MET Laboratories, Inc. ***Safety Certification - EMI - Telecom Environmental Simulation***

914 WEST PATAPSCO AVENUE ● BALTIMORE, MARYLAND 21230-3432 ● PHONE (410) 354-3300 ● FAX (410) 354-3313
33439 WESTERN AVENUE ● UNION CITY, CALIFORNIA 94587 ● PHONE (510) 489-6300 ● FAX (510) 489-6372
3162 BELICK STREET ● SANTA CLARA, CALIFORNIA 95054 ● PHONE (408) 748-3585 ● FAX (510) 489-6372
13501 MCCALLEN PASS ● AUSTIN, TX 78753 ● PHONE (512) 287-2500 ● FAX (512) 287-2513

December 19, 2017

Weir Group Management Services
1 West Regent Street
Glasgow, Scotland G2 1RW

Dear Wayne Cooke,

Enclosed is the EMC Wireless test report for compliance testing of the Weir Group Management Services, Weir Industrial Gateway as tested to the requirements of Title 47 of the CFR, Ch. 1, Title 47 of the CFR, Part 15.407, Subpart E (UNII 1).

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Joel Huna
Documentation Department

Reference: (\Weir Group Management Services\ EMCA92659-FCC407 UNII 1 Rev. 1)

ACCREDITED
TESTING CERT #0591.06

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Electromagnetic Compatibility Criteria
Test Report

for the

Weir Group Management Services
Model Weir Industrial Gateway

Tested under
The FCC Certification Rules
contained in
Title 47 of the CFR
15.407 Subpart E

MET Report: EMCA92659-FCC407 UNII 1 Rev. 1

December 19, 2017

Prepared For:

Weir Group Management Services
1 West Regent Street
Glasgow, Scotland G2 1RW

Prepared By:
MET Laboratories, Inc.
13501 McCallen Pass,
Austin TX 78753

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15.407 Subpart E

Giuliano Messina, Project Engineer
Electromagnetic Compatibility Lab

Joel Huna
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Parts 15B, 15.407, of the FCC Rules under normal use and maintenance.

John Mason,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	November 29, 2017	Initial Issue.
1	December 19, 2017	Engineer Corrections and Customer Name Update.

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**K**ilo**h**ert**z**
kPa	**K**ilo**pa**scal
kV	**K**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**Microh**enry
µ	**Microf**arad
µs	**Micros**econds
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Weir Group Management Services Weir Industrial Gateway, with the requirements of Part 15, §15.407. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Weir Industrial Gateway. Weir Group Management Services should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Weir Industrial Gateway, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.407, in accordance with Weir Group Management Services, purchase order number T10536863. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference	Description	Results
§15.203	Antenna Requirement	Compliant
§15.403(i)	26dB Occupied Bandwidth	Compliant
§15.407	Duty Cycle	Compliant
§15.407 (a)(1)	Maximum Conducted Output Power	Compliant
§15.407 (a)(1)	Maximum Power Spectral Density	Compliant
§15.407 (b)(1)& (6 - 7)	Undesirable Emissions	Compliant
§15.407(b)(6)	Conducted Emission Limits	Compliant
§15.407(c)	Automatic Discontinue of Transmitter	Not Applicable
§15.407(f)	RF Exposure	Compliant
§15.407(g)	Frequency Stability	Not Applicable

Table 1. Executive Summary of EMC Part 15.407 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Weir Group Management Services to perform testing on the Weir Industrial Gateway, under Weir Group Management Services's purchase order number T10536863.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Weir Group Management Services Weir Industrial Gateway.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	Weir Industrial Gateway	
Model(s) Covered:	Weir Industrial Gateway	
EUT Specifications:	Primary Power: 120/240VAC 50/60 Hz	
	FCC ID: 2ANXR-STXMPM	
	Type of Modulations:	OFDM
	Equipment Code:	NII
	Max. RF Output Power:	9.29 dBm, 8.49 mW
	Max. EIRP:	-32.53 dBm @ 802.11ac HT40, 5190 MHz
	EUT Frequency Ranges:	5180 – 5240 MHz
	Duty Cycle:	802.11a: 90.8% max 802.11n: 87.4% max 802.11ac: 69.8% max
	Data rates:	1M **(worst case)**, 2M, 5.5M, 11M, 22M, 6M, 9M, 12M, 18M, 24M, 36M, 48M, 54M, 72M, MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7, MCS8, MCS9, MCS10, MCS11, MCS12, MCS13, MCS14, MCS15, VHT_SS1_MCS0, VHT_SS1_MCS1, VHT_SS1_MCS2, VHT_SS1_MCS3, VHT_SS1_MCS4, VHT_SS1_MCS5, VHT_SS1_MCS6, VHT_SS1_MCS7, VHT_SS1_MCS8, VHT_SS1_MCS9, VHT_SS2_MCS0, VHT_SS2_MCS1, VHT_SS2_MCS2, VHT_SS2_MCS3, VHT_SS2_MCS4, VHT_SS2_MCS5, VHT_SS2_MCS6, VHT_SS2_MCS7, VHT_SS2_MCS8, VHT_SS2_MCS9
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Type of Filing:	Original	
Evaluated by:	Giuliano Messina	
Report Date(s):	December 19, 2017	

Table 2. EUT Summary

B. References

CFR 47, Part 15, Subpart E	Unlicensed National Information Infrastructure Devices (UNII)
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
KDB 789033 D02 General UNII Test Procedures New Rules v01r04	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 13501 McCallen Pass, Austin TX 78753. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 10 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

MET Laboratories is a ISO/IEC 17025 accredited site by A2LA. Austin #0591.06.

D. Description of Test Sample

The Weir Group Management Services Weir Industrial Gateway, Equipment Under Test (EUT), is used to monitor the operation of the components of a drilling rig, in particular the sound and vibration from the bearings in the system. This is monitored through digital signal processing to determine if the bearing is nearing the end of its life and needs to be replaced.

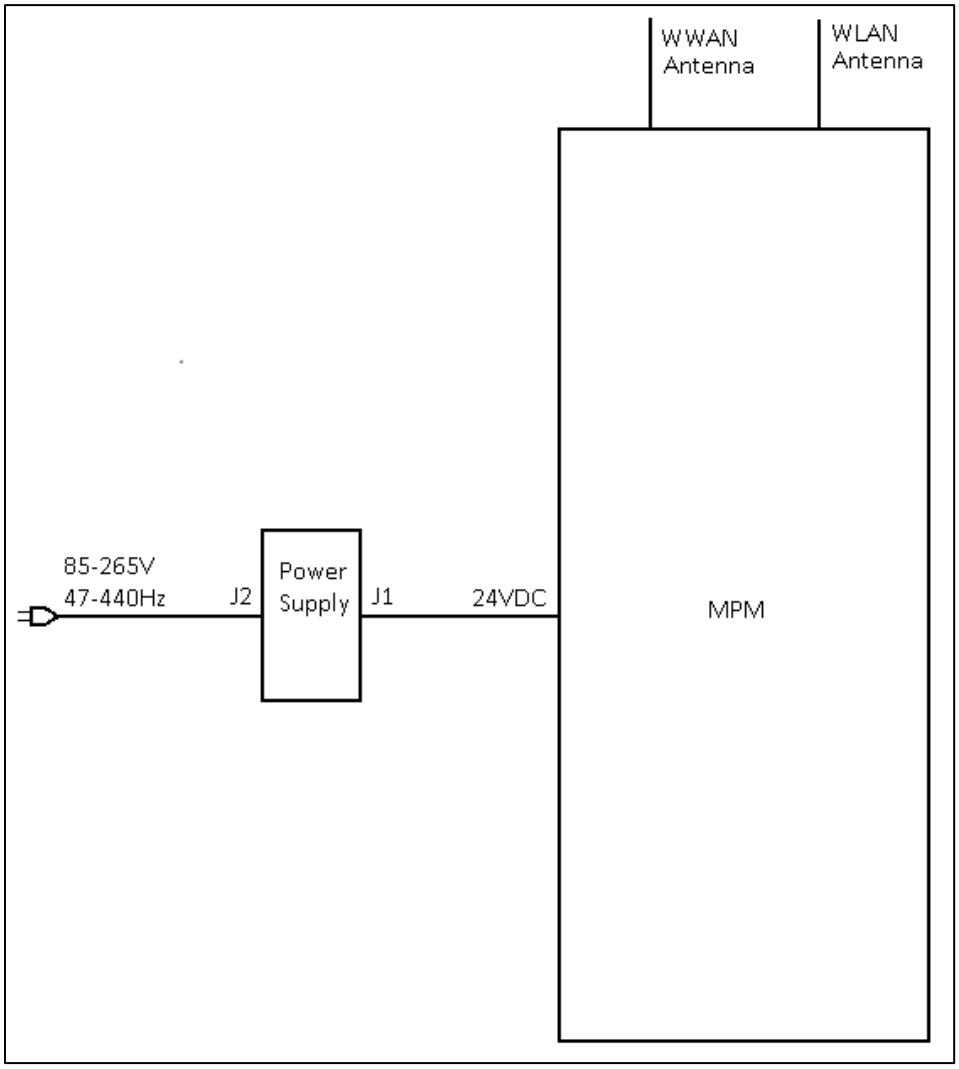


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Serial Number	Rev. #
A	Power Supply	CH-SAN500AC-24	161103	01
B	MPM	North America: STX-000004	006	01
P	Antenna	MY-0W4VW8-74431-5CM-0668-A00	N/A	N/A

Table 4. Equipment Configuration

F. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
E	Ethernet Switch	Netgear	N300	N/A
F	External Laptop	Dell	Latitude E5570	N/A
The 'Customer Supplied Calibration Data' column will be marked as either not applicable, not available, or will contain the calibration date supplied by the customer.				

Table 5. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded ? (Y/N)	Termination Box ID & Port Name
1	AC Input	3 conductor, bare wires at AC Mains end, 14 AWG	1	10	50	No	Power Box.J2
2	24VDC	4 conductor, 14 AWG	1	2	50	No	Power Box.J1
9	LAN	8 conductor, 20 AWG	1	5	50	Yes	Ethernet switch
33	MPM	Antenna cable, 1 conductor, coax, CA120/195-XC	1	10	10	Yes	Antenna

Table 6. Ports and Cabling Information

H. Mode of Operation

Custom software (Labtool) will exercise the transmitter and display the system performance via ethernet link to be monitored by an external laptop.

I. Method of Monitoring EUT Operation

An external laptop with an ethernet link will monitor the system and display the system performance.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Weir Group Management Services upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall 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 manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The EUT as tested is compliant the criteria of §15.203.

EUT is professionally installed only.

Test Engineer(s): Giuliano Messina

Test Date(s): May19, 2017

Gain (dBi)	Type	Model	Manufacturer
9	Dipole	PDV24515-DE1	Laird

Table 7. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 403(i) 26dB Bandwidth

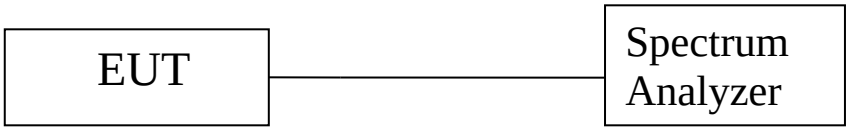
Test Requirements: **§ 15.403(i):** For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1-5% of the emission bandwidth of the device under measurement.

Test Procedure: The transmitter was set to low, mid, and high operating frequencies at the highest output power and connected to the spectrum analyzer through a cable. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1-5% of the total emission bandwidth, VBW > RBW. The 26 dB Bandwidth was measured and recorded.

Test Results The 26 dB Bandwidth was compliant with the requirements of this section.

Test Engineer(s): Giuliano Messina

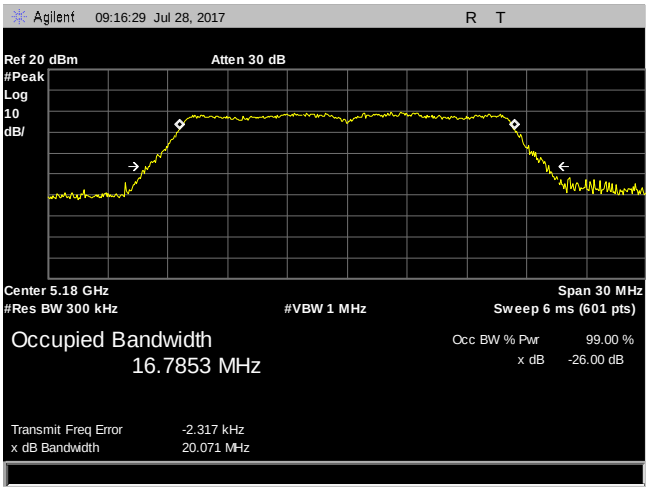
Test Date(s): May 1, 2017



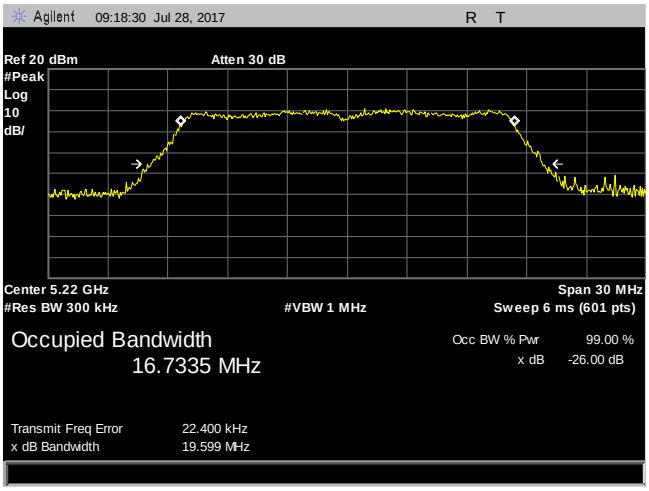
BW	Mode	Freq (MHz)	Path A		Path B	
			99% (MHz)	-26dB (MHz)	99% (MHz)	-26dB (MHz)
20	A	5180	16.7853	20.071	16.7564	19.838
		5220	16.7335	19.599	16.7063	19.567
		5240	16.6963	19.844	16.7114	19.946
20	N	5180	17.7204	20.404	17.7000	20.247
		5220	17.7184	20.189	17.7019	20.179
		5240	17.7009	20.331	17.6736	20.236
40		5190	36.4565	41.684	36.3084	41.370
		5230	36.2809	41.360	36.3192	41.315
20	AC	5180	17.7028	20.344	17.6695	20.102
		5220	17.6967	20.365	17.6703	20.223
		5240	17.6794	20.278	17.6631	20.213
40		5190	36.3606	41.242	36.2955	40.982
		5230	36.3703	41.226	36.2935	41.459
80		5210	76.0449	81.624	76.0920	81.682

Table 8. 26 dB Occupied Bandwidth, Value Table

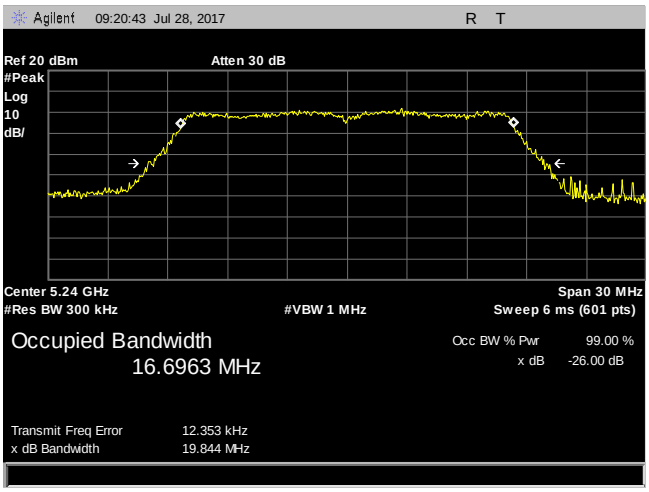
26 dB Bandwidth Path A



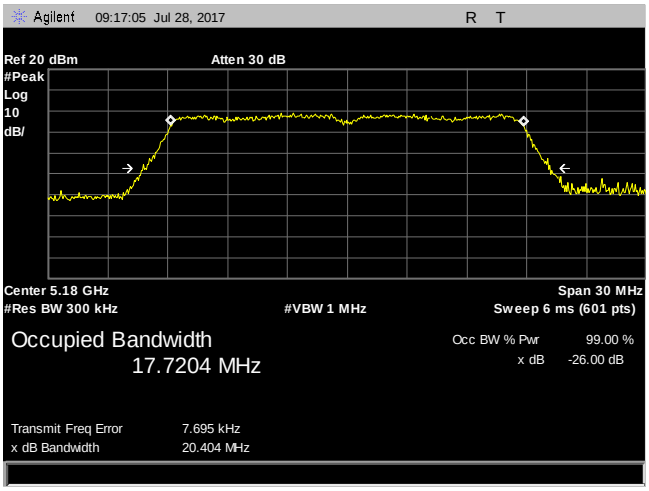
Plot 1. 26 dB Occupied Bandwidth, 802.11a 20 – 5180 – Path A



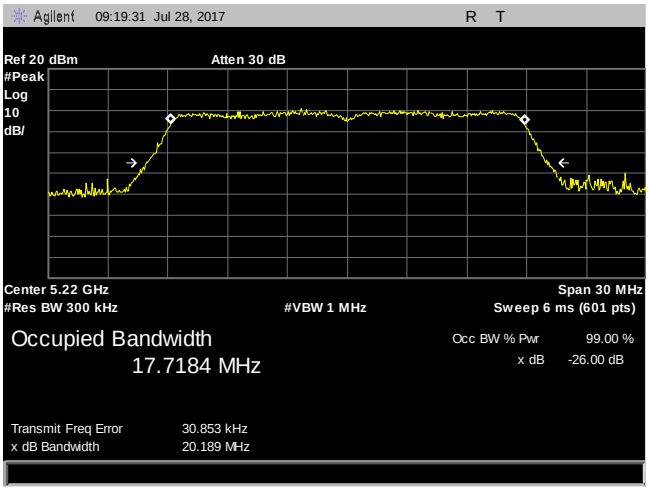
Plot 2. 26 dB Occupied Bandwidth, 802.11a 20 – 5220 – Path A



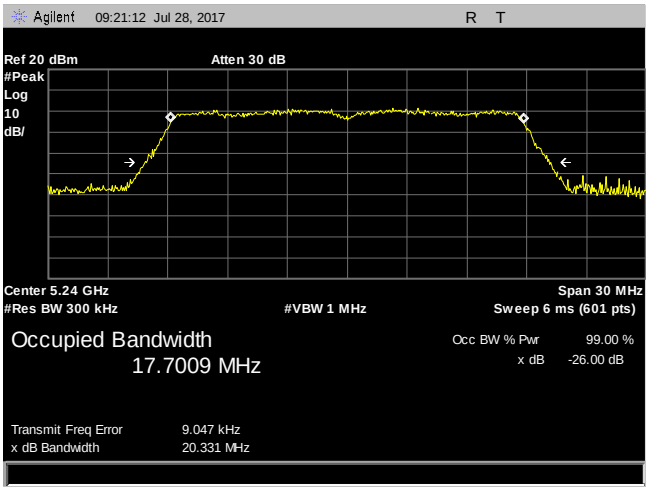
Plot 3. 26 dB Occupied Bandwidth, 802.11a 20 – 5240 – Path A



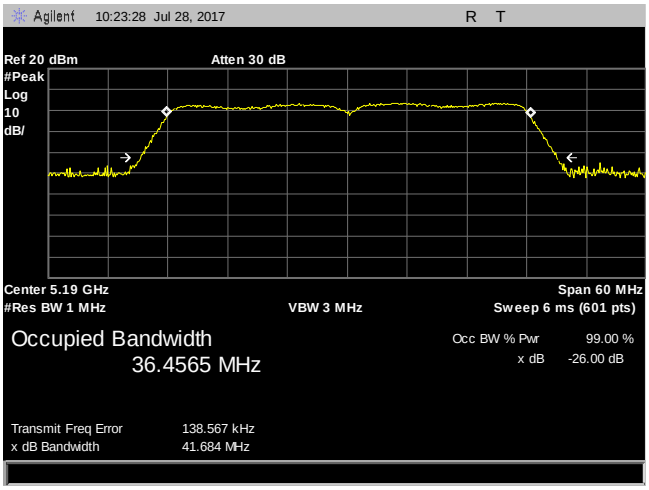
Plot 4. 26 dB Occupied Bandwidth, 802.11n 20 – 5180 – Path A



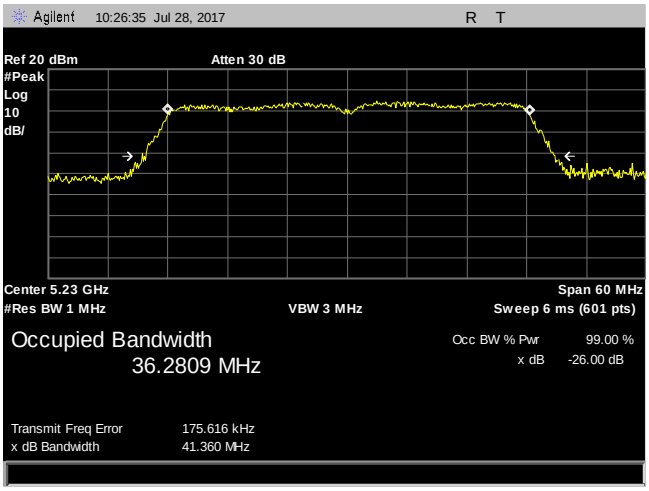
Plot 5. 26 dB Occupied Bandwidth, 802.11n 20 – 5220 – Path A



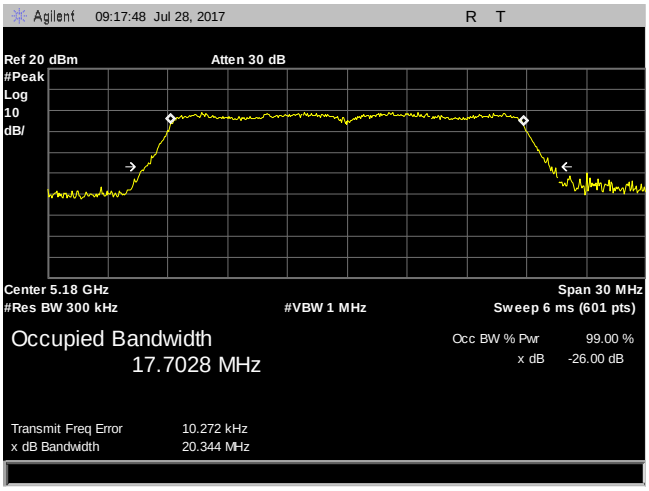
Plot 6. 26 dB Occupied Bandwidth, 802.11n 20 – 5240 – Path A



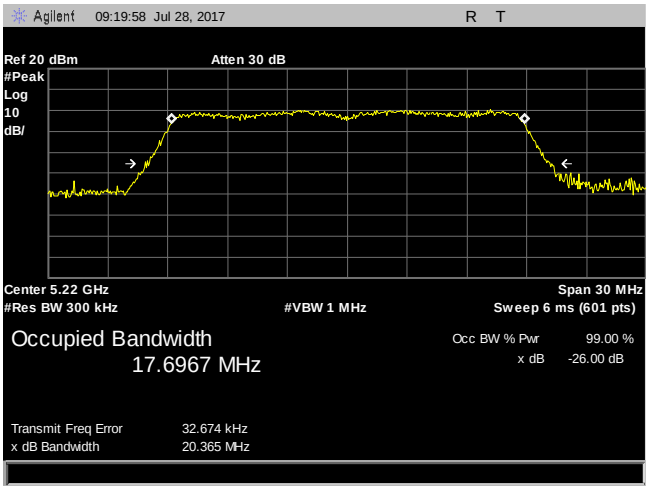
Plot 7. 26 dB Occupied Bandwidth, 802.11n 40 – 5190 – Path A



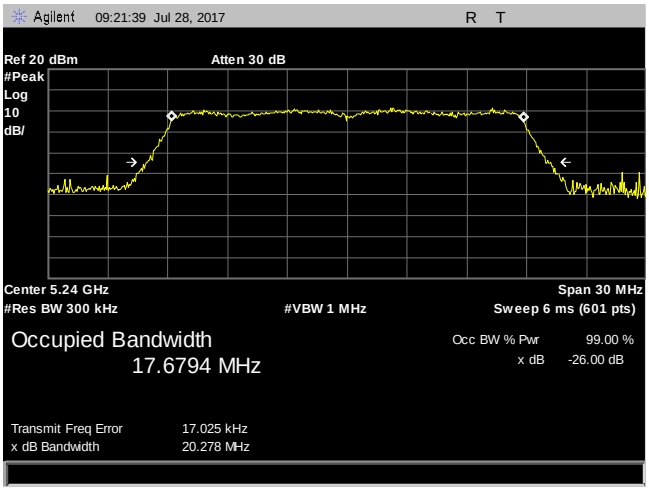
Plot 8. 26 dB Occupied Bandwidth, 802.11n 40 – 5230 – Path A



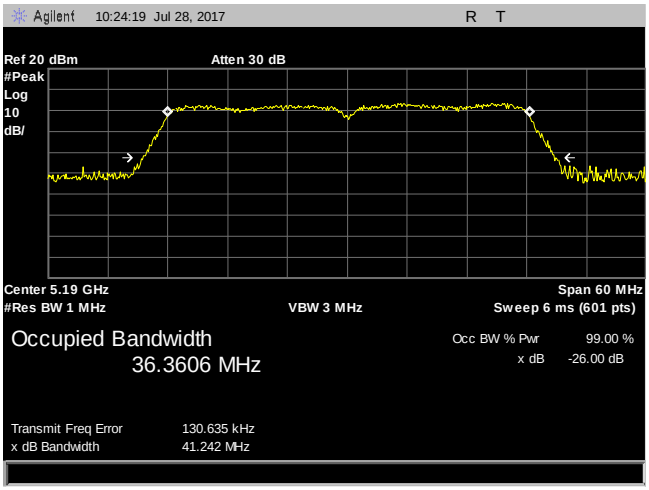
Plot 9. 26 dB Occupied Bandwidth, 802.11ac 20 – 5180 – Path A



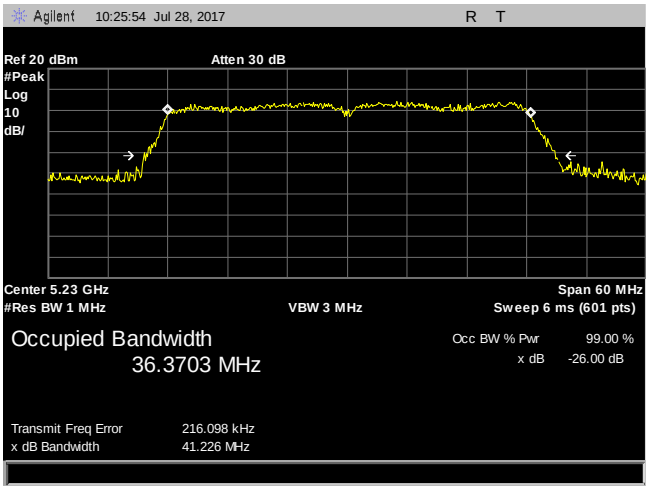
Plot 10. 26 dB Occupied Bandwidth, 802.11ac 20 – 5220 – Path A



