www.nemko.com

Compliance test report ID **223263-1TRFWL**

Date of issue
November 20, 2012

FCC 47 CFR Part 15 Subpart C, §15.247

Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

RSS-210, Issue 8 Annex 8

Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz Bands

Applicant	**BelAir Networks**
Product	**Dual-band WIFI router**
Model	**BelAir20E**
FCC ID	**RAR40015001**
IC Reg. #	**4674A-40015001**

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

Nemko Canada Inc.
303 River Road
Ottawa, ON, K1V 1H2
Canada
FCC test site registration number: 176392 and IC registered site number: 2040A-4 (3 m semi anechoic chamber)

Telephone +1 613 737 9680
Facsimile +1 613 737 9691
Toll free +1 800 563 6336
Website www.nemko.com

Tested by Andrey Adelberg, Senior Wireless/EMC Specialist

Reviewed by Kevin Rose, Wireless/EMC Specialist

November 20, 2012
Date

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

BelAir Networks Inc.
603 March Road,
Ottawa, ON, Canada
K2K 2M5

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
RSS-210, Issue 8 Annex 8	Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz Bands

1.3 Test methods

Guidance for compliance measurements on DTS operating under 15.247	558074 D01 Meas Guidance v02 (October 4, 2012)
Emissions testing of transmitters with multiple outputs in the same band (MIMO)	662911 D01 Multiple Transmitter Output v01r02 (September 26, 2012)

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 C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Pass
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Not applicable
§15.247(b)(4)	Maximum peak output power	Pass
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Pass
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

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
A8.1	Frequency hopping systems	
A8.1 (a)	Bandwidth of a frequency hopping channel	Not applicable
A8.1 (b)	Minimum channel spacing for frequency hopping systems	Not applicable
A8.1 (c)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
A8.1 (d)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
A8.1 (e)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
A8.2	Digital modulation systems	
A8.2 (a)	Minimum 6 dB bandwidth	Pass
A8.2 (b)	Maximum power spectral density	Pass
A8.3	Hybrid systems	
A8.3 (1)	Digital modulation turned off	Not applicable
A8.3 (2)	Frequency hopping turned off	Not applicable
A8.4	Transmitter output power and e.i.r.p. requirements	
A8.4 (1)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
A8.4 (2)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
A8.4 (3)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
A8.4 (4)	Systems employing digital modulation techniques	Pass
A8.4 (5)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
A8.4 (6)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
A8.5	Out-of-band emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	October 10, 2012
Nemko sample ID number	1

3.2 EUT information

Product name	Dual-band WIFI router
Model	BelAir20E
Serial number	BA114300032

3.3 Technical information

Operating band	2400–2483.5 MHz
Operating frequency	2412–2462 MHz (20 MHz channel) and 2422–2457 MHz (40 MHz channel)
Modulation type	802.11b/g/n
Occupied bandwidth (99 %)	13.85 MHz (802.11b); 16.97 MHz (802.11g); 18.13 MHz (802.11n HT20); 36.78 MHz (802.11n HT40)
Emission designator	W7D
Power requirements	48 V_{DC}
Antenna information	2 internal 3 dBi 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 2×2 MIMO device designed to operate in the 2.4 GHz band, and 5 GHz ISM and UNII bands.
There are two independent radio units. This report covers only the 2.4 GHz radio.

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

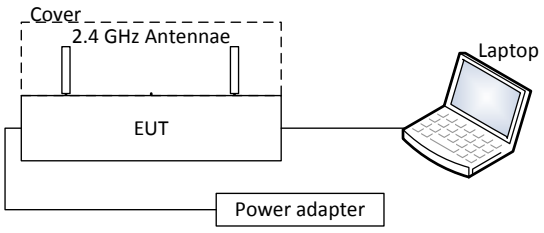


Diagram 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Laptop	Toshiba	Satellite	BelAir 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. 09/13
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Power supply	California Inst.	3001I	FA001021	1 year	Feb 08/13
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	May 16/13
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Jan. 10/13
Bilog antenna	Sunol	JB3	FA002108	1 year	Feb. 07/13
Horn antenna #2	EMCO	3115	FA000825	1 year	Feb. 24/13
Horn antenna 18–26.5 GHz	Electro-metrics	SH-50/60-1	FA000479	—	VOU
1–18 GHz pre-amplifier	JCA	JCA118-503	FA002091	1 year	July 03/13
18–26 GHz pre-amplifier	Narda	BBS-1826N612	FA001550	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Nov. 18/12
Power meter	Agilent	N1911A	FA001946	1 year	Feb. 13/13
Power sensor	Agilent	N1922A	FA001947	1 year	Feb. 13/13

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	October 15, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1006 mbar	**Relative humidity**	32 %

8.1.3 Observations/special notes

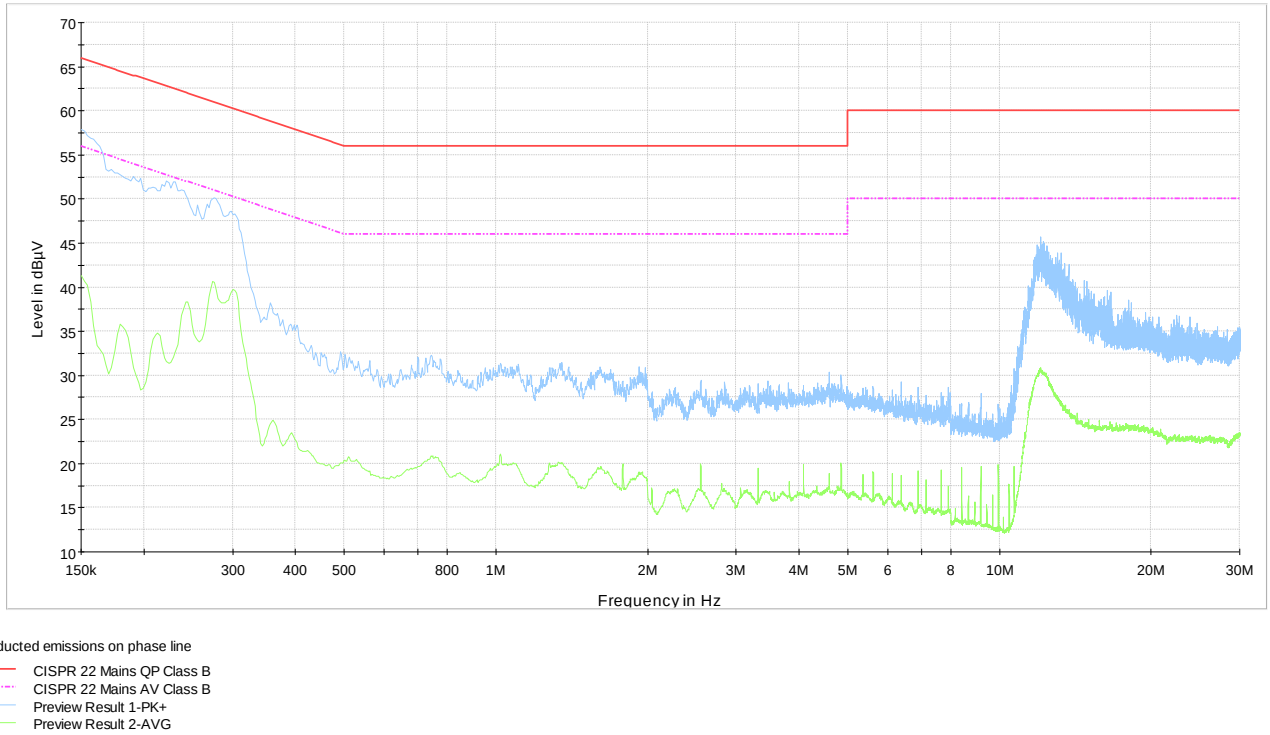
The EUT was set up as tabletop configuration.

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.

