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November 4, 2015

General Dynamics
77 A Street Needham, MA 02494

Dear Ramin Taraz,

Enclosed is the EMC Wireless test report for compliance testing of the General Dynamics, ES520 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Title 47 of the CFR, Part 15.247.

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: (\General Dynamics\ EMC86277B-FCC247)

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Electromagnetic Compatibility Criteria Test Report

for the

**General Dynamics
Model ES520 (with Senao Modular Approved Radio)**

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart B
for Class A Digital Devices
&
15.247 Subpart C
for Intentional Radiators

MET Report: EMC86277B-FCC247

November 4, 2015

Prepared For:

**General Dynamics
77 A Street
Needham, MA 02494**

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



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&
15.247 Subpart C
for Intentional Radiators

Jeffrey Pratt, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

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

Asad Bajwa,
Director, Electromagnetic Compatibility Lab



Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	November 4, 2015	Initial Issue.



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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
DSL	Digital Subscriber Line
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
NEBS	Network Equipment-Building System
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts per meter
VCP	Vertical Coupling Plane



I. Executive Summary



A. Purpose of Test

An EMC evaluation was performed to determine compliance of the General Dynamics ES520 (with Senao Modular Approved Radio), 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 General Dynamics ES520 (with Senao Modular Approved Radio). General Dynamics should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the General Dynamics ES520 (with Senao Modular Approved Radio), 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 General Dynamics, purchase order number 01ESM798728. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference 47 CFR Part 15.247	Description	Compliance
47 CFR Part 15.107 (a)	Conducted Emission Limits for a Class A Digital Device	Compliant
47 CFR Part 15.109 (a)	Radiated Emission Limits for a Class A Digital Device	Compliant
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.
Title 47 of the CFR, Part 15 §15.247(a)(2)	6dB Occupied Bandwidth	Refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.
	99% Occupied Bandwidth	Refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.
Title 47 of the CFR, Part 15 §15.247(b)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	RF Conducted Spurious Emissions Requirements	Refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.
Title 47 of the CFR, Part 15 §15.247(d)	RF Conducted Band Edge	Refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.
Title 47 of the CFR, Part 15; §15.247(e)	Peak Power Spectral Density	Refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.
Title 47 of the CFR, Part 15 §15.247(i)	Maximum Permissible Exposure (MPE)	Refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.
N/A	Receiver Spurious Emissions	Refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.

Table 1. Executive Summary of EMC Part 15.247 Compliance Testing



II. Equipment Configuration

**A. Overview**

MET Laboratories, Inc. was contracted by 01ESM798728 to perform testing on the General Dynamics ES520 (with Senao Modular Approved Radio), under 01ESM798728' purchase order number 01ESM798728.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the General Dynamics ES520 (with Senao Modular Approved Radio).

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

Model(s) Tested:	General Dynamics ES520 (with Senao Modular Approved Radio)		
Model(s) Covered:	General Dynamics ES520 (with Senao Modular Approved Radio)		
EUT Specifications:	Primary Power: 120 VAC, 60 Hz		
	FCC ID: MIJ-ES520P		
	Type of Modulations:	OFDM	
	Equipment Code:	D7D	
	Peak RF Output Power:	24.66 dBm	
	EUT Frequency Ranges:	2412 – 2462 MHz	
Analysis:	The results obtained relate only to the item(s) tested.		
Environmental Test Conditions:	Temperature: 15-35° C		
	Relative Humidity: 30-60%		
	Barometric Pressure: 860-1060 mbar		
Evaluated by:	Jeff Pratt		
Report Date(s):	November 4, 2015		

Table 2. EUT Summary Table



B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
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
ANSI C63.10-2009	American National Standard for Testing Unlicensed Wireless Devices

Table 3. References

C. Test Site

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

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

D. Description of Test Sample

The General Dynamics Model ES520 (with Senao Modular Approved Radio), Equipment Under Test (EUT), is a dual radio access point/bridge. It embeds two COTS high power radios and multiple Ethernet ports in a ruggedized enclosure. The radio operates in accordance to the 802.11a and 802.11g standards.

The ES520 is intended to provide outdoor mobile connectivity in a secure manner both wired and wirelessly.



Photograph 1. General Dynamics Model ES520 (with Senao Modular Approved Radio)

E. Equipment Configuration

All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Serial Number
1	General Dynamics	ES520	108530006

Table 4. Equipment Configuration

F. Support Equipment

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



G. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty.	Length (m)	Shielded? (Y/N)	Termination Box ID & Port ID
1	ANT 1, ANT 2	Antenna	2	--	--	--
2	12/24V 48V	Provides power	1	--	--	External AC Charger
3	1,2,3,4,5,6,7, or 8	Ethernet Port; Standard CAT5 Ethernet Cable	8	--	--	--
4	WAN	Ethernet Port; Standard CAT5 Ethernet Cable	1	--	--	--
5	Serial	Not Used	1	--	--	--
6	Console	Serial Console Port; Standard CAT5 Ethernet cable	1	--	--	--
6	USB	Not used	1	--	--	--

Table 5. Ports and Cabling Information

H. Mode of Operation

The ES520 can operate in 802.11a and 802.11g modes. These modes may be configured using the UI of the product (either through the GUI or CLI).

I. Method of Monitoring EUT Operation

When performing conducted tests, the radios were set to transmit and were monitored through a directional coupler that was connected to a wireless access card and a spectrum analyzer. During radiated tests, the radios were paired with a wireless access card and its transmissions were observed. In either case, the EUT was observed for any cessation of transmission.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

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



III. Electromagnetic Compatibility Criteria for Unintentional Radiators

Electromagnetic Compatibility Criteria

§ 15.107 Conducted Emissions Limits

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

15.107 (b) For a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in Table 6. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals. The lower limit applies at the band edges.

15.207(a), Except as shown in paragraphs (b) and (c) of this section*, charging, AC adapters or battery eliminators the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the Table 6, as measured using a 50 μ H/50 ohms 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 frequencies ranges.

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

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

Test Results: The EUT was compliant with the Class A requirement(s) of this section.

