**MET Laboratories, Inc.** *Safety Certification - EMI - Telecom Environmental Simulation*
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3162 BELICK STREET • SANTA CLARA, CA 95054 • PHONE (408) 748-3585 • FAX (510) 489-6372
13301 MCCALLEN PASS • AUSTIN, TEXAS 78753 • PHONE (512) 287-2500 • FAX (512) 287-2513

November 14, 2013

Firefly Design, LLC
210 Lavaca Street #2303
Austin, TX 78701

Dear Denis Bohm,

Enclosed is the EMC Wireless test report for compliance testing of the Firefly Design, LLC, Firefly Ice as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), FCC Part 15 Subpart C and RSS-210, Issue 8, Dec. 2010 for Intentional Radiators.

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

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Firefly Design, LLC\EMCA40120-FCC247)

# Electromagnetic Compatibility Criteria
# Test Report

for the

**Firefly Design, LLC**
**Firefly Ice**

**Tested under**
the FCC Certification Rules
contained in
Title 47 of the CFR, 15.247 Subpart C
&
RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

**MET Report: EMCA40120-FCC247**

November 14, 2013

**Prepared For:**

**Firefly Design, LLC**
**210 Lavaca Street #2303**
**Austin, TX 78701**

**Prepared By:**
**MET Laboratories, Inc.**
13301 McCallen Pass
Austin, TX 78753

# Electromagnetic Compatibility Criteria
# Test Report

for the

## Firefly Design, LLC
## Firefly Ice

**Tested under**
Title 47 of the CFR, 15.247 Subpart C
&
RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

Poona Saber, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

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

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

  

# Report Status Sheet

| Revision | Report Date | Reason for Revision |
|---|---|---|
| ∅ | November 14, 2013 | Initial Issue. |

  

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# List of Terms and Abbreviations

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

# I. Executive Summary

## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Firefly Design, LLC Firefly Ice, 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 Firefly Ice. Firefly Design, LLC should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Firefly Ice, 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 Firefly Design, LLC, purchase order number 100. 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; RSS-GEN Issue 3: 2010 | Description | Compliance |
|---|---|---|---|
| Title 47 of the CFR, Part 15 §15.203 | N/A | Antenna Requirement | Compliant |
| Title 47 of the CFR, Part 15 §15.207(a) | RSS-GEN (7.2.4) | Conducted Emission Limits | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(2) | RSS-Gen(4.6) | 6dB Occupied Bandwidth | Compliant |
| | | 99% Occupied Bandwidth | Compliant |
| Title 47 of the CFR, Part 15 §15.247(b) | RSS-210(A8.4) | Peak Power Output | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205 | RSS-210(A8.5) | Radiated Spurious Emissions Requirements | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d) | RSS-210(A8.5) | RF Conducted Spurious Emissions Requirements | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d) | RSS-210(A8.5) | RF Conducted Band Edge | Compliant |
| Title 47 of the CFR, Part 15; §15.247(e) | RSS-210(A8.2) | Peak Power Spectral Density | Compliant |
| Title 47 of the CFR, Part 15 §15.247(i) | RSS-Gen(5.6) | Maximum Permissible Exposure (MPE) | Not Required – low power |

**Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting**

# II. Equipment Configuration

# A. Overview

MET Laboratories, Inc. was contracted by Firefly Design, LLC to perform testing on the Firefly Ice, under Firefly Design, LLC's purchase order number 100.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Firefly Design, LLC, Firefly Ice.

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

| | | |
|---|---|---|
| **Model(s) Tested:** | Firefly Ice | |
| **Model(s) Covered:** | Firefly Ice | |
| **EUT Specifications:** | Primary Power: 120 VAC, 60 Hz | |
| | FCC ID: U49-ICE<br>IC: 11557A-ICE | |
| | Type of Modulations: | GFSK |
| | Equipment Code: | DTS |
| | Peak RF Output Power: | -4.99 dBm |
| | EUT Frequency Ranges: | 2412 – 2472 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:** | Poona Saber | |
| **Report Date(s):** | November 14, 2013 | |

**Table 2. EUT Summary Table**

## B. References

| | |
|---|---|
| **CFR 47, Part 15, Subpart C** | Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies |
| **RSS-210, Issue 8, Dec. 2010** | Low-power Licence-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment |
| **RSS-GEN, Issue 3, Dec. 2010** | General Requirements and Information for the Certification of Radio Apparatus |
| **ANSI C63.4:2003** | Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz |
| **ISO/IEC 17025:2005** | General Requirements for the Competence of Testing and Calibration Laboratories |
| **ANSI C63.10-2009** | American National Standard for Testing Unlicensed Wireless Devices |

**Table 3. References**

## C. Test Site

All testing was performed at MET Laboratories, Inc., 13301 McCallen Pass, Austin, TX 78753. 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 10 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 Firefly Design, LLC Firefly Ice, Equipment Under Test (EUT), is a human activity monitor. It keeps track of how active a person is. The person typically carries the device in their pocket. The data is uploaded via Bluetooth Low Energy radio and/or USB connection. The device is small and low power. The 80 mAh battery lasts for over 2 weeks on a charge. The battery is rechargeable lithium ion and recharges via a USB cable.

**Photograph 1. Firefly Design, LLC Firefly Ice**

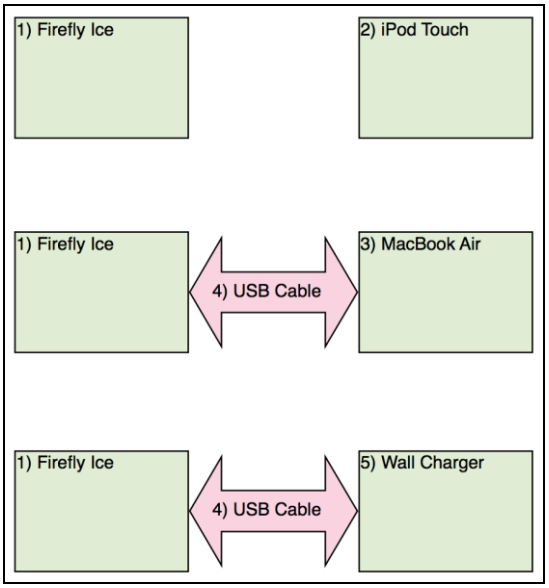



**Figure 1. Block Diagram of Test Configuration**

## E. Equipment Configuration

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

| Ref. ID | Name / Description | Model Number | Part Number | Serial Number | Revision |
|---|---|---|---|---|---|
| 1 | Firefly Ice | -- | -- | -- | 1 |

**Table 4. Equipment Configuration**

## F. Support Equipment

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

| Ref. ID | Name / Description | Manufacturer | Model Number |
|---|---|---|---|
| 2 | iPod Touch | Apple | -- |
| 3 | MacBook Air | Apple | -- |
| 4 | USB Cable | -- | -- |
| 5 | USB Wall Charger | -- | -- |

**Table 5. Support Equipment**

## G. Ports and Cabling Information

| Ref. ID | Port Name on EUT | Cable Description | Qty. | Length (m) | Shielded (Y/N) | Termination Point |
|---|---|---|---|---|---|---|
| 4 | Data & Charging | USB | 1 | 1 | -- | -- |

**Table 6. Ports and Cabling Information**

## H. Mode of Operation

The device is always on collecting data. Periodically user uploads the data via Bluetooth Low Energy radio and/or USB connection. Every 2 weeks or less the user charges the device via a USB connection.

## I. Method of Monitoring EUT Operation

There is an iOS test app that can be used to connect to the device via Bluetooth Low Energy radio and check its status. There is also a Mac OS X test app that can be used to connect to the device via USB and check its status.

## 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 Firefly Design, LLC upon completion of testing.

# III. Electromagnetic Compatibility Criteria for Intentional Radiators

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.203 Antenna Requirement

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

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

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

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

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

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

**Test Engineer(s):** Poona Saber

**Test Date(s):** 10/11/13

| Gain | Type | Model | Manufacturer |
|---|---|---|---|
| 0.2 dB | Chip Antenna | FR05-S1-N-0-110 | Fractus |

**Table 7. Antenna List**

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.207(a) 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 Σ 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. Scans were performed with the transmitter on.

