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Test report

262215-1TRFWL

Date of issue: July 25, 2014

Applicant:

Ericsson WiFi Inc.

Product:

DRU-E

Model:

B5CH118AA

FCC ID:

RAR50005001

IC Registration number:

4674A-50005001

Specifications:

- FCC 47 CFR Part 15 Subpart E, §15.407
  Unlicensed National Information Infrastructure Devises
- RSS-210, Issue 8, December 2010, Annex 9
  Local Area Network Devices

Test location

Company name:	Nemko Canada Inc.
Address:	303 River Road
City:	Ottawa
Province:	Ontario
Postal code:	K1V 1H2
Country:	Canada
Telephone:	+1 613 737 9680
Facsimile:	+1 613 737 9691
Toll free:	+1 800 563 6336
Website:	www.nemko.com
Site number:	FCC: 176392; IC: 2040A-4 (3 m semi anechoic chamber)

Tested by:	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by:	Kevin Rose, Wireless/EMC Specialist
Date:	July 25, 2014
Signature:	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Ericsson WiFi Inc.
Address	6300 Legacy Drive
City	Plano
Province/State	TX
Postal/Zip code	75024
Country	USA

1.2 Test specifications

FCC 47 CFR Part 15, Subpart E, Clause 15.407	Unlicensed National Information Infrastructure Devises
RSS-210, Issue 8, December 2010, Annex 9	Local Area Network Devices

1.3 Test methods

789033 D02 General UNII Test Procedures New Rules v01 (June 6, 2014)	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E
662911 D01 Multiple Transmitter Output v02r01 (October 31, 2013)	Emissions testing of transmitters with multiple outputs in the same band (MIMO)
662911 D02 MIMO with Cross Polarized Antenna v01 (October 25, 2011)	Emissions testing of transmitters with multiple outputs in the same band (MIMO) with Cross Polarized Antenna
ANSI C64.3 v 2003	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]

Notes: [1]Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

[2]The Antennas are located within the enclosure of EUT and not user accessible.

2.2 FCC Part 15 Subpart E, test results

Part	Test description	Verdict
§15.403(i)	Emission bandwidth	Not applicable
§15.407(a)(1)	5.15–5.25 GHz band power and density limits	Pass
§15.407(a)(2)	5.25–5.35 GHz and 5.47–5.725 GHz bands power and density limits	Not applicable
§15.407(a)(3)	5.725–5.850 GHz band power and density limits	Not applicable
§15.407(b)(1)	5.15–5.25 GHz band undesired emission limits	Pass
§15.407(b)(2)	5.25–5.35 GHz band undesired emission limits	Not applicable
§15.407(b)(3)	5.47–5.725 GHz band undesired emission limits	Not applicable
§15.407(b)(4)	5.725–5.850 GHz band undesired emission limits	Not applicable
§15.407(b)(6)	Unwanted emissions below 1 GHz	Pass
§15.407(b)(7)	Radiated emissions within restricted bands	Pass
§15.407(e)	6 dB bandwidth for 5.725–5.850 GHz band	Pass
§15.407(g)	Frequency stability	Pass
§15.407(h)(1)	Transmit power control (TPC)[1]	Not applicable
§15.407(h)(2)	Dynamic Frequency Selection (DFS)[1]	Not applicable

Note: [1]Not applicable for devices operating within 5.15–5.25 GHz U-NII band.

2.3 IC RSS-GEN, Issue 3, test results

Part	Test description	Verdict
4.6.1	Occupied bandwidth	Pass
4.7	Transmitter frequency stability	Not applicable
6.1	Receiver spurious emissions limits (radiated)	Not applicable
6.2	Receiver spurious emissions limits (antenna conducted)	Not applicable
7.2.4	AC power lines conducted emission limits	Pass

Notes: [1]According to Notice 2012-DRS0126 (from January 2012) section 2.2 of RSS-Gen, Issue 3 has been revised. The EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.4 IC RSS-210, Issue 8, test results

Part	Test description	Verdict
A9.2	Transmitter power and e.i.r.p. limits	
A9.2 (1)	5150–5250 MHz band	Pass
A9.2 (2)	5250–5350 MHz and 5470–5725 MHz bands	Not applicable
A9.2 (3)	5725–5825 MHz band	Not applicable
A9.3	Out-of-band emission limits	
A9.3 (1)	5150–5250 MHz band	Pass
A9.3 (2)	5250–5350 MHz band	Not applicable
A9.3 (3)	5470–5725 MHz band	Not applicable
A9.3 (4)	5725–5825 MHz band	Not applicable
A9.4	Dynamic Frequency Selection (DFS) for devices operating in the 5250–5350 MHz and 5470–5725 MHz bands	Not applicable
A9.5	Other Requirements for all bands	
A9.5 (a)	Digital modulation	Pass
A9.5 (b)	PSD to average power ratio	Pass
A9.5 (c)	Test frequencies	Pass
A9.5 (d)	Discontinuation of transmission	Not applicable
A9.5 (e)	Transmitter frequency stability	Not applicable
A9.5 (f)	Mobile satellite services	Not applicable

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	November 15, 2013
Nemko sample ID number	1, 2

3.2 EUT information

Product name	DRU-E 5.3 GHz radio
Model	B5CH118AA
Serial number	M142980021

3.3 Technical information

Operating band	5150–5250 MHz
Operating frequency	5180–5220 MHz (20 MHz channel) and 5190–5210 MHz (40 MHz channel)
Modulation type	802.11a/n
Occupied bandwidth (99 %)	17.16 MHz (802.11a); 18.24 MHz (802.11n HT20); 37.12 MHz (802.11n HT40)
Emission designator	W7D
Power requirements	120 V_{AC}, 60 Hz
Antenna information	Ericsson WiFi Inc., MN# B1BG123AA-A Rev A02, 6.5 dBi (3 ×) antennas Ericsson WiFi Inc., MN# B1BG154AA-A, 4.0 dBi (3 ×) antennas The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The EUT is a 3×3 MIMO combo Wi-Fi module designed to operate in the 2.4 GHz band, and 5 GHz bands. There are two independent radio units. This report covers only the 5.1 GHz radio band.

3.5 EUT exercise details

The EUT was controlled to transmit at desired frequency and modulation from laptop using Art GUI software and telnet session.

3.6 EUT setup diagram

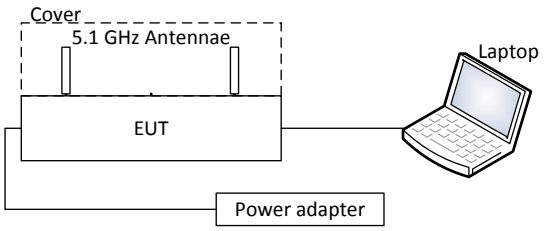


Figure 3.6-1: Setup diagram

3.7 EUT sub assemblies

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
Laptop	Toshiba	Satellite	Asset number: 441
I.T.E. Power Supply	Leader Electronics Inc.	MU24-B480050-A1	None

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Nemko Canada Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 “Uncertainty in EMC measurements.” Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Mar. 18/15
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Power source	California Instruments	5001ix	FA002494	1 year	Oct. 22/14
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Oct. 24/14
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Jan. 27/15
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Mar. 12/15
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Mar. 10/15
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	2 year	Sept. 06/14
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 21/14
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Oct. 28/14
Power meter	Agilent	N1911A	FA001946	1 year	Mar. 04/15
Power sensor	Agilent	N1922A	FA001947	1 year	Mar. 04/15
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR
Multimeter	Fluke	16	FA001831	1 year	Feb. 04/15

Note: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 FCC 15.207(a) and RSS-Gen 7.2.4 AC power line conducted emissions limits

8.1.1 Definitions and limits

FCC:
Except as shown in paragraphs (b) and (c) of this section, 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 30 MHz, 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.

IC:
The purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network.

Except when the requirements applicable to a given device state otherwise, for any licence-exempt radiocommunication device equipped to operate from the public utility AC power supply, either directly or indirectly, the radio frequency voltage that is conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in Table 2. The tighter limit applies at the frequency range boundaries.

The conducted emissions shall be measured with a 50 Ω/50 µH line impedance stabilization network (LISN).

Table 8.1-1: Conducted emissions limit

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * - Decreases with the logarithm of the frequency.

