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Test report

379384 - 5TRFWL

Date of issue: October 17, 2019

Applicant:

Carnegie Technologies

Product:

SatBridge

Model:

AP-TH1118

Model variant:

N/A

FCC ID:

2ARIP-0007

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

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

NVLAP Code 200116-0

Test location

Company name	Nemko USA, Inc.
Address	2210 Faraday Ave, Suite 150
City	Carlsbad
Province	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com

Tested by	Andres Martinez
Reviewed by	Chip Fleury
Review date	November 11, 2019
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 the Nemko USA ISO/IEC 17025 accreditation.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Carnegie Technologies
Address	9737 Great Hillis Trails Suite 260
City	Austin
Province/State	Texas
Postal/Zip code	78759
Country	U.S.A.

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 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

662911 D01 Multiple Transmitter Output v02r01 (October 31, 2013)	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

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

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

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

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]

Notes: [1] Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

[2] Integral PCB Antenna.

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(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 5, test results

Part	Test description	Verdict
6.7	Section 1. Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth	Pass
7.3	Receiver radiated emission limits	Pass
7.4	Receiver conducted emission limits	Pass
8.8	Power Line Conducted Emissions Limits for License-Exempt Radio Apparatus	Pass
8.10	Restricted Frequency Bands	Pass

Notes: None.

2.4 IC RSS-247, Issue 2, test results

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

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	August 28, 2019
Nemko sample ID number	379384

3.2 EUT information

Product name	SatBridge
Model	AP-TH1118
Model variant	N/A
Serial number	192630034 (Main AP Board), 193031066 (Main Ant Board) & 192629006 (HPA SN)

3.3 Technical information

All used IC test site(s) Reg. number	2040A-4
RSS number and Issue number	RSS-247 Issue 2, February 2017
Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2412MHz
Frequency Max (MHz)	2462MHz
RF power Max (dB), Conducted/ERP/EIRP	23.75
Measured BW (MHz) (6 dB)	Highest Measurement was 802.11n HT40 = 22.566MHz
Power requirements	12VDC, 6 Amps (approved power adapter 100-240 VAC, 1.5 A, 50-60 Hz)
Antenna information	Integral with 3dBi gain in the 2.4GHz band

3.4 Product description and theory of operation

The SatBridge enables remote communications via satellite when other services are unavailable. Limited functionality in US and Canada (This device will be sold in the US but will not operate to make satellite calls. The satellite system only operates in Europe and Asia.)

3.5 EUT exercise details

Proprietary scripts provided by the manufacturer were used to exercise the EUT. Once a script is executed the EUT will transmit at maximum power at low or high channel with chosen modulation.

3.6 EUT setup diagram

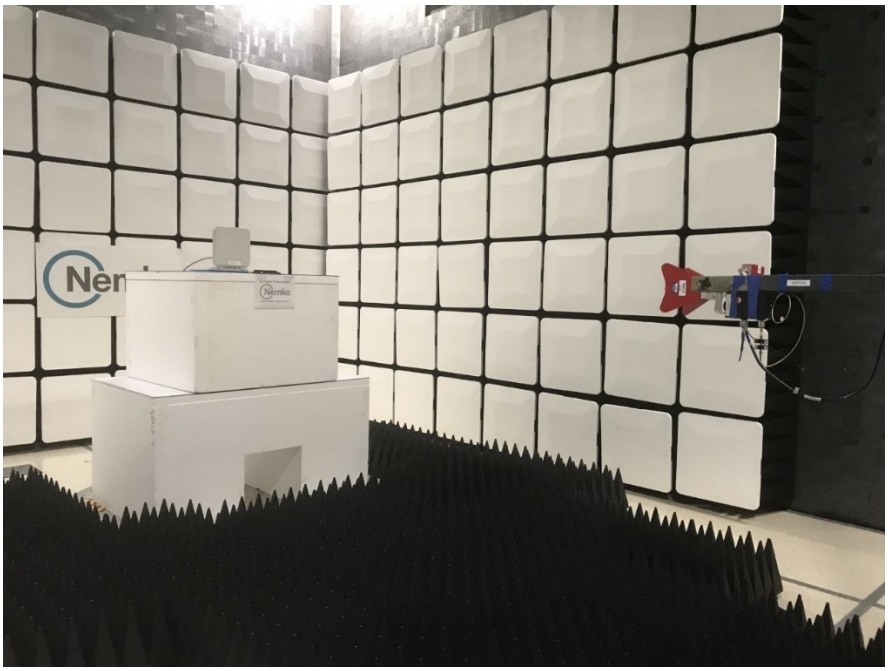


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Access point	Carnegie technologies	N/A	N/A

Table 3.7-2: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Computer Laptop	DELL	Latitude 7490	8KC8QN2	-
USB – CAT 5C Adapter	-	-	-	-
CAT-5c cable	-	-	-	-

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

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

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

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

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

5.2 Power supply range

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

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

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

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	1.38

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.
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1131	1 year	05-25-2020
Antenna, Bilog	Schaffner-Chase	CBL6111C	1480	1 year	04-18-2020
Antenna, Horn	ETS	3117-PA	E1139	1 year	03-21-2020
Spectrum Analyzer	Rohde & Schwarz	FSV40	E1120	1 year	10-24-2019
Temperature chamber	Test Equity	115A	E1162	1 year	06-18-2020
Variac	Dayton	1520	S1045	NCR	Verified with 813
Multimiter	Fluke	111	813	1 year	06-13-2020
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1121	1 year	05-25-2020
Antenna, Bilog	Schaffner-Chase	CBL6111C	1480	1 year	04-18-2020
System controller	SUNOL SCIENCES	SC104V	E1191	NCR	NCR
Power Sensor	ETS-Lindgren	7002-006	E1061	1 year`	05-31-2020

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

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:
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.

ISED:
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: *Conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

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

8.1.2 Test summary

Test date	August 28, 2019	Temperature	25 °C
Test engineer	Andres Martinez	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	45 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

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

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

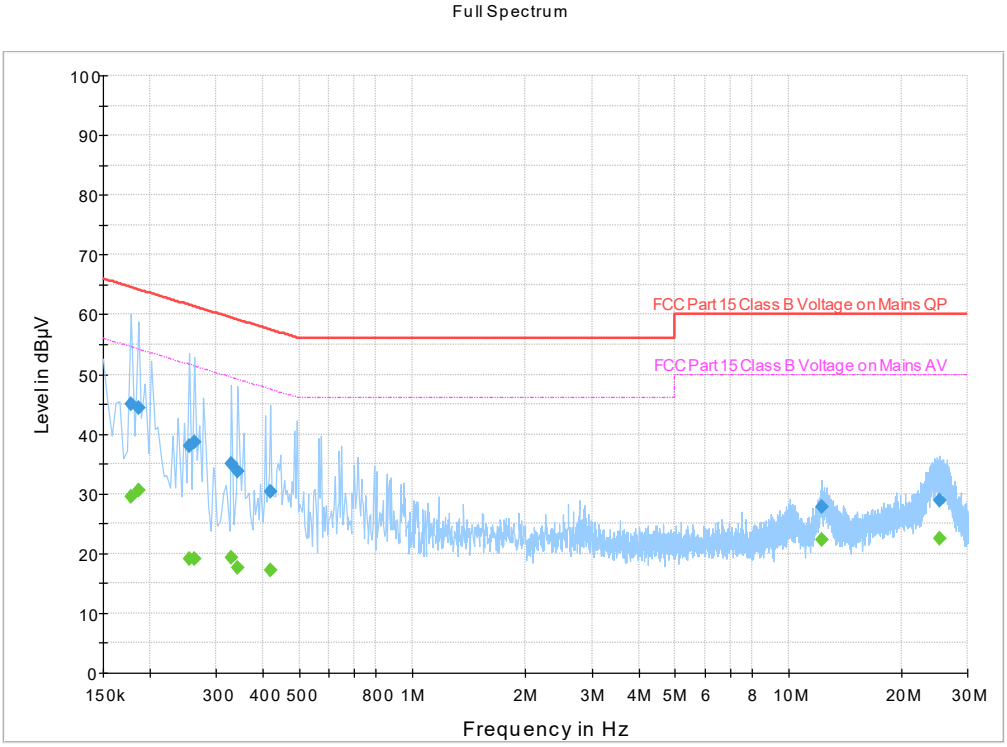
Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.1.4 Test data



Plot 8.1-1: *Conducted emissions plot 150k to 30MHz*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.178000	45.01	---	64.58	19.57	5000.0	9.000	N	ON	19.6
0.178000	---	29.56	54.58	25.02	5000.0	9.000	N	ON	19.6
0.186000	44.43	---	64.21	19.78	5000.0	9.000	N	ON	19.6
0.186000	---	30.65	54.21	23.56	5000.0	9.000	N	ON	19.6
0.254000	---	19.00	51.63	32.62	5000.0	9.000	L1	ON	19.5
0.254000	38.04	---	61.63	23.59	5000.0	9.000	L1	ON	19.5
0.262000	---	19.18	51.37	32.19	5000.0	9.000	L1	ON	19.5
0.262000	38.71	---	61.37	22.66	5000.0	9.000	L1	ON	19.5
0.330000	35.07	---	59.45	24.38	5000.0	9.000	N	ON	19.5
0.330000	---	19.27	49.45	30.18	5000.0	9.000	N	ON	19.5
0.342000	33.74	---	59.16	25.42	5000.0	9.000	L1	ON	19.5
0.342000	---	17.53	49.16	31.62	5000.0	9.000	L1	ON	19.5
0.418000	30.33	---	57.49	27.16	5000.0	9.000	N	ON	19.5
0.418000	---	17.27	47.49	30.22	5000.0	9.000	N	ON	19.5
12.274000	27.72	---	60.00	32.28	5000.0	9.000	L1	ON	20.2
12.274000	---	22.27	50.00	27.73	5000.0	9.000	L1	ON	20.2
25.230000	---	22.52	50.00	27.48	5000.0	9.000	N	ON	20.2
25.230000	28.84	---	60.00	31.16	5000.0	9.000	N	ON	20.2

Table 8.1-2: *Conducted emissions results*

8.2 FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for systems using digital modulation techniques and RSS-GEN

8.2.1 Definitions and limits

FCC 15.247:

(a) (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.

ISED RSS-247

5.2 (a) The minimum 6 dB bandwidth shall be 500 kHz.

ISED RSS-GEN

Section 6.7 Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth

8.2.2 Test summary

Test date	October 3, 2019	Temperature	24 °C
Test engineer	Andres Martinez	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	45 %

8.2.3 Observations, settings and special notes

6dB and 99% BW plots represent the worst-case scenario on all data rates.
Frequency:
2412 for 802.11/b/g/n20.
2422 for 802.11/n40.

