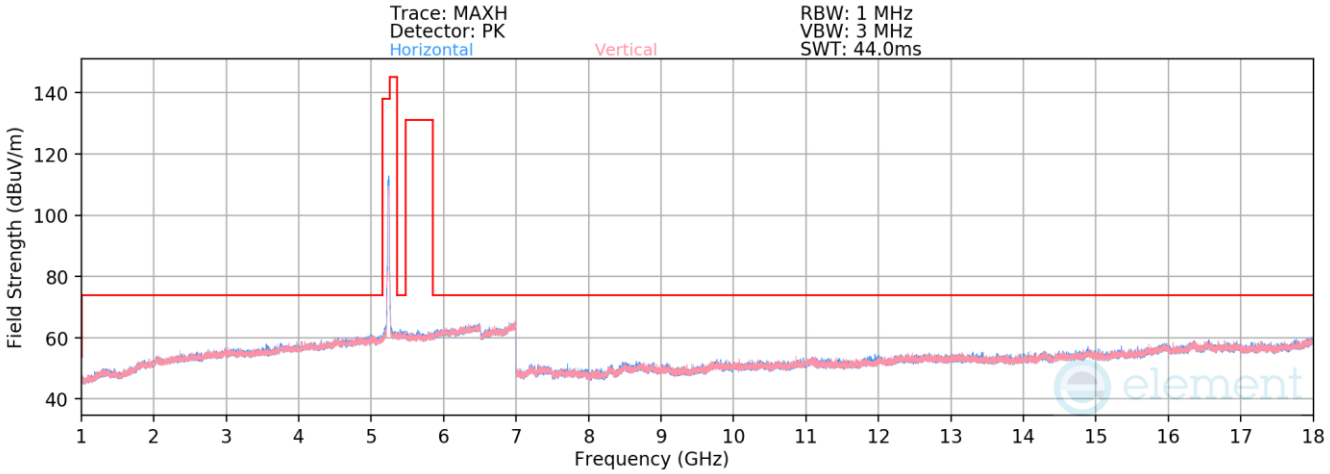


Plot 7-34. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 40)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5200MHz
Channel:	40

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4341.00	Average	H	225	50	-80.04	16.76	43.72	53.98	-10.26
*	4341.00	Peak	H	225	50	-68.47	16.76	55.29	73.98	-18.69
*	5149.00	Average	H	282	191	-74.87	18.86	50.99	53.98	-2.99
*	5149.00	Peak	H	282	191	-61.28	18.86	64.58	73.98	-9.40
*	5361.00	Average	H	336	187	-77.05	19.05	49.00	53.98	-4.98
*	5361.00	Peak	H	336	187	-65.37	19.05	60.68	73.98	-13.30
	10400.00	Peak	-	-	-	-71.91	15.45	50.54	68.20	-17.66
*	15600.00	Peak	-	-	-	-71.05	20.22	56.17	73.98	-17.81
*	15600.00	Average	-	-	-	-82.70	20.22	44.52	53.98	-9.46

Table 7-13. Radiated Spurious Emissions Measurements

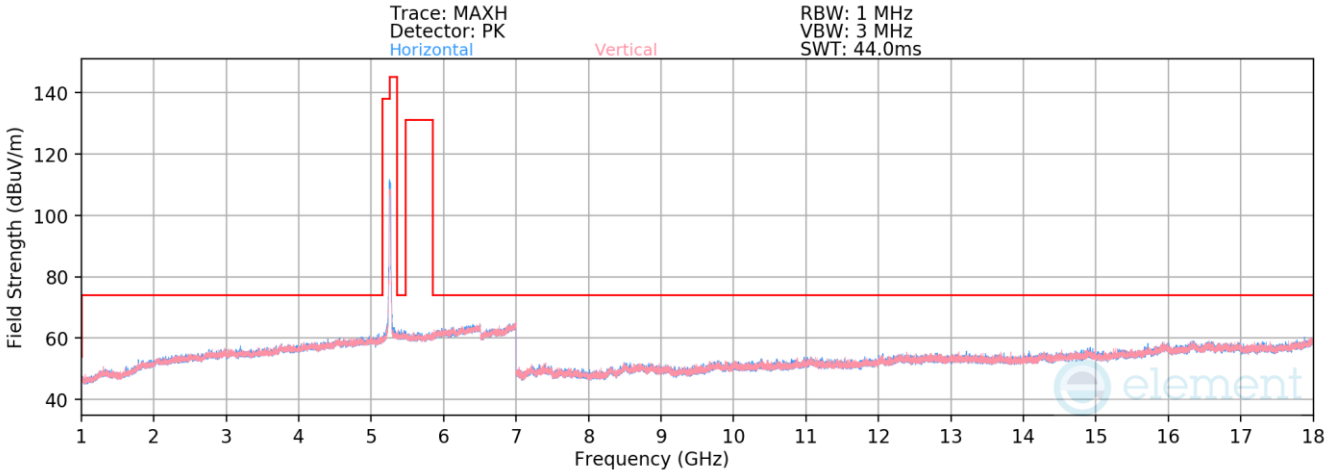


Plot 7-35. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 48)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5240MHz
Channel:	48

