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Compliance test report ID **211074-2TRFWL**

Date of issue
June 21, 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	**Wi-Fi Access Point**
IC Model	**BelAir20EO-11ER2**
IC Reg #	**4674A-40005111**
FCC Model	**BelAir20EO-11E**
FCC ID	**RAR40005111**

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
Test site FCC ID: 176392 and IC ID: 2040A-4 (3 m semi anechoic chamber)

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Tested by Andrey Adelberg, Senior Wireless/EMC Specialist

Reviewed by Kevin Rose, Wireless/EMC Specialist

June 21, 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.

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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 guidance

558074 D01 DTS Meas. Guidance v01

662911 D01 Multiple Transmitter Output v01 r01

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	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	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§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
6.1	Receiver spurious emissions limits (radiated)	Not applicable[1]
6.2	Receiver spurious emissions limits (antenna conducted)	Not applicable[1]
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.		

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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

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Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	June 7, 2012
Nemko sample ID number	1

3.2 EUT information

Product name	Wi-Fi Access Point
Serial number	BA120700303
Product code	BelAir20EO-11E
FCC Model number	BelAir20EO-11E
IC Model number	BelAir20EO-11ER2

3.3 Technical information

Operating band	5725–5850 MHz
Operating frequency	5745–5825 MHz (HT20 or 20 MHz channel) and 5755–5795 MHz (HT40 or 40 MHz channel)
Modulation type	802.11a/n
Occupied bandwidth (99 %)	17.71 MHz (802.11a); 18.83 MHz (802.11n HT20); 37.50 MHz (802.11n HT40)
Emission designator	W7D
Power requirements	48 V_{DC}
Antenna information	2 × BelAir antenna, M/N: BMAG00300, 12 dBi

Table 3.3-1: Channel plan for 802.11a/n HT20

Channel (Chn)	Frequency	Channel (Chn)	Frequency
149 (Low)	5745 MHz	161	5805 MHz
153	5765 MHz	165 (High)	5825 MHz
157 (Mid)	5785 MHz		

Table 3.3-2: Channel plan for 802.11n HT40

Channel (Chn)	Frequency	Channel (Chn)	Frequency
151 (Low)	5755 MHz	159	5795 MHz

3.4 Product description and theory of operation

The EUT is a 2×2 MIMO combo Wi-Fi device designed to operate in the 2.4 GHz band, and 5.8 GHz ISM bands.
There are two independent radio units. This report covers only the 5.8 GHz radio. The EUT consists of two 2.4 GHz antenna ports: chain 0 (CH0) and chain 1 (CH1) and two 5 GHz antenna ports: chain 0 (CH0) and chain 1 (CH1)

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

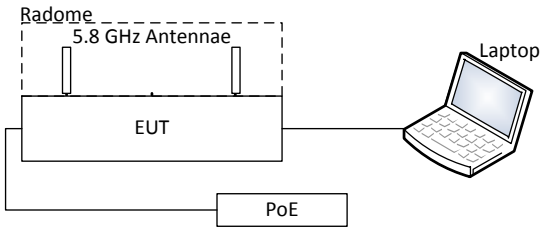

Diagram 3.6-1: Setup diagram

3.7 Support equipment

Description	Brand name	Model/Part number	Serial number
Laptop	Toshiba	Satellite	BelAir asset number: 441
PoE adapter	Cincon Electronics Co., Ltd.	TRG60A-POE-L	RD Sample 4 1127

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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.

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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.

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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.

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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. 09/13
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	May 16/13
Bilog antenna	Sunol	JB3	FA002108	1 year	Feb. 07/13
Horn antenna #2	EMCO	3115	FA000825	1 year	Feb. 24/13
1–18 GHz pre-amplifier	JCA	JCA118-503	FA002091	1 year	Aug. 15/12
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Feb. 09/13
Horn antenna 18–40 GHz	EMCO	3116	FA001847	1 year	Aug. 20/12
18–26 GHz pre-amplifier	Narda	BBS-1826N612	FA001550	—	VOU
26–40 GHz pre-amplifier	Narda	DBL-2640N610	FA001556	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Nov. 18/12
Note: NCR - no calibration required, VOU - verify on use					

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Section 8 Testing data

8.1 FCC Clause 15.207(a) Conducted limits and RSS-Gen Clause 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. A description of the method of measurement that is acceptable to Industry Canada is found in RSS-212.

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.		

8.1.2 Test summary

Test date	April 24, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	24 °C	**Air pressure**	1003 mbar	**Relative humidity**	31 %

8.1.3 Observations/special notes

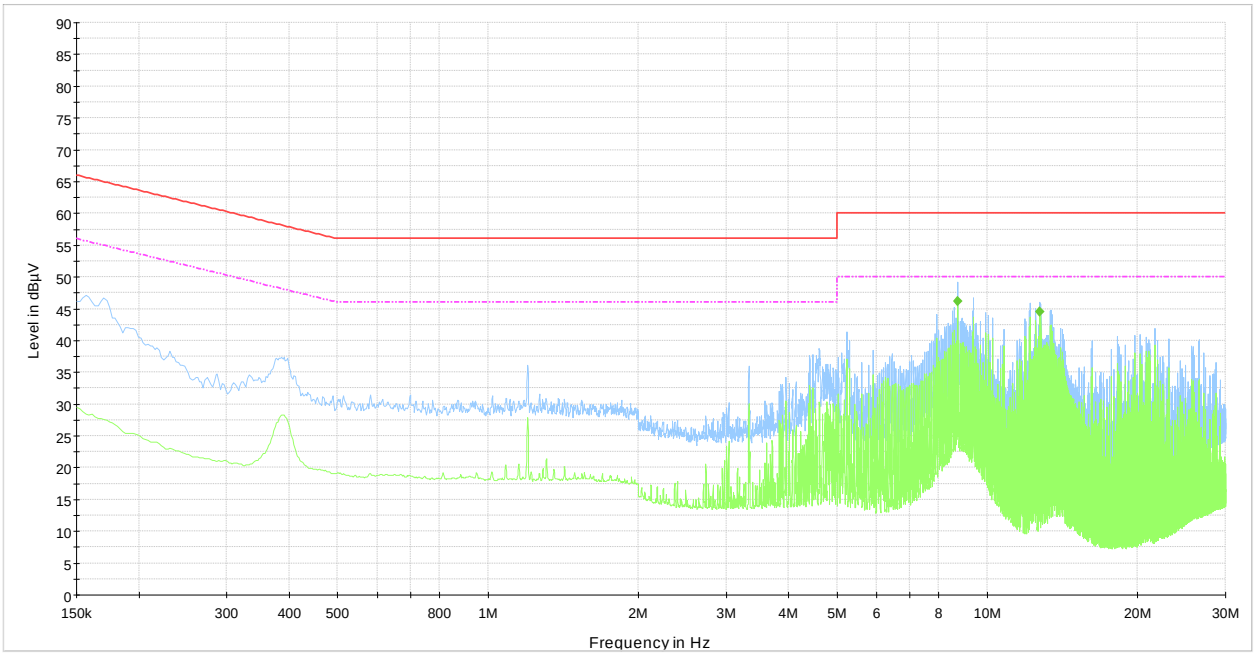
The EUT was set up as tabletop configuration.

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

Receiver/spectrum analyzer settings
Preview measurements – Receiver:
Peak and Average detector (Max hold), RBW = 9 kHz, VBW = 30 kHz, Measurement time = 100 ms
Final measurements – Receiver:
Q-Peak and Average detector, RBW = 9 kHz, VBW = 30 kHz, Measurement time = 100 ms

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

8.1.4 Test data



Plot 8.1-1: Conducted emissions on phase line

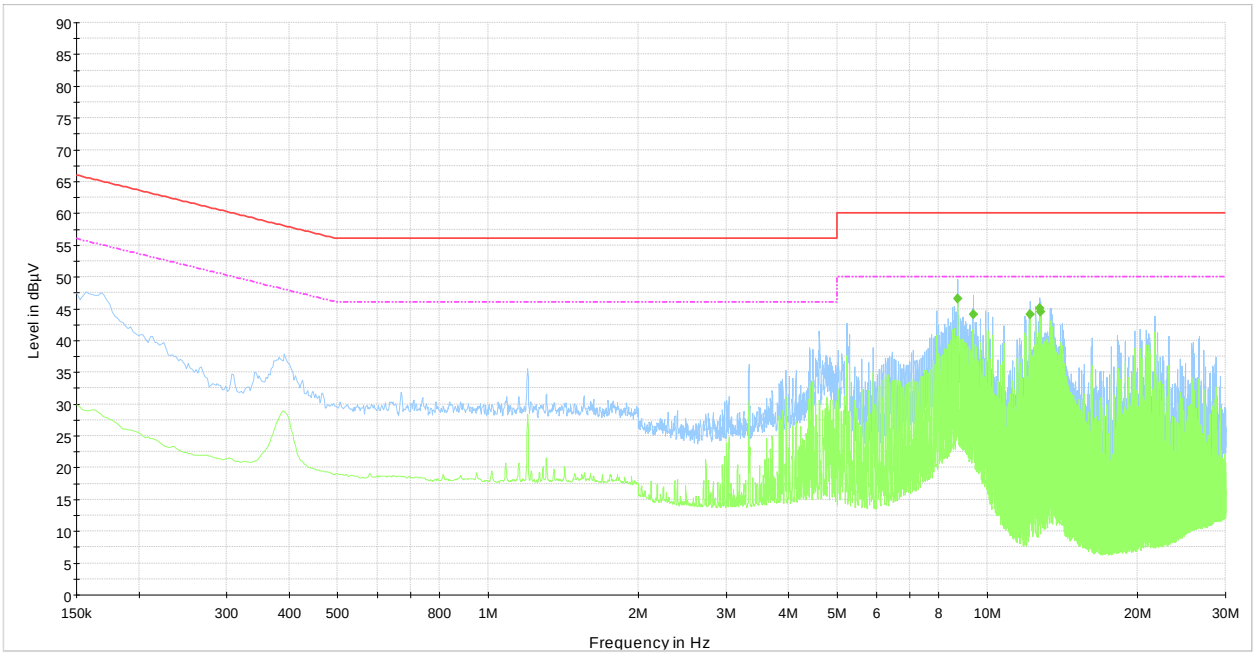
Table 8.1-2: Average conducted emissions results

Frequency (MHz)	Average result (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Conductor	Correction (dB)	Margin (dB)	Limit (dBµV)
8.718000	46.1	100.0	9.000	On	Phase	10.3	3.9	50.0
12.747250	44.5	100.0	9.000	On	Phase	10.5	5.5	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:
46.1 dBµV = 35.8 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss)

8.1.4 Test data, continued



Plot 8.1-2: Conducted emissions on neutral line

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)
8.718000	46.6	100.0	9.000	On	Neutral	10.3	3.4	50.0
9.388500	44.1	100.0	9.000	On	Neutral	10.3	5.9	50.0
12.198250	44.2	100.0	9.000	On	Neutral	10.5	5.8	50.0
12.747250	45.0	100.0	9.000	On	Neutral	10.5	5.0	50.0
12.808000	44.6	100.0	9.000	On	Neutral	10.5	5.4	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:
46.6 dBµV = 36.3 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss)

