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Test report

283771-1TRFWL

Date of issue: August 31, 2015

Applicant:

BLiNQ Wireless Inc.

Product:

HUB and RBM

Model:

X1200

FCC ID:

ROR00000003

Specification:

- FCC 47 CFR Part 15 Subpart E, §15.407

  Unlicensed National Information Infrastructure Devises

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada. The tests included in this report are within the scope of this accreditation

SCC Accredited LAB
LAB Accrédité CCN

Test location

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Reviewed by	Kevin Rose, Wireless/EMC Specialist
Review date	August 31, 2015
Reviewer 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.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	BLiNQ Wireless Inc.
Address	400 March Road Suite 240
City	Ottawa
Province/State	ON
Postal/Zip code	K2K 3H4
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart E, Clause 15.407	Unlicensed National Information Infrastructure Devises

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
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 C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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. EUT is professionally installed.

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)	5.725–5.85 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)	5.725–5.85 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)	Minimum 6 dB bandwidth for 5.725–5.85 GHz band	Not applicable
§15.407(g)	Frequency stability	Pass
§15.407(h)(1)[1]	Transmit power control (TPC)	Not applicable
§15.407(h)(2)[1]	Dynamic Frequency Selection (DFS)	Not applicable

Note: [1]Applicable only to U-NII devices operating in the 5.25–5.35 GHz band and the 5.47–5.725 GHz band.

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	April 22, 2015
Nemko sample ID number	1

3.2 EUT information

Product name	HUB and RBM
Model	X1200
Serial number	BA141008024

3.3 Technical information

Frequency band	5150–5250 MHz
Frequency Min (MHz)	5180 MHz
Frequency Max (MHz)	5240 MHz
RF power Min (W), Conducted	0.11 (20.53 dBm) for PMP application
RF power Max (W), Conducted	0.28 (24.41 dBm) for PTP application
Field strength, Units @ distance	N/A
Measured BW (MHz) (26 dBc)	20.14
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	OFDM
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, Units @ distance	48.59 dBµV/m @ 3 m at 15.54 GHz
Power requirements	120 V_{AC}, 60 Hz
Antenna information	Antenna configuration 1: Gain is 15 dBi , cable loss is 1 dB Antenna configuration 2: Gain is 12 dBi , cable loss is 2 dB The EUT is professionally installed.

3.4 Product description and theory of operation

The radio modules associated with this limited modular certification are part of BLiNQ Networks' X1200 Dual Carrier, Point-to-Multipoint and Point-to-Point Transceiver Modules. These Transceiver Modules are used to backhaul data from small cell mobile access points. One Hub Module communicates with up to 8 Remote Backhaul Modules (RBM) in a Point-to-Multipoint configuration or 1 Remote Backhaul Module (RBM) in a Point-to-Point configuration.
The radio module has the following characteristics:

- operates in the 5.15 to 5.25 GHz frequency band
- supports QPSK, 16QAM, 64QAM and 256QAM
- supports 2x2 MIMO with 2 uncorrelated data streams
- supports user configurable traffic ratios 50:50 and 70:30
- outputs power in the range of −15 to 23 dBm
- the maximum output power is limited by the antenna configuration which is particular to each module, HM or RBM, and dependent on the Point-to-Point or Point-to-Multipoint scenarios

3.5 EUT exercise details

The EUT was controlled from laptop via Ethernet using Putty telnet session.

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

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

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	Feb. 25/16
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Power source	California Instruments	3001i	FA001021	1 year	June 27/15
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Mar. 27/16
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 07/16
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 12/16
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 01/16
Horn antenna (18–26.5 GHz)	Electro-metrics	SH-50/60-1	FA000479	—	VOU
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 23/15
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Horn antenna (26.5–40 GHz)	Electro-metrics	SH-50/60-2	FA000485	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Jan. 09/16
50 Ω coax cable	C.C.A.	None	FA002556	1 year	June 23/15

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

Section 8. Testing data

8.1 FCC 15.407(6) AC power line conducted emissions limits

8.1.1 Definitions and limits

15.407(6) Any U-NII devices using an AC power line are required to comply with the conducted limits set forth in §15.207.

§15.207 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.

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: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

8.1.2 Test summary

Test date	April 23, 2015	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	31 %

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.

