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

June 30, 2011

Echelon Corporation
550 Meridian Avenue
San Jose, CA 95126

Dear James Smith,

Enclosed is the EMC Wireless test report for compliance testing of the Echelon Corporation, Edge Control Node (ECN) 70101-0026 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, Industry Canada ICES-003 Issue 4 February 2004 for Unintentional Radiators and Part 15.407, Industry Canada 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: (\Echelon Corporation\EMCS83011-FCC407 Rev. 3)

MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
33439 WESTERN AVENUE ● UNION CITY, CALIFORNIA 94587-3201 ● PHONE (510) 489-6300 ● FAX (510) 489-6372

Electromagnetic Compatibility Criteria
Test Report

for the

Echelon Corporation
Model Edge Control Node (ECN) 70101-0026

Tested under
the Certification Rules
contained in
Title 47 of the CFR, Part 15, Subpart B and
ICES-003 Issue 4 February 2004
for Unintentional Radiators
and
Title 47 of the CFR, Part 15.407 and
Industry Canada RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

MET Report: EMCS83011-FCC407 Rev. 3

June 30, 2011

Prepared For:

Echelon Corporation
550 Meridian Avenue
San Jose, CA 95126

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

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Industry Canada RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

Lionel Gabrillo, 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 and ICES-003 and RSS-210 of the Industry Canada rules under normal use and maintenance.

Shawn McMillen, Wireless Manager
Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	June 17, 2011	Initial Issue.
1	June 22, 2011	Revised to reflect customer corrections.
2	June 27, 2011	Revised to reflect engineer corrections.
3	June 30, 2011	Revised to reflect engineer corrections.

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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**er**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**er**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 Echelon Corporation Edge Control Node (ECN) 70101-0026, 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 Edge Control Node (ECN) 70101-0026. Echelon Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Edge Control Node (ECN) 70101-0026, 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 Echelon Corporation, purchase order number 32432. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference	Industry Canada Reference	Description	Results
15.107	ICES-003 Issue 4 February 2004	Conducted Emissions	Compliant
15.109		Radiated Emissions	Compliant
15.203	RSS-GEN 7.1.4	Antenna Requirements	Compliant
15.205/15.209	2.2	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Compliant
15.207	RSS-GEN 7.2.2; RSS-210 2.2	AC Conducted Emissions 150KHz – 30MHz	Compliant
15.403 (c)	A8.2	26dB Occupied Bandwidth	Compliant
15.407 (a)(1), (2), (3)	A9.2(3)	Conducted Transmitter Output Power	Compliant
15.407 (a)(1), (2), (3), (5)	A9.2(3)	Power Spectral Density	Compliant
15.407 (a)(6)	A8.2	Peak Excursion	Compliant
15.407 (b)(1), (2), (5), (6)	A9.3(4)	Undesirable Emissions	Compliant
15.407(f)	RSS-GEN	RF Exposure	Compliant
15.407(g)	2.1	Frequency Stability	Compliant

Table 1. Executive Summary of EMC Part 15.407 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Echelon Corporation to perform testing on the Edge Control Node (ECN) 70101-0026, under Echelon Corporation's purchase order number 32432.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Echelon Corporation Edge Control Node (ECN) 70101-0026.

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

Model(s) Tested:	Edge Control Node (ECN) 70101-0026	
Model(s) Covered:	Edge Control Node (ECN) 70101-0026	
EUT Specifications:	Primary Power: 240 VAC, 60 Hz	
	FCC ID: IZP70101-R003	
	Type of Modulations:	OFDM
	Equipment Code:	NII
	Peak RF Output Power:	16.681 dBm
	EUT Frequency Ranges:	5745 MHz – 5805MHz
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:	Lionel Gabrillo	
Report Date(s):	June 30, 2011	

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
ICES-003, Issue 4 February 2004	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
ANSI C63.4:2003	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI/NCSL Z540-1-1994	Calibration Laboratories and Measuring and Test Equipment - General Requirements
ANSI/ISO/IEC 17025:2000	General Requirements for the Competence of Testing and Calibration Laboratories

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 3162 Belick Street, Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 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.

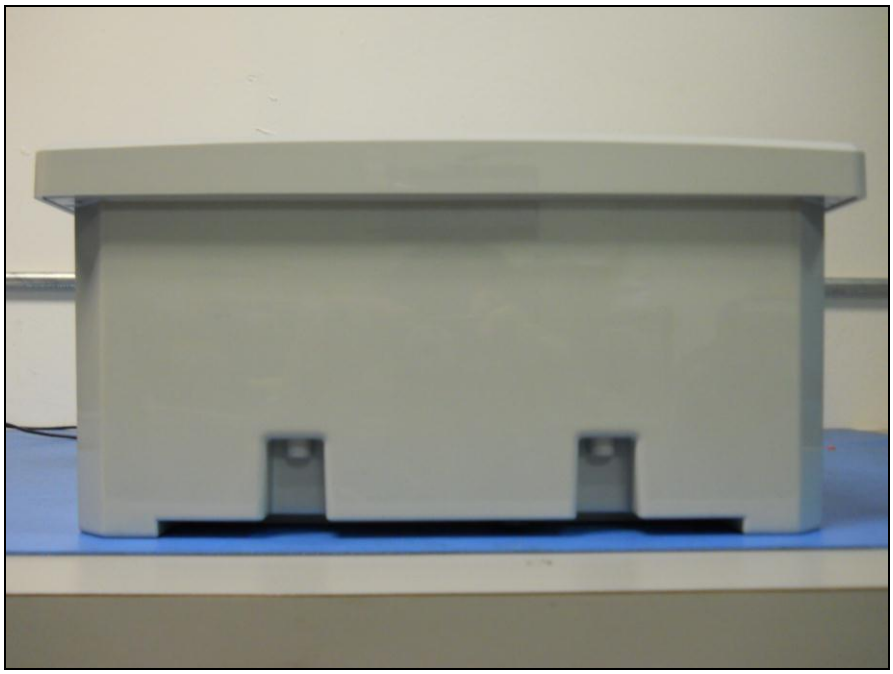
D. Description of Test Sample

The Echelon Corporation Edge Control Node (ECN) 70101-0026, Equipment Under Test (EUT), is as follows:

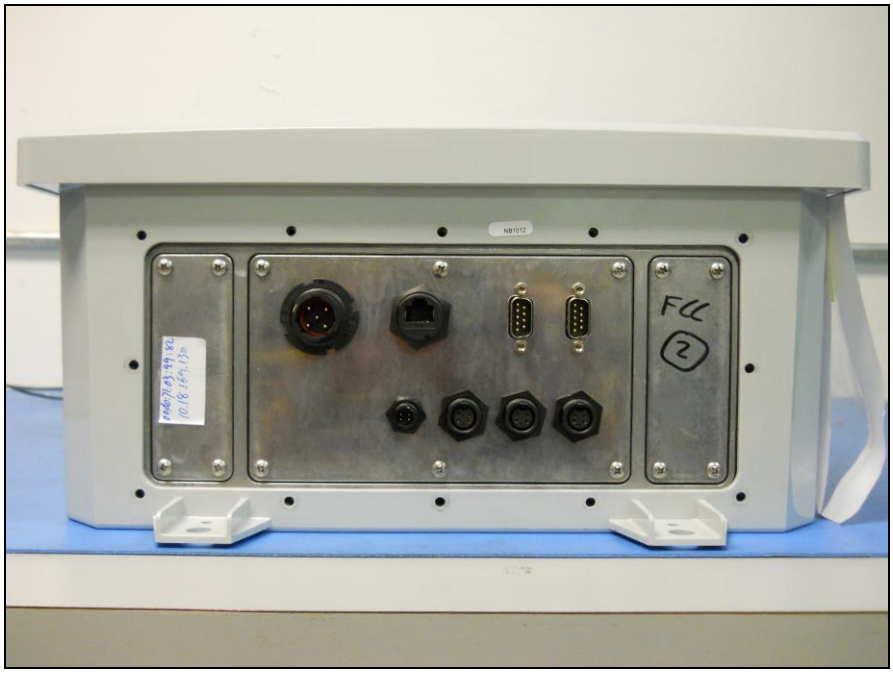
The nBox is a telemetry device that is intended to collect electrical power usage data from electrical utility power meters, and gas meters. Electrical power meters can communicate over PLC band A or band C; or they can use 900 MHz ISM band.

The new version added an OEM 802.11a/b/g/n Wi-Fi simultaneous dual band access point, a 900 MHz ISM band receiver, a second PLC (Power Line Communications) card, a serial (RS-232) interface, and a local power line current monitor. The unit is a fixed stationary device, powered from the AC line, with a battery backup option. This unit is intended for mounting on a utility pole or on a pad mounted distribution transformer. The original unit has FCC ID number IZP70101-0002. Generic information on the product can be found on our web page at "http://www.echelon.com/metering/ecn.htm."

List of Interfaces
Ethernet
802.11a/an/b/g/gn 2x2 simultaneous dual band Wi-Fi access point.
RS-232 2X
Power Line Communications (PLC) Band A
Power Line Communications (PLC) Band C
900 MHz ISM band receiver



Photograph 1. Echelon Corporation Edge Control Node (ECN) 70101-0026, Front View



Photograph 2. Echelon Corporation Edge Control Node (ECN) 70101-0026, Rear View

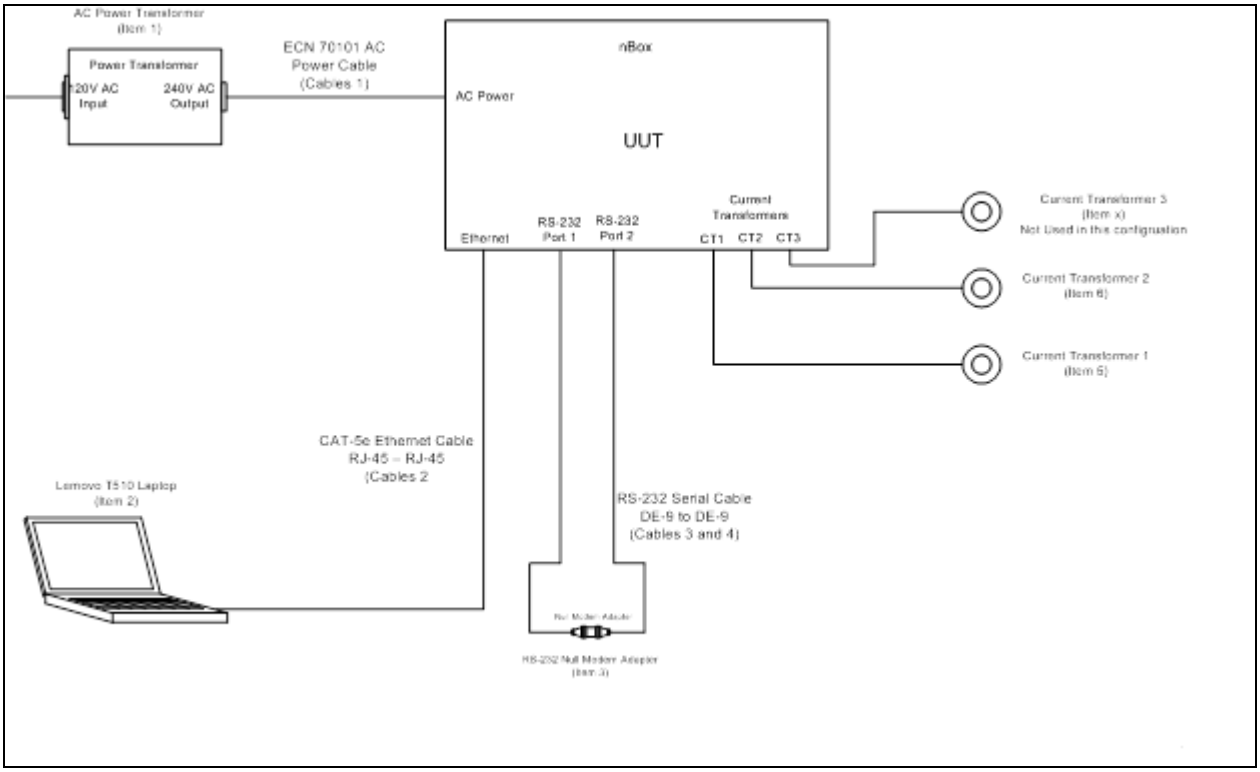


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

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

Ref. ID	Name / Description	Model Number	Serial Number
1	7xxx series Edge Control Node	770101-0026	0020, 0093, 0094

Table 4. Equipment Configuration

F. Support Equipment

Echelon Corporation supplied support equipment necessary for the operation and testing of the Edge Control Node (ECN) 70101-0026. All support equipment supplied is listed in the following Support Equipment List.

Ref. ID	Name / Description	Manufacturer	Model Number
1	Power Transformer 120V in 240V CT out	Echelon	NA
2	Laptop PC (Echelon Asset 105331)	Lenovo	T510
3	Null Modem Adapter	Pan Pacific	D25NM3
5	Current Transformer	Dent Instruments	CT-RMV-16-1000
6	Current Transformer	Dent Instruments	CT-RMV-16-1000

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	AC Power	AC Power cable	1	6’	N	1
2	Ethernet	CAT-5e Ethernet cable with clamp on ferrites on the PC end.	1	6’	N	2
3	RS-232 Serial Port 1	DE-9 –DE-9 Serial Cable	1	6’	Y	3
4	RS-232 Serial Port 2	DE-9 –DE-9 Serial Cable	1	6’	Y	3

Table 6. Ports and Cabling Information

H. Mode of Operation

The Ethernet port will be connected to a Lenovo laptop PC which will be used to control the UUT and provide stimulus to the Ethernet port.

A script will be run on the UUT main processor that sends data on the Serial port.

A script will be run on the UUT main processor that sends data on the PLC Band A port.

A script will be run on the UUT main processor that sends data on the PLC Band C port.

The laptop will be used to run the ART (Atheros Radio Test) software to control the Wi-Fi access point. A laptop could also be used as a client connecting to the wireless point to provide traffic in the normal Wi-Fi operation.

A script can be run on the UUT main processor or the laptop that reads the data from the 900 MHz ISM band receiver over the Ethernet.

I. Method of Monitoring EUT Operation

A series of ping messages were sent from the laptop to the UUT over the Ethernet and monitored in a separate command window to verify the Ethernet port and the UUT main CPU is operating normally.

Data received on the Serial port can be forwarded to a terminal session window on the PC where it can be monitored to verify activity.

A PLC A band and C band node can be connected to the PC to monitor PLC data sent by the UUT.

Read data from the 900 MHz ISM band receiver.

J. Modifications

a) Modifications to EUT

No modifications were made to the test standard.

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

Test Engineer(s): Lionel Gabrillo and Tunji Yusuf

Test Date(s): 05/09/11

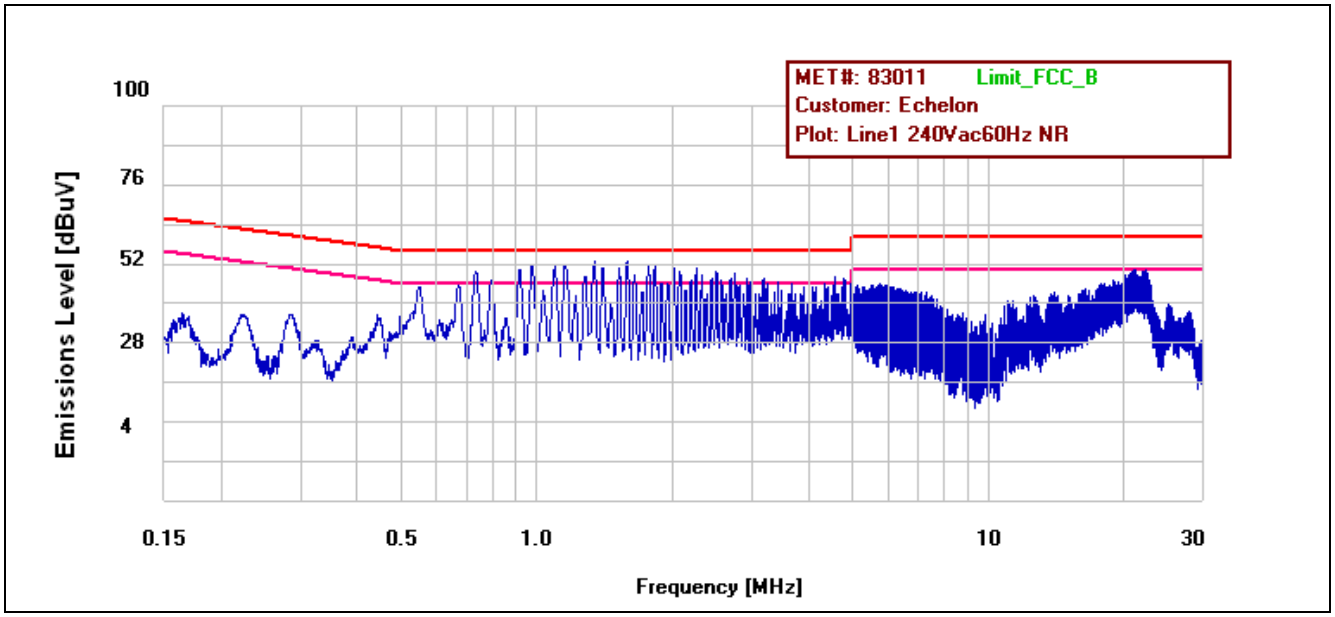
Conducted Emissions - Voltage, AC Power

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line1 240Vac60Hz	0.162	48.3	65.363	-17.063	Pass	35.1	55.363	-20.263	Pass
Line1 240Vac60Hz	0.542	50.87	56	-5.13	Pass	39.6	46	-6.4	Pass
Line1 240Vac60Hz	0.650	49.91	56	-6.09	Pass	38.6	46	-7.4	Pass
Line1 240Vac60Hz	0.706	54.95	56	-1.05	Pass	43.56	46	-2.44	Pass
Line1 240Vac60Hz	0.762	51.42	56	-4.58	Pass	39.9	46	-6.1	Pass
Line1 240Vac60Hz	0.922	54.4	56	-1.6	Pass	42.6	46	-3.4	Pass
Line1 240Vac60Hz	0.978	48.41	56	-7.59	Pass	37.3	46	-8.7	Pass
Line1 240Vac60Hz	1.086	54.2	56	-1.8	Pass	43	46	-3	Pass
Line1 240Vac60Hz	1.142	53.5	56	-2.5	Pass	42.5	46	-3.5	Pass
Line1 240Vac60Hz	1.302	52.57	56	-3.43	Pass	41.6	46	-4.4	Pass
Line1 240Vac60Hz	1.522	53.34	56	-2.66	Pass	42.32	46	-3.68	Pass
Line1 240Vac60Hz	1.783	51.72	56	-4.28	Pass	40.6	46	-5.4	Pass
Line1 240Vac60Hz	22.006	44.15	60	-15.85	Pass	29.8	50	-20.2	Pass

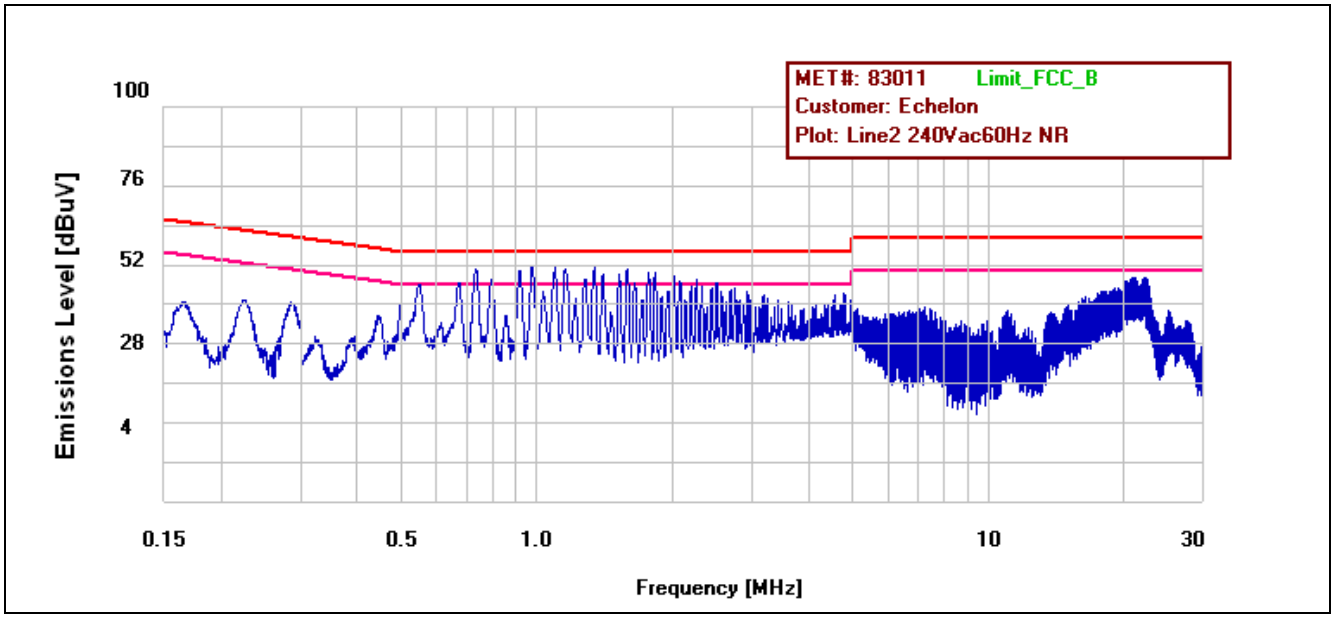
Table 8. Conducted Emissions - Voltage, AC Power, Phase Line 1 (240 VAC, 60 Hz)

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line2 240Vac60Hz	0.162	55.65	65.363	-9.713	Pass	43.34	55.363	-12.023	Pass
Line2 240Vac60Hz	0.546	50.85	56	-5.15	Pass	39.8	46	-6.2	Pass
Line2 240Vac60Hz	0.654	51.07	56	-4.93	Pass	39.6	46	-6.4	Pass
Line2 240Vac60Hz	0.706	55.69	56	-0.31	Pass	44.3	46	-1.7	Pass
Line2 240Vac60Hz	0.762	51.98	56	-4.02	Pass	40.73	46	-5.27	Pass
Line2 240Vac60Hz	0.870	53.82	56	-2.18	Pass	42.71	46	-3.29	Pass
Line2 240Vac60Hz	0.926	53.77	56	-2.23	Pass	42.5	46	-3.5	Pass
Line2 240Vac60Hz	1.086	53.39	56	-2.61	Pass	42.02	46	-3.98	Pass
Line2 240Vac60Hz	1.142	53.14	56	-2.86	Pass	41.91	46	-4.09	Pass
Line2 240Vac60Hz	1.306	52.43	56	-3.57	Pass	41.21	46	-4.79	Pass
Line2 240Vac60Hz	1.522	51.84	56	-4.16	Pass	40.6	46	-5.4	Pass
Line2 240Vac60Hz	1.738	49.69	56	-6.31	Pass	38.2	46	-7.8	Pass
Line2 240Vac60Hz	22.014	44.32	60	-15.68	Pass	30.8	50	-19.2	Pass

Table 9. Conducted Emissions - Voltage, AC Power, Phase Line 2 (240 VAC, 60 Hz)



Plot 1. Conducted Emission, Phase Line 1 Plot

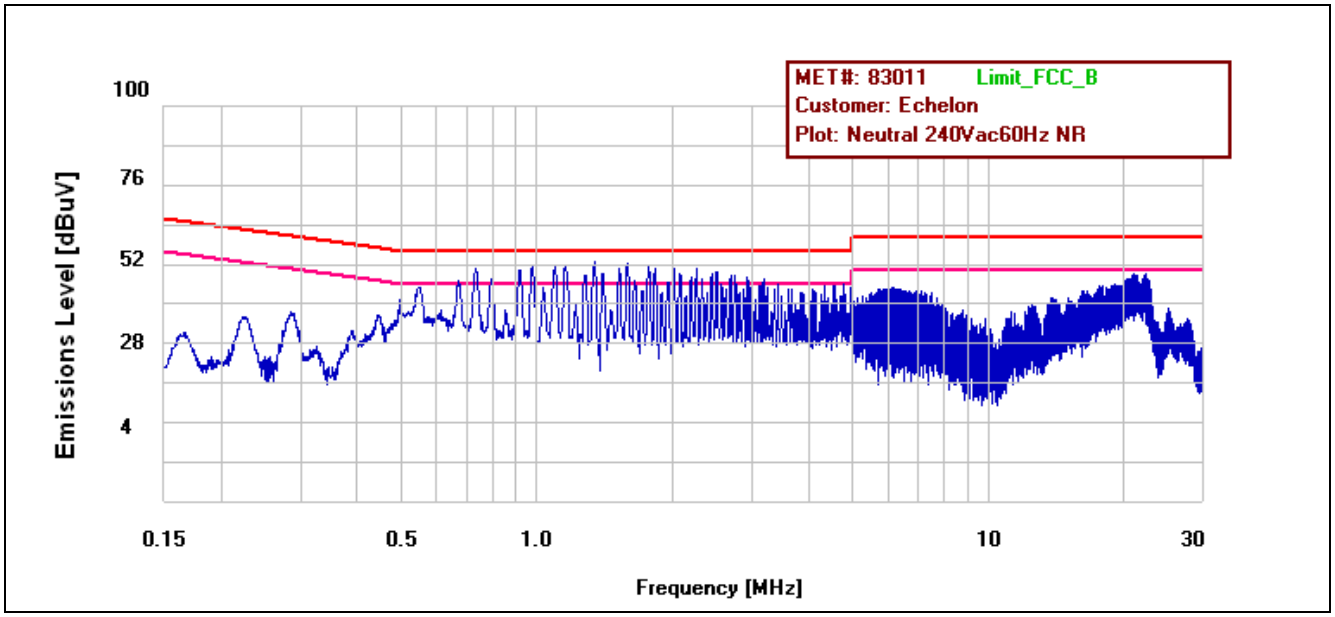


Plot 2. Conducted Emission, Phase Line 2 Plot

Conducted Emissions - Voltage, AC Power

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Neutral 240Vac60Hz	0.162	45.78	65.363	-19.583	Pass	33.6	55.363	-21.763	Pass
Neutral 240Vac60Hz	0.546	49.92	56	-6.08	Pass	38.9	46	-7.1	Pass
Neutral 240Vac60Hz	0.654	50.58	56	-5.42	Pass	39.4	46	-6.6	Pass
Neutral 240Vac60Hz	0.706	54.76	56	-1.24	Pass	43.75	46	-2.25	Pass
Neutral 240Vac60Hz	0.762	51.15	56	-4.85	Pass	39.92	46	-6.08	Pass
Neutral 240Vac60Hz	0.870	53.7	56	-2.3	Pass	42.3	46	-3.7	Pass
Neutral 240Vac60Hz	0.926	53.94	56	-2.06	Pass	42.67	46	-3.33	Pass
Neutral 240Vac60Hz	1.086	53.87	56	-2.13	Pass	42.6	46	-3.4	Pass

Table 10. Conducted Emissions - Voltage, AC Power, Neutral Line (240 VAC, 60 Hz)



Plot 3. Conducted Emission, Neutral Line Plot

Conducted Emission Limits Test Setup

Photograph 3. 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 11.

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 11.

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

Test Procedures: The EUT was placed on a 0.8m-high wooden table inside a semi-anechoic chamber. 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 (30MHz – 1GHz) and 1MHz bandwidth (1GHz – 10GHz).