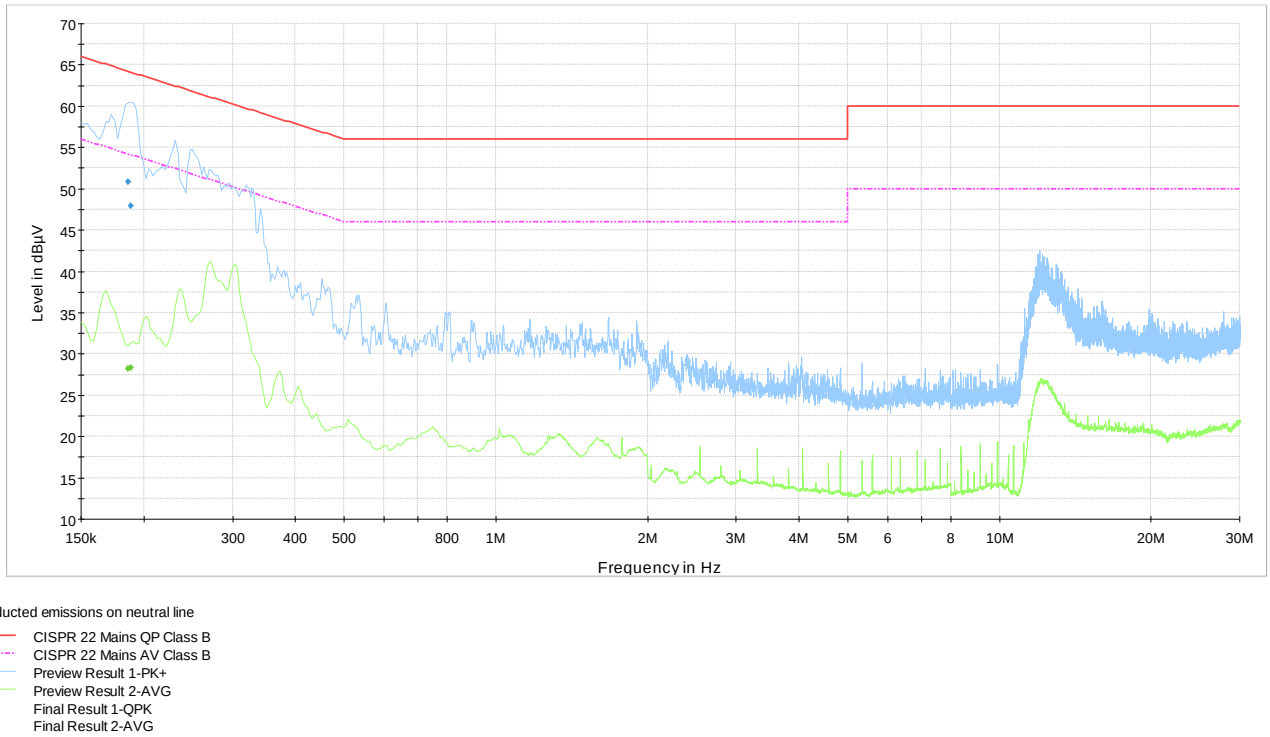
Receiver settings for preview measurements: Peak and Average detector (Max hold), RBW = 9 kHz, VBW = 30 kHz, Measurement time = 100 ms
Receiver settings for final measurements: Q-Peak and Average detector, RBW = 9 kHz, VBW = 30 kHz, Measurement time = 100 ms

8.1.4 Test data



Plot 8.1-1: *Conducted emissions on phase line*

8.1.4 Test data, continued



Plot 8.1-2: *Conducted emissions on neutral line*

Table 8.1-2: *Quasi-Peak conducted emissions results*

Frequency, MHz	Q-Peak result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Conductor	Correction, dB	Margin, dB	Limit, dBµV
0.186000	50.8	100.0	9.000	On	N	10.2	13.4	64.2
0.188250	47.9	100.0	9.000	On	N	10.2	16.2	64.1

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*

Frequency, MHz	Average result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Conductor	Correction, dB	Margin, dB	Limit, dBµV
0.186000	28.2	100.0	9.000	On	N	10.2	26.1	54.2
0.188250	28.3	100.0	9.000	On	N	10.2	25.8	54.1

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 15.247(a)(2) and RSS-210 A8.2(a) Minimum 6 dB bandwidth for systems using digital modulation techniques

8.2.1 Definitions and limits

FCC and IC:

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.2.2 Test summary

Test date	October 11, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1004 mbar	**Relative humidity**	33 %

8.2.3 Observations/special notes

Measurements were performed with peak detector using RBW = 1–5 % of DTS BW (no wider than 100 kHz). VBW was set three times RBW.

8.2.4 Test data

Table 8.2-1: *6 dB bandwidth results*

Antenna chain	Modulation	Channel	6 dB bandwidth, kHz	Limit, kHz	Margin, kHz
ch0	802.11b	2412	10,096.2	500.0	9,596.2
ch0	802.11b	2437	10,000.0	500.0	9,500.0
ch0	802.11b	2462	8,509.6	500.0	8,009.6
ch0	802.11g	2412	16,740.4	500.0	16,240.4
ch0	802.11g	2437	16,730.8	500.0	16,230.8
ch0	802.11g	2462	16,682.7	500.0	16,182.7
ch0	802.11n HT20	2412	17,894.2	500.0	17,394.2
ch0	802.11n HT20	2437	17,884.6	500.0	17,384.6
ch0	802.11n HT20	2462	17,884.6	500.0	17,384.6
ch0	802.11n HT40	2422	36,794.9	500.0	36,294.9
ch0	802.11n HT40	2437	36,714.7	500.0	36,214.7
ch0	802.11n HT40	2457	36,570.5	500.0	36,070.5
ch1	802.11b	2412	8,942.3	500.0	8,442.3
ch1	802.11b	2437	9,519.2	500.0	9,019.2
ch1	802.11b	2462	9,663.5	500.0	9,163.5
ch1	802.11g	2412	16,714.7	500.0	16,214.7
ch1	802.11g	2437	16,634.6	500.0	16,134.6
ch1	802.11g	2462	16,730.7	500.0	16,230.7
ch1	802.11n HT20	2412	17,868.6	500.0	17,368.6
ch1	802.11n HT20	2437	17,884.6	500.0	17,384.6
ch1	802.11n HT20	2462	18,028.8	500.0	17,528.8
ch1	802.11n HT40	2422	36,762.8	500.0	36,262.8
ch1	802.11n HT40	2437	36,314.1	500.0	35,814.1
ch1	802.11n HT40	2457	36,794.9	500.0	36,294.9

8.2.4 Test data, continued

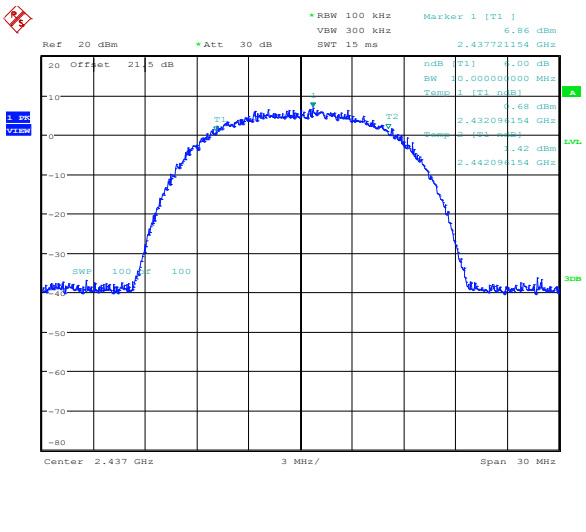


Diagram 8.2-1: *6 dB bandwidth on 802.11b, sample plot*

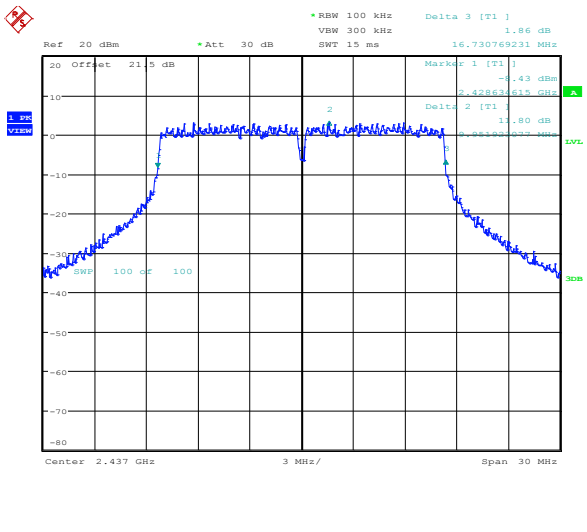


Diagram 8.2-2: *6 dB bandwidth on 802.11g, sample plot*

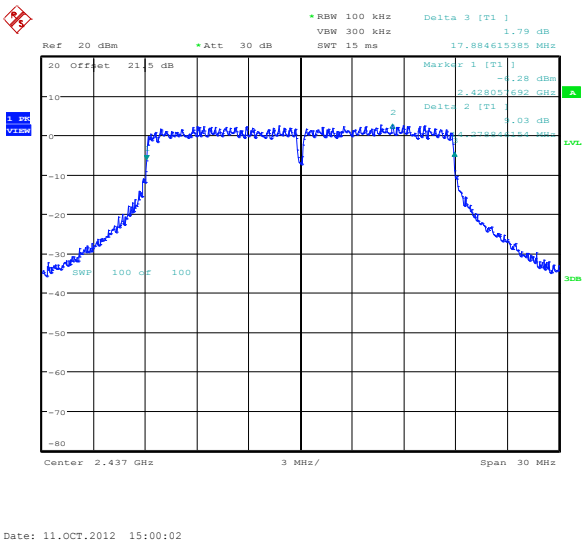


Diagram 8.2-3: *6 dB bandwidth on 802.11n HT20, sample plot*

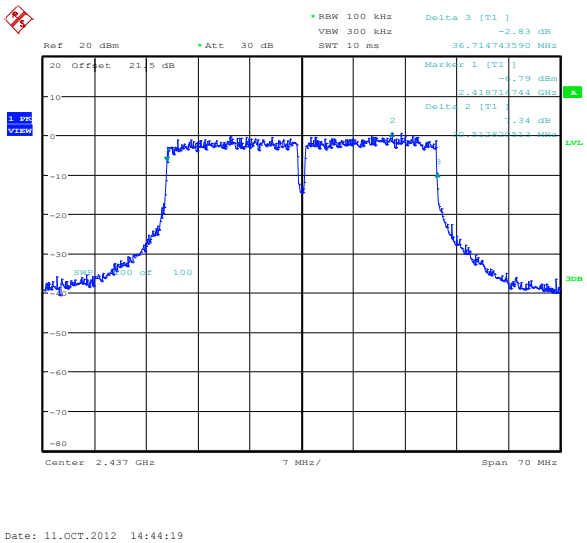


Diagram 8.2-4: *6 dB bandwidth on 802.11n HT40, sample plot*

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	October 11, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1004 mbar	**Relative humidity**	33 %

8.3.3 Observations/special notes

Measurements were performed with peak detector using RBW ≥ 1 % of span; VBW was set three times RBW.