Test Engineer(s): Jeff Pratt

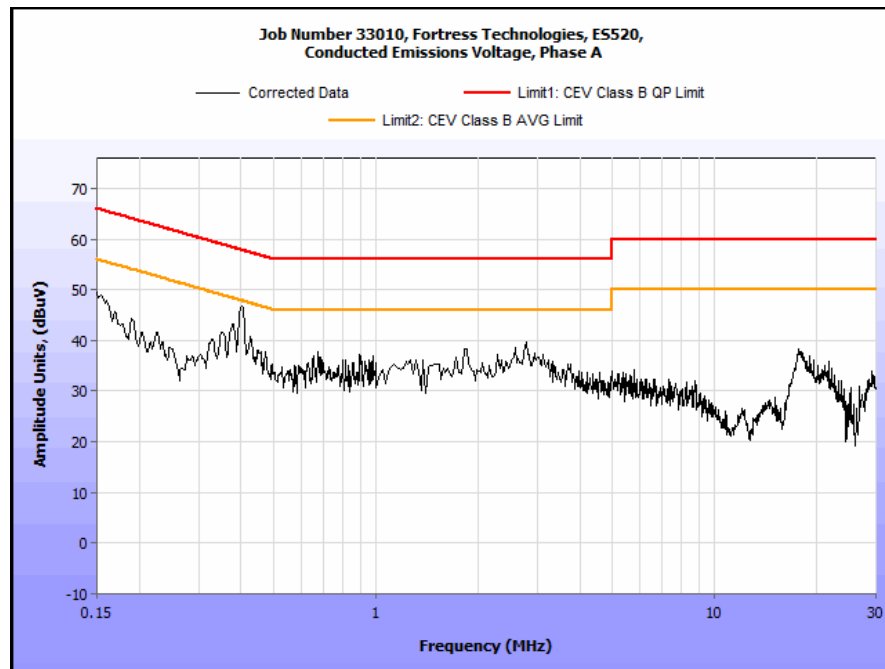
Test Date(s): 01/12/12 – 02/2/12



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

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.241	38.75	0.02	38.77	79	-40.23	32.44	0.02	32.46	66	-33.54
0.401	37.07	0	37.07	79	-41.93	34.41	0	34.41	66	-31.59
0.48	36.01	0	36.01	79	-42.99	34.38	0	34.38	66	-31.62
8.068	32.26	0.11	32.37	73	-40.63	29.1	0.11	29.21	60	-30.79
15.15	49.54	0.12	49.66	73	-23.34	48.15	0.12	48.27	60	-11.73
23.05	17.71	0.18	17.89	73	-55.11	12.35	0.18	12.53	60	-47.47

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



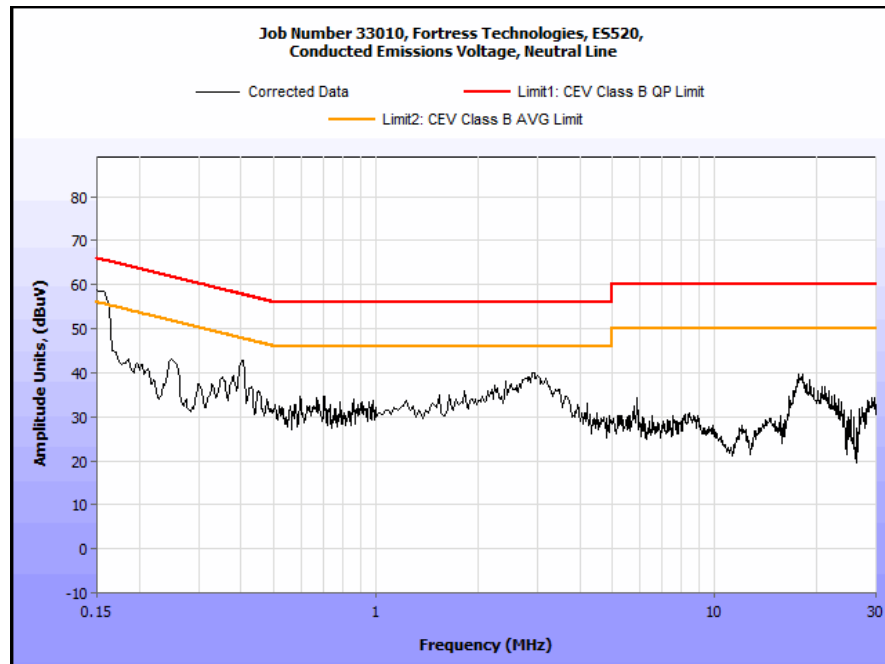
Plot 1. Conducted Emission, Phase Line Plot



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

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.322	30.82	0.02	30.84	79	-48.16	25.91	0.02	25.93	66	-40.07
0.483	33.5	0	33.5	79	-45.5	30.99	0	30.99	66	-35.01
1.45	33.87	0	33.87	73	-39.13	33.52	0	33.52	60	-26.48
8.191	48.33	0.11	48.44	73	-24.56	47.07	0.11	47.18	60	-12.82
15.15	49.16	0.12	49.28	73	-23.72	47.34	0.12	47.46	60	-12.54
22.74	36.68	0.18	36.86	73	-36.14	34.76	0.18	34.94	60	-25.06

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



Plot 2. Conducted Emission, Neutral Line Plot

Conducted Emission Limits Test Setup



Photograph 2. Conducted Emissions, Test Setup



Radiated Emission Limits

§ 15.109 Radiated Emissions Limits

Test Requirement(s): **15.109 (a)** Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the Class B limits expressed in Table 9.

15.109 (b) The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the Class A limits expressed in Table 9.

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

Table 9. Radiated Emissions Limits calculated from FCC Part 15, §15.109 (a) (b)

Test Procedures: The EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4 were used. An antenna was located 3 m from the EUT on an adjustable mast. A pre-scan was first performed in order to find prominent radiated emissions. For final emissions measurements at each frequency of interest, the EUT was rotated and the antenna height was varied between 1 m and 4 m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. Unless otherwise specified, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

Test Results: The EUT was compliant with the Class A requirement(s) of this section.

