



## MET Laboratories, Inc.

*Safety Certification - EMI - Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313

33439 WESTERN AVENUE • UNION CITY, CALIFORNIA 94587 • PHONE (510) 489-6300 • FAX (510) 489-6372

3162 BELICK STREET • SANTA CLARA, CA 95054 • PHONE (408) 748-3585 • FAX (510) 489-6372

13301 MCCALLEN PASS • AUSTIN, TEXAS 78753 • PHONE (512) 287-2500 • FAX (512) 287-2513

December 8, 2014

Autani Corp.  
7170 Riverwood Drive, Suite B  
Columbia, MD 21046

Dear Mark Plasterer,

Enclosed is the EMC Wireless test report for compliance testing of the Autani Corp., WAT3, Model No. 1000153 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart B and ICES-003, Issue 5 August 2012 for a Class B Digital Device, and 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: (\Autani Corp.\EMC83373-FCC247 Rev. 1)

Certificates and reports shall not be reproduced except in full, without the written permission of MET Laboratories, Inc.

---

## Electromagnetic Compatibility Criteria Test Report

for the

**Autani Corp.**  
**WAT3, Model No. 1000153**

**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: EMC83373-FCC247 Rev. 1**

December 8, 2014

**Prepared For:**

**Autani Corp.**  
**7170 Riverwood Drive, Suite B**  
**Columbia, MD 21046**

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

## Electromagnetic Compatibility Criteria Test Report

for the

**Autani Corp.**  
**WAT3, Model No. 1000153**

**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



Jason Allnutt, 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 5 August 2012, 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
Ø	November 24, 2014	Initial Issue.
1	December 8, 2014	Revised to reflect engineer corrections.

## Table of Contents

<b>I.</b>	<b>Executive Summary .....</b>	<b>1</b>
	A. Purpose of Test .....	2
	B. Executive Summary .....	2
<b>II.</b>	<b>Equipment Configuration .....</b>	<b>3</b>
	A. Overview.....	4
	B. References.....	5
	C. Test Site .....	5
	D. Description of Test Sample .....	6
	E. Equipment Configuration.....	7
	F. Support Equipment .....	7
	G. Mode of Operation.....	7
	H. Method of Monitoring EUT Operation.....	8
	I. Modifications .....	8
	a) Modifications to EUT .....	8
	b) Modifications to Test Standard.....	8
	J. Disposition of EUT .....	8
<b>III.</b>	<b>Electromagnetic Compatibility Criteria for Unintentional Radiators .....</b>	<b>9</b>
	§ 15.107(a) Conducted Emissions Limits.....	10
	§ 15.109(a) Radiated Emissions Limits.....	14
<b>IV.</b>	<b>Electromagnetic Compatibility Criteria for Intentional Radiators.....</b>	<b>17</b>
	§ 15.203 Antenna Requirement .....	18
	§ 15.207(a) Conducted Emissions Limits.....	19
	§ 15.247(a)(a) 6 dB and 99% Bandwidth .....	25
	§ 15.247(b) Peak Power Output .....	29
	§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge.....	32
	§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge.....	43
	§ 15.247(e) Peak Power Spectral Density .....	48
	§ 15.247(i) Maximum Permissible Exposure .....	51
<b>V.</b>	<b>Test Equipment .....</b>	<b>52</b>
<b>VI.</b>	<b>Certification &amp; User's Manual Information .....</b>	<b>54</b>
	A. Certification Information .....	55
	B. Label and User's Manual Information .....	59
<b>VII.</b>	<b>ICES-003 Procedural &amp; Labeling Requirements.....</b>	<b>61</b>

## List of Tables

Table 1. Executive Summary of EMC Part 15.247 Compliance Testing .....	2
Table 2. EUT Summary Table.....	4
Table 3. References .....	5
Table 4. Equipment Configuration.....	7
Table 5. Support Equipment.....	7
Table 6. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b) .....	10
Table 7. Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC, 60 Hz).....	11
Table 8. Conducted Emissions - Voltage, AC Power, Neutral Line (120 VAC, 60 Hz).....	12
Table 9. Radiated Emissions Limits calculated from FCC Part 15, §15.109 (a) (b) .....	14
Table 10. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz .....	15
Table 11. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a) .....	19
Table 12. Conducted Emissions, 15.207(a), Phase Line, Test Results .....	20
Table 13. Conducted Emissions, 15.207(a), Neutral Line, Test Results .....	22
Table 14. 6 dB Occupied Bandwidth, Test Results .....	26
Table 15. 99% Occupied Bandwidth, Test Results .....	26
Table 16. Output Power Requirements from §15.247(b) .....	29
Table 17. Peak Power Output, Test Results .....	30
Table 18. Restricted Bands of Operation.....	32
Table 19. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a) .....	33
Table 20. Peak Power Spectral Density, Test Results .....	49
Table 21. Test Equipment List .....	53

## List of Plots

Plot 1. Conducted Emissions, Phase Line Plot .....	11
Plot 2. Conducted Emissions, Neutral Line Plot .....	12
Plot 3. Radiated Emissions, 30 MHz - 1 GHz .....	15
Plot 4. Conducted Emissions, 15.207(a), Phase Line, Low Channel .....	20
Plot 5. Conducted Emissions, 15.207(a), Phase Line, Mid Channel .....	21
Plot 6. Conducted Emissions, 15.207(a), Phase Line, High Channel .....	21
Plot 7. Conducted Emissions, 15.207(a), Neutral Line, Low Channel .....	22
Plot 8. Conducted Emissions, 15.207(a), Neutral Line, Mid Channel .....	23
Plot 9. Conducted Emissions, 15.207(a), Neutral Line, High Channel .....	23
Plot 10. 6 dB Occupied Bandwidth, Low Channel.....	27
Plot 11. 6 dB Occupied Bandwidth, Mid Channel .....	27
Plot 12. 6 dB Occupied Bandwidth, High Channel .....	27
Plot 13. 99% Occupied Bandwidth, Low Channel .....	28
Plot 14. 99% Occupied Bandwidth, Mid Channel.....	28
Plot 15. 99% Occupied Bandwidth, High Channel .....	28
Plot 16. Peak Power Output, Low Channel .....	31
Plot 17. Peak Power Output, Mid Channel.....	31
Plot 18. Peak Power Output, High Channel .....	31
Plot 19. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz .....	34
Plot 20. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average .....	34
Plot 21. Radiated Spurious Emissions, Low Channel, 7 GHz – 14 GHz, Average .....	34
Plot 22. Radiated Spurious Emissions, Low Channel, 14 GHz – 18 GHz, Average .....	35
Plot 23. Radiated Spurious Emissions, Low Channel, 1 GHz – 18 GHz, Peak .....	35
Plot 24. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz .....	35
Plot 25. Radiated Spurious Emissions, Mid Channel, 1 MHz – 7 GHz, Average .....	36
Plot 26. Radiated Spurious Emissions, Mid Channel, 7 MHz – 14 GHz, Average .....	36

Plot 27. Radiated Spurious Emissions, Mid Channel, 14 MHz – 18 GHz, Average .....	36
Plot 28. Radiated Spurious Emissions, Mid Channel, 1 MHz – 18 GHz, Peak .....	37
Plot 29. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz .....	37
Plot 30. Radiated Spurious Emissions, High Channel, 1 MHz – 7 GHz, Average .....	37
Plot 31. Radiated Spurious Emissions, High Channel, 1 MHz – 7 GHz, Average, Zoom .....	38
Plot 32. Radiated Spurious Emissions, High Channel, 7 MHz – 14 GHz, Average .....	38
Plot 33. Radiated Spurious Emissions, High Channel, 14 MHz – 18 GHz, Average .....	38
Plot 34. Radiated Spurious Emissions, High Channel, 1 MHz – 18 GHz, Peak .....	39
Plot 35. Radiated Restricted Band Edge, Low Channel, Average .....	40
Plot 36. Radiated Restricted Band Edge, Low Channel, Peak .....	40
Plot 37. Radiated Restricted Band Edge, High Channel, Average .....	41
Plot 38. Radiated Restricted Band Edge, High Channel, Peak .....	41
Plot 39. Conducted Spurious Emissions, Low Channel, 30 MHz – 1 GHz .....	44
Plot 40. Conducted Spurious Emissions, Low Channel, 1 GHz – 25 GHz .....	44
Plot 41. Conducted Spurious Emissions, Mid Channel, 30 MHz – 1 GHz .....	45
Plot 42. Conducted Spurious Emissions, Mid Channel, 1 GHz – 25 GHz .....	45
Plot 43. Conducted Spurious Emissions, High Channel, 30 MHz – 1 GHz .....	46
Plot 44. Conducted Spurious Emissions, High Channel, 1 GHz – 25 GHz .....	46
Plot 45. Conducted Band Edge, Low Channel .....	47
Plot 46. Conducted Band Edge, High Channel .....	47
Plot 47. Peak Power Spectral Density, Low Channel .....	50
Plot 48. Peak Power Spectral Density, Mid Channel .....	50
Plot 49. Peak Power Spectral Density, High Channel .....	50

## List of Figures

Figure 1. Block Diagram of Test Configuration .....	6
Figure 2. Block Diagram, Occupied Bandwidth Test Setup .....	25
Figure 3. Peak Power Output Test Setup .....	29
Figure 4. Block Diagram, Conducted Spurious Emissions Test Setup .....	43
Figure 5. Block Diagram, Peak Power Spectral Density Test Setup .....	48

## List of Photographs

Photograph 1. Autani Corp. WAT3, Model No. 1000153 .....	6
Photograph 2. Conducted Emissions, Test Setup .....	13
Photograph 3. Radiated Emissions, Test Setup .....	16
Photograph 4. Conducted Emissions, 15.207(a), Test Setup .....	24
Photograph 5. Radiated Spurious Emissions, Test Setup .....	42

## List of Terms and Abbreviations

<b>AC</b>	Alternating Current
<b>ACF</b>	Antenna Correction Factor
<b>Cal</b>	Calibration
<i>d</i>	Measurement Distance
<b>dB</b>	Decibels
<b>dB<sub>μ</sub>A</b>	Decibels above one <b>microamp</b>
<b>dB<sub>μ</sub>V</b>	Decibels above one <b>microvolt</b>
<b>dB<sub>μ</sub>A/m</b>	Decibels above one <b>microamp per meter</b>
<b>dB<sub>μ</sub>V/m</b>	Decibels above one <b>microvolt per meter</b>
<b>DC</b>	Direct Current
<b>E</b>	Electric Field
<b>DSL</b>	Digital Subscriber Line
<b>ESD</b>	Electrostatic Discharge
<b>EUT</b>	Equipment Under Test
<i>f</i>	Frequency
<b>FCC</b>	Federal Communications Commission
<b>GRP</b>	Ground Reference Plane
<b>H</b>	Magnetic Field
<b>HCP</b>	Horizontal Coupling Plane
<b>Hz</b>	Hertz
<b>IEC</b>	International Electrotechnical Commission
<b>kHz</b>	kilohertz
<b>kPa</b>	kilopascal
<b>kV</b>	kilovolt
<b>LISN</b>	Line Impedance Stabilization Network
<b>MHz</b>	Megahertz
<b>μH</b>	<b>microhenry</b>
<b>μ</b>	<b>microfarad</b>
<b>μs</b>	<b>microseconds</b>
<b>NEBS</b>	Network Equipment-Building System
<b>PRF</b>	Pulse Repetition Frequency
<b>RF</b>	Radio Frequency
<b>RMS</b>	Root-Mean-Square
<b>TWT</b>	Traveling Wave Tube
<b>V/m</b>	Volts <b>per meter</b>
<b>VCP</b>	Vertical Coupling Plane

## I. Executive Summary

## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Autani Corp. WAT3, Model No. 1000153, 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 WAT3, Model No. 1000153. 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 WAT3, Model No. 1000153, 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 20141021. 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
47 CFR Part 15.107 (a)	ICES-003 Issue 5 August 2012	Conducted Emission Limits for a Class B Digital Device	Compliant
47 CFR Part 15.109 (a)	ICES-003 Issue 5 August 2012	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-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)	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 WAT3, Model No. 1000153, under Autani Corp.'s purchase order number 20141021.

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., WAT3, Model No. 1000153.

