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Test report

309365-5TRFWL

Date of issue: June 30, 2016

Applicant:

Digital Security Controls a div. of Tyco Safety Products Canada Ltd.

Product:

Self-Contained Wireless Security System

Model:

WS900-19

FCC ID: F5316WS90019

IC Registration number: 160A-WS90019

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247
  Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
- RSS-247, Issue 1, May 2015, Section 5
  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Test location

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

Tested by	David Duchesne, Senior EMC/Wireless Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Review date	June 30, 2016
Reviewer signature	

Limits of responsibility

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

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Digital Security Controls a div. of Tyco Safety Products Ltd.
Address	3301 Langstaff Road, Concord, ON, Canada, L4K 4L2

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-247, Issue 1, May 2015, Section 5	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test methods

558074 D01 DTS Meas Guidance v03 r05 (April 8, 2016)	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

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

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

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

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass[1]
§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 antenna is 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
§15.215(c)	20 dB bandwidth	Pass
§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)(3,4)	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(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

Notes: None

2.3 IC RSS-GEN, Issue 4, test results

Part	Test description	Verdict
7.1.2	Receiver radiated emission limits	Not applicable[1]
7.1.3	Receiver conducted emission limits	Not applicable[1]
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Pass
6.6	Occupied bandwidth	Pass

Notes: 1 According to sections 5.2 and 5.3 of RSS-Gen, Issue 4 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.4 IC RSS-247, Issue 1, test results

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

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	May 24, 2016
Nemko sample ID number	133-002706 (Conducted sample) and 133-002708 (Radiated sample)

3.2 EUT information

Product name	Self-Contained Wireless Security System
Model	WS900-29
Serial number	133-002706 (Conducted sample) and 133-002709 (Radiated sample)

3.3 Technical information

All used IC test site(s) Reg. number	2040A-4
RSS number and Issue number	RSS-247 Issue 1, May 2015
Frequency band (MHz)	2400–2483.5
Frequency Min (MHz)	2412 (for 802.11b, 802.11g and 802.11n HT20) 2422 (for 802.11n HT40)
Frequency Max (MHz)	2462(for 802.11b, 802.11g and 802.11n HT20) 2452 (for 802.11n HT40)
RF power Max (W), Conducted	0.115 (20.62 dBm for 802.11b), 0.087 (19.42 dBm for 802.11g), 0.086 (19.33 dBm for 802.11n HT20), 0.124 (20.95 dBm for 802.11n HT40)
Field strength, Units @ distance	N/A
Measured BW (MHz) (6 dB)	10.08 (802.11b), 16.44 (802.11g), 17.64 (802.11n HT20) and 35.70 (802.11n HT40)
Measured BW (kHz) (20 dB)	16.44 (802.11b), 19.14 (802.11g), 19.62 (802.11n HT20) and 40.32 (802.11n HT40)
Measured BW (kHz) (99%)	14.40 (802.11b), 16.80 (802.11g), 17.82 (802.11n HT20) and 36.68 (802.11n HT40)
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	802.11b/g/n HT20 and HT40
Emission classification	W7D
Transmitter spurious, Units @ distance	67.99 dBµV/m Peak and 50.18 dBµV/m Average @ 3 m @ 2389.91 MHz
Power requirements	12 V_{DC} (Powered via external AC-DC adapter 90–264 V_{AC} 47–63 Hz) and via 7.5 V_{DC} battery
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator. The antennas are a proprietary design by DSC and are integrated into the printed circuit board.

3.4 Product description and theory of operation

The Wireless alarm system has support for 128 wireless zones. It monitors the wireless initiating devices and activates the integrated siren when an alarm occurs and also provides communication of the alarm event over the integrated Wi-Fi interface. The control unit is also capable to communicate with Z-Wave compatible home automation devices. The security portion can be armed and disarmed via the integrated keypad. Trouble/alarm/signal strength status is indicated on the front panel using LED's.

3.5 EUT exercise details

EUT was connected to a laptop via Ethernet connector. A putty application was running on the computer that controlled the transmitter parameters. Client provided a modified sample with a direct connection to the antenna port for conducted measurements at the antenna ports.

3.6 EUT setup diagram

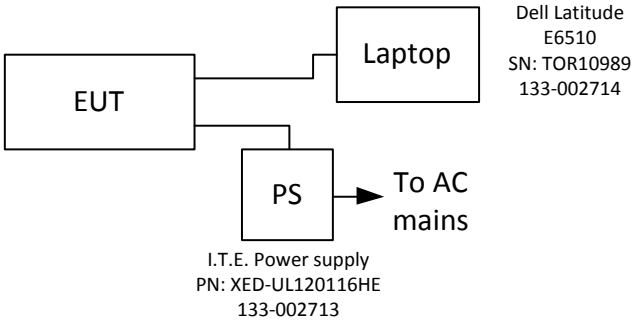


Figure 3.6-1: *Setup diagram*

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

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

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

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

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

5.2 Power supply range

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

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

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

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 07/17
AC Power source	California Instruments	3001i	FA001021	1 year	Aug. 27/16
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Mar. 08/17
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Dec. 01/16
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 28/17
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 26/17
Horn antenna 18–40 GHz	EMCO	3116	FA001847	1 year	Apr.15/17
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	April 26/17
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Spectrum analyzer	Rohde & Schwarz	FSP	FA001920	1 year	Aug. 20/16
Notch filter 2400–2483 MHz	Microwave Circuits	2400–2483 MHz	FA001940	—	VOU

Notes: None

Table 7.1-2: *test software*

Test description	Manufacturer of Software	Details
Radiated emissions – Ottawa	Rhode & Schwarz	EMC32, Software for EMC Measurements, Version 9.26.01

Notes: None

Section 8. Testing data

8.1 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.1.1 Definitions and limits

FCC §15.207 (a):
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.

RSS-GEN, Clause 8.8:
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which 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 table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions 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 below. The more stringent limit applies at the frequency range boundaries.

Table 8.1-1: *AC power line conducted emissions limits*

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

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

8.1.2 Test summary

Verdict	Pass				
Test date	May 25, 2016	Test engineer	David Duchesne		
Temperature	23.4 °C	Relative humidity	35.7 %	Air pressure	1001 mbar

8.1.3 Notes

None

8.1.4 Setup details

Port under test	AC input (External adapter)
EUT setup configuration	Table top
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.

Receiver settings:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	– Peak and Average (Preview measurement) – Quasi-peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak and Average preview measurement) – 1000 ms (Quasi-peak final measurement) – 160 ms (CAverage final measurement)

8.1.5 Test data

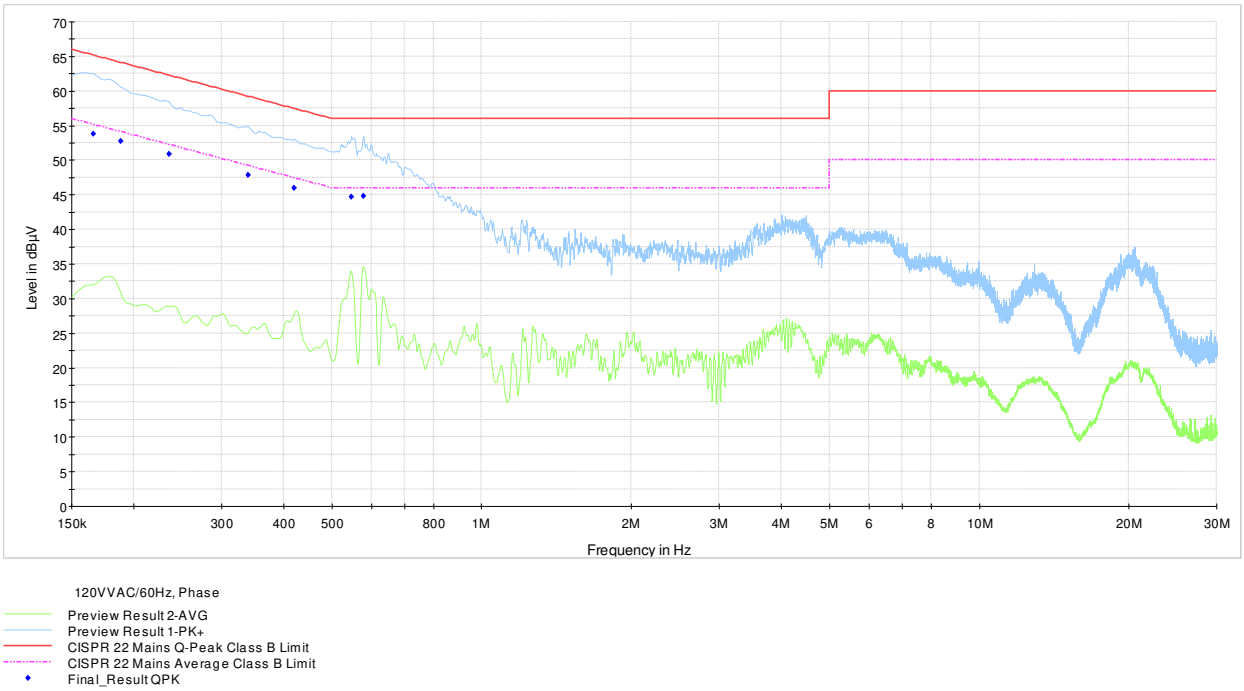


Figure 8.1-1: *AC power line conducted emissions limits – phase line*

Table 8.1-2: *Quasi-Peak results AC power line conducted emissions limits – phase line*

Frequency (MHz)	Quasi-Peak result[1 and 3] (dBµV)	Quasi-Peak limit (dBµV)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Conductor	Filter	Correction factor[2] (dB)
0.165750	53.77	65.17	11.40	1000	9	L1	ON	10.1
0.188250	52.76	64.11	11.35	1000	9	L1	ON	10.0
0.235500	50.85	62.25	11.40	1000	9	L1	ON	9.7
0.339000	47.88	59.23	11.35	1000	9	L1	ON	9.9
0.420000	45.97	57.45	11.48	1000	9	L1	ON	10.0
0.548250	44.72	56.00	11.28	1000	9	L1	ON	10.0
0.579750	44.78	56.00	11.22	1000	9	L1	ON	10.0

Notes:
[1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.

Sample calculation: 44.78 dBµV (result) = 34.78 dBµV (receiver reading) + 10.00 dB (Correction factor)

8.1.5 Test data, continued

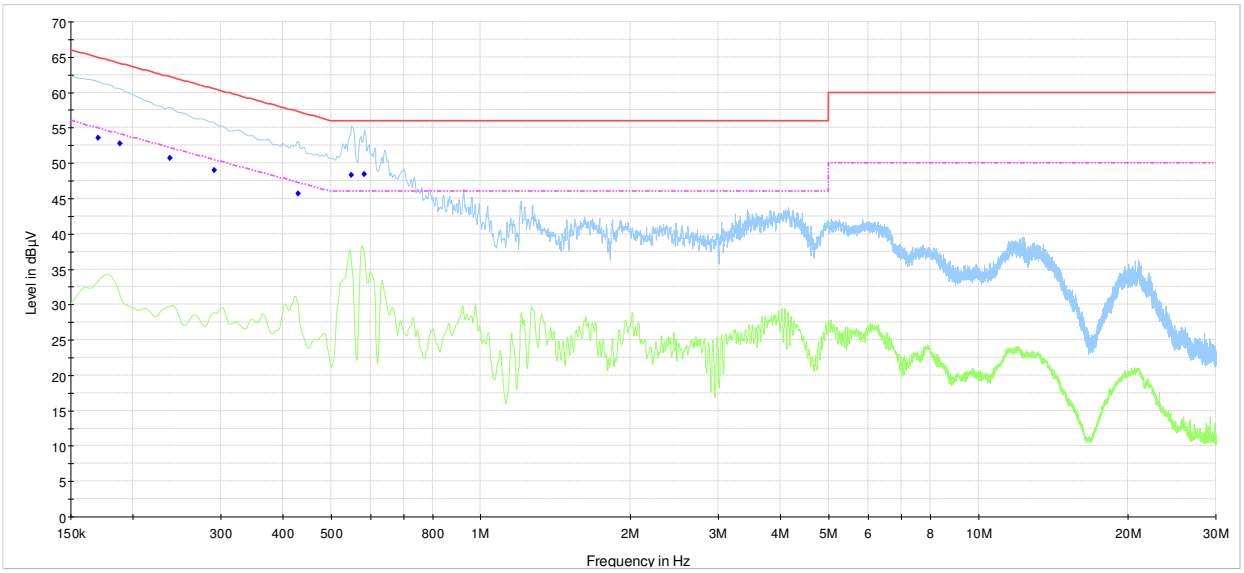


Figure 8.1-2: *AC power line conducted emissions limits – neutral line*

Table 8.1-3: *Quasi-Peak results AC power line conducted emissions limits – neutral line*

Frequency (MHz)	Quasi-Peak result[1 and 3] (dBµV)	Quasi-Peak limit (dBµV)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Conductor	Filter	Correction factor[2] (dB)
0.170250	53.57	64.95	11.38	1000	9	N	ON	10.1
0.188250	52.70	64.11	11.41	1000	9	N	ON	10.0
0.237750	50.67	62.17	11.50	1000	9	N	ON	9.7
0.291750	49.01	60.47	11.46	1000	9	N	ON	9.8
0.429000	45.73	57.27	11.54	1000	9	N	ON	10.0
0.550500	48.25	56.00	7.75	1000	9	N	ON	10.0
0.584250	48.38	56.00	7.62	1000	9	N	ON	10.0

Notes:
[1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.

Sample calculation: 48.38 dBµV (result) = 38.38 dBµV (receiver reading) + 10.00 dB (Correction factor)

8.1.6 Setup photos

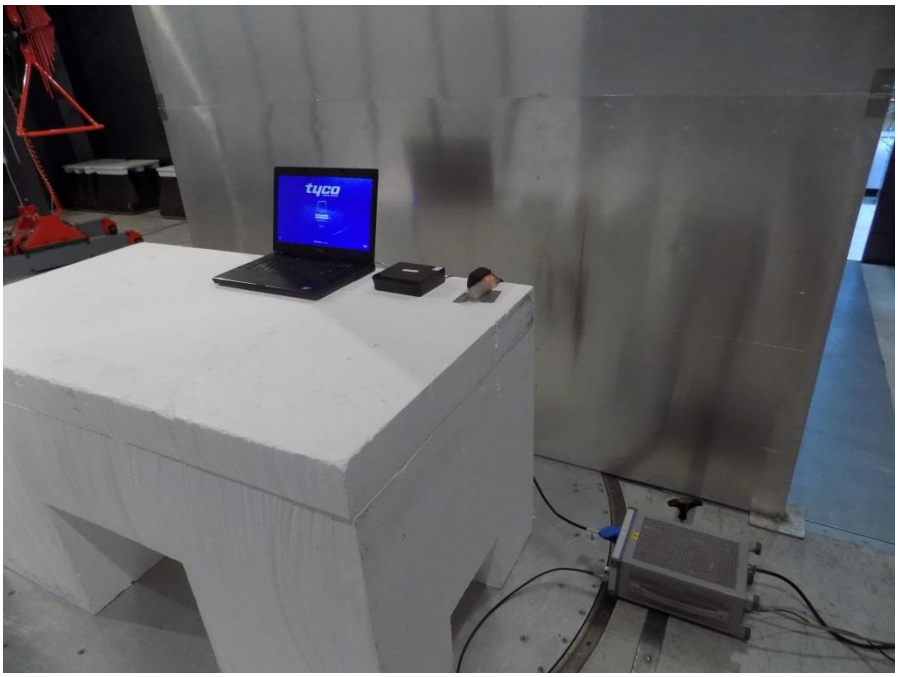


Figure 8.1-3: *AC power line conducted emissions limits setup photo*

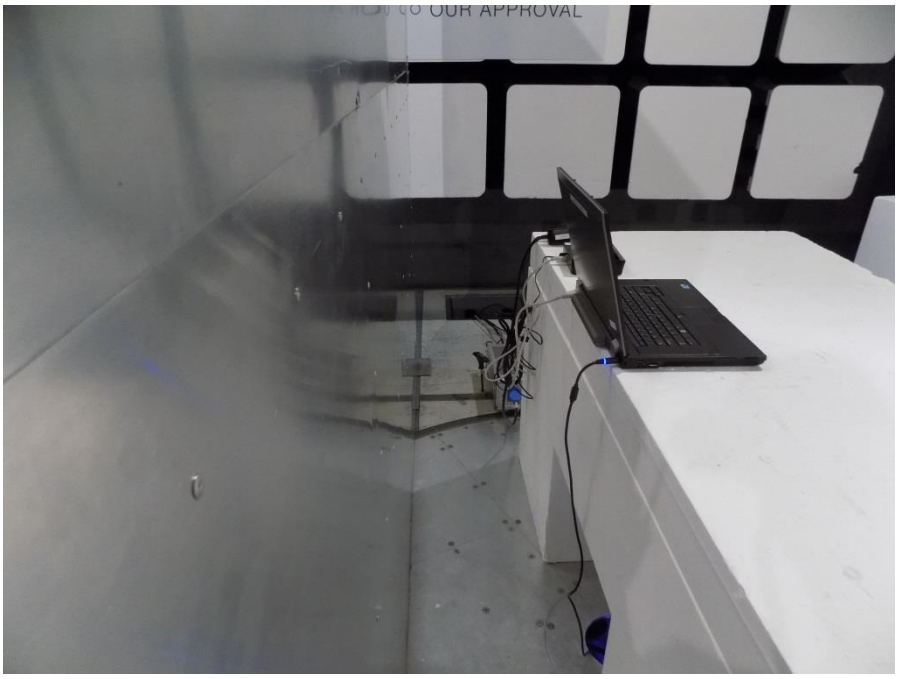


Figure 8.1-4: *AC power line conducted emissions limits setup photo*

8.2 FCC 15.247(a)(2) and RSS-247 5.2(1): 6 dB bandwidth, RSS-Gen (6.6): 99% bandwidth and FCC 15.215(c): 20 dB bandwidth

8.2.1 Definitions and limits

FCC §15.247 (a)(2):

(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.

