MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
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33439 WESTERN AVENUE ● UNION CITY, CALIFORNIA 94587 ● PHONE (510) 489-6300 ● FAX (510) 489-6372
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February 17, 2011

Autani Corp
7125 Columbia Gateway Drive
Columbia, MD 21046

Dear Mark Plasterer,

Enclosed is the EMC Wireless test report for compliance testing of the Autani Corp, ZigBee to RS485/RS232 Bridge (ZRB2) as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart B, ICES-003, Issue 4 February 2004 for a Class B Digital Device and FCC Part 15 Subpart C, RSS-210, Issue 8, Dec. 2010 for Intentional Radiators.

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

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Autani Corp\EMC29994-FCC247 Rev. 2)

Electromagnetic Compatibility Criteria
Test Report

for the

Autani Corp
ZigBee to RS485/RS232 Bridge (ZRB2)

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart B & ICES-003
for Class B Digital Devices
&
15.247 Subpart C & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

MET Report: EMC29994-FCC247 Rev. 2

February 17, 2011

Prepared For:

Autani Corp
7125 Columbia Gateway Drive
Columbia, MD 21046

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

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for Intentional Radiators

Len Knight, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Parts 15B, 15.247 and Industry Canada standards ICES-003, Issue 4 February 2004, RSS-210, Issue 8, Dec. 2010 under normal use and maintenance.

Shawn McMillen,
Wireless Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	January 19, 2011	Initial Issue.
1	February 11, 2011	Revised per engineer corrections.
2	February 17, 2011	Editorial corrections.

Table of Contents

List of Tables

List of Plots

List of Figures

List of Photographs

List of Terms and Abbreviations

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

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Autani Corp ZigBee to RS485/RS232 Bridge (ZRB2), with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the ZigBee to RS485/RS232 Bridge (ZRB2). Autani Corp should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the ZigBee to RS485/RS232 Bridge (ZRB2), has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Autani Corp, purchase order number 20100199-02. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference 47 CFR Part 15.247:2005	IC Reference RSS-210 Issue 8: 2010	Description	Compliance
47 CFR Part 15.107 (a)	ICES-003 Issue 4 February 2004	Conducted Emission Limits for a Class B Digital Device	Compliant
47 CFR Part 15.109 (a)	ICES-003 Issue 4 February 2004	Radiated Emission Limits for a Class B Digital Device	Compliant
Title 47 of the CFR, Part 15 §15.203	N/A	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	RSS-210(7.2.2)	Conducted Emission Voltage	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	RSS-210(A8.1)	Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	RSS-210(A8.4)	RF Output Power	Compliant
Title 47 of the CFR, Part 15 §15.209, §15.247(d)	RSS-210(A8.5)	Radiated Spurious Emissions	Compliant
Title 47 of the CFR, Part 15 §15.205	RSS-210(A8.5)	Emissions at Restricted Band	Compliant
Title 47 of the CFR, Part 15 §15.209, §15.247(d)	RSS-210(A8.5)	Conducted Spurious Emissions	Compliant
Title 47 of the CFR, Part 15; §15.247(e)	RSS-210(A8.3)	Power Spectral Density	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	RSS-Gen(5.6)	Maximum Permissible Exposure	Compliant
N/A	RSS-Gen(6.1)	Receiver Spurious Emissions	Compliant

Table 1. Executive Summary of EMC Part 15.247 Compliance Testing

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Autani Corp to perform testing on the ZigBee to RS485/RS232 Bridge (ZRB2), under Autani Corp's purchase order number 20100199-02.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Autani Corp, ZigBee to RS485/RS232 Bridge (ZRB2).

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

Model(s) Tested:	ZigBee to RS485/RS232 Bridge (ZRB2)	
Model(s) Covered:	ZigBee to RS485/RS232 Bridge (ZRB2)	
EUT Specifications:	Primary Power: 120 VAC, 60 Hz	
	FCC ID: V8NZRB1000141 IC: 7737A-ZRB1000141	
	Type of Modulations:	O-QPSK
	Equipment Code:	DTS
	Peak RF Output Power:	79.43 mW
	EUT Frequency Ranges:	2405 – 2480 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:	Len Knight	
Report Date(s):	February 17, 2011	

Table 2. EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
RSS-210, Issue 8, Dec. 2010	Low-power Licence-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment
CFR 47, Part 15, Subpart B	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
ICES-003, Issue 4 February 2004	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
ANSI C63.4:2003	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI/NCSL Z540-1-1994	Calibration Laboratories and Measuring and Test Equipment - General Requirements
ANSI/ISO/IEC 17025:2000	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2009	American National Standard for Testing Unlicensed Wireless Devices

Table 3. References

C. Test Site

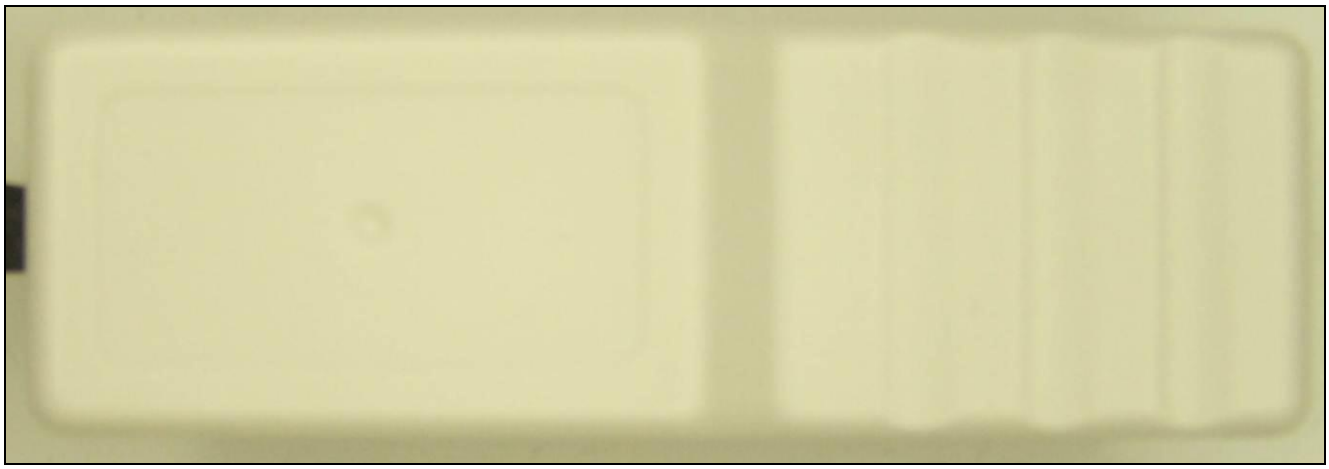
All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave., Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

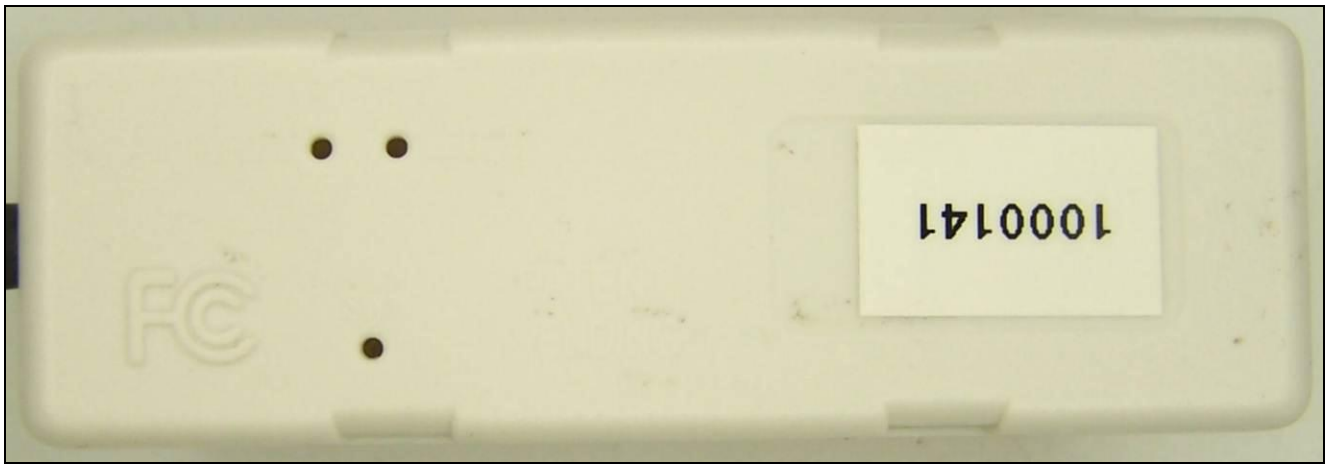
D. Description of Test Sample

The Autani Corp ZRB2, Equipment Under Test (EUT), is a bridge between two interfaces: wireless ZigBee and wired (half/full-duplex) RS485 or RS232. Messages, data, and control are passed from one medium to the other by this device. Information can originate on either side of the interface. The firmware loaded into the ZRB2 controls how the information is processed and forwarded on each interface. ZigBee is the only wireless protocol supported; however, many wired protocols can be supported (i.e. BakNET, LonWorks, etc.).

The ZRB2 supports 3 primary product lines: RS485, RS232, and the Integrated Thermostat (iSat).



Photograph 1. Autani Corp ZigBee to RS485/RS232 Bridge (ZRB2), Front View



Photograph 2. Autani Corp ZigBee to RS485/RS232 Bridge (ZRB2), Rear View

Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

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

Ref. ID	Name / Description	Model Number	Part Number	Manufacturer	Revision
A	ZigBee to RS485/RS232 Bridge (ZRB2)	1000141	N/A	Autani Corp.	1
B	24 VAC Wall Wart	48A-24-500	EPA 240050-S/T-SZ	CUI Inc.	N/A

Table 4. Equipment Configuration

F. Support Equipment

The EUT did not require any support equipment for operation or monitoring.

G. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
1	Unit Interface	6 conductor, 26 AWG	1	0.33	No	B

Table 5. Ports and Cabling Information

H. Mode of Operation

Production Mode:
The ZRB2 is configured wirelessly through the ZigBee interface. Once configured, the mode of the operation is dependent on the firmware loaded into the device; however, each mode has the same basic features. Each mode allows wireless traffic to be transferred to the wired interface and vice-versa.

FCC Mode:
The ZRB2 has a special image programmed into the SoC to facilitate the FCC testing. This image represents the worse possible case from a noise perspective. The following details the operation and how to change states.

There is one switch (SW1) and two LED's (LED1 and LED2) on the ZRB2. The function is as follows:

1) At board power-on, both LED's are off and there is no RF transmission.
2) A long press, ~3 seconds, of SW1 repeatedly sequences the user through the following 4 states:
   State 1) RF channel 11 is selected and a CW tone is transmitted. LED2 turns solid green.
   State 2) RF channel 18 is selected and a CW tone is transmitted. LED2 turns solid amber.
   State 3) RF channel 25 is selected and a CW tone is transmitted. LED2 turns solid red.
   State 4) RF channel 26 is selected and a CW tone is transmitted. LED2 turns solid green.
   State 5) No channel is selected and the RF transmitter is turned off. ALL LED's are turned off.
3) A short press, ~1 second, of SW1while states in 1-4 above causes the CW tone to be replaced with a modulated tone containing pseudo-random data. LED1 turns solid green while the pseudo-random modulation is in effect.

I. Method of Monitoring EUT Operation

Production Mode:
The device has two indicating LED's which provide status feedback to the user/installer. If the device is operating as anticipated one of the LED's will be blinking red or green. If the device is not performing to the manufacturer's intended operation, the LED's should be off.

FCC Mode:
If the device is operating as described in the Modes of Operation section, in states 1-4 above, one should see RF energy in the ISM band. If the device is not operating properly, states 1-4 above will show no RF energy in the ISM band.

J. Modifications

a) Modifications to EUT
No modifications were made to the EUT.

b) Modifications to Test Standard
No modifications were made to the test standard.

K. Disposition of EUT

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

III. Electromagnetic Compatibility Criteria for Unintentional Radiators

Electromagnetic Compatibility Criteria

§ 15.107 Conducted Emissions Limits

Test Requirement(s): **15.107 (a)** Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in Table 6. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

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

Table 6. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b) and 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2003 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter.

Two difference units were evaluated; the RS485 and the RS232. Both devices have identical transmitters. The only difference is the digital interface.

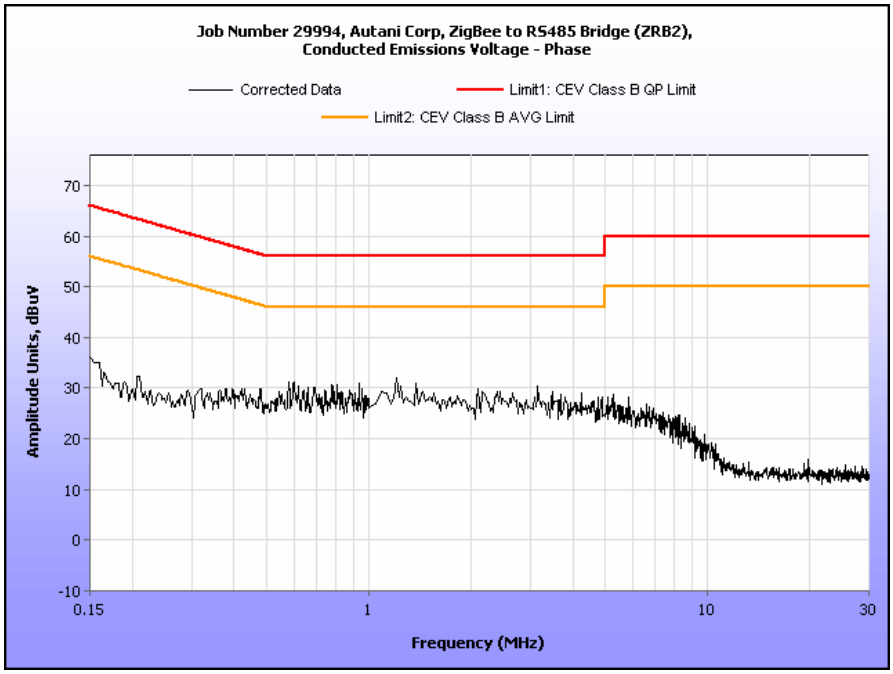
In order to show compliance, peak data was compared to a quasi-peak and average limit line. No additional measurements were made since the peak data was more than 10 dB below the average limit line.

