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January 21, 2010

Fortress Technologies
2 Technology Park Drive
Westford, MA 01886

Dear John Pacheco,

Enclosed is the EMC Wireless test report for compliance testing of the Fortress Technologies, Vehicle Mesh Point ES820 (containing M25 and M5 Radios) as tested to the requirements of FCC Part 15 Subpart C and 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: (\Fortress Technologies\EMC28036-FCC247)

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Electromagnetic Compatibility Criteria
Test Report

for the

Fortress Technologies
Vehicle Mesh Point ES820 (M25 and M5 Radios)

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C & RSS-210, Issue 7, June 2007
for Intentional Radiators

MET Report: EMC28036-FCC247

January 21, 2010

Prepared For:

Fortress Technologies
2 Technology Park Drive
Westford, MA 01886

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

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15.247 Subpart C & RSS-210, Issue 7, June 2007
for Intentional Radiators

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 Part 15.247 and Industry Canada standard RSS-210, Issue 7, June 2007 under normal use and maintenance.

Shawn McMillen,
Wireless Manager, Electromagnetic Compatibility Lab

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Report Status Sheet

Revision	Report Date	Reason for Revision
∅	January 21, 2010	Initial Issue.

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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

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I. Executive Summary

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A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Fortress Technologies Vehicle Mesh Point ES820 (M25 and M5Radios), with the requirements of Part §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 Vehicle Mesh Point ES820 (M25 and M5 Radios). Fortress Technologies should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Vehicle Mesh Point ES820 (M25 and M5 Radios), 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 §15.247, in accordance with Fortress Technologies, purchase order number 0002200. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference	IC Reference	Description	Compliance
47 CFR Part 15.247:2005	RSS-210 Issue 7: 2007	Applicable Standard	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-GEN(7.2.2)	Conducted Emission Voltage	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	RSS-210(A8.2a)	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(A8.2b)	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(6)	Receiver Spurious Emissions	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

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II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Fortress Technologies to perform testing on the Vehicle Mesh Point ES820 (M25 Radio), under Fortress Technologies' purchase order number 0002200.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Fortress Technologies, Vehicle Mesh Point ES820 (M25 and M5 Radios).

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

Model(s) Tested:	Vehicle Mesh Point ES820 (M25 and M5 Radios)		
Model(s) Covered:	Vehicle Mesh Point ES820 (M25 and M5 Radios)		
EUT Specifications:	Primary Power: 120 VAC, 60 Hz		
	FCC ID: WYK-ES820		
	Type of Modulations:	OFDM	
	Equipment Code:	DTS	
	Peak RF Output Power:	M25	2.4 GHz: 23.17 dBm (0.207 W)
			5.8 GHz: 23.35 dBm (0.216 W)
		M5	26.77 dBm (0.475 W)
	EUT Frequency Ranges:	M25	2412 – 2462 MHz and 5745 – 5825 MHz
		M5	5745 – 5825 MHz
Analysis:	The results obtained relate only to the item(s) tested.		
Environmental Test Conditions:	Temperature: 15-35° C		
	Relative Humidity: 30-60%		
	Barometric Pressure: 860-1060 mbar		
Evaluated by:	Dusmantha Tennakoon		
Report Date(s):	January 21, 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 License-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
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

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 Fortress Technologies Vehicle Mesh Point ES820, Equipment Under Test (EUT), is a dual radio access point/bridge. It embeds two COTS high power radios (M25 and M5) and two Ethernet ports in a ruggedized enclosure. The radio operates in accordance to the 802.11a and 802.11g standards.

The ES820 is intended to provided outdoor mobile connectivity in a secure manner both wired and wirelessly.

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Photograph 1. Front View of EUT

Photograph 2. Rear View of EUT

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E. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number
1	Fortress Vehicle Mesh Point	ES820	109260332

Table 4. Equipment Configuration

F. Support Equipment

Support equipment was not necessary for the operation and testing of the Vehicle Mesh Point ES820 (M25 Radio).

G. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty.	Length (m)	Shielded (Y/N)	Termination Box ID & Port Name
N/A	Ant (1 & 2)	Antenna	2	N/A	N/A	Spectrum Analyzer
N/A	AC Pwr	Provides power	1	N/A	N/A	External AC Charger
N/A	N/A	37-pin cable to provide connections for Ethernet, serial, LEDs, and push buttons	1	N/A	N/A	N/A

Table 5. Ports and Cabling Information

H. Mode of Operation

The ES820 can operate in 802.11a and 802.11g modes. These modes may be configured using the UI of the product. Additionally, these modes may be entered by using ART, the Atheros Radio Test tool. This is a standard tool provide by Atheros for directly manipulating and configuring their chips during testing and manufacturing.

I. 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.

J. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Fortress Technologies upon completion of testing.

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III. Electromagnetic Compatibility Criteria for Intentional Radiators – M25 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement – M25

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 by virtue of being professionally installed.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/01/09

Frequency	Gain/Model	Manufacturer
2.4 GHz	9 dBi / OD9-2400	Mobile Mark Communications
5.8 GHz	9 dBi / ECO9 – 5500	Mobile Mark Communications

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207 Conducted Emissions Limits – M25

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

Test Procedure: The EUT was placed on a 0.8 m-high wooden table. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2003 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. 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.

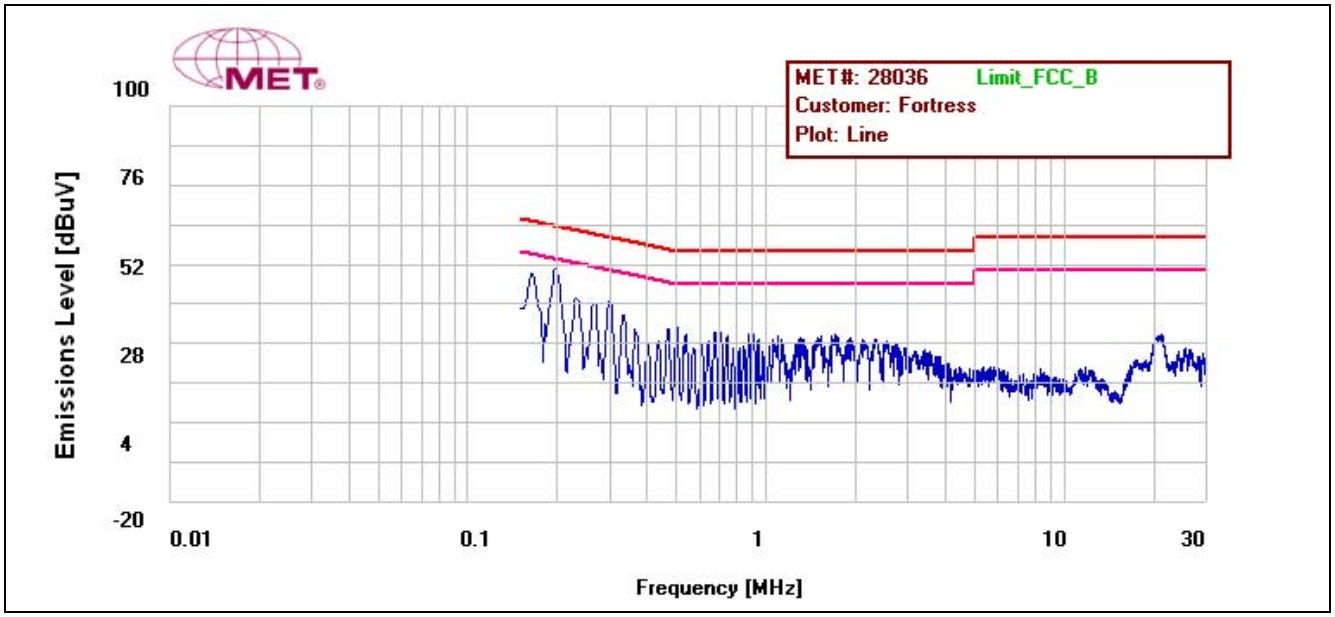
Test Results: The EUT was compliant with this requirement.

Test Engineer(s): Anderson Soungpanya

Test Date(s): 11/24/09

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line	0.169	49.33	65.012	-15.68	Pass	41.07	55.01	-13.94	Pass
Line	0.204	46.70	63.453	-16.75	Pass	41.84	53.45	-11.61	Pass
Line	2.24	34.01	56	-21.99	Pass	20.92	46.00	-25.08	Pass
Neutral	0.17	50.32	64.963	-14.64	Pass	40.76	54.96	-14.20	Pass
Neutral	0.203	45.71	63.494	-17.78	Pass	39.15	53.49	-14.34	Pass
Neutral	2.24	35.50	56	-20.50	Pass	27.86	46.00	-18.14	Pass

Table 7. Conducted Emissions, 15.207, Test Results, M25 Radio



Plot 1. Conducted Emissions, Phase Line, M25 Radio

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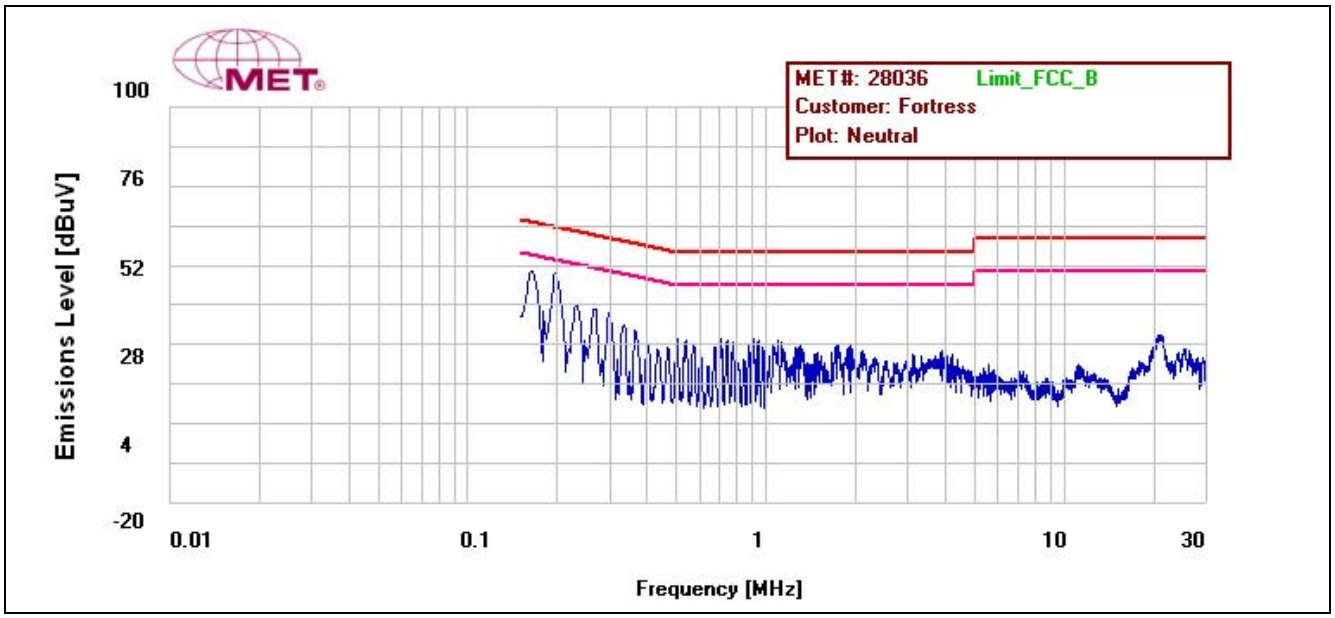
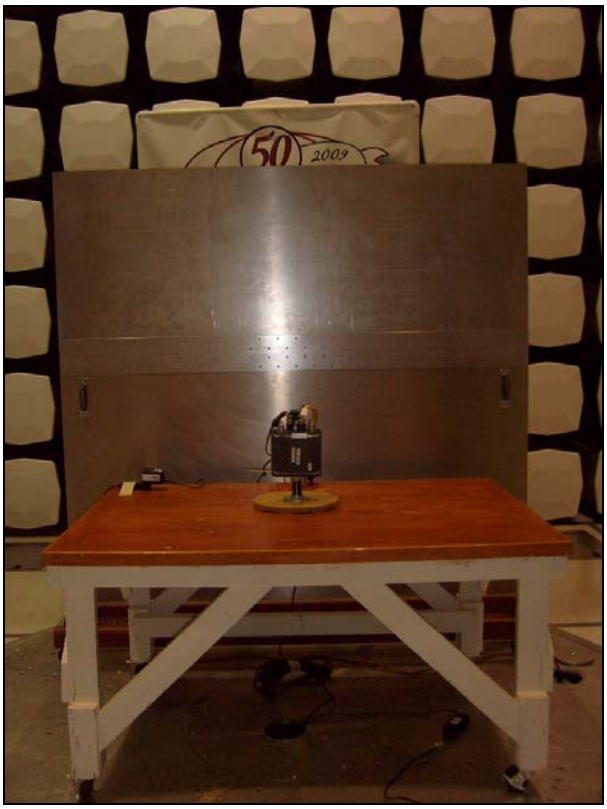


Plot 2. Conducted Emissions, Neutral Line, M25 Radio



Photograph 3. Conducted Emissions, Test Setup, M25 Radio

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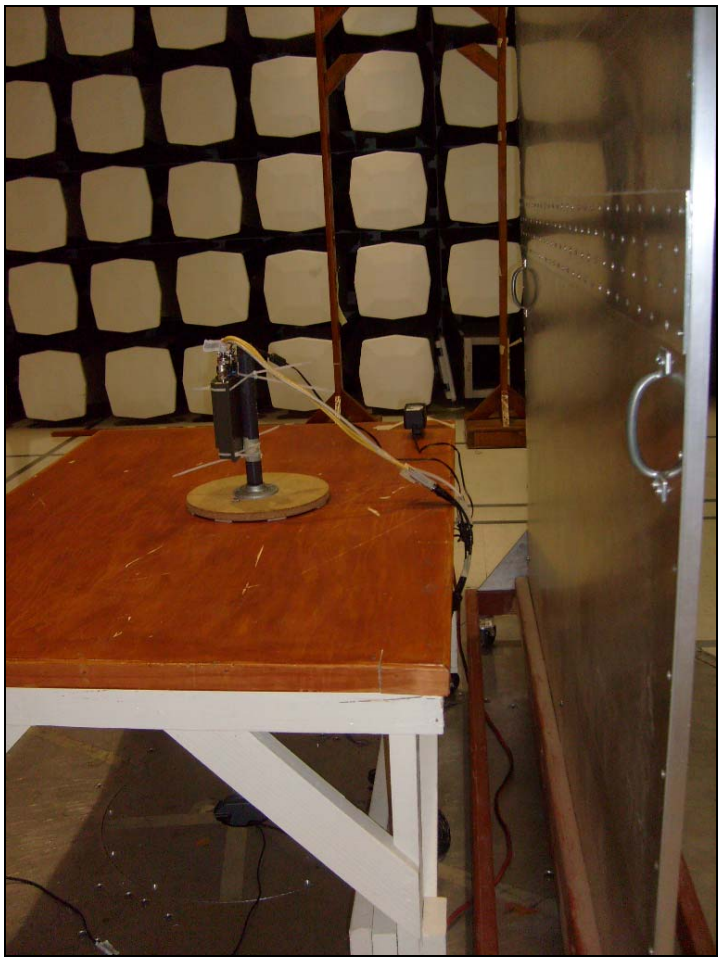

Photograph 4. Conducted Emissions, Test Setup, Side View, M25 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a) 6 dB and 99% Bandwidth – M25

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 = 100 kHz for FCC and approximately 1% of the total emission bandwidth for IC. 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).

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

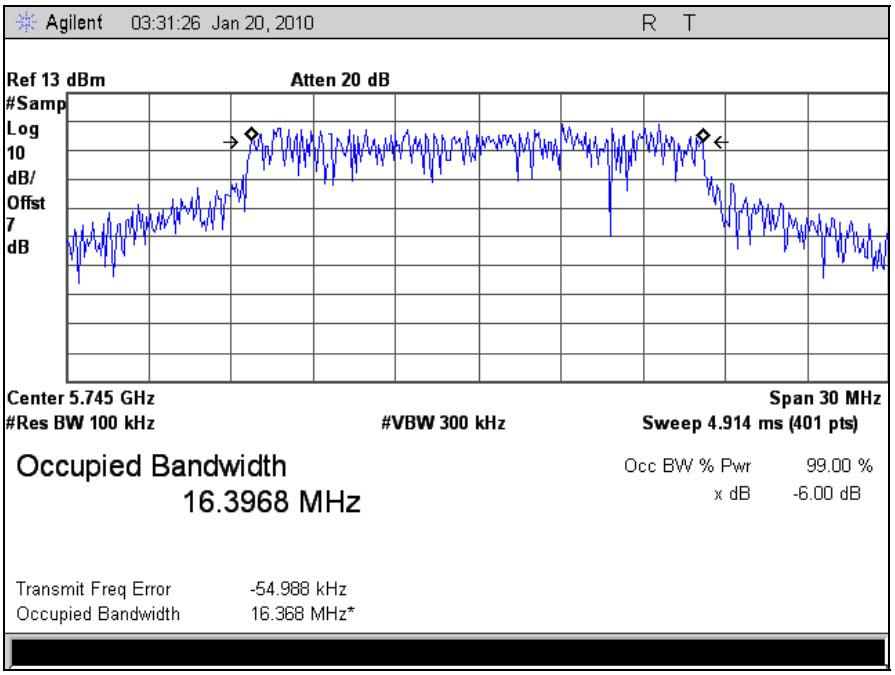
Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

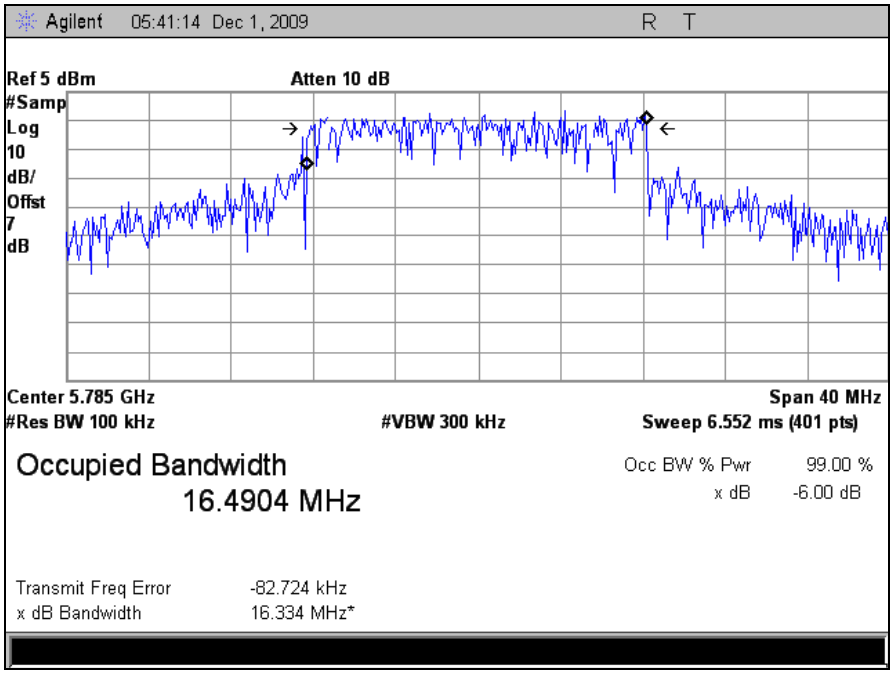
Requirement	Carrier Channel	Frequency (MHz)	Measured 6 dB Bandwidth (MHz)	Measured 99% Bandwidth (MHz)
FCC	802.11a Low	5745	16.397	
	802.11a Mid	5785	16.334	
	802.11a High	5825	16.022	
	802.11g Low	2412	16.449	
	802.11g Mid	2437	16.382	
	802.11g High	2462	16.497	
IC	802.11a Low	5745	16.347	16.869
	802.11a Mid	5785	15.820	16.529
	802.11a High	5825	16.324	16.582
	802.11g Low	2412	16.129	16.828
	802.11g Mid	2437	16.244	16.654
	802.11g High	2462	16.211	16.483

Table 8. Occupied Bandwidth Test Results, M25 Radio

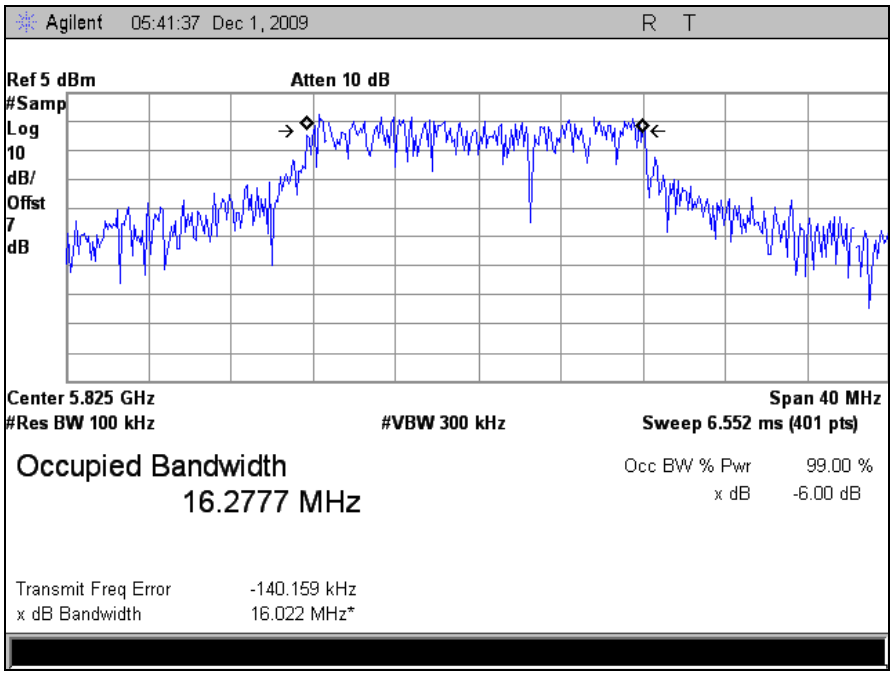
Electromagnetic Compatibility Criteria for Intentional Radiators



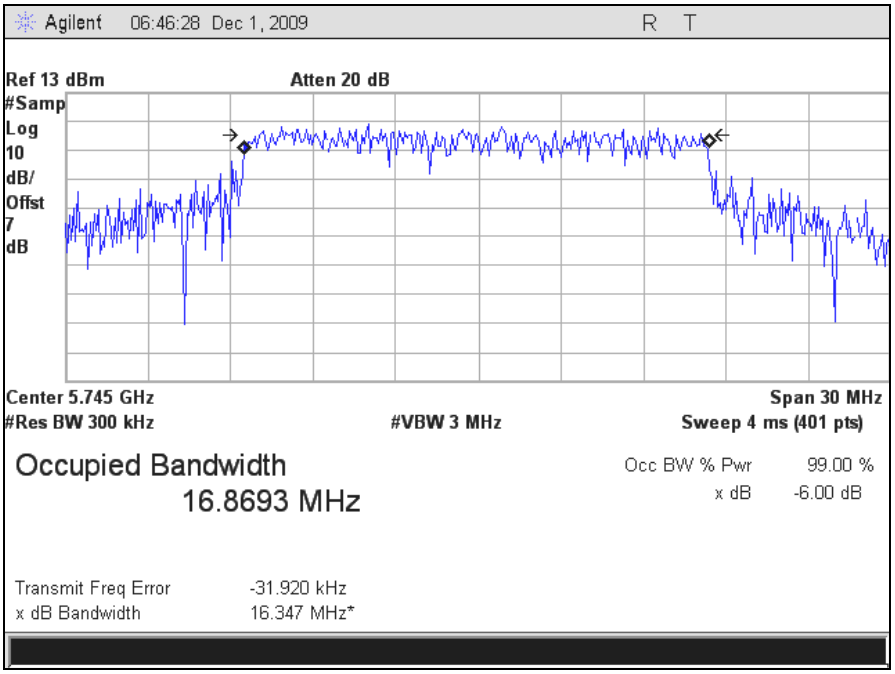
Plot 3. Occupied Bandwidth, Low Channel (5745MHz), 802.11a, 6dB BW, M25 Radio



Plot 4. Occupied Bandwidth, Mid Channel (5785MHz), 802.11a, 6dB BW, M25 Radio



Plot 5. Occupied Bandwidth, High Channel (5825MHz), 802.11a, 6dB BW, M25 Radio



Plot 6. Occupied Bandwidth, Low Channel (5745MHz), 802.11a, 99% BW, M25 Radio

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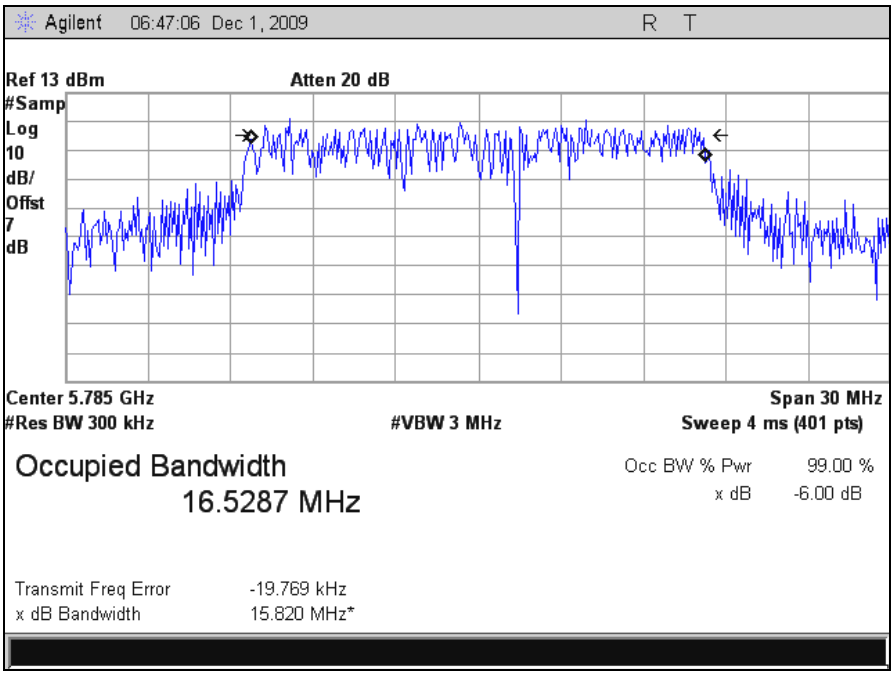
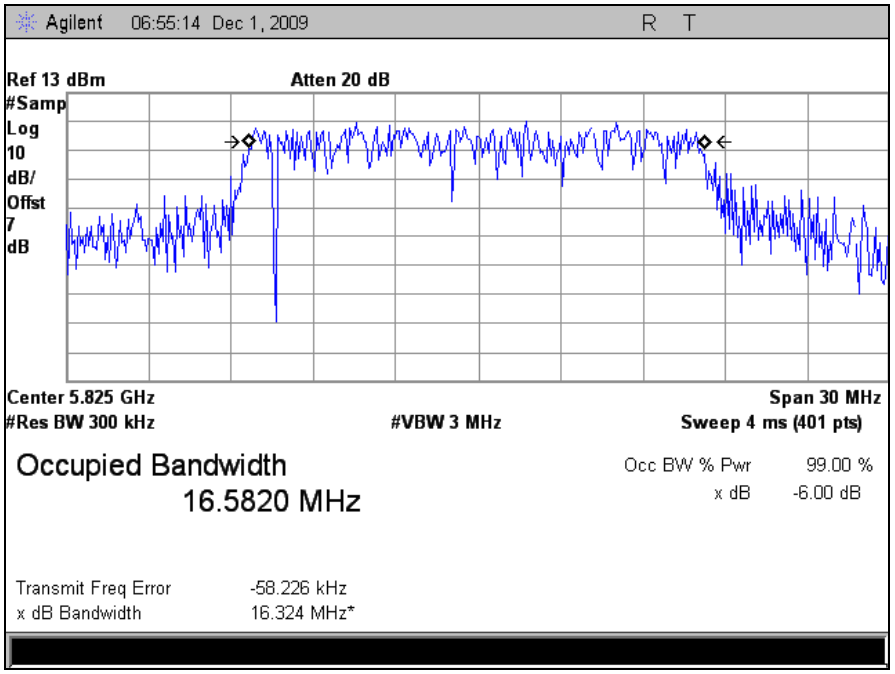