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

<b>Model(s) Tested:</b>	WAT3, Model No. 1000153
<b>Model(s) Covered:</b>	WAT3, Model No. 1000153
<b>EUT Specifications:</b>	Primary Power: 120 VAC, 60 Hz
	FCC ID: V8NWAT1000153
	IC: 7737A-WAT1000153
	Type of Modulations: FSK
	Equipment Code: DTS
	Peak RF Output Power: 5.34 dBm
<b>EUT Frequency Ranges:</b>	2405-2475 MHz
<b>Analysis:</b>	The results obtained relate only to the item(s) tested.
<b>Environmental Test Conditions:</b>	Temperature: 15-35° C
	Relative Humidity: 30-60%
	Barometric Pressure: 860-1060 mbar
<b>Evaluated by:</b>	Jason Allnutt
<b>Report Date(s):</b>	December 8, 2014

**Table 2. EUT Summary Table**

## B. References

<b>CFR 47, Part 15, Subpart C</b>	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
<b>CFR 47, Part 15, Subpart B</b>	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
<b>RSS-210, Issue 8, Dec. 2010</b>	Low-power Licence-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment
<b>RSS-GEN, Issue 3, Dec. 2010</b>	General Requirements and Information for the Certification of Radio Apparatus
<b>ICES-003, Issue 5 August 2012</b>	Information Technology Equipment (ITE) — Limits and methods of measurement
<b>ANSI C63.4:2003</b>	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
<b>ISO/IEC 17025:2005</b>	General Requirements for the Competence of Testing and Calibration Laboratories
<b>ANSI C63.10-2009</b>	American National Standard for Testing Unlicensed Wireless Devices

**Table 3. References**

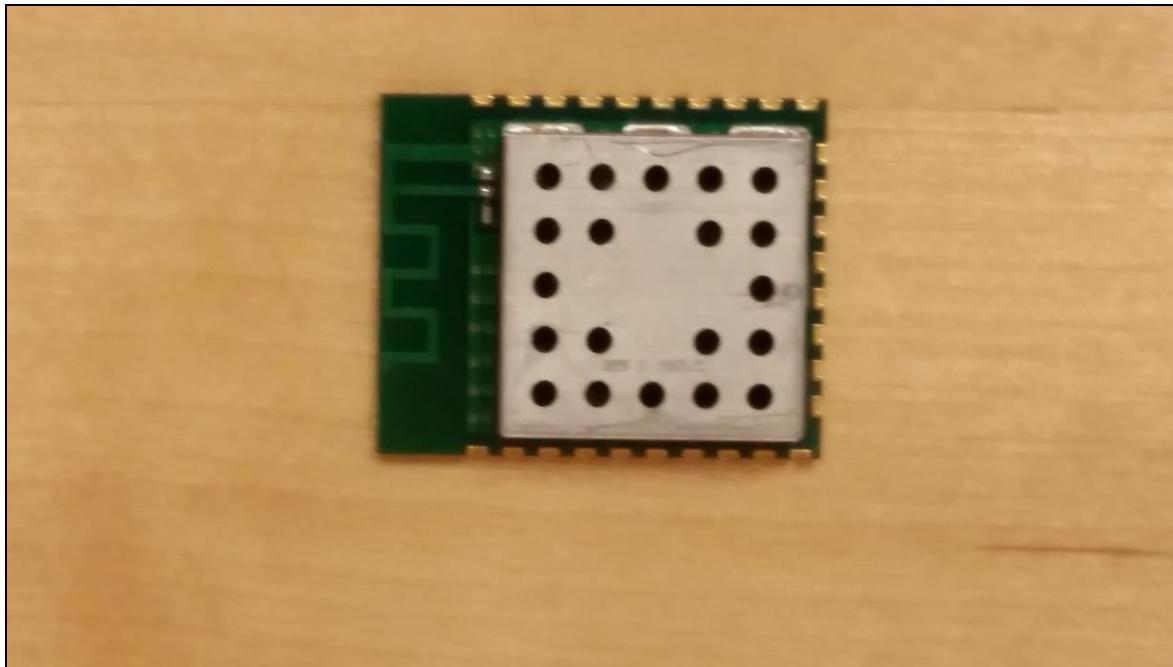
## C. Test Site

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. WAT3, Model No. 1000153, Equipment Under Test (EUT), is a 2.4 GHz wireless transceiver module which contains an integrated 2.4 GHz, IEEE 802.15.4-2003-compliant transceiver. The Autani WAT3 Module will primarily be used by Autani for its wirelessly controlled products, but may also be sold to other companies for their wireless controlled products.



Photograph 1. Autani Corp. WAT3, Model No. 1000153

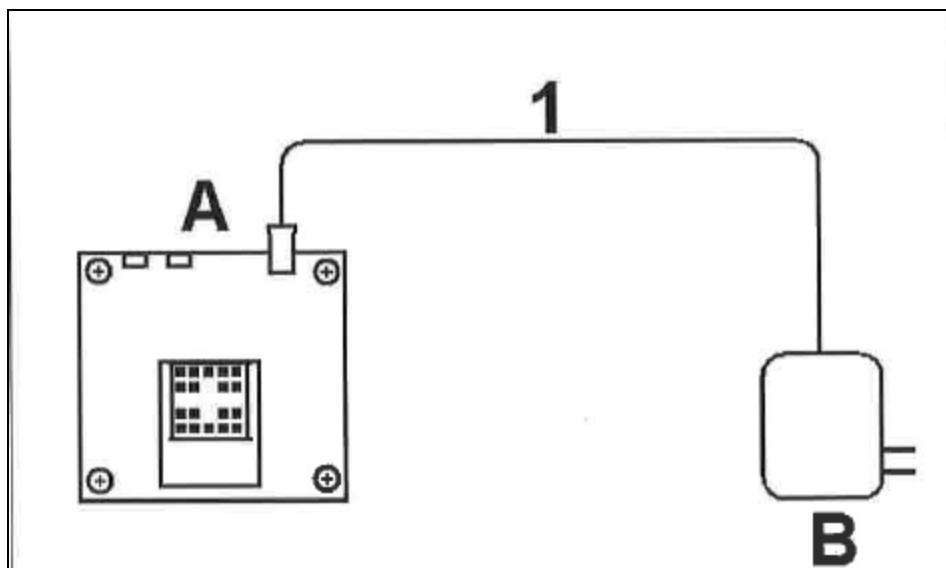


Figure 1. Block Diagram of Test Configuration

## 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
A	WAT3 Module	1000153	1000153-01

**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
A	WAT Test Board	Autani	60371-01
B, 1	AC/DC Power Supply	Various	Various

**Table 5. Support Equipment**

## G. Mode of Operation

### Production Mode:

The WAT3 is configured wirelessly. Once configured the mode of operation is dependent on the firmware loaded into the device; however, each mode has the same basic features.

### FCC Mode:

The WAT3 has a special image programmed into the SoC to facilitate FCC testing. This image represents the worst possible case from a noise perspective. The following details the operation and how to change states.

There are three switches (SW1, SW3, & SW3), a Power LED (LED3) and two Status LED's (LED1 & LED2) on the WAT3 test board. The functions are as follows:

- 1) A power-on, LED3 (VBRD) should ON solid, LED1 should be flashing, LED2 should be OFF and there is no RF transmission.
- 2) Pressing SW1 repeatedly sequences through the following states:
  - Short button press advances scan to next channel in sequence, green LED toggles;
  - Long button press toggles tone modulation, red LED toggles;
  - The small green LED will increase its frequency when transmitting and will decrease its frequency after last channel in sequence has been reached.

Comms using HyperTerminal: 115.2KB, N,8,1

```
param
mode "fcc" | "ping"
txpower -20..+8
fem "off" | "bypass" | "lna" | "on"
txboost "off" | "on"
status
```

fcc  
strategy “subset” | “all”  
modulation – toggle tone/stream  
scan – next channel according to strategy  
status

ping  
mode “client” | “server”  
start  
stop  
channel 11..26  
frequency 10..100 per second  
status

reset

Examples for wat3 fcc testing:

```
param mode fcc
param txpower 8
param txboost on
param fem off
fcc strategy subset
```

Verify settings:

```
param status
fcc status
```

## H. Method of Monitoring EUT Operation

### Production Mode:

The device has two indicated LEDs which provide status feedback to the user/installer. If the device is operating as anticipated one of the LEDs will be blinking red or green. If the device is not performing to the manufacturer's intended operation, the LEDs 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, status 1-4 above will show no RF energy in the ISM band.

## I. Modifications

### a) Modifications to EUT

No modifications were made to the EUT.

### b) Modifications to Test Standard

No modifications were made to the test standard.

## J. Disposition of EUT

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



Autani Corp.  
WAT3, Model No. 1000153

Electromagnetic Compatibility  
Unintentional Radiators  
CFR Title 47, Part 15B, 15.247; RSS-210, Issue 8, Dec. 2010 & ICES-003

### 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.

**15.107 (b)** For a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in Table 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. The lower limit applies at the band edges.

Frequency range (MHz)	Class A Conducted Limits (dB $\mu$ V)		*Class B Conducted Limits (dB $\mu$ V)	
	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.

**Table 6. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(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, test conditions, and test procedures of ANSI C63.4 were used. The EUT was powered through a 50 $\Omega$ /50 $\mu$ H LISN. An EMI receiver, connected to the measurement port of the LISN, scanned the frequency range from 150 kHz to 30 MHz in order to find the peak conducted emissions. All peak emissions within 6 dB of the limit were re-measured using a quasi-peak and/or average detector as appropriate.

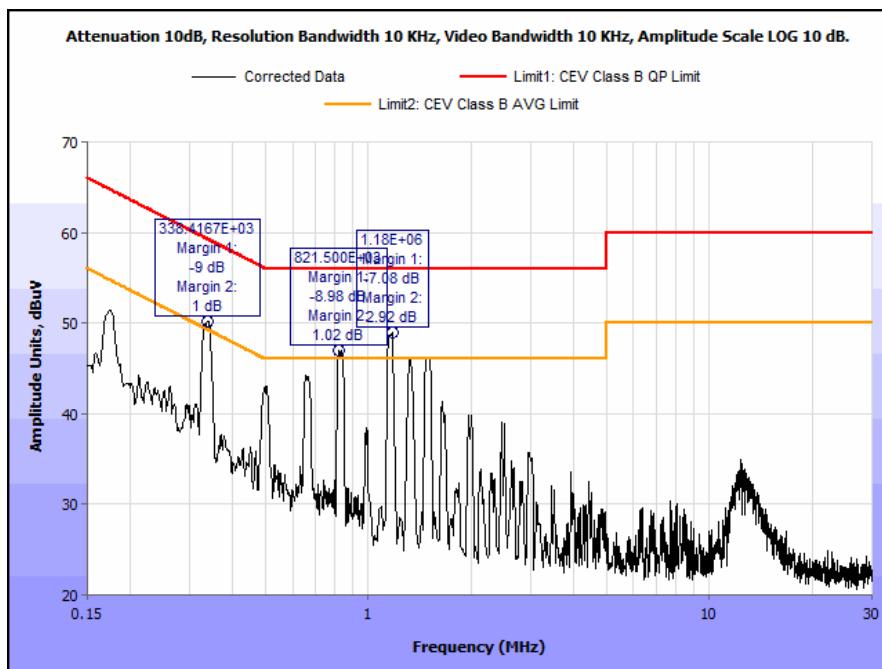
**Test Results:** The EUT was compliant with the Class B requirement(s) of this section. Measured emissions were below applicable limits.

**Test Engineer(s):** Jason Allnutt

**Test Date(s):** 08/28/14

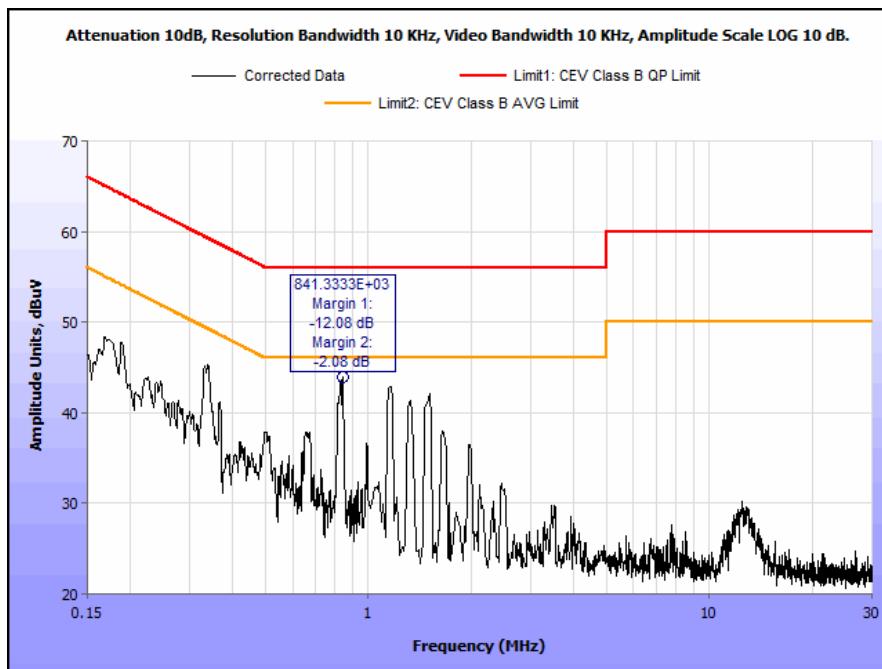
**Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC, 60 Hz)**

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.1652	49.8	0	49.8	65.2	-15.4	43.66	0	43.66	55.2	-11.54
0.3354	47	0	47	59.32	-12.32	40.75	0	40.75	49.32	-8.57
0.8222	43.81	0	43.81	56	-12.19	37.09	0	37.09	46	-8.91
1.1735	44.55	0	44.55	56	-11.45	38.33	0	38.33	46	-7.67
1.5061	43	0	43	56	-13	36.68	0	36.68	46	-9.32
1.978	38.81	0	38.81	56	-17.19	32	0	32	46	-14