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

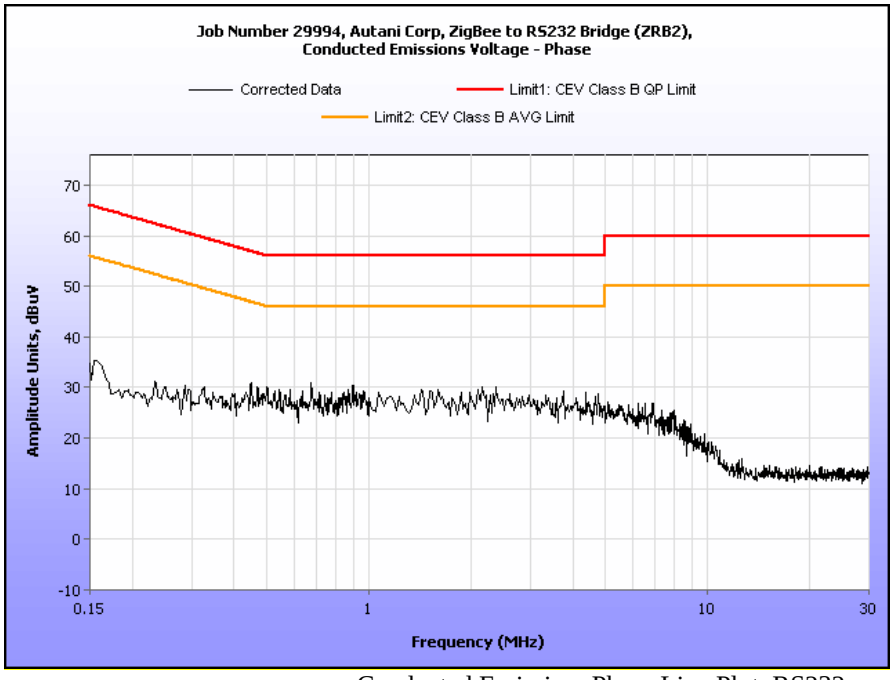
Test Engineer(s): Len Knight

Test Date(s): 01/04/11

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

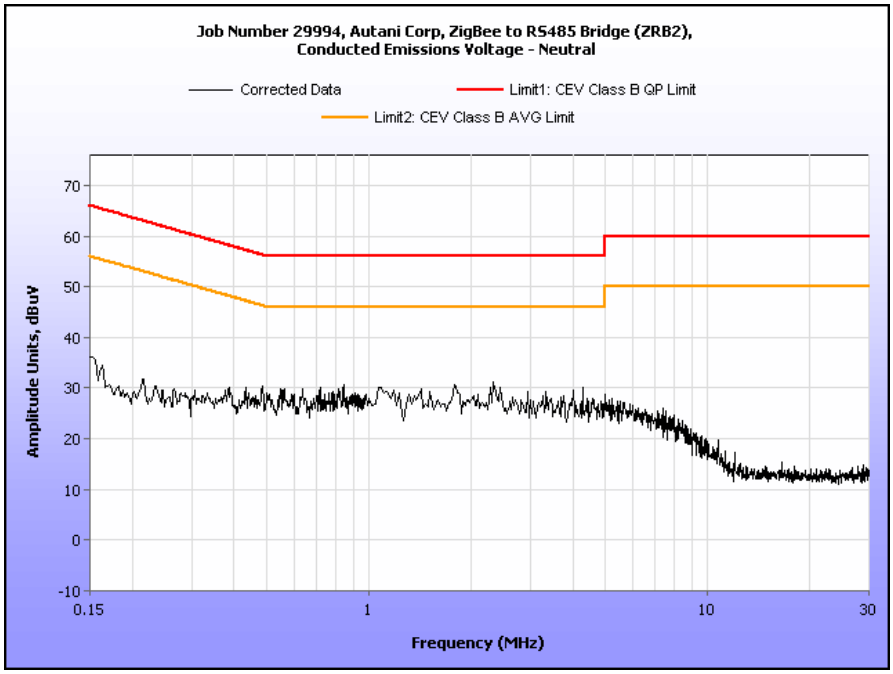


. Conducted Emission, Phase Line Plot, RS485

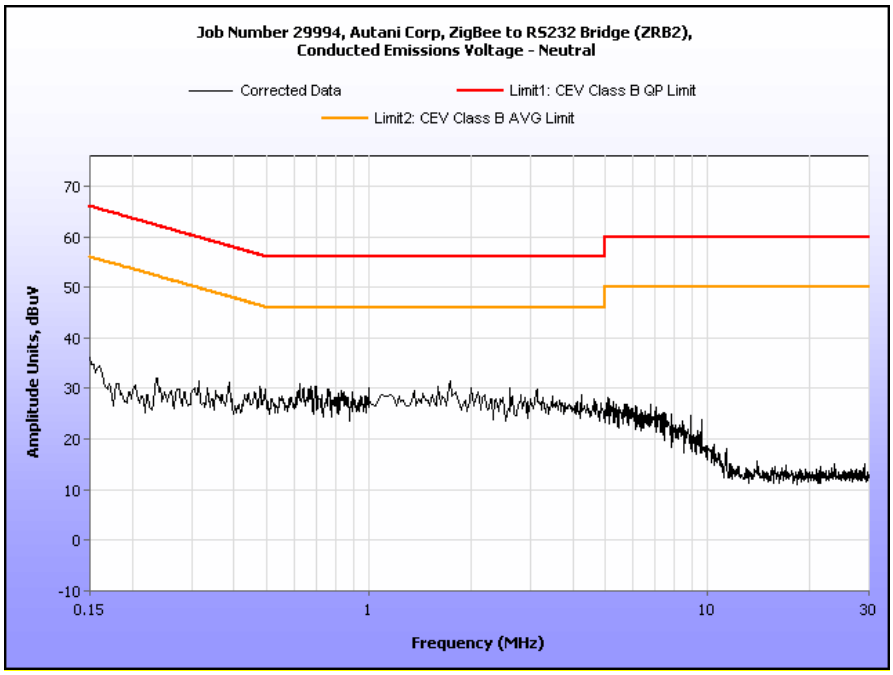


. Conducted Emission, Phase Line Plot, RS232

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



Plot 1. Conducted Emission, Neutral Line Plot, RS485



Plot 2. Conducted Emission, Neutral Line Plot, RS232

Conducted Emission Limits Test Setup

Photograph 3. Conducted Emissions, Test Setup

Radiated Emission Limits

§ 15.109 Radiated Emissions Limits

Test Requirement(s): **15.109 (a)** Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the Class B limits expressed in Table 7.

15.109 (b) The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the Class A limits expressed in Table 7.

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

Table 7. Radiated Emissions Limits calculated from FCC Part 15, §15.109 (a) (b)

Test Procedures: The EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4 were used. An antenna was located 3 m from the EUT on an adjustable mast. A pre-scan was first performed in order to find prominent radiated emissions. The antenna height was varied between 1 m and 4 m in order to maximize the emissions. Measurements were made in both horizontal and vertical polarities. Scans were made using a peak detector with a 100 kHz bandwidth.

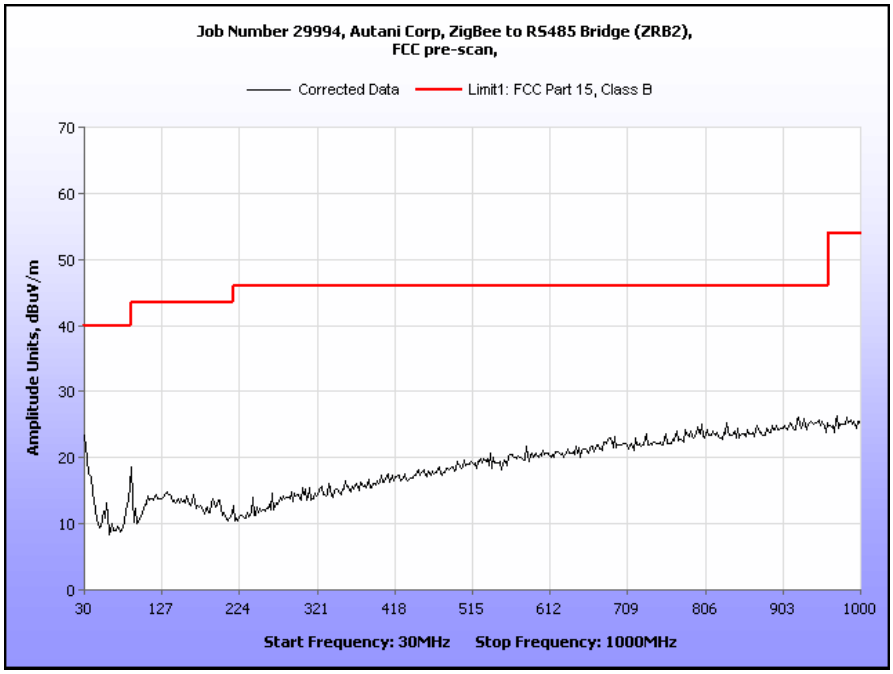
Two different units were evaluated; the RS485 and the RS232. Both devices have identical transmitters. The only difference is the digital interface.

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

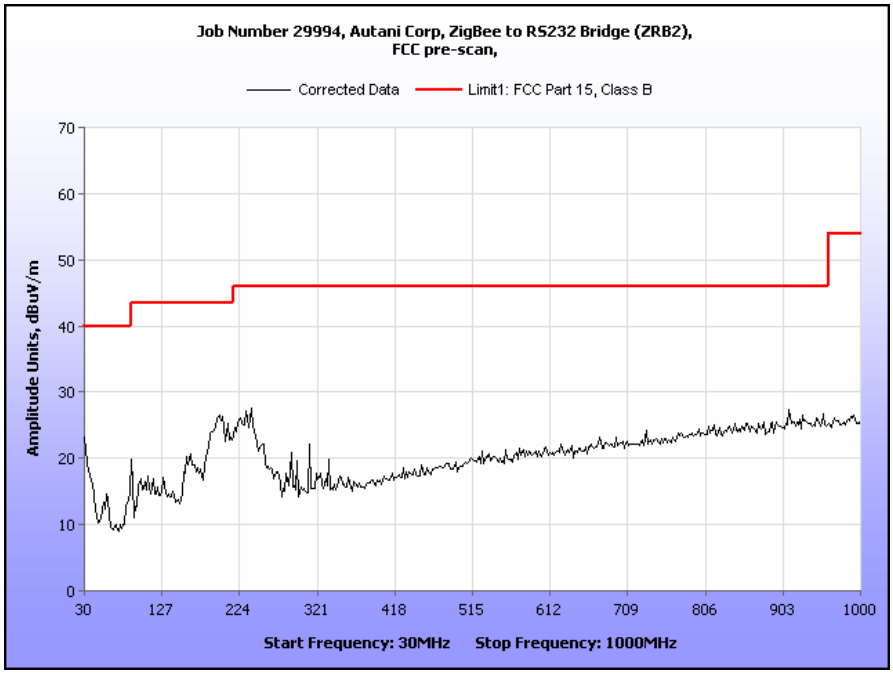
Test Engineer(s): Len Knight

Test Date(s): 12/27/10

Radiated Emissions Limits Test Results, Class B

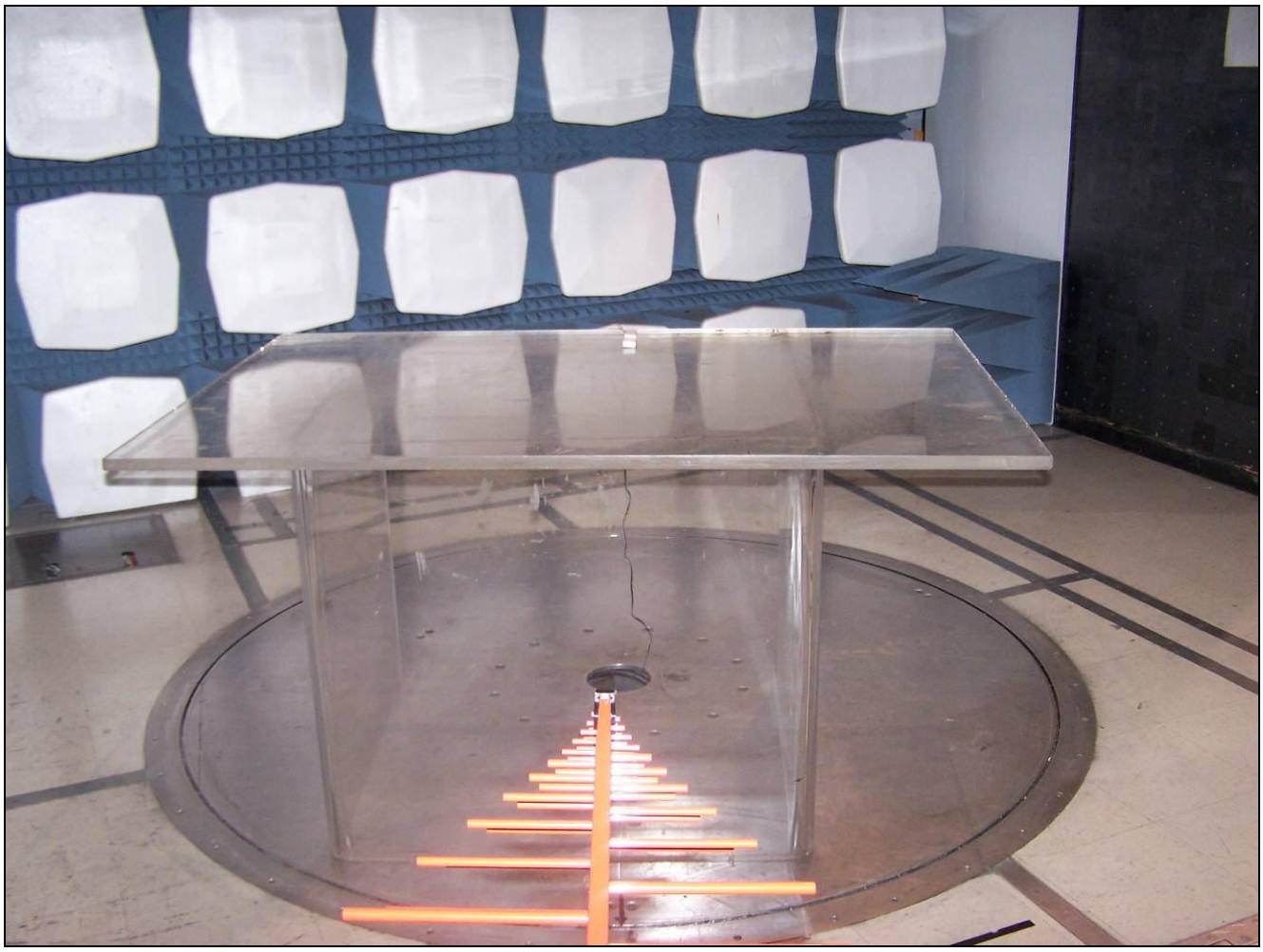


Plot 3. Radiated Emissions, 30 MHz - 1 GHz, RS485



Plot 4. Radiated Emissions, 30 MHz - 1 GHz, RS232

Radiated Emission Limits Test Setup



Photograph 4. Radiated Emission, Test Setup

IV. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The EUT as tested is compliant the criteria of §15.203. The EUT has an integral antenna.

Test Engineer(s): Len Knight

Test Date(s): 01/03/11

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207 Conducted Emissions Limits

Test Requirement(s): **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dBμV)	
	Quasi-Peak	Average
* 0.15- 0.45	66 - 56	56 - 46
0.45 - 0.5	56	46
0.5 - 30	60	50

Table 8. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2003 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on to the channel will the highest power.

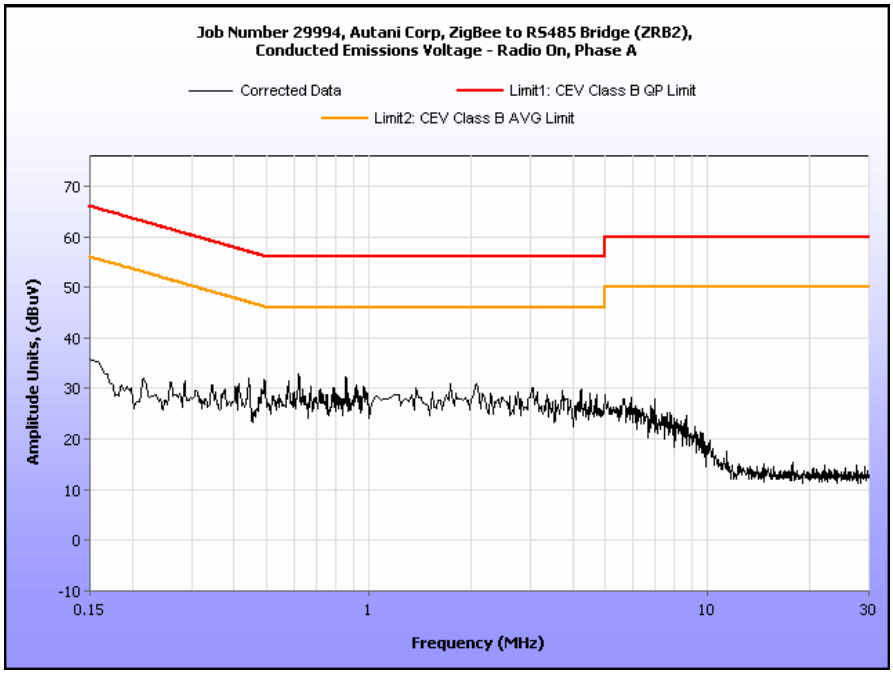
In order to show compliance, peak data was compared to a quasi-peak and average limit line. No additional measurements were made since the peak data was more than 10 dB below the average limit line.

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

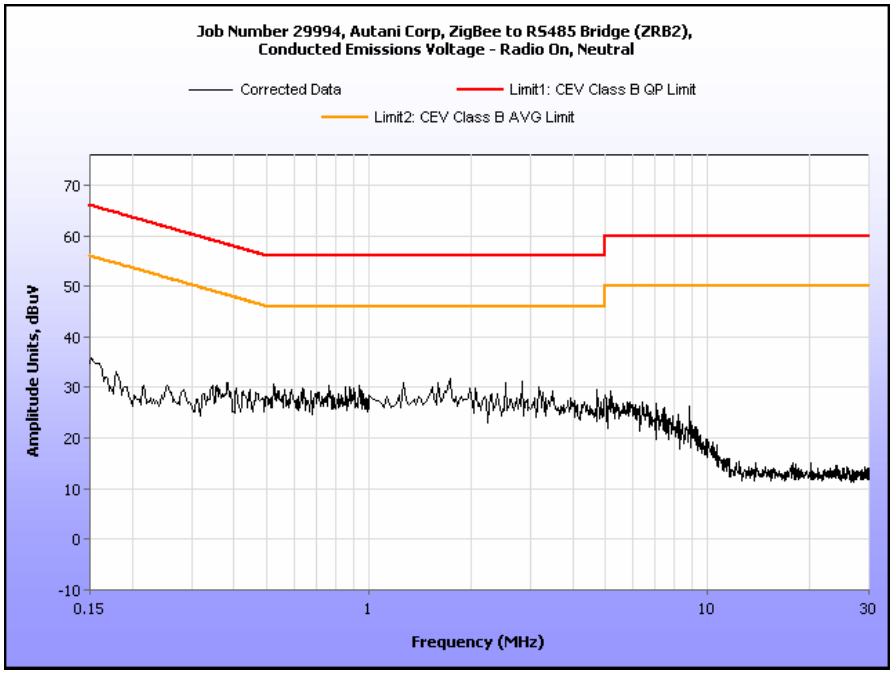
Test Engineer(s): Len Knight

Test Date(s): 01/04/11

15.207 Conducted Emissions Test Results



Plot 5. Conducted Emissions, Phase Line



Plot 6. Conducted Emissions, Neutral Line

15.207 Conducted Emissions Test Setup Photo

Photograph 5. Conducted Emissions, 15.207, Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a) 6 dB and 99% Bandwidth

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

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

Test Procedure: The transmitter was on and transmitting at the highest output power according to each channel as appropriate. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately 1% of the total emission bandwidth, VBW > RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and two high channels.

