MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
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November 3, 2011

Ubiquiti Networks, Inc.
91 E. Tasman
San Jose, CA 95134

Dear Jennifer Sanchez,

Enclosed is the EMC test report for compliance testing of the Ubiquiti Networks, Inc., AirRouterHP tested to the requirements of ETSI EN 300 328 (Article 3.2 of R&TTE Directive).

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: (\Ubiquiti Networks, Inc.\EMCS32997-ETS328)

MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
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Electromagnetic Compatibility Criteria
Test Report

For the

Ubiquiti Networks, Inc.
Model AirRouterHP

Tested under

ETSI EN 300 328

(Article 3.2 of R&TTE Directive)

MET Report: EMCS32997-ETS328

November 3, 2011

Prepared For:

Ubiquiti Networks, Inc.
91 E. Tasman
San Jose, CA 95134

Prepared By:
MET Laboratories, Inc.
3162 Belick St.
Santa Clara, CA 95054

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ETSI EN 300 328

(Article 3.2 of R&TTE Directive)

MET Report: EMCS32997-ETS328

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 ETSI EN 300 328 of the EU Rules under normal use and maintenance.

Shawn McMillen,
Wireless Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	November 3, 2011	Initial Issue.

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
CISPR	**C**omite **I**nternational **S**pecial des **P**erturbations **R**adioelectriques (International Special Committee on Radio Interference)
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**H**ert**z**
kPa	**k**ilo**Pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**H**ertz
µH	**micro**H**enry
µF	**micro**F**arad
µs	**micros**econds
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Requirements Summary

A. Requirements Summary

ETSI EN 300 328 Section Number	Descriptive Name	Compliance
Sections 4.3.1	Maximum Transmit Power	Compliant
Sections 4.3.2	Maximum EIRP Spectral Density	Compliant
Sections 4.3.3	Frequency Range	Compliant
Sections 4.3.5	Medium Access Protocol	Compliant
Sections 4.3.6	Conducted Transmitter Spurious Emissions	Compliant
	Radiated Transmitter Spurious Emissions	Compliant
Sections 4.3.7	Conducted Receiver Spurious Emissions	Compliant
	Radiated Receiver Spurious Emissions	Compliant

Table 1. Summary of EMC ETSI EN 300 328 (Article 3.2 of R&TTE Directive) Compliance Testing

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Ubiquiti Networks, Inc. to perform testing on a AirRouterHP.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Ubiquiti Networks, Inc. model AirRouterHP.

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

Model(s) Tested:	AirRouterHP
Model(s) Number:	AirRouterHP
EUT Specifications:	Primary Power: 120-230 VAC, 50-60 Hz
	Frequency Range: 2412 – 2472 MHz
Lab Ambient (Normal) Test Conditions:	Temperature: 15-35º C
	Relative Humidity: 30-60%
	Atmospheric Pressure: 860-1060 mbar
Extreme Test Conditions:	Temperature: -20 to + 50º C
	Relative Humidity: 30-60%
Evaluated by:	Lionel Gabrillo
Report Date(s):	November 3, 2011

B. References

ETSI EN 300 328 V1.7.1 (2006-10)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband Transmission systems; data transmission equipment in the 2.4 GHz ISM band and using spread spectrum modulation techniques; Part1: Technical characteristics and test conditions

Table 2. Test References

C. Test Site

All testing was performed at MET Laboratories, Inc., 3162 Belick St., 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.

D. Description of Test Sample

The Ubiquiti Networks, Inc. AirRouterHP, Equipment Under Test (EUT), is a 2400MHz 802. 11b/g/n Radio.

Photograph 1. Front View of EUT

E. Equipment Configuration

Ref. ID	Name / Description	Model Number	Part Number	Serial Number
A	2400MHz Radio	AirRouterHP	NA	1129C00272222A234
B	Poe Adapter	GFP121T-050200-1	NA	1002-0010465

Table 3. Equipment Configuration

F. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number
C	Laptop	Dell	Vostro 1000

Table 4. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
1	A, Ethernet	Ethernet	1	2	Y	C
2	A, Power Input	2 Conductor DC Cable	1	1	N	B, 100-240VAC 50/60Hz

Table 5. Ports and Cabling Information

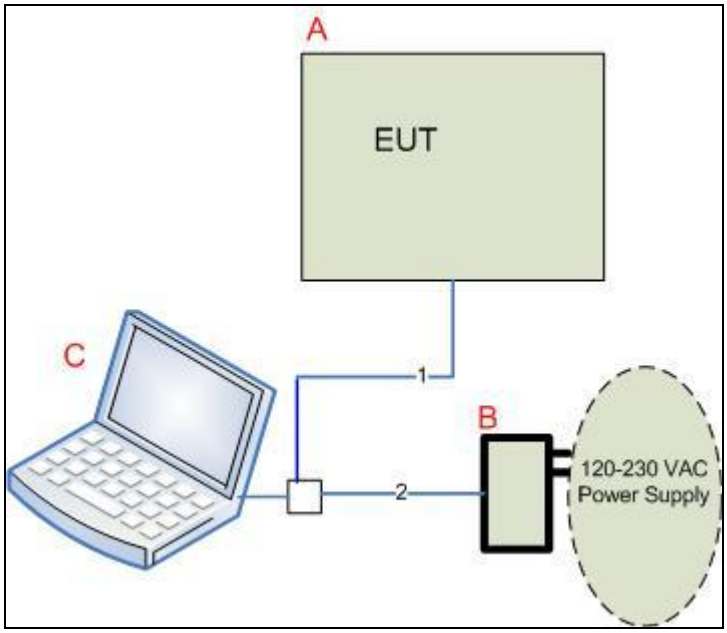


Figure 1. Block Diagram of Test Configuration

H. Mode of Operation

Using Atheros Radio Test Software.

I. Method of Monitoring EUT Operation

Ping Times out and doesn't return. Unit locks up requires power down is a fail.

J. Modifications

a) Modifications to EUT

No modifications to the EUT

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

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

III. Conformance Requirements

Conformance Requirements

4.3.1 Maximum Transmit Power

Test Requirement(s): **ETSI EN 300 328-1, Clause 4.3.1:**

4.3.1.1 Definition

The maximum transmit power is defined as the maximum isotropic radiated power of the equipment.

4.3.1.2 Limit

The equivalent isotropic radiated power (e.i.r.p.) shall be equal to or less than -10 dBW (100 mW). This limit shall apply for any combination of power level and intended antenna assembly.

Test Procedure: Measurements were carried out in all modulations available and at the low, mid and high channels of the transmit band. Both normal and extreme test conditions were observed. The EIRP was calculated from the following equation:

P = A + G + 10 log (1/x); where A is the measured power, x is the duty cycle and G is the antenna assembly gain.

Test Results: The EUT as tested was found compliant with the specified limits in clause 4.3.1.2.

Test Engineer: Lionel Gabrillo

Test Date: 10/25/11

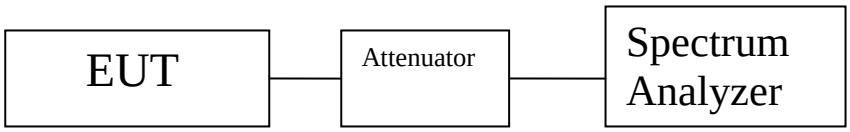


Figure 2. Maximum Transmit Power

Maximum Transmit Power (EIRP) Test Results

Maximum Average Power Under Normal and Extreme Conditions							
Channel (MHz)		Temperature (C)	Voltage AC	Mode DSSS	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)
2412	Low	20	230	802.11b	12.99	5	17.99
2442	Mid	20	230	802.11b	13.22	5	18.22
2472	High	20	230	802.11b	13.03	5	18.03
2412	Low	70	207	802.11b	11.18	5	16.18
2412	Low	70	253	802.11b	10.79	5	15.79
2442	Mid	70	207	802.11b	11.74	5	16.74
2442	Mid	70	253	802.11b	12.31	5	17.31
2472	High	70	207	802.11b	12.31	5	17.31
2472	High	70	253	802.11b	11.84	5	16.84
2412	Low	-20	207	802.11b	14.70	5	19.70
2412	Low	-20	253	802.11b	14.32	5	19.32
2442	Mid	-20	207	802.11b	14.88	5	19.88
2442	Mid	-20	253	802.11b	14.58	5	19.58
2472	High	-20	207	802.11b	14.25	5	19.25
2472	High	-20	253	802.11b	14.47	5	19.47

Table 6. EIRP, Test Results, 802.11b

Maximum Average Power Under Normal and Extreme Conditions							
Channel (MHz)		Temperature (C)	Voltage AC	Mode DSSS	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)
2412	Low	20	230	802.11g 20MHz	13.22	5	18.22
2442	Mid	20	230	802.11g 20MHz	13.71	5	18.71
2472	High	20	230	802.11g 20MHz	11.68	5	16.68
2412	Low	70	207	802.11g 20MHz	12.24	5	17.24
2412	Low	70	253	802.11g 20MHz	12.37	5	17.37
2442	Mid	70	207	802.11g 20MHz	12.83	5	17.83
2442	Mid	70	253	802.11g 20MHz	12.62	5	17.62
2472	High	70	207	802.11g 20MHz	10.43	5	15.43
2472	High	70	253	802.11g 20MHz	10.77	5	15.77
2412	Low	-20	207	802.11g 20MHz	14.45	5	19.45
2412	Low	-20	253	802.11g 20MHz	14.36	5	19.36
2442	Mid	-20	207	802.11g 20MHz	14.60	5	19.60
2442	Mid	-20	253	802.11g 20MHz	14.68	5	19.68
2472	High	-20	207	802.11g 20MHz	12.97	5	17.97
2472	High	-20	253	802.11g 20MHz	12.90	5	17.90

Table 7. EIRP, Test Results, 802.11g

Maximum Average Power Under Normal and Extreme Conditions							
Channel (MHz)		Temperature (C)	Voltage AC	Mode DSSS	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)
2412	Low	20	230	HT20	14.06	5	19.06
2442	Mid	20	230	HT20	13.35	5	18.35
2472	High	20	230	HT20	11.66	5	16.66
2412	Low	70	207	HT20	12.54	5	17.54
2412	Low	70	253	HT20	12.67	5	17.67
2442	Mid	70	207	HT20	12.26	5	17.26
2442	Mid	70	253	HT20	11.98	5	16.98
2472	High	70	207	HT20	10.29	5	15.29
2472	High	70	253	HT20	10.53	5	15.53
2412	Low	-20	207	HT20	14.85	5	19.85
2412	Low	-20	253	HT20	14.89	5	19.89
2442	Mid	-20	207	HT20	14.61	5	19.61
2442	Mid	-20	253	HT20	14.52	5	19.52
2472	High	-20	207	HT20	13.05	5	18.05
2472	High	-20	253	HT20	13.12	5	18.12

Table 8. EIRP, Test Results, 802.11n 20 MHz

Maximum Average Power Under Normal and Extreme Conditions							
Channel (MHz)		Temperature (C)	Voltage AC	Mode DSSS	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)
2422	Low	20	230	HT40	13.92	5	18.92
2442	Mid	20	230	HT40	14.04	5	19.04
2462	High	20	230	HT40	12.93	5	17.93
2462	Low	70	207	HT40	13.08	5	18.08
2422	Low	70	253	HT40	12.93	5	17.93
2442	Mid	70	207	HT40	13.23	5	18.23
2442	Mid	70	253	HT40	13.52	5	18.52
2462	High	70	207	HT40	11.72	5	16.72
2462	High	70	253	HT40	11.54	5	16.54
2422	Low	-20	207	HT40	14.93	5	19.93
2422	Low	-20	253	HT40	14.81	5	19.81
2442	Mid	-20	207	HT40	14.67	5	19.67
2442	Mid	-20	253	HT40	14.70	5	19.70
2462	High	-20	207	HT40	14.28	5	19.28
2462	High	-20	253	HT40	14.21	5	19.21

Table 9. EIRP, Test Results, 802.11n 40 MHz

Conformance Requirements

4.3.2 Maximum EIRP Spectral Density

Test Requirement(s): **ETSI EN 300 328 Section 4.3.2:**

4.3.2.1 Definition
The maximum EIRP spectral density is defined as the highest EIRP level in Watts per Hertz generated by the transmitter within the power envelope.

4.3.2.2 Limit
For wide band modulations other than FHSS (e.g. DSSS, OFDM, etc.), the maximum EIRP spectral density is limited to 10 mW per MHz.

Test Procedure: Option 1 was used to measure the power (A). The maximum spectral power density EIRP was determined using the following equation:
P = A + G + 10 log (1/x); where A is the measured power, x is the duty cycle and G is the antenna assembly gain.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 4.3.2.2.

Maximum SPD <= 10mW (10 dBm) per MHz EIRP in Normal Test Condition, SPD = Spectral Power Density.

Test Engineer: Lionel Gabrillo

Test Date: 10/21/11

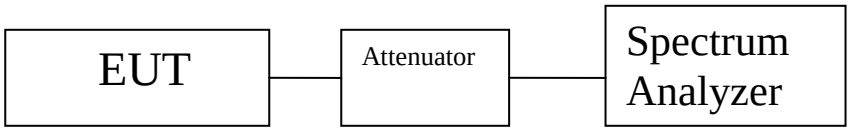
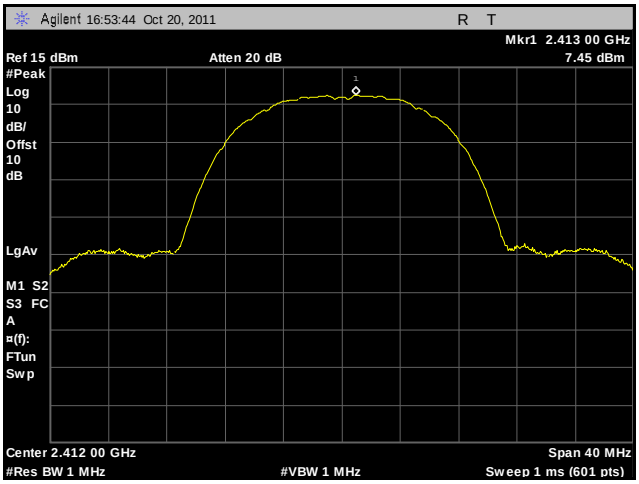


Figure 3. Maximum Spectral Density

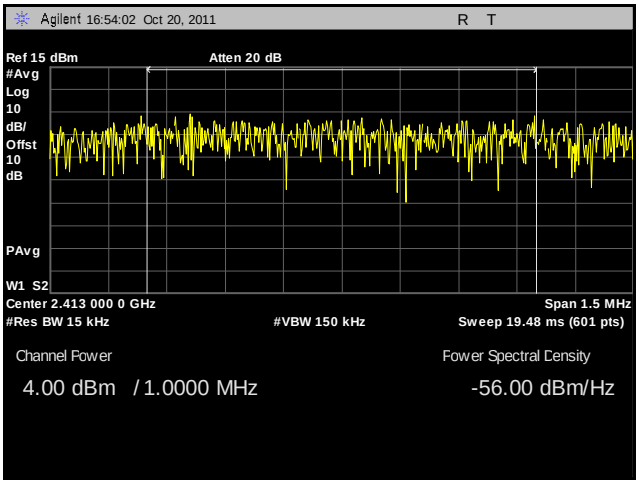
Power Spectral Density							
Channel (MHz)		Mode OFDM	Measured Power Density dBm	Antenna Gain dBi	EIRP dBm	Limit dBm	Margin dB
2412	Low	802.11b	4.00	5	9	10.00	-1.00
2442	Mid	802.11b	3.84	5	8.84	10.00	-1.16
2472	High	802.11b	3.52	5	8.52	10.00	-1.48
2412	Low	802.11g 20MHz	2.45	5	7.45	10.00	-2.55
2442	Mid	802.11g 20MHz	3.10	5	8.1	10.00	-1.90
2472	High	802.11g 20MHz	2.27	5	7.27	10.00	-2.73
2412	Low	HT20	2.87	5	7.87	10.00	-2.13
2442	Mid	HT20	2.97	5	7.97	10.00	-2.03
2472	High	HT20	3.04	5	8.04	10.00	-1.96
2412	Low	HT40	0.54	5	5.54	10.00	-4.46
2442	Mid	HT40	-0.42	5	4.58	10.00	-5.42
2472	High	HT40	0.02	5	5.02	10.00	-4.98

Table 10. Peak Spectral Density, Test Results

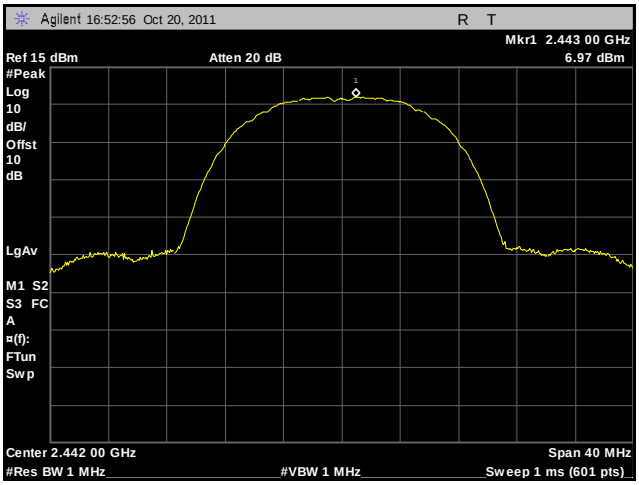
Maximum EIRP Spectral Density, Test Results, 802.11b



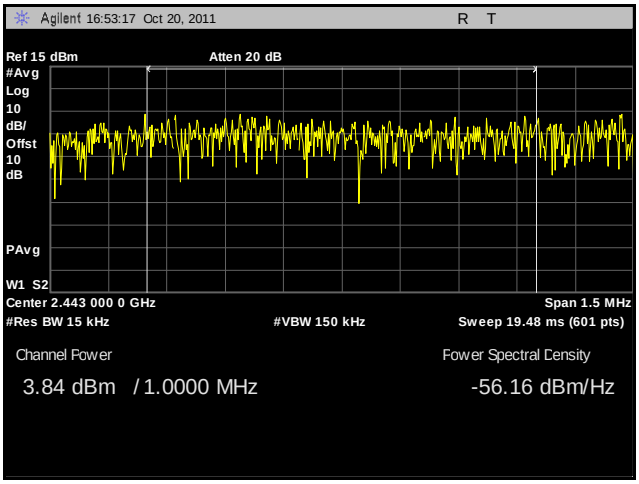
Plot 1. Power Spectral Density, Low Channel, 802.11b, Determination



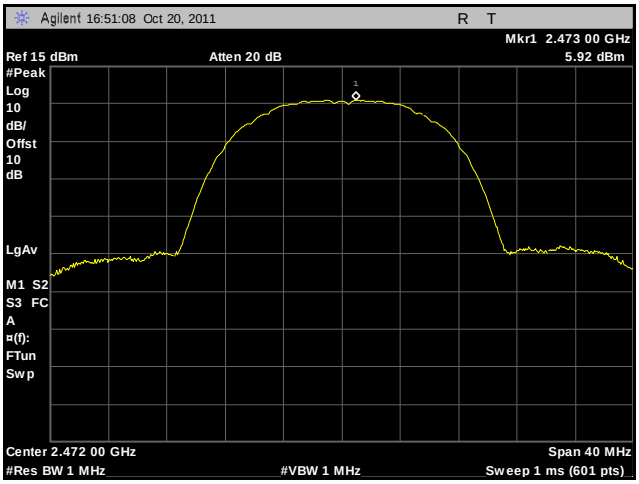
Plot 2. Power Spectral Density, Low Channel, 802.11b