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

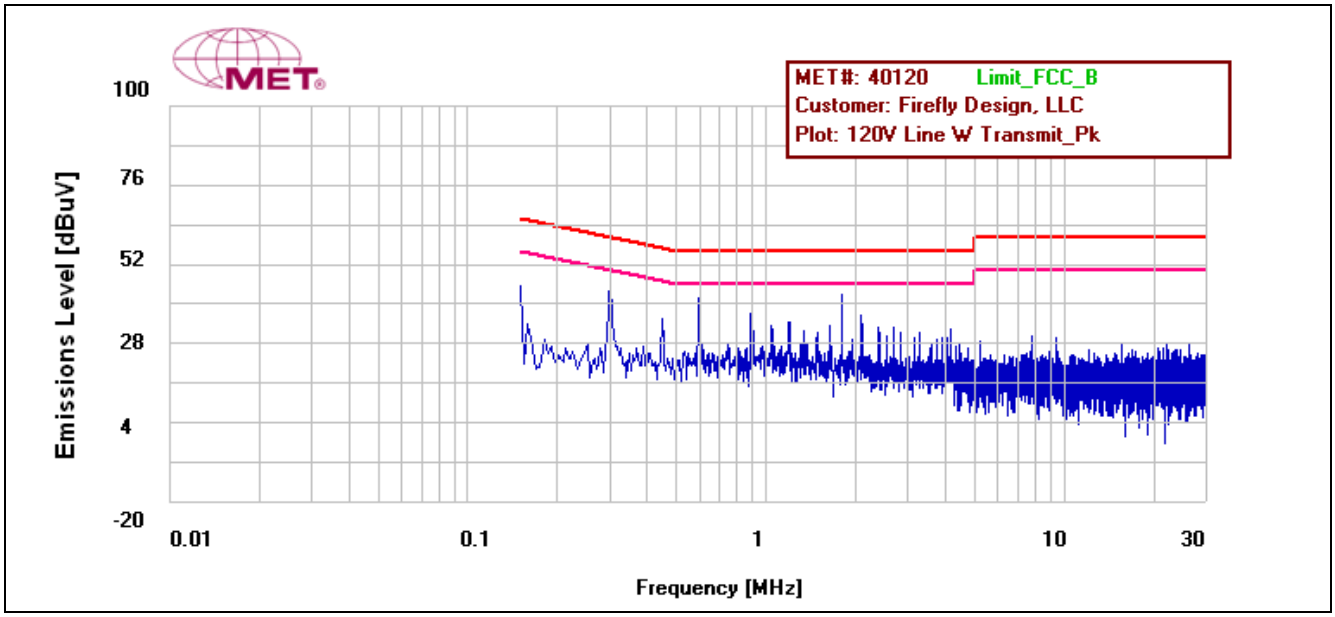
**Test Engineer(s):** Matthew Sharpe

**Test Date(s):** 10/16/13

## 15.207(a) Conducted Emissions Test Results

| Line | Freq. (MHz) | QP Amplitude | QP Limit | Delta | Pass | Average Amplitude | Average Limit | Delta | Pass |
|---|---|---|---|---|---|---|---|---|---|
| Line Tx | .299 | 46.59 | 60.286 | -13.696 | Pass | 41.6 | 50.286 | -8.686 | Pass |
| Line Tx | .6 | 47.8 | 56 | -8.2 | Pass | 43.03 | 46 | -2.97 | Pass |
| Line Tx | .9 | 45.42 | 56 | -10.58 | Pass | 40.5 | 46 | -5.5 | Pass |

**Table 9. Conducted Emissions, 15.207(a), Phase Line, Test Results**

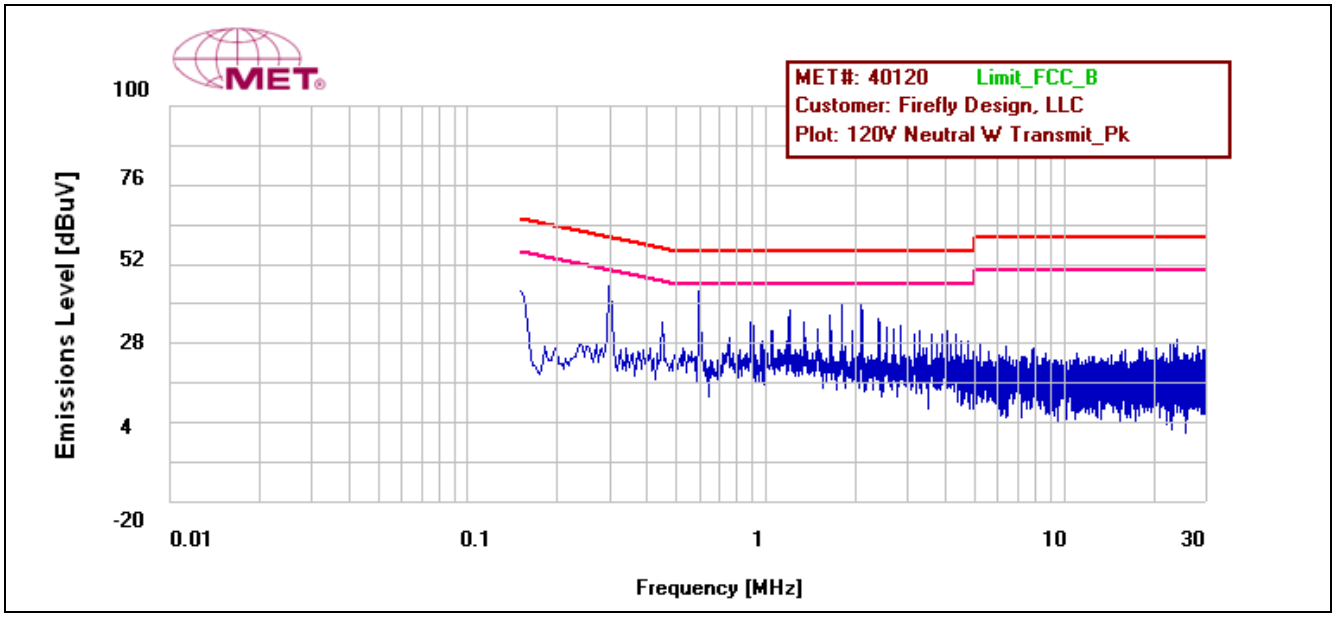



**Plot 1. Conducted Emissions, 15.207(a), Phase Line Transmitter**

## 15.207(a) Conducted Emissions Test Results

| Line | Freq. (MHz) | QP Amplitude | QP Limit | Delta | Pass | Average Amplitude | Average Limit | Delta | Pass |
|---|---|---|---|---|---|---|---|---|---|
| Neutral Tx | .299 | 46.52 | 60.286 | -13.766 | Pass | 43.34 | 50.286 | -6.946 | Pass |
| Neutral Tx | .6 | 45.55 | 56 | -10.45 | Pass | 44.73 | 46 | -1.27 | Pass |
| Neutral Tx | .9 | 43.05 | 56 | -12.95 | Pass | 42.21 | 46 | -3.79 | Pass |

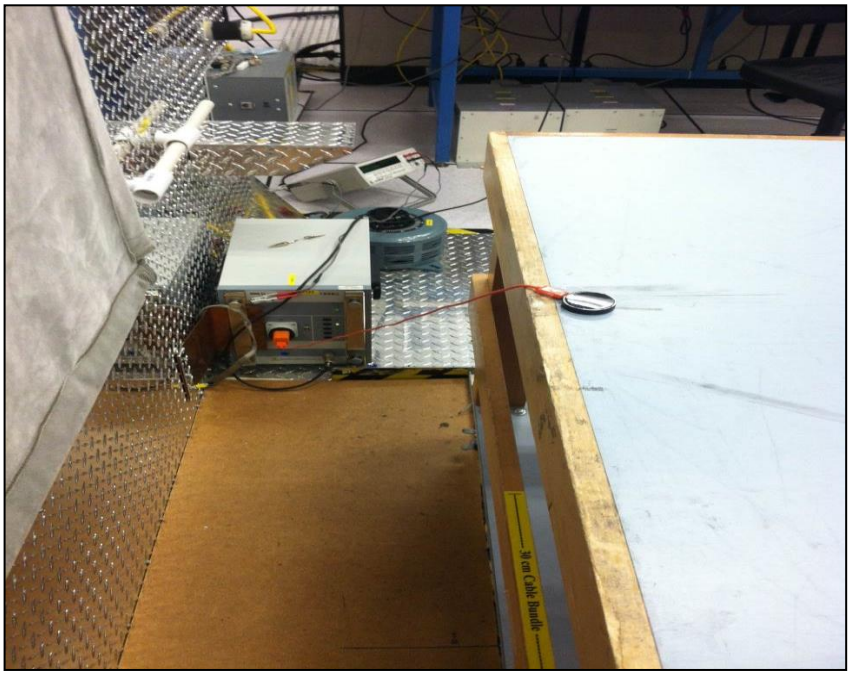
**Table 10. Conducted Emissions, 15.207(a), Neutral Line, Test Results**




**Plot 2. Conducted Emissions, 15.207(a), Neutral Line Transmitter**

## 15.207(a) Conducted Emissions Test Setup Photo


**Photograph 2. Conducted Emissions, 15.207(a), Test Setup**



**Photograph 3. Conducted Emissions, 15.207(a), Test Setup, Rear View**

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(a)(2) 6 dB and 99% Bandwidth

