MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE ● BALTIMORE, MARYLAND 21230-3432 ● PHONE (410) 354-3300 ● FAX (410) 354-3313
33439 WESTERN AVENUE ● UNION CITY, CALIFORNIA 94587 ● PHONE (510) 489-6300 ● FAX (510) 489-6372
3162 BELICK STREET ● SANTA CLARA, CALIFORNIA 95054 ● PHONE (408 748-3585 ● FAX (510) 489-6372

January 25, 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 Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Title 47 of the CFR, Part 15.407 and Industry Canada RSS-210, Annex 9, 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-UNII 3)

MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE ● BALTIMORE, MARYLAND 21230-3432 ● PHONE (410) 354-3300 ● FAX (410) 354-3313
33439 WESTERN AVENUE ● UNION CITY, CALIFORNIA 94587 ● PHONE (510) 489-6300 ● FAX (510) 489-6372
3162 BELICK STREET ● SANTA CLARA, CALIFORNIA 95054 ● PHONE (408 748-3585 ● FAX (510) 489-6372

Electromagnetic Compatibility Criteria
Test Report

for the

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

Tested under
the Certification Rules
contained in
Title 47 of the CFR, Part 15.407
and
Industry Canada RSS-210, Annex 9
for Intentional Radiators

MET Report: EMC28036-UNII 3

January 25, 2010

Prepared For:

Fortress Technologies
2 Technology Park Drive
Westford, MA 01886

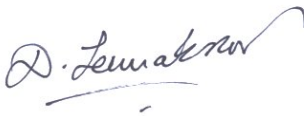
Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Ave.
Baltimore, MD 21230

Electromagnetic Compatibility Criteria
Test Report

for the

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

the Certification Rules
contained in
Title 47 of the CFR, Part 15.407
and
Industry Canada RSS-210, Annex 9
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 Part 15.407, of the FCC Rules and RSS-210 Annex 9 of the Industry Canada Rules under normal use and maintenance.

Shawn McMillen, Wireless Manager
Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	January 25, 2010	Initial Issue.

Table of Contents

List of Tables

List of Figures

List of Photographs

List of Plots

List of Terms and Abbreviations

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

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Fortress Technologies Vehicle Mesh Point ES820 (containing M25 and M5 Radios), with the requirements of FCC Part §15.407 and Industry Canada RSS-210 Annex 9. 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 (containing 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 (containing 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 FCC Part §15.407 and Industry Canada RSS-210, Annex 9, in accordance with Fortress Technologies, quote number 1FOR0910R1. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference	Industry Canada Reference	Description	Results
15.203	RSS-GEN 7.1.4	Antenna Requirements	Compliant
15.207	RSS-GEN 7.2.2; RSS-210 2.2	AC Conducted Emissions 150KHz – 30MHz	Compliant
15.403 (i)	A8.2	26dB Occupied Bandwidth	Compliant
15.407 (a)(3)	A9.2(3)	Conducted Transmitter Output Power	Compliant
15.407 (a)(3)	A9.2(3)	Power Spectral Density	Compliant
15.407 (a)(6)	N/A	Peak Excursion	Compliant
15.407 (b)(4), (6)	A9.3(4)	Undesirable Emissions (15.205/15.209 - General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Compliant
15.407(f)	RSS-GEN	RF Exposure	Compliant
15.407(g)	2.1	Frequency Stability	Compliant
N/A	RSS-Gen(4.8)	Receiver Spurious Emissions	Compliant

Table 1. Executive Summary of EMC Part 15.407 & RSS-210 Annex 9 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Fortress Technologies to perform testing on the Vehicle Mesh Point ES820 (containing M25 and M5 Radios), under Fortress Technologies' quote 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 (containing M25 and M5 Radios).

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

Model(s) Tested:	Vehicle Mesh Point ES820 (containing M25 and M5 Radios)		
Model(s) Covered:	Vehicle Mesh Point ES820 (containing M25 and M5 Radios)		
EUT Specifications:	Primary Power: 120 VAC, 60 Hz		
	FCC ID: WYK-ES820 IC ID: 8190A-ES820		
	Type of Modulations:	OFDM	
	Emission Designators:	D7D	
	Equipment Code:	NII	
	Peak RF Output Power:	M25	34.35 mW
		M5	60.39 mW
	EUT Frequency Ranges:	5745-5805 MHz	
Analysis:	The results obtained relate only to the item(s) tested.		
Environmental Test Conditions:	Temperature: 15-35º C		
	Relative Humidity: 30-60%		
	Barometric Pressure: 860-1060 mbar		
Evaluated by:	Dusmantha Tennakoon		
Report Date(s):	January 25, 2010		

Table 2. EUT Summary

B. References

RSS-210, Issue 7, June 2007	Low-power License-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment
CFR 47, Part 15, Subpart E	Unlicensed National Information Infrastructure Devices (UNII)
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 (containing M25 and M5 Radios), Equipment Under Test (EUT), is a dual radio access point/bridge. It embeds two COTS high power radios 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.

Photograph 1. Front View of EUT

Photograph 2. Rear View of EUT

E. Equipment Configuration

All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Serial Number
1	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 (containing M25 and M5 Radios).

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.

III. Electromagnetic Compatibility Criteria for Intentional Radiators – M25

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 unit is professionally installed. Therefore, the EUT as tested is compliant with the criteria of §15.203.

Frequency	Gain/Model	Manufacturer
5 GHz	9 dBi / EC09-5500	Mobile Mark Communications

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/03/09

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 non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. 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 C63.4-1992 "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.

Test Results: The EUT was compliant with the Class A requirement(s) of this section. Pre-scans revealed that emissions profiles and amplitudes of emissions were similar when the EUT was transmitting on low, mid and high channels. Therefore, final measurements were taken when the EUT was transmitting on high channel (i.e. 5805 MHz)

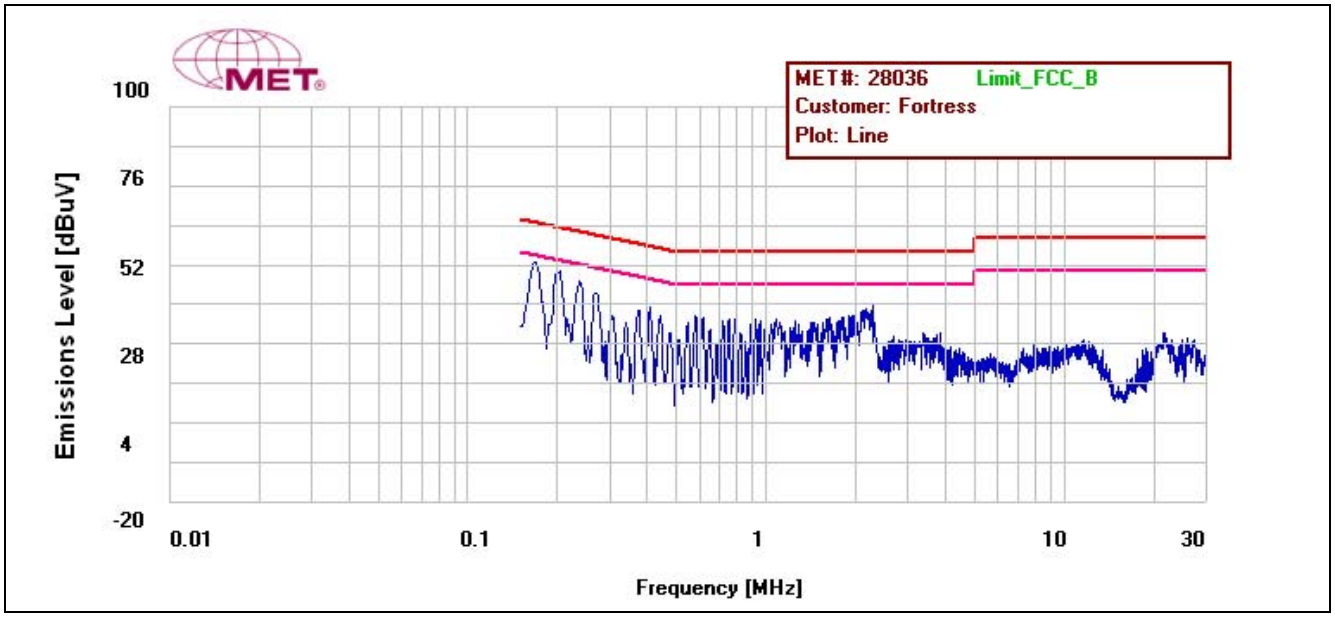
Test Engineer(s): Anderson Soungpanya

Test Date(s): 11/24/09

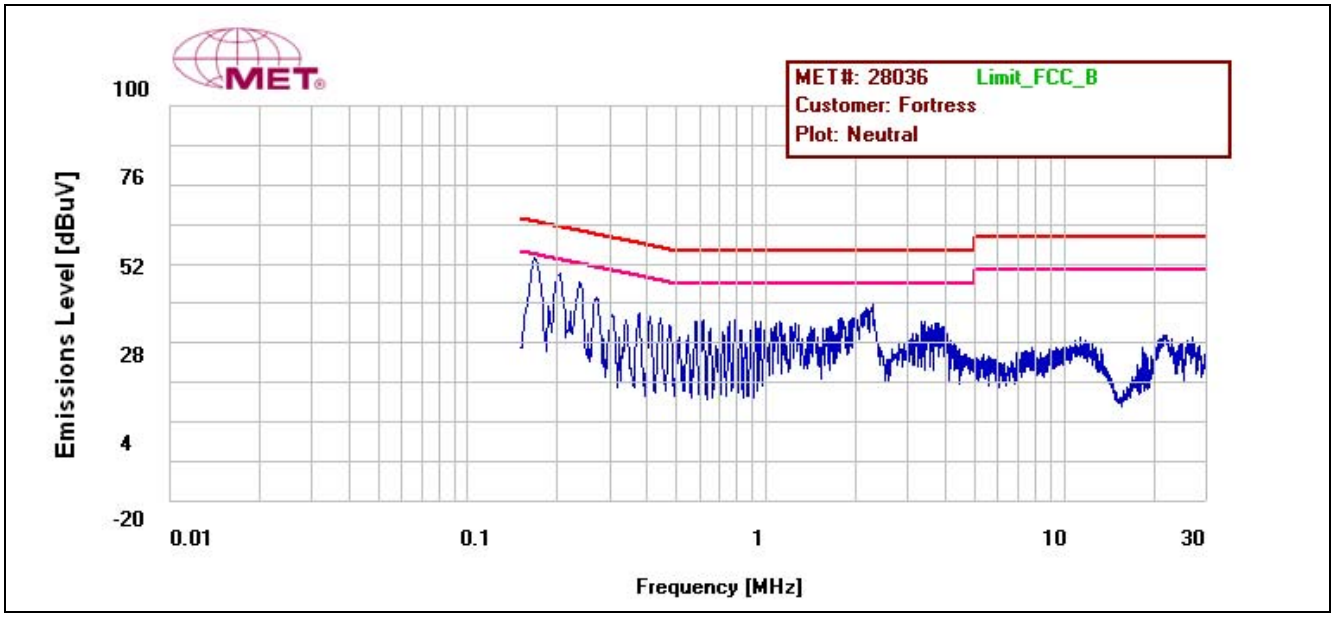
Conducted Emissions - Voltage, AC Power, (120V/60Hz)

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line	.169	51.96	65.012	-13.052	Pass	43.66	55.012	-11.352	Pass
Line	.204	49.33	63.453	-14.123	Pass	44.43	53.453	-9.023	Pass
Line	2.24	36.64	56	-19.36	Pass	23.51	46	-22.49	Pass
Neutral	.170	52.95	64.963	-12.013	Pass	43.35	54.963	-11.613	Pass
Neutral	.203	48.34	63.494	-15.154	Pass	41.74	53.494	-11.754	Pass
Neutral	2.24	38.13	56	-17.87	Pass	30.45	46	-15.55	Pass

Table 7. Conducted Emissions - Voltage, AC Power, M25 Radio

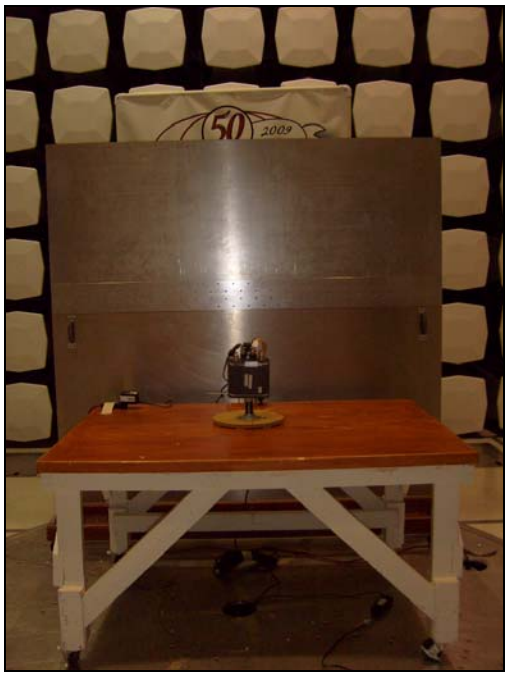


Plot 1. Conducted Emission, Phase Line Plot, M25 Radio

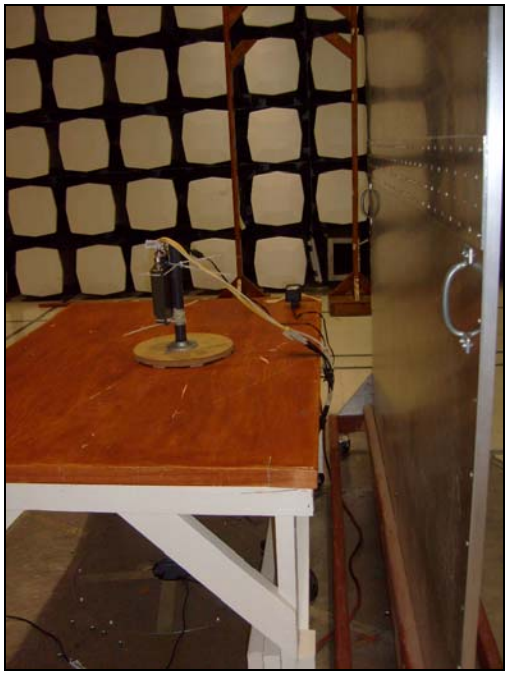


Plot 2. Conducted Emission, Neutral Line Plot, M25 Radio

Conducted Emission Limits Test Setup



Photograph 3. Conducted Emissions, Test Setup, M25 Radio



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

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 403(c) 26dB Bandwidth – M25 Radio

Test Requirements: **§ 15.403 (i):** For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

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

Test Results The 26 dB Bandwidth was compliant with the requirements of this section and was determined from the plots on the following pages.

Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
5745	16.7899	25.302
5785	16.7548	25.160
5805	16.8276	25.305

Table 8. Occupied Bandwidth, Test Results, M25 Radio

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/03/09

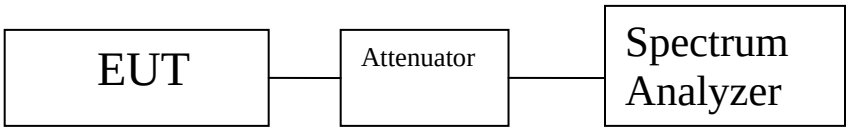
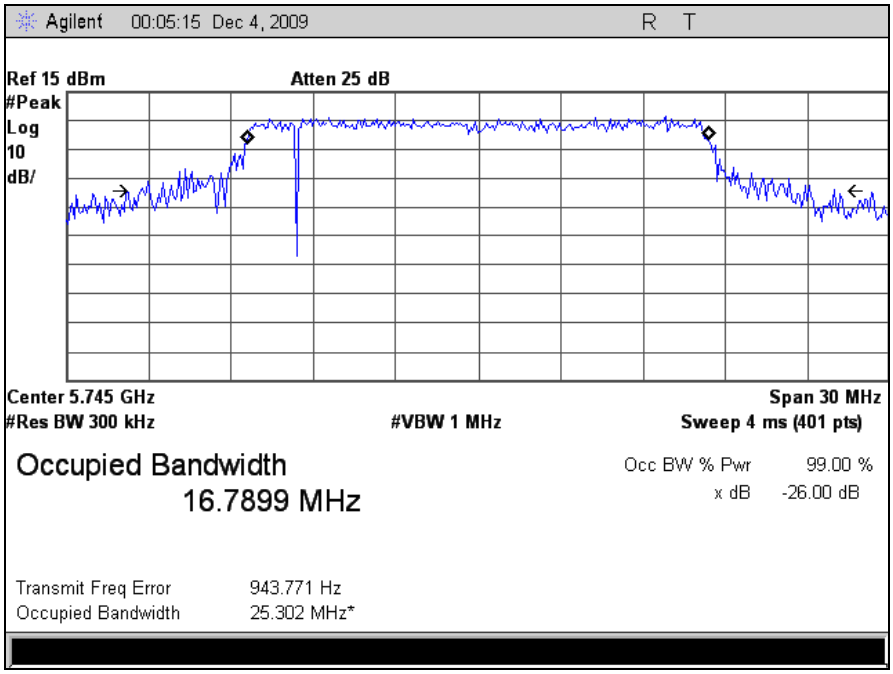
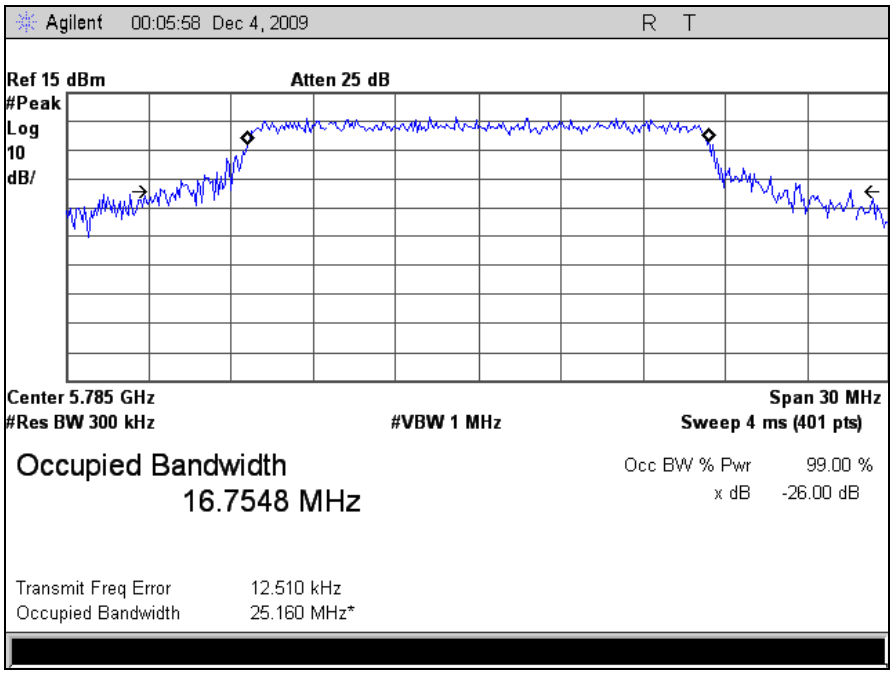


Figure 1. Occupied Bandwidth, Test Setup

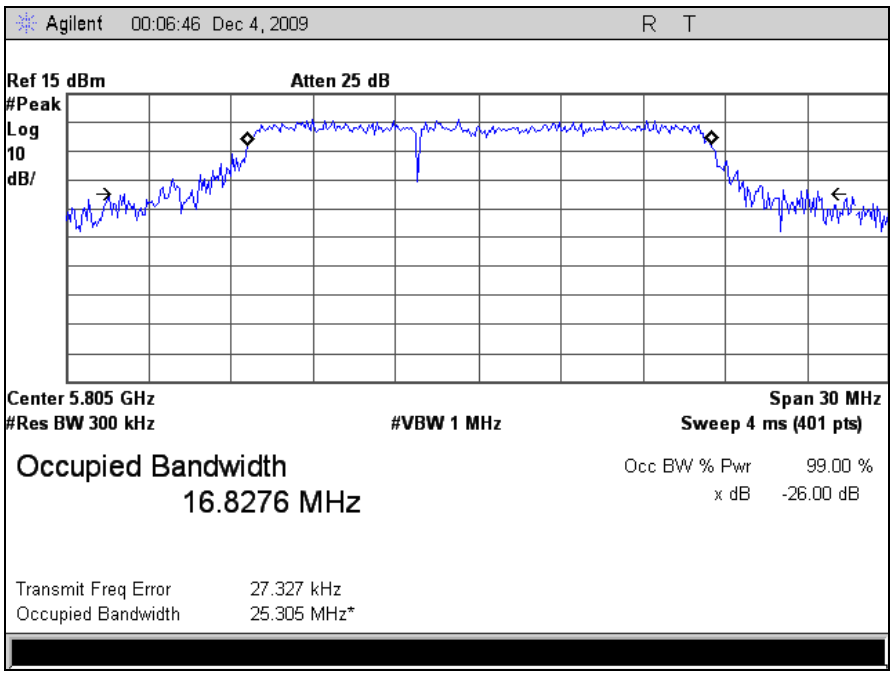
Occupied Bandwidth Test Results



Plot 3. Occupied Bandwidth, 5745 MHz, M25 Radio



Plot 4. Occupied Bandwidth, 5785 MHz, M25 Radio



Plot 5. Occupied Bandwidth, 5805 MHz, M25 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 407(a)(3) RF Power Output – M25

Test Requirements: **§15.407(a) (3):** The maximum output power of the intentional radiator shall not exceed the following:

Digital Transmission Systems (MHz)	Output Limit
5150-5250	50mW
5250-5350	250mW
5470–5725	250mW
5725–5825	1W

Table 9. Output Power Requirements from §15.407

§15.407(a) (3): For the band 5.725–5.825 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 1 W or 17 dBm + 10 log B, where B is the 26-dB emission bandwidth in MHz.

Test Procedure: The EUT was connected to a Spectrum Analyzer. The power was measured on three channels.

Test Results: Equipment was compliant with the Peak Power Output limits of **§ 15.401(a)(2)**.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/03/09

Frequency (MHz)	Conducted Power (dBm)	Conducted Power (mW)	Limit (W)
5745	14.21	26.36	1
5785	15.35	34.35	1
5805	15.26	33.57	1

Table 10. RF Power Output, Test Results, M25 Radio

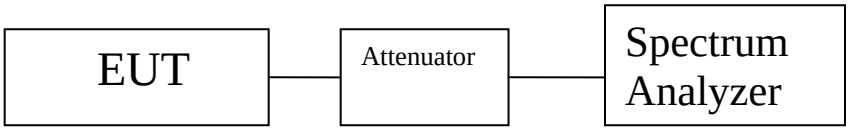
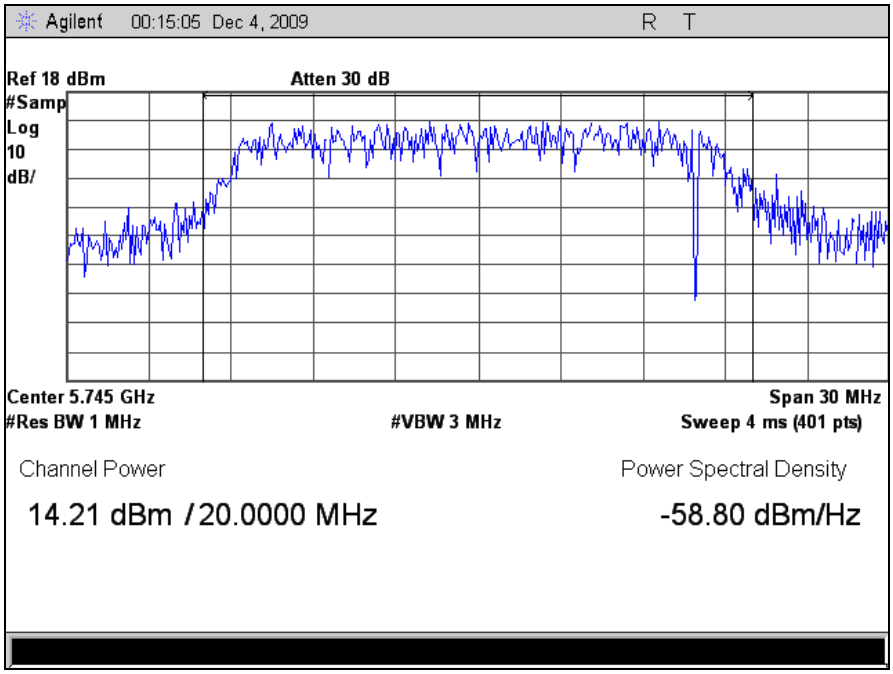
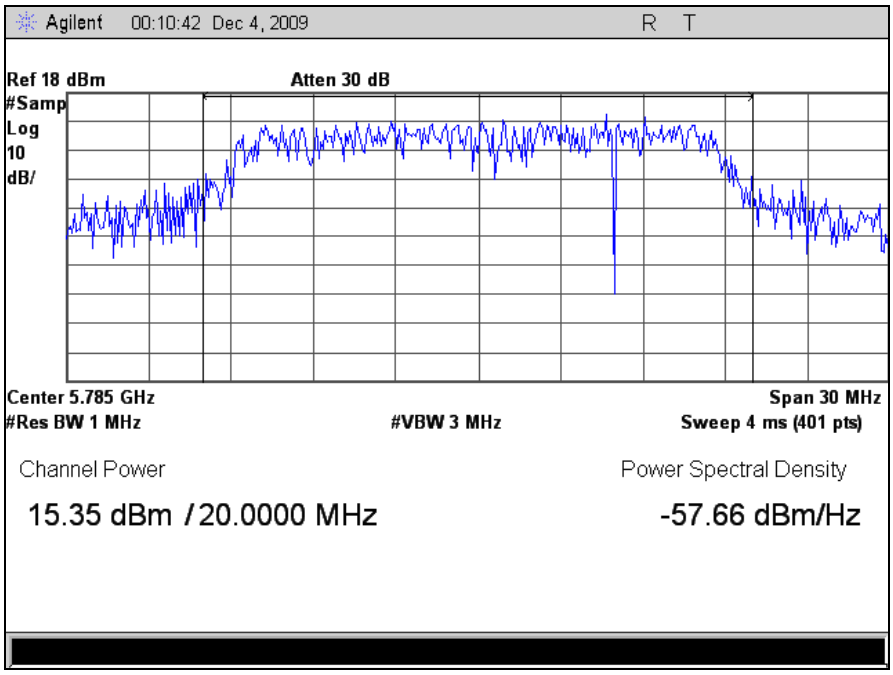


Figure 2. Power Output Test Setup

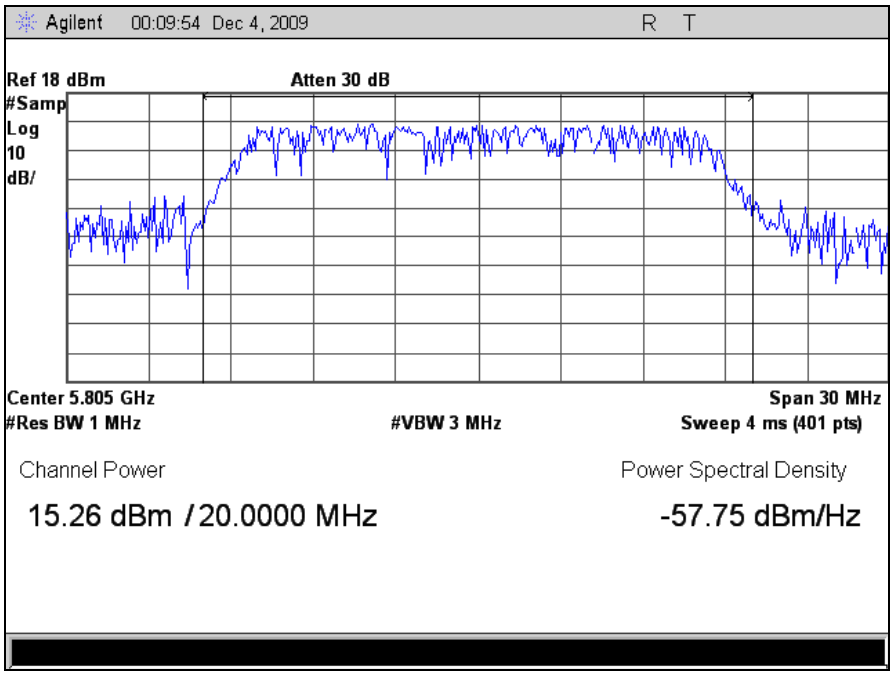
RF Output Power Test Results



Plot 6. RF Power Output, 5745 MHz, M25 Radio



Plot 7. RF Power Output, 5785 MHz, M25 Radio



Plot 8. RF Power Output, 5805 MHz, M25 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(a)(3) Peak Power Spectral Density – M25

Test Requirements: **§ 15.407(a)(3):** The peak power spectral density shall not exceed 17 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain up to 23dBi without any corresponding reduction in the transmitter peak output power or peak power spectral density. For fixed, point-to-point U-NII transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in peak transmitter power and peak power spectral density for each 1 dB of antenna gain in excess of 23 dBi would be required. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, Omni directional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level on the EUT. The RBW was set to 1MHz and the VBW was set to 3MHz. The method of measurement #2 from the FCC Public Notice DA 02-2138 was used.

Test Results: Equipment was compliant with the peak power spectral density limits of **§ 15.407 (a)(2).** The peak power spectral density was determined from plots on the following page(s).

