



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

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April 9, 2007

Crossbow  
4145 North First Street  
San Jose, CA 95134

Dear Afshin Afzali,

Enclosed is the EMC test report for compliance testing of the Crossbow, SSM1000 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-03 ed.), Part 15, Subpart B for a Class A Digital Device and Subpart C 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 Sanchez  
Documentation Department

Reference: (\Crossbow\EMCS80080-FCC247)

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Crossbow  
SSM1000

Electromagnetic Compatibility  
Cover Page  
CFR Title 47, Part 15, Subpart B and C

## **Electromagnetic Compatibility Criteria Test Report**

for the

**Crossbow  
Model SSM1000**

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

**MET Report: EMC80080-FCC247**

April 9, 2007

**Prepared For:**

**Crossbow  
4145 North First Street  
San Jose, CA 95134**

**Prepared By:**  
**MET Laboratories, Inc.**  
4855 Patrick Henry Dr., Building 6  
Santa Clara, CA 95054



Crossbow  
SSM1000

Electromagnetic Compatibility  
Cover Page  
CFR Title 47, Part 15, Subpart B and C

## Electromagnetic Compatibility Criteria Test Report

for the

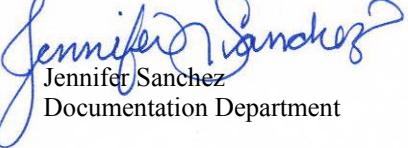
**Crossbow  
Model SSM1000**

### Tested Under

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



Shawn McMillen, Project Engineer  
Electromagnetic Compatibility Lab



Jennifer Sanchez  
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 15.247 & 15B, of the FCC Rules under normal use and maintenance.



Tony Permsombut, Manager  
Electromagnetic Compatibility Lab



Crossbow  
SSM1000

Electromagnetic Compatibility  
Report Status  
CFR Title 47, Part 15, Subpart B and C

## Report Status Sheet

Revision	Report Date	Reason for Revision
∅	April 9, 2007	Initial Issue.



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Electromagnetic Compatibility  
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## 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<math>\mu</math>A</b>	Decibels above one <b>microamp</b>
<b>dB<math>\mu</math>V</b>	Decibels above one <b>microvolt</b>
<b>dB<math>\mu</math>A/m</b>	Decibels above one <b>microamp per meter</b>
<b>dB<math>\mu</math>V/m</b>	Decibels above one <b>microvolt per meter</b>
<b>DC</b>	Direct Current $\mu$
<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>GR-1089-CORE</b>	( <b>GR</b> ) General Requirement(s) imposed by the NEBS standard, ( <b>CORE</b> ) Central Office Recovery Express (AT&T), ( <b>1089</b> ) specifies various parts of the General Requirements under Bellcore Technical Standard, Requirements for Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment
<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><math>\mu</math>H</b>	microhenry
$\mu$	microfarad
<b><math>\mu</math>s</b>	microseconds
<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 per meter
<b>VCP</b>	Vertical Coupling Plane



Crossbow  
SSM1000

Electromagnetic Compatibility  
Executive Summary  
CFR Title 47, Part 15, Subpart B and C

## I. Executive Summary



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Electromagnetic Compatibility  
Executive Summary  
CFR Title 47, Part 15, Subpart B and C

## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Crossbow SSM1000, 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 SSM1000. Crossbow should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the SSM1000, 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 Crossbow, purchase order number 22825. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference	RSS-210 and RSS-GEN	Description	Results
<b>Transmitter Mode (TX)</b>			
§15.207	6.6	AC Power Line Conducted Emissions	Compliant
§15.203/15.247(c)	A8.4	Antenna Requirement	Compliant
§15.247(a)	A8.2	20dB & 99% Occupied Bandwidth	Compliant
§15.247(b)	A8.4	Maximum Peak Conducted Output Power	Compliant
§15.247(d), §15.205, §15.209	A8.5	Spurious Radiated and Conducted Emissions	Compliant
§15.247(e)	A8.2/RSS-102	RF Exposure	Compliant
<b>Receiver Mode (RX)</b>			
15.107	7.4	AC Power Line Conducted Emissions	Compliant
15.109	7.3	Radiated Spurious Emissions	Compliant

**Table 1 Executive Summary of EMC Part 15.247 Compliance Testing**



Crossbow  
SSM1000

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

## II. Equipment Configuration



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Electromagnetic Compatibility  
Equipment Configuration  
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## A. Overview

MET Laboratories, Inc. was contracted by Crossbow to perform testing on the SSM1000, under Crossbow's purchase order number 22825.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Crossbow, SSM1000.

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

<b>Model(s) Tested:</b>	SSM1000
<b>Model(s) Covered:</b>	SSM1000
<b>EUT Specifications:</b>	Primary Power: 3.6 – 4.8V
	FCC ID: SHU006SSM1000
	Type of Modulations: BFSK
	Emission Designators: 155KF7D
	Equipment Code: DSS
	Peak RF Output Power: 28.97dBm
	EUT Frequency Ranges: 902 – 928MHz
<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>	Shawn McMillen
<b>Date(s):</b>	April 9, 2007

## 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>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>ANSI/NCSL Z540-1-1994</b>	Calibration Laboratories and Measuring and Test Equipment - General Requirements
<b>ANSI/ISO/IEC 17025:2000</b>	General Requirements for the Competence of Testing and Calibration Laboratories

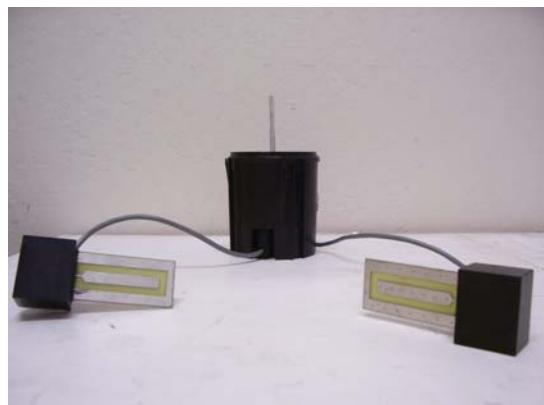
## C. Test Site

All testing was performed at MET Laboratories, Inc., 4855 Patrick Henry Dr., Building 6, Santa Clara, CA 95054. 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 (equivalent to an Open Area Test Site). 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 A2LA (Certificate Number 591.02).

## D. Description of Test Sample

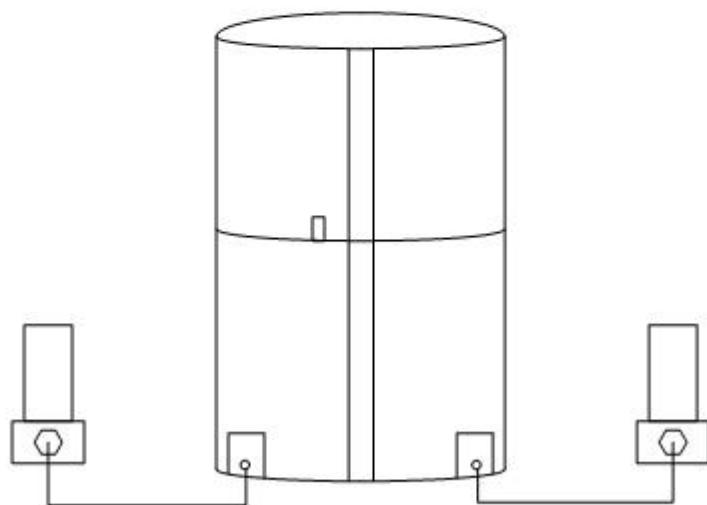
The Crossbow SSM1000, is buried under the ground and provides wireless connectivity between similar EUTs and central controller (server) to monitor the temperature, moisture and conductivity of the soil.