RSS-247, Clause 5.2 (1):

The minimum 6 dB bandwidth shall be 500 kHz.

FCC §15.215 (c):

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

RSS-GEN, Clause 6.6:

The emission bandwidth (×dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated × dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3× the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% 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 (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3×RBW.

Note: Video averaging is not permitted.

A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

8.2.2 Test summary

Verdict	Pass				
Test date	May 27, 2016	Test engineer	David Duchesne		
Temperature	21.6 °C	Relative humidity	50.9 %	Air pressure	1003 mbar

8.2.3 Notes

Measurements were performed as per 558074 D01 DTS Meas Guidance v03r05 (The test was performed using method described in Section 8.1)

8.2.4 Setup details

Spectrum analyser settings: for 6 dB bandwidth test:

Resolution bandwidth	100 kHz
Video bandwidth	≥3 × RBW
Frequency span	– 30 MHz (802.11b, 802.11g and 802.11n HT20) – 70 MHz (802.11n HT40)
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings: for 20 dB and 99% bandwidth test:

Resolution bandwidth	– 300 kHz (802.11b, 802.11g and 802.11n HT20) – 1 MHz (802.11n HT40)
Video bandwidth	≥3 × RBW
Frequency span	– 30 MHz (802.11b, 802.11g and 802.11n HT20) – 70 MHz (802.11n HT40)
Detector mode	Peak
Trace mode	Max Hold

8.2.5 Test data

Table 8.2-1: *6 dB bandwidth results*

Modulation	Frequency, MHz	Modulation coding scheme	6 dB bandwidth, MHz	Limit, MHz	Margin, MHz
802.11b	2412	CCK: 1 Mbps	10.02	0.50	9.52
		CCK: 11 Mbps	8.88	0.50	8.38
	2437	CCK: 1 Mbps	10.08	0.50	9.58
		CCK: 11 Mbps	9.84	0.50	9.34
	2462	CCK: 1 Mbps	10.08	0.50	9.58
		CCK: 11 Mbps	8.88	0.50	8.38
802.11g	2412	OFDM: BPSK_1/2_6Mbps	16.20	0.50	15.7
		OFDM: QAM 64_3/4_54Mbps	16.26	0.50	15.76
	2437	OFDM: BPSK_1/2_6Mbps	16.32	0.50	15.82
		OFDM: QAM 64_3/4_54Mbps	16.38	0.50	15.88
	2462	OFDM: BPSK_1/2_6Mbps	16.14	0.50	15.64
		OFDM: QAM 64_3/4_54Mbps	16.44	0.50	15.94
802.11n HT20	2412	OFDM: BPSK_1/2_6.5Mbps	17.64	0.50	17.14
		OFDM: QAM 64_3/4_65Mbps	17.64	0.50	17.14
	2437	OFDM: BPSK_1/2_6.5Mbps	17.58	0.50	17.08
		OFDM: QAM 64_3/4_65Mbps	17.52	0.50	17.02
	2462	OFDM: BPSK_1/2_6.5Mbps	17.58	0.50	17.08
		OFDM: QAM 64_3/4_65Mbps	17.52	0.50	17.02
802.11n HT40	2412	OFDM: BPSK_1/2_6.5Mbps	35.70	0.50	35.20
		OFDM: QAM 64_3/4_65Mbps	36.40	0.50	35.90
	2437	OFDM: BPSK_1/2_6.5Mbps	35.56	0.50	35.06
		OFDM: QAM 64_3/4_65Mbps	35.56	0.50	35.06
	2452	OFDM: BPSK_1/2_6.5Mbps	35.28	0.50	34.78
		OFDM: QAM 64_3/4_65Mbps	35.21	0.50	34.71

Notes: None

Table 8.2-2: *20 dB and 99% bandwidth results*

Modulation	Frequency, MHz	Modulation coding scheme	20 dB bandwidth, MHz	99% bandwidth , MHz
802.11b	2412	CCK: 1 Mbps	16.38	14.34
		CCK: 11 Mbps	16.26	13.98
	2437	CCK: 1 Mbps	16.38	14.34
		CCK: 11 Mbps	16.38	14.04
	2462	CCK: 1 Mbps	16.44	14.40
		CCK: 11 Mbps	16.44	14.04
802.11g	2412	OFDM: BPSK_1/2_6Mbps	18.96	16.68
		OFDM: QAM 64_3/4_54Mbps	18.36	16.62
	2437	OFDM: BPSK_1/2_6Mbps	19.14	16.68
		OFDM: QAM 64_3/4_54Mbps	18.48	16.56
	2462	OFDM: BPSK_1/2_6Mbps	19.14	16.80
		OFDM: QAM 64_3/4_54Mbps	18.30	16.56
802.11n HT20	2412	OFDM: BPSK_1/2_6.5Mbps	19.62	17.70
		OFDM: QAM 64_3/4_65Mbps	19.14	17.70
	2437	OFDM: BPSK_1/2_6.5Mbps	19.62	17.76
		OFDM: QAM 64_3/4_65Mbps	19.32	17.70
	2462	OFDM: BPSK_1/2_6.5Mbps	19.50	17.82
		OFDM: QAM 64_3/4_65Mbps	19.14	17.70
802.11n HT40	2422	OFDM: BPSK_1/2_6.5Mbps	40.32	36.68
		OFDM: QAM 64_3/4_65Mbps	39.90	36.40
	2437	OFDM: BPSK_1/2_6.5Mbps	39.76	36.40
		OFDM: QAM 64_3/4_65Mbps	39.90	36.26
	2452 [1]	OFDM: BPSK_1/2_6.5Mbps	39.48	36.26
		OFDM: QAM 64_3/4_65Mbps	40.11	36.19

Notes: None

8.2.5 Test data, continued

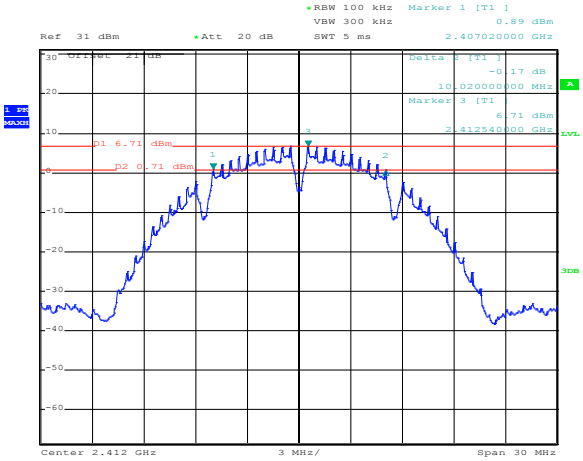


Figure 8.2-1: *6 dB bandwidth on 802.11b, sample plot – CCK: 1 Mbps*

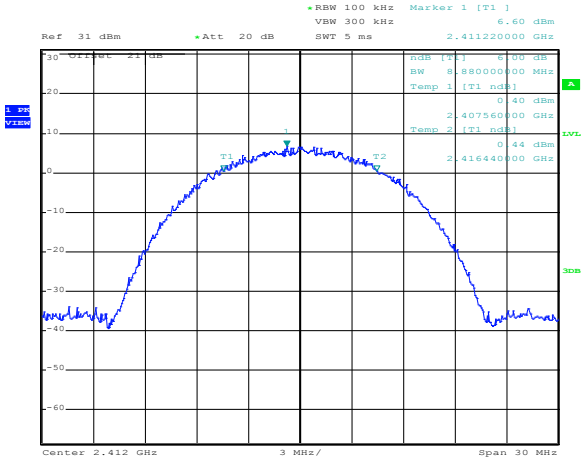


Figure 8.2-2: *6 dB bandwidth on 802.11b, sample plot – CCK: 11 Mbps*

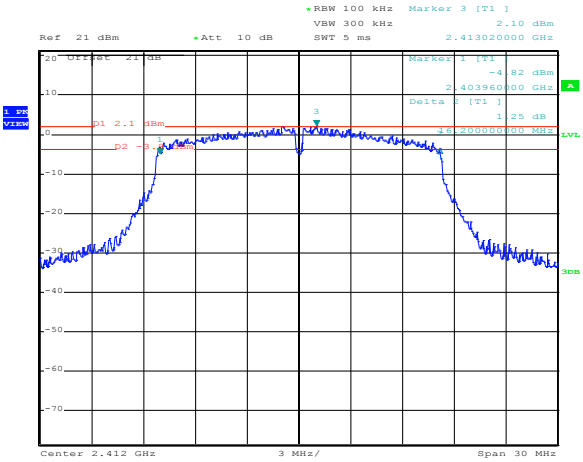


Figure 8.2-3: *6 dB bandwidth on 802.11g, sample plot – OFDM: BPSK_1/2_6Mbps*

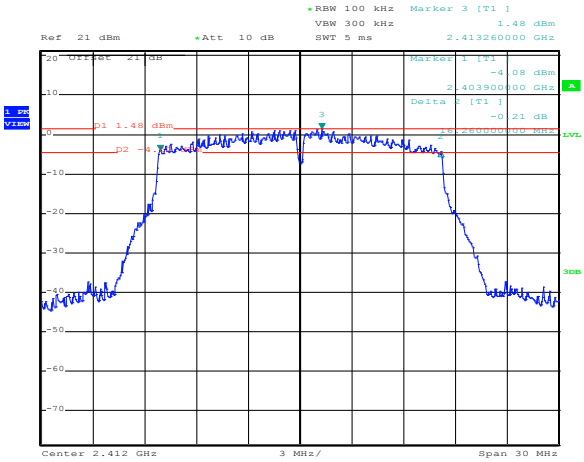


Figure 8.2-4: *6 dB bandwidth on 802.11g, sample plot – OFDM: QAM 64_3/4_54Mbps*

8.2.5 Test data, continued

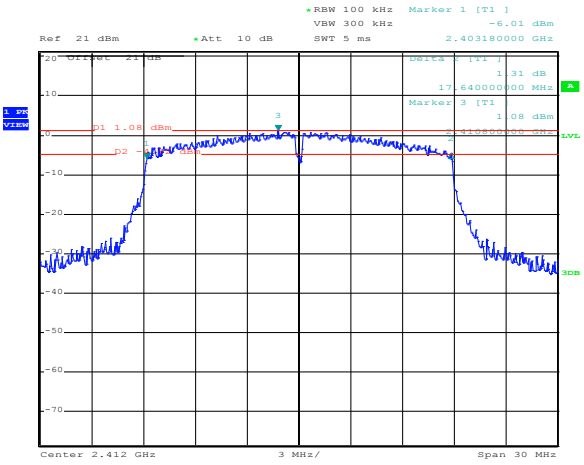


Figure 8.2-5: *6 dB bandwidth on 802.11n HT20, sample plot – OFDM: BPSK_1/2_6.5Mbps*

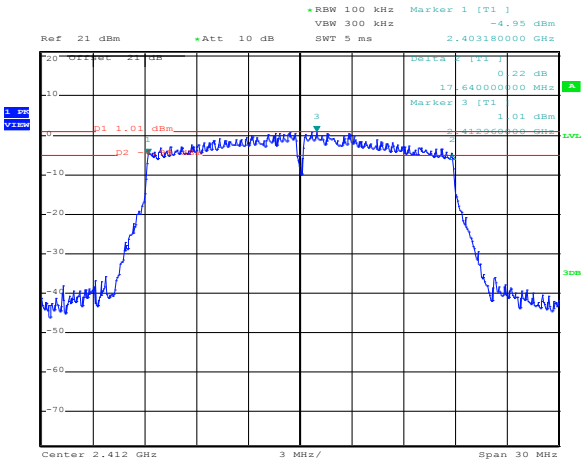


Figure 8.2-6: *6 dB bandwidth on 802.11n HT20, sample plot – QAM 64_3/4_65Mbps*

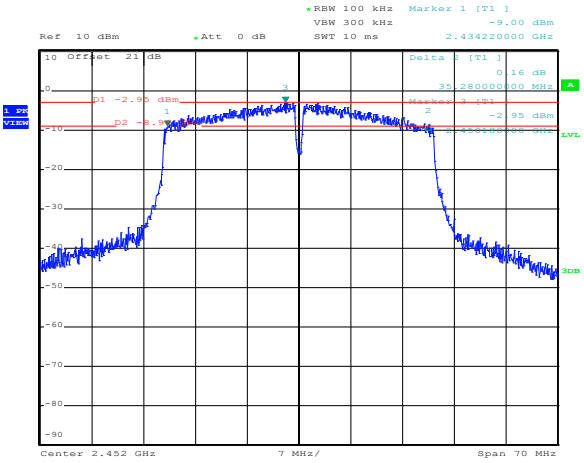


Figure 8.2-7: *6 dB bandwidth on 802.11n HT40, sample plot – OFDM: BPSK_1/2_6.5Mbps*

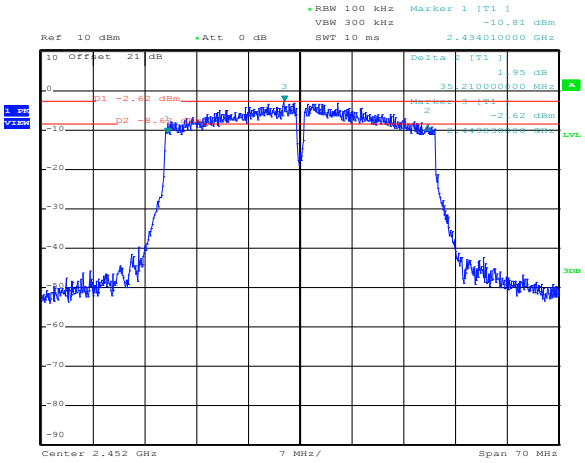


Figure 8.2-8: *6 dB bandwidth on 802.11n HT40, sample plot – OFDM: QAM 64_3/4_65Mbps*

8.2.5 Test data, continued

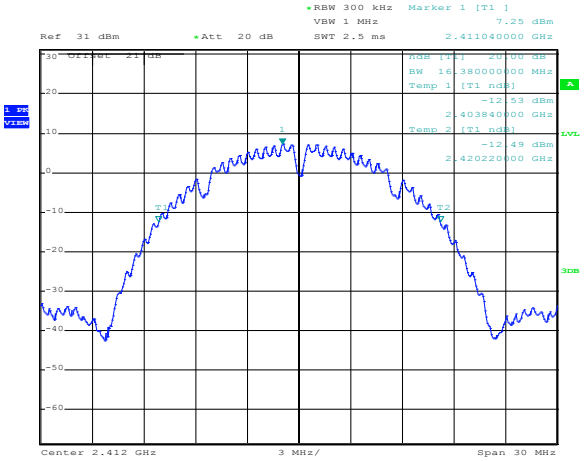


Figure 8.2-9: *20 dB bandwidth on 802.11b, sample plot – CCK: 1 Mbps*

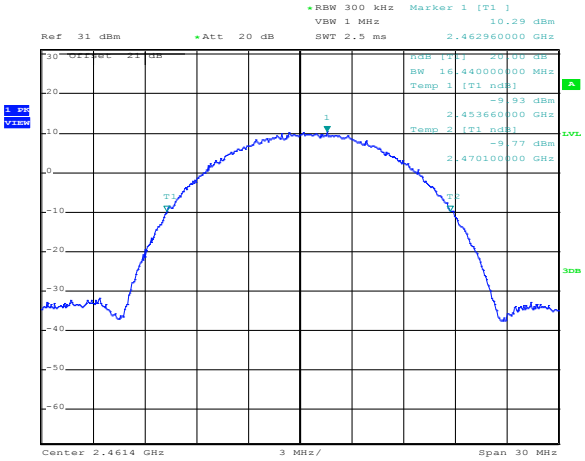


Figure 8.2-10: *20 dB bandwidth on 802.11b, sample plot – CCK: 11 Mbps*

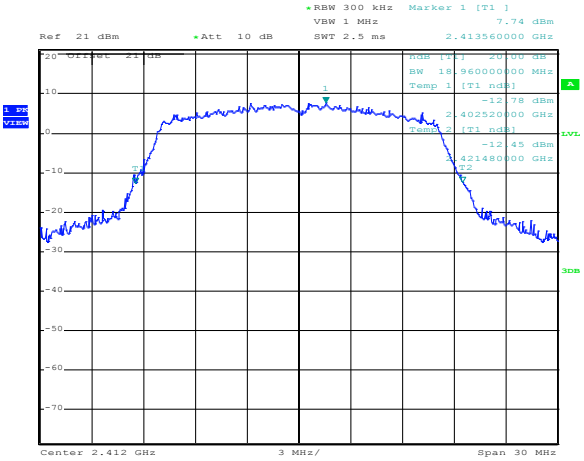


Figure 8.2-11: *20 dB bandwidth on 802.11g, sample plot – OFDM: BPSK_1/2_6Mbps*

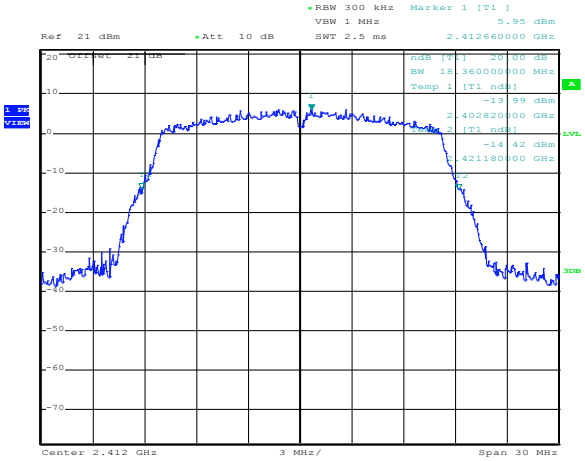


Figure 8.2-12: *20 dB bandwidth on 802.11g, sample plot – OFDM: QAM 64_3/4_54Mbps*

