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

November 19, 2009

Amimon, Ltd.
2 Maskit St.
Herzelia, Israel 46733

Dear Ronen Korman,

Enclosed is the EMC Wireless test report for compliance testing of the Amimon, Ltd., Shaldag TX (VSU) as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Title 47 of the CFR, Part 15, Subpart B for Unintentional Radiators and Part 15.407 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: (\Amimon, Ltd.\EMC27656A-FCC407)

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Electromagnetic Compatibility Criteria
Test Report

for the

Amimon, Ltd.
Model Shaldag TX (VSU)

Tested under
the Certification Rules
contained in
Title 47 of the CFR, Part 15, Subpart B
for Unintentional Radiators
and
Title 47 of the CFR, Part 15.407
for Intentional Radiators

MET Report: EMC27656A-FCC407

November 19, 2009

Prepared For:

Amimon, Ltd.
2 Maskit St.
Herzelia, Israel 46733

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

Electromagnetic Compatibility Criteria
Test Report

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Amimon, Ltd.
Model Shaldag TX (VSU)

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Title 47 of the CFR, Part 15, Subpart B
for Unintentional Radiators
and
Title 47 of the CFR, Part 15.407
for Intentional Radiators

Dusmantha Tennakoon, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Parts 15B, 15.407, of the FCC Rules under normal use and maintenance.

Shawn McMillen, Wireless Manager
Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	November 19, 2009	Initial Issue.

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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**ilovolt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**micro**henry
µ	**micro**farad
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 Amimon, Ltd. Shaldag TX (VSU), 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 Shaldag TX (VSU). Amimon, Ltd. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Shaldag TX (VSU), 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 Amimon, Ltd., purchase order number 90203. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference	Description	Results
15.107	Conducted Emissions	Compliant
15.109	Radiated Emissions	Compliant
15.203	Antenna Requirements	Compliant
15.205/15.209	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Compliant
15.207	AC Conducted Emissions 150KHz – 30MHz	Compliant
15.403 (i)	26dB Occupied Bandwidth	Compliant
15.407 (a)(2)	Conducted Transmitter Output Power	Compliant
15.407 (a)(2)	Power Spectral Density	Compliant
15.407 (a)(6)	Peak Excursion	Compliant
15.407 (b)(2), (3), (6), (7)	Undesirable Emissions	Compliant
15.407(f)	RF Exposure	Compliant
15.407(g)	Frequency Stability	Compliant
15.407 (h)(1)	Transmit Power Control (TPC)	N/A – device operates with a e.i.r.p of less than 500 mW
15.407 (h)(2)(iii)	Channel Move Time and Channel Closing Time	Compliant
15.407 (h)(2)	Radar Detection Function of Dynamic Frequency Selection (DFS)	Compliant

Table 1. Executive Summary of EMC Part 15.407 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Amimon, Ltd. to perform testing on the Shaldag TX (VSU), under Amimon, Ltd.'s purchase order number 90203.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Amimon, Ltd. Shaldag TX (VSU).

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

Model(s) Tested:	Shaldag TX (VSU)	
Model(s) Covered:	Shaldag TX (VSU)	
EUT Specifications:	Primary Power: 120 VAC, 60 Hz	
	FCC ID: VQSAMN31100	
	Type of Modulations:	OFDM
	Emission Designators:	38M0D7D
	Equipment Code:	NII
	Peak RF Output Power:	17.38 dBm (55 mW)
	EUT Frequency Ranges:	5300 MHz and 5550 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:	Dusmantha Tennakoon	
Report Date(s):	November 19, 2009	

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)
ANSI C63.4:2003	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI/NCSL Z540-1-1994	Calibration Laboratories and Measuring and Test Equipment - General Requirements
ANSI/ISO/IEC 17025:2000	General Requirements for the Competence of Testing and Calibration Laboratories

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 Amimon, Ltd. Shaldag TX (VSU), is a 4x1, spatial multiplexing MIMO. The AMN3100 (shaldag TX) WHDI Video Source Unit (VSU), i.e. EUT, is designed to modulate and transmit downstream video and audio content over the wireless medium and receive a control channel over the wireless upstream using WHDI technology. The modulation uses 40 MHz bandwidth and is carried over the 5 GHz unlicensed band.

Photograph 1. Amimon, Ltd. Shaldag TX (VSU)

E. Equipment Configuration

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

Name / Description	Model Number	Serial Number	Rev. #
4x1 MIMO Transceiver Module (Shaldag TX –VSU)	AMN 31100	T097430017	4.0

Table 4. Equipment Configuration

F. Support Equipment

Shaldag TX (VSU) supplied support equipment necessary for the operation and testing of the Shaldag TX (VSU). All support equipment supplied is listed in the following Support Equipment List.

Ref. ID	Name / Description	Manufacturer	Serial Number	Rev. #
N/A	Shaldag Regulation Board	Amimon	A01153692	1.0

Table 5. Support Equipment

G. Mode of Operation

The EUT was configured to transmit continuously on channels 5300 MHz and 5550 MHz for testing.

H. 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.

I. Disposition of EUT

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

III. Electromagnetic Compatibility Criteria for Unintentional Radiators

Electromagnetic Compatibility Criteria

§ 15.107 Conducted Emissions Limits

Test Requirement(s):

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

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

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

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

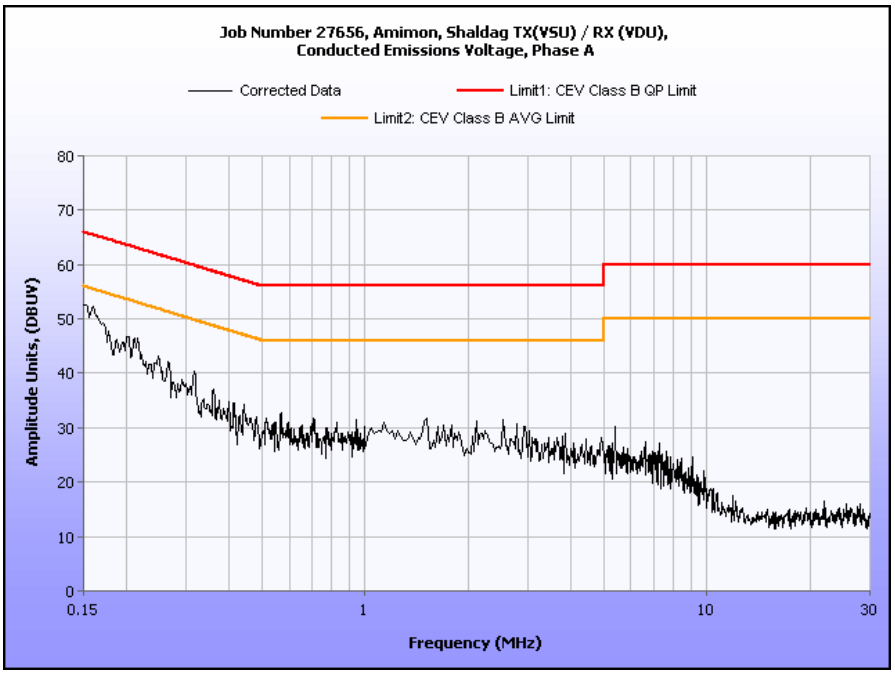
Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 09/10/09

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

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) Avg.	Limit (dBuV) Avg.	Margin (dB) Avg.
0.158	38.95	0.0986	39.0486	65.57	-26.5214	26.43	0.0986	26.5286	55.57	-29.0414
0.21	25.89	0.17	26.06	63.21	-37.15	15.21	0.17	15.38	53.21	-37.83
0.982	18.21	0.17	18.38	56	-37.62	11.54	0.17	11.71	46	-34.29
1.54	16.45	0.17	16.62	56	-39.38	11.13	0.17	11.3	46	-34.7
11.28	7.27	0.33	7.6	60	-52.4	1.8	0.33	2.13	50	-47.87
29.85	8.41	0.1724	8.5824	60	-51.4176	1.75	0.1724	1.9224	50	-48.0776

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

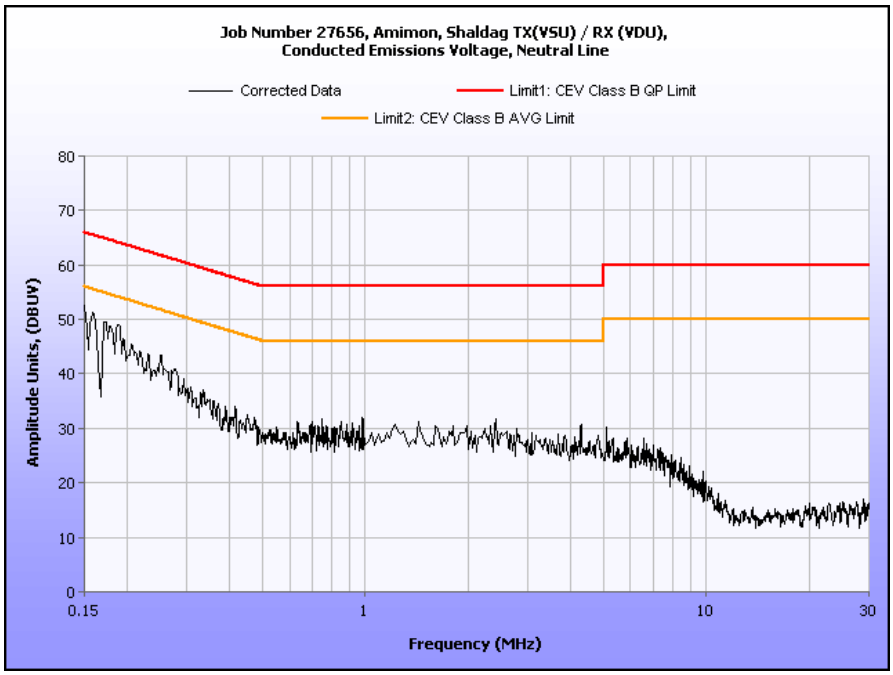


Plot 1. Conducted Emissions, Phase Line Plot

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

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) Avg.	Limit (dBuV) Avg.	Margin (dB) Avg.
0.1518	37.46	0.08806	37.54806	65.9	-28.3519	25.3	0.08806	25.38806	55.9	-30.5119
0.2082	26.95	0.17	27.12	63.28	-36.16	15.94	0.17	16.11	53.28	-37.17
0.9112	17.09	0.17	17.26	56	-38.74	11.28	0.17	11.45	46	-34.55
1.63	17.22	0.17	17.39	56	-38.61	10.15	0.17	10.32	46	-35.68
10.45	6.716	0.33	7.046	60	-52.954	1.4	0.33	1.73	50	-48.27
29.93	7.5	0.17112	7.67112	60	-52.3289	1.98	0.17112	2.15112	50	-47.8489

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



Plot 2. Conducted Emissions, Neutral Line Plot

Conducted Emission Limits Test Setup

Photograph 2. Conducted Emissions, Test Setup

Radiated Emission Limits

§ 15.109 Radiated Emissions Limits

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

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

Frequency (MHz)	Field Strength (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 9. Radiated Emissions Limits calculated from FCC Part 15, §15.109 (a) (b)

Test Procedures: The EUT was placed on a 0.8m-high acrylic table 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 found to comply with the Class B requirement(s) of this section. Measured emissions were below applicable limits

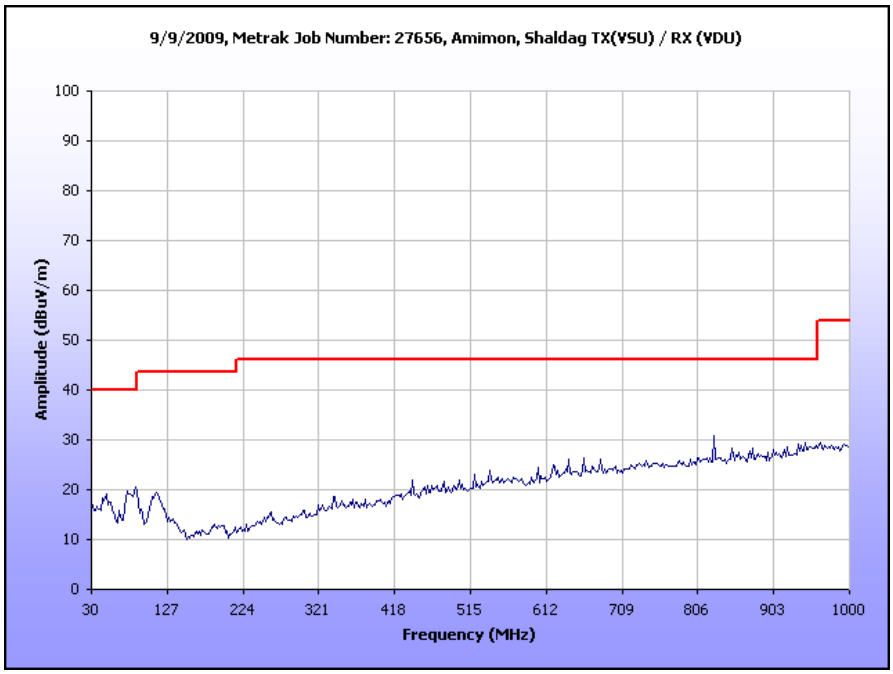
Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 09/09/09

Radiated Emissions Limits Test Results, Class B

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
50.513	360	H	1.00	5.87	9.34	1.07	0.00	16.28	40.00	-23.72
50.513	0	V	1.00	9.09	9.30	1.07	0.00	19.47	40.00	-20.53
87.950	360	H	1.00	5.95	6.56	1.30	0.00	13.81	40.00	-26.19
87.950	35	V	1.00	10.28	6.82	1.30	0.00	18.40	40.00	-21.60
118.503	360	H	1.00	6.02	7.27	1.41	0.00	14.70	43.50	-28.80
118.503	1	V	1.00	9.87	7.54	1.41	0.00	18.82	43.50	-24.68
259.832	360	H	1.00	4.94	12.91	2.27	0.00	20.12	46.00	-25.88
259.832	0	V	1.00	4.94	12.41	2.27	0.00	19.62	46.00	-26.38
645.431	0	H	1.00	5.87	20.11	3.71	0.00	29.68	46.00	-16.32
645.431	0	V	1.00	5.87	20.10	3.71	0.00	29.68	46.00	-16.32
829.457	0	H	1.00	6.09	21.88	4.49	0.00	32.46	46.00	-13.54
829.457	360	V	1.00	7.09	21.70	4.49	0.00	33.28	46.00	-12.72

Table 10. Radiated Emissions Limits, Test Results



Plot 3. Radiated Emissions, Pre-Scan

Radiated Emission Limits Test Setup

Photograph 3. Radiated Emissions, Test Setup

IV. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

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

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

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The antenna is a Planar Inverted F antenna (PIFA) that is permanently mounted. Therefore, the EUT as tested is compliant with the criteria of §15.203.

Gain/Model	Manufacturer
1.9 dBi	Amimon

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 09/08/09

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 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

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

Table 11. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a chamber. 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 C63.4-1992 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter.

Test Results: The EUT was found to comply with the Class B requirement(s) of this section. Pre-scans revealed that the emission profiles and amplitudes were similar on channel 5300 MHz and 5550 MHz. Therefore, final measurements were made on channel 5550 MHz.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 09/10/09

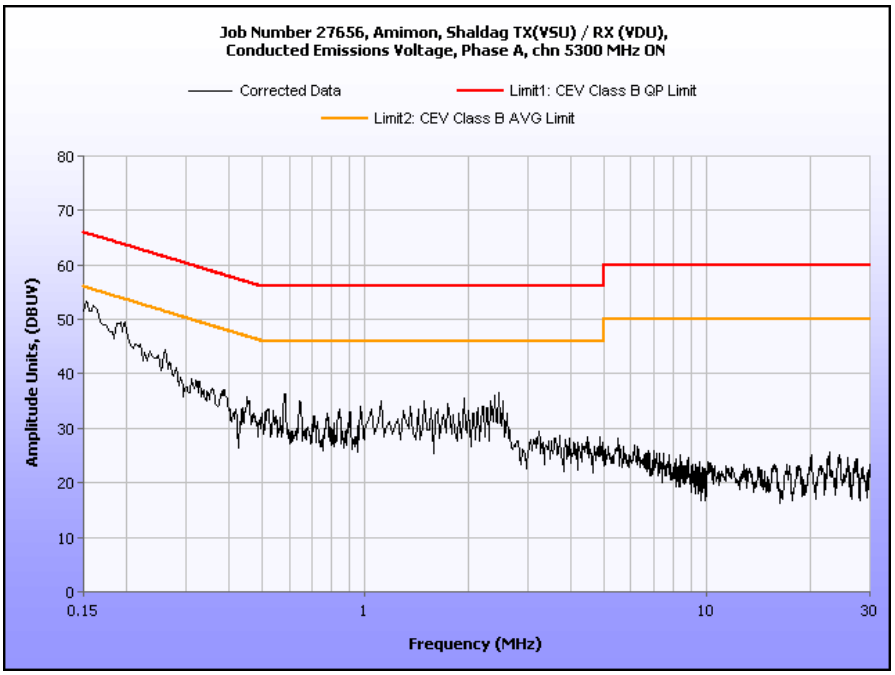
Conducted Emissions - Voltage, AC Power, (120 VAC, 60 Hz)

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.1509	36.77	0.08653	36.85653	65.95	-29.0935	21.04	0.08653	21.12653	55.95	-34.8235
0.2008	31.7	0.17	31.87	63.58	-31.71	22.28	0.17	22.45	53.58	-31.13
0.8375	27.71	0.17	27.88	56	-28.12	24.6	0.17	24.77	46	-21.23
2.462	18.46	0.17	18.63	56	-37.37	13.88	0.17	14.05	46	-31.95
18.09	15.86	0.33	16.19	60	-43.81	10.6	0.33	10.93	50	-39.07
22.07	17.3	0.29688	17.59688	60	-42.4031	13.33	0.29688	13.62688	50	-36.3731

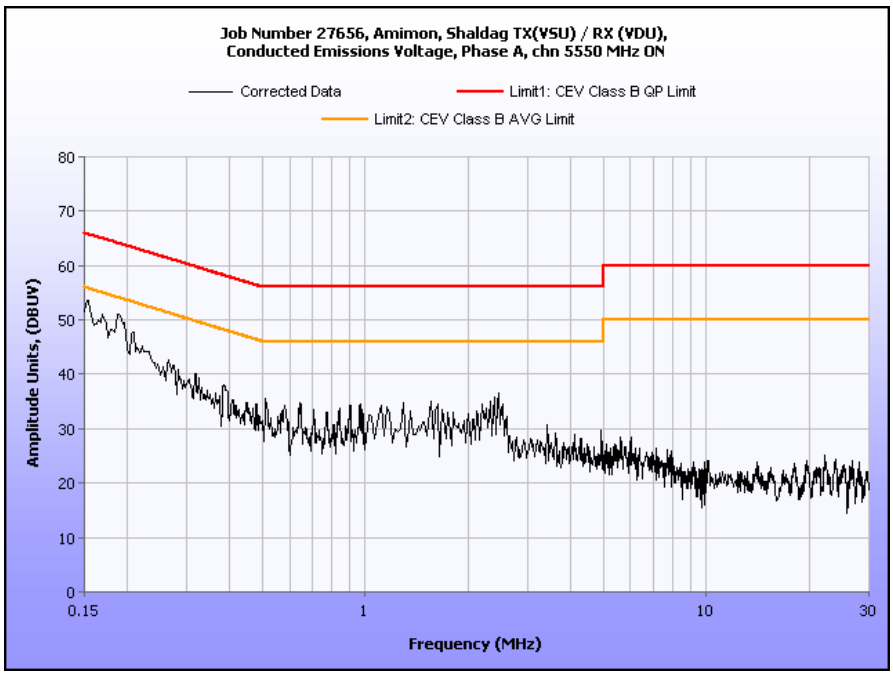
Table 12. Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC, 60 Hz)

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.152	38.11	0.0884	38.1984	65.89	-27.6916	22.01	0.0884	22.0984	55.89	-33.7916
0.2068	24.66	0.17	24.83	63.33	-38.5	22.64	0.17	22.81	53.33	-30.52
0.9	27.26	0.17	27.43	56	-28.57	26.48	0.17	26.65	46	-19.35
2.445	32.24	0.17	32.41	56	-23.59	30.28	0.17	30.45	46	-15.55
18.07	18.77	0.33	19.1	60	-40.9	15.33	0.33	15.66	50	-34.34
23.55	20.61	0.2732	20.8832	60	-39.1168	16.92	0.2732	17.1932	50	-32.8068

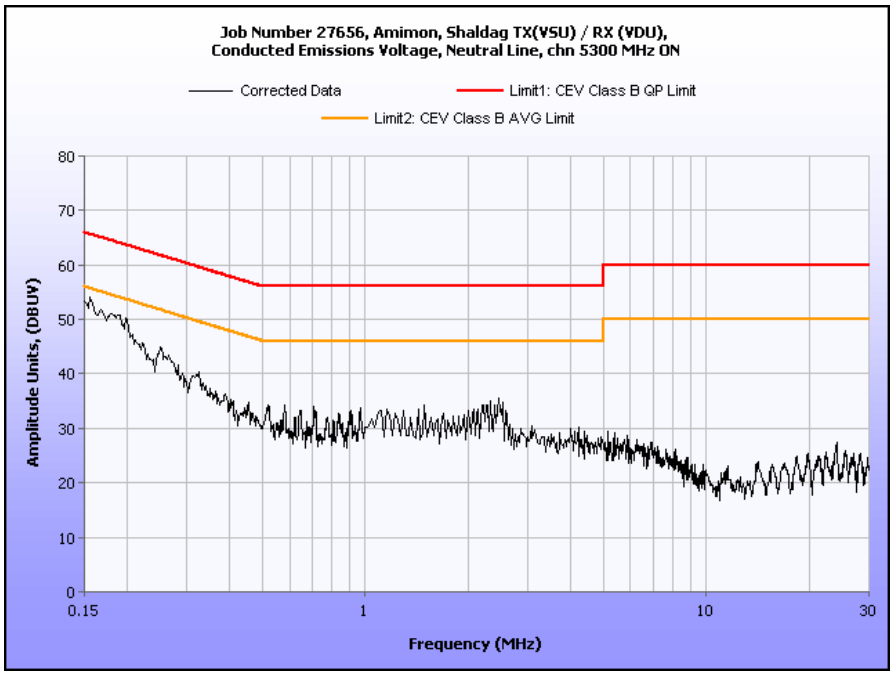
Table 13. Conducted Emissions - Voltage, AC Power, Neutral Line (120 VAC, 60 Hz)



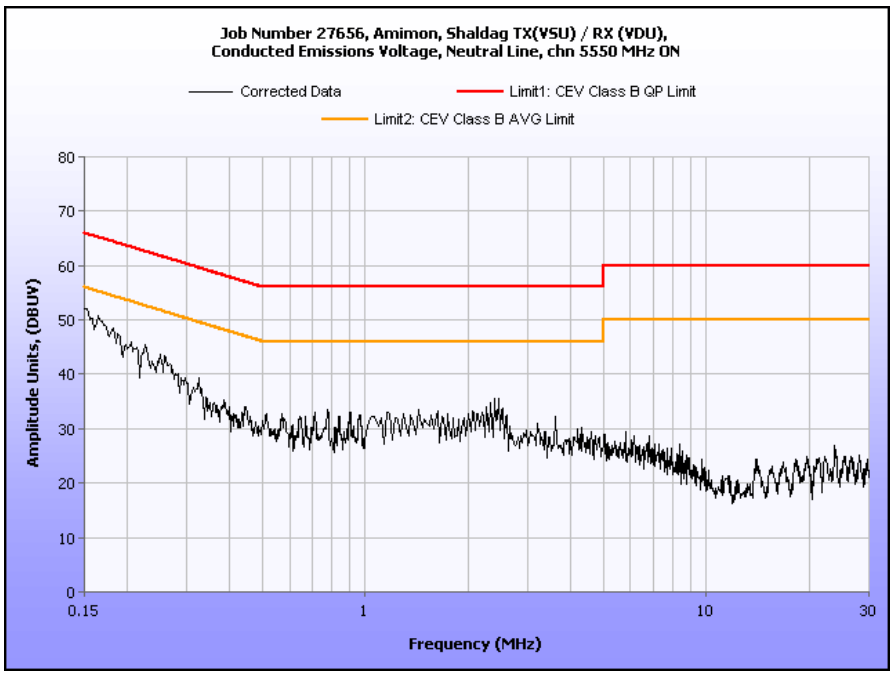
Plot 4. Conducted Emissions, Phase Line Plot, 5300 MHz



Plot 5. Conducted Emissions, Phase Line Plot, 5550 MHz



Plot 6. Conducted Emissions, Neutral Line Plot, 5300 MHz



Plot 7. Conducted Emissions, Neutral Line Plot, 5550 MHz

Conducted Emission Limits Test Setup

Photograph 4. Conducted Emissions, Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 403(i) 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. A combiner was used to measure the bandwidth of the combined antenna ports as well.

