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Compliance test report ID: **182563-1TRFWL**

Date of issue
October 28, 2011

FCC 47 CFR Part 15 Subpart C

§15.247 - Operation within the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz

Applicant	**BelAir Networks Inc.**
Product	**DRUE 2.4 GHz radio**
Model	**B2CH118AA**
FCC ID	**RAR50002001**

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.
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Test site FCC ID: 176392 (3 m semi anechoic chamber)

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Tested by Andrey Adelberg, Senior Wireless/EMC Specialist

Reviewed by

David Duchesne, Senior Wireless/EMC Specialist

October 28, 2011
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

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Section 1: Report summary

1.1 Applicant

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

1.2 Test specifications

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§15.247 - Operation within the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz

1.3 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.

1.4 Test report revision history

Original report issued

Section 2: Summary of test results

2.1 FCC Part 15 – General requirements, test results

Part	Test description	Verdict
§15.31(e)	Variation of power source	See Notes 1
§15.31(m)	Number of operating frequencies	See Notes 2
§15.203	Antenna requirement	See Notes 3
§15.207(a)	Conducted limits	Pass

Notes:
1. Transmit output power was measured while supply voltage was varied from 102 to 138 V_{AC} (85 to 115 % of the nominal rated supply voltage). No change in transmit output power was observed
2. The frequency range over which the device operates is greater than 10 MHz. Tests were performed on three operating channels. (low, mid and high)
3. This requirement does not apply to intentional radiators that must be professionally installed

2.2 FCC Part 15, Subpart C, 15.247, test results

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	N/A[1]
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	
§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	N/A[1]
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	
§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	Pass
§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	Pass
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	N/A[2]
§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	N/A[1]

Notes: [1] - The EUT is not a hopping nor hybrid system
[2] - This equipment does not emit multiple directional beams

Section 3: Equipment under test (EUT) details

3.1 Sample information

Receipt date	July 28, 2011
Nemko sample ID number	1

3.2 EUT information

Product name	DRUE 2.4 GHz radio
Model	B2CH118AA
Serial number	M1817E0018

3.3 Technical information

Operating band	2400–2483.5 MHz
Operating frequency	2412–2462 MHz
Modulation type	802.11b, 802.11g and 802.11n
Channel bandwidth	20 MHz
Emission designator	W7D
Power requirements	120 V_{AC}, 60 Hz
Antenna information	
Type:	Omni-directional (professionally installed)
Gain:	4.5 dBi.
Model:	BMAG00290-A
Manufacturer:	BelAir Networks

3.4 Product description and theory of operation

The EUT is a 3×3 MIMO combo Wi-Fi module designed to operate in the 2.4–2.4835 GHz band, and 5.725–5.85 GHz band. 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

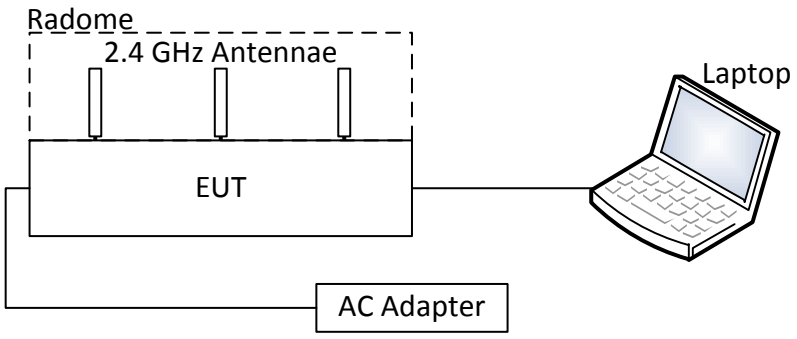


Diagram 3.6-1: Setup diagram

Section 4: Engineering considerations

1.4 Modifications incorporated in the EUT

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

1.5 Technical judgment

None

1.6 Deviations from laboratory tests procedures

No deviations were made from laboratory test procedures.

Section 5: Test conditions

5.1 Atmospheric conditions

Temperature: 15–30 °C
Relative humidity: 20–75 %
Air pressure: 86–106 kPa

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

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Mar. 09/12
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	Jan. 26/12
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	April 27/12
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Dec.06/11
Bilog antenna	Sunol	JB3	FA002108	1 year	Jan. 31/12
Horn antenna #2	EMCO	3115	FA000825	1 year	Feb. 04/12
1–18 GHz pre-amplifier	JCA	JCA118-503	FA002091	1 year	Sept. 23/11
Horn antenna 18–40 GHz	EMCO	3116	FA001847	1 year	May 20/12
18–26 GHz pre-amplifier	Narda	BBS-1826N612	FA001550	—	VOU

Note: NCR = no cal required, VOU = verify on use

Section 8: Testing data

8.1 Clause 15.207(a) Conducted limits

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 ohms 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
*-Decreases with the logarithm of the frequency.		

8.1.1 Test summary

Test date	August 5, 2011	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	25 °C	**Air pressure**	1005 mbar	**Relative humidity**	45 %

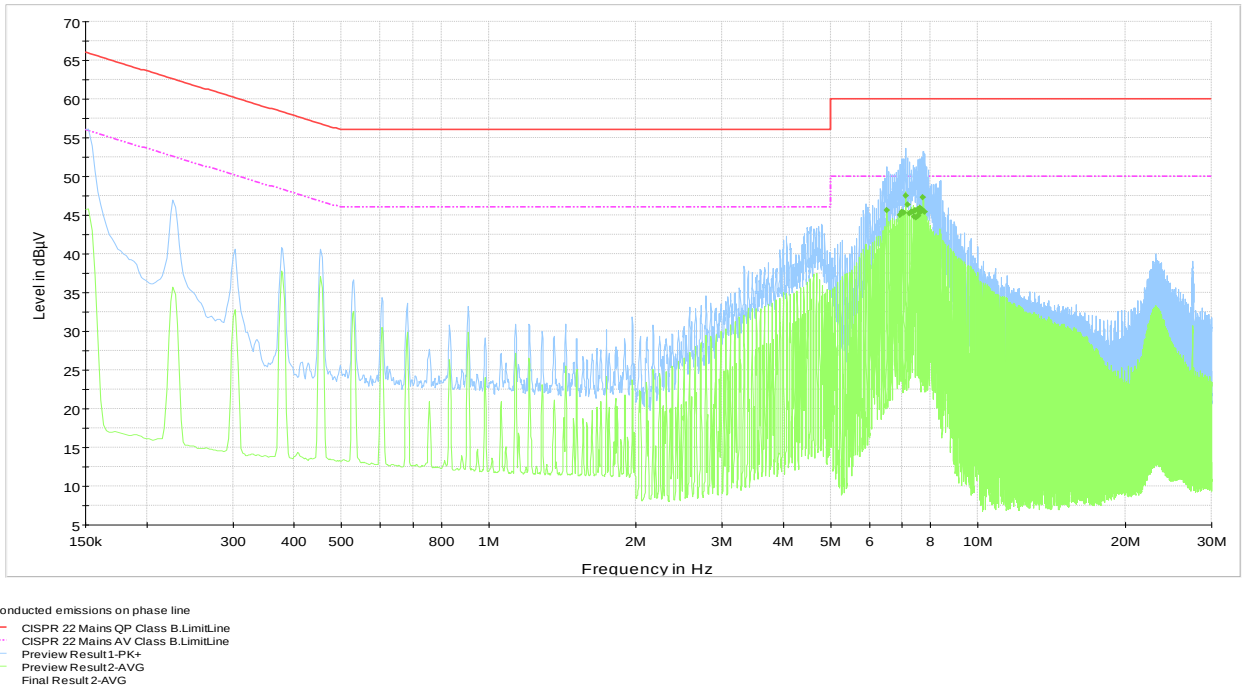
8.1.2 Observations/special notes

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.

8.1.3 Test data



Plot 8.1-1: Conducted emissions on phase line

Frequency range	0.15 MHz to 30 MHz
Preview measurements	Receiver: 9 kHz RBW, Peak (blue) and Average (green) detector, max hold
Final measurement	Receiver: 9 kHz RBW, Quasi-peak and Average (green) detector
Measurement time	100 ms

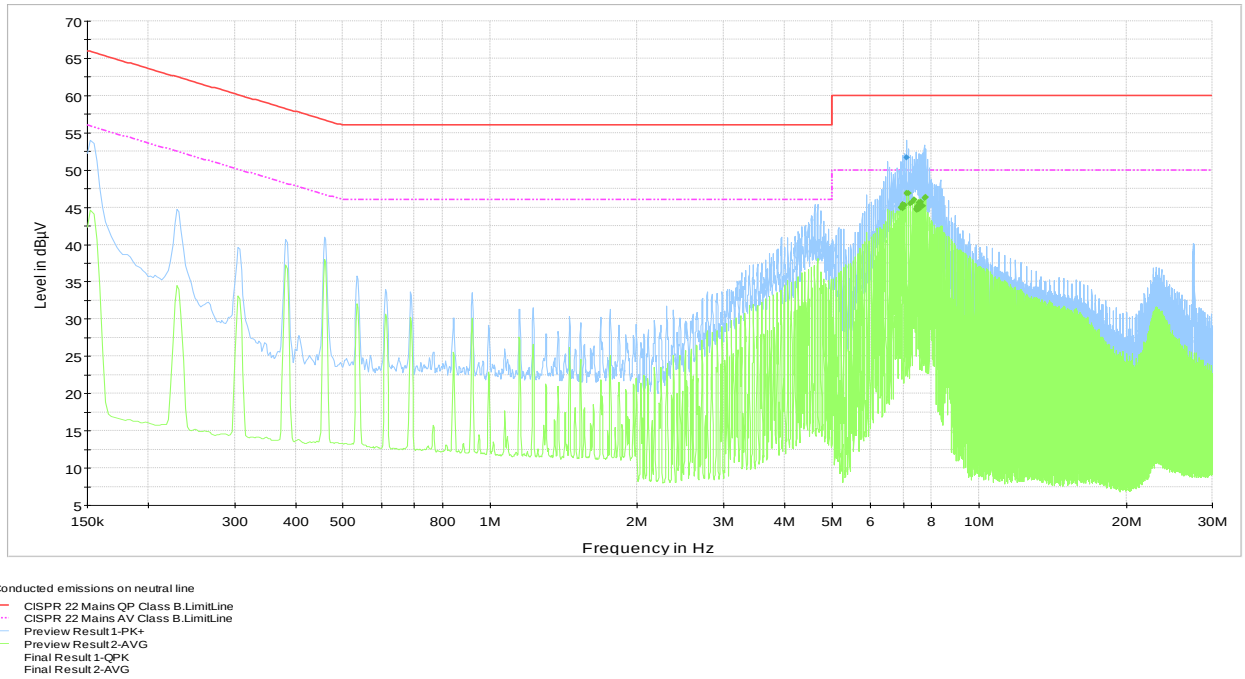
Table 8.1-2: Average conducted emissions results on phase line

Frequency (MHz)	Average result (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Conductor	Correction (dB)	Margin (dB)	Limit (dBµV)
7.480500	44.7	100.0	9.000	On	Phase	10.2	5.3	50.0
7.419750	44.8	100.0	9.000	On	Phase	10.2	5.2	50.0
7.541250	44.9	100.0	9.000	On	Phase	10.2	5.1	50.0
6.931500	45.0	100.0	9.000	On	Phase	10.2	5.0	50.0
7.248750	45.2	100.0	9.000	On	Phase	10.2	4.8	50.0
7.602000	45.3	100.0	9.000	On	Phase	10.2	4.7	50.0
6.992250	45.4	100.0	9.000	On	Phase	10.2	4.6	50.0
7.053000	45.4	100.0	9.000	On	Phase	10.2	4.6	50.0
7.316250	45.4	100.0	9.000	On	Phase	10.2	4.6	50.0
7.383750	45.4	100.0	9.000	On	Phase	10.2	4.6	50.0
7.791000	45.4	100.0	9.000	On	Phase	10.2	4.6	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)