8.2.5 Test data, continued

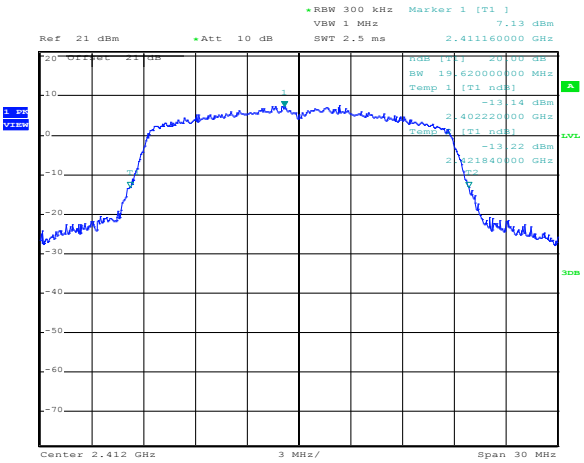


Figure 8.2-13: *20 dB bandwidth on 802.11n HT20, sample plot – OFDM: BPSK_1/2_6.5Mbps*

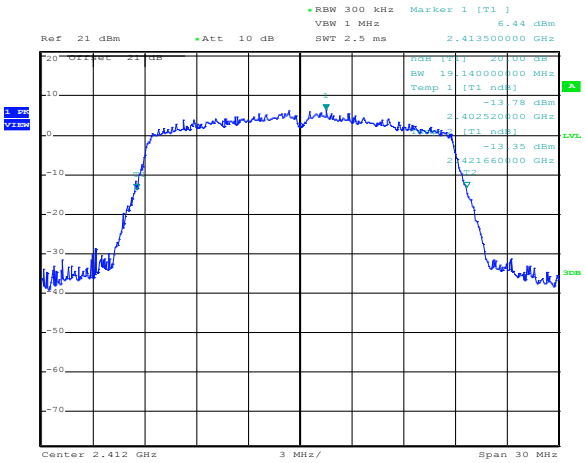


Figure 8.2-14: *20 dB bandwidth on 802.11n HT20, sample plot – QAM 64_3/4_65Mbps*

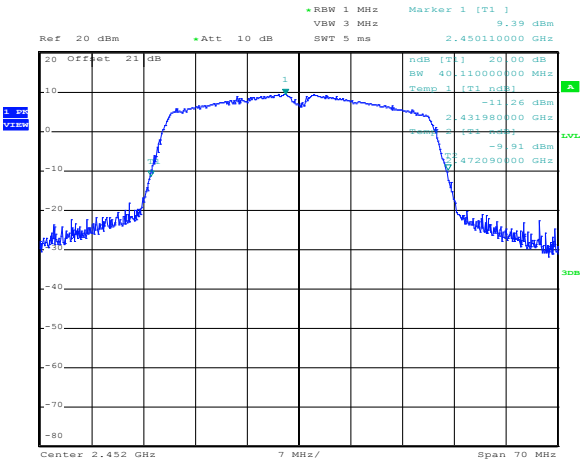


Figure 8.2-15: *20 dB bandwidth on 802.11n HT40, sample plot – OFDM: BPSK_1/2_6.5Mbps*

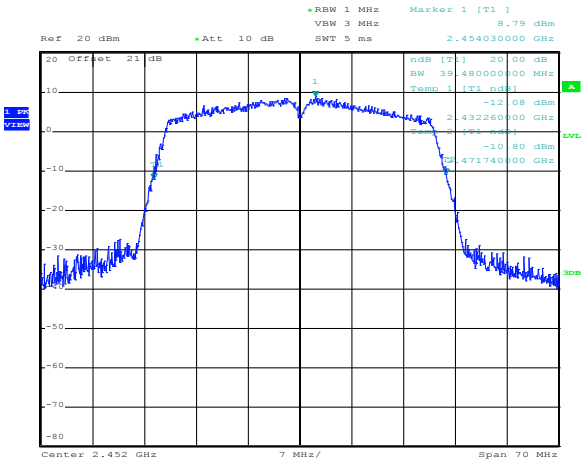


Figure 8.2-16: *20 dB bandwidth on 802.11n HT40, sample plot – OFDM: QAM 64_3/4_65Mbps*

8.2.5 Test data, continued

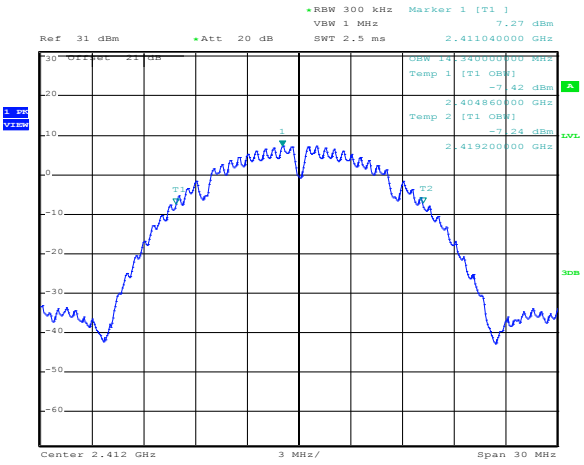


Figure 8.2-17: *99% bandwidth on 802.11b, sample plot – CCK: 1 Mbps*

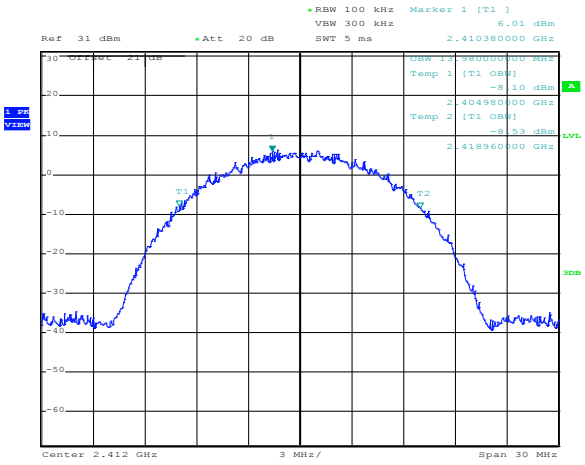


Figure 8.2-18: *99% bandwidth on 802.11b, sample plot – CCK: 11 Mbps*

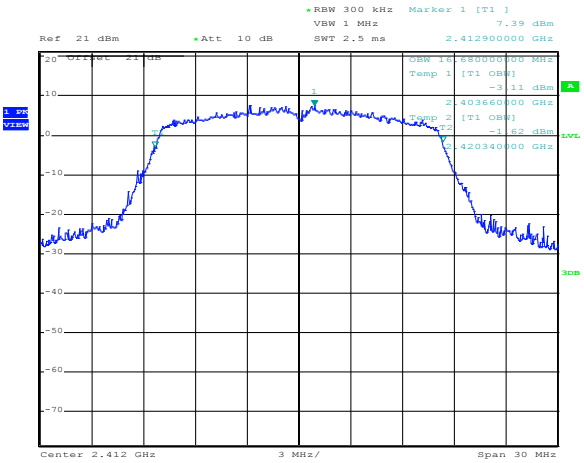


Figure 8.2-19: *99% bandwidth on 802.11g, sample plot – OFDM: BPSK_1/2_6Mbps*

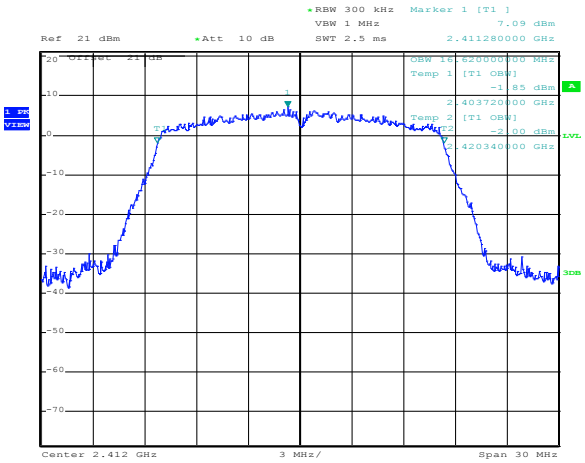


Figure 8.2-20: *99% bandwidth on 802.11g, sample plot – OFDM: QAM 64_3/4_54Mbps*

8.2.5 Test data, continued

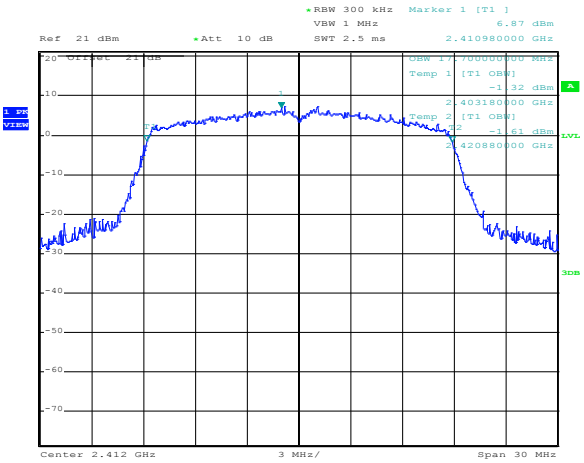


Figure 8.2-21: *99% bandwidth on 802.11n HT20, sample plot – OFDM: BPSK_1/2_6.5Mbps*

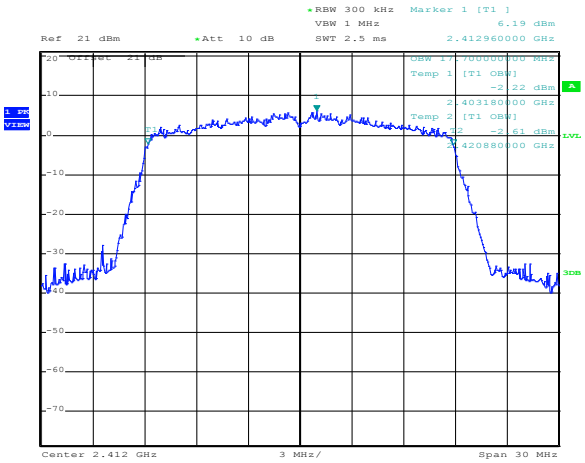


Figure 8.2-22: *99% bandwidth on 802.11n HT20, sample plot – QAM 64_3/4_65Mbps*

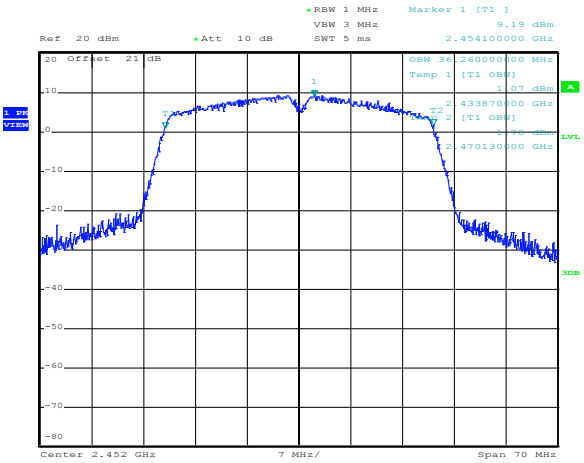


Figure 8.2-23: *99% bandwidth on 802.11n HT40, sample plot – OFDM: BPSK_1/2_6.5Mbps*

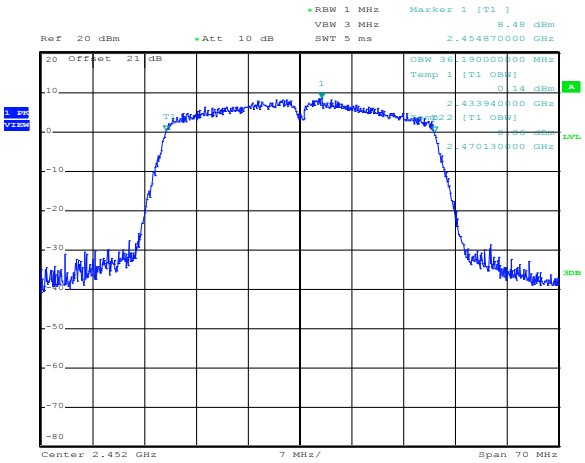


Figure 8.2-24: *99% bandwidth on 802.11n HT40, sample plot – OFDM: QAM 64_3/4_65Mbps*

8.3 FCC 15.247(b) and RSS-247 5.4 (4) Transmitter output power and e.i.r.p. requirements

8.3.1 Definitions and limits

FCC §15.247 (b)(3,4):

(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 W (30 dBm). 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.

RSS-247, Clause 5.4 (4):

For DTSs employing digital modulation techniques operating in the bands 902–928 MHz and 2400–2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(5), the e.i.r.p. shall not exceed 4 W.
Fixed point-to-point systems in the bands 2400-2483.5 MHz and 5725-5850 MHz are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W.

8.3.2 Test summary

Verdict	Pass				
Test date	May 27, 2016	Test engineer	David Duchesne		
Temperature	21.6 °C	Relative humidity	50.9 %	Air pressure	1003 mbar

8.3.3 Notes

– Measurements were performed as per 558074 D01 DTS Meas Guidance v03r05 (The test was performed using method described in Section 9.2.2.1. Measurement using a spectrum analyzer (SA) Method AVGSA-1 averaging with the EUT transmitting at full power throughout each sweep. The measurements were performed at the Wi-Fi module antenna port.

8.3.4 Setup details

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	≥3 × RBW
Frequency span	– 30 MHz (802.11b, 802.11g and 802.11n HT20) – 70 MHz (802.11n HT40)
Detector mode	RMS
Trace mode	Power Average
Averaging sweeps number	100
Sweep points	4001

8.3.5 Test data

Table 8.3-1: *Output power and EIRP results*

Modulation	Power Setting	Frequency, MHz	Modulation coding scheme	Conducted output power, dBm	Conducted output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
802.11b	30	2412	CCK: 1 Mbps	14.05	30.00	15.95	0.50	14.55	36.00	21.45
			CCK: 11 Mbps	15.27	30.00	14.73	0.50	15.77	36.00	20.23
	40	2437	CCK: 1 Mbps	20.21	30.00	9.79	0.50	20.71	36.00	15.29
			CCK: 11 Mbps	20.62	30.00	9.38	0.50	21.12	36.00	14.88
	30	2462	CCK: 1 Mbps	15.17	30.00	14.83	0.50	15.67	36.00	20.33
			CCK: 11 Mbps	14.87	30.00	15.13	0.50	15.37	36.00	20.63
802.11g	30	2412	CCK: 11 Mbps	14.87	30.00	15.13	0.50	15.37	36.00	20.63
			OFDM: BPSK_1/2_6Mbps	14.35	30.00	15.65	0.50	14.85	36.00	21.15
	40	2437	OFDM: QAM 64_3/4_54Mbps	19.42	30.00	10.58	0.50	19.92	36.00	16.08
			OFDM: BPSK_1/2_6Mbps	17.68	30.00	12.32	0.50	18.18	36.00	17.82
	30	2462	OFDM: QAM 64_3/4_54Mbps	15.03	30.00	14.97	0.50	15.53	36.00	20.47
			OFDM: BPSK_1/2_6Mbps	14.12	30.00	15.88	0.50	14.62	36.00	21.38
802.11n HT20	30	2412	OFDM: QAM 64_3/4_54Mbps	12.32	30.00	17.68	0.50	12.82	36.00	23.18
			OFDM: BPSK_1/2_6.5Mbps	13.21	30.00	16.79	0.50	13.71	36.00	22.29
	40	2437	OFDM: QAM 64_3/4_65Mbps	19.33	30.00	10.67	0.50	19.83	36.00	16.17
			OFDM: BPSK_1/2_6.5Mbps	17.55	30.00	12.45	0.50	18.05	36.00	17.95
	30	2462	OFDM: QAM 64_3/4_65Mbps	12.20	30.00	17.80	0.50	12.70	36.00	23.30
			OFDM: BPSK_1/2_6.5Mbps	13.95	30.00	16.05	0.50	14.45	36.00	21.55
802.11n HT40	30	2422	OFDM: QAM 64_3/4_65Mbps	12.19	30.00	17.81	0.50	12.69	36.00	23.31
			OFDM: BPSK_1/2_6.5Mbps	16.44	30.00	13.56	0.50	16.94	36.00	19.06
	40	2437	OFDM: QAM 64_3/4_65Mbps	20.95	30.00	9.05	0.50	21.45	36.00	14.55
			OFDM: BPSK_1/2_6.5Mbps	19.46	30.00	10.54	0.50	19.96	36.00	16.04
	23	2452	OFDM: QAM 64_3/4_65Mbps	13.53	30.00	16.47	0.50	14.03	36.00	21.97
			OFDM: BPSK_1/2_6.5Mbps	11.83	30.00	18.17	0.50	12.33	36.00	23.67