**Photograph 1. Crossbow SSM1000**

## Radiated Measurement

A Front



**Figure 1. Block Diagram of Test Configuration (Radiated Emissions)**

## Conducted Measurement

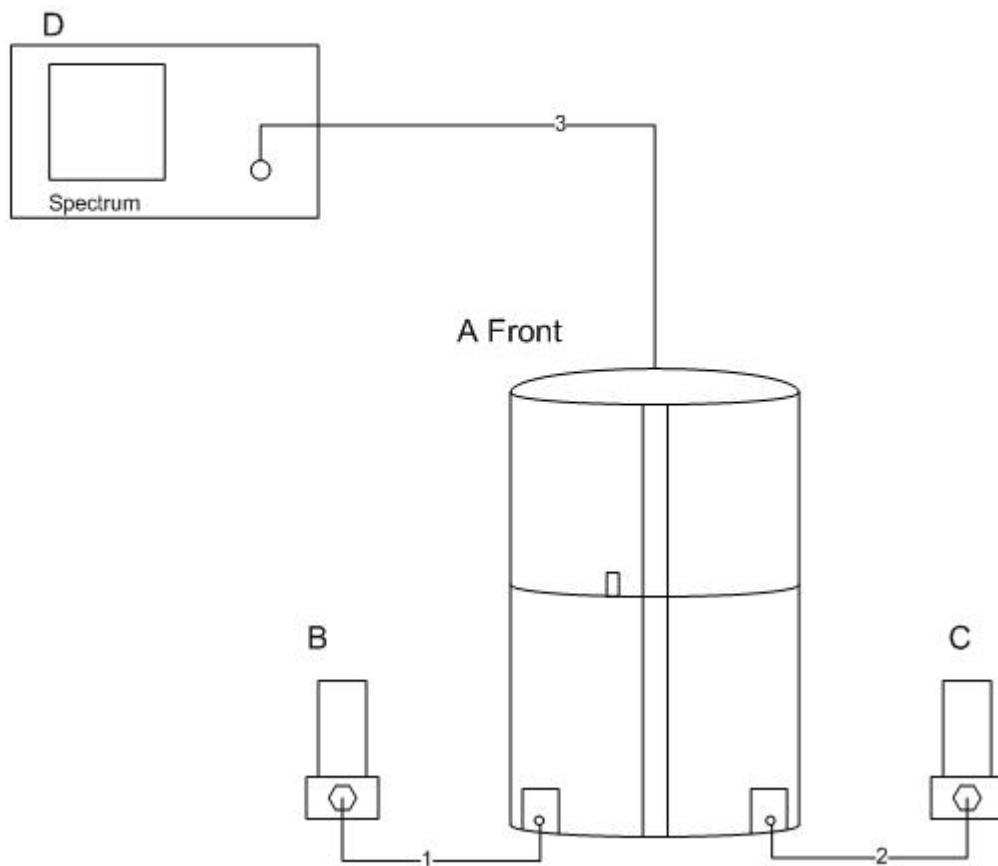


Figure 2. Block Diagram of Test Configuration (Conducted Measurement)



Crossbow  
SSM1000

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

## 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	Serial Number
A	SSM1000	SSM1000CB	0601003398
B	Sensor	N/A	N/A
C	Sensor	N/A	N/A

**Table 2. Equipment Configuration**

## F. Support Equipment

Crossbow supplied support equipment necessary for the operation and testing of the SSM1000. All support equipment supplied is listed in the following Support Equipment List.

Ref. ID	Name / Description	Manufacturer	Model Number	Serial Number
D	Spectrum Analyzer	HP	E4407B	MY45102898

**Table 3. Support Equipment (Radiated Emissions)**

## G. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty.	Length (m)	Shielded (Yes/No)	Termination Box ID & Port ID
<b>Conducted Measurement</b>						
1	A Front	Coax	1	0.4	Yes	B
2	A Front	Coax	1	0.4	Yes	C
3	A Top	Coax	1	0.2	Yes	D
<b>Unintentional Radiated Emission</b>						
1	A Front	Coax	1	0.4	Yes	B
2	A Front	Coax	1	0.4	Yes	C

**Table 4. Ports and Cabling Information**



Crossbow  
SSM1000

Electromagnetic Compatibility  
Equipment Configuration  
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## **H. Mode of Operation**

There are the following three modes of operation:

- 1- Transmit mode: EUT transmits packets within certain period of time based on its firmware to maintain its network connectivity
- 2- Receive mode: After each transmission, EUT spends some time in the receive mode to receive the required network acknowledgements
- 3- Sleep mode: EUT spends most of its life time in sleep mode where it doesn't do anything.

## **I. Method of Monitoring EUT Operation**

- 1- Three Blinking LEDs: (LEDs blink in different patterns corresponding to the firmware that they are running)
- 2- One Buzzer

## **J. Modifications**

- a) **Modifications to EUT**  
No modifications were made to the EUT.
- b) **Modifications to Test Standard**  
No modifications were made to the test standards.

## **K. Disposition of EUT**

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



Crossbow  
SSM1000

Electromagnetic Compatibility  
Unintentional Radiators  
CFR Title 47, Part 15, Subpart B

### III. Electromagnetic Compatibility Criteria for Unintentional Radiators



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Electromagnetic Compatibility  
Unintentional Radiators  
CFR Title 47, Part 15, Subpart B

## Electromagnetic Compatibility Criteria for Unintentional Radiators

### § 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 5.

**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 5.

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

**Test Procedures:** The EUT was placed on a 0.8m-high wooden table inside a semi-anechoic chamber (See Photograph 2 and Photograph 3). 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 found Compliant with the Class **A** requirement(s) of this section. Measured emissions were below applicable limits.

