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Test report

FCC-15.247 WIFI KIC Smart Profiler #323702

Date of issue: May 23, 2017

Applicant: KIC

Product: Smart Profiler

Model: GPS Profiler Model variant: N/A

FCC ID: MWNKIC86

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 2, February 2017

  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

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City	Carlsbad
Province	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
Site number	FCC: US5058; IC: 2040B

Tested by	Feng You, Sr. Wireless Engineer
Reviewed by	James Morris, EMC and Wireless Divisions Manager
Review date	May 23, 2017
Reviewer signature	James E Morris

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 USA's ISO/IEC 17025 accreditation.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	KIC
Address	16120 W Bernardo Dr.
City	San Diego
Province/State	CA
Postal/Zip code	92127
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, 5725–5850 MHz
RSS-247, Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test methods

ANSI C64.3-2014	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	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
1	Original report issued
2	Updated per review comment.

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
§15.203	Antenna requirement	Pass[1]
§15.205	Restricted bands of operation	Pass

Notes: [1] The EUT uses PCB antennas internally.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)	20 dB bandwidth of the hopping channel	Not applicable
§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 4, test results

Part	Test description	Verdict
7.1.2	Receiver radiated emission limits	Not applicable
7.1.3	Receiver conducted emission limits	Not applicable
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Pass
8.10	Restricted Frequency Bands	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 modulation systems	
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	Unwanted Emissions	Pass

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	January 31, 2017
Nemko sample ID number	EMC40131

3.2 EUT information

Product name	Smart Profiler
Model	GPS Profiler
Model variant	N/A
Serial number	GPS-031007
FCC ID	MWNKIC86
IC Registration Number	N/A

3.3 Technical information

Applicant IC company number	N/A
IC UPN number	N/A
All used IC test site(s) Reg. number	2040B
RSS number and Issue number	RSS-247, Issue 2, February 2017
Frequency band	2400-2483.5 MHz
Frequency Min (MHz)	2412
Frequency Max (MHz)	2462
RF power Min (W), Conducted/ERP/EIRP	N/A
RF power Max (W), Conducted/ERP/EIRP	0.0708 (Conducted)
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	17720
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	DSSS/(BPSK, QPSK, CCK), OFDM/(BPSK, QPSK, QAM16, QAM64)
Emission classification (F1D, G1D, D1D)	G1D, W7D
Transmitter spurious, Units @ distance	51.97 dBµV/m @ 3m AVG, 65.25 dBµV/m @ 3m Peak
Power requirements	External 5V DC microUSB charger, AC power 100-240V 50/60Hz; Internal rechargeable battery.
Antenna information	Chip antennas on PCB. Antenna gain is 1.6dBi. (TAIYO YUDEN AF216M245001-T) The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The GPS Profiler is smart profiler to send sensor data using ANT technology (2.456MHz) and Wi-Fi (2.4GHz b/g/n).

3.5 EUT exercise details

A test software was used that allows the change of different RF modes/channels. EUT is set to fixed channel test mode with modulation.

RF conducted test was performed on unit with temporary RF output modification (50Ω SMA before antennas). There is 1 reset switch added to Wifi controller, for test software use only.

3.6 EUT setup diagram

Please see separate photo exhibit

Figure 3.6-1: *Radiated Emissions Test Setup – below 1GHz*

Please see separate photo exhibit

Figure 3.6-2: *Radiated Emissions Test Setup – above 1GHz*

Please see separate photo exhibit

Figure 3.6-3: *AC Conducted Emissions Test Setup*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
EUT – Radiated Unit	KIC	PTG-101240	GPS-061006
EUT – RF Conducted Unit	KIC	PTG-400120-000	GPB-000215
AC Power Supply / micro USB Charger	XPPower	VER05US050-BB	N/A

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

Test channels and test modes (modulation) were optimized according to ANSI 63.10-2013 sec.5.6.2.

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.

120VAC 60Hz (AC charger Rating 100-240V AC 50-60Hz)

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	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Asset Tag	Description	Manufacturer	Model	Serial #	Next Cal
811	Multimeter	Fluke	111	78130057	8-Jul-17
1033	Antenna, Horn	EMCO	3115	8812-3035	27-Jul-17
E1019	Two Line V-Network	Rohde & Schwarz	ENV216	101045	15-Jun-2017
E1035	Variac (Variable Transformer) 3KVA	Shanghai China	TDGC	N/A	VOU
1480	Antenna, Bilog	Schaffner-Chase	CBL6111C	2572	21-Jul-2017
E1120	Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101395	25-May-2017
E1121	EMI Test Receiver	Rohde & Schwarz	ESU 40	100064	28-Apr-2017
E1120	Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101395	25-May-2017
1767	Receiver, EMI Test 20Hz - 26.5 GHz - 150 - +30 dBm LCD	Rohde & Schwartz	ESIB26	837491/0002	21-Feb-2019
E1013	Antenna, Horn	ETS-Lindgren	3116	00119488	18-Nov-2017

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

Section 8. Test Data

8.1 FCC 15.247(a) (2) and RSS-247 5.2(1) Minimum 6 dB bandwidth

8.1.1 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.

IC RSS-247

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

8.1.2 Test summary

Test date	April 12, 2017	Temperature	21 °C
Test engineer	Feng You	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	51 %

8.1.3 Observations, settings and special notes

Spectrum analyzer settings:

Resolution bandwidth	100 kHz
Video bandwidth	≥3 × RBW
Frequency span	1.5 x OBW
Detector mode	Peak
Trace mode	Max Hold

Per ANSI 63.10-2013 5.6.2.1

a) For each operating mode, if the measured channel bandwidth on the middle channel is at least 150% of the minimum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.

8.1.4 Test data

Table 8.1-1: *6 dB bandwidth results with middle channel 2437MHz*

Channel BW, MHz	Modulation	Data Rate	6dB bandwidth, kHz	Limit, kHz	Margin, kHz
20	DSSS/BPSK	1	9110	500	8610
20	DSSS/QPSK	2	9090	500	8590
20	DSSS/CCK	5.5	8600	500	8100
20	DSS/CCK	11	5530	500	5030
20	OFDM/BPSK	6	15040	500	14540
20	OFDM/BPSK	9	15080	500	14580
20	OFDM/QPSK	12	15110	500	14610
20	OFDM/QPSK	18	15090	500	14590
20	OFDM/QAM16	24	16460	500	15960
20	OFDM/QAM16	36	16490	500	15990
20	OFDM/QAM64	48	16460	500	15960
20	OFDM/QAM64	54	16450	500	15950
20	OFDM/BPSK	MCS0	15090	500	14590
20	OFDM/QPSK	MCS1	15110	500	14610
20	OFDM/QPSK	MCS2	15090	500	14590
20	OFDM/QAM16	MCS3	17690	500	17190
20	OFDM/QAM16	MCS4	17720	500	17220
20	OFDM/QAM64	MCS5	17720	500	17220
20	OFDM/QAM64	MCS6	17710	500	17210
20	OFDM/QAM64	MCS7	17690	500	17190