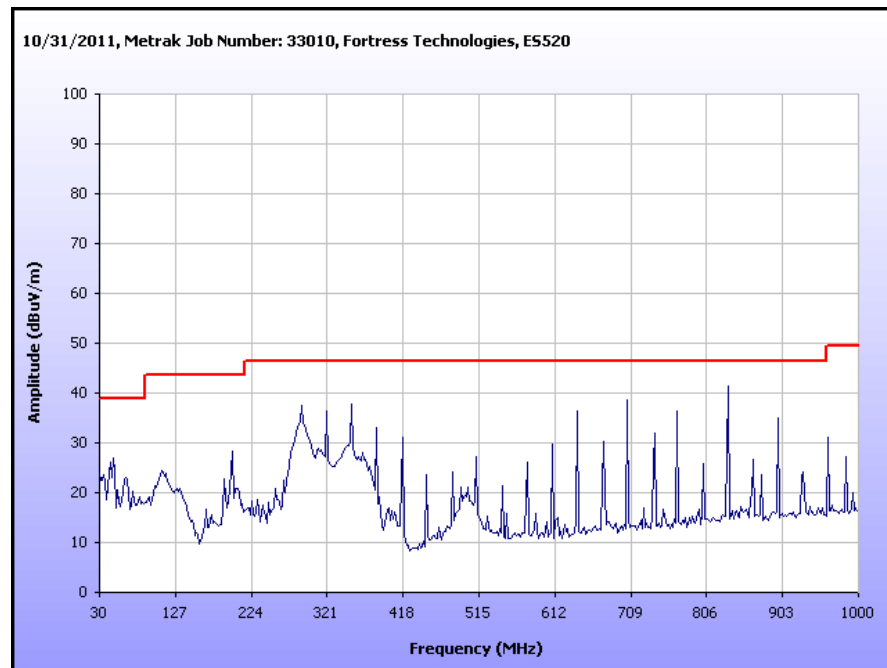
Test Engineer(s): Jeff Pratt

Test Date(s): 10/31/11

Radiated Emissions Limits Test Results, Class A

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
48.569639	296	H	3.57	13.65	9.03	0.23	10.46	12.45	39.00	-26.55
48.569639	21	V	1.01	25.73	9.03	0.23	10.46	24.53	39.00	-14.47
64.749499	300	H	1.90	12.18	7.80	0.23	10.46	9.75	39.00	-29.25
64.749499	10	V	1.07	23.65	7.80	0.23	10.46	21.22	39.00	-17.78
200.03507	312	H	1.01	21.52	12.99	0.23	10.46	24.28	43.50	-19.22
200.03507	283	V	1.01	21.21	12.99	0.23	10.46	23.97	43.50	-19.53
288.0511	270	H	1.05	32.06	13.86	0.75	10.46	36.21	46.40	-10.19
288.0511	171	V	1.01	20.23	13.86	0.75	10.46	24.38	46.40	-22.02
384.0506	66	H	1.01	25.80	15.70	0.83	10.46	31.87	46.40	-14.53
384.0506	208	V	1.01	24.19	15.70	0.83	10.46	30.26	46.40	-16.14
320.0263	63	H	1.00	32.02	14.50	0.83	10.46	36.89	46.40	-9.51
320.0263	282	V	1.35	21.06	14.50	0.83	10.46	25.93	46.40	-20.47

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



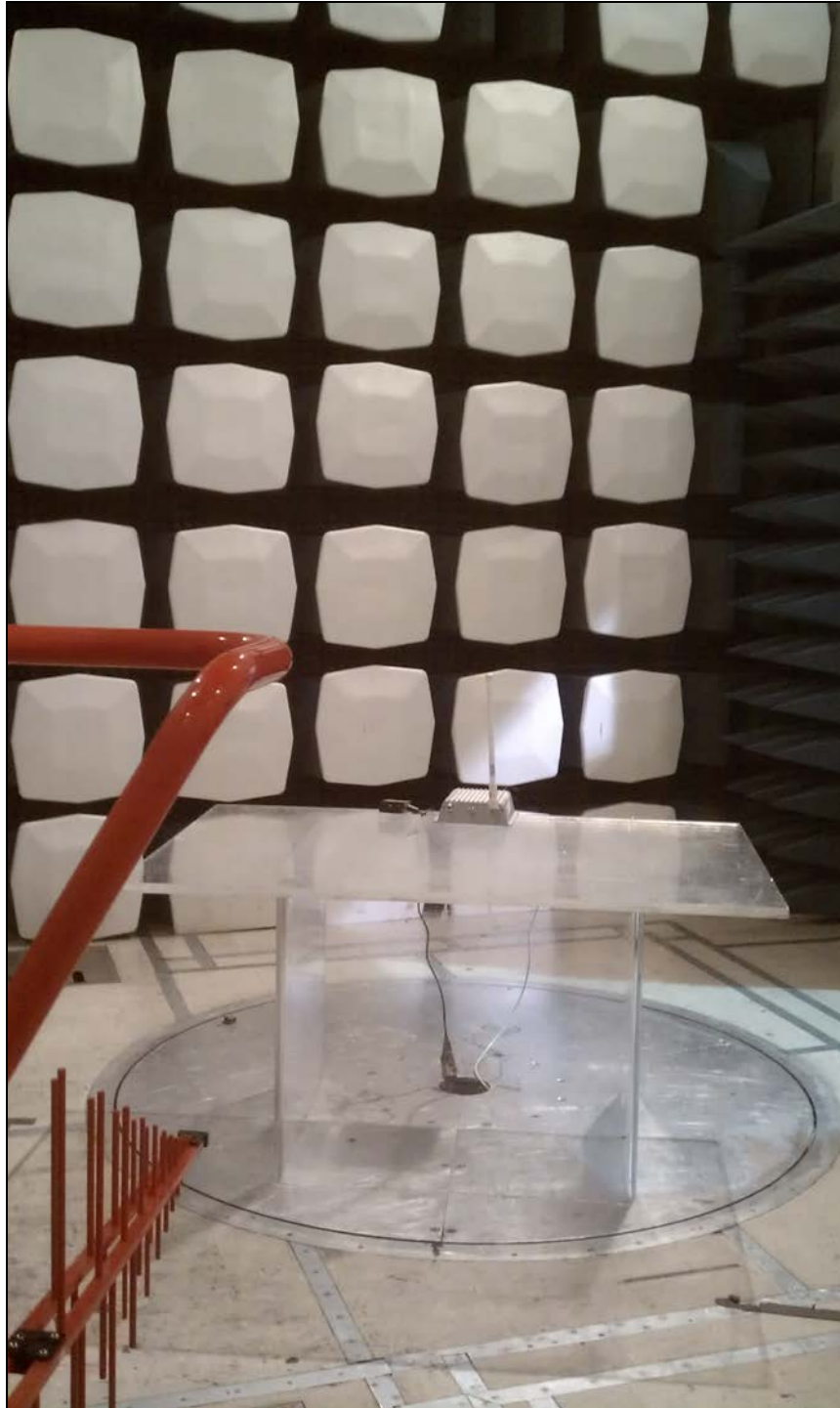
Plot 3. Radiated Emissions, 30 MHz - 1 GHz, FCC Limits

**Radiated Emissions Limits Test Results, Class A**

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
48.569639	296	H	3.57	13.65	9.03	0.23	10.46	12.45	40.00	-27.55
48.569639	21	V	1.01	25.73	9.03	0.23	10.46	24.53	40.00	-15.47
64.749499	300	H	1.90	12.18	7.80	0.23	10.46	9.75	40.00	-30.25
64.749499	10	V	1.07	23.65	7.80	0.23	10.46	21.22	40.00	-18.78
200.03507	312	H	1.01	21.52	12.99	0.23	10.46	24.28	40.00	-15.72
200.03507	283	V	1.01	21.21	12.99	0.23	10.46	23.97	40.00	-16.03
288.0511	270	H	1.05	32.06	13.86	0.75	10.46	36.21	47.00	-10.79
288.0511	171	V	1.01	20.23	13.86	0.75	10.46	24.38	47.00	-22.62
384.0506	66	H	1.01	25.80	15.70	0.83	10.46	31.87	47.00	-15.13
384.0506	208	V	1.01	24.19	15.70	0.83	10.46	30.26	47.00	-16.74
320.0263	63	H	1.00	32.02	14.50	0.83	10.46	36.89	47.00	-10.11
320.0263	282	V	1.35	21.06	14.50	0.83	10.46	25.93	47.00	-21.07

Table 11. Radiated Emissions Limits, Test Results, ICES-003 Limits

Radiated Emission Limits Test Setup



Photograph 3. Radiated Emission, Test Setup



IV. Electromagnetic Compatibility Criteria for Intentional Radiators



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

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

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

- a.) Antenna must be permanently attached to the unit.
- b.) Antenna must use a unique type of connector to attach to the EUT.
- c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The EUT as tested is compliant the criteria of §15.203. The EUT is professionally installed.