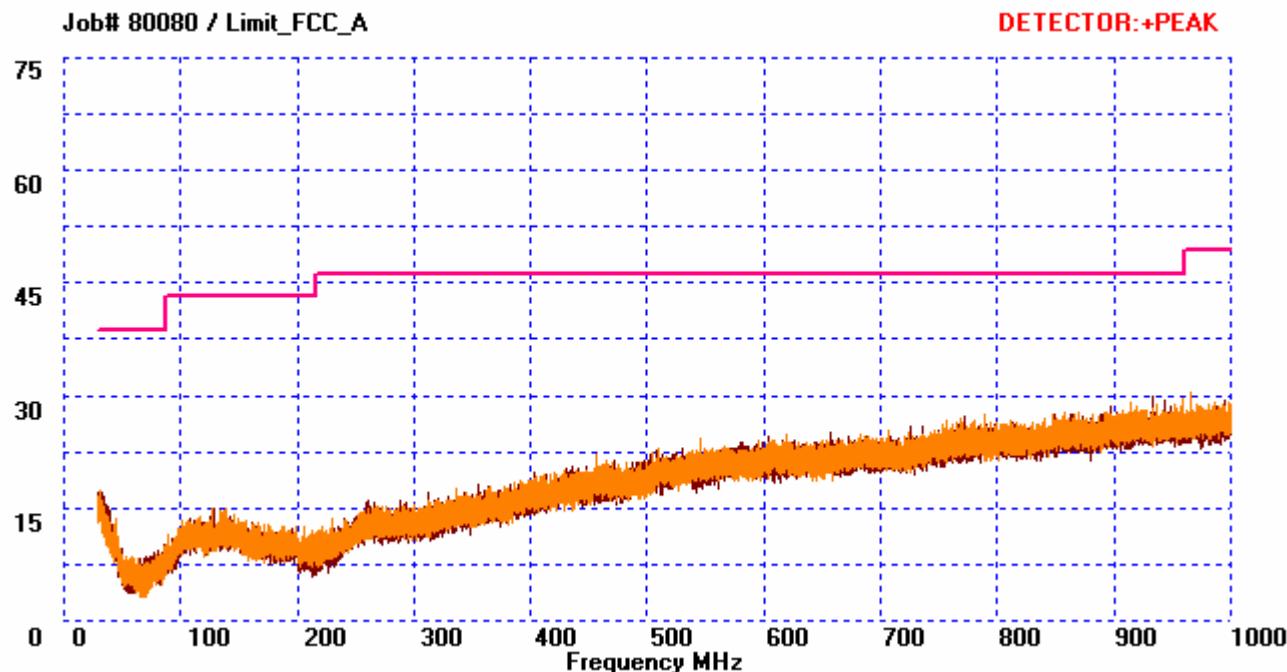
**Test Engineer(s):** Billy Kwan

**Test Date(s):** April 9, 2007

## Radiated Emissions Limits Test Results, 30 MHz – 1 GHz, Class A

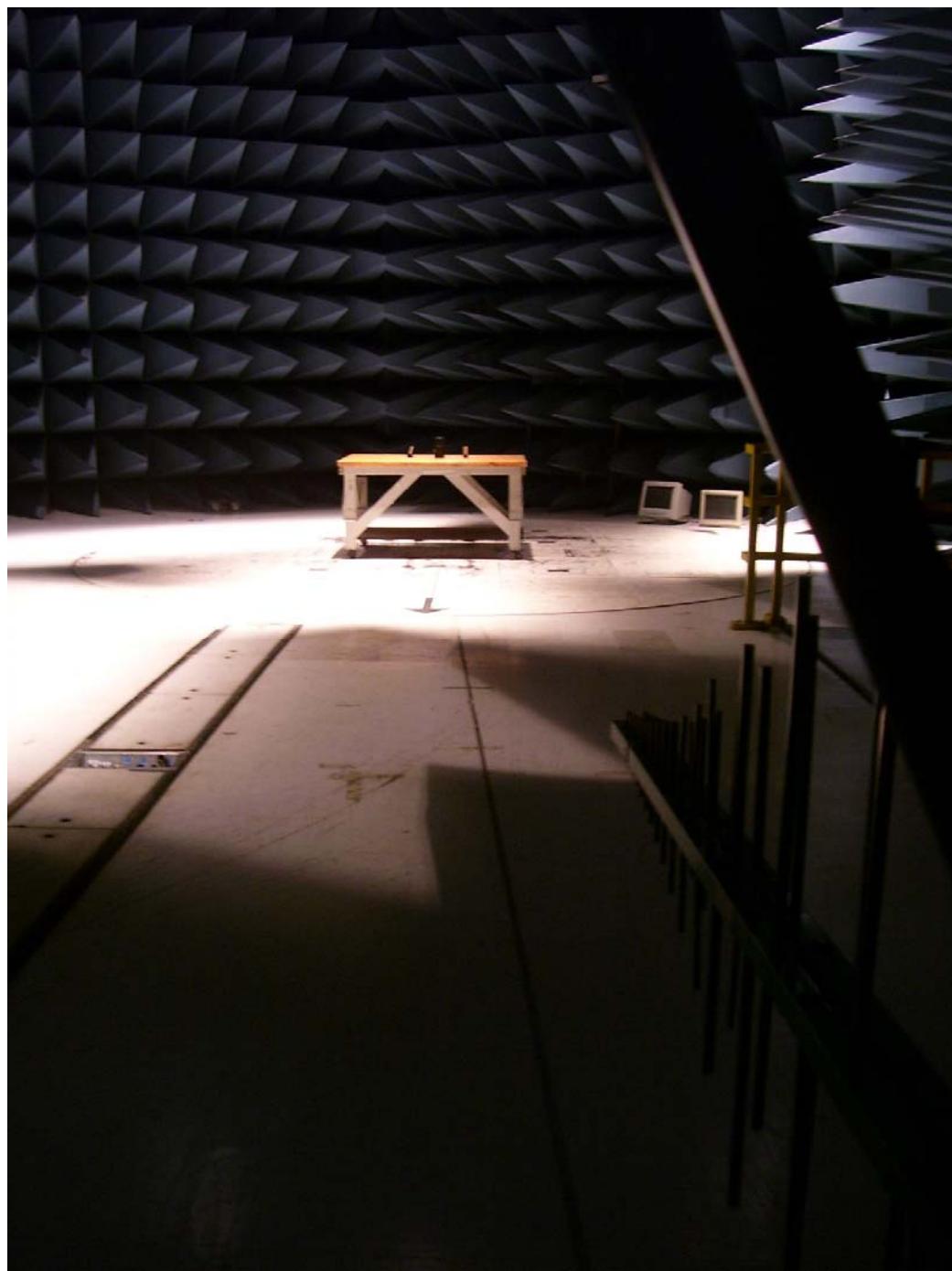
Frequency (MHz)	Antenna Polarity (H/V)	EUT Azimuth (Degrees)	Antenna Height (m)	Uncorrected Amplitude QP Detector (dBuV)	Antenna Correction Factor (dB/m) (+)	Cable Loss (dB) (+)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
545.68	V	0	1	-3.84	18.80	4.29	19.25	46.40	-27.15
786.92	V	0	1	-3.56	20.12	5.38	21.95	46.40	-24.46
843.28	H	0	1	-3.49	20.43	5.66	22.60	46.40	-23.80
903.56	H	0	1	-3.29	20.66	5.93	23.30	46.40	-23.11
936.52	H	0	1	-3.29	21.20	6.09	24.00	46.40	-22.41
966.92	V	289	1	2.50	21.64	6.23	30.37	49.50	-19.13

Table 6. Radiated Emissions Limits Test Results, 30 MHz – 1 GHz, Class A



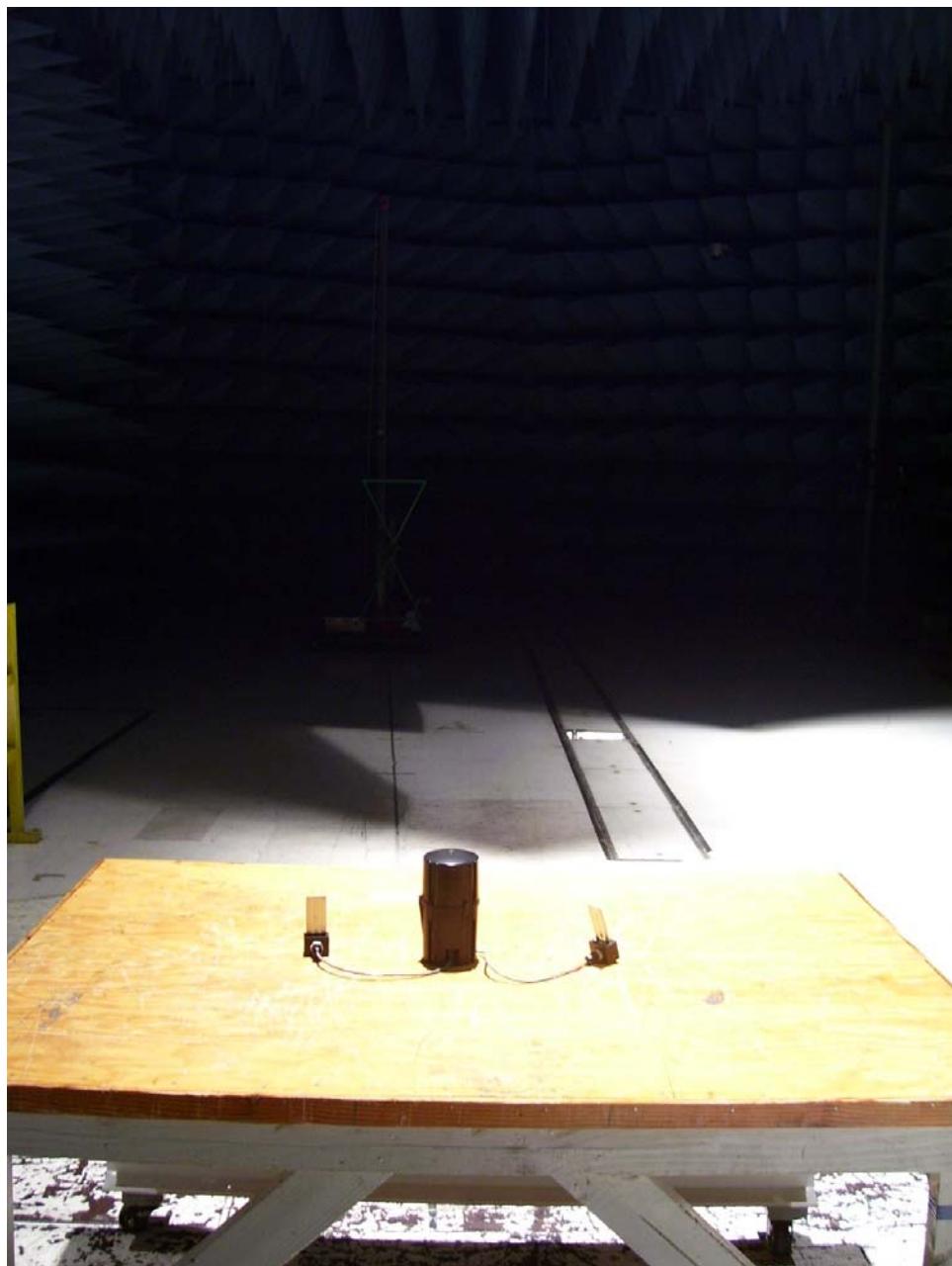
Radiated Emissions Limits Test Results, 30 MHz – 1 GHz, Class A

## Radiated Emission Limits Test Setup



Photograph 2. Radiated Emission Test Setup – Front View

## Radiated Emission Limits Test Setup



Photograph 3. Radiated Emission Test Setup – Back View



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

## IV. Electromagnetic Compatibility Criteria for Intentional Radiators



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

## 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 meets the criteria of this rule by virtue of having professionally installed. The EUT is therefore compliant with §15.203.

Model/Gain	Manufacturer
Monopole/2dBi	Crossbow

**Test Engineer(s):** Shawn McMillen



Crossbow  
SSM1000

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

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(a) Bandwidth & Channelization Requirements

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

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. For DTS, the minimum 6 dB bandwidth shall be at least 500 kHz. For frequency hopping systems, the EUT shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

**Test Procedure:** The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% of the total emission bandwidth. The 20 dB bandwidth was measured and recorded.

**Test Results:** The EUT was found compliant with the Radiated Emission limits of **§15.247(a)** for Intentional Radiators. See following pages for detailed test results.