**Test Requirements:** **§ 15.247(a)(2):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

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

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

**Test Results** The EUT was compliant with § 15.247 (a)(2).

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

**Test Engineer(s):** Poona Saber

**Test Date(s):** 10/11/13 – 10/17/13

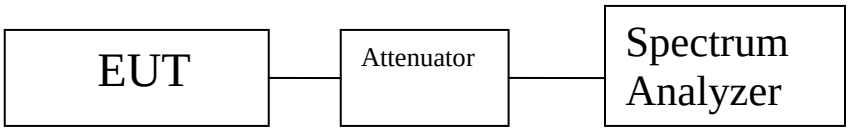



**Figure 2. Block Diagram, Occupied Bandwidth Test Setup**

## Occupied Bandwidth Test Results

| Occupied Bandwidth | | |
|---|---|---|
| **Carrier Channel** | **Frequency (MHz)** | **Measured 6 dB Bandwidth (kHz)** |
| Low | 2412 | 687.6 kHz |
| Mid | 2442 | 679.9 kHz |
| High | 2472 | 693.0 kHz |

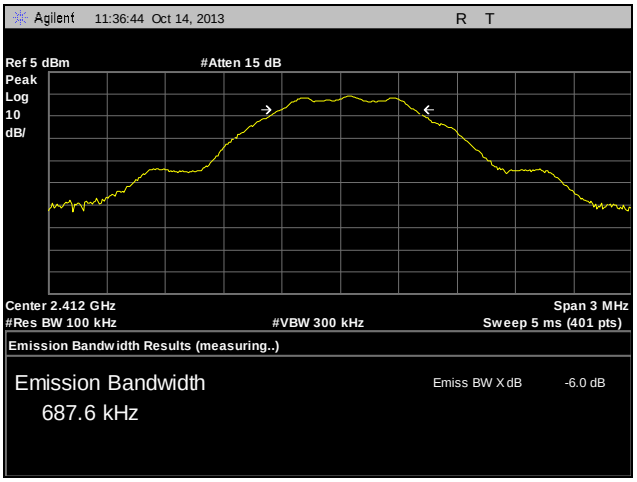
**Table 11. 6 dB Occupied Bandwidth, Test Results**

| Occupied Bandwidth | | |
|---|---|---|
| **Carrier Channel** | **Frequency (MHz)** | **Measured 99% Bandwidth** |
| Low | 2412 | 966.4 kHz |
| Mid | 2442 | 1.048 MHz |
| High | 2472 | 1.003 MHz |

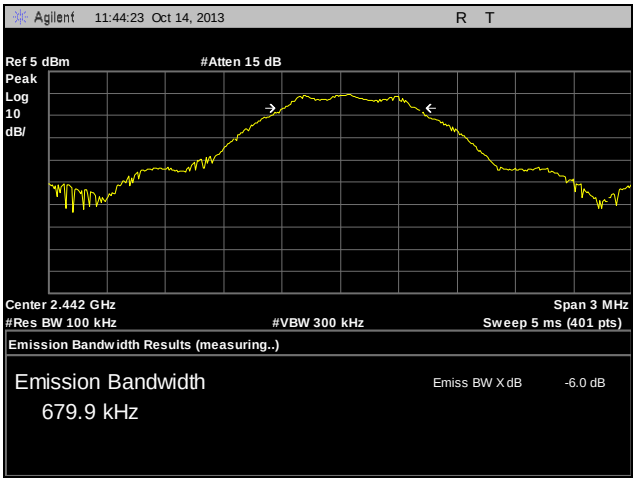
**Table 12. 99% Occupied Bandwidth, Test Results**

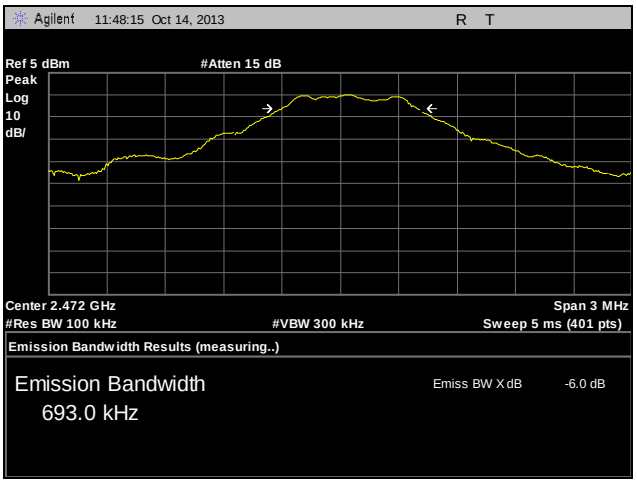
## 6 dB Occupied Bandwidth Test Results




**Plot 3. 6 dB Occupied Bandwidth, Low Channel**

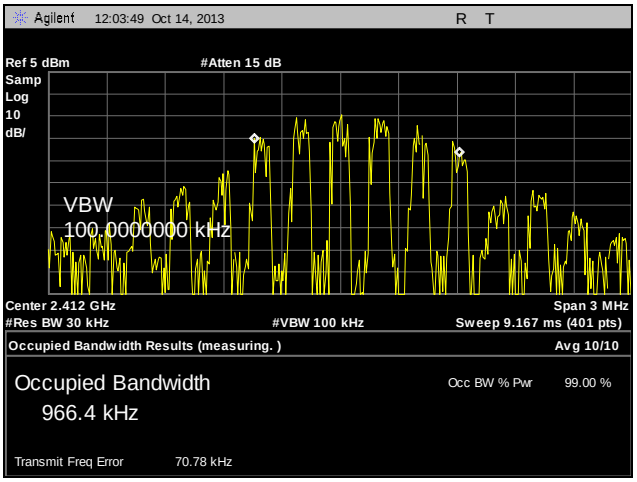



**Plot 4. 6 dB Occupied Bandwidth, Mid Channel**

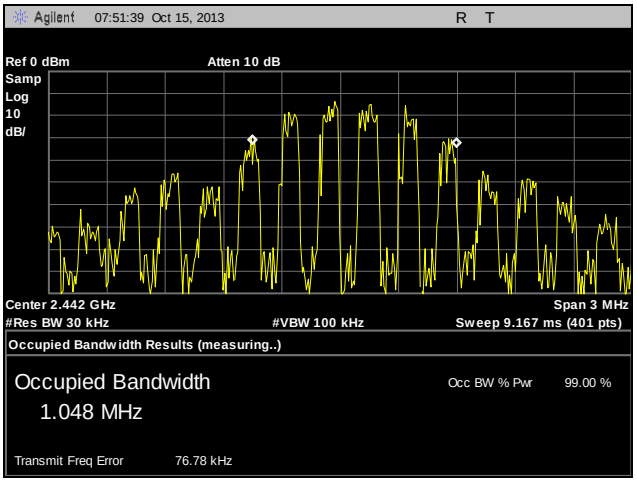



**Plot 5. 6 dB Occupied Bandwidth, High Channel**

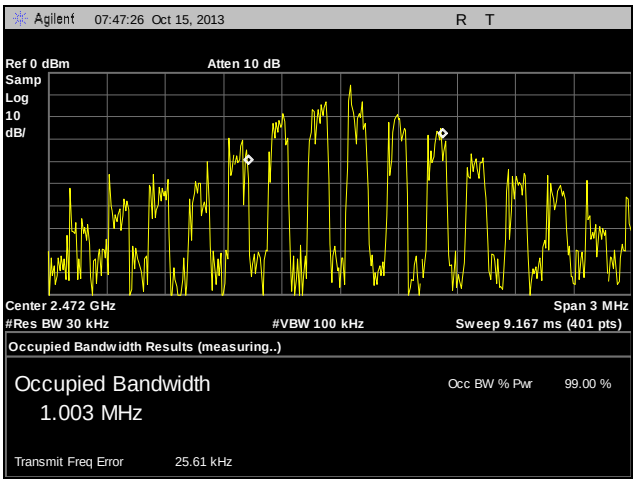
## 99% Occupied Bandwidth Test Results




**Plot 6. 99% Occupied Bandwidth, Low Channel**




**Plot 7. 99% Occupied Bandwidth, Mid Channel**




**Plot 8. 99% Occupied Bandwidth, High Channel**

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(b) Peak Power Output

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

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

**Table 13. Output Power Requirements from §15.247(b)**

**§15.247(b)(4):** The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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