Notes: EIRP = Output power + Antenna gain

8.3.5 Test data, continued

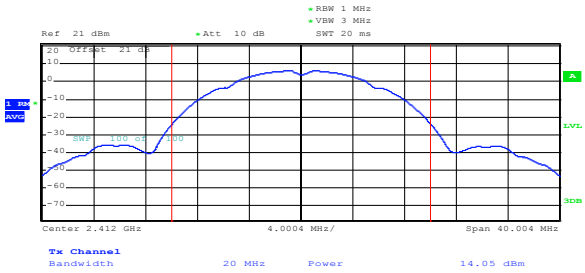


Figure 8.3-1: *Conducted output power on 802.11b, sample plot – CCK: 1 Mbps*

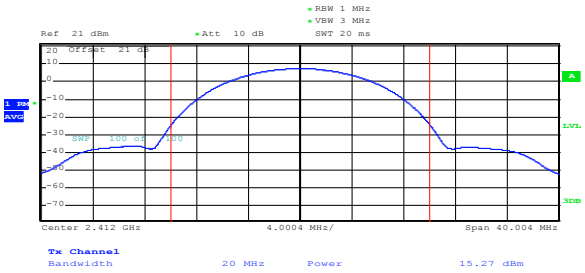


Figure 8.3-2: *Conducted output power on 802.11b, sample plot – CCK: 11 Mbps*

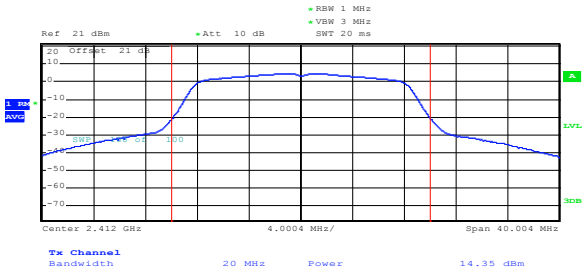


Figure 8.3-3: *Conducted output power on 802.11g, sample plot – OFDM: BPSK_1/2_6Mbps*

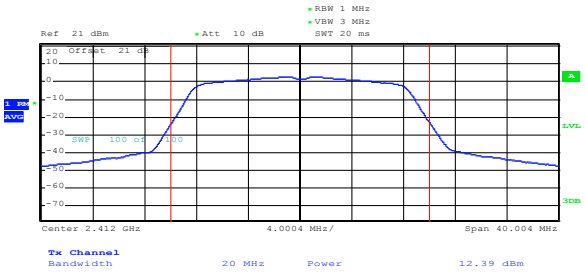


Figure 8.3-4: *Conducted output power on 802.11g, sample plot – OFDM: QAM 64_3/4_54Mbps*

8.3.5 Test data, continued

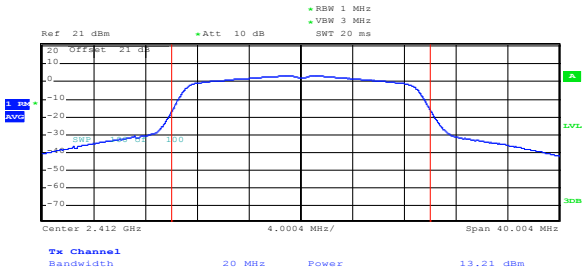


Figure 8.3-5: *Conducted output power on 802.11n HT20, sample plot – OFDM: BPSK_1/2_6.5Mbps*

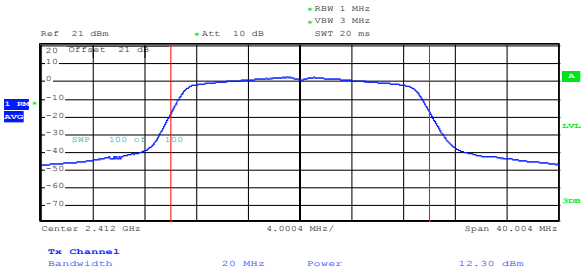


Figure 8.3-6: *Conducted output power on 802.11n HT20, sample plot – QAM 64_3/4_65Mbps*

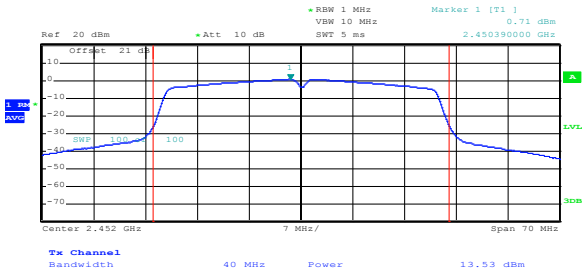


Figure 8.3-7: *Conducted output power on 802.11n HT40, sample plot – OFDM: BPSK_1/2_6.5Mbps*

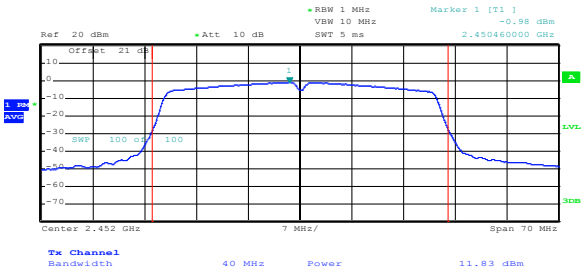


Figure 8.3-8: *Conducted output power on 802.11n HT40, sample plot – OFDM: QAM 64_3/4_65Mbps*

8.4 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions

8.4.1 Definitions and limits

FCC §15.247 (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)).

RSS-247, Clause 5.5:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

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

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

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

Table 8.4-2: *IC restricted frequency bands*

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

Notes: Certain frequency bands listed in this 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

Table 8.4-3: *FCC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.4.2 Test summary

Verdict	Pass				
Test date	June 7, 2016	Test engineer	David Duchesne		
Temperature	21 °C	Relative humidity	55 %	Air pressure	1010 mbar

8.4.3 Notes

- Measurements were performed as per 558074 D01 DTS Meas Guidance v03r05
- The spectrum was searched from 30 MHz to the 10th harmonic.
- EUT was set to transmit with 100 % duty cycle.
- Power was measured using average method as detailed in section 9.2.2.1 of 558074 D01 DTS Meas Guidance v03r05. The spurious emissions limit of −30 dBc/100 kHz was used to determine compliance.
- For radiated spurious emissions at the upper band edge method as detailed in section 13.3.2 of 558074 D01 DTS Meas Guidance v03r05 was used to determine compliance

8.4.4 Setup details

Spectrum analyser settings for conducted measurements:

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

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

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

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

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

Spectrum analyser settings for average radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	10 Hz
Detector mode:	Peak
Trace mode:	Max Hold

8.4.5 Test data

Conducted spurious emissions within non-restricted bands, test results

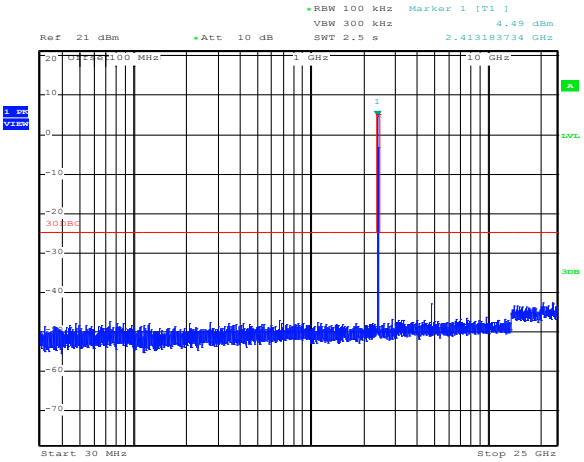


Figure 8.4-1: *Conducted spurious emissions for 802.11b (TX 2412 MHz)*

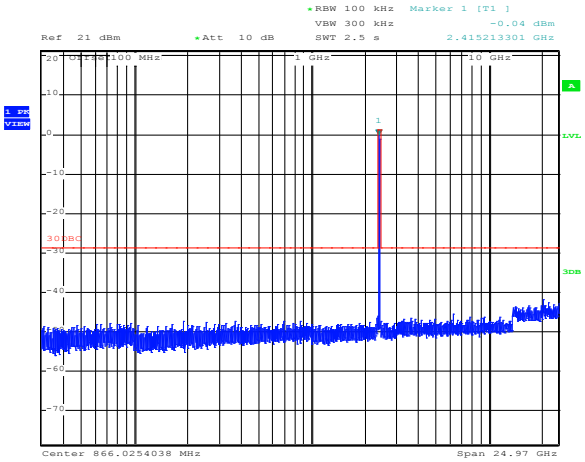


Figure 8.4-2: *Conducted spurious emissions for 802.11g (TX 2412 MHz)*

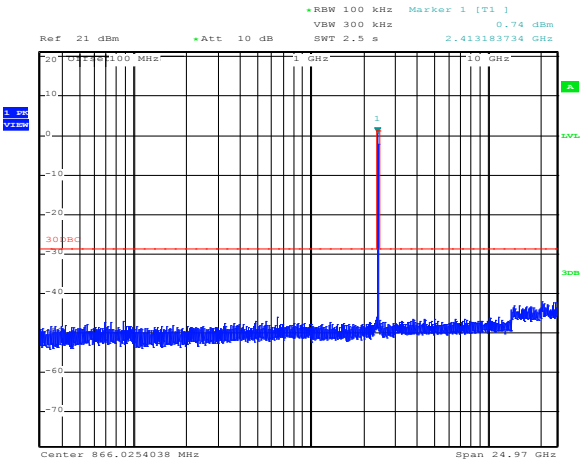


Figure 8.4-3: *Conducted spurious emissions for 802.11n HT20 (TX 2412 MHz)*

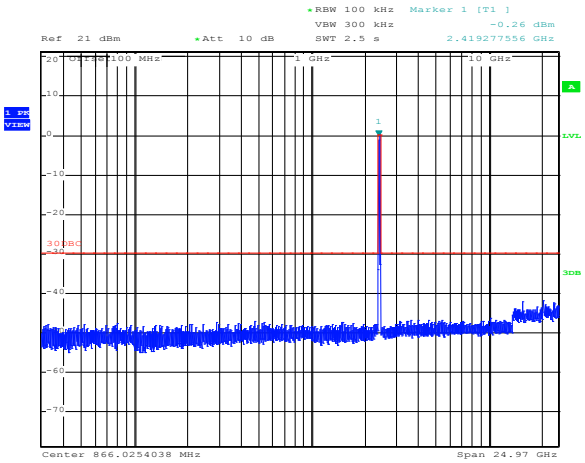


Figure 8.4-4: *Conducted spurious emissions for 802.11n HT40 (TX 2422 MHz)*

8.4.6 Test data, continued

Conducted spurious emissions within non-restricted bands, test results continued

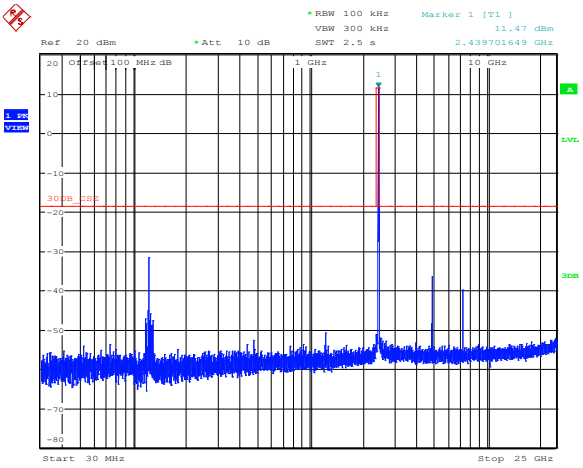


Figure 8.4-5: *Conducted spurious emissions for 802.11b (TX 2437 MHz)*

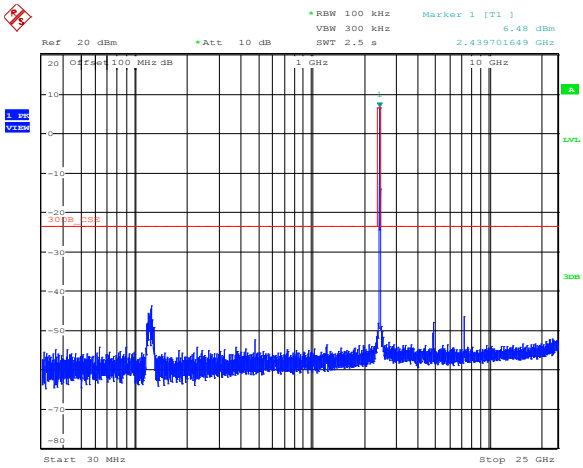


Figure 8.4-6: *Conducted spurious emissions for 802.11g (TX 2437 MHz)*

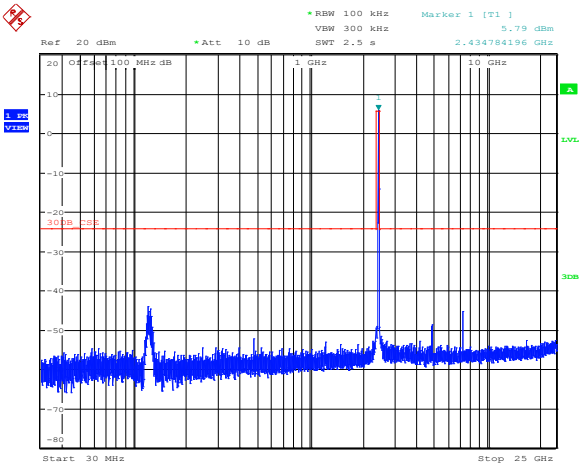


Figure 8.4-7: *Conducted spurious emissions for 802.11n HT20 (TX 2437 MHz)*

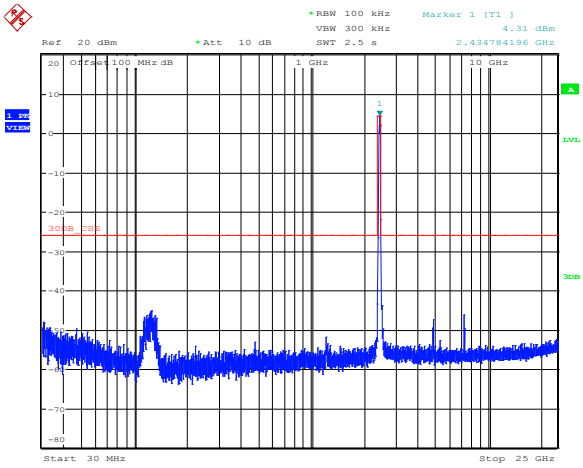


Figure 8.4-8: *Conducted spurious emissions for 802.11n HT40 (TX 2437 MHz)*

8.4.5 Test data, continued

Conducted spurious emissions within non-restricted bands, test results continued

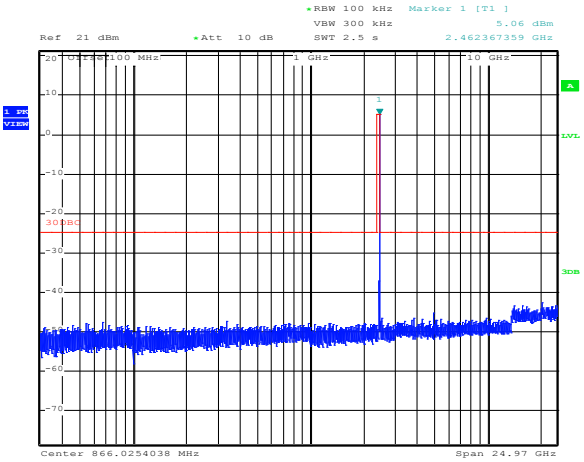


Figure 8.4-9: *Conducted spurious emissions for 802.11b (TX 2462 MHz)*

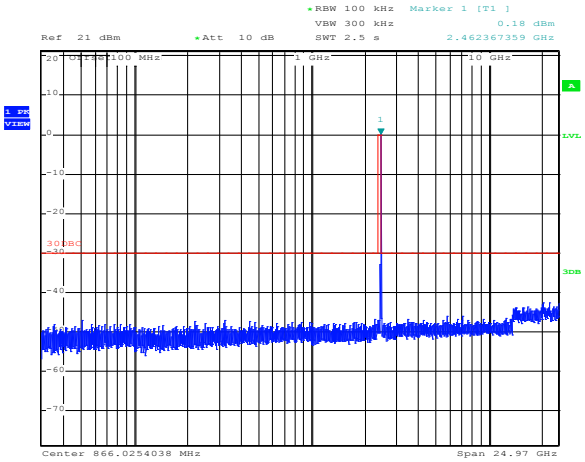


Figure 8.4-10: *Conducted spurious emissions for 802.11g (TX 2462 MHz)*

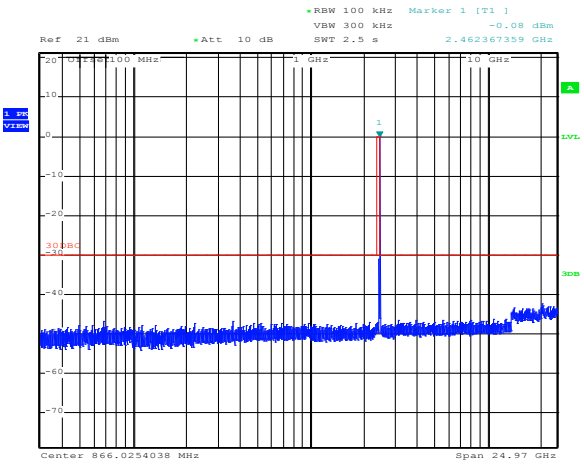


Figure 8.4-11: *Conducted spurious emissions for 802.11n HT20 (TX 2462 MHz)*

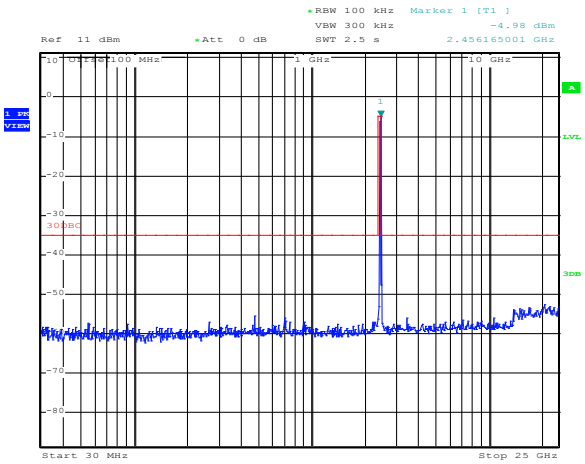


Figure 8.4-12: *Conducted spurious emissions for 802.11n HT40 (TX 2452 MHz)*

8.4.5 Test data, continued

Conducted spurious emissions within non-restricted bands test results, continued

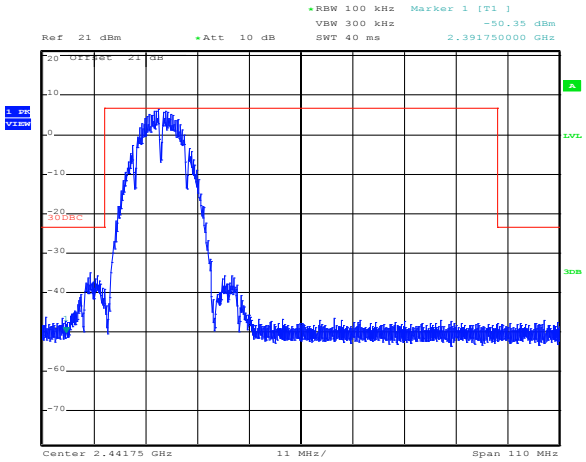


Figure 8.4-13: *Conducted spurious emissions Lower band edge for 802.11b, (TX 2412 MHz)*