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4231.00	Average	H	266	215	-80.23	16.71	43.48	53.98	-10.50
*	4231.00	Peak	H	266	215	-69.09	16.71	54.62	73.98	-19.36
*	5096.00	Average	H	340	188	-76.18	18.63	49.45	53.98	-4.53
*	5096.00	Peak	H	340	188	-63.82	18.63	61.81	73.98	-12.17
*	5439.00	Average	H	270	182	-76.91	19.03	49.12	53.98	-4.86
*	5439.00	Peak	H	270	182	-65.32	19.03	60.71	73.98	-13.27
	10480.00	Peak	-	-	-	-71.40	15.09	50.69	68.20	-17.51
*	15720.00	Peak	-	-	-	-72.53	21.50	55.97	73.98	-18.01
*	15720.00	Average	-	-	-	-83.00	21.50	45.50	53.98	-8.48

Table 7-14. Radiated Spurious Emissions Measurements

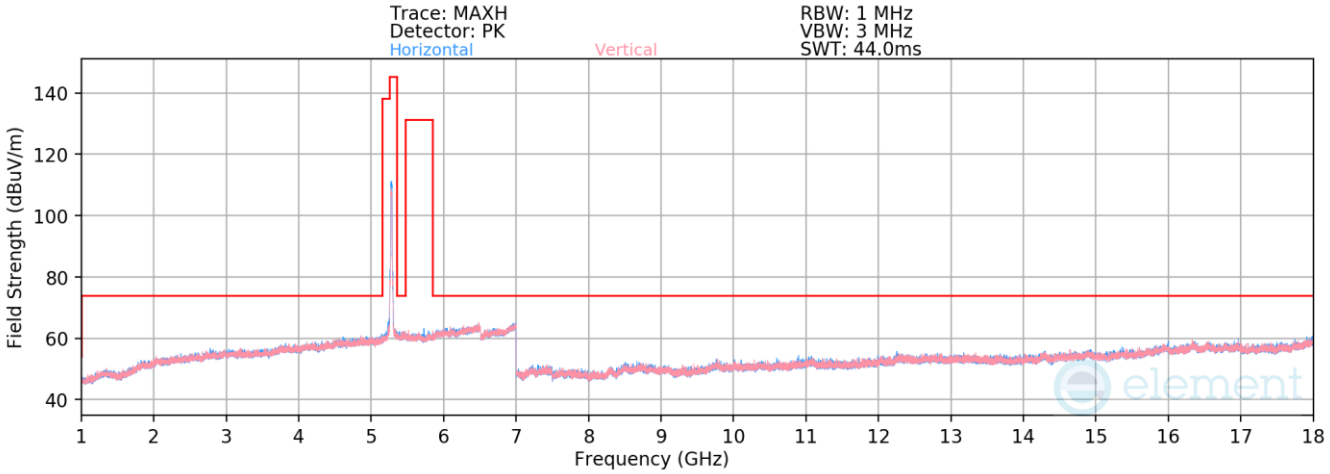


Plot 7-36. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 52)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5260MHz
Channel:	52

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4264.00	Average	V	372	61	-80.08	16.13	43.05	53.98	-10.93
*	4264.00	Peak	V	372	61	-68.66	16.13	54.47	73.98	-19.51
*	5113.00	Average	H	250	194	-76.40	18.70	49.30	53.98	-4.68
*	5113.00	Peak	H	250	194	-64.94	18.70	60.76	73.98	-13.22
*	5356.00	Average	H	266	185	-76.83	19.07	49.24	53.98	-4.74
*	5356.00	Peak	H	266	185	-64.68	19.07	61.39	73.98	-12.59
	10520.00	Peak	-	-	-	-71.46	14.85	50.39	68.20	-17.81
*	15780.00	Peak	-	-	-	-72.10	20.56	55.46	73.98	-18.52
*	15780.00	Average	-	-	-	-82.82	20.56	44.74	53.98	-9.24