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

**Test Engineer(s):** Poona Saber

**Test Date(s):** 10/14/13 – 10/17/13

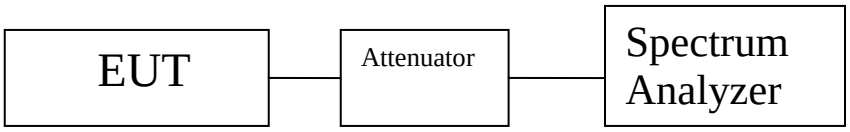
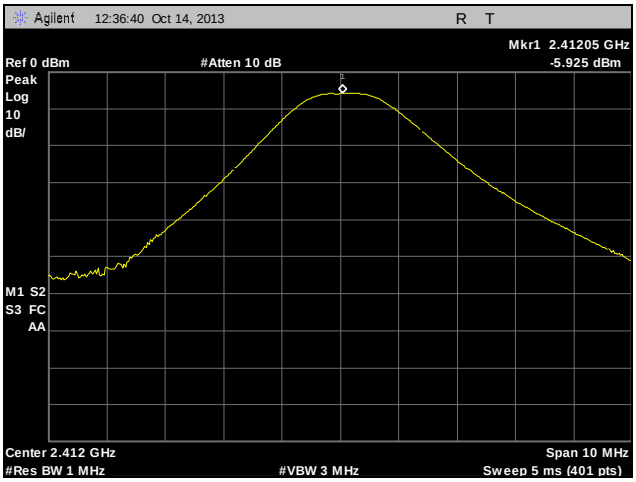
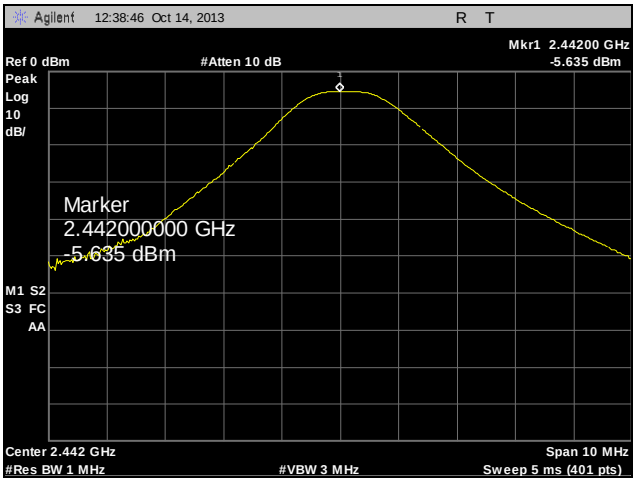



**Figure 3. Peak Power Output Test Setup**

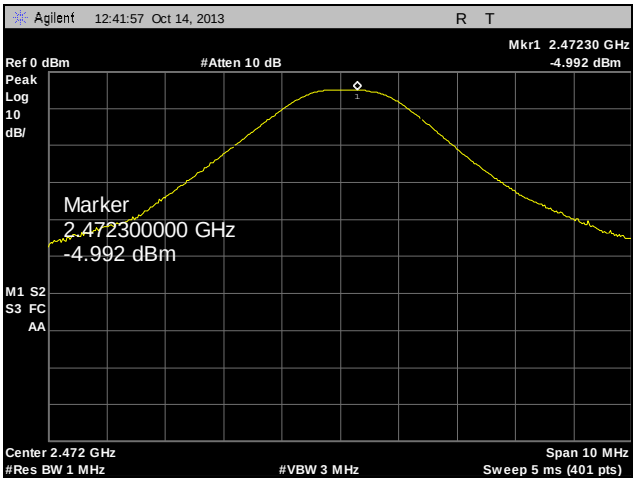
## Peak Power Output Test Results




**Plot 9. Peak Power Output, Low Channel, Peak**




**Plot 10. Peak Power Output, Mid Channel, Peak**




**Plot 11. Peak Power Output, High Channel, Peak**

# 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 14. 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 15.

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

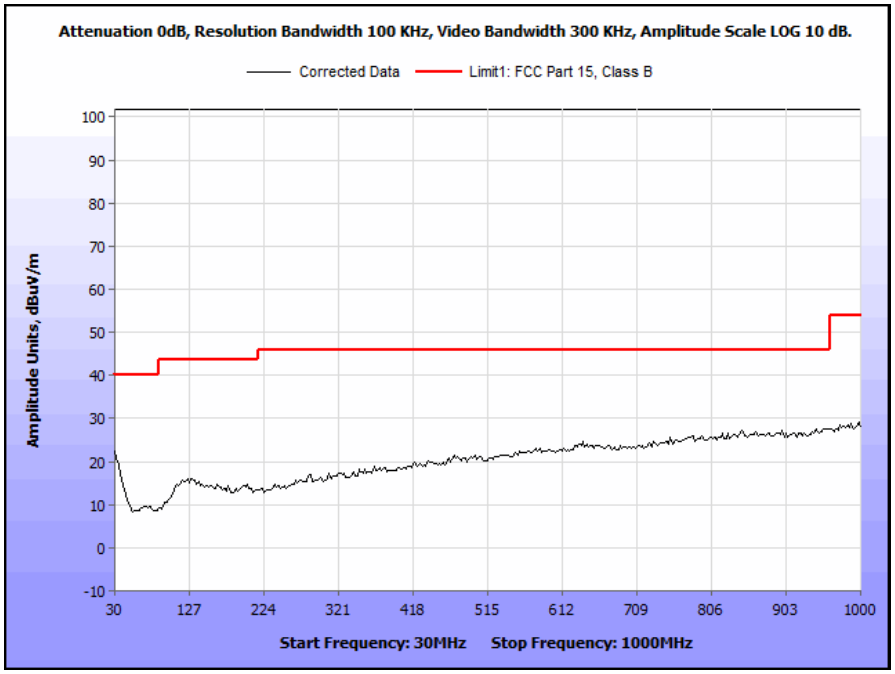
**Test Procedures:** The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was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

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

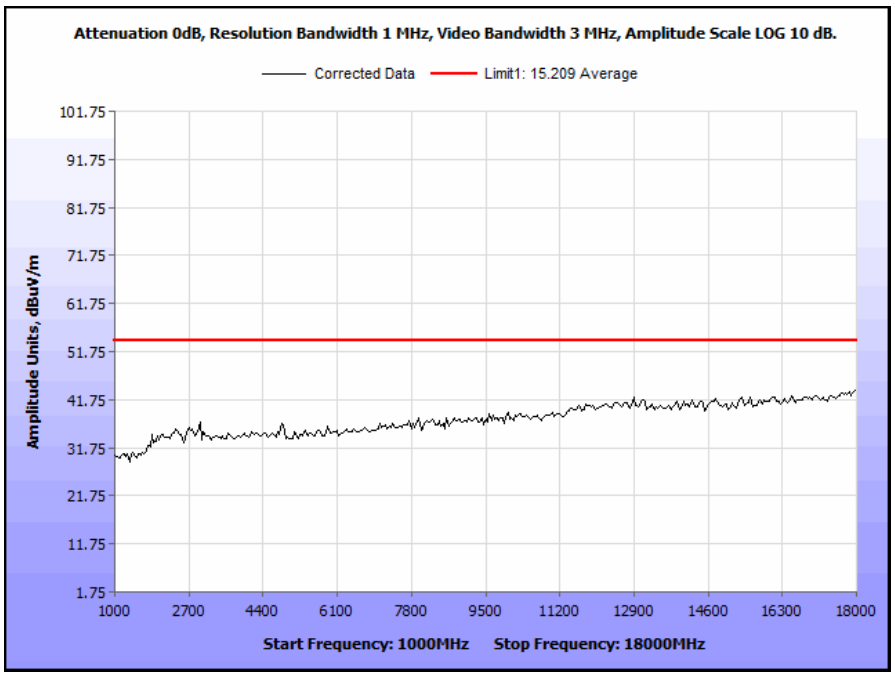
**Test Engineer(s):** Poona Saber

**Test Date(s):** 10/15/13 – 10/17/13

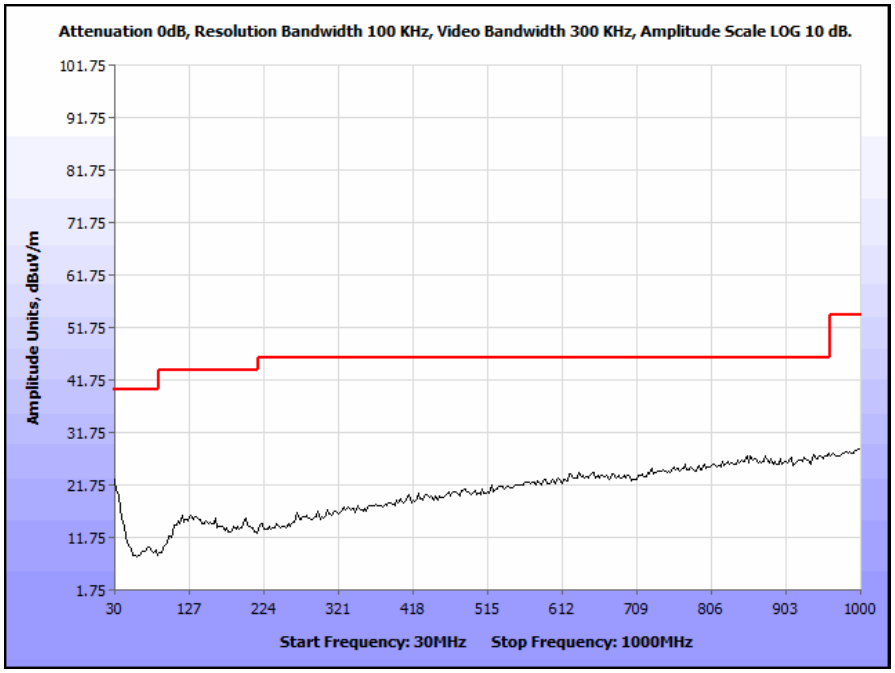
## Radiated Spurious Emissions Test Results