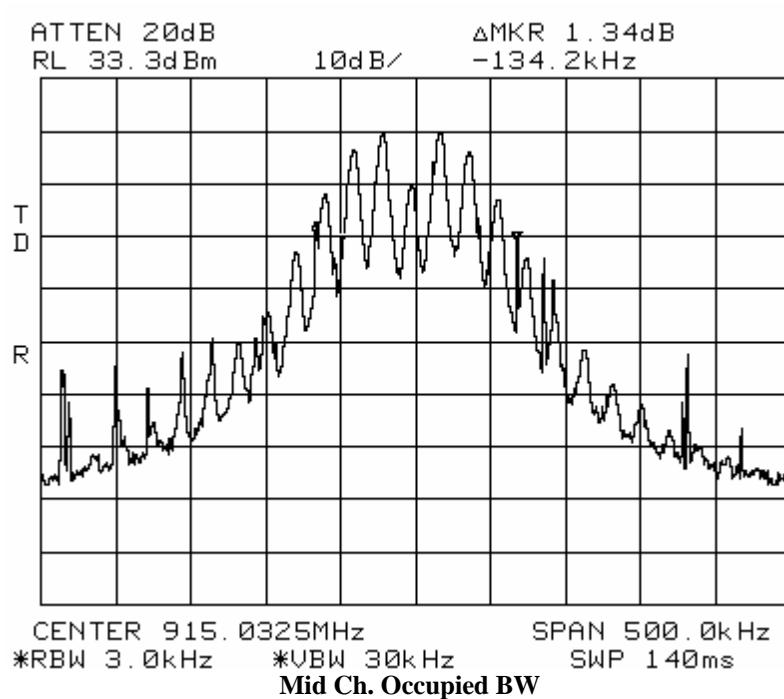
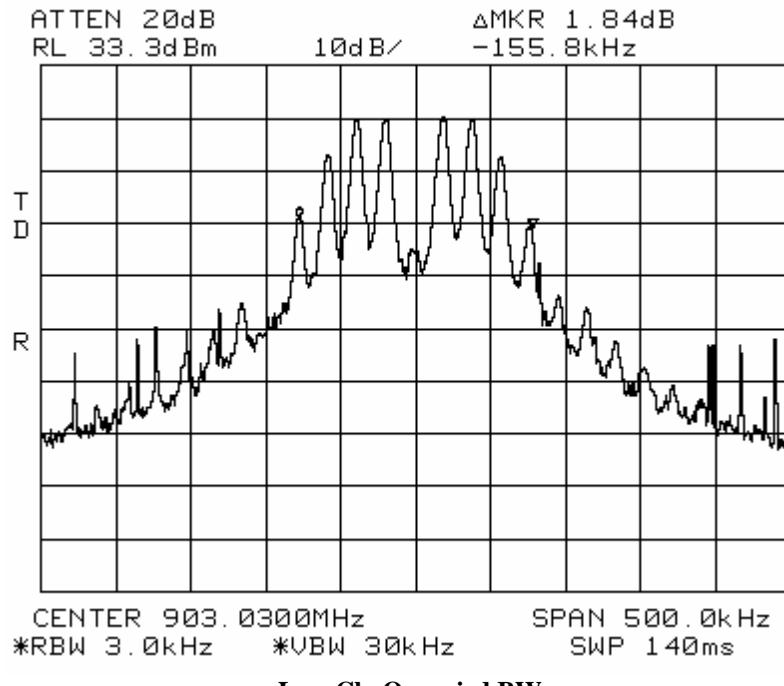
Carrier Channel	Frequency (MHz)	Measured 20 dB Bandwidth (kHz)	Measured 99% Bandwidth (kHz)
Low	903	155.8	125.8
Mid	915	134.2	120.0
High	927	125.0	121.7