For the purposes of testing, a sample of the EUT was prepared with an SMA connector in place of the integral antenna.

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): Len Knight

Test Date(s): 01/04/11

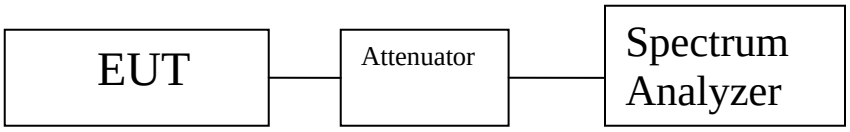


Figure 2. Block Diagram, Occupied Bandwidth Test Setup

Occupied Bandwidth Test Results

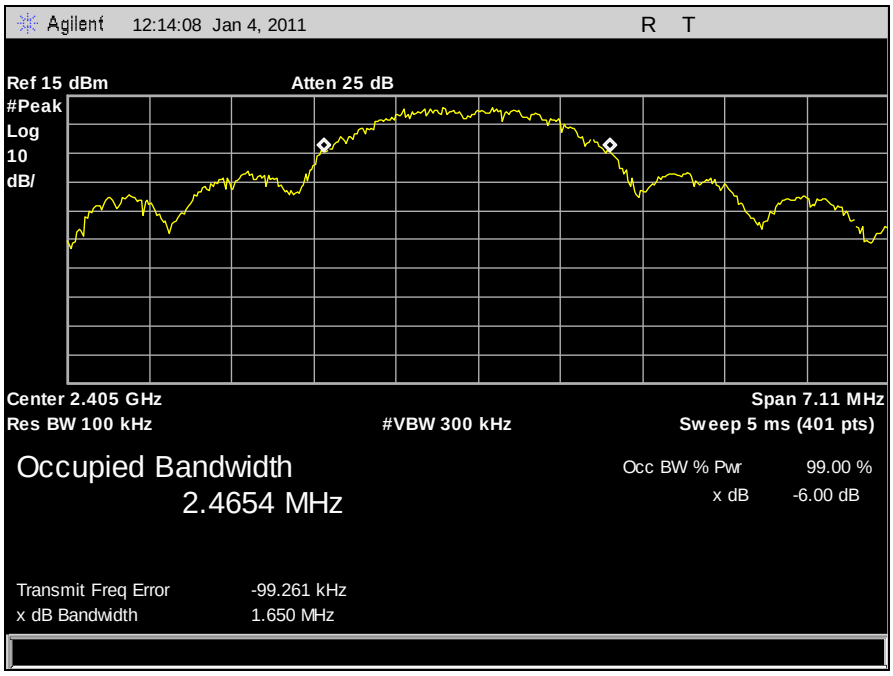
Occupied Bandwidth		
Carrier Channel	**Frequency (MHz)**	**Measured 6 dB Bandwidth (MHz)**
11	2405	1.650
18	2440	1.581
25	2475	1.576
26	2480	1.497

Table 9. 6 dB Occupied Bandwidth, Test Results

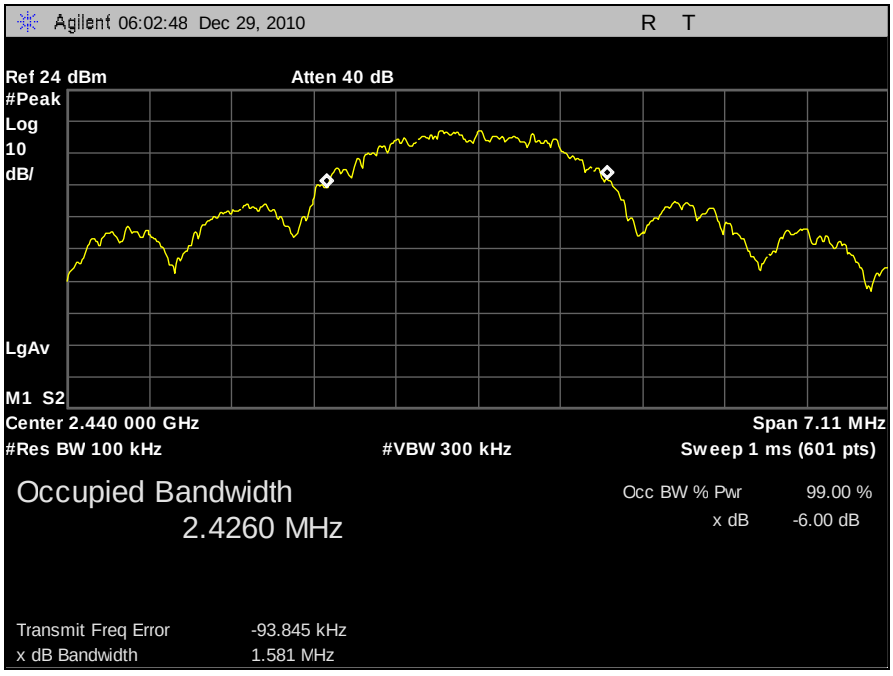
Occupied Bandwidth		
Carrier Channel	**Frequency (MHz)**	**Measured 99% Bandwidth (MHz)**
11	2405	2.3897
18	2440	2.3727
25	2475	2.3135
26	2480	2.4562

Table 10. 99% Occupied Bandwidth, Test Results

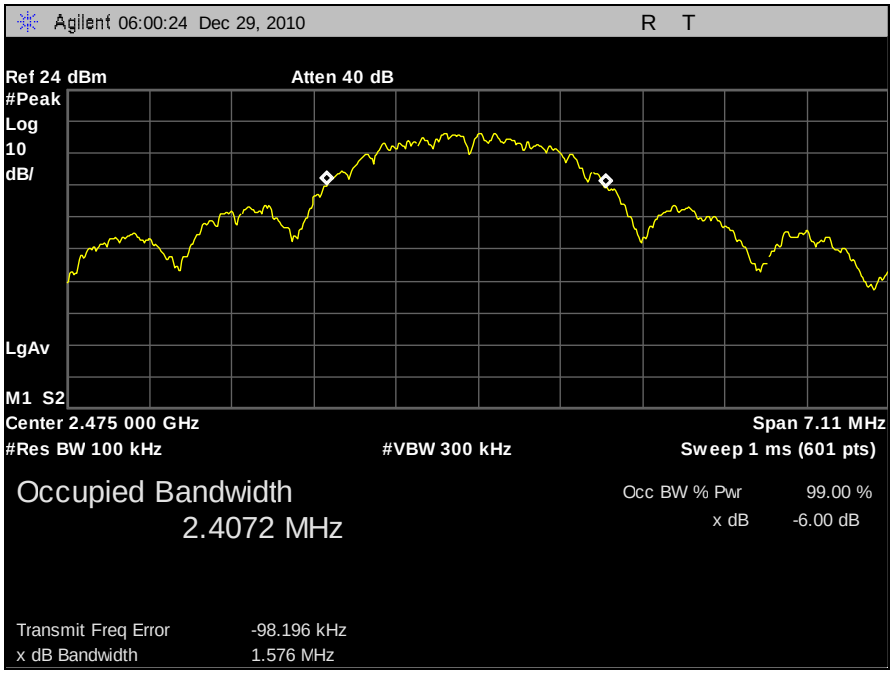
Occupied Bandwidth Test Results



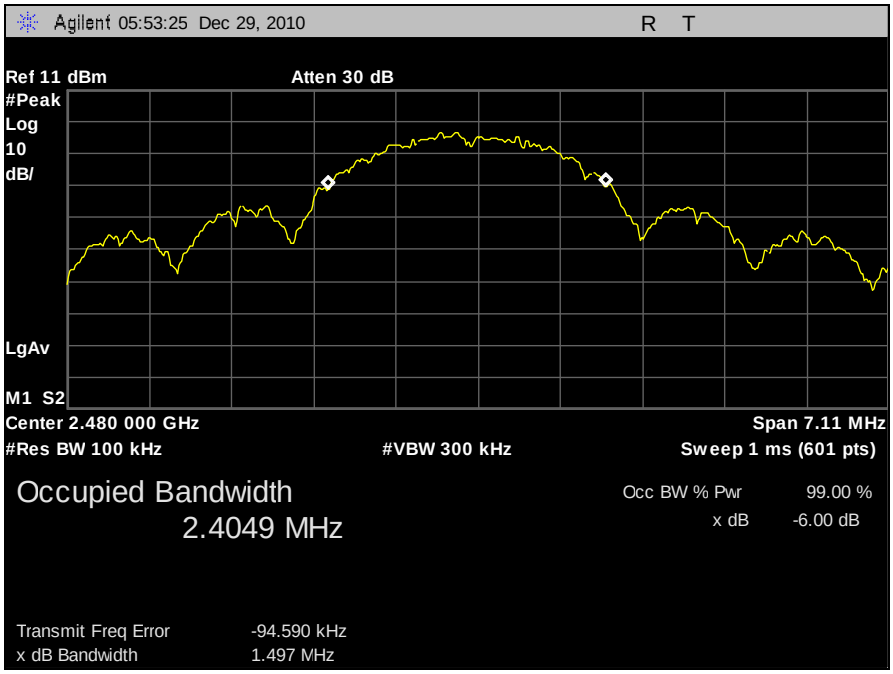
Plot 7. 6 dB Occupied Band Width, Channel 11



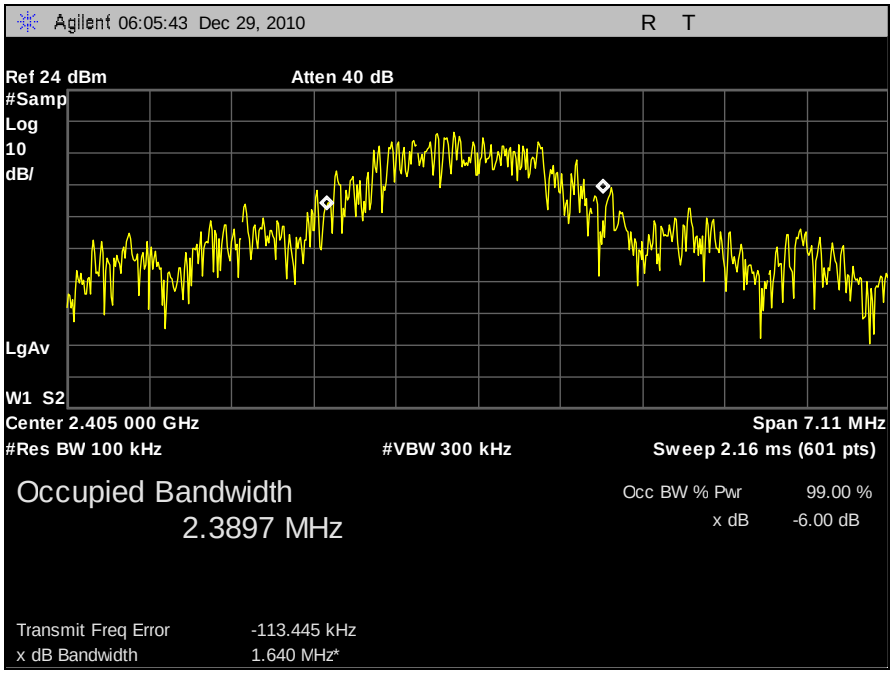
Plot 8. 6 dB Occupied Band Width, Channel 18



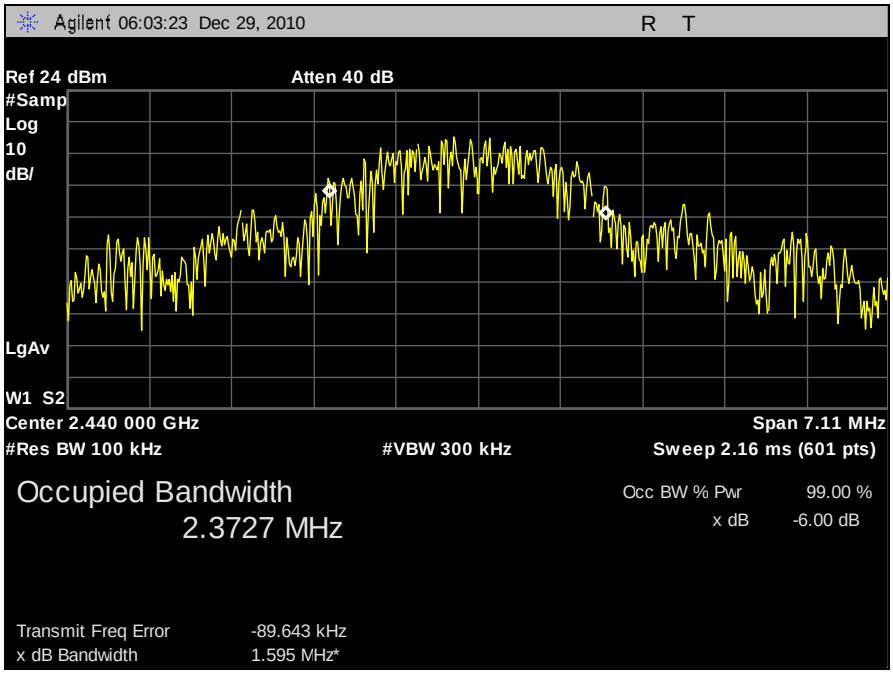
Plot 9. 6 dB Occupied Band Width, Channel 25



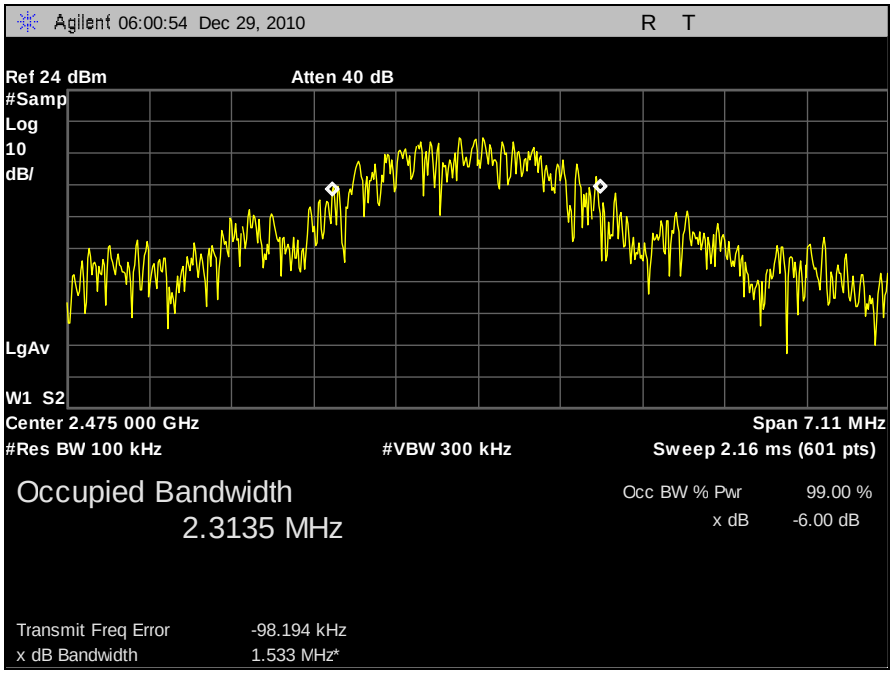
Plot 10. 6 dB Occupied Band Width, Channel 26



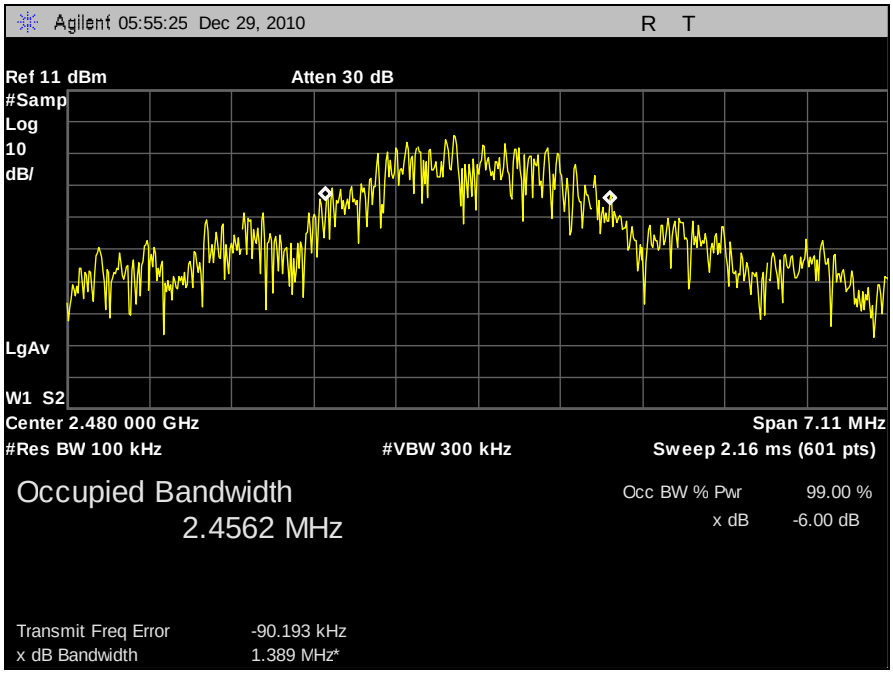
Plot 11. 99% Occupied Band Width, Channel 11



Plot 12. 99% Occupied Band Width, Channel 18



Plot 13. 99% Occupied Band Width, Channel 25



Plot 14. 99% Occupied Band Width, Channel 26

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output and RF Exposure

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

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

Table 11. 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 11, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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

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

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

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The power measuring function of the spectrum analyzer was used. The EUT was measured at the low, mid and two high channels.

