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

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April 16, 2013

Motorola Solutions, Inc.
1064 Greenwood Blvd. Suite 400
Lake Mary, FL 32746

Dear Bob Greenway,

Enclosed is the EMC Wireless test report for continuing compliance testing of the Motorola Solutions, Inc., AP-7161 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C and RSS-210, Issue 8, Dec. 2010 for Intentional Radiators.

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

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Motorola Solutions, Inc.\EMC37797A-FCC247 Rev. 1)

Electromagnetic Compatibility Criteria
Class II Permissive Change Test Report

for the

Motorola Solutions, Inc.
AP-7161

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

MET Report: EMC37797A-FCC247 Rev. 1

April 16, 2013

Prepared For:

Motorola Solutions, Inc.
1064 Greenwood Blvd. Suite 400
Lake Mary, FL 32746

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Ave.
Baltimore, MD 21230

Electromagnetic Compatibility Criteria
Class II Permissive Change Test Report

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Tested under
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15.247 Subpart C & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

Jeff Pratt, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
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 and Industry Canada standard RSS-210, Issue 8, Dec. 2010 under normal use and maintenance.

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	March 7, 2013	Initial Issue.
1	April 16, 2013	Revised to reflect corrected antenna gains.

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**microh**enry
µ	**microf**arad
µs	**micros**econds
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 Motorola Solutions, Inc. AP-7161, 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 AP-7161. Motorola Solutions, Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the AP-7161, has been **permanently** discontinued.

This is a Class II Permissive Change report to add higher gain antenna.

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 Motorola Solutions, Inc., quote number 1MOT2002. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference 47 CFR Part 15.247:2005	IC Reference RSS-210 Issue 8: 2010	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	N/A	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	RSS-210(A8.4)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	RSS-210(A8.5)	Radiated Spurious Emissions Requirements	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Motorola Solutions, Inc. to perform testing on the AP-7161, under Motorola Solutions, Inc.'s quote number 1MOT2002.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Motorola Solutions, Inc., AP-7161.

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

Model(s) Tested:	AP-7161	
Model(s) Covered:	AP-7161	
EUT Specifications:	Primary Power: 120 VAC, 60 Hz	
	FCC ID: QJEAP716101 IC: 4602A-AP716101	
	Equipment Code:	DTS
	Peak RF Output Power:	15.16 dBm
	EUT Frequency Ranges:	5745 – 5825 MHz 5755 – 5815 MHz (HT40)
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:	Jeff Pratt	
Report Date(s):	April 16, 2013	

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
RSS-210, Issue 8, Dec. 2010	Low-power Licence-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment
ANSI C63.4:2003	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 C63.10-2009	American National Standard for Testing Unlicensed Wireless Devices
EN 55022: 2006/A1:2007 **CISPR 22: 2005/A1:2005**	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement CISPR 22:2005 (Modified)

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave., Baltimore, MD 21230. 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 3 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. Description of Test Sample

The Motorola Solutions, Inc. AP-7161, Equipment Under Test (EUT), is an Outdoor 802.11n access point.

Photograph 1. Motorola Solutions, Inc, AP-7161

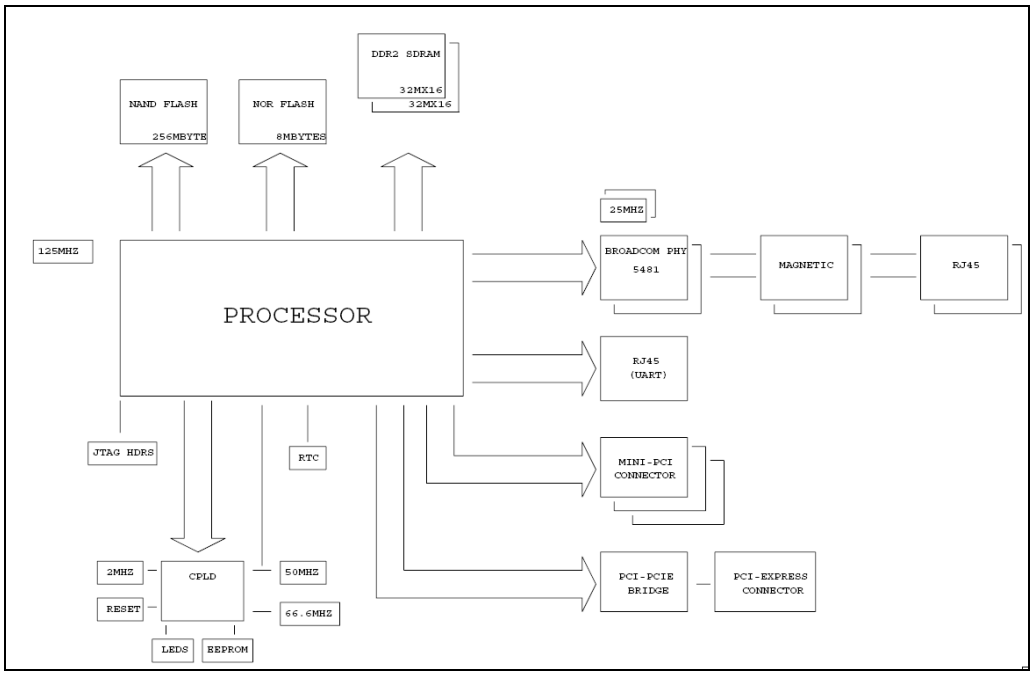


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

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

Ref. ID	Name / Description	Model Number
1	AP 7161	AP-7161
2	Power Cable	N/A

Table 4. Equipment Configuration

F. Support Equipment

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

Ref. ID	Name / Description	Manufacturer	Model Number
1	Laptop with ART software	Dell	D600

Table 5. Support Equipment

G. Ports and Cabling Information

Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
GE1 (LAN)	Cat5	1	N/A	Y	N/A
GE2 (WAN)	Cat5	1	N/A	Y	N/A
Console (Serial)	RJ-45	1	N/A	N	N/A
Power	16 AWG Power Cable	1	6	N/A	N/A

Table 6. Ports and Cabling Information

H. Mode of Operation

Test software (WinPrius) running on laptop and EUT which communicate over Ethernet.

I. Method of Monitoring EUT Operation

Wireless radios are monitored in the intended frequency bands.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Motorola Solutions, Inc. 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 is professionally installed.

Test Engineer(s): Jeff Pratt

Test Date(s): 02/22/13

Gain	Type	Model	Manufacturer
19.77	Panel	MT-465019/NVD	MTI
Polarization	Vertical	Dual Slant +/- 45°	
Gain	21 dBi	19 dBi	

When in 802.11n-mode, array gain can be calculated in one of two ways. Based on KDB 662911, when an antenna with multiple ports of unequal gain is fed with completely uncorrelated signals of equal power (i.e. power across the ports deviates by less than 2dB), the directional gain of the antenna is calculated using the following equation:

$$Directional\ Gain = 10\log\left(\frac{\left(10^{\frac{G1}{20}}+10^{\frac{G2}{20}}+\cdots+10^{\frac{GN}{20}}\right)^2}{N_{ANT}}\right)$$

When an antenna with multiple ports of unequal gain is fed with completely uncorrelated signals of unequal power (i.e. power across the ports deviates by more than 2dB), the directional gain of the antenna is calculated using the following equation (see KDB tracking number 704031):

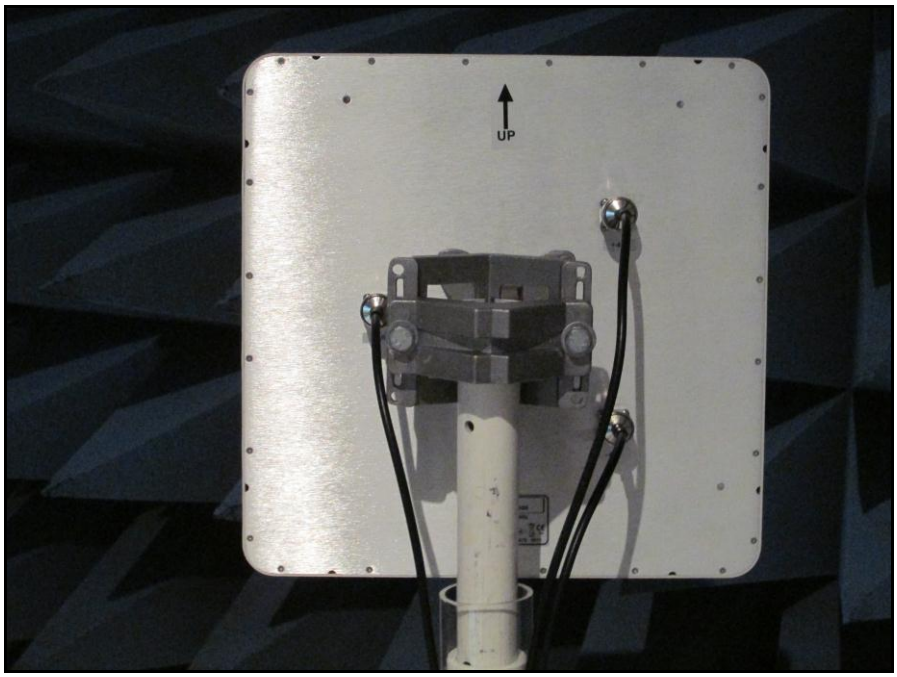
$$Directional\ Gain = 10\log\left((p_1 g_1 + p_2 g_2 + \cdots + p_N g_N)/(p_1 + p_2 + \cdots + p_N)\right)$$

Where, p_N =output power of port N in mW

$g_N = 10^{\frac{GN}{10}}$ = linear gain of the antenna

Based on the measured output power of the EUT, the equation for directional gain for antennas fed with signals of unequal power resulted in a lower directional gain than the equation for antennas fed with signals of equal power. For this reason, the equal power directional gain equation was used throughout testing, resulting in a gain of 19.77dBi.

Photograph 2. Antenna, Front View



Photograph 3. Antenna, Rear View

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output

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

Digital Transmission Systems (MHz)	Output Limit (Watts)
902-928	1.000
2400–2483.5	1.000
5725– 5850	1.000

Table 7. Output Power Requirements from §15.247(b)

§15.247(c): if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the Table 7, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band and using a point to point application may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Fixed, point-to-point operation excludes the use of point-to-multipoint systems, Omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

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.

Test Results: The EUT was compliant with the Peak Power Output limits of **§15.247(b)**.

Test Engineer(s): Jeff Pratt

Test Date(s): 02/22/13 – 02/28/13

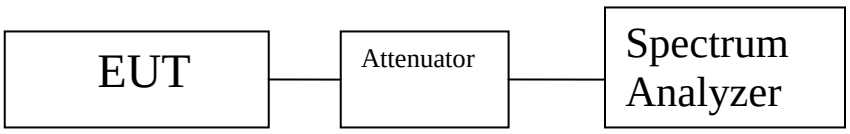
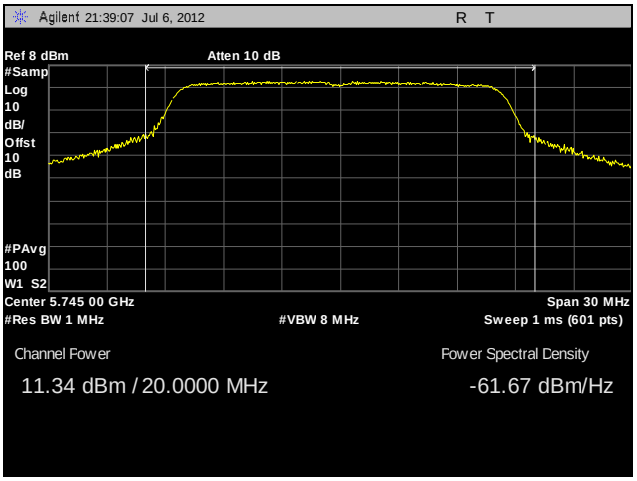


Figure 2. Peak Power Output Test Setup

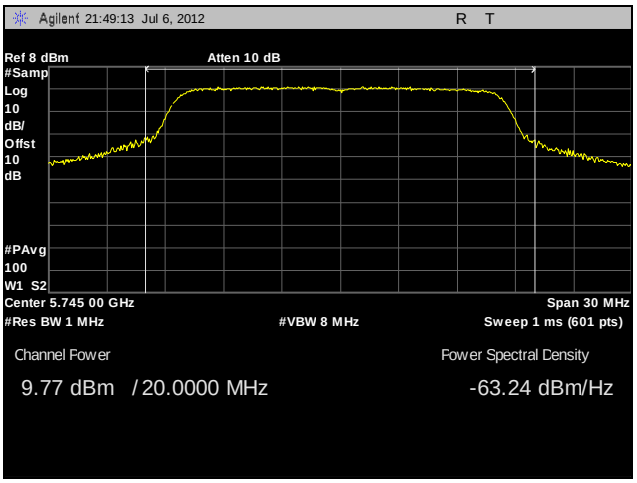
Peak Power Output Test Results

Frequency (MHz)	Mode	Port A Conducted Power (dBm)	Port B Conducted Power (dBm)	Port C Conducted Power (dBm)	Aggregate Conducted Power (dBm)	Antenna Gain (dBm)	Limit (dBm)	Margin (dB)
5745	802.11a	11.34	--	--	11.34	21.00	15.00	-3.66
5785	802.11a	9.77	--	--	9.77	21.00	15.00	-5.23
5825	802.11a	7.39	--	--	7.39	21.00	15.00	-7.61
5745	802.11n HT20	9.08	10.20	10.66	14.80	19.77	16.23	-1.43
5785	802.11n HT20	8.23	10.83	11.07	14.99	19.77	16.23	-1.24
5825	802.11n HT20	7.35	10.79	11.88	15.16	19.77	16.23	-1.06
5755	802.11n HT40	9.07	10.07	11.02	14.90	19.77	16.23	-1.33
5785	802.11n HT40	8.12	10.99	11.06	15.03	19.77	16.23	-1.20
5815	802.11n HT40	7.27	10.22	11.49	14.76	19.77	16.23	-1.46