8.2 FCC Clause 15.247(a)(2) and RSS-210 Clause 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.

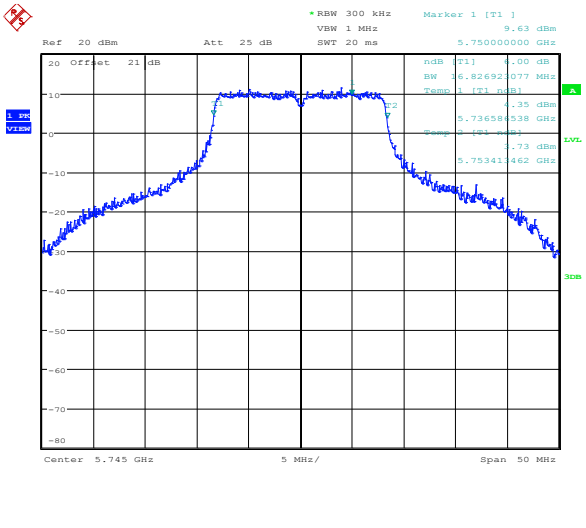
8.2.2 Test summary

Test date	June 12, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	21 °C	**Air pressure**	1004 mbar	**Relative humidity**	32 %

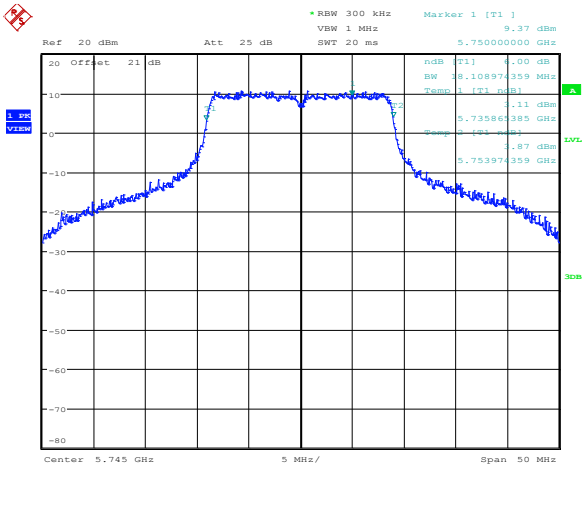
8.2.3 Observations/special notes

Measurements were performed with peak detector using RBW = 1–5 % of EBW. VBW was set wider than RBW.

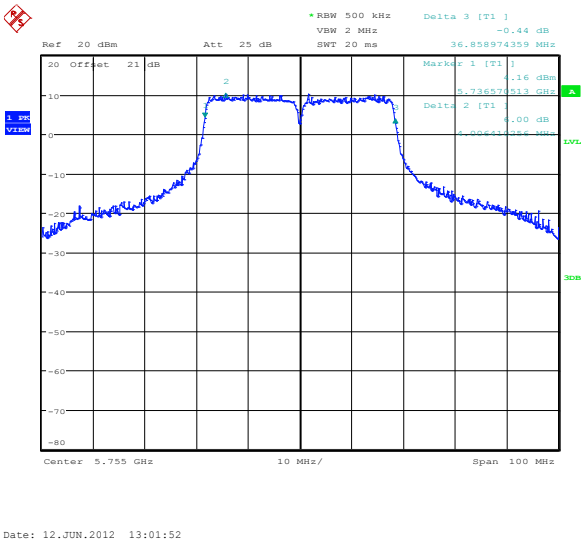
8.2.4 Test data



Sample plot 8.2-1: 6 dB bandwidth on 802.11a



Sample plot 8.2-2: 6 dB bandwidth on 802.11n HT20



Sample plot 8.2-3: 6 dB bandwidth on 802.11n HT40

Table 8.2-1: 6 dB bandwidth results

Modulation	6 dB bandwidth (MHz)	Limit (MHz)
802.11a	16.83	> 0.5
802.11n HT20	18.11	> 0.5
802.11n HT40	36.86	> 0.5

8.3 RSS-Gen Clause 4.6.1 Occupied bandwidth

8.3.1 Definitions and limits

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

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

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

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

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

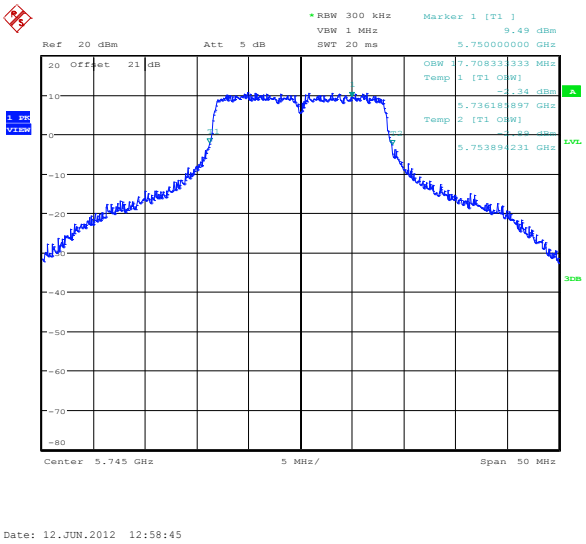
8.3.2 Test summary

Test date	June 12, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	21 °C	**Air pressure**	1004 mbar	**Relative humidity**	32 %

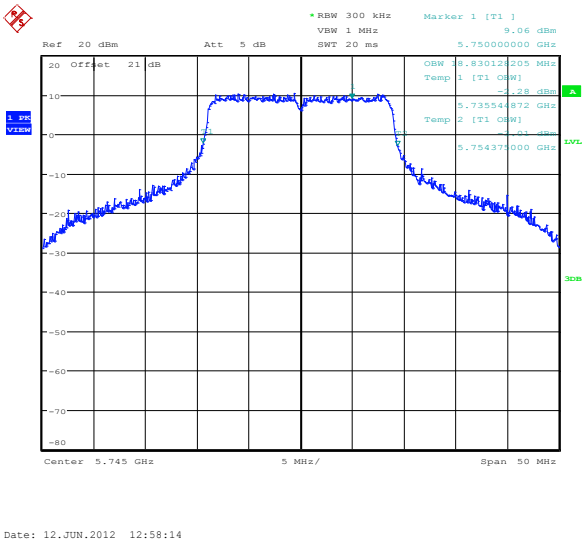
8.3.3 Observations/special notes

Measurements were performed with peak detector using RBW = 1–5 % of EBW. VBW was set wider than RBW.

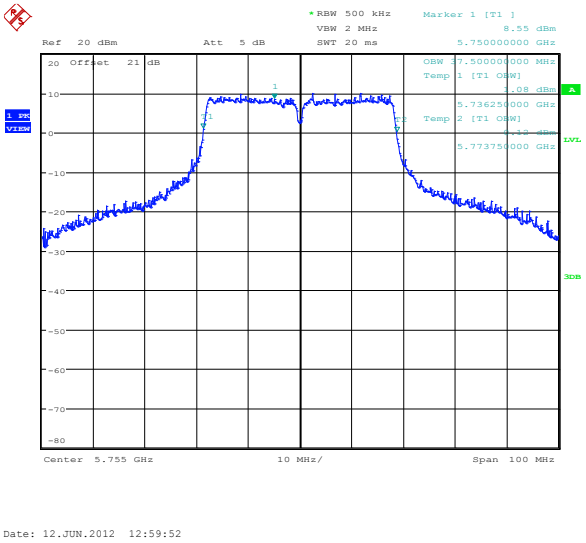
8.3.4 Test data



Sample plot 8.3-1: 99 % bandwidth on 802.11a



Sample plot 8.3-2: 99 % bandwidth on 802.11n HT20



Sample plot 8.3-3: 99 % bandwidth on 802.11n HT40

Table 8.3-1: 99 % bandwidth results

Modulation	99 % bandwidth (MHz)
802.11a	17.71
802.11n HT20	18.83
802.11n HT40	37.50

8.4 FCC Clause 15.247(b) and RSS-210 Clause 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.

(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.

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	April 18, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1001 mbar	**Relative humidity**	32 %

8.4.3 Observations/special notes

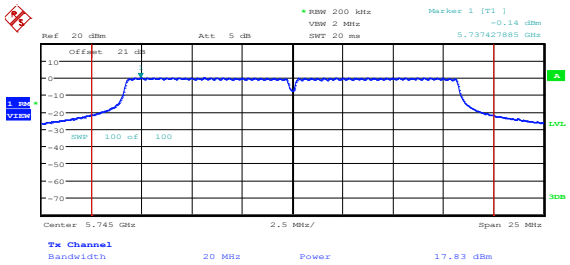
The test was performed using guidelines of ANSI C63.10-2009, Clause 6.10.2.1 and 6.10.2.2. The RMS detector was used to measure average power over EBW

8.4.4 Test data

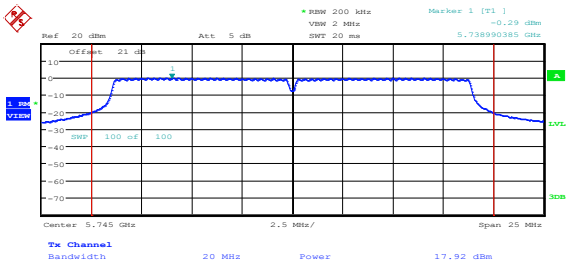
Table 8.4-1: Output power and EIRP results

Modulation	Frequency (MHz)	Conducted Avg. Power CH0 (dBm)	Conducted Avg. Power CH1 (dBm)	Combined Output Power (dBm)	Conducted Output Power Limit (dBm)	Conducted Output Power Margin (dB)	Direct. Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
802.11n HT20	5745	16.84	17.97	20.45	21.0	0.55	15.0	35.45	36.00	0.55
	5785	18.07	17.88	20.99	21.0	0.01	15.0	35.99	36.00	0.01
	5825	17.71	18.17	20.96	21.0	0.04	15.0	35.96	36.00	0.04
802.11n HT40	5755	17.00	18.03	20.56	21.0	0.44	15.0	35.56	36.00	0.44
	5795	18.02	17.85	20.95	21.0	0.05	15.0	35.95	36.00	0.05
802.11a	5745	17.00	18.22	20.66	21.0	0.34	15.0	35.66	36.00	0.34
	5785	18.02	17.89	20.97	21.0	0.03	15.0	35.97	36.00	0.03
	5825	17.49	17.62	20.57	21.0	0.43	15.0	35.57	36.00	0.43

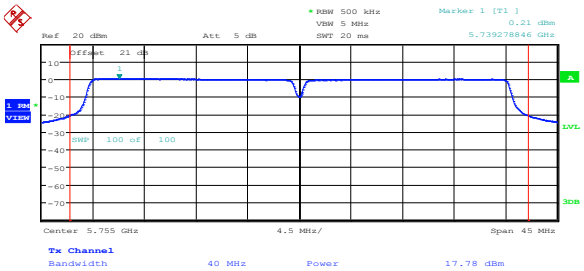
- Combined output power (dBm) = (CAP0 + CAP1) ÷ 2 + 10 × Log_{10} (N)
- CAP0 is Conducted Average Power CH0; CAP1 is Conducted Average Power CH1; “N” is number of antenna ports
- EIRP (dBm) = Combined output power (dBm) + Antenna gain (dBi)
- MIMO Correlated 2×2, Directional gain = 12 dBi + 10 × Log_{10} (N) dB = 12 dBi + 3 dB = 15 dBi, where “N” is number of antennas.
- Conducted output power limit calculation: 30 dBm – (15 dBi – 6 dBi) = 30 dBm – 9 dB = 21 dBm



Sample plot 8.4-1: Output power for 802.11a

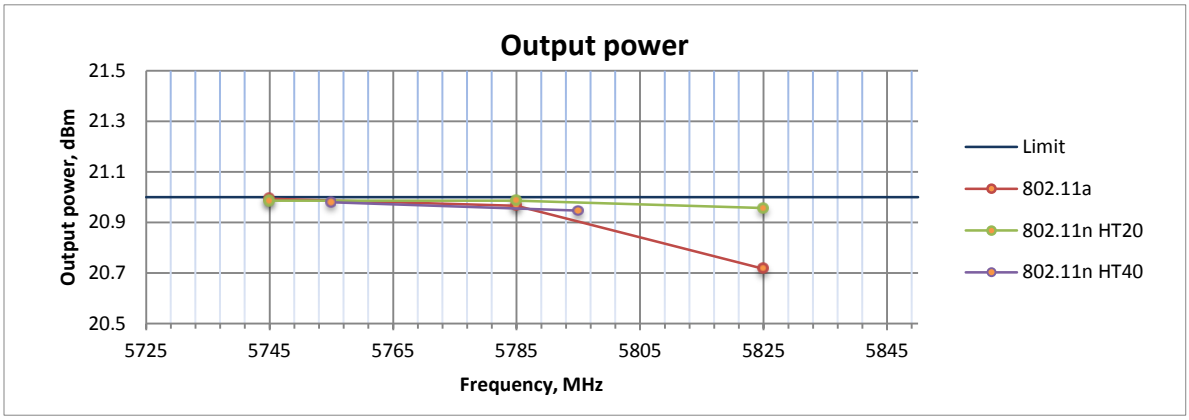


Sample plot 8.4-2: Output power for 802.11n HT20



Sample plot 8.4-3: Output power for 802.11n HT40

8.4.4 Test data, continued



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8.5 FCC Clause 15.247(d) and RSS-210 Clause 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.