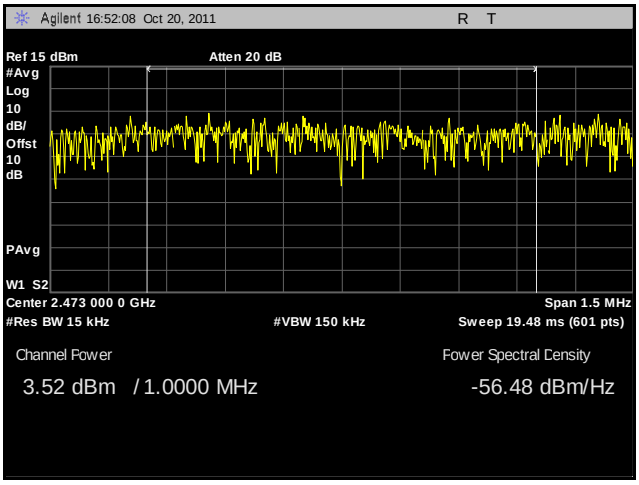
Plot 3. Power Spectral Density, Mid Channel, 802.11b, Determination



Plot 4. Power Spectral Density, Mid Channel, 802.11b

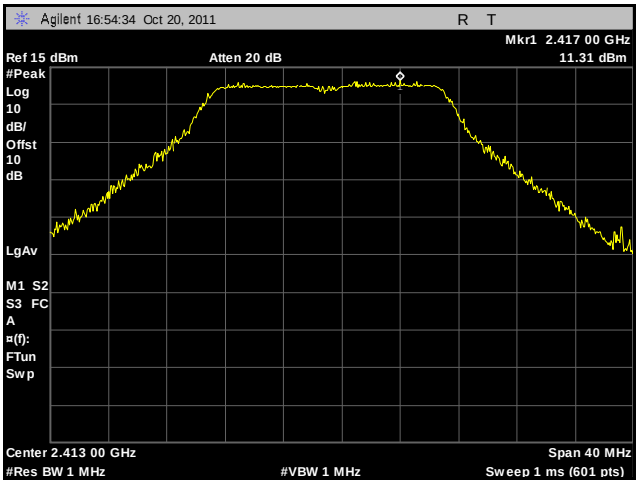


Plot 5. Power Spectral Density, High Channel, 802.11b, Determination

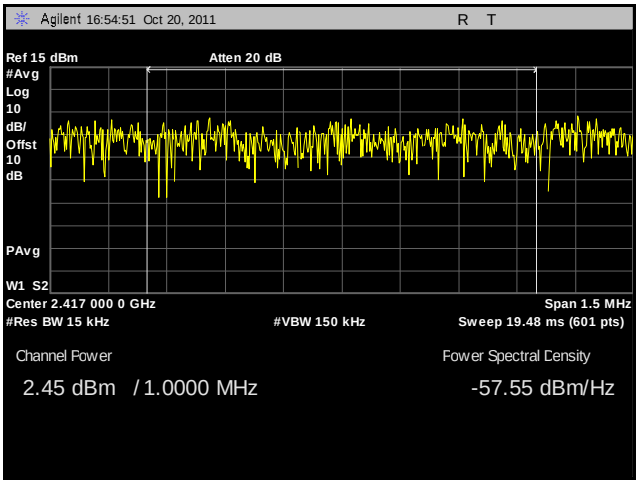


Plot 6. Power Spectral Density, High Channel, 802.11b

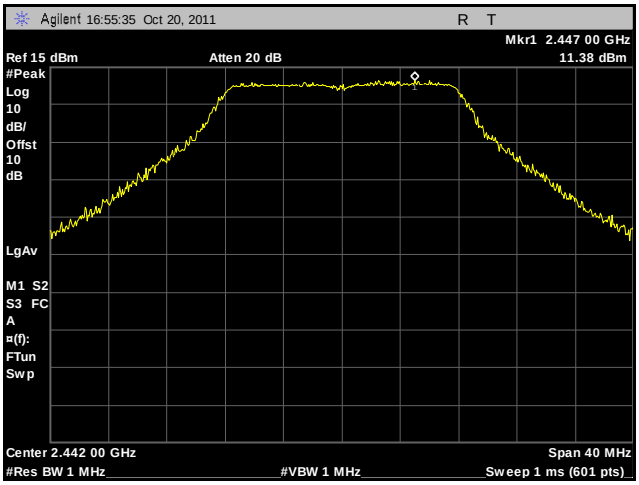
Maximum EIRP Spectral Density, Test Results, 802.11g



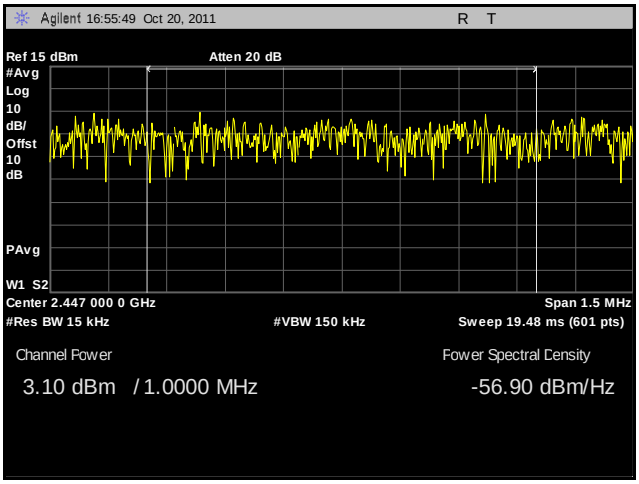
Plot 7. Power Spectral Density, Low Channel, 802.11g, Determination



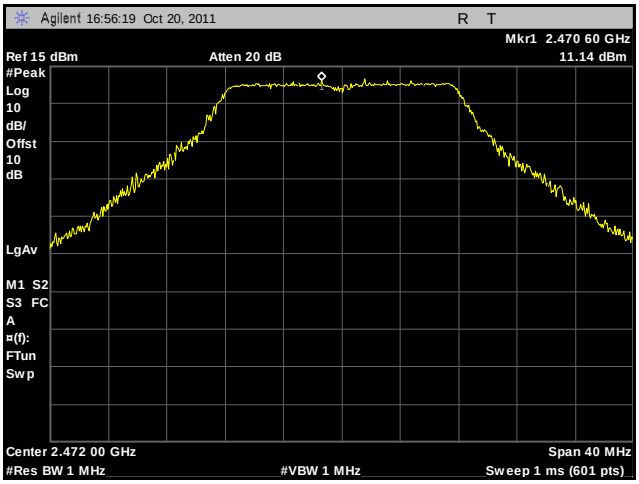
Plot 8. Power Spectral Density, Low Channel, 802.11g



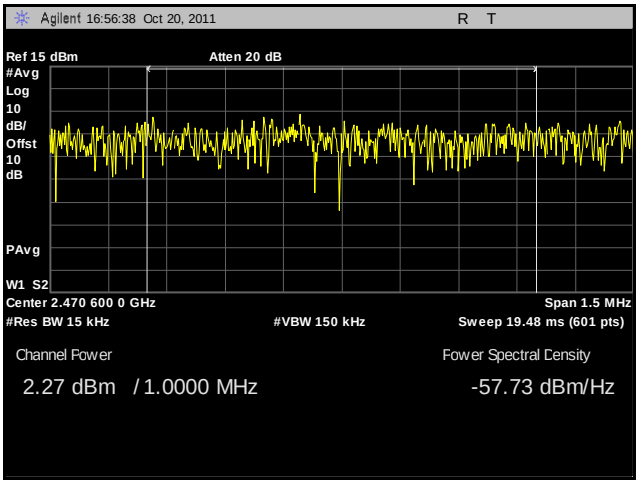
Plot 9. Power Spectral Density, Mid Channel, 802.11g, Determination



Plot 10. Power Spectral Density, Mid Channel, 802.11g

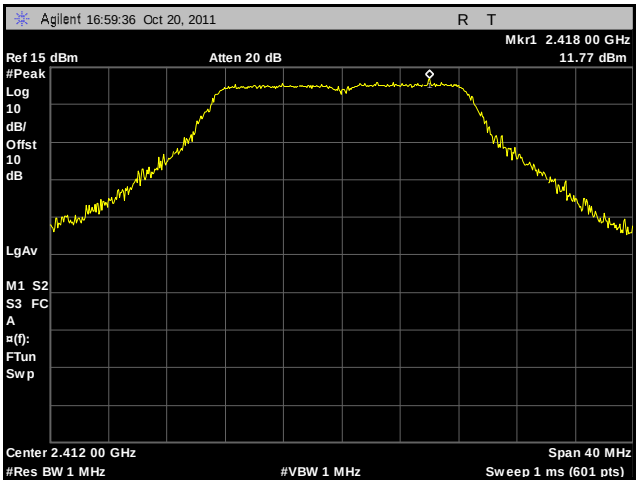


Plot 11. Power Spectral Density, High Channel, 802.11g, Determination

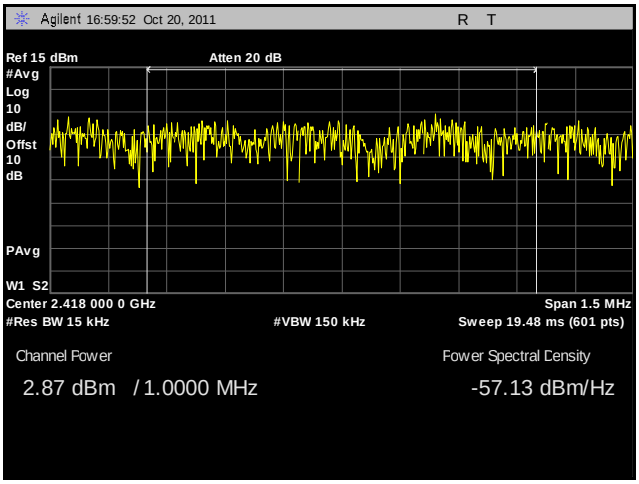


Plot 12. Power Spectral Density, High Channel, 802.11g

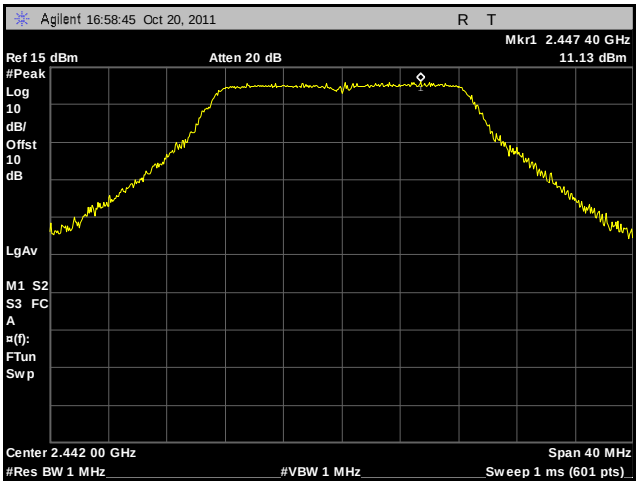
Maximum EIRP Spectral Density, Test Results, 802.11n 20 MHz



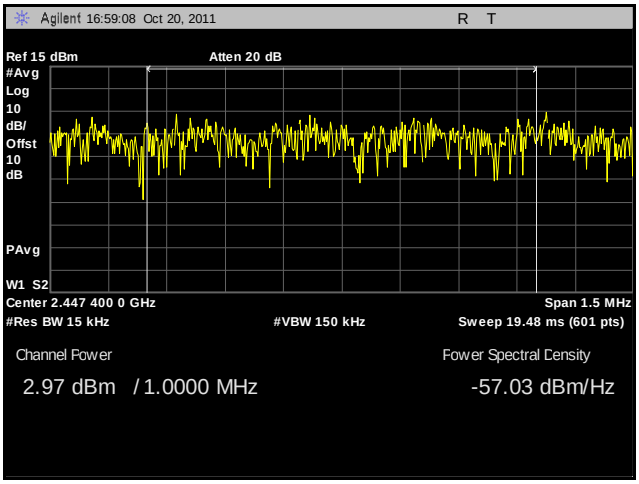
Plot 13. Power Spectral Density, Low Channel, 802.11n 20 MHz, Determination



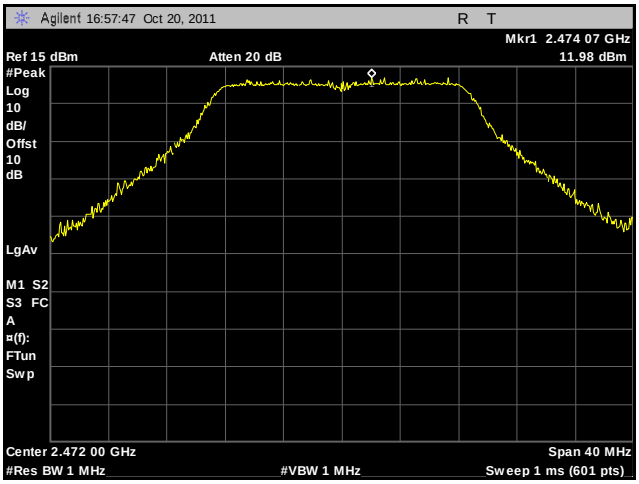
Plot 14. Power Spectral Density, Low Channel, 802.11n 20 MHz



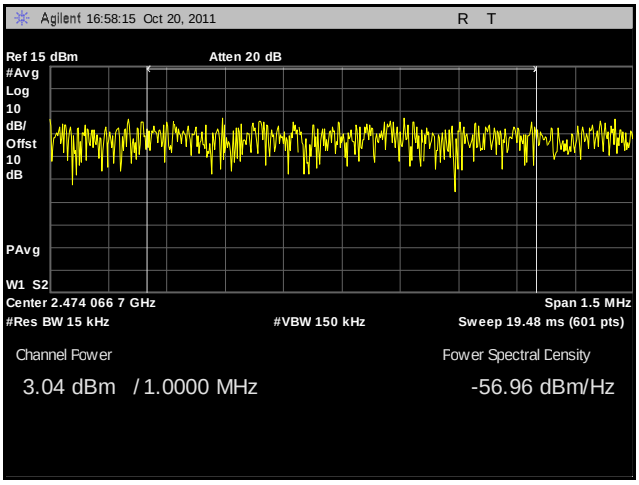
Plot 15. Power Spectral Density, Mid Channel, 802.11n 20 MHz, Determination



Plot 16. Power Spectral Density, Mid Channel, 802.11n 20 MHz

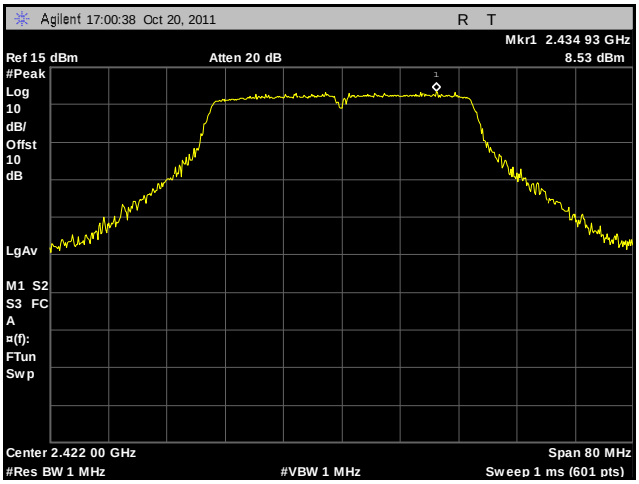


Plot 17. Power Spectral Density, High Channel, 802.11n 20 MHz, Determination

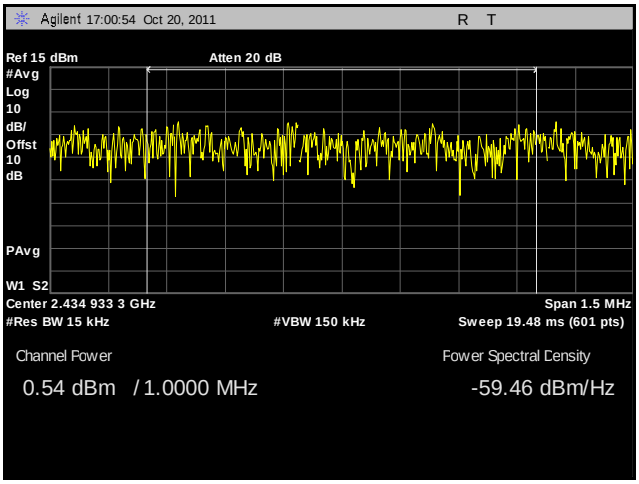


Plot 18. Power Spectral Density, High Channel, 802.11n 20 MHz

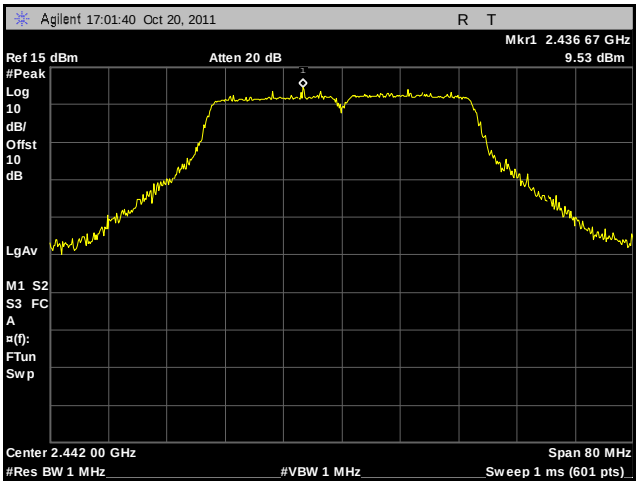
Maximum EIRP Spectral Density, Test Results, 802.11n 40 MHz



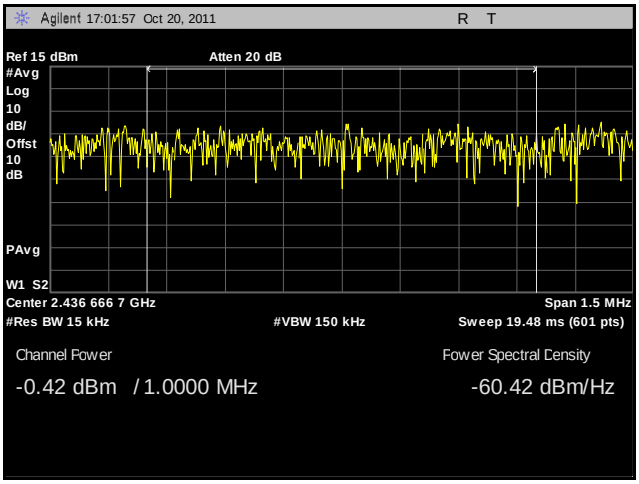
Plot 19. Power Spectral Density, Low Channel, 802.11n 40 MHz, Determination



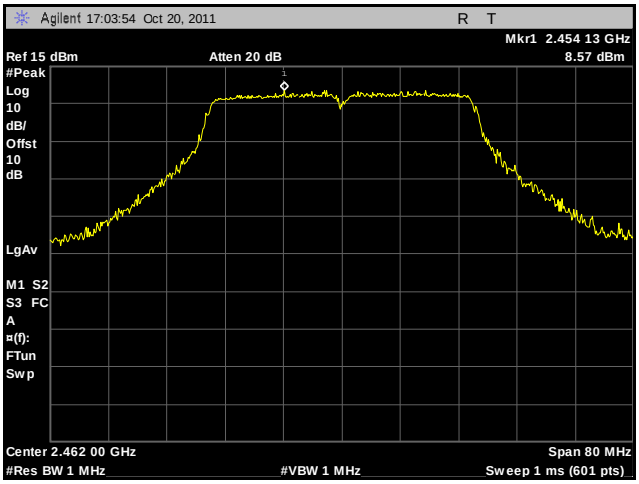
Plot 20. Power Spectral Density, Low Channel, 802.11n 40 MHz



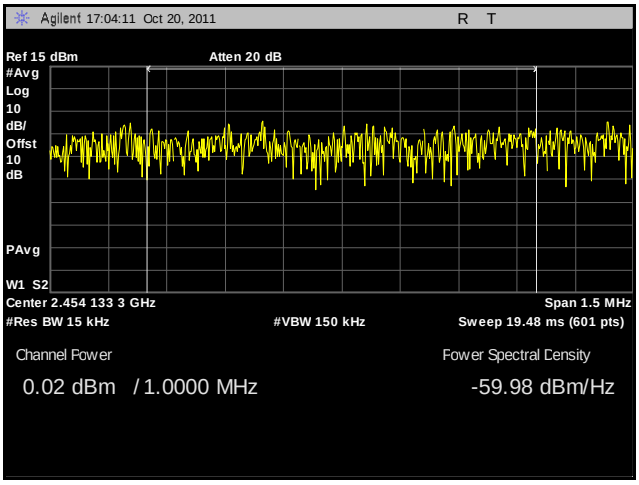
Plot 21. Power Spectral Density, Mid Channel, 802.11n 40 MHz, Determination



Plot 22. Power Spectral Density, Mid Channel, 802.11n 40 MHz



Plot 23. Power Spectral Density, High Channel, 802.11n 40 MHz, Determination



Plot 24. Power Spectral Density, High Channel, 802.11n 40 MHz

Conformance Requirements

4.3.3 Frequency Range

Test Requirement(s): **EN 300 328 Clause 4.3.3:**

4.3.3.1 Definition

The frequency range of the equipment is determined by the lowest and highest frequencies occupied by the spectrum envelope.

fH is the highest frequency of the spectrum envelope: it is the frequency furthest above the frequency of maximum power where the EIRP spectral density drops below the level of -80 dBm/Hz (-30 dBm if measured in a 100 kHz bandwidth).

fL is the lowest frequency of the spectrum envelope; it is the frequency furthest below the frequency of maximum power where the EIRP spectral density drops below the level of -80 dBm/Hz (or -30 dBm if measured in a 100 kHz bandwidth).