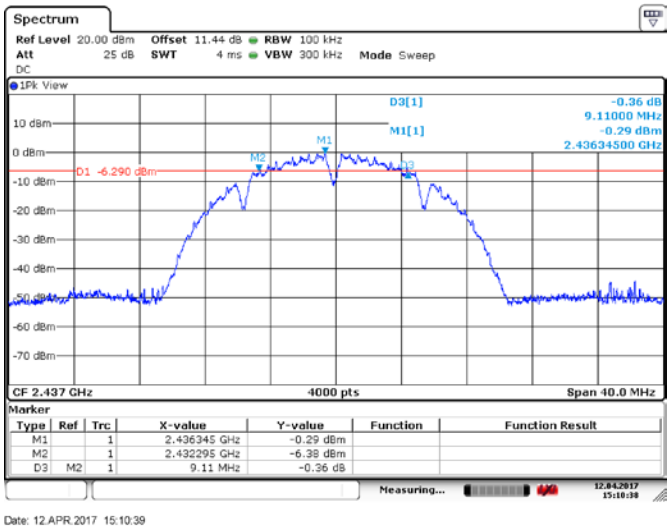


Figure 8.1-1: *6 dB bandwidth, 20MHz BW DSSS/BPSK 1 Mbps*

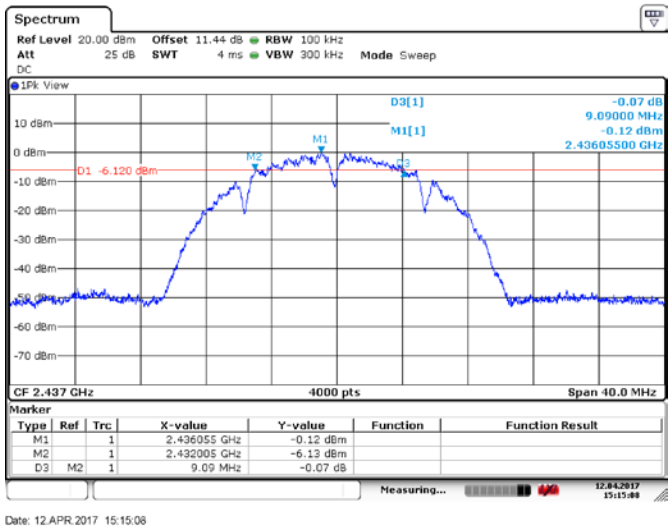


Figure 8.1-2: *6 dB bandwidth, 20MHz BW DSSS/QPSK 2 Mbps*

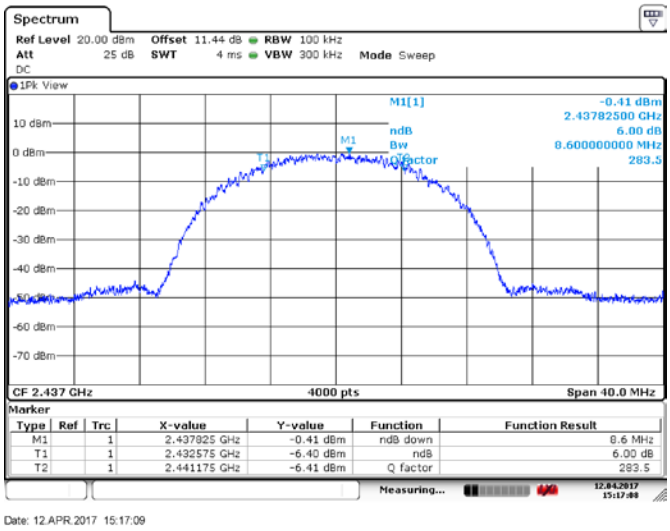


Figure 8.1-3: *6 dB bandwidth, 20MHz BW DSSS/CCK 5.5 Mbps*

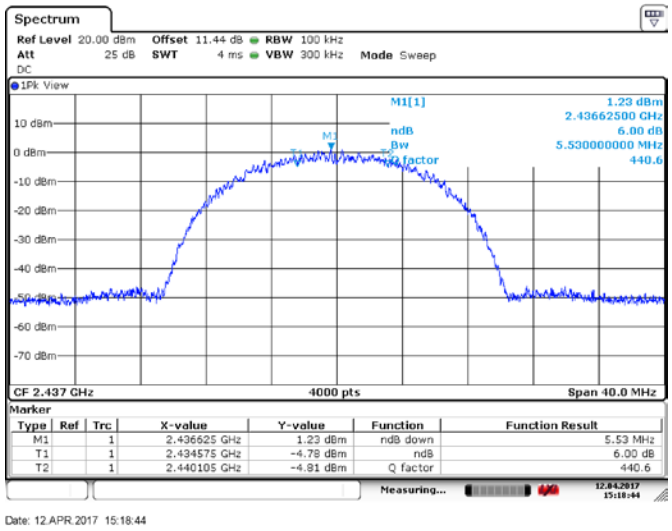


Figure 8.1-4: *6 dB bandwidth, 20MHz BW DSSS/CCK 11 Mbps*

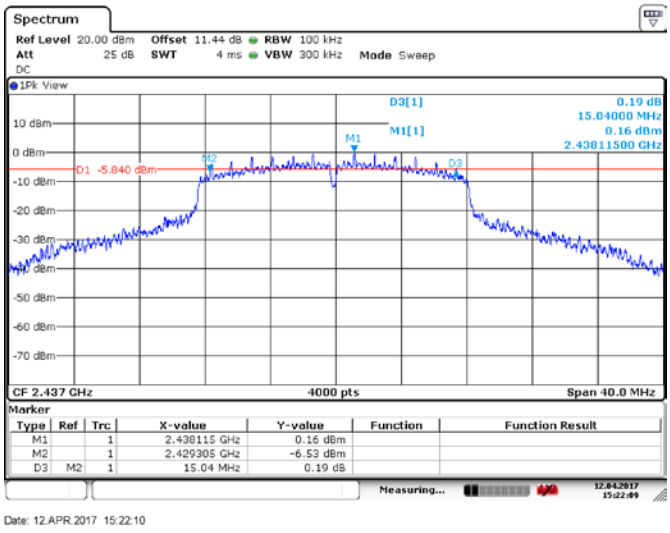


Figure 8.1-5: *6 dB bandwidth, 20MHz BW OFDM/BPSK 6 Mbps*

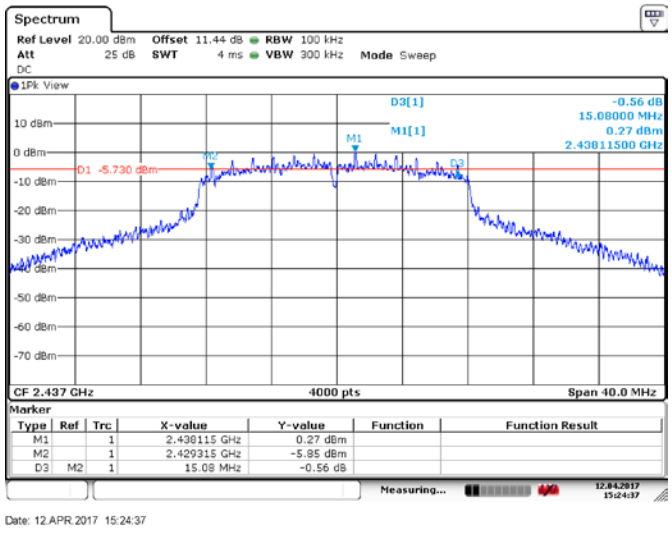


Figure 8.1-6: *6 dB bandwidth, 20MHz BW OFDM/BPSK 9 Mbps*

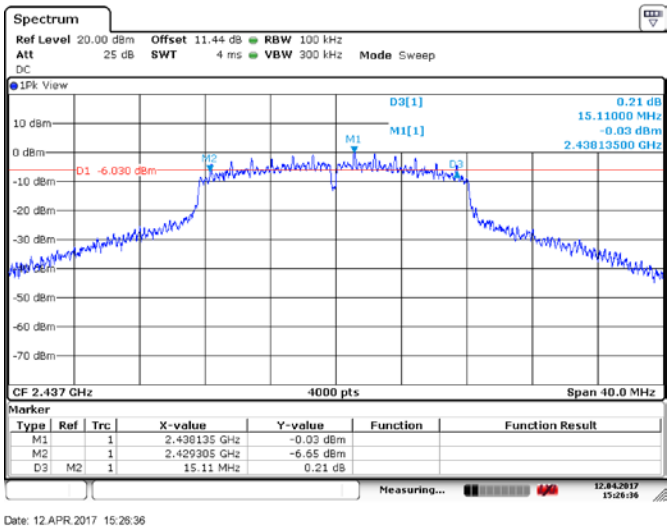


Figure 8.1-7: *6 dB bandwidth, 20MHz BW OFDM/QPSK 12 Mbps*

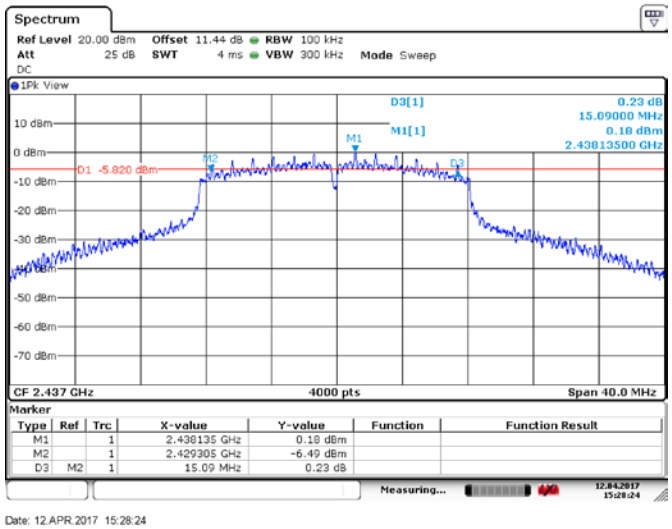


Figure 8.1-8: *6 dB bandwidth, 20MHz BW OFDM/QPSK 18 Mbps*

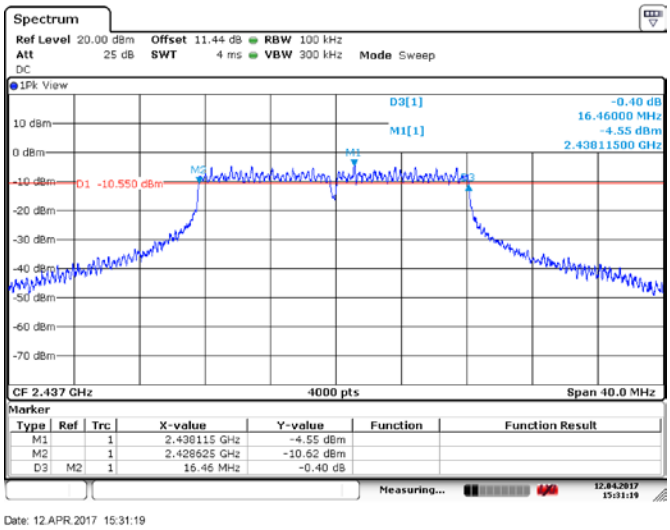


Figure 8.1-9: *6 dB bandwidth, 20MHz BW OFDM/QAM16 24 Mbps*

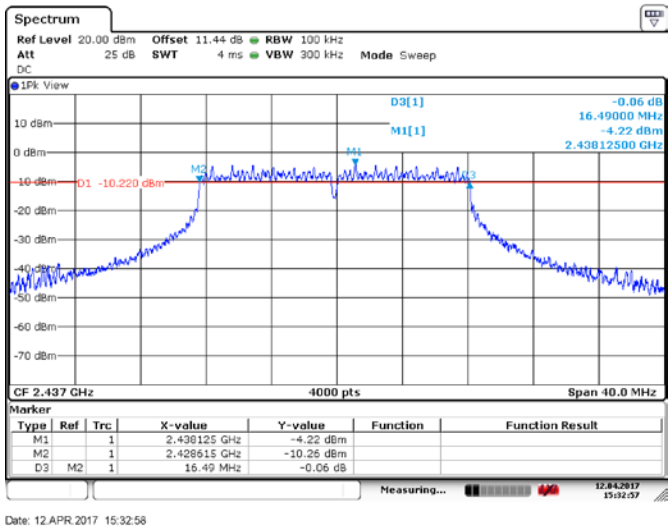


Figure 8.1-10: *6 dB bandwidth, 20MHz BW OFDM/QAM16 36 Mbps*

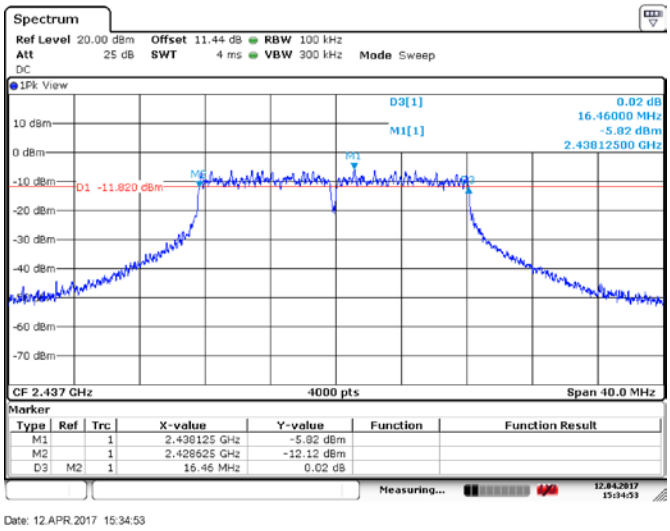


Figure 8.1-11: *6 dB bandwidth, 20MHz BW OFDM/QAM64 48 Mbps*

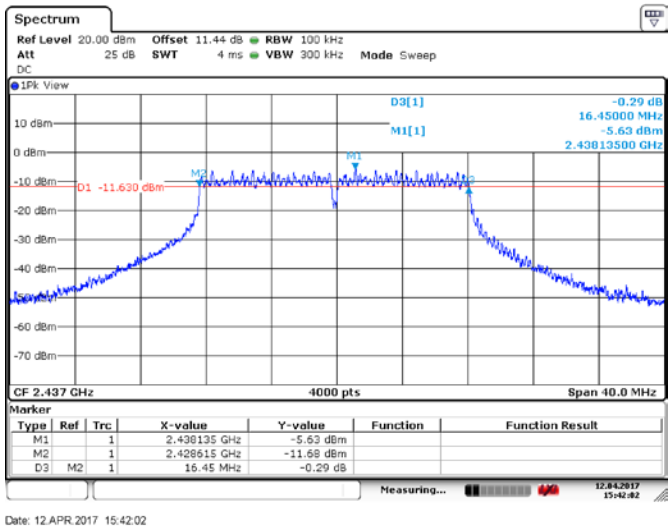


Figure 8.1-12: *6 dB bandwidth, 20MHz BW OFDM/QAM64 54 Mbps*

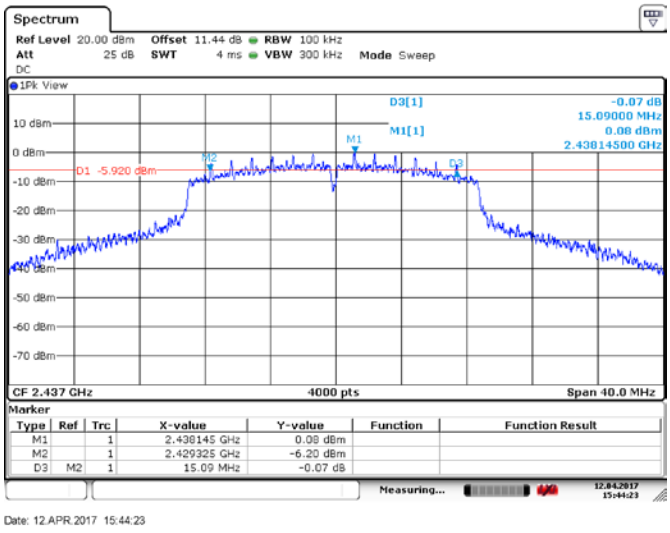


Figure 8.1-13: *6 dB bandwidth, 20MHz BW OFDM/BPSK MCS0*