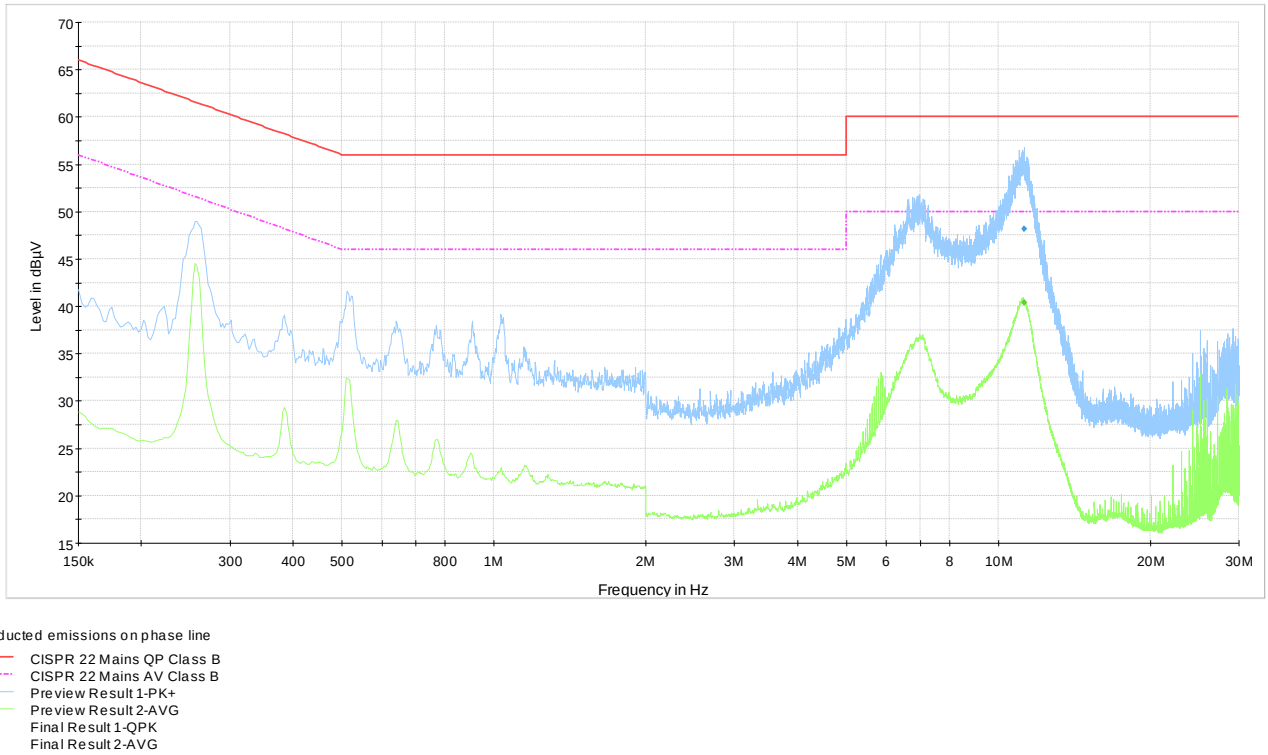
Receiver settings for preview measurements:

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	100 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
11.253250	48.1	1000.0	9.000	On	L1	10.3	11.9

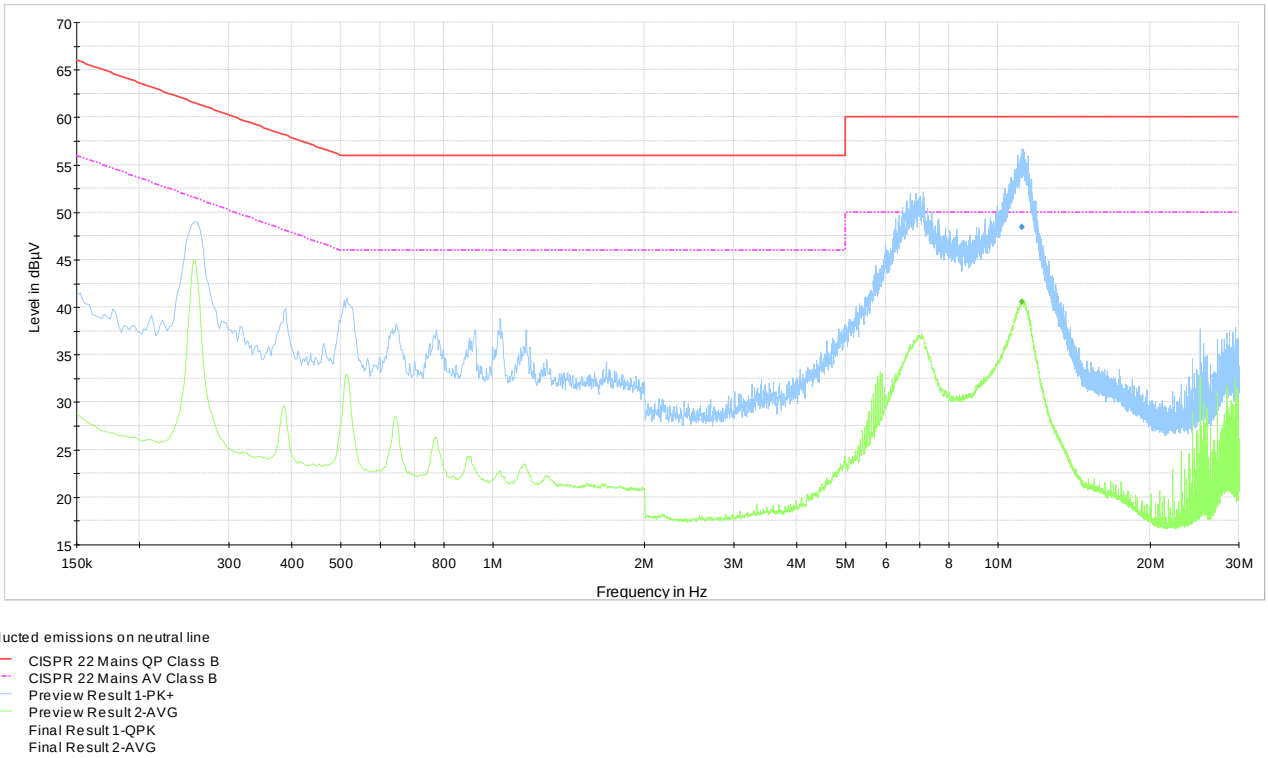
Note: 43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