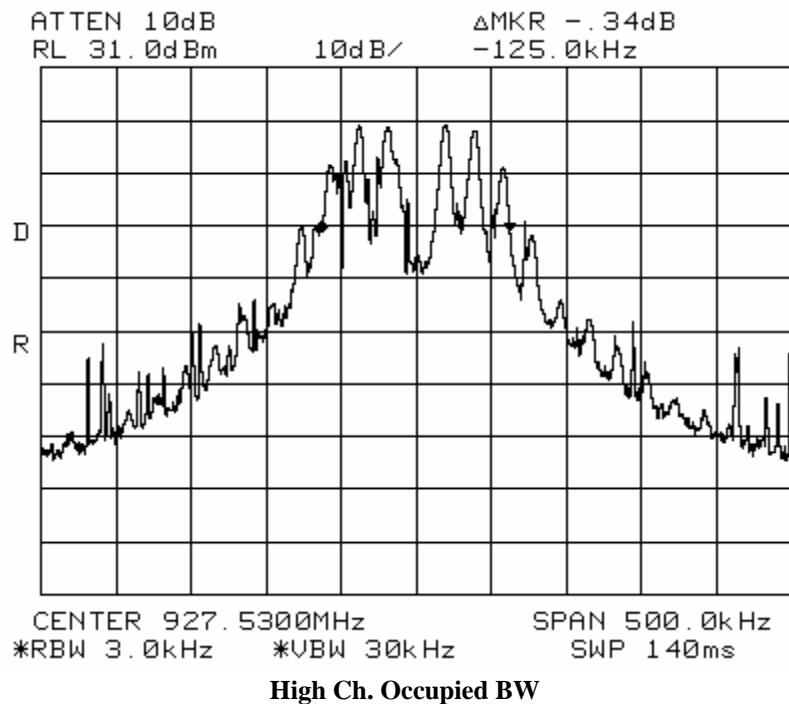
**Test Engineer:** Shawn McMillen

**Test Date(s):** April 5, 2007

## Electromagnetic Compatibility Criteria for Intentional Radiators

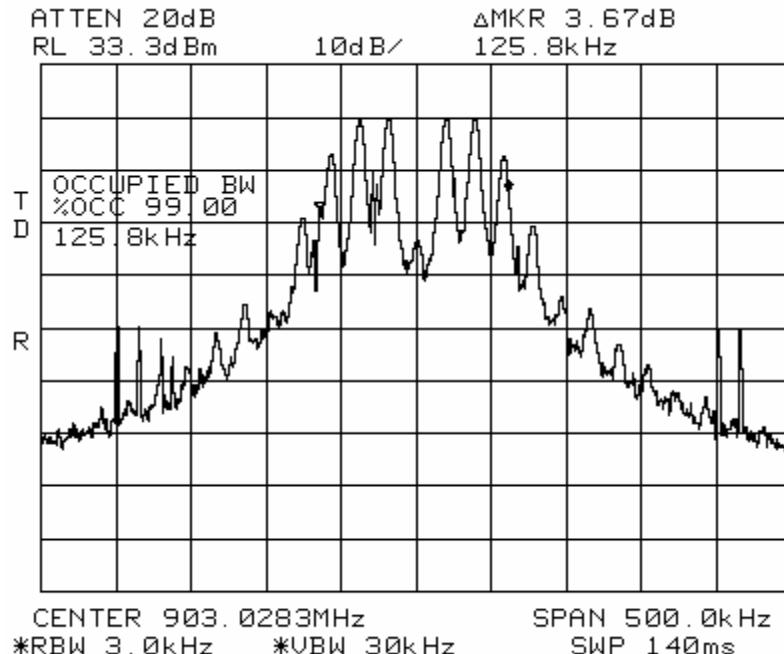
## § 15.247      20 dB Bandwidth



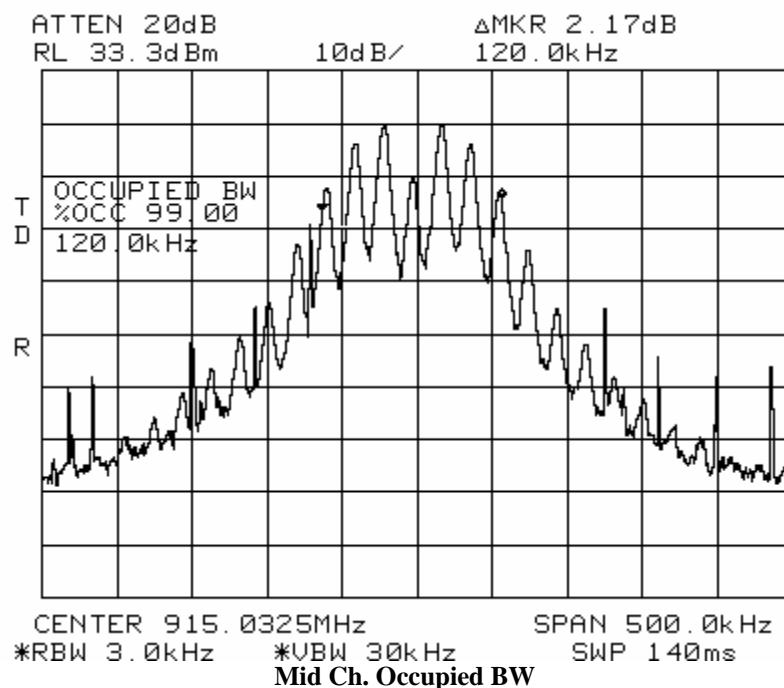


## Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247      99% Bandwidth



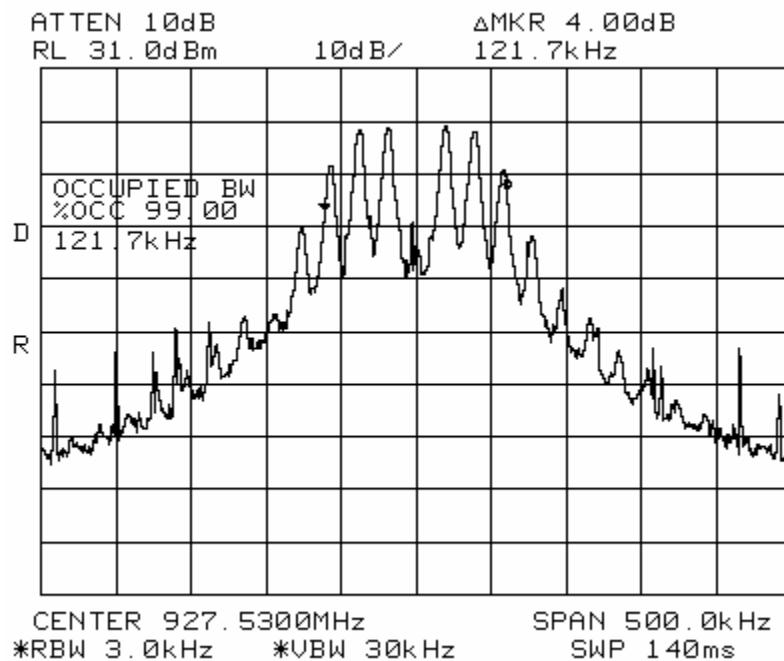
## Low Ch. Occupied BW





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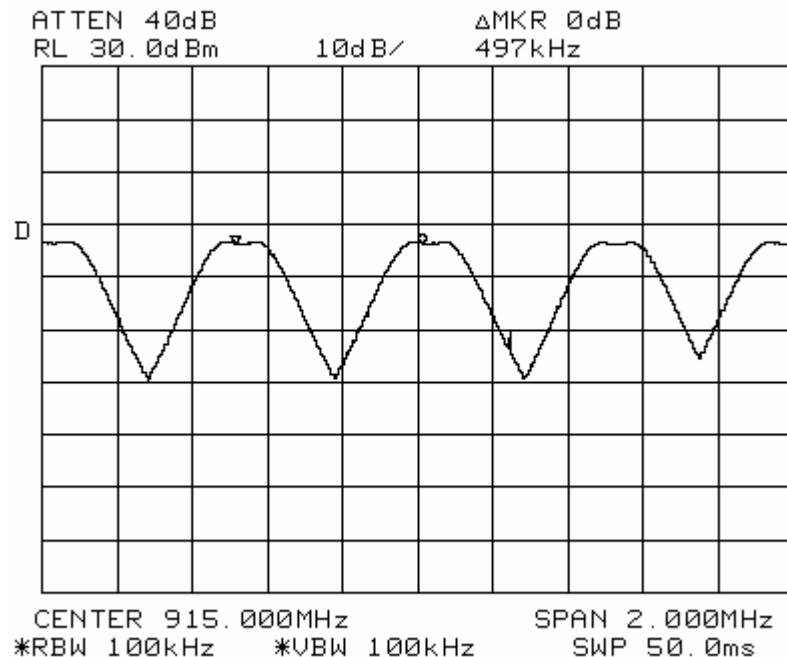
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Intentional Radiators  
CFR Title 47, Part 15, Subpart C



**High Ch. Occupied BW**

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247 Carrier Frequency Separation


**Remarks:**

Total hopping channels = 50. The EUT meets the specifications of **Section 15.247(a) (1) (iii)** for Number of Hopping Channels.

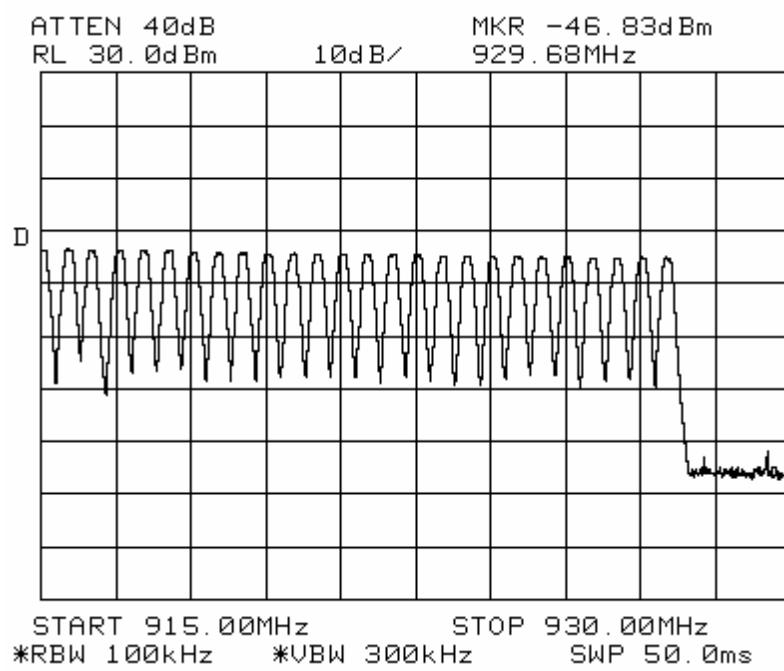
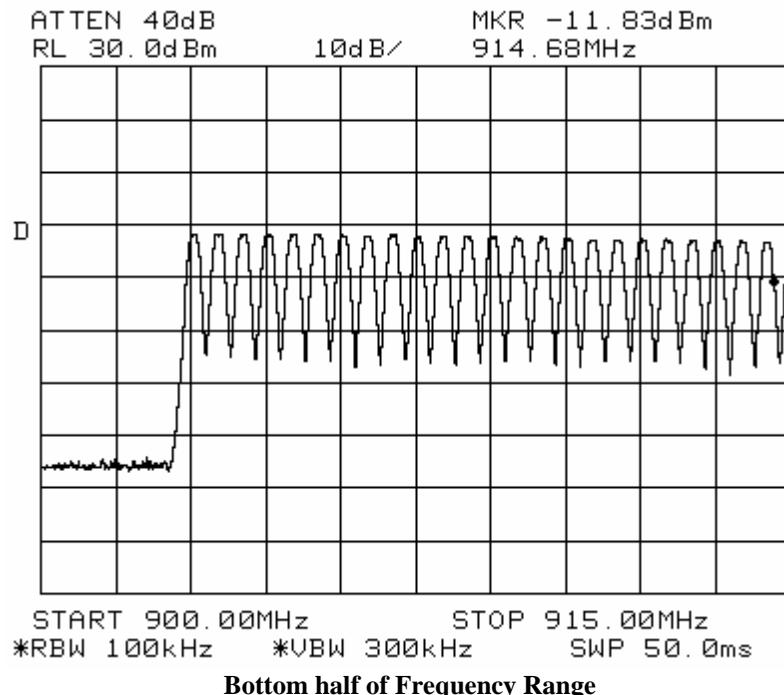


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CFR Title 47, Part 15, Subpart C**

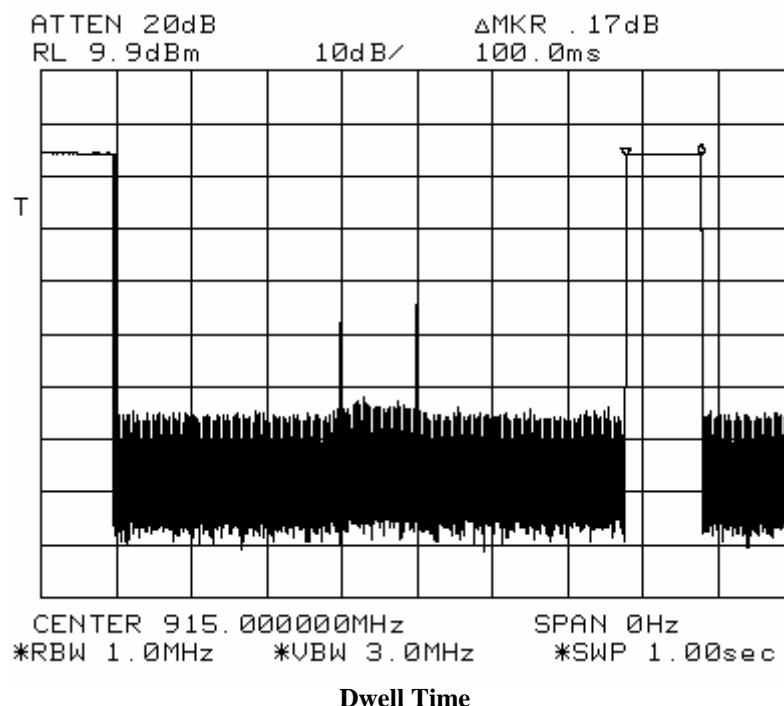
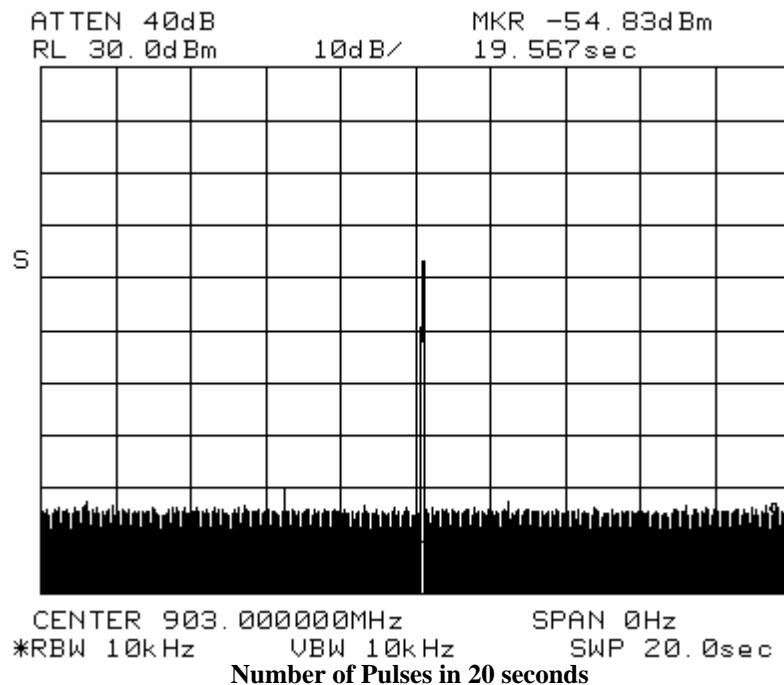
## Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247 Number of Hopping Channels



## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247 Time of Occupancy





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## Electromagnetic Compatibility Criteria for Intentional Radiators

**Remarks:** The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

1 event was captured in 20 seconds.