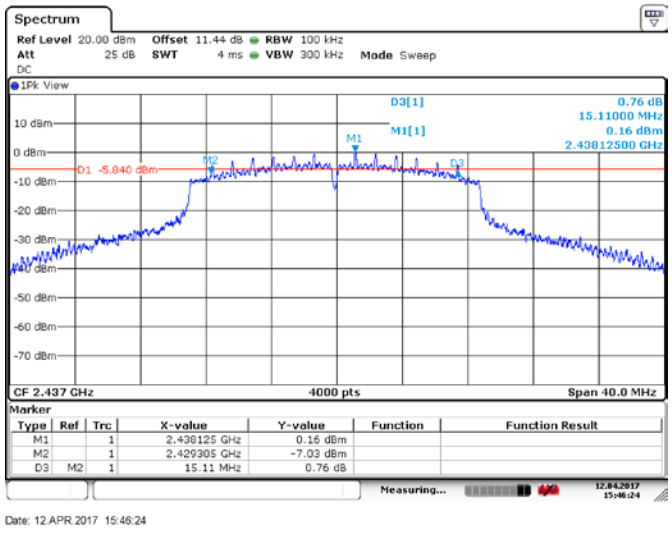


Figure 8.1-14: *6 dB bandwidth, 20MHz BW OFDM/QPSK MCS1*

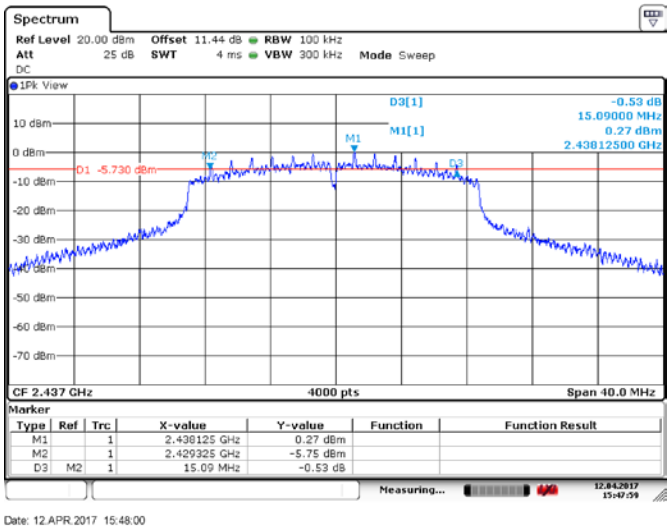


Figure 8.1-15: *6 dB bandwidth, 20MHz BW OFDM/QPSK MCS2*

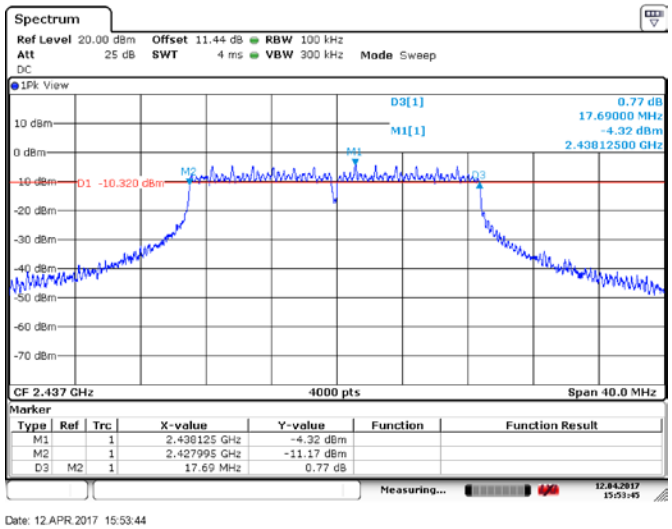


Figure 8.1-16: *6 dB bandwidth, 20MHz BW OFDM/QAM16 MCS3*

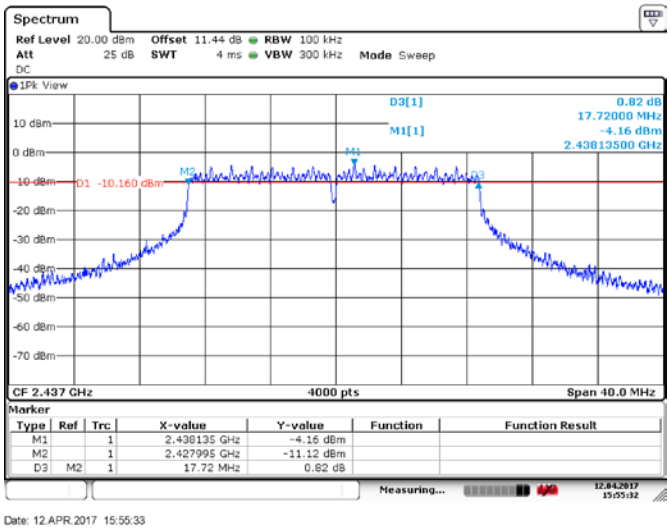


Figure 8.1-17: *6 dB bandwidth, 20MHz BW OFDM/QAM16 MCS4*

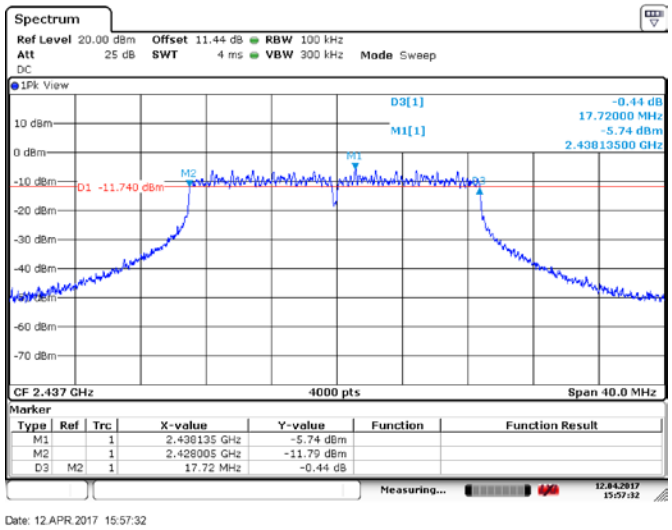


Figure 8.1-18: *6 dB bandwidth, 20MHz BW OFDM/QAM64 MCS5*

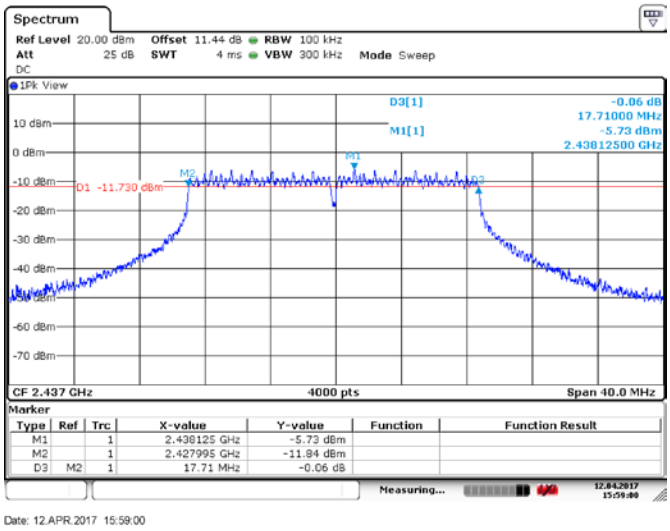


Figure 8.1-19: *6 dB bandwidth, 20MHz BW OFDM/QAM64 MCS6*

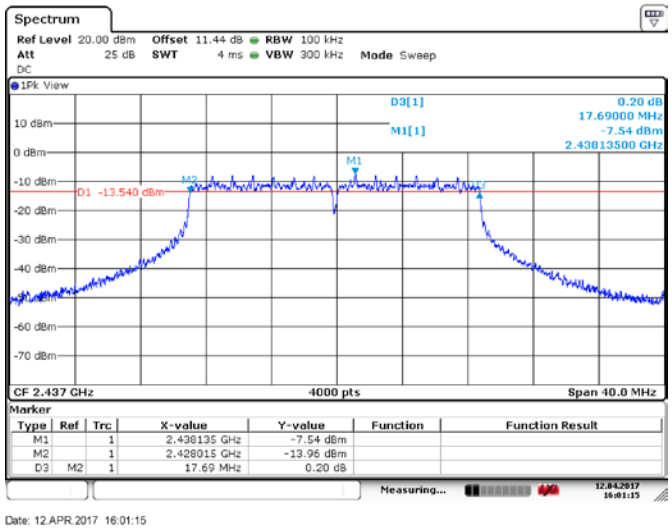


Figure 8.1-20: *6 dB bandwidth, 20MHz BW OFDM/QAM64 MCS7*

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

8.2.1 Definitions and limits

FCC:

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

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

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

IC:

5.4 Transmitter Output Power and Equivalent Isotropically Radiated Power (E.I.R.P.) Requirements

(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.

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling 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 transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

8.2.2 Test summary

Test date	April 12, 2017	Temperature	21 °C