Table 7-15. Radiated Spurious Emissions Measurements

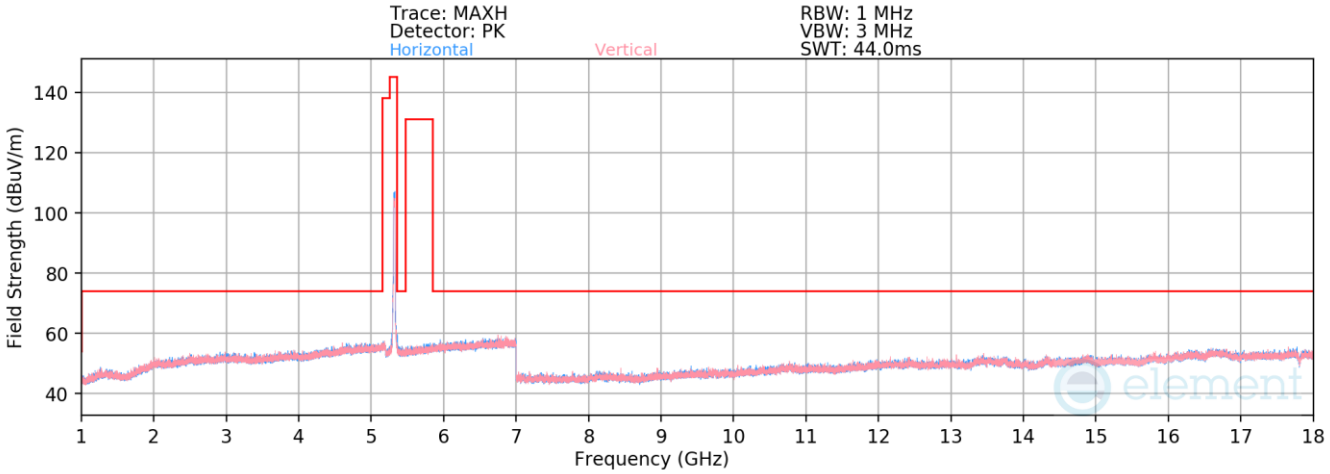


Plot 7-37. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 56)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5280MHz
Channel:	56

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4209.00	Average	V	258	357	-80.13	16.59	43.46	53.98	-10.52
*	4209.00	Peak	V	258	357	-68.70	16.59	54.89	73.98	-19.09
*	5072.00	Average	H	278	197	-76.34	18.49	49.15	53.98	-4.83
*	5072.00	Peak	H	278	197	-64.82	18.49	60.67	73.98	-13.31
*	5351.00	Average	H	352	185	-76.11	19.10	49.99	53.98	-3.99
*	5351.00	Peak	H	352	185	-62.89	19.10	63.21	73.98	-10.77
	10560.00	Peak	-	-	-	-71.69	15.23	50.54	68.20	-17.66
*	15840.00	Peak	-	-	-	-72.02	20.87	55.85	73.98	-18.13
*	15840.00	Average	-	-	-	-82.63	20.87	45.24	53.98	-8.74

Table 7-16. Radiated Spurious Emissions Measurements

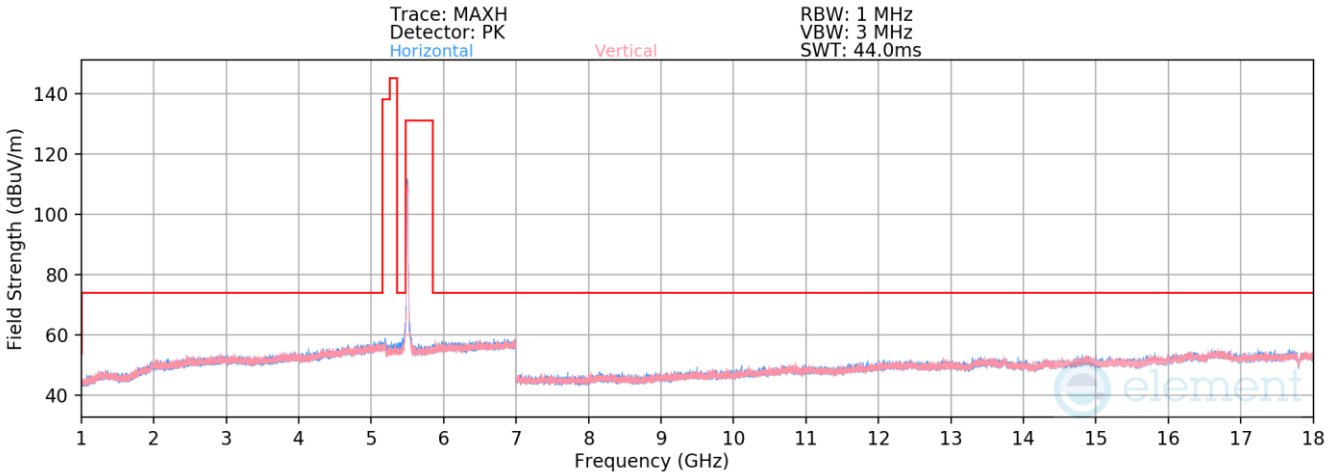


Plot 7-38. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 64)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5320MHz
Channel:	64