8.3.4 Test data

Table 8.3-1: *99 % bandwidth results*

Modulation	99 % bandwidth, MHz
802.11b	13.85
802.11g	16.97
802.11n HT20	18.13
802.11n HT40	36.78

8.3.4 Test data, continued

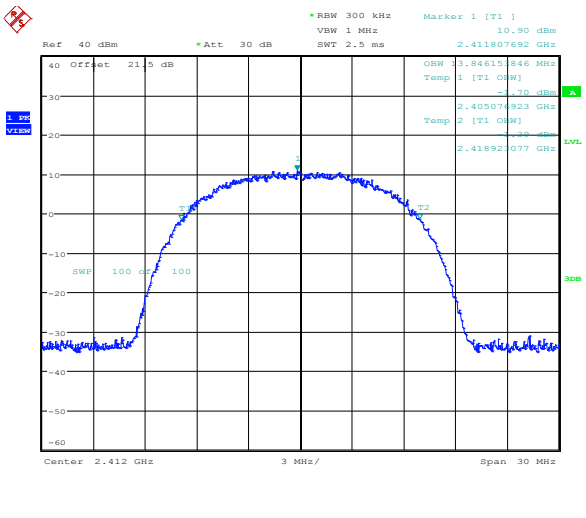


Diagram 8.3-1: *99 % bandwidth on 802.11b, sample plot*

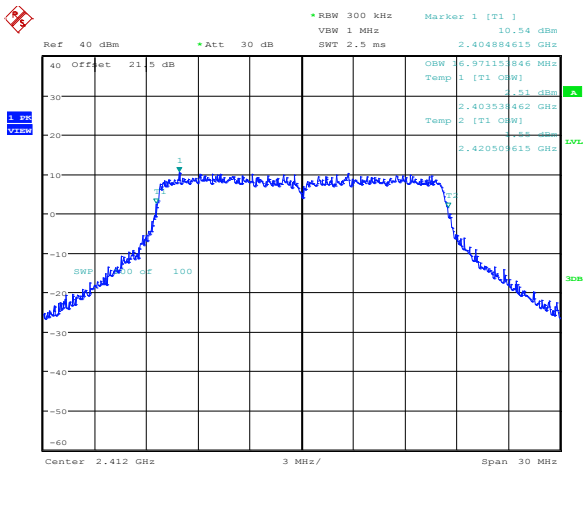


Diagram 8.3-2: *99 % bandwidth on 802.11g, sample plot*

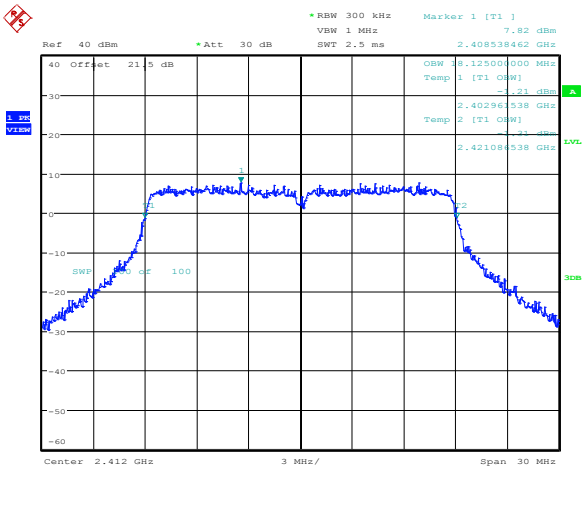


Diagram 8.3-3: *99 % bandwidth on 802.11n HT20, sample plot*

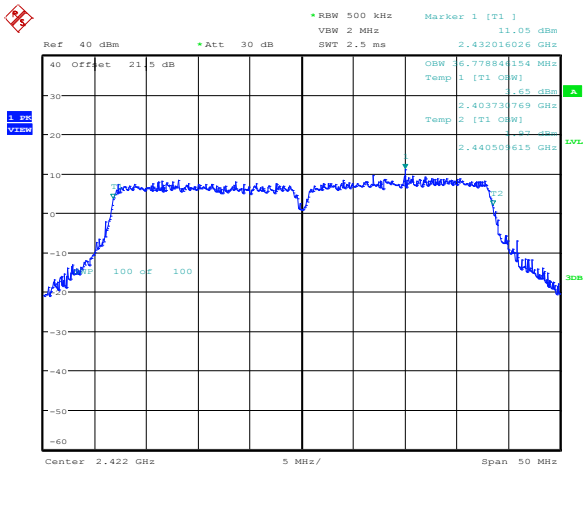


Diagram 8.3-4: *99 % bandwidth on 802.11n HT40, sample plot*

8.4 FCC 15.247(b) and RSS-210 A8.4 (4) Transmitter output power and e.i.r.p. requirements

8.4.1 Definitions and limits

FCC:

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(c) Operation with directional antenna gains greater than 6 dBi.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

IC:

A8.4 (4) Transmitter Output Power and e.i.r.p. Requirements for systems employing digital modulation techniques operating in the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz bands

For systems employing digital modulation techniques operating in the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz, the maximum peak conducted output power shall not exceed 1 W. Except as provided in Section A8.4(5), the e.i.r.p. shall not exceed 4 W.

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power (see RSS-Gen).

8.4.2 Test summary

Test date	October 11, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1004 mbar	**Relative humidity**	33 %

8.4.3 Observations/special notes

The test was performed according to DTS guidelines section 8.2.3 Option 3: maximum conducted (average) output power using RF average power meter with a thermocouple detector.

8.4.4 Test data

Table 8.4-1: *Output power measurements and EIRP calculations results*

Modulation	Frequency, MHz	Average power on ch0, dBm	Average power on ch1, dBm	Combined average power, dBm	Output power limit, dBm	Output power margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
802.11n HT40	2422	19.80	19.75	22.79	30.00	7.21	6.00	28.79	36.00	7.21
802.11n HT40	2437	21.70	22.15	24.94	30.00	5.06	6.00	30.94	36.00	5.06
802.11n HT40	2457	19.50	20.20	22.87	30.00	7.13	6.00	28.87	36.00	7.13
802.11n HT20	2412	17.00	17.30	20.16	30.00	9.84	6.00	26.16	36.00	9.84
802.11n HT20	2437	23.45	23.33	26.40	30.00	3.60	6.00	32.40	36.00	3.6
802.11n HT20	2462	18.05	16.50	20.35	30.00	9.65	6.00	26.35	36.00	9.65
802.11g	2412	20.20	20.30	23.26	30.00	6.74	6.00	29.26	36.00	6.74
802.11g	2437	22.60	23.00	25.81	30.00	4.19	6.00	31.81	36.00	4.19
802.11g	2462	19.15	19.80	22.50	30.00	7.50	6.00	28.50	36.00	7.5
802.11b	2412	22.05	21.65	24.86	30.00	5.14	6.00	30.86	36.00	5.14
802.11b	2437	24.15	24.35	27.26	30.00	2.74	6.00	33.26	36.00	2.74
802.11b	2462	20.55	20.50	23.54	30.00	6.46	6.00	29.54	36.00	6.46

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:

$$EIRP = P_{combined} + antenna\ gain$$

MIMO Correlated 2×2 (CDD/TXBF), Directional gain = 3 dBi + 10×log$_{10}$ (N) dB = 3 dBi + 3 dB = 6 dBi, where “N” is number of antennae.

8.5 FCC 15.247(d) and RSS-210 A8.5 Spurious (out-of-band) emissions

8.5.1 Definitions and limits

FCC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

IC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required.