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

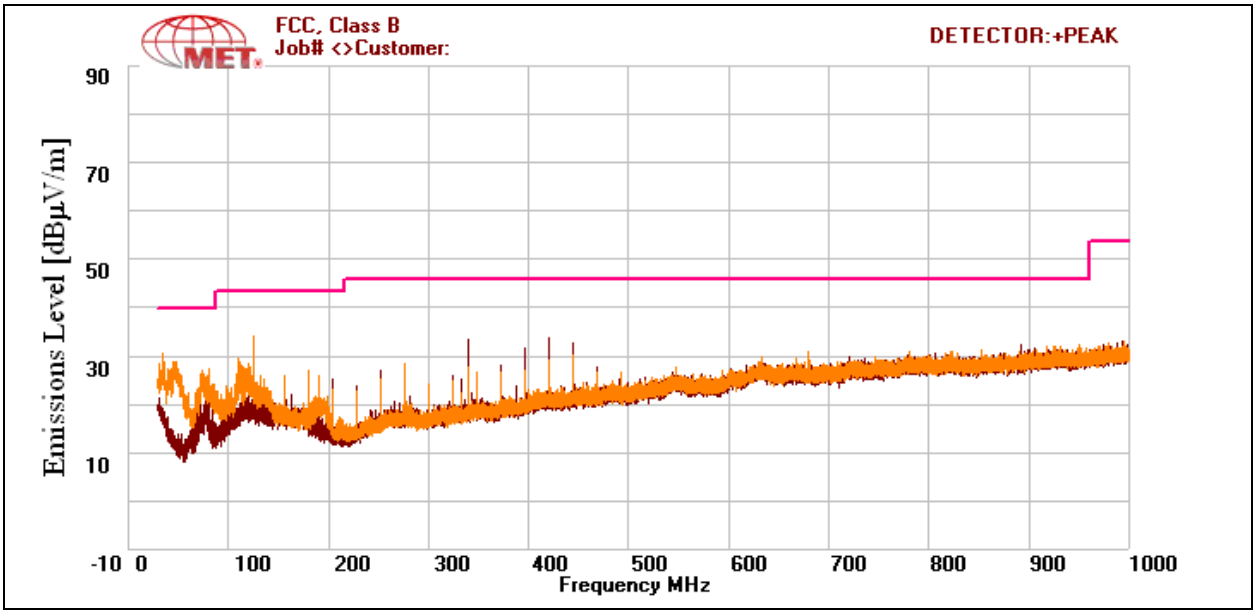
Test Engineer(s): Joe Vang

Test Date(s): 05/12/11

Radiated Emissions Limits Test Results, Class B

Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBuV)	ACF (dB/m)	Pre Amp Gain (dB)	CBL (dB)	DCF (dB)	Corrected Amplitude (dBuV)	Limit (dBuV)	Margin (dB)
45.24	V	86	100	15.24	10.156	0	1.684	0	27.08	40	-12.92
125	V	151	110.4	20.49	12.2	0	3.115	0	35.805	43.5	-7.695
276	V	324	100	8.03	13.18	0	3.652	0	24.862	46	-21.138
340	H	116	100	12.54	14.1	0	3.802	0	30.442	46	-15.558
420	H	239	100	11.67	16.3	0	4.264	0	32.234	46	-13.766
444	H	227	100	11.62	16.48	0	4.401	0	32.501	46	-13.499

Table 12. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz, FCC Limits

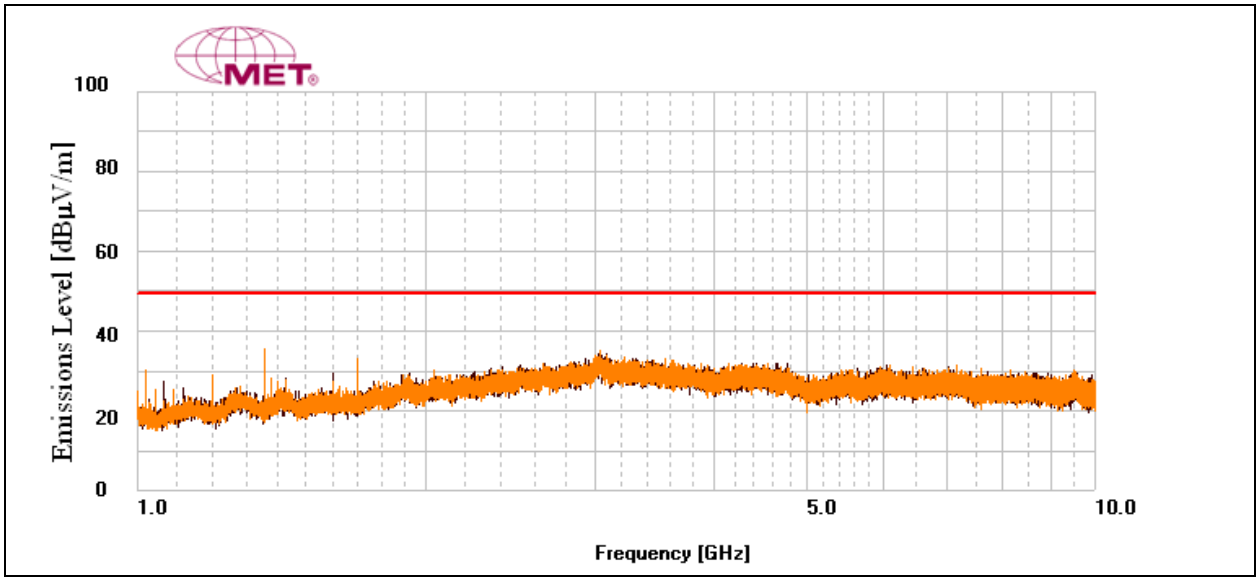


Plot 4. Radiated Emissions, 30 MHz - 1 GHz, FCC Limits

Radiated Emissions Limits Test Results, Class B

Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBuV)	ACF (dB/m)	Pre Amp Gain (dB)	CBL (dB)	DCF (dB)	Corrected Amplitude (dBuV)	Limit (dBuV)	Margin (dB)
1360	V	277.0	100.0	75.38	29.005	76.258	8.602	0	36.729	54	-17.271
1700	V	329.0	100.0	74.81	28.495	75.636	9.59	0	37.259	54	-16.741
1700	H	116.0	134.35	68.66	28.495	75.636	9.59	0	31.109	54	-22.891

Table 13. Radiated Emissions Limits, Test Results, Above 1 GHz, FCC Limits

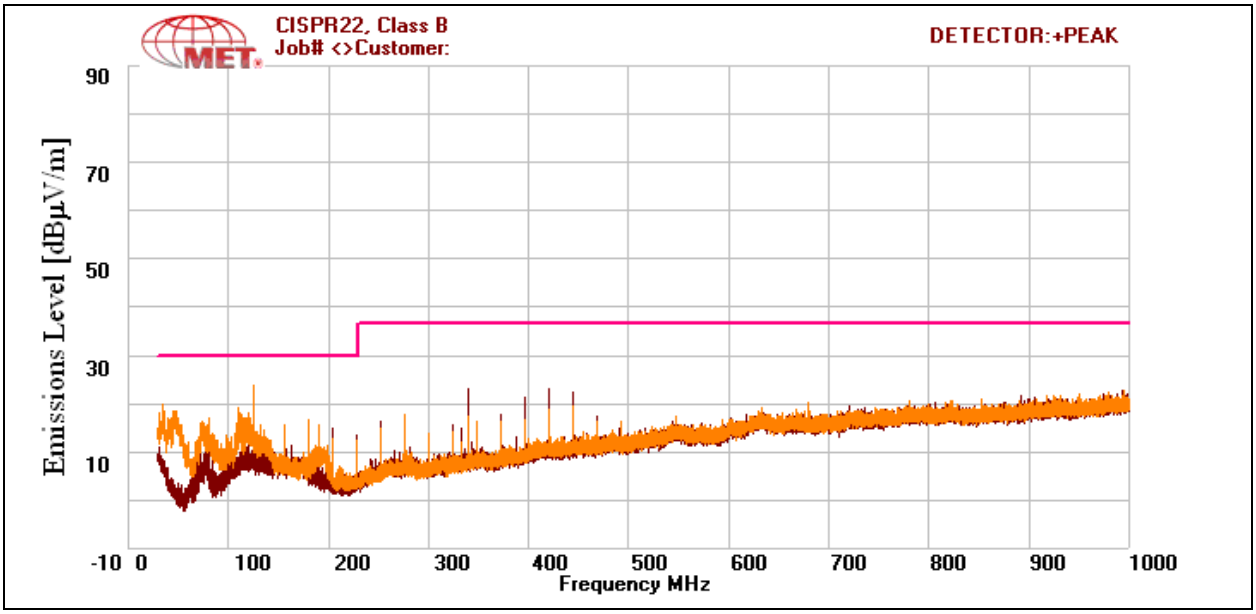


Plot 5. Radiated Emissions, Above 1 GHz, FCC Limits

Radiated Emissions Limits Test Results, Class B

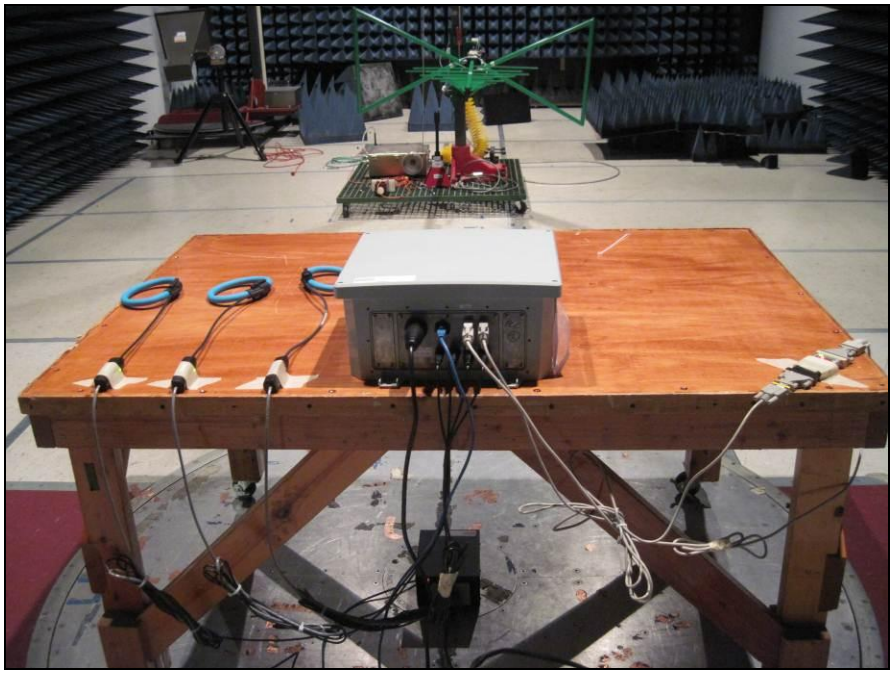
Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBuV)	ACF (dB/m)	Pre Amp Gain (dB)	CBL (dB)	DCF (dB)	Corrected Amplitude (dBuV)	Limit (dBuV)	Margin (dB)
45.24	V	86	100	15.24	10.156	0	1.684	-10.46	16.62	30	-13.38
125	V	151	110.4	20.49	12.2	0	3.115	-10.46	25.345	30	-4.655
276	V	324	100	8.03	13.18	0	3.652	-10.46	14.402	37	-22.598
340	H	116	100	12.54	14.1	0	3.802	-10.46	19.982	37	-17.018
420	H	239	100	11.67	16.3	0	4.264	-10.46	21.774	37	-15.226
444	H	227	100	11.62	16.48	0	4.401	-10.46	22.041	37	-14.959

Table 14. Radiated Emissions Limits, Test Results, ICES-003 Limits



Plot 6. Radiated Emissions, ICES-003 Limits

Radiated Emission Limits Test Setup



Photograph 4. Radiated Emission, Test Setup, 30 MHz – 1 GHz

Photograph 5. Radiated Emission, Test Setup, 1 GHz – 10 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. Antennas are internal (not accessible to the user) and are permanently attached to the radio transceivers.

Test Engineer(s): Lionel Gabrillo

Test Date(s): 05/31/11

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 15. 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 semi-anechoic 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 compliant with this requirement. Measured emissions were below applicable limits.

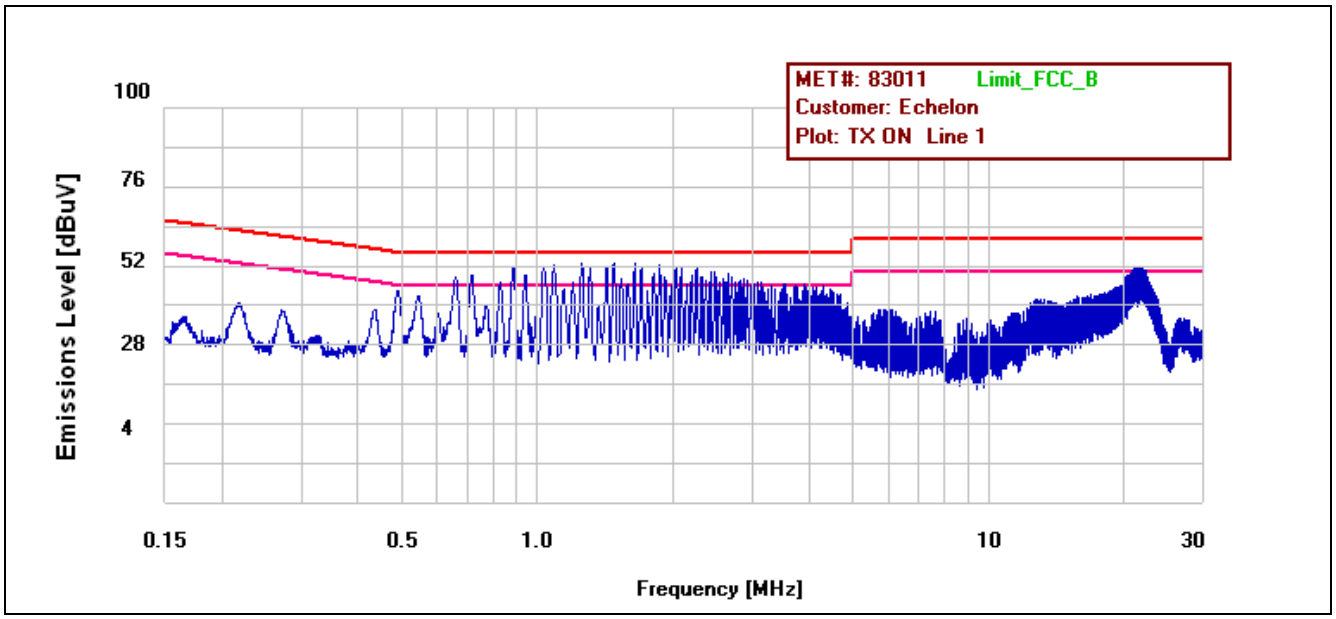
Test Engineer(s): Lionel Gabrillo

Test Date(s): 05/09/11

15.207(a) Conducted Emissions Test Results

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
TX ON Line 1	0.162	47.62	65.363	-17.743	Pass	37.19	55.363	-18.173	Pass
TX ON Line 1	0.870	55.23	56	-0.77	Pass	45.5	46	-0.5	Pass
TX ON Line 1	0.218	52.12	62.903	-10.783	Pass	42.45	52.903	-10.453	Pass
TX ON Line 1	0.654	53.11	56	-2.89	Pass	43.45	46	-2.55	Pass
TX ON Line 1	0.706	53.12	56	-2.88	Pass	42.65	46	-3.35	Pass
TX ON Line 1	0.926	52.1	56	-3.9	Pass	42.66	46	-3.34	Pass
TX ON Line 1	1.088	54.7	56	-1.3	Pass	45.35	46	-0.65	Pass
TX ON Line 1	1.632	53.1	56	-2.9	Pass	43.4	46	-2.6	Pass
TX ON Line 1	1.468	53.22	56	-2.78	Pass	43.71	46	-2.29	Pass
TX ON Line 1	2.232	51.11	56	-4.89	Pass	41.6	46	-4.4	Pass
TX ON Line 1	2.448	48.59	56	-7.41	Pass	39.14	46	-6.86	Pass
TX ON Line 1	3.268	44.75	56	-11.25	Pass	35.94	46	-10.06	Pass
TX ON Line 1	21.448	49.12	60	-10.88	Pass	34.54	50	-15.46	Pass

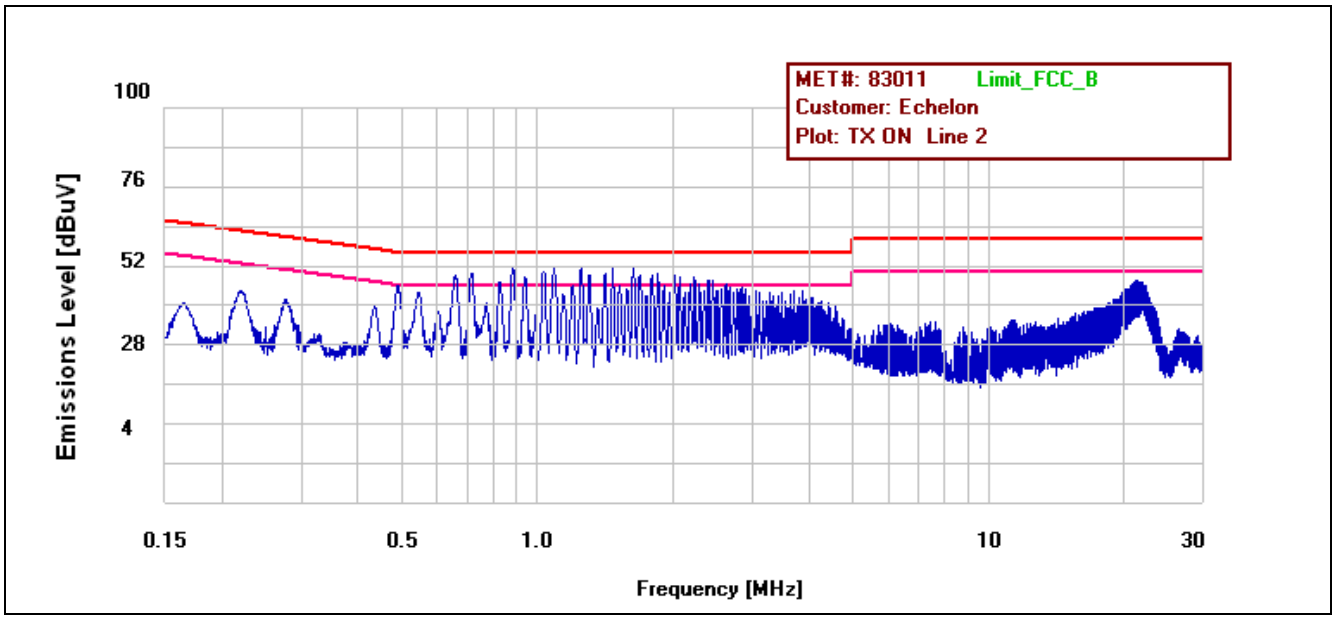
Table 16. Conducted Emissions, 15.207(a), Test Results, TX ON, Line 1



Plot 7. Conducted Emissions, 15.207(a), TX ON, Line 1

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
TX ON Line 2	0.870	54.94	56	-1.06	Pass	45.31	46	-0.69	Pass
TX ON Line 2	0.654	54.24	56	-1.76	Pass	44.57	46	-1.43	Pass
TX ON Line 2	0.218	57.33	62.903	-5.573	Pass	47.07	52.903	-5.833	Pass
TX ON Line 2	0.706	53.93	56	-2.07	Pass	44.32	46	-1.68	Pass
TX ON Line 2	0.162	54.14	65.363	-11.223	Pass	44.15	55.363	-11.213	Pass
TX ON Line 2	0.818	50.1	56	-5.9	Pass	40.36	46	-5.64	Pass
TX ON Line 2	1.088	53.95	56	-2.05	Pass	44.34	46	-1.66	Pass
TX ON Line 2	1.252	53.43	56	-2.57	Pass	43.69	46	-2.31	Pass
TX ON Line 2	1.036	52.29	56	-3.71	Pass	42.62	46	-3.38	Pass
TX ON Line 2	1.472	51.44	56	-4.56	Pass	41.74	46	-4.26	Pass
TX ON Line 2	2.068	48.65	56	-7.35	Pass	38.76	46	-7.24	Pass
TX ON Line 2	2.232	48.42	56	-7.58	Pass	38.35	46	-7.65	Pass
TX ON Line 2	2.016	48.23	56	-7.77	Pass	38.34	46	-7.66	Pass
TX ON Line 2	3.704	42.19	56	-13.81	Pass	31.6	46	-14.4	Pass
TX ON Line 2	21.56	45.35	60	-14.65	Pass	33.77	50	-16.23	Pass

Table 17. Conducted Emissions, 15.207(a), Test Results, TX ON, Line 2



Plot 8. Conducted Emissions, 15.207(a), TX ON, Line 2

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
TX On Neutral	0.870	53.72	56	-2.28	Pass	44	46	-2	Pass
TX On Neutral	1.09	53.35	56	-2.65	Pass	43.66	46	-2.34	Pass
TX On Neutral	0.710	53.33	56	-2.67	Pass	42.6	46	-3.4	Pass
TX On Neutral	0.654	53.84	56	-2.16	Pass	43.05	46	-2.95	Pass
TX On Neutral	1.254	53.23	56	-2.77	Pass	42.94	46	-3.06	Pass
TX On Neutral	1.47	52.46	56	-3.54	Pass	43.05	46	-2.95	Pass
TX On Neutral	0.218	52.74	62.903	-10.163	Pass	42.5	52.903	-10.403	Pass
TX On Neutral	0.490	51.85	56.173	-4.323	Pass	42.56	46.173	-3.613	Pass
TX On Neutral	0.926	51.45	56	-4.55	Pass	41.98	46	-4.02	Pass
TX On Neutral	1.634	51.17	56	-4.83	Pass	41.53	46	-4.47	Pass
TX On Neutral	2.07	49.63	56	-6.37	Pass	39.92	46	-6.08	Pass
TX On Neutral	2.234	48.84	56	-7.16	Pass	39.08	46	-6.92	Pass
TX On Neutral	21.456	46.59	60	-13.41	Pass	35.33	50	-14.67	Pass

Table 18. Conducted Emissions, 15.207(a), Test Results, TX ON, Neutral

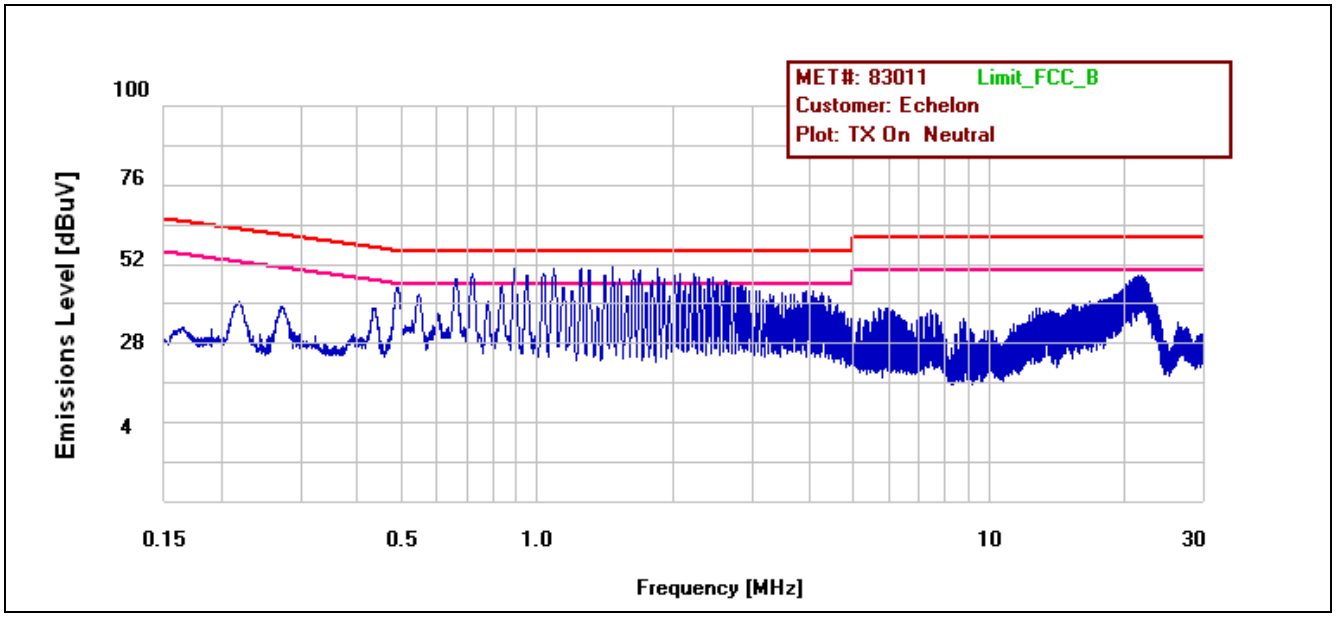


Table 19. Conducted Emissions, 15.207(a), TX ON, Neutral

15.207(a) Conducted Emissions Test Setup Photo

Photograph 6. Conducted Emissions, 15.207(a), Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 403(c) 26dB Bandwidth

Test Requirements: **§ 15.403 (c):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

Test Procedure: The transmitter was set to the mid channel 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. The measurements were repeated at the low, mid and high channels.

Test Results Equipment complies with § 15.407 (c). The 26 dB Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Lionel Gabrillo

Test Date(s): 05/11/11 – 05/12/11

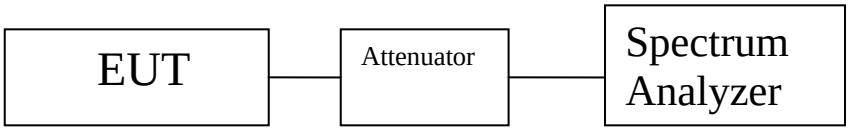


Figure 2. Occupied Bandwidth Test Setup

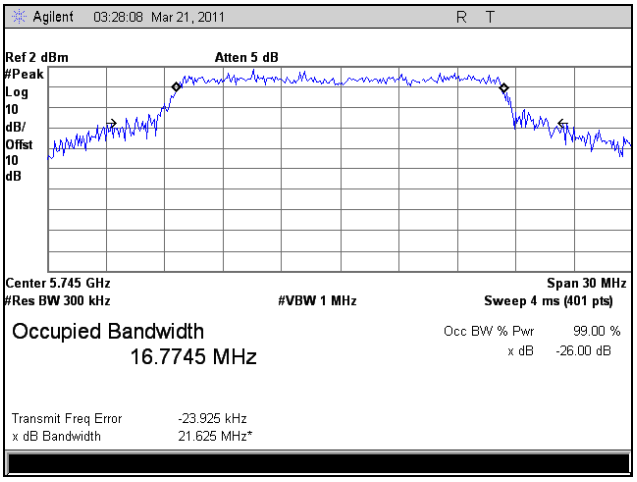
26 dB Occupied Bandwidth			
Mode	**Channel**	**Frequency (MHz)**	**Measured 26 dB Bandwidth (MHz)**
802.11a	Low	5745	21.625
	Mid	5785	23.699
	High	5805	23.518
802.11n 20 MHz Port 0	Low	5745	23.149
	Mid	5785	23.450
	High	5805	23.684
802.11n 20 MHz Port 1	Low	5745	24.140
	Mid	5785	23.765
	High	5805	23.074
802.11n 40 MHz Port 0	Low	5755	49.962
	High	5795	49.917
802.11n 40 MHz Port 0	Low	5755	49.841
	High	5795	49.819

Table 20. 26 dB Occupied Bandwidth, Test Results

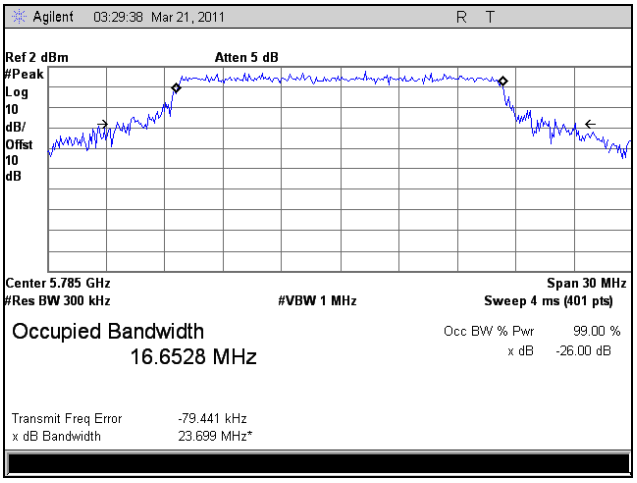
99% Occupied Bandwidth			
Mode	**Channel**	**Frequency (MHz)**	**99 % Bandwidth (MHz)**
802.11a	Low	5745	16.5275
	Mid	5785	16.5969
	High	5805	16.5293
802.11n 20 MHz Port 0	Low	5745	17.7831
	Mid	5785	17.7289
	High	5805	17.7770
802.11n 20 MHz Port 1	Low	5745	17.7548
	Mid	5785	17.7789
	High	5805	17.7647
802.11n 40 MHz Port 0	Low	5755	36.6683
	High	5795	36.6501
802.11n 40 MHz Port 0	Low	5755	36.6388
	High	5795	36.5386

Table 21. 99% Occupied Bandwidth, Test Results

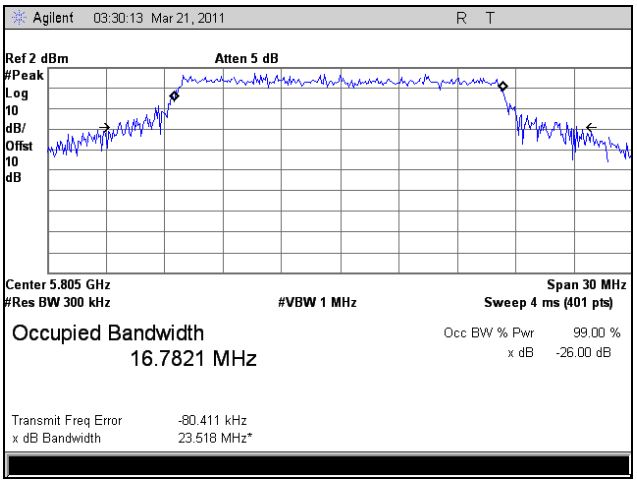
26 dB Occupied Bandwidth, 802.11a



Plot 9. 26 dB Occupied Bandwidth, 802.11a, Low Channel

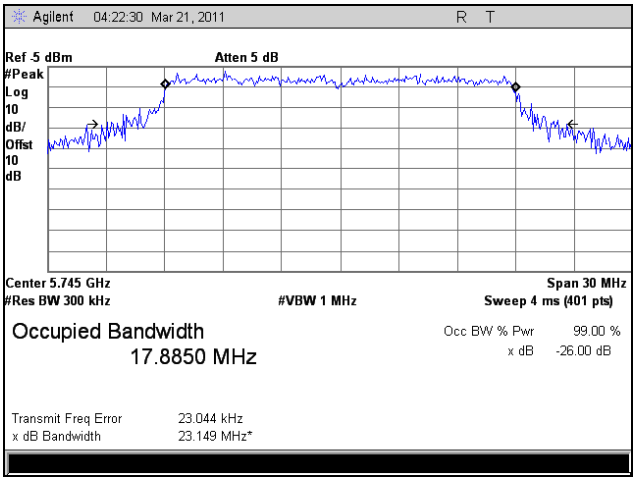


Plot 10. 26 dB Occupied Bandwidth, 802.11a, Mid Channel

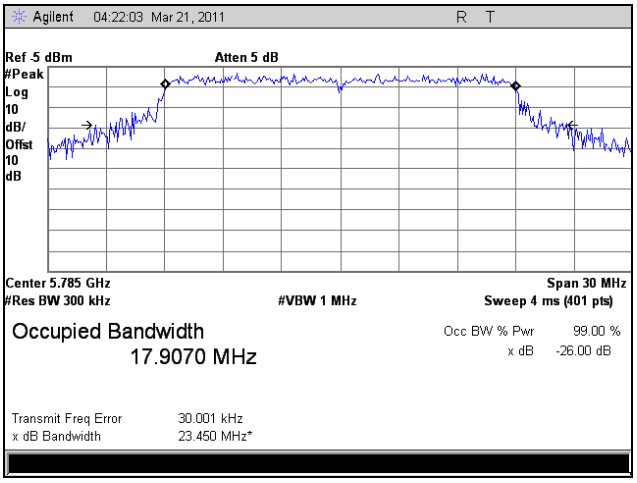


Plot 11. 26 dB Occupied Bandwidth, 802.11a, High Channel

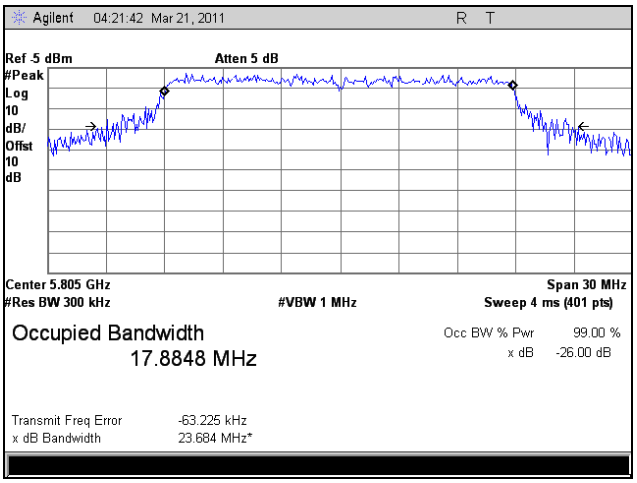
26 dB Occupied Bandwidth, 802.11n 20 MHz, Port 0