Test engineer	Feng You	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	51 %

8.2.3 Observations, settings and special notes

Peak Conducted Power Measured
Spectrum analyzer settings:

Resolution bandwidth	1MHz
Video bandwidth	3MHz
Channel Power bandwidth	20MHz / 40MHz
Frequency span	30MHz / 60MHz
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *Output power measurements results – Low Channel (2412MHz @20MHz BW)*

Channel BW MHz	Modulation	Data Rate	Conducted Power dBm	Power Limit dBm	Margin dB	Ant gain dBi	ERIP dBm	EIRP Limit dBm	EIRP margin dB
20	DSSS/BPSK	1	12.4	30	17.6	1.6	14.0	36	22.0
20	DSSS/QPSK	2	12.4	30	17.6	1.6	14.0	36	22.0
20	DSSS/CCK	5.5	14.0	30	16.0	1.6	15.6	36	20.4
20	DSS/CCK	11	15.6	30	14.4	1.6	17.2	36	18.8
20	OFDM/BPSK	6	15.0	30	15.0	1.6	16.6	36	19.4
20	OFDM/BPSK	9	15.1	30	14.9	1.6	16.7	36	19.3
20	OFDM/QPSK	12	14.7	30	15.3	1.6	16.3	36	19.7
20	OFDM/QPSK	18	14.5	30	15.5	1.6	16.1	36	19.9
20	OFDM/QAM16	24	14.1	30	15.9	1.6	15.7	36	20.3
20	OFDM/QAM16	36	13.9	30	16.1	1.6	15.5	36	20.5
20	OFDM/QAM64	48	12.6	30	17.4	1.6	14.2	36	21.8
20	OFDM/QAM64	54	12.8	30	17.2	1.6	14.4	36	21.6
20	OFDM/BPSK	MCS0	14.5	30	15.5	1.6	16.1	36	19.9
20	OFDM/QPSK	MCS1	14.3	30	15.7	1.6	15.9	36	20.1
20	OFDM/QPSK	MCS2	14.4	30	15.6	1.6	16.0	36	20.0
20	OFDM/QAM16	MCS3	13.6	30	16.4	1.6	15.2	36	20.8
20	OFDM/QAM16	MCS4	13.9	30	16.1	1.6	15.5	36	20.5