For a given operating frequency, the width of the spectrum envelope is (*fH* - *fL*). In equipment that allows adjustment or selection of different operating frequencies, the power envelope takes up different positions in the allocated band. The frequency range is determined by the lowest value of *fL* and the highest value of *fH* resulting from the adjustment of the equipment to the lowest and highest operating frequencies.

4.3.3.2 Limit

For all equipment the frequency range shall lie within the band 2.4 GHz to 2.4835 GHz (*fL* > 2.4 GHz and *fH* < 2.4835 GHz).

Test Procedure: Option 1 (using a spectrum analyzer average detector) was used to perform testing. A positive 15 dB offset was programmed into SA to account for a 5 dBi antenna and a 10dB attenuator.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 4.3.3.2.

Test Engineer: Lionel Gabrillo

Test Date: 10/21/11

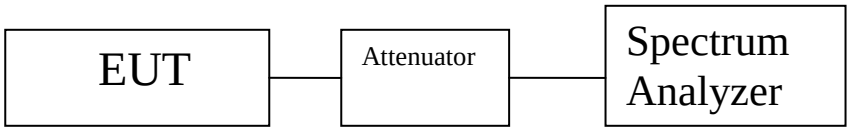


Figure 4. Frequency Range Test Setup

Frequency Range, Test Results

Frequency Range Table							
Temperature (C)	**Voltage AC**	**Mode DSSS**	**Frequency (f_L) MHz**	**Frequency (f_H) MHz**	**Frequency (fH-fL) MHz**	**Limit MHz**	**Margin MHz**
20	230	802.11b	2402.125	2481.750	79.63	83.5	-3.88
70	253	802.11b	2402.375	2481.300	78.93	83.5	-4.57
70	207	802.11b	2402.375	2481.400	79.03	83.5	-4.47
-30	253	802.11b	2402.000	2482.030	80.03	83.5	-3.47
-30	207	802.11b	2402.000	2482.030	80.03	83.5	-3.47

Table 11. Frequency Range, Test Results, 802.11b

Frequency Range Table							
Temperature (C)	**Voltage AC**	**Mode OFDM**	**Frequency (f_L) MHz**	**Frequency (f_H) MHz**	**Frequency (fH-fL) MHz**	**Limit MHz**	**Margin MHz**
20	230	802.11g 20MHz	2400.625	2483.050	82.43	83.5	-1.07
70	253	802.11g 20MHz	2400.875	2482.200	81.32	83.5	-2.18
70	207	802.11g 20MHz	2400.750	2482.400	81.65	83.5	-1.85
-30	253	802.11g 20MHz	2400.250	2483.030	82.78	83.5	-0.72
-30	207	802.11g 20MHz	2400.250	2483.030	82.78	83.5	-0.72

Table 12. Frequency Range, Test Results, 802.11g

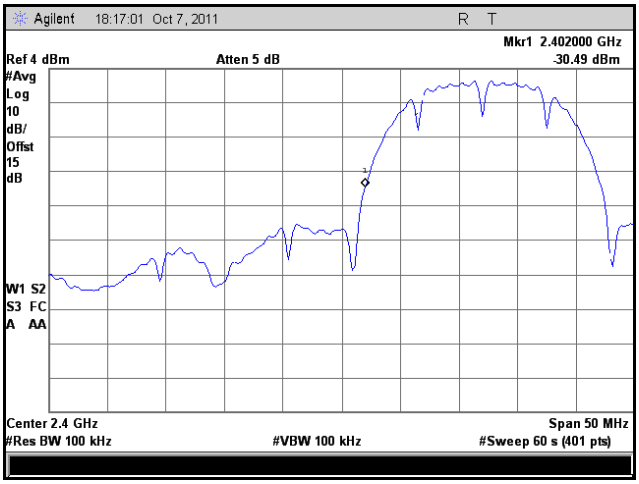
Frequency Range Table							
Temperature (C)	**Voltage AC**	**Mode OFDM**	**Frequency (f_L) MHz**	**Frequency (f_H) MHz**	**Frequency (fH-fL) MHz**	**Limit MHz**	**Margin MHz**
20	230	HT20	2401.100	2483.250	82.15	83.5	-1.35
70	253	HT20	2401.350	2482.800	81.45	83.5	-2.05
70	207	HT20	2401.400	2482.800	81.40	83.5	-2.10
-30	253	HT20	2400.250	2483.420	83.17	83.5	-0.33
-30	207	HT20	2400.000	2483.420	83.42	83.5	-0.08

Table 13. Frequency Range, Test Results, 802.11n 20 MHz

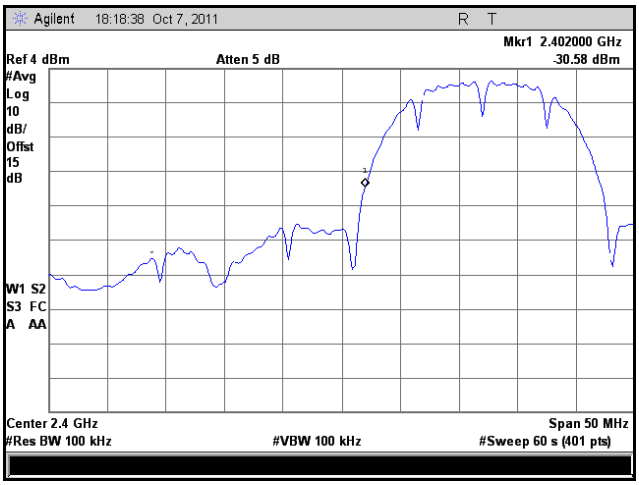
Frequency Range Table							
Temperature (C)	**Voltage AC**	**Mode OFDM**	**Frequency (f_L) MHz**	**Frequency (f_H) MHz**	**Frequency (fH-fL) MHz**	**Limit MHz**	**Margin MHz**
20	230	HT40	2401.250	2482.100	80.85	83.5	-2.65
70	253	HT40	2402.250	2481.500	79.25	83.5	-4.25
70	207	HT40	2402.250	2481.500	79.25	83.5	-4.25
-30	253	HT40	2401.350	2483.100	81.75	83.5	-1.75
-30	207	HT40	2401.350	2483.100	81.75	83.5	-1.75

Table 14. Frequency Range, Test Results, 802.11n 40 MHz

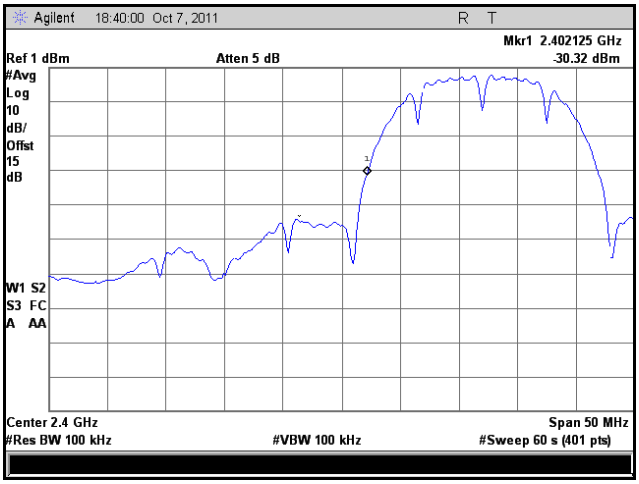
Frequency Range, 802.11b



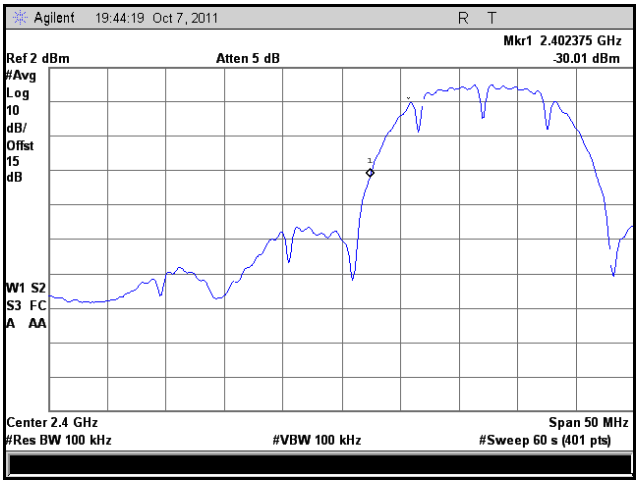
Plot 25. Frequency Range, 802.11b, Low Channel, Low Temperature, Low Voltage



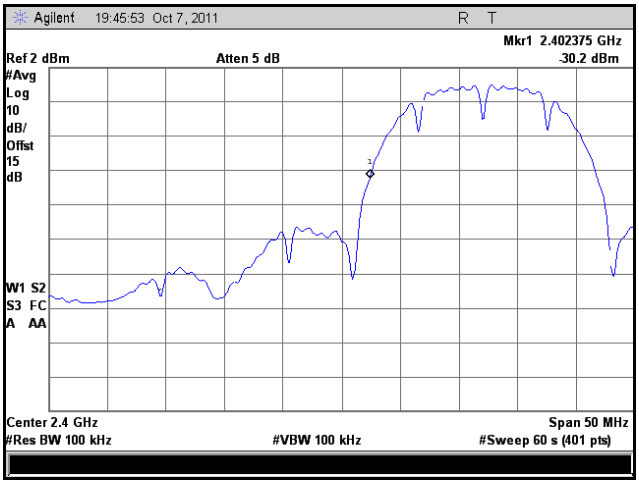
Plot 26. Frequency Range, 802.11b, Low Channel, Low Temperature, High Voltage



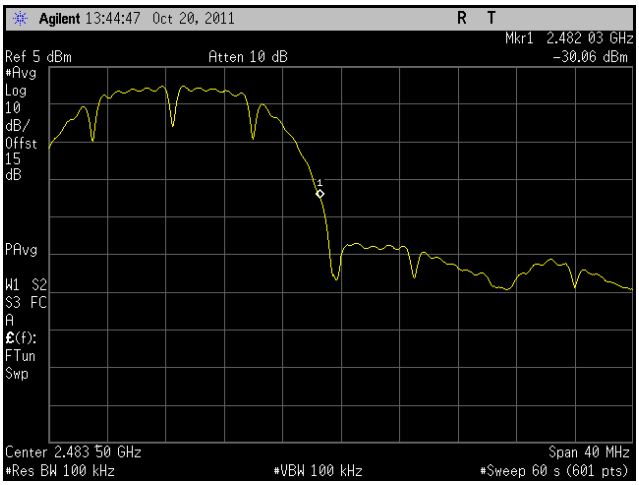
Plot 27. Frequency Range, 802.11b, Low Channel, Room Temperature, Nominal Voltage



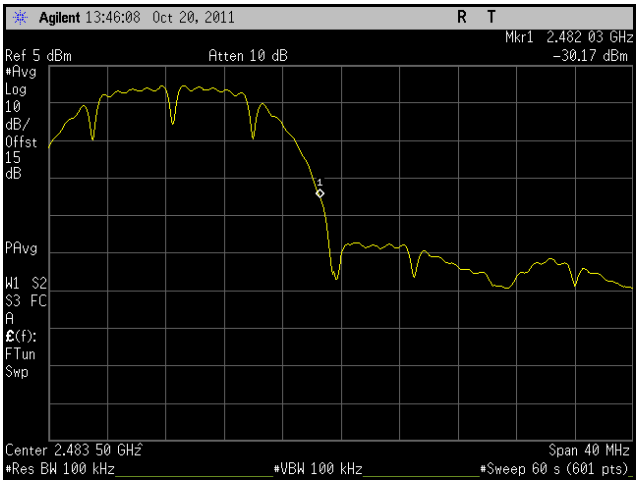
Plot 28. Frequency Range, 802.11b, Low Channel, High Temperature, Low Voltage



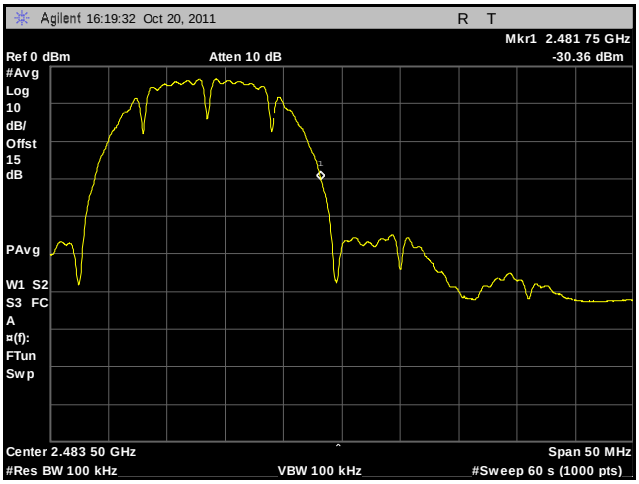
Plot 29. Frequency Range, 802.11b, Low Channel, High Temperature, High Voltage



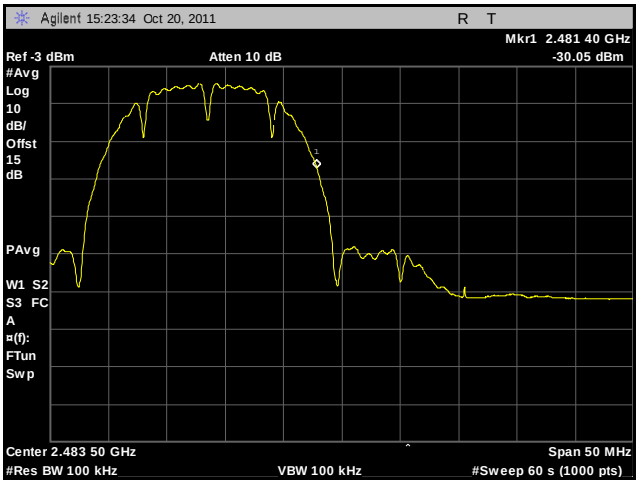
Plot 30. Frequency Range, 802.11b, High Channel, Low Temperature, Low Voltage



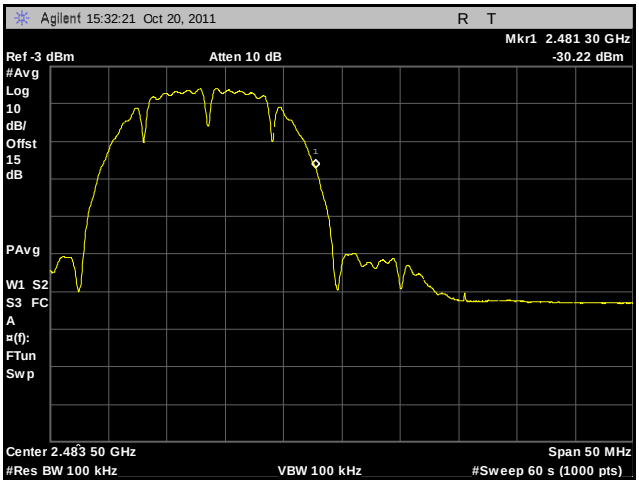
Plot 31. Frequency Range, 802.11b, High Channel, Low Temperature, High Voltage



Plot 32. Frequency Range, 802.11b, High Temperature, Room Temperature, Nominal Voltage