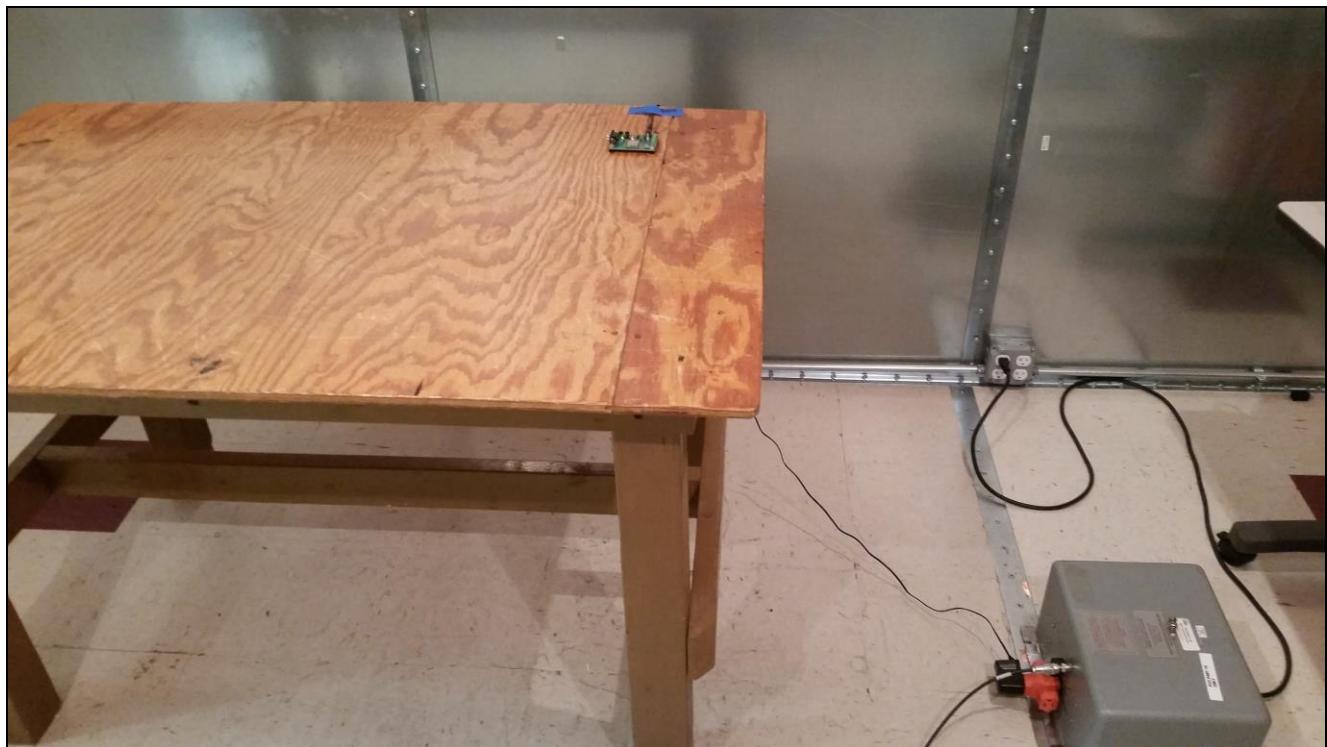
**Table 7. Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC, 60 Hz)**

**Plot 1. Conducted Emissions, Phase Line Plot**

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

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.1685	45.2	0	45.2	65.03	-19.83	34.8	0	34.8	55.03	-20.23
0.3376	39.2	0	39.2	59.26	-20.06	32	0	32	49.26	-17.26
0.8332	37.88	0	37.88	56	-18.12	29	0	29	46	-17
1.1688	38.9	0	38.9	56	-17.1	30	0	30	46	-16
1.3084	36.9	0	36.9	56	-19.1	27	0	27	46	-19
1.4996	37.2	0	37.2	56	-18.8	27	0	27	46	-19

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

**Plot 2. Conducted Emissions, Neutral Line Plot**

## Conducted Emissions Limits Test Setup



Photograph 2. 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 9.

**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 9.

Frequency (MHz)	Field Strength (dB $\mu$ V/m)	
	§15.109 (b), Class A Limit (dB $\mu$ V) @ 10m	§15.109 (a), Class B Limit (dB $\mu$ V) @ 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 9. 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. For final emissions measurements at each frequency of interest, the EUT was rotated and the antenna height was varied between 1 m and 4 m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. Unless otherwise specified, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

**Test Results:**

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

**Test Engineer(s):**

Jason Allnutt

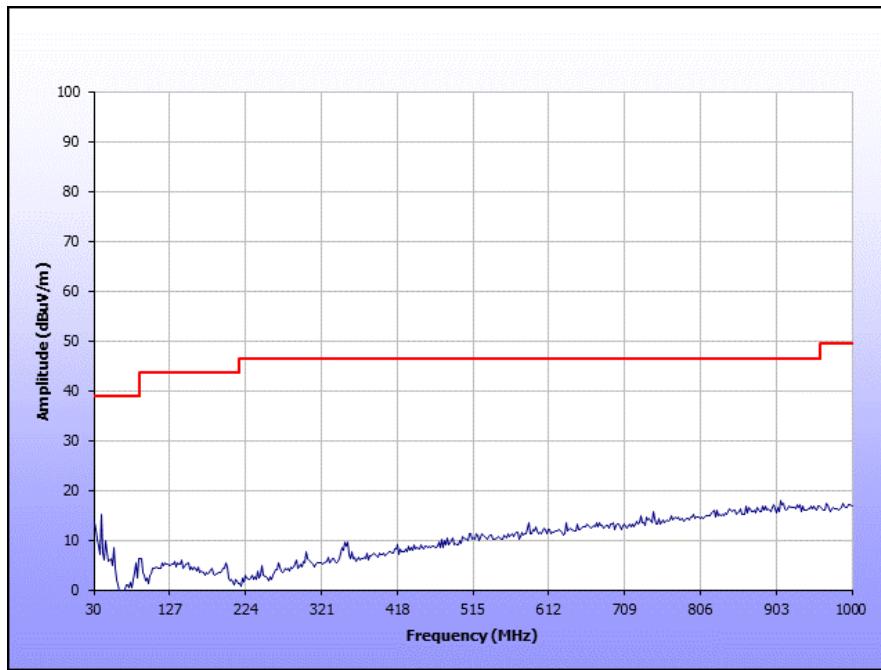
**Test Date(s):**

08/28/14

## Radiated Emissions Limits Test Results, Class B

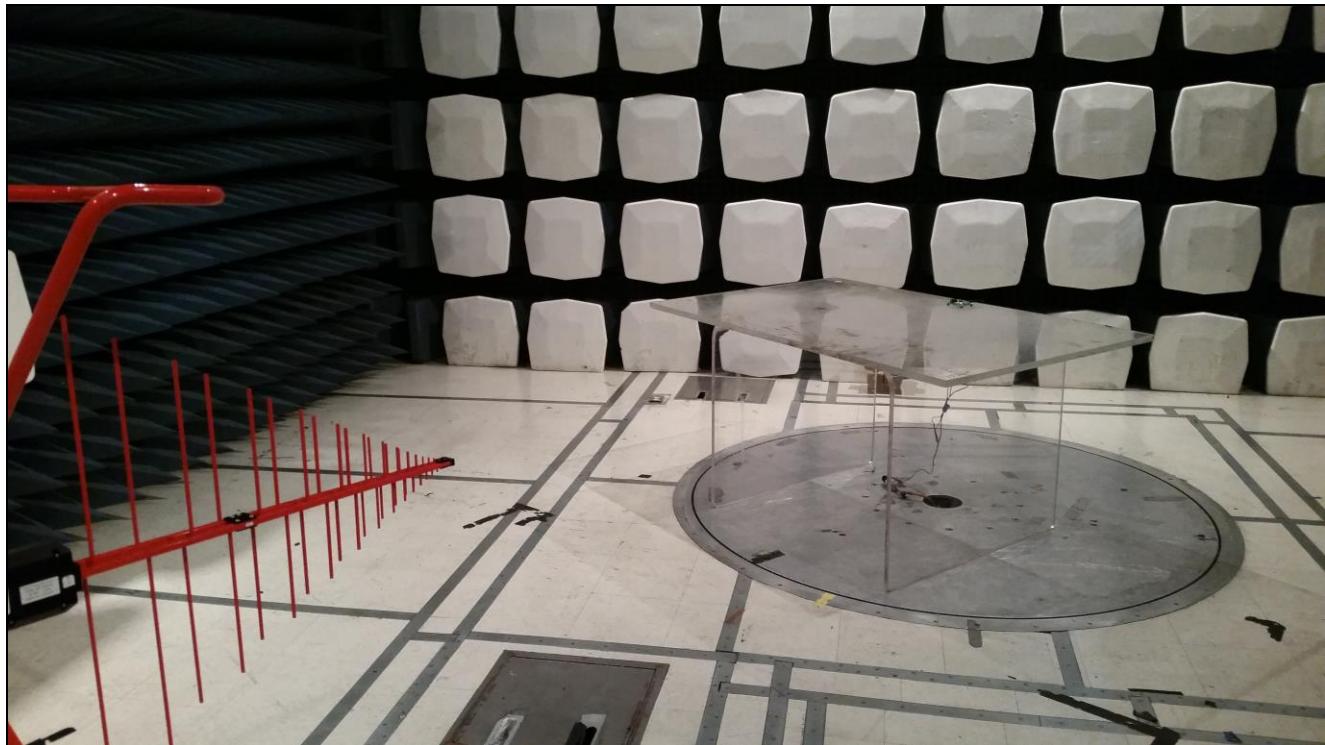
Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
52.322141	4	H	1.04	7.42	8.04	0.69	0.00	16.15	40.00	-23.85
52.322141	70	V	1.01	7.42	8.04	0.69	0.00	16.15	40.00	-23.85
171.33016	14	H	1.06	6.09	11.87	1.11	0.00	19.07	43.50	-24.43
171.33016	3	V	1.06	6.16	11.87	1.11	0.00	19.14	43.50	-24.36
328.36611	25	H	1.03	4.94	14.77	1.60	0.00	21.31	46.00	-24.69
328.36611	11	V	1.04	4.94	14.77	1.60	0.00	21.31	46.00	-24.69
534.80711	14	H	1.28	5.95	18.60	1.95	0.00	26.50	46.00	-19.50
534.80711	6	V	1.26	5.95	18.60	1.95	0.00	26.50	46.00	-19.50
674.28607	11	H	1.05	5.80	20.60	2.19	0.00	28.59	46.00	-17.41
674.28607	9	V	1.19	5.72	20.60	2.19	0.00	28.51	46.00	-17.49
883.96794	152	H	1.13	6.16	22.60	2.91	0.00	31.67	46.00	-14.33
883.96794	11	V	1.49	6.16	22.60	2.91	0.00	31.67	46.00	-14.33

Table 10. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz



Plot 3. Radiated Emissions, 30 MHz - 1 GHz

## Radiated Emissions Limits Test Setup



Photograph 3. Radiated Emissions, 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 device has an integrated PCB antenna.

**Test Engineer(s):** Jason Allnutt

**Test Date(s):** 08/29/14

## 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  $\mu$ H/50  $\Omega$  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 (dB $\mu$ V)	
	Quasi-Peak	Average
* 0.15- 0.45	66 - 56	56 - 46
0.45 - 0.5	56	46
0.5 - 30	60	50

**Table 11. 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  $\Omega$ /50  $\mu$ H 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  $\Omega$ /50  $\mu$ H 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.

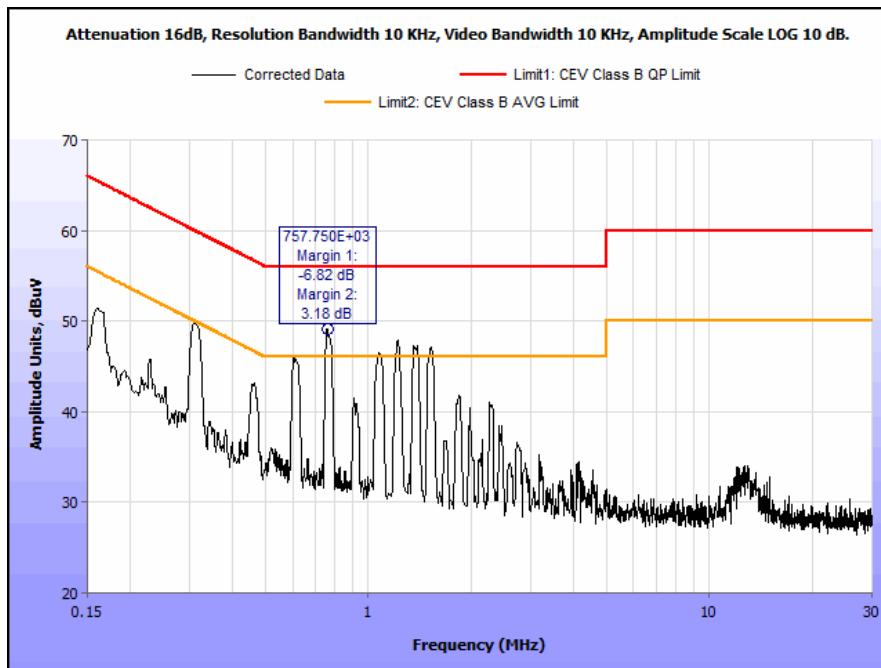
**Test Engineer(s):** Jason Allnutt

**Test Date(s):** 08/28/14

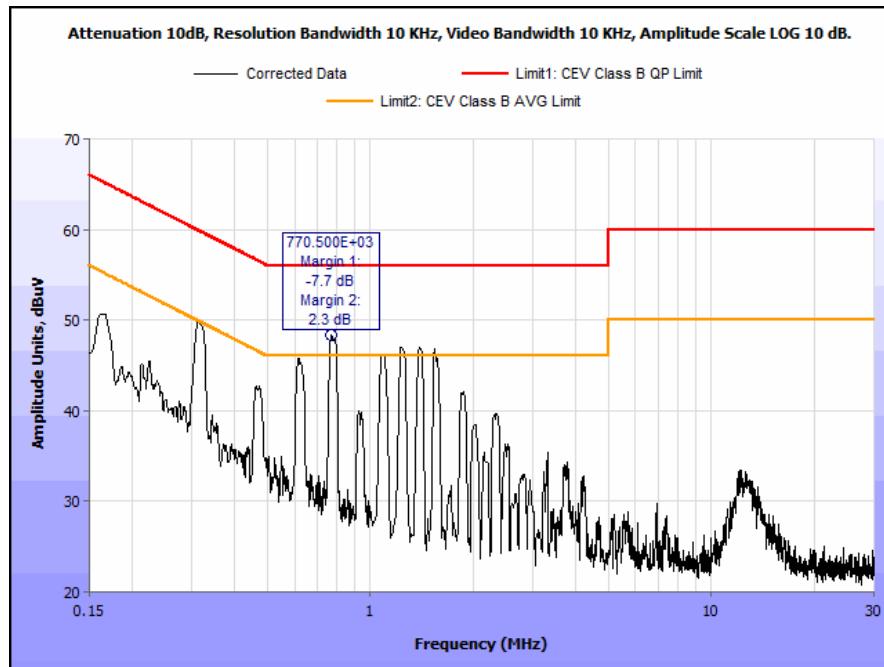
## 15.207(a) Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.304	47.38	0	47.38	60.13	-12.75	40	0	40	50.13	-10.13
0.606	42.7	0	42.7	56	-13.3	33	0	33	46	-13
0.757	45.1	0	45.1	56	-10.9	36	0	36	46	-10
1.077	42.9	0	42.9	56	-13.1	33	0	33	46	-13
1.2198	40.3	0	40.3	56	-15.7	27	0	27	46	-19
1.511	43.5	0	43.5	56	-12.5	33	0	33	46	-13
1.814	38.3	0	38.3	56	-17.7	25	0	25	46	-21