8.5.2 Test summary

Test date	June 12, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	23 °C	**Air pressure**	1003 mbar	**Relative humidity**	32 %

8.5.3 Observations/special notes

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

Frequency (MHz)	Field strength (μV/m)	Field strength (dBμV/m)	Measurement distance (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
*– applicable only to FCC requirements			

- The spectrum was searched from 30 MHz to the 40 GHz.
- All radiated measurements were performed at a distance of 3 m:
  - within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
  - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
  - and using peak detector with 1 MHz/10 Hz RBW/VBW for average results.
  - EUT was set to transmit on both antennas (chains) in MIMO mode.
- All conducted measurements were performed using peak detector with 100 kHz/300 kHz RBW/VBW

8.5.3 Observations/special notes, continued

Table 8.5-2: FCC Restricted bands of operation

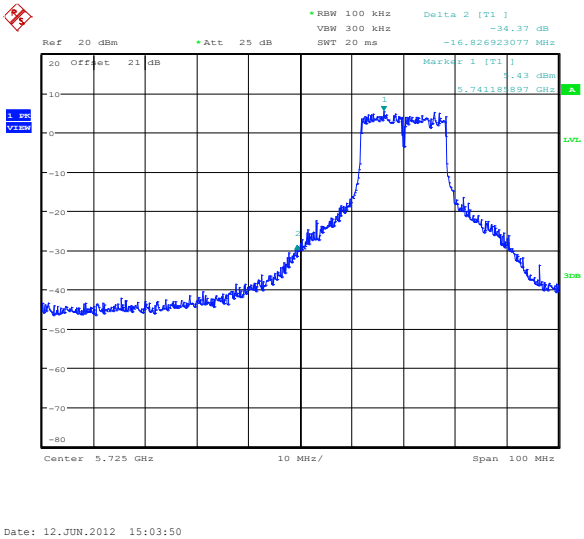
MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	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			

Table 8.5-3: IC Restricted bands of operation

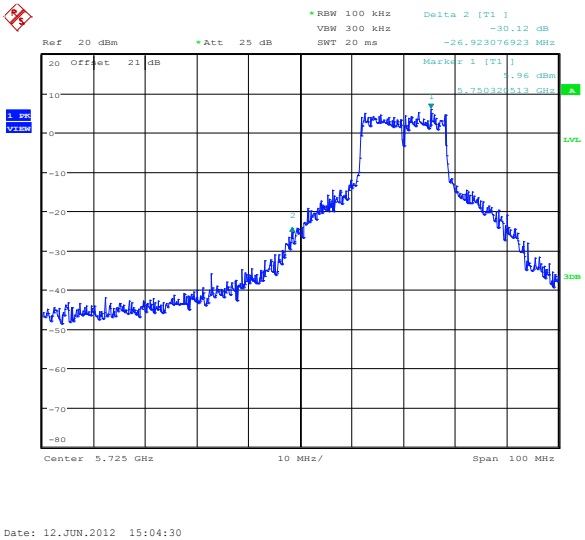
MHz	MHz	MHz	GHz
0.090–0.110	12.51975–12.52025	399.9–410	5.35–5.46
2.1735–2.1905	12.57675–12.57725	608–614	7.25–7.75
3.020–3.026	13.36–13.41	960–1427	8.025–8.5
4.125–4.128	16.42–16.423	1435–1626.5	9.0–9.2
4.17725–4.17775	16.69475–16.69525	1645.5–1646.5	9.3–9.5
4.20725–4.20775	16.80425–16.80475	1660–1710	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 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

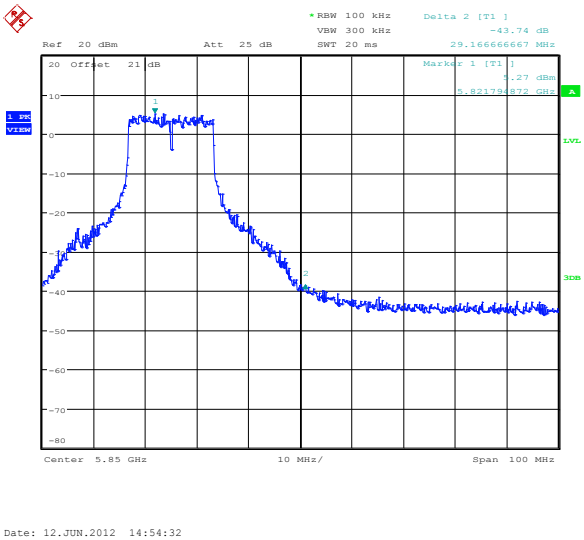
8.5.4 Test data



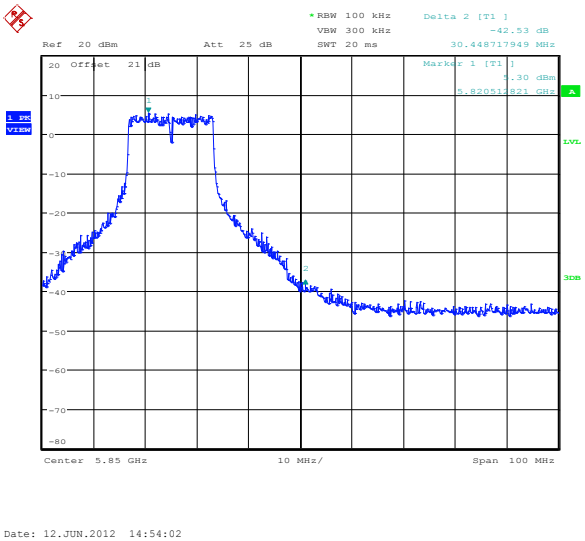
Plot 8.5-1: Lower band edge for 802.11a, CH0



Plot 8.5-2: Lower band edge for 802.11a, CH1



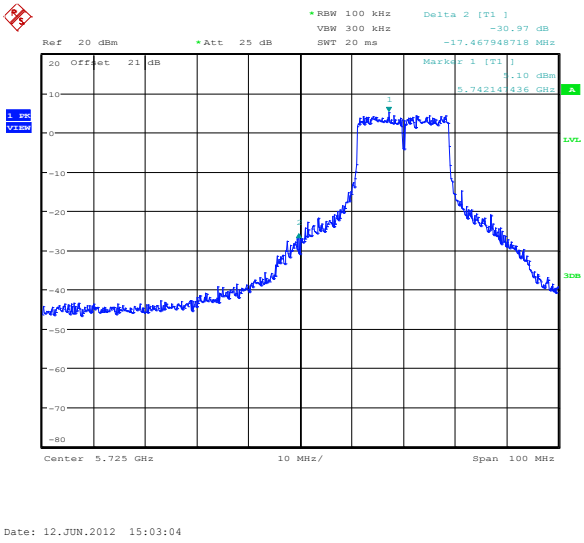
Plot 8.5-3: Upper band edge for 802.11a, CH0



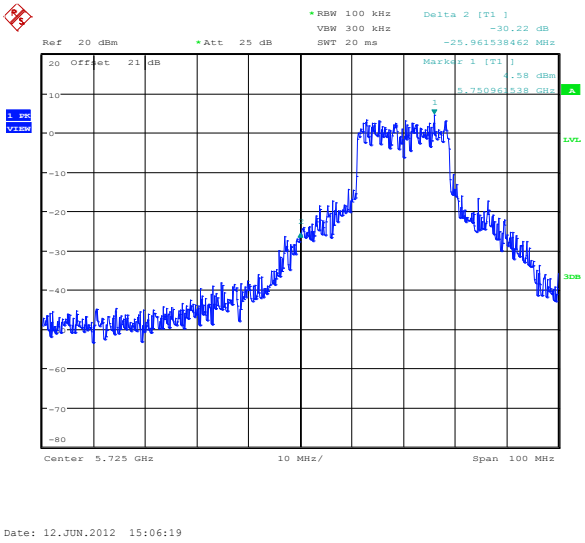
Plot 8.5-4: Upper band edge for 802.11a, CH1

Note: `Delta 2 [T1 ]` on the plots above indicates the band edge result.

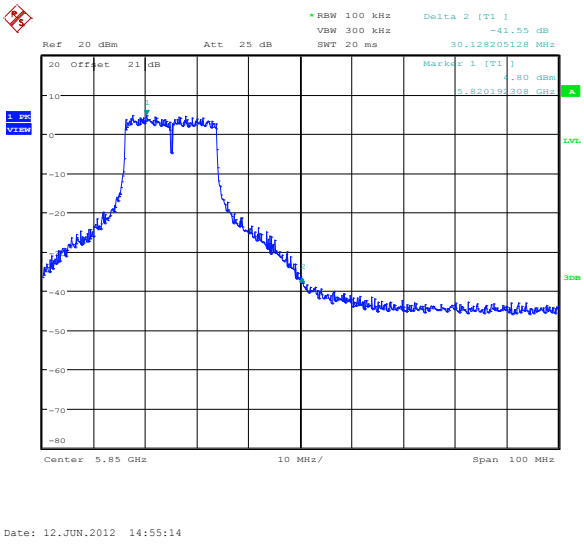
8.5.4 Test data, continued



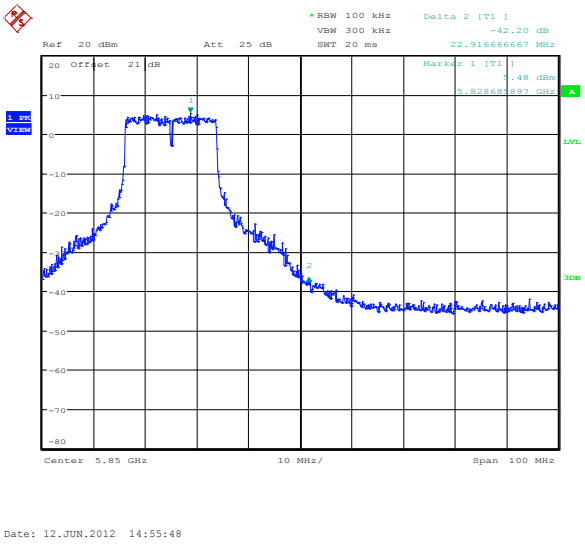
Plot 8.5-5: Lower band edge for 802.11n HT20, CH0