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

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

8.5.1 Definitions and limits, continued

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	October 10, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	22 °C	**Air pressure**	1006 mbar	**Relative humidity**	33 %

8.5.3 Observations/special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
Radiated measurements were performed at a distance of 3 m, the EUT was transmitting on both MIMO chains simultaneously.
Settings for radiated measurements within restricted bands:
For frequencies below 1 GHz, RBW was set to 100 kHz, VBW was 3 times wider than RBW.
Peak detector was used for measurements.
For frequencies above 1 GHz, RBW was set to 1 MHz, VBW was 3 times wider than RBW for peak measurements, and VBW was set to 10 Hz for average measurements. Peak detector was used for measurements.
EUT was set to transmit with 100 % duty cycle.
Conducted spurious emissions were performed on each individual MIMO chain with added 10 × log(total number of chains) = 3 dB and antenna gain of 3 dBi.
Since fundamental power was tested using average method, the spurious emissions limit is −30 dBc/100 kHz

8.5.4 Test data

Table 8.5-4: *Restricted band edge measurement results*

Modulation	Frequency, MHz	Peak field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Average field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
802.11b	2390.0	62.16	74.00	11.84	50.72	54.00	3.28
802.11b	2483.5	59.06	74.00	14.94	46.30	54.00	7.70
802.11g	2390.0	73.41	74.00	0.59	52.45	54.00	1.55
802.11g	2483.5	73.94	74.00	0.06	52.43	54.00	1.57
802.11n HT20	2390.0	73.15	74.00	0.85	53.37	54.00	0.63
802.11n HT20	2483.5	72.53	74.00	1.47	53.63	54.00	0.37
802.11n HT40	2390.0	73.45	74.00	0.55	52.85	54.00	1.15
802.11n HT40	2483.5	72.93	74.00	1.07	53.59	54.00	0.41

8.5.4 Test data, continued

Table 8.5-5: *Radiated field strength measurement results for 802.11b*

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
Low	4824	66.00	74.00	8.00	53.42	54.00	0.58
Low	7236	53.53	74.00	20.47	NA	54.00	NA
Mid	4874	66.41	74.00	7.59	53.57	54.00	0.43
Mid	7311	59.28	74.00	14.72	43.90	54.00	10.10
High	4924	66.82	74.00	7.18	53.97	54.00	0.03
High	7386	53.93	74.00	20.07	NA	54.00	NA

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.
NA (not applicable) is where the peak value is below average limit.

Table 8.5-6: *Radiated field strength measurement results for 802.11g*

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
Low	4824	68.71	74.00	5.29	53.83	54.00	0.17
Low	7236	53.18	74.00	20.82	NA	54.00	NA
Mid	4874	66.77	74.00	7.23	53.68	54.00	0.32
Mid	7311	71.93	74.00	2.07	53.22	54.00	0.78
High	4924	68.59	74.00	5.41	54.00	54.00	0.00
High	7386	68.47	74.00	5.53	41.02	54.00	12.98

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.
NA (not applicable) is where the peak value is below average limit.

Table 8.5-7: *Radiated field strength measurement results for 802.11n HT20*

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
Low	4824	67.92	74.00	6.08	53.70	54.00	0.30
Low	7236	59.57	74.00	14.43	40.91	54.00	13.09
Mid	4874	66.99	74.00	7.01	53.25	54.00	0.75
Mid	7311	73.99	74.00	0.01	53.07	54.00	0.93
High	4924	69.08	74.00	4.92	53.98	54.00	0.02
High	7386	68.78	74.00	5.22	43.45	54.00	10.55

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

Table 8.5-8: *Radiated field strength measurement results for 802.11n HT40*

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
Low	4844	66.38	74.00	7.62	52.81	54.00	1.19
Low	7266	70.92	74.00	3.08	53.23	54.00	0.77
Mid	4874	64.83	74.00	9.17	50.53	54.00	3.47
Mid	7311	68.44	74.00	5.56	52.90	54.00	1.10
High	4914	66.27	74.00	7.73	52.92	54.00	1.08
High	7371	65.76	74.00	8.24	44.90	54.00	9.10