For the purposes of testing, a sample of the EUT was prepared with an SMA connector in place of the integral antenna.

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

Test Engineer(s): Len Knight

Test Date(s): 05/05/11

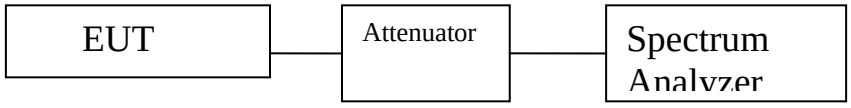


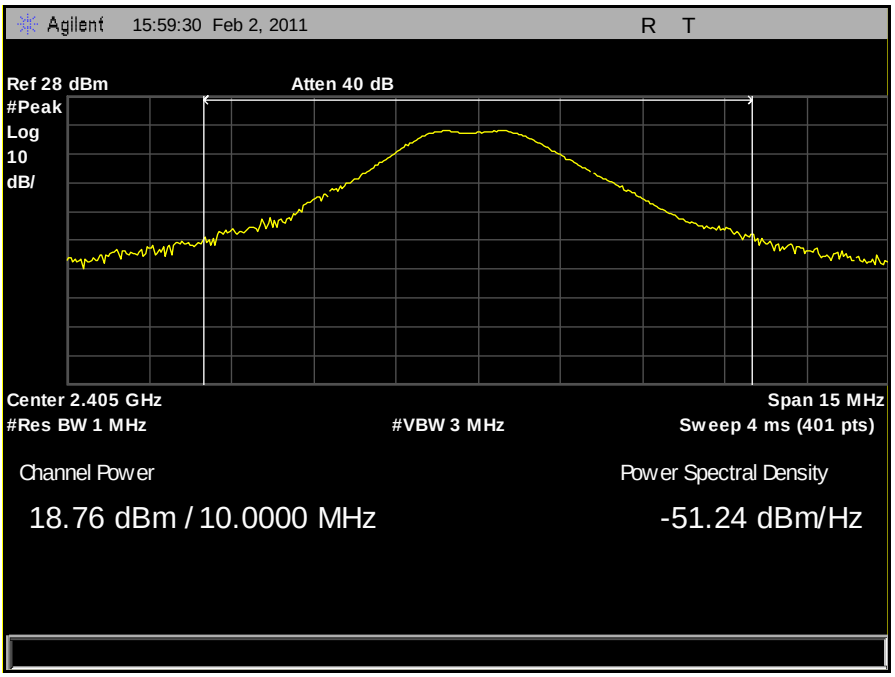
Figure 3. Peak Power Output Test Setup

RF Power Output Test Results

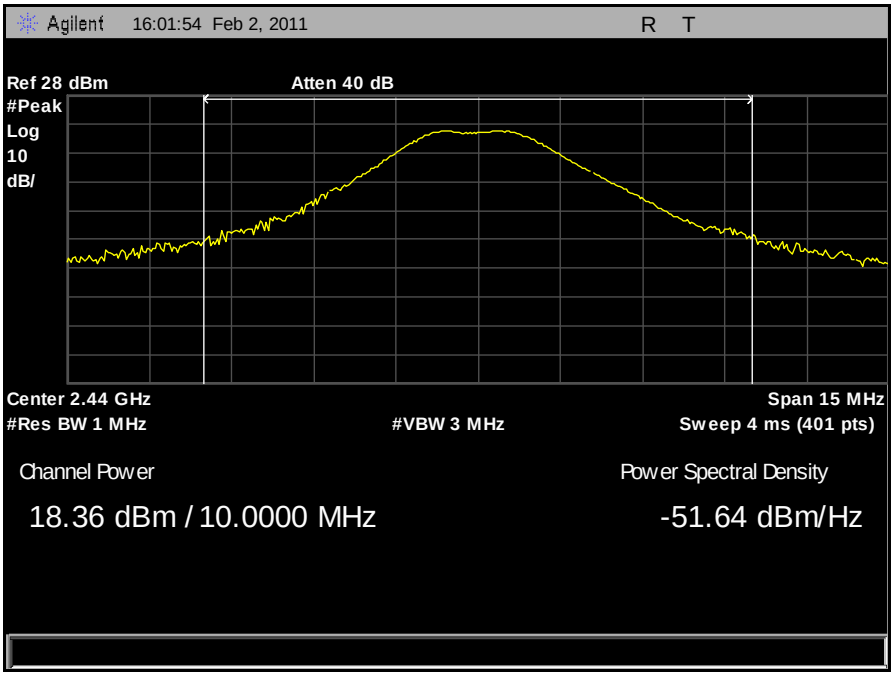
Peak Conducted Output Power			
Carrier Channel	**GUI**	**Frequency (MHz)**	**Measured Peak Output Power dBm**
11	1	2405	18.76
18	1	2440	18.36
25	1	2475	17.51
26	-14	2480	3.52

Table 12. RF Output Power Test Results

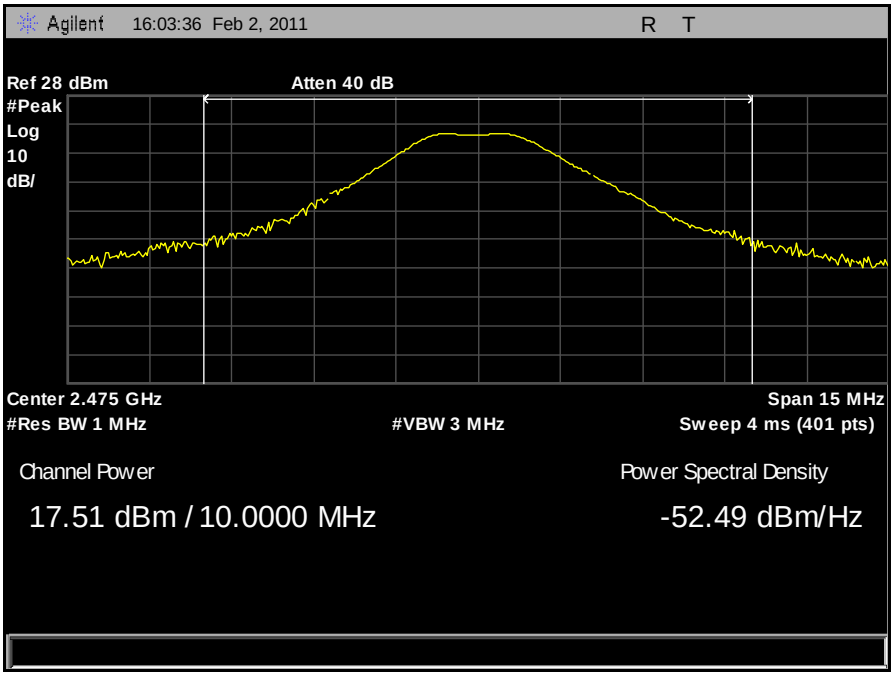
RF Output Power Test Results



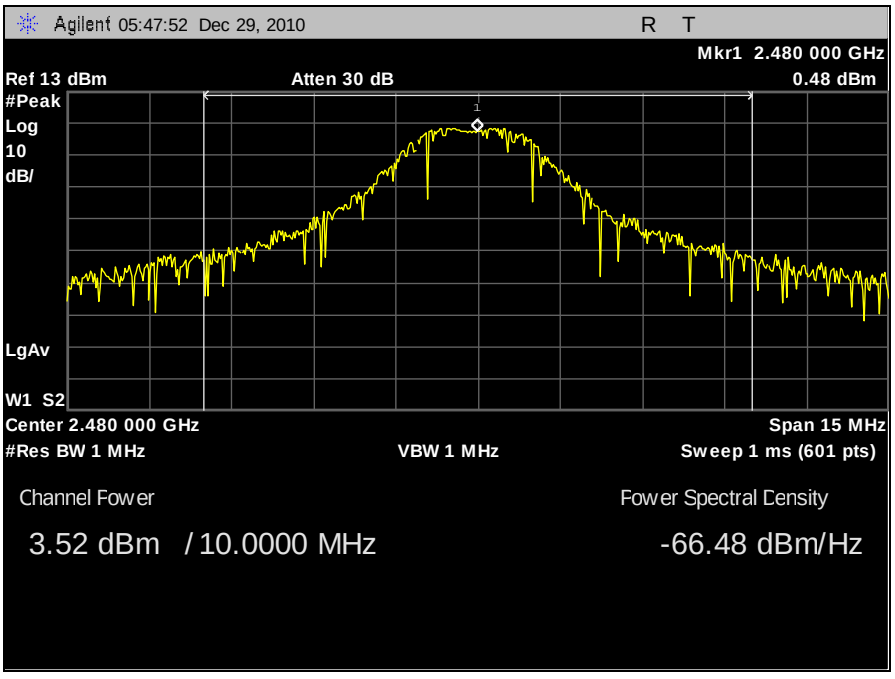
Plot 15. Peak Output Power, Channel 11



Plot 16. Peak Output Power, Channel 18



Plot 17. Peak Output Power, Channel 25



Plot 18. Peak Output Power, Channel 26

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) RF Exposure

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Limit Calculation: EUT's operating frequencies @ 2400-2483.5 MHz; highest conducted power = *18.15dBm* (peak) therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

EUT maximum antenna gain = *5.3 dBi.*

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

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

where, P = Power Input to antenna (31.62mW)
G = Antenna Gain (3.39 numeric)
R = 20cm

$S = 79.43 * 3.39 / 4\pi R^2 (20)^2$
$S = 0.0536$ mW/cm^2

Electromagnetic Compatibility Criteria for Intentional Radiators

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

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

§15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

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

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

Table 13. 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 14.

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

Test Procedures: For all channels tested, the transmitter was turned on at the highest data rate. Measurements were performed on channels 11, 18, 25, and 26. 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.

In order to demonstrate compliance for channels 11, 18, and 25, radiated measurements were made at the harmonics and tabulated. These measurements were corrected for Duty Cycle Correction Factor for those frequencies falling within the restricted bands. The calculation for DCF is shown on the following page.

Spurious emissions not falling within the restricted band were measured with a 100 kHz RBW and compared to the carrier to show compliance with the 20 dBc requirements.

Since channel 26 had significantly less power, compliance was demonstrated through peak plots compared to a quasi-peak and average limit line as appropriate.

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

Test Engineer(s): Len Knight

Test Date(s): 01/04/11

Duty Cycle Correction Factor

IEEE 802.15.4-2003 2.4 GHz PHY Constants

Data Rate	250000	bits / sec	
	31250	bytes / sec	
Symbols/byte	2	sym / bytes	
Symbol Timing	62500	sym / sec	
	0.000016	sec / sym	
Byte Timing	0.000032	sec / byte	
PHY PSDU	6	bytes	4 Pramble, SPD, Length
Max Length	127	bytes	
Total Packet Length	133	bytes	
Maximum Time TX PKT	0.004256	sec	

Long Frame Scenario:

1) TX Frame — Assume Frame is Data Frame
2) Wait for ACK
3) RX ACK
4) CPU Processing of ACK
5) Wait for Backoff
6) Repeat 1)

MAC-Level Calculation (LIFS)

Long InterFrame Spacing (Slotted w/ ACK)			
Long Frame	127	bytes	
Data Frame Payload	102	bytes	
ACK Frame	5	bytes	
tack	12	sym	
LIFS	40	sym	
Backoff Period	20	sym	
Maximum Backoff	7		Random between 0 and 7
Backoff Required	2		
Backoff Time	70	sym	Average at 3.5

Transmit Time	
TX Time (Packet)	0.004256
Total TX Time (sec)	0.004256

NOT Transmit time (RX or Idle)		
Wait for ACK (tack)	0.000192	
RX Time (ACK)	0.000352	
Backoff Time (tbo)	0.00112	(Backoff Time * Backoff Period)
CPU Processing (tcpu)	0.0002	(0.2ms average on EM2xx running EmberZNet)
CCA Assessment (tcca)	0.000128	(averaged over 8 symbols in RX Mode)
Turn Around Time (RX to TX)	0.000192	(After CCA, Radio turns over to TX in 12 symbols)
Total Off Time (sec)	0.002184	

Total Time (ttotal)	0.00644
Number of RX / TX cycles in 100ms	15.52795
Worse Case (100ms window)	
TX Frame 10 times	0.04256
RX or IDLE 10 Times	0.02184
Sum	0.0644
MAC TX Duty Cycle (On /total)	66.09%

DCCF = 20 log (0.6609) = -3.6 dB

Harmonic Emissions Requirements – Radiated

Channel 11	Frequency	Meter Reading (dBuV/m)		DCCF	Corrected (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
Harmonic	(GHz)	Peak	Average		Peak	Average	Peak	Average	Peak	Average
2nd	4.81	56.73	48.88	3.6	53.13	45.28	74	54	-20.87	-8.72
3rd	7.216	55.92			20 dBc		74	54	-35.19	
4th	9.622	63.49			20 dBc		74	54	-27.62	
5th	12.027	64.97	56.16		61.37	52.56	74	54	-12.63	-1.44
6th	14.427	64.27	54.11		60.67	50.51	74	54	-13.33	-3.49
7th	16.831	64.44	55.42		60.84	51.82	74	54	-13.16	-2.18

Table 15. Radiated Harmonic Emissions, Channel 11

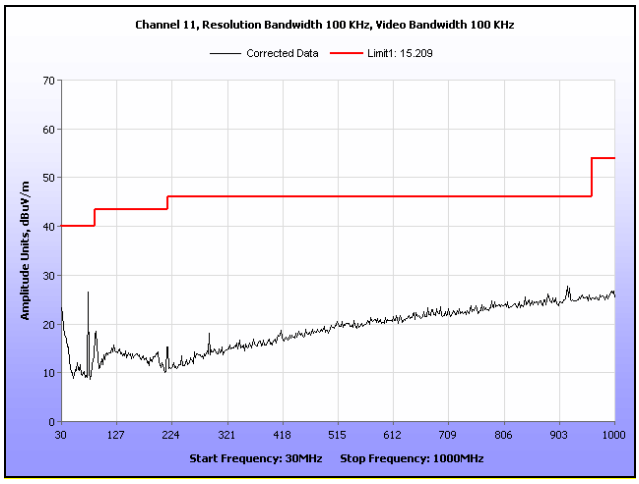
Channel 18	Frequency	Meter Reading (dBuV/m)		DCCF	Corrected (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
Harmonic	(GHz)	Peak	Average		Peak	Average	Peak	Average	Peak	Average
2nd	4.88	60.09	52.03	3.6	56.49	48.43	74	54	-17.51	-5.57
3rd	7.318	63.73	53.63		60.13	50.03	74	54	-13.87	-3.97
4th	9.761	65.22			20 dBc		74	54	-24.48	
5th	12.202	64.14	56.38		60.54	52.78	74	54	-13.46	-1.22
6th	14.637	58.56	48.4		54.96	44.8	74	54	-19.04	-9.2
7th	17.083	62.28	50.62		58.68	47.02	74	54	-15.32	-6.98

Table 16. Radiated Harmonic Emissions, Channel 18

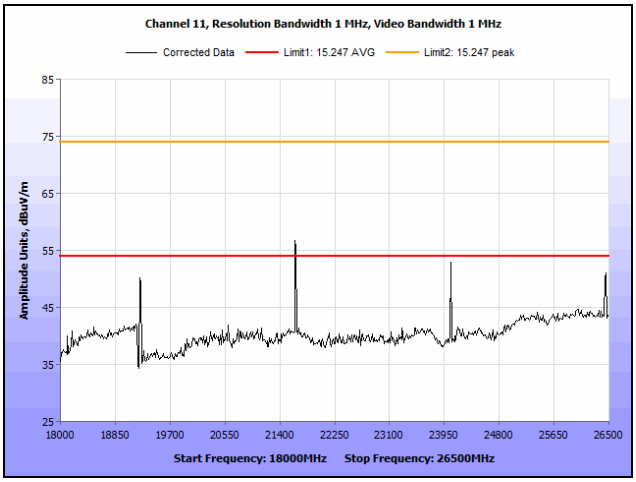
Channel 25	Frequency	Meter Reading (dBuV/m)		DCCF	Corrected (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
Harmonic	(GHz)	Peak	Average		Peak	Average	Peak	Average	Peak	Average
2nd	4.951	62.23	55.12	3.6	58.63	51.52	74	54	-15.37	-2.48
3rd	7.423	59.96	52.88		56.36	49.28	74	54	-17.64	-4.72
4th	9.902	65.08			20 dBc		74	54	-26.66	
5th	12.372	67.36	57.37		63.76	53.77	74	54	-10.24	-0.23
6th	14.853	61.93	51.38		58.33	47.78	74	54	-15.67	-6.22
7th	17.321	64.19	54.23		60.59	50.63	74	54	-13.41	-3.37