8.1.3 Test data, continued



Plot 8.1-2: Conducted emissions on neutral line

Frequency range	0.15 MHz to 30 MHz
Preview measurements	Receiver: 9 kHz RBW, Peak (blue) and Average (green) detector, max hold
Final measurement	Receiver: 9 kHz RBW, Quasi-peak (blue) and Average (green) detector
Measurement time	100 ms

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

Frequency (MHz)	Average result (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Conductor	Correction (dB)	Margin (dB)	Limit (dBµV)
7.480500	44.6	100.0	9.000	On	Neutral	10.2	5.4	50.0
7.541250	44.7	100.0	9.000	On	Neutral	10.2	5.3	50.0
7.419750	44.8	100.0	9.000	On	Neutral	10.2	5.2	50.0
6.976500	44.9	100.0	9.000	On	Neutral	10.2	5.1	50.0
6.931500	45.0	100.0	9.000	On	Neutral	10.2	5.0	50.0
7.451250	45.1	100.0	9.000	On	Neutral	10.2	4.9	50.0
7.602000	45.1	100.0	9.000	On	Neutral	10.2	4.9	50.0
7.653750	45.2	100.0	9.000	On	Neutral	10.2	4.8	50.0
7.053000	45.3	100.0	9.000	On	Neutral	10.2	4.7	50.0
6.992250	45.4	100.0	9.000	On	Neutral	10.2	4.6	50.0
7.246500	45.5	100.0	9.000	On	Neutral	10.2	4.5	50.0

Table 8.1-4: Quasi-peak conducted emissions results

Frequency (MHz)	Quasi-peak result (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Conductor	Correction (dB)	Margin (dB)	Limit (dBµV)
7.113750	51.6	100.0	9.000	On	Neutral	10.2	8.4	60.0

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 Clause 15.247(a)(2) Minimum 6 dB bandwidth for systems using digital modulation techniques

(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.

8.2.1 Test summary

Test date	July 27, 2011	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1005 mbar	**Relative humidity**	38 %

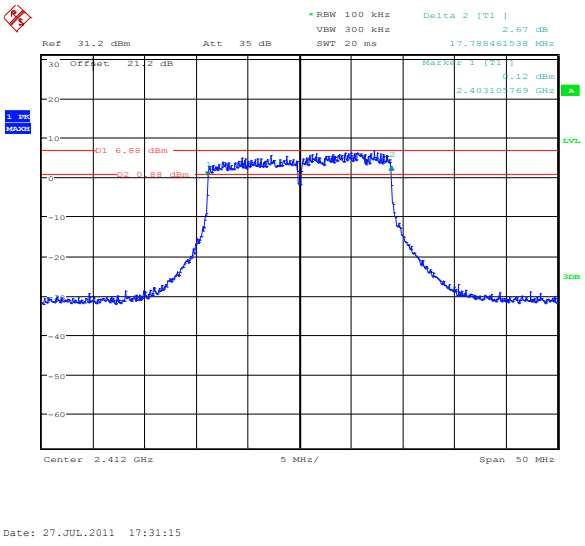
8.2.2 Observations/special notes

A peak detector with 100 kHz RBW and 300 kHz VBW was used to perform measurement.

8.2.3 Test data

Table 8.2-1: 6 dB bandwidth results

Modulation	Frequency, MHz	6 dB BW, MHz	Limit, MHz	Margin, MHz
802.11n	2412	17.79	0.5	17.29
	2437	17.79	0.5	17.29
	2462	17.79	0.5	17.29
802.11g	2412	16.59	0.5	16.09
	2437	16.59	0.5	16.09
	2462	16.59	0.5	16.09
802.11b	2412	9.78	0.5	9.28
	2437	9.86	0.5	9.36
	2462	9.94	0.5	9.44



Sample plot 8.2-1: 6 dB BW

8.3 Clause 15.247(b)(3) and (4) Maximum peak conducted output power

(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.

(ii) Systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

(iii) 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.

8.3.1 Test summary

Test date	July 27, 2011	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1005 mbar	**Relative humidity**	38 %

8.3.2 Observations/special notes

The output RF power was measured on the antenna port 1, 2 and 3 by means of a spectrum analyzer and following the *'Power Output Option 2, Method 1'* procedure from the FCC guidelines for Measurement of Digital Transmission Systems operating under Section 15.247. The total output power equal to the summary of the output RF power was measured on the antenna port 1, 2 and 3.

8.3.3 Test data

Table 8.3-1: Power and EIRP results for 3×3 MIMO non-correlated operational mode

Modulation	Frequency (MHz)	SW setting	Conducted Avg. Power ANT 1 (mW)	Conducted Avg. Power ANT 2 (mW)	Conducted Avg. Power ANT 3 (mW)	Combined Output Power (dBm)	Conducted Output Power Limit (dBm)	Conducted Output Power Margin (dB)	Antenna Gain (dBi)	Cable loss (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
802.11n	2412	17.0	92.659	86.568	98.359	24.43	30.0	5.57	4.5	0.5	28.43	36.0	7.57
	2437	23.0	289.959	335.047	296.701	29.65	30.0	0.35	4.5	0.5	33.65	36.0	2.35
	2462	16.5	76.909	78.244	82.212	23.75	30.0	6.25	4.5	0.5	27.75	36.0	8.25
802.11g	2412	16.5	63.509	63.576	76.908	23.10	30.0	6.90	4.5	0.5	27.10	36.0	8.90
	2437	23.0	291.778	333.255	301.041	29.67	30.0	0.33	4.5	0.5	33.67	36.0	2.33
	2462	18.0	119.749	121.046	118.144	25.55	30.0	4.45	4.5	0.5	29.55	36.0	6.45
802.11b	2412	22.5	274.610	291.645	296.838	29.36	30.0	0.64	4.5	0.5	33.36	36.0	2.64
	2437	23.0	295.486	334.036	315.754	29.76	30.0	0.24	4.5	0.5	33.76	36.0	2.24
	2462	22.5	333.772	309.173	334.17	29.90	30.0	0.10	4.5	0.5	33.90	36.0	2.10

– Combined output power (dBm) = $10\times\text{Log}_{10}$ (Conducted Avg. Power ANT-1 (mW) + Conducted Avg. Power ANT-2 (mW) + Conducted Avg. Power ANT-3 (mW))
– EIRP (dBm) = Combined output power (dBm) + ((Antenna gain (dBi) - Cable loss (dB))

Table 8.3-2: Power and EIRP results for MIMO Correlated 3×3 CDD and TXBF operational mode

Modulation	Frequency (MHz)	SW setting	Conducted Avg. Power ANT 1 (mW)	Conducted Avg. Power ANT 2 (mW)	Conducted Avg. Power ANT 3 (mW)	Combined Output Power (dBm)	Conducted Output Power Limit (dBm)	Conducted Output Power Margin (dB)	Direct. Antenna Gain (dBi)	Cable loss (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
802.11n	2412	17.0	92.659	86.568	98.359	24.43	27.2	2.77	9.27	0.5	33.20	36.0	2.80
	2437	20.0	155.723	162.341	171.043	26.89	27.2	0.31	9.27	0.5	35.66	36.0	0.34
	2462	16.5	76.909	78.244	82.212	23.75	27.2	3.45	9.27	0.5	32.52	36.0	3.48
802.11g	2412	16.5	63.509	63.576	76.908	23.10	27.2	4.10	9.27	0.5	31.87	36.0	4.13
	2437	20.0	120.532	201.521	149.601	26.74	27.2	0.46	9.27	0.5	35.51	36.0	0.49
	2462	18.0	119.749	121.046	118.144	25.55	27.2	1.65	9.27	0.5	34.32	36.0	1.68
802.11b	2412	20.0	139.705	182.975	158.725	26.83	27.2	0.37	9.27	0.5	35.60	36.0	0.40
	2437	20.5	144.240	221.265	134.261	26.99	27.2	0.21	9.27	0.5	35.76	36.0	0.24
	2462	19.0	168.112	170.362	141.83	26.82	27.2	0.38	9.27	0.5	35.59	36.0	0.41

– Combined output power (dBm) = $10\times\text{Log}_{10}$ (Conducted Avg. Power ANT-1 (mW) + Conducted Avg. Power ANT-2 (mW) + Conducted Avg. Power ANT-3 (mW))
– EIRP (dBm) = Combined output power (dBm) + ((Antenna gain (dBi) - Cable loss (dB))
– MIMO Correlated 3×3 (CCD/TXBF), Directional gain = 4.5 + $10\times\log_{10}$ (N) dB = 4.5 dBi + 4.77 dB = 9.27 dBi, where “N” is number of antennae.

Table 8.3-3: Power and EIRP results for MIMO Correlated 2×3 CDD and TXBF operational mode

Modulation	Frequency (MHz)	SW setting	Conducted Avg. Power ANT 1 (mW)	Conducted Avg. Power ANT 2 (mW)	Conducted Avg. Power ANT 3 (mW)	Combined Output Power (dBm)	Conducted Output Power Limit (dBm)	Conducted Output Power Margin (dB)	Direct. Antenna Gain (dBi)	Cable loss (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
802.11n	2412	17.0	92.659	N/A	98.359	22.81	29.0	6.19	7.5	0.5	29.81	36.0	6.19
	2437	23.0	289.959	N/A	296.701	27.68	29.0	1.32	7.5	0.5	34.68	36.0	1.32
	2462	16.5	76.909	N/A	82.212	22.02	29.0	6.98	7.5	0.5	29.02	36.0	6.98
802.11g	2412	16.5	63.509	N/A	76.908	21.47	29.0	7.53	7.5	0.5	28.47	36.0	7.53
	2437	23.0	291.778	N/A	301.041	27.73	29.0	1.27	7.5	0.5	34.73	36.0	1.27
	2462	18.0	119.749	N/A	118.144	23.76	29.0	5.24	7.5	0.5	30.76	36.0	5.24
802.11b	2412	22.5	274.61	N/A	296.838	27.57	29.0	1.43	7.5	0.5	34.57	36.0	1.43
	2437	23.0	295.486	N/A	315.754	27.86	29.0	1.14	7.5	0.5	34.86	36.0	1.14
	2462	22.5	333.772	N/A	334.17	28.25	29.0	0.75	7.5	0.5	35.25	36.0	0.75

– Combined output power (dBm) = $10\times\text{Log}_{10}$ (Conducted Avg. Power ANT-1 (mW) + Conducted Avg. Power ANT-3 (mW))
– EIRP (dBm) = Combined output power (dBm) + ((Antenna gain (dBi) - Cable loss (dB))
– MIMO Correlated 2×3 (CCD/TXBF), Directional gain = 4.5 + $10\times\log_{10}$ (N) dB = 4.5 dBi + 3 dB = 7.5 dBi, where “N” is number of antennae.