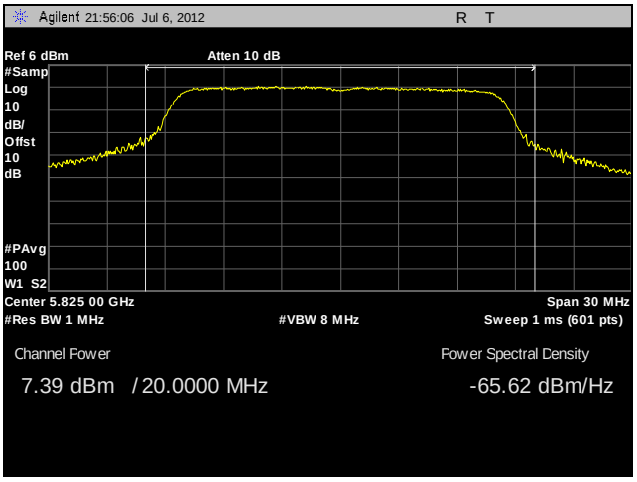
Table 8. Peak Power Output, Test Results



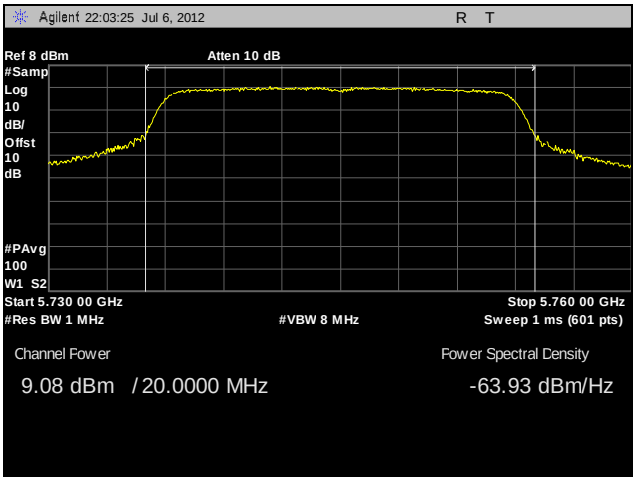
Plot 1. RF Output Power, 802.11a, 5745 MHz, Port 1



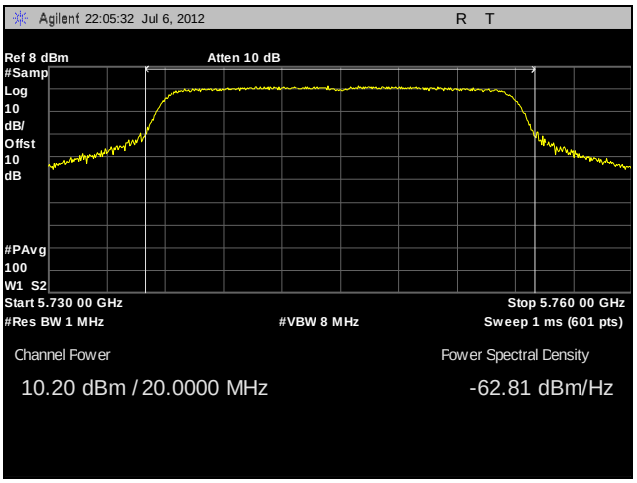
Plot 2. RF Output Power, 802.11a, 5785 MHz, Port 1



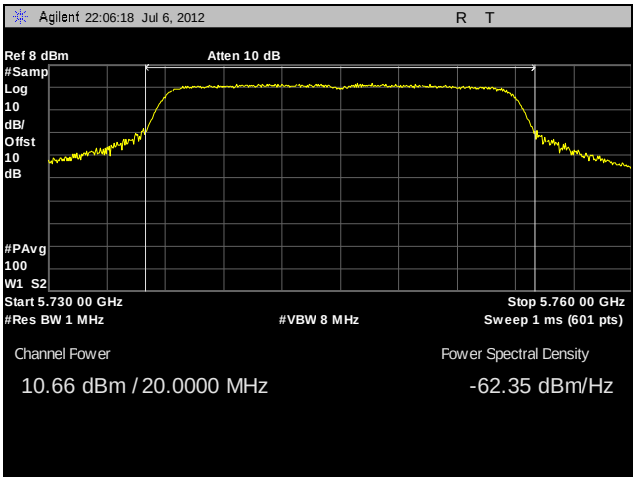
Plot 3. RF Output Power, 802.11a, 5825 MHz, Port 1



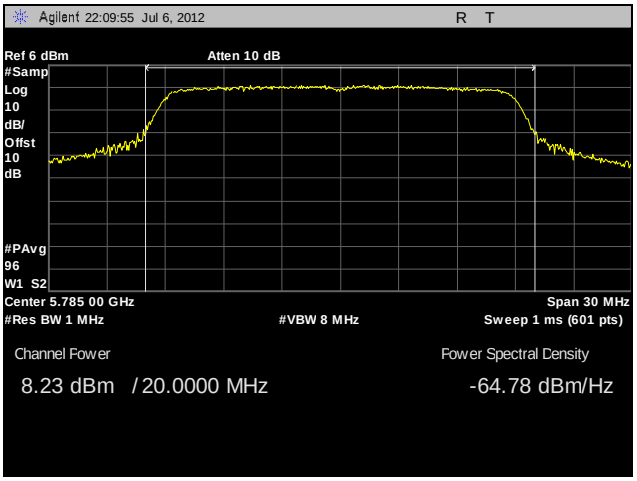
Plot 4. RF Output Power, 802.11n 20 MHz, 5745 MHz, Port 1



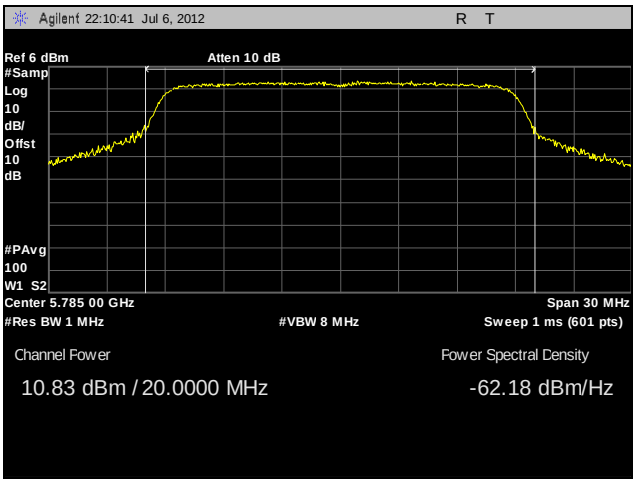
Plot 5. RF Output Power, 802.11n 20 MHz, 5745 MHz, Port 2



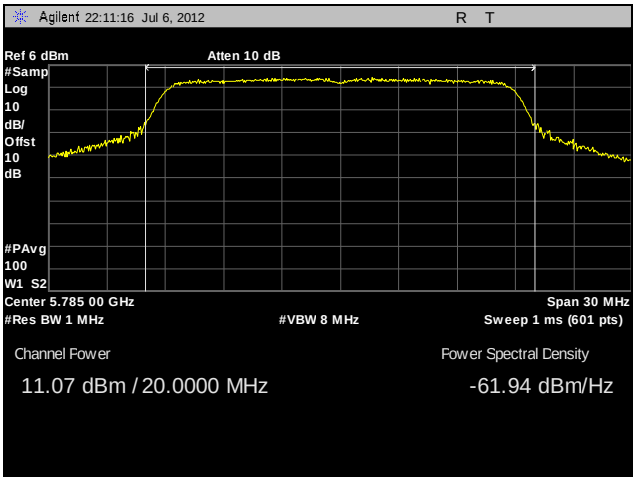
Plot 6. RF Output Power, 802.11n 20 MHz, 5745 MHz, Port 3



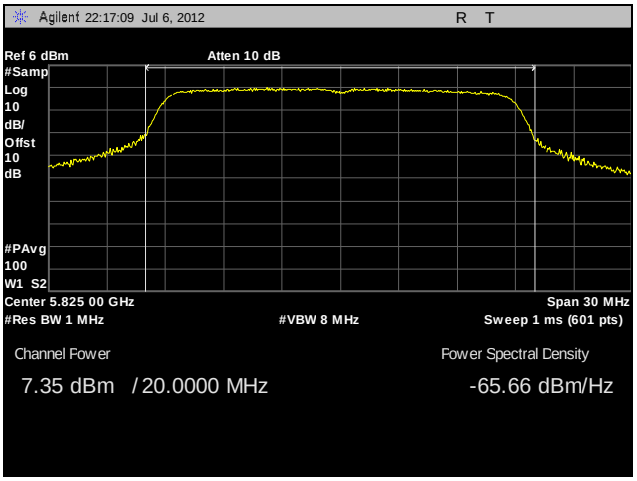
Plot 7. RF Output Power, 802.11n 20 MHz, 5785 MHz, Port 1



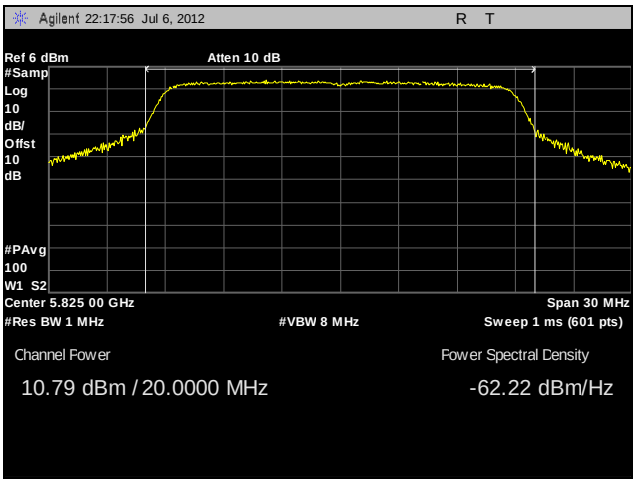
Plot 8. RF Output Power, 802.11n 20 MHz, 5785 MHz, Port 2



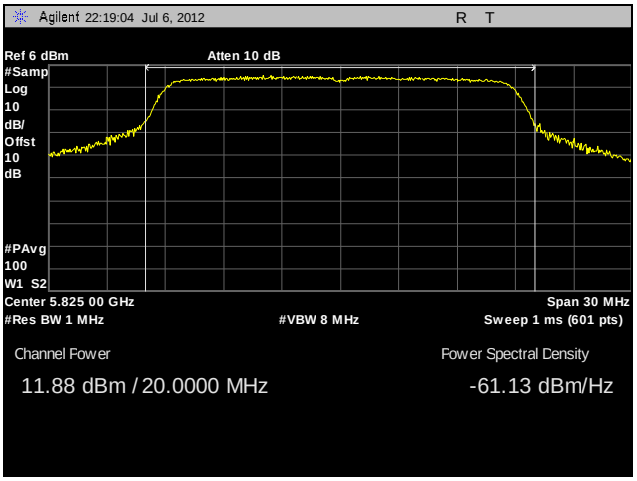
Plot 9. RF Output Power, 802.11n 20 MHz, 5785 MHz, Port 3



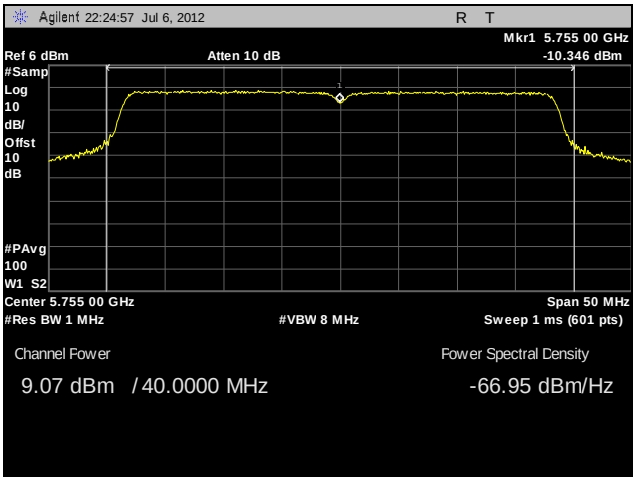
Plot 10. RF Output Power, 802.11n 20 MHz, 5825 MHz, Port 1



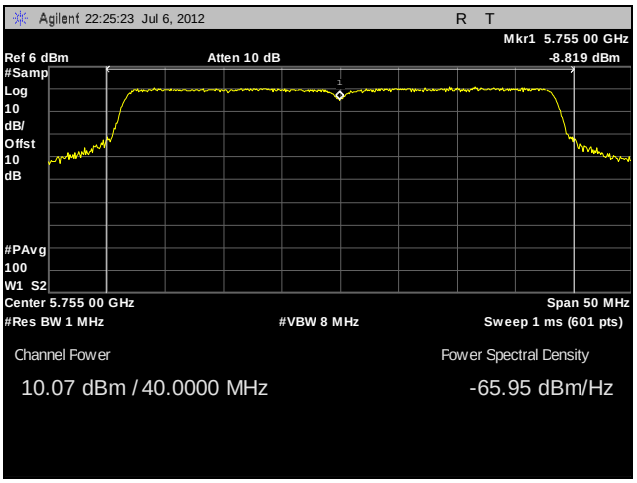
Plot 11. RF Output Power, 802.11n 20 MHz, 5825 MHz, Port 2



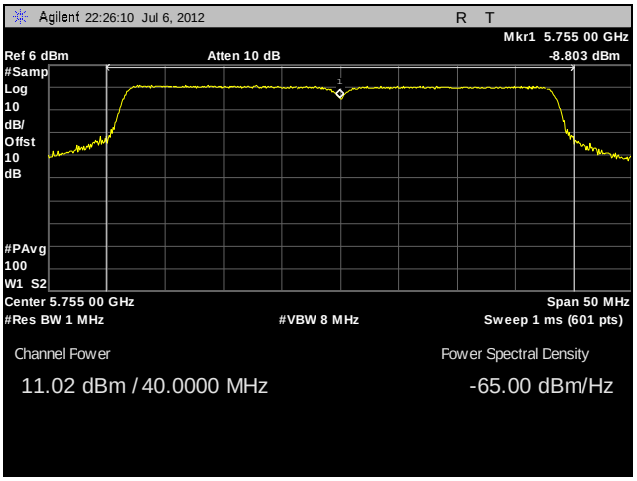
Plot 12. RF Output Power, 802.11n 20 MHz, 5825 MHz, Port 3