Table 17. Radiated Harmonic Emissions, Channel 25

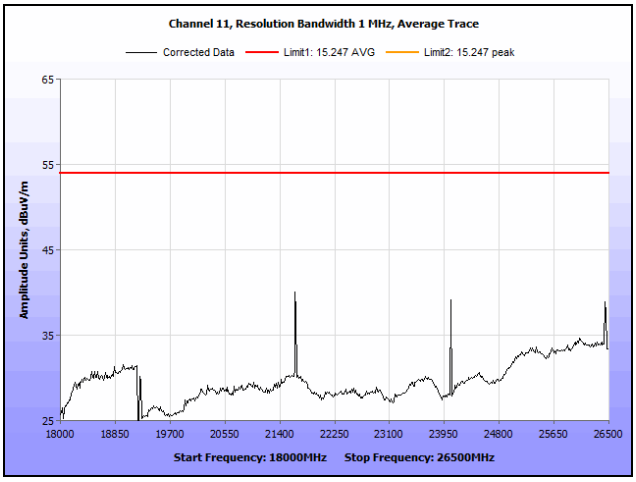
Radiated Spurious Emissions Test Results



Plot 19. Radiated Spurious Emissions, Channel 11, 30 MHz – 1 GHz

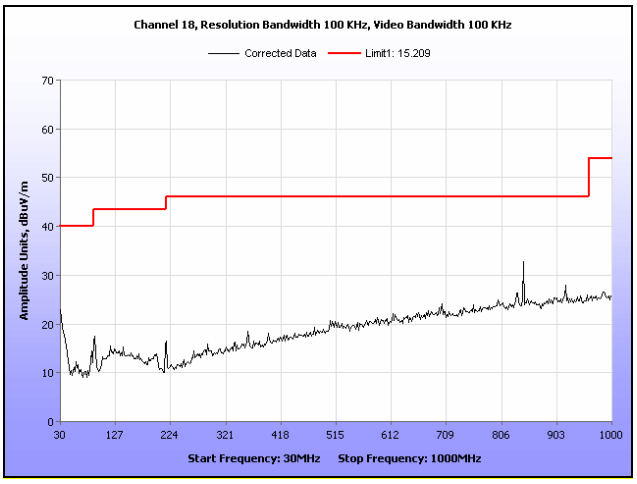


Plot 20. Radiated Spurious Emissions, Channel 11, 18 GHz – 26.5 GHz, Peak

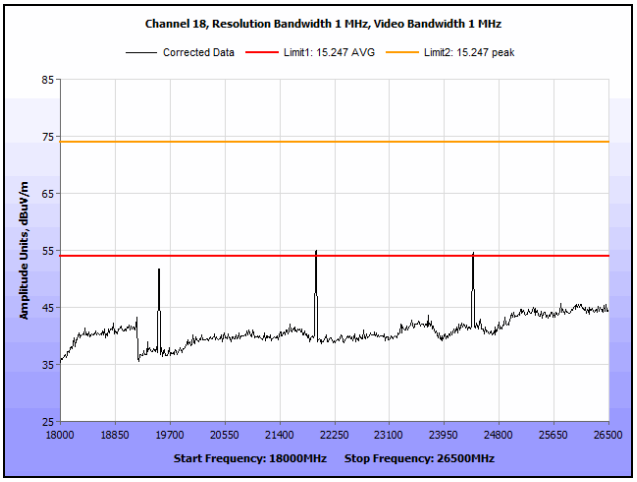


Plot 21. Radiated Spurious Emissions, Channel 11, 18 GHz – 26.5 GHz, Average

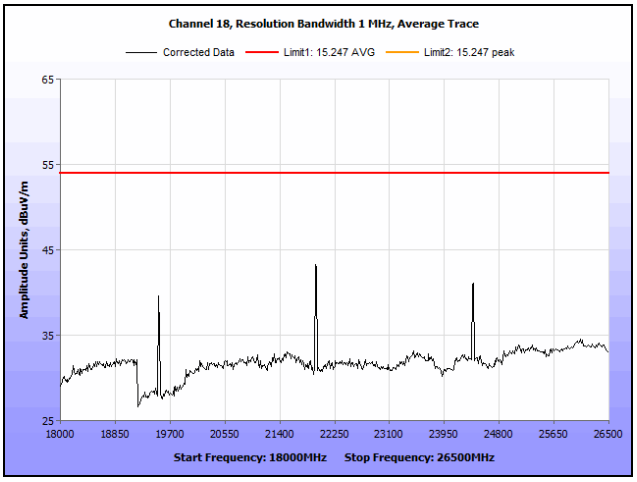
Radiated Spurious Emissions Test Results



Plot 22. Radiated Spurious Emissions, Channel 18, 30 MHz – 1 GHz

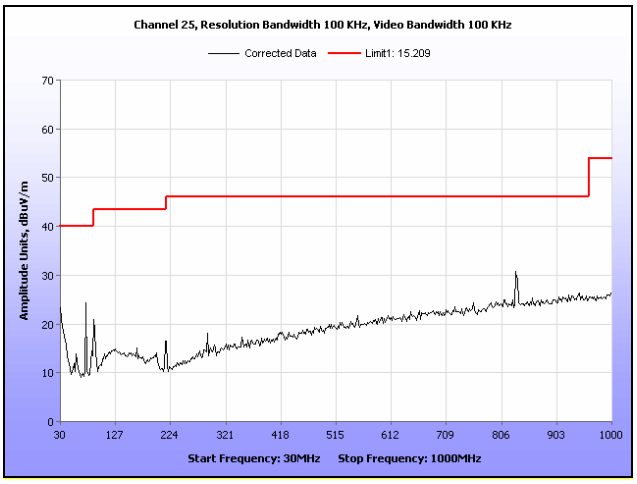


Plot 23. Radiated Spurious Emissions, Channel 18, 18 GHz – 26.5 GHz, Peak

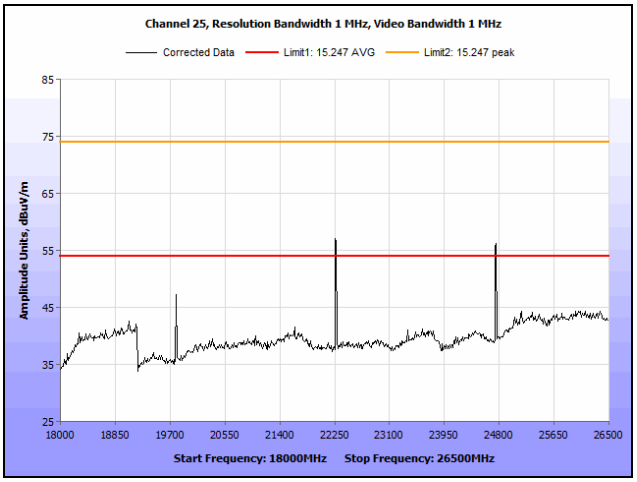


Plot 24. Radiated Spurious Emissions, Channel 18, 18 GHz – 26.5 GHz, Average

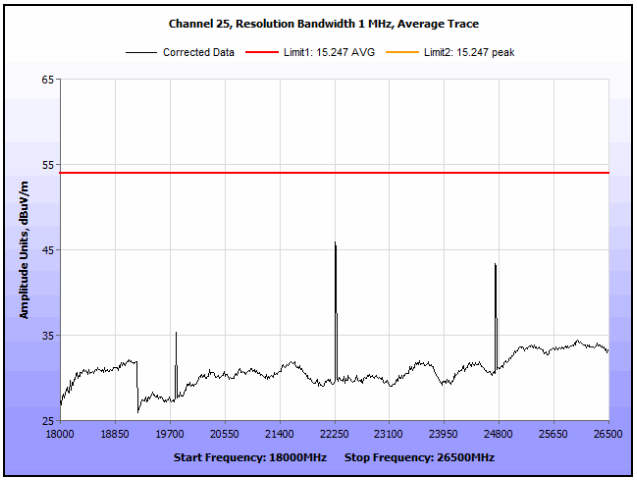
Radiated Spurious Emissions Test Results



Plot 25. Radiated Spurious Emissions, Channel 25, 30 MHz – 1 GHz

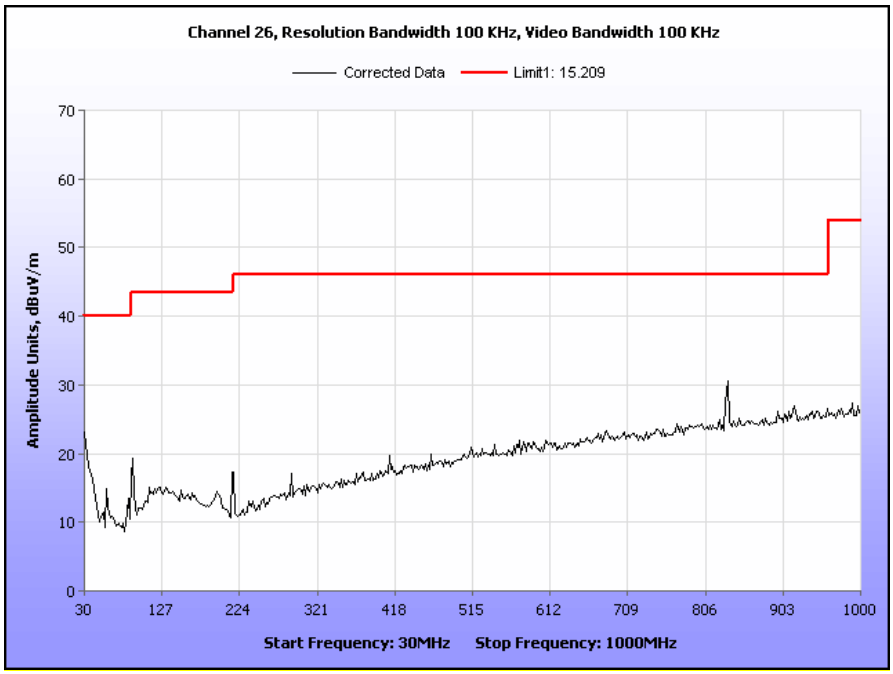


Plot 26. Radiated Spurious Emissions, Channel 25, 18 GHz – 26.5 GHz, Peak

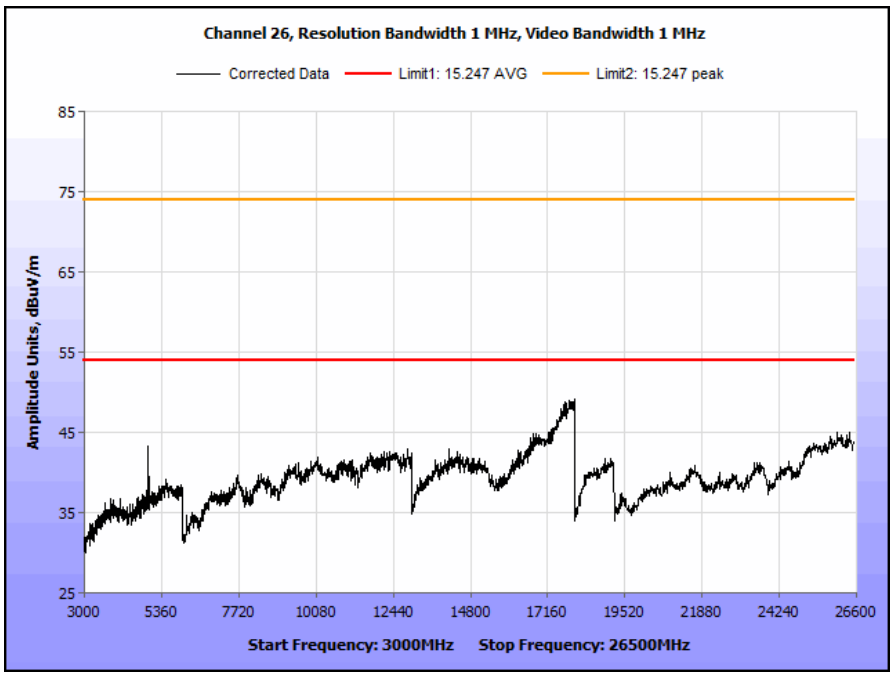


Plot 27. Radiated Spurious Emissions, Channel 25, 18 GHz – 26.5 GHz, Average

Radiated Spurious Emissions Test Results



Plot 28. Radiated Spurious Emissions, Channel 26, 30 MHz – 1 GHz



Plot 29. Radiated Spurious Emissions, Channel 26, 3 GHz – 26.5 GHz

Radiated Band Edge Measurements

Test Procedures: The transmitter was turned on with the highest data rate. Measurements were performed of the low channel 11, high channel 25 and high channel 26. 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.

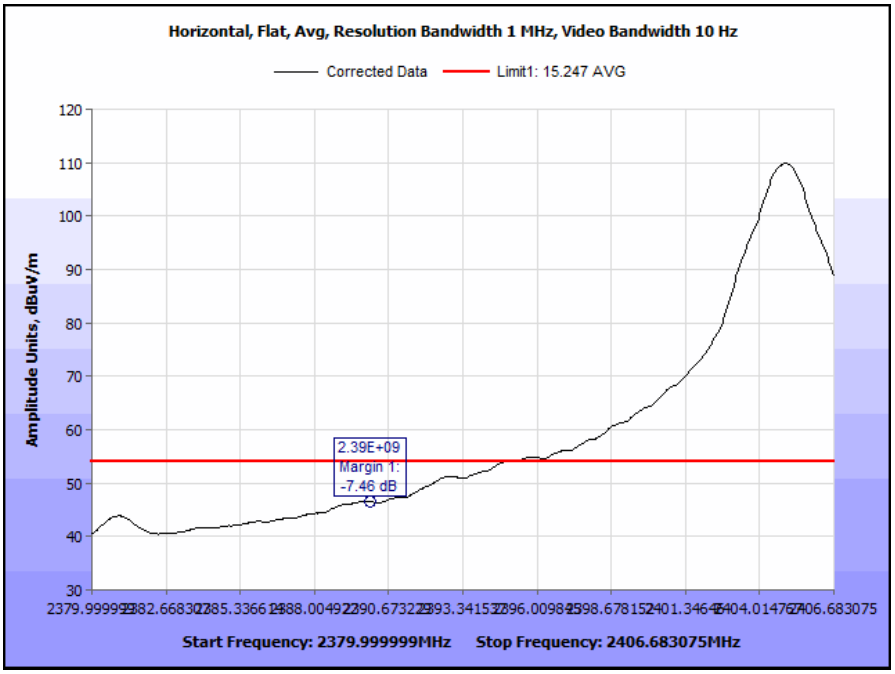
For demonstrating compliance to the band edge for channel 11, a field strength measurement was used. Both peak and average plots are shown.

Fundamental Max Average Value @ 3m		Delta Value		Calculated Value		Limit
Channel 25	Channel 26	Channel 25	Channel 26	Channel 25	Channel 26	54 dBuV/m
111.28 dBuV/m	97.95 dBuV/m	59.37 dB	45.37 dB	51.91 dBuV/m	52.58 dBuV/m	

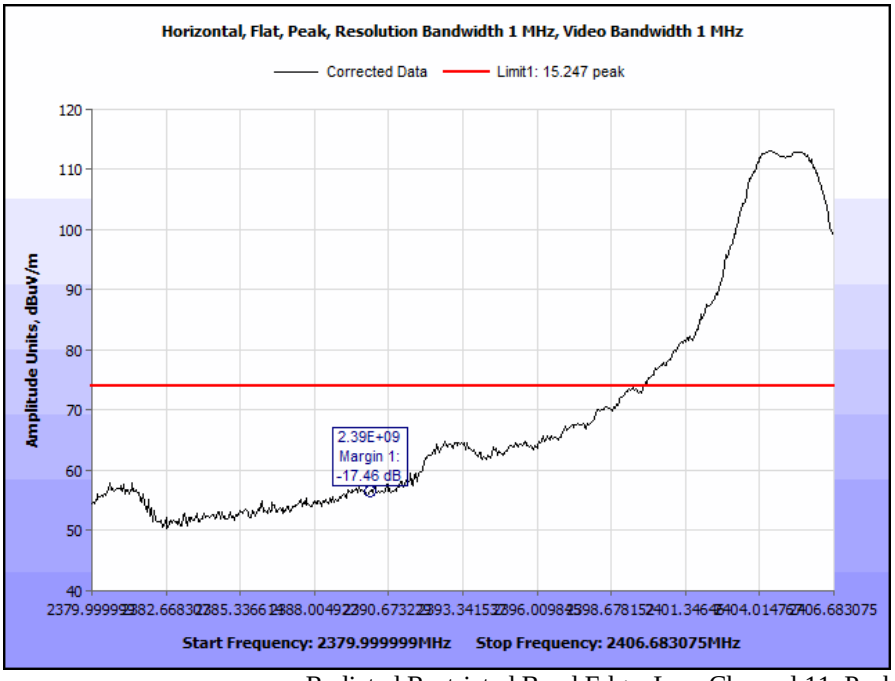
Table 18. Radiated Band Edge, Test Results, Average

Fundamental Max Peak Value @ 3m		Delta Value		Calculated Value		Limit
Channel 25	Channel 26	Channel 25	Channel 26	Channel 25	Channel 26	74 dBuV/m
113.39 dBuV/m	100.27 dBuV/m	59.37 dB	45.37 dB	54.02 dBuV/m	54.9 dBuV/m	

Table 19. Radiated Band Edge, Test Results, Peak

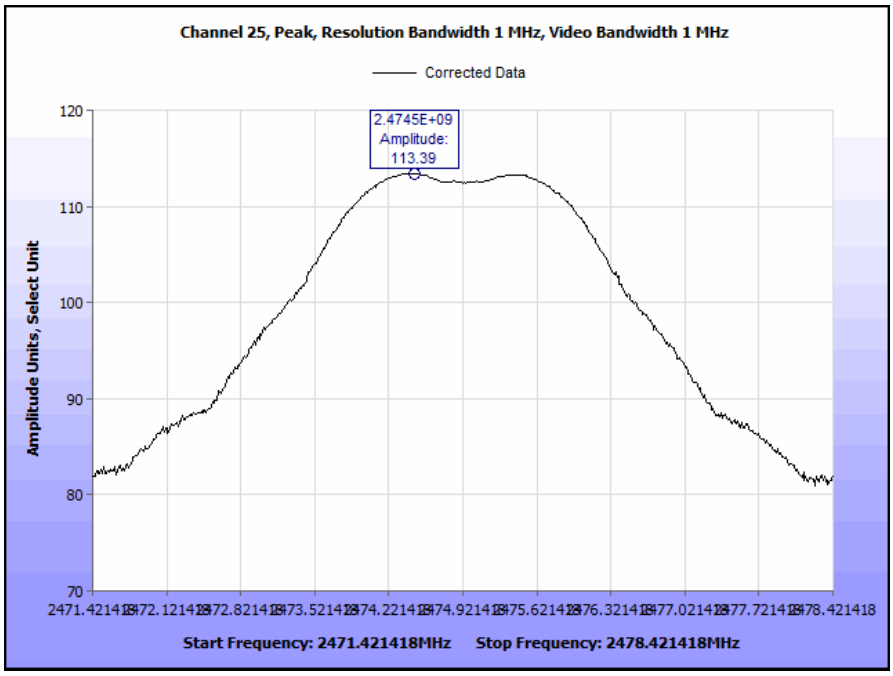


. Radiated Restricted Band Edge, Low Channel 11, Avg.