Table 8.3-4: Power and EIRP results for STBC and STC operational mode

Modulation	Frequency (MHz)	SW setting	Conducted Avg. Power ANT 1 (mW)	Conducted Avg. Power ANT 2 (mW)	Conducted Avg. Power ANT 3 (mW)	Combined Output Power (dBm)	Conducted Output Power Limit (dBm)	Conducted Output Power Margin (dB)	Direct. Antenna Gain (dBi)	Cable loss (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
802.11n	2412	17.0	92.659	86.568	98.359	24.43	30.0	5.57	4.5	0.5	28.43	36.0	7.57
	2437	23.0	289.959	335.047	296.701	29.65	30.0	0.35	4.5	0.5	33.65	36.0	2.35
	2462	16.5	76.909	78.244	82.212	23.75	30.0	6.25	4.5	0.5	27.75	36.0	8.25

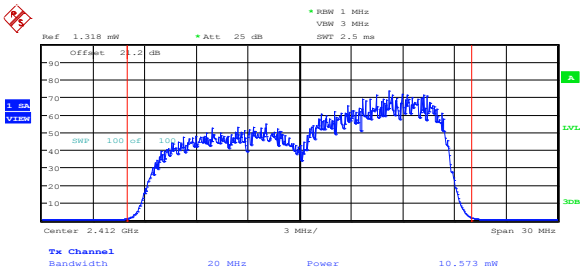
– Combined output power (dBm) = $10\times\text{Log}_{10}$ (Conducted Avg. Power ANT-1 (mW) + Conducted Avg. Power ANT-2 (mW) + Conducted Avg. Power ANT-3 (mW))
– EIRP (dBm) = Combined output power (dBm) + ((Antenna gain (dBi) - Cable loss (dB))

8.3.3 Test data, continued

Table 8.3-5: Point-to-Point Maximum Output Power and EIRP results for MIMO Correlated 3×3 TXBF operational mode

Modulation	Frequency (MHz)	SW setting	Conducted Avg. Power ANT 1 (mW)	Conducted Avg. Power ANT 2 (mW)	Conducted Avg. Power ANT 3 (mW)	Combined Output Power (dBm)	Conducted Output Power Limit (dBm)	Conducted Output Power Margin (dB)	Direct. Antenna Gain (dBi)	Cable loss (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
802.11n	2412	17.0	92.659	86.568	98.359	24.43	29.1	4.67	9.27	0.5	33.20	37.9	4.70
	2437	22.0	224.992	263.384	254.595	28.71	29.1	0.39	9.27	0.5	37.48	37.9	0.42
	2462	16.5	76.909	78.244	82.212	23.75	29.1	5.35	9.27	0.5	32.52	37.9	5.38
802.11g	2412	16.5	63.509	63.576	76.908	23.10	29.1	6.00	9.27	0.5	31.87	37.9	6.03
	2437	22.0	234.389	282.418	253.517	28.87	29.1	0.23	9.27	0.5	37.64	37.9	0.26
	2462	18.0	119.749	121.046	118.144	25.55	29.1	3.55	9.27	0.5	34.32	37.9	3.58
802.11b	2412	22.0	253.562	263.872	262.641	28.92	29.1	0.18	9.27	0.5	37.69	37.9	0.21
	2437	22.5	258.427	306.851	240.965	29.06	29.1	0.04	9.27	0.5	37.83	37.9	0.07
	2462	21.5	276.513	257.903	275.48	29.08	29.1	0.02	9.27	0.5	37.85	37.9	0.05

- Combined output power (dBm) = $10\times Log_{10}$ (Conducted Avg. Power ANT-1 (mW) + Conducted Avg. Power ANT-2 (mW) + Conducted Avg. Power ANT-3 (mW))
- EIRP (dBm) = Combined output power (dBm) + ((Antenna gain (dBi) - Cable loss (dB))
- MIMO Correlated 3×3 (TXBF), Directional gain = 4.5 + $10\times\log_{10}$ (N) dB = 4.5 dBi + 4.77 dB = 9.27 dBi, where "N" is number of antennae.
- Point-to-Point limit calculation: Power limit = 30 – (9.27-0.5-6)/3 = 29.1 dBm and EIRP limit = 29.1+(9.27-0.5) = 37.9 dBm



Sample plot 8.3-1: Output power

8.4 Clause 15.247(d) Spurious emissions

d) 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)).

8.4.1 Test summary

Test date	July 27, 2011	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1005 mbar	**Relative humidity**	38 %

8.4.2 Observations/special notes

Conducted measurements

- The spectrum was searched from 30 MHz to 25 GHz for low, mid and high carrier frequencies.
- All measurements for spurious emissions were performed conducted using a spectrum analyzer with Peak Detector with 100 kHz/300 kHz RBW/VBW.
- The spurious emissions were measured individually on antenna port 1, 2 and 3.
- Only the worst-case test results are provided.

Radiated measurements

Table 8.4-1: §15.209 – Radiated emission limits

Frequency (MHz)	Field strength		Measurement distance (m)
	(µV/m)	(dBµV/m)	
0.009–0.490	2400/F	67.6−20log(F)	300
0.490–1.705	24000/F	87.6−20log(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:

- F = fundamental frequency in kHz
- 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.

8.4.2 Observations/special notes, continued

Table 8.4-2: §15.205 – Restricted bands of operation

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			

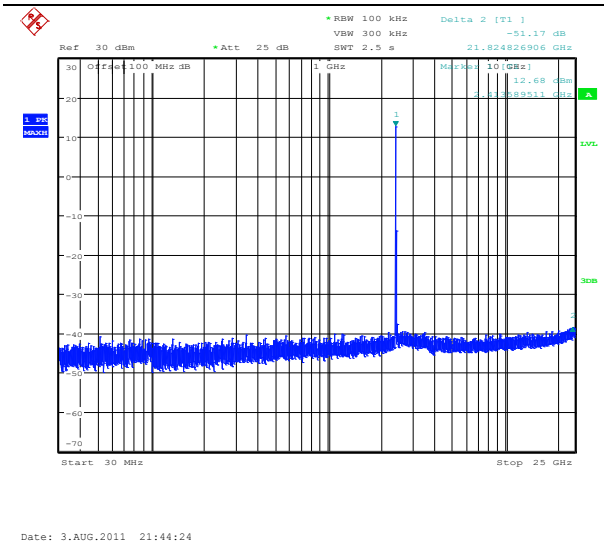
Notes:
- The spectrum was searched from 30 MHz to 10th harmonics for low, mid and high carrier frequencies
- These results apply to emissions found in the restricted bands defined in FCC Part 15 Subpart C, 15.205.
- Peak Detector with 100 kHz/300 kHz RBW/VBW was used for measurements below 1 GHz and 1 MHz/3 MHz RBW/VBW for frequencies above 1 GHz. Since EUT has 100 % duty cycle, average measurements were performed at the frequencies above 1 GHz with 1 MHz/10 Hz RBW/VBW spectrum analyzer settings.
- Only the worst-case test results are provided.

8.4.3 Test data

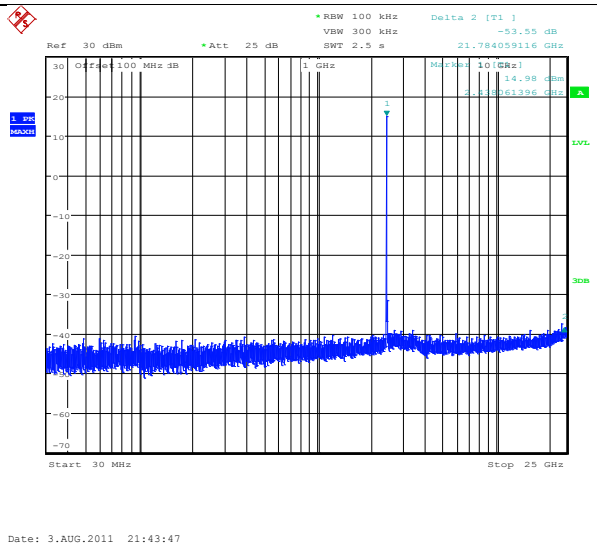
Table 8.4-3: Radiated spurious emissions results

Channel	Modulation	SW setting	Frequency (MHz)	FS Peak (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	FS Avg. (dBµV/m)	Avg. Limit (dBµV/m)	Avg. Margin (dB)
Low	802.11b	22.5	2390	64.62	74.00	9.38	52.92	54.00	1.08
	802.11g	16.5	2390	72.09	74.00	1.91	53.27	54.00	0.73
	802.11n	17	2390	72.77	74.00	1.23	53.76	54.00	0.24
High	802.11b	22.5	2483.5	65.65	74.00	8.35	53.47	54.00	0.53
	802.11g	18	2483.5	72.53	74.00	1.47	53.57	54.00	0.43
	802.11n	16.5	2483.5	70.81	74.00	3.19	53.44	54.00	0.56

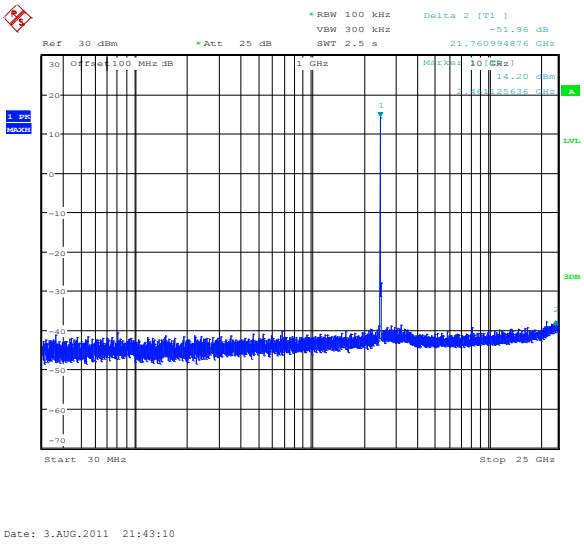
8.4.3 Test data, continued



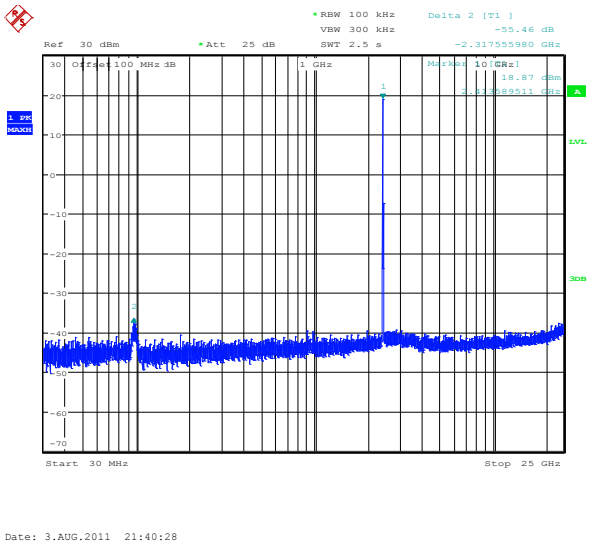
Plot 8.4-1: Conducted spurious emissions, 802.11b, Antenna port 1, low channel



Plot 8.4-2: Conducted spurious emissions, 802.11b, Antenna port 1, mid channel

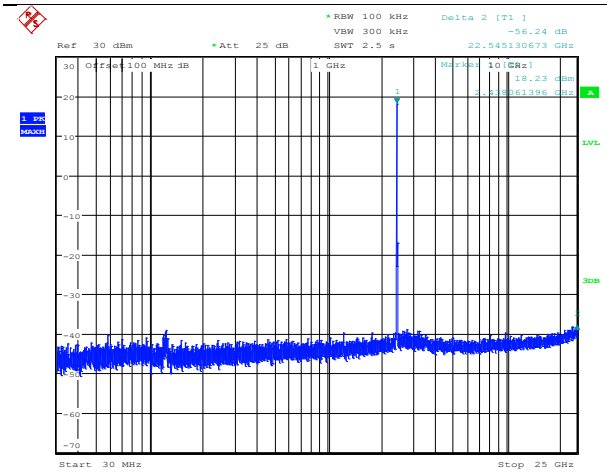


Plot 8.4-3: Conducted spurious emissions, 802.11b, Antenna port 1, high channel



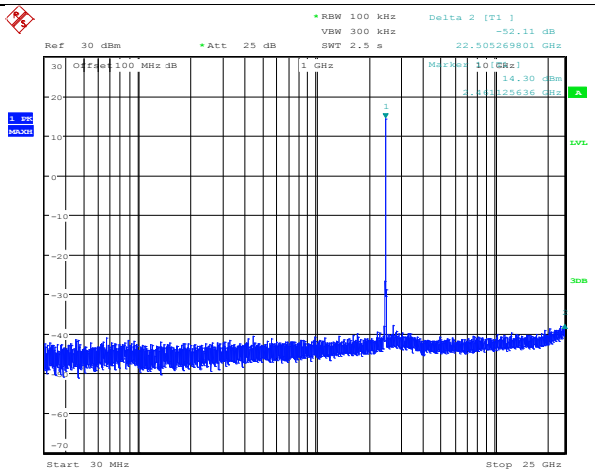
Plot 8.4-4: Conducted spurious emissions, 802.11b, Antenna port 2, low channel