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

8.5.4 Test data, continued

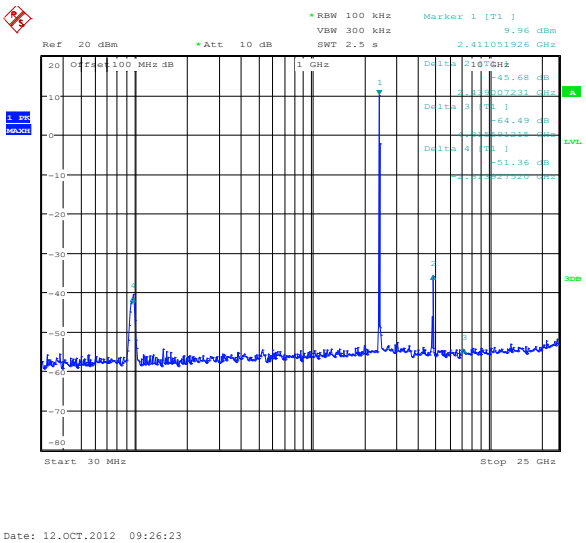


Diagram 8.5-1: *Conducted spurious emissions for 802.11b, ch0, low channel*

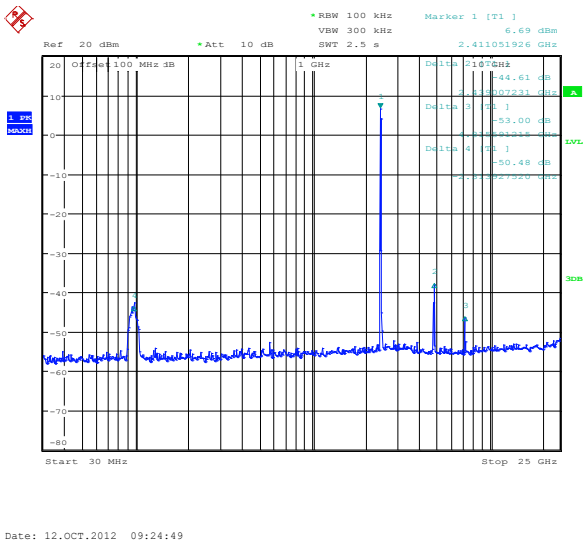


Diagram 8.5-2: *Conducted spurious emissions for 802.11g, ch0, low channel*

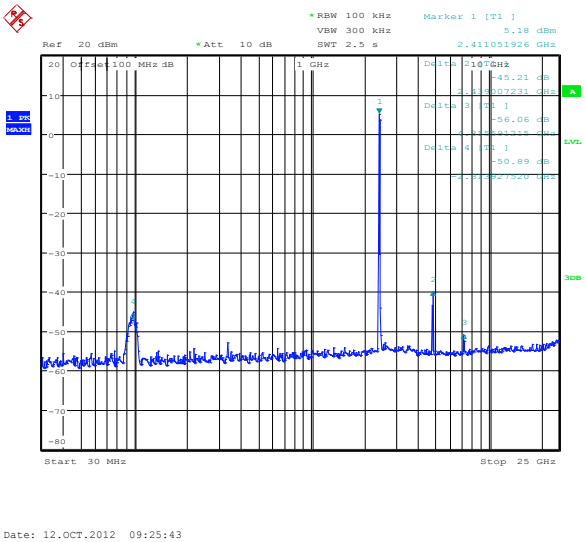


Diagram 8.5-3: *Conducted spurious emissions for 802.11n HT20, ch0, low channel*

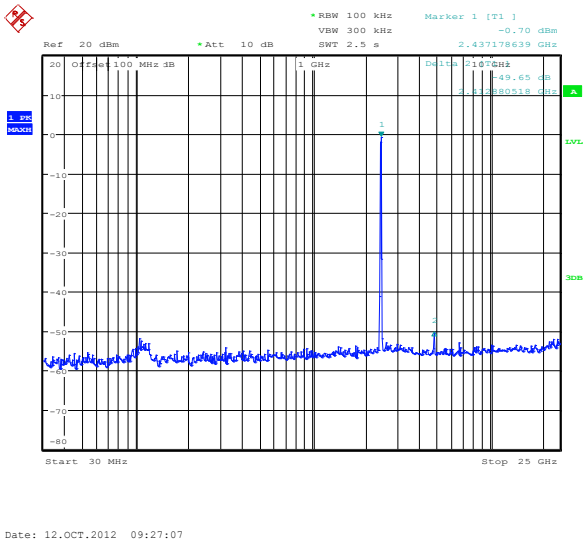


Diagram 8.5-4: *Conducted spurious emissions for 802.11n HT40, ch0, low channel*

8.5.4 Test data, continued

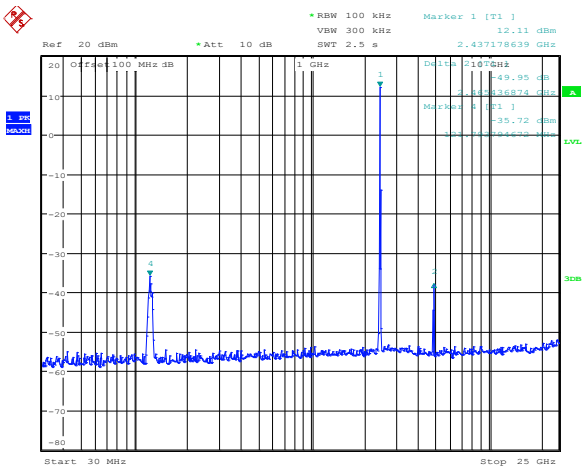


Diagram 8.5-5: *Conducted spurious emissions for 802.11b, ch0, mid channel*

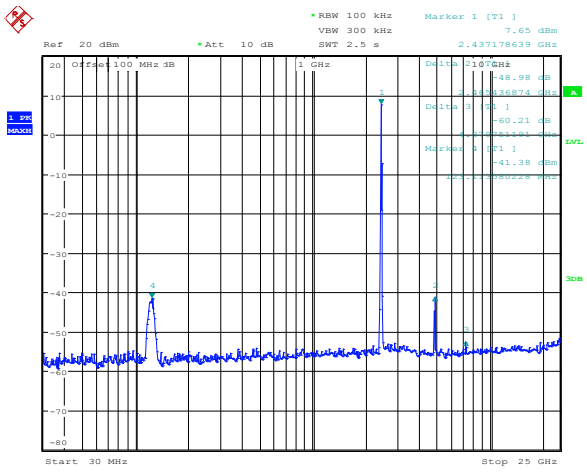


Diagram 8.5-6: *Conducted spurious emissions for 802.11g, ch0, mid channel*

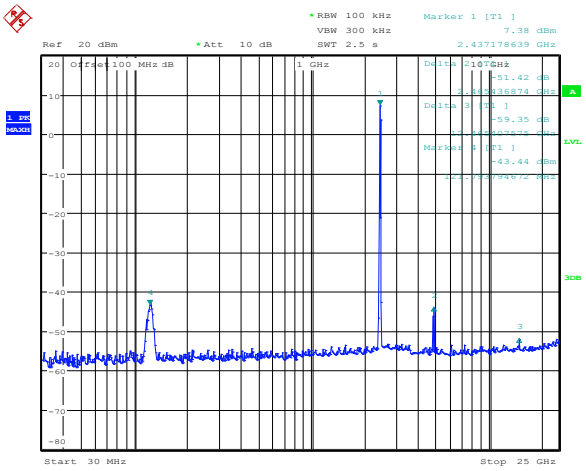


Diagram 8.5-7: *Conducted spurious emissions for 802.11n HT20, ch0, mid channel*

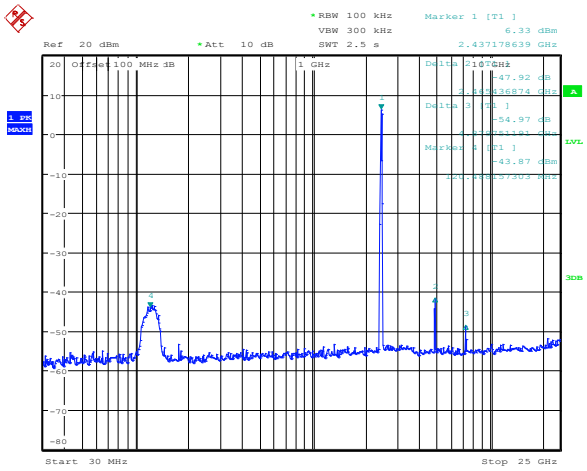


Diagram 8.5-8: *Conducted spurious emissions for 802.11n HT40, ch0, mid channel*

8.5.4 Test data, continued

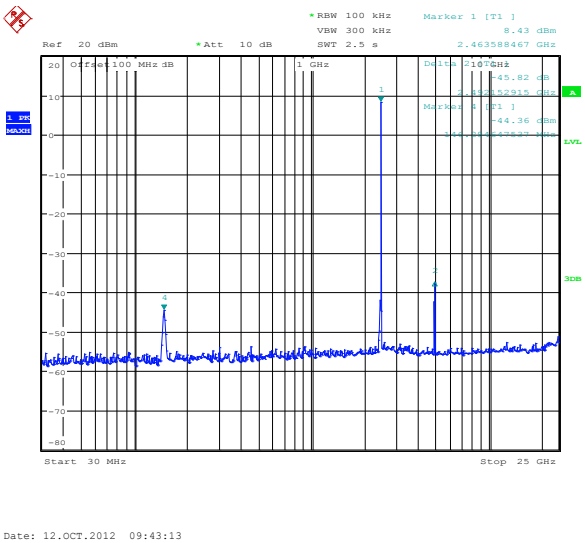


Diagram 8.5-9: *Conducted spurious emissions for 802.11b, cho, high channel*

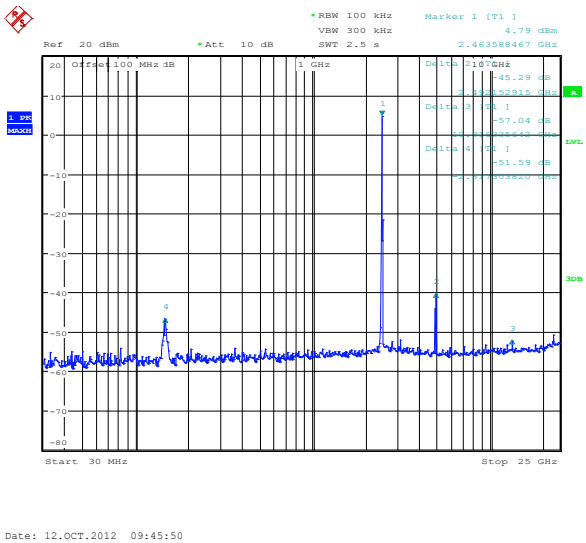


Diagram 8.5-10: *Conducted spurious emissions for 802.11g, cho, high channel*

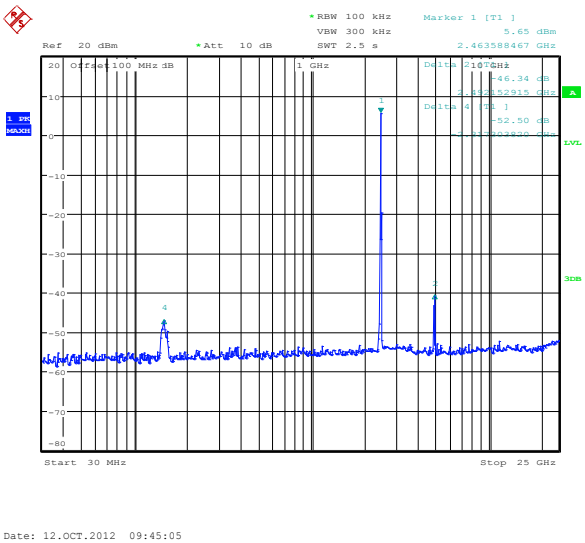


Diagram 8.5-11: *Conducted spurious emissions for 802.11n HT20, cho, high channel*

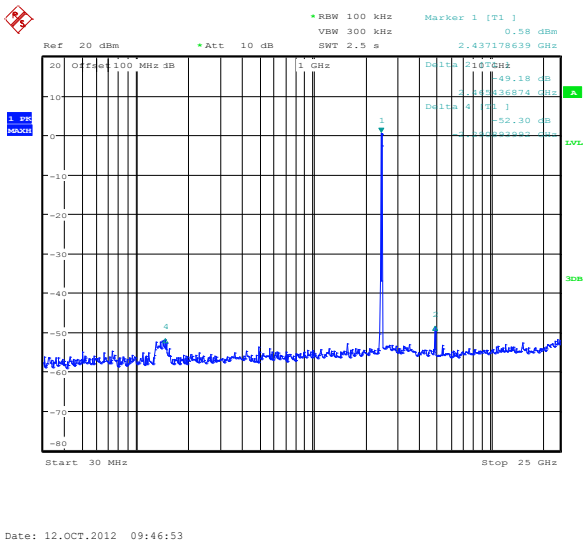


Diagram 8.5-12: *Conducted spurious emissions for 802.11n HT40, cho, high channel*