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
11.253250	40.3	1000.0	9.000	On	L1	10.3	9.7

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)



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
11.185750	48.5	1000.0	9.000	On	N	10.4	11.5

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
11.185750	40.6	1000.0	9.000	On	N	10.4	9.4

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	April 22, 2015	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	32 %

8.2.3 Observations, settings and special notes

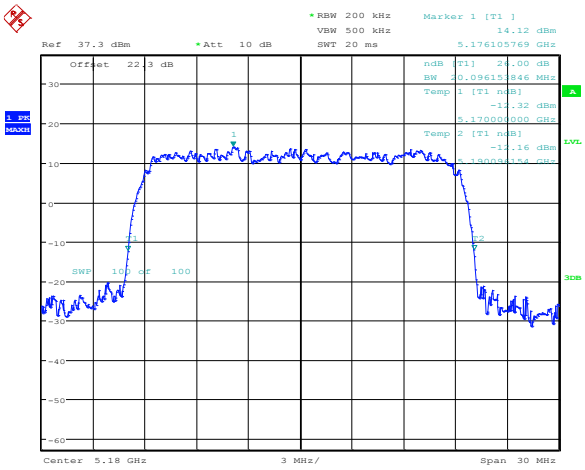
Spectrum analyser settings:

Resolution bandwidth	200 kHz
Video bandwidth	500 kHz
Frequency span	30 MHz
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

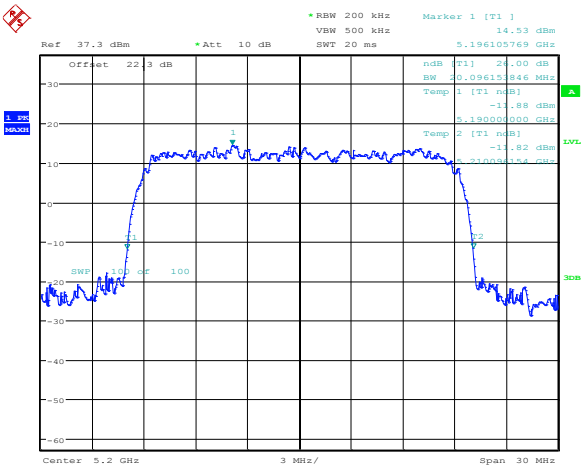
Table 8.2-1: *26 dB bandwidth results*

Antenna chain	Frequency, MHz	26 dB bandwidth, MHz
ch0	5180	20.09
	5200	20.09
	5240	20.09
ch1	5180	20.14
	5200	20.09
	5240	20.14



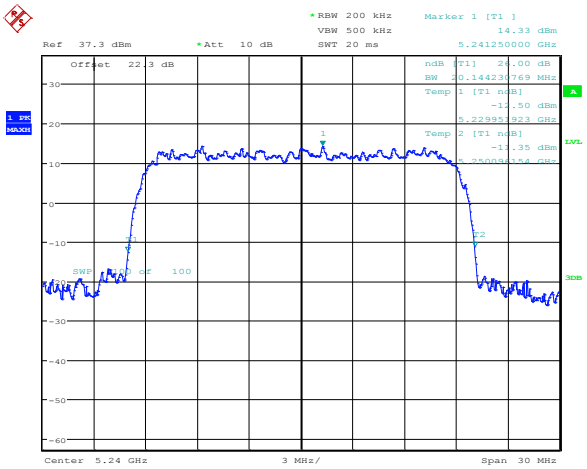
High channel
Date: 22.APR.2015 11:00:43

Figure 8.2-1: *26 dB bandwidth on low channel, sample plot*



High channel
Date: 22.APR.2015 10:53:19

Figure 8.2-2: *26 dB bandwidth on mid channel, sample plot*



High channel
Date: 22.APR.2015 10:56:01

Figure 8.2-3: *26 dB bandwidth on high channel, sample plot*

8.3 FCC 15.407(a)(1) 5.15–5.25 GHz band output power, EIRP and spectral density limits

8.3.1 Definitions and limits

(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 megahertz 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).

(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. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. 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.

(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.

8.3.2 Test summary

Test date:	April 22, 2015	Temperature:	23 °C
Test engineer:	Andrey Adelberg	Air pressure:	1007 mbar
Verdict:	Pass	Relative humidity:	32 %

8.3.3 Observations, settings and special notes

Combined average output power was calculated as follows: $P_{combined} = 10 \times log_{10}\left(\left(10^{P_{ch0}/10}\right) + \left(10^{P_{ch1}/10}\right)\right)$
EIRP was calculated as follows: $EIRP = P_{combined} + antenna\ gain$
Combined PPSD was calculated as follows: $PPSD_{combined} = 10 \times log_{10}\left(\left(10^{PSD_{ch0}/10}\right) + \left(10^{PSD_{ch1}/10}\right)\right)$
Directional gain for cross-polarized MIMO 2 × 2 antenna configuration 1 is 15 dBi – 1 dB (cable loss) = 14 dBi . No summation of gain is needed for cross-polarized antennas as per manufacturer's definition of the cross-polarized MIMO signal type, which is completely uncorrelated.
Directional gain for cross-polarized MIMO 2 × 2 antenna configuration 2 is 12 dBi – 2 dB (cable loss) = 10 dBi . No summation of gain is needed for cross-polarized antennas as per manufacturer's definition of the cross-polarized MIMO signal type, which is completely uncorrelated.