Test Engineer(s): Jeff Pratt

Test Date(s): 02/12/12

Gain	Type	Model	Manufacturer
9	Omni	OD9-2400	Mobile Mark

Table 12. Antenna List

**Electromagnetic Compatibility Criteria for Intentional Radiators****§ 15.207(a) Conducted Emissions Limits**

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

Frequency range (MHz)	§ 15.207(a), Conducted Limit (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 13. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Results: Please refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(2) 6 dB and 99% Bandwidth

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

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

Test Results: Please refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.

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 14. Output Power Requirements from §15.247(b)

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

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

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

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

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

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

Test Engineer(s): Jeff Pratt

Test Date(s): 10/25/11 – 12/1/11



Figure 1. Peak Power Output Test Setup

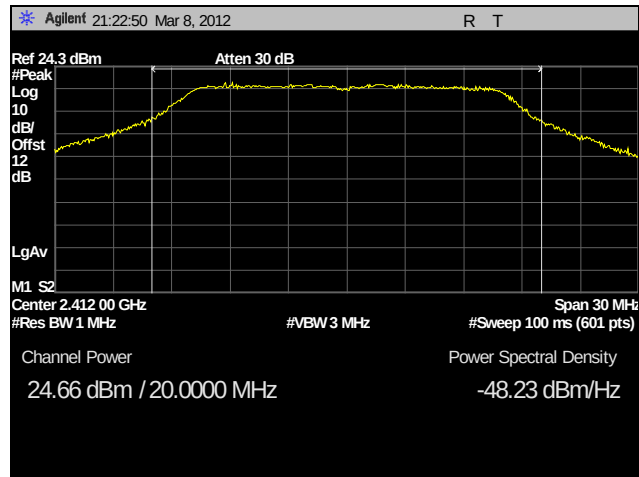


Peak Power Output Test Results

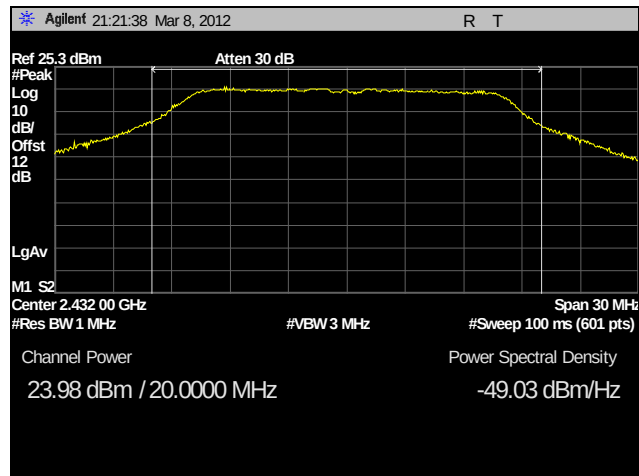
Peak Conducted Output Power		
Carrier Channel	Frequency (MHz)	Measured Peak Output Power dBm
Low	2412	24.66
Mid	2432	23.98
High	2462	24.37

Table 15. Peak Power Output, Test Results

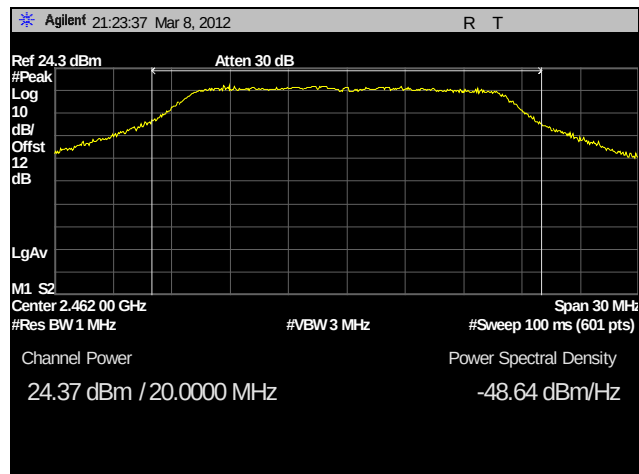
Peak Power Output Test Results



Plot 4. Peak Power Output, Low Channel



Plot 5. Peak Power Output, Mid Channel



Plot 6. Peak Power Output, High Channel



Electromagnetic Compatibility Criteria for Intentional Radiators

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

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

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

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

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

Table 16. Restricted Bands of Operation

¹ Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.

² Above 38.6



Test Requirement(s): § 15.209 (a): Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 17.

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

Table 17. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

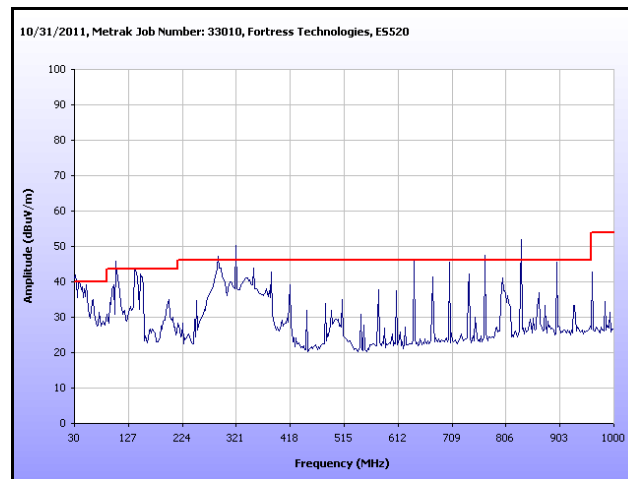
Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.