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/03/09

Frequency (MHz)	PSD (dBm)
5745	12.40
5785	12.68
5805	12.61

Table 11. Power Spectral Density, Test Results, M25 Radio

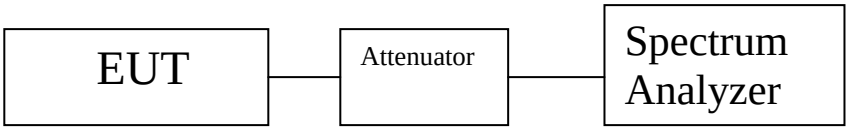
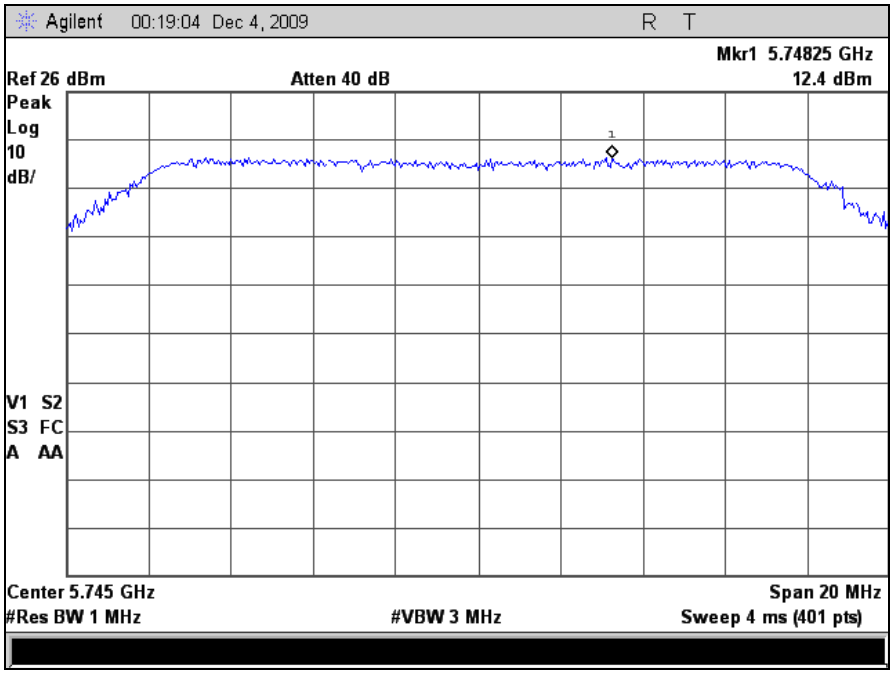
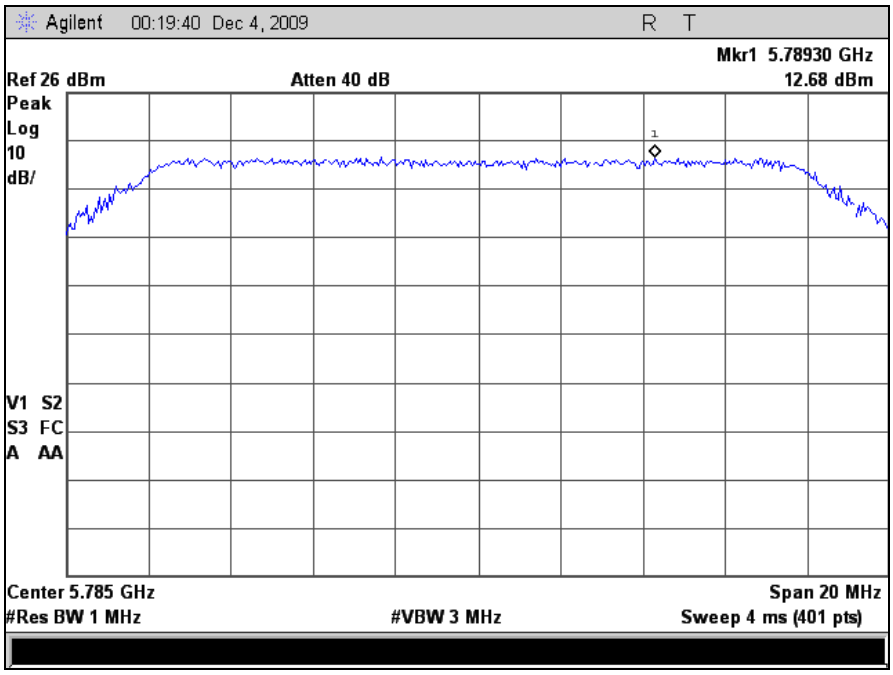


Figure 3. Power Spectral Density Test Setup

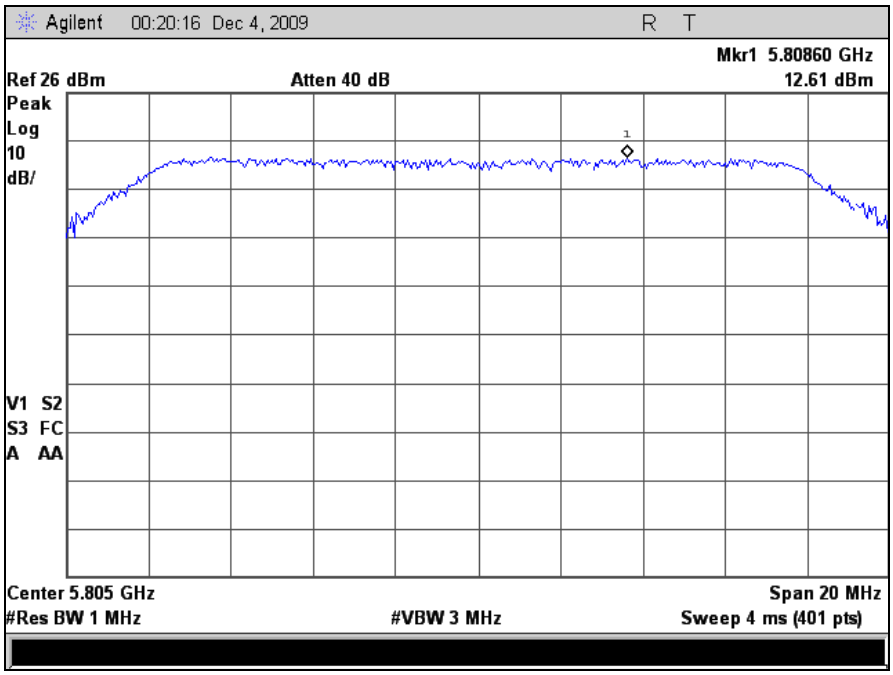
Power Spectral Density Test Results



Plot 9. Power Spectral Density, 5745 MHz, M25 Radio



Plot 10. Power Spectral Density, 5785 MHz, M25 Radio



Plot 11. Power Spectral Density, 5805 MHz, M25 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(a)(6) Peak Excursion Ratio – M25

Test Requirements: **§ 15.407(a)(6):** The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

Test Procedure: The EUT was connected directly to the spectrum analyzer through cabling and attenuation. The 1st trace on the spectrum analyzer was set to RBW=1MHz, VBW=3MHz. The peak detector mode was used and the trace max held. The 2nd trace on the spectrum analyzer was set according to measurement method #1 from the FCC Public Notice DA 02-2138 for making conducted power measurements.

Test Results: Equipment was compliant with the peak excursion ratio limits of **§ 15.407(a)(6).** The peak excursion ratio was determined from plots on the following page(s).

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/03/09

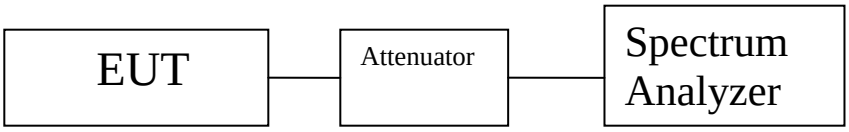
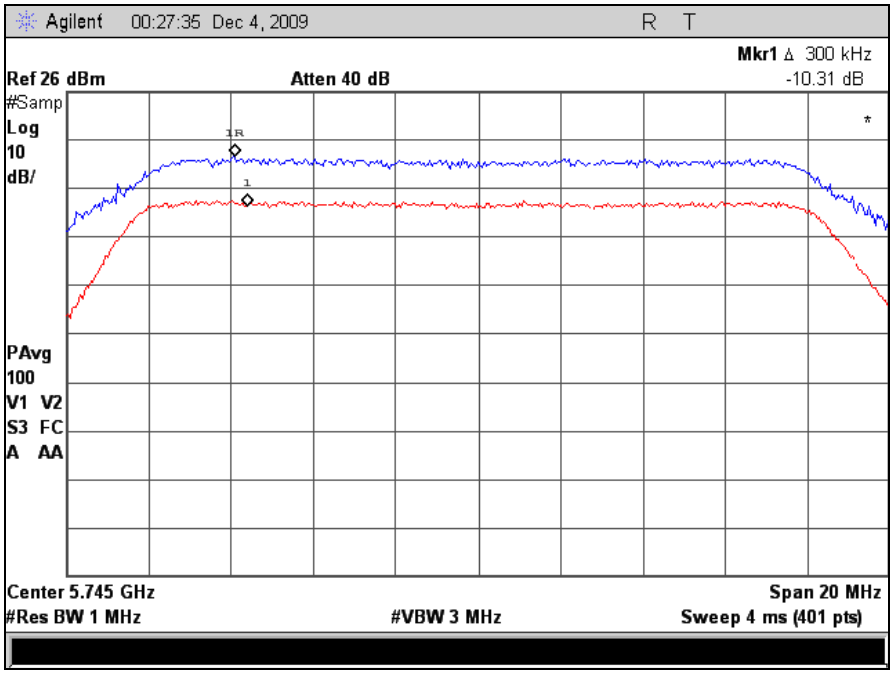
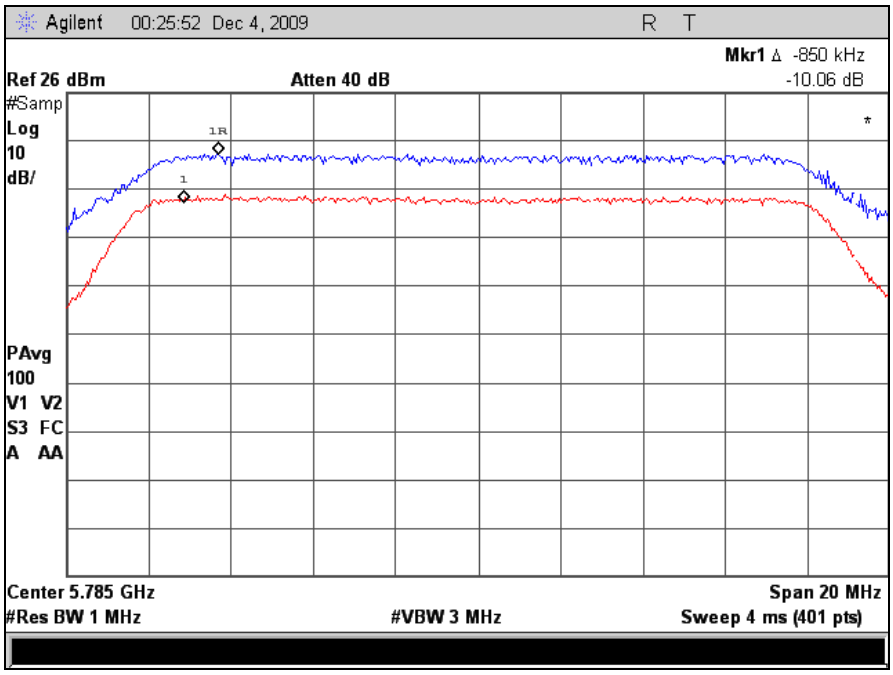


Figure 4. Peak Excursion Ration Test Setup

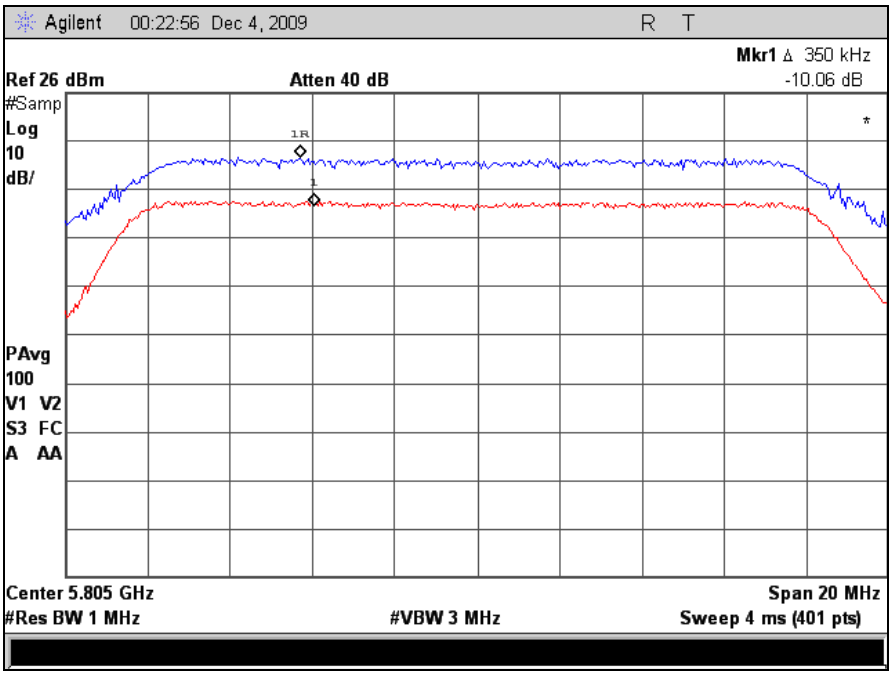
Peak Excursion Test Results



Plot 12. Peak Excursion Ratio, 5745 MHz, M25 Radio



Plot 13. Peak Excursion Ratio, 5785 MHz, M25 Radio



Plot 14. Peak Excursion Ratio, 5805 MHz, M25 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(b) Undesirable Emissions – M25

Test Requirements: **§ 15.407(b)(4), (b)(6), (b)(7), §15.205:** Emissions outside the frequency band.

§ 15.407(b)(4): For transmitters operating in the 5.725–5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of –17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of –27 dBm/MHz.

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

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

Test Procedure: The transmitter was placed on an acrylic stand inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast height to determine worst case orientation for maximum emissions.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

For measurements above 1 GHz, measurements were made with a Peak detector with 1 MHz resolution bandwidth. Where the spurious emissions fell into a restricted band, measurements were also made with an average detector to make sure they complied with 15.209 limits. Emissions were explored up to 40 GHz.
The equation, **EIRP= E + 20 log D – 104.8** was used to convert an EIRP limit to a field strength limit.
E = field strength (dBuV/m)
D = Reference measurement distance (m)

Test Results: The EUT was compliant with the Radiated Emission limits for Intentional Radiators. See following pages for detailed test results.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/22/09

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(b)(4): Harmonic and Spurious Emissions Requirements – Radiated

Channel (MHz)	Frequency (GHz)	Measured value (corrected) @ 1m dBuV/m	Limit @ 1m	Margin	Remark
5745	5.167	77.17	77.8	-0.63	Peak
	5.3623	61.97	63.5	-1.53	Avg
	5.3639	75.23	83.5	-8.27	Peak
	6.5307	71.16	77.8	-6.64	Peak
	17.945	68	77.8	-9.8	Peak
5785	5.1575	77.4	77.8	-0.4	Peak
	5.3619	61.86	63.5	-1.64	Avg
	5.4536	75.94	83.5	-7.56	Peak
	6.6545	71.06	77.8	-6.74	Peak
	17.89	67.86	77.8	-9.94	Peak
5805	5.1575	77.03	77.8	-0.77	Peak
	5.3577	62.03	63.5	-1.47	Avg
	5.3639	77.38	83.5	-6.12	Peak
	5.8443	72.79	77.8	-5.01	Peak
	17.8625	67.69	77.8	-10.11	Peak

Table 12. Radiated Spurs, Test Results, M25 Radio

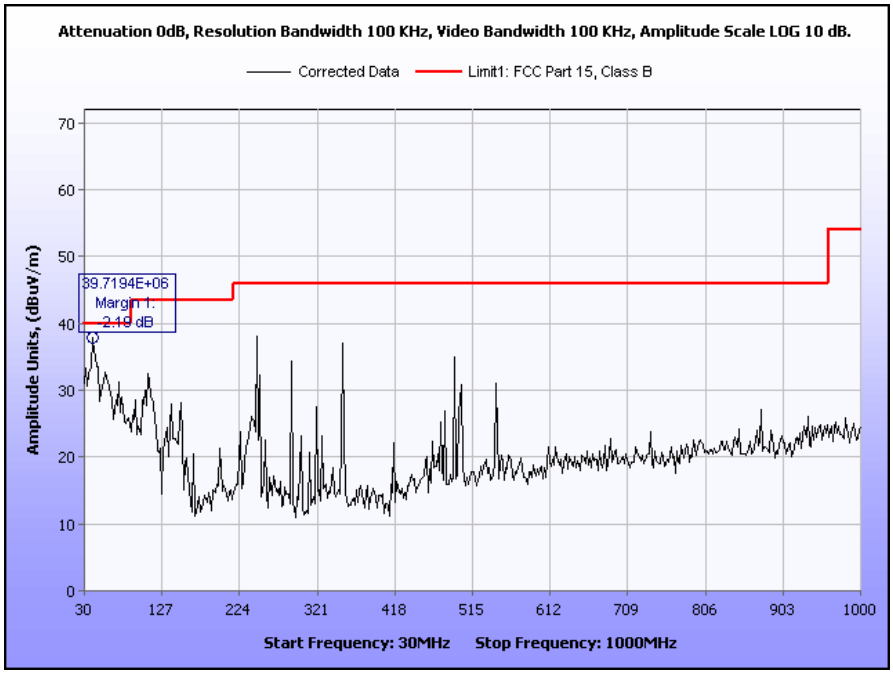
Note: All other emissions were measured at the noise floor of the spectrum analyzer.

Limit Calculations:

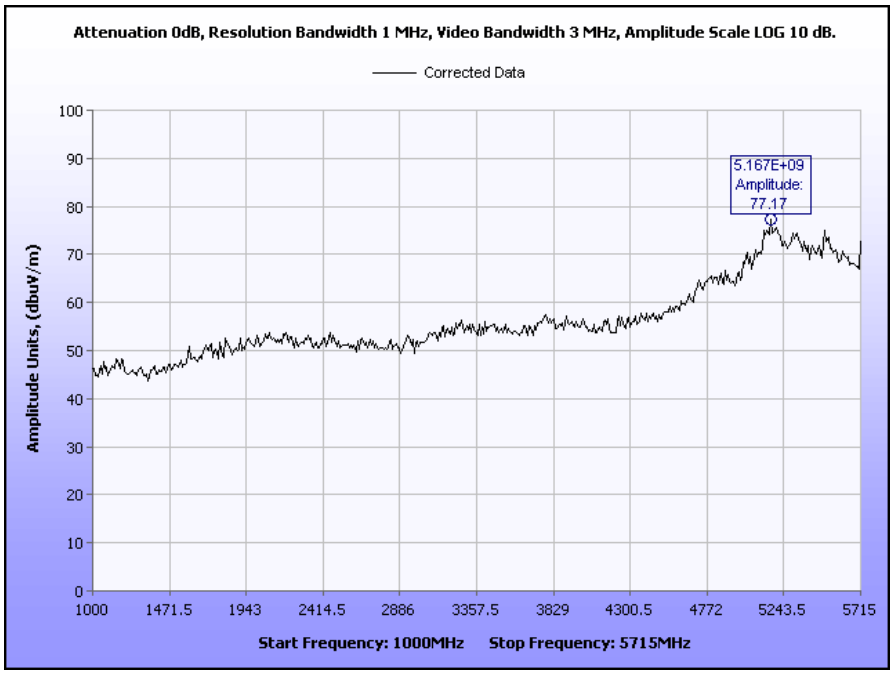
-27 dBm/MHz
EIRP = E0 + 20log (D) – 104.8
E0 = -27+104.8 (measurements made at 1m)
E0 =77.8 dBuV/m

-17 dBm/MHz:
EIRP = E0 + 20log (D) – 104.8
E0 = -17+104.8 (measurements made at 1m)
E0 = 87.8 dBuV/m

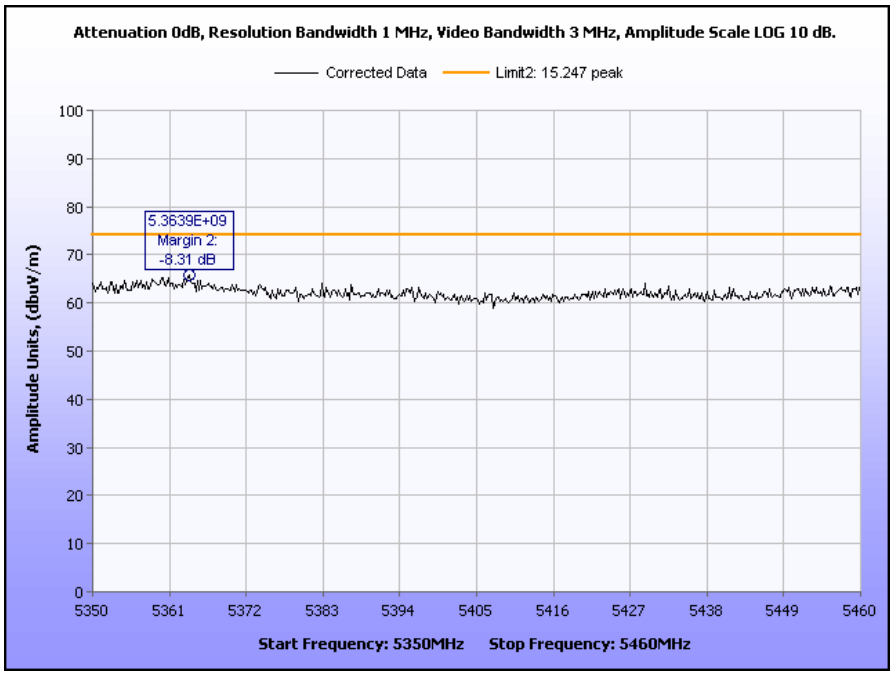
Radiated Spurious Emissions Test Results



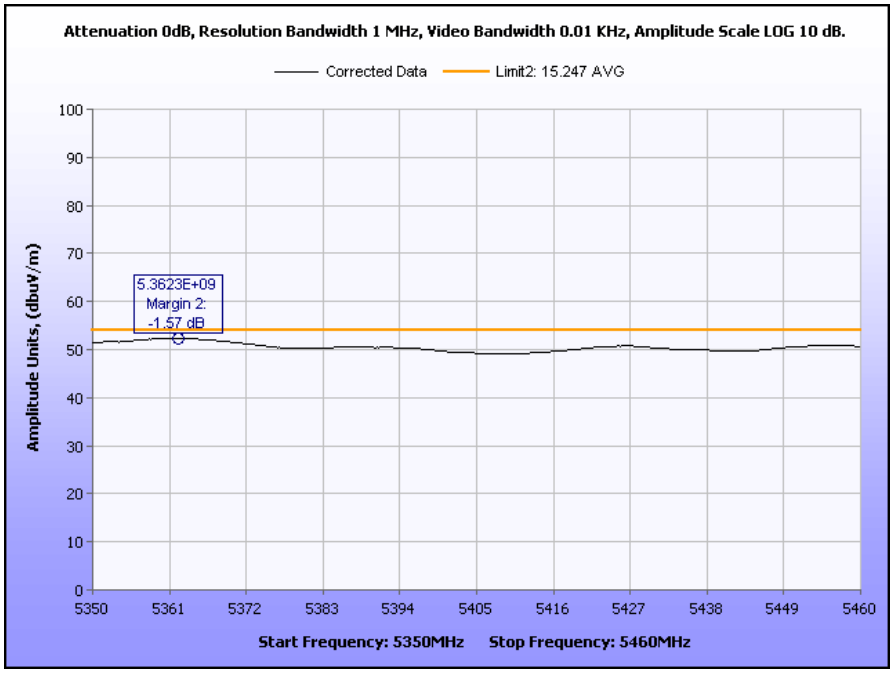
Plot 15. Radiated Spurs, 30 MHz – 1 GHz, Channel 5745 MHz, M25 Radio



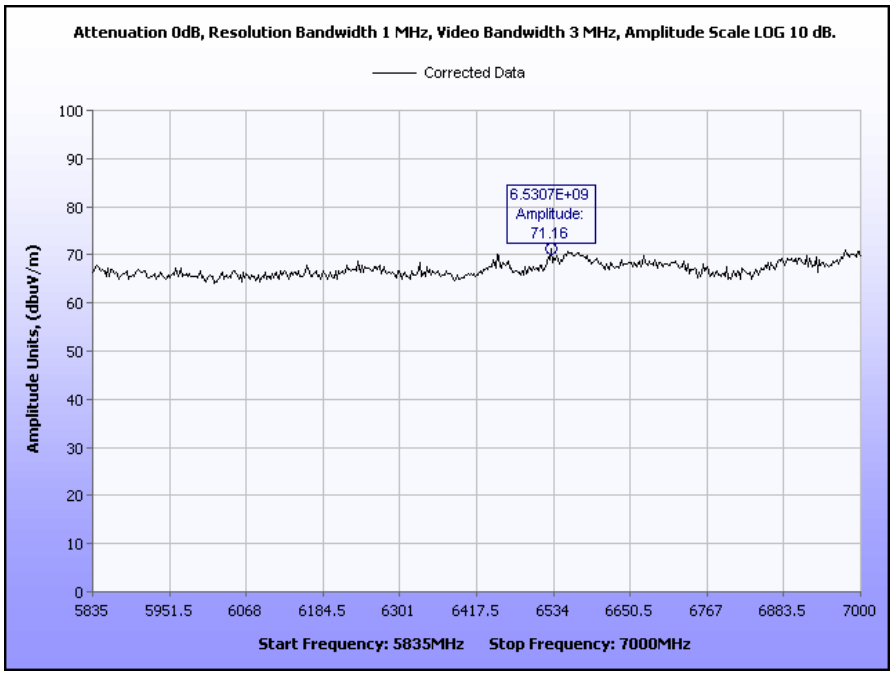
Plot 16. Radiated Spurs, 1 GHz – 5.715 GHz, Channel 5745 MHz, M25 Radio



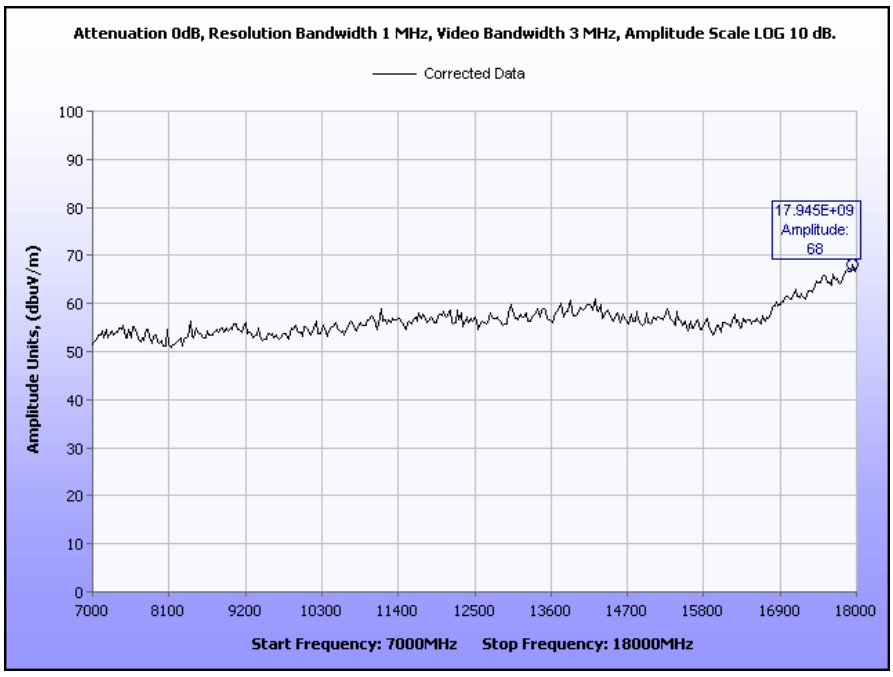
Plot 17. Radiated Spurs, 5.35 GHz – 5.46 GHz, Peak, Channel 5745 MHz, M25 Radio



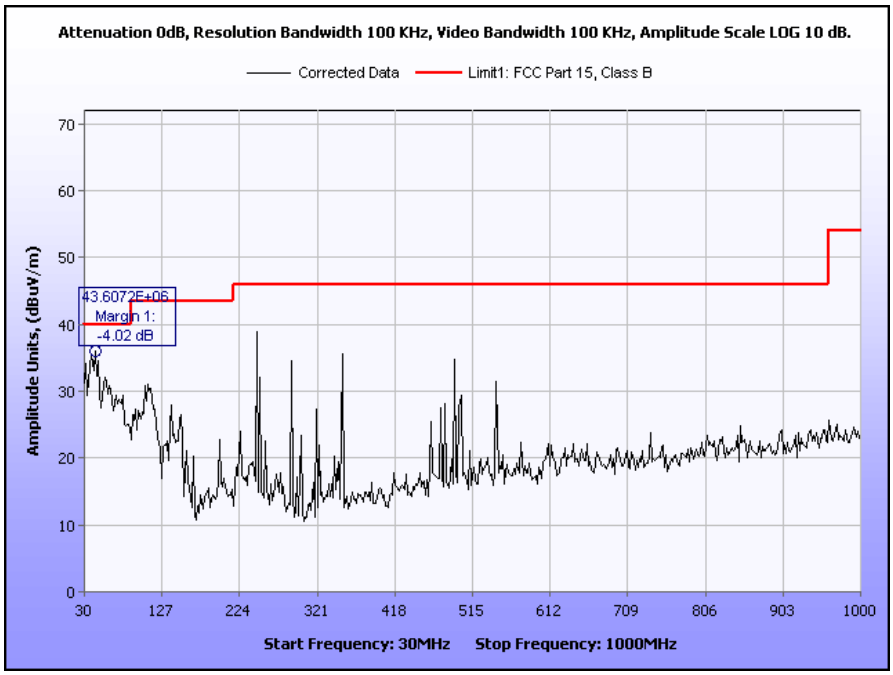
Plot 18. Radiated Spurs, 5.35 GHz – 5.46 GHz, Average, Channel 5745 MHz, M25 Radio



