MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313
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March 24, 2014

Spirent Communications
20324 Seneca Meadows Parkway
Germantown, MD 20876

Dear Jim Wasel,

Enclosed is the EMC Wireless test report for compliance testing of the Spirent Communications, Flex NG2 Base Unit / T5100 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart B and ICES-003, Issue 5 August 2012 for Unintentional Radiators, and Part 15.407 Subpart E and RSS-210, Issue 8, Dec. 2010 for Intentional Radiators.

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

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Spirent Communications\EMC38436B-FCC407 Rev. 2)

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Electromagnetic Compatibility Criteria
Test Report

for the

Spirent Communications
Model Flex NG2 Base Unit / T5100

Tested under
the Certification Rules
contained in
Title 47 of the CFR, Part 15, Subpart B& ICES-003
for Unintentional Radiators
and
15.407 Subpart E & & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

MET Report: EMC38436B-FCC407 Rev. 2

March 24, 2014

Prepared For:

Spirent Communications
20324 Seneca Meadows Parkway
Germantown, MD 20876

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

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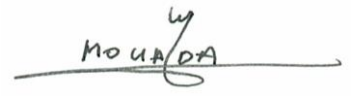


Djed Mouada, Project Engineer
Electromagnetic Compatibility Lab

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 Parts 15B, 15.407, of the FCC Rules under normal use and maintenance.

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	March 18, 2014	Initial Issue.
1	March 20, 2014	Revised to reflect engineer corrections.

Table of Contents

List of Tables

List of Figures

List of Photographs

List of Plots

List of Terms and Abbreviations

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

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Spirent Communications Flex NG2 Base Unit / T5100, with the requirements of Part 15, §15.407. 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 Flex NG2 Base Unit / T5100. Spirent Communications should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Flex NG2 Base Unit / T5100, 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, §15.407, in accordance with Spirent Communications, purchase order number 76678. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference	IC Reference RSS-210 Issue 8: 2010; RSS-GEN Issue 3: 2010	Description	Results
47 CFR Part 15.107 (a)	ICES-003 Issue 5 August 2012	Conducted Emissions	Compliant
47 CFR Part 15.109 (a)	ICES-003 Issue 5 August 2012	Radiated Emissions	Compliant
Title 47 of the CFR, Part 15 §15.203	N/A	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	RSS-GEN (7.2.4)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.403 (i)	RSS-Gen (4.6)	26dB Occupied Bandwidth	Compliant
		99% Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.407 (a)(2)	RSS-210 (A9.2)	Conducted Transmitter Output Power	Compliant
Title 47 of the CFR, Part 15 §15.407 (a)(2)	RSS-210 (A8.2)	Power Spectral Density	Compliant
Title 47 of the CFR, Part 15 §15.407 (a)(6)	N/A	Peak Excursion	Compliant
Title 47 of the CFR, Part 15 §15.407 (b)(2), (3), (5), (6)	RSS-210 (A9.2)	Undesirable Emissions (15.205/15.209 - General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Compliant
Title 47 of the CFR, Part 15 §15.407(f)	RSS-102 (4.1)	RF Exposure	Compliant
15.407(g)	N/A	Frequency Stability	Compliant
15.407(h)(1)	RSS-210 (A9.2)	Transmit Power Control (TPC)	Compliant
15.407 (h)(2)(iii)	RSS-210 (A9.3)	Channel Move Time and Channel Closing Time	Complaint
15.407 (h)(2)(iv)	RSS-210 (A9.3)	Non-Occupancy Period	Compliant

Table 1. Executive Summary of EMC Part 15.407 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Spirent Communications to perform testing on the Flex NG2 Base Unit / T5100, under Spirent Communications' purchase order number 76678.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Spirent Communications Flex NG2 Base Unit / T5100.

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

Model(s) Tested:	Flex NG2 Base Unit / T5100	
Model(s) Covered:	Flex NG2 Base Unit / T5100	
EUT Specifications:	Primary Power: 120 VAC, 60 Hz	
	FCC ID: WR2-TXFLEX-NG2	
	Type of Modulations:	OFDM
	Equipment Code:	NII
	Peak RF Output Power:	19.66 dBm
	EUT Frequency Ranges:	5290-5290 MHz 5530-5530 MHz 5690-5690 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Djed Mouada	
Report Date(s):	March 24, 2014	

Table 2. EUT Summary

B. References

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

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 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 Spirent Communications Flex NG2 Base Unit / T5100, Equipment Under Test (EUT), is a handheld tester for Ethernet (10/100/1000Mbps) and IP connectivity. The EUT has two radio modules. This test report addresses the 2nd radio module that supports 802.11ac 80 MHz mode (3x3 MIMO)

Photograph 1. Spirent Communications Flex NG2 Base Unit / T5100

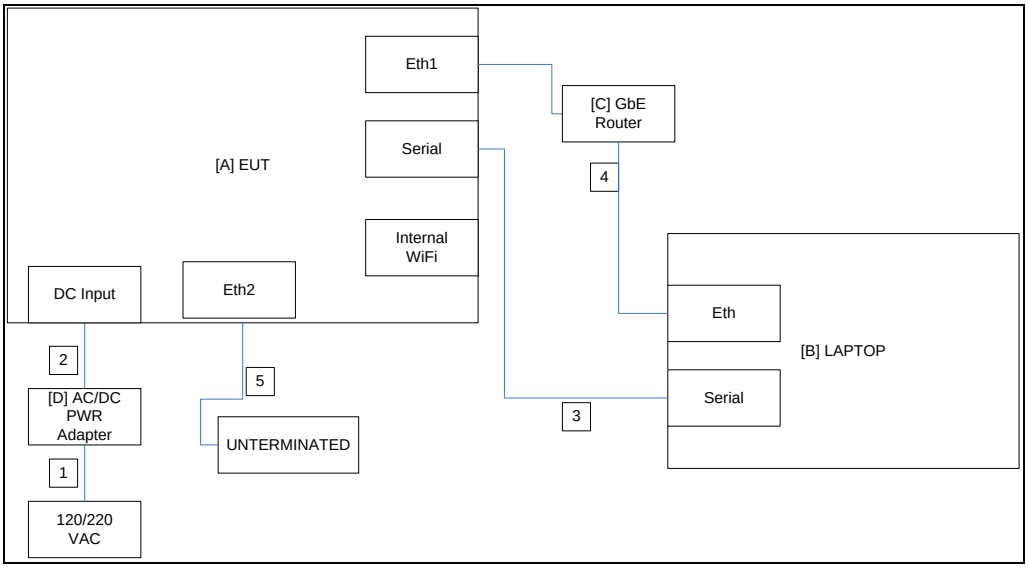


Figure 1. Block Diagram of Test Configuration

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	Part Number	Serial Number	Revision
A	Flex NG2 Base Unit	T5100	53-004638	00E18130001	A

Table 4. Equipment Configuration

F. Support Equipment

Spirent Communications supplied support equipment necessary for the operation and testing of the Flex NG2 Base Unit / T5100. All support equipment supplied is listed in the following Support Equipment List.

Ref. ID	Name / Description	Manufacturer	Model Number
B	LAPTOP	Dell	E6400
C	GbE Router	Netgear (or sim.)	GS605NA
D	AC/DC Wall adapter	Sinpro	SPU25A-105

Table 5. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
1	N/A	3 conductor, 18 awg	1	2	1	N/A
2	DC Input	2 conductor, UL1185 18 awg	1	2	2	DC Input
3	Serial	--	1	2	3	Serial
4	Eth1	Cat5E	2	2	4	Eth1
5	Eth2	No connect	0	N/A	5	Eth2

Table 6. Ports and Cabling Information

H. Mode of Operation

Data test Mode: Serial connection to the Flex base unit provides the communication interface with laptop. Peer to peer Ethernet connection between laptop and Flex is established for ping test. The WiFi function is also enabled during this test to perform scans. Statistics of the ping and WiFi are gathered via the serial link (validating both Ethernet and WiFi functionality). Statistics gathering is set in a repetitive loop in which the stats are displayed every 5 seconds. Loss of Ethernet connectivity or WiFi stats will result in a "Fail" notification.

I. Method of Monitoring EUT Operation

There will be a clear "PASS" or "FAIL" indication on the laptop running the repetitive measurements and stats gathering. Pass or Fail indication, along with all the stats, are updated every 5 seconds.

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 Spirent Communications 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 7. 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 7. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals. The lower limit applies at the band edges.

Frequency range (MHz)	Class A Conducted Limits (dBµV)		*Class B Conducted Limits (dBµV)	
	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 7. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b) and 15.207(a)

Test Procedures: The EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. The method of testing, test conditions, and test procedures of ANSI C63.4 were used. The EUT was powered through a 50Ω/50µH LISN. An EMI receiver, connected to the measurement port of the LISN, scanned the frequency range from 150 kHz to 30 MHz in order to find the peak conducted emissions. All peak emissions within 6 dB of the limit were re-measured using a quasi-peak and/or average detector as appropriate.

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

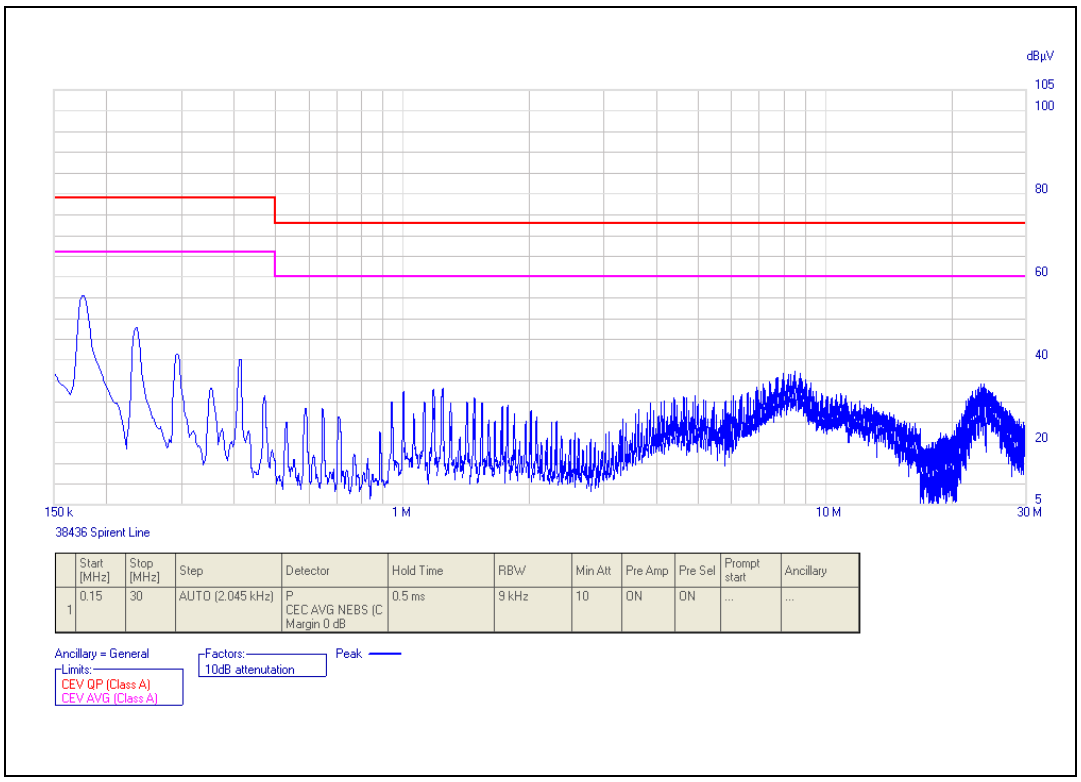
Test Engineer(s): Arden Huang

Test Date(s): 08/23/13

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

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line	0.17454	53.31	79	-25.69	Pass	43.63	66	-22.37	Pass
Line	0.15	33.85	79	-45.15	Pass	13.69	66	-52.31	Pass
Line	0.2338	45.67	79	-33.33	Pass	37.34	66	-28.66	Pass
Line	0.29315	39.31	79	-39.69	Pass	34.7	66	-31.3	Pass
Line	0.41176	38.57	79	-40.43	Pass	36.11	66	-29.89	Pass
Line	8.45745	32	73	-41	Pass	27.68	60	-32.32	Pass

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

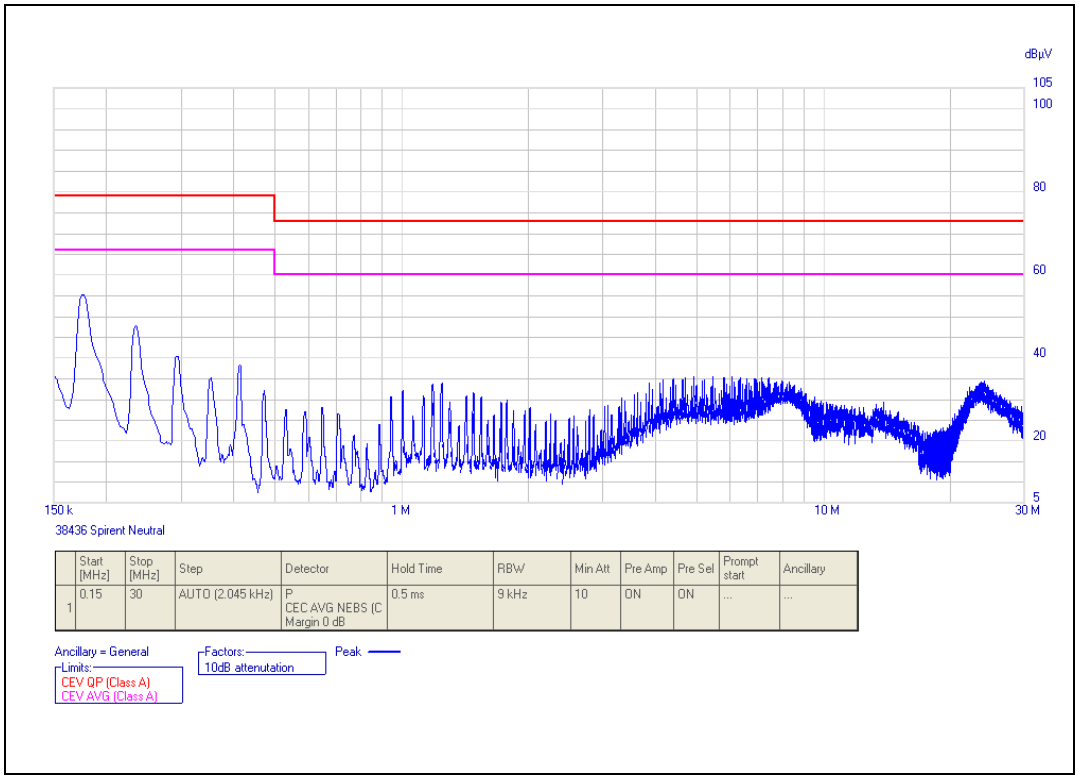


Plot 1. Conducted Emission, Phase Line Plot

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

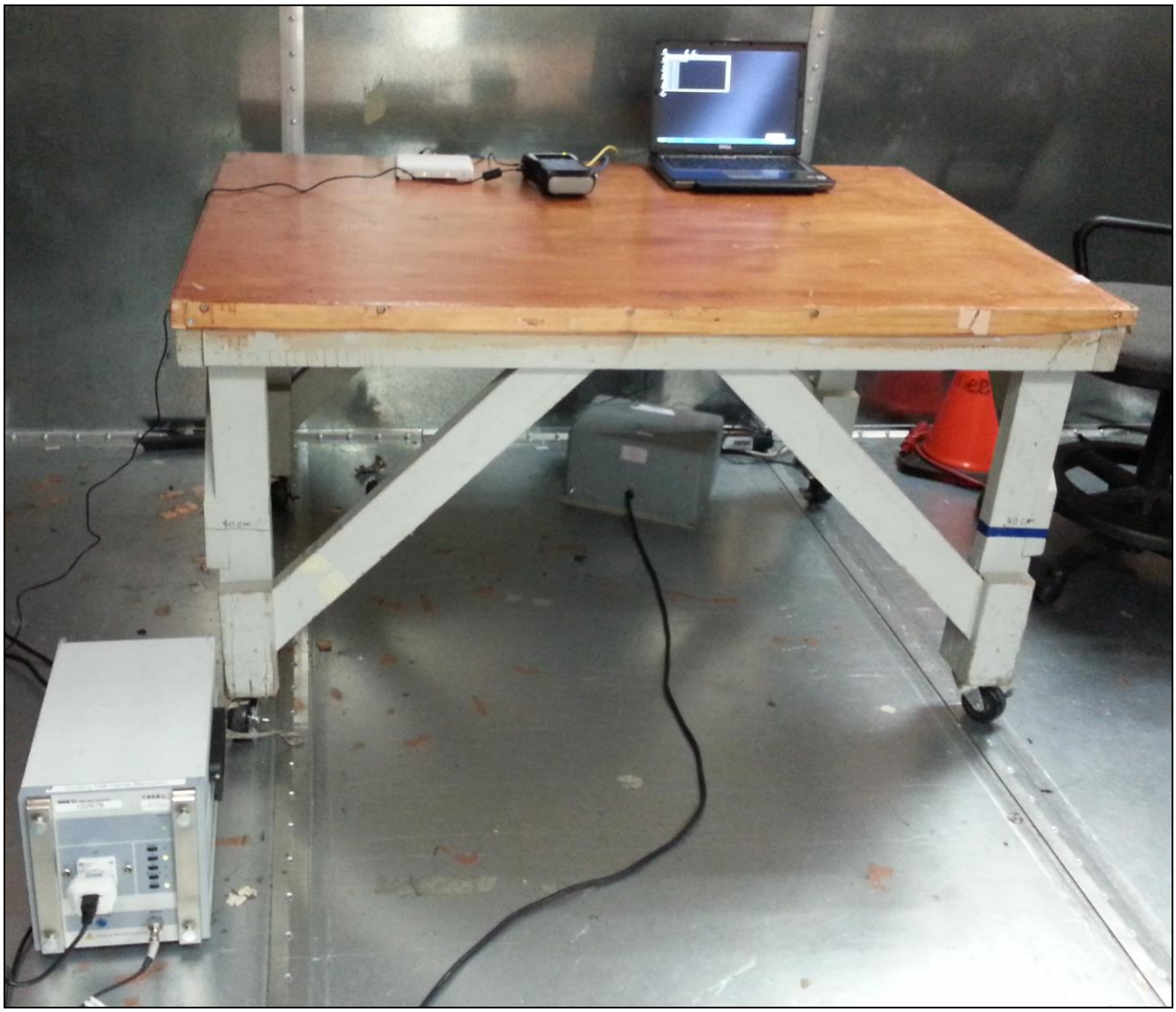
Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Neutral	0.15	33	79	-46	Pass	13.81	66	-52.19	Pass
Neutral	0.17454	53	79	-26	Pass	43.37	66	-22.63	Pass
Neutral	0.233845	45.43	79	-33.57	Pass	37.18	66	-28.82	Pass
Neutral	0.29315	38.44	79	-40.56	Pass	31.86	66	-34.14	Pass
Neutral	0.41176	36	79	-43	Pass	33.08	66	-32.92	Pass
Neutral	6.03142	33.54	73	-39.46	Pass	30.37	60	-29.63	Pass

Table 9. 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 10.

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 10.

Frequency (MHz)	Field Strength (dBµV/m)	
	§15.109 (b), Class A Limit (dBµV) @ 10m	§15.109 (a),Class B Limit (dBµV) @ 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 10. 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. Measured emissions were below applicable limits.