Test Results The 26 dB Bandwidth was determined from the plots on the following pages.

Frequency (MHz)	Antenna Port #	26 dB Bandwidth (MHz)
5300	0	40.832
	1	41.102
	2	40.396
	3	40.415
	0+1+2+3	39.881
5550	0	40.707
	1	45.643
	2	40.608
	3	40.558
	0+1+2+3	39.509

Table 14. Occupied Bandwidth, Test Results

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 09/10/09

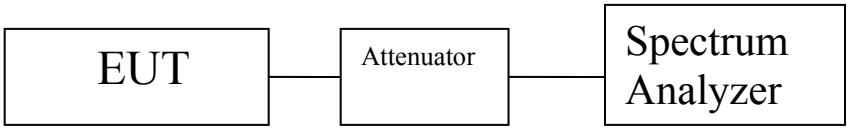
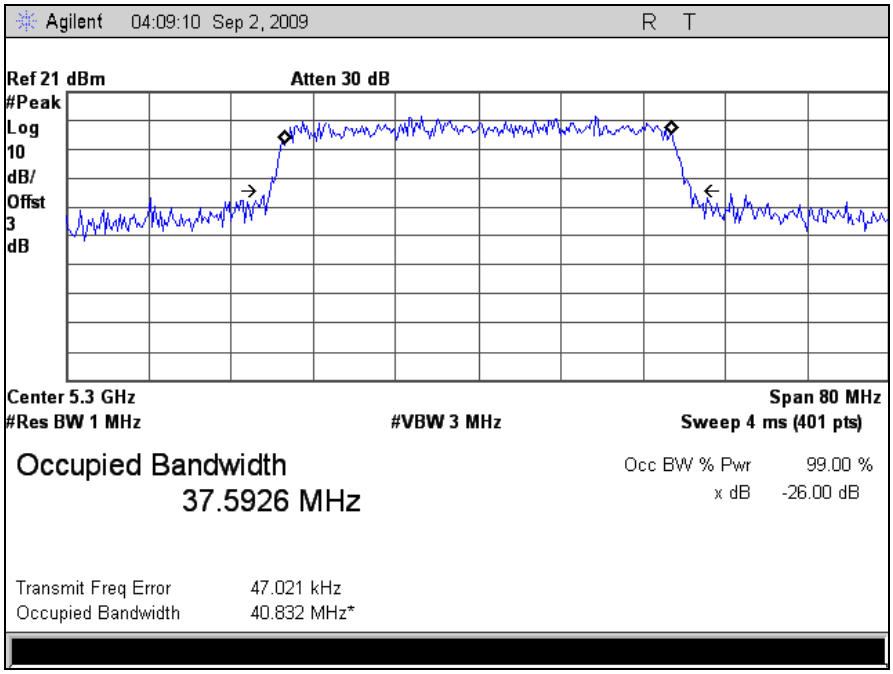
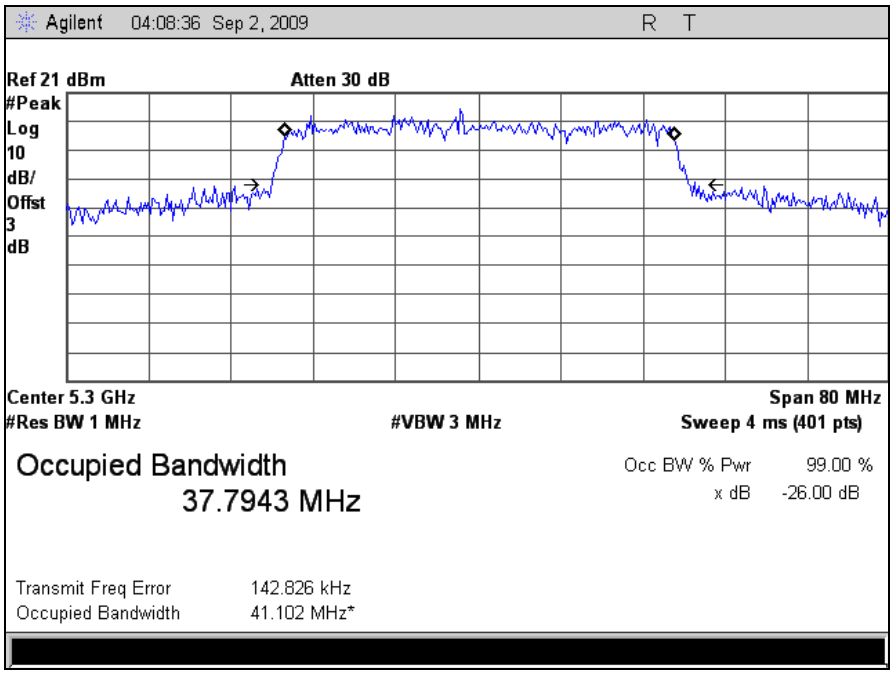


Figure 1. Occupied Bandwidth Test Setup

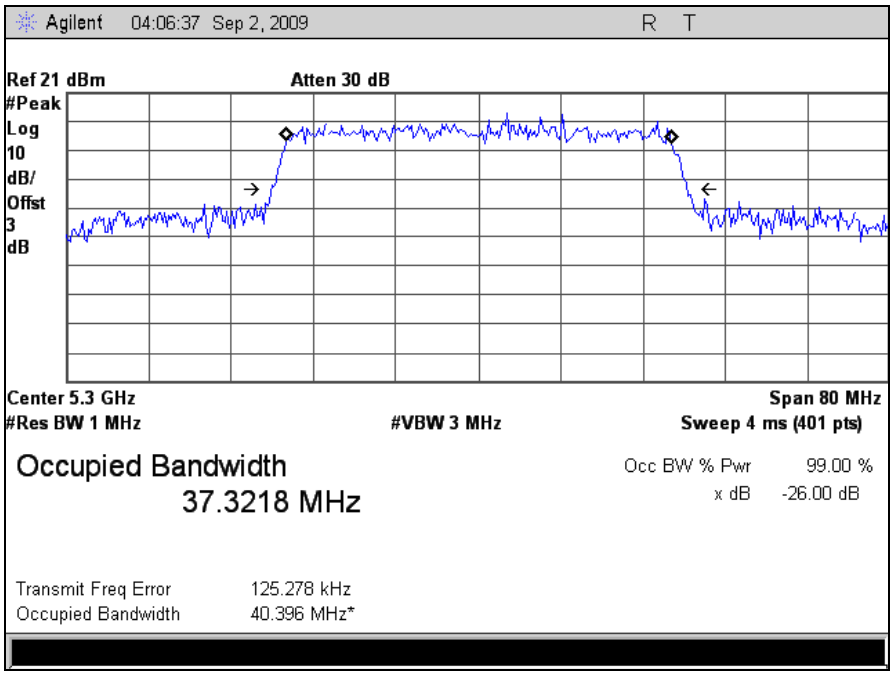
Electromagnetic Compatibility Criteria for Intentional Radiators



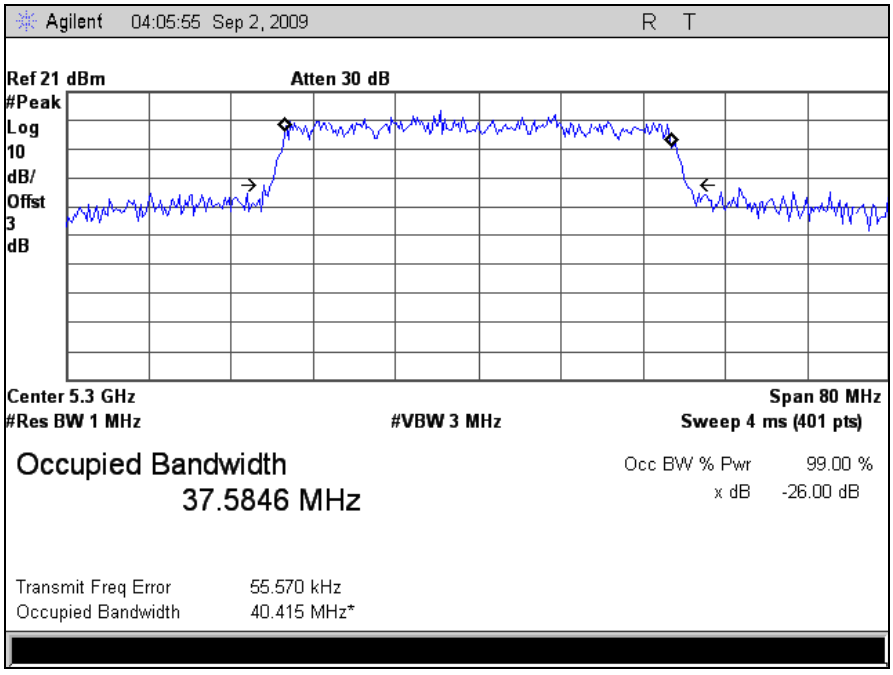
Plot 8. Occupied Bandwidth, Antenna Port 0, 5300 MHz



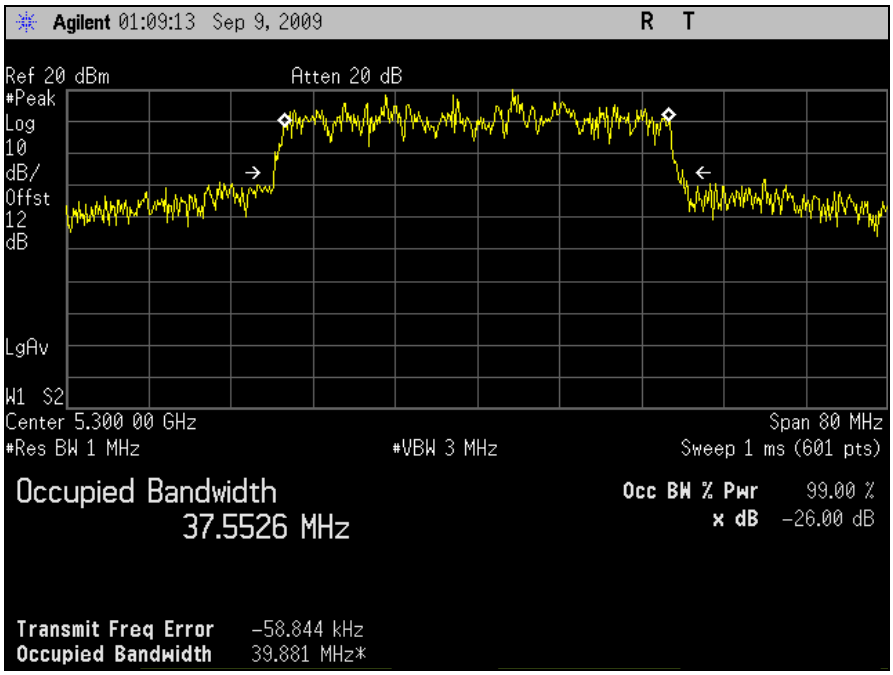
Plot 9. Occupied Bandwidth, Antenna Port 1, 5300 MHz



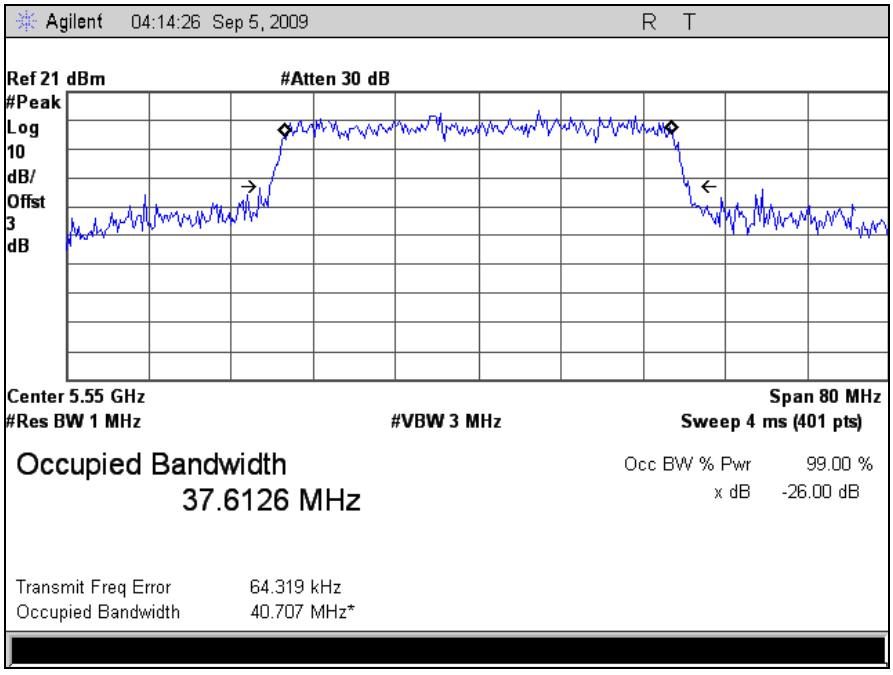
Plot 10. Occupied Bandwidth, Antenna Port 2, 5300 MHz



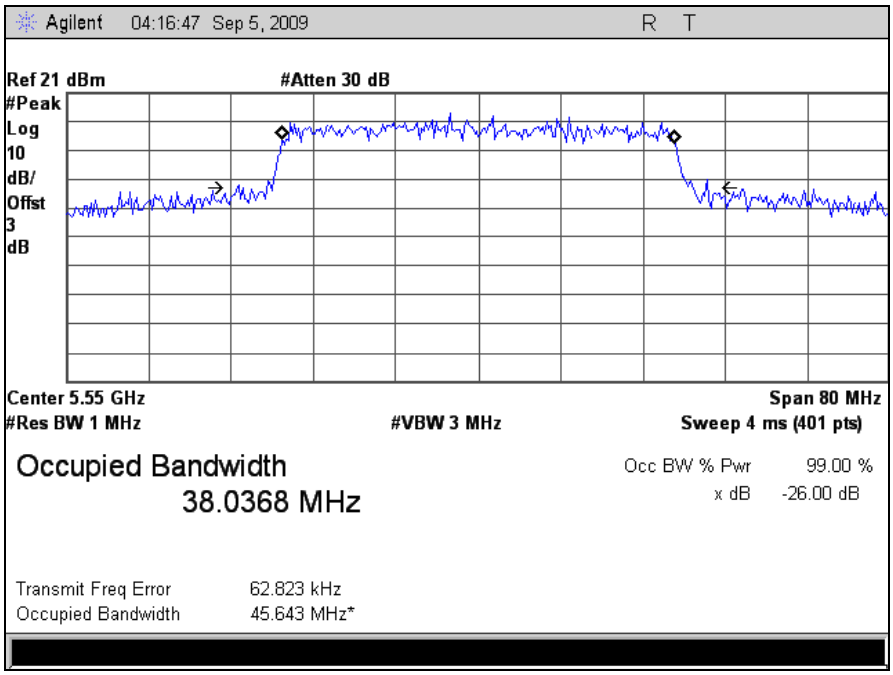
Plot 11. Occupied Bandwidth, Antenna Port 3, 5300 MHz



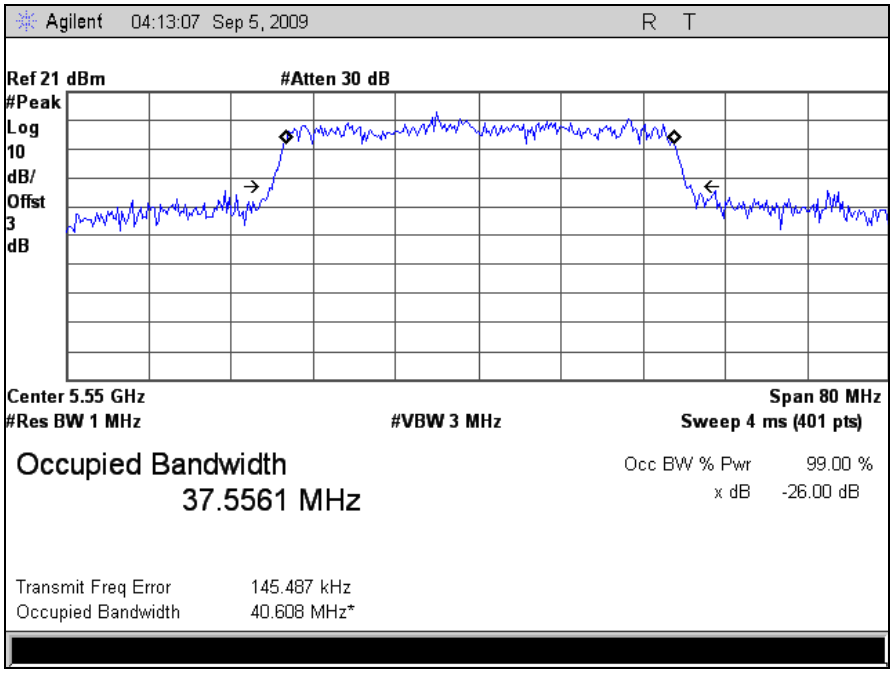
Plot 12. Occupied Bandwidth, Antenna Port 0+1+2+3, 5300 MHz



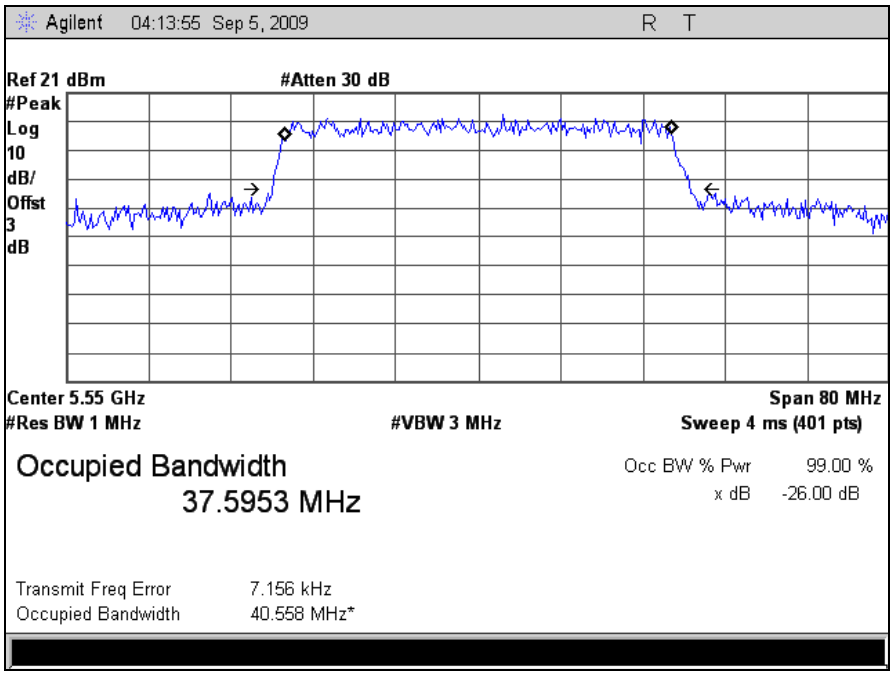
Plot 13. Occupied Bandwidth, Antenna Port 0, 5550 MHz



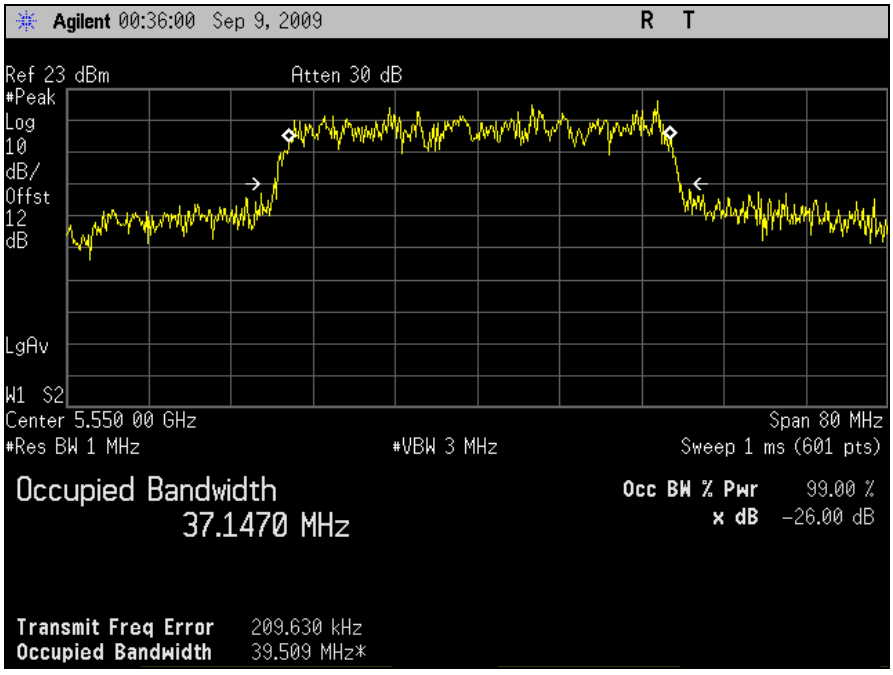
Plot 14. Occupied Bandwidth, Antenna Port 1, 5550 MHz



Plot 15. Occupied Bandwidth, Antenna Port 2, 5550 MHz



Plot 16. Occupied Bandwidth, Antenna Port 3, 5550 MHz



Plot 17. Occupied Bandwidth, Antenna Port 0+1+2+3, 5550 MHz

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 through an attenuator. The power was measured on both channels on all TX antenna ports. Then, the power on each channel was linearly added to calculate the combined power. The method of measurement #1 from the FCC Public Notice DA 02-2138 was used.

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

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 09/11/09

Frequency (MHz)	Antenna Port #	Conducted power (dBm)	Conducted power (mW)
5300	0	17.09	51.2
	1	17.38	54.7
	2	16.14	41.1
	3	17.25	53.1
5550	0	17.25	53.1
	1	17	50.1
	2	16.38	43.4
	3	17.31	53.8

Table 15. RF Power Output, Test Results

Note 1: Combined power for 5300 MHz (antenna port 0+1+2+3) = 200.1 mW.

Note 2: Combined power for 5550 MHz (antenna port 0+1+2+3) = 200.4 mW.