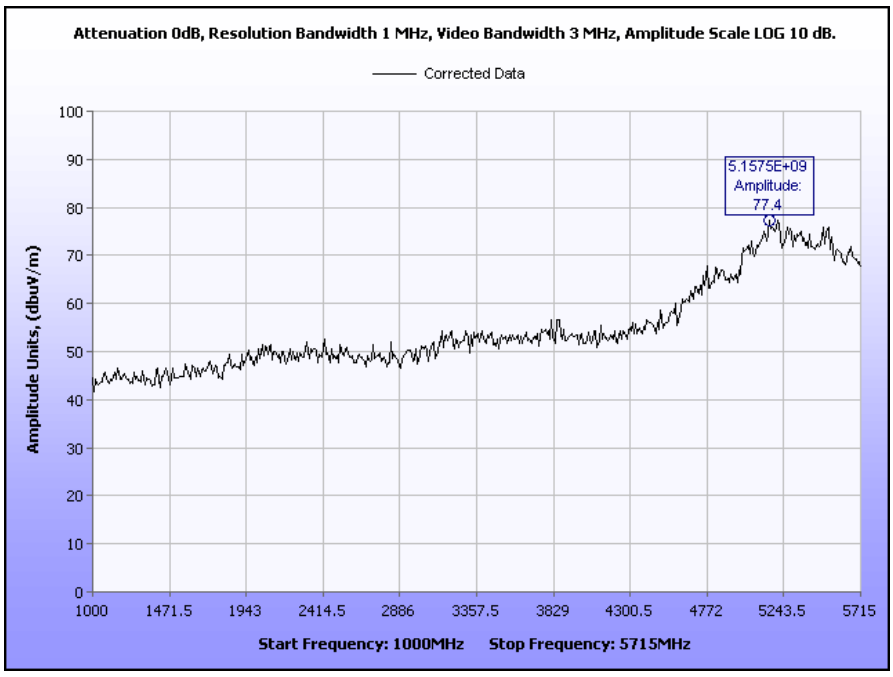
Plot 19. Radiated Spurs, 5.835 GHz – 7 GHz, Channel 5745 MHz, M25 Radio



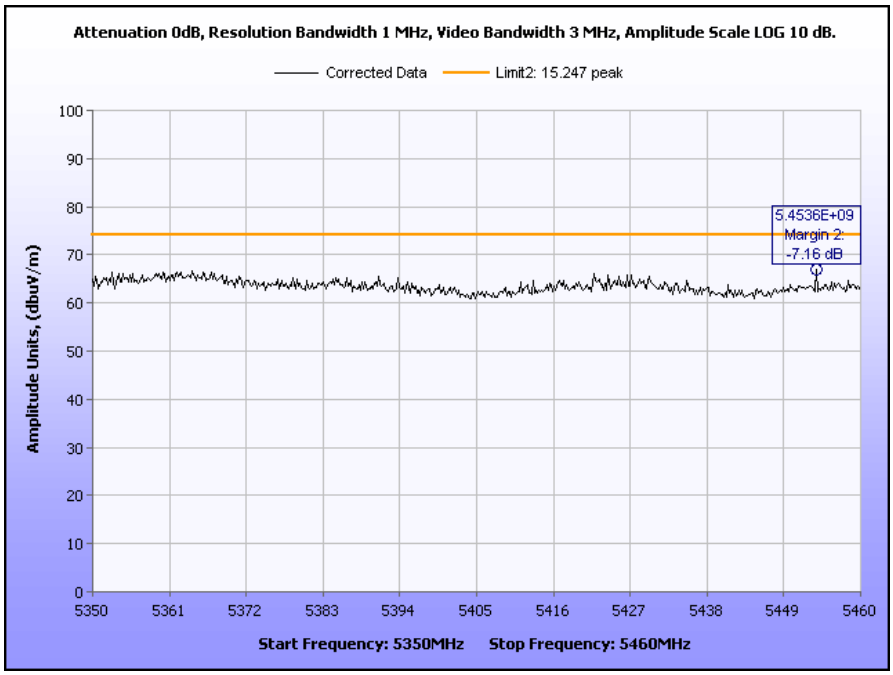
Plot 20. Radiated Spurs, 7 GHz – 18 GHz, Channel 5745 MHz, M25 Radio



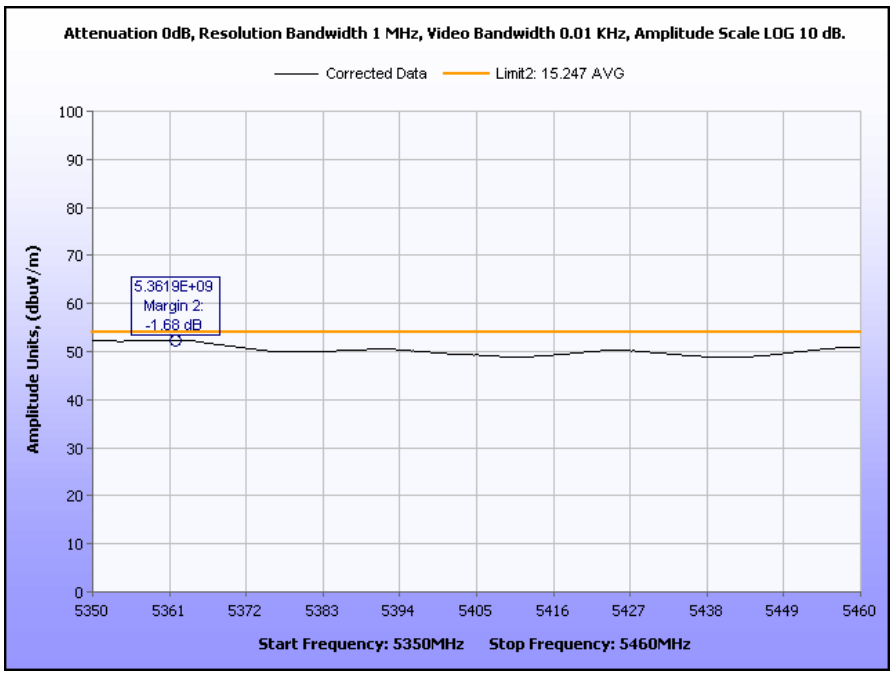
Plot 21. Radiated Spurs, 30 MHz – 1 GHz, Channel 5785 MHz, M25 Radio



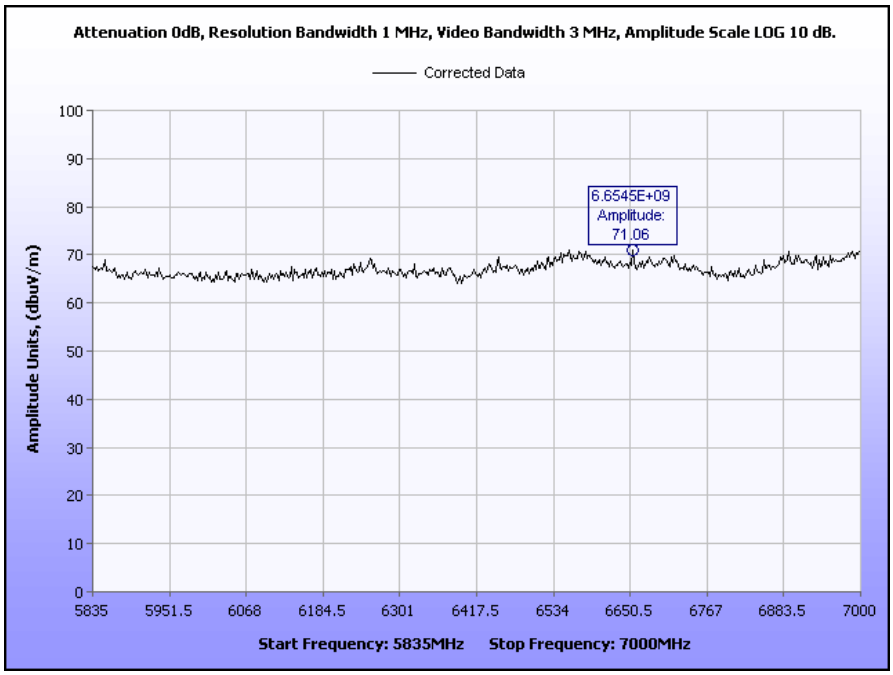
Plot 22. Radiated Spurs, 1 GHz – 5.715 GHz, Channel 5785 MHz, M25 Radio



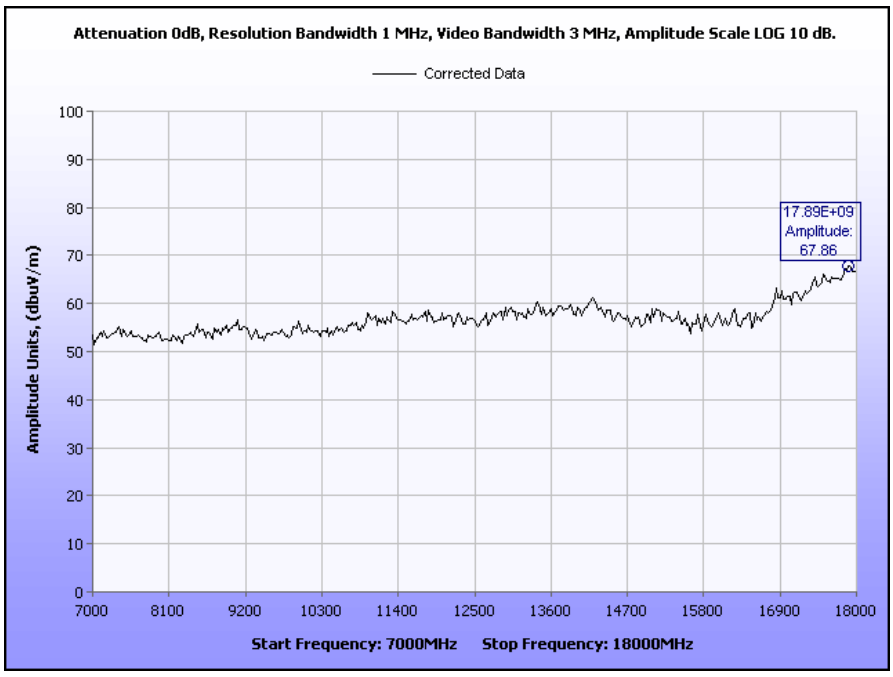
Plot 23. Radiated Spurs, 5.35 GHz – 5.46 GHz, Peak, Channel 5785 MHz, M25 Radio



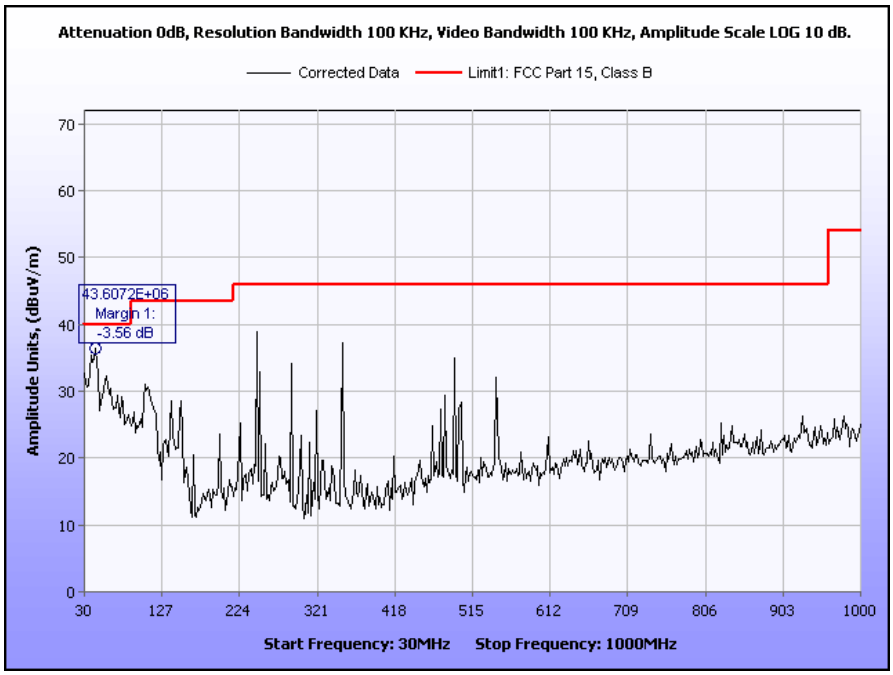
Plot 24. Radiated Spurs, 5.35 GHz – 5.46 GHz, Avg, Channel 5785 MHz, M25 Radio



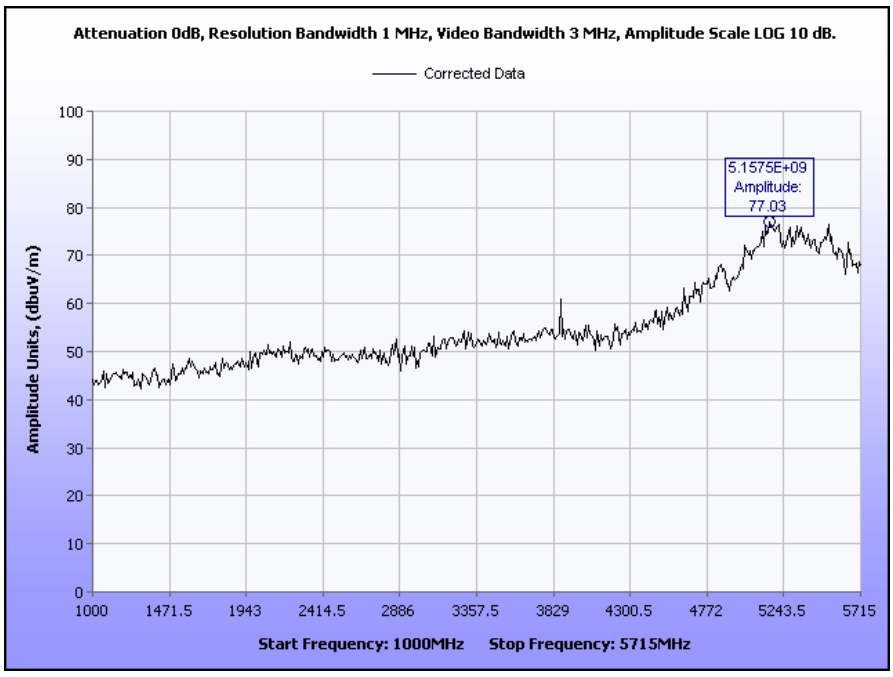
Plot 25. Radiated Spurs, 5.835 GHz – 7 GHz, Channel 5785 MHz, M25 Radio



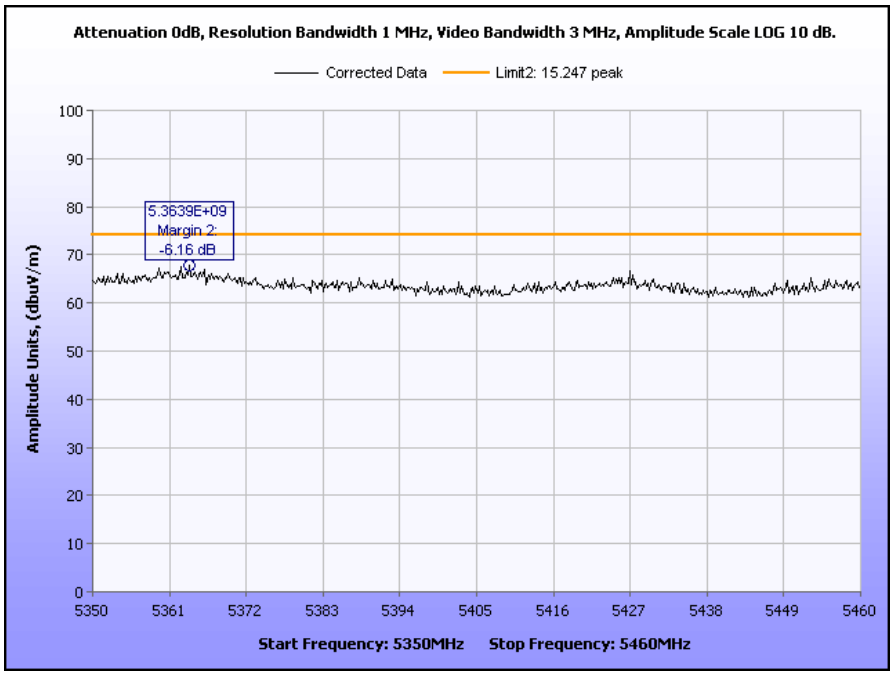
Plot 26. Radiated Spurs, 7 GHz – 18 GHz, Channel 5785 MHz, M25 Radio



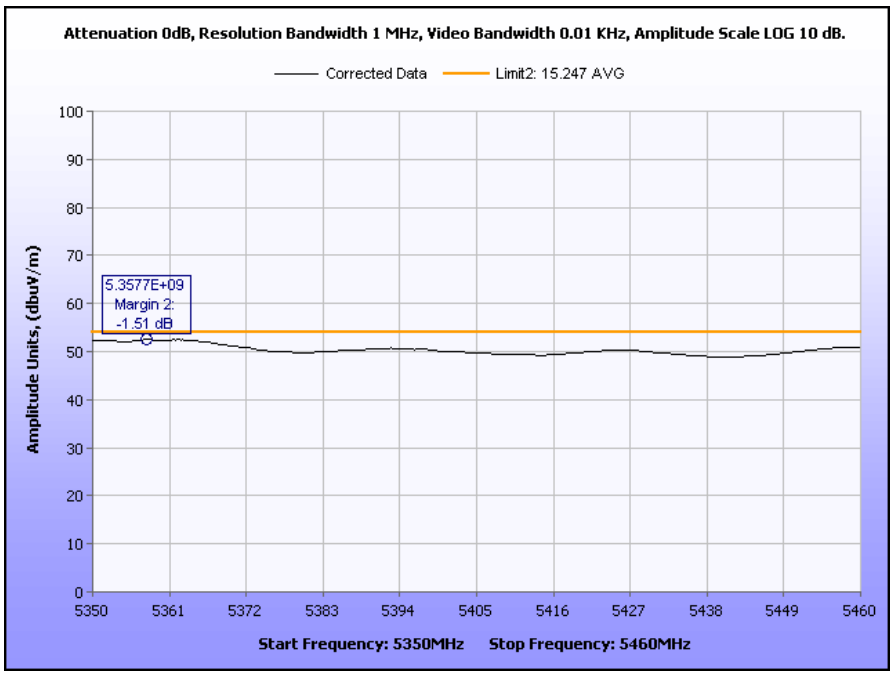
Plot 27. Radiated Spurs, 30 MHz – 1 GHz, Channel 5805 MHz, M25 Radio



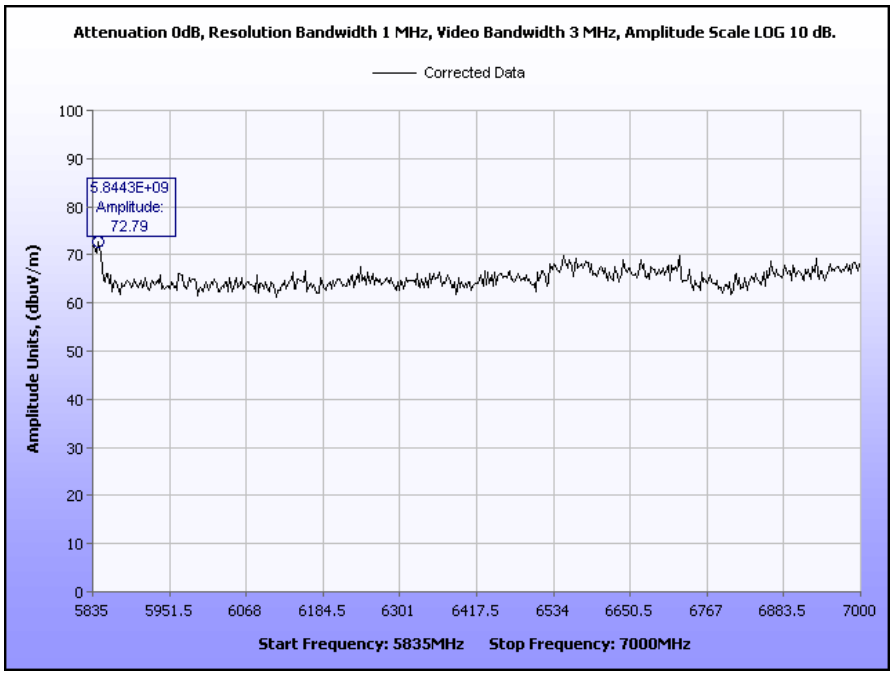
Plot 28. Radiated Spurs, 1 GHz – 5.715 GHz, Channel 5805 MHz, M25 Radio



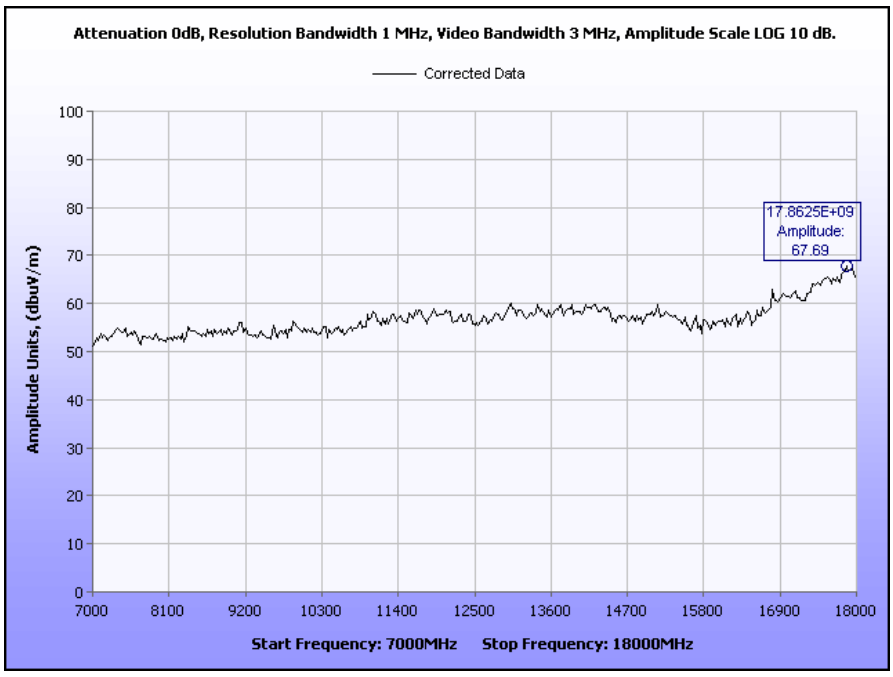
Plot 29. Radiated Spurs, 5.35 GHz – 5.46 GHz, Peak, Channel 5805 MHz, M25 Radio



Plot 30. Radiated Spurs, 5.35 GHz – 5.46 GHz, Avg, Channel 5805 MHz, M25 Radio

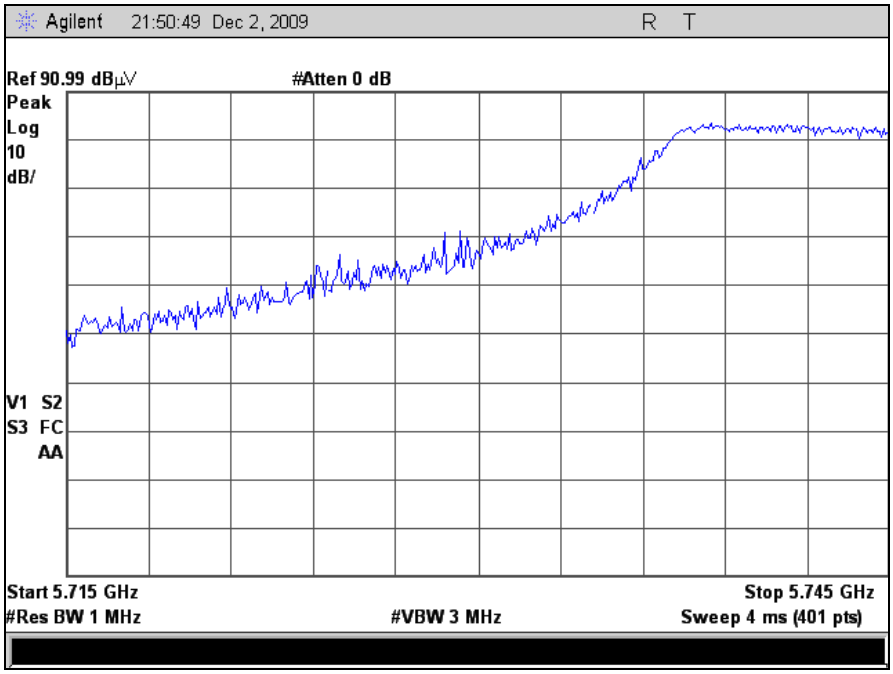


Plot 31. Radiated Spurs, 5.835 GHz – 7 GHz, Channel 5805 MHz, M25 Radio

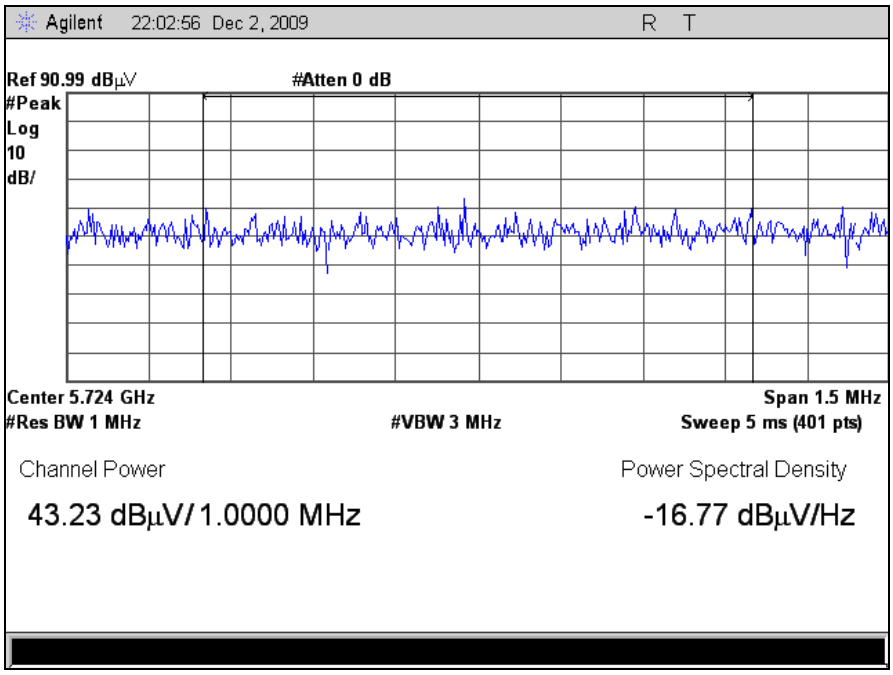


Plot 32. Radiated Spurs, 7 GHz – 18 GHz, Channel 5805 MHz, M25 Radio

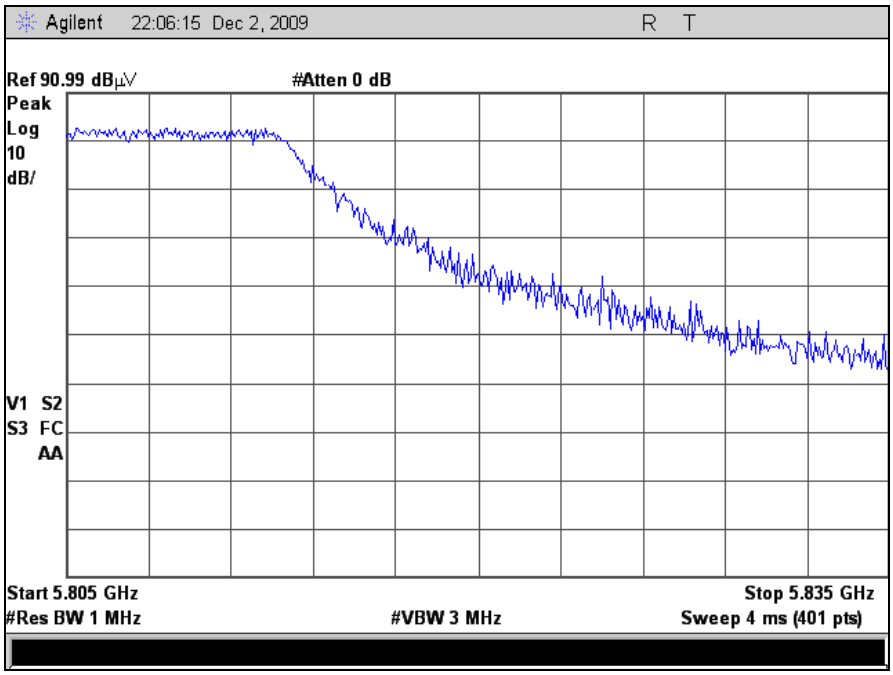
Radiated Band Edge Test Results



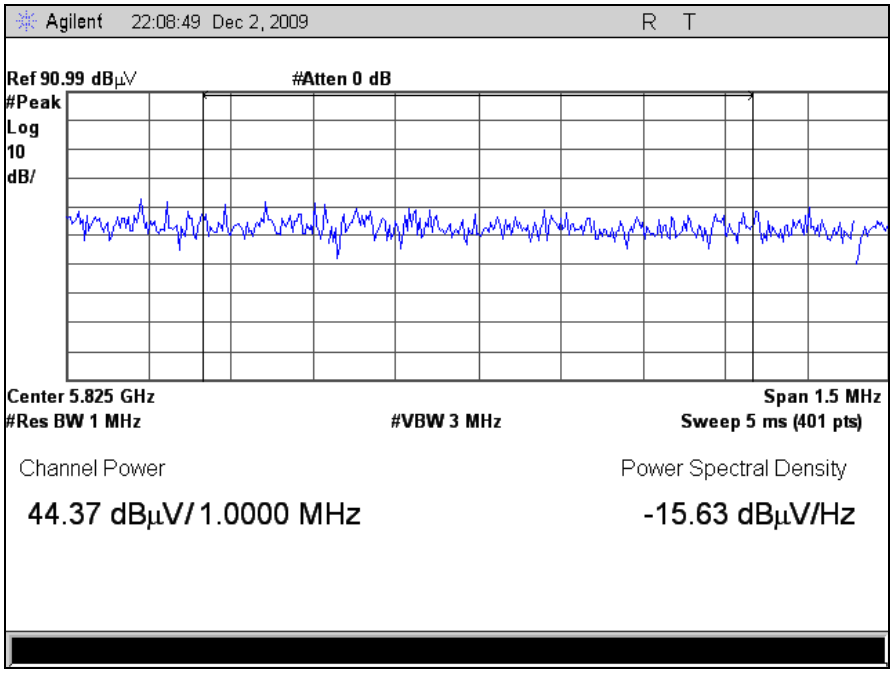
Plot 33. Radiated Band Edge, Lower Channel, 10 MHz Outside Band, M25 Radio