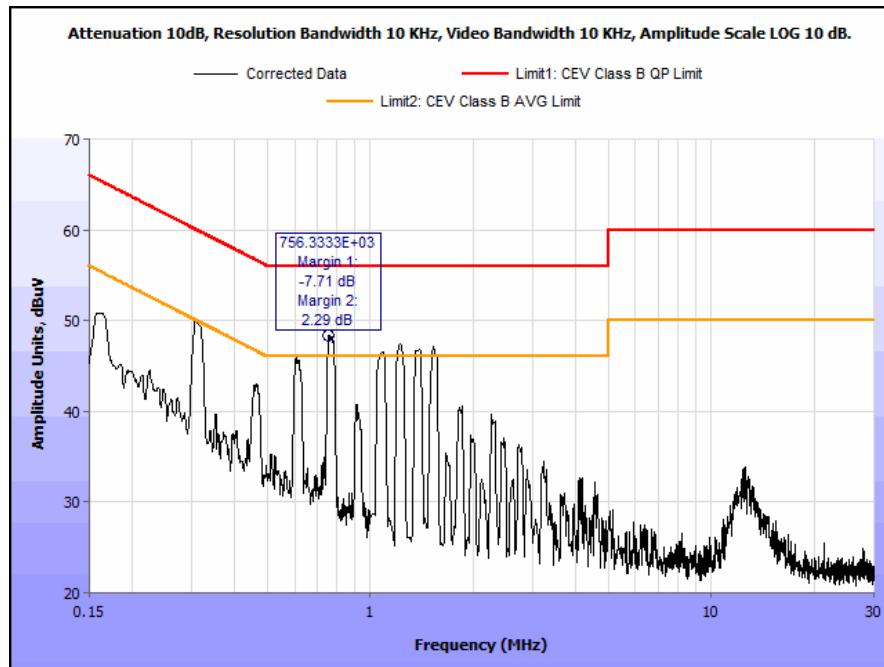
Table 12. Conducted Emissions, 15.207(a), Phase Line, Test Results



Plot 4. Conducted Emissions, 15.207(a), Phase Line, Low Channel



**Plot 5. Conducted Emissions, 15.207(a), Phase Line, Mid Channel**

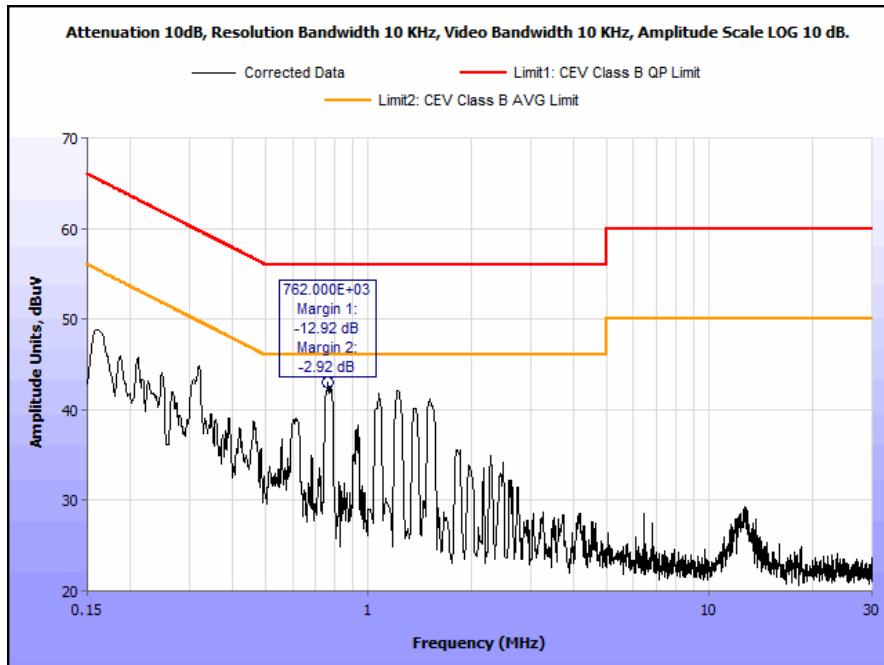


**Plot 6. Conducted Emissions, 15.207(a), Phase Line, High Channel**

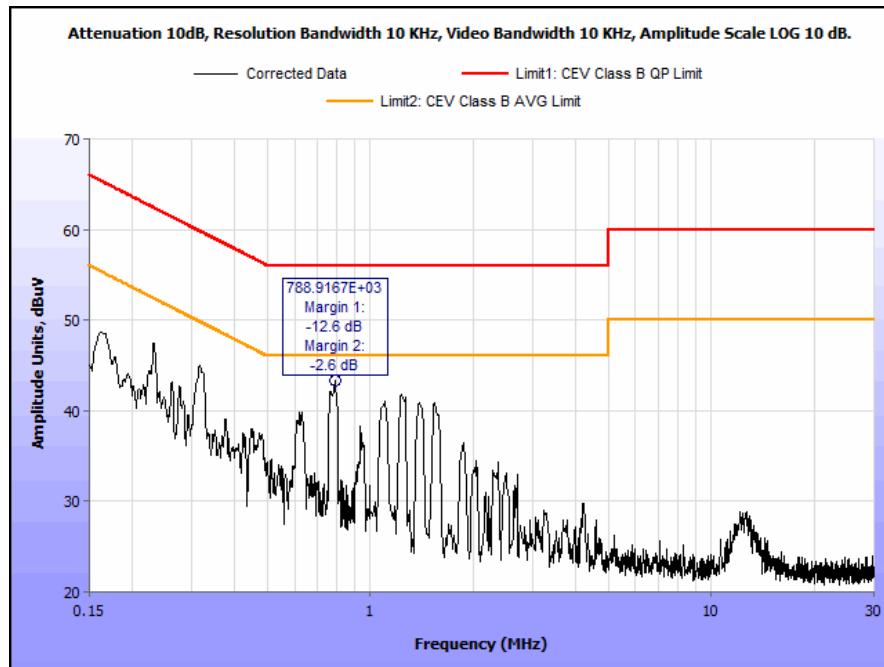
## 15.207(a) Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.3093	39.6	0	39.6	59.99	-20.39	30	0	30	49.99	-19.99
0.6083	36.1	0	36.1	56	-19.9	25	0	25	46	-21
0.777	36.36	0	36.36	56	-19.64	20	0	20	46	-26
1.2158	37.56	0	37.56	56	-18.44	25	0	25	46	-21
1.515	36.8	0	36.8	56	-19.2	24	0	24	46	-22
1.813	30.6	0	30.6	56	-25.4	16	0	16	46	-30

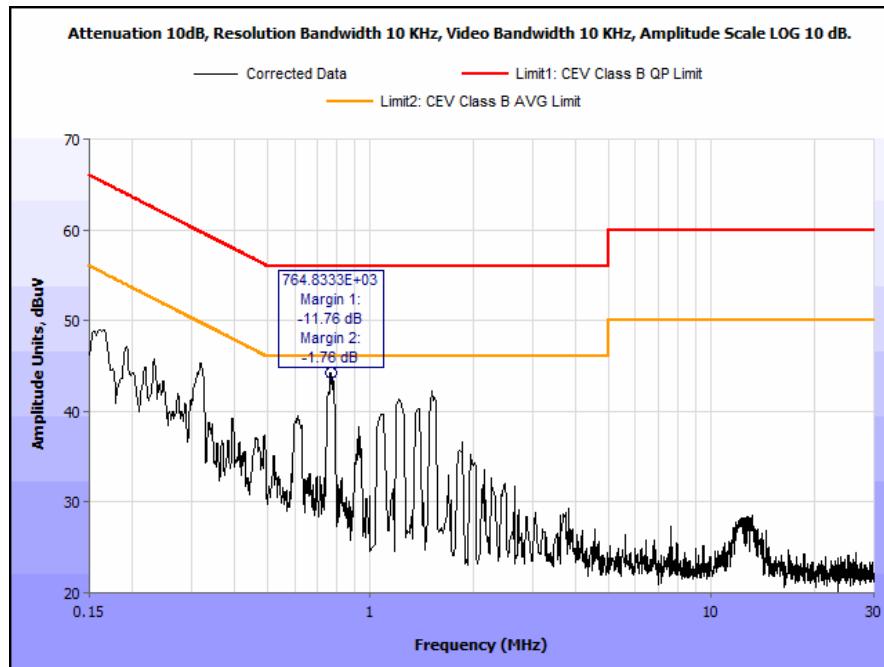
Table 13. Conducted Emissions, 15.207(a), Neutral Line, Test Results



Plot 7. Conducted Emissions, 15.207(a), Neutral Line, Low Channel



Plot 8. Conducted Emissions, 15.207(a), Neutral Line, Mid Channel



Plot 9. Conducted Emissions, 15.207(a), Neutral Line, High Channel

### 15.207(a) Conducted Emissions Test Setup Photo



Photograph 4. Conducted Emissions, 15.207(a), Test Setup

## 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 equal to 100 kHz,  $VBW > \text{or } = 3 \times RBW$ . 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):** Jason Allnutt

**Test Date(s):** 08/29/14



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

## Occupied Bandwidth Test Results

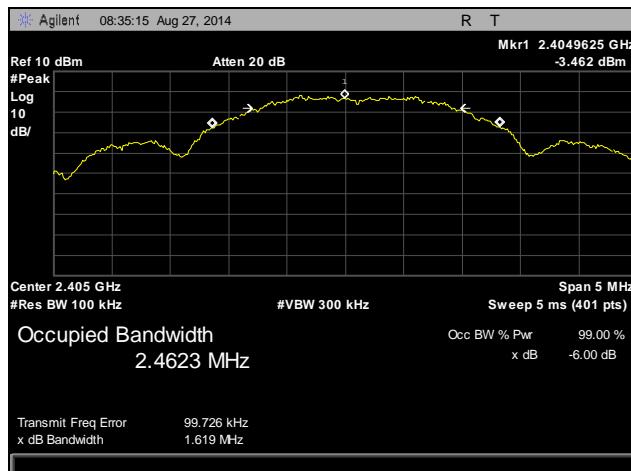
Occupied Bandwidth		
Carrier Channel	Frequency (MHz)	Measured 6 dB Bandwidth (MHz)
Low	2405	1.619
Mid	2440	1.614
High	2475	1.612

Table 14. 6 dB Occupied Bandwidth, Test Results

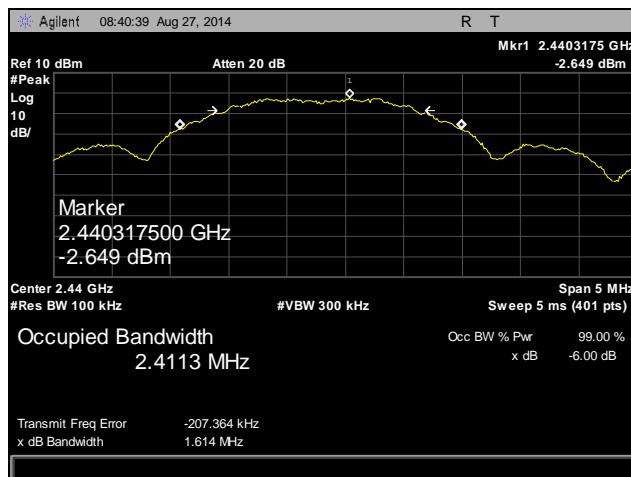
Occupied Bandwidth		
Carrier Channel	Frequency (MHz)	Measured 99% Bandwidth (MHz)
Low	2405	2.4626
Mid	2440	2.4263
High	2475	2.4245