8.4.3 Test data, continued



Date: 3.AUG.2011 21:41:12

Plot 8.4-5: Conducted spurious emissions, 802.11b, Antenna port 2, mid channel



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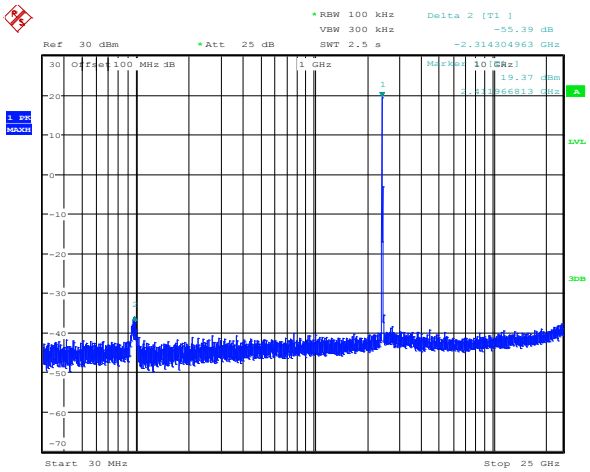
Plot 8.4-6: Conducted spurious emissions, 802.11b, Antenna port 2, high channel



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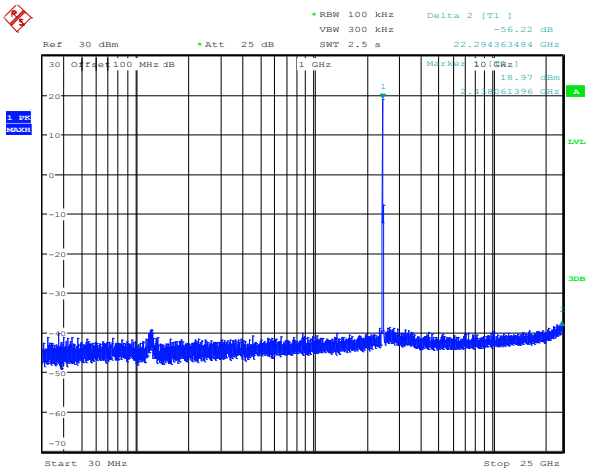
Plot 8.4-7: Conducted spurious emissions, 802.11b, Antenna port 3, low channel



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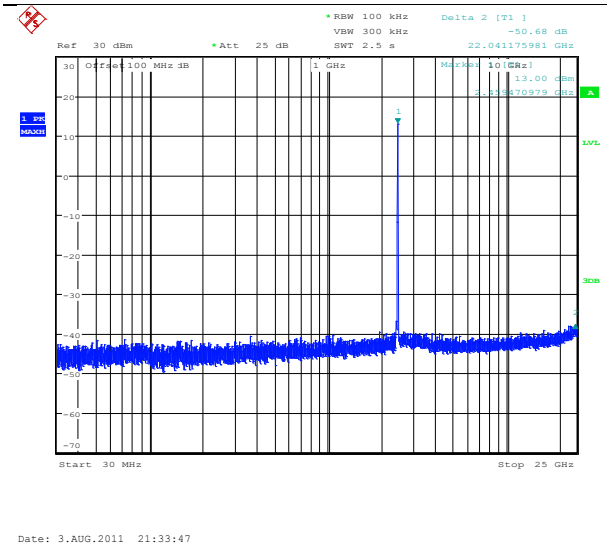
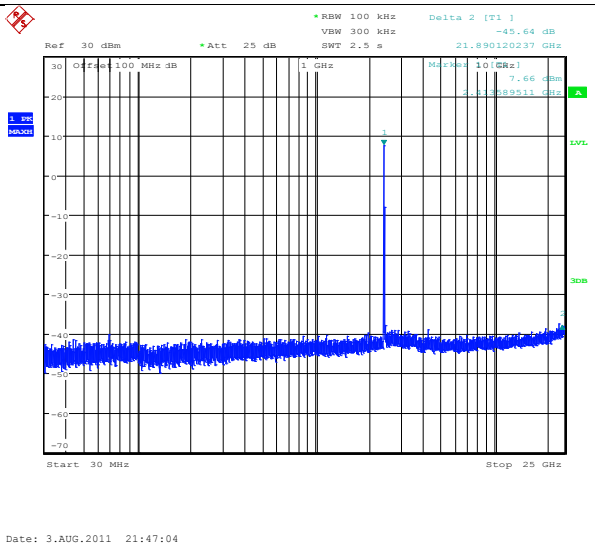
Plot 8.4-8: Conducted spurious emissions, 802.11b, Antenna port 3, mid channel

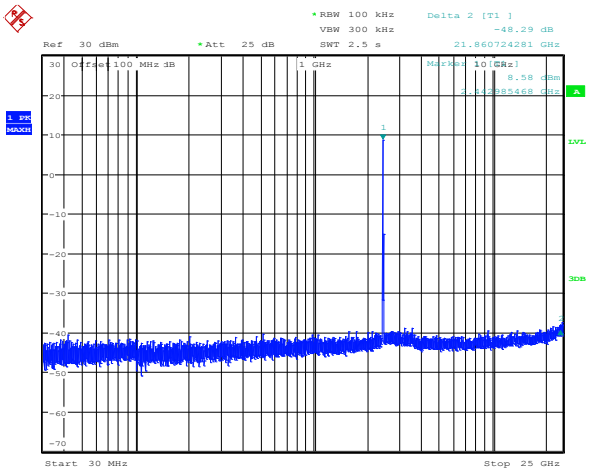
8.4.3 Test data, continued



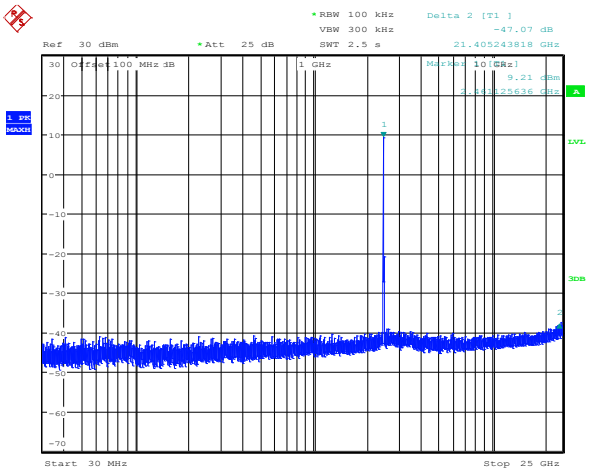
Plot 8.4-9: Conducted spurious emissions, 802.11b, Antenna port 3, high channel



Plot 8.4-10: Conducted spurious emissions, 802.11g, Antenna port 1, low channel

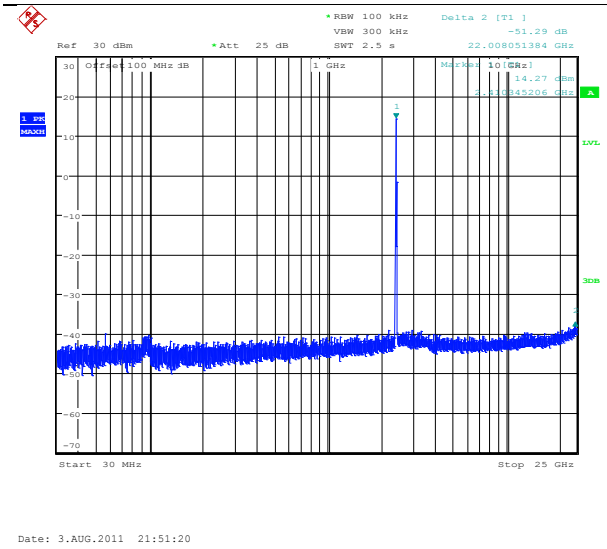


Plot 8.4-11: Conducted spurious emissions, 802.11g, Antenna port 1, mid channel

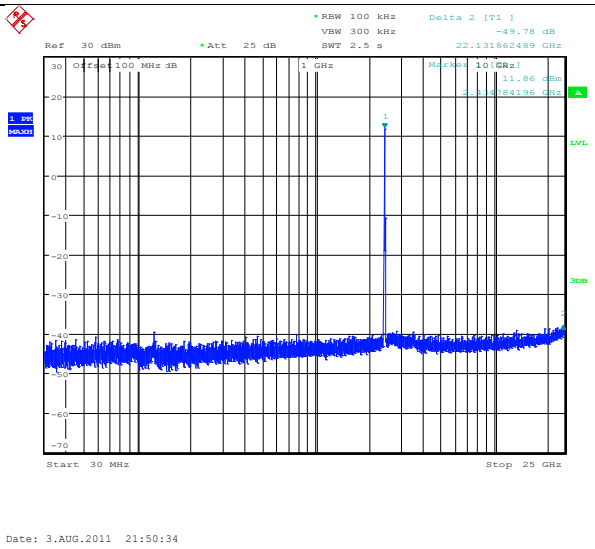


Plot 8.4-12: Conducted spurious emissions, 802.11g, Antenna port 1, high channel

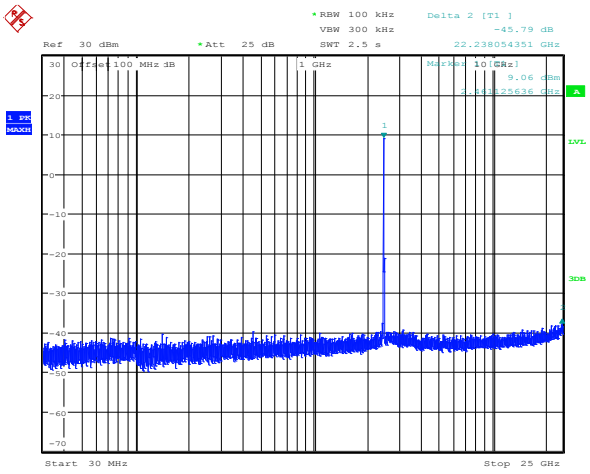
8.4.3 Test data, continued



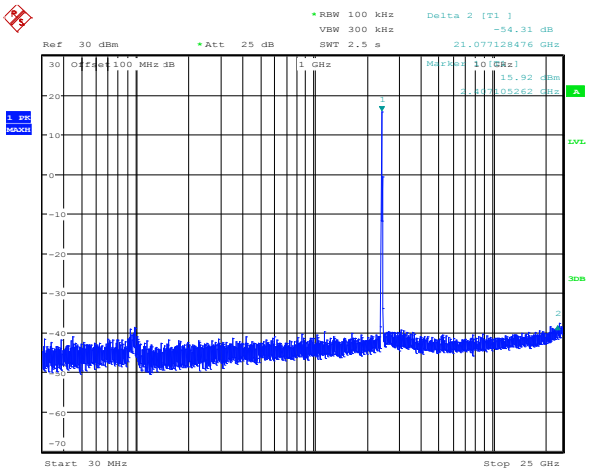
Plot 8.4-13: Conducted spurious emissions, 802.11g, Antenna port 2, low channel