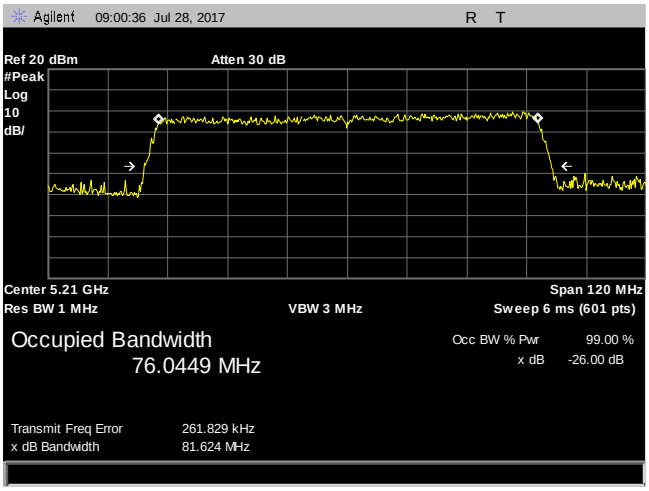
Plot 11. 26 dB Occupied Bandwidth, 802.11ac 20 – 5240 – Path A



Plot 12. 26 dB Occupied Bandwidth, 802.11ac 40 – 5190 – Path A

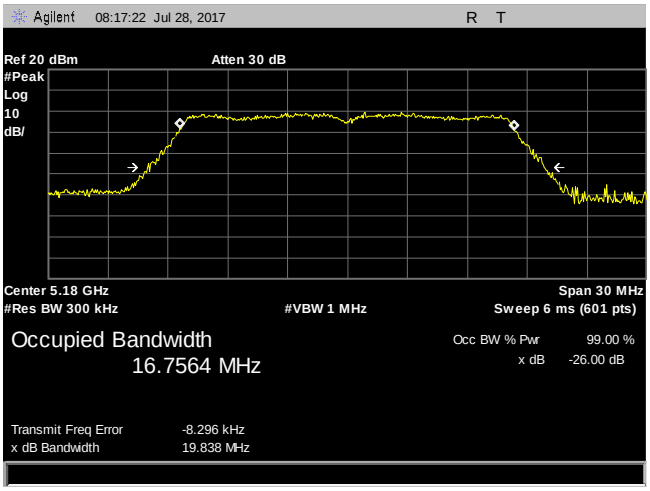


Plot 13. 26 dB Occupied Bandwidth, 802.11ac 40 – 5230 – Path A

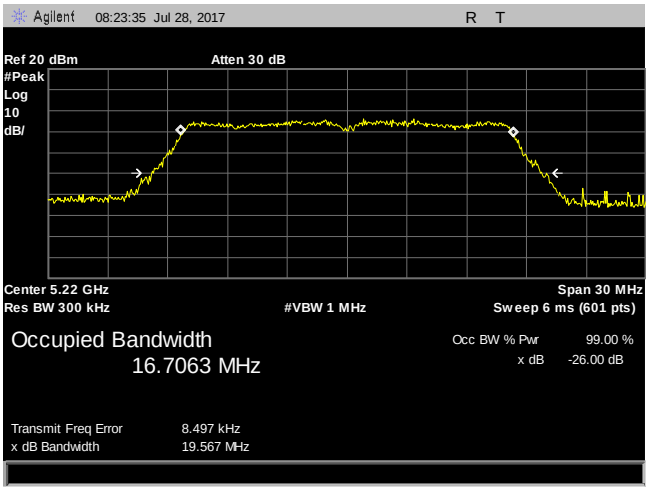


Plot 14. 26 dB Occupied Bandwidth, 802.11ac 80 – 5210 – Path A

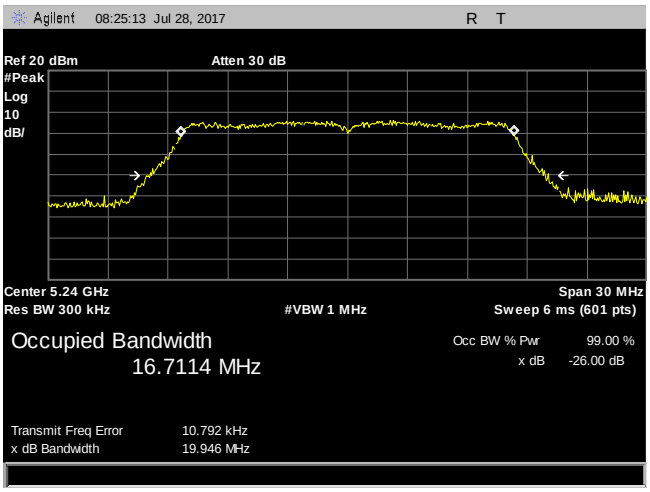
26 dB Bandwidth Path B



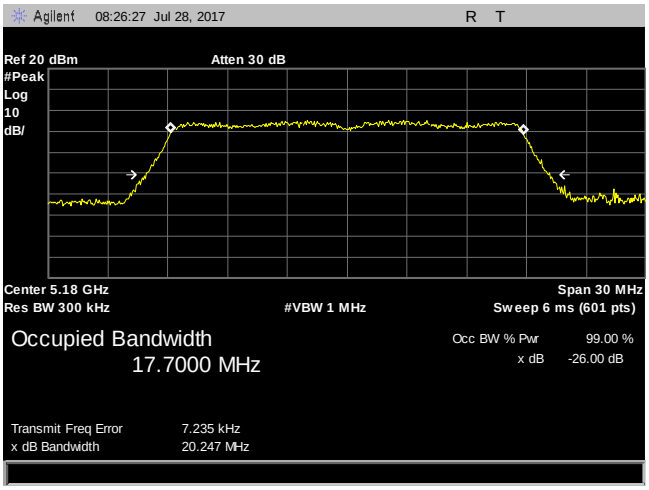
Plot 15. 26 dB Occupied Bandwidth, 802.11a – 5180 – Path B



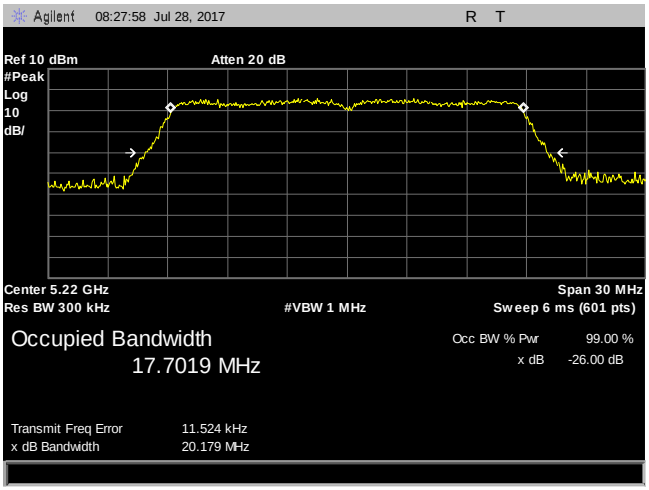
Plot 16. 26 dB Occupied Bandwidth, 802.11a – 5220 – Path B



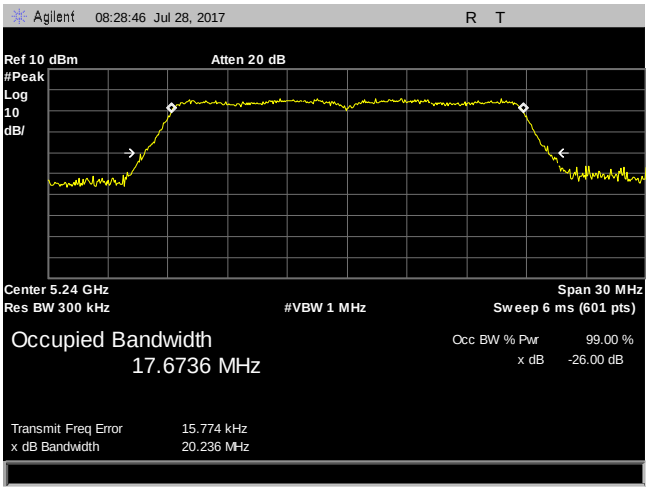
Plot 17. 26 dB Occupied Bandwidth, 802.11a – 5240 – Path B



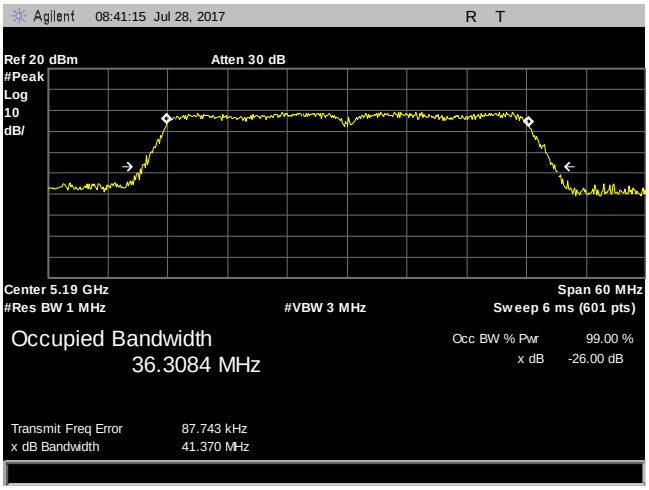
Plot 18. 26 dB Occupied Bandwidth, 802.11n 20 – 5180 – Path B



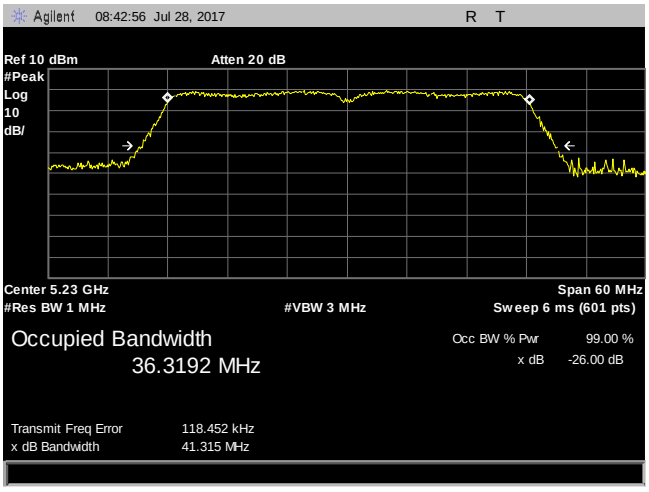
Plot 19. 26 dB Occupied Bandwidth, 802.11n 20 – 5220 – Path B



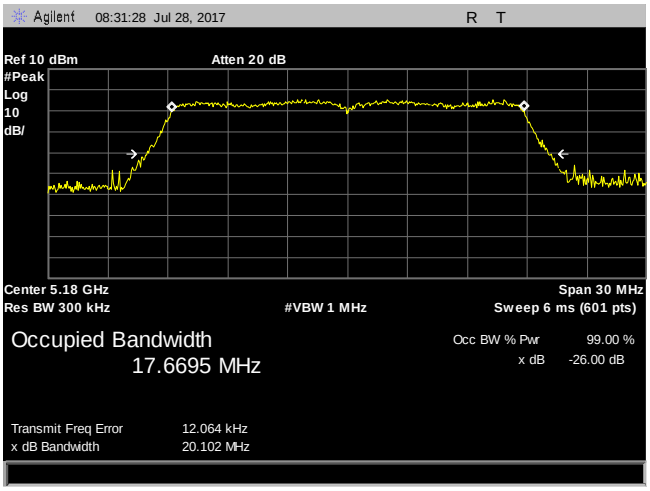
Plot 20. 26 dB Occupied Bandwidth, 802.11n 20 – 5240 – Path B



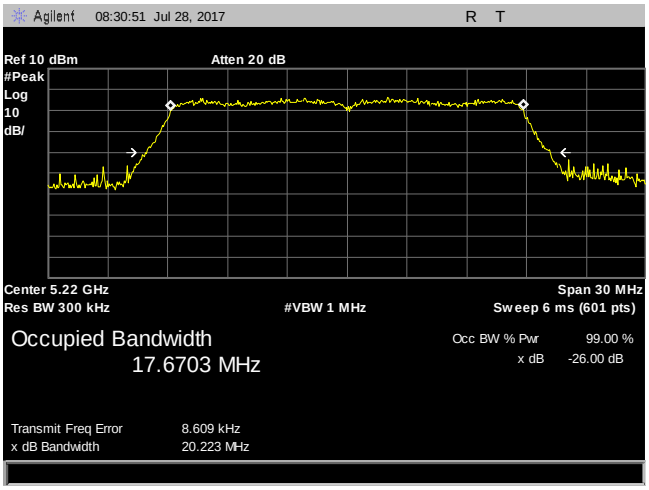
Plot 21. 26 dB Occupied Bandwidth, 802.11n 40 – 5190 – Path B



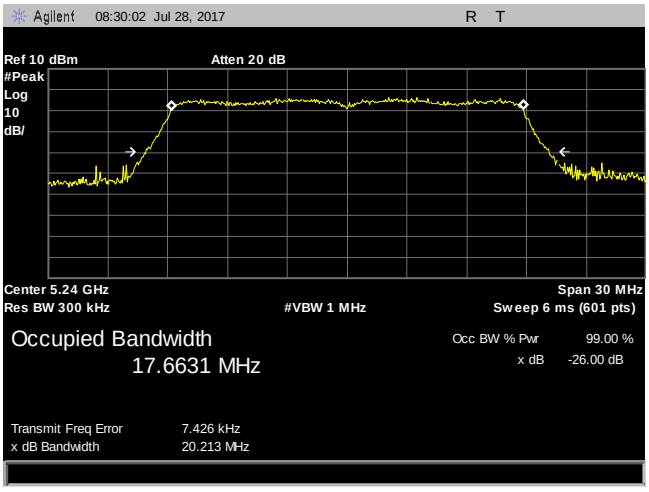
Plot 22. 26 dB Occupied Bandwidth, 802.11n 40 – 5230 – Path B



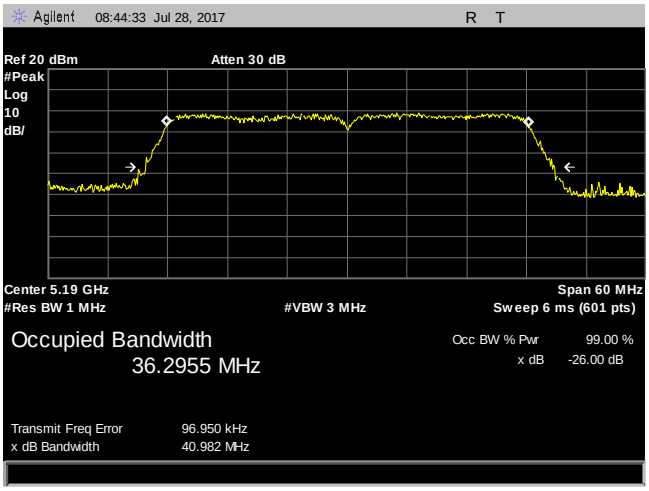
Plot 23. 26 dB Occupied Bandwidth, 802.11ac 20 – 5180 – Path B



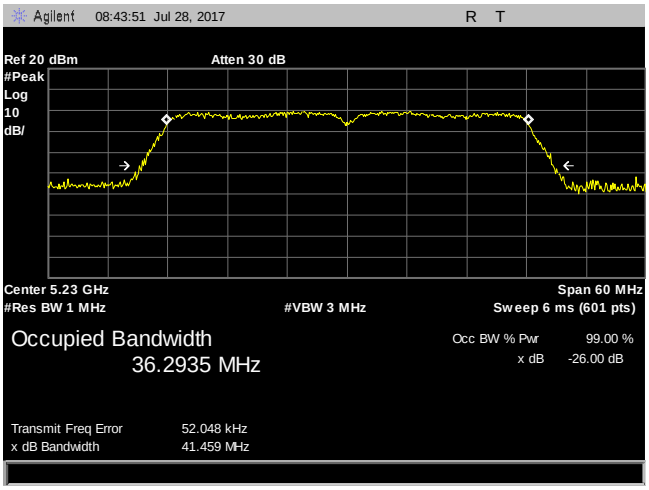
Plot 24. 26 dB Occupied Bandwidth, 802.11ac 20 – 5220 – Path B



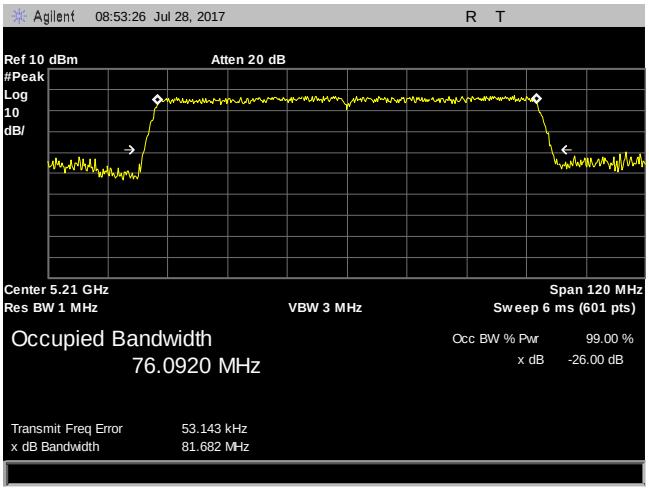
Plot 25. 26 dB Occupied Bandwidth, 802.11ac 20 – 5240 – Path B



Plot 26. 26 dB Occupied Bandwidth, 802.11ac 40 – 5190 – Path B



Plot 27. 26 dB Occupied Bandwidth, 802.11ac 40 – 5230 – Path B



Plot 28. 26 dB Occupied Bandwidth, 802.11ac 80 – 5210 – Path B

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.407 Duty Cycle

Test Results: For data recording purposes only.

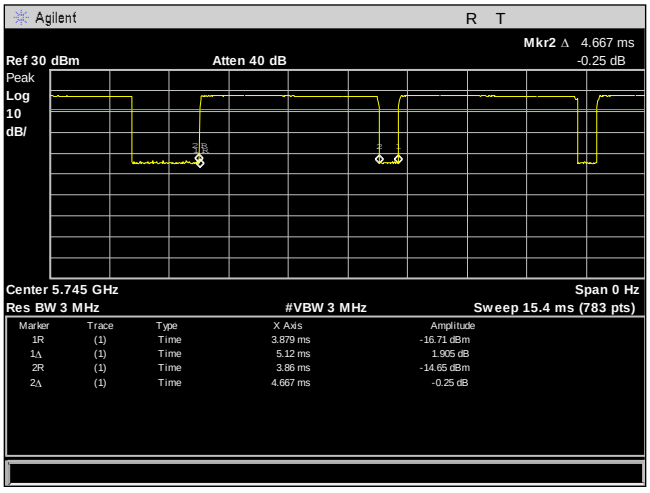
Test Engineer: Giuliano Messina

Test Date: May 19, 2017

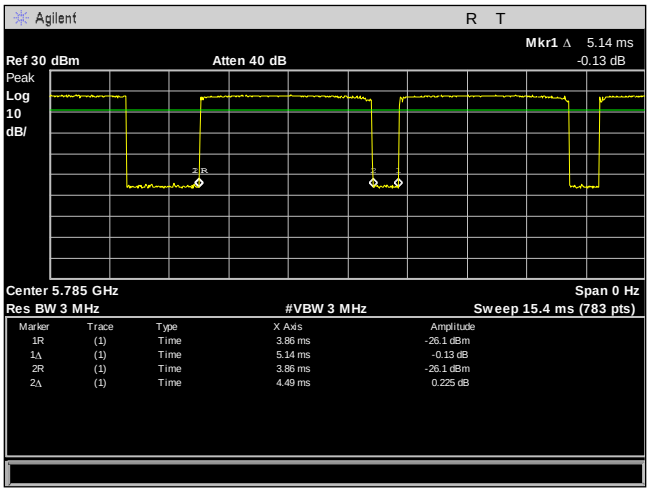
Mode	Bandwidth (MHz)	Duty Cycle (%)	Duty Cycle Correction (dB)
A	20	90.8	0.418
N	20	87.3	0.587
	40	65.6	1.827
AC	20	70	1.56
	40	29.2	5.349
	80	18.2	7.388

Plot 29. Duty Cycle, Test Results

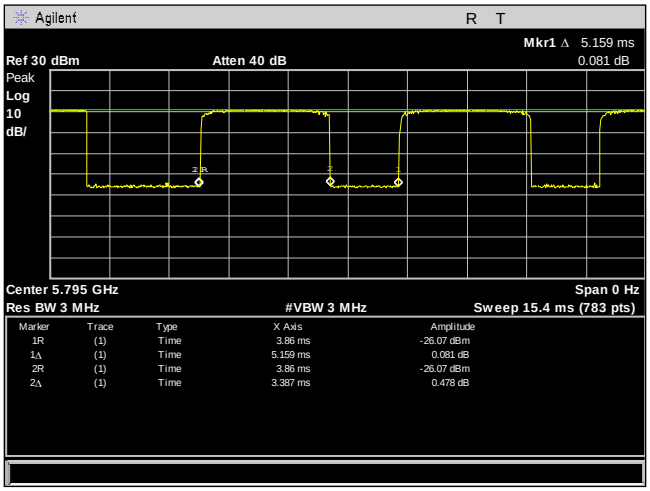
Per KDB 789033 v01r04: Duty Cycle Correction (dB) = 10*log(1/Duty Cycle)



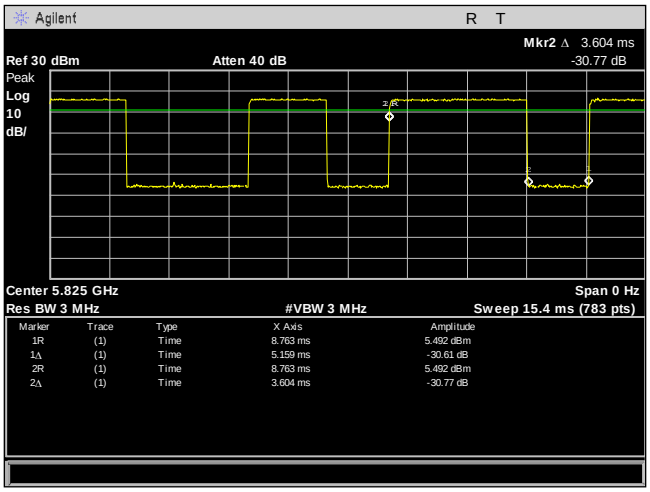
Plot 30. Duty Cycle, 802.11a



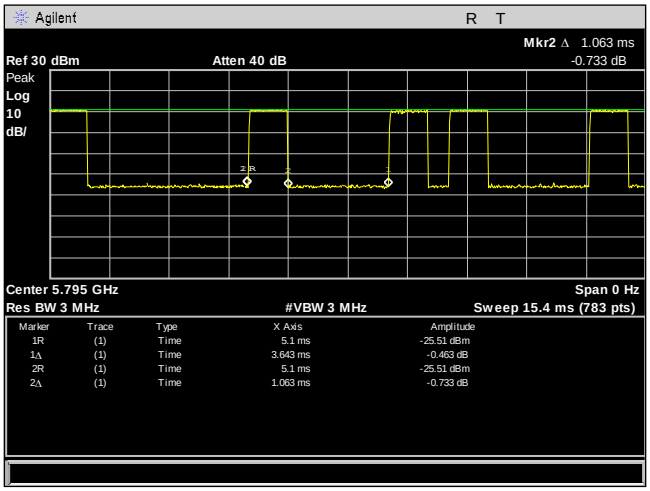
Plot 31. Duty Cycle, 802.11n 20



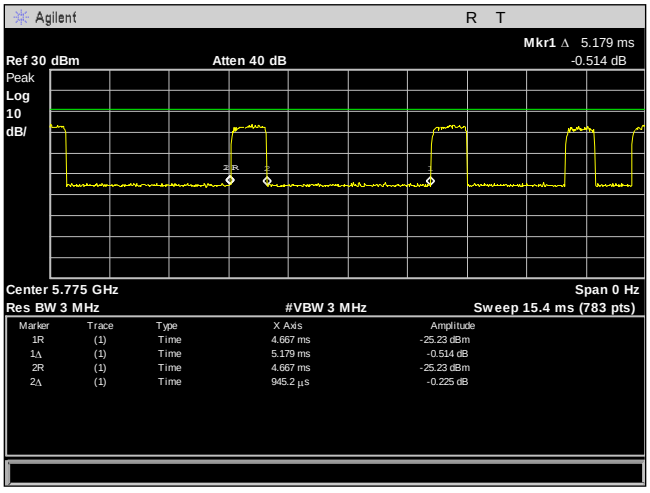
Plot 32. Duty Cycle, 802.11n 40



Plot 33. Duty Cycle, 802.11ac 20



Plot 34. Duty Cycle, 802.11ac 40



Plot 35. Duty Cycle, 802.11ac 80

Electromagnetic Compatibility Criteria for Intentional Radiators

§15. 407(a)(1) Maximum Conducted Output Power

Test Requirements: **§15.407(a)(1)(iv):** For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi.

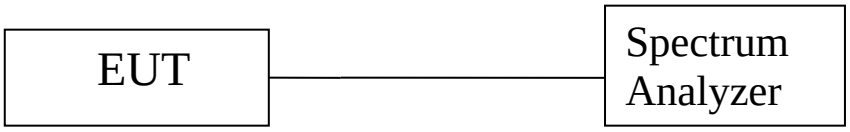
If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure: The EUT was connected to a spectrum analyzer through a cable. Measurements were taken with the EUT set to transmit continuously on its low, mid, and high channels. Its power was measured according to measurement method SA-1, as described in 789033 D02 General UNII Test Procedures v01r04, Method SA-3.

Test Results: The EUT as tested is compliant with the requirements of this section.