Plot 8.5-6: Lower band edge for 802.11 n HT20, CH1



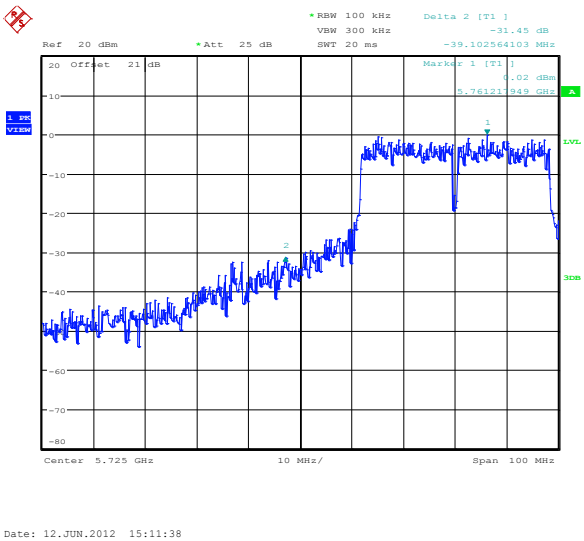
Plot 8.5-7: Upper band edge for 802.11 n HT20, CH0



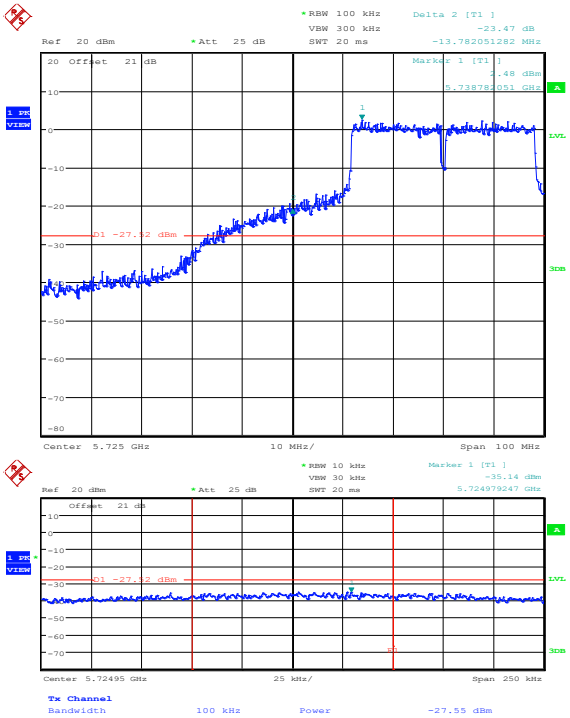
Plot 8.5-8: Upper band edge for 802.11 n HT20, CH1

Note: `Delta 2 [T1 ]` on the plots above indicates the band edge result.

8.5.4 Test data, continued

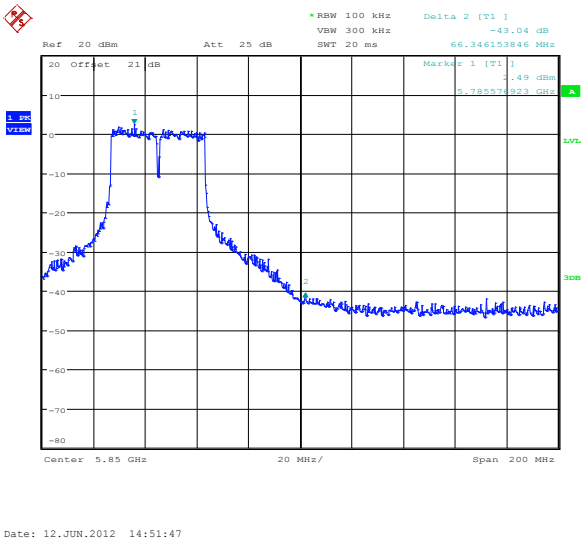


Plot 8.5-9: Lower band edge for 802.11n HT40, CH0

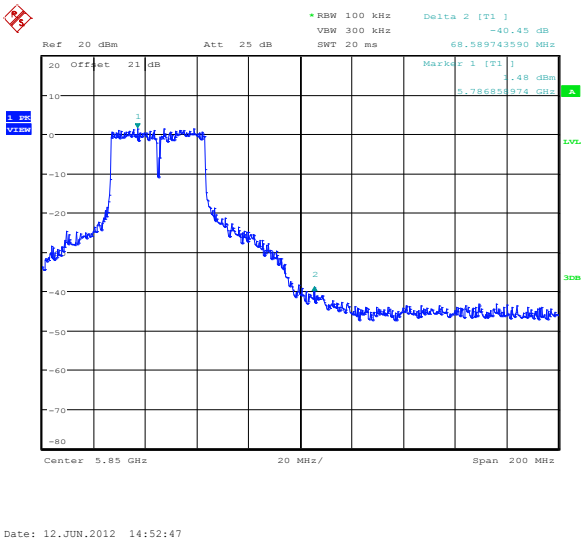


Plot 8.5-10: Lower band edge for 802.11 n HT40, CH1

Note: Band edge attenuation is 2.48 dBm − (−27.55 dBm) = 30.03 dB



Plot 8.5-11: Upper band edge for 802.11 n HT40, CH0



Plot 8.5-12: Upper band edge for 802.11 n HT40, CH1

Note: `Delta 2 [T1 ]` on the plots above indicates the band edge result.

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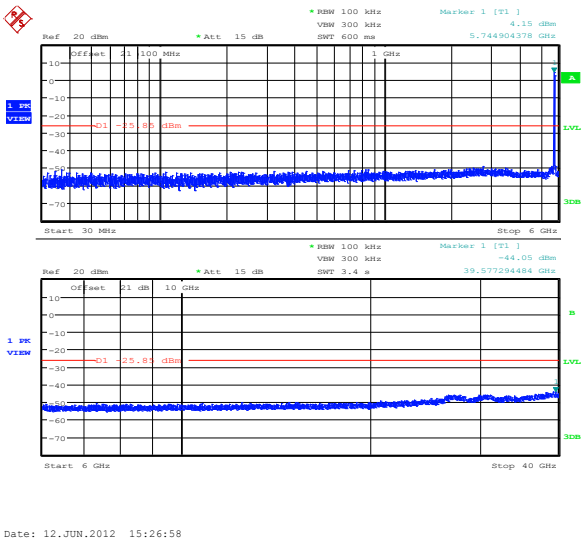
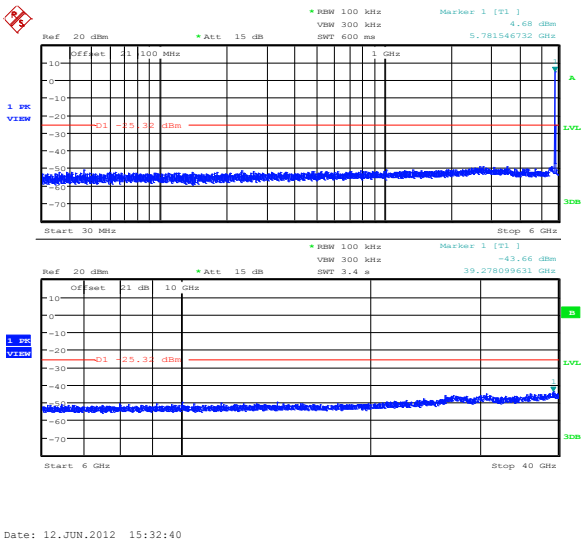
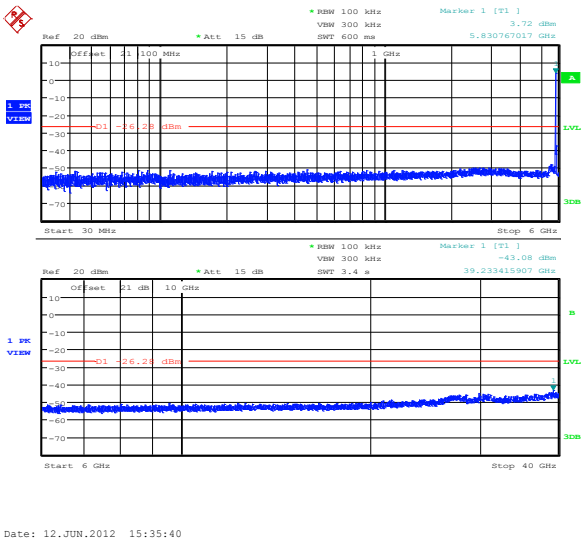
8.5.4 Test data, continued



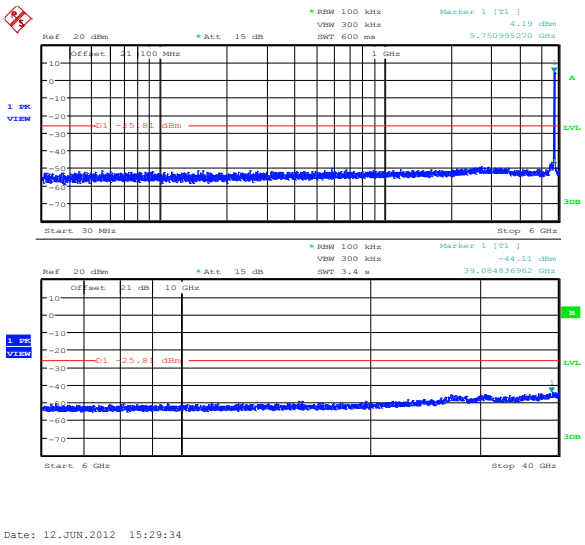
Plot 8.5-13: Conducted spurious emissions for 802.11a, CH0, Chn149



Plot 8.5-14: Conducted spurious emissions for 802.11a, CH0, Chn157



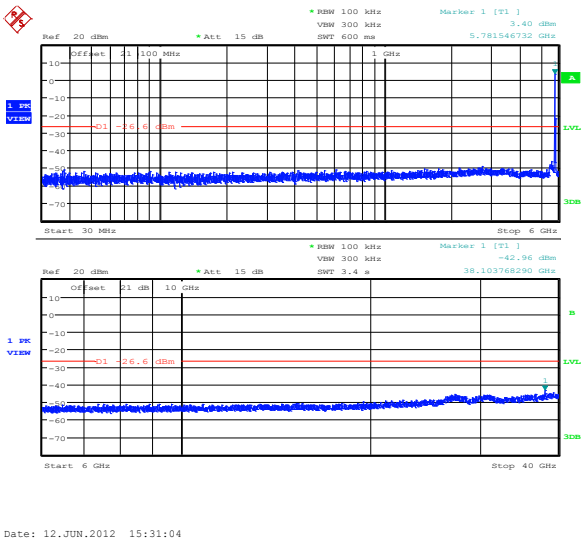
Plot 8.5-15: Conducted spurious emissions for 802.11a, CH0, Chn165



Plot 8.5-16: Conducted spurious emissions for 802.11a, CH1, Chn149

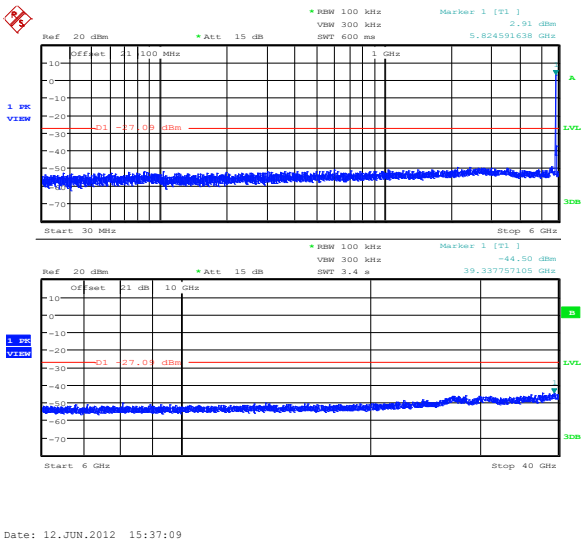
Note: Display line (in red) on the plots indicate spurious emissions limit which is 30 dB below the fundamental marked with `Marker 1 [T1]` on the upper plot of the split screen capture.