Plot 12. 26 dB Occupied Bandwidth, 802.11n 20 MHz, Port 0, Low Channel

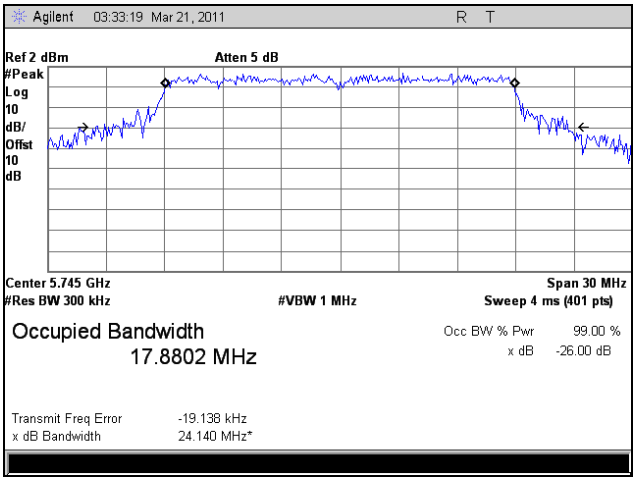


Plot 13. 26 dB Occupied Bandwidth, 802.11n 20 MHz, Port 0, Mid Channel

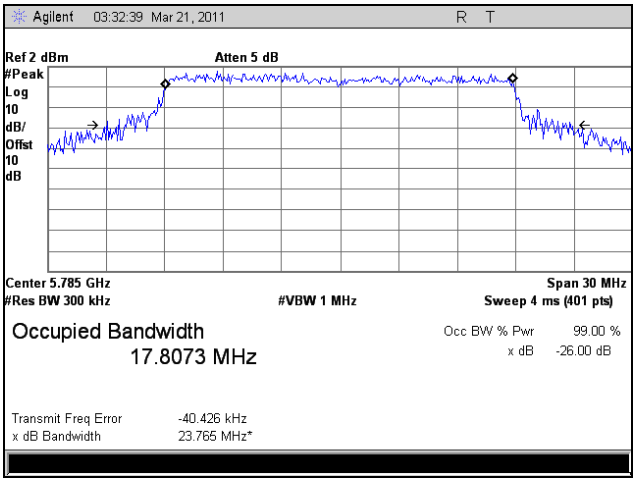


Plot 14. 26 dB Occupied Bandwidth, 802.11n 20 MHz, Port 0, High Channel

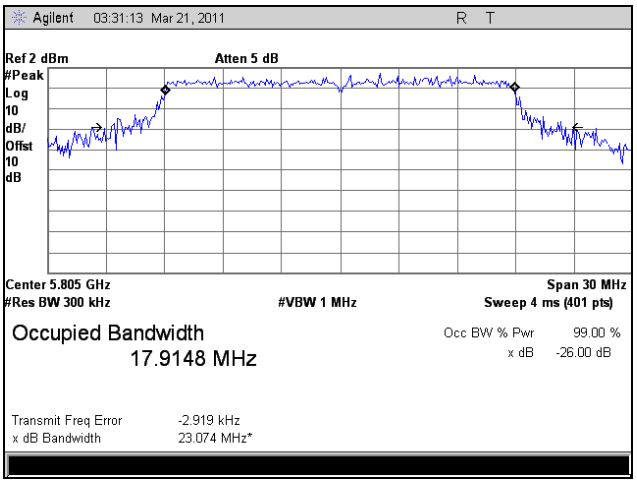
26 dB Occupied Bandwidth, 802.11n 20 MHz, Port 1



Plot 15. 26 dB Occupied Bandwidth, 802.11n 20 MHz, Port 1, Low Channel

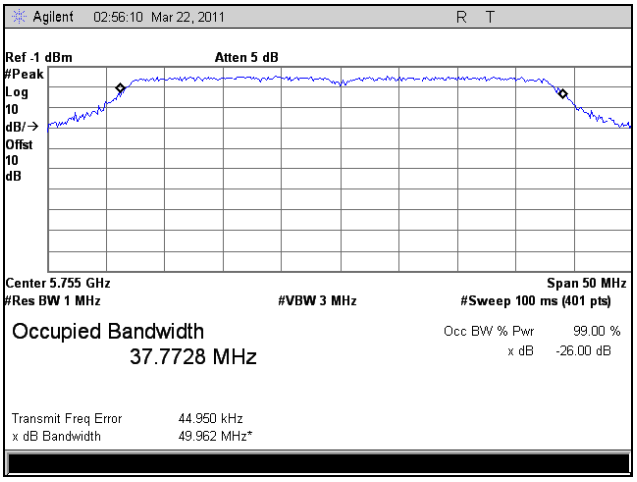


Plot 16. 26 dB Occupied Bandwidth, 802.11n 20 MHz, Port 1, Mid Channel

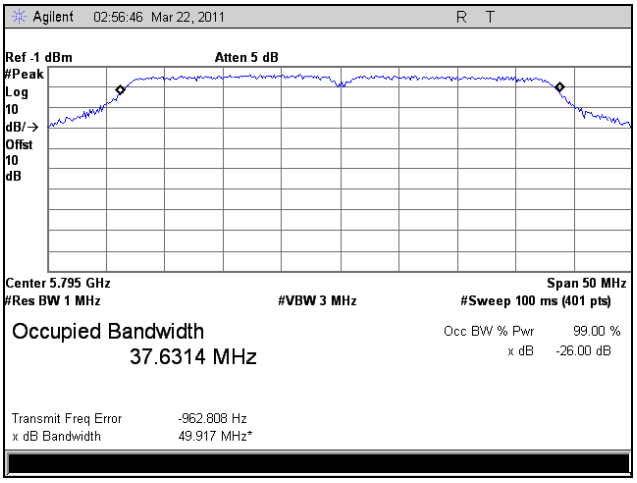


Plot 17. 26 dB Occupied Bandwidth, 802.11n 20 MHz, Port 1, High Channel

26 dB Occupied Bandwidth, 802.11n 40 MHz, Port 0

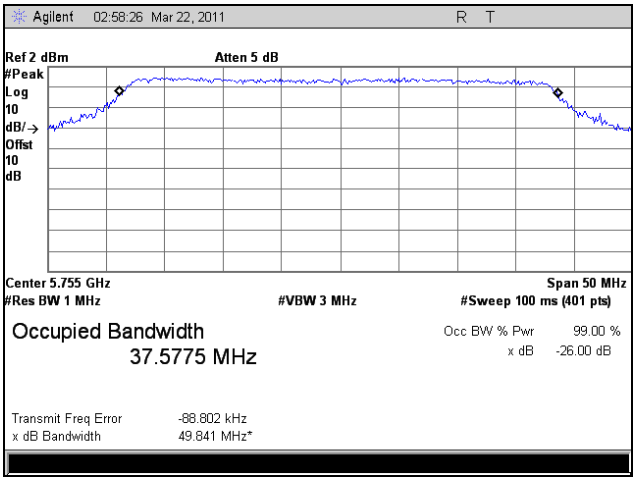


Plot 18. 26 dB Occupied Bandwidth, 802.11n 40 MHz, Port 0, Low Channel

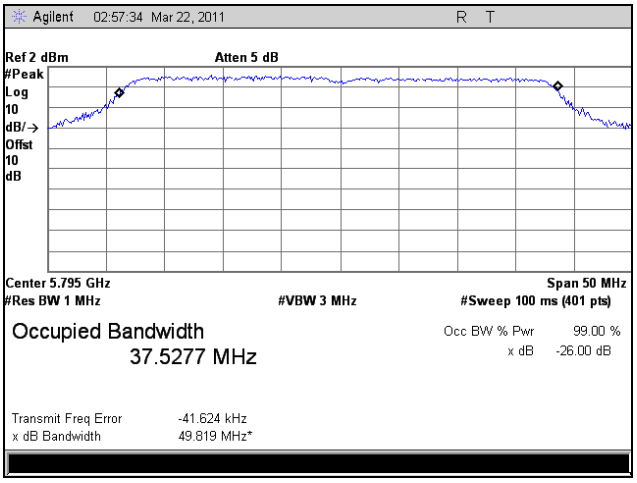


Plot 19. 26 dB Occupied Bandwidth, 802.11n 40 MHz, Port 0, High Channel

26 dB Occupied Bandwidth, 802.11n 40 MHz, Port 1

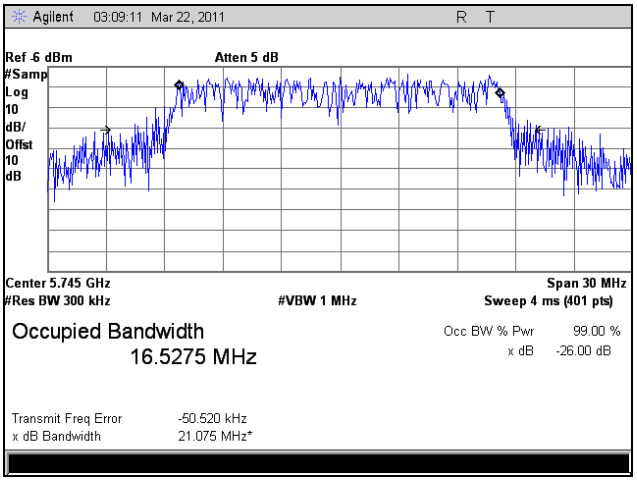


Plot 20. 26 dB Occupied Bandwidth, 802.11n 40 MHz, Port 1, Low Channel

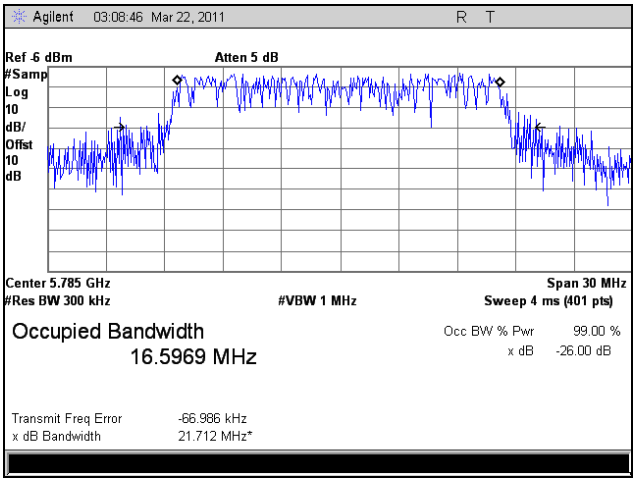


Plot 21. 26 dB Occupied Bandwidth, 802.11n 40 MHz, Port 1, High Channel

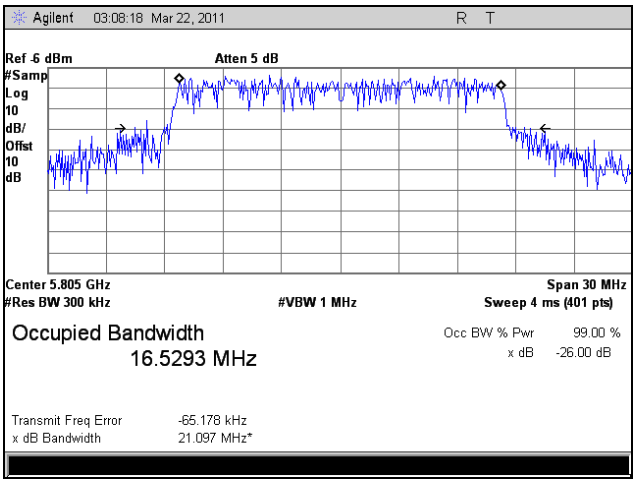
99% Occupied Bandwidth, 802.11a



Plot 22. 99% Occupied Bandwidth, 802.11a, Low Channel

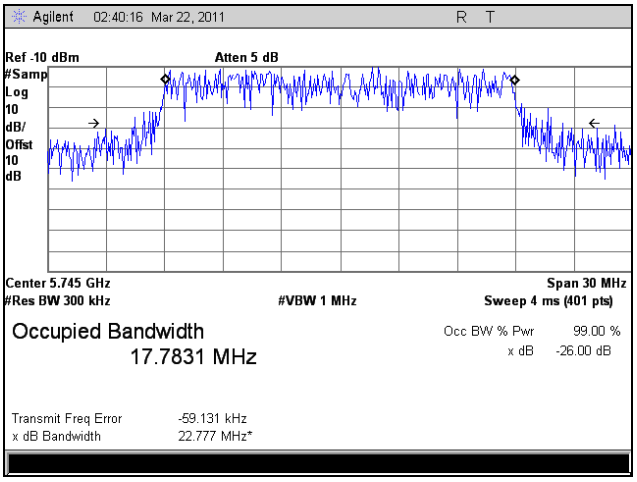


Plot 23. 99% Occupied Bandwidth, 802.11a, Mid Channel

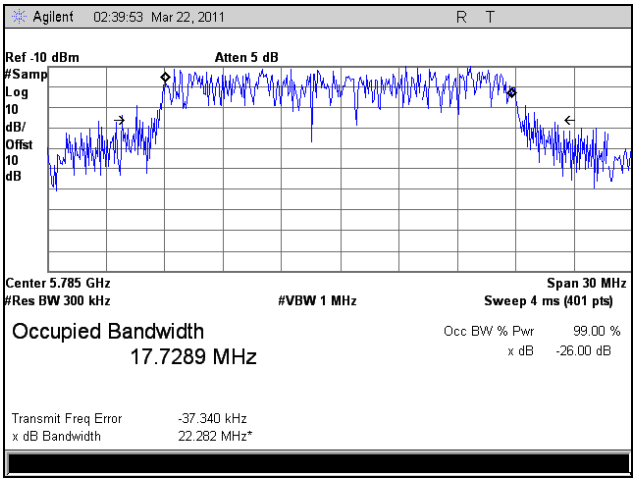


Plot 24. 99% Occupied Bandwidth, 802.11a, High Channel

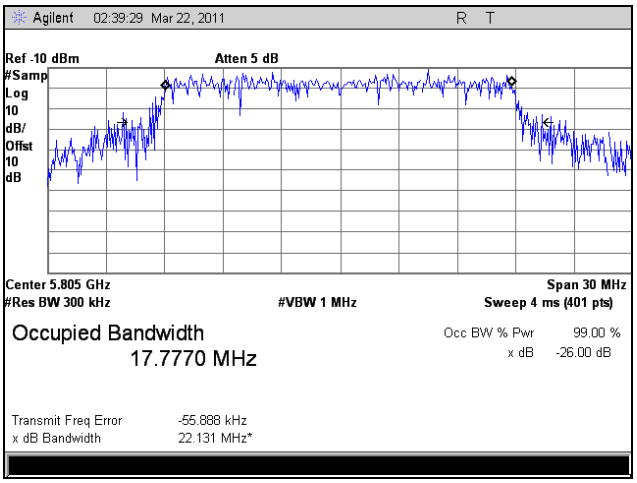
99% Occupied Bandwidth, 802.11n 20 MHz, Port 0



Plot 25. 99% Occupied Bandwidth, 802.11n 20 MHz, Port 0, Low Channel

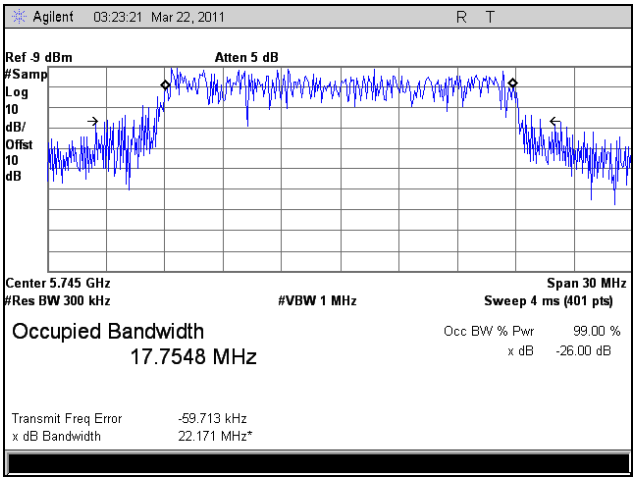


Plot 26. 99% Occupied Bandwidth, 802.11n 20 MHz, Port 0, Mid Channel

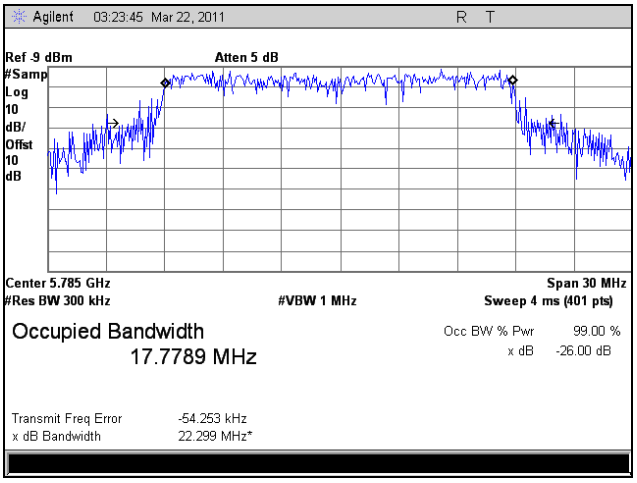


Plot 27. 99% Occupied Bandwidth, 802.11n 20 MHz, Port 0, High Channel

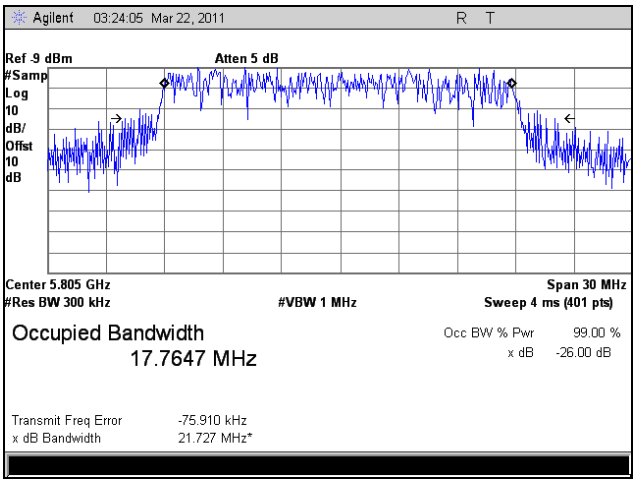
99% Occupied Bandwidth, 802.11n 20 MHz, Port 1



Plot 28. 99% Occupied Bandwidth, 802.11n 20 MHz, Port 1, Low Channel

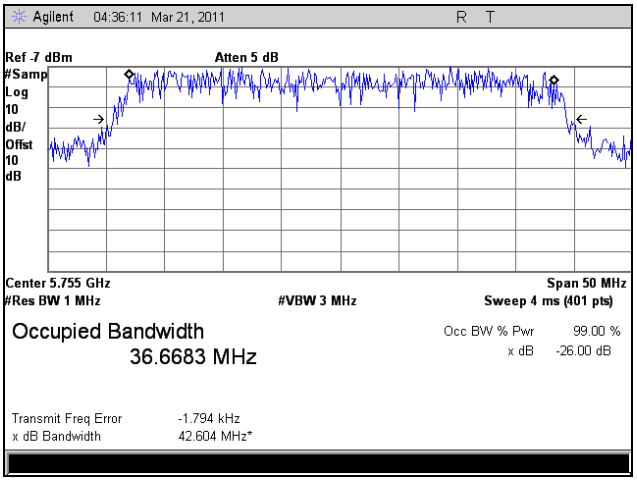


Plot 29. 99% Occupied Bandwidth, 802.11n 20 MHz, Port 1, Mid Channel

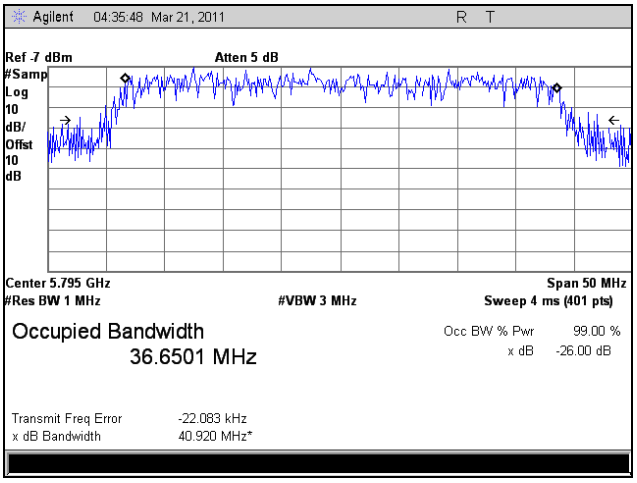


Plot 30. 99% Occupied Bandwidth, 802.11n 20 MHz, Port 1, High Channel

99% Occupied Bandwidth, 802.11n 40 MHz, Port 0

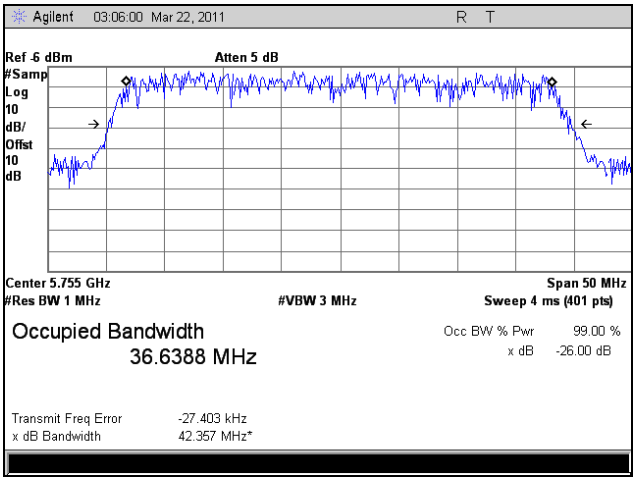


Plot 31. 99% Occupied Bandwidth, 802.11n 40 MHz, Port 0, Low Channel

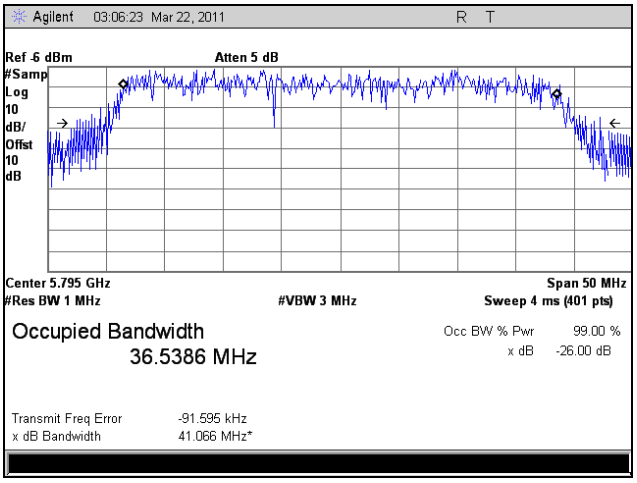


Plot 32. 99% Occupied Bandwidth, 802.11n 40 MHz, Port 0, High Channel

99% Occupied Bandwidth, 802.11n 40 MHz, Port 1



Plot 33. 99% Occupied Bandwidth, 802.11n 40 MHz, Port 1, Low Channel



Plot 34. 99% Occupied Bandwidth, 802.11n 40 MHz, Port 1, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 407(a) (1), (2) RF Power Output

Test Requirements: **§15.407(a) (1), (2):** The maximum output power of the intentional radiator shall not exceed the following:

Digital Transmission Systems (MHz)	Output Limit (mW)
5150-5250	50
5250-5350	250
5470-5725	250
5725-5825	1000

Table 22. Output Power Requirements from §15.407

§15.407(a) (1): For the band 5.15-5.25 GHz the peak transmit power over the frequency band of operation shall not exceed the lesser 50mW or 4dBm + 10logB, where B is the 26-dB emission bandwidth in MHz.

§15.407(a) (2): For the band 5.25-5.35GHz & 5.470-5.72GHz the peak transmit power over the frequency band of operation shall not exceed the lesser of 250mW or 11dBm + 10logB, where B is the 26-dB emission bandwidth in MHz.

§15.407(a) (3): For the band 5.725 – 5.825 GHz the peak transmit power over the frequency band of operation shall not exceed the lesser 1W or 17dBm + 10logB, where B is the 26-dB emission bandwidth in MHz.

Test Procedure: The transmitter was connected to a calibrated Spectrum analyzer. The EUT was measured at the low, mid and high channels of each band with the data rate that produced the highest output power.

Test Results: Equipment complies with the Peak Power Output limits of **§ 15.401(a) (3)**.

Test Engineer(s): Lionel Gabrillo

Test Date(s): 05/25/11

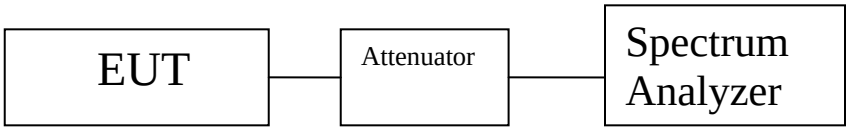


Figure 3. Peak Power Output Test Setup

RF POWER OUTPUT			
Mode	**Channel**	**Frequency (MHz)**	**Measured Output Power (dBm)**
802.11a	Low	5745	13.64
	Mid	5785	15.29
	High	5805	13.84
802.11n 20 MHz Port 0	Low	5745	11.49
	Mid	5785	10.48
	High	5805	10.80
802.11n 20 MHz Port 1	Low	5745	13.03
	Mid	5785	15.49
	High	5805	13.18
802.11n 40 MHz Port 0	Low	5755	9.54
	High	5795	8.54
802.11n 40 MHz Port 1	Low	5755	8.21
	High	5795	7.83

Table 23. RF Power Output, Test Results

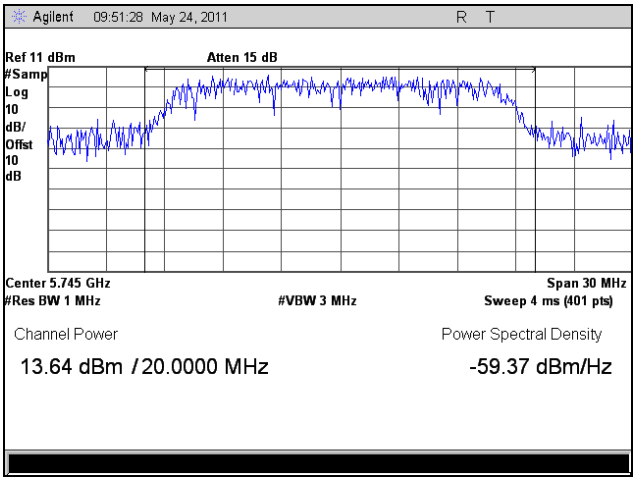
Channel	Port 0 (dBm)	Port 0 (mW)	Port 1 (dBm)	Port 1 (mW)	Sum (mW)	Sum (dBm)	Limit (dBm)	Delta
Low	11.49	14.093	13.03	20.091	34.184	15.338	29	-13.662
Mid	10.48	11.169	15.49	35.400	46.568	16.681	29	-12.319
High	10.8	12.023	13.18	20.797	32.820	15.161	29	-13.839

Table 24. RF Power Output, Test Results, Summed Ports, 802.11n 20 MHz

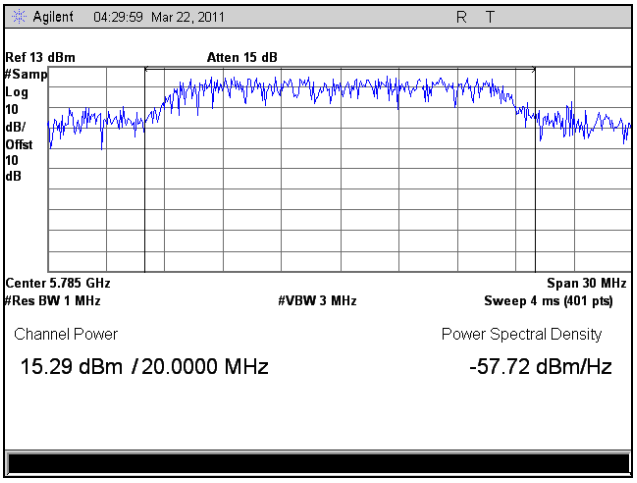
Channel	Port 0 (dBm)	Port 0 (mW)	Port 1 (dBm)	Port 1 (mW)	Sum (mW)	Sum (dBm)	Limit (dBm)	Delta
Low	9.54	8.995	8.21	6.622	15.617	11.936	29	-17.064
High	8.54	7.145	7.83	6.067	13.212	11.210	29	-17.790

