



MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

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November 13, 2007

Rajant Corporation
400 E. King Street
Malvern, PA 19355

Dear Brian Hassick,

Enclosed is the EMC test report for compliance testing of the Rajant Corporation, XLR as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-03 ed.), Part 15, Subpart C.

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: (\Rajant Corporation\EMC22978-FCC247 Rev. 1)

DOC EMC702 9/13/2007

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The Nation's First Licensed Nationally Recognized Testing Laboratory





Rajant Corporation
XLR

CFR Title 47, Part 15, Subpart C

Electromagnetic Compatibility Test Report

for the

**Rajant Corporation
XLR**

Verified under
the FCC Certification Rules
contained in
Title 47 of the CFR, Part 15.247, Subpart C
for Intentional Radiators

MET Report: EMC22978-FCC247 Rev. 1

November 13, 2007

Prepared For:

**Rajant Corporation
400 E. King Street
Malvern, PA 19355**

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Avenue
Baltimore, Maryland 21230



Rajant Corporation
XLR

CFR Title 47, Part 15, Subpart C

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Title 47 of the CFR, Part 15.247, Subpart C
for Intentional Radiators

Dusmantha Tennakoon
Project Engineer, Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 15.407, of the FCC Rules under normal use and maintenance.

Shawn McMillen,
Wireless Coordinator, Electromagnetic Compatibility Lab



Rajant Corporation
XLR

CFR Title 47, Part 15, Subpart C

Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	November 9, 2007	Initial Issue.
1	November 13, 2007	Corrected power setting note.



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List of Terms and Abbreviations

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



Rajant Corporation
XLR

Executive Summary
CFR Title 47, Part 15, Subpart C

I. Executive Summary



1.1 Purpose of Test

An EMC evaluation was performed to determine compliance of the Rajant Corporation, XLR, 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 XLR. Rajant Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the XLR, has been **permanently** discontinued

1.2 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 Rajant Corporation, purchase order number 2007216. All tests were conducted using measurement procedure ANSI C63.4-2003.

Reference	Description	Results
Title 47 of the CFR, Part 15, Subpart C, §15.207	AC Power Line Conducted Emissions	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.203/15.247(b)(c)	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.205(d)	Band Edge Emissions	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.247(a)(2)	6dB Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.247(b)(3)	Maximum Peak Conducted Output Power	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.247(d)	Spurious Radiated Emissions	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.247(e)	Peak Power Spectral Density	Compliant

Table 1 Executive Summary of EMC Part 15.247 Compliance Testing



Rajant Corporation
XLR

Electromagnetic Compatibility
Equipment Configuration
CFR Title 47, Part 15, Subpart C

II. Equipment Configuration



2.1 Overview

MET Laboratories, Inc. was contracted by Rajant Corporation to perform testing on the XLR, under Rajant Corporation's purchase order number 2007216.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Rajant Corporation, XLR.

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

Model(s) Tested:	XLR	
Model(s) Covered:	XLR	
EUT Specifications:	Primary Power: 120 VAC Secondary Power: 12 VDC	
	FCC ID: VJA-XLR	
	Type of Modulations:	DSSS, BPSK, QPSK, CCK
	Equipment Code:	DTS
	Peak RF Conducted Output Power:	26.76 dBm
	EUT TX Frequency Ranges:	2412 MHz – 2462 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Evaluated by:	Dusmantha Tennakoon	
Date(s):	November 9, 2007	

Note: The internal Rajant power setting were the following:

Channel 1: +2

Channel 11: +16



2.2 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
CFR 47, Part 15, Subpart B	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
ANSI C63.4:2003	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI/NCSL Z540-1-1994	Calibration Laboratories and Measuring and Test Equipment - General Requirements
ANSI/ISO/IEC 17025:2000	General Requirements for the Competence of Testing and Calibration Laboratories

2.3 Test Site

All testing was performed at MET Laboratories, Inc., 914 West Patapsco Avenue, 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 semi-anechoic chamber. In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories. In accordance with §2.948(d), MET Laboratories has been accredited by the National Voluntary Laboratory Accreditation Program (Lab Code: 100273-0).

2.4 Description of Test Sample

The XLR, Equipment Under Test (EUT), is a portable networking device that supports wired and wireless routing, and amplified 802.11b access point/bridging/meshing functionality. It can be powered from external batteries or an external AC/DC power supply.



Rajant Corporation
XLR

Electromagnetic Compatibility
Equipment Configuration
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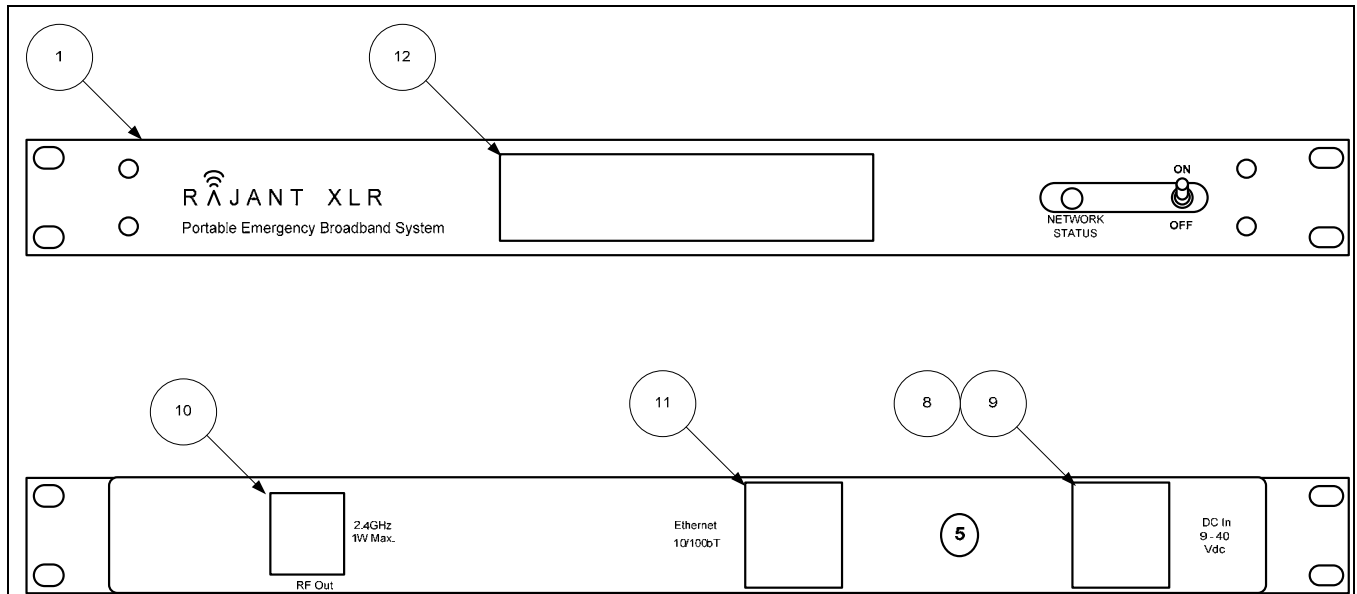


Figure 1. Block Diagram of Test Configuration, Ports

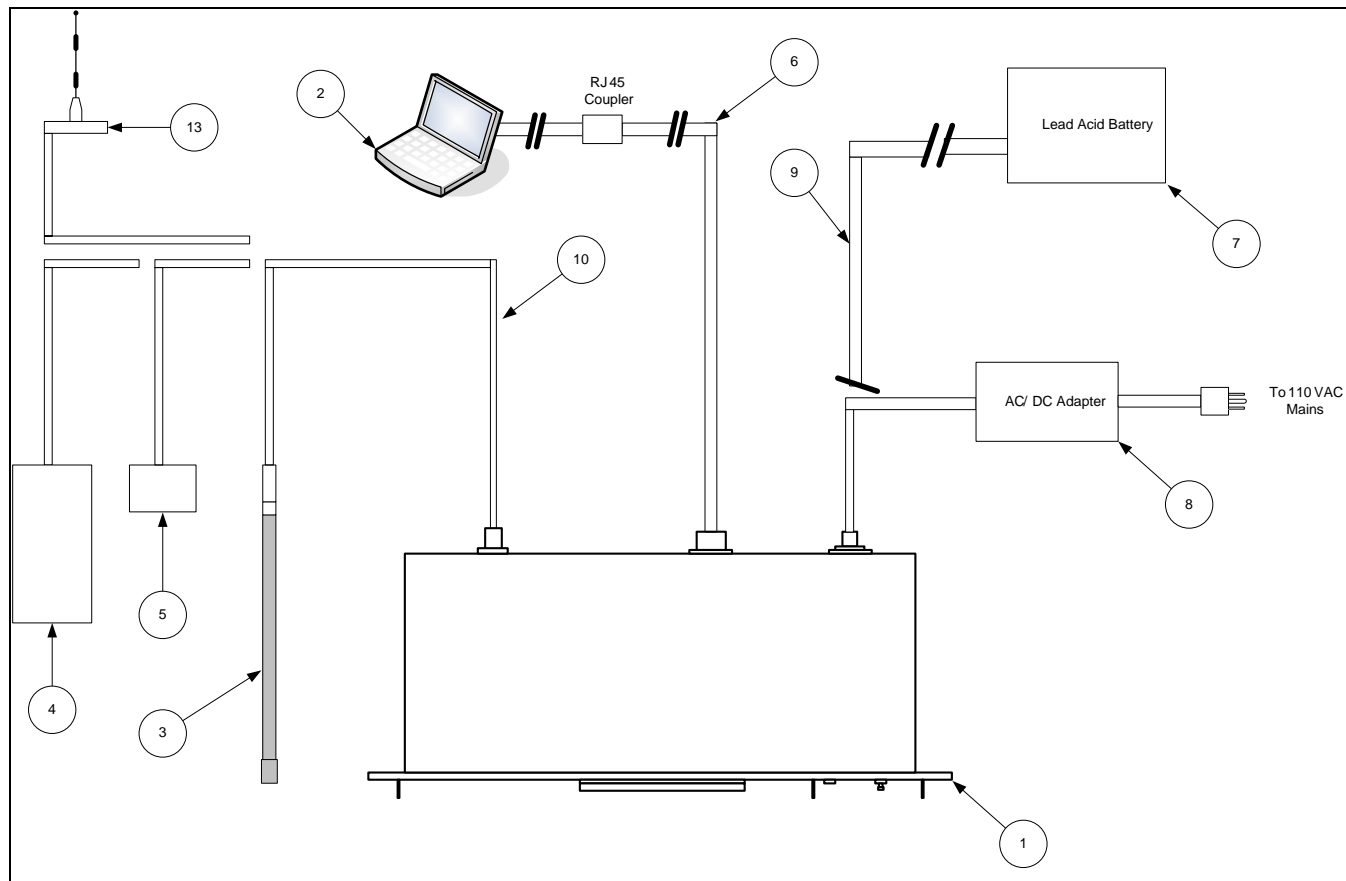


Figure 2. Block Diagram of Test Configuration, Cabling

2.5 Equipment Configuration

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

Ref. ID	Name / Description	Model Number
1	XLR	XLR

Table 2. Equipment Configuration



2.6 Support Equipment

Rajant Corporation supplied support equipment necessary for the operation and testing of the XLR. All support equipment supplied is listed in the following Support Equipment List.