8.5.4 Test data, continued



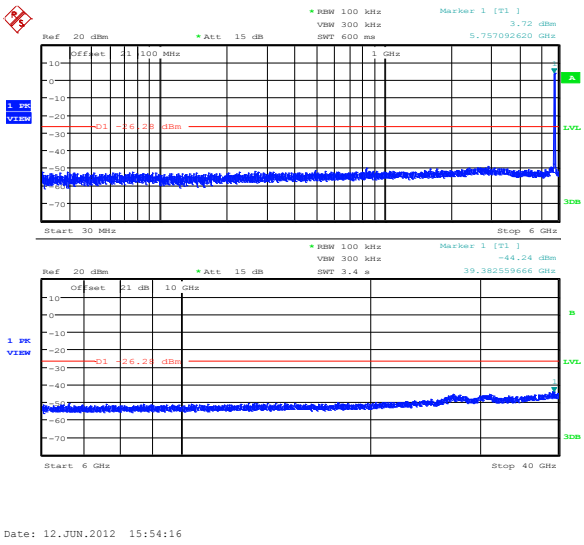
Date: 12.JUN.2012 15:31:04

Plot 8.5-17: Conducted spurious emissions for 802.11a, CH1, Chn157



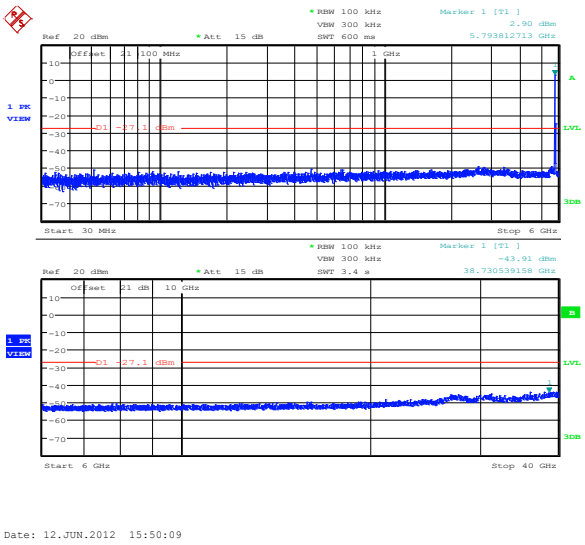
Date: 12.JUN.2012 15:37:09

Plot 8.5-18: Conducted spurious emissions for 802.11a, CH1, Chn165



Date: 12.JUN.2012 15:54:16

Plot 8.5-19: Conducted spurious emissions for 802.11n HT20, CH0, Chn149



Date: 12.JUN.2012 15:50:09

Plot 8.5-20: Conducted spurious emissions for 802.11n HT20, CH0, Chn157

Note: Display line (in red) on the plots indicate spurious emissions limit which is 30 dB below the fundamental marked with `Marker 1 [T1]` on the upper plot of the split screen capture.

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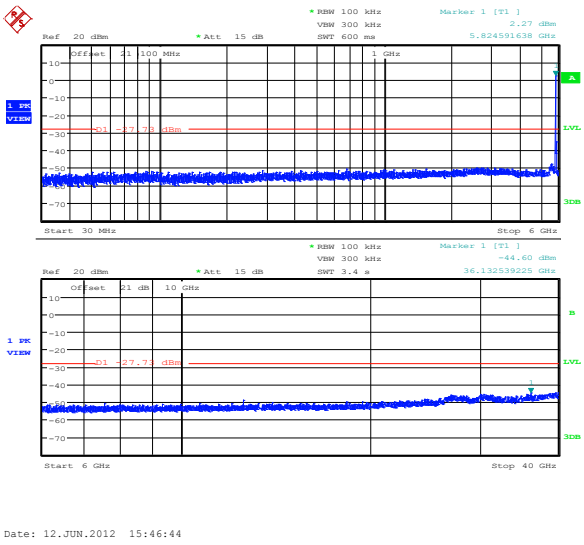
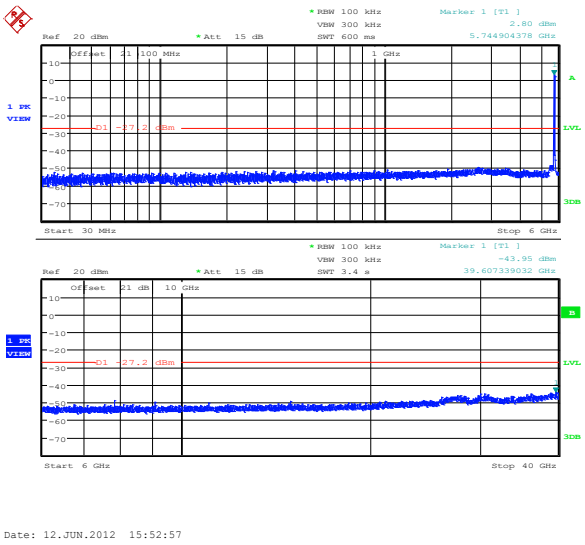
8.5.4 Test data, continued



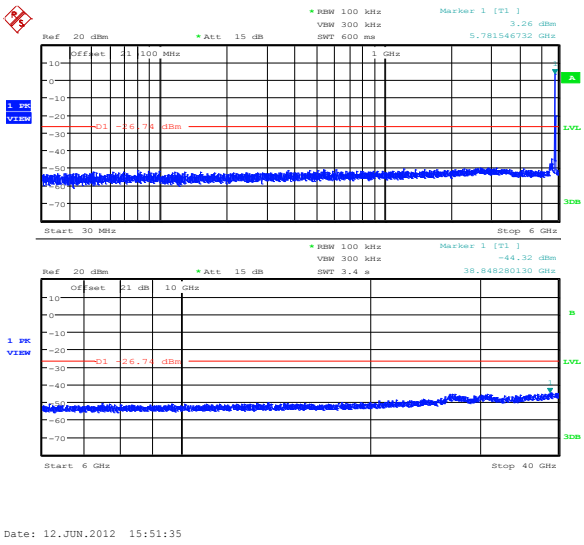
Date: 12.JUN.2012 15:46:44

Plot 8.5-21: Conducted spurious emissions for 802.11n HT20, CH0, Chn165



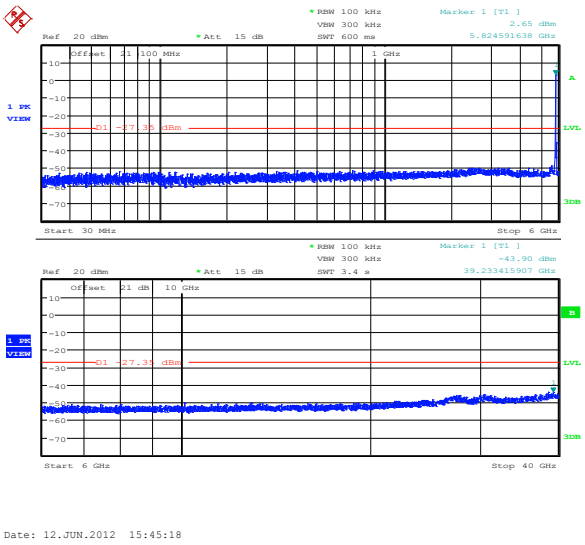
Date: 12.JUN.2012 15:52:57

Plot 8.5-22: Conducted spurious emissions for 802.11n HT20, CH1, Chn149



Date: 12.JUN.2012 15:51:35

Plot 8.5-23: Conducted spurious emissions for 802.11n HT20, CH1, Chn157

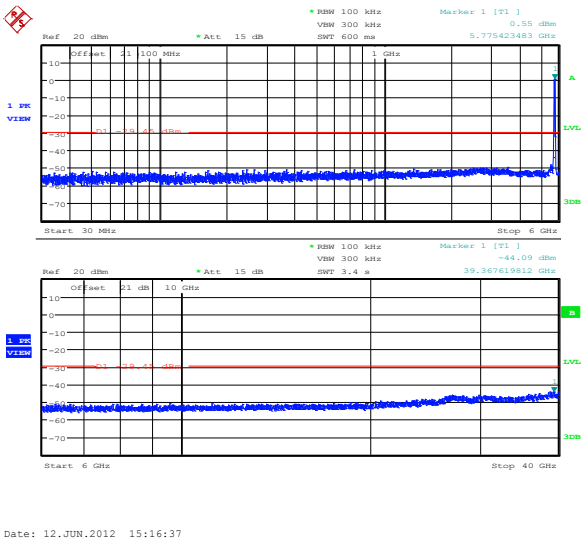


Date: 12.JUN.2012 15:45:18

Plot 8.5-24: Conducted spurious emissions for 802.11n HT20, CH1, Chn165

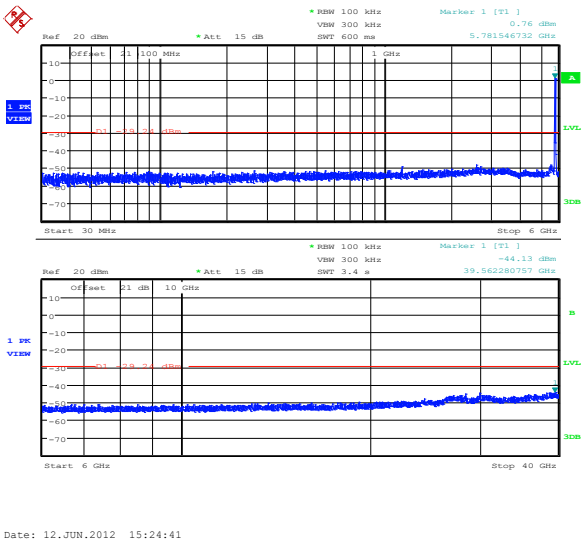
Note: Display line (in red) on the plots indicate spurious emissions limit which is 30 dB below the fundamental marked with `Marker 1 [T1]` on the upper plot of the split screen capture.