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4260.00	Average	-	-	-	-79.24	13.39	41.15	53.98	-12.83
*	4260.00	Peak	-	-	-	-67.45	13.39	52.94	73.98	-21.04
*	4970.00	Average	V	210	87	-75.82	14.38	45.56	53.98	-8.42
*	4970.00	Peak	V	210	87	-64.52	14.38	56.86	73.98	-17.12
*	5350.00	Average	V	360	141	-71.66	15.40	50.74	53.98	-3.24
*	5350.00	Peak	V	360	141	-59.27	15.40	63.13	73.98	-10.85
*	10640.00	Average	-	-	-	-80.95	12.01	38.06	53.98	-15.92
*	10640.00	Peak	-	-	-	-70.42	12.01	48.59	73.98	-25.39
*	15960.00	Average	-	-	-	-82.85	16.67	40.82	53.98	-13.16
*	15960.00	Peak	-	-	-	-71.22	16.67	52.45	73.98	-21.53

Table 7-17. Radiated Spurious Emissions Measurements

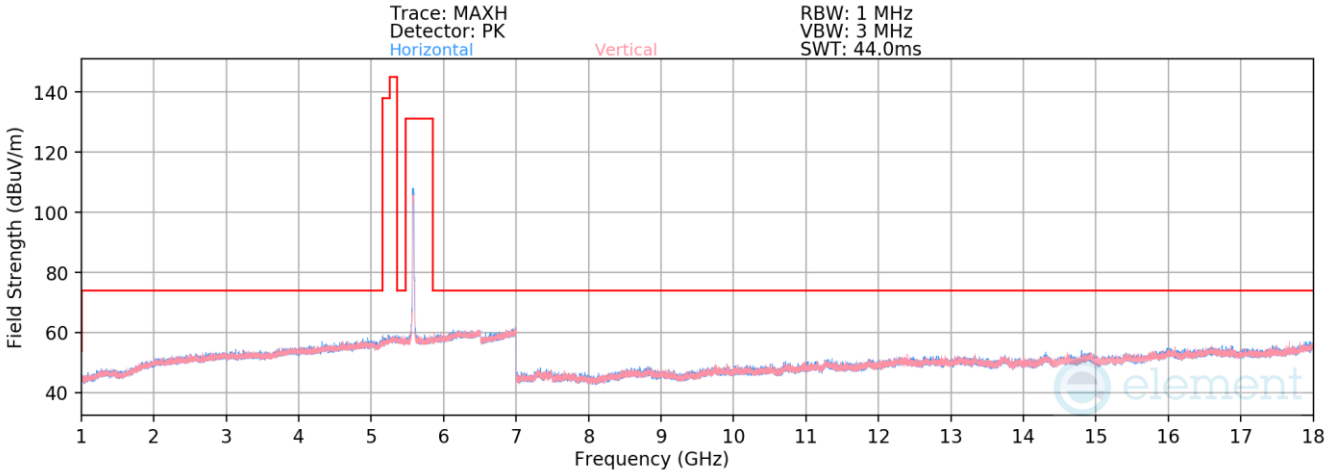


Plot 7-39. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 100)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5500MHz
Channel:	100

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4294.00	Average	H	-	-	-79.36	13.53	41.17	53.98	-12.81
*	4294.00	Peak	H	-	-	-68.40	13.53	52.13	73.98	-21.85
*	5078.00	Average	H	280	200	-73.82	14.52	47.70	53.98	-6.28
*	5078.00	Peak	H	280	200	-62.17	14.52	59.35	73.98	-14.63
*	5458.00	Average	H	276	191	-71.25	15.09	50.84	53.98	-3.14
*	5458.00	Peak	H	276	191	-55.74	15.09	66.35	73.98	-7.63
*	11000.00	Average	H	227	194	-80.78	12.86	39.08	53.98	-14.90
*	11000.00	Peak	H	227	194	-69.30	12.86	50.56	73.98	-23.42
	16500.00	Peak	H	-	-	-71.25	17.20	52.95	68.20	-15.25