Ref. ID	Name / Description	Manufacturer	Model Number	Serial Number
2	LAPTOP	IBM	THINKPAD 08N1180	11608K6451ZFX082091JX
3	OMNI ANTENNA, 9DBI	PACIFIC WIRELESS	OD24M-9	N/A
4	120 DEG SECTOR, 9DBI	PACIFIC WIRELESS	SA24-120-9	N/A
5	CUPCAKE, 3DBI	WIFI PLUS	WFP0200507	N/A
6	CAT5E ETHERNET CABLE	N/A	N/A	N/A
7	LEAD ACID BATTERY	N/A	N/A	N/A
13	MAGNETIC MOUNT, OMNI, 7DBI	PACIFIC WIRELESS	MA24-7	N/A

Table 3. Support Equipment

2.7 Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
8	PRI POWER CONNECTOR	XLR AC/DC POWER SUPPLY	1	~8.0FT	N	110 AC MAINS
9	PRI POWER CONNECTOR	XLR AC/DC VEHICLE CABLE	1	12.0FT	N	LEAD ACID BATTERY(5)
10	RF OUT	COAXIAL CABLE (LMR400)	1	25.0 FT	Y	COAXIAL CABLE (13)
11	ETHERNET PORT	XLR ETHERNET CABLE	1	~8.0FT	N	CAT5E CABLE (4) AND LAPTOP (2)
12	RADIO ACCESS PORT	MAINTENANCE ACCESS	N/A	N/A	N/A	N/A

Table 4. Ports and Cabling Information



2.8 Mode of Operation

The unit will simulate a network packing routing operation internally and by fully exercising the radio transceiver cards by forcing them into a mode where they continuously transmit. A setup procedure will be found on the controlling laptop.

2.9 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.

2.10 Disposition of EUT

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



Rajant Corporation
XLR

Electromagnetic Compatibility
Criteria for Intentional Radiators
CFR Title 47, Part 15, Subpart C

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 antennas will be professionally installed. The EUT is therefore compliant with §15.203. The following antennas will be used with the XLR.

Antenna Type	Gain (dBi)	Manufacturer
Omni	3	WiFi-Plus, Inc.
Omin	9	Pacific Wireless
120 ° Sector	9	Pacific Wireless
Monopole	7	Pacific Wireless

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 10/29/07



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.205 Band Edge Emissions

Test Requirement(s): § 15.205 (a): Except as shown in paragraph (d) of **15.205 Restricted bands of operation**, only spurious emissions are permitted in any of the frequency bands specified in Table 5:

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
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	Note
13.36–13.41.			
Note : Above 38.6			

Table 5. Restricted Bands of Operation from FCC Part 15, § 15.205

Test Procedure: The EUT was set up at maximum power. It was verified that the channels tested were within the band and not infringing upon the restricted bands. Measurements were made at 1m. The plots have been corrected for distance, cable loss and antenna correction factors. Channels 1 and 11 were simultaneously transmitting during testing.

Test Results: The EUT was compliant with the requirements of this section.

Test Engineer(s): Dusmantha Tennakoon

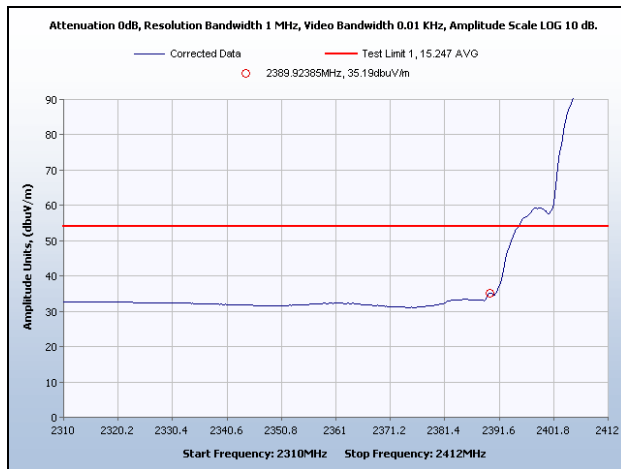
Test Date(s): 10/25/07



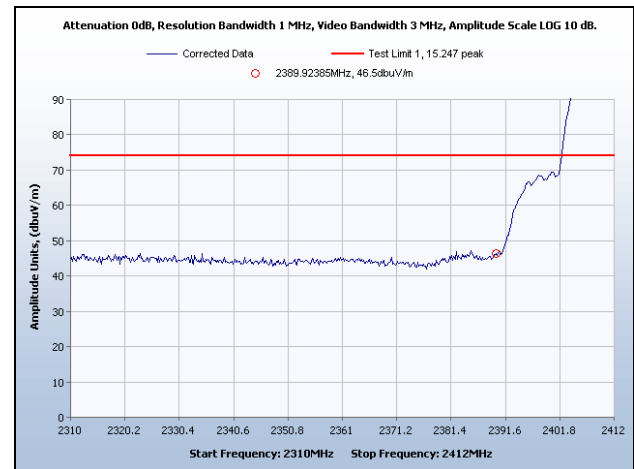
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Criteria for Intentional Radiators
CFR Title 47, Part 15, Subpart C

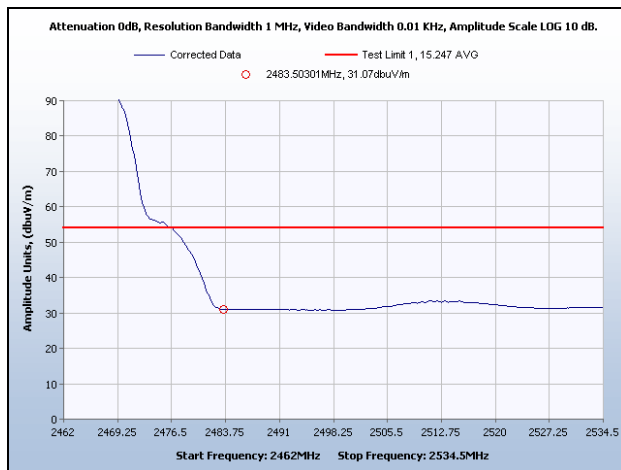
3 dBi Omni



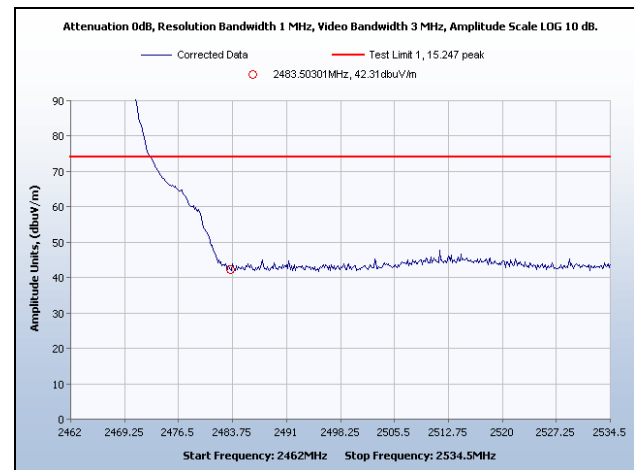
Restricted Band Edge, Channel 1, 3 dBi Omni, Average