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

Test Engineer(s): Jeff Pratt

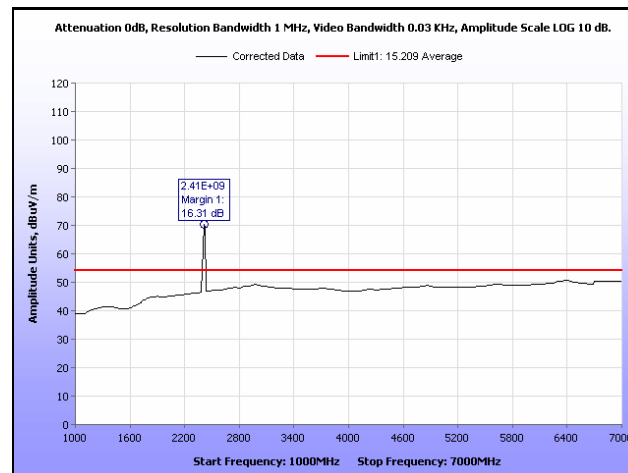
Test Date(s): 12/01/11

Radiated Spurious Emissions Test Results

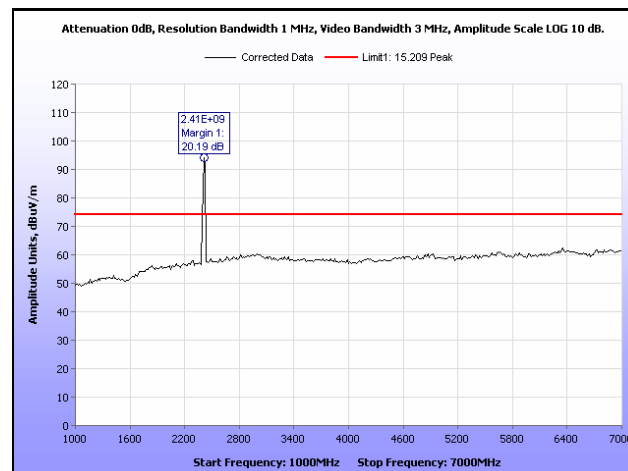


Plot 7. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz

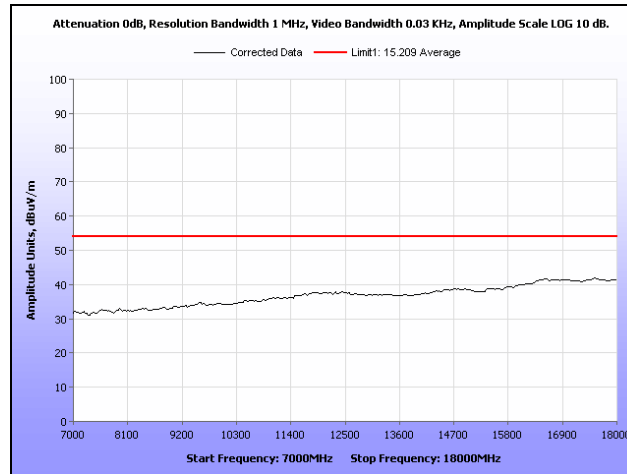
Note: Emissions which exceed the 15.209 limit line are digital emissions were meet the Class A limit as seen in the 15.109 section.



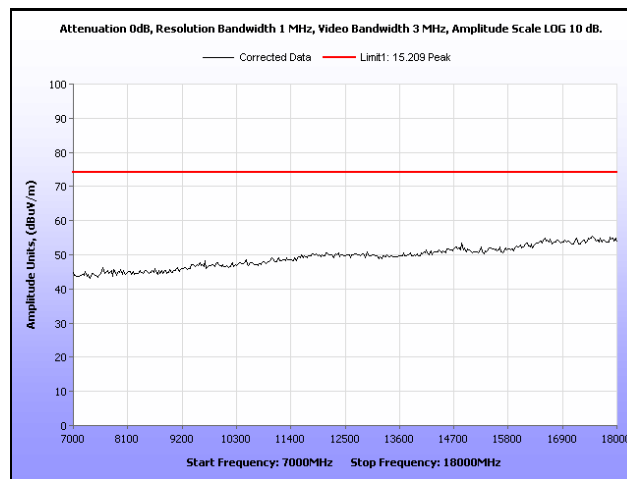
Plot 8. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average



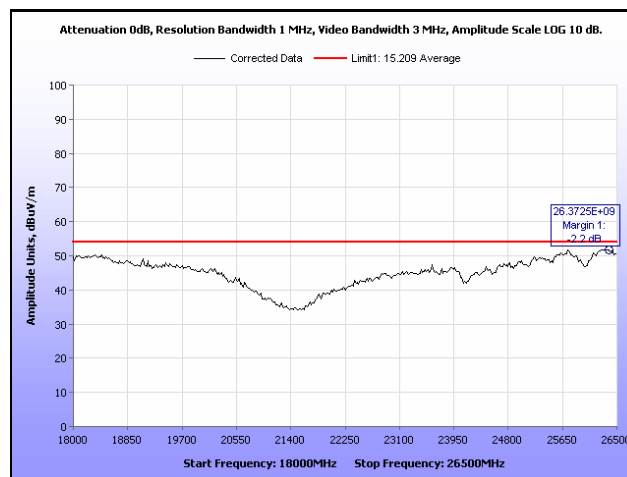
Plot 9. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Peak



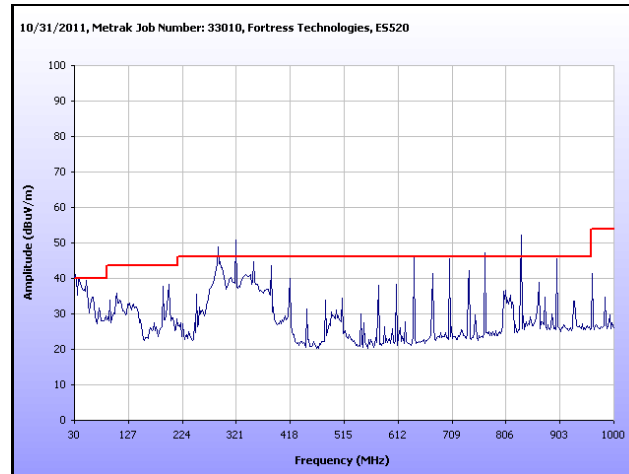
Plot 10. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Average



Plot 11. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Peak

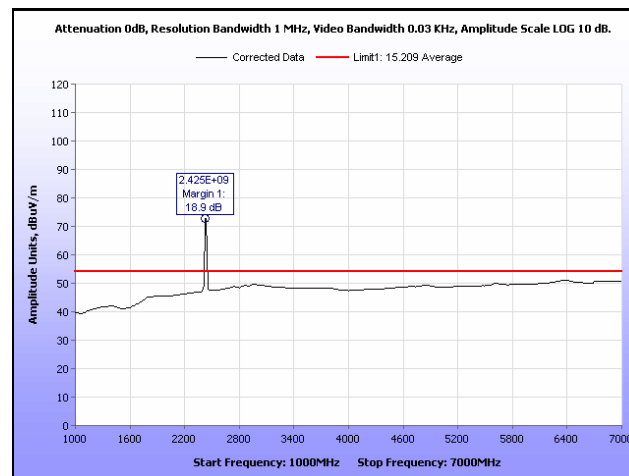


Plot 12. Radiated Spurious Emissions, Low Channel, 18 GHz – 26.5 GHz, Peak Under Average

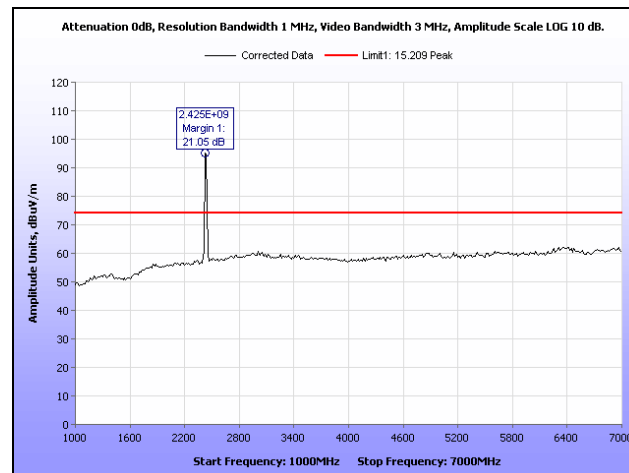


Plot 13. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz

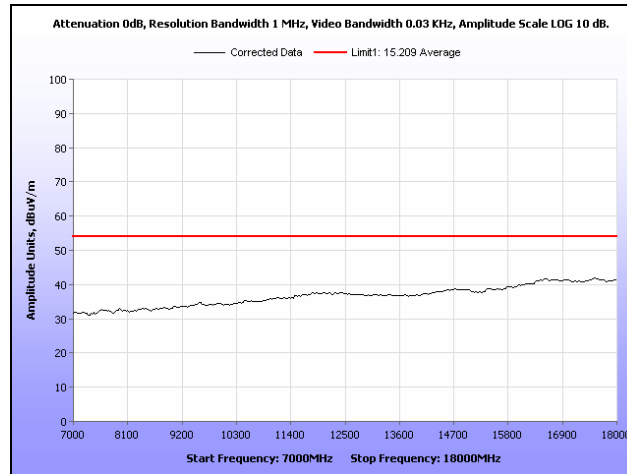
Note: Emissions which exceed the 15.209 limit line are digital emissions were meet the Class A limit as seen in the 15.109 section.