8.5.4 Test data, continued

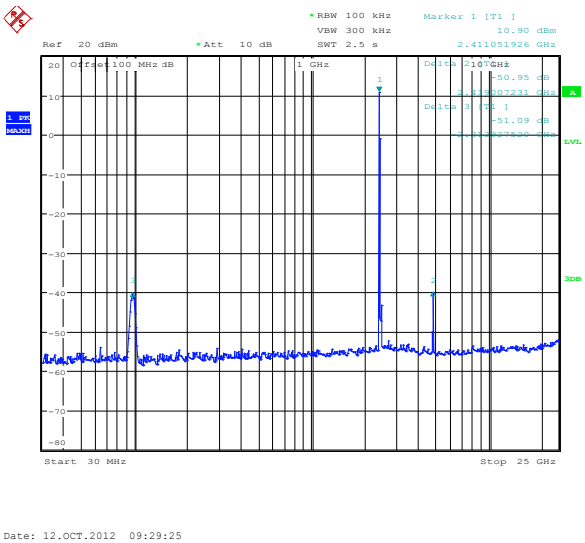


Diagram 8.5-13: *Conducted spurious emissions for 802.11b, ch1, low channel*

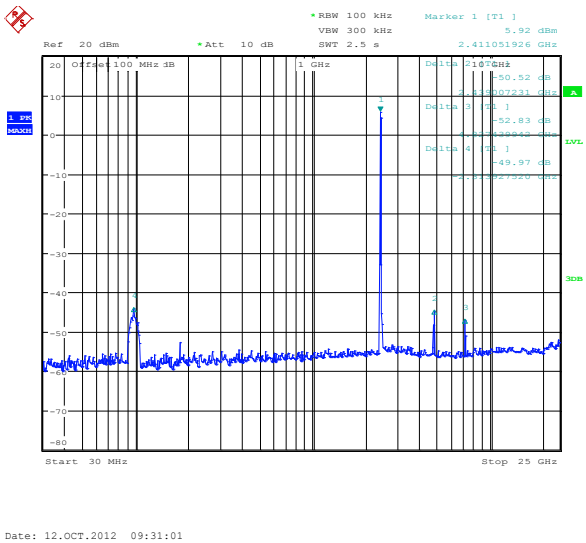


Diagram 8.5-14: *Conducted spurious emissions for 802.11g, ch1, low channel*

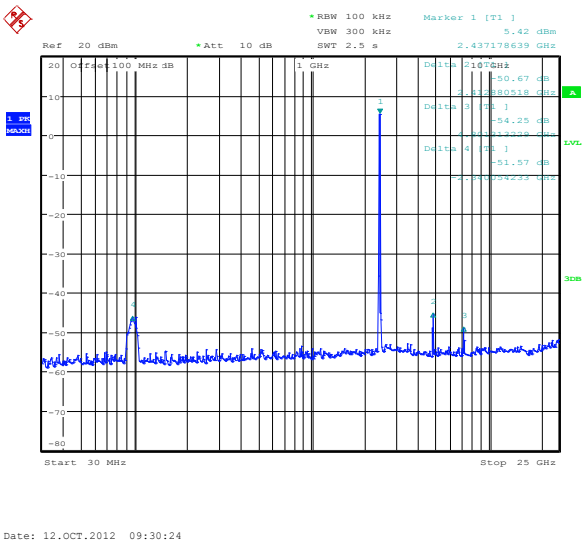


Diagram 8.5-15: *Conducted spurious emissions for 802.11n HT20, ch1, low channel*

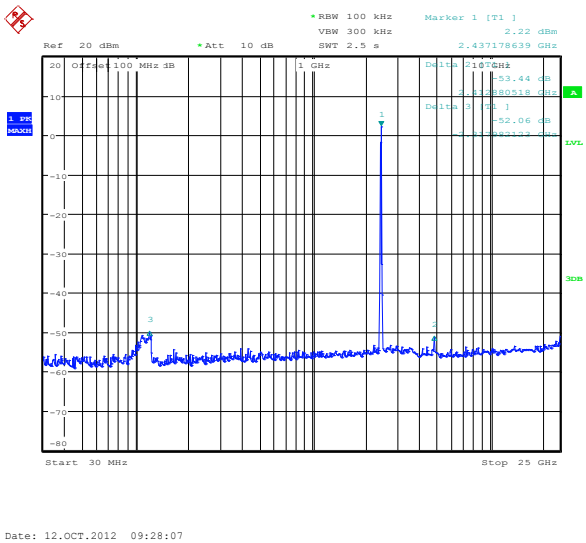


Diagram 8.5-16: *Conducted spurious emissions for 802.11n HT40, ch1, low channel*

8.5.4 Test data, continued

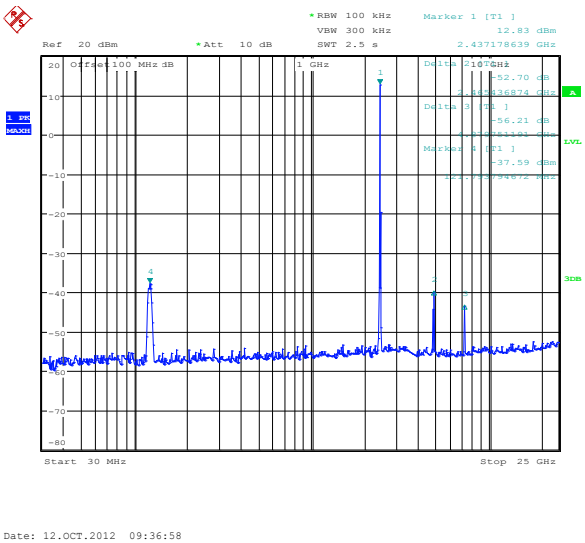


Diagram 8.5-17: *Conducted spurious emissions for 802.11b, ch1, mid channel*

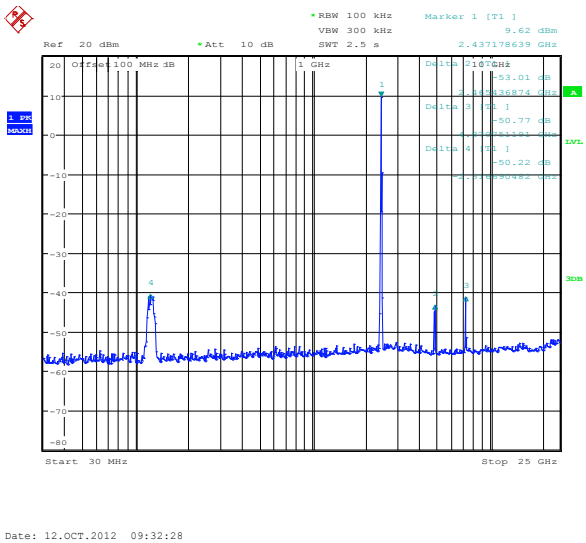


Diagram 8.5-18: *Conducted spurious emissions for 802.11g, ch1, mid channel*

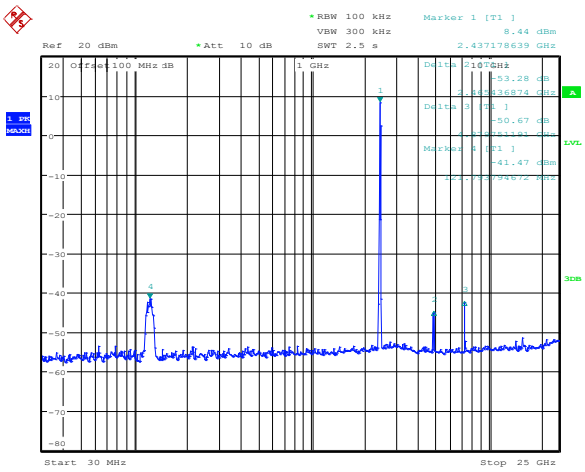


Diagram 8.5-19: *Conducted spurious emissions for 802.11n HT20, ch1, mid channel*

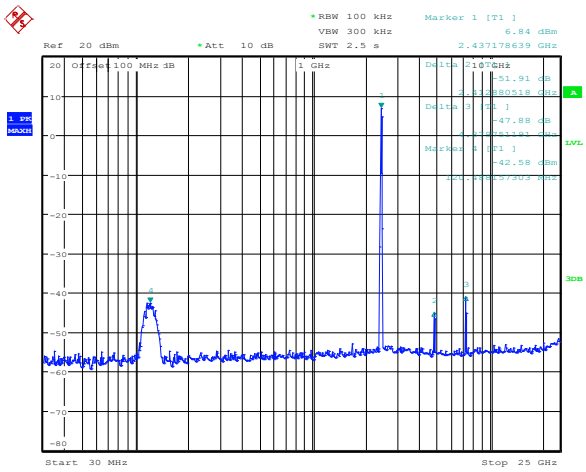


Diagram 8.5-20: *Conducted spurious emissions for 802.11n HT40, ch1, mid channel*