Test Engineer(s): Arden Huang

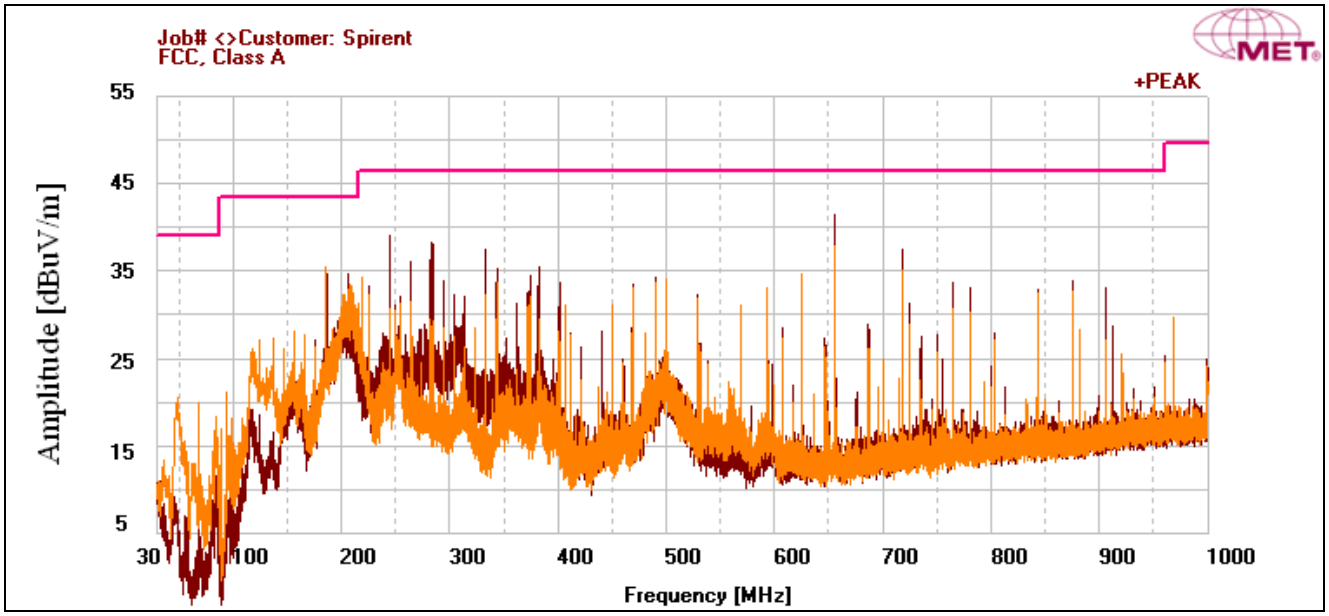
Test Date(s): 08/29/13

Radiated Emissions Limits Test Results, Class A

Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBµV)	ACF (dB/m)	Pre Amp Gain (dB)	CBL (dB)	DCF (dB)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
656.257	H	121	121.82	24.51	20.2	0	3.884	-10.46	38.134	46.4	-8.266
244.4	H	109	119.29	19.2	12.2	0	2.362	-10.46	23.302	46.4	-23.098
284.21	H	167	100	23.05	13.716	0	2.547	-10.46	28.853	46.4	-17.547
333.2	H	115	100	30.3	14.636	0	2.746	-10.46	37.222	46.4	-9.178
718.75	H	64	108.52	23.29	20.85	0	4.095	-10.46	37.775	46.4	-8.625
186.19	V	241	100	26.5	11.5	0	1.997	-10.46	29.537	43.5	-13.963

Table 11. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz

Note: The EUT was tested at 3 m.



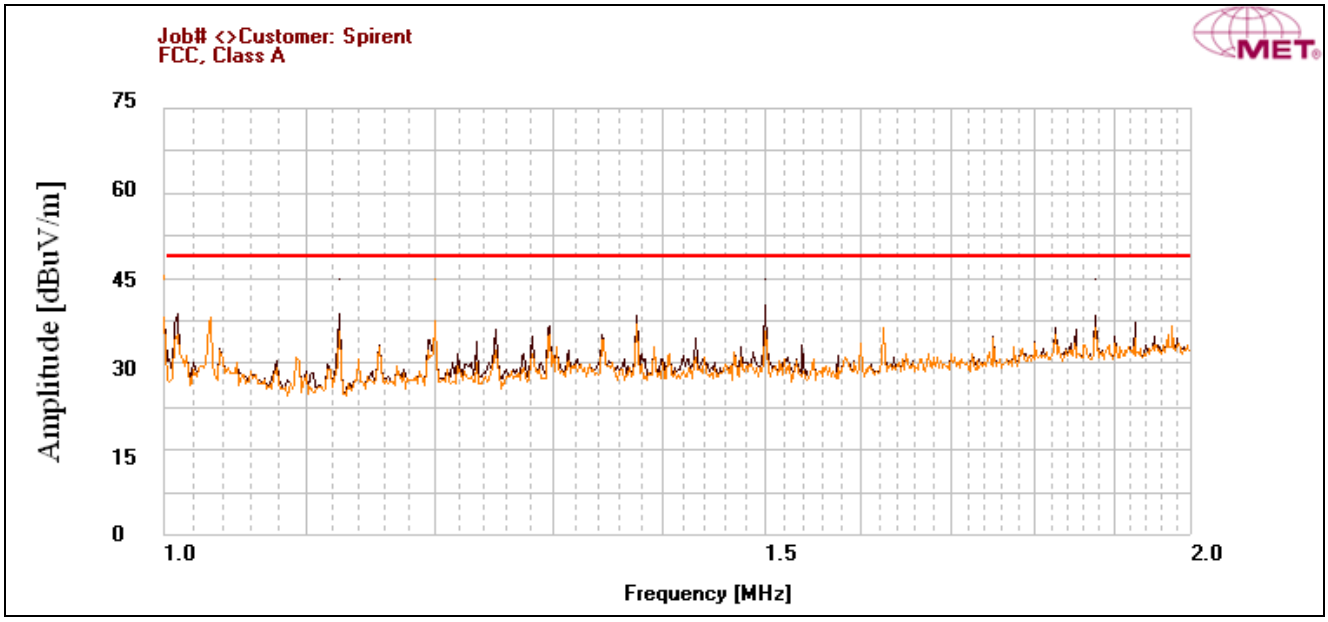
Plot 3. Radiated Emissions, 30 MHz - 1 GHz

Radiated Emissions Limits Test Results, Class A

Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBµV)	ACF (dB/m)	Pre Amp Gain (dB)	CBL (dB)	DCF (dB)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1499	H	156	123,23	55.26	28.978	34.103	0	-10.46	39.675	49.5	-9.825
1125	H	219	100	52.96	27.616	35.3	0	-10.46	34.816	49.5	-14.684

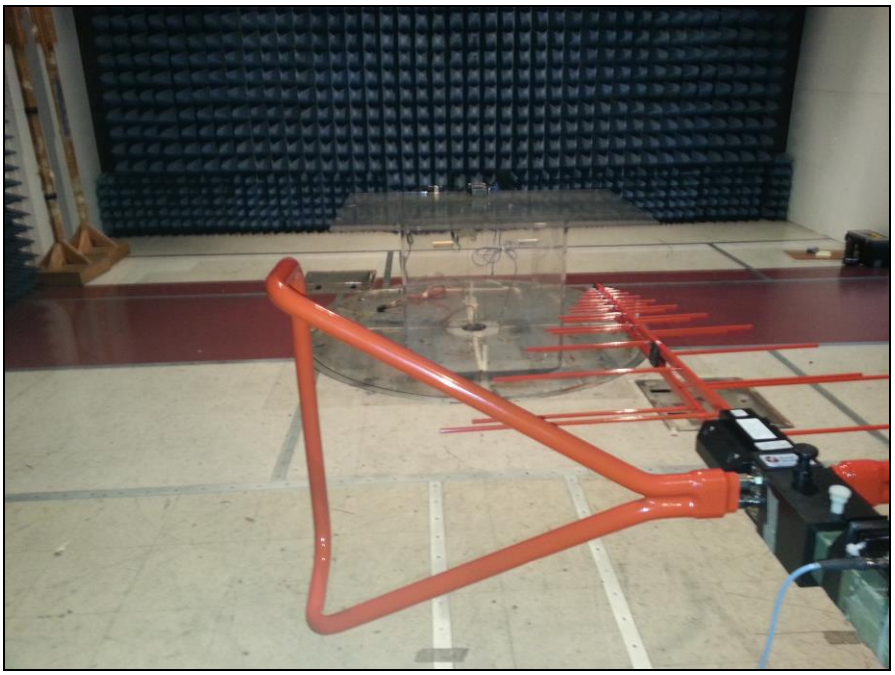
Table 12. Radiated Emissions Limits, Test Results, Above 1 GHz

Note: The EUT was tested at 3 m.

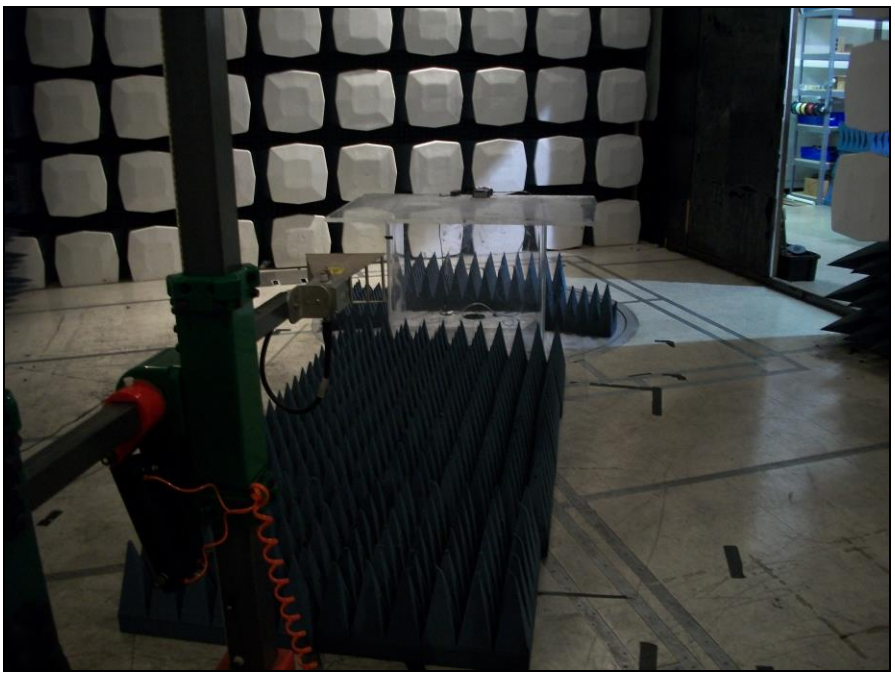


Plot 4. Radiated Emissions, Above 1 GHz

Radiated Emissions Limits Test Setup



Photograph 3. Radiated Emissions, Test Setup, 30 MHz – 1 GHz



Photograph 4. Radiated Emissions, Test Setup, Above 1 GHz

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 has an integral antenna; 3x3 MIMO.
Array gain = 3.7+ 10log (3) = 8.47 dBi

Test Engineer(s): Djed Mouada

Test Date(s): 11/25/13

Gain	Type	Model	Manufacturer
3.7 dBi	5 GHz Band	47950-1001	Molex

Table 13. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207 Conducted Emissions Limits

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

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

Table 14. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2003 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

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

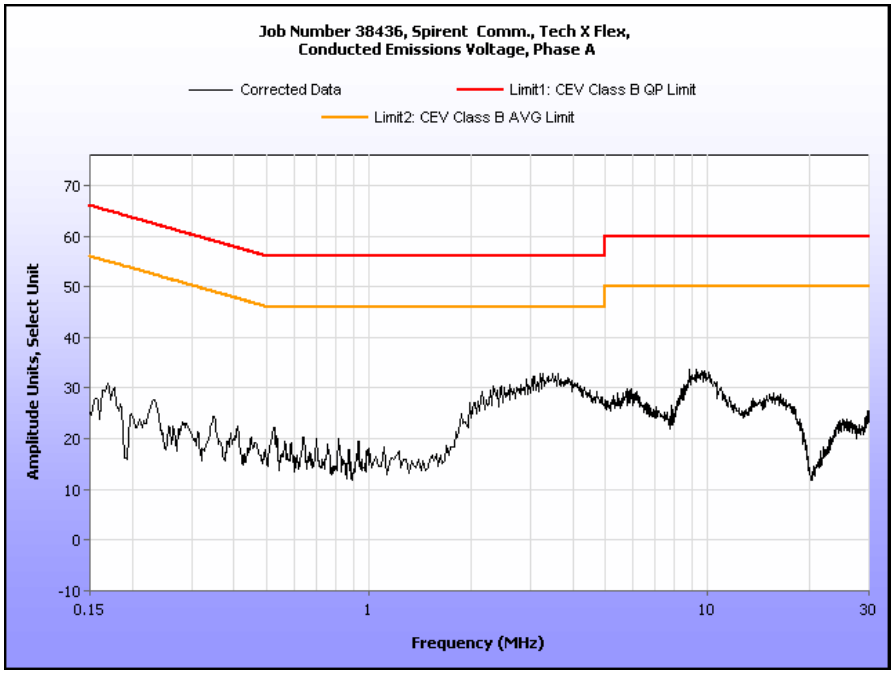
Test Engineer(s): Djed Mouada

Test Date(s): 12/09/13

15.207(a) Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dBµV) QP	Cable Loss (dB)	Corrected Measurement (dBµV) QP	Limit (dBµV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBµV) Avg.	Cable Loss (dB)	Corrected Measurement (dBµV) AVG	Limit (dBµV) AVG	Margin (dB) AVG
0.1684	21.76	0	21.76	65.04	-43.28	14.23	0	14.23	55.04	-40.81
0.3507	19.23	0	19.23	58.95	-39.72	11.52	0	11.52	48.95	-37.43
0.5229	17.49	0	17.49	56	-38.51	9.373	0	9.373	46	-36.627
3.341	27.46	0	27.46	56	-28.54	18.34	0	18.34	46	-27.66
10.24	26.22	0.17	26.39	60	-33.61	19.09	0.17	19.26	50	-30.74
29.71	18.92	0.31	19.23	60	-40.77	12.09	0.31	12.4	50	-37.6

Table 15. Conducted Emissions, 15.207(a), Phase Line, Test Results

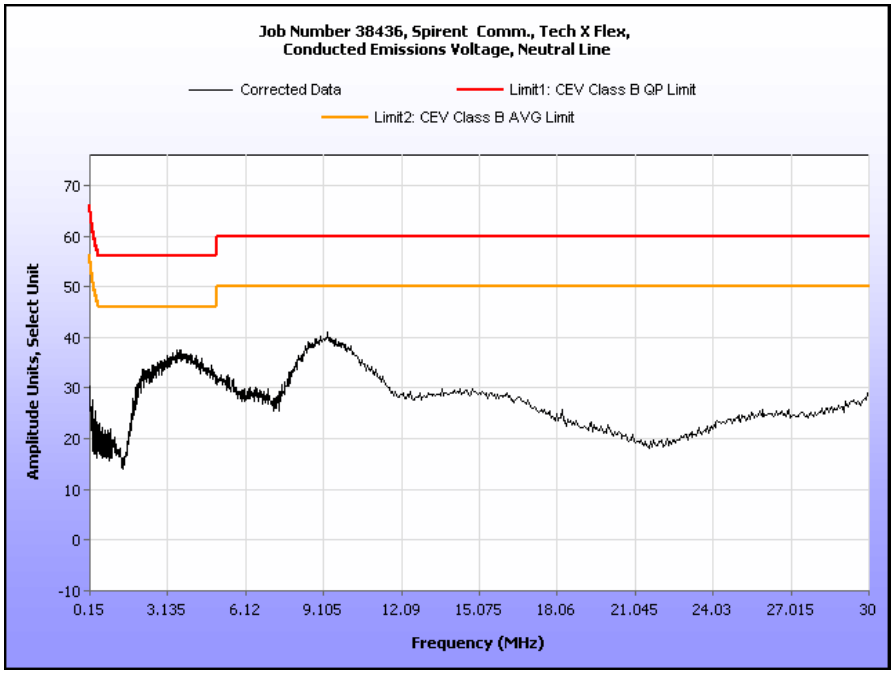


Plot 5. Conducted Emissions, 15.207(a), Phase Line

15.207(a) Conducted Emissions Test Results

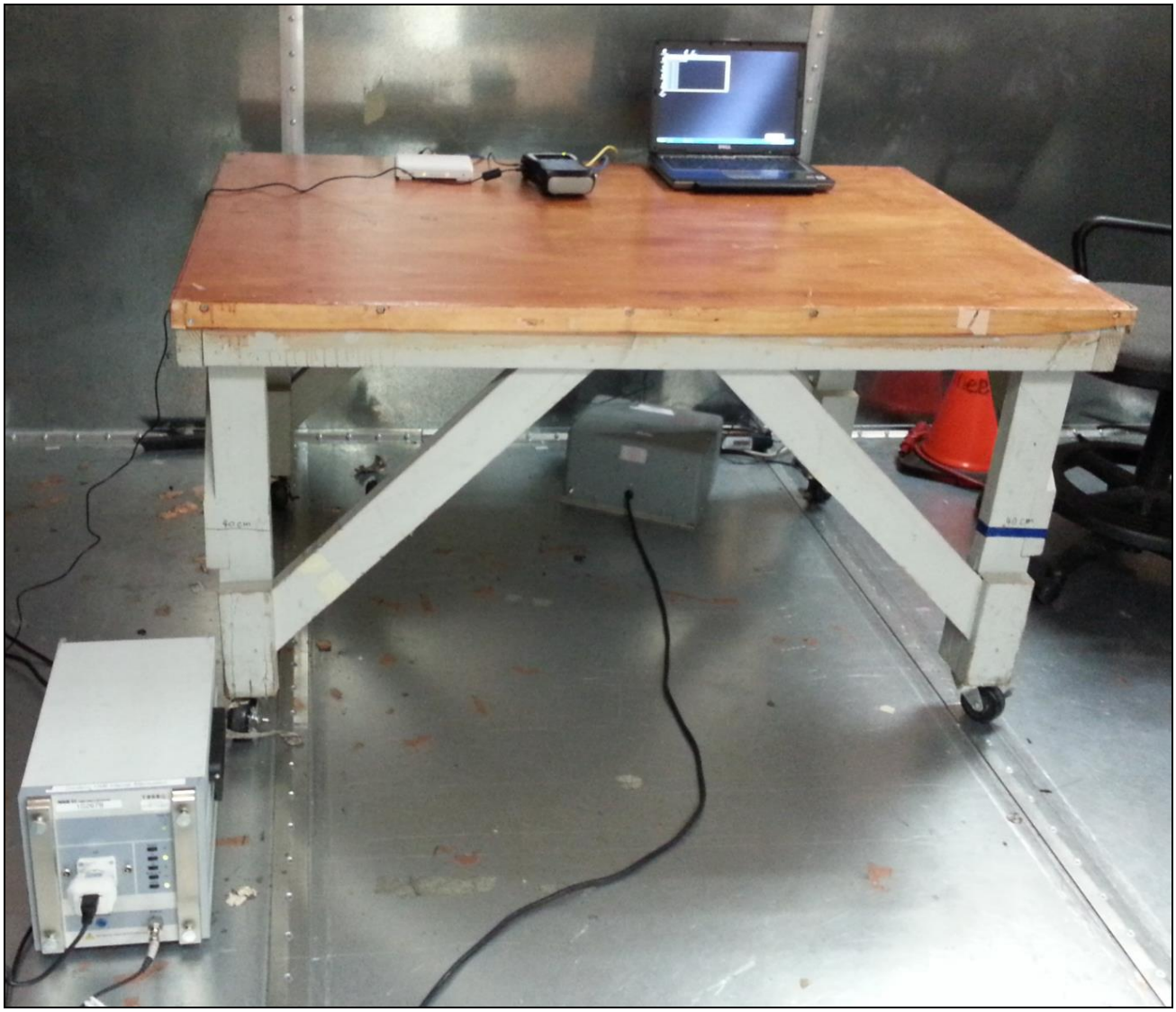
Frequency (MHz)	Uncorrected Meter Reading (dBµV) QP	Cable Loss (dB)	Corrected Measurement (dBµV) QP	Limit (dBµV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBµV) Avg.	Cable Loss (dB)	Corrected Measurement (dBµV) AVG	Limit (dBµV) AVG	Margin (dB) AVG
0.1516	18.48	0	18.48	65.91	-47.43	6.81	0	6.81	55.91	-49.1
0.3491	21.42	0	21.42	58.98	-37.56	16.69	0	16.69	48.98	-32.29
0.8175	17.4	0	17.4	56	-38.6	11.16	0	11.16	46	-34.84
9.438	35.76	0.33	36.09	60	-23.91	30.45	0.33	30.78	50	-19.22
10.38	32.08	0.17	32.25	60	-27.75	25.96	0.17	26.13	50	-23.87
29.96	23.44	0.33	23.77	60	-36.23	16.66	0.33	16.99	50	-33.01

Table 16. Conducted Emissions, 15.207(a), Neutral Line, Test Results



Plot 6. Conducted Emissions, 15.207(a), Neutral Line

15.207(a) Conducted Emissions Test Setup Photo



Photograph 5. Conducted Emissions, 15.207(a), Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 403(c) 26dB Bandwidth

Test Requirements: **§ 15.403 (i):** For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

Test Procedure: The transmitter was set to both operating frequencies at the highest output power and connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% of the total emission bandwidth, VBW > RBW. The 26 dB Bandwidth was measured and recorded.