Table 7-18. Radiated Spurious Emissions Measurements

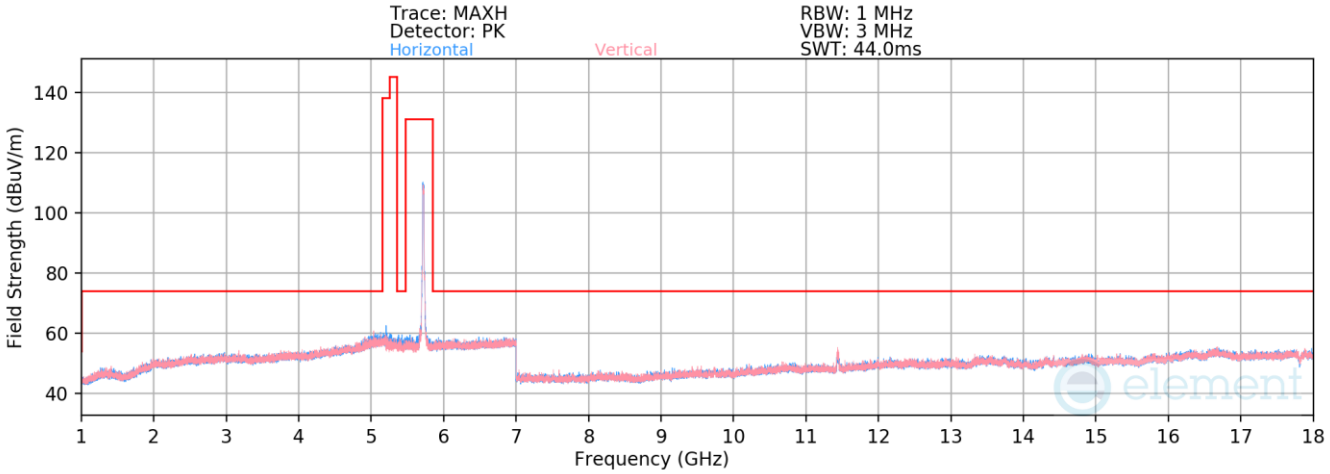


Plot 7-40. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 116)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5580Hz
Channel:	116

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4217.00	Average	H	-	-	-81.15	16.63	42.48	53.98	-11.50
*	4217.00	Peak	H	-	-	-68.64	16.63	54.99	73.98	-18.99
*	5071.00	Average	H	280	194	-75.34	18.47	50.13	53.98	-3.85
*	5071.00	Peak	H	280	194	-51.96	18.47	60.62	73.98	-13.36
*	5352.00	Average	H	258	192	-75.39	19.09	50.70	53.98	-3.28
*	5352.00	Peak	H	258	192	-64.71	19.09	61.38	73.98	-12.60
*	11160.00	Average	H	225	212	-79.24	15.72	43.48	53.98	-10.50
*	11160.00	Peak	H	225	212	-68.00	15.72	54.72	73.98	-19.26
	16740.00	Peak	H	-	-	-73.52	21.49	54.97	68.20	-13.23

Table 7-19. Radiated Spurious Emissions Measurements

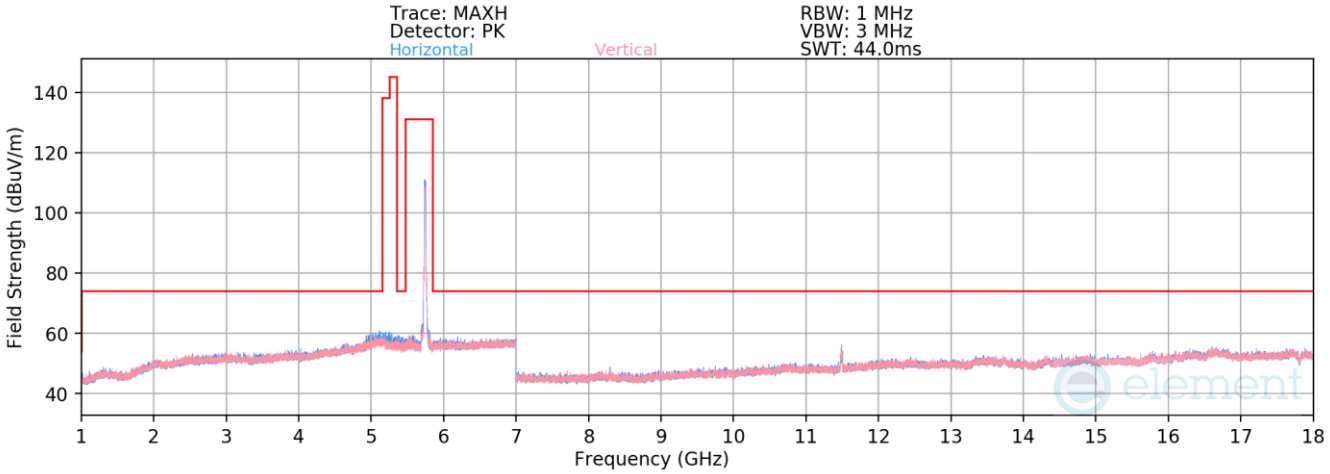


Plot 7-41. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 144)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5720
Channel:	144