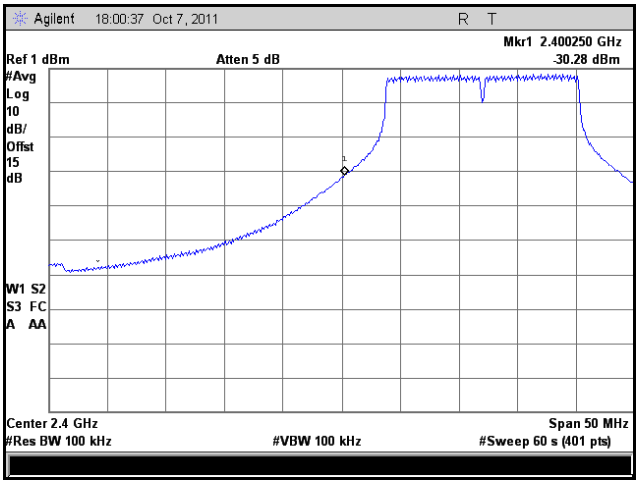


Plot 33. Frequency Range, 802.11b, High Channel, High Temperature, Low Voltage

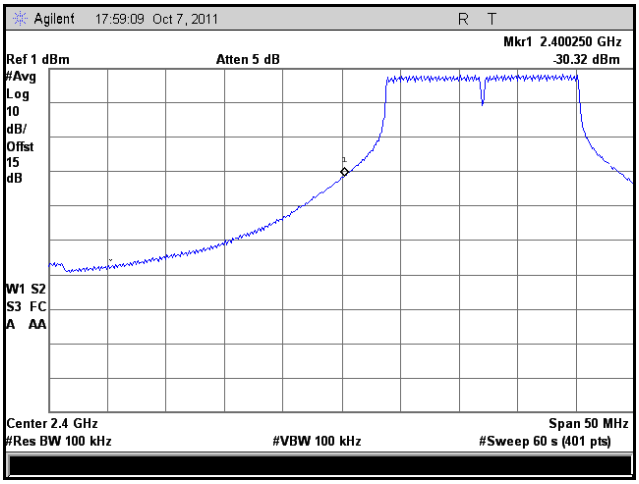


Plot 34. Frequency Range, 802.11b, High Channel, High Temperature, High Voltage

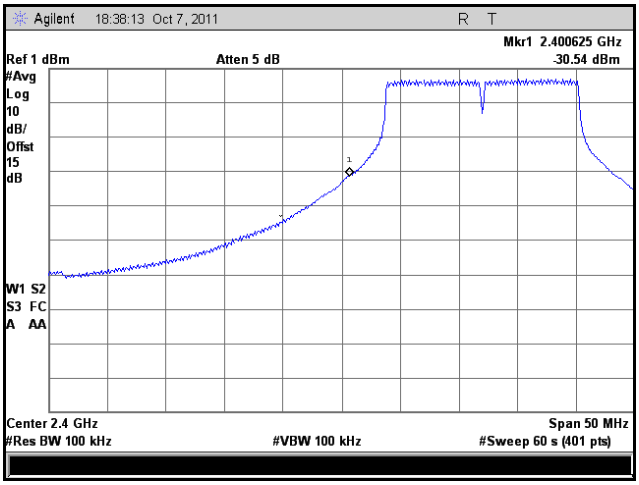
Frequency Range, 802.11g



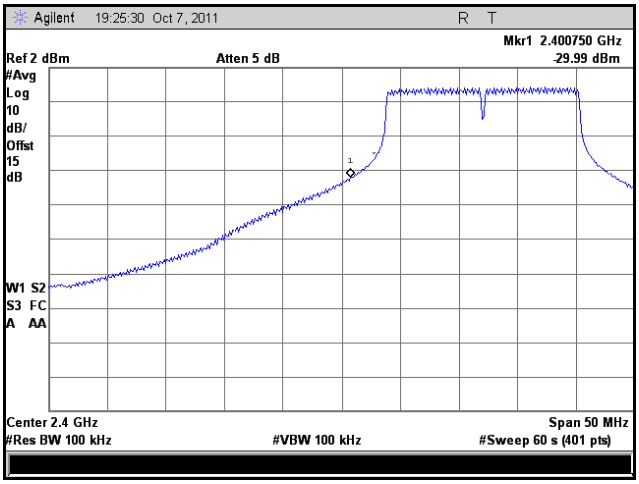
Plot 35. Frequency Range, 802.11g, Low Channel, Low Temperature, Low Voltage



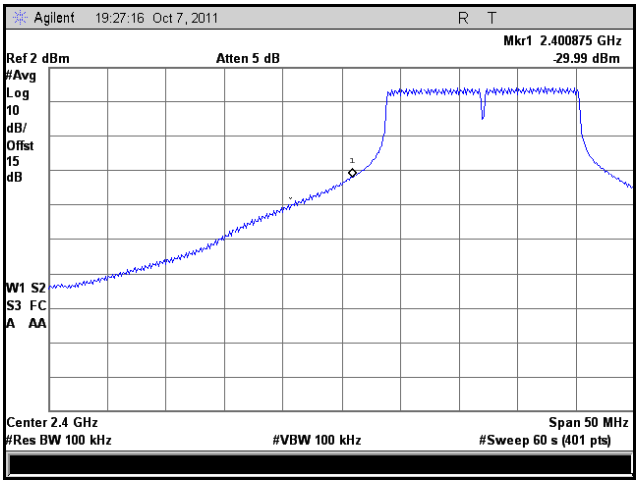
Plot 36. Frequency Range, 802.11g, Low Channel, Low Temperature, High Voltage



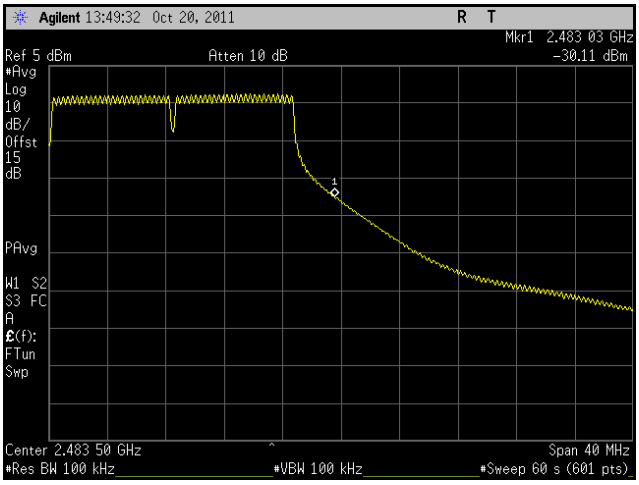
Plot 37. Frequency Range, Low Channel, Room Temperature, Nominal Voltage



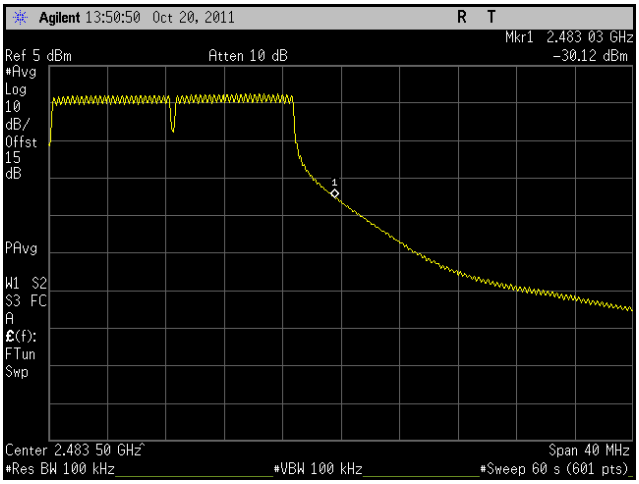
Plot 38. Frequency Range, 802.11g, Low Channel, High Temperature, Low Voltage



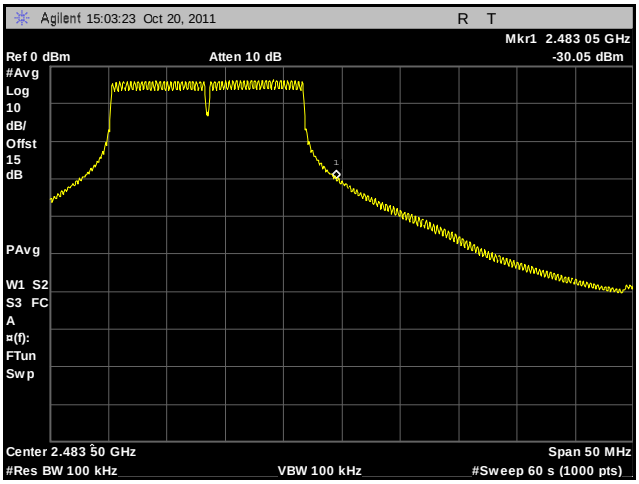
Plot 39. Frequency Range, 802.11g, Low Channel, High Temperature, High Voltage



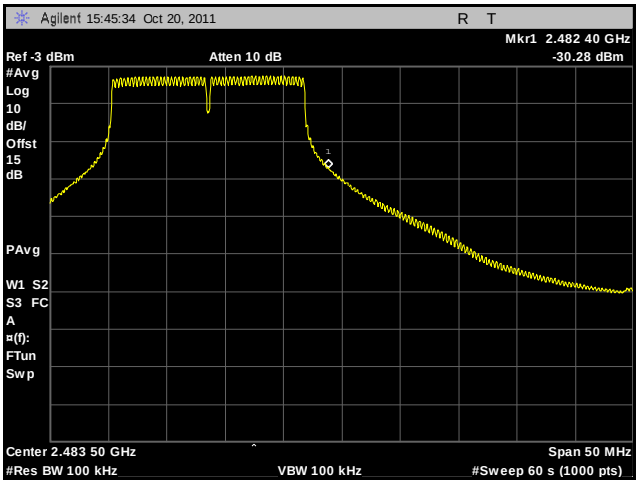
Plot 40. Frequency Range, 802.11g, High Channel, Low Temperature, Low Voltage



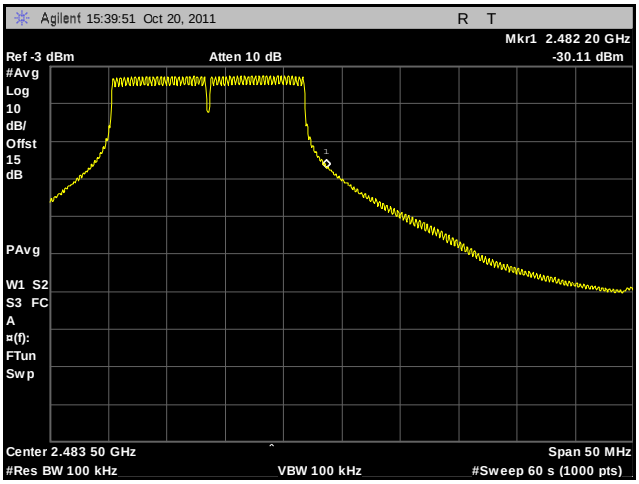
Plot 41. Frequency Range, 802.11g, High Channel, Low Temperature, High Voltage



Plot 42. Frequency Range, 802.11g, High Channel, Room Temperature, Nominal Voltage

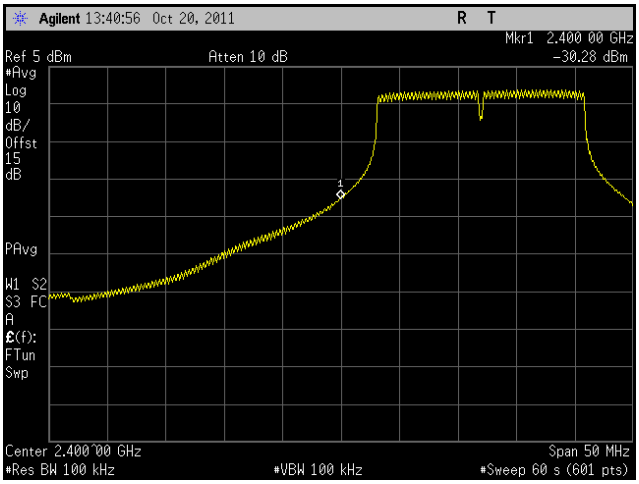


Plot 43. Frequency Range, 802.11g, High Channel, High Temperature, Low Voltage

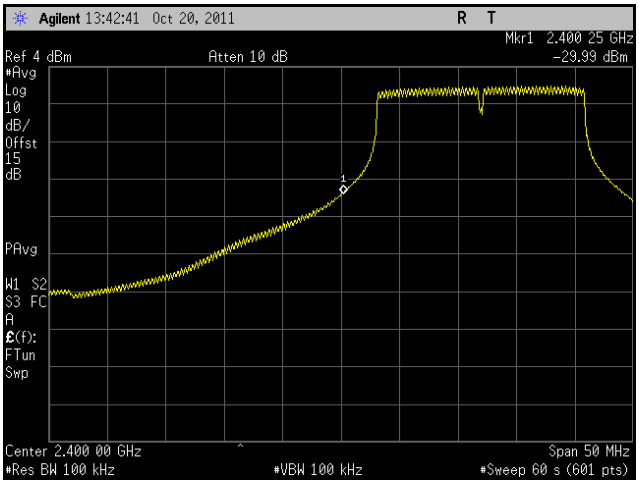


Plot 44. Frequency Range, High Channel, High Temperature, High Voltage

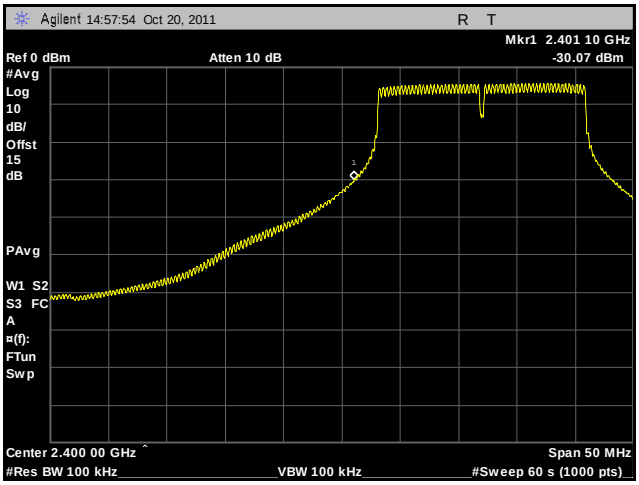
Frequency Range, 802.11n 20 MHz



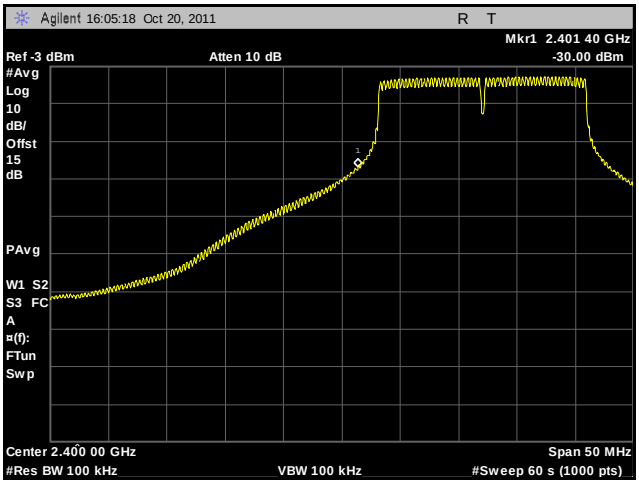
Plot 45. Frequency Range, 802.11n 20 MHz, Low Channel, Low Temperature, Low Voltage



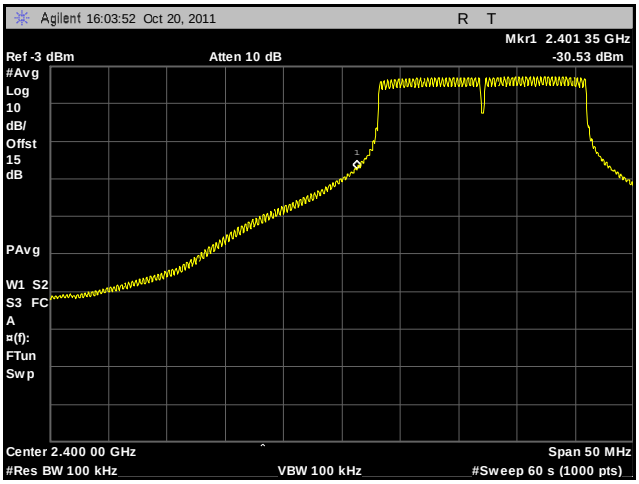
Plot 46. Frequency Range, 802.11n 20 MHz, Low Channel, Low Temperature, High Voltage



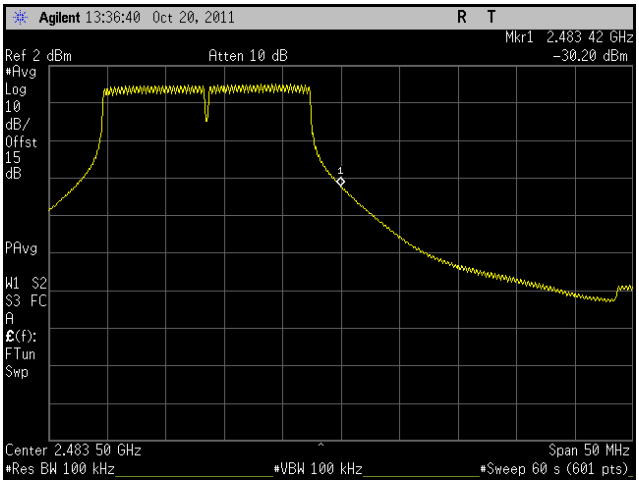
Plot 47. Frequency Range, 802.11n 20 MHz, Low Channel, Room Temperature, Nominal Voltage



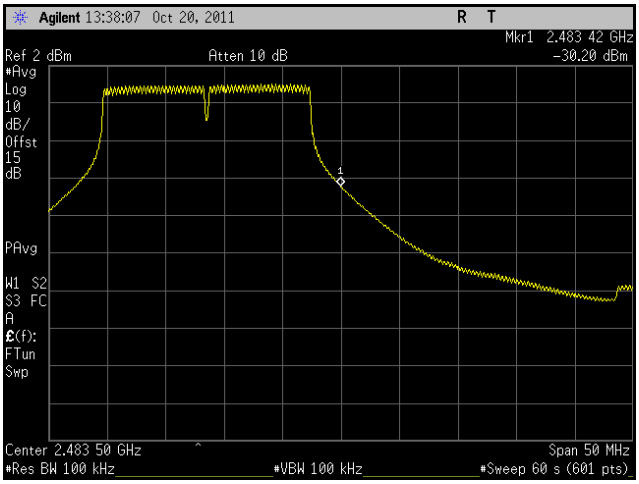
Plot 48. Frequency Range, 802.11n 20 MHz, Low Channel, High Temperature, Low Voltage



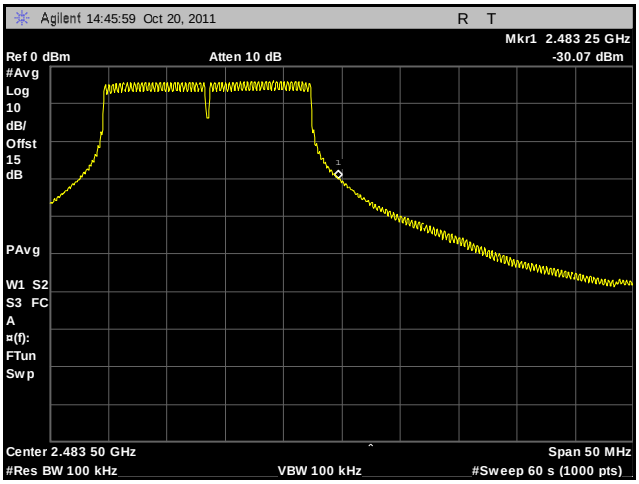
Plot 49. Frequency Range, 802.11n 20 MHz, Low Channel, High Temperature, High Voltage



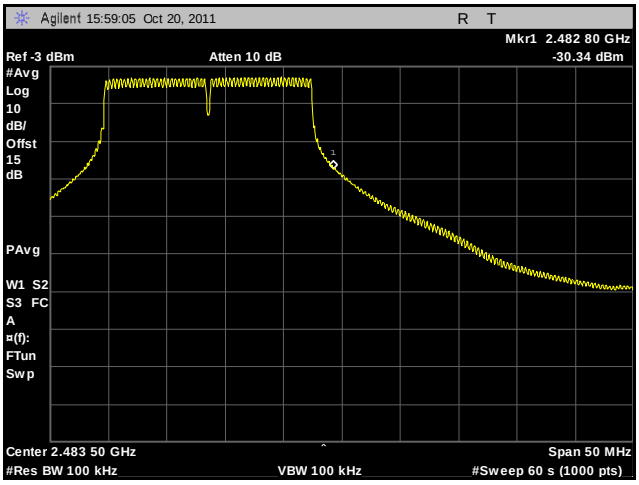
Plot 50. Frequency Range, 802.11n 20 MHz, High Channel, Low Temperature, Low Voltage



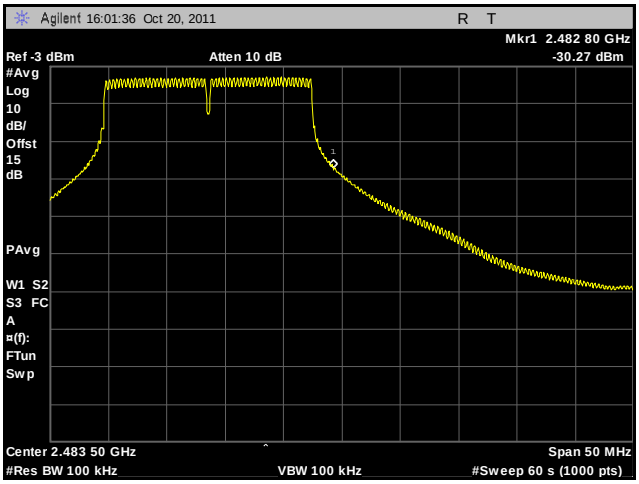
Plot 51. Frequency Range, 802.11n 20 MHz, High Channel, Low Temperature, High Voltage