20	OFDM/QAM64	MCS5	12.4	30	17.6	1.6	14.0	36	22.0
20	OFDM/QAM64	MCS6	12.6	30	17.4	1.6	14.2	36	21.8
20	OFDM/QAM64	MCS7	10.4	30	19.6	1.6	12.0	36	24.0

Table 8.2-2: *Output power measurements results – Mid Channel (2437MHz)*

Channel BW MHz	Modulation	Data Rate	Conducted Power dBm	Power Limit dBm	Margin dB	Ant gain dBi	ERIP dBm	EIRP Limit dBm	EIRP margin dB
20	DSSS/BPSK	1	13.1	30	17.0	1.6	14.7	36	21.4
20	DSSS/QPSK	2	13.3	30	16.7	1.6	14.9	36	21.1
20	DSSS/CCK	5.5	15.1	30	14.9	1.6	16.7	36	19.3
20	DSS/CCK	11	16.7	30	13.3	1.6	18.3	36	17.7
20	OFDM/BPSK	6	18.2	30	11.8	1.6	19.8	36	16.2
20	OFDM/BPSK	9	18.4	30	11.6	1.6	20.0	36	16.0
20	OFDM/QPSK	12	18.1	30	11.9	1.6	19.7	36	16.3
20	OFDM/QPSK	18	18.3	30	11.7	1.6	19.9	36	16.1
20	OFDM/QAM16	24	16.1	30	13.9	1.6	17.7	36	18.3
20	OFDM/QAM16	36	16.1	30	13.9	1.6	17.7	36	18.3
20	OFDM/QAM64	48	14.5	30	15.5	1.6	16.1	36	19.9
20	OFDM/QAM64	54	14.5	30	15.5	1.6	16.1	36	19.9
20	OFDM/BPSK	MCS0	17.9	30	12.1	1.6	19.5	36	16.5
20	OFDM/QPSK	MCS1	17.9	30	12.2	1.6	19.5	36	16.6
20	OFDM/QPSK	MCS2	18.1	30	11.9	1.6	19.7	36	16.3
20	OFDM/QAM16	MCS3	15.8	30	14.2	1.6	17.4	36	18.6
20	OFDM/QAM16	MCS4	16.0	30	14.0	1.6	17.6	36	18.4
20	OFDM/QAM64	MCS5	14.3	30	15.7	1.6	15.9	36	20.1
20	OFDM/QAM64	MCS6	14.4	30	15.6	1.6	16.0	36	20.0
20	OFDM/QAM64	MCS7	12.2	30	17.8	1.6	13.8	36	22.2

Table 8.2-3: *Output power measurements results – High Channel (2462MHz @20MHz BW)*