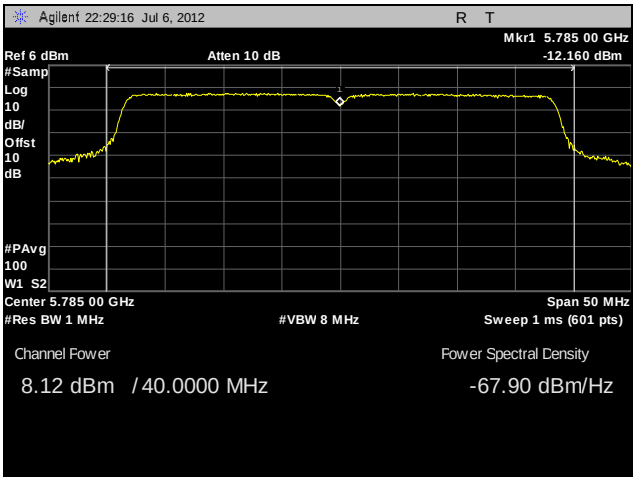
Plot 13. RF Output Power, 802.11n 40 MHz, 5755 MHz, Port 1



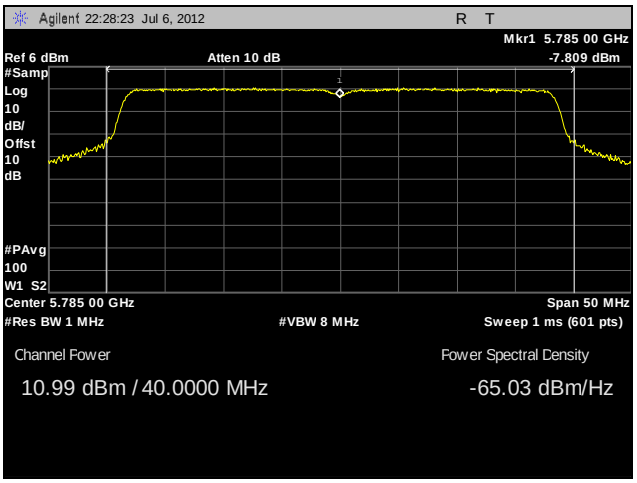
Plot 14. RF Output Power, 802.11n 40 MHz, 5755 MHz, Port 2



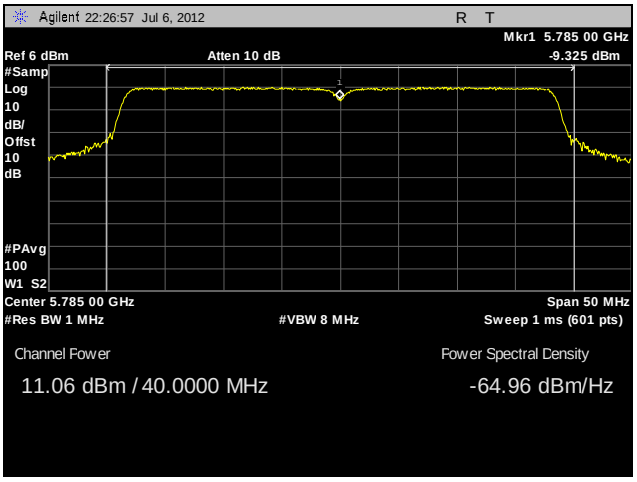
Plot 15. RF Output Power, 802.11n 40 MHz, 5755 MHz, Port 3



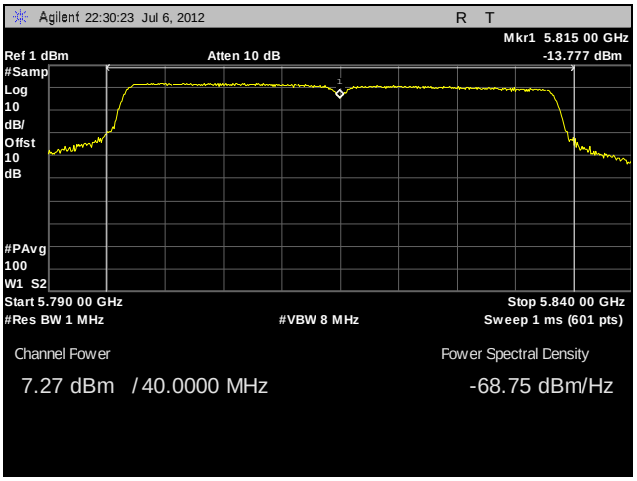
Plot 16. RF Output Power, 802.11n 40 MHz, 5785 MHz, Port 1



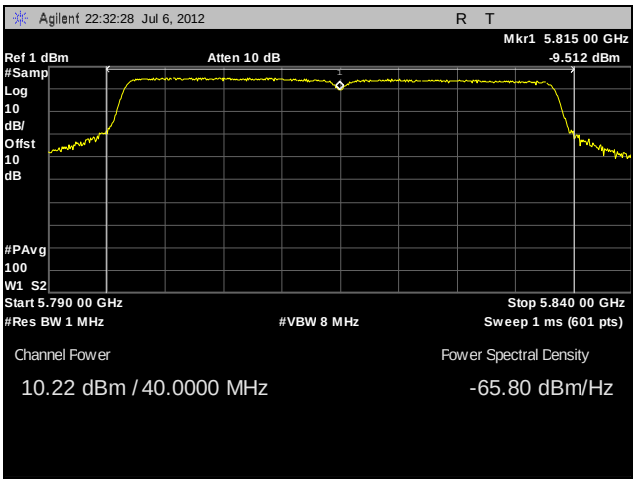
Plot 17. RF Output Power, 802.11n 40 MHz, 5785 MHz, Port 2



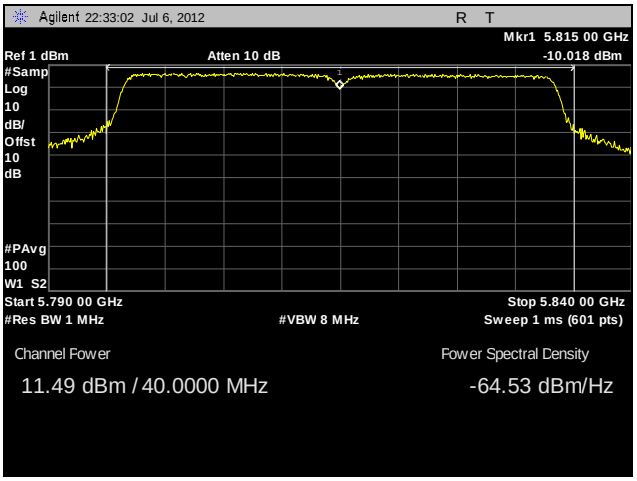
Plot 18. RF Output Power, 802.11n 40 MHz, 5785 MHz, Port 3



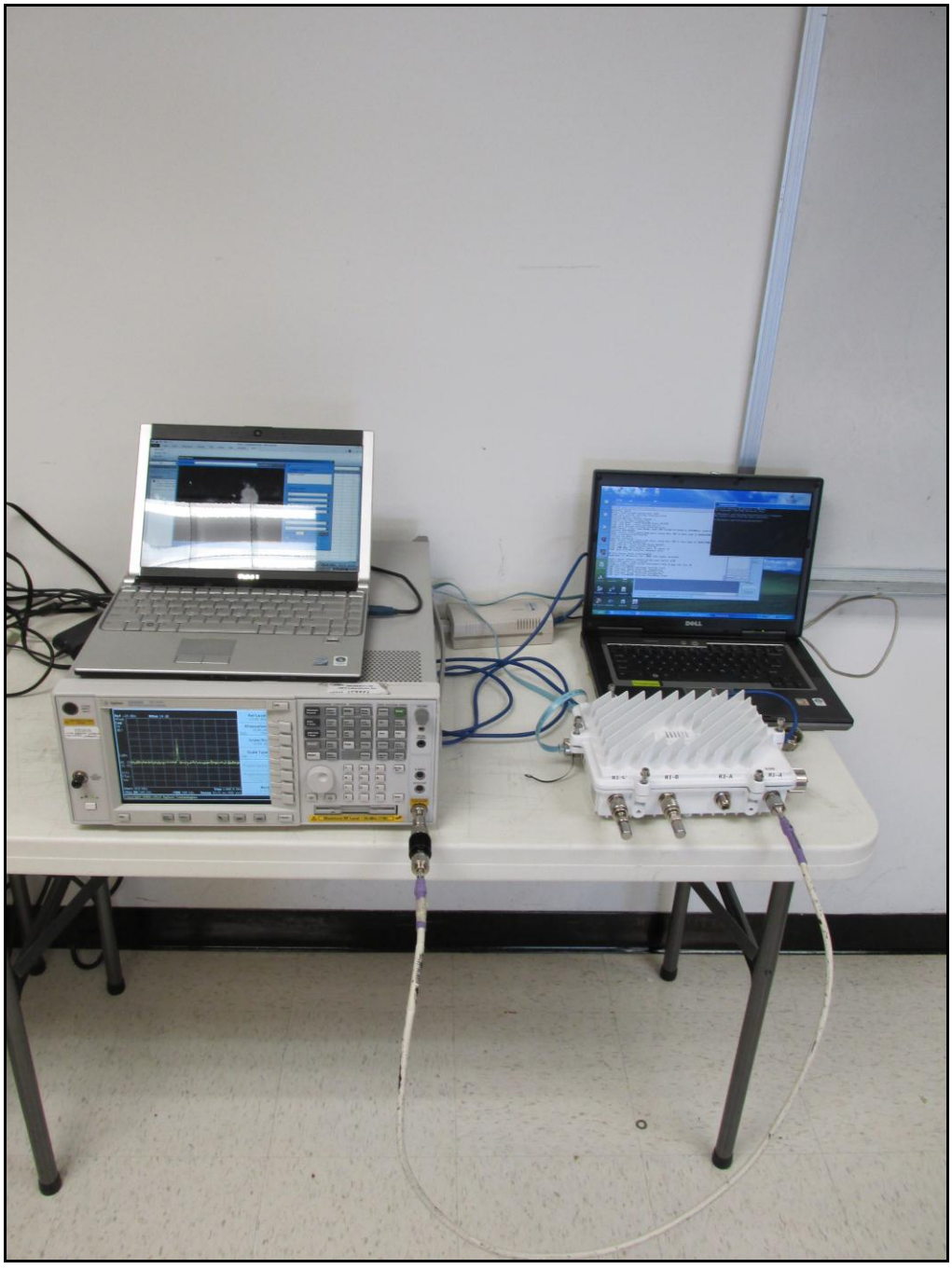
Plot 19. RF Output Power, 802.11n 40 MHz, 5815 MHz, Port 1



Plot 20. RF Output Power, 802.11n 40 MHz, 5815 MHz, Port 2



Plot 21. RF Output Power, 802.11n 40 MHz, 5815 MHz, Port 3



Photograph 4. Conducted Power, Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d), 15.205, 15.209(a) Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: **§15.247(d); §15.205; §15.209(a):** Emissions outside the frequency band.

§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. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

§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 9. 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 10.

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

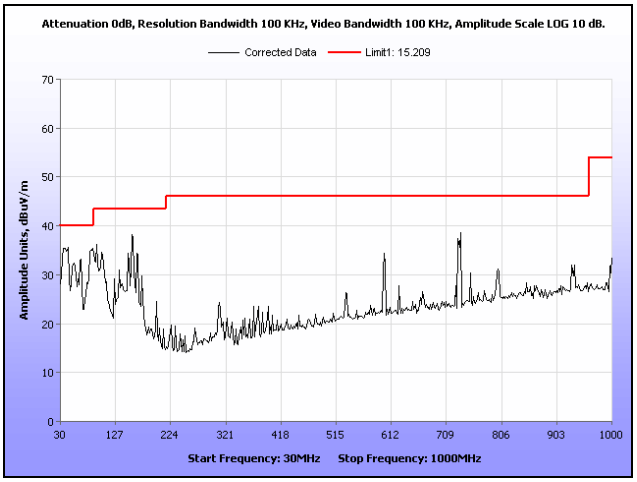
Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.

Test Results: The EUT was completed with the Radiated Spurious Emission limits of **§ 15.247(d)**. No emissions were found beyond 18 GHz.