Plot 52. Frequency Range, 802.11n 20 MHz, High Channel, Room Temperature, Nominal Voltage

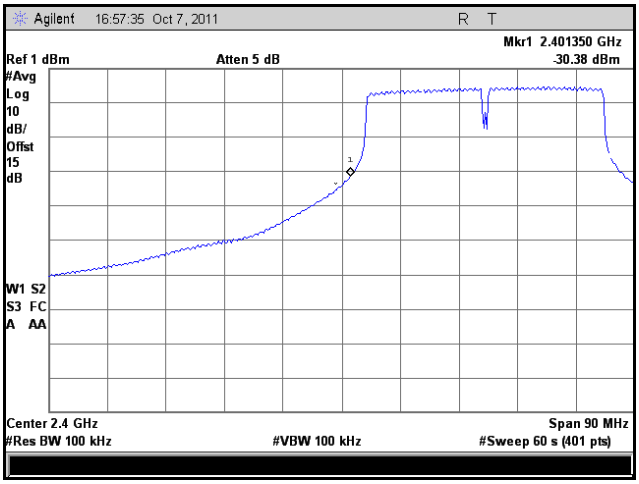


Plot 53. Frequency Range, 802.11n 20 MHz, High Channel, High Temperature, Low Voltage

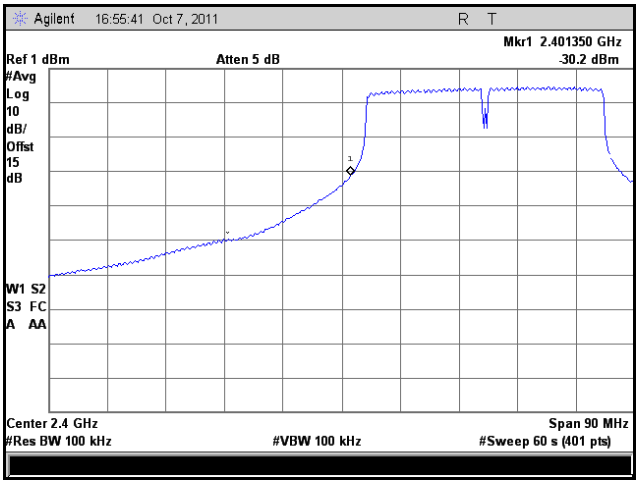


Plot 54. Frequency Range, 802.11n 20 MHz, High Channel, High Temperature, High Voltage

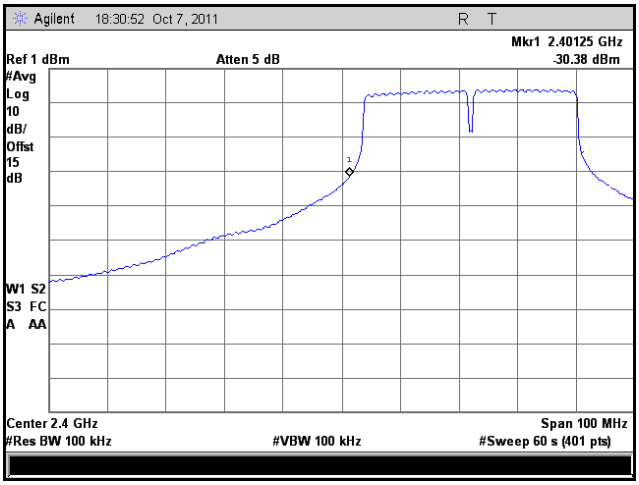
Frequency Range, 802.11n 40 MHz



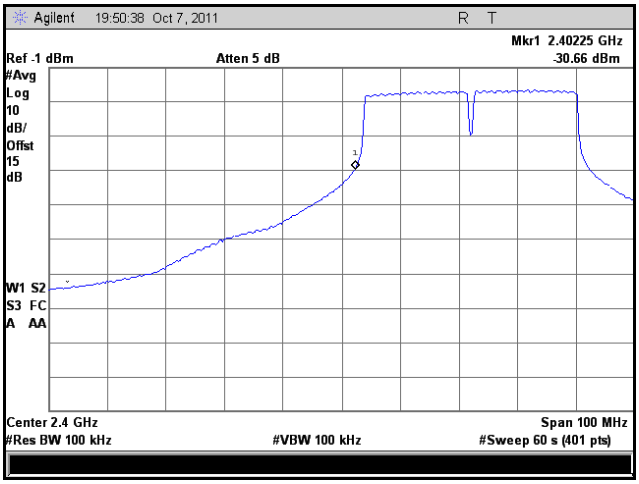
Plot 55. Frequency Range, 802.11n 40 MHz, Low Channel, Low Temperature, Low Voltage



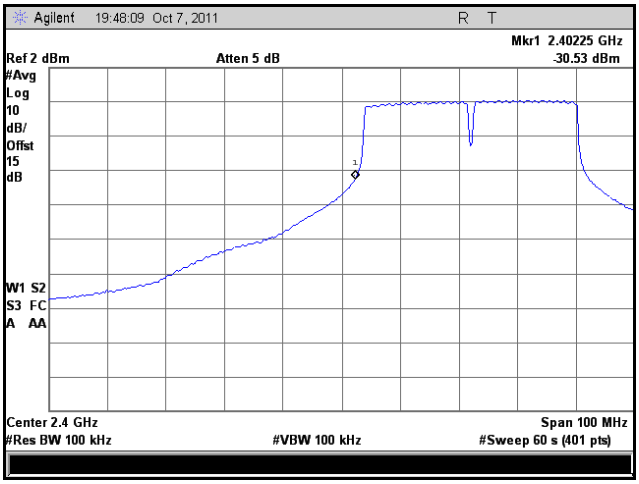
Plot 56. Frequency Range, 802.11n 40 MHz, Low Channel, Low Temperature, High Voltage



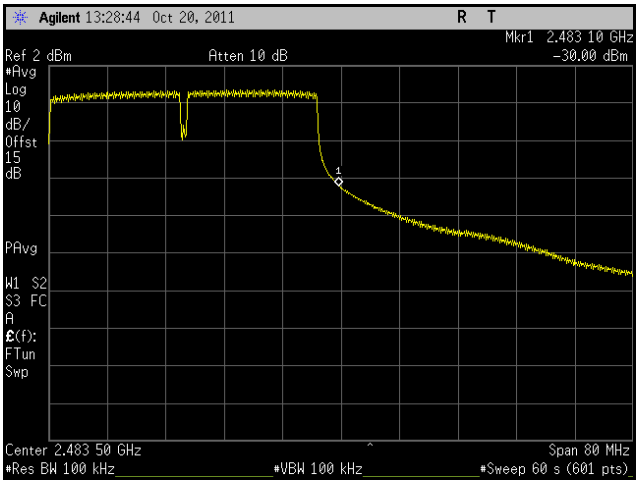
Plot 57. Frequency Range, 802.11n 40 MHz, Low Channel, Room Temperature, Nominal Voltage



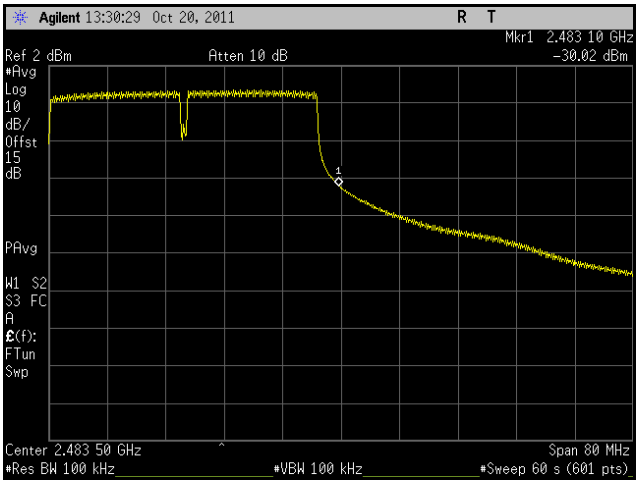
Plot 58. Frequency Range, 802.11n 40 MHz, Low Channel, High Temperature, Low Voltage



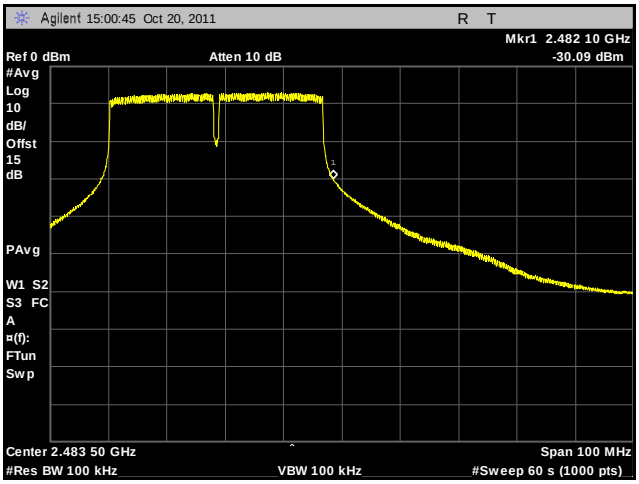
Plot 59. Frequency Range, 802.11n 40 MHz, Low Channel, High Temperature, High Voltage



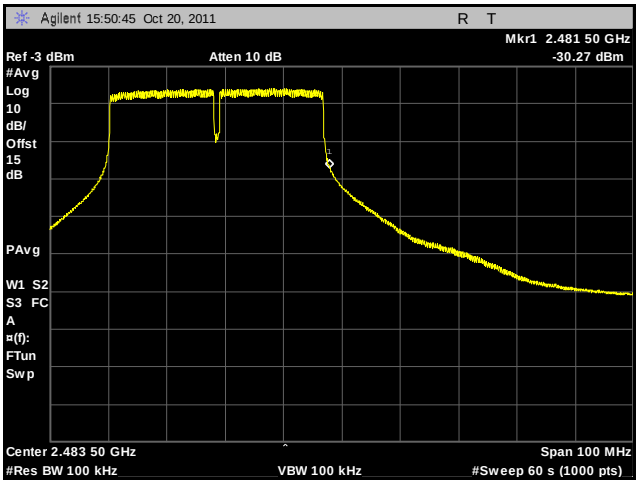
Plot 60. Frequency Range, 802.11n 40 MHz, High Channel, Low Temperature, Low Voltage



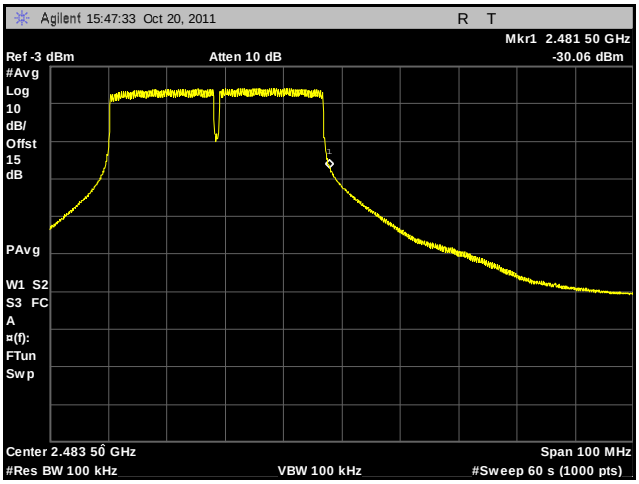
Plot 61. Frequency Range, 802.11n 40 MHz, High Channel, Low Temperature, High Voltage



Plot 62. Frequency Range, 802.11n 40 MHz, High Channel, Room Temperature, Nominal Voltage



Plot 63. Frequency Range, 802.11n 40 MHz, High Channel, High Temperature, Low Voltage



Plot 64. Frequency Range, 802.11n 40 MHz, High Channel, High Temperature, High Voltage

4.3.5 Medium Access Protocol

Test Requirement(s): **EN 300 328, Clause 4.3.5:**

4.3.5.1 Definition

A medium access protocol is a mechanism designed to facilitate spectrum sharing with other devices in a wireless network.

4.3.5.2 Limit

A medium access protocol shall be implemented by the equipment.

Test Results: The EUT facilitates medium access protocol and therefore is compliant with the requirements of Clause 4.3.5.2.

Test Engineer: Lionel Gabrillo

Test Date: 10/25/11

4.3.6 Transmitter Spurious Emissions - Conducted

Test Requirement(s): **EN 300 328, Clause 4.3.6:**

4.3.6.1 Definition

Transmitter spurious emissions are emissions outside the frequency range(s) of the equipment as defined in *Clause 4.3.3.1* when the equipment is in Transmit mode and/or in Standby mode.

4.3.6.2 Limit

The spurious emissions of the transmitter shall not exceed the values in Table 15 and Table 16 and in the indicated bands.

Frequency Range	Limit when operating	Limit when in standby
30 MHz to 1 GHz	-36 dBm	-57 dBm
above 1 GHz to 12,75 GHz	-30 dBm	-47 dBm
1,8 GHz to 1,9 GHz 5,15 GHz to 5,3 GHz	-47 dBm	-47 dBm

Table 15. Transmitter limits for narrowband spurious emissions

The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage. The measurement bandwidth for such emissions may be as small as necessary to achieve a reliable measurement result.

Wideband emissions shall not exceed the values given in Table 16.

Frequency Range	Limit when operating	Limit when in standby
30 MHz to 1 GHz	-86 dBm	-107 dBm/Hz
above 1 GHz to 12,75 GHz	-80 dBm	-97 dBm/Hz
1,8 GHz to 1,9 GHz 5,15 GHz to 5,3 GHz	-97 dBm	-97 dBm/Hz

Table 16. Transmitter limits for wideband spurious emissions

4.3.6 Transmitter Spurious Emissions - Conducted

Test Procedure: The EUT was connected directly to a spectrum analyzer through an attenuator. The resolution band width of the spectrum analyzer was set to 100 KHz and the video band width set to 30 KHz. A positive peak detector was used along with peak hold function. The measurement was performed using normal operation of the equipment. Cable loss has been pre-programmed into SA.

Test Results: The EUT as tested was found compliant with the specified requirements of Clause 4.3.6.2.

Test Engineer: Lionel Gabrillo

Test Date: 10/25/11

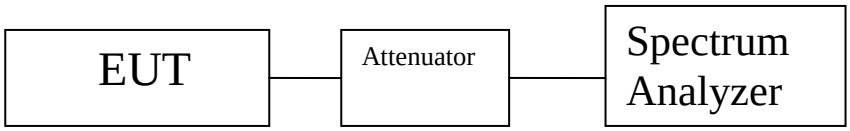
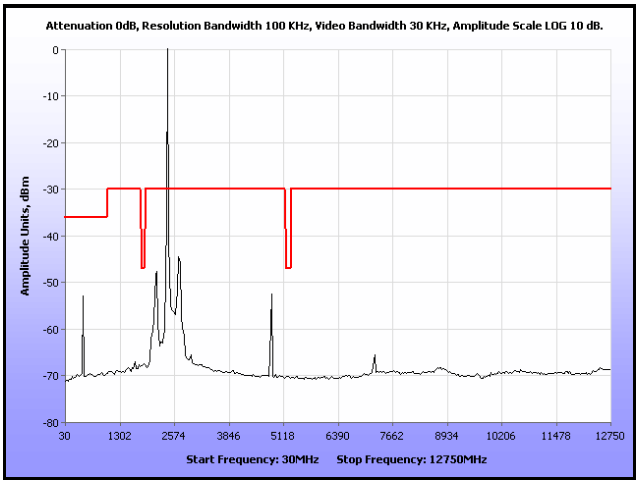
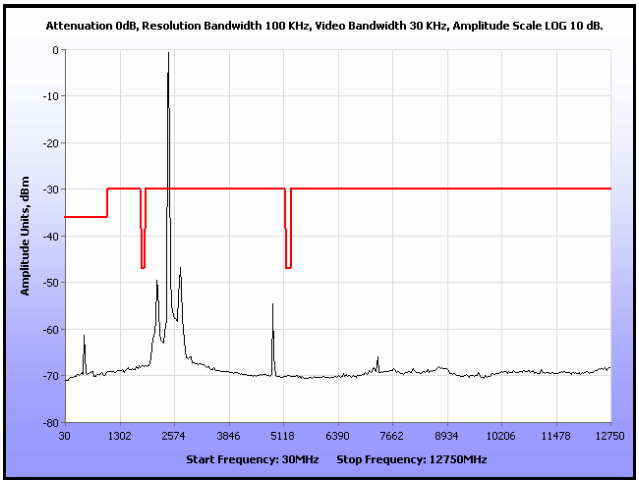


Figure 5. Transmitter Spurious Emissions - Conducted Test Setup

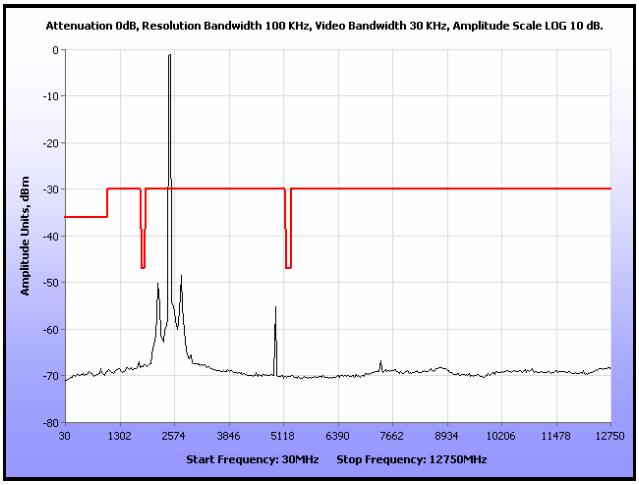
Transmitter Spurious Emissions – Conducted, Test Results, 802.11b