Plot 8.4-14: Conducted spurious emissions, 802.11g, Antenna port 2, mid channel

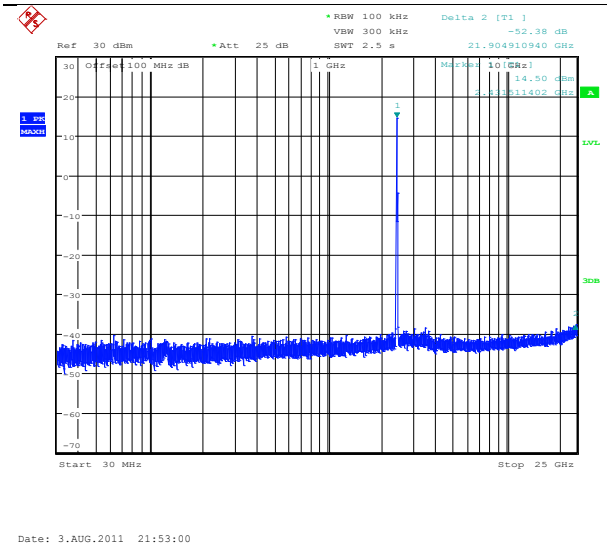


Plot 8.4-15: Conducted spurious emissions, 802.11g, Antenna port 2, high channel



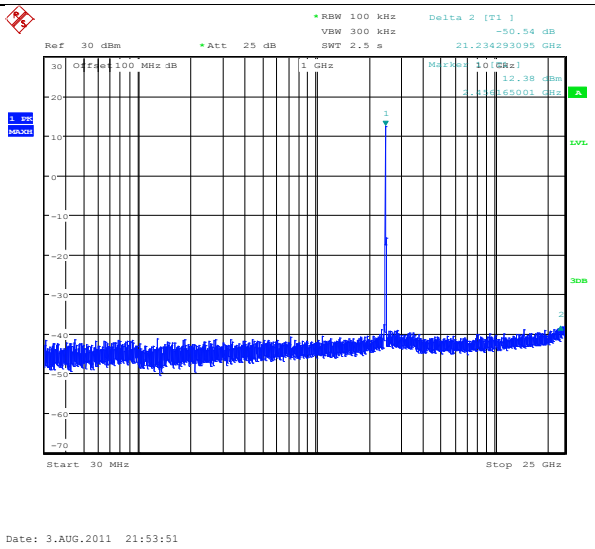
Plot 8.4-16: Conducted spurious emissions, 802.11g, Antenna port 3, low channel

8.4.3 Test data, continued



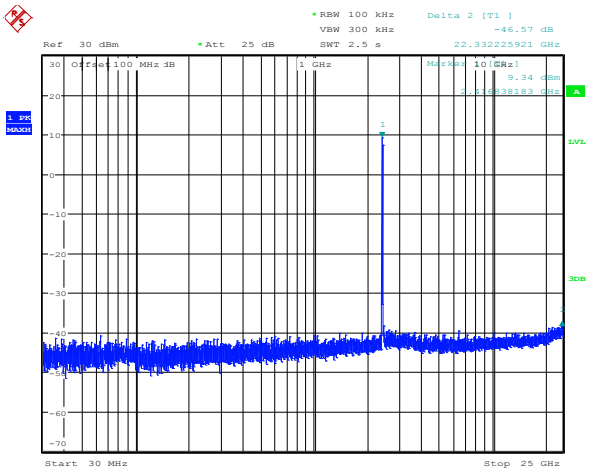
Date: 3.AUG.2011 21:53:00

Plot 8.4-17: Conducted spurious emissions, 802.11g, Antenna port 3, mid channel



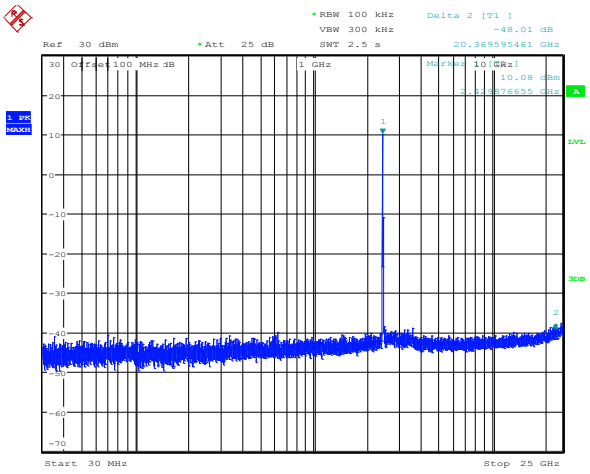
Date: 3.AUG.2011 21:53:51

Plot 8.4-18: Conducted spurious emissions, 802.11g, Antenna port 3, high channel



Date: 3.AUG.2011 22:02:25

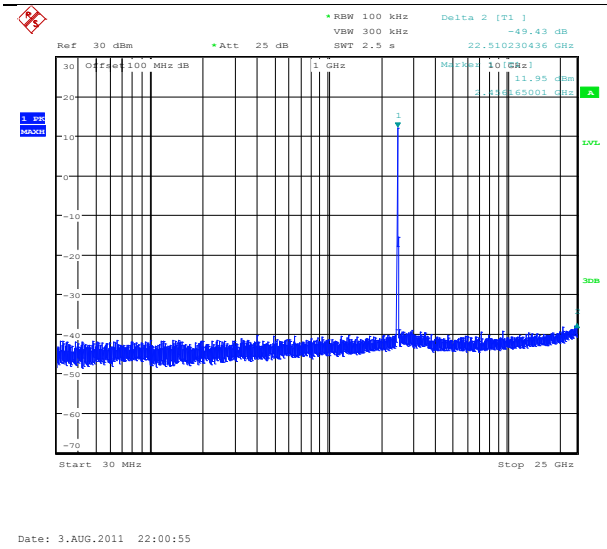
Plot 8.4-19: Conducted spurious emissions, 802.11n, Antenna port 1, low channel



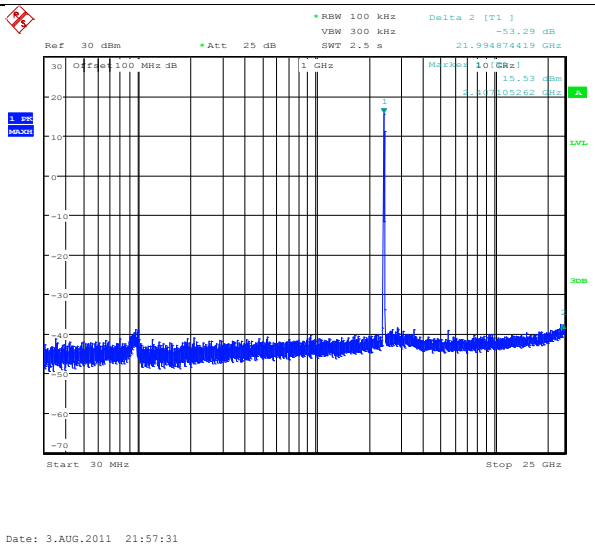
Date: 3.AUG.2011 22:01:38

Plot 8.4-20: Conducted spurious emissions, 802.11n, Antenna port 1, mid channel

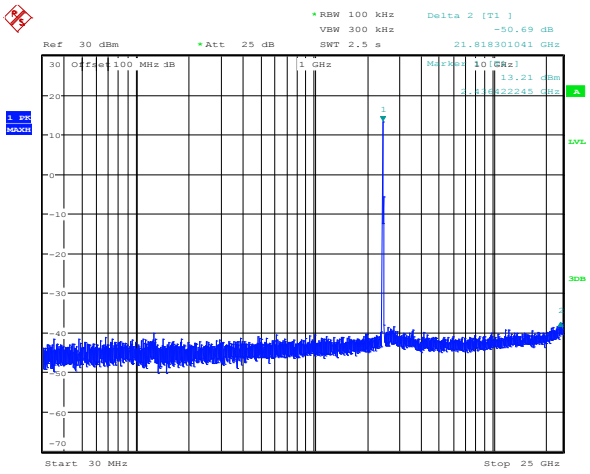
8.4.3 Test data, continued



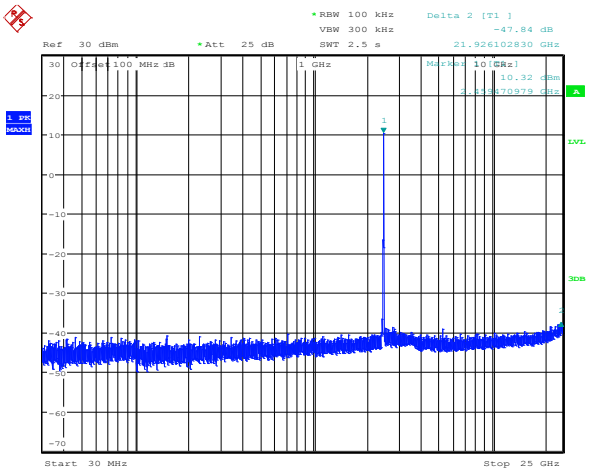
Plot 8.4-21: Conducted spurious emissions, 802.11n, Antenna port 1, high channel



Plot 8.4-22: Conducted spurious emissions, 802.11n, Antenna port 2, low channel

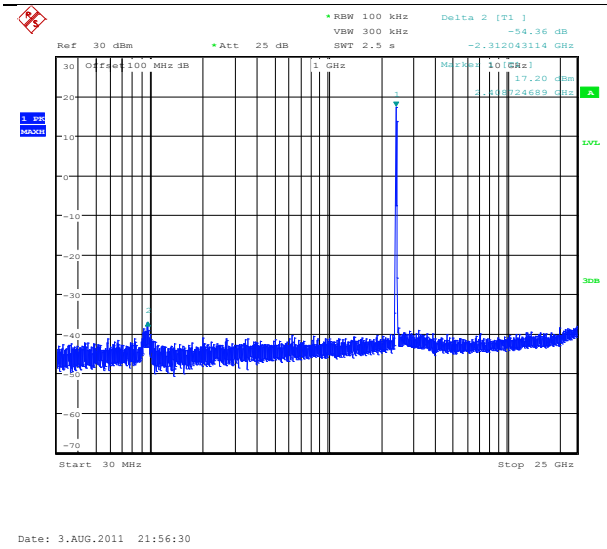


Plot 8.4-23: Conducted spurious emissions, 802.11n, Antenna port 2, mid channel

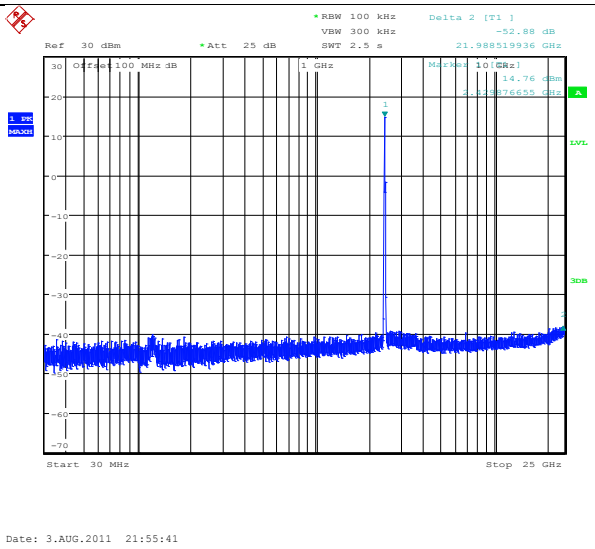


Plot 8.4-24: Conducted spurious emissions, 802.11n, Antenna port 2, high channel

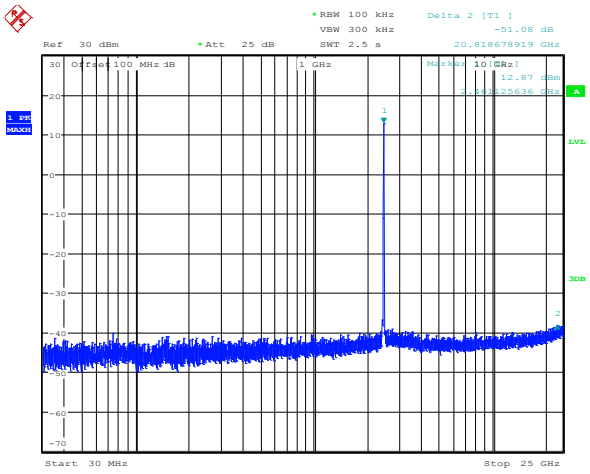
8.4.3 Test data, continued



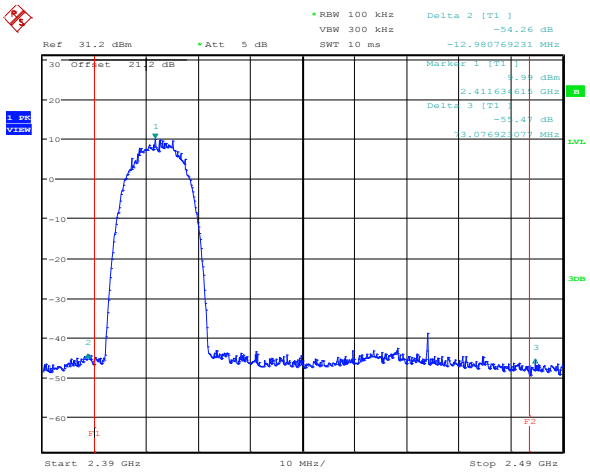
Plot 8.4-25: Conducted spurious emissions, 802.11n, Antenna port 3, low channel