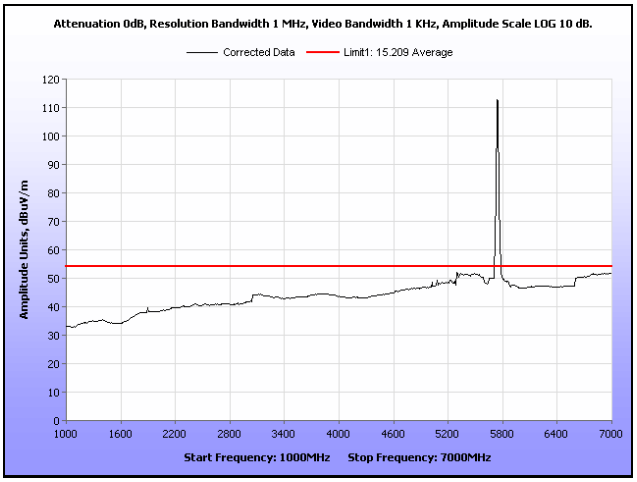
Test Engineer(s): Jeff Pratt

Test Date(s): 02/22/13 – 02/28/13

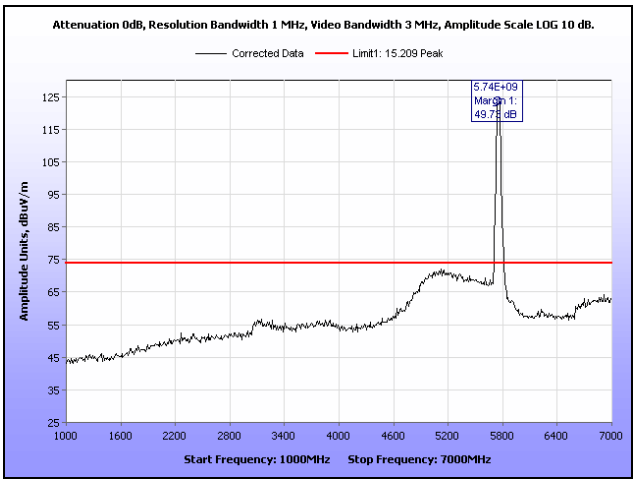
Radiated Spurious Emissions Test Results



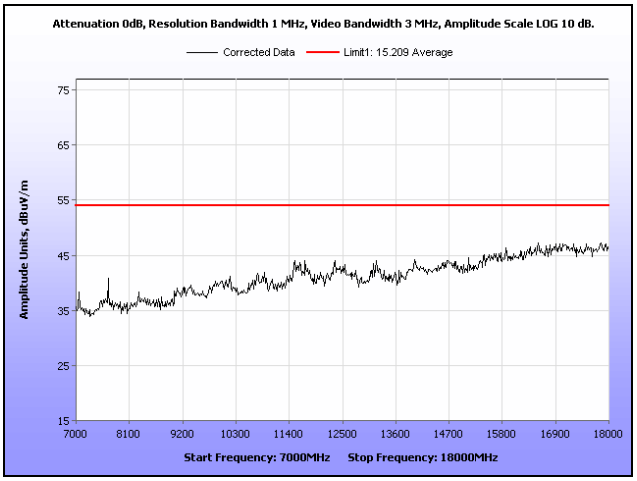
Plot 22. Radiated Spurious Emissions, 802.11a, 5745 MHz, 30 MHz – 1 GHz



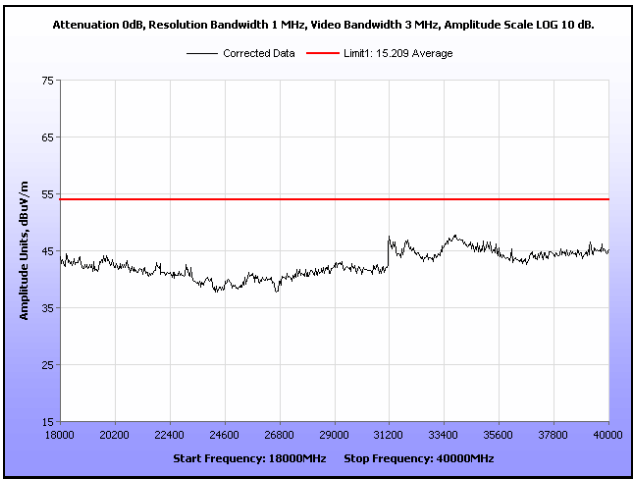
Plot 23. Radiated Spurious Emissions, 802.11a, 5745 MHz, 1 GHz – 7 GHz, Average



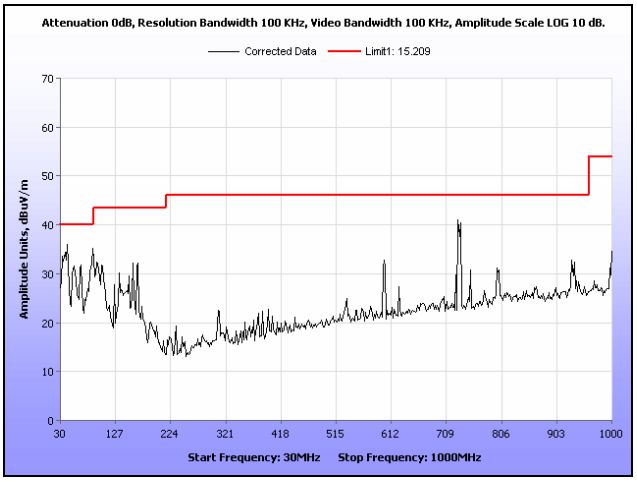
Plot 24. Radiated Spurious Emissions, 802.11a, 5745 MHz, 1 GHz – 7 GHz, Peak



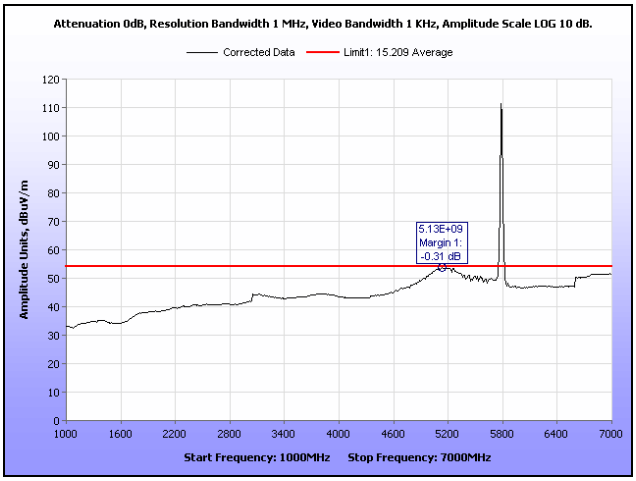
Plot 25. Radiated Spurious Emissions, 802.11a, 5745 MHz, 7 GHz – 18 GHz, Peak under Average



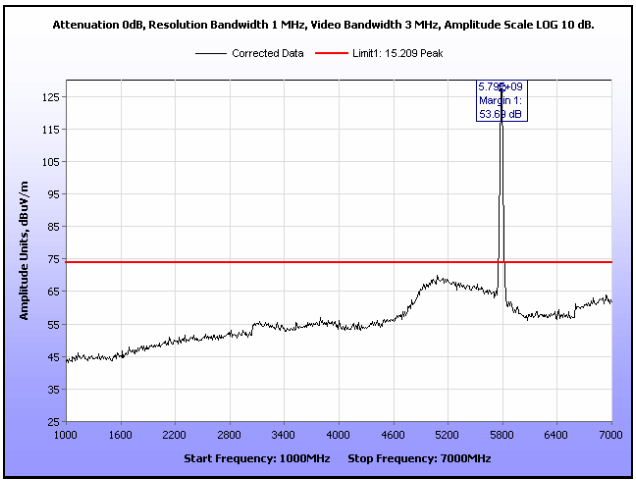
Plot 26. Radiated Spurious Emissions, 802.11a, 5745 MHz, 18 GHz – 40 GHz, Peak under Average



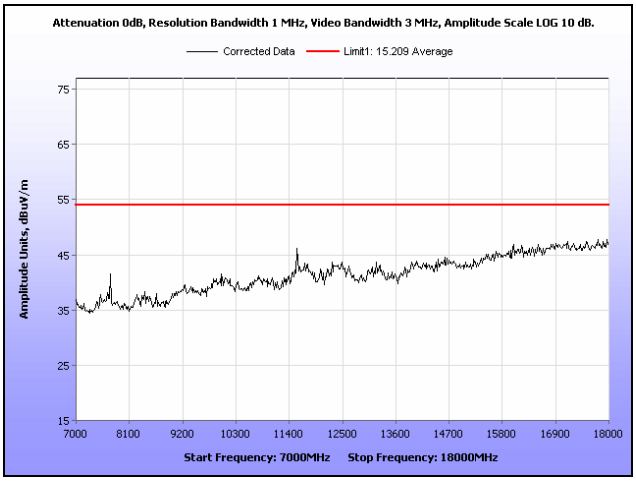
Plot 27. Radiated Spurious Emissions, 802.11a, 5785 MHz, 30 MHz – 1 GHz



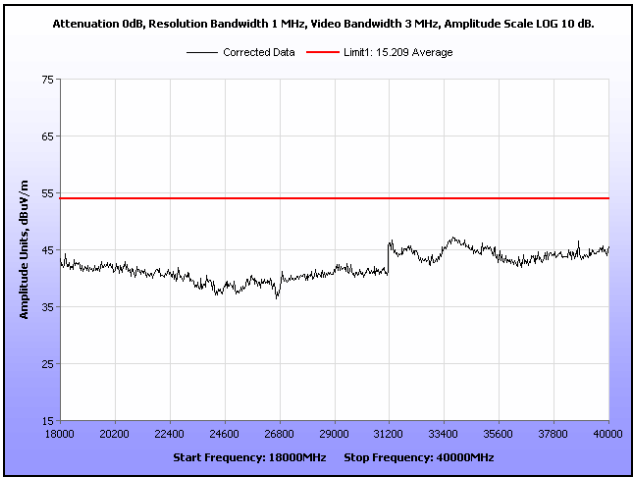
Plot 28. Radiated Spurious Emissions, 802.11a, 5785 MHz, 1 GHz – 7 GHz, Average



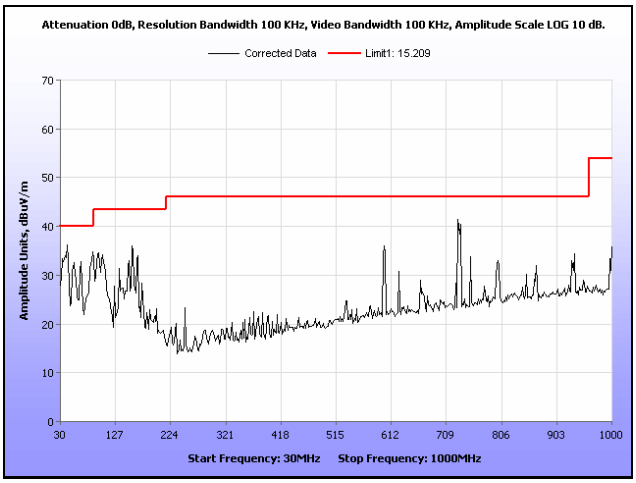
Plot 29. Radiated Spurious Emissions, 802.11a, 5785 MHz, 1 GHz – 7 GHz, Peak



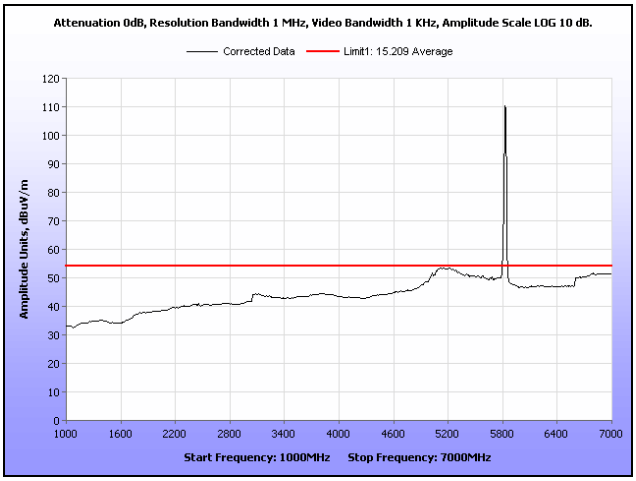
Plot 30. Radiated Spurious Emissions, 802.11a, 5785 MHz, 7 GHz – 18 GHz, Peak under Average



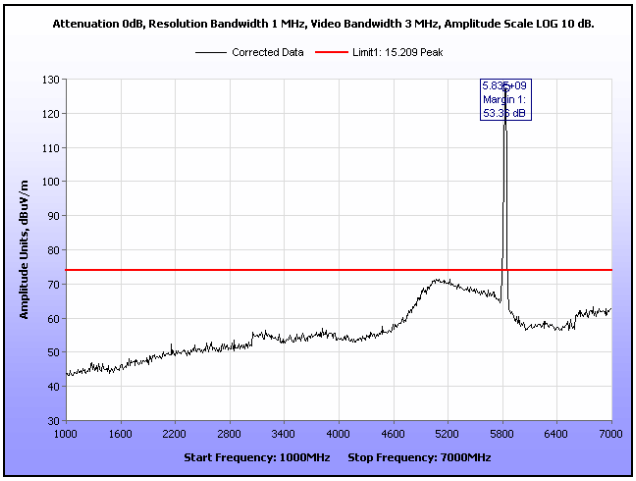
Plot 31. Radiated Spurious Emissions, 802.11a, 5785 MHz, 18 GHz – 40 GHz, Peak under Average



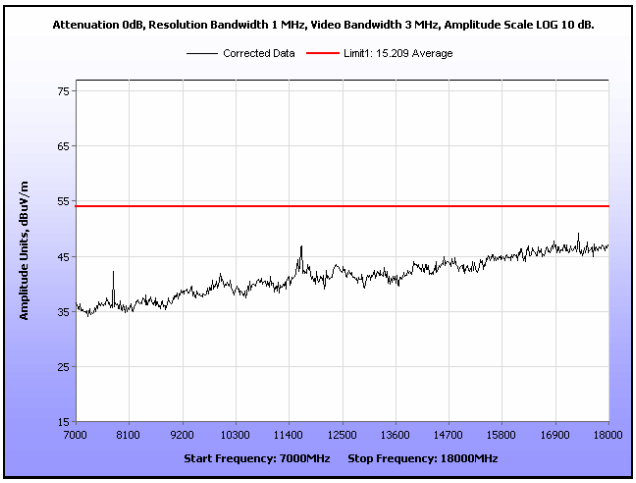
Plot 32. Radiated Spurious Emissions, 802.11a, 5825 MHz, 30 MHz – 1 GHz



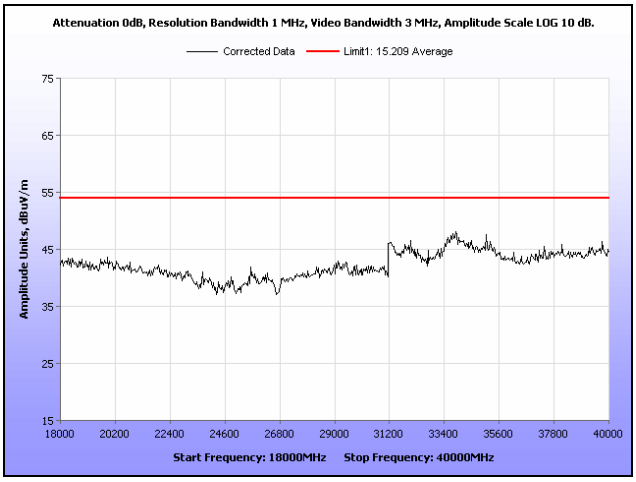
Plot 33. Radiated Spurious Emissions, 802.11a, 5825 MHz, 1 GHz – 7 GHz, Average