8.5.4 Test data, continued



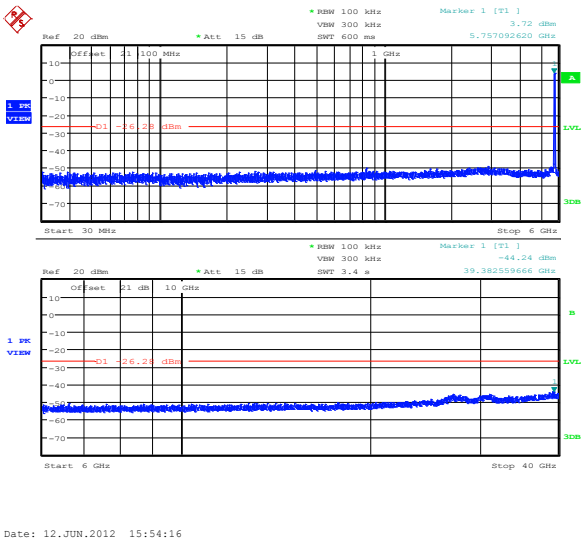
Date: 12.JUN.2012 15:16:37

Plot 8.5-25: Conducted spurious emissions for 802.11n HT40 channel, CH0, Chn151



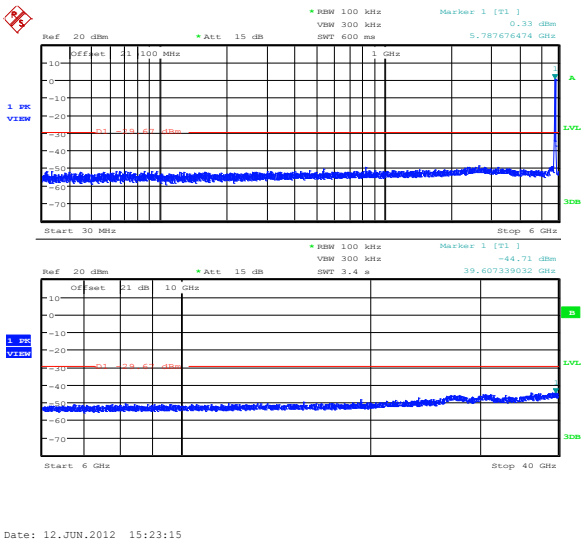
Date: 12.JUN.2012 15:24:41

Plot 8.5-26: Conducted spurious emissions for 802.11n HT40 channel, CH0, Chn159



Date: 12.JUN.2012 15:54:16

Plot 8.5-27: Conducted spurious emissions for 802.11n HT40 channel, CH1, Chn151

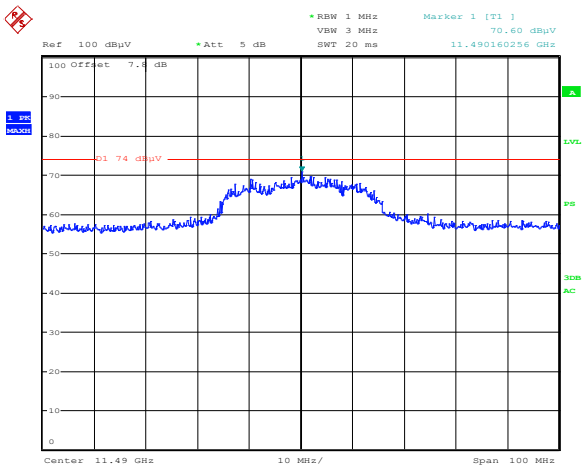


Date: 12.JUN.2012 15:23:15

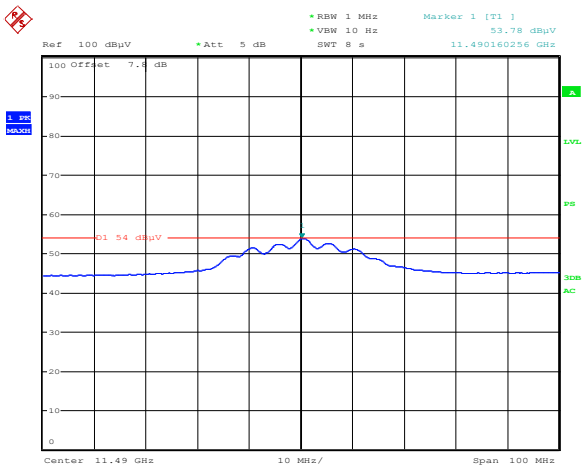
Plot 8.5-28: Conducted spurious emissions for 802.11n HT40 channel, CH1, Chn159

Note: Display line (in red) on the plots indicate spurious emissions limit which is 30 dB below the fundamental marked with `Marker 1 [T1]` on the upper plot of the split screen capture.

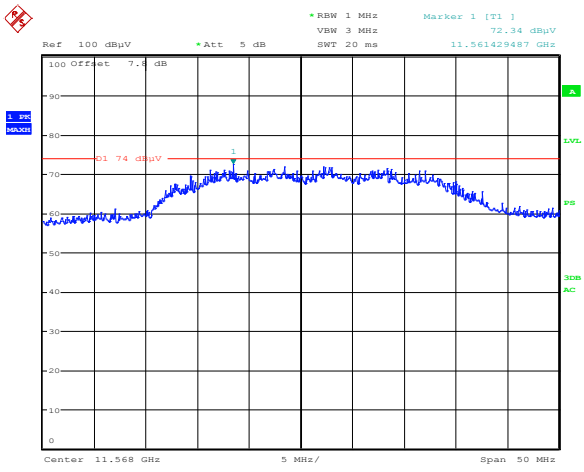
8.5.4 Test data, continued



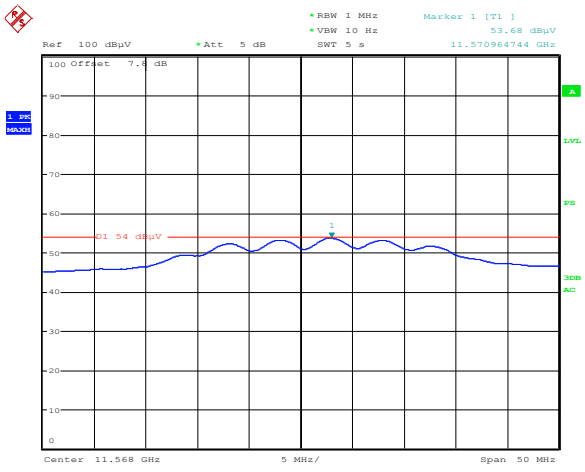
Plot 8.5-29: Radiated spurious emission (2nd harmonic) for 802.11a, Chn149, peak



Plot 8.5-30: Radiated spurious emission (2nd harmonic) for 802.11a, Chn149, average

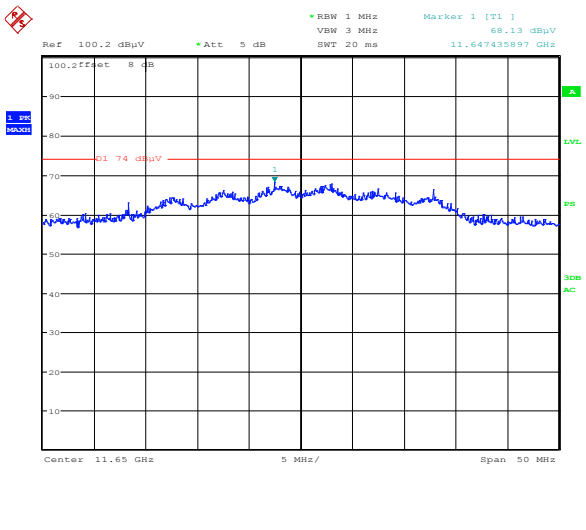


Plot 8.5-31: Radiated spurious emission (2nd harmonic) for 802.11a, Chn157, peak

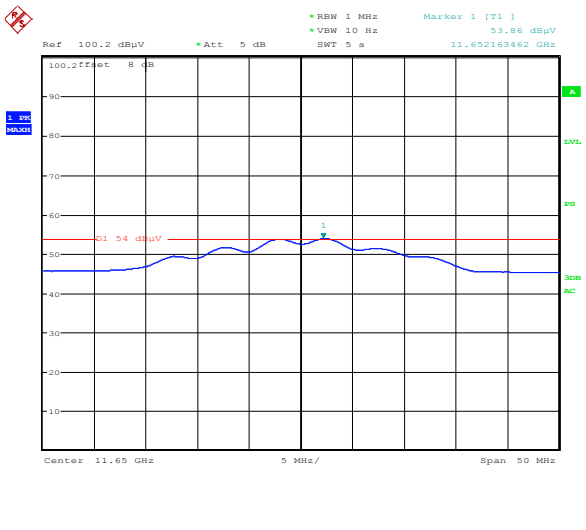


Plot 8.5-32: Radiated spurious emission (2nd harmonic) for 802.11a, Chn157, average

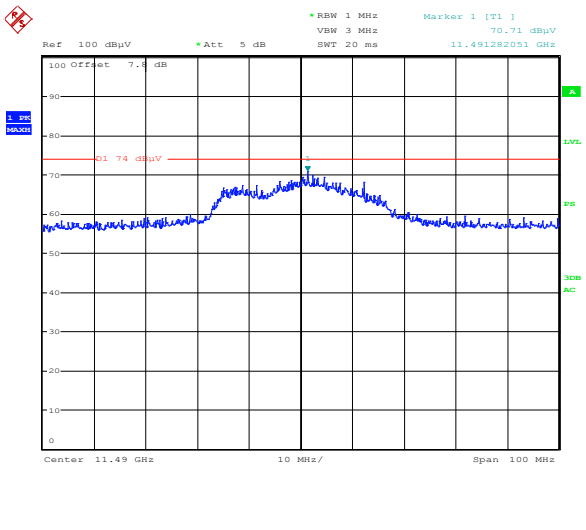
8.5.4 Test data, continued



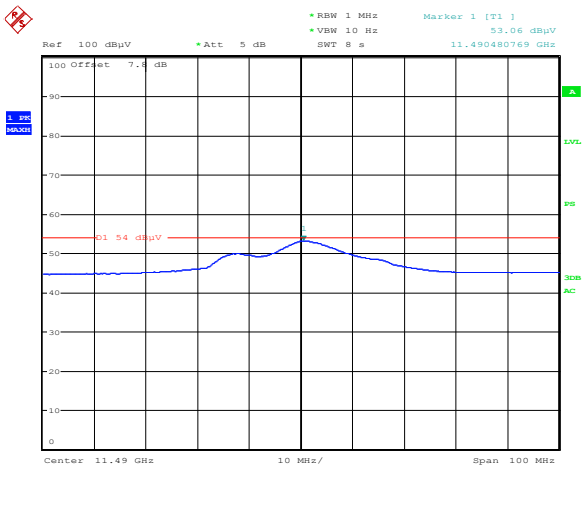
Plot 8.5-33: Radiated spurious emission (2nd harmonic) for 802.11a, Chn165, peak



Plot 8.5-34: Radiated spurious emission (2nd harmonic) for 802.11a, Chn165, average



Plot 8.5-35: Radiated spurious emission (2nd harmonic) for 802.11n HT20, Chn149, peak



Plot 8.5-36: Radiated spurious emission (2nd harmonic) for 802.11n HT20, Chn149, average