Test Results The 26 dB Bandwidth was compliant with the requirements of this section and was determined from the plots on the following pages.

Test Engineer(s): Djed Mouada and Benjamin Taylor

Test Date(s): 12/04/13 – 12/06/13

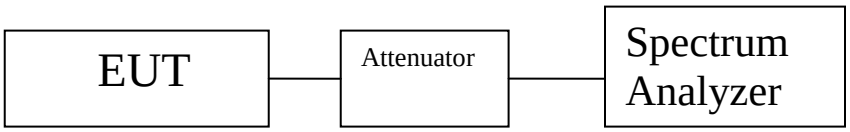


Figure 2. Occupied Bandwidth, Test Setup

	Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Chain 0	56	5290	81.516
Chain 1	56	5290	81.860
Chain 2	56	5290	81.629

Table 17. 26 dB Occupied Bandwidth, Test Results, Channel 56

	Channel	Frequency (MHz)	99% Bandwidth (MHz)
Chain 0	56	5290	75.3855
Chain 1	56	5290	75.4852
Chain 2	56	5290	75.5210

Table 18. 99% Occupied Bandwidth, Test Results, Channel 56

	Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Chain 0	100	5530	82.296
Chain 1	100	5530	83.073
Chain 2	100	5530	82.054

Table 19. 26 dB Occupied Bandwidth, Test Results, Channel 100

	Channel	Frequency (MHz)	99% Bandwidth (MHz)
Chain 0	100	5530	75.5672
Chain 1	100	5530	75.5982
Chain 2	100	5530	75.6146

Table 20. 99% Occupied Bandwidth, Test Results, Channel 100

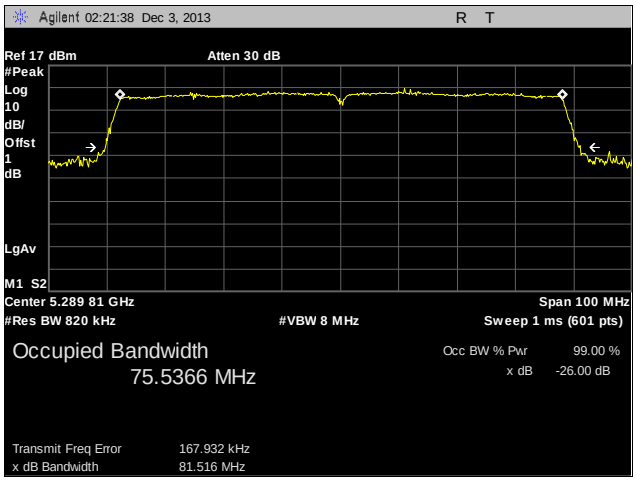
	Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Chain 0	132	5690	82.636
Chain 1	132	5690	81.053
Chain 2	132	5690	83.934

Table 21. 26 dB Occupied Bandwidth, Test Results, Channel 132

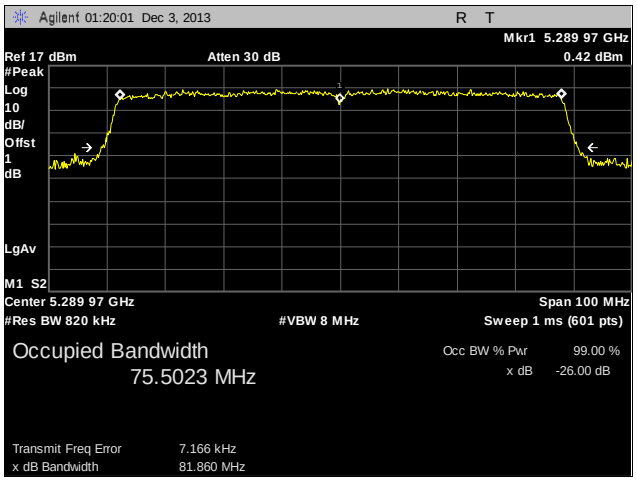
	Channel	Frequency (MHz)	99% Bandwidth (MHz)
Chain 0	132	5690	75.5901
Chain 1	132	5690	75.5512
Chain 2	132	5690	75.5075

Table 22. 99% Occupied Bandwidth, Test Results, Channel 132

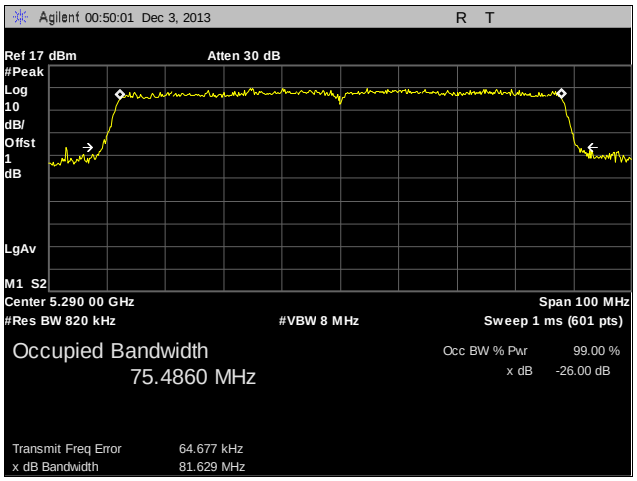
Electromagnetic Compatibility Criteria for Intentional Radiators



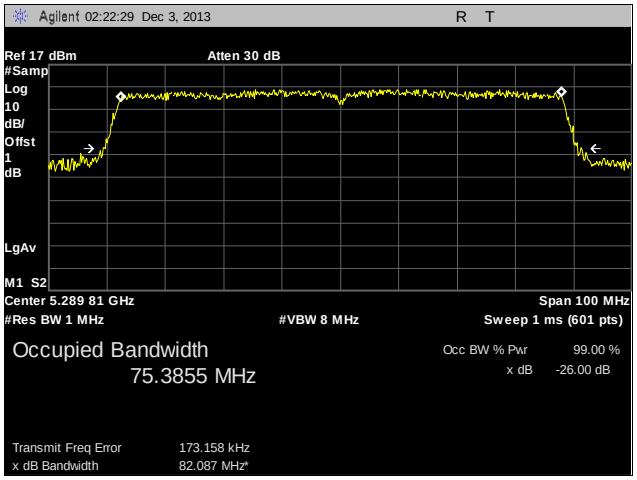
Plot 7. 26 dB Occupied Bandwidth, Channel 56, Chain 0



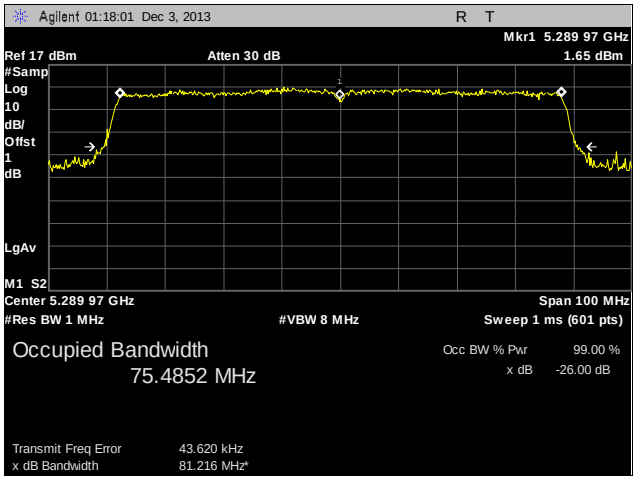
Plot 8. 26 dB Occupied Bandwidth, Channel 56, Chain 1



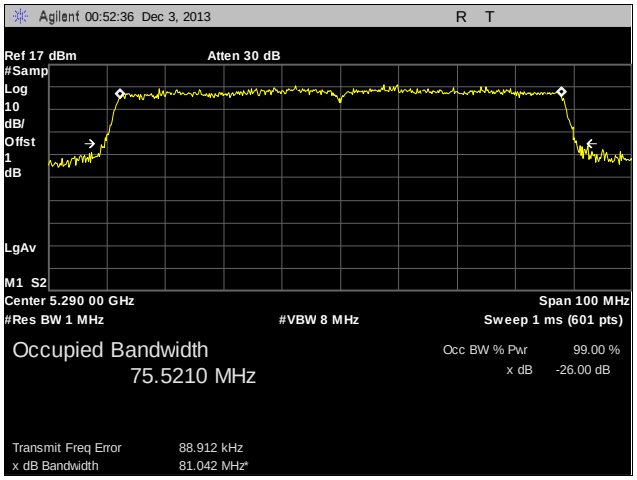
Plot 9. 26 dB Occupied Bandwidth, Channel 56, Chain 2



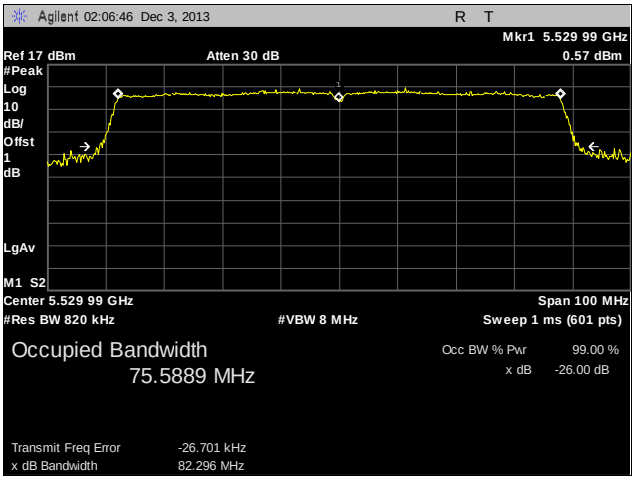
Plot 10. 99% Occupied Bandwidth, Channel 56, Chain 0



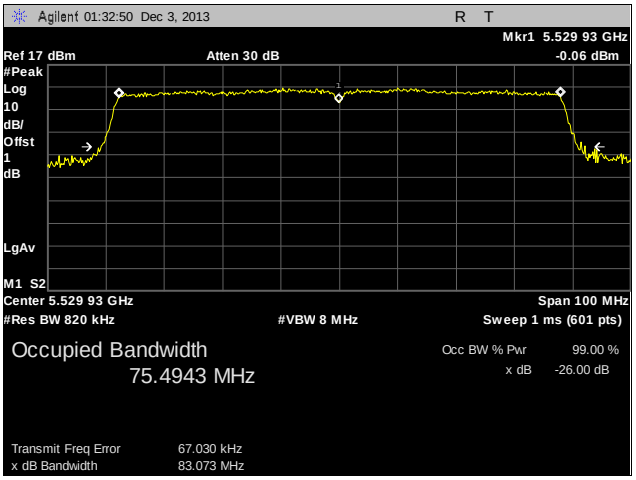
Plot 11. 99% Occupied Bandwidth, Channel 56, Chain 1



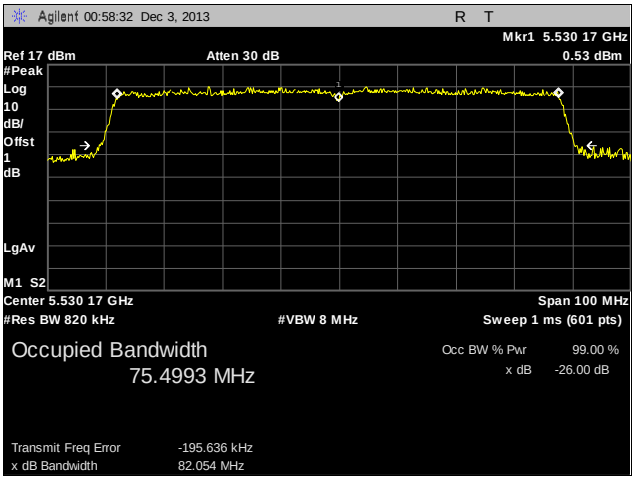
Plot 12. 99% Occupied Bandwidth, Channel 56, Chain 2



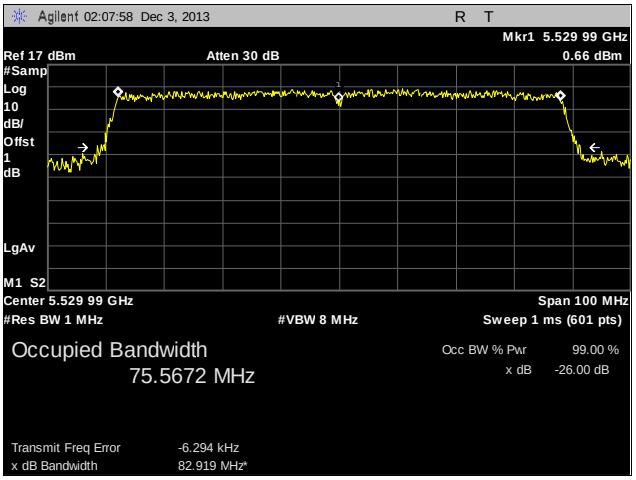
Plot 13. 26 dB Occupied Bandwidth, Channel 100, Chain 0



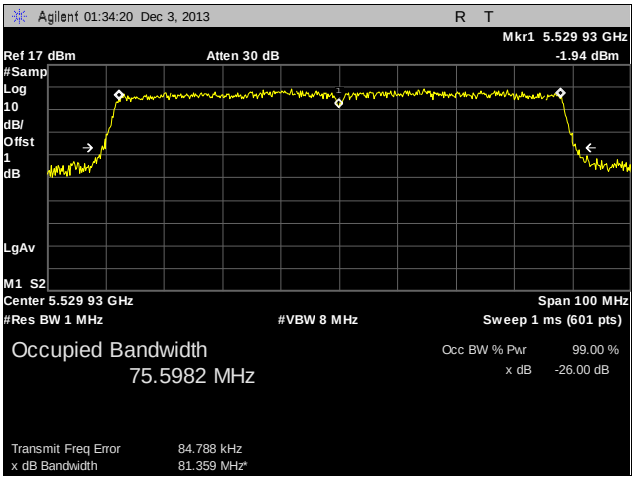
Plot 14. 26 dB Occupied Bandwidth, Channel 100, Chain 1



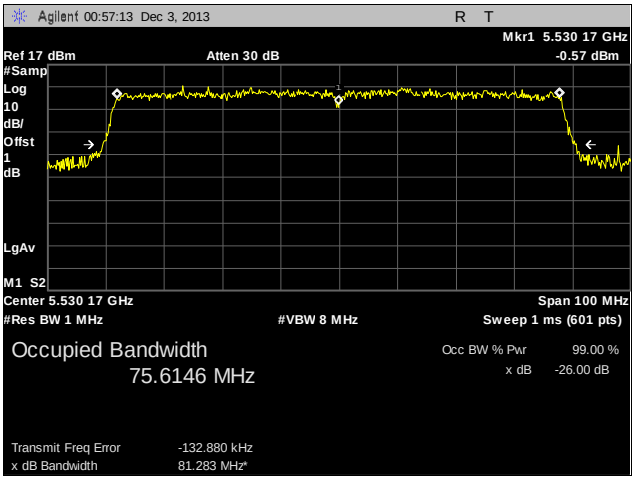
Plot 15. 26 dB Occupied Bandwidth, Channel 100, Chain 2



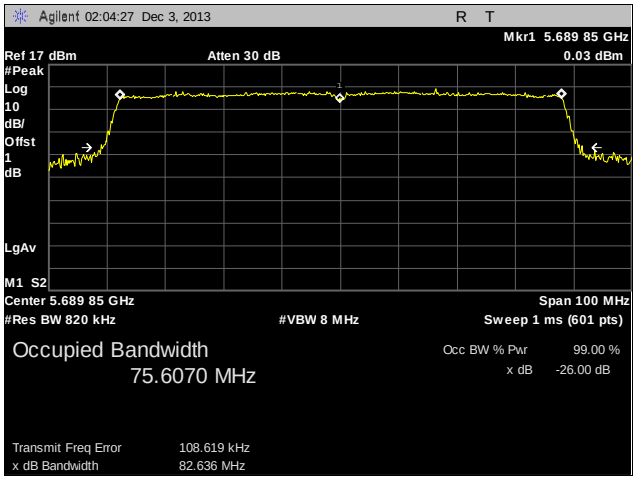
Plot 16. 99% Occupied Bandwidth, Channel 100, Chain 0



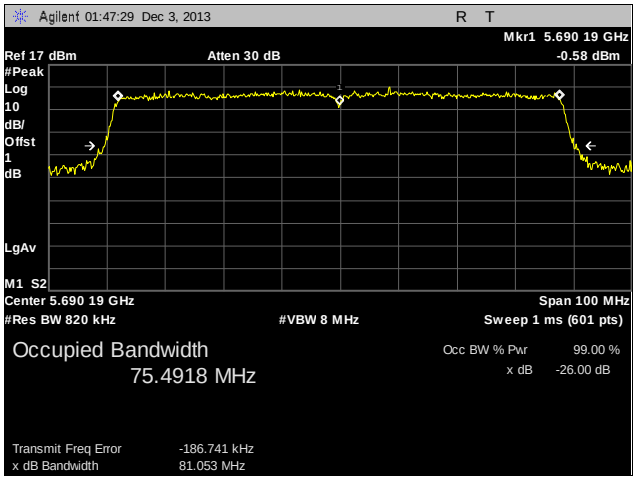
Plot 17. 99% Occupied Bandwidth, Channel 100, Chain 1



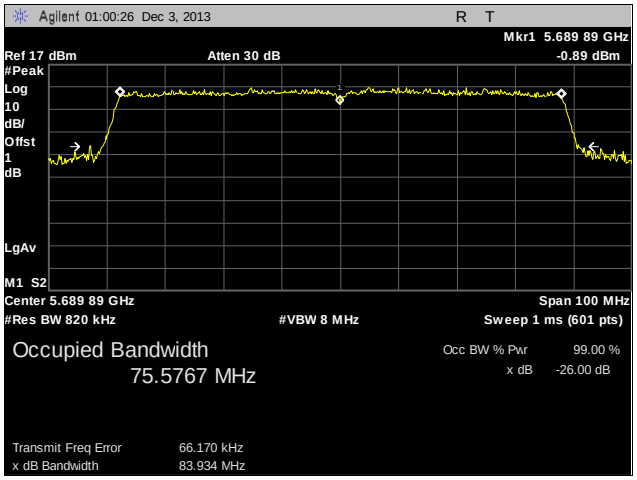
Plot 18. 99% Occupied Bandwidth, Channel 100, Chain 2



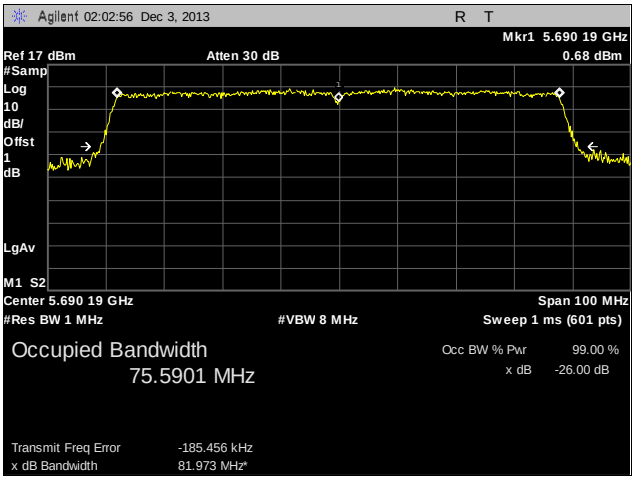
Plot 19. 26 dB Occupied Bandwidth, Channel 132, Chain 0



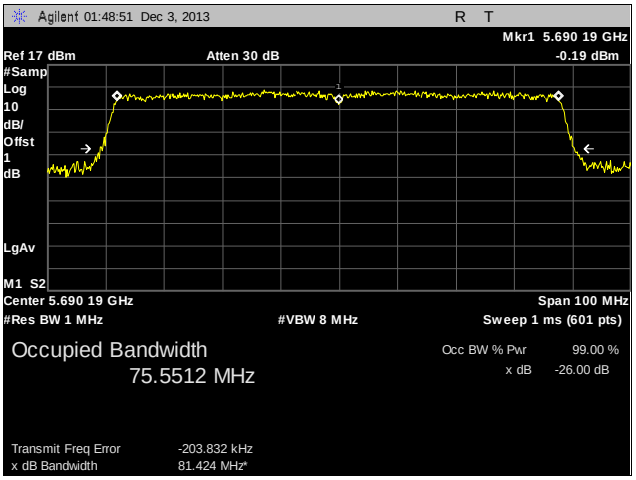
Plot 20. 26 dB Occupied Bandwidth, Channel 132, Chain 1



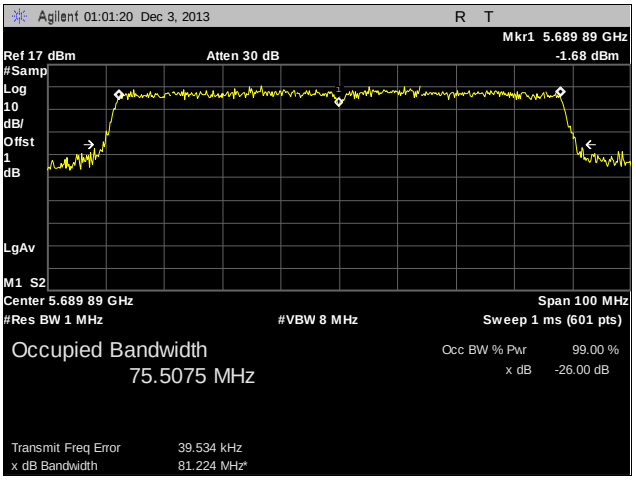
Plot 21. 26 dB Occupied Bandwidth, Channel 132, Chain 2



Plot 22. 99% Occupied Bandwidth, Channel 132, Chain 0



Plot 23. 99% Occupied Bandwidth, Channel 132, Chain 1



Plot 24. 99% Occupied Bandwidth, Channel 132, Chain 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 407(a)(2) RF Power Output

Test Requirements: **§15.407(a)(2):** The maximum output power of the intentional radiator shall not exceed the following:

§15.407(a) (2): For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10log B, where B is the 26 dB emission bandwidth in megahertz.