### Test Results:

Mode	Pulse Width (sec)	Number of Pulses in 20 Seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
FSK	0.100s	1	0.100s	0.4s	0.3s



## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(b) Peak Power Output and RF Exposure

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

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

**Table 7. 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 7, 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.

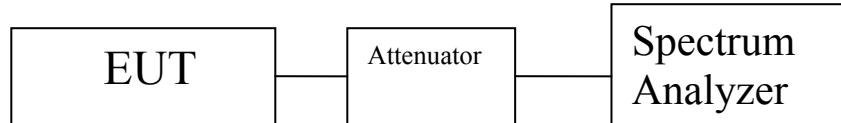
**Test Procedure:** The transmitter was connected to a calibrated Peak Power Meter. The EUT was measured at the low, mid and high channels of each band at a data rate which gave the maximum power level.

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

Carrier Channel	Frequency (MHz)	Measured Peak Output Power dBm
Low	903	28.97
Mid	915	26.80
High	927.5	26.13

**Test Engineer(s):** Shawn McMillen

**Test Date(s):** April 5, 2007



**Block Diagram 1. Peak Power Output Test Setup**



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## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(b) Peak Power Output and RF Exposure

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

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

MPE Limit Calculation: EUT's operating frequencies @ 902-928 MHz; highest conducted power = 28.97dBm (peak) therefore, **Limit for Uncontrolled exposure: .6 mW/cm<sup>2</sup> or 6 W/m<sup>2</sup>**

EUT maximum antenna gain = 2 dBi.

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

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

where,  $S$  = Power Density (1 mW/cm<sup>2</sup>)  
 $P$  = Power Input to antenna (788.86mW)  
 $G$  = Antenna Gain (1.58 numeric)

$$S = 0.789W * 1.58 / 4 * 3.14 * (0.2)^2 = 2.48W/m^2$$



## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(d) Harmonic Emissions – Radiated and Conducted

**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 8. 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



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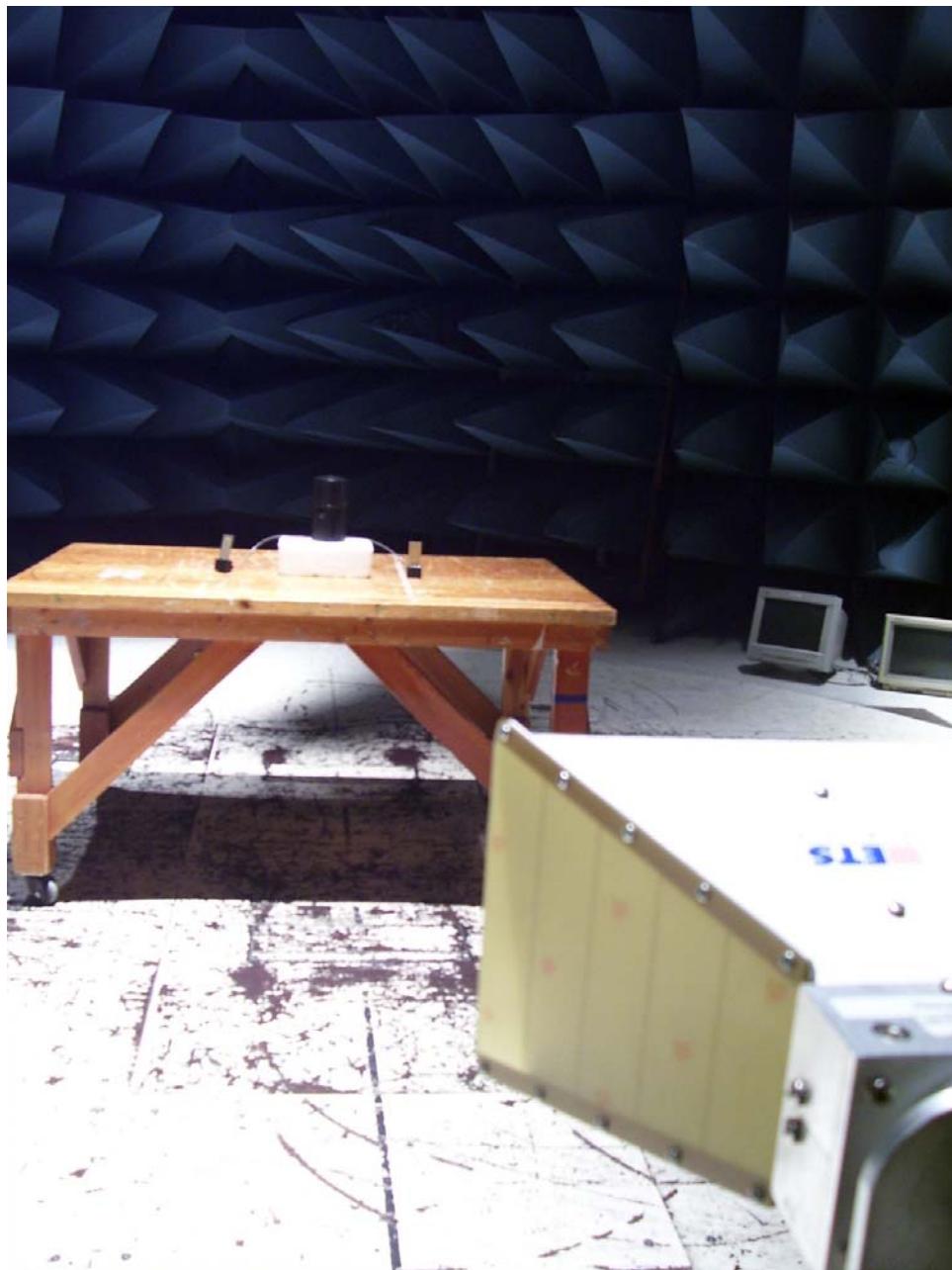
## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(d) Harmonic Emissions Requirements – Radiated (FHSS)

Frequency (MHz)	Receive Antenna Polarity	Uncorrected Field Strength (dB $\mu$ V)@ 3m	Preamp (dB)	Antenna Factor (dB)	Cable (dB)	Corrected Field Strength (dB $\mu$ V) @ 3m	Limit (dB $\mu$ V) @ 3m	Margin (dB)	Measurement Type
1806	V	74.36	34.87	28.4	3.2	71.09	74	-2.9	Peak
2709	V	58.97	34.98	29.9	3.7	57.59	74	-16.4	Peak
2709	V	46.93	34.98	29.9	3.7	45.55	54	-8.5	Avg
3612	V	52.97	34.82	32.6	4.3	55.05	74	-19.0	Peak
3612	V	40.93	34.82	32.6	4.3	43.01	54	-11.0	Avg
4515	V	58.63	34.76	33.9	5.0	62.77	74	-11.2	Peak
4515	V	46.59	34.76	33.9	5.0	50.73	54	-3.3	Avg
5418	V	49.8	34.9	35.3	5.6	55.80	74	-18.2	Peak
5418	V	37.76	34.9	35.3	5.6	43.76	54	-10.2	Avg
<b>Low Channel 903</b>									
Frequency (MHz)	Receive Antenna Polarity	Uncorrected Field Strength (dB $\mu$ V)@ 3m	Preamp (dB)	Antenna Factor (dB)	Cable (dB)	Corrected Field Strength (dB $\mu$ V) @ 3m	Limit (dB $\mu$ V) @ 3m	Margin (dB)	Measurement Type
1830	V	73.50	34.87	28.4	3.2	70.23	74	-3.8	Peak
2745	V	57.33	34.98	29.9	3.7	55.95	74	-18.1	Peak
2745	V	45.29	34.98	29.9	3.7	43.91	54	-10.1	Avg
3660	V	47.33	34.82	32.6	4.3	49.41	74	-24.6	Peak
3660	V	35.29	34.82	32.6	4.3	37.37	54	-16.6	Avg
4575	V	49.00	34.76	33.9	5.0	53.14	74	-20.9	Peak
4575	V	36.96	34.76	33.9	5.0	41.10	54	-12.9	Avg
5490	V	48.17	34.9	35.3	5.6	54.17	74	-19.8	Peak
5490	V	36.13	34.9	35.3	5.6	42.13	54	-11.9	Avg
6405	V	47	35.1	35.1	6.0	53.00	74	-21.0	Peak
<b>Mid Channel 915</b>									
Frequency (MHz)	Receive Antenna Polarity	Uncorrected Field Strength (dB $\mu$ V)@ 3m	Preamp (dB)	Antenna Factor (dB)	Cable (dB)	Corrected Field Strength (dB $\mu$ V) @ 3m	Limit (dB $\mu$ V) @ 3m	Margin (dB)	Measurement Type
1855	V	74.53	34.87	28.4	3.2	71.26	74	-2.7	Peak
2782.5	V	60.67	34.98	29.9	3.7	59.29	74	-14.7	Peak
2782.5	V	48.63	34.98	29.9	3.7	47.25	54	-6.7	Avg
3710	V	49.00	34.82	32.6	4.3	51.08	74	-22.9	Peak
3710	V	36.96	34.82	32.6	4.3	39.04	54	-15.0	Avg
4637.5	V	47.33	34.76	33.9	5.0	51.47	74	-22.5	Peak
4637.5	V	35.29	34.76	33.9	5.0	39.43	54	-14.6	Avg
5565	V	47.17	34.9	35.3	5.6	53.17	74	-20.8	Peak
5565	V	35.13	34.9	35.3	5.6	41.13	54	-12.9	Avg
<b>High Channel 927.5</b>									