8.1.2 Test summary

Test date	November 22, 2013	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	32 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

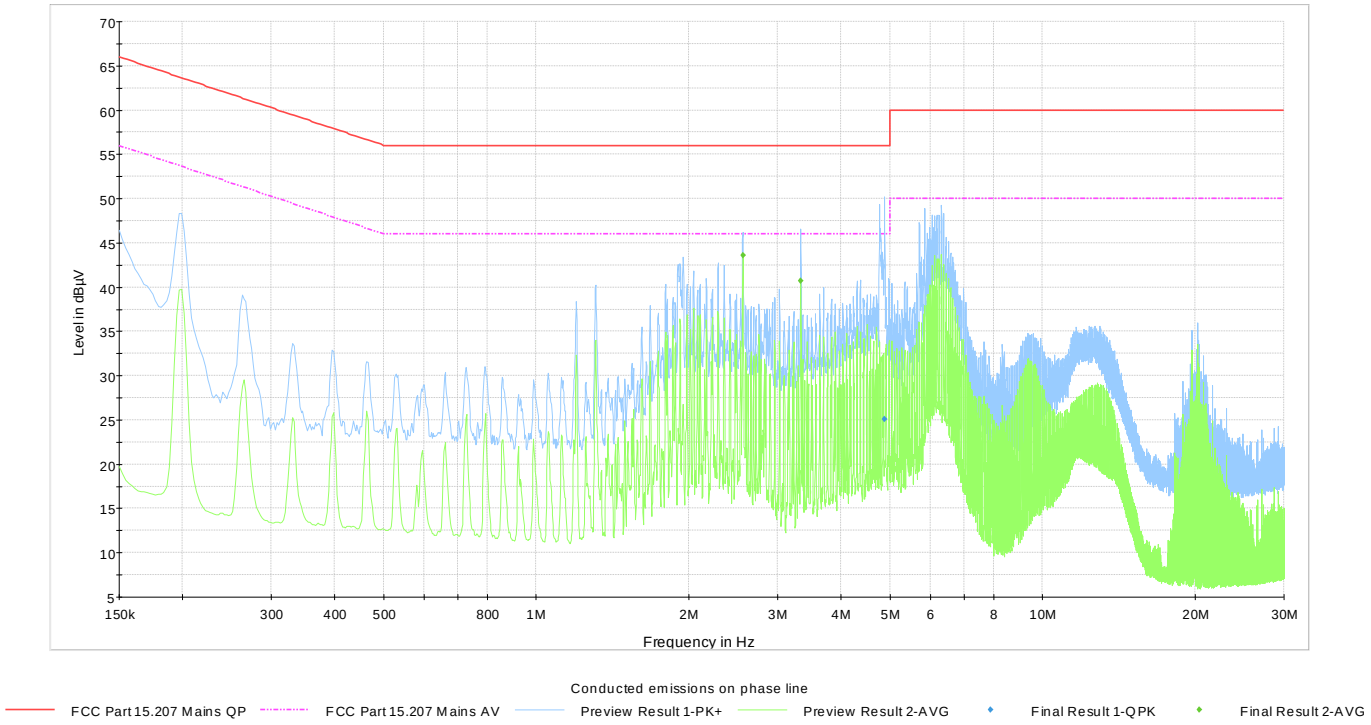
Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time:	100 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.1.4 Test data



Plot 8.1-1: Conducted emissions on phase line

Table 8.1-2: Quasi-Peak conducted emissions results on phase line

Frequency, MHz	Q-Peak result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
4.877250	25.0	1000.0	9	On	10.1	31.0	56.0

Note: 43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

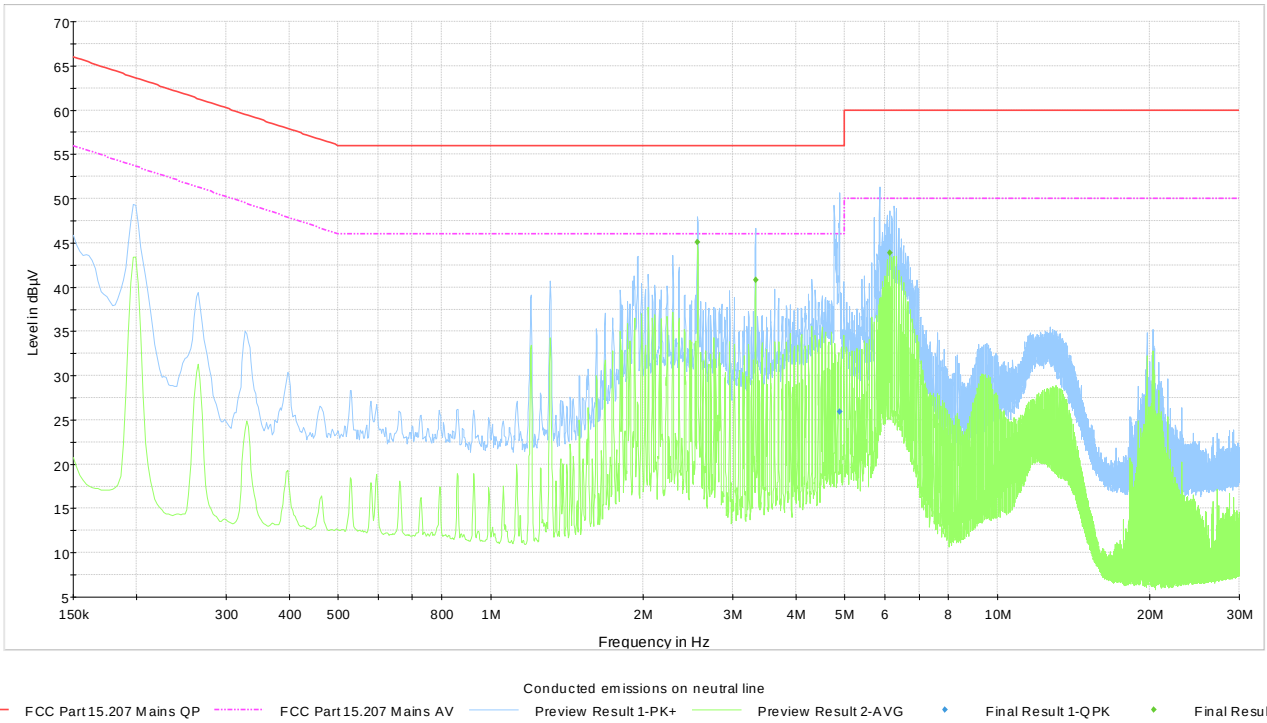
Table 8.1-3: Average conducted emissions results on phase line

Frequency, MHz	Average result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
2.559750	43.5	1000.0	9	On	10.0	2.5	46.0
3.329250	40.7	1000.0	9	On	10.1	5.3	46.0

Sample calculation:
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
Result (dBµV) = XX dBµV (reading from receiver) + XX dB (Correction factor)

Example:
43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

8.1.4 Test data, continued



Plot 8.1-2: Conducted emissions on neutral line

Table 8.1-4: Quasi-Peak conducted emissions results on neutral line

Frequency, MHz	Q-Peak result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
4.877250	25.9	1000.0	9	On	10.1	30.1	56.0

Note: 43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

Table 8.1-5: Average conducted emissions results on neutral line

Frequency, MHz	Average result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
2.559750	45.1	1000.0	9	On	10.0	0.9	46.0
3.329250	40.8	1000.0	9	On	10.1	5.2	46.0
6.119250	43.9	1000.0	9	On	10.1	6.1	50.0

Sample calculation:
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
Result (dBµV) = XX dBµV (reading from receiver) + XX dB (Correction factor)

Example:
43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

8.2 FCC 15.403(i) Emission bandwidth

8.2.1 Definitions and limits

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

8.2.2 Test summary

Test date	June 16, 2014	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	31 %

8.2.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	≥ 1 % of emission BW
Video bandwidth	≥3 × RBW
Frequency span	30 MHz for 20 MHz channel; 50 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: 26 dB bandwidth results for ch0

Modulation	Frequency, MHz	26 dB bandwidth, MHz
802.11a	5180	23.46
	5200	23.76
	5220	23.28
802.11n HT20	5180	24.30
	5200	24.72
	5220	24.30
802.11n HT40	5190	47.98
	5210	47.31

Table 8.2-2: 26 dB bandwidth results for ch1

Modulation	Frequency, MHz	26 dB bandwidth, MHz
802.11a	5180	23.82
	5200	23.40
	5220	23.88
802.11n HT20	5180	24.18
	5200	24.48
	5220	24.24
802.11n HT40	5190	47.50
	5210	47.50

8.2.4 Test data, continued

Table 8.2-3: 26 dB bandwidth results for ch2

Modulation	Frequency, MHz	26 dB bandwidth, MHz
802.11a	5180	23.88
	5200	23.16
	5220	23.52
802.11n HT20	5180	24.54
	5200	24.00
	5220	24.42
802.11n HT40	5190	47.98
	5210	47.69