Test Procedure: The EUT was connected to a Spectrum Analyzer. The power was measured on both channels.

Test Results: Equipment was compliant with the Peak Power Output limits of **§ 15.401(a)(2)**.

Test Engineer(s): Djed Mouada

Test Date(s): 12/04/13 – 12/06/13

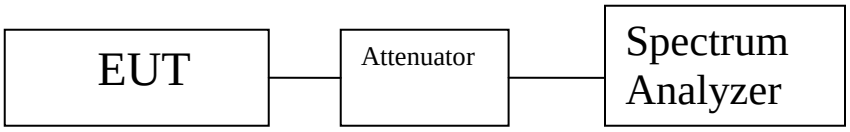
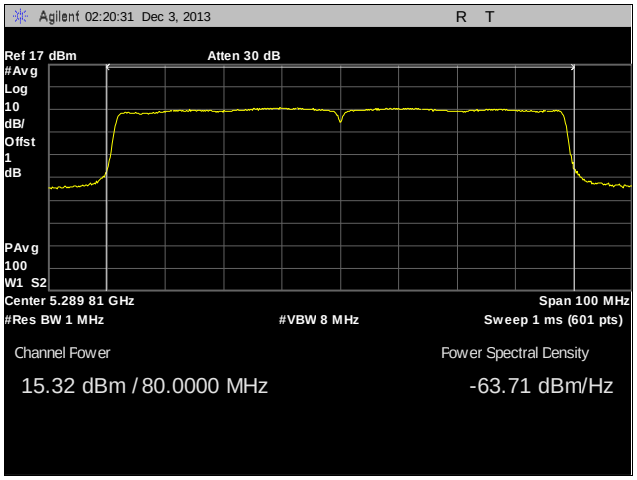


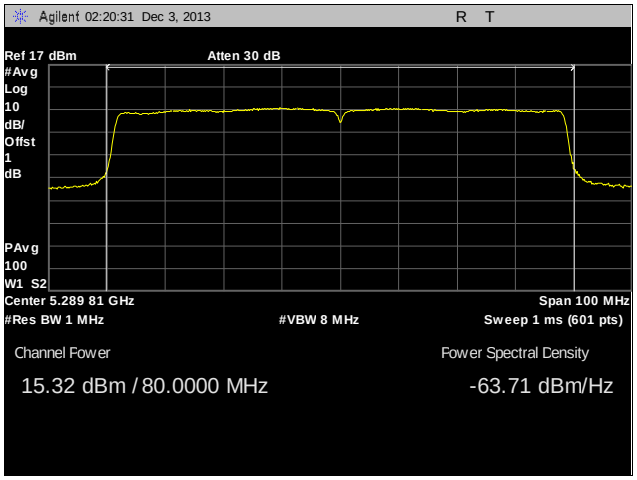
Figure 3. Power Output Test Setup

Channel	Port 0 Power dBm	Port 1 Power dBm	Port 2 Power dBm	Sum Power dBm	Limit Power dBm	Margin dBm
56	15.32	14.44	14.69	19.6	21.53	-1.93
100	14.94	14.26	15.38	19.66	21.53	-1.87
132	15.19	13.86	14.43	19.3	21.53	-2.23

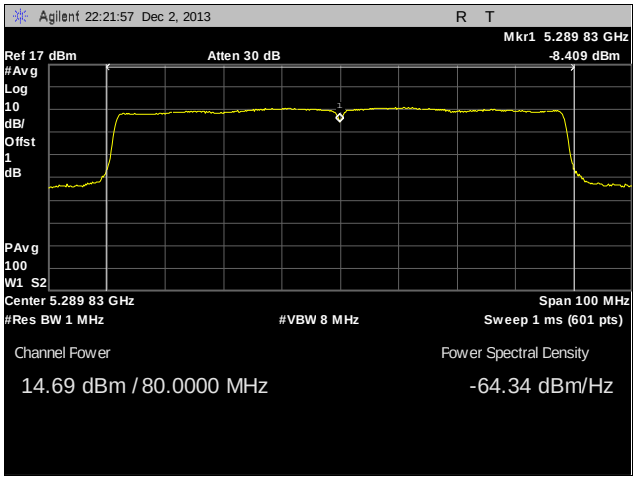
Table 23. RF Power Output, Test Results



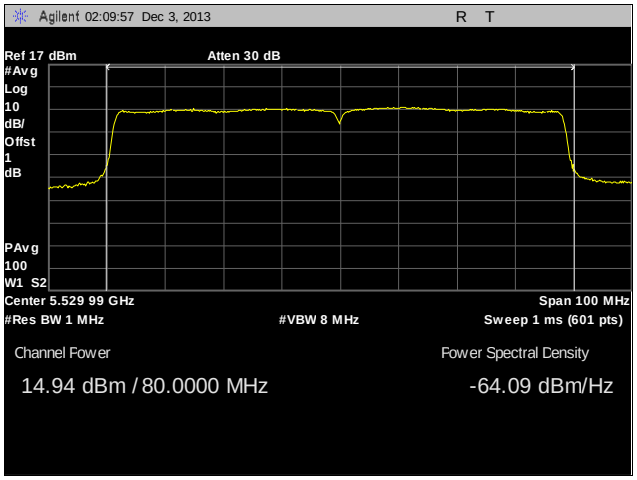
Plot 25. RF Power Output, Channel 56, Chain 0



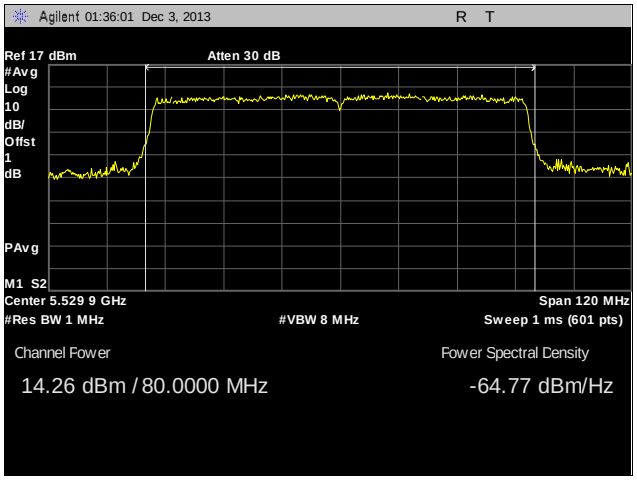
Plot 26. RF Power Output, Channel 56, Chain 1



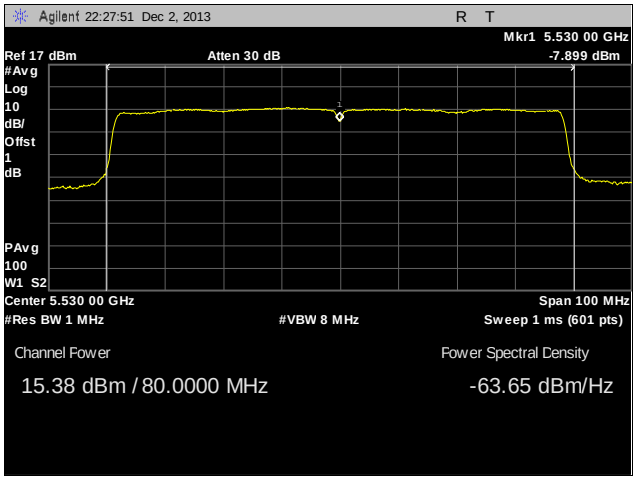
Plot 27. RF Power Output, Channel 56, Chain 2



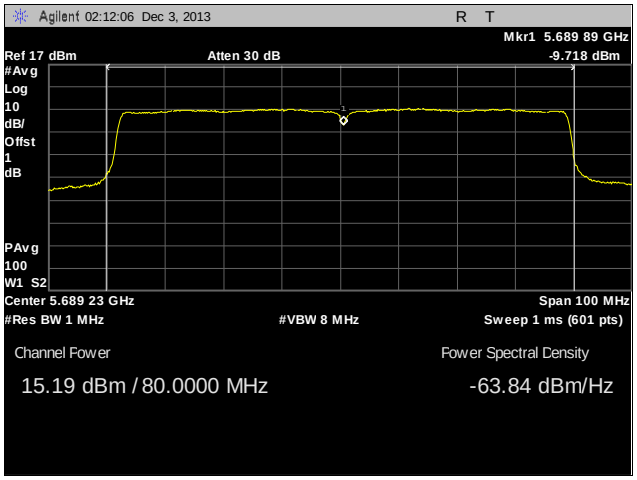
Plot 28. RF Power Output, Channel 100, Chain 0



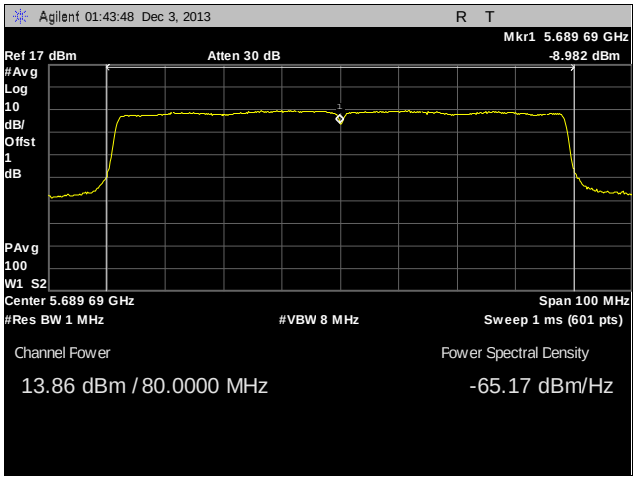
Plot 29. RF Power Output, Channel 100, Chain 1



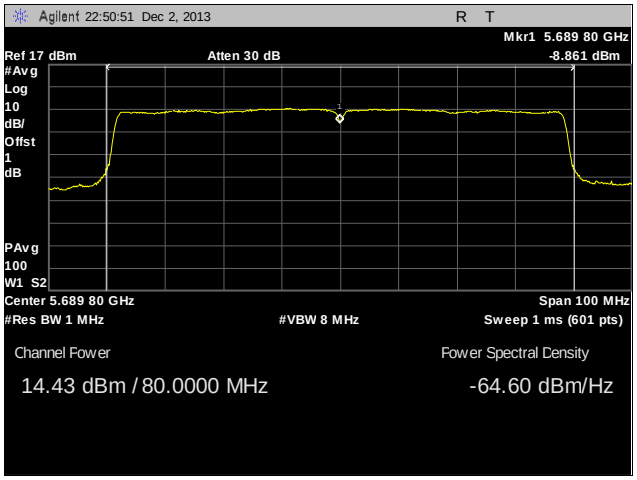
Plot 30. RF Power Output, Channel 100, Chain 2



Plot 31. RF Power Output, Channel 132, Chain 0



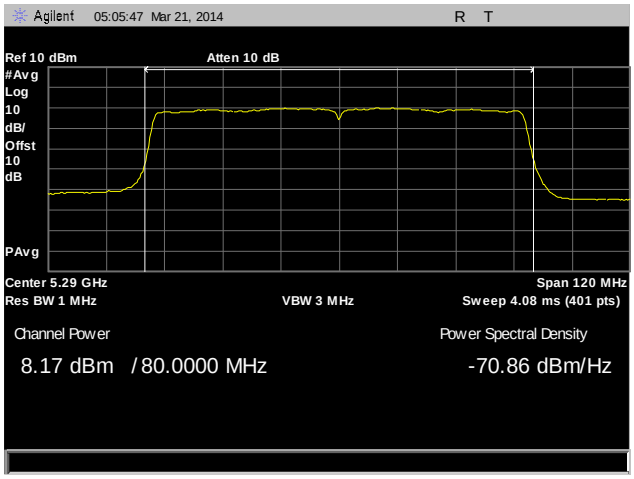
Plot 32. RF Power Output, Channel 132, Chain 1



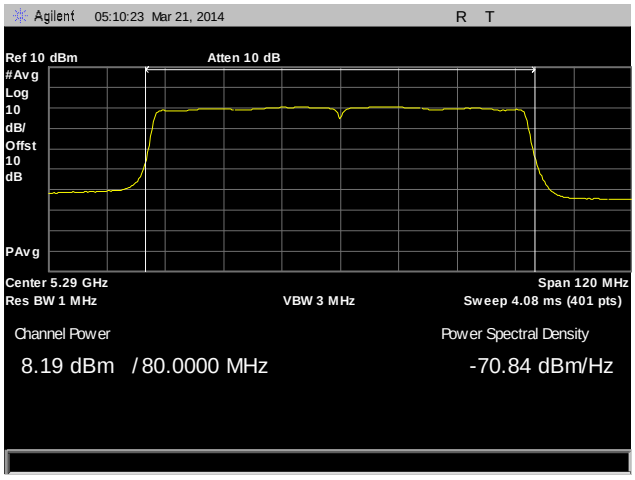
Plot 33. RF Power Output, Channel 132, Chain 2

TPC Requirements:

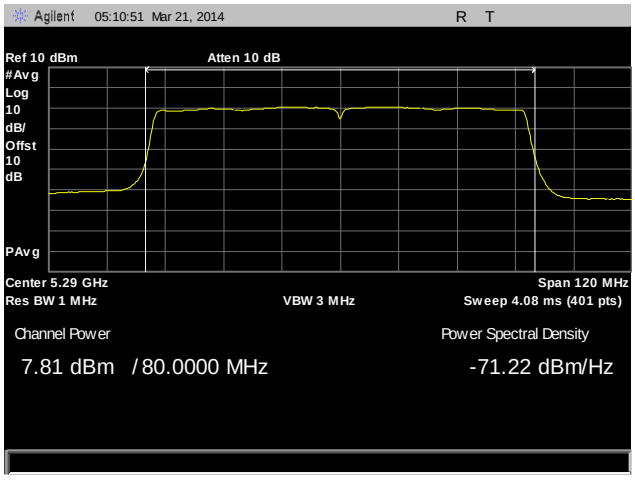
Following plots show that the radio can decrease its power by at least 6 dB from maximum operating power.



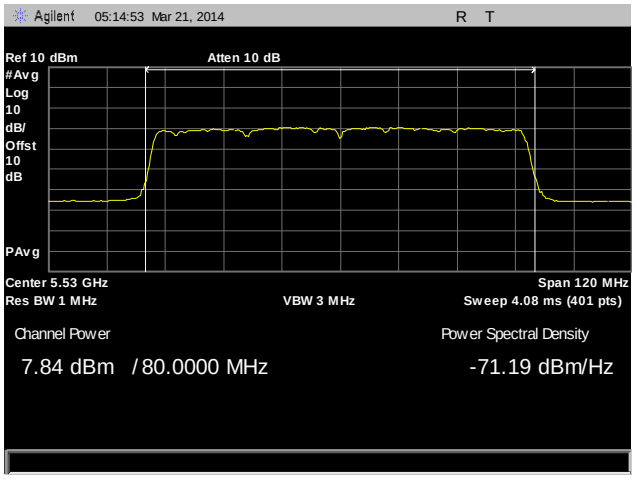
Plot 34. RF Power Output, Channel 56, Chain 0



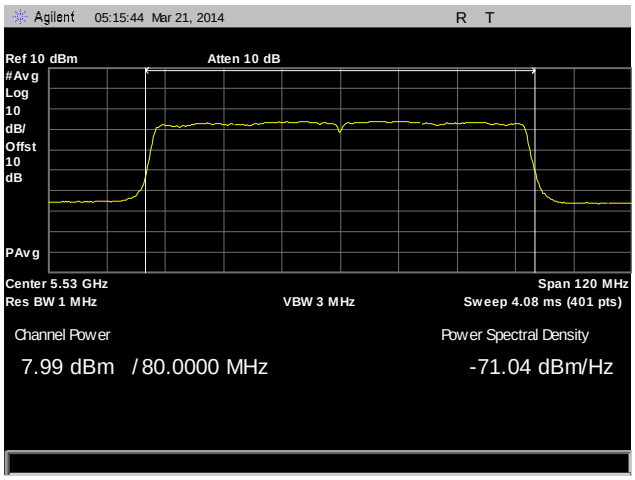
Plot 35. RF Power Output, Channel 56, Chain 1



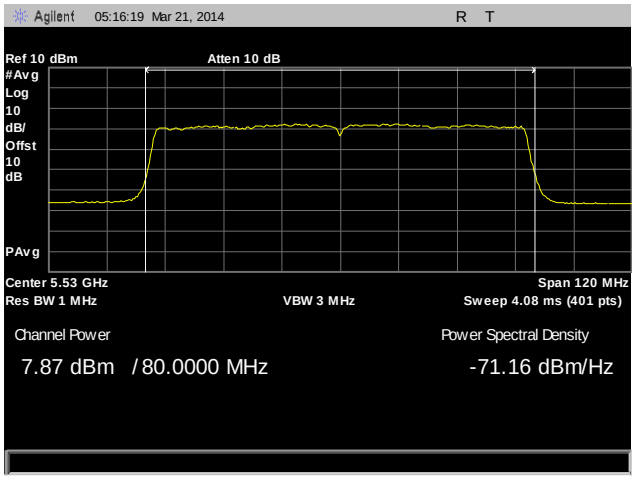
Plot 36. RF Power Output, Channel 56, Chain 2



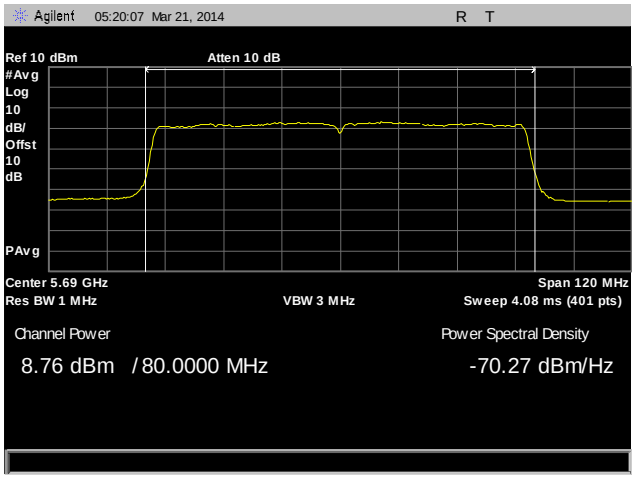
Plot 37. RF Power Output, Channel 100, Chain 0



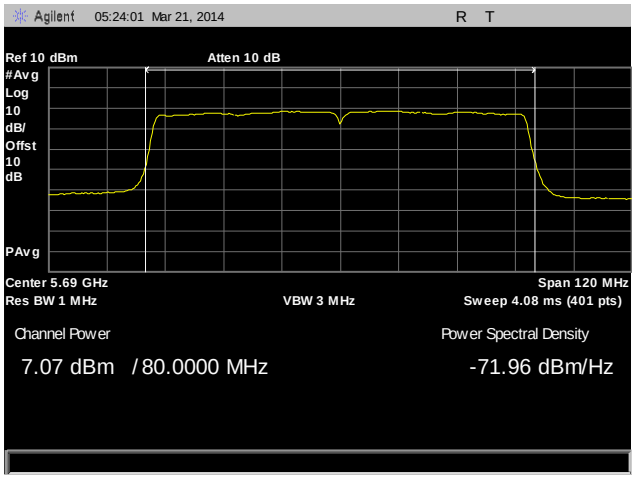
Plot 38. RF Power Output, Channel 100, Chain 1



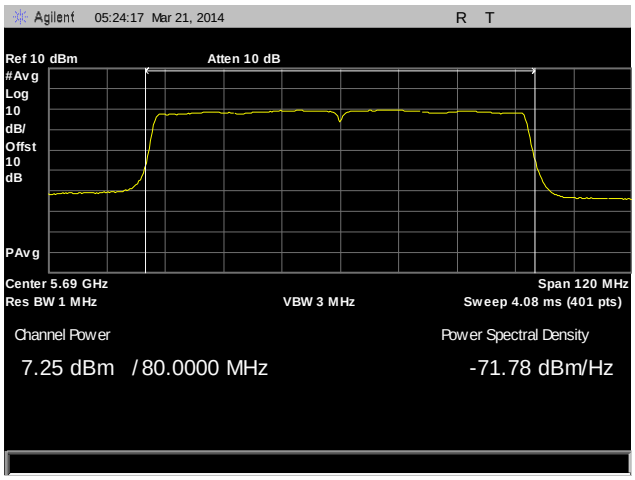
Plot 39. RF Power Output, Channel 100, Chain 2



Plot 40. RF Power Output, Channel 132, Chain 0



Plot 41. RF Power Output, Channel 132, Chain 1



Plot 42. RF Power Output, Channel 132, Chain 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(a)(2) Peak Power Spectral Density

Test Requirements: **§ 15.407(a)(2):** In addition, the peak power spectral density shall not exceed 11 dBm in any 1 megahertz band.