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4293.00	Average	V	259	90	-76.29	13.54	44.25	53.98	-8.73
*	4293.00	Peak	V	259	90	-65.63	13.54	54.91	73.98	-19.07
*	5100.00	Average	H	292	197	-70.77	14.55	50.78	53.98	-3.20
*	5100.00	Peak	H	292	197	-58.24	14.55	63.31	73.98	-10.67
*	5355.00	Average	H	305	189	-72.89	15.38	49.49	53.98	-4.49
*	5355.00	Peak	H	305	189	-60.97	16.38	61.41	73.98	-12.57
*	11440.00	Average	H	272	214	-73.92	13.34	46.42	53.98	-7.56
*	11440.00	Peak	H	272	214	-63.04	13.34	57.30	73.98	-16.68
	17160.00	Peak	-	-	-	-72.15	17.60	52.45	68.20	-15.75

Table 7-20. Radiated Spurious Emissions Measurements

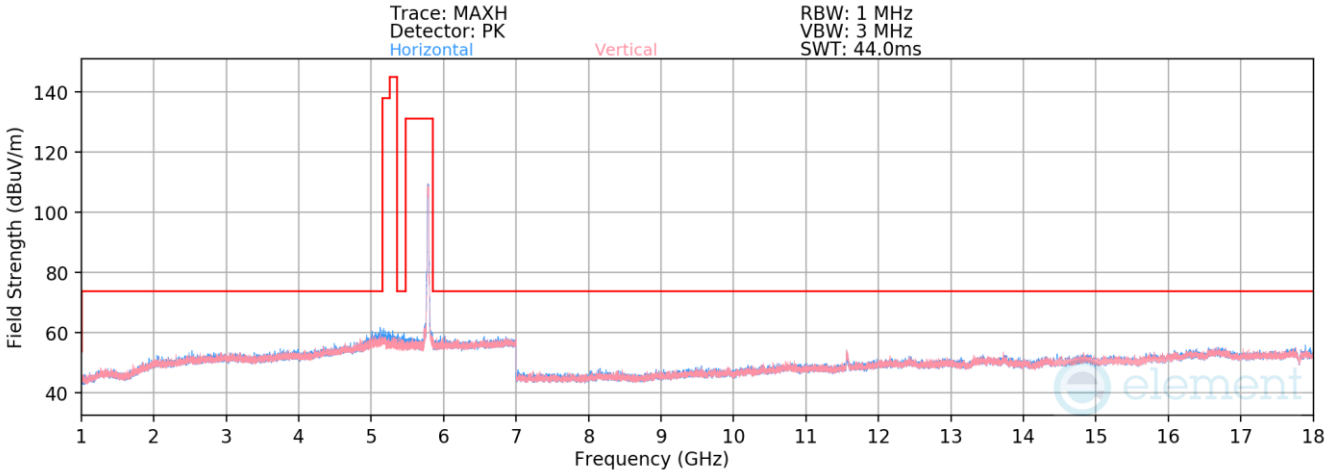


Plot 7-42. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 149)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5745MHz
Channel:	149

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4317.00	Average	V	263	84	-75.43	13.92	45.49	53.98	-8.49
*	4317.00	Peak	V	263	84	-65.28	13.92	55.64	73.98	-18.34
*	5120.00	Average	H	343	193	-70.81	14.49	50.68	53.98	-3.30
*	5120.00	Peak	H	343	193	-58.45	14.49	63.04	73.98	-10.94
*	5361.00	Average	H	284	186	-72.50	15.34	49.84	53.98	-4.14
*	5361.00	Peak	H	284	186	-59.29	15.34	63.05	73.98	-10.93
*	11490.00	Average	H	267	213	-73.66	13.20	46.54	53.98	-7.44
*	11490.00	Peak	H	267	213	-62.18	13.20	58.02	73.98	-15.96
	17235.00	Peak	-	-	-	-72.11	17.48	52.37	68.20	-15.83