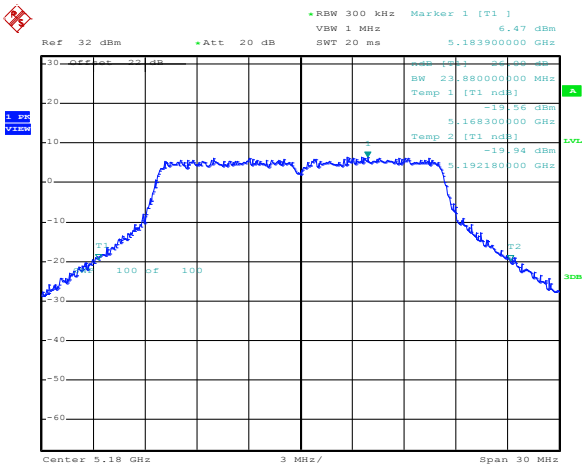


Figure 8.2-1: 26 dB bandwidth on 802.11a, sample plot

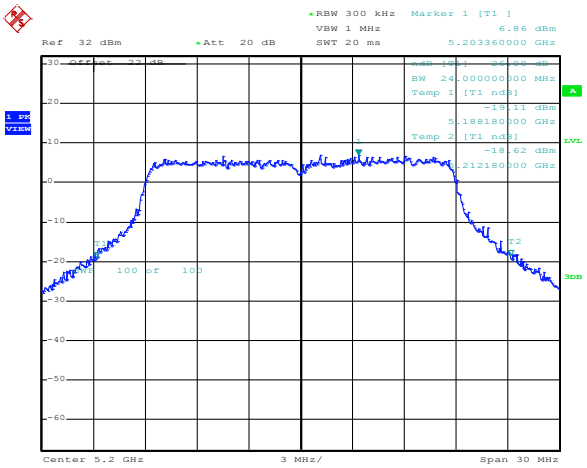


Figure 8.2-2: 26 dB bandwidth on 802.11n HT20, sample plot

8.2.4 Test data, continued

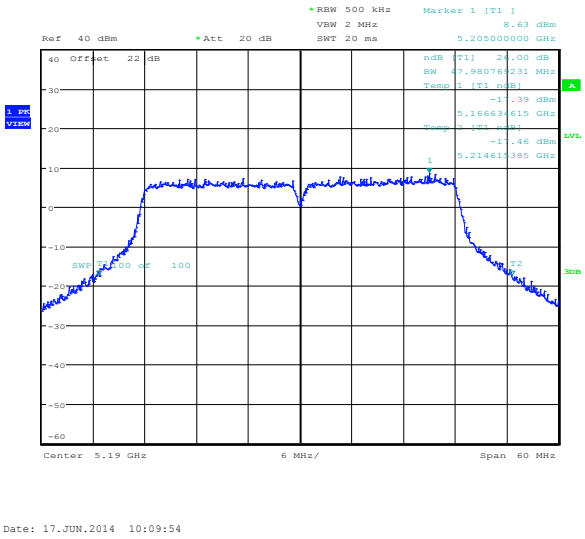


Figure 8.2-3: 26 dB bandwidth on 802.11n HT40, sample plot

8.3 RSS-Gen 4.6.1 Occupied bandwidth

8.3.1 Definitions and limits

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 percent emission bandwidth, as calculated or measured.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1 percent of the selected span as is possible without being below 1 percent. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used since a peak or, peak hold, may produce a wider bandwidth than actual.

The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 percent of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded.

The span between the two recorded frequencies is the occupied bandwidth.

8.3.2 Test summary

Test date	June 16, 2014	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	31 %

8.3.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	≥ 1 % of span
Video bandwidth	≥3 × RBW
Frequency span	30 MHz for 20 MHz channel; 50 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

8.3.4 Test data

Table 8.3-1: 99 % bandwidth results

Modulation	99 % bandwidth, MHz
802.11a	17.16
802.11n HT20	18.24
802.11n HT40	37.12

8.3.4 Test data, continued

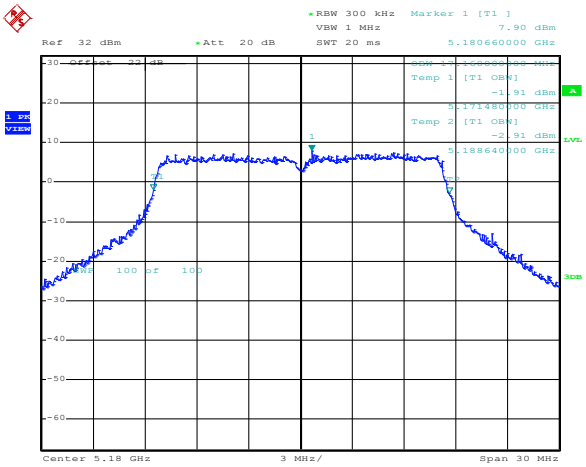


Figure 8.3-1: 99 % bandwidth on 802.11a, sample plot

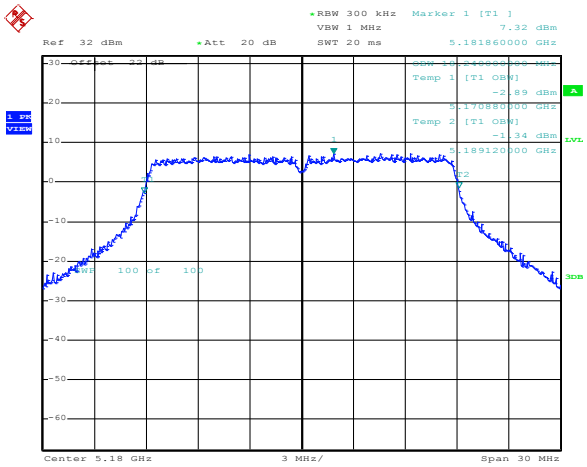


Figure 8.3-2: 99 % bandwidth on 802.11n HT20, sample plot

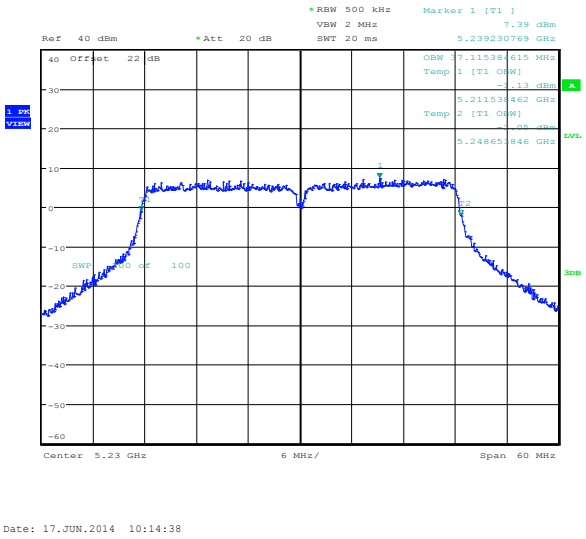


Figure 8.3-3: 99 % bandwidth on 802.11n HT40, sample plot

8.4 FCC 15.407(a)(1) and RSS-210 A9.2(1) 5.15–5.25 GHz band output power, EIRP and spectral density limits

8.4.1 Definitions and limits

FCC:

(i) For an outdoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15–5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(4) The maximum conducted output power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage.

(5) The maximum power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements in the 5.15–5.25 GHz, 5.25–5.35 GHz, and the 5.47–5.725 GHz bands are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

IC:

The maximum e.i.r.p. shall not exceed 200 mW (23 dBm) or $10 + 10 \log_{10}$ (B), dBm, whichever power is less. B is the 99 % emission bandwidth in MHz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1 MHz band.

8.4.2 Test summary

Test date	June 18, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	32 %

8.4.3 Observations, settings and special notes

The output power test was performed according to 789033 D02 General UNII Test Procedures section E) 3) a) Method PM: maximum conducted (average) output power using wideband RF average power meter with a thermocouple detector.
The PPSD test was performed according to 789033 D01 General UNII Test Procedures section F.
Combined average output power was calculated as follows: $P_{combined} = 10 \times log_{10}\left(\left(10^{P_{ch0}/10}\right) + \left(10^{P_{ch1}/10}\right) + \left(10^{P_{ch2}/10}\right)\right)$
EIRP was calculated as follows: $EIRP = P_{combined} + antenna\ gain$
Combined PPSD was calculated as follows: $PPSD_{combined} = 10 \times log_{10}\left(\left(10^{PSD_{ch0}/10}\right) + \left(10^{PSD_{ch1}/10}\right) + \left(10^{PSD_{ch2}/10}\right)\right)$
Total gain = single antenna gain + 10 × $\log_{10}$ (N), where N is number of correlated/beam-forming antennas

Table 8.4-1: Elevation vs gain table for MN# B1BG123AA-A Rev A02, 6.5 dBi antenna

Angle, deg	Antenna gain, dBi
90	-18.7
88	-14.7
86	-12.3
84	-9.9
82	-8.9
80	-8.6
78	-8.8
76	-9.6
74	-10.6
72	-10.6
70	-10.3
68	-10.8
66	-9.9
64	-8.1
62	-6.9
60	-6.5
58	-6.9
56	-6.8
54	-6.2
52	-6.3
50	-7.3
48	-8.7
46	-8.8
44	-8.4
42	-7.7
40	-7.6
38	-7.4
36	-6.5
34	-5.7
32	**-5.3**
30	-5.5

Note: 4 dBi antenna gain configuration has ≤ 21 dBm EIRP results, therefore elevation mask is not applicable.