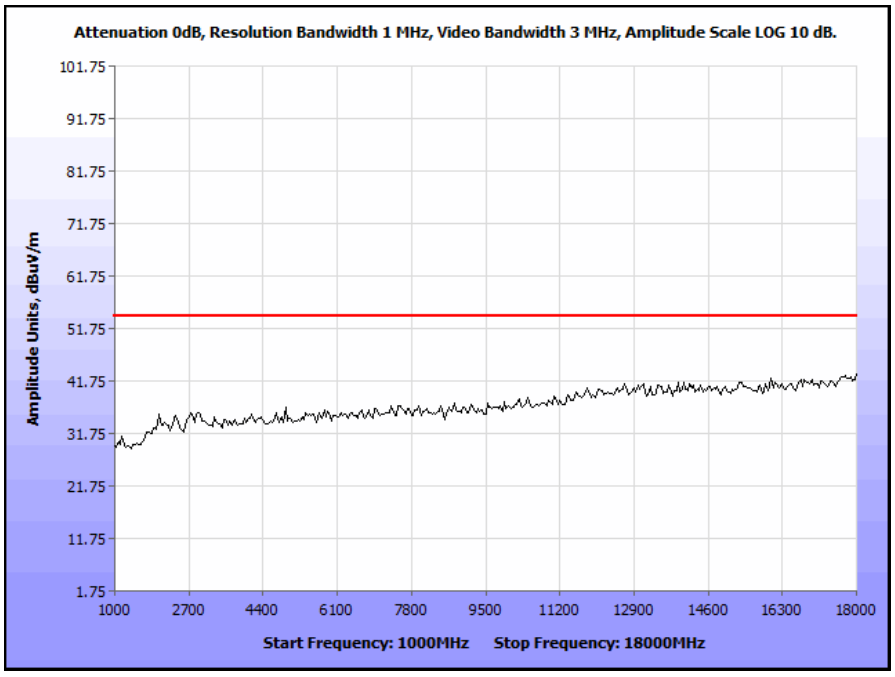

**Plot 12. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz**



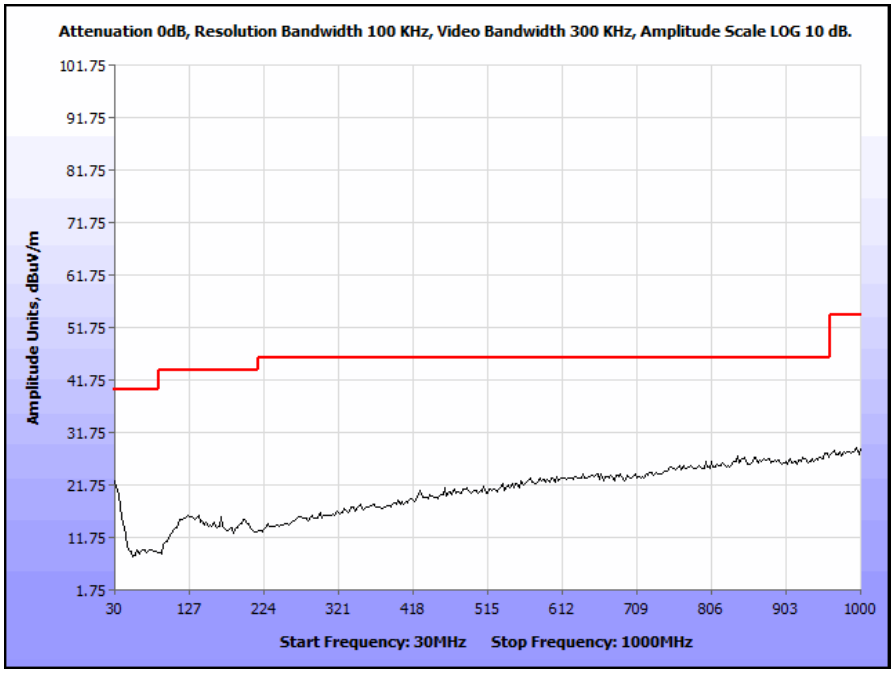

**Plot 13. Radiated Spurious Emissions, Low Channel, 1 GHz – 18 GHz, Peak with Average Limit**



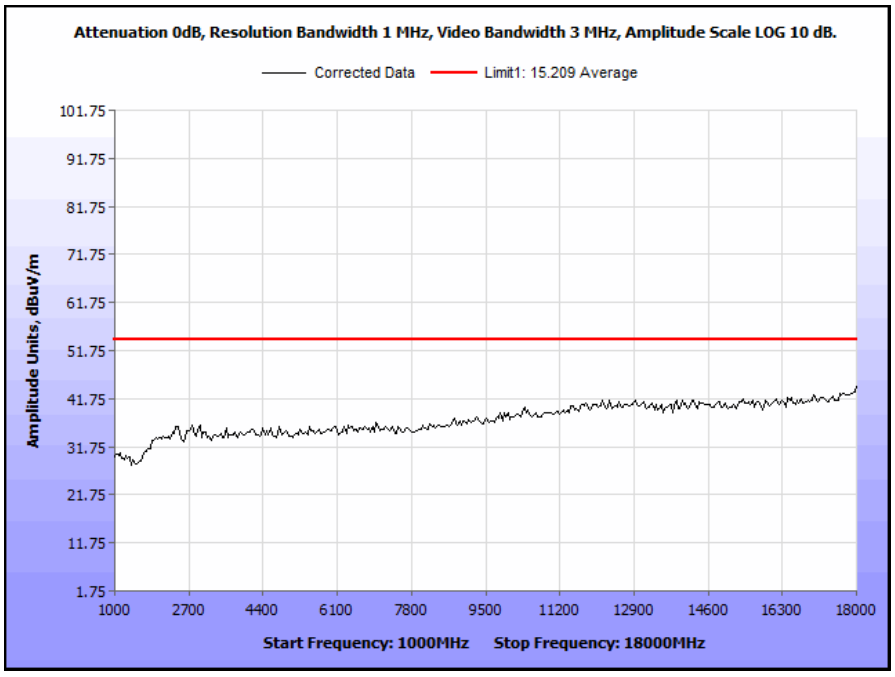

**Plot 14. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz**




**Plot 15. Radiated Spurious Emissions, Mid Channel, 1 GHz – 18 GHz, Peak with Average Limit**



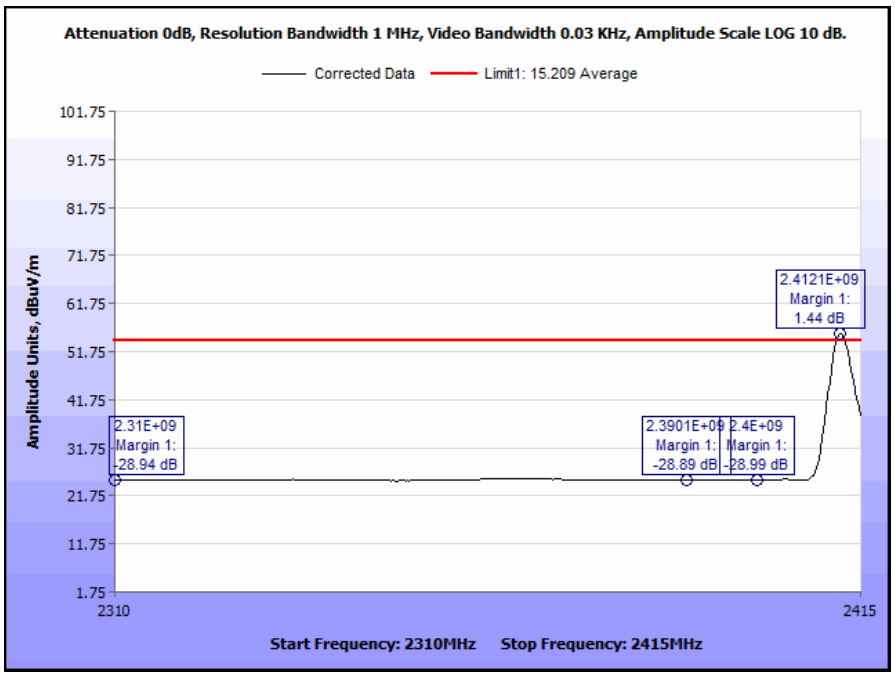

**Plot 16. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz**



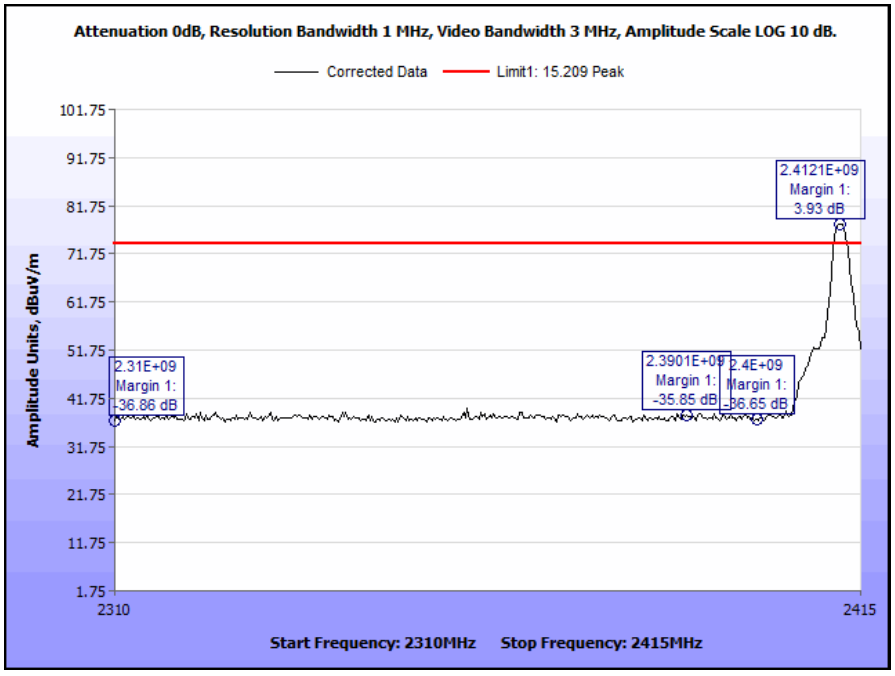

**Plot 17. Radiated Spurious Emissions, High Channel, 1 GHz – 18 GHz, Peak with Average Limit**

## Radiated Band Edge Measurements

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

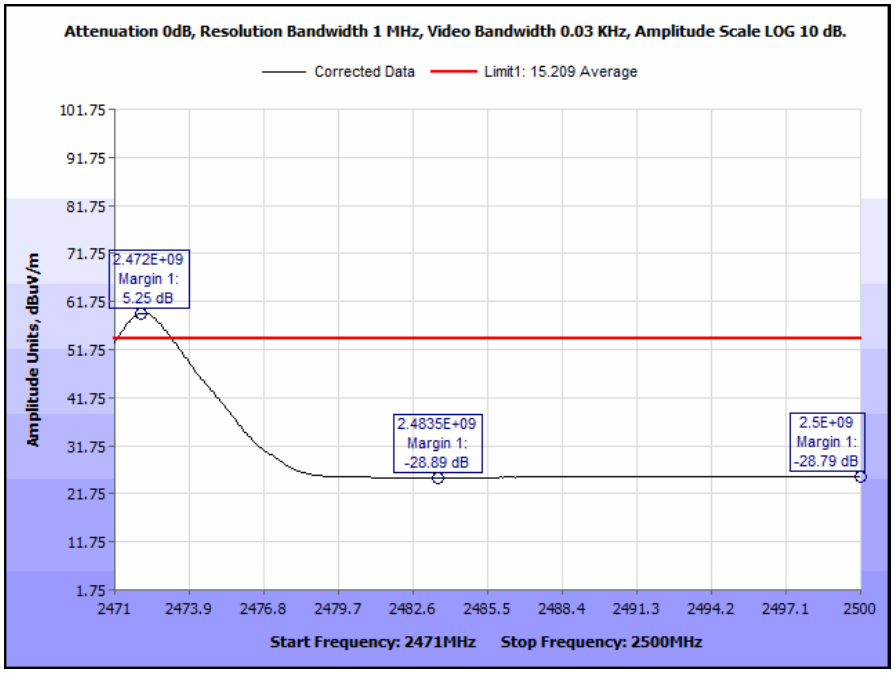



**Plot 18. Radiated Restricted Band Edge, Average, Low Channel**

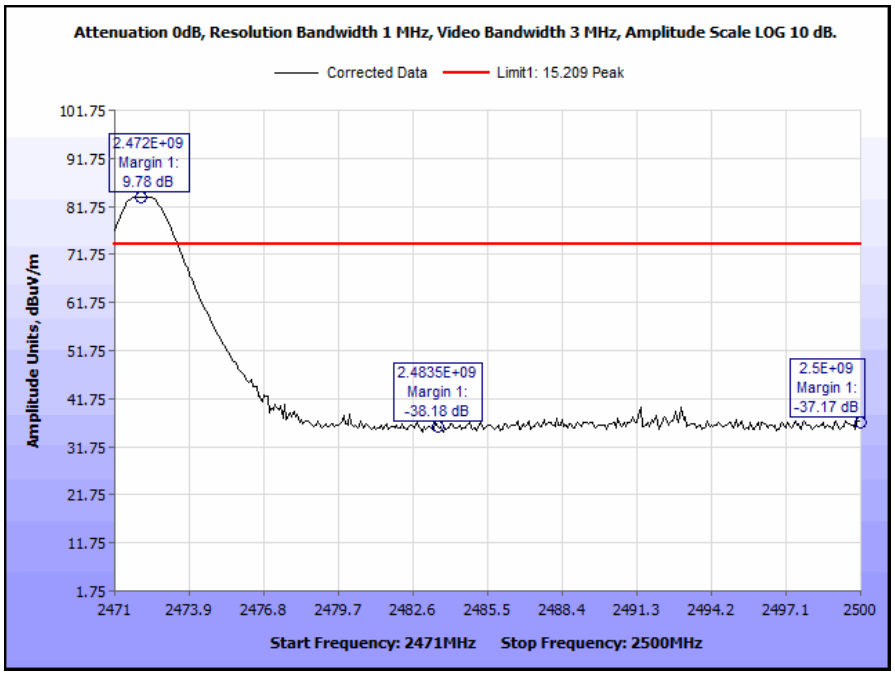