Table 15. 99% Occupied Bandwidth, Test Results

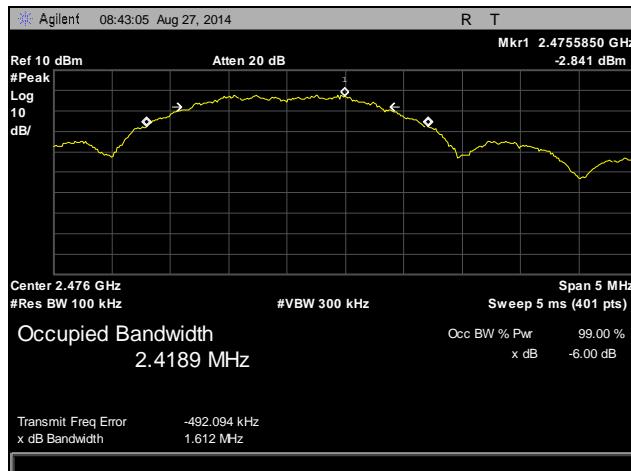
## 6 dB Occupied Bandwidth Test Results



**Plot 10. 6 dB Occupied Bandwidth, Low Channel**

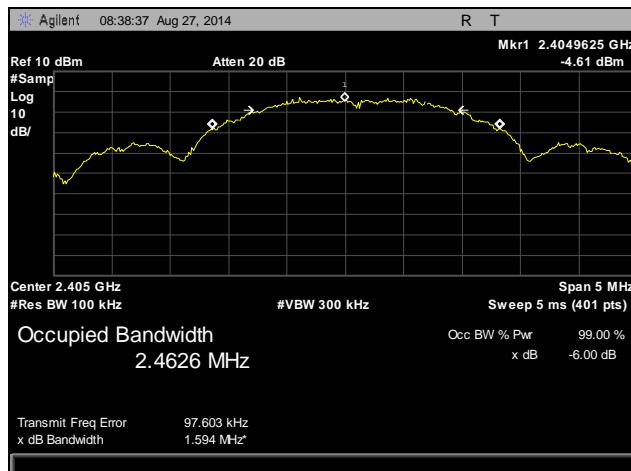


**Plot 11. 6 dB Occupied Bandwidth, Mid Channel**

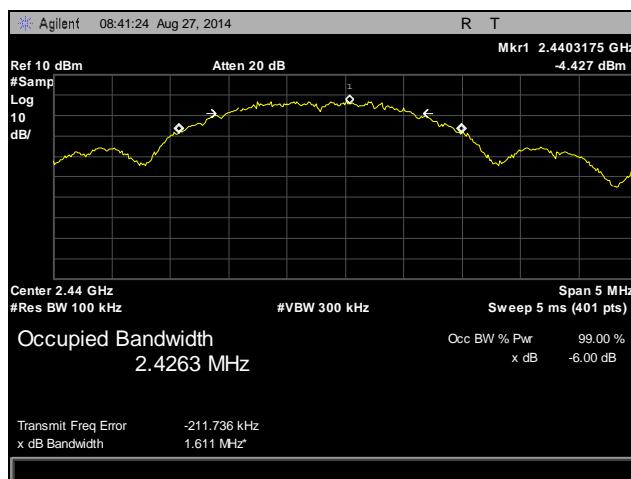


**Plot 12. 6 dB Occupied Bandwidth, High Channel**

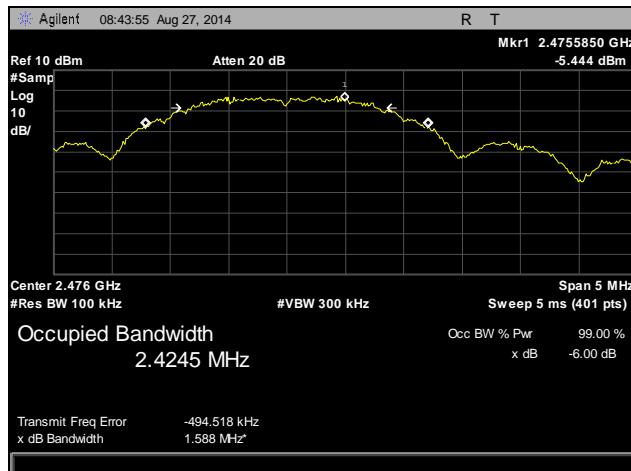
## 99% Occupied Bandwidth Test Results



**Plot 13. 99% Occupied Bandwidth, Low Channel**



**Plot 14. 99% Occupied Bandwidth, Mid Channel**



**Plot 15. 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 16. Output Power Requirements from §15.247(b)**

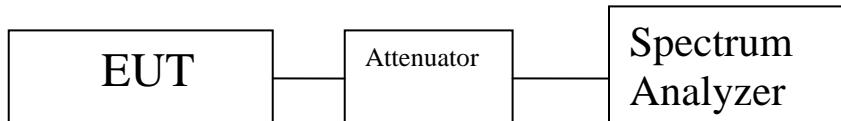
**§15.247(b)(4):** The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the 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):** Jason Allnutt

**Test Date(s):** 08/29/14



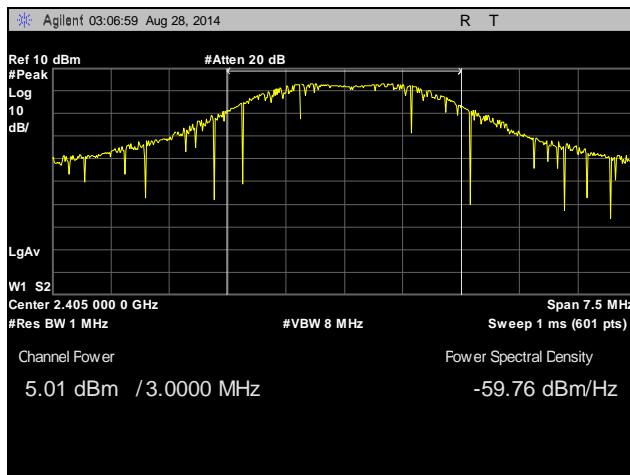
**Figure 3. Peak Power Output Test Setup**

## Peak Power Output Test Results

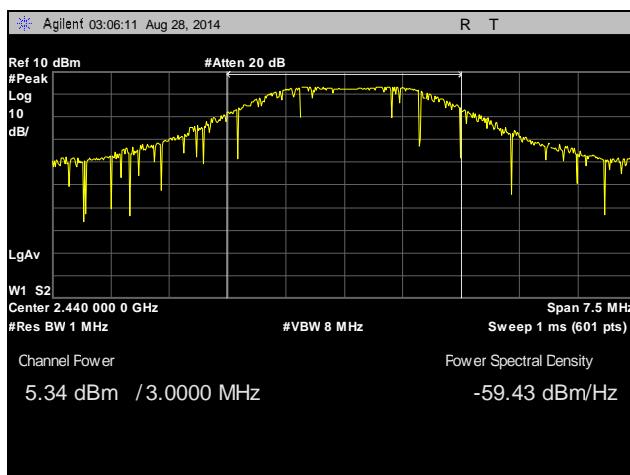
Peak Conducted Output Power			
Carrier Channel	Frequency (MHz)	Measured Peak Output Power dBm	Measured Peak Output Power Watts
Low	2405	5.01	0.003
Mid	2440	5.34	0.003
High	2475	4.79	0.003

Table 17. Peak Power Output, Test Results

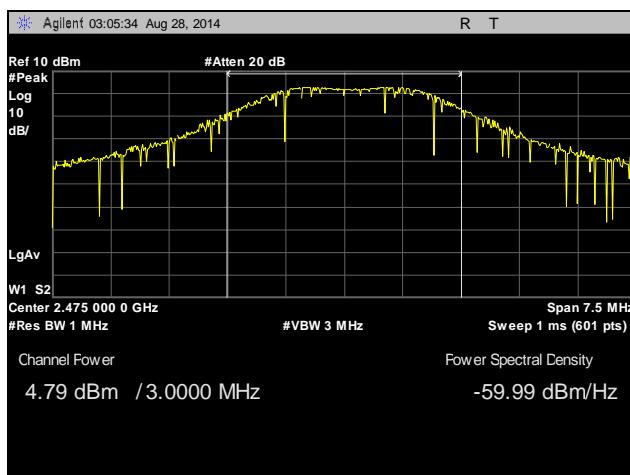
## Peak Power Output Test Results



**Plot 16. Peak Power Output, Low Channel**



**Plot 17. Peak Power Output, Mid Channel**



**Plot 18. Peak Power Output, High Channel**

## 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
<sup>1</sup> 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	( <sup>2</sup> )

**Table 18. Restricted Bands of Operation**

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.

<sup>2</sup> 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 19.

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

**Table 19. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)**

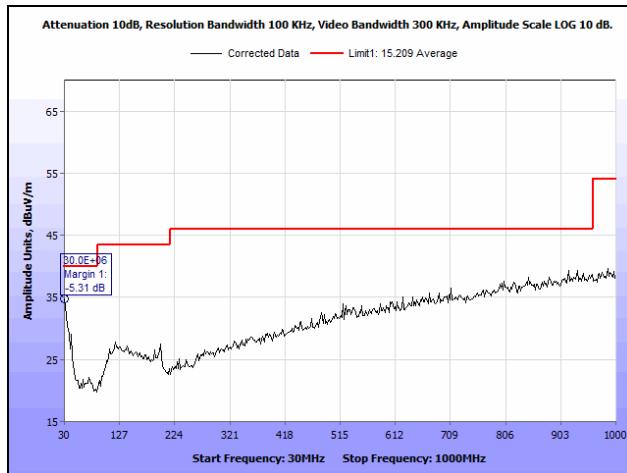
**Test Procedures:** The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was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

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

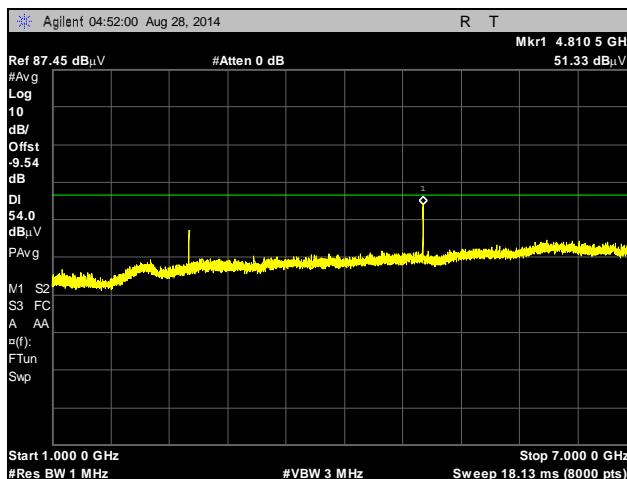
**Test Engineer(s):** Jason Allnutt

**Test Date(s):** 08/29/14

## Radiated Spurious Emissions Test Results



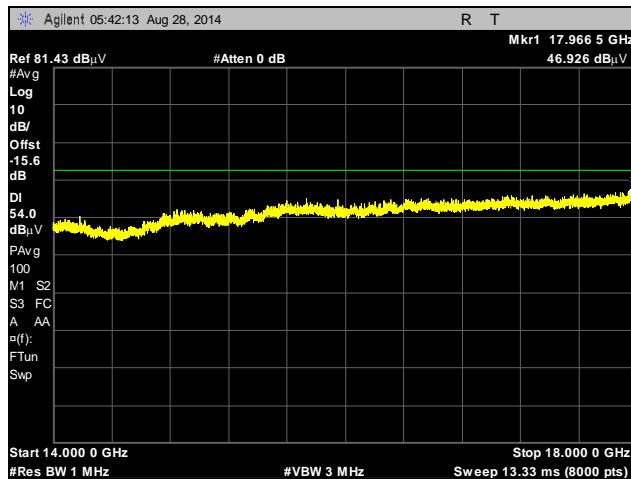
**Plot 19. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz**



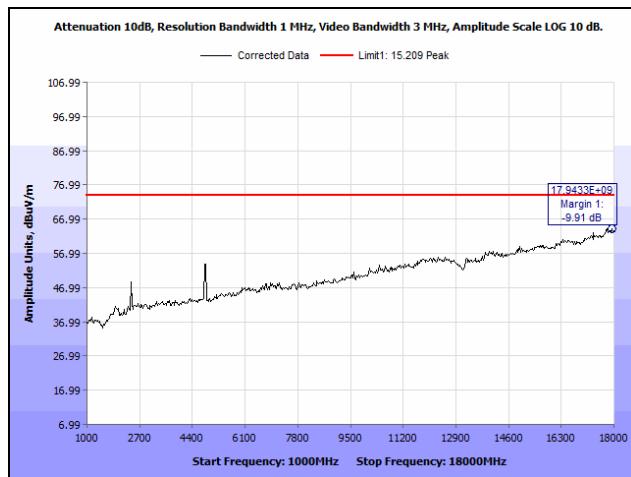
**Plot 20. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average**



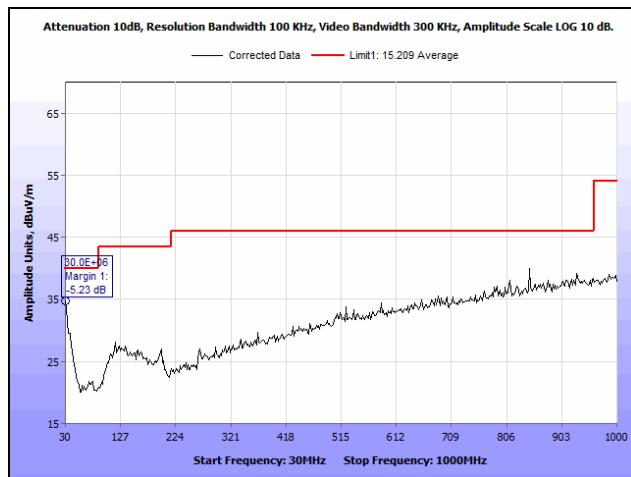
**Plot 21. Radiated Spurious Emissions, Low Channel, 7 GHz – 14 GHz, Average**