Plot 65. Conducted Spurious Emissions, 802.11b, Low Channel, 30 MHz – 12.75 GHz

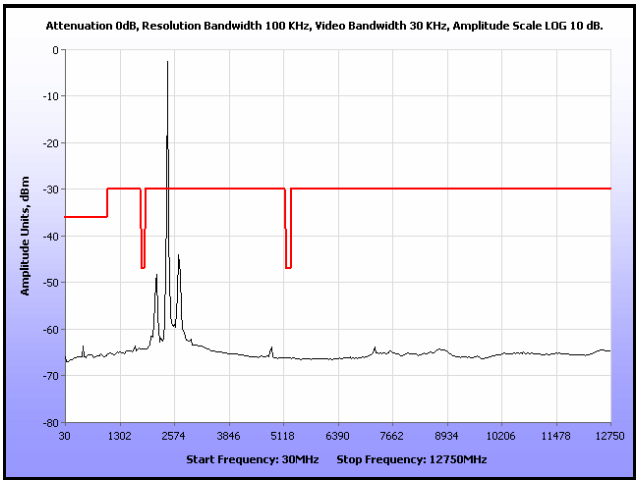


Plot 66. Conducted Spurious Emissions, 802.11b, Mid Channel, 30 MHz – 12.75 MHz

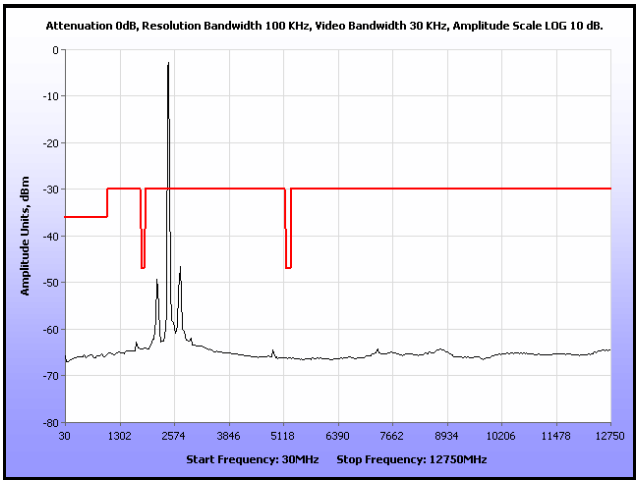


Plot 67. Conducted Spurious Emissions, 802.11b, High Channel, 30 MHz – 12.75 GHz

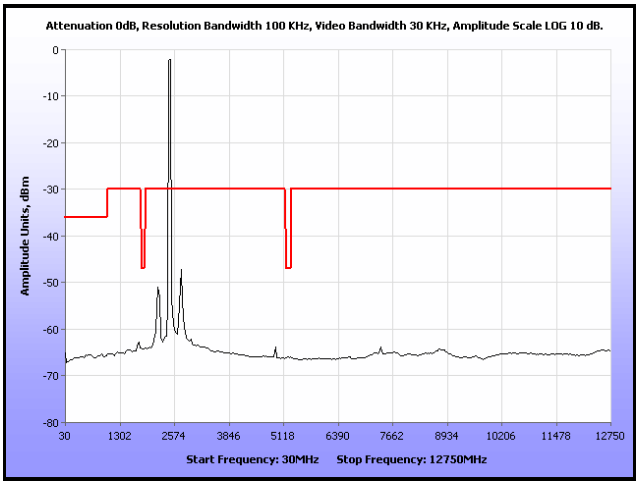
Transmitter Spurious Emissions – Conducted, Test Results, 802.11g



Plot 68. Conducted Spurious Emissions, 802.11g, Low Channel, 30 MHz – 12.75 GHz

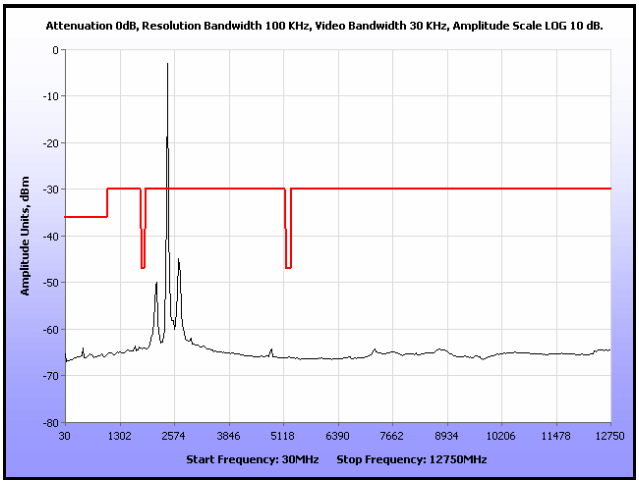


Plot 69. Conducted Spurious Emissions, 802.11g, Mid Channel, 30 MHz – 12.75 GHz

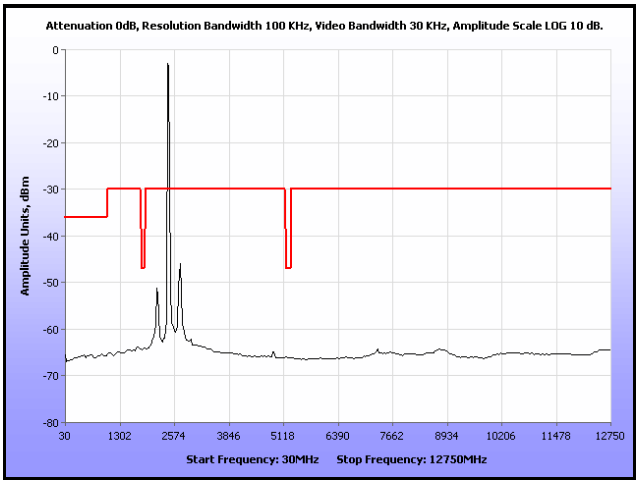


Plot 70. Conducted Spurious Emissions, 802.11g, High Channel, 30 MHz – 12.75 GHz

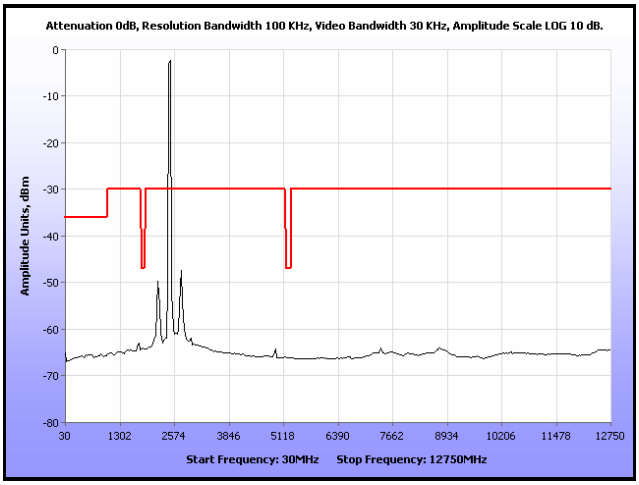
Transmitter Spurious Emissions – Conducted, Test Results, 802.11n 20 MHz



Plot 71. Conducted Spurious Emissions, 802.11n 20 MHz, Low Channel, 30 MHz – 12.75 GHz

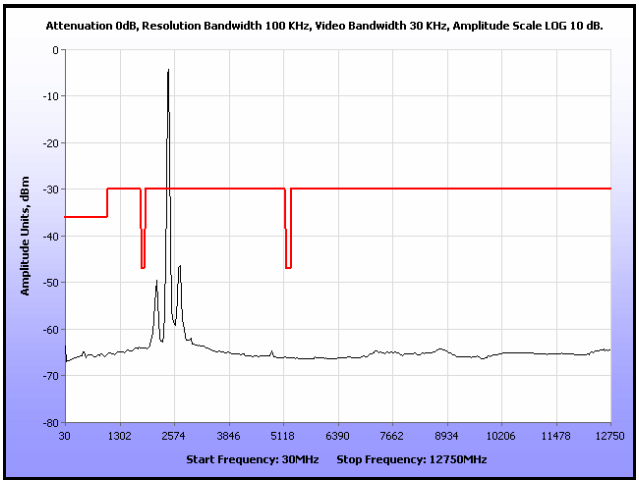


Plot 72. Conducted Spurious Emissions, 802.11n 20 MHz, Mid Channel, 30 MHz – 12.75 GHz

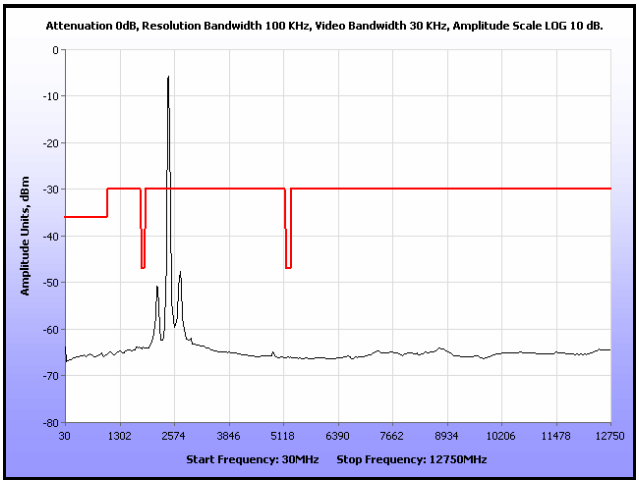


Plot 73. Conducted Spurious Emissions, 802.11n 20 MHz, High Channel, 30 MHz – 12.75 GHz

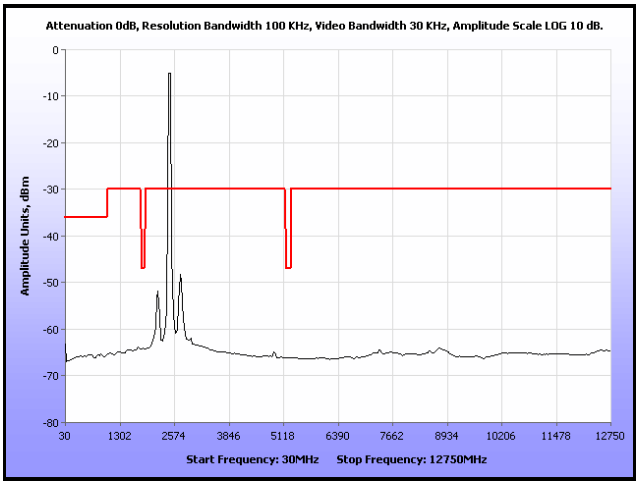
Transmitter Spurious Emissions – Conducted, Test Results, 802.11n 40 MHz



Plot 74. Conducted Spurious Emissions, 802.11n 40 MHz, Low Channel, 30 MHz – 12.75 GHz



Plot 75. Conducted Spurious Emissions, 802.11n 40 MHz, Mid Channel, 30 MHz – 12.75 GHz



Plot 76. Conducted Spurious Emissions, 802.11n 40 MHz, High Channel, 30 MHz – 12.75 GHz

4.3.6 Transmitter Spurious Emissions - Radiated

Test Requirement(s): **EN 300 328, Clause 4.3.6:**

4.3.6.1 Definition

Transmitter spurious emissions are emissions outside the frequency range(s) of the equipment as defined in *Clause 4.3.3.1* when the equipment is in Transmit mode and/or in Standby mode.

4.3.6.2 Limit

The spurious emissions of the transmitter shall not exceed the values in Table 15 and Table 16 and in the indicated bands.

Frequency Range	Limit when operating	Limit when in standby
30 MHz to 1 GHz	-36 dBm	-57 dBm
above 1 GHz to 12,75 GHz	-30 dBm	-47 dBm
1,8 GHz to 1,9 GHz 5,15 GHz to 5,3 GHz	-47 dBm	-47 dBm

Table 17. Transmitter limits for narrowband spurious emissions

The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage. The measurement bandwidth for such emissions may be as small as necessary to achieve a reliable measurement result.

Wideband emissions shall not exceed the values given in Table 16.

Frequency Range	Limit when operating	Limit when in standby
30 MHz to 1 GHz	-86 dBm	-107 dBm/Hz
above 1 GHz to 12,75 GHz	-80 dBm	-97 dBm/Hz
1,8 GHz to 1,9 GHz 5,15 GHz to 5,3 GHz	-97 dBm	-97 dBm/Hz

Table 18. Transmitter limits for wideband spurious emissions

Test Procedure: The EUT was placed on a 1.5m high wooden table inside a semi-anechoic chamber. The measurements were performed using normal operation of the equipment. The method of testing, test conditions, and test procedures of *Annex B* were used. The frequencies and amplitudes of field strengths were recorded for reference during final measurements.

The EUT was set to transmit at its highest output power at both the low, mid and high channels of the transmit band as well as all applicable modulations. The receive antenna was adjusted in order to find the maximum emission. The table was also rotated about 360^0. Both vertical and horizontal polarizations were used to determine the maximum emission.

Measurements were made at 3m.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 4.3.6.2. There were no emissions within 6 dB of the limit.

Test Engineer: Lionel Gabrillo

Test Date: 10/25/11

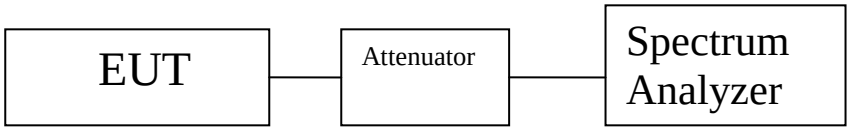
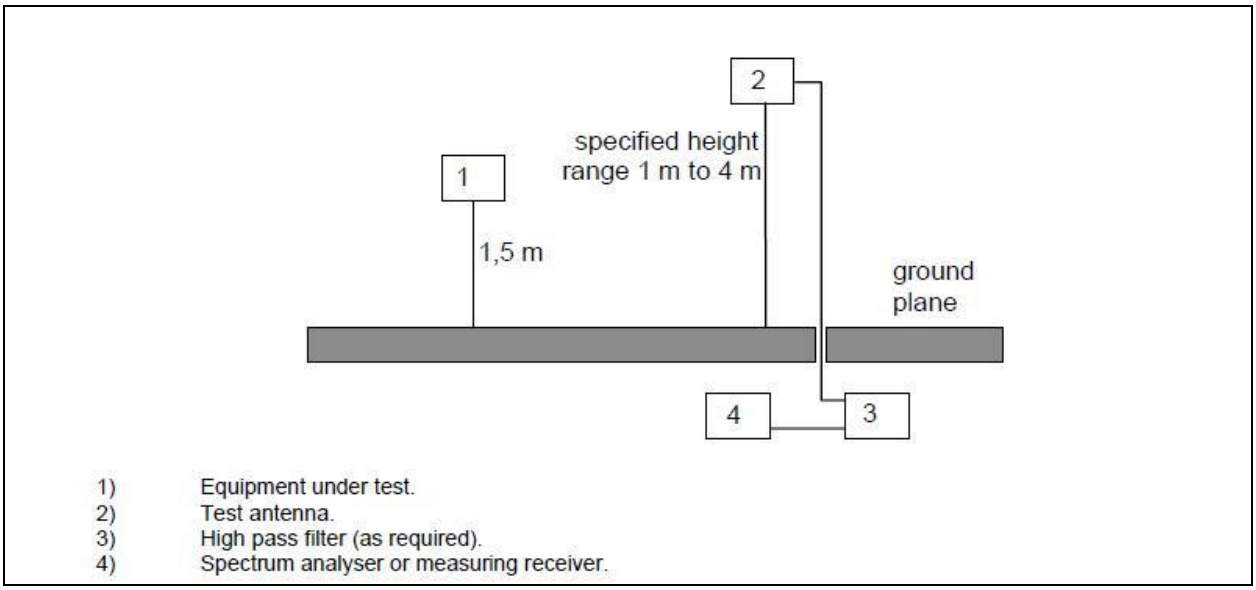
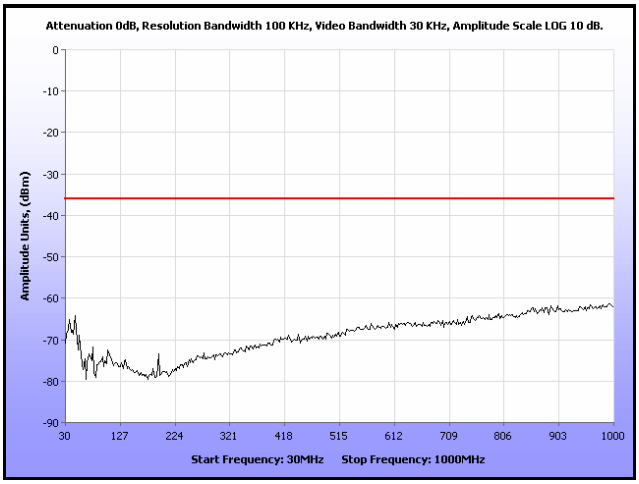


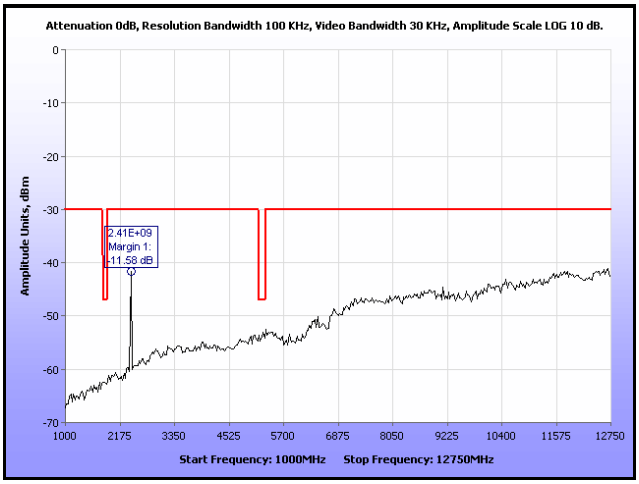
Figure 6. Transmitter Spurious Emissions - Radiated Test Setup



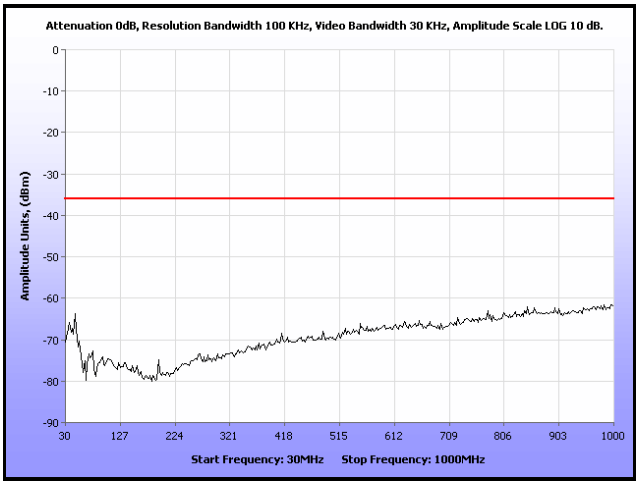
Transmitter Spurious Emissions – Radiated, Test Results, 802.11b



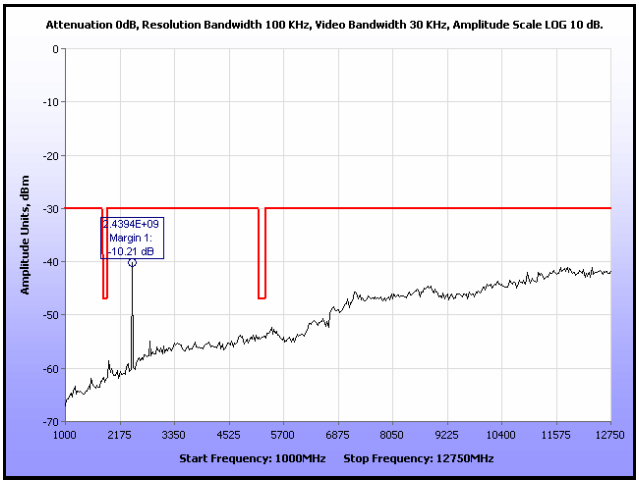
Plot 77. Radiated Spurious Emissions, 802.11b, Low Channel, 30 MHz – 1 GHz



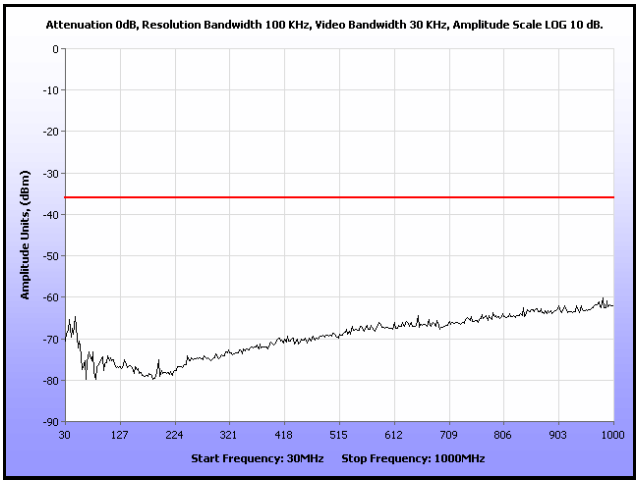
Plot 78. Radiated Spurious Emissions, 802.11b, Low Channel, 1 GHz – 12.75 GHz