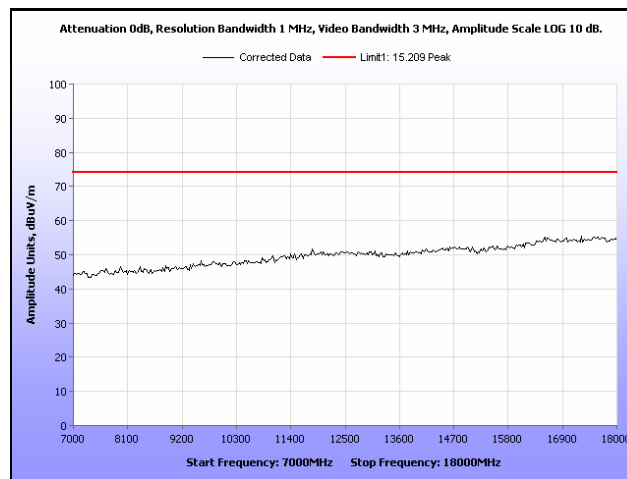
Plot 14. Radiated Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Average



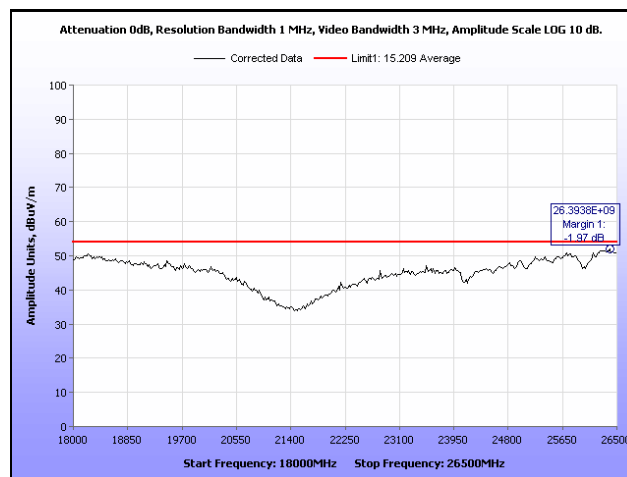
Plot 15. Radiated Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Peak



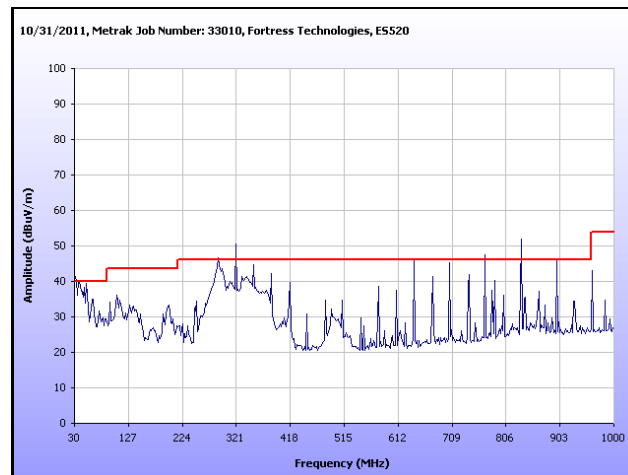
Plot 16. Radiated Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Average



Plot 17. Radiated Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Peak

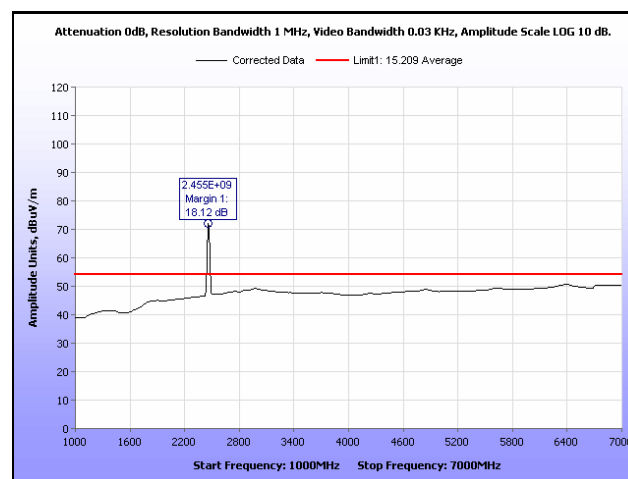


Plot 18. Radiated Spurious Emissions, Mid Channel, 18 GHz – 26.5 GHz, Peak Under Average

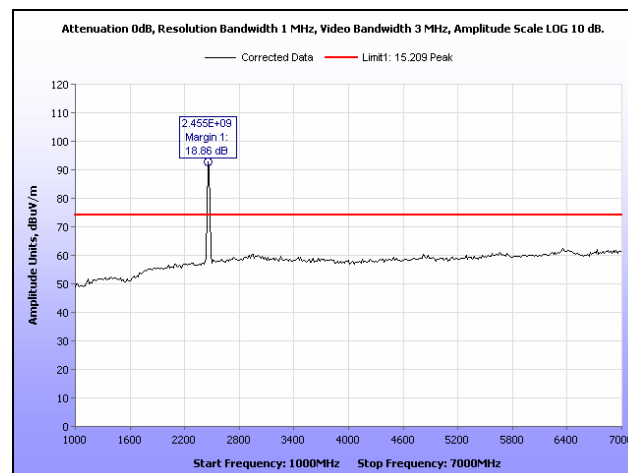


Plot 19. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz

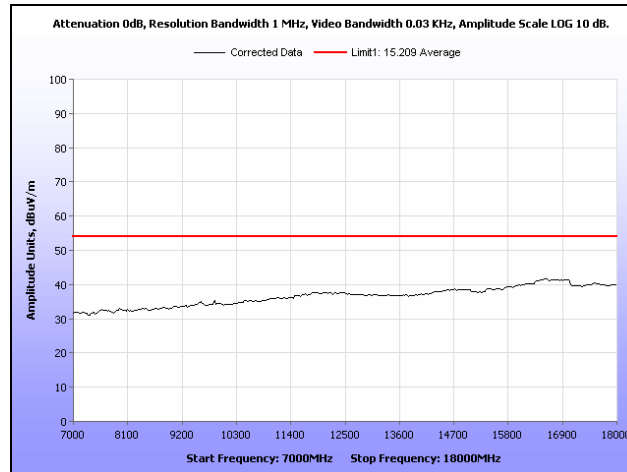
Note: Emissions which exceed the 15.209 limit line are digital emissions were meet the Class A limit as seen in the 15.109 section.