Channel BW MHz	Modulation	Data Rate	Conducted Power dBm	Power Limit dBm	Margin dB	Ant gain dBi	ERIP dBm	EIRP Limit dBm	EIRP margin dB
20	DSSS/BPSK	1	12.4	30	17.6	1.6	14.0	36	22.0
20	DSSS/QPSK	2	12.9	30	17.1	1.6	14.5	36	21.5
20	DSSS/CCK	5.5	14.5	30	15.5	1.6	16.1	36	19.9
20	DSS/CCK	11	16.6	30	13.4	1.6	18.2	36	17.8
20	OFDM/BPSK	6	15.4	30	14.6	1.6	17.0	36	19.0
20	OFDM/BPSK	9	15.5	30	14.5	1.6	17.1	36	18.9
20	OFDM/QPSK	12	15.2	30	14.8	1.6	16.8	36	19.2
20	OFDM/QPSK	18	15.0	30	15.0	1.6	16.6	36	19.4
20	OFDM/QAM16	24	14.4	30	15.6	1.6	16.0	36	20.0
20	OFDM/QAM16	36	14.4	30	15.7	1.6	16.0	36	20.1
20	OFDM/QAM64	48	13.7	30	16.3	1.6	15.3	36	20.7
20	OFDM/QAM64	54	13.8	30	16.2	1.6	15.4	36	20.6
20	OFDM/BPSK	MCS0	15.0	30	15.0	1.6	16.6	36	19.4
20	OFDM/QPSK	MCS1	14.9	30	15.1	1.6	16.5	36	19.5
20	OFDM/QPSK	MCS2	15.0	30	15.0	1.6	16.6	36	19.4
20	OFDM/QAM16	MCS3	14.1	30	15.9	1.6	15.7	36	20.3
20	OFDM/QAM16	MCS4	14.3	30	15.7	1.6	15.9	36	20.1
20	OFDM/QAM64	MCS5	13.3	30	16.7	1.6	14.9	36	21.1
20	OFDM/QAM64	MCS6	13.5	30	16.5	1.6	15.1	36	20.9
20	OFDM/QAM64	MCS7	11.3	30	18.7	1.6	12.9	36	23.1

Table 8.2-4: *Output power measurements results – over voltage change (Worst case)*

Voltage	Channel	Mbps	Modulation	Conduct Power dBm	Power Limit dBm	Margin dB	Ant gain dBi	ERIP dBm	EIRP Limit dBm	EIRP margin dB
120V	Low	11	DSS/CCK	15.60	30	14.4	1.6	17.2	36	18.8
120V	Mid	9	OFDM/BPSK	18.42	30	11.58	1.6	20.02	36	15.98
120V	Hi	11	DSS/CCK	16.57	30	13.43	1.6	18.17	36	17.83
85V	Low	11	DSS/CCK	15.52	30	14.48	1.6	17.12	36	18.88
85V	Mid	9	OFDM/BPSK	18.37	30	11.63	1.6	19.97	36	16.03
85V	Hi	11	DSS/CCK	16.55	30	13.45	1.6	18.15	36	17.85
276V	Low	11	DSS/CCK	15.48	30	14.52	1.6	17.08	36	18.92
276V	Mid	9	OFDM/BPSK	18.33	30	11.67	1.6	19.93	36	16.07
276V	Hi	11	DSS/CCK	16.60	30	13.4	1.6	18.2	36	17.8
Battery	Low	11	DSS/CCK	15.52	30	14.48	1.6	17.12	36	18.88
Battery	Mid	9	OFDM/BPSK	18.50	30	11.5	1.6	20.1	36	15.9
Battery	Hi	11	DSS/CCK	16.57	30	13.43	1.6	18.17	36	17.83

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

8.3.1 Definitions and limits

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

IC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the 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.

(a) Fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of Table 8.4-1 except for apparatus complying under RSS-287;
(b) Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and
(c) Unwanted emissions that do not fall within the restricted frequency bands of Table 8.4-1 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Table 8.3-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

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

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 8.3-2: *IC restricted frequency bands*

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

Note: Certain frequency bands listed in Table 8.3-2 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 8.3-3: *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			

8.3.2 Test summary

Test date	April 17, 2017	Temperature	22 °C
Test engineer	Feng You	Air pressure	1006 mbar
Verdict	Pass	Relative humidity	57 %

8.3.3 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.
Worst case radiated test cases were checked in 3 orthogonal positions.

Spectrum analyzer settings for conducted spurious emissions measurements:

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

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:	AVG
Trace mode:	Max Hold

Per ANSI 63.10-2013 5.6.2.2

a) Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).

b) Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).

For radiated test, both antenna output were enabled. For RF conducted test, RF2 was selected as worst case.

8.3.4 Test data

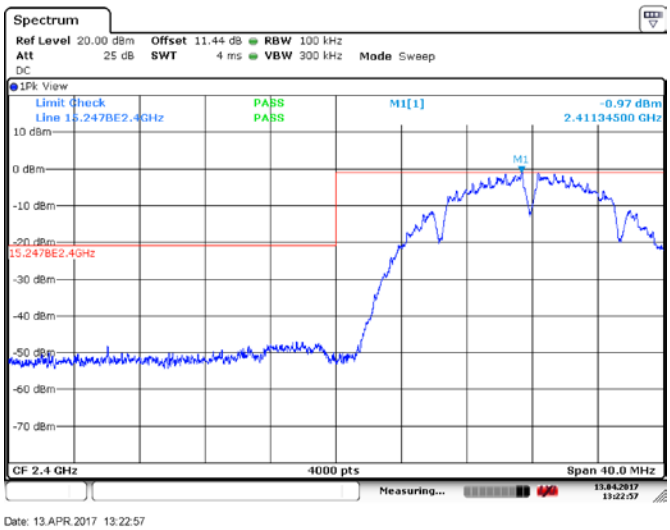


Figure 8.3.1: *Bandedge Measurement, 2412MHz, 20MHz BW, DSSS/Mbps1*

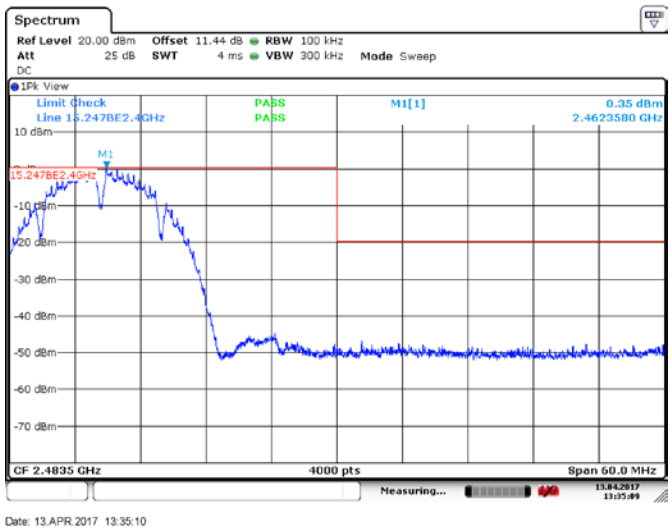
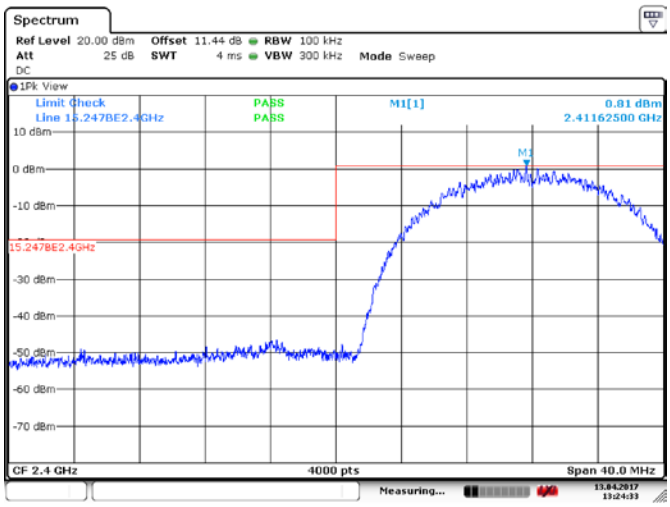
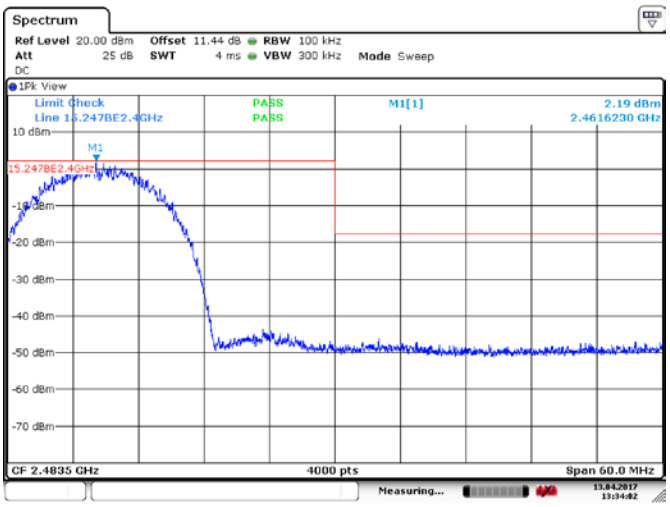


