MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
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June 10, 2010

Rajant Corporation
400 E. King Street
Malvern, PA 19355

Dear Keith Sullivan,

Enclosed is the EMC Wireless test report for compliance testing of the Rajant Corporation, BreadCrumb JR-24 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart B, ICES-003, Issue 4 February 2004 for a Class A Digital Device and FCC Part 15 Subpart C, RSS-210, Issue 7, June 2007 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: (\Rajant Corporation\EMC29072-FCC247 Rev. 2)

Electromagnetic Compatibility Criteria
Test Report

for the

Rajant Corporation
BreadCrumb JR-24

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart B & ICES-003
for Class A Digital Devices
&
15.247 Subpart C & RSS-210, Issue 7, June 2007
for Intentional Radiators

MET Report: EMC29072-FCC247 Rev. 2

June 10, 2010

Prepared For:

Rajant Corporation
400 E. King Street
Malvern, PA 19355

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

Electromagnetic Compatibility Criteria
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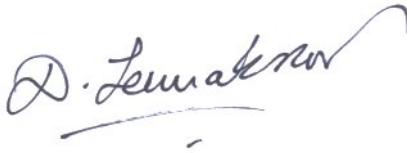

Dusmantha Tennakoon, Project Engineer
Electromagnetic Compatibility Lab

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 Parts 15B, 15.247 and Industry Canada standards ICES-003, Issue 4 February 2004, RSS-210, Issue 7, June 2007 under normal use and maintenance.

Shawn McMillen,
Wireless Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	May 24, 2010	Initial Issue.
1	May 28, 2010	Editorial correction.
2	June 10, 2010	Revised to add additional note for spurious emissions.

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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**ilovolt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**micro**henry
µ	**micro**farad
µs	**micro**seconds
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 Rajant Corporation BreadCrumb JR-24, 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 BreadCrumb JR-24. Rajant Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the BreadCrumb JR-24, 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 Rajant Corporation, purchase order number 2010140. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference 47 CFR Part 15.247:2005	IC Reference RSS-210 Issue 7: 2007	Description	Compliance
47 CFR Part 15.107 (a)	ICES-003 Issue 4 February 2004	Conducted Emission Limits for a Class A Digital Device – AC/DC	Compliant
47 CFR Part 15.107 (a)	ICES-003 Issue 4 February 2004	Conducted Emission Limits for a Class A Digital Device – DC/DC	Not Applicable – The EUT is DC powered.
47 CFR Part 15.109 (a)	ICES-003 Issue 4 February 2004	Radiated Emission Limits for a Class A Digital Device – AC/DC	Compliant
47 CFR Part 15.109 (a)	ICES-003 Issue 4 February 2004	Radiated Emission Limits for a Class A Digital Device – DC/DC	Compliant
Title 47 of the CFR, Part 15 §15.203	N/A	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	RSS-210(7.2.2)	Conducted Emission Voltage	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	RSS-210(A8.1)	Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	RSS-210(A8.4)	RF Output Power	Compliant
Title 47 of the CFR, Part 15 §15.209, §15.247(d)	RSS-210(A8.5)	Radiated Spurious Emissions	Compliant
Title 47 of the CFR, Part 15 §15.205	RSS-210(A8.5)	Emissions at Restricted Band	Compliant
Title 47 of the CFR, Part 15 §15.209, §15.247(d)	RSS-210(A8.5)	Conducted Spurious Emissions	Compliant
Title 47 of the CFR, Part 15; §15.247(e)	RSS-210(A8.3)	Power Spectral Density	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	RSS-Gen(5.5)	Maximum Permissible Exposure	Compliant
N/A	RSS-Gen(4.8)	Receiver Spurious Emissions	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Rajant Corporation to perform testing on the BreadCrumb JR-24, under Rajant Corporation's purchase order number 2010140.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Rajant Corporation, BreadCrumb JR-24.

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

Model(s) Tested:	BreadCrumb JR-24	
Model(s) Covered:	BreadCrumb JR-24	
EUT Specifications:	Primary Power: 120 VAC, 60 Hz	
	FCC ID: VJA-JR24 IC: 7382A-JR24	
	Type of Modulations:	DSSS and OFDM
	Equipment Code:	DTS
	Peak RF Output Power:	27.75 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:	Dusmantha Tennakoon	
Report Date(s):	June 10, 2010	

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 7, June 2007	Low-power Licence-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment
CFR 47, Part 15, Subpart B	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
ICES-003, Issue 4 February 2004	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
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
ANSI/NCSL Z540-1-1994	Calibration Laboratories and Measuring and Test Equipment - General Requirements
ANSI/ISO/IEC 17025:2000	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2009	American National Standard for Testing Unlicensed Wireless Devices

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 Rajant Corporation BreadCrumb JR-24, Equipment Under Test (EUT), is a wireless networking device. The DUT is a portable 802.11 b/g access point and mesh networking node. The DUT operates in the 2.4 GHz ISM band. The JR can be powered from either an AC/DC power supply, or a DC/DC power supply. Both power supplies will be provided for test of the DUT. The JR is configured with a N-female antenna port. A 5dBi fiberglass Omni antenna can be ordered with the unit, and will be used for qualification testing. DC power input, Ethernet RX/TX, Serial I/O, 3.3 V external power, and GPIO pin (future implementation) are ported to a 10 pin Amphenol circular. A 6 segment LED array provides an indication of unit status, system status, and warning conditions.

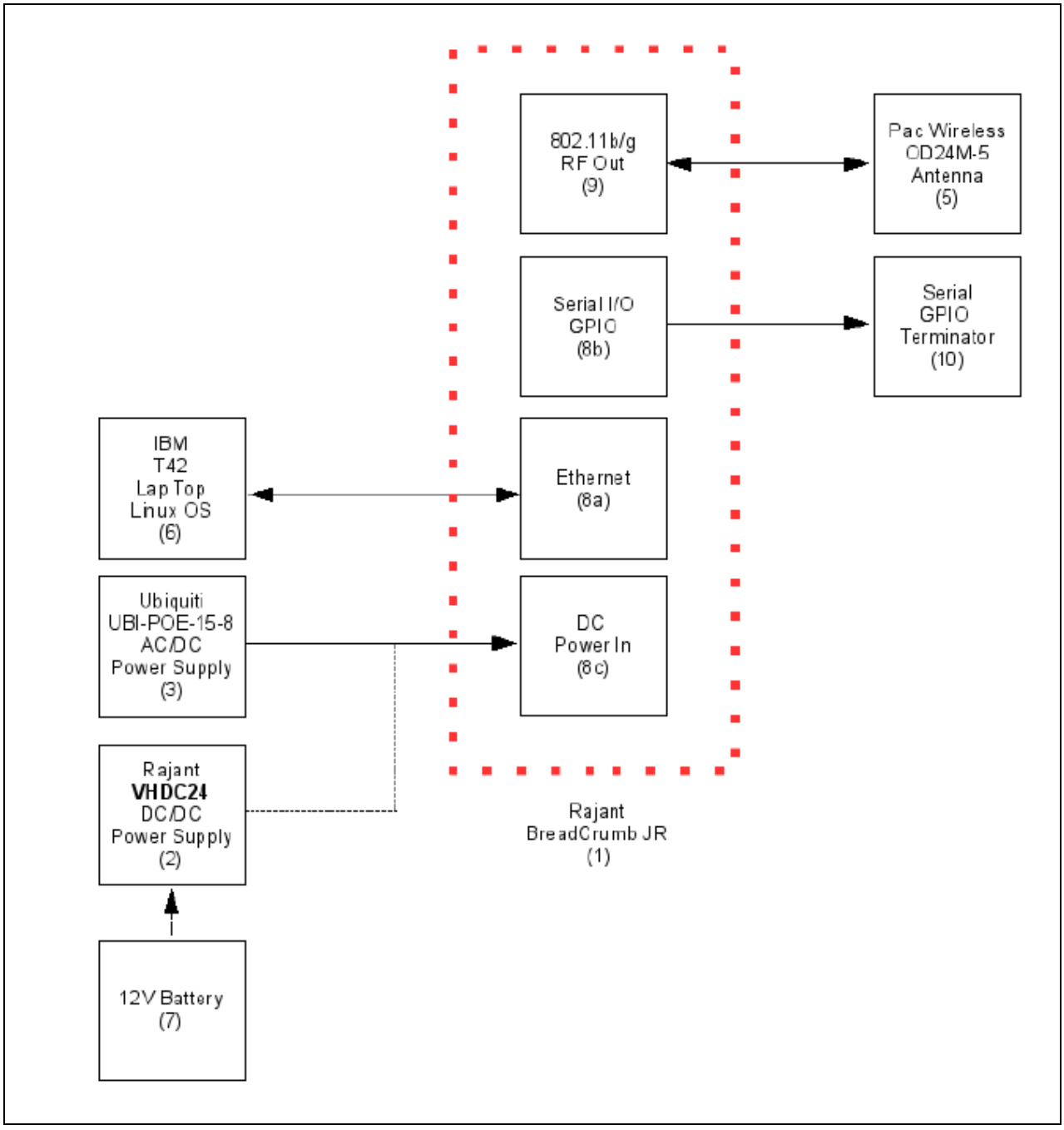


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

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

Ref. ID	Name / Description	Model Number	Serial Number
1	Rajant BreadCrumb JR	JR-24	N/A
2	Rajant VHDC-24 DC/DC converter	VHDC-24	N/A
3	Ubiquiti Networks Carrier POE Adapter	UBI-POE-15-8	N/A
4	BreadCrumb JR IO Cable	06-100043	N/A
5	2.4 GHz Omni Antenna Pacific Wireless	OD24M-5	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
6	Laptop Computer, Linux	IBM	ThinkPad T42
7	12V Lead Acid Battery	Panasonic	N/A
10	Serial, GPIO Terminator	N/A	N/A

Table 5. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
8a	Ethernet	Shielded Twisted Pair	1	0.3	Y	ETH0 of Laptop
8b	Serial I/O, GPIO	multi-conductor	1	0.3	N	Terminator
8c	DC Power	Shielded Twisted Pair	1	0.3	Y	Power Supply
9	RF Output	Antenna, Direct Attach	1	N/A	N	Antenna

Table 6. Ports and Cabling Information

H. Mode of Operation

The BreadCrumb JR DUT will be configured with standard firmware. Operational status of the DUT will be monitored from BCCommander, a mesh network administration tool.

Utility software will be used to create continuous transmit power conditions for intentional radiator test scenarios.

I. Method of Monitoring EUT Operation

LEDs on the JR, and the BCCommander network administration software will be monitor the operation of the EUT. A PING test shall be run over Ethernet to establish that the DUT is operating.

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 Rajant Corporation upon completion of testing.

III. Electromagnetic Compatibility Criteria for Unintentional Radiators

Electromagnetic Compatibility Criteria

§ 15.107 Conducted Emissions Limits

Test Requirement(s):

15.107 (a) Except for Class A digital devices, for equipment 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 30 MHz shall not exceed the limits in Table 7. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

15.107 (b) For a Class A digital device 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 30 MHz shall not exceed the limits in Table 7. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals. The lower limit applies at the band edges.

15.207(a), Except as shown in paragraphs (b) and (c) of this section*, charging, AC adapters or battery eliminators the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the Table 7, as measured using a 50 µH/50 ohms 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 frequencies ranges.

Frequency range (MHz)	Class A Conducted Limits (dBµV)		*Class B Conducted Limits (dBµV)	
	Quasi-Peak	Average	Quasi-Peak	Average
* 0.15- 0.45	79	66	66 - 56	56 - 46
0.45 - 0.5	79	66	56	46
0.5 - 30	73	60	60	50
Note 1 — The lower limit shall apply at the transition frequencies. Note 2 — The limit decreases linearly with the logarithm if the frequency in the range 0.15 MHz to 0.5 MHz. * -- Limits per Subsection 15.207(a).				

Table 7. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b) and 15.207(a)

Test Results: The EUT was compliant with the Class A requirement(s) of this section. For AC/DC power supply, the measured emissions were below applicable limits. The EUT is DC powered and therefore, DC/DC power supply is not applicable.

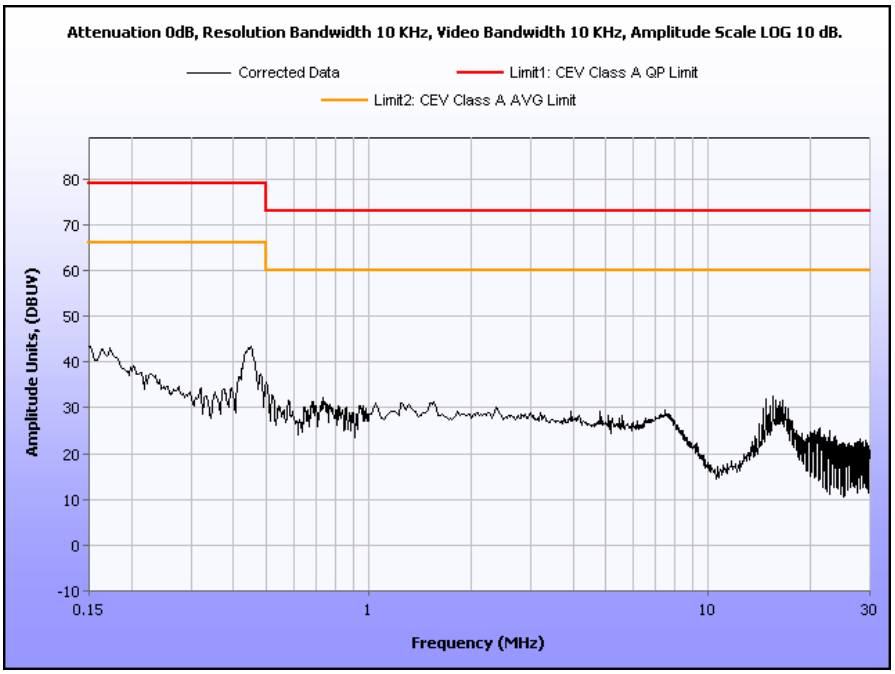
Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 05/04/10

Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC, 60 Hz)

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.15	39.54	0	39.54	79	-39.46	28.11	0	28.11	66	-37.89
0.4	28.52	0	28.52	79	-50.48	19.2	0	19.2	66	-46.8
0.5204	26.88	0	26.88	73	-46.12	19.8	0	19.8	60	-40.2
1.5625	24.13	0	24.13	73	-48.87	18.23	0	18.23	60	-41.77
16.9	21.66	0.08	21.74	73	-51.26	15.53	0.08	15.61	60	-44.39
20.45	7.43	0.13	7.56	73	-65.44	5.21	0.13	5.34	60	-54.66

Table 8. Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC, 60 Hz)

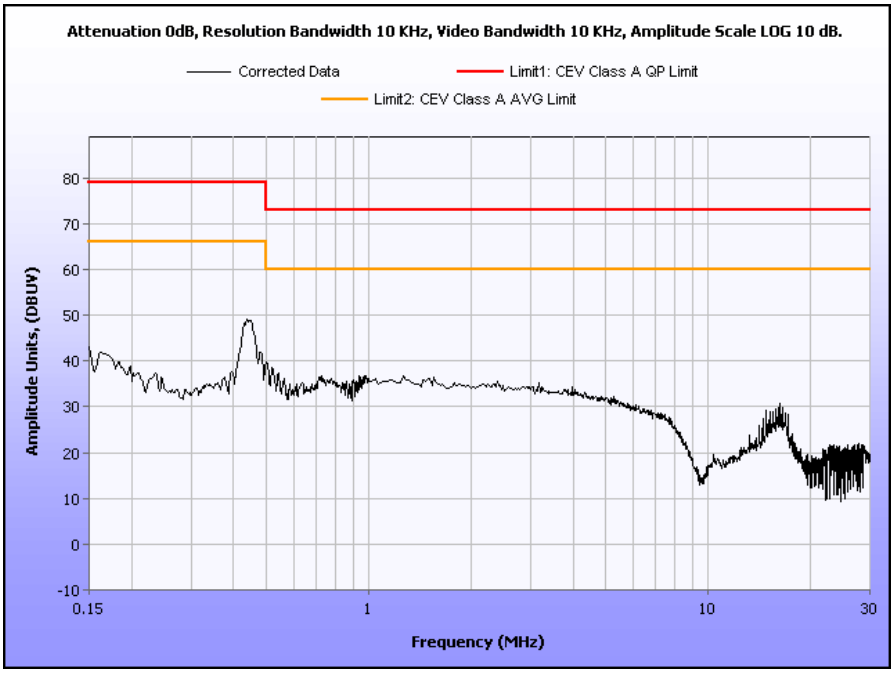


Plot 1. Conducted Emission, Phase Line Plot

Conducted Emissions - Voltage, AC Power, Neutral Line (120 VAC, 60 Hz)

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.1556	36.89	0	36.89	79	-42.11	29.75	0	29.75	66	-36.25
0.4465	47.1	0	47.1	79	-31.9	40.13	0	40.13	66	-25.87
0.5	37.36	0	37.36	73	-35.64	32.07	0	32.07	60	-27.93
1.1575	28.35	0	28.35	73	-44.65	24.39	0	24.39	60	-35.61
15.875	21.12	0.06	21.18	73	-51.82	17.35	0.06	17.41	60	-42.59
27.65	6.83	0.14	6.97	73	-66.03	4.52	0.14	4.66	60	-55.34

Table 9. Conducted Emissions - Voltage, AC Power, Neutral Line (120 VAC, 60 Hz)



Plot 2. Conducted Emission, Neutral Line Plot

Radiated Emission Limits

§ 15.109 Radiated Emissions Limits

Test Requirement(s): **15.109 (a)** Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the Class B limits expressed in Table 10.

15.109 (b) The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the Class A limits expressed in Table 10.

Frequency (MHz)	Field Strength (dBµV/m)	
	§15.109 (b), Class A Limit (dBµV) @ 10m	§15.109 (a),Class B Limit (dBµV) @ 3m
30 - 88	39.00	40.00
88 - 216	43.50	43.50
216 - 960	46.40	46.00
Above 960	49.50	54.00

Table 10. Radiated Emissions Limits calculated from FCC Part 15, §15.109 (a) (b)

Test Procedures: The EUT was isolated from the ground plane up to 12 mm of thin insulating material inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4 were used. An antenna was located 3 m from the EUT on an adjustable mast. A pre-scan was first performed in order to find prominent radiated emissions. For final emissions measurements at each frequency of interest, the EUT was rotated and the antenna height was varied between 1 m and 4 m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. Unless otherwise specified, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

Test Results: The EUT was compliant with the Class A requirement(s) of this section. Measured emissions were below applicable limits.

Test Engineer(s): Dusmantha Tennakoon

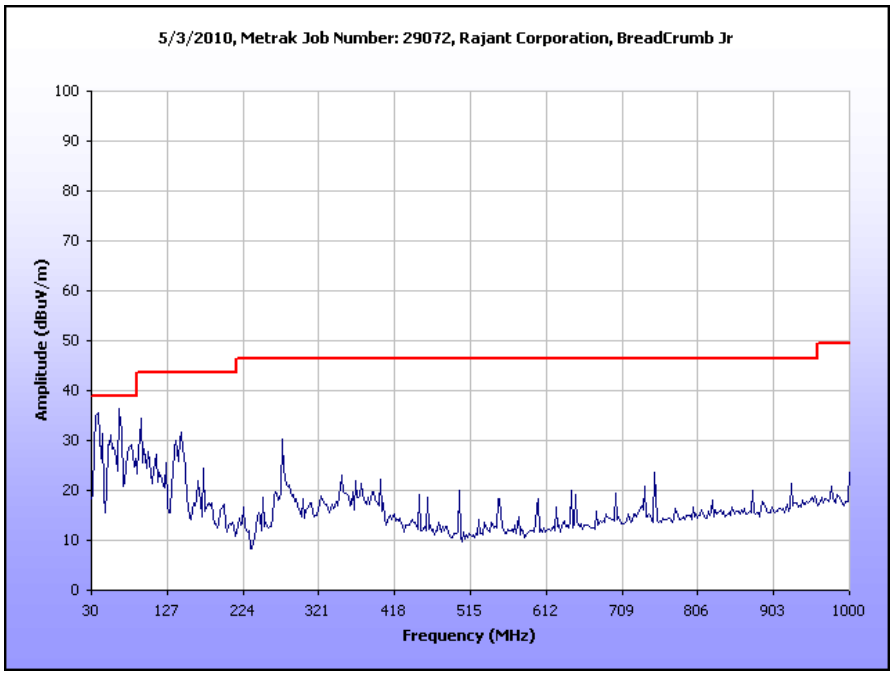
Test Date(s): 05/04/10

Radiated Emissions Limits Test Results, Class A

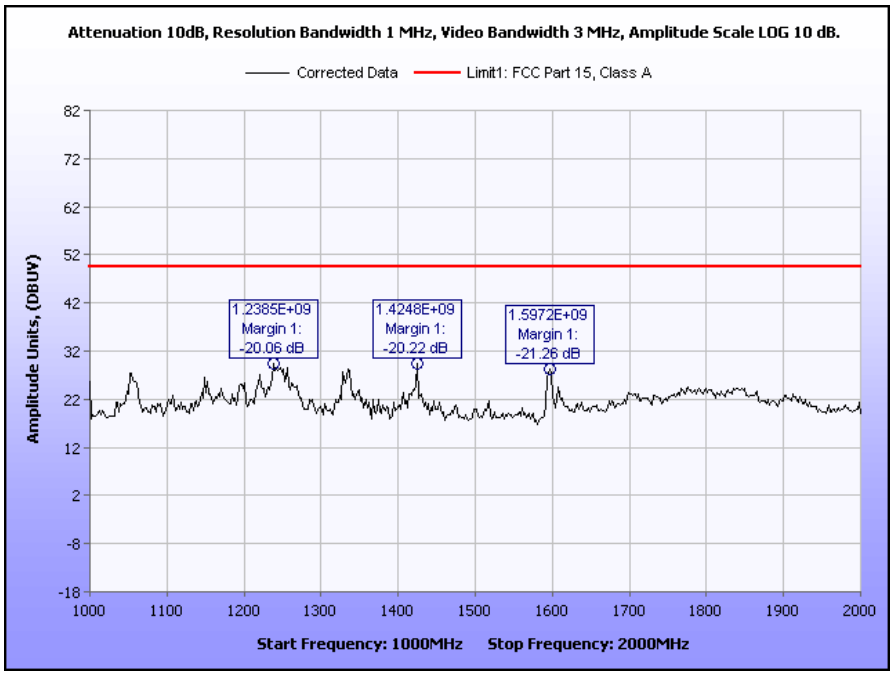
Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
37.367	86	H	2.70	15.82	8.05	0.23	10.46	13.64	39.00	-25.36
37.367	360	V	1.00	37.83	7.45	0.23	10.46	35.05	39.00	-3.95
66.292	337	H	2.30	14.88	10.04	0.23	10.46	14.69	39.00	-24.31
66.292	29	V	1.00	35.99	9.68	0.23	10.46	35.44	39.00	-3.56
138.399	352	H	2.20	17.02	7.67	0.23	10.46	14.46	43.50	-29.04
138.399	26	V	1.00	30.34	7.76	0.23	10.46	27.87	43.50	-15.63
145.251	143	H	2.00	18.89	8.01	0.23	10.46	16.67	43.50	-26.83
145.251	29	V	1.00	32.36	7.69	0.23	10.46	29.82	43.50	-13.68
276.014	19	H	1.00	15.80	12.24	0.68	10.46	18.26	46.40	-28.14
276.014	360	V	1.00	28.20	11.98	0.68	10.46	30.40	46.40	-16.00
749.982	0	H	2.00	8.30	21	1.5	10.46	20.34	46.40	-26.06
749.982	326	V	1.00	8.46	20.9	1.5	10.46	20.40	46.40	-26.00

Table 11. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz, FCC Limits, AC/DC Power Supply

Note: The EUT was tested at 3 m.



Plot 3. Radiated Emissions, 30 MHz - 1 GHz, FCC Limits, AC/DC Power Supply



Plot 4. Radiated Emissions, 1 GHz – 2 GHz, FCC Limits, AC/DC Power Supply

Radiated Emissions Limits Test Results, Class A

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
37.367	86	H	2.70	15.82	8.05	0.23	10.46	13.64	40.00	-26.36
37.367	360	V	1.00	37.83	7.45	0.23	10.46	35.05	40.00	-4.95
66.292	337	H	2.30	14.88	10.04	0.23	10.46	14.69	40.00	-25.31
66.292	29	V	1.00	35.99	9.68	0.23	10.46	35.44	40.00	-4.56
138.399	352	H	2.20	17.02	7.67	0.23	10.46	14.46	40.00	-25.54
138.399	26	V	1.00	30.34	7.76	0.23	10.46	27.87	40.00	-12.13
145.251	143	H	2.00	18.89	8.01	0.23	10.46	16.67	40.00	-23.33
145.251	29	V	1.00	32.36	7.69	0.23	10.46	29.82	40.00	-10.18
276.014	19	H	1.00	15.80	12.24	0.68	10.46	18.26	47.00	-28.74
276.014	360	V	1.00	28.20	11.98	0.68	10.46	30.40	47.00	-16.60
749.982	0	H	2.00	8.30	21	1.5	10.46	20.34	47.00	-26.66
749.982	326	V	1.00	8.46	20.9	1.5	10.46	20.40	47.00	-26.60

Table 12. Radiated Emissions Limits, Test Results, ICES-003 Limits, AC/DC Power Supply

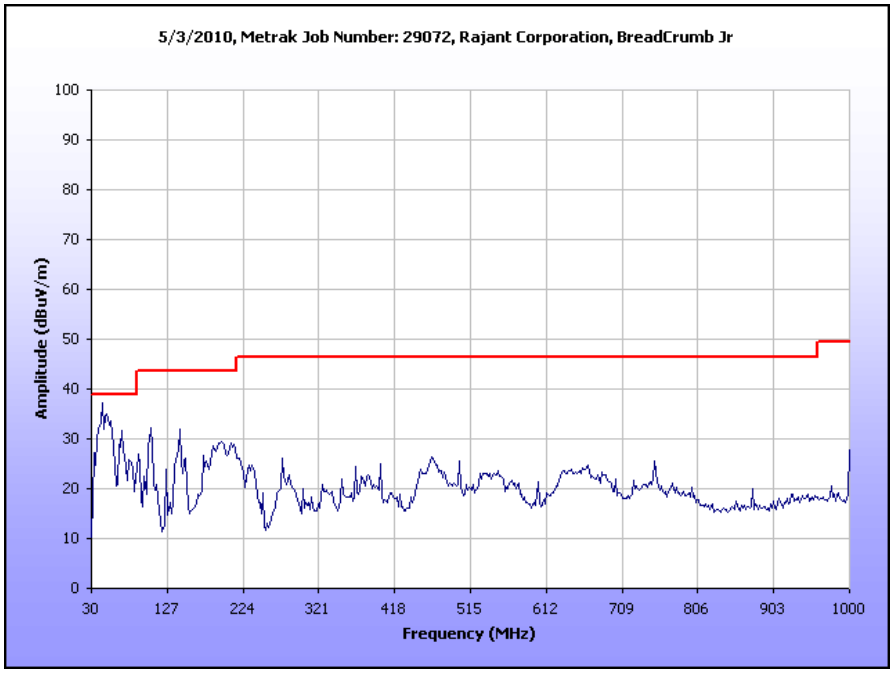
Note: The EUT was tested at 3 m.