8.5.4 Test data, continued

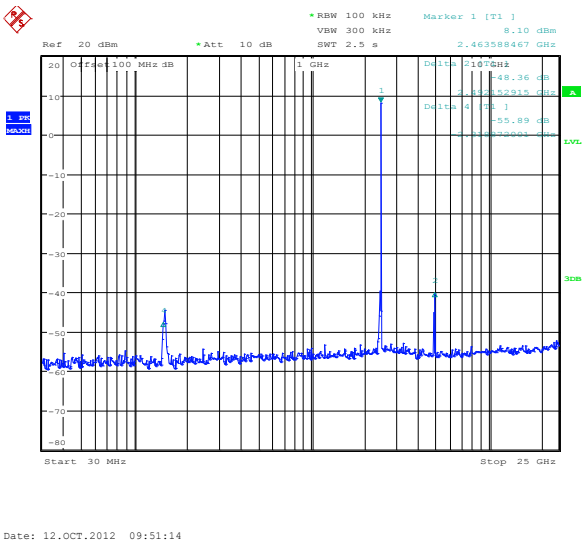


Diagram 8.5-21: *Conducted spurious emissions for 802.11b, ch1, high channel*

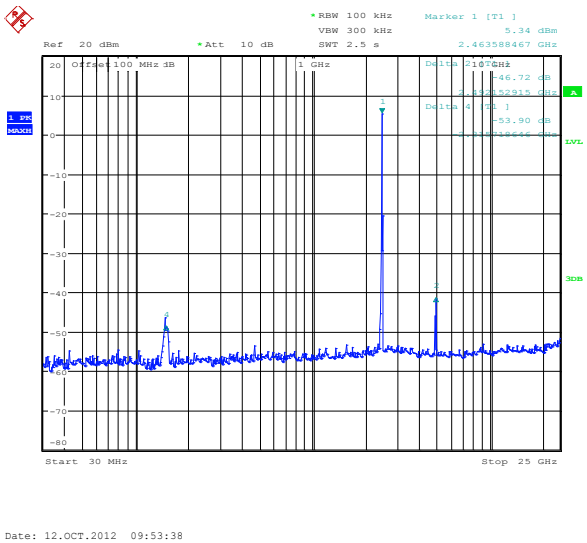


Diagram 8.5-22: *Conducted spurious emissions for 802.11g, ch1, high channel*

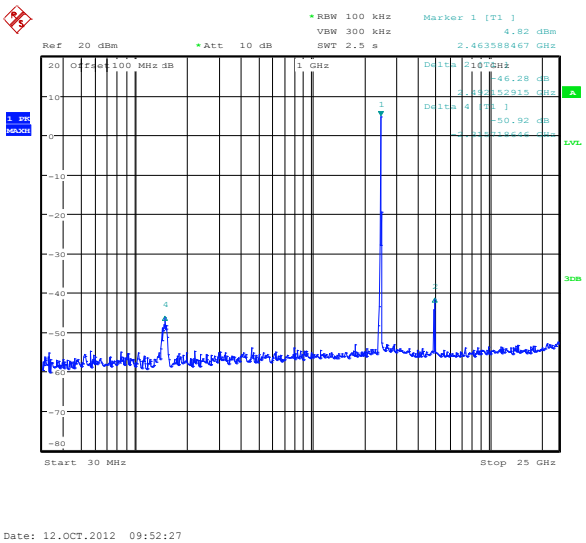


Diagram 8.5-23: *Conducted spurious emissions for 802.11n HT20, ch1, high channel*

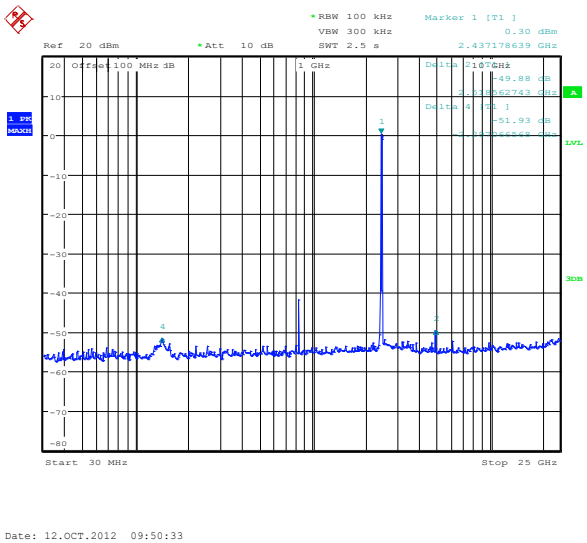


Diagram 8.5-24: *Conducted spurious emissions for 802.11n HT40, ch1, high channel*

Table 8.5-9: *Radiated field strength measurement results below 1 GHz*

Modulation	Channel	Frequency, MHz	Peak Field strength, dBµV/m	Limit, dBµV/m	Margin, dB
802.11b	Mid	118.56	34.7	43.5	8.8
802.11g	Mid	113.56	34.7	43.5	8.8
802.11n HT20	Mid	116.28	34.2	43.5	9.3
802.11n HT40	Mid	119.00	34.5	43.5	9.0