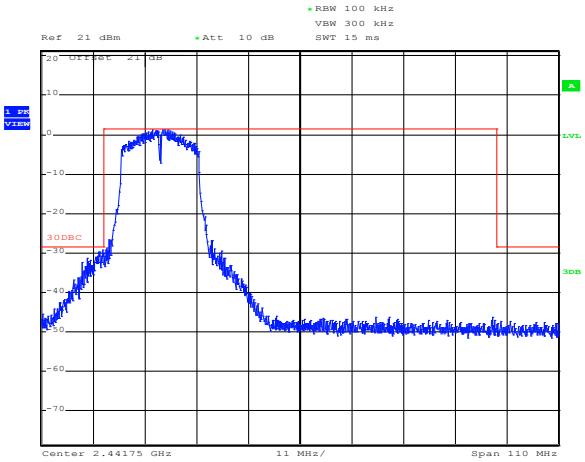


Figure 8.4-14: *Conducted spurious emissions Lower band edge for 802.11g, (TX 2412 MHz)*

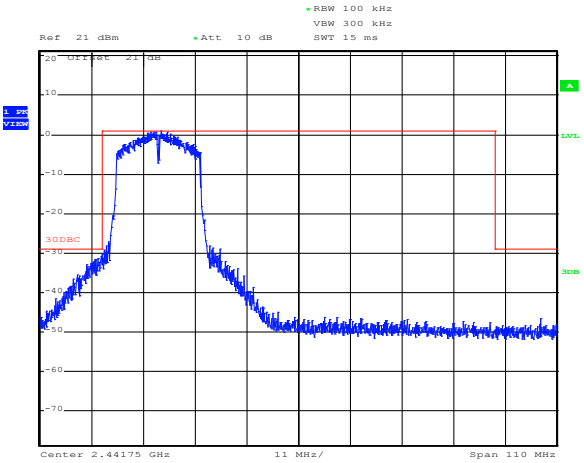


Figure 8.4-15: *Conducted spurious emissions Lower band edge for 802.11n HT20, (TX 2412 MHz)*

8.4.5 Test data, continued

Conducted spurious emissions within non-restricted bands test results, continued

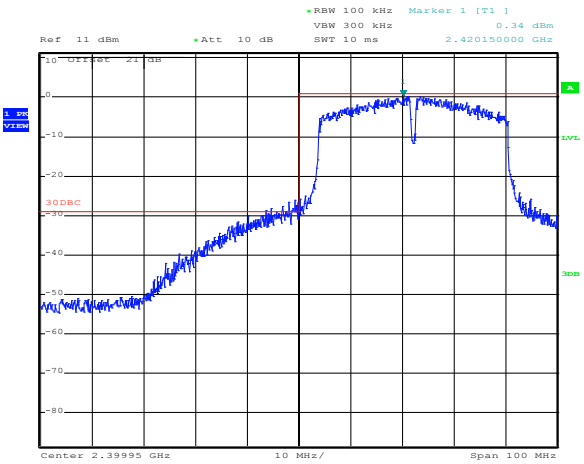


Figure 8.4-16: *Conducted spurious emissions Lower band edge for 802.11n HT40, (TX 2412 MHz)*

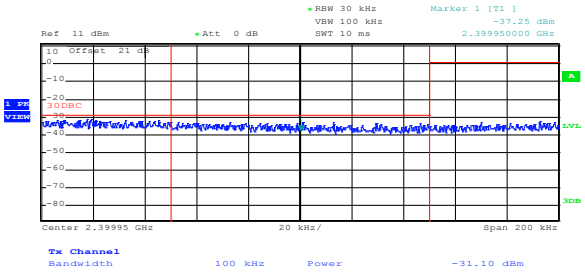


Figure 8.4-17: *Conducted spurious emissions Lower band edge for 802.11n HT40, (TX 2412 MHz)*

Notes: *Maker peak = 0.34 dBm (See Figure 8.4-16)*
Band edge maker = -31.10 dBm (See Figure 8.4-17)
Delta = 30.34 dB = 0.34 – (- 31.10)

8.4.5 Test data, continued

Conducted spurious emissions within non-restricted bands test results, continued

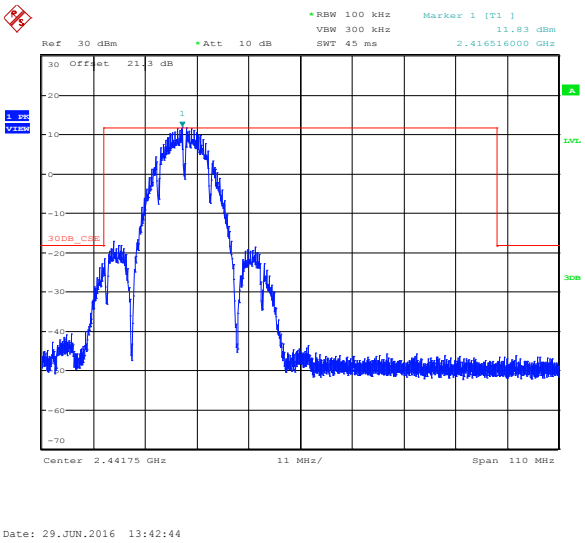


Figure 8.4-18: *Conducted spurious emissions Lower band edge for 802.11b, (TX 2417 MHz)*

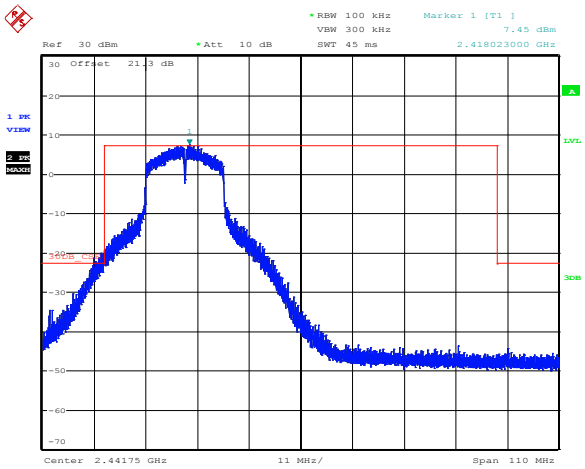


Figure 8.4-19: *Conducted spurious emissions Lower band edge for 802.11g, (TX 2417 MHz)*

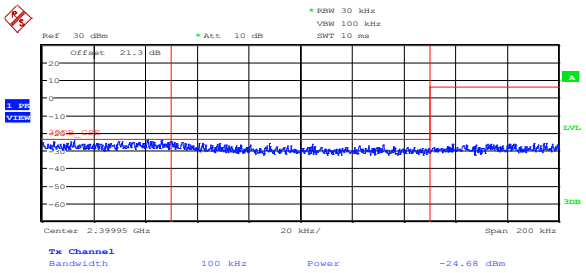


Figure 8.4-20: *Conducted spurious emissions Lower band edge for 802.11g, (TX 2417 MHz)*

Notes: *Maker peak = 7.45 dBm (See Figure 8.4-19)*
Band edge maker = -24.68 dBm (See Figure 8.4-20)
Delta = 32.13 dB = 7.45 – (- 24.68)

8.4.6 Test data, continued

Conducted spurious emissions within non-restricted bands test results, continued

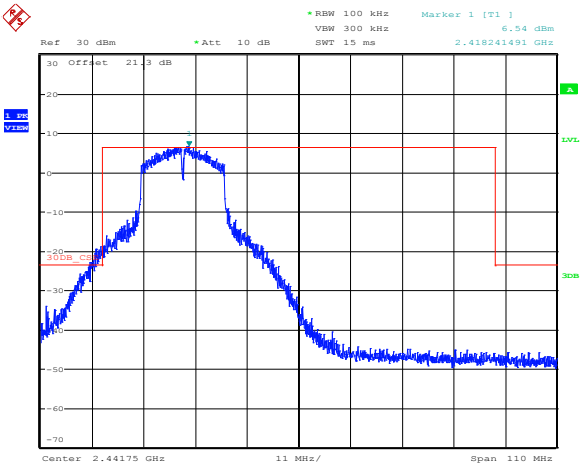


Figure 8.4-21: *Conducted spurious emissions Lower band edge for 802.11n HT20, (TX 2417 MHz)*

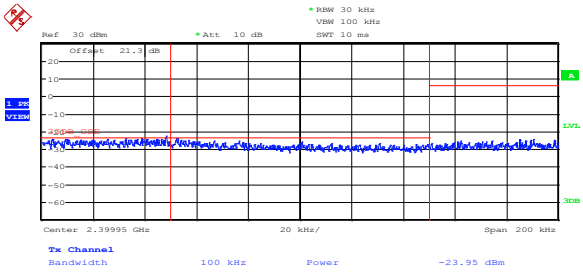


Figure 8.4-22: *Conducted spurious emissions Lower band edge for 802.11n HT20, (TX 2417 MHz)*

Notes: *Maker peak = 6.54 dBm (See Figure 8.4-21)*
Band edge maker = -23.95 dBm (See Figure 8.4-22)
Delta = 30.49 dB = 6.54– (- 23.95)

8.4.5 Test data, continued

Conducted spurious emissions within non-restricted bands test results, continued

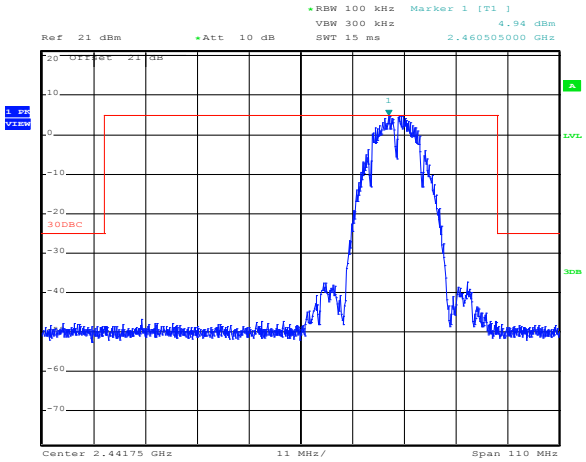


Figure 8.4-23: *Conducted spurious emissions Upper band edge for 802.11b, (TX 2462 MHz)*

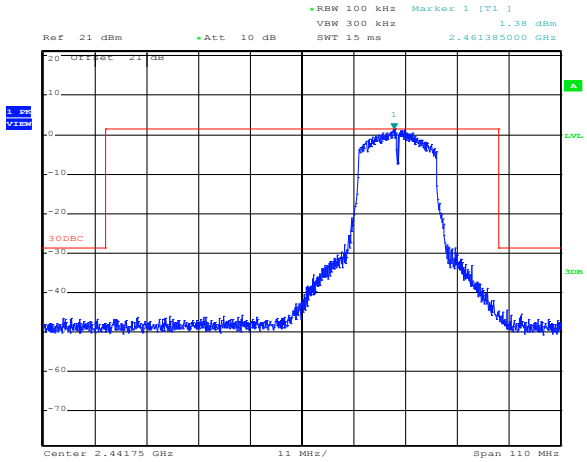


Figure 8.4-24: *Conducted spurious emissions Upper band edge for 802.11g, (TX 2462 MHz)*

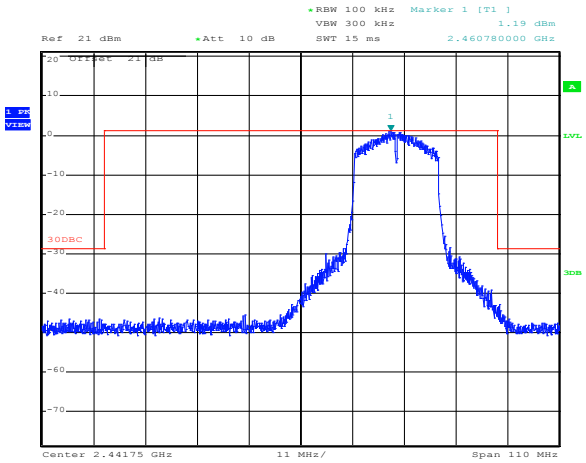


Figure 8.4-25: *Conducted spurious emissions Upper band edge for 802.11n HT20, (TX 2462 MHz)*

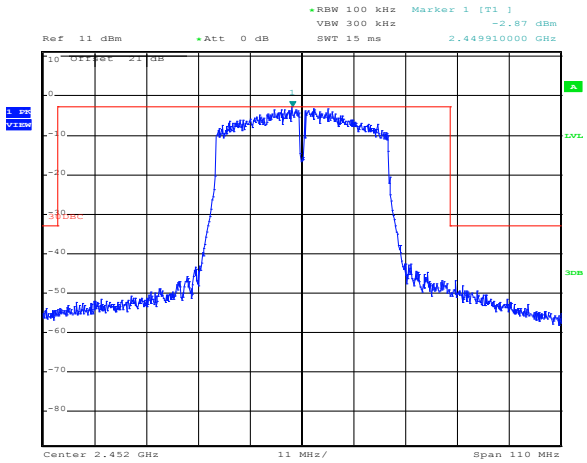


Figure 8.4-26: *Conducted spurious emissions Upper band edge for 802.11n HT40, (TX 2462 MHz)*

8.4.5 Test data, continued

Conducted spurious emissions within non-restricted bands test results, continued

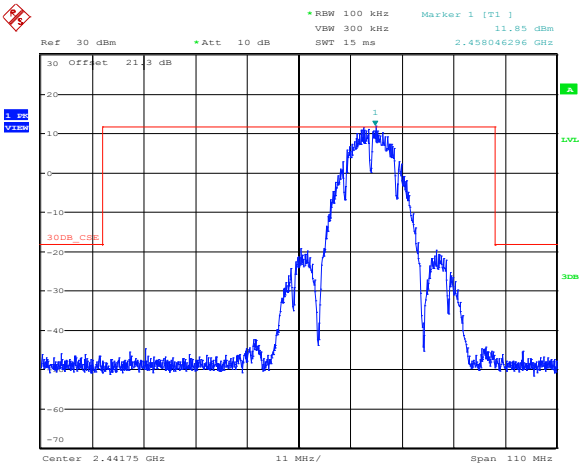


Figure 8.4-27: *Conducted spurious emissions Upper band edge for 802.11b, (TX 2457 MHz)*

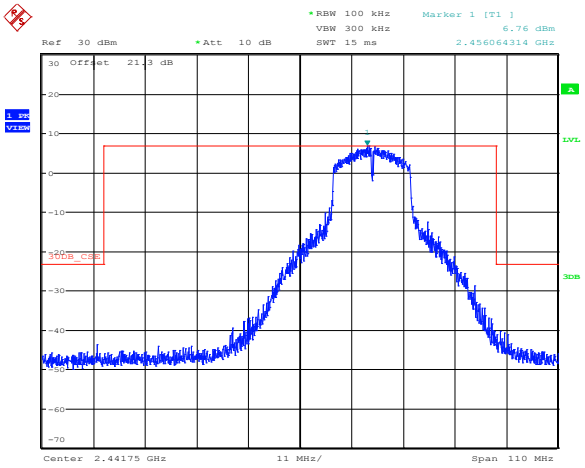


Figure 8.4-28: *Conducted spurious emissions Upper band edge for 802.11g, (TX 2457 MHz)*

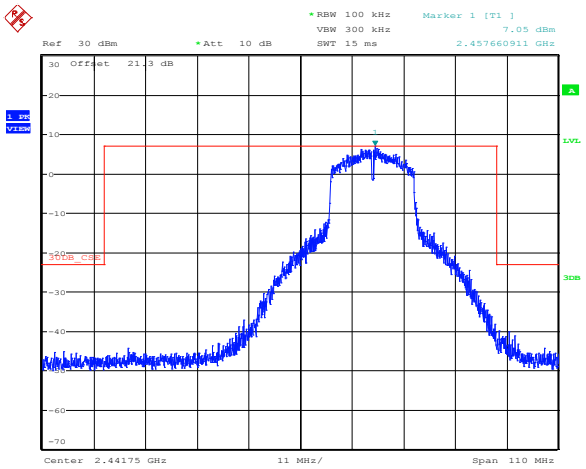


Figure 8.4-29: *Conducted spurious emissions Upper band edge for 802.11n HT20, (TX 2457 MHz)*