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

### Electromagnetic Compatibility Criteria for Intentional Radiators Test Setup Photograph



Photograph 4. Test Equipment and setup for various Radiated Measurements

**Electromagnetic Compatibility Criteria for Intentional Radiators****§ 15.247(d) Spurious Emissions Requirements –RF Conducted**

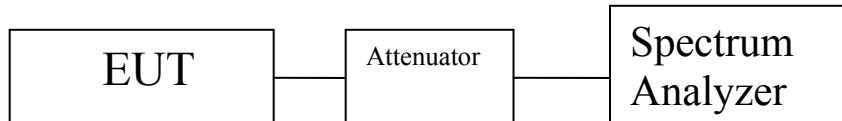
**Test Procedure:** For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10<sup>th</sup> harmonic of the highest fundamental frequency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

For frequencies 1-18GHz, measurements were made at coupler port of a 20dB directional coupler. The output of the coupler was terminated by a 50Ω load. For frequencies 18-40GHz a HP11970A and HP11970K harmonic mixer was used. Each harmonic mixer was fed with a SMA to wave guide adapter.

**Test Results:** Equipment complies with the Spurious Emissions Requirements – Radiated and RF Conducted limits of **§ 15.247 (d)**. For Radiated Emissions result, refer to section “§15.209: Radiated Emission Limits”. See following pages for detailed test results with RF Conducted Spurious Emissions and §15.205.

**Test Engineer(s):** Shawn McMillen

**Test Date(s):** April 5, 2007

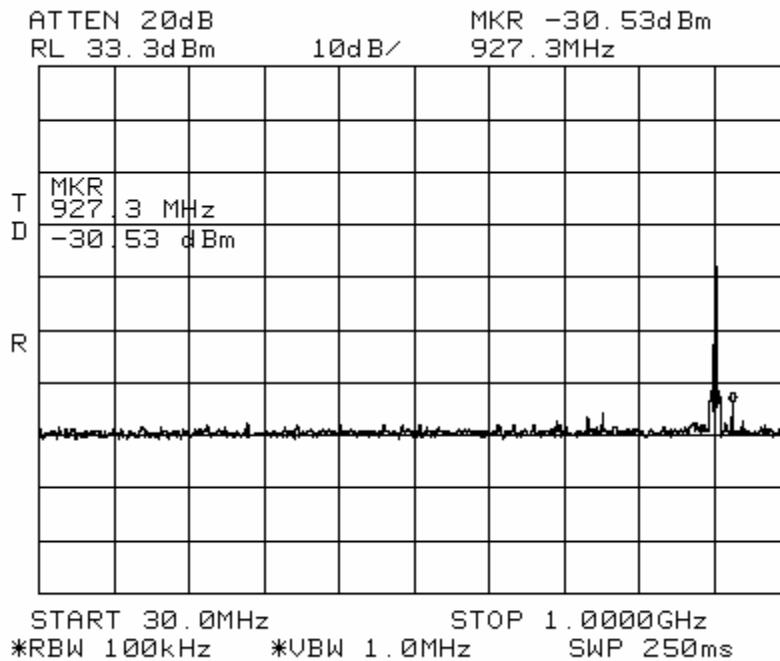


**Block Diagram 2. Spurious Conducted Emissions Test Setup**

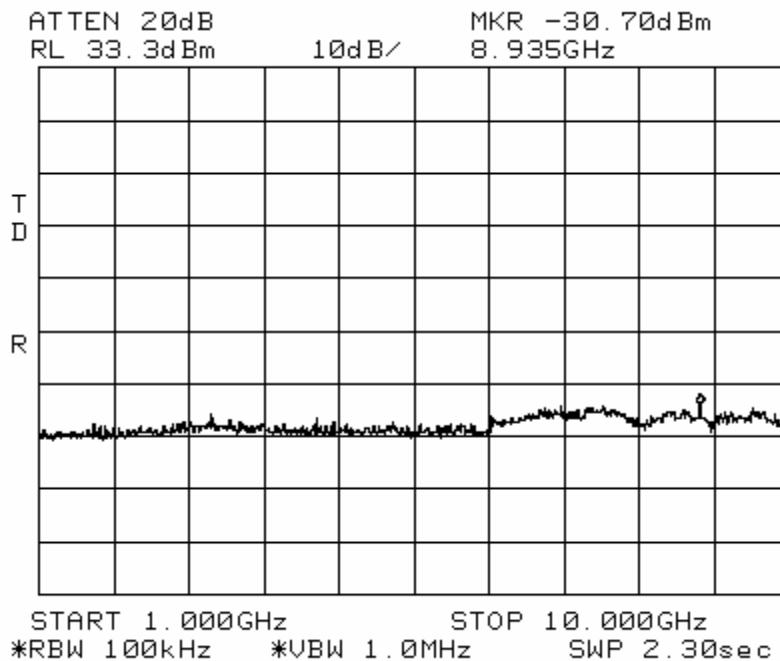


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#### Low Channel Conducted Emissions 30MHz - 1GHz

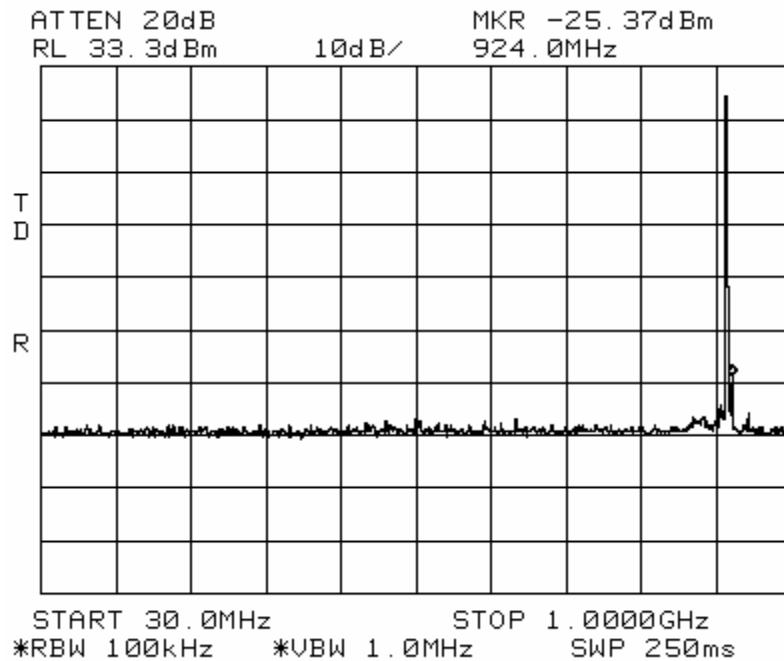


#### Low Channel Conducted Emissions 1-10GHz

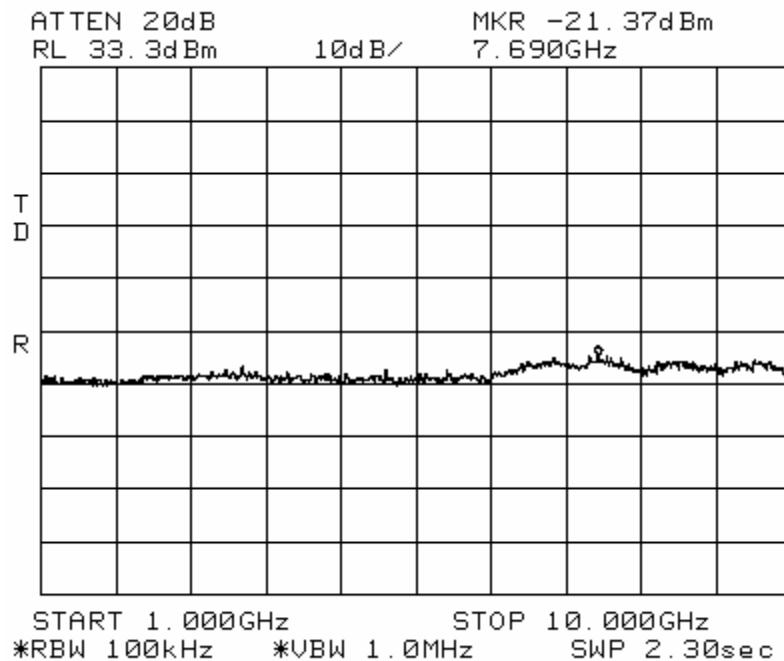


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#### Mid Channel Conducted Emissions 30MHz – 1GHz