Spectrum analyzer settings: for 6 dB BW

Resolution bandwidth	100 kHz
Video bandwidth	≥3 × RBW
Frequency span	30 MHz for 20 MHz channel; 70 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyzer settings: for 99% BW

Resolution bandwidth	1–5 % of Occupied BW
Video bandwidth	≥3 × RBW
Frequency span	40 MHz for 20 MHz channel; 80 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *6 dB bandwidth results for cho*

Modulation	Frequency, MHz	6 dB bandwidth, MHz	Minimum Limit, kHz	Verdict
802.11b	2412	3.099	500	Pass
802.11g	2412	3.099	500	Pass
802.11n HT20	2412	3.761	500	Pass
802.11n HT40	2422	22.566	500	Pass

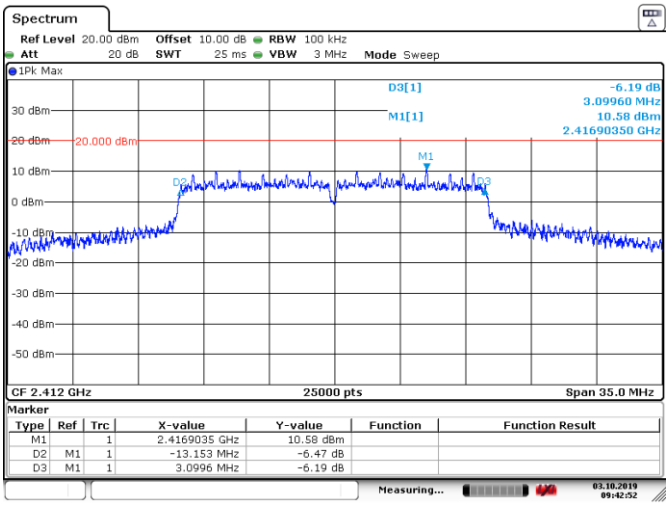


Figure 8.2-1: *6 dB bandwidth on 802.11b*

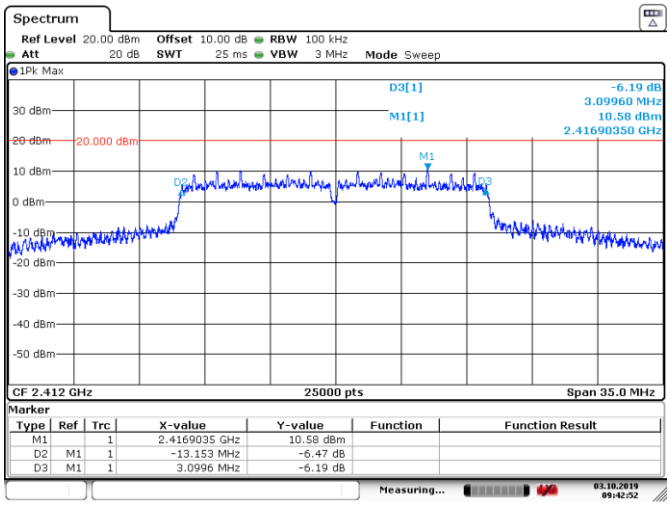


Figure 8.2-2: *6 dB bandwidth on 802.11g*

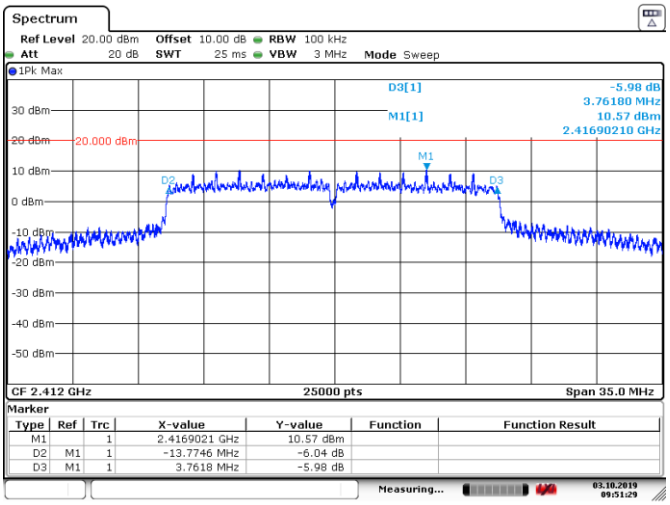


Figure 8.2-3: *6 dB bandwidth on 802.11n HT20*

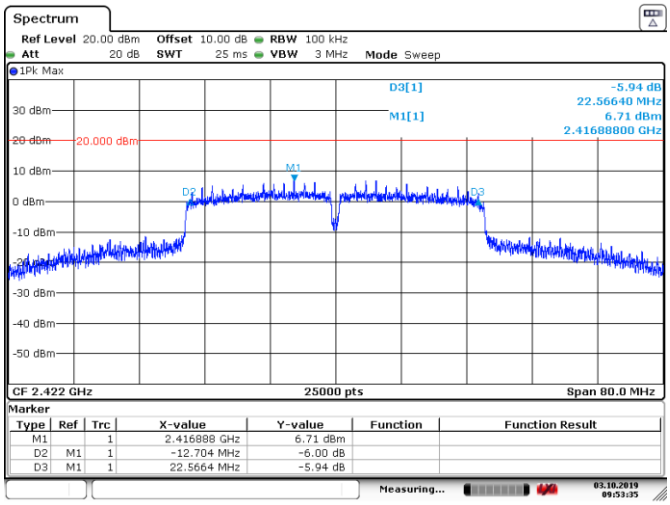


Figure 8.2-4: *6 dB bandwidth on 802.11n HT40*

Table 8.2-2: *99% bandwidth results for cho*

Modulation	Frequency, MHz	99% bandwidth, MHz
802.11b	2462	15.65
802.11g	2462	17.57
802.11n HT20	2412	18.64
802.11n HT40	2422	37.61

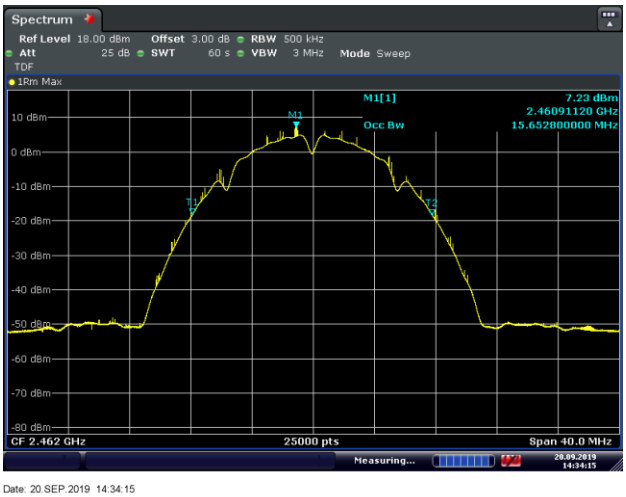


Figure 8.2-5: *99% bandwidth on 802.11b*

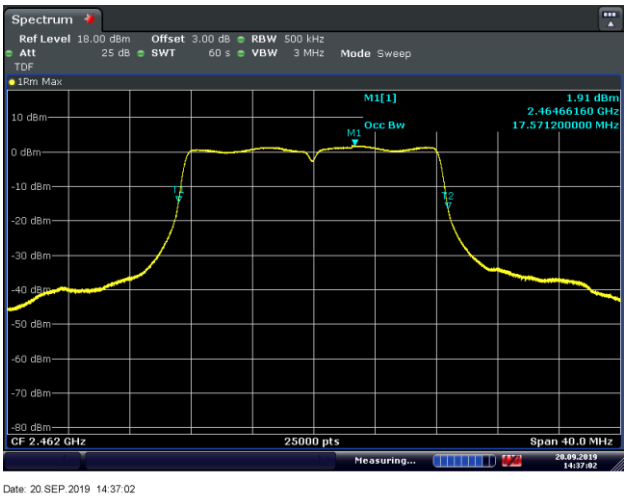


Figure 8.2-6: *99% bandwidth on 802.11g*

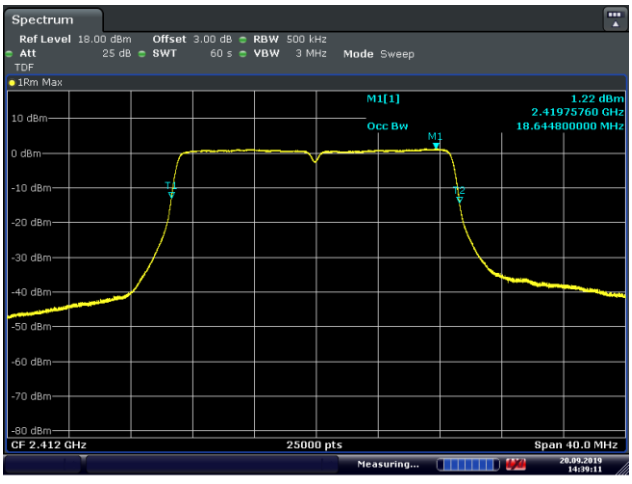


Figure 8.2-7: *99% bandwidth on 802.11n HT20*

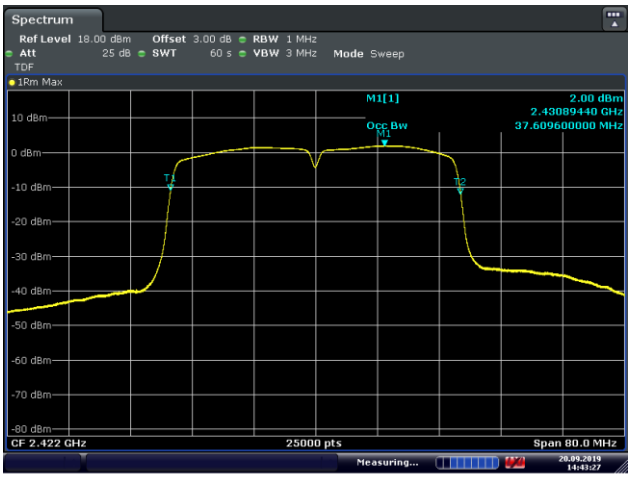


Figure 8.2-8:*99% bandwidth on 802.11n HT40*

8.3 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements (FCC 15.31(e) and RSS-GEN

8.3.1 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 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.

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

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

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

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

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

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

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

15.31(e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

ISED:

d. 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 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

e. 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,[Footnote2] omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W

RSS GEN 6.11 Transmitter frequency stability

Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage.

a. For licence-exempt devices, the following conditions apply:

b. at the temperature of +20°C (+68°F) and at ±15% of the manufacturer's rated supply voltage

8.3.2 Test summary

Test date	August 27, 2019	Temperature	24 °C
Test engineer	Andres Martinez	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	45 %

8.3.3 Observations, settings and special notes

The test was performed according to DTS guidelines 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.

