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December 21, 2018

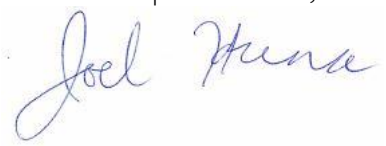
Carnegie Technologies
9737 Great Hills Trail, Suite 260
Austin, Texas 78759

Dear Mark Jones,

Enclosed is the EMC Wireless test report for compliance testing of the Carnegie Technologies, Longview as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

Thank you for using the services of Eurofins | MET Labs, 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,
EUROFINS | MET LABS, INC.



Joel Huna
Documentation Department

Reference: (\Carnegie Technologies\EMCA98009B-FCC247 DTS Rev. 1)

Electromagnetic Compatibility Criteria
Test Report

for the

Carnegie Technologies
Longview

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C for Intentional Radiators

MET Report: EMCA98009B-FCC247

December 21, 2018

Prepared For:

Carnegie Technologies
9737 Great Hills Trail, Suite 260
Austin, Texas 78759

Prepared By:
Eurofins | MET Labs, Inc.
13501 McCallen Pass
Austin, TX 78753

Electromagnetic Compatibility Criteria
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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 the FCC Rules Part 15.247 under normal use and maintenance.

John Mason,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	December 21, 2018	Initial Issue.
1	February 18, 2019	TCB Corrections

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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**er**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**er**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	**micro**henry
µ	**micro**farad
µs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
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 Carnegie Technologies Longview, with the requirements of Part 15, §15.247. 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 Longview. Carnegie Technologies should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Longview, 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, §15.247, in accordance with Carnegie Technologies, purchase order number POLABS1654. All tests were conducted using measurement procedure ANSI C63.10-2013.

FCC Reference 47 CFR Part 15.247	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(2)	6dB Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	Spurious Emissions in Non-restricted Bands	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15; §15.247(e)	Power Spectral Density	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	Maximum Permissible Exposure (MPE)	Compliant

Table 1. Executive Summary of EMC Part 15.247 Compliance Testing

II. Equipment Configuration

A. Overview

Eurofins | MET Labs, Inc. was contracted by Carnegie Technologies to perform testing on the Longview, under Carnegie Technologies' purchase order number POLABS1654.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Carnegie Technologies, Longview.

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

Model(s) Tested:	Longview (ANG-171)	
Model(s) Covered:	Longview (ANG-171)	
EUT Specifications:	Primary Power: 15VDC	
	FCC ID: 2ARIP-0001	
	Type of Modulations:	OFDM
	Equipment Code:	DTS
	Peak RF Output Power:	7.562 dBm
	EUT Frequency Ranges:	2412-2462 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Giuliano Messina	
Report Date(s):	December 21, 2018	

Table 2. EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
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 558074 v05	Guidance For Performing Compliance Measurements On Digital Transmission Systems (DTS) Operating Under Section 15.247

Table 3. References

C. Test Site

All testing was performed at Eurofins | MET Labs, 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.

D. Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.97 dB	2	95%
RF Power Radiated Emissions, >1GHz	±3.54 dB	2	95%
RF Power Radiated Emissions, <1GHz	±2.95 dB	2	95%

Table 4. Uncertainty Calculations Summary

E. Description of Test Sample

The Carnegie Technologies Longview, Equipment Under Test (EUT), is an Access Node that is used to gather data from tags in the field and then send that data to a hub.

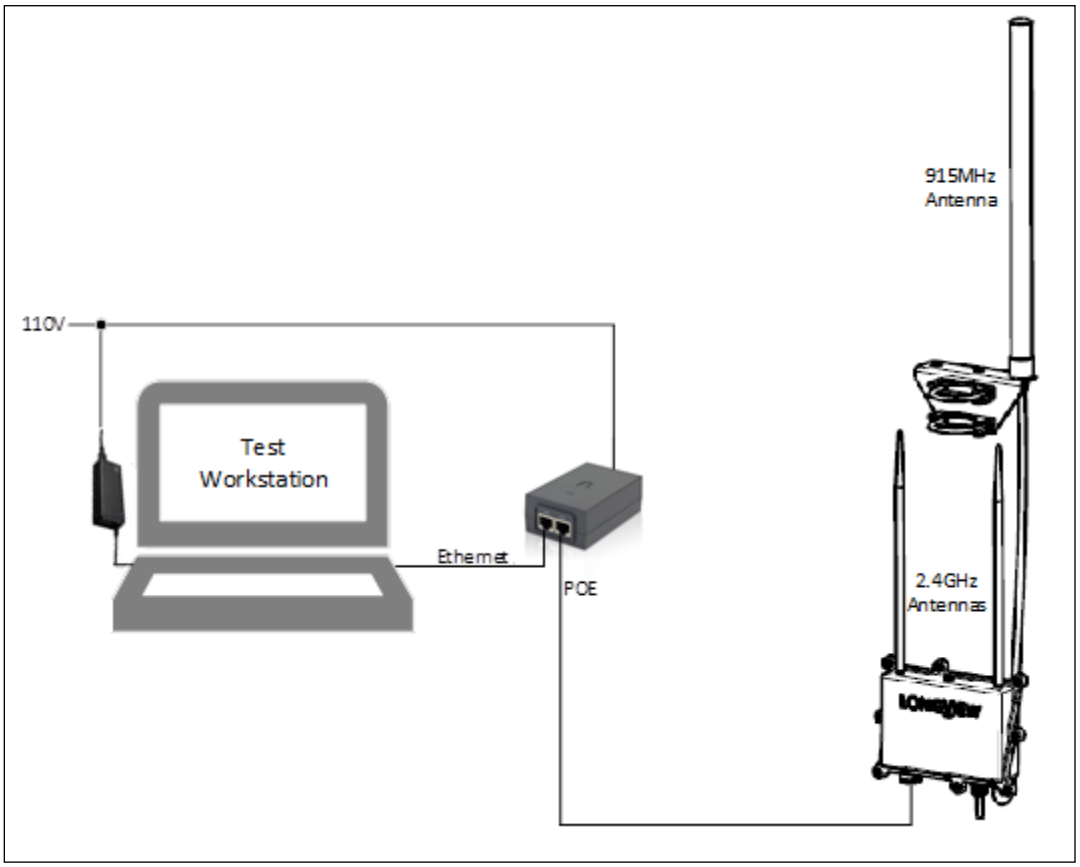


Figure 1. Block Diagram of Test Configuration 1

F. 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	Slot #	Name / Description	Model Number	Part Number (White / Light Almond)	Serial Number	Rev. #
N/A	N/A	Access Node	ANG-171	N/A	N/A	N/A
N/A	N/A	2.4GHz Antenna	N/A	N/A	N/A	N/A
N/A	N/A	2.4GHz Antenna	N/A	N/A	N/A	N/A
N/A	N/A	900Mhz Antenna	N/A	N/A	N/A	N/A

Table 5. Equipment Configuration

G. 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
N/A	laptop	N/A	N/A	N/A
N/A	PoE	N/A	N/A	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 6. Support Equipment

H. 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	Ethernet Port 0	CAT 5E Shielded Ethernet	1	5	100	Y	(A) J18
3	2.4GHz Antenna	SMA Direct Mount Antenna	1	N/A	N/A	N/A	(A) J10
4	2.4GHz Antenna	SMA Direct Mount Antenna	1	N/A	N/A	N/A	(A) J11
6	900Mhz Antenna	Type N Direct Mount Antenna	1	N/A	N/A	N/A	(A) J1

Table 7. Ports and Cabling Information

I. Mode of Operation

Power to the unit will be supplied via Power-Over-Ethernet (POE) to properly stress this portion of the circuit. The EUT was connected via ethernet to a laptop where a MobaXTerm connection and Qualcomm QCA Radio Control Kit provided transmitter parameter control.

J. Method of Monitoring EUT Operation

An indication of proper operation is by monitoring software applications running on the test laptop. In particular, the Qualcomm QRCT utility is used to stimulate the 2.4GHz WiFi transmitters and any failure to communicate with the EUT WiFi subsystems would result in failure of QRCT and an appropriate error message displayed on the laptop.
Similarly, the ping response on the MobaXterm utility would change state given any communication failures.

K. 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.

L. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Carnegie Technologies 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. The EUT utilizes a unique connector.

Test Engineer(s): Giuliano Messina

Test Date(s): November 12, 2018

Antenna Gain	Type	Model	Manufacturer
9 dBi	Omni	N/A	N/A

Table 8. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): **§ 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 Ω 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- 0.5	66 - 56	56 - 46
0.5 - 5	56	46
5 - 30	60	50

Table 9. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table. 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 C63.4-2003 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. For the purpose of this testing, the transmitter was turned on.

Test Results: The EUT was compliant with this requirement. Measured emissions were within applicable limits.

Test Engineer(s): Giuliano Messina

Test Date(s): December 7, 2018

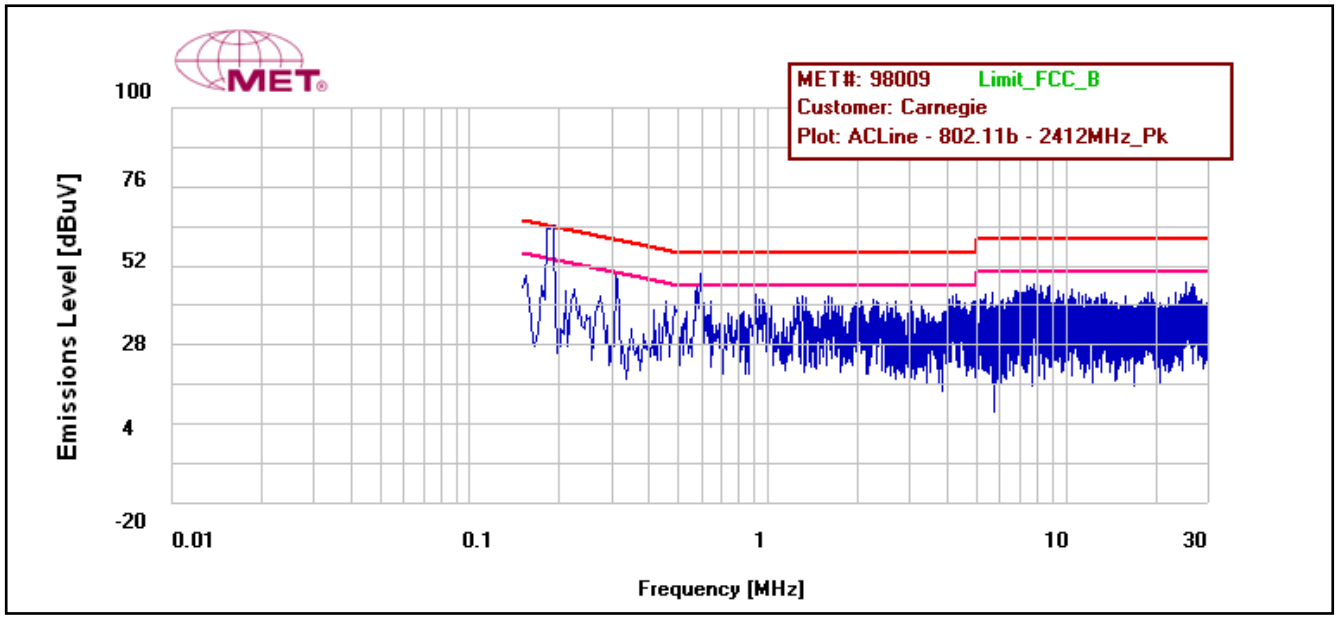
15.207(a) Conducted Emissions Test Results

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
ACLine - 802.11b - 2412MHz	0.154	55.4	65.782	-10.382	Pass	35.6	55.782	-20.182	Pass
ACLine - 802.11b - 2412MHz	0.190	59.9	64.042	-4.142	Pass	41	54.042	-13.042	Pass
ACLine - 802.11b - 2412MHz	0.310	46.6	59.987	-13.387	Pass	31.2	49.987	-18.787	Pass
ACLine - 802.11b - 2412MHz	0.598	48.5	56	-7.5	Pass	36.6	46	-9.4	Pass
ACLine - 802.11b - 2412MHz	7.798	42.7	60	-17.3	Pass	34.9	50	-15.1	Pass
ACLine - 802.11b - 2412MHz	25.506	40	60	-20	Pass	34.7	50	-15.3	Pass
ACNeutral - 802.11b - 2412MHz	0.186	60.2	64.218	-4.018	Pass	45.6	54.218	-8.618	Pass
ACNeutral - 802.11b - 2412MHz	0.238	53.4	62.176	-8.776	Pass	37.7	52.176	-14.476	Pass
ACNeutral - 802.11b - 2412MHz	0.258	51.4	61.508	-10.108	Pass	31.9	51.508	-19.608	Pass
ACNeutral - 802.11b - 2412MHz	0.274	51.1	61.009	-9.909	Pass	39.3	51.009	-11.709	Pass
ACNeutral - 802.11b - 2412MHz	0.586	49.4	56	-6.6	Pass	41.8	46	-4.2	Pass
ACNeutral - 802.11b - 2412MHz	7.738	42.8	60	-17.2	Pass	34.9	50	-15.1	Pass
ACLine - 802.11g - 2412MHz	0.158	52.2	65.57	-13.37	Pass	31.2	55.57	-24.37	Pass
ACLine - 802.11g - 2412MHz	0.190	58	64.042	-6.042	Pass	45.3	54.042	-8.742	Pass
ACLine - 802.11g - 2412MHz	0.226	56.6	62.605	-6.005	Pass	43.9	52.605	-8.705	Pass
ACLine - 802.11g - 2412MHz	0.266	51.4	61.255	-9.855	Pass	38.9	51.255	-12.355	Pass
ACLine - 802.11g - 2412MHz	0.594	48.6	56	-7.4	Pass	38.5	46	-7.5	Pass
ACLine - 802.11g - 2412MHz	7.978	43.5	60	-16.5	Pass	35.8	50	-14.2	Pass
ACNeutral - 802.11g - 2412MHz	0.150	62.6	66	-3.4	Pass	40.6	56	-15.4	Pass
ACNeutral - 802.11g - 2412MHz	0.174	62.7	64.771	-2.071	Pass	46	54.771	-8.771	Pass
ACNeutral - 802.11g - 2412MHz	0.210	47.2	63.213	-16.013	Pass	31.8	53.213	-21.413	Pass
ACNeutral - 802.11g - 2412MHz	0.278	49.3	60.889	-11.589	Pass	36.1	50.889	-14.789	Pass
ACNeutral - 802.11g - 2412MHz	0.578	48.2	56	-7.8	Pass	40	46	-6	Pass
ACNeutral - 802.11g - 2412MHz	7.858	42.9	60	-17.1	Pass	34.7	50	-15.3	Pass

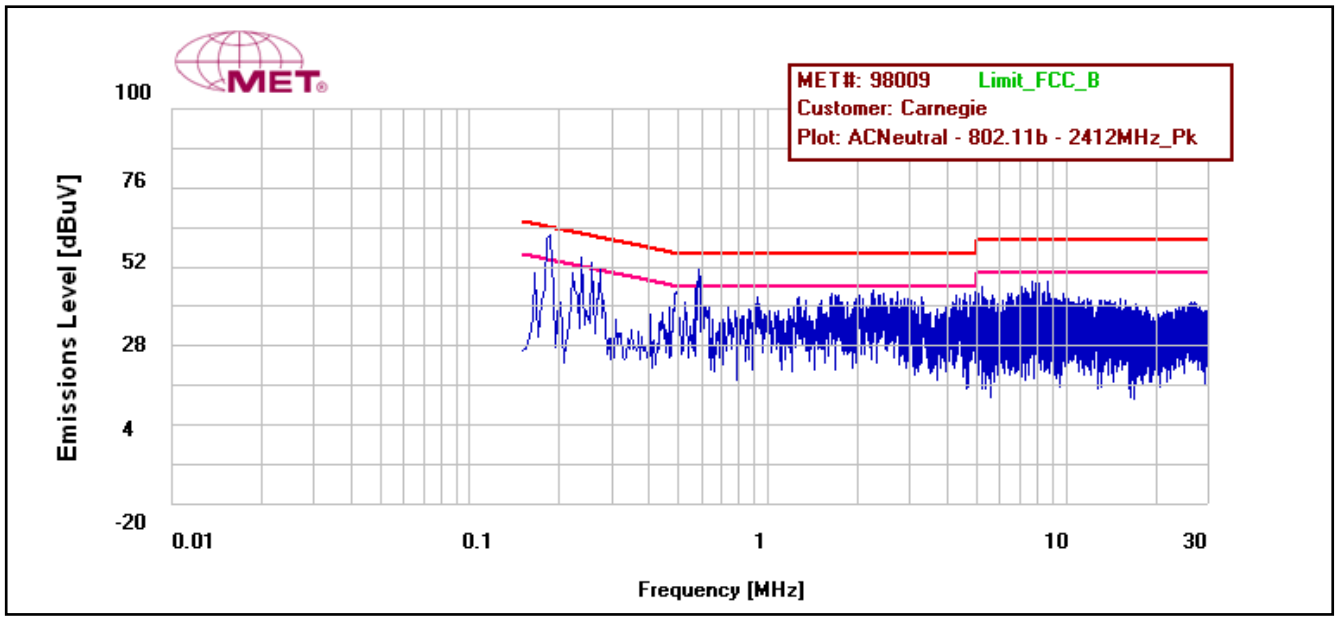
Table 10. Conducted Emissions, 802.11b and g, Test Results

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
ACLine - 802.11n20 - 2412MHz	0.182	62.1	64.398	-2.298	Pass	47.3	54.398	-7.098	Pass
ACLine - 802.11n20 - 2412MHz	0.218	56.7	62.903	-6.203	Pass	42.1	52.903	-10.803	Pass
ACLine - 802.11n20 - 2412MHz	0.254	42.7	61.637	-18.937	Pass	30.6	51.637	-21.037	Pass
ACLine - 802.11n20 - 2412MHz	0.294	44	60.426	-16.426	Pass	30.3	50.426	-20.126	Pass
ACLine - 802.11n20 - 2412MHz	0.582	48.6	56	-7.4	Pass	40.7	46	-5.3	Pass
ACLine - 802.11n20 - 2412MHz	7.642	44	60	-16	Pass	35.7	50	-14.3	Pass
ACNeutral - 802.11n20 - 2412MHz	0.150	63.1	66	-2.9	Pass	46.2	56	-9.8	Pass
ACNeutral - 802.11n20 - 2412MHz	0.194	57.6	63.869	-6.269	Pass	46.7	53.869	-7.169	Pass
ACNeutral - 802.11n20 - 2412MHz	0.234	51.8	62.317	-10.517	Pass	38.3	52.317	-14.017	Pass
ACNeutral - 802.11n20 - 2412MHz	0.266	51.5	61.255	-9.755	Pass	39.3	51.255	-11.955	Pass
ACNeutral - 802.11n20 - 2412MHz	0.602	48.6	56	-7.4	Pass	35.5	46	-10.5	Pass
ACNeutral - 802.11n20 - 2412MHz	7.698	43.3	60	-16.7	Pass	35	50	-15	Pass
ACLine - 802.11n40 - 2422MHz	0.182	61.8	64.398	-2.598	Pass	47.3	54.398	-7.098	Pass
ACLine - 802.11n40 - 2422MHz	0.218	55.5	62.903	-7.403	Pass	42.7	52.903	-10.203	Pass
ACLine - 802.11n40 - 2422MHz	0.578	48.2	56	-7.8	Pass	39.2	46	-6.8	Pass
ACLine - 802.11n40 - 2422MHz	4.978	40.5	56	-15.5	Pass	30.6	46	-15.4	Pass
ACLine - 802.11n40 - 2422MHz	7.174	42.4	60	-17.6	Pass	34	50	-16	Pass
ACLine - 802.11n40 - 2422MHz	8.742	42	60	-18	Pass	33.7	50	-16.3	Pass
ACNeutral - 802.11n40 - 2422MHz	0.178	62.6	64.582	-1.982	Pass	48.8	54.582	-5.782	Pass
ACNeutral - 802.11n40 - 2422MHz	0.206	47.9	63.372	-15.472	Pass	31	53.372	-22.372	Pass
ACNeutral - 802.11n40 - 2422MHz	0.238	52.9	62.176	-9.276	Pass	38.3	52.176	-13.876	Pass
ACNeutral - 802.11n40 - 2422MHz	0.274	50.4	61.009	-10.609	Pass	38.3	51.009	-12.709	Pass
ACNeutral - 802.11n40 - 2422MHz	0.594	50	56	-6	Pass	39.7	46	-6.3	Pass
ACNeutral - 802.11n40 - 2422MHz	9.830	41.3	60	-18.7	Pass	33.6	50	-16.4	Pass

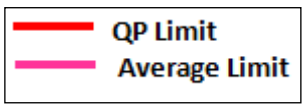
Table 11. Conducted Emissions, 802.11n 20 and 40, Test Results

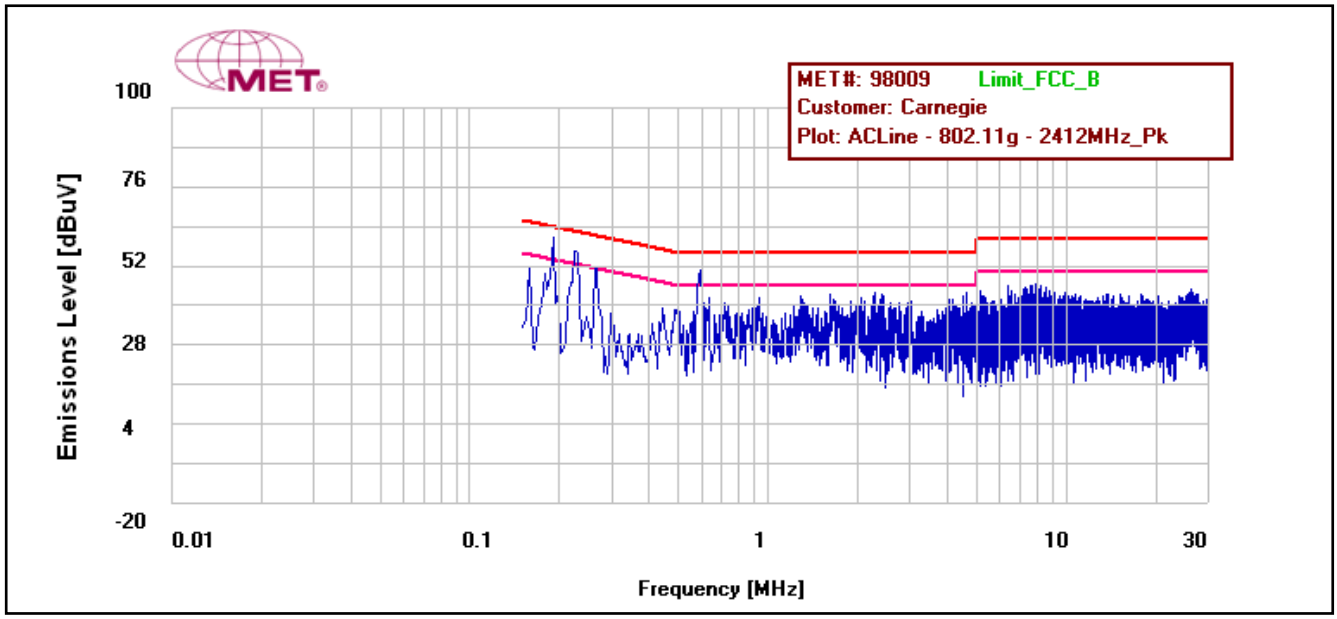


Plot 1. Conducted Emissions, 802.11b, Phase Line

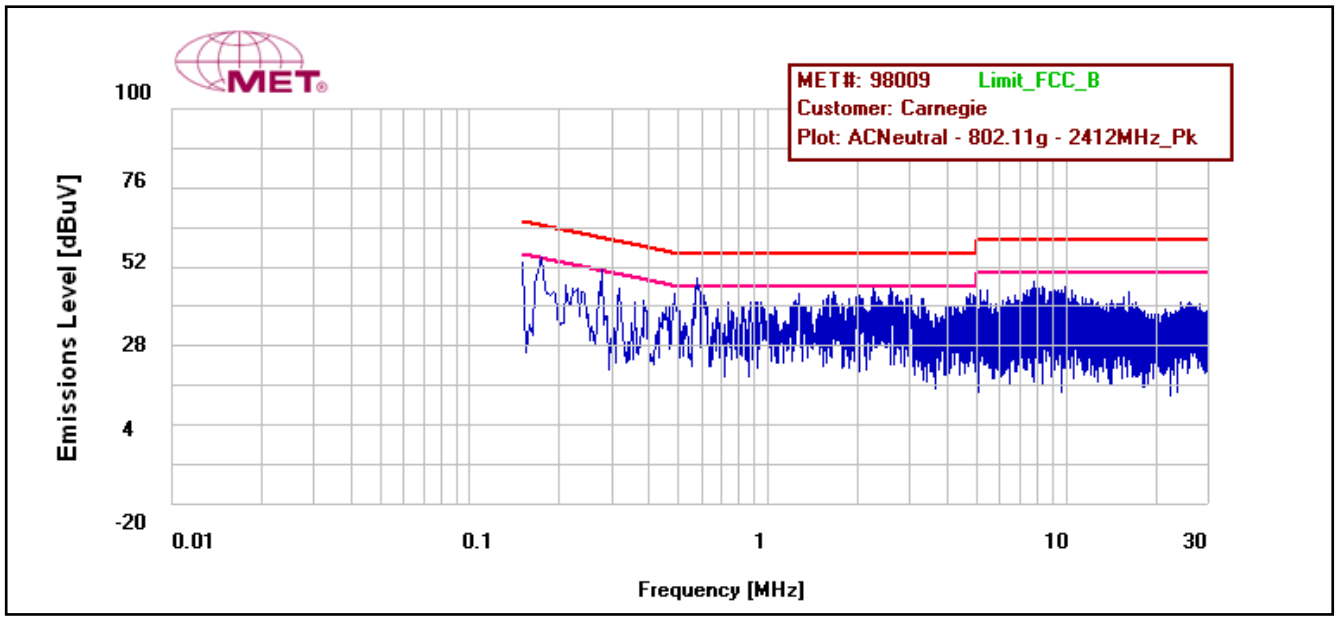


Plot 2. Conducted Emissions, 802.11b, Neutral Line

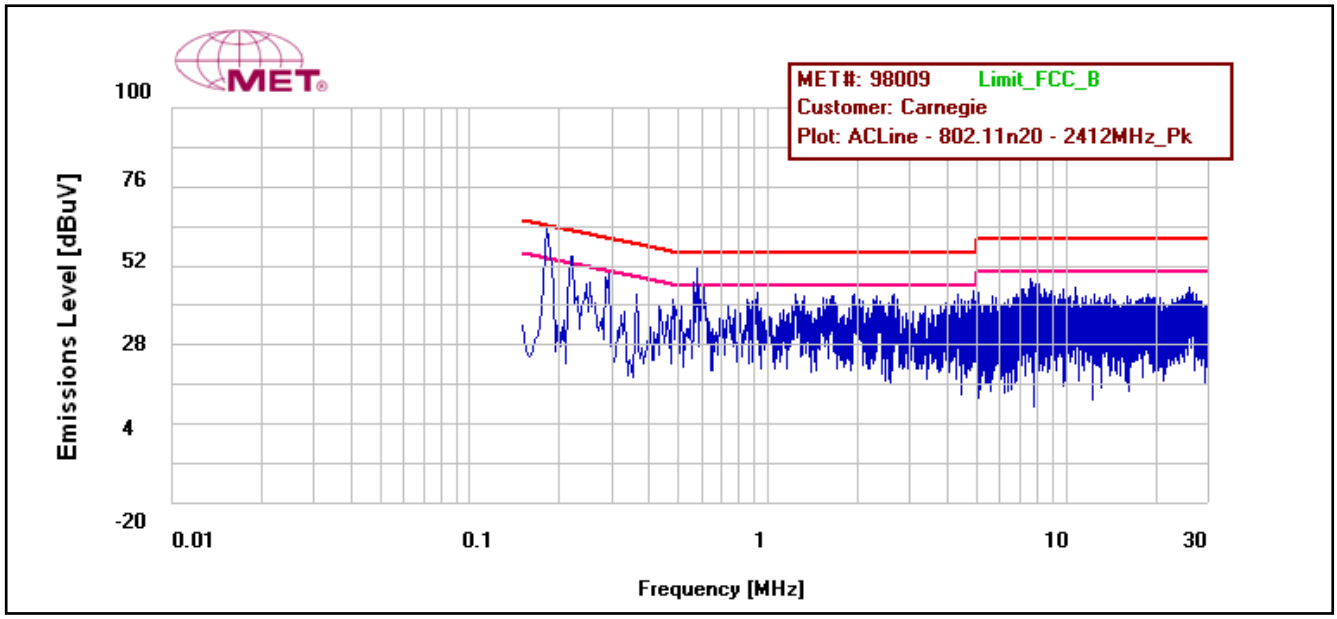




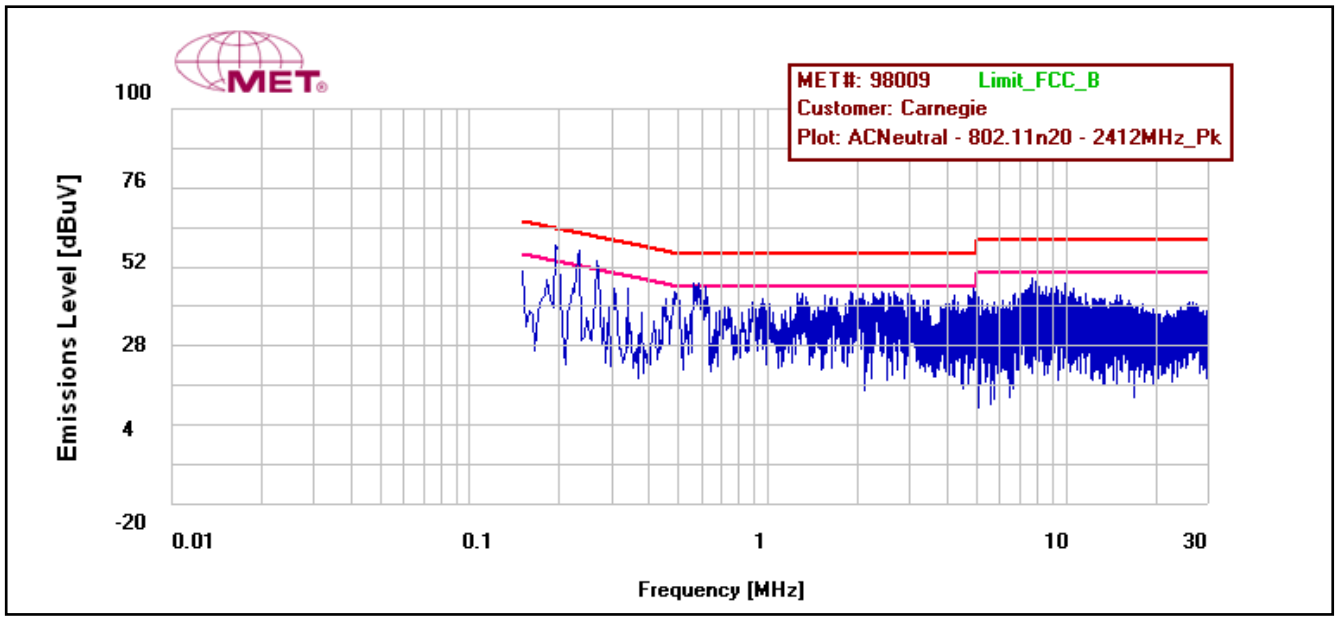
Plot 3. Conducted Emissions, 802.11g, Phase Line



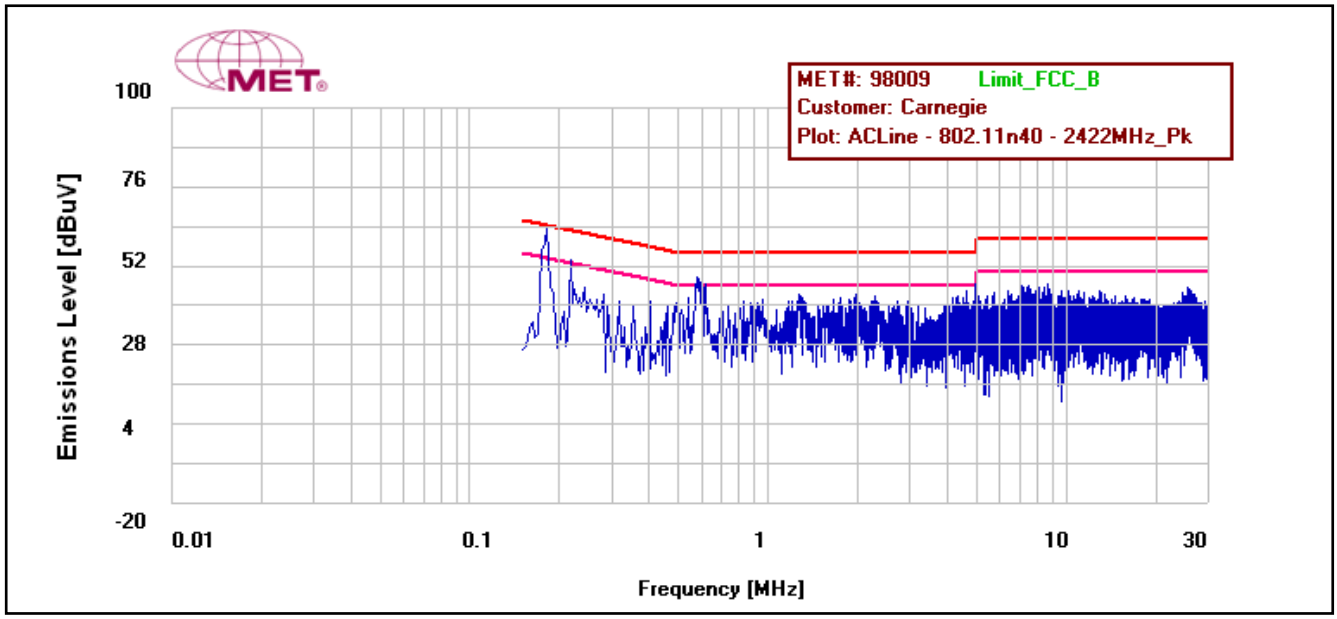
Plot 4. Conducted Emissions, 802.11g, Neutral Line



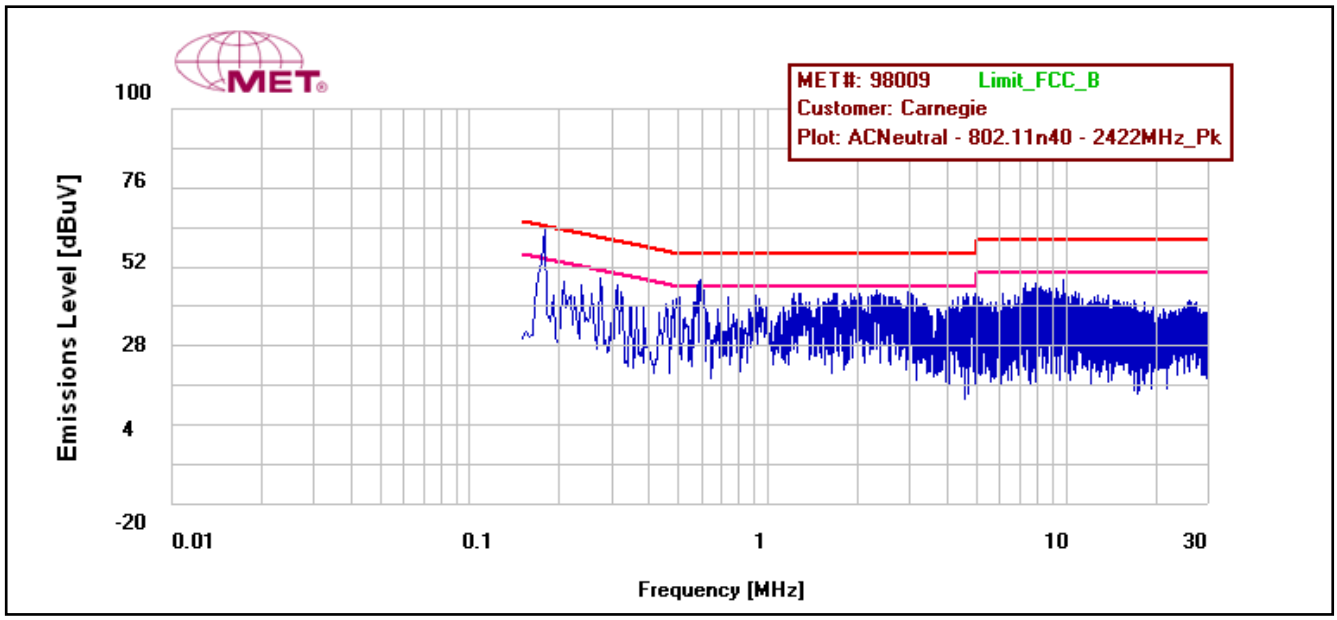
Plot 5. Conducted Emissions, 802.11n20, Phase Line



Plot 6. Conducted Emissions, 802.11n20, Neutral Line

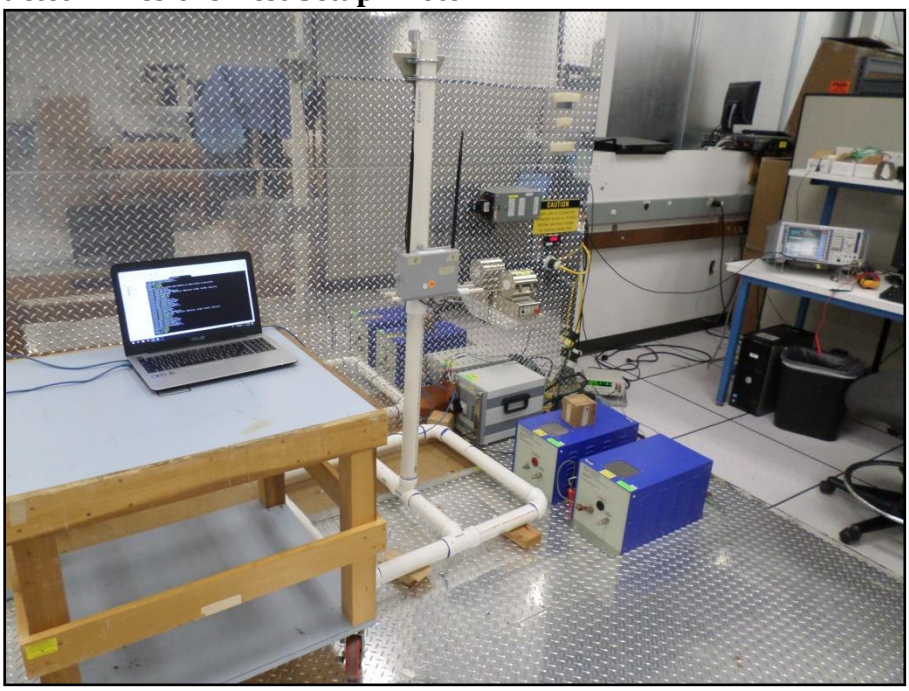


Plot 7. Conducted Emissions, 802.11n40, Phase Line



Plot 8. Conducted Emissions, 802.11n40, Neutral Line

15.207(a) Conducted Emissions Test Setup Photo



Photograph 1. Conducted Emissions, Test Setup

Photograph 2. Conducted Emissions, LISN Connection, Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(2) 6 dB Bandwidth

Test Requirements: **§ 15.247(a)(2):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

Test Procedure: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW = 100kHz, VBW = 3*RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

Test Results The EUT was compliant with § 15.247 (a)(2).