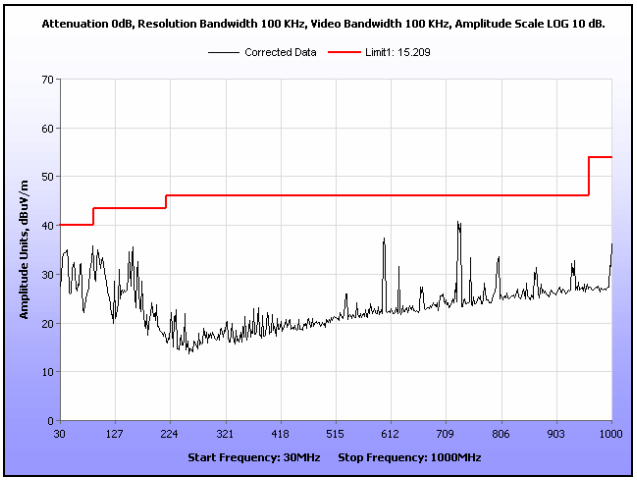
Plot 34. Radiated Spurious Emissions, 802.11a, 5825 MHz, 1 GHz – 7 GHz, Peak



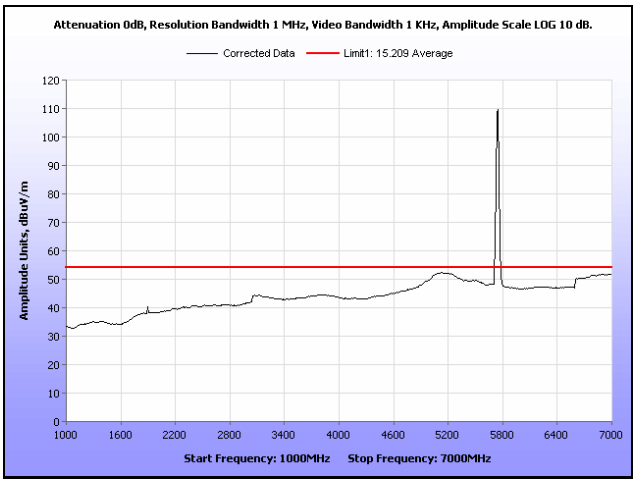
Plot 35. Radiated Spurious Emissions, 802.11a, 5825 MHz, 7 GHz – 18 GHz, Peak under Average



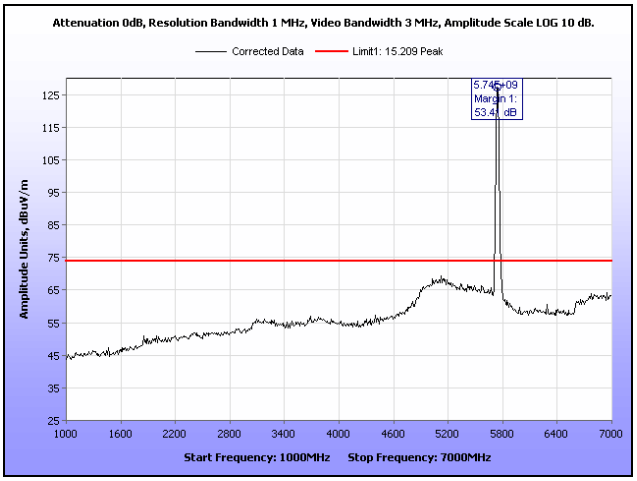
Plot 36. Radiated Spurious Emissions, 802.11a, 5825 MHz, 18 GHz – 40 GHz, Peak under Average



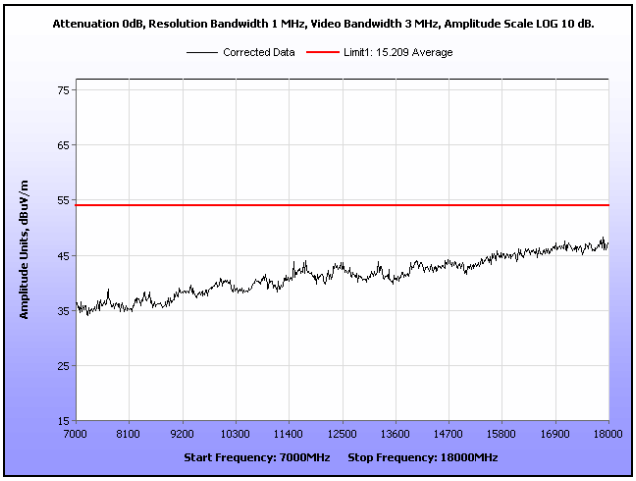
Plot 37. Radiated Spurious Emissions, 802.11n 20 MHz, 5745 MHz, 30 MHz – 1 GHz



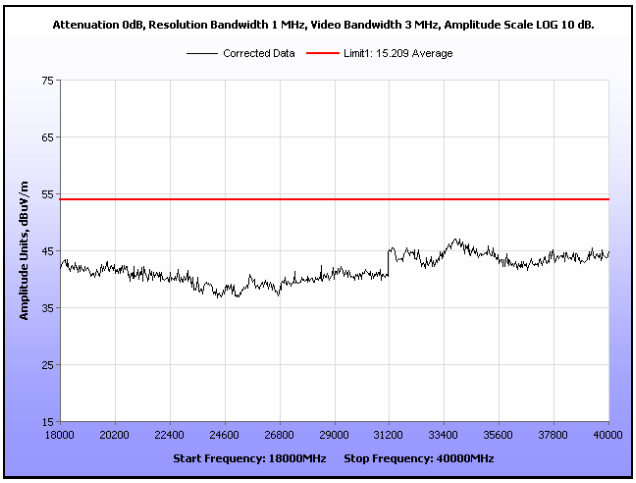
Plot 38. Radiated Spurious Emissions, 802.11n 20 MHz, 5745 MHz, 1 GHz – 7 GHz, Average



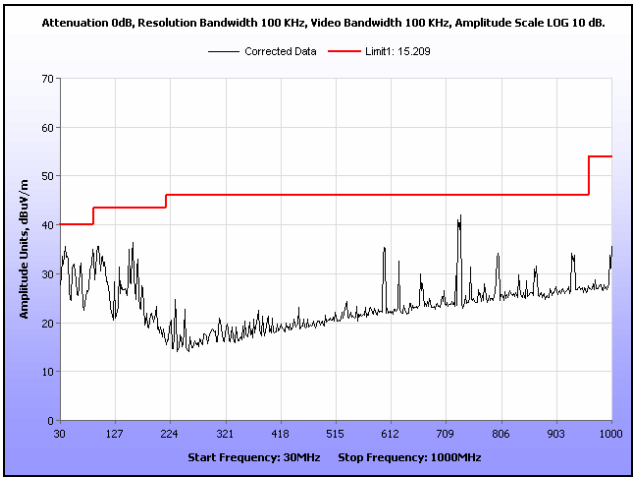
Plot 39. Radiated Spurious Emissions, 802.11n 20 MHz, 5745 MHz, 1 GHz – 7 GHz, Peak



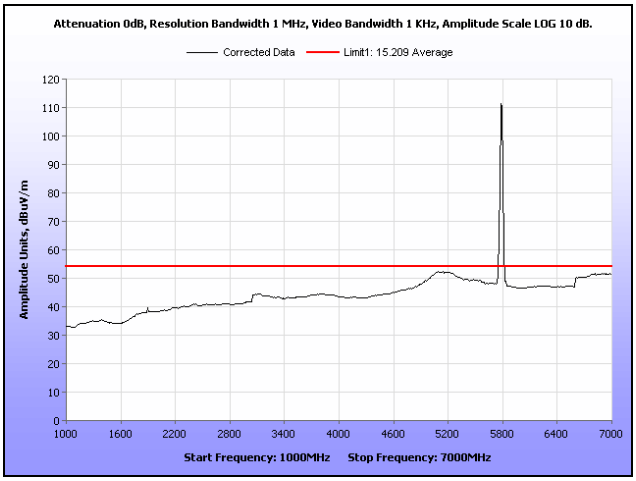
Plot 40. Radiated Spurious Emissions, 802.11n 20 MHz, 5745 MHz, 7 GHz – 18 GHz, Peak under Average



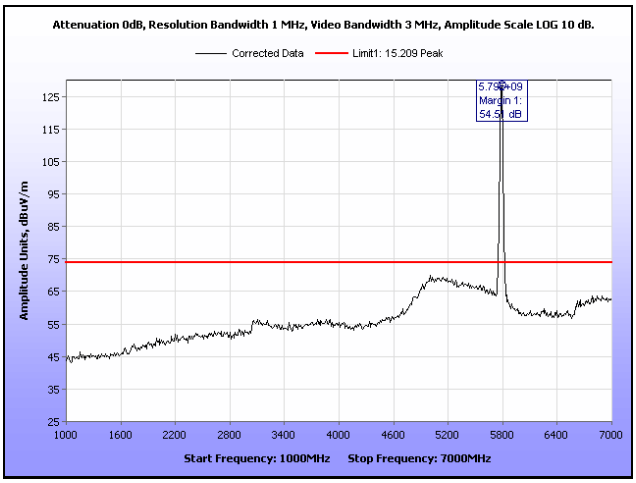
Plot 41. Radiated Spurious Emissions, 802.11n 20 MHz, 5745 MHz, 18 GHz – 40 GHz, Peak under Average



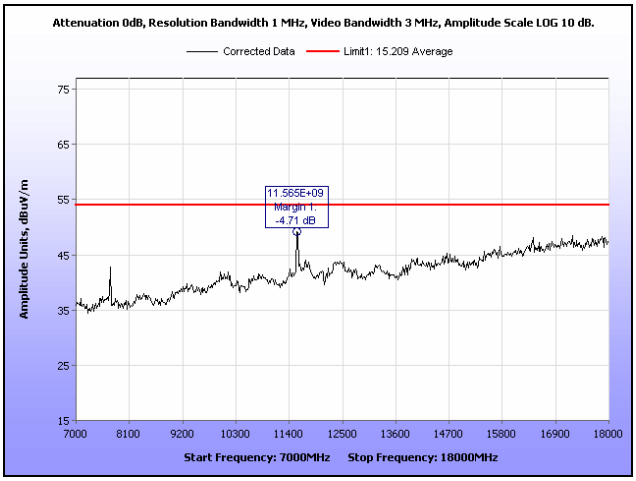
Plot 42. Radiated Spurious Emissions, 802.11n 20 MHz, 5785 MHz, 30 MHz – 1 GHz



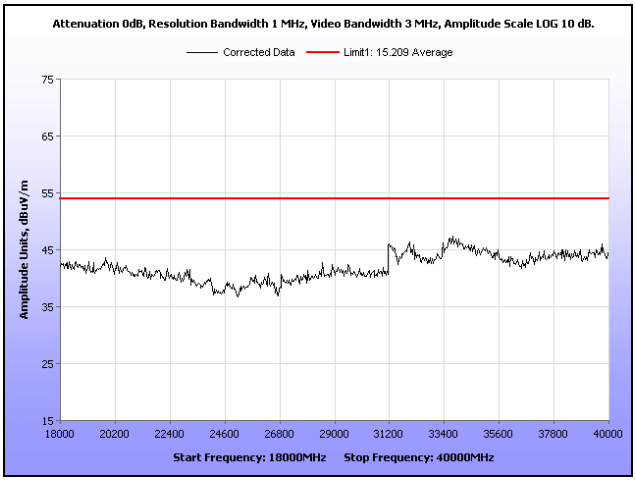
Plot 43. Radiated Spurious Emissions, 802.11n 20 MHz, 5785 MHz, 1 GHz – 7 GHz, Average



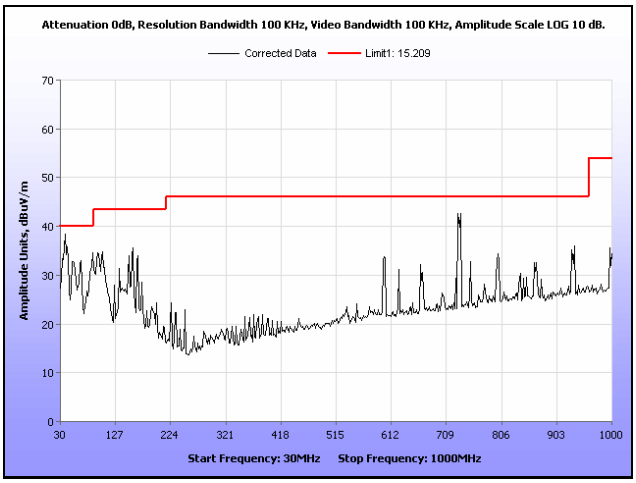
Plot 44. Radiated Spurious Emissions, 802.11n 20 MHz, 5785 MHz, 1 GHz – 7 GHz, Peak



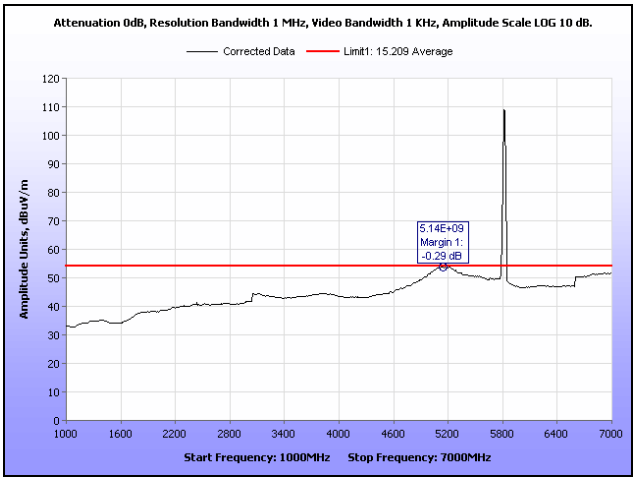
Plot 45. Radiated Spurious Emissions, 802.11n 20 MHz, 5785 MHz, 7 GHz – 18 GHz, Peak under Average