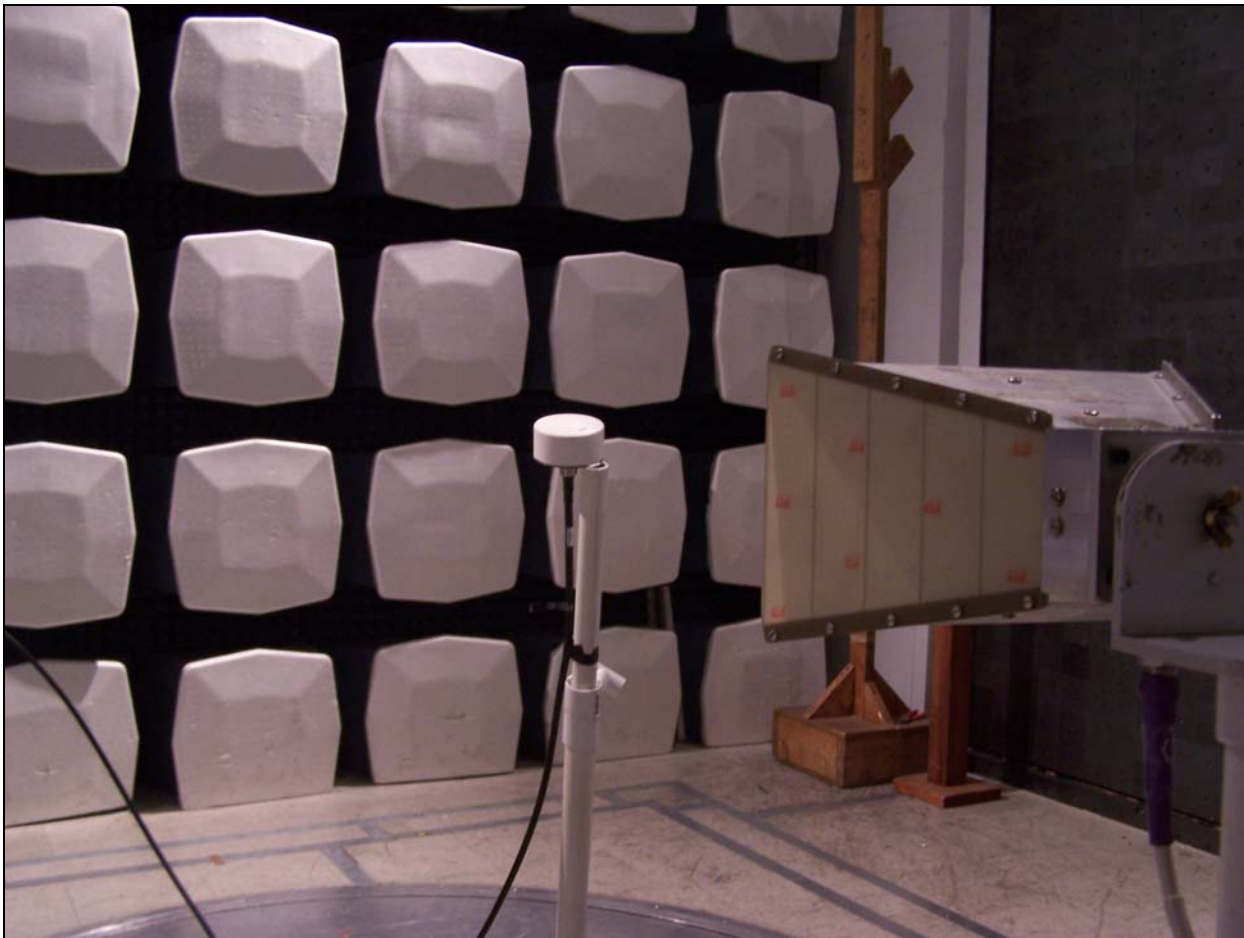
Restricted Band Edge, Channel 1, 3 dBi Omni, Peak



Restricted Band Edge, Channel 11, 3 dBi Omni, Average



Restricted Band Edge, Channel 11, 3 dBi Omni, Peak



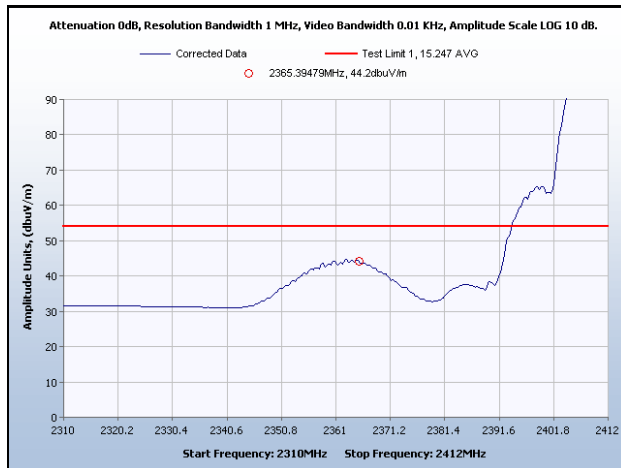
Photograph 1. Band Edge Test Setup, 3 dBi Omni



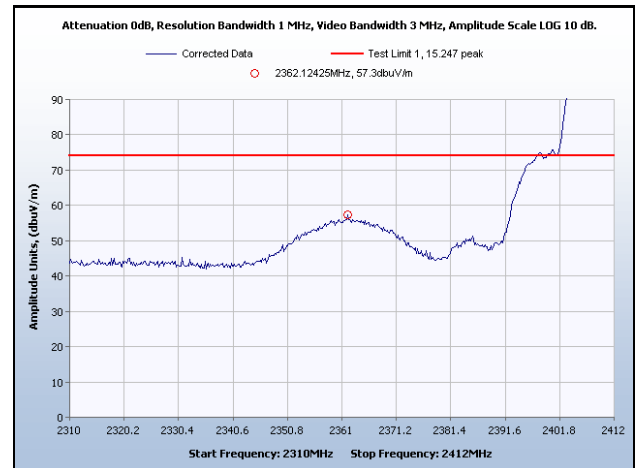
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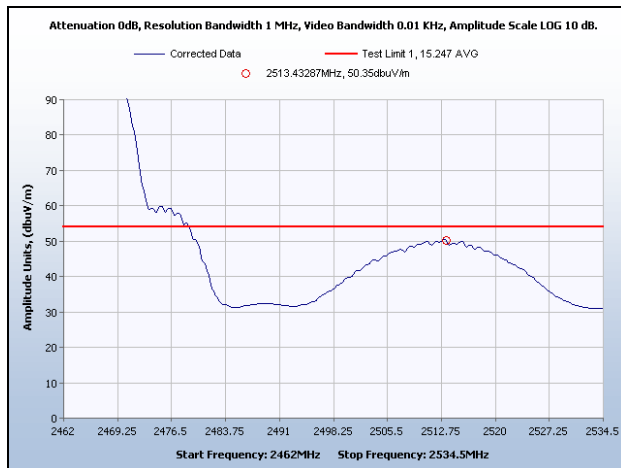
9 dBi Omni



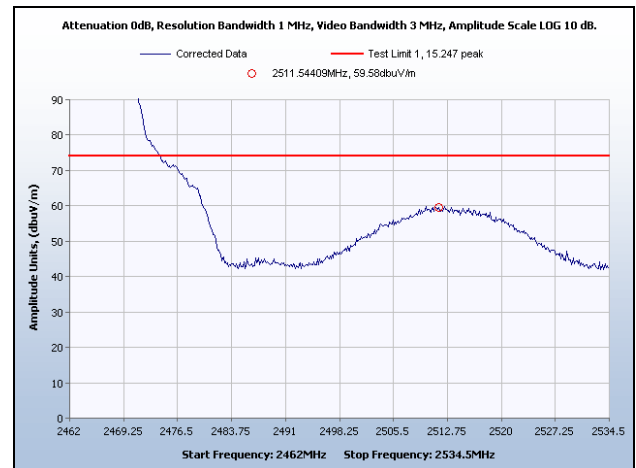
Restricted Band Edge, Channel 1, 9 dBi Omni, Average



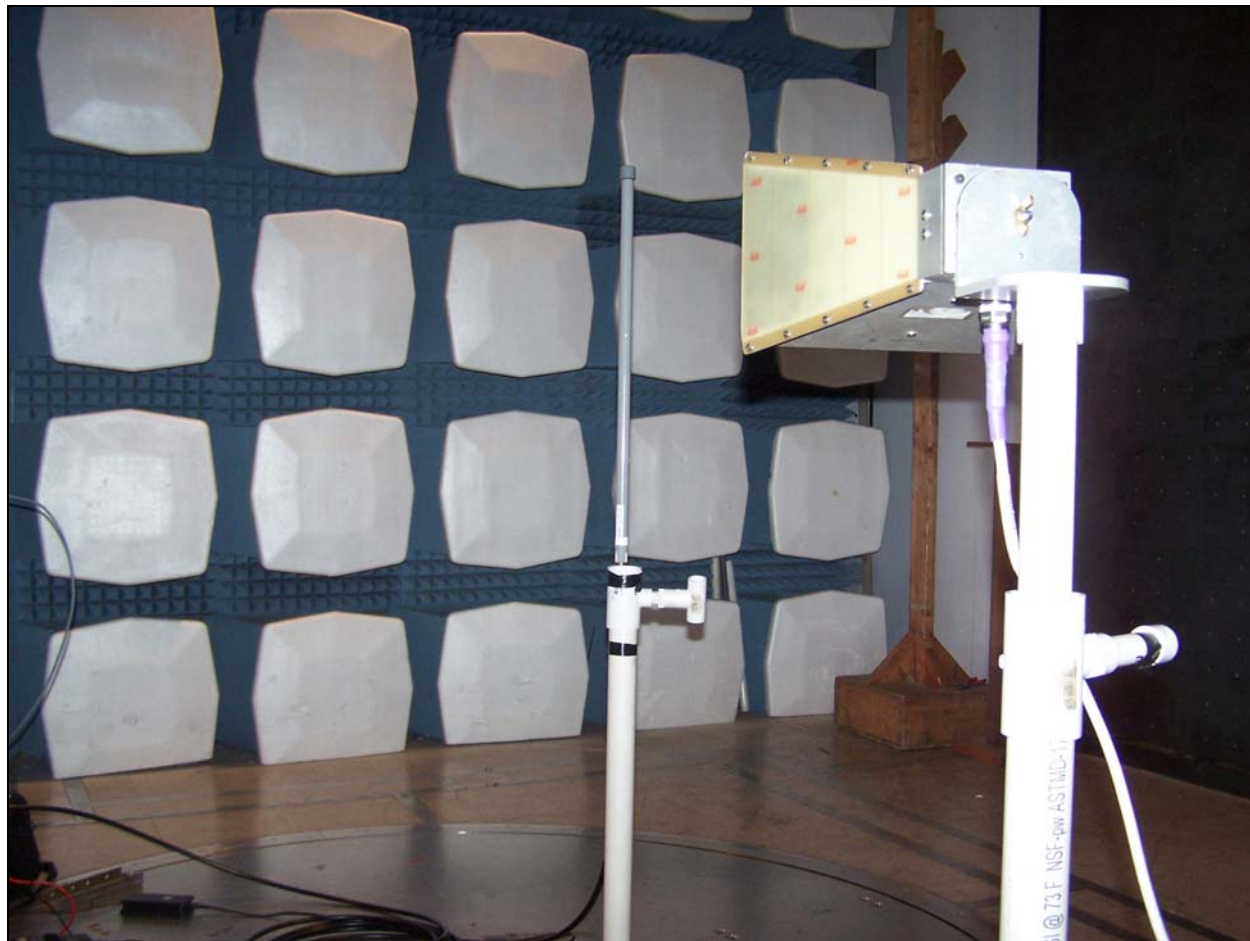
Restricted Band Edge, Channel 1, 9 dBi Omni, Peak