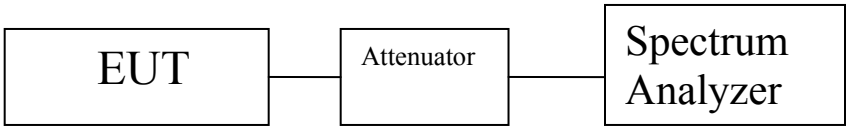
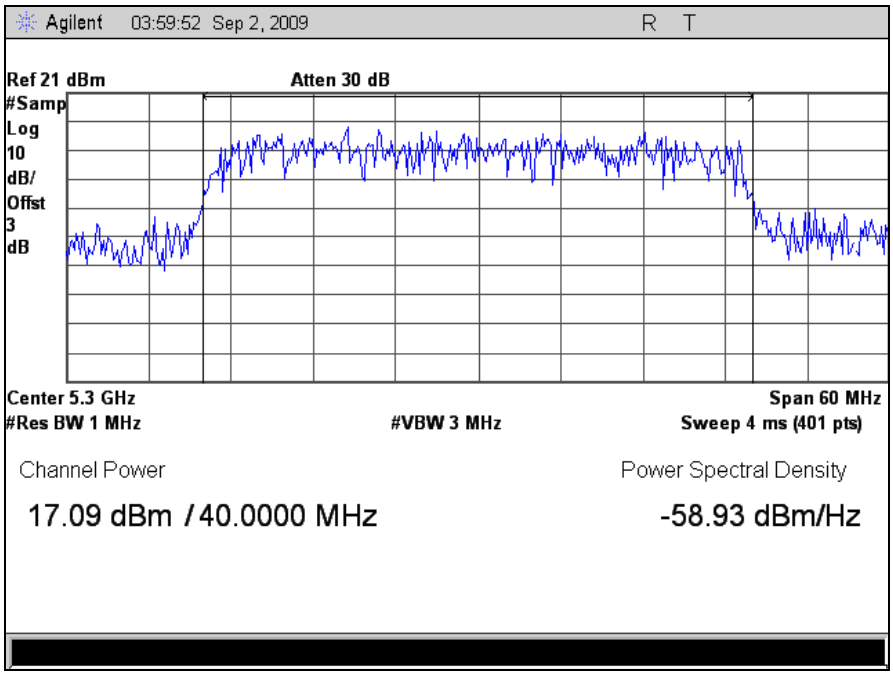
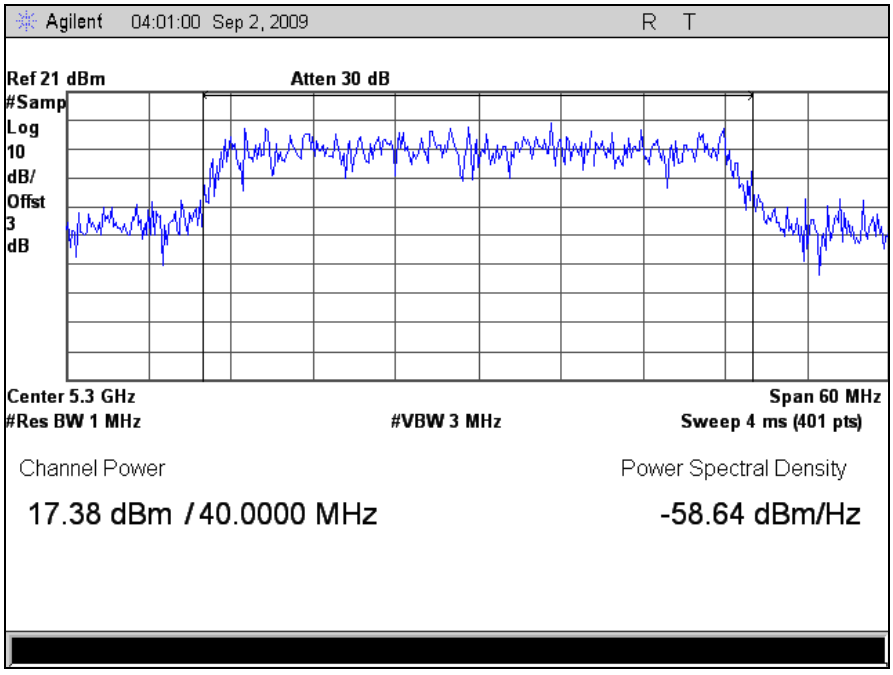


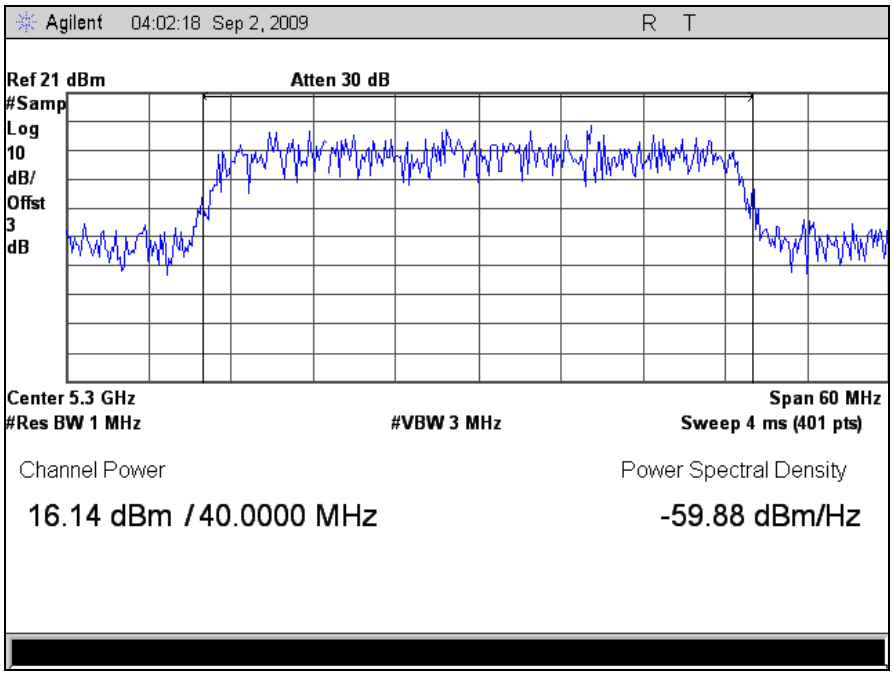
Figure 2. Peak Power Output Test Setup



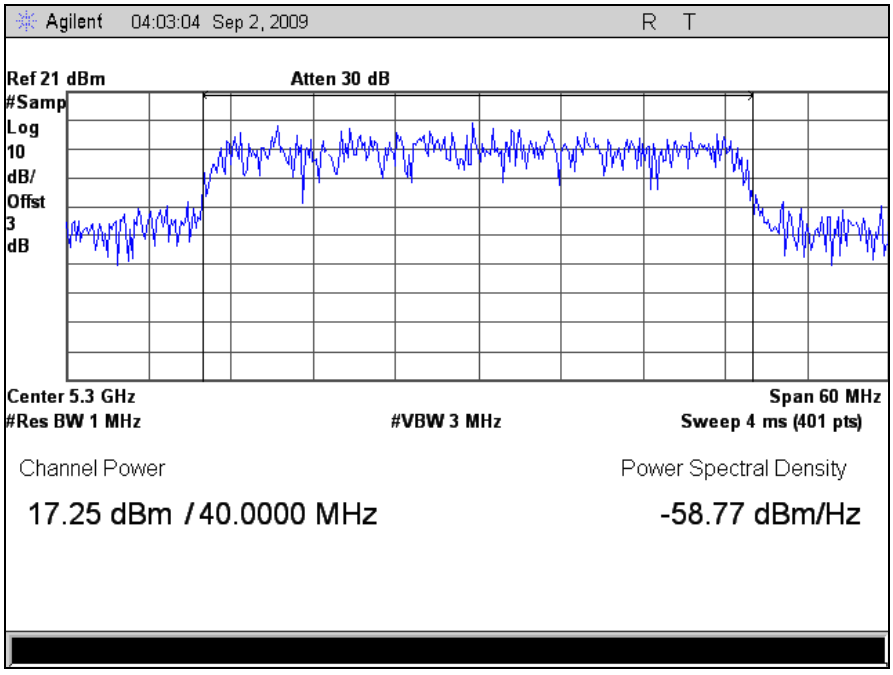
Plot 18. RF Output Power, Antenna Port 0, 5300 MHz



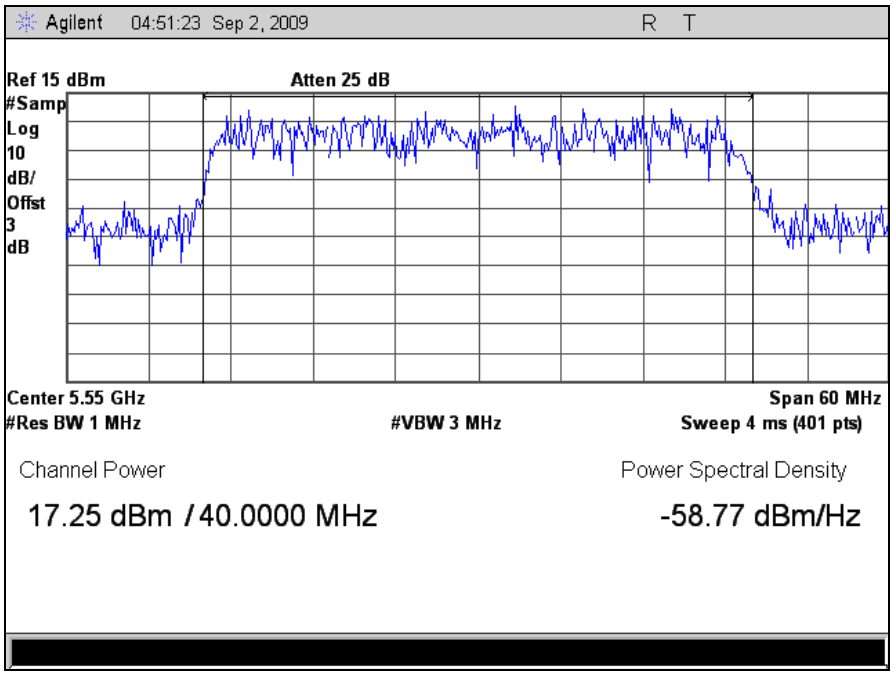
Plot 19. RF Output Power, Antenna Port 1, 5300 MHz



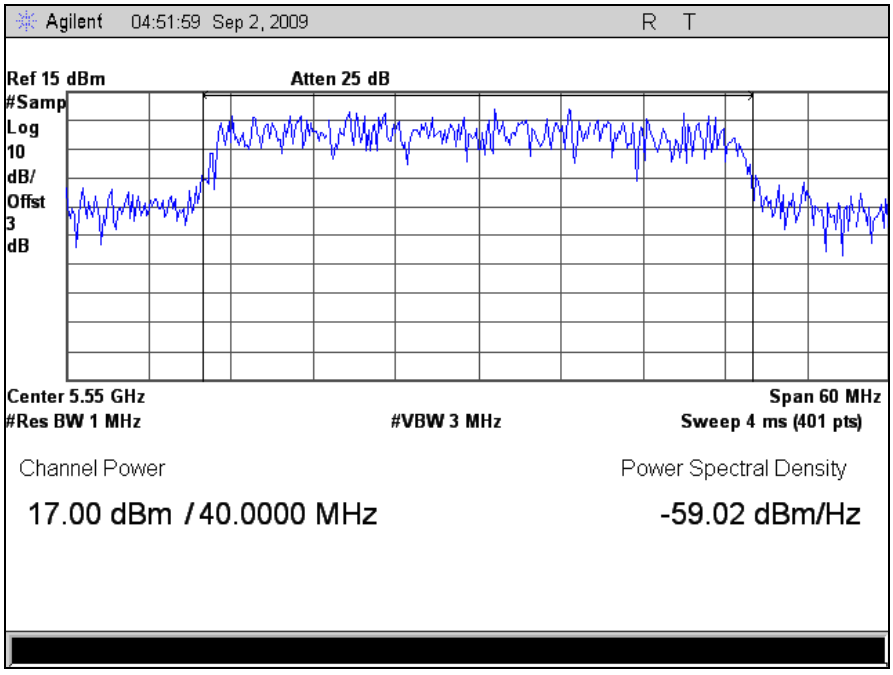
Plot 20. RF Output Power, Antenna Port 2, 5300 MHz



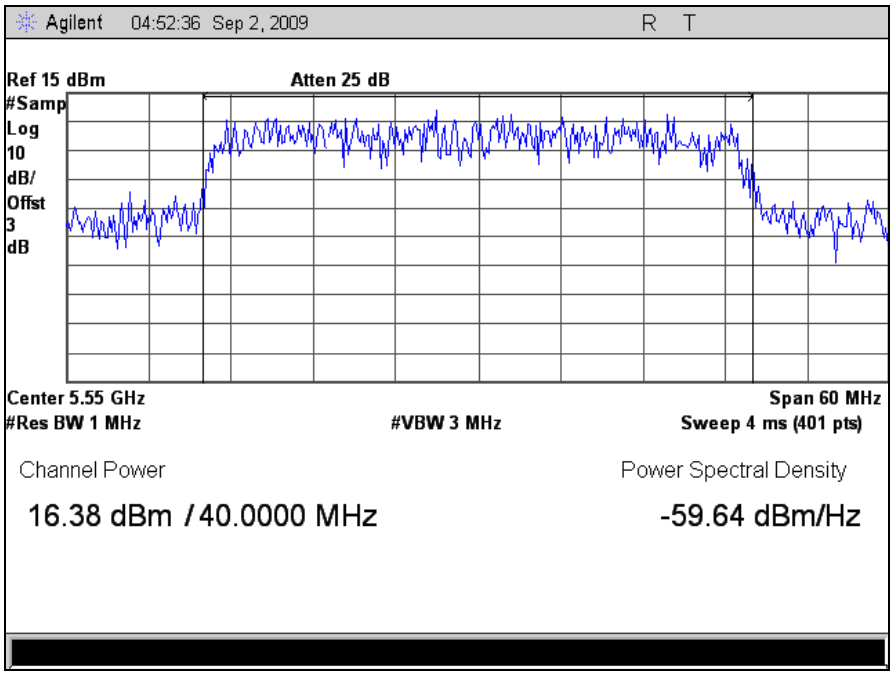
Plot 21. RF Output Power, Antenna Port 3, 5300 MHz



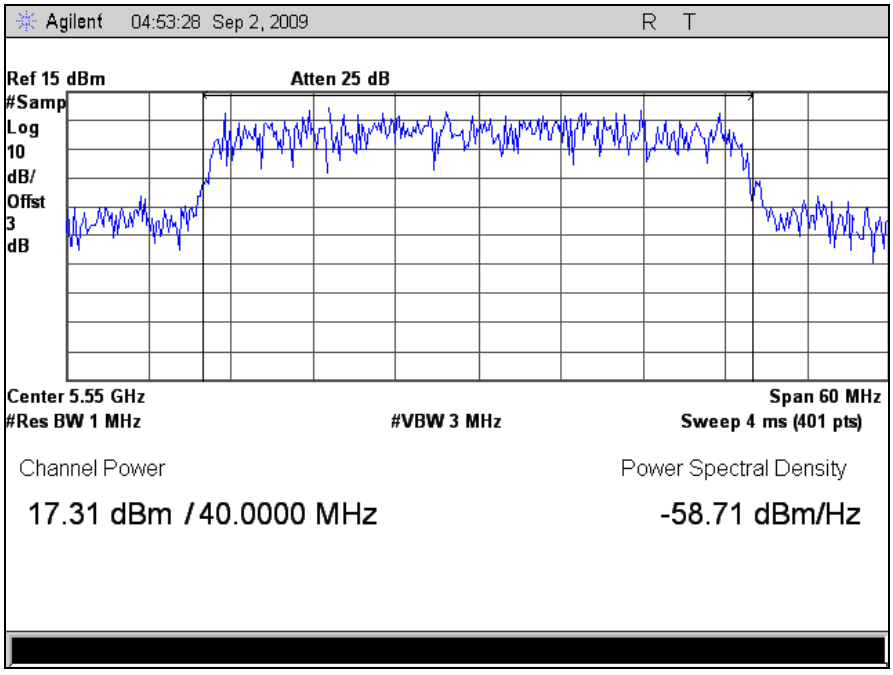
Plot 22. RF Output Power, Antenna Port 0, 5550 MHz



Plot 23. RF Output Power, Antenna Port 1, 5550 MHz



Plot 24. RF Output Power, Antenna Port 2, 5550 MHz



Plot 25. RF Output Power, Antenna Port 3, 5550 MHz

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. A combiner was used for making measurement on combined signal from all antenna ports.

Test Results: Equipment complies 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).

Frequency (MHz)	Antenna Port #	PSD (dBm)
5300	0	2.892
	1	3.003
	2	1.638
	3	3.273
	0+1+2+3	7.667
5550	0	3.764
	1	2.865
	2	2.906
	3	4.375
	0+1+2+3	6.710

Table 16. Power Spectral Density, Test Results

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 09/10/09

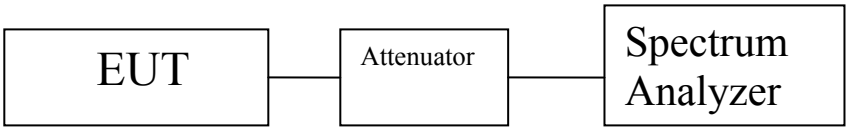
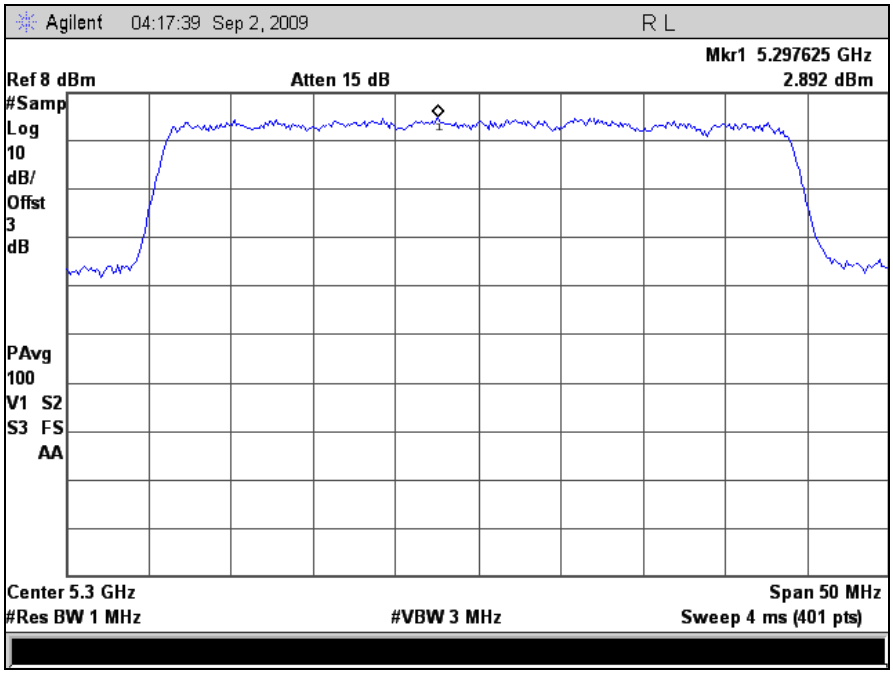
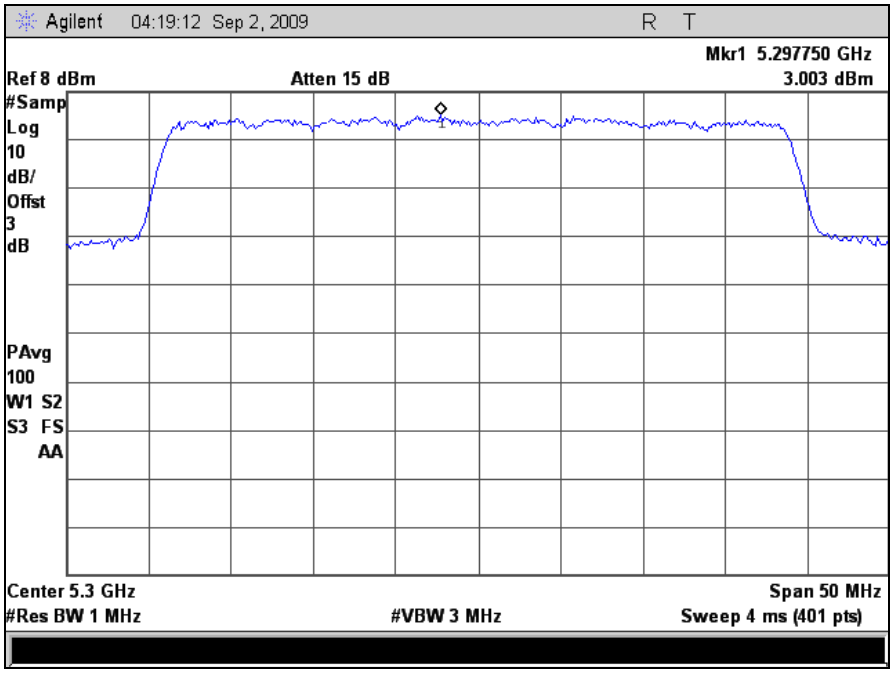


Figure 3. Peak Power Spectral Density Test Setup

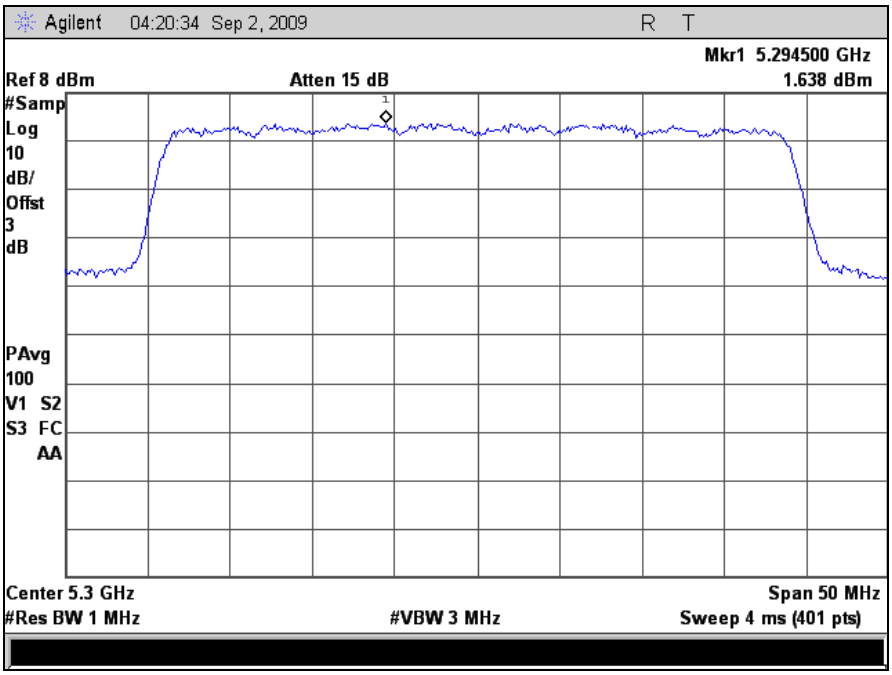
Electromagnetic Compatibility Criteria for Intentional Radiators



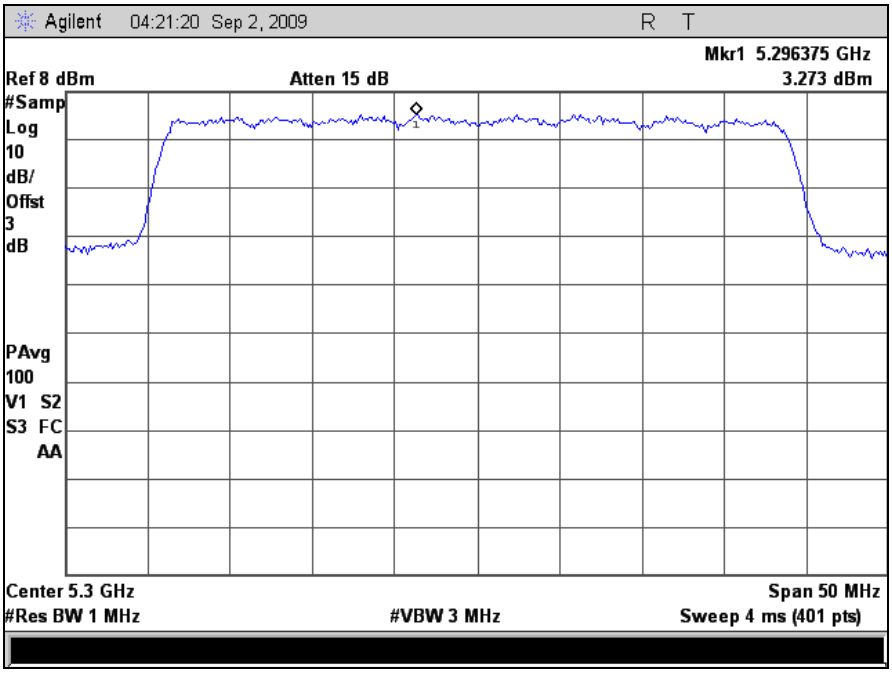
Plot 26. Power Spectral Density, Antenna Port 0, 5300 MHz