Program power settings are as follows for FCC
a. For 802.11b (CCK)– complies with power setting of 28
b. For 802.11g (No HT) – complies with power setting of 23
c. For 802.11N20 (HT20)– complies with power setting of 22
d. For 802.11N40 (HT40)– complies with power setting of 20

8.3.4 Test data

Table 8.3-1: *Output power measurements results*

Modulation	Frequency, MHz	Conducted output power, dBm				Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		EUT	10 log (2) MIMO (dB)	Total Power	Limit (dB)					
802.11b	2412	23.60	3	**26.60**	30	3.40	2.0	**28.60**	36.00	7.40
	2442	23.75	3	**26.75**	30	3.25	2.0	**28.75**	36.00	7.25
	2462	23.45	3	**26.45**	30	3.55	2.0	**28.45**	36.00	7.55
802.11g	2412	22.63	3	**25.63**	30	4.37	2.0	**27.63**	36.00	8.37
	2442	22.41	3	**25.41**	30	4.59	2.0	**27.41**	36.00	8.59
	2462	22.84	3	**25.84**	30	4.16	2.0	**27.84**	36.00	8.16
802.11n HT20	2412	23.24	3	**26.24**	30	3.76	2.0	**28.24**	36.00	7.76
	2442	23.30	3	**26.30**	30	3.70	2.0	**28.30**	36.00	7.70
	2462	23.19	3	**26.19**	30	3.81	2.0	**28.19**	36.00	7.81
802.11n HT40	2422	23.37	3	**26.37**	30	3.63	2.0	**28.37**	36.00	7.63
	2442	23.35	3	**26.35**	30	3.65	2.0	**28.35**	36.00	7.65
	2457	23.30	3	**26.30**	30	3.70	2.0	**28.30**	36.00	7.70

Note: 2x2 MIMO = 10 log (2) = 3 dB
Antenna Gain at 2.4GHz = 2dB

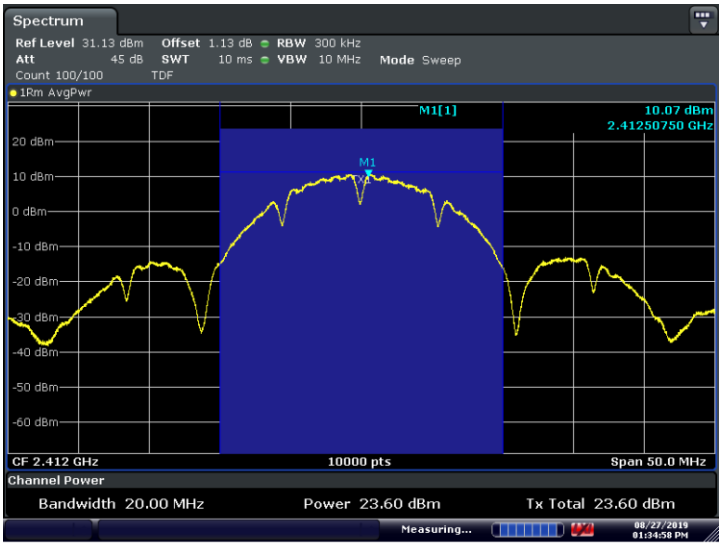


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Figure 8.3-1: Output Power Measurement Sample Plot, 802.11b at 2412MHz

Table 8.3-2: *Output power Voltage Variation measurements results*

Modulation	Frequency, MHz	Conducted Power	85% (10.2V)	115% (13.8V)	Verdict
802.11b	2412	23.60	23.60	23.60	Pass
	2442	23.75	23.74	23.75	Pass
	2462	23.45	23.45	23.45	Pass
802.11g	2412	22.63	22.62	22.63	Pass
	2442	22.41	22.41	22.41	Pass
	2462	22.84	22.84	22.85	Pass
802.11n HT20	2412	23.24	23.23	23.24	Pass
	2442	23.30	23.30	23.30	Pass
	2462	23.19	23.19	23.20	Pass
802.11n HT40	2422	23.37	23.36	23.38	Pass
	2442	23.35	23.34	23.36	Pass
	2457	23.30	23.29	23.31	Pass

Nominal Voltage is 12VDC

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

8.4.1 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)).

ISED:
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(d), 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: *ISED restricted frequency bands*

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

Note: Certain frequency bands listed in Table 8.4-2 and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

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

Test date	October 9, 2019	Temperature	24 °C
Test engineer	Andres Martinez	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	45 %

8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to transmit with 100 % duty cycle.
Radiated measurements were performed at a distance of 3 m, the EUT was transmitting on both MIMO chains simultaneously.
Since fundamental power was tested using average method, the spurious emissions limit is −30 dBc/100 kHz
There were no emissions from 18GHz to 26GHz, hence 26GHz to 40GHz was not required.
From 30MHz to 1GHz only one plot was selected.
Only the worst-case scenarios were taken for Spurious Emissions testing for 802.11b/g/n20/n40.

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

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

8.4.4 Test data

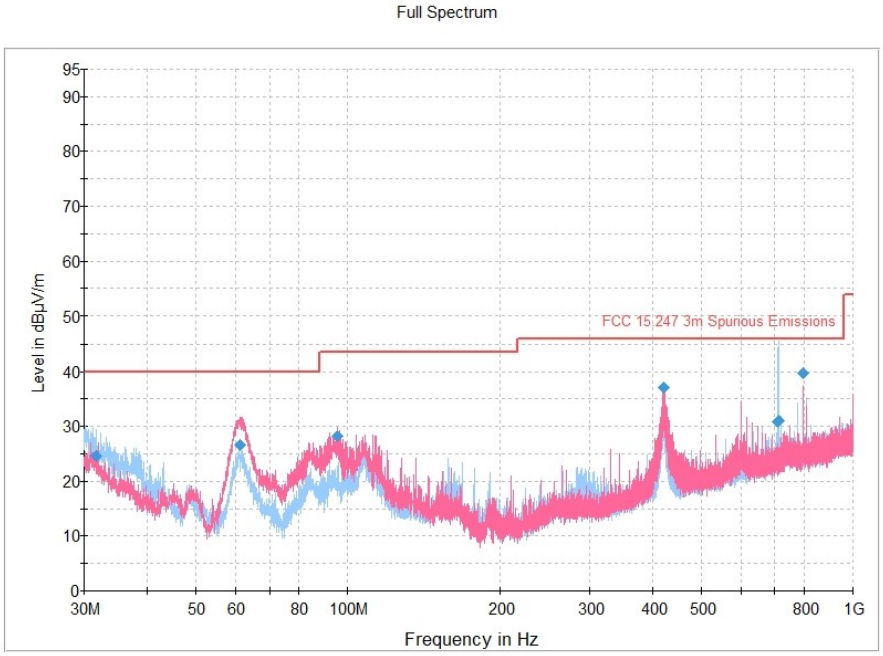


Figure 8.4-1: *Radiated spurious emissions for 802.11b, High CH, 30MHz to 1GHz.*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.693000	24.70	40.00	15.30	1000.0	120.000	102.0	H	5.0	19.8
61.137000	26.56	40.00	13.44	1000.0	120.000	102.0	V	306.0	6.8
95.522667	28.25	43.50	15.25	1000.0	120.000	104.0	V	-11.0	11.4
420.630333	37.13	46.00	8.87	1000.0	120.000	115.0	V	288.0	20.0
709.980000	30.96	46.00	15.04	1000.0	120.000	150.0	H	262.0	24.8
713.415333	31.06	46.00	14.94	1000.0	120.000	119.0	H	298.0	24.9
797.973667	39.70	46.00	6.30	1000.0	120.000	98.0	H	205.0	25.8

Table 8.4-4: *Radiated field strength measurement results for 802.11b*

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

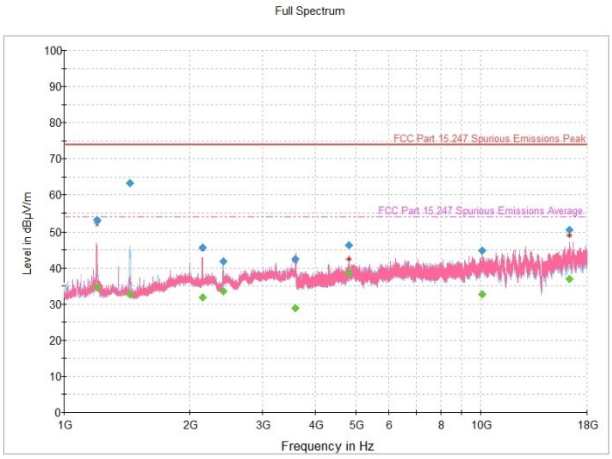


Figure 8.4-2: *Radiated spurious emissions for 802.11b, 2412MHz, 1GHz to 18GHz.*

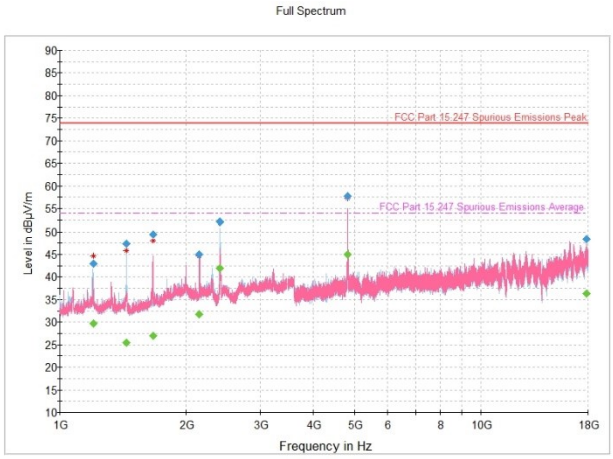


Figure 8.4-3: *Radiated spurious emissions for 802.11g, 2412MHz, 1GHz to 18GHz.*

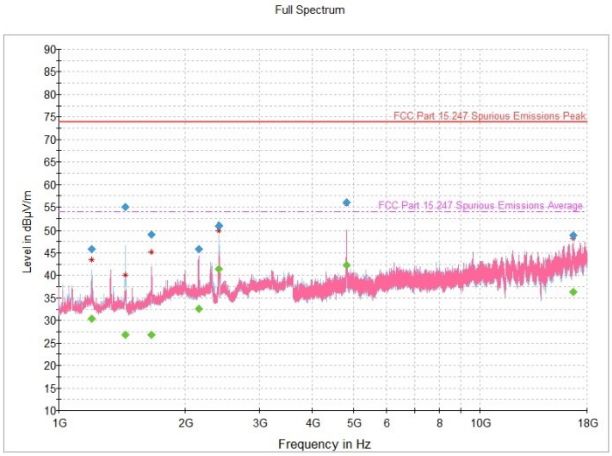


Figure 8.4-4: *Radiated spurious emissions for 802.11n20, 2412MHz, 1GHz to 18GHz.*