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level on the EUT. The RBW was set to 1MHz and the VBW was set to 3MHz. The method of measurement #2 from the FCC Public Notice DA 02-2138 was used.

Test Results: Equipment was compliant with the peak power spectral density limits of **§ 15.407 (a)(2).** The peak power spectral density was determined from plots on the following page(s).

Test Engineer(s): Djed Mouada

Test Date(s): 12/04/13 – 12/06/13

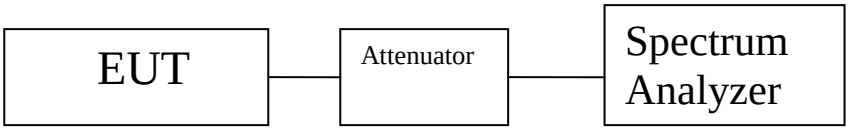
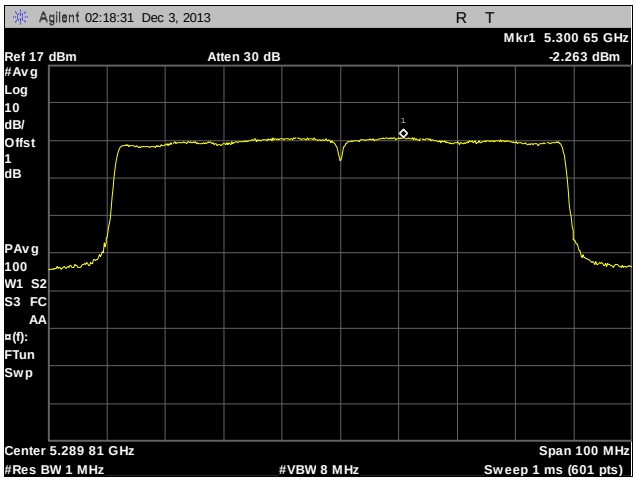


Figure 4. Power Spectral Density Test Setup

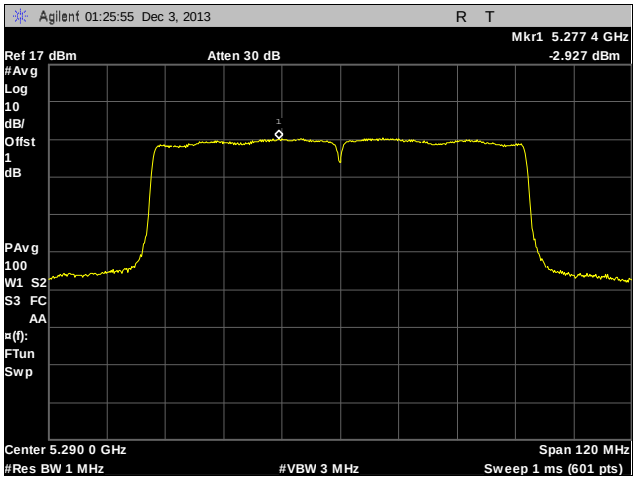
Channel	Port 0 PSD dBm	Port 1 PSD dBm	Port 2 PSD dBm	Sum PSD dBm	Limit PSD dBm	Margin dBm
56	-2.26	-2.93	-2.47	2.23	8.53	-6.3
100	-2.47	-3.36	-2.27	2.1	8.53	-6.43
132	-2.96	-4.3	-2.83	1.46	8.53	-7.07

Table 24. Power Spectral Density, Test Results

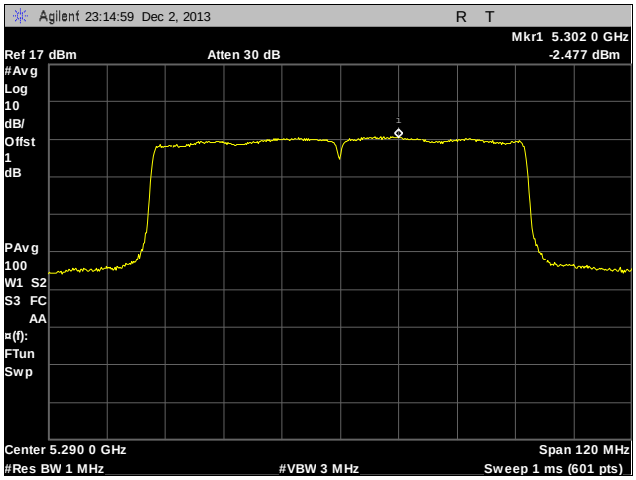
Electromagnetic Compatibility Criteria for Intentional Radiators



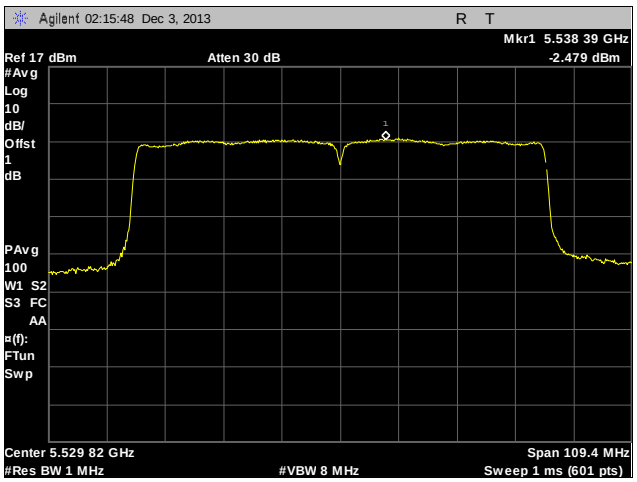
Plot 43. Power Spectral Density, Channel 56, Chain 0



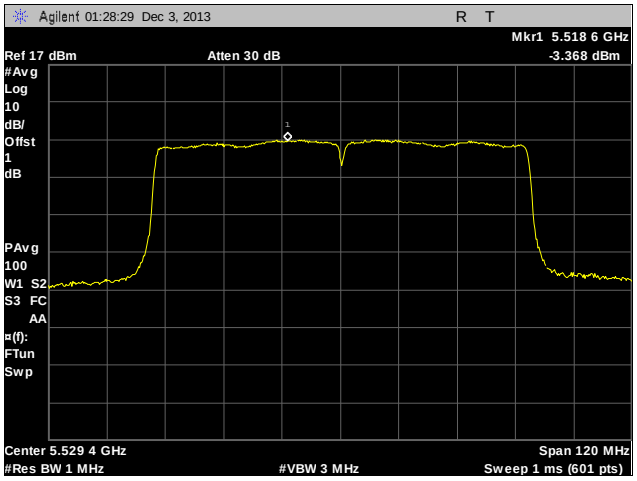
Plot 44. Power Spectral Density, Channel 56, Chain 1



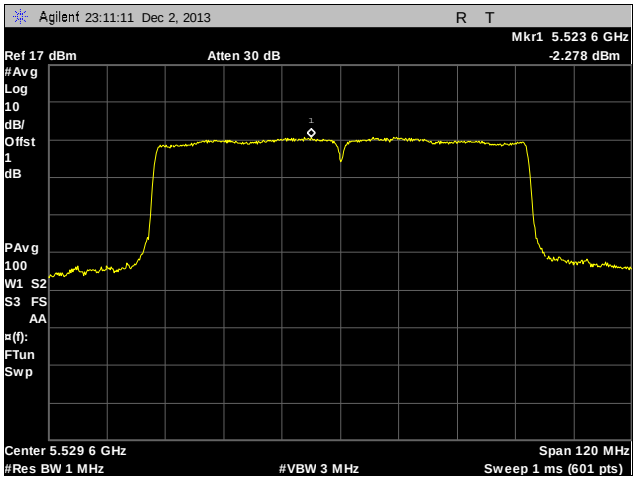
Plot 45. Power Spectral Density, Channel 56, Chain 2



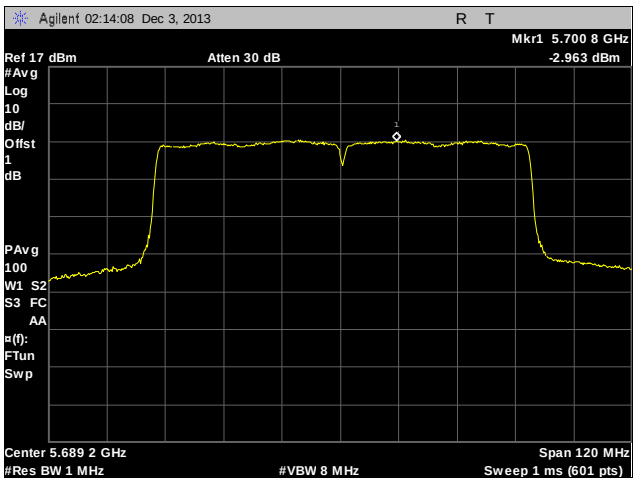
Plot 46. Power Spectral Density, Channel 100, Chain 0



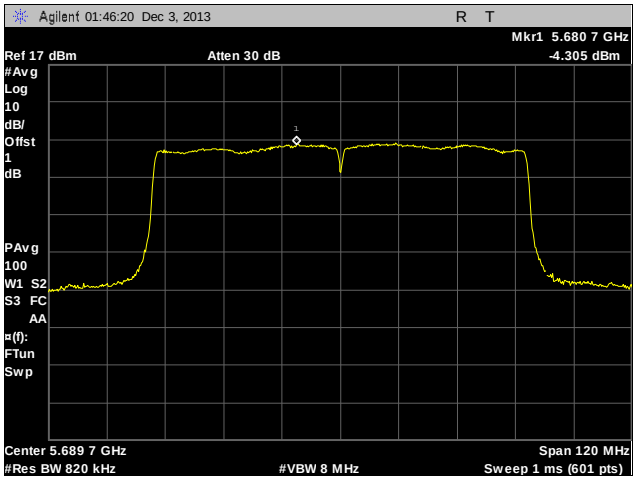
Plot 47. Power Spectral Density, Channel 100, Chain 1



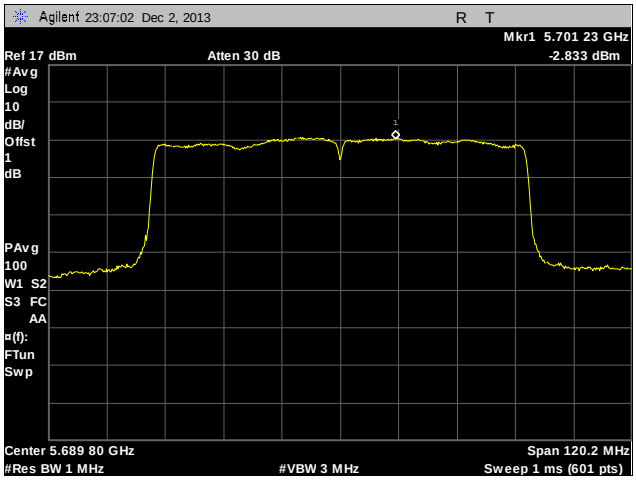
Plot 48. Power Spectral Density, Channel 100, Chain 2



Plot 49. Power Spectral Density, Channel 132, Chain 0



Plot 50. Power Spectral Density, Channel 132, Chain 1



Plot 51. Power Spectral Density, Channel 132, Chain 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(a)(6) Peak Excursion Ratio

Test Requirements: **§ 15.407(a)(6):** The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

Test Procedure: The EUT was connected directly to the spectrum analyzer through cabling and attenuation. Measurements were made according to FCC Public Notice DA 02-2138 for making measurements.

Test Results: Equipment was compliant with the peak excursion ratio limits of **§ 15.407(a)(6).** The peak emissions was first measured then compared to the PSD value.

Test Engineer(s): Djed Mouada

Test Date(s): 12/04/13 – 02/05/14

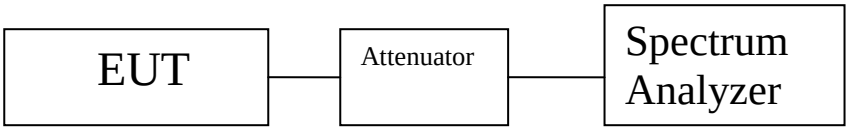
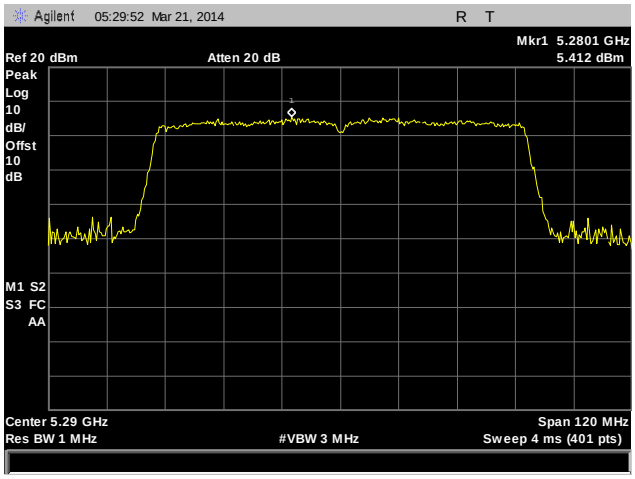


Figure 5. Peak Excursion Ration Test Setup

Channel	Peak Emission (dBm)	PSD (dBm)	Ratio (dB)	Limit (dB)	Margin (dB)
56	5.41	-2.26	7.7	13	-5.3



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(b)(1), (6), (7) Undesirable Emissions

Test Requirements: **§ 15.407(b)(1), (6), (7)**; **§15.205:** Emissions outside the frequency band.

§ 15.407(b)(1): For transmitters operating in the 5.15-5.25 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

§ 15.407(b)(6): Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in Section 15.207.

§ 15.407(b)(7): The provisions of Section 15.205 of this part apply to intentional radiators operating under this section.

Test Procedure: The EUT was placed on a non-conducting 0.8m high stand on a turntable in a semi-anechoic chamber. The EUT was set to transmit on low, mid, and high channels, while the turntable was rotated 360 degrees through three orthogonal axes and the receiving antenna height was varied to maximize emissions.

For frequencies from 30MHz to 1GHz, measurements were first made using a peak detector with a 100kHz resolution bandwidth. Emissions which exceeded the limits were re-measured using a quasi-peak detector with a 120kHz resolution bandwidth.

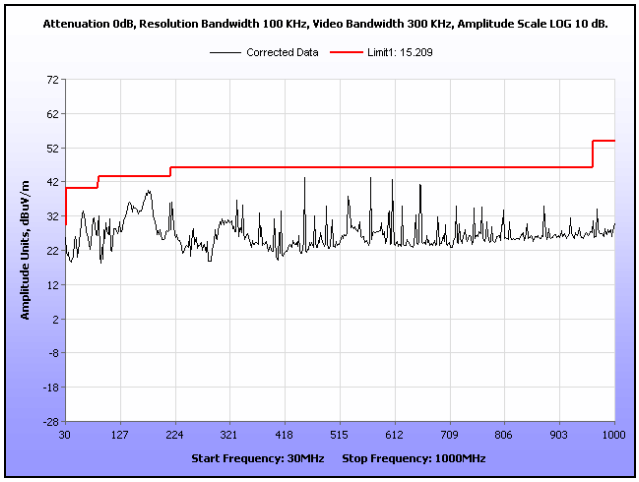
For measurements above 1 GHz, measurements were made with a Peak detector with 1 MHz resolution bandwidth. Where the spurious emissions fell into a restricted band, measurements were also made with an average detector to make sure they complied with 15.209 limits. Emissions were explored up to 40 GHz.
The equation, **EIRP= E + 20 log D – 104.8** was used to convert an EIRP limit to a field strength limit.
E = field strength (dBUv/m)
D = Reference measurement distance

Test Results: The EUT was compliant with the Radiated Emission limits for Intentional Radiators. See following pages for detailed test results. Emissions above 18 GHz are in the noise floor of the spectrum analyzer.

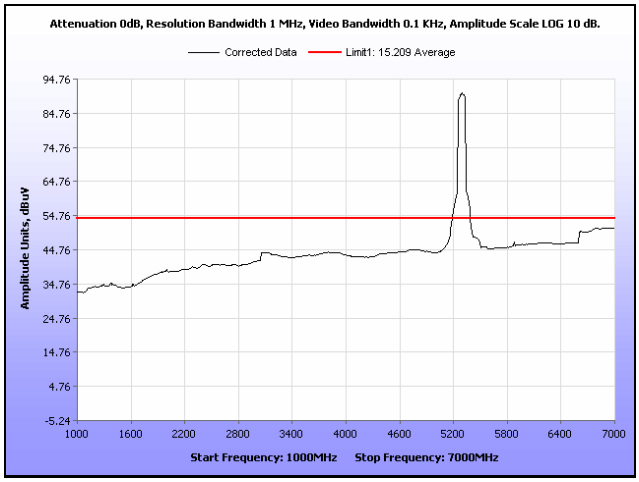
Test Engineer(s): Djed Mouada

Test Date(s): 12/06/13 – 12/09/13

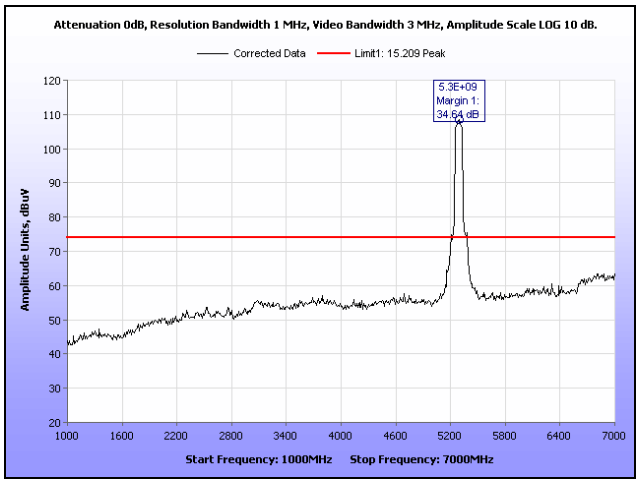
§ 15.209 Radiated Emissions Limits



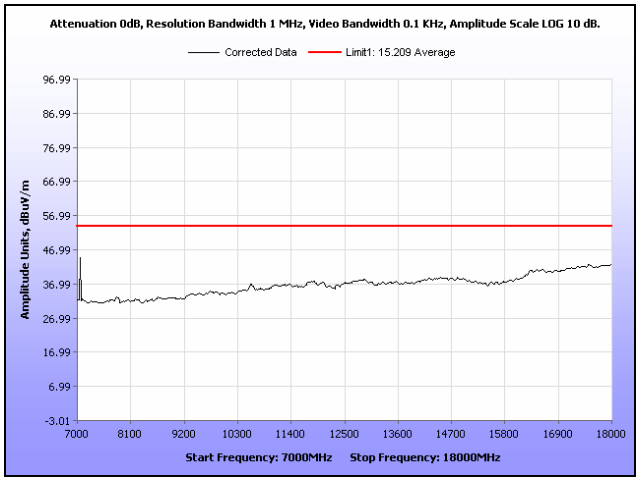
Plot 52. Radiated Spurious Emissions, Channel 56, 30 MHz – 1 GHz