Radiated Emissions Limits Test Results, Class A

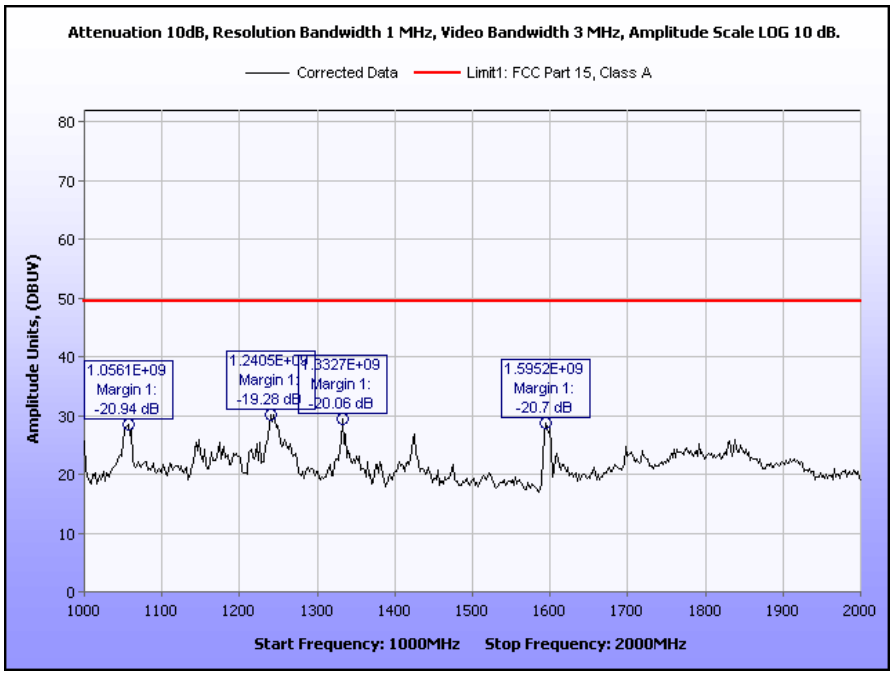
Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
43.773	197	H	3.00	22.97	8.98	0.23	10.46	21.72	39.00	-17.28
43.773	360	V	1.00	37.55	8.35	0.23	10.46	35.67	39.00	-3.33
106.695	360	H	1.80	17.24	7.33	0.23	10.46	14.34	43.50	-29.16
106.695	273	V	1.00	33.35	7.57	0.23	10.46	30.69	43.50	-12.81
174.992	360	H	1.50	11.89	9.2	0.23	10.46	10.86	43.50	-32.64
174.992	25.1	V	1.00	26.59	9	0.23	10.46	25.36	43.50	-18.14
460.068	328	H	1.00	10.63	16.7	1	10.46	17.87	46.40	-28.53
460.068	360	V	1.00	14.06	17.3	1	10.46	21.90	46.40	-24.50
643.983	0	H	1.00	9.25	20.08	1.17	10.46	20.04	46.40	-26.36
643.983	30	V	1.00	11.53	20.1	1.17	10.46	22.34	46.40	-24.06
750.010	128	H	1.00	10.24	21	1.5	10.46	22.28	46.40	-24.12
750.010	233	V	1.00	13.03	20.9	1.5	10.46	24.97	46.40	-21.43

Table 13. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz, FCC Limits, DC/DC Power Supply

Note: The EUT was tested at 3 m.



Plot 5. Radiated Emissions, 30 MHz - 1 GHz, FCC Limits, DC/DC Power Supply



Plot 6. Radiated Emissions, 1 GHz – 2 GHz, FCC Limits, DC/DC Power Supply

Radiated Emissions Limits Test Results, Class A

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
43.773	197	H	3.00	22.97	8.98	0.23	10.46	21.72	40.00	-18.28
43.773	360	V	1.00	37.55	8.35	0.23	10.46	35.67	40.00	-4.33
106.695	360	H	1.80	17.24	7.33	0.23	10.46	14.34	40.00	-25.66
106.695	273	V	1.00	33.35	7.57	0.23	10.46	30.69	40.00	-9.31
174.992	360	H	1.50	11.89	9.2	0.23	10.46	10.86	40.00	-29.14
174.992	25.1	V	1.00	26.59	9	0.23	10.46	25.36	40.00	-14.64
460.068	328	H	1.00	10.63	16.7	1	10.46	17.87	47.00	-29.13
460.068	360	V	1.00	14.06	17.3	1	10.46	21.90	47.00	-25.10
643.983	0	H	1.00	9.25	20.08	1.17	10.46	20.04	47.00	-26.96
643.983	30	V	1.00	11.53	20.1	1.17	10.46	22.34	47.00	-24.66
750.010	128	H	1.00	10.24	21	1.5	10.46	22.28	47.00	-24.72
750.010	233	V	1.00	13.03	20.9	1.5	10.46	24.97	47.00	-22.03

Table 14. Radiated Emissions Limits, Test Results, ICES-003 Limits, DC/DC Power Supply

Note: The EUT was tested at 3 m.

IV. 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 unit is professionally installed. The antenna is a 5 dBi Omni antenna.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 05/04/10

Gain	Type	Model	Manufacturer
5 dBi	Omni	OD24M-5	Pacific Wireless

Table 15. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207 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- 0.45	66 - 56	56 - 46
0.45 - 0.5	56	46
0.5 - 30	60	50

Table 16. 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 inside a screen room. 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"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were preformed with the transmitter on.

Test Results: The EUT was compliant with this requirement. Measured emissions were below applicable limits. Pre-scans revealed that amplitudes and emissions profiles were similar on low, middle and high channels on both modes of operation. Therefore, final measurements were made on channel 11, g mode.

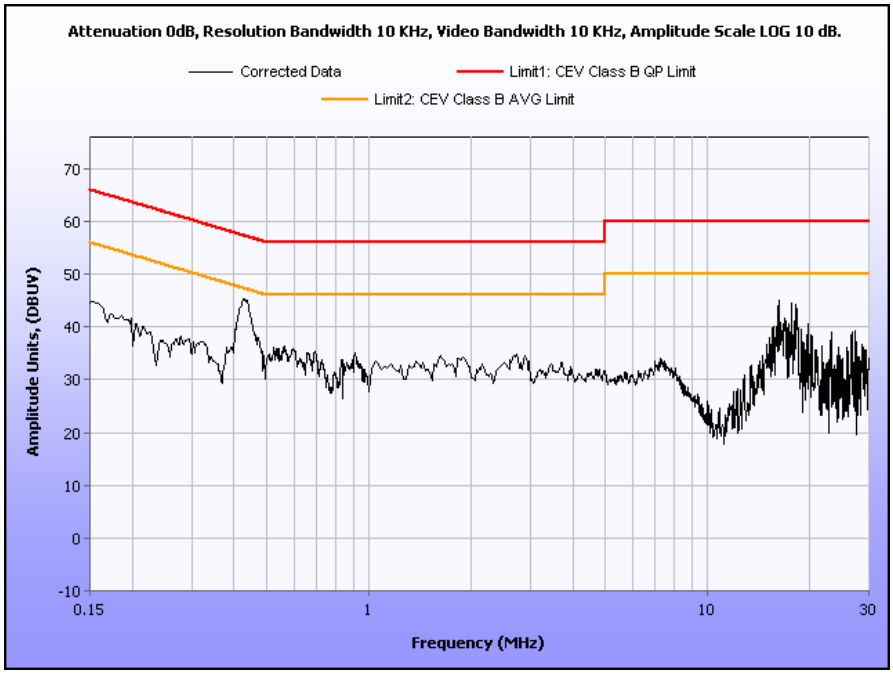
Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 05/04/10

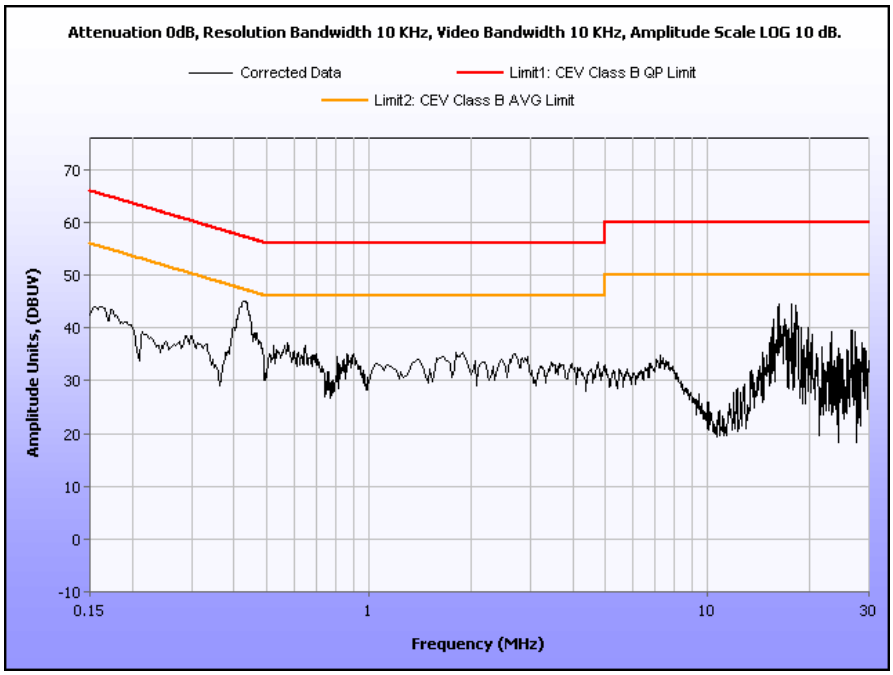
15.207 Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.1676	39.36	0.01	39.37	65.08	-25.71	27.37	0.01	27.38	55.08	-27.7
0.4275	40.08	0	40.08	57.3	-17.22	23.82	0	23.82	47.3	-23.48
0.5963	29.45	0	29.45	56	-26.55	18.7	0	18.7	46	-27.3
2.6875	29.98	0	29.98	56	-26.02	18.33	0	18.33	46	-27.67
16.25	23.62	0.07	23.69	60	-36.31	17.01	0.07	17.08	50	-32.92
23.1	14.97	0.14	15.11	60	-44.89	10.44	0.14	10.58	50	-39.42

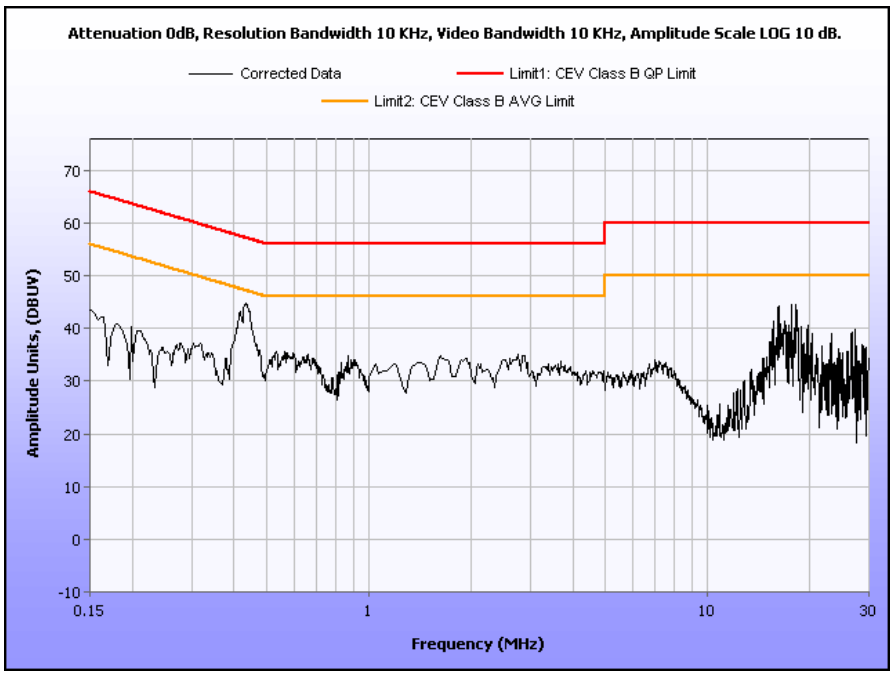
Table 17. Conducted Emissions, 15.207, Phase Line, Test Results



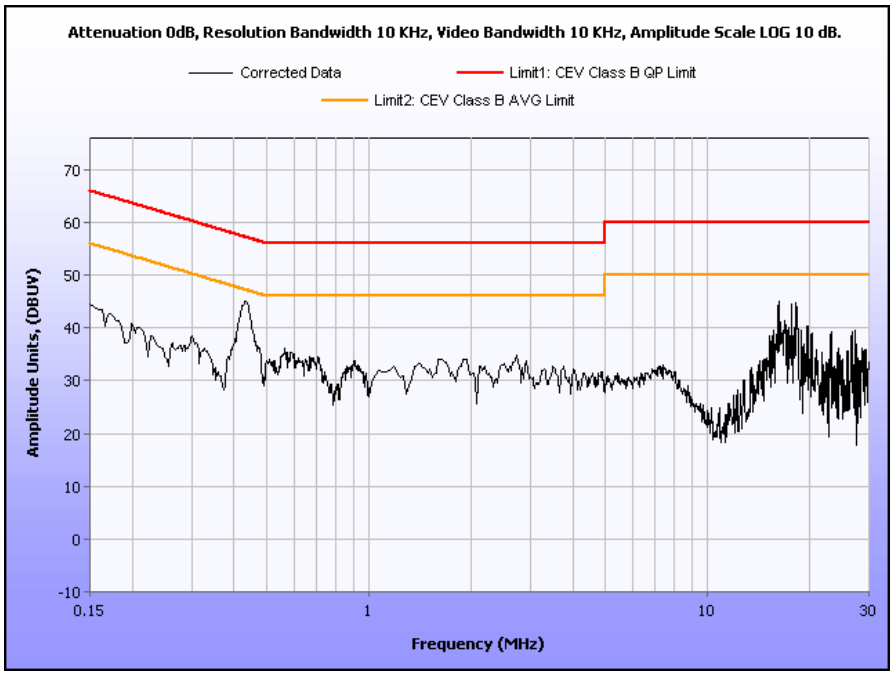
Plot 7. Conducted Emissions, Phase Line Plot, 802.11b, Channel 1



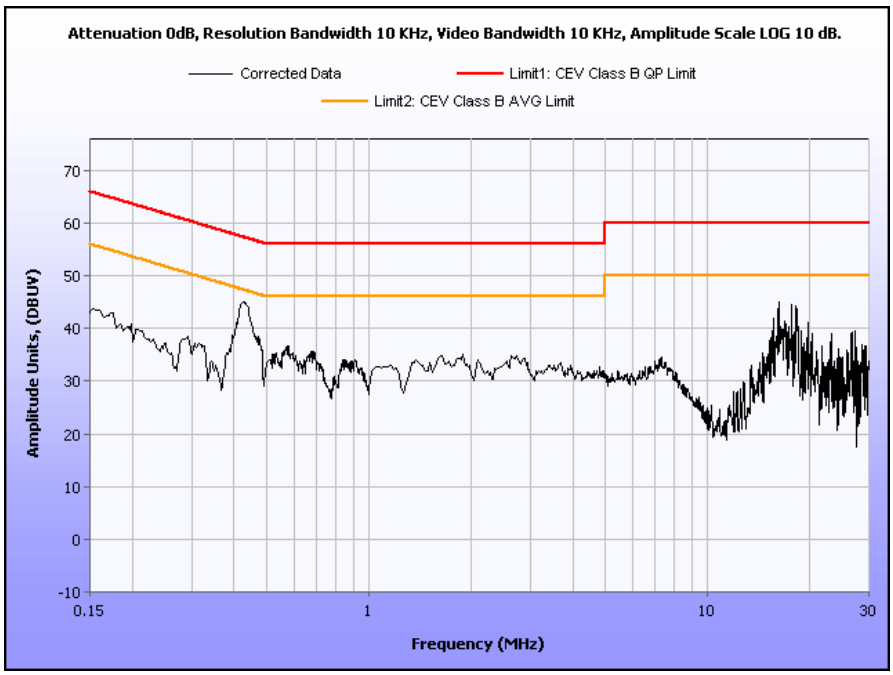
Plot 8. Conducted Emissions, Phase Line Plot, 802.11b, Channel 6



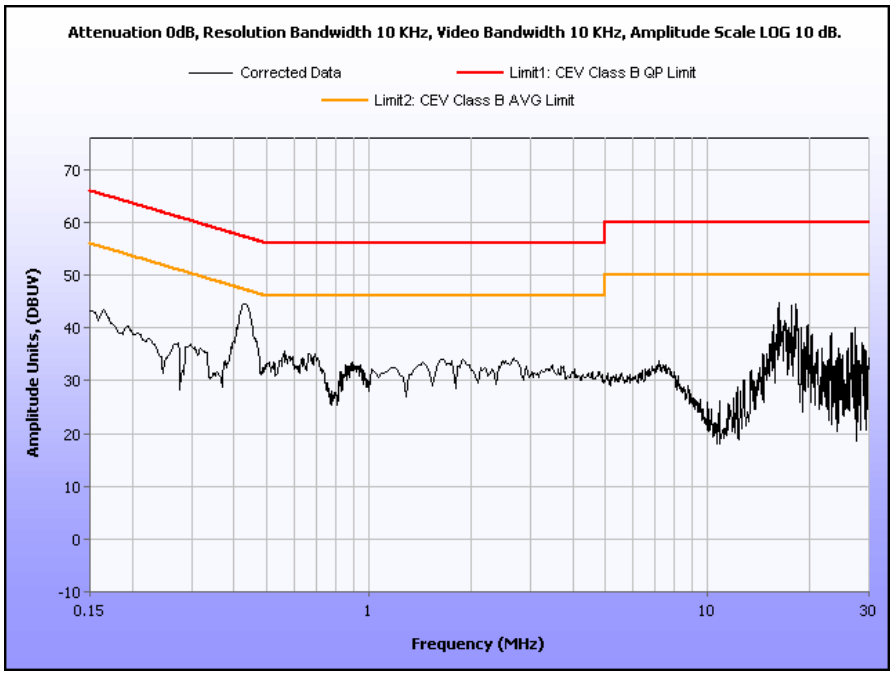
Plot 9. Conducted Emissions, Phase Line Plot, 802.11b, Channel 11



Plot 10. Conducted Emissions, Phase Line Plot, 802.11g, Channel 1



Plot 11. Conducted Emissions, Phase Line Plot, 802.11g, Channel 6

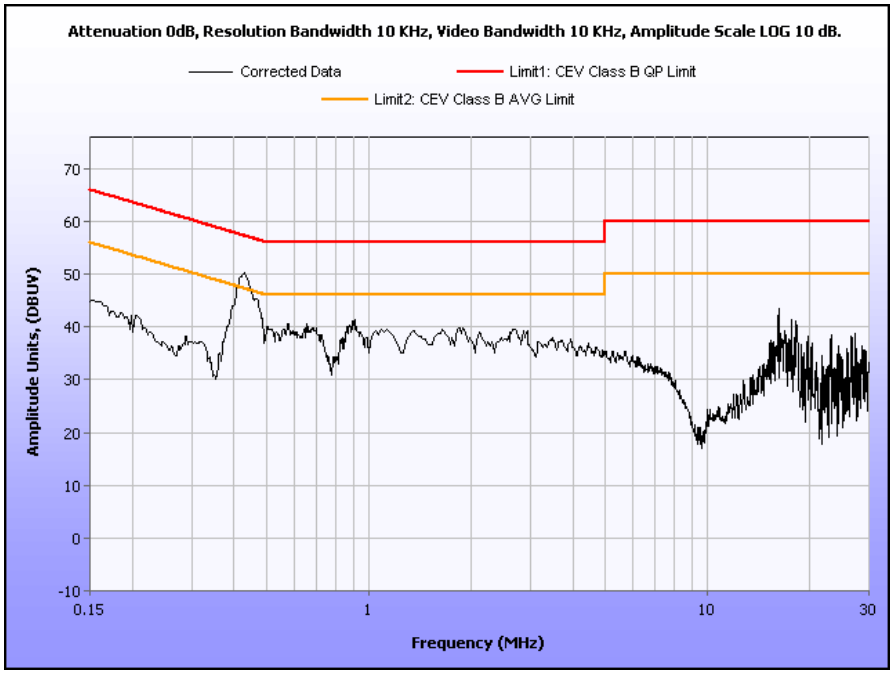


Plot 12. Conducted Emissions, Phase Line Plot, 802.11g, Channel 11

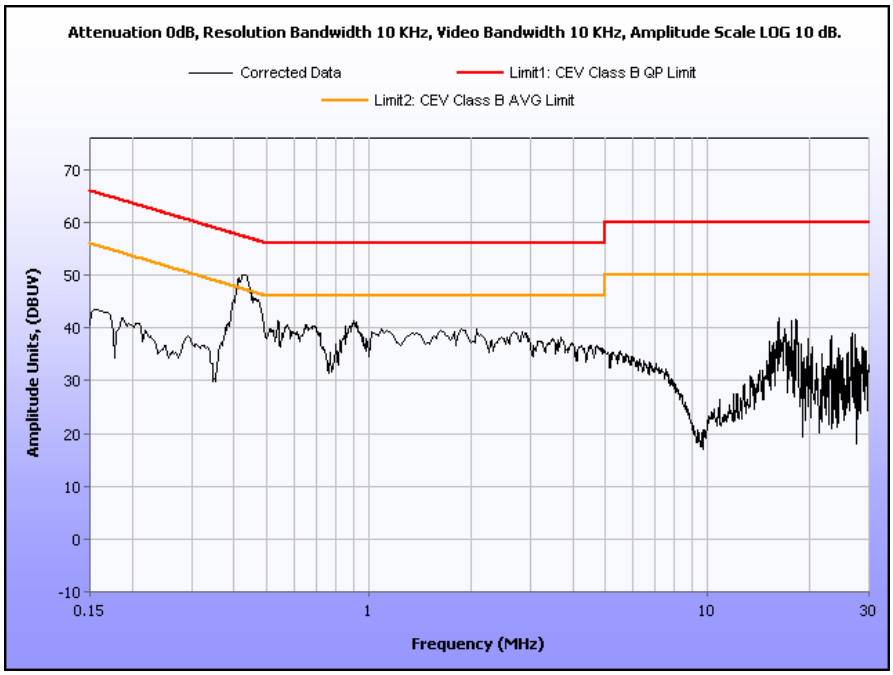
15.207 Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.1508	40.25	0	40.25	65.96	-25.71	34.59	0	34.59	55.96	-21.37
0.4345	47.91	0	47.91	57.17	-9.26	42.53	0	42.53	47.17	-4.64
0.9013	37.47	0	37.47	56	-18.53	31.31	0	31.31	46	-14.69
1.4275	34.79	0	34.79	56	-21.21	28.32	0	28.32	46	-17.68
17.725	25.94	0.09	26.03	60	-33.97	20.83	0.09	20.92	50	-29.08
26.625	18.28	0.14	18.42	60	-41.58	15.24	0.14	15.38	50	-34.62

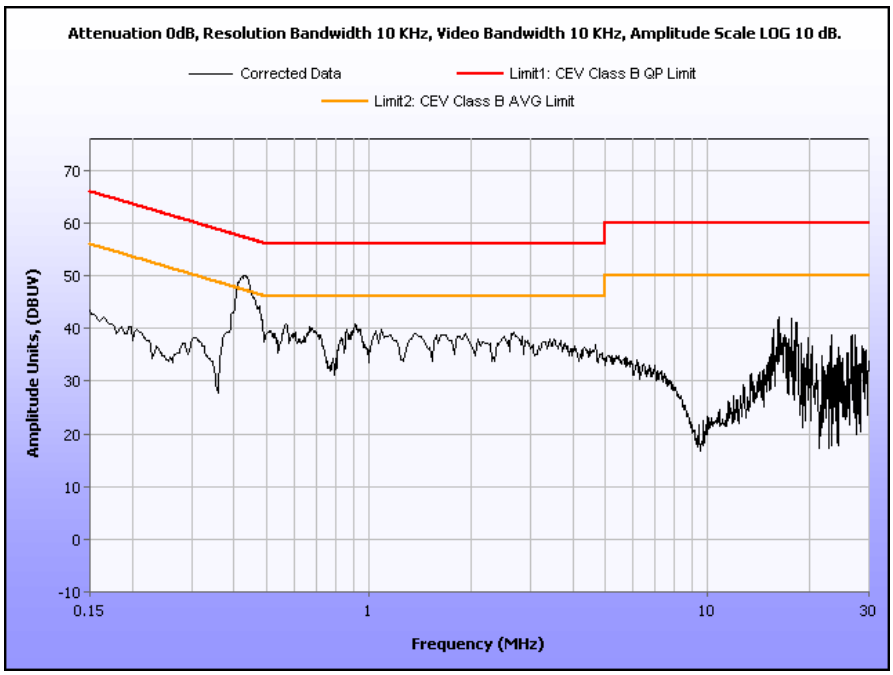
Table 18. Conducted Emissions, 15.207, Neutral Line, Test Results