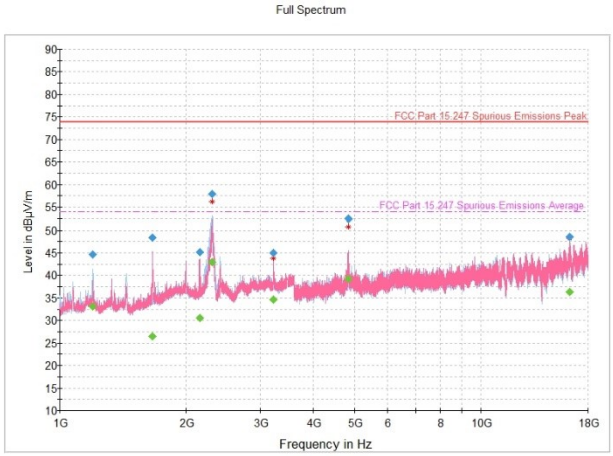


Figure 8.4-5: *Radiated spurious emissions for 802.11n40, 2422MHz, 1GHz to 18GHz.*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1198.466667	---	34.62	53.90	19.28	5000.0	1000.000	253.0	V	270.0	-14.5
1198.466667	53.09	---	73.90	20.81	5000.0	1000.000	253.0	V	270.0	-14.5
1440.066667	---	32.65	53.90	21.25	5000.0	1000.000	145.0	H	302.0	-15.5
1440.066667	63.30	---	73.90	10.60	5000.0	1000.000	145.0	H	302.0	-15.5
2153.533333	---	31.91	53.90	21.99	5000.0	1000.000	126.0	V	35.0	-12.1
2153.533333	45.60	---	73.90	28.30	5000.0	1000.000	126.0	V	35.0	-12.1
2411.066667	41.84	---	73.90	32.06	5000.0	1000.000	100.0	H	167.0	-10.9
2411.066667	---	33.59	53.90	20.31	5000.0	1000.000	100.0	H	167.0	-10.9
3585.366667	42.40	---	73.90	31.50	5000.0	1000.000	243.0	V	232.0	-6.5
3585.366667	---	28.94	53.90	24.96	5000.0	1000.000	243.0	V	232.0	-6.5
4823.866667	---	38.56	53.90	15.34	5000.0	1000.000	148.0	V	313.0	-3.1
4823.866667	46.27	---	73.90	27.63	5000.0	1000.000	148.0	V	313.0	-3.1
10051.966667	---	32.66	53.90	21.24	5000.0	1000.000	136.0	V	44.0	2.1
10051.966667	44.83	---	73.90	29.07	5000.0	1000.000	136.0	V	44.0	2.1
16297.366667	---	36.89	53.90	17.01	5000.0	1000.000	137.0	V	199.0	10.2
16297.366667	50.46	---	73.90	23.44	5000.0	1000.000	137.0	V	199.0	10.2

Table 8.4-5: *Radiated field strength measurement results for 802.11b*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1200.266667	---	29.66	53.97	24.31	5000.0	1000.000	235.0	H	67.0	-14.5
1200.266667	42.99	---	73.90	30.91	5000.0	1000.000	235.0	H	67.0	-14.5
1440.700000	---	25.42	53.97	28.55	5000.0	1000.000	113.0	H	196.0	-15.5
1440.700000	47.38	---	73.90	26.52	5000.0	1000.000	113.0	H	196.0	-15.5
1665.033333	49.33	---	73.90	24.57	5000.0	1000.000	150.0	V	30.0	-14.2
1665.033333	---	27.06	53.97	26.91	5000.0	1000.000	150.0	V	30.0	-14.2
2149.400000	---	31.68	53.97	22.29	5000.0	1000.000	161.0	V	42.0	-12.2
2149.400000	45.00	---	73.90	28.90	5000.0	1000.000	161.0	V	42.0	-12.2
2406.300000	52.11	---	73.90	21.79	5000.0	1000.000	153.0	H	79.0	-10.9
2406.300000	---	41.91	53.97	12.06	5000.0	1000.000	153.0	H	79.0	-10.9
4824.833333	---	44.99	53.97	8.98	5000.0	1000.000	139.0	V	62.0	-3.1
4824.833333	57.70	---	73.90	16.20	5000.0	1000.000	139.0	V	62.0	-3.1
17869.100000	48.37	---	73.90	25.53	5000.0	1000.000	234.0	V	23.0	11.0
17869.100000	---	36.25	53.97	17.72	5000.0	1000.000	234.0	V	23.0	11.0

Table 8.4-6: *Radiated field strength measurement results for 802.11g*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1199.666667	---	30.34	53.97	23.63	5000.0	1000.000	129.0	H	322.0	-14.5
1199.666667	45.79	---	73.90	28.11	5000.0	1000.000	129.0	H	322.0	-14.5
1440.300000	---	26.76	53.97	27.21	5000.0	1000.000	150.0	H	71.0	-15.5
1440.300000	55.06	---	73.90	18.84	5000.0	1000.000	150.0	H	71.0	-15.5
1662.966667	---	26.77	53.97	27.20	5000.0	1000.000	112.0	V	20.0	-14.3
1662.966667	49.07	---	73.90	24.83	5000.0	1000.000	112.0	V	20.0	-14.3
2153.400000	---	32.55	53.97	21.42	5000.0	1000.000	102.0	V	34.0	-12.1
2153.400000	45.84	---	73.90	28.06	5000.0	1000.000	102.0	V	34.0	-12.1
2404.433333	50.87	---	73.90	23.03	5000.0	1000.000	125.0	H	97.0	-10.9
2404.433333	---	41.45	53.97	12.52	5000.0	1000.000	125.0	H	97.0	-10.9
4826.533333	---	42.32	53.97	11.65	5000.0	1000.000	137.0	V	67.0	-3.1
4826.533333	56.09	---	73.90	17.81	5000.0	1000.000	137.0	V	67.0	-3.1
16687.133333	---	36.38	53.97	17.59	5000.0	1000.000	182.0	V	216.0	10.9
16687.133333	48.84	---	73.90	25.06	5000.0	1000.000	182.0	V	216.0	10.9

Table 8.4-7: *Radiated field strength measurement results for 802.11n20*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1200.033333	44.67	---	73.90	29.23	5000.0	1000.000	158.0	H	315.0	-14.5
1200.033333	---	33.10	53.97	20.87	5000.0	1000.000	158.0	H	315.0	-14.5
1662.100000	---	26.49	53.97	27.48	5000.0	1000.000	131.0	V	37.0	-14.3
1662.100000	48.31	---	73.90	25.59	5000.0	1000.000	131.0	V	37.0	-14.3
2155.566667	---	30.49	53.97	23.48	5000.0	1000.000	148.0	V	45.0	-12.1
2155.566667	45.12	---	73.90	28.78	5000.0	1000.000	148.0	V	45.0	-12.1
2308.733333	---	42.96	53.97	11.01	5000.0	1000.000	151.0	H	149.0	-11.5
2308.733333	57.92	---	73.90	15.98	5000.0	1000.000	151.0	H	149.0	-11.5
3229.266667	---	34.58	53.97	19.39	5000.0	1000.000	113.0	V	-2.0	-8.0
3229.266667	44.98	---	73.90	28.92	5000.0	1000.000	113.0	V	-2.0	-8.0
4848.533333	52.44	---	73.90	21.46	5000.0	1000.000	145.0	V	64.0	-3.1
4848.533333	---	39.29	53.97	14.68	5000.0	1000.000	145.0	V	64.0	-3.1
16301.333333	48.50	---	73.90	25.40	5000.0	1000.000	142.0	V	290.0	10.3
16301.333333	---	36.25	53.97	17.72	5000.0	1000.000	142.0	V	290.0	10.3

Table 8.4-8: *Radiated field strength measurement results for 802.11n40*

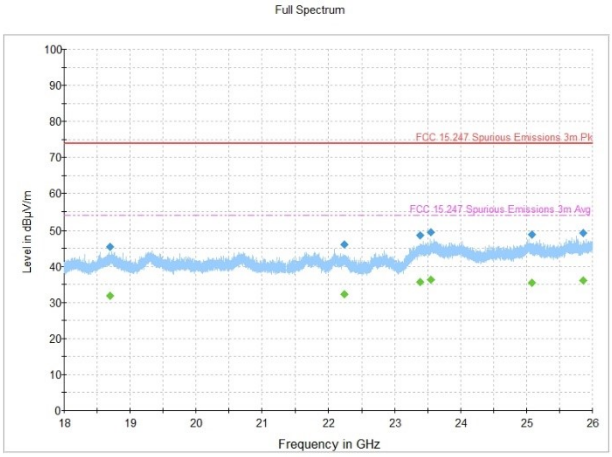


Figure 8.4-6: *Radiated spurious emissions for 802.11b, 2412MHz, 18GHz to 26GHz*

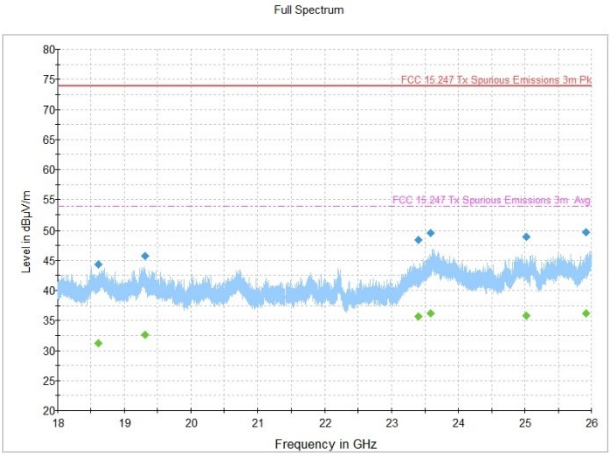


Figure 8.4-7: *Radiated spurious emissions for 802.11g, 2412MHz, 18GHz to 26GHz*

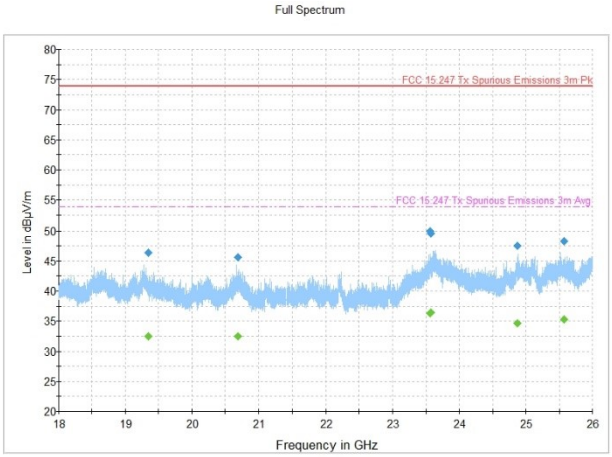


Figure 8.4-8: *Radiated spurious emissions for 802.11n20, 2412MHz, 18GHz to 26GHz*