Plot 7. Occupied Bandwidth, Mid Channel (5785MHz), 802.11a, 99% BW, M25 Radio



Plot 8. Occupied Bandwidth, High Channel (5825MHz), 802.11a, 99% BW, M25 Radio

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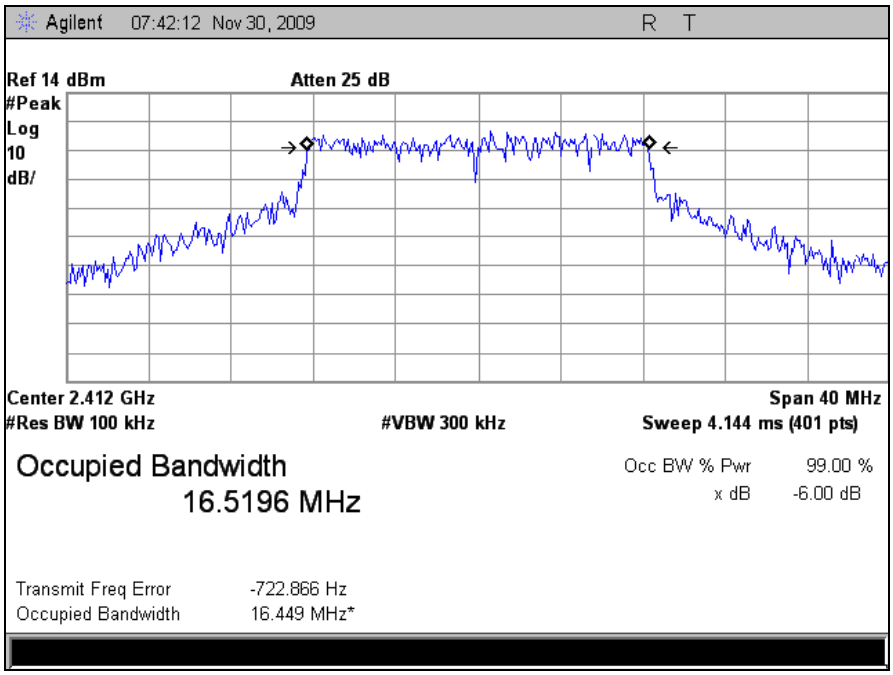
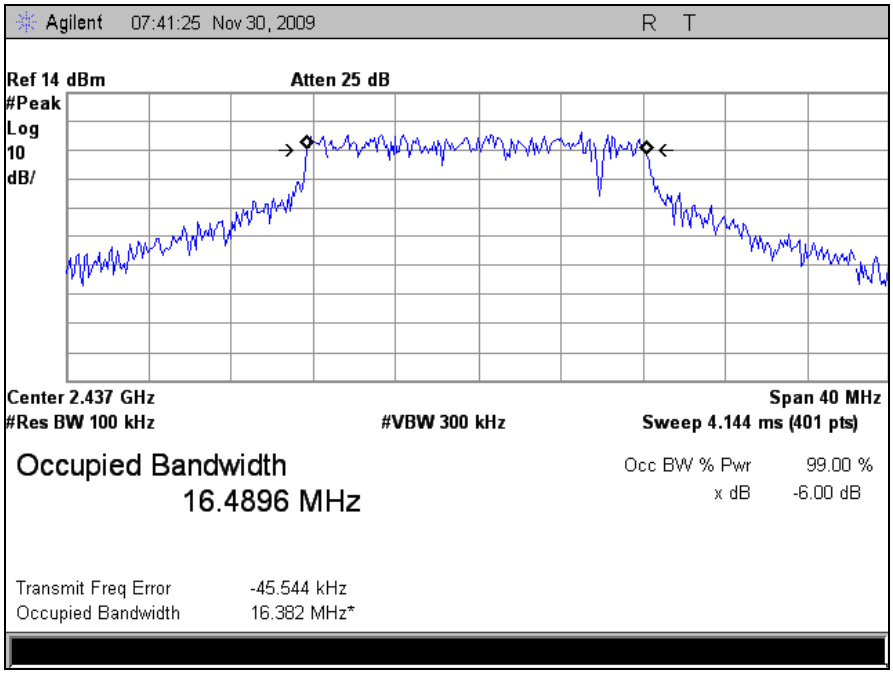


Plot 9. Occupied Bandwidth, Low Channel (2412MHz), 802.11g, 6dB BW, M25 Radio



Plot 10. Occupied Bandwidth, Low Channel (2437MHz), 802.11g, 6dB BW, M25 Radio

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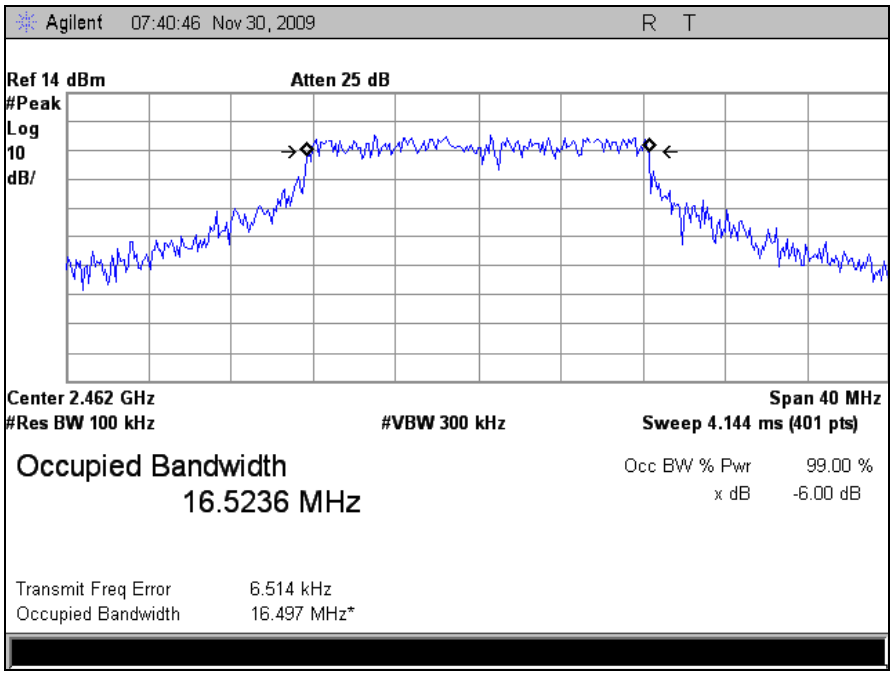
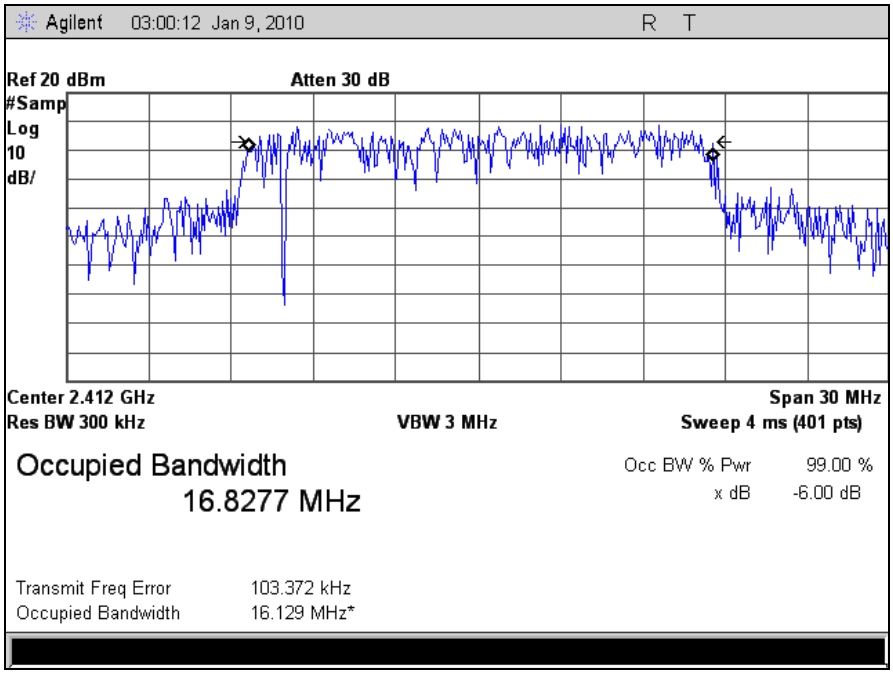


Plot 11. Occupied Bandwidth, High Channel (2462MHz), 802.11g, 6dB BW, M25 Radio



Plot 12. Occupied Bandwidth, Low Channel (2412 MHz), 802.11g, 99% BW, M25 Radio

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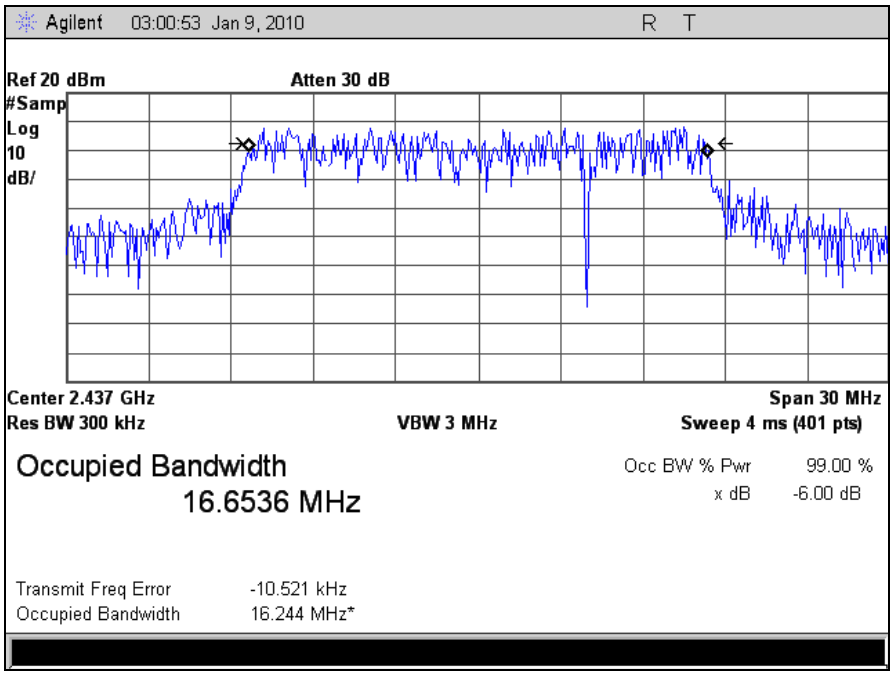
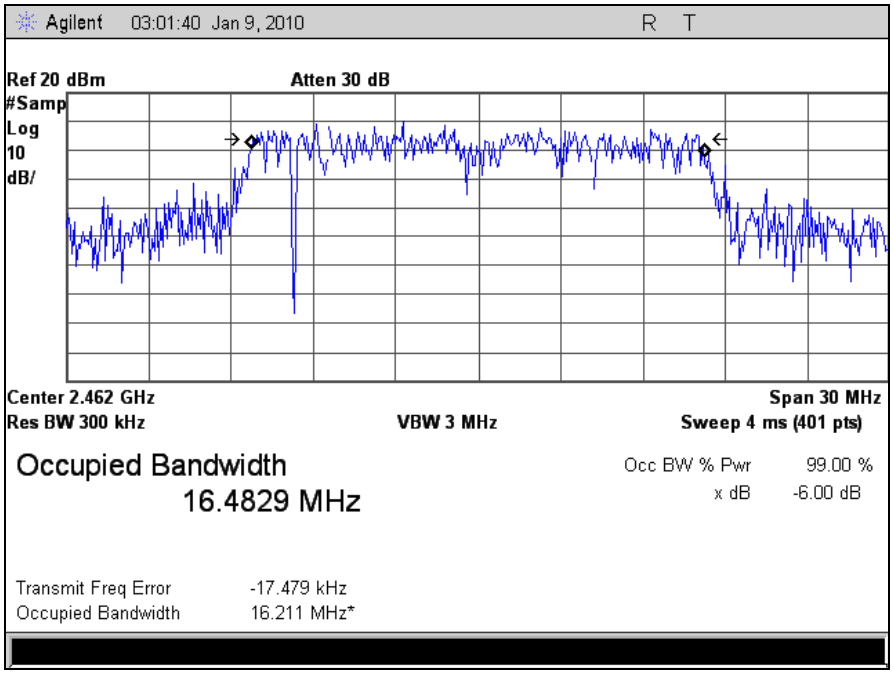


Plot 13. Occupied Bandwidth, Mid Channel (2437 MHz), 802.11g, 99% BW, M25 Radio



Plot 14. Occupied Bandwidth, High Channel (2462 MHz), 802.11g, 99% BW, M25 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output – M25

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 9. 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 9, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band at the maximum power level.

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

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/03/09

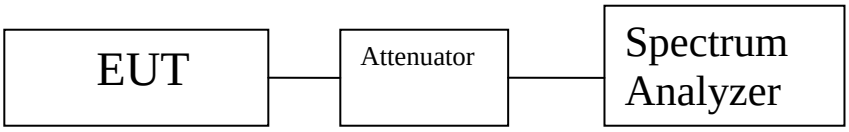
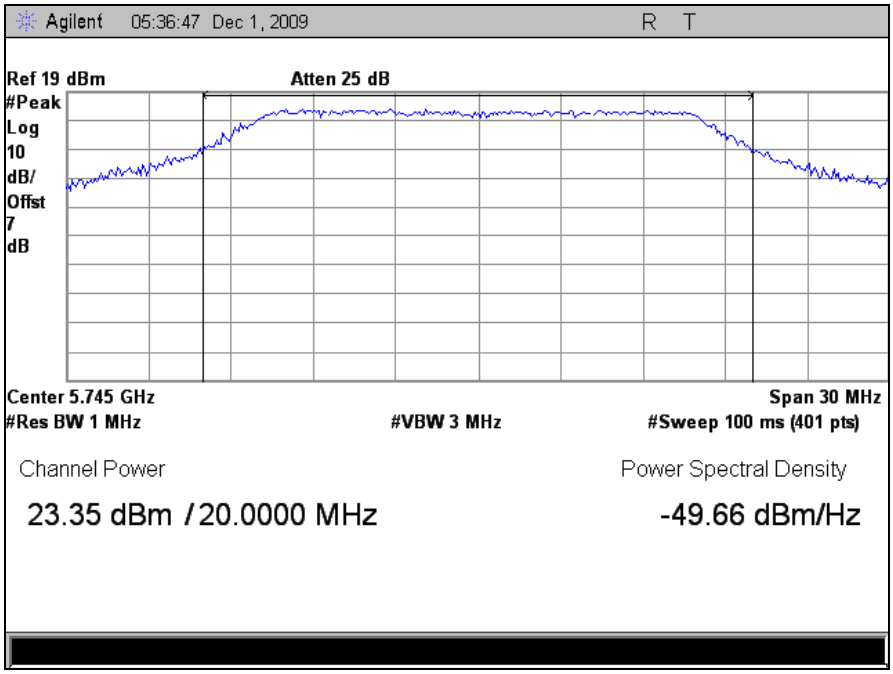


Figure 1. Peak Power Output Test Setup

Peak Conducted Output Power		
Carrier Channel	**Frequency (MHz)**	**Measured Peak Output Power dBm**
802.11a Low	5745	23.35
802.11a Mid	5785	22.68
802.11a High	5825	22.15
802.11g Low	2412	22.12
802.11g Mid	2437	22.87
802.11g High	2462	23.17

Table 10. Peak Conducted Output Power, Test Results, M25 Radio



Plot 15. Peak Output Power, Low Channel (5745MHz), 802.11a, M25 Radio

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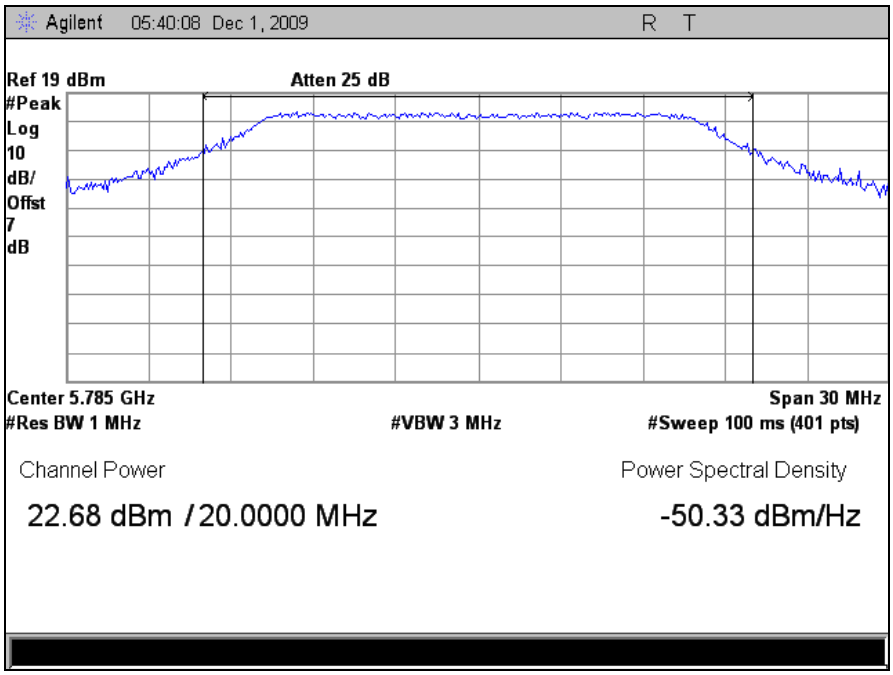
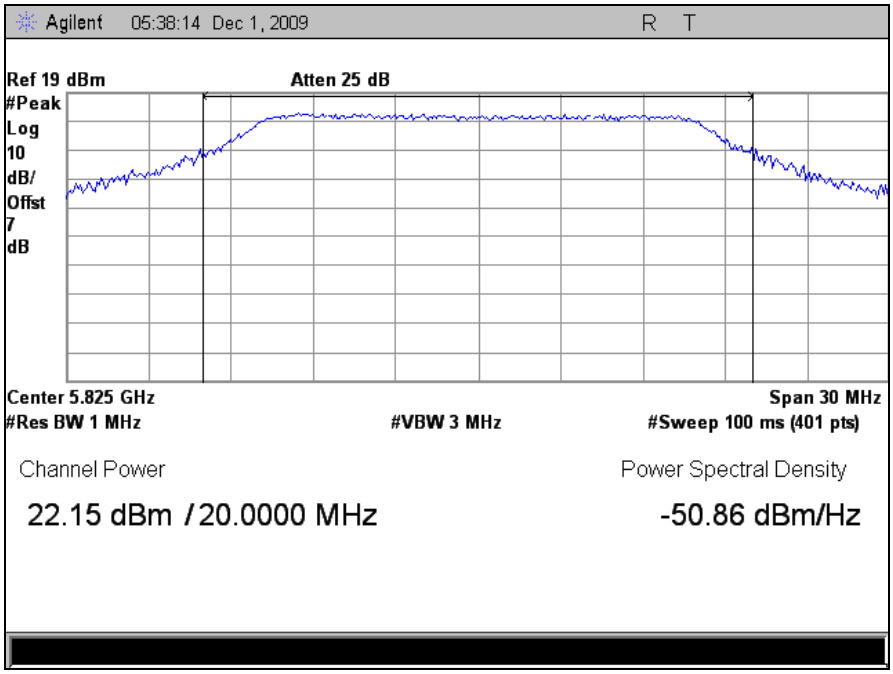


Plot 16. Peak Output Power, Mid Channel (5785MHz), 802.11a, M25 Radio



Plot 17. Peak Output Power, High Channel (5825MHz), 802.11a, M25 Radio

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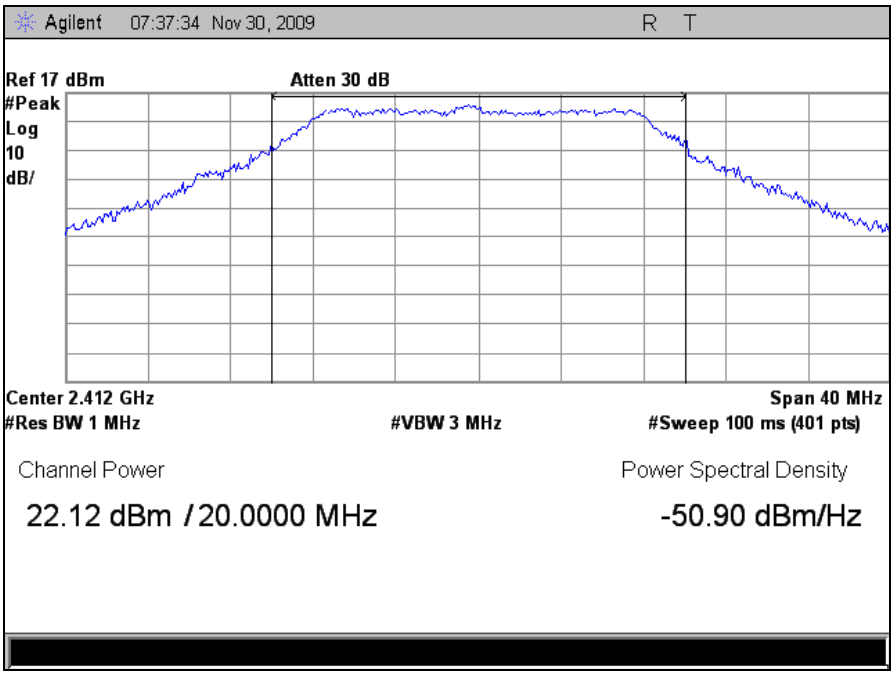
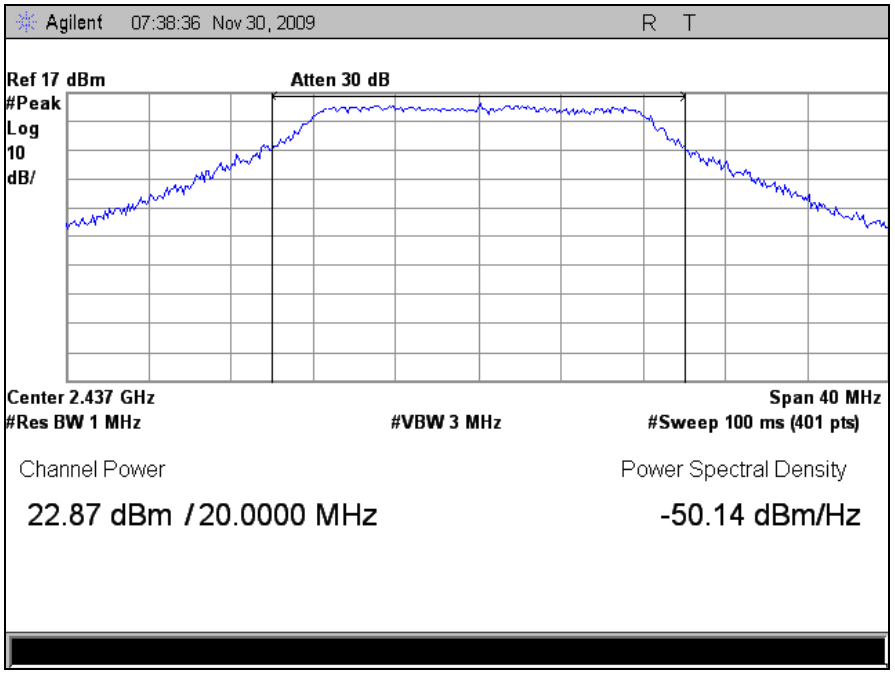


Plot 18. Peak Output Power, Low Channel (2412MHz), 802.11g, M25 Radio



Plot 19. Peak Output Power, Mid Channel (2434MHz), 802.11g, M25 Radio

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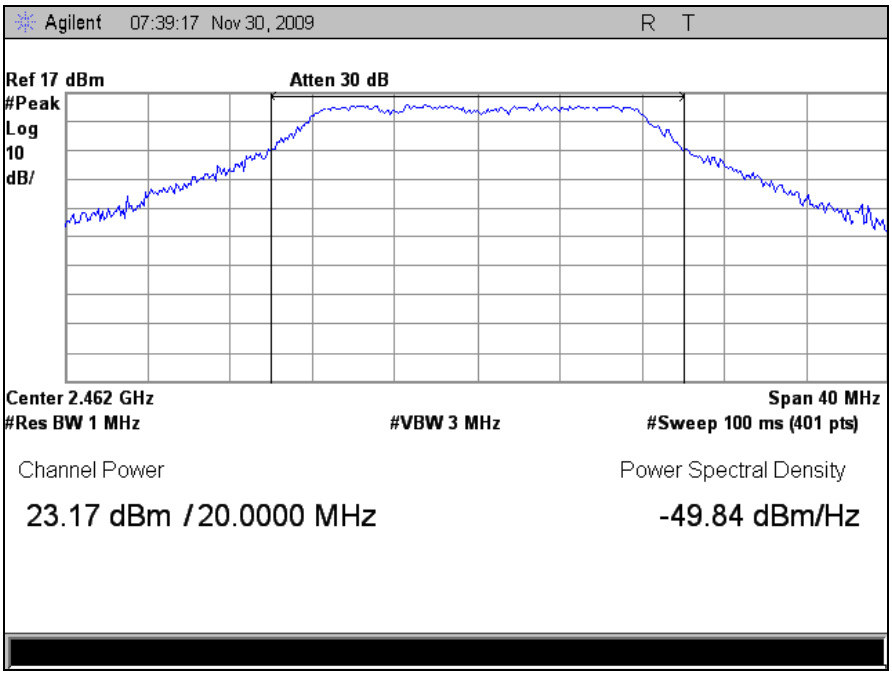

Plot 20. Peak Output Power, High Channel (2462MHz), 802.11g, M25 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge – M25

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 11. Restricted Bands of Operation

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

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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 12.

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

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

Test Results: The EUT was compliant with the Radiated Spurious Emission limits of **§ 15.247(d)**. No harmonics were detected. There were also no emissions above 18 GHz.

Test Engineer(s): Shawn McMillen

Test Date(s): 12/22/09

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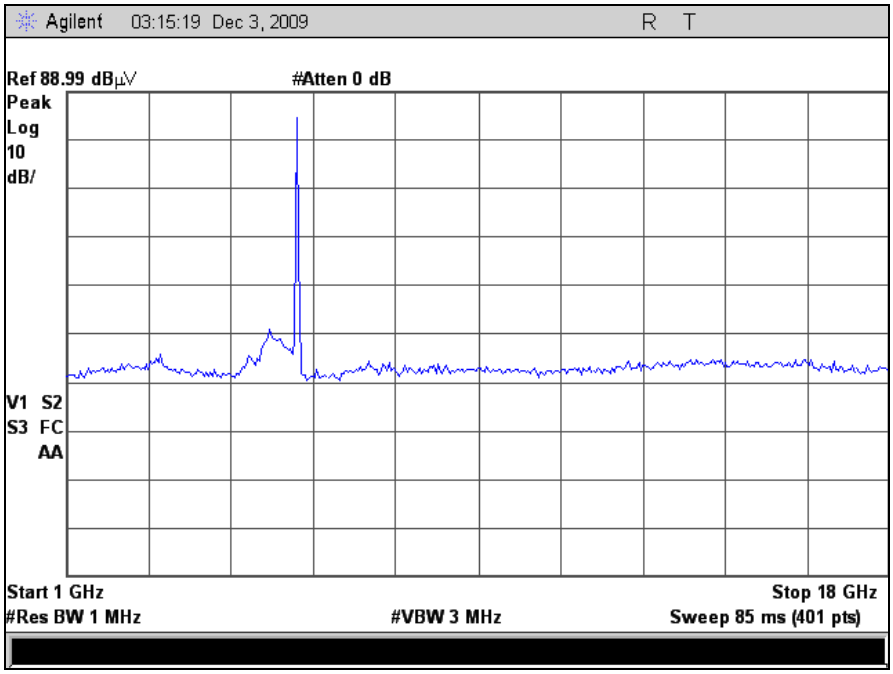
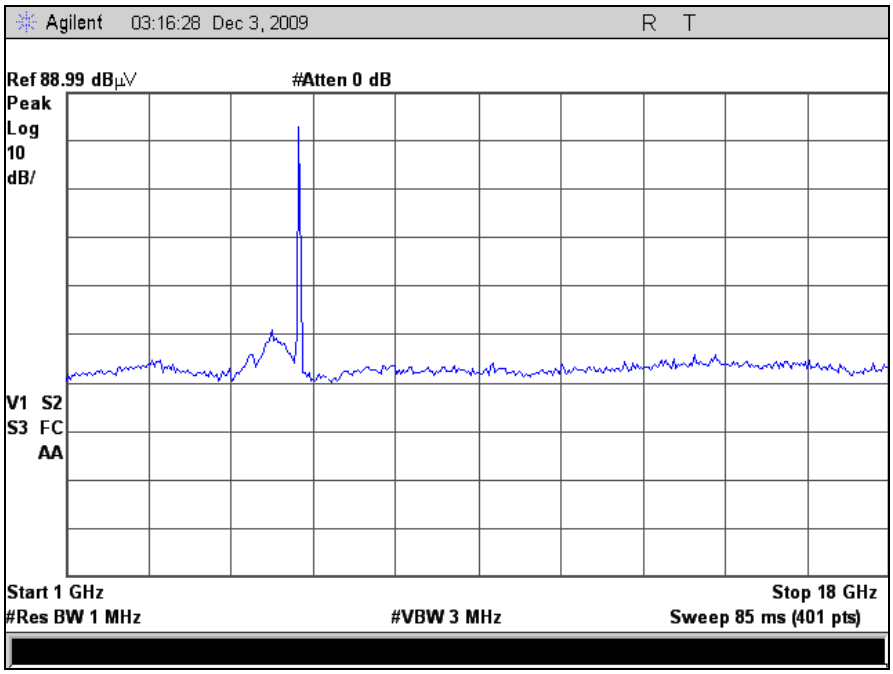
Radiated Spurious Emissions



Plot 21. Radiated Spurious Emissions, Low Channel, 802.11a, 1 GHz – 18 GHz, M25 Radio



Plot 22. Radiated Spurious Emissions, Mid Channel, 802.11a, 1 GHz – 18 GHz, M25 Radio