Table 7-21. Radiated Spurious Emissions Measurements

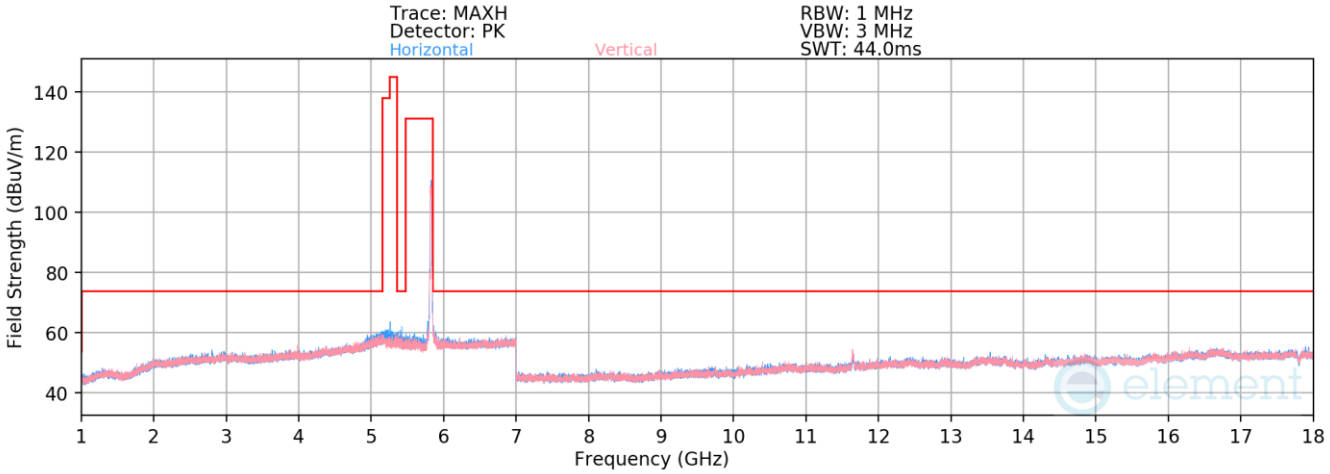


Plot 7-43. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 157)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5785MHz
Channel:	157

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4347.00	Average	V	276	93	-74.95	13.74	45.79	53.98	-8.19
*	4347.00	Peak	V	276	93	-64.02	13.74	56.72	73.98	-17.26
*	5125.00	Average	H	345	190	-70.80	14.56	50.76	53.98	-3.22
*	5125.00	Peak	H	345	190	-58.14	14.56	63.42	73.98	-10.56
*	5351.00	Average	H	280	188	-72.07	15.40	50.33	53.98	-3.65
*	5351.00	Peak	H	280	188	-59.48	15.40	62.92	73.98	-11.06
*	11570.00	Average	H	268	213	-74.54	13.59	46.05	53.98	-7.93
*	11570.00	Peak	H	268	213	-63.22	13.59	57.37	73.98	-16.61
	17355.00	Peak	-	-	-	-72.51	17.68	52.17	68.20	-16.03

Table 7-22. Radiated Spurious Emissions Measurements



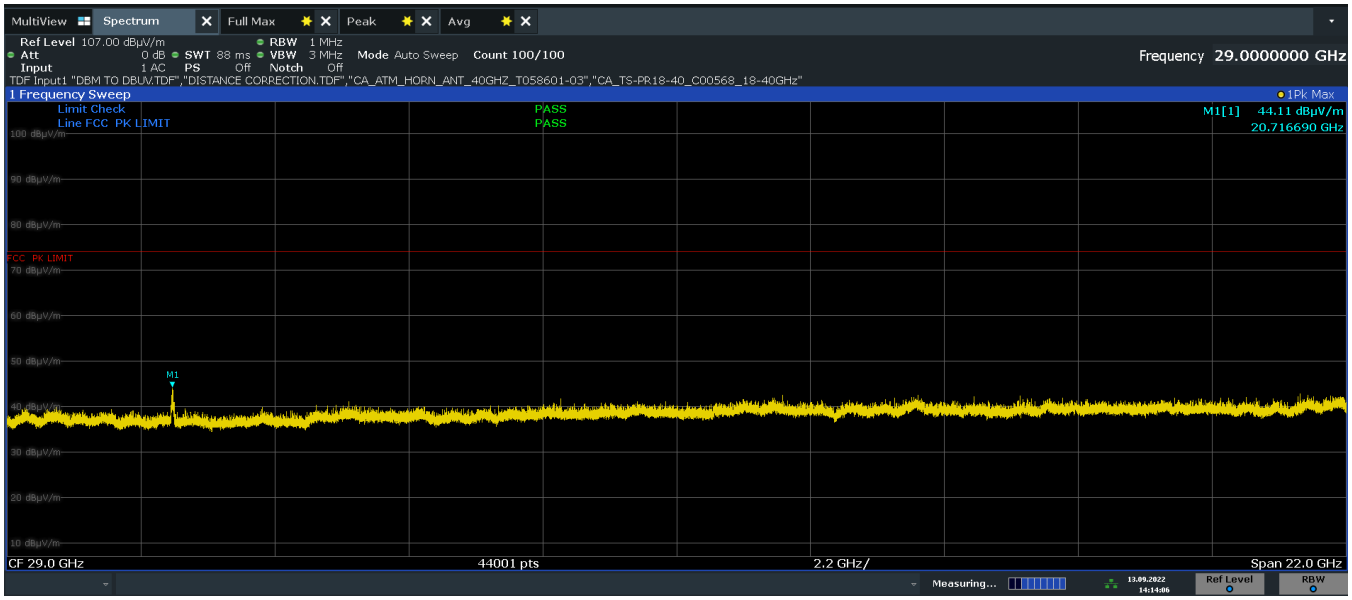
Plot 7-44. Radiated Spurious Emissions above 1GHz (802.11n – Ch. 165)