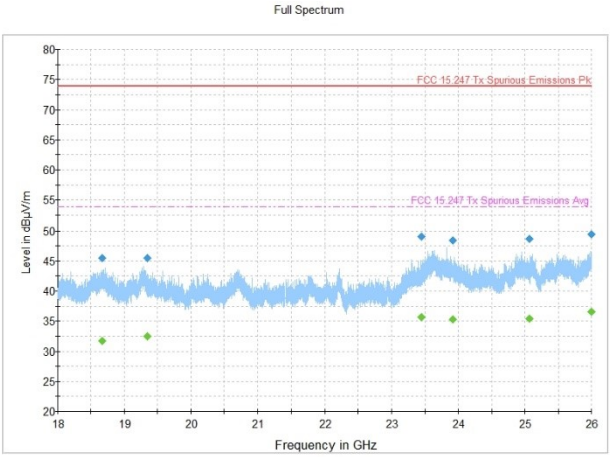


Figure 8.4-9: *Radiated spurious emissions for 802.11n40, 2422MHz, 18GHz to 26GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18692.866000	---	31.80	53.90	22.10	5000.0	1000.000	212.0	H	174.0	14.3
18692.866000	45.37	---	73.90	28.53	5000.0	1000.000	212.0	H	174.0	14.3
22233.934500	46.10	---	73.90	27.80	5000.0	1000.000	199.0	H	0.0	15.8
22233.934500	---	32.28	53.90	21.62	5000.0	1000.000	199.0	H	0.0	15.8
23391.821667	---	35.61	53.90	18.29	5000.0	1000.000	99.0	V	258.0	19.8
23391.821667	48.53	---	73.90	25.37	5000.0	1000.000	99.0	V	258.0	19.8
23551.474833	---	36.30	53.90	17.60	5000.0	1000.000	111.0	V	282.0	20.5
23551.474833	49.39	---	73.90	24.51	5000.0	1000.000	111.0	V	282.0	20.5
25081.917667	48.76	---	73.90	25.14	5000.0	1000.000	209.0	H	10.0	19.0
25081.917667	---	35.46	53.90	18.44	5000.0	1000.000	209.0	H	10.0	19.0
25863.511667	---	36.09	53.90	17.81	5000.0	1000.000	125.0	V	147.0	19.6
25863.511667	49.27	---	73.90	24.63	5000.0	1000.000	125.0	V	147.0	19.6
18692.866000	---	31.80	53.90	22.10	5000.0	1000.000	212.0	H	174.0	14.3
18692.866000	45.37	---	73.90	28.53	5000.0	1000.000	212.0	H	174.0	14.3

Table 8.4-9: *Radiated field strength measurement results for 802.11b*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18610.654667	44.37	---	73.90	29.53	5000.0	1000.000	114.0	H	278.0	14.1
18610.654667	---	31.26	53.90	22.64	5000.0	1000.000	114.0	H	278.0	14.1
19310.372500	45.77	---	73.90	28.13	5000.0	1000.000	111.0	V	249.0	15.0
19310.372500	---	32.66	53.90	21.24	5000.0	1000.000	111.0	V	249.0	15.0
23401.197833	48.45	---	73.90	25.45	5000.0	1000.000	203.0	V	182.0	19.8
23401.197833	---	35.64	53.90	18.26	5000.0	1000.000	203.0	V	182.0	19.8
23584.094167	49.50	---	73.90	24.40	5000.0	1000.000	150.0	H	356.0	20.6
23584.094167	---	36.18	53.90	17.72	5000.0	1000.000	150.0	H	356.0	20.6
25023.728000	48.98	---	73.90	24.92	5000.0	1000.000	174.0	H	177.0	19.1
25023.728000	---	35.82	53.90	18.08	5000.0	1000.000	174.0	H	177.0	19.1
25918.785667	49.71	---	73.90	24.19	5000.0	1000.000	101.0	V	7.0	20.0
25918.785667	---	36.16	53.90	17.74	5000.0	1000.000	101.0	V	7.0	20.0
18610.654667	44.37	---	73.90	29.53	5000.0	1000.000	114.0	H	278.0	14.1
18610.654667	---	31.26	53.90	22.64	5000.0	1000.000	114.0	H	278.0	14.1

Table 8.4-10: *Radiated field strength measurement results for 802.11g*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19342.471667	---	32.54	53.90	21.36	5000.0	1000.000	225.0	V	206.0	14.9
19342.471667	46.40	---	73.90	27.50	5000.0	1000.000	225.0	V	206.0	14.9
20695.316667	---	32.48	53.90	21.42	5000.0	1000.000	172.0	V	10.0	15.9
20695.316667	45.55	---	73.90	28.35	5000.0	1000.000	172.0	V	10.0	15.9
23557.934667	---	36.30	53.90	17.60	5000.0	1000.000	218.0	H	334.0	20.6
23557.934667	49.93	---	73.90	23.97	5000.0	1000.000	218.0	H	334.0	20.6
23574.636667	49.55	---	73.90	24.35	5000.0	1000.000	205.0	H	343.0	20.7
23574.636667	---	36.48	53.90	17.42	5000.0	1000.000	205.0	H	343.0	20.7
24873.404000	47.54	---	73.90	26.36	5000.0	1000.000	225.0	V	185.0	18.6
24873.404000	---	34.61	53.90	19.29	5000.0	1000.000	225.0	V	185.0	18.6
25570.718000	---	35.27	53.90	18.63	5000.0	1000.000	225.0	V	103.0	19.2
25570.718000	48.25	---	73.90	25.65	5000.0	1000.000	225.0	V	103.0	19.2
19342.471667	---	32.54	53.90	21.36	5000.0	1000.000	225.0	V	206.0	14.9
19342.471667	46.40	---	73.90	27.50	5000.0	1000.000	225.0	V	206.0	14.9

Table 8.4-11: *Radiated field strength measurement results for 802.11n20*

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18665.381667	---	31.76	53.90	22.14	5000.0	1000.000	103.0	V	199.0	14.3
18665.381667	45.47	---	73.90	28.43	5000.0	1000.000	103.0	V	199.0	14.3
19345.504333	45.52	---	73.90	28.38	5000.0	1000.000	225.0	V	208.0	14.9
19345.504333	---	32.51	53.90	21.39	5000.0	1000.000	225.0	V	208.0	14.9
23451.332833	48.99	---	73.90	24.91	5000.0	1000.000	172.0	V	269.0	20.0
23451.332833	---	35.67	53.90	18.23	5000.0	1000.000	172.0	V	269.0	20.0
23916.287833	48.42	---	73.90	25.48	5000.0	1000.000	225.0	V	-8.0	18.9
23916.287833	---	35.33	53.90		5000.0	1000.000	225.0	V	-8.0	18.9
25073.743667	48.62	---	73.90	25.28	5000.0	1000.000	125.0	H	168.0	19.0
25073.743667	---	35.38	53.90	18.52	5000.0	1000.000	125.0	H	168.0	19.0
25999.853833	---	36.60	53.90	17.30	5000.0	1000.000	223.0	V	10.0	20.5
25999.853833	49.43	---	73.90	24.47	5000.0	1000.000	223.0	V	10.0	20.5
18665.381667	---	31.76	53.90	22.14	5000.0	1000.000	103.0	V	199.0	14.3
18665.381667	45.47	---	73.90	28.43	5000.0	1000.000	103.0	V	199.0	14.3

Table 8.4-12: *Radiated field strength measurement results for 802.11n40*

Lower Band-Edge Measurements

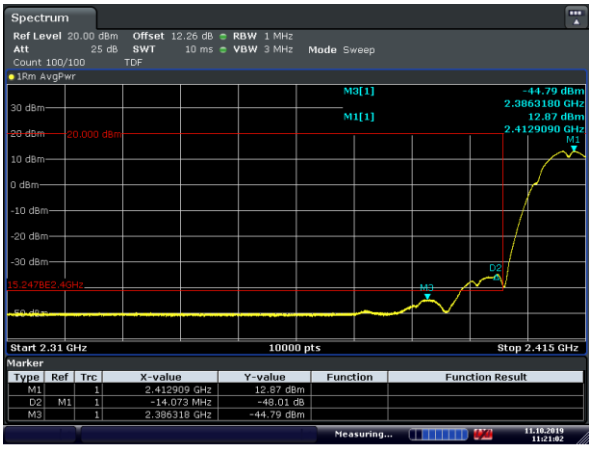


Figure 8.4-10: *Band-edge for 802.11b, 2412MHz,*

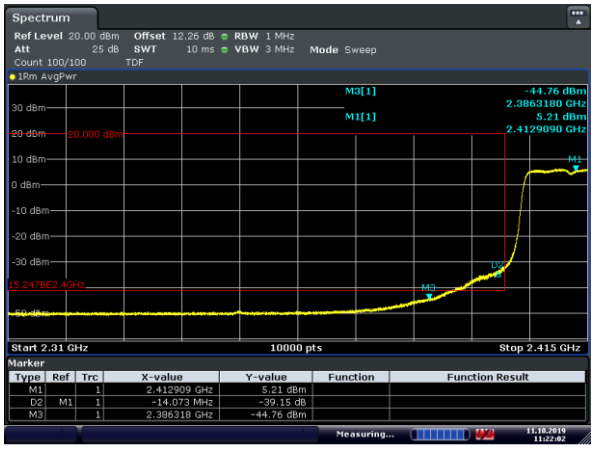


Figure 8.4-11: *Band-edge for 802.11g, 2412MHz,*

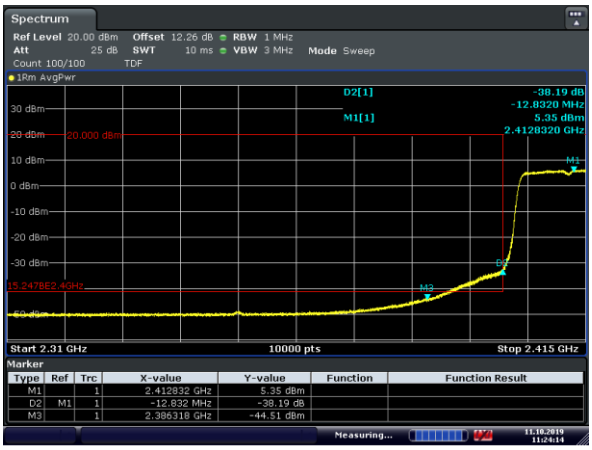


Figure 8.4-12: *Band-edge for 802.11n20, 2412MHz,*

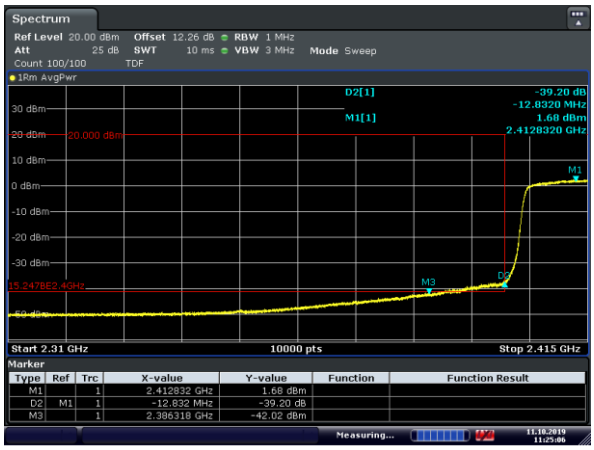


Figure 8.4-13: *Band-edge for 802.11n40, 2422MHz,*

Upper Band-Edge Measurements

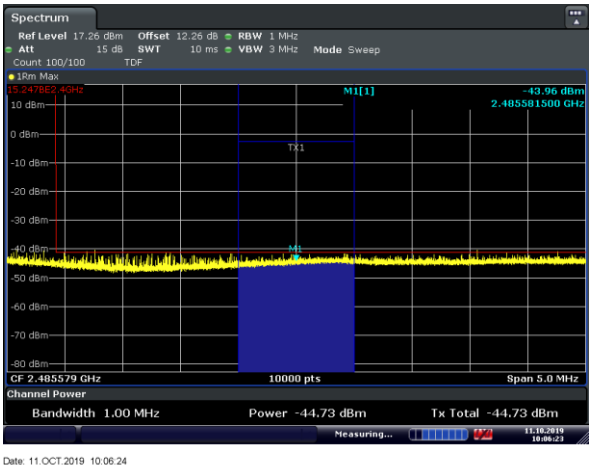


Figure 8.4-14: *Upper Band-edge 802.11b 2462 MHz. Highest peak in Restricted Band near Band-Edge Overall view*