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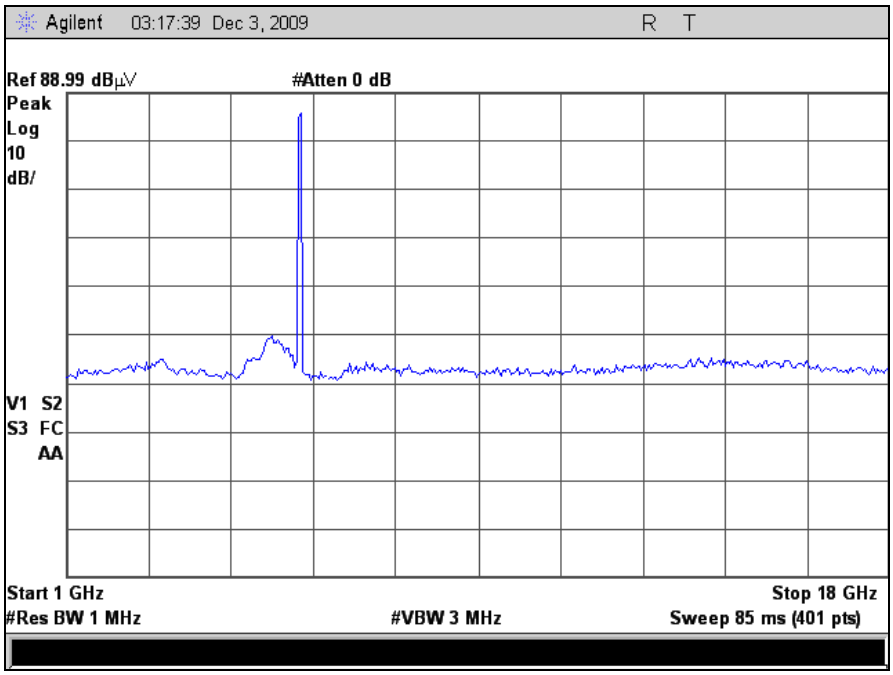
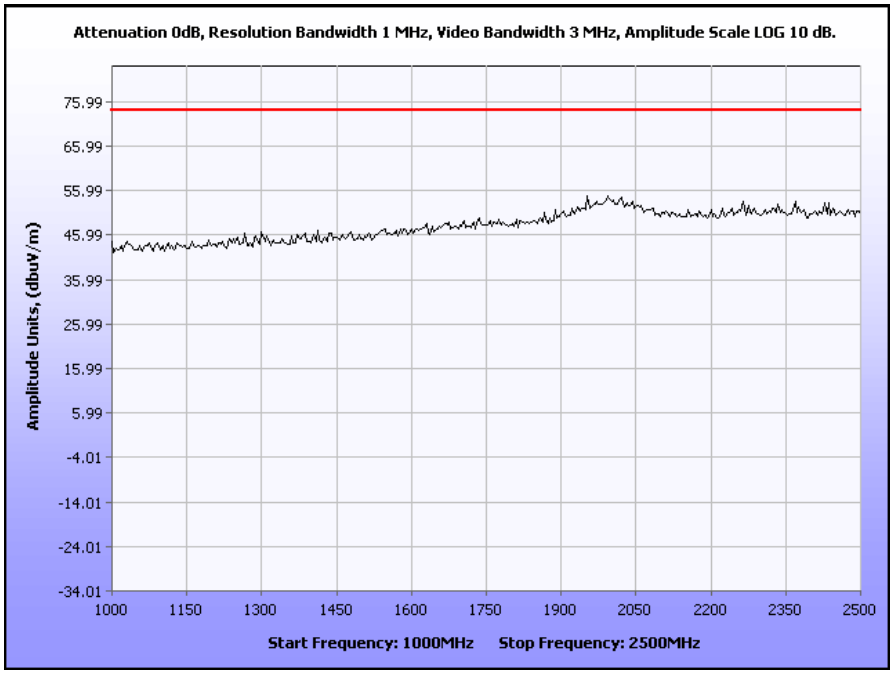


Plot 23. Radiated Spurious Emissions, High Channel, 802.11a, 1 GHz – 18 GHz, M25 Radio



Plot 24. Radiated Spurious Emissions, Low Channel, 802.11g, 1 GHz – 2.5 GHz (Peak), M25 Radio

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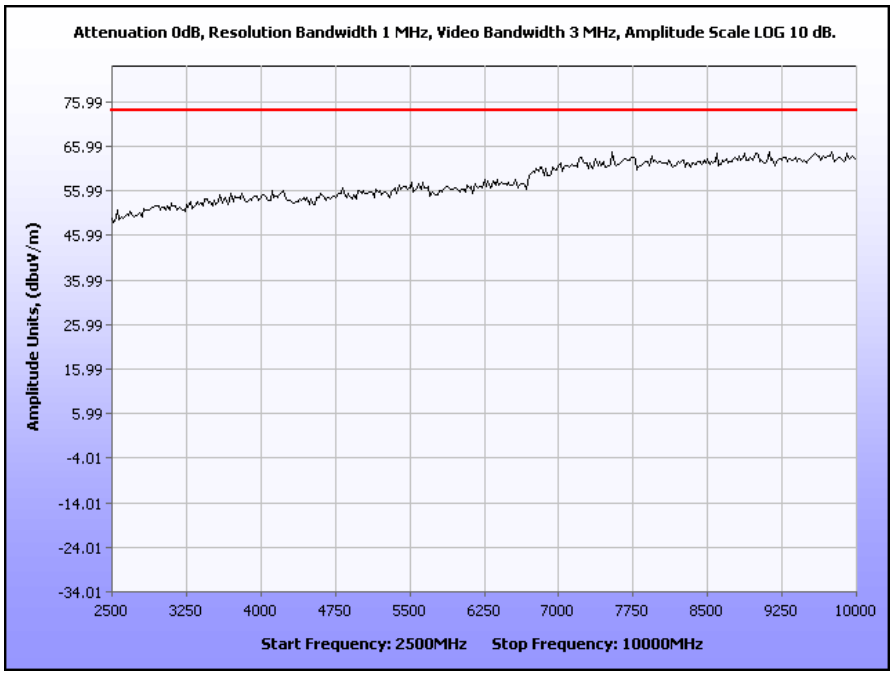
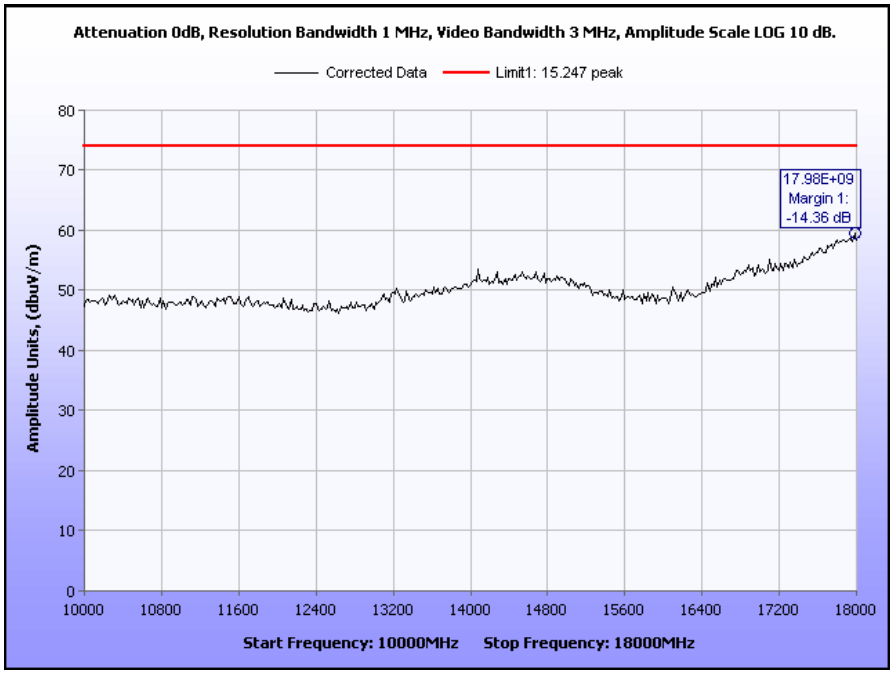


Plot 25. Radiated Spurious Emissions, Low Channel, 802.11g, 2.5 GHz – 10 GHz (Peak), M25 Radio



Plot 26. Radiated Spurious Emissions, Low Channel, 802.11g, 10 GHz – 18 GHz (Peak with Pre-Amp), M25 Radio

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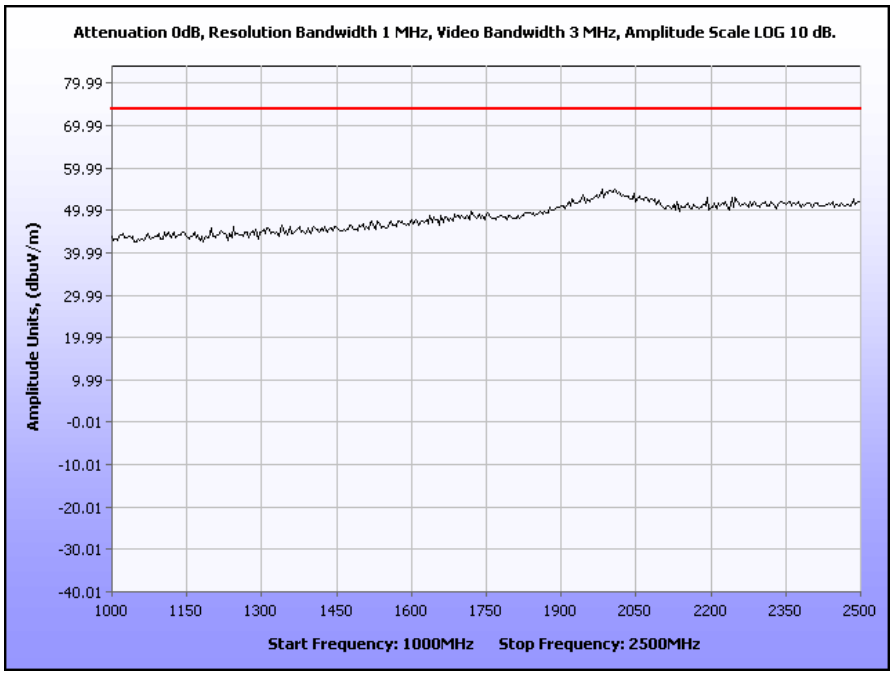
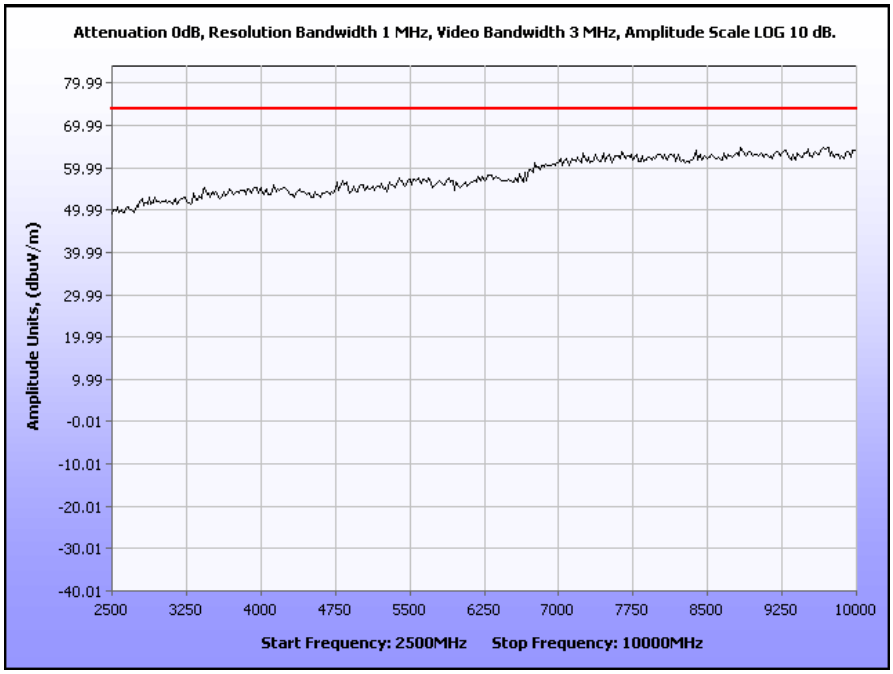


Plot 27. Radiated Spurious Emissions, Mid Channel, 802.11g, 1 GHz – 2.5 GHz (Peak), M25 Radio



Plot 28. Radiated Spurious Emissions, Mid Channel, 802.11g, 2.5 GHz – 10 GHz (Peak), M25 Radio

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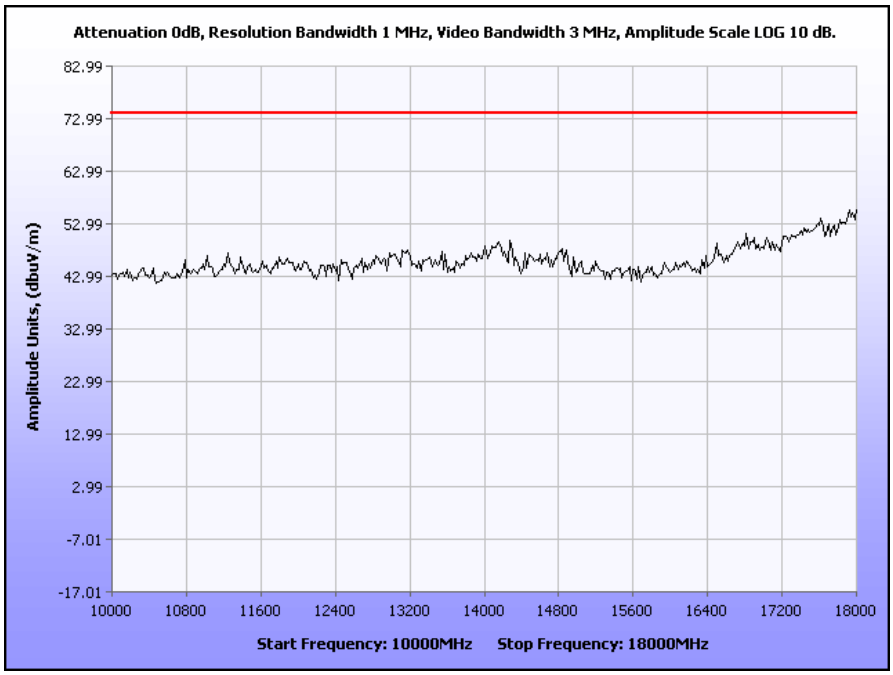
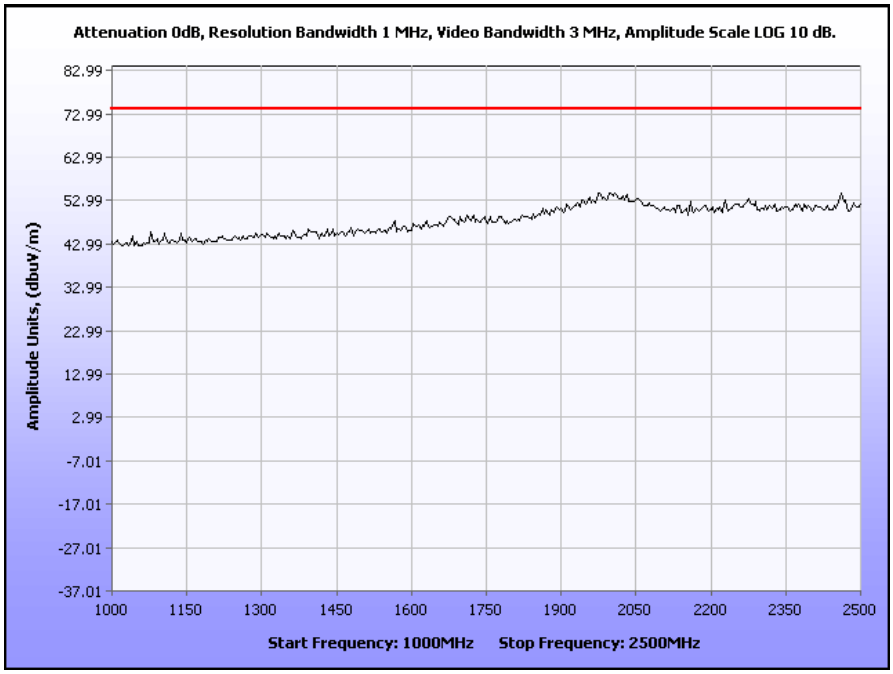


Plot 29. Radiated Spurious Emissions, Mid Channel, 802.11g, 10 GHz – 18 GHz (Peak with Pre-Amp), M25 Radio



Plot 30. Radiated Spurious Emissions, High Channel, 802.11g, 1 GHz – 2.5 GHz (Peak), M25 Radio

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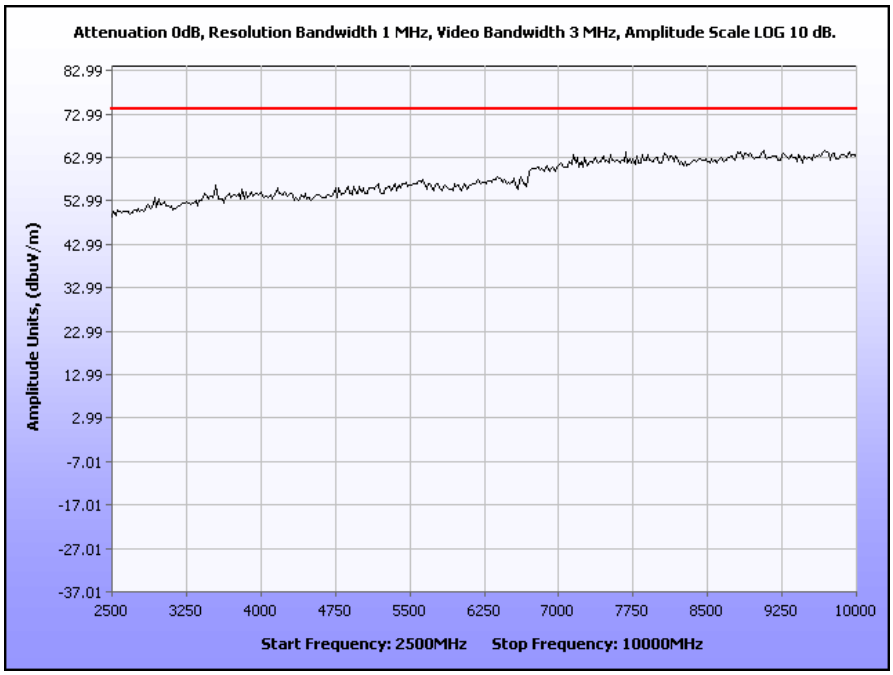
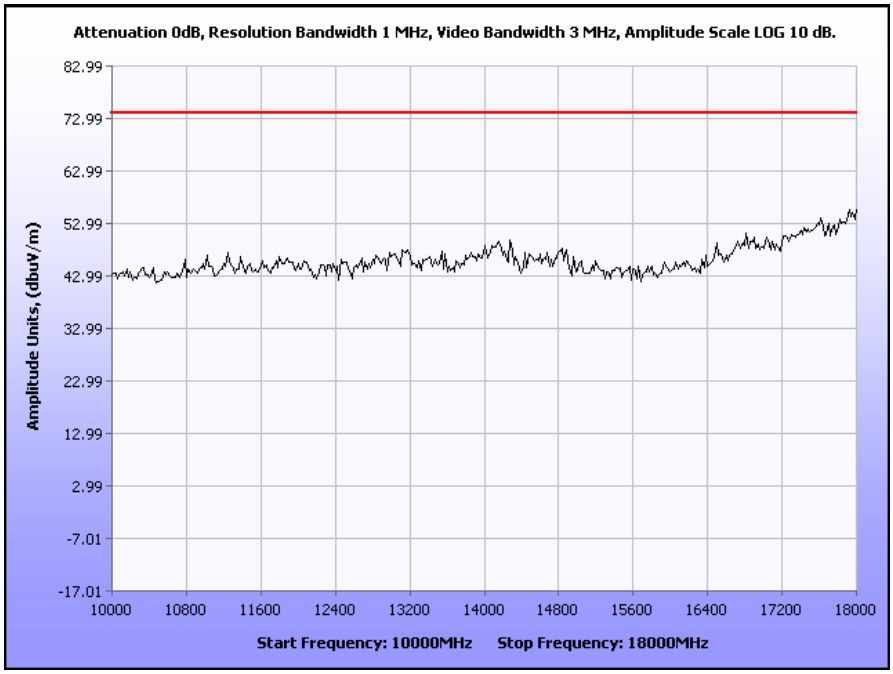


Plot 31. Radiated Spurious Emissions, High Channel, 802.11g, 2.5 GHz – 10 GHz (Peak), M25 Radio



Plot 32. Radiated Spurious Emissions, High Channel, 802.11g, 10 GHz – 18 GHz (Peak with Pre-Amp), M25 Radio

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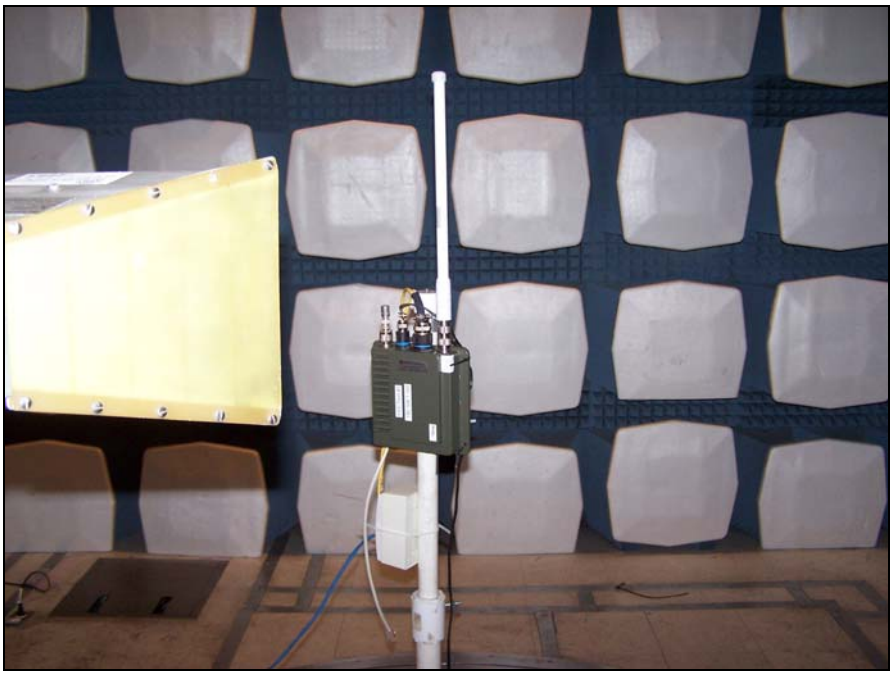

Photograph 5. Radiated Spurious Emission, Test Setup, M25 Radio

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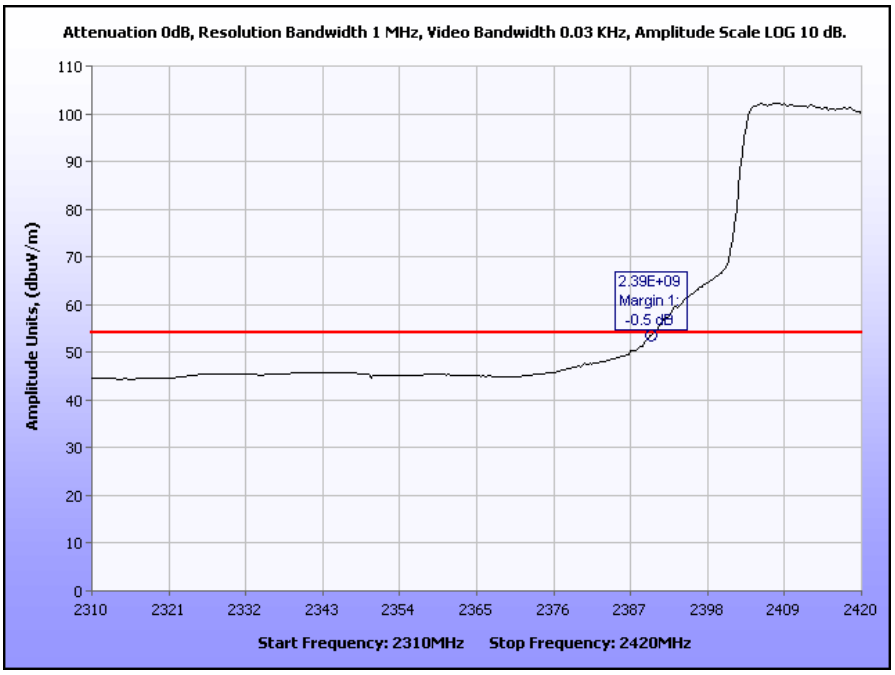
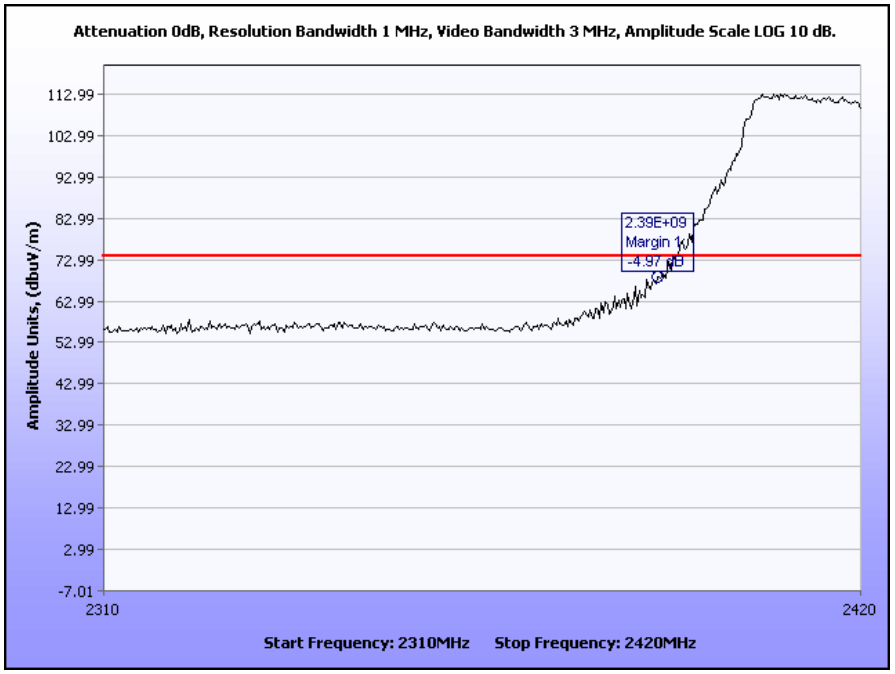
Radiated Band Edge Measurements



Plot 33. Lower Band Edge, Average, 802.11g, M25 Radio



Plot 34. Lower Band Edge, Peak, 802.11g, M25 Radio

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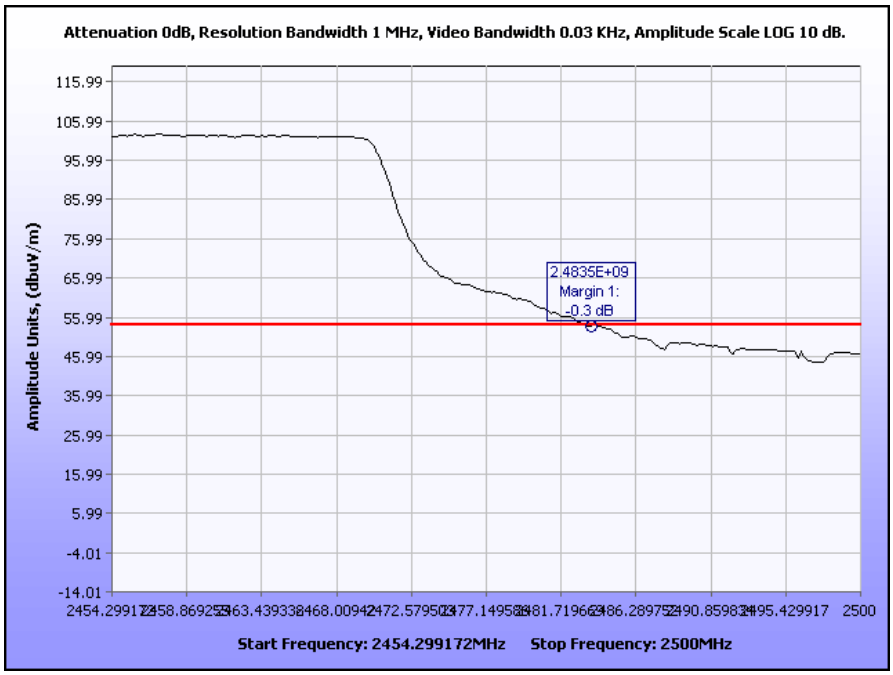
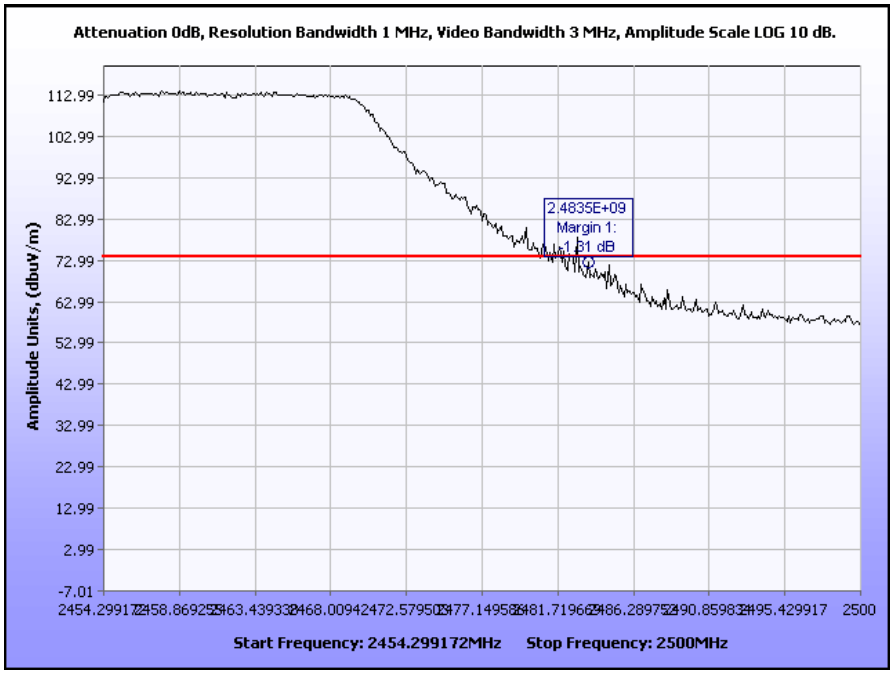


Plot 35. Upper Band Edge, Average, 802.11g, M25 Radio



Plot 36. Upper Band Edge, Peak, 802.11g, M25 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

Receiver Spurious Emissions – M25

Test Requirement: 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 13.