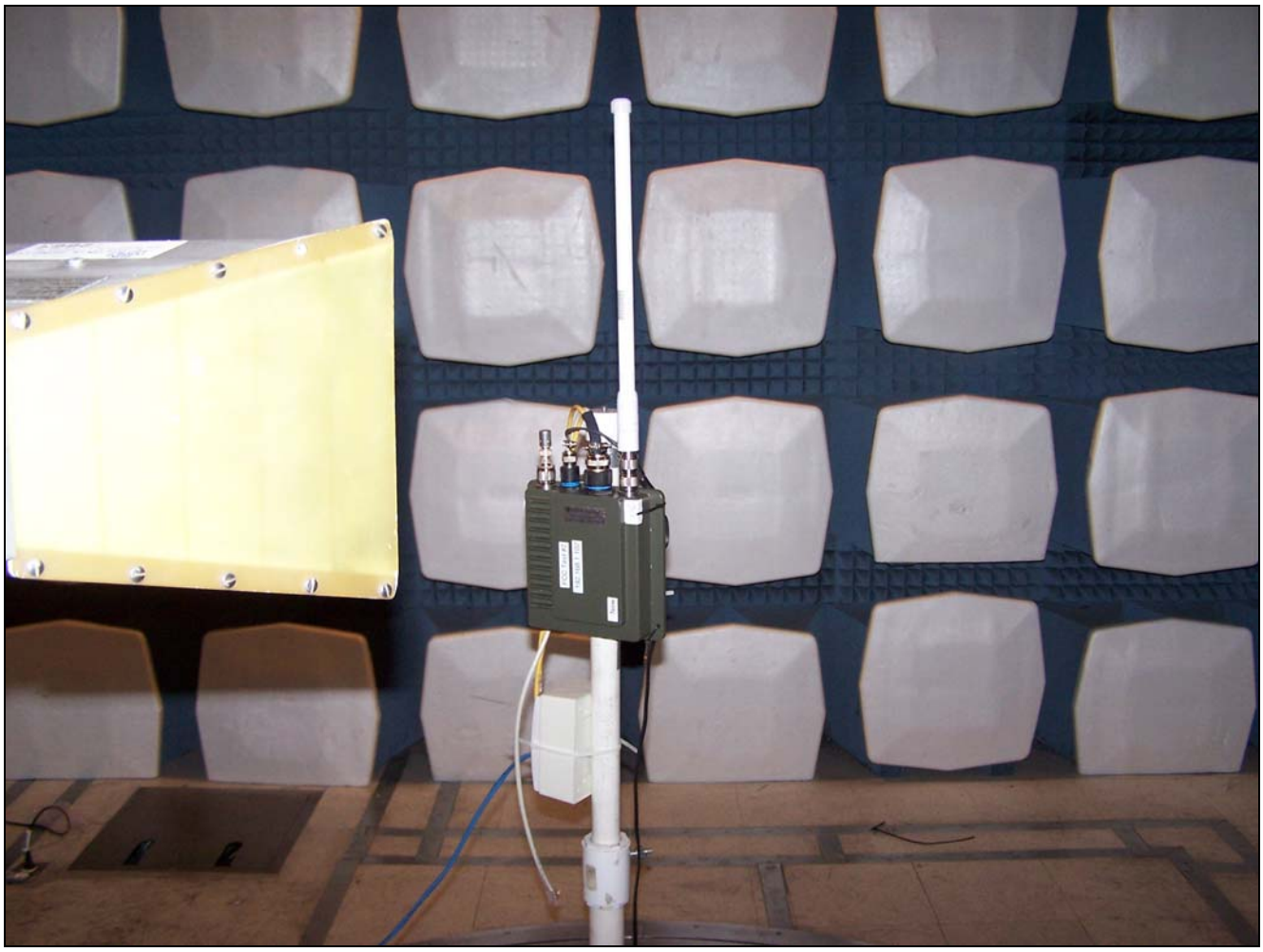
Plot 34. Radiated Band Edge, Lower Channel, 10 MHz Outside Band Integration, M25 Radio



Plot 35. Radiated Band Edge, Upper Channel, 10 MHz Outside Band, M25 Radio



Plot 36. Radiated Band Edge, Upper Channel, 10 MHz Outside Band Integration, M25 Radio



Photograph 5. Radiated Emissions, Test Setup, M25 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(g) Frequency Stability – M25

Test Requirements: **§ 15.407(g):** Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

Test Procedure: The EUT was connected directly to a spectrum analyzer through a attenuator. The resolution band width of the spectrum analyzer was set to 10 KHz. The 1st trace of the Spectrum Analyzer was used as a reference at 20°C. A 2nd trace was used to show the drift of the carrier at extreme conditions. A delta marker was used to find the drift at a given extreme condition.

Test Results: The EUT was compliant with the requirements of **§15.407(g)**.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/22/09

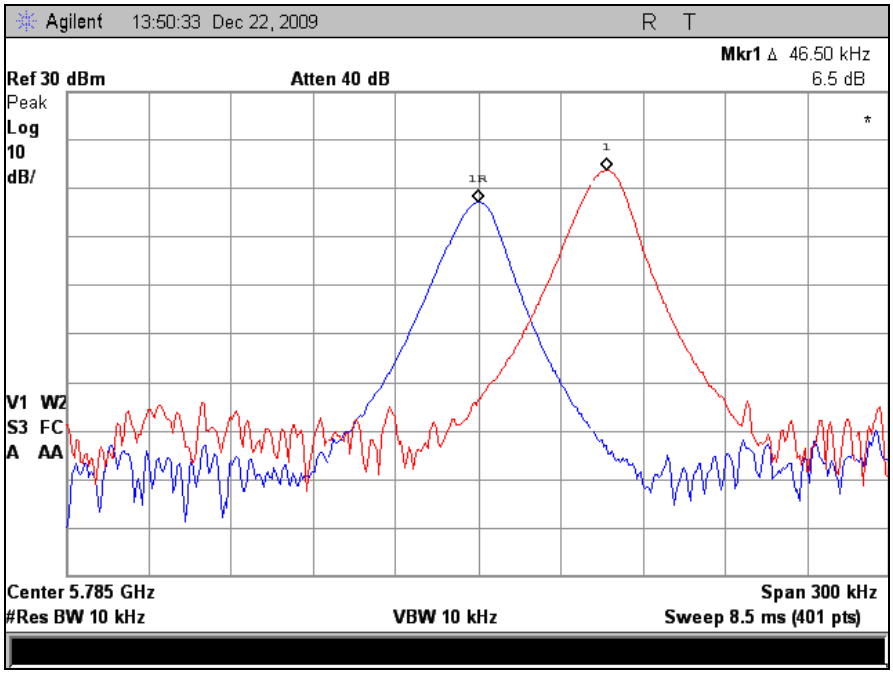
Temperature (centigrade)	Drift (kHz)	Drift (ppm)
55	32.3	5.6
50	27.0	4.7
40	10.5	1.8
30	0.0	0
20	ref	ref
10	3.0	0.5
0	15.0	2.6
-10	24.8	4.3
-20	46.5	8

Table 13. Frequency Stability, Reference 5785 MHz at 20°C, Test Results, M25 Radio

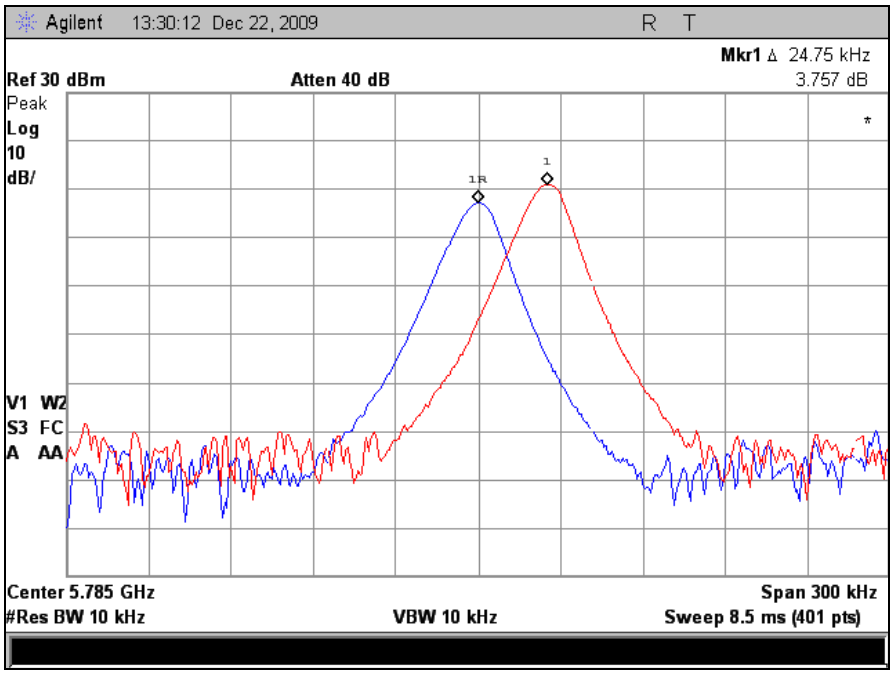
Voltage variation		
Voltage (VAC)	Drift (kHz)	Drift (ppm)
102	0	0
138	-1	-0.2

Table 14. Frequency Stability, Reference 5785 MHz at 120 VAC and 20°C, Test Results, M25 Radio

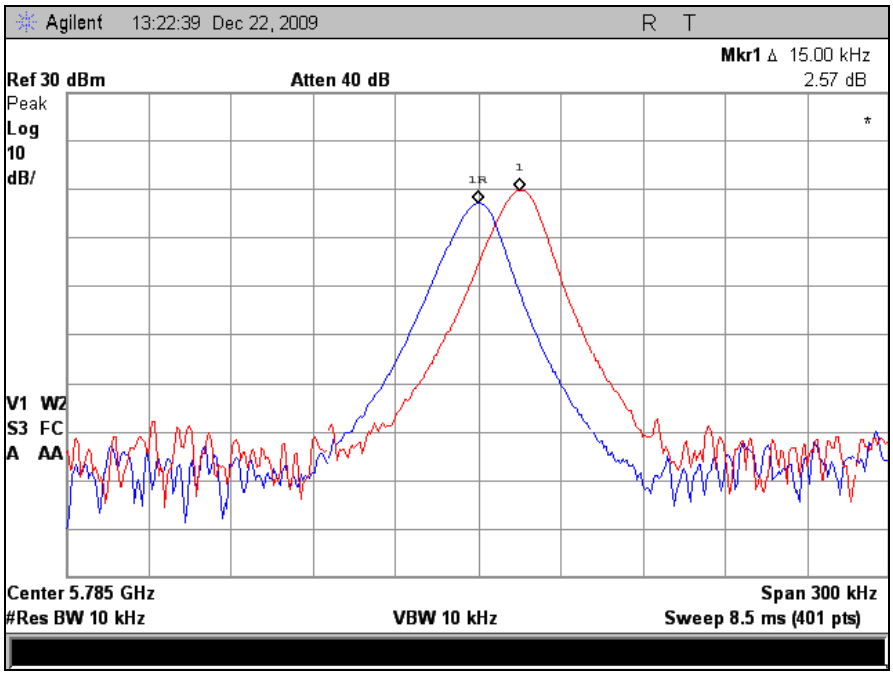
Frequency Stability Test Results



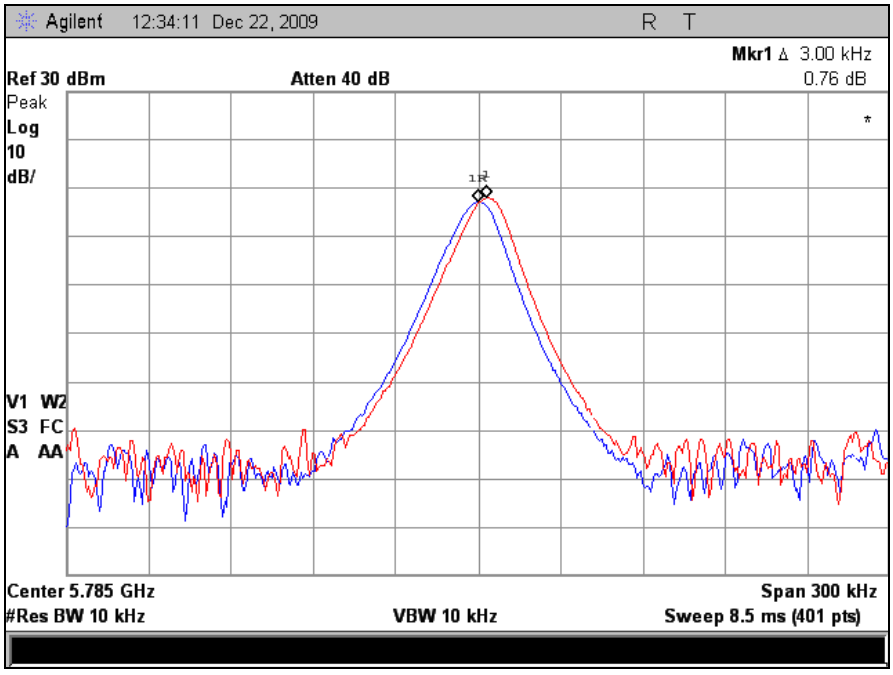
Plot 37. Frequency Stability, -20°C, M25 Radio



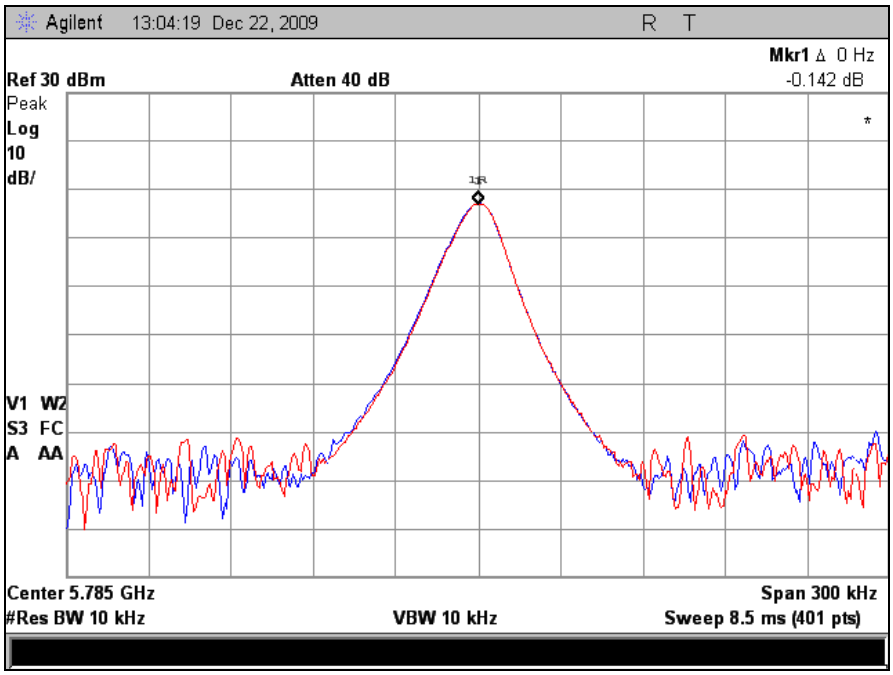
Plot 38. Frequency Stability, -10°C, M25 Radio



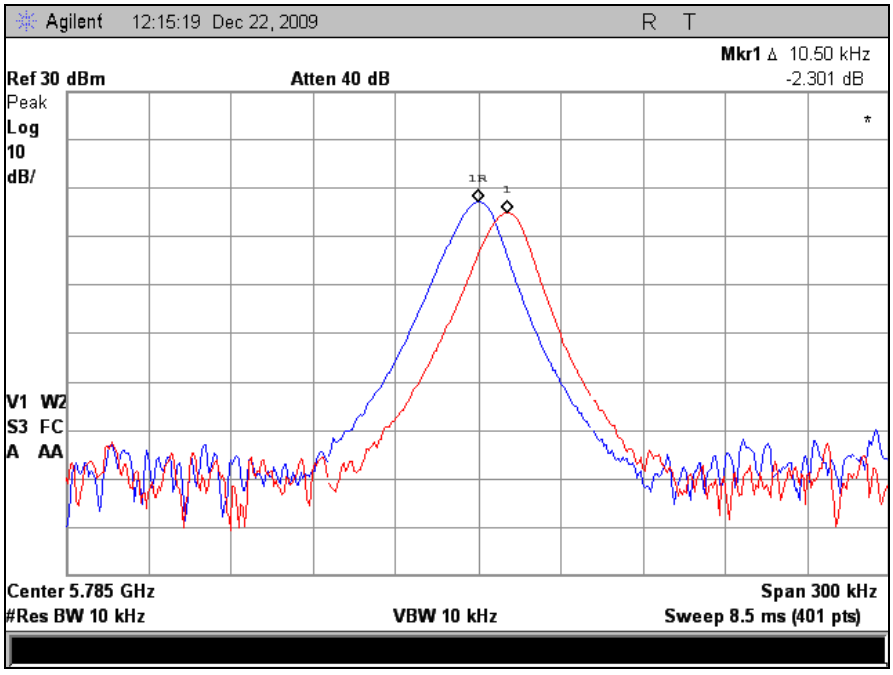
Plot 39. Frequency Stability, 0°C, M25 Radio



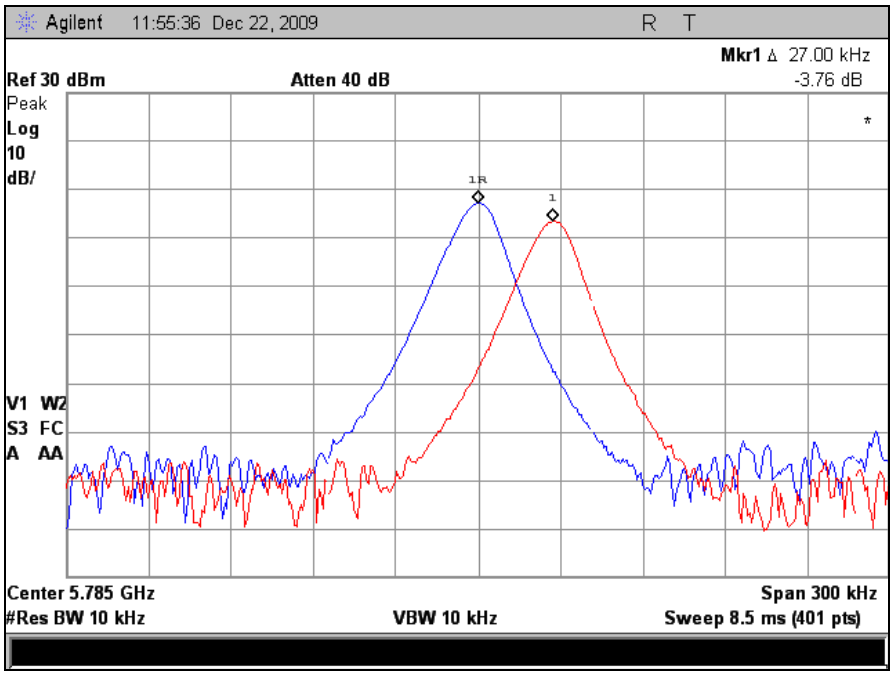
Plot 40. Frequency Stability, 10°C, M25 Radio



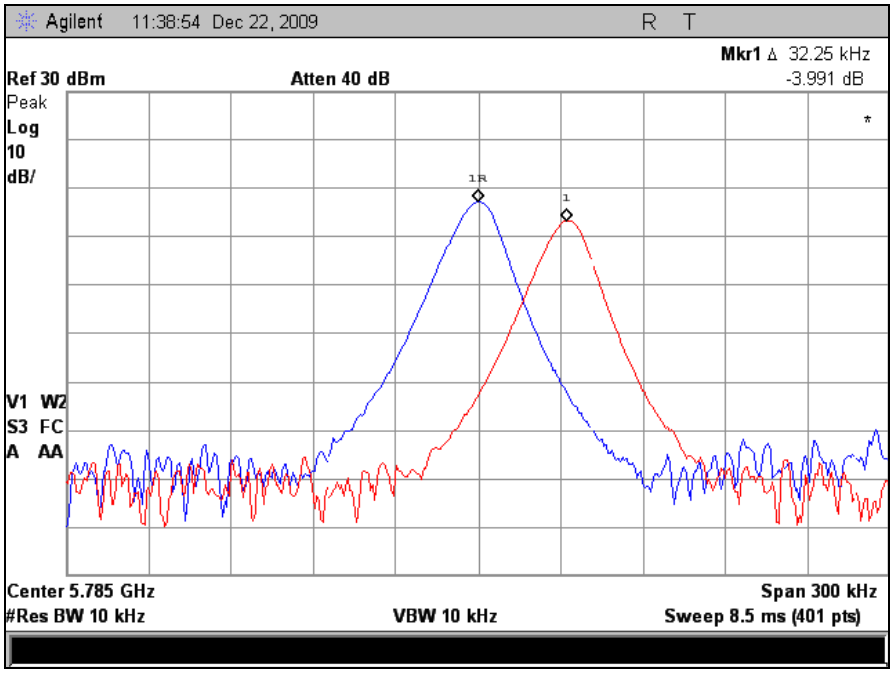
Plot 41. Frequency Stability, 30°C, M25 Radio



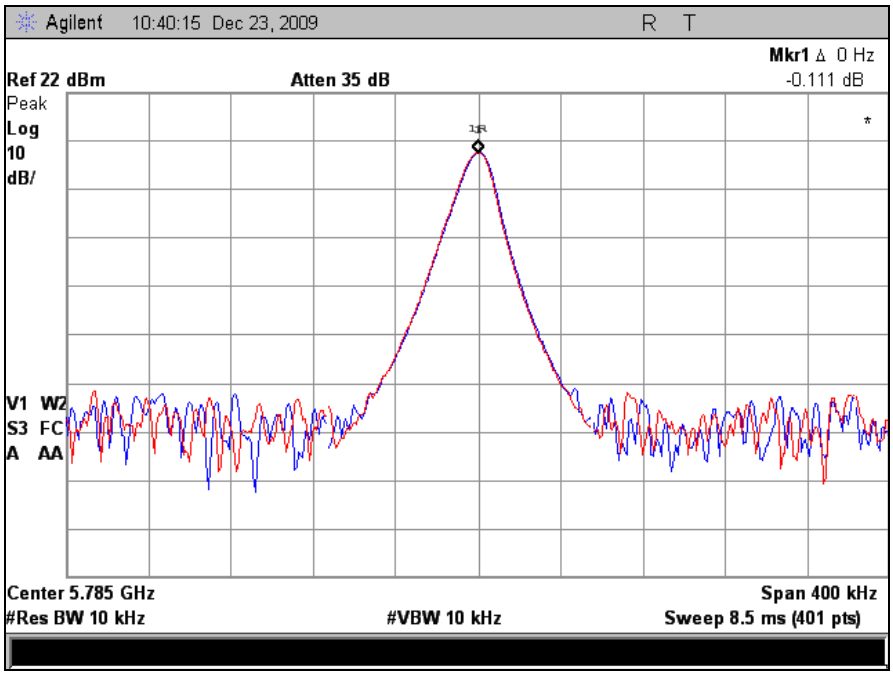
Plot 42. Frequency Stability, 40°C, M25 Radio



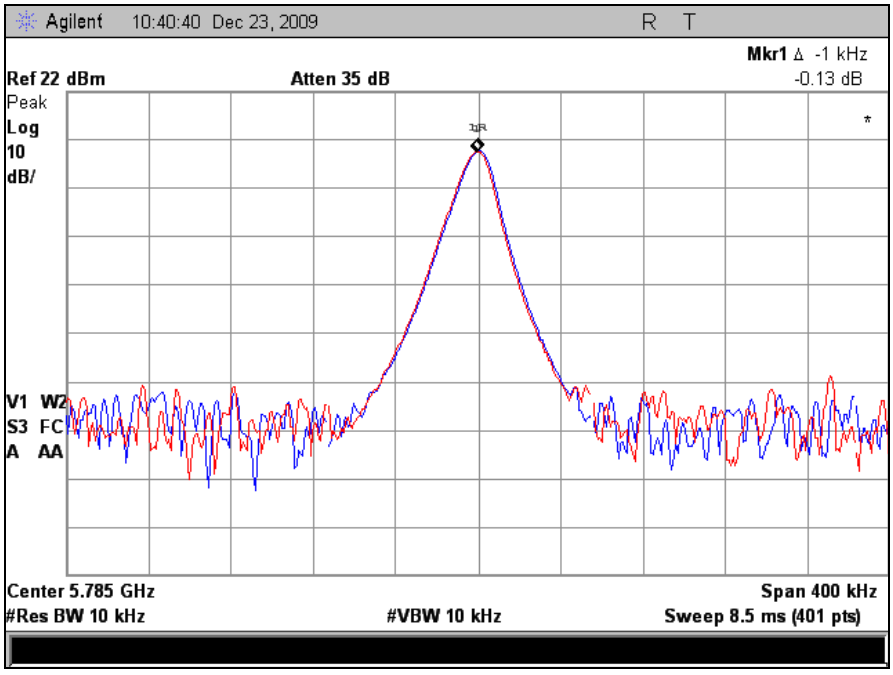
Plot 43. Frequency Stability, 50°C, M25 Radio



Plot 44. Frequency Stability, 55°C, M25 Radio



Plot 45. Frequency Stability, 102VAC, M25 Radio



Plot 46. Frequency Stability, 138VAC, M25 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

RSS-GEN Receiver Spurious – M25

Test Requirement: If the device has a detachable antenna of known antenna impedance, then the antenna conducted method is permitted in lieu of a radiated measurement.

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.

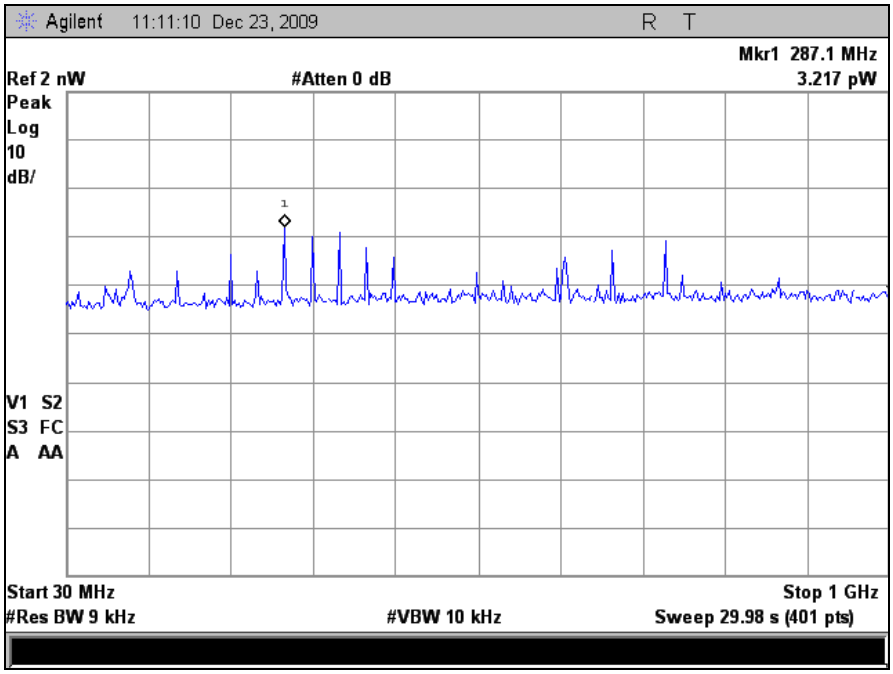
Test Procedure: The EUT was directly connected to a spectrum analyzer. Testing was performed when the EUT was receiving on channel 5785 MHz. Testing was performed conducted.

Results: The EUT as tested is compliant with the requirements of RSS-GEN.