Test Engineer(s): Giuliano Messina

Test Date(s): May 3, 2017



COP Limit (mW)	COP Limit (dBm)	Antenna Gain (dBi)	New COP Limit (dBm)
250	23.9794	9	20.9794

Peak Conducted Output Power						
Carrier Channel	Frequency (MHz)	Measured PCOP (dBm) PathA	Measured PCOP (dBm) PathB	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5180	3.8	5.25	7.6	20.9794	-13.3794
Mid	5220	5.93	5.63	8.8	20.9794	-12.1794
High	5240	5.69	5.43	8.58	20.9794	-12.3994

Table 9. Peak Conducted Output Power with Duty Factor, 802.11a Mode, Test Results

Peak Conducted Output Power						
Carrier Channel	Frequency (MHz)	Measured PCOP (dBm) PathA	Measured PCOP (dBm) PathB	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5180	5.64	6.03	8.85	20.9794	-12.1294
Mid	5220	5.3	5.2	8.27	20.9794	-12.7094
High	5240	6.03	5.32	8.7	20.9794	-12.2794

Table 10. Peak Conducted Output Power with Duty Factor, 802.11n 20 Mode, Test Results

Peak Conducted Output Power						
Carrier Channel	Frequency (MHz)	Measured PCOP (dBm) PathA	Measured PCOP (dBm) PathB	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5180	4.27	5.11	7.73	20.9794	-13.2494
Mid	5220	5.36	5.08	8.24	20.9794	-12.7394
High	5240	4.94	4.06	7.54	20.9794	-13.4394

Table 11. Peak Conducted Output Power with Duty Factor, 802.11ac 20 Mode, Test Results

Peak Conducted Output Power						
Carrier Channel	Frequency (MHz)	Measured PCOP (dBm) PathA	Measured PCOP (dBm) PathB	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5190	-0.98	-0.30	2.39	20.9794	-18.5894
High	5230	6.75	5.75	9.29	20.9794	-11.6894

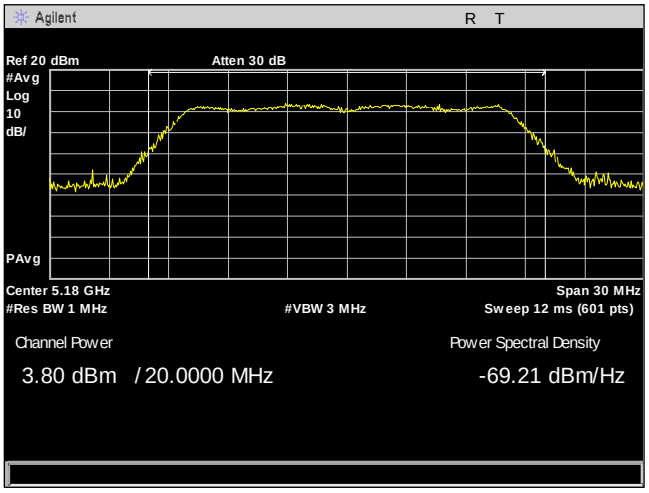
Table 12. Peak Conducted Output Power with Duty Factor, 802.11n 40 Mode, Test Results

Peak Conducted Output Power						
Carrier Channel	Frequency (MHz)	Measured PCOP (dBm) PathA	Measured PCOP (dBm) PathB	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5190	-1.16	-0.37	2.27	20.9794	-18.7094
High	5230	5.62	5.06	8.36	20.9794	-12.6194

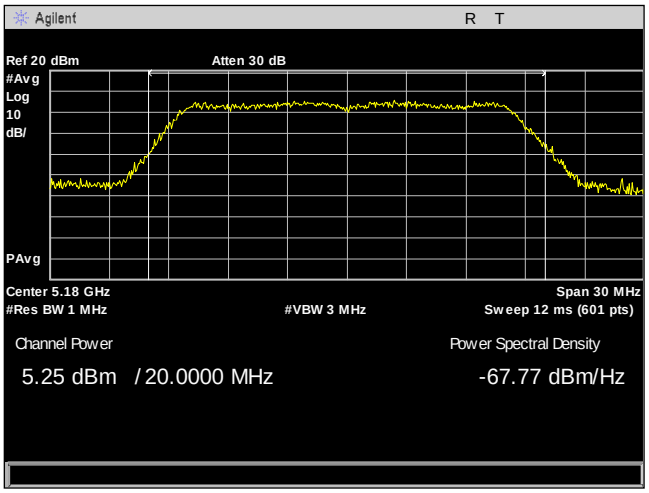
Table 13. Peak Conducted Output Power with Duty Factor, 802.11ac 40 Mode, Test Results

Peak Conducted Output Power						
Carrier Channel	Frequency (MHz)	Measured PCOP (dBm) PathA	Measured PCOP (dBm) PathB	Total Power (dBm)	Limit (dBm)	Margin (dB)
Mid	5210	-5	-4.92	-1.94	20.9794	-22.9194

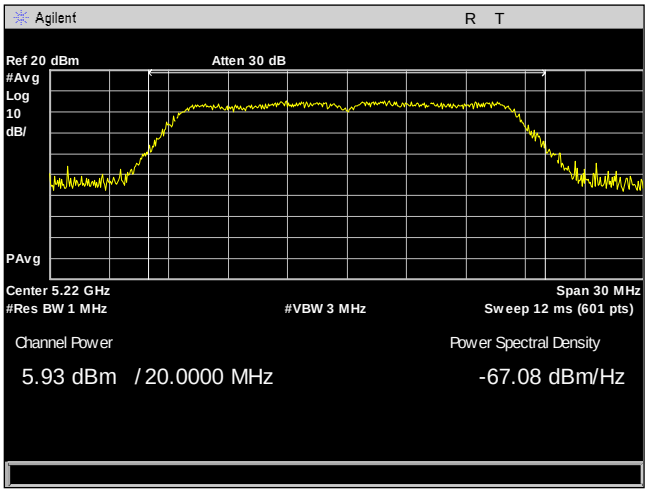
Table 14. Peak Conducted Output Power with Duty Factor, 802.11ac 80 Mode, Test Results



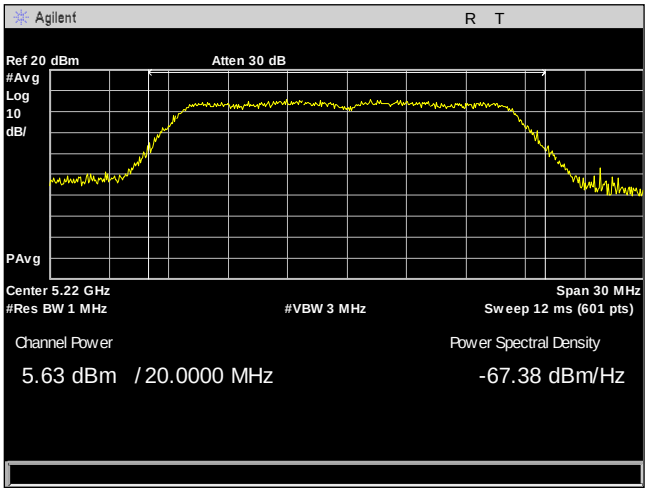
Plot 36. Conducted TX Power - 802.11a - 5180 - Path A



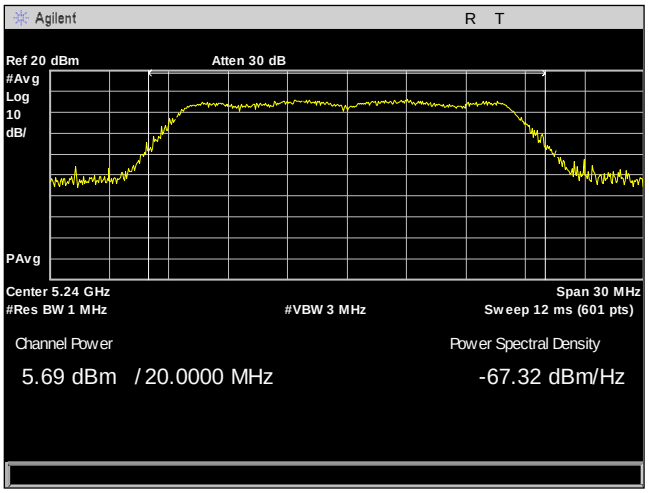
Plot 37. Conducted TX Power - 802.11a - 5180 - Path B



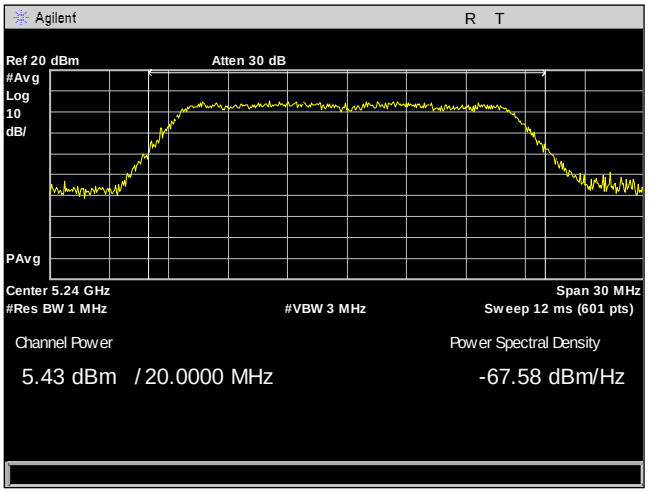
Plot 38. Conducted TX Power - 802.11a - 5220 - Path A



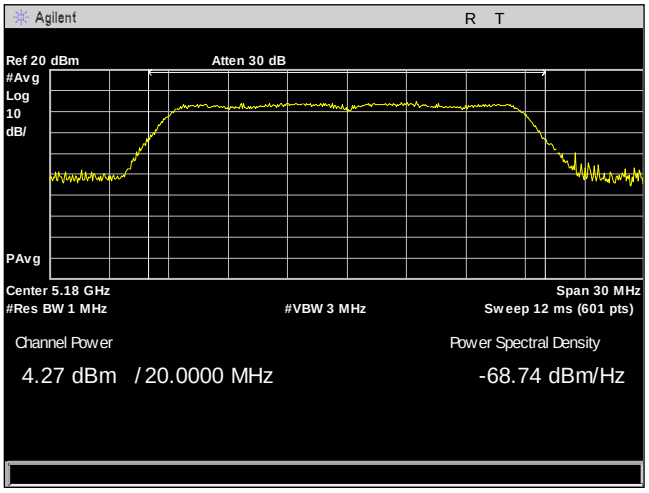
Plot 39. Conducted TX Power - 802.11a - 5220 - Path B



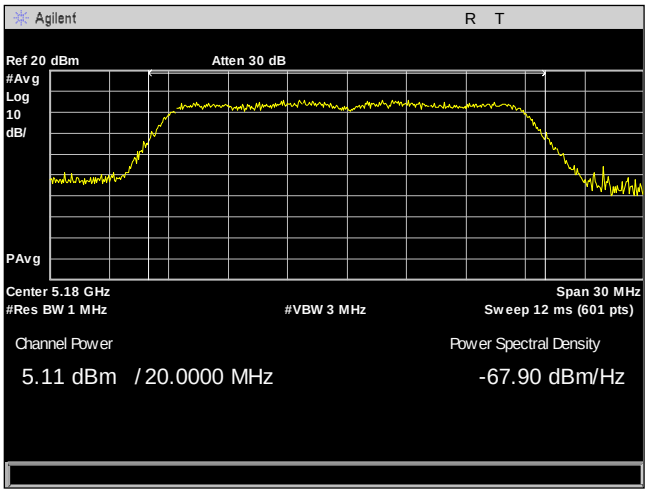
Plot 40. Conducted TX Power - 802.11a - 5240 - Path A



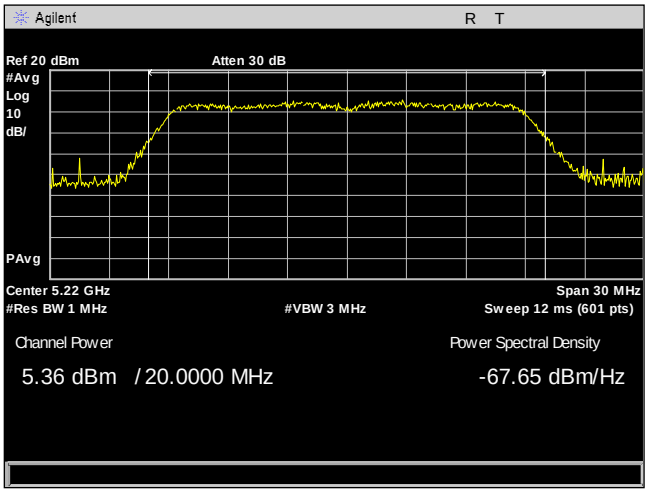
Plot 41. Conducted TX Power - 802.11a - 5240 - Path B



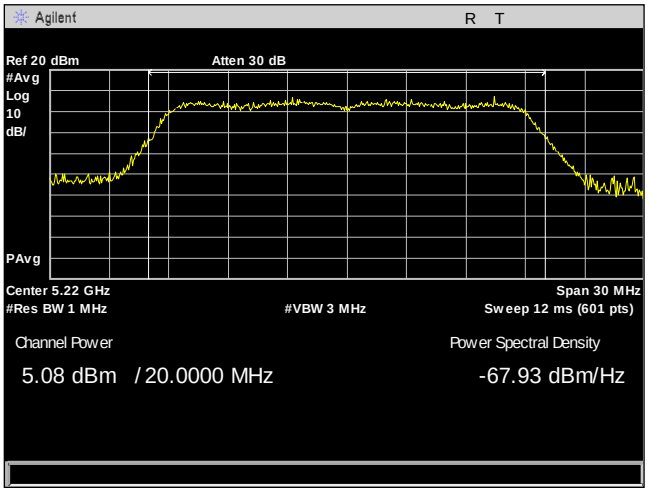
Plot 42. Conducted TX Power - 802.11ac 20 - 5180 - Path A



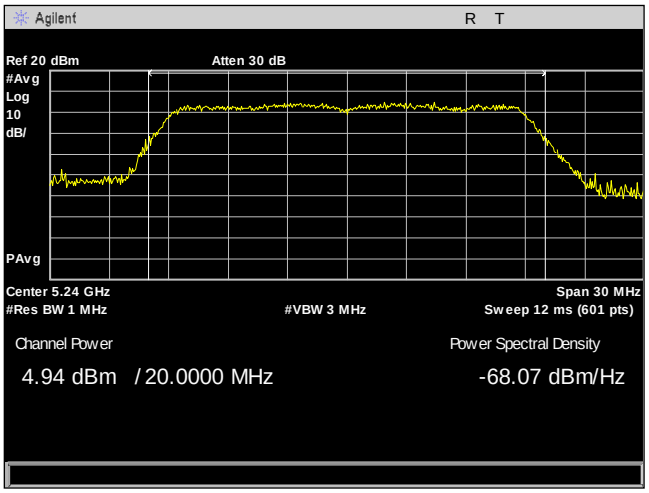
Plot 43. Conducted TX Power - 802.11ac 20 - 5180 - Path B



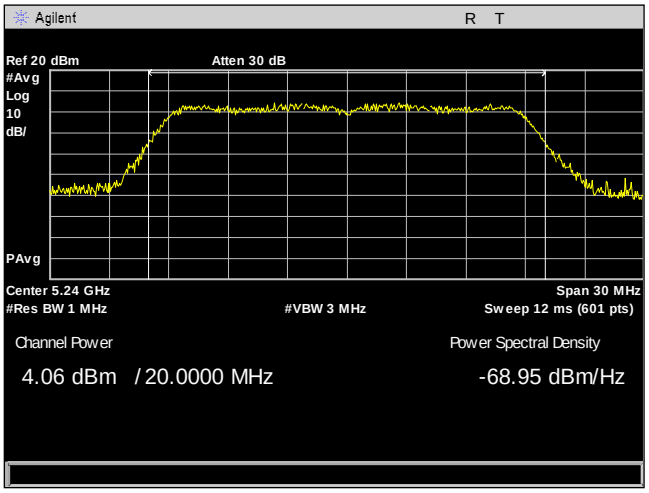
Plot 44. Conducted TX Power - 802.11ac 20 - 5220 - Path A



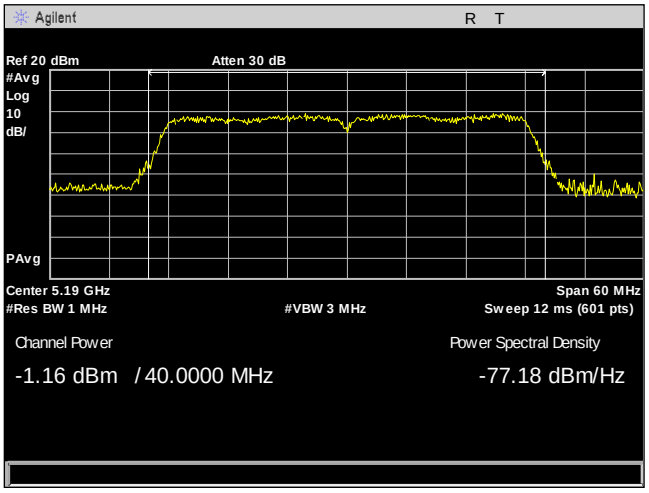
Plot 45. Conducted TX Power - 802.11ac 20 - 5220 - Path B



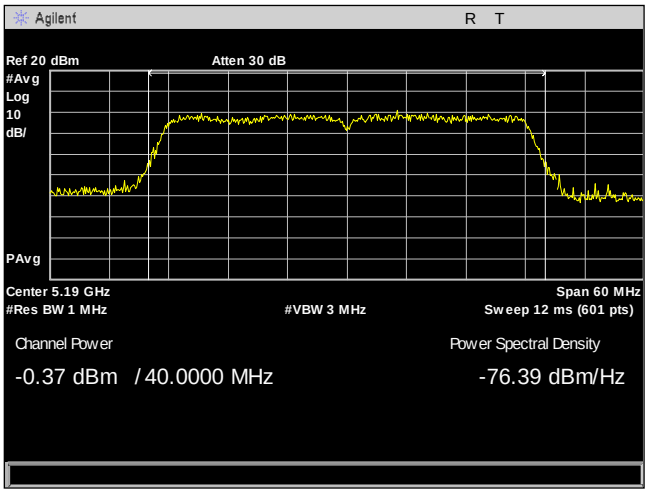
Plot 46. Conducted TX Power - 802.11ac 20 - 5240 - Path A



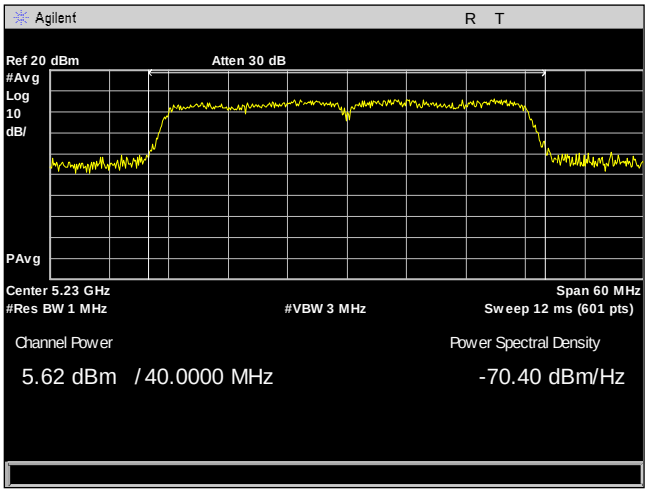
Plot 47. Conducted TX Power - 802.11ac 20 - 5240 - Path B



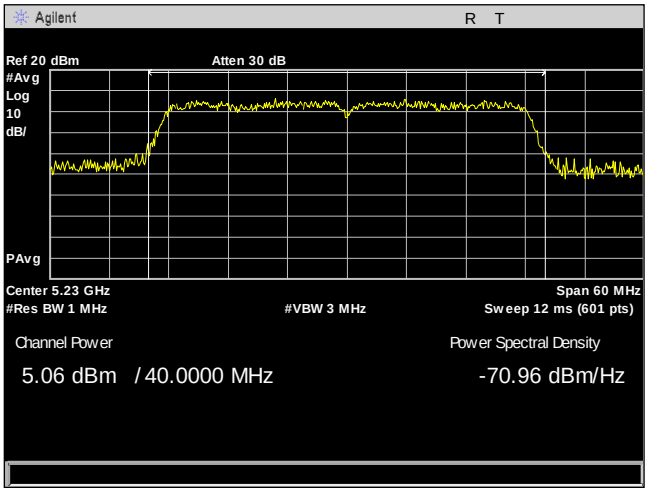
Plot 48. Conducted TX Power - 802.11ac 40 - 5190 - Path A



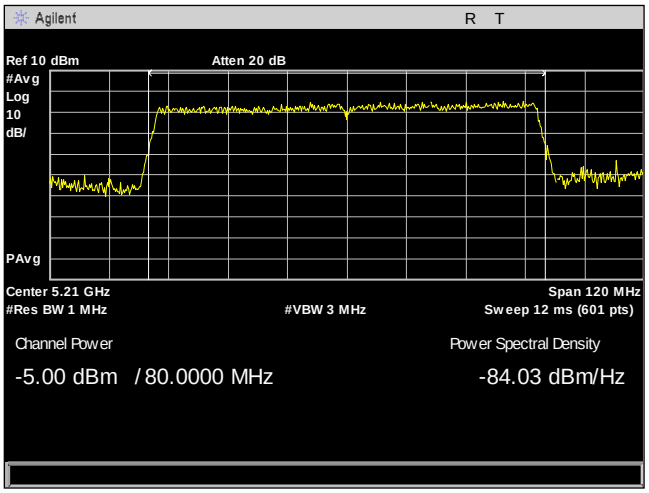
Plot 49. Conducted TX Power - 802.11ac 40 - 5190 - Path B



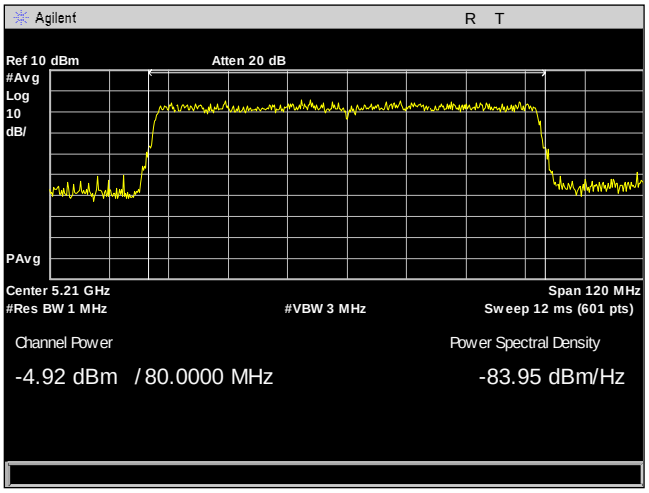
Plot 50. Conducted TX Power - 802.11ac 40 - 5230 - Path A



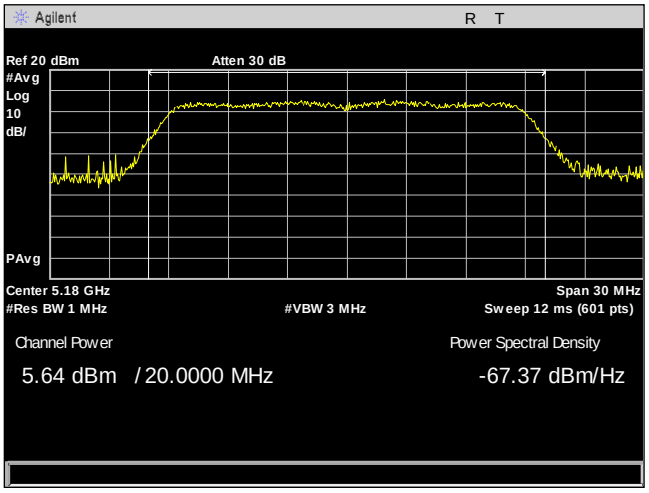
Plot 51. Conducted TX Power - 802.11ac 40 - 5230 - Path B



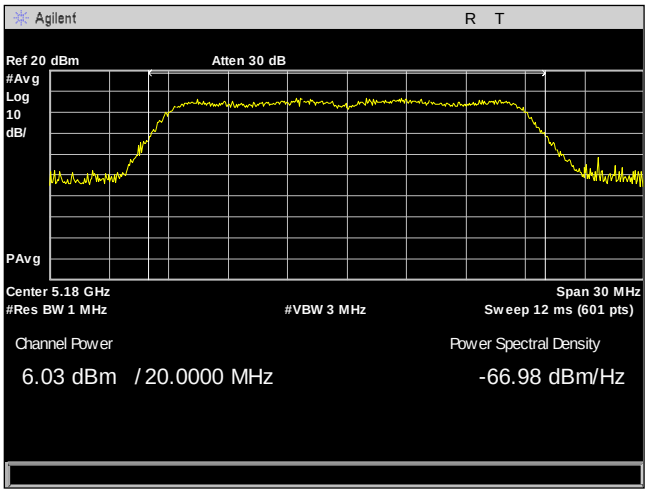
Plot 52. Conducted TX Power - 802.11ac 80 - 5210 - Path A



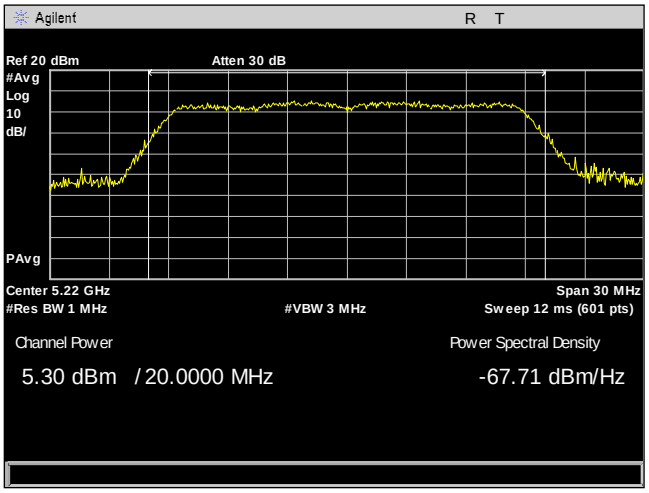
Plot 53. Conducted TX Power - 802.11ac 80 - 5210 - Path B



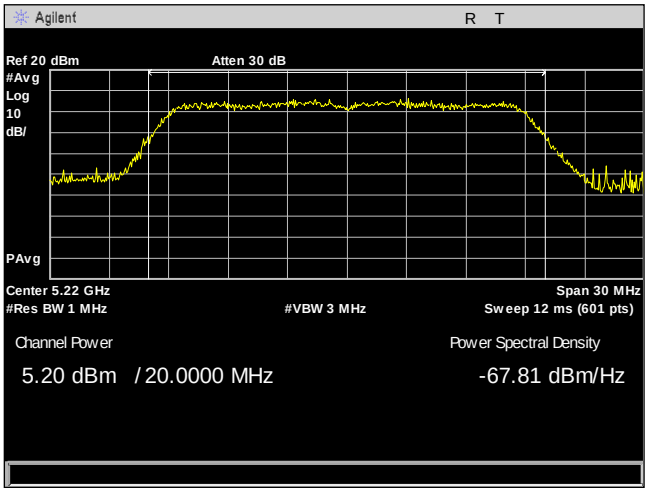
Plot 54. Conducted TX Power - 802.11n 20 - 5180 - Path A



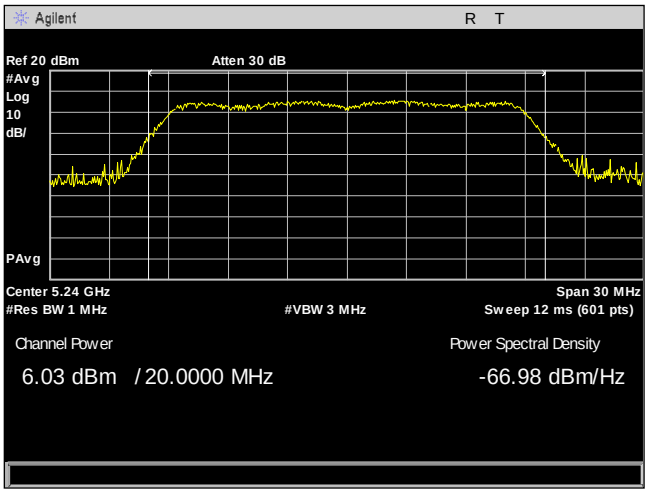
Plot 55. Conducted TX Power - 802.11n 20 - 5180 - Path B



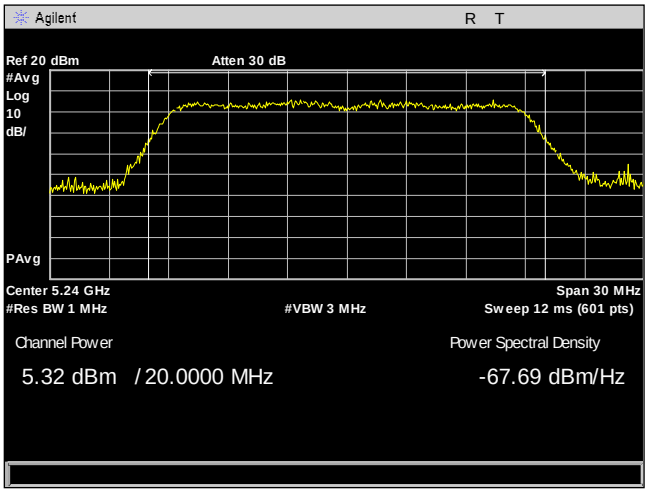
Plot 56. Conducted TX Power - 802.11n 20 - 5220 - Path A