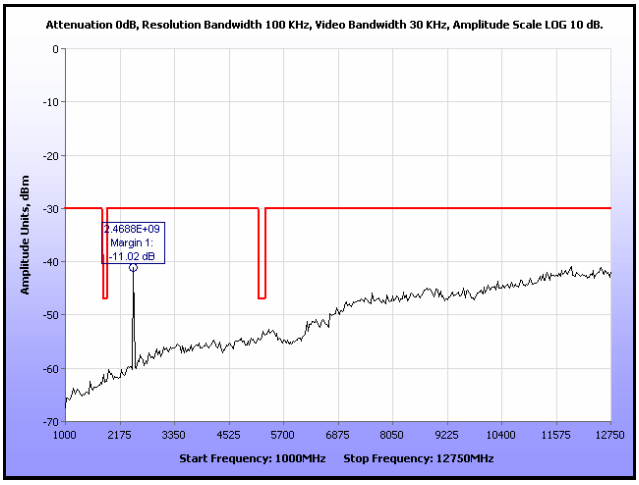
Plot 79. Radiated Spurious Emission, 802.11b, Mid Channel, 30 MHz - 1 GHz



Plot 80. Radiated Spurious Emissions, 802.11b, Mid Channel, 1 GHz – 12.75 GHz

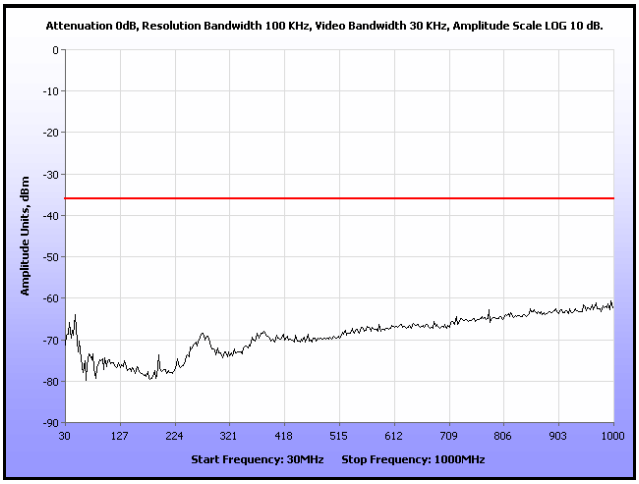


Plot 81. Radiated Spurious Emissions, 802.11b, High Channel, 30 MHz – 1 GHz

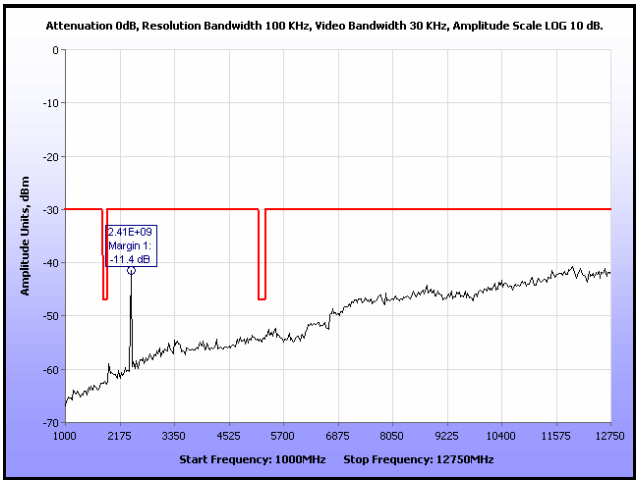


Plot 82. Radiated Spurious Emission, 802.11b, High Channel, 1 GHz - 12.75 GHz

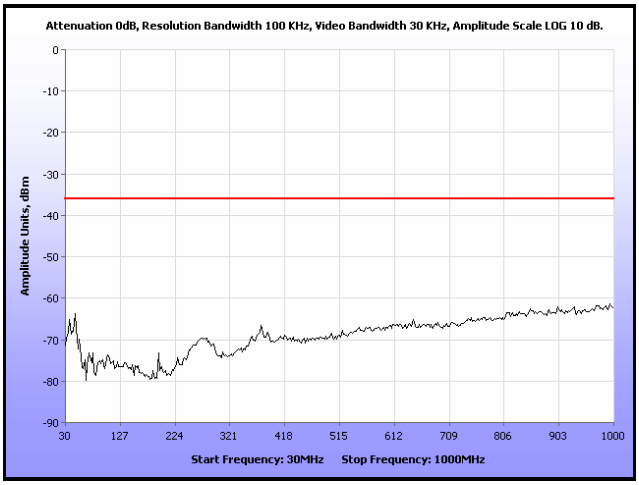
Transmitter Spurious Emissions – Radiated, Test Results, 802.11g



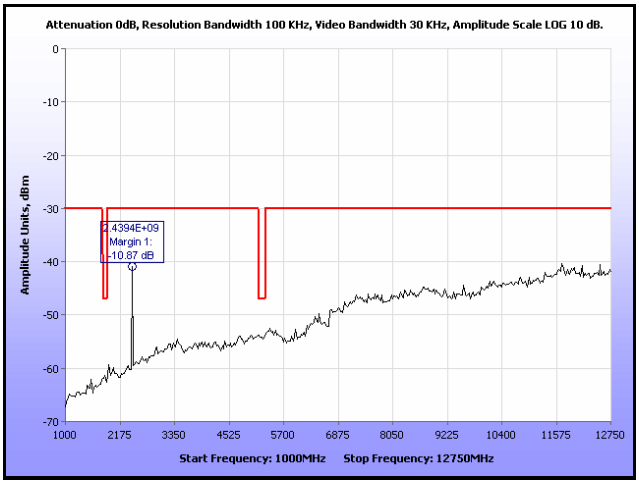
Plot 83. Radiated Spurious Emissions, 802.11g, Low Channel, 30 MHz – 1 GHz



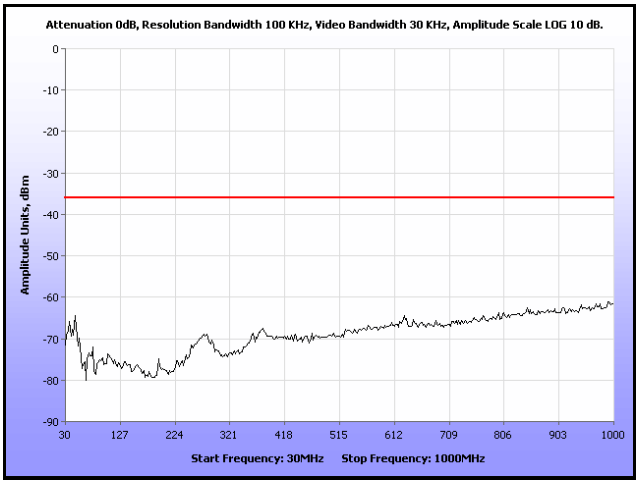
Plot 84. Radiated Spurious Emissions, 802.11g, Low Channel, 1 GHz – 12.75 GHz



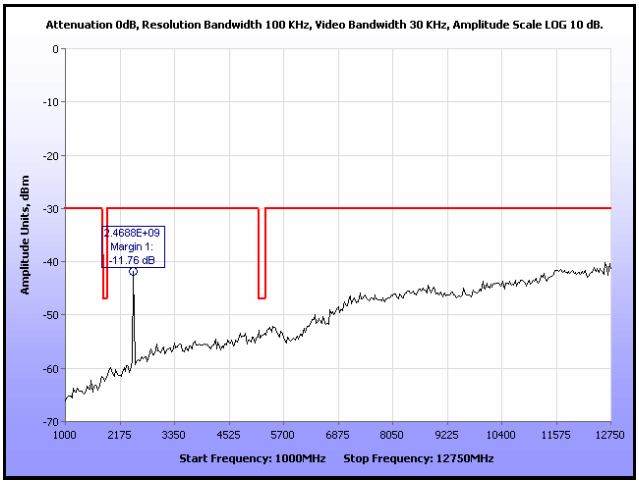
Plot 85. Radiated Spurious Emission, 802.11g, Mid Channel, 30 MHz - 1 GHz



Plot 86. Radiated Spurious Emissions, 802.11g, Mid Channel, 1 GHz – 12.75 GHz

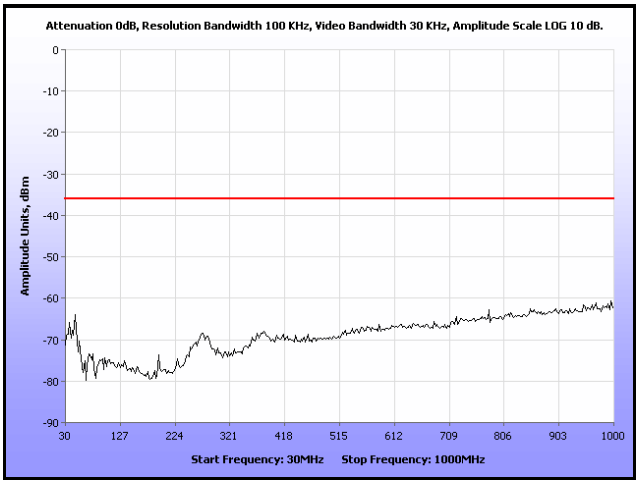


Plot 87. Radiated Spurious Emissions, 802.11g, High Channel, 30 MHz – 1 GHz

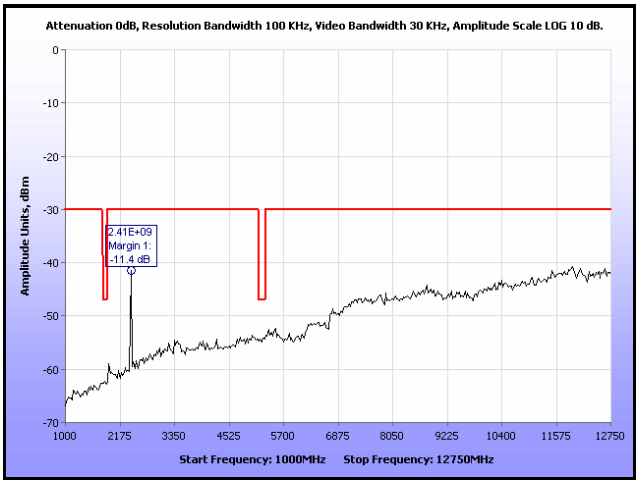


Plot 88. Radiated Spurious Emission, 802.11g, High Channel, 1 GHz - 12.75 GHz

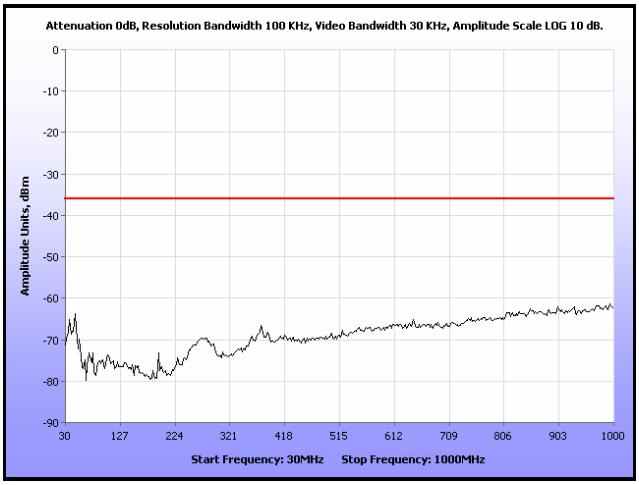
Transmitter Spurious Emissions – Radiated, Test Results, 802.11g



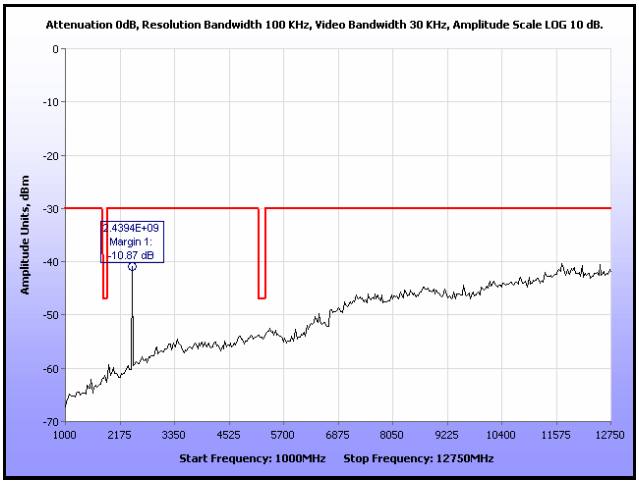
Plot 89. Radiated Spurious Emissions, 802.11g, Low Channel, 30 MHz – 1 GHz



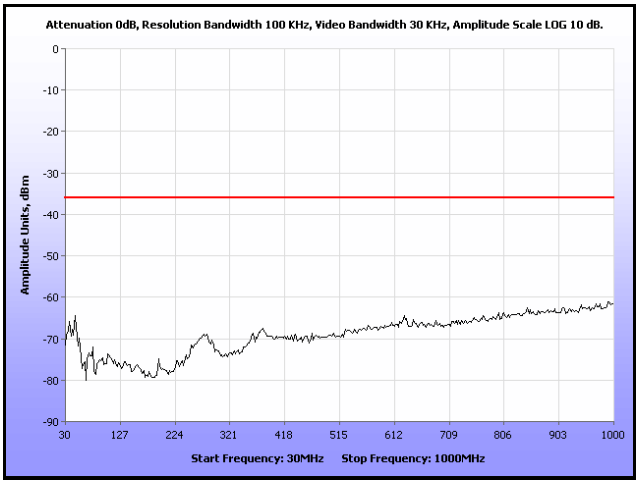
Plot 90. Radiated Spurious Emissions, 802.11g, Low Channel, 1 GHz – 12.75 GHz



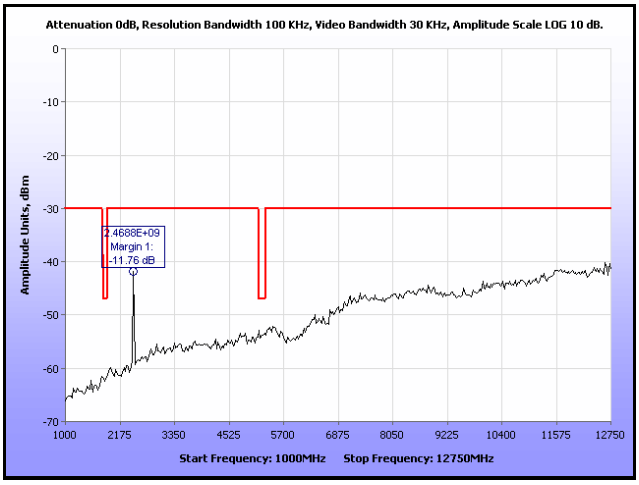
Plot 91. Radiated Spurious Emission, 802.11g, Mid Channel, 30 MHz - 1 GHz



Plot 92. Radiated Spurious Emissions, 802.11g, Mid Channel, 1 GHz – 12.75 GHz

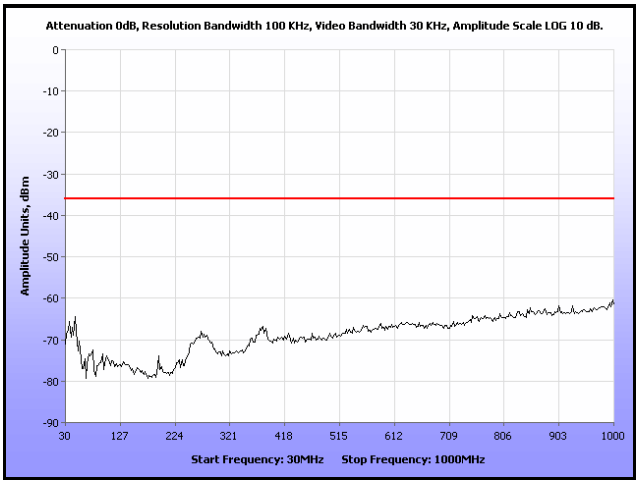


Plot 93. Radiated Spurious Emissions, 802.11g, High Channel, 30 MHz – 1 GHz

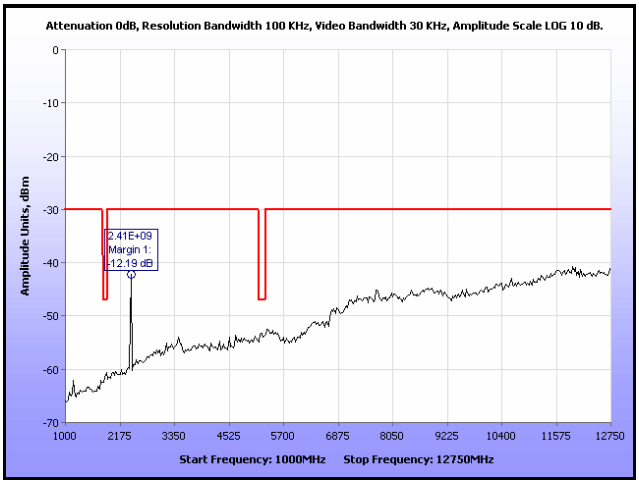


Plot 94. Radiated Spurious Emission, 802.11g, High Channel, 1 GHz - 12.75 GHz

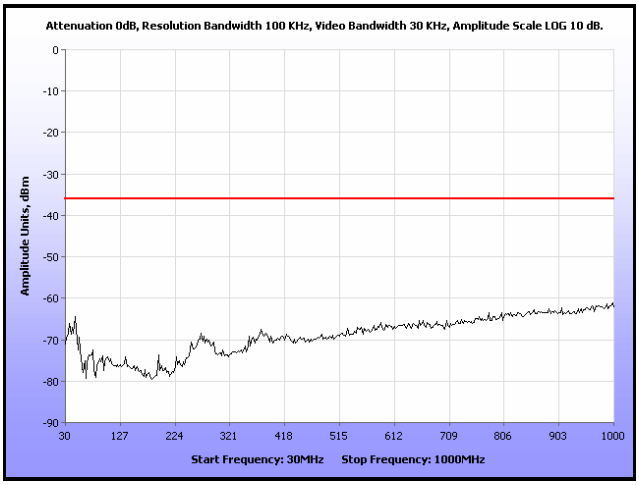
Transmitter Spurious Emissions – Radiated, Test Results, 802.11n 20 MHz



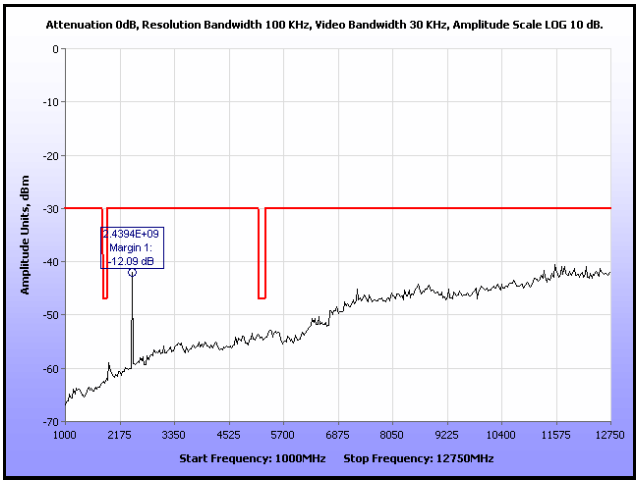
Plot 95. Radiated Spurious Emissions, 802.11n 20 MHz, Low Channel, 30 MHz – 1 GHz