Plot 8.4-26: Conducted spurious emissions, 802.11n, Antenna port 3, mid channel

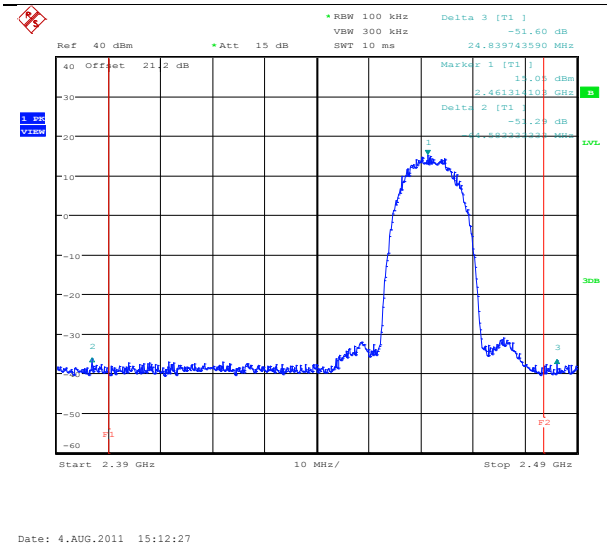


Plot 8.4-27: Conducted spurious emissions, 802.11n, Antenna port 3, high channel

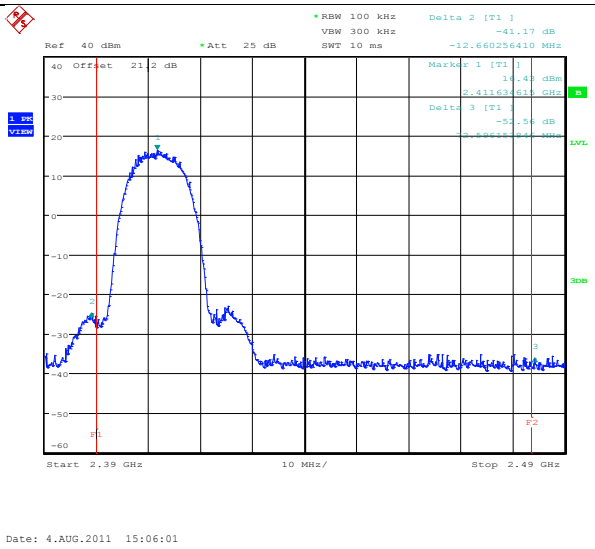


Plot 8.4-28: Conducted band edges, 802.11b, Antenna port 1, low channel

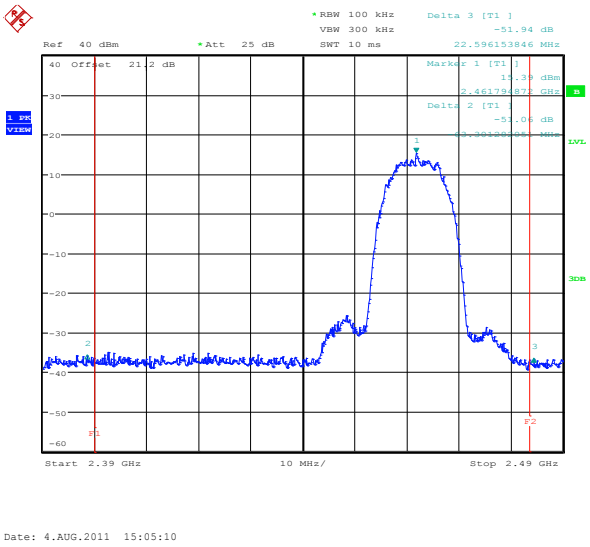
8.4.3 Test data, continued



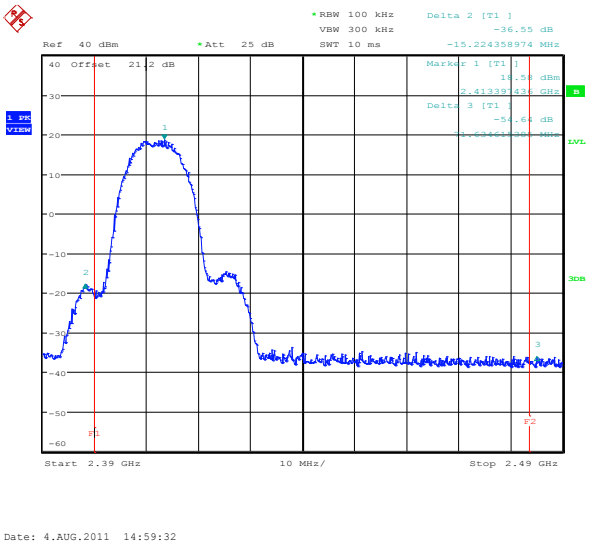
Plot 8.4-29: Conducted band edges, 802.11b, Antenna port 1, high channel



Plot 8.4-30: Conducted band edges, 802.11b, Antenna port 2, low channel

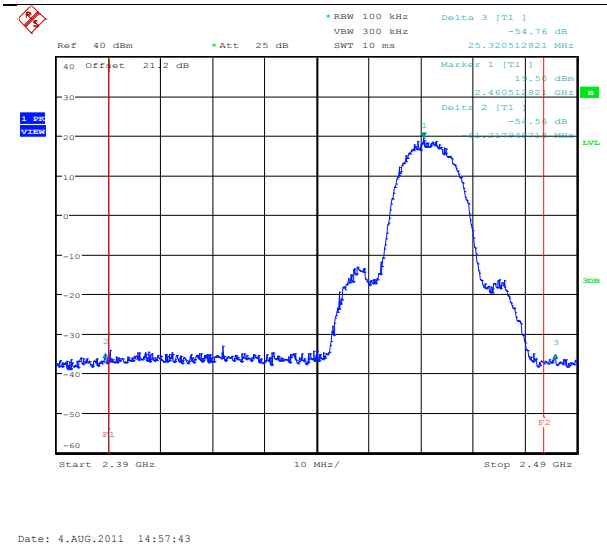


Plot 8.4-31: Conducted band edges, 802.11b, Antenna port 2, high channel

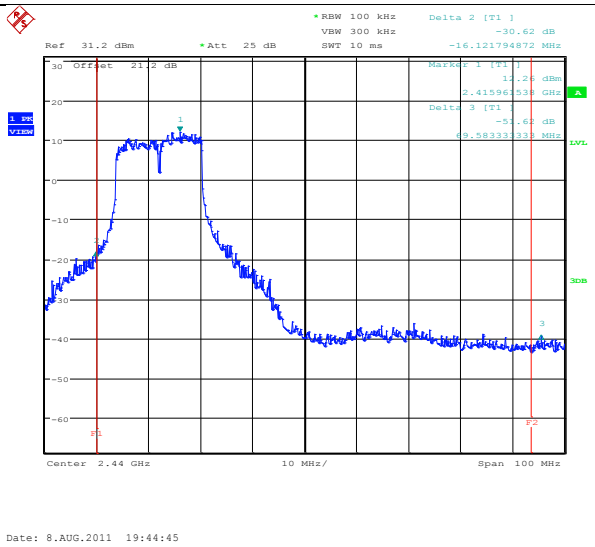


Plot 8.4-32: Conducted band edges, 802.11b, Antenna port 3, low channel

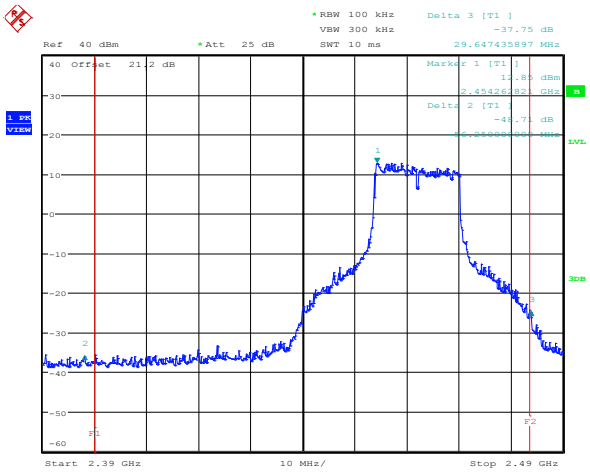
8.4.3 Test data, continued



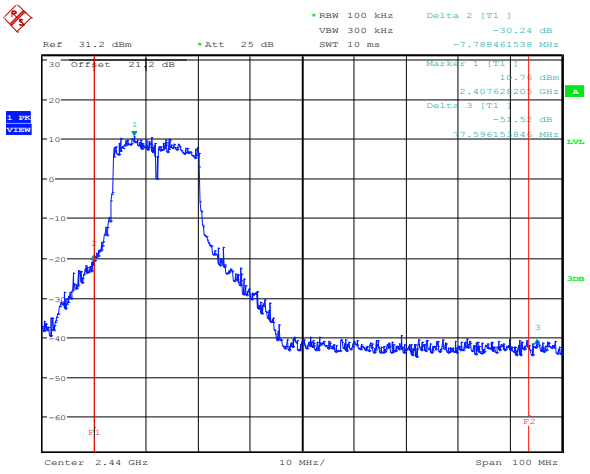
Plot 8.4-33: Conducted band edges, 802.11b, Antenna port 3, high channel