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

Table 13. 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 Procedure: The receiver spurious emissions were tested conducted.

Test Results: The EUT was compliant with the Receiver Spurious Emission limits of this requirement.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/23/09

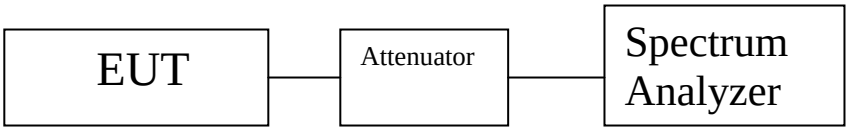
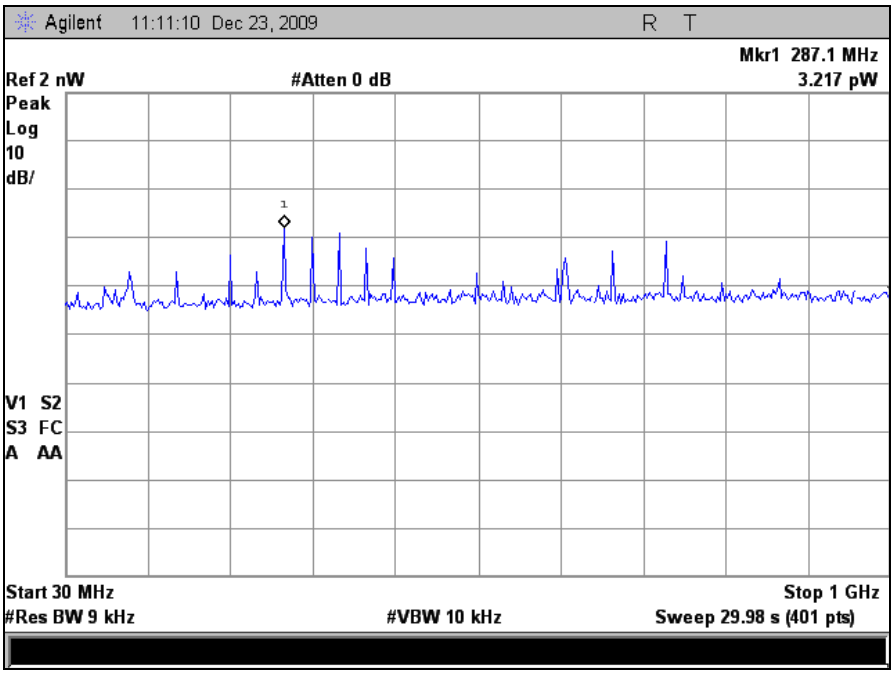
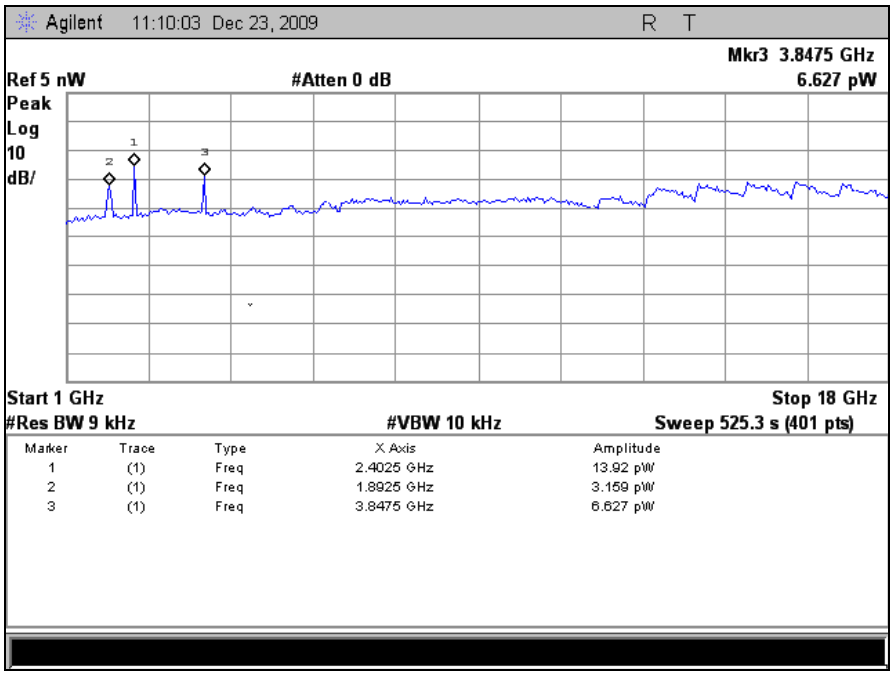


Figure 2. Receiver Spurious Emissions Test Setup

Receiver Spurious Emissions



Plot 37. Receiver Spurious Emission, 30 MHz – 1 GHz, 802.11a, M25 Radio



Plot 38. Receiver Spurious Emission, 1 GHz – 18 GHz, 802.11a, M25 Radio

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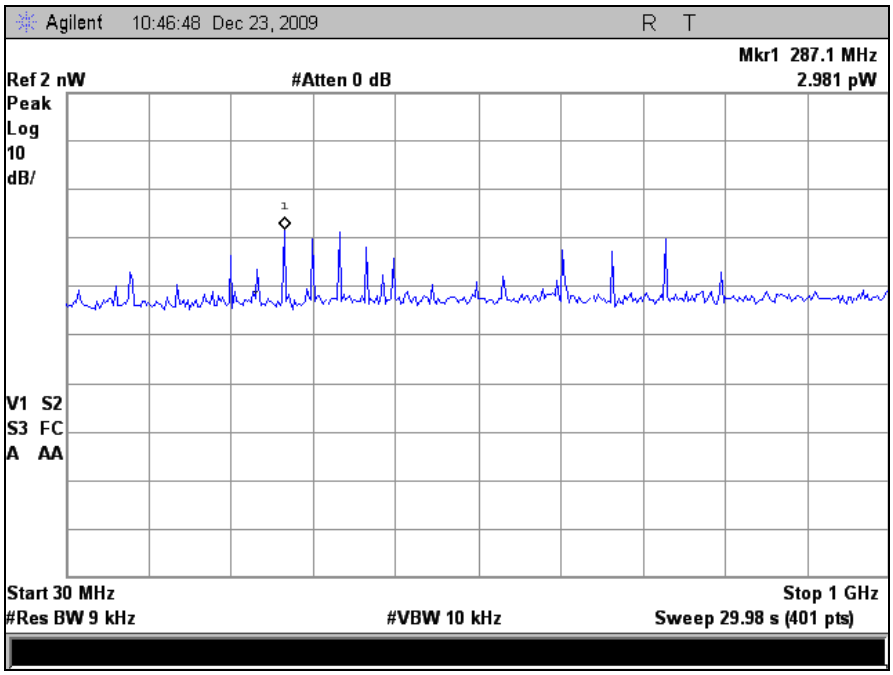
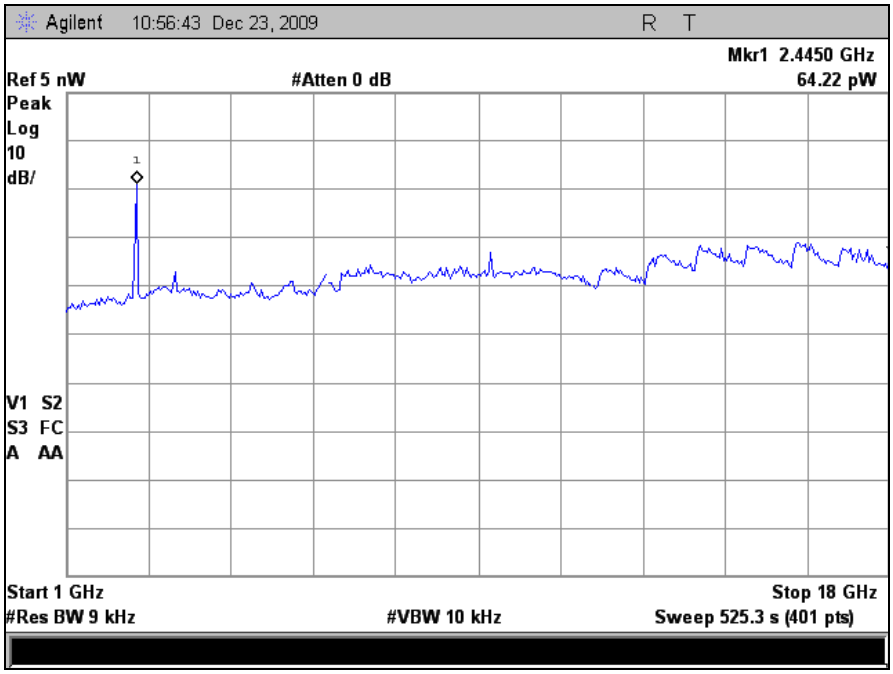


Plot 39. Receiver Spurious Emission, 30 MHz – 1 GHz, 802.11g, M25 Radio



Plot 40. Receiver Spurious Emission, 1 GHz – 18 GHz, 802.11g, M25 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge – M25

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)**.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

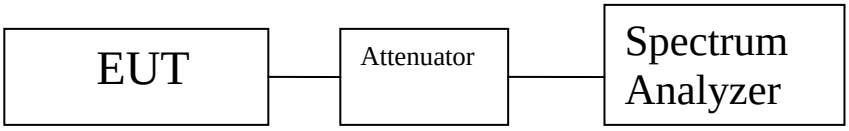
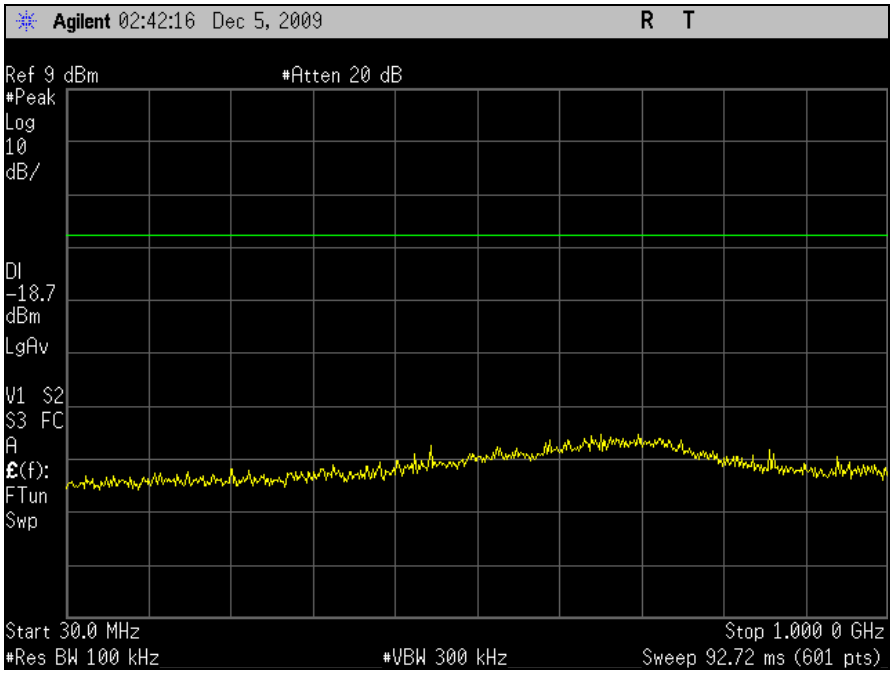
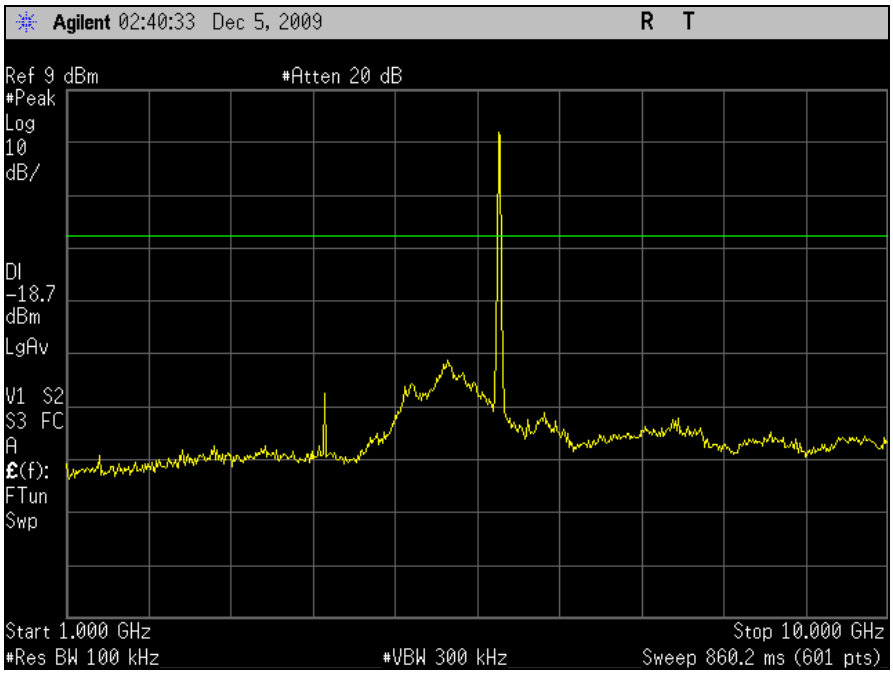


Figure 3. RF Conducted Spurious Emissions Test Setup

RF Conducted Spurious Emissions Requirements



Plot 41. Conducted Emissions, Low Channel, 30 MHz – 1 GHz, 802.11a, M25 Radio



Plot 42. Conducted Emissions, Low Channel, 1 GHz – 10 GHz, 802.11a, M25 Radio

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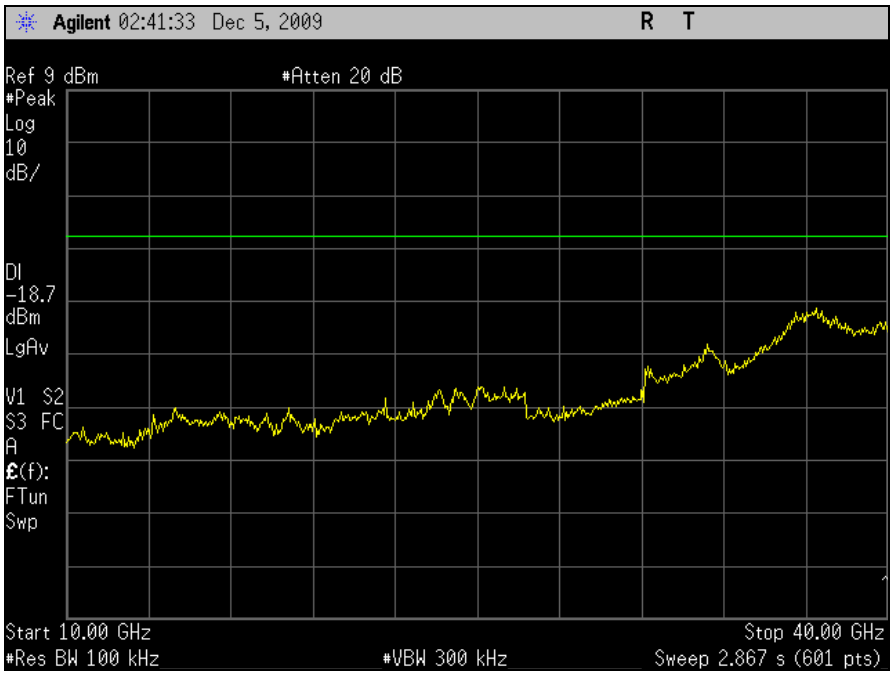
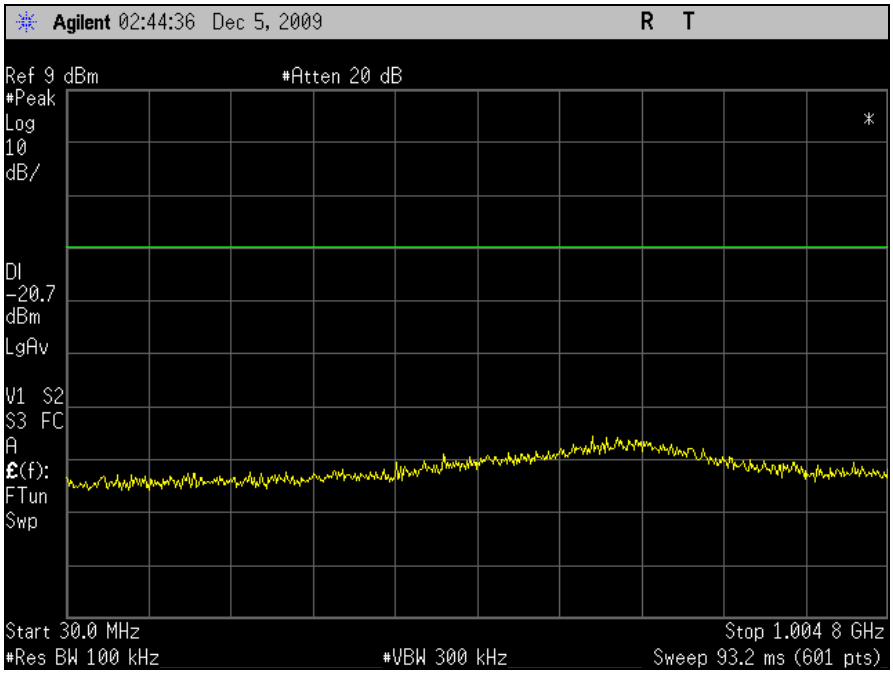
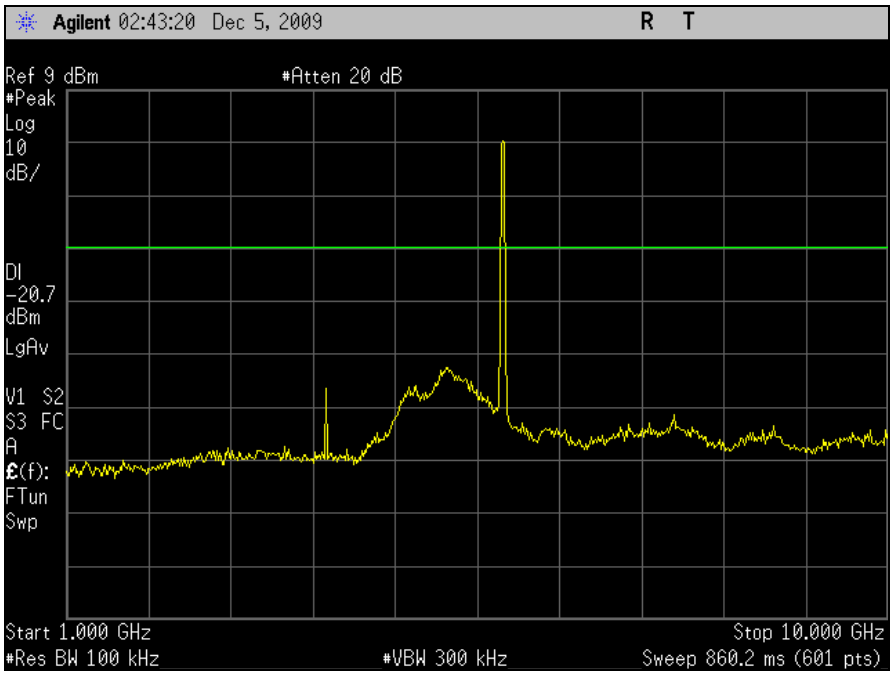


Plot 43. Conducted Emissions, Low Channel, 10 GHz – 40 GHz, 802.11a, M25 Radio

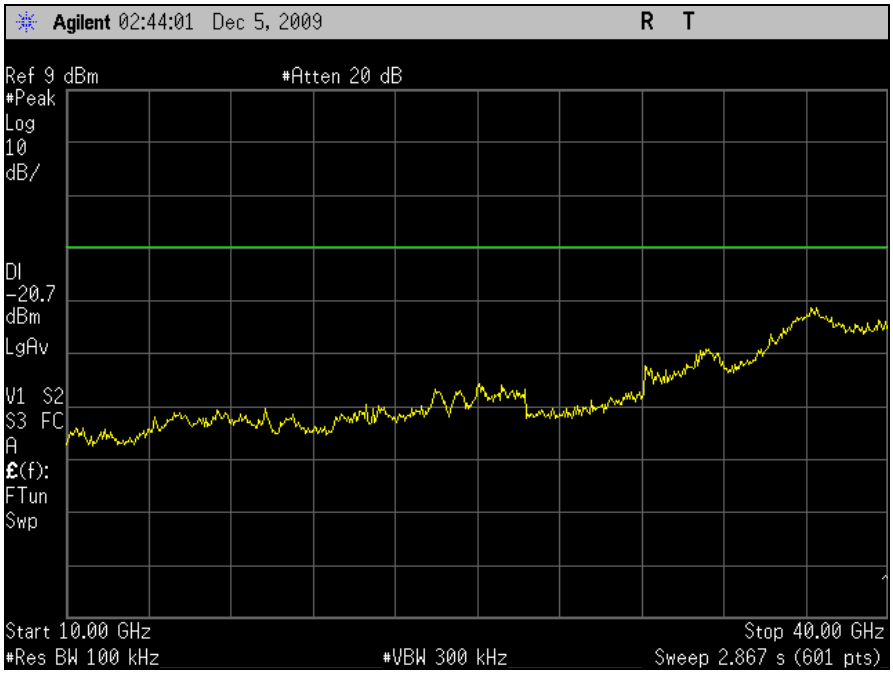


Plot 44. Conducted Emissions, Mid Channel, 30 MHz – 1 GHz, 802.11a, M25 Radio

© 2010, MET Laboratories, Inc.



Plot 45. Conducted Emissions, Mid Channel, 1 GHz – 10 GHz, 802.11a, M25 Radio



Plot 46. Conducted Emissions, Mid Channel, 10 GHz – 40 GHz, 802.11a, M25 Radio

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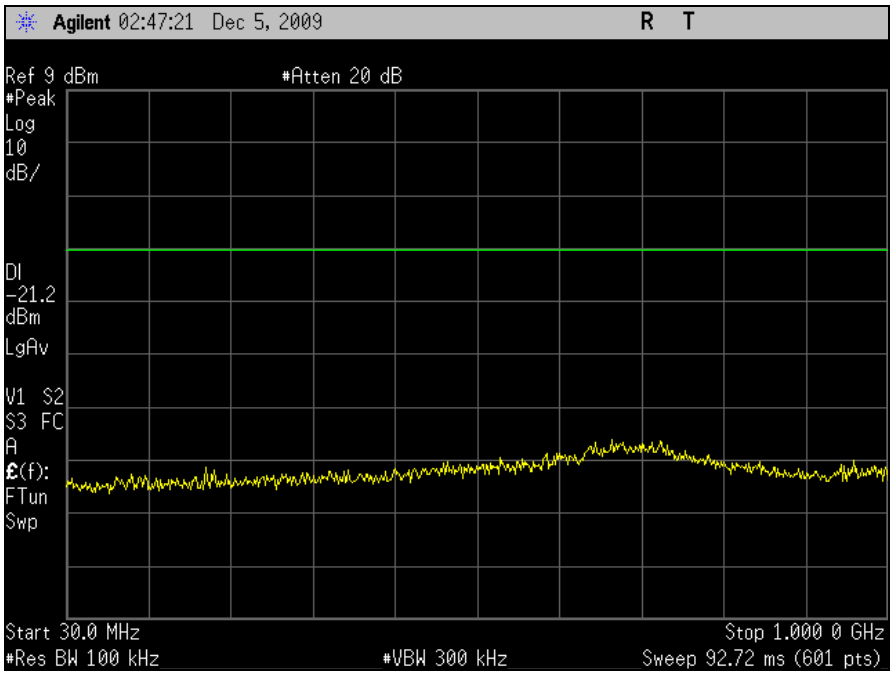
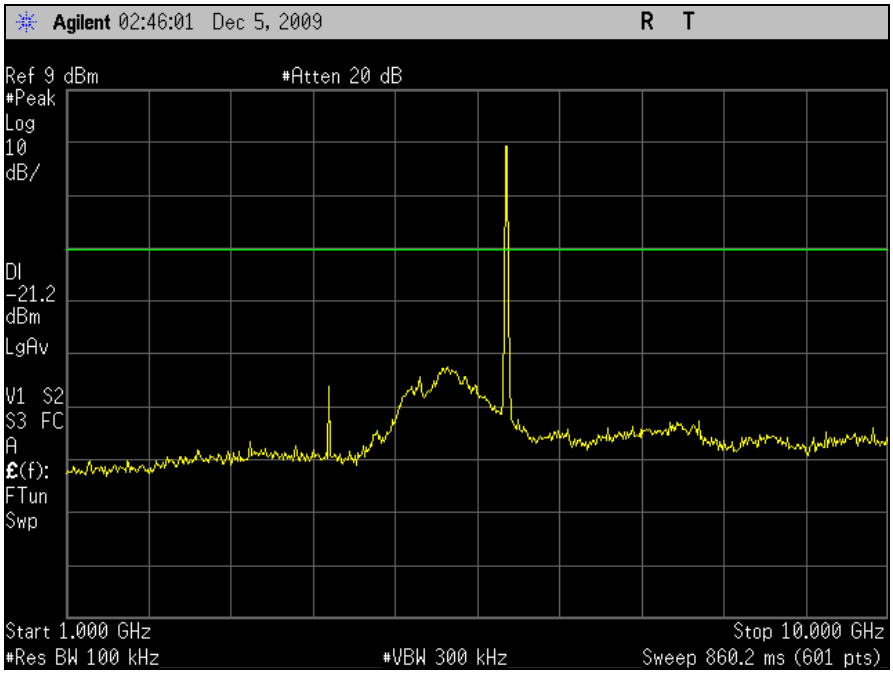
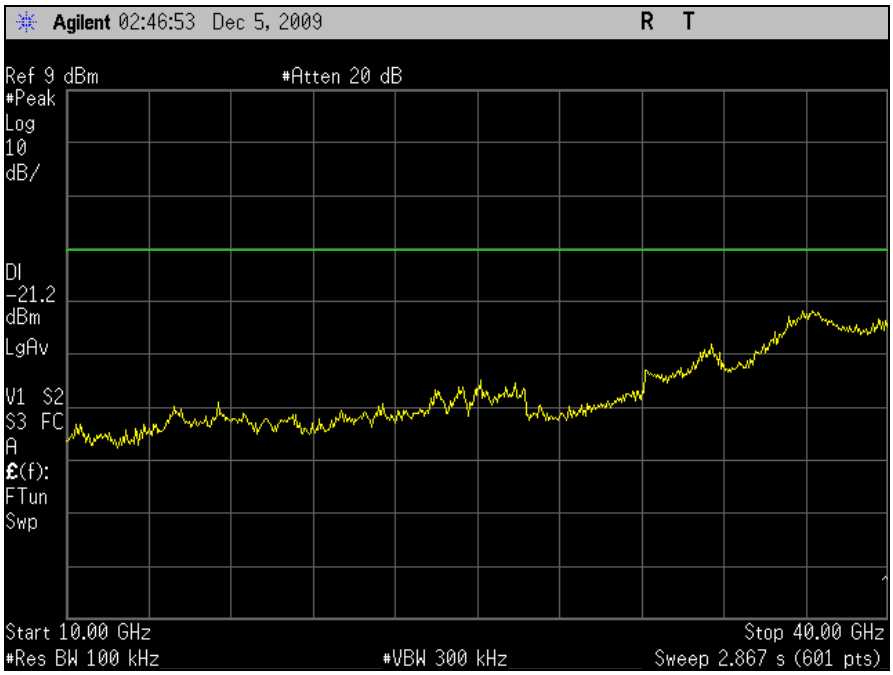


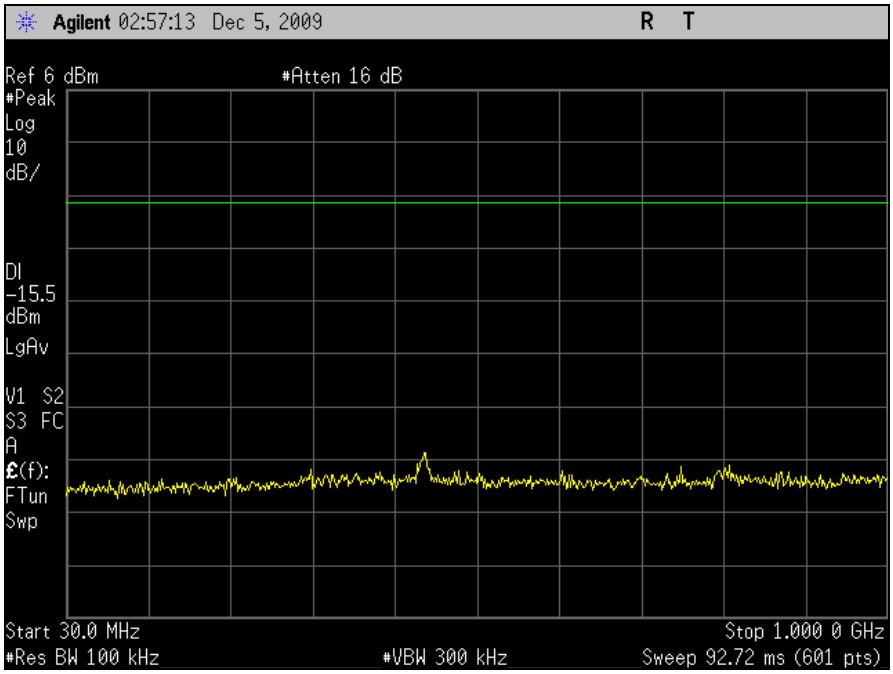
Plot 47. Conducted Emissions, High Channel, 30 MHz – 1 GHz, 802.11a, M25 Radio