**Plot 19. Radiated Restricted Band Edge, Peak, Low Channel**



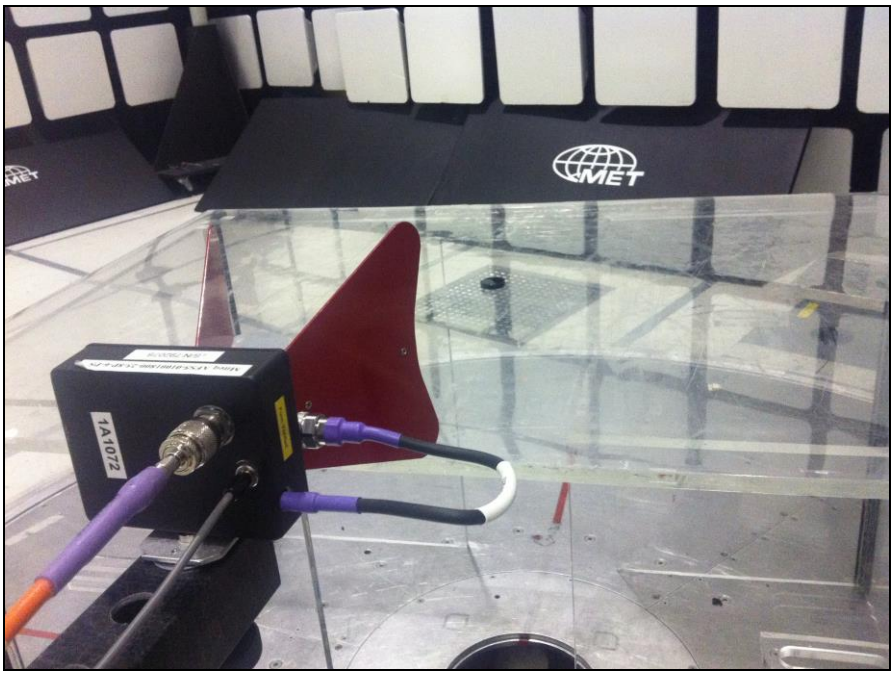

**Plot 20. Radiated Restricted Band Edge, Average, High Channel**



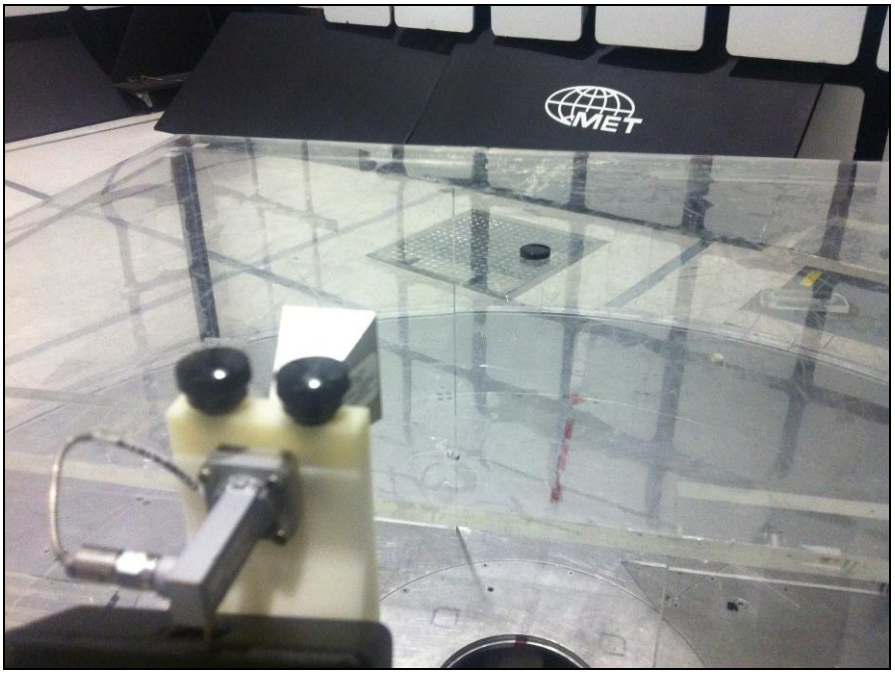

**Plot 21. Radiated Restricted Band Edge, Peak, High Channel**

## Radiated Spurious Emissions Test Setup

**Photograph 4. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz**




**Photograph 5. Radiated Spurious Emissions, Test Setup, 1 GHz – 18 GHz**




**Photograph 6. Radiated Spurious Emissions, Test Setup, 18 GHz – 26 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 10$^{th}$ harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Since the EUT had an integral antenna, conducted measurements could not be performed. Measurements needed to be taken radiated. An antenna was located 3 m away from the EUT and plots were taken. The EUT was rotated through all three orthogonal axes. The plots were corrected for both antenna correction factor and cable lost.