Output power limit for PTP mode with antenna configuration 1 is 30 dBm. Since antenna gain is 15 dBi – 1 dB (cable loss) = 14 dBi < 23 dBi, therefore no corresponding reduction in the maximum conducted output power is required.
Output power limit for PTP mode with antenna configuration 2 is 30 dBm. Since antenna gain is 12 dBi – 2 dB (cable loss) = 10 dBi < 23 dBi, therefore no corresponding reduction in the maximum conducted output power is required.
PPSD limit for PTP mode is 17 dBm/MHz, since both antenna variants have direct gain, that is less than 23 dBi

Output power limit for PMP mode with antenna configuration 1 was calculated as follows: 30 dBm – (14 – 6) = 22 dBm.
Output power limit for PMP mode with antenna configuration 2 was calculated as follows: 30 dBm – (10 – 6) = 26 dBm.
PPSD limit for PMP mode with antenna configuration 1 was calculated as follows: 17 dBm/MHz – (14 – 6) = 9 dBm/MHz.
PPSD limit for PMP mode with antenna configuration 2 was calculated as follows: 17 dBm/MHz – (10 – 6) = 13 dBm/MHz.

8.3.4 Test data

Table 8.3-1: *Output power measurements results for PTP*

Frequency, MHz	Measured average conducted output power, dBm			Combined power, W	Power limit, dBm	Margin, dB
	On ch0	On ch1	Combined			
5180	21.44	21.29	24.38	0.274	30.00	5.62
5200	21.45	21.34	24.41	0.276	30.00	5.59
5240	21.51	21.21	24.37	0.274	30.00	5.63

Table 8.3-2: *PPSD measurements results for PTP*

Frequency, MHz	Measured Peak Power Spectral Density (PPSD), dBm/MHz			PPSD limit, dBm/MHz	Margin, dB
	On ch0	On ch1	Combined		
5180	11.02	11.10	14.07	17.00	2.93
5200	11.38	11.24	14.32	17.00	2.68
5240	11.18	11.18	14.19	17.00	2.81

Table 8.3-3: *Output power measurements results for PMP with antenna configuration 1*

Frequency, MHz	Measured average conducted output power, dBm			Combined power, W	Power limit, dBm	Margin, dB
	On ch0	On ch1	Combined			
5180	17.46	17.38	20.43	0.110	22.00	1.57
5200	17.48	17.55	20.53	0.113	22.00	1.47
5240	17.47	17.34	20.42	0.110	22.00	1.58

Table 8.3-4: *PPSD measurements results for PMP with antenna configuration 1*

Frequency, MHz	Measured Peak Power Spectral Density (PPSD), dBm/MHz			PPSD limit, dBm/MHz	Margin, dB
	On ch0	On ch1	Combined		
5180	5.98	5.82	8.91	9.00	0.09
5200	5.80	5.76	8.79	9.00	0.21
5240	5.93	5.80	8.88	9.00	0.12

Table 8.3-5: *Output power measurements results for PMP with antenna configuration 2*

Frequency, MHz	Measured average conducted output power, dBm			Combined power, W	Power limit, dBm	Margin, dB
	On ch0	On ch1	Combined			
5180	21.44	21.29	24.38	0.274	26.00	1.62
5200	21.45	21.34	24.41	0.276	26.00	1.59
5240	21.51	21.21	24.37	0.274	26.00	1.63

Table 8.3-6: *PPSD measurements results for PMP with antenna configuration 2*

Frequency, MHz	Measured Peak Power Spectral Density (PPSD), dBm/MHz			PPSD limit, dBm/MHz	Margin, dB
	On ch0	On ch1	Combined		
5180	9.57	9.92	12.76	13.00	0.24
5200	9.91	9.98	12.96	13.00	0.04
5240	9.86	9.97	12.93	13.00	0.07