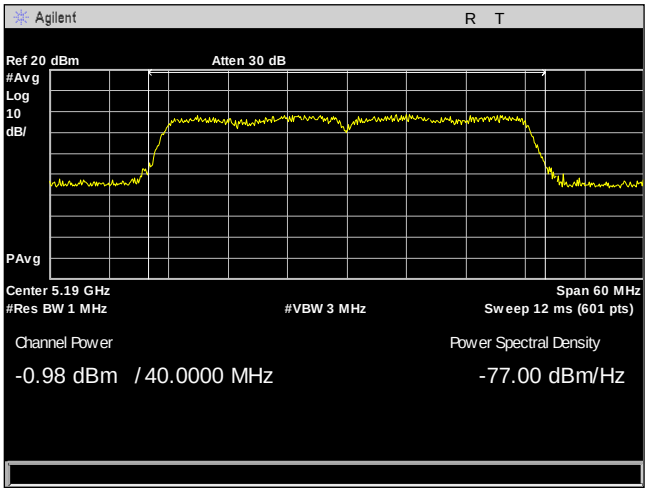
Plot 57. Conducted TX Power - 802.11n 20 - 5220 - Path B



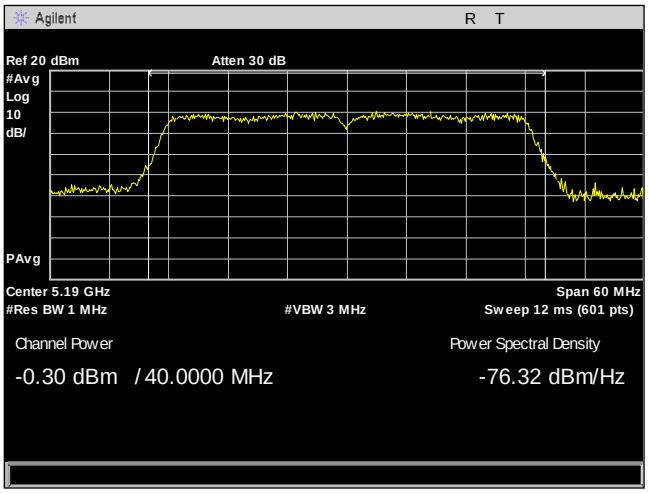
Plot 58. Conducted TX Power - 802.11n 20 - 5240 - Path A



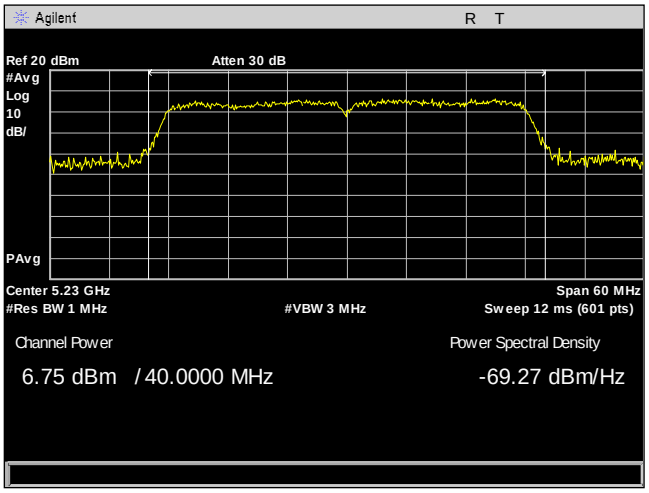
Plot 59. Conducted TX Power - 802.11n 20 - 5240 - Path B



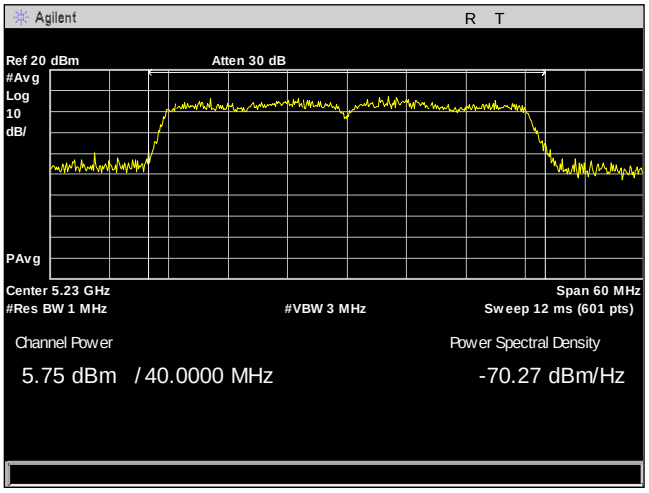
Plot 60. Conducted TX Power - 802.11n 40 - 5190 - Path A



Plot 61. Conducted TX Power - 802.11n 40 - 5190 - Path B



Plot 62. Conducted TX Power - 802.11n 40 - 5230 - Path A



Plot 63. Conducted TX Power - 802.11n 40 - 5230 - Path B

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.407(a)(1) Maximum Power Spectral Density

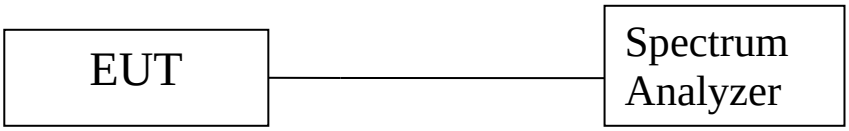
Test Requirements: **§15.407(a)(1)(iv):** For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure: The EUT was connected to a spectrum analyzer through a cable. Measurements were taken with the EUT set to transmit continuously on its low, mid, and high channels. The PSD was measured according KDB 789033 D02 General UNII Test Procedures v01r04, Method SA-3.

Test Results: The EUT as tested is compliant with the requirements of this section.

Test Engineer(s): Giuliano Messina

Test Date(s): May 3, 2017



PSD Limit (dBm)	Antenna Gain (dBi)	New PSD Limit (dBm)
11	9	8

Peak Power Spectral Density						
Carrier Channel	**Frequency (MHz)**	**Measured PSD (dBm) PathA**	**Measured PSD (dBm) PathB**	**Total PSD**	**Limit (dBm)**	**Margin (dB)**
Low	5180	4.396	4.41	7.42	8	-0.58
Mid	5220	4.415	4.94	7.7	8	-0.3
High	5240	4.729	4.505	7.63	8	-0.37

Table 15. Peak Power Spectral Density, 802.11a Mode, Test Results

Peak Power Spectral Density						
Carrier Channel	**Frequency (MHz)**	**Measured PSD (dBm) PathA**	**Measured PSD (dBm) PathB**	**Total PSD**	**Limit (dBm)**	**Margin (dB)**
Low	5180	4.98	4.873	7.94	8	-0.06
Mid	5220	3.706	4.857	7.33	8	-0.67
High	5240	4.416	4.523	7.49	8	-0.51

Table 16. Peak Power Spectral Density, 802.11n 20 Mode, Test Results

Peak Power Spectral Density						
Carrier Channel	**Frequency (MHz)**	**Measured PSD (dBm) PathA**	**Measured PSD (dBm) PathB**	**Total PSD**	**Limit (dBm)**	**Margin (dB)**
Low	5180	3.938	2.86	6.45	8	-1.55
Mid	5220	4.254	4.469	7.38	8	-0.62
High	5240	3.902	3.045	6.51	8	-1.49

Table 17. Power Spectral Density, 802.11ac 20 Mode, Test Results

Peak Power Spectral Density						
Carrier Channel	**Frequency (MHz)**	**Measured PSD (dBm) PathA**	**Measured PSD (dBm) PathB**	**Total PSD**	**Limit (dBm)**	**Margin (dB)**
Low	5190	-2.035	-1.4	1.31	8	-6.69
Mid	--	--	--	--	--	--
High	5230	4.707	4.584	7.66	8	-0.34

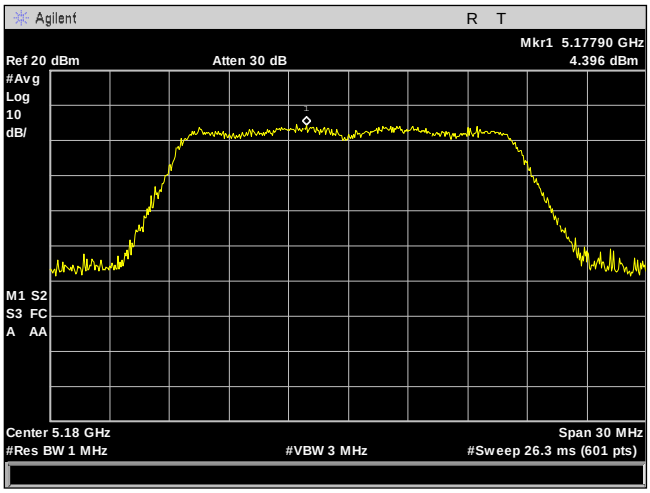
Table 18. Power Spectral Density, 802.11n 40 Mode, Test Results

Peak Power Spectral Density						
Carrier Channel	**Frequency (MHz)**	**Measured PSD (dBm) PathA**	**Measured PSD (dBm) PathB**	**Total PSD**	**Limit (dBm)**	**Margin (dB)**
Low	5190	-1.696	-1.687	1.32	8	-6.68
Mid	--	--	--	--	--	--
High	5230	4.723	4.815	7.78	8	-0.22

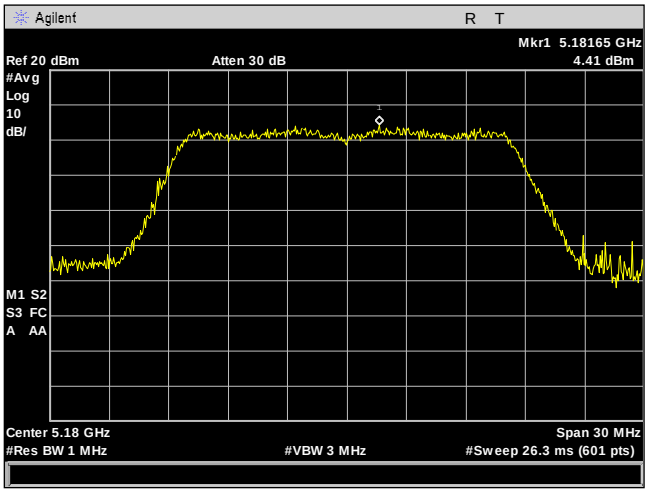
Table 19. Peak Power Spectral Density, 802.11ac 40 Mode, Test Results

Peak Power Spectral Density						
Carrier Channel	**Frequency (MHz)**	**Measured PSD (dBm) PathA**	**Measured PSD (dBm) PathB**	**Total PSD**	**Limit (dBm)**	**Margin (dB)**
Low	--	--	--	--	--	--
Mid	5210	-5.119	-5.197	-2.14	8	-10.14
High	--	--	--	--	--	--

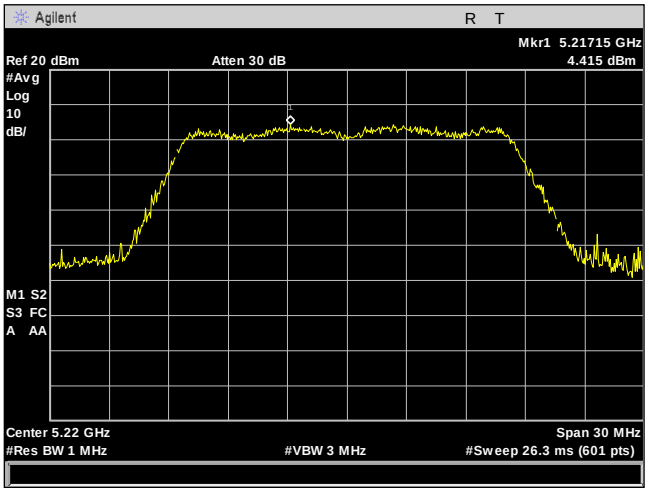
Table 20. Peak Power Spectral Density, 802.11ac 80 Mode, Test Results



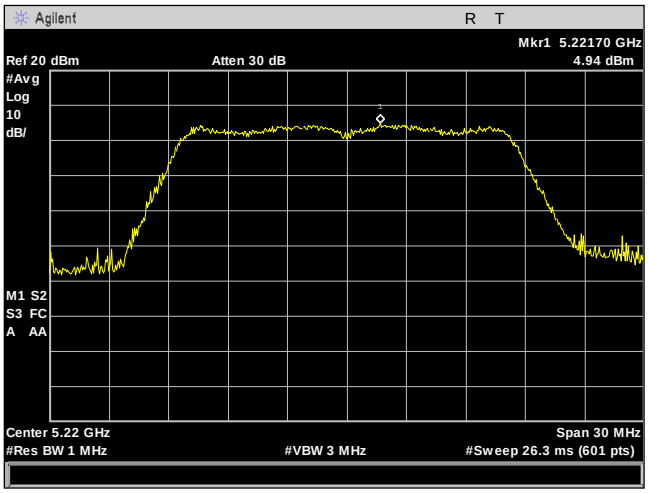
Plot 64. Power Spectral Density, 802.11a - 5180 - Path A



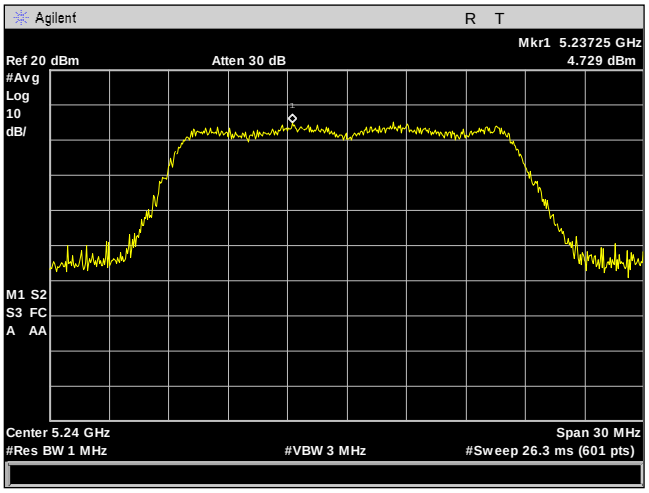
Plot 65. Power Spectral Density, 802.11a - 5180 - Path B



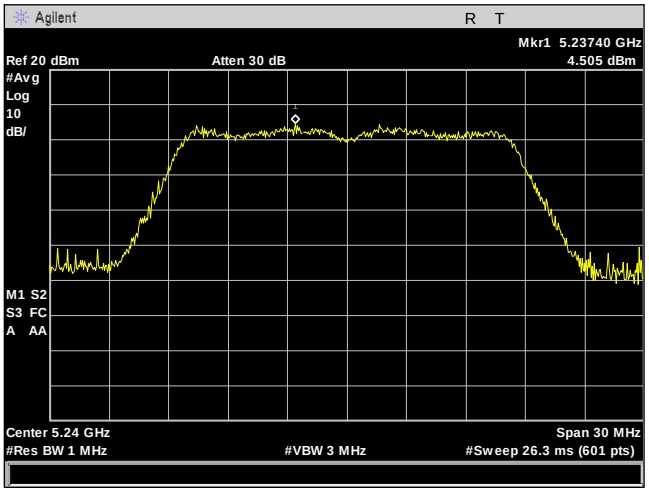
Plot 66. Power Spectral Density, 802.11a - 5220 - Path A



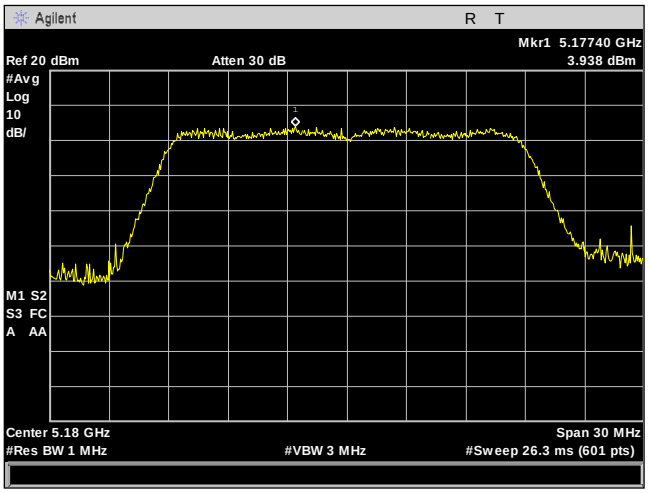
Plot 67. Power Spectral Density, 802.11a - 5220 - Path B



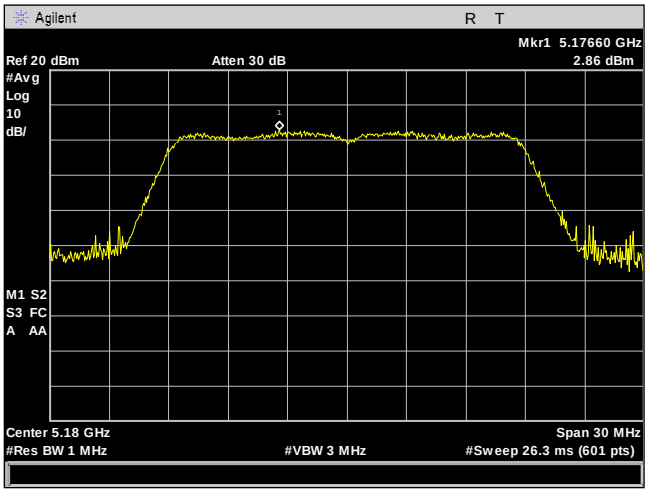
Plot 68. Power Spectral Density, 802.11a - 5240 - Path A



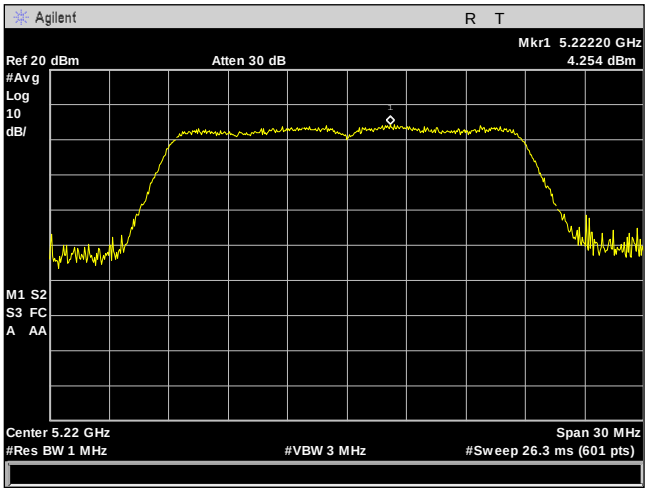
Plot 69. Power Spectral Density, 802.11a - 5240 - Path B



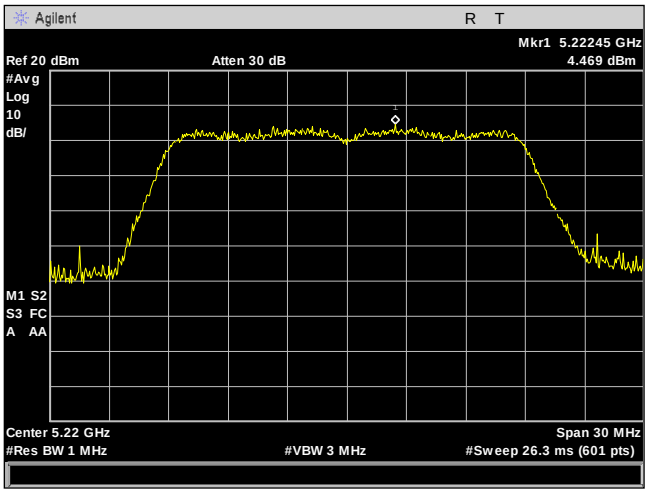
Plot 70. Power Spectral Density, 802.11ac 20 - 5180 - Path A



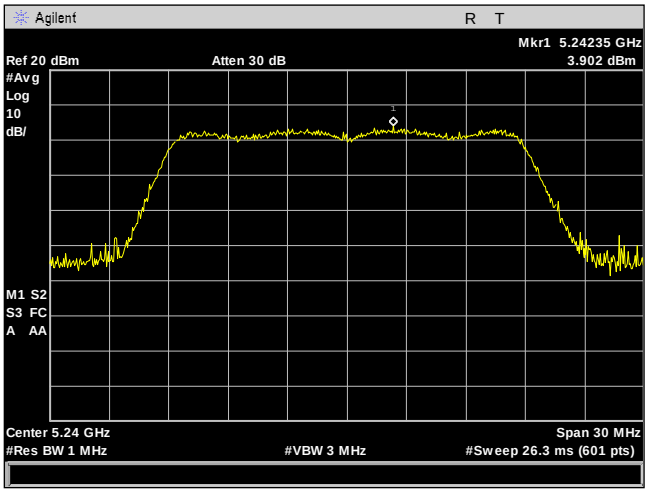
Plot 71. Power Spectral Density, 802.11ac 20 - 5180 - Path B



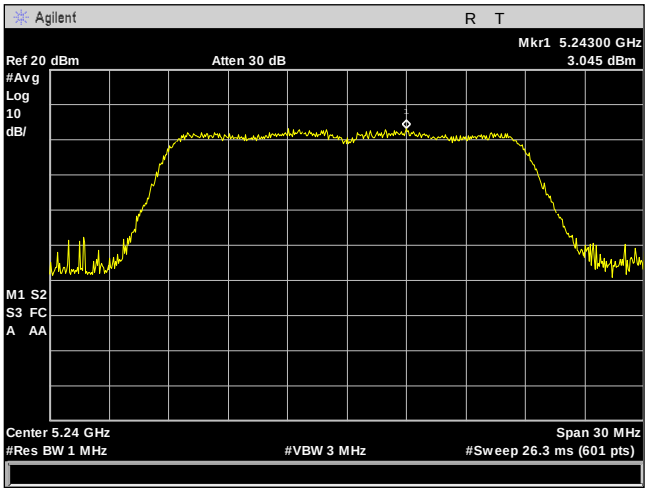
Plot 72. Power Spectral Density, 802.11ac 20 - 5220 - Path A



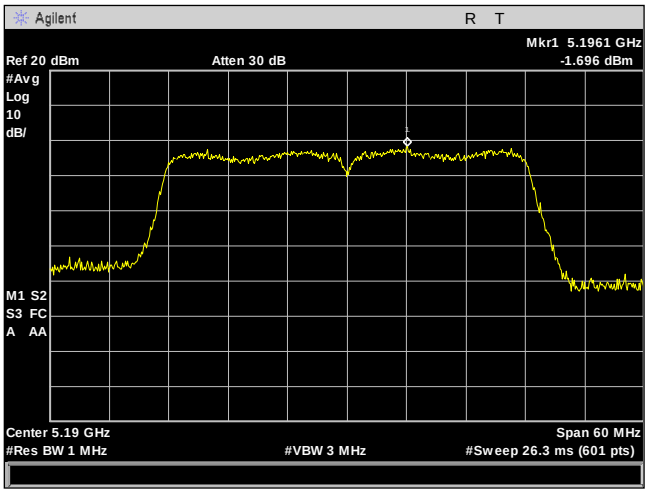
Plot 73. Power Spectral Density, 802.11ac 20 - 5220 - Path B



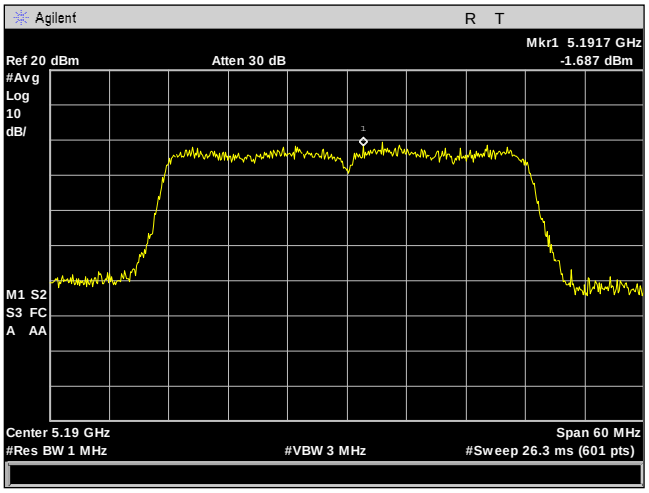
Plot 74. Power Spectral Density, 802.11ac 20 - 5240 - Path A



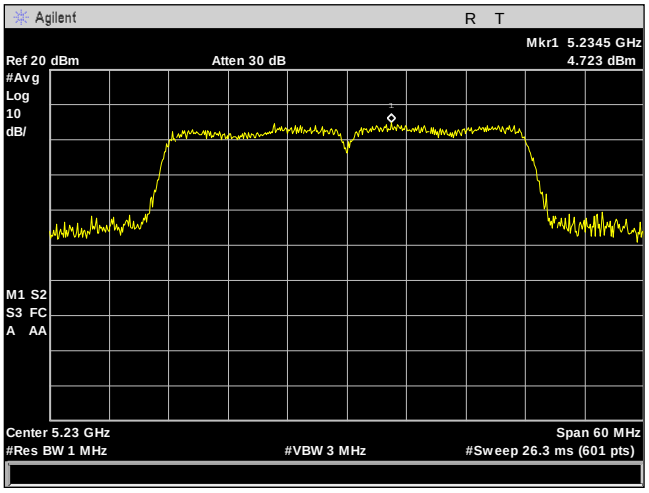
Plot 75. Power Spectral Density, 802.11ac 20 - 5240 - Path B



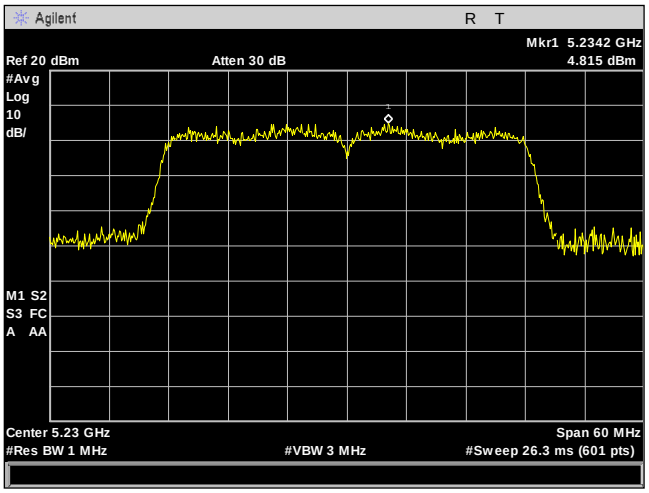
Plot 76. Power Spectral Density, 802.11ac 40 - 5190 - Path A



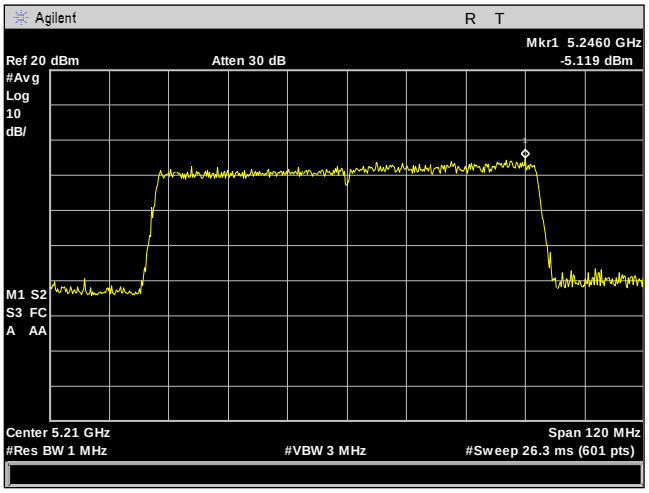
Plot 77. Power Spectral Density, 802.11ac 40 - 5190 - Path B



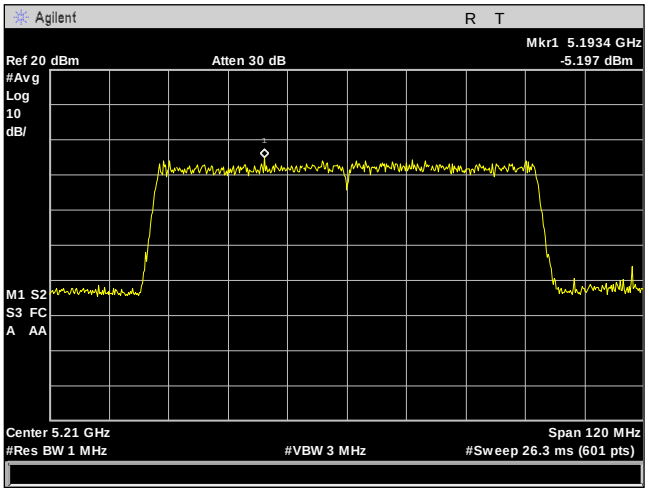
Plot 78. Power Spectral Density, 802.11ac 40 - 5230 - Path A