Plot 48. Conducted Emissions, High Channel, 1 GHz – 10 GHz, 802.11a, M25 Radio



Plot 49. Conducted Emissions, High Channel, 10 GHz – 40 GHz, 802.11a, M25 Radio



Plot 50. Conducted Emissions, Low Channel, 30 MHz – 1 GHz, 802.11g, M25 Radio

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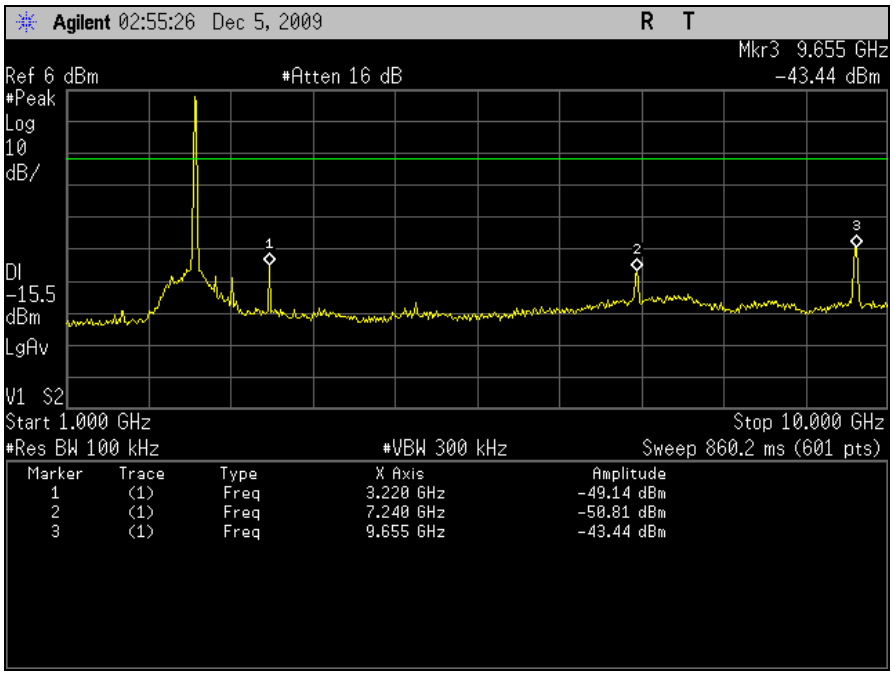
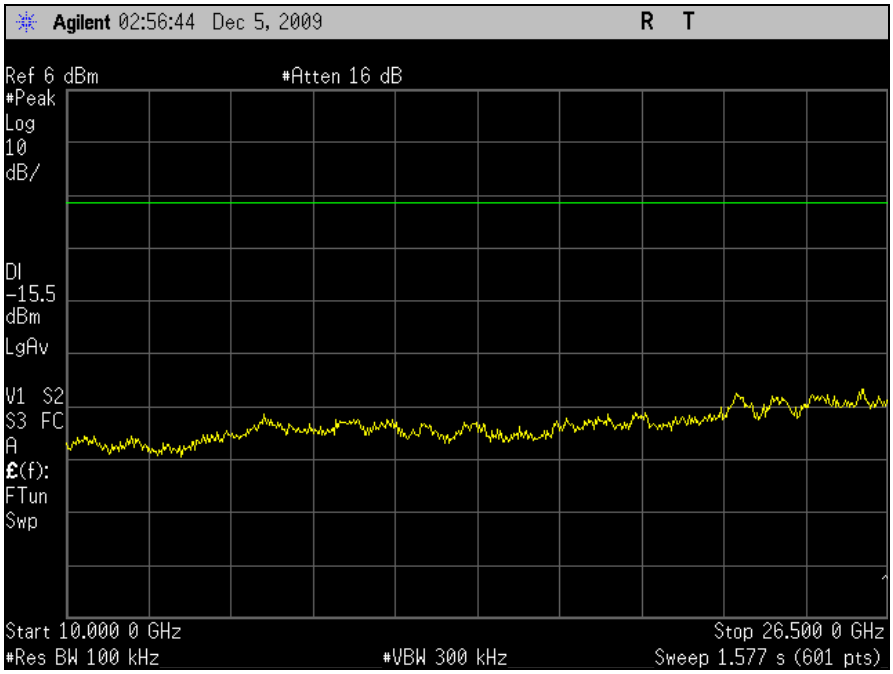
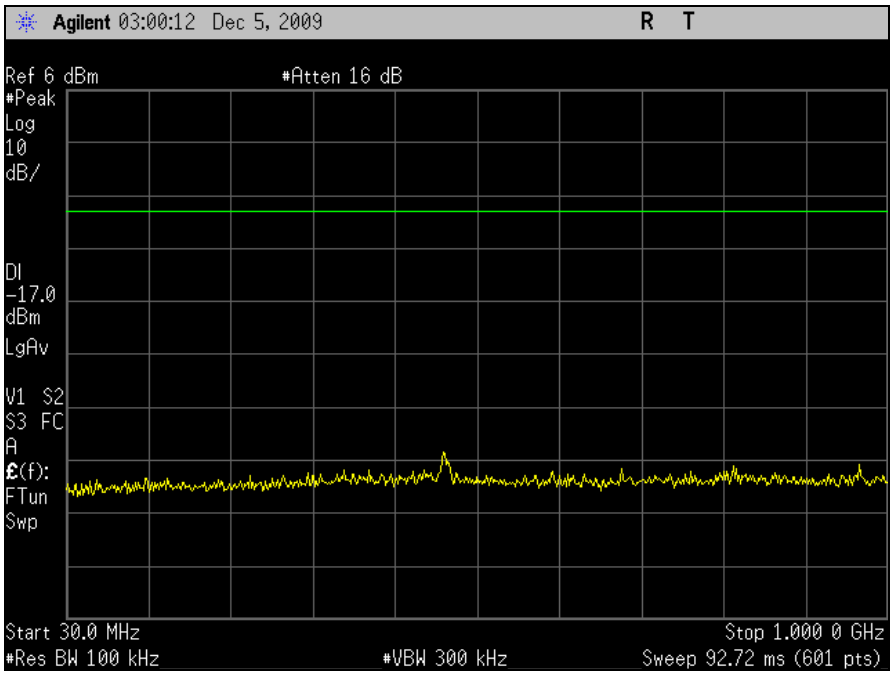


Plot 51. Conducted Emissions, Low Channel, 1 GHz – 10 GHz, 802.11g, M25 Radio

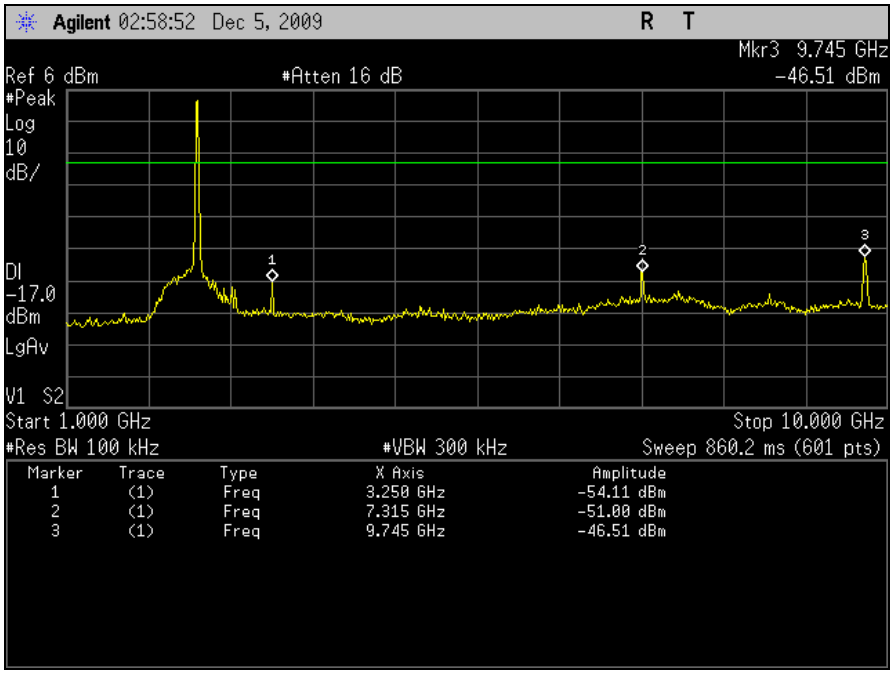


Plot 52. Conducted Emissions, Low Channel, 10 GHz – 26.5 GHz, 802.11g, M25 Radio

© 2010, MET Laboratories, Inc.

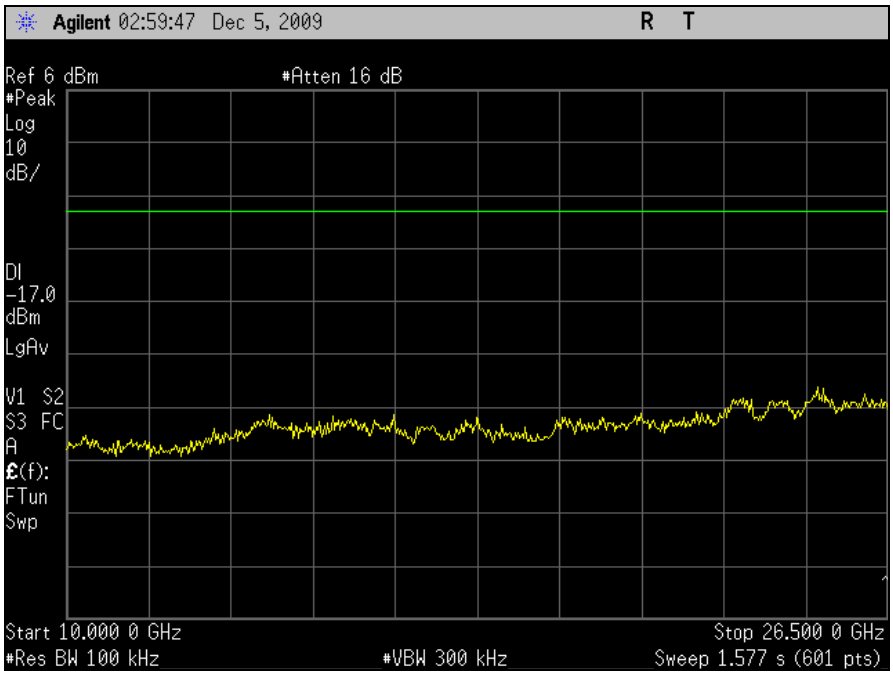


Plot 53. Conducted Emissions, Mid Channel, 30 MHz – 1 GHz, , 802.11g, M25 Radio

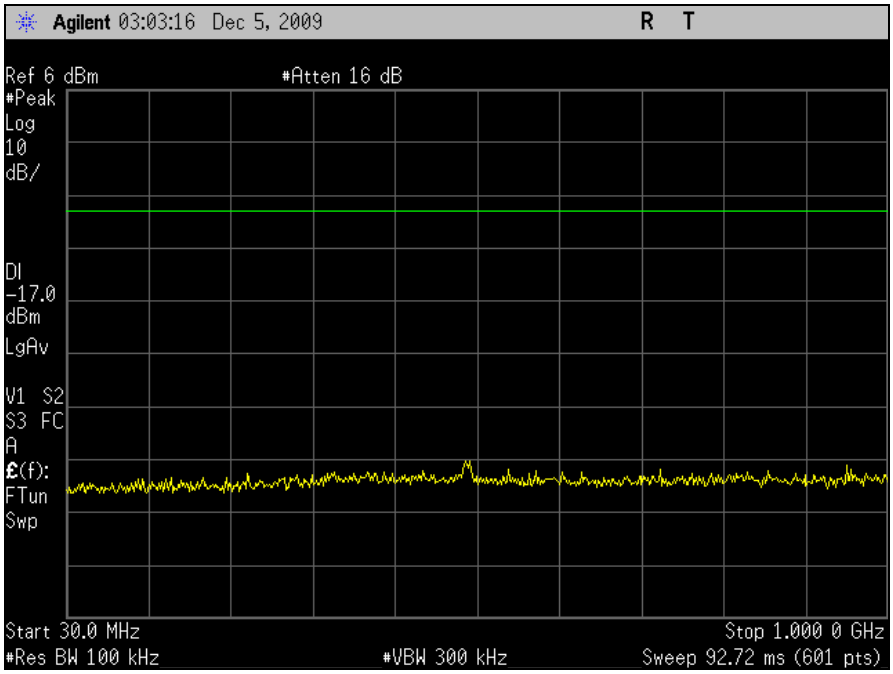


Plot 54. Conducted Emissions, Mid Channel, 1 GHz – 10 GHz, 802.11g, M25 Radio

© 2010, MET Laboratories, Inc.



Plot 55. Conducted Emissions, Mid Channel, 10 GHz – 26.5 GHz, 802.11g, M25 Radio



Plot 56. Conducted Emissions, High Channel, 30 MHz – 1 GHz, 802.11g, M25 Radio

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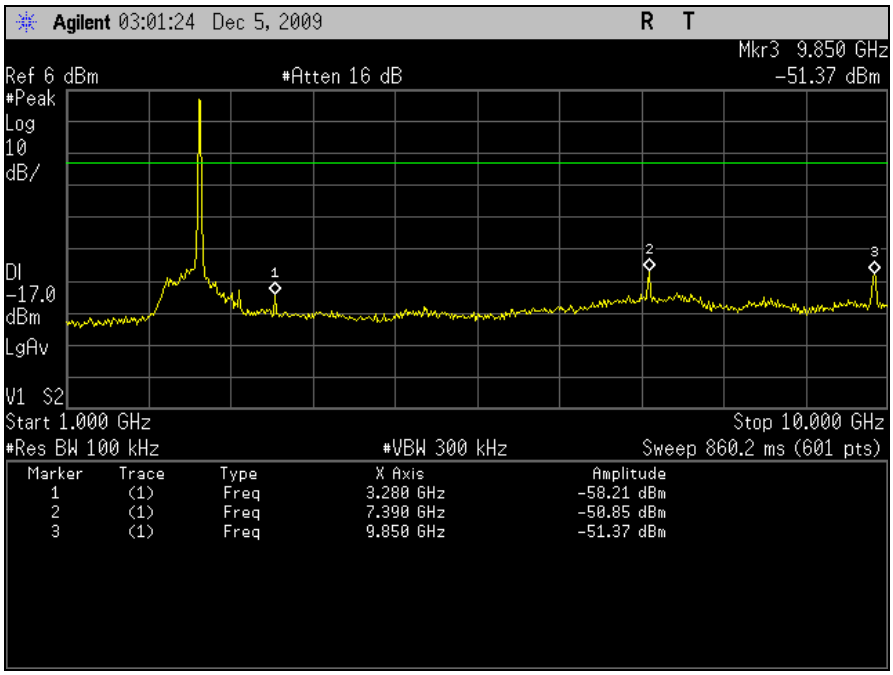
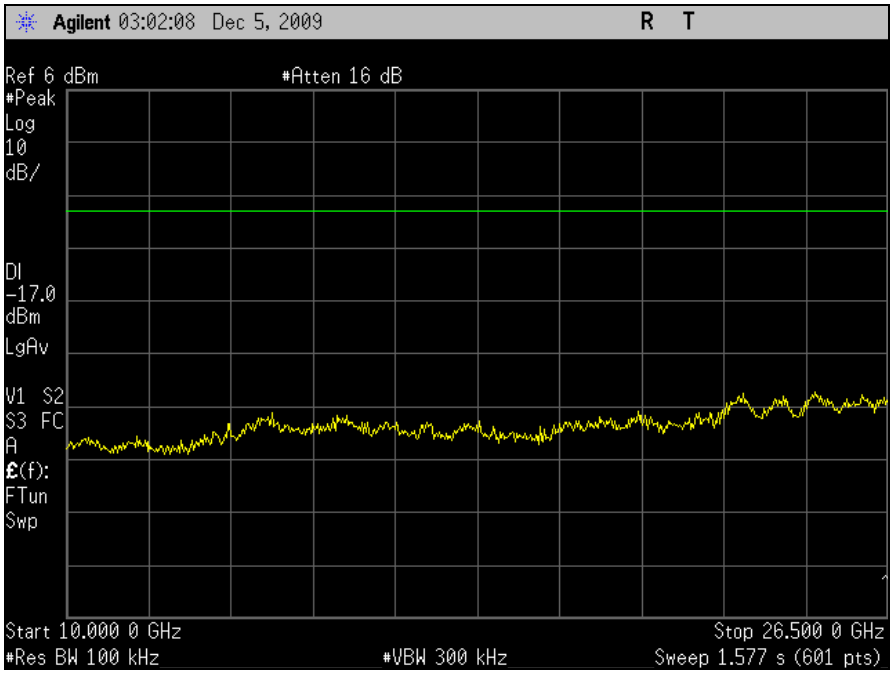


Plot 57. Conducted Emissions, High Channel, 1 GHz – 10 GHz, 802.11g, M25 Radio



Plot 58. Conducted Emissions, High Channel, 10 GHz – 26.5 GHz, 802.11g, M25 Radio

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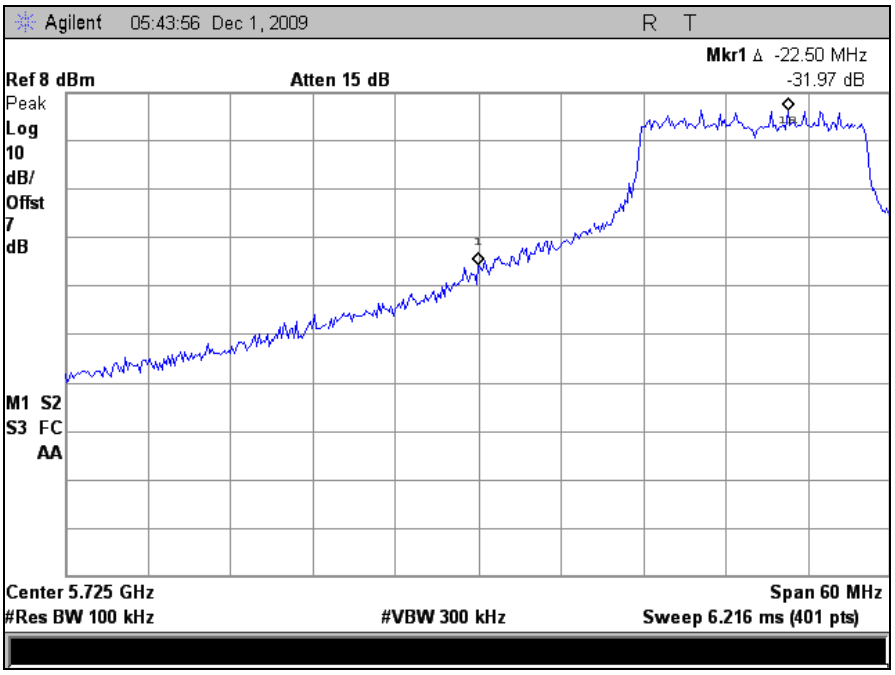
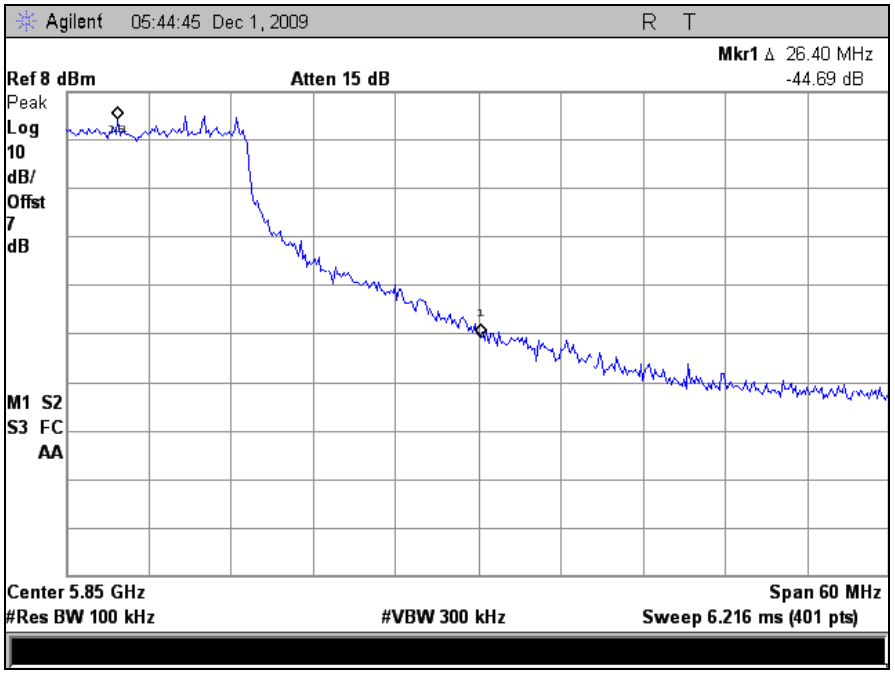
Conducted Band Edge



Plot 59. Conducted Band Edge, Low, 802.11a, M25 Radio



Plot 60. Conducted Band Edge, High, 802.11a, M25 Radio

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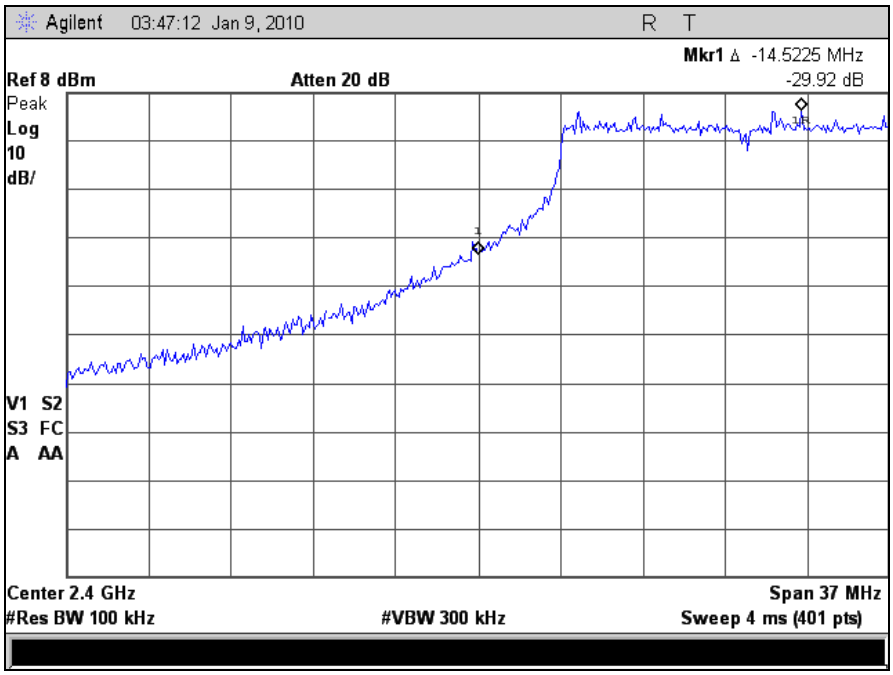
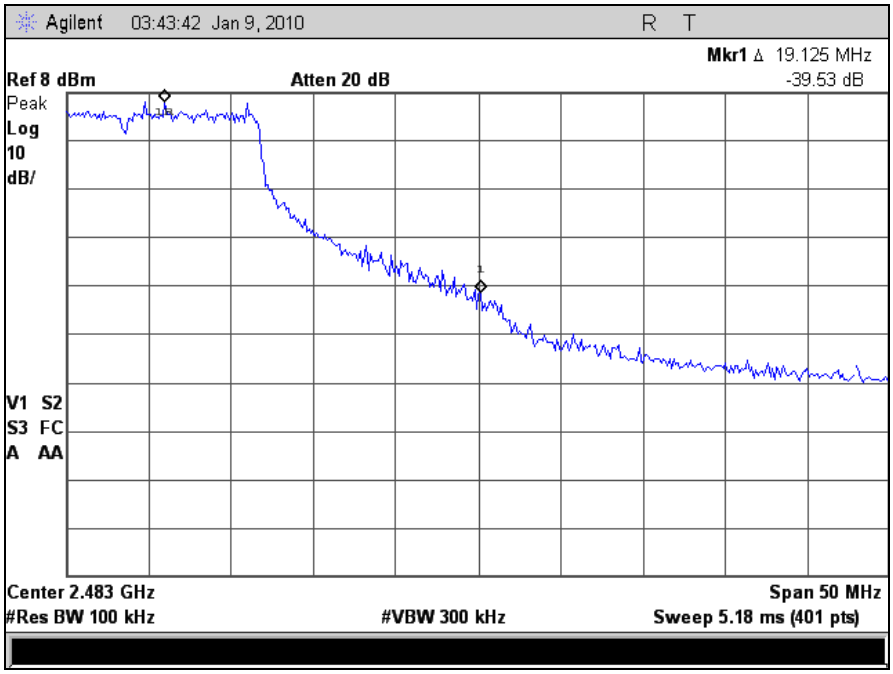


Plot 61. Conducted Band Edge, Low, 802.11g, M25 Radio



Plot 62. Conducted Band Edge, High, 802.11g, M25 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Peak Power Spectral Density – M25

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. 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)**.

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

Test Engineer: Dusmantha Tennakoon

Test Date: 12/03/09

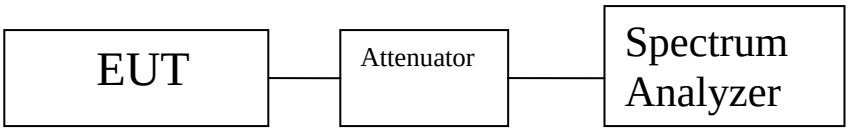

Figure 4. Peak Power Spectral Density Test Setup

Peak Power Spectral Density				
Carrier Channel	**Frequency (MHz)**	**Measured PPSD (dBm)**	**Limit (dBm)**	**Margin (dB)**
802.11a Low	5742	-10.15	5	-15.15
802.11a Mid	5780	-9.66	5	-14.66
802.11a High	5819	-9.445	5	-14.445
802.11g Low	2412	-3.896	5	-8.896
802.11g Mid	2437	-3.859	5	-8.859
802.11g High	2462	-4.217	5	-9.217

Table 14. Peak Power Spectral Density, Test Results, M25 Radio

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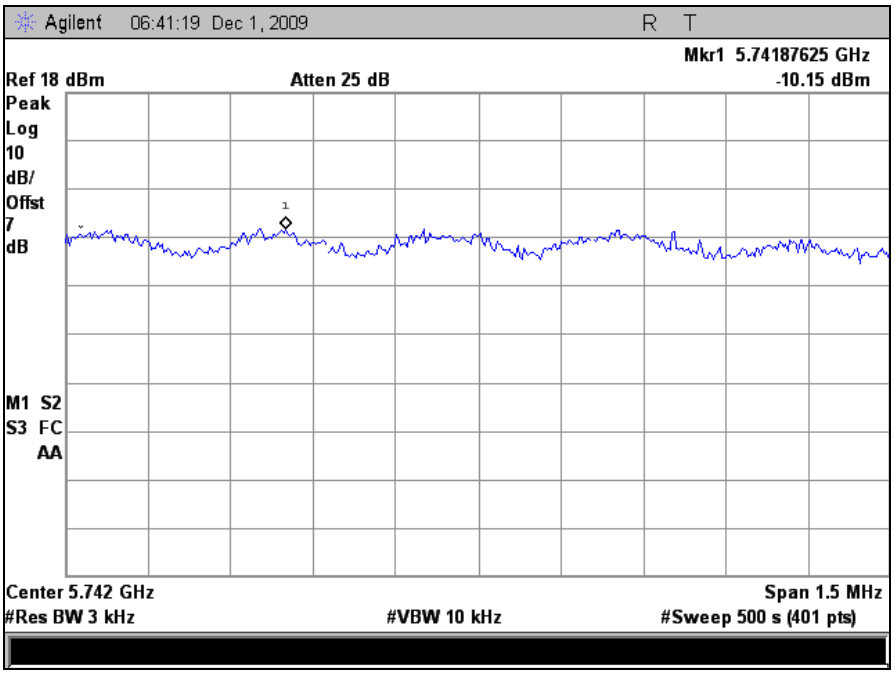
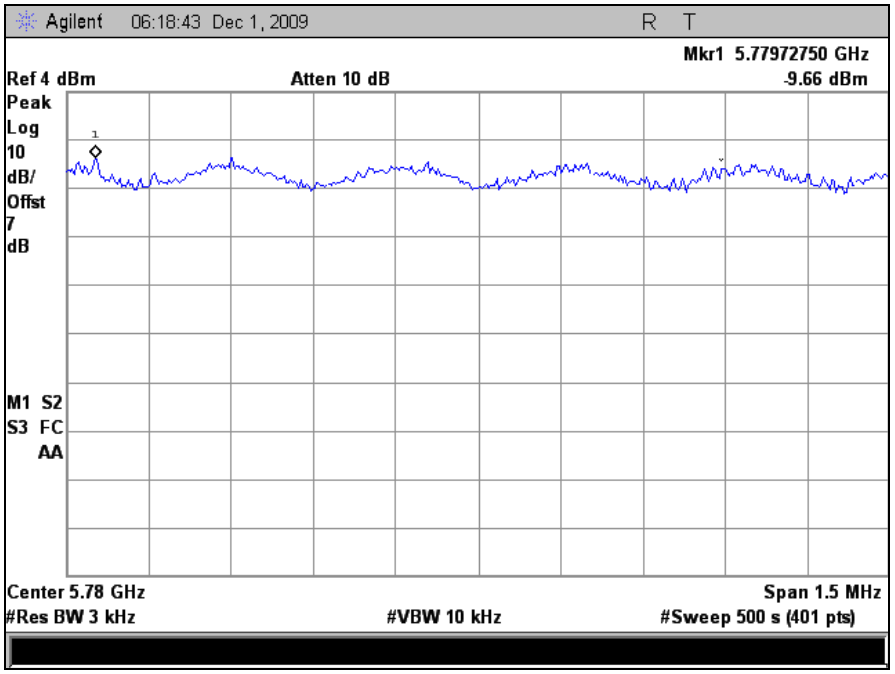
Peak Power Spectral Density