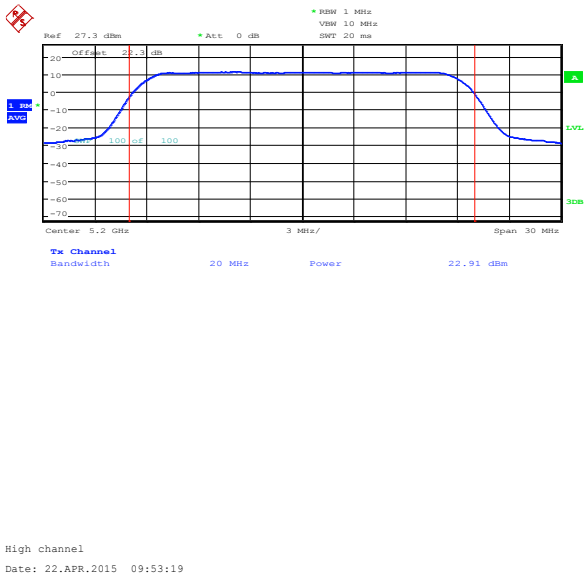


Figure 8.3-1: *Sample plot for output power measurement*

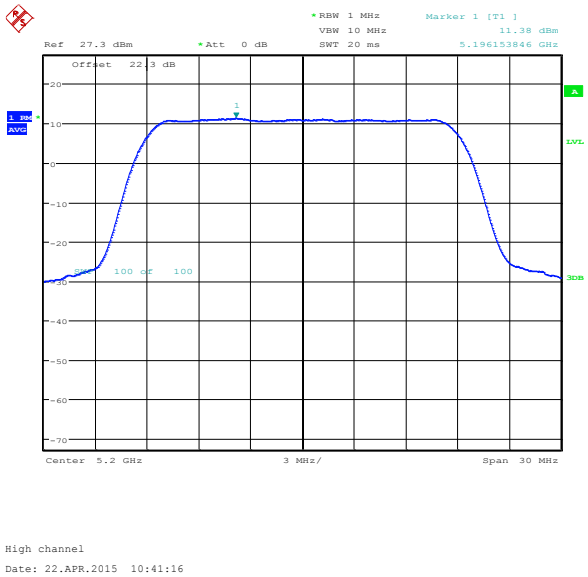


Figure 8.3-2: *Sample plot for PPSD measurement*

8.4 FCC 15.407(b) Spurious (Undesirable) emissions

8.4.1 Definitions and limits

(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.

Table 8.4-1: *FCC §15.209 – Radiated emission limits*

Frequency, MHz	Field strength of emissions µV/m	dBµV/m	Measurement distance, m
0.009–0.490	2400/F	67.6 – 20 × $\log_{10}$(F)	300
0.490–1.705	24000/F	87.6 – 20 × $\log_{10}$(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: 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

Table 8.4-2: *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			

8.4.2 Test summary

Test date:	April 22, 2015	Temperature:	23 °C
Test engineer:	Andrey Adelberg	Air pressure:	1007 mbar
Verdict:	Pass	Relative humidity:	32 %

8.4.3 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

Limit line was set as follows: 54 dBµV/m – 95.23 dB – 14 dBi − 4.7 dB – 3 dB = −62.93 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 set as follows: 54 dBµV/m – 95.23 dB – 14 dBi – 3 dB = −58.23 dBm/MHz where 3 dB is a multiple antenna ports compensation: $10 \times \log_{10}(2) = 3$ dB

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

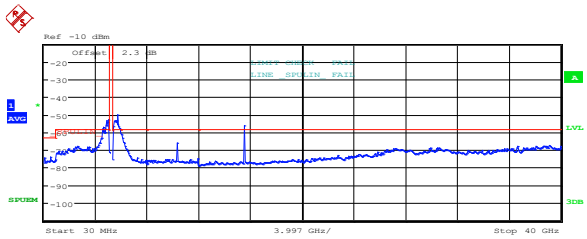
Peak limit is 20 dB higher than the average limit: −58.23 dBm/MHz + 20 dB = −38.23 dBm/MHz

Spectrum analyser for peak conducted measurements outside restricted bands:

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

Conducted emissions measurements outside restricted bands were performed on each individual MIMO chain. The limit was adjusted to include antenna directional gain of 14 dBi and a compensation of two antenna ports: −27 dBm/MHz − $10 \times \log_{10}(2)$ – 14 dBi = −44 dBm/MHz

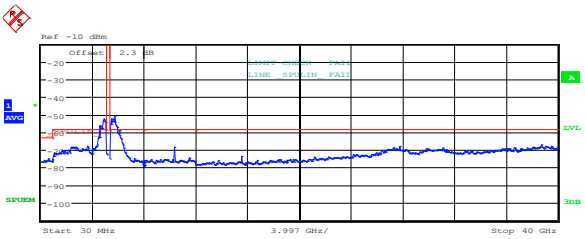
8.4.4 Test data



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
30.000 M	1.000 G	1.00 M	567.962000 M	-73.85	-10.85
1.000 G	5.150 G	1.00 M	5.041934 G	-53.17	5.13 *
5.350 G	6.000 G	1.00 M	5.743835 G	-50.02	8.28 *
6.000 G	8.000 G	1.00 M	6.005200 G	-61.04	-2.74
8.000 G	12.000 G	1.00 M	10.353200 G	-65.88	-7.58
12.000 G	40.000 G	1.00 M	15.530800 G	-56.46	1.84 *

High channel
Date: 22.APR.2015 11:37:38

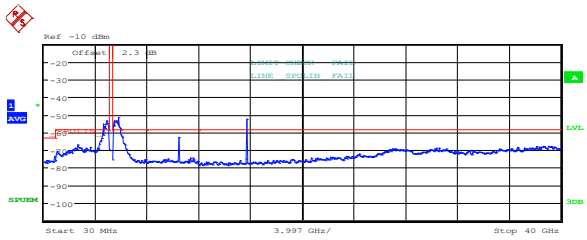
Figure 8.4-1: *Conducted peak spurious emissions within restricted bands at low channel, ch0*



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
30.000 M	1.000 G	1.00 M	620.827000 M	-74.82	-11.82
1.000 G	5.150 G	1.00 M	4.919592 G	-52.57	5.73 *
5.350 G	6.000 G	1.00 M	5.740780 G	-50.40	7.90 *
6.000 G	8.000 G	1.00 M	6.103600 G	-59.27	-0.97
8.000 G	12.000 G	1.00 M	10.349600 G	-68.49	-10.19
12.000 G	40.000 G	1.00 M	38.717600 G	-66.94	-8.64