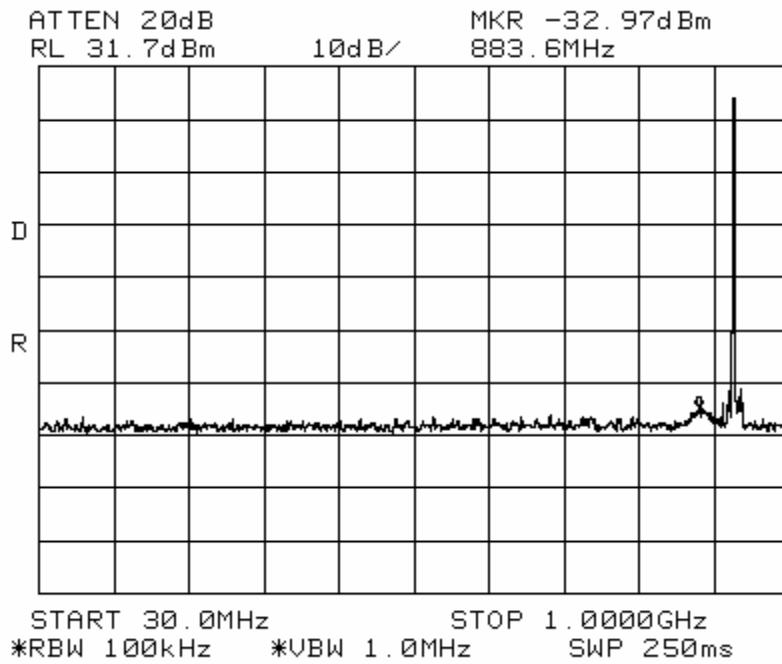


#### Mid Channel Conducted Emissions 1 - 10GHz

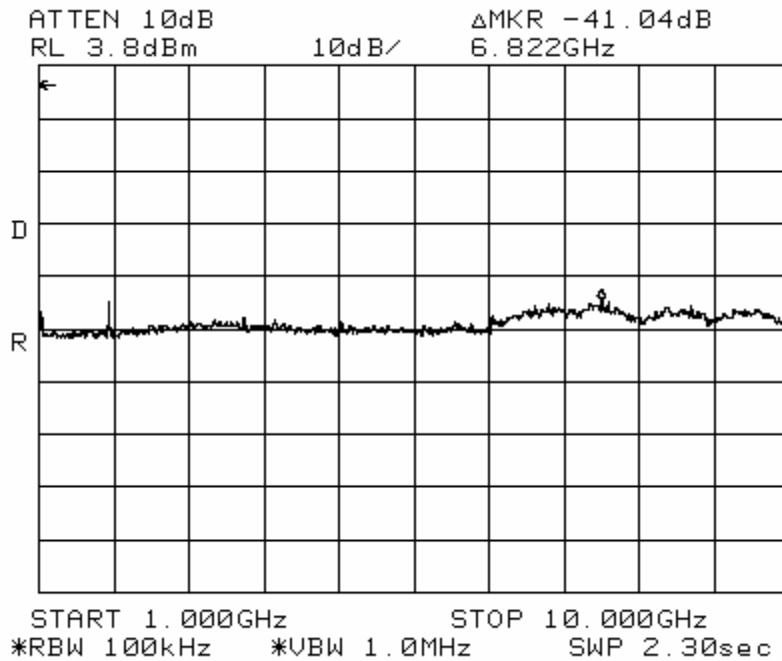


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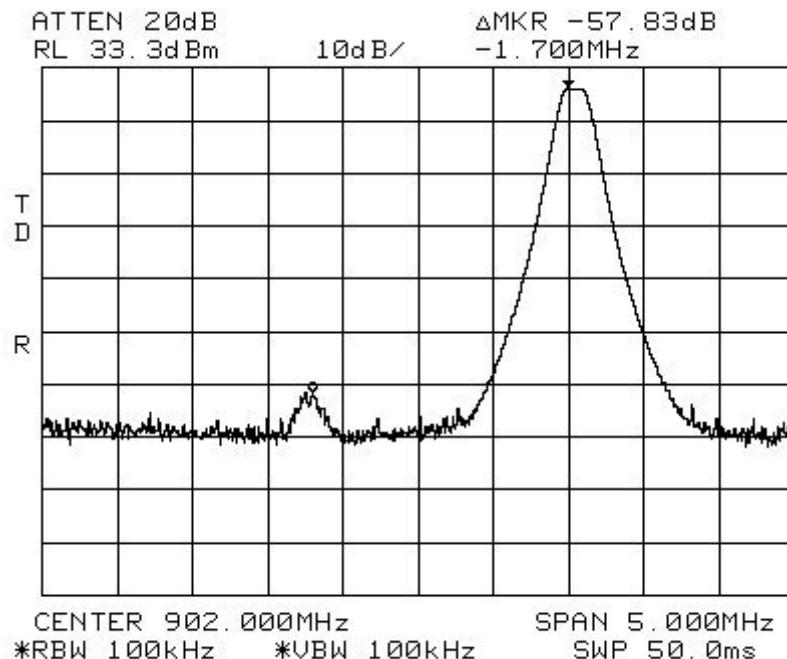
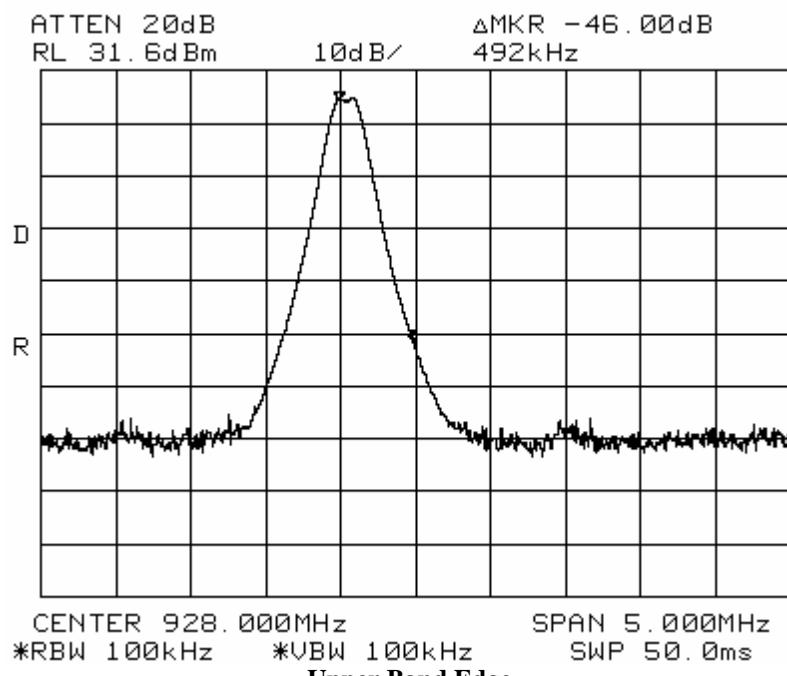
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#### High Channel Conducted Emissions 30MHz- 1GHz



#### High Channel Conducted Emissions 1-10GHz

**Electromagnetic Compatibility Criteria for Intentional Radiators**
**§ 15.247(d) Spurious Emissions Requirements –Band Edge (Conducted)**

**Lower Band Edge**

**Upper Band Edge**



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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/NCSL Z540-1-1994 and ANSI/ISO/IEC 17025:2000.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1S2421	EMI RECEIVER	ROHDE&SCHWARZ	ESIB 7	3/23/2007	3/23/2008
1S2184	BILOG ANTENNA	CHASE	CBL6112A	1/3/2007	1/3/2008
1S2121	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	11/28/2006	11/28/2007
1S2198	ANTENNA, HORN	EMCO	3115	8/17/2006	8/17/2007
1S2202	ANTENNA, HORN, 1 METER	EMCO	3116	3/23/2004	3/23/2007
N/A	HIGH PASS FILTER	MICRO-TRONICS	HPM13146	SEE NOTE	
1S2263	CHAMBER, 10 METER	RANTEC	N2-14	8/15/2006	8/15/2007
1S2034	COUPLER, DIRECTIONAL 1-20 GHz	KRYTAR	101020020	SEE NOTE	
1S2041	COUPLER, BI DIRECTIONALCOAXIAL	NARDA	N/A	SEE NOTE	
1U0173	Analyzer, Spectrum 9 kHz-40GHz	Hewlett Packard	8564E	11/15/06	11/15/07
1S2034	COUPLER, DIRECTIONAL 1-20 GHz	KRYTAR	101020020	SEE NOTE	
1S2041	COUPLER, BI DIRECTIONALCOAXIAL	NARDA	N/A	SEE NOTE	
1S2128	Harmonic Mixer	Hewlett Packard	11970A	10/26/2006	10/26/2009
1S2129	Harmonic Mixer	Hewlett Packard	11970K	10/26/2006	10/26/2009

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



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## V. Certification & User's Manual Information



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## 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.



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(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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## 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.

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<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.



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## 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.



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## Certification & User's Manual Information

### Label and User's Manual Information

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

#### § 15.19 Labeling requirements.

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

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

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

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

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

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

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

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

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

#### § 15.21 Information to user.

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



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## 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 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.



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## End of Report

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