Restricted Band Edge, Channel 11, 9 dBi Omni, Average



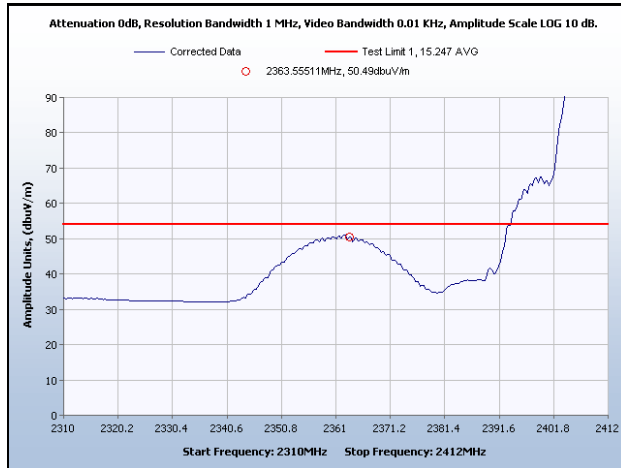
Restricted Band Edge, Channel 11, 9 dBi Omni, Peak



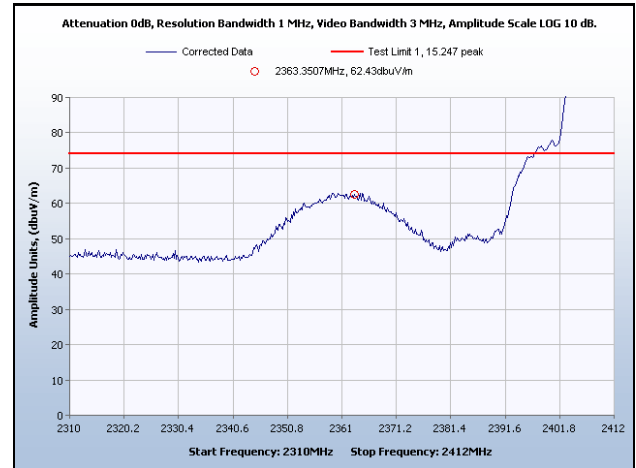
Photograph 2. Band Edge Test Setup, 9 dBi Omni



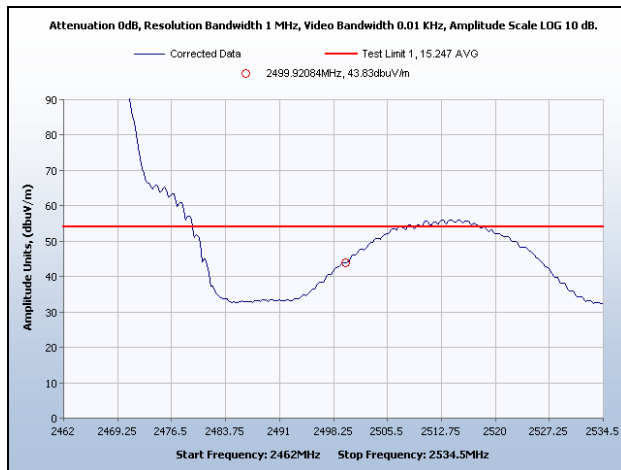
9 dBi Sector



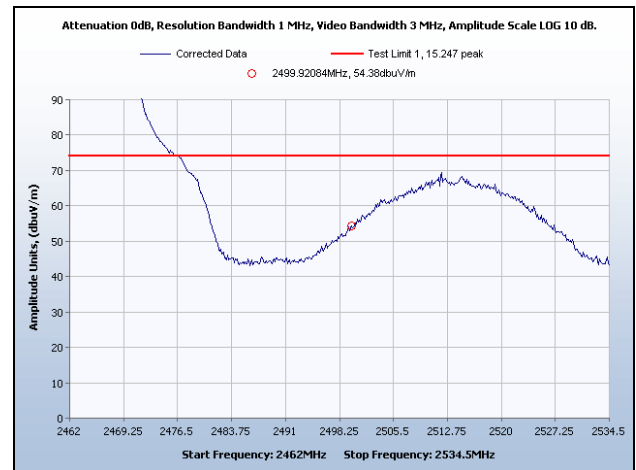
Restricted Band Edge, Channel 1, 9 dBi Sector, Average



Restricted Band Edge, Channel 1, 9 dBi Sector, Peak



Restricted Band Edge, Channel 11, 9 dBi Sector, Average



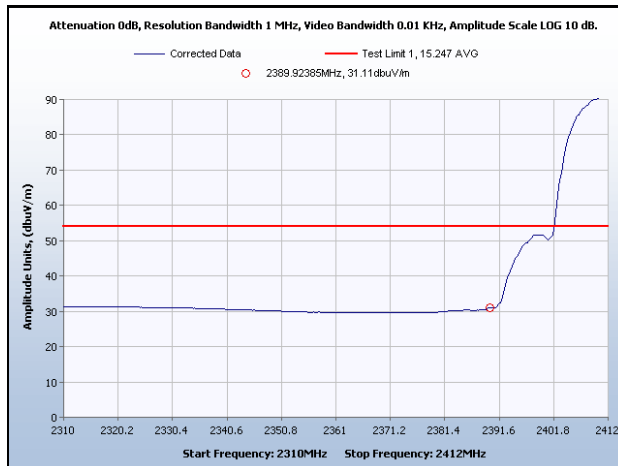
Restricted Band Edge, Channel 11, 9 dBi Sector, Peak



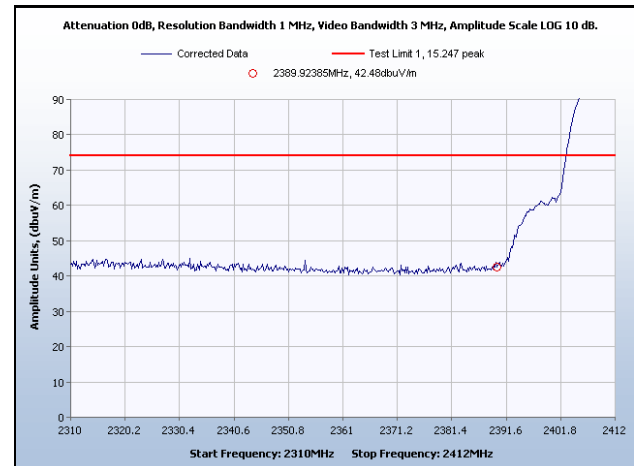
Photograph 3. Band Edge Test Setup, 9 dBi Sector



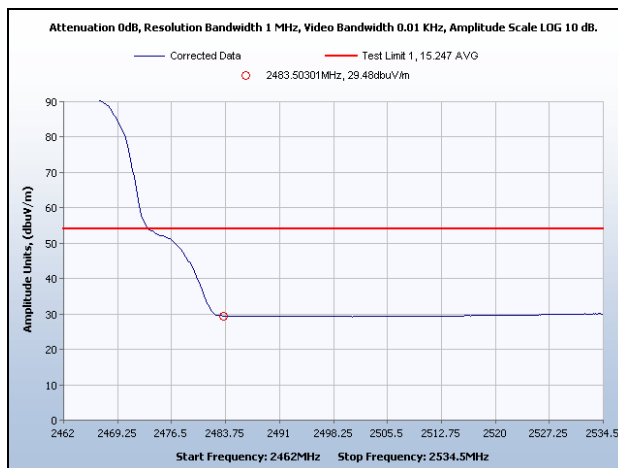
7 dBi Monopole



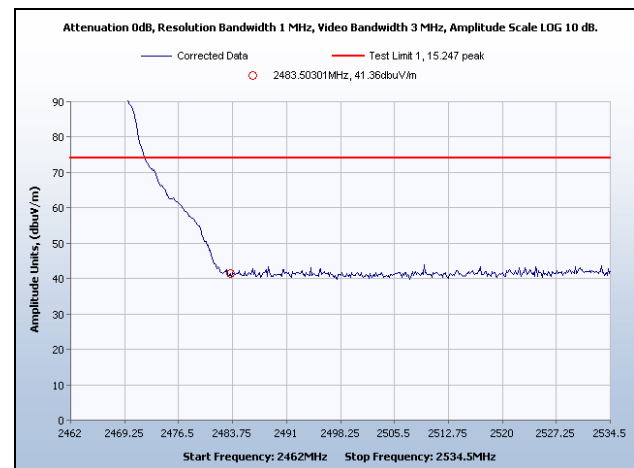
Restricted Band Edge, Channel 1, 7 dBi Monopole, Average



Restricted Band Edge, Channel 1, 7 dBi Monopole, Peak



Restricted Band Edge, Channel 11, 7 dBi Monopole, Average



Restricted Band Edge, Channel 11, 7 dBi Monopole, Peak



Photograph 4. Band Edge Test Setup, 7 dBi Monopole

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207 Conducted Emissions Limits

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

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

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

Test Procedure:

The EUT was 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 μ 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 C63.4-1992 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz". The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω /50 μ H LISN as the input transducer to an EMC/field intensity meter. The tests were conducted in a RF-shielded enclosure.

The EUT was transmitting on channels 1 and 11 simultaneously during testing.

Test Results:

The EUT was compliant with the Conducted Emission limits of §15.207(a) for Intentional Radiators. See following pages for detailed test results.