Plot 8.4-34: Conducted band edges, 802.11g, Antenna port 1, low channel

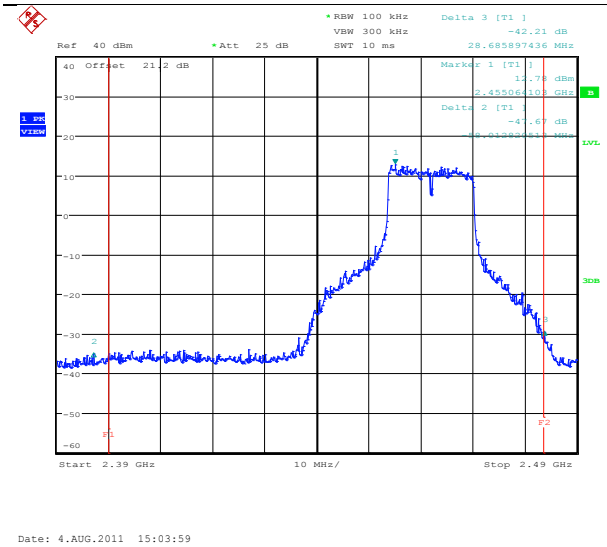


Plot 8.4-35: Conducted band edges, 802.11g, Antenna port 1, high channel

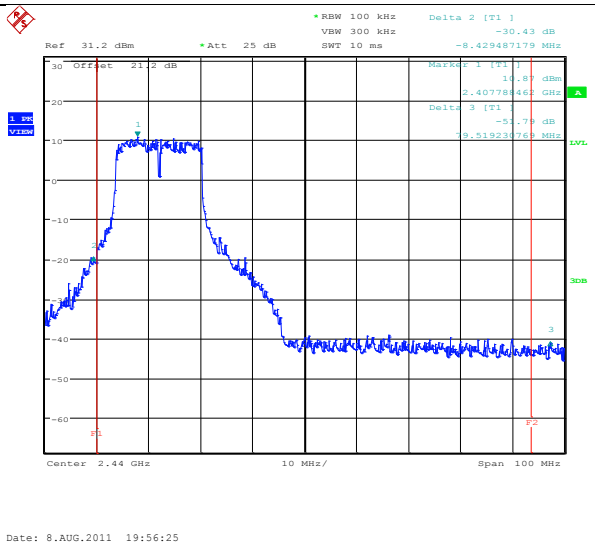


Plot 8.4-36: Conducted band edges, 802.11g, Antenna port 2, low channel

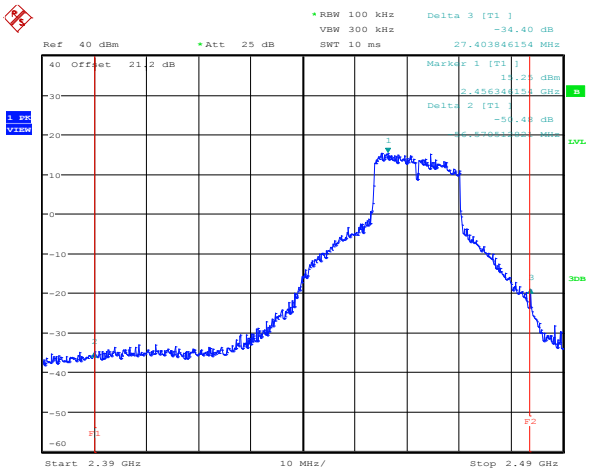
8.4.3 Test data, continued



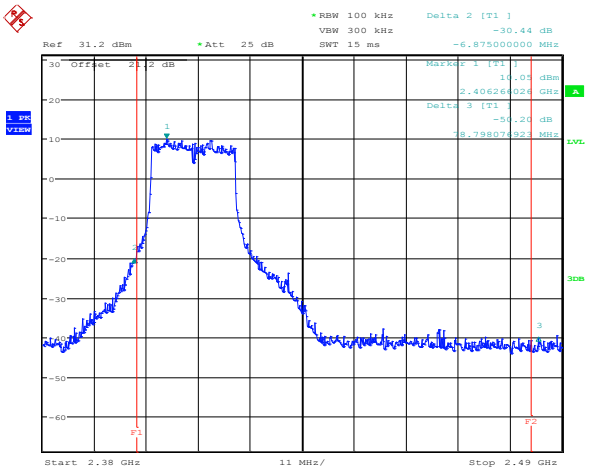
Plot 8.4-37: Conducted band edges, 802.11g, Antenna port 2, high channel



Plot 8.4-38: Conducted band edges, 802.11g, Antenna port 3, low channel

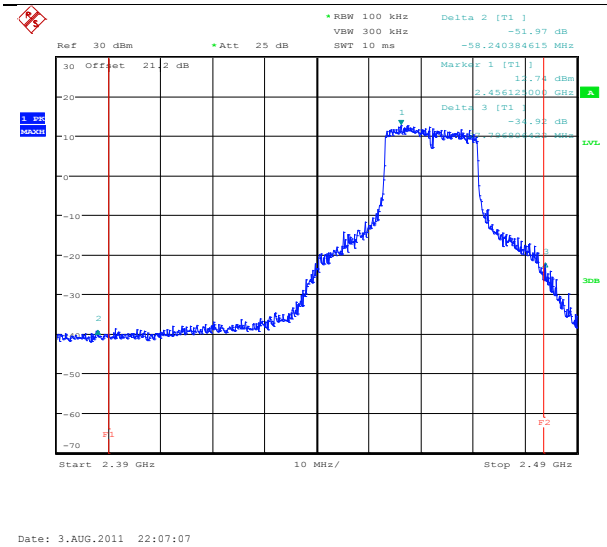


Plot 8.4-39: Conducted band edges, 802.11g, Antenna port 3, high channel

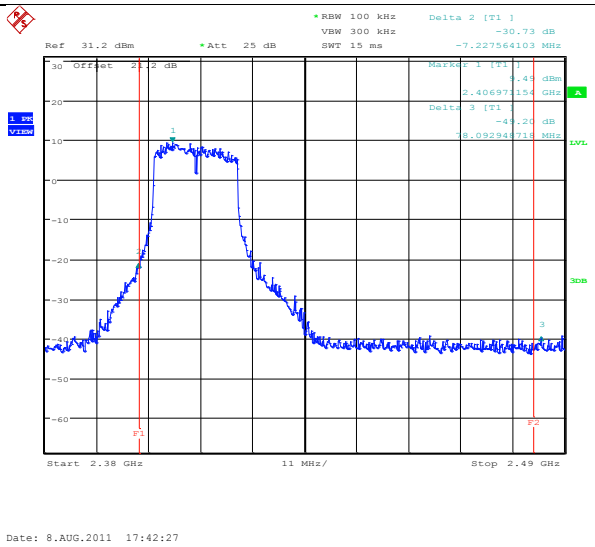


Plot 8.4-40: Conducted band edges, 802.11n, Antenna port 1 low channel

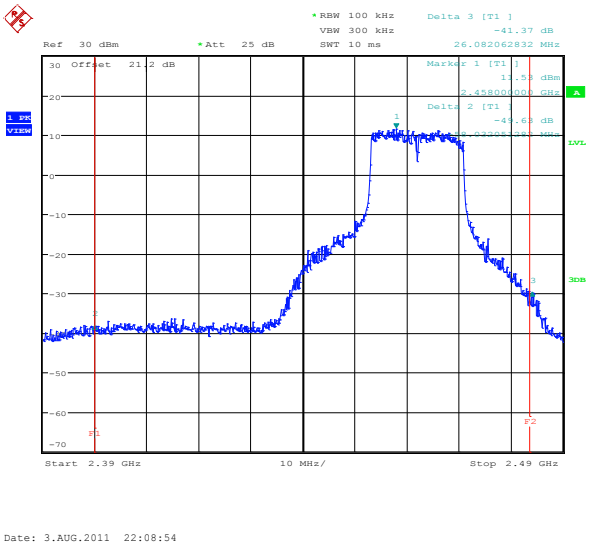
8.4.3 Test data, continued



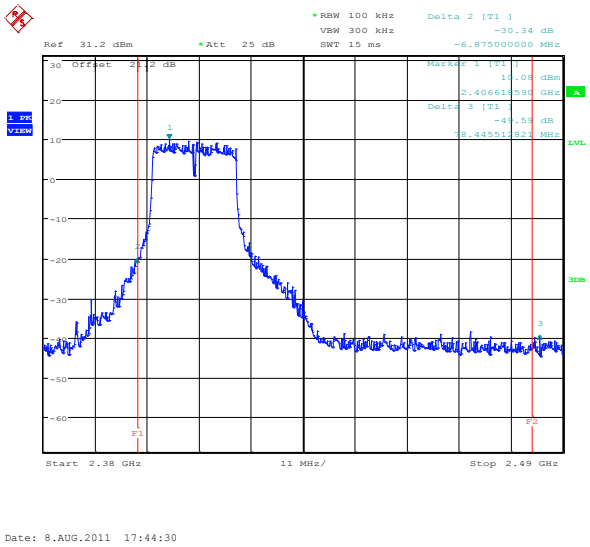
Plot 8.4-41: Conducted band edges, 802.11n, Antenna port 1, high channel



Plot 8.4-42: Conducted band edges, 802.11n, Antenna port 2, low channel

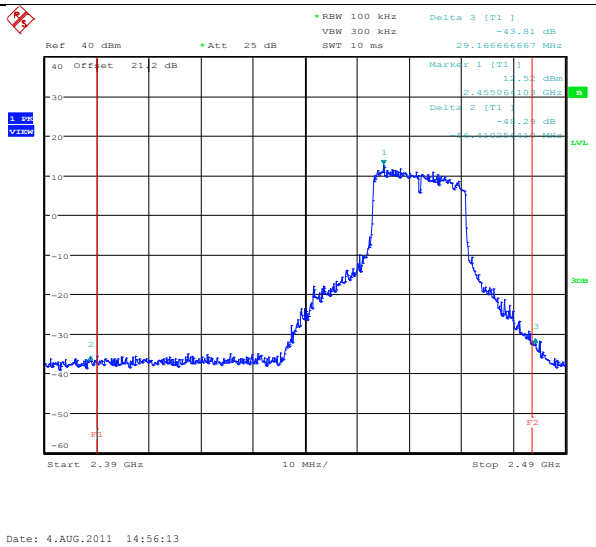


Plot 8.4-43: Conducted band edges, 802.11n, Antenna port 2, high channel



Plot 8.4-44: Conducted band edges, 802.11n, Antenna port 3 low channel

8.4.3 Test data, continued



Plot 8.4-45: Conducted band edges, 802.11n, Antenna port 3, high channel

8.5 Clause 15.247(e) Power spectral density for digitally modulated devices

(e) 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.

8.5.1 Test summary

Test date	July 27, 2011	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1005 mbar	**Relative humidity**	38 %

8.5.2 Observations/special notes

The Power Spectral Density was measured on the antenna port 1, 2 and 3 individually by means of a spectrum analyzer and following procedure described in 'PSD Option 1' in FCC guidelines for Measurement of Digital Transmission Systems operating under Section 15.247. The total PSD equal to the summary of the PSD was measured on the antenna port 1, 2 and 3.