Table 25. RF Power Output, Test Results, Summed Ports, 802.11n 40 MHz

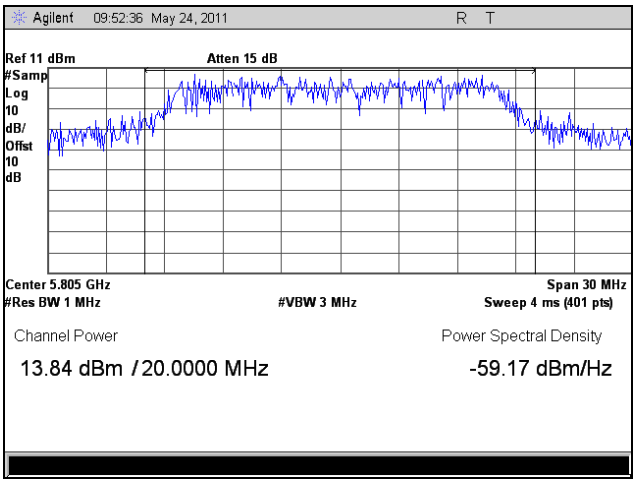
RF Power Output, 802.11a



Plot 35. RF Power Output, 802.11a, Low Channel

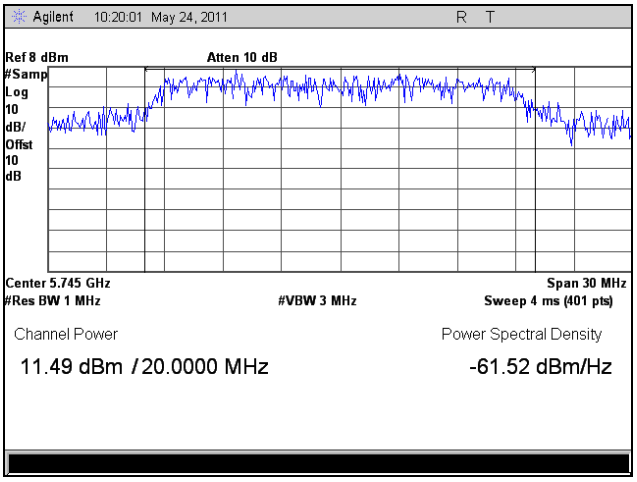


Plot 36. RF Power Output, 802.11a, Mid Channel

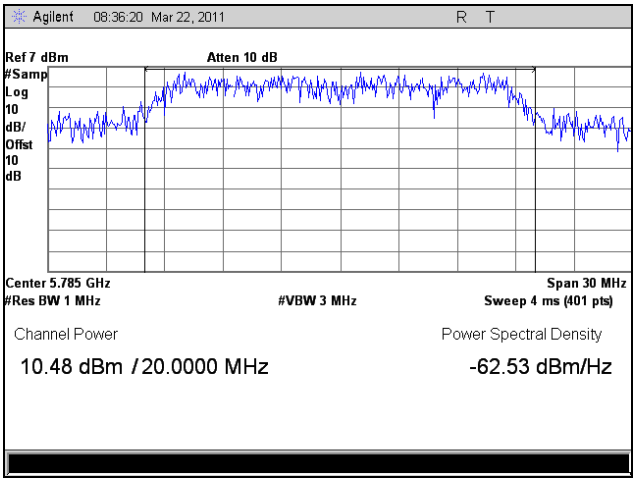


Plot 37. RF Power Output, 802.11a, High Channel

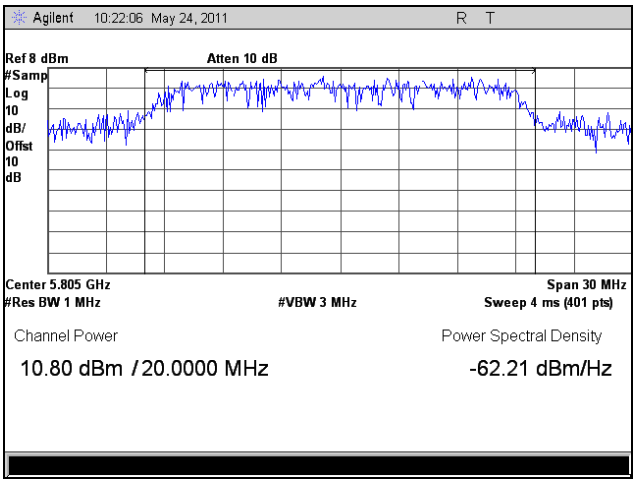
RF Power Output, 802.11n 20 MHz, Port 0



Plot 38. RF Power Output, 802.11n 20 MHz, Port 0, Low Channel

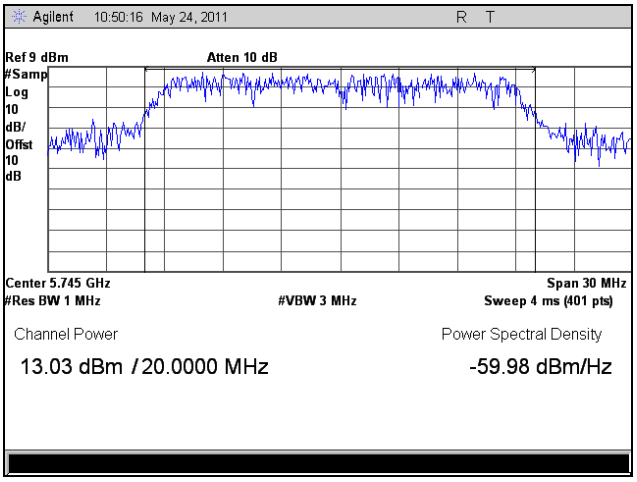


Plot 39. RF Power Output, 802.11n 20 MHz, Port 0, Mid Channel

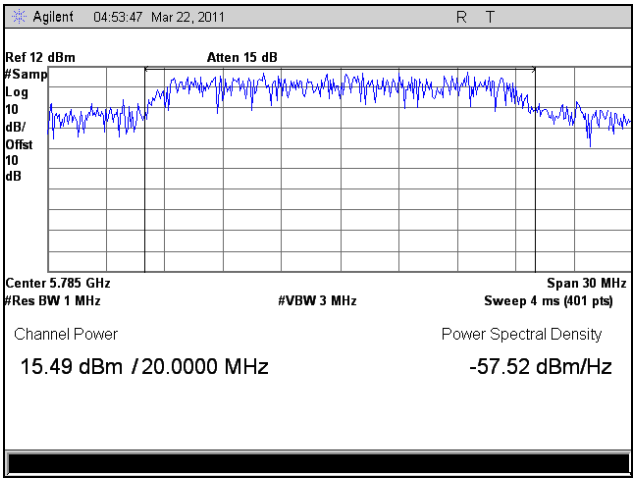


Plot 40. RF Power Output, 802.11n 20 MHz, Port 0, High Channel

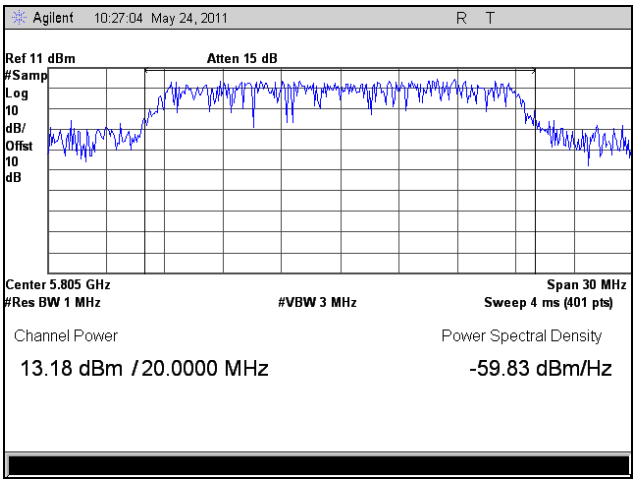
RF Power Output, 802.11n 20 MHz, Port 1



Plot 41. RF Power Output, 802.11n 20 MHz, Port 1, Low Channel

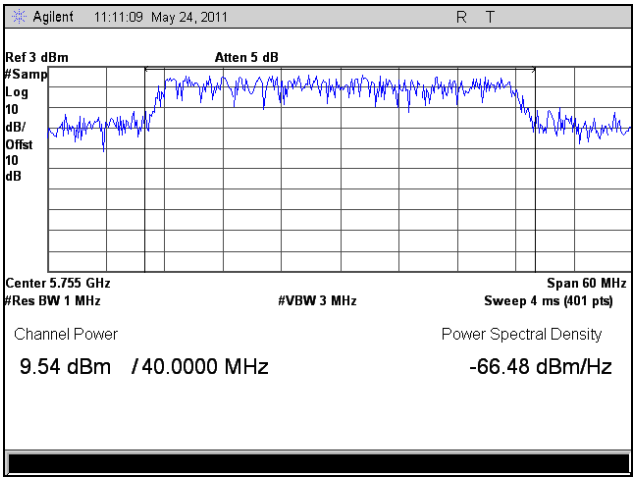


Plot 42. RF Power Output, 802.11n 20 MHz, Port 1, Mid Channel

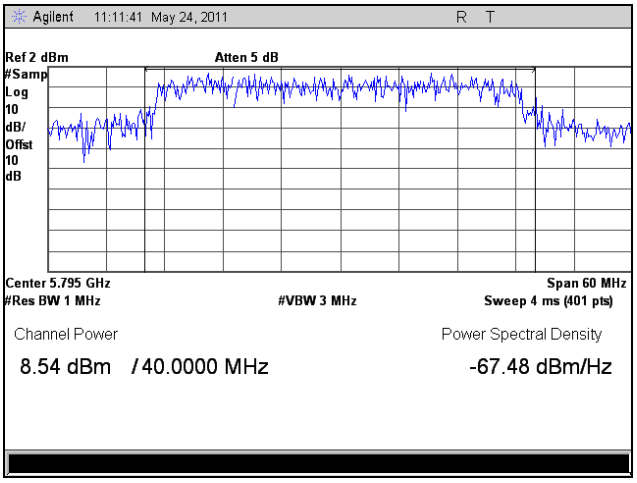


Plot 43. RF Power Output, 802.11n 20 MHz, Port 1, High Channel

RF Power Output, 802.11n 40 MHz, Port 0

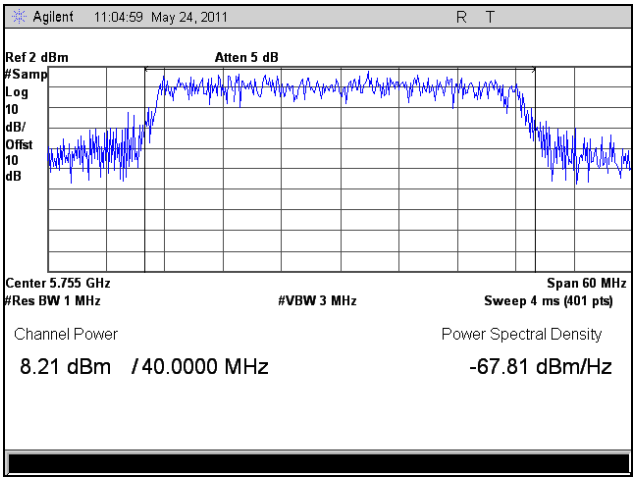


Plot 44. RF Power Output, 802.11n 40 MHz, Port 0, Low Channel

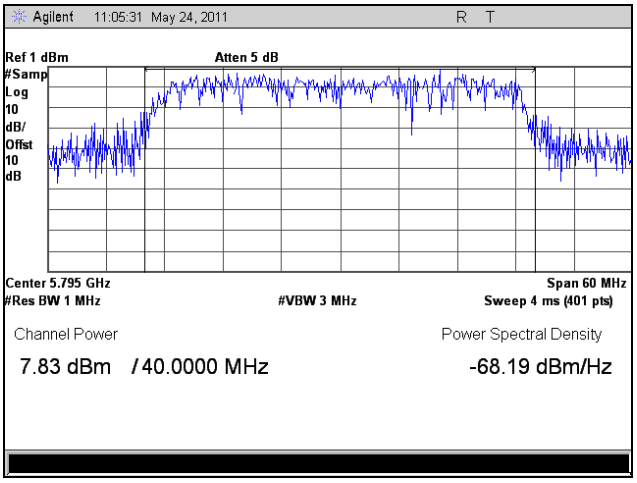


Plot 45. RF Power Output, 802.11n 40 MHz, Port 0, High Channel

RF Power Output, 802.11n 40 MHz, Port 1



Plot 46. RF Power Output, 802.11n 40 MHz, Port 1, Low Channel



Plot 47. RF Power Output, 802.11n 40 MHz, Port 1, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(a)(1), (a)(2) Peak Power Spectral Density

Test Requirements: **§ 15.407(a)(3):** For digitally modulated systems, the conducted peak power spectral density from the intentional radiator to the antenna shall not be greater than 17dBm/MHz in the frequency band 5.725 – 5.825GHz.

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 combined ports were measured using a splitter/combiner. The method of measurement #2 from the FCC Public Notice CA 02-2138 was used.

Test Results: Equipment complies with the peak power spectral density limits of **§ 15.407(a)(3).** The peak power spectral density was determined from plots on the following page(s).

Test Engineer(s): Lionel Gabrillo

Test Date(s): 05/25/11

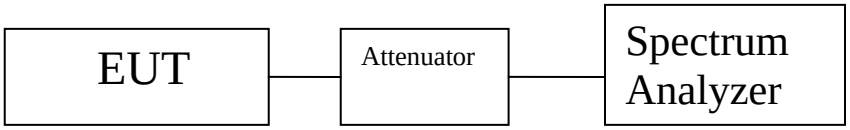


Figure 4. Peak Power Spectral Density Test Setup

Peak Power Spectral Density					
Mode	**Channel**	**Frequency (MHz)**	**Measured PPSD (dBm)**	**Limit (dBm)**	**Margin (dB)**
802.11a	Low	5745	4.067	16	-11.933
	Mid	5785	3.969	16	-12.031
	High	5805	3.784	16	-12.216

Table 26. Peak Power Spectral Density, Test Results

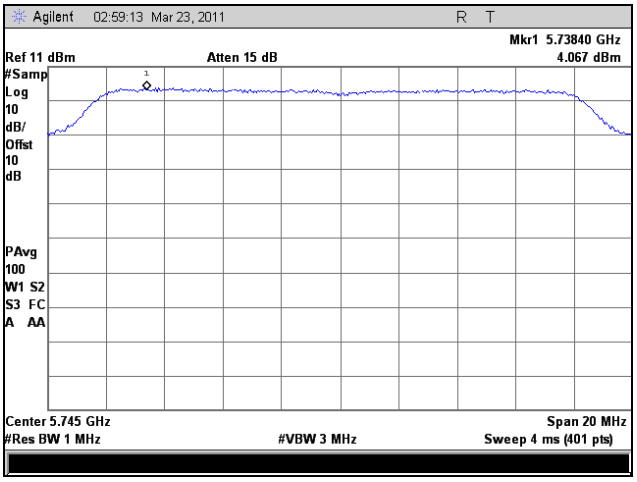
Channel	Port 0 (dBm)	Port 0 (mW)	Port 1 (dBm)	Port 1 (mW)	Sum (mW)	Sum (dBm)	Limit (dBm)	Delta
Low	-0.022	0.995	3.946	2.481	3.476	5.411	17	-11.589
Mid	-1.049	0.785	3.361	2.168	2.954	4.704	17	-12.2965
High	-0.624	0.866	3.709	2.349	3.215	5.072	17	-11.9278

Table 27. Peak Power Spectral Density, Test Results, Summed Ports, 802.11n 20 MHz

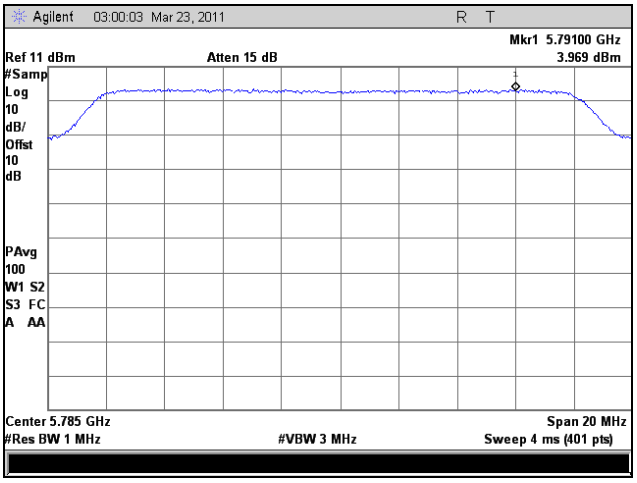
Channel	Port 0 (dBm)	Port 0 (mW)	Port 1 (dBm)	Port 1 (mW)	Sum (mW)	Sum (dBm)	Limit (dBm)	Delta
Low	-4.586	0.348	0.828	1.210	1.558	1.925	17	-15.0746
High	-4.245	0.376	0.746	1.187	1.564	1.941	17	-15.0585

Table 28. Peak Power Spectral Density, Test Results, Summed Ports, 802.11n 40 MHz

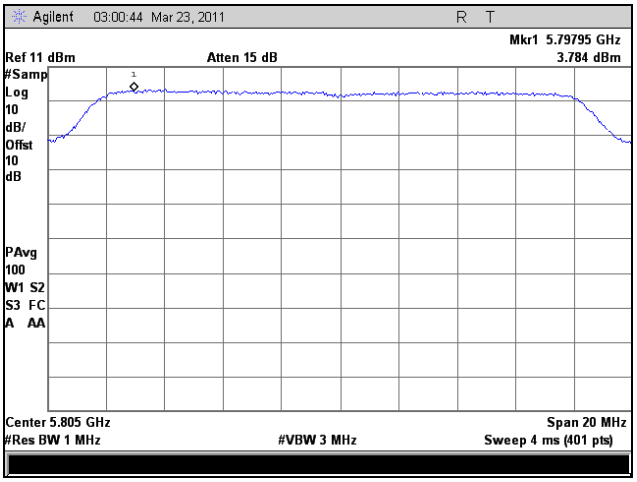
Peak Power Spectral Density, 802.11a



Plot 48. PPSD, 802.11a, Low Channel

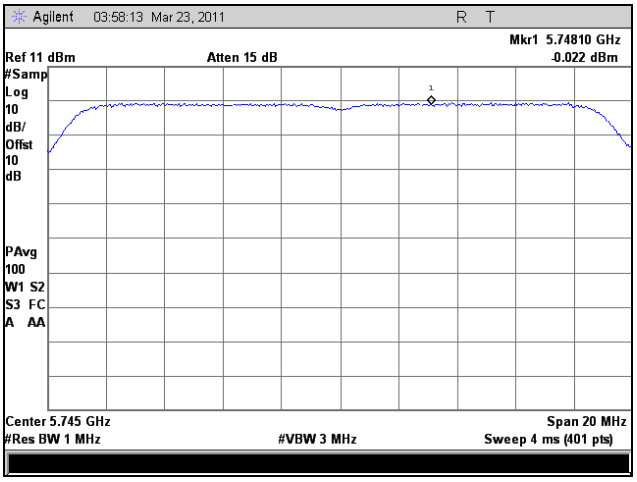


Plot 49. PPSD, 802.11a, Mid Channel

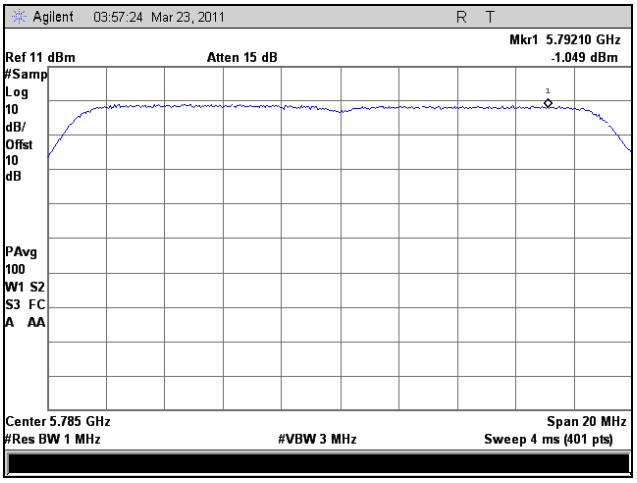


Plot 50. PPSD, 802.11a, High Channel

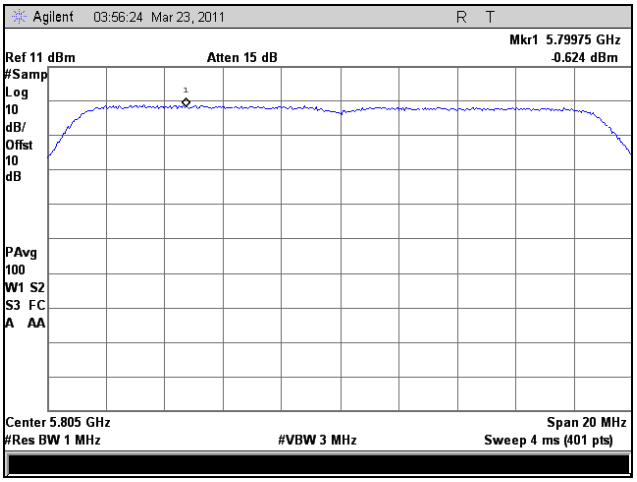
Peak Power Spectral Density, 802.11n 20 MHz, Port 0



Plot 51. PPSD, 802.11n 20 MHz, Port 0, Low Channel

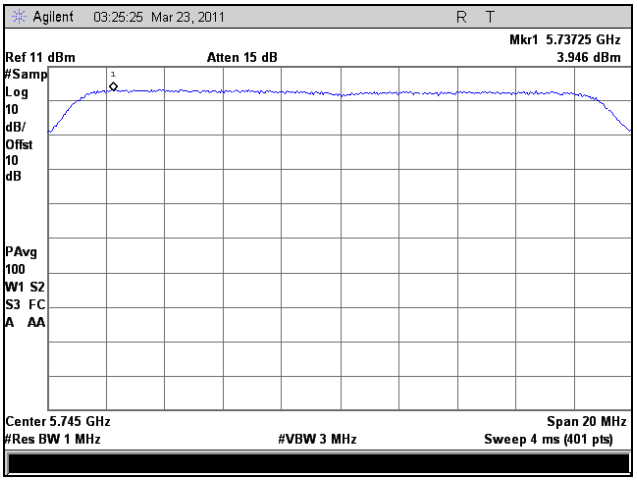


Plot 52. PPSD, 802.11n 20 MHz, Port 0, Mid Channel

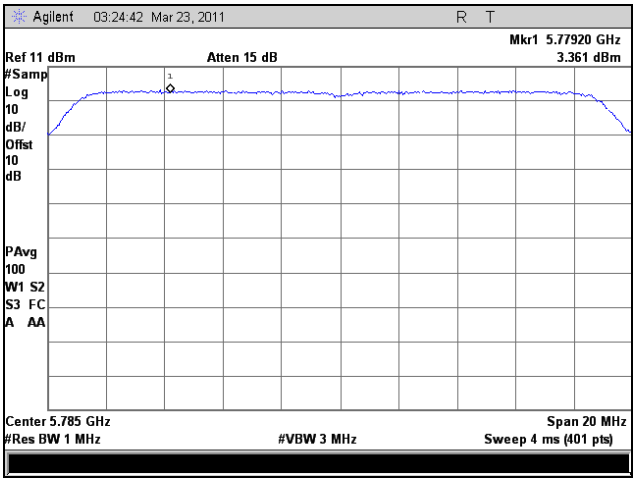


Plot 53. PPSD, 802.11n 20 MHz, Port 0, High Channel

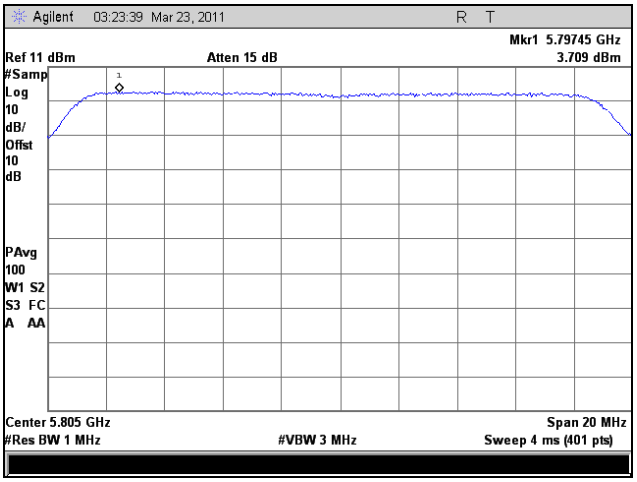
Peak Power Spectral Density, 802.11n 20 MHz, Port 1



Plot 54. PPSD, 802.11n 20 MHz, Port 1, Low Channel

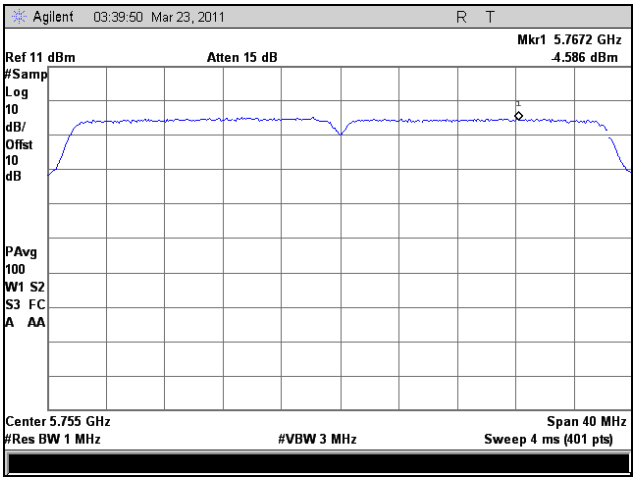


Plot 55. PPSD, 802.11n 20 MHz, Port 1, Mid Channel

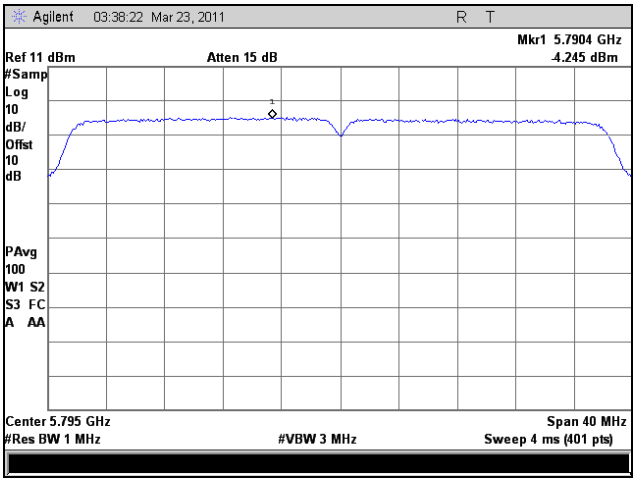


Plot 56. PPSD, 802.11n 20 MHz, Port 1, High Channel

Peak Power Spectral Density, 802.11n 40 MHz, Port 0

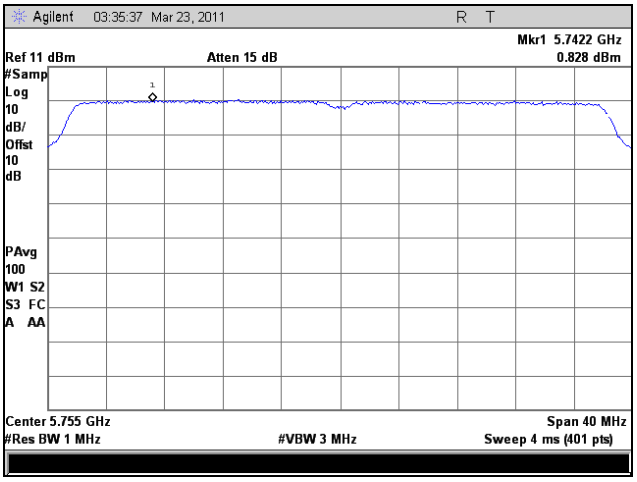


Plot 57. PPSD, 802.11n 40 MHz, Port 0, Low Channel

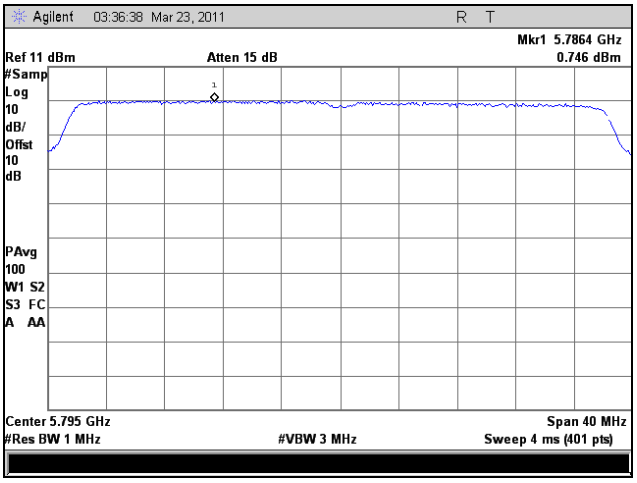


Plot 58. PPSD, 802.11n 40 MHz, Port 0, High Channel

Peak Power Spectral Density, 802.11n 40 MHz, Port 1



Plot 59. PPSD, 802.11n 40 MHz, Port 1, Low Channel



Plot 60. PPSD, 802.11n 40 MHz, Port 1, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(a)(6) Peak Excursion Ratio

Test Requirements: **§ 15.407(a)(6):** For digitally modulated systems, the peak excursion of the modulation envelope to the peak transmit power shall not exceed 13dB across any 1MHz bandwidth of the emission bandwidth whichever is less.

Test Procedure: The method of measurement #2 from the FCC Public Notice CA 02-2138 was used. 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 to a RBW=1MHz, VBW=30 KHz. The detector mode was set to sample detector.

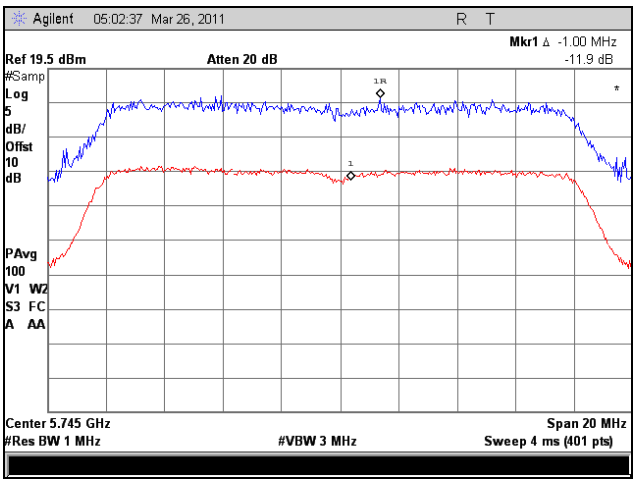
The Peak Excursion Ratio was determined from the difference between the maximum found in each trace.

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).