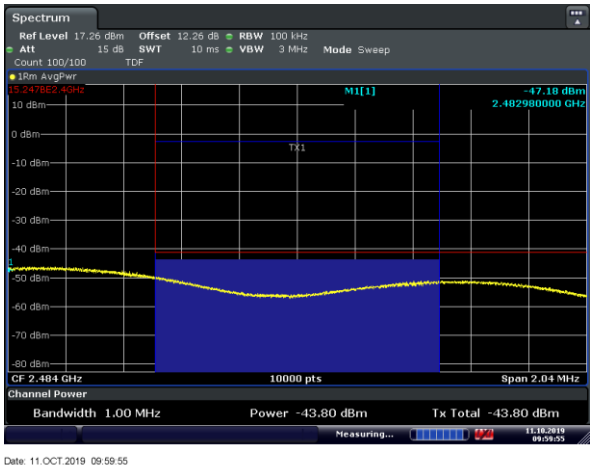


Figure 8.4-15: *Upper Band-edge for 802.11b, 2462 MHz, (2484MHz)*

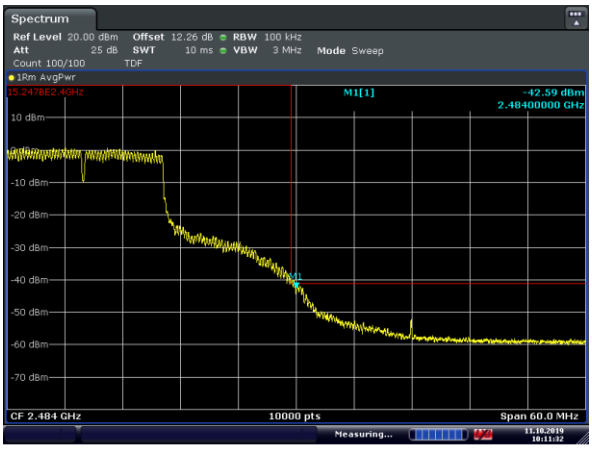


Figure 8.4-16: *Upper Band-edge for 802.11g, 2457 MHz, overall view*

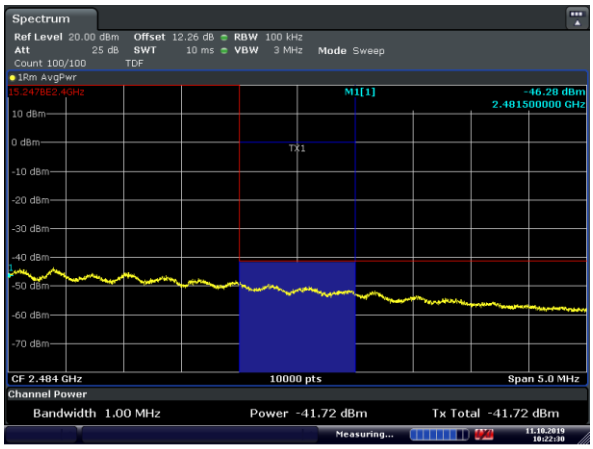


Figure 8.4-17: *Upper Band-edge for 802.1g, 2457 MHz, zoomed in at 2484MHz*

Upper Band-Edge Measurements

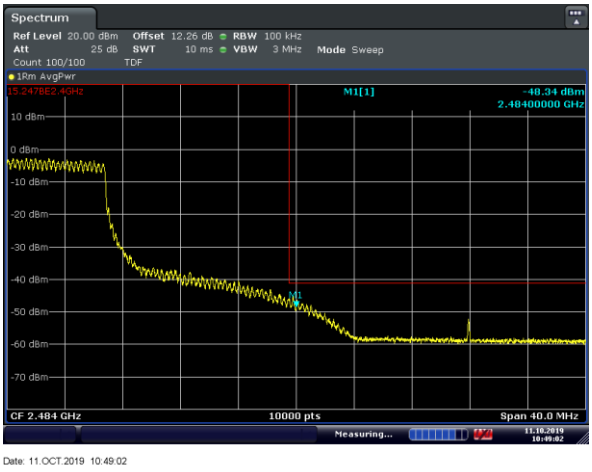


Figure 8.4-18: *Upper Band-edge 802.11n20 2462MHz. Highest peak in Restricted Band near Band-Edge Overall view*

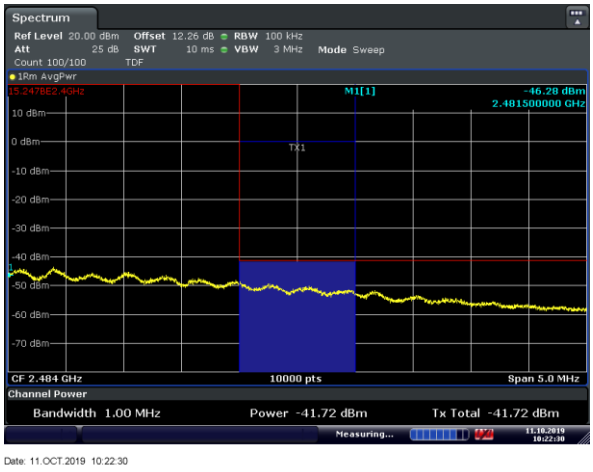


Figure 8.4-19: *Upper Band-edge for 802.11n20, 2462MHz, (2484MHz)*

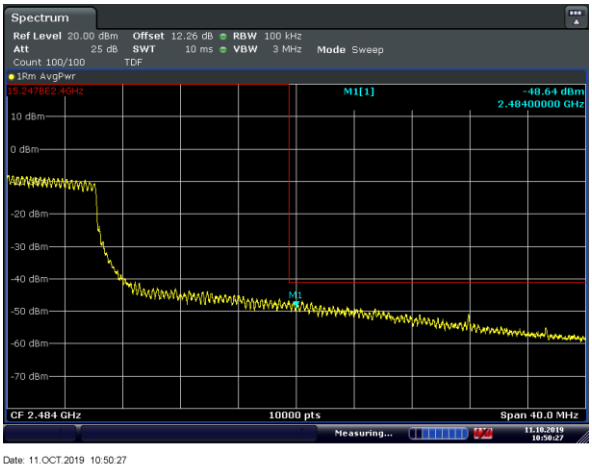


Figure 8.4-20: *Upper Band-edge for 802.11n40, 2462MHz, overall view*

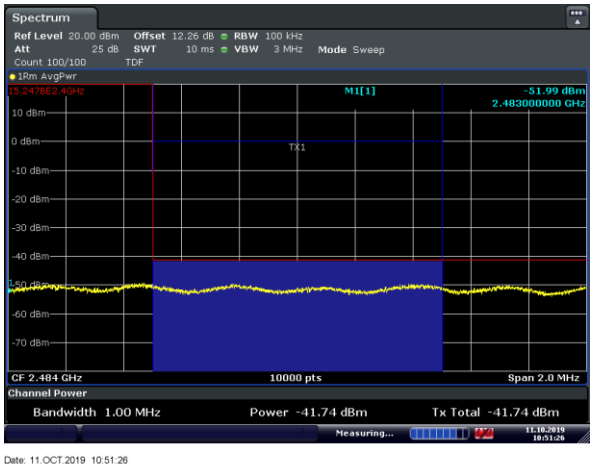


Figure 8.4-21: *Upper Band-edge for 802.11n40, 2462MHz, zoomed in at 2484MHz*

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

8.5.1 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.

ISED:
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 5.2(d), (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

Test date	September 10, 2019	Temperature	24 °C
Test engineer	Andres Martinez	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	45 %

8.5.3 Observations, settings and special notes

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). Spectrum analyzer settings:

Resolution bandwidth:	3kHz to 100 kHz
Video bandwidth:	1 MHz
Frequency span:	30 MHz (1.5 × DTS channel BW for 802.11b), 30 MHz (1.5 × DTS channel BW for 802.11g and 802.11n HT20) and to 60 MHz (1.5 × DTS channel BW for 802.11n HT40)
Detector mode:	RMS
Trace mode:	Power average
Averaging sweeps number:	100

Combined PSD for MIMO 2 × 2 application was calculated as follows: $PSD_{combined} = 10 \times log_{10}\left(\left(10^{PSD_{ch0}/10}\right) + \left(10^{PSD_{ch1}/10}\right)\right)$

Combined PSD for MIMO 3 × 3 application was calculated as follows: $PSD_{combined} = 10 \times log_{10}\left(\left(10^{PSD_{ch0}/10}\right) + \left(10^{PSD_{ch1}/10}\right) + \left(10^{PSD_{ch2}/10}\right)\right)$

8.5.4 Test data

Table 8.5-1: *PSD measurements results.*

Modulation	Frequency, MHz	PSD, dBm/100 kHz	10log (2) + Ant gain	Total PSD	PSD limit, dBm/3kHz	Margin, dB
802.11b	2412	-5.77 (10kHz)	5	-0.77	8.00	8.77
	2437	-5.23 (10kHz)	5	-0.23	8.00	8.23
	2452	-6.12 (10kHz)	5	-1.12	8.00	9.12
802.11g	2412	-0.51	5	4.49	8.00	3.51
	2442	0.43	5	5.43	8.00	2.57
	2462	0.24	5	5.24	8.00	2.76
802.11n HT20	2412	-0.73	5	4.27	8.00	3.73
	2442	0.23	5	5.23	8.00	2.77
	2462	-0.14	5	4.86	8.00	3.14
802.11n HT40	2422	-4.13	5	0.87	8.00	7.13
	2442	-2.66	5	2.34	8.00	5.66
	2462	-2.38	5	2.62	8.00	5.38

Note: 2x2 MIMO = 10 log (2) = 3 dB
Antenna Gain at 2.4GHz = 2dB
802.11b measurement were done at 10kHz RBW.