Plot 63. Peak Power Spectral Density, Low Channel, 802.11a, M25 Radio



Plot 64. Peak Power Spectral Density, Mid Channel, 802.11a, M25 Radio

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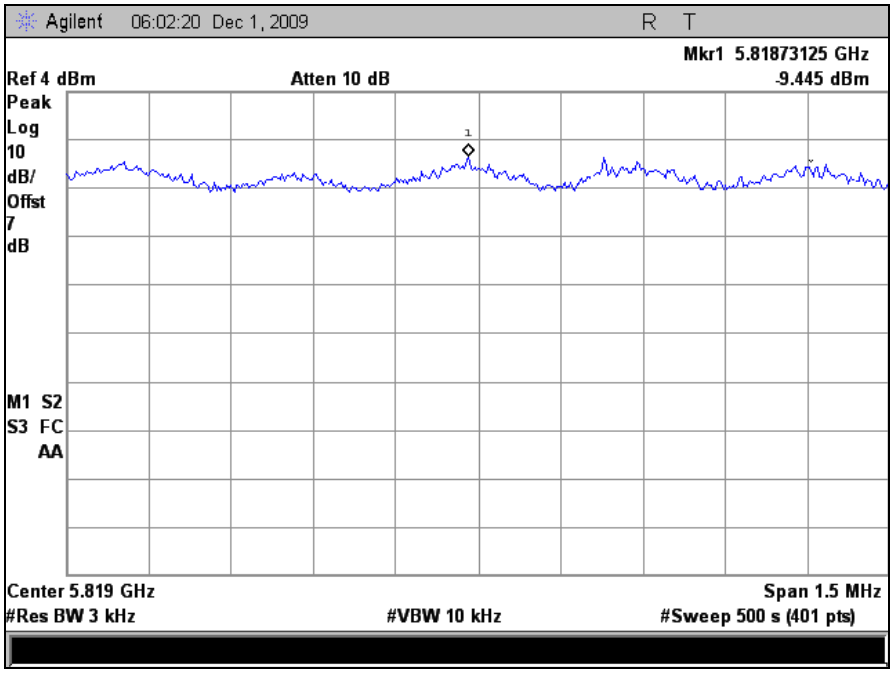
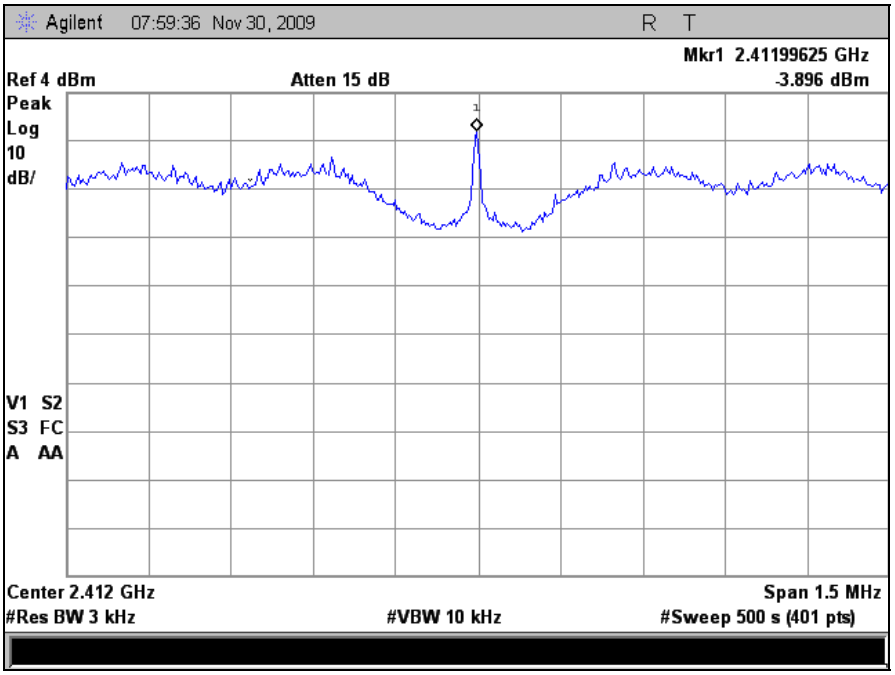


Plot 65. Peak Power Spectral Density, High Channel, 802.11a, M25 Radio



Plot 66. Peak Power Spectral Density, Low Channel, 802.11g, M25 Radio

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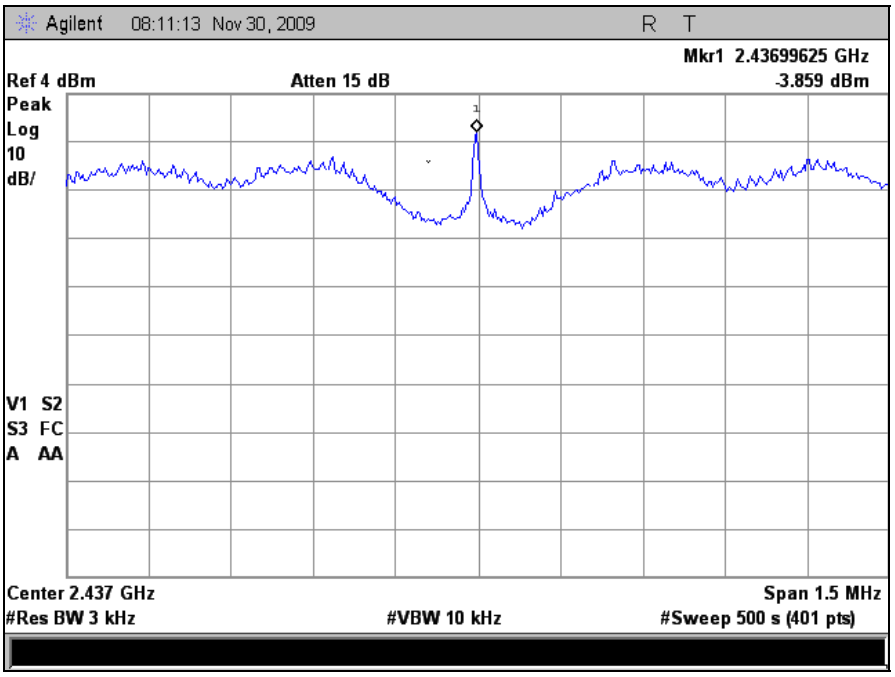
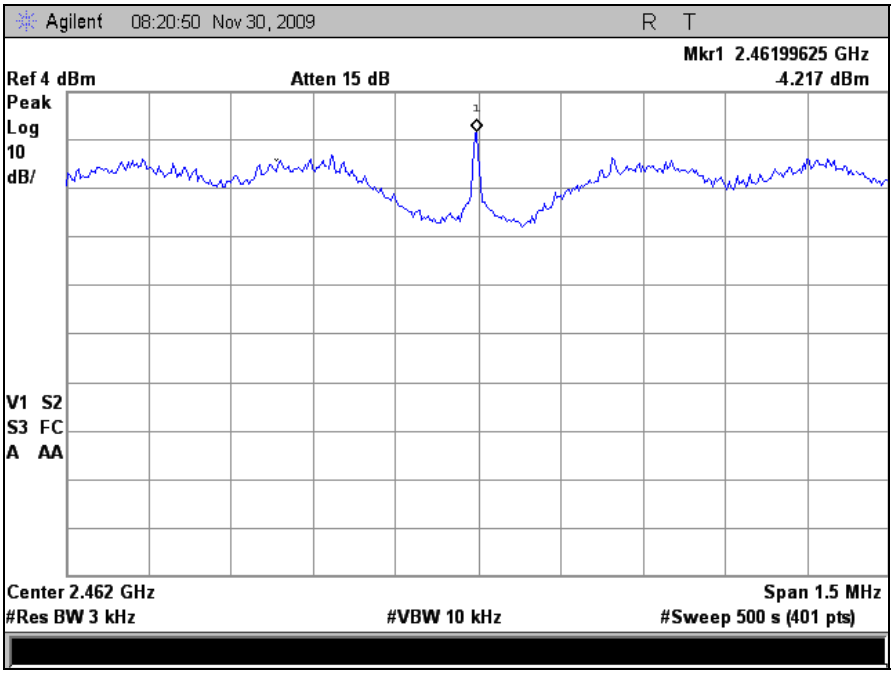


Plot 67. Peak Power Spectral Density, Mid Channel, 802.11g, M25 Radio



Plot 68. Peak Power Spectral Density, High Channel, 802.11g, M25 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators – M5 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement – M5

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 by virtue of being professionally installed.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

Frequency	Gain/Model	Manufacturer
5.8 GHz	9 dBi / ECO9 – 5500	Mobile Mark Communications

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207 Conducted Emissions Limits – M5

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

Test Procedure: The EUT was placed on a 0.8 m-high wooden table. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2003 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. 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.

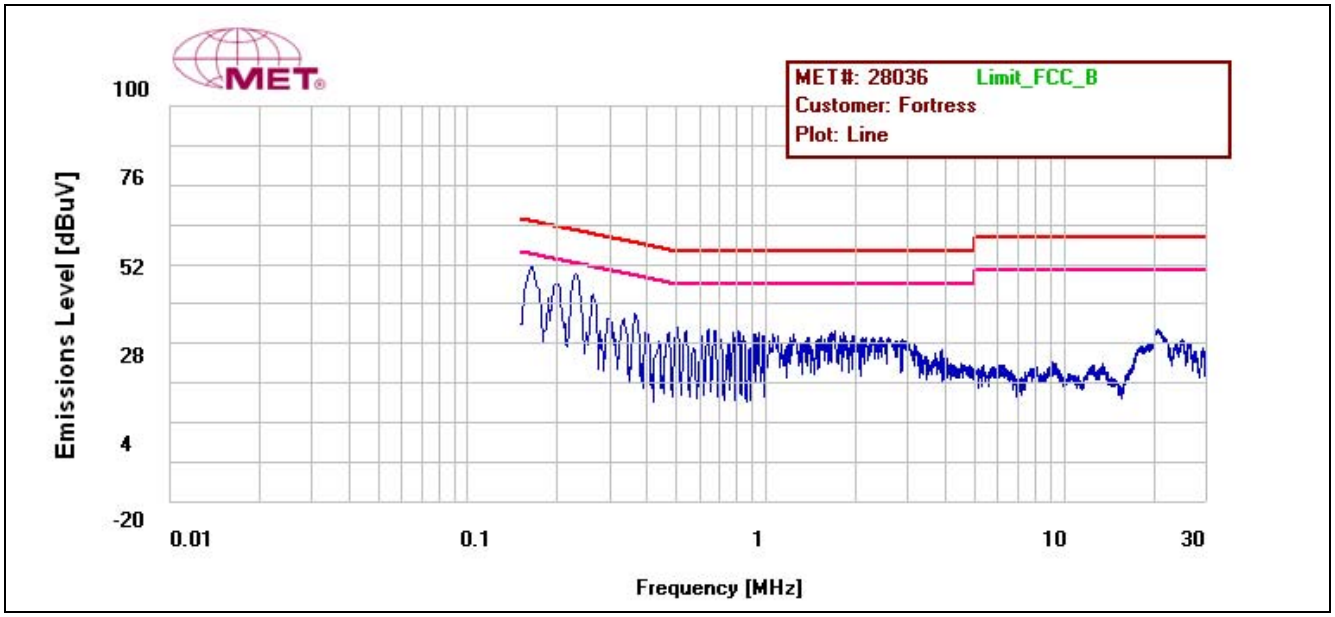
Test Results: The EUT was compliant with this requirement.

Test Engineer(s): Anderson Soungpanya

Test Date(s): 11/24/09

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line	0.169	50.65	65.012	-14.37	Pass	42.36	55.01	-12.65	Pass
Line	0.204	48.02	63.453	-15.44	Pass	43.13	53.45	-10.32	Pass
Line	2.24	35.33	56	-20.67	Pass	22.21	46.00	-23.78	Pass
Neutral	0.17	51.64	64.963	-13.33	Pass	42.05	54.96	-12.91	Pass
Neutral	0.203	47.03	63.494	-16.47	Pass	40.44	53.49	-13.05	Pass
Neutral	2.24	36.82	56	-19.18	Pass	29.15	46.00	-16.84	Pass

Table 16. Conducted Emissions, 15.207, Test Results, M5 Radio



Plot 69. Conducted Emissions, Phase Line, M5 Radio

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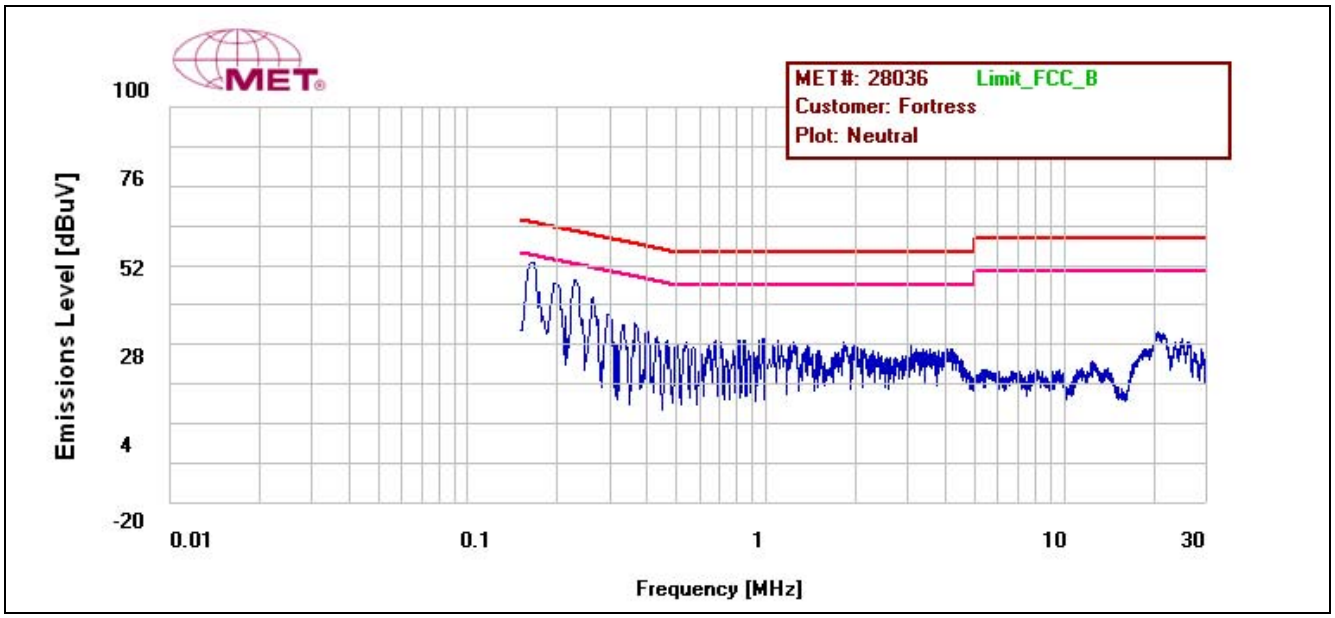
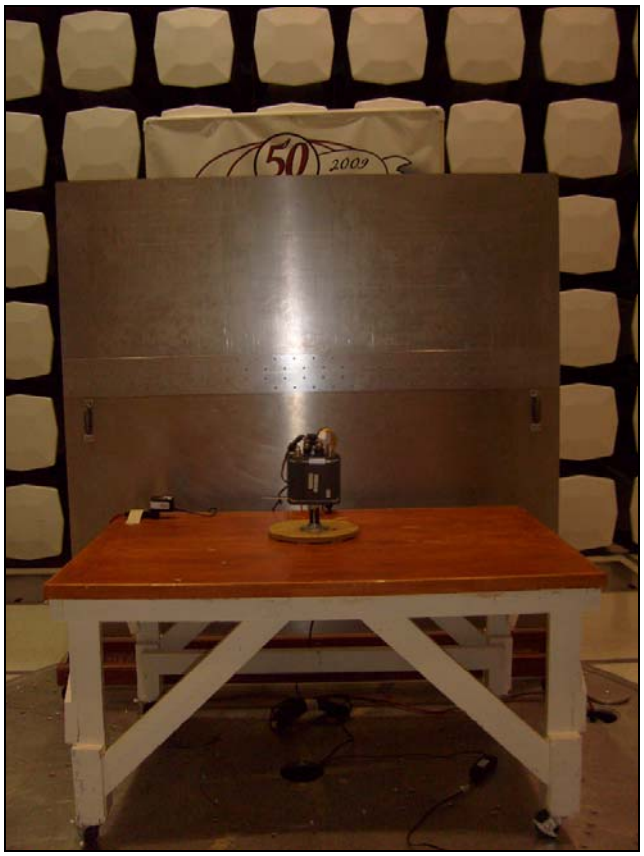


Plot 70. Conducted Emissions, Neutral Line, M5 Radio



Photograph 6. Conducted Emissions, Test Setup, M5 Radio

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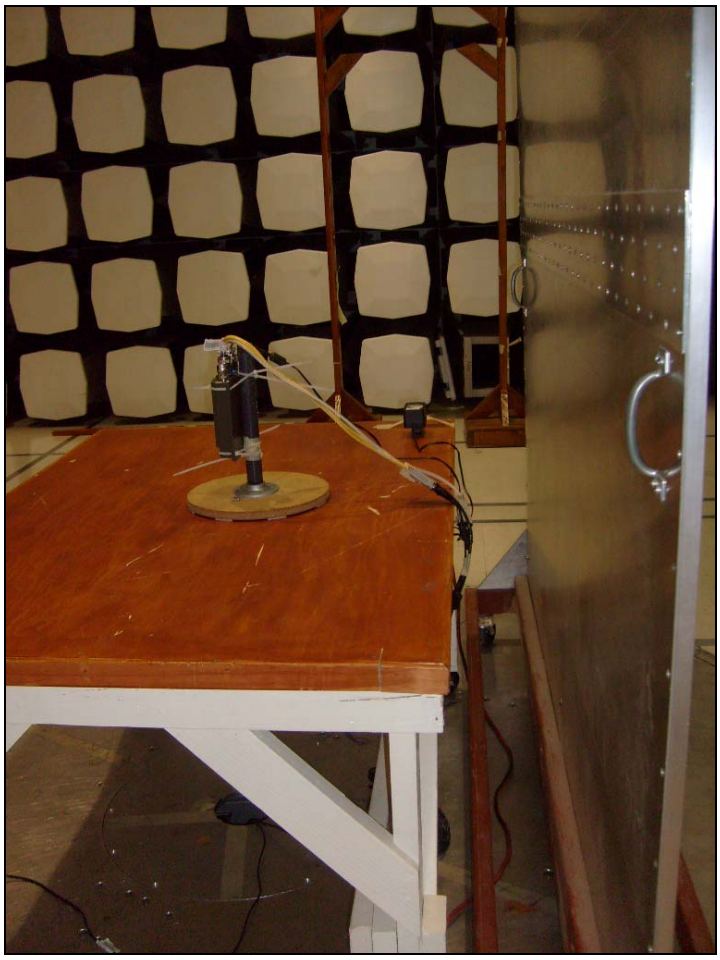

Photograph 7. Conducted Emissions, Test Setup, Side View, M5 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a) 6 dB and 99% Bandwidth – M5

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 = 100 kHz for FCC and approximately 1% of the total emission bandwidth for IC. 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).

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

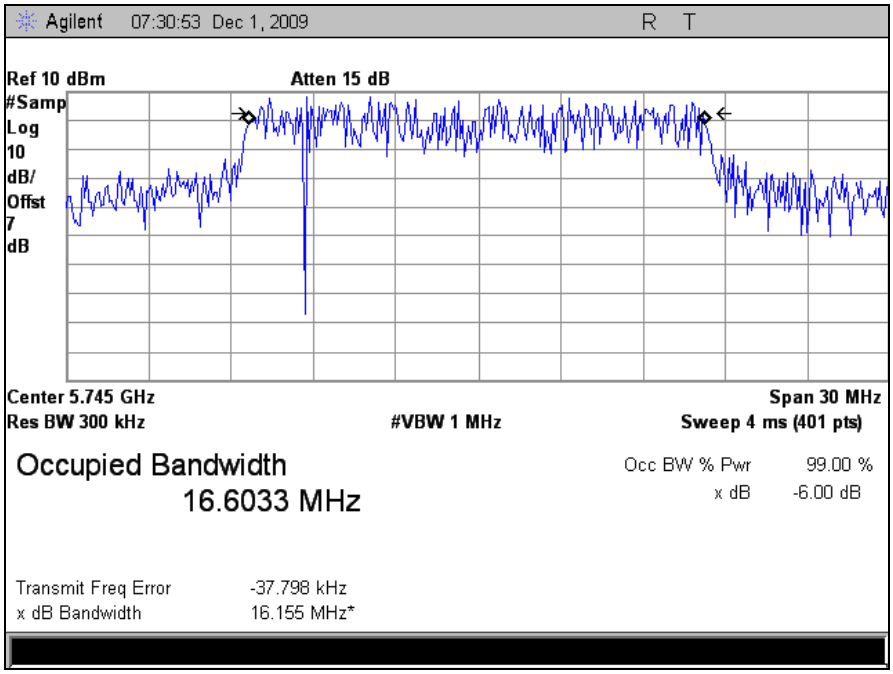
Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

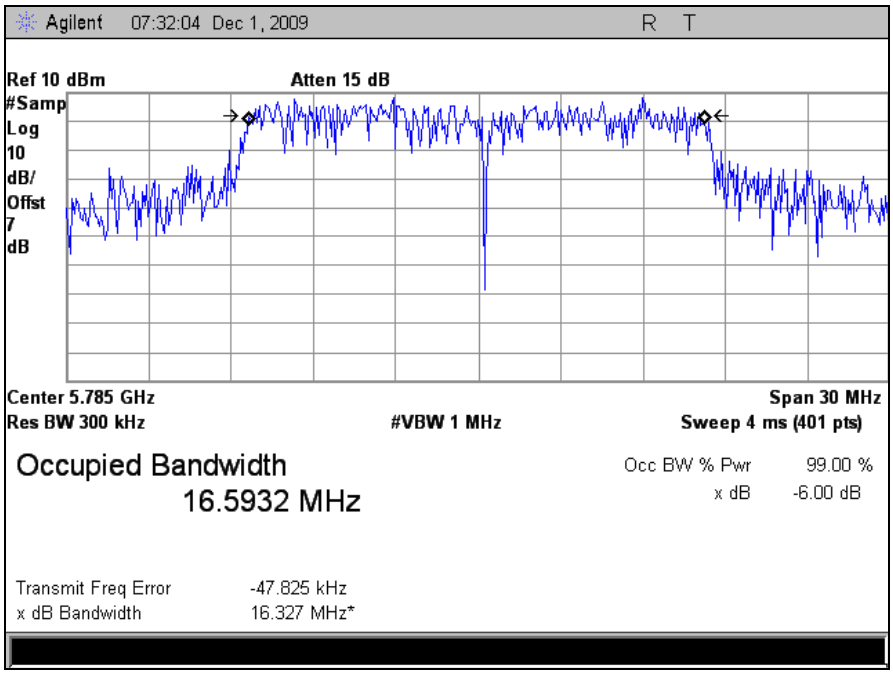
Requirement	Carrier Channel	Frequency (MHz)	Measured 6 dB Bandwidth (MHz)	Measured 99% Bandwidth (MHz)
IC	Low (99%)	5745	16.155	16.6033
	Mid (99%)	5785	16.327	16.5932
	High (99%)	5825	15.528	16.7583
FCC	Low (6 dB)	5745	16.359	
	Mid (6 dB)	5785	16.131	
	High (6 dB)	5825	16.477	

Table 17. Occupied Bandwidth, Test Results, M5 Radio

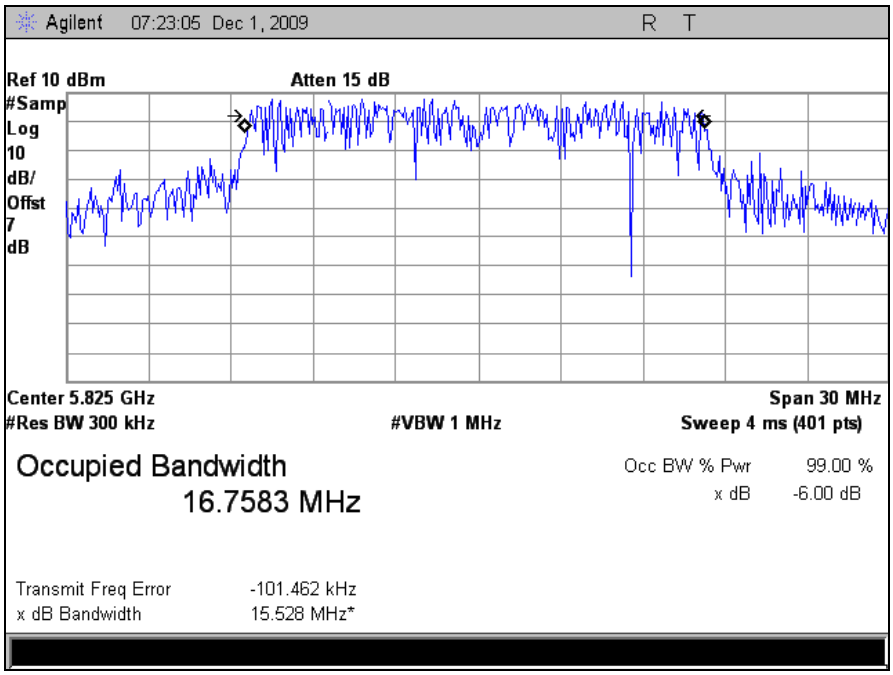
Electromagnetic Compatibility Criteria for Intentional Radiators



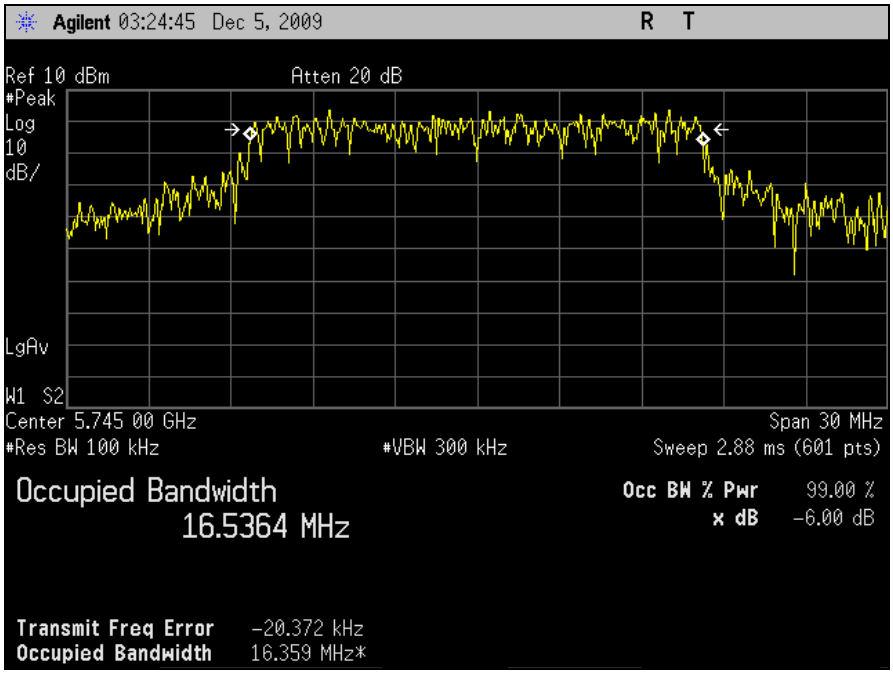
Plot 71. Occupied Bandwidth, Low Channel (5745MHz), 99% BW, M5 Radio



Plot 72. Occupied Bandwidth, Mid Channel (5785MHz), 99% BW, M5 Radio



Plot 73. Occupied Bandwidth, High Channel (5825MHz), 99% BW, M5 Radio



Plot 74. Occupied Bandwidth, Low Channel (5745MHz), 6dB BW, M5 Radio

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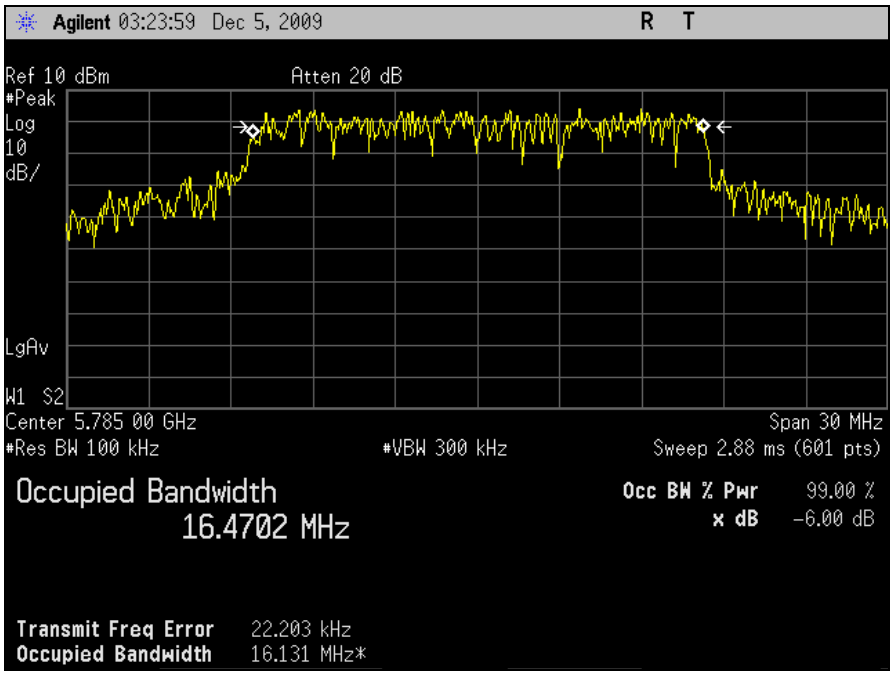
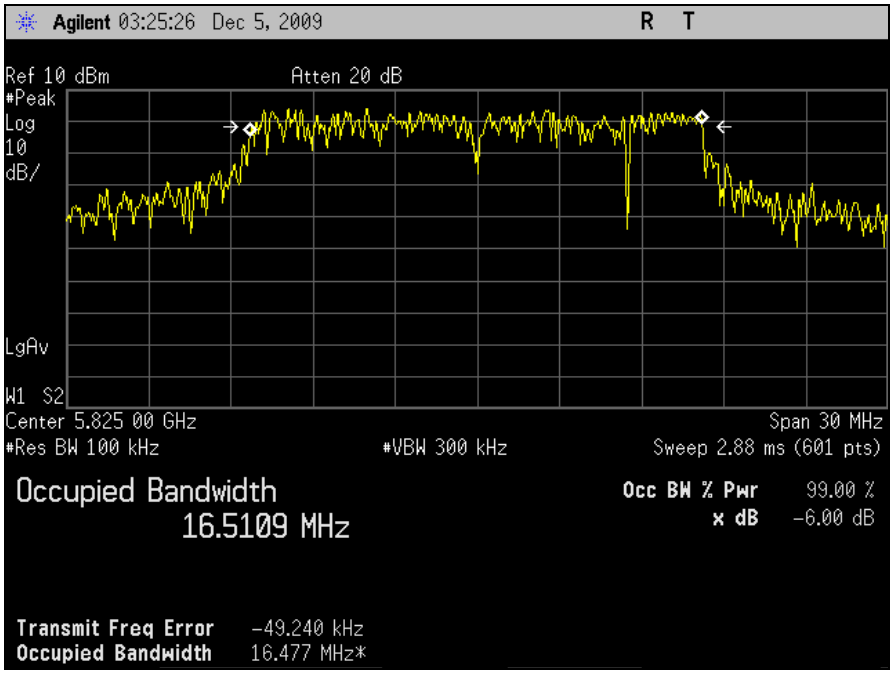


Plot 75. Occupied Bandwidth, Mid Channel (5785MHz), 6dB BW, M5 Radio



Plot 76. Occupied Bandwidth, High Channel (5825MHz), 6dB BW, M5 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output– M5

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 18. 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 9, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band at the maximum power level.