The 6 dB Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Giuliano Messina

Test Date(s): December 7, 2018

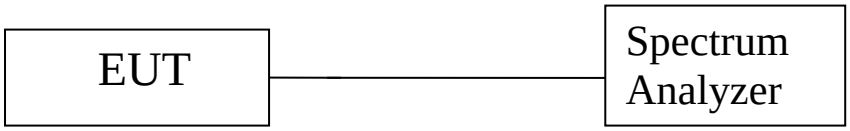


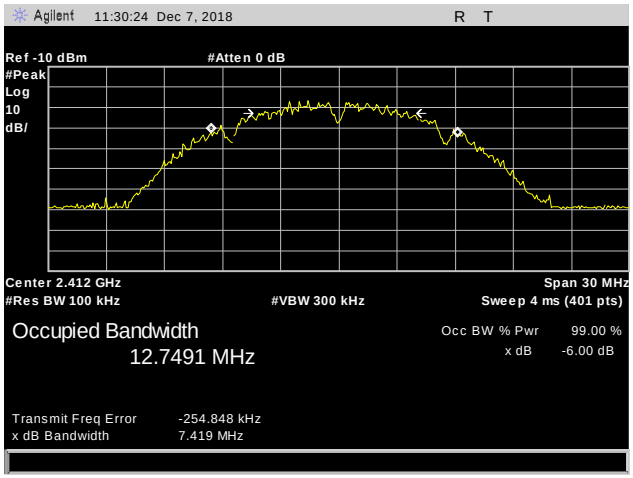
Figure 2. Block Diagram, Occupied Bandwidth Test Setup

Occupied Bandwidth Test Results

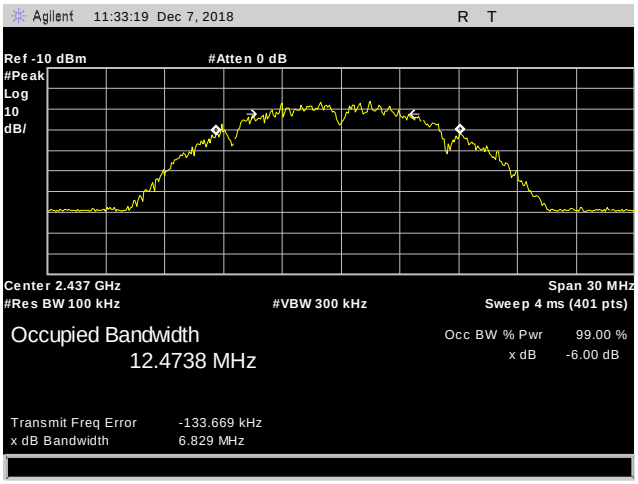
Occupied Bandwidth				
Mode	**Carrier Channel**	**Frequency (MHz)**	**Measured 6 dB Bandwidth (MHz) – Antenna 1**	**Measured 6 dB Bandwidth (MHz) – Antenna 2**
802.11b	Low	2412	7.419	8.086
802.11b	Mid	2437	6.829	7.558
802.11b	High	2462	7.603	7.201
802.11g	Low	2412	16.429	16.383
802.11g	Mid	2437	16.409	16.391
802.11g	High	2462	16.400	16.340
802.11n HT20	Low	2412	17.628	17.571
802.11n HT20	Mid	2437	17.705	17.625
802.11n HT20	High	2462	17.622	17.644
802.11n HT40	Low	2422	35.278	35.511
802.11n HT40	Mid	2437	35.505	35.572
802.11n HT40	High	2452	35.204	35.383

Table 12. 6 dB Occupied Bandwidth, Test Results

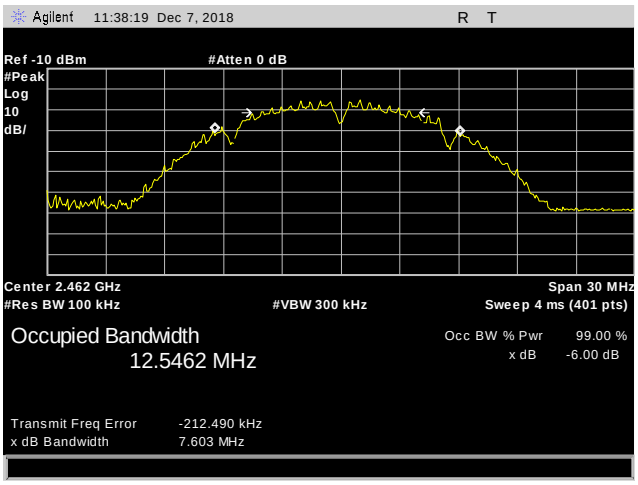
6 dB Occupied Bandwidth Test Results



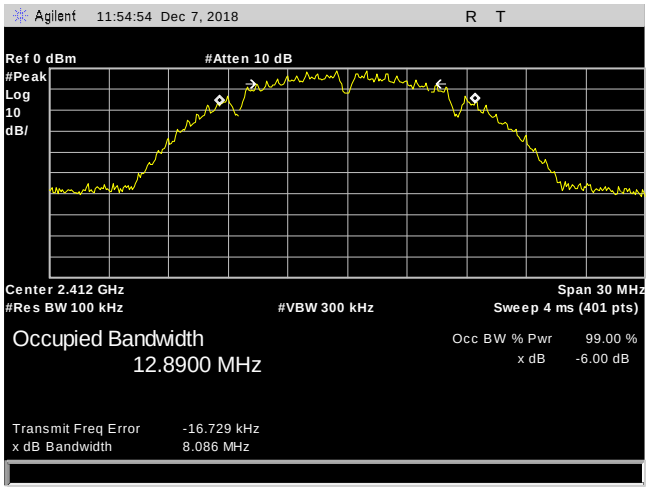
Plot 9. 6 dB Occupied Bandwidth, 802.11b - PWR 1000, Antenna 1, 2412



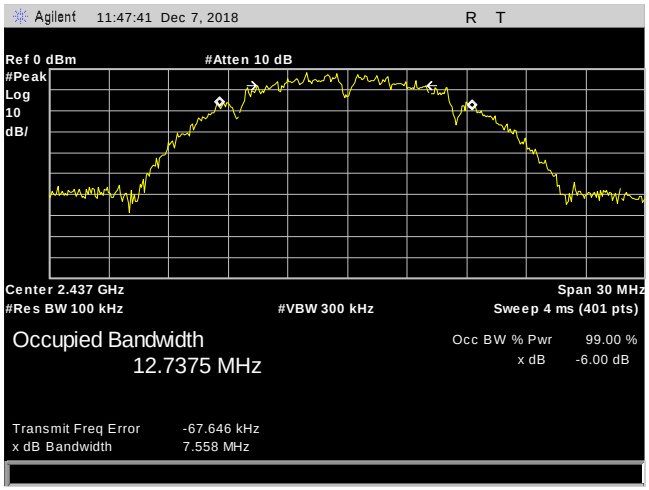
Plot 10. 6 dB Occupied Bandwidth, 802.11b - PWR 1000, Antenna 1, 2437



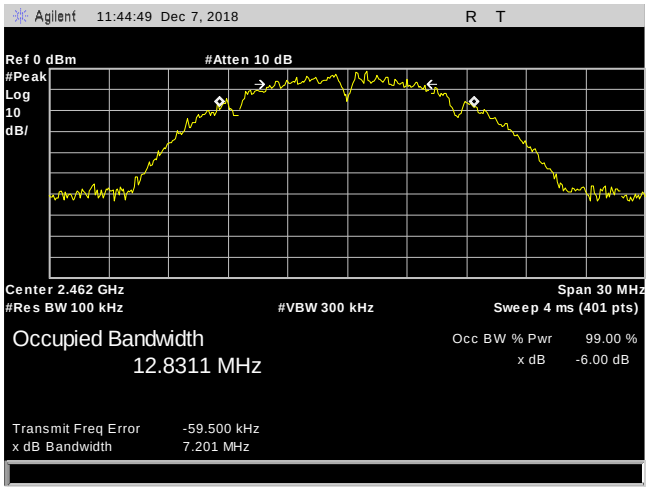
Plot 11. 6 dB Occupied Bandwidth, 802.11b - PWR 1000, Antenna 1, 2462



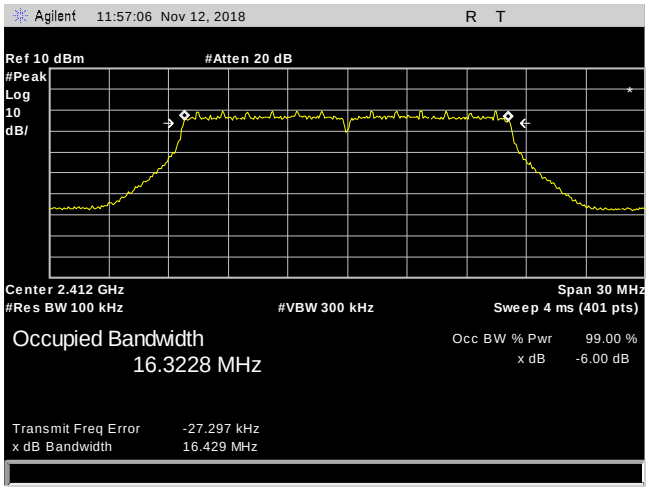
Plot 12. 6 dB Occupied Bandwidth, 802.11b - PWR 1000, Antenna 2, 2412



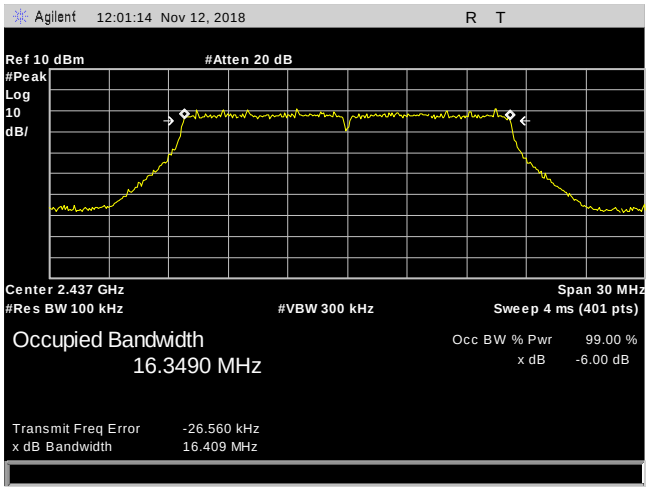
Plot 13. 6 dB Occupied Bandwidth, 802.11b - PWR 1000, Antenna 2, 2437



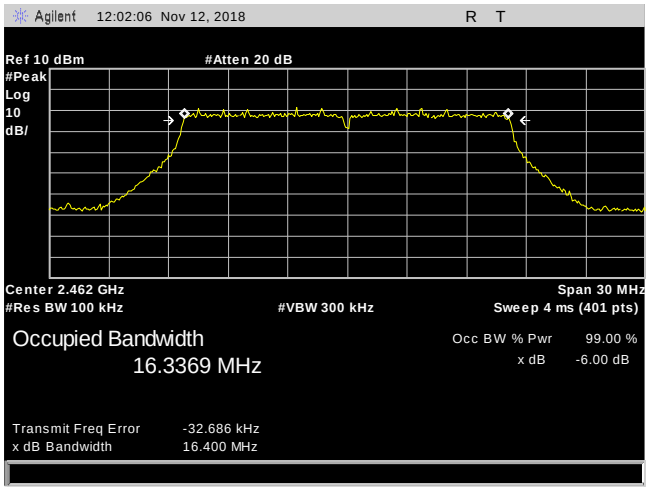
Plot 14. 6 dB Occupied Bandwidth, 802.11b - PWR 1000, Antenna 2, 2462



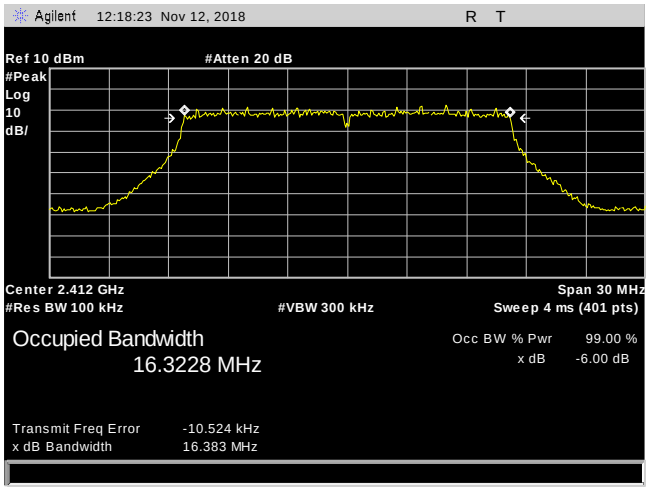
Plot 15. 6 dB Occupied Bandwidth, 802.11g - PWR 3, Antenna 1, 2412



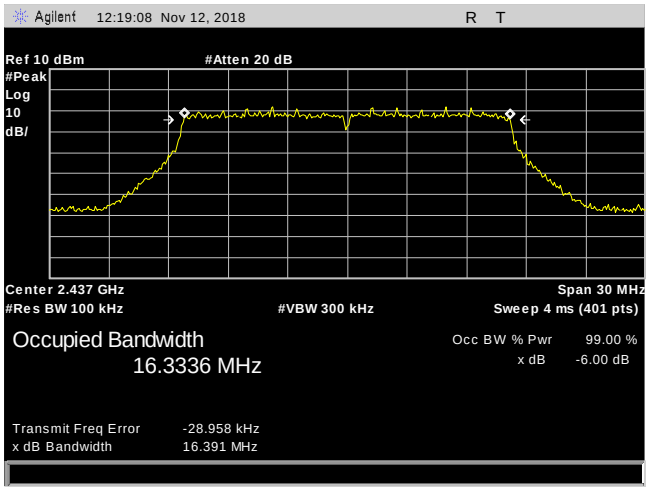
Plot 16. 6 dB Occupied Bandwidth, 802.11g - PWR 3, Antenna 1, 2437



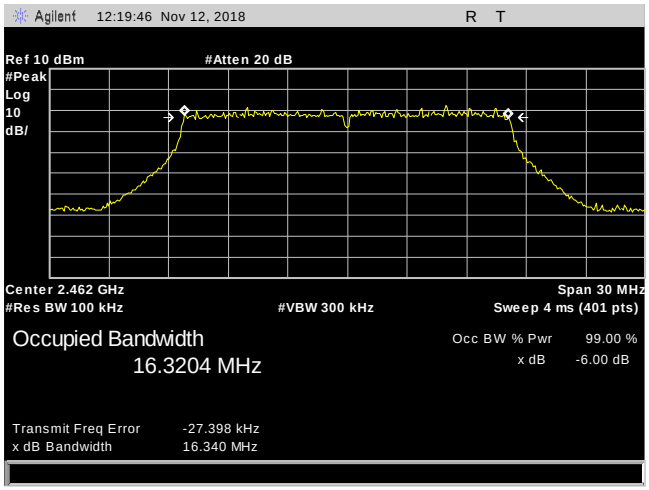
Plot 17. 6 dB Occupied Bandwidth, 802.11g - PWR 3, Antenna 1, 2462



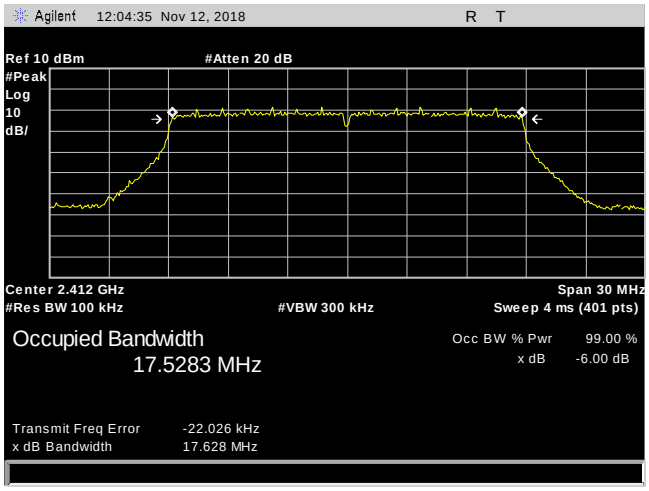
Plot 18. 6 dB Occupied Bandwidth, 802.11g - PWR 3, Antenna 2, 2412



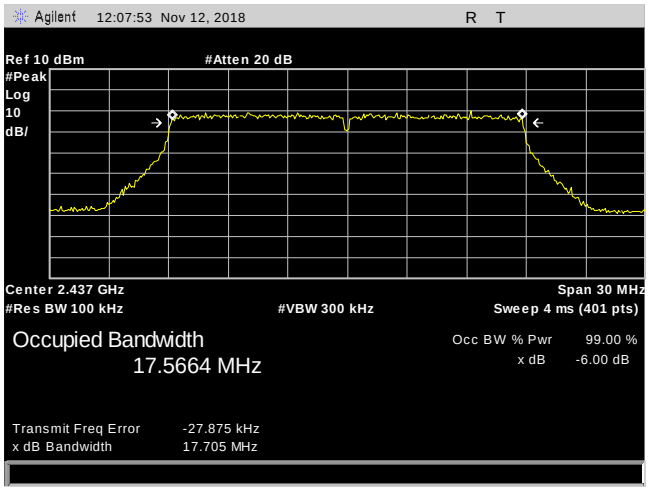
Plot 19. 6 dB Occupied Bandwidth, 802.11g - PWR 3, Antenna 2, 2437



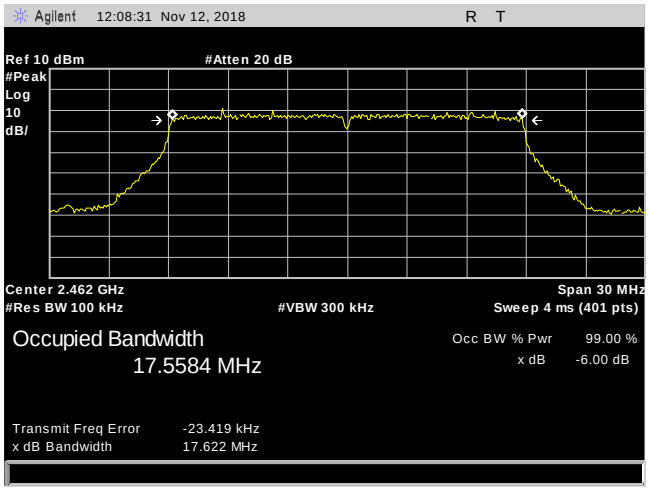
Plot 20. 6 dB Occupied Bandwidth, 802.11g - PWR 3, Antenna 2, 2462



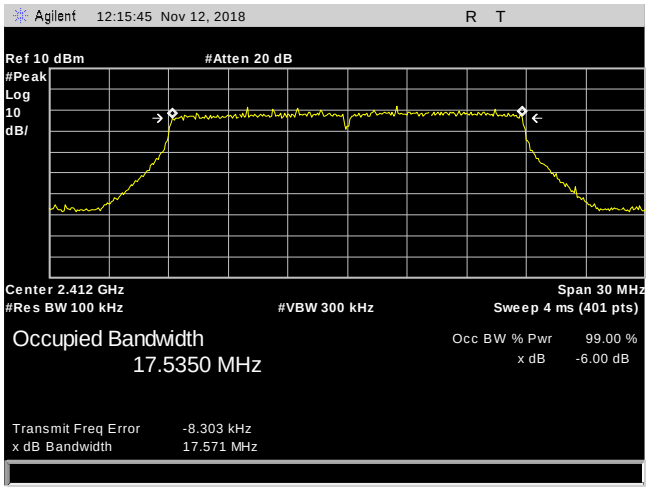
Plot 21. 6 dB Occupied Bandwidth, 802.11n HT20 - PWR 3, Antenna 1, 2412



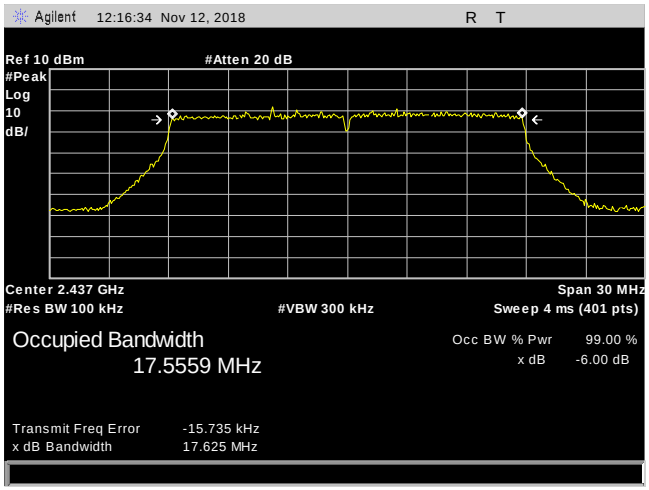
Plot 22. 6 dB Occupied Bandwidth, 802.11n HT20 – PWR 3 Antenna 1, 2437



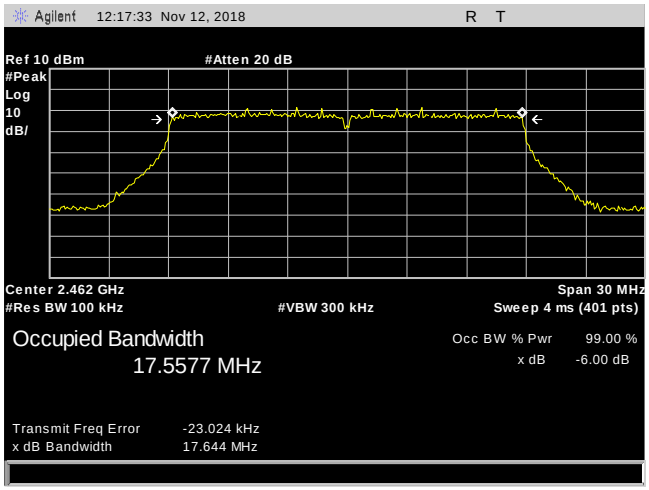
Plot 23. 6 dB Occupied Bandwidth, 802.11n HT20 - PWR 3, Antenna 1, 2462



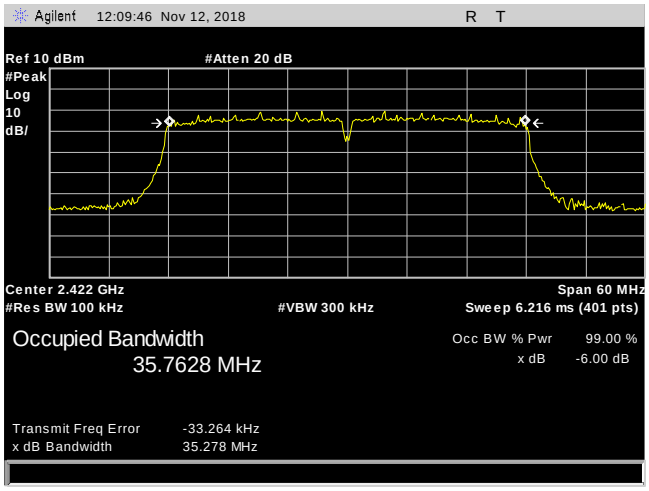
Plot 24. 6 dB Occupied Bandwidth, 802.11n HT20 - PWR 3, Antenna 2, 2412



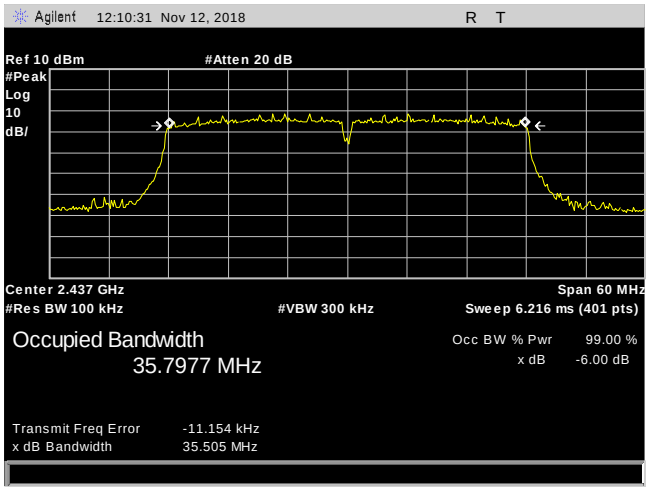
Plot 25. 6 dB Occupied Bandwidth, 802.11n HT20 - PWR 3, Antenna 2, 2437



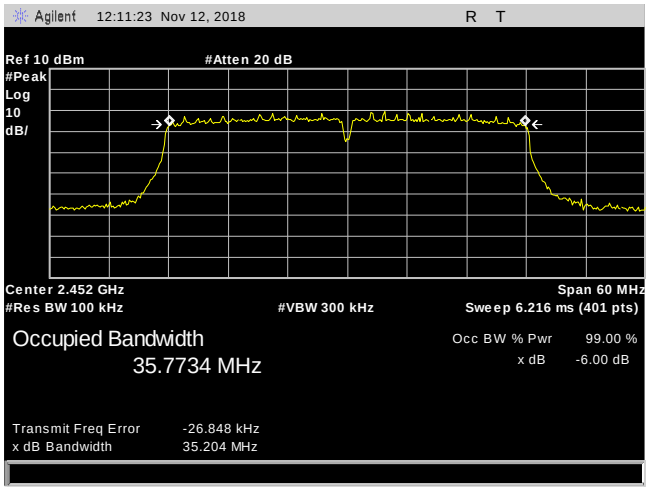
Plot 26. 6 dB Occupied Bandwidth, 802.11n HT20 - PWR 3, Antenna 2, 2462



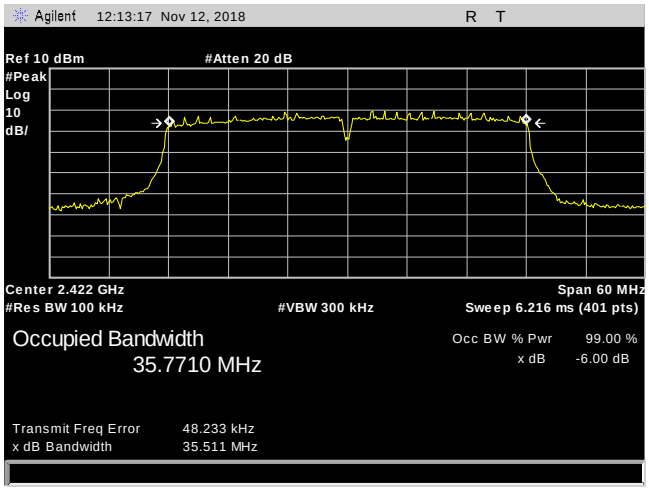
Plot 27. 6 dB Occupied Bandwidth, 802.11n HT40 - PWR 3, Antenna 1, 2422



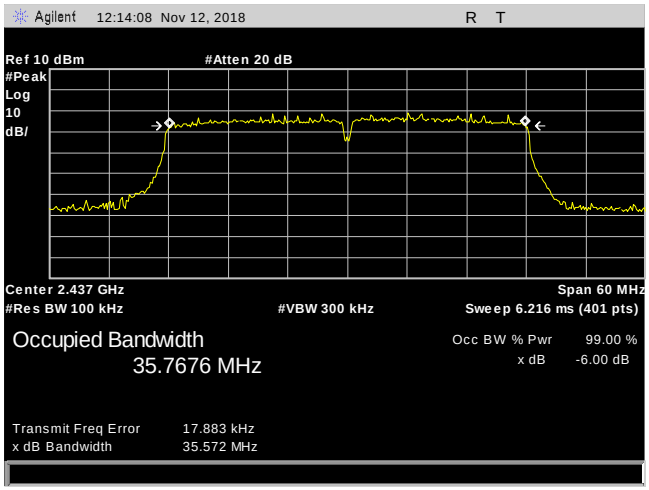
Plot 28. 6 dB Occupied Bandwidth, 802.11n HT40 - PWR 3, Antenna 1, 2437



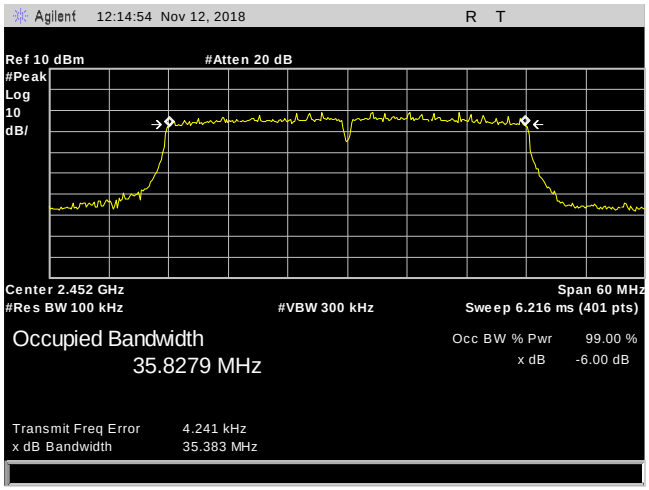
Plot 29. 6 dB Occupied Bandwidth, 802.11n HT40 - PWR 3, Antenna 1, 2452



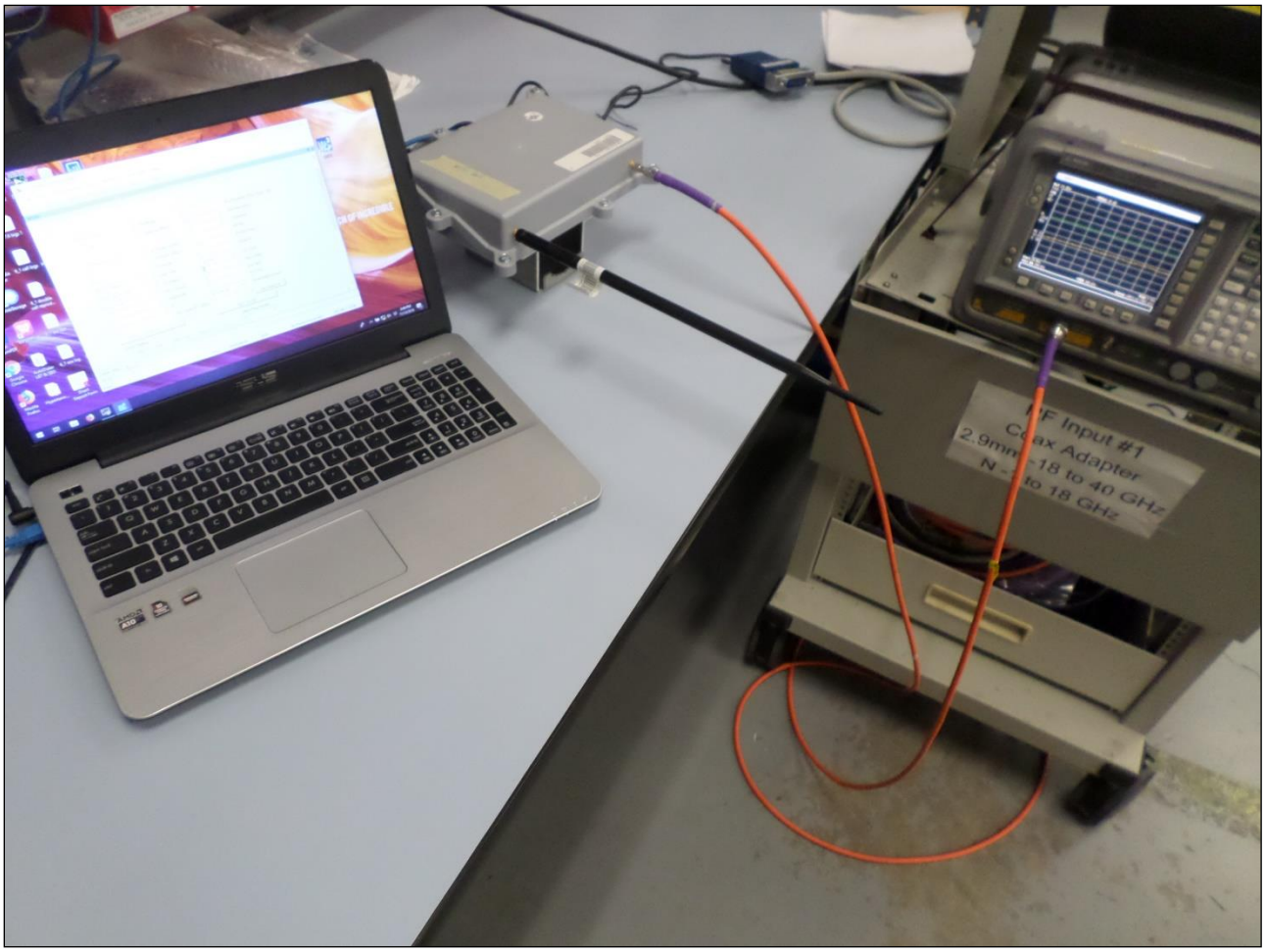
Plot 30. 6 dB Occupied Bandwidth, 802.11n HT40 - PWR 3, Antenna 2, 2422



Plot 31. 6 dB Occupied Bandwidth, 802.11n HT40 - PWR 3, Antenna 2, 2437



Plot 32. 6 dB Occupied Bandwidth, 802.11n HT40 - PWR 3, Antenna 2, 2452



Photograph 3. Conducted Testing Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Power Output

Test Requirements: **§15.247(b):** The maximum peak output power of the intentional radiator shall not exceed the following:

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

Digital Transmission Systems (MHz)	Output Limit (Watts)
2400–2483.5	1.000

Table 13. Output Power Requirements from §15.247(b)

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of 15.247, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band at the maximum power level. All other operational modes had a duty cycle of > 98%.

Test Results: The EUT was compliant with the Power Output limits of **§15.247(b)**. Duty Cycle applies only to Mode 802.11b which had an operating duty cycle of 1%.

Test Engineer(s): Giuliano Messina

Test Date(s): December 7, 2018

Test Notes: The EUT antenna has a gain of 9 dBi, and the EUT uses two antennas. The below tables show the resulting change in allowable output power.

1 Ant. gain, dB	# of antennas	GAIN
9	2	12.01029996

Max MPCOP	GAIN	Allowed PCOP
30	12.01029996	23.98970004
mW per chain	mW per ant.	PCOP limit per ant.
250.5936168	125.2968084	20.97940009

Table 14. Allowable Output Power

Power Output Test Results

Max Conducted Output Power				
Mode	**Carrier Channel**	**Frequency (MHz)**	**Average Conducted Power (dBm) – Antenna 1**	**Average Conducted Power (dBm) – Antenna 2**
802.11b	Low	2412	-13.74	7.53
802.11b	Mid	2437	-14.66	7.52
802.11b	High	2462	-15.65	7.25
802.11g	Low	2412	2.62	2.63
802.11g	Mid	2437	2.14	2.47
802.11g	High	2462	2.16	2.42
802.11n HT20	Low	2412	2.69	2.58
802.11n HT20	Mid	2437	2.26	2.42
802.11n HT20	High	2462	2.31	2.46
802.11n HT40	Low	2422	2.15	2.04
802.11n HT40	Mid	2437	1.89	1.89
802.11n HT40	High	2452	1.75	1.84

Table 15. Power Output, Test Results

Power Setting Table	
Mode	**Power Setting**
802.11b	1000
802.11g	3
802.11n HT20	3
802.11n HT40	3

Table 16. Power Setting limits (per client software settings) necessary for compliance

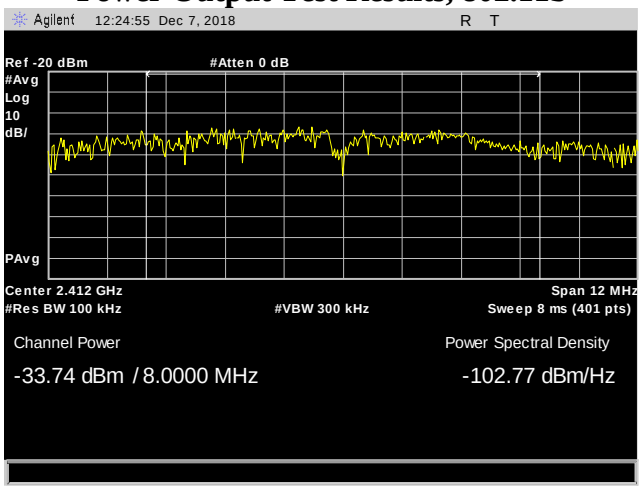
Mode	Ant 1 power (dBm)	Ant 2 power (dBm)	Combined power (dBm)
802.11b	-13.74	7.53	7.562

Table 17. 2 Antenna max combined output power

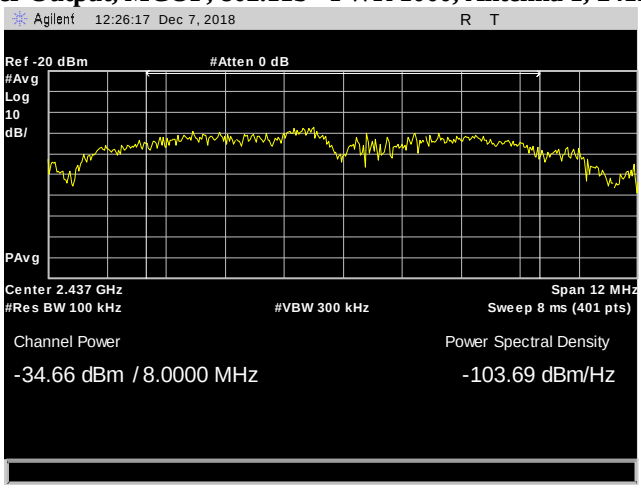
Calculation used for above combined power result:

$$Combined\ Pwr = 10 * \log\left(10^{\frac{Ant\ 1}{10}} + 10^{\frac{Ant\ 2}{10}}\right)$$

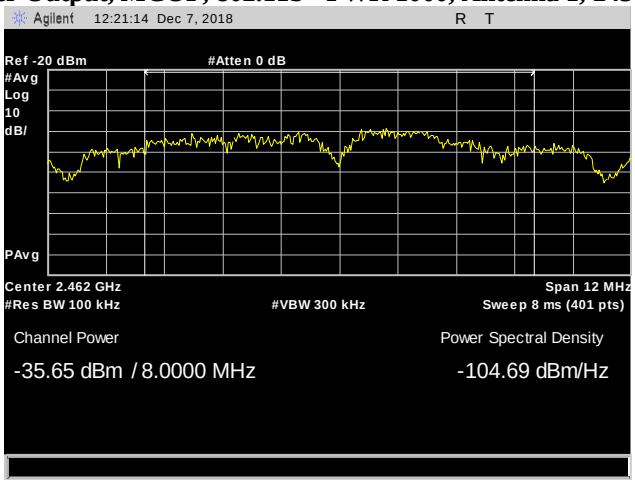
Power Output Test Results, 802.11b



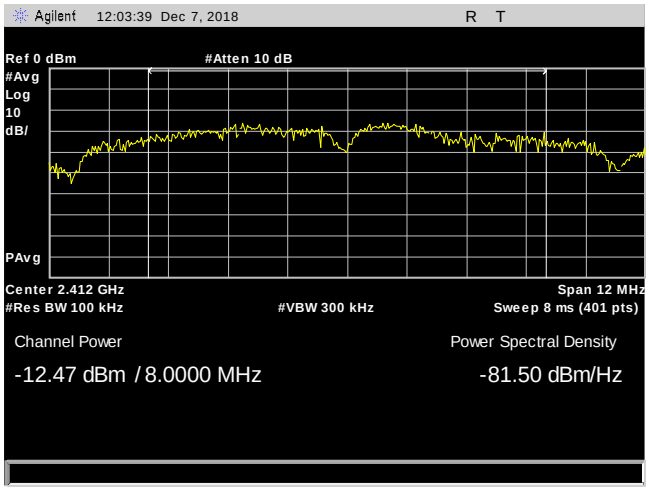
Plot 33. Power Output, MCOP, 802.11b - PWR 1000, Antenna 1, 2412, -33.74 dBm



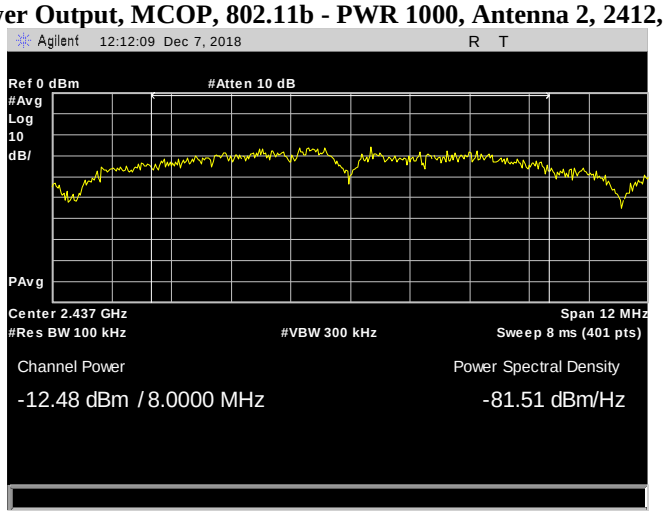
Plot 34. Power Output, MCOP, 802.11b - PWR 1000, Antenna 1, 2437, -34.66 dBm