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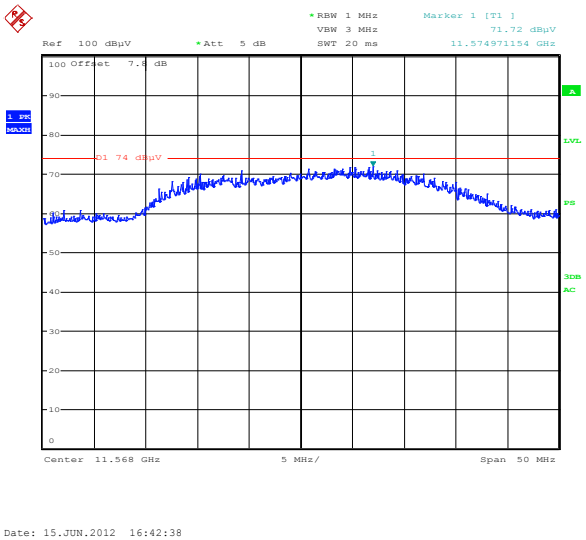
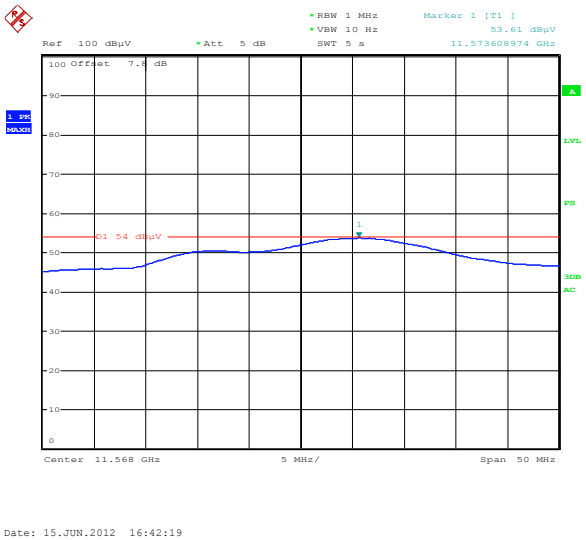
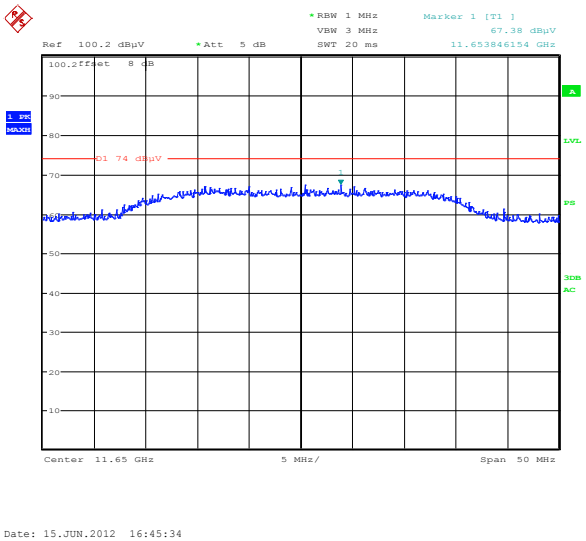
8.5.4 Test data, continued



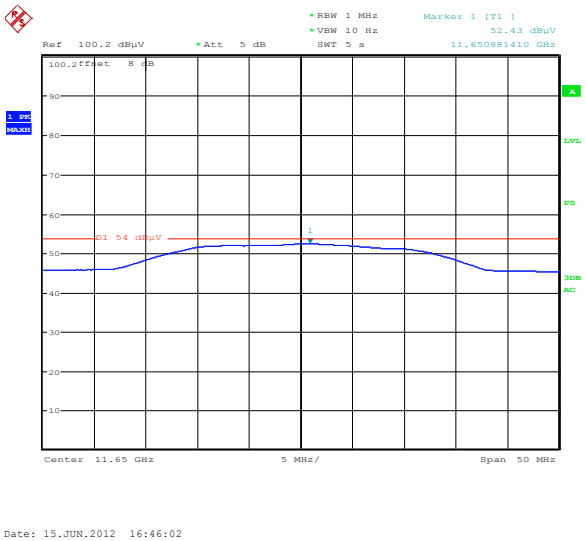
Plot 8.5-37: Radiated spurious emission (2nd harmonic) for 802.11n HT20, Chn157, peak



Plot 8.5-38: Radiated spurious emission (2nd harmonic) for 802.11n HT20, Chn157, average

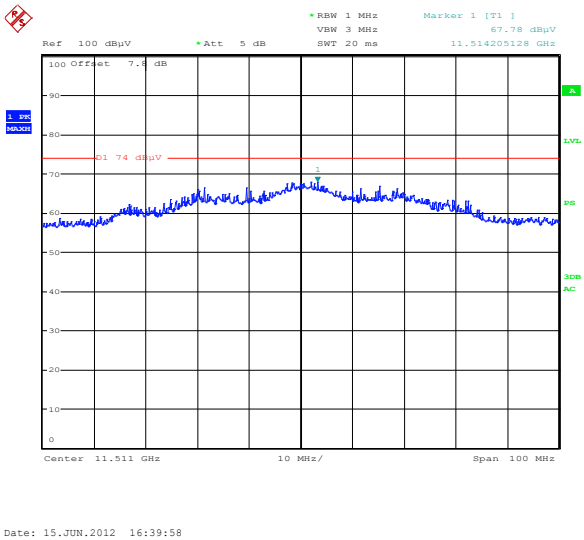


Plot 8.5-39: Radiated spurious emission (2nd harmonic) for 802.11n HT20, Chn165, peak

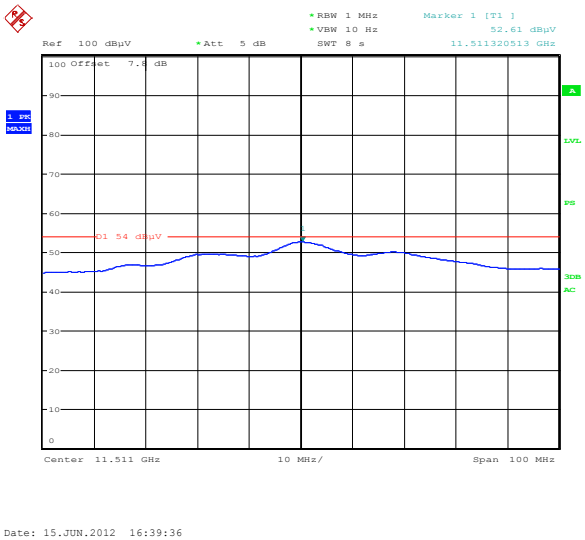


Plot 8.5-40: Radiated spurious emission (2nd harmonic) for 802.11n HT20, Chn165, average

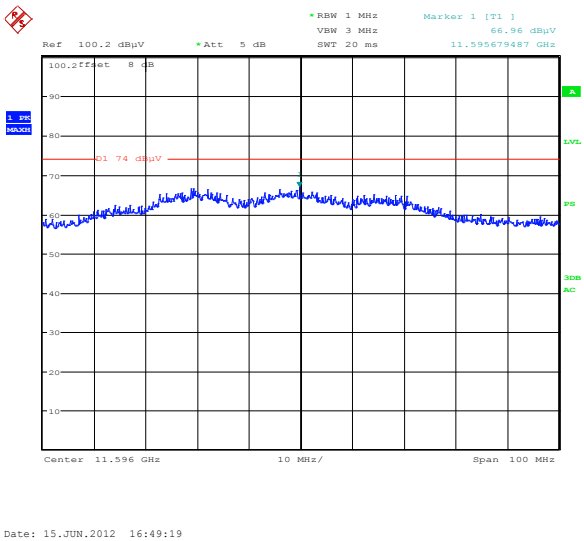
8.5.4 Test data, continued



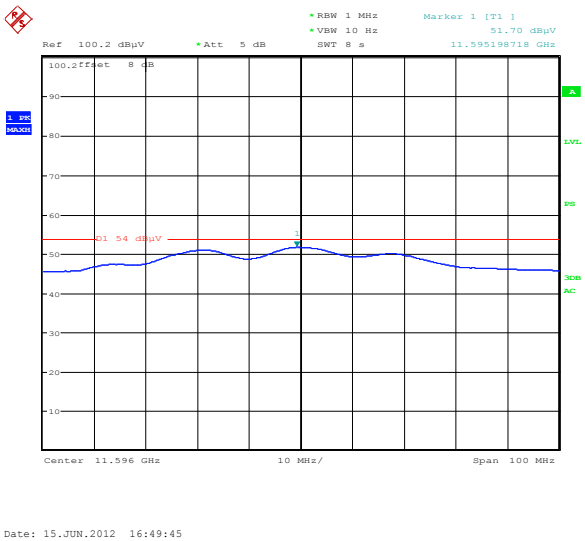
Plot 8.5-41: Radiated spurious emission (2nd harmonic) for 802.11n HT40, Chn151, peak



Plot 8.5-42: Radiated spurious emission (2nd harmonic) for 802.11n HT40, Chn151, average



Plot 8.5-43: Radiated spurious emission (2nd harmonic) for 802.11n HT40, Chn159, peak



Plot 8.5-44: Radiated spurious emission (2nd harmonic) for 802.11n HT40, Chn159, average

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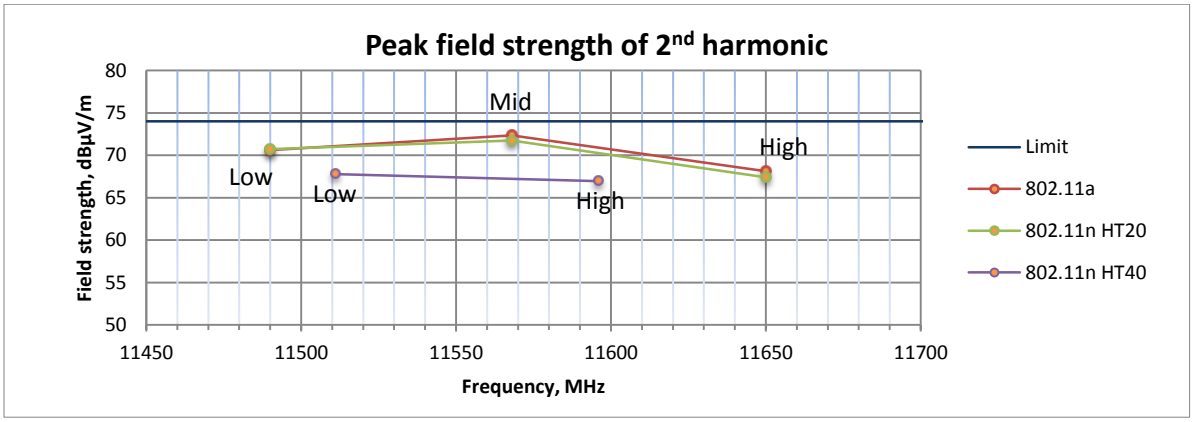
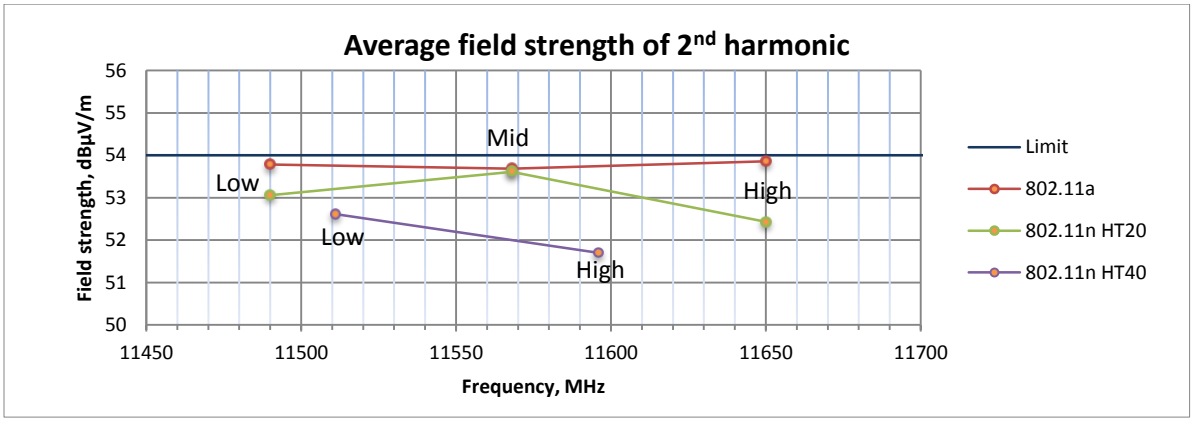
8.5.4 Test data, continued

Table 8.5-4: Radiated spurious emissions results

Modulation	Channel	Frequency (MHz)	Peak measurement			Average measurement		
			Field strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Field strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
802.11a	149	11490	70.60	74.00	3.40	53.78	54.00	0.22
	157	11568	72.34	74.00	1.66	53.68	54.00	0.32
	165	11650	68.13	74.00	5.87	53.86	54.00	0.14
802.11n HT20	149	11490	70.71	74.00	3.29	53.06	54.00	0.94
	157	11568	71.72	74.00	2.28	53.61	54.00	0.39
	165	11650	67.38	74.00	6.62	52.43	54.00	1.57
802.11n HT40	151	11511	67.78	74.00	6.22	52.61	54.00	1.39
	159	11596	66.96	74.00	7.04	51.70	54.00	2.30





8.5.4 Test data, continued

Table 8.5-5: Conducted spurious emissions results

Modulation	Chain	Channel	Frequency (MHz)	Attenuation below carrier (dBc)	Minimum limit (dBc)	Margin (dB)
802.11a	CH0	149	5725	34.37	30.00	4.37
		165	5850	43.74	30.00	13.74
	CH1	149	5725	30.12	30.00	0.12
		165	5850	42.53	30.00	12.53
802.11n HT20	CH0	149	5725	30.97	30.00	0.97
		165	5850	41.55	30.00	11.55
	CH1	149	5725	30.22	30.00	0.22
		165	5850	42.20	30.00	12.20
802.11n HT40	CH0	151	5725	31.45	30.00	1.45
		159	5850	43.04	30.00	13.04
	CH1	151	5725	30.03	30.00	0.03
		159	5850	40.45	30.00	10.45

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8.6 FCC Clause 15.247(e) and RSS-210 Clause 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	June 12, 2012	**Test engineer**	Andrey Adelberg	**Verdict**	Pass
Temperature	22 °C	**Air pressure**	1005 mbar	**Relative humidity**	33 %

8.6.3 Observations/special notes

The test was performed using RMS detector with 100 kHz RBW.