Test Engineer(s):

Jeremy Karnes

Test Date(s):

10/29/07



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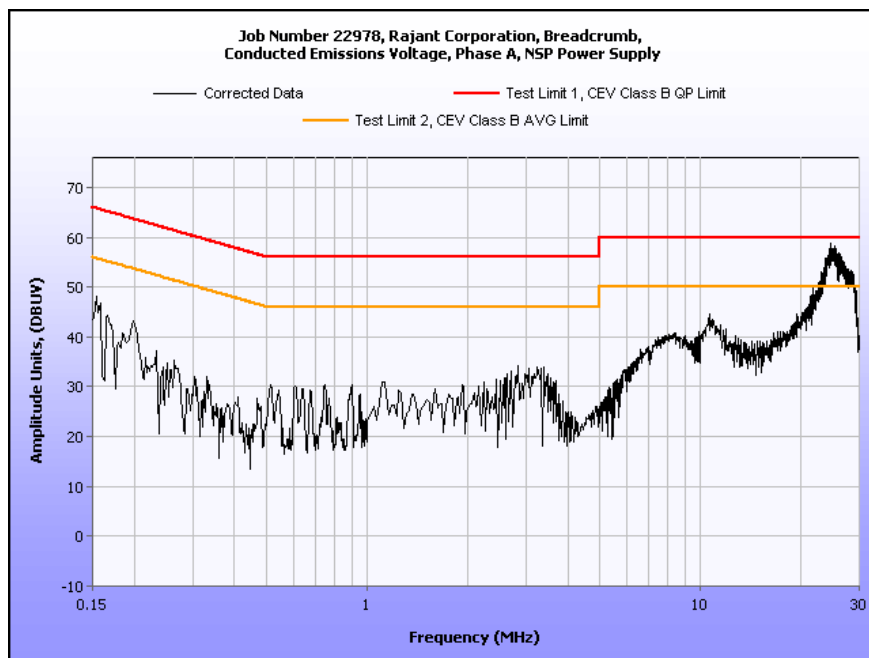
Electromagnetic Compatibility
Criteria for Intentional Radiators
CFR Title 47, Part 15, Subpart C

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207 Conducted Emissions Limits

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
0.15	41.5	0	41.5	66	-24.5	6.1	0	6.1	56	-49.9
0.199	40.5	0	40.5	63.65	-23.15	27.1	0	27.1	53.65	-26.55
0.161	39.7	0	39.7	65.41	-25.71	7.2	0	7.2	55.41	-48.21
10.77	41.3	0.18232	41.48232	60	-18.5177	34.6	0.18232	34.78232	50	-15.2177
10.5	41.3	0.178	41.478	60	-18.522	34.9	0.178	35.078	50	-14.922
11.04	40.5	0.18664	40.68664	60	-19.3134	33.7	0.18664	33.88664	50	-16.1134
24.656	54.3	0.176352	54.476352	60	-5.52365	46.5	0.176352	46.676352	50	-3.32365
25.29	53.3	0.15543	53.45543	60	-6.54457	45.5	0.15543	45.65543	50	-4.34457
24.1	53	0.1947	53.1947	60	-6.8053	45.4	0.1947	45.5947	50	-4.4053

Table 7. Conducted Emissions - Voltage, Phase (120 VAC)



Plot 1. Conducted Emissions, Phase Line Plot

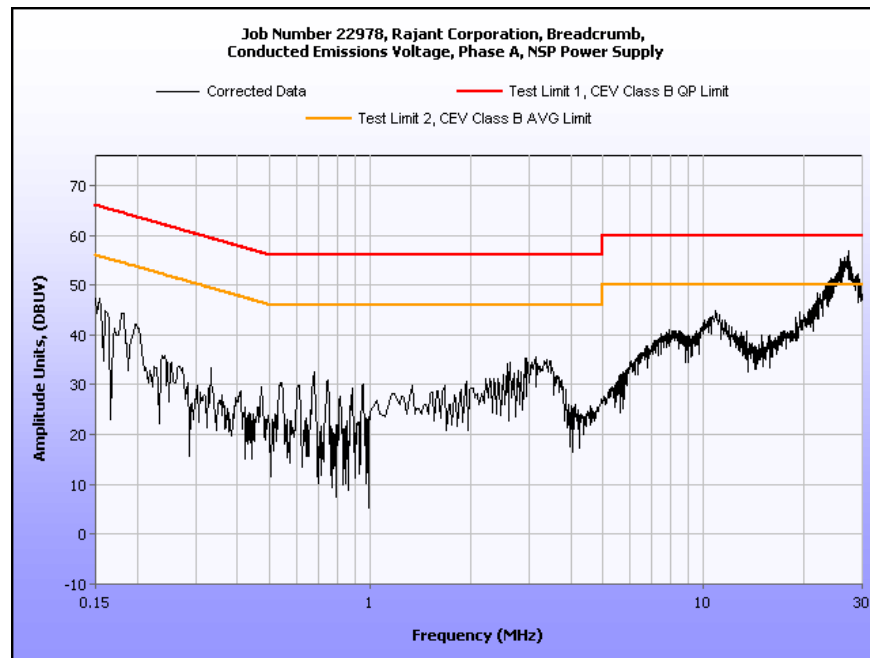


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Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
26.95	51.2	0.10065	51.30065	60	-8.69935	45.4	0.10065	45.50065	50	-4.49935
24	48.3	0.198	48.498	60	-11.502	42.6	0.198	42.798	50	-7.202
29.22	48.3	0.02574	48.32574	60	-11.6743	42.5	0.02574	42.52574	50	-7.47426
23.75	46.7	0.20625	46.90625	60	-13.0938	41.1	0.20625	41.30625	50	-8.69375
10.88	42.5	0.18408	42.68408	60	-17.3159	37.9	0.18408	38.08408	50	-11.9159
10.54	42.3	0.17864	42.47864	60	-17.5214	37.8	0.17864	37.97864	50	-12.0214
0.153	40.3	0	40.3	65.84	-25.54	13.8	0	13.8	55.84	-42.04
0.164	39.3	0	39.3	65.26	-25.96	4.5	0	4.5	55.26	-50.76

Table 8. Conducted Emissions - Voltage, Neutral (120 VAC)



Plot 2. Conducted Emissions, Neutral Line Plot



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.209 Radiated Emissions – Spurious

Test Requirement(s): § 15.205 (a): Except as shown in paragraph (d) of 15.205 Restricted bands of operation, only spurious emissions are permitted in any of the frequency bands specified in Table 9:

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
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	Note
13.36–13.41.			
Note: Above 38.6			

Table 9. Restricted Bands of Operation from FCC Part 15, § 15.205

§ 15.205 (b): (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.



§ 15.35 (b): ...When average radiated emission measurements are specified in this part, including emission measurements below 1000 MHz, there also is a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules...

Frequency (MHz)	Field Strength (Microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F (kHz)	300
0.490 – 1.705	24000/F (kHz)	30
1.705 – 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.		

Table 10. Radiated Emissions Limits from § 15.209 (a)

Test Procedure:

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

In accordance with §15.35 (b) the limit on the radio frequency emissions as measured using instrumentation with a peak detector function shall be 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

For radiated Spurious emissions, the EUT was scanned from 1 GHz to 18 GHz, excluding the band 2.3 GHz to 2.5 GHz, which was covered under Band Edge Emissions. In order to demonstrate compliance, measurements were taken in the form of peak plots shown with a peak and an average limit line. The plots were made at a 1m measurement distance and corrected for cable loss, distance correction, and antenna correction factors, by the capture software. At each channel of interest, the EUT was rotated to find maximum emissions. Channels 1 and 11 were simultaneously transmitting during testing..

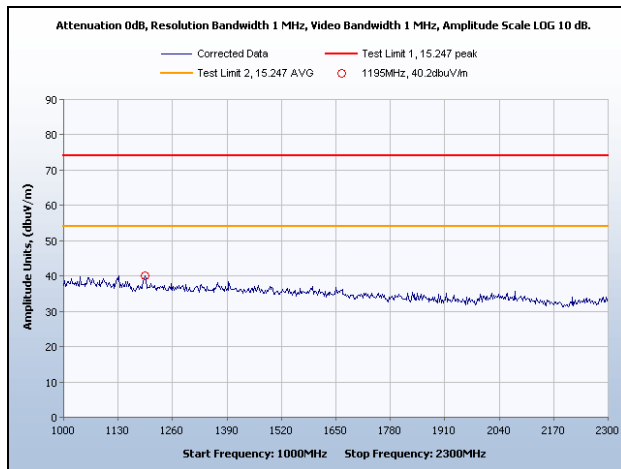
Peak measurements, which exceeded the average limit line were remeasured using video averaging and plotted against an average limit line. Tabular data shows measurements of interest.



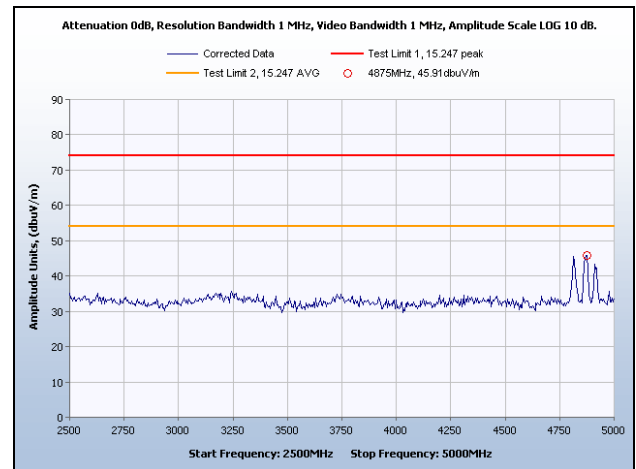
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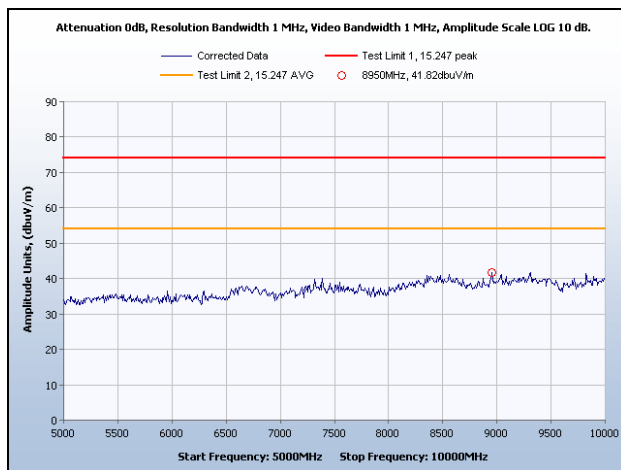
3 dBi Omni