8.4.5 Test data, continued

Radiated spurious emissions within restricted bands, test results

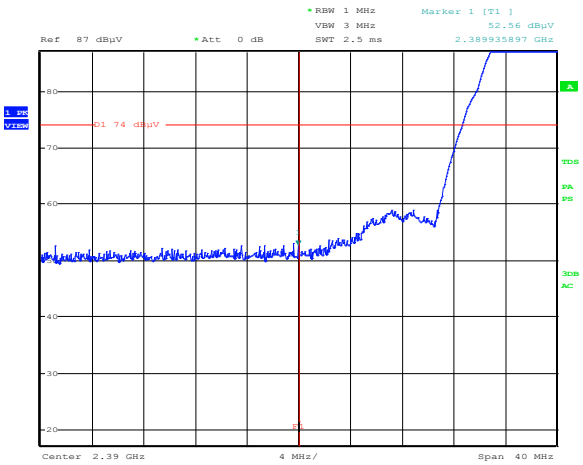


Figure 8.4-30: *Radiated spurious emissions Lower band edge for 802.11b, (TX 2412 MHz Low) – Peak*

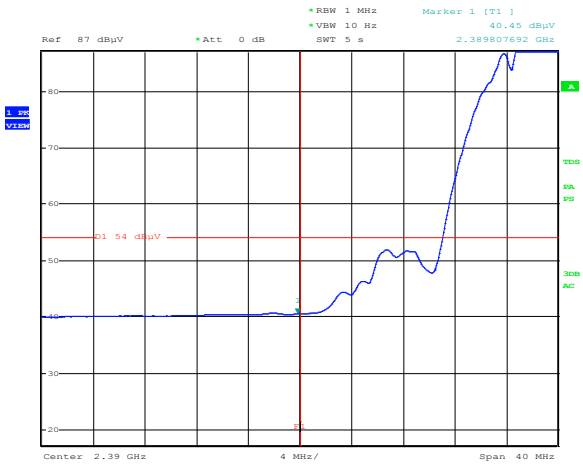


Figure 8.4-31: *Radiated spurious emissions Lower band edge for 802.11b, (TX 2412 MHz) – Average*

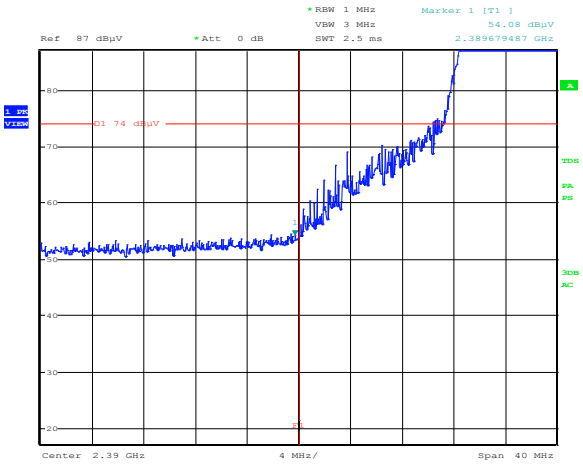


Figure 8.4-32: *Radiated spurious emissions Lower band edge for 802.11g, (TX 2412 MHz) – Peak*

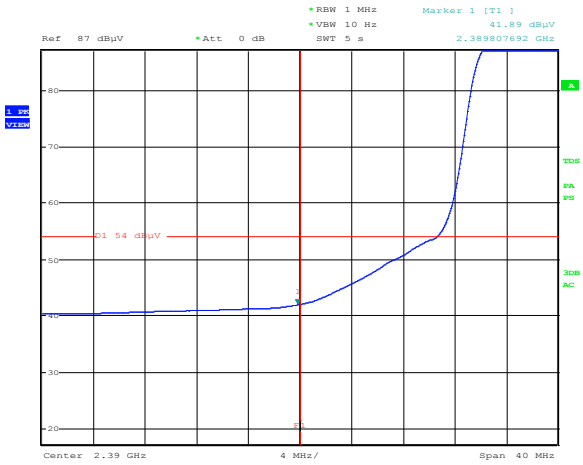


Figure 8.4-33: *Radiated spurious emissions Lower band edge for 802.11g, (TX 2412 MHz) – Average*

8.4.5 Test data, continued

Radiated spurious emissions within restricted bands, test results

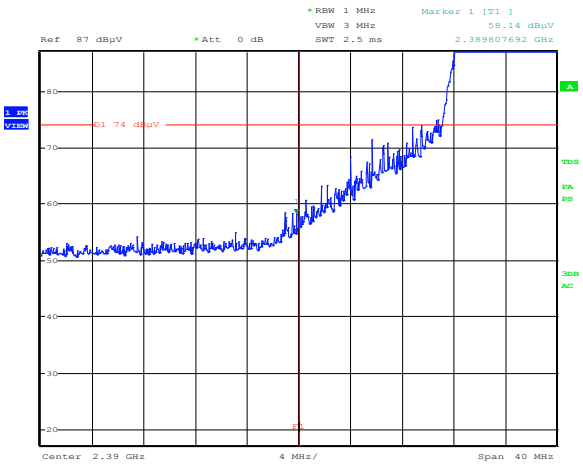


Figure 8.4-34: *Radiated spurious emissions Lower band edge for 802.11n HT20, (TX 2412 MHz) – Peak*

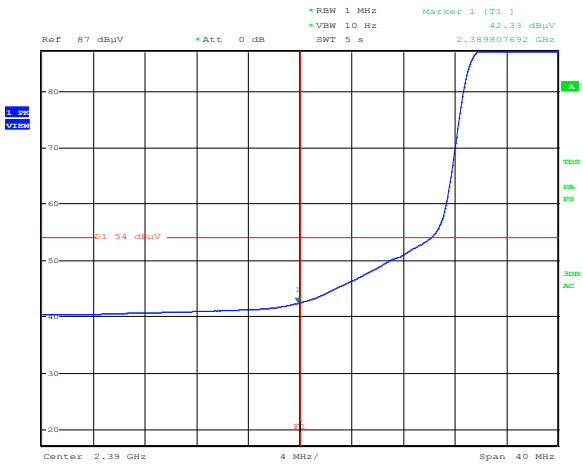


Figure 8.4-35: *Radiated spurious emissions Lower band edge for 802.11n HT20, (TX 2412 MHz) – Average*

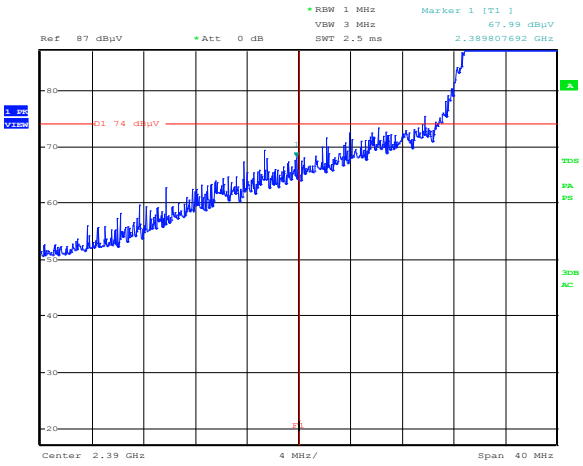


Figure 8.4-36: *Radiated spurious emissions Lower band edge for 802.11n HT40, (TX 2422 MHz) – Peak*

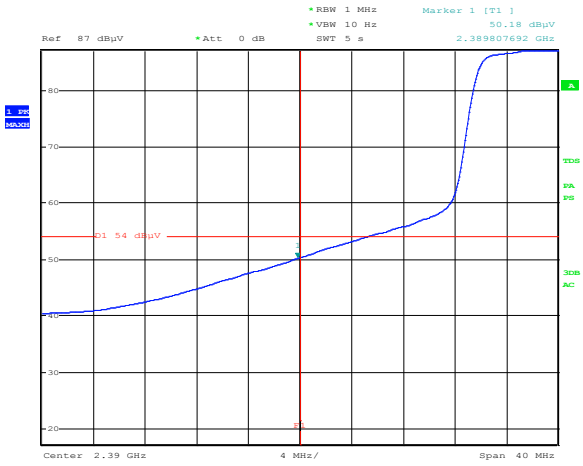


Figure 8.4-37: *Radiated spurious emissions Lower band edge for 802.11n HT40, (TX 2422 MHz) – Average*

8.4.5 Test data, continued

Radiated spurious emissions within restricted bands, test results

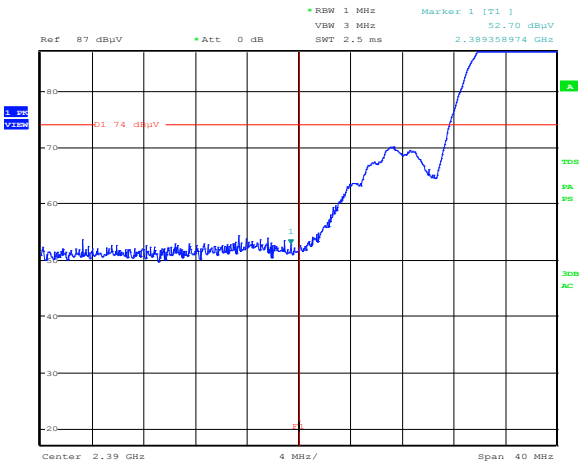


Figure 8.4-38: *Radiated spurious emissions Lower band edge for 802.11b, (TX 2417 MHz Low) – Peak*

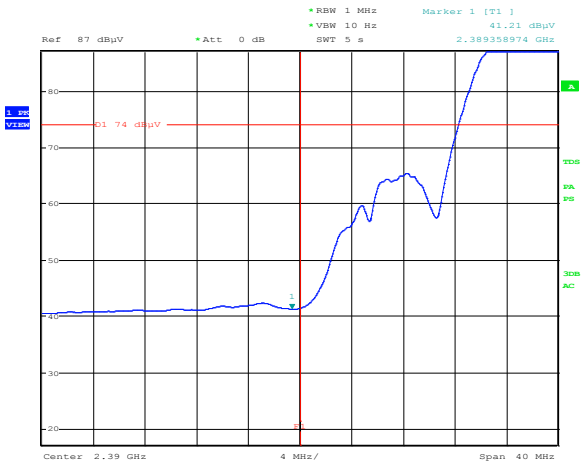


Figure 8.4-39: *Radiated spurious emissions Lower band edge for 802.11b, (TX 2417 MHz) – Average*

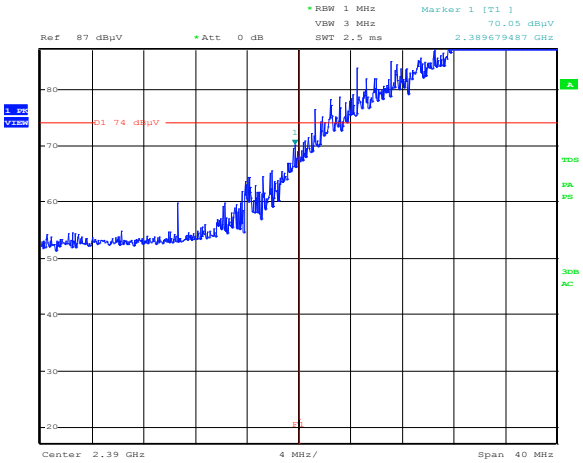


Figure 8.4-40: *Radiated spurious emissions Lower band edge for 802.11g, (TX 2417 MHz) – Peak*

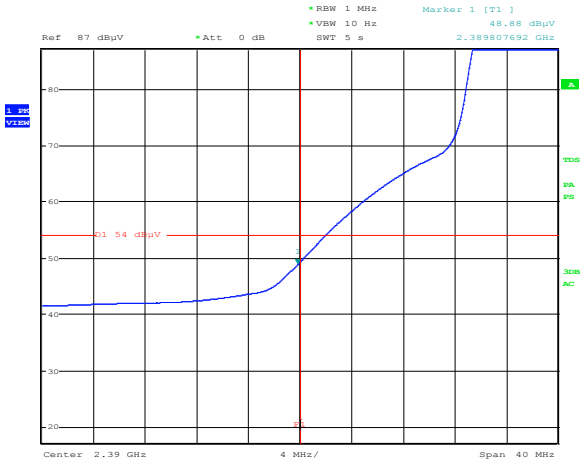


Figure 8.4-41: *Radiated spurious emissions Lower band edge for 802.11g, (TX 2417 MHz) – Average*

8.4.5 Test data, continued

Radiated spurious emissions within restricted bands, test results

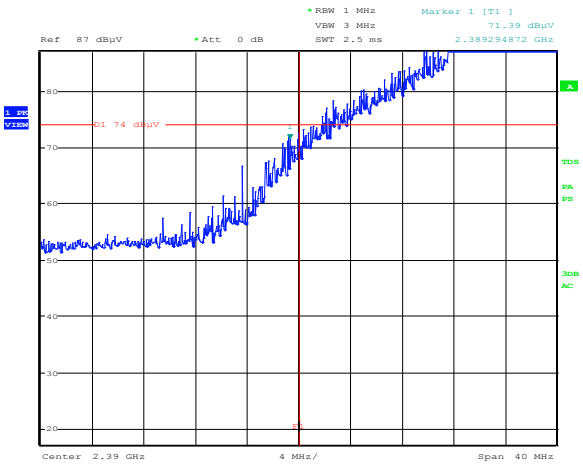


Figure 8.4-42: *Radiated spurious emissions Lower band edge for 802.11n HT20, (TX 2417 MHz) – Peak*

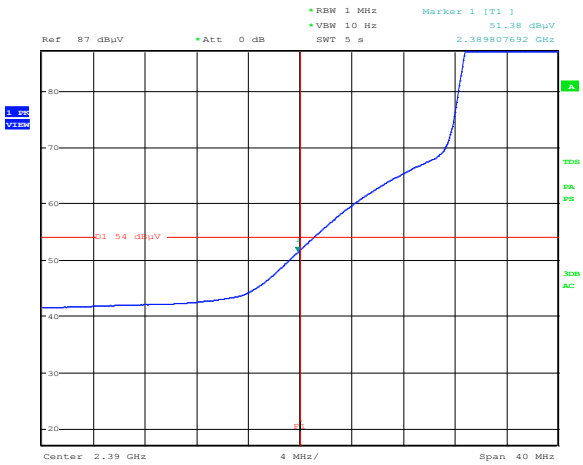


Figure 8.4-43: *Radiated spurious emissions Lower band edge for 802.11n HT20, (TX 2417 MHz) – Average*

8.4.5 Test data, continued

Radiated spurious emissions within restricted bands, test results

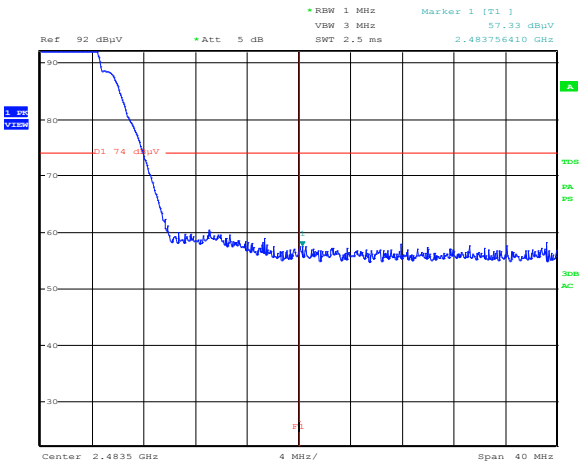


Figure 8.4-44: *Radiated spurious emissions Upper band edge for 802.11b, (TX 2462 MHz) – Peak*

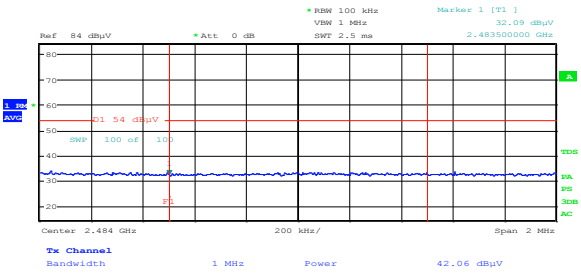


Figure 8.4-45: *Radiated spurious emissions Upper band edge for 802.11b, (TX 2462 MHz) – Average*

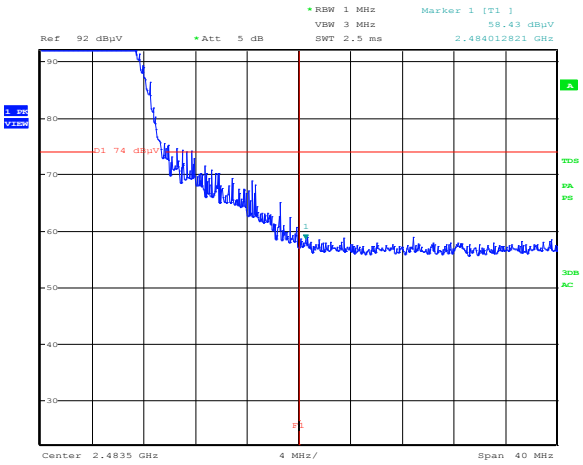


Figure 8.4-46: *Radiated spurious emissions Upper band edge for 802.11g, (TX 2462 MHz) – Peak*

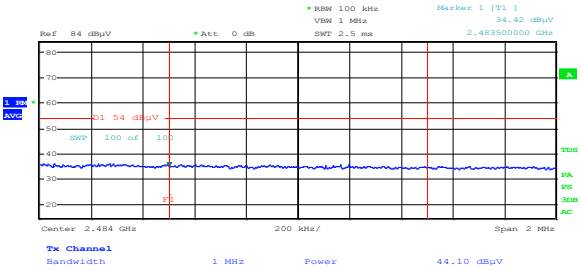


Figure 8.4-47: *Radiated spurious emissions Upper band edge for 802.11g, (TX 2462 MHz) – Average*