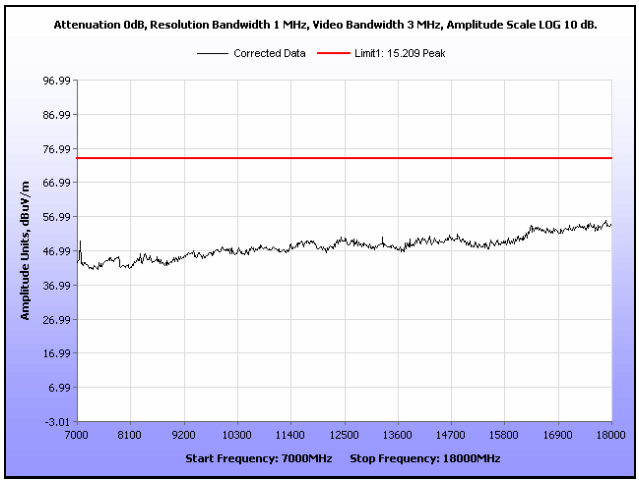
Plot 53. Radiated Spurious Emissions, Channel 56, 1 GHz – 7 GHz, Average



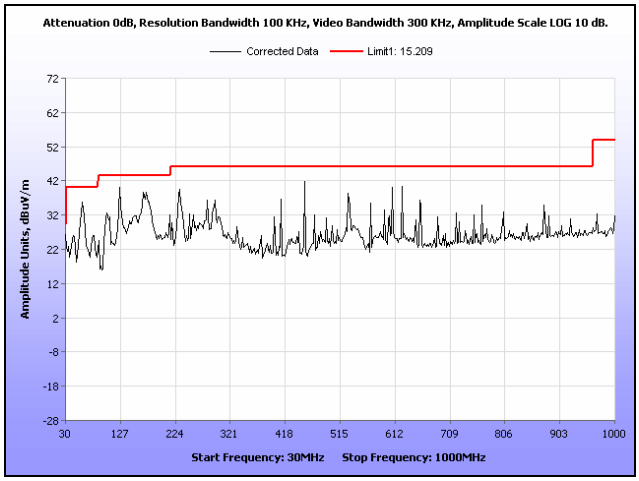
Plot 54. Radiated Spurious Emissions, Channel 56, 1 GHz – 7 GHz, Peak



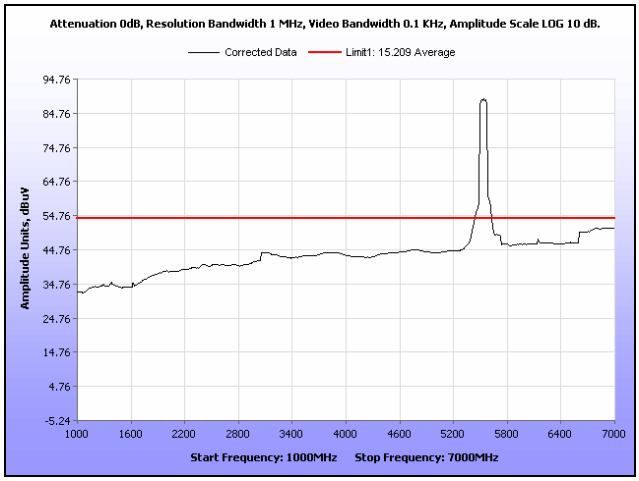
Plot 55. Radiated Spurious Emissions, Channel 56, 7 GHz – 18 GHz, Average



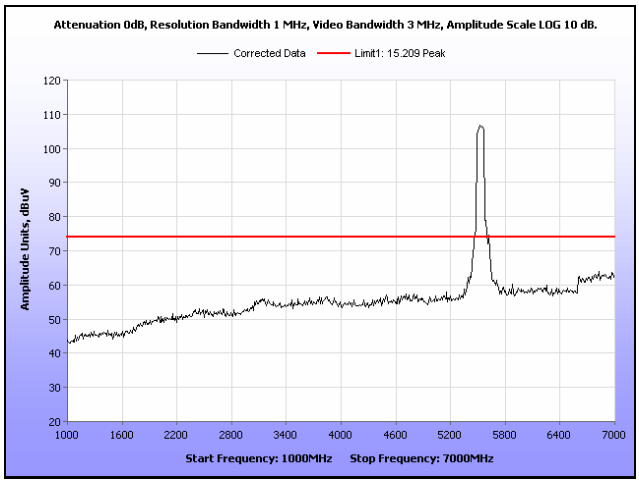
Plot 56. Radiated Spurious Emissions, Channel 56, 7 GHz – 18 GHz, Peak



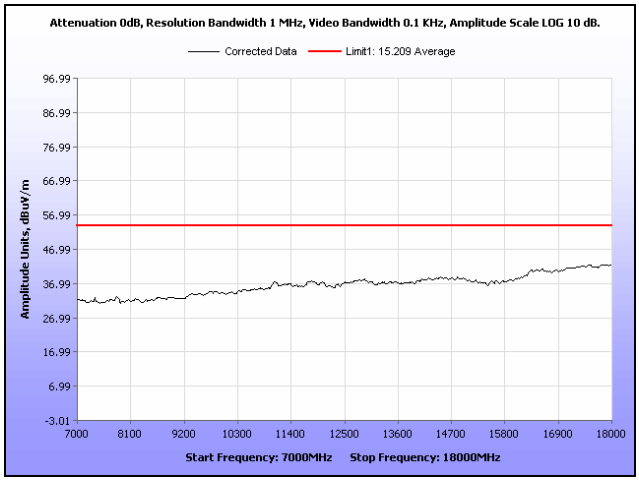
Plot 57. Radiated Spurious Emissions, Channel 100, 30 MHz – 1 GHz



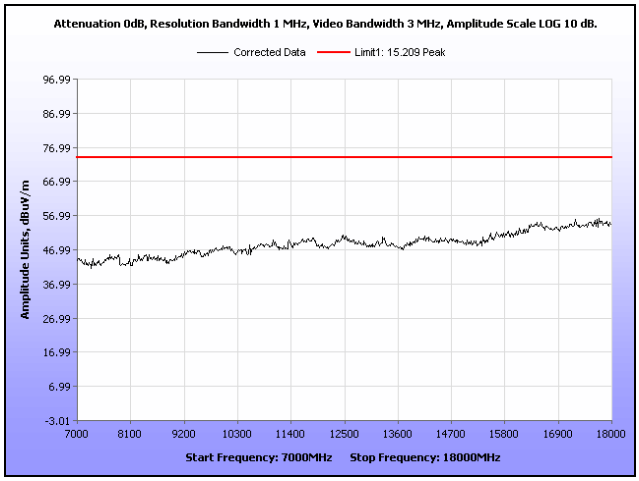
Plot 58. Radiated Spurious Emissions, Channel 100, 1 GHz – 7 GHz, Average



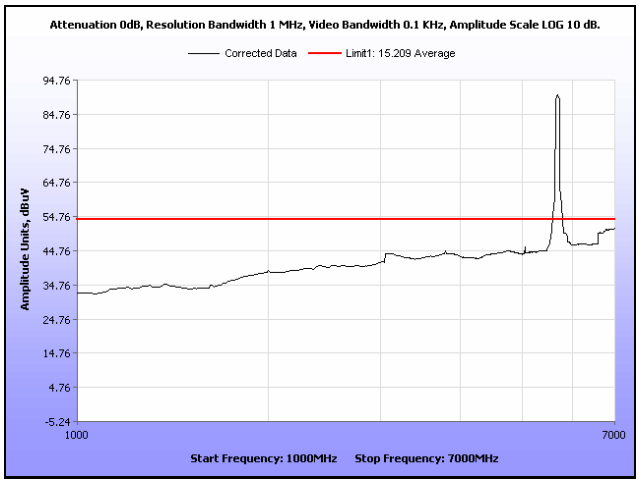
Plot 59. Radiated Spurious Emissions, Channel 100, 1 GHz – 7 GHz, Peak



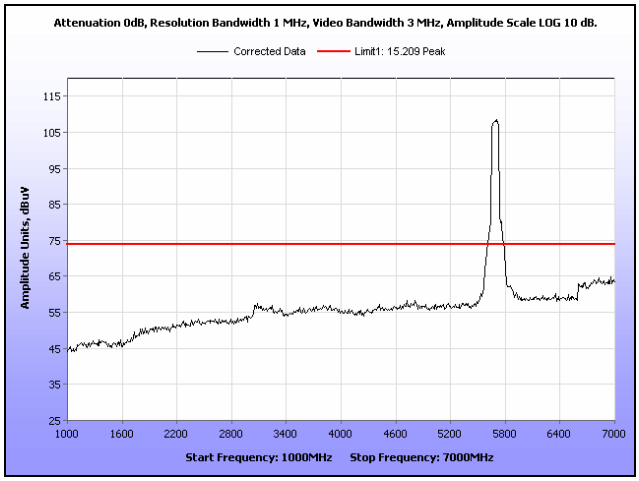
Plot 60. Radiated Spurious Emissions, Channel 100, 7 GHz – 18 GHz, Average



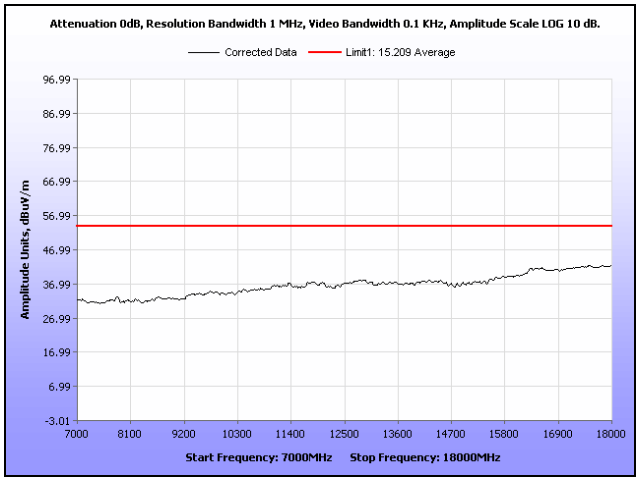
Plot 61. Radiated Spurious Emissions, Channel 100, 7 GHz – 18 GHz, Peak



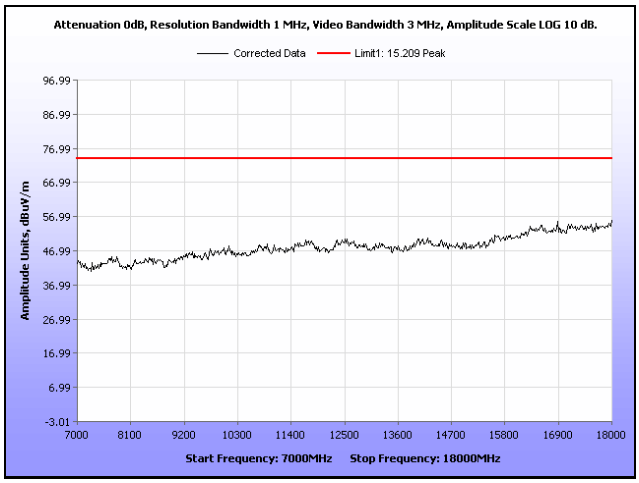
Plot 62. Radiated Spurious Emissions, Channel 132, 1 GHz – 7 GHz, Average



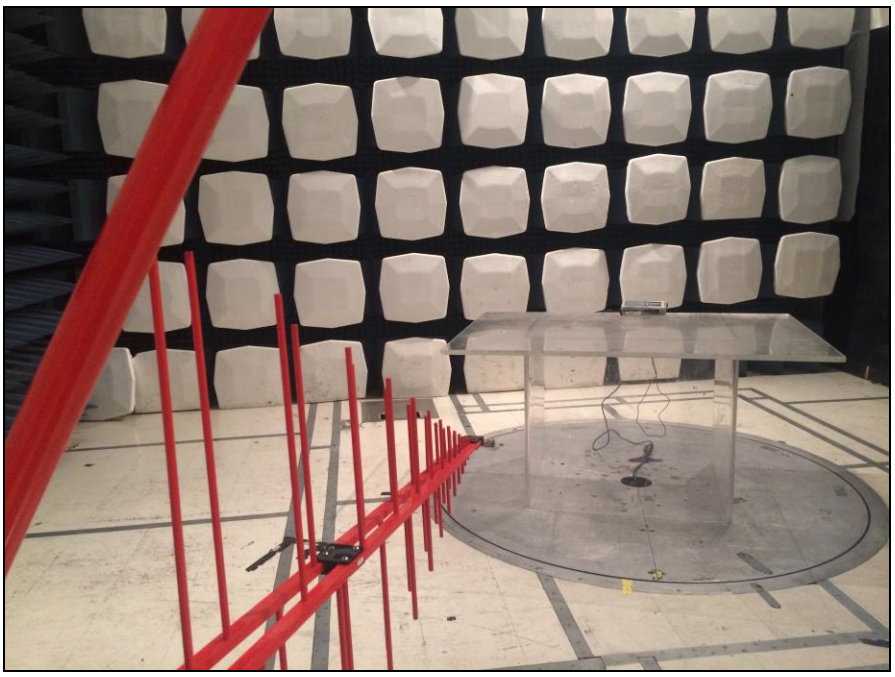
Plot 63. Radiated Spurious Emissions, Channel 132, 1 GHz – 7 GHz, Peak



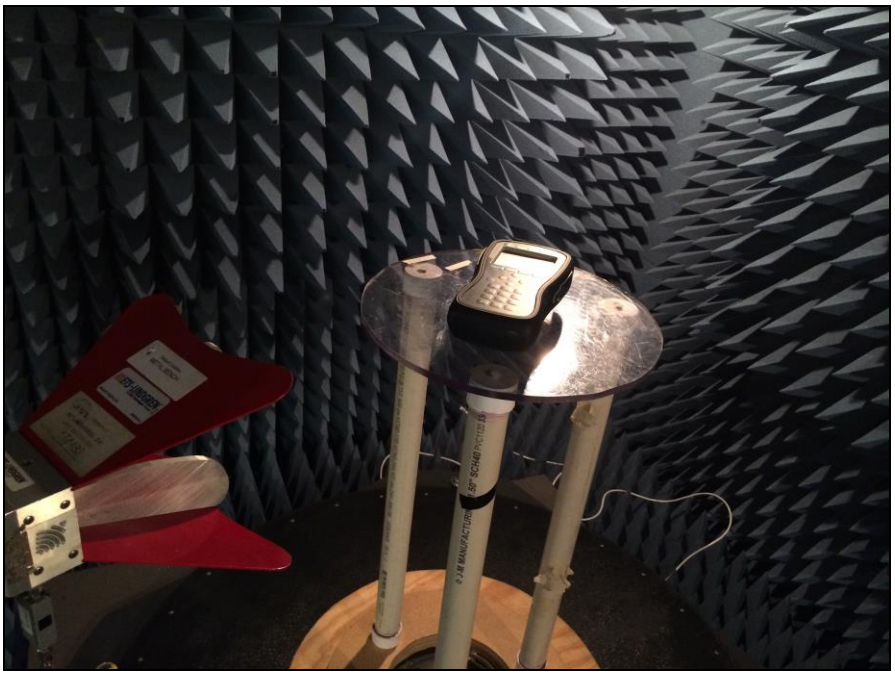
Plot 64. Radiated Spurious Emissions, Channel 132, 7 GHz – 18 GHz, Average



Plot 65. Radiated Spurious Emissions, Channel 132, 7 GHz – 18 GHz, Peak



Photograph 6. Radiated Spurious Emissions, Test Setup. Below 1 GHz



Photograph 7. Radiated Spurious Emissions, Test Setup. Above 1 GHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(f) 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 @ 5.15-5.25, 5.25-5.35 GHz and 5.47-5.725 ; highest conducted power = *19.667 dBm* (peak) therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

EUT maximum antenna gain = *3.7+(10*LOG(3)) dBi.*
= 8.47 dBi
Equation from page 18 of OET 65, Edition 97-01

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

where, S = Power Density
P = Power Input to antenna (92.61mW)
G = Antenna Gain (7.03 numeric)
R = 20 cm

$S = (92.61*7.03/ 4\pi*20^2) = 0.129$ mW/cm^2

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(g) Frequency Stability

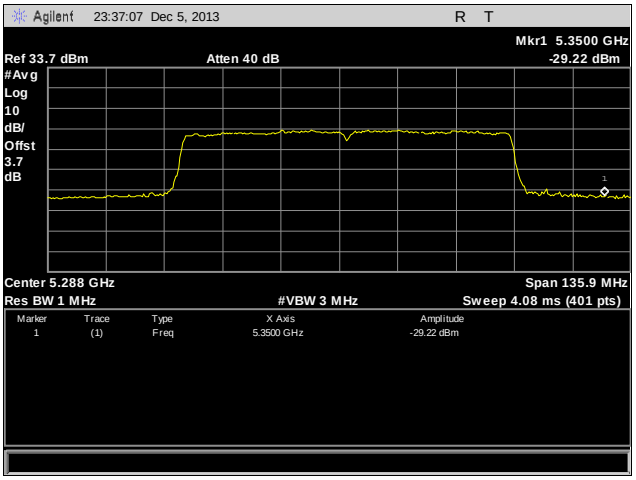
Test Requirements: **§ 15.407(g):** Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

Test Procedure: The EUT was connected directly to a spectrum analyzer through an attenuator and set to transmit at normal operating power. The resolution band width of the spectrum analyzer was set to 1 MHz the Center frequency was set to the band edge (i.e. 5150 MHz). At normal operating temperature, the voltage was varied to (+/-85%), and Then the temperature was changed to extreme conditions while maintaining nominal voltage. The signal was observed for drifts beyond the band edge (Center frequency).

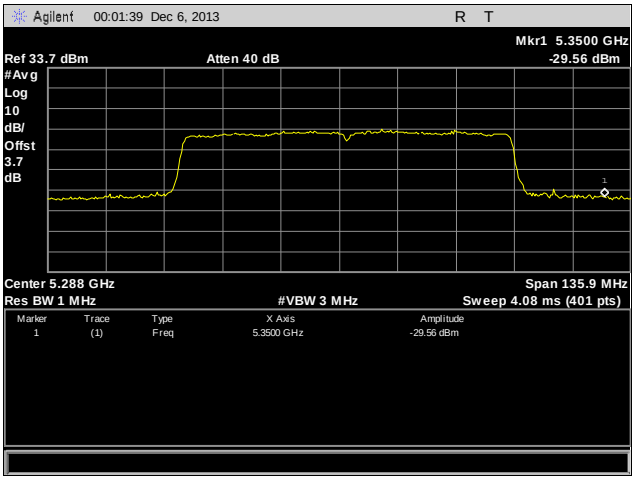
Test Results: The EUT was compliant with the requirements of **§15.407(g)**.