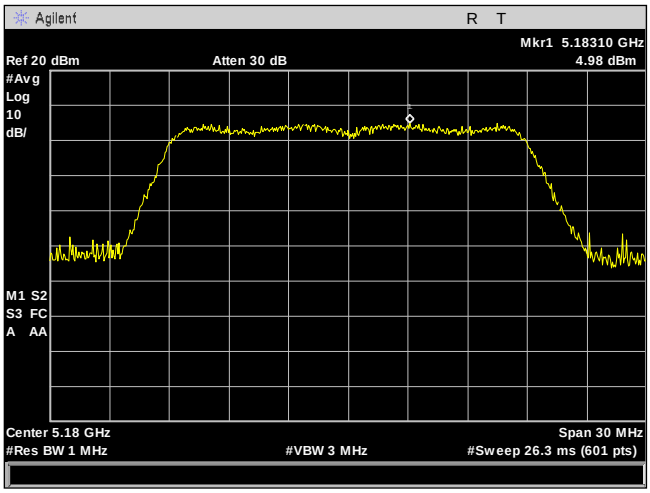
Plot 79. Power Spectral Density, 802.11ac 40 - 5230 - Path B



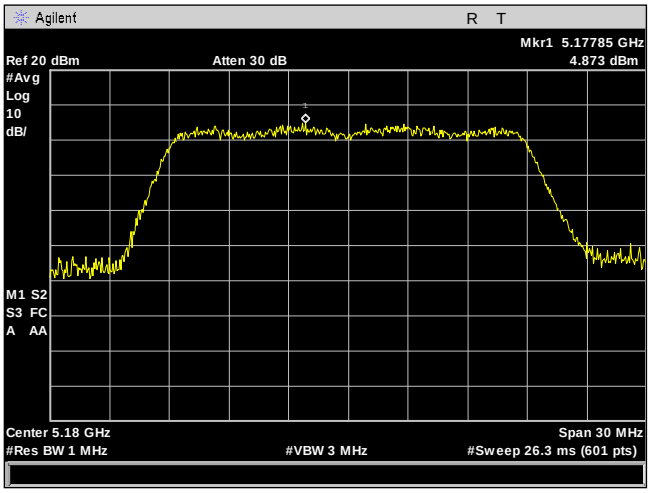
Plot 80. Power Spectral Density, 802.11ac 80 - 5210 - Path A



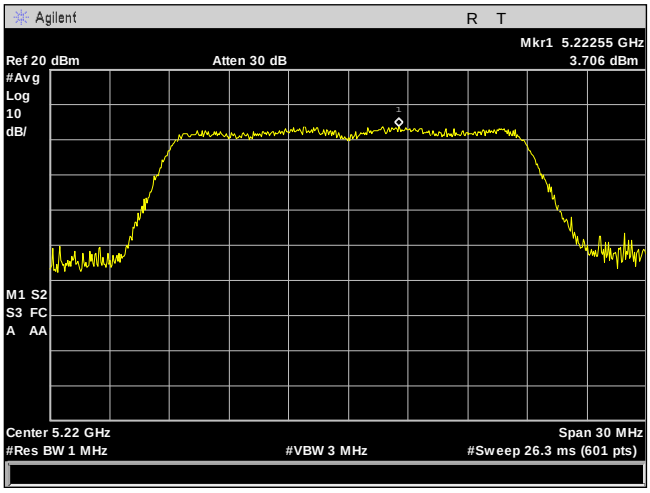
Plot 81. Power Spectral Density, 802.11ac 80 - 5210 - Path B



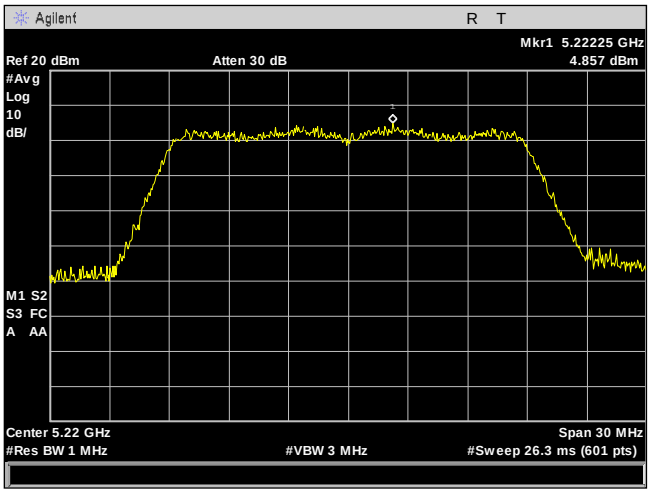
Plot 82. Power Spectral Density, 802.11n 20 - 5180 - Path A



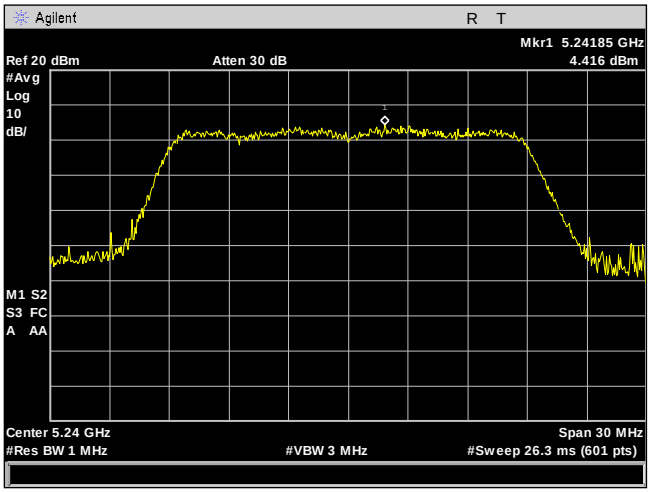
Plot 83. Power Spectral Density, 802.11n 20 - 5180 - Path B



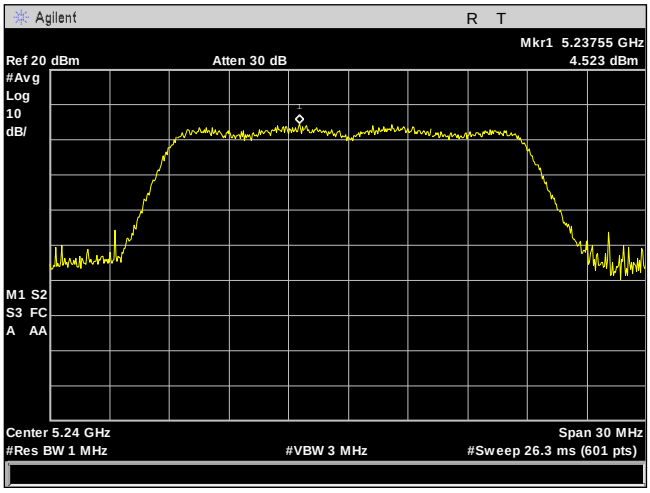
Plot 84. Power Spectral Density, 802.11n 20 - 5220 - Path A



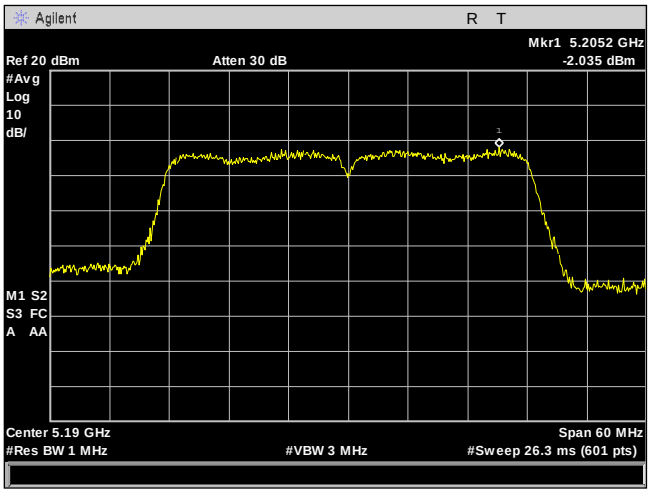
Plot 85. Power Spectral Density, 802.11n 20 - 5220 - Path B



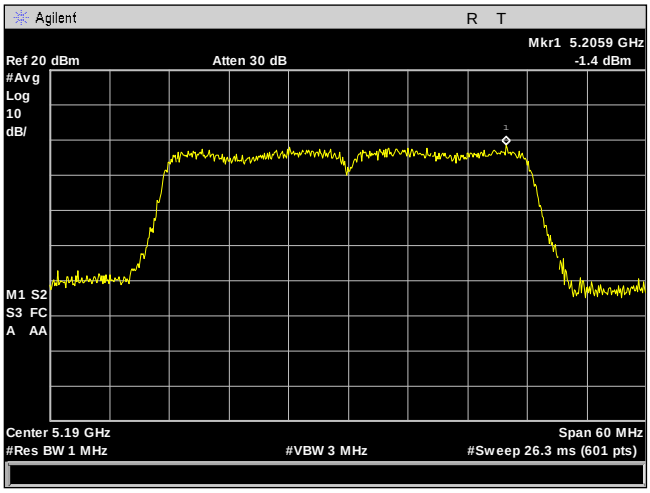
Plot 86. Power Spectral Density, 802.11n 20 - 5240 - Path A



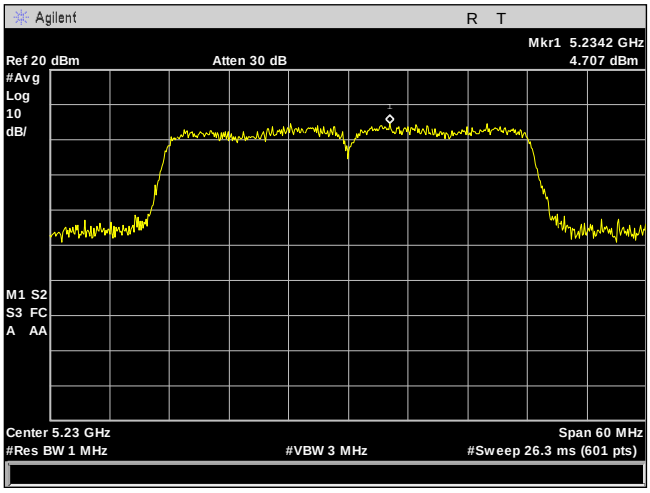
Plot 87. Power Spectral Density, 802.11n 20 - 5240 - Path B



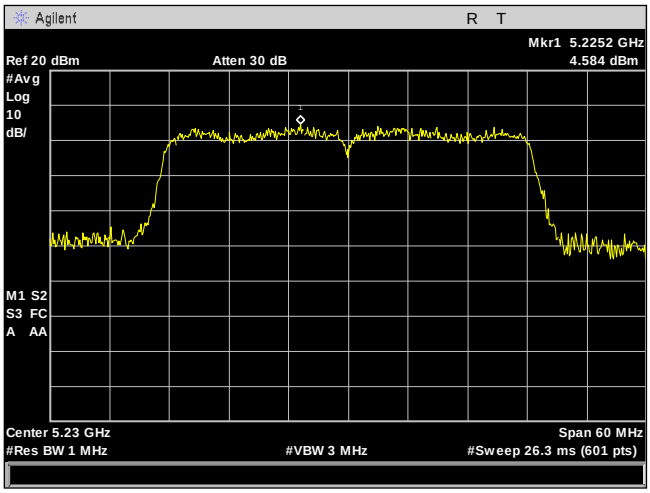
Plot 88. Power Spectral Density, 802.11n 40 - 5190 - Path A



Plot 89. Power Spectral Density, 802.11n 40 - 5190 - Path B



Plot 90. Power Spectral Density, 802.11n 40 - 5230 - Path A



Plot 91. Power Spectral Density, 802.11n 40 - 5230 - Path B

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.407(b)(1) & (6 – 7) Undesirable Emissions

Test Requirements:

§ 15.407(b)(1): For transmitters operating in the 5.15-5.25 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

§ 15.407(b)(6): Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in Section 15.207.

§ 15.407(b)(7): The provisions of Section 15.205 of this part apply to intentional radiators operating under this section.

Test Procedure:

The EUT was placed on a non-conducting stand on a turntable in a chamber. To find the maximum emission the EUT was set to transmit on low, mid, and high channels. Additionally, the turntable was rotated 360 degrees, the EUT was oriented through its three orthogonal axes, and the receive antenna height was varied in order to maximize emissions.

For frequencies from 30 MHz to 1 GHz, measurements were first made using a peak detector with a 100 kHz resolution bandwidth. Emissions which exceeded the limits were re-measured using a quasi-peak detector with a 120 kHz resolution bandwidth.

Above 1 GHz, measurements were made pursuant the method described in FCC KDB 789033 D02 General UNII Test Procedure New Rules v01r04. The equation, **EIRP= E + 20 log D – 104.8** was used to convert field strength to EIRP (**E** = field strength (dBµV/m) and **D** = Reference measurement distance).

For emissions above 1 GHz and in restricted bands, measurements of the field strength were made with a peak detector and an average detector and compared with the limits of 15.209. For measurements above 1 GHz (spurious emissions only), a bandpass filter was used in between the horn antenna and the preamp in order to block the fundamental frequency.

As an alternative, according to FCC KDB 789033 D02 General UNII Test Procedure New Rules v01r04, all emissions above 1 GHz that comply with the peak and average limits of 15.209 satisfy the requirements of unwanted emissions in 15.407.

Measurements were taken with the transmitter off to ensure that any frequencies over the limit were not caused by the transmitter.

Test Results:

For below 1 GHz, the EUT was compliant with the requirements of this section.

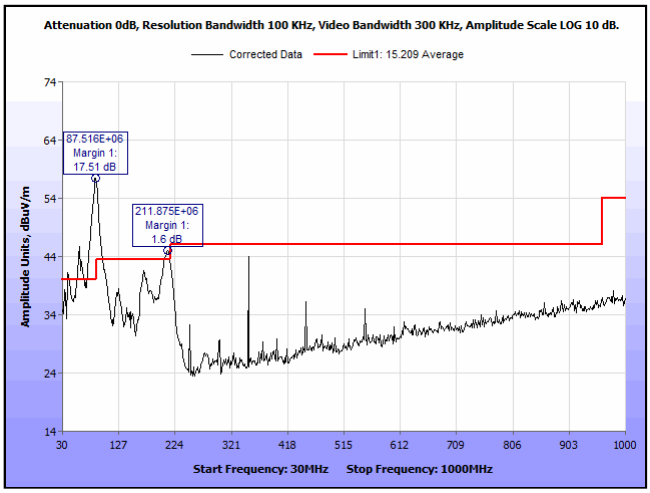
For above 1 GHz, the EUT was compliant with the requirements of this section.

Only noise floor was measured above 18 GHz.

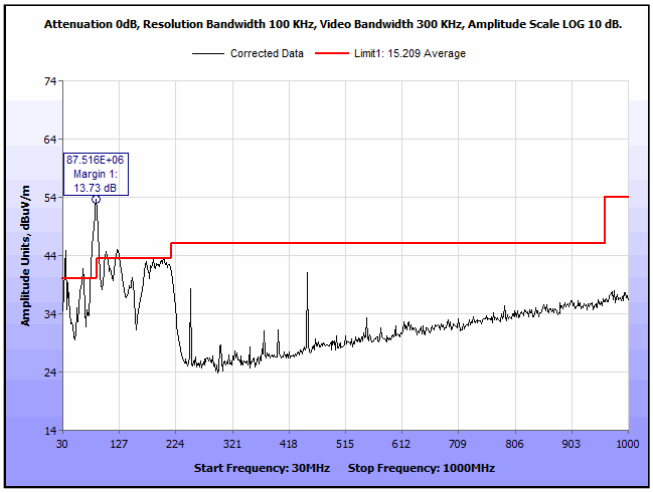
Measured emissions were within applicable limits. Emissions above the limit (Below 1 GHz) were present with the transmitter off and are likely to not be caused by the transmitter.

Test Engineer(s): Giuliano Messina

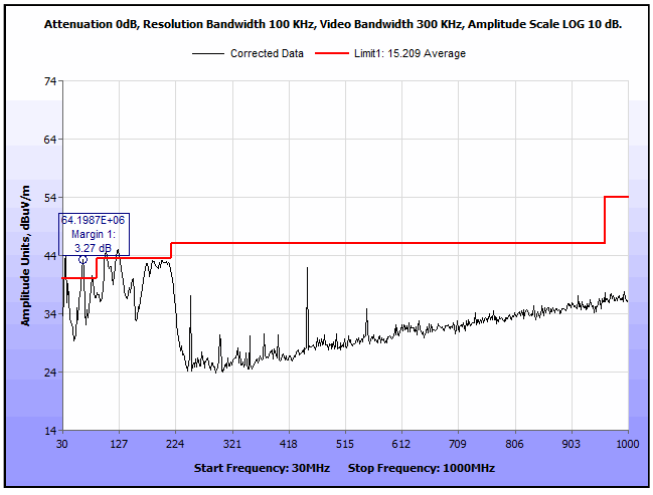
Test Date(s): May 16, 2017



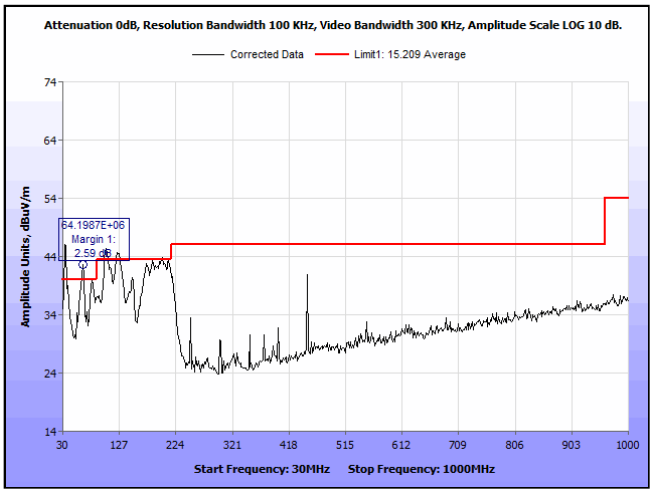
Plot 92. Spurious Emissions, TX Off



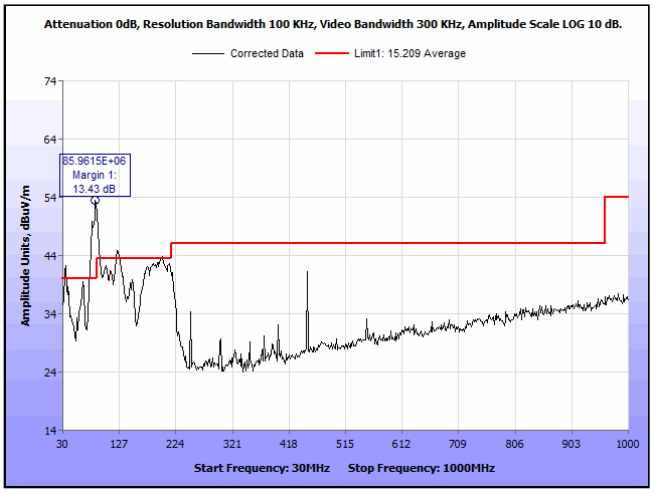
Plot 93. Spurious Emissions, 802.11a - 5180 - 30M-1GHz - QP



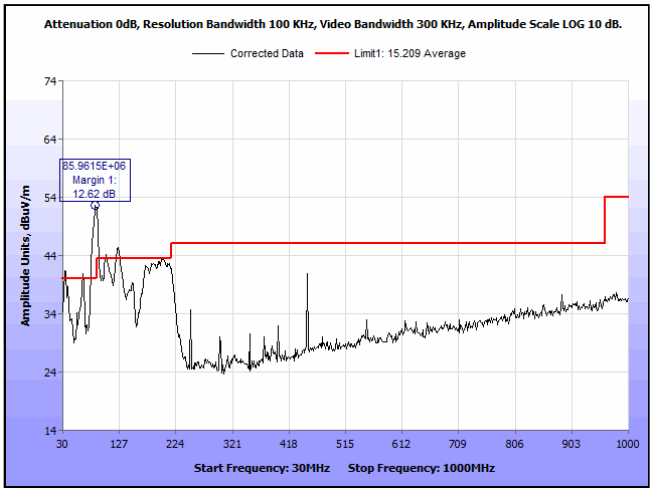
Plot 94. Spurious Emissions, 802.11a - 5220 - 30M-1GHz - QP



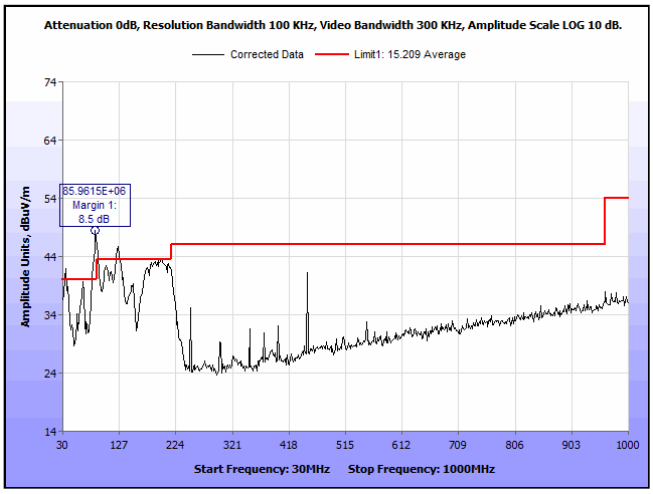
Plot 95. Spurious Emissions, 802.11a - 5240 - 30M-1GHz - QP



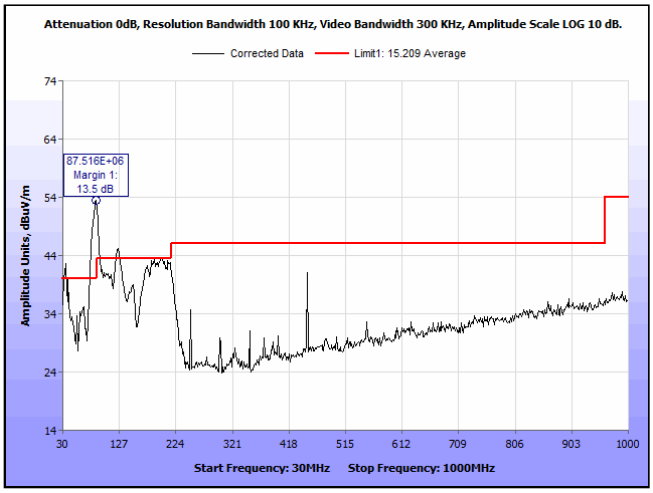
Plot 96. Spurious Emissions, 802.11ac 20 - 5180 - 30M-1GHz - QP



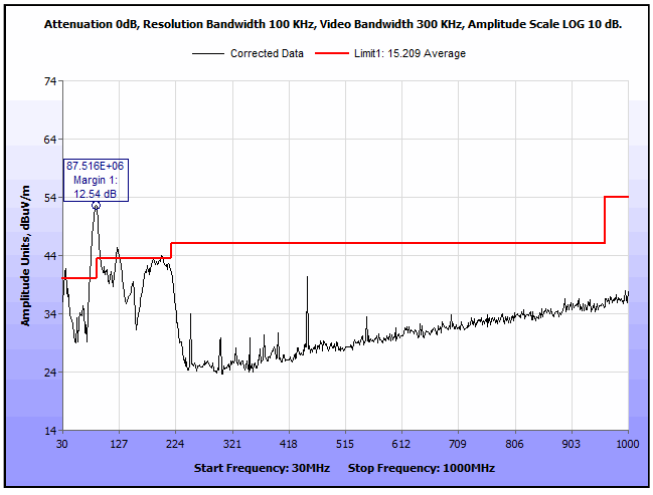
Plot 97. Spurious Emissions, 802.11ac 20 - 5220 - 30M-1GHz - QP



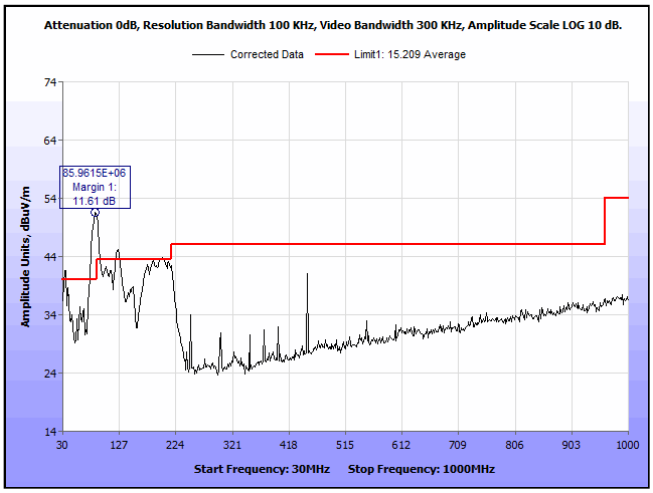
Plot 98. Spurious Emissions, 802.11ac 20 - 5240 - 30M-1GHz - QP



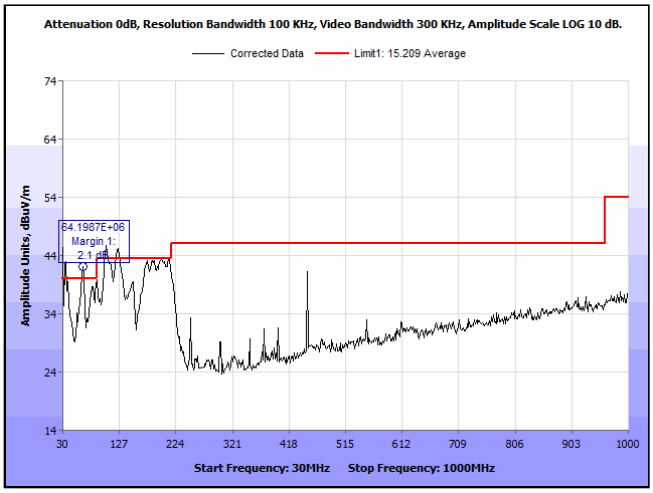
Plot 99. Spurious Emissions, 802.11ac 40 - 5190 - 30M-1GHz - QP



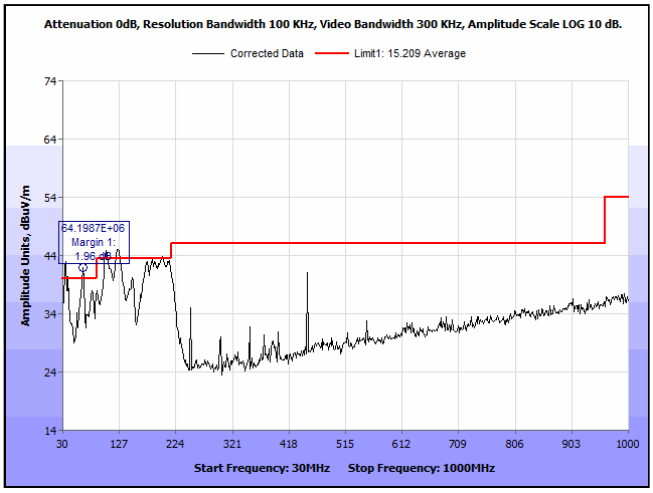
Plot 100. Spurious Emissions, 802.11ac 40 - 5230 - 30M-1GHz - QP