Date: 22.APR.2015 11:38:10

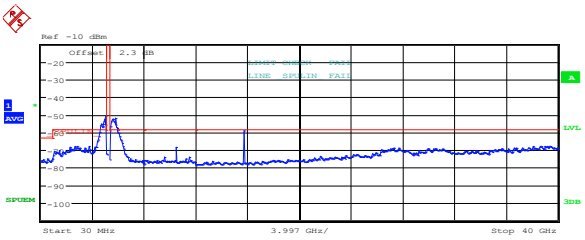
Figure 8.4-2: *Conducted peak spurious emissions within restricted bands at low channel, ch1*



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
30.000 M	1.000 G	1.00 M	832.869000 M	-73.61	-10.61
1.000 G	5.150 G	1.00 M	4.875104 G	-53.29	5.01 *
5.350 G	6.000 G	1.00 M	5.816050 G	-51.37	6.93 *
6.000 G	8.000 G	1.00 M	6.006200 G	-60.66	-2.36
8.000 G	12.000 G	1.00 M	10.487600 G	-63.03	-4.73
12.000 G	40.000 G	1.00 M	15.724000 G	-52.40	5.90 *

High channel
Date: 22.APR.2015 11:34:09

Figure 8.4-3: *Conducted peak spurious emissions within restricted bands at high channel, ch0*

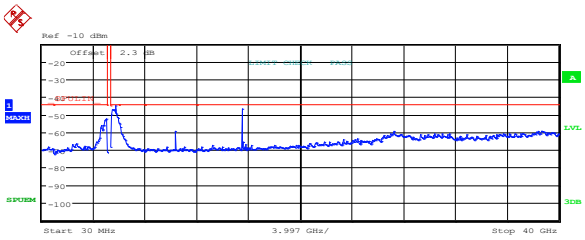


Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
30.000 M	1.000 G	1.00 M	568.253000 M	-74.89	-11.89
1.000 G	5.150 G	1.00 M	5.024172 G	-50.46	7.84 *
5.350 G	6.000 G	1.00 M	5.803960 G	-52.04	6.26 *
6.000 G	8.000 G	1.00 M	6.006600 G	-60.30	-2.00
8.000 G	12.000 G	1.00 M	10.485600 G	-68.48	-10.18
12.000 G	40.000 G	1.00 M	15.721200 G	-59.26	-0.96

High channel
Date: 22.APR.2015 11:33:03

Figure 8.4-4: *Conducted peak spurious emissions within restricted bands at high channel, ch1*

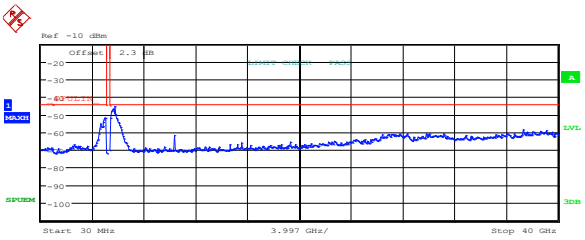
Note: all measurement results marked in red on the plots above were retested radiated with appropriate antennas connected to the EUT.



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
30.000 M	1.000 G	1.00 M	567.671000 M	-68.53	-24.53
1.000 G	5.150 G	1.00 M	5.038448 G	-52.57	-8.57
5.350 G	6.000 G	1.00 M	5.750270 G	-44.93	-0.93
6.000 G	8.000 G	1.00 M	6.006200 G	-54.55	-10.55
8.000 G	12.000 G	1.00 M	10.354000 G	-59.54	-15.54
12.000 G	40.000 G	1.00 M	15.525200 G	-46.74	-2.74

High channel
Date: 22.APR.2015 11:20:32

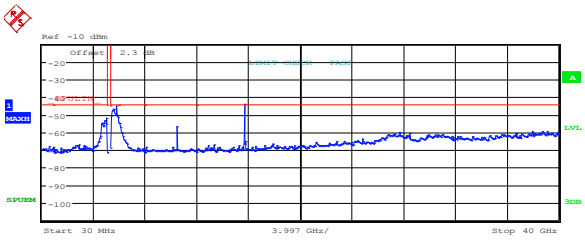
Figure 8.4-5: *Conducted peak spurious emissions outside restricted bands at low channel, ch0*



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
30.000 M	1.000 G	1.00 M	570.193000 M	-68.95	-24.95
1.000 G	5.150 G	1.00 M	4.978688 G	-51.84	-7.84
5.350 G	40.000 G	1.00 M	5.741545 G	-45.45	-1.45

High channel
Date: 22.APR.2015 11:15:52

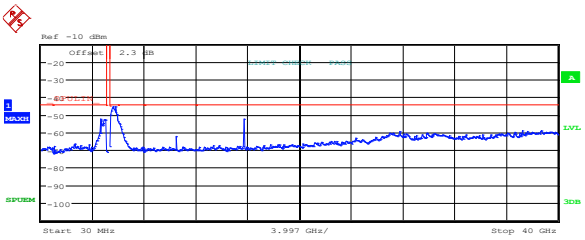
Figure 8.4-6: *Conducted peak spurious emissions outside restricted bands at low channel, ch1*