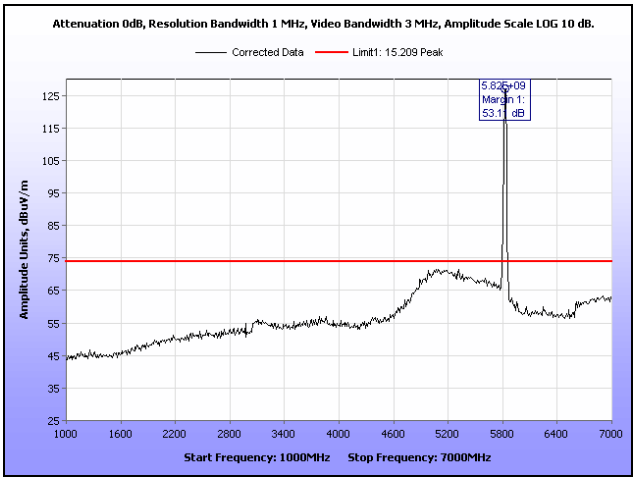
Plot 46. Radiated Spurious Emissions, 802.11n 20 MHz, 5785 MHz, 18 GHz – 40 GHz, Peak under Average



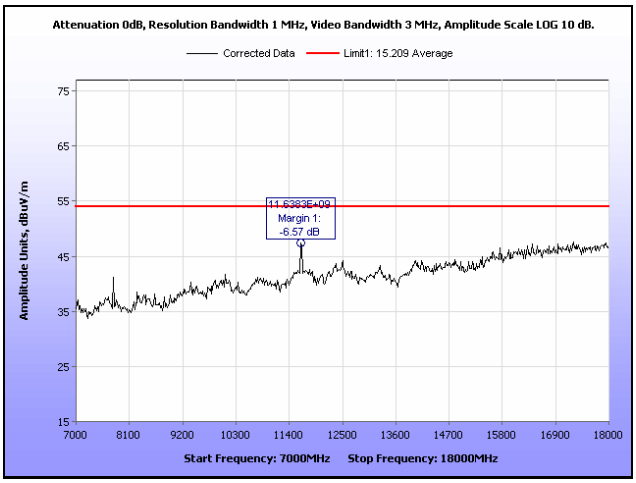
Plot 47. Radiated Spurious Emissions, 802.11n 20 MHz, 5825 MHz, 30 MHz – 1 GHz



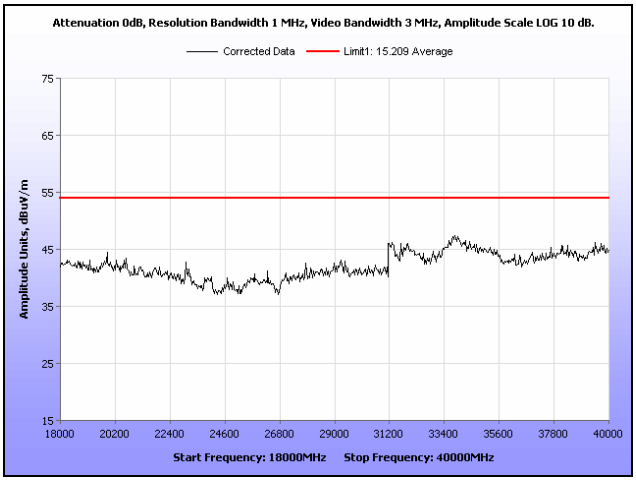
Plot 48. Radiated Spurious Emissions, 802.11n 20 MHz, 5825 MHz, 1 GHz – 7 GHz, Average



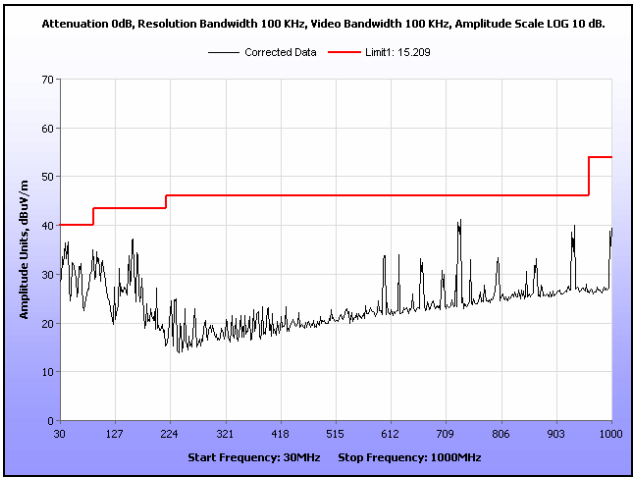
Plot 49. Radiated Spurious Emissions, 802.11n 20 MHz, 5825 MHz, 1 GHz – 7 GHz, Peak



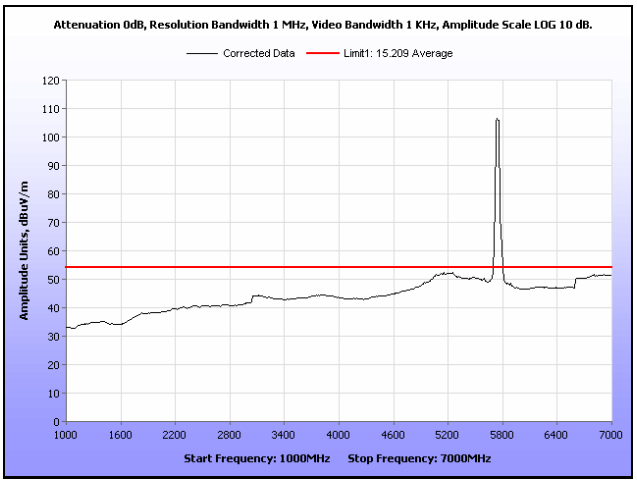
Plot 50. Radiated Spurious Emissions, 802.11n 20 MHz, 5825 MHz, 7 GHz – 18 GHz, Peak under Average



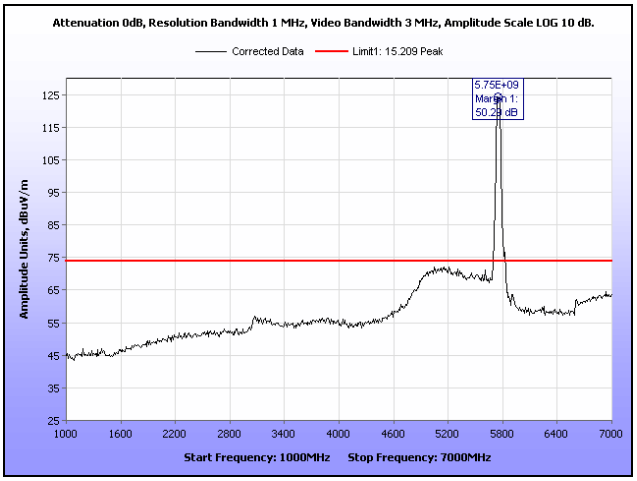
Plot 51. Radiated Spurious Emissions, 802.11n 20 MHz, 5825 MHz, 18 GHz – 40 GHz, Peak under Average



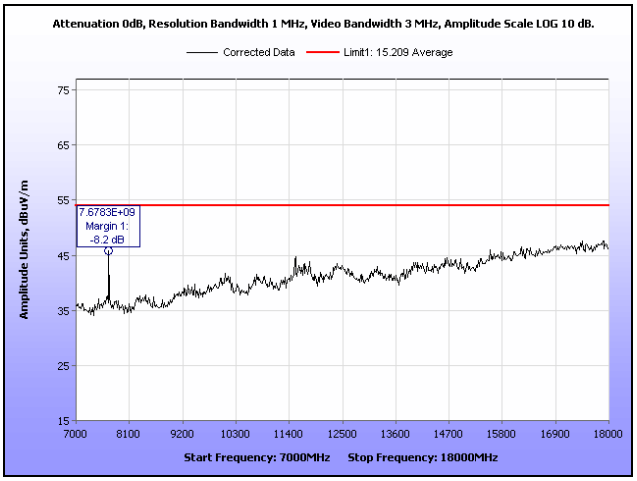
Plot 52. Radiated Spurious Emissions, 802.11n 40 MHz, 5755 MHz, 30 MHz – 1 GHz



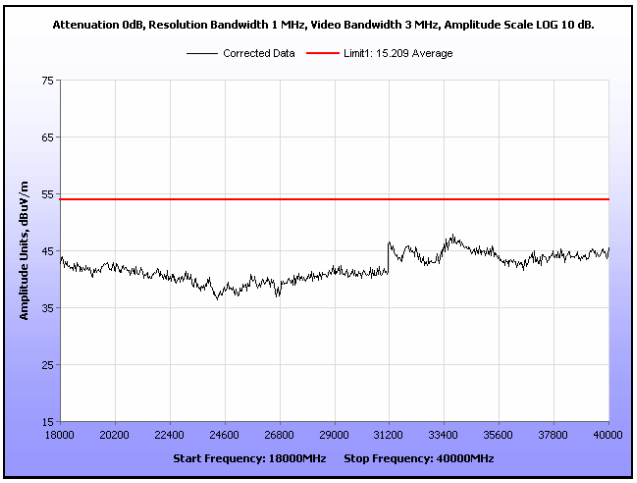
Plot 53. Radiated Spurious Emissions, 802.11n 40 MHz, 5755 MHz, 1 GHz – 7 GHz, Average



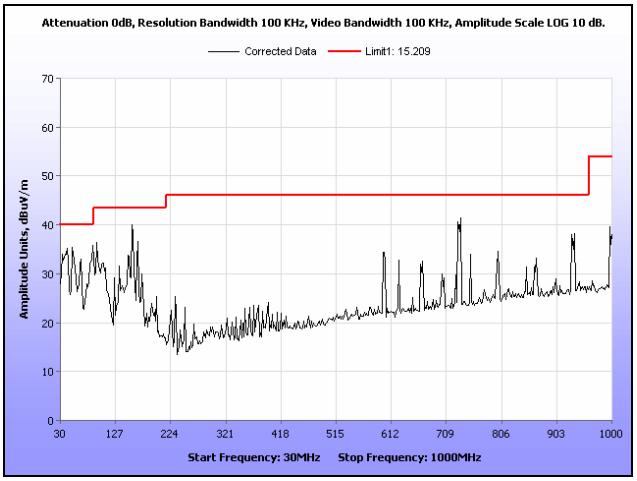
Plot 54. Radiated Spurious Emissions, 802.11n 40 MHz, 5755 MHz, 1 GHz – 7 GHz, Peak



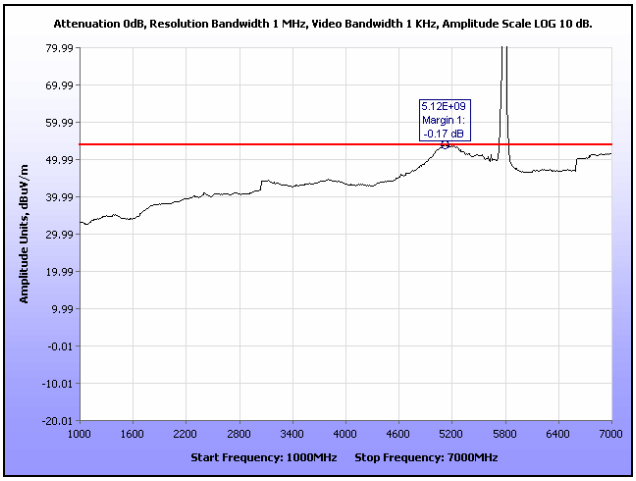
Plot 55. Radiated Spurious Emissions, 802.11n 40 MHz, 5755 MHz, 7 GHz – 18 GHz, Peak under Average



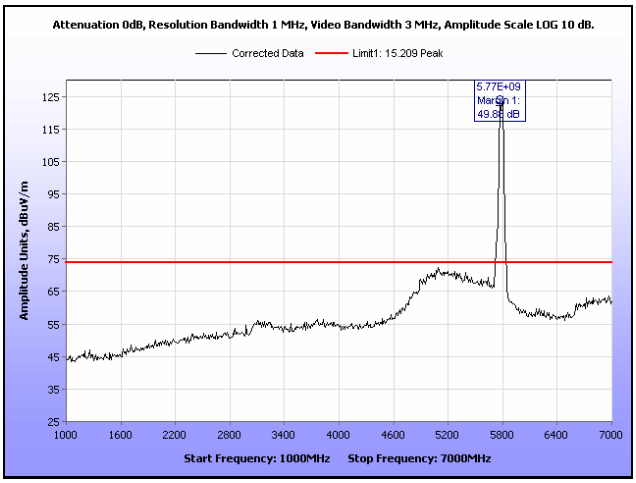
Plot 56. Radiated Spurious Emissions, 802.11n 40 MHz, 5755 MHz, 18 GHz – 40 GHz, Peak under Average



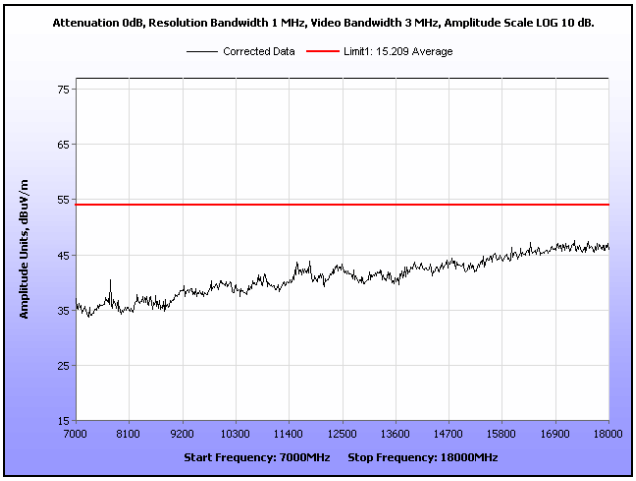
Plot 57. Radiated Spurious Emissions, 802.11n 40 MHz, 5785 MHz, 30 MHz – 1 GHz