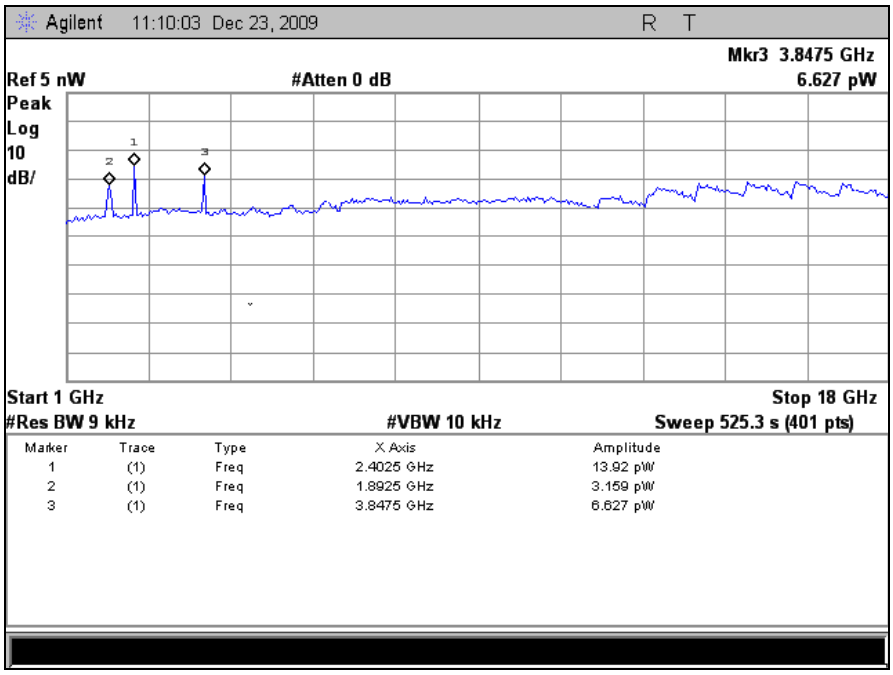
Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/23/09

Receiver Spurious Emissions Test Results



Plot 47. Receiver Spurious Emission, 3 0MHz – 1 GHz, M25 Radio



Plot 48. Receiver Spurious Emission, 1 GHz – 18 GHz, M25 Radio

IV. Electromagnetic Compatibility Criteria for Intentional Radiators – M5

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 unit is professionally installed. Therefore, the EUT as tested is compliant with the criteria of §15.203.

Frequency	Gain/Model	Manufacturer
5 GHz	9 dBi / EC09-5500	Mobile Mark Communications

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

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 non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. 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 C63.4-1992 "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.

Test Results: The EUT was compliant with the Class A requirement(s) of this section. Pre-scans revealed that emissions profiles and amplitudes of emissions were similar when the EUT was transmitting on low, mid and high channels. Therefore, final measurements were taken when the EUT was transmitting on high channel (i.e. 5805 MHz)

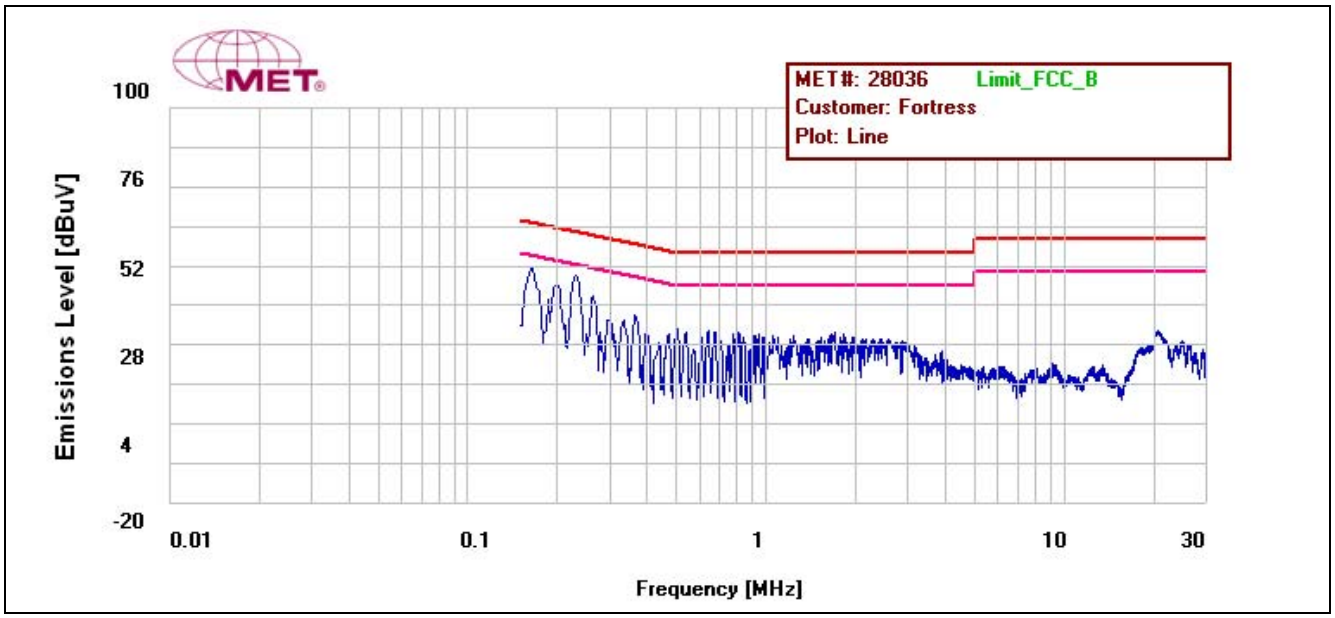
Test Engineer(s): Anderson Soungpanya

Test Date(s): 11/24/09

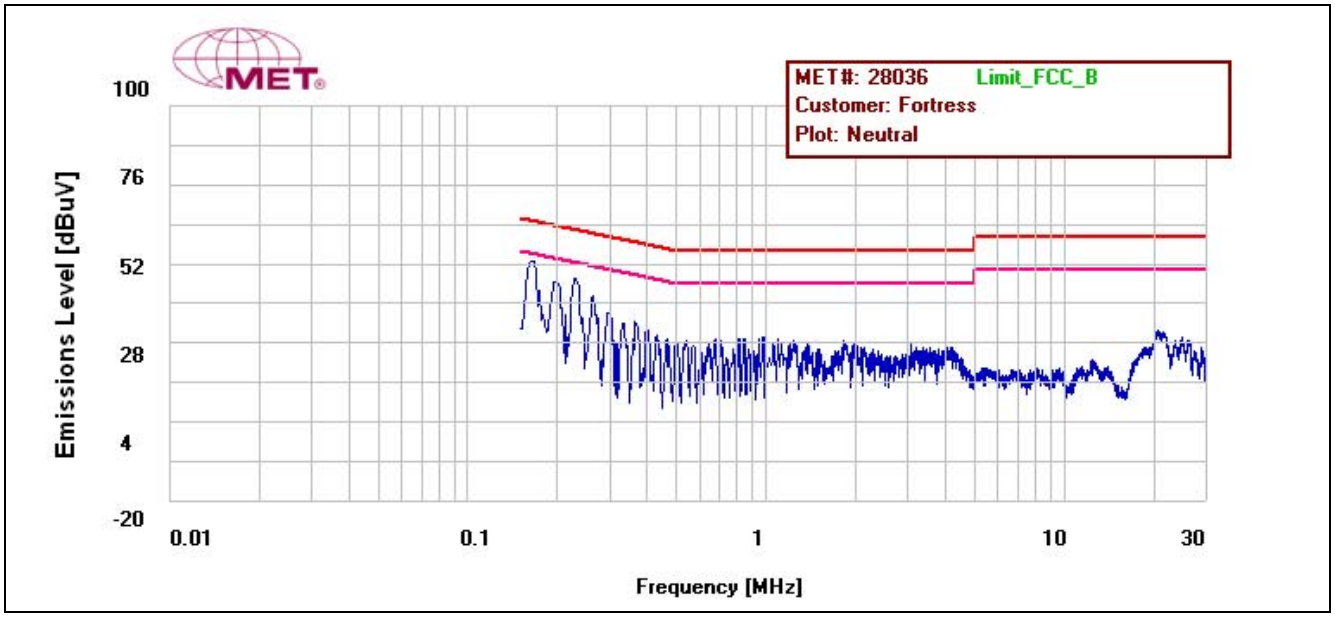
Conducted Emissions - Voltage, AC Power, (120V/60Hz)

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 - Voltage, AC Power, M5 Radio

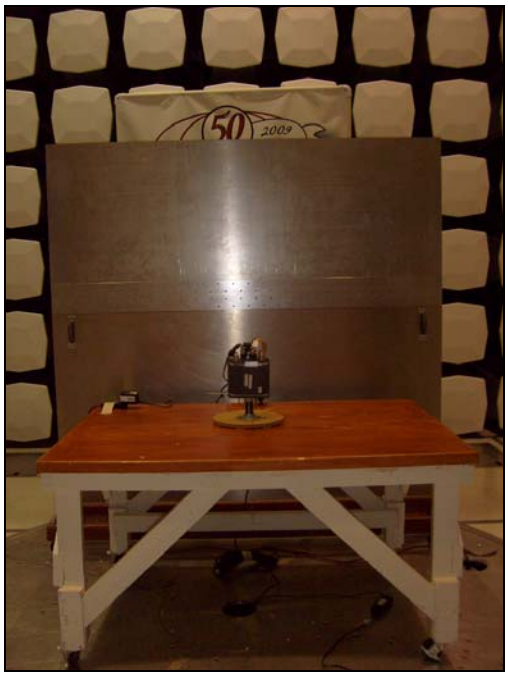


Plot 49. Conducted Emission, Phase Line Plot, M5 Radio

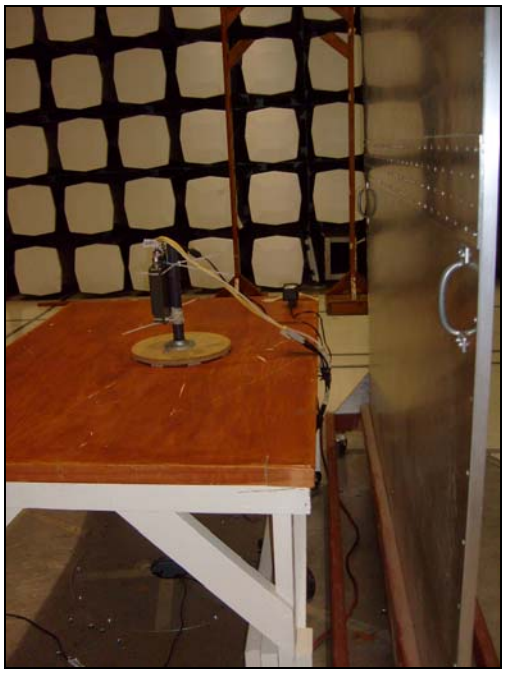


Plot 50. Conducted Emission, Neutral Line Plot, M5 Radio

Conducted Emission Limits Test Setup



Photograph 6. Conducted Emissions, Test Setup, M5 Radio



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

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 403(c) 26dB Bandwidth – M5 Radio

Test Requirements: **§ 15.403 (i):** For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

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

Test Results The 26 dB Bandwidth was compliant with the requirements of this section and was determined from the plots on the following pages.

Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
5745	16.6827	24.316
5785	16.8397	24.324
5805	16.9131	25.897

Table 17. Occupied Bandwidth, Test Results, M5 Radio

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

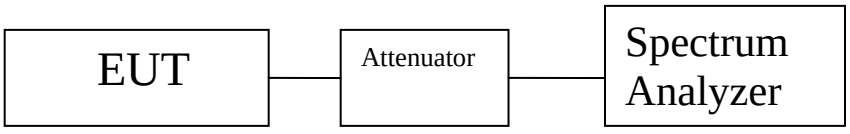
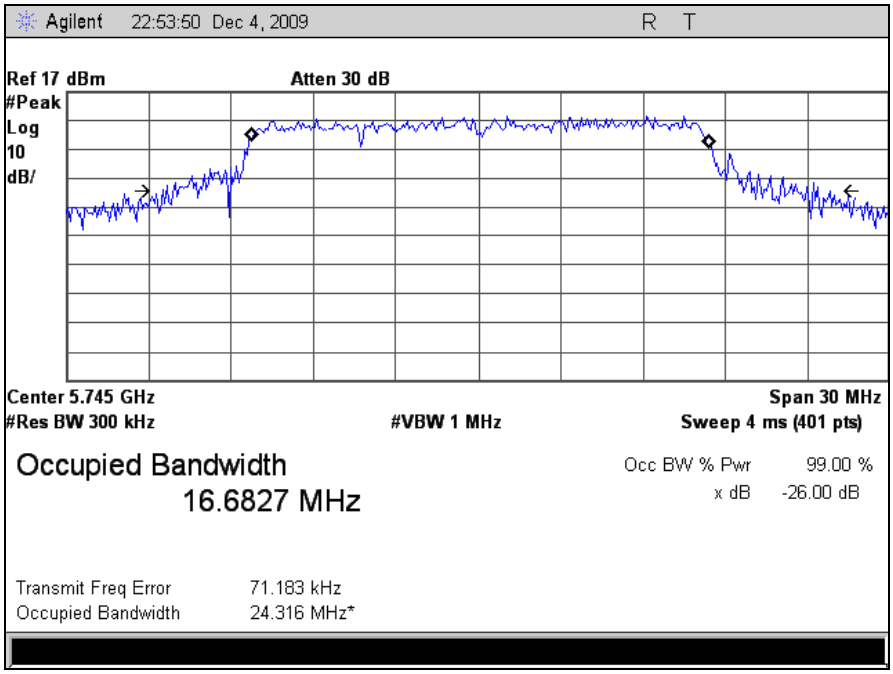
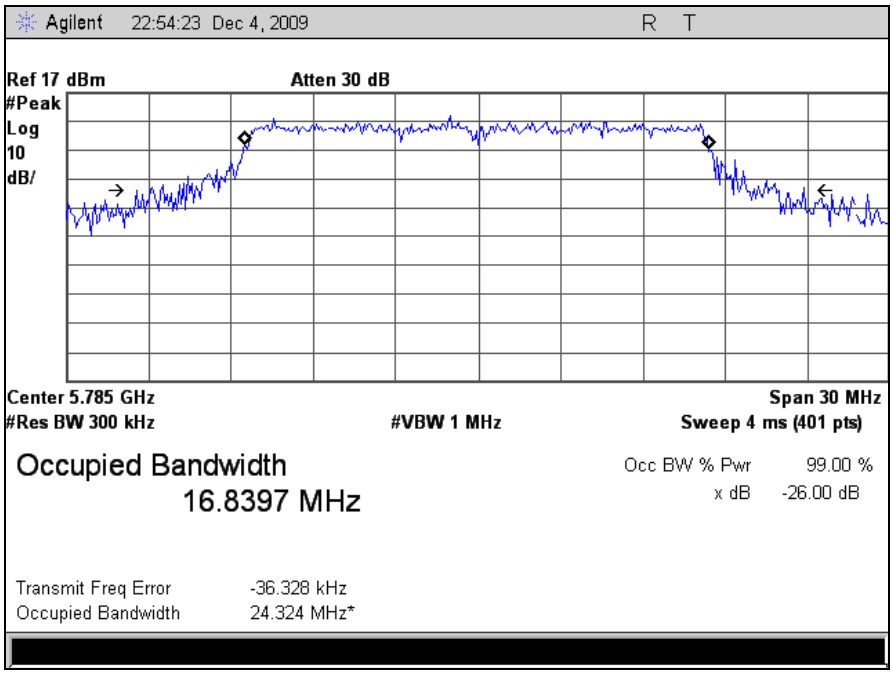


Figure 5. Occupied Bandwidth, Test Setup

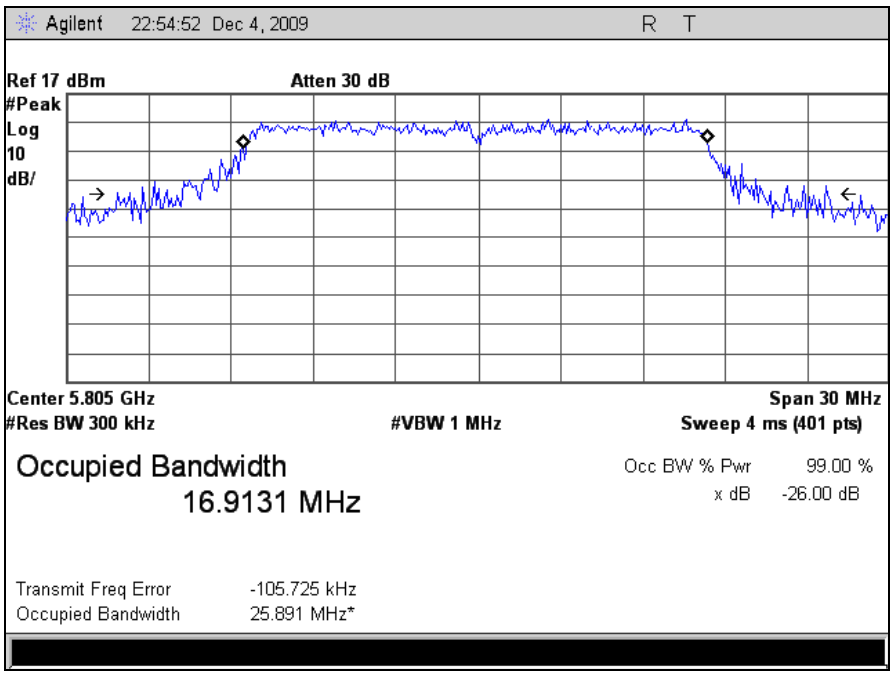
Occupied Bandwidth Test Results



Plot 51. Occupied Bandwidth, 5745 MHz, M5 Radio



Plot 52. Occupied Bandwidth, 5785 MHz, M5 Radio



Plot 53. Occupied Bandwidth, 5805 MHz, M5 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 407(a)(3) RF Power Output – M5

Test Requirements: **§15.407(a) (3):** The maximum output power of the intentional radiator shall not exceed the following:

Digital Transmission Systems (MHz)	Output Limit
5150-5250	50mW
5250-5350	250mW
5470–5725	250mW
5725–5825	1W

Table 18. Output Power Requirements from §15.407

§15.407(a) (3): For the band 5.725–5.825 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 1 W or 17 dBm + 10 log B, where B is the 26-dB emission bandwidth in MHz.

Test Procedure: The EUT was connected to a Spectrum Analyzer. The power was measured on three channels.

Test Results: Equipment was compliant with the Peak Power Output limits of **§ 15.401(a)(2)**.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

Frequency (MHz)	Conducted Power (dBm)	Conducted Power (mW)	Limit (W)
5745	17.47	55.84	1
5785	17.81	60.39	1
5805	17.04	50.58	1

Table 19. RF Power Output, Test Results, M5 Radio

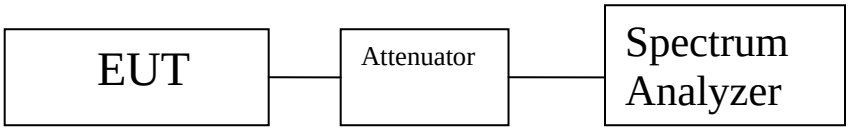
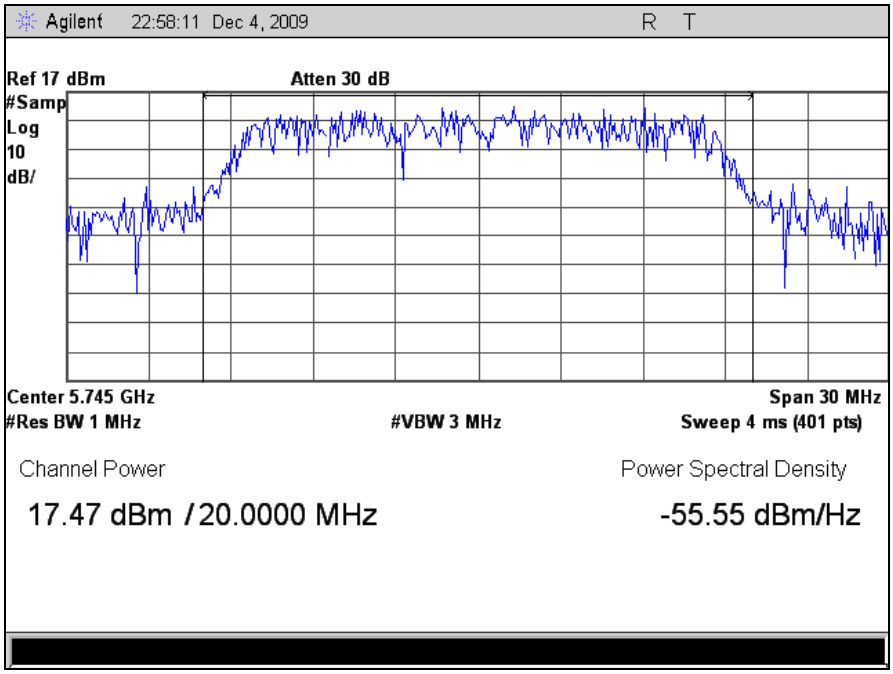
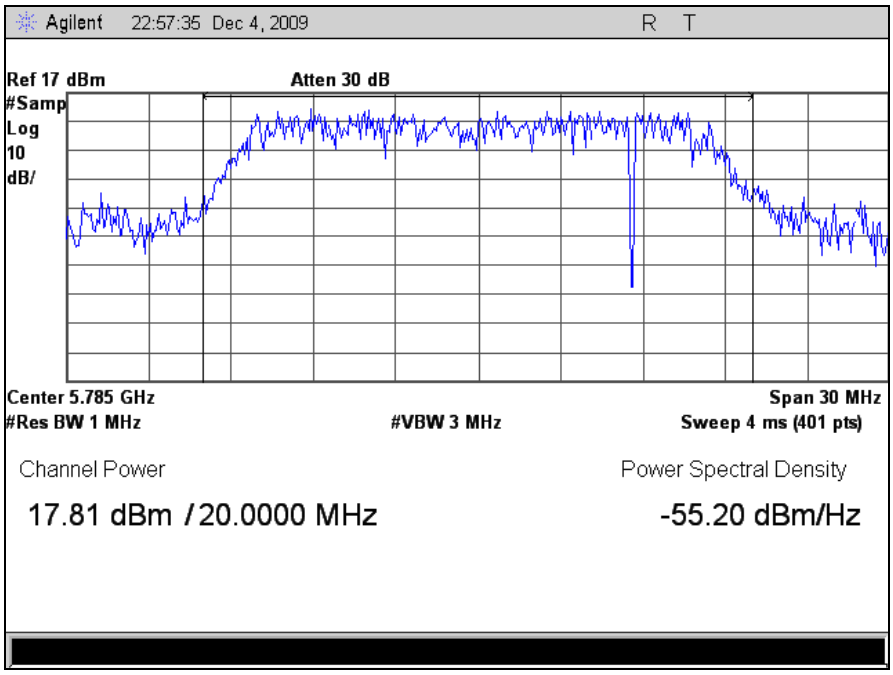


Figure 6. Power Output Test Setup

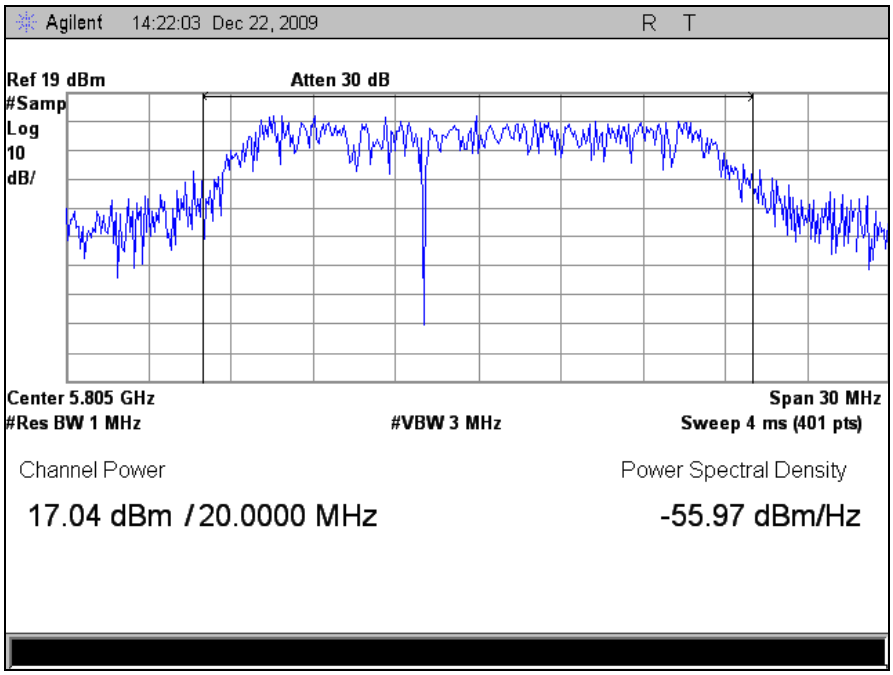
RF Output Power Test Results



Plot 54. RF Power Output, 5745 MHz, M5 Radio



Plot 55. RF Power Output, 5785 MHz, M5 Radio



Plot 56. RF Power Output, 5805 MHz, M5 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(a)(3) Peak Power Spectral Density – M5

Test Requirements: **§ 15.407(a)(3):** The peak power spectral density shall not exceed 17 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain up to 23dBi without any corresponding reduction in the transmitter peak output power or peak power spectral density. For fixed, point-to-point U-NII transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in peak transmitter power and peak power spectral density for each 1 dB of antenna gain in excess of 23 dBi would be required. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, Omni directional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level on the EUT. The RBW was set to 1MHz and the VBW was set to 3MHz. The method of measurement #2 from the FCC Public Notice DA 02-2138 was used.

Test Results: Equipment was compliant with the peak power spectral density limits of **§ 15.407 (a)(2).** The peak power spectral density was determined from plots on the following page(s).

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

Frequency (MHz)	PSD (dBm)
5745	6.822
5785	6.779
5805	8.685

Table 20. Power Spectral Density, Test Results, M5 Radio

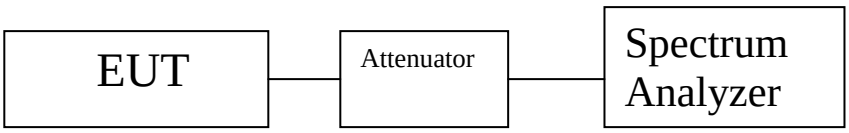
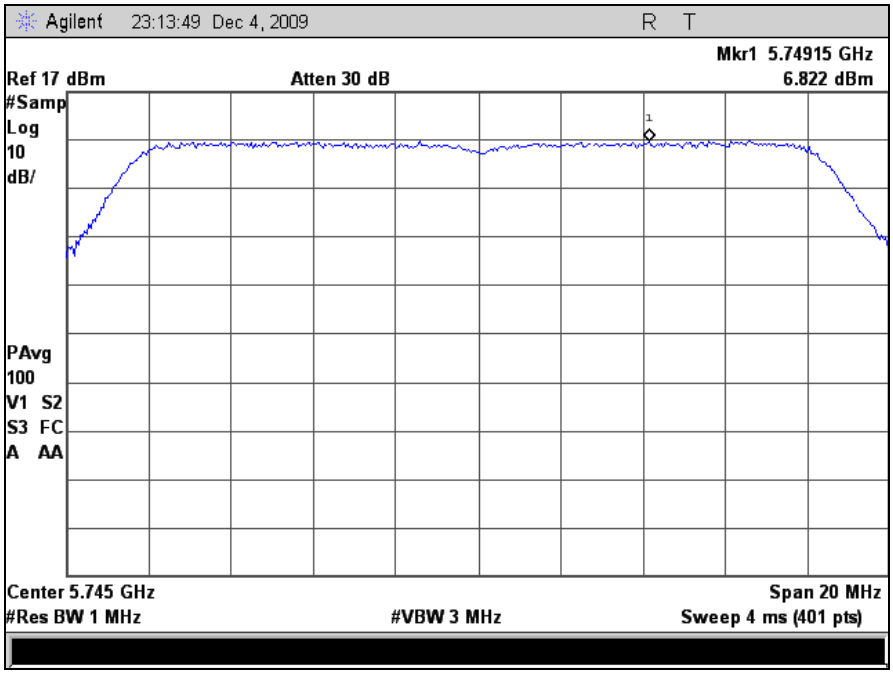
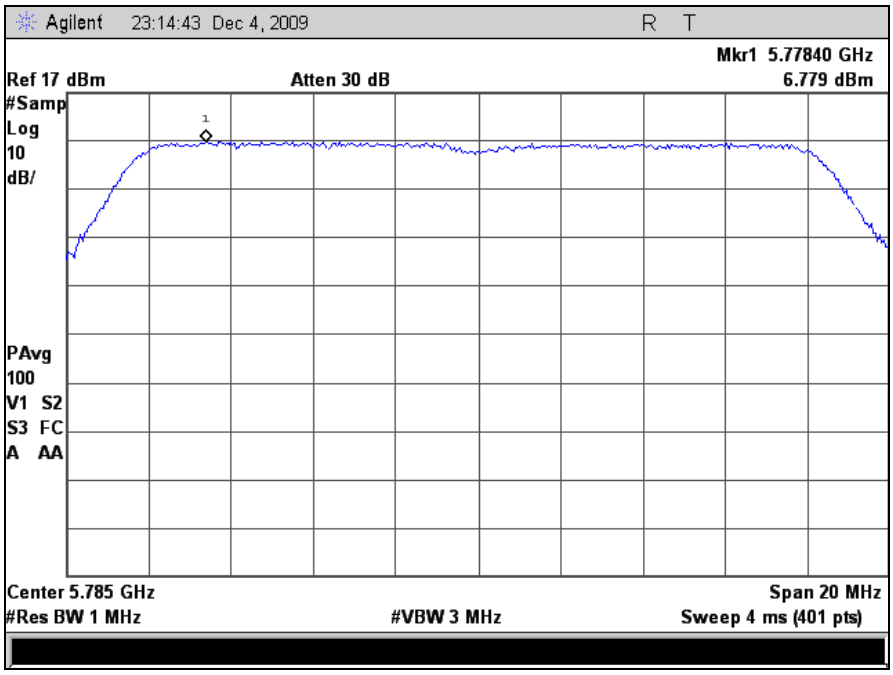


Figure 7. Power Spectral Density Test Setup

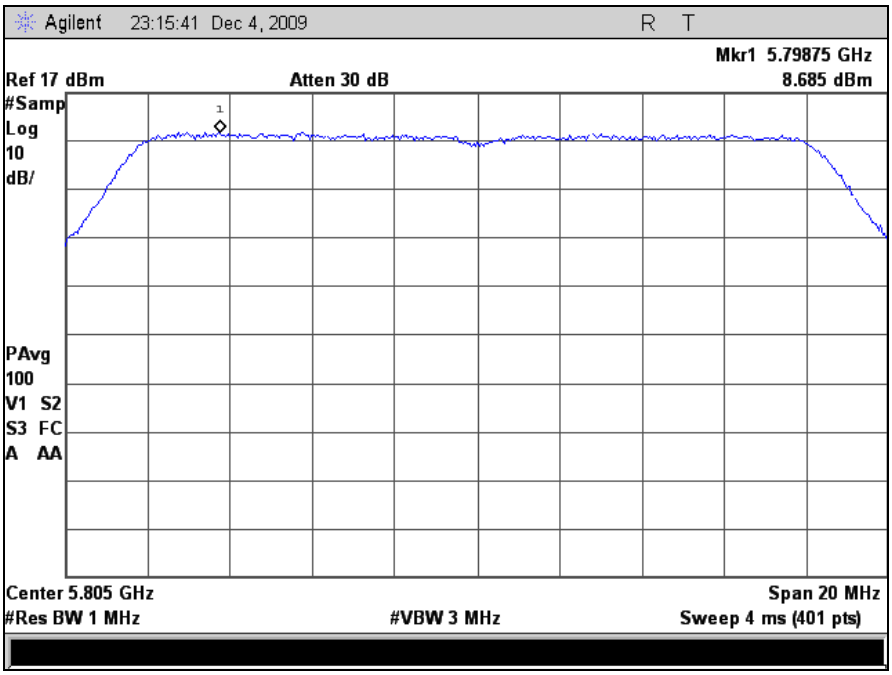
Power Spectral Density Test Results



Plot 57. Power Spectral Density, 5745 MHz, M5 Radio



Plot 58. Power Spectral Density, 5785 MHz, M5 Radio



Plot 59. Power Spectral Density, 5805 MHz, M5 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(a)(6) Peak Excursion Ratio – M5

Test Requirements: **§ 15.407(a)(6):** The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

Test Procedure: The EUT was connected directly to the spectrum analyzer through cabling and attenuation. The 1st trace on the spectrum analyzer was set to RBW=1MHz, VBW=3MHz. The peak detector mode was used and the trace max held. The 2nd trace on the spectrum analyzer was set according to measurement method #1 from the FCC Public Notice DA 02-2138 for making conducted power measurements.