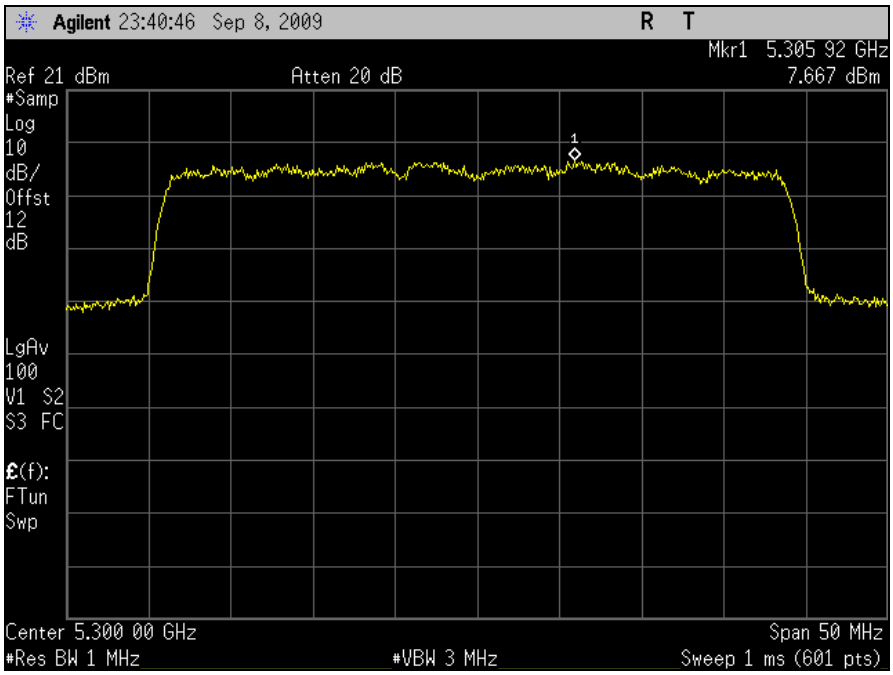
Plot 27. Power Spectral Density, Antenna Port 1, 5300 MHz



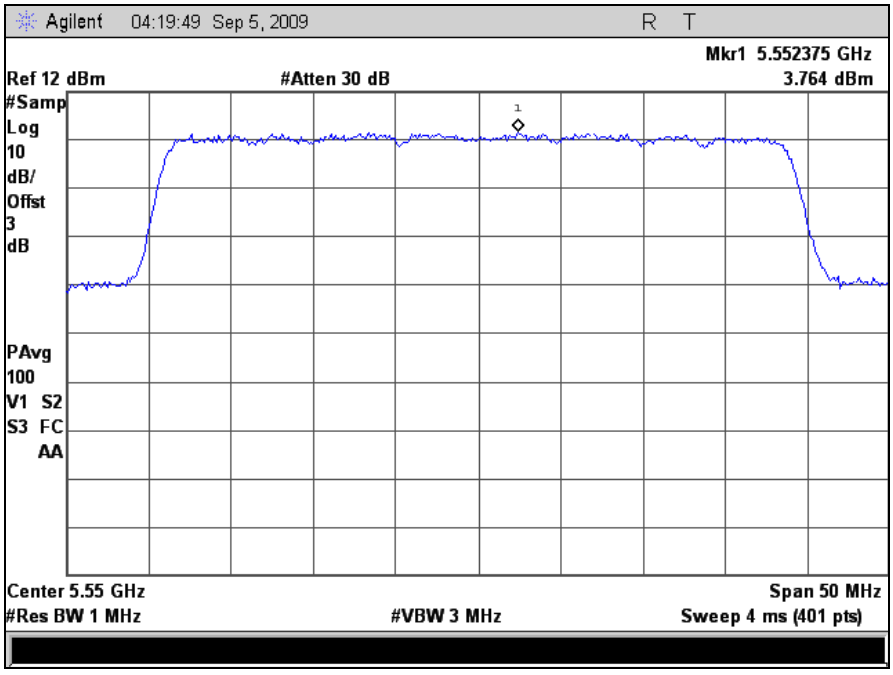
Plot 28. Power Spectral Density, Antenna Port 2, 5300 MHz



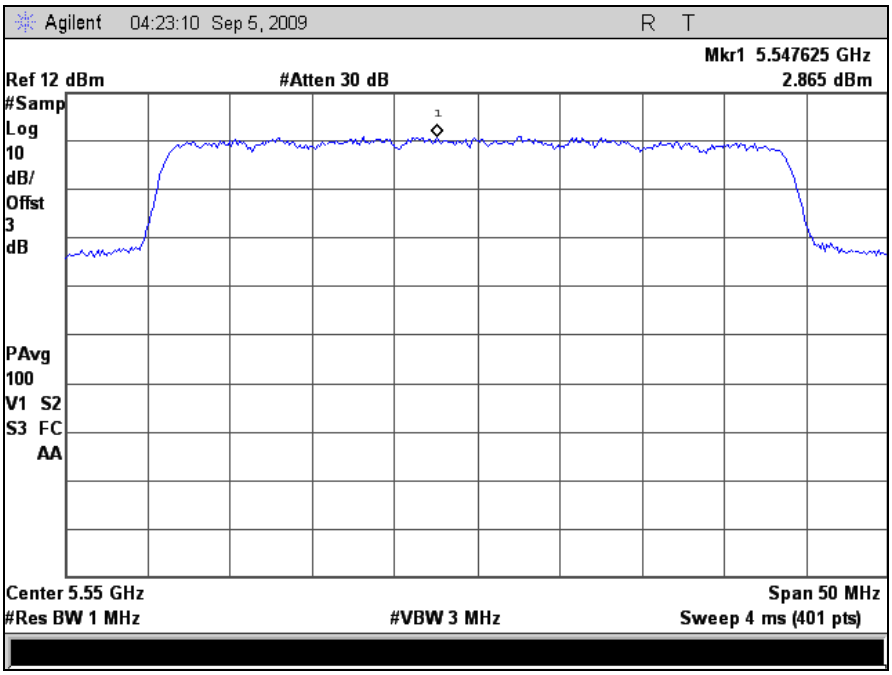
Plot 29. Power Spectral Density, Antenna Port 3, 5300 MHz



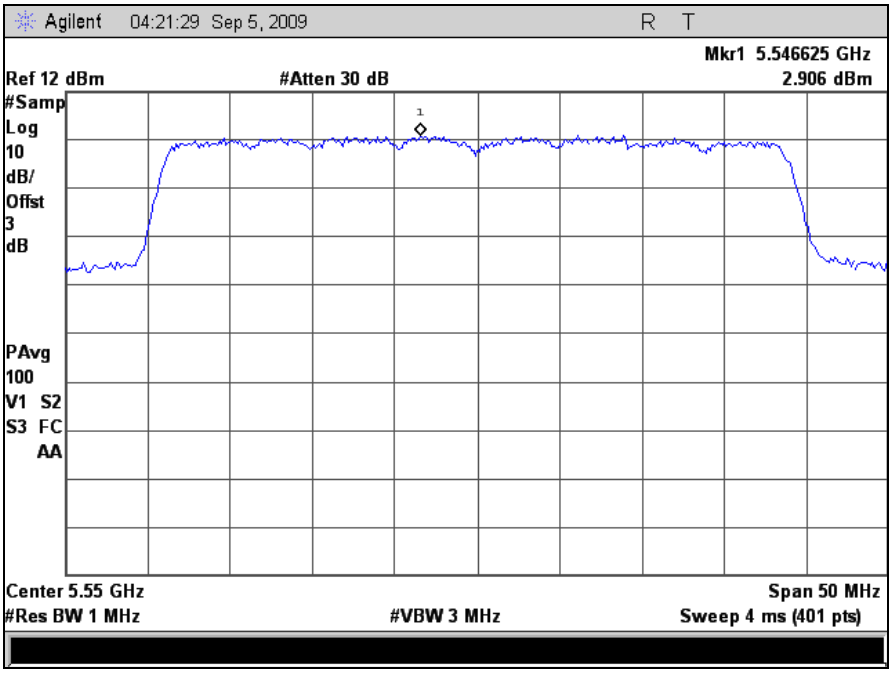
Plot 30. Power Spectral Density, Antenna Port 0+1+2+3, 5300 MHz



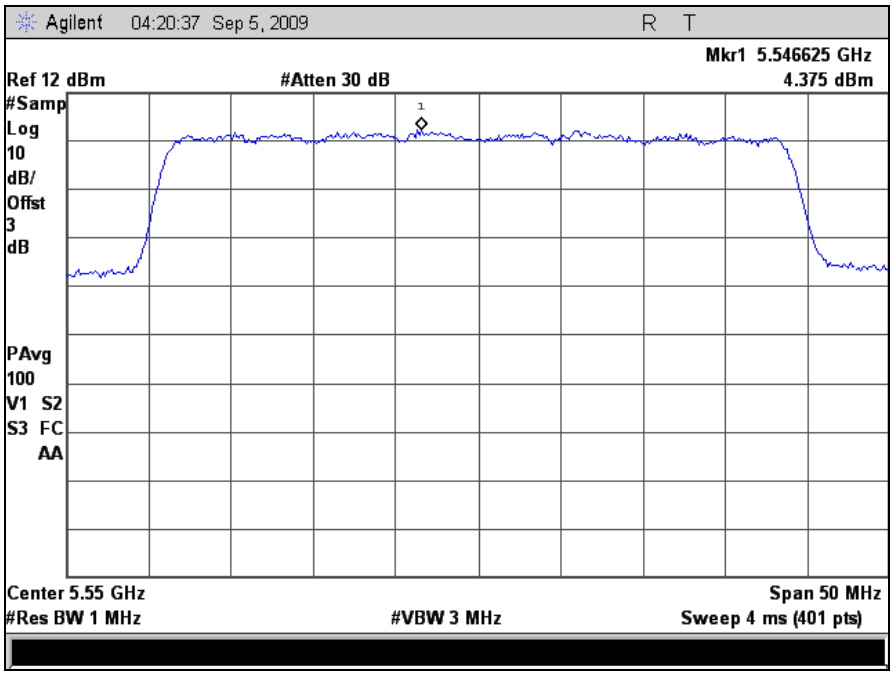
Plot 31. Power Spectral Density, Antenna Port 0, 5550 MHz



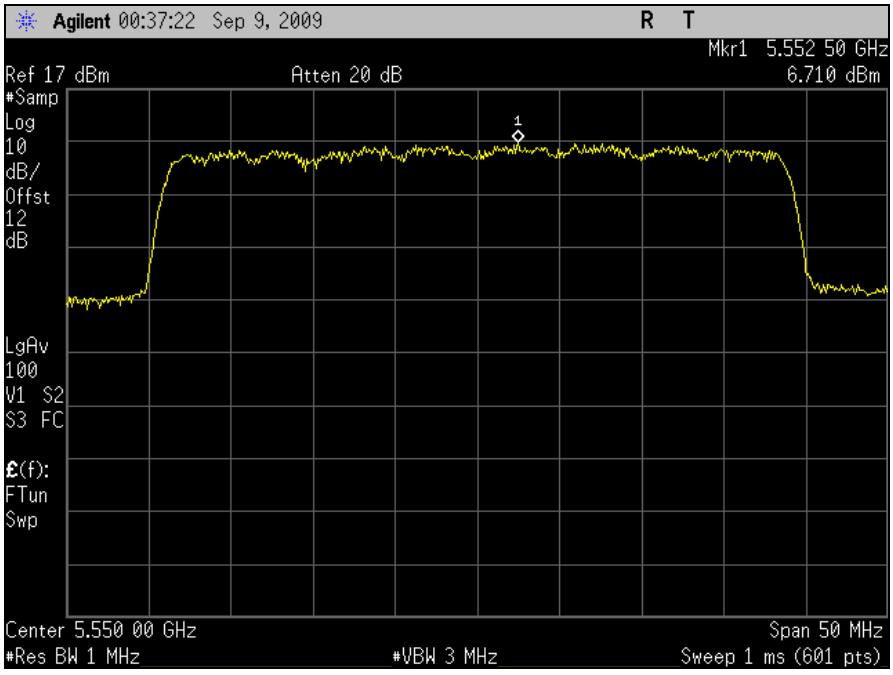
Plot 32. Power Spectral Density, Antenna Port 1, 5550 MHz



Plot 33. Power Spectral Density, Antenna Port 2, 5550 MHz



Plot 34. Power Spectral Density, Antenna Port 3, 5550 MHz



Plot 35. Power Spectral Density, Antenna Port 0+1+2+3, 5550 MHz

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. The 1st trace on the spectrum analyzer was set to RBW=1MHz, VBW=3MHz. The peak detector mode was used and the trace max held. The 2nd trace on the spectrum analyzer was set according to measurement method #1 from the FCC Public Notice DA 02-2138 for making conducted power measurements. A combiner was also used to couple output of all antenna ports.

Test Results: Equipment complies with the peak excursion ratio limits of **§ 15.407(a)(6).** The peak excursion ratio was determined from plots on the following page(s).

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 09/10/09

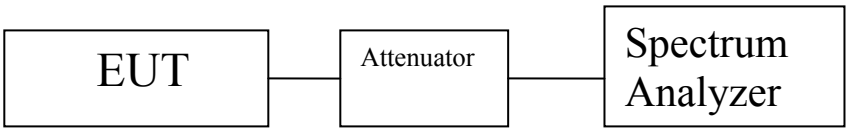
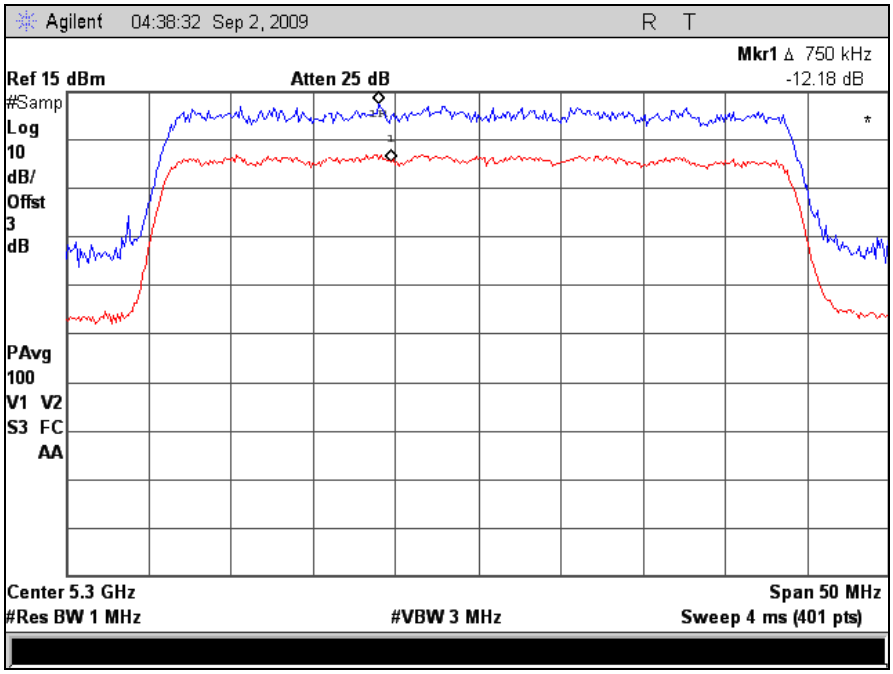
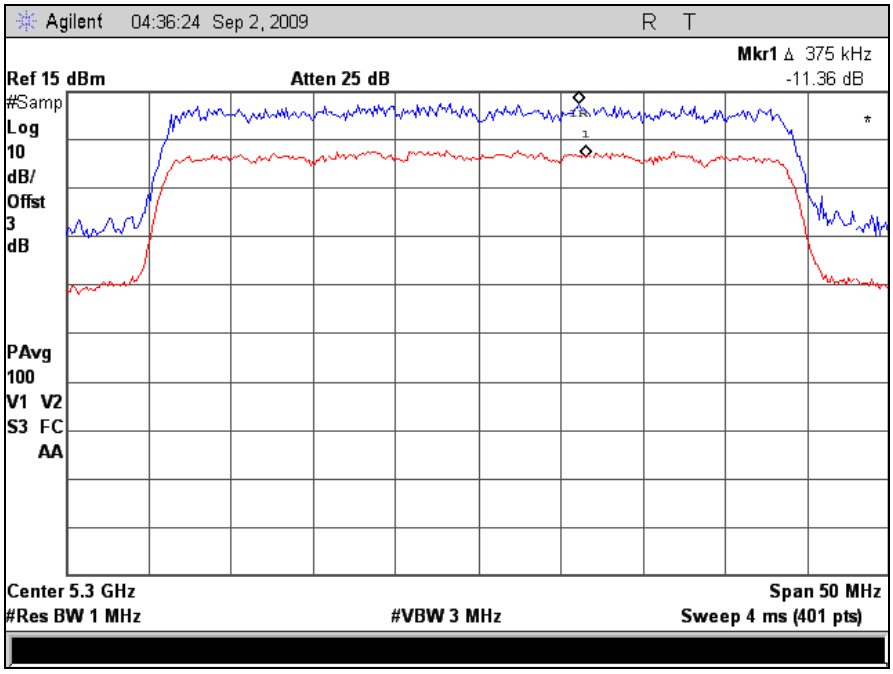


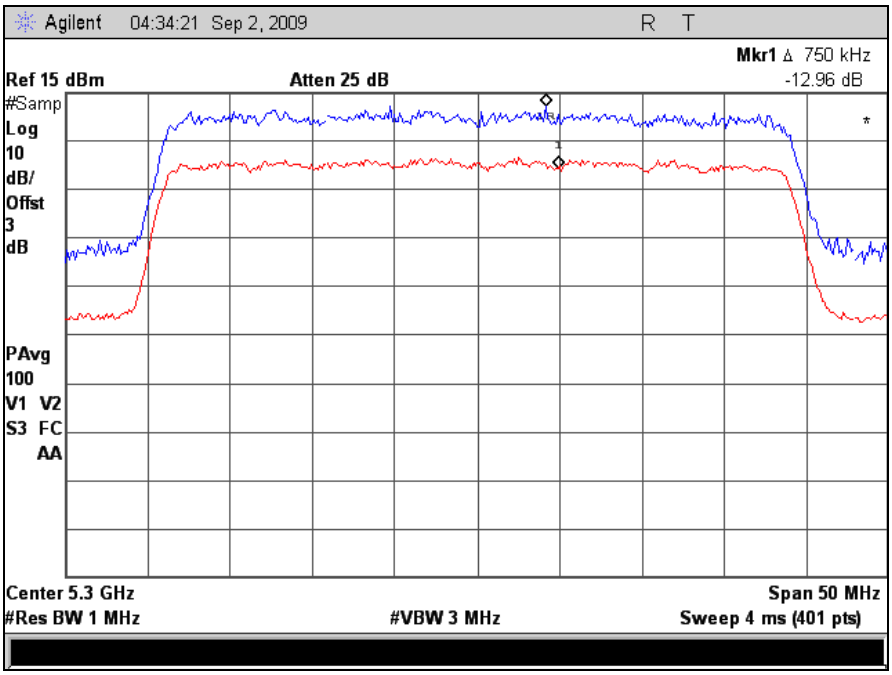
Figure 4. Peak Excursion Ration Test Setup



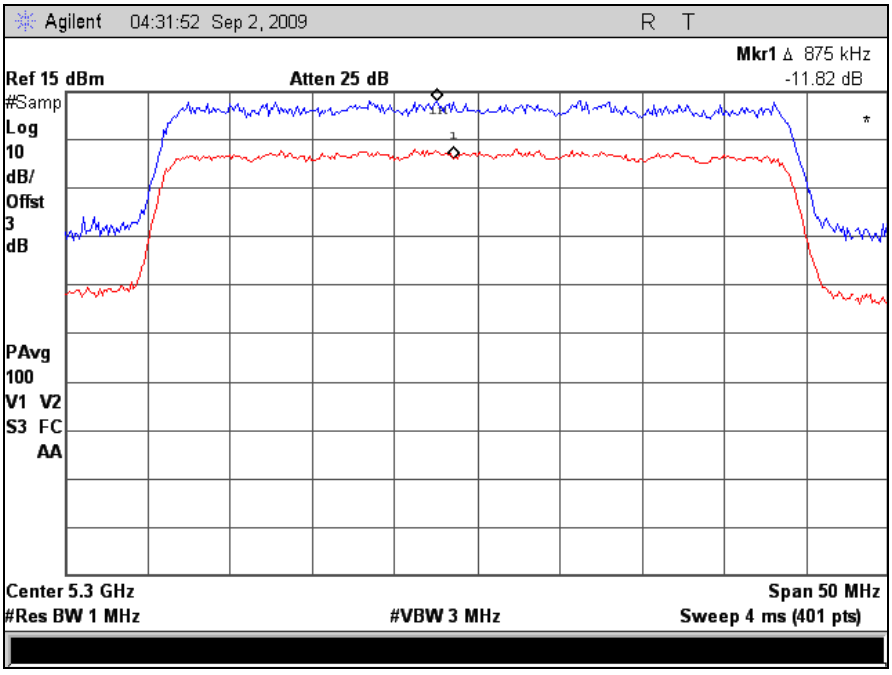
Plot 36. Peak Excursion Ratio, Antenna Port 0, 5300 MHz



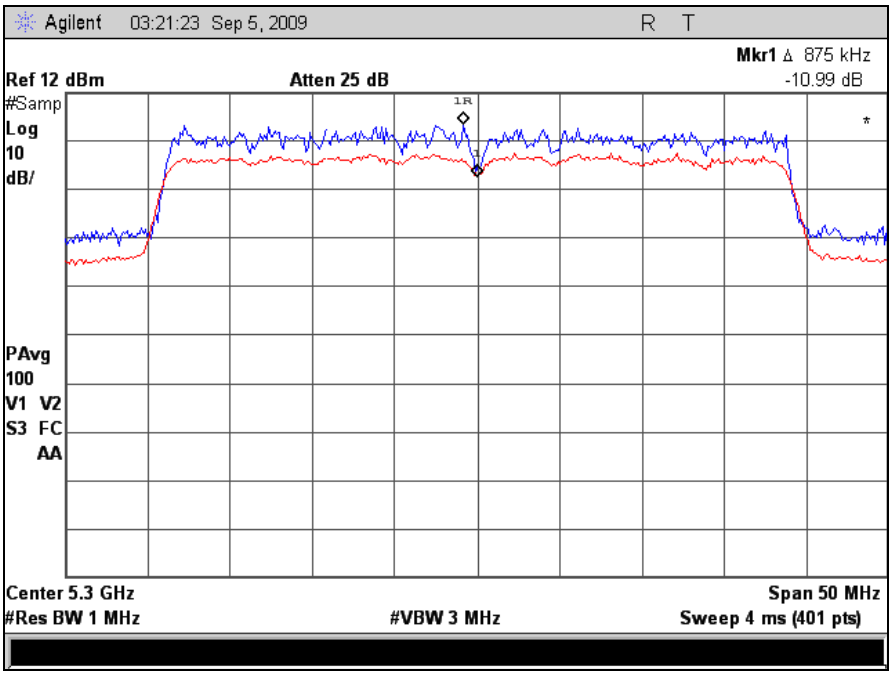
Plot 37. Peak Excursion Ratio, Antenna Port 1, 5300 MHz