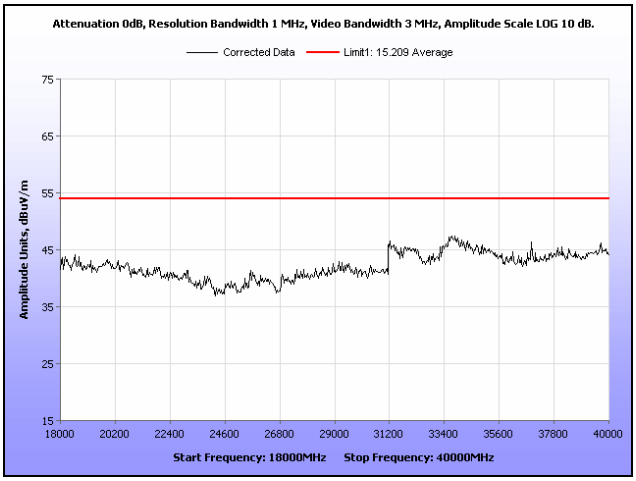
Plot 58. Radiated Spurious Emissions, 802.11n 40 MHz, 5785 MHz, 1 GHz – 7 GHz, Average



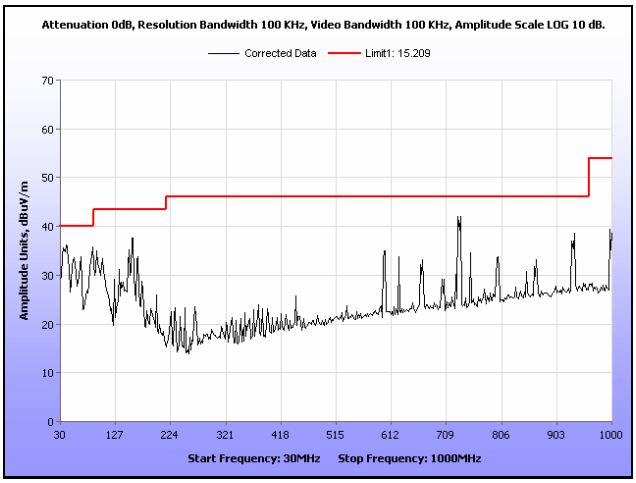
Plot 59. Radiated Spurious Emissions, 802.11n 40 MHz, 5785 MHz, 1 GHz – 7 GHz, Peak



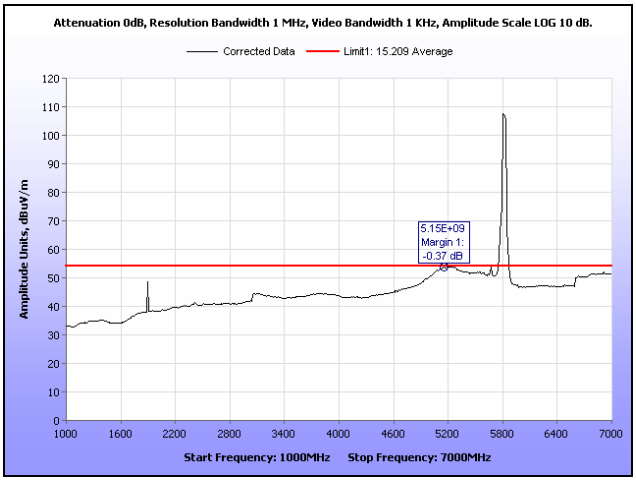
Plot 60. Radiated Spurious Emissions, 802.11n 40 MHz, 5785 MHz, 7 GHz – 18 GHz, Peak under Average



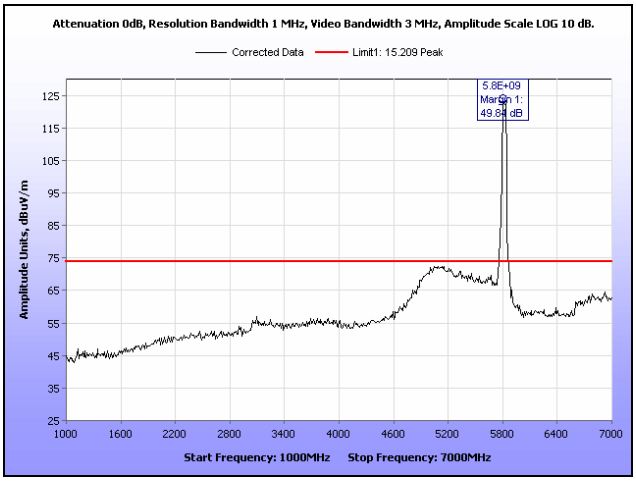
Plot 61. Radiated Spurious Emissions, 802.11n 40 MHz, 5785 MHz, 18 GHz – 40 GHz, Peak under Average



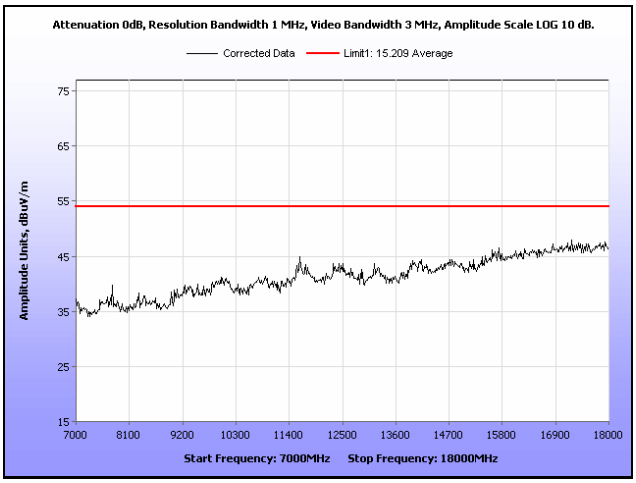
Plot 62. Radiated Spurious Emissions, 802.11n 40 MHz, 5815 MHz, 30 MHz – 1 GHz



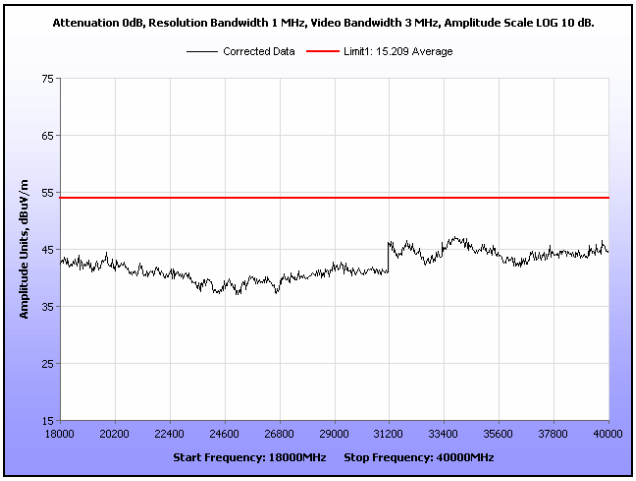
Plot 63. Radiated Spurious Emissions, 802.11n 40 MHz, 5815 MHz, 1 GHz – 7 GHz, Average



Plot 64. Radiated Spurious Emissions, 802.11n 40 MHz, 5815 MHz, 1 GHz – 7 GHz, Peak



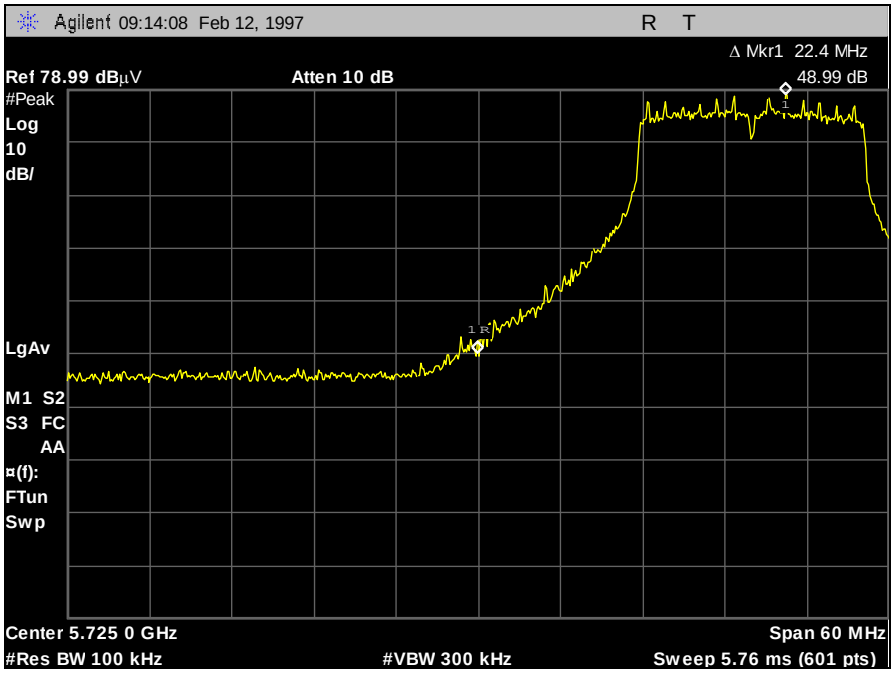
Plot 65. Radiated Spurious Emissions, 802.11n 40 MHz, 5815 MHz, 7 GHz – 18 GHz, Peak under Average



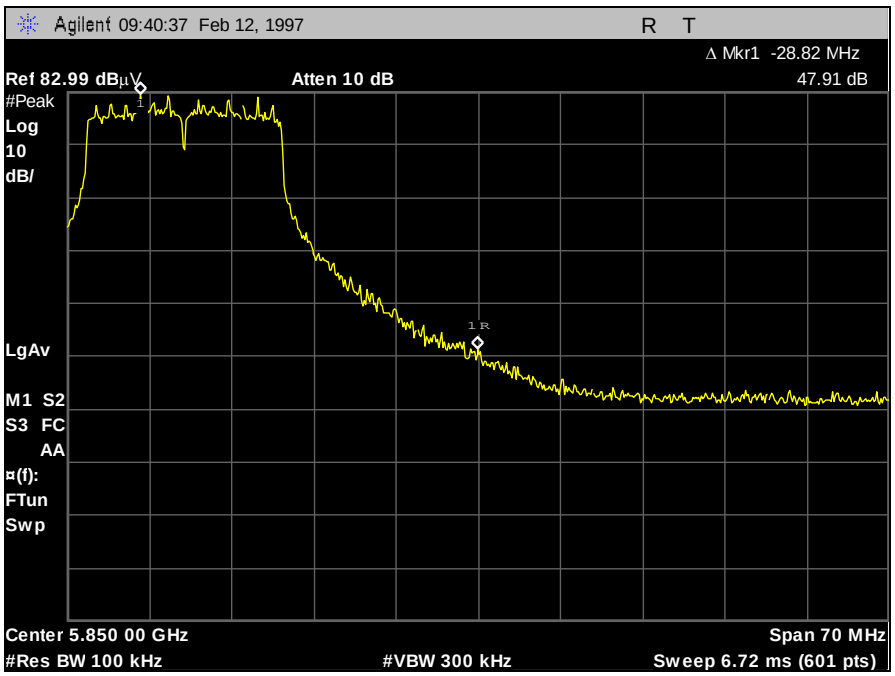
Plot 66. Radiated Spurious Emissions, 802.11n 40 MHz, 5815 MHz, 18 GHz – 40 GHz, Peak under Average

Radiated Band Edge Measurements

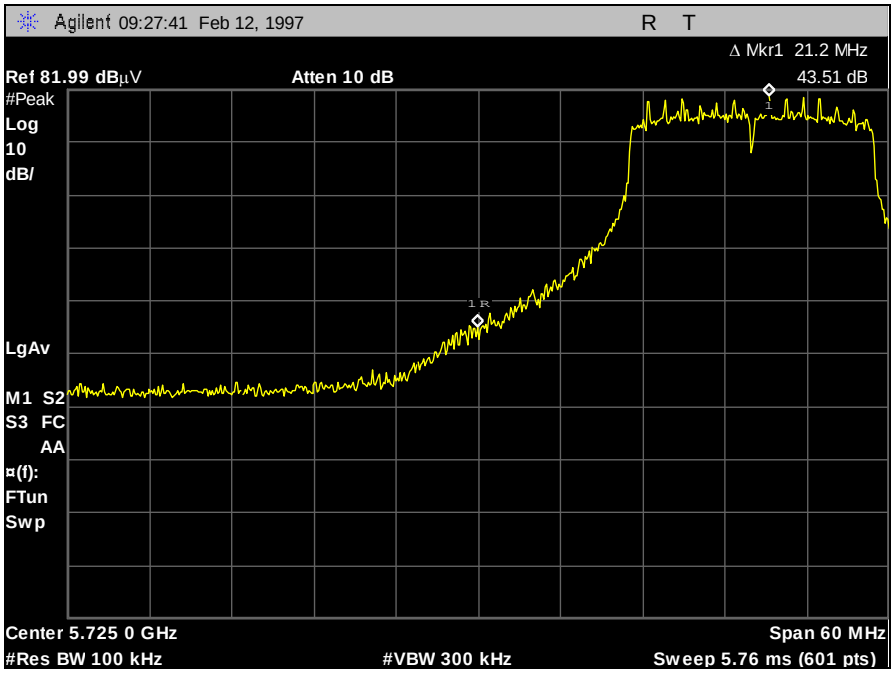
Test Procedures: The transmitter was turned on. Measurements were performed of the low and high Channels in each mode. The EUT was rotated orthogonally through all three axes. The emission level at the band edge was compared to the peak of the carrier in a 100kHz bandwidth. This delta was compared to the limit of 15.247(d).