Test Results: Equipment was compliant with the peak excursion ratio limits of **§ 15.407(a)(6).** The peak excursion ratio was determined from plots on the following page(s).

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/04/09

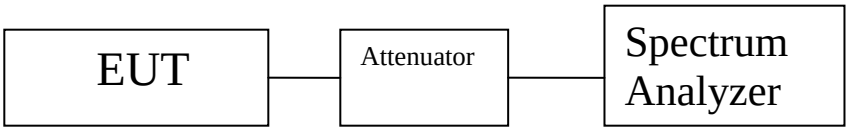
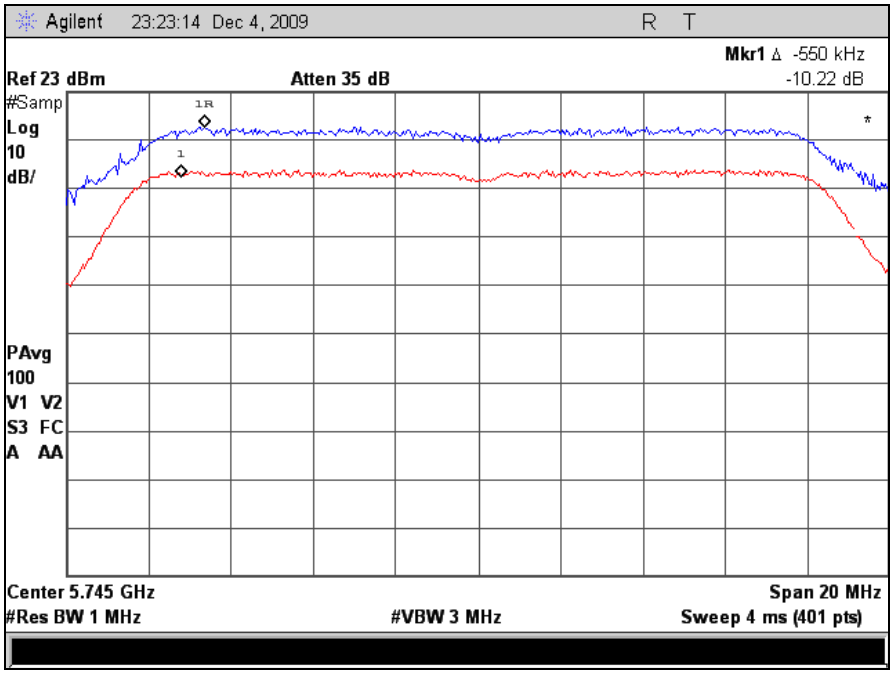
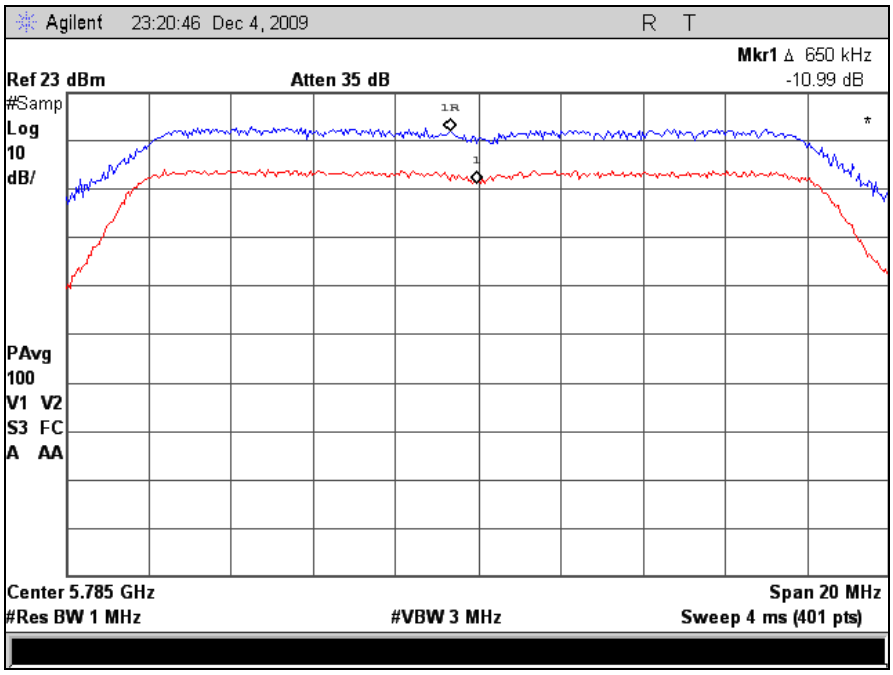


Figure 8. Peak Excursion Ration Test Setup

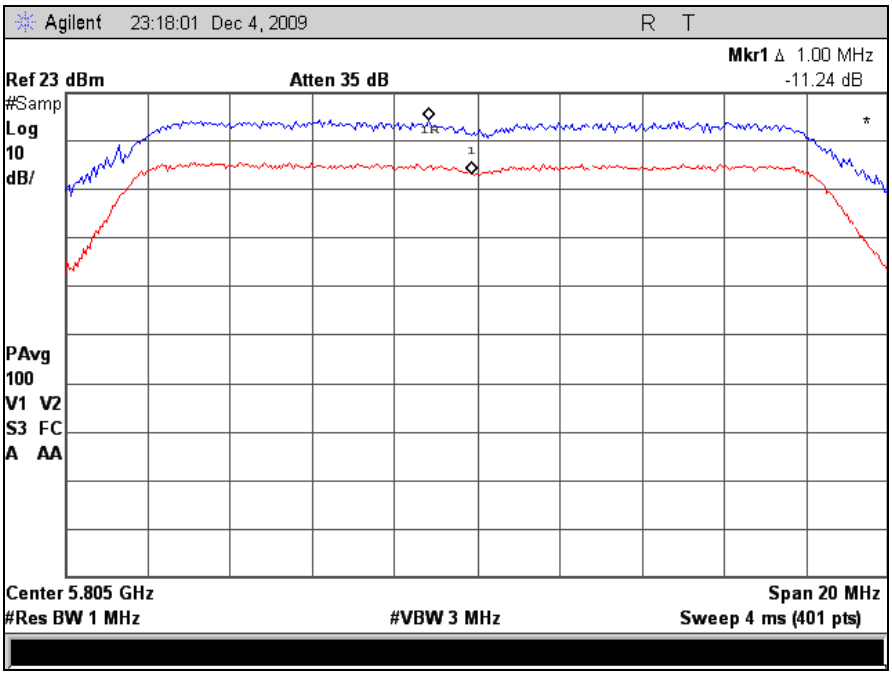
Peak Excursion Test Results



Plot 60. Peak Excursion Ratio, 5745 MHz, M5 Radio



Plot 61. Peak Excursion Ratio, 5785 MHz, M5 Radio



Plot 62. Peak Excursion Ratio, 5805 MHz, M5 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(b) Undesirable Emissions – M5

Test Requirements: **§ 15.407(b)(4), (b)(6), (b)(7), §15.205:** Emissions outside the frequency band.

§ 15.407(b)(4): For transmitters operating in the 5.725–5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of –17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of –27 dBm/MHz.

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

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

Test Procedure: The transmitter was placed on an acrylic stand inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast height to determine worst case orientation for maximum emissions.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

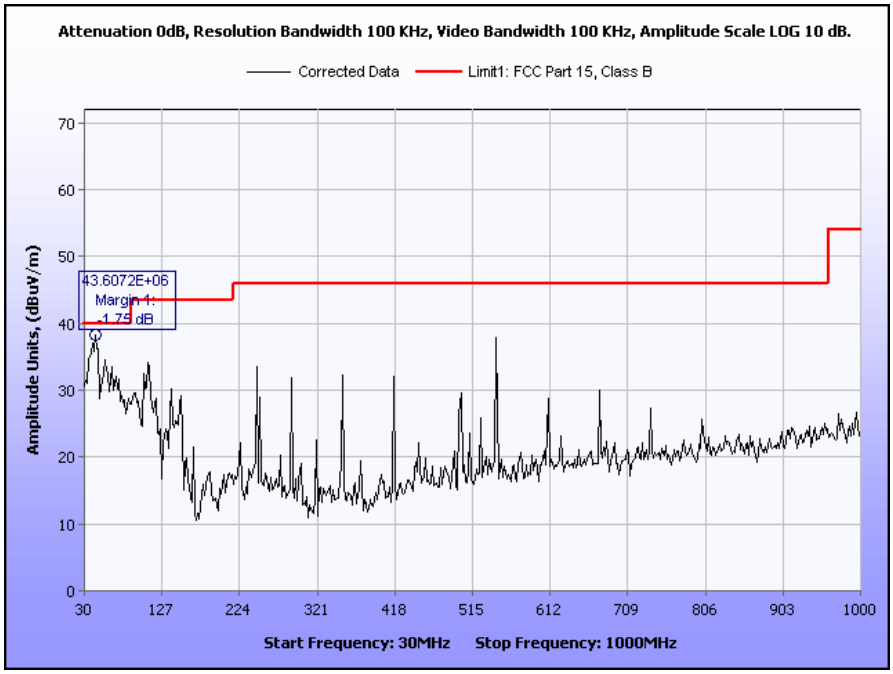
For measurements above 1 GHz, measurements were made with a Peak detector with 1 MHz resolution bandwidth. Where the spurious emissions fell into a restricted band, measurements were also made with an average detector to make sure they complied with 15.209 limits. Emissions were explored up to 40 GHz.
The equation, **EIRP= E + 20 log D – 104.8** was used to convert an EIRP limit to a field strength limit.
E = field strength (dBuV/m)
D = Reference measurement distance (m)

Test Results: The EUT was compliant with the Radiated Emission limits for Intentional Radiators. See following pages for detailed test results.

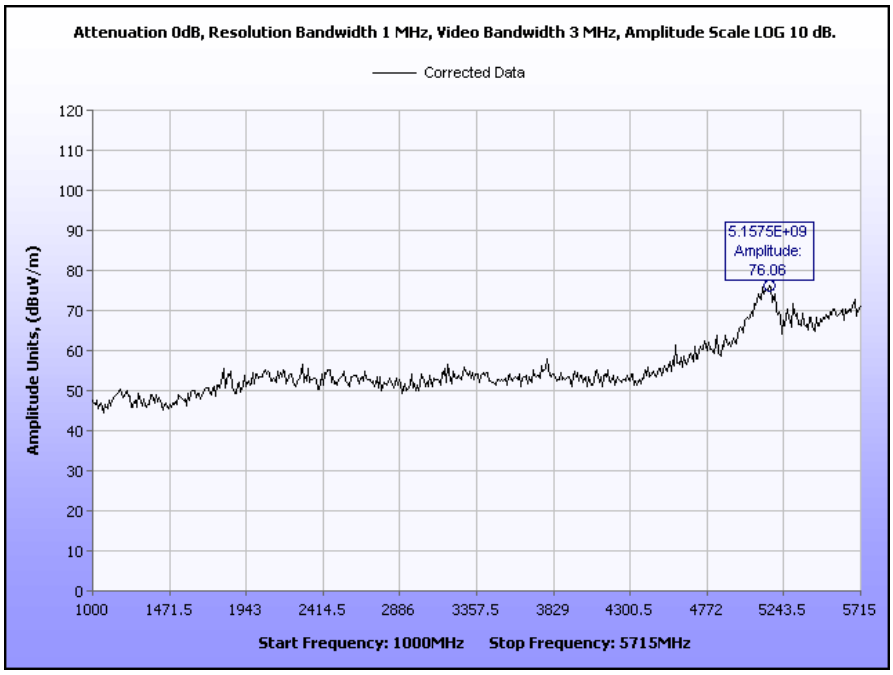
Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/29/09

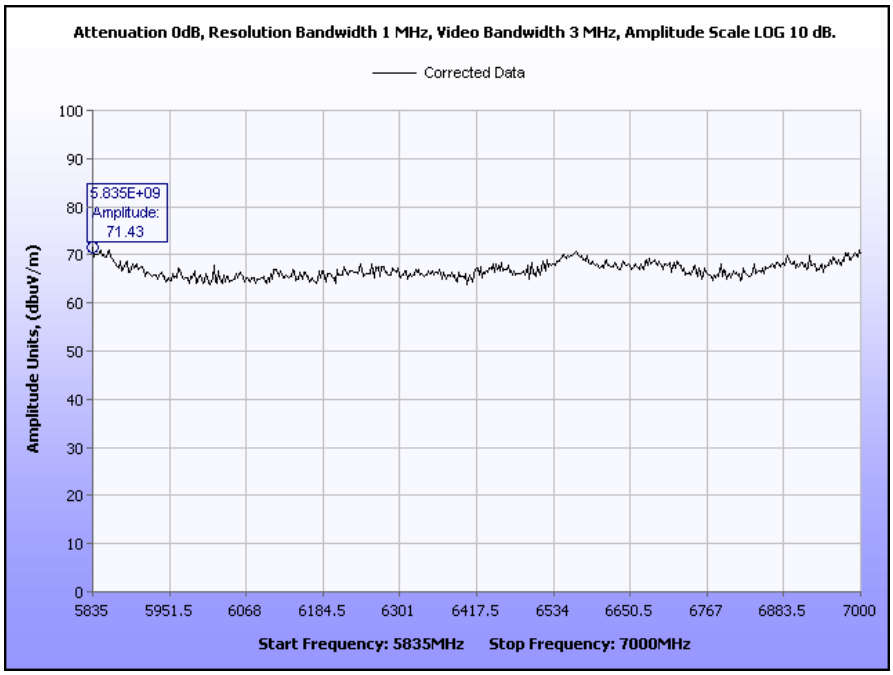
Radiated Spurious Emissions Test Results



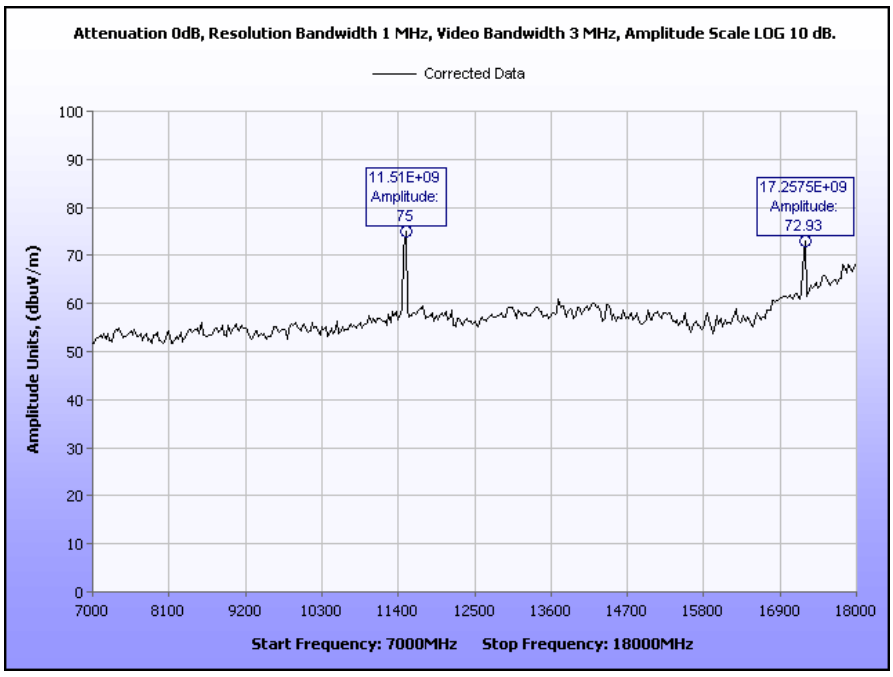
Plot 63. Radiated Spurs, 30 MHz – 1 GHz, Channel 5745 MHz, M5 Radio



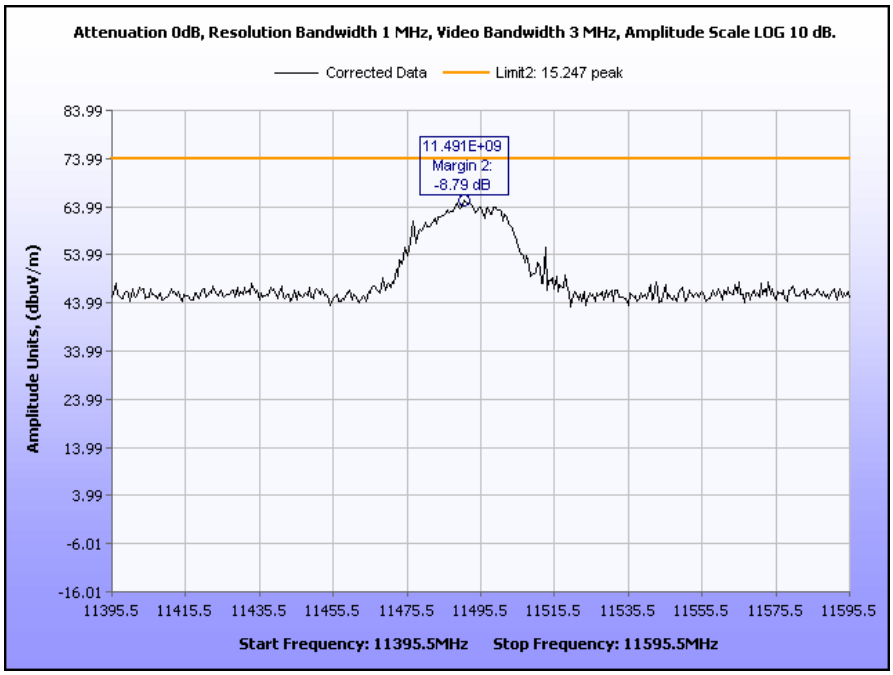
Plot 64. Radiated Spurs, 1 GHz – 5.715 GHz, Channel 5745 MHz, M5 Radio



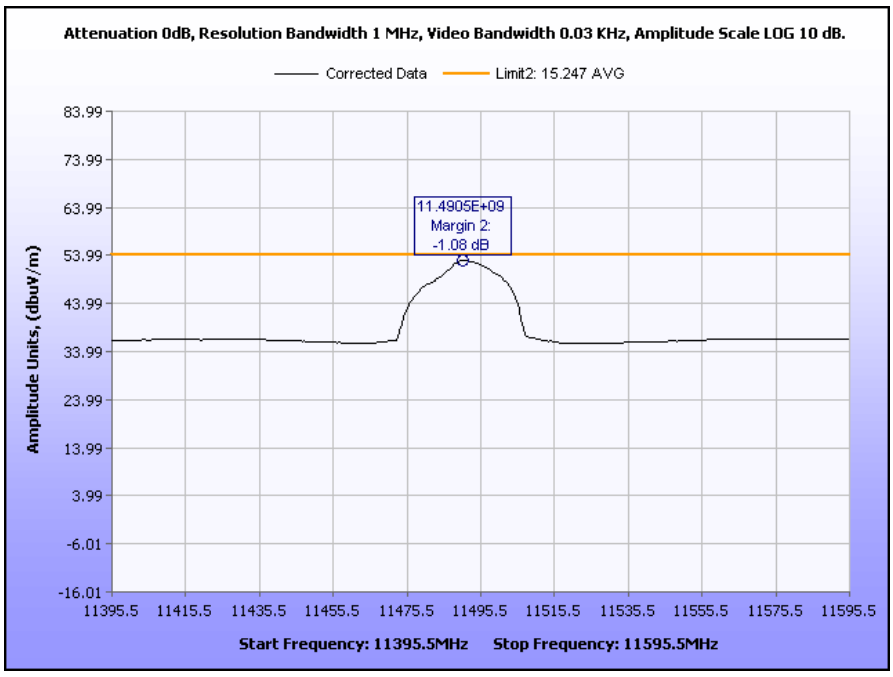
Plot 65. Radiated Spurs, 5.825 GHz – 7 GHz, Channel 5745 MHz, M5 Radio



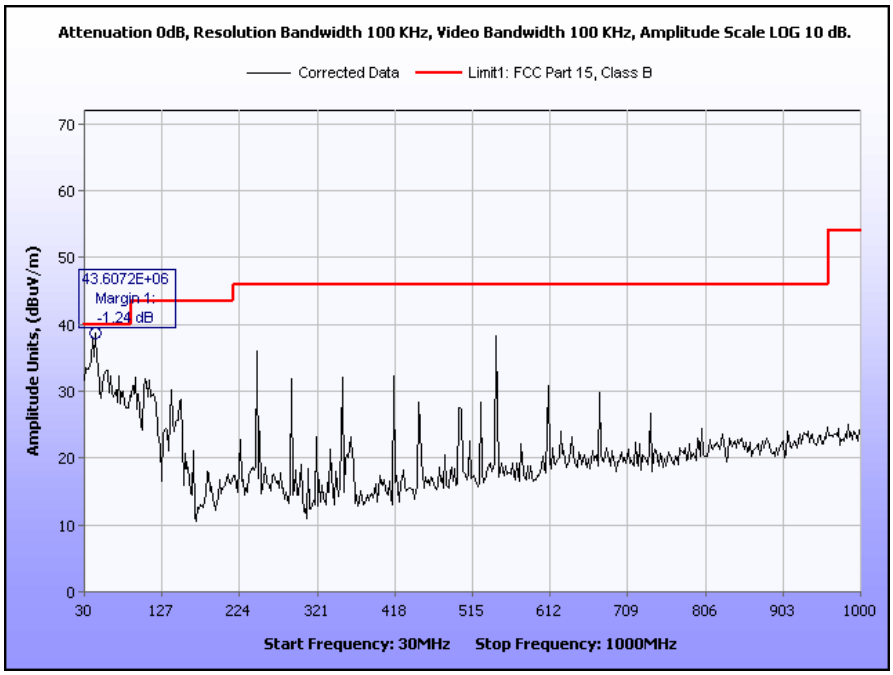
Plot 66. Radiated Spurs, 7 GHz – 18 GHz, Channel 5745 MHz, M5 Radio



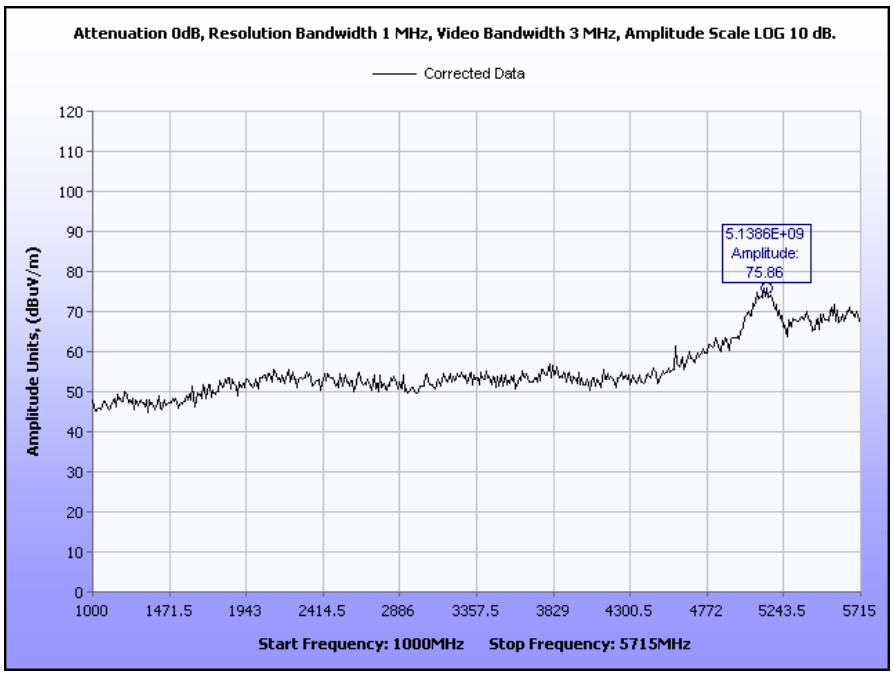
Plot 67. Radiated Spurs, 2nd Harmonic, Peak, Channel 5745 MHz, M5 Radio



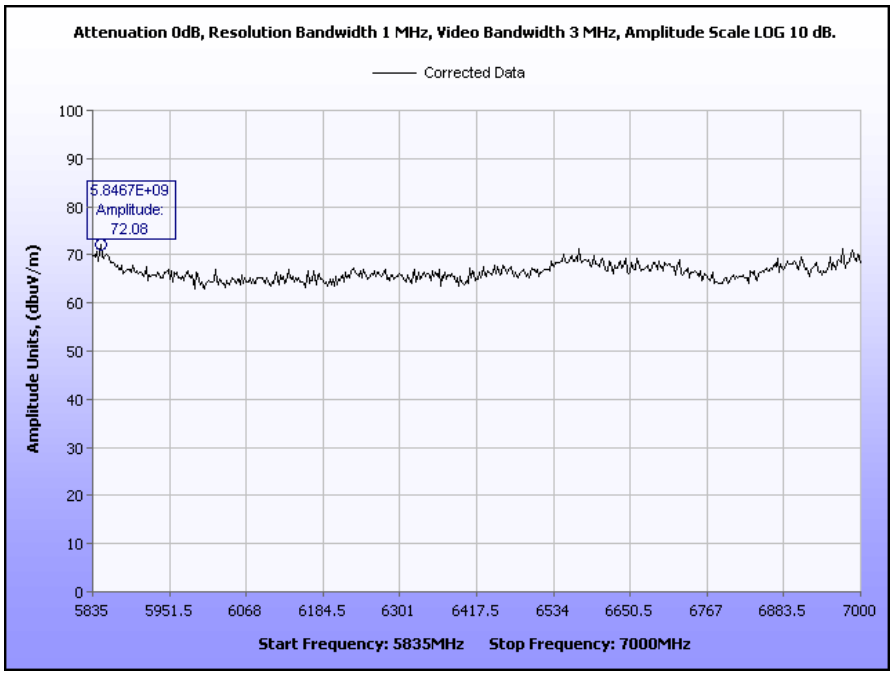
Plot 68. Radiated Spurs, 2nd Harmonic, Average, Channel 5745 MHz, M5 Radio



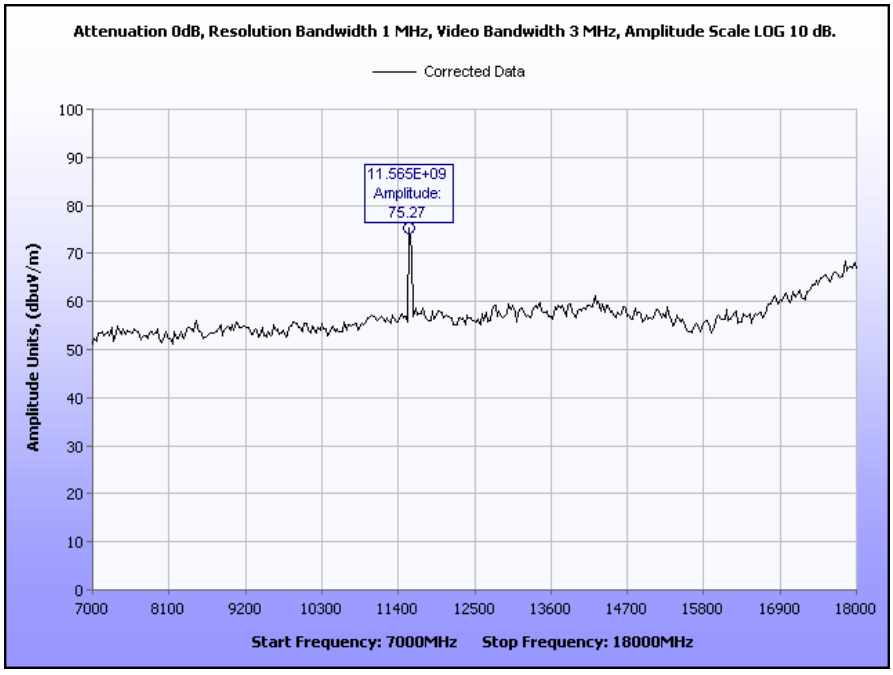
Plot 69. Radiated Spurs, 30 MHz – 1 GHz, Channel 5785 MHz, M5 Radio