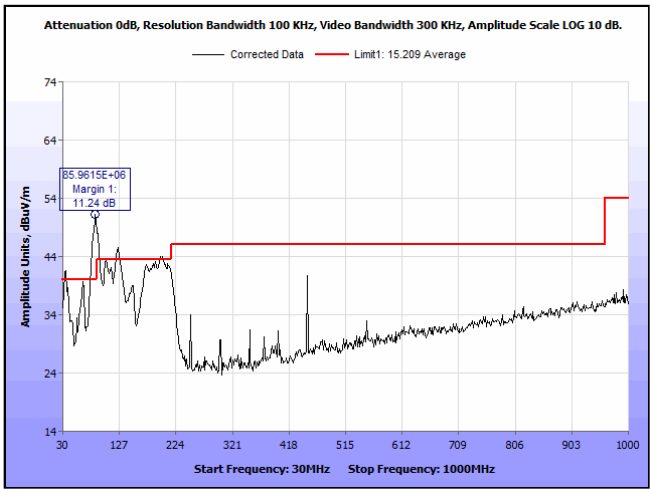
Plot 101. Spurious Emissions, 802.11ac 80 - 5210 - 30M-1GHz - QP



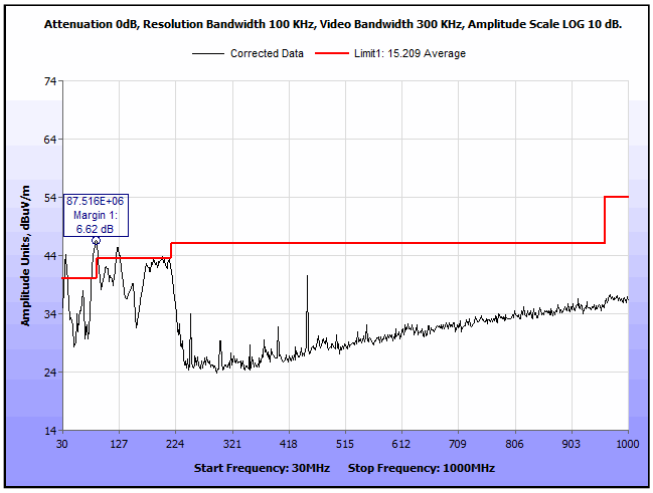
Plot 102. Spurious Emissions, 802.11n 20 - 5180 - 30M-1GHz - QP



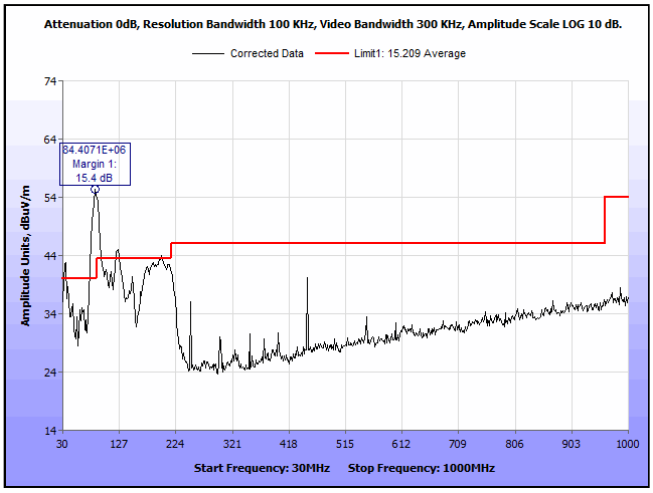
Plot 103. Spurious Emissions, 802.11n 20 - 5220 - 30M-1GHz - QP



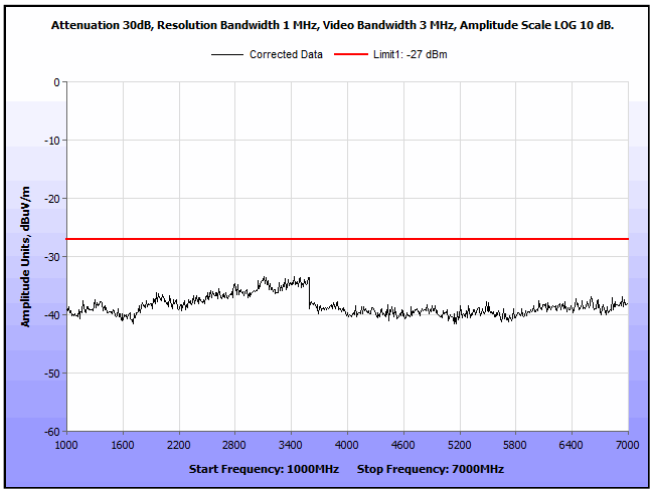
Plot 104. Spurious Emissions, 802.11n 20 - 5240 - 30M-1GHz - QP



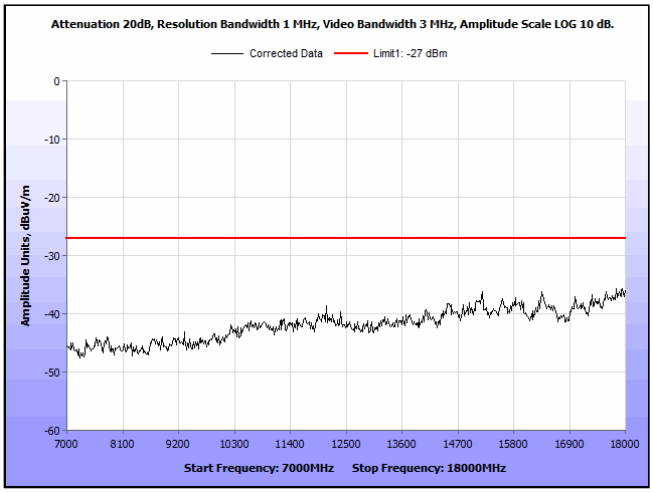
Plot 105. Spurious Emissions, 802.11n 40 - 5190 - 30M-1GHz - QP



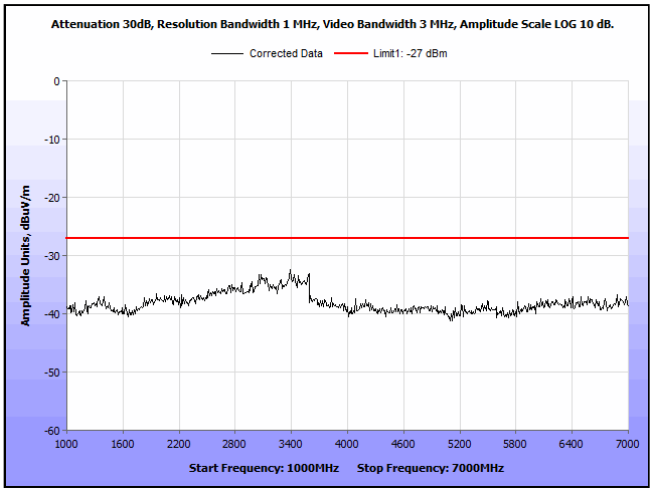
Plot 106. Spurious Emissions, 802.11n 40 - 5230 - 30M-1GHz - QP



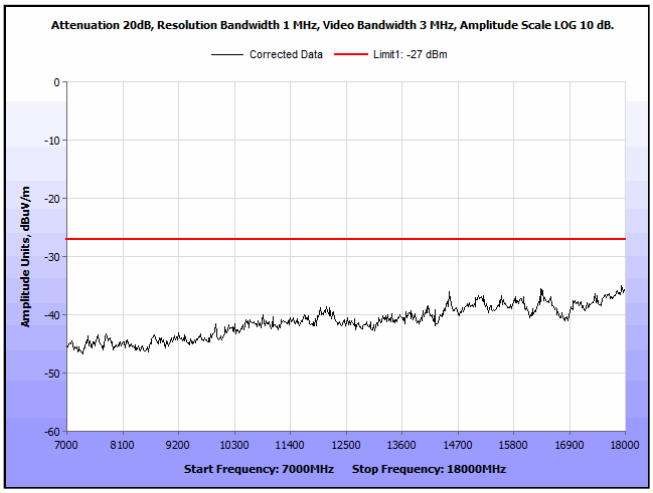
Plot 107. Undesirable Emissions, 802.11a - 5180 - EIRP - 1-7GHz



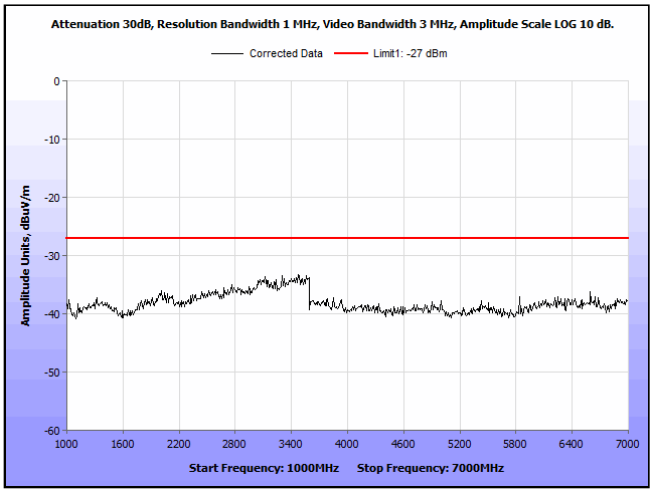
Plot 108. Undesirable Emissions, 802.11a - 5180 - EIRP - 7-18GHz



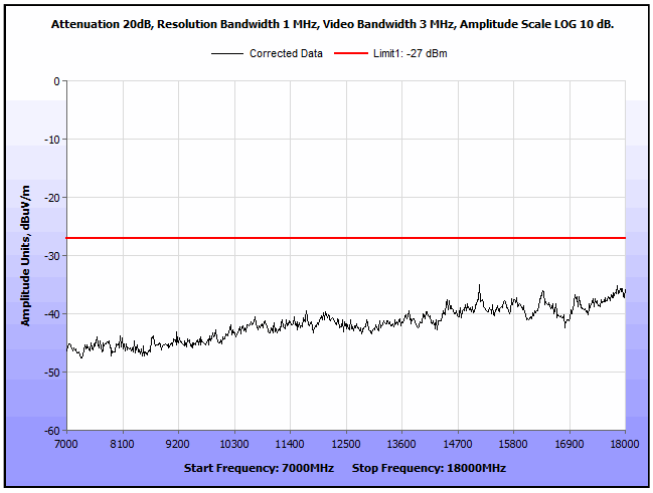
Plot 109. Undesirable Emissions, 802.11a - 5220 - EIRP - 1-7GHz



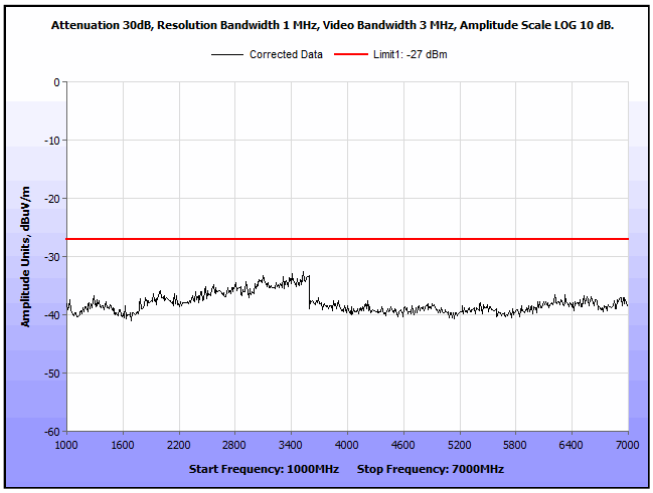
Plot 110. Undesirable Emissions, 802.11a - 5220 - EIRP - 7-18GHz



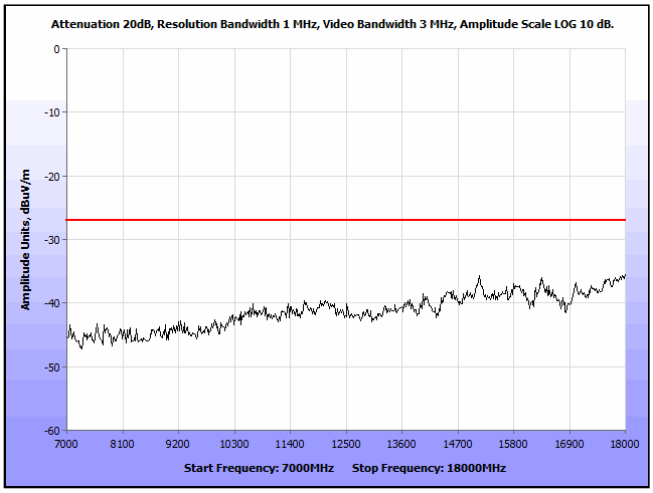
Plot 111. Undesirable Emissions, 802.11a - 5240 - EIRP - 1-7GHz



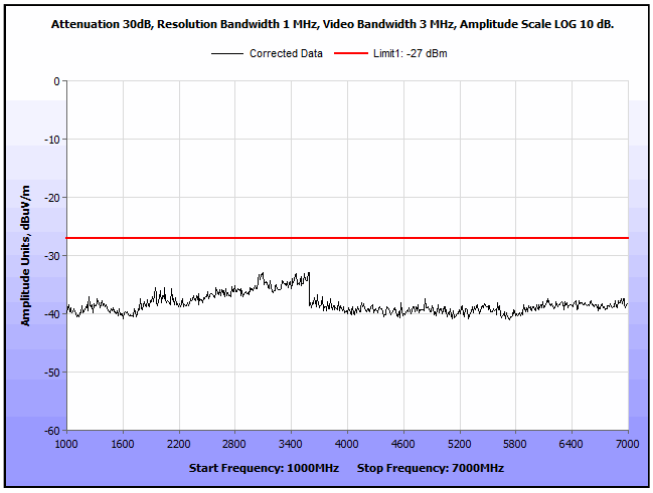
Plot 112. Undesirable Emissions, 802.11a - 5240 - EIRP - 7-18GHz



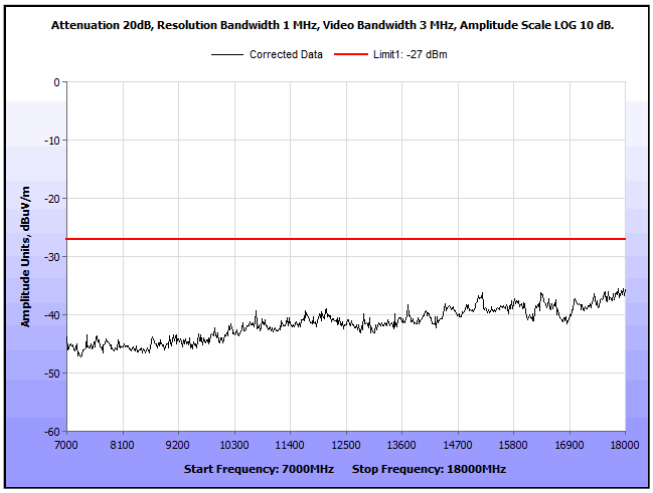
Plot 113. Undesirable Emissions, 802.11ac 20 - 5180 - EIRP - 1-7GHz



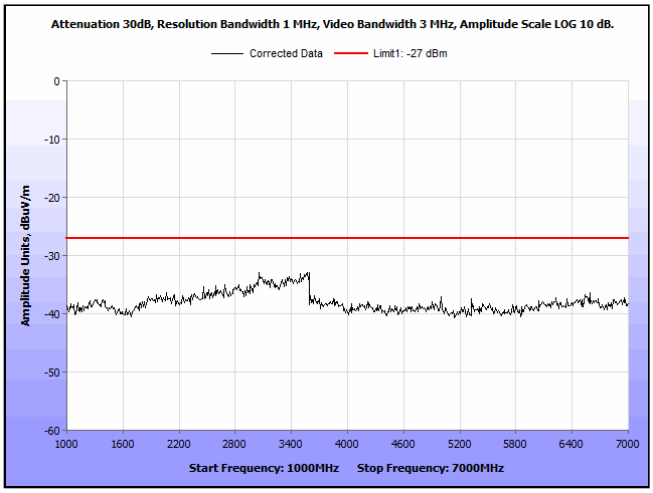
Plot 114. Undesirable Emissions, 802.11ac 20 - 5180 - EIRP - 7-18GHz



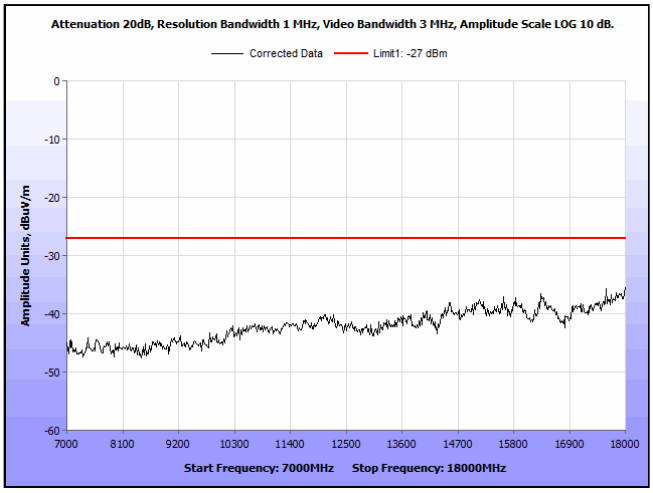
Plot 115. Undesirable Emissions, 802.11ac 20 - 5220 - EIRP - 1-7GHz



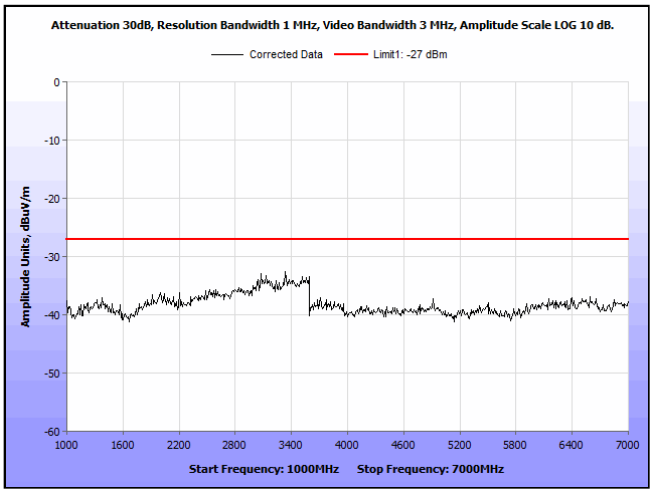
Plot 116. Undesirable Emissions, 802.11ac 20 - 5220 - EIRP - 7-18GHz



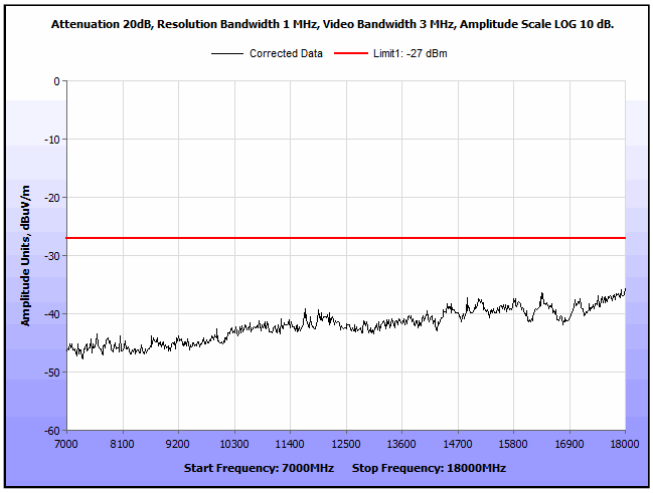
Plot 117. Undesirable Emissions, 802.11ac 20 - 5240 - EIRP - 1-7GHz



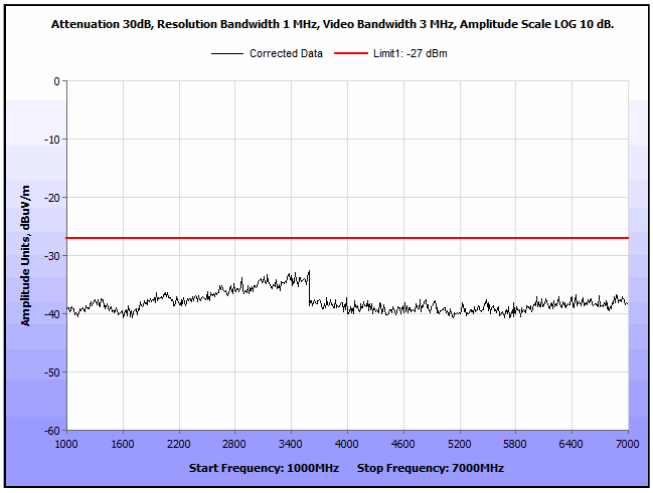
Plot 118. Undesirable Emissions, 802.11ac 20 - 5240 - EIRP - 7-18GHz



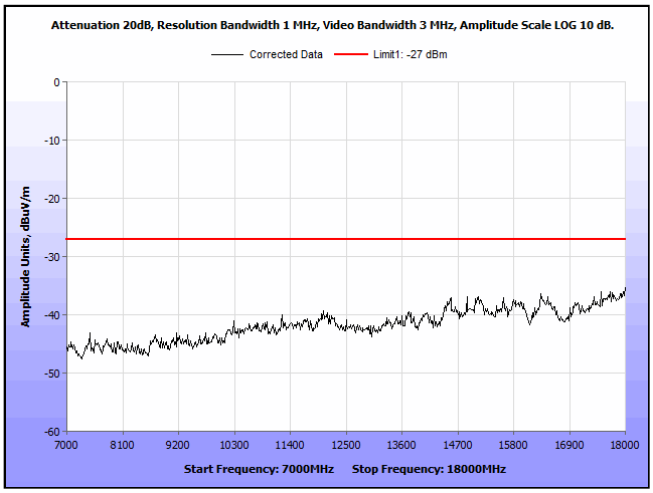
Plot 119. Undesirable Emissions, 802.11ac 40 - 5190 - EIRP - 1-7GHz



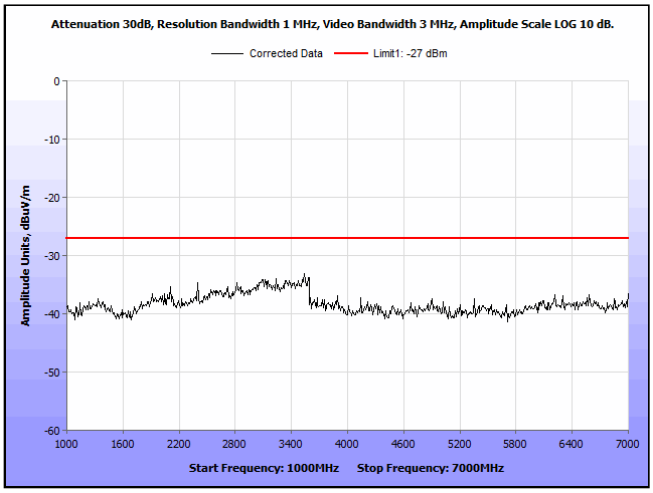
Plot 120. Undesirable Emissions, 802.11ac 40 - 5190 - EIRP - 7-18GHz



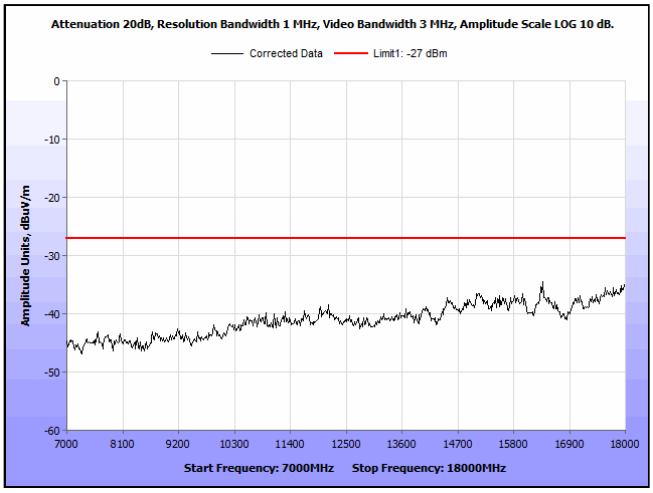
Plot 121. Undesirable Emissions, 802.11ac 40 - 5230 - EIRP - 1-7GHz



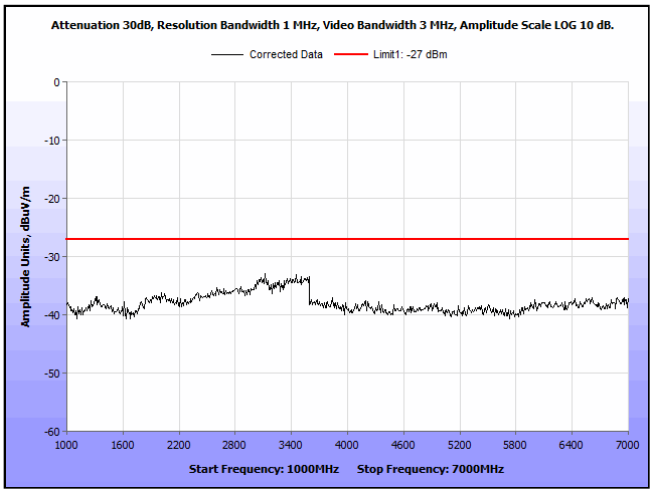
Plot 122. Undesirable Emissions, 802.11ac 40 - 5230 - EIRP - 7-18GHz



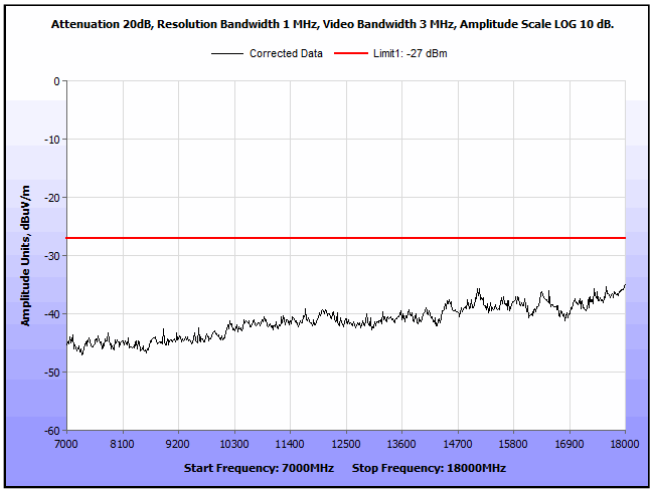
Plot 123. Undesirable Emissions, 802.11ac 80 - 5210 - EIRP - 1-7GHz



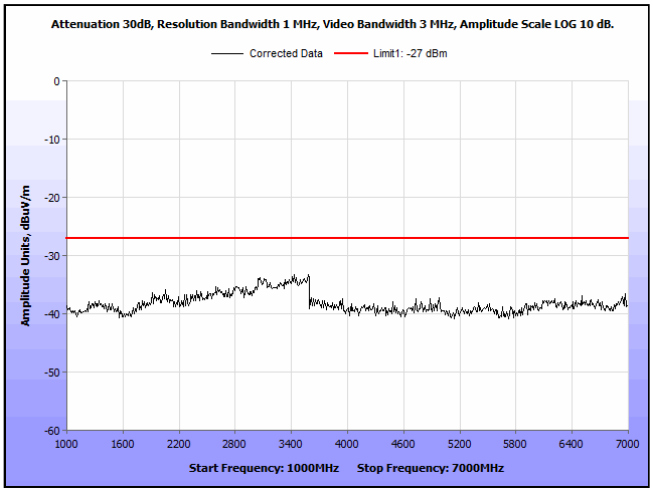
Plot 124. Undesirable Emissions, 802.11ac 80 - 5210 - EIRP - 7-18GHz