Figure 8.3.2: *Bandedge Measurement, 2462MHz, 20MHz BW, DSSS/Mbps1*



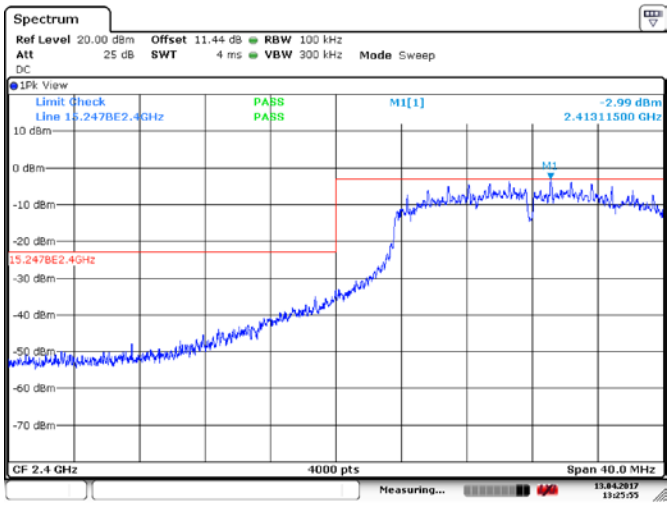
Date: 13.APR.2017 13:24:34

Figure 8.3.3: *Bandedge Measurement, 2412MHz, 20MHz BW, DSSS/Mbps11*



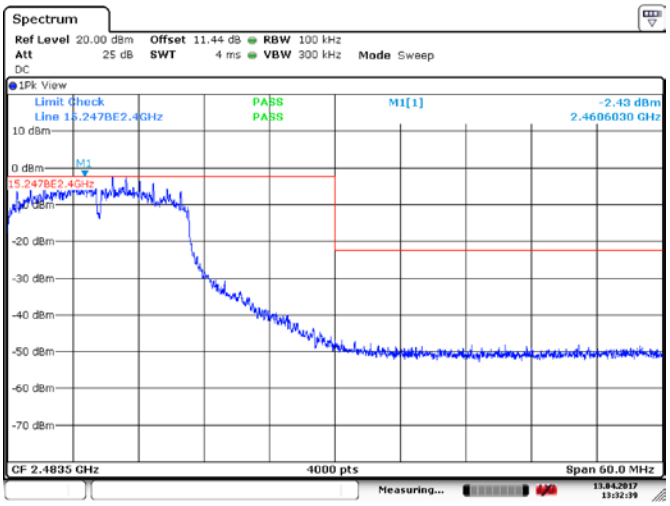
Date: 13.APR.2017 13:34:02

Figure 8.3.4: *Bandedge Measurement, 2462MHz, 20MHz BW, DSSS/Mbps11*



Date: 13.APR.2017 13:25:55

Figure 8.3.5: *Bandedge Measurement, 2412MHz, 20MHz BW, OFDM/Mbps9*



Date: 13.APR.2017 13:32:39

Figure 8.3.6: *Bandedge Measurement, 2462MHz, 20MHz BW, OFDM/Mbps9*

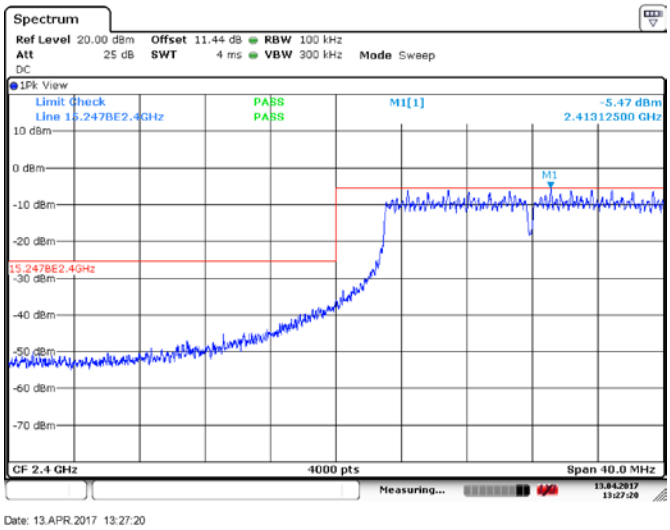


Figure 8.3.7: *Bandedge Measurement, 2412MHz, 20MHz BW, OFDM/MCS4*

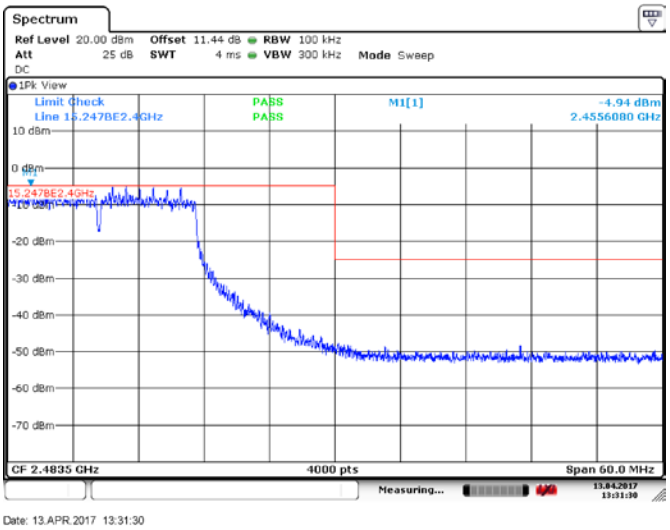


Figure 8.3.8: *Bandedge Measurement, 2462MHz, 20MHz BW, OFDM/MCS4*

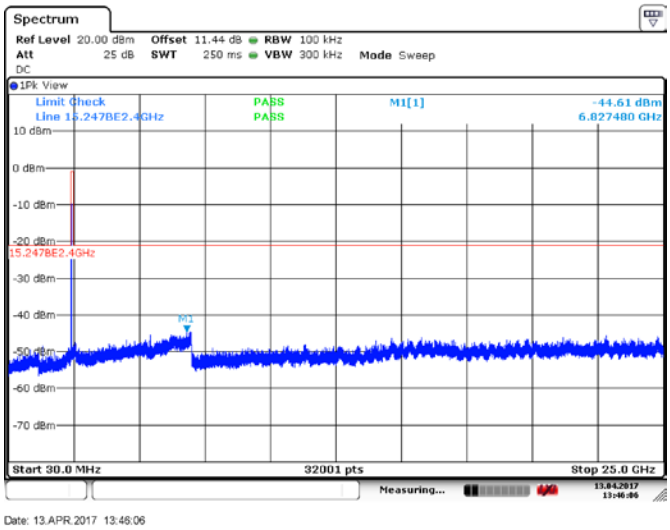


Figure 8.3.9: *Conducted spurious emissions, 2412MHz, 20MHz BW, DSSS/Mbps11*