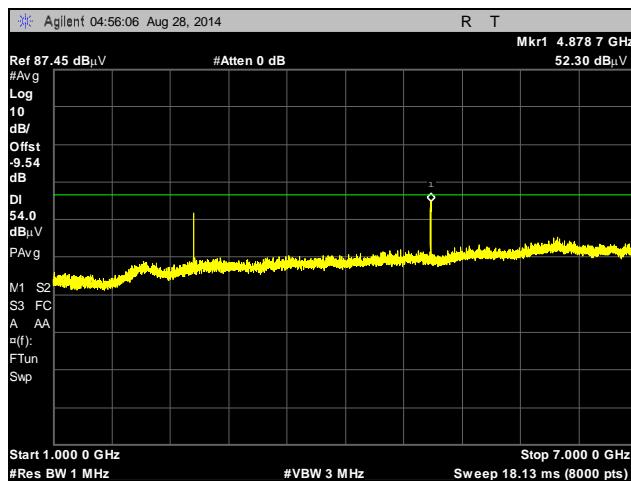
Plot 22. Radiated Spurious Emissions, Low Channel, 14 GHz – 18 GHz, Average



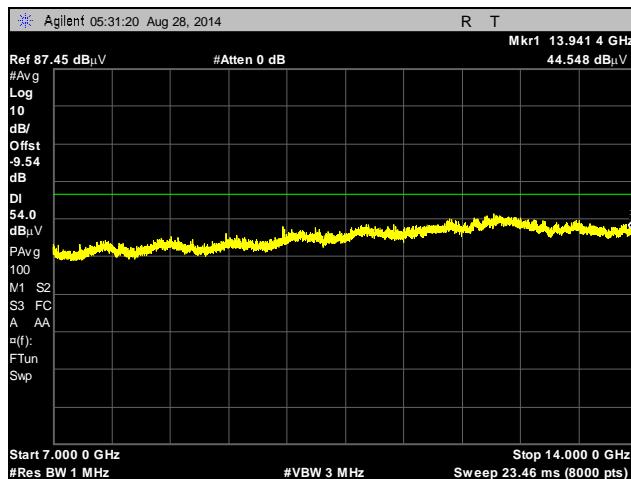
Plot 23. Radiated Spurious Emissions, Low Channel, 1 GHz – 18 GHz, Peak



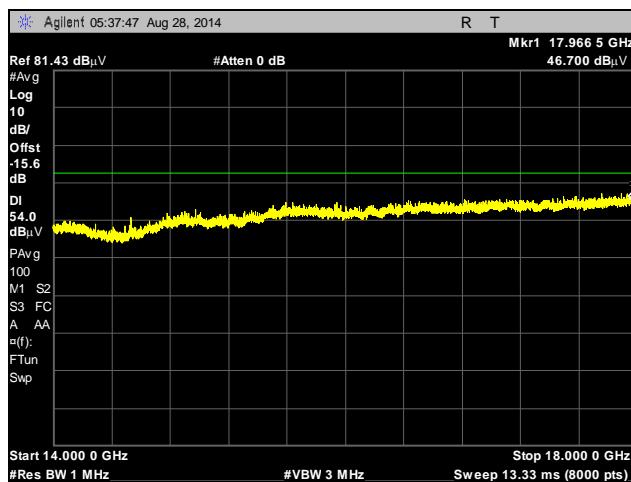
Plot 24. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz



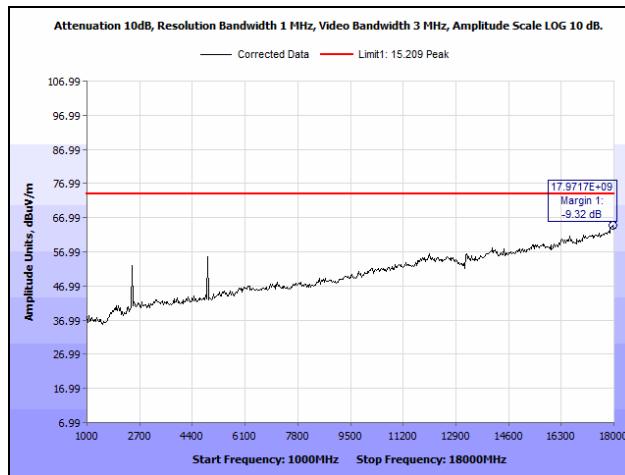
Plot 25. Radiated Spurious Emissions, Mid Channel, 1 MHz – 7 GHz, Average



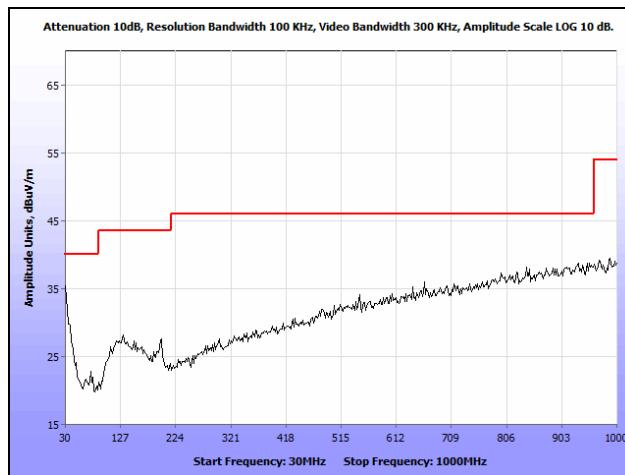
Plot 26. Radiated Spurious Emissions, Mid Channel, 7 MHz – 14 GHz, Average



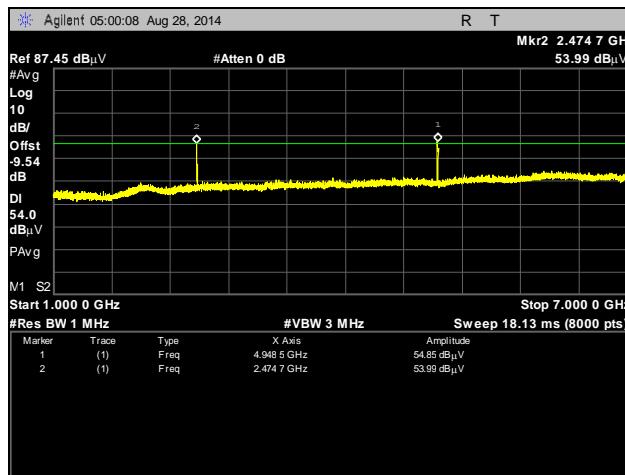
Plot 27. Radiated Spurious Emissions, Mid Channel, 14 MHz – 18 GHz, Average



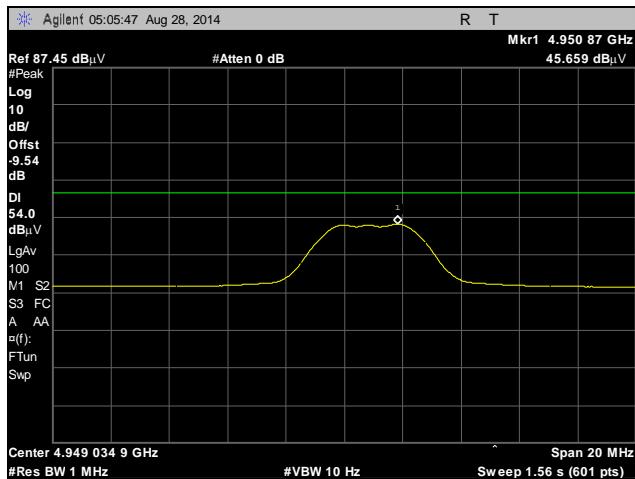
**Plot 28. Radiated Spurious Emissions, Mid Channel, 1 MHz – 18 GHz, Peak**



**Plot 29. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz**



**Plot 30. Radiated Spurious Emissions, High Channel, 1 MHz – 7 GHz, Average**



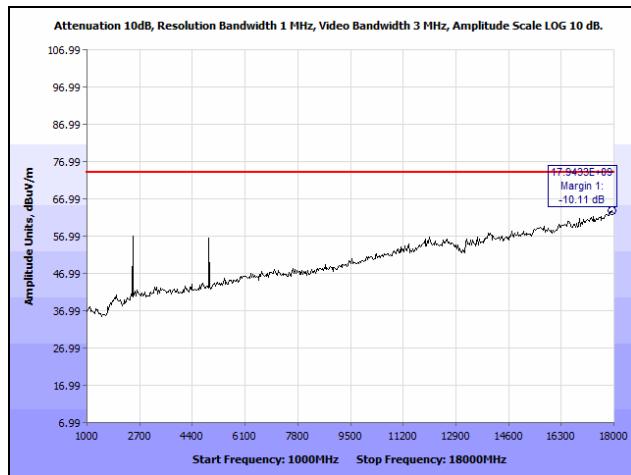
**Plot 31. Radiated Spurious Emissions, High Channel, 1 MHz – 7 GHz, Average, Zoom**



**Plot 32. Radiated Spurious Emissions, High Channel, 7 MHz – 14 GHz, Average**



**Plot 33. Radiated Spurious Emissions, High Channel, 14 MHz – 18 GHz, Average**

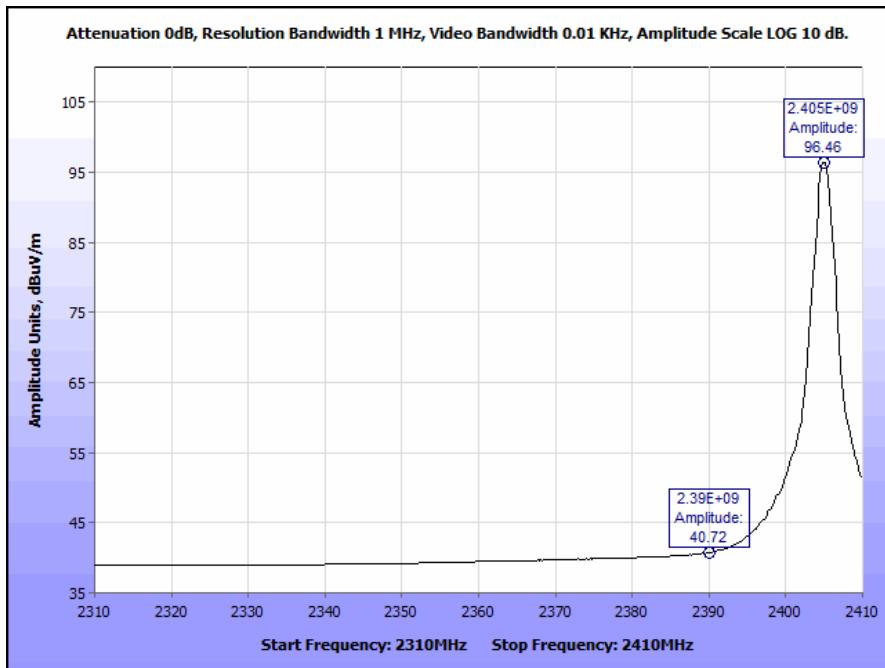


Plot 34. Radiated Spurious Emissions, High Channel, 1 MHz – 18 GHz, Peak

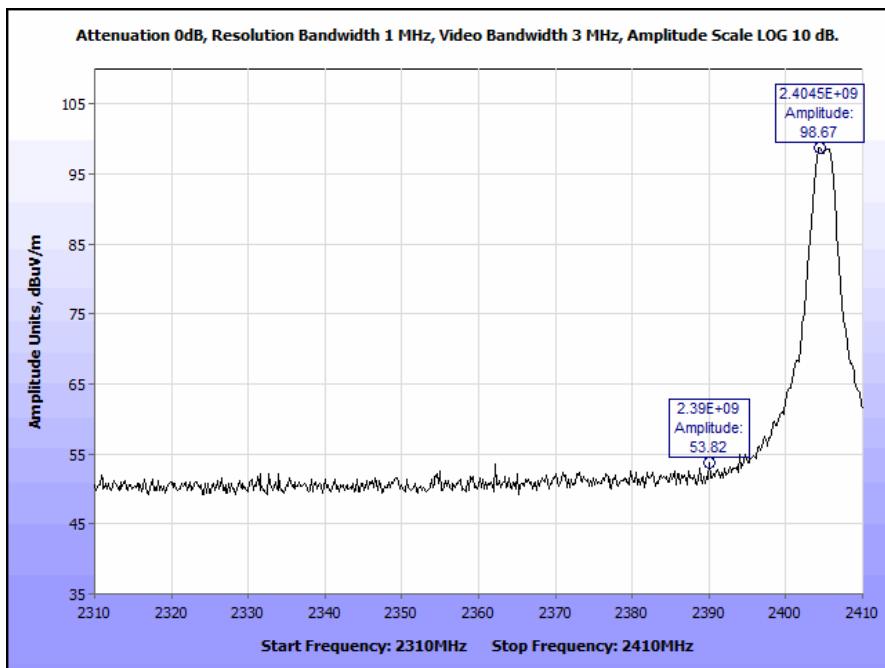
## Radiated Band Edge Measurements

### Test Procedures:

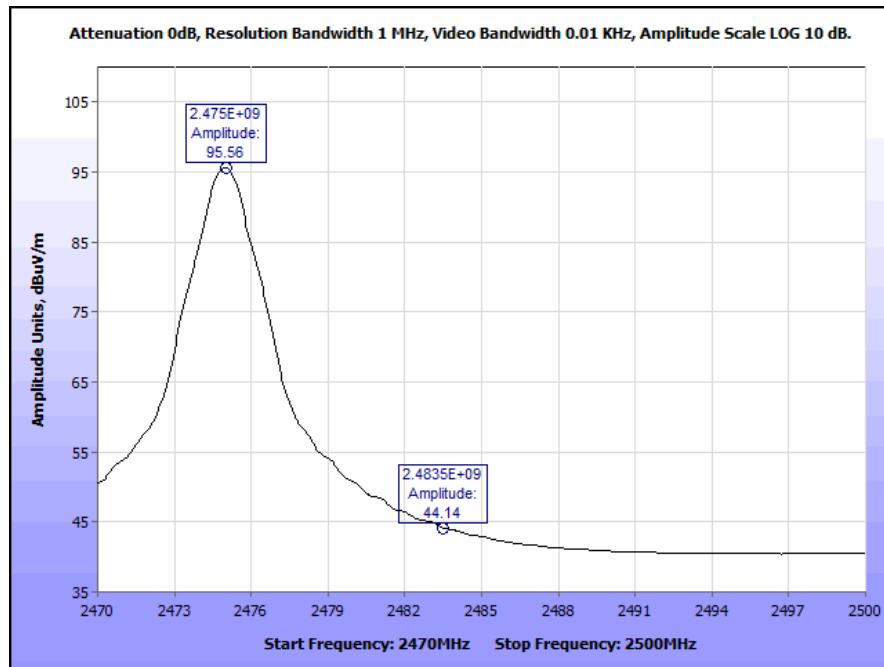
The transmitter was turned on. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.