Directional total gain for correlated MIMO 3 × 3 with 6.5 dBi single antenna gain for elevations below 30° was calculated as follows:
Total gain = 6.5 dBi + 10 × $\log_{10}$ (3) – 0.5 dB (cable loss) = 10.77 dBi
Directional total gain for correlated MIMO 3 × 3 with 6.5 dBi single antenna gain for elevations above 30° was calculated as follows:
Total gain = −5.3 dBi + 10 × $\log_{10}$ (3) – 0.5 dB (cable loss) = −1.03 dBi
Directional total gain for correlated MIMO 3 × 3 with 4 dBi single antenna gain was calculated as follows:
Total gain = 4 dBi + 10 × $\log_{10}$ (3) – 0.5 dB (cable loss) = 8.27 dBi
Directional gain for completely uncorrelated MIMO 3 × 3 with 6.5 dBi single antenna gain for elevations below 30° is 6.5 dBi – 0.5 dB (cable loss) = 6 dBi
Directional gain for completely uncorrelated MIMO 3 × 3 with 6.5 dBi single antenna gain for elevations above 30° is −5.3 dBi – 0.5 dB (cable loss) = −5.8 dBi
Directional gain for completely uncorrelated MIMO 3 × 3 with 4 dBi single antenna gain is 4 dBi – 0.5 dB (cable loss) = 3.5 dBi

8.4.3 Observations, settings and special notes, continued

FCC output power limit for correlated 3 × 3 with 6.5 dBi antennas was calculated as follows:

30 dBm − (10.77 dBi – 6 dBi) = 25.23 dBm

FCC PPSD limit was calculated as follows: 17 – (10.77 – 6) = 12.23 dBm/MHz

FCC output power limit for correlated 3 × 3 with 4 dBi antennas was calculated as follows:

30 dBm − (8.27 dBi – 6 dBi) = 27.73 dBm

FCC PPSD limit was calculated as follows: 17 – (8.77 – 0.5 – 6) = 14.73 dBm/MHz

FCC output power limit for completely uncorrelated 3 × 3 with 6.5 dBi antennas is 30.00 dBm
FCC PPSD limit is 17.00 dBm/MHz

FCC output power limit for completely uncorrelated 3 × 3 with 4 dBi antennas (with 0.5 dB cable loss) is 30.00 dBm
FCC PPSD limit is 17.00 dBm/MHz

The 99 % measured occupied bandwidth for 802.11a was 17.16 MHz, for 802.11n HT20 was 18.24 MHz and for 802.11n HT40 was 37.18 MHz.
IC output power limit for 802.11a was calculated as follows: $10 + 10 \times \text{Log}_{10}(17.16) = 22.35$ dBm < 23 dBm, therefore the limit is: 22.35 dBm.
IC output power limit for 802.11n HT20 was calculated as follows: $10 + 10 \times \text{Log}_{10}(18.24) = 22.61$ dBm < 23 dBm, therefore the limit is: 22.61 dBm.
IC output power limit for 802.11n HT40 was calculated as follows: $10 + 10 \times \text{Log}_{10}(37.18) = 25.70$ dBm > 23 dBm, therefore the limit is: 23.00 dBm.
IC PPSD limit is 10 dBm/MHz

8.4.4 Test data

Table 8.4-2: Output power and EIRP measurements results for FCC correlated MIMO 3 × 3 with 6.5 dBi antennas below 30 degree elevation

Modulation	Frequency, MHz	P_{ch0}, dBm	P_{ch1}, dBm	P_{ch2}, dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
802.11a	5180	16.50	16.77	16.30	21.30	25.23	3.93	10.77	32.07	36.00	3.93
	5200	16.30	16.62	16.30	21.18	25.23	4.05	10.77	31.95	36.00	4.05
	5220	16.78	16.14	16.61	21.29	25.23	3.94	10.77	32.06	36.00	3.94
802.11n HT20	5180	16.15	16.17	16.17	20.93	25.23	4.29	10.77	31.70	36.00	4.30
	5200	16.32	16.12	15.79	20.85	25.23	4.38	10.77	31.62	36.00	4.38
	5220	16.62	15.64	16.12	20.92	25.23	4.31	10.77	31.69	36.00	4.31
802.11n HT40	5190	11.68	12.64	13.08	17.28	25.23	7.95	10.77	28.05	36.00	7.95
	5210	14.01	14.31	14.37	19.00	25.23	6.22	10.77	29.77	36.00	6.23

Table 8.4-3: Output power and EIRP measurements results for FCC correlated MIMO 3 × 3 with 6.5 dBi antennas above 30 degree elevation

Modulation	Frequency, MHz	P_{ch0}, dBm	P_{ch1}, dBm	P_{ch2}, dBm	Aggregated power, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
802.11a	5180	16.50	16.77	16.30	21.30	-1.03	20.27	21.00	0.73
	5200	16.30	16.62	16.30	21.18	-1.03	20.15	21.00	0.85
	5220	16.78	16.14	16.61	21.29	-1.03	20.26	21.00	0.74
802.11n HT20	5180	16.15	16.17	16.17	20.93	-1.03	19.90	21.00	1.10
	5200	16.32	16.12	15.79	20.85	-1.03	19.82	21.00	1.18
	5220	16.62	15.64	16.12	20.92	-1.03	19.89	21.00	1.11
802.11n HT40	5190	11.68	12.64	13.08	17.28	-1.03	16.25	21.00	4.75
	5210	14.01	14.31	14.37	19.00	-1.03	17.97	21.00	3.03

Table 8.4-4: Output power and EIRP measurements results for FCC completely uncorrelated MIMO 3 × 3 with 6.5 dBi antennas below 30 degree elevation

Modulation	Frequency, MHz	P_{ch0}, dBm	P_{ch1}, dBm	P_{ch2}, dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
802.11a	5180	18.23	18.58	18.69	23.28	30.00	6.72	6.00	29.28	36.00	6.72
	5200	21.81	21.27	21.27	26.23	30.00	3.77	6.00	32.23	36.00	3.77
	5220	21.67	21.27	21.58	26.28	30.00	3.72	6.00	32.28	36.00	3.72
802.11n HT20	5180	18.19	17.94	18.16	22.87	30.00	7.13	6.00	28.87	36.00	7.13
	5200	21.77	20.54	20.61	25.78	30.00	4.22	6.00	31.78	36.00	4.22
	5220	21.12	21.24	21.55	26.08	30.00	3.92	6.00	32.08	36.00	3.92
802.11n HT40	5190	13.96	15.16	15.61	19.74	30.00	10.26	6.00	25.74	36.00	10.26
	5210	16.83	17.88	17.43	22.17	30.00	7.83	6.00	28.17	36.00	7.83

Table 8.4-5: Output power and EIRP measurements results for FCC completely uncorrelated MIMO 3 × 3 with 6.5 dBi antennas above 30 degree elevation

Modulation	Frequency, MHz	P_{ch0}, dBm	P_{ch1}, dBm	P_{ch2}, dBm	Aggregated power, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
802.11a	5180	18.23	18.58	18.69	23.28	-5.80	17.48	21.00	3.52
	5200	21.81	21.27	21.27	26.23	-5.80	20.43	21.00	0.57
	5220	21.67	21.27	21.58	26.28	-5.80	20.48	21.00	0.52
802.11n HT20	5180	18.19	17.94	18.16	22.87	-5.80	17.07	21.00	3.93
	5200	21.77	20.54	20.61	25.78	-5.80	19.98	21.00	1.02
	5220	21.12	21.24	21.55	26.08	-5.80	20.28	21.00	0.72
802.11n HT40	5190	13.96	15.16	15.61	19.74	-5.80	13.94	21.00	7.06
	5210	16.83	17.88	17.43	22.17	-5.80	16.37	21.00	4.63

8.4.4 Test data, continued

Table 8.4-6: Output power and EIRP measurements results for FCC correlated MIMO 3 × 3 with 4 dBi antennas

Modulation	Frequency, MHz	P_{ch0}, dBm	P_{ch1}, dBm	P_{ch2}, dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
802.11a	5180	7.12	7.54	7.7	12.23	27.73	15.50	8.27	20.50	21.00	0.50
	5200	7.34	7.04	6.73	11.82	27.73	15.91	8.27	20.09	21.00	0.91
	5220	7.71	6.81	7.09	11.99	27.73	15.74	8.27	20.26	21.00	0.74
802.11n HT20	5180	7.11	6.68	7.12	11.75	27.73	15.98	8.27	20.02	21.00	0.98
	5200	7.29	7	6.73	11.78	27.73	15.95	8.27	20.05	21.00	0.95
	5220	7.66	6.83	7.05	11.97	27.73	15.76	8.27	20.24	21.00	0.76
802.11n HT40	5190	7.32	7.42	7.37	12.14	27.73	15.59	8.27	20.41	21.00	0.59
	5210	7.38	7.66	7.13	12.17	27.73	15.56	8.27	20.44	21.00	0.56

Table 8.4-7: Output power and EIRP measurements results for FCC completely uncorrelated MIMO 3 × 3 with 4 dBi antennas

Modulation	Frequency, MHz	P_{ch0}, dBm	P_{ch1}, dBm	P_{ch2}, dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
802.11a	5180	11.73	12.08	12.19	16.78	30.00	13.22	3.50	20.28	21.00	0.72
	5200	12.81	11.77	11.77	16.92	30.00	13.08	3.50	20.42	21.00	0.58
	5220	12.67	11.27	11.58	16.65	30.00	13.35	3.50	20.15	21.00	0.85
802.11n HT20	5180	11.69	11.44	11.66	16.37	30.00	13.63	3.50	19.87	21.00	1.13
	5200	13.27	11.54	11.11	16.85	30.00	13.15	3.50	20.35	21.00	0.65
	5220	12.62	11.74	11.55	16.77	30.00	13.23	3.50	20.27	21.00	0.73
802.11n HT40	5190	11.82	11.92	11.87	16.64	30.00	13.36	3.50	20.14	21.00	0.86
	5210	11.88	11.66	11.63	16.50	30.00	13.50	3.50	20.00	21.00	1.00

Table 8.4-8: PPSD measurements results for FCC correlated MIMO 3 × 3 with 6.5 dBi antennas