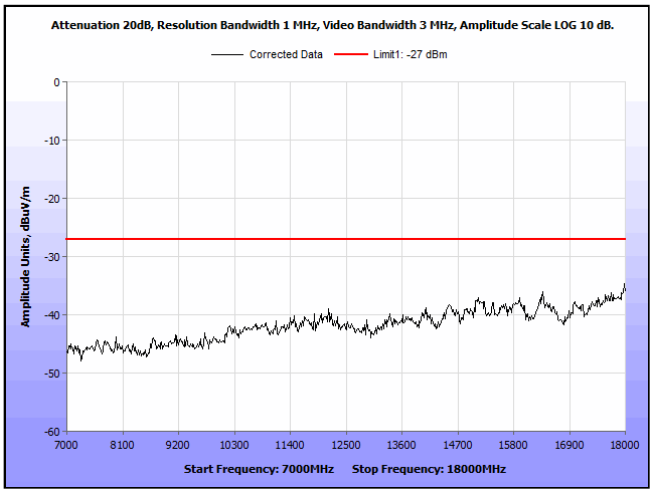
Plot 125. Undesirable Emissions, 802.11n 20 - 5180 - EIRP - 1-7GHz



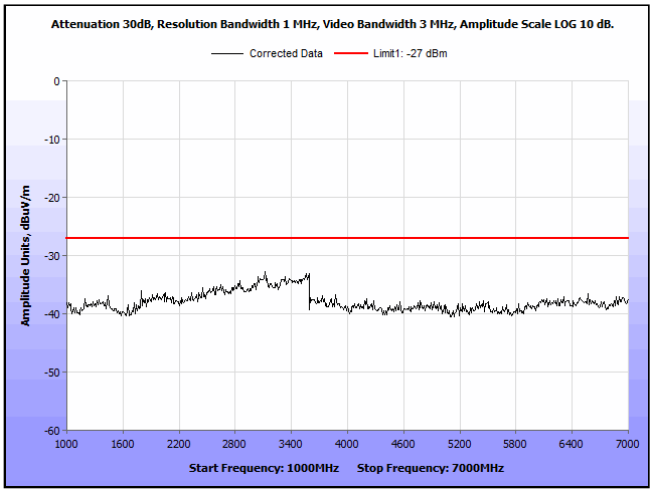
Plot 126. Undesirable Emissions, 802.11n 20 - 5180 - EIRP - 7-18GHz



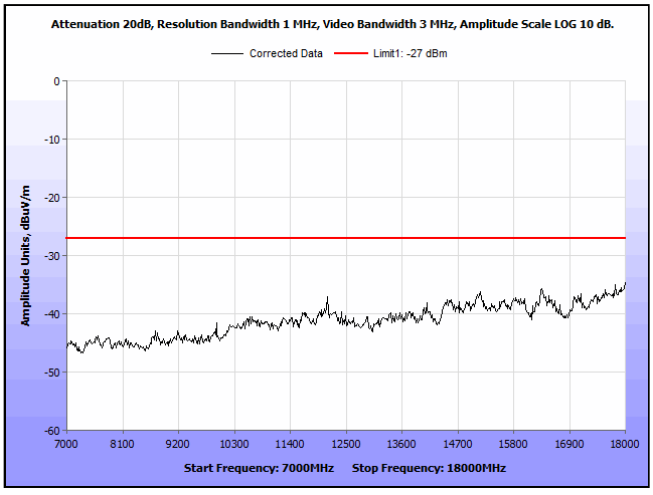
Plot 127. Undesirable Emissions, 802.11n 20 - 5220 - EIRP - 1-7GHz



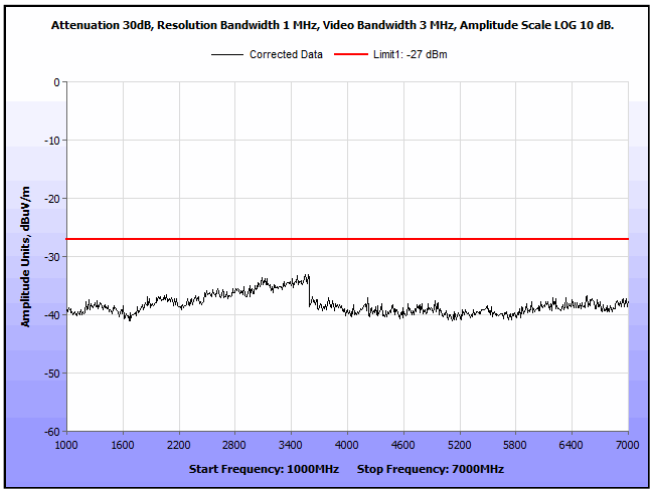
Plot 128. Undesirable Emissions, 802.11n 20 - 5220 - EIRP - 7-18GHz



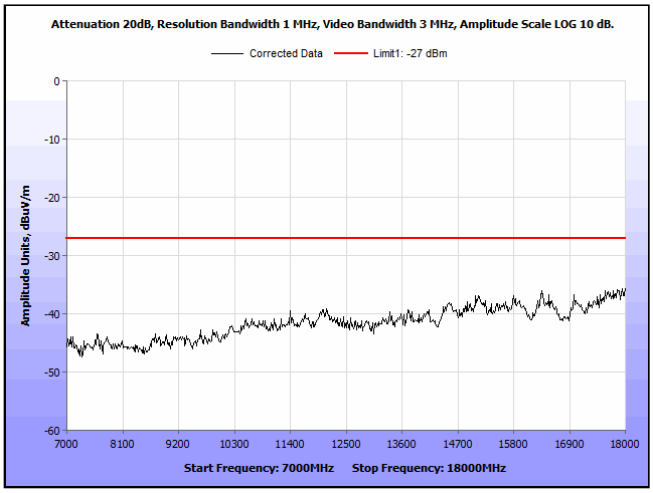
Plot 129. Undesirable Emissions, 802.11n 20 - 5240 - EIRP - 1-7GHz



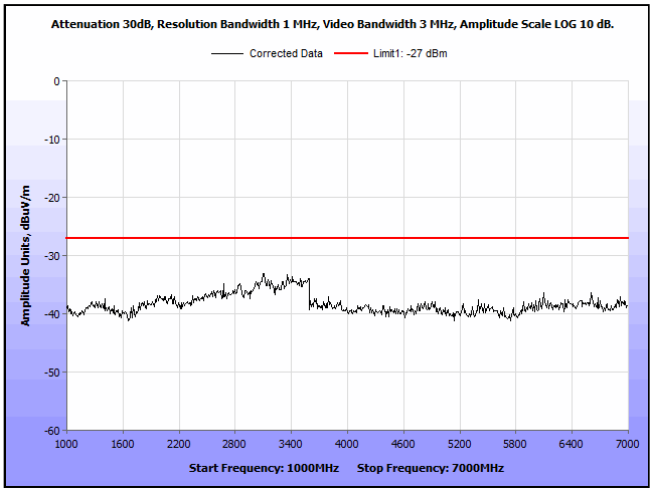
Plot 130. Undesirable Emissions, 802.11n 20 - 5240 - EIRP - 7-18GHz



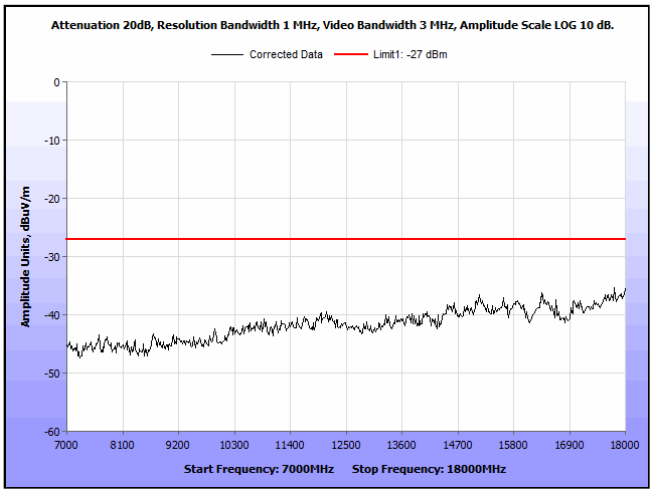
Plot 131. Undesirable Emissions, 802.11n 40 - 5190 - EIRP - 1-7GHz



Plot 132. Undesirable Emissions, 802.11n 40 - 5190 - EIRP - 7-18GHz

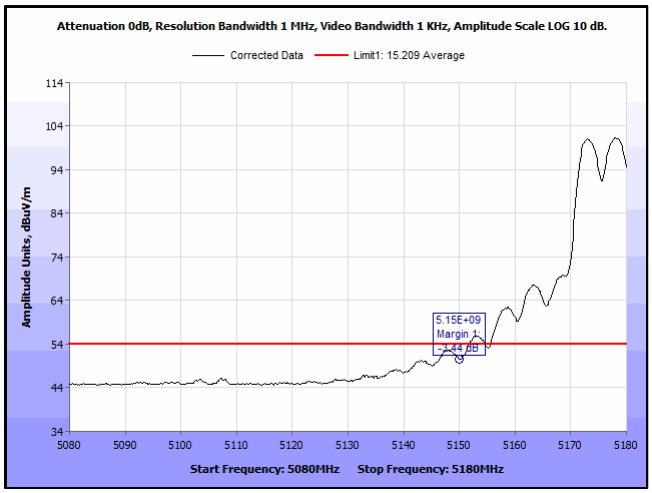


Plot 133. Undesirable Emissions, 802.11n 40 - 5230 - EIRP - 1-7GHz

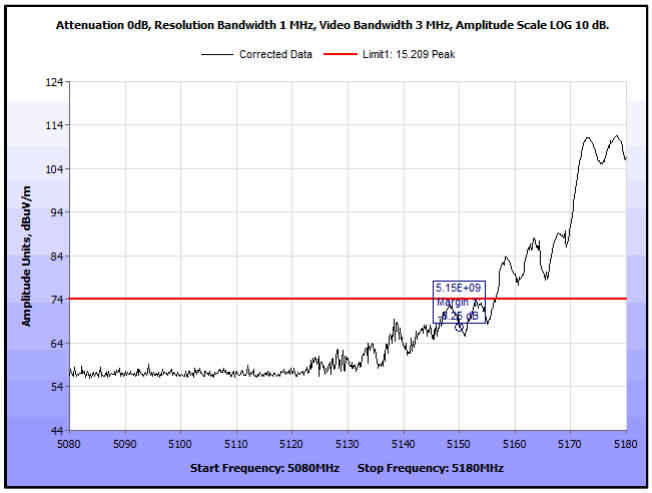


Plot 134. Undesirable Emissions, 802.11n 40 - 5230 - EIRP - 7-18GHz

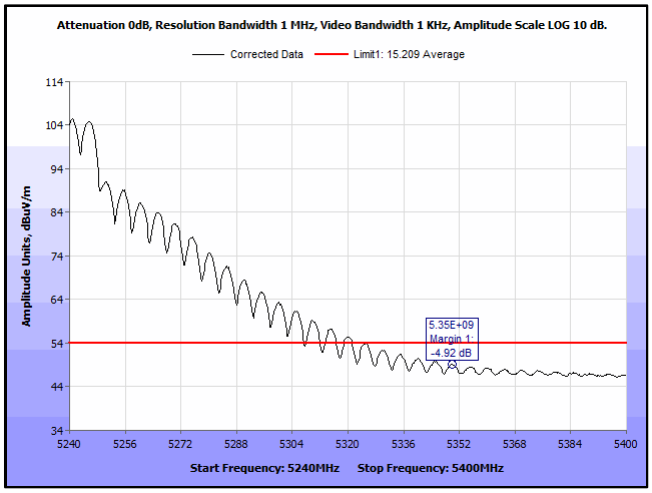
Band Edge



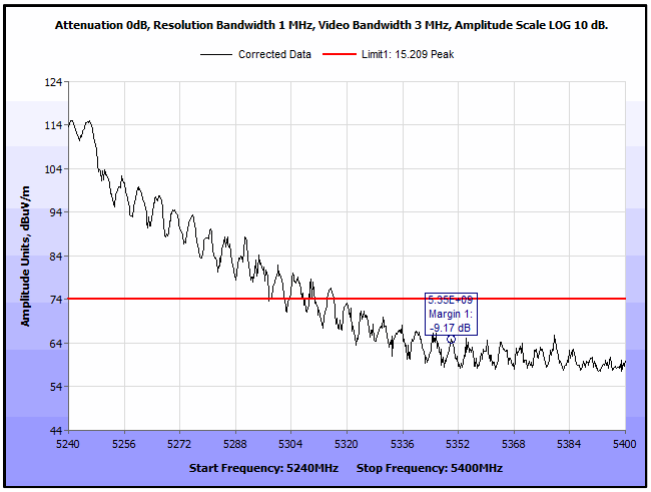
Plot 135. Undesirable Emissions, Bandedge, 802.11a, 5180 MHz, Average



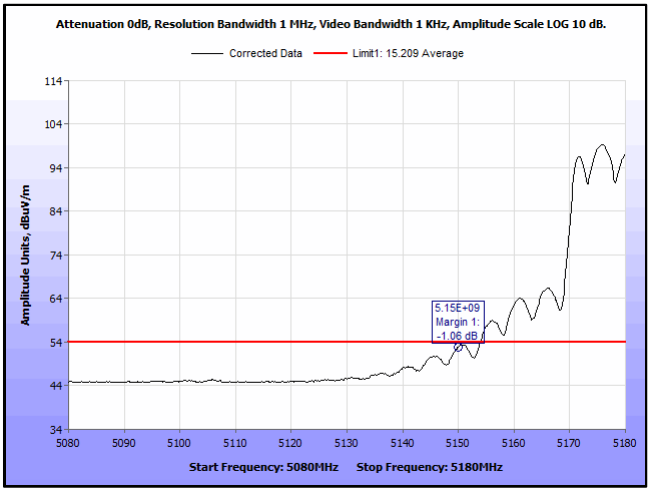
Plot 136. Undesirable Emissions, Bandedge, 802.11a, 5180 MHz, Peak



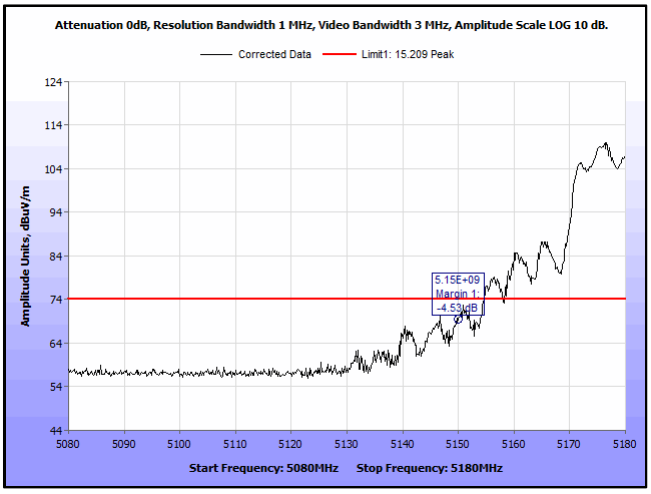
Plot 137. Undesirable Emissions, Bandedge, 802.11a, 5240 MHz, Average



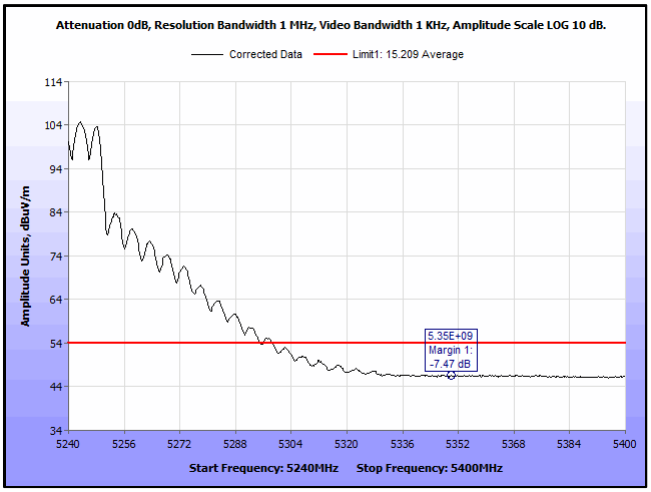
Plot 138. Undesirable Emissions, Bandedge, 802.11a, 5240 MHz, Peak



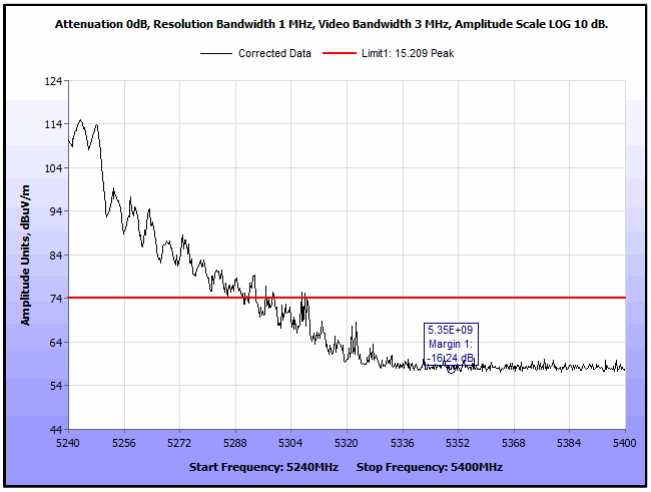
Plot 139. Undesirable Emissions, Bandedge, 802.11ac 20 MHz, 5180 MHz, Average



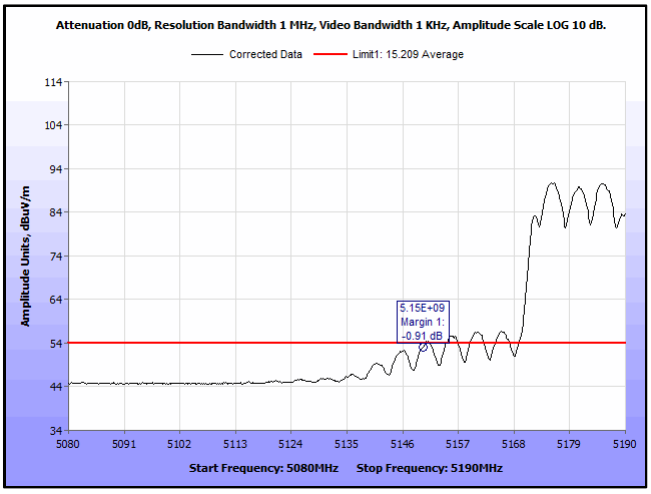
Plot 140. Undesirable Emissions, Bandedge, 802.11ac 20 MHz, 5180 MHz, Peak



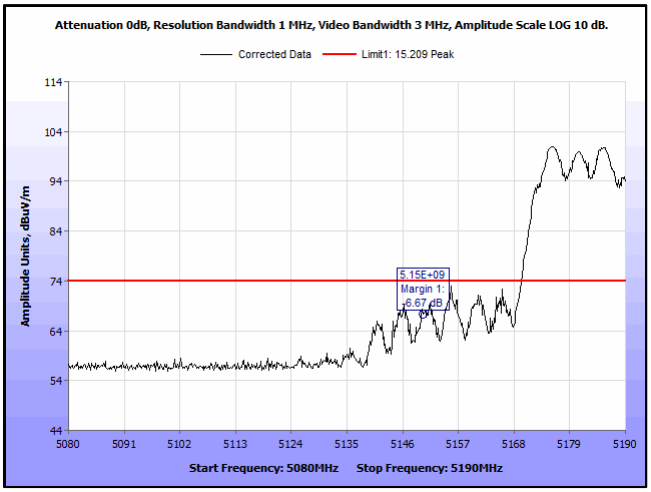
Plot 141. Undesirable Emissions, Bandedge, 802.11ac 20 MHz, 5240 MHz, Average



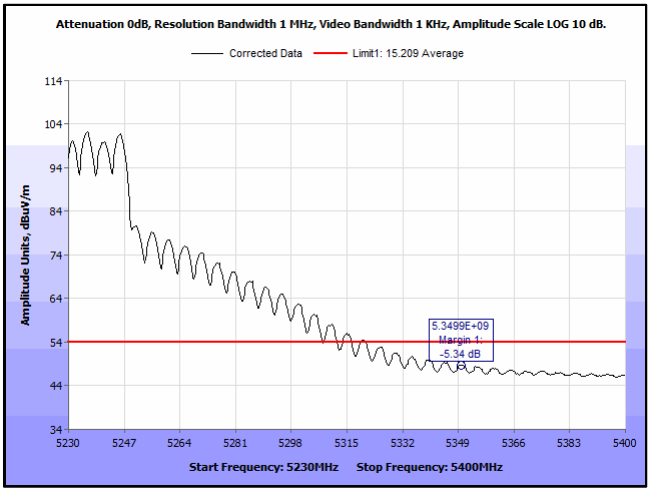
Plot 142. Undesirable Emissions, Bandedge, 802.11ac 20 MHz, 5240 MHz, Peak



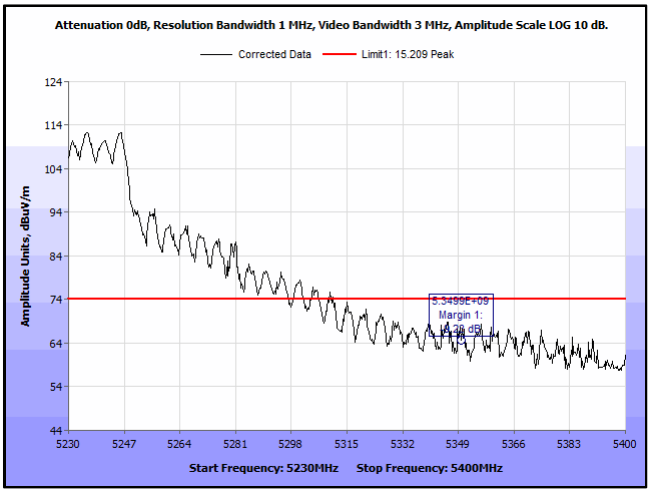
Plot 143. Undesirable Emissions, Bandedge, 802.11ac 40 MHz, 5190 MHz, Average



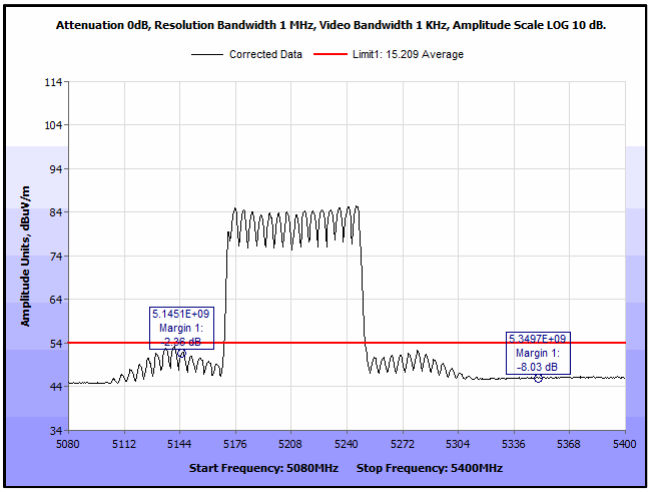
Plot 144. Undesirable Emissions, Bandedge, 802.11ac 40 MHz, 5190 MHz, Peak



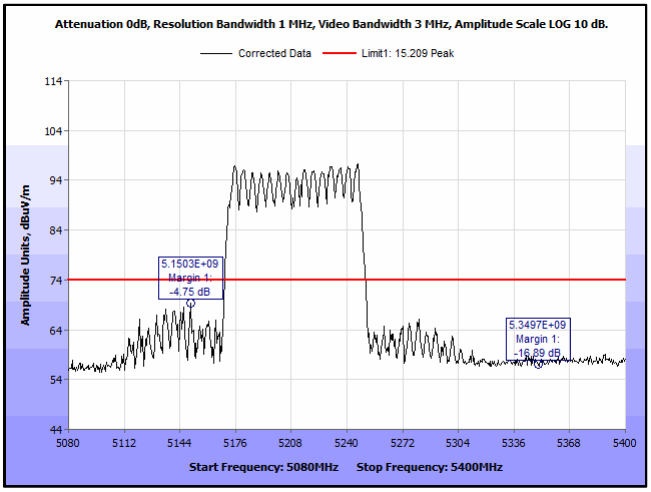
Plot 145. Undesirable Emissions, Bandedge, 802.11ac 40 MHz, 5230 MHz, Average



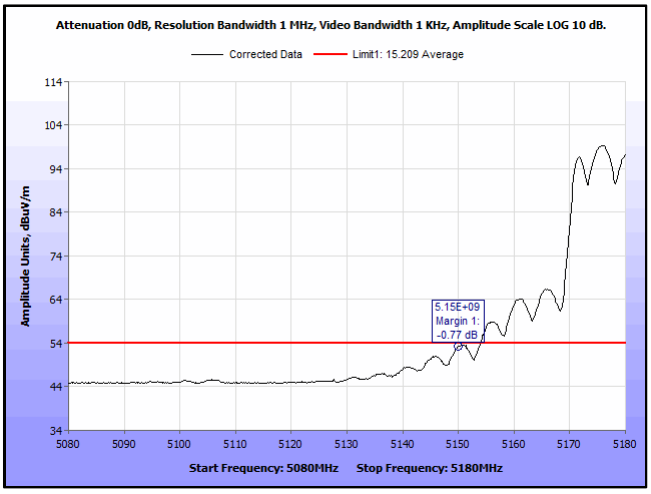
Plot 146. Undesirable Emissions, Bandedge, 802.11ac 40 MHz, 5230 MHz, Peak



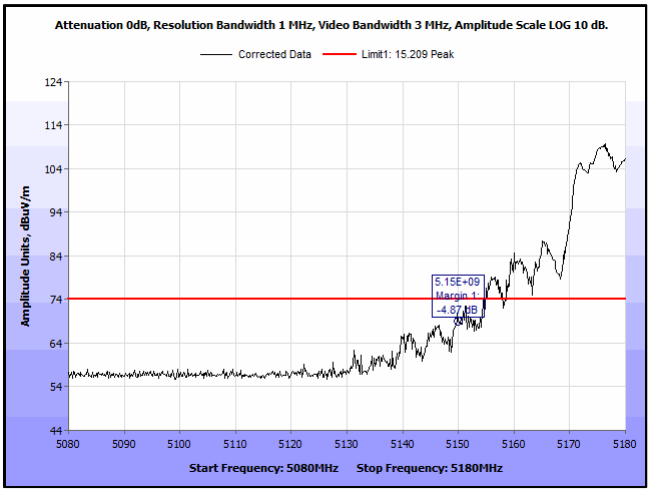
Plot 147. Undesirable Emissions, Bandedge, 802.11ac 80 MHz, 5210 MHz, Average



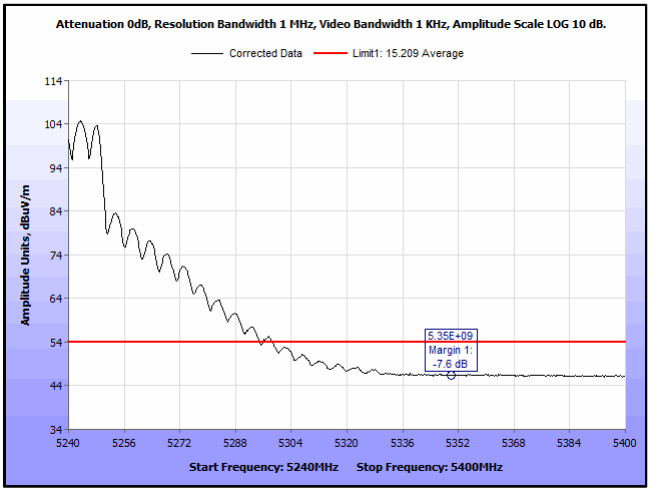
Plot 148. Undesirable Emissions, Bandedge, 802.11ac 80 MHz, 5210 MHz, Peak