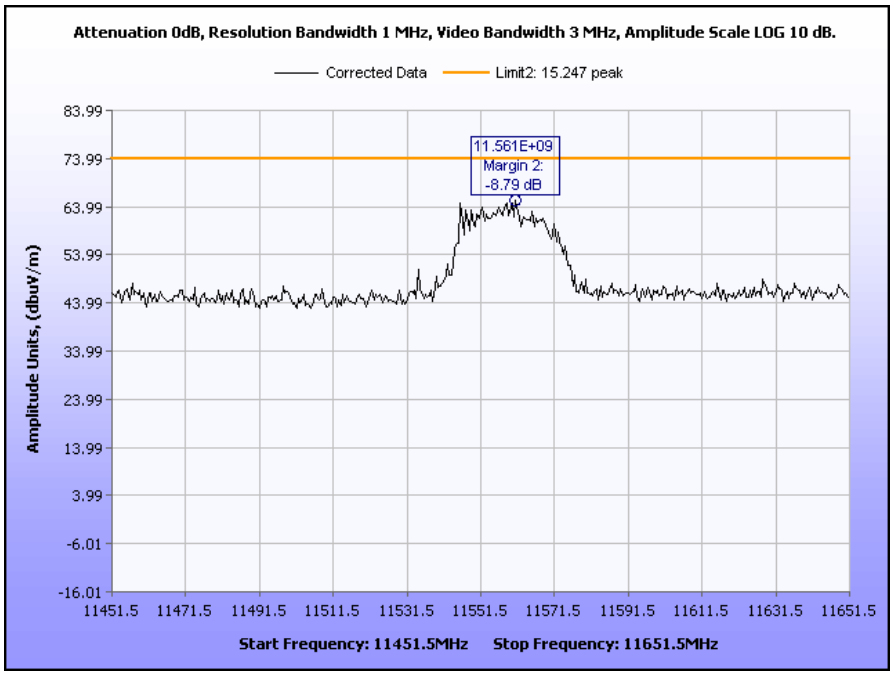
Plot 70. Radiated Spurs, 1 GHz – 5.715 GHz, Channel 5785 MHz, M5 Radio



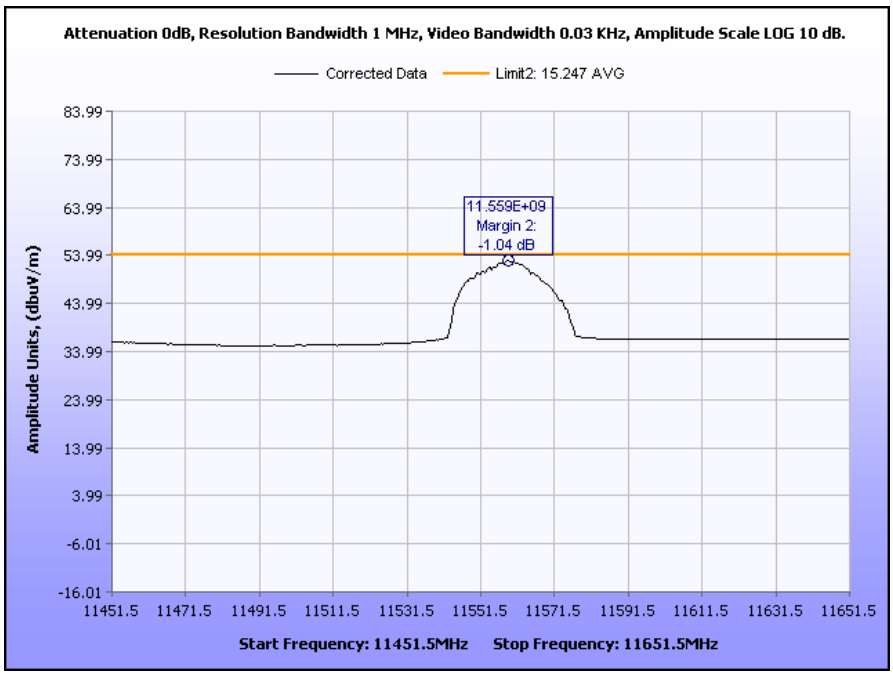
Plot 71. Radiated Spurs, 5.835 GHz – 7 GHz, Channel 5785 MHz, M5 Radio



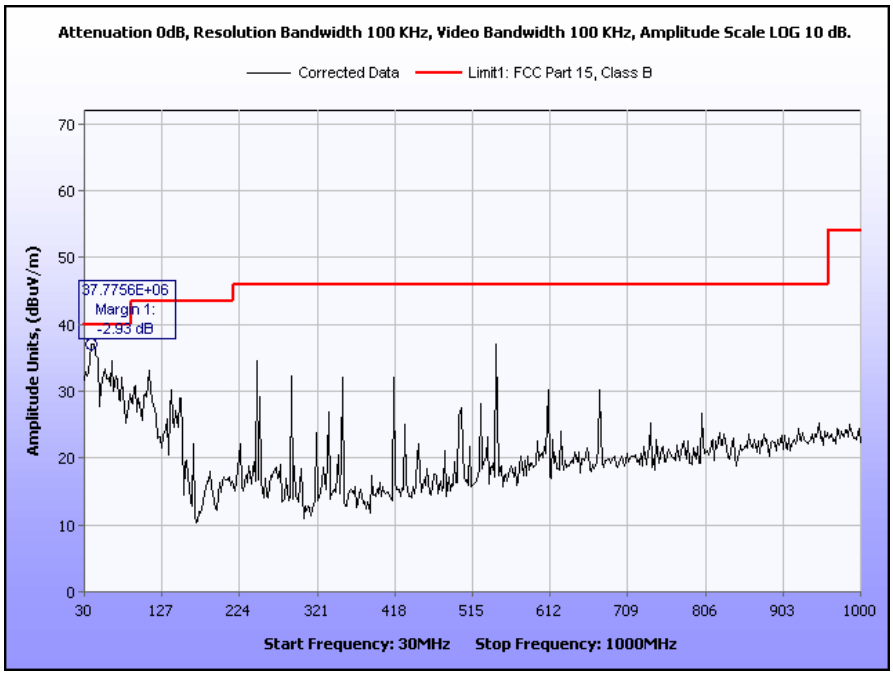
Plot 72. Radiated Spurs, 7 GHz – 18 GHz, Channel 5785 MHz, M5 Radio



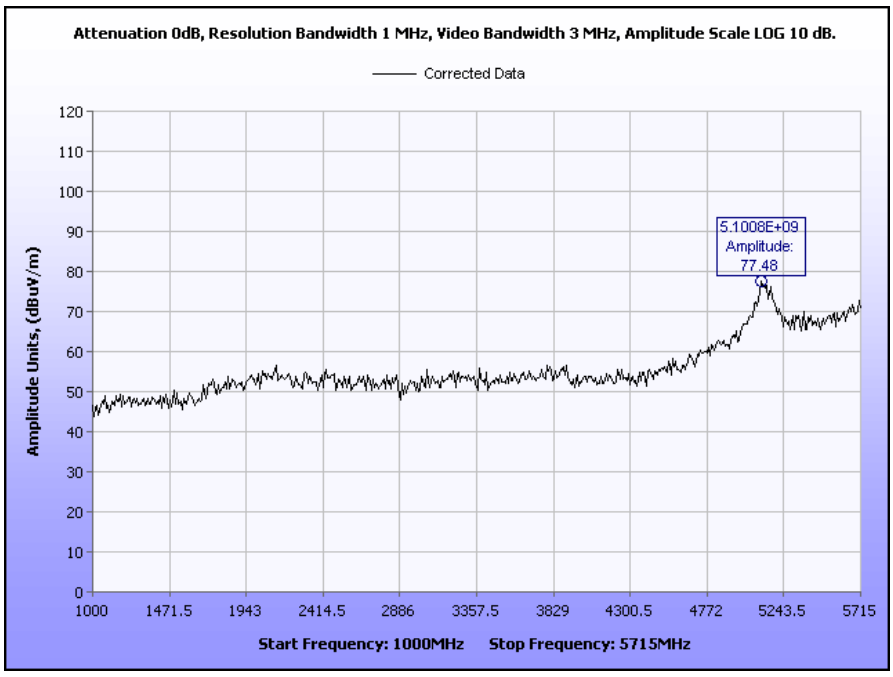
Plot 73. Radiated Spurs, 2nd Harmonic, Peak, Channel 5785 MHz, M5 Radio



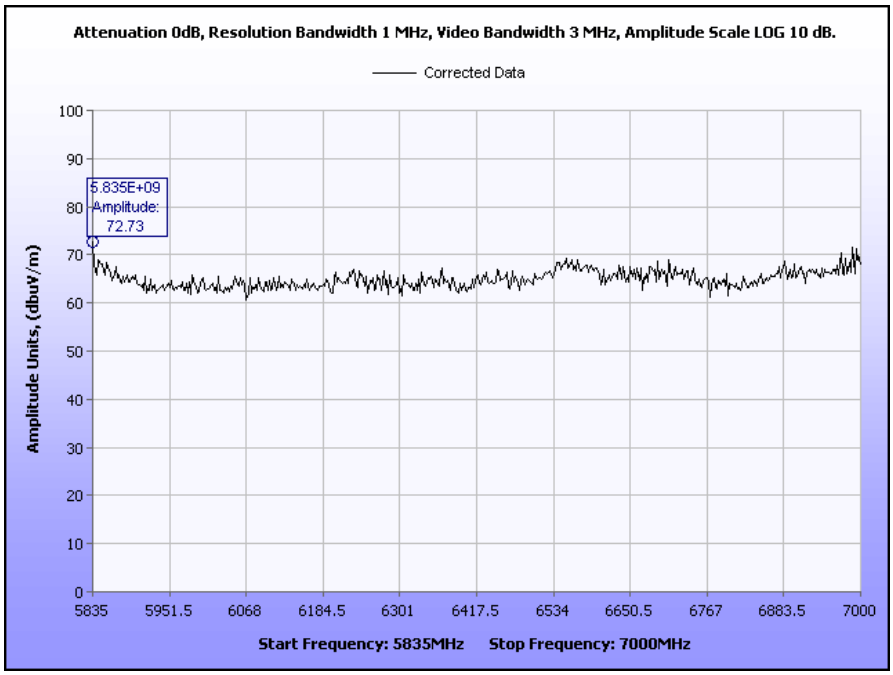
Plot 74. Radiated Spurs, 2nd Harmonic, Average, Channel 5785 MHz, M5 Radio



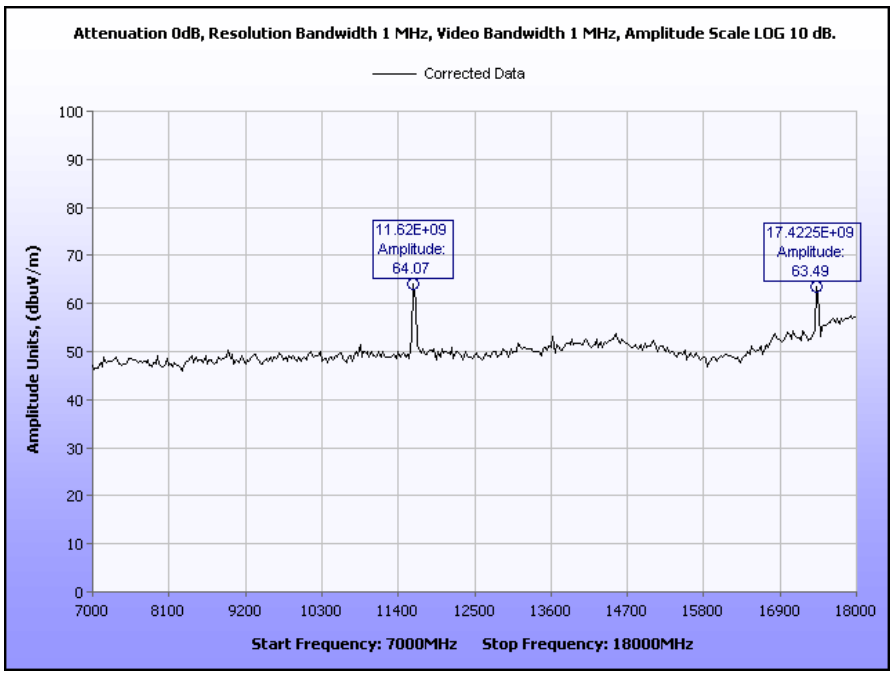
Plot 75. Radiated Spurs, 30 MHz – 1 GHz, Channel 5805 MHz, M5 Radio



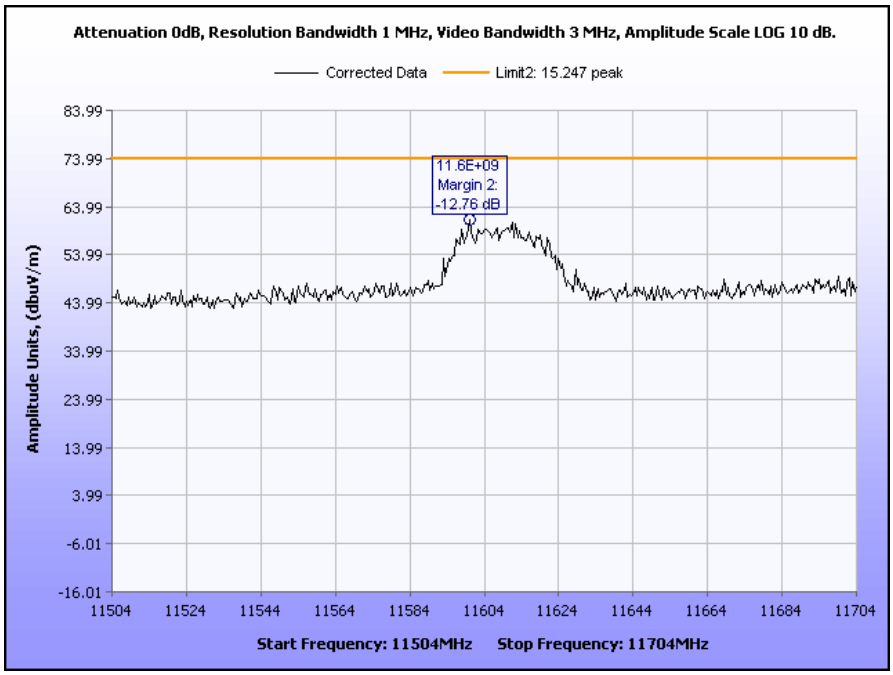
Plot 76. Radiated Spurs, 1 GHz – 5.715 GHz, Channel 5805 MHz, M5 Radio



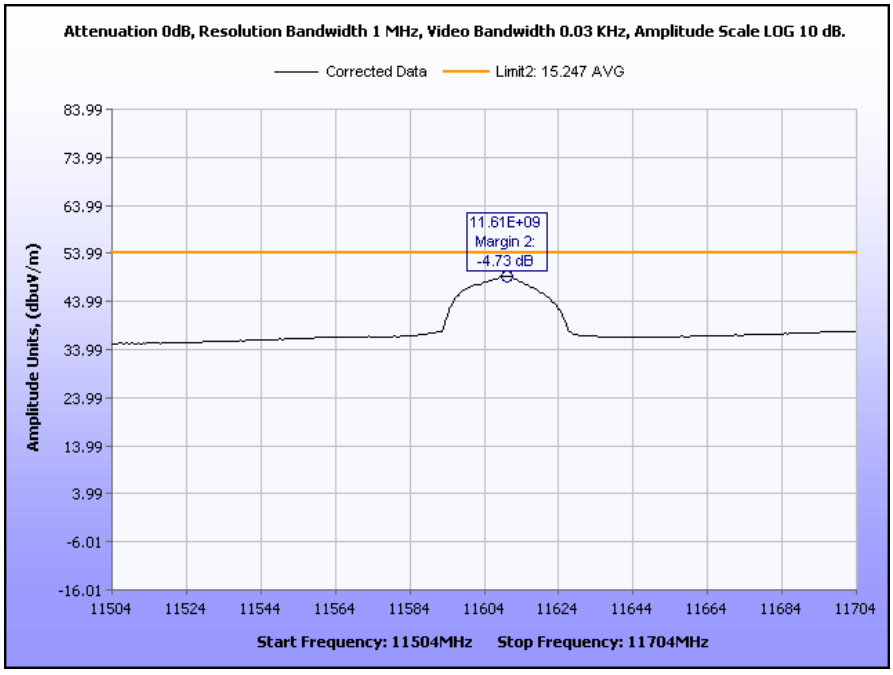
Plot 77. Radiated Spurs, 5.835 GHz – 7 GHz, Channel 5805 MHz, M5 Radio



Plot 78. Radiated Spurs, 7 GHz – 18 GHz, Channel 5805 MHz, M5 Radio

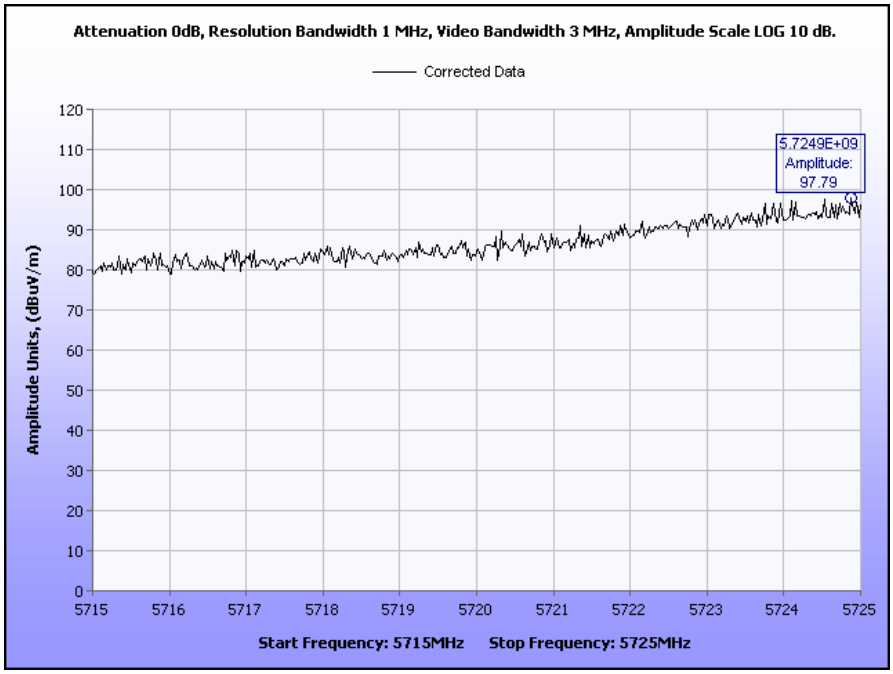


Plot 79. Radiated Spurs, 2nd Harmonic, Peak, Channel 5805 MHz, M5 Radio

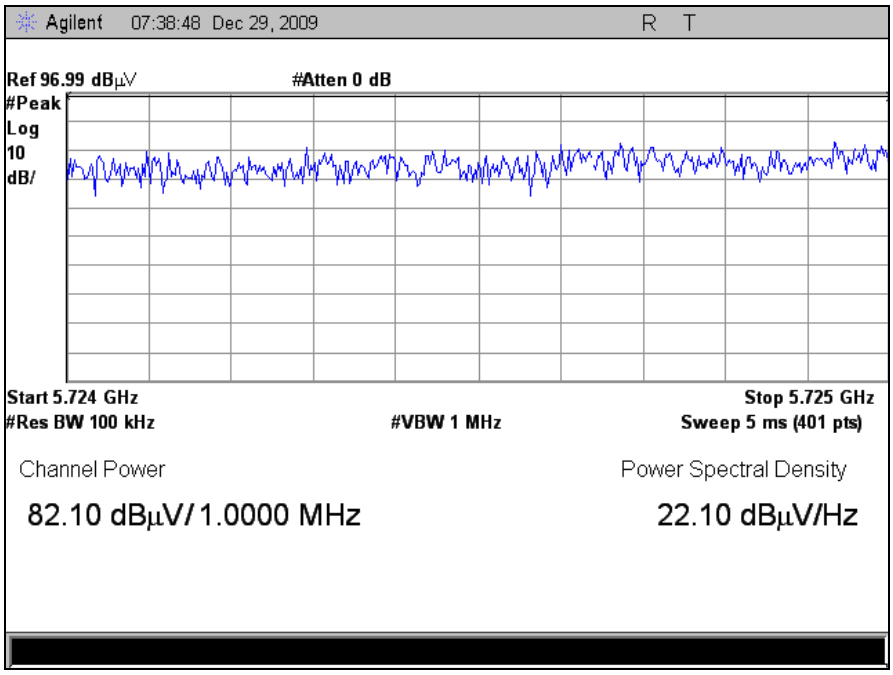


Plot 80. Radiated Spurs, 2nd Harmonic, Average, Channel 5805 MHz, M5 Radio

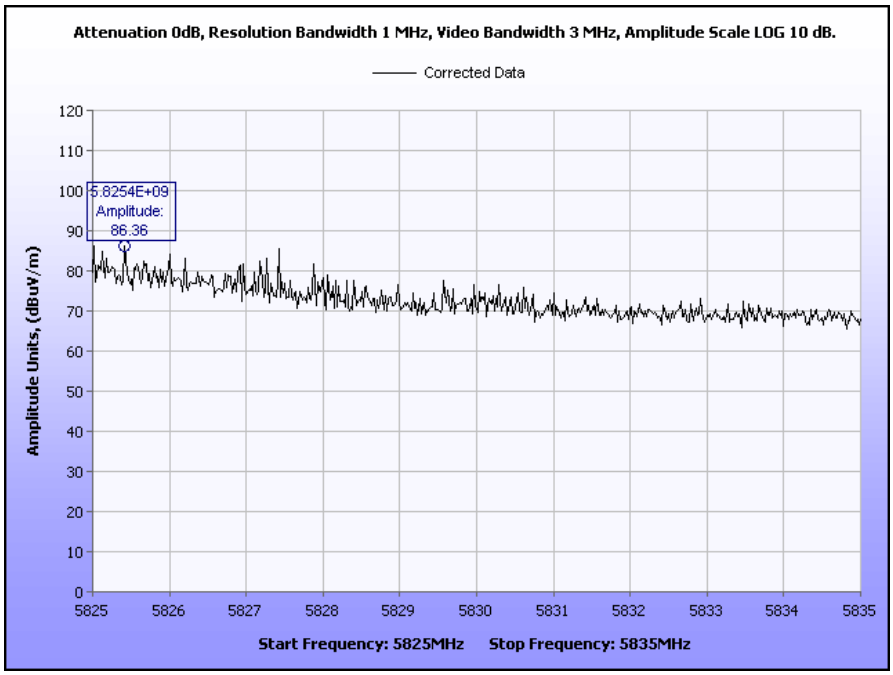
Radiated Band Edge Test Results



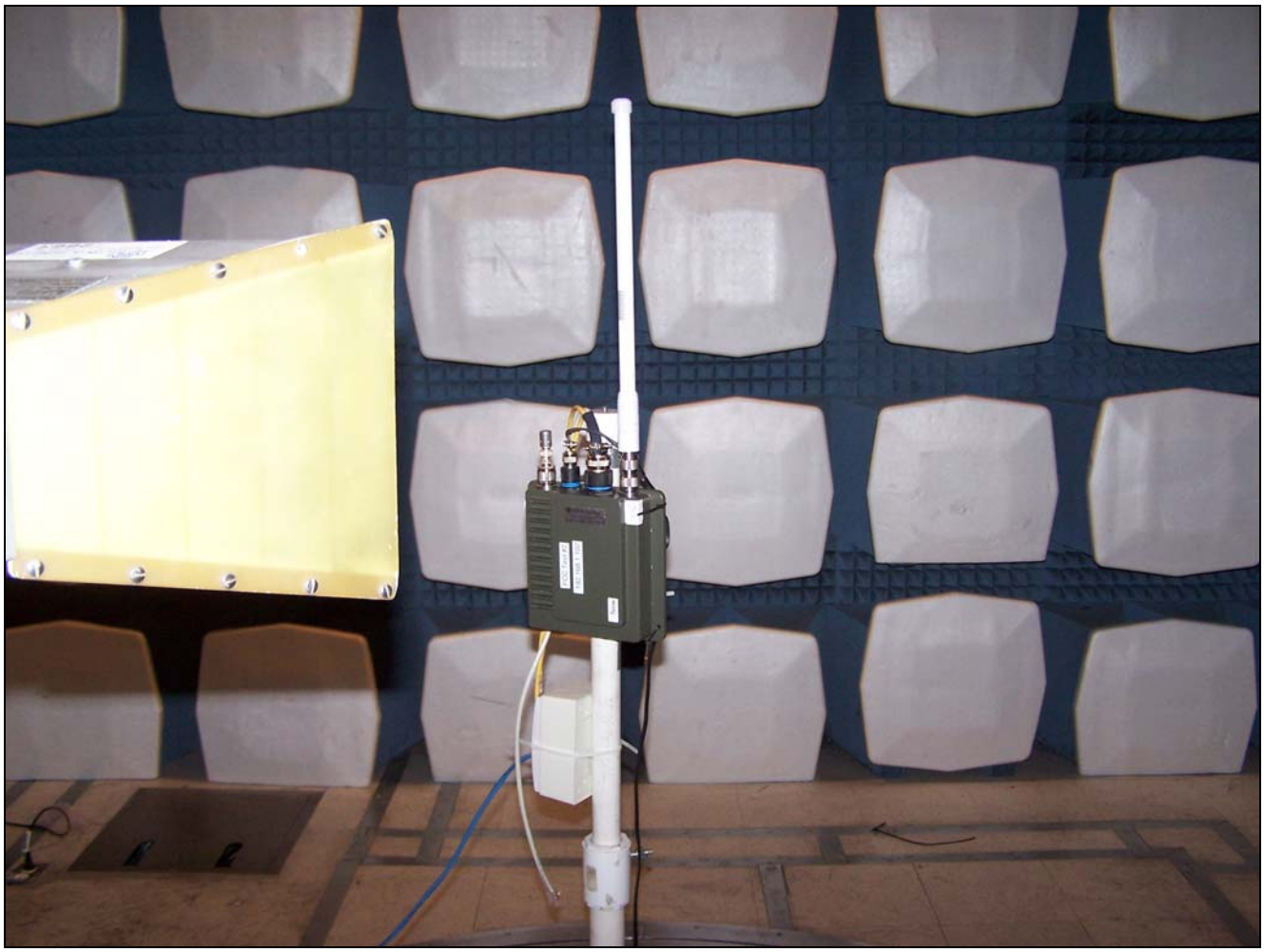
Plot 81. Radiated Band Edge, Lower Channel, 10 MHz Outside Band, M5 Radio



Plot 82. Radiated Band Edge, Lower Channel, 10 MHz Outside Band Integration, M5 Radio



Plot 83. Radiated Band Edge, Upper Channel, 10 MHz Outside Band, M5 Radio



Photograph 8. Radiated Emissions, Test Setup, M5 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(g) Frequency Stability – M5

Test Requirements: **§ 15.407(g):** Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

Test Procedure: The EUT was connected directly to a spectrum analyzer through a attenuator. The resolution band width of the spectrum analyzer was set to 10 KHz. The 1st trace of the Spectrum Analyzer was used as a reference at 20°C. A 2nd trace was used to show the drift of the carrier at extreme conditions. A delta marker was used to find the drift at a given extreme condition.