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
30.000 M	1.000 G	1.00 M	598.226000 M	-68.17	-24.17
1.000 G	5.150 G	1.00 M	5.000102 G	-52.04	-8.04
5.350 G	6.000 G	1.00 M	5.801295 G	-45.20	-1.20
6.000 G	8.000 G	1.00 M	6.010400 G	-54.93	-10.93
8.000 G	12.000 G	1.00 M	10.480400 G	-56.92	-12.92
12.000 G	40.000 G	1.00 M	15.729600 G	-44.18	-0.18

High channel
Date: 22.APR.2015 11:22:47

Figure 8.4-7: *Conducted peak spurious emissions outside restricted bands at high channel, ch0*



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
30.000 M	1.000 G	1.00 M	567.962000 M	-68.28	-24.28
1.000 G	5.150 G	1.00 M	4.669430 G	-52.48	-8.48
5.350 G	6.000 G	1.00 M	5.812865 G	-45.33	-1.33
6.000 G	8.000 G	1.00 M	6.055000 G	-53.78	-9.78
8.000 G	12.000 G	1.00 M	10.480000 G	-62.53	-18.53
12.000 G	40.000 G	1.00 M	15.712800 G	-52.69	-8.69

High channel
Date: 22.APR.2015 11:24:20

Figure 8.4-8: *Conducted peak spurious emissions outside restricted bands at high channel, ch1*

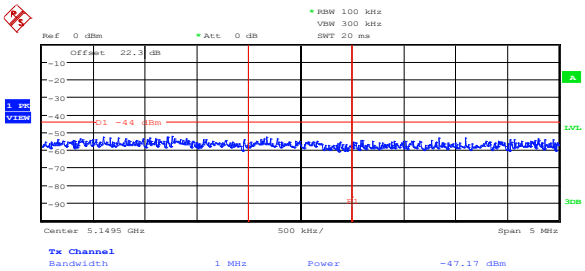


Figure 8.4-9: *Lower band edge emission, ch0*

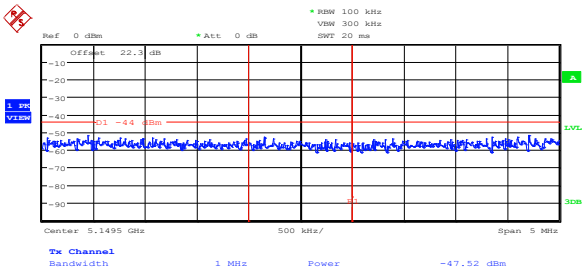


Figure 8.4-10: *Lower band edge emission, ch1*

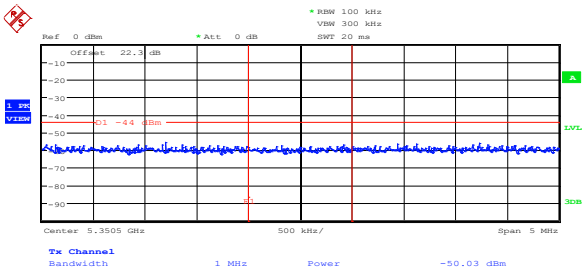


Figure 8.4-11: *Upper band edge emission, ch0*

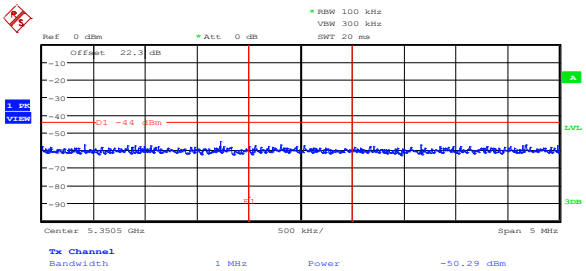


Figure 8.4-12: *Upper band edge emission, ch1*

Table 8.4-3: *Radiated field strength measurement results for emissions that fall outside restricted bands*

Frequency, MHz	Peak Field strength, dBµV/m	FS to EIRP conversion factor, dB	EIRP, dBm/MHz	Limit, dBm/MHz	Margin, dB
(low channel) 5744.0	61.19	-95.23	-34.04	-27.00	7.04
(high channel)5816.0	61.32	-95.23	-33.91	-27.00	6.91

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

Table 8.4-4: *Radiated field strength measurement results for emissions that fall within restricted bands*

Frequency, MHz	Peak Field strength, dBµV/m	Peak limit, dBµV/m	Peak margin, dB	Average Field strength, dBµV/m	Average limit, dBµV/m	Average margin, dB
(low channel) 5040.0	57.16	74.00	16.84	42.11	54.00	11.89
(low channel) 15540.0	62.11	74.00	11.89	48.59	54.00	5.41
4875.0	54.32	74.00	19.68	40.70	54.00	13.30
15720.0	62.08	74.00	11.92	47.85	54.00	6.15

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

8.5 FCC 15.407(g) Frequency stability

8.5.1 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.