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

8.5.4 Test data, continued

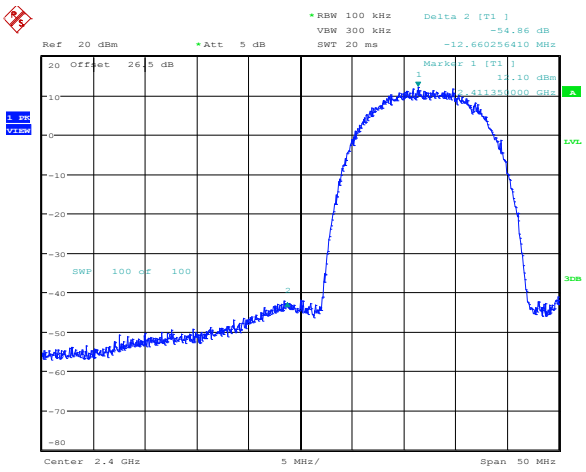


Diagram 8.5-25: *Conducted lower band edge for 802.11b, ch0*

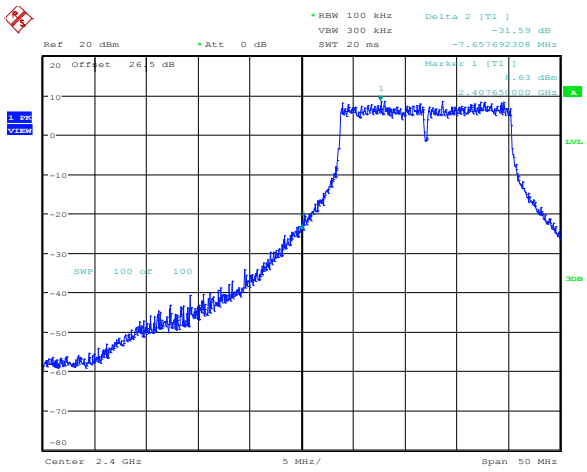


Diagram 8.5-26: *Conducted lower band edge for 802.11g, ch0*

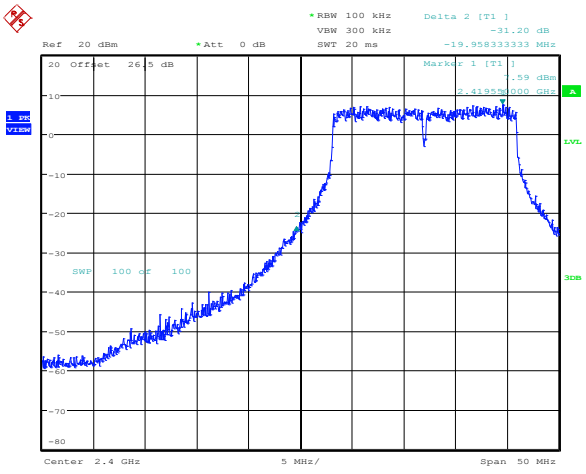


Diagram 8.5-27: *Conducted lower band edge for 802.11n HT20, ch0*

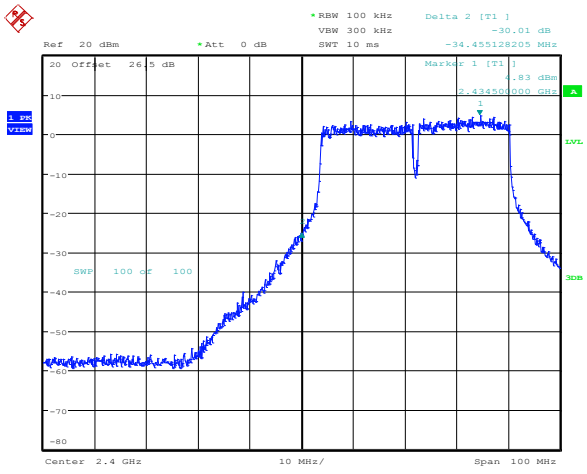


Diagram 8.5-28: *Conducted lower band edge for 802.11n HT40, ch0*

8.5.1 Test data, continued

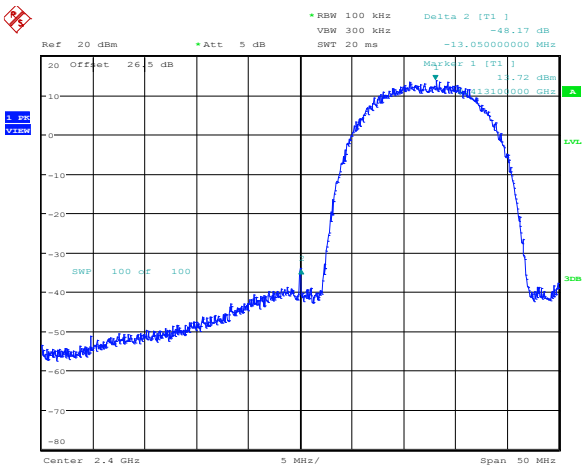


Diagram 8.5-29: *Conducted lower band edge for 802.11b, ch1*

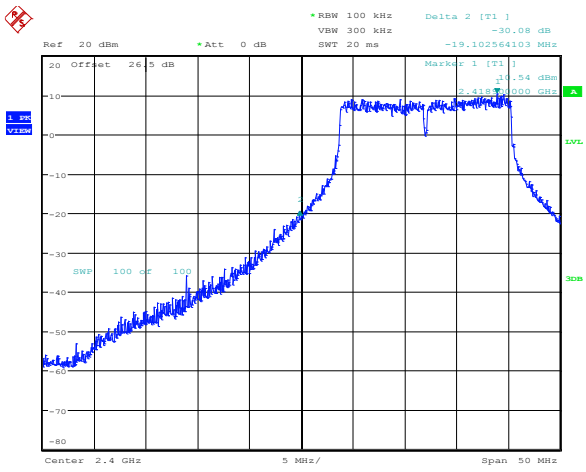


Diagram 8.5-30: *Conducted lower band edge for 802.11g, ch1*

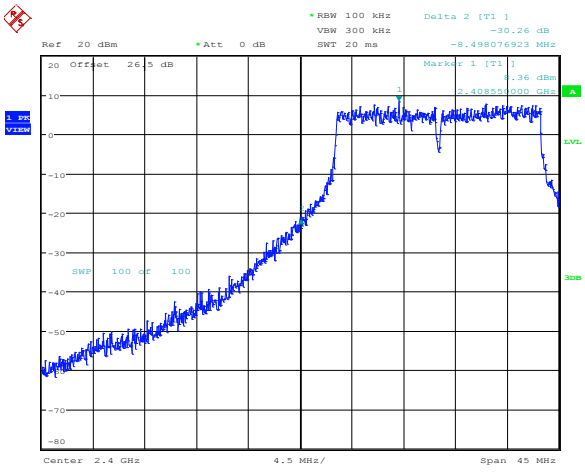


Diagram 8.5-31: *Conducted lower band edge for 802.11n HT20, ch1*

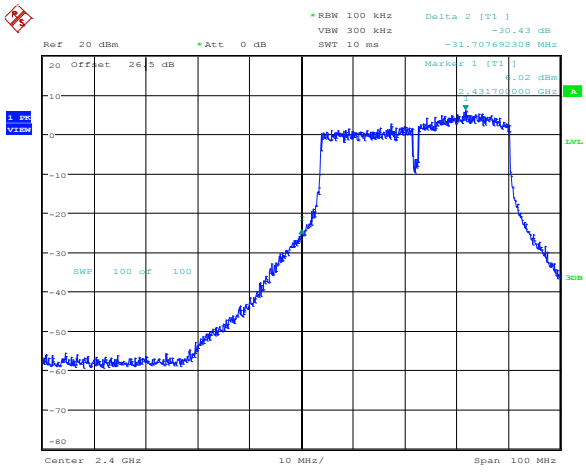


Diagram 8.5-32: *Conducted lower band edge for 802.11n HT40, ch1*

8.6 FCC 15.247(e) and RSS-210 A8.2(b) Power spectral density for digitally modulated devices

8.6.1 Definitions and limits

FCC:
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

IC:
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0-second duration. This power spectral density shall be determined in accordance with the provisions of Section A8.4(4); (i.e. the power spectral density shall be determined using the same method for determining the conducted output power).

8.6.2 Test summary

Test date	October 11, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1004 mbar	**Relative humidity**	33 %

8.6.3 Observations/special notes

The test was performed using method described in section 9.2 Option 2 of the 558074 D01 DTS Meas Guidance v02.
The RBW was set to 100 kHz.

8.6.4 Test data

Table 8.6-1: *PSD measurements results*

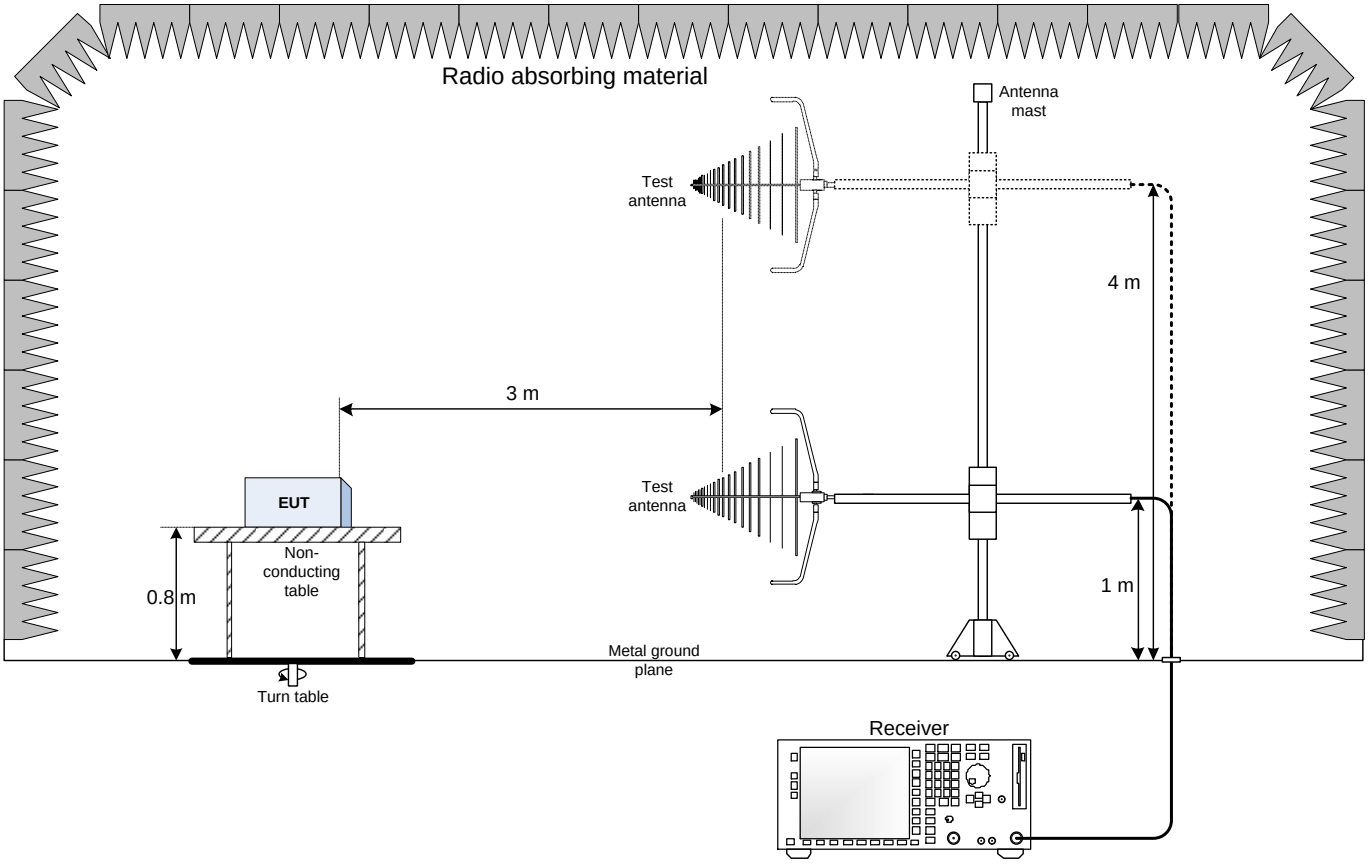
Modulation	Frequency, MHz	PSD at ch0, dBm/100 kHz	PSD at ch1, dBm/100 kHz	Combined PSD, dBm/100 kHz	PSD limit, dBm/3 kHz	Margin, dB
802.11b	2412	-1.16	-1.00	1.93	8.00	6.07
802.11b	2437	0.82	1.66	4.27	8.00	3.73
802.11b	2462	-0.88	-0.01	2.59	8.00	5.41
802.11g	2422	-6.12	-5.08	-2.56	8.00	10.56
802.11g	2437	-0.38	0.61	3.15	8.00	4.85
802.11g	2457	-5.42	-6.60	-2.96	8.00	10.96
802.11n HT20	2412	-0.45	-0.35	2.61	8.00	5.39
802.11n HT20	2437	1.73	2.60	5.20	8.00	2.80
802.11n HT20	2462	-0.95	0.04	2.58	8.00	5.42
802.11n HT40	2412	3.77	2.12	6.03	8.00	1.97
802.11n HT40	2437	5.00	4.98	8.00	8.00	0.00
802.11n HT40	2462	1.20	1.46	4.34	8.00	3.66

Notes: Combined PSD was calculated as follows:

$$PSD_{combined} = 10 \times log_{10}\left(\left(10^{PSD_{ch0}/10}\right) + \left(10^{PSD_{ch1}/10}\right)\right)$$

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up