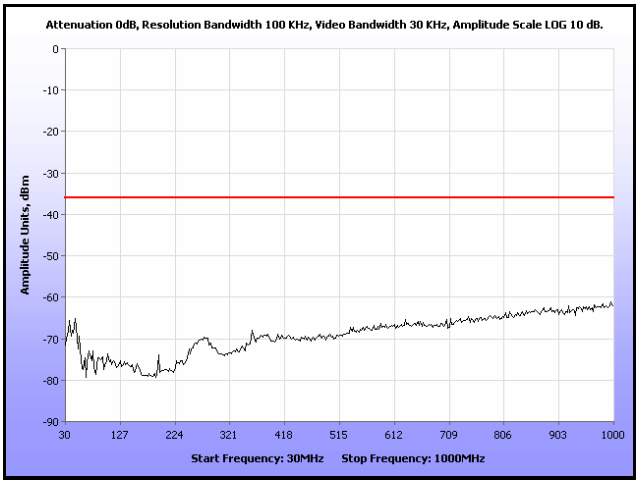
Plot 96. Radiated Spurious Emissions, 802.11n 20 MHz, Low Channel, 1 GHz – 12.75 GHz



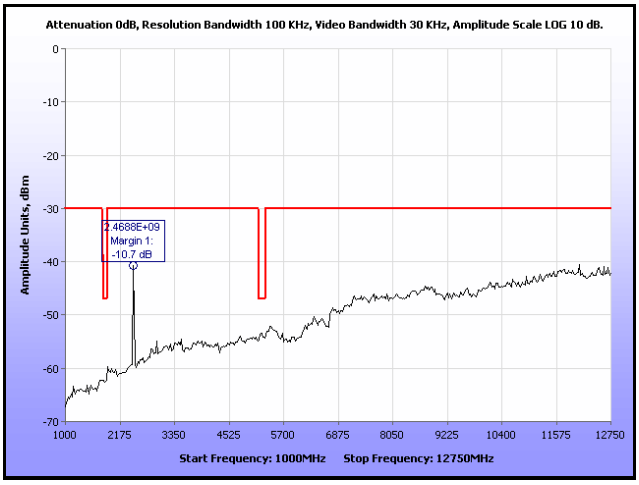
Plot 97. Radiated Spurious Emission, 802.11n 20 MHz, Mid Channel, 30 MHz - 1 GHz



Plot 98. Radiated Spurious Emissions, 802.11n 20 MHz, Mid Channel, 1 GHz – 12.75 GHz

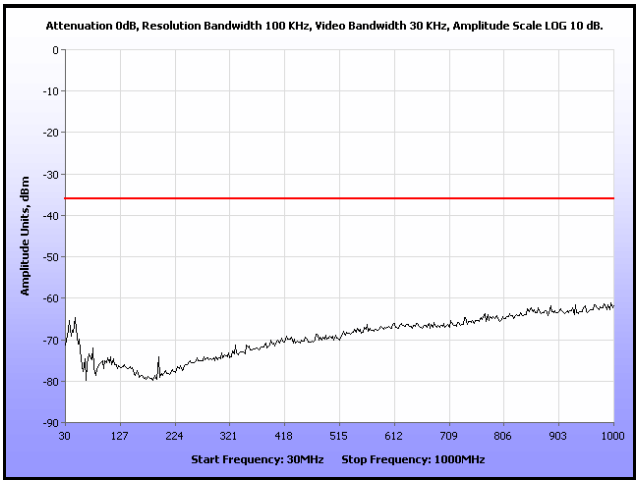


Plot 99. Radiated Spurious Emissions, 802.11n 20 MHz, High Channel, 30 MHz – 1 GHz

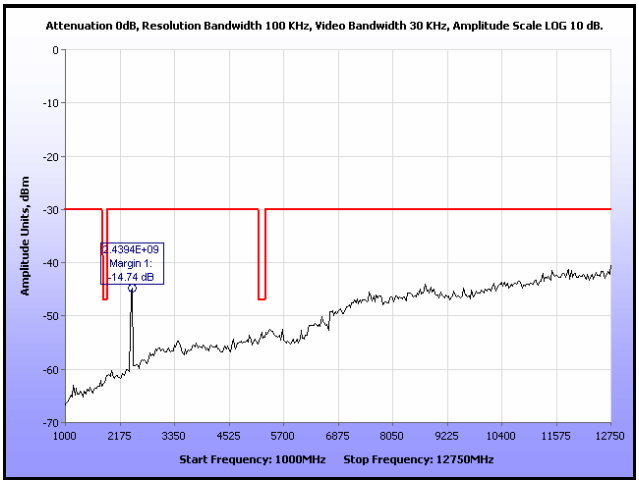


Plot 100. Radiated Spurious Emission, 802.11n 20 MHz, High Channel, 1 GHz - 12.75 GHz

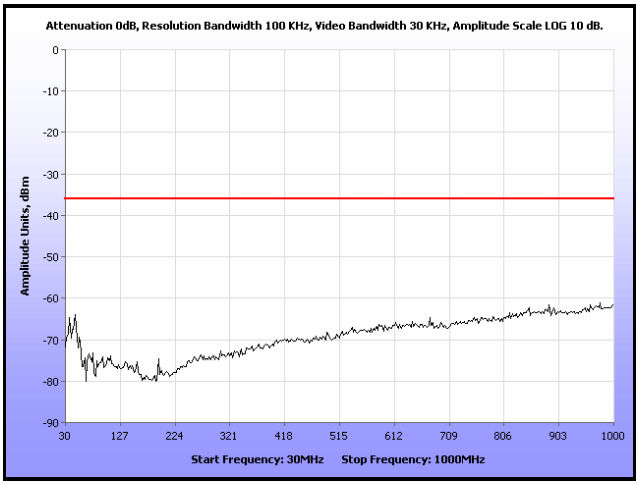
Transmitter Spurious Emissions – Radiated, Test Results, 802.11n 40 MHz



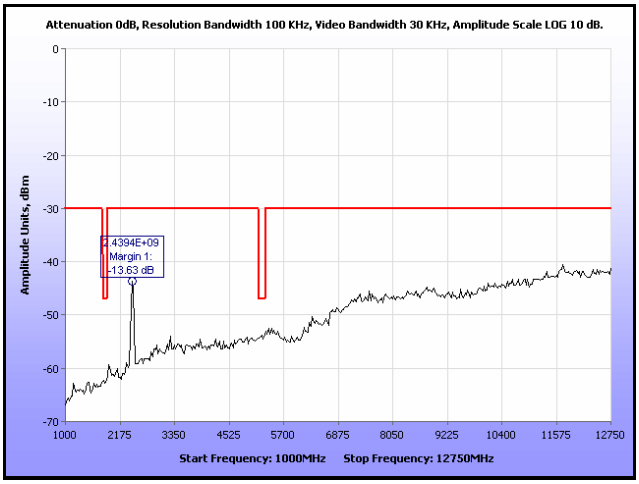
Plot 101. Radiated Spurious Emissions, 802.11n 40 MHz, Low Channel, 30 MHz – 1 GHz



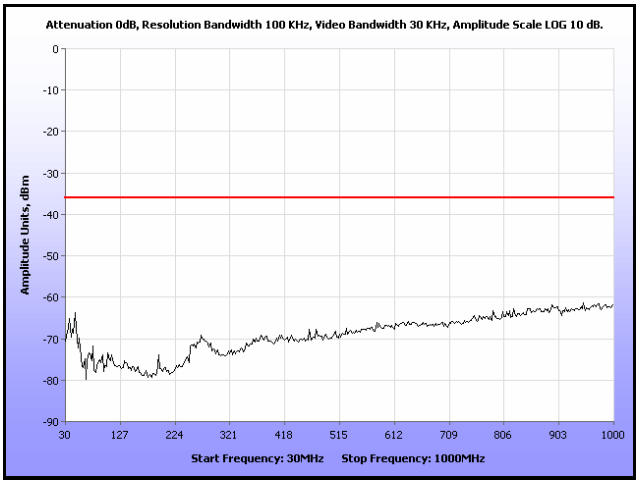
Plot 102. Radiated Spurious Emissions, 802.11n 40 MHz, Low Channel, 1 GHz – 12.75 GHz



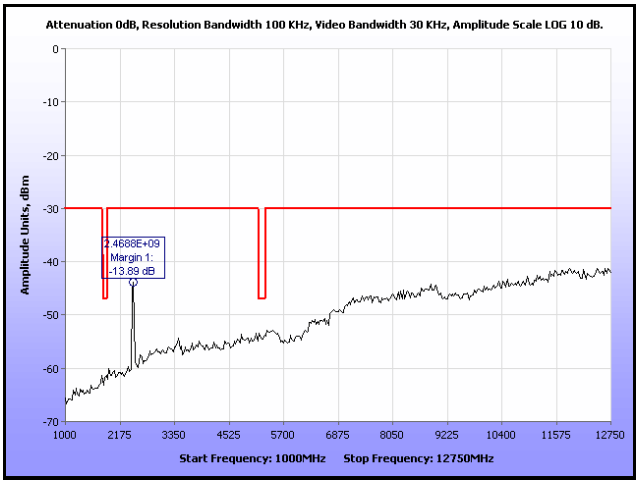
Plot 103. Radiated Spurious Emission, 802.11n 40 MHz, Mid Channel, 30 MHz - 1 GHz



Plot 104. Radiated Spurious Emissions, 802.11n 40 MHz, Mid Channel, 1 GHz – 12.75 GHz



Plot 105. Radiated Spurious Emissions, 802.11n 40 MHz, High Channel, 30 MHz – 1 GHz



Plot 106. Radiated Spurious Emission, 802.11n 40 MHz, High Channel, 1 GHz - 12.75 GHz

Transmitter Spurious Emissions – Radiated, Test Setup

Photograph 2. Radiated Emissions, Test Setup, 30 MHz – 1 GHz

Photograph 3. Radiated Emissions, Test Setup, 1 GHz – 12.75 GHz

Conformance Requirements

4.3.7 Receiver Spurious Emissions - Conducted

Test Requirement(s): 4.3.7.1 Definition

Receiver spurious emissions are emissions at any frequency when the equipment is in received mode.

4.3.7.2 Limit

The spurious emissions of the receiver shall not exceed the values in tables Table 19 and Table 20 and in the indicated bands.

Frequency Range	Limit
30 MHz to 1 GHz	-57 dBm
above 1 GHz to 12,75 GHz	-47 dBm

Table 19. Narrowband spurious emission limits for receivers

The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage. The measurement bandwidth for such emissions may be as small as necessary to get a reliable measurement result.

Wideband emissions shall not exceed the values given in Table 20.

Frequency Range	Limit
30 MHz to 1 GHz	-107dBm/Hz
above 1 GHz to 12,75 GHz	-97 dBm/Hz

Table 20. Wideband spurious emission limits for receivers

Test Procedure: The EUT was directly connected to a SA through a 10dB antenuator. Cable loss has been pre-programmed into SA.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 4.3.7.2.

Test Engineer: Lionel Gabrillo

Test Date: 10/25/11

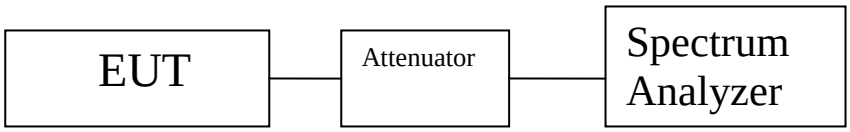
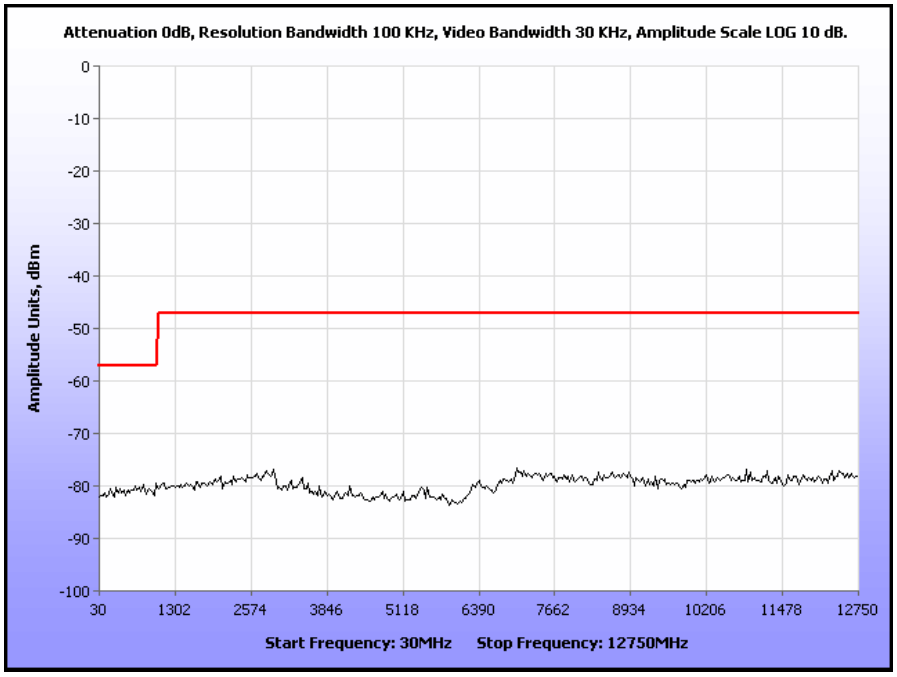


Figure 7. Receiver Spurious Emissions

Conducted Receiver Spurious Emissions, Test Results



Plot 107. Conducted Receiver Spurious Emissions, 30 MHz – 12.75 GHz

Conformance Requirements

4.3.7 Receiver Spurious Emissions – Radiated

Test Requirement(s): 4.3.7.1 Definition

Receiver spurious emissions are emissions at any frequency when the equipment is in received mode.

4.3.7.2 Limit

The spurious emissions of the receiver shall not exceed the values in tables Table 19 and Table 21 and in the indicated bands.

Frequency Range	Limit
30 MHz to 1 GHz	-57 dBm
above 1 GHz to 12,75 GHz	-47 dBm

Table 21. Narrowband spurious emission limits for receivers

The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage. The measurement bandwidth for such emissions may be as small as necessary to get a reliable measurement result.

Wideband emissions shall not exceed the values given in Table 22.

Frequency Range	Limit
30 MHz to 1 GHz	-107dBm/Hz
above 1 GHz to 12,75 GHz	-97 dBm/Hz

Table 22. Wideband spurious emission limits for receivers

Test Procedure: The EUT was placed on a 1.5m high wooden table inside a semi-anechoic chamber. The measurements were performed using normal operation of the equipment. The method of testing, test conditions, and test procedures of *Annex B* were used. The frequencies and amplitudes of field strengths were recorded for reference during final measurements.

The receive antenna was adjusted in order to find the maximum emission. The table was also rotated about 360^0. Both vertical and horizontal polarizations were used to determine the maximum emission.

Measurements were made at 3m.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 4.3.7.2.

Test Engineer: Lionel Gabrillo

Test Date: 10/25/11

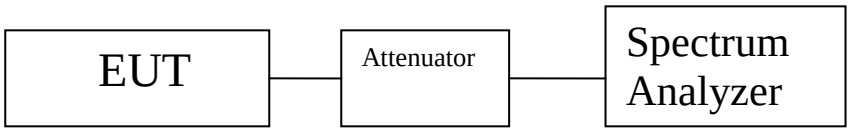
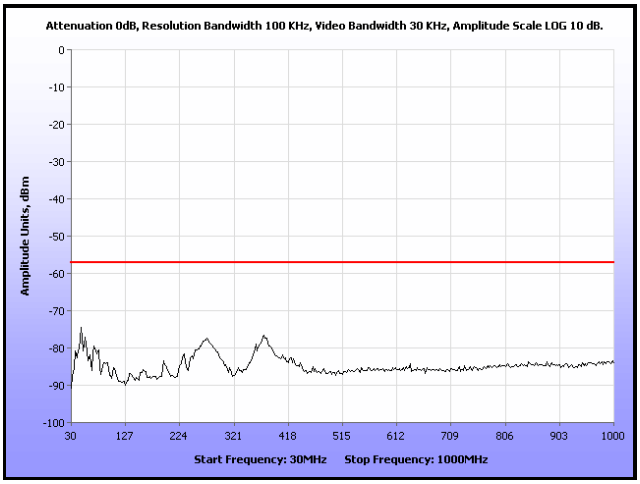
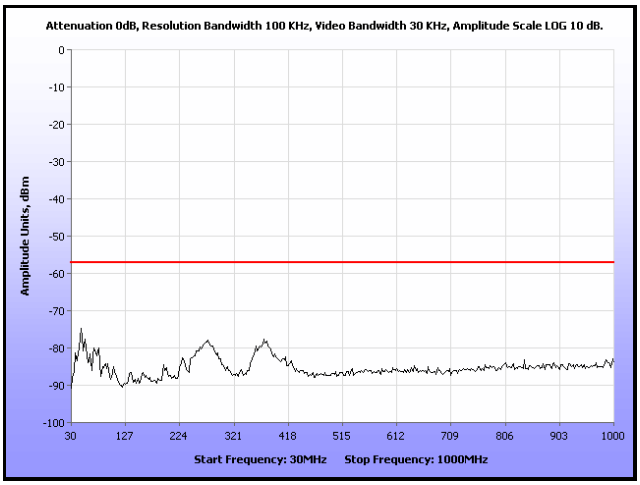


Figure 8. Receiver Spurious Emissions

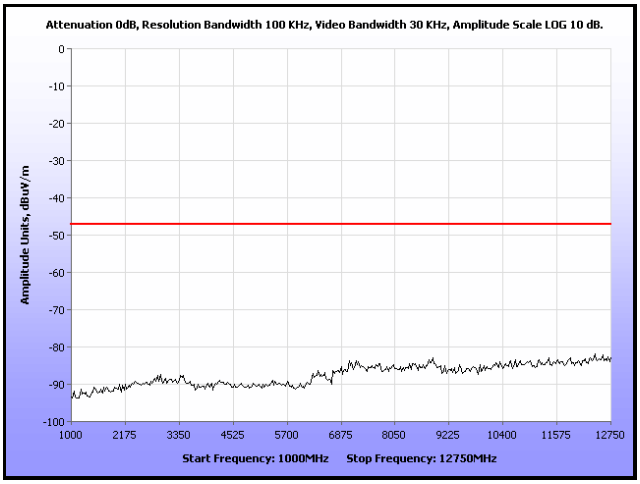
Receiver Spurious Emissions – Radiated, Test Results



Plot 108. Ambient 30 MHz – 1 GHz



Plot 109. Radiated Receiver Spurious Emissions, 30 MHz – 1 GHz



Plot 110. Radiated Receiver Spurious Emissions, 1 GHz – 12.75 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
1S2198	HORN ANTENNA	EMCO	3115	9/29/2011	9/29/2012
1S2603	HORN ANTENNA	ETS-Lindgren	3117	4/15/2011	4/15/2013
1S2583	ANALYZER, SPECTRUM	AGILENT	E4447A	03/18/2011	03/18/2012
1S2460	ANALYZER, SPECTRUM	AGILENT	E4407B	07/12/2011	07/12/2012
1S2482	CHAMBER, 5 METER	PANASHIELD	641431	11/13/2010	11/13/2011
1S2399	TURNTABLE CONTROLLER	SUNOL SCIENCE	SC99V	SEE NOTE	
1S2498	VARIABLE POWER SUPPLY	ISE., INC	5021CT-DVAM	SEE NOTE	
1S2229	TEMPERATURE CHAMBER	TENNY	T6	02/18/2011	02/18/2012
1S2484	BILOG ANTENNA	TESEQ	CBL6112D	2/27/2011	2/27/2012

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

End of Report