Test Engineer(s): Djed Mouada

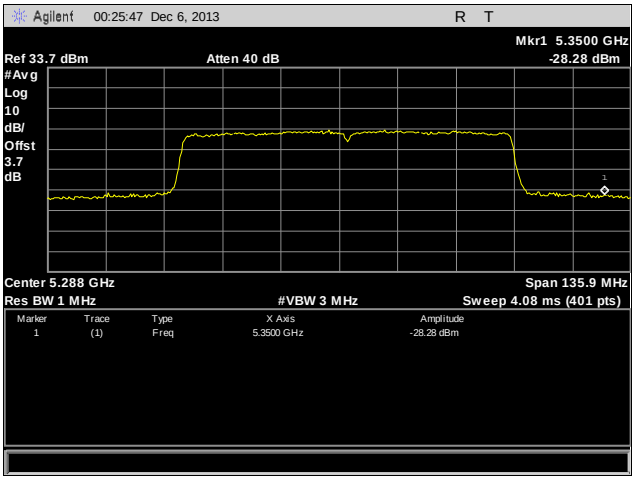
Test Date(s): 12/05/13 – 12/06/13



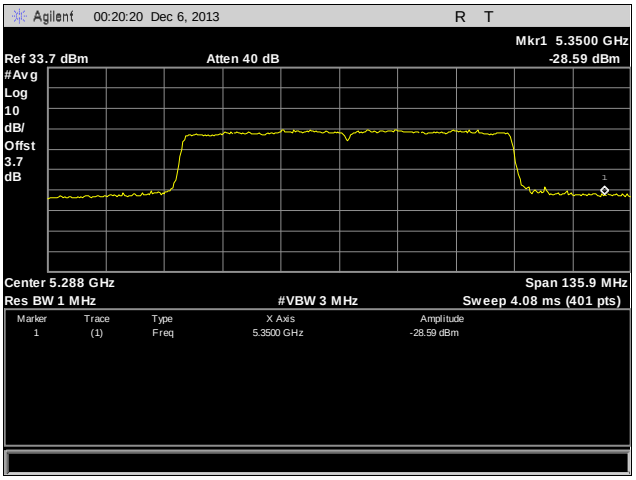
Plot 66. Frequency Stability, Channel 56, 5350 MHz, +5°C, 120V



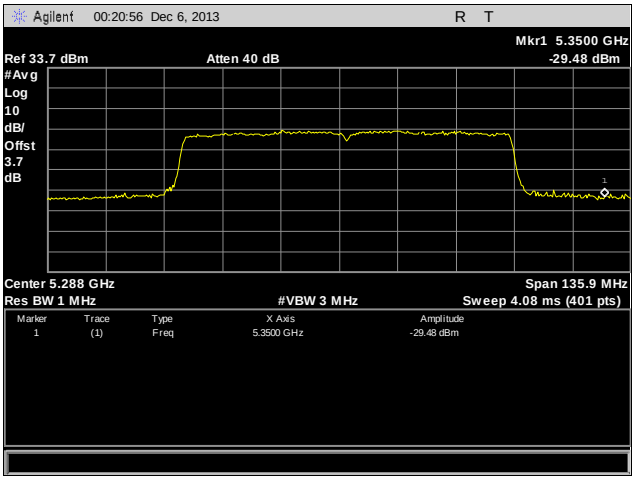
Plot 67. Frequency Stability, Channel 56, 5350 MHz, +15°C, 120V



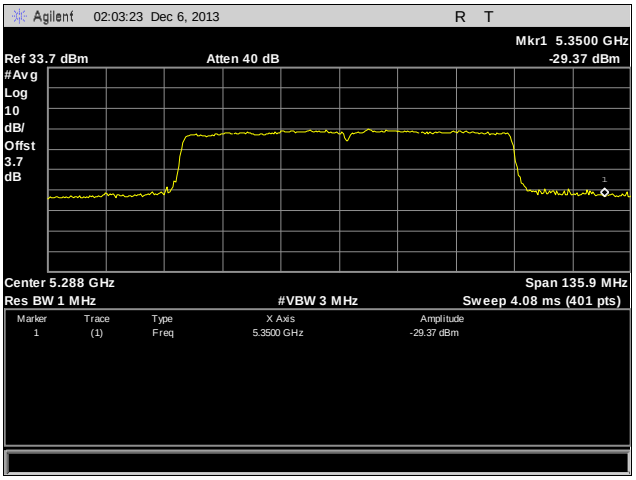
Plot 68. Frequency Stability, Channel 56, 5350 MHz, +20°C, 102V



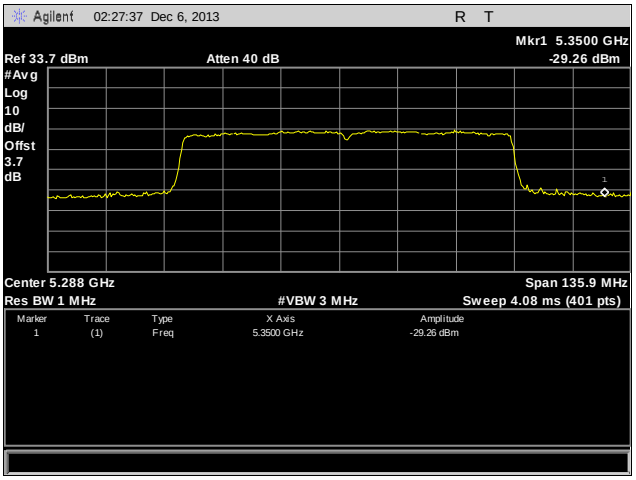
Plot 69. Frequency Stability, Channel 56, 5350 MHz, +20°C, 120V



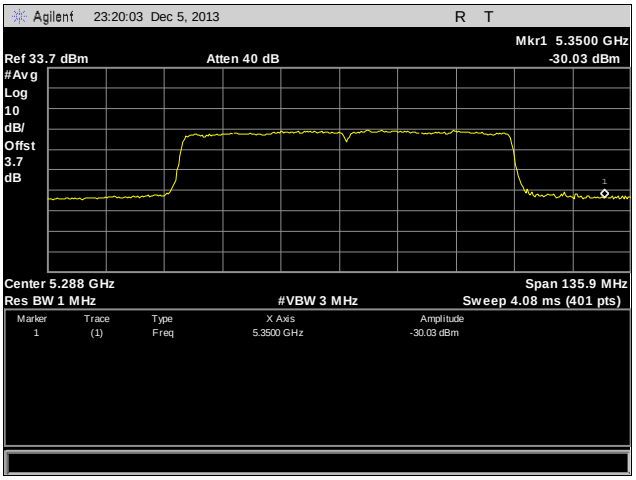
Plot 70. Frequency Stability, Channel 56, 5350 MHz, +20°C, 138V



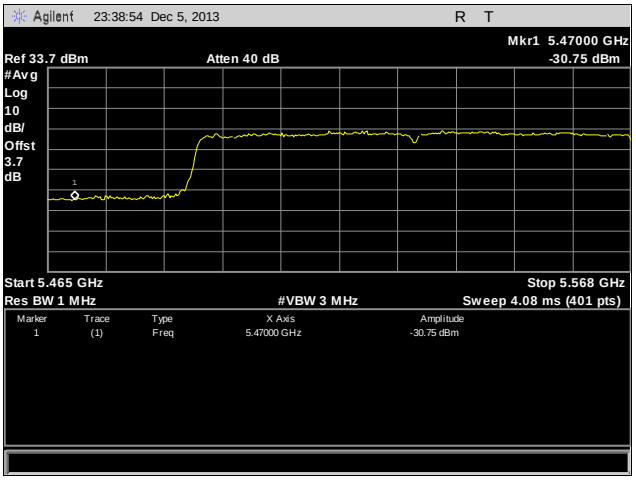
Plot 71. Frequency Stability, Channel 56, 5350 MHz, +30°C, 120V



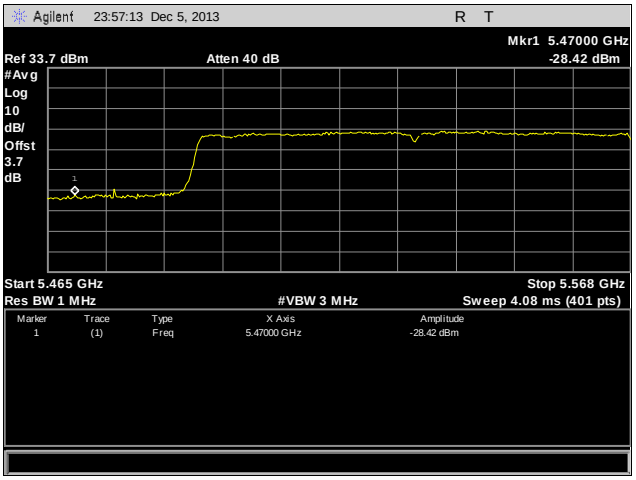
Plot 72. Frequency Stability, Channel 56, 5350 MHz, +40°C, 120V



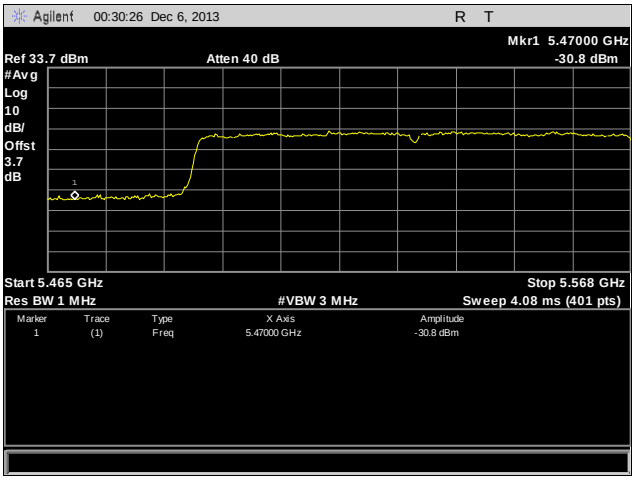
Plot 73. Frequency Stability, Channel 56, 5350 MHz, -5°C, 120V



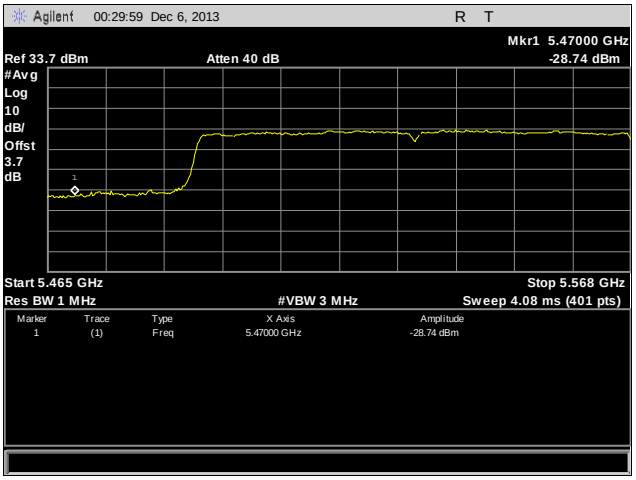
Plot 74. Frequency Stability, Channel 100, 5470 MHz, +5°C, 120V



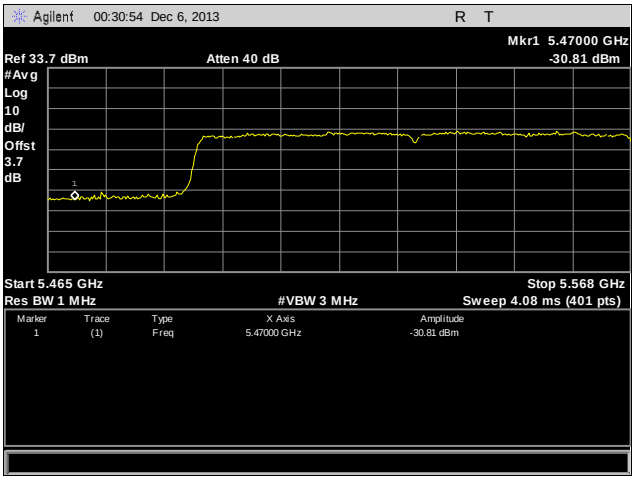
Plot 75. Frequency Stability, Channel 100, 5470 MHz, +15°C, 120V



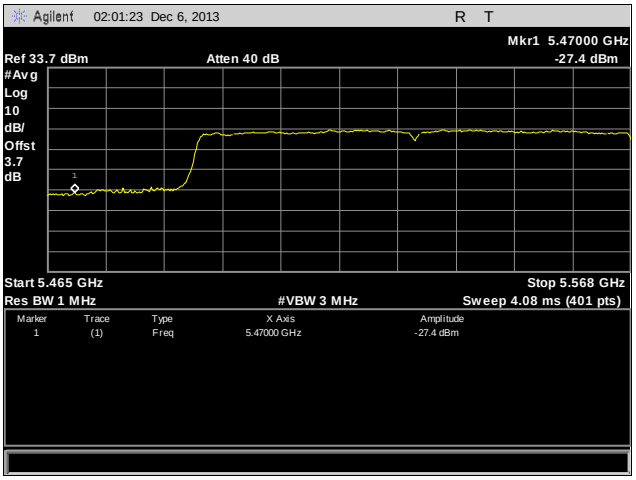
Plot 76. Frequency Stability, Channel 100, 5470 MHz, +20°C, 102V



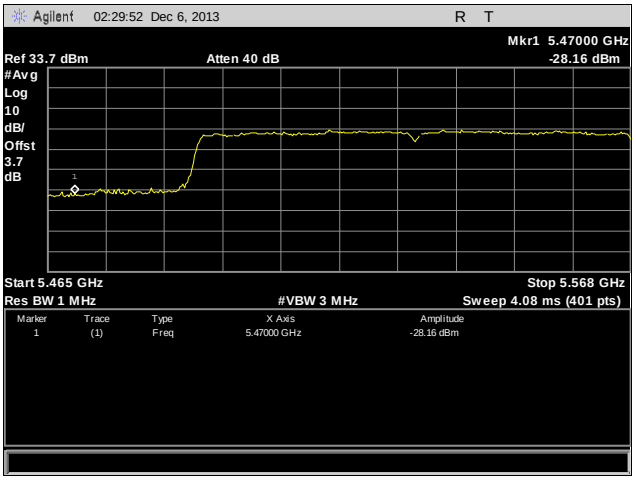
Plot 77. Frequency Stability, Channel 100, 5470 MHz, +20°C, 120V



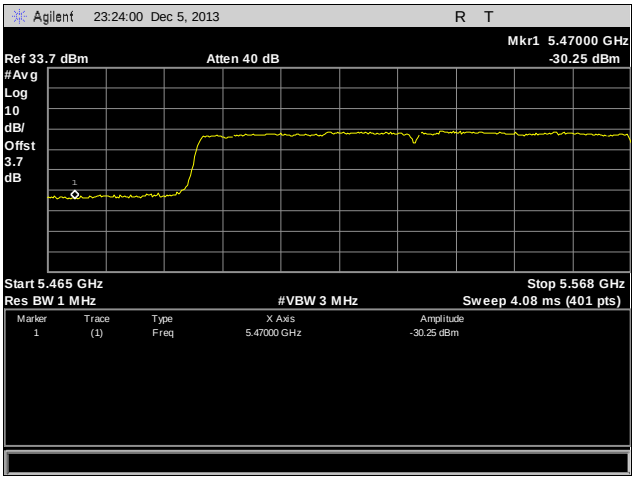
Plot 78. Frequency Stability, Channel 100, 5470 MHz, +20°C, 138V



Plot 79. Frequency Stability, Channel 100, 5470 MHz, +30°C, 120V



Plot 80. Frequency Stability, Channel 100, 5470 MHz, +40°C, 120V



Plot 81. Frequency Stability, Channel 100, 5470 MHz, -5°C, 120V

V. DFS Requirements and Radar Waveform Description & Calibration

A. DFS Requirements

Requirement	Operational Mode		
	Master	Client Without Radar Detection	Client With Radar Detection
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
Uniform Spreading	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 25. Applicability of DFS Requirements Prior to Use of a Channel

Requirement	Operational Mode		
	Master	Client Without Radar Detection	Client With Radar Detection
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	Yes	Yes
Channel Move Time	Yes	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 26. Applicability of DFS Requirements During Normal Operation

Maximum Transmit Power	Value
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna **Note 2:** Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.	

Table 27. DFS Detection Thresholds for Master or Client Devices Incorporating DFS

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds See Note 1
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2
U-NII Detection Bandwidth	Minimum 80% of the 99% power bandwidth. See Note 3.

Note 1: The instant that the *Channel Move Time* and the *Channel Closing Transmission Time* begins is as follows:

- For the Short pulse radar Test Signals this instant is the end of the *Burst*.
- For the Frequency Hopping radar Test Signal, this instant is the end of the last radar *Burst* generated.
- For the Long Pulse radar Test Signal this instant is the end of the 12 second period defining the radar transmission.

Note 2: The *Channel Closing Transmission Time* is comprised of 200 milliseconds starting at the beginning of the *Channel Move Time* plus any additional intermittent control signals required facilitating *Channel* changes (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Note 3: During the *U-NII Detection Bandwidth* detection test, radar type 1 is used and for each frequency step the minimum percentage of detection is 90%. Measurements are performed with no data traffic.

Table 28. DFS Response Requirement Values

B. Radar Test Waveforms

This section provides the parameters for required test waveforms, minimum percentage of successful detections, and the minimum number of trials that must be used for determining DFS conformance. Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Trials
1	1	1428	18	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

A minimum of 30 unique waveforms are required for each of the short pulse radar types 2 through 4. For short pulse radar type 1, the same waveform is used a minimum of 30 times. If more than 30 waveforms are used for short pulse radar types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. The aggregate is the average of the percentage of successful detections of short pulse radar types 1-4.

Long Pulse Radar Test Waveform

Radar Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Number of Pulses per Bursts	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

The parameters for this waveform are randomly chosen. Thirty unique waveforms are required for the Long Pulse radar test signal. If more than 30 waveforms are used for the Long Pulse radar test signal, then each additional waveform must also be unique and not repeated from the previous waveforms.

Each waveform is defined as follows:

1) The transmission period for the Long Pulse Radar test signal is 12 seconds.
2) There are a total of 8 to 20 Bursts in the 12 second period, with the number of Bursts being randomly chosen. This number is Burst_Count.
3) Each Burst consists of 1 to 3 pulses, with the number of pulses being randomly chosen. Each Burst within the 12 second sequence may have a different number of pulses.
4) The pulse width is between 50 and 100 microseconds, with the pulse width being randomly chosen. Each pulse within a Burst will have the same pulse width. Pulses in different Bursts may have different pulse widths.
5) Each pulse has a linear FM chirp between 5 and 20 MHz, with the chirp width being randomly chosen. Each pulse within a Burst will have the same chirp width. Pulses in different Bursts may have different chirp widths. The chirp is centered on the pulse. For example, with radar frequency of 5300 MHz and a 20 MHz chirped signal, the chirp starts at 5290 MHz and ends at 5310 MHz.
6) If more than one pulse is present in a Burst, the time between the pulses will be between 1000 and 2000 microseconds, with the time being randomly chosen. If three pulses are present in a Burst, the time between the first and second pulses is chosen independently of the time between the second and third pulses.
7) The 12 second transmission period is divided into even intervals. The number of intervals is equal to Burst_Count. Each interval is of length (12,000,000 / Burst_Count) microseconds. Each interval contains one Burst. The start time for the Burst, relative to the beginning of the interval, is between 1 and [(12,000,000 / Burst_Count) – (Total Burst Length) + (One Random PRI Interval)] microseconds, with the start time being randomly chosen. The step interval for the start time is 1 microsecond. The start time for each Burst is chosen independently.

A representative example of a Long Pulse radar test waveform:

1) The total test signal length is 12 seconds.
2) 8 Bursts are randomly generated for the Burst_Count.
3) Burst 1 has 2 randomly generated pulses.
4) The pulse width (for both pulses) is randomly selected to be 75 microseconds.
5) The PRI is randomly selected to be at 1213 microseconds.
6) Bursts 2 through 8 are generated using steps 3 – 5.
7) Each Burst is contained in even intervals of 1,500,000 microseconds. The starting location for Pulse 1, Burst 1 is randomly generated (1 to 1,500,000 minus the total Burst 1 length + 1 random PRI interval) at the 325,001 microsecond step. Bursts 2 through 8 randomly fall in successive 1,500,000 microsecond intervals (i.e. Burst 2 falls in the 1,500,001 – 3,000,000 microsecond range).

Graphical Representation of a Long Pulse radar Test Waveform

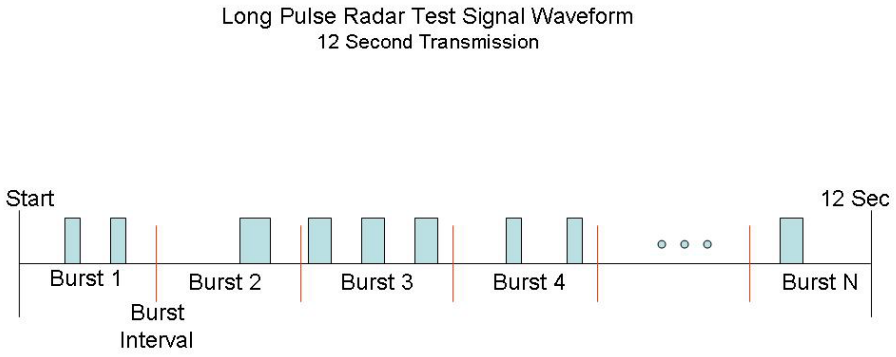


Figure 6. Long Pulse Radar Test Signal Waveform

Frequency Hopping Radar Test Waveform

Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	9	.333	300	70%	30

For the Frequency Hopping Radar Type, the same *Burst* parameters are used for each waveform. The hopping sequence is different for each waveform and a 100-length segment is selected1 from the hopping sequence defined by the following algorithm:

The first frequency in a hopping sequence is selected randomly from the group of 475 integer frequencies from 5250 – 5724 MHz. Next, the frequency that was just chosen is removed from the group and a frequency is randomly selected from the remaining 474 frequencies in the group. This process continues until all 475 frequencies are chosen for the set. For selection of a random frequency, the frequencies remaining within the group are always treated as equally likely.