8.4.5 Test data, continued

Radiated spurious emissions within restricted bands, test results

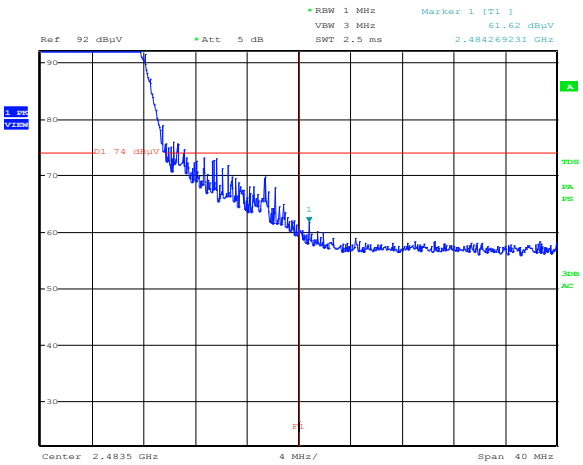


Figure 8.4-48: *Radiated spurious emissions Upper band edge for 802.11n HT20, (TX 2462 MHz) – Peak*

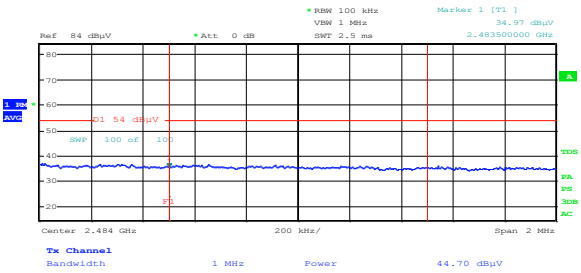


Figure 8.4-49: *Radiated spurious emissions Upper band edge for 802.11n HT20, (TX 2462 MHz) – Average*

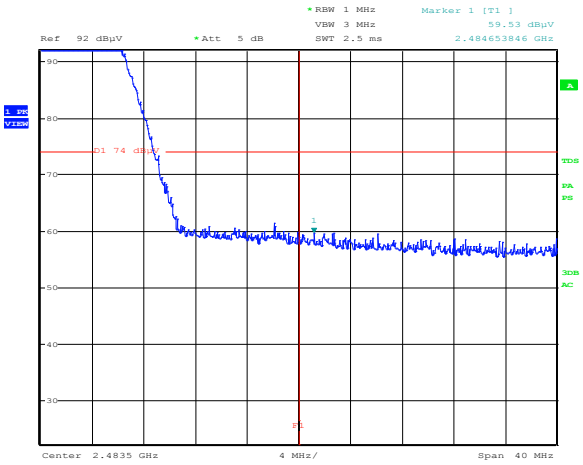


Figure 8.4-50: *Radiated spurious emissions Upper band edge for 802.11n HT40, (TX 2452 MHz) – Peak*

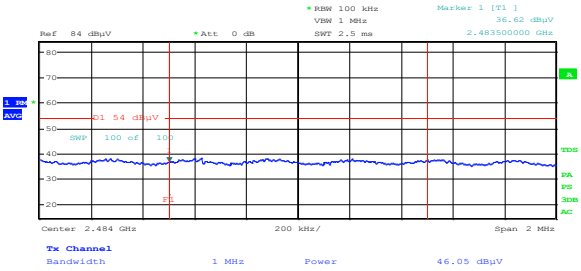


Figure 8.4-51: *Radiated spurious emissions Upper band edge for 802.11n HT40, (TX 2452 MHz Low Channel) – Average*

8.4.5 Test data, continued

Radiated spurious emissions within restricted bands, test results

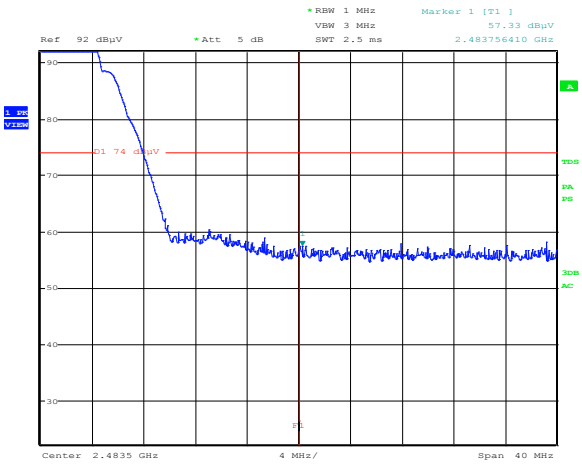


Figure 8.4-52: *Radiated spurious emissions Upper band edge for 802.11b, (TX 2457 MHz) – Peak*

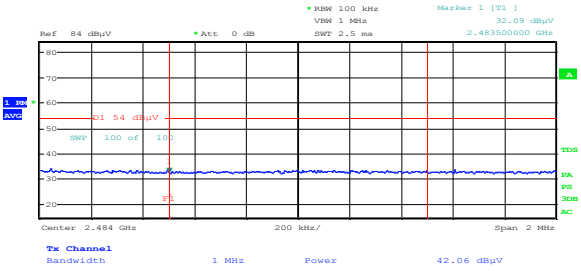


Figure 8.4-53: *Radiated spurious emissions Upper band edge for 802.11b, (TX 2457 MHz) – Average*

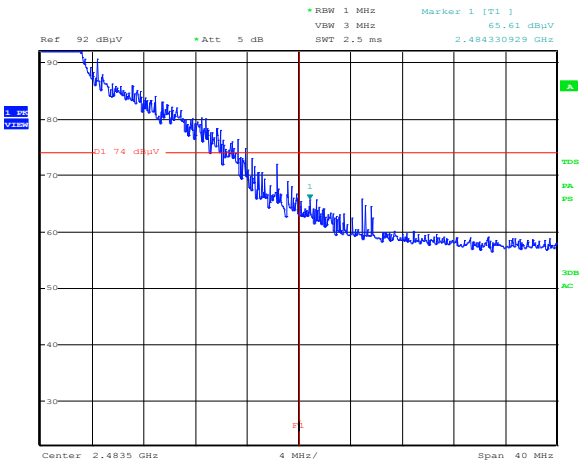


Figure 8.4-54: *Radiated spurious emissions Upper band edge for 802.11g, (TX 2457 MHz) – Peak*

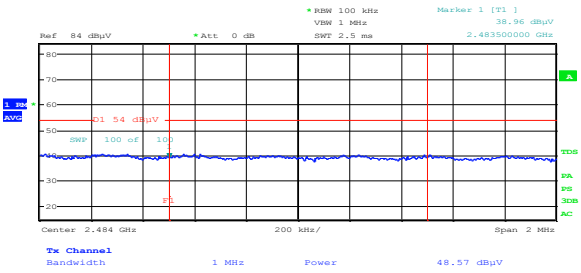


Figure 8.4-55: *Radiated spurious emissions Upper band edge for 802.11g, (TX 2457 MHz) – Average*

8.4.5 Test data, continued

Radiated spurious emissions within restricted bands, test results

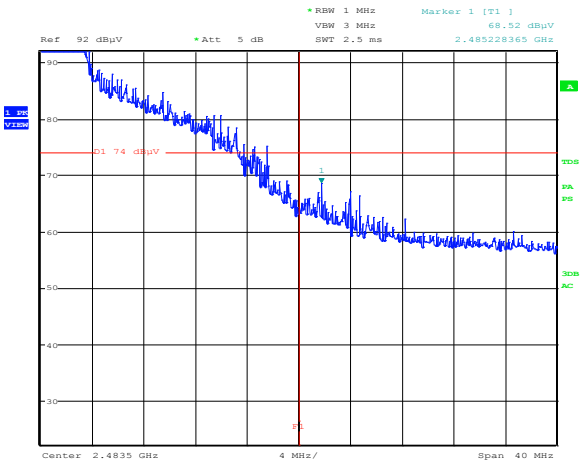


Figure 8.4-56: *Radiated spurious emissions Upper band edge for 802.11n HT20, (TX 2457 MHz) – Peak*

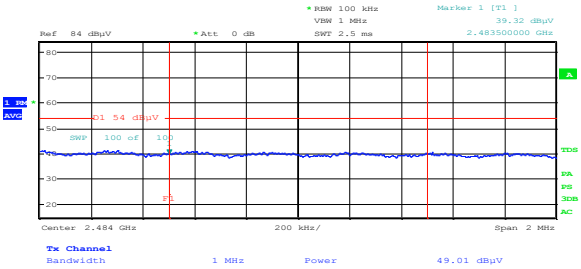


Figure 8.4-57: *Radiated spurious emissions Upper band edge for 802.11n HT20, (TX 2457 MHz) – Average*

8.4.5 Test data, continued

Spurious emissions within restricted bands, test results continued

Table 8.4-4: *Spurious emissions within restricted bands*

Modulation	Freq., MHz	Modulation coding scheme	Freq., MHz	Pol.	Peak field strength[1], dBµV/m	Peak field strength limit, dBµV/m	Peak margin, dB	Average field strength[1], dBµV/m	Average field strength limit, dBµV/m	Average margin, dB
Low band edge (Power setting 30)										
802.11b	2412	CCK: 1 Mbps	2389.91	H	52.56	74.00	21.44	40.45	54.00	13.55
802.11g	2412	OFDM: BPSK_1/2_6Mbps	2389.91	H	54.08	74.00	19.92	41.89	54.00	12.11
802.11n HT20	2412	OFDM: BPSK_1/2_6.5Mbps	2389.91	H	58.14	74.00	15.86	42.33	54.00	11.67
802.11n HT40	2422	OFDM: BPSK_1/2_6.5Mbps	2389.91	H	67.99	74.00	6.01	50.18	54.00	3.82
Low band edge (Power setting 40)										
802.11b	2417	CCK: 1 Mbps	2389.91	H	52.70	74.00	21.30	41.21	54.00	12.79
802.11g	2417	OFDM: BPSK_1/2_6Mbps	2389.91	H	70.05	74.00	3.95	48.88	54.00	5.12
802.11n HT20	2417	OFDM: BPSK_1/2_6.5Mbps	2389.91	H	71.39	74.00	2.61	51.38	54.00	2.62
High band edge (Power setting 30)										
802.11b	2462	CCK: 1 Mbps	2483.50	H	57.33	74.00	16.67	42.06	54.00	11.94
802.11g	2462	OFDM: BPSK_1/2_6Mbps	2483.50	H	58.43	74.00	15.57	44.10	54.00	9.90
802.11n HT20	2462	OFDM: BPSK_1/2_6.5Mbps	2483.50	H	61.62	74.00	12.38	44.70	54.00	9.30
High band edge (Power setting 23)										
802.11n HT40	2452	OFDM: BPSK_1/2_6.5Mbps	2483.50	H	59.53	74.00	14.47	46.05	54.00	7.95
High band edge (Power setting 40)										
802.11b	2457	CCK: 1 Mbps	2483.50	H	58.11	74.00	15.89	44.52	54.00	9.48
802.11g	2457	OFDM: BPSK_1/2_6Mbps	2483.50	H	65.61	74.00	8.39	48.57	54.00	5.43
802.11n HT20	2457	OFDM: BPSK_1/2_6.5Mbps	2483.50	H	68.52	74.00	5.48	49.01	54.00	4.99
Low channel (Power setting 30)										
802.11b	2412	CCK: 1 Mbps	4824.00	H	52.29	74.00	21.71	41.56	54.00	12.44
802.11b	2412	CCK: 1 Mbps	7236.00	H	52.75	74.00	21.25	41.61	54.00	12.39
802.11g	2412	OFDM: BPSK_1/2_6Mbps	4824.00	H	50.16	74.00	23.84	36.35	54.00	17.65
802.11n HT20	2412	OFDM: BPSK_1/2_6.5Mbps	4824.00	H	49.58	74.00	24.42	36.12	54.00	17.88
802.11n HT40	2422	OFDM: BPSK_1/2_6.5Mbps	4844.00	H	50.01	74.00	23.99	36.21	54.00	17.79
Mid Channel (Power setting 40)										
802.11b	2437	CCK: 1 Mbps	4874.00	H	52.35	74.00	21.65	41.54	54.00	12.46
802.11g	2437	OFDM: BPSK_1/2_6Mbps	4874.00	H	51.55	74.00	22.45	36.21	54.00	17.79
802.11n HT20	2437	OFDM: BPSK_1/2_6.5Mbps	4874.00	H	51.30	74.00	22.70	36.87	54.00	17.13
802.11n HT40	2437	OFDM: BPSK_1/2_6.5Mbps	4874.00	H	50.10	74.00	23.90	36.12	54.00	17.88
High Channel (Power setting 30)										
802.11b	2462	CCK: 1 Mbps	4924.00	H	51.07	74.00	22.93	40.10	54.00	13.90
802.11g	2462	OFDM: BPSK_1/2_6Mbps	4924.00	H	49.87	74.00	24.13	36.00	54.00	18.00
802.11n HT20	2462	OFDM: BPSK_1/2_6.5Mbps	4924.00	H	50.70	74.00	23.30	36.50	54.00	17.50
High Channel (Power setting 23)										
802.11n HT40	2452	OFDM: BPSK_1/2_6.5Mbps	4904.00	H	50.40	74.00	23.60	36.30	54.00	17.70

Notes: [1] Field strength (dBµV/m) = Spectrum analyzer value (dBµV) + transducer factors (dB)
Transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.

All other emissions were greater than 20 dB form limit.

8.4.6 Setup photos

Figure 8.4-58: *Radiated spurious (out-of-band) emissions setup photo – 30 to 1000 MHz*

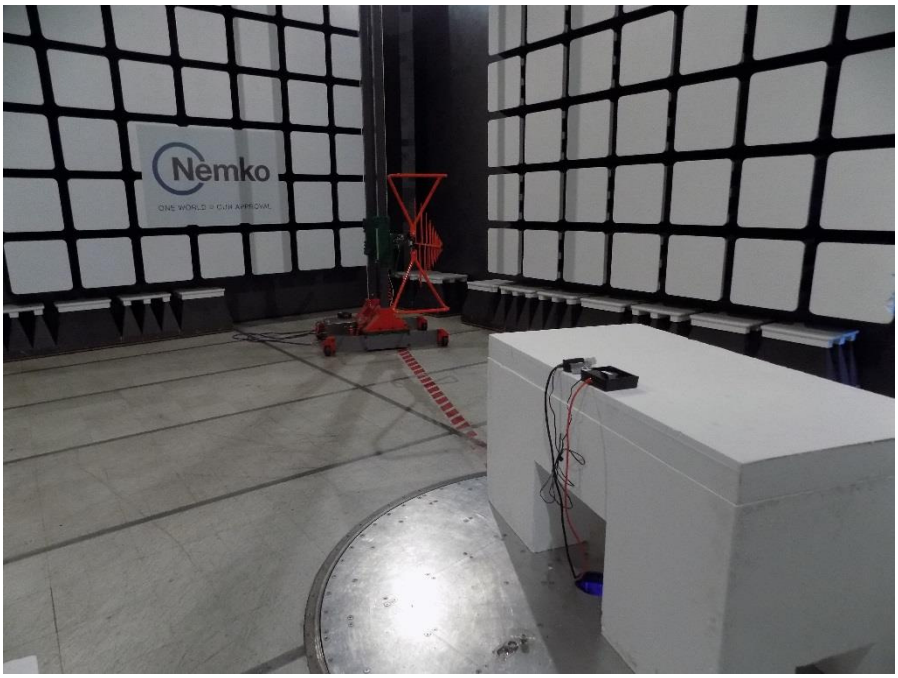


Figure 8.4-59: *Radiated spurious (out-of-band) emissions setup photo – 30 to 1000 MHz*

8.4.6 Setup photos, continued

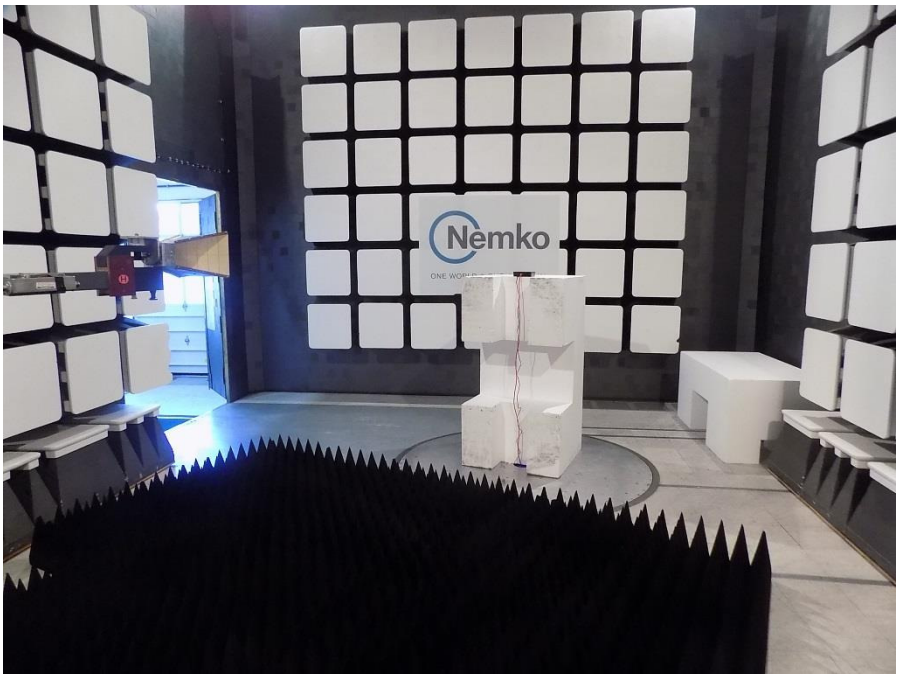


Figure 8.4-60: *Radiated spurious (out-of-band) emissions setup photo – above 1 GHz*