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

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

**Test Engineer(s):** Poona Saber

**Test Date(s):** 10/11/13 – 10/15/13

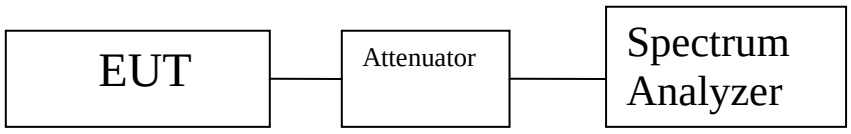
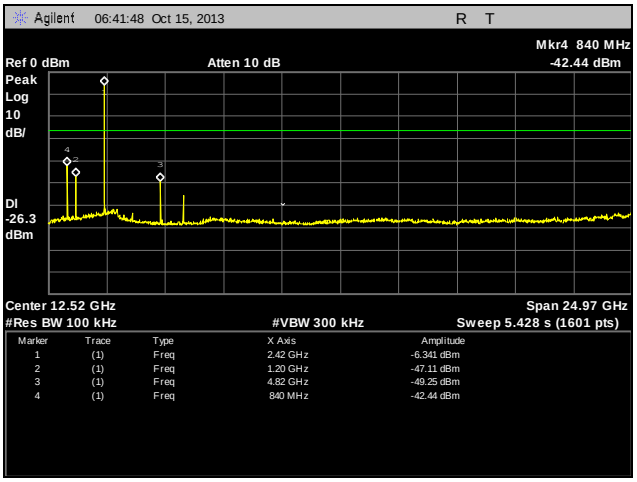


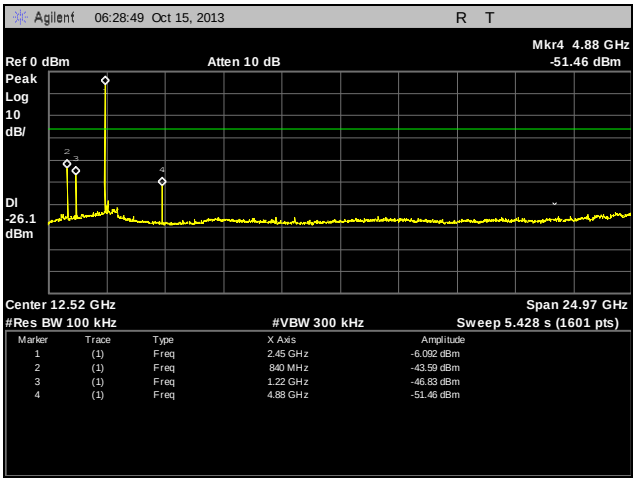

**Figure 4. Block Diagram, Conducted Spurious Emissions Test Setup**

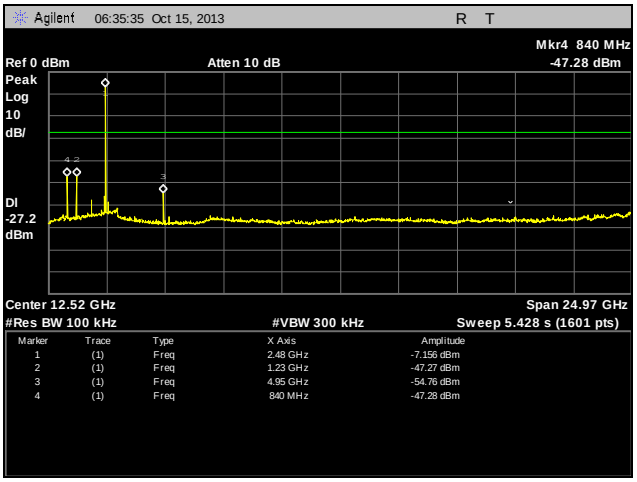
## Conducted Spurious Emissions Test Results




**Plot 22. Conducted Spurious Emissions, Low Channel**

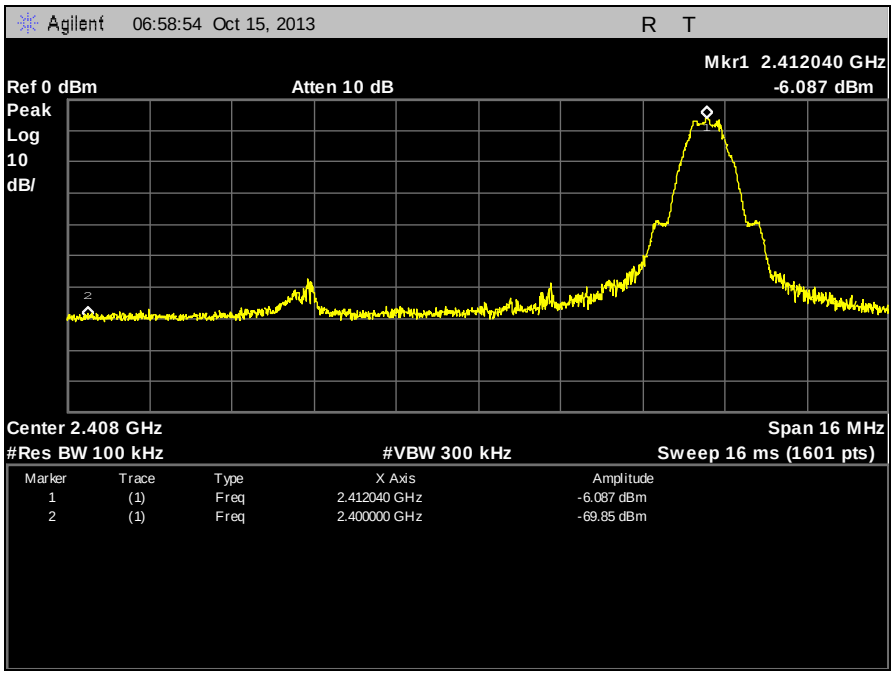



**Plot 23. Conducted Spurious Emissions, Mid Channel**

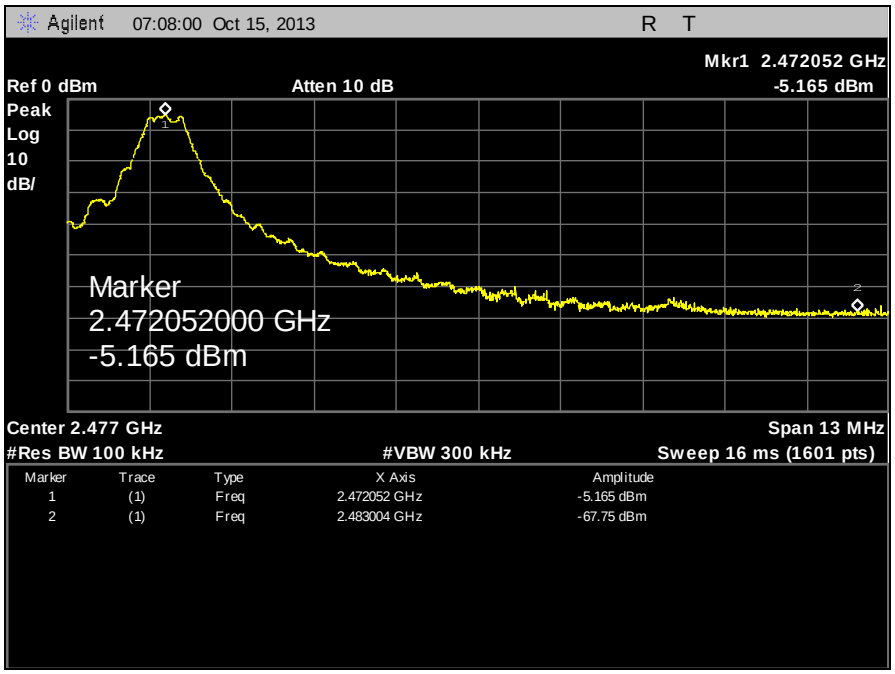



**Plot 24. Conducted Spurious Emissions, High Channel**

## Conducted Band Edge Test Results




**Plot 25. Conducted Band Edge, Low Channel**




**Plot 26. Conducted Band Edge, High Channel**

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(e) Peak Power Spectral Density

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

**Test Procedure:** The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level. A RBW of 1 MHz and VBW of 3 MHz were used to determine the peak emissions within the band. The Spectrum analyzer was then set to a RBW of 3 kHz and VBW was set to 10 kHz. The SPAN of the analyzer was set to 1 MHz with a 333.3 second sweep. Measurements were carried out at the low, mid and high channels.