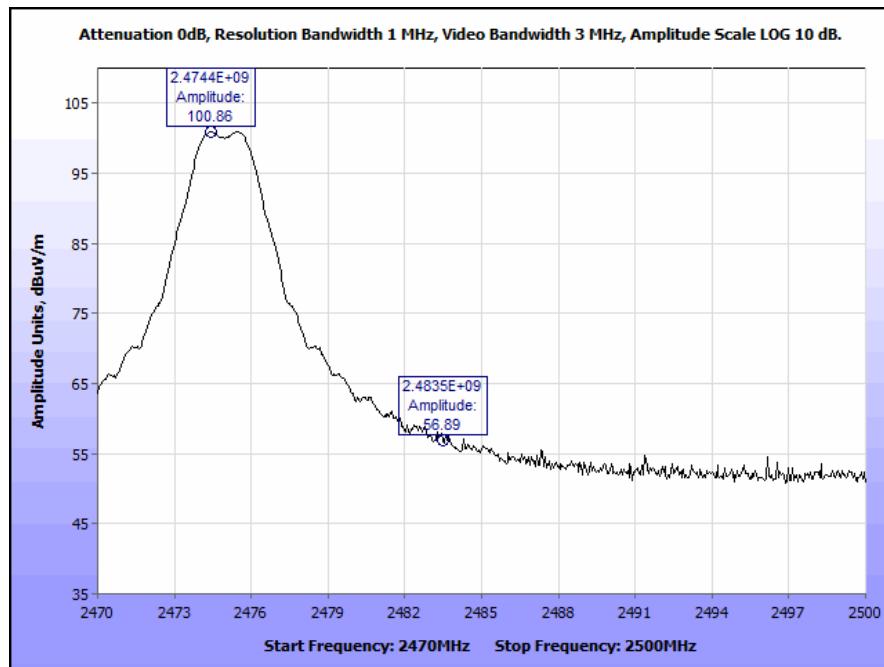
Plot 35. Radiated Restricted Band Edge, Low Channel, Average



Plot 36. Radiated Restricted Band Edge, Low Channel, Peak

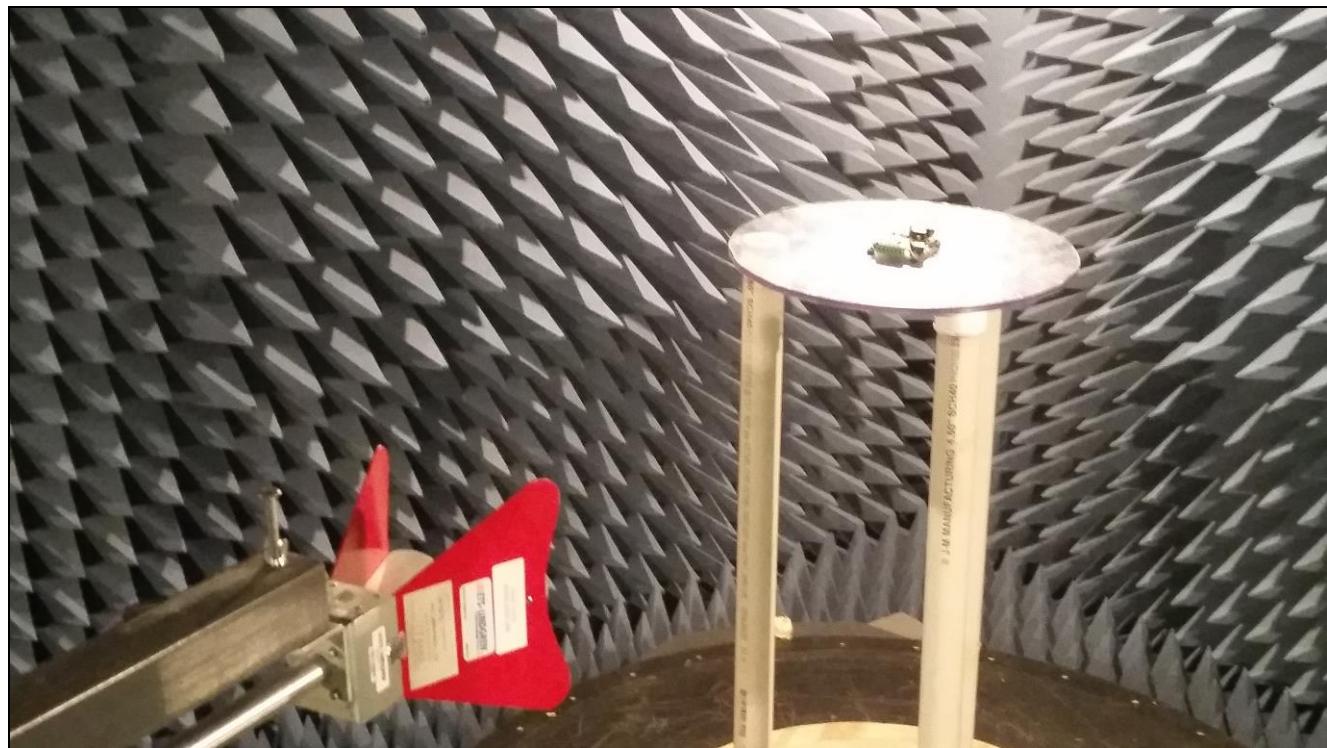


**Plot 37. Radiated Restricted Band Edge, High Channel, Average**



**Plot 38. Radiated Restricted Band Edge, High Channel, Peak**

## Radiated Spurious Emissions Test Setup



Photograph 5. Radiated Spurious Emissions, Test Setup

## 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<sup>th</sup> harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

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

**Test Results:**

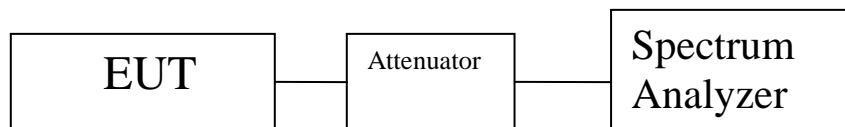
The EUT was compliant with the Conducted Spurious Emission limits of **§15.247(d)**.

**Test Engineer(s):**

Jason Allnutt

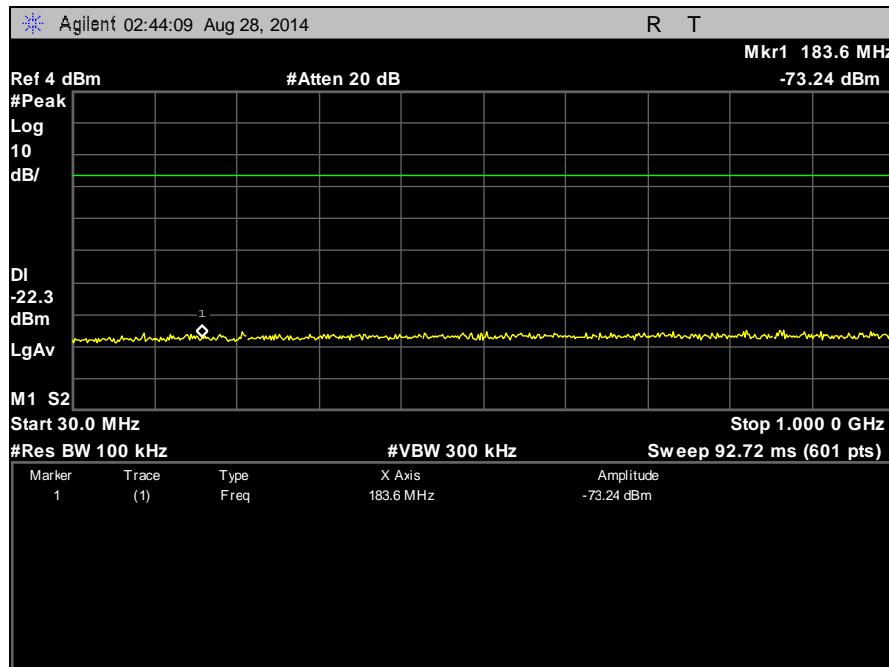
**Test Date(s):**

08/29/14

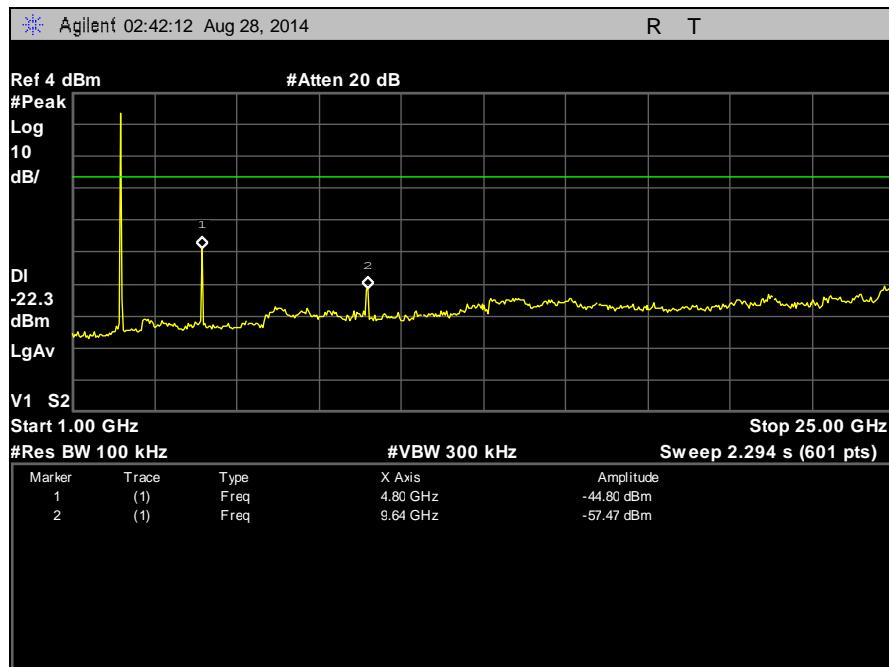


**Figure 4. Block Diagram, Conducted Spurious Emissions Test Setup**

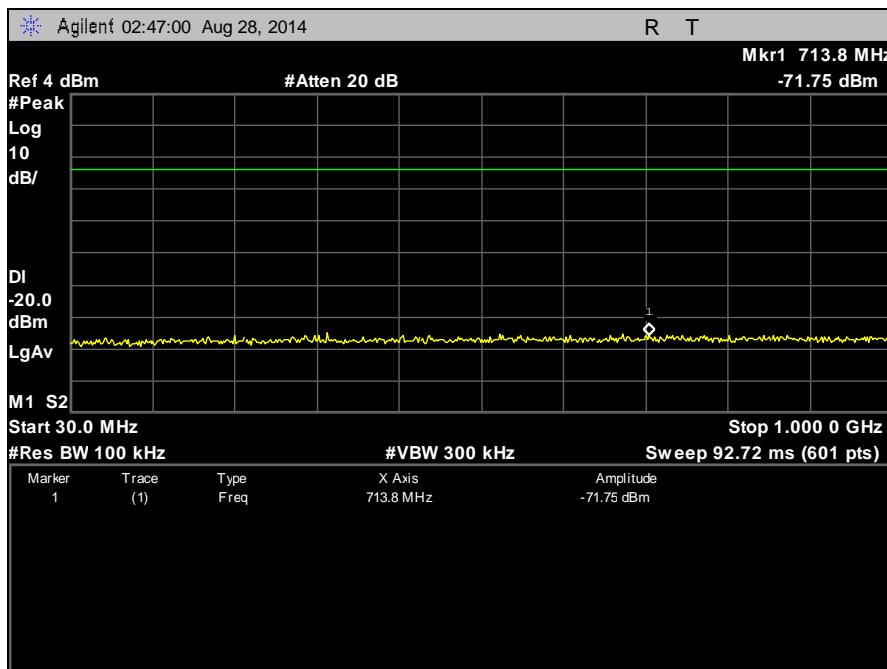
## Conducted Spurious Emissions Test Results