Test Results: The EUT was compliant with the requirements of **§15.407(g)**.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/22/09

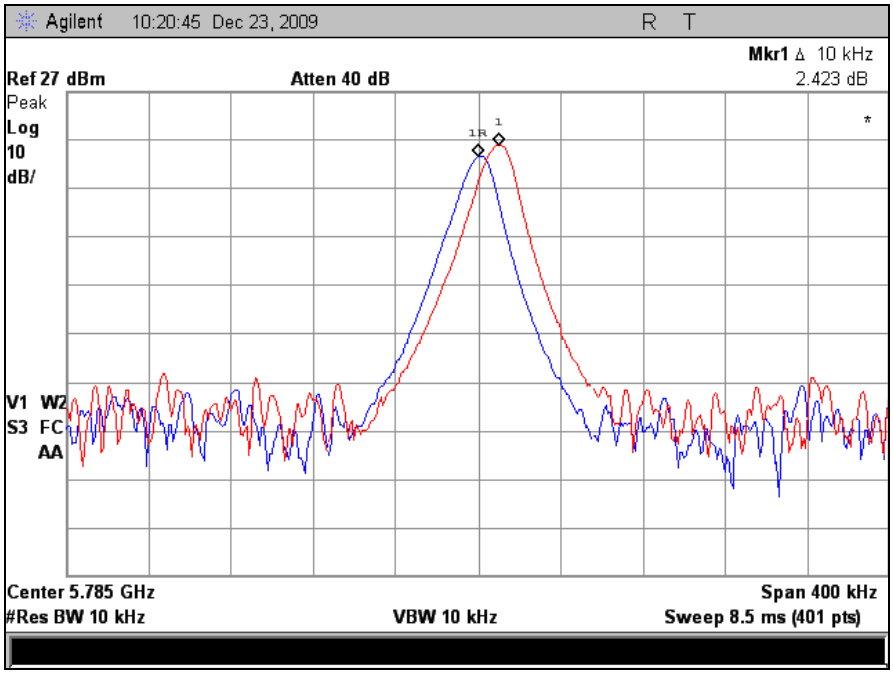
Temperature (centigrade)	Drift (kHz)	Drift (ppm)
55	130.0	22.5
50	124.0	21.4
40	84.0	14.5
30	45.0	7.8
20	ref	ref
10	6.0	1
0	-3.0	-0.5
-10	5.0	0.9
-20	10.0	1.7

Table 21. Frequency Stability, Reference 5785 MHz at 20°C, Test Results, M5 Radio

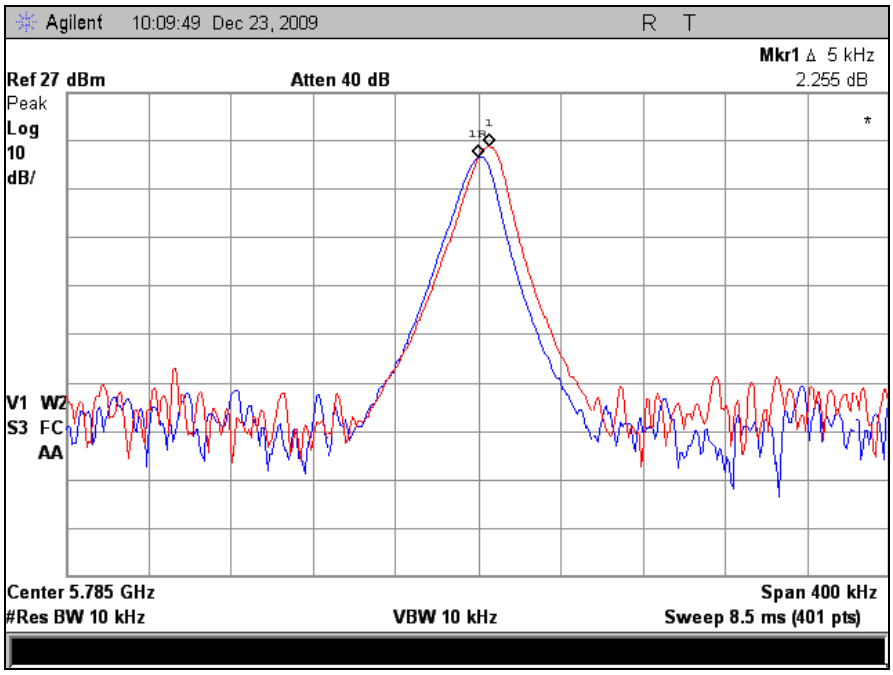
Voltage variation		
Voltage (VAC)	Drift (kHz)	Drift (ppm)
102	1	0.2
138	2	0.4

Table 22. Frequency Stability, Reference 5785 MHz at 120 VAC and 20°C, Test Results, M5 Radio

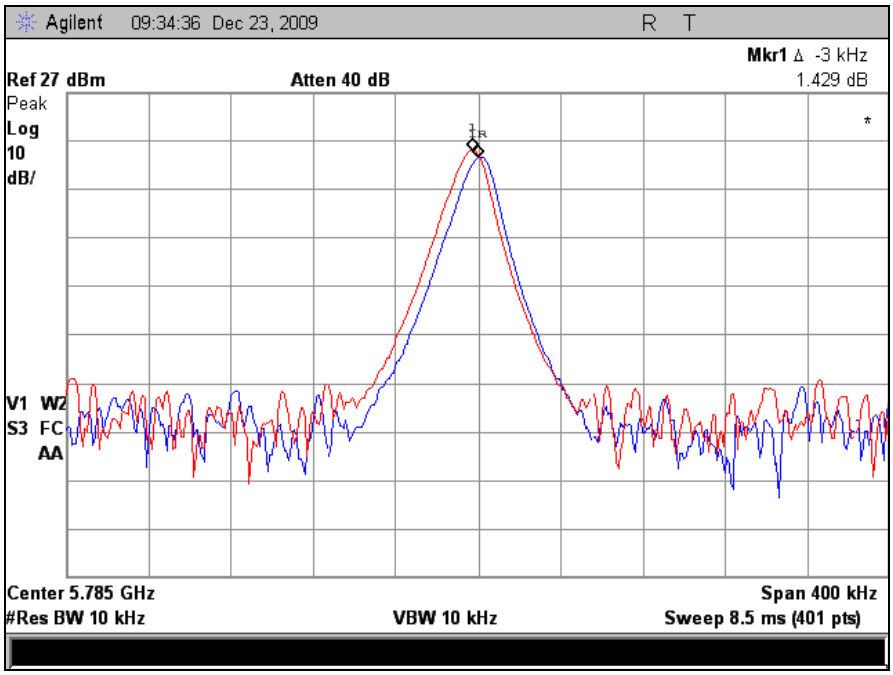
Frequency Stability Test Results



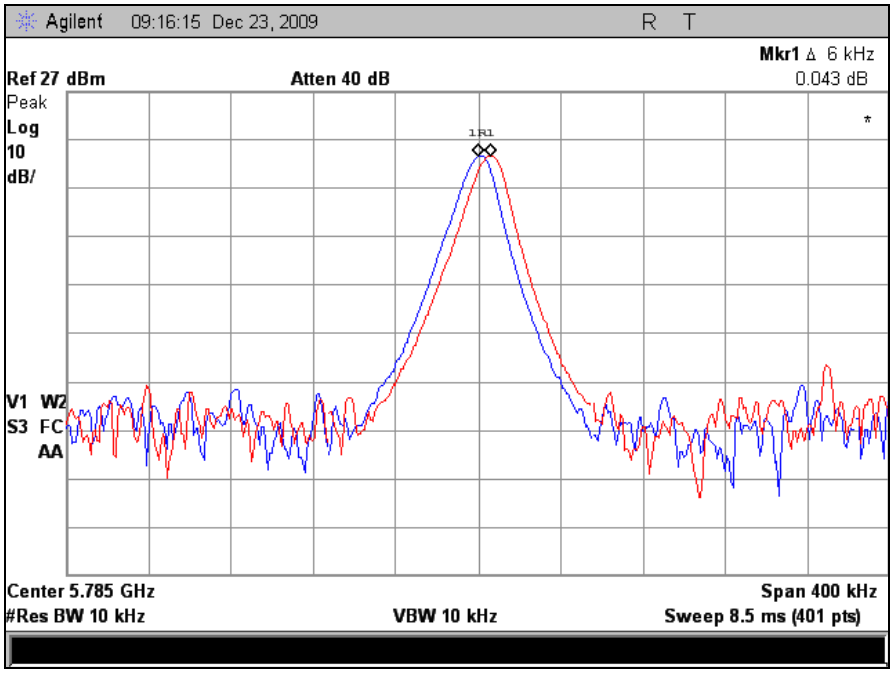
Plot 84. Frequency Stability, -20°C, M5 Radio



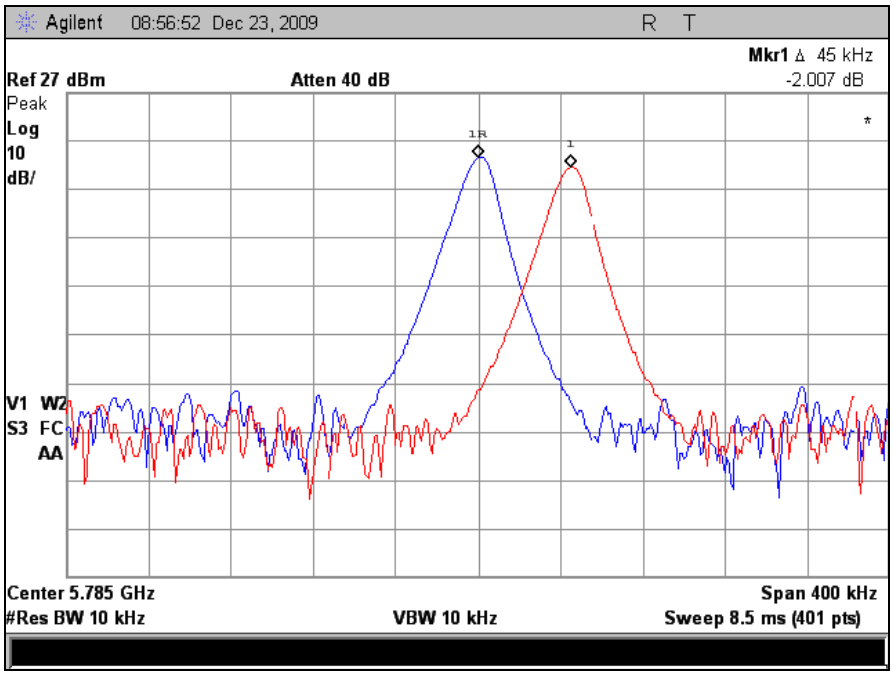
Plot 85. Frequency Stability, -10°C, M5 Radio



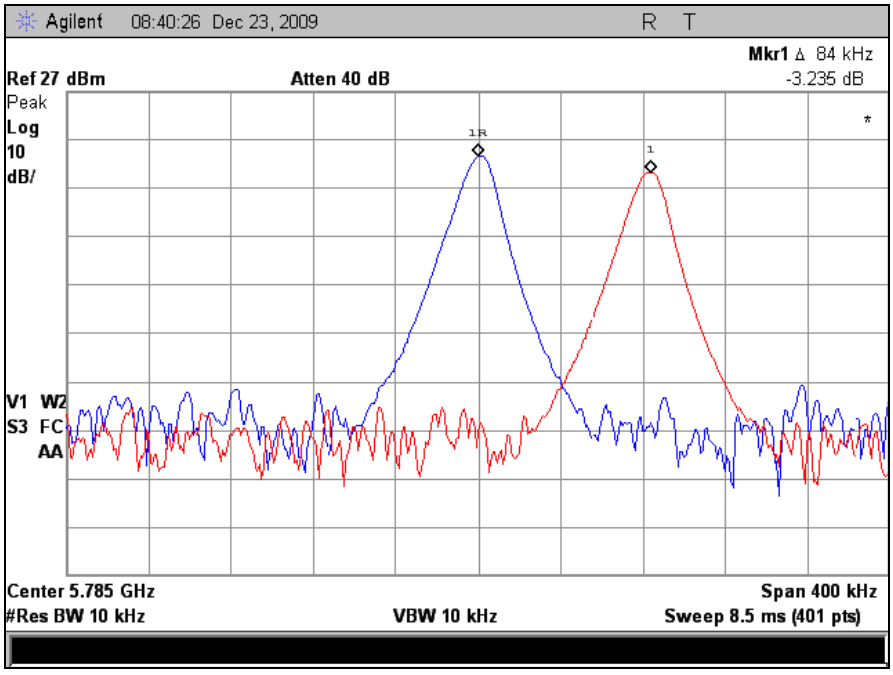
Plot 86. Frequency Stability, 0°C, M5 Radio



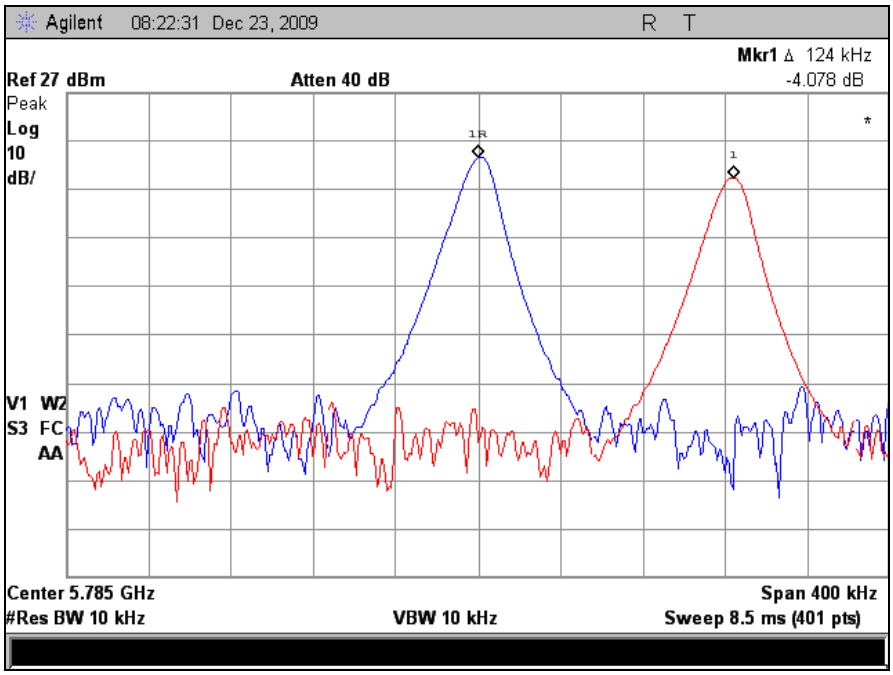
Plot 87. Frequency Stability, 10°C, M5 Radio



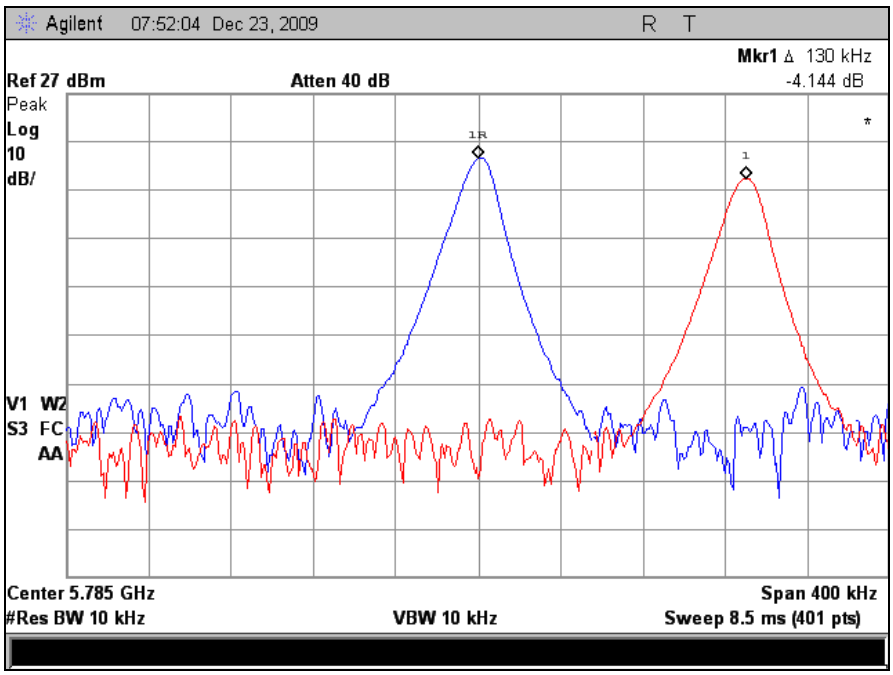
Plot 88. Frequency Stability, 30°C, M5 Radio



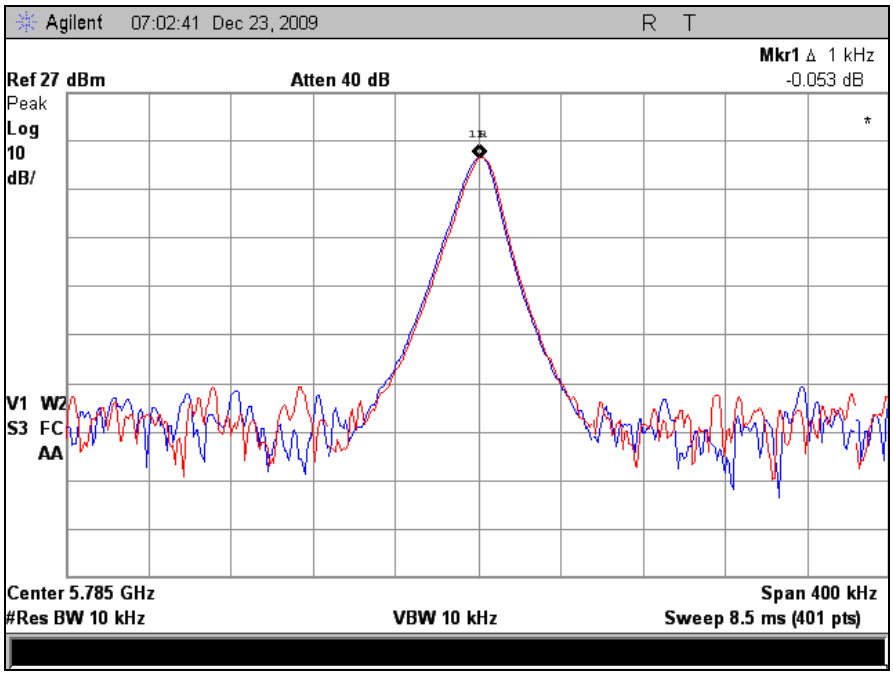
Plot 89. Frequency Stability, 40°C, M5 Radio



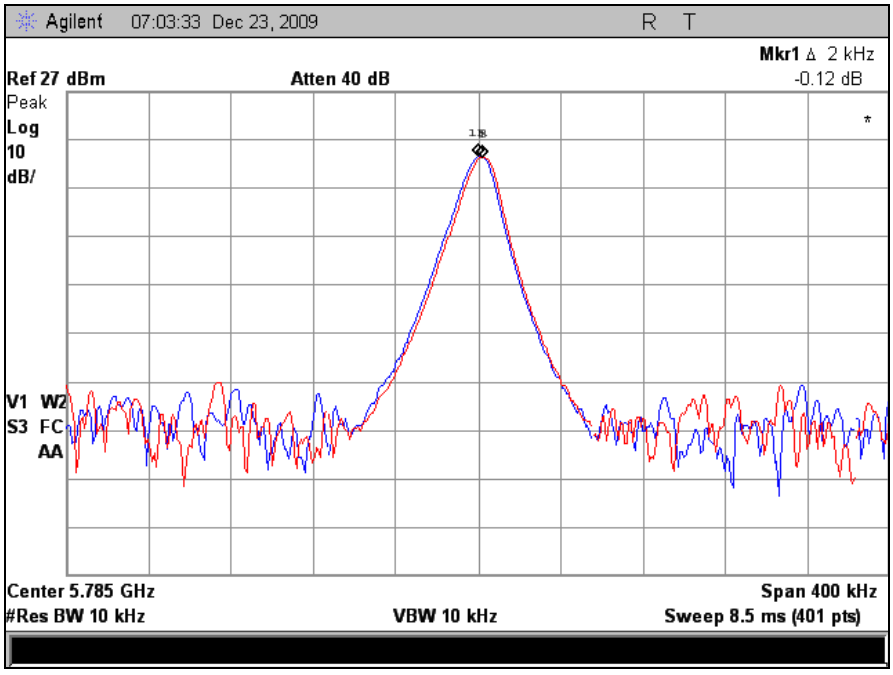
Plot 90. Frequency Stability, 50°C, M5 Radio



Plot 91. Frequency Stability, 55°C, M5 Radio



Plot 92. Frequency Stability, 102VAC, M5 Radio



Plot 93. Frequency Stability, 138VAC, M5 Radio

Photograph 9. Extreme Test Conditions, M5 Radio

Electromagnetic Compatibility Criteria for Intentional Radiators

RSS-GEN Receiver Spurious – M5

Test Requirement: If the device has a detachable antenna of known antenna impedance, then the antenna conducted method is permitted in lieu of a radiated measurement.

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.

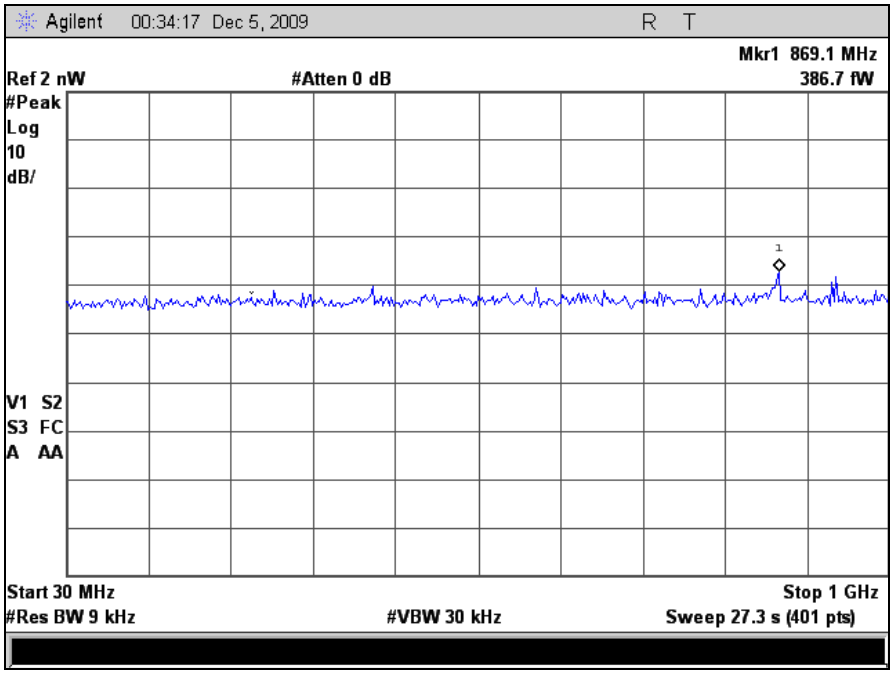
Test Procedure: The EUT was directly connected to a spectrum analyzer. Testing was performed when the EUT was receiving on channel 5785 MHz. Testing was performed conducted.

Results: The EUT as tested is compliant with the requirements of RSS-GEN.

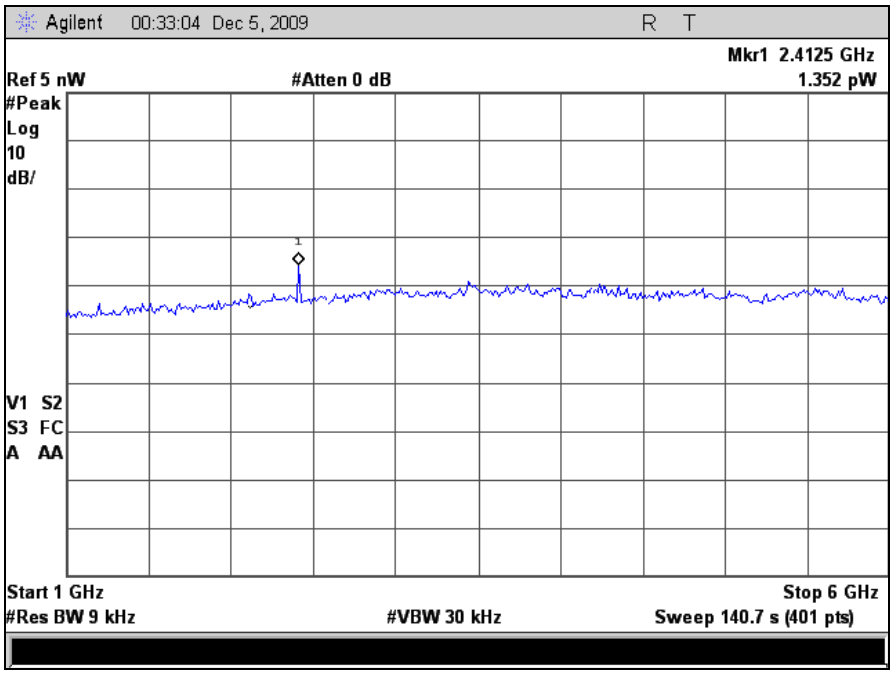
Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 12/22/09

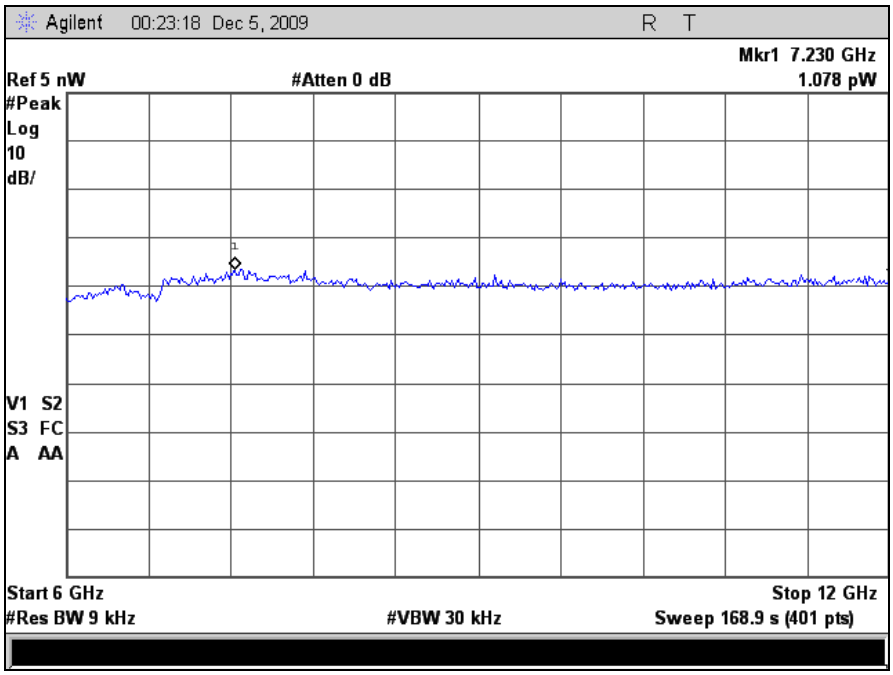
Receiver Spurious Emissions Test Results



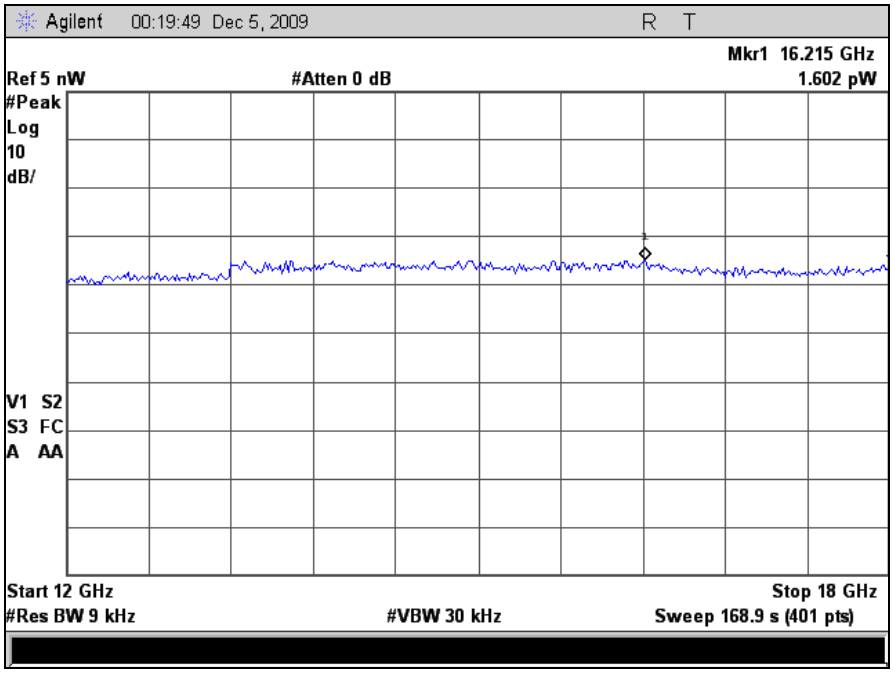
Plot 94. Receiver Spurious Emission, 3 0MHz – 1 GHz, M5 Radio



Plot 95. Receiver Spurious Emission, 1 GHz – 6 GHz, M5 Radio



Plot 96. Receiver Spurious Emission, 6 GHz – 12 GHz, M5 Radio



Plot 97. Receiver Spurious Emission, 12 GHz – 18 GHz, M5 Radio

IV. MPE Calculation – M25 and M5

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(f) 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.

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 = 7.9

M25 Radio:

MPE Limit Calculation: EUT's operating frequency is 5745 - 5805 MHz;. Highest conducted power = 34.3 mW (i.e. 15.35 dBm). Therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2.**

P = 34.3 mW
R = 20 cm
G = 7.9

$$S1 = 34.3*7.9 / 4(3.1416)(20)^2$$

$$S1 = 0.054\ mW/cm^2$$

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

M5 Radio:

MPE Limit Calculation: EUT's operating frequency is 5745 - 5805 MHz;. Highest conducted power = 60.4 mW (i.e. 17.81 dBm). Therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2.**

P = 60.4 mW
R = 20 cm
G = 7.9

$S2 = 60.4*7.9 / 4(3.1416)(20)^2$

$S\ 2= 0.095\ mW/cm^2$

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

Co-location:

S	Power density (mW/cm²)	General Population Limit (mW/cm²)	S as a fraction of the limit (%)
S1	0.054	1	5.4
S2	0.095	1	9.5

The total percentages do not exceed 100 % per OET 65 requirements when the spectral power density is calculated at least 20cm away from the unit.

V. Test Equipment

Test Equipment

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

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4303	ANTENNA; BILOG	SCHAFNER - CHASE EMC	CBL6140A	07/29/2009	07/29/2010
1T4414	MICROWAVE PRE-AMPLIFIER	AH SYSTEMS	PAM-0118	SEE NOTE	
1T4300	SEMI-ANECHOIC CHAMBER # 1	EMC TEST SYSTEMS	NONE	08/24/2007	08/24/2010
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	05/07/2009	05/07/2010
1T4548	AC POWER SOURCE	CALIFORNIA INSTRUMENTS	1251P	SEE NOTE	
1T2511	ANTENNA; HORN	EMCO	3115	08/21/2009	08/21/2010
1T4592	RF FILTER KIT	VARIOUS	N/A	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
1T2665	HORN ANTENNA	EMCO	3115	07/06/2009	07/06/2010

Table 23. Test Equipment List

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

VI. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

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

§ 2.801 Radio-frequency device defined.

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

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

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

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

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

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

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

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

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

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

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

(i) Compliance testing;

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

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

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

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

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

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

Certification & User's Manual Information

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

§ 2.901 Basis and Purpose

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

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

§ 2.907 Certification.

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

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

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

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

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

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

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

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

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

Certification & User's Manual Information

Label and User's Manual Information

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

§ 15.19 Labeling requirements.

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

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

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

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

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

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

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

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

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

§ 15.21 Information to user.

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

Verification & User's Manual Information

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

§ 15.105 Information to the user.

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

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

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

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

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

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

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

End of Report