**Test Results:** The EUT was compliant with the peak power spectral density limits of **§ 15.247 (e)**.

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

**Test Engineer:** Poona Saber

**Test Date:** 10/14/13 – 10/17/13

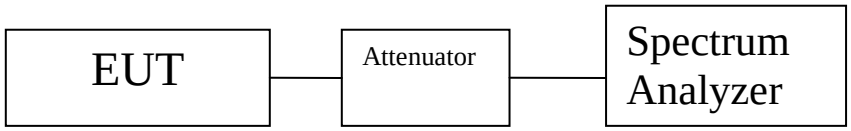
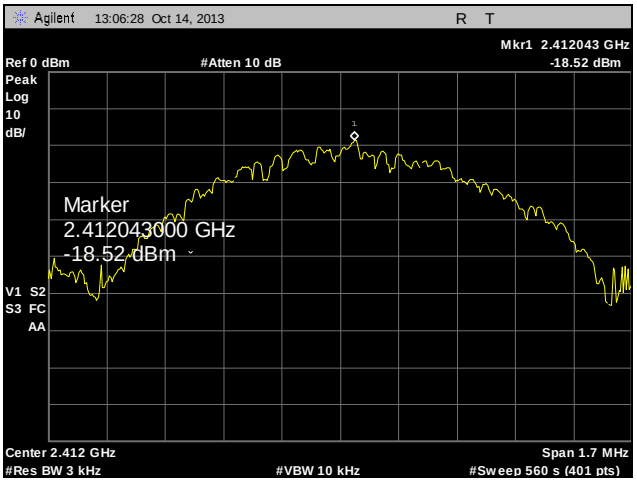



**Figure 5. Block Diagram, Peak Power Spectral Density Test Setup**

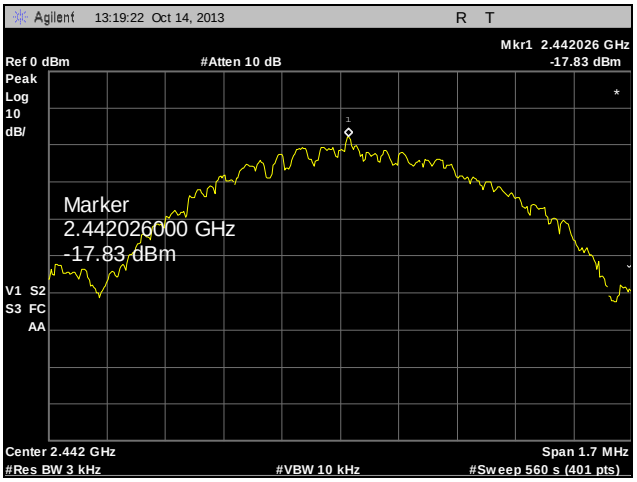
| Peak Power Spectral Density | | | | |
|---|---|---|---|---|
| **Carrier Channel** | **Frequency (MHz)** | **Measured PPSD (dBm)** | **Limit (dBm)** | **Margin (dB)** |
| Low | 2412 | -18.52 | 8 | -26.52 |
| Mid | 2442 | -17.83 | 8 | -25.83 |
| High | 2472 | -17.21 | 8 | -25.21 |

**Table 16. Peak Power Spectral Density, Test Results, Method 1**

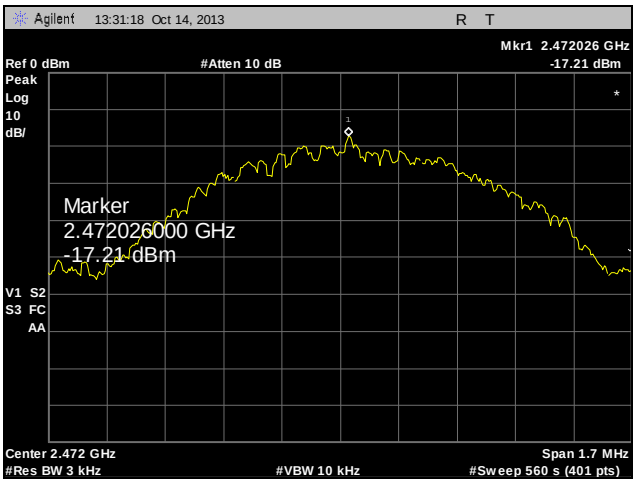
## Peak Power Spectral Density Method 1




**Plot 27. Peak Power Spectral Density, Low Channel, Method 1**




**Plot 28. Peak Power Spectral Density, Mid Channel, Method 1**




**Plot 29. Peak Power Spectral Density, High Channel, Method 1**

# IV. Test Equipment

## Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| MET Asset # | Equipment | Manufacturer | Model | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| 1A1083 | EMI TEST RECEIVER | ROHDE & SCHWARZ | ESU40 | 05/31/2013 | 05/31/2014 |
| 1A1065 | EMI RECEIVER | ROHDE & SCHWARZ | ESCI | 01/22/2013 | 01/22/2014 |
| 1A1088 | PRE-AMP | RHODE & SCHWARZ | TS-PR1 | SEE NOTE | |
| 1A1047 | BI-CONILOG ANTENNA (30MHZ TO 1GHZ) | SUNOL SCIENCES | JB3 | 01/03/2013 | 01/03/2014 |
| 1A1106 | 10M CHAMBER | ETS | SEMI-ANECHOIC | 9/12/2012 | 03/12/2014 |
| 2A1004 | TEMPERATURE, HUMIDITY & PRESSURE RECORDER | OMEGA | OM-CP-PRHTEMP2000 | 05/13/2013 | 05/13/2014 |
| 1A1083 | EMI TEST RECEIVER | ROHDE & SCHWARZ | ESU40 | 05/13/2013 | 05/13/2014 |
| 1A1088 | PRE-AMP | RHODE & SCHWARZ | TS-PR1 | SEE NOTE | |
| 1A1113 | PRE-AMP | MINI-CIRCUIT | ZVA-183+ | SEE NOTE | |
| 1A1072 | PRE-AMP | MITEQ | AFS5-01001800-25-8P-6-PS | SEE NOTE | |
| 1A1047 | HORN ANTENNA | ETS | 3117 | 04/03/2012 | 11/03/2013 |
| 1A1050 | BI-CONILOG ANTENNA (30MHZ TO 1GHZ) | SUNOL SCIENCES | JB3 | 01/03/2013 | 01/03/2014 |
| 1A1106 | 10M CHAMBER | ETS | SEMI-ANECHOIC | 09/12/2012 | 03/12/2014 |
| 1A1066 | PYRAMIDAL GAIN HORN | ETS LINDGREN | 3160-10 | 05/08/2012 | 11/08/2013 |
| 1A1026 | PYRAMIDAL GAIN HORN | ETS LINDGREN | 3160-09 | 05/09/2012 | 11/09/2013 |
| 1A1065 | EMI RECEIVER | ROHDE & SCHWARZ | ESCI | 01/22/2013 | 01/22/2014 |
| 1A1087 | ATTENUATOR | ROHDE & SCHWARZ | ESH3Z2 | 10/04/2012 | 11/04/2013 |
| 1A1022 | ESH3-25 LISN (AE) | ROHDE & SCHWARZ | 831-5518.2 | 03/18/2013 | 03/18/2014 |
| 1A1119 | TEST AREA | CUSTOM MADE | N/A | 03/19/2013 | 08/19/2014 |

**Table 17. Test Equipment List**

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

# V. Certification & User's Manual Information

# Certification & User's Manual Information

## A. Certification Information

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

**§ 2.801 Radio-frequency device defined.**

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

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

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

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

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

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

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

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

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

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

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

*(i) Compliance testing;*

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

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

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

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

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

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

## Certification & User's Manual Information

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

**§ 2.901 Basis and Purpose**

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

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

**§ 2.907 Certification.**

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

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

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

## Certification & User's Manual Information

**§ 2.948 Description of measurement facilities.**

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

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

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

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

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

# Certification & User's Manual Information

## 1. Label and User's Manual Information

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

**§ 15.19 Labeling requirements.**

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

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

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

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

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

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

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

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

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

**§ 15.21 Information to user.**

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

## Verification & User's Manual Information

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

**§ 15.105 Information to the user.**

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

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

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

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

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

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

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

## ICES-003 Procedural & Labeling Requirements

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

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

**Procedural Requirements:**

According to Industry Canada's Interference Causing Equipment Standard for Digital Apparatus ICES-003 Issue 5 August 2012:

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 users' 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