8.5.2 Test summary

Test date:	April 22, 2015	Temperature:	23 °C
Test engineer:	Andrey Adelberg	Air pressure:	1007 mbar
Verdict:	Pass	Relative humidity:	32 %

8.5.3 Observations, settings and special notes

Spectrum analyser settings:

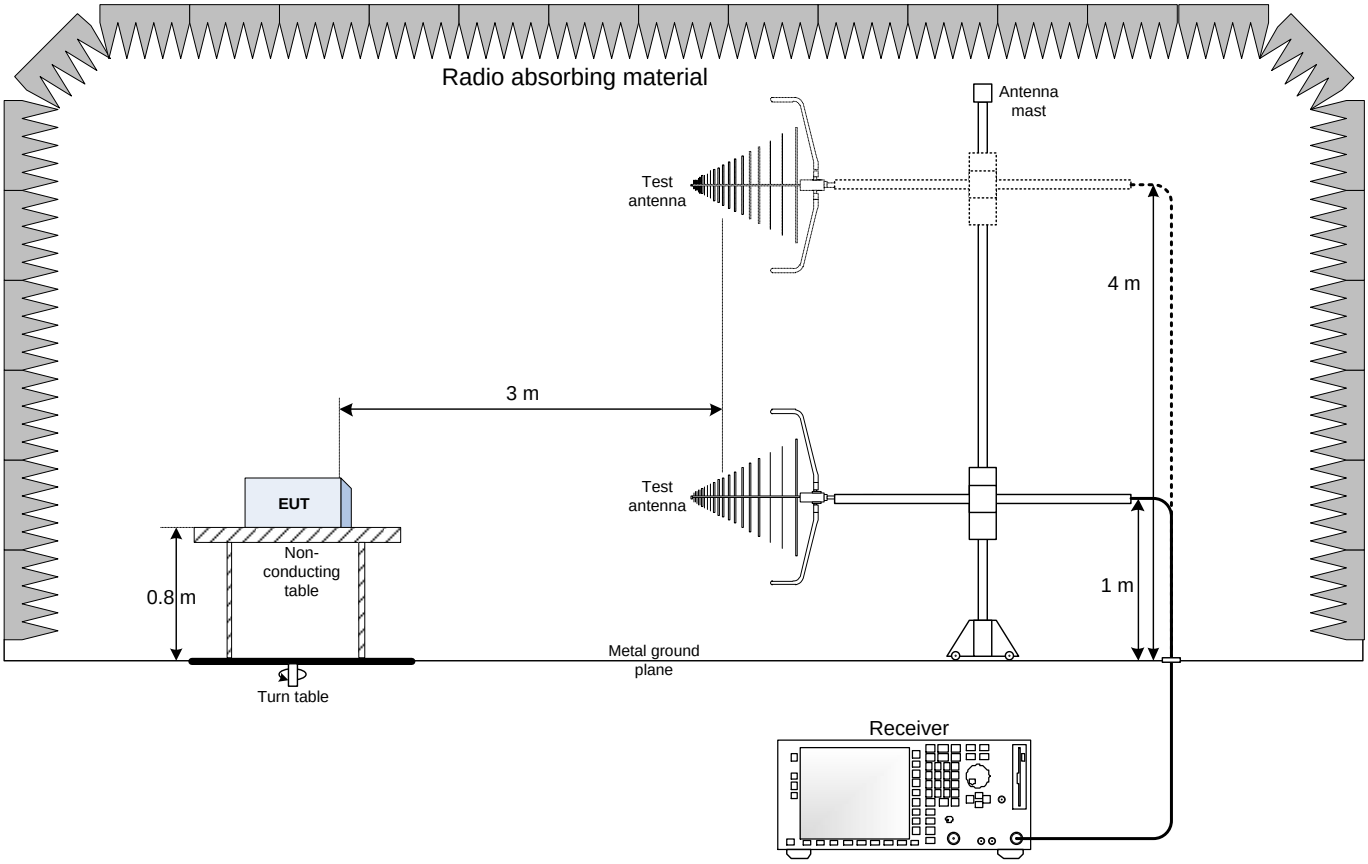
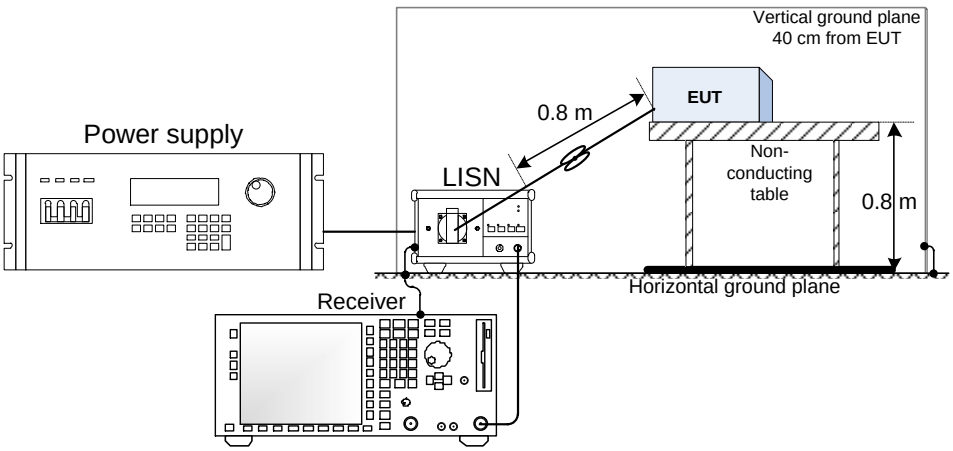
Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.5.4 Test data

Frequency stability was assessed between two extreme temperatures +55 °C and −30 °C.
Maximum recorded frequency drift was 140 kHz, which is 27 ppm

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up