Modulation	Frequency, MHz	Measured Peak Power Spectral Density (PPSD), dBm/MHz				PPSD limit, dBm/MHz	Margin, dB
		On ch0	On ch1	On ch2	Combined		
802.11a	5180	5.01	5.70	5.24	10.10	12.23	2.13
	5200	5.26	5.52	5.22	10.11	12.23	2.12
	5220	5.81	5.11	5.64	10.30	12.23	1.93
802.11n HT20	5180	4.80	4.78	4.88	9.59	12.23	2.64
	5200	4.94	4.71	4.40	9.46	12.23	2.77
	5220	5.36	4.33	4.81	9.62	12.23	2.60
802.11n HT40	5190	-2.29	-1.49	-0.90	3.25	12.23	8.98
	5210	0.14	0.43	0.47	5.12	12.23	7.11

Table 8.4-9: PPSD measurements results for FCC correlated MIMO 3 × 3 with 4 dBi antennas

Modulation	Frequency, MHz	Measured Peak Power Spectral Density (PPSD), dBm/MHz				PPSD limit, dBm/MHz	Margin, dB
		On ch0	On ch1	On ch2	Combined		
802.11a	5180	-4.04	-3.50	-3.33	1.16	14.73	13.57
	5200	-3.75	-4.06	-4.35	0.72	14.73	14.00
	5220	-3.28	-4.20	-3.88	1.00	14.73	13.73
802.11n HT20	5180	-4.28	-4.69	-4.25	0.37	14.73	14.36
	5200	-4.08	-4.42	-4.66	0.39	14.73	14.34
	5220	-3.65	-4.48	-4.25	0.66	14.73	14.07
802.11n HT40	5190	-6.76	-6.71	-6.70	-1.95	14.73	16.68
	5210	-6.59	-6.35	-6.86	-1.82	14.73	16.55

8.4.4 Test data, continued

Table 8.4-10: PPSD measurements results for FCC completely correlated MIMO 3 × 3 with 6.5 dBi antennas

Modulation	Frequency, MHz	Measured Peak Power Spectral Density (PPSD), dBm/MHz				PPSD limit, dBm/MHz	Margin, dB
		On ch0	On ch1	On ch2	Combined		
802.11a	5180	7.21	7.52	7.61	12.22	17.00	4.78
	5200	10.72	10.20	10.19	15.15	17.00	1.85
	5220	10.69	10.24	10.57	15.28	17.00	1.72
802.11n HT20	5180	6.80	6.58	6.86	11.52	17.00	5.48
	5200	10.39	9.13	9.24	14.40	17.00	2.60
	5220	9.82	9.95	10.28	14.79	17.00	2.21
802.11n HT40	5190	0.03	1.10	1.57	5.72	17.00	11.28
	5210	3.01	3.94	3.55	8.29	17.00	8.71

Table 8.4-11: PPSD measurements results for FCC completely correlated MIMO 3 × 3 with 4 dBi antennas

Modulation	Frequency, MHz	Measured Peak Power Spectral Density (PPSD), dBm/MHz				PPSD limit, dBm/MHz	Margin, dB
		On ch0	On ch1	On ch2	Combined		
802.11a	5180	-0.54	0.00	0.17	4.66	17.00	12.34
	5200	0.75	-0.06	0.15	5.06	17.00	11.94
	5220	0.72	-0.20	0.12	5.00	17.00	12.00
802.11n HT20	5180	-0.78	-1.19	-0.75	3.87	17.00	13.13
	5200	0.92	0.58	0.34	5.39	17.00	11.61
	5220	0.35	-0.48	-0.25	4.66	17.00	12.34
802.11n HT40	5190	-2.26	-2.21	-2.20	2.55	17.00	14.45
	5210	-2.09	-2.35	-2.36	2.51	17.00	14.49

Table 8.4-12: Output power measurements results for IC

Modulation	Frequency, MHz	Conducted average output power, dBm					Margin, dB
		On ch0	On ch1	On ch2	Combined	Limit	
802.11a	5180	16.50	16.21	16.30	21.11	22.35	1.24
	5200	16.33	16.31	16.30	21.08	22.35	1.27
	5220	16.31	16.12	16.14	20.96	22.35	1.39
802.11n HT20	5180	16.15	16.17	16.17	20.93	22.61	1.68
	5200	16.36	16.34	16.80	21.28	22.61	1.33
	5220	16.77	16.55	16.16	21.27	22.61	1.34
802.11n HT40	5190	11.68	12.64	13.08	17.28	23.00	5.72
	5210	14.01	14.31	14.37	19.00	23.00	4.00

8.4.4 Test data, continued

Table 8.4-13: PSD measurements results for IC

Modulation	Frequency, MHz	Measured Power Spectral Density (PSD), dBm/MHz				PSD limit, dBm/MHz	Margin, dB
		On ch0	On ch1	On ch2	Combined		
802.11a	5180	5.01	5.17	5.24	9.91	10.00	0.09
	5200	5.26	5.24	5.19	10.00	10.00	0.00
	5220	5.26	5.22	5.15	9.98	10.00	0.02
802.11n HT20	5180	4.80	4.78	4.88	9.59	10.00	0.41
	5200	4.97	4.97	5.45	9.91	10.00	0.09
	5220	5.48	5.27	4.85	9.98	10.00	0.02
802.11n HT40	5190	-2.29	-1.49	-0.90	3.25	10.00	6.75
	5210	0.14	0.43	0.47	5.12	10.00	4.88

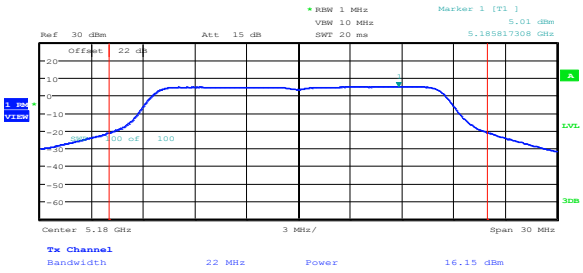


Figure 8.4-1: Sample plot for PSD on 802.11a

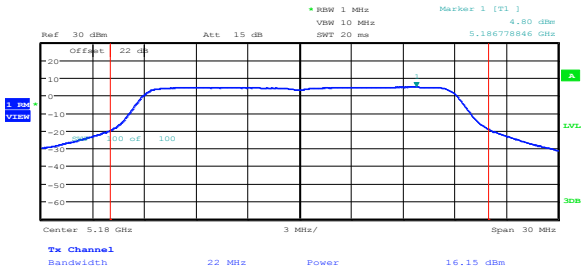


Figure 8.4-2: Sample plot for PSD on 802.11n HT20

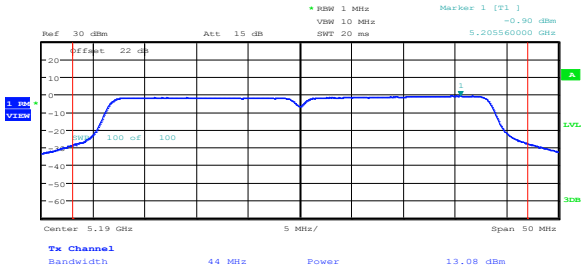


Figure 8.4-3: Sample plot for PSD on 802.11n HT40

8.5 FCC 15.407(b) and RSS-210 A9.2(1) Spurious (out-of-band) emissions

8.5.1 Definitions and limits

FCC:
(1) For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of −27 dBm/MHz.
(5) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.
(6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209.
(7) The provisions of § 15.205 apply to intentional radiators operating under this section.
(8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency block edges as the design of the equipment permits.

IC:
Emissions outside the band 5150–5250 MHz shall not exceed −27 dBm/MHz e.i.r.p.
The outermost carrier frequencies or channels, as permitted by the design of the equipment, shall be used when measuring unwanted emissions. Such carrier or channel center frequencies are to be indicated in the test report.

RSS-Gen 7.2.2 Emissions falling within restricted frequency bands
Restricted bands, identified in below, are designated primarily for safety-of-life services (distress calling and certain aeronautical bands), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following restrictions apply:
(a) fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of below;
(b) unwanted emissions falling into restricted bands of below shall comply with the limits specified in RSS-Gen;
(c) unwanted emissions not falling within restricted frequency bands shall either comply with the limits specified in the applicable RSS, or with those specified in RSS-Gen.

Table 8.5-1: FCC §15.209 and RSS-Gen – Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490*	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705*	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0*	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: Applicable only to FCC requirements
In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

8.5.1 Definitions and limits, continued

Table 8.5-2: IC restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	12.51975–12.52025	399.9–410	5.35–5.46
2.1735–2.1905	12.57675–12.57725	608–614	7.25–7.75
3.020–3.026	13.36–13.41	960–1427	8.025–8.5
4.125–4.128	16.42–16.423	1435–1626.5	9.0–9.2
4.17725–4.17775	16.69475–16.69525	1645.5–1646.5	9.3–9.5
4.20725–4.20775	16.80425–16.80475	1660–1710	10.6–12.7
5.677-5.683	25.5–25.67	1718.8–1722.2	13.25–13.4
6.215–6.218	37.5–38.25	2200–2300	14.47–14.5
6.26775–6.26825	73–74.6	2310–2390	15.35–16.2
6.31175–6.31225	74.8–75.2	2655–2900	17.7–21.4
8.291–8.294	108–138	3260–3267	22.01–23.12
8.362–8.366	156.52475–156.52525	3332–3339	23.6–24.0
8.37625–8.38675	156.7–156.9	3345.8–3358	31.2–31.8
8.41425–8.41475	240–285	3500–4400	36.43–36.5
12.29–12.293	322–335.4	4500–5150	Above 38.6

Note: Certain frequency bands listed in Table 8.5-2 and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

Table 8.5-3: FCC restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
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	2690–2900	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	Above 38.6
13.36–13.41			

8.5.2 Test summary

Test date	June 12, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	32 %

8.5.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 40 GHz.
EUT was set to transmit with 100 % duty cycle.
Radiated measurements were performed at a distance of 3 m, the EUT was transmitting on both MIMO chains simultaneously. Radiated emissions were performed while both antenna connectors were terminated with 50 Ω load.