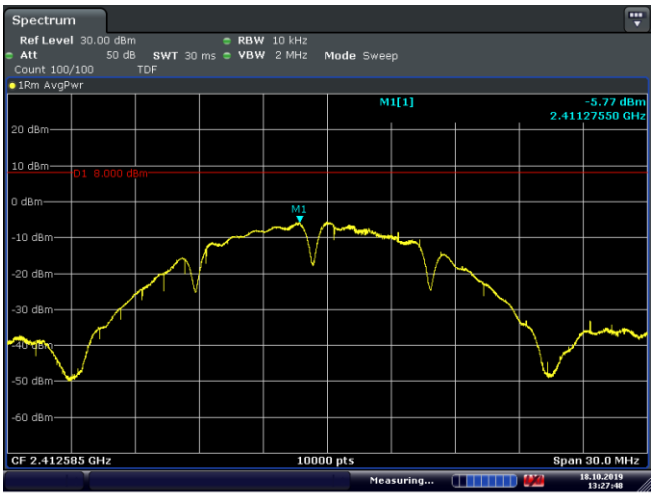


Figure 8.5-1: *PSD sample plot on 802.11b – Low Channel*

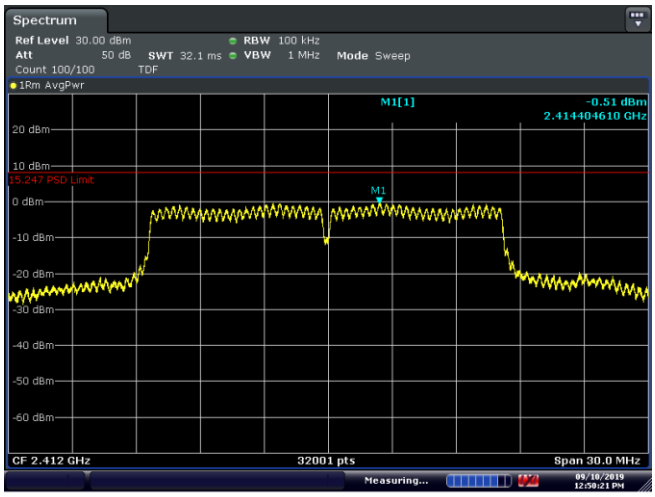


Figure 8.5-2: *PSD sample plot on 802.11g – Low Channel*

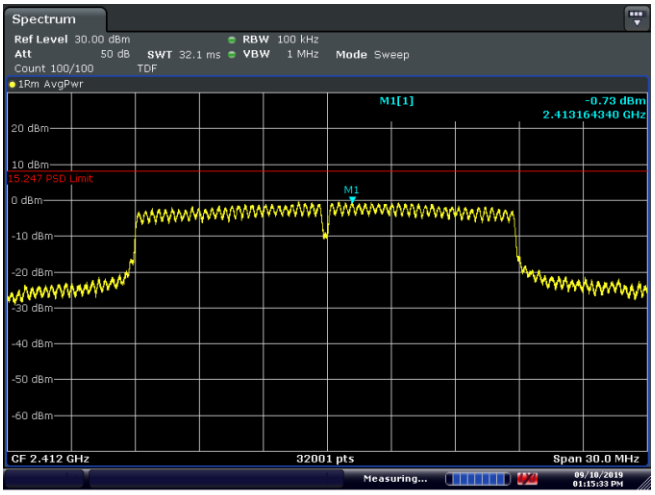


Figure 8.5-3: *PSD sample plot on 802.11n20– Low Channel*

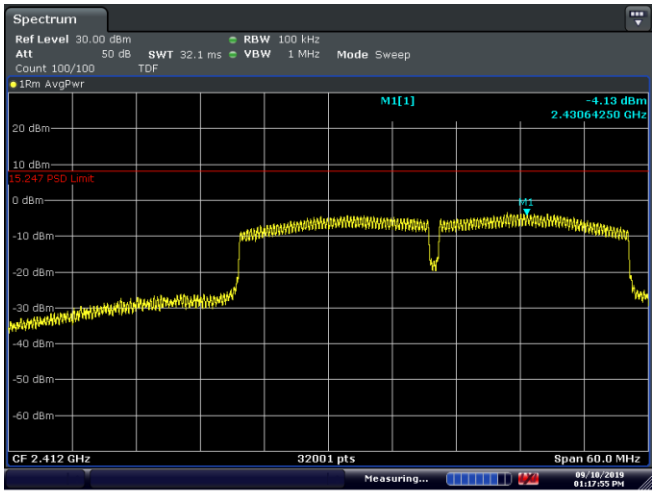
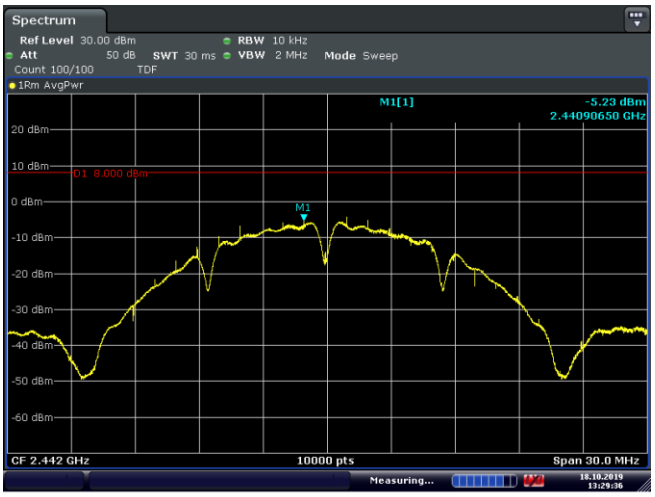
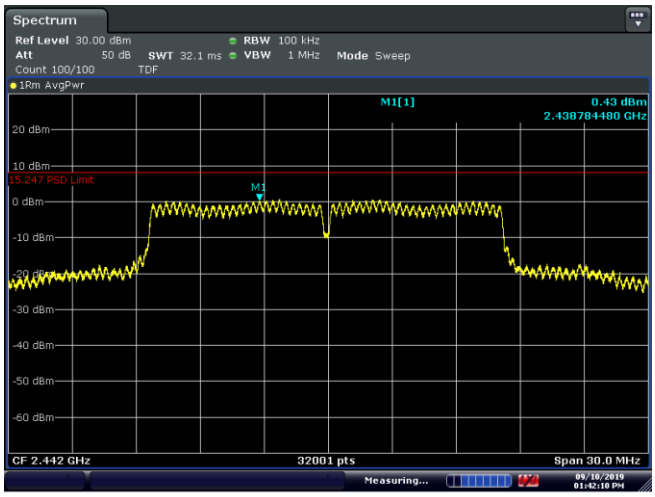