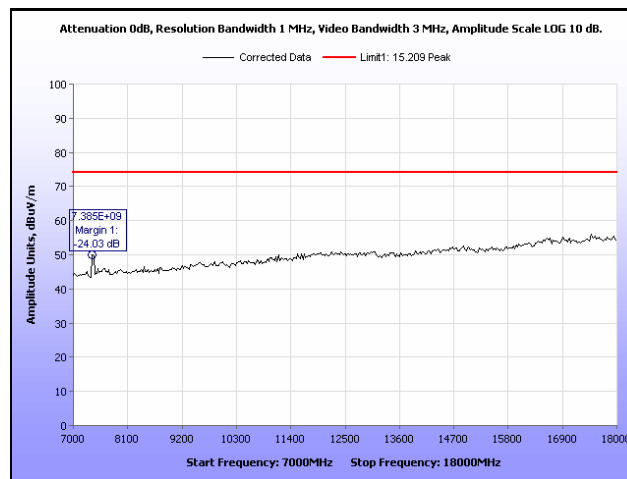
Plot 20. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Average



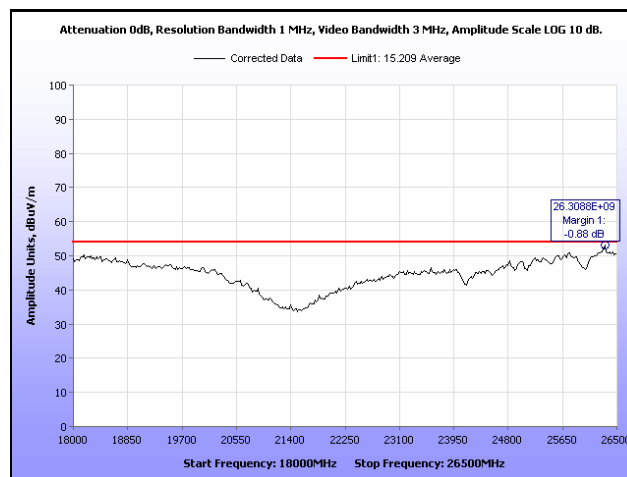
Plot 21. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Peak



Plot 22. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Average



Plot 23. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Peak

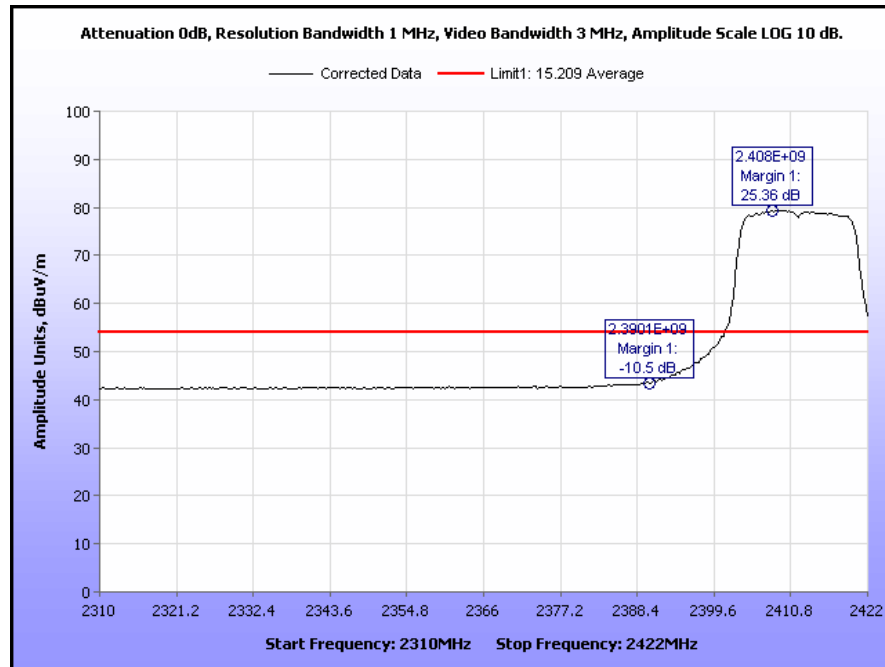


Plot 24. Radiated Spurious Emissions, High Channel, 18 GHz – 26.5 GHz, Peak Under Average

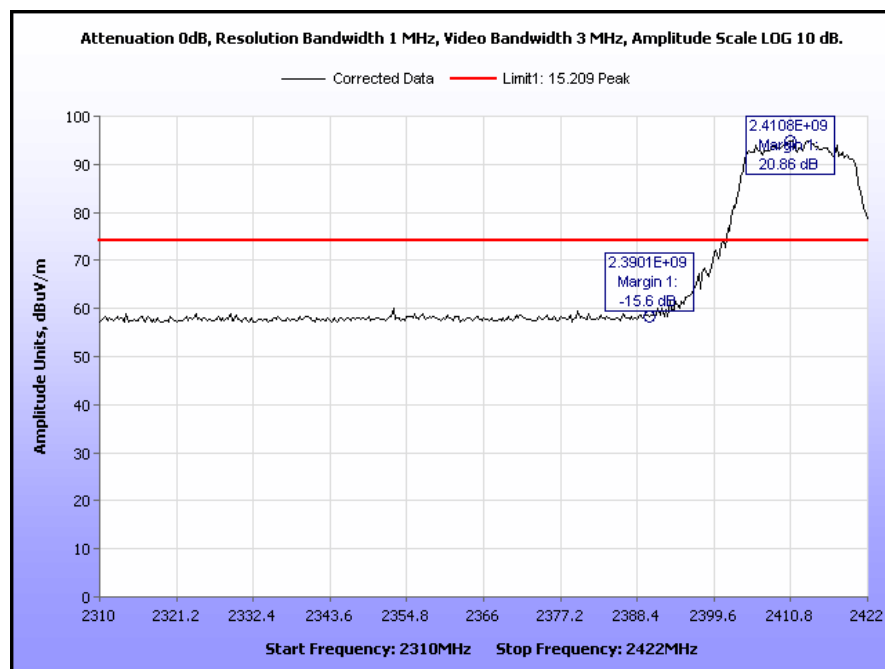
Radiated Band Edge Measurements

Test Procedures:

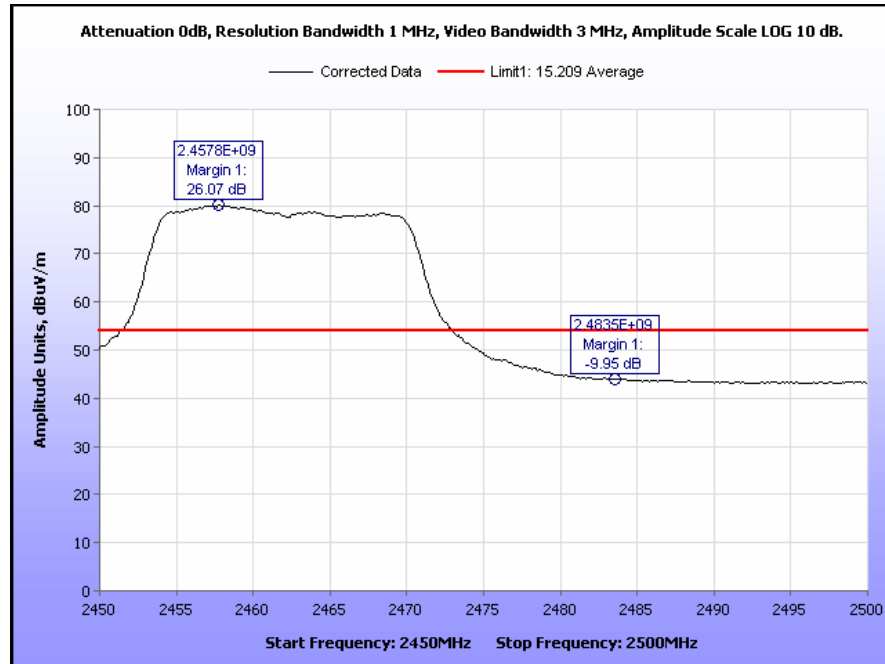
The transmitter was turned on. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.