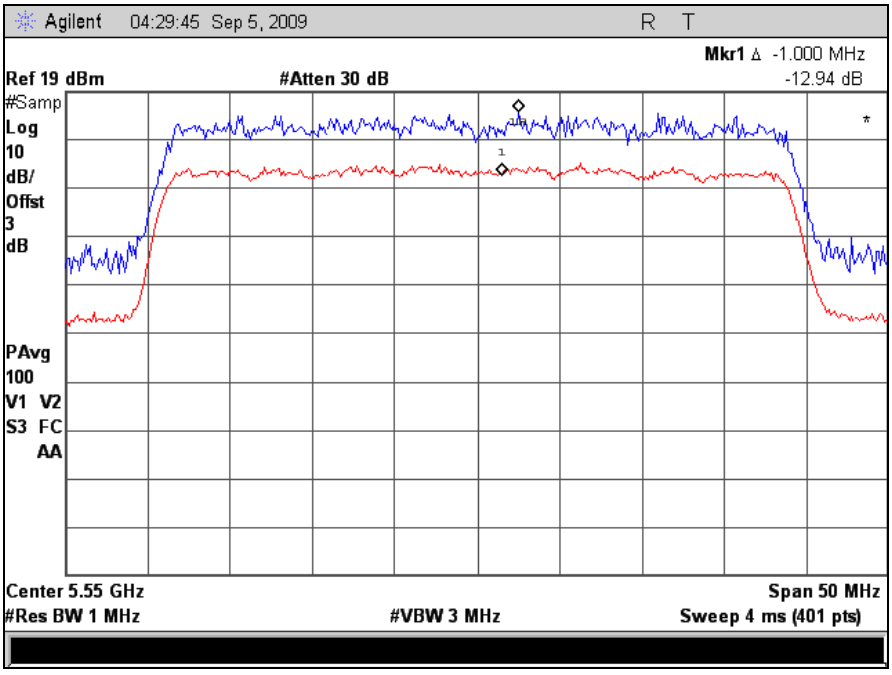
Plot 38. Peak Excursion Ratio, Antenna Port 2, 5300 MHz



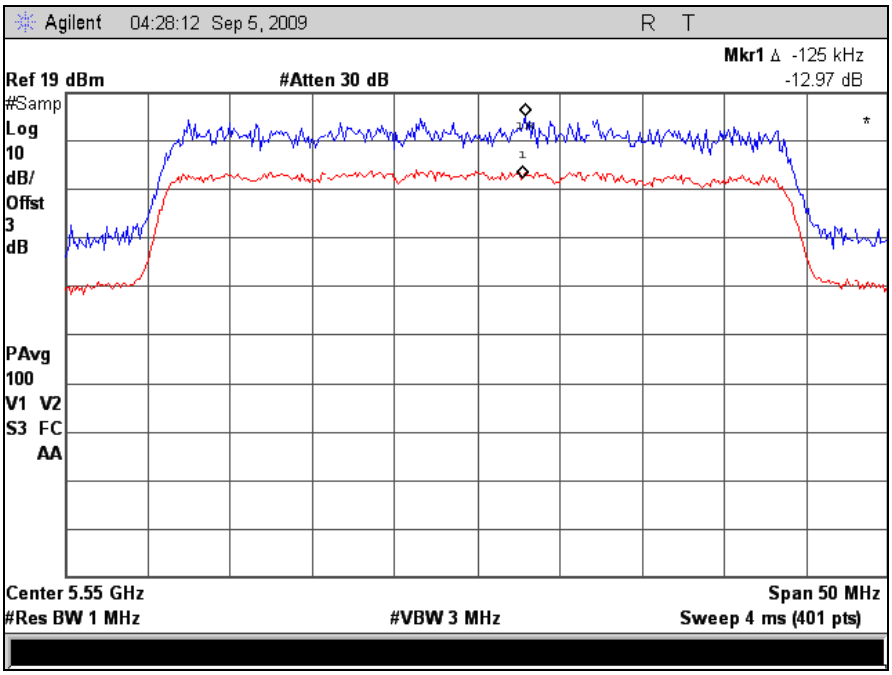
Plot 39. Peak Excursion Ratio, Antenna Port 3, 5300 MHz



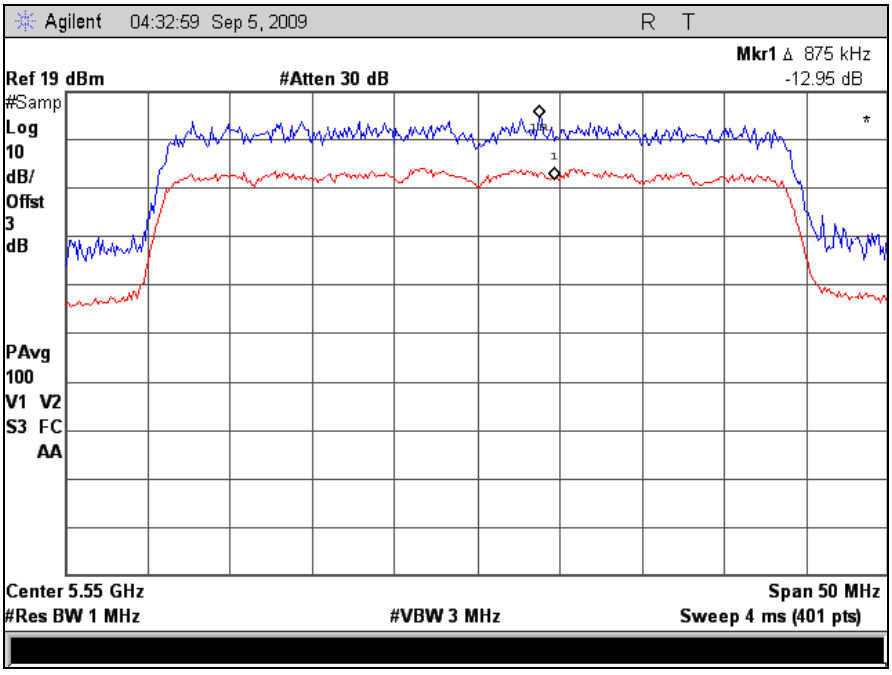
Plot 40. Peak Excursion Ratio, Antenna Port 0+1+2+3, 5300 MHz



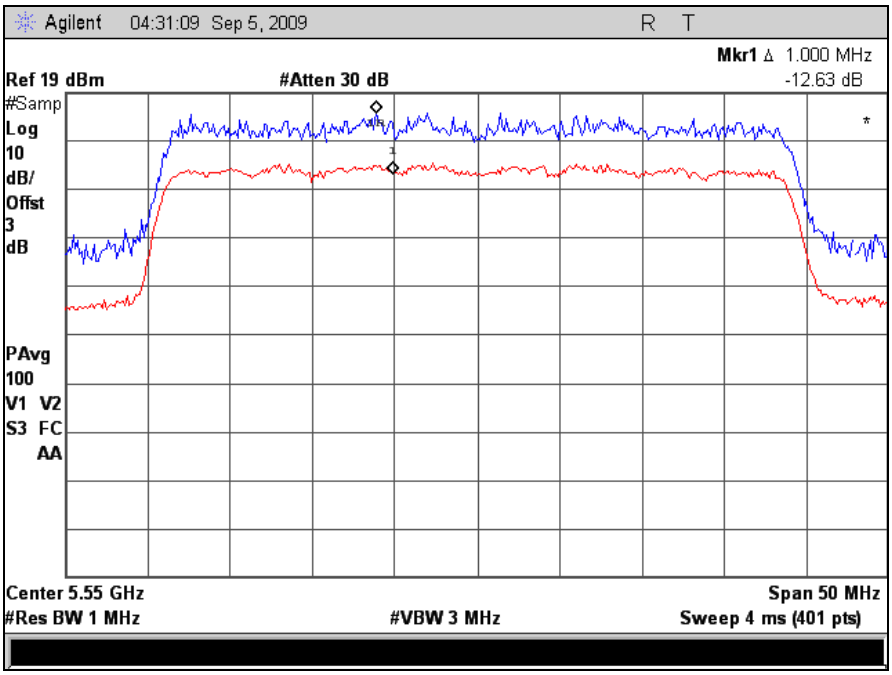
Plot 41. Peak Excursion Ratio, Antenna Port 0, 5550 MHz



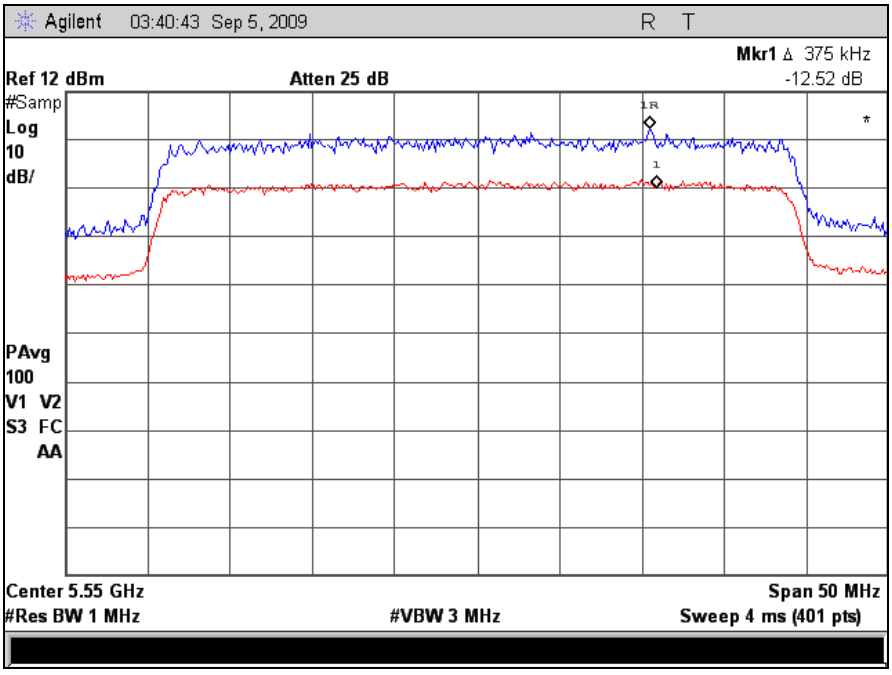
Plot 42. Peak Excursion Ratio, Antenna Port 1, 5550 MHz



Plot 43. Peak Excursion Ratio, Antenna Port 2, 5550 MHz



Plot 44. Peak Excursion Ratio, Antenna Port 3, 5550 MHz



Plot 45. Peak Excursion Ratio, Antenna Port 0+1+2+3, 5550 MHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(b)(2), (3), (6), (7) Undesirable Emissions

Test Requirements: **§ 15.407(b)(2), (3), (6), (7)**; **§15.205:** Emissions outside the frequency band.

§ 15.407(b)(2): For transmitters operating in the 5.25-5.35 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz. Devices operating in the 5.25-5.35 GHz band that generate emissions in the 5.15-5.25 GHz band must meet all applicable technical requirements for operation in the 5.15-5.25 GHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of -27 dBm/MHz in the 5.15-5.25 GHz band.

§ 15.407(b)(3): For transmitters operating in the 5.47-5.725 GHz band: all emissions outside of the 5.47-5.725 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 transmitter was placed on an acrylic stand inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast with 1 m to 4 m height to determine worst case orientation for maximum emissions.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz 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 found compliant with the Radiated Emission limits of **§15.209(a)** for Intentional Radiators. See following pages for detailed test results.

Test Engineer(s): Dusmantha Tennakoon

Test Date(s): 09/10/09

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(b): Harmonic Emissions Requirements – Radiated

Frequency (GHz)	Measured value (corrected) @ 3m dBuV/m	Limit @ 3m	Margin	Remark	Restricted band
4.8284	59.39	68.3	-8.91	Peak	No
5.2445	66.41	68.3	-1.89	Peak	No
5.35	52.85	54	-1.15	Avg.	Yes
5.35	67.6	74	-6.4	Peak	
5.4657	61.9	68.3	-6.4	Peak	No
5.5446	61.69	68.3	-6.61	Peak	No
10.6	46.93	54	-7.07	Avg.	Yes
10.6	61.38	74	-12.62	Peak	
15.902	36.19	54	-17.81	Avg.	Yes
15.902	47.24	74	-26.76	Peak	

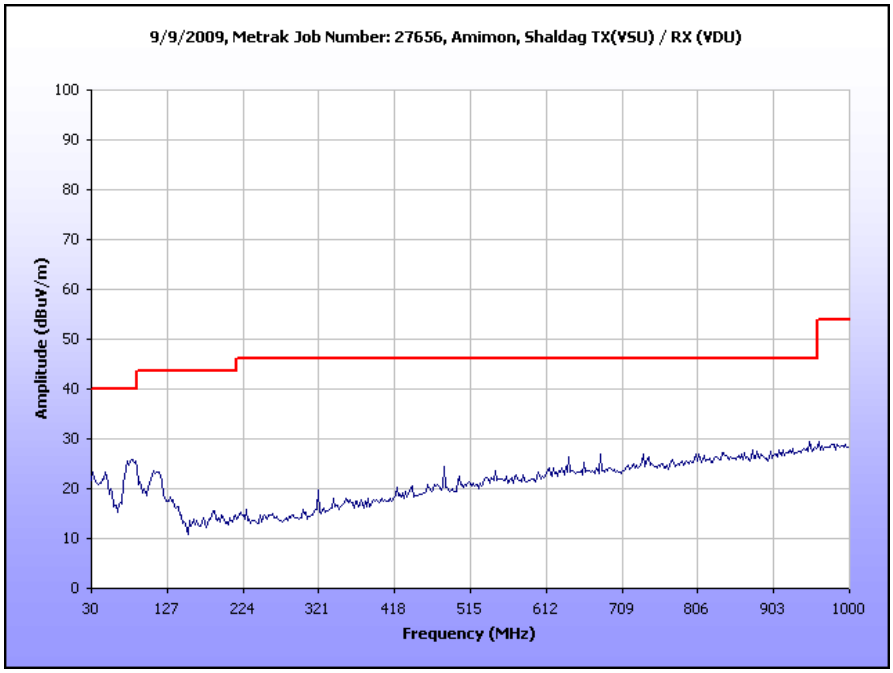
Table 17. Radiated Spurs, Test Results, 5300 MHz

Note: All other emissions were measured at the noise floor of the spectrum analyzer. Additional plots are shown in the following pages to substantiate the results shown in the above table.

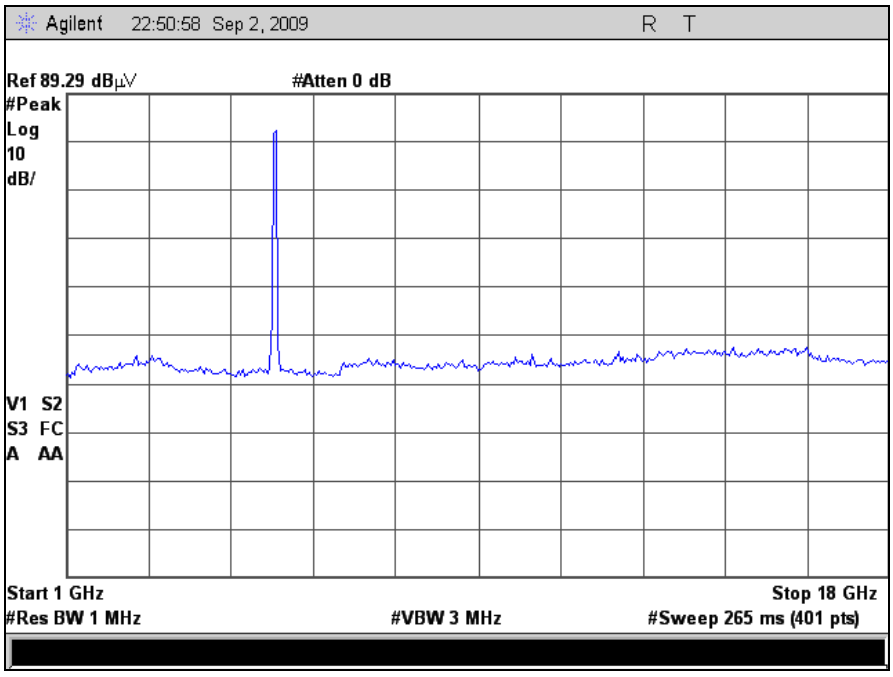
Frequency (GHz)	Measured value (corrected) @ 3m dBuV/m	Limit @ 3m	Margin	Remark	Restricted band
5.3283	56.87	68.3	-11.43	Peak	No
5.4193	46.78	54	-7.22	Avg.	Yes
5.4193	59.18	74	-14.82	Peak	
5.4659	57.83	68.3	-10.47	Peak	No
10	62.22	68.3	-6.08	Peak	No
11.1	45.97	54	-8.03	Avg.	Yes
11.1	61.21	74	-12.79	Peak	

Table 18. Radiated Spurs, Test Results, 5550 MHz

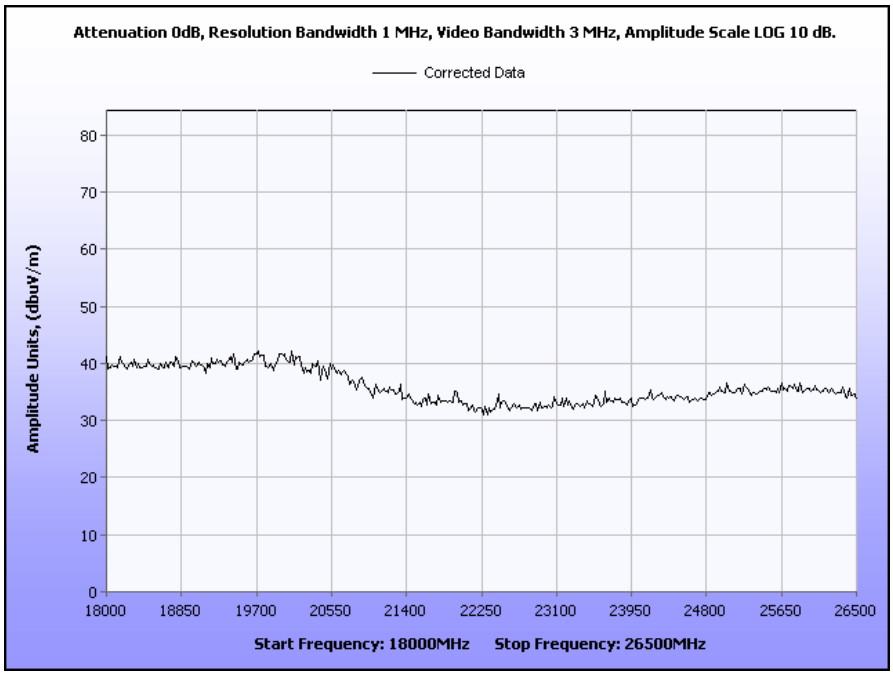
Note: All other emissions were measured at the noise floor of the spectrum analyzer. Additional plots are shown in the following pages to substantiate the results shown in the above table.



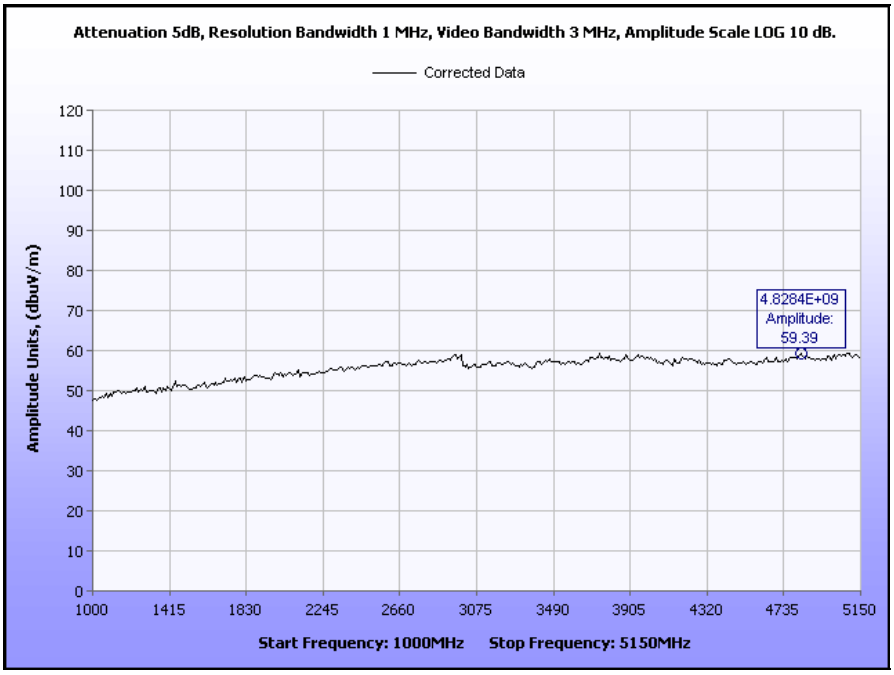
Plot 46. Scan of Radiated Spurs below 1 GHz, ch. 5300 MHz



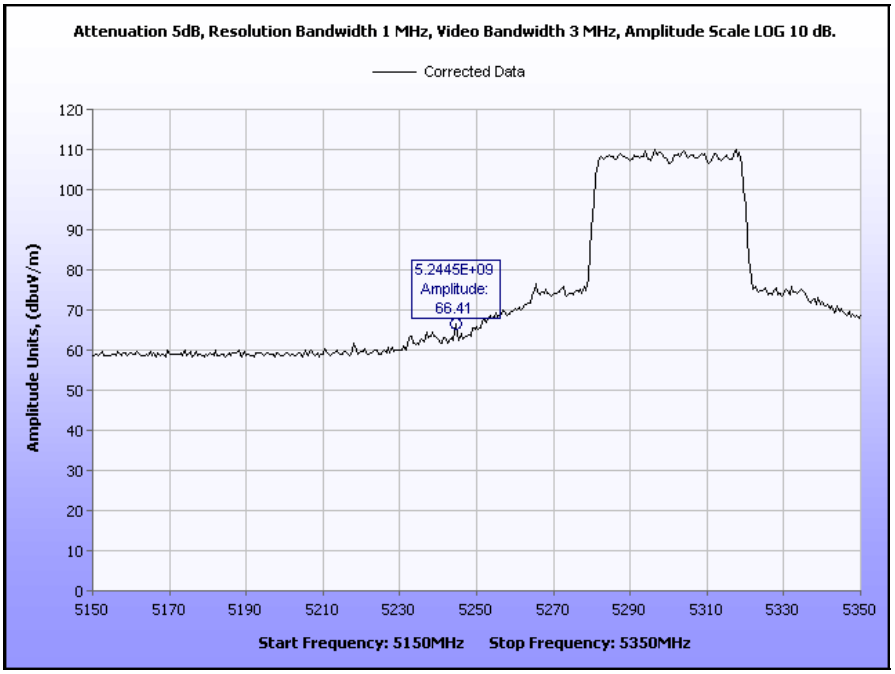
Plot 47. Scan of Radiated Spurs between 1 and 18 GHz, ch. 5300 MHz



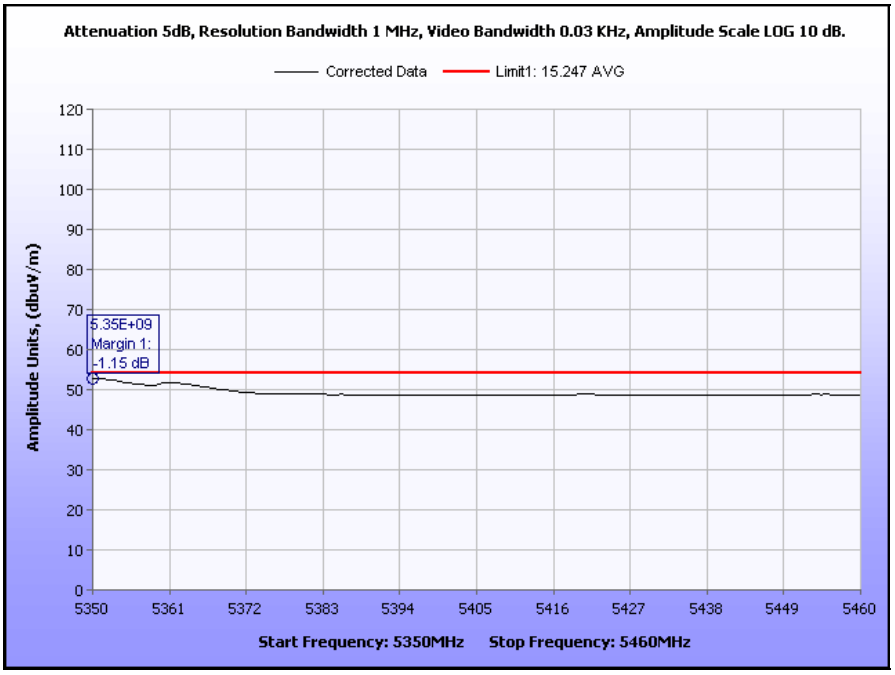
Plot 48. Scan of Radiated Spurs between 18 and 26.5 GHz, ch. 5300 MHz