C. Radar Waveform Calibration

The following equipment setup was used to calibrate the radiated Radar Waveform. A spectrum analyzer was used to establish the test signal level for each radar type. During this process there were no transmissions by either the Master or Client Device. The spectrum analyzer was switched to the zero span (Time Domain) mode at the frequency of the Radar Waveform generator. Peak detection was utilized. The spectrum analyzer's resolution bandwidth (RBW) was set to 3 MHz and the video bandwidth (VBW) was set to 3 MHz. The calibration setup is diagrammed in Figure 7, and the radar test signal generator is shown in Photograph 7.

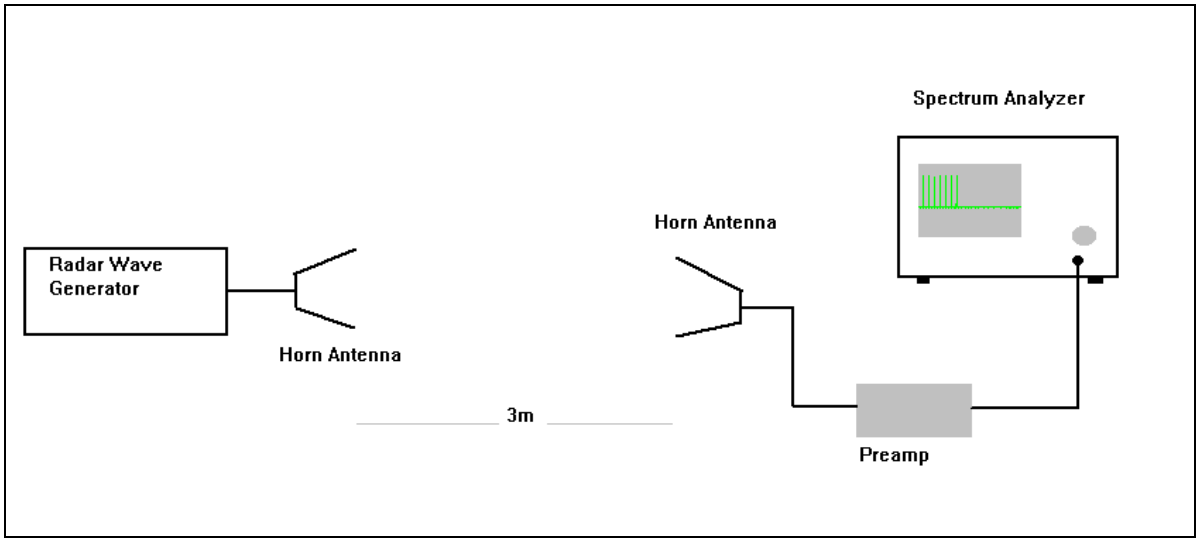
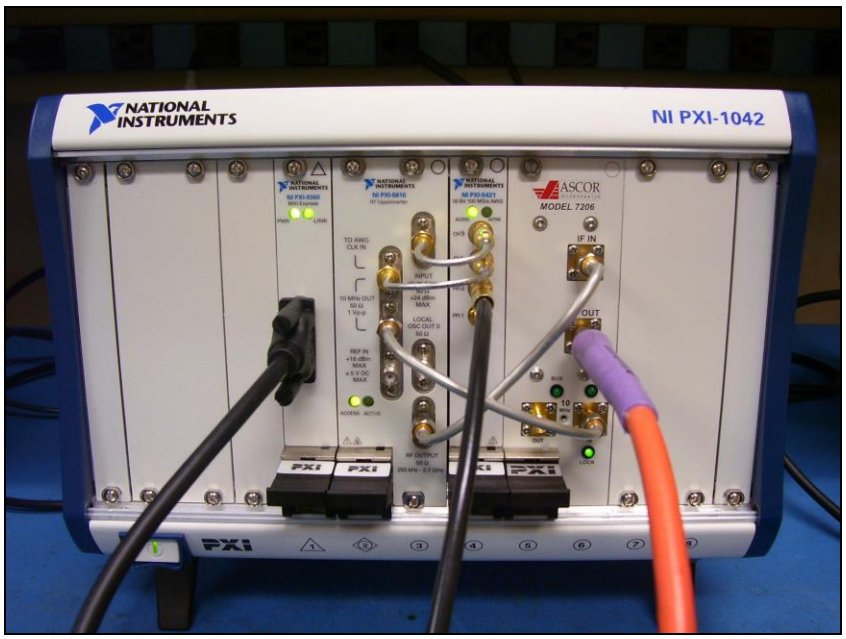
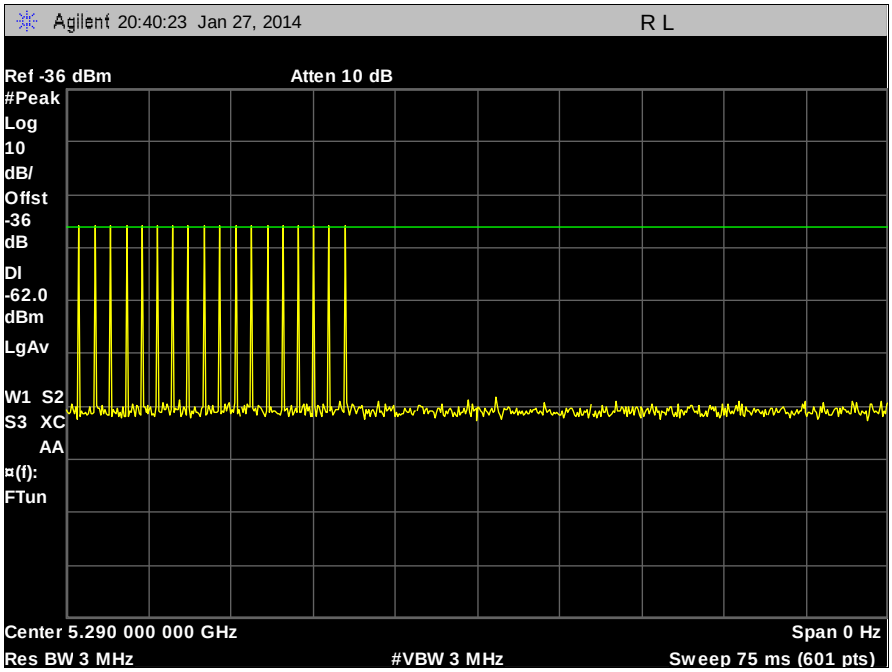


Figure 7. Calibration Test setup



Photograph 7. DFS Radar Test Signal Generator

Radar Waveform Calibration



Plot 82. Calibration, Channel 5290 MHz

VI. DFS Test Procedure and Test Results

A. DFS Test Setup

1. A spectrum analyzer is used as a monitor to verify that the Unit Under Test (UUT) has vacated the Channel within the Channel Closing Transmission Time and Channel Move Time, and does not transmit on a Channel during the Non-Occupancy Period after the detection and subsequent Channel move. It is also used to monitor UUT transmissions during the Channel Availability Check Time.
2. The test setup, which consists of test equipment and equipment under test (EUT), is diagrammed in Figure 8 and pictured in Photograph .

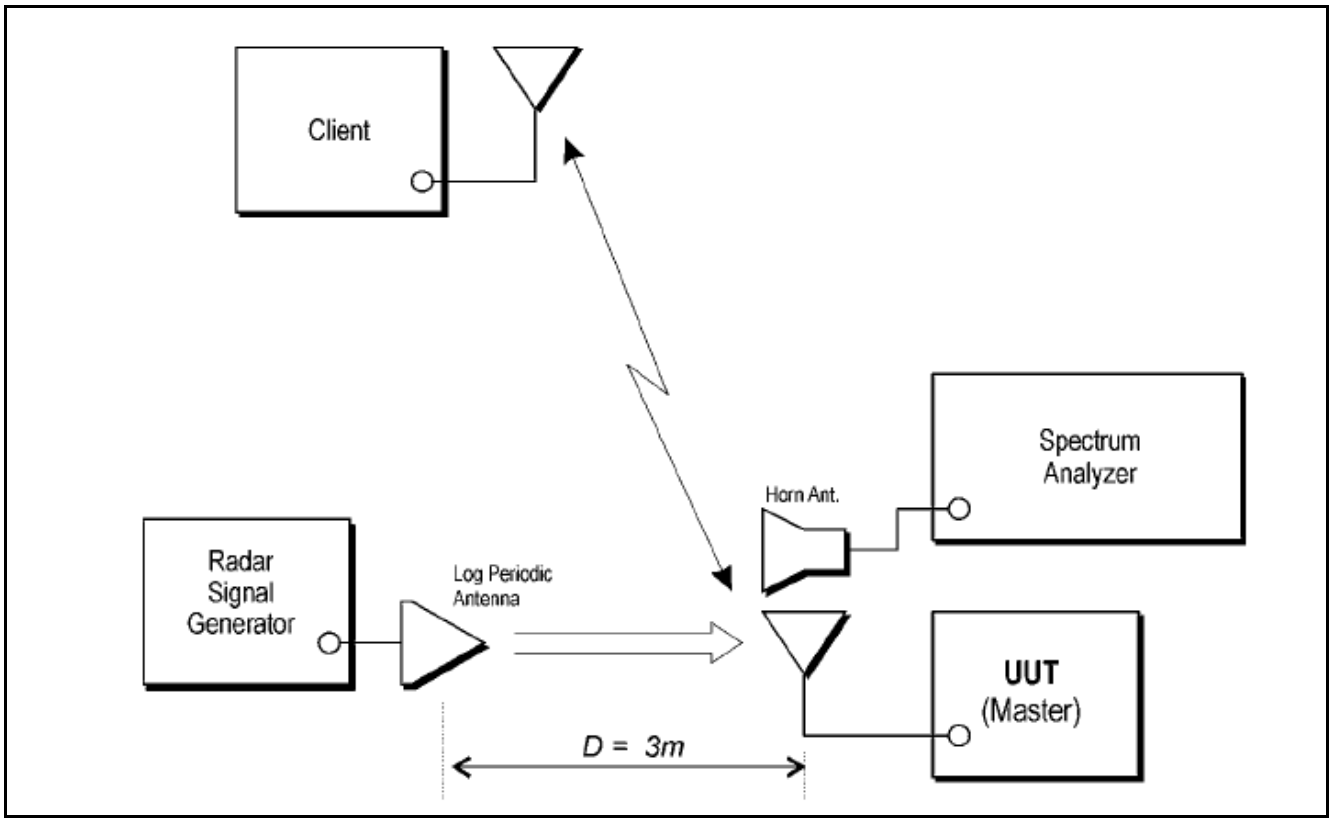
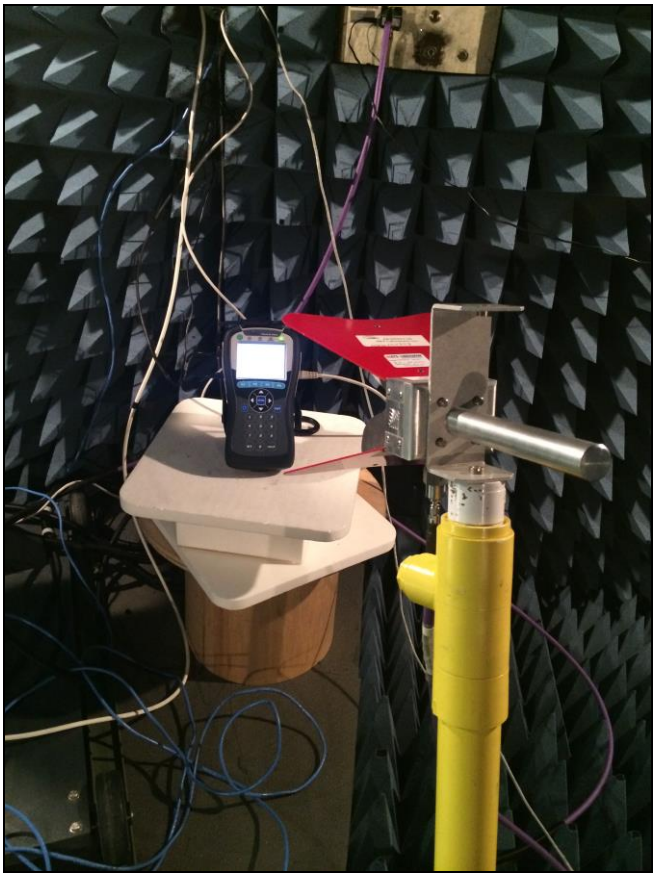


Figure 8. Test Setup Diagram

Note: A horn antenna was used to transmit the Radar Signals instead of a Log Periodic antenna.



Photograph 9. DFS, Test Setup

B. Description of Client Device

1. Operating Frequency Range: 5150-5250 MHz, 5250-5350 MHz, 5470-5725 MHz, 5725-5825 MHz
2. Modes of Operation: Client device without radar detection
3. Master device used to test client device – FCC ID: LDK102087
4. List all antennas and associated gains: See antenna data sheet
5. List antenna impedance: 50 Ohms

C. In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time, and Non-Occupancy Period

Test Requirements: **§ 15.407** (Refer to DFS Response Requirement Values table in section III-A of this report.) The UUT shall continuously monitor for radar transmissions in the operating test channel. When a radar burst occurs in the test channel, it has 10 seconds to move to another channel. This 10 second window is termed Channel Move Time (CMT).

When a radar burst occurs, the UUT has 200 milliseconds, plus an aggregate of 60 milliseconds, to cease transmission in the operating test channel. This 200 ms + 60 ms requirement is termed Channel Closing Transmission Time (CCT).

After radar burst and subsequent move to another channel, the UUT shall not resume transmission, on the channel it moved from, for a period of 30 minutes. This requirement is termed Non-Occupancy Period (NOP).

Test Procedure: These tests define how the following DFS parameters are verified during In-Service Monitoring: Channel Closing Transmission Time, Channel Move Time, and Non-Occupancy Period.

The steps below define the procedure to determine the above mentioned parameters when a radar Burst with a level equal to the DFS Detection Threshold + 1dB (-63dBm) is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the UUT (Master) at 5300 MHz. Stream the MPEG test file from the Master Device to the Client Device on the selected Channel for the entire period of the test.

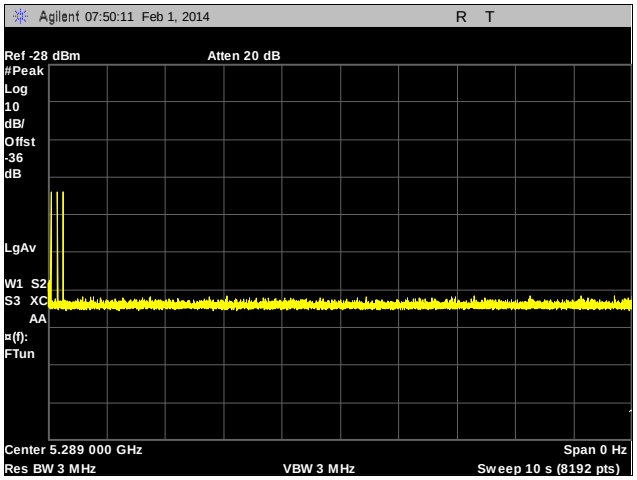
At time T0 the Radar Waveform generator sends a Burst of pulses for each of the radar types at -63dBm.

Observe the transmissions of the UUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds. Measure and record the transmissions from the UUT during the observation time (Channel Move Time). Compare the Channel Move Time and Channel Closing Transmission Time results to the limits defined in the *DFS Response Requirement Values table*.

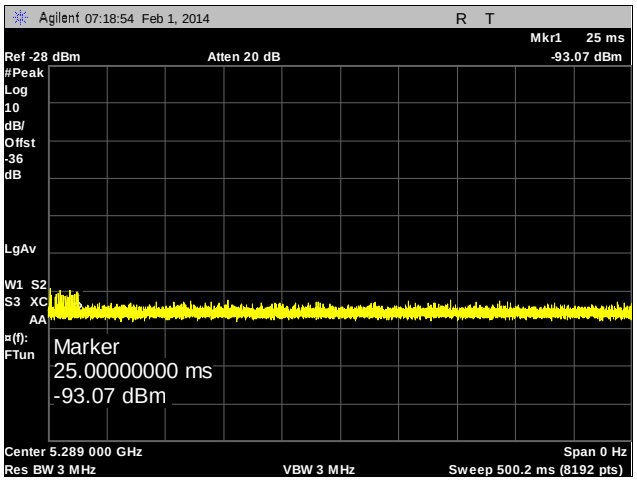
Test Results: The EUT was compliant with § 15.407 In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time, and Non-Occupancy Period.

Test Engineer: Djed Mouada

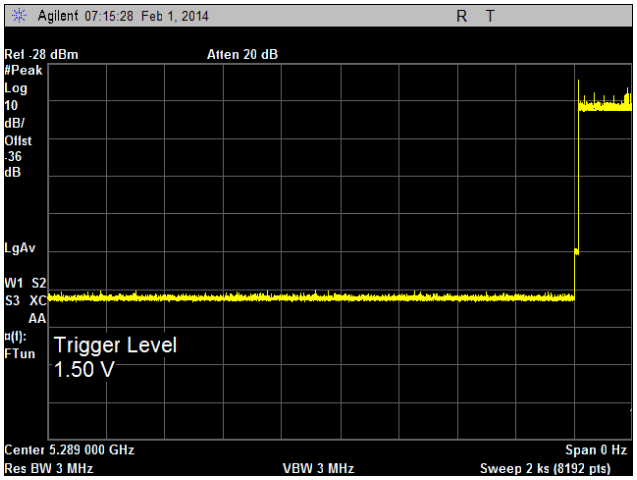
Test Date: 02/03/14



Plot 83. Channel Close Time, Channel 56, 5289 MHz



Plot 84. Channel Move Transmission, 5289 MHz



Plot 85. Non-Occupancy Period, 30minutes, 5289 MHz

IV. Test Equipment

Test Equipment

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

MET ASSET #	EQUIPMENT	MANUFACTURER	MODEL	LAST CAL DATE	CAL DUE DATE
1T4149	HIGH-FREQUENCY ANECHOIC CHAMBER	RAY-PROOF	81	SEE NOTE	
1T4300	SEMI-ANECHOIC CHAMBER #1 (FCC)	EMC TEST SYSTEMS	NONE	7/24/2012	7/24/2015
1T4612	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	5/23/2012	11/23/2013
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	7/16/2012	7/16/2013
1T4753	ANTENNA - BILOG	SUNOL SCIENCES	JB6	1/5/2012	7/5/2013
1T4505	TEMPERATURE CHAMBER	TEST EQUITY	115	12/2/2012	12/2/2013
1T4483	ANTENNA; HORN	ETS-LINDGREN	3117	8/6/2012	2/6/2014
1T2511	ANTENNA; HORN	EMCO	3115	9/22/2011	3/22/2013
1T4502	COMB GENERATOR	COM-POWER	CGC-255	8/21/2012	2/21/2014
1T4568	RADIATING NOISE SOURCE	MET LABORATORIES	N/A	SEE NOTE	
1T4791	THERM./CLOCK/HUMIDITY	CONTROL COMPANY	06-662-4	3/8/2012	3/8/2014
1T4563	LISN (10 AMP)	SOLAR ELECTRONICS	9322-50-R-10-BNC	11/27/2012	5/27/2014
1T2948	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	1/30/2012	7/30/2013
1T4503	SHIELDED ROOM	UNIVERSAL SHIELDING CORP	N/A	SEE NOTE	
1T4504	SHIELDED ROOM	UNIVERSAL SHIELDING CORP	N/A	SEE NOTE	
1T4814	COMB GENERATOR	COM-POWER	CGO-5100	SEE NOTE	
1T4479	POWER SUPPLY PROGRAMMABLE	CALIFORNIA INSTRUMENTS	1501TC	SEE NOTE	

Table 29. 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

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

The manufacturer, importer or supplier shall meet the labelling requirements set out in this section for every ITE unit[Footnote 3].

- (i) Prior to marketing in Canada, for ITE manufactured in Canada, and;
- (ii) Prior to importation into Canada, for imported ITE.

The presence of the label on the ITE represents the manufacturer's or importer's Self-Declaration of Compliance (SDoC) to Industry Canada ICES-003. Each unit of an ITE model shall bear a label indicating the model's compliance with ICES-003.

The label shall be permanently affixed to the ITE or displayed electronically and its text must be clearly legible. When the dimension of the device is too small or it is otherwise not practical to place the label on the ITE, the label shall be placed in a prominent location in the user manual supplied with the ITE. The user manual may be in an electronic format and must be readily available.

Labeling Requirements:

Industry Canada ICES-003 Compliance Label:

CAN ICES-3 (*)/NMB-3(*)

* Insert either "A" or "B" but not both to identify the applicable Class of ITE

End of Report