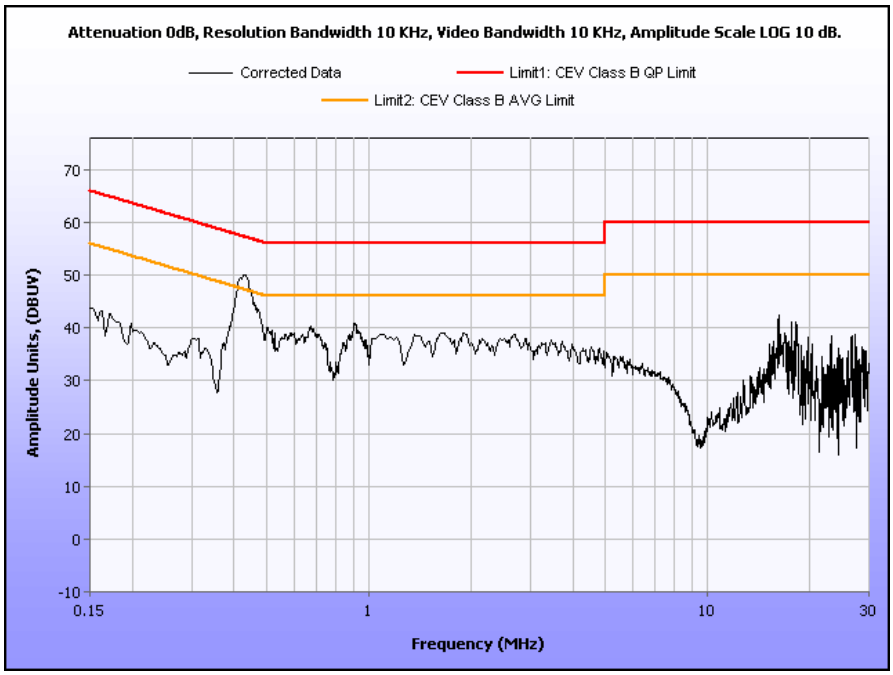
Plot 13. Conducted Emissions, Neutral Line Plot, 802.11b, Channel 1



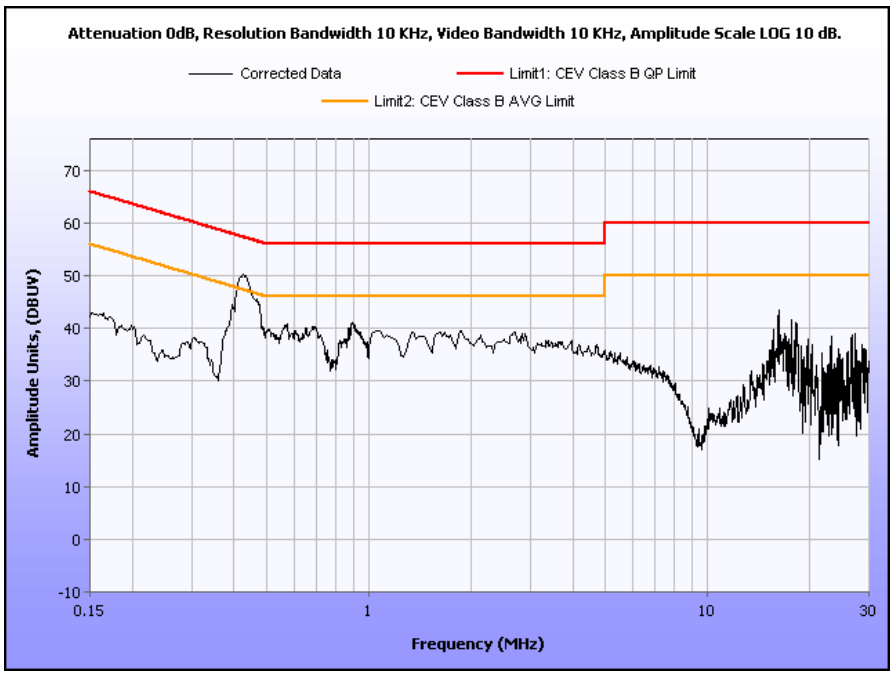
Plot 14. Conducted Emissions, Neutral Line Plot, 802.11b, Channel 6



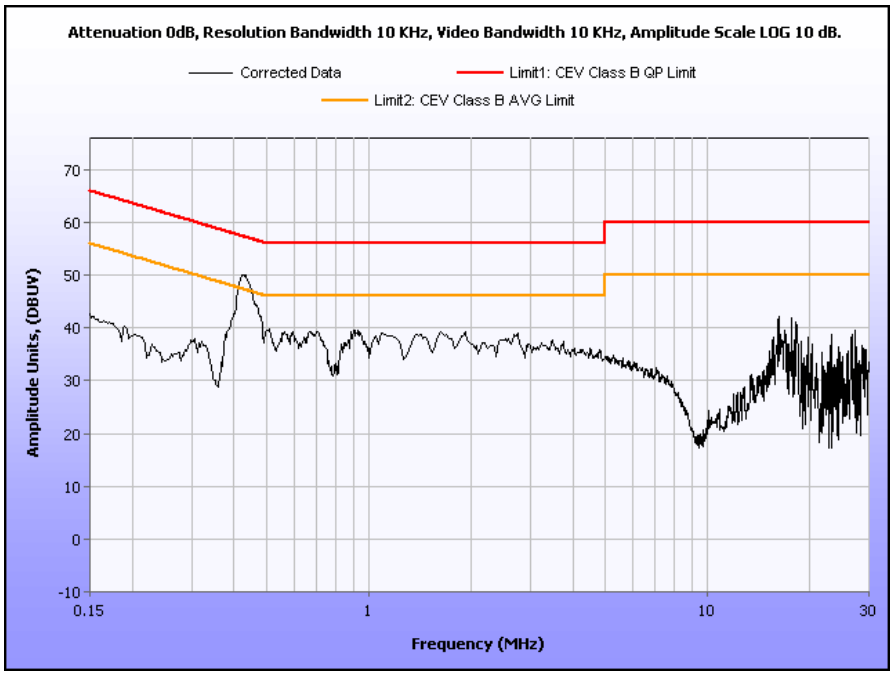
Plot 15. Conducted Emissions, Neutral Line Plot, 802.11b, Channel 11



Plot 16. Conducted Emissions, Neutral Line Plot, 802.11g, Channel 1



Plot 17. Conducted Emissions, Neutral Line Plot, 802.11g, Channel 6



Plot 18. Conducted Emissions, Neutral Line Plot, 802.11g, Channel 11

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a) 6 dB and 99% Bandwidth

Test Requirements: **§ 15.247(a):** 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 approximately 1% of the total emission bandwidth, VBW > 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). No anomalies were noted.

The 6 dB and 99% Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 05/04/10

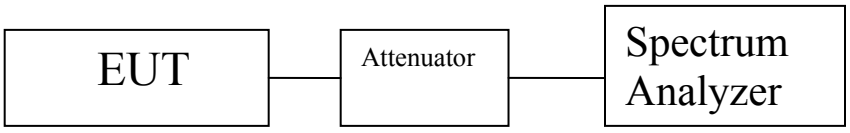


Figure 2. Block Diagram, Occupied Bandwidth Test Setup

Occupied Bandwidth Test Results

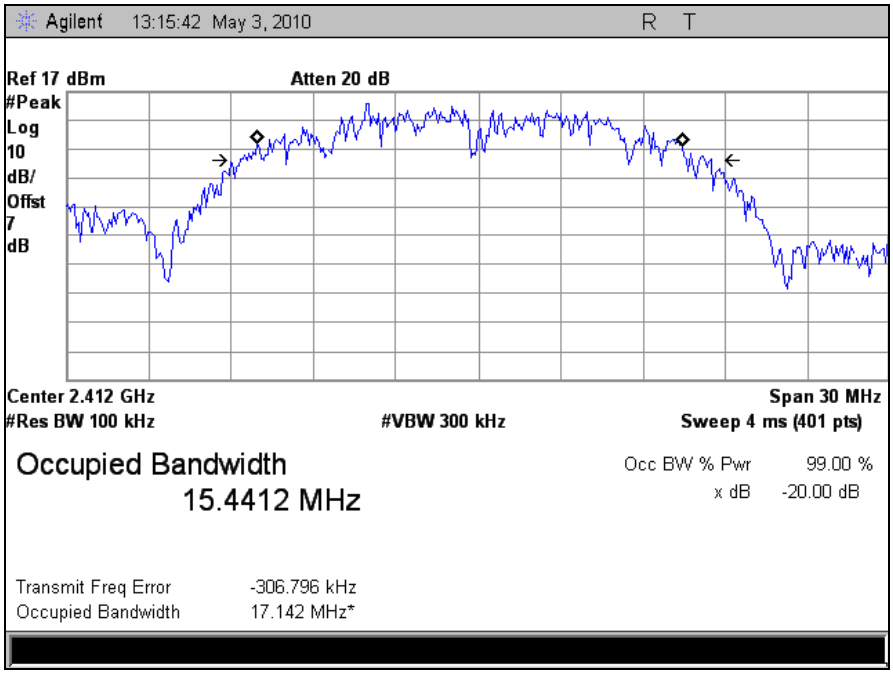
Occupied Bandwidth			
Carrier Channel	**Frequency (MHz)**	**Measured 6 dB Bandwidth (MHz)**	**Measured 99% Bandwidth (MHz)**
Low	2412	17.142	15.3255
Mid	2437	16.692	15.9803
High	2462	18.098	15.2047

Table 19. Occupied Bandwidth, 802.11b Mode, Test Results

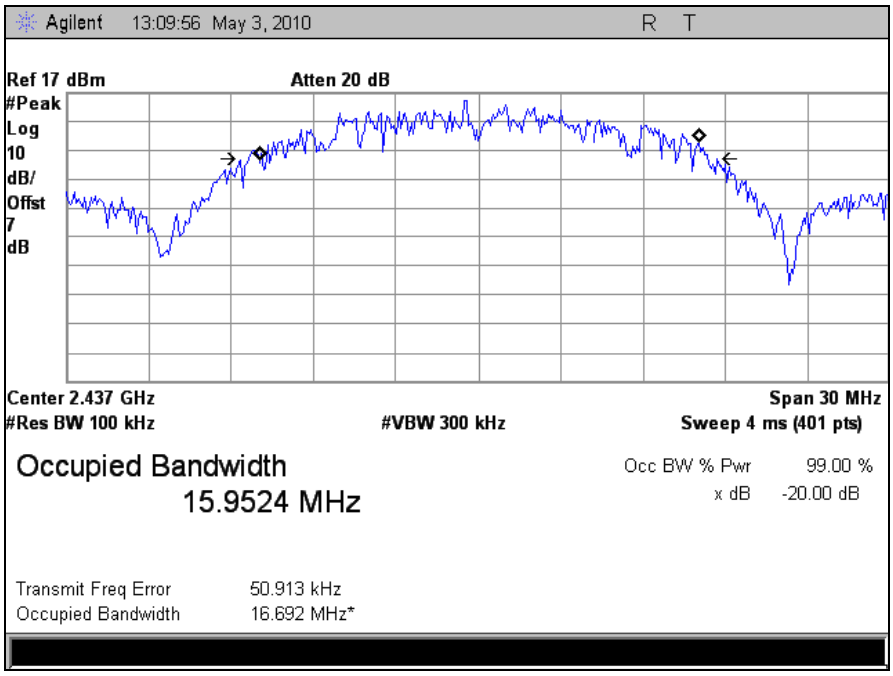
Occupied Bandwidth			
Carrier Channel	**Frequency (MHz)**	**Measured 6 dB Bandwidth (MHz)**	**Measured 99% Bandwidth (MHz)**
Low	2412	18.508	16.5000
Mid	2437	19.677	16.7366
High	2462	17.758	16.5258

Table 20. Occupied Bandwidth, 802.11g Mode, Test Results

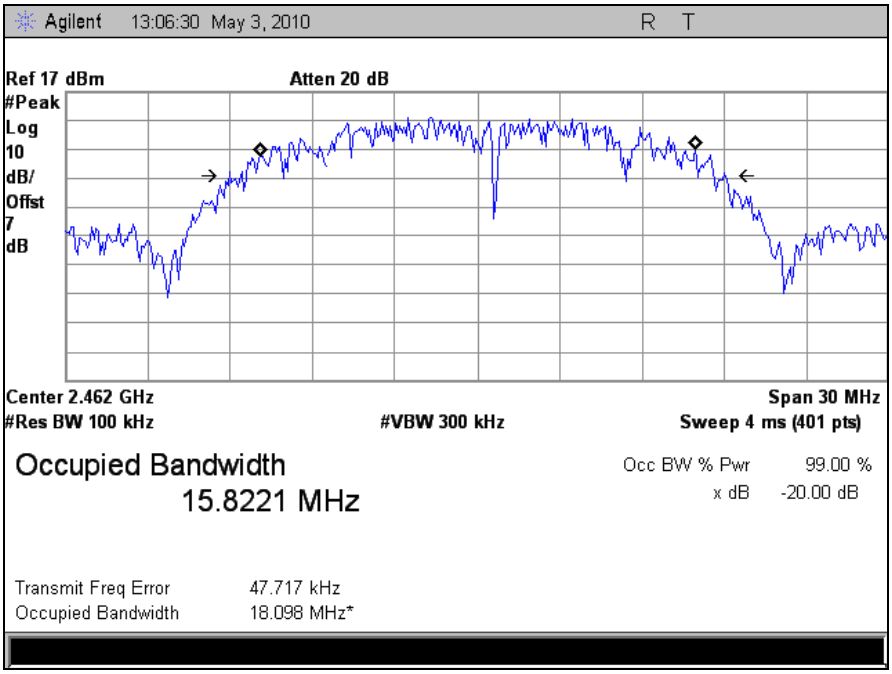
Occupied Bandwidth Test Results



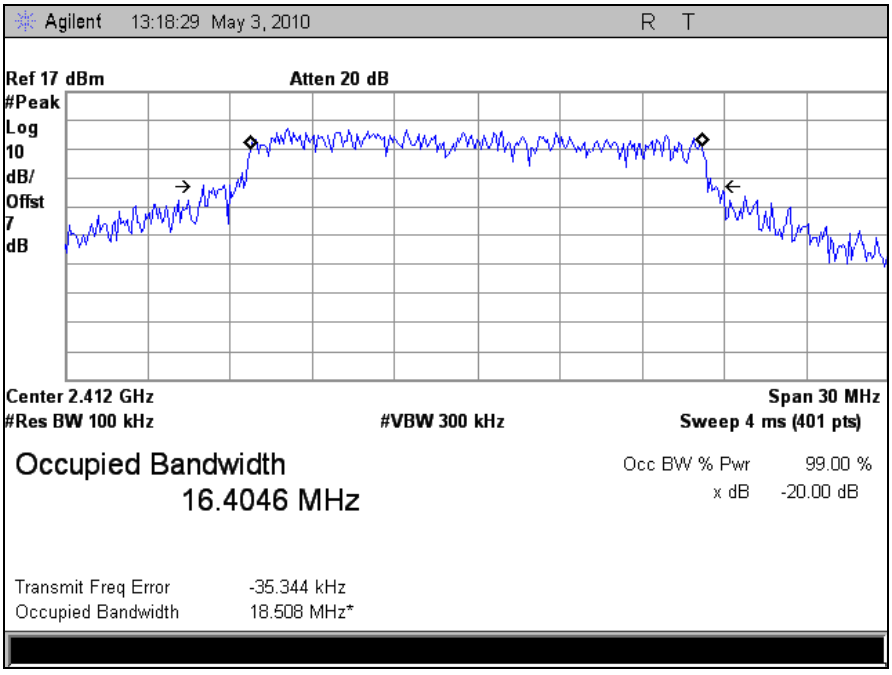
Plot 19. Occupied Band Width, 802.11b, Low Channel, FCC Limits



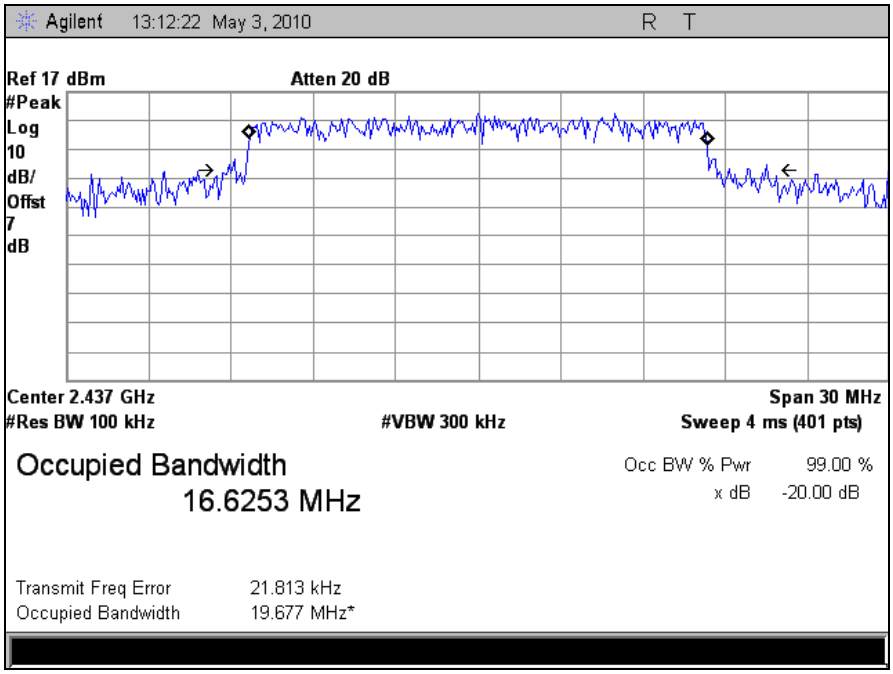
Plot 20. Occupied Band Width, 802.11b, Mid Channel, FCC Limits



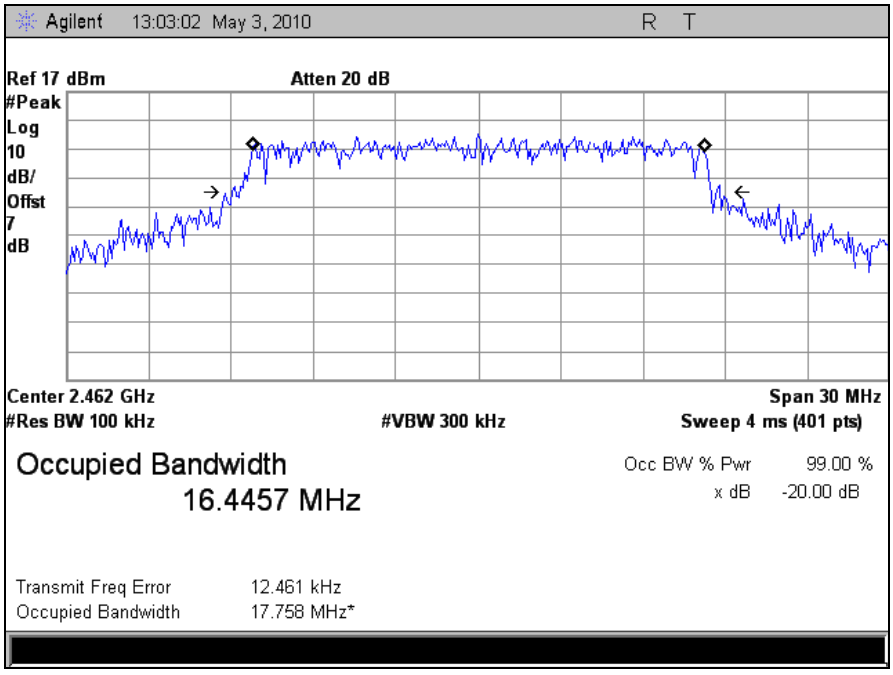
Plot 21. Occupied Band Width, 802.11b, High Channel, FCC Limits



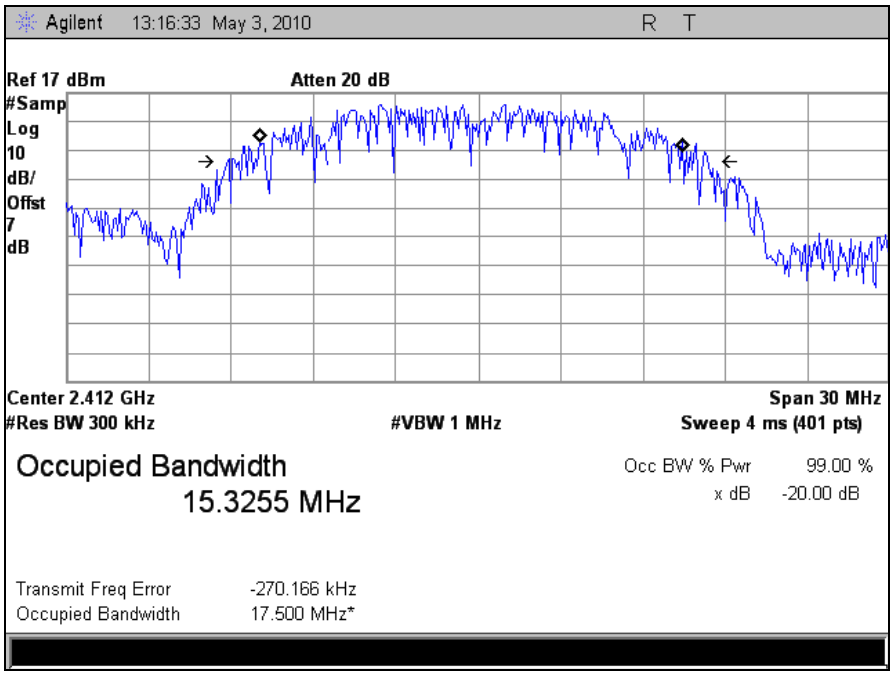
Plot 22. Occupied Band Width, 802.11g, Low Channel, FCC Limits



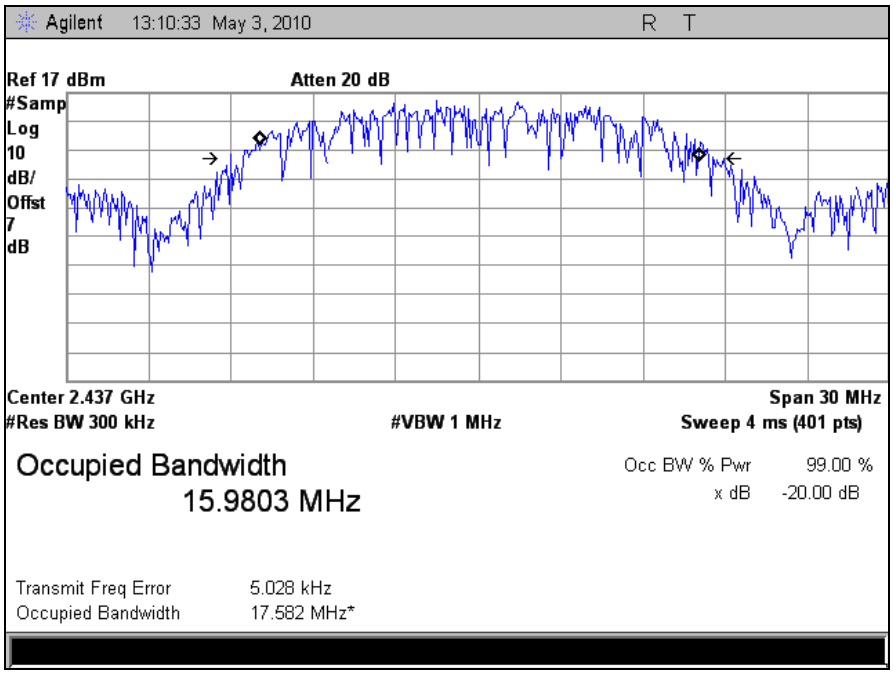
Plot 23. Occupied Band Width, 802.11g, Mid Channel, FCC Limits



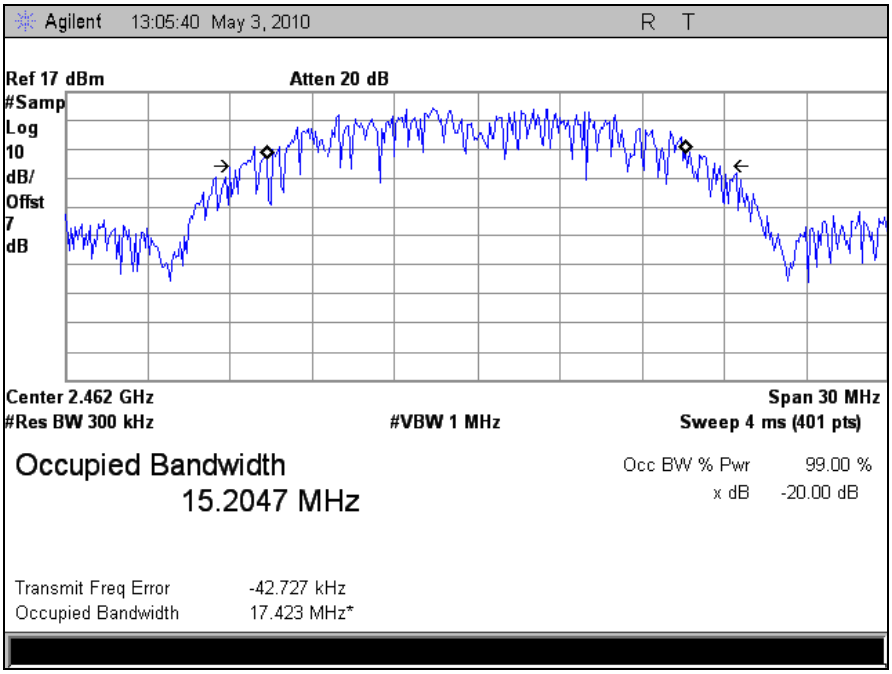
Plot 24. Occupied Band Width, 802.11g, High Channel, FCC Limits