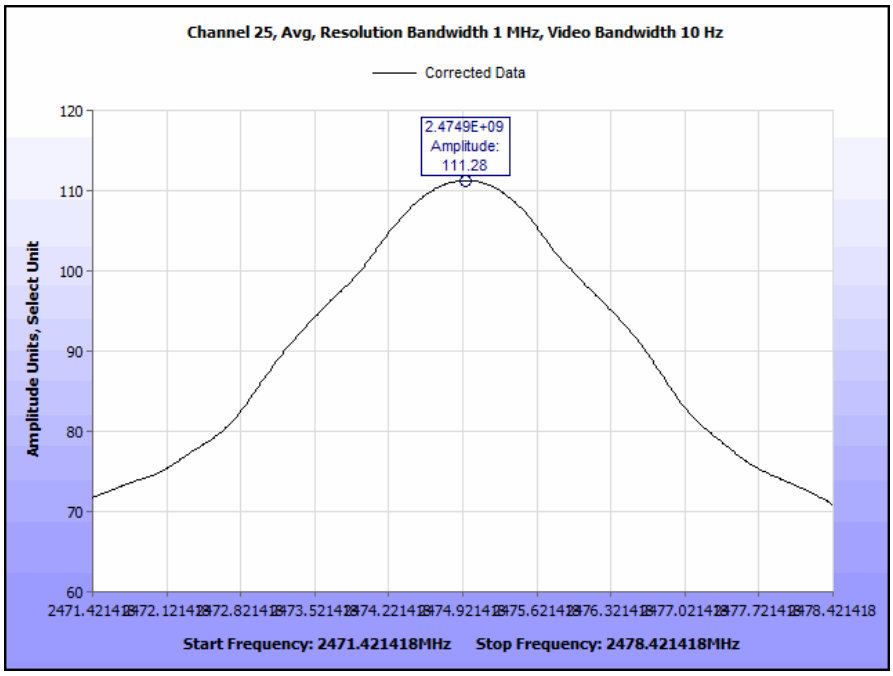


. Radiated Restricted Band Edge, Low Channel 11, Peak

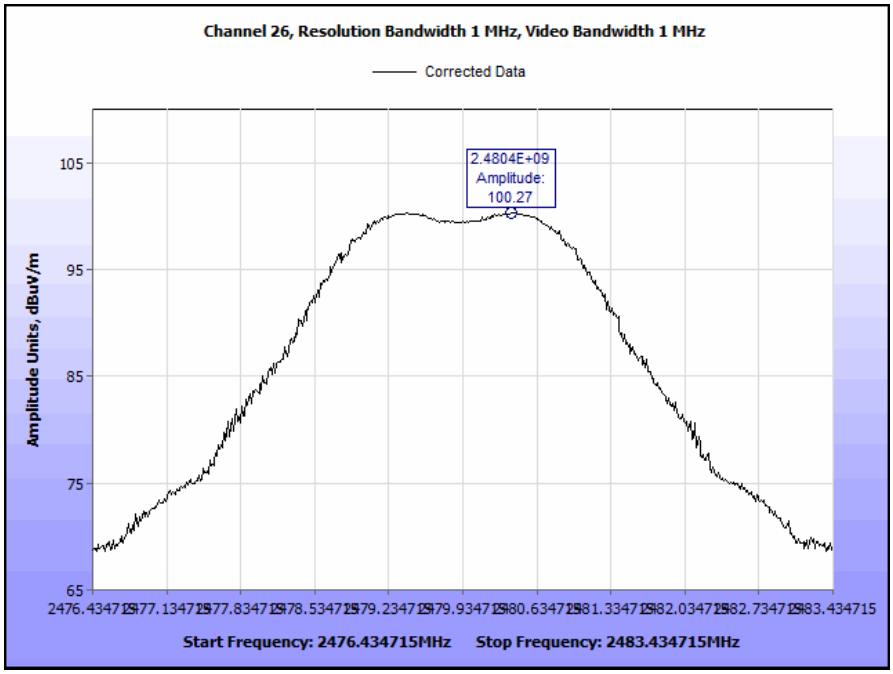
Test Procedures (Cont.): For demonstrating compliance to the band edge for channels 25 and 26, the delta-marker method was used.



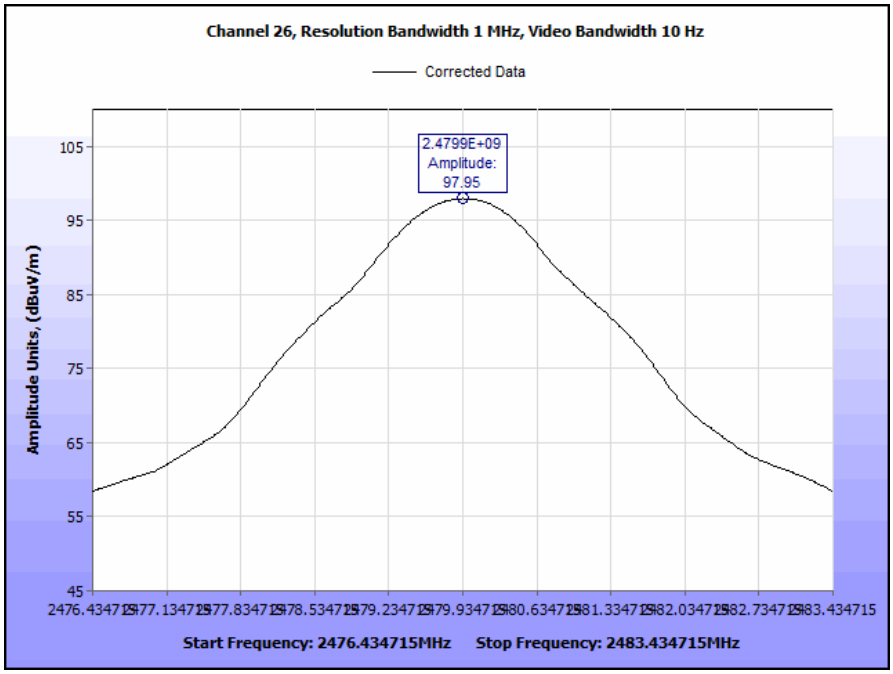
Plot 30. Maximum Field Strength of Channel 25 at 3m, Peak Value



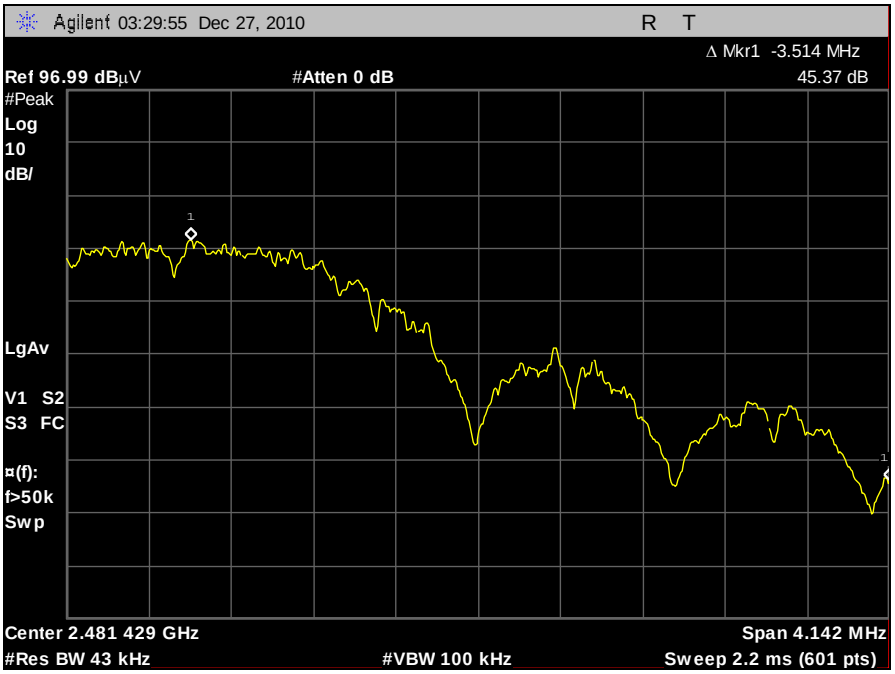
Plot 31. Maximum Field Strength of Channel 25 at 3m, Average Value



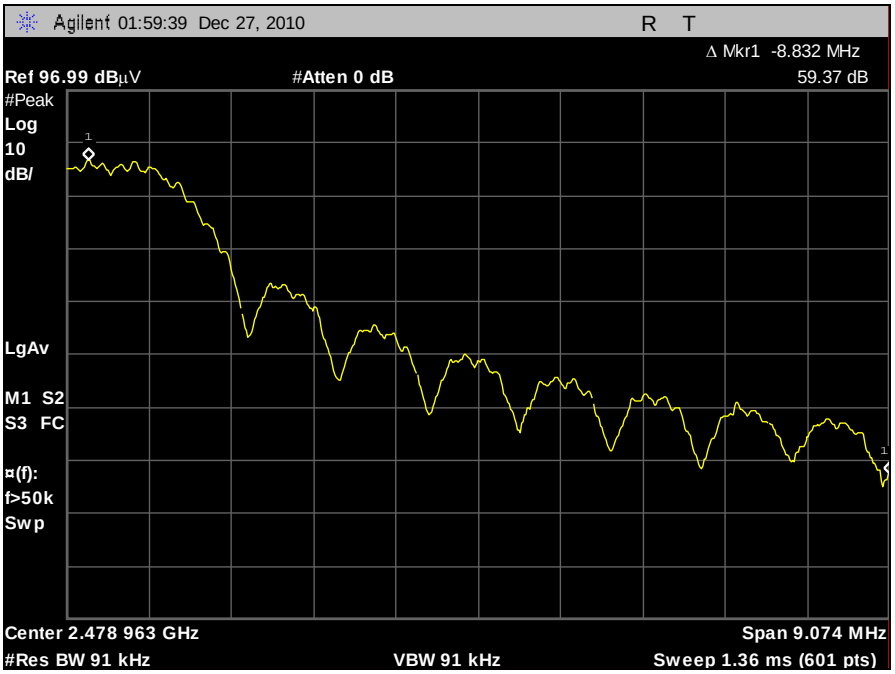
Plot 32. Maximum Field Strength of Channel 26 at 3m, Peak Value



Plot 33. Maximum Field Strength of Channel 26 at 3m, Average Value

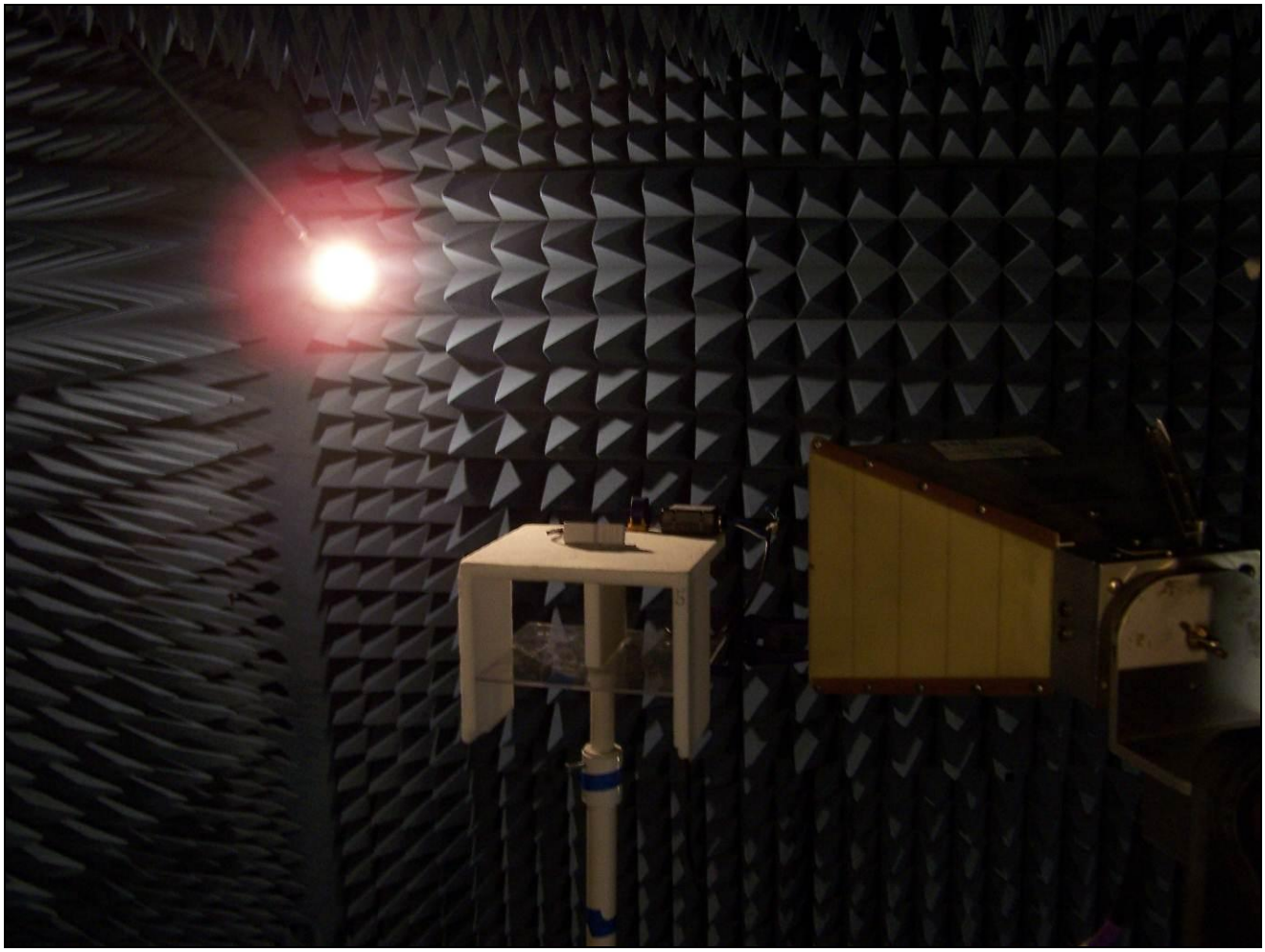


Plot 34. Delta Marker Method for Channel 26 at -14



Plot 35. Delta Marker Method for Channel 25

Radiated Spurious Emissions Test Setup



Photograph 6. Radiated Spurious Emissions, Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

RSS-GEN Receiver Spurious Emissions Requirements

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

(a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 20.