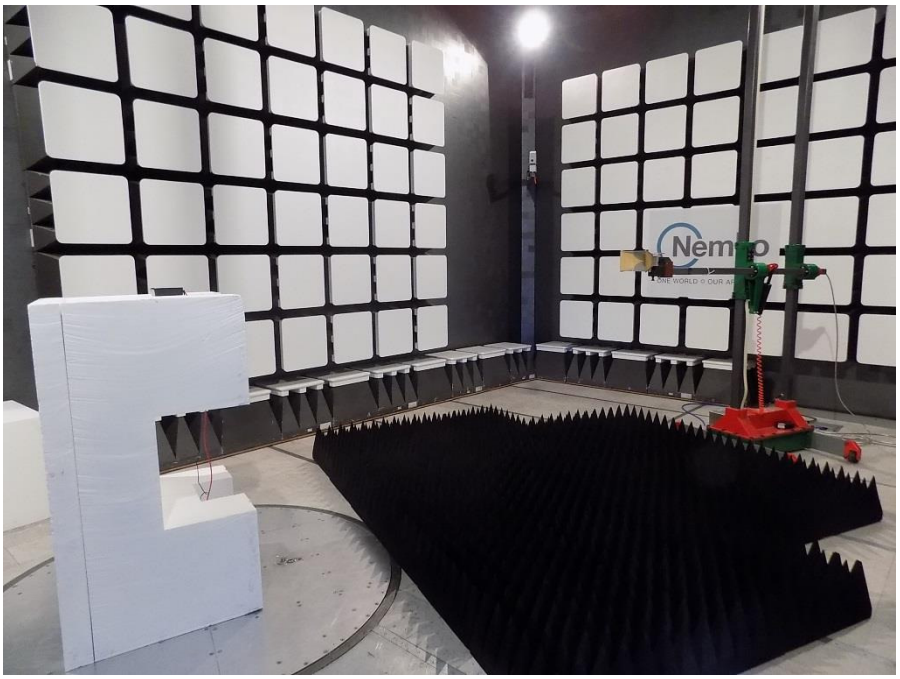


Figure 8.4-61: *Radiated spurious (out-of-band) emissions setup photo – above 1 GHz*

8.5 FCC 15.247(e) and RSS-247 5.2(2) Power spectral density for digitally modulated devices

8.5.1 Definitions and limits

FCC §15.247 (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.

RSS-247, Clause 5.2 (2):

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. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

8.5.2 Test summary

Verdict	Pass				
Test date	May 30, 2016	Test engineer	David Duchesne		
Temperature	22.1 °C	Relative humidity	54 %	Air pressure	1011 mbar

8.5.3 Notes

Measurements were performed as per 558074 D01 DTS Meas Guidance v03r05. (The test was performed using method described in section 10.3 Method AVGPSD-1 (trace averaging with EUT transmitting at full power throughout each sweep).

8.5.4 Setup details

Spectrum analyser settings:

Resolution bandwidth:	100 kHz
Video bandwidth:	1 MHz
Frequency span:	– 50 MHz (802.11b, 802.11g and 802.11n (20 MHz channel)) – 70 MHz (802.11n (40 MHz channel))
Detector mode:	RMS
Trace mode:	Power Average
Averaging sweeps number	100
Sweep points	4001

8.5.5 Test data

Table 8.5-1: *PSD measurements results*

Modulation	Power setting	Frequency, MHz	Modulation coding scheme	PSD, dBm/100 kHz	PSD limit, dBm/3 kHz	Margin, dB
802.11b	30	2412	CCK: 1 Mbps	-1.78	8.00	9.78
			CCK: 11 Mbps	-2.32	8.00	10.32
	40	2437	CCK: 1 Mbps	3.48	8.00	4.52
			CCK: 11 Mbps	3.54	8.00	4.46
	30	2462	CCK: 1 Mbps	-1.41	8.00	9.41
			CCK: 11 Mbps	-2.42	8.00	10.42
802.11g	30	2412	OFDM: BPSK_1/2_6Mbps	-4.29	8.00	12.29
			OFDM: QAM 64_3/4_54Mbps	-6.22	8.00	14.22
	40	2437	OFDM: BPSK_1/2_6Mbps	0.87	8.00	7.13
			OFDM: QAM 64_3/4_54Mbps	-1.15	8.00	9.15
	30	2462	OFDM: BPSK_1/2_6Mbps	-4.61	8.00	12.61
			OFDM: QAM 64_3/4_54Mbps	-6.25	8.00	14.25
802.11n HT20	30	2412	OFDM: BPSK_1/2_6.5Mbps	-4.57	8.00	12.57
			OFDM: QAM 64_3/4_65Mbps	-6.26	8.00	14.26
	40	2437	OFDM: BPSK_1/2_6.5Mbps	0.46	8.00	7.54
			OFDM: QAM 64_3/4_65Mbps	-0.97	8.00	8.97
	30	2462	OFDM: BPSK_1/2_6.5Mbps	-4.64	8.00	12.64
			OFDM: QAM 64_3/4_65Mbps	-6.36	8.00	14.36
802.11n HT40	30	2422	OFDM: BPSK_1/2_6.5Mbps	-5.02	8.00	13.02
			OFDM: QAM 64_3/4_65Mbps	-6.71	8.00	14.71
	40	2437	OFDM: BPSK_1/2_6.5Mbps	-0.76	8.00	8.76
			OFDM: QAM 64_3/4_65Mbps	-2.24	8.00	10.24
	23 [1]	2452	OFDM: BPSK_1/2_6.5Mbps	-8.53	8.00	16.53
			OFDM: QAM 64_3/4_65Mbps	-10.20	8.00	18.20

Notes: None

8.5.5 Test data, continued

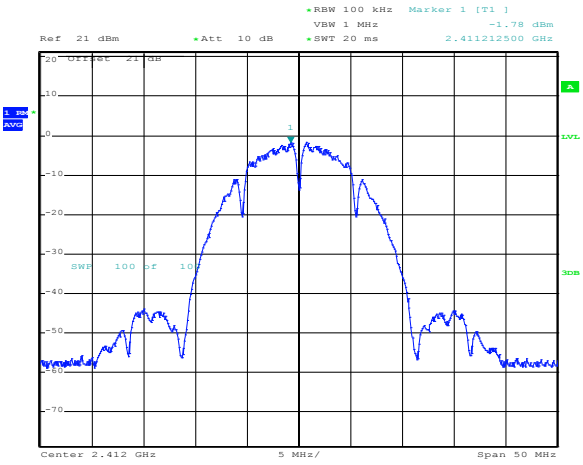


Figure 8.5-1: *PSD sample plot on 802.11b – CCK: 1 Mbps*

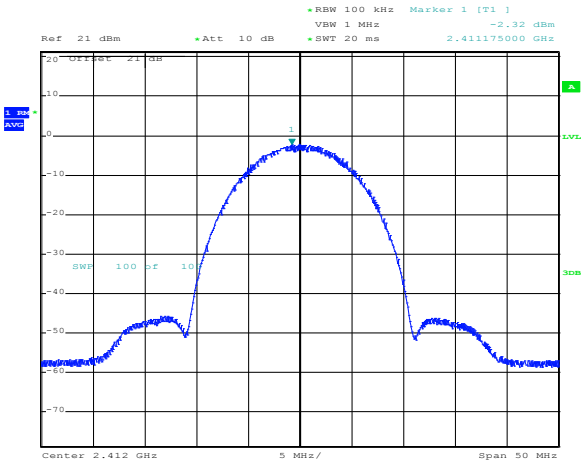


Figure 8.5-2: *PSD sample plot on 802.11b – CCK: 11 Mbps*

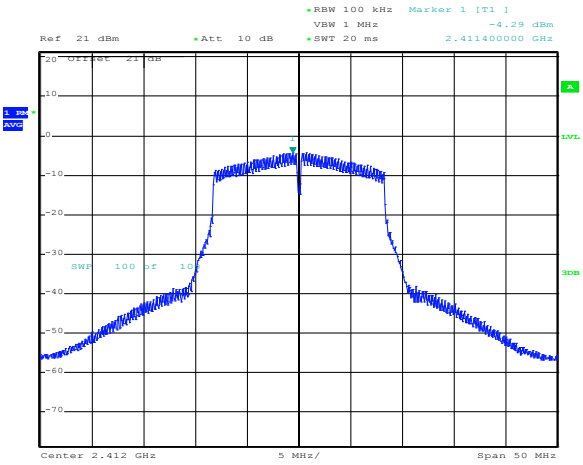


Figure 8.5-3: *PSD sample plot on 802.11g – OFDM: BPSK_1/2_6Mbps*

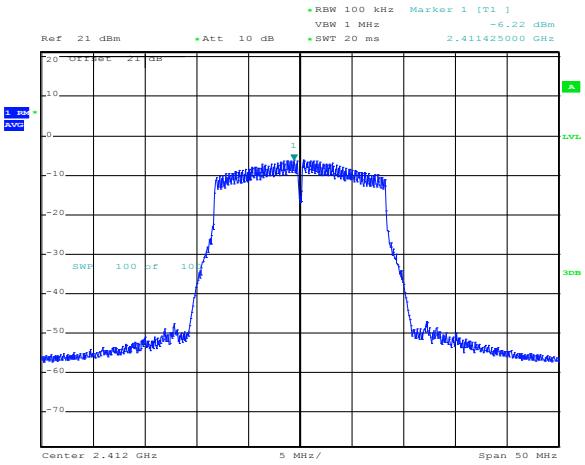


Figure 8.5-4: *PSD sample plot on 802.11g – OFDM: QAM 64_3/4_54Mbps*

8.5.5 Test data, continued

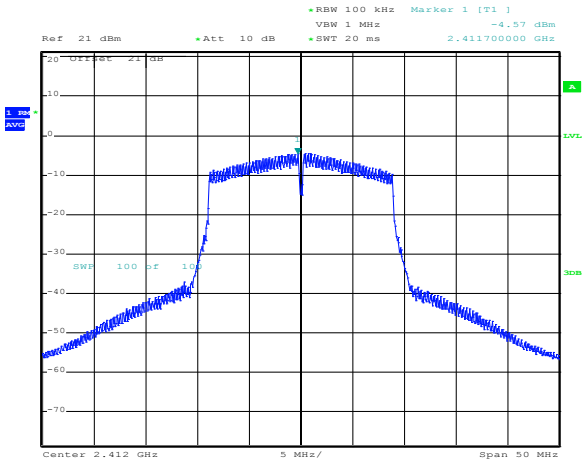


Figure 8.5-5: *PSD sample plot on 802.11n HT20 – OFDM: BPSK_1/2_6.5Mbps*

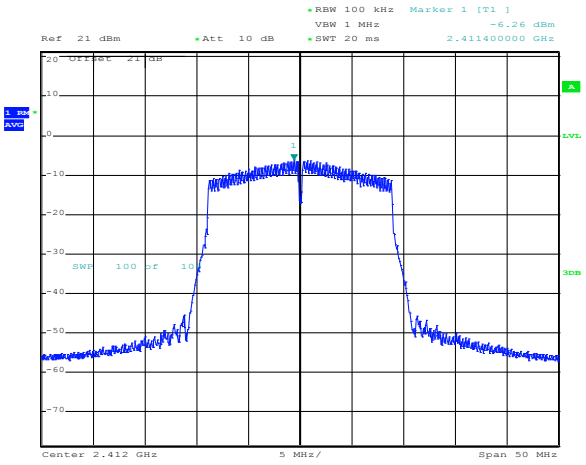


Figure 8.5-6: *PSD sample plot on 802.11n HT20 – QAM 64_3/4_65Mbps*

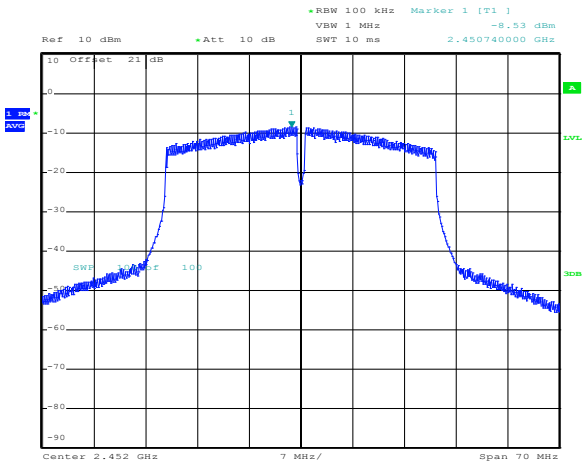


Figure 8.5-7: *PSD sample plot on 802.11n HT40 – OFDM: BPSK_1/2_6.5Mbps*

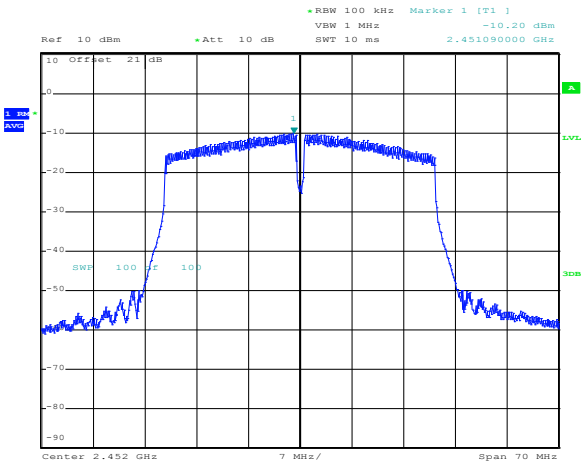
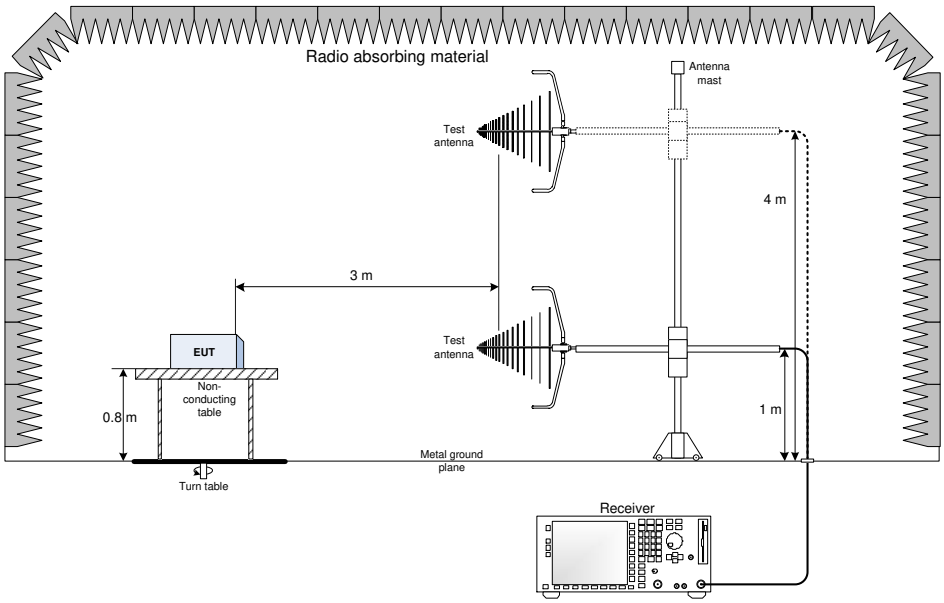


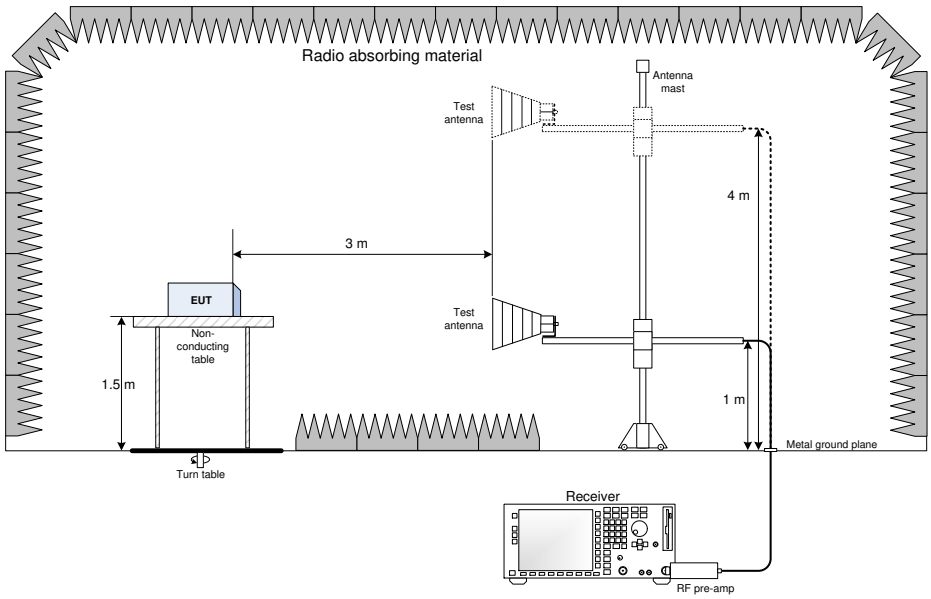
Figure 8.5-8: *PSD sample plot on 802.11n HT40 – OFDM: QAM 64_3/4_65Mbps*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up