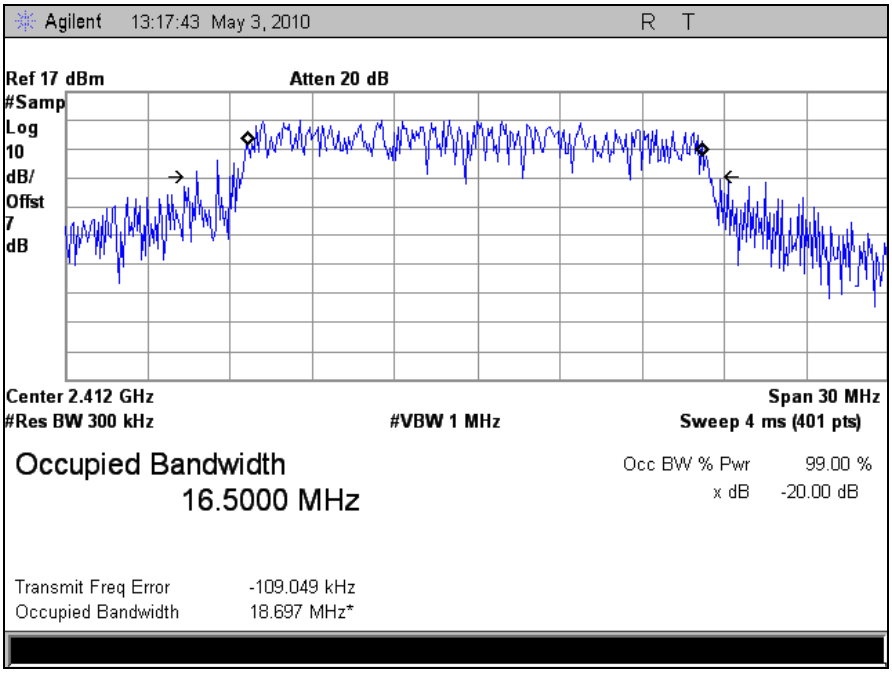
Plot 25. Occupied Band Width, 802.11b, Low Channel, IC Limits



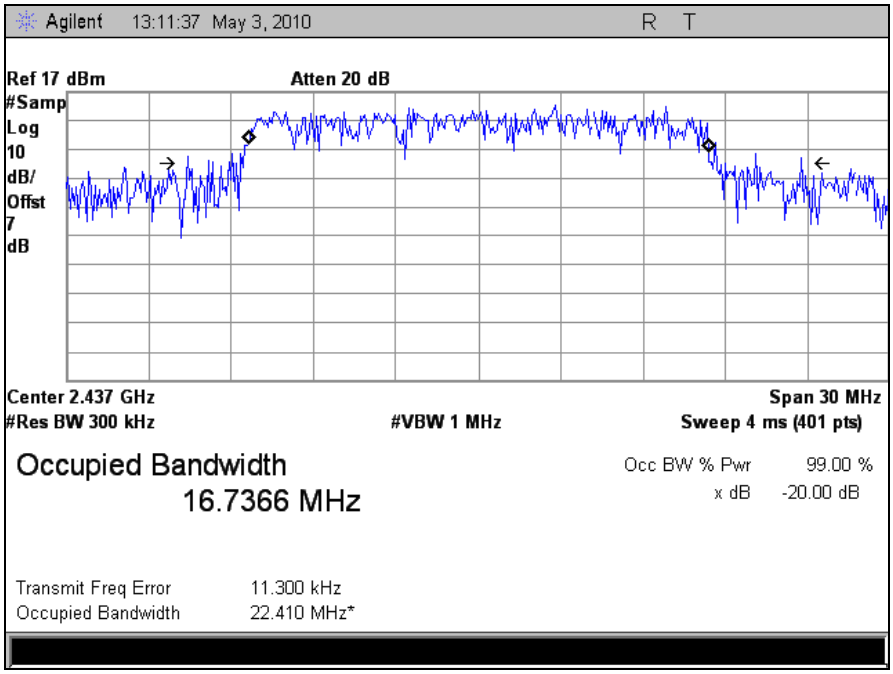
Plot 26. Occupied Band Width, 802.11b, Mid Channel, IC Limits



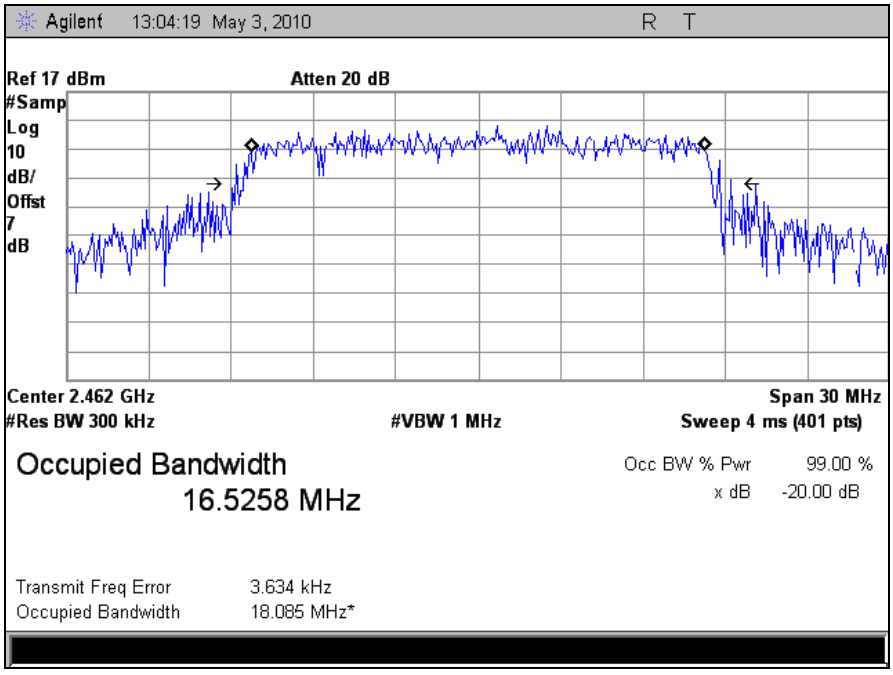
Plot 27. Occupied Band Width, 802.11b, High Channel, IC Limits



Plot 28. Occupied Band Width, 802.11g, Low Channel, IC Limits



Plot 29. Occupied Band Width, 802.11g, Mid Channel, IC Limits



Plot 30. Occupied Band Width, 802.11g, High Channel, IC Limits

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output and RF Exposure

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 21. Output Power Requirements from §15.247

§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 21, 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)**. No anomalies were noted.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 05/04/10

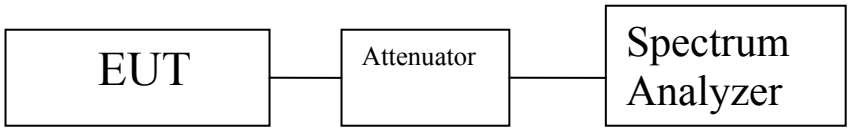


Figure 3. Peak Power Output Test Setup

RF Power Output Test Results

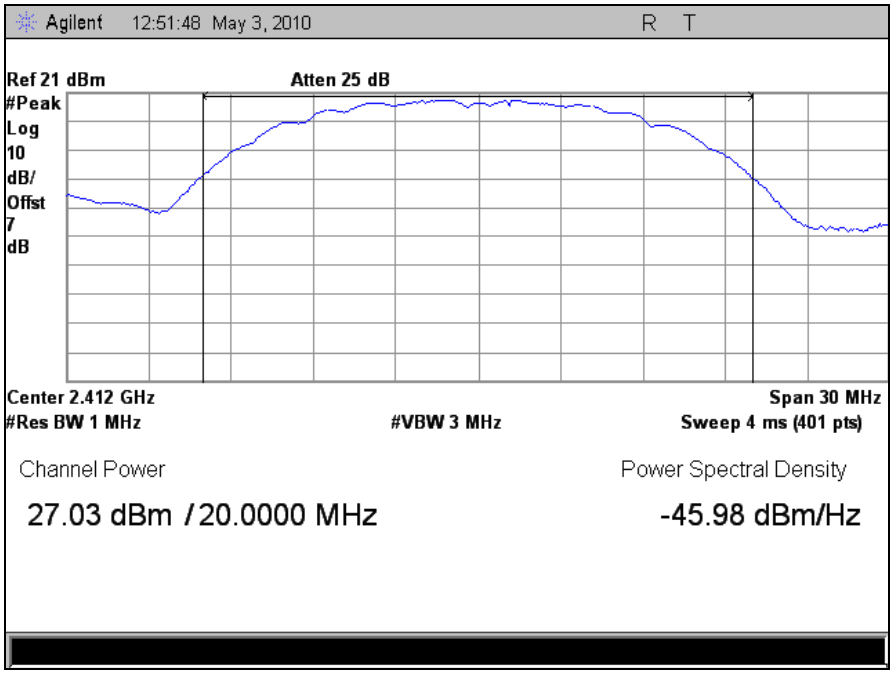
Peak Conducted Output Power		
Carrier Channel	**Frequency (MHz)**	**Measured Peak Output Power dBm**
Low	2412	27.03
Mid	2437	27.75
High	2462	25.02

Table 22. RF Output Power Test Results, 802.11b Mode

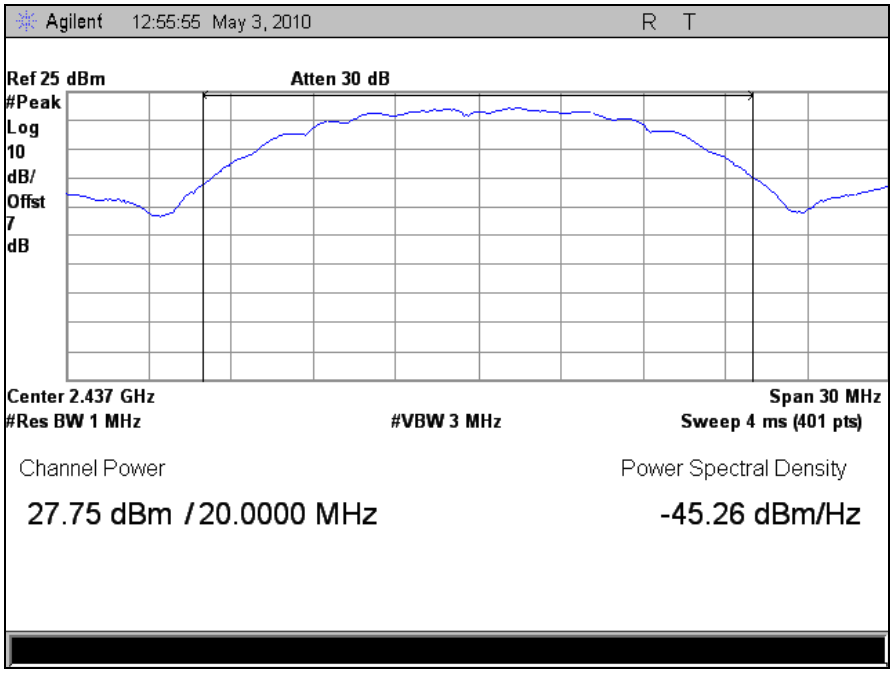
Peak Conducted Output Power		
Carrier Channel	**Frequency (MHz)**	**Measured Peak Output Power dBm**
Low	2412	23.90
Mid	2437	27.73
High	2462	21.80

Table 23. RF Output Power Test Results, 802.11g Mode

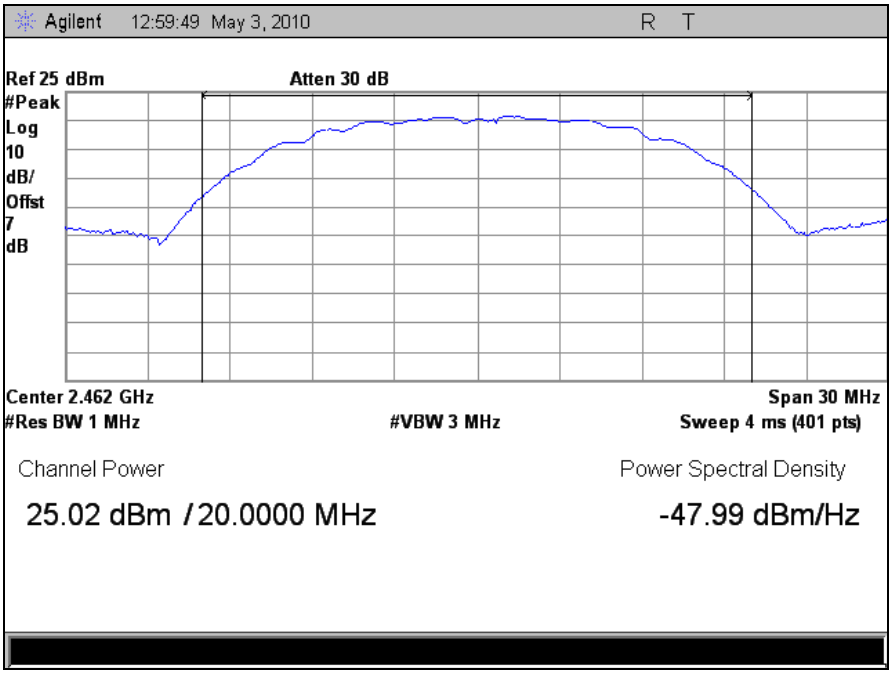
RF Output Power Test Results



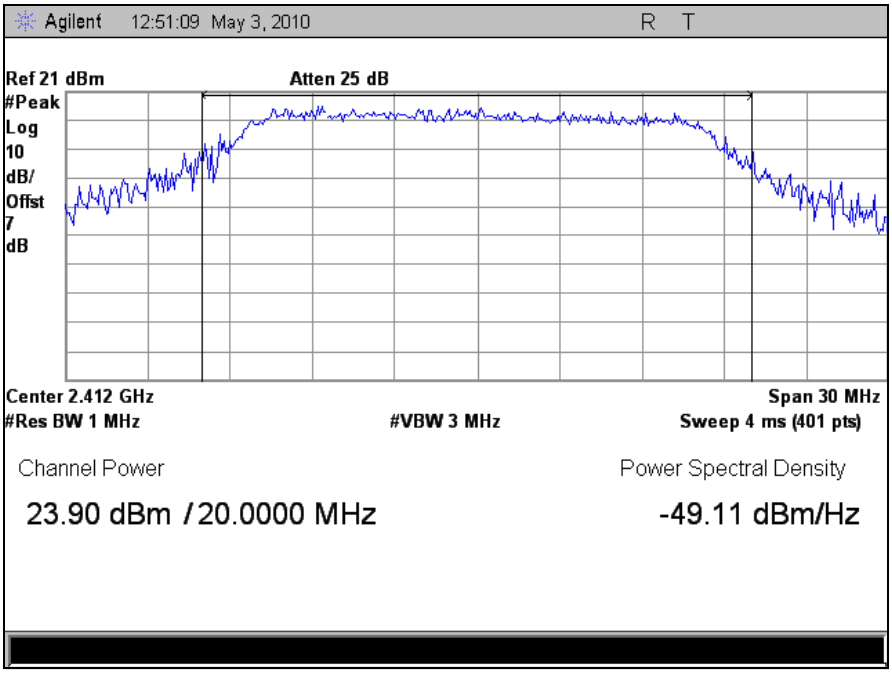
Plot 31. Peak Output Power, 802.11b, Low Channel



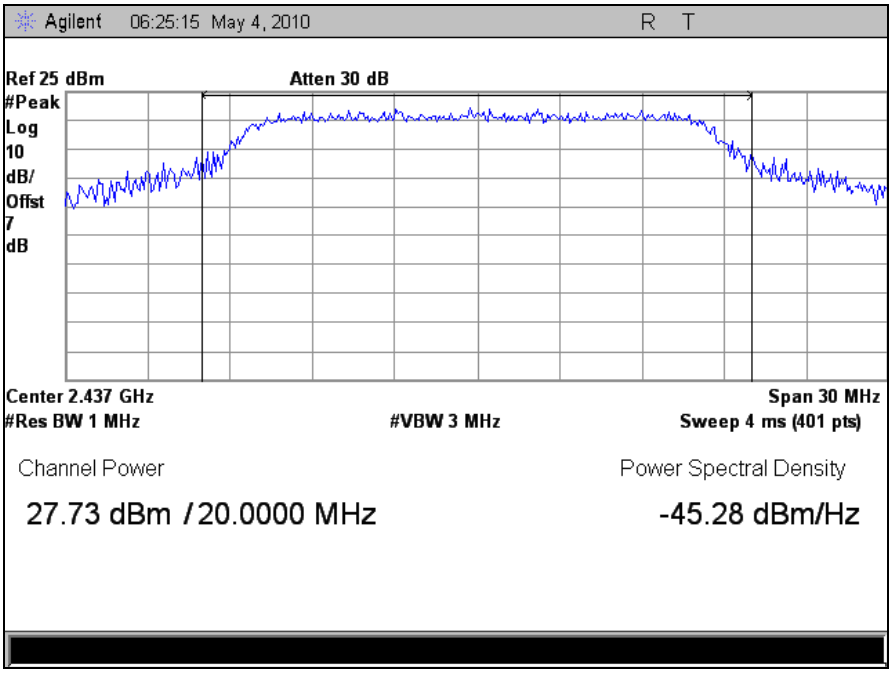
Plot 32. Peak Output Power, 802.11b, Mid Channel



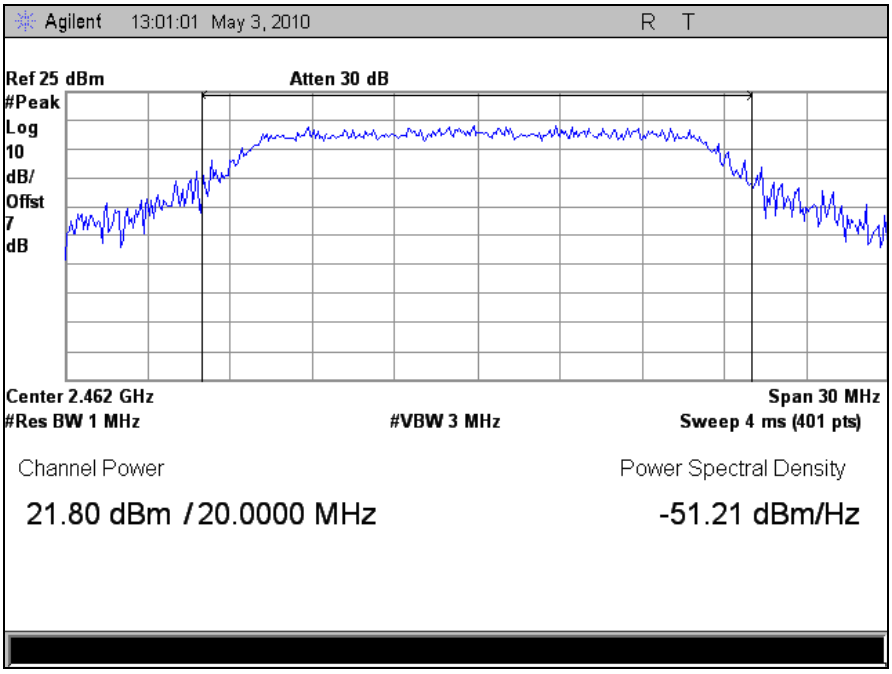
Plot 33. Peak Output Power, 802.11b, High Channel



Plot 34. Peak Output Power, 802.11g, Low Channel



Plot 35. Peak Output Power, 802.11g, Mid Channel



Plot 36. Peak Output Power, 802.11g, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) RF 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 frequency is 2412-2462 MHz;. Highest conducted power = 595.7 mW (i.e. 27.75 dBm). Therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2.**

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

$$S = P G / 4\pi R^2$$

where,

S = Power Density mW/m^2
P = Power (mW)
R = Distance to the center of radiation of the antenna
G = Maximum antenna gain

Maximum antenna gain for EUT = 5 dBi = 3.16

P = 595.7 mW
R = 20 cm
G = 3.16

$$S = 595.7*3.16 / 4(3.14)(20)^2$$

$$S = 0.374 \text{ mW/cm}^2$$

Therefore, EUT meets the Uncontrolled Exposure limit at 20cm.

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: **§15.247(d); §15.205:** 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 24. 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 25.

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 25. 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. Measurements were made at 1m and then corrected to 3m and compared to the limit. Only noise floor was measured above 18 GHz.

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

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 05/04/10 – 05/05/10

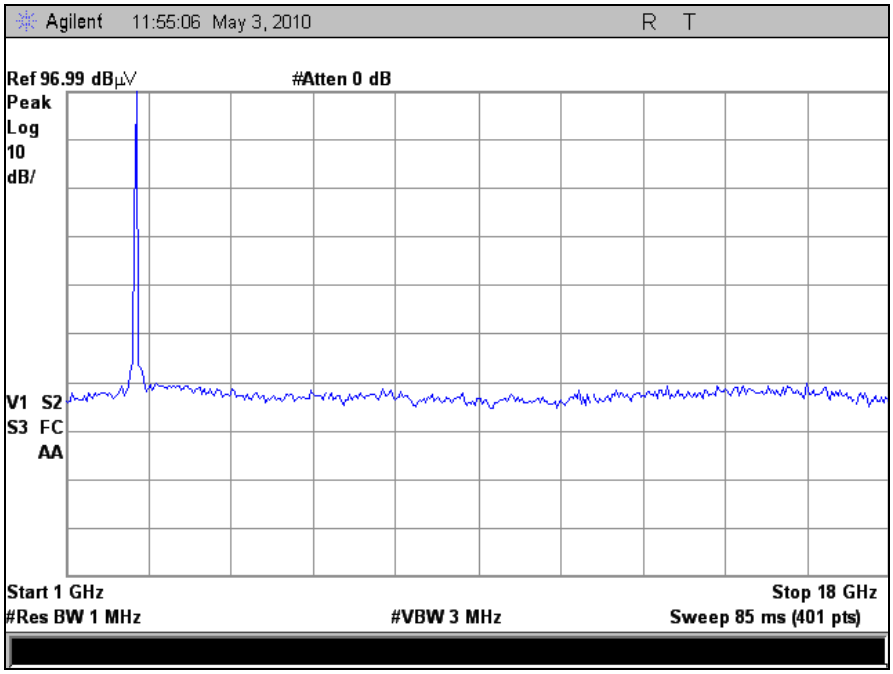
Harmonic Emissions Requirements – Radiated

Mode	Channel	Frequency (GHz)	Final corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin	Detector
b mode	1	2.288	40.1	54	-13.9	Avg.
		2.288	48.6	74	-25.4	Peak
	6	2.288	42.29	54	-11.71	Avg.
		2.288	50.61	74	-23.39	Peak
	11	2.288	38.71	54	-15.29	Avg.
		2.288	46.82	74	-27.18	Peak
g mode	1	2.288	40.62	54	-13.38	Avg.
		2.288	48.72	74	-25.28	Peak
	6	2.287	38.43	54	-15.57	Avg.
		2.282	49.32	74	-24.68	Peak
	11	2.288	39.74	54	-24.26	Avg.
		2.288	48.8	74	-25.2	Peak

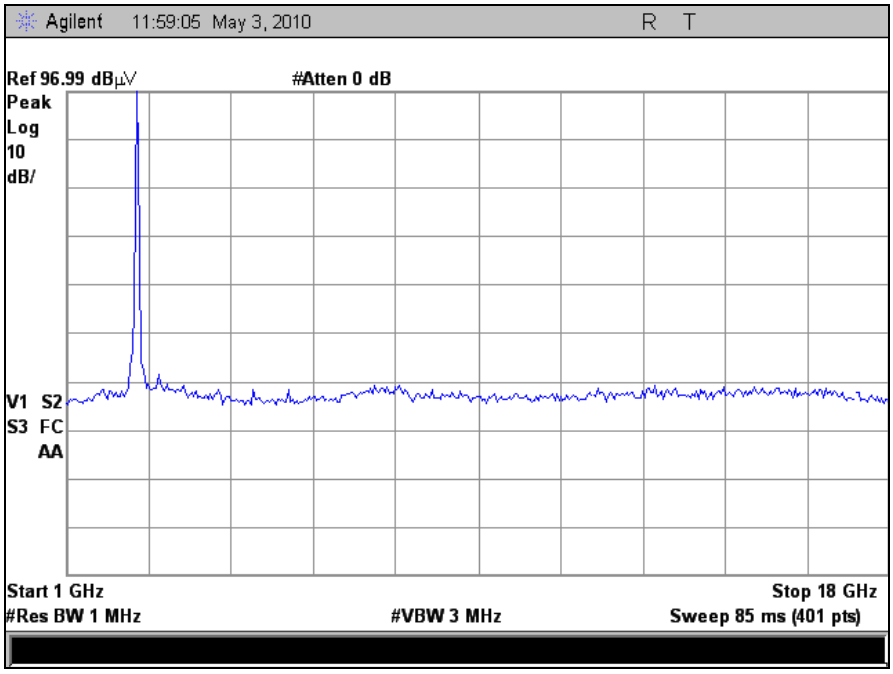
Table 26. Radiated Harmonic Emissions

Note 1: All other emissions were measured at the noise floor of the spectrum analyzer.
Note 2: These were the only spurious emissions seen above 1 GHz. There were no harmonics.