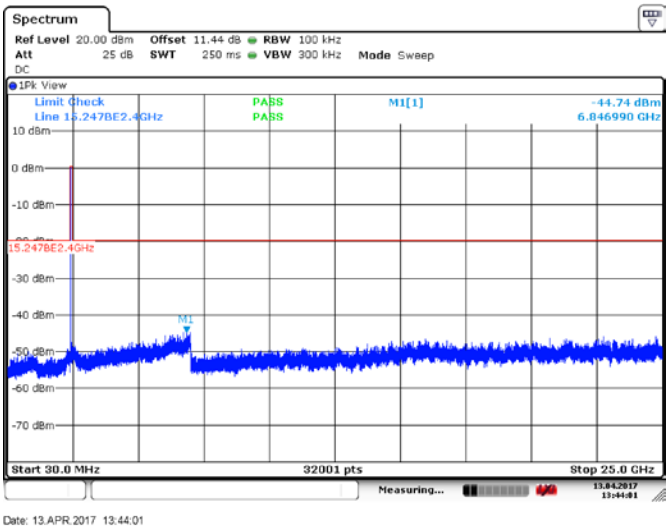


Figure 8.3.10: *Conducted spurious emissions, 2437MHz, 20MHz BW, DSSS/Mbps11*

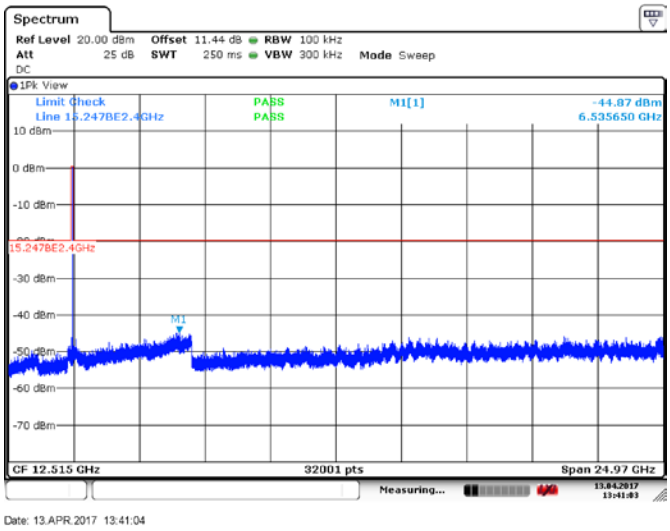


Figure 8.3.11: *Conducted spurious emissions, 2462MHz, 20MHz BW, DSSS/Mbps11*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

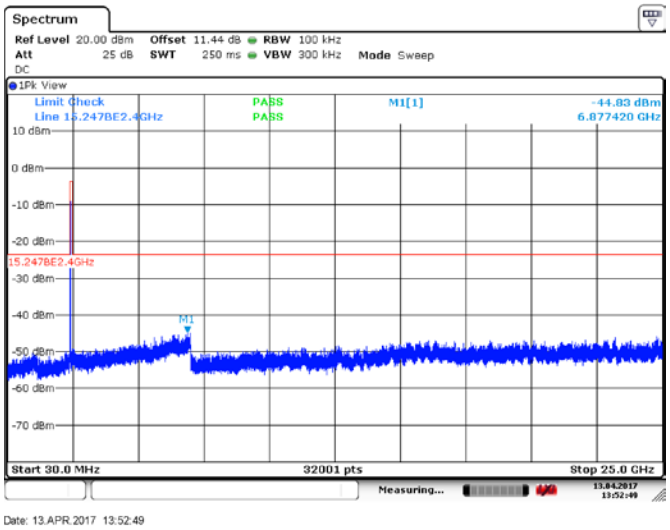


Figure 8.3.12: *Conducted spurious emissions, 2412MHz, 20MHz BW, OFDM/Mbps6*

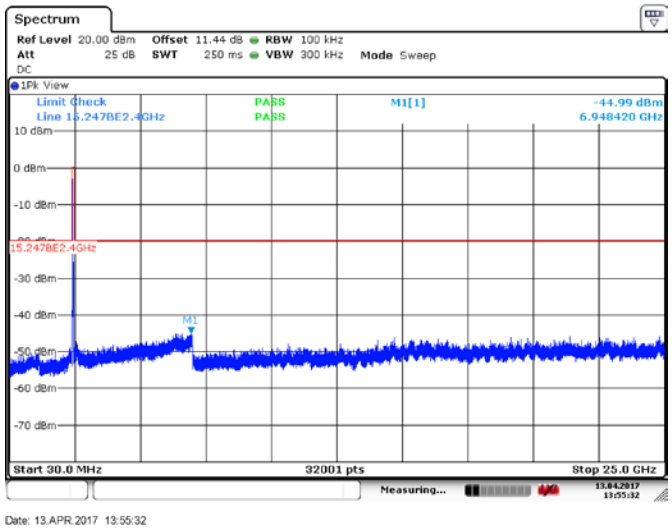


Figure 8.3.13: *Conducted spurious emissions, 2437MHz, 20MHz BW, OFDM/Mbps6*

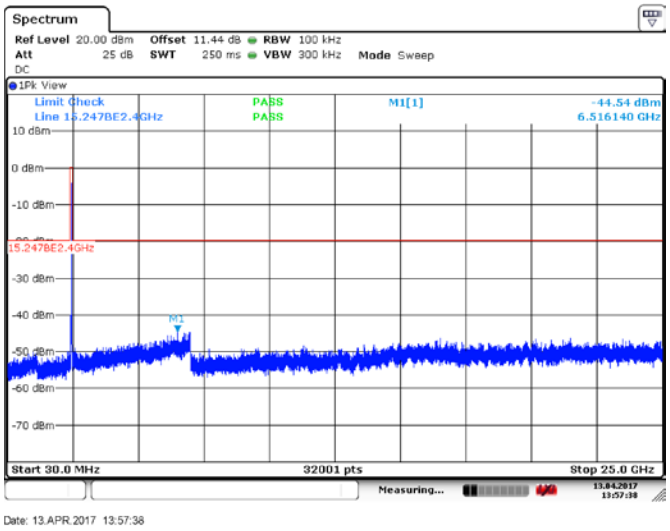


Figure 8.3.14: *Conducted spurious emissions, 2462MHz, 20MHz BW, OFDM/Mbps6*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

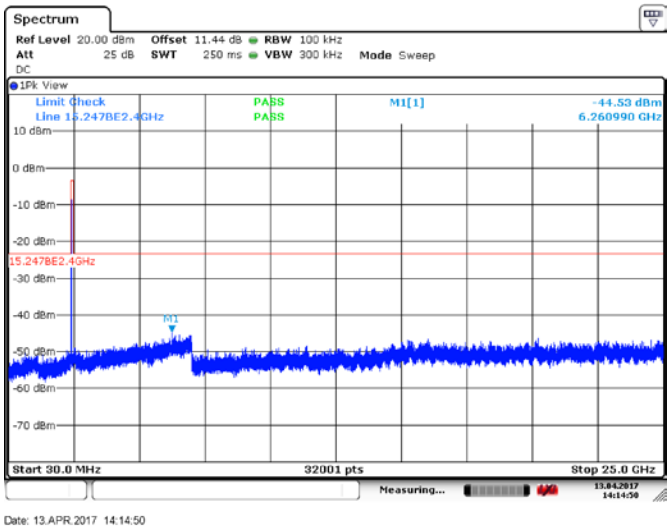


Figure 8.3.15: *Conducted spurious emissions, 2412MHz, 20MHz BW, OFDM/Mbps9*