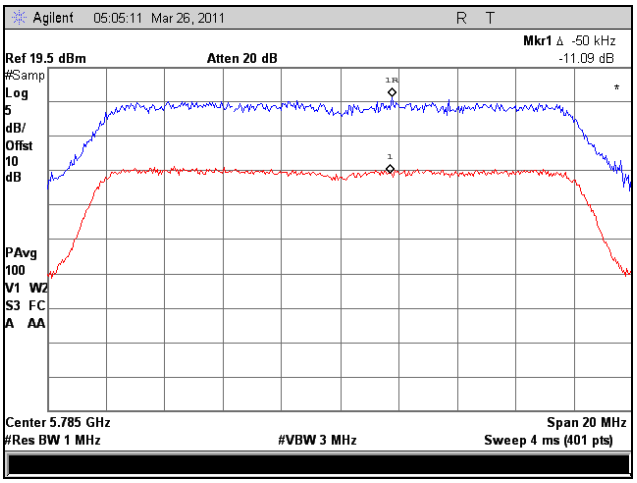
Test Engineer(s): Lionel Gabrillo

Test Date(s): 05/16/11

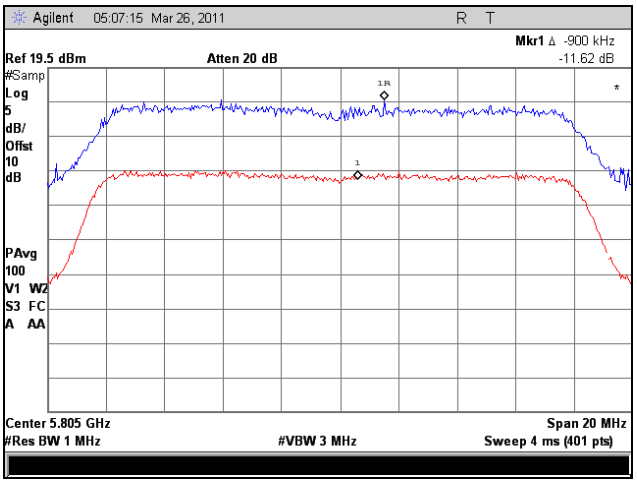
Peak Excursion Ratio, 802.11a



Plot 61. Peak Excursion, 802.11a, Low Channel

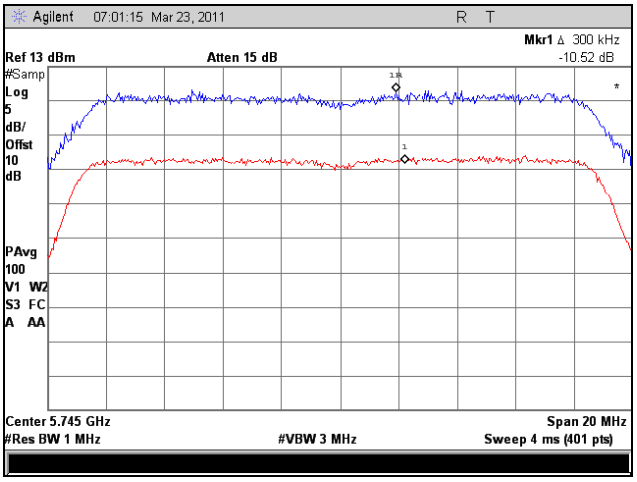


Plot 62. Peak Excursion, 802.11a, Mid Channel

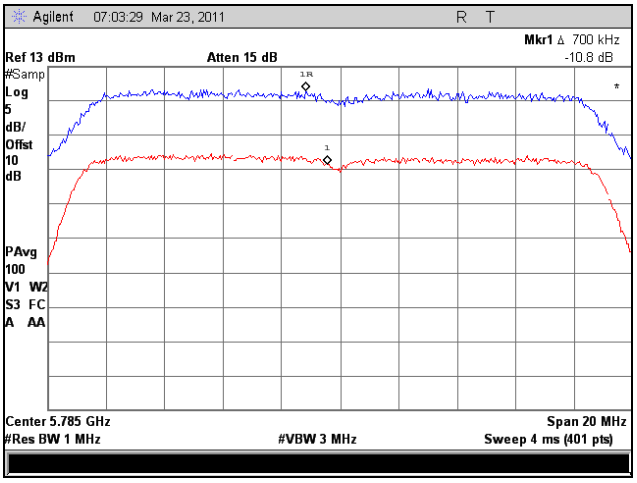


Plot 63. Peak Excursion, 802.11a, High Channel

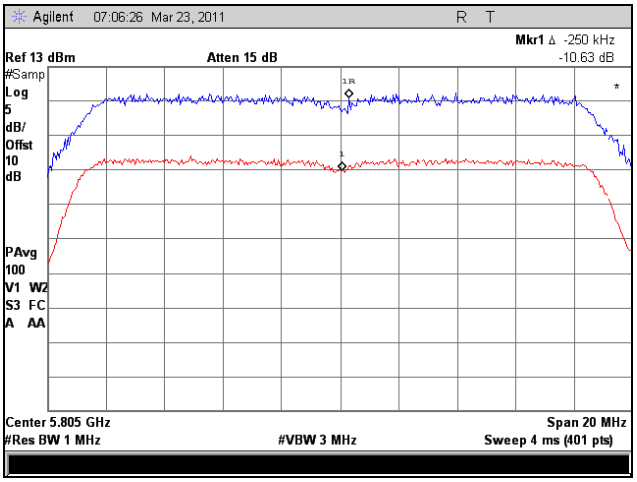
Peak Excursion Ratio, 802.11n 20 MHz, Port 0



Plot 64. Peak Excursion, 802.11n 20 MHz, Port 0, Low Channel

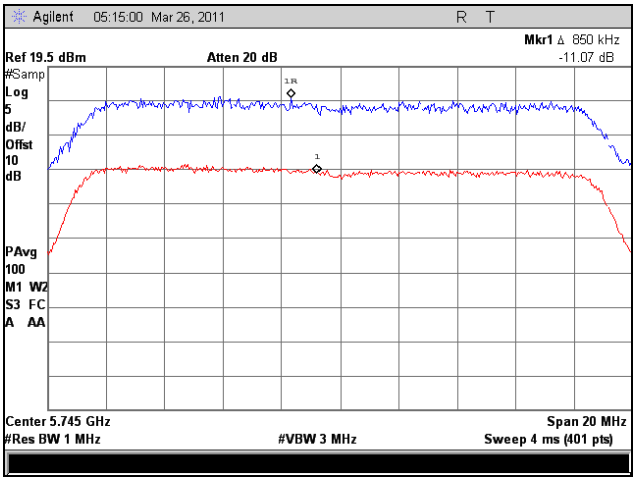


Plot 65. Peak Excursion, 802.11n 20 MHz, Port 0, Mid Channel

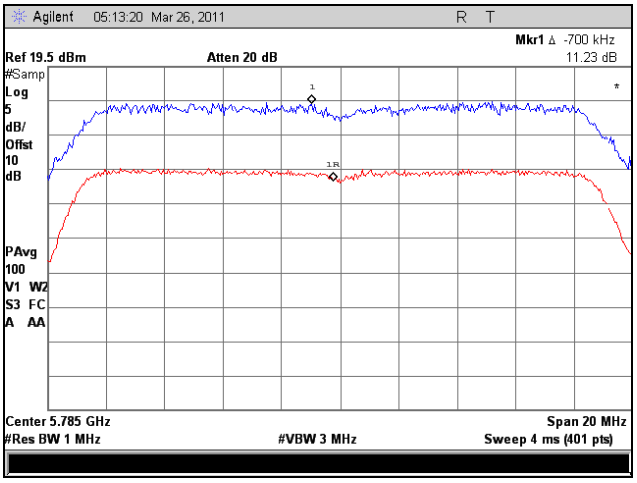


Plot 66. Peak Excursion, 802.11n 20 MHz, Port 0, High Channel

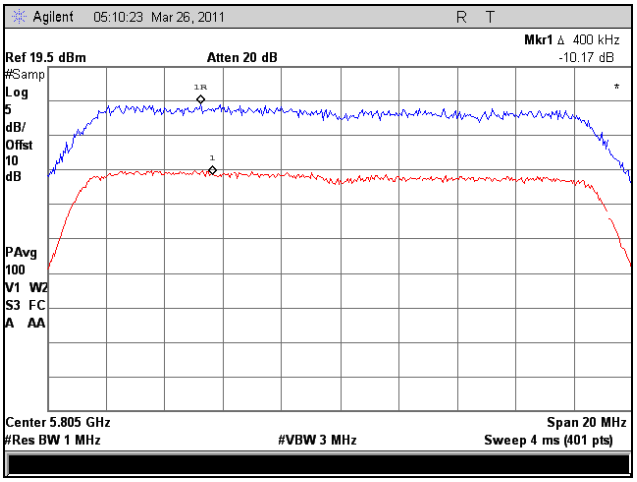
Peak Excursion Ratio, 802.11n 20 MHz, Port 1



Plot 67. Peak Excursion, 802.11n 20 MHz, Port 1, Low Channel

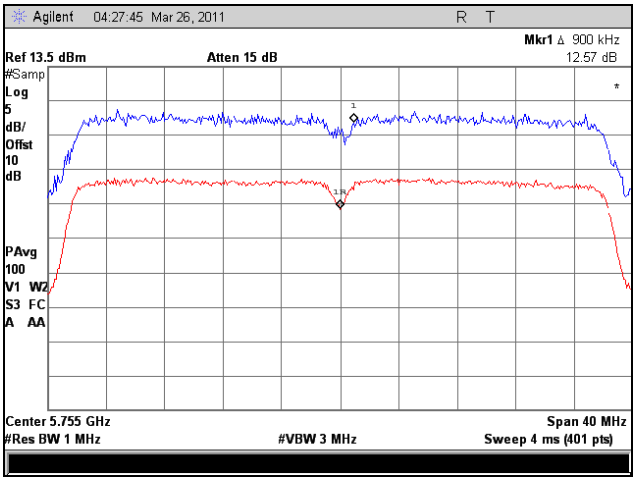


Plot 68. Peak Excursion, 802.11n 20 MHz, Port 1, Mid Channel

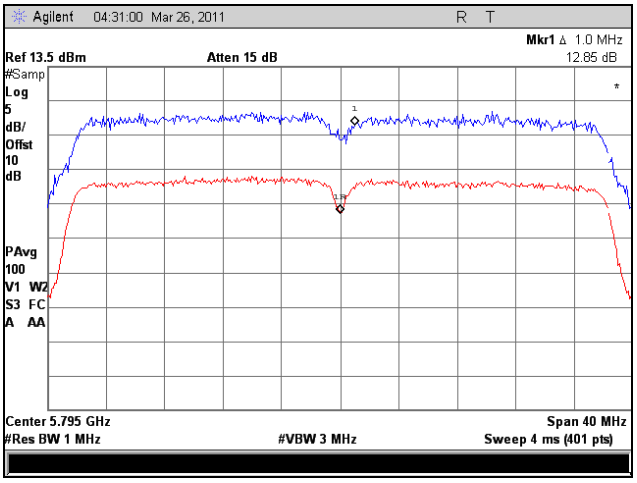


Plot 69. Peak Excursion, 802.11n 20 MHz, Port 1, High Channel

Peak Excursion Ratio, 802.11n 40 MHz, Port 0

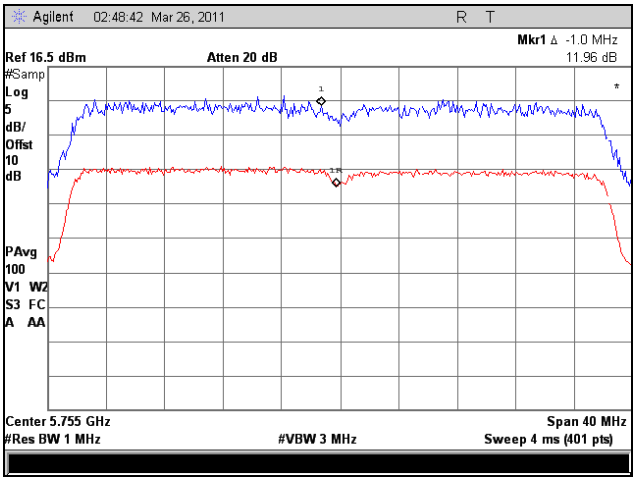


Plot 70. Peak Excursion, 802.11n 40 MHz, Port 0, Low Channel

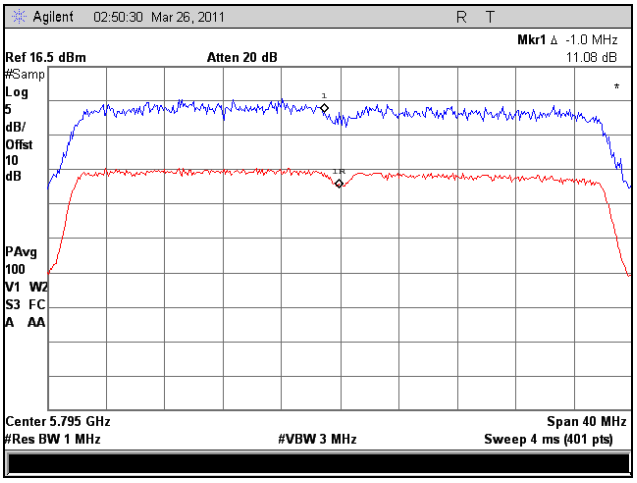


Plot 71. Peak Excursion, 802.11n 40 MHz, Port 0, High Channel

Peak Excursion Ratio, 802.11n 40 MHz, Port 1



Plot 72. Peak Excursion, 802.11n 40 MHz, Port 1, Low Channel



Plot 73. Peak Excursion, 802.11n 40 MHz, Port 1, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.407(b)(1),(2), (5), (6) Undesirable Emissions

Test Requirements: **§ 15.407(b)(1),(2), (5), (6)**; **§15.205:** Emissions outside the frequency band.

§ 15.407(b)(1): In any 1MHz bandwidth outside the frequency band 5.15-5.25GHz in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power shall not exceed -27dBm.

§ 15.407(b)(2): In any 1MHz bandwidth outside the frequency band 5.25-5.35GHz in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power shall not exceed -27dBm.

§ 15.407(b)(4): In any 1MHz bandwidth outside the frequency band 5.725-5.825GHz in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power shall not exceed -17dBm.

§ 15.407(b)(6): Radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

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

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

Table 29. Restricted Bands of Operation

Test Procedure: The EUT was installed placed on a 0.8m-high wooden table inside a semi-anechoic chamber. The harmonic frequencies the carriers were recorded for reference for final measurements. A receiving horn antenna was placed 3m away from the EUT. Unless otherwise specified, measurements were made using 1MHz RBW & 3MHz VBW with a Peak Detector for peak measurements and 1MHz RBW & 3MHz VBW with an Average Detector for average measurements on a spectrum analyzer.

The turntable was rotated, the positions of the interface cables were varied, and the antenna height was varied between 1 m and 4 m, in order to find the maximum radiated emissions.

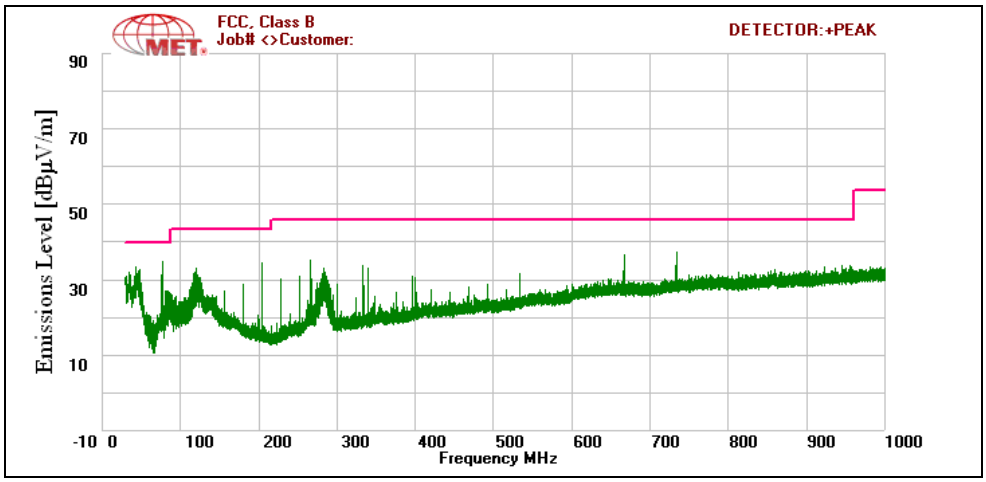
The equipment isotropic radiated power (EIRP) at -17dBm/MHz was converted to field strength at 78.24dBuV/m. At the band edge of each band, the EIRP energy measurement is integrated to show the total power over 1MHz.

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

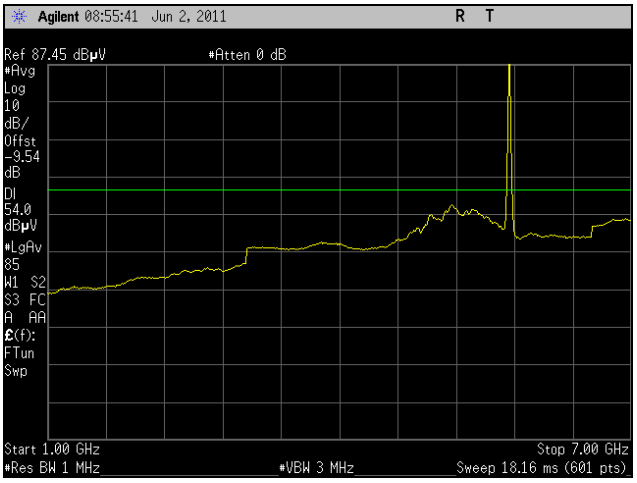
Test Engineer(s): Lionel Gabrillo

Test Date(s): 05/23/11

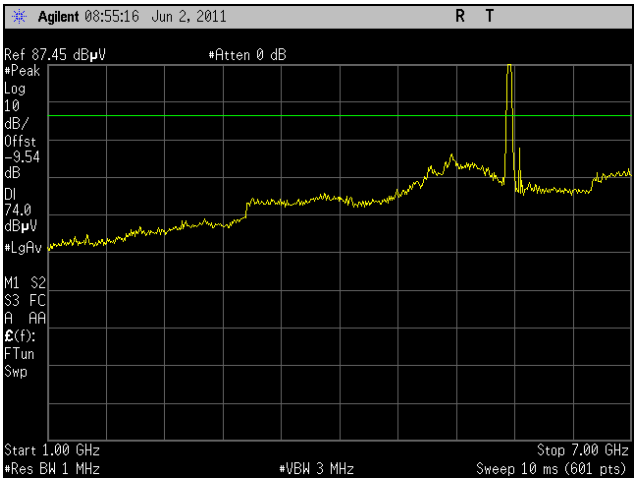
Radiated Spurious Emissions, 802.11a



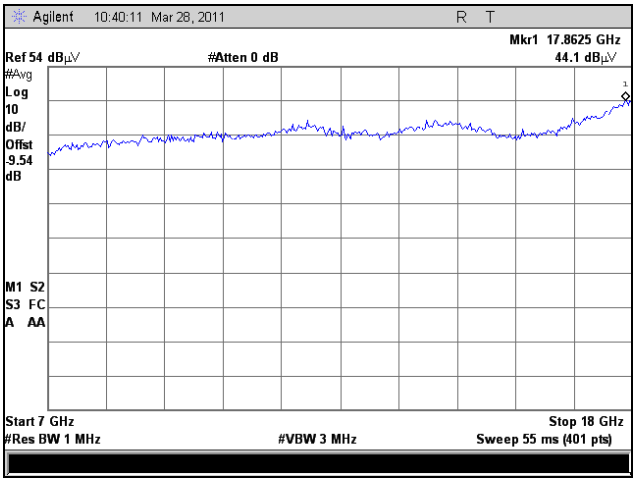
Plot 74. Radiated Spurious Emissions, 802.11a, Low Channel, 30 MHz – 1 GHz



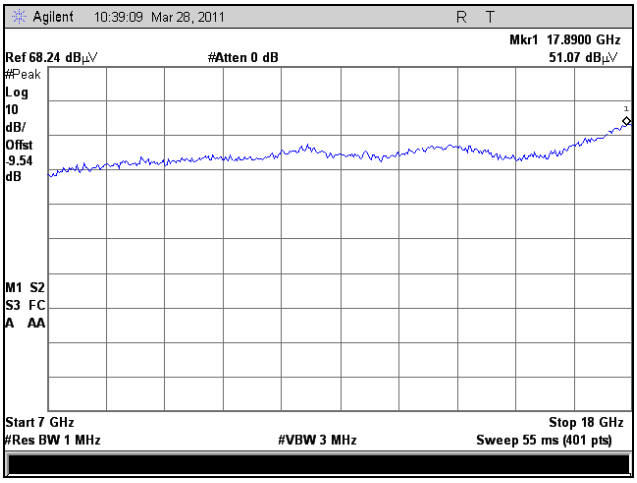
Plot 75. Radiated Spurious Emissions, 802.11a, Low Channel, 1 GHz – 7 GHz, Average



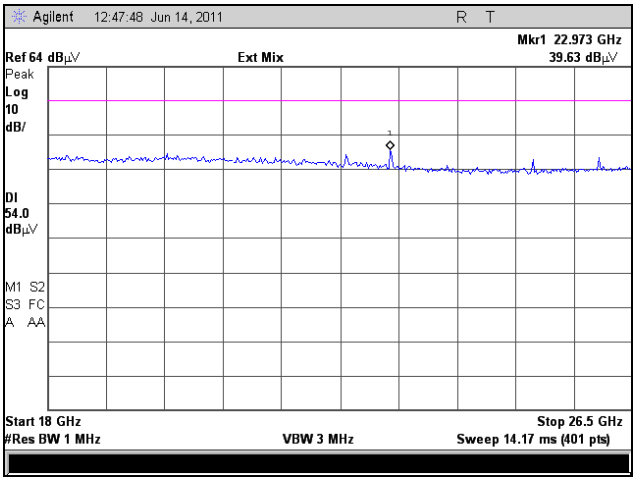
Plot 76. Radiated Spurious Emissions, 802.11a, Low Channel, 1 GHz – 7 GHz, Peak



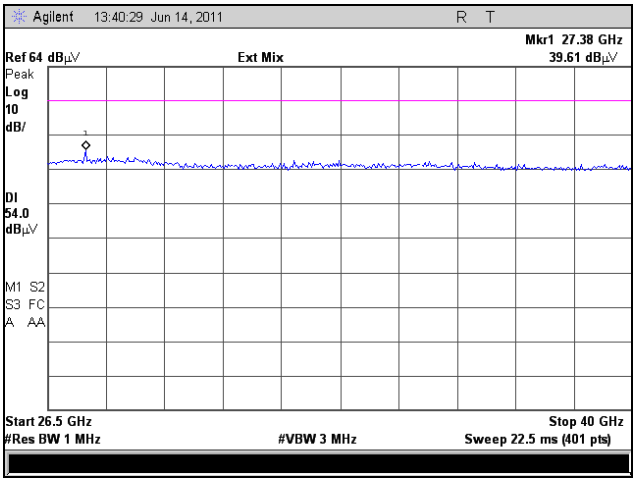
Plot 77. Radiated Spurious Emissions, 802.11a, Low Channel, 7 GHz – 18 GHz, Average



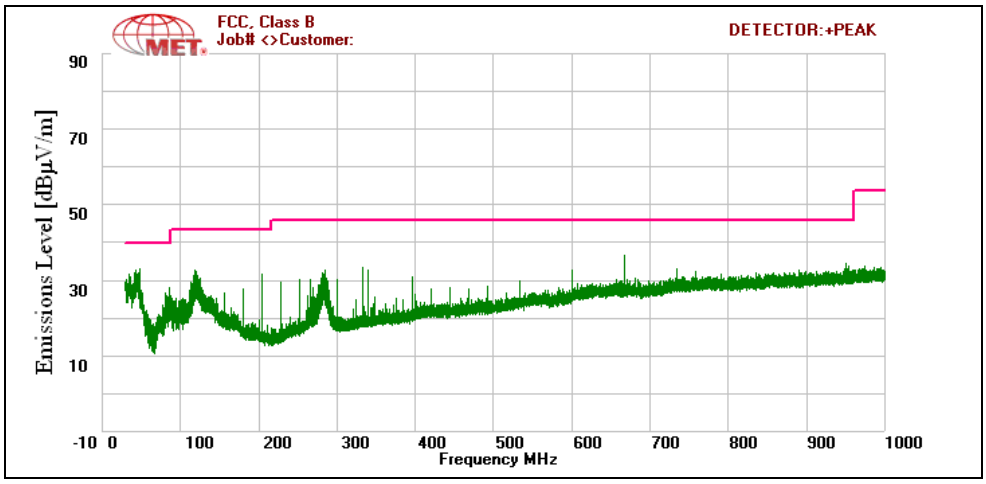
Plot 78. Radiated Spurious Emissions, 802.11a, Low Channel, 7 GHz – 18 GHz, Peak



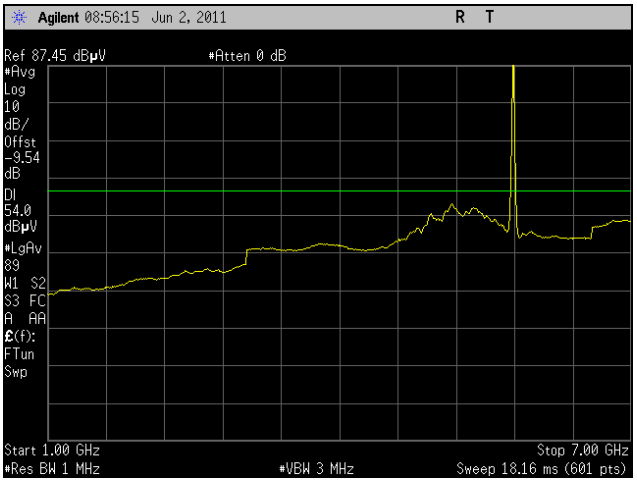
Plot 79. Radiated Spurious Emissions, 802.11a, Low Channel, 18 GHz – 26.5 GHz



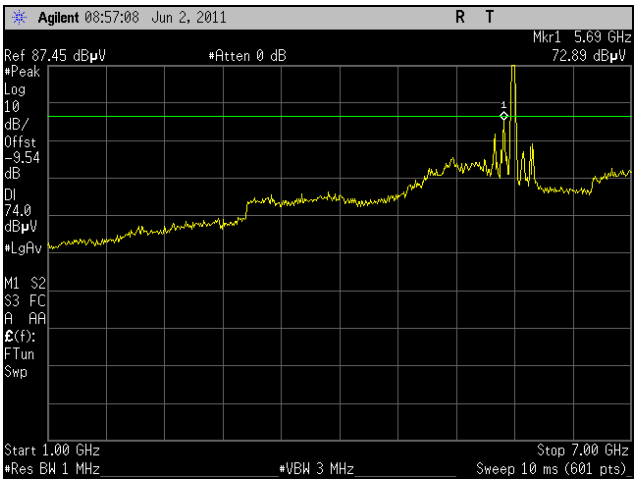
Plot 80. Radiated Spurious Emissions, 802.11a, Low Channel, 26.5 GHz – 40 GHz



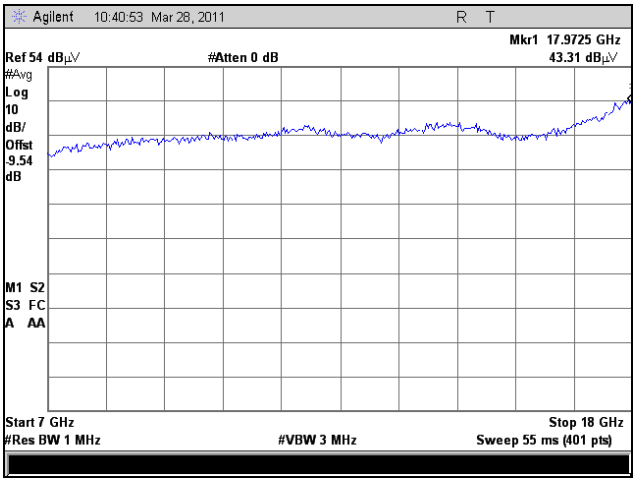
Plot 81. Radiated Spurious Emissions, 802.11a, Mid Channel, 30 MHz – 1 GHz



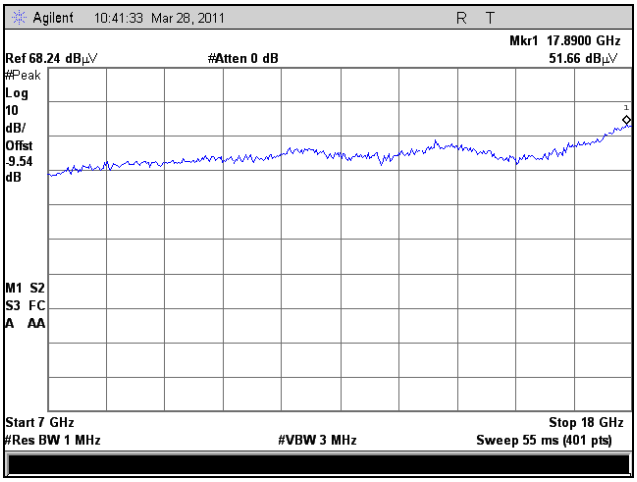
Plot 82. Radiated Spurious Emissions, 802.11a, Mid Channel, 1 GHz – 7 GHz, Average



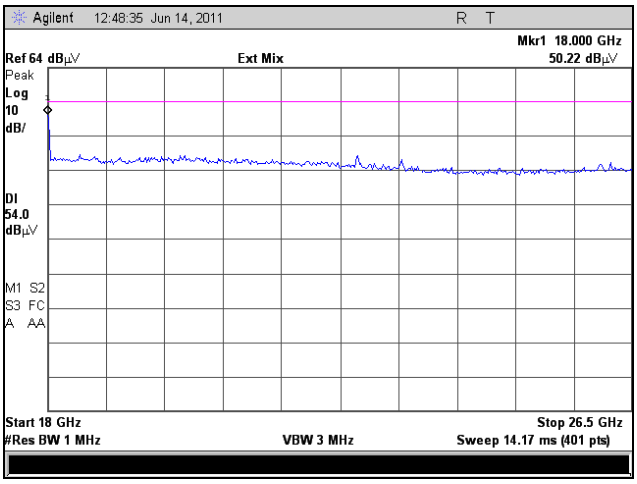
Plot 83. Radiated Spurious Emissions, 802.11a, Mid Channel, 1 GHz – 7 GHz, Peak



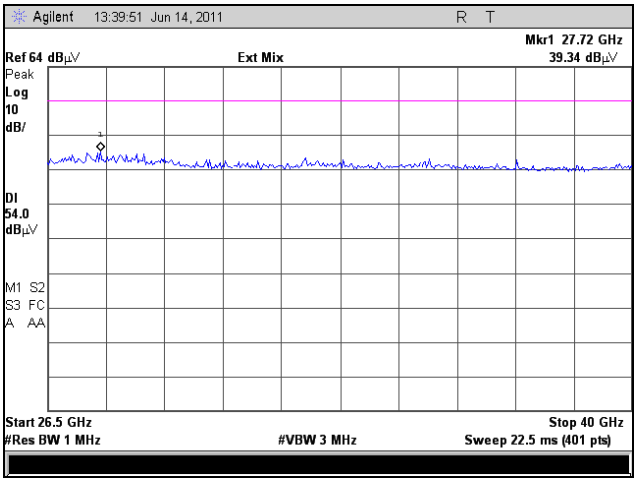
Plot 84. Radiated Spurious Emissions, 802.11a, Mid Channel, 7 GHz – 18 GHz, Average



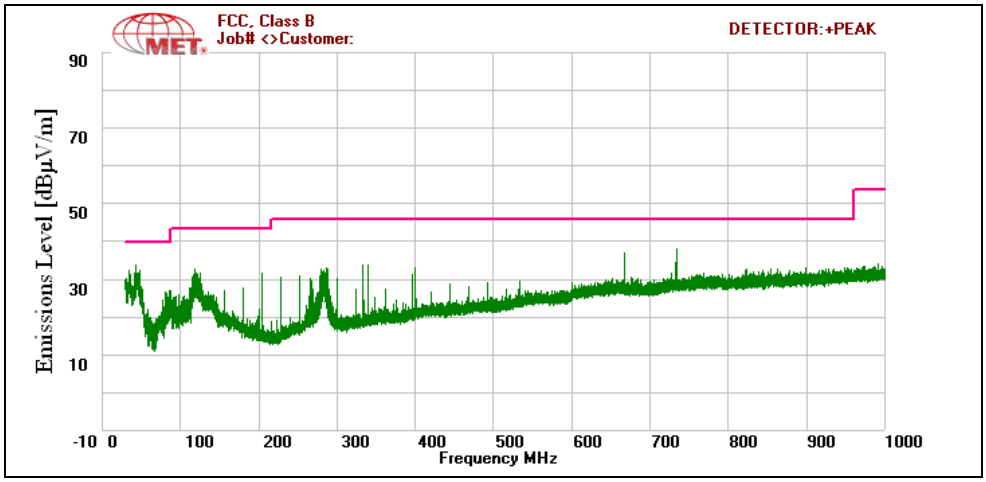
Plot 85. Radiated Spurious Emissions, 802.11a, Mid Channel, 7 GHz – 18 GHz, Peak