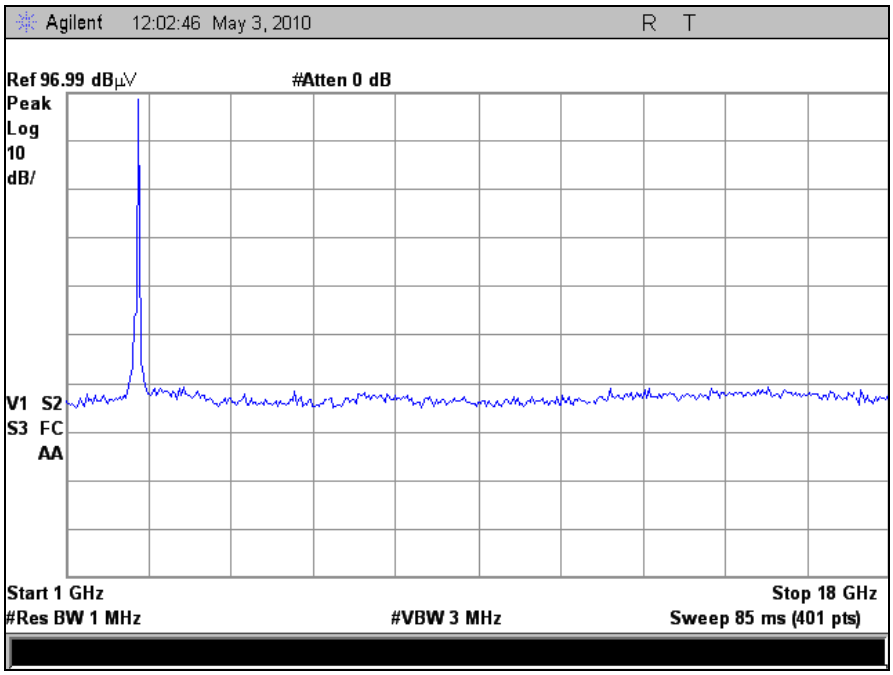
Radiated Spurious Emissions Test Results



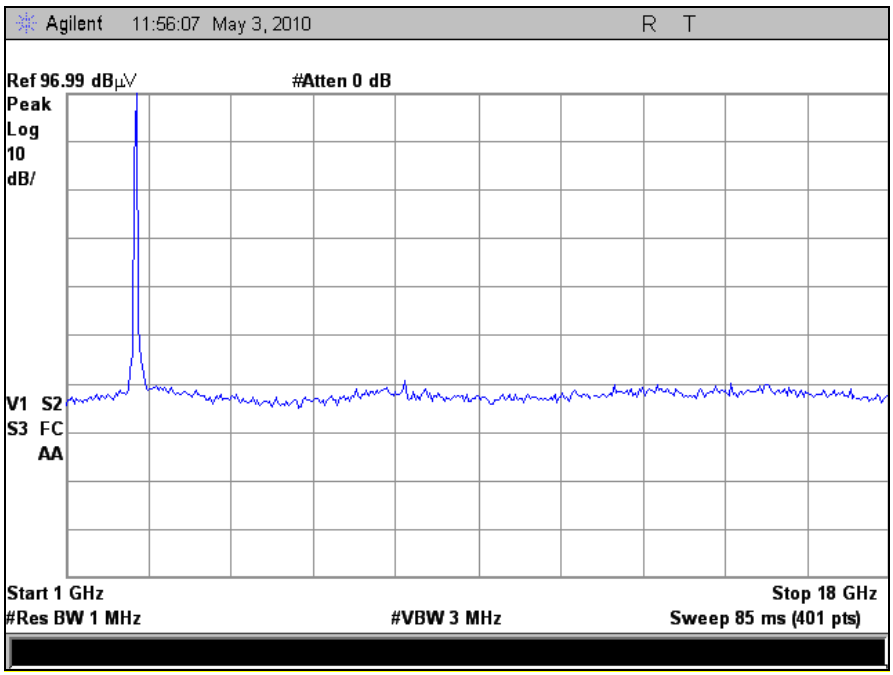
Plot 37. Radiated Spurious Emissions, 802.11b, Low Channel, 1 GHz – 18 GHz



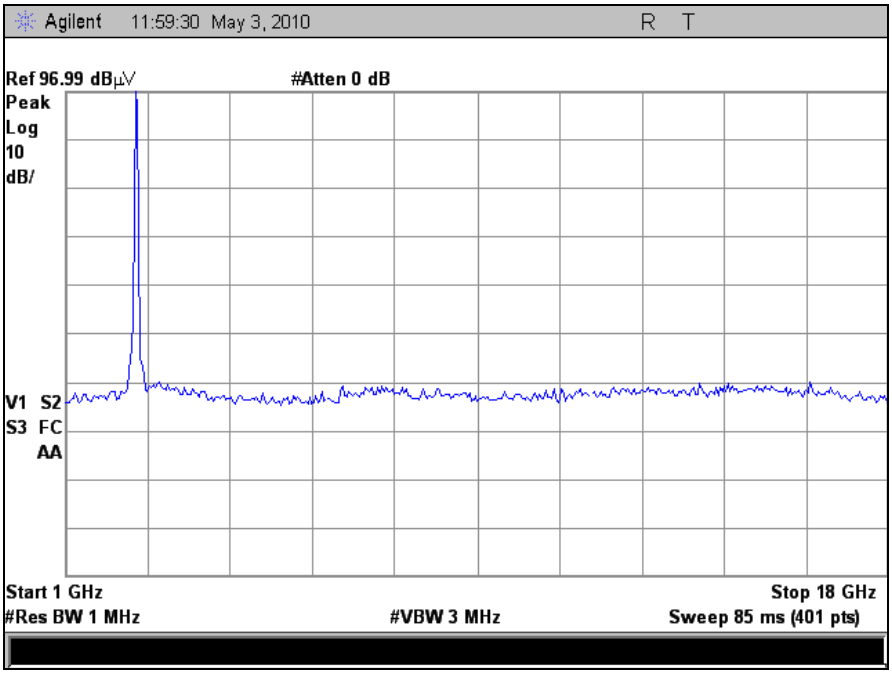
Plot 38. Radiated Spurious Emissions, 802.11b, Mid Channel, 1 GHz – 18 GHz



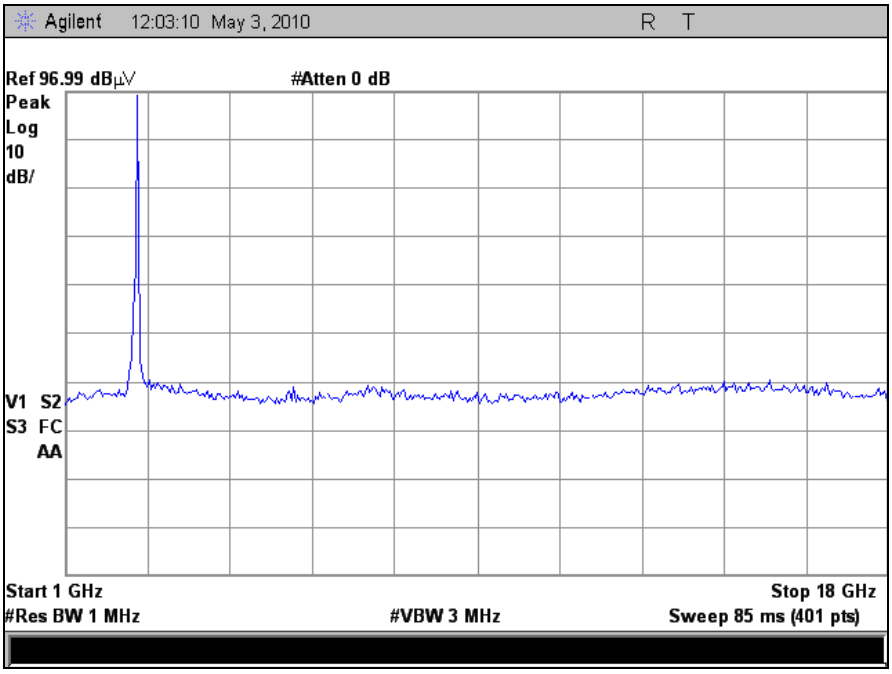
Plot 39. Radiated Spurious Emissions, 802.11b, High Channel, 1 GHz – 18 GHz



Plot 40. Radiated Spurious Emissions, 802.11g, Low Channel, 1 GHz – 18 GHz



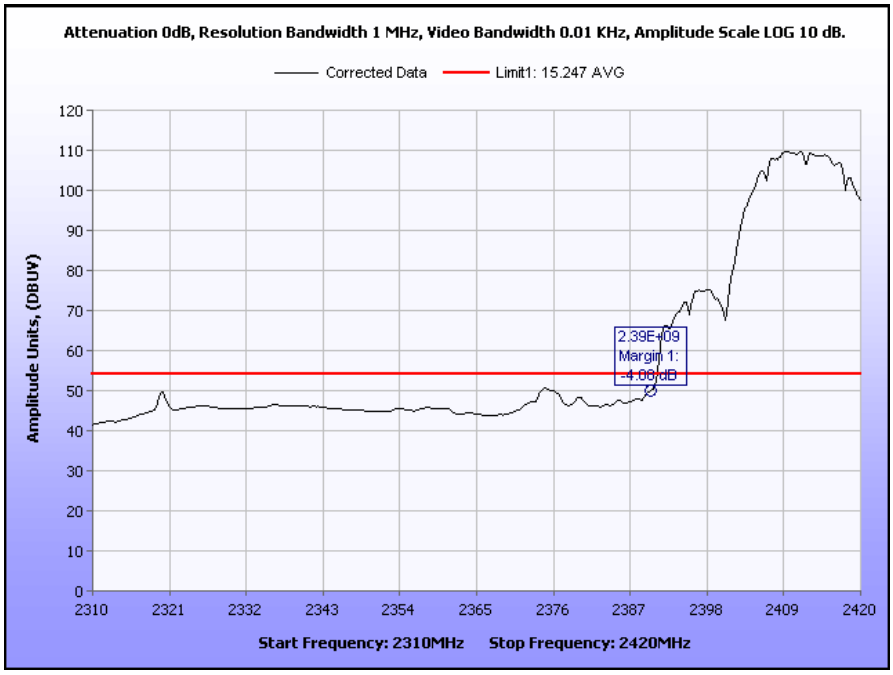
Plot 41. Radiated Spurious Emissions, 802.11g, Mid Channel, 1 GHz – 18 GHz



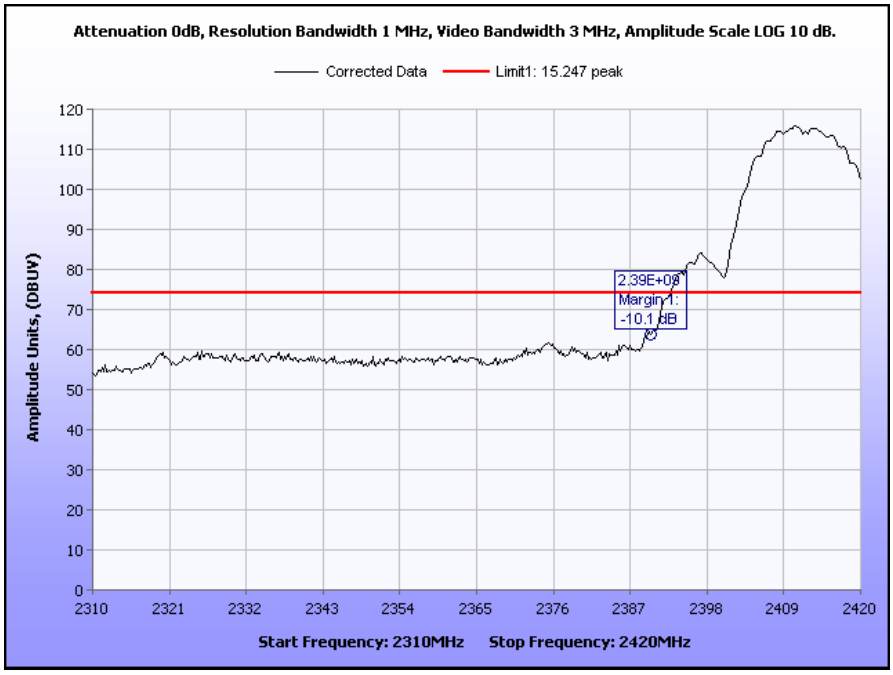
Plot 42. Radiated Spurious Emissions, 802.11g, High Channel, 1 GHz – 18 GHz

Radiated Band Edge Measurements

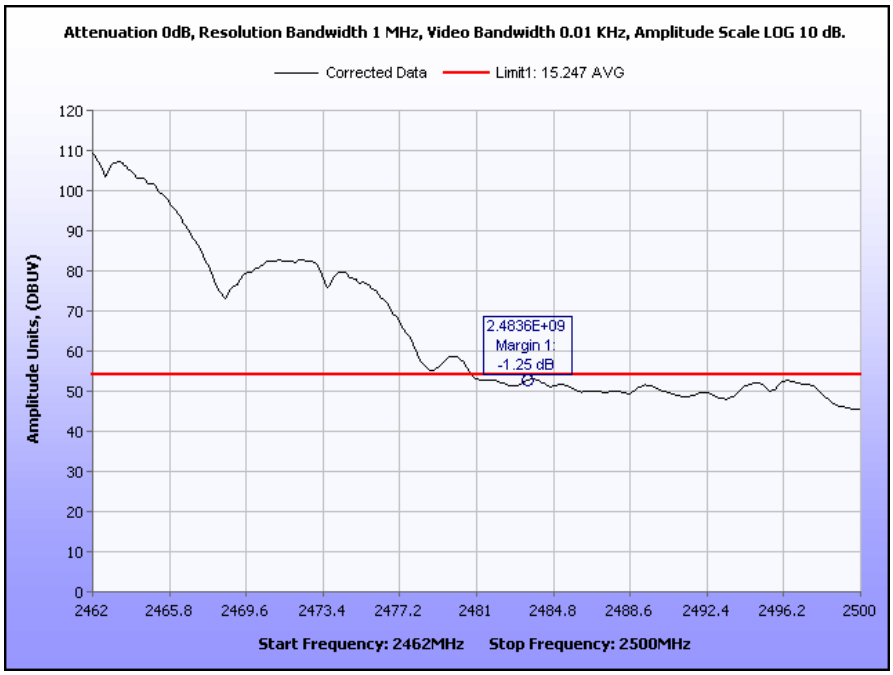
Test Procedures: Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor, cable loss and distance and compared to a 3 m limit line. In some instances power needed to be backed off from the maximum on the low and high channels. Therefore, adjacent channels were also measured.



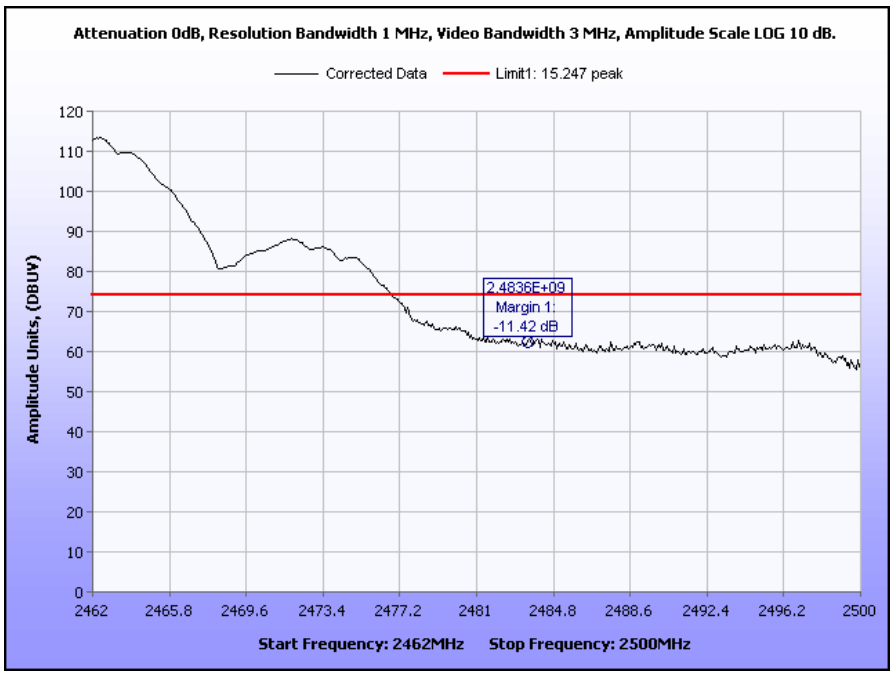
Plot 43. Radiated Restricted Band Edge, 802.11b, Channel 1, Average



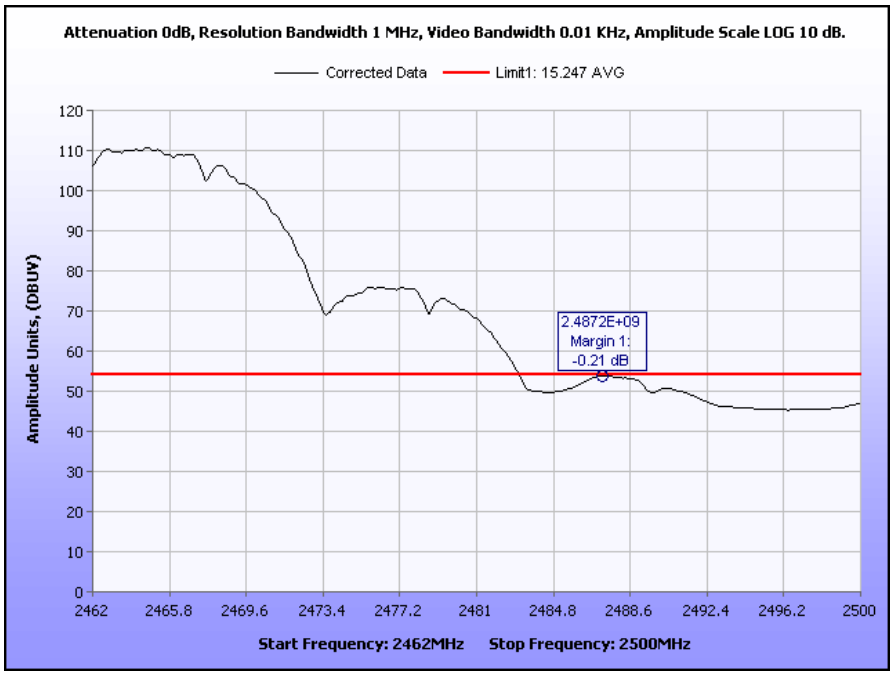
Plot 44. Radiated Restricted Band Edge, 802.11b, Channel 1, Peak



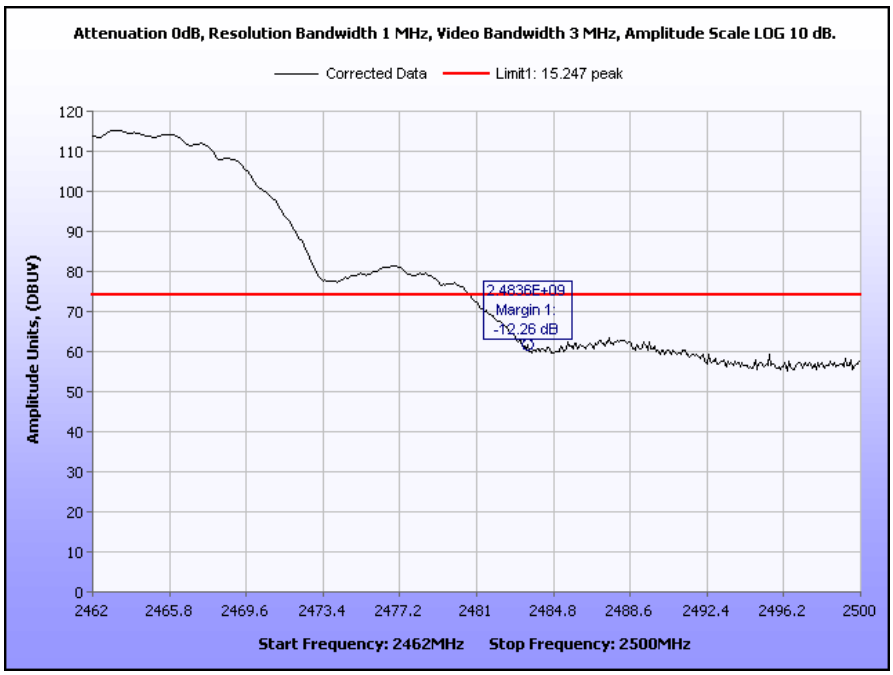
Plot 45. Radiated Restricted Band Edge, 802.11b, Channel 10, Average



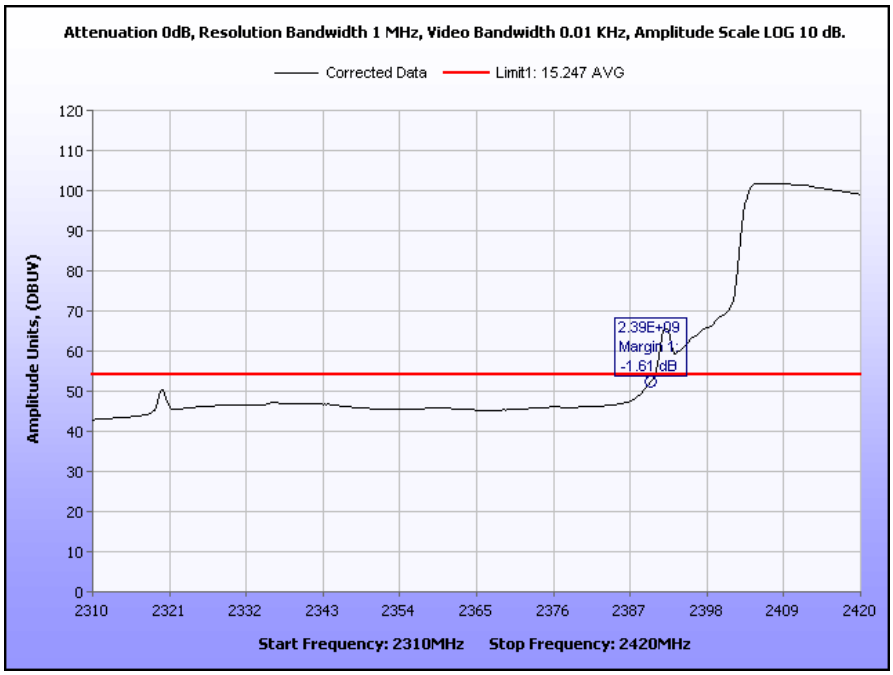
Plot 46. Radiated Restricted Band Edge, 802.11b, Channel 10, Peak



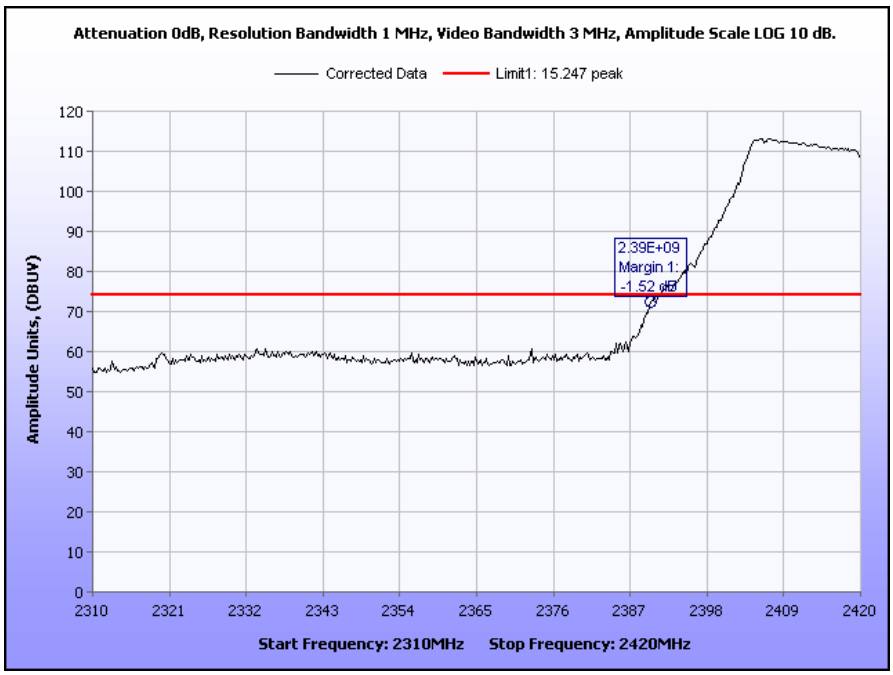
Plot 47. Radiated Restricted Band Edge, 802.11b, Channel 11, Average



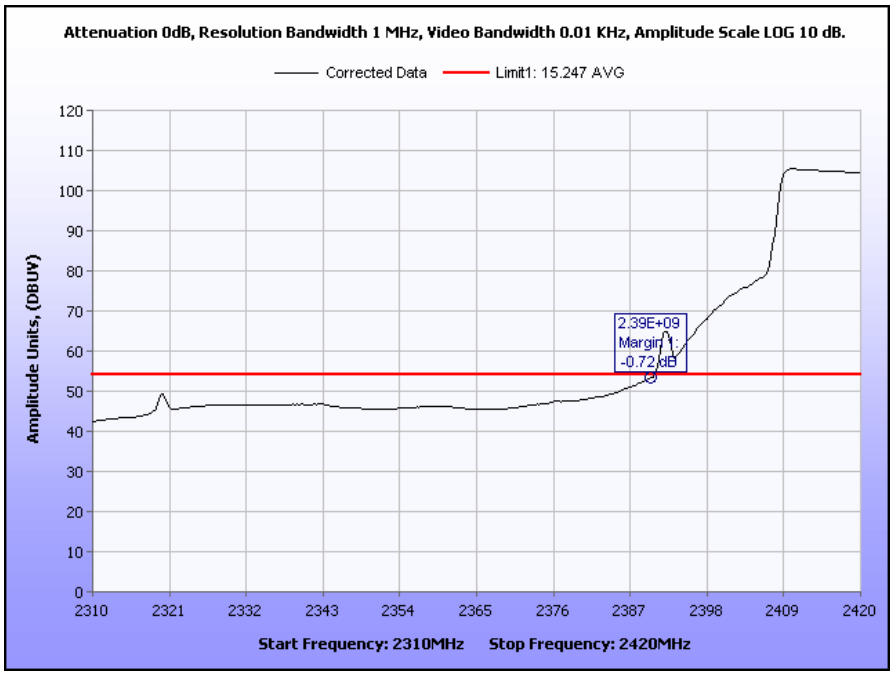
Plot 48. Radiated Restricted Band Edge, 802.11b, Channel 11, Peak