Spectrum analyser for peak conducted measurements within restricted bands below 1 GHz:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold

Average limit line was calculated as follows:
For correlated MIMO 3 × 3 with 6.5 dBi antenna: 54 dBµV/m – 95.23 dB – 10 × $\log_{10}$ (3) dB − (6.5 + 10 × $\log_{10}$ (3)) dBi − 4.7 dB = −61.97 dBm
For correlated MIMO 3 × 3 with 4 dBi antenna: 54 dBµV/m – 95.23 dB – 10 × $\log_{10}$ (3) dB – (4 + 10 × $\log_{10}$ (3)) dBi − 4.7 dB = −59.47 dBm
For completely uncorrelated MIMO 3 × 3 with 6.5 dBi antenna: 54 dBµV/m – 95.23 dB – 10 × $\log_{10}$ (3) dB – 6.5 dBi − 4.7 dB = −57.20 dBm
For completely uncorrelated MIMO 3 × 3 with 4 dBi antenna: 54 dBµV/m – 95.23 dB – 10 × $\log_{10}$ (3) dB – 4 dBi − 4.7 dB = −54.70 dBm

Spectrum analyser for peak conducted measurements within restricted bands above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace mode	Max Hold

Average limit line was calculated as follows:
For correlated MIMO 3 × 3 with 6.5 dBi antenna: 54 dBµV/m – 95.23 dB – 10 × $\log_{10}$ (3) − (6.5 + 10 × $\log_{10}$ (3)) dBi = −57.27 dBm
For correlated MIMO 3 × 3 with 4 dBi antenna: 54 dBµV/m – 95.23 dB – 10 × $\log_{10}$ (3) – (4 + 10 × $\log_{10}$ (3)) dBi = −54.77 dBm
For completely uncorrelated MIMO 3 × 3 with 6.5 dBi antenna: 54 dBµV/m – 95.23 dB – 10 × $\log_{10}$ (3) – 6.5 dBi = −52.50 dBm
For completely uncorrelated MIMO 3 × 3 with 4 dBi antenna: 54 dBµV/m – 95.23 dB – 10 × $\log_{10}$ (3) – 4 dBi = −50.00 dBm

Spectrum analyser for average conducted measurements within restricted bands above 1 GHz for frequencies where peak results were above the average limit:

Resolution bandwidth	1 MHz
Video bandwidth	10 MHz
Detector mode	RMS
Trace mode	Power average
Number of averaging traces	100

Peak limit is 20 dB higher than the average limit.

Spectrum analyser for peak conducted measurements outside restricted bands:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace mode	Max Hold

The limit line was calculated as follows:
For correlated MIMO 3 × 3 with 6.5 dBi antenna: −27 dBm/MHz – 10 × $\log_{10}$ (3) − (6.5 + 10 × $\log_{10}$ (3)) dBi = −43.04 dBm/MHz
For correlated MIMO 3 × 3 with 4 dBi antenna: −27 dBm/MHz – 10 × $\log_{10}$ (3) – (4 + 10 × $\log_{10}$ (3)) dBi = −40.54 dBm/MHz
For completely uncorrelated MIMO 3 × 3 with 6.5 dBi antenna: −27 dBm/MHz – 10 × $\log_{10}$ (3) – 6.5 dBi = −38.27 dBm/MHz
For completely uncorrelated MIMO 3 × 3 with 4 dBi antenna: −27 dBm/MHz – 10 × $\log_{10}$ (3) – 6.5 dBi = −35.77 dBm/MHz

8.5.4 Test data

Table 8.5-4: Radiated field strength worst case measurement results

Modulation	Channel	Frequency, MHz	Peak Field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Average Field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
802.11a	Low	5150	69.72	74.00	4.28	53.38	54.00	0.62
802.11n HT20	Low	5150	68.00	74.00	6.00	53.92	54.00	0.08
802.11n HT40	Mid	5150	65.16	74.00	8.84	53.21	54.00	0.79

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.5-5: Band edge measurements results for correlated MIMO 3 × 3 with 6.5 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak result, dBm/MHz	Limit, dBm/MHz	Margin, dB
ch 0	802.11a	Low	5150	-43.72	-43.04	0.68
		High	5250	-43.76	-43.04	0.72
	802.11n HT20	Low	5150	-43.19	-43.04	0.15
		High	5250	-43.35	-43.04	0.31
	802.11n HT40	Low	5150	-43.08	-43.04	0.04
		High	5250	-43.54	-43.04	0.50
ch 1	802.11a	Low	5150	-43.08	-43.04	0.04
		High	5250	-43.09	-43.04	0.05
	802.11n HT20	Low	5150	-43.60	-43.04	0.56
		High	5250	-43.52	-43.04	0.48
	802.11n HT40	Low	5150	-43.68	-43.04	0.64
		High	5250	-43.34	-43.04	0.30
ch 2	802.11a	Low	5150	-43.09	-43.04	0.05
		High	5250	-43.26	-43.04	0.22
	802.11n HT20	Low	5150	-43.64	-43.04	0.60
		High	5250	-43.58	-43.04	0.54
	802.11n HT40	Low	5150	-43.07	-43.04	0.03
		High	5250	-43.15	-43.04	0.11

Table 8.5-6: Band edge measurements results for correlated MIMO 3 × 3 with 4 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak result, dBm/MHz	Limit, dBm/MHz	Margin, dB
ch 0	802.11a	Low	5150	-41.08	-40.54	0.54
		High	5250	-40.79	-40.54	0.25
	802.11n HT20	Low	5150	-40.75	-40.54	0.21
		High	5250	-41.16	-40.54	0.62
	802.11n HT40	Low	5150	-41.19	-40.54	0.65
		High	5250	-40.73	-40.54	0.19
ch 1	802.11a	Low	5150	-40.69	-40.54	0.15
		High	5250	-40.55	-40.54	0.01
	802.11n HT20	Low	5150	-40.77	-40.54	0.23
		High	5250	-41.34	-40.54	0.80
	802.11n HT40	Low	5150	-40.90	-40.54	0.36
		High	5250	-40.79	-40.54	0.25
ch 2	802.11a	Low	5150	-40.62	-40.54	0.08
		High	5250	-40.99	-40.54	0.45
	802.11n HT20	Low	5150	-40.90	-40.54	0.36
		High	5250	-40.99	-40.54	0.45
	802.11n HT40	Low	5150	-40.55	-40.54	0.01
		High	5250	-40.64	-40.54	0.10

8.5.4 Test data, continued

Table 8.5-7: Band edge measurements results for completely uncorrelated MIMO 3 × 3

Chain	Modulation	Channel	Frequency, MHz	Peak result, dBm/MHz	Limit, dBm/MHz	Margin, dB
ch 0	802.11a	Low	5150	-38.87	-38.27	0.60
		High	5250	-38.48	-38.27	0.21
	802.11n HT20	Low	5150	-38.32	-38.27	0.05
		High	5250	-38.55	-38.27	0.28
	802.11n HT40	Low	5150	-38.57	-38.27	0.30
		High	5250	-38.34	-38.27	0.07
ch 1	802.11a	Low	5150	-38.30	-38.27	0.03
		High	5250	-38.39	-38.27	0.12
	802.11n HT20	Low	5150	-38.46	-38.27	0.19
		High	5250	-38.28	-38.27	0.01
	802.11n HT40	Low	5150	-38.79	-38.27	0.52
		High	5250	-38.43	-38.27	0.16
ch 2	802.11a	Low	5150	-38.42	-38.27	0.15
		High	5250	-38.30	-38.27	0.03
	802.11n HT20	Low	5150	-38.51	-38.27	0.24
		High	5250	-38.43	-38.27	0.16
	802.11n HT40	Low	5150	-38.37	-38.27	0.10
		High	5250	-38.96	-38.27	0.69

Table 8.5-8: Spurious emissions outside restricted bands measurements results for correlated MIMO 3 × 3 with 6.5 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak power, dBm/MHz	Peak limit, dBm/MHz	Peak margin, dB
ch 0	802.11a	Low	5760	-43.72	-43.04	0.68
		High	5760	-44.43	-43.04	1.39
	802.11n HT20	Low	5760	-44.25	-43.04	1.21
		High	5760	-44.63	-43.04	1.59
	802.11n HT40	Low	5750	-45.25	-43.04	2.21
		High	5770	-45.61	-43.04	2.57
ch 1	802.11a	Low	5760	-44.00	-43.04	0.96
		High	5760	-45.08	-43.04	2.04
	802.11n HT20	Low	5760	-44.11	-43.04	1.07
		High	5760	-44.21	-43.04	1.17
	802.11n HT40	Low	5750	-45.78	-43.04	2.74
		High	5770	-45.95	-43.04	2.91
ch 2	802.11a	Low	5760	-44.59	-43.04	1.55
		High	5760	-45.13	-43.04	2.09
	802.11n HT20	Low	5760	-44.39	-43.04	1.35
		High	5760	-44.27	-43.04	1.23
	802.11n HT40	Low	5750	-46.39	-43.04	3.35
		High	5770	-47.01	-43.04	3.97