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

Table 20. Spurious Emission Limits for Receivers

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

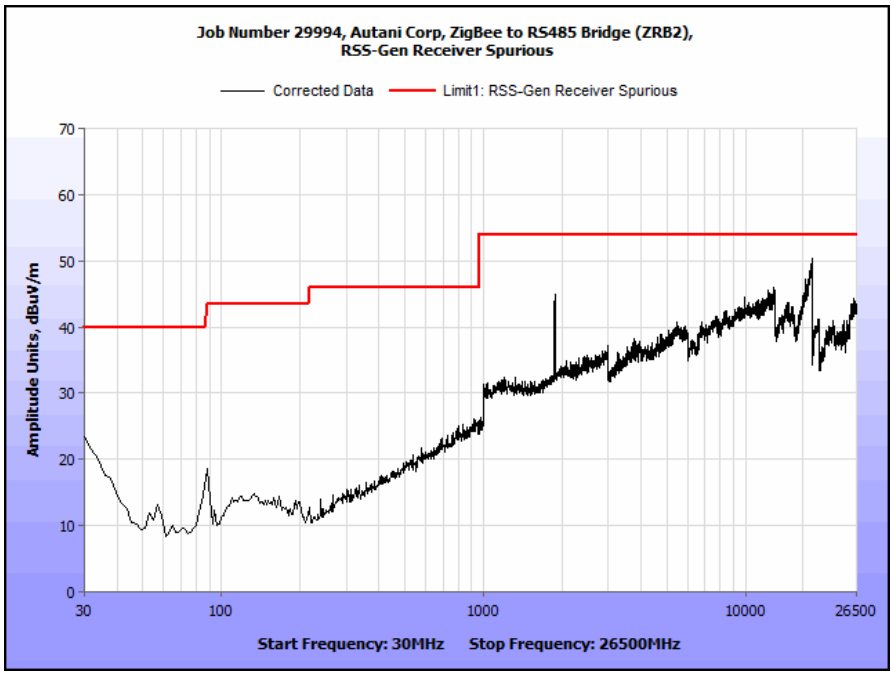
Test Procedures: The EUT was programmed for receive mode only. Peak Radiated scans were taken from 30 MHz to 26.5 GHz. Plots shown are corrected for antenna correction factor, cable loss, and distance correction factors.

Test Results: Equipment is compliant with the Receiver Spurious Emissions Requirements of RSS-GEN. Peak Receiver Spurious Emission 1870 MHz, 44.89 dBuV/m @ 3m.

Test Engineer(s): Len Knight

Test Date(s): 01/05/11

Conducted Receiver Spurious Emissions



Plot 36. Receiver Spurious Emission, 30 MHz – 26.5 GHz

Electromagnetic Compatibility Criteria for Intentional Radiators

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

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

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

For the purposes of testing, a sample of the EUT was prepared with an SMA connector in place of the integral antenna.

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

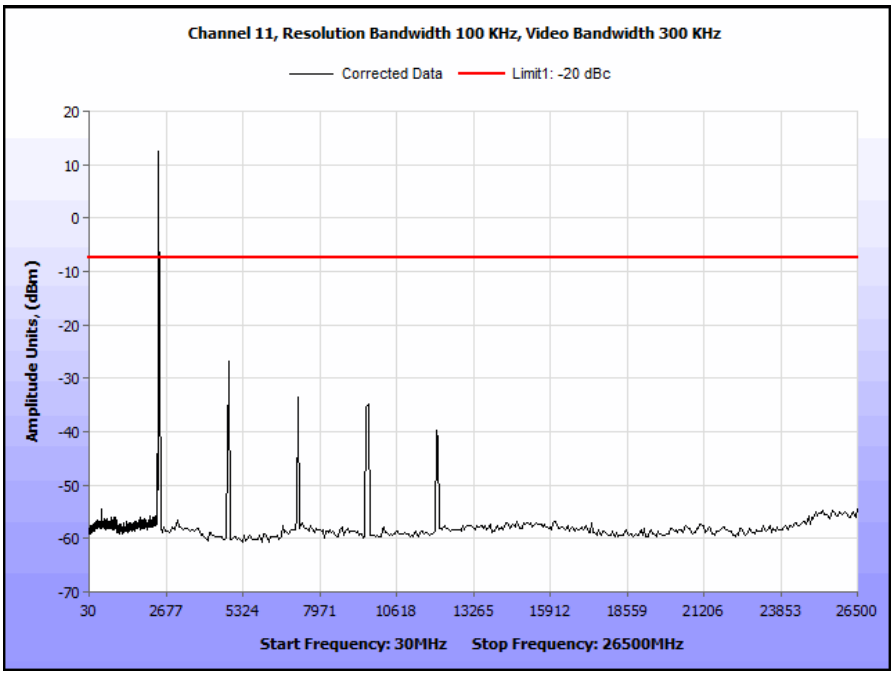
Test Results: The EUT was compliant with the Conducted Spurious Emission limits of **§15.247(d)**. Measured emissions were below applicable limits.

Test Engineer(s): Len Knight

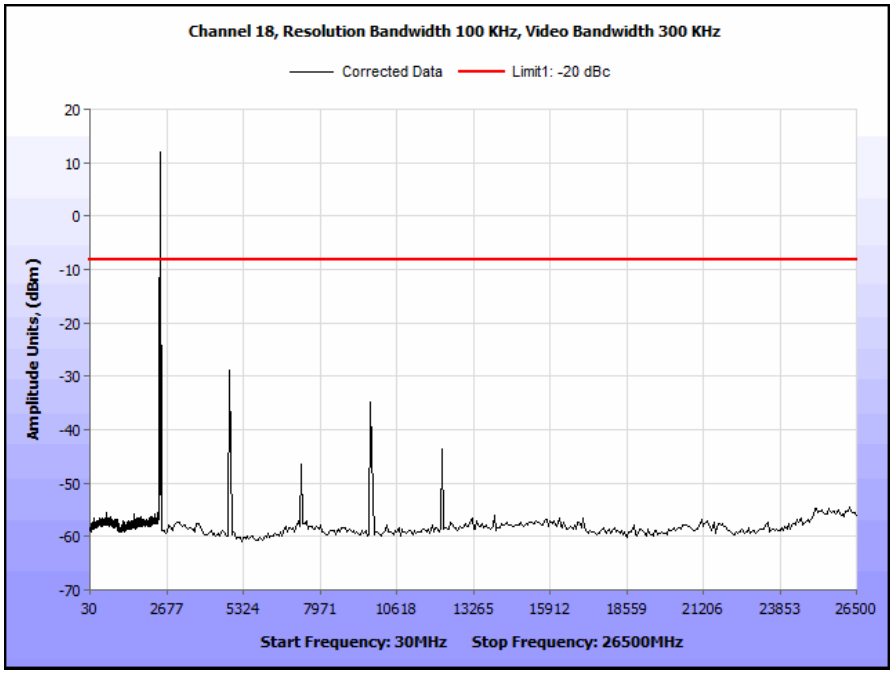
Test Date(s): 01/04/11

Figure 4. Block Diagram, Conducted Spurious Emissions Test Setup

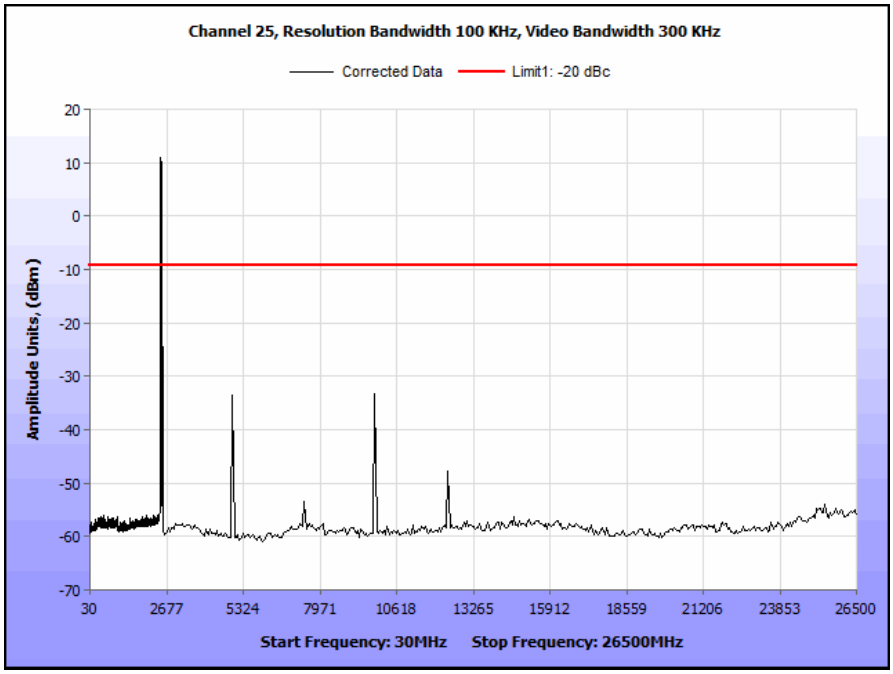
Conducted Spurious Emissions Test Results



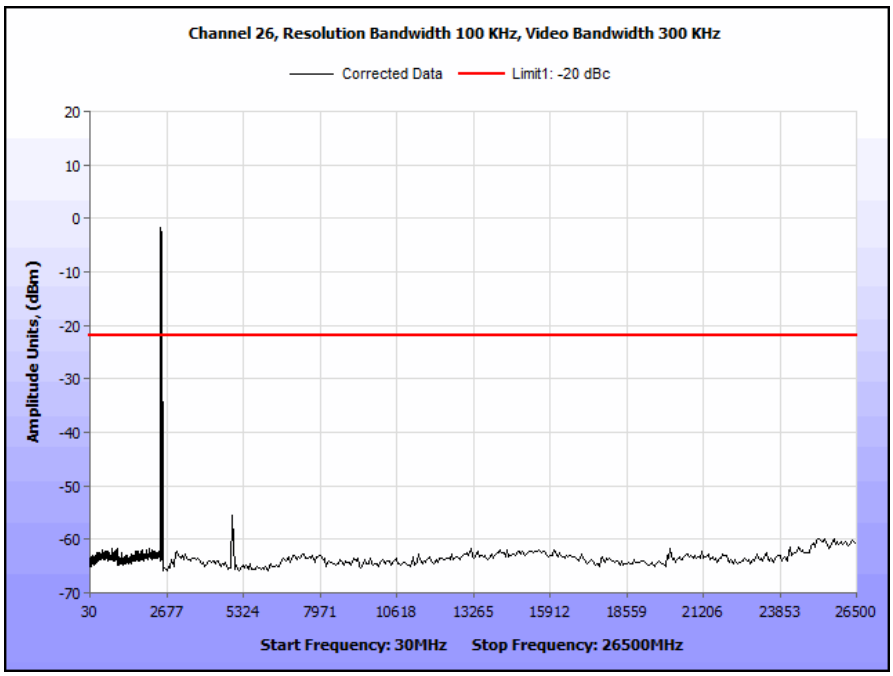
. Conducted Spurious Emissions, Channel 11



. Conducted Spurious Emissions, Channel 18

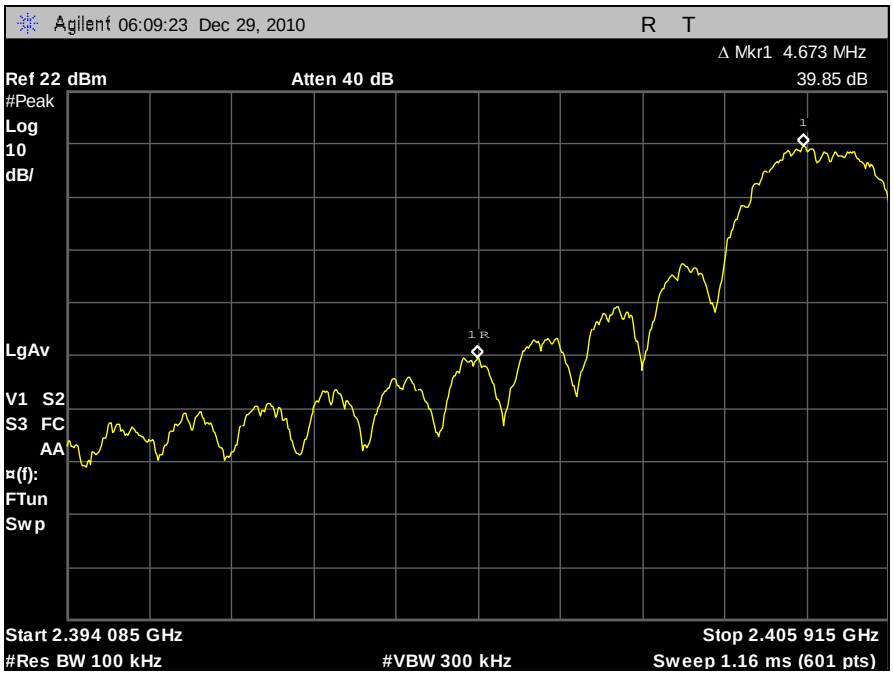


Plot 37. Conducted Spurious Emissions, Channel 25

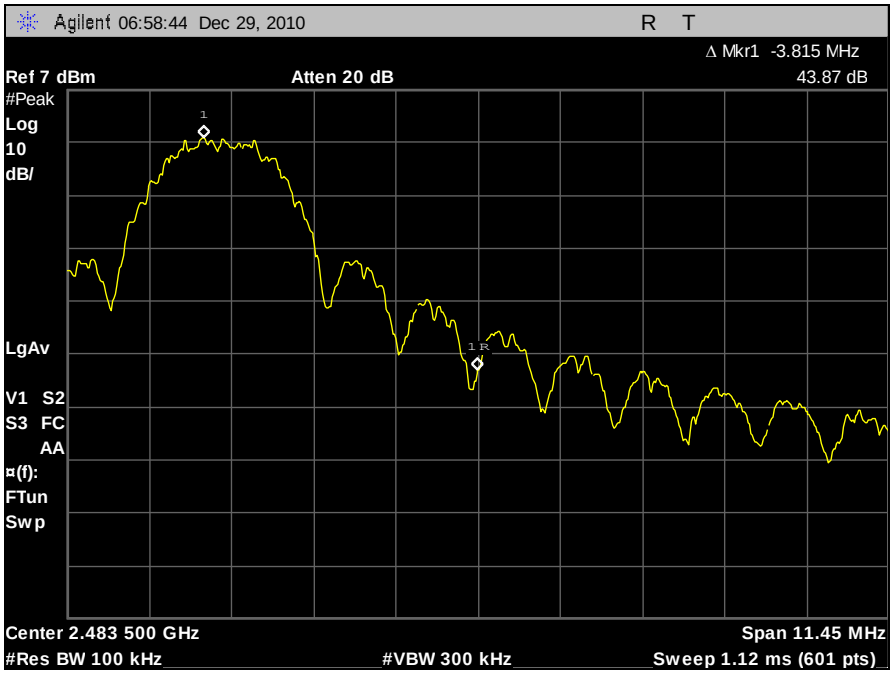


Plot 38. Conducted Spurious Emissions, Channel 26

Conducted Band Edge Test Results



Plot 39. Conducted Band Edge, Channel 11, 20 dBc



Plot 40. Conducted Band Edge, Channel 26, 20 dBc

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Peak Power Spectral Density

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

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer through an attenuator. Emission peaks were located within the pass-band. For final measurements, the spectrum analyzer was set as follows:
RBW = 3 kHz, VBW > RBW
sweep= (SPAN/3 kHz).

Final measurements were made on channels 11, 18, 25 and 26

For the purposes of testing, a sample of the EUT was prepared with an SMA connector in place of the integral antenna.