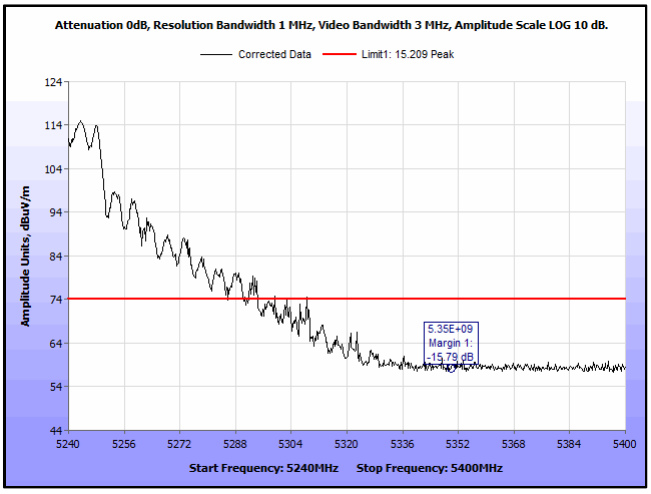
Plot 149. Undesirable Emissions, Bandedge, 802.11n 20 MHz, 5180 MHz, Average



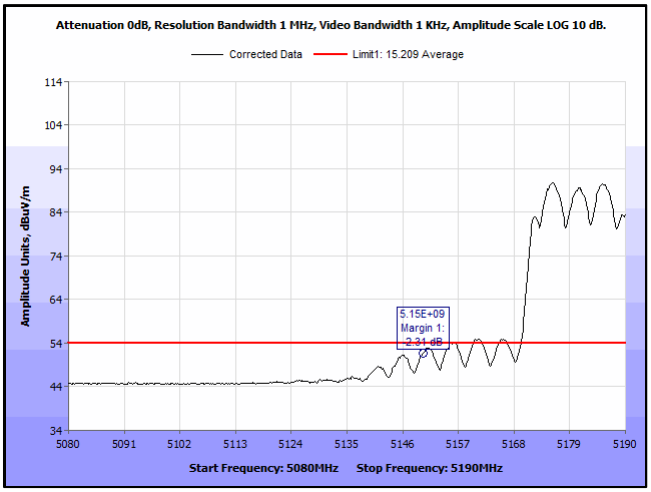
Plot 150. Undesirable Emissions, Bandedge, 802.11n 20 MHz, 5180 MHz, Peak



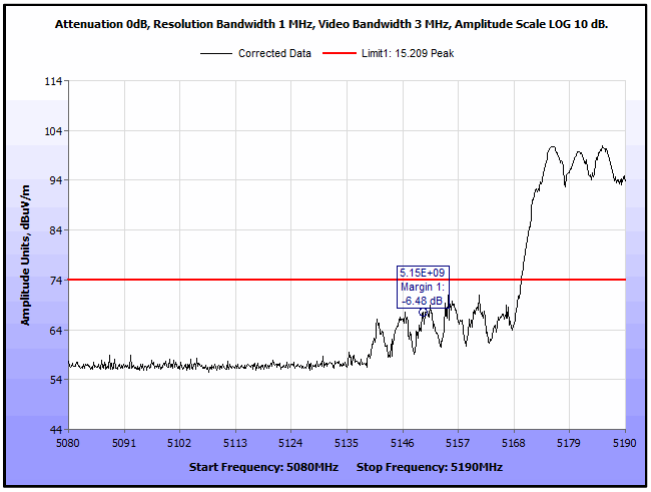
Plot 151. Undesirable Emissions, Bandedge, 802.11n 20 MHz, 5240 MHz, Average



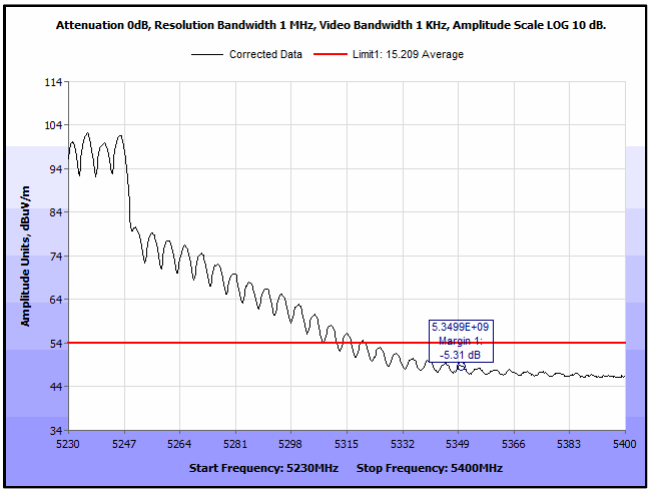
Plot 152. Undesirable Emissions, Bandedge, 802.11n 20 MHz, 5240 MHz, Peak



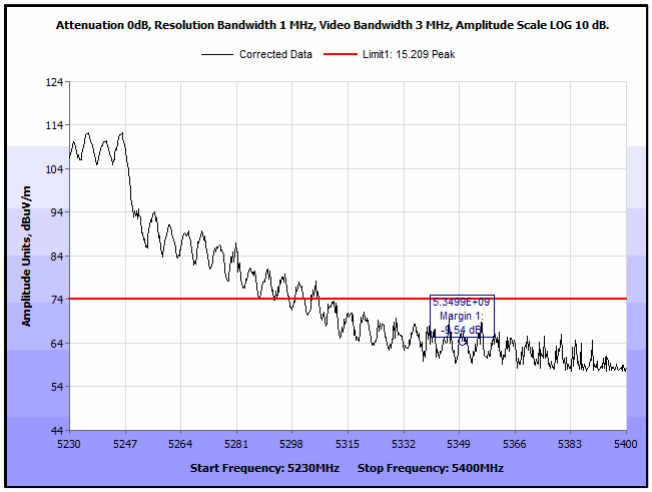
Plot 153. Undesirable Emissions, Bandedge, 802.11n 40 MHz, 5190 MHz, Average



Plot 154. Undesirable Emissions, Bandedge, 802.11n 40 MHz, 5190 MHz, Peak

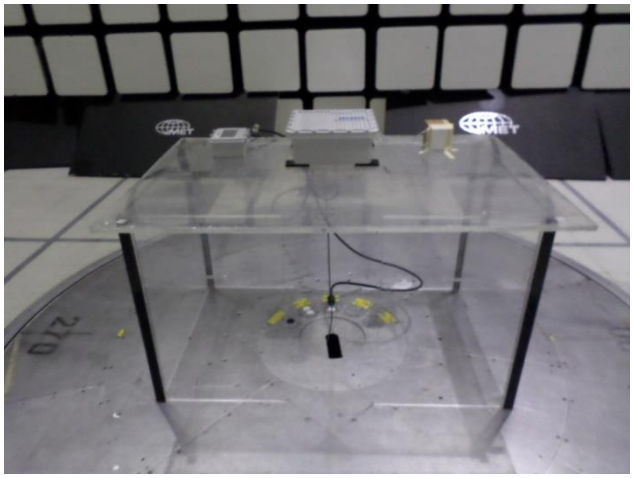


Plot 155. Undesirable Emissions, Bandedge, 802.11n 40 MHz, 5230 MHz, Average

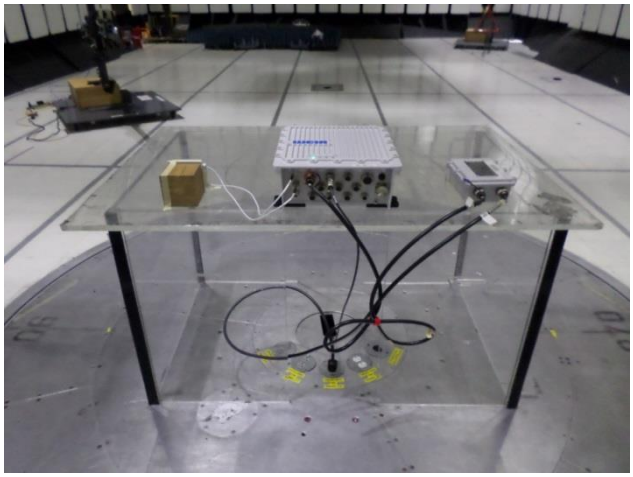


Plot 156. Undesirable Emissions, Bandedge, 802.11n 40 MHz, 5230 MHz, Peak

Radiated Emissions Test Setup Photos

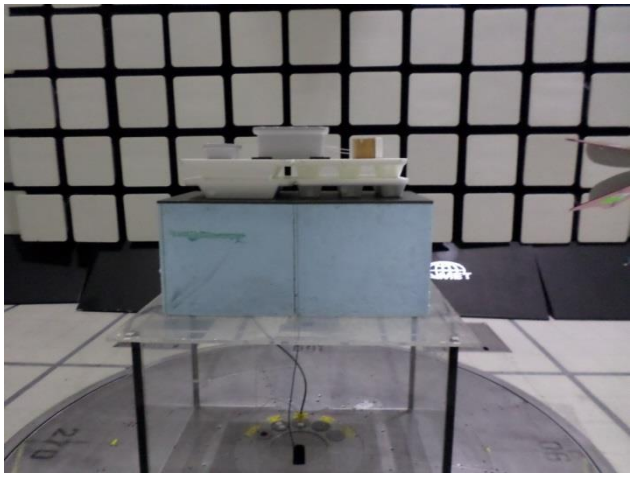


Photograph 1. Radiated setup, 30M-1GHz front view



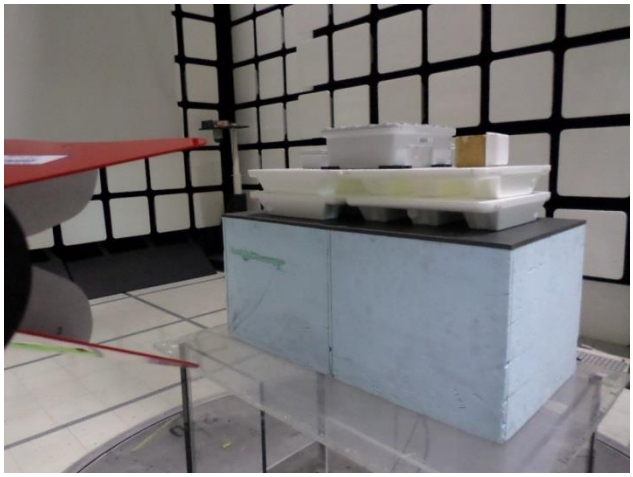
Photograph 2. Radiated setup, 30M-1GHz rear view

Photograph 3. Radiated setup, 30M-1GHz antenna view

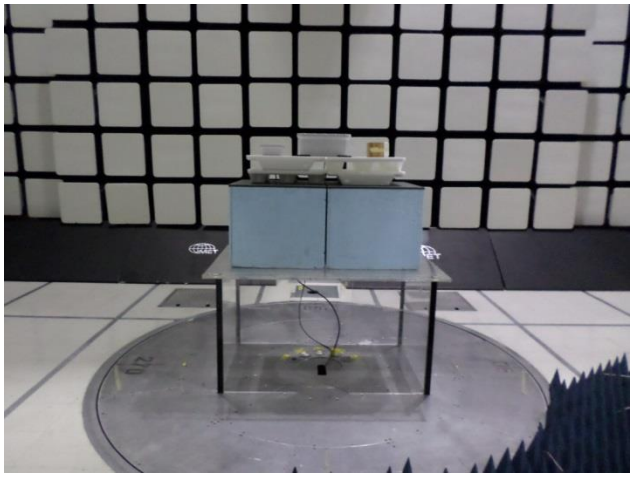


Photograph 4. Radiated setup, 1-18GHz front view

Photograph 5. Radiated setup, 1-18GHz rear view



Photograph 6. Radiated setup, 1-18GHz, antenna view



Photograph 7. Radiated setup, 18-40GHz front view

Photograph 8. Radiated setup, 18-40GHz rear view

Photograph 9. Radiated setup, 18-40GHz antenna view

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(b)(6) Conducted Emissions

Test Requirement(s): **§ 15.407 (b)(6):** Any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.

§ 15.207 (a): For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Σ line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dBμV)	
	Quasi-Peak	Average
* 0.15- 0.45	66 – 56	56 - 46
0.45 - 0.5	56	46
0.5 - 30	60	50

Table 21. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

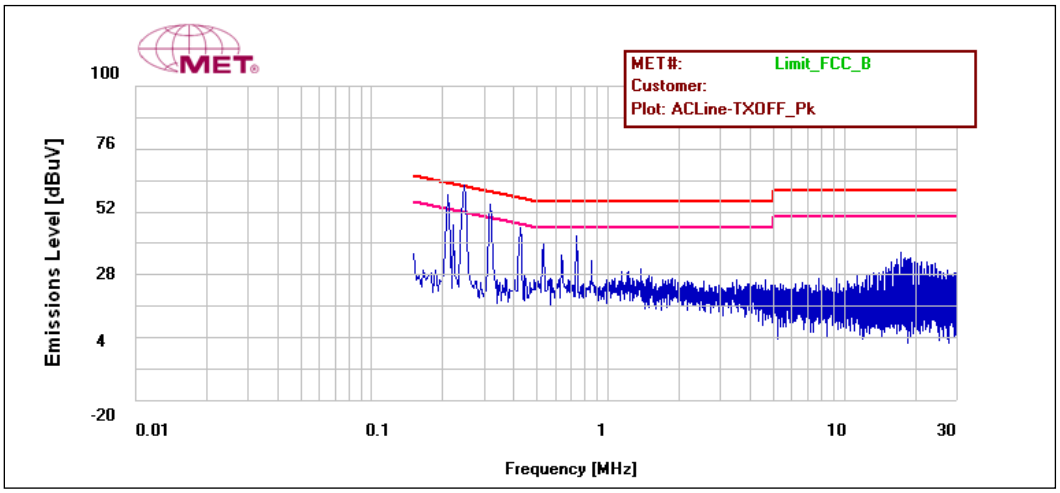
Test Procedure: The EUT was placed on a non-metallic table above a ground plane. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2014 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. Scans were performed with the transmitter on. Measurements were taken with the transmitter off to ensure that any frequencies over the limit were not caused by the transmitter.

Test Results: The EUT was compliant with requirements of this section. Emissions above the limit were also present with the transmitter off and are likely to not be caused by the transmitter.

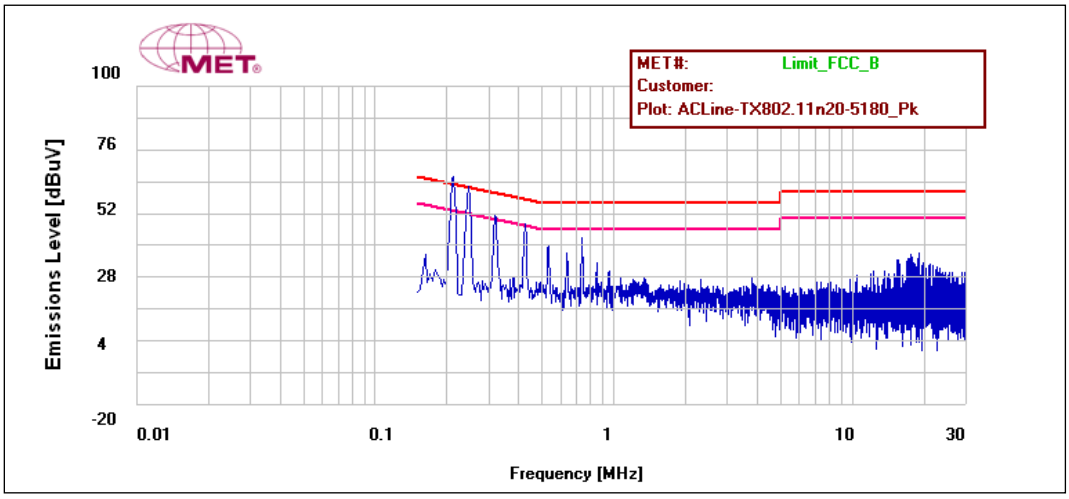
Test Engineer(s): Giuliano Messina

Test Date(s): May 12, 2017

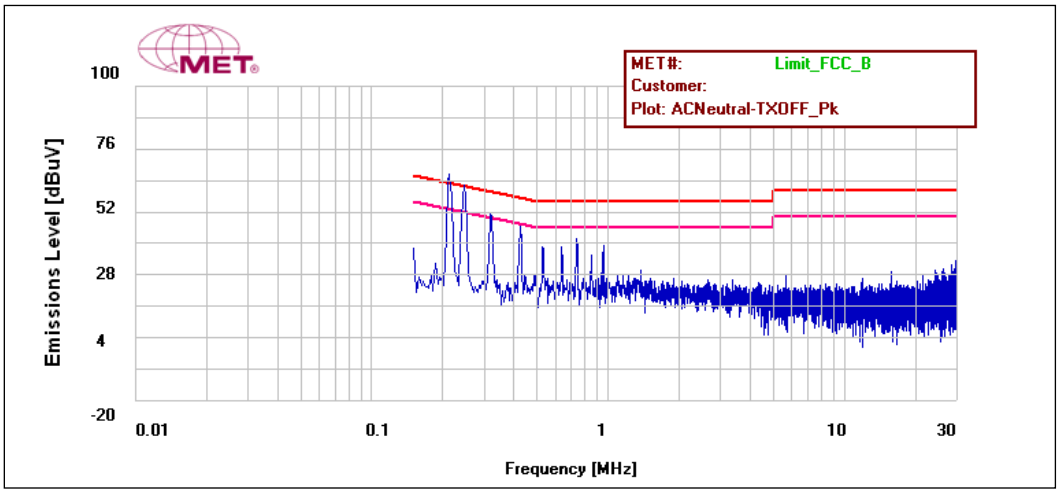
15.207(a) Conducted Emissions Test Results



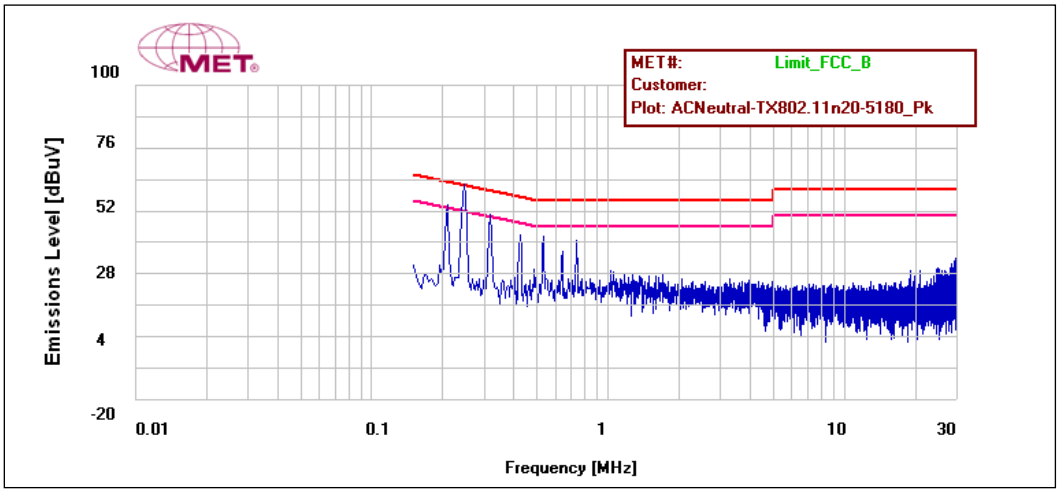
Plot 157. Conducted Emissions, 15.207(a), Transmit Off, Phase Line



Plot 158. Conducted Emissions, 15.207(a), 5 GHz UNII-1, 802.11n HT20, Phase Line

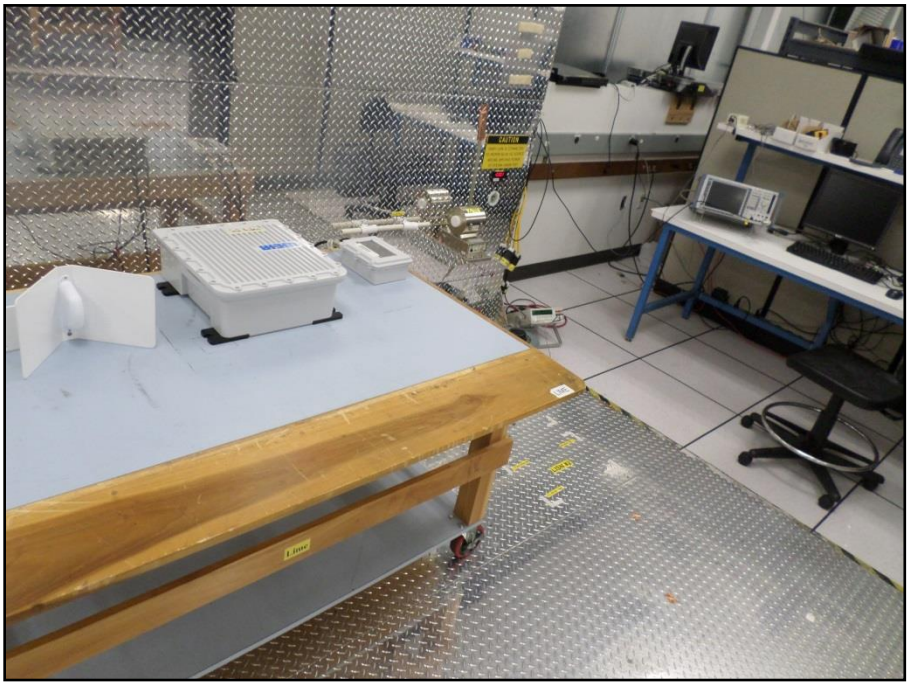


Plot 159. Conducted Emissions, 15.207(a), Transmit Off, Neutral Line

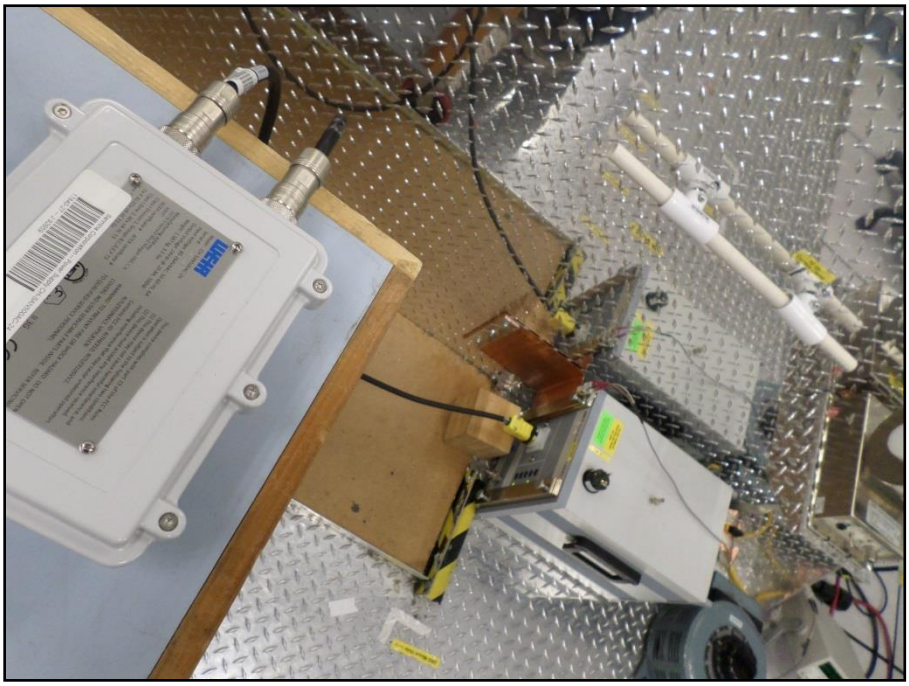


Plot 160. Conducted Emissions, 15.207(a), 5 GHz UNII-1, 802.11n HT20, Neutral Line

15.207(a) Conducted Emissions Test Setup Photos



Photograph 10. Conducted Emissions, 15.207(a), CEV Station Setup



Photograph 11. Conducted Emissions, 15.207(a), LISN Connection

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(c) Automatic Discontinue of Transmission

Test Requirement(s): **§ 15.207 (c):** The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signaling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals.

Test Results: Per the Manufacturer, the EUT was not applicable with the requirement of this section.

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(f) Maximum Permissible Exposure

Test Requirement(s): **§15.407(f):** U-NII devices are subject to the radio frequency radiation exposure requirements specified in §1.1307(b), §2.1091 and §2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a "general population/uncontrolled" environment.

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Limit: EUT's operating frequencies @ 5150-5250 MHz; **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

Equation from page 18 of OET 65, Edition 97-01

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{(PG / 4\pi S)}$$

where, S = Power Density (mW/cm^2)
P = Power Input to antenna (mW)
G = Antenna Gain (numeric value)
R = Distance (cm)

Test Results:

FCC									
Frequency (MHz)	**Con. Pwr. (dBm)**	**Con. Pwr. (mW)**	**Ant. Gain (dBi)**	**Ant. Gain numeric**	**Pwr. Density (mW/cm^2)**	**Limit (mW/cm^2)**	**Margin**	**Distance (cm)**	**Result**
5230	9.29	8.492	9	7.943	0.01342	1	0.98658	20	Pass

Table 22. Maximum Permissible Exposure

The safe distance where Power Density is less than the MPE Limit listed above was found to be 20 cm.

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(g) Frequency Stability

Test Requirements: Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

Test Procedure: The EUT was connected directly to a spectrum analyzer through an attenuator. The 1st trace of the Spectrum Analyzer was taken at ambient conditions and used as a reference. A 2nd trace was used to show the drift of the carrier at extreme conditions. A delta marker was used to find the drift at a given extreme condition.

Test Results: The EUT was not applicable with the requirements of this section.

Frequency stability has been verified by the module manufacturer (FCC ID: VBYLB1EN). This host device leverages those results.

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1A1083	EMI Test Receiver	Rohde & Schwarz	ESU40	8/2/2016	8/2/2017
1A1106A	10m Chamber (FCC)	ETS	Semi-Anechoic	12/1/2016	12/1/2017
1A1147	Bilog Antenna (30MHz to 1GHz)	Sunol Sciences Corp	JB3	3/9/2017	3/9/2018
1A1047	Horn Antenna	ETS	3117	2/23/2017	8/23/2018
1A1161	DRG Horn Antenna	ETS	3116C-PA	3/6/2017	9/6/2018
1A1099	Generator	COM-Power Corp	CGO-51000	See Note	
1A1088	Pre-Amp	Rohde & Schwarz	TS-PR1	See Note	
1A1044	Generator	COM-Power Corp	CG-520	See Note	
1A1073	Multi Device Controller	ETS EMCO	2090	See Note	
1A1074	System Controller	Panasonic	WV-CU101	See Note	
1A1075	System Controller	Panasonic	WV-CU101	See Note	
1A1080	Multi Device Controller	ETS EMCO	2090	See Note	
1A1180	Pre-Amp	Miteq	AMF-7D-01001800-22-10P	See Note	
1A1065	EMI Receiver	Rohde & Schwarz	ESCI	3/14/2017	3/14/2018
1A1177	Pulse Limiter	Rohde & Schwarz	ESH3Z2	2/21/2017	8/21/2018
1A1119	Test Area	Custom Made	N/A	8/14/2015	8/14/2017
1A1122	LISN	Teseq	NNB 51	5/26/2016	5/26/2017
1A1149	Milliohm Meter	GW Instek	GOM-802	4/27/2017	4/27/2018
1A1141	Spectrum Analyzer	Agilent	E4407B	4/10/2017	4/10/2018

Table 23. Test Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

V. Certification & User's Manual Information

Certification & User's Manual Information

L. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

(i) Compliance testing;

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