8.5.5 Test data, continued

Table 8.5-9: Spurious emissions outside restricted bands measurements results for correlated MIMO 3 × 3 with 4 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak power, dBm/MHz	Peak limit, dBm/MHz	Peak margin, dB
ch 0	802.11a	Low	5760	-41.67	-40.54	1.13
		High	5760	-42.33	-40.54	1.79
	802.11n HT20	Low	5760	-41.76	-40.54	1.22
		High	5760	-41.98	-40.54	1.44
	802.11n HT40	Low	5750	-43.25	-40.54	2.71
		High	5770	-43.61	-40.54	3.07
ch 1	802.11a	Low	5760	-44.66	-40.54	4.12
		High	5760	-45.39	-40.54	4.85
	802.11n HT20	Low	5760	-45.18	-40.54	4.64
		High	5760	-45.45	-40.54	4.91
	802.11n HT40	Low	5750	-43.68	-40.54	3.14
		High	5770	-43.75	-40.54	3.21
ch 2	802.11a	Low	5760	-43.08	-40.54	2.54
		High	5760	-43.13	-40.54	2.59
	802.11n HT20	Low	5760	-43.05	-40.54	2.51
		High	5760	-43.08	-40.54	2.54
	802.11n HT40	Low	5750	-42.95	-40.54	2.41
		High	5770	-42.79	-40.54	2.25

Table 8.5-10: Spurious emissions outside restricted bands measurements results for completely uncorrelated MIMO 3 × 3 with 6.5 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak power, dBm/MHz	Peak limit, dBm/MHz	Peak margin, dB
ch 0	802.11a	Low	5760	-39.64	-38.27	1.37
		High	5760	-38.94	-38.27	0.67
	802.11n HT20	Low	5760	-39.77	-38.27	1.50
		High	5760	-38.54	-38.27	0.27
	802.11n HT40	Low	5750	-46.86	-38.27	8.59
		High	5770	-47.76	-38.27	9.49
ch 1	802.11a	Low	5760	-38.44	-38.27	0.17
		High	5760	-41.70	-38.27	3.43
	802.11n HT20	Low	5760	-41.50	-38.27	3.23
		High	5760	-41.14	-38.27	2.87
	802.11n HT40	Low	5750	-46.55	-38.27	8.28
		High	5770	-47.92	-38.27	9.65
ch 2	802.11a	Low	5760	-39.39	-38.27	1.12
		High	5760	-39.67	-38.27	1.40
	802.11n HT20	Low	5760	-38.93	-38.27	0.66
		High	5760	-39.96	-38.27	1.69
	802.11n HT40	Low	5750	-46.15	-38.27	7.88
		High	5770	-47.35	-38.27	9.08

8.5.4 Test data, continued

Table 8.5-11: Spurious emissions outside restricted bands measurements results for completely uncorrelated MIMO 3 × 3 with 4 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak power, dBm/MHz	Peak limit, dBm/MHz	Peak margin, dB
ch 0	802.11a	Low	5760	-39.64	-35.77	3.87
		High	5760	-38.94	-35.77	3.17
	802.11n HT20	Low	5760	-39.77	-35.77	4.00
		High	5760	-38.54	-35.77	2.77
	802.11n HT40	Low	5750	-46.86	-35.77	11.09
		High	5770	-47.76	-35.77	11.99
ch 1	802.11a	Low	5760	-38.44	-35.77	2.67
		High	5760	-41.70	-35.77	5.93
	802.11n HT20	Low	5760	-41.50	-35.77	5.73
		High	5760	-41.14	-35.77	5.37
	802.11n HT40	Low	5750	-46.55	-35.77	10.78
		High	5770	-47.92	-35.77	12.15
ch 2	802.11a	Low	5760	-39.39	-35.77	3.62
		High	5760	-39.67	-35.77	3.90
	802.11n HT20	Low	5760	-38.93	-35.77	3.16
		High	5760	-39.96	-35.77	4.19
	802.11n HT40	Low	5750	-46.15	-35.77	10.38
		High	5770	-47.35	-35.77	11.58

Table 8.5-12: Spurious emissions within restricted bands measurements results for correlated MIMO 3 × 3 with 6.5 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak power, dBm	Average limit, dBm	Margin, dB
ch 0	802.11a	Low	5460	-57.99	-57.27	0.72
		High	5460	-58.58	-57.27	1.31
	802.11n HT20	Low	5460	-58.15	-57.27	0.88
		High	5460	-58.90	-57.27	1.63
	802.11n HT40	Low	5460	-57.50	-57.27	0.23
		High	5460	-57.89	-57.27	0.62
ch 1	802.11a	Low	5460	-58.95	-57.27	1.68
		High	5460	-58.99	-57.27	1.72
	802.11n HT20	Low	5460	-59.28	-57.27	2.01
		High	5460	-59.06	-57.27	1.79
	802.11n HT40	Low	5460	-59.26	-57.27	1.99
		High	5460	-58.66	-57.27	1.39
ch 2	802.11a	Low	5460	-57.41	-57.27	0.14
		High	5460	-59.37	-57.27	2.10
	802.11n HT20	Low	5460	-58.38	-57.27	1.11
		High	5460	-60.15	-57.27	2.88
	802.11n HT40	Low	5460	-57.28	-57.27	0.01
		High	5460	-57.83	-57.27	0.56

8.5.4 Test data, continued

Table 8.5-13: Spurious emissions within restricted bands measurements results for correlated MIMO 3 × 3 with 4 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak power, dBm	Average limit, dBm	Margin, dB
ch 0	802.11a	Low	5460	-55.94	-54.77	1.17
		High	5460	-56.48	-54.77	1.71
	802.11n HT20	Low	5460	-55.66	-54.77	0.89
		High	5460	-56.25	-54.77	1.48
	802.11n HT40	Low	5460	-55.50	-54.77	0.73
		High	5460	-55.89	-54.77	1.12
ch 1	802.11a	Low	5460	-56.62	-54.77	1.85
		High	5460	-56.24	-54.77	1.47
	802.11n HT20	Low	5460	-56.93	-54.77	2.16
		High	5460	-56.83	-54.77	2.06
	802.11n HT40	Low	5460	-56.73	-54.77	1.96
		High	5460	-56.32	-54.77	1.55
ch 2	802.11a	Low	5460	-55.49	-54.77	0.72
		High	5460	-56.57	-54.77	1.80
	802.11n HT20	Low	5460	-55.75	-54.77	0.98
		High	5460	-57.86	-54.77	3.09
	802.11n HT40	Low	5460	-55.14	-54.77	0.37
		High	5460	-55.43	-54.77	0.66

Table 8.5-14: Spurious emissions within restricted bands measurements results for completely uncorrelated MIMO 3 × 3 with 6.5 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak power, dBm	Average limit, dBm	Margin, dB
ch 0	802.11a	Low	5460	-53.05	-52.50	0.55
		High	5460	-53.93	-52.50	1.43
	802.11n HT20	Low	5460	-53.28	-52.50	0.78
		High	5460	-54.25	-52.50	1.75
	802.11n HT40	Low	5460	-52.72	-52.50	0.22
		High	5460	-53.11	-52.50	0.61
ch 1	802.11a	Low	5460	-54.02	-52.50	1.52
		High	5460	-54.24	-52.50	1.74
	802.11n HT20	Low	5460	-54.48	-52.50	1.98
		High	5460	-54.35	-52.50	1.85
	802.11n HT40	Low	5460	-54.24	-52.50	1.74
		High	5460	-53.84	-52.50	1.34
ch 2	802.11a	Low	5460	-52.93	-52.50	0.43
		High	5460	-54.99	-52.50	2.49
	802.11n HT20	Low	5460	-53.21	-52.50	0.71
		High	5460	-55.24	-52.50	2.74
	802.11n HT40	Low	5460	-52.62	-52.50	0.12
		High	5460	-52.90	-52.50	0.40

8.5.4 Test data, continued

Table 8.5-15: Spurious emissions within restricted bands measurements results for completely uncorrelated MIMO 3 × 3 with 4 dBi antennas

Chain	Modulation	Channel	Frequency, MHz	Peak power, dBm	Average limit, dBm	Margin, dB
ch 0	802.11a	Low	5460	-53.05	-50.00	3.05
		High	5460	-53.93	-50.00	3.93
	802.11n HT20	Low	5460	-53.28	-50.00	3.28
		High	5460	-54.25	-50.00	4.25
	802.11n HT40	Low	5460	-52.72	-50.00	2.72
		High	5460	-53.11	-50.00	3.11
ch 1	802.11a	Low	5460	-54.02	-50.00	4.02
		High	5460	-54.24	-50.00	4.24
	802.11n HT20	Low	5460	-54.48	-50.00	4.48
		High	5460	-54.35	-50.00	4.35
	802.11n HT40	Low	5460	-54.24	-50.00	4.24
		High	5460	-53.84	-50.00	3.84
ch 2	802.11a	Low	5460	-52.93	-50.00	2.93
		High	5460	-54.99	-50.00	4.99
	802.11n HT20	Low	5460	-53.21	-50.00	3.21
		High	5460	-55.24	-50.00	5.24
	802.11n HT40	Low	5460	-52.62	-50.00	2.62
		High	5460	-52.90	-50.00	2.90