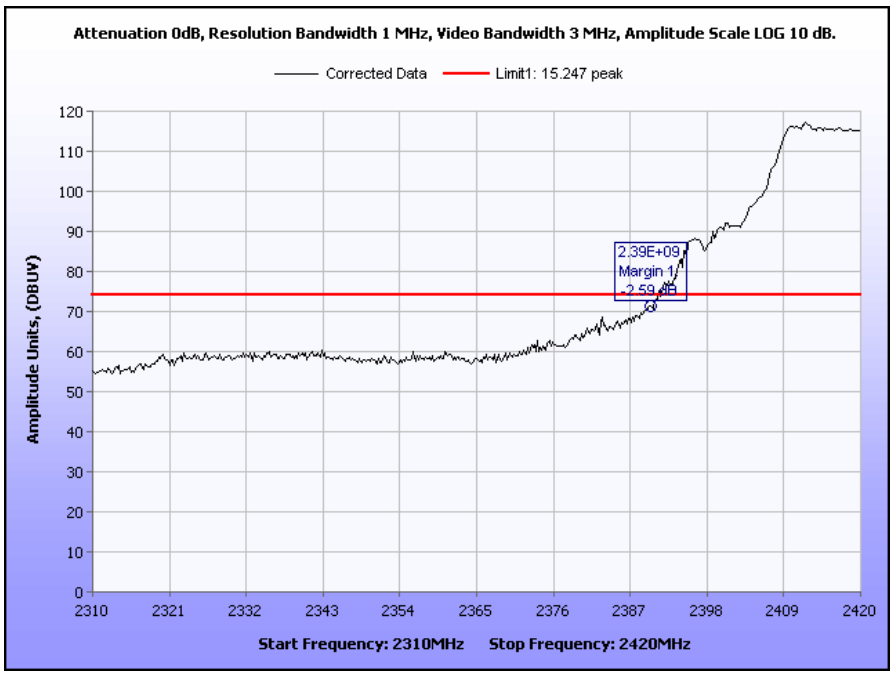
Plot 49. Radiated Restricted Band Edge, 802.11g, Channel 1, Average



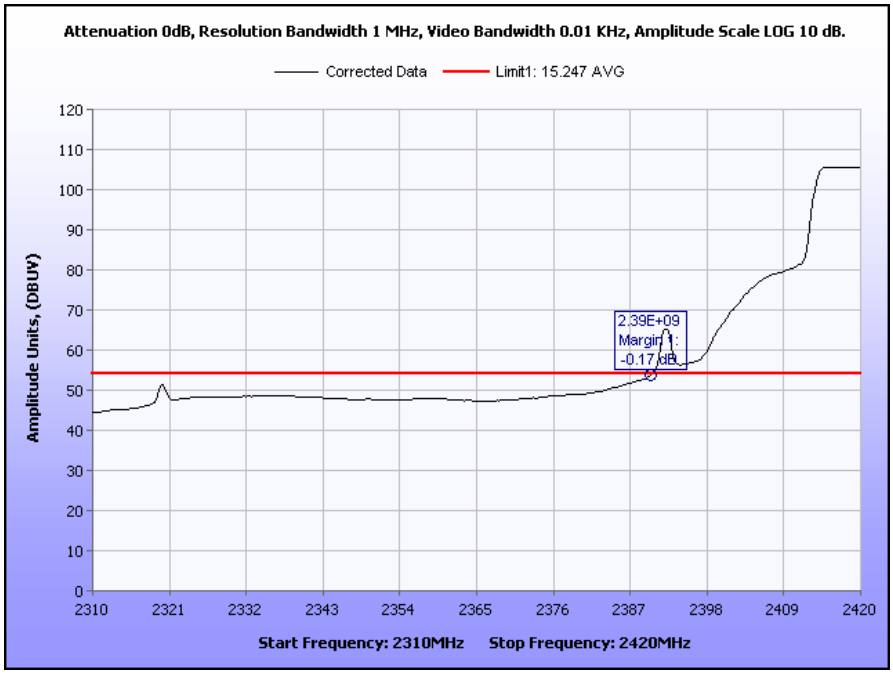
Plot 50. Radiated Restricted Band Edge, 802.11g, Channel 1, Peak



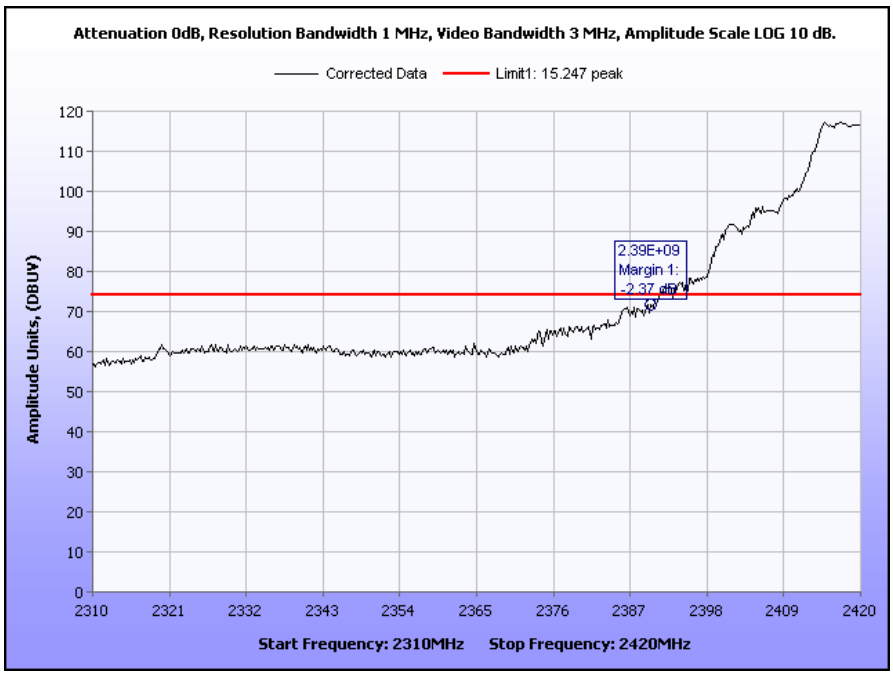
Plot 51. Radiated Restricted Band Edge, 802.11g, Channel 2, Average



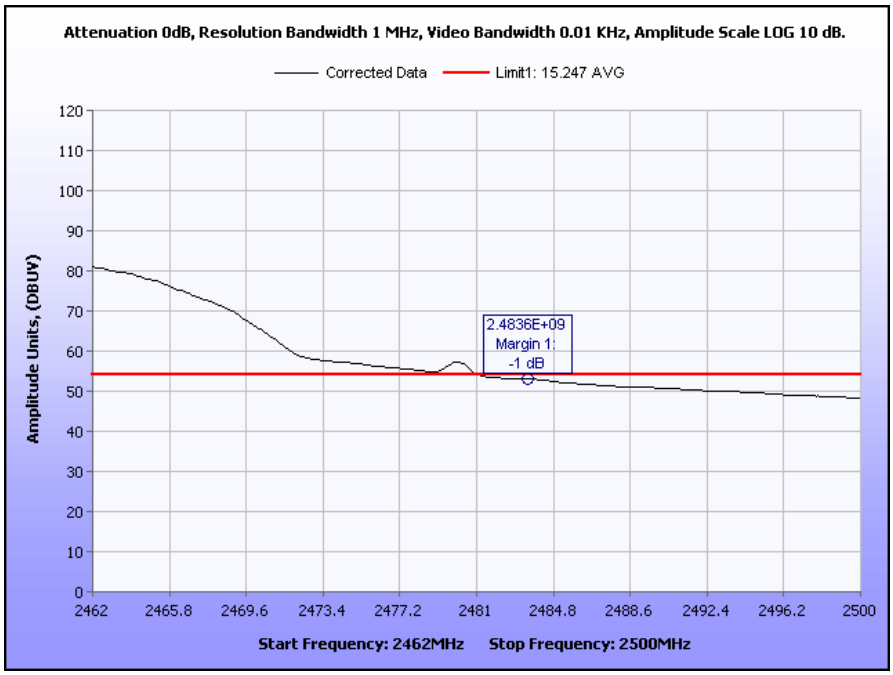
Plot 52. Radiated Restricted Band Edge, 802.11g, Channel 2, Peak



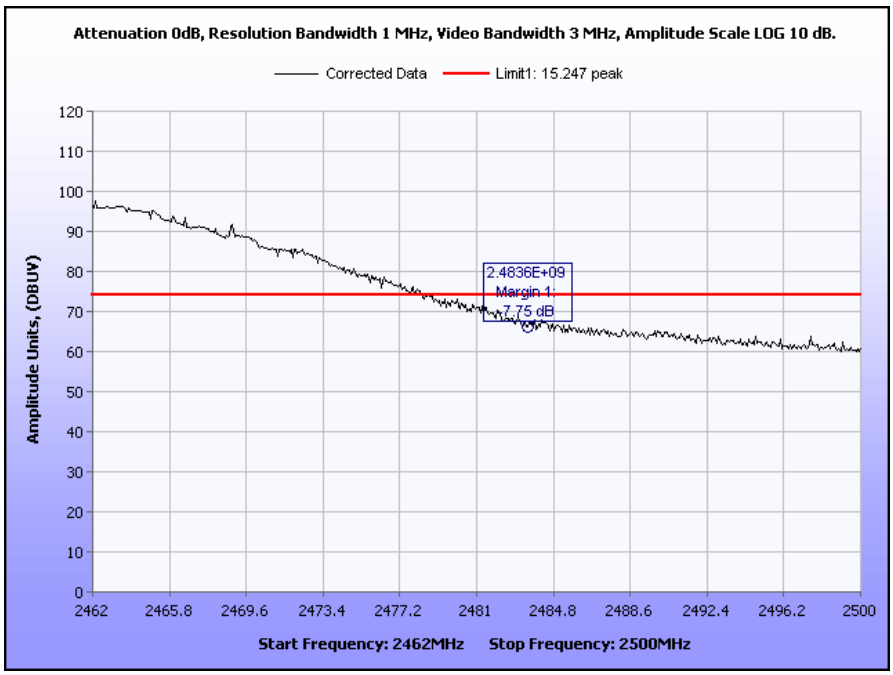
Plot 53. Radiated Restricted Band Edge, 802.11g, Channel 3, Average



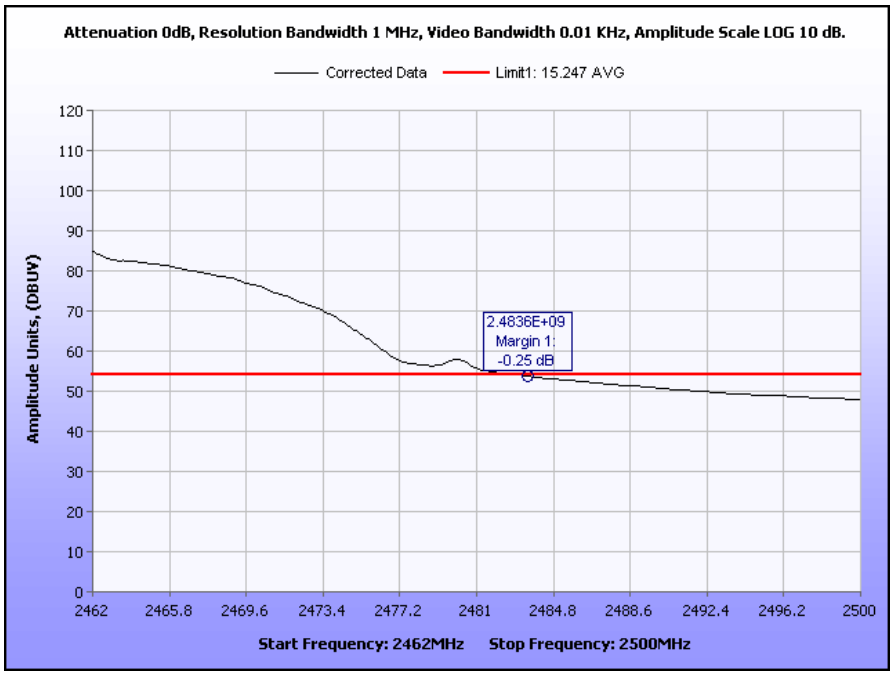
Plot 54. Radiated Restricted Band Edge, 802.11g, Channel 3, Peak



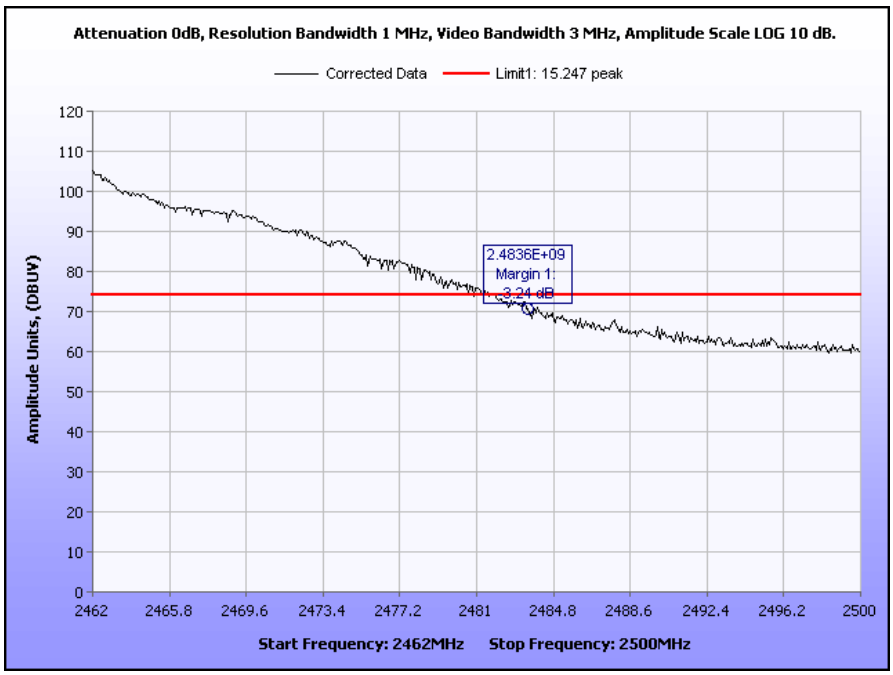
Plot 55. Radiated Restricted Band Edge, 802.11g, Channel 8, Average



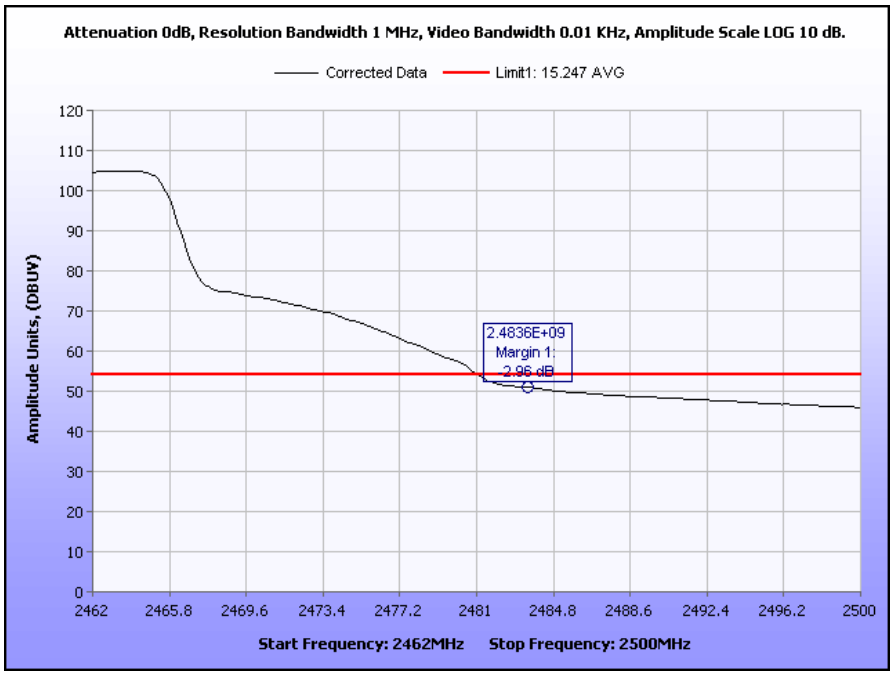
Plot 56. Radiated Restricted Band Edge, 802.11g, Channel 8, Peak



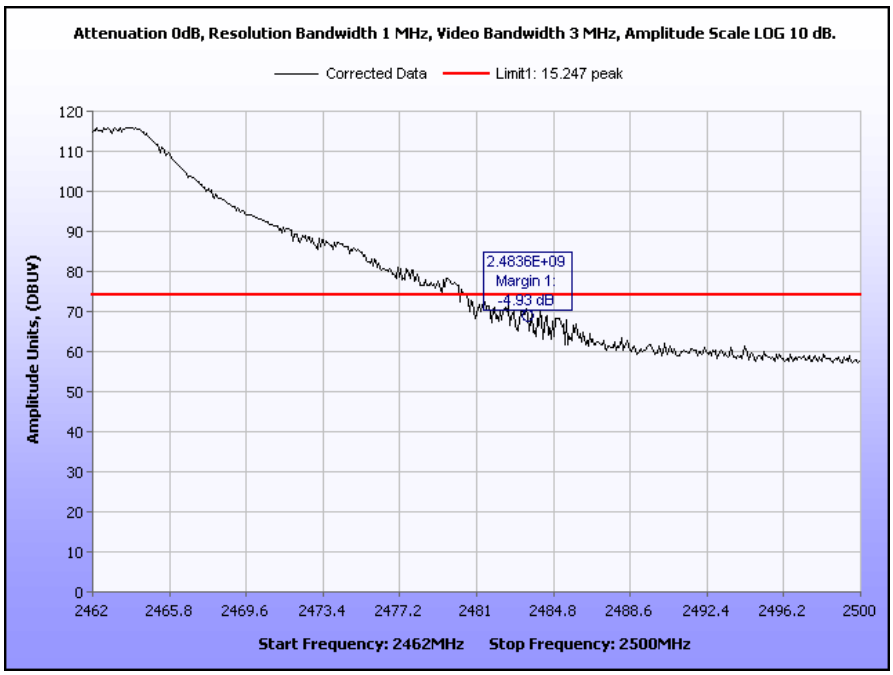
Plot 57. Radiated Restricted Band Edge, 802.11g, Channel 9, Average



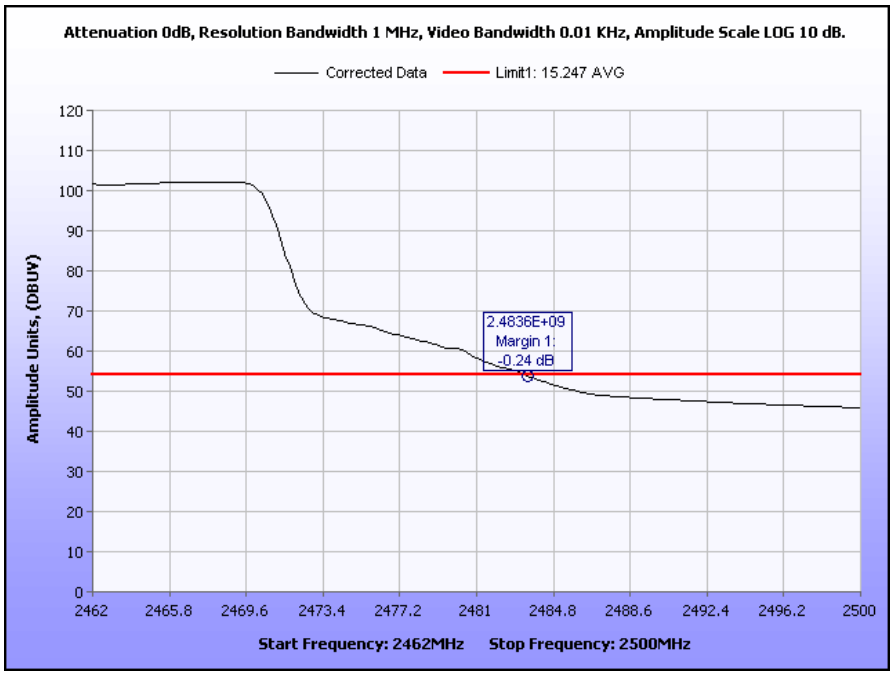
Plot 58. Radiated Restricted Band Edge, 802.11g, Channel 9, Peak



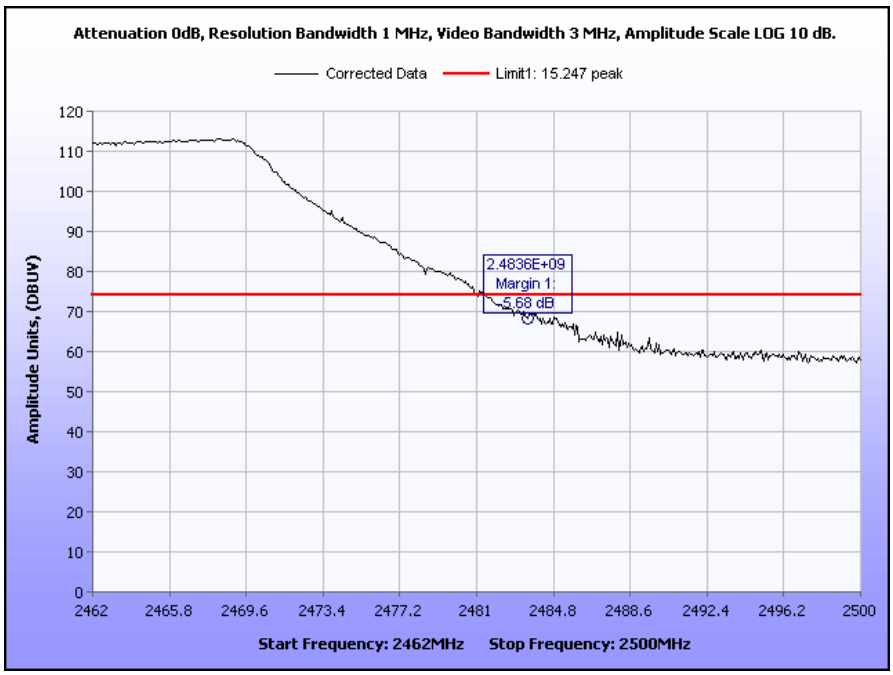
Plot 59. Radiated Restricted Band Edge, 802.11g, Channel 10, Average



Plot 60. Radiated Restricted Band Edge, 802.11g, Channel 10, Peak



Plot 61. Radiated Restricted Band Edge, 802.11g, Channel 11, Average



Plot 62. Radiated Restricted Band Edge, 802.11g, Channel 11, Peak

Electromagnetic Compatibility Criteria for Intentional Radiators

RSS-GEN Receiver Spurious Emissions Requirements

Test Requirements: The following receiver spurious emission limits shall be complied with:

(a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 27.

Spurious Frequency (MHz)	Field Strength (microvolt/m at 3 metres)
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 27. Spurious Emission Limits for Receivers

(b) If a conducted measurement is made, no spurious output signals appearing at the antenna terminals shall exceed 2 nanowatts per any 4 kHz spurious frequency in the band 30-1000 MHz, or 5 nanowatts above 1 GHz.

Test Procedures: The EUT was programmed for receive mode only. Conducted measurements were taken at the antenna port of the EUT. All plots are corrected for cable loss.