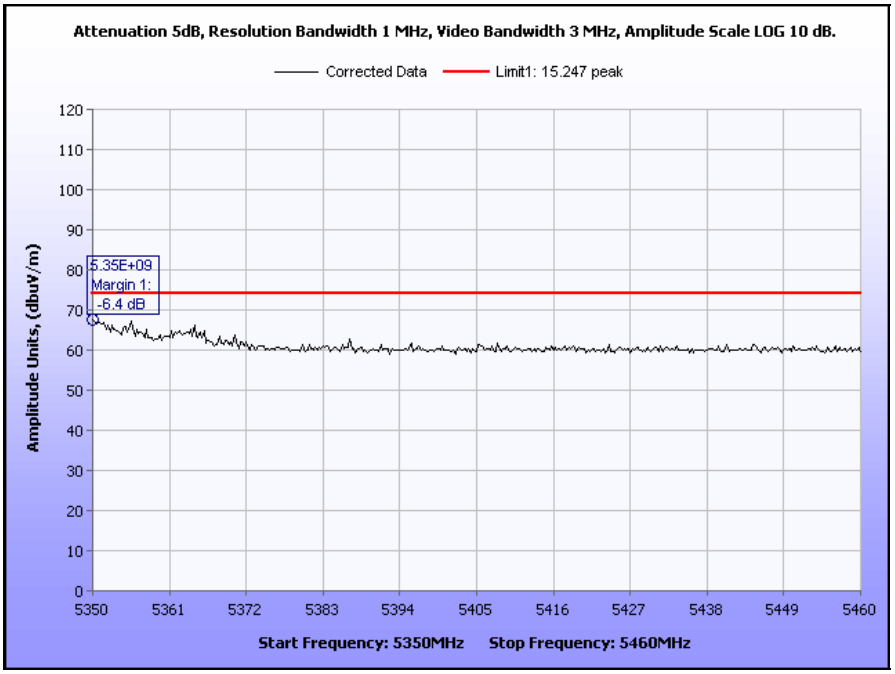
Plot 49. Radiated Spurs, 1000 MHz – 5150 MHz, ch. 5300 MHz



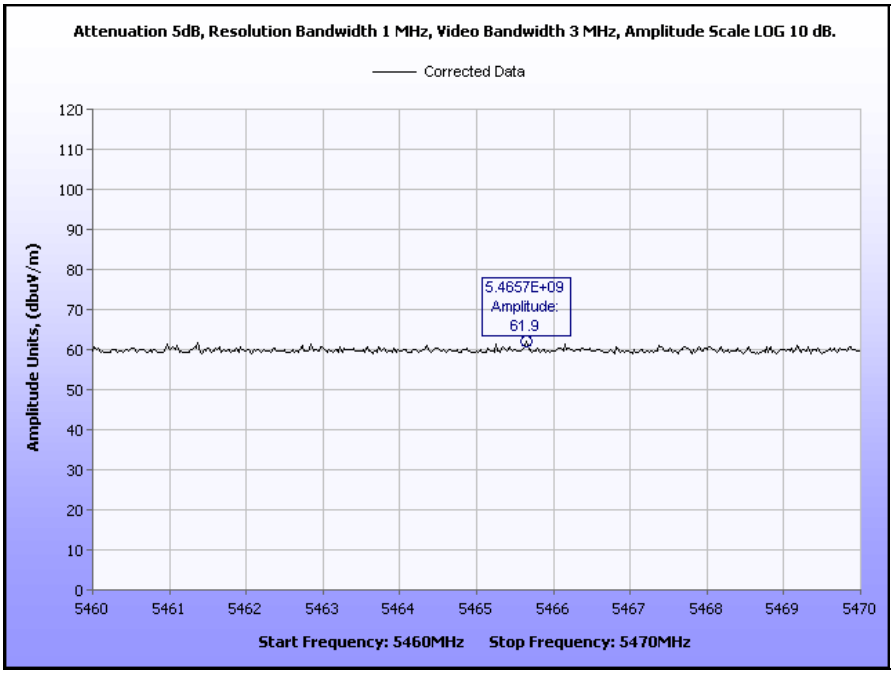
Plot 50. Radiated Spurs, 5150 MHz – 5350 MHz, ch. 5300 MHz



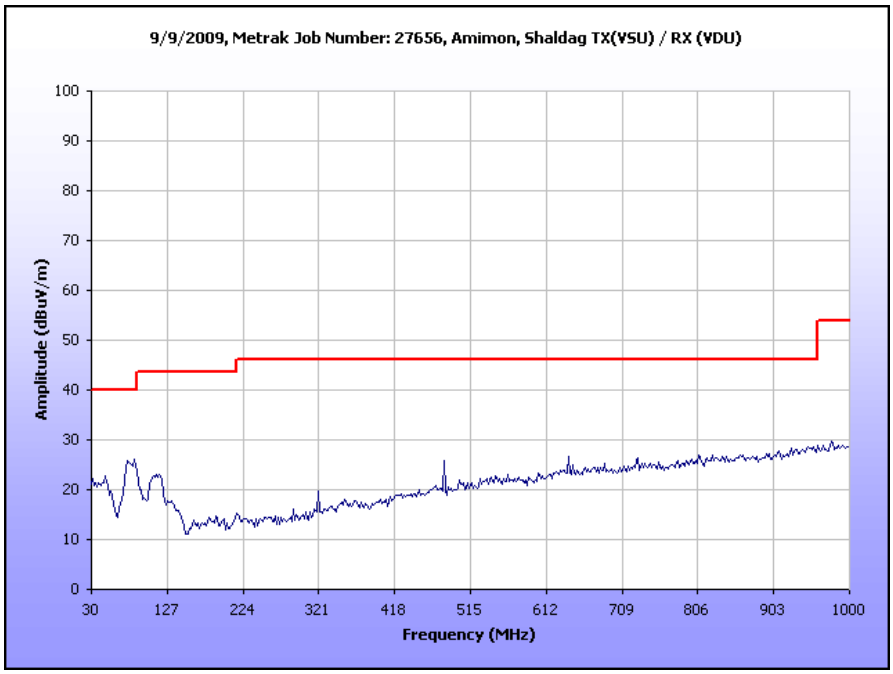
Plot 51. Radiated Spurs, 5350 MHz – 5460 MHz, Avg., ch. 5300 MHz



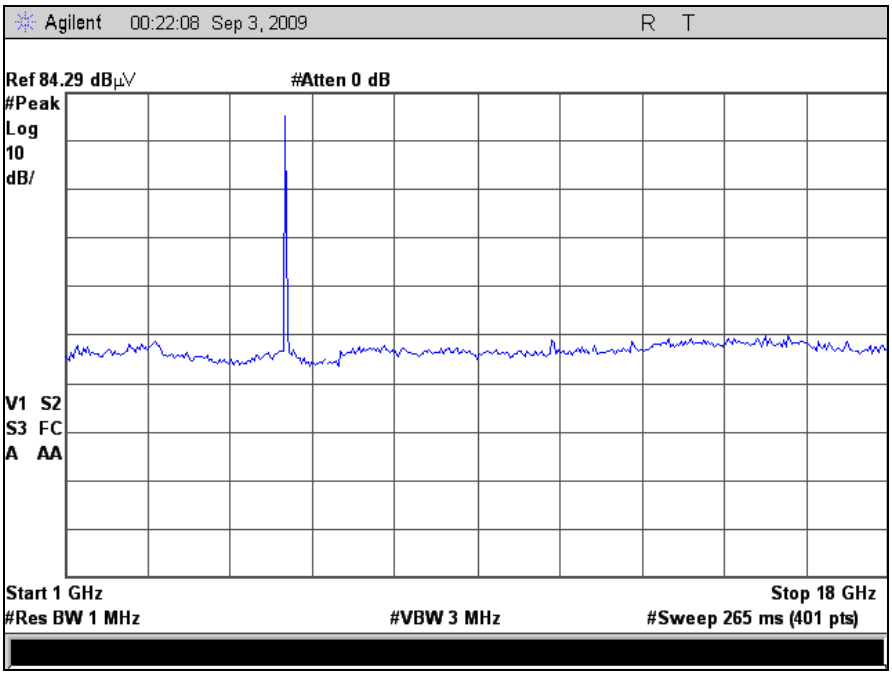
Plot 52. Radiated Spurs, 5350 MHz – 5460 MHz, Peak, ch. 5300 MHz



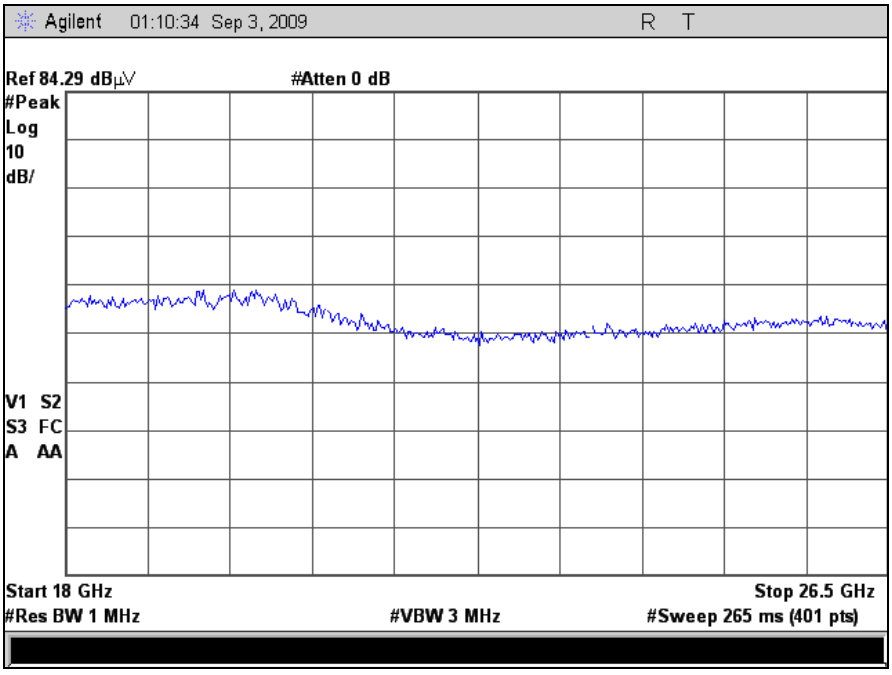
Plot 53. Radiated Spurs, 5460 MHz – 5470 MHz, ch. 5300 MHz



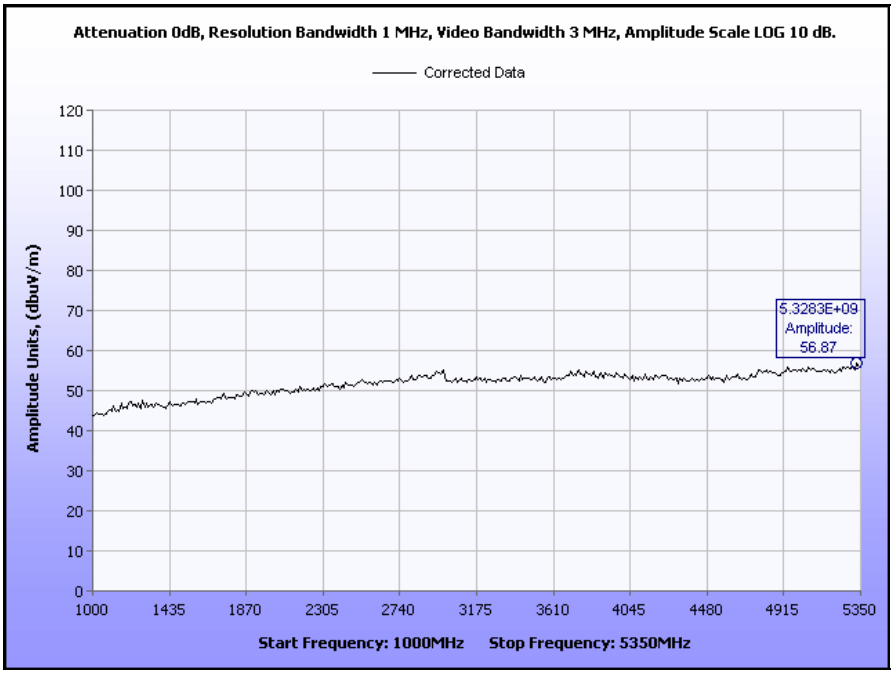
Plot 54. Scan of Radiated Spurs Below 1 GHz, ch. 5550 MHz



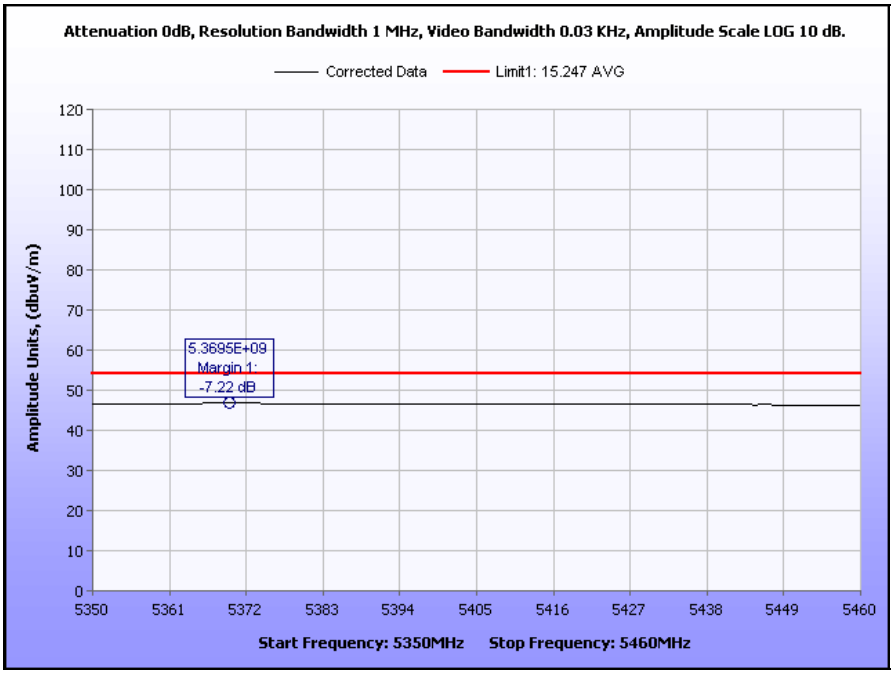
Plot 55. Scan of Radiated Spurs Between 1 and 18 GHz, ch. 5550 MHz



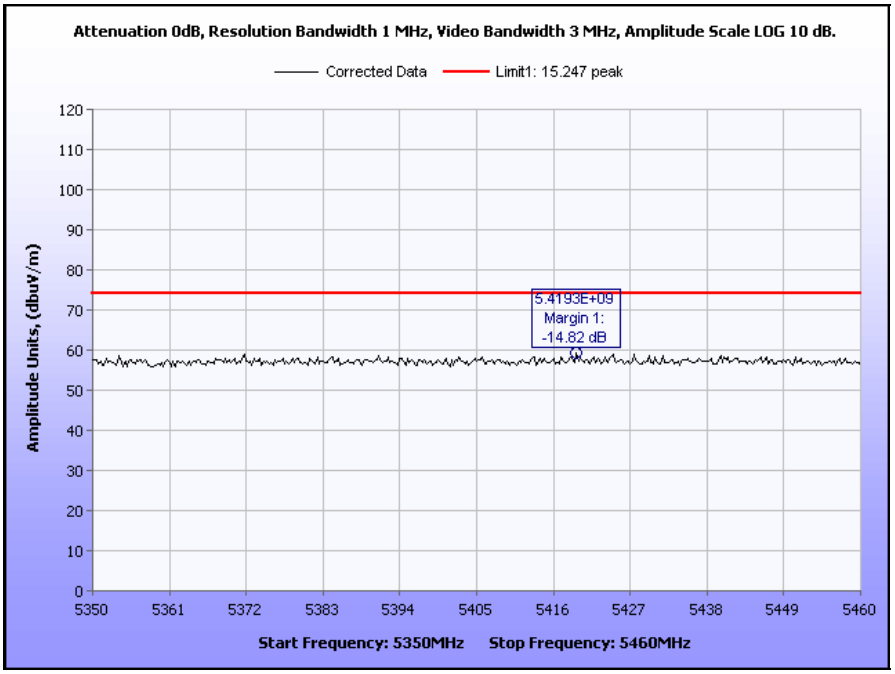
Plot 56. Scan of Radiated Spurs Between 18 and 26.5 GHz, ch. 5550 MHz



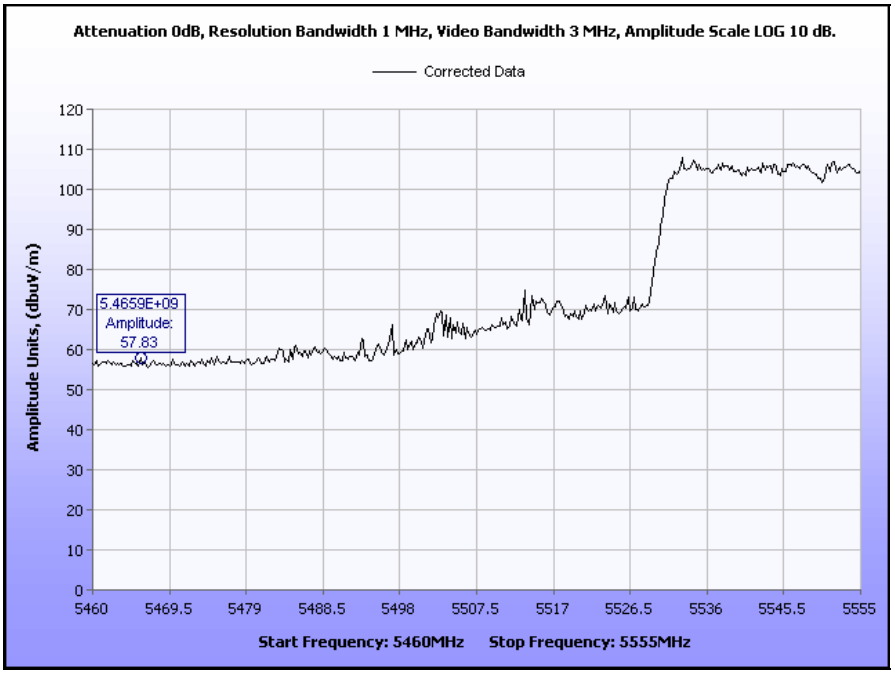
Plot 57. Radiated Spurs, 1000 MHz – 5350 MHz, ch. 5550 MHz



Plot 58. Radiated Spurs, 5350 MHz – 5460 MHz, Avg., ch. 5550 MHz



Plot 59. Radiated Spurs, 5350 MHz – 5460 MHz, Peak, ch. 5550 MHz



Plot 60. Radiated Spurs, 5460 MHz – 5470 MHz, ch. 5550 MHz

Photograph 5. Radiated Spurs, Test Setup

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 frequency is 5300 MHz and 5550 MHz;. Highest conducted power (combined from all for antenna ports) = 200.4 mW (i.e. 23.02 dBm). Therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2.**

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

$$S = P G / 4\pi R^2$$

where,

S = Power Density mW/m^2
P = Power (mW)
R = Distance to the center of radiation of the antenna
G = Maximum antenna gain

Maximum antenna gain for EUT = 1.9 dBi = 1.55

P = 200.4 mW
R = 20 cm
G = 1.55

$$S = 200.4*1.55 / 4(3.1416)(20)^2$$

$$S = 0.0618 \text{ mW/cm}^2$$

Therefore, EUT meets the Uncontrolled Exposure limit at 20cm.

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 users manual.

Test Procedure: The EUT was connected directly to a spectrum analyzer through a attenuator. The resolution band width of the spectrum analyzer was set to 10 KHz. The 1st trace of the Spectrum Analyzer was used as a reference at 23°C. A 2nd trace was used to show the drift of the carrier at extreme conditions. A delta marker was used to find the drift at a given extreme condition. The two frequencies (i.e. 5300 MHz and 5550 MHz) are derived from one oscillator. Therefore, only one channel was investigated for frequency stability. Antenna Port 0 was used for measurements.

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

Test Engineer(s): Dusmantha Tennakoon

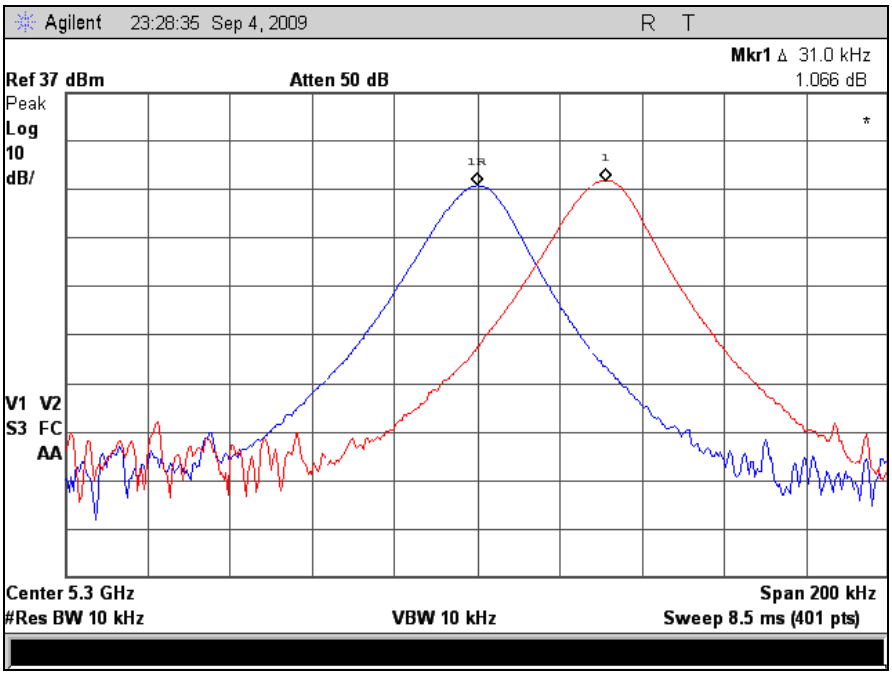
Test Date(s): 09/10/09

Temperature (centigrade)	Drift (kHz)	Drift (ppm)
50	26.5	5
40	10.5	1.9
30	1.0	0.2
23	ref	ref
20	2.0	0.4
10	6.5	1.2
0	15.5	2.9
-10	24.0	4.5
-20	30.0	5.7
-30	31.0	5.8

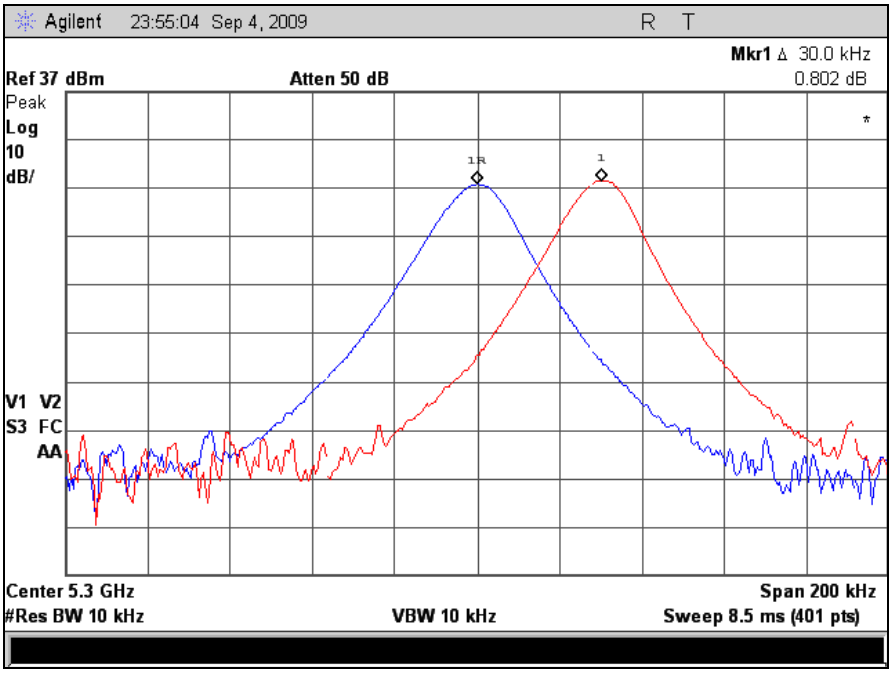
Table 19. Frequency Stability, Reference 5300 MHz at 23°C, Test Results