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: Len Knight

Test Date: 01/05/11

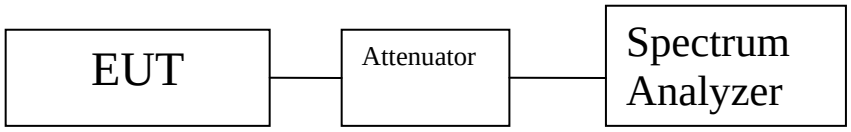


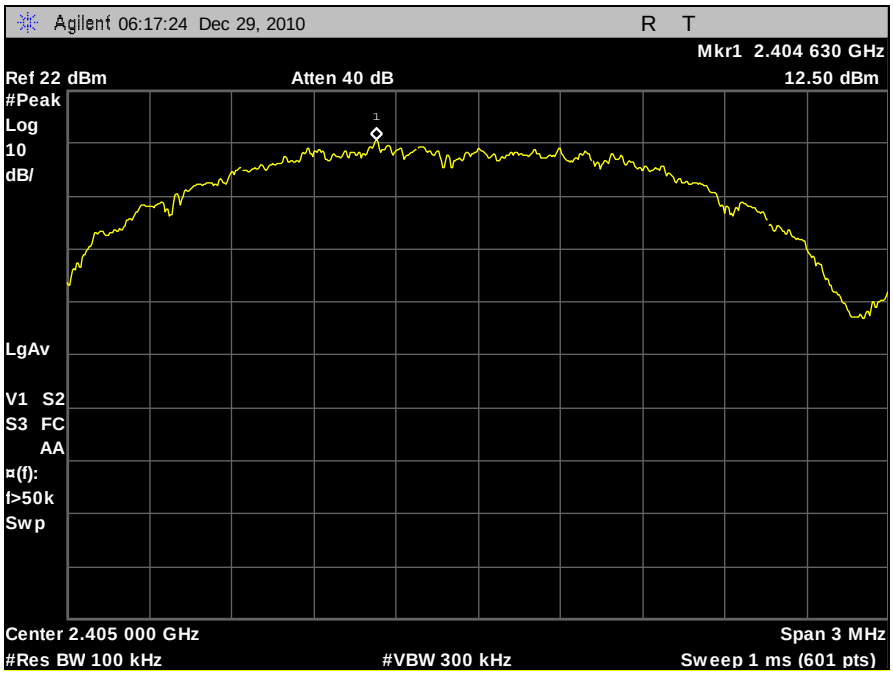
Figure 5. Block Diagram, Peak Power Spectral Density Test Setup

Peak Power Spectral Density Test Results

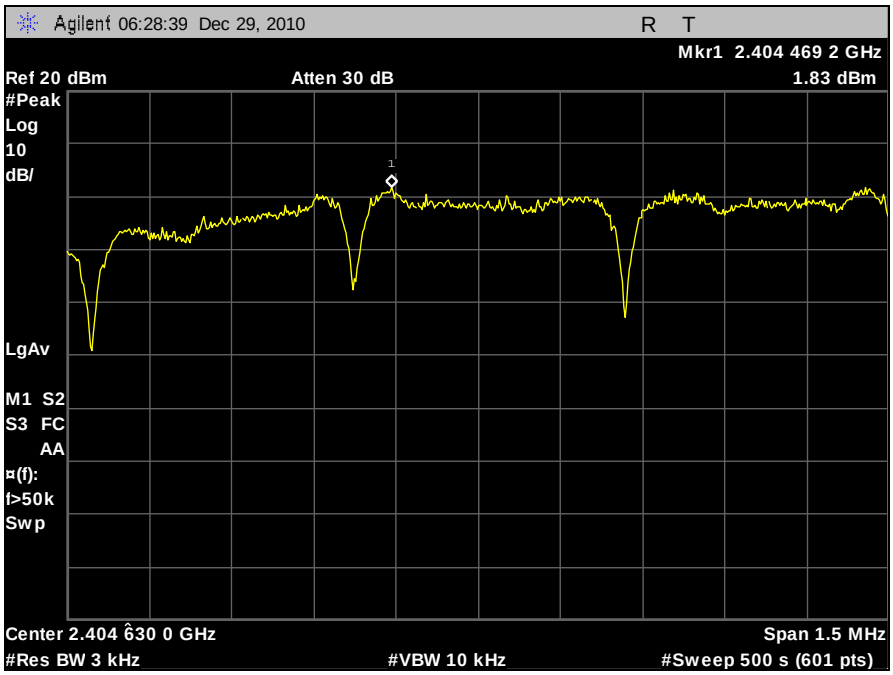
Frequency (MHz)	Channel	GUI	PSD (dBm)	Limit (dBm)
2405	11	1	1.83	8
2440	18	1	1.53	8
2475	25	1	0.05	8
2480	26	-14	-12.73	8

Table 21. Spectral Density, Test Results

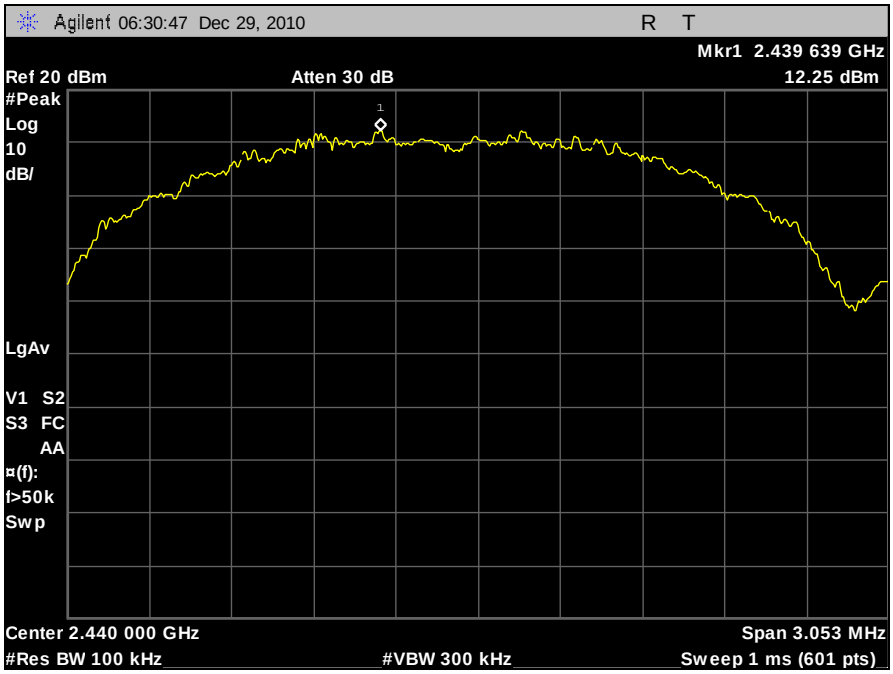
Peak Power Spectral Density



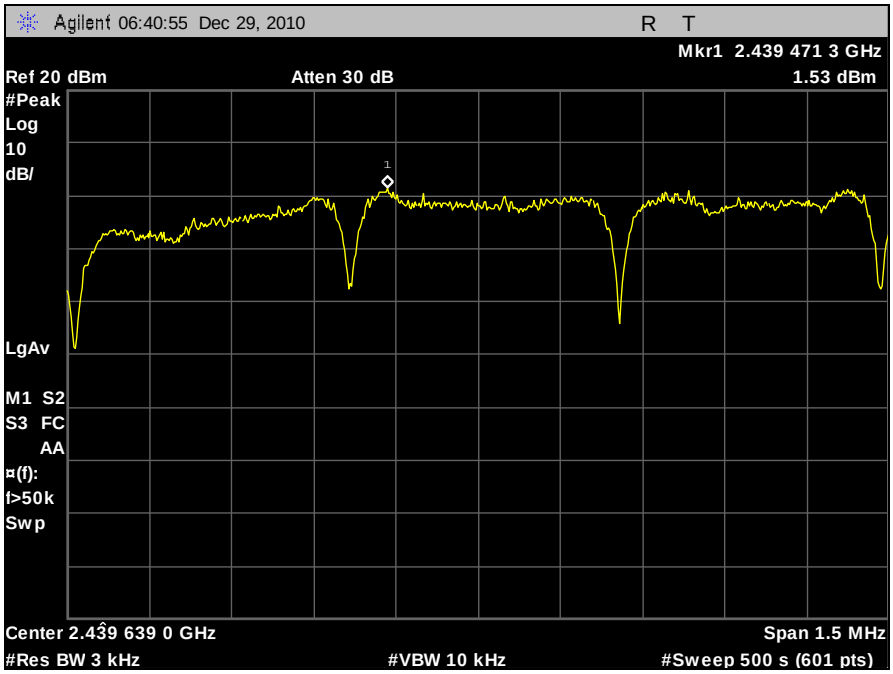
Plot 41. Peak Power Spectral Density, Channel 11, Peak Determination



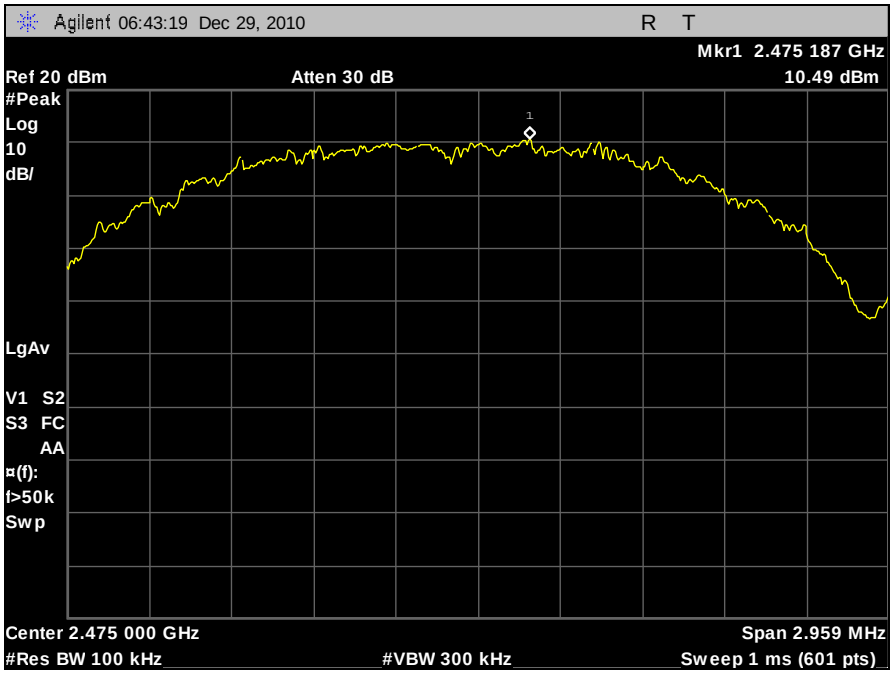
Plot 42. Peak Power Spectral Density, Channel 11



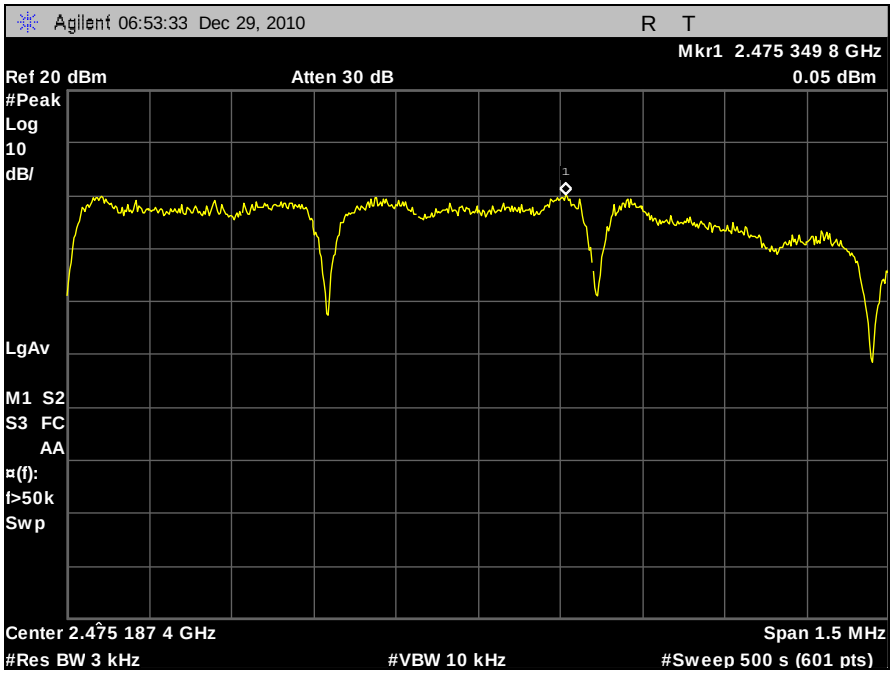
Plot 43. Peak Power Spectral Density, Channel 18, Peak Determination



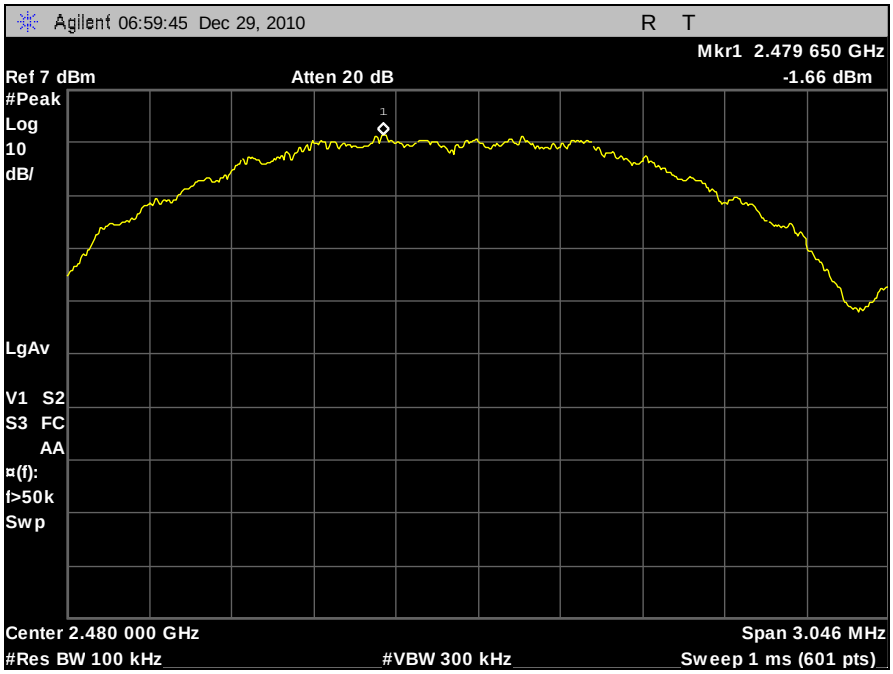
Plot 44. Peak Power Spectral Density, Channel 18



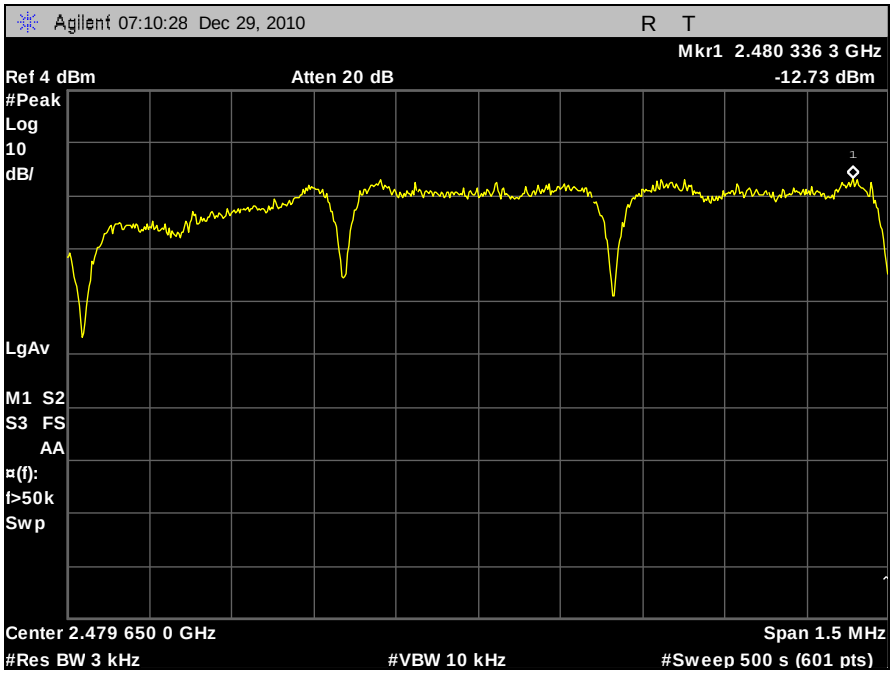
Plot 45. Peak Power Spectral Density, Channel 25, Peak Determination



Plot 46. Peak Power Spectral Density, Channel 25



Plot 47. Peak Power Spectral Density, Channel 26, Peak Determination



Plot 48. Peak Power Spectral Density, Channel 26

IV. Test Equipment

Test Equipment

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

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4612	ESA-E SERIES SPECTRUM ANALYZER	AGILENT	E4407B	09/27/2010	09/27/2011
1T4564	LISN (24 AMP)	SOLAR ELECTRONICS	9252-50-R-24-BNC	10/06/2010	10/06/2011
1T4503	SHIELDED ROOM	UNIVERSAL SHIELDING CORP	N/A	SEE NOTE	
1T4502	COMB GENERATOR	COM-POWER	CGC-255	10/06/2010	10/06/2011
1T4681	SPECTRUM ANALYZER	AGILENT	E4448A	12/03/2010	12/03/2011
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	05/25/2010	05/25/2011
1T4300	SEMI-ANECHOIC CHAMBER # 1	EMC TEST SYSTEMS	NONE	08/23/2010	08/23/2013
1T4751	ANTENNA - BILOG	SUNOL SCIENCES	JB6	11/03/2010	11/03/2011
1T2511	ANTENNA; HORN	EMCO	3115	08/31/2010	08/31/2011
1T4744	ANTENNA, HORN	ETS-LINDGREN	3116	05/27/2010	05/27/2011
1T4752	PRE-AMPLIFIER	MITEQ	JS44-18004000-35-8P	SEE NOTE	
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	

Table 22. Test Equipment List

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

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

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

§ 2.801 Radio-frequency device defined.

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

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

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

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

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

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

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

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

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

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

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

(i) Compliance testing;

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

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

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

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

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

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

Certification & User's Manual Information

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

§ 2.901 Basis and Purpose

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

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

§ 2.907 Certification.

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

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

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

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

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

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

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

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

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

Certification & User's Manual Information

Label and User's Manual Information

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

§ 15.19 Labeling requirements.

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

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

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

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

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

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

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

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

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

§ 15.21 Information to user.

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

Verification & User's Manual Information

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

§ 15.105 Information to the user.

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

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

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

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

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

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

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

ICES-003 Procedural & Labeling Requirements

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

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

Procedural Requirements:

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

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

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

Labeling Requirements:

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

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

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

End of Report