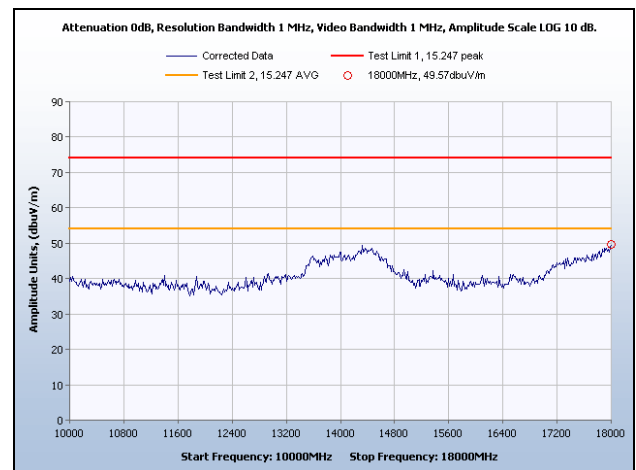
Spurious Radiated Emissions, 3 dBi Omni, 1 GHz – 2.3 GHz



Spurious Radiated Emissions, 3 dBi Omni, 2.5 GHz – 5 GHz



Spurious Radiated Emissions, 3 dBi Omni, 5 GHz – 10 GHz

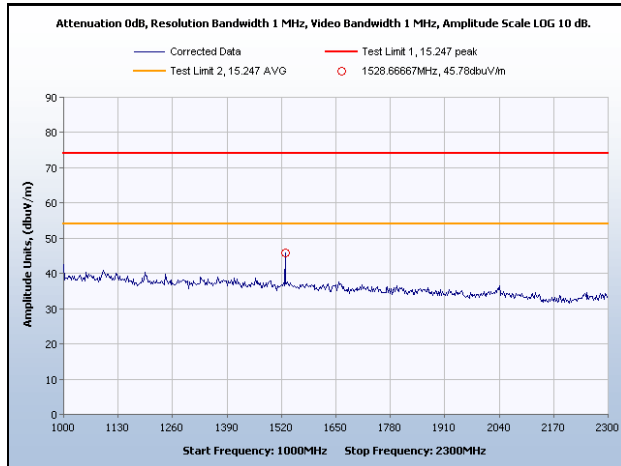


Spurious Radiated Emissions, 3 dBi Omni, 10 GHz – 18 GHz

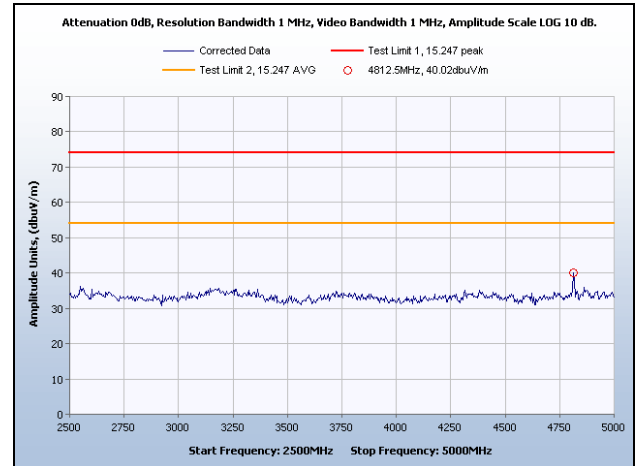
Note: Highest emissions were recorded when the measuring antenna was vertically polarized. Only these plots are shown above.



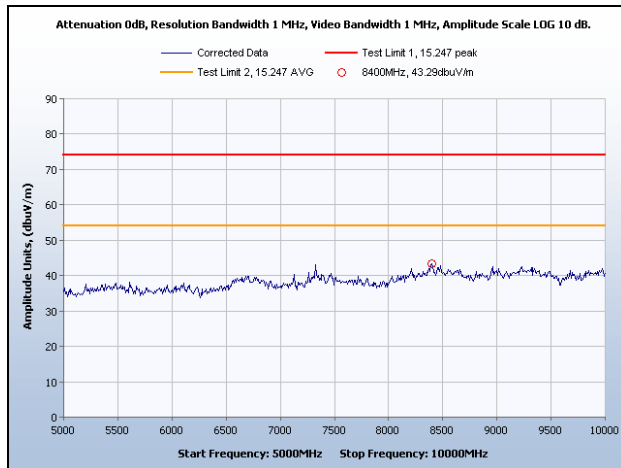
9 dBi Omni



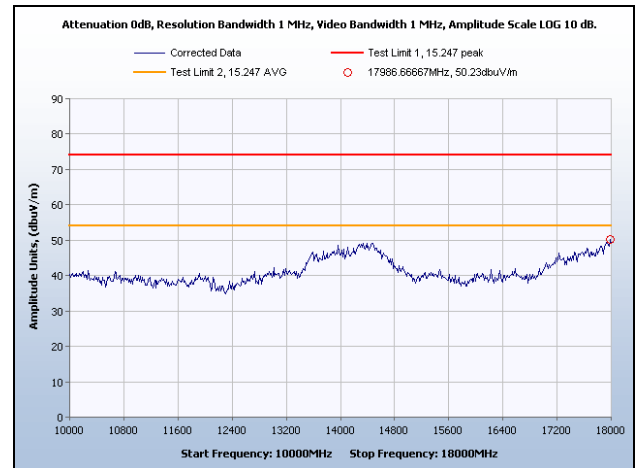
Spurious Radiated Emissions, 9 dBi Omni, 1 GHz – 2.3 GHz



Spurious Radiated Emissions, 9 dBi Omni, 2.5 GHz – 5 GHz



Spurious Radiated Emissions, 9 dBi Omni, 5 GHz – 10 GHz

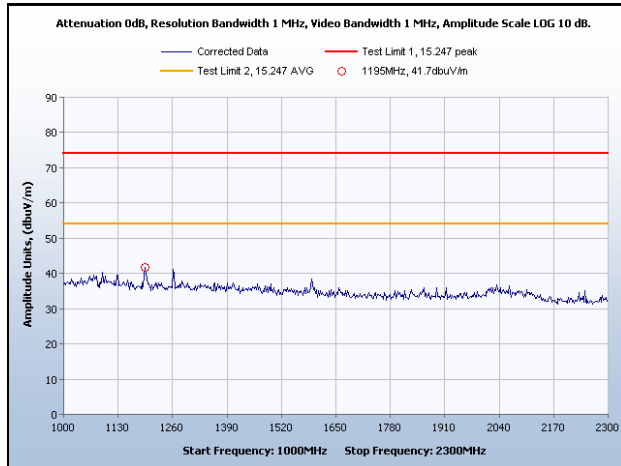


Spurious Radiated Emissions, 9 dBi Omni, 10 GHz – 18 GHz

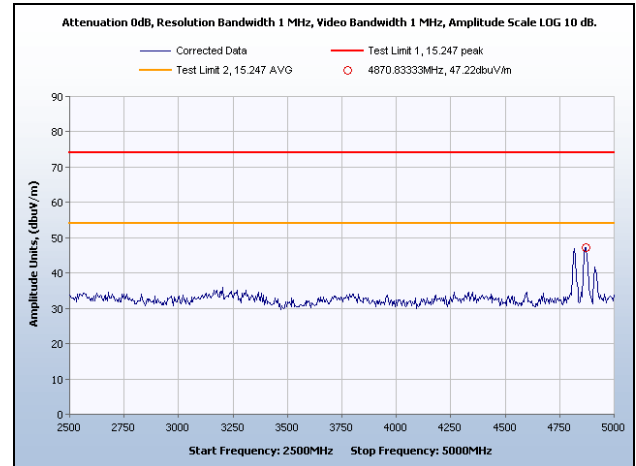
Note: Highest emissions were recorded when the measuring antenna was vertically polarized. Only these plots are shown above.



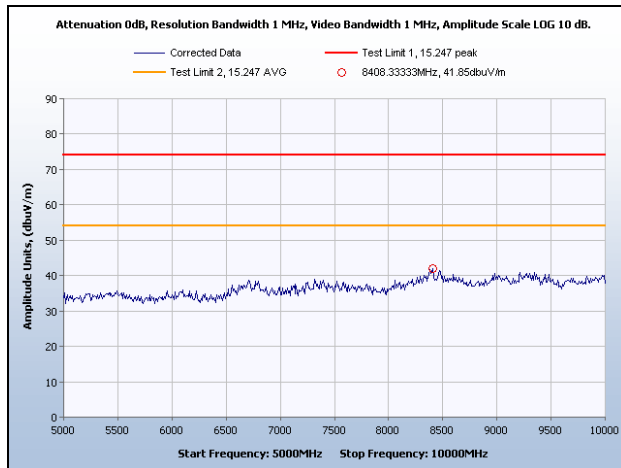
9 dBi Sector



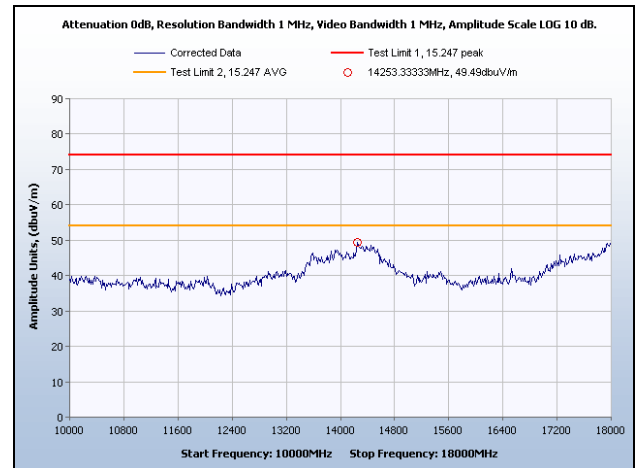
Spurious Radiated Emissions, 9 dBi Sector, 1 GHz – 2.3 GHz



Spurious Radiated Emissions, 9 dBi Sector, 2.5 GHz – 5 GHz



Spurious Radiated Emissions, 9 dBi Sector, 5 GHz – 10 GHz



Spurious Radiated Emissions, 9 dBi Sector, 10 GHz – 18 GHz

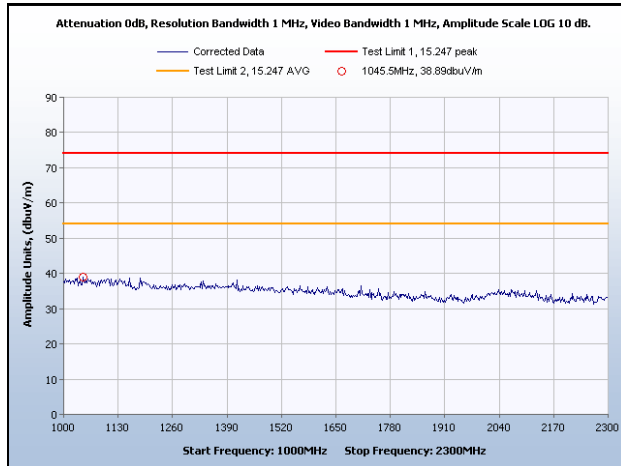
Note: Highest emissions were recorded when the measuring antenna was vertically polarized. Only these plots are shown above.