8.5.3 Test data

Table 8.5-1: PSD results for 3×3 MIMO non-correlated operational mode

Modulation	Frequency (MHz)	SW setting	Conducted PSD Ant 1 (dBm/3 kHz)	Conducted PSD Ant 2 (dBm/3 kHz)	Conducted PSD Ant 3 (dBm/3 kHz)	Combined PSD (dBm/3 kHz)	PSD Limit (dBm/3 kHz)	Margin (dB)
802.11n	2412	17.0	-4.32	-4.47	-4.17	0.45	8.0	7.55
	2437	23.0	-0.22	1.38	0.33	5.32	8.0	2.68
	2462	16.5	-4.79	-5.35	-3.92	0.12	8.0	7.88
802.11g	2412	16.5	-5.53	-5.42	-5.34	-0.66	8.0	8.66
	2437	23.0	0.43	1.54	1.23	5.86	8.0	2.14
	2462	18.0	-2.75	-3.16	-2.71	1.90	8.0	6.10
802.11b	2412	22.5	3.62	1.30	2.73	7.42	8.0	0.58
	2437	23.0	1.75	4.25	3.24	7.97	8.0	0.03
	2462	22.5	3.11	1.70	4.29	7.93	8.0	0.07

Combined PSD [dBm/3 kHz] $= 10 \times Log_{10}\left(10^{\frac{CPSD1}{10}} + 10^{\frac{CPSD2}{10}} + 10^{\frac{CPSD3}{10}}\right)$

CPSD1 = Conducted PSD ANT-1 [dBm/3 kHz]; *CPSD2* = Conducted PSD ANT-2 [dBm/3 kHz]; *CPSD3* = Conducted PSD ANT-3 [dBm/3 kHz]

Table 8.5-2: PSD results for MIMO Correlated 3×3 CDD and TXBF operational mode

Modulation	Frequency (MHz)	SW setting	Conducted PSD Ant 1 (dBm/3 kHz)	Conducted PSD Ant 2 (dBm/3 kHz)	Conducted PSD Ant 3 (dBm/3 kHz)	Combined PSD (dBm/3 kHz)	PSD Limit (dBm/3 kHz)	Margin (dB)
802.11n	2412	17.0	-4.32	-4.47	-4.17	0.45	8.0	7.55
	2437	20.0	-2.92	-1.77	-2.06	2.55	8.0	5.45
	2462	16.5	-4.79	-5.35	-3.97	0.11	8.0	7.89
802.11g	2412	16.5	-5.53	-5.42	-5.34	-0.66	8.0	8.66
	2437	20.0	-3.41	-0.64	-1.81	2.96	8.0	5.04
	2462	18.0	-2.75	-3.16	-2.71	1.90	8.0	6.10
802.11b	2412	20.0	0.68	-0.72	0.01	4.80	8.0	3.20
	2437	20.5	-1.36	2.46	-0.47	5.30	8.0	2.70
	2462	19.0	0.13	-0.89	0.57	4.75	8.0	3.25

Combined PSD [dBm/3 kHz] $= 10 \times Log_{10}\left(10^{\frac{CPSD1}{10}} + 10^{\frac{CPSD2}{10}} + 10^{\frac{CPSD3}{10}}\right)$

CPSD1 = Conducted PSD ANT-1 [dBm/3 kHz]; *CPSD2* = Conducted PSD ANT-2 [dBm/3 kHz]; *CPSD3* = Conducted PSD ANT-3 [dBm/3 kHz]

Table 8.5-3: PSD results for MIMO Correlated 2×3 CDD and TXBF operational mode

Modulation	Frequency (MHz)	SW setting	Conducted PSD Ant 1 (dBm/3 kHz)	Conducted PSD Ant 2 (dBm/3 kHz)	Conducted PSD Ant 3 (dBm/3 kHz)	Combined PSD (dBm/3 kHz)	PSD Limit (dBm/3 kHz)	Margin (dB)
802.11n	2412	17.0	-4.32	N/A	-4.17	-1.23	8.0	9.23
	2437	23.0	-0.22	N/A	0.33	3.07	8.0	4.93
	2462	16.5	-4.79	N/A	-3.97	-1.35	8.0	9.35
802.11g	2412	16.5	-5.53	N/A	-5.34	-2.43	8.0	10.43
	2437	23.0	0.43	N/A	1.23	3.86	8.0	4.14
	2462	18.0	-2.75	N/A	-2.71	0.28	8.0	7.72
802.11b	2412	22.5	3.62	N/A	2.73	6.21	8.0	1.79
	2437	23.0	1.75	N/A	3.24	5.57	8.0	2.43
	2462	22.5	3.11	N/A	4.29	6.75	8.0	1.25

Combined PSD [dBm/3 kHz] $= 10 \times \mathrm{Log}_{10}\left(10^{\frac{CPSD1}{10}} + 10^{\frac{CPSD3}{10}}\right)$

CPSD1 = Conducted PSD ANT-1 [dBm/3 kHz]; *CPSD3* = Conducted PSD ANT-3 [dBm/3 kHz]

8.5.3 Test data, continued

Table 8.5-4: PSD results for STBC and STC operational mode

Modulation	Frequency (MHz)	SW setting	Conducted PSD Ant 1 (dBm/3 kHz)	Conducted PSD Ant 2 (dBm/3 kHz)	Conducted PSD Ant 3 (dBm/3 kHz)	Combined PSD (dBm/3 kHz)	PSD Limit (dBm/3 kHz)	Margin (dB)
802.11n	2412	17.0	-4.32	-4.47	-4.17	0.45	8.0	7.55
	2437	23.0	-0.22	1.38	0.33	5.32	8.0	2.68
	2462	16.5	-4.79	-5.35	-3.92	0.12	8.0	7.88

Combined PSD [dBm/3 kHz] $= 10 \times Log_{10}\left(10^{\frac{CPSD1}{10}} + 10^{\frac{CPSD2}{10}} + 10^{\frac{CPSD3}{10}}\right)$

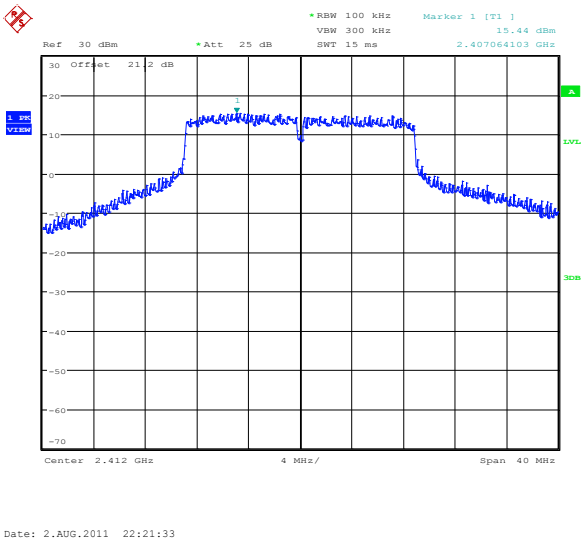
CPSD1 = Conducted PSD ANT-1 [dBm/3 kHz]; *CPSD2* = Conducted PSD ANT-2 [dBm/3 kHz]; *CPSD3* = Conducted PSD ANT-3 [dBm/3 kHz]

Table 8.5-5: PSD results for MIMO Correlated 3×3 TXBF operational Point-to-Point mode

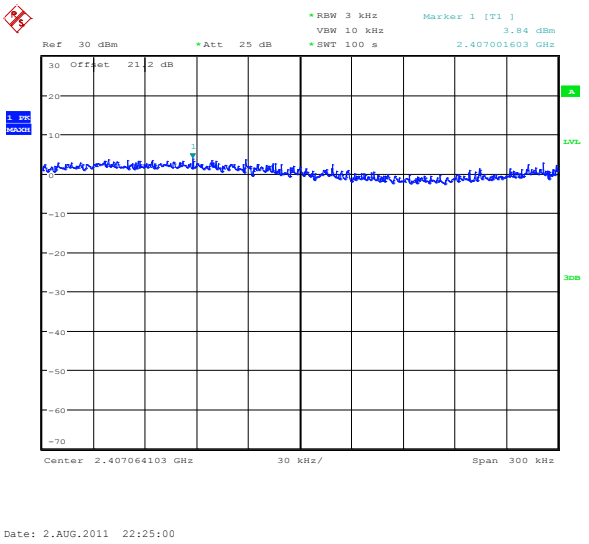
Modulation	Frequency (MHz)	SW setting	Conducted PSD Ant 1 (dBm/3 kHz)	Conducted PSD Ant 2 (dBm/3 kHz)	Conducted PSD Ant 3 (dBm/3 kHz)	Combined PSD (dBm/3 kHz)	PSD Limit (dBm/3 kHz)	Margin (dB)
802.11n	2412	17.0	-4.32	-4.47	-4.17	0.45	8.0	7.55
	2437	23.0	-0.22	1.38	0.33	5.32	8.0	2.68
	2462	16.5	-4.79	-5.35	-3.92	0.12	8.0	7.88
802.11g	2412	16.5	-5.53	-5.42	-5.34	-0.66	8.0	8.66
	2437	23.0	0.43	1.54	1.23	5.86	8.0	2.14
	2462	18.0	-2.75	-3.16	-2.71	1.90	8.0	6.10
802.11b	2412	22.5	3.62	1.30	2.73	7.42	8.0	0.58
	2437	23.0	1.75	4.25	3.24	7.97	8.0	0.03
	2462	22.5	3.11	1.70	4.29	7.93	8.0	0.07

Combined PSD [dBm/3 kHz] $= 10 \times Log_{10}\left(10^{\frac{CPSD1}{10}} + 10^{\frac{CPSD2}{10}} + 10^{\frac{CPSD3}{10}}\right)$

CPSD1 = Conducted PSD ANT-1 [dBm/3 kHz]; *CPSD2* = Conducted PSD ANT-2 [dBm/3 kHz]; *CPSD3* = Conducted PSD ANT-3 [dBm/3 kHz]



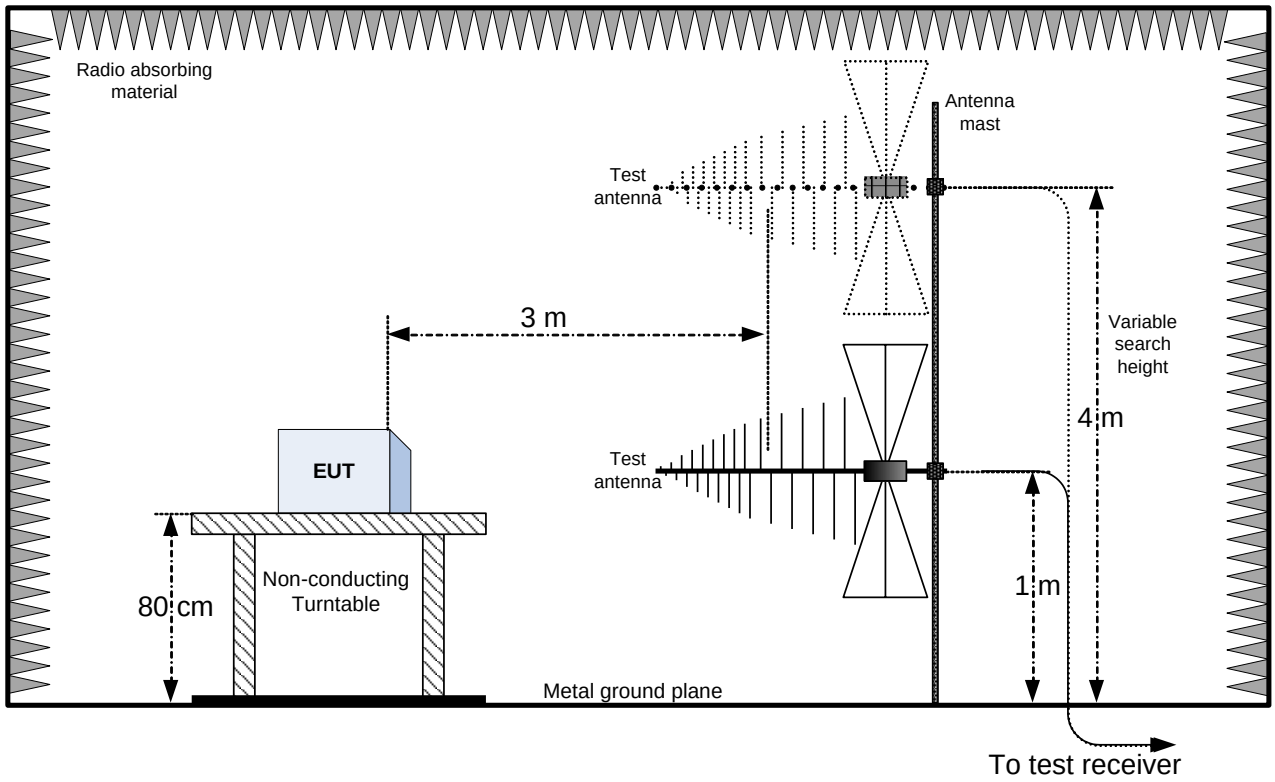
Sample plot 8.5-1: PSD, step 1



Sample plot 8.5-2: PSD, step 2

Section 9: Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up