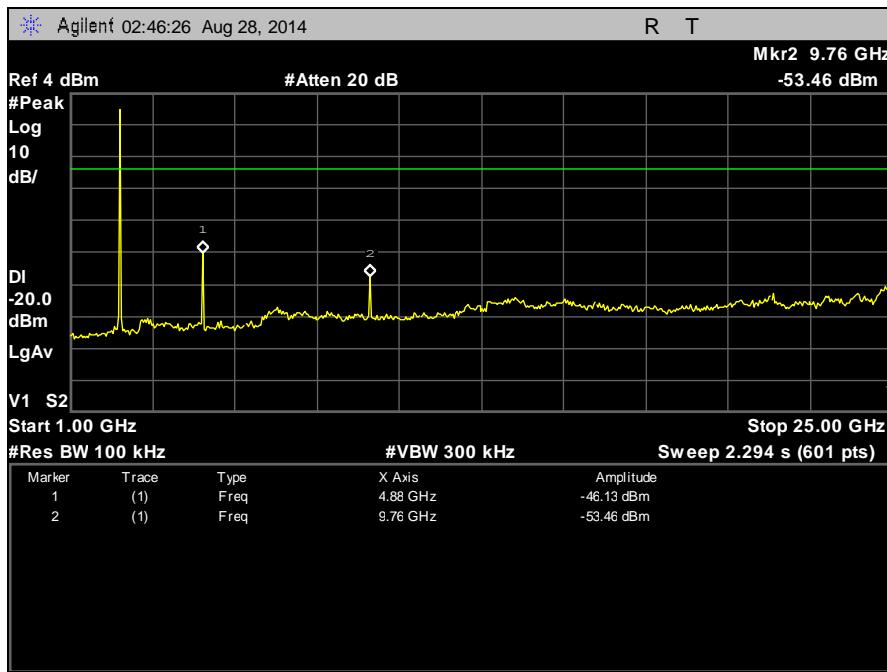
Plot 39. Conducted Spurious Emissions, Low Channel, 30 MHz – 1 GHz



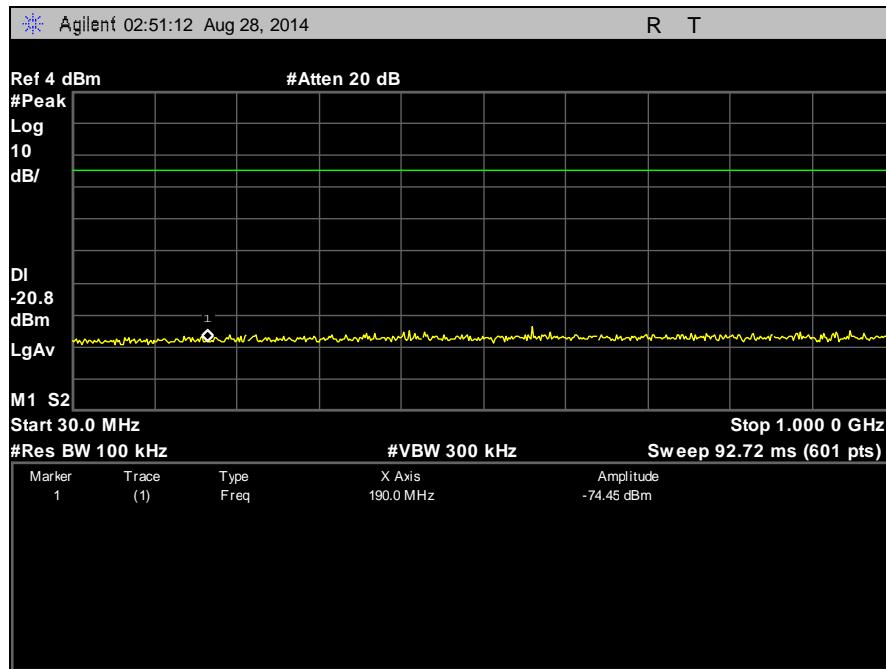
Plot 40. Conducted Spurious Emissions, Low Channel, 1 GHz – 25 GHz



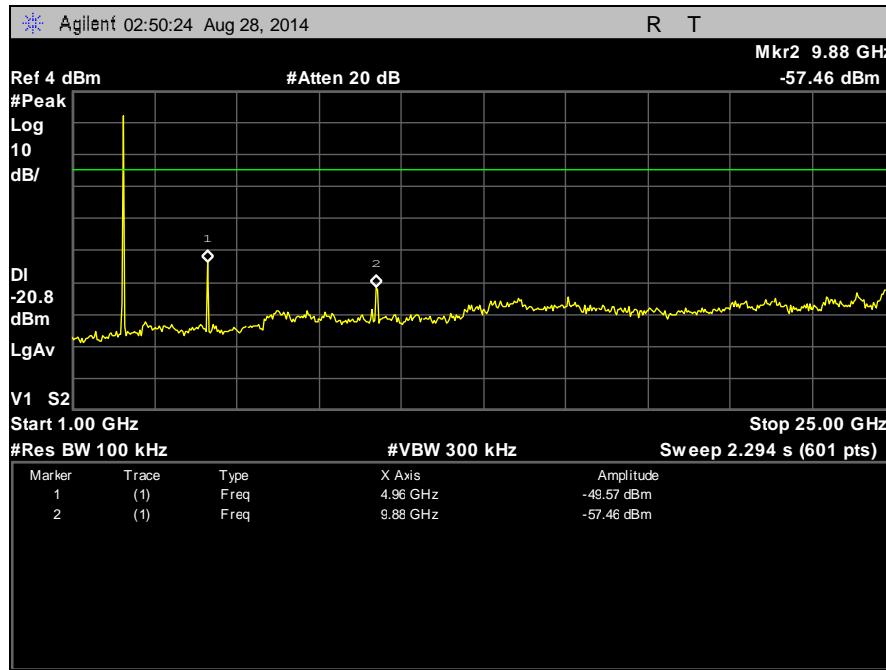
Plot 41. Conducted Spurious Emissions, Mid Channel, 30 MHz – 1 GHz



Plot 42. Conducted Spurious Emissions, Mid Channel, 1 GHz – 25 GHz

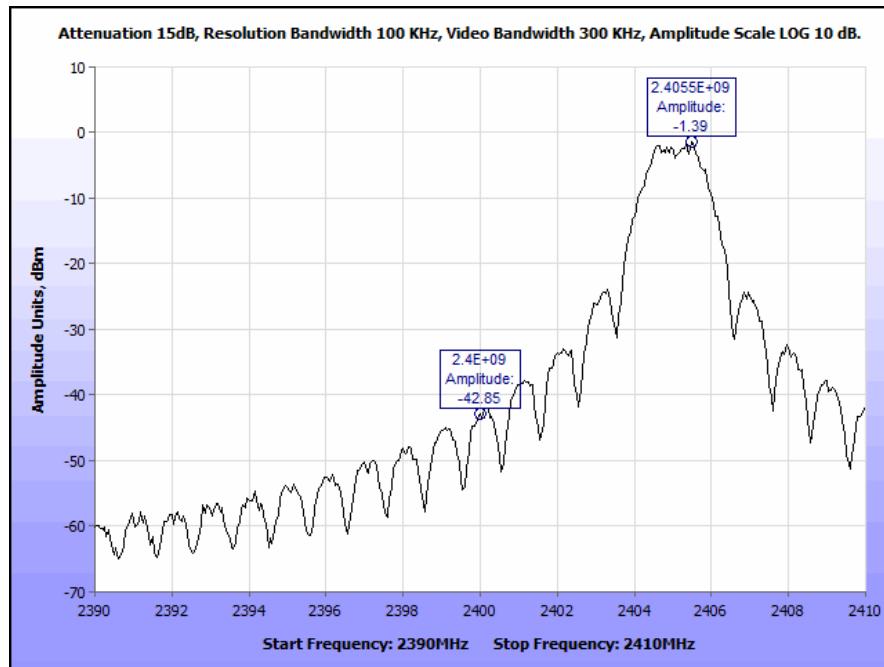


**Plot 43. Conducted Spurious Emissions, High Channel, 30 MHz – 1 GHz**

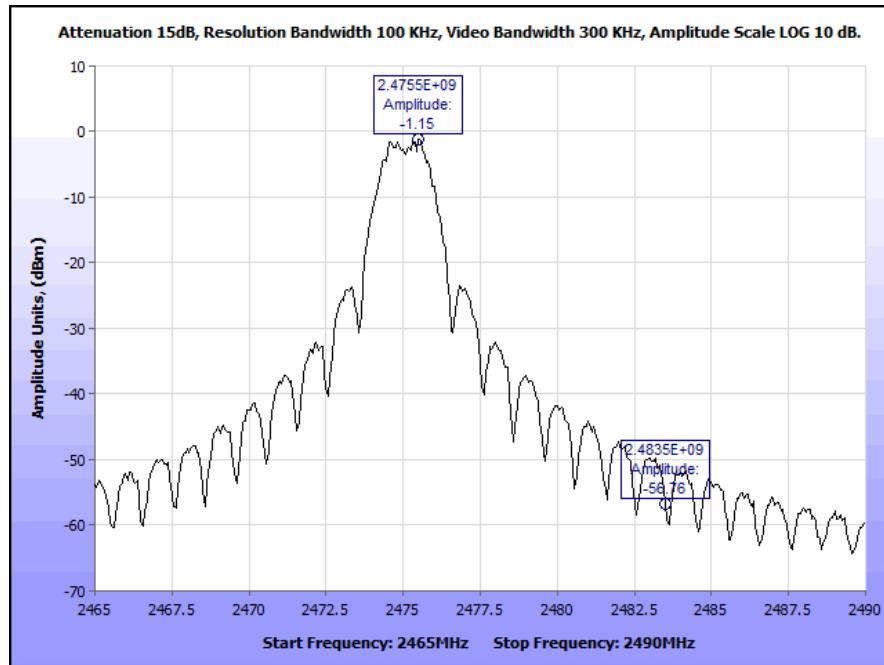


**Plot 44. Conducted Spurious Emissions, High Channel, 1 GHz – 25 GHz**

## Conducted Band Edge Test Results



Plot 45. Conducted Band Edge, Low Channel



Plot 46. 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.

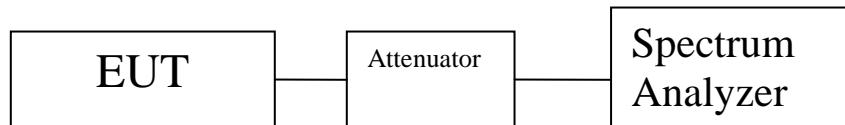
**Test Procedure:** The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level. The RBW was set to 100 kHz and a VBW set to 300 kHz. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.

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

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

**Test Engineer:** Jason Allnutt

**Test Date:** 08/29/14



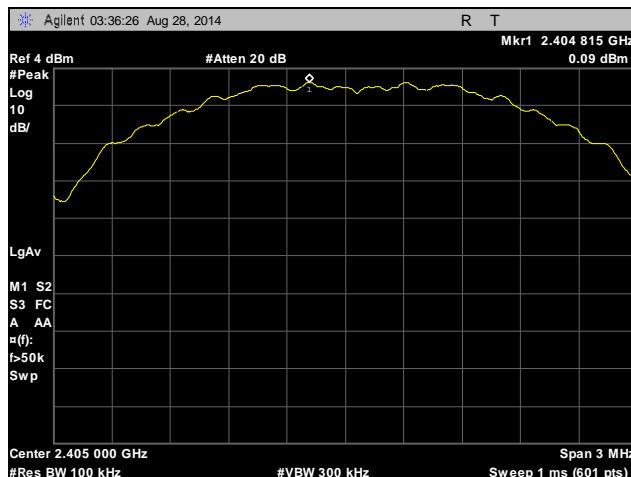
**Figure 5. Block Diagram, Peak Power Spectral Density Test Setup**

## Peak Power Spectral Density Test Results

Peak Power Spectral Density				
Carrier Channel	Frequency (MHz)	Measured PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2405	0.09	8	-7.91
Mid	2440	-0.32	8	-8.32
High	2475	-0.97	8	-8.97

Table 20. Peak Power Spectral Density, Test Results

## Peak Power Spectral Density



Plot 47. Peak Power Spectral Density, Low Channel



Plot 48. Peak Power Spectral Density, Mid Channel



Plot 49. Peak Power Spectral Density, High Channel

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(i) Maximum Permissible 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 = 3.42 mW (i.e. 5.34dBm) (peak) therefore, Limit for Uncontrolled exposure: 1 mW/cm<sup>2</sup> or 10 W/m<sup>2</sup>

EUT maximum antenna gain = 2 dBi.

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

$$S = PG / 4\pi R^2$$

where, S = Power Density (1 mW/cm<sup>2</sup>)

P = Power Input to antenna (3.42mW)

G = Antenna Gain (1.58 numeric)

R = Distance to the center of Radiation of the antenna

P = 3.42 mW

R = 20 cm

G = 1.58

$$S = 3.42 * 1.58 / 4(3.1416)(20)^2$$

$$S = 0.00108 \text{ mW/cm}^2$$

Therefore, EUT meets the Uncontrolled Exposure limit at 20cm

## 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
1T4829	SPECTRUM ANALYZER	AGILENT	E4407B	5/14/2013	11/14/2014
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T4483	ANTENNA; HORN	ETS-LINDGREN	3117	2/28/2014	8/28/2015
1T4300A	SEMI-ANECHOIC CHAMBER # 1 (FCC)	EMC TEST SYSTEMS	NONE	07/24/2012	07/24/2015
1T4753	ANTENNA - BILOG	SUNOL SCIENCES	JB6	07/24/2013	01/24/2015
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	07/18/2014	07/18/2016
1T4565	LISN (24 AMP)	SOLAR ELECTRONICS	9252-50-R-24-BNC	6/26/2014	12/26/2015

**Table 21. 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 stages; 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.<sup>1</sup> *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.

---

<sup>1</sup> 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 <sup>[2]</sup> digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe <sup>[1]</sup> est conforme à la norme NMB-003 du Canada.

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

# End of Report