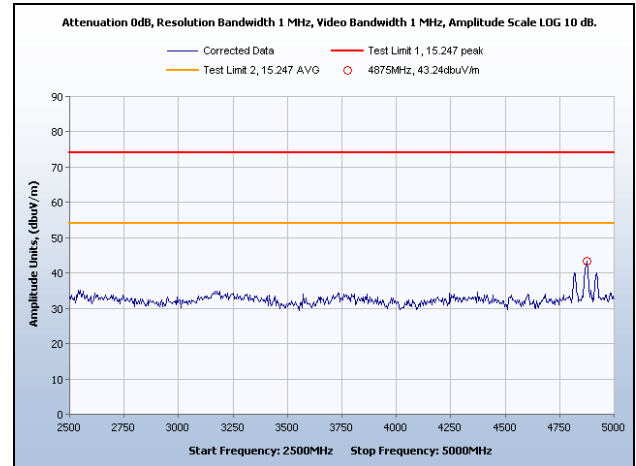
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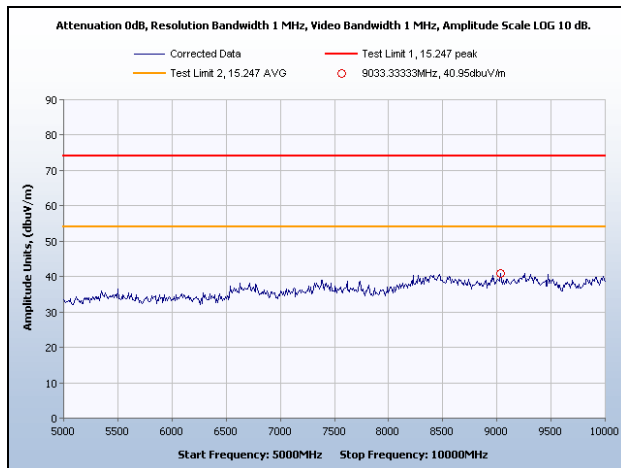
7 dBi Monopole



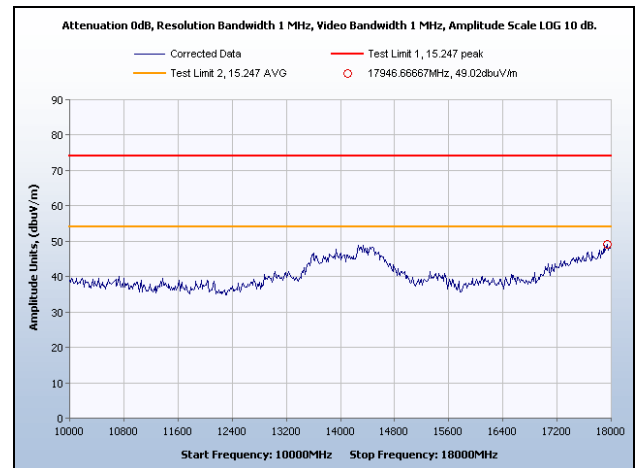
Spurious Radiated Emissions, 7 dBi Monopole, 1 GHz – 2.3 GHz



Spurious Radiated Emissions, 7 dBi Monopole, 2.5 GHz – 5 GHz



Spurious Radiated Emissions, 7 dBi Monopole, 5 GHz – 10 GHz



Spurious Radiated Emissions, 7 dBi Monopole, 10 GHz – 18 GHz

Note: Highest emissions were recorded when the measuring antenna was vertically polarized. Only these plots are shown above.



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a) 6 dB a Bandwidth

Test Requirements:	<p>§ 15.247(a): Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:</p> <p>§ 15.247(a)(2): 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.</p>
Test Procedure:	The transmitter was set to the channels 1 and 11 at the highest output power and connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured with the spectrum analyzer. The 6 dB Bandwidth was measured and recorded.
Test Results:	Equipment complies with § 15.247 (a). The 6 dB Bandwidth was determined from the plots on the following pages.
Test Engineer(s):	Dusmantha Tennakoon
Test Date(s):	10/17/07

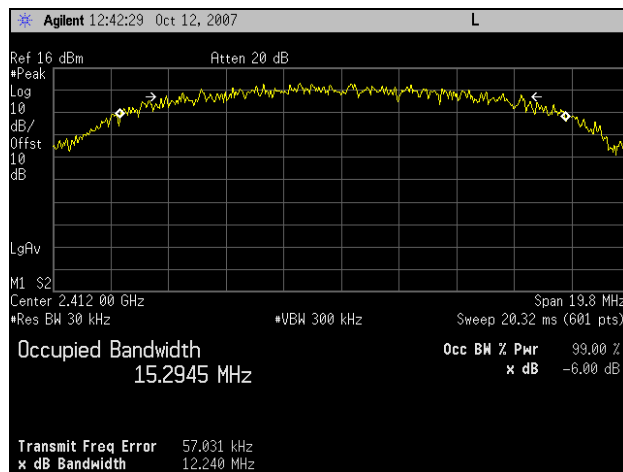


Electromagnetic Compatibility Criteria for Intentional Radiators

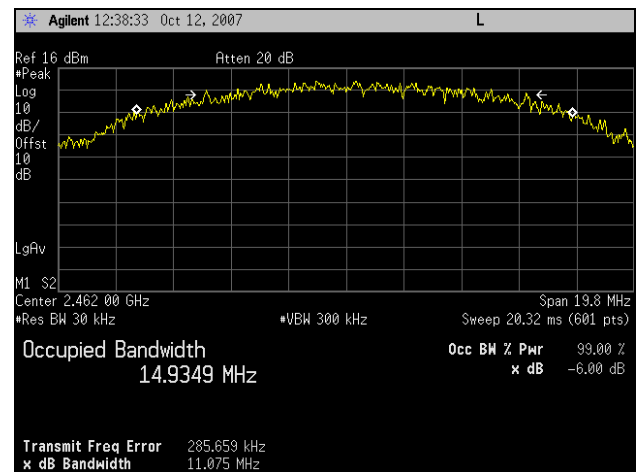
§ 15.247(a) 6 dB Bandwidth

Channel	Measured 6 dB Bandwidth	Test Limit
1	12.240 MHz	0.500 MHz
11	11.075 MHz	0.500 MHz

Table 11. 6 dB Bandwidth Test Results



6 dB Occupied Bandwidth, Channel 1



6 dB Occupied Bandwidth, Channel 11



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 12. Output Power Requirements from §15.247

§15.247(c): if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the Table 12, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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

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

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



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output

Test Procedure: The transmitter was connected to a calibrated PSA Spectrum Analyzer through an attenuator. The EUT was measured at each channel.

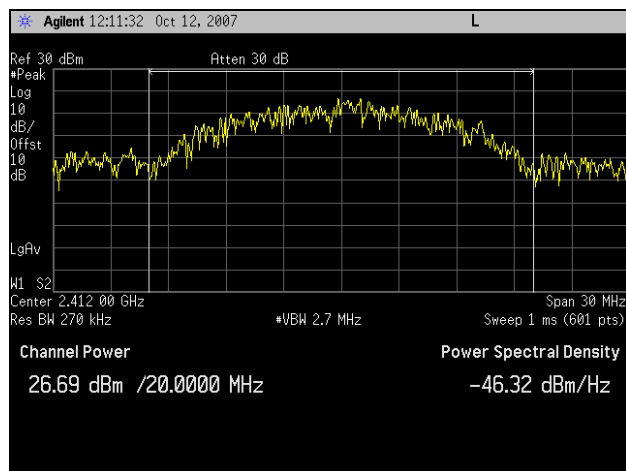
Test Results: Equipment complies with the Peak Power Output limits of § 15.247(b).

Channel #	Measured Output Power (dBm)
1	26.69
11	26.76

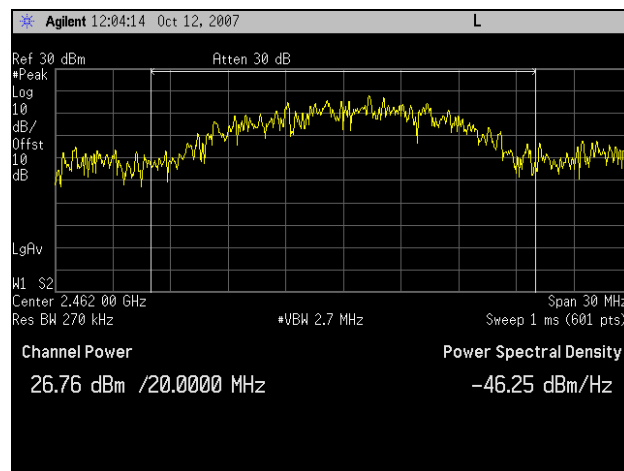
Table 13. Peak Output Power

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 10/17/07



Output Power, Channel 1



Output Power, Channel 11



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) RF Exposure

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

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

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
30-300	61.4	0.163	1.0	6
300-1,500	--	--	F/300	6
1,500-100,000	--	--	5	6
(B) Limits for General Population/Uncontrolled Exposure				
30-300	27.5	0.073	0.2	30
300-1,500	--	--	F/1,500	30
1,500-100,000	--	--	1.0	30

Table 14. Limits for Maximum Permissible Exposure

Note: F=Frequency in MHz

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

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

where,

S = Power Density mW/m²

P = Power Input to antenna mili Watts

G = Numeric Antenna Gain

R = Distance to the center of radiation of the antenna (20 cm for Mobile minimum

distance)



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) RF Exposure

Test Procedures: Antenna substitution was used, in order to find the maximum EIRP. The methods of TIA/EIA 603 were used. From the EIRP, the power density was calculated.