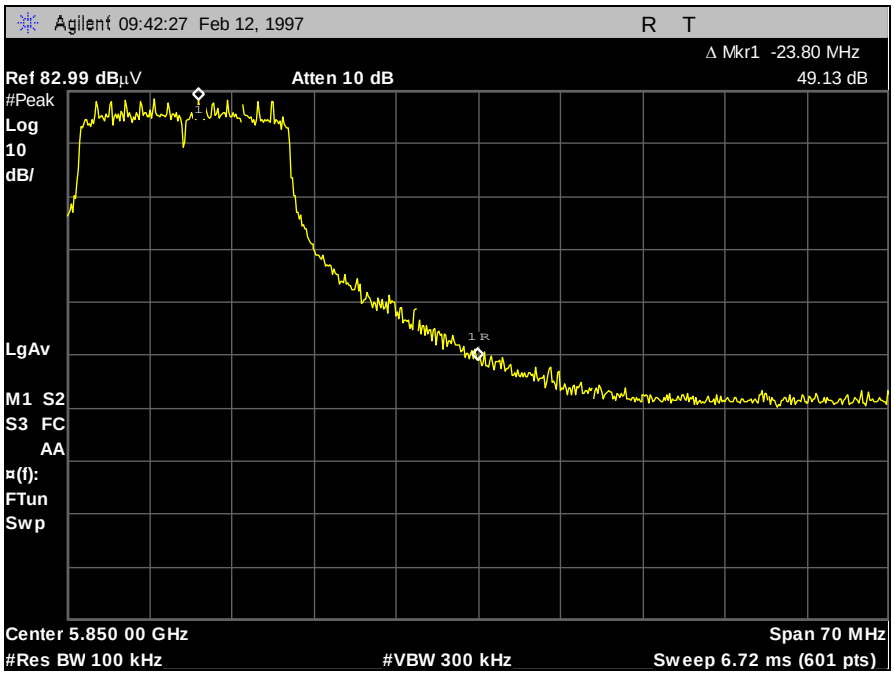
Plot 67. Radiated Band Edge, 802.11a, 5745 MHz



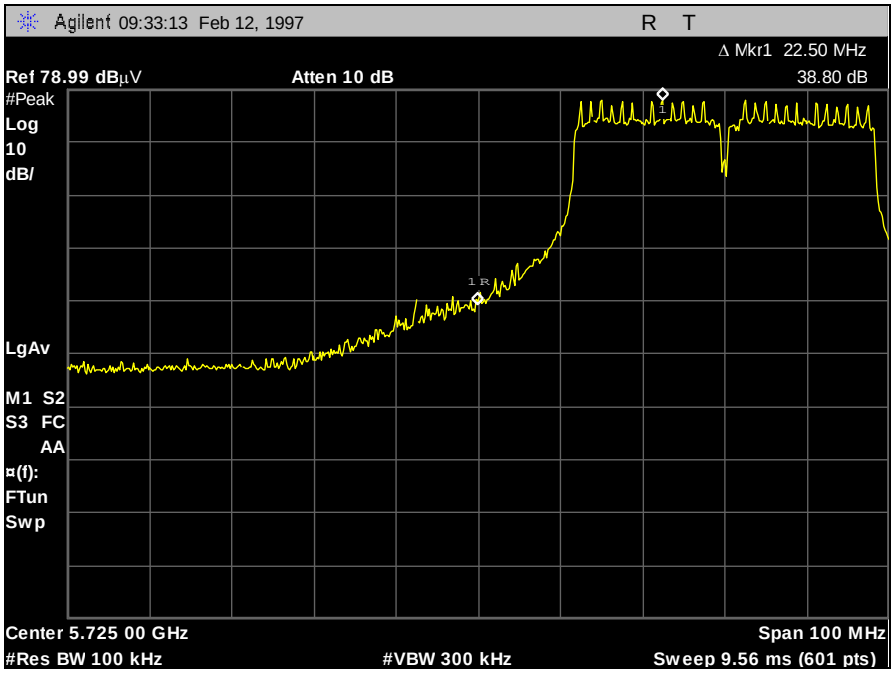
Plot 68. Radiated Band Edge, 802.11a, 5825 MHz



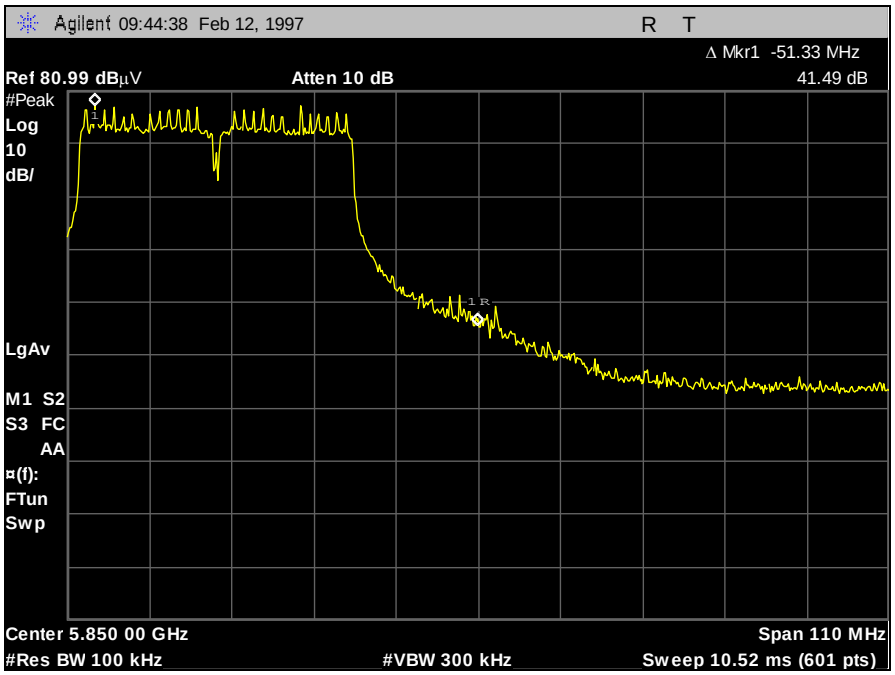
Plot 69. Radiated Band Edge, 802.11n 20 MHz, 5745 MHz



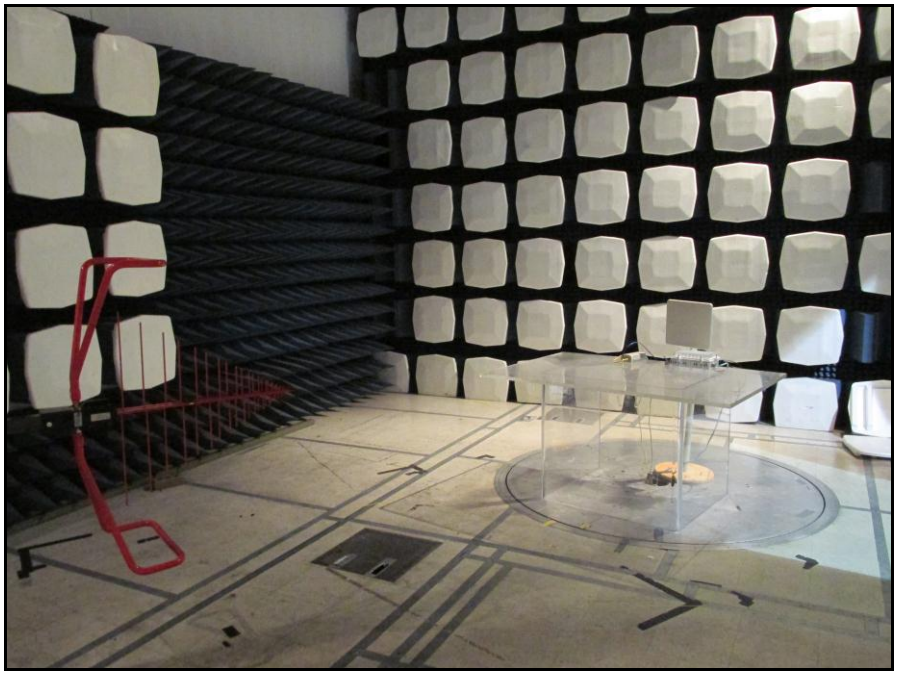
Plot 70. Radiated Band Edge, 802.11n 20 MHz, 5825 MHz



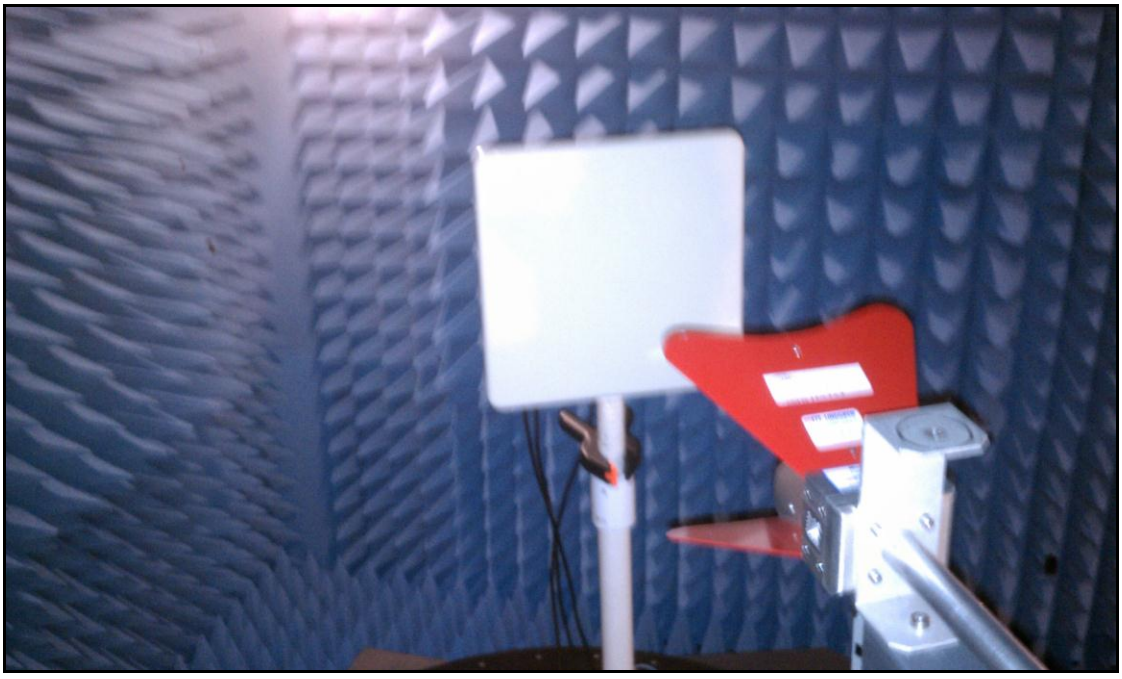
Plot 71. Radiated Band Edge, 802.11n 40 MHz, 5755 MHz



Plot 72. Radiated Band Edge, 802.11n 40 MHz, 5815 MHz



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



Photograph 6. Radiated Emissions, Test Setup, Panel Antenna

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 Calculation: EUT's operating frequencies @ 5745-5825 MHz; highest conducted power = 15.16*dBm* (avg) therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

Gain of Vertical Antenna Element @ 5.8GHz = 21dBi
Gain of Dual Slant 45° Elements @ 5.8GHz = 19dBi
# of Antenna Elements = 3
Directional Gain = $10\log[(10^{G1/10}+10^{G2/10}+10^{G3/10})/N_{ANT}]$ = 19.77 dBi

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

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

where, S = Power Density (1 mW/cm^2)
P = Power Input to antenna (32.81 mW)
G = Antenna Gain (94.92)

$R = (32.81*94.92/ 4*3.14*1.0)^{1/2} = (3114.26/12.56)^{1/2}$ = 15.75 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 #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4612	SPECTRUM ANALYZER	AGILENT	E4407B	5/23/2012	11/23/2013
1T4149	HIGH-FREQUENCY ANECHOIC CHAMBER	RAY-PROOF	81	SEE NOTE	
1T4483	ANTENNA; HORN	ETS-LINDGREN	3117	8/6/2012	2/6/2014
1T4771	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	2/15/2013	8/15/2014
1T4791	THERMO./CLOCK/HUMIDITY	CONTROL COMPANY	06-662-4	3/8/2012	3/8/2014
1T4442	PRE-AMPLIFIER; MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T4745	ANTENNA; HORN	ETS-LINDGREN	3116	10/19/2012	10/19/2013
1T4752	PRE-AMPLIFIER	MITEQ	JS44-18004000-35-8P	SEE NOTE	
1T4300	SEMI-ANECHOIC CHAMBER #1	EMC TEST SYSTEMS	N/A	7/24/2012	7/24/2015
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	7/16/2012	7/16/2013
1T4568	RADIATING NOISE SOURCE	MET LABORATORIES	N/A	SEE NOTE	
1T4814	COMB GENERATOR	COM-POWER	CGO-5100	SEE NOTE	
1T2278	SWEPT SIGNAL GENERATOR	HEWLETT PACKARD	83650B	10/31/2012	10/31/2013
1T4751	ANTENNA – BILOG	SUNOL SCIENCES	JB6	1/8/2013	7/8/2014

Table 11. 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 users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

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

§ 15.105 Information to the user.

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

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

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

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

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

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

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

ICES-003 Procedural & Labeling Requirements

From the Industry Canada Electromagnetic Compatibility Advisory Bulletin entitled, "Implementation and Interpretation of the Interference-Causing Equipment Standard for Digital Apparatus, ICES-003" (EMCAB-3, Issue 2, July 1995):

> "At present, CISPR 22: 2002 and ICES technical requirements are essentially equivalent. Therefore, if you have CISPR 22: 2002 approval by meeting CISPR Publication 22, the only additional requirements are: to attach a note to the report of the test results for compliance, indicating that these results are deemed satisfactory evidence of compliance with ICES-003 of the Canadian Interference-Causing Equipment Regulations; to maintain these records on file for the requisite five year period; and to provide the device with a notice of compliance in accordance with ICES-003."

Procedural Requirements:

According to Industry Canada's Interference Causing Equipment Standard for Digital Apparatus ICES-003 Issue 4, February 2004:

Section 6.1: A record of the measurements and results, showing the date that the measurements were completed, shall be retained by the manufacturer or importer for a period of at least five years from the date shown in the record and made available for examination on the request of the Minister.

Section 6.2: A written notice indicating compliance must accompany each unit of digital apparatus to the end user. The notice shall be in the form of a label that is affixed to the apparatus. Where because of insufficient space or other constraints it is not feasible to affix a label to the apparatus, the notice may be in the form of a statement in the user's manual.

Labeling Requirements:

The suggested text for the notice, in English and in French, is provided below, from the Annex of ICES-003:

> This Class [2] digital apparatus complies with Canadian ICES-003.
>
> Cet appareil numérique de la classe [1] est conforme à la norme NMB-003 du Canada.

[2] Insert either A or B but not both as appropriate for the equipment requirements.

End of Report