Figure 8.5-4: *PSD sample plot on 802.11n40– Low Channel*



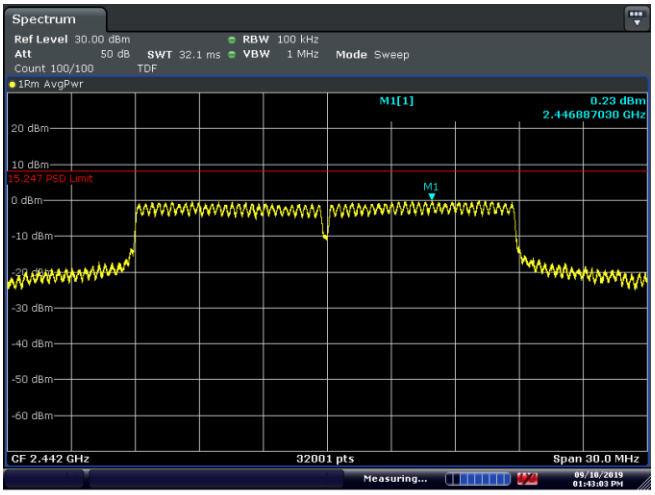
Date: 18.OCT.2019 13:29:37

Figure 8.5-5: *PSD sample plot on 802.11b – Mid Channel*



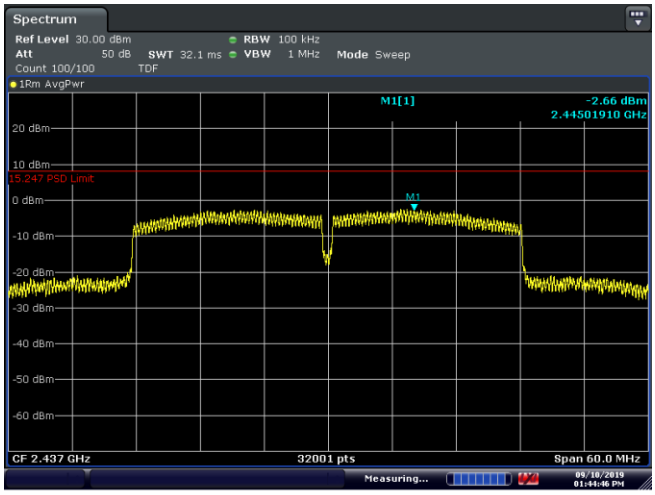
Date: 10.SEP.2019 13:42:10

Figure 8.5-6: *PSD sample plot on 802.11g – Mid Channel*



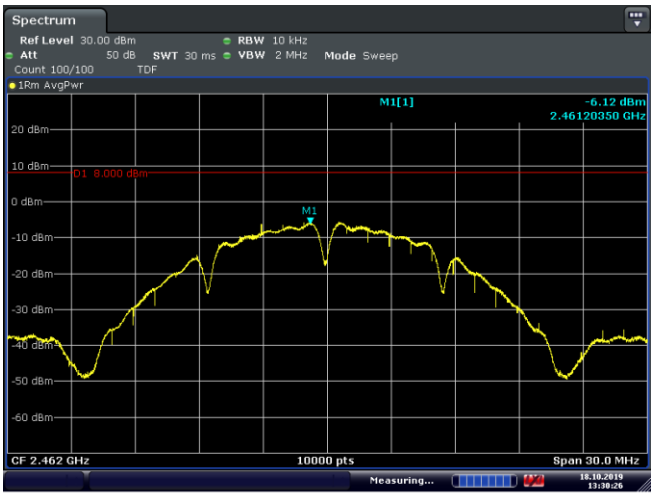
Date: 10.SEP.2019 13:43:03

Figure 8.5-7: *PSD sample plot on 802.11n20 – Mid Channel*



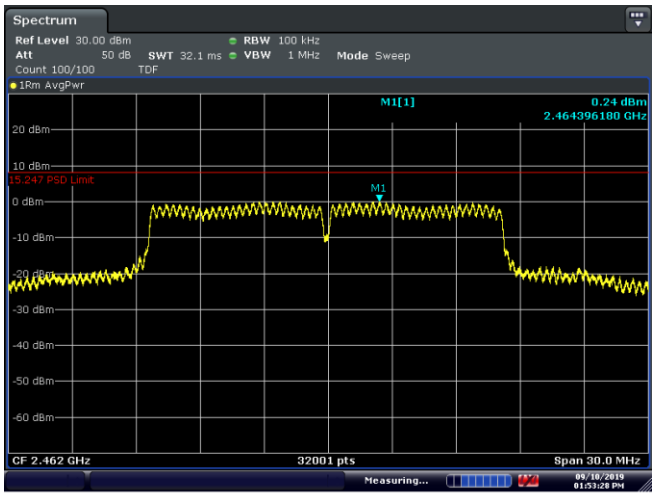
Date: 10.SEP.2019 13:44:47

Figure 8.5-8: *PSD sample plot on 802.11n40 – Mid Channel*



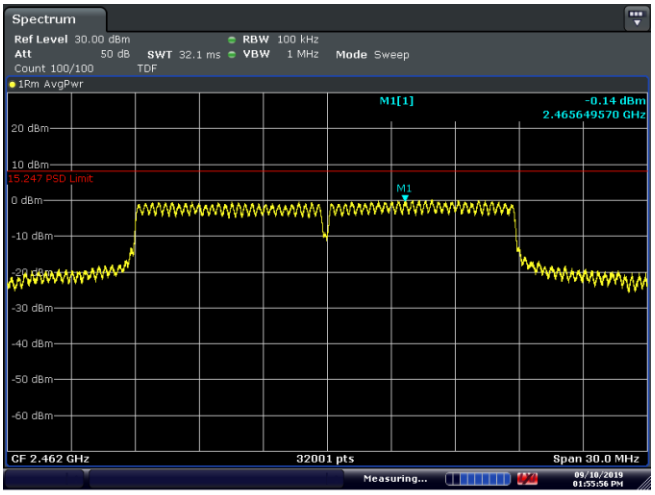
Date: 18.OCT.2019 13:30:27

Figure 8.5-9: *PSD sample plot on 802.11b – High Channel*



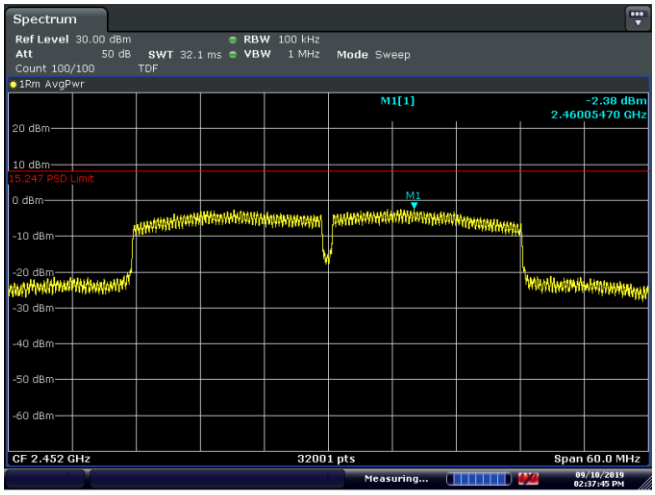
Date: 10.SEP.2019 13:53:29

Figure 8.5-10: *PSD sample plot on 802.11g – High Channel*



Date: 10.SEP.2019 13:55:57

Figure 8.5-11: *PSD sample plot on 802.11n20 – High Channel*

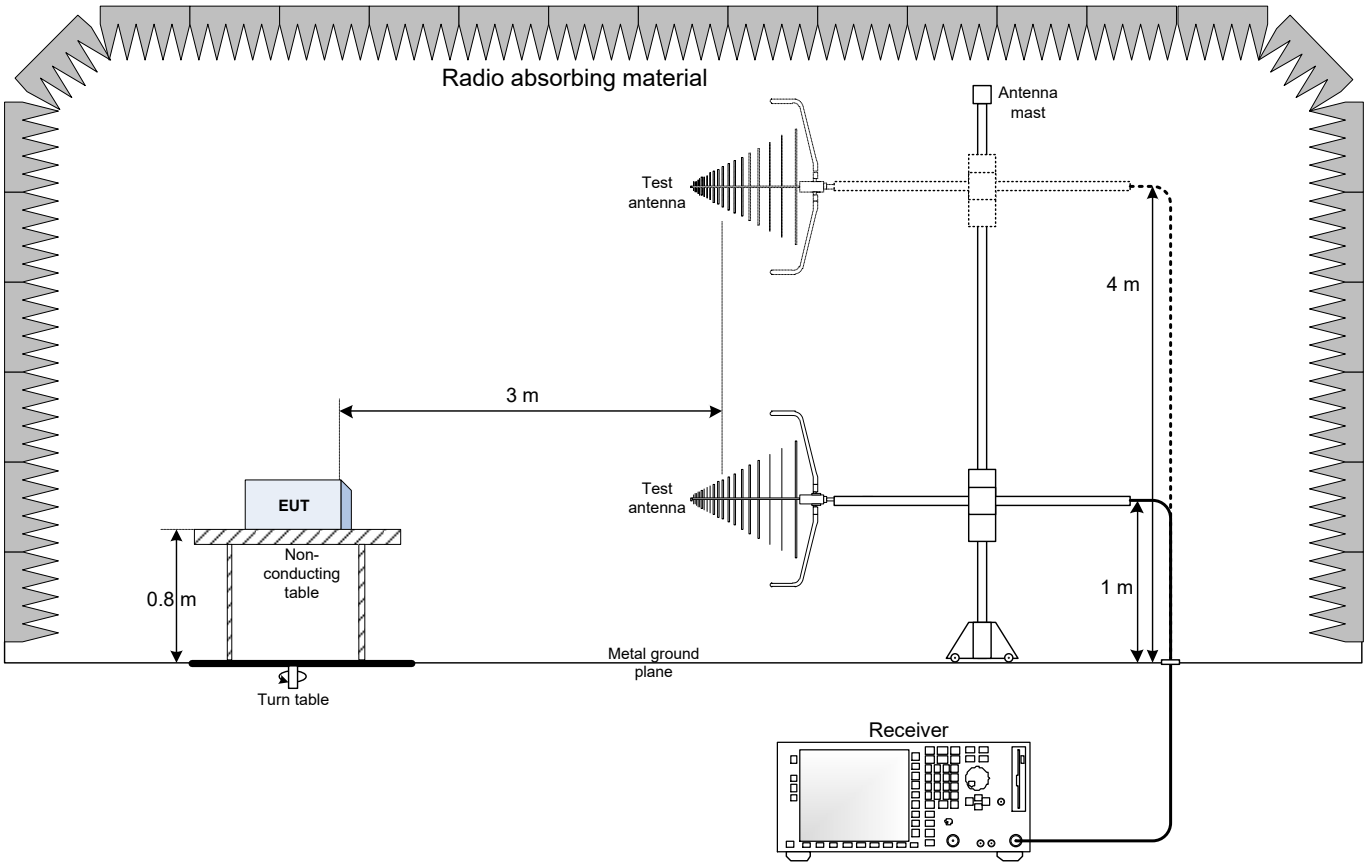


Date: 10.SEP.2019 14:37:45

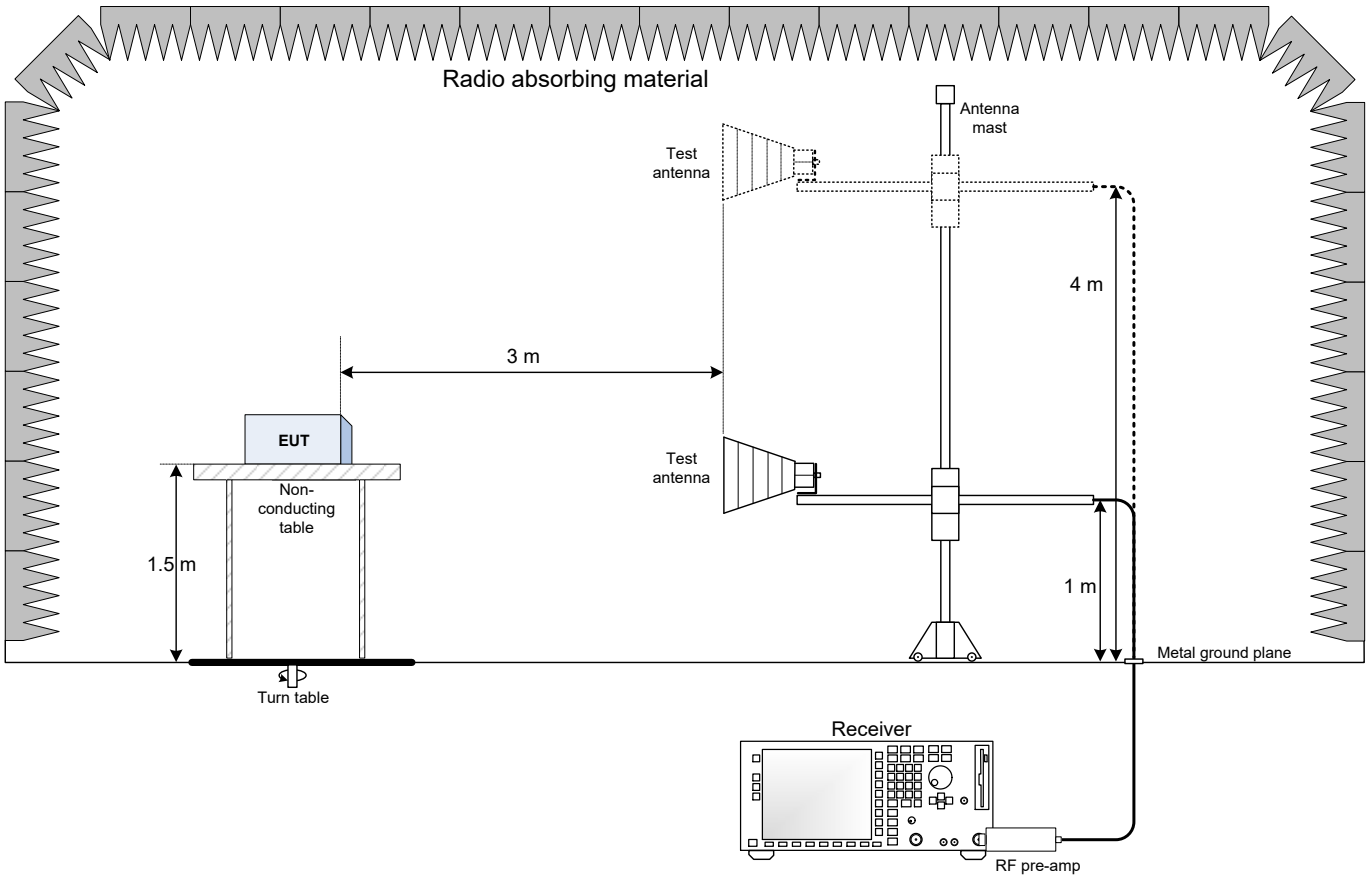
Figure 8.5-12: *PSD sample plot on 802.11n40 – High Channel*

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