Measured voltage (+/- 15% of nominal)	Drift (kHz)	Drift (ppm)
102	0	0
138	0.5	0.1

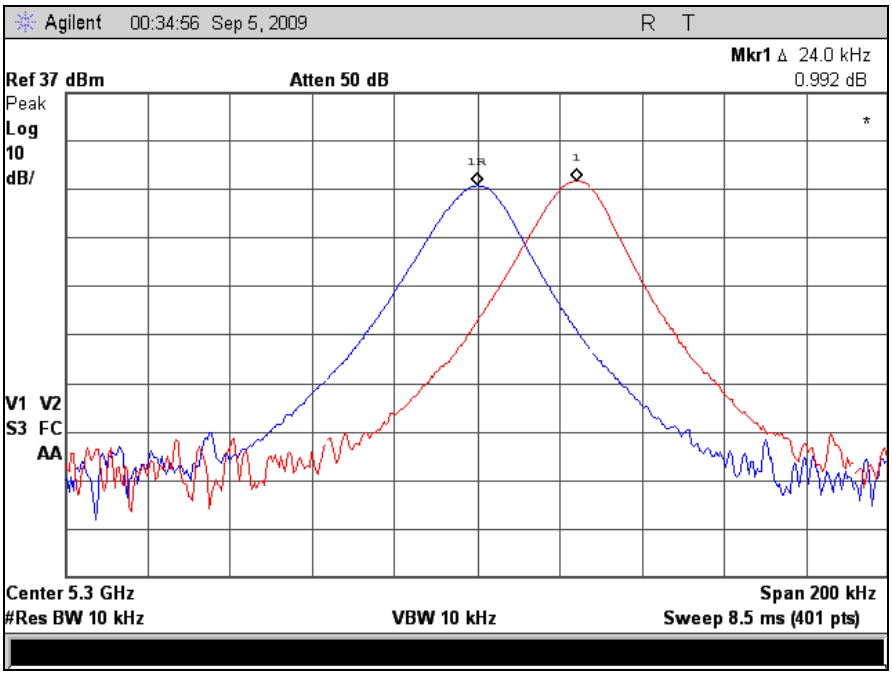
Table 20. Frequency Stability, Reference 5300 MHz at 120 VAC and 23°C, Test Results



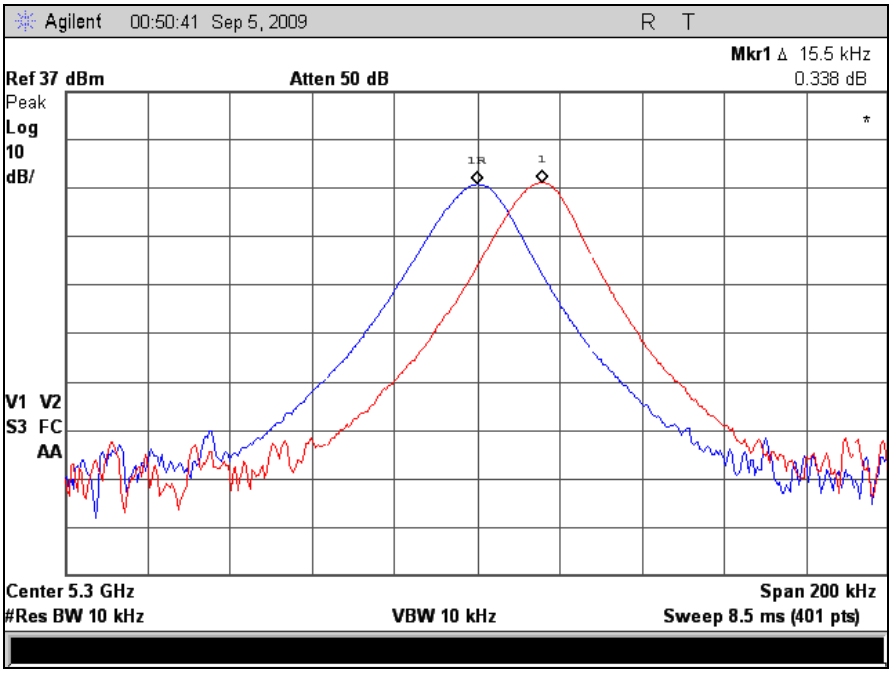
Plot 61. Frequency Stability, -30°C



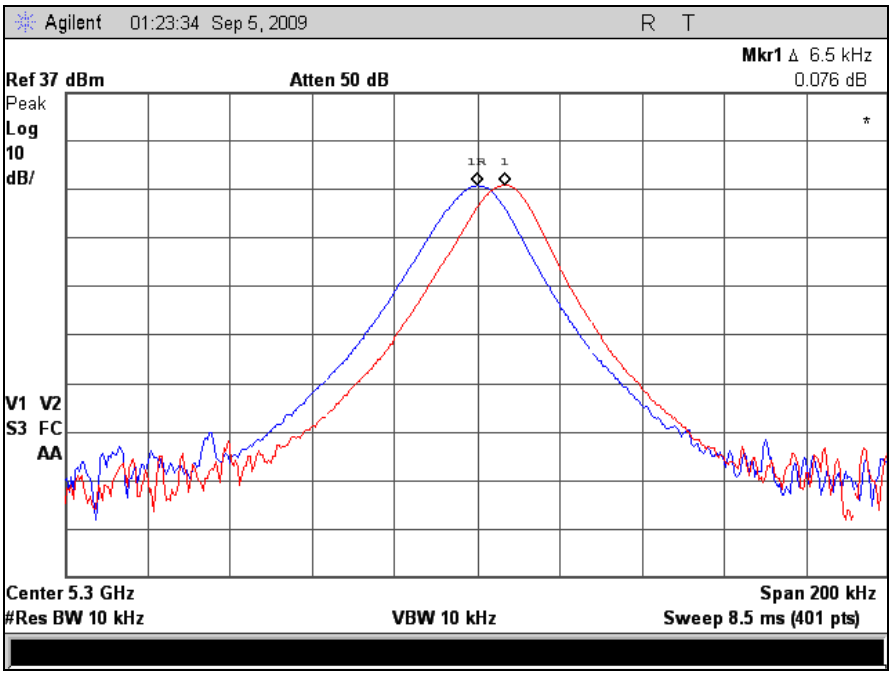
Plot 62. Frequency Stability, -20°C



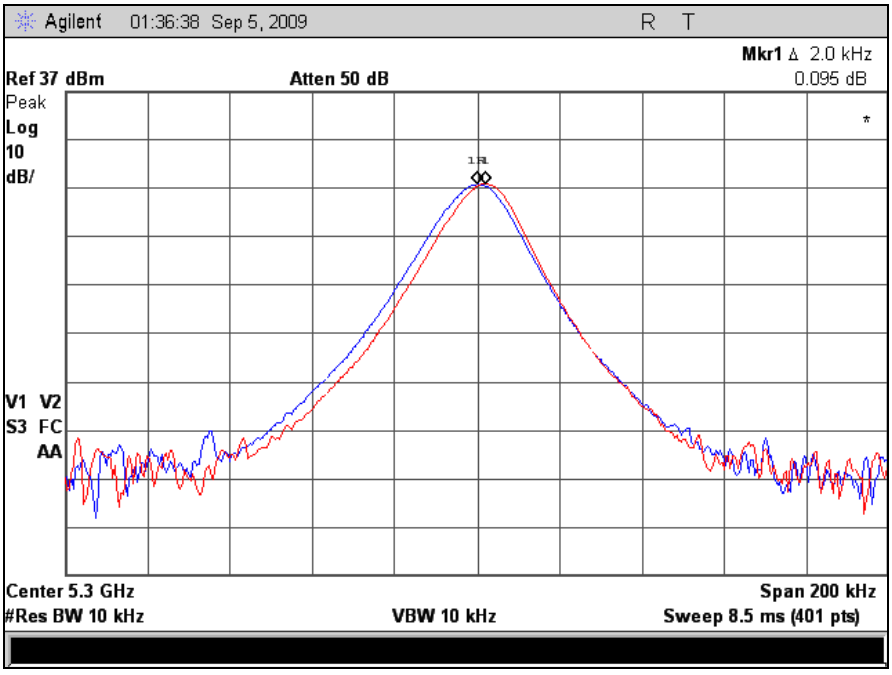
Plot 63. Frequency Stability, -10°C



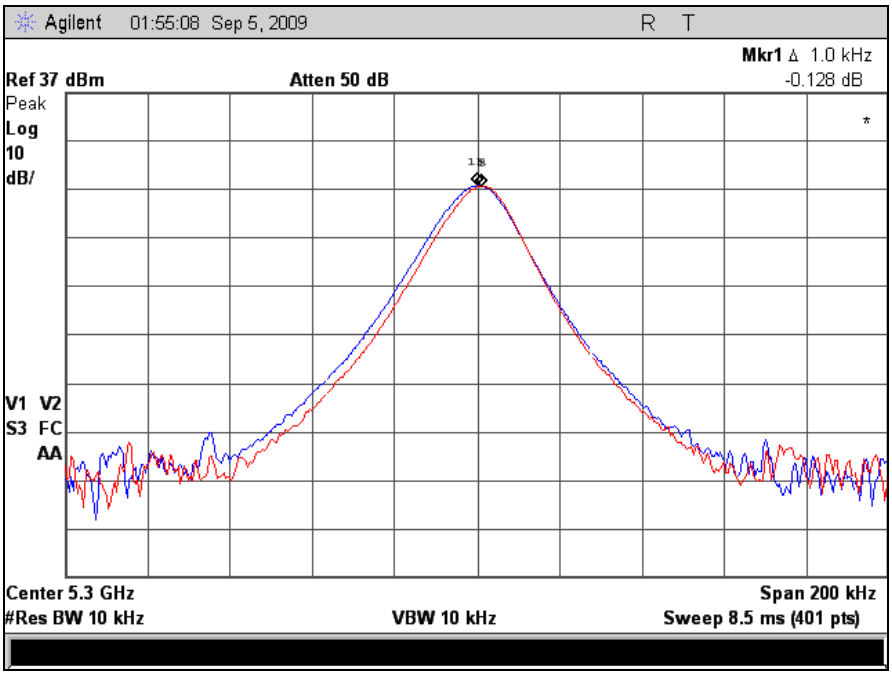
Plot 64. Frequency Stability, 0°C



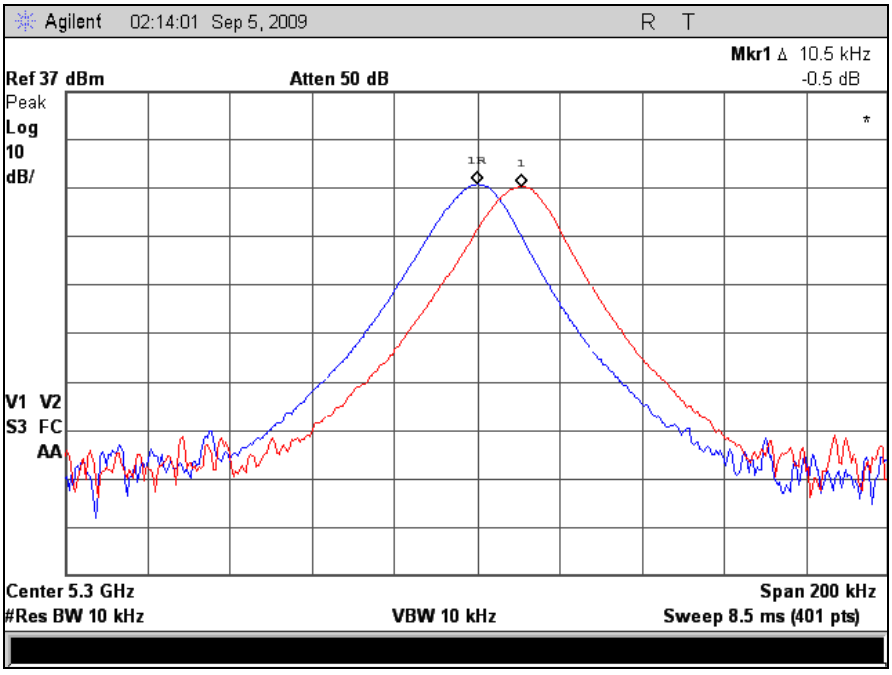
Plot 65. Frequency Stability, 10°C



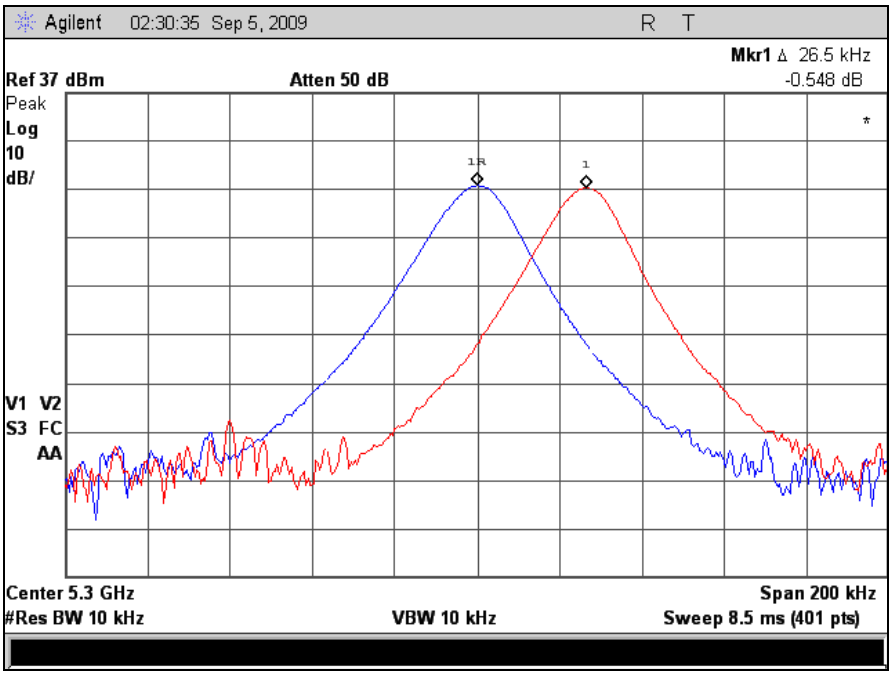
Plot 66. Frequency Stability, 20°C



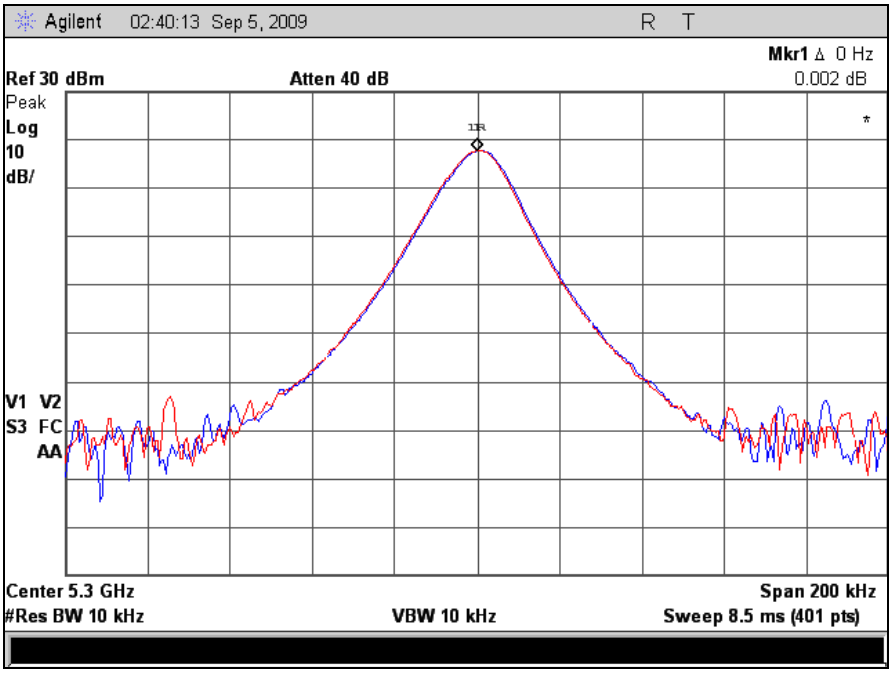
Plot 67. Frequency Stability, 30°C



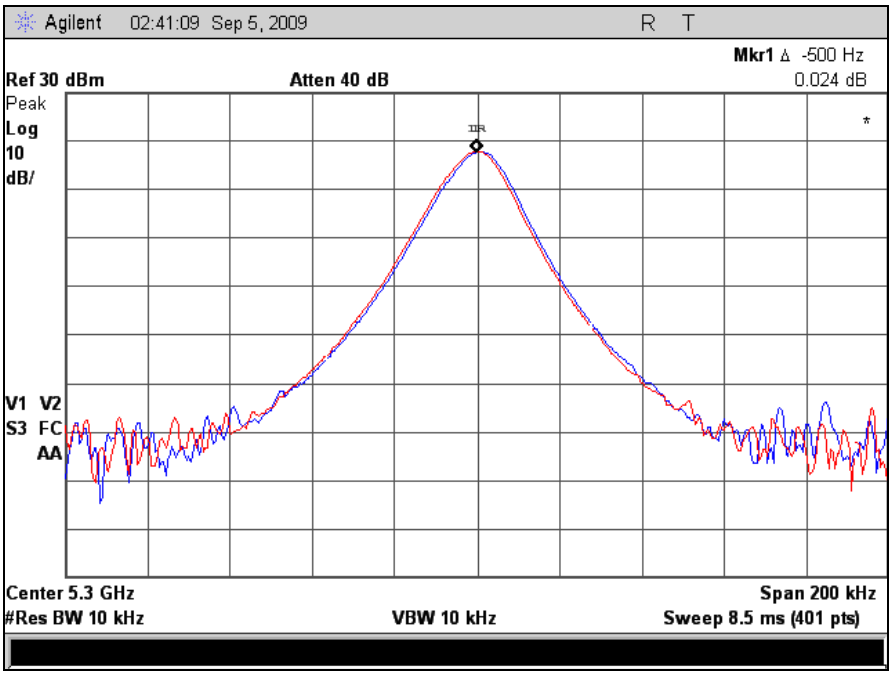
Plot 68. Frequency Stability, 40°C



Plot 69. Frequency Stability, 50°C



Plot 70. Frequency Stability, 120 VAC



Plot 71. Frequency Stability, 138 VAC

Photograph 6. Frequency Stability, Test Setup

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 21. 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 22. 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 23. 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 24. DFS Response Requirement Values

Note: The EUT is a client device without radar detection.

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

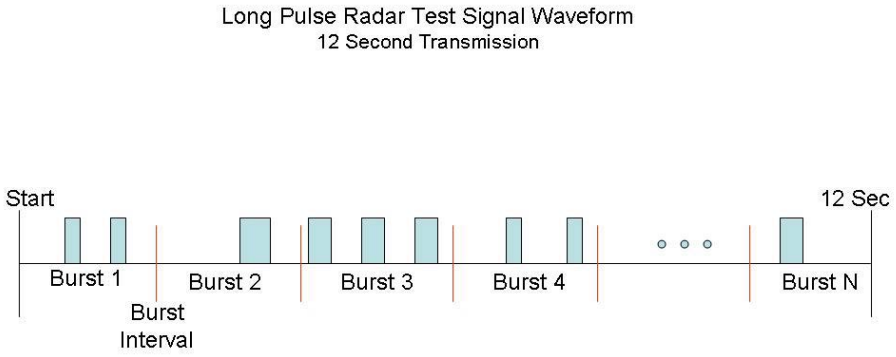


Figure 5. Long Pulse Radar Test Signal Waveform

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 6, and the radar test signal generator is shown in Photograph 7.

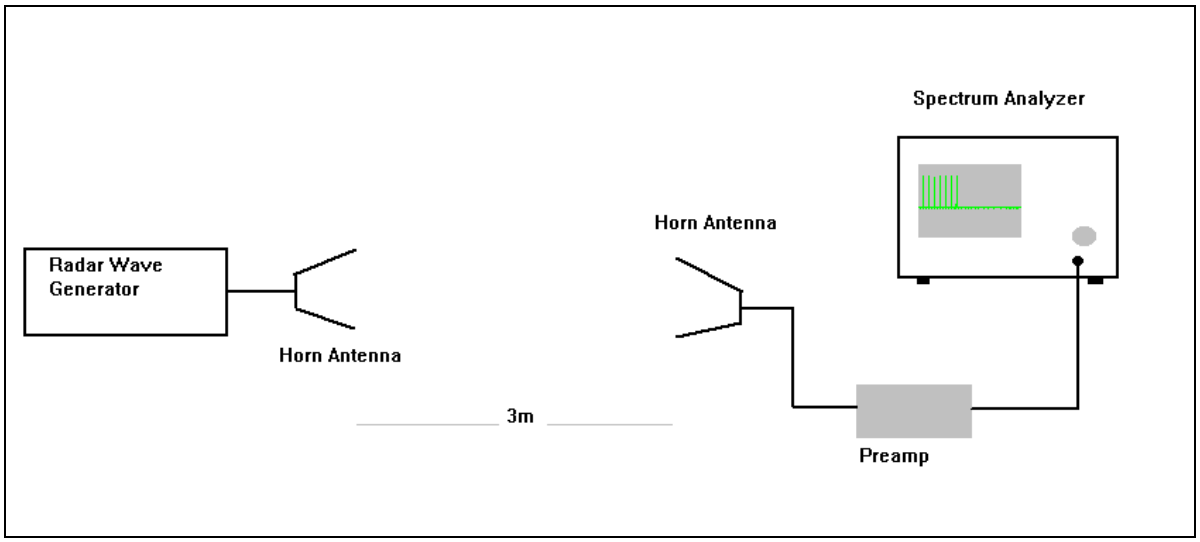
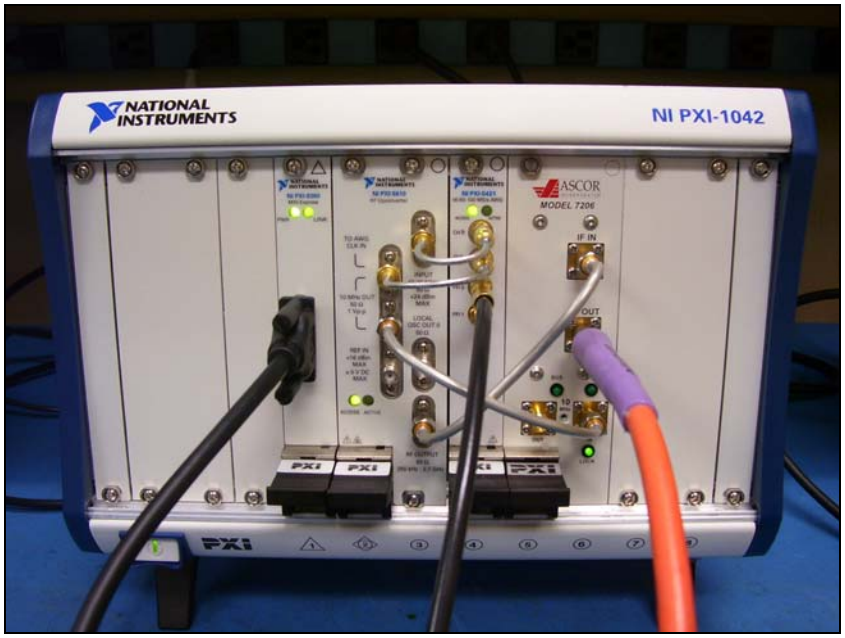
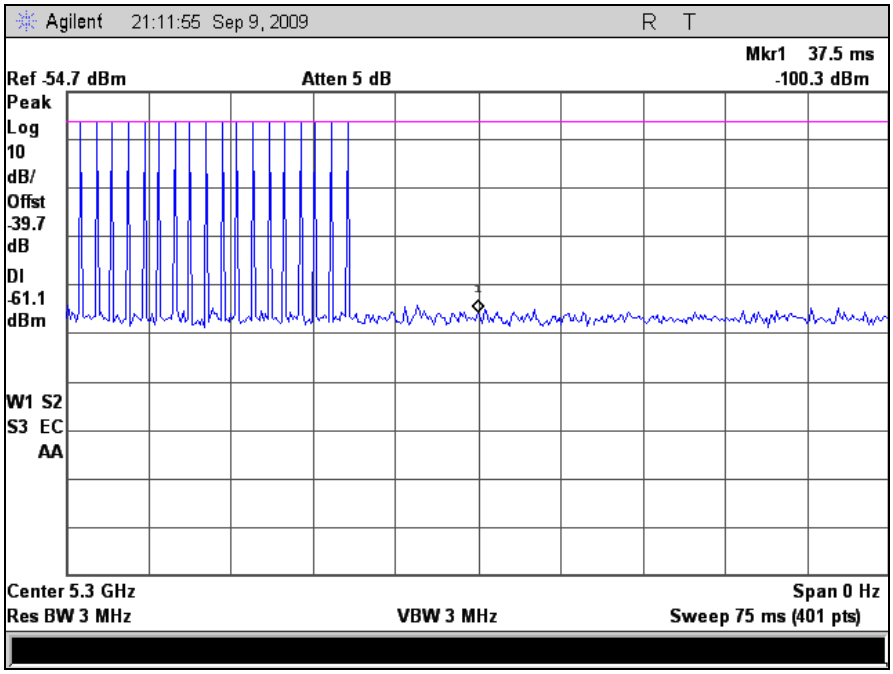