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

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

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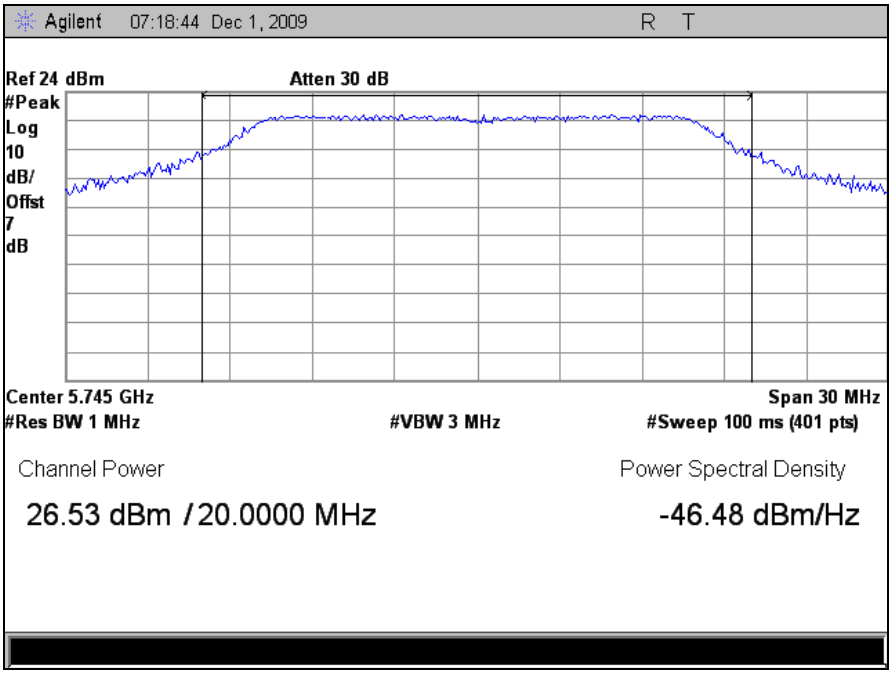
Peak Conducted Output Power		
Carrier Channel	**Frequency (MHz)**	**Measured Peak Output Power dBm**
Low	5745	26.53
Mid	5785	26.59
High	5825	26.77

Table 19. Peak Conducted Output Power, Test Results, M5 Radio



Plot 77. Peak Output Power, Low Channel (5745MHz), M5 Radio

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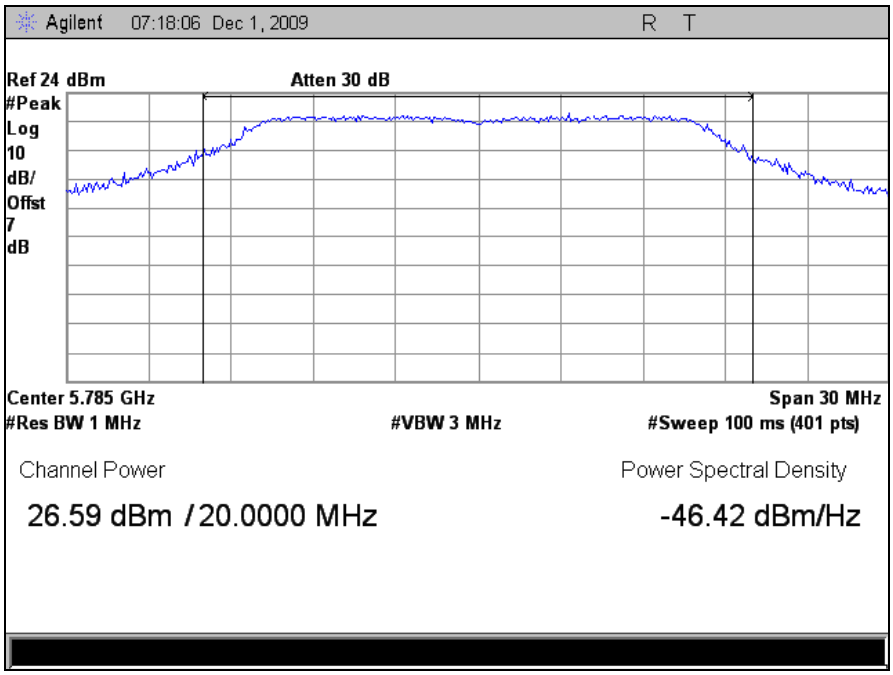
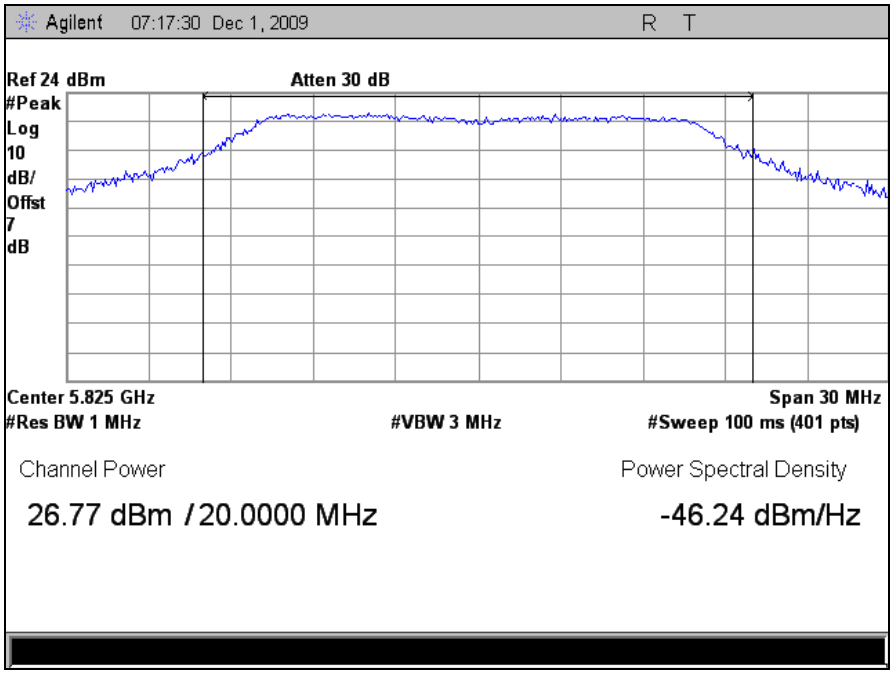


Plot 78. Peak Output Power, Mid Channel (5785MHz), M5 Radio



Plot 79. Peak Output Power, High Channel (5825MHz), M5 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge – M5

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 20. Restricted Bands of Operation

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

Test Requirement(s): **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 12.

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

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

Test Procedures: Measurements were performed of the low, mid and high Channels. Only noise floor was measured above 18 GHz.

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

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/22/09

Channel (MHz)	Measured Frequency (MHz)	Measured corrected amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
5745	11490	52.92	54	-1.08	Avg.
	11490	65.21	74	-8.79	Peak
5785	11570	52.96	54	-1.04	Avg.
	11570	65.21	74	-8.79	Peak
5825	11650	49.27	54	-4.73	Avg.
	11650	61.24	74	-12.76	Peak

Table 22. Radiated Spurious Emissions, Test Results, M5 Radio

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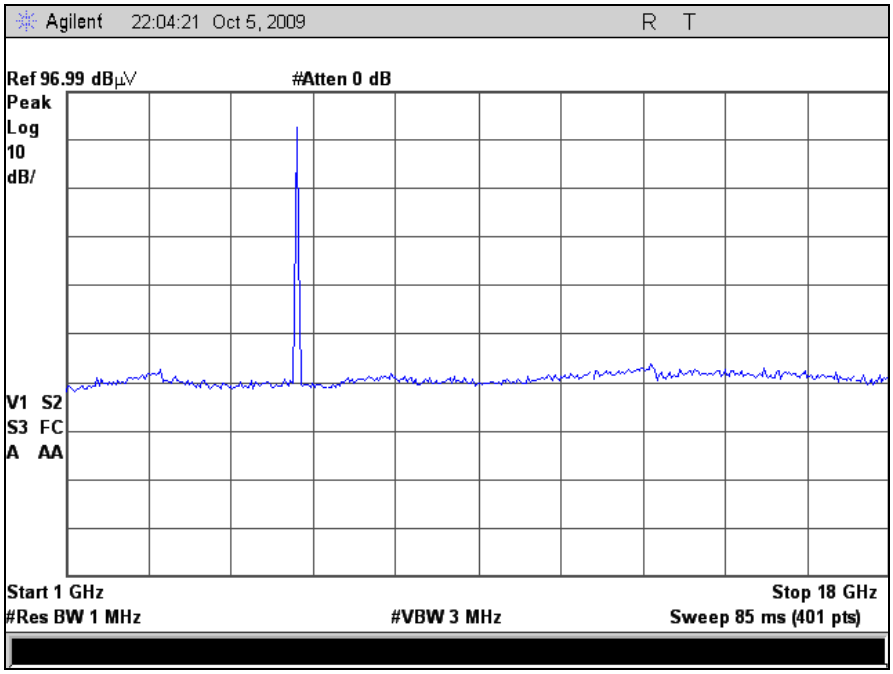
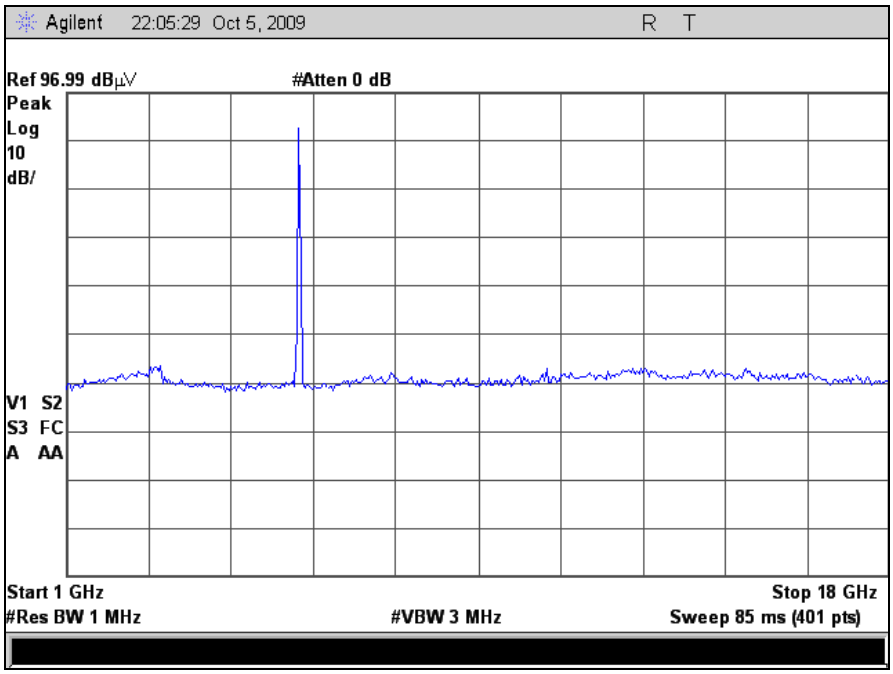
Radiated Spurious Emissions



Plot 80. Radiated Spurious Emissions, Low Channel, 802.11a, 1 GHz – 18 GHz, M5 Radio



Plot 81. Radiated Spurious Emissions, Mid Channel, 802.11a, 1 GHz – 18 GHz, M5 Radio

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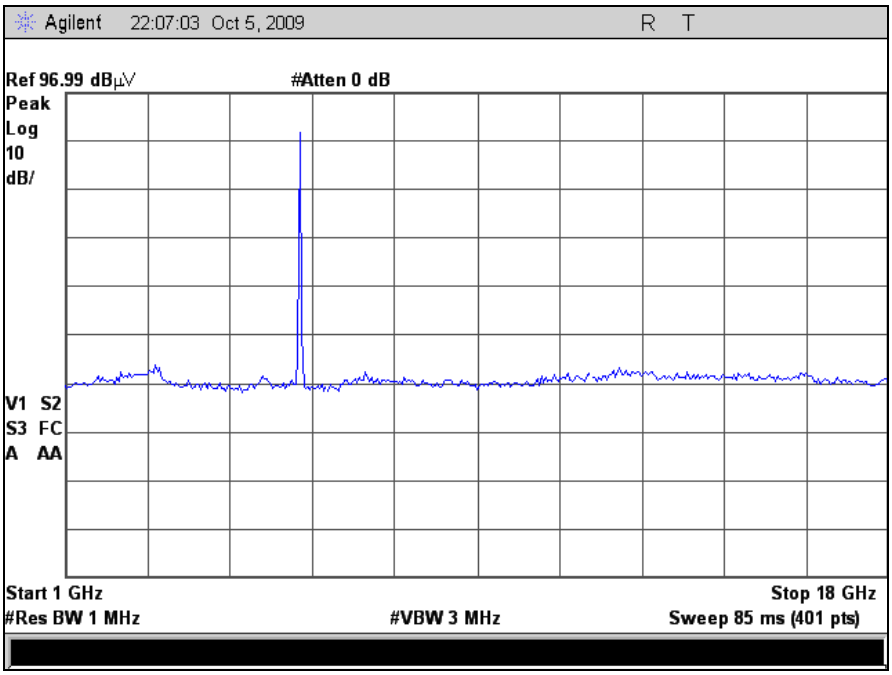
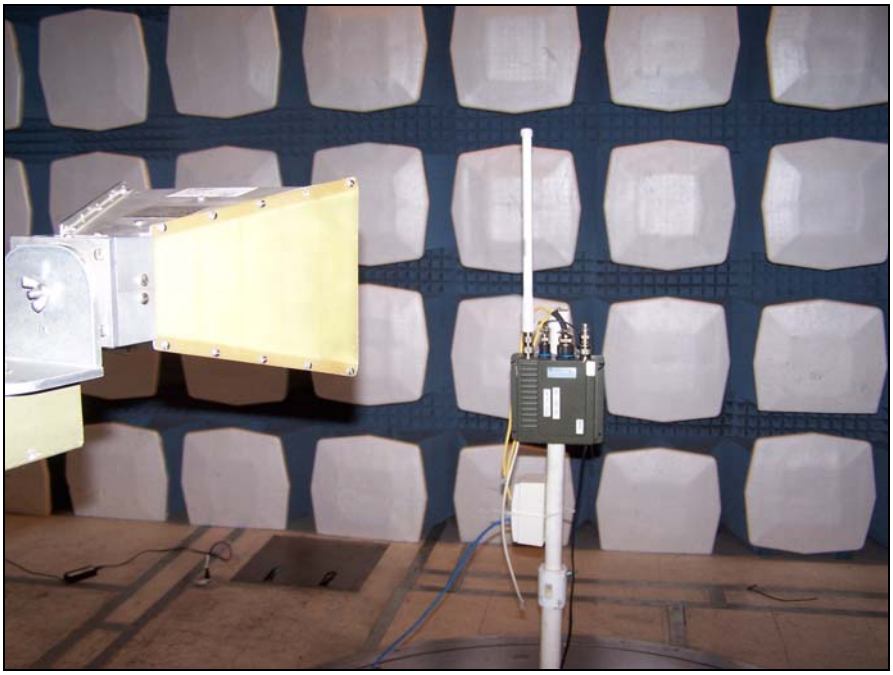


Plot 82. Radiated Spurious Emissions, High Channel, 802.11a, 1 GHz – 18 GHz, M5 Radio



Photograph 8. Radiated Spurious Emission, Test Setup, M5 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

Receiver Spurious Emissions – M5

Test Requirement: 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 13.

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

Table 23. 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 Procedure: The receiver spurious emissions were tested in compliance with the limits of Table 12. The testing was performed conducted.

Test Results: The EUT was compliant with the Receiver Spurious Emission limits of this requirement.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/23/09

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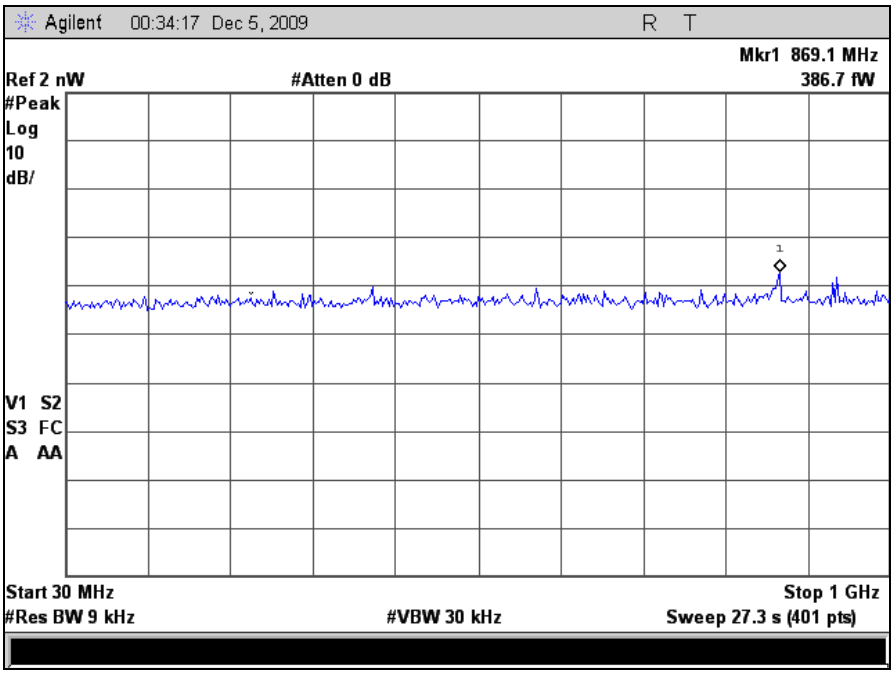
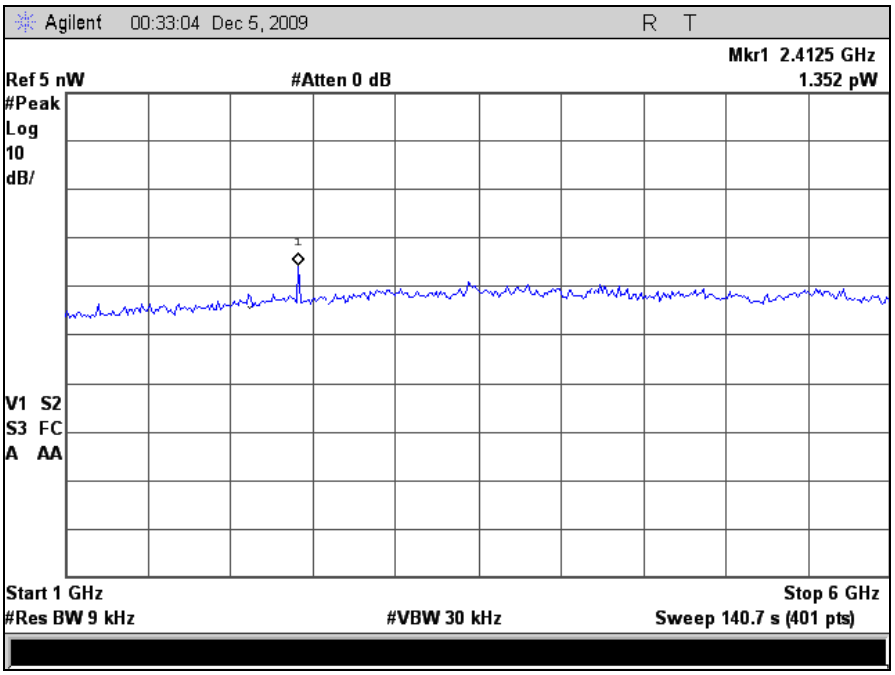
Receiver Spurious Emissions



Plot 83. Receiver Spurious Emission, 30 MHz – 1 GHz, M5 Radio



Plot 84. Receiver Spurious Emission, 1 GHz – 6 GHz, M5 Radio

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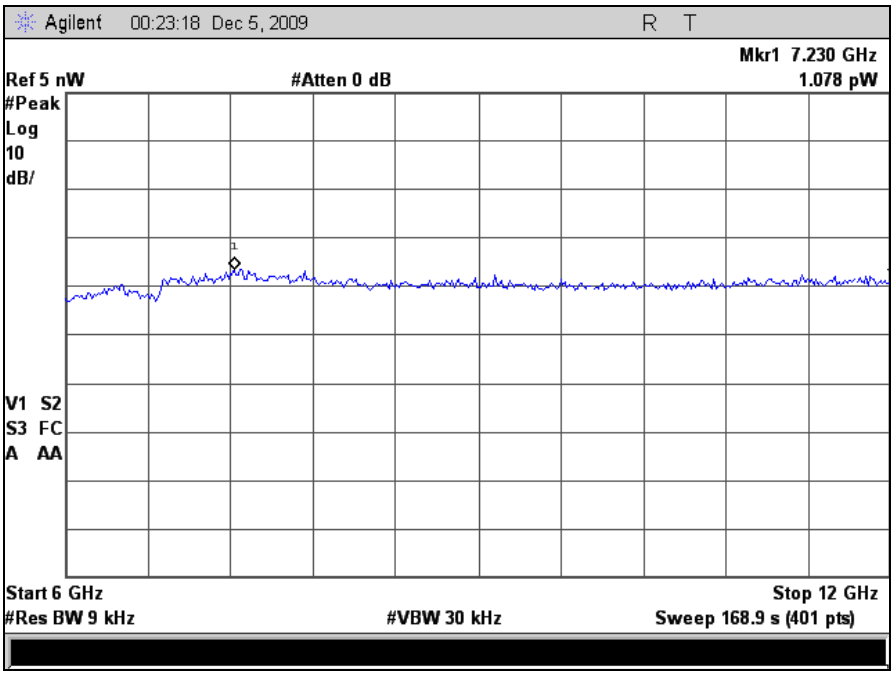
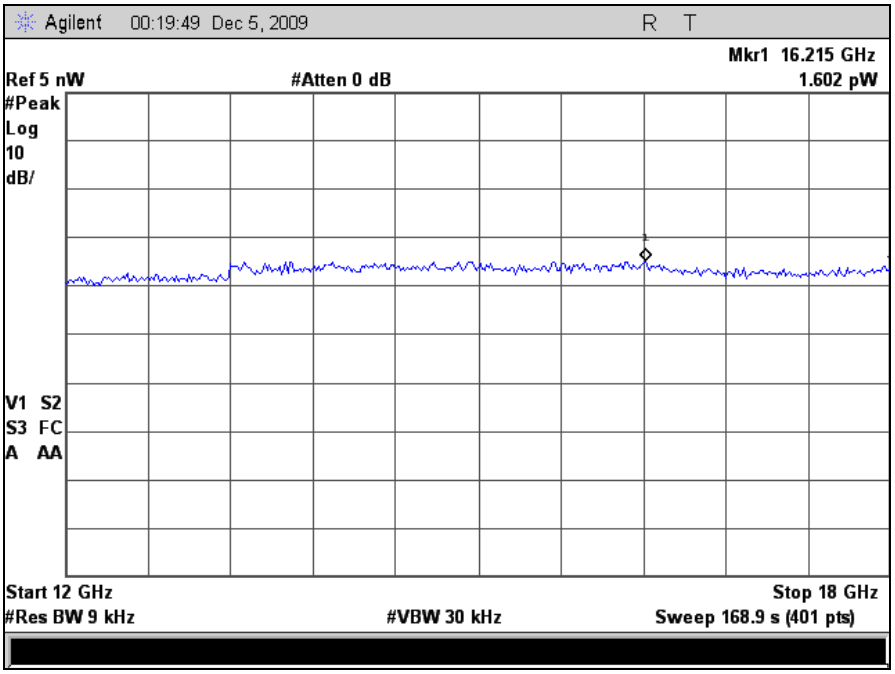


Plot 85. Receiver Spurious Emission, 6 GHz – 12 GHz, M5 Radio



Plot 86. Receiver Spurious Emission, 12 GHz – 18 GHz, M5 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge – M5

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)**.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

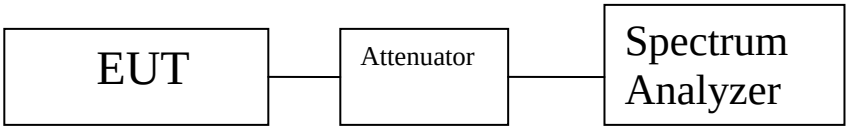
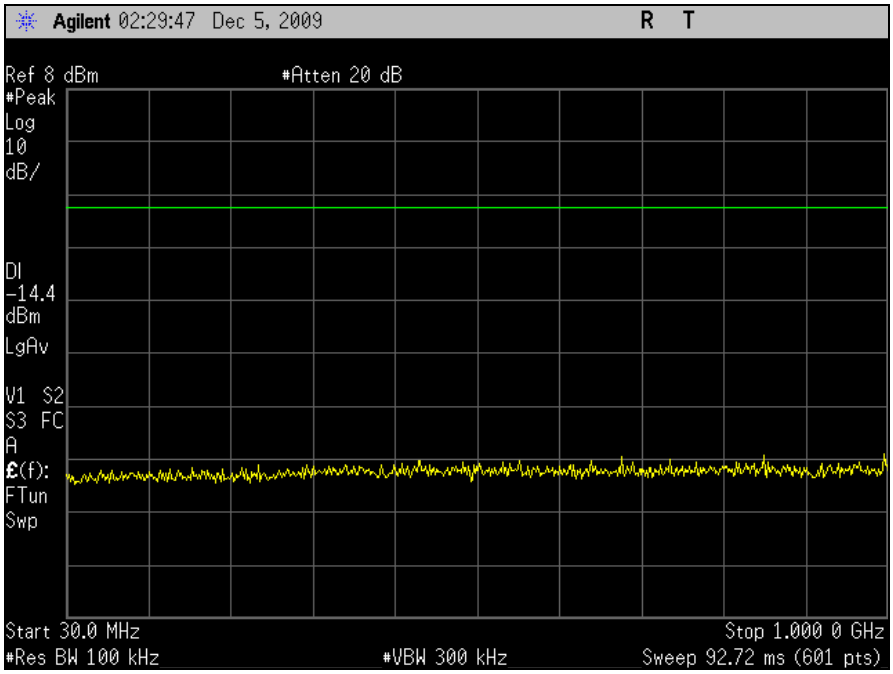
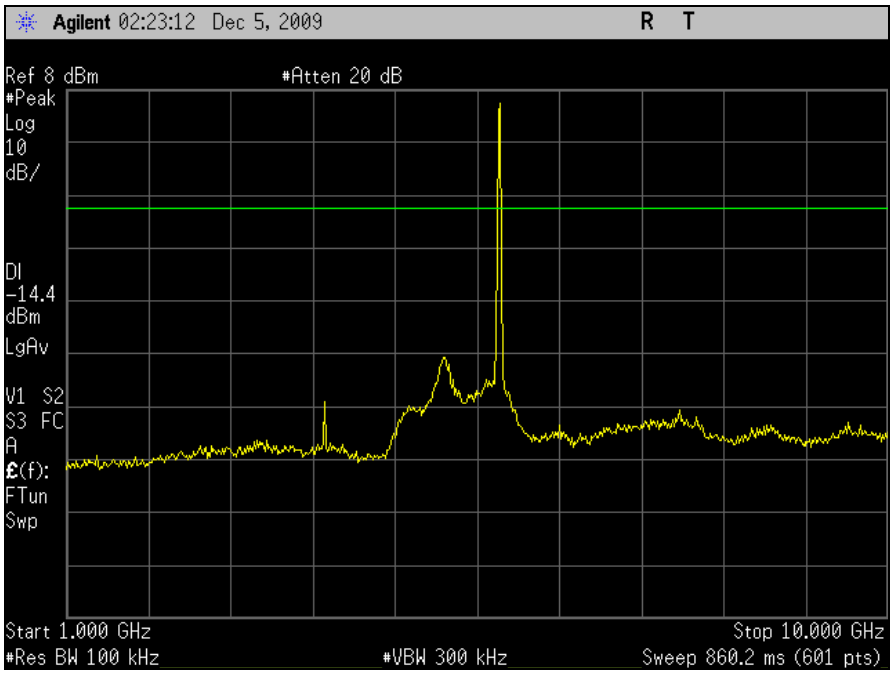