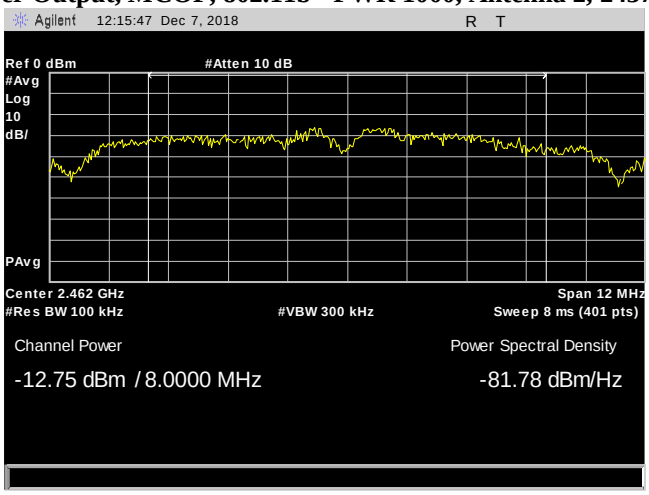
Plot 35. Power Output, MCOP, 802.11b - PWR 1000, Antenna 1, 2462, -35.65 dBm



Plot 36. Power Output, MCOP, 802.11b - PWR 1000, Antenna 2, 2412, -12.47 dBm

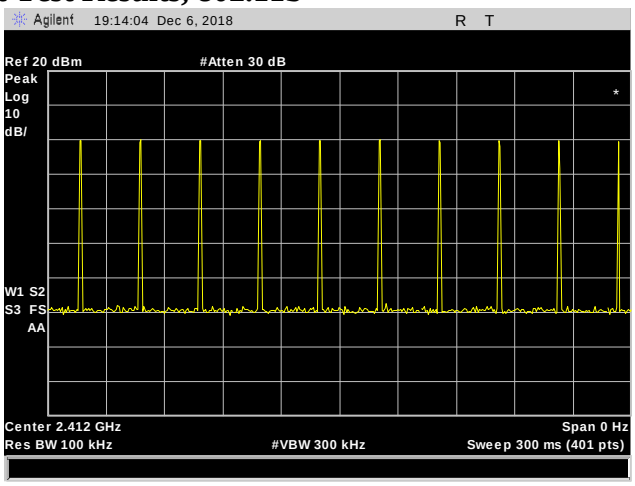


Plot 37. Power Output, MCOP, 802.11b - PWR 1000, Antenna 2, 2437, -12.48 dBm

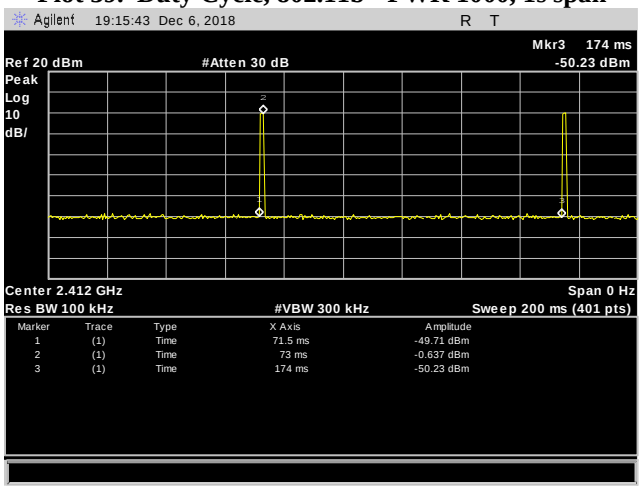


Plot 38. Power Output, MCOP, 802.11b - PWR 1000, Antenna 2, 2462, -12.75 dBm

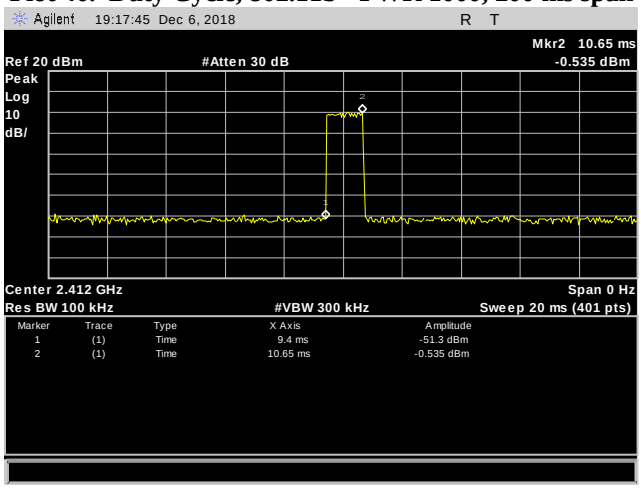
Duty Cycle Measurement Test Results, 802.11b



Plot 39. Duty Cycle, 802.11b - PWR 1000, 1s span



Plot 40. Duty Cycle, 802.11b - PWR 1000, 200 ms span



Plot 41. Duty Cycle, 802.11b - PWR 1000, Single Pulse

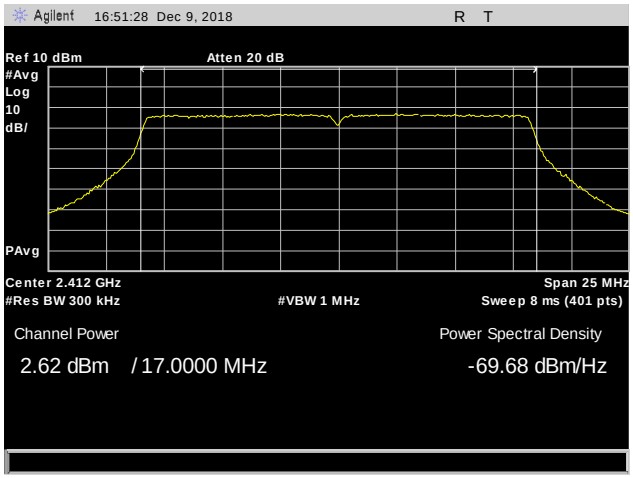
Antenna 1			
Frequency (MHz)	**Amplitude (dBm)**	**Duty Cycle correction**	**Corrected Amplitude (dBm)**
2412	-33.74	20	-13.74
2437	-34.66	20	-14.66
2462	-35.65	20	-15.65

Table 18. Duty Cycle Correction, 802.11b – PWR 1000, Antenna 1

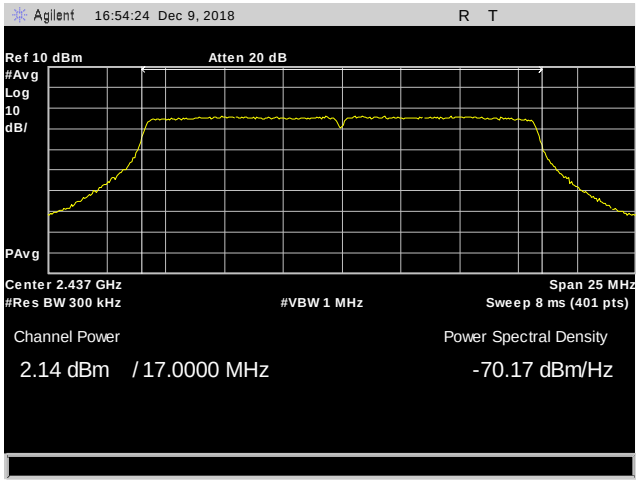
Antenna 2			
Frequency (MHz)	**Amplitude (dBm)**	**Duty Cycle correction**	**Corrected Amplitude (dBm)**
2412	-12.47	20	7.53
2437	-12.48	20	7.52
2462	-12.75	20	7.25

Table 19. Duty Cycle Correction, 802.11b – PWR 1000, Antenna 2

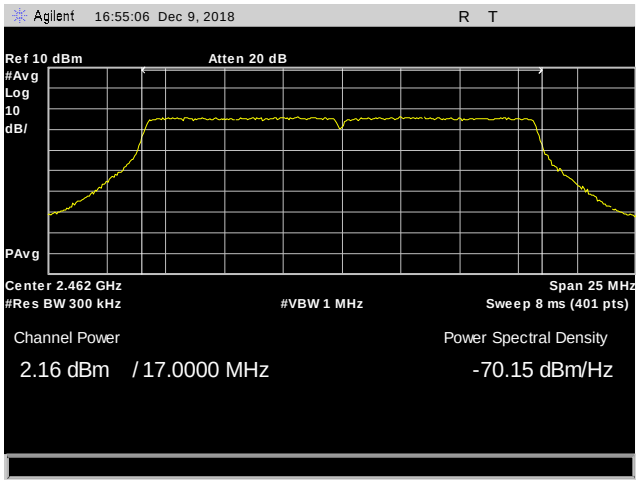
Power Output Test Results, 802.11g/n



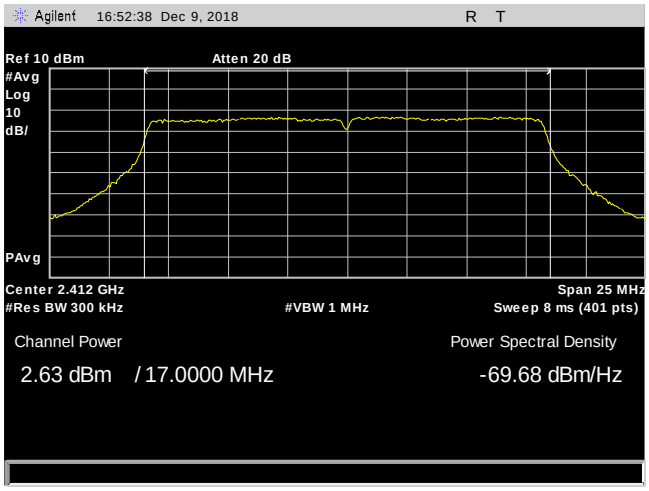
Plot 42. Power Output, MCOP, 802.11g - PWR 3, Antenna 1, 2412, 2.62 dBm



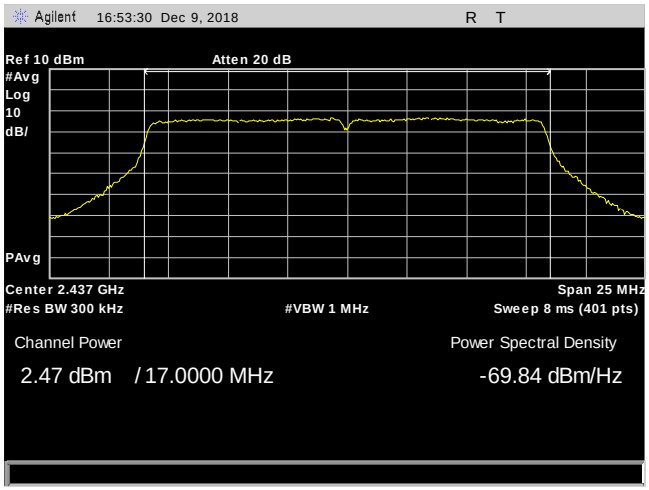
Plot 43. Power Output, MCOP, 802.11g - PWR 3, Antenna 1, 2437, 2.14 dBm



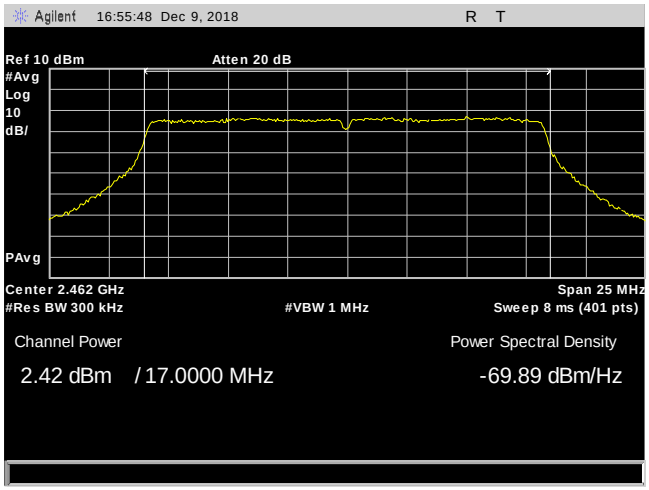
Plot 44. Power Output, MCOP, 802.11g - PWR 3, Antenna 1, 2462, 2.16 dBm



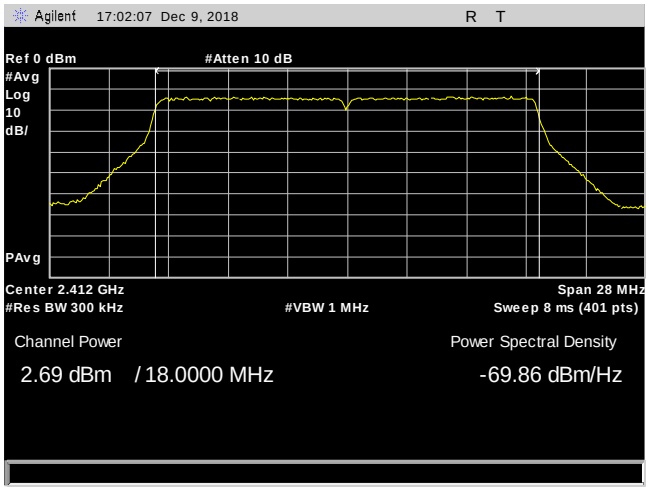
Plot 45. Power Output, MCOP, 802.11g - PWR 3, Antenna 2, 2412, 2.63 dBm



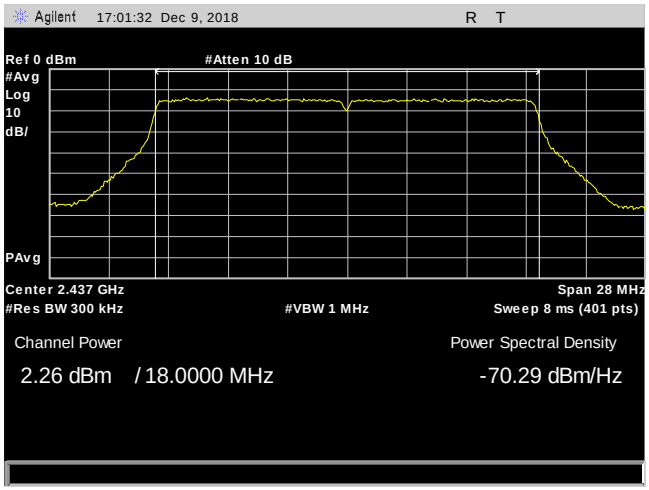
Plot 46. Power Output, MCOP, 802.11g - PWR 3, Antenna 2, 2437, 2.47 dBm



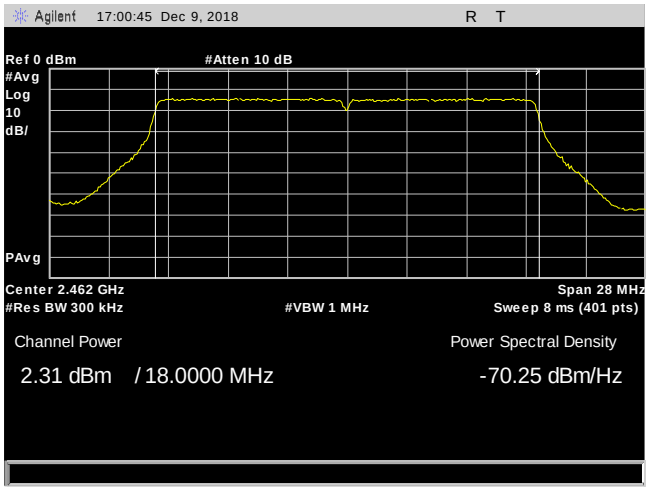
Plot 47. Power Output, MCOP, 802.11g - PWR 3, Antenna 2, 2462, 2.42 dBm



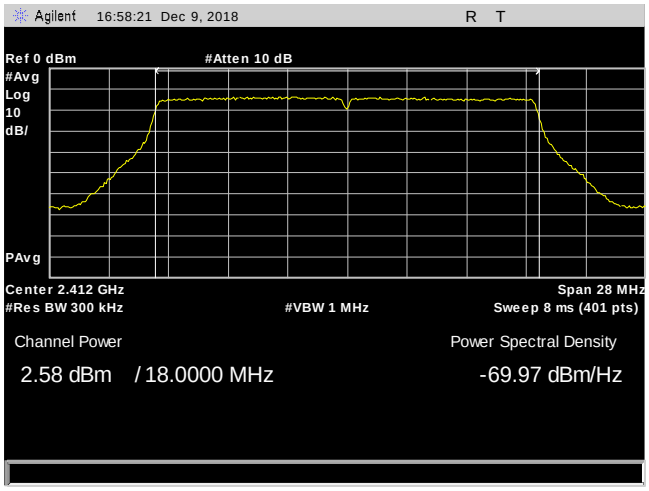
Plot 48. Power Output, MCOP, 802.11n HT20 - PWR 3, Antenna 1, 2412, 2.69 dBm



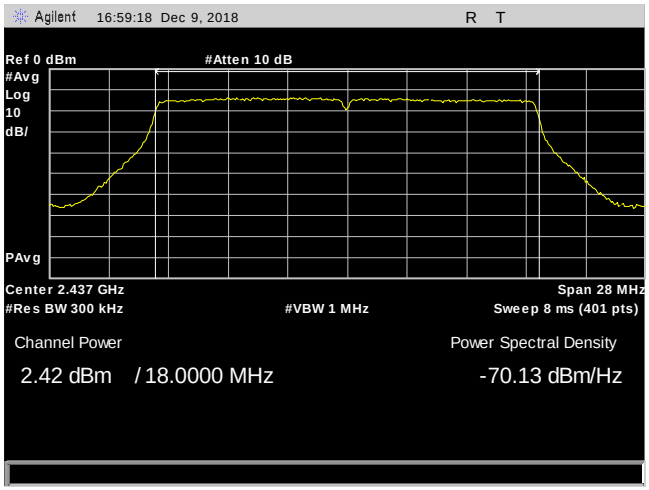
Plot 49. Power Output, MCOP, 802.11n HT20 - PWR 3, Antenna 1, 2437, 2.26 dBm



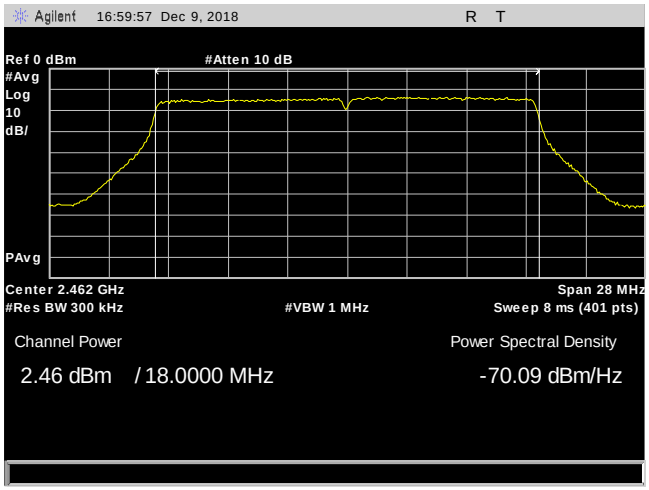
Plot 50. Power Output, MCOP, 802.11n HT20 - PWR 3, Antenna 1, 2462, 2.31 dBm



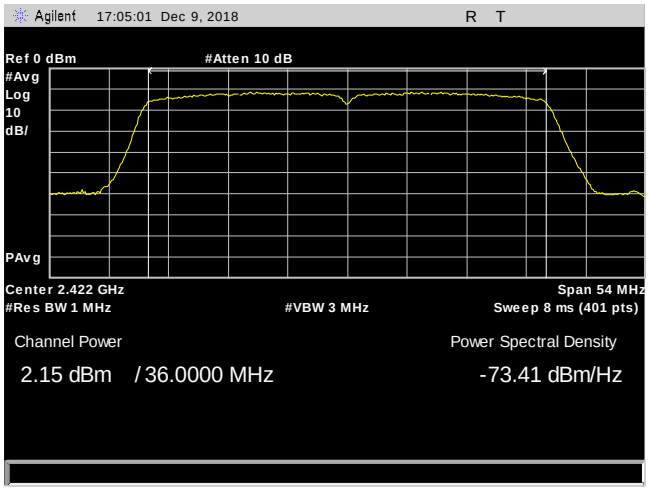
Plot 51. Power Output, MCOP, 802.11n HT20 - PWR 3, Antenna 2, 2412, 2.58 dBm



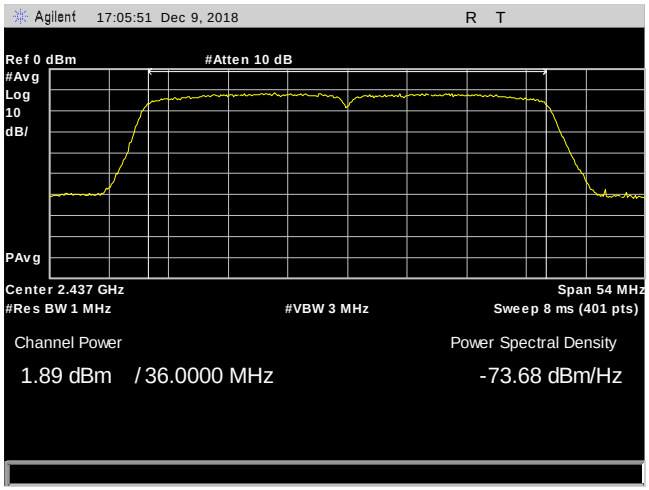
Plot 52. Power Output, MCOP, 802.11n HT20 - PWR 3, Antenna 2, 2437, 2.42 dBm



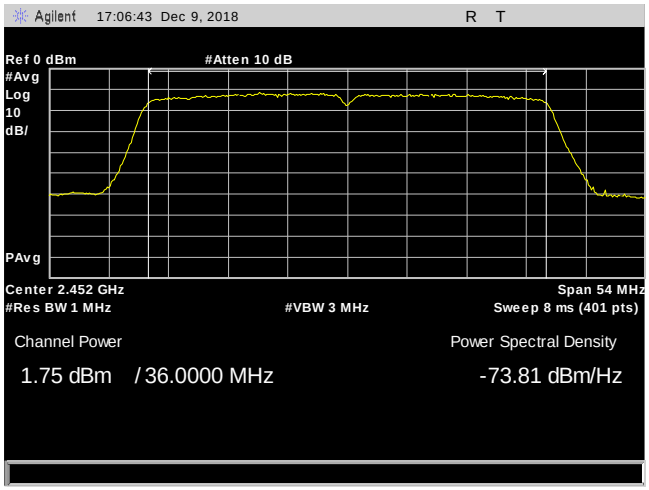
Plot 53. Power Output, MCOP, 802.11n HT20 - PWR 3, Antenna 2, 2462, 2.15 dBm



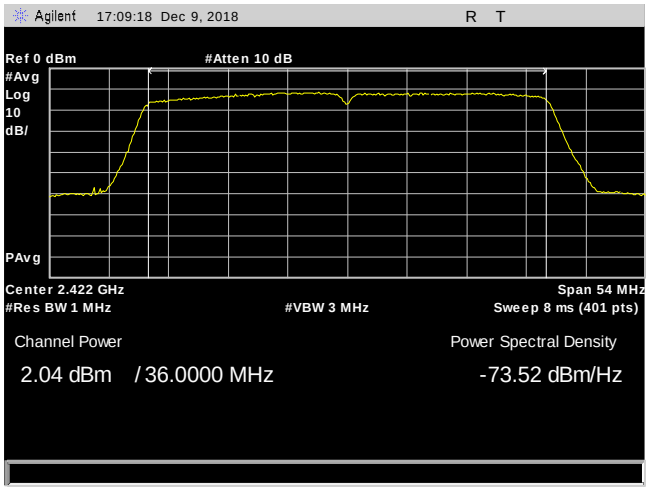
Plot 54. Power Output, MCOP, 802.11n HT40 - PWR 3, Antenna 1, 2422, 2.15 dBm



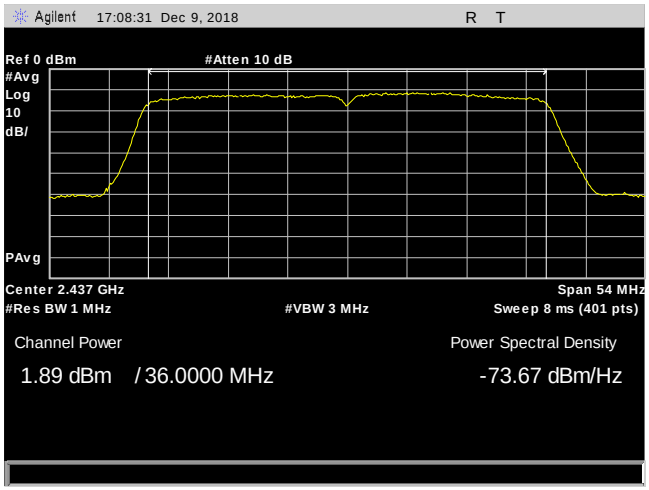
Plot 55. Power Output, MCOP, 802.11n HT40 - PWR 3, Antenna 1, 2437, 1.89 dBm



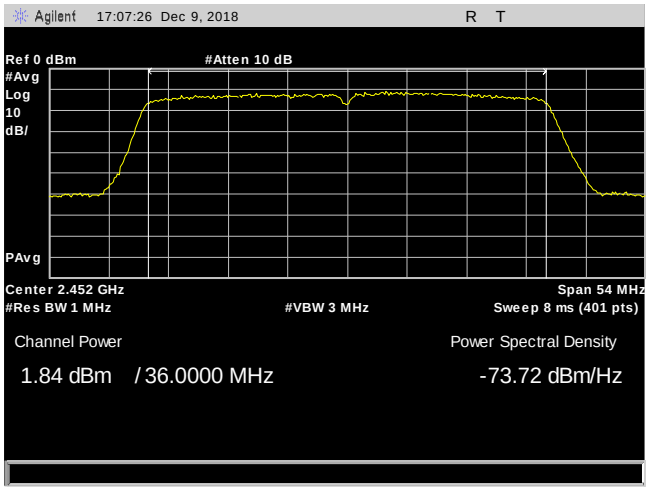
Plot 56. Power Output, MCOP, 802.11n HT40 - PWR 3, Antenna 1, 2452, 1.75 dBm



Plot 57. Power Output, MCOP, 802.11n HT40 - PWR 3, Antenna 2, 2422, 2.04 dBm



Plot 58. Power Output, MCOP, 802.11n HT40 - PWR 3, Antenna 2, 2437, 1.89 dBm



Plot 59. Power Output, MCOP, 802.11n HT40 - PWR 3, Antenna 2, 2452, 1.84 dBm

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.209 Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: **§15.247(d); §15.205:** Emissions outside the frequency band.

§15.205(a): Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110----------	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505----------	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905----------	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128----------	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775----------	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775----------	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218----------	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825----------	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225----------	123–138	2200–2300	14.47–14.5
8.291–8.294----------	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366----------	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675----------	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475----------	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293----------	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025----------	240–285	3345.8–3358 36.	43–36.5
12.57675–12.57725----------	322–335.4	3600–4400	([2])

Table 20. Restricted Bands of Operation

[1] Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.
[2] Above 38.6

Test Requirement(s): **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 21.

Frequency (MHz)	§ 15.209(a),Radiated Emission Limits (dBµV) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

Table 21. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured above 18 GHz.

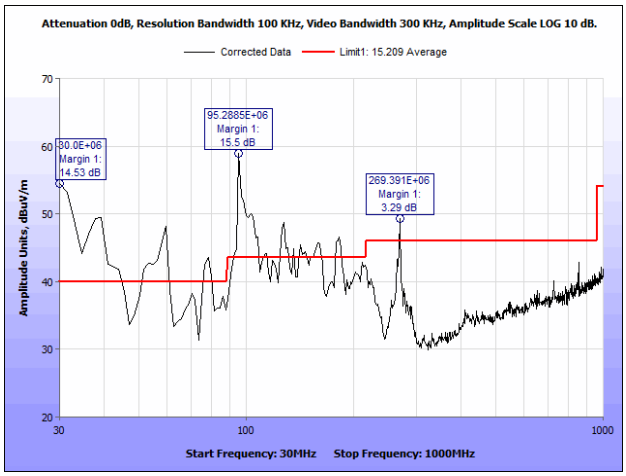
Test Results: The EUT was compliant with the Radiated Spurious Emission limits of **§ 15.247(d) and § 15.209**. Measured emissions were within applicable limits.

Test Engineer(s): Giuliano Messina

Test Date(s): December 7, 2018

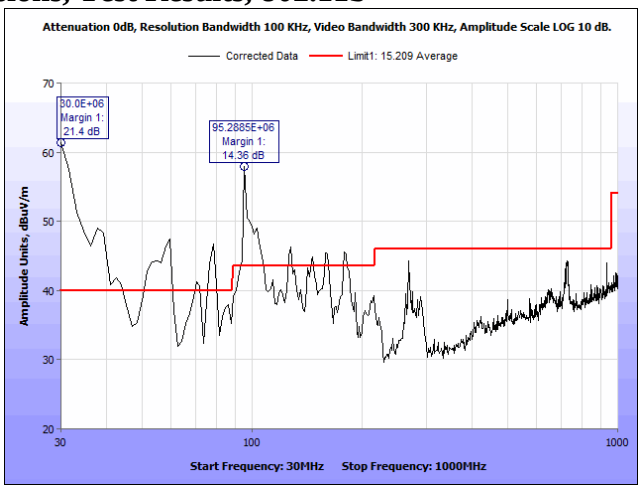
Test Notes: Any emissions over the limit were confirmed to not be caused by the transmitter. Plots with the transmitter turned off are shown below to confirm that any emissions over the limit are digital.

A peak plot against an average limit demonstrates compliance with both the peak and average limits of this section.

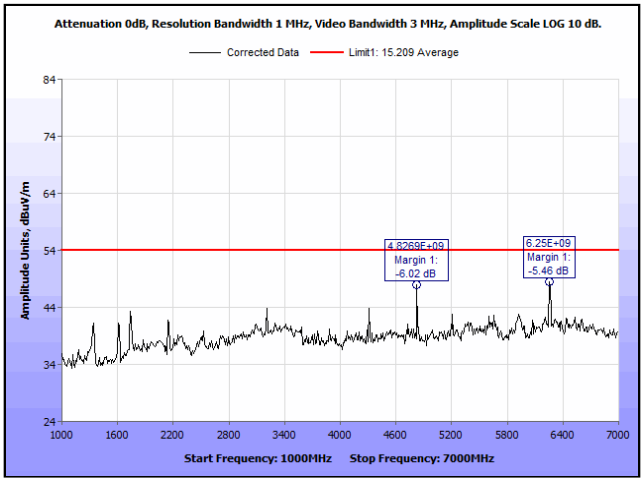


Plot 60. Radiated Emissions, TX Off, 30 – 1000 MHz

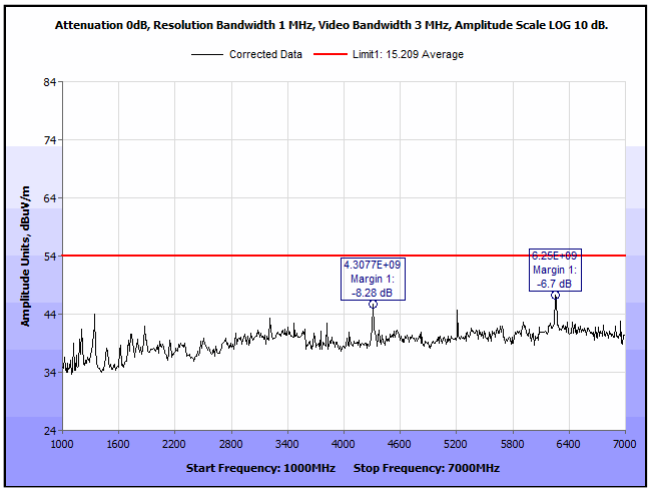
Radiated Spurious Emissions, Test Results, 802.11b



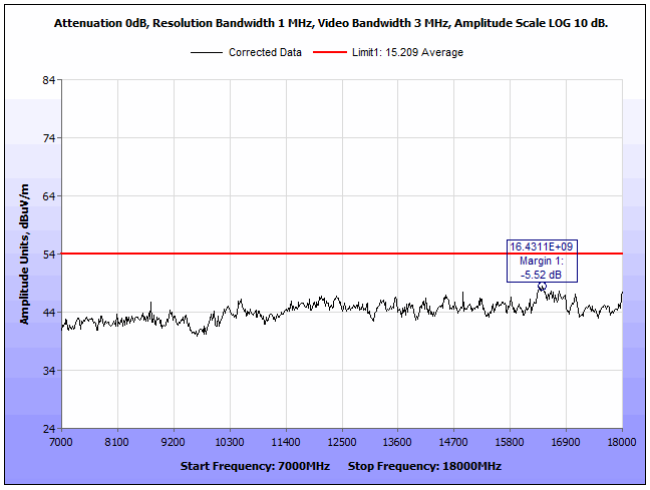
Plot 61. Radiated Emissions, 802.11b - PWR 1000, 2412, 30 – 1000 MHz



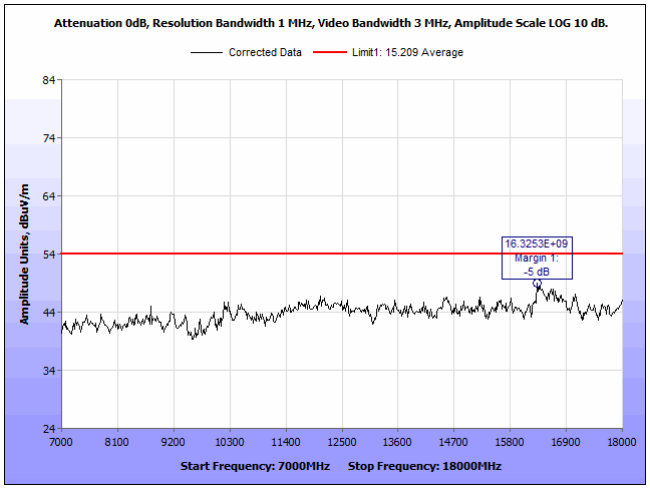
Plot 62. Radiated Emissions, 802.11b - PWR 1000, 2412, 1 – 7 GHz, Peak, Horizontal



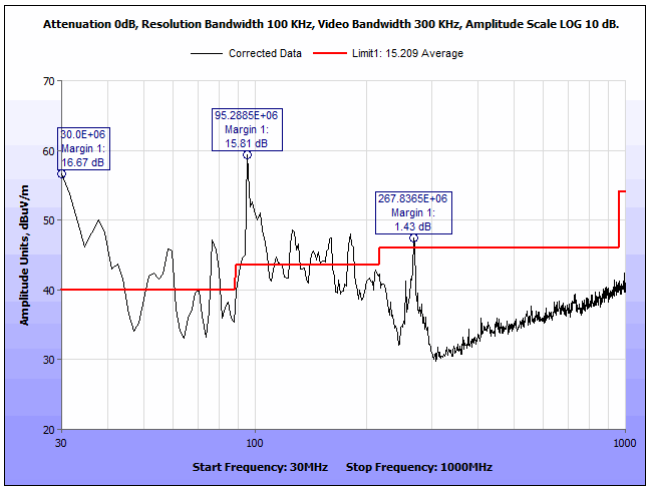
Plot 63. Radiated Emissions, 802.11b - PWR 1000, 2412, 1 – 7 GHz, Peak, Vertical



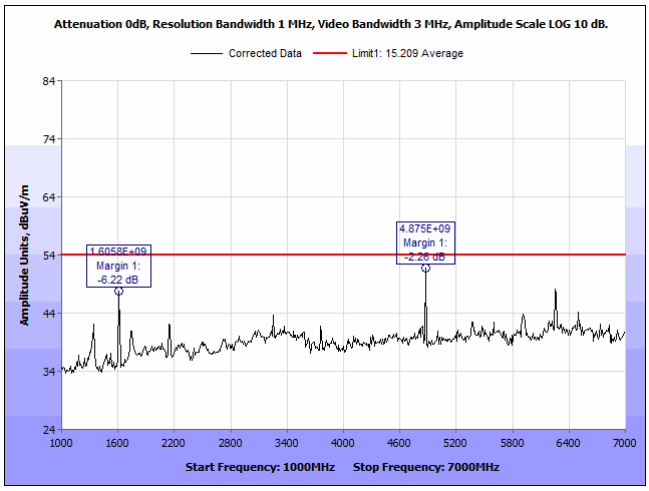
Plot 64. Radiated Emissions, 802.11b - PWR 1000, 2412, 7 – 18 GHz, Peak, Horizontal



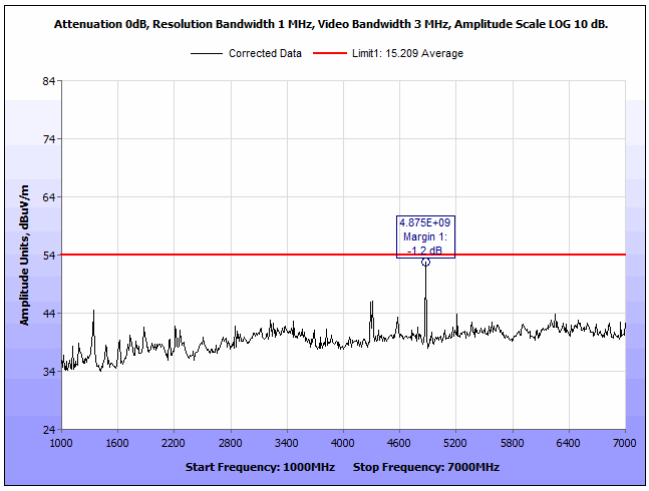
Plot 65. Radiated Emissions, 802.11b - PWR 1000, 2412, 7 – 18 GHz, Peak, Vertical



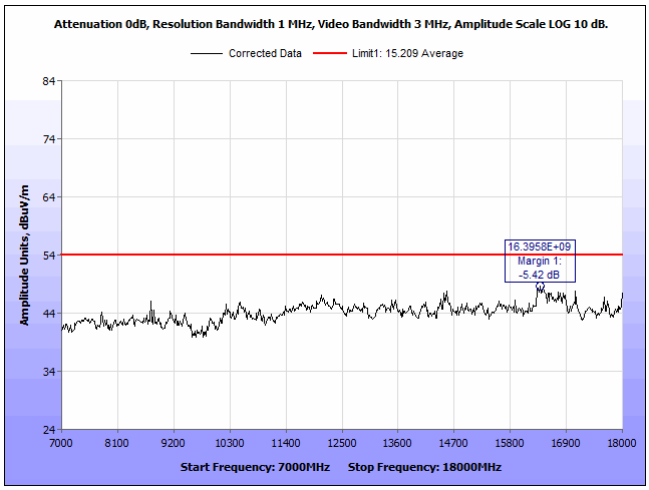
Plot 66. Radiated Emissions, 802.11b - PWR 1000, 2437, 30 – 1000 MHz



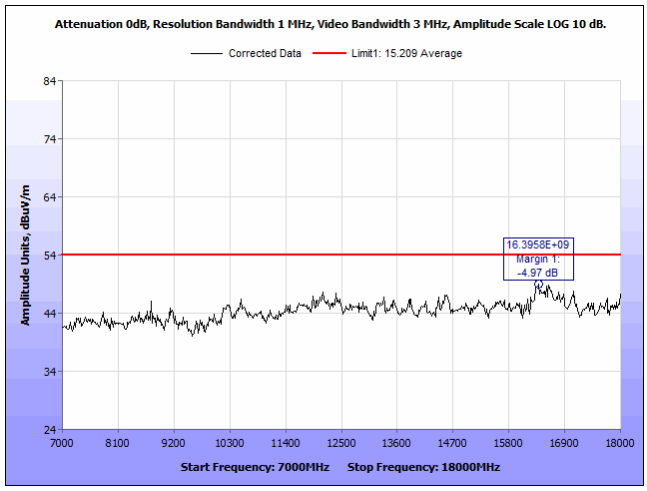
Plot 67. Radiated Emissions, 802.11b - PWR 1000, 2437, 1 – 7 GHz, Peak, Horizontal