Test Results: Equipment is compliant with the Receiver Spurious Emissions Requirements of RSS-GEN. Measured emissions were below applicable limits.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 05/05/10

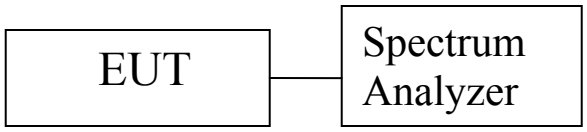
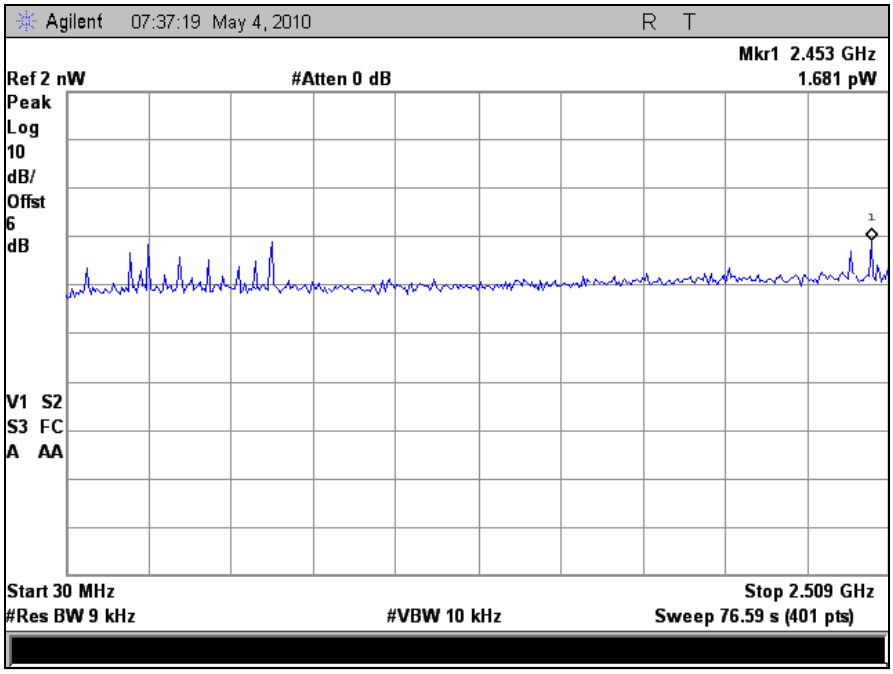
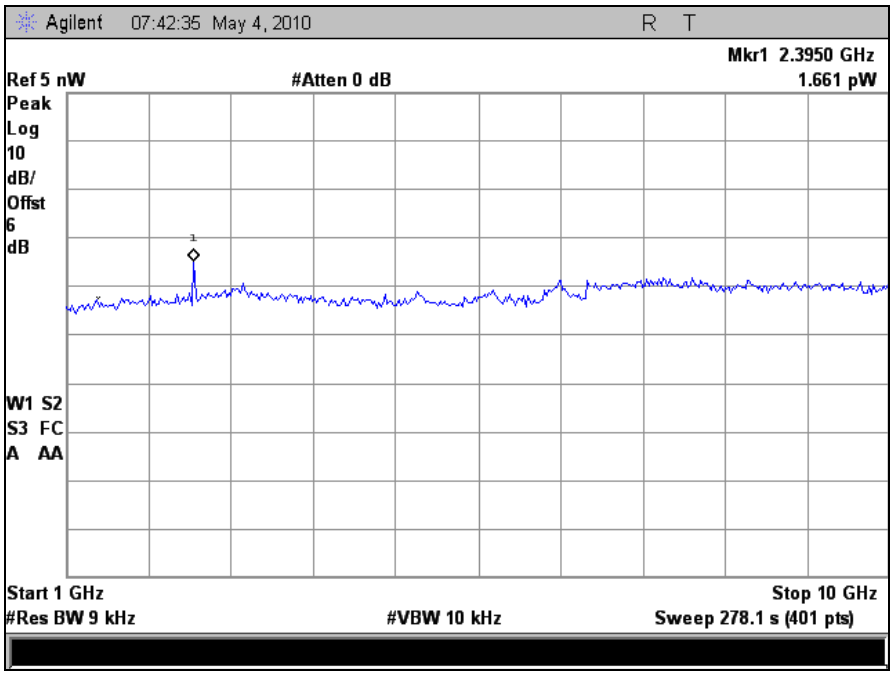


Figure 4. Block Diagram, Conducted Receiver Spurious Emissions Test Setup

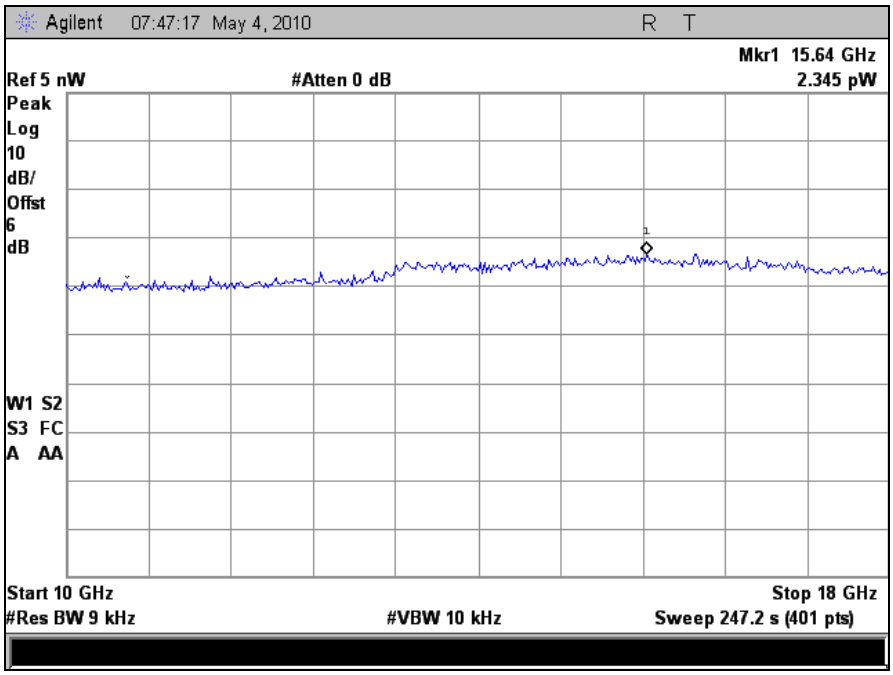
Conducted Receiver Spurious Emissions



Plot 63. Receiver Spurious Emissions, 30 MHz – 1 GHz



Plot 64. Receiver Spurious Emissions, 1 GHz – 10 GHz



Plot 65. Receiver Spurious Emissions, 10 GHz – 18 GHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge

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 leas 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.

See following pages for detailed test results with RF Conducted Spurious Emissions.

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

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 05/04/10

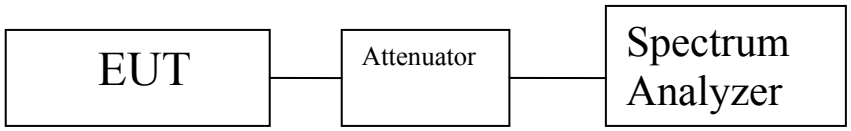
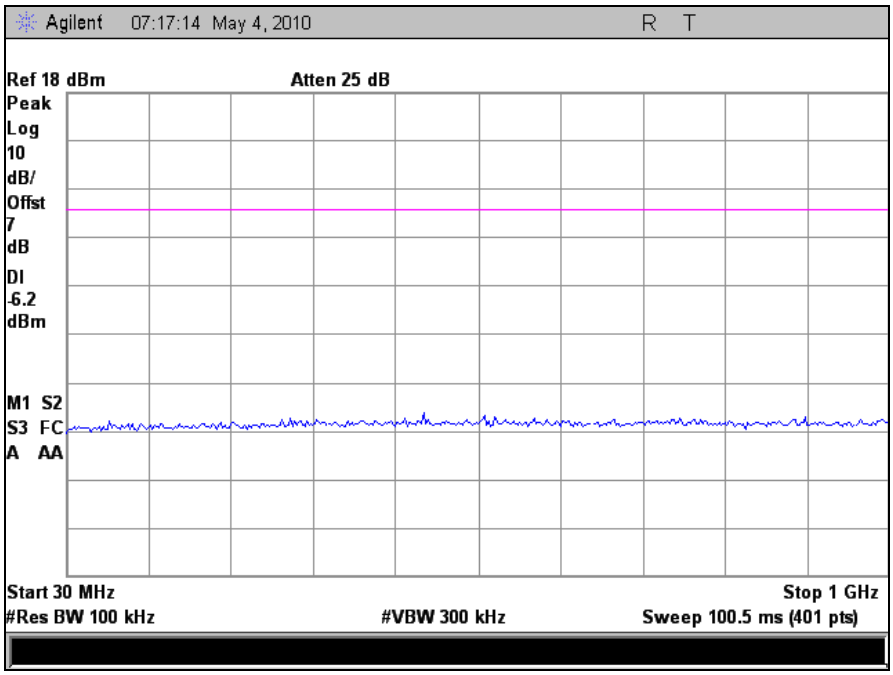
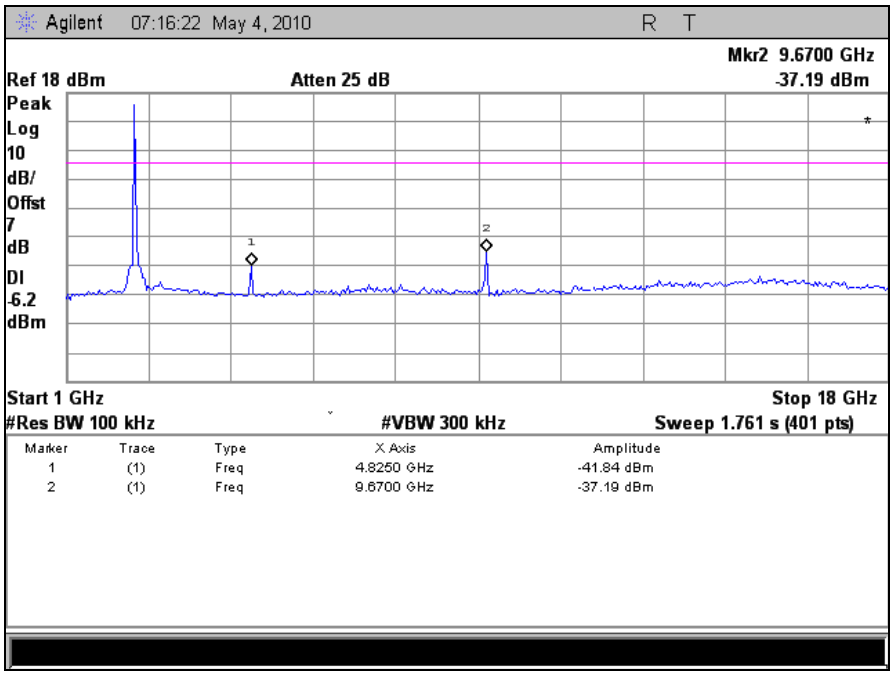


Figure 5. Block Diagram, Conducted Spurious Emissions Test Setup

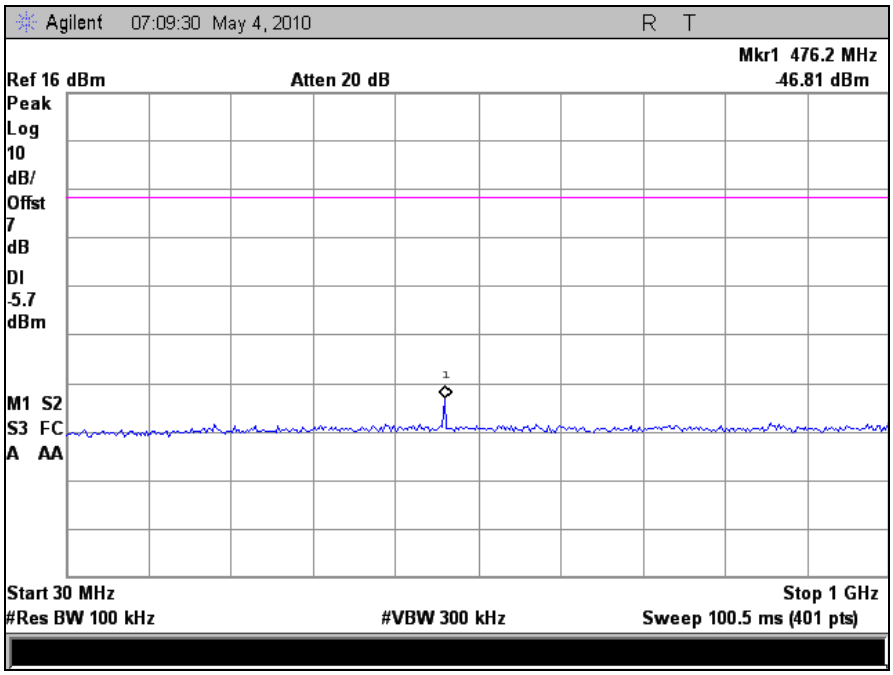
Conducted Spurious Emissions Test Results



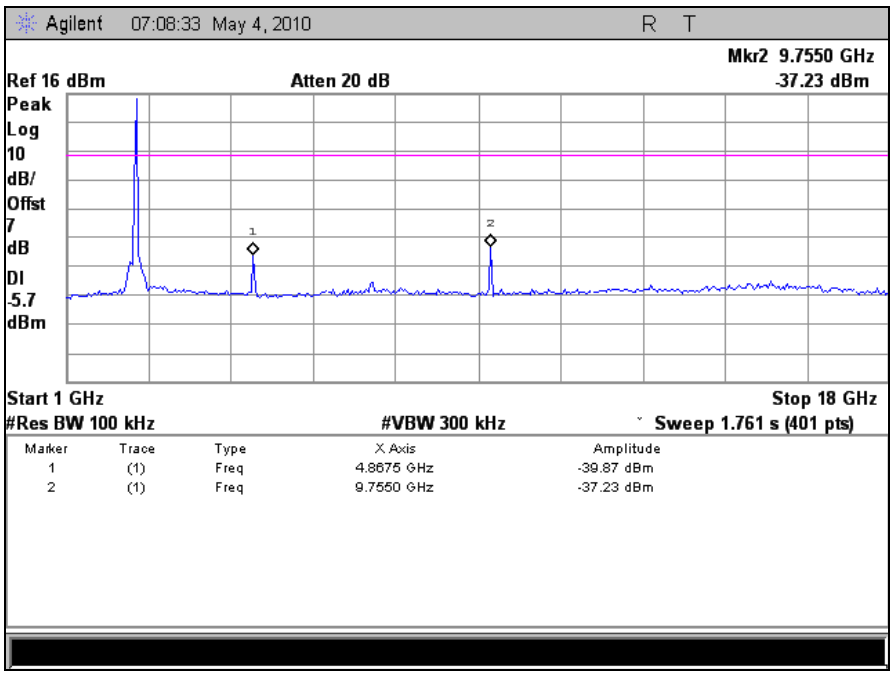
Plot 66. Conducted Emissions, Low Channel, 802.11b, 30 MHz – 1 GHz



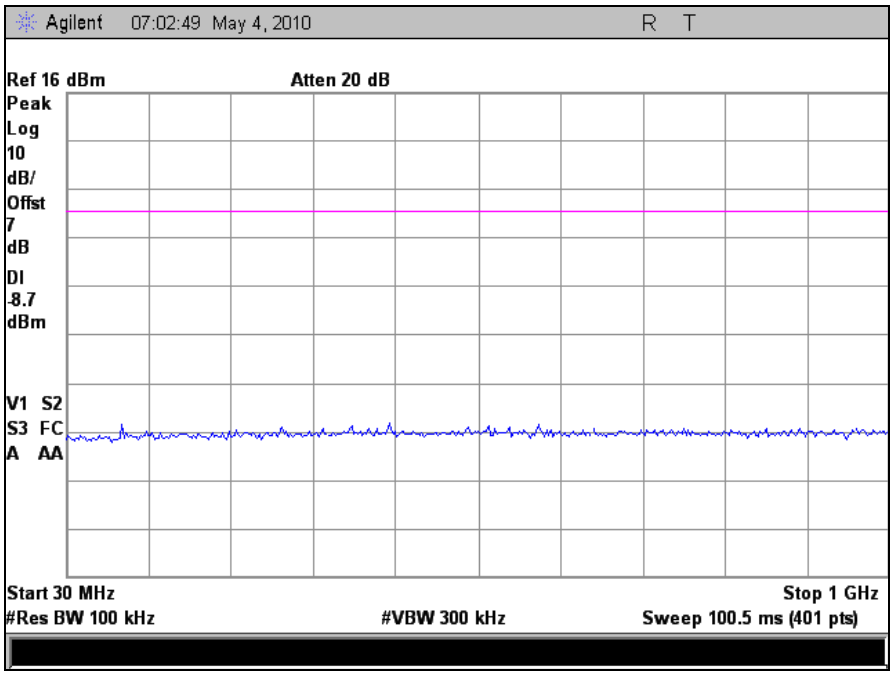
Plot 67. Conducted Emissions, Low Channel, 802.11b, 1 GHz – 18 GHz



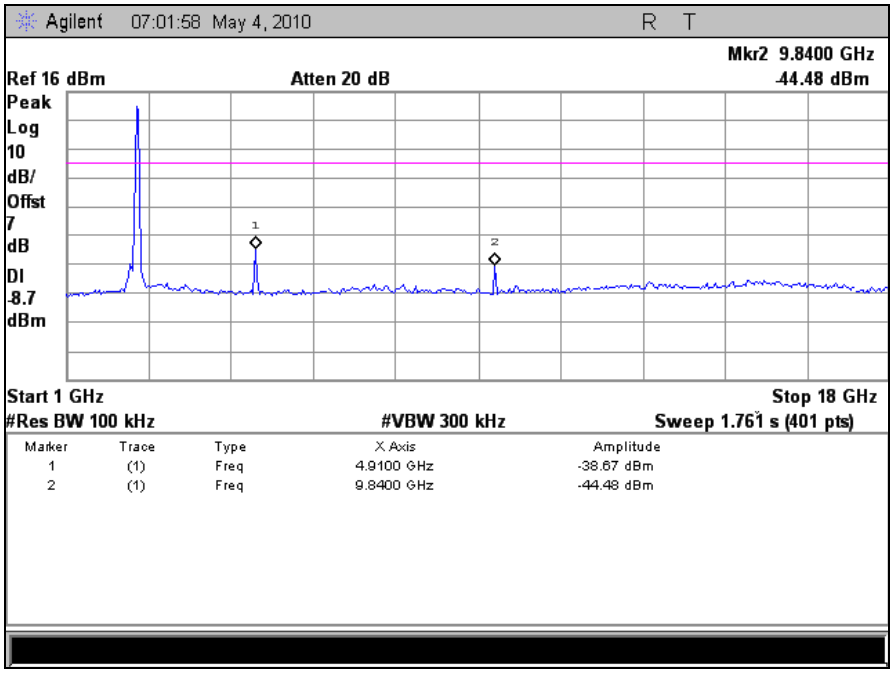
Plot 68. Conducted Emissions, Mid Channel, 802.11b, 30 MHz – 1 GHz



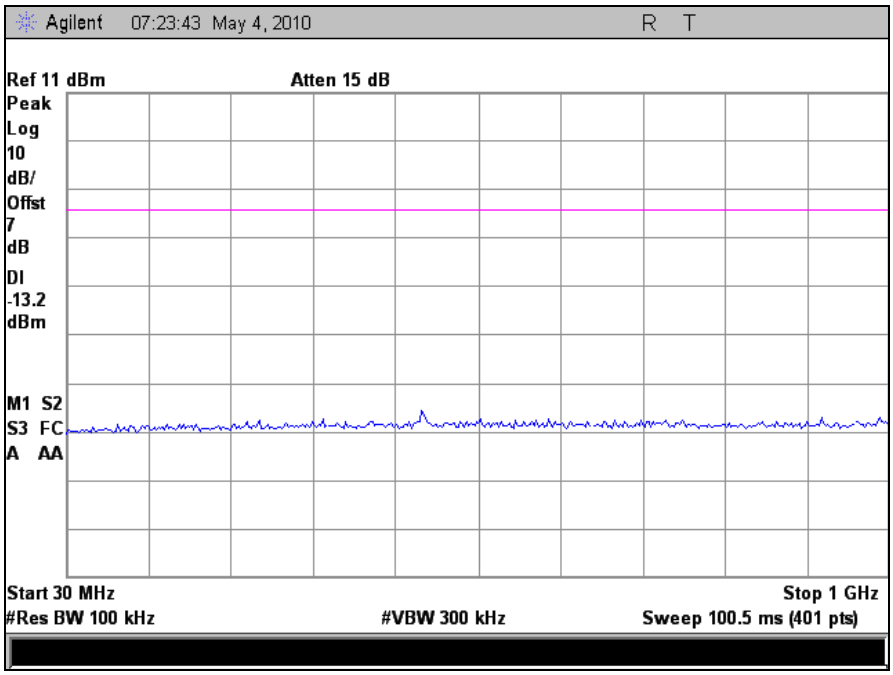
Plot 69. Conducted Emissions, Mid Channel, 802.11b, 1 GHz – 18 GHz



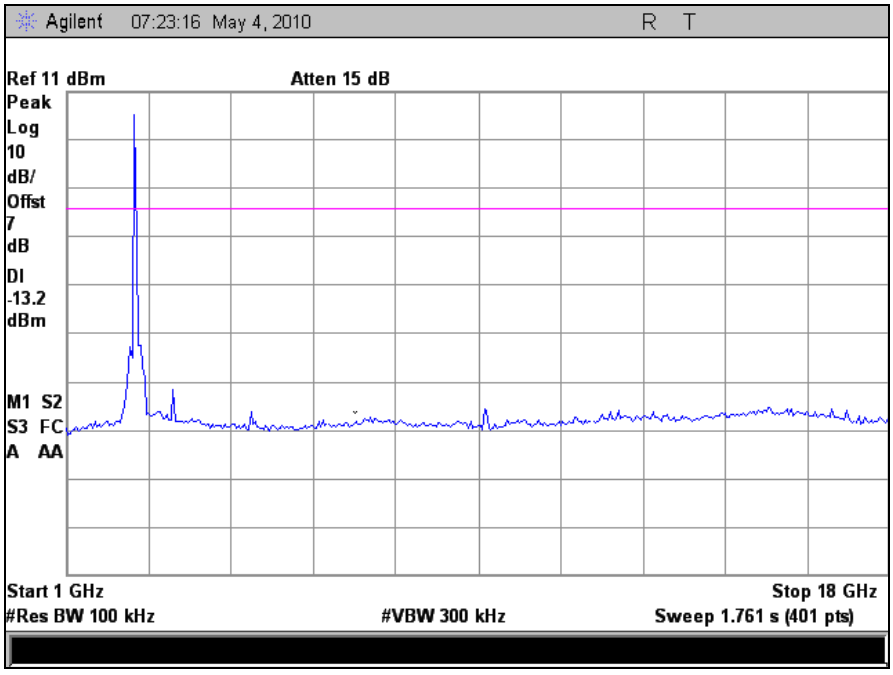
Plot 70. Conducted Emissions, High Channel, 802.11b, 30 MHz – 1 GHz



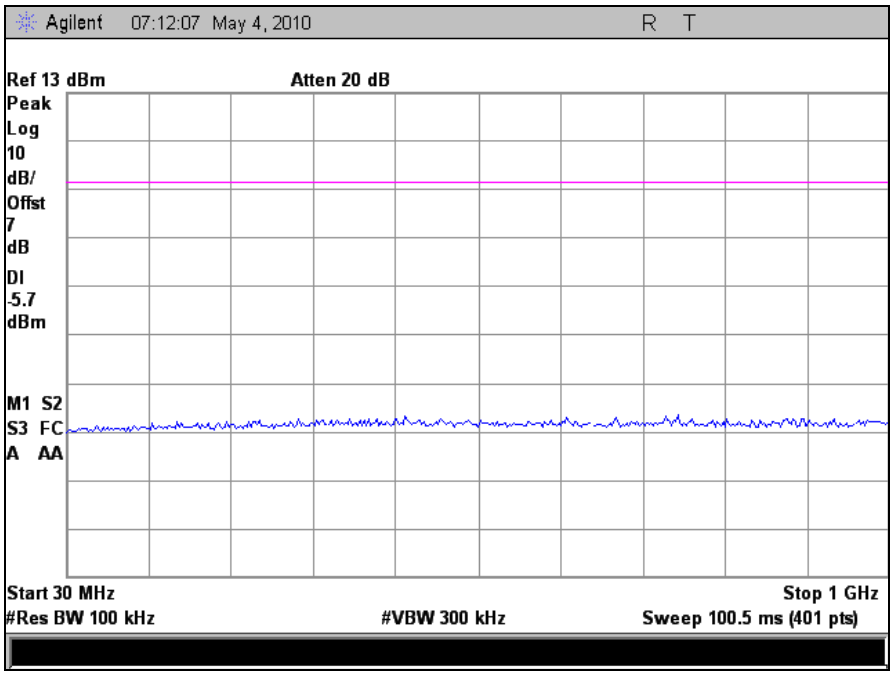
Plot 71. Conducted Emissions, High Channel, 802.11b, 1 GHz – 18 GHz



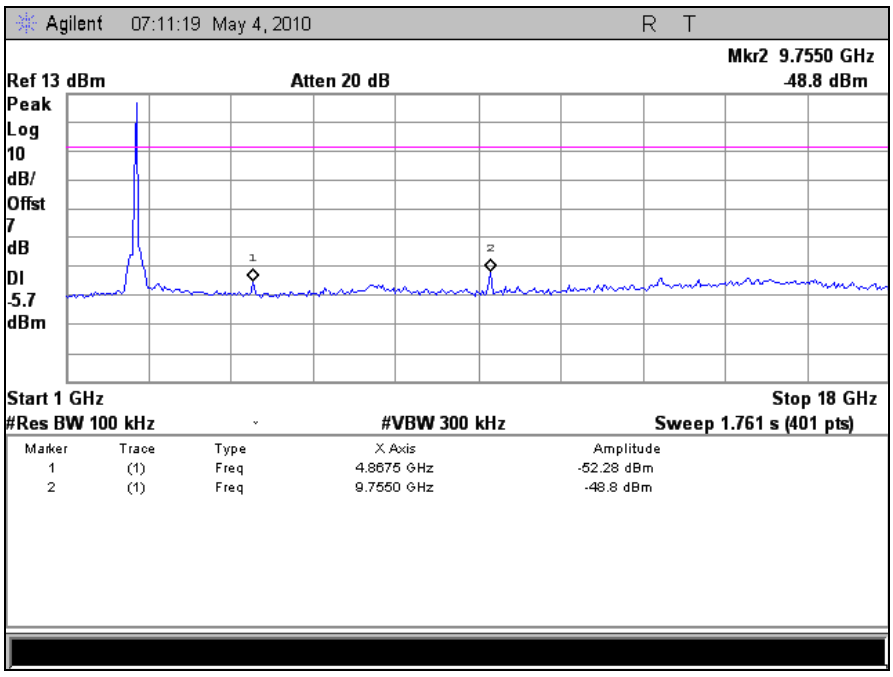
Plot 72. Conducted Emissions, Low Channel, 802.11g, 30 MHz – 1 GHz



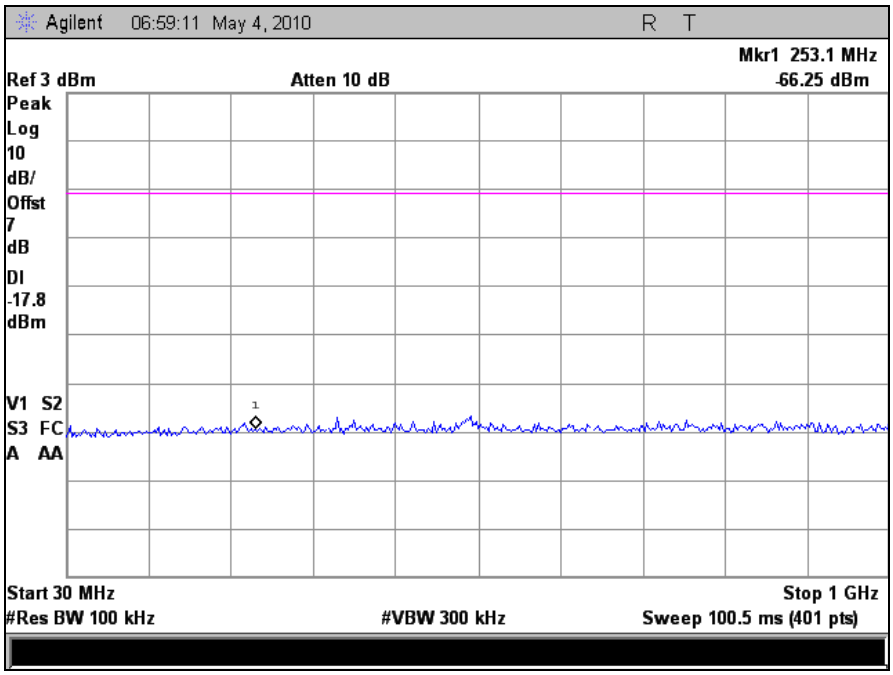
Plot 73. Conducted Emissions, Low Channel, 802.11g, 1 GHz – 18 GHz