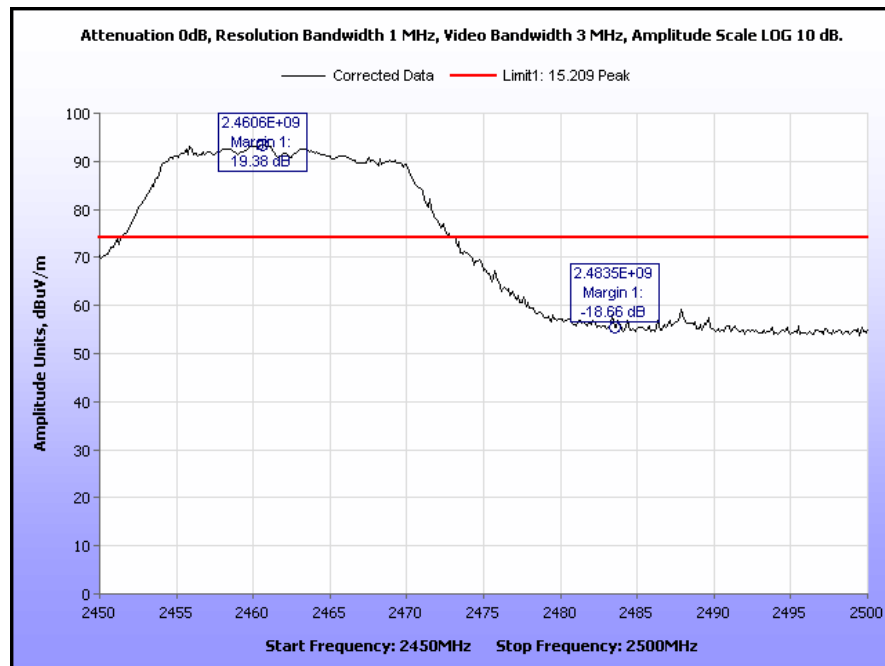
Plot 25. Radiated Restricted Band Edge, Low Channel, Average



Plot 26. Radiated Restricted Band Edge, Low Channel, Peak



Plot 27. Radiated Restricted Band Edge, High Channel, Average



Plot 28. Radiated Restricted Band Edge, High Channel, Peak

Radiated Spurious Emissions Test Setup



Photograph 4. Radiated Spurious Emissions, Test Setup



Electromagnetic Compatibility Criteria for Intentional Radiators

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

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

Test Results: Please refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.



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 Results: Please refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.



Electromagnetic Compatibility Criteria for Intentional Radiators

RSS-GEN Receiver Spurious Emissions Requirements

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

- (a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 18.

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

Table 18. Spurious Emission Limits for Receivers

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

Test Results: Please refer to FCC ID: NI3-MP86005001 / IC: 3616A-MP860601.



IV. Test Equipment



Test Equipment

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

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4214	SHIELD ROOM #4	UNIVERSAL SHIELD INC	N/A	SEE NOTE	
1T4621	ESA-E SERIES SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4402B	5/31/2011	5/31/2012
1T4565	LISN (10 AMP)	SOLAR ELECTRONICS	9252-50-R-24-BNC	12/15/2011	12/15/2012
1T4758	THERMO/HYGROMETER	CONTROL COMPANY	4040	5/21/2010	5/21/2012
1T4300	SEMI-ANECHOIC CHAMBER # 1	EMC TEST SYSTEMS	NONE	8/23/2010	8/23/2013
1T4751	ANTENNA; BILOG	SUNOL SCIENCES	JB6	12/7/2011	12/7/2012
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	6/14/2011	6/14/2012
1T4634	THERMO/HYGROMETER	CONTROL COMPANY	02-401	3/11/2010	3/11/2012
1T4505	TEMPERATURE CHAMBER	TEST EQUITY	115	11/30/2011	11/30/2012
1T4728	PROGRAMMABLE AC POWER SOURCE	QUADTECH	31010	SEE NOTE	
1T4612	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	12/15/2010	6/15/2012
1T4483	ANTENNA; HORN	ETS-LINDGREN	3117	7/19/2011	7/19/2012
1T4745	ANTENNA; HORN	ETS-LINDGREN	3116	10/4/2011	10/4/2012
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T4752	PRE-AMPLIFIER	MITEQ	JS44-18004000-35-8P	SEE NOTE	
1T4771	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	6/25/2011	6/25/2012
1T4502	COMB GENERATOR	COM-POWER	CGC-255	11/3/2011	11/3/2012
1T4568	RADIATING NOISE SOURCE	MET LABORATORIES	N/A	SEE NOTE	
1T4149	HIGH-FREQUENCY ANECHOIC CHAMBER	RAY-PROOF	81	CAL NOT REQUIRED	
1T4246	DIRECTIONAL COUPLER	HP	11691D	SEE NOTE	

Table 19. Test Equipment List

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



V. Certification & User's Manual Information



Certification & User's Manual Information

A. Certification Information

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

§ 2.801 Radio-frequency device defined.

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

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) *The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

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

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
 - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
 - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.



- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
- (i) *Compliance testing;*
 - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
 - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.



Certification & User's Manual Information

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

§ 2.901 Basis and Purpose

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

§ 2.907 Certification.

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

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



Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

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



Certification & User's Manual Information

1. Label and User's Manual Information

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

§ 15.19 Labeling requirements.

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

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

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

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

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

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

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

- (4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.
- (5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

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



Verification & User's Manual Information

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

§ 15.105 Information to the user.

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

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

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

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.



ICES-003 Procedural & Labeling Requirements

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

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

Procedural Requirements:

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

- Section 6.1: A record of the measurements and results, showing the date that the measurements were completed, shall be retained by the manufacturer or importer for a period of at least five years from the date shown in the record and made available for examination on the request of the Minister.
- Section 6.2: A written notice indicating compliance must accompany each unit of digital apparatus to the end user. The notice shall be in the form of a label that is affixed to the apparatus. Where because of insufficient space or other constraints it is not feasible to affix a label to the apparatus, the notice may be in the form of a statement in the user's manual.

Labeling Requirements:

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

This Class [²] digital apparatus complies with Canadian ICES-003.

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

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



End of Report