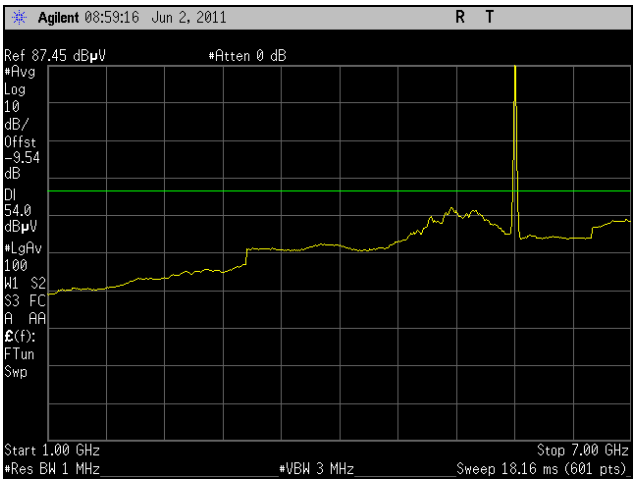
Plot 86. Radiated Spurious Emissions, 802.11a, Mid Channel, 18 GHz – 26.5 GHz



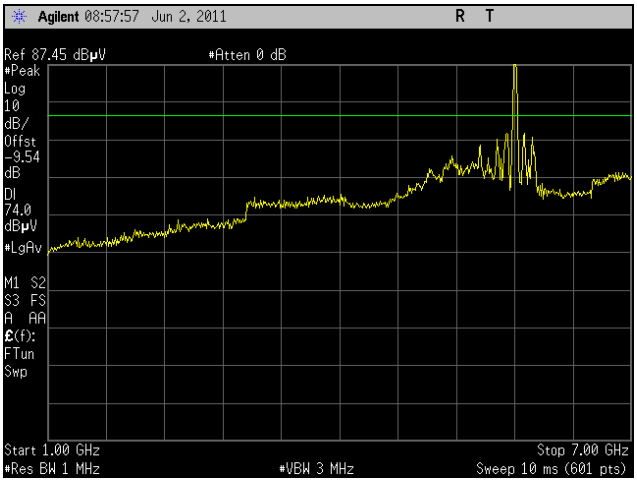
Plot 87. Radiated Spurious Emissions, 802.11a, Mid Channel, 26.5 GHz – 40 GHz



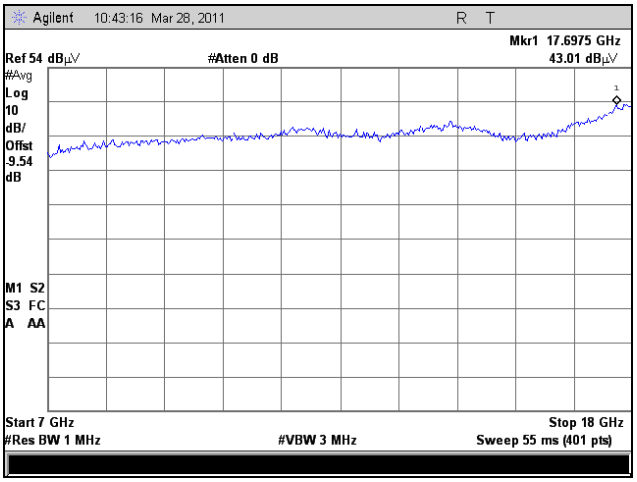
Plot 88. Radiated Spurious Emissions, 802.11a, High Channel, 30 MHz – 1 GHz



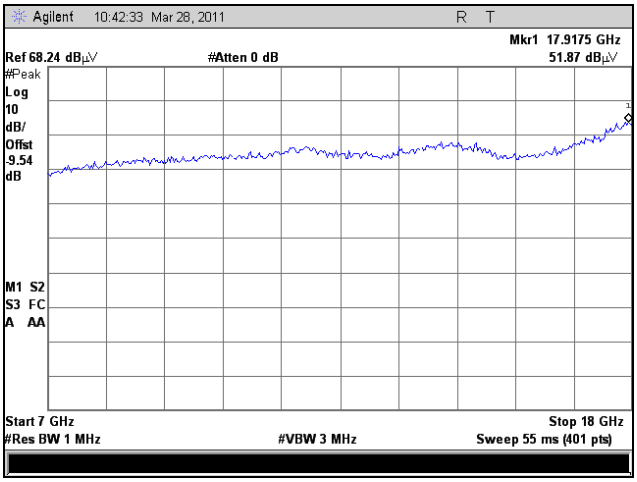
Plot 89. Radiated Spurious Emissions, 802.11a, High Channel, 1 GHz – 7 GHz, Average



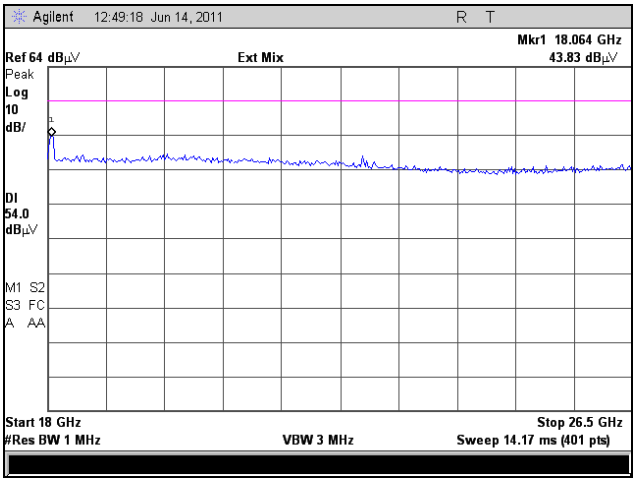
Plot 90. Radiated Spurious Emissions, 802.11a, High Channel, 1 GHz – 7 GHz, Peak



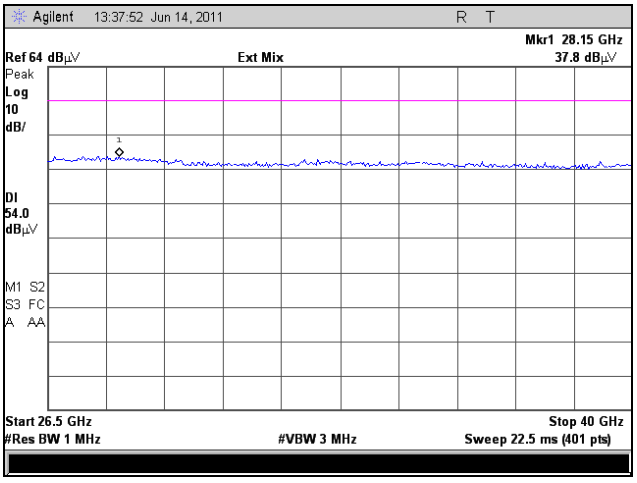
Plot 91. Radiated Spurious Emissions, 802.11a, High Channel, 7 GHz – 18 GHz, Average



Plot 92. Radiated Spurious Emissions, 802.11a, High Channel, 7 GHz – 18 GHz, Peak

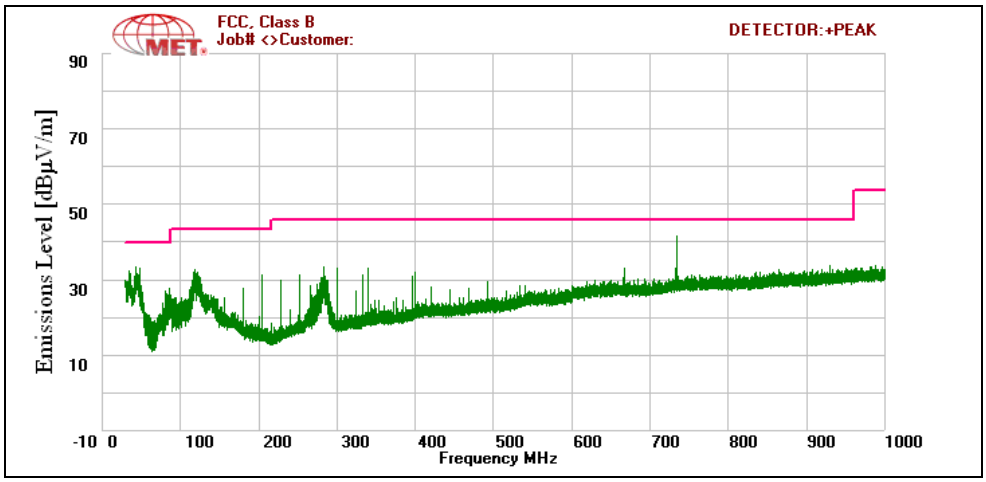


Plot 93. Radiated Spurious Emissions, 802.11a, High Channel, 18 GHz – 26.5 GHz

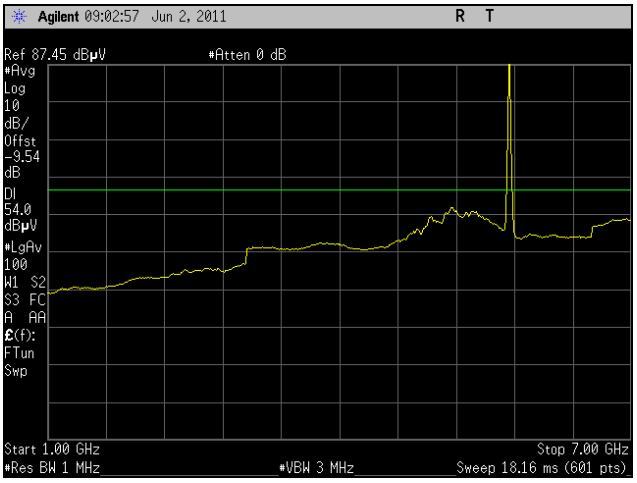


Plot 94. Radiated Spurious Emissions, 802.11a, High Channel, 26.5 GHz – 40 GHz

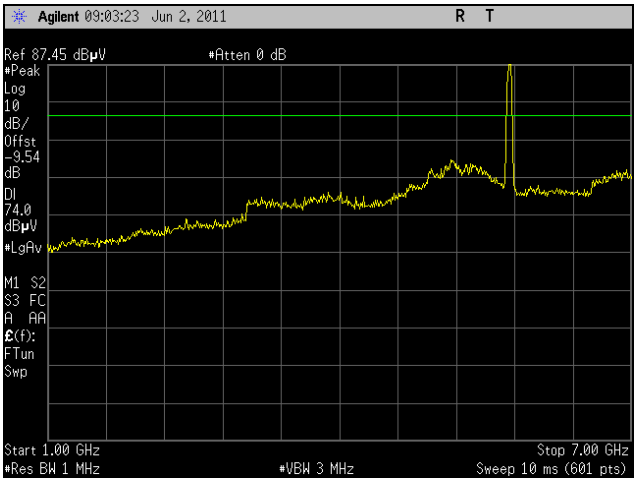
Radiated Spurious Emissions, 802.11n 20 MHz



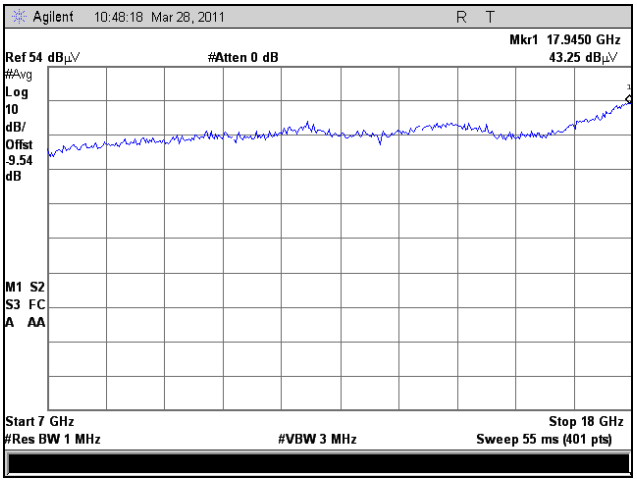
Plot 95. Radiated Spurious Emissions, 802.11n 20 MHz, Low Channel, 30 MHz – 1 GHz



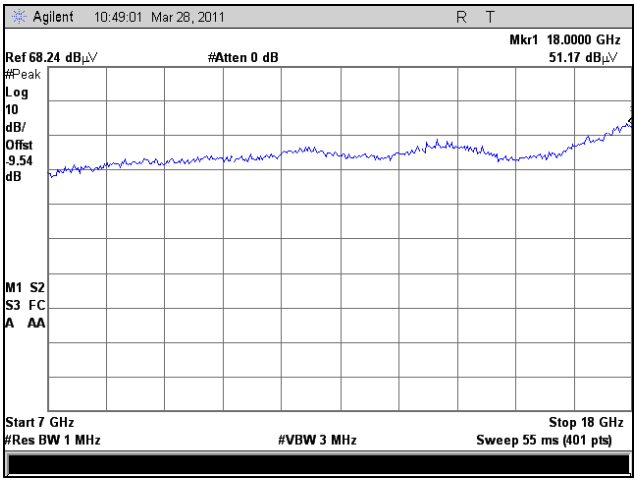
Plot 96. Radiated Spurious Emissions, 802.11n 20 MHz, Low Channel, 1 GHz – 7 GHz, Average



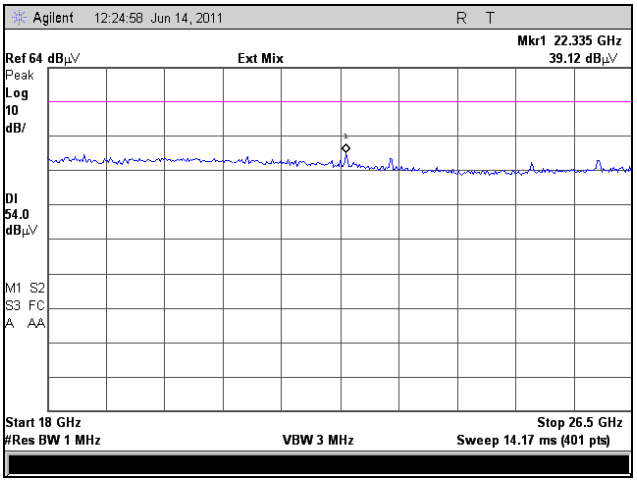
Plot 97. Radiated Spurious Emissions, 802.11n 20 MHz, Low Channel, 1 GHz – 7 GHz, Peak



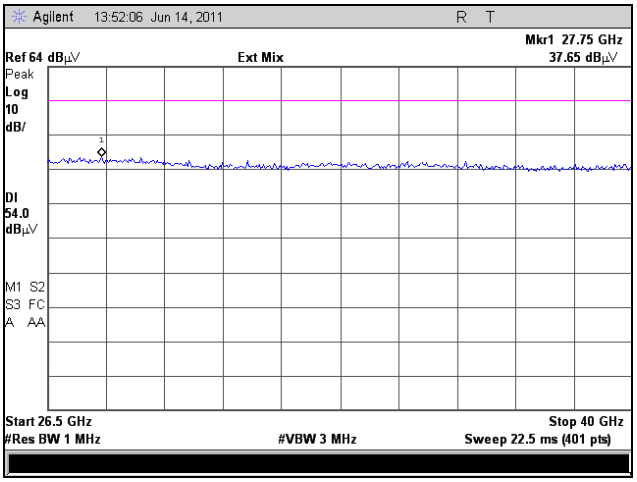
Plot 98. Radiated Spurious Emissions, 802.11n 20 MHz, Low Channel, 7 GHz – 8 GHz, Average



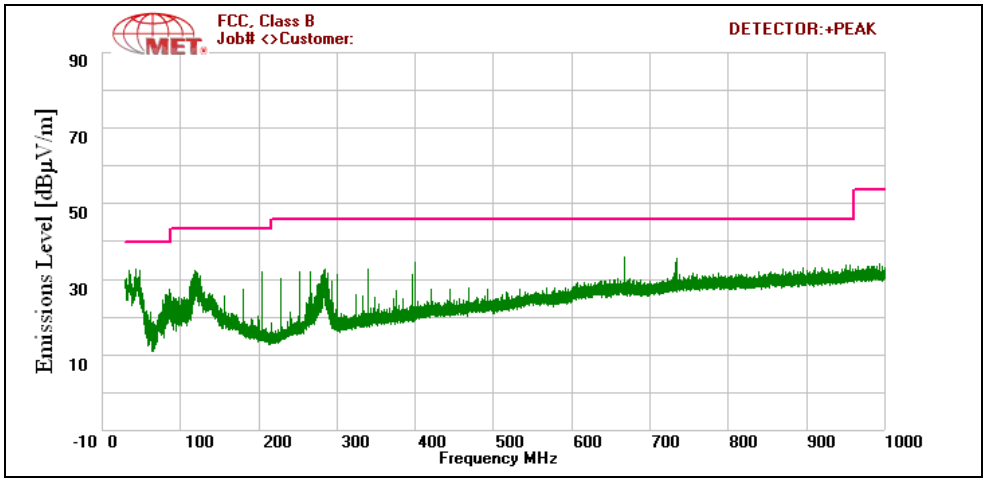
Plot 99. Radiated Spurious Emissions, 802.11n 20 MHz, Low Channel, 7 GHz – 18 GHz, Peak



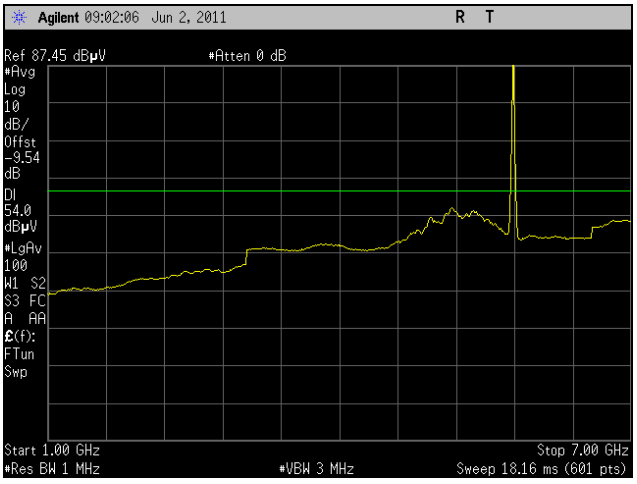
Plot 100. Radiated Spurious Emissions, 802.11n 20 MHz, Low Channel, 18 GHz – 26.5 GHz



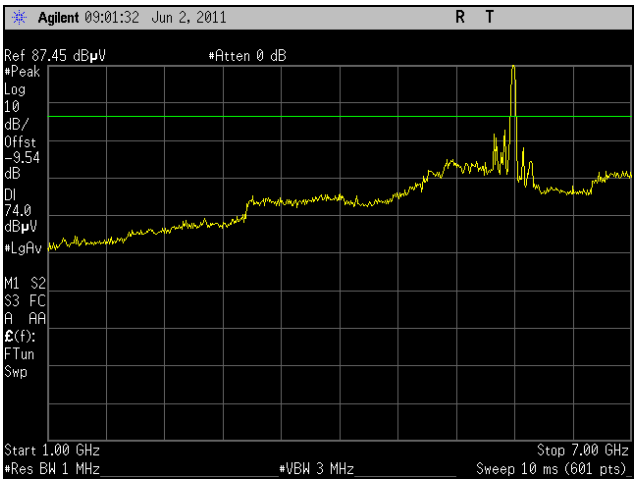
Plot 101. Radiated Spurious Emissions, 802.11n 20 MHz, Low Channel, 26.5 GHz – 40 GHz



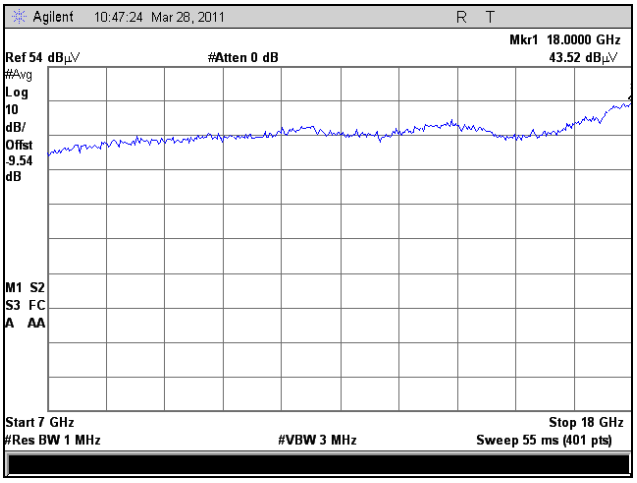
Plot 102. Radiated Spurious Emissions, 802.11n 20 MHz, Mid Channel, 30 MHz – 1 GHz



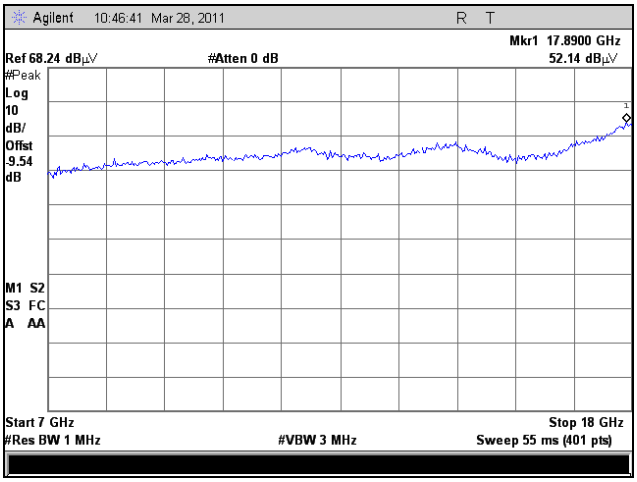
Plot 103. Radiated Spurious Emissions, 802.11n 20 MHz, Mid Channel, 1 GHz – 7 GHz, Average



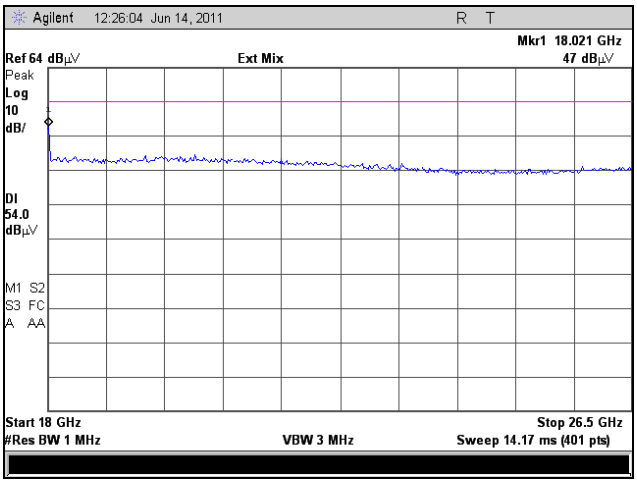
Plot 104. Radiated Spurious Emissions, 802.11n 20 MHz, Mid Channel, 1 GHz – 7 GHz, Peak



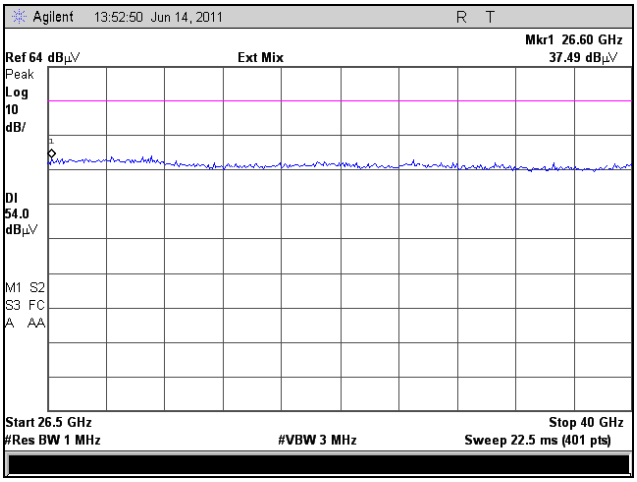
Plot 105. Radiated Spurious Emissions, 802.11n 20 MHz, Mid Channel, 7 GHz – 18 GHz, Average



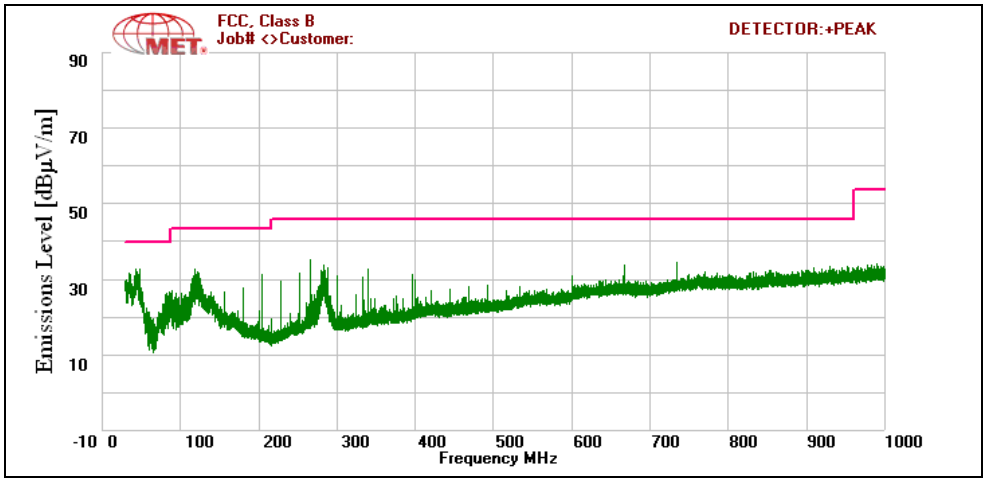
Plot 106. Radiated Spurious Emissions, 802.11n 20 MHz, Mid Channel, 7 GHz – 18 GHz, Peak



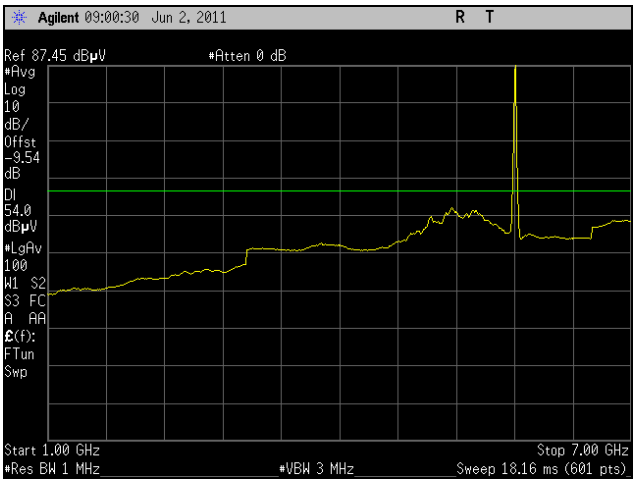
Plot 107. Radiated Spurious Emissions, 802.11n 20 MHz, Mid Channel, 18 GHz – 26.5 GHz



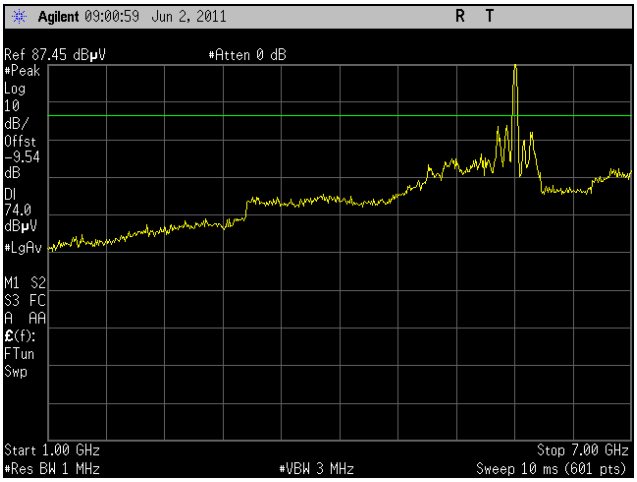
Plot 108. Radiated Spurious Emissions, 802.11n 20 MHz, Mid Channel, 26.5 GHz – 40 GHz



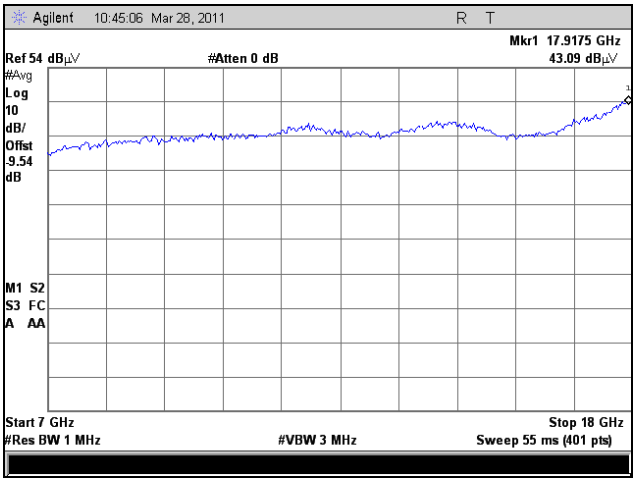
Plot 109. Radiated Spurious Emissions, 802.11n 20 MHz, High Channel, 30 MHz – 1 GHz



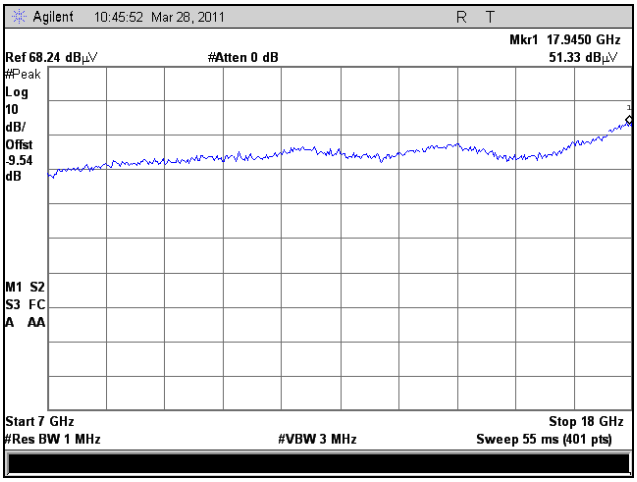
Plot 110. Radiated Spurious Emissions, 802.11n 20 MHz, High Channel, 1 GHz – 7 GHz, Average