Mode:	802.11n
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5825MHz
Channel:	165

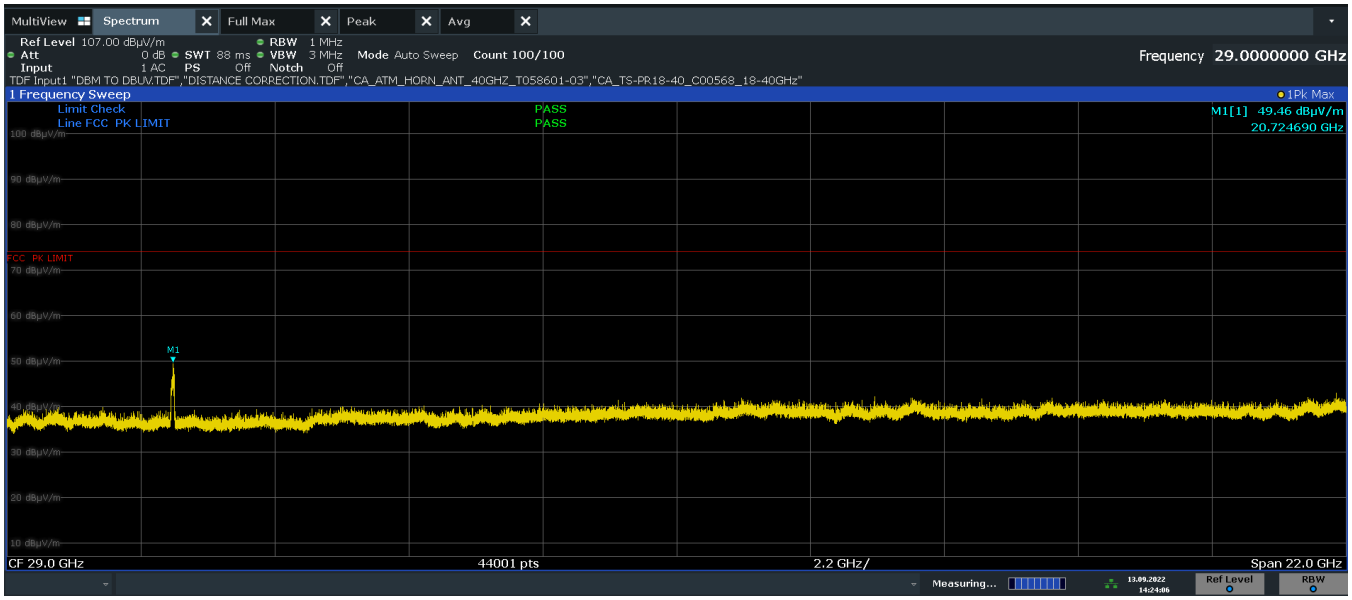
	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	4377.00	Average	V	349	88	-74.07	13.85	46.78	53.98	-7.20
*	4377.00	Peak	V	349	88	-64.35	13.85	56.50	73.98	-17.48
*	5117.00	Average	H	346	197	-70.61	14.48	50.87	53.98	-3.11
*	5117.00	Peak	H	346	197	-60.36	14.48	61.12	73.98	-12.86
*	5377.00	Average	H	354	191	-71.49	15.22	50.73	53.98	-3.25
*	5377.00	Peak	H	354	191	-59.73	15.22	62.49	73.98	-11.49
*	11650.00	Average	H	259	214	-76.98	13.65	43.67	53.98	-10.31
*	11650.00	Peak	H	259	214	-65.83	13.65	54.82	73.98	-19.16
	17475.00	Peak	H	-	-	-70.80	18.16	54.36	68.20	-13.84

Table 7-23. Radiated Spurious Emissions Measurements

7.6.2 Radiated Spurious Emissions Measurements (Above 18GHz)



Plot 7-45. Radiated Spurious Emissions Above 18GHz (802.11n – Ch. 36, Ant. Pol H)



Plot 7-46. Radiated Spurious Emissions Above 18GHz (802.11n – Ch. 36, Ant. Pol V)

	Frequency [GHz]	Detector	Ant. Pol. [H/V]	Positioner [degree]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	20.72	Average	V	6	225	-51.69	-7.45	-9.54	38.32	53.98	-15.66
*	20.72	Peak	V	6	225	-40.00	-7.45	-9.54	50.01	73.98	-23.97

Table 7-24. Radiated Spurious Emissions Above 18GHz Measurements