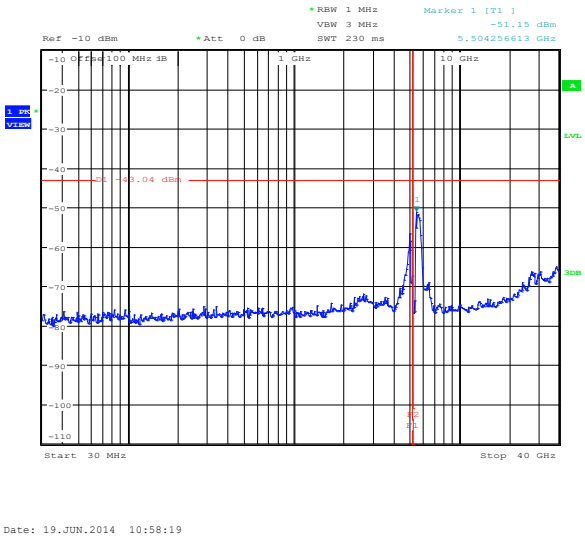


Figure 8.5-1: Conducted spurious emissions outside restricted bands sample plot

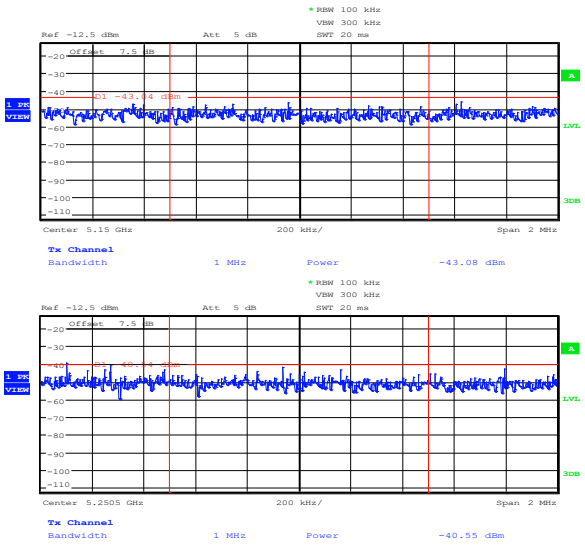


Figure 8.5-2: Lower and upper band edge sample plots

8.6 FCC 15.407(g) Frequency stability

8.6.1 Definitions and limits

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.

8.6.2 Test summary

Test date	June 19, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1006 mbar
Verdict	Pass	Relative humidity	35 %

8.6.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold

8.6.4 Test data

Table 8.6-1: Frequency drift measurement

Test conditions	Frequency, GHz	Drift, Hz
+50 °C, Nominal	5.20099728	174
+40 °C, Nominal	5.20099733	218
+30 °C, Nominal	5.20099733	217
+20 °C, +15 %	5.2009971	-12
+20 °C, Nominal	5.20099711	*Reference*
+20 °C, -15 %	5.20099726	150
+10 °C, Nominal	5.20099719	78
0 °C, Nominal	5.20099691	-200
−10 °C, Nominal	5.20099696	-147
−20 °C, Nominal	5.20099698	-133
−30 °C, Nominal	5.20099703	-84

Table 8.6-2: Band edge drift calculation

Modulation	−26 dBc lower cross point, GHz	Max negative drift, Hz	Drifted lower cross point, GHz	Band edge, GHz	Margin, MHz
802.11a	5.16830000	200	5.16829980	5.15	18.29980
802.11n HT20	5.16712312	200	5.16712292	5.15	17.12292
802.11n HT40	5.16663462	200	5.16663442	5.15	16.63442
Modulation	**−26 dBc upper cross point, GHz**	**Max positive drift, Hz**	**Drifted upper cross point, GHz**	**Band edge, GHz**	**Margin, MHz**
802.11a	5.23547332	218	5.23547352	5.25	14.526480
802.11n HT20	5.23617248	218	5.23617265	5.25	13.827325
802.11n HT40	5.23476591	218	5.23476611	5.25	15.233889

Notes: Drifted lower cross point = −26 dBc lower cross point – max negative drift. Drifted upper cross point = −26 dBc upper cross point + max positive drift.

8.7 RSS-210 A9.4(2) PSD-to-average ratio

8.7.1 Definitions and limits

Within the emission bandwidth, when the peak spectral density per MHz over any continuous transmission exceeds the average (10 $\log_{10}$ (B)) value by more than 3 dB, the permissible power spectral density shall be reduced by the excess amount.

8.7.2 Test summary

Test date	June 19, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1006 mbar
Verdict	Pass	Relative humidity	35 %

8.7.3 Observations/special notes

The measurement results for PSD to average calculation are in the Section 8.4

8.7.4 Test data

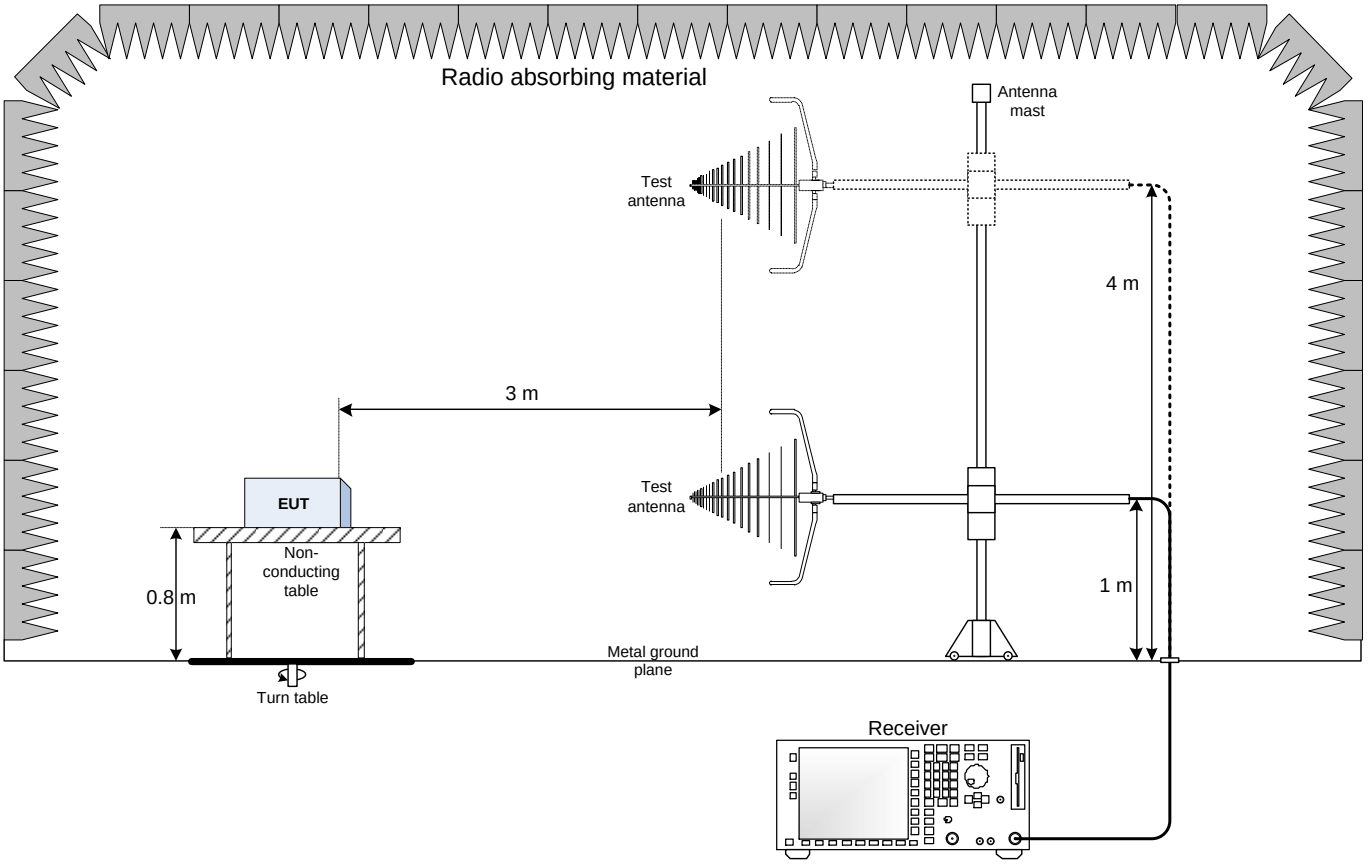
Table 8.7-1: PSD-to-average calculations results

Modulation	Frequency, MHz	PSD result, dBm/MHz	Average result, dBm	Delta dB	Limit, dB	Margin, dB
802.11a	5180	9.91	21.11	-11.20	3.00	14.20
	5200	10.00	21.08	-11.08	3.00	14.08
	5220	9.98	20.96	-10.98	3.00	13.98
802.11n HT20	5180	9.59	20.93	-11.34	3.00	14.34
	5200	9.91	21.28	-11.37	3.00	14.37
	5220	9.98	21.27	-11.29	3.00	14.29
802.11n HT40	5190	3.25	17.28	-14.03	3.00	17.03
	5210	5.12	19.00	-13.88	3.00	16.88

Note: Delta is calculated as follows: PSD result – Average result.

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up