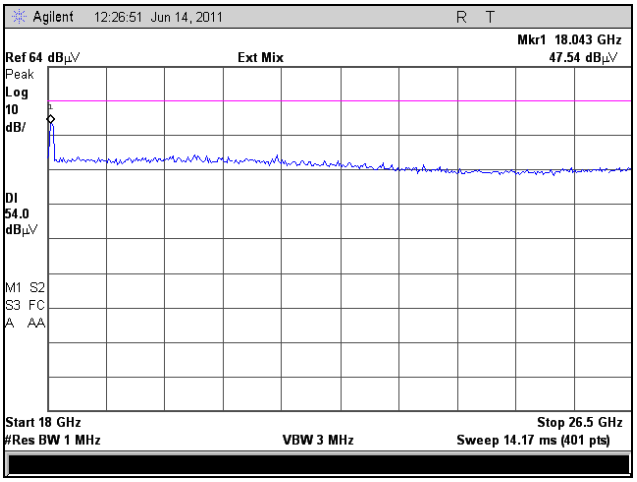
Plot 111. Radiated Spurious Emissions, 802.11n 20 MHz, High Channel, 1 GHz – 7 GHz, Peak



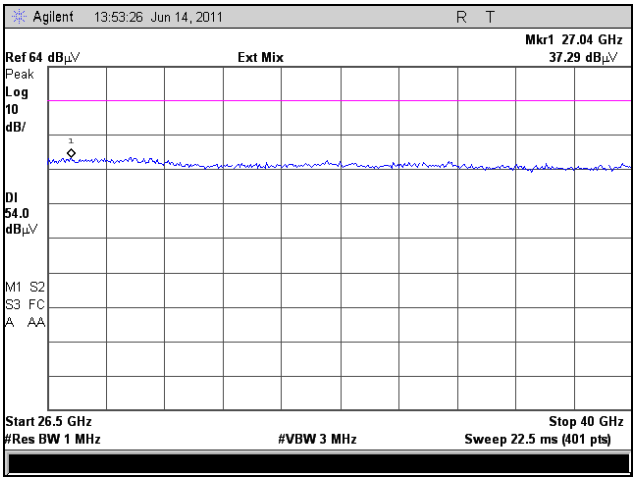
Plot 112. Radiated Spurious Emissions, 802.11n 20 MHz, High Channel, 7 GHz – 18 GHz, Average



Plot 113. Radiated Spurious Emissions, 802.11n 20 MHz, High Channel, 7 GHz – 18 GHz, Peak

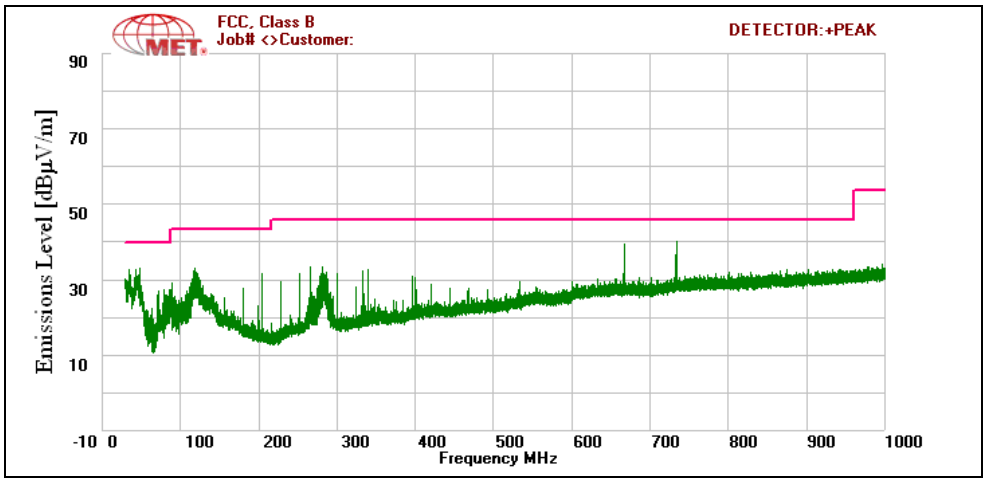


Plot 114. Radiated Spurious Emissions, 802.11n 20 MHz, High Channel, 18 GHz – 26.5 GHz

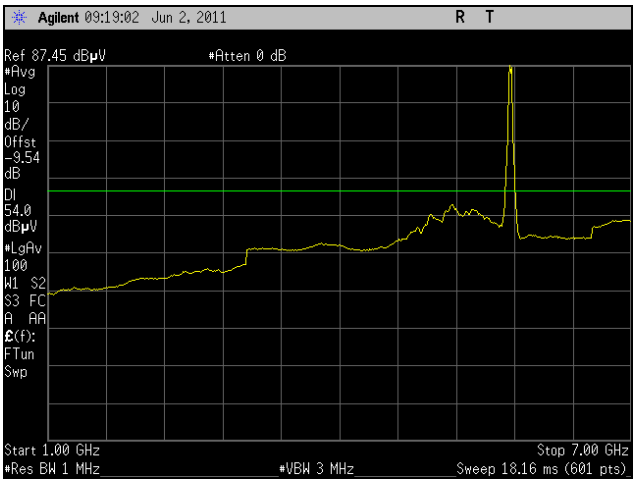


Plot 115. Radiated Spurious Emissions, 802.11n 20 MHz, High Channel, 26.5 GHz – 40 GHz

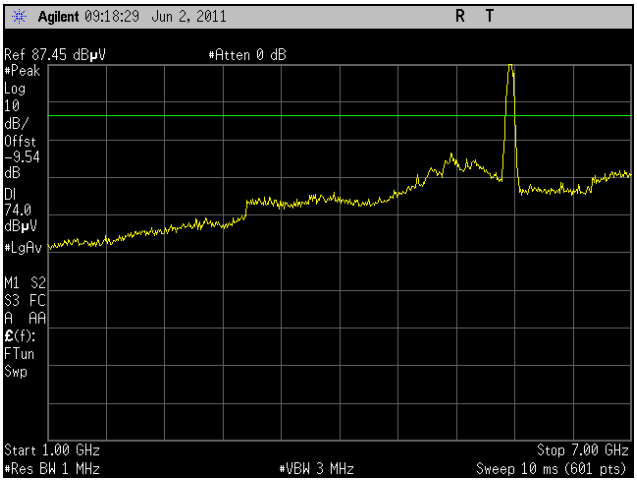
Radiated Spurious Emissions, 802.11n 40 MHz



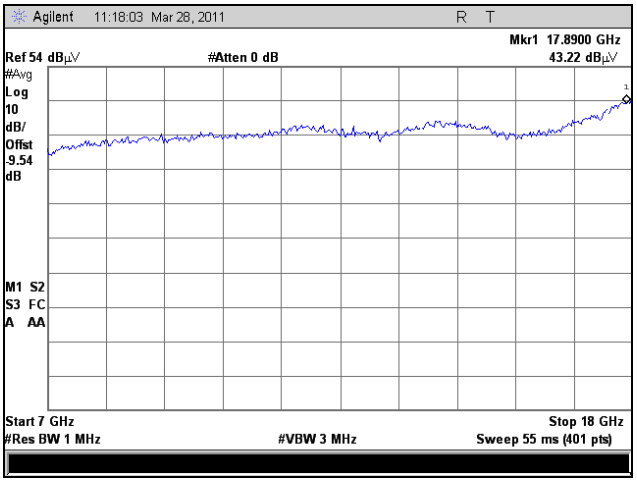
Plot 116. Radiated Spurious Emissions, 802.11n 40 MHz, Low Channel, 30 MHz – 1 GHz



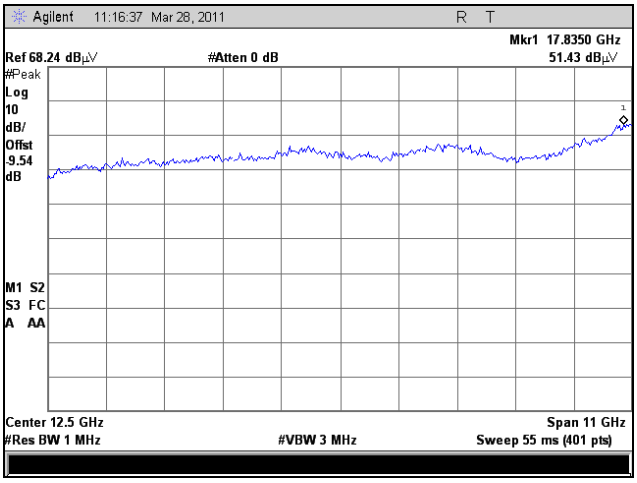
Plot 117. Radiated Spurious Emissions, 802.11n 40 MHz, Low Channel, 1 GHz – 7 GHz, Average



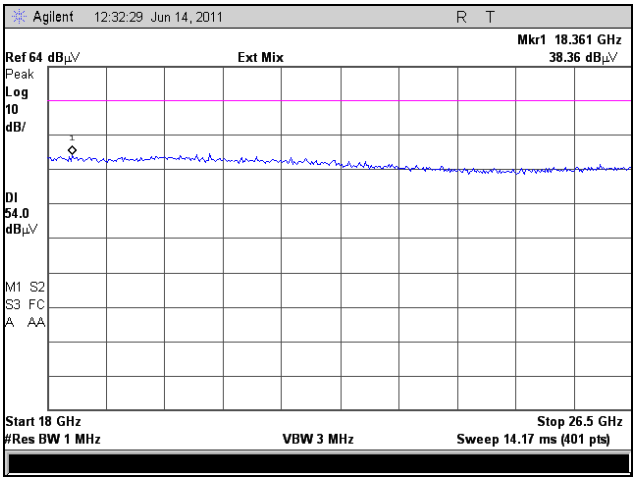
Plot 118. Radiated Spurious Emissions, 802.11n 40 MHz, Low Channel, 1 GHz – 7 GHz, Peak



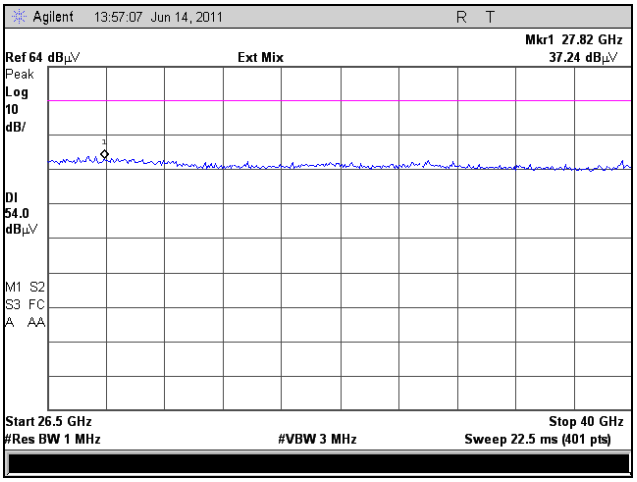
Plot 119. Radiated Spurious Emissions, 802.11n 40 MHz, Low Channel, 7 GHz – 18 GHz, Average



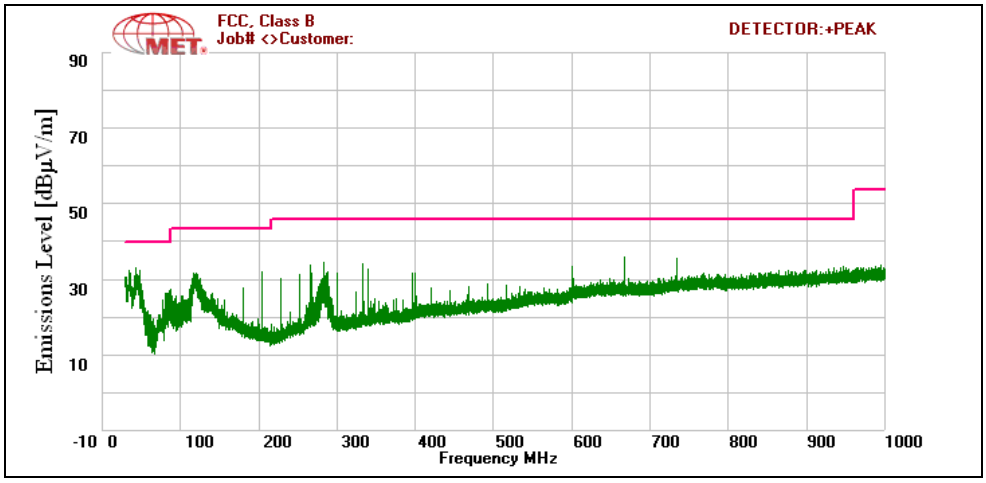
Plot 120. Radiated Spurious Emissions, 802.11n 40 MHz, Low Channel, 7 GHz – 18 GHz, Peak



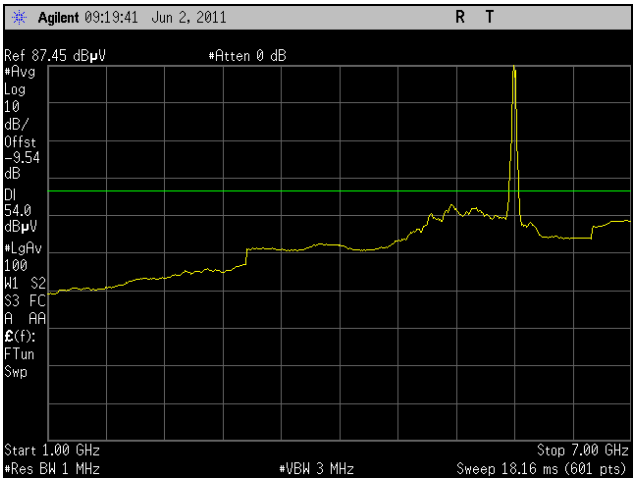
Plot 121. Radiated Spurious Emissions, 802.11n 40 MHz, Low Channel, 18 GHz – 26.5 GHz



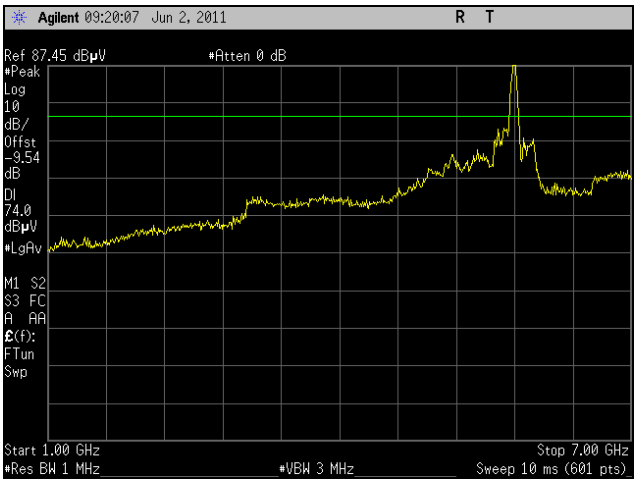
Plot 122. Radiated Spurious Emissions, 802.11n 40 MHz, Low Channel, 26.5 GHz – 40 GHz



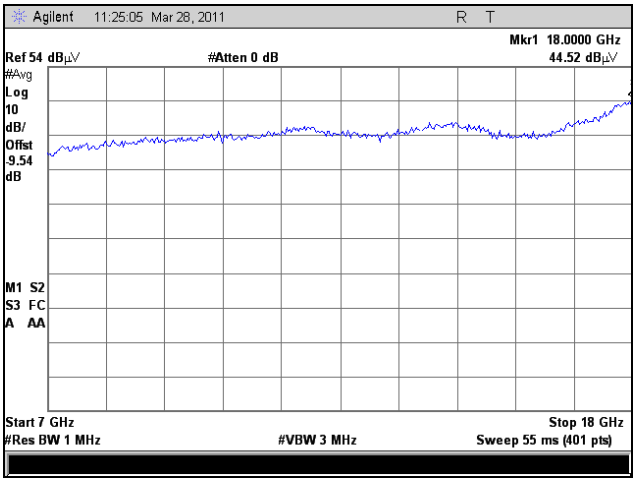
Plot 123. Radiated Spurious Emissions, 802.11n 40 MHz, High Channel, 30 MHz – 1 GHz, Average



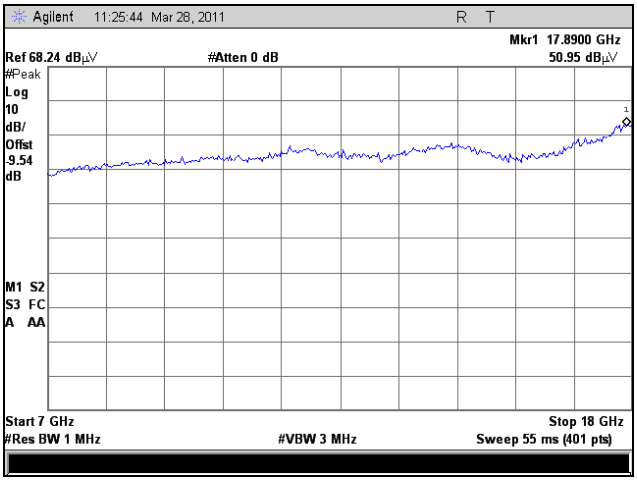
Plot 124. Radiated Spurious Emissions, 802.11n 40 MHz, High Channel, 1 GHz – 7 GHz, Average



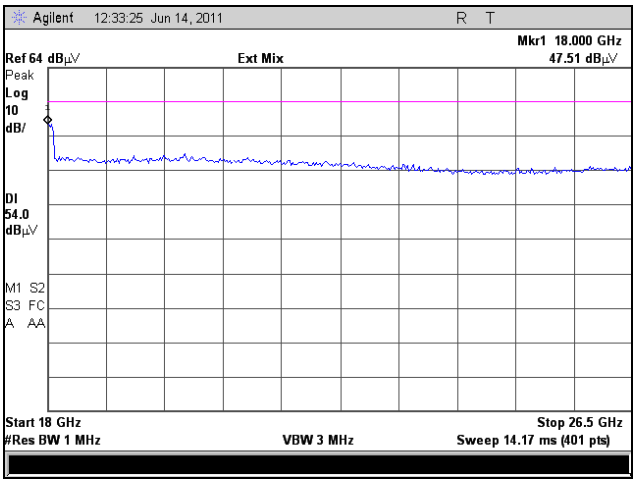
Plot 125. Radiated Spurious Emissions, 802.11n 40 MHz, High Channel, 1 GHz – 7 GHz, Peak



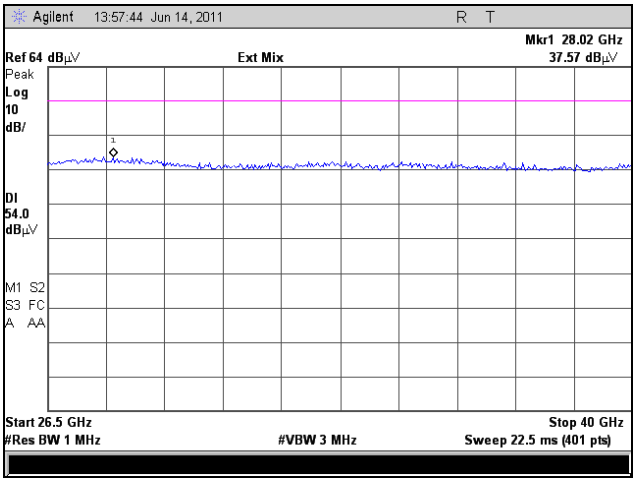
Plot 126. Radiated Spurious Emissions, 802.11n 40 MHz, High Channel, 7 GHz – 18 GHz, Average



Plot 127. Radiated Spurious Emissions, 802.11n 40 MHz, High Channel, 7 GHz – 18 GHz, Peak



Plot 128. Radiated Spurious Emissions, 802.11n 40 MHz, High Channel, 18 GHz – 26.5 GHz



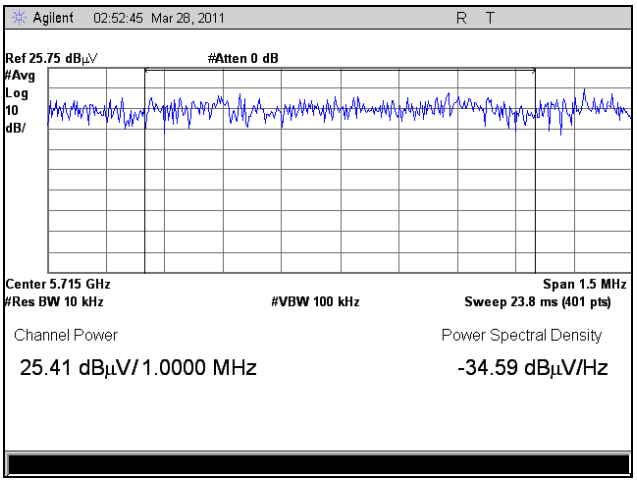
Plot 129. Radiated Spurious Emissions, 802.11n 40 MHz, High Channel, 26.5 GHz – 40 GHz

EIRP

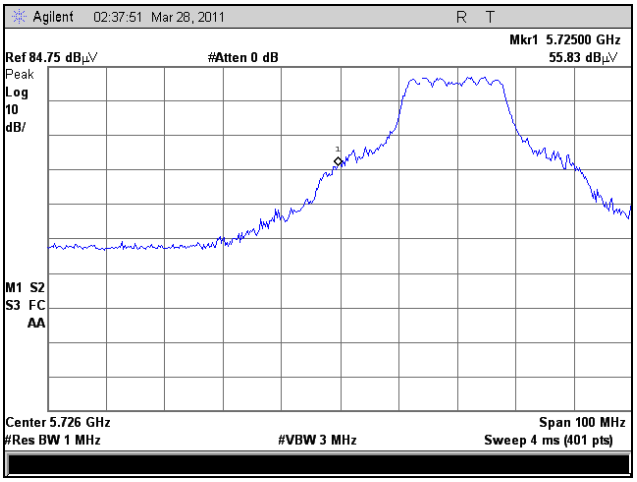
	Band Edge Freq.	Uncorrected (dBuV)	Cable Loss	ACF	Corrected	Limit (dBm)	Limit (dBuV/m)	Margin
802.11a	5725	39.93	4.16	34.032	78.122	-17	78.24	-0.118
	5715	25.41	4.15	34.013	63.573	-27	68.24	-4.667
	5825	39.42	4.2	33.887	77.507	-17	78.23	-0.723
	5835	25.08	4.21	33.861	63.151	-27	68.24	-5.089
802.11n 20MHz	5725	39.76	4.16	34.032	77.952	-17	78.24	-0.288
	5715	25.24	4.15	34.013	63.403	-27	68.24	-4.837
	5825	40.03	4.2	33.887	78.117	-17	78.23	-0.113
	5835	24.98	4.21	33.861	63.051	-27	68.24	-5.189
802.11n 40MHz	5725	33.63	4.16	34.032	71.822	-17	78.24	-6.418
	5715	29.15	4.15	34.013	67.313	-27	68.24	-0.927
	5825	35.1	4.2	33.887	73.187	-17	78.23	-5.043
	5835	29.87	4.21	33.861	67.941	-27	68.24	-0.299

Table 30. EIRP Calculation

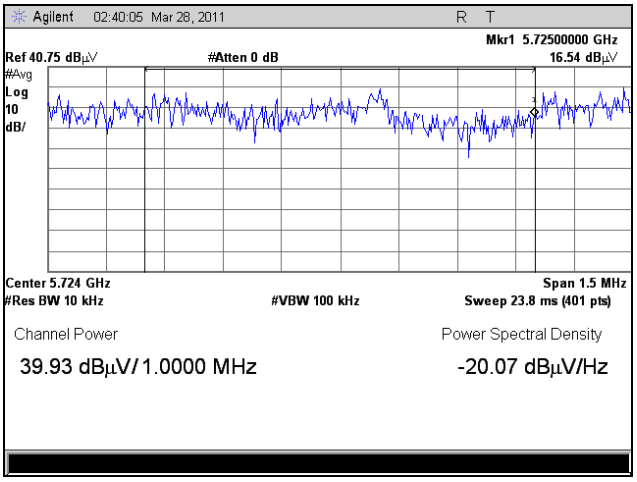
EIRP, 802.11a



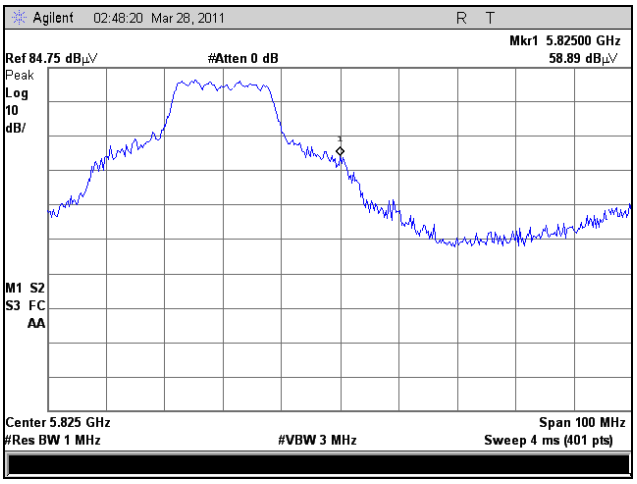
Plot 130. EIRP, 802.11a, 5715 MHz



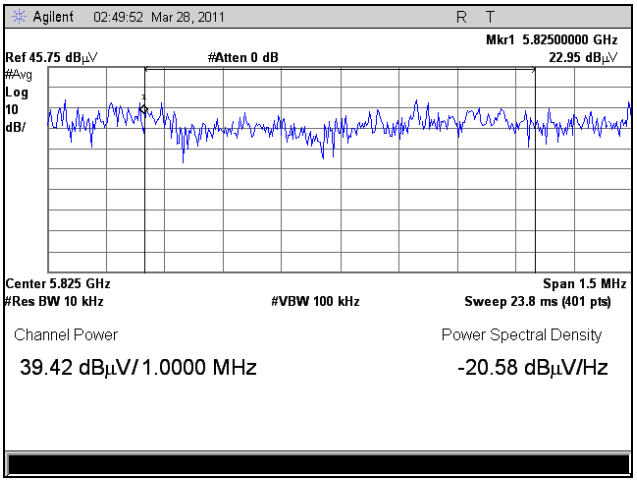
Plot 131. EIRP, 802.11a, 5725 MHz, Peak



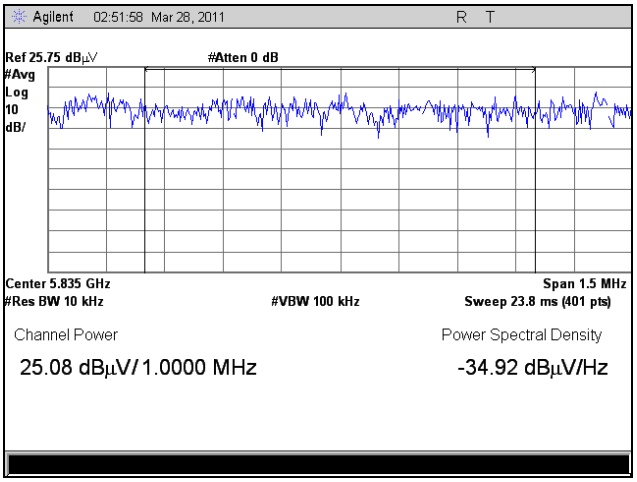
Plot 132. EIRP, 802.11a, 5725 MHz



Plot 133. EIRP, 802.11a, 5825 MHz, Peak

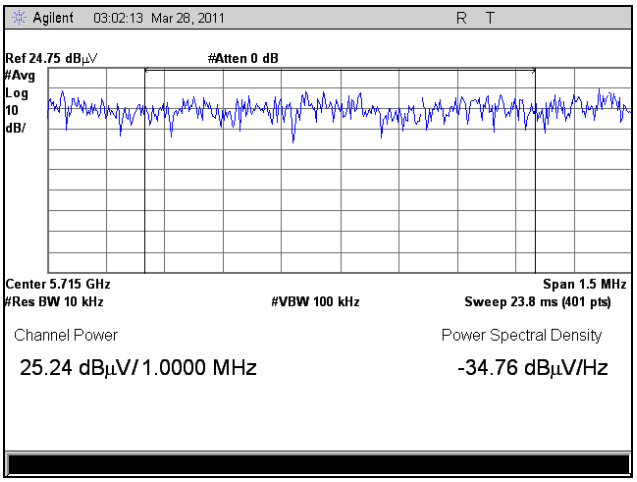


Plot 134. EIRP, 802.11a, 5825 MHz

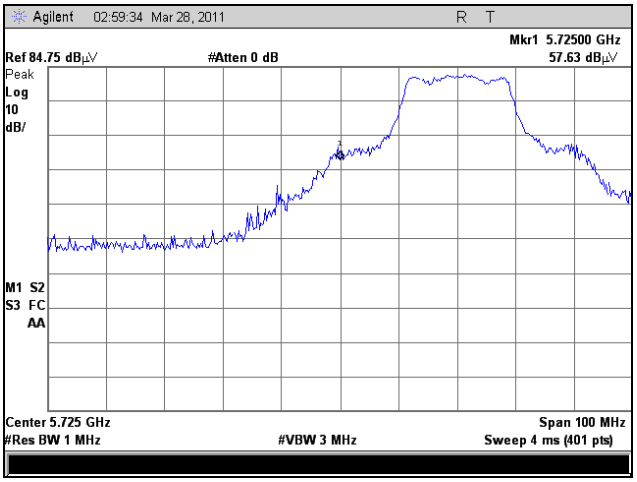


Plot 135. EIRP, 802.11a, 5835 MHz

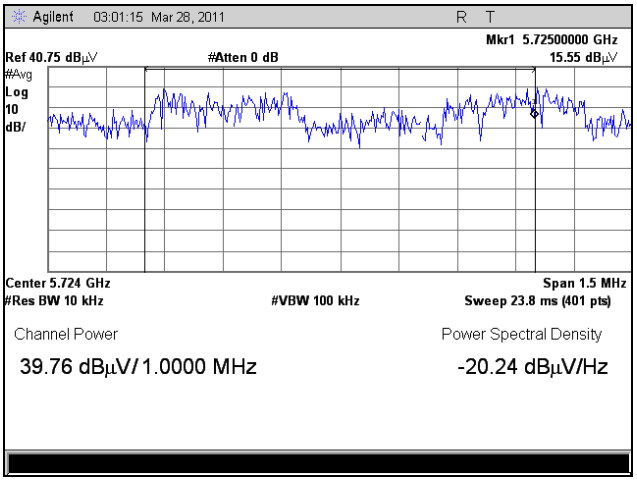
EIRP, 802.11n 20 MHz



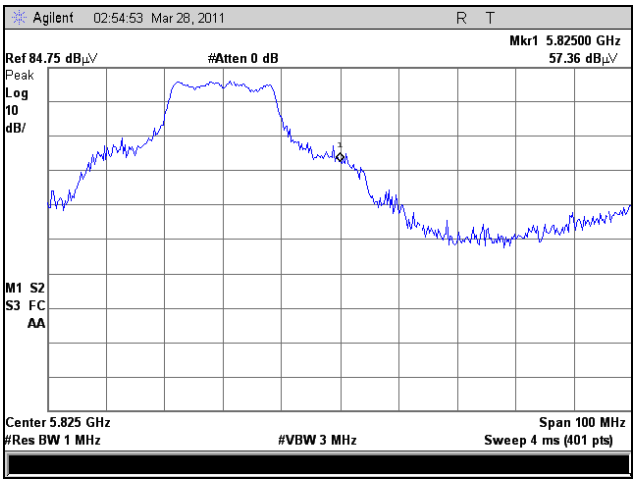
Plot 136. EIRP, 802.11n 20 MHz, 5715 MHz