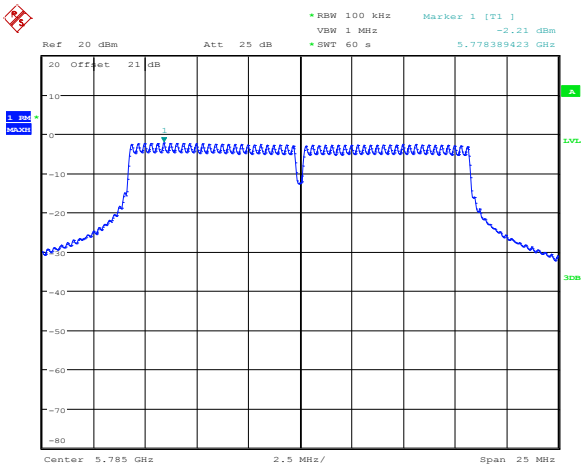
8.6.4 Test data

Table 8.5-1: PSD results

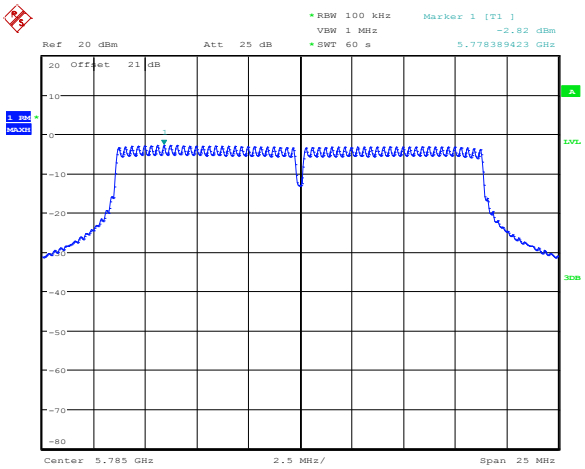
Modulation	Frequency (MHz)	Conducted PSD CH0 (dBm/100 kHz)	Conducted PSD CH1 (dBm/100 kHz)	Combined PSD (dBm/100 kHz)	BW correction factor (dB)	Combined PSD (dBm/3 kHz)	PSD Limit (dBm/3 kHz)	Margin (dB)
802.11n HT20	5745	-2.89	-2.53	0.30	-15.23	-14.92	8.00	22.92
	5785	-2.82	-3.08	0.06	-15.23	-15.17	8.00	23.17
	5825	-3.18	-2.85	0.00	-15.23	-15.23	8.00	23.23
802.11n HT40	5755	-6.42	-5.69	-3.03	-15.23	-18.26	8.00	26.26
	5795	-5.63	-6.40	-2.99	-15.23	-18.22	8.00	26.22
802.11a	5745	-2.52	-2.27	0.62	-15.23	-14.61	8.00	22.61
	5785	-2.21	-4.04	-0.02	-15.23	-15.25	8.00	23.25
	5825	-4.00	-3.82	-0.90	-15.23	-16.13	8.00	24.13

Combined PSD [dBm/100 kHz] = (CPSD0 + CPSD1) ÷ 2 + 10 × Log_{10} (N)
CPSD0 = Conducted PSD CH0 [dBm/100 kHz]; *CPSD1* = Conducted PSD CH1 [dBm/100 kHz]; "N" is number antenna ports (chains)
BW correction factor calculation = 10 × Log_{10}(required BW/tested BW) = 10 × Log_{10} (3 kHz/100 kHz) = −15.23 dB

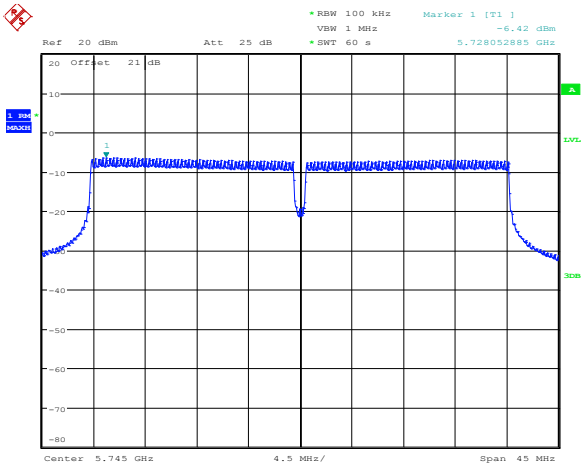
8.6.4 Test data, continued



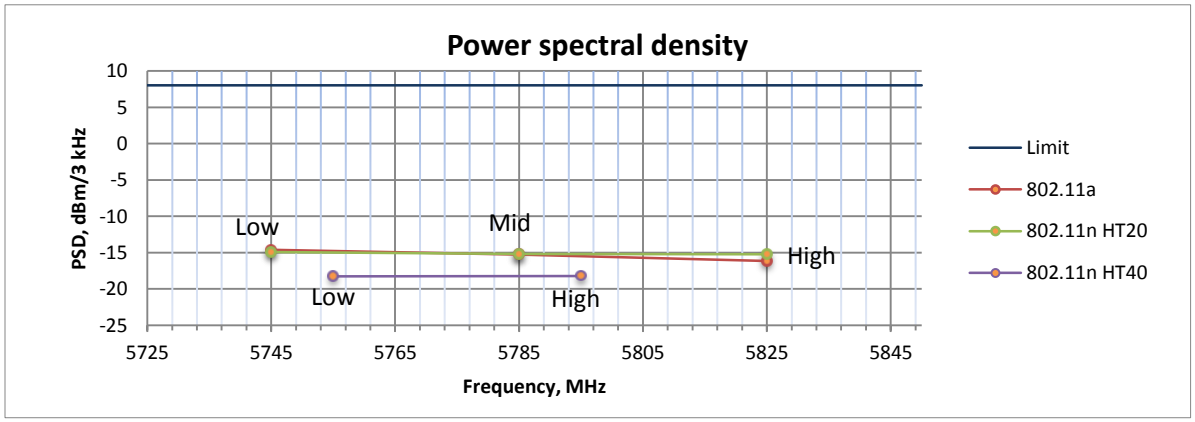
Sample plot 8.6-1: PSD 802.11a



Sample plot 8.6-2: PSD 802.11 n HT20

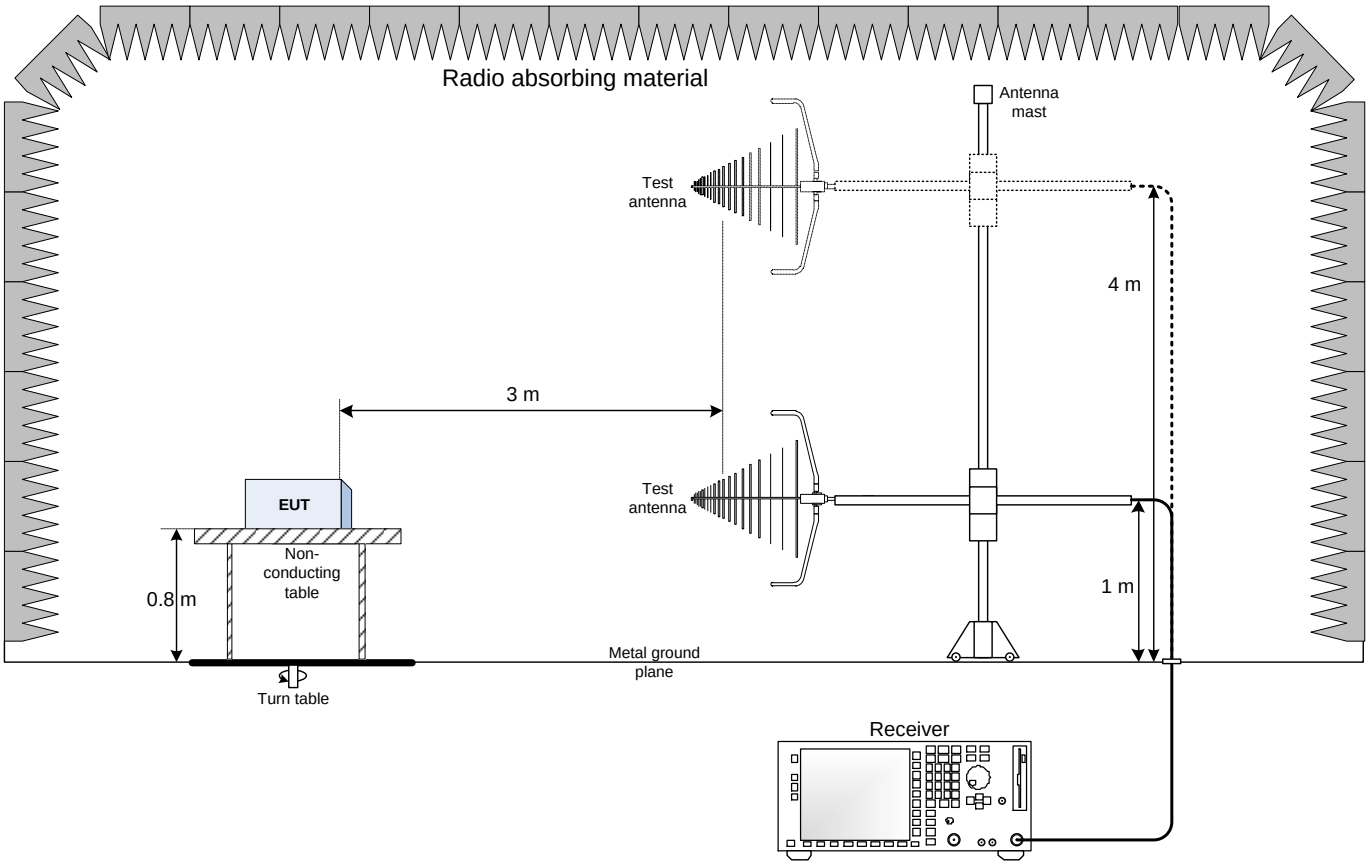


Sample plot 8.6-3: PSD 802.11n HT40



Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up