Figure 6. Calibration test setup

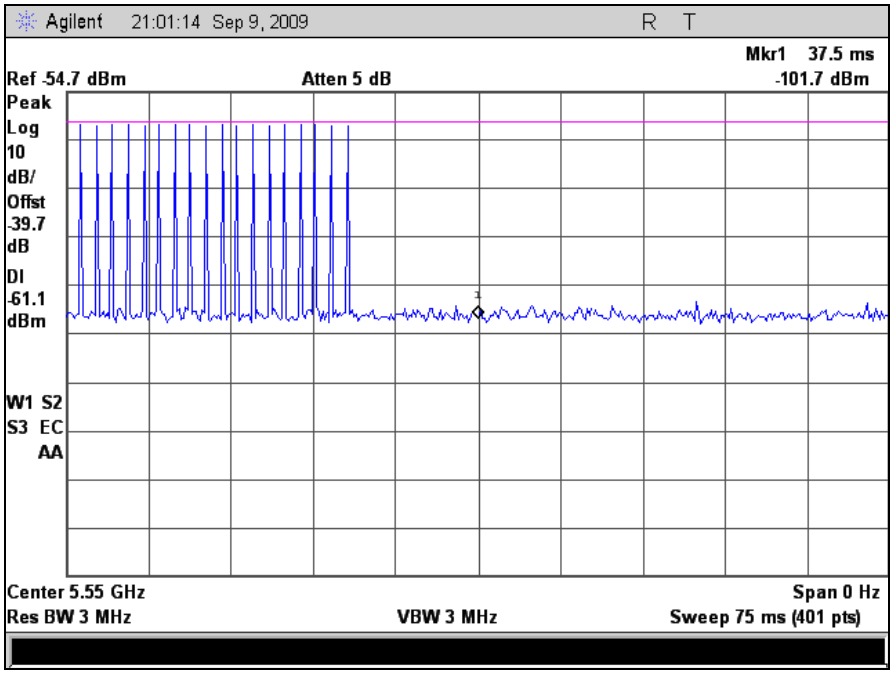


Photograph 7. DFS Radar Test Signal Generator

Radar Waveform Calibration



Plot 72. Radar Type 1 Calibration, 5300 MHz



Plot 73. Radar Type 1 Calibration, 5550 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. The test setup, which consists of test equipment and equipment under test (EUT), is diagrammed in Figure 7 and pictured in Photograph 8

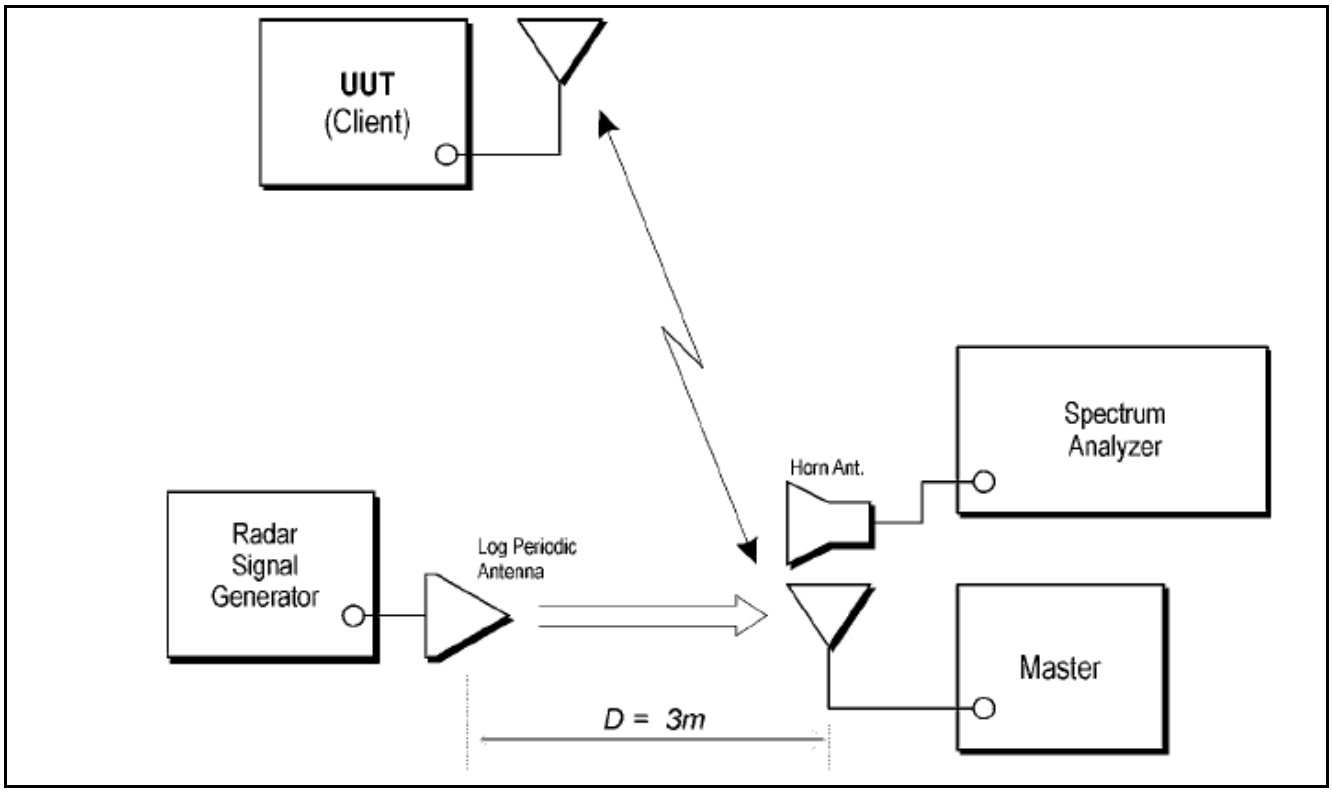


Figure 7. Test Setup Diagram showing UUT is client and Radar Test Waveforms are injected into the Master

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

Photograph 8. Test Setup Photo

B. Description of Client Device

1. Operating Frequency Range – 5300 MHz and 5550 MHz
2. Modes of Operation – Client device without radar detecting capability
3. Highest and Lowest EIRP – Highest = 19.3 dBm; Lowest = 8 dBm
4. Antenna gain – PIFA, 1.9 dBi
5. Antenna impedance – 50 Ohms
6. Antenna gain verification – Use antenna datasheet
7. The test file that was transmitted was the designated MPEG test file that streams full motion video at 30 frames per second from the Master to the Client
8. TPC is not required for UNII devices with less than 500 mW EIRP
9. Time for client to complete its power-on-cycle is about 10s
10. Uniform channel spreading is not required for Client devices.

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*.

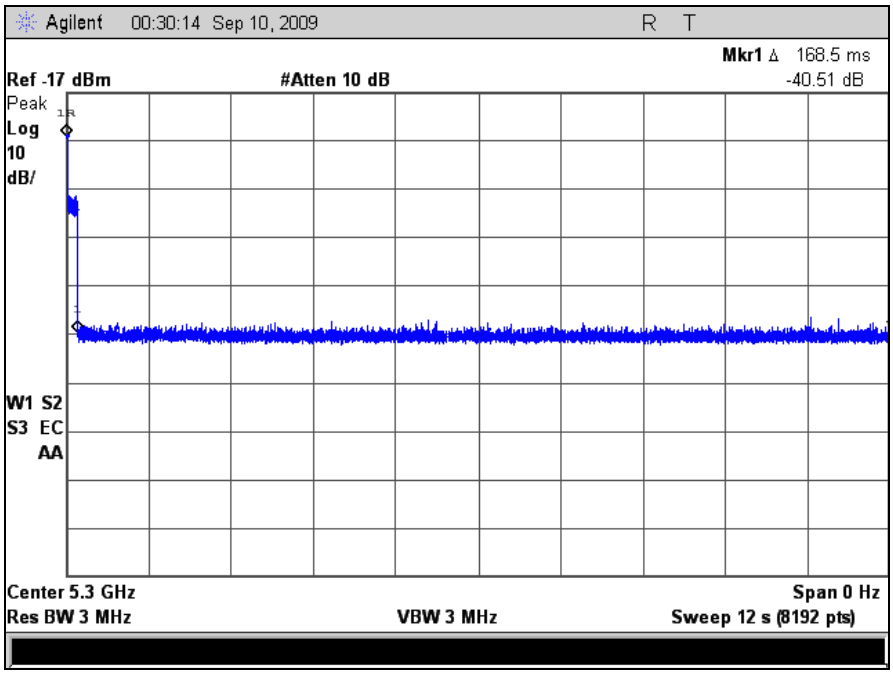
Test Results: Plot 74 and Plot 75 indicate cessation of transmission for more than 10 seconds after a radar burst. Plots 76 through 79 shows that all transmissions close within 200 ms after the detection of a radar burst.

The UUT complies with § 15.407 In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time.

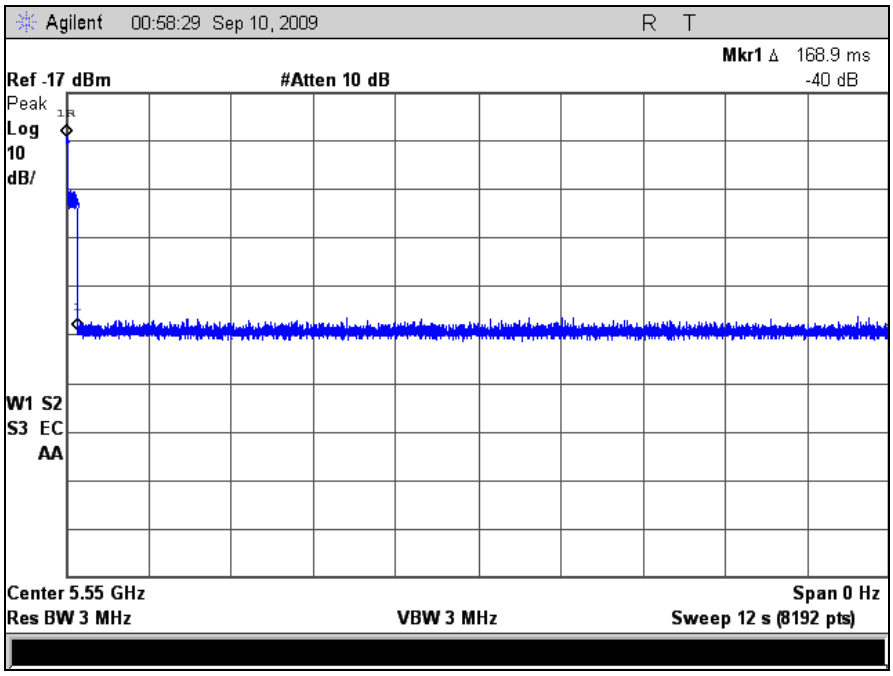
Test Engineer: Jeffrey Hazen

Test Date: 09/09/09

Channel Move Time – Plots

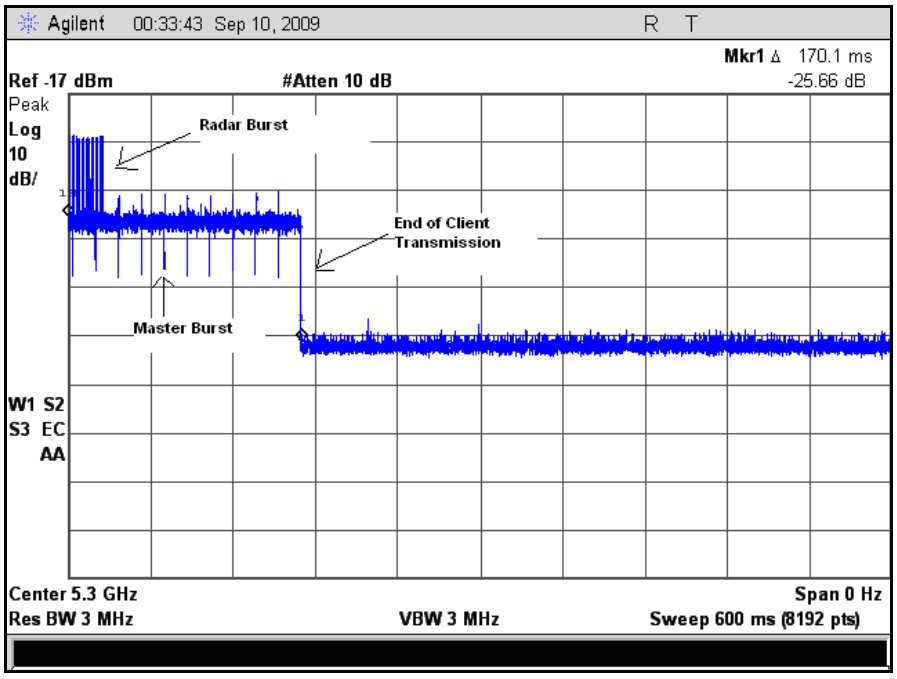


Plot 74. Channel Move Time for Radar Type 1, 12 seconds, 5300 MHz

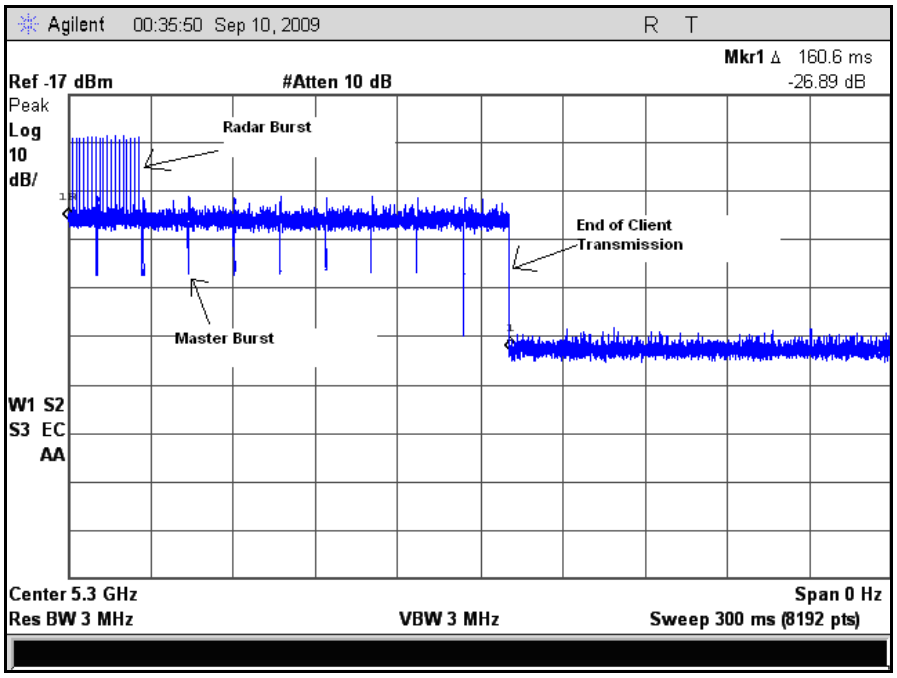


Plot 75. Channel Move Time for Radar Type 1, 12 seconds, 5550 MHz

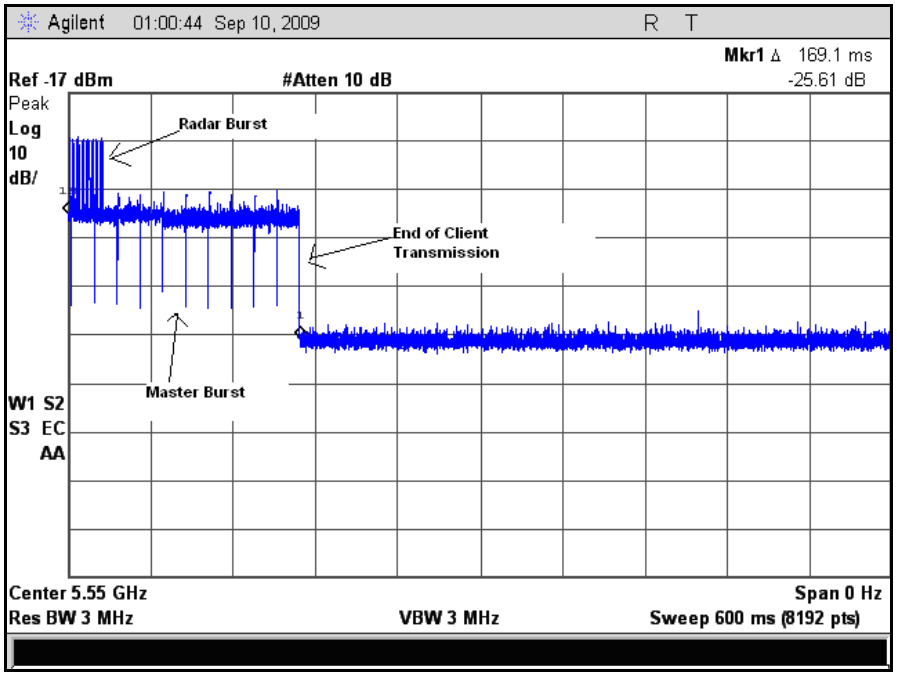
Channel Closing Transmission Time – Plots



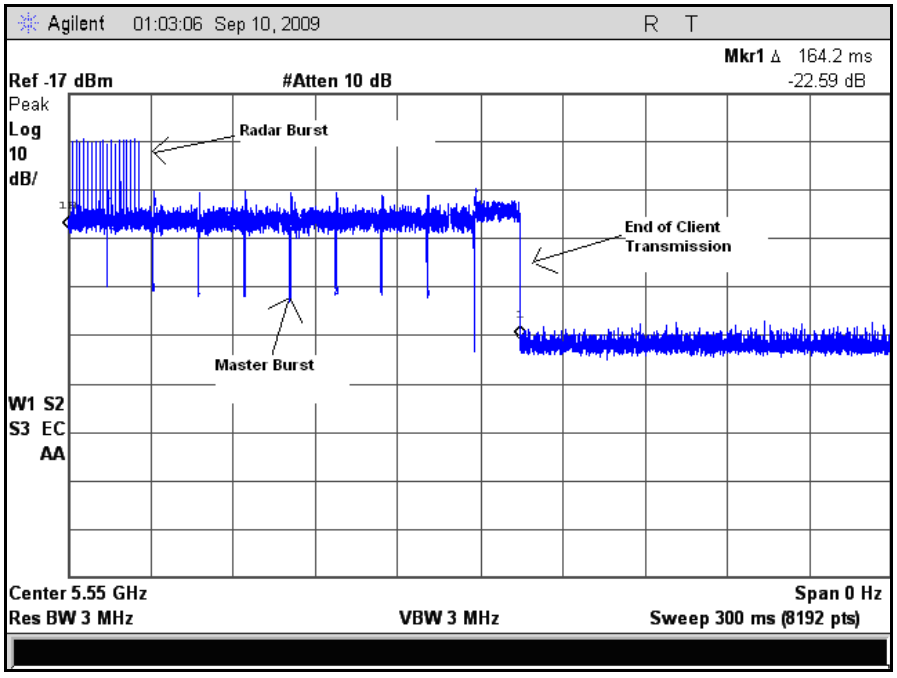
Plot 76. Channel Closing Transmission Time, 600 milliseconds, 5300 MHz



Plot 77. Channel Closing Transmission Time, 300 milliseconds, 5300 MHz



Plot 78. Channel Closing Transmission Time, 600 milliseconds, 5550 MHz



Plot 79. Channel Closing Transmission Time, 300 milliseconds, 5550 MHz

IV. Test Equipment

Test Equipment

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

MET ASSET #	EQUIPMENT	MANUFACTURER	MODEL	LAST CAL DATE	CAL DUE DATE
1T4214	SHIELD ROOM #4	UNIVERSAL SHIELD INC	N/A	SEE NOTE	
1T4621	ESA-E SERIES SPECTRUM ANALYZER	AGILENT	E4402B	03/20/2009	03/20/2010
1T4563	LISN (10 AMP)	SOLAR ELECTRONICS	9322-50-R-10-BNC	09/25/2008	09/25/2009
1T4578	THERMO/HYGROMETER	CONTROL COMPANY	S6-627-9	11/06/2008	11/06/2010
1T4300	SEMI-ANECHOIC CHAMBER # 1	EMC TEST SYSTEMS	NONE	08/24/2007	08/24/2010
1T4303	ANTENNA; BILOG	SCHAFNER - CHASE EMC	CBL6140A	07/29/2009	07/29/2010
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	05/07/2009	05/07/2010
1T4632	THERMO/HYGROMETER	CONTROL COMPANY	S6-627-9	09/25/2007	09/25/2009
1T4505	TEMPERATURE CHAMBER	TEST EQUITY	115	09/02/2008	10/02/2009
1T4548	AC POWER SOURCE	CALIFORNIA INSTRUMENTS	1251P	SEE NOTE	
S/N:MY45108123	ESA-E SERIES SPECTRUM ANALYZER	AGILENT	E4407B	06/01/2009	06/01/2010
1T2665	HORN ANTENNA	EMCO	3115	07/06/2009	07/06/2010
1T2511	ANTENNA; HORN	EMCO	3115	08/21/2009	08/21/2010
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T4592	RF FILTER KIT	VARIOUS	N/A	SEE NOTE	
1T4688	HORN ANTENNA	CUSTOM MICROWAVE, INC.	HO42S	SEE NOTE	
1T4609	4-PORT MICROWAVE SIGNAL COMBINER/SPLITTER	MINI-CIRCUITS	ZN4PD1-63-S+	SEE NOTE	

Table 25. Test Equipment List

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

MET ASSET #	EQUIPMENT	MANUFACTURER	LAST CAL DATE	CAL DUE DATE
1S2243	NI PXI-1042 8-SLOT 3U CHASSIS	NATIONAL INSTRUMENTS	SEE NOTE	
1S2460	NI PXI-5421 16-BIT 100MS/S ARBITRARY WAVEFORM GENERATOR	NATIONAL INSTRUMENTS	SEE NOTE	
1S2278	NI PXI-5610 2.7GHZ RF UPCONVERTER	NATIONAL INSTRUMENTS	SEE NOTE	
1S2069	UPCONVERTER, 7206 PXI 4.9 TO 6GHZ	ASCOR	SEE NOTE	
N/A	SPLITTER/COMBINER, ZFSC-2-9G (QTY 2)	MINI-CIRCUITS	SEE NOTE	
N/A	30DB ATTENUATOR, BW-S30W2 (QTY 2)	PASTERNAK	SEE NOTE	
N/A	10DB ATTENUATOR, BW-S10W2 (QTY 2)	PASTERNAK	SEE NOTE	
1T4414	MICROWAVE PRE-AMPLIFIER	AH SYSTEMS	SEE NOTE	
1T4612	SPECTRUM ANALYZER, E4407B	AGILENT	02/17/09	02/17/10

Table 26. DFS 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.

End of Report