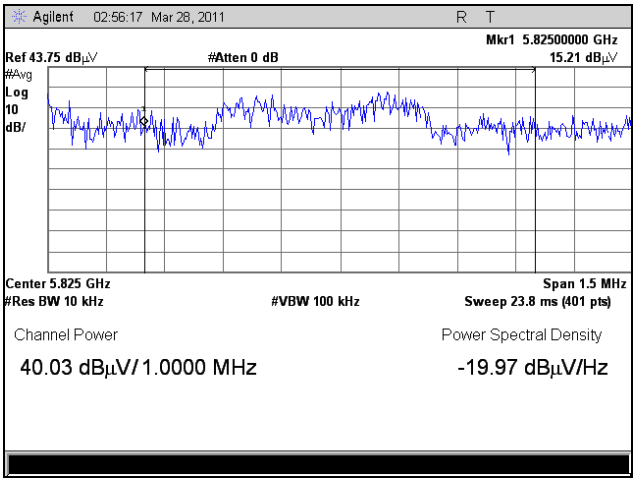
Plot 137. EIRP, 802.11n 20 MHz, 5725 MHz, Peak



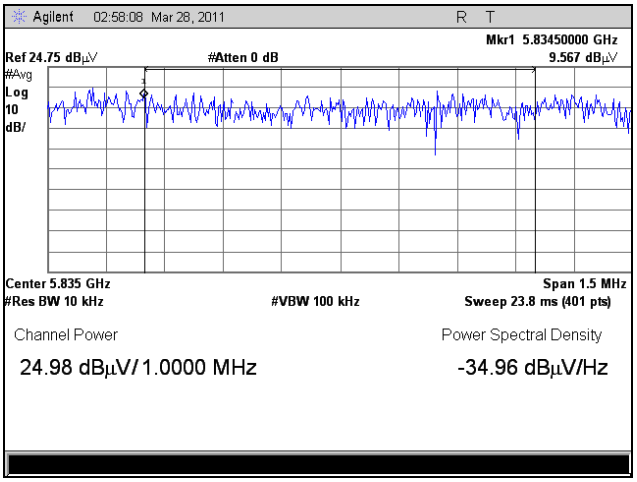
Plot 138. EIRP, 802.11n 20 MHz, 5725 MHz



Plot 139. EIRP, 802.11n 20 MHz, 5825 MHz, Peak

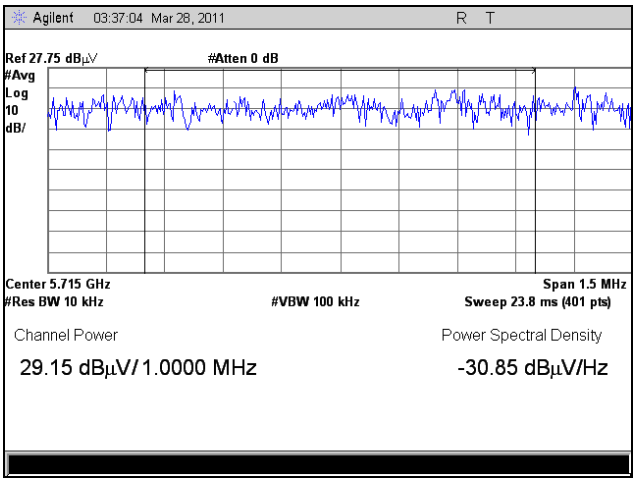


Plot 140. EIRP, 802.11n 20 MHz, 5825 MHz

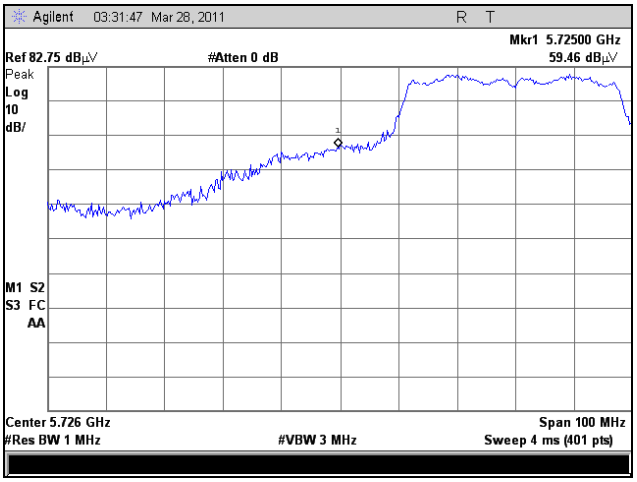


Plot 141. EIRP, 802.11n 20 MHz, 5835 MHz

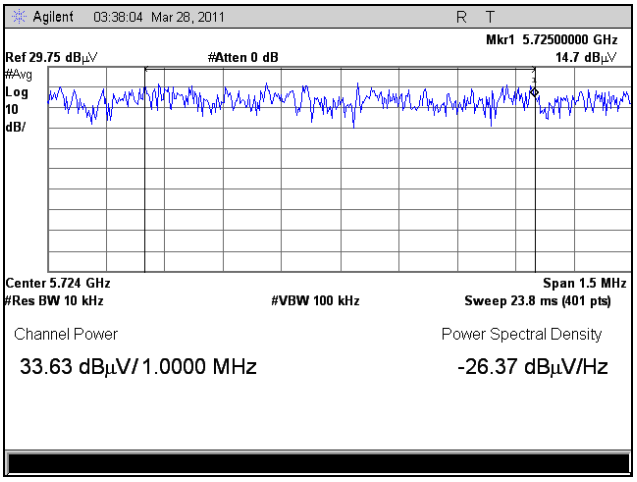
EIRP, 802.11n 40 MHz



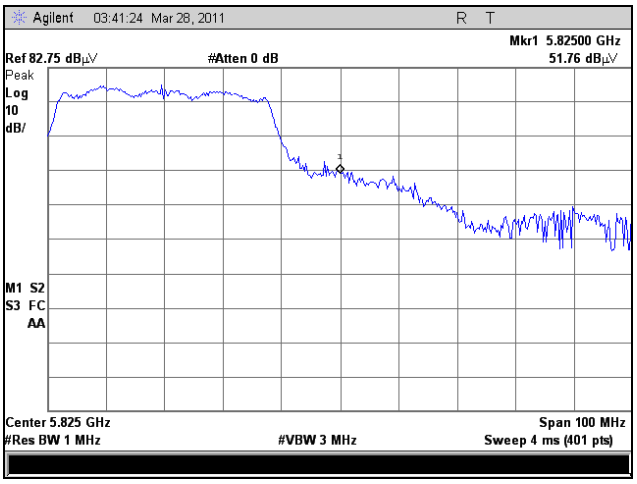
Plot 142. EIRP, 802.11n 40 MHz, 5715 MHz



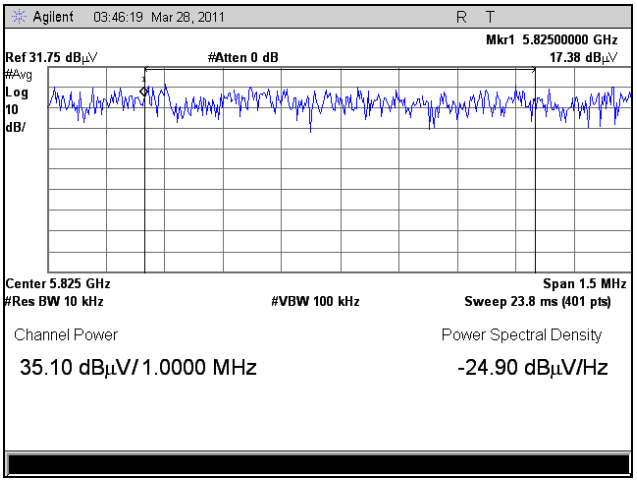
Plot 143. EIRP, 802.11n 40 MHz, 5725 MHz, Peak



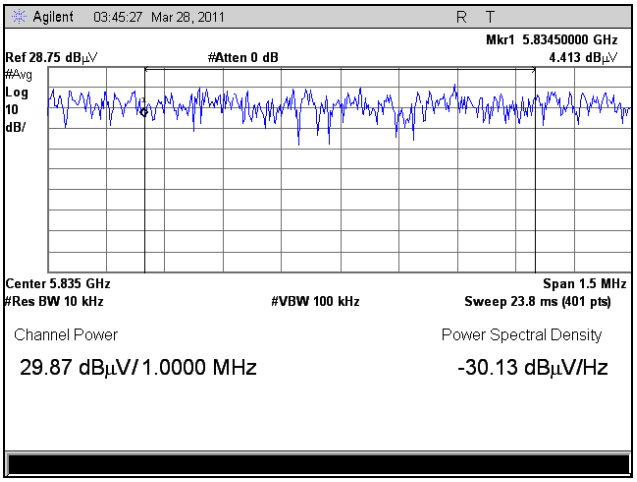
Plot 144. EIRP, 802.11n 40 MHz, 5725 MHz



Plot 145. EIRP, 802.11n 40 MHz, 5825 MHz, Peak

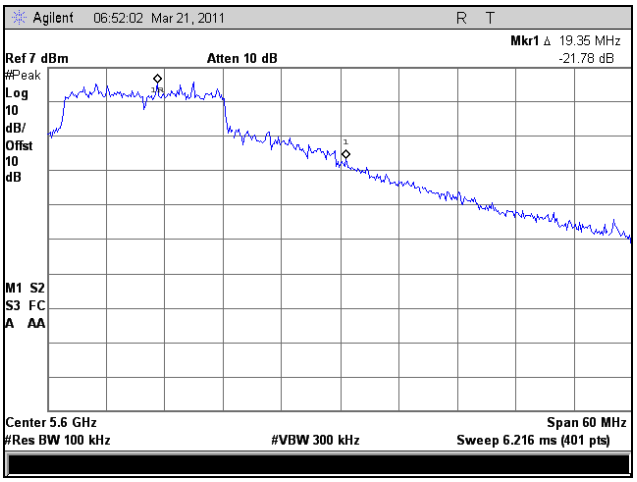


Plot 146. EIRP, 802.11n 40 MHz, 5825 MHz

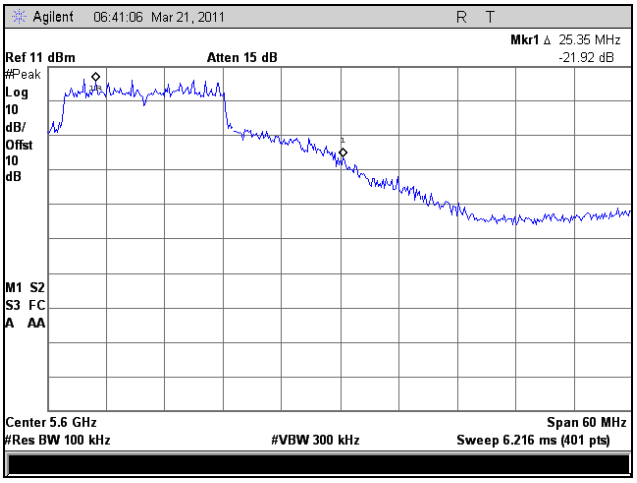


Plot 147. EIRP, 802.11n 40 MHz, 5835 MHz

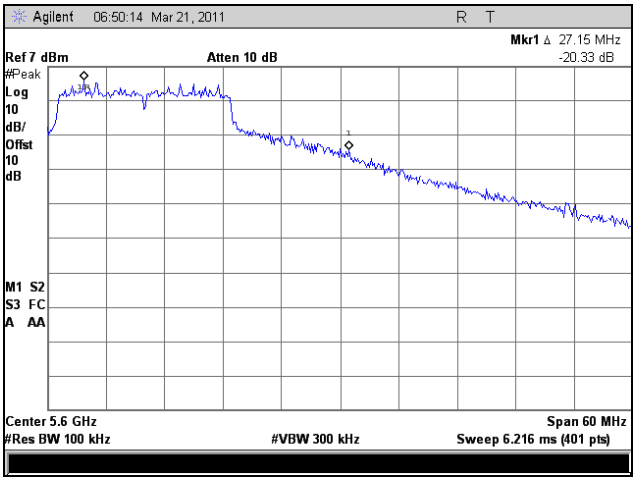
Conducted Band Edge



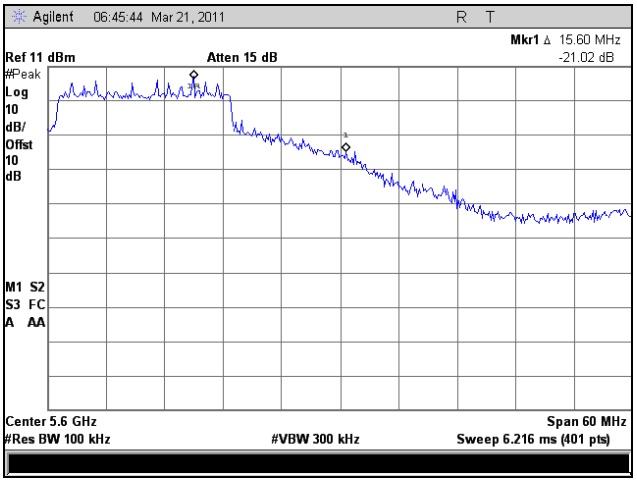
Plot 148. Conducted Band Edge, 802.11a, 5580 MHz, Port 0



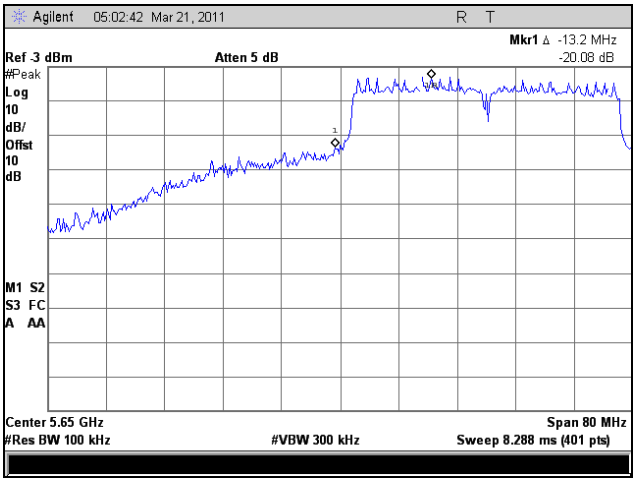
Plot 149. Conducted Band Edge, 802.11a, 5580 MHz, Port 1



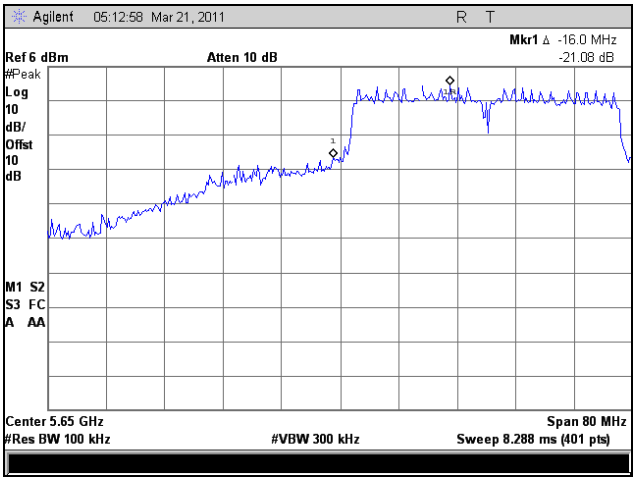
Plot 150. Conducted Band Edge, 802.11n 20 MHz, 5580 MHz, Port 0



Plot 151. Conducted Band Edge, 802.11n 20 MHz, 5580 MHz, Port 1



Plot 152. Conducted Band Edge, 802.11n 40 MHz, 5670 MHz, Port 0



Plot 153. Conducted Band Edge, 802.11n 40 MHz, 5670 MHz, Port 1

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.

Since EUT has co-located antennas:

MPE Limit Calculation: EUT's operating frequencies @ 824.2 – 849.2 MHz; highest conducted power = ERP – Max Antenna Gain = 23.93 – 11.5 = *12.43dBm* (peak) therefore, **Limit for Uncontrolled exposure = Freq/1500 = 824.2/1500= 0.549 mW/cm^2 or 5.49 W/m^2**

EUT maximum antenna gain = *8.5 dBi + 10log(# of antennas) = 8.5 + 3.0 =11.5dBi*

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

$$S1 = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{PG / 4\pi S}$$

where, S1 = Power Density (Limit = 0.549 mW/cm^2)
P = Power Input to antenna (17.498mW)
G = Antenna Gain (14.125 numeric)
R = Minimum Distance between User and Antenna (20 cm)

$S1 = (17.498*14.125)/(4*3.14*20^2) = 247.172/5024 = 0.049$ mW/cm^2
$S1 < 0.549$ mW/cm^2,

MPE Limit Calculation: EUT's operating frequencies @ 1850-1910 MHz; highest conducted power = EIRP – Antenna Gain = 26.107 – 8.4 = 17.71*dBm* (peak) therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

EUT maximum antenna gain = *5.4 dBi + 10log(# of antennas) = 5.4 + 3.0 = 8.4dBi*

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

$$S2 = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{PG / 4\pi S}$$

where, S2 = Power Density (Limit = 1 mW/cm^2)
P = Power Input to antenna (59.020mW)
G = Antenna Gain (6.918 numeric)
R = Minimum Distance between User and Antenna (20 cm)

$S2 = (59.020*6.918)/(4*3.14*20^2) = 408.319/5024 = 0.082$ mW/cm^2
$S2 < 1$ mW/cm^2,

MPE Limit Calculation: EUT's operating frequencies @ 2400-2483.5 MHz; highest conducted power = *28.86dBm* (peak) therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

EUT maximum antenna gain = *4.3dBi + 10log(# of antennas) = 4.3 + 3.0 = 7.3dBi*

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

$S3 = PG / 4\pi R^2$ or $R = \sqrt{PG / 4\pi S}$

where, S3 = Power Density (Limit = 1 mW/cm^2)
P = Power Input to antenna (770.96mW)
G = Antenna Gain (5.383 numeric)
R = Minimum Distance between User and Antenna (20 cm)

$S3 = (770.96*5.383)/(4*3.14*20^2) = 4130.08/5024 = 0.826$ mW/cm^2
$S3 < 1$ mW/cm^2

MPE Limit Calculation: EUT's operating frequencies @ 5745-5850 MHz; highest conducted power = *16.681dBm* therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

EUT maximum antenna gain = *4 dBi + 10log(# of antennas) = 4.0 + 3.0 = 7.0dBi.*

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

$S4 = PG / 4\pi R^2$ or $R = \sqrt{PG / 4\pi S}$

where, S4 = Power Density (Limit = 1 mW/cm^2)
P = Power Input to antenna (46.57mW)
G = Antenna Gain (5.024 numeric)
R = Minimum Distance between User and Antenna (20 cm)

$S4 = (46.57*5.024)/(4*3.14*20^2) = 233.4/5024 = 0.046$ mW/cm^2
$S4 < 1$ mW/cm^2

For Co-located Antennas:

S1 + S2 + S3 + S4 < 1mW/cm2

Since,
0.049 mW/cm2 + 0.082 mW/cm2 + 0.826 mW/cm2 + 0.046 mW/cm2 > 1 mW/cm2

The Minimum Distance between User and Antennas is

$R = (\sqrt{P1G1} / (4*3.14*0.549)) + (\sqrt{(P2G2 + P3G3 + P4G4)} / (4*3.14*1))$
$= (\sqrt{247.17}/3.79) + ((408.32 + 4130.48 + 233.4)/ 12.56)$
$= 21.1$ cm

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 placed in an environmental chamber and the RF port was connected directly to a spectrum analyzer through an attenuator. Depending on which band was being investigated, the EUT was set to transmit at the low, mid, and high with the appropriate power level. If the EUT was capable of transmitting a CW carrier then the spectrum analyzer's frequency counting function was used to measure the actual frequency. If only a modulated carrier was available then the frequency relative to -10dBc above and below the carrier was measured and the carrier frequency was determined using (f1+f2)/2. The frequency of the carrier was measured at normal and extreme conditions with the temperature range of -40°C to +60°C.

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

Test Engineer(s): Lionel Gabrillo

Test Date(s): 05/32/11

Frequency (MHz)	Temperature (deg. C)	Drift (MHz)	Delta (MHz)	Delta (kHz)
5745	-30	5745.01194	-0.03046	30.46
	-20	5745.01304	-0.03156	31.56
	-10	5745.00949	-0.02801	28.01
	0	5744.99596	-0.01448	14.48
	10	5744.99494	-0.01346	13.46
	20	5744.98148	0.00000	0
	30	5744.97910	0.00238	2.38
	40	5744.97694	0.00454	4.54
	50	5744.97793	0.00355	3.55
5755	-30	5755.01164	-0.03070	30.7
	-20	5755.01287	-0.03193	31.93
	-10	5755.00953	-0.02859	28.59
	0	5754.99584	-0.01490	14.9
	10	5754.99452	-0.01358	13.58
	20	5754.98094	0.00000	0
	30	5754.97916	0.00178	1.78
	40	5754.97674	0.00420	4.2
	50	5754.97756	0.00338	3.38
5785	-30	5785.01169	-0.03075	30.75
	-20	5785.01292	-0.03198	31.98
	-10	5785.00972	-0.02878	28.78
	0	5784.99599	-0.01505	15.05
	10	5784.99535	-0.01441	14.41
	20	5784.98094	0.00000	0
	30	5784.97918	0.00176	1.76
	40	5784.97664	0.00430	4.3
	50	5784.97731	0.00363	3.63
5795	-30	5795.01189	-0.03086	30.86
	-20	5795.01319	-0.03216	32.16
	-10	5795.01020	-0.02917	29.17
	0	5794.99634	-0.01531	15.31
	10	5794.99578	-0.01475	14.75
	20	5794.98103	0.00000	0
	30	5794.97958	0.00145	1.45
	40	5794.97692	0.00411	4.11
	50	5794.97746	0.00357	3.57
5805	-30	5805.01166	-0.03090	30.9
	-20	5805.01304	-0.03228	32.28
	-10	5805.01019	-0.02943	29.43
	0	5804.99625	-0.01549	15.49
	10	5804.99574	-0.01498	14.98
	20	5804.98076	0.00000	0
	30	5804.97978	0.00098	0.98
	40	5804.97676	0.00400	4
	50	5804.97717	0.00359	3.59

Table 31. Frequency Stability, Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

RSS-GEN Receiver Spurious Emissions

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

a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 32.

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

Table 32. Spurious Emission Limits for Receivers

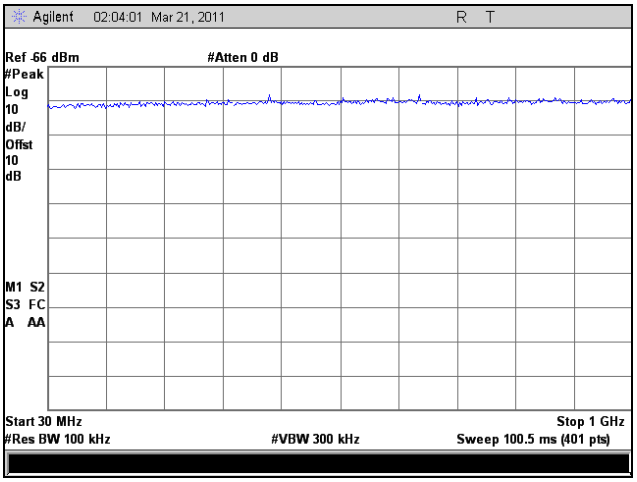
b) If a conducted measurement is made, no spurious output signals appearing at the antenna terminals shall exceed 2 nanowatts per any 4 kHz spurious frequency in the band 30-1000 MHz, or 5 nanowatts above 1 GHz.

Test Procedure: The receiver spurious emissions were tested in compliance with the limits of Table 12. The testing was performed conducted.

Test Results: The EUT was compliant with the Receiver Spurious Emission limits of this requirement.

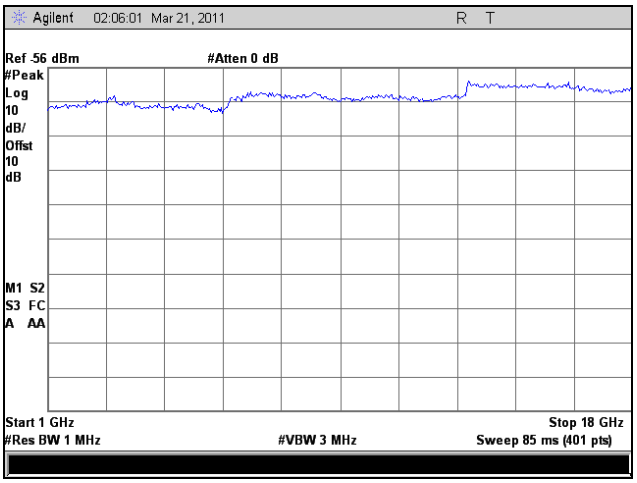
Test Engineer(s): Lionel Gabrillo

Test Date(s): 05/23/11



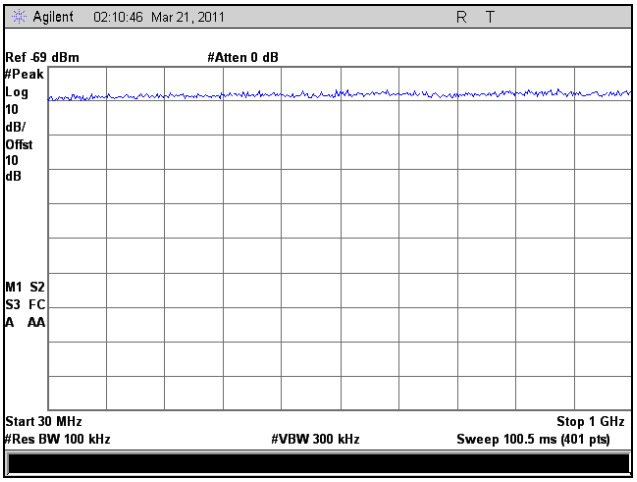
Ref Level = -66dBm = 0.251pW

Plot 154. Receiver Spurious Emissions, Port 0, 30 MHz – 1 GHz



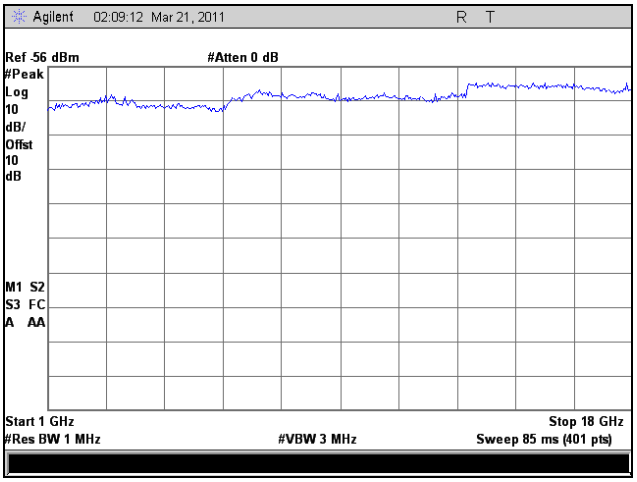
Ref Level = -56dBm = 2.517pW

Plot 155. Receiver Spurious Emissions, Port 0, 1 GHz – 18 GHz



Ref Level = -69dBm = 0.126pW

Plot 156. Receiver Spurious Emissions, Port 1, 30 MHz – 1 GHz



Ref Level = -56dBm = 2.517pW

Plot 157. Receiver Spurious Emissions, Port 1, 1 GHz – 18 GHz

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
1S2607	SPECTRUM ANALYZER	AGILENT	E4407B	7/30/10	7/30/11
1S2270	LISN	SCHWARZBECK	NNLK8121	2/15/2011	2/15/2012
1S2399	TURNTABLE CONTROLLER	SUNOL SCIENCE	SC99V	NO CALIBRATION REQUIRED	
1S2481	10M CHAMBER	ETS-LINDGREN	DKE 8X8 DBL	11/6/2010	11/6/2011
1S2482	5 METER CHAMBER	PANASHIELD	641431	11/13/2010	11/13/2011
1S2600	BILOG ANTENNA	TESEQ	CBL6112D	4/14/2010	4/14/2013
1S2499	MULTI DEVICE CONTROLLER	ETS	2090	NO CALIBRATION REQUIRED	
1S2421	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB7	7/6/2010	7/6/2011
1S2460	SPECTRUM ANALYZER	AGILENT	E4407B	7/13/2010	7/13/2011
1S2198	HORN ANTENNA	EMCO	3115	9/22/2010	9/22/2011
N/A	HIGH PASS FILTER	MICRO-TRONICS	HPM13147	SEE NOTE	
1S2521	THERMO-HYGROMETER	FISHER SCIENTIFIC	11-661-7D	12/2/2009	12/2/2011
1S2523	PREAMP (1-26.5GHZ)	AGILENT	8449B	SEE NOTE	
1S2670	HIGHPASS FILTER	TTE, INC.	H613-150K-50-21378	CAL NOT REQUIRED	
1S2587	PRE AMPLIFIER	AML COMM	AML0126L3801	SEE NOTE	
1S2229	TEMPERATURE CHAMBER	TENNY ENGINEERING	T63C	2/18/2011	2/18/2012

Table 33. 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

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

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

Procedural Requirements:

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

Section 6.1: A record of the measurements and results, showing the date that the measurements were completed, shall be retained by the manufacturer or importer for a period of at least five years from the date shown in the record and made available for examination on the request of the Minister.

Section 6.2: A written notice indicating compliance must accompany each unit of digital apparatus to the end user. The notice shall be in the form of a label that is affixed to the apparatus. Where because of insufficient space or other constraints it is not feasible to affix a label to the apparatus, the notice may be in the form of a statement in the user's manual.

Labeling Requirements:

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

> This Class [2] digital apparatus complies with Canadian ICES-003.
>
> Cet appareil numérique de la classe [1] est conforme à la norme NMB-003 du Canada.

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

End of Report