Figure 5. RF Conducted Spurious Emissions Test Setup

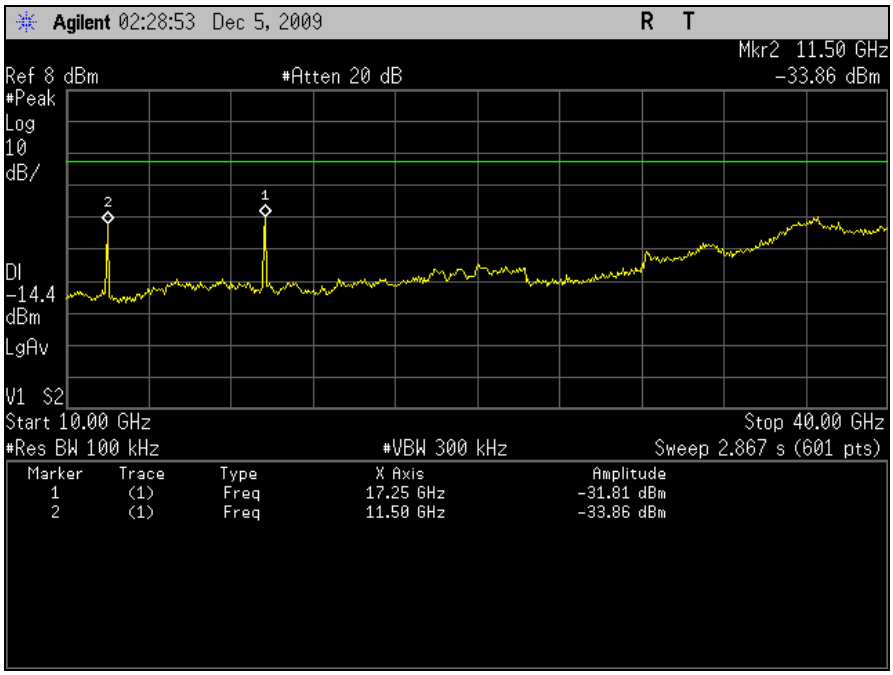
RF Conducted Spurious Emissions Requirements



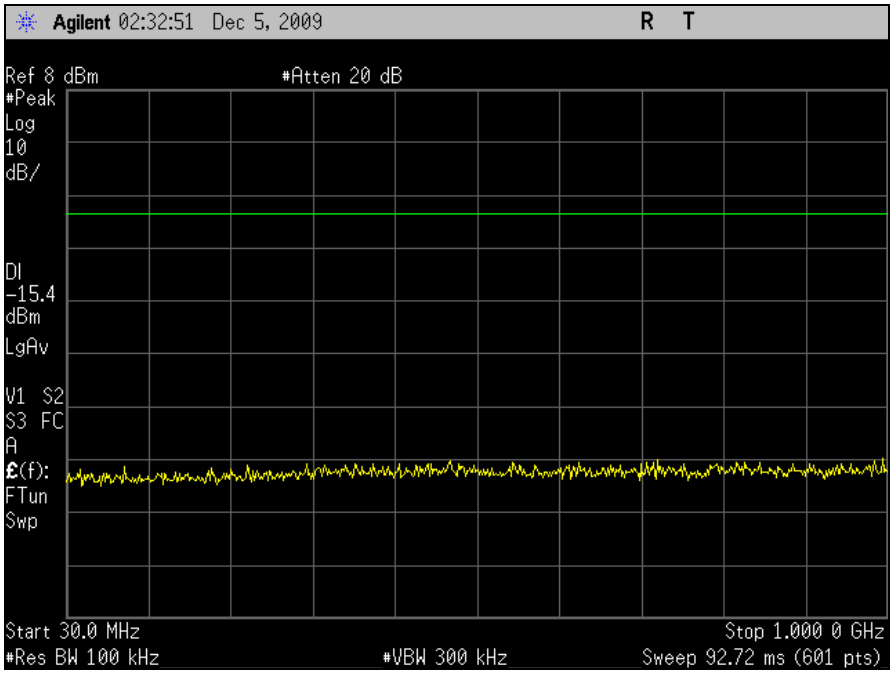
Plot 87. Conducted Emissions, Low Channel, 30 MHz – 1 GHz, 802.11a, M5 Radio



Plot 88. Conducted Emissions, Low Channel, 1 GHz – 10 GHz, 802.11a, M5 Radio



Plot 89. Conducted Emissions, Low Channel, 10 GHz – 40 GHz, 802.11a, M5 Radio



Plot 90. Conducted Emissions, Mid Channel, 30 MHz – 1 GHz, , 802.11a, M5 Radio

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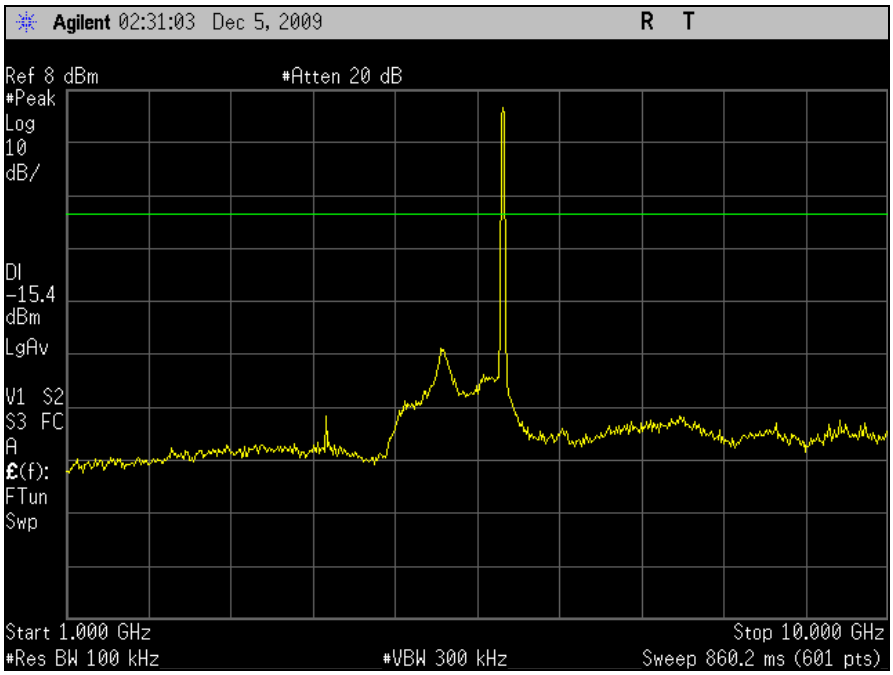
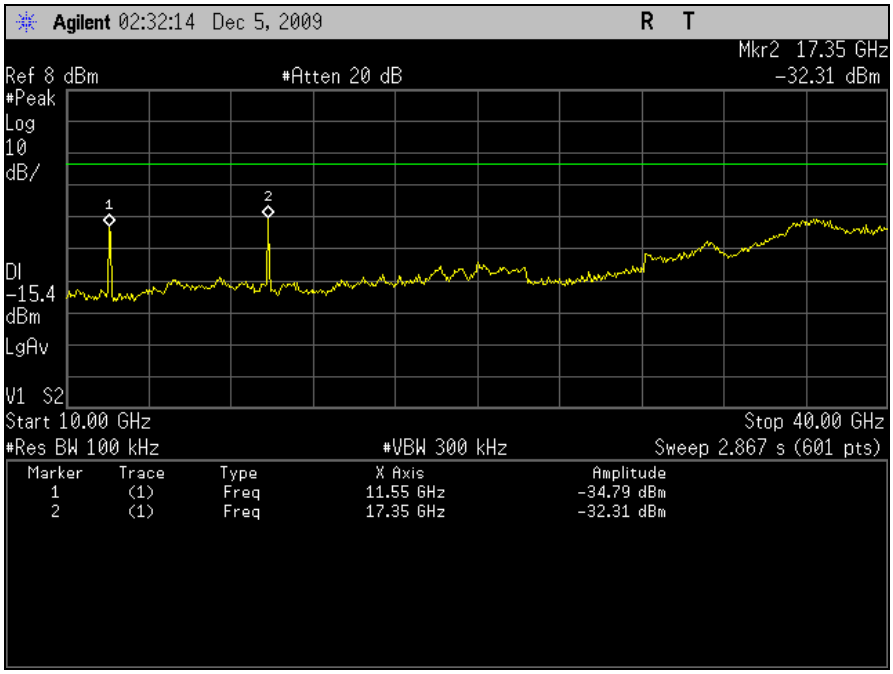


Plot 91. Conducted Emissions, Mid Channel, 1 GHz – 10 GHz, 802.11a, M5 Radio



Plot 92. Conducted Emissions, Mid Channel, 10 GHz – 40 GHz, 802.11a, M5 Radio

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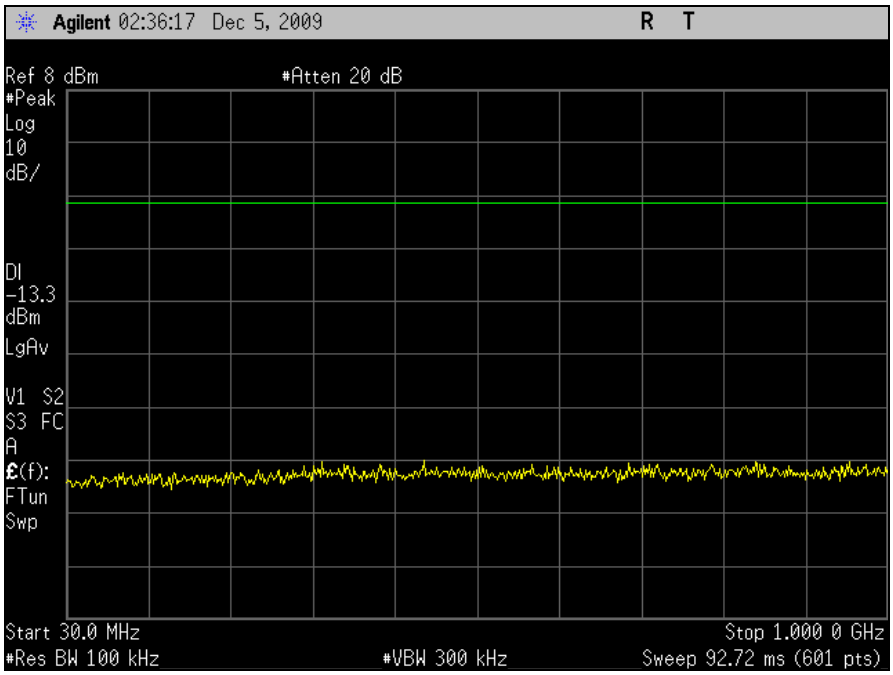
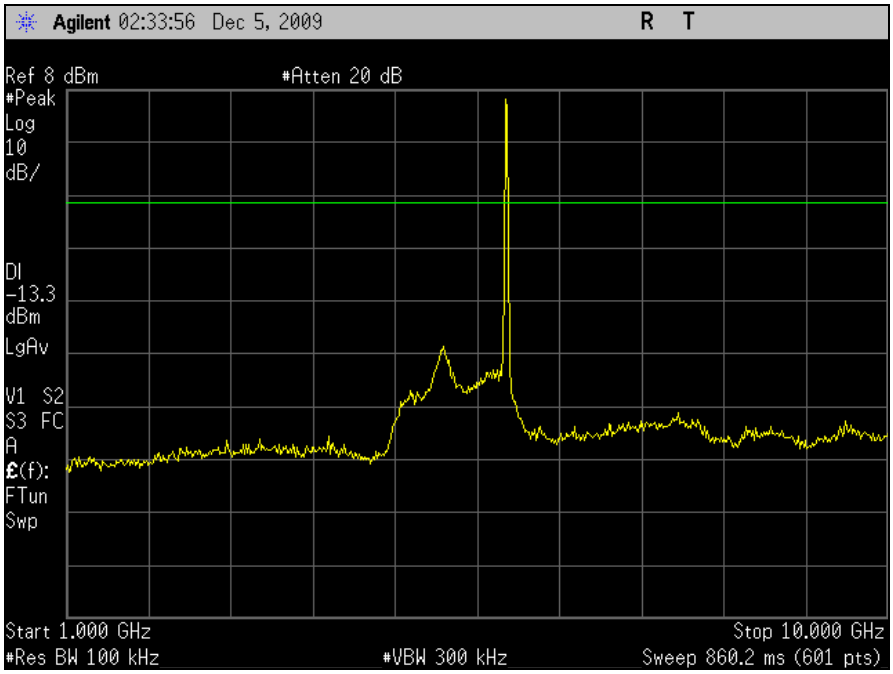


Plot 93. Conducted Emissions, High Channel, 30 MHz – 1 GHz, 802.11a, M5 Radio



Plot 94. Conducted Emissions, High Channel, 1 GHz – 10 GHz, 802.11a, M5 Radio

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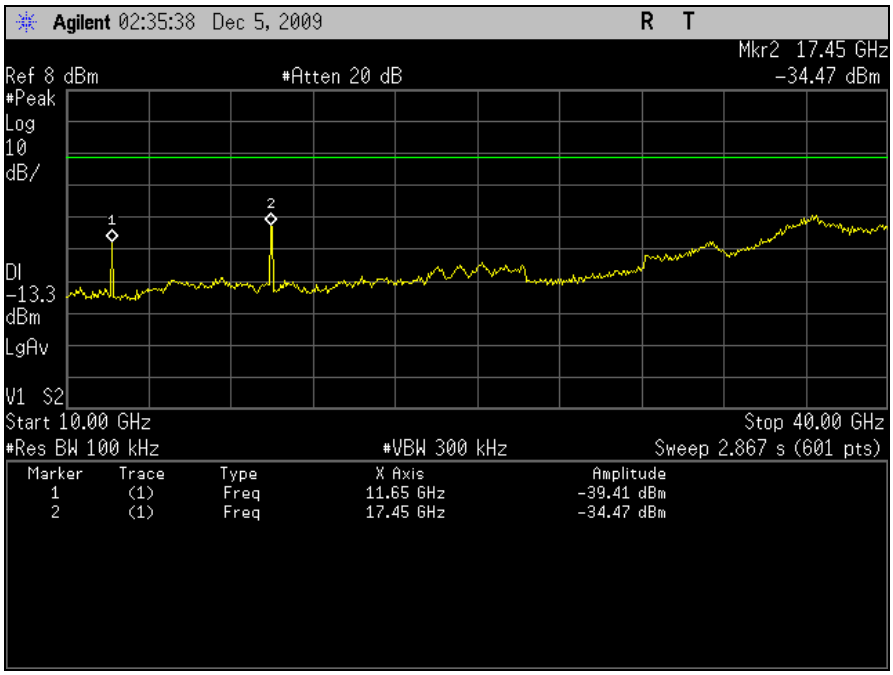

Plot 95. Conducted Emissions, High Channel, 10 GHz – 40 GHz, 802.11a, M5 Radio

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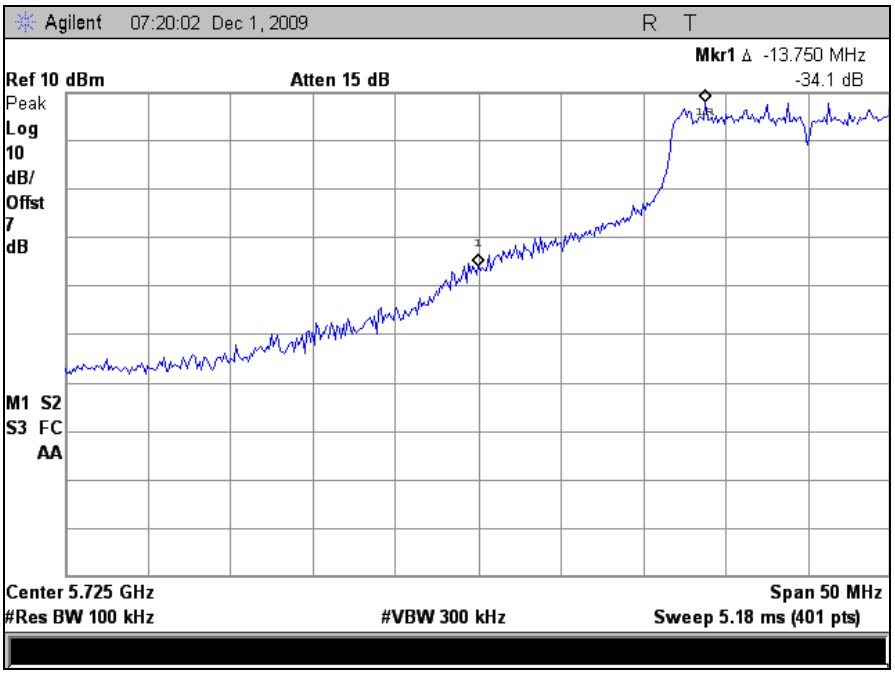
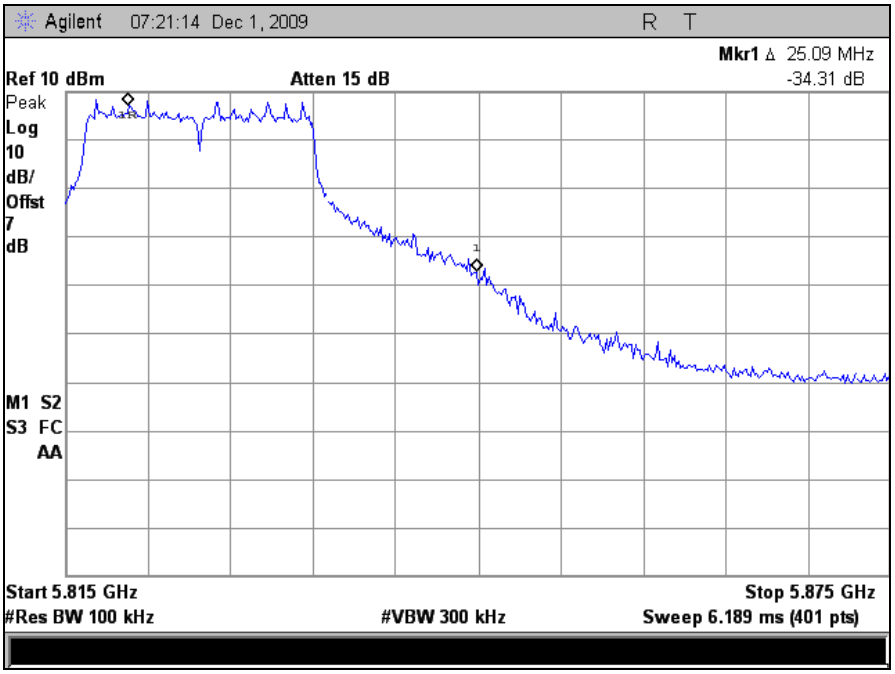
Conducted Band Edge



Plot 96. Conducted Band Edge, Low, M5 Radio



Plot 97. Conducted Band Edge, High, M5 Radio

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Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Peak Power Spectral Density – M5

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. 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)**.

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

Test Engineer: Dusmantha Tennakoon

Test Date: 12/03/09

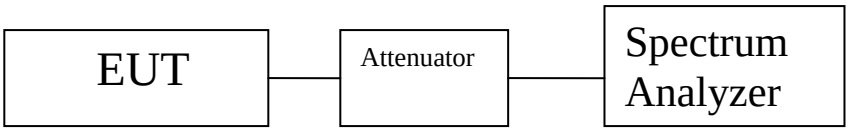
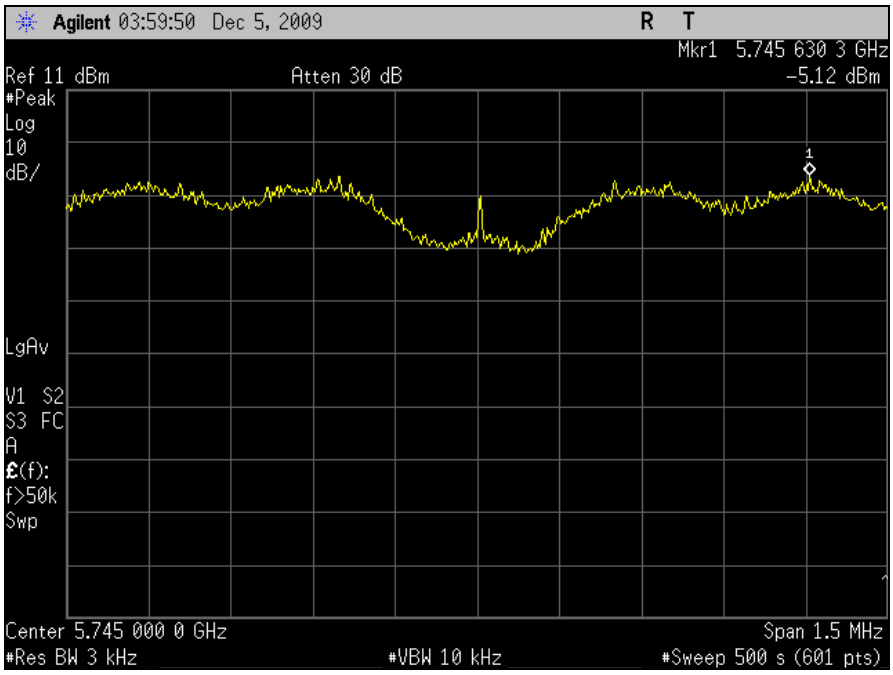


Figure 6. Peak Power Spectral Density Test Setup

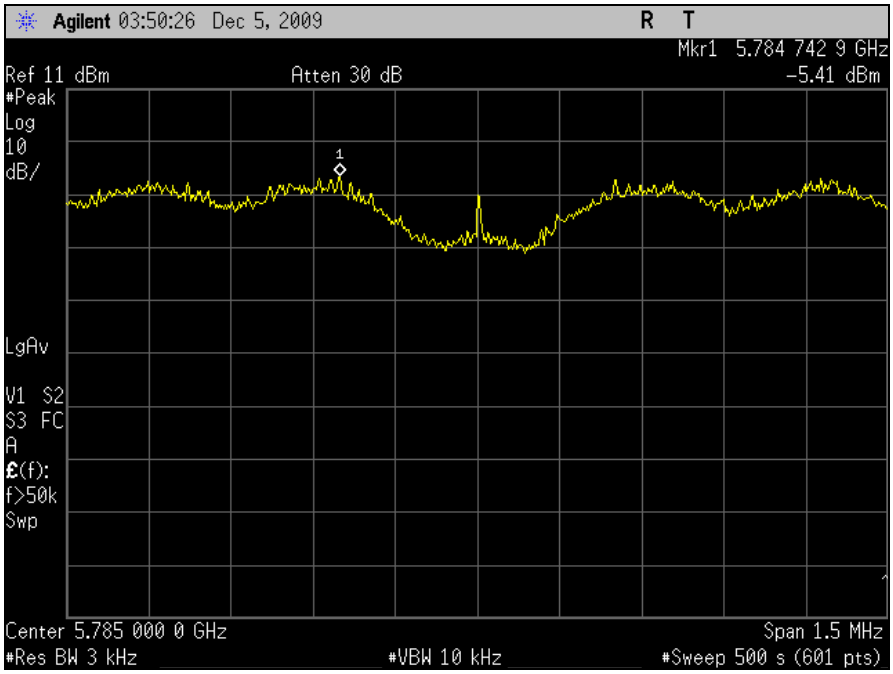
Peak Power Spectral Density				
Carrier Channel	**Frequency (MHz)**	**Measured PPSD (dBm)**	**Limit (dBm)**	**Margin (dB)**
Low	5742	-5.12	5	-10.12
Mid	5780	-5.41	5	-10.41
High	5819	-5.06	5	-10.06

Table 24. Peak Power Spectral Density, Test Results, M5 Radio

Peak Power Spectral Density



Plot 98. Peak Power Spectral Density, Low Channel, M5 Radio



Plot 99. Peak Power Spectral Density, Mid Channel, M5 Radio

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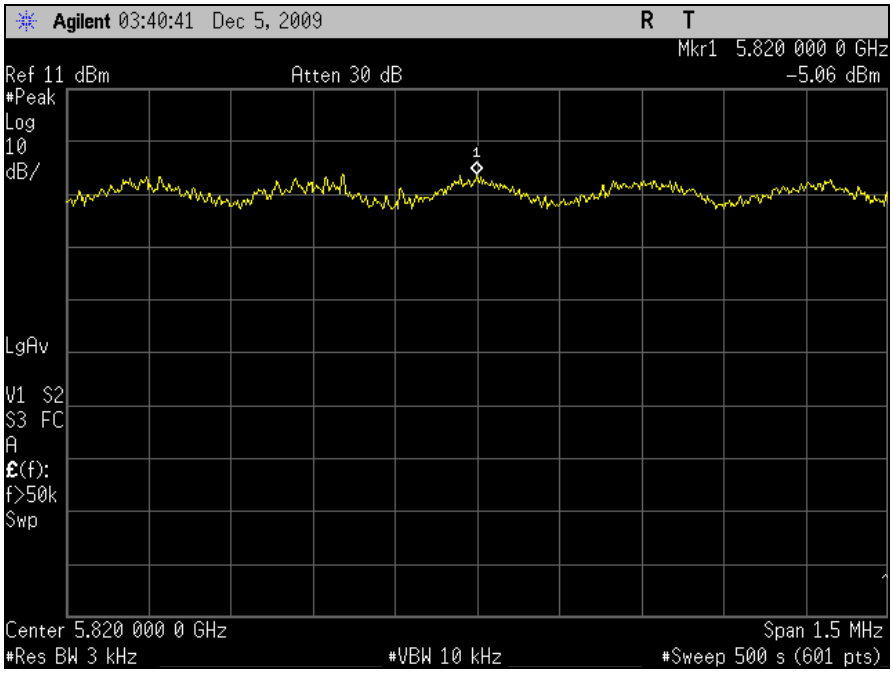

Plot 100. Peak Power Spectral Density, High Channel, M5 Radio

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IV. MPE Calculation – M25 and M5

§ 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.

M25 Radio:

MPE Limit Calculation: EUT's operating frequency is 2412 - 2462 MHz and 5745 – 5825 MHz;.

2.4 GHz 802.11 g mode:

Highest conducted power = 207.5 mW (i.e. 23.17 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 = 9 dBi = 7.94

P = 207.5 mW
R = 20 cm
G = 7.94

$$S1 = 207.5*7.94 / 4(3.1416)(20)^2$$

$$S1 = 0.33 \text{ mW/cm}^2$$

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

5.8 GHz 802.11 a mode:

Highest conducted power = 216.3 mW (i.e. 23.35 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 = 9 dBi = 7.94

P = 216.3 mW
R = 20 cm
G = 7.94

$$S2 = 216.3*7.94 / 4(3.1416)(20)^2$$

$$S2 = 0.34 \text{ mW/cm}^2$$

Therefore, EUT meets the Uncontrolled Exposure limit at 20cm

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M5 Radio:

EUT's operating frequency is 5745 - 5825 MHz;. Highest conducted power = 475.3 mW (i.e. 26.76 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 = 9 dBi = 7.94

P = 475.3 mW
R = **22 cm**
G = 7.94

$$S3 = 475.3*7.94 / 4(3.1416)(22)^2$$

$$S3 = 0.62 \text{ mW/cm}^2$$

Therefore, EUT meets the Uncontrolled Exposure limit at 22cm

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Co-location:

S	Power density (mW/cm²)	General Population Limit (mW/cm²)	S as a fraction of the limit (%)
S1	0.33	1	33
S3	0.62	1	62

S	Power density (mW/cm²)	General Population Limit (mW/cm²)	S as a fraction of the limit (%)
S2	0.34	1	34
S3	0.48	1	48

The total percentages do not exceed 100 % per OET 65 requirements when the spectral power density is calculated at least **22cm** away from the unit.

V. Test Equipment

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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
1S2512	TRANSIENT LIMITER	AGILENT	11947A	SEE NOTE	
1S2109	EMI RECEIVER (RECEIVER SECTION)	HEWLETT PACKARD	85462A	11/10/2009	11/10/2010
1S2372	CUSTOM 50A A/C LISN	FCC	CUSTOM MADE	02/02/2009	02/02/2010
1S2370	CUSTOM 50A A/C LISN	FCC	CUSTOM MADE	02/02/2009	02/02/2010
1S2481	10M CHAMBER	ETS-LINDGREN	DKE 8X8 DBL	10/19/2009	10/19/2010
1T4303	ANTENNA; BILOG	SCHAFNER - CHASE EMC	CBL6140A	07/29/2009	07/29/2010
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
1T2511	ANTENNA; HORN	EMCO	3115	08/21/2009	08/21/2010
1T4414	MICROWAVE PRE-AMPLIFIER	AH SYSTEMS	PAM-0118	SEE NOTE	
1T4505	TEMPERATURE CHAMBER	TEST EQUITY	115	10/01/2009	11/01/2010
1T4612	ESA-E SERIES SPECTRUM ANALYZER	AGILENT	E4407B	09/09/2009	09/09/2010
1T4548	AC POWER SOURCE	CALIFORNIA INSTRUMENTS	1251P	SEE NOTE	
1T2665	HORN ANTENNA	EMCO	3115	07/06/2009	07/06/2010
1T4681	PSA SPECTRUM ANALYZER	AGILENT	E4448A	10/22/2009	10/22/2010
1T4592	RF FILTER KIT	VARIOUS	N/A	SEE NOTE	

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

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VI. Certification & User's Manual Information

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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.

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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.

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

Verification & User's Manual Information

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

§ 15.105 Information to the user.

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

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

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

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

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

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

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

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.

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End of Report

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