Test Results: MPE Limit Calculation: EUT's operating frequencies @ 2412 and 2462 MHz; only channel 1 and 11 are active on this unit. Highest conducted power = 26.76 dBm (peak) therefore, **Limit for Uncontrolled exposure: 1 mW/cm²**.

EUT maximum antenna gain = 9 dBi.

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

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

where, S = Power Density mW/m²

P = Power Input to antenna mili Watts

G = Numeric Antenna Gain

R = Distance to the center of radiation of the antenna (20 cm for Mobile minimum distance)

$$\text{Antenna Numeric Gain} = 10^{\text{dBi}/10}$$

$$\text{Power at antenna port} = 475.4 \text{ mW}$$

$$\text{Antenna Gain} = 9 \text{ dBi}$$

$$\text{Numeric antenna gain} = 10^{9/10} = 7.94$$

$$S = (475.4)(7.94) / 4(3.1416)(20)^2$$

$$S = 0.751 \text{ mW/cm}^2$$

Therefore, EUT meets the Uncontrolled Exposure limit.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 11/1/07



Electromagnetic Compatibility Criteria for Intentional Radiators

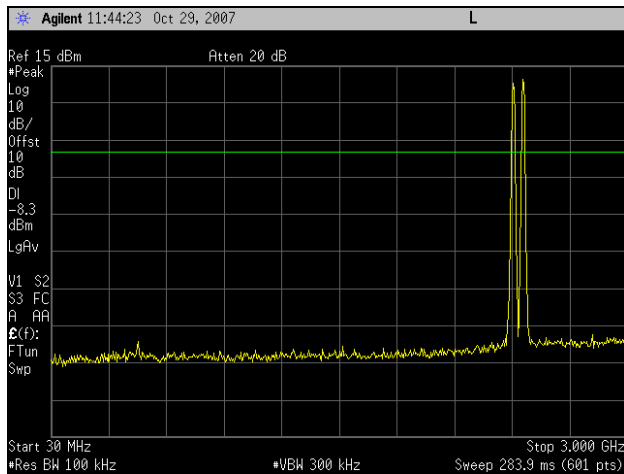
§ 15.247(d) Spurious Emissions – RF Conducted

Test Requirements:	§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).
Test Procedure:	The EUT was configured with the control software to transmit at maximum power. The transmit output was connected to the analyzer through an attenuator. $RBW = 100\text{ kHz}$, $VBW \geq RBW$. Testing was performed while channels 1 and 11 are transmitting simultaneously.
Test Results:	The EUT was compliant with the requirements of this section.
Test Engineer(s):	Dusmantha Tennakoon
Test Date(s):	10/29/07

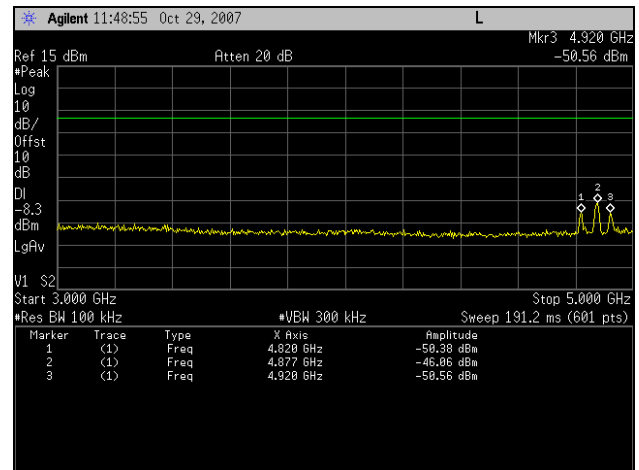


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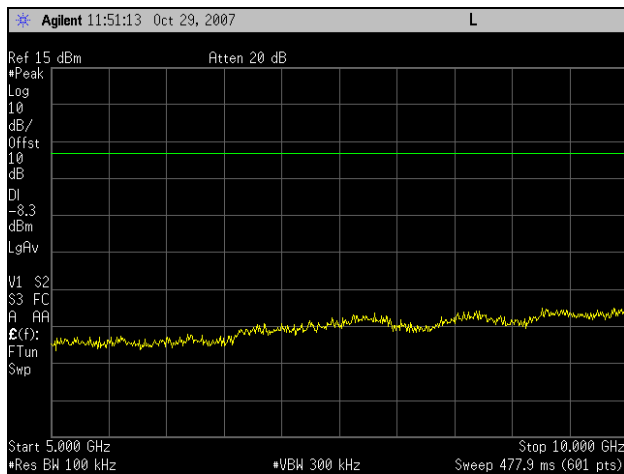
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RF Conducted Spurious Emissions, 30 MHz to 3 GHz



RF Conducted Spurious Emissions, 3 GHz to 5 GHz



RF Conducted Spurious Emissions, 5 GHz to 10 GHz



RF Conducted Spurious Emissions, 10 GHz to 26.5 GHz



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.
RBW = 3 kHz, VBW>RBW
Sweep = Span/ 3 kHz

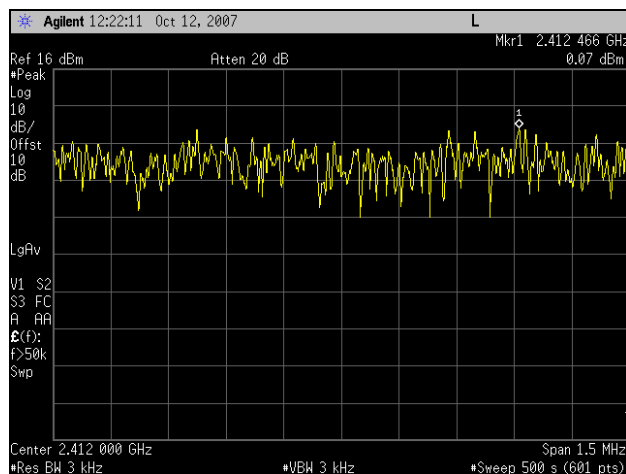
Test Results: Equipment complies with the peak power spectral density limits of § 15.247 (e). The peak power spectral density was determined from plots on the following page(s).

Test Engineer(s): Dusmantha Tennakoon

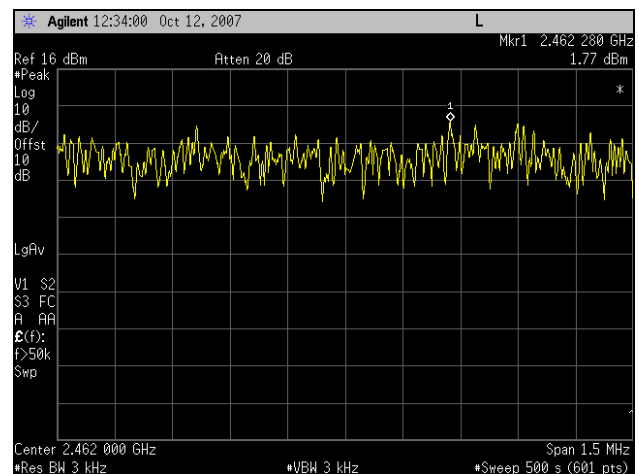
Test Date(s): 10/17/07

Channel	Measured PPSD (dBm)	Test Limit (dBm)
1	0.07	8
11	1.77	8

Table 15. Peak Power Spectral Density Test Results



Peak Power Spectral Density, Channel 1



Peak Power Spectral Density, Channel 11



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IV. Test Equipment



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Test Equipment

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

Test Name: Conducted Emissions					
MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4214	SHIELD ROOM #4	UNIVERSAL SHIELD INC	NONE	01/26/2007	01/26/2008
1T4578	THERMO/HYGROMETER	CONTROL COMPANY	S6-627-9	09/24/2006	09/24/2008
1T4502	COMB GENERATOR	COM-POWER	CGC-255	08/30/2007	08/30/2008
1T4212	LISN; SWITCH	SOLAR ELECTRONICS CO	9252-R-24-BNC	12/18/2006	12/18/2007
1T4302	EMI RECEIVER	HEWLETT PACKARD	85462A	11/20/2006	11/20/2007
Test Name: Radiated Emissions - Spurious					
MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T2665	ANTENNA; HORN	EMCO	3115	4/17/07	4/17/08
1T4300	SEMI-ANECHOIC CHAMBER	EMC TEST SYSTEMS	NONE	2/17/07	1/17/09
1T4414	MICROWAVE PRE-AMP	AH SYSTEMS	PAM-0118	SEE NOTE	
S/N: US42070103	PSA	AGILENT	E448A	2/20/07	2/20/08
1T4592	RF FILTER KIT	VARIOUS	N/A	SEE NOTE	
Test Name: Conducted Measurements					
MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4583	10 DB ATTENUATOR	INMET	18N10W-10	SEE NOTE	
S/N: US42070103	PSA	AGILENT	E448A	2/20/07	2/20/08

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



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V. Certification & User's Manual Information



Certification & User's Manual Information

5.1 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.



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

§ 2.901 Basis and Purpose

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

§ 2.907 Certification.

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

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



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§ 2.948 Description of measurement facilities.

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
 - (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
 - (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
 - (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
 - (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.



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5.2 Label and User's Manual Information

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

§ 15.19 Labeling requirements.

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

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

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

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

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

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

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

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

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

§ 15.21 Information to user.

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



Verification & User's Manual Information

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

§ 15.105 Information to the user.

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

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a 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.