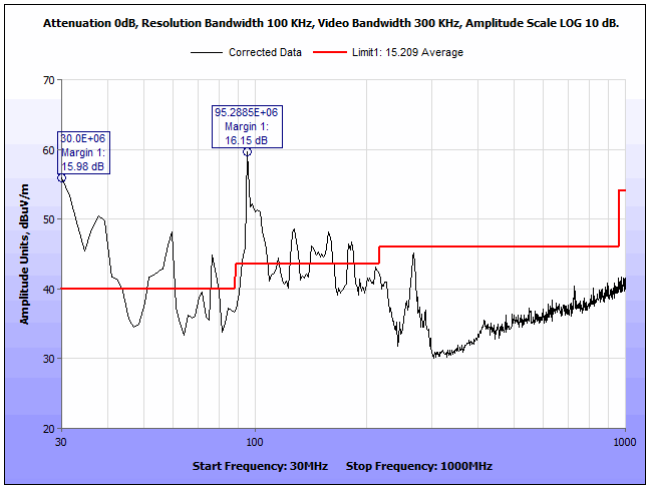
Plot 68. Radiated Emissions, 802.11b - PWR 1000, 2437, 1 – 7 GHz, Peak, Vertical



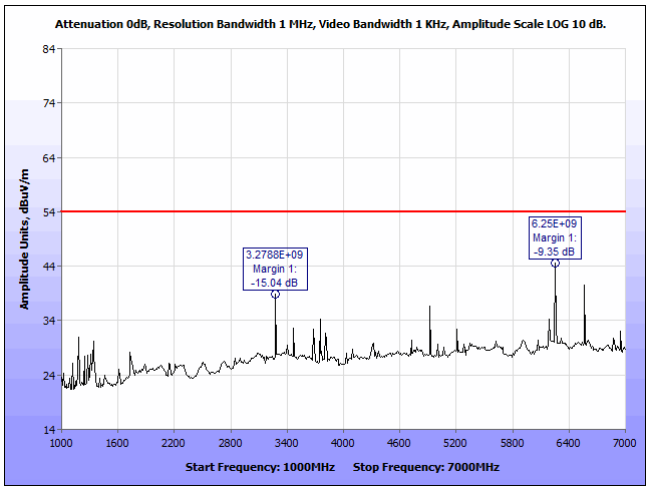
Plot 69. Radiated Emissions, 802.11b - PWR 1000, 2437, 7 – 18 GHz, Peak, Horizontal



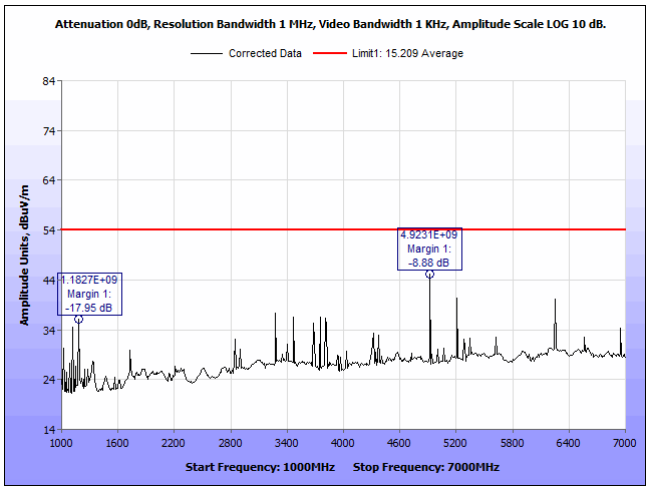
Plot 70. Radiated Emissions, 802.11b - PWR 1000, 2437, 7 – 18 GHz, Peak, Vertical



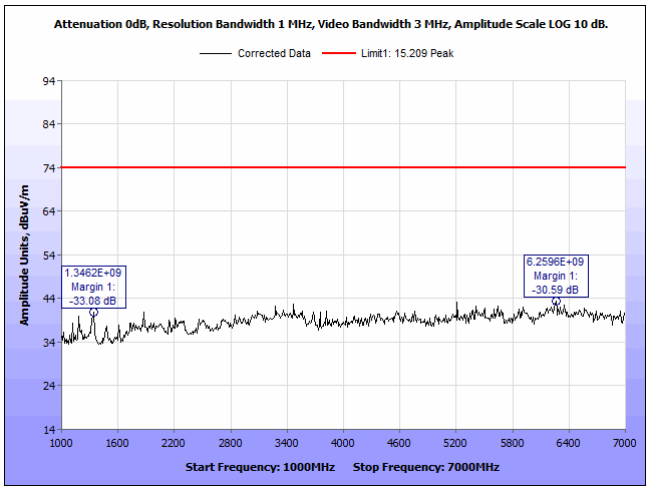
Plot 71. Radiated Emissions, 802.11b - PWR 1000, 2462, 30 – 1000 MHz



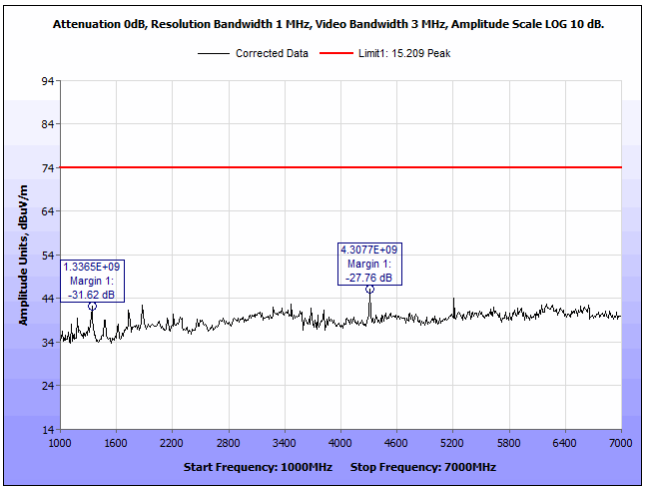
Plot 72. Radiated Emissions, 802.11b - PWR 1000, 2462, 1 – 7 GHz, Average, Horizontal



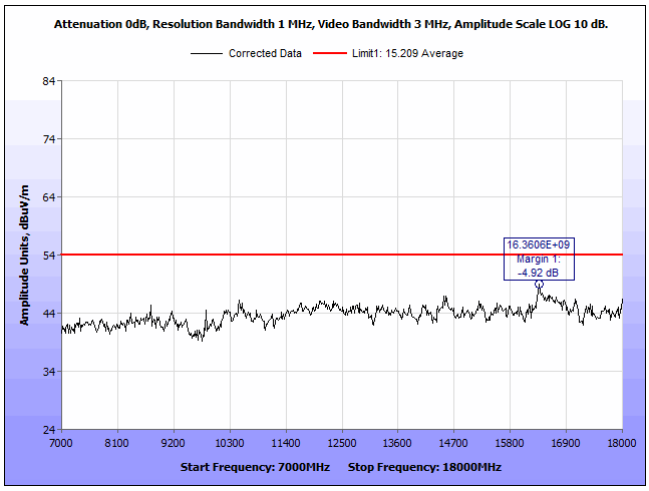
Plot 73. Radiated Emissions, 802.11b - PWR 1000, 2462, 1 – 7 GHz, Average, Vertical



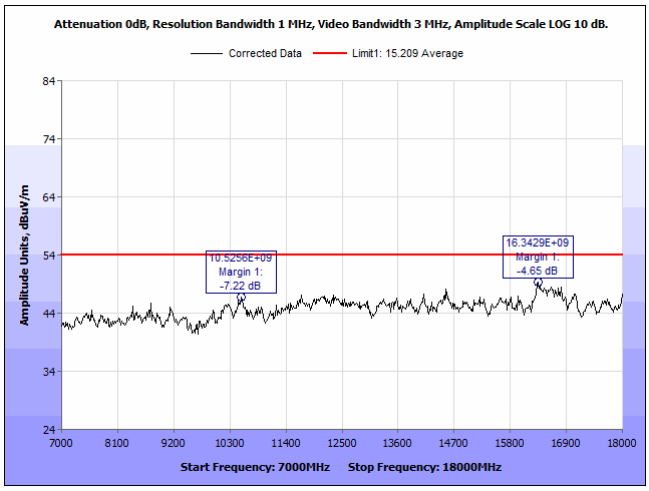
Plot 74. Radiated Emissions, 802.11b - PWR 1000, 2462, 1 – 7 GHz, Peak, Horizontal



Plot 75. Radiated Emissions, 802.11b - PWR 1000, 2462, 1 – 7 GHz, Peak, Vertical

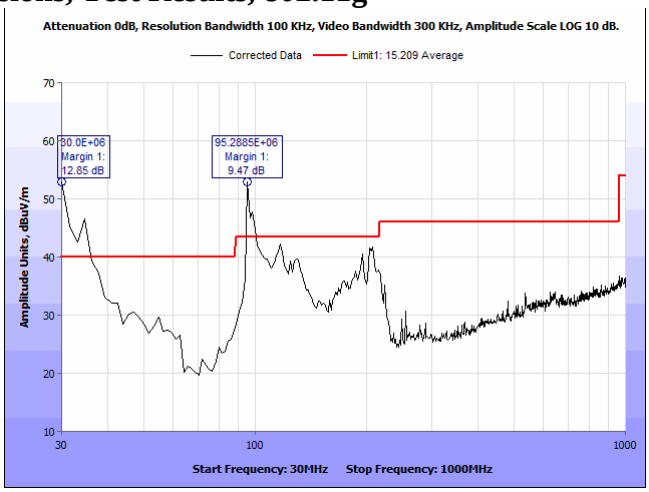


Plot 76. Radiated Emissions, 802.11b - PWR 1000, 2462, 7 – 18 GHz, Peak, Horizontal

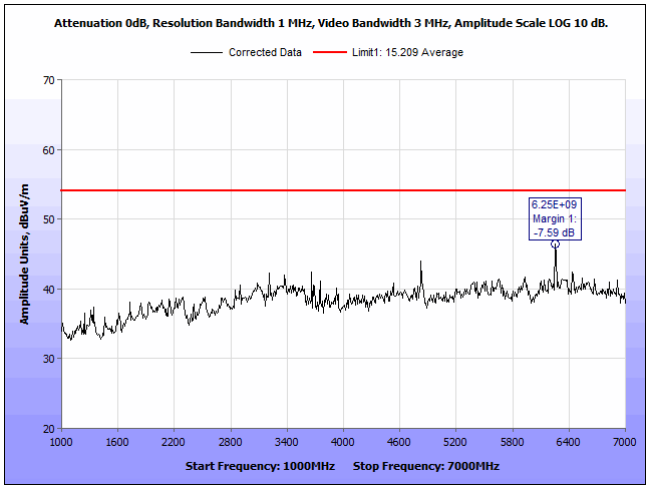


Plot 77. Radiated Emissions, 802.11b - PWR 1000, 2462, 7 -18 GHz, Peak, Vertical

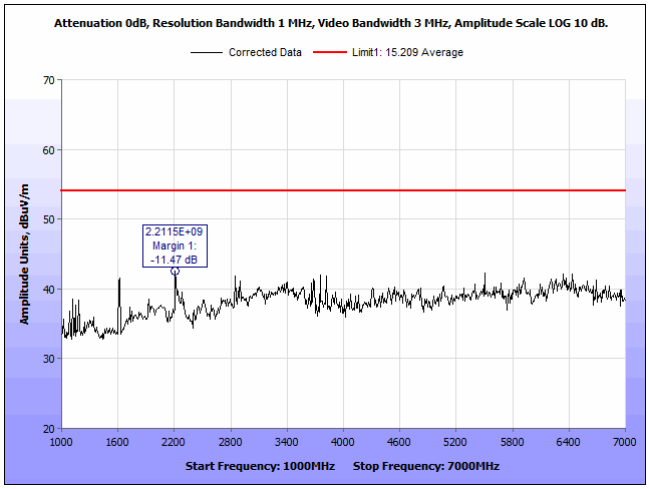
Radiated Spurious Emissions, Test Results, 802.11g



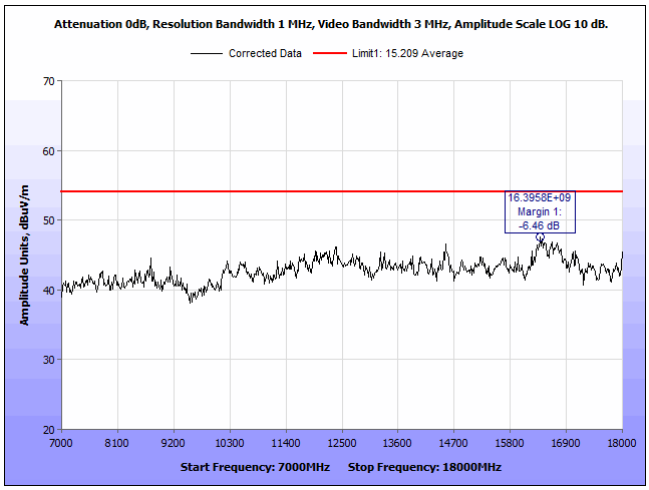
Plot 78. Radiated Emissions, 802.11g - PWR 3, 2412, 30 – 1000 MHz



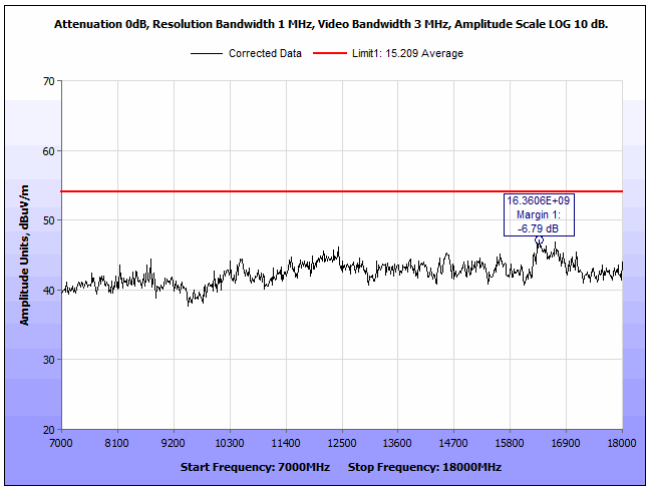
Plot 79. Radiated Emissions, 802.11g - PWR 3, 2412, 1 – 7 GHz, Peak, Horizontal



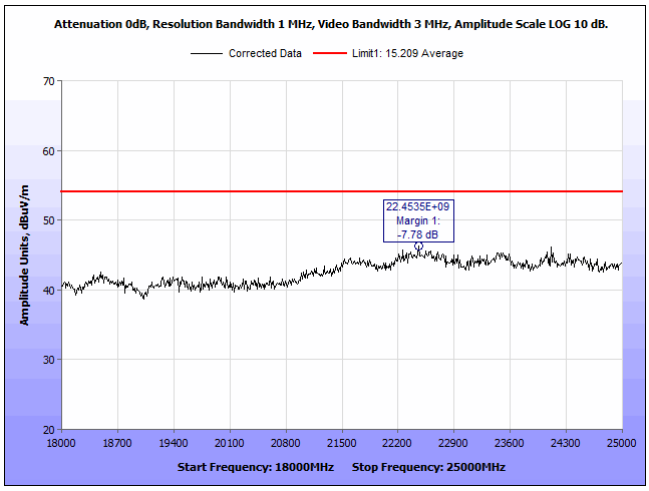
Plot 80. Radiated Emissions, 802.11g - PWR 3, 2412, 1 – 7 GHz, Peak, Vertical



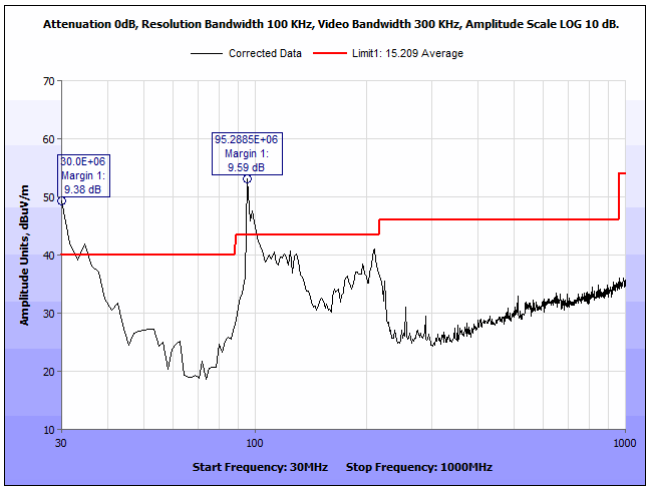
Plot 81. Radiated Emissions, 802.11g - PWR 3, 2412, 7 – 18 GHz, Peak, Horizontal



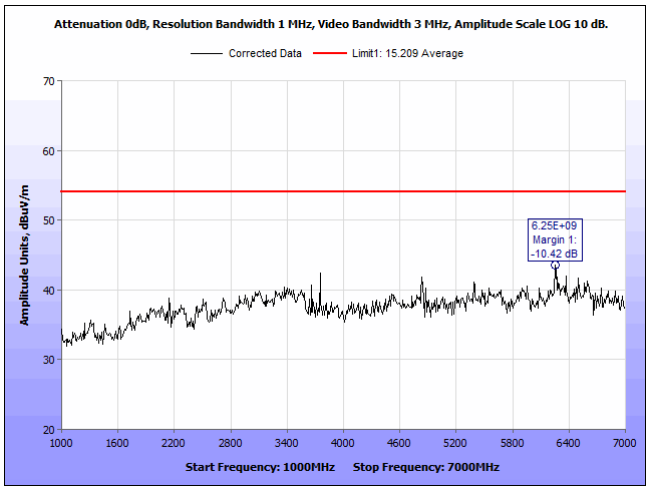
Plot 82. Radiated Emissions, 802.11g - PWR 3, 2412, 7 – 18 GHz, Peak, Vertical



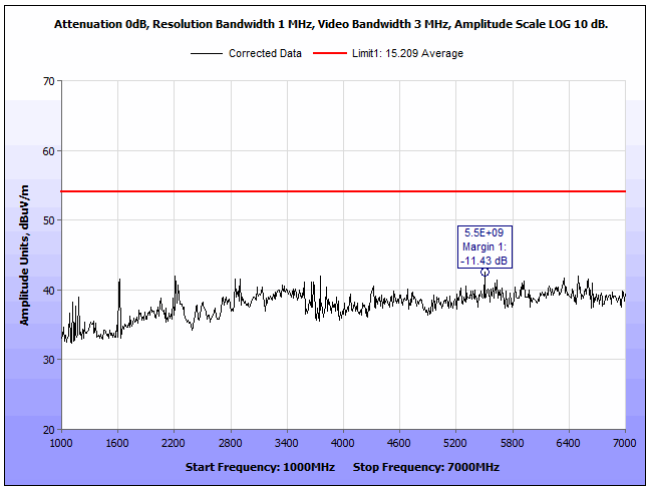
Plot 83. Radiated Emissions, 802.11g - PWR 3, 2412, 18 – 25 GHz, Peak



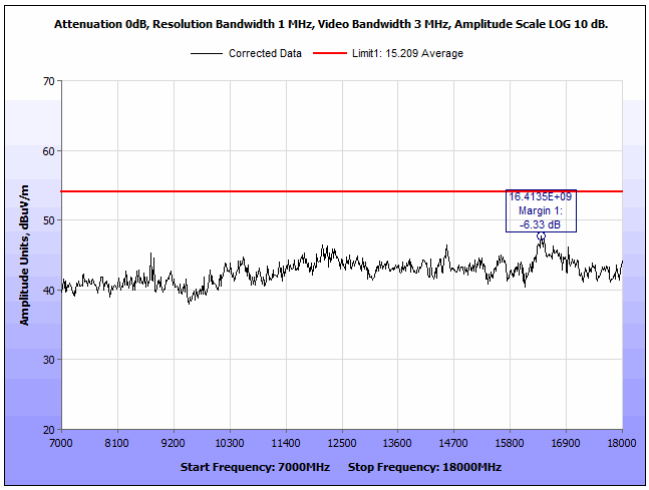
Plot 84. Radiated Emissions, 802.11g - PWR 3, 2437, 30 – 1000 MHz



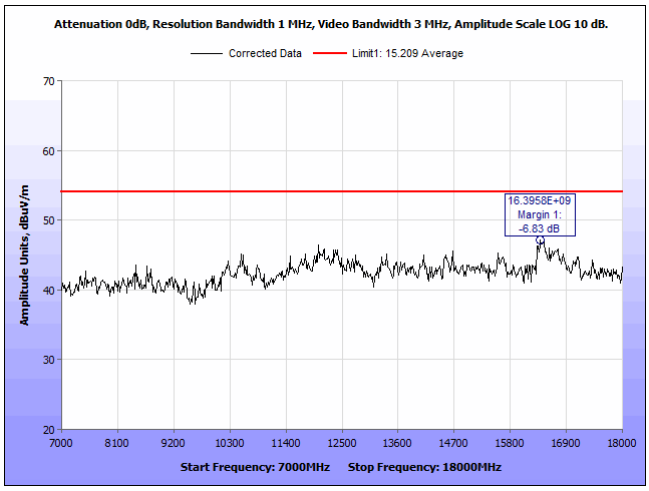
Plot 85. Radiated Emissions, 802.11g - PWR 3, 2437, 1 – 7 GHz, Peak, Horizontal



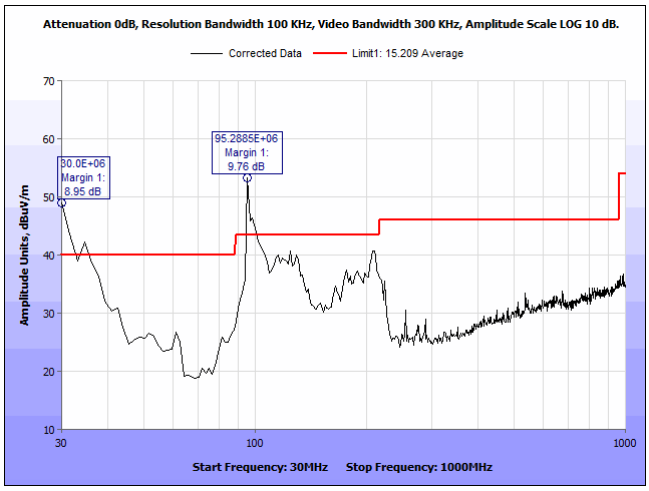
Plot 86. Radiated Emissions, 802.11g - PWR 3, 2437, 1 – 7 GHz, Peak, Vertical



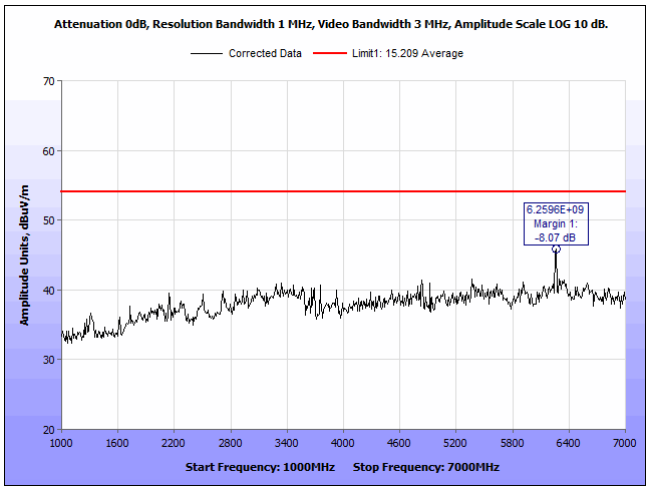
Plot 87. Radiated Emissions, 802.11g - PWR 3, 2437, 7 – 18 GHz, Peak, Horizontal



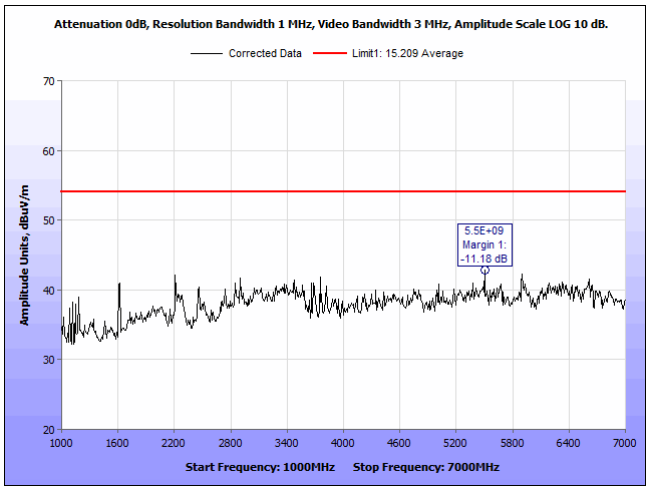
Plot 88. Radiated Emissions, 802.11g - PWR 3, 2437, 7 – 18 GHz, Peak, Vertical



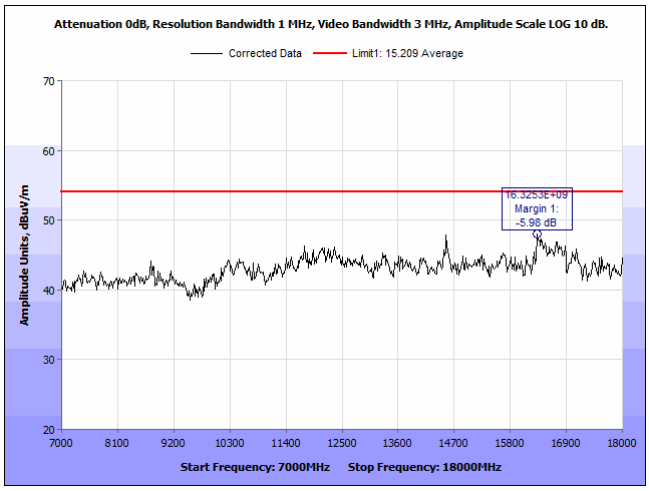
Plot 89. Radiated Emissions, 802.11g - PWR 3, 2462, 30 – 1000 MHz



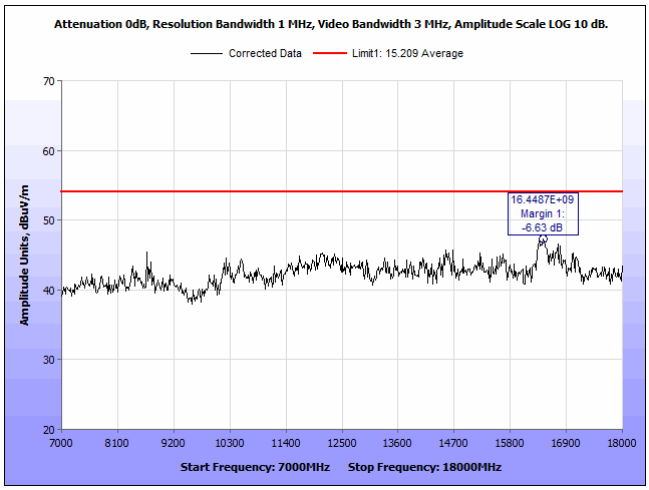
Plot 90. Radiated Emissions, 802.11g - PWR 3, 2462, 1 – 7 GHz, Peak, Horizontal



Plot 91. Radiated Emissions, 802.11g - PWR 3, 2462, 1 – 7 GHz, Peak, Vertical

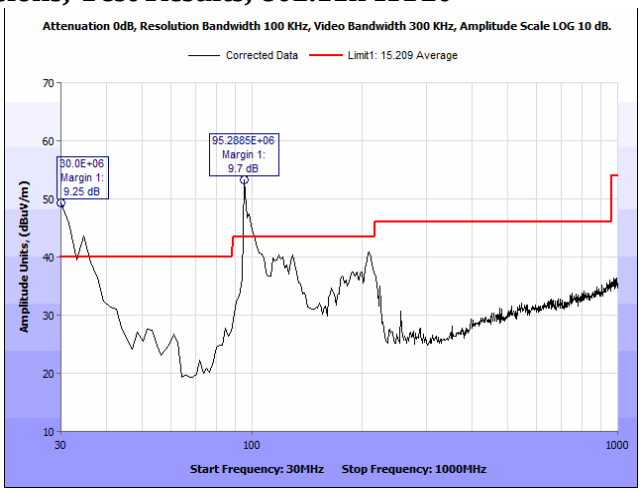


Plot 92. Radiated Emissions, 802.11g - PWR 3, 2462, 7 – 18 GHz, Peak, Horizontal

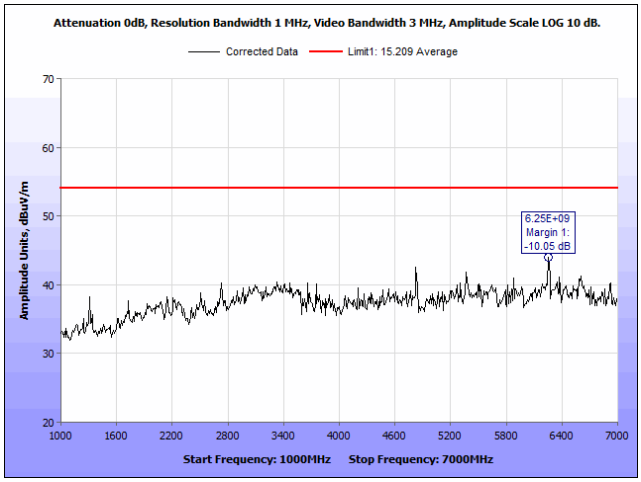


Plot 93. Radiated Emissions, 802.11g - PWR 3, 2462, 7 – 18 GHz, Peak, Vertical

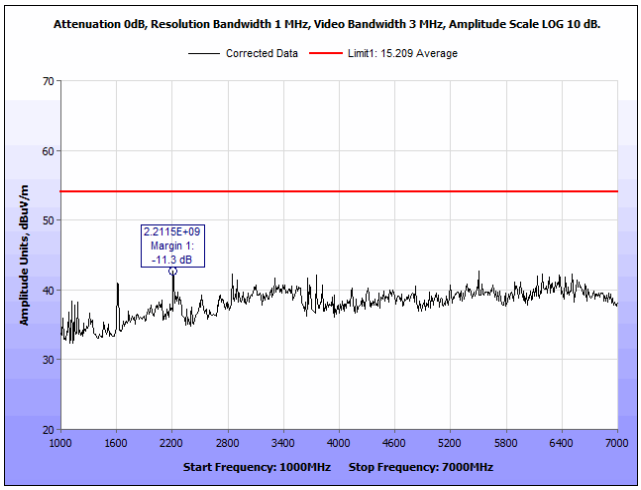
Radiated Spurious Emissions, Test Results, 802.11n HT20



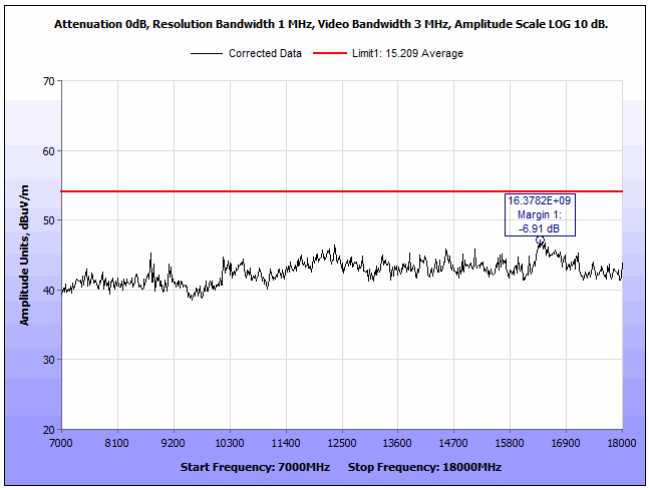
Plot 94. Radiated Emissions, 802.11n HT20 - PWR 3, 2412, 30 – 1000 MHz



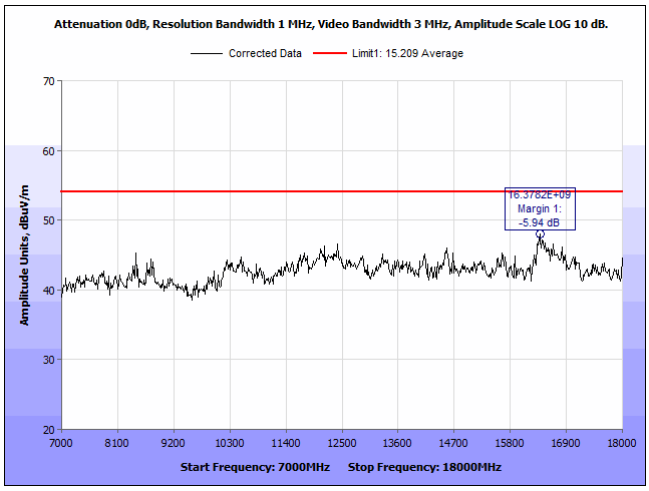
Plot 95. Radiated Emissions, 802.11n HT20 - PWR 3, 2412, 1 – 7 GHz, Peak, Horizontal



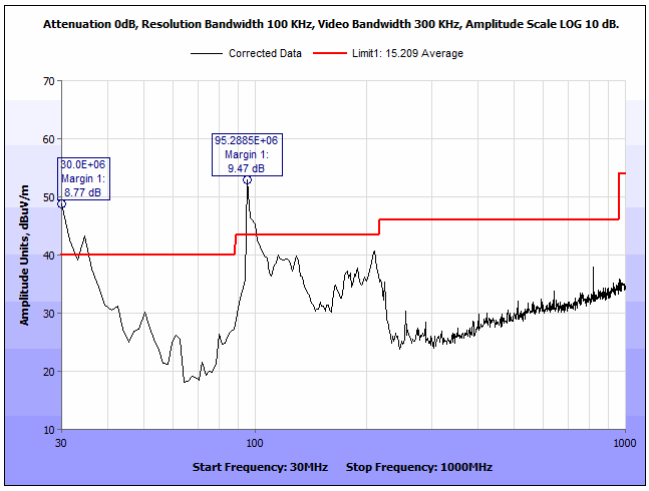
Plot 96. Radiated Emissions, 802.11n HT20 - PWR 3, 2412, 1 – 7 GHz, Peak, Vertical



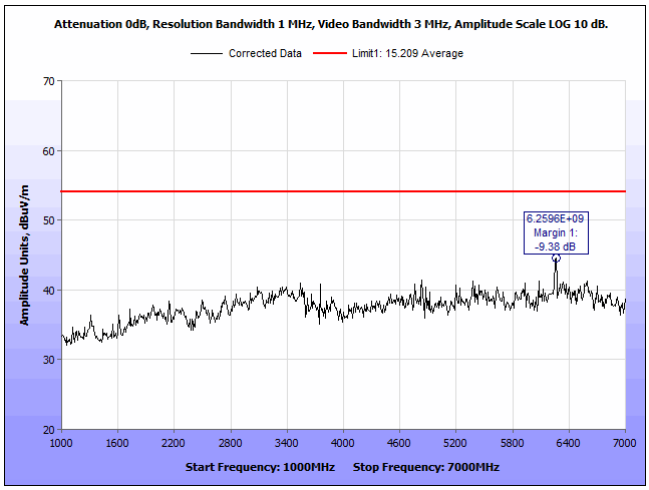
Plot 97. Radiated Emissions, 802.11n HT20 - PWR 3, 2412, 7 – 18 GHz, Peak, Horizontal



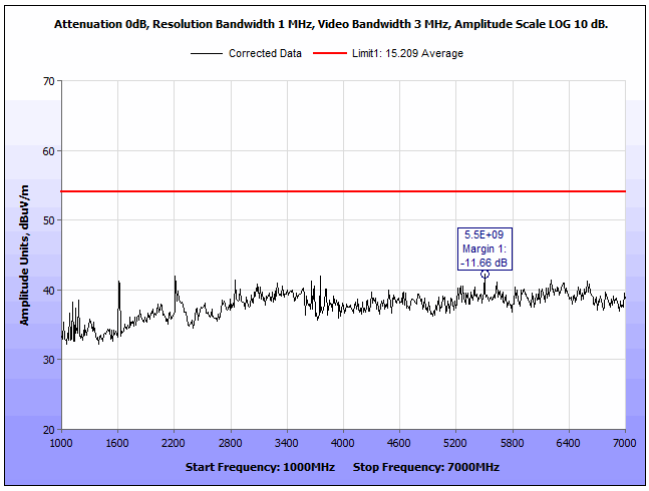
Plot 98. Radiated Emissions, 802.11n HT20 - PWR 3, 2412, 7 – 18 GHz, Peak, Vertical



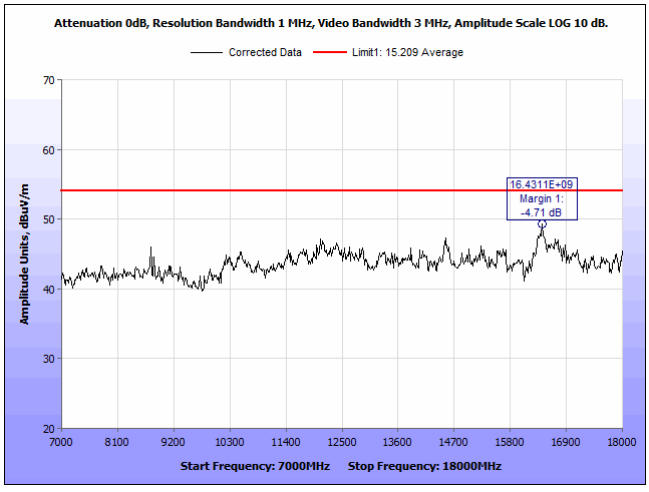
Plot 99. Radiated Emissions, 802.11n HT20 - PWR 3, 2437, 30 – 1000 MHz



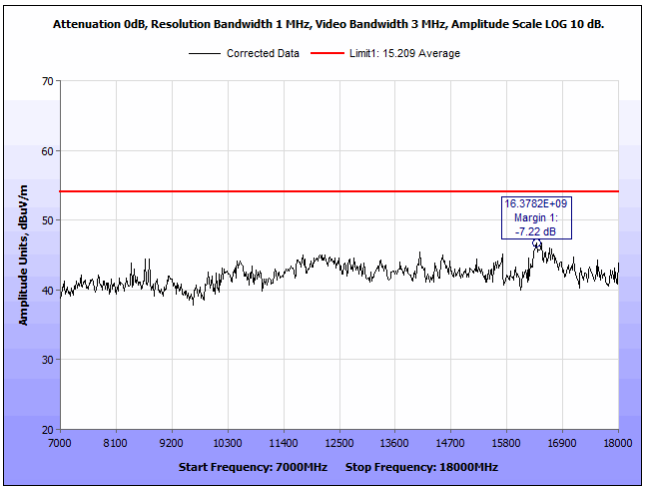
Plot 100. Radiated Emissions, 802.11n HT20 - PWR 3, 2437, 1 – 7 GHz, Peak, Horizontal



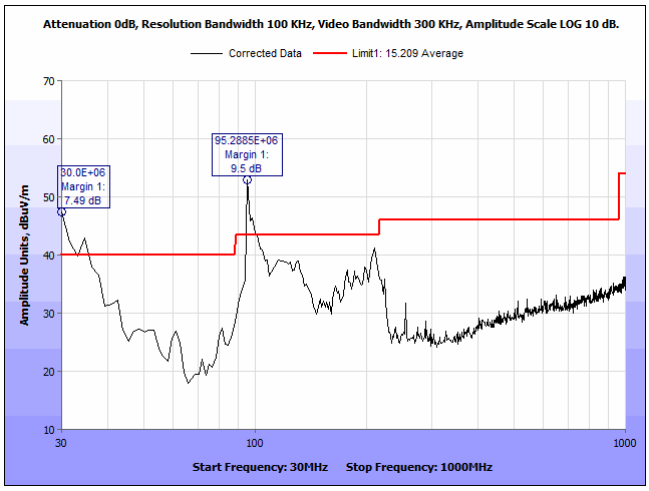
Plot 101. Radiated Emissions, 802.11n HT20 - PWR 3, 2437, 1 – 7 GHz, Peak, Vertical



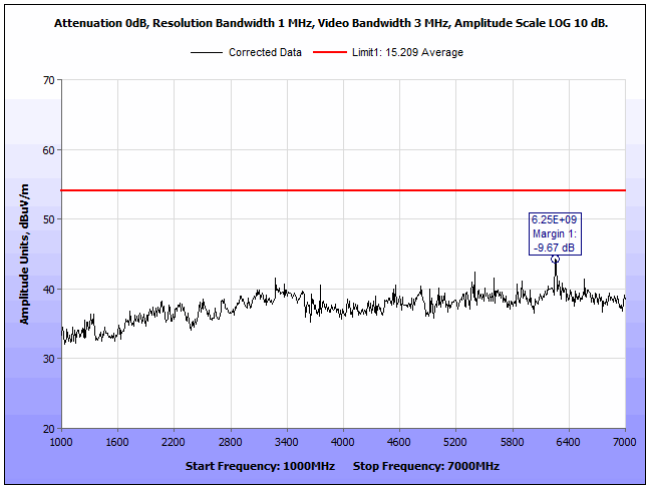
Plot 102. Radiated Emissions, 802.11n HT20 - PWR 3, 2437, 7 – 18 GHz, Peak, Horizontal



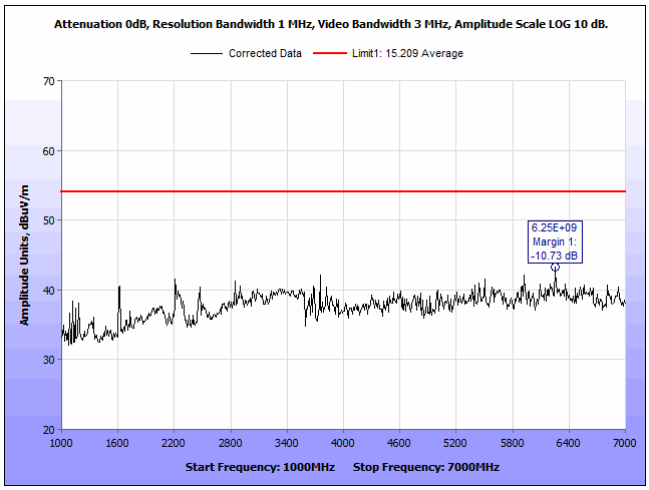
Plot 103. Radiated Emissions, 802.11n HT20 - PWR 3, 2437, 7 – 18 GHz, Peak, Vertical



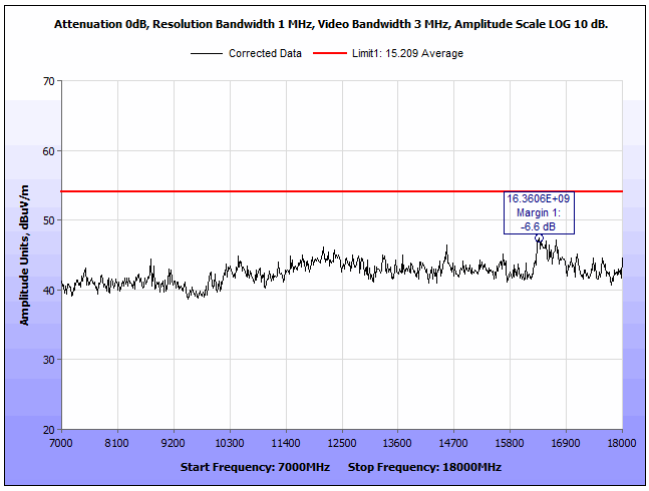
Plot 104. Radiated Emissions, 802.11n HT20 - PWR 3, 2462, 30 – 1000 MHz



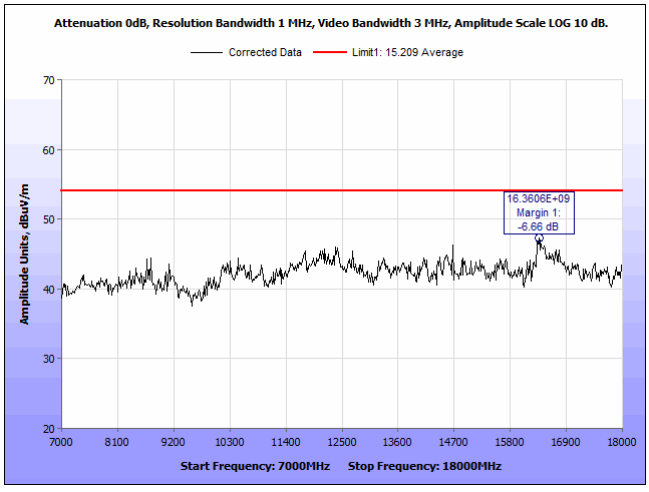
Plot 105. Radiated Emissions, 802.11n HT20 - PWR 3, 2462, 1 – 7 GHz, Peak, Horizontal



Plot 106. Radiated Emissions, 802.11n HT20 - PWR 3, 2462, 1 – 7 GHz, Peak, Vertical

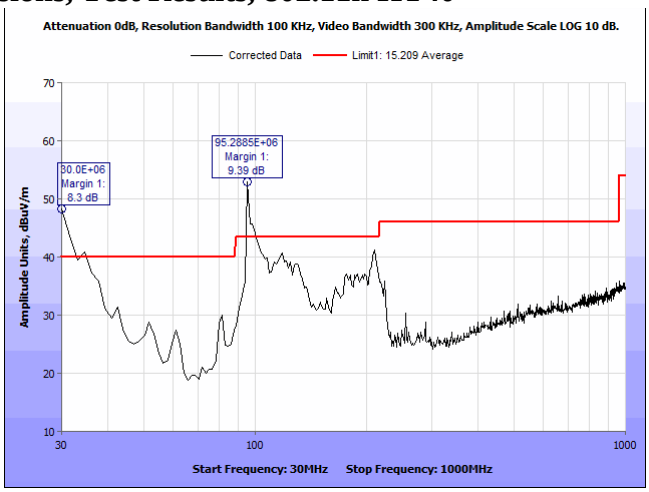


Plot 107. Radiated Emissions, 802.11n HT20 - PWR 3, 2462, 7 – 18 GHz, Peak, Horizontal

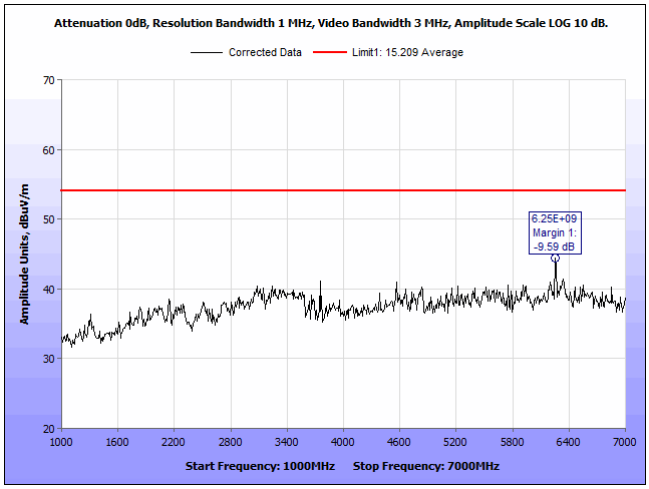


Plot 108. Radiated Emissions, 802.11n HT20 - PWR 3, 7 – 18 GHz, Peak, Vertical

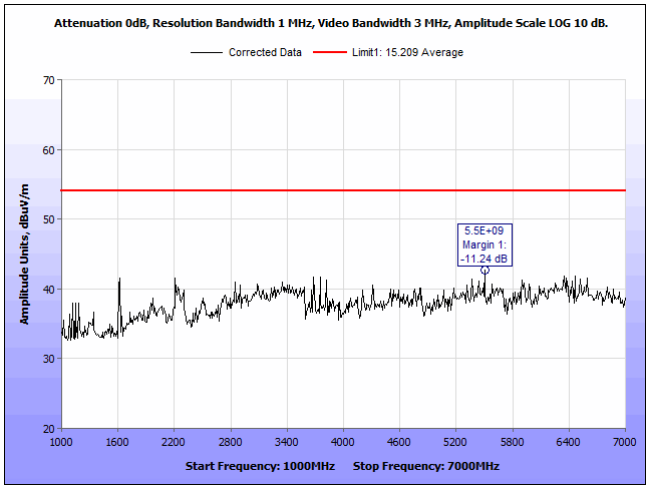
Radiated Spurious Emissions, Test Results, 802.11n HT40



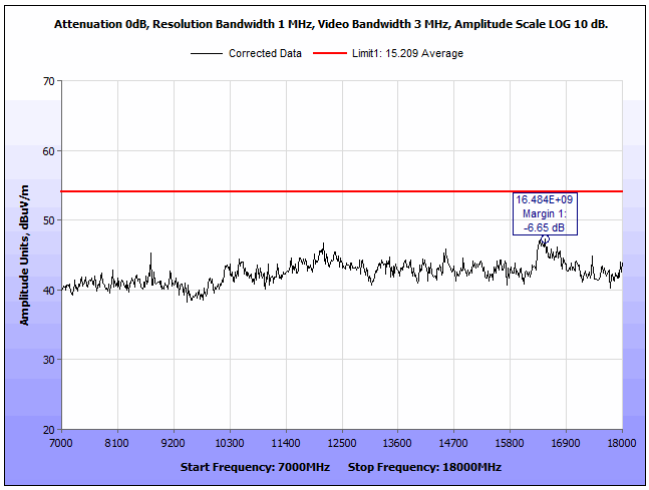
Plot 109. Radiated Emissions, 802.11n HT40 - PWR 3, 2422, 30 – 1000 MHz



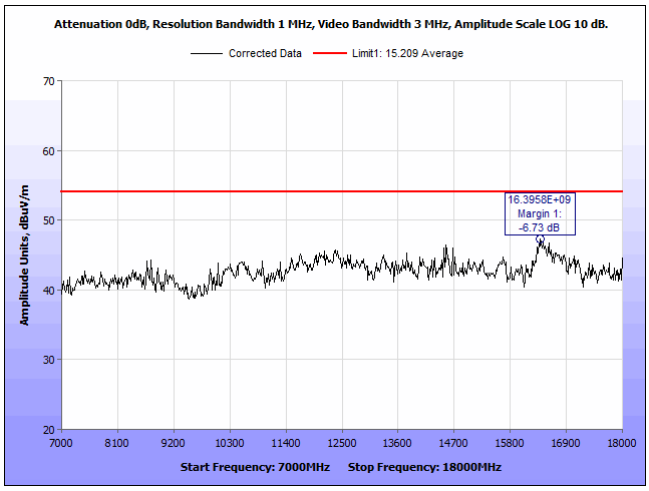
Plot 110. Radiated Emissions, 802.11n HT40 - PWR 3, 2422, 1 – 7 GHz, Peak, Horizontal



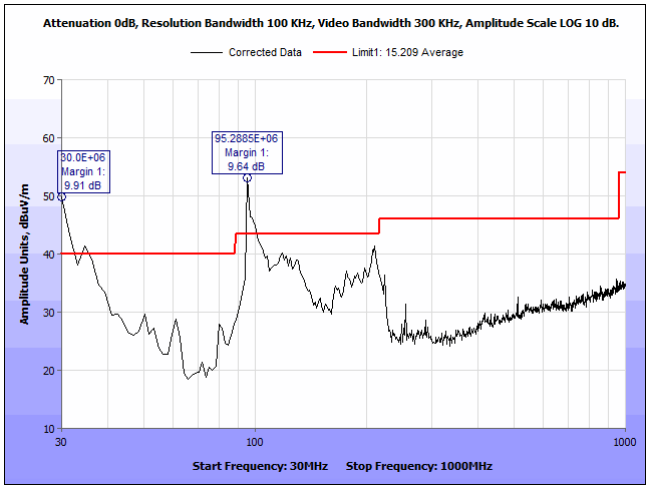
Plot 111. Radiated Emissions, 802.11n HT40 - PWR 3, 2422, 1 – 7 GHz, Peak, Vertical



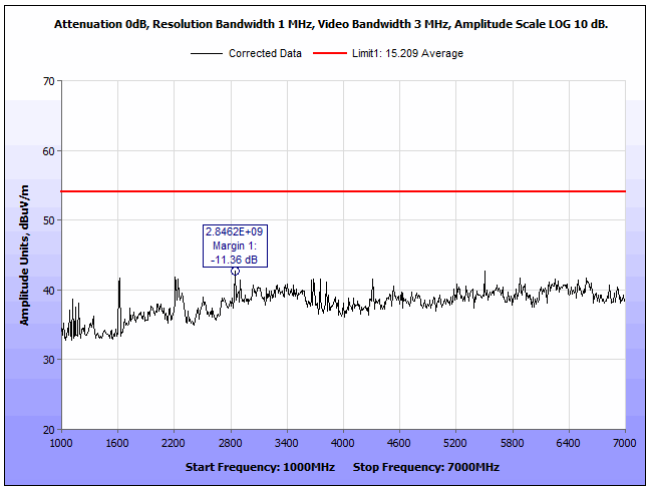
Plot 112. Radiated Emissions, 802.11n HT40 - PWR 3, 2422, 7 – 18 GHz, Peak, Horizontal



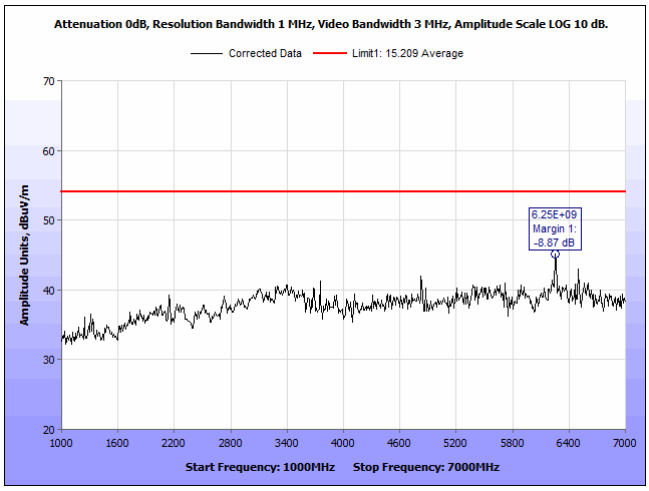
Plot 113. Radiated Emissions, 802.11n HT40 - PWR 3, 2422, 7 – 18 GHz, Peak, Vertical



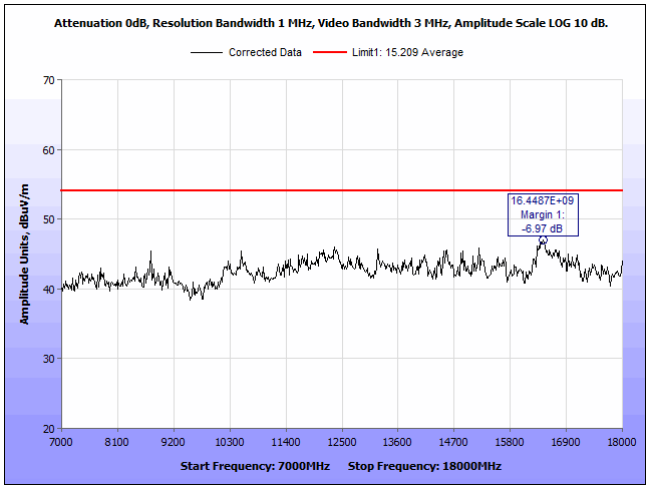
Plot 114. Radiated Emissions, 802.11n HT40 - PWR 3, 2437, 30 – 1000 MHz



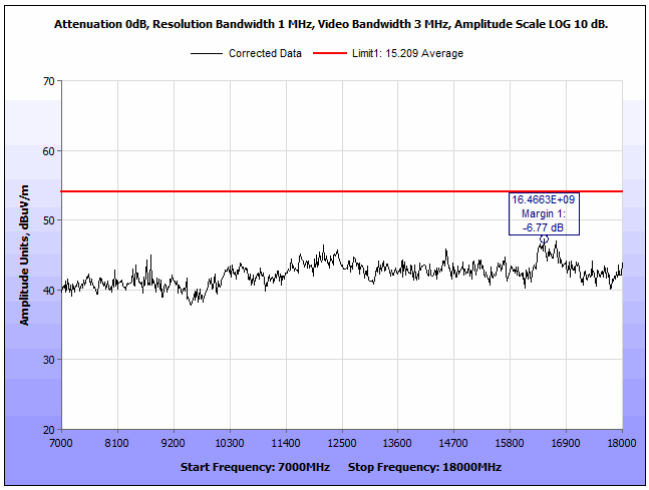
Plot 115. Radiated Emissions, 802.11n HT40 - PWR 3, 2437, 1 – 7 GHz, Peak, Vertical



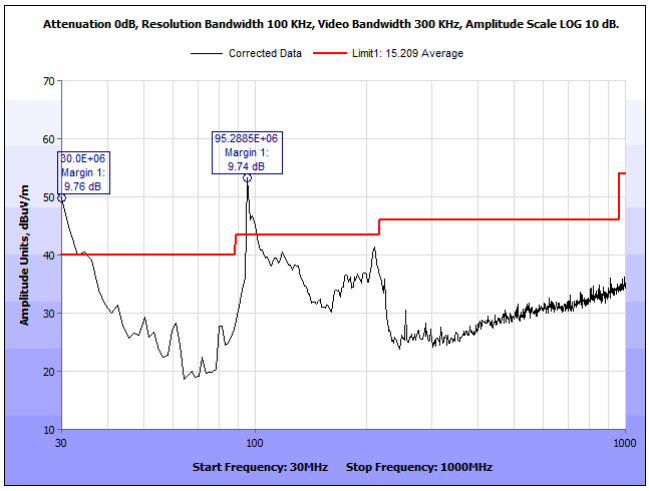
Plot 116. Radiated Emissions, 802.11n HT40 - PWR 3, 2437, 1 - 7 GHz, Peak, Horizontal



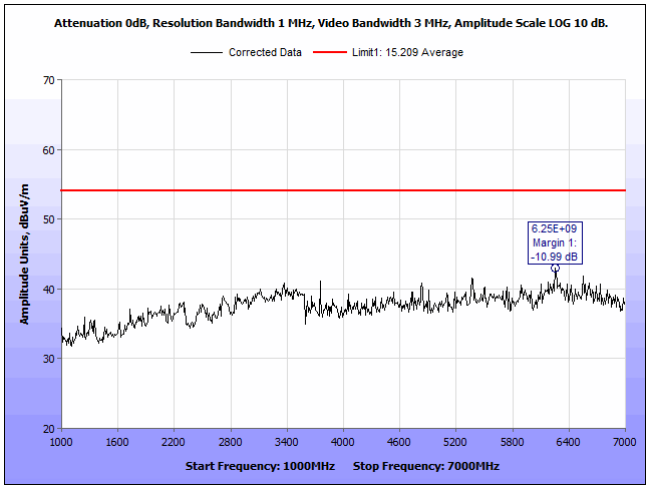
Plot 117. Radiated Emissions, 802.11n HT40 - PWR 3, 2437, 7 – 18 GHz, Peak, Horizontal



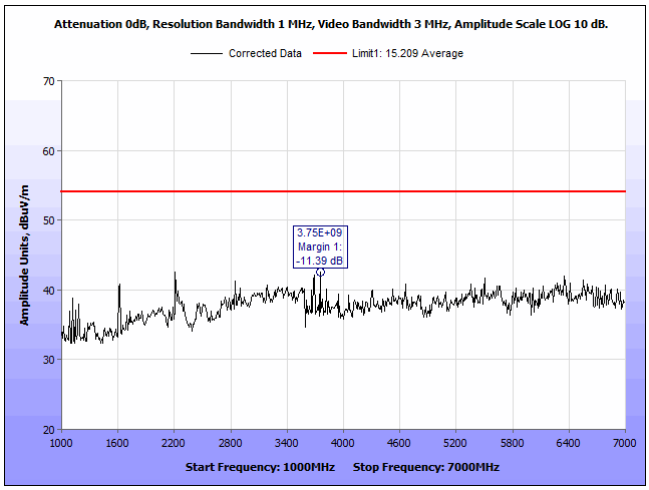
Plot 118. Radiated Emissions, 802.11n HT40 - PWR 3, 2437, 7 – 18 GHz, Peak, Vertical



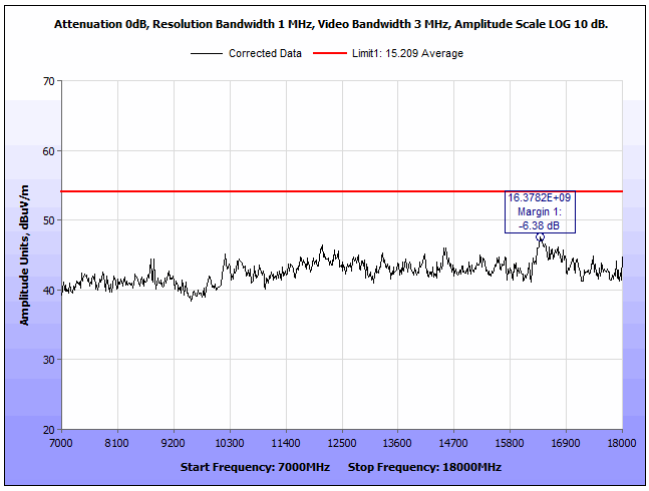
Plot 119. Radiated Emissions, 802.11n HT40 PWR 3, 2452, 30 – 1000 MHz



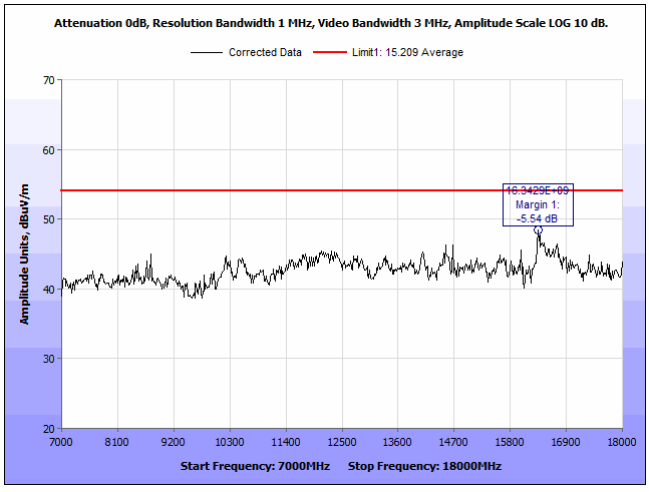
Plot 120. Radiated Emissions, 802.11n HT40 PWR - 3, 2452, 1 – 7 GHz, Peak, Horizontal



Plot 121. Radiated Emissions, 802.11n HT40 PWR - 3, 2452, 1 – 7 GHz, Peak, Vertical

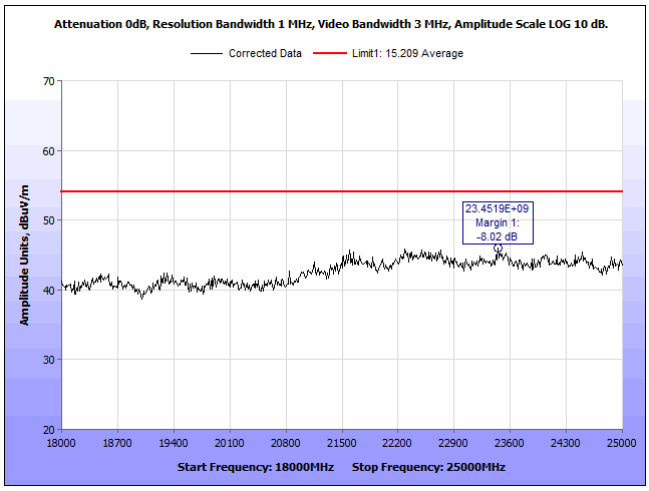


Plot 122. Radiated Emissions, 802.11n HT40 PWR - 3, 2452, 7 – 18 GHz, Peak, Horizontal



Plot 123. Radiated Emissions, 802.11n HT40 PWR - 3, 2452, 7 – 18 GHz, Peak, Vertical

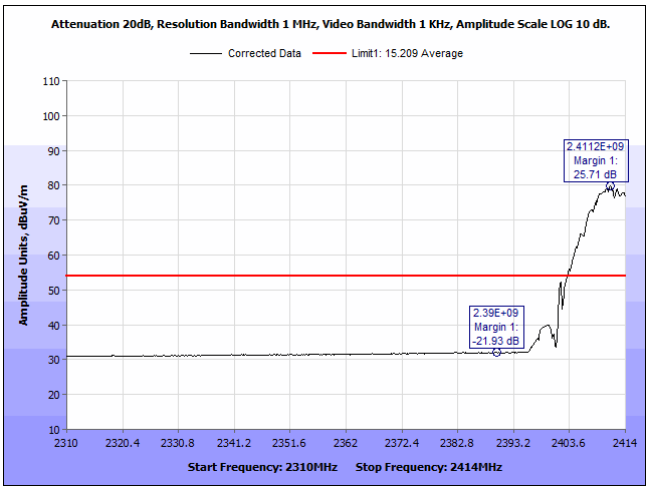
Note: The below plot is representative of all plots taken above 18GHz, which contained no measureable spurious emissions.



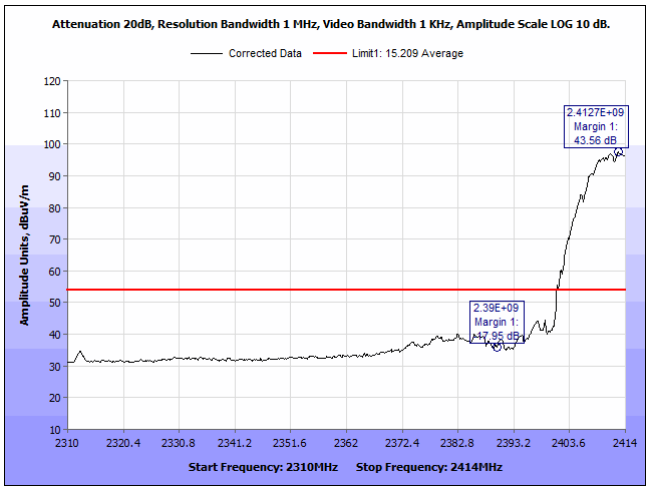
Plot 124. Radiated Emissions, 802.11n HT20 - PWR 3, 18 – 25 GHz, Peak

Radiated Band Edge Measurements

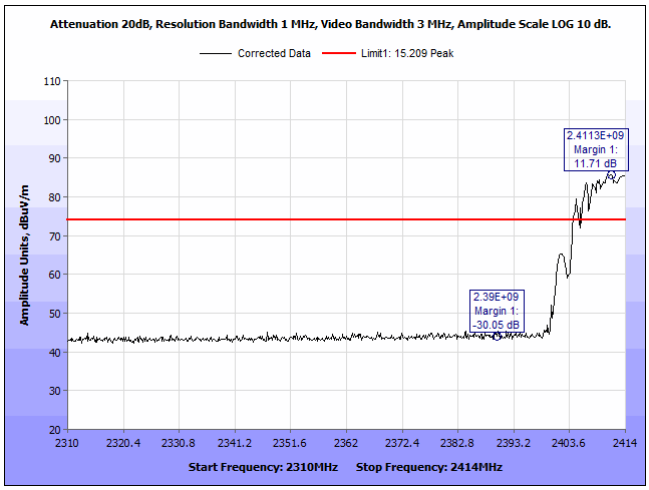
Test Procedures: The transmitter was turned on. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.



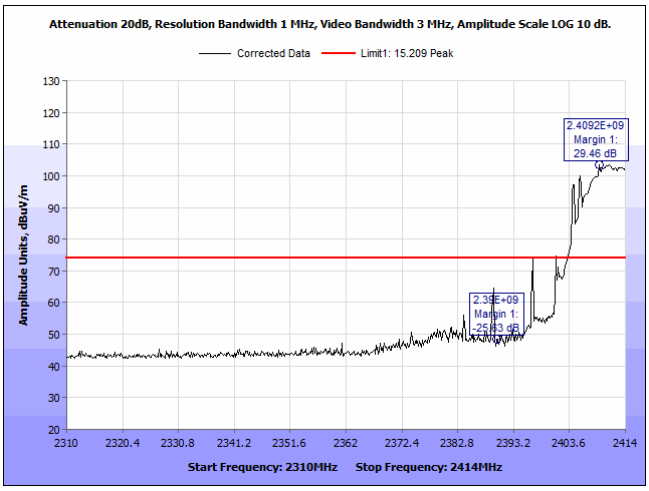
Plot 125. Radiated Restricted Bandedge, 802.11b - PWR 1000, 2412, Average, Horizontal



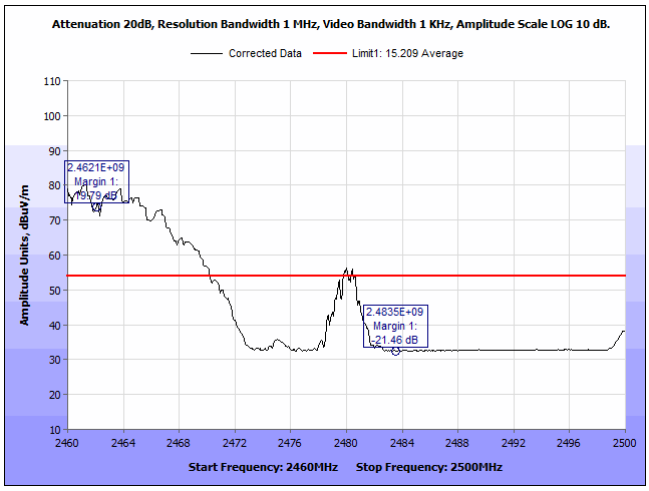
Plot 126. Radiated Restricted Bandedge, 802.11b - PWR 1000, 2412, Average, Vertical



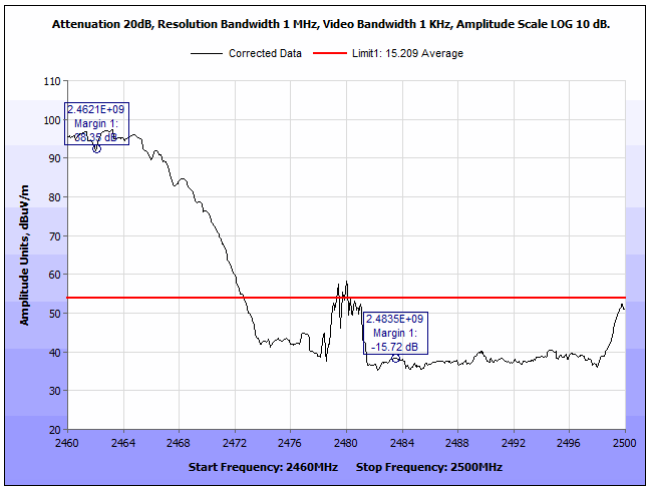
Plot 127. Radiated Restricted Bandedge, 802.11b - PWR 1000, 2412, Peak, Horizontal



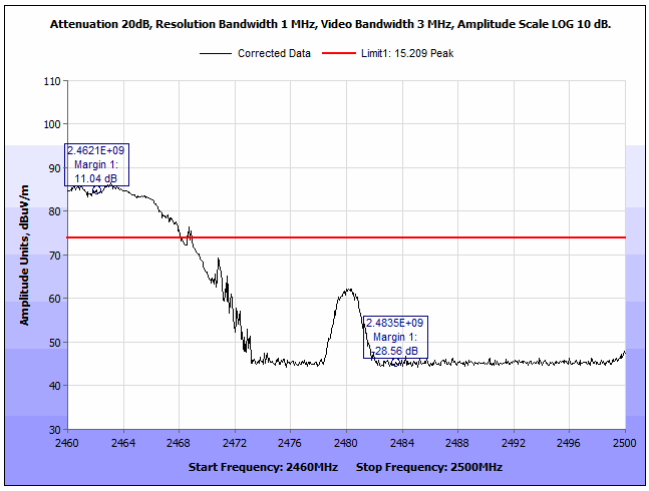
Plot 128. Radiated Restricted Bandedge, 802.11b - PWR 1000, 2412, Peak, Vertical



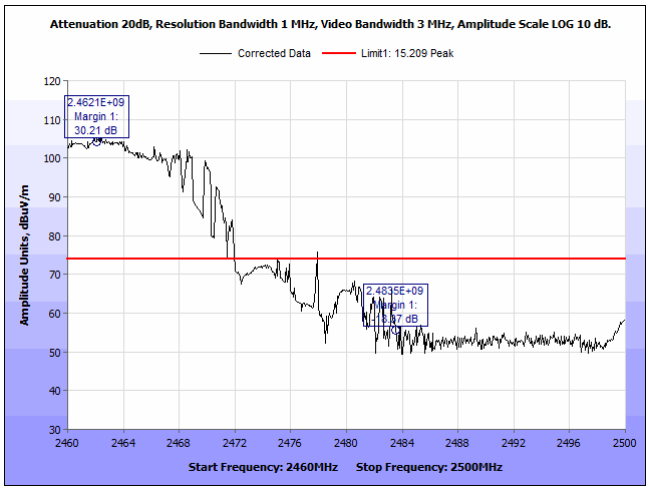
Plot 129. Radiated Restricted Bandedge, 802.11b - PWR 1000, 2462, Average, Horizontal



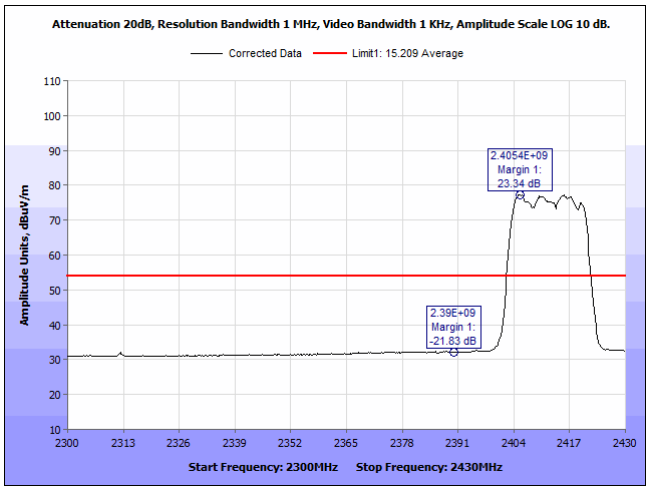
Plot 130. Radiated Restricted Bandedge, 802.11b - PWR 1000, 2462, Average, Vertical



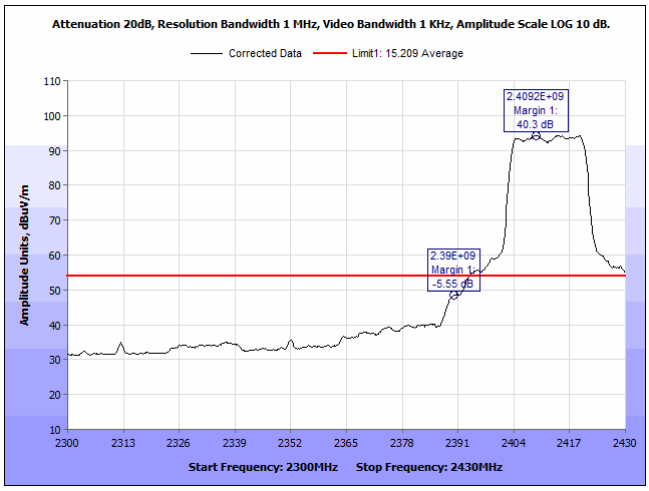
Plot 131. Radiated Restricted Bandedge, 802.11b - PWR 1000, 2462, Peak, Horizontal



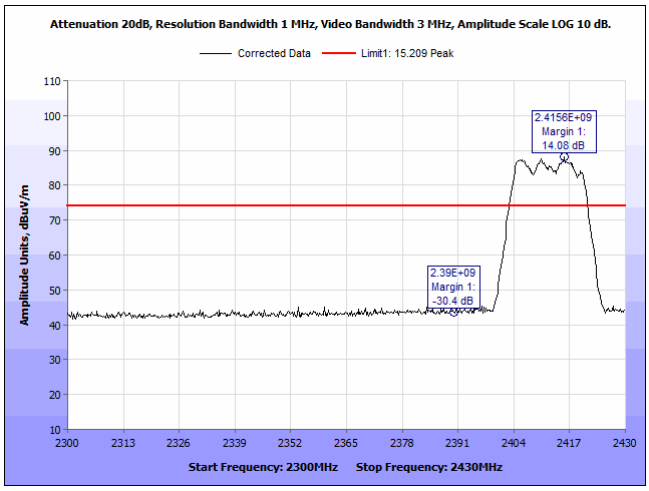
Plot 132. Radiated Restricted Bandedge, 802.11b - PWR 1000, 2462, Peak, Vertical



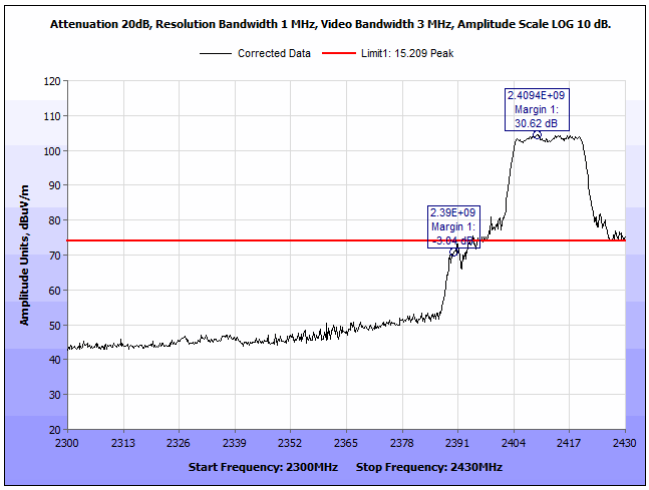
Plot 133. Radiated Restricted Bandedge, 802.11g - PWR 3, 2412, Average, Horizontal



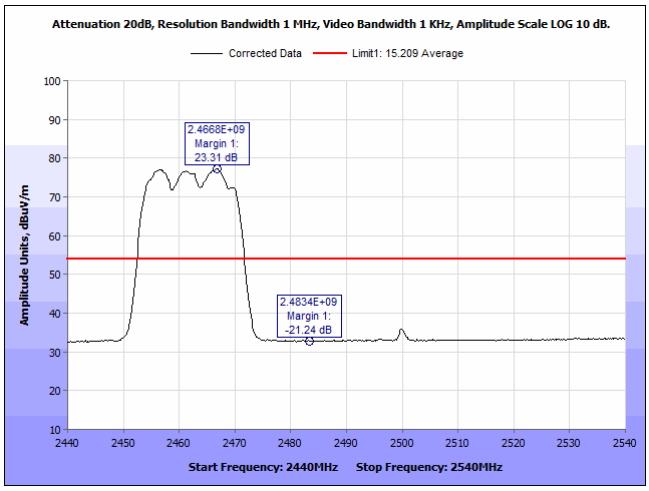
Plot 134. Radiated Restricted Bandedge, 802.11g - PWR 3, 2412, Average, Vertical



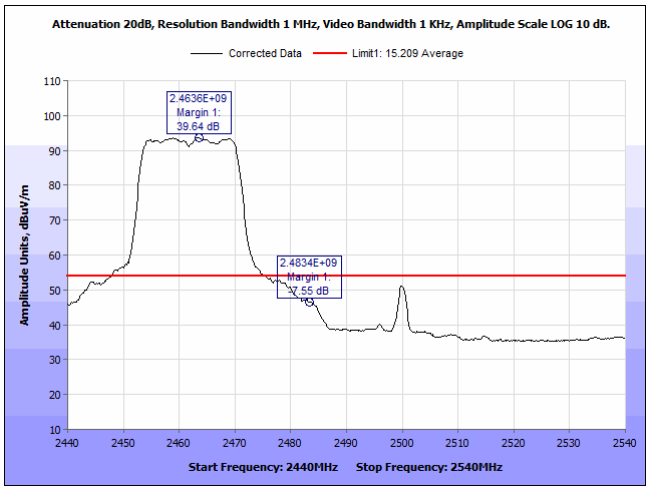
Plot 135. Radiated Restricted Bandedge, 802.11g - PWR 3, 2412, Peak, Horizontal



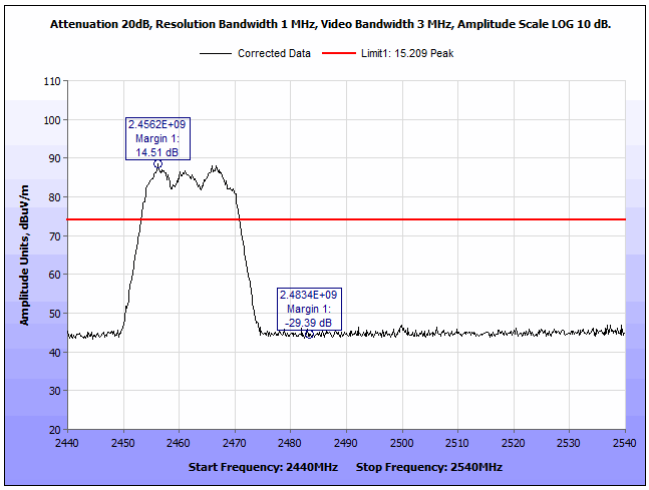
Plot 136. Radiated Restricted Bandedge, 802.11g - PWR 3, 2412, Peak, Vertical



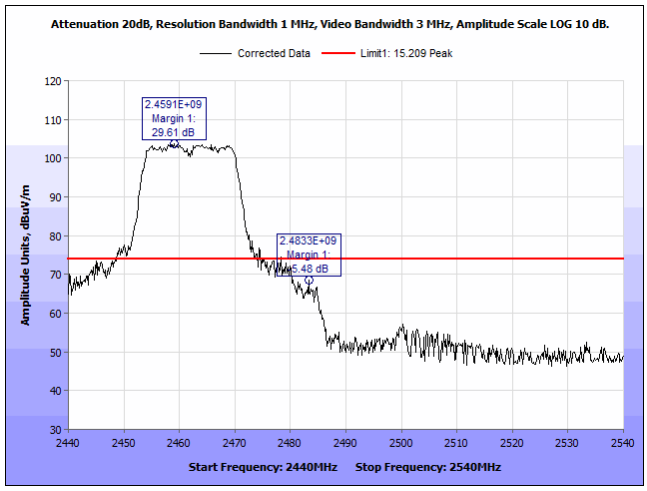
Plot 137. Radiated Restricted Bandedge, 802.11g - PWR 3, 2462, Average, Horizontal



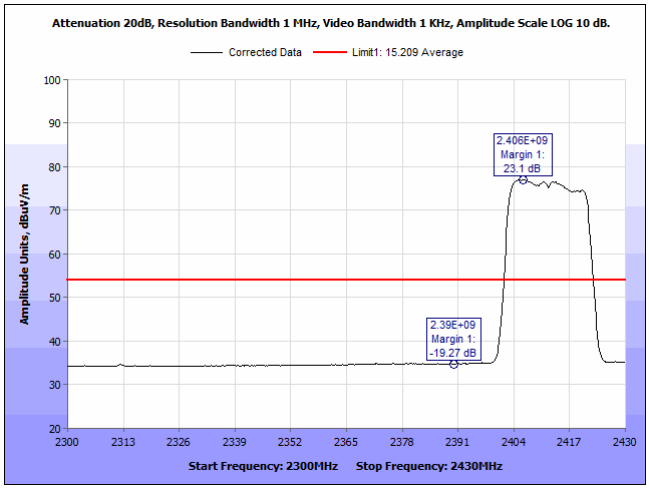
Plot 138. Radiated Restricted Bandedge, 802.11g - PWR 3, 2462, Average, Vertical



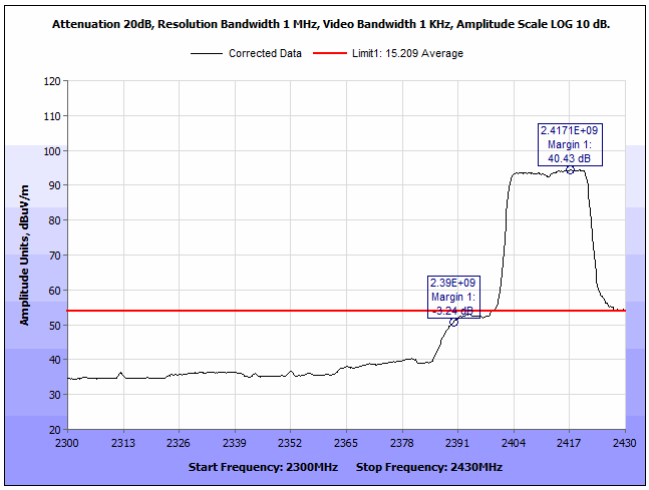
Plot 139. Radiated Restricted Bandedge, 802.11g - PWR 3, 2462, Peak, Horizontal



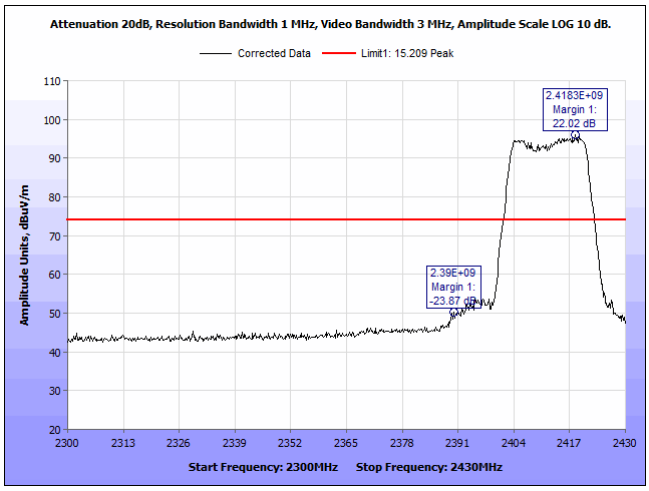
Plot 140. Radiated Restricted Bandedge, 802.11g - PWR 3, 2462, Peak, Vertical



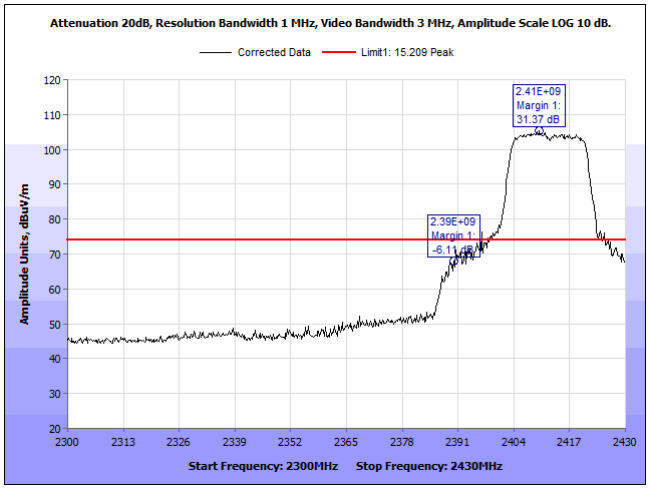
Plot 141. Radiated Restricted Bandedge, 802.11n HT20 - PWR 3, 2412, Average, Horizontal



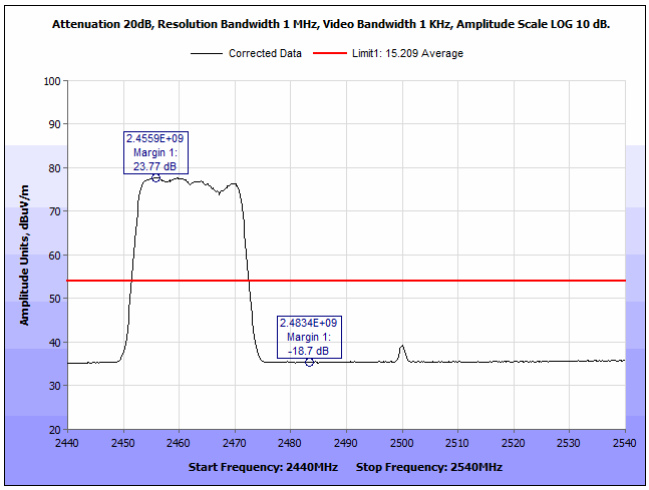
Plot 142. Radiated Restricted Bandedge, 802.11n HT20 - PWR 3, 2412, Average, Vertical



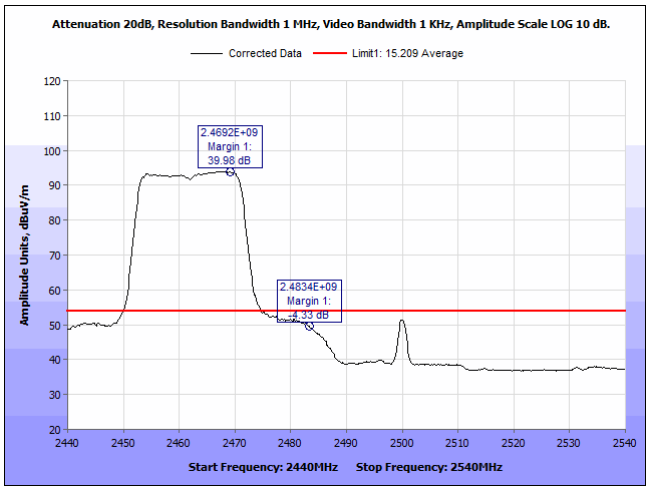
Plot 143. Radiated Restricted Bandedge, 802.11n HT20 - PWR 3, 2412, Peak, Horizontal



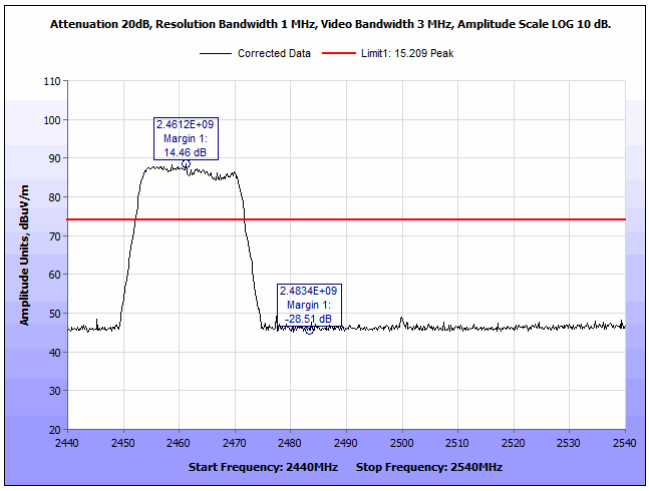
Plot 144. Radiated Restricted Bandedge, 802.11n HT20 - PWR 3, 2412, Peak, Vertical



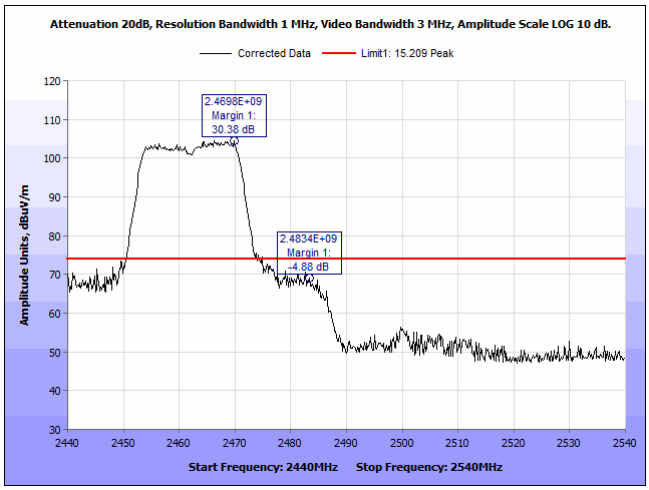
Plot 145. Radiated Restricted Bandedge, 802.11n HT20 - PWR 3, 2462, Average, Horizontal



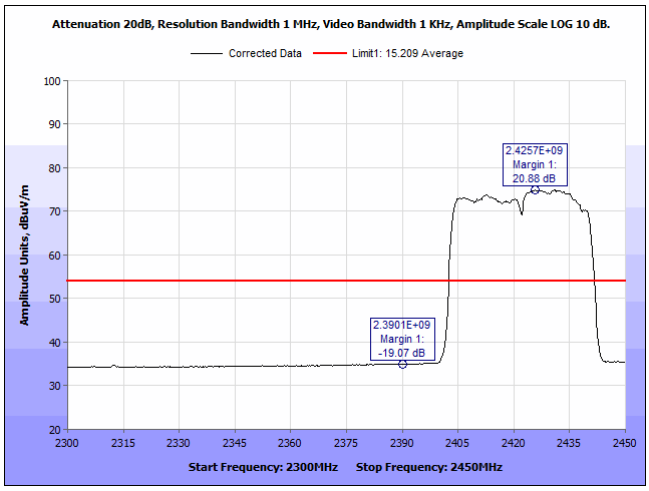
Plot 146. Radiated Restricted Bandedge, 802.11n HT20 - PWR 3, 2462, Average, Vertical



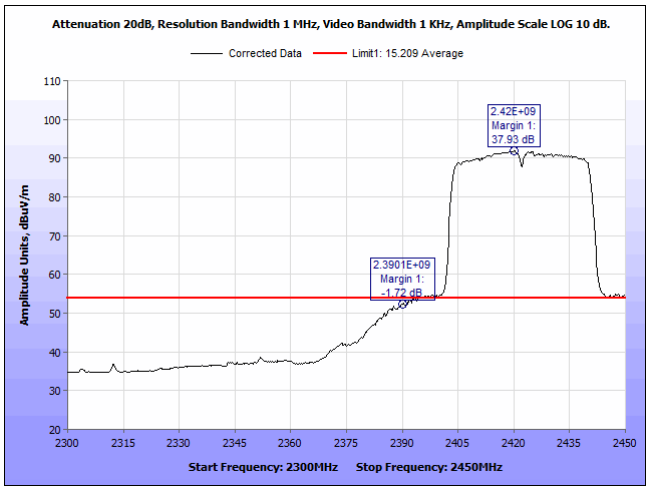
Plot 147. Radiated Restricted Bandedge, 802.11n HT20 - PWR 3, 2462, Peak, Horizontal



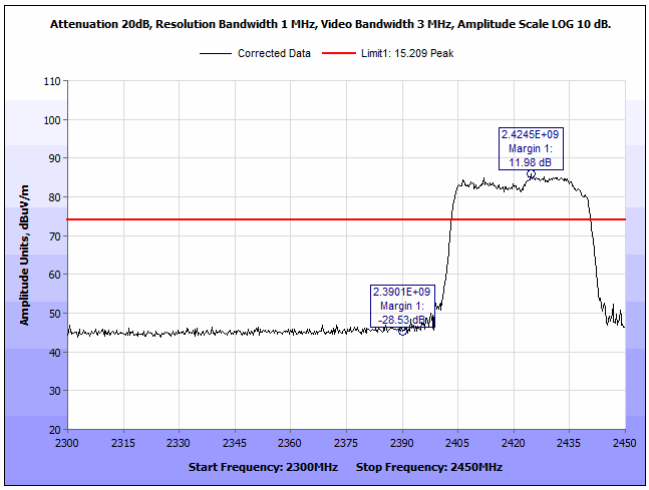
Plot 148. Radiated Restricted Bandedge, 802.11n HT20 - PWR 3, 2462, Peak, Vertical



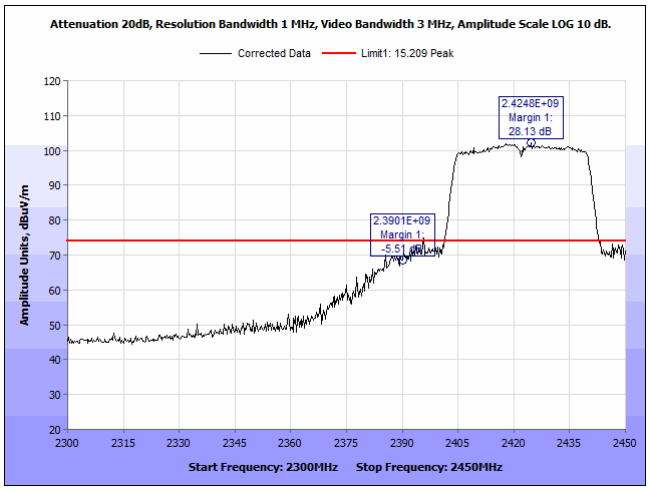
Plot 149. Radiated Restricted Bandedge, 802.11n HT40 – PWR 3, 2422, Average, Horizontal



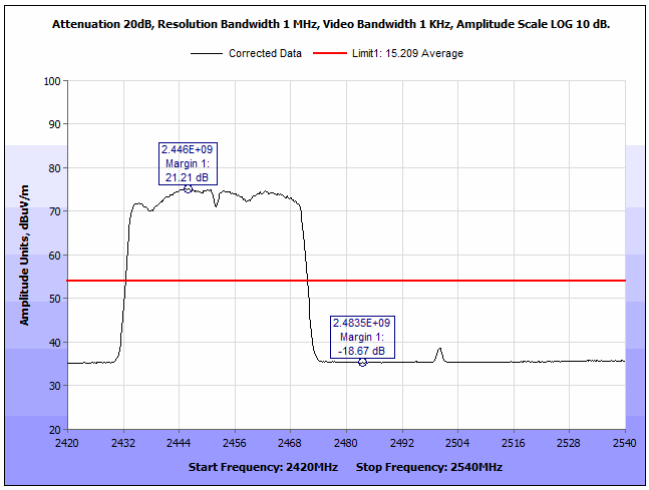
Plot 150. Radiated Restricted Bandedge, 802.11n HT40 – PWR 3, 2422, Average, Vertical



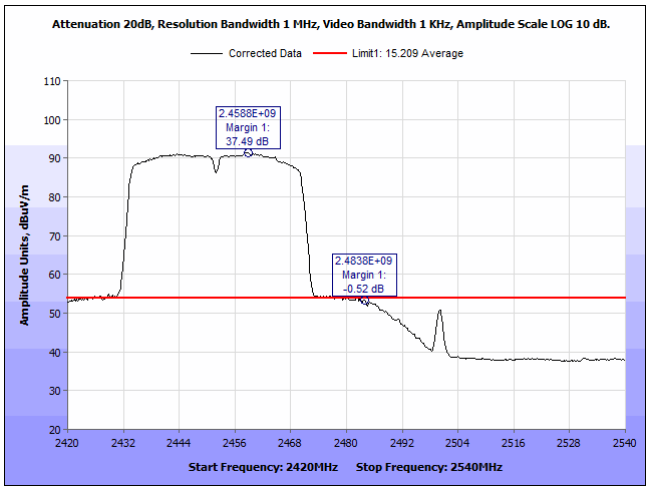
Plot 151. Radiated Restricted Bandedge, 802.11n HT40 – PWR 3, 2422, Peak, Horizontal



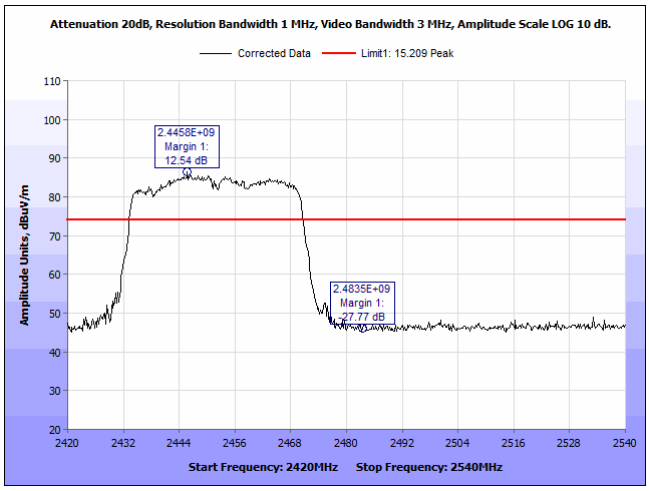
Plot 152. Radiated Restricted Bandedge, 802.11n HT40 – PWR 3, 2422, Peak, Vertical



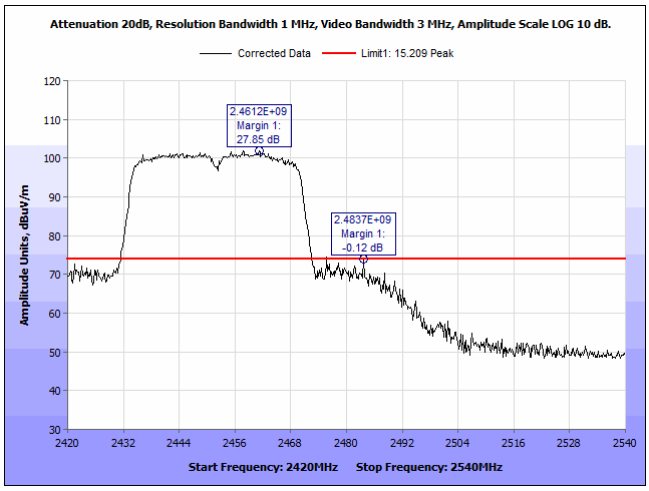
Plot 153. Radiated Restricted Bandedge, 802.11n HT40 – PWR 3, 2452, Average, Horizontal



Plot 154. Radiated Restricted Bandedge, 802.11n HT40 – PWR 3, 2452, Average, Vertical

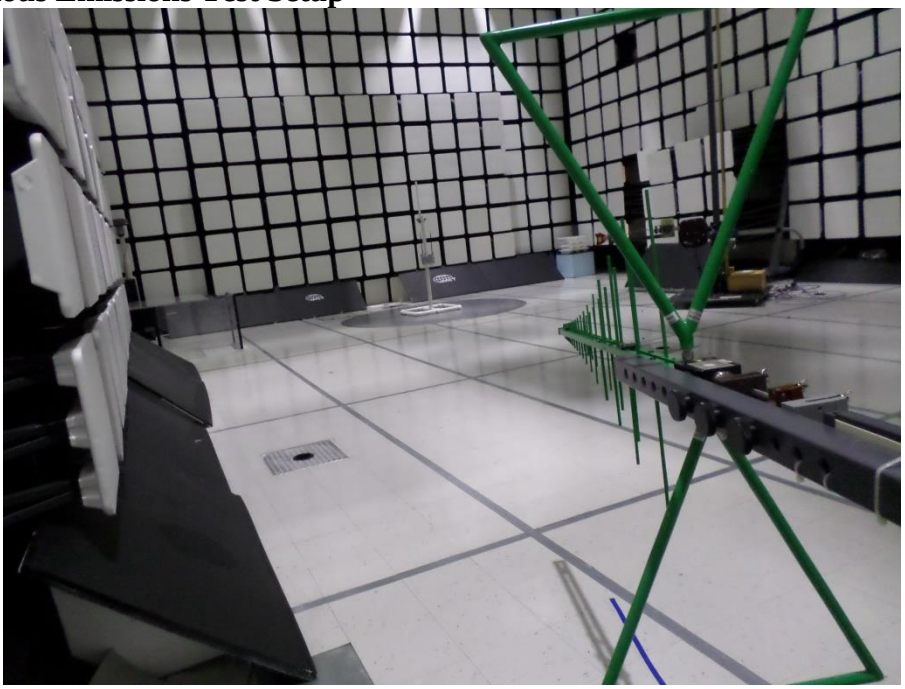


Plot 155. Radiated Restricted Bandedge, 802.11n HT40 – PWR 3, 2452, Peak, Horizontal

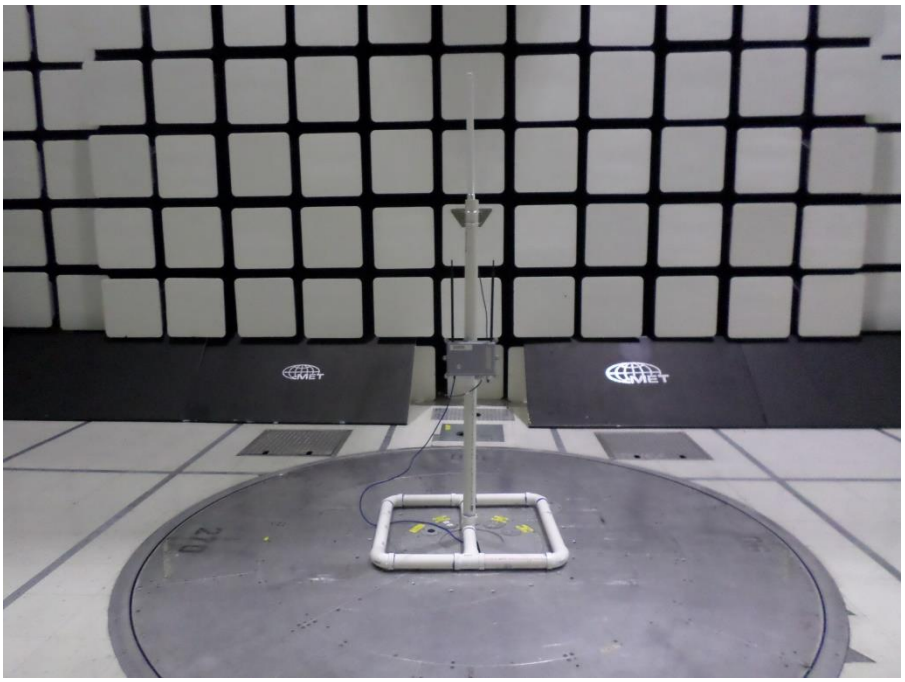


Plot 156. Radiated Restricted Bandedge, 802.11n HT40 – PWR 3, 2452, Peak, Vertical

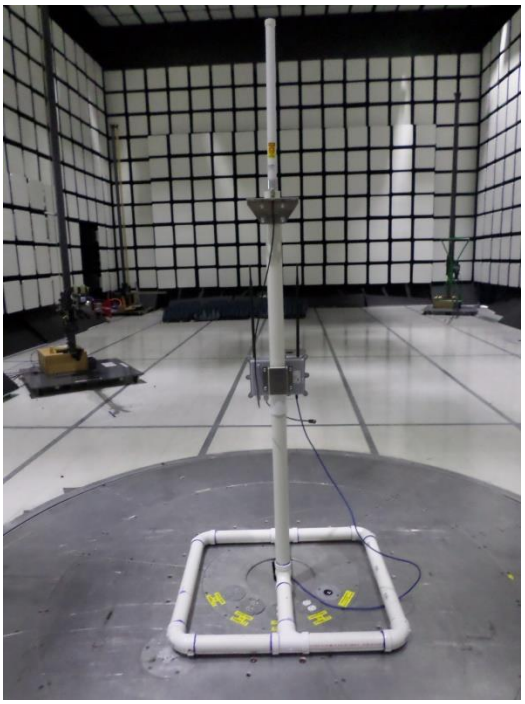
Radiated Spurious Emissions Test Setup



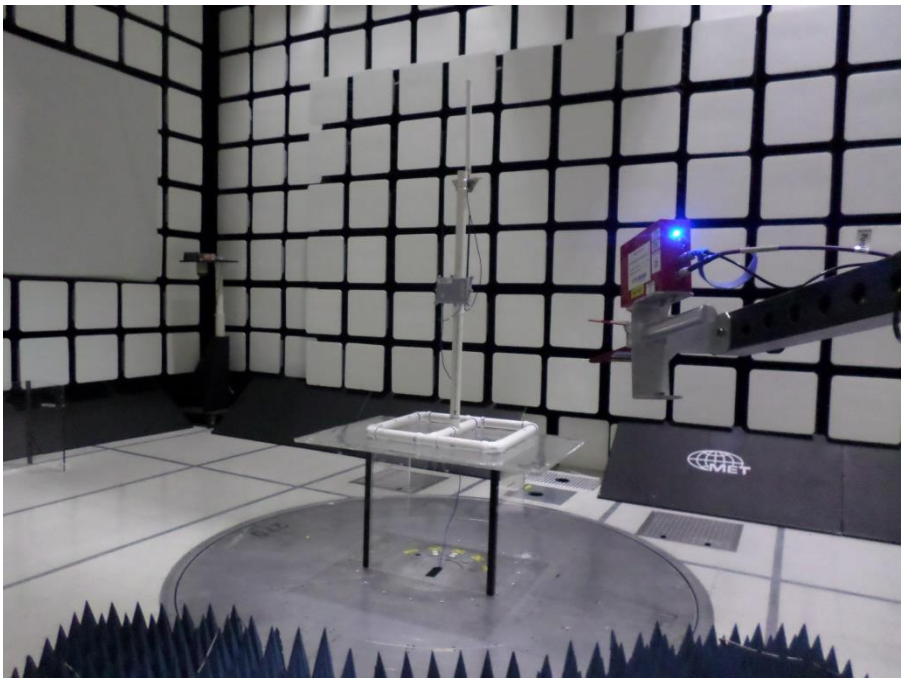
Photograph 4. Radiated Emissions, Setup Below 1GHz, Antenna



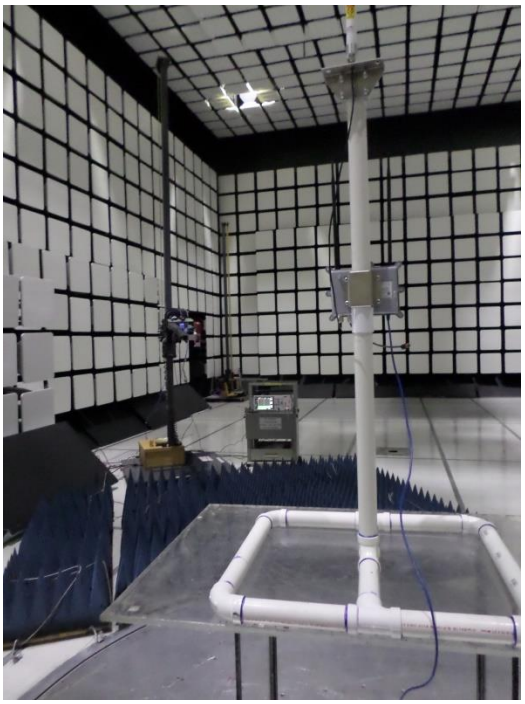
Photograph 5. Radiated Emissions, Setup Below 1GHz, Front



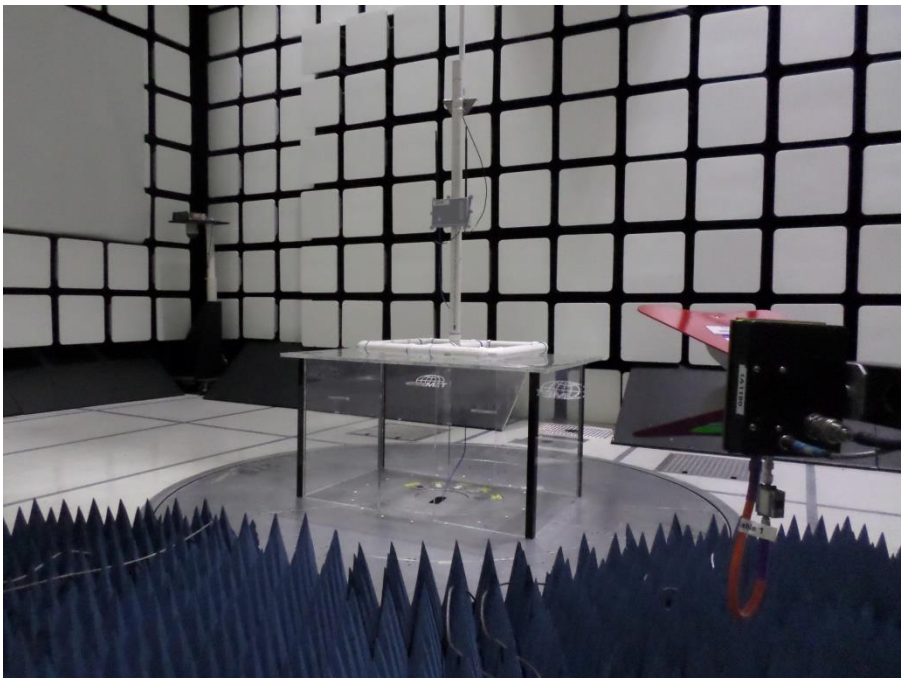
Photograph 6. Radiated Emissions, Setup Below 1GHz, Rear



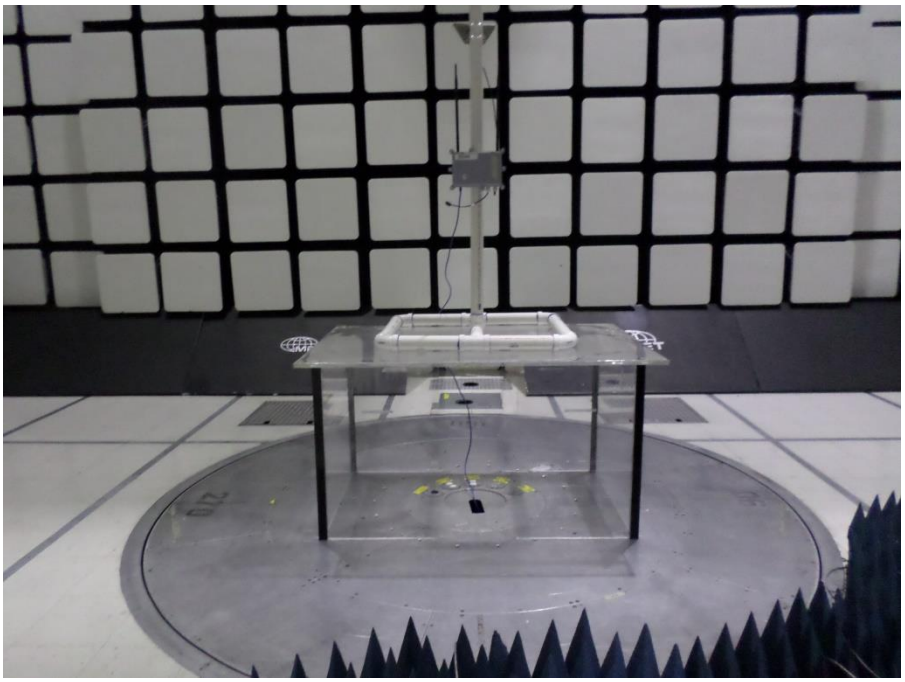
Photograph 7. Radiated Emissions, Setup Above 18 GHz, Antenna



Photograph 8. Radiated Emissions, Setup Above 18 GHz, Rear



Photograph 9. Radiated Emissions, Setup Above 1GHz, Antenna



Photograph 10. Radiated Emissions, Setup Above 1GHz, Front

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Spurious Emissions in Non-restricted Bands

Test Requirement: **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

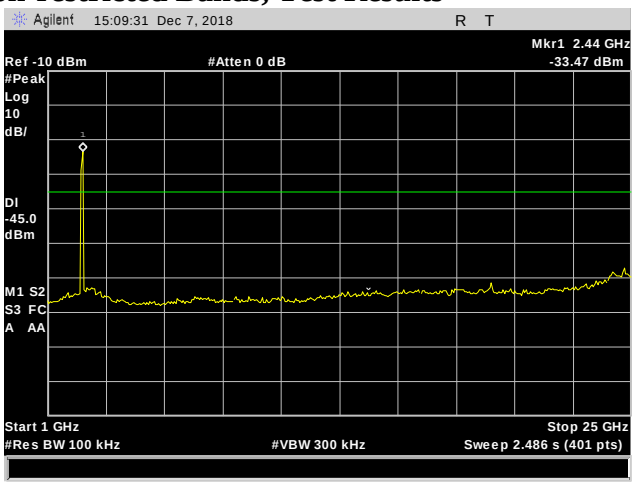
Test Procedure: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Test Results: The EUT was compliant with the Spurious Emission limits of **§15.247(d)**. Measured emissions were within applicable limits.

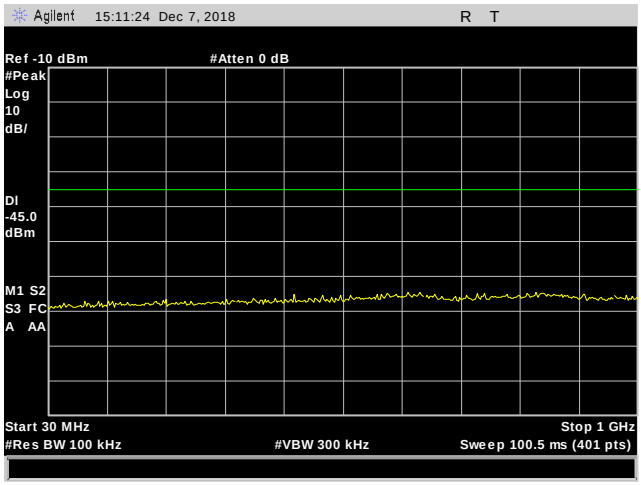
Test Engineer(s): Giuliano Messina

Test Date(s): December 7, 2018

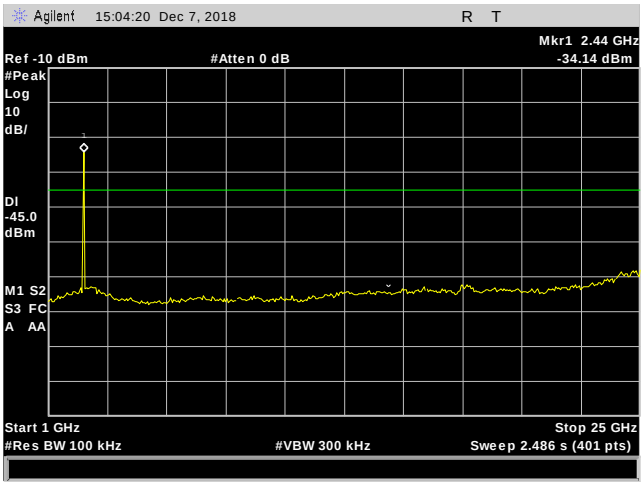
Spurious Emissions in Non-restricted Bands, Test Results



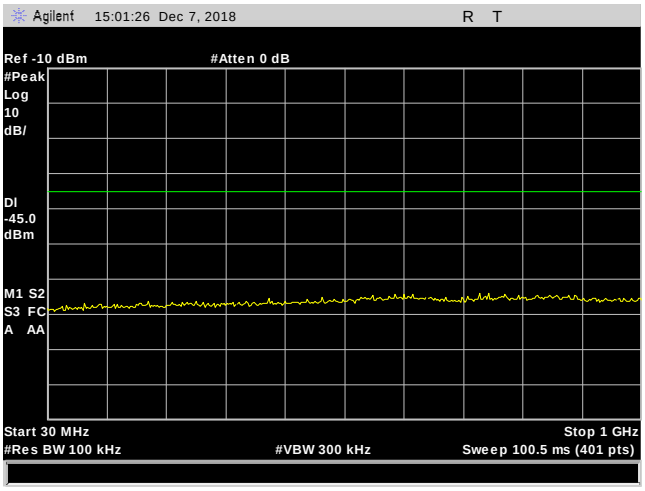
Plot 157. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 1, 2412, 1 – 25 GHz



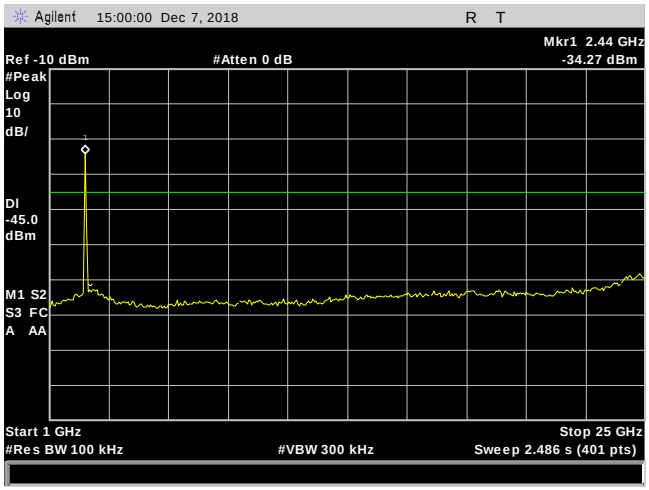
Plot 158. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 1, 2412, 30 MHz – 1 GHz



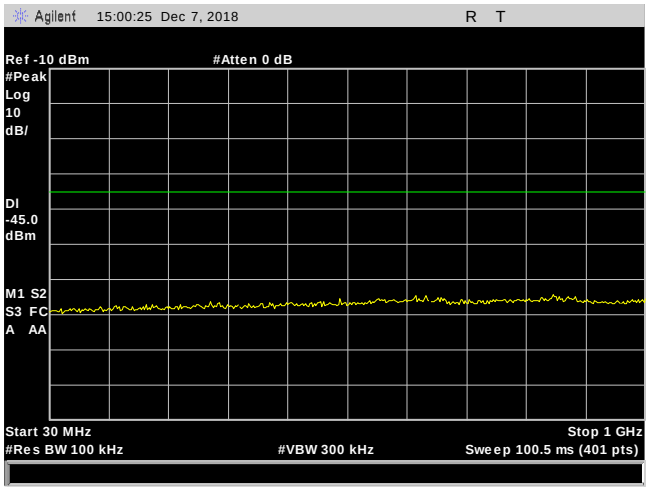
Plot 159. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 1, 2437, 1 – 25 GHz



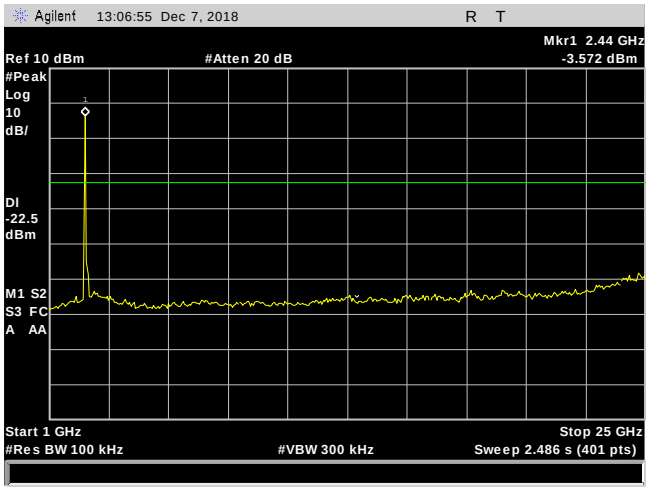
Plot 160. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 1, 2437, 30 MHz – 1 GHz



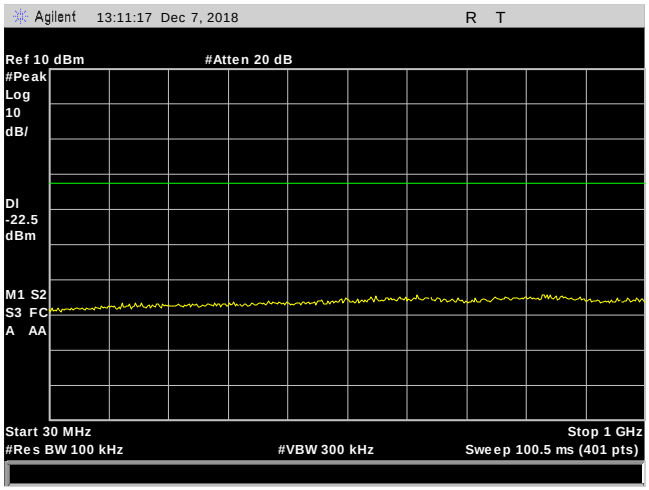
Plot 161. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 1, 2462, 1 – 25 GHz



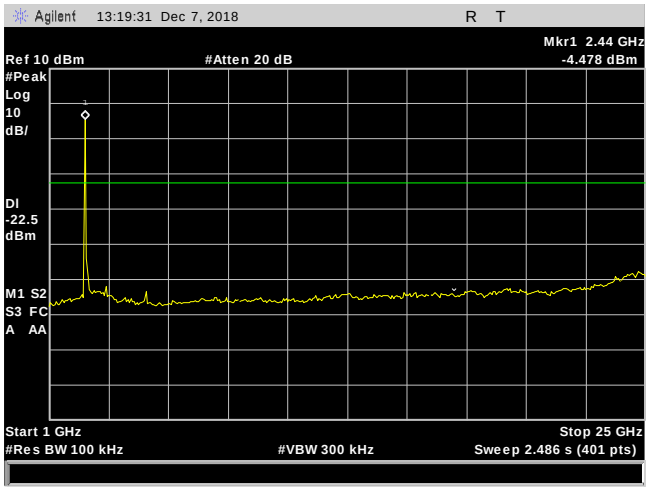
Plot 162. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 1, 2462, 30 MHz – 1 GHz



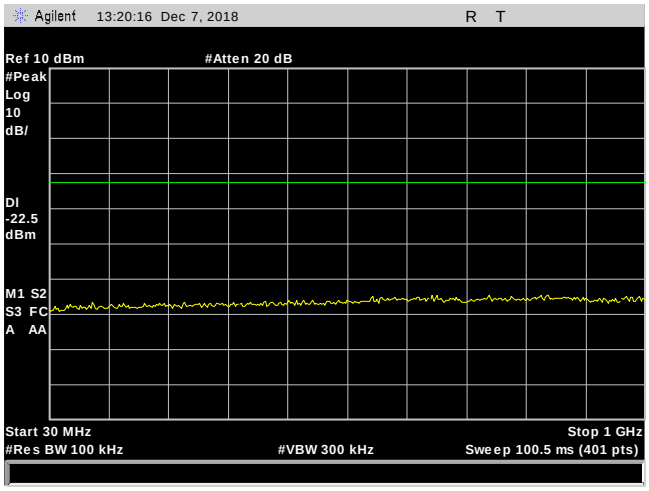
Plot 163. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 2, 2412, 1 – 25 GHz



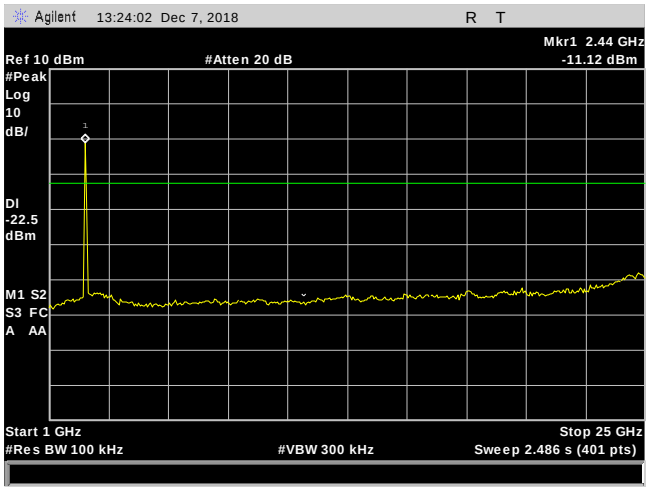
Plot 164. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 2, 2412, 30 MHz – 1 GHz



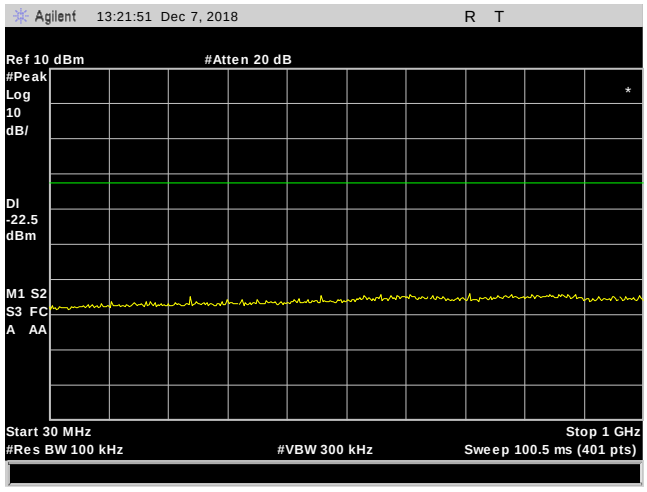
Plot 165. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 2, 2437, 1 – 25 GHz



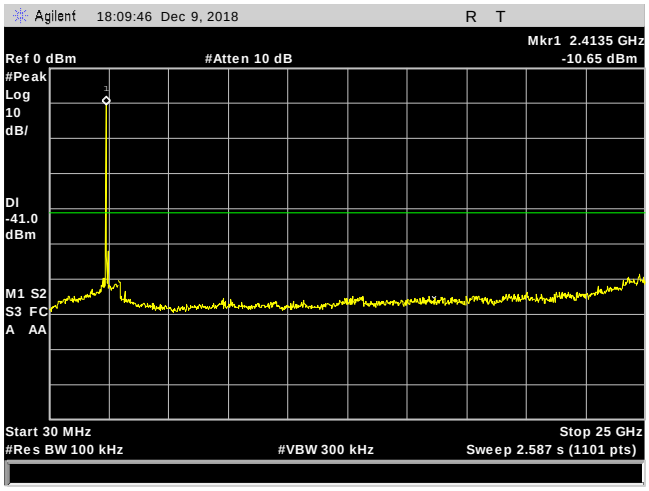
Plot 166. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 2, 2437, 30 MHz – 1 GHz



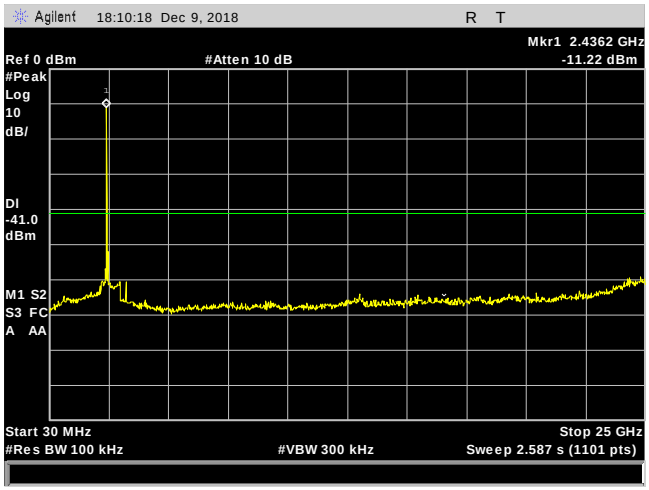
Plot 167. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 2, 2462, 1 – 25 GHz



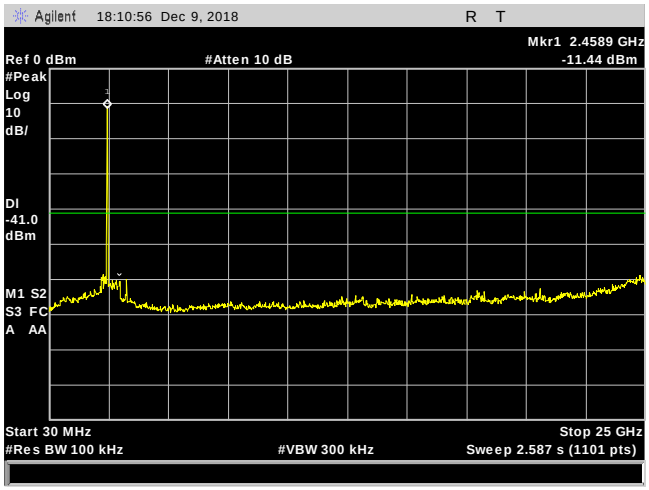
Plot 168. 100 kHz Spurious Emissions, 802.11b - PWR 1000, Antenna 2, 2462, 30 MHz – 1 GHz



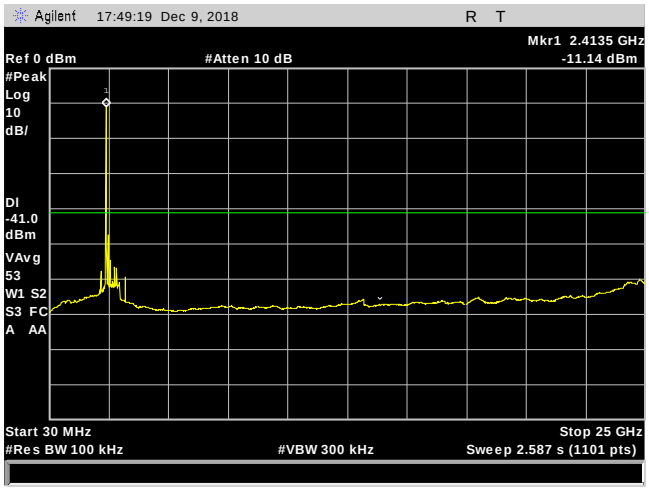
Plot 169. 100 kHz Spurious Emissions, 802.11g - PWR 3, Antenna 1, 2412, 30 MHz – 25 GHz



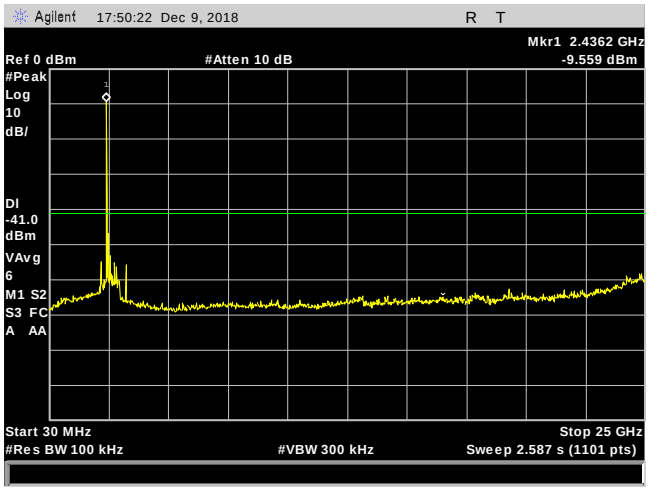
Plot 170. 100 kHz Spurious Emissions, 802.11g - PWR 3, Antenna 1, 2437, 30 MHz – 25 GHz



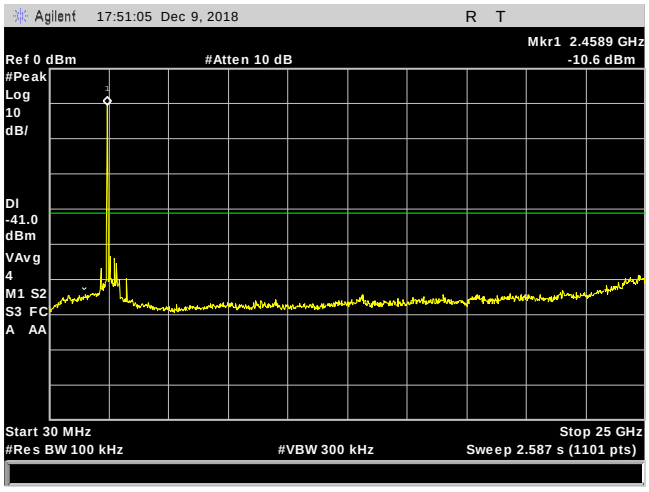
Plot 171. 100 kHz Spurious Emissions, 802.11g - PWR 3, Antenna 1, 2462, 30M – 25 GHz



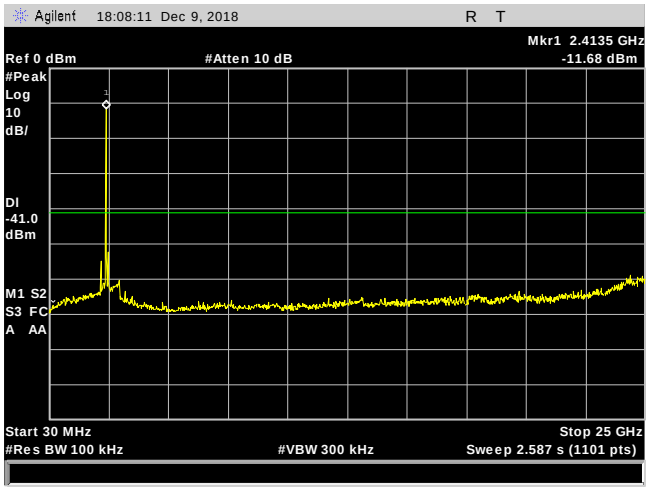
Plot 172. 100 kHz Spurious Emissions, 802.11g - PWR 3, Antenna 2, 2412, 30 MHz – 25 GHz



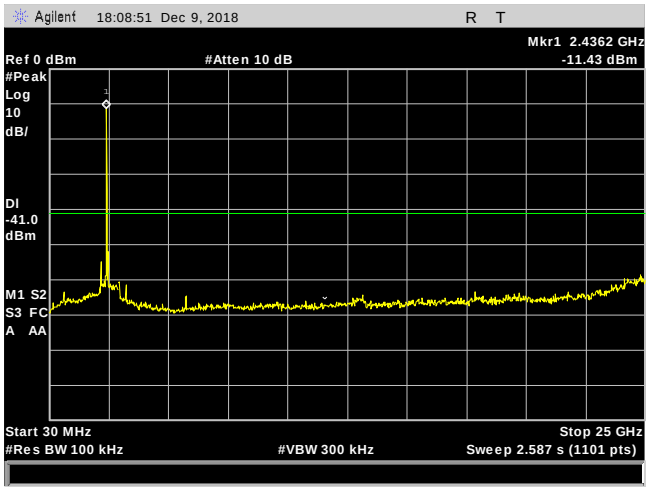
Plot 173. 100 kHz Spurious Emissions, 802.11g - PWR 3, Antenna 2, 2437, 30 MHz – 25 GHz



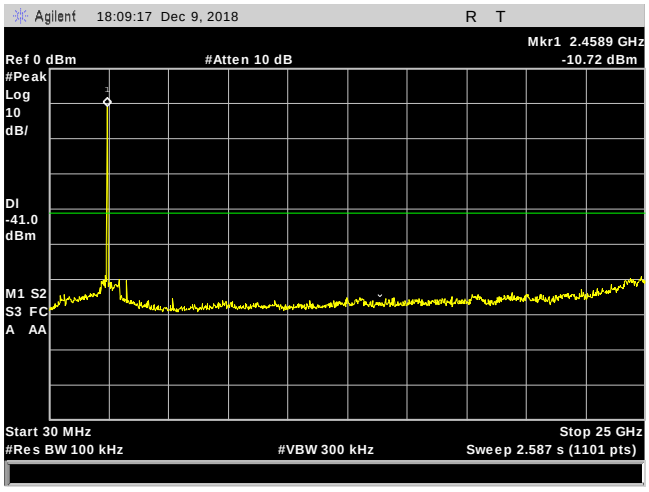
Plot 174. 100 kHz Spurious Emissions, 802.11g - PWR 3, Antenna 2, 2462, 30M – 25 GHz



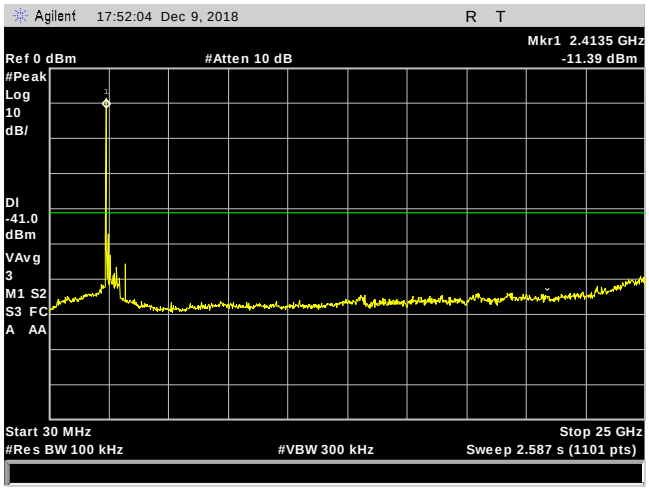
Plot 175. 100 kHz Spurious Emissions, 802.11n HT20 - PWR 3, Antenna 1, 2412, 30M – 25 GHz



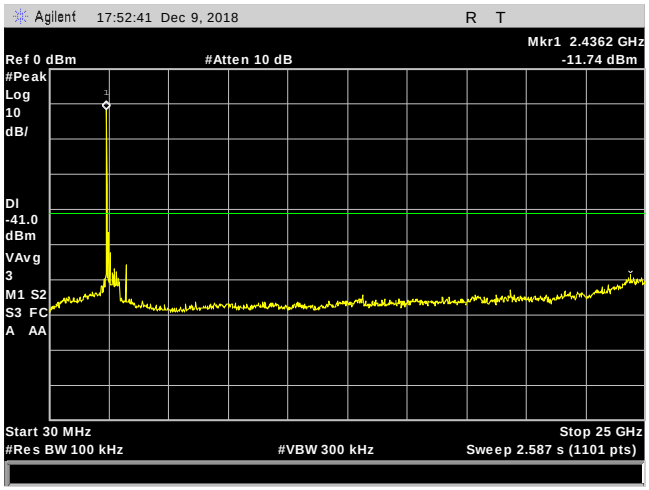
Plot 176. 100 kHz Spurious Emissions, 802.11n HT20 - PWR 3, Antenna 1, 2437, 30 MHz – 25 GHz



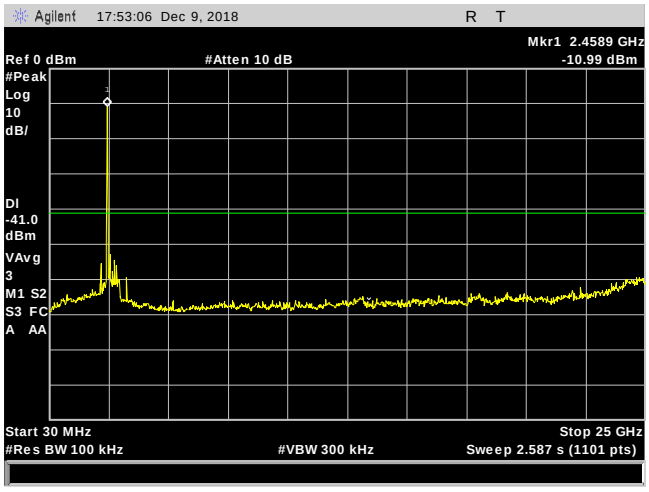
Plot 177. 100 kHz Spurious Emissions, 802.11n HT20 - PWR 3, Antenna 1, 2462, 30M – 25 GHz



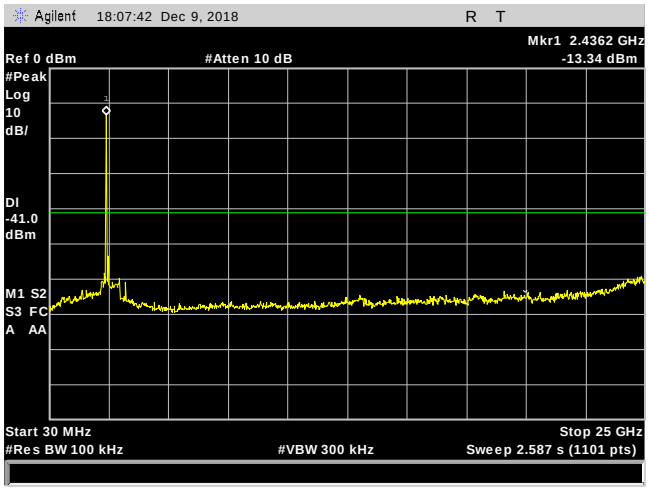
Plot 178. 100 kHz Spurious Emissions, 802.11n HT20 - PWR 3, Antenna 2, 2412, 30M – 25 GHz



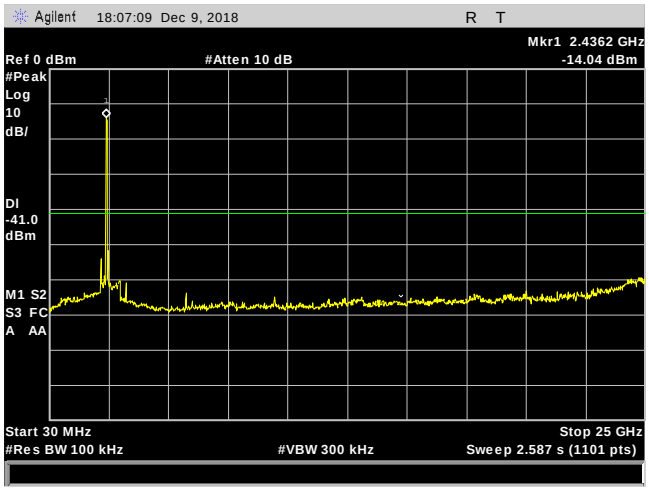
Plot 179. 100 kHz Spurious Emissions, 802.11n HT20 - PWR 3, Antenna 2, 2437, 30 MHz – 25 GHz



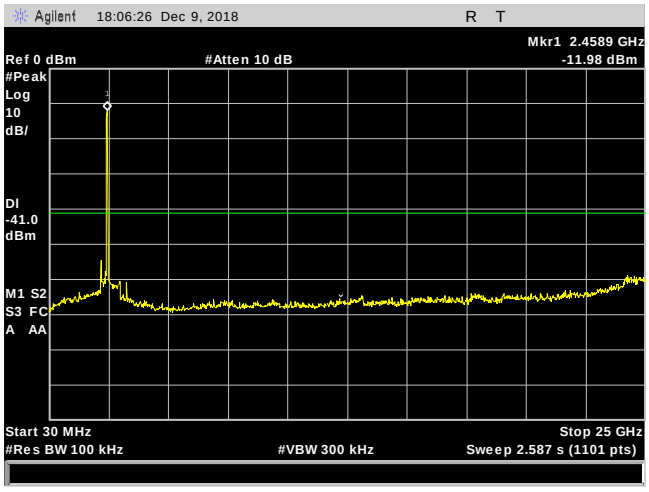
Plot 180. 100 kHz Spurious Emissions, 802.11n HT20 - PWR 3, Antenna 2, 2462, 30 MHz – 25 GHz



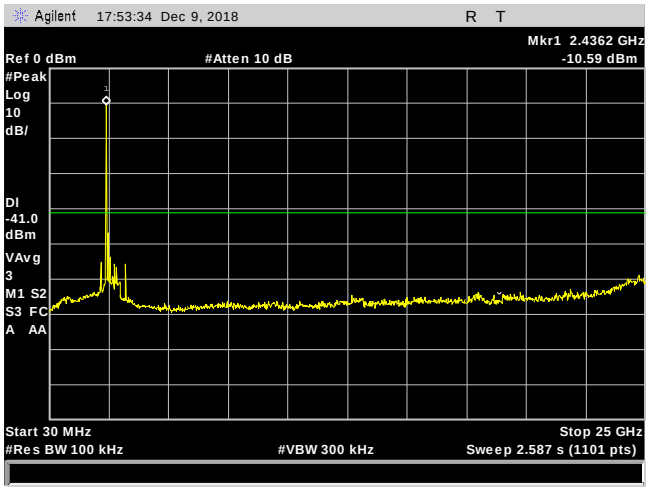
Plot 181. 100 kHz Spurious Emissions, 802.11n HT40 - PWR 3, Antenna 1, 2422, 30 MHz – 25 GHz



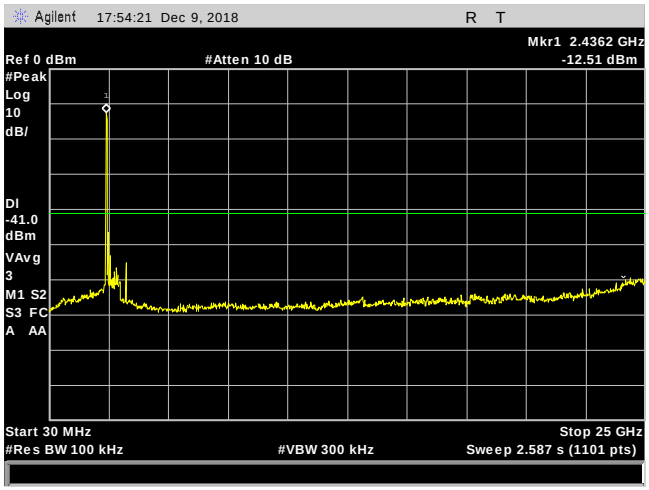
Plot 182. 100 kHz Spurious Emissions, 802.11n HT40 - PWR 3, Antenna 1, 2437, 30 MHz – 25 GHz



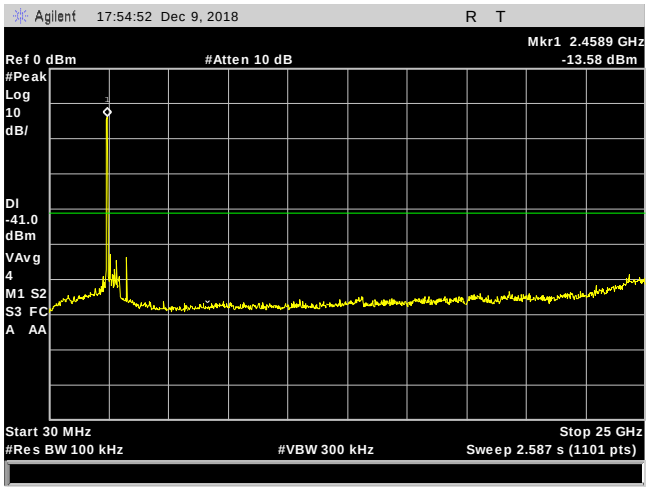
Plot 183. 100 kHz Spurious Emissions, 802.11n HT40 - PWR 3, Antenna 1, 2452, 30 MHz – 25 GHz



Plot 184. 100 kHz Spurious Emissions, 802.11n HT40 - PWR 3, Antenna 2, 2422, 30 MHz – 25 GHz

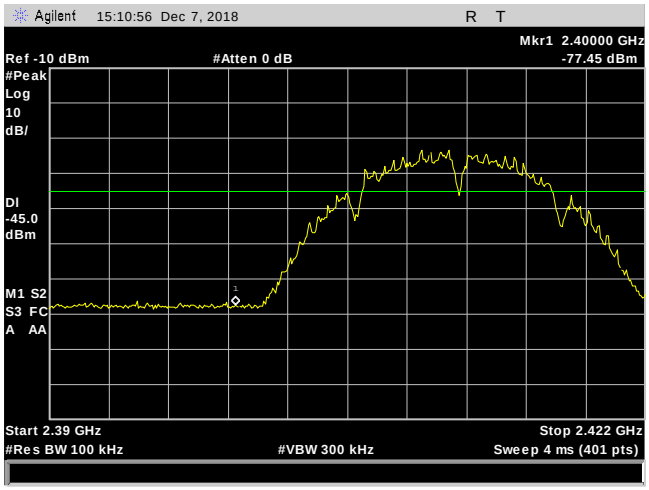


Plot 185. 100 kHz Spurious Emissions, 802.11n HT40 - PWR 3, Antenna 2, 2437, 30 MHz – 25 GHz

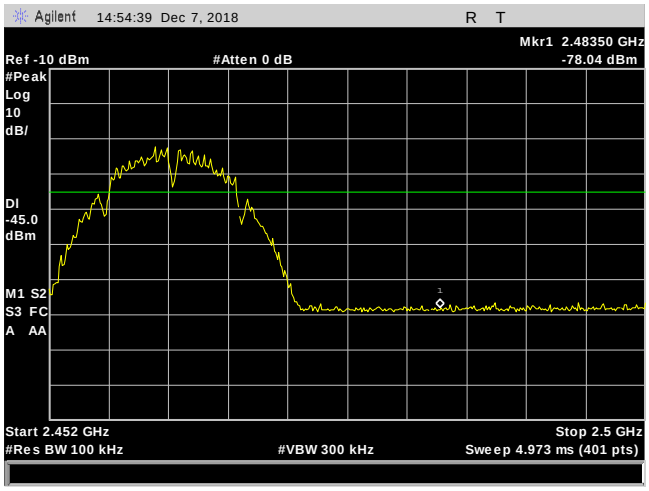


Plot 186. 100 kHz Spurious Emissions, 802.11n HT40 - PWR 3, Antenna 2, 2452, 30 MHz – 25 GHz

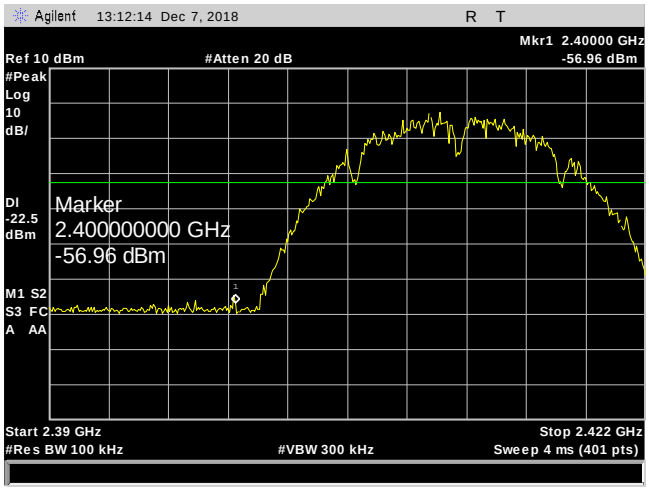
Conducted Band Edge



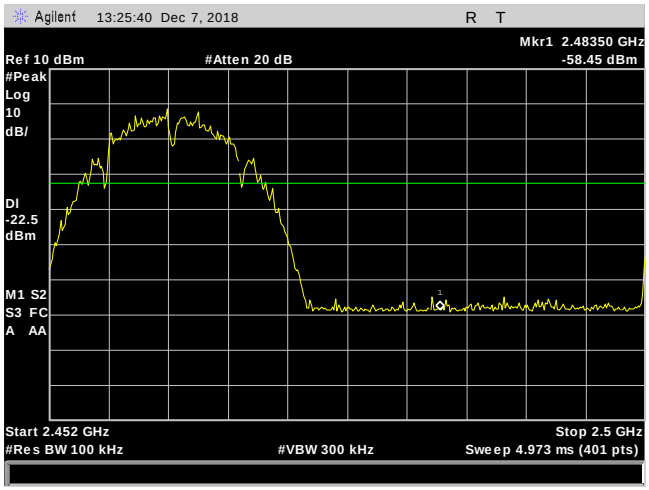
Plot 187. Conducted Bandedge, 802.11b - PWR 1000, Antenna 1, 2412



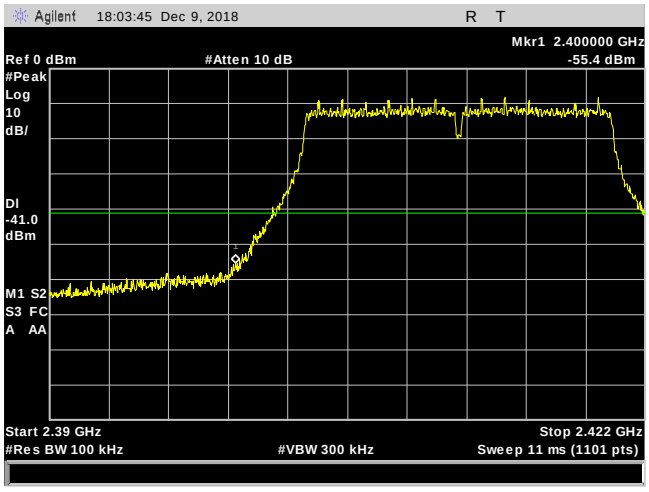
Plot 188. Conducted Bandedge, 802.11b - PWR 1000, Antenna 1, 2462



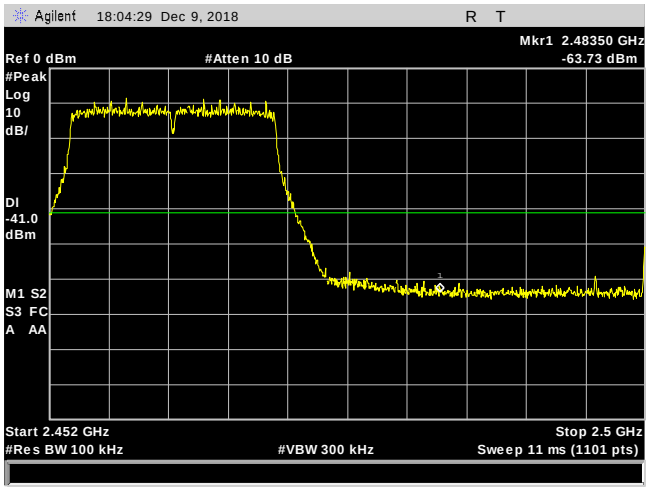
Plot 189. Conducted Bandedge, 802.11b - PWR 1000, Antenna 2, 2412



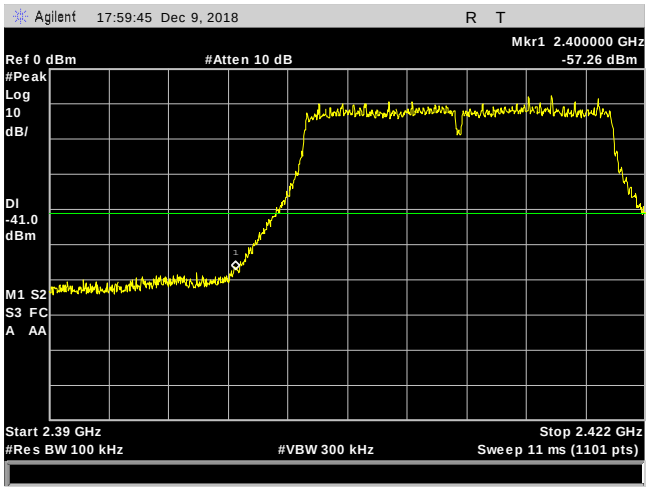
Plot 190. Conducted Bandedge, 802.11b - PWR 1000, Antenna 2, 2642



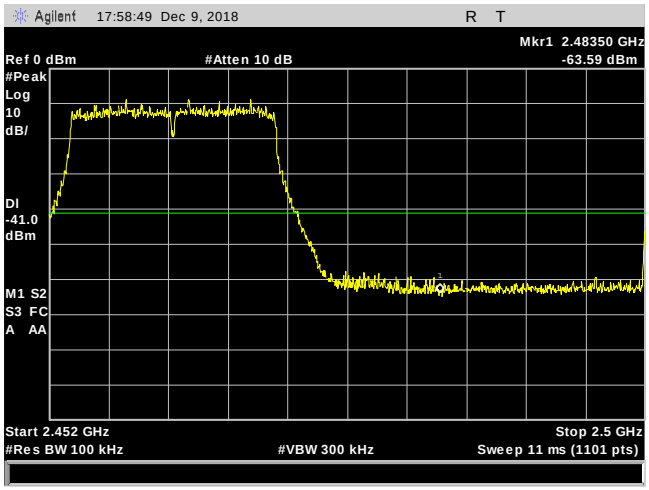
Plot 191. Conducted Bandedge, 802.11g - PWR 3, Antenna 1, 2412



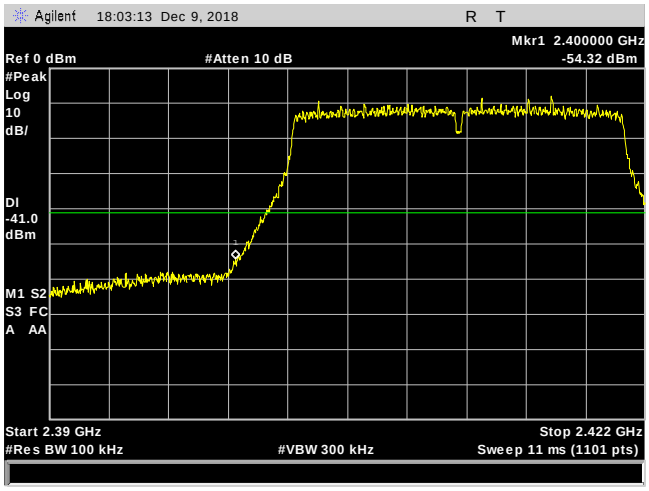
Plot 192. Conducted Bandedge, 802.11g - PWR 3, Antenna 1, 2462



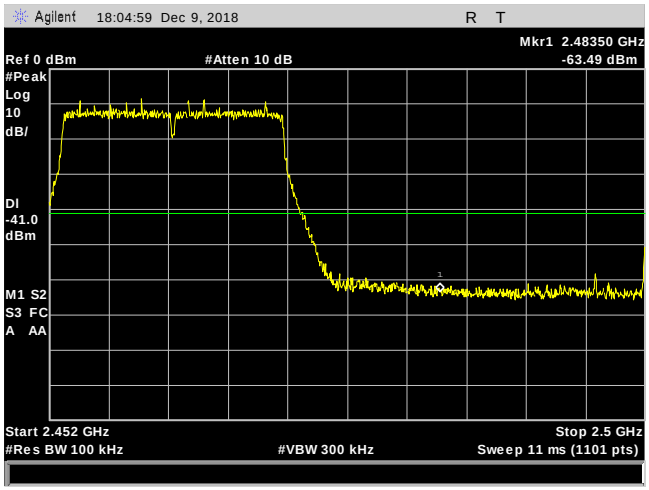
Plot 193. Conducted Bandedge, 802.11g - PWR 3, Antenna 2, 2412



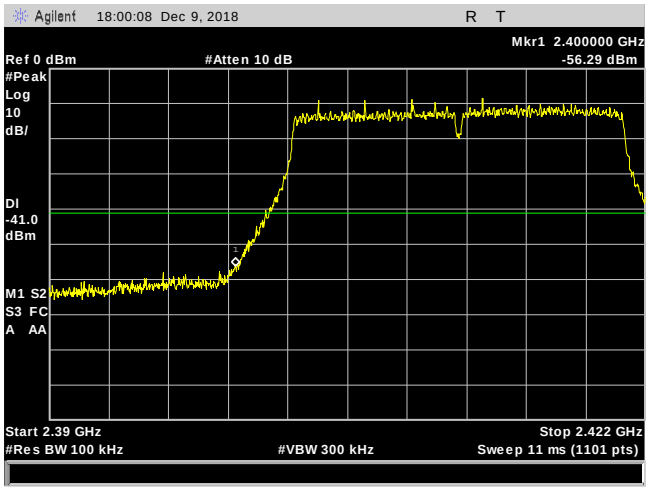
Plot 194. Conducted Bandedge, 802.11g - PWR 3, Antenna 2, 2462



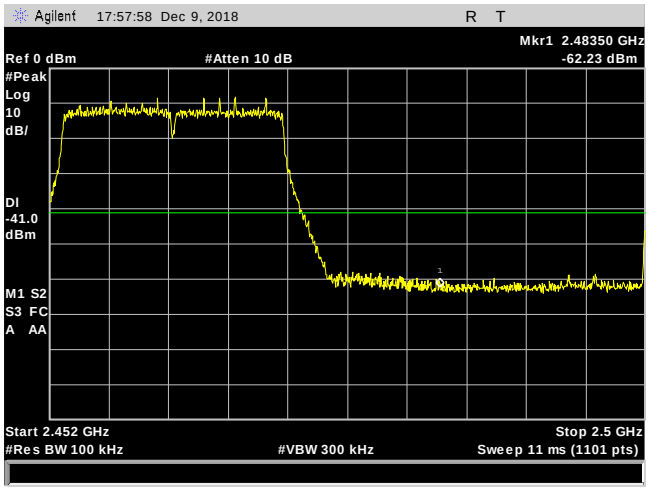
Plot 195. Conducted Bandedge, 802.11n HT20 - PWR 3, Antenna 1, 2412



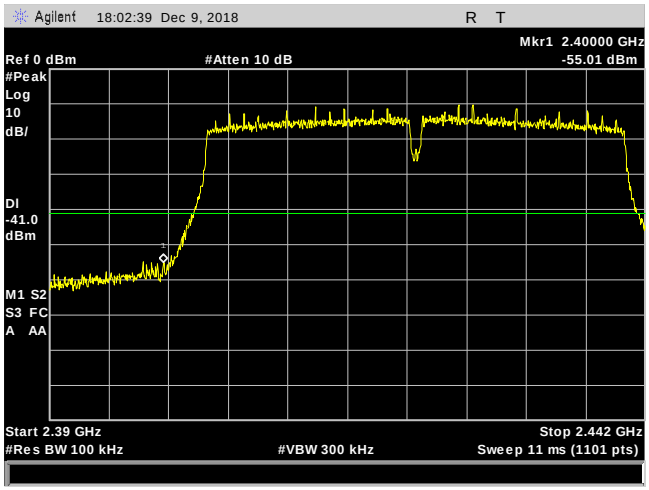
Plot 196. Conducted Bandedge, 802.11n HT20 - PWR 3, Antenna 1, 2462



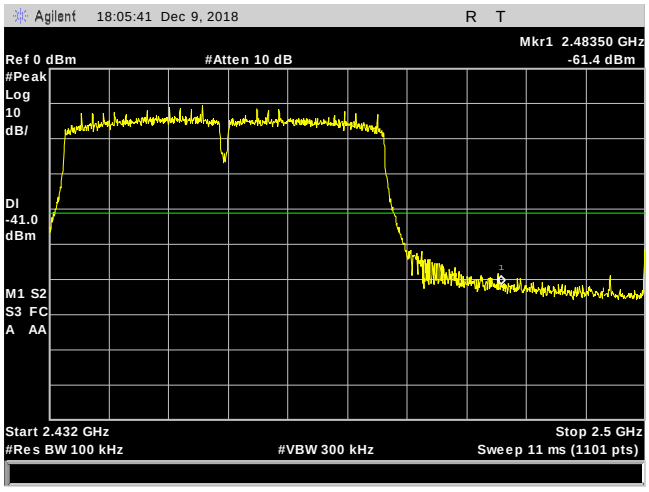
Plot 197. Conducted Bandedge, 802.11n HT20 - PWR 3, Antenna 2, 2412



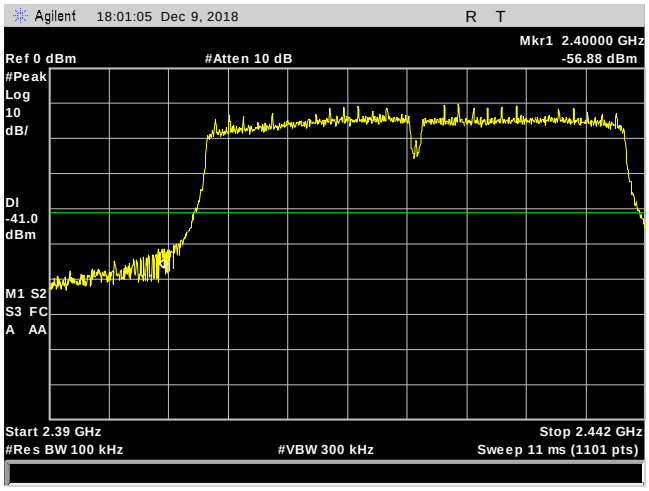
Plot 198. Conducted Bandedge, 802.11n HT20 - PWR 3, Antenna 2, 2462



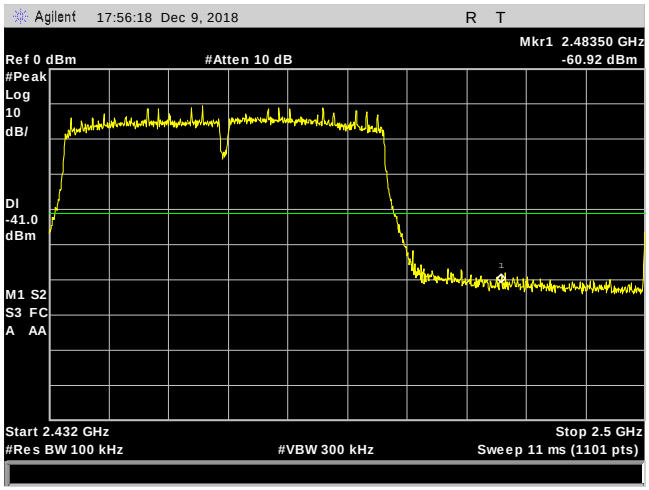
Plot 199. Conducted Bandedge, 802.11n HT40 - PWR 3, Antenna 1, 2422



Plot 200. Conducted Bandedge, 802.11n HT40 - PWR 3, Antenna 1, 2452



Plot 201. Conducted Bandedge, 802.11n HT40 - PWR 3, Antenna 2, 2422



Plot 202. Conducted Bandedge, 802.11n HT40 - PWR 3, Antenna 2, 2452

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Power Spectral Density

Test Requirements: **§15.247(e):** For digitally modulated systems, the Power Spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer. The power level was set to the maximum level throughout each of the 100 sweeps of power averaging. The RBW was set to 100 kHz and a VBW set to 300 kHz. The spectrum analyzer was set to an auto sweep time and an average detector was used. Measurements were carried out at low, mid and high channels.

Test Results: The EUT was compliant with the Power Spectral density limits of **§ 15.247 (e)**. Duty cycle correction applies only to mode 802.11b, which had an operating duty cycle of 1%.

The Power Spectral density was determined from plots on the following page(s).

Test Engineer: Giuliano Messina

Test Date: December 7, 2018

Test Notes: The EUT antenna has a gain of 9 dBi, and the EUT uses two antennas. The below table shows the resulting change in allowable power spectral density.

Max PSD	GAIN	Allowed PSD
8	12.01029996	1.989700043
mW per chain	mW per ant.	PSD limit per ant.,
1.58113883	0.790569415	-1.020599913

Table 22. Allowable Power Spectral Density

Power Spectral Density Test Results

Power Spectral Density				
Mode	**Carrier Channel**	**Frequency (MHz)**	**Power Spectral Density (dBm) – Antenna 1**	**Power Spectral Density (dBm) – Antenna 2**
802.11b	Low	2412	-27.85	-8.38
802.11b	Mid	2437	-29.1	-6.79
802.11b	High	2462	-27.71	-8.3
802.11g	Low	2412	-17	-16.85
802.11g	Mid	2437	-17.66	-17.16
802.11g	High	2462	-17.29	-17.85
802.11n HT20	Low	2412	-17.58	-16.97
802.11n HT20	Mid	2437	-18.15	-17.14
802.11n HT20	High	2462	-17.43	-18.16
802.11n HT40	Low	2422	-20.03	-19.71
802.11n HT40	Mid	2437	-20.32	-19.96
802.11n HT40	High	2452	-19.78	-20.16

Table 23. Power Spectral Density, Test Results

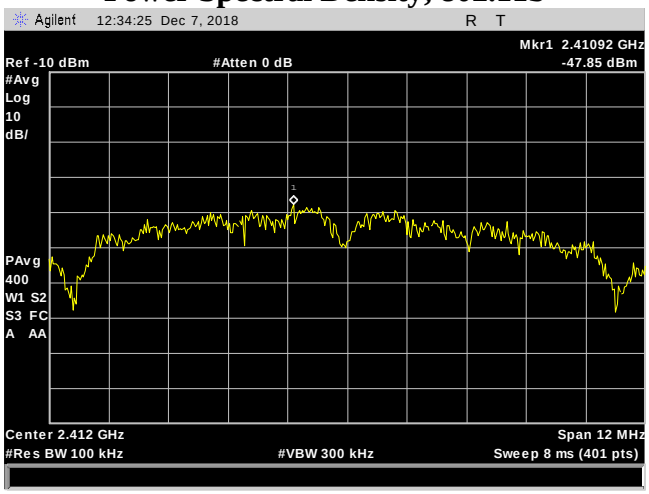
Mode	Ant 1 PSD (dBm)	Ant 2 PSD (dBm)	Combined PSD (dBm)
802.11b	-29.1	-6.79	-6.764

Table 24. 2 Antenna combined PSD

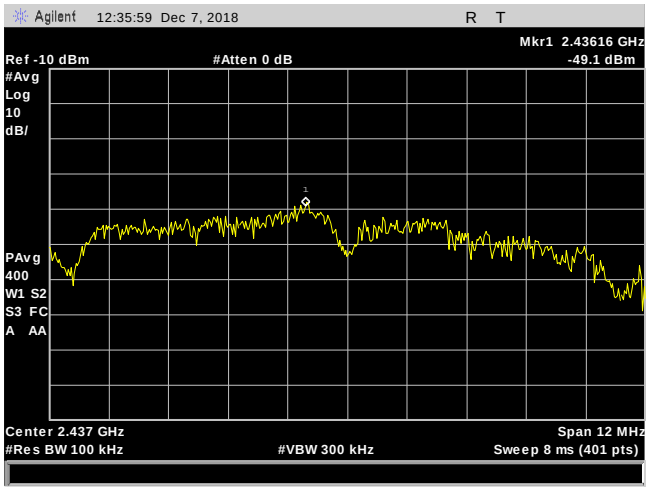
Calculation used for above combined power result:

$$Combined\ Pwr = 10 * \log\left(10^{\frac{Ant\ 1}{10}} + 10^{\frac{Ant\ 2}{10}}\right)$$

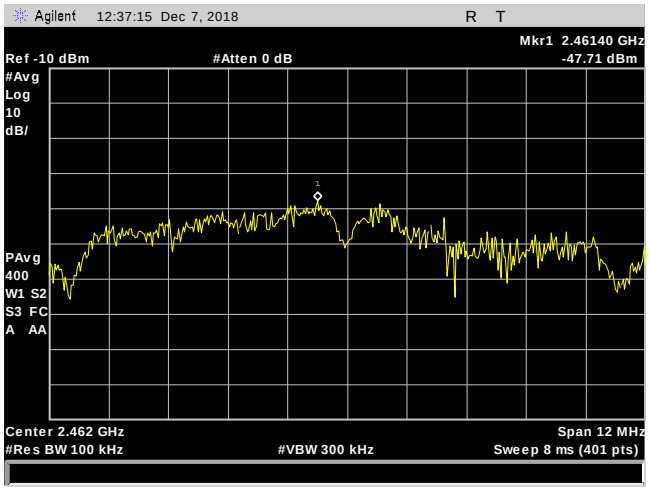
Power Spectral Density, 802.11b



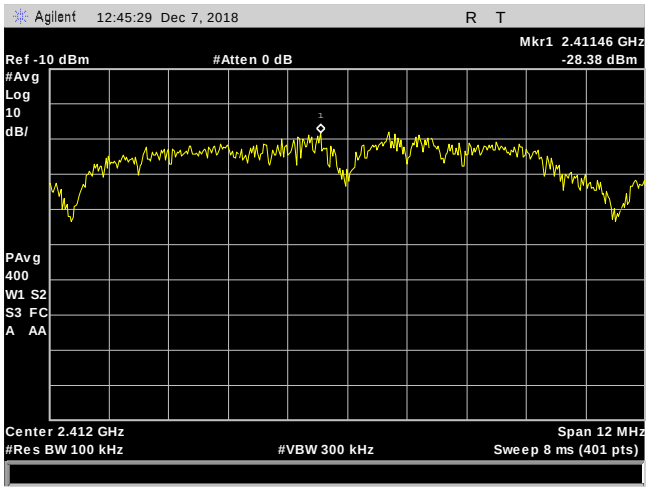
Plot 203. Power Density, 802.11b – PWR 1000, Antenna 1, 2412, -47.85 dBm



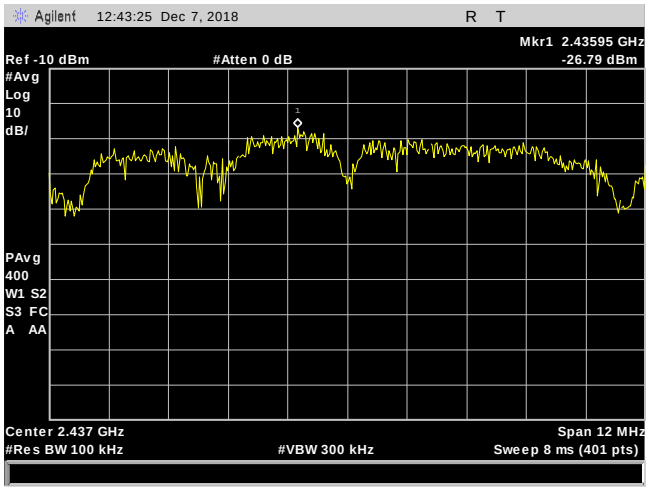
Plot 204. Power Density, 802.11b – PWR 1000, Antenna 1, 2437, -49.1 dBm



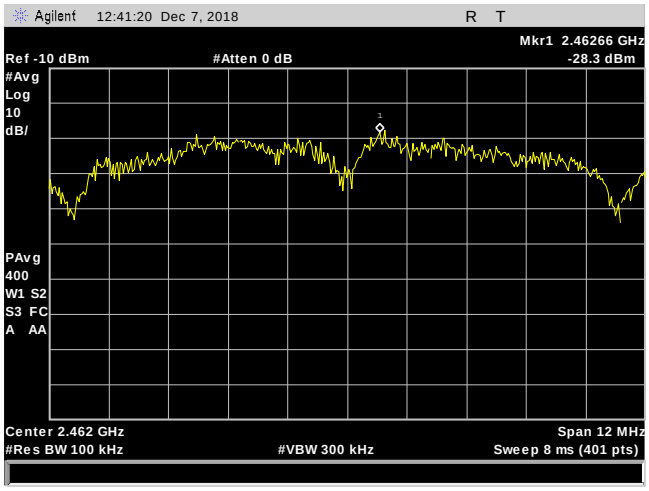
Plot 205. Power Density, 802.11b – PWR 1000, Antenna 1, 2462, -47.71 dBm



Plot 206. Power Density, 802.11b – PWR 1000, Antenna 2, 2412, -28.38 dBm



Plot 207. Power Density, 802.11b – PWR 1000, Antenna 2, 2437, -26.79 dBm



Plot 208. Power Density, 802.11b – PWR 1000, Antenna 2, 2462, -28.3 dBm

Duty Cycle Correction Tables, 802.11b

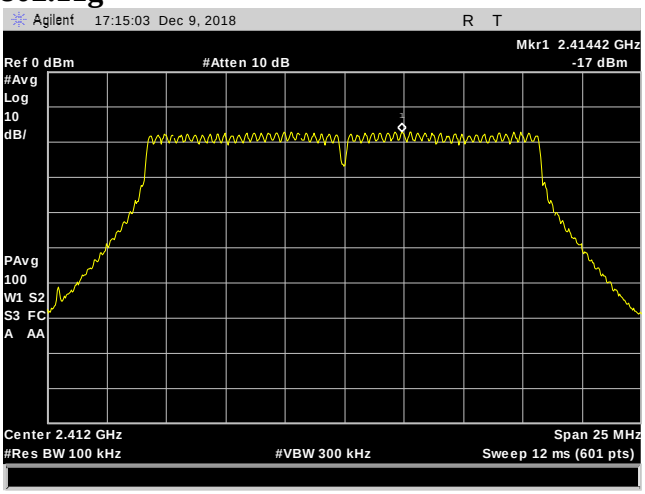
Antenna 1			
Frequency (MHz)	**Amplitude (dBm)**	**Duty Cycle correction**	**Corrected Amplitude (dBm)**
2412	-47.85	20	-27.85
2437	-49.1	20	-29.1
2462	-47.71	20	-27.71

Table 25. Duty Cycle, 802.11b - PWR 1000, Antenna 1

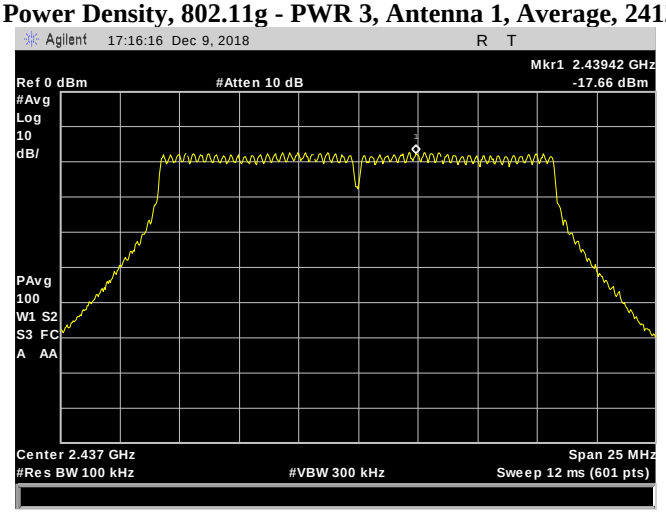
Antenna 2			
Frequency (MHz)	**Amplitude (dBm)**	**Duty Cycle correction**	**Corrected Amplitude (dBm)**
2412	-28.38	20	-8.38
2437	-26.79	20	-6.79
2462	-28.3	20	-8.3

Table 26. Duty Cycle, 802.11b - PWR 1000, Antenna 2

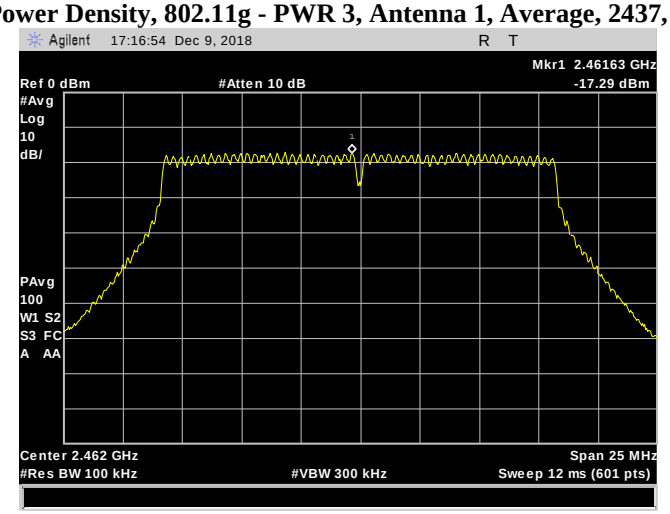
Power Spectral Density, 802.11g



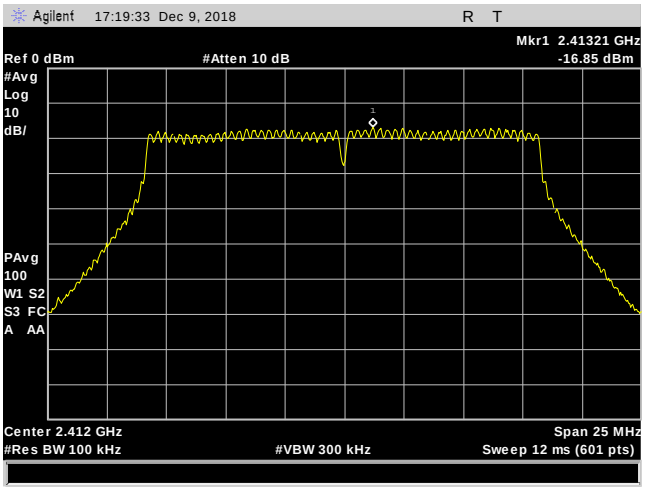
Plot 209. Power Density, 802.11g - PWR 3, Antenna 1, Average, 2412, -17dBm



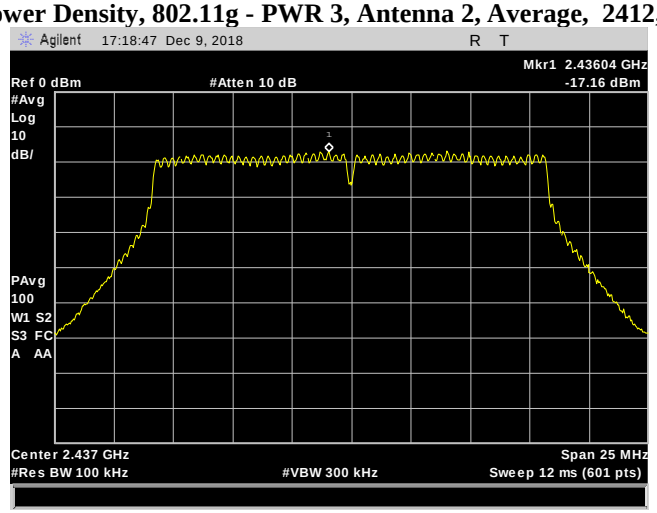
Plot 210. Power Density, 802.11g - PWR 3, Antenna 1, Average, 2437, -17.66 dBm



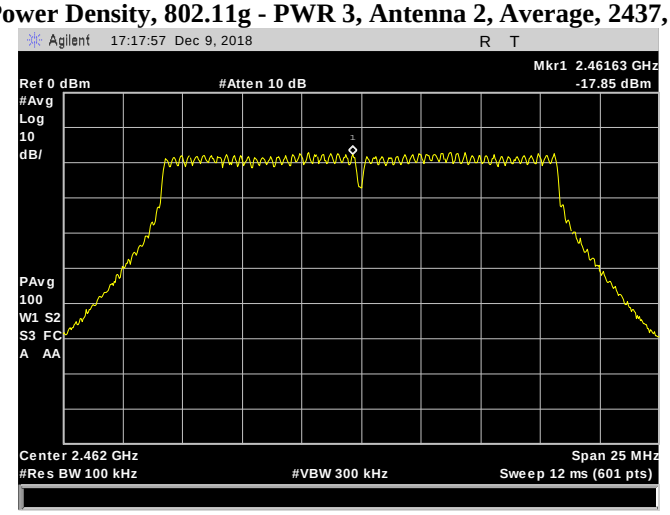
Plot 211. Power Density, 802.11g - PWR 3, Antenna 1, Average, 2462, -17.29 dBm



Plot 212. Power Density, 802.11g - PWR 3, Antenna 2, Average, 2412, -16.85 dBm

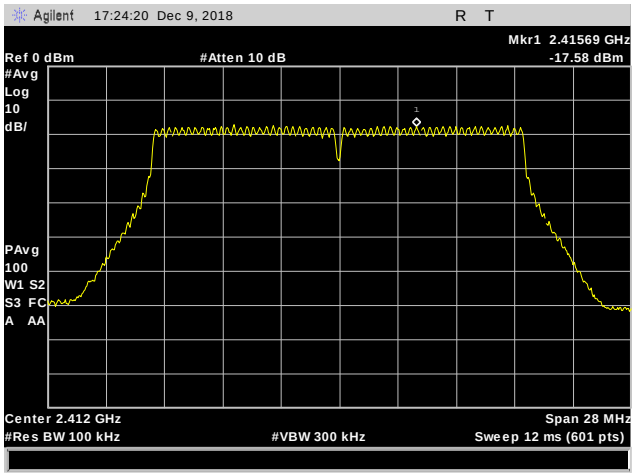


Plot 213. Power Density, 802.11g - PWR 3, Antenna 2, Average, 2437, -17.16 dBm

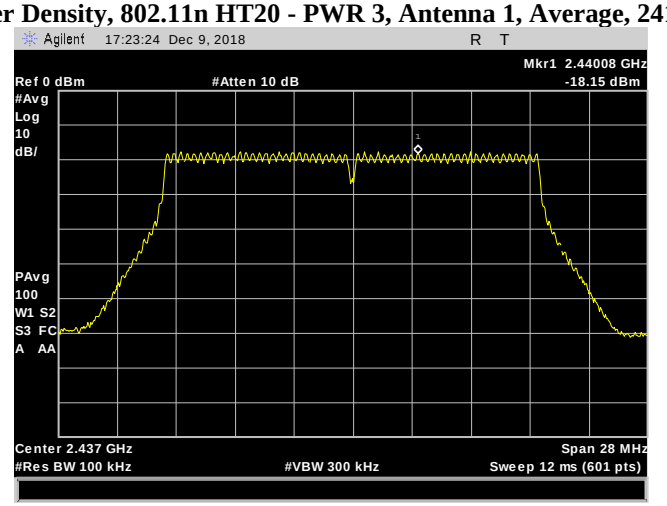


Plot 214. Power Density, 802.11g - PWR 3, Antenna 2, Average, 2462, -17.85 dBm

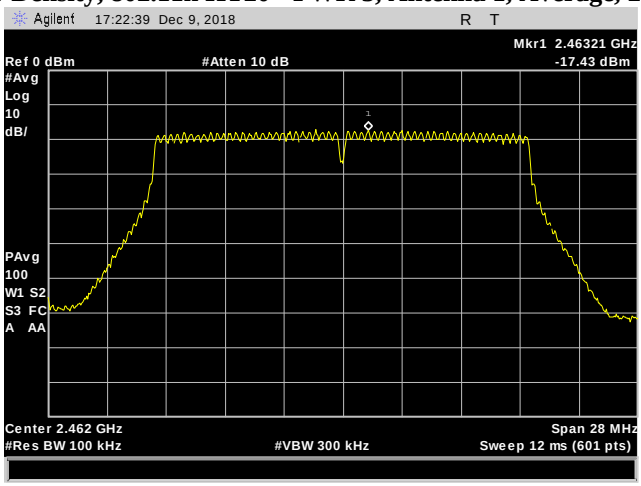
Power Spectral Density, 802.11n



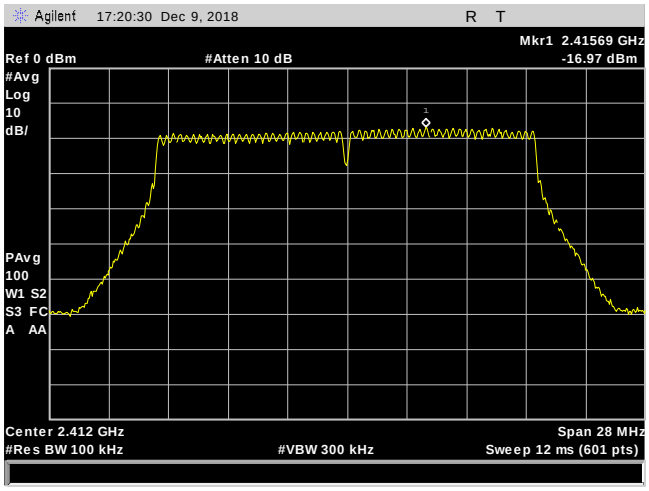
Plot 215. Power Density, 802.11n HT20 - PWR 3, Antenna 1, Average, 2412, -17.58 dBm



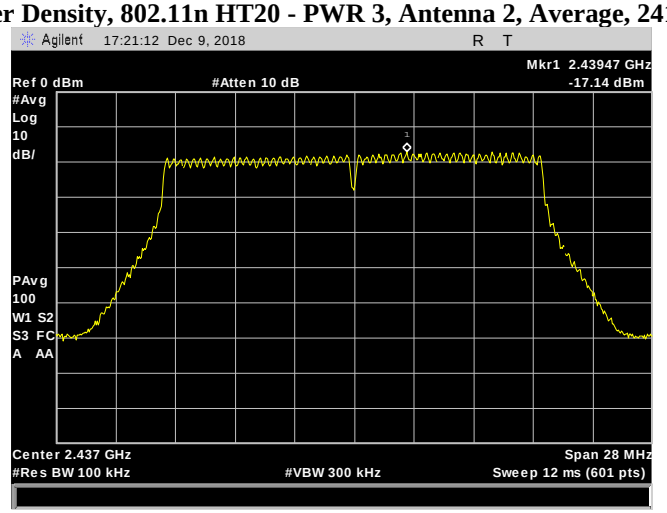
Plot 216. Power Density, 802.11n HT20 - PWR 3, Antenna 1, Average, 2437, -18.15 dBm



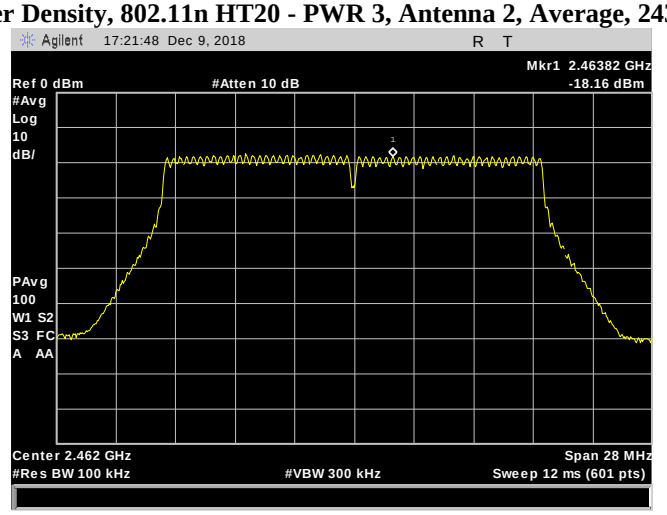
Plot 217. Power Density, 802.11n HT20 - PWR 3, Antenna 1, Average, 2462, -17.43 dBm



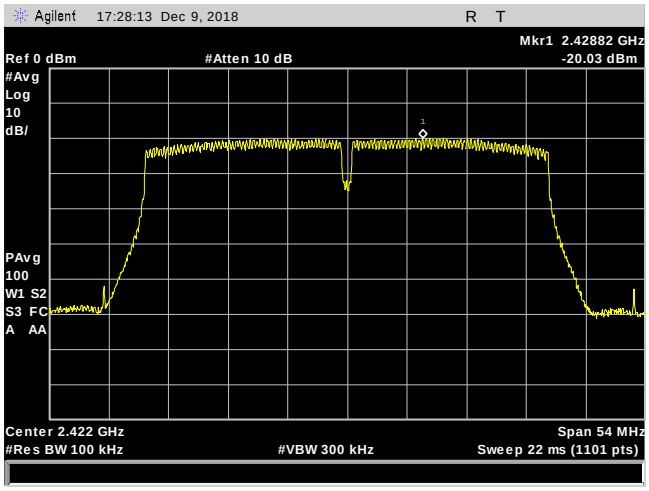
Plot 218. Power Density, 802.11n HT20 - PWR 3, Antenna 2, Average, 2412, -16.97 dBm



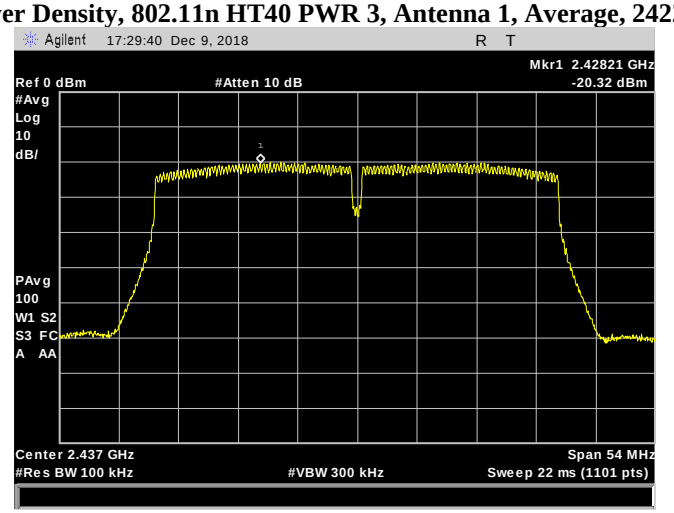
Plot 219. Power Density, 802.11n HT20 - PWR 3, Antenna 2, Average, 2437, -17.14 dBm



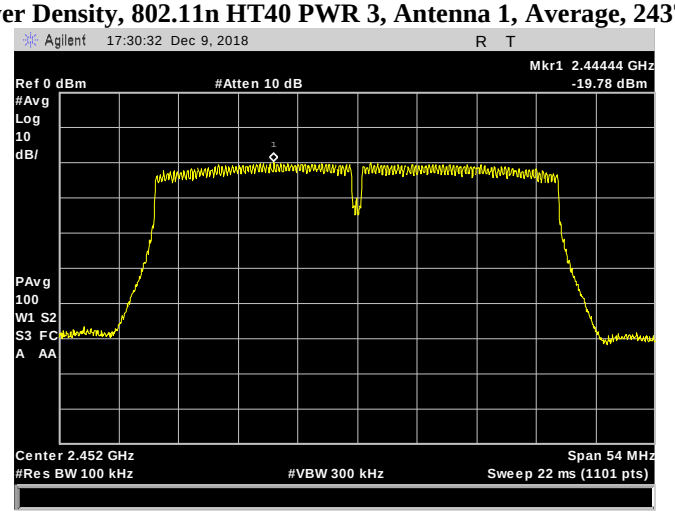
Plot 220. Power Density, 802.11n HT20 - PWR 3, Antenna 2, Average, 2462, -18.16 dBm



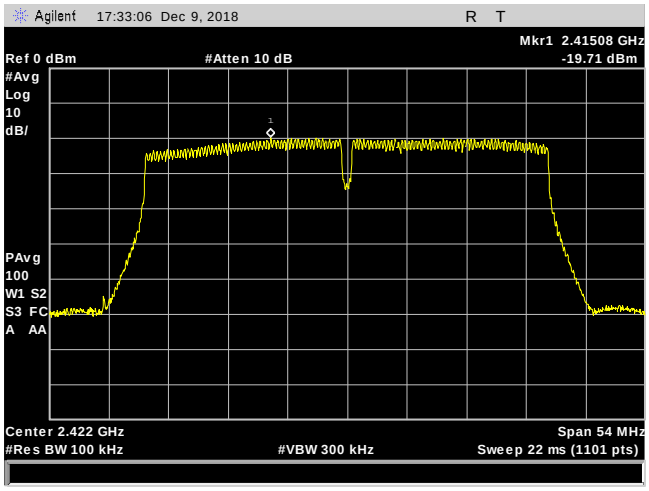
Plot 221. Power Density, 802.11n HT40 PWR 3, Antenna 1, Average, 2422, -18.16 dBm



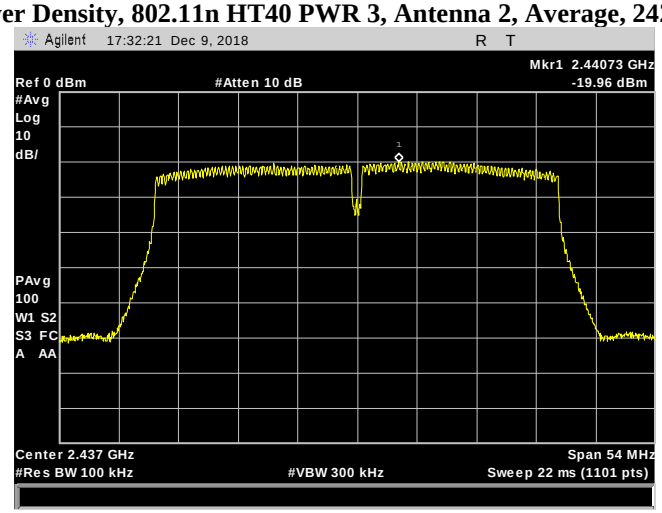
Plot 222. Power Density, 802.11n HT40 PWR 3, Antenna 1, Average, 2437, -20.03 dBm



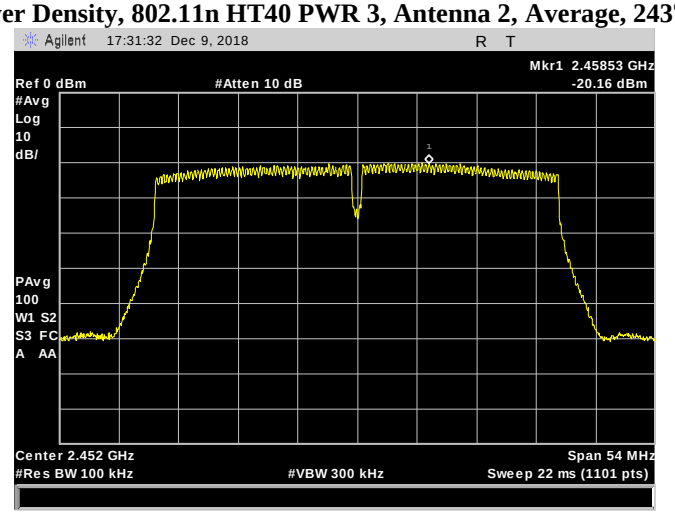
Plot 223. Power Density, 802.11n HT40 PWR 3, Antenna 1, Average, 2452, -19.78 dBm



Plot 224. Power Density, 802.11n HT40 PWR 3, Antenna 2, Average, 2422, -19.71 dBm



Plot 225. Power Density, 802.11n HT40 PWR 3, Antenna 2, Average, 2437, -19.96 dBm



Plot 226. Power Density, 802.11n HT40 PWR 3, Antenna 2, 2452, -20.16 dBm

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(i) Maximum Permissible Exposure

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 @ 2400-2483.5 MHz; **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

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

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

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

Test Results:

FCC										
Mode (802.11)	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
b	2412	7.53	5.662	9	7.943	0.00895	1	0.99105	20	Pass
g	2412	2.63	1.832	9	7.943	0.0029	1	0.9971	20	Pass
n HT20	2412	2.69	1.858	9	7.943	0.00294	1	0.99706	20	Pass
n HT40	2422	2.15	1.641	9	7.943	0.00259	1	0.99741	20	Pass

FCC										
Mode	Frequency (MHz)	Combined Con. Pwr. (dBm)	Combined Con. Pwr. (mW)	Combined Ant. Gain (dBi)	Combined Ant. Gain numeric	Pwr. Density (mW/cm^2)	Limit (mW/cm^2)	Margin	Distance (cm)	Result
802.11b	2412	7.562	5.704	12.01	15.885	0.01803	1	0.98197	20	Pass
802.11g	2412	5.635	3.66	12.01	15.885	0.01157	1	0.98843	20	Pass
802.11n20	2412	5.645	3.669	12.01	15.885	0.01159	1	0.98841	20	Pass
802.11n40	2422	5.105	3.24	12.01	15.885	0.01024	1	0.98976	20	Pass

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

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 #	Nomenclature	Manufacturer	Model	Last Cal Date	Cal Due Date
1A1184	Spectrum Analyzer	Agilent	E4407B	4/20/2018	4/20/2019
1A1083	EMI Test Receiver	Rohde & Schwarz	ESU40	10/17/2018	10/17/2019
1A1106	10m Chamber (FCC)	ETS	Semi-Anechoic	See Note	
1A1050	Bilog Antenna (30MHz to 1GHz)	Schaffner	CBL 6112D	8/29/2018	2/29/2020
1A1050-A	Attenuator	Fairview Microwave	SA6N5WA-04	8/29/2018	2/29/2020
1A1047	Horn Antenna	ETS	3117	10/30/2018	4/30/2020
1A1161	DRG Horn Antenna	ETS	3116C-PA	10/9/2018	4/9/2020
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	
1A1080	Multi Device Controller	ETS EMCO	2090	See Note	
1A1180	Pre-Amp	Miteq	AMF-7D-01001800-22-10P	See Note	

Table 27. 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

A. 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

1. 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 user's 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.

End of Report