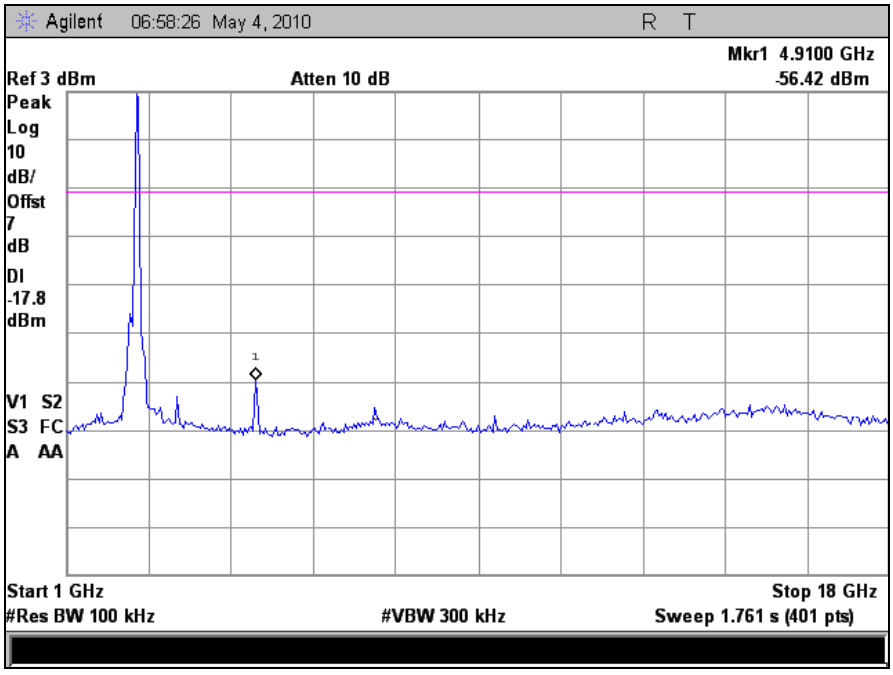
Plot 74. Conducted Emissions, Mid Channel, 802.11g, 30 MHz – 1 GHz



Plot 75. Conducted Emissions, Mid Channel, 802.11g, 1 GHz – 18 GHz

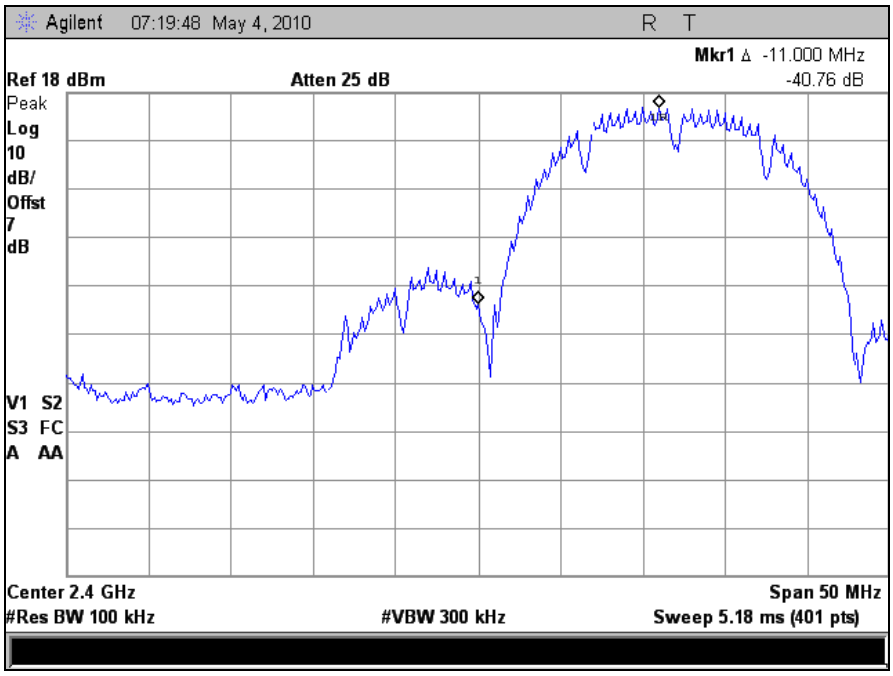


Plot 76. Conducted Emissions, High Channel, 802.11g, 30 MHz – 1 GHz

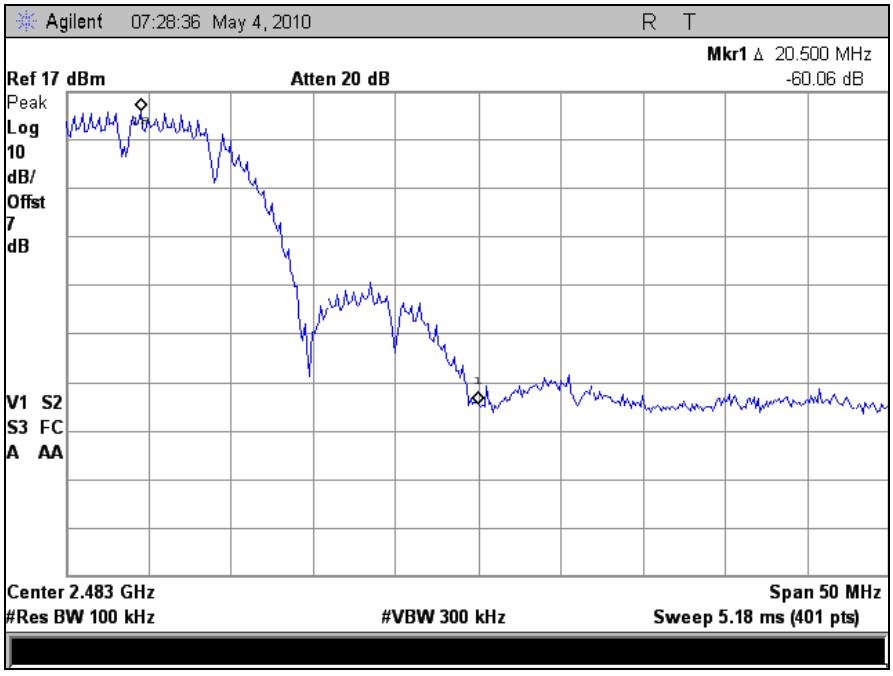


Plot 77. Conducted Emissions, High Channel, 802.11g, 1 GHz – 18 GHz

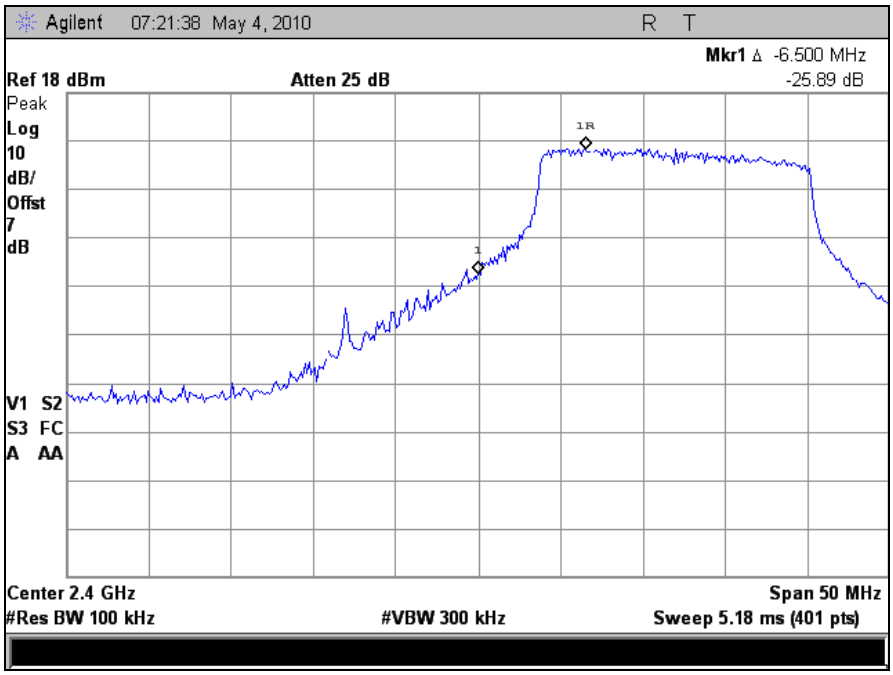
Conducted Band Edge Test Results



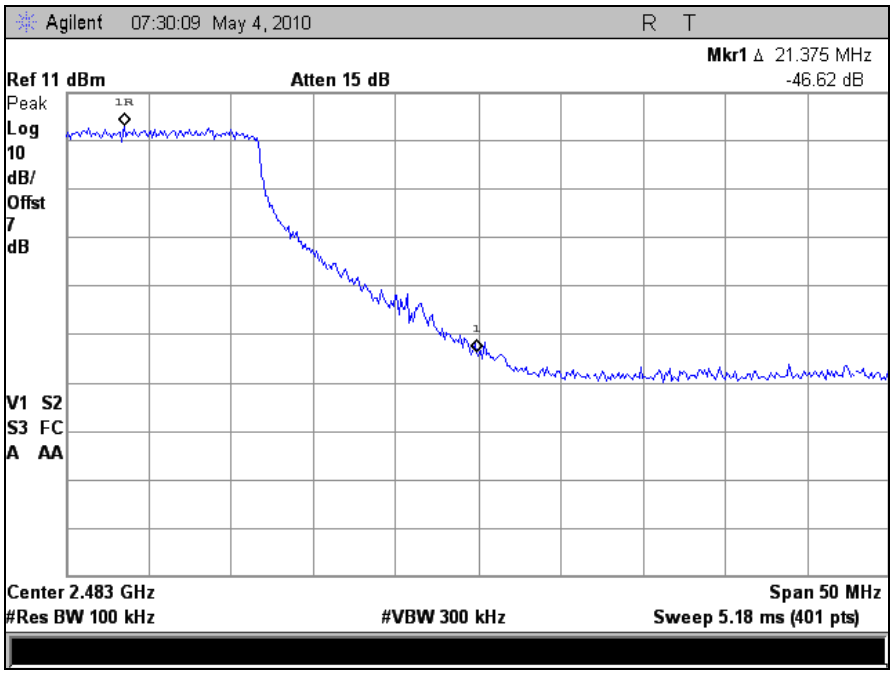
Plot 78. Conducted Band Edge, 802.11b, Low Channel



Plot 79. Conducted Band Edge, 802.11b, High Channel



Plot 80. Conducted Band Edge, 802.11g, Low Channel



Plot 81. Conducted Band Edge, 802.11g, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Peak Power Spectral Density

Test Requirements: **§15.247(e):** For digitally modulated systems, the peak 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 through an attenuator. The power level was set to the maximum level throughout each of the 100 sweeps of power averaging. The RBW was set to 3 kHz and a VBW set to 9 kHz or greater. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.

Test Results: The EUT was compliant with the peak power spectral density limits of **§ 15.247 (e)**. No anomalies were noted.

The peak power spectral density was determined from plots on the following page(s).

Test Engineer: Dusmantha Tennakoon

Test Date: 05/04/10

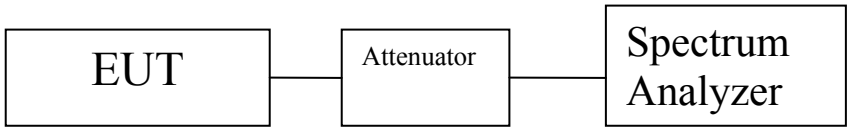


Figure 6. Block Diagram, Peak Power Spectral Density Test Setup

Peak Power Spectral Density Test Results

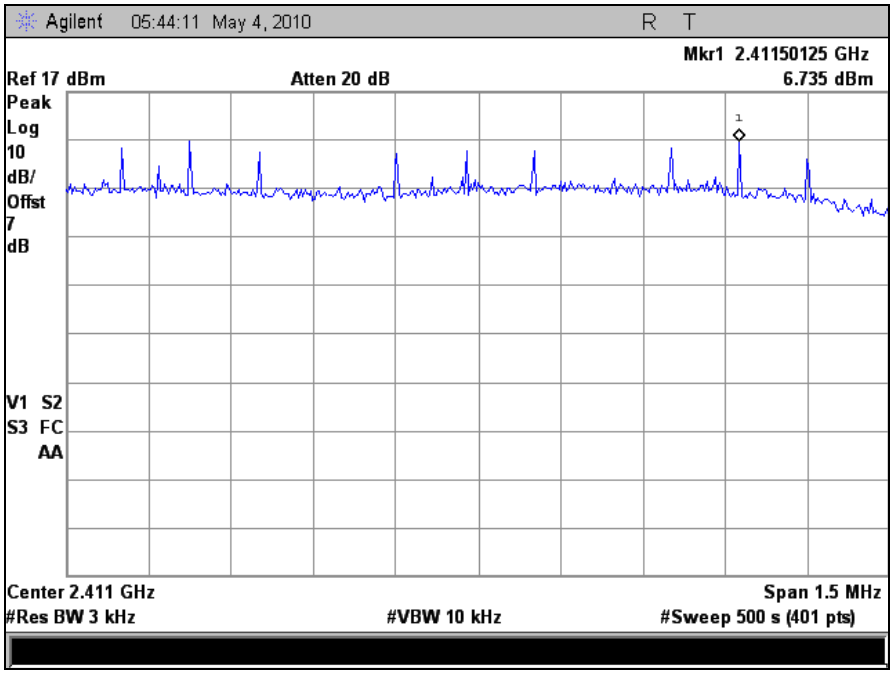
Peak Power Spectral Density				
Carrier Channel	Frequency (MHz)	Measured PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2411	6.735	8	-1.265
Mid	2437	3.652	8	-4.348
High	2462	3.16	8	-4.84

Table 28. Spectral Density, Test Results, 802.11b

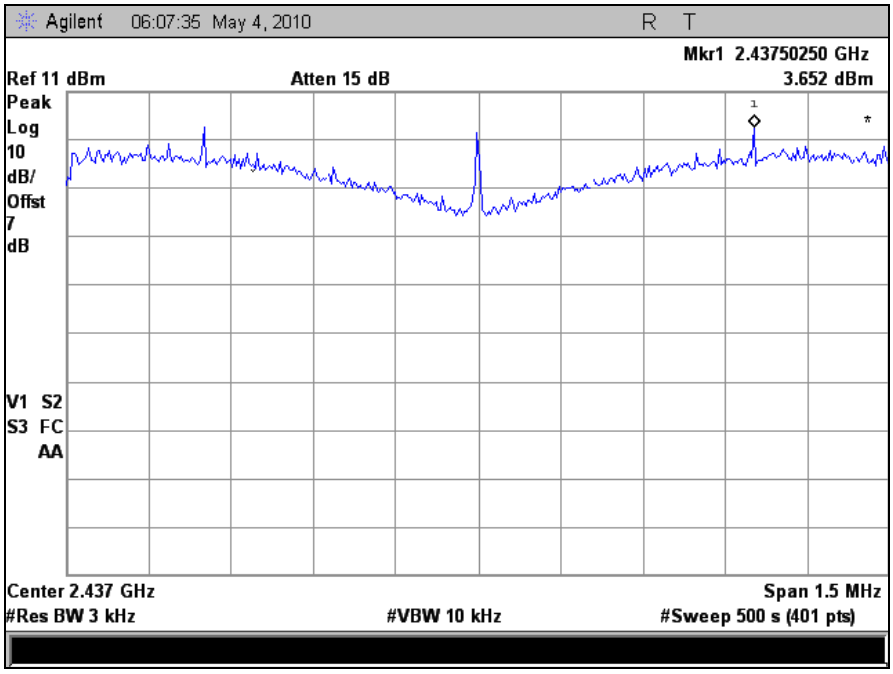
Peak Power Spectral Density				
Carrier Channel	Frequency (MHz)	Measured PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	6.939	8	-1.061
Mid	2437	6.148	8	-1.852
High	2462	0.539	8	-7.461

Table 29. Spectral Density, Test Results, 802.11g

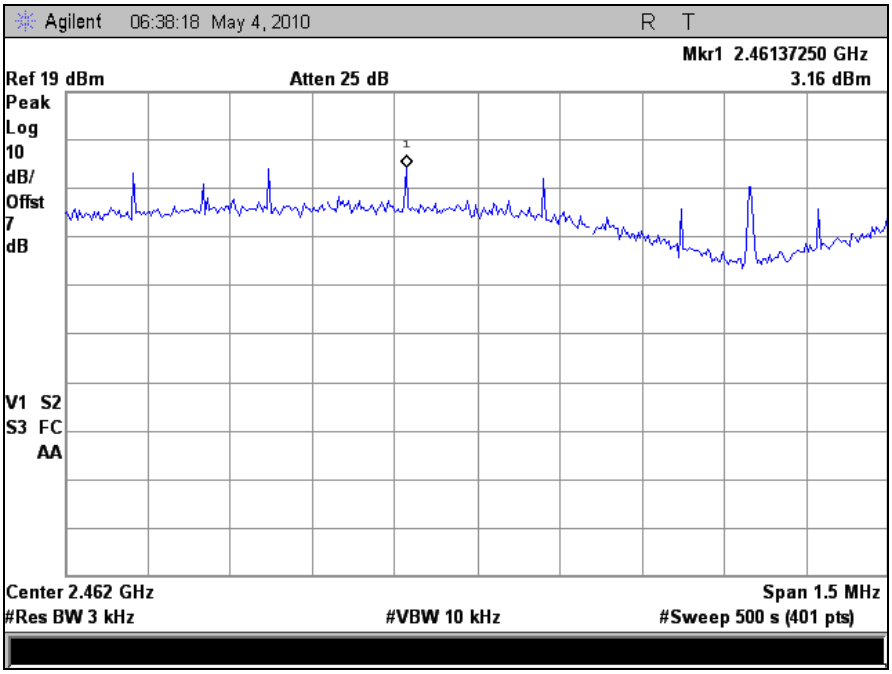
Peak Power Spectral Density



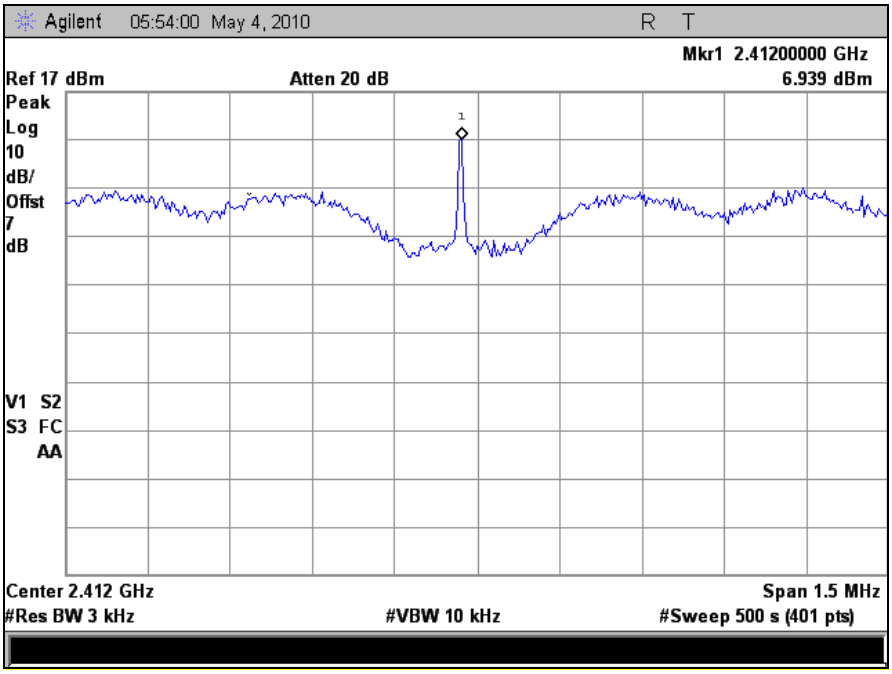
Plot 82. Peak Power Spectral Density, 802.11b, Low Channel



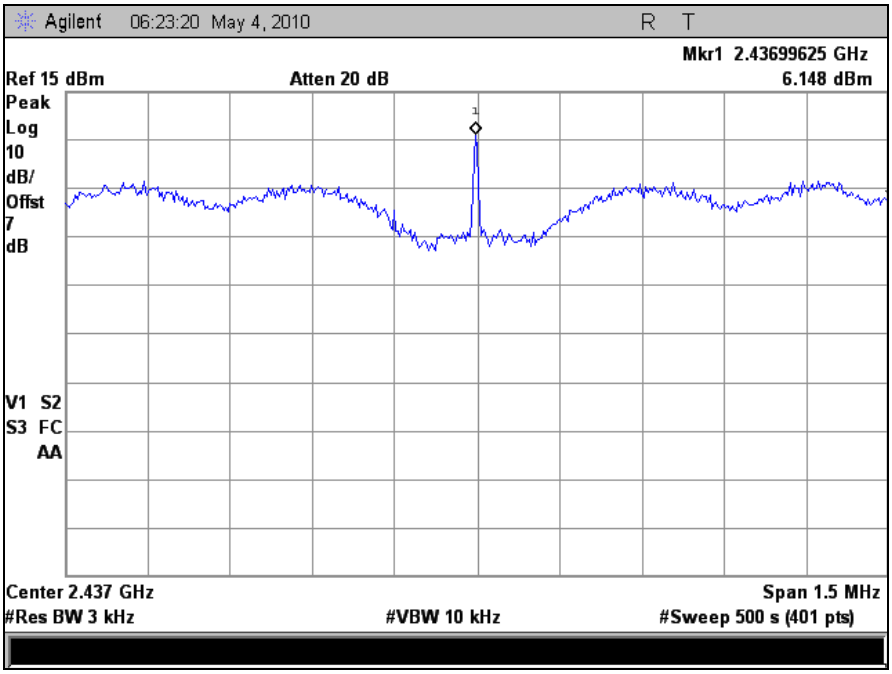
Plot 83. Peak Power Spectral Density, 802.11b, Mid Channel



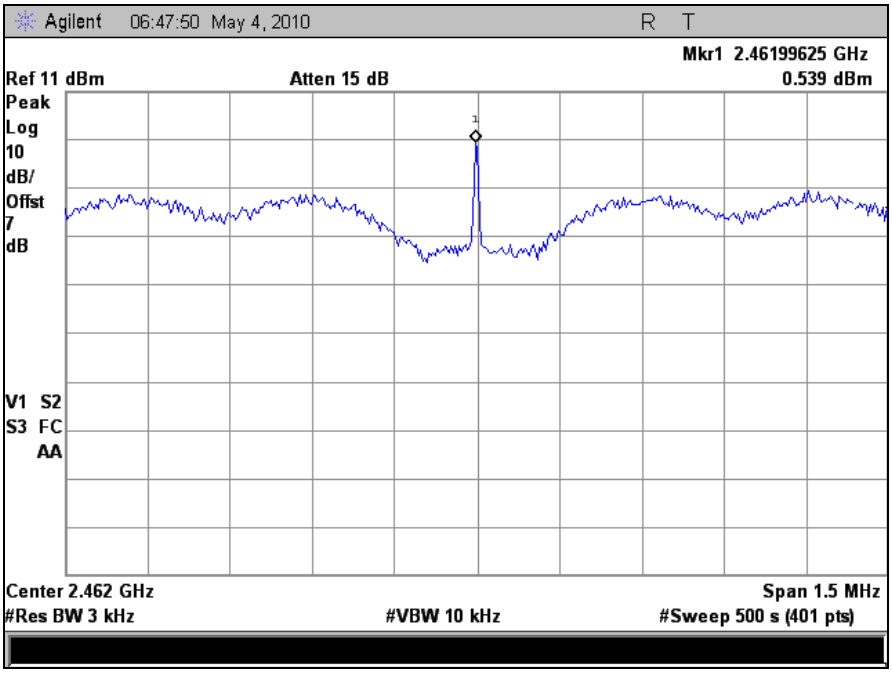
Plot 84. Peak Power Spectral Density, 802.11b, High Channel



Plot 85. Peak Power Spectral Density, 802.11g, Low Channel



Plot 86. Peak Power Spectral Density, 802.11g, Mid Channel



Plot 87. Peak Power Spectral Density, 802.11g, High Channel

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ANSI/NCSL Z540-1-1994 and ANSI/ISO/IEC 17025:2000.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4303	ANTENNA; BILOG	SCHAFNER - CHASE EMC	CBL6140A	07/29/2009	07/29/2010
1T4592	RF FILTER KIT	VARIOUS	N/A	SEE NOTE	
1T4300	SEMI-ANECHOIC CHAMBER # 1	EMC TEST SYSTEMS	NONE	08/24/2007	08/24/2010
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	05/07/2009	05/07/2010
1T4612	ESA-E SERIES SPECTRUM ANALYZER	AGILENT	E4407B	09/09/2009	09/09/2010
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T2665	HORN ANTENNA	EMCO	3115	07/06/2009	07/06/2010
1T2511	ANTENNA; HORN	EMCO	3115	08/21/2009	08/21/2010
1T4302	EMI RECEIVER	HEWLETT PACKARD	85462A	06/26/2009	06/26/2010
1T4565	LISN (24 AMP)	SOLAR ELECTRONICS	9252-50-R-24-BNC	10/14/2009	10/14/2010
1T4627	THERMO/HYGROMETER	CONTROL COMPANY	S6-627-9	10/09/2009	10/09/2011
1T4564	LISN (24 AMP)	SOLAR ELECTRONICS	9252-50-R-24-BNC	09/09/2009	09/09/2010
1T4382	SHIELD ROOM 6	FIL-SHIELD	N/A	SEE NOTE	
1T4568	RADIATING NOISE SOURCE	MET LABORATORIES	N/A	SEE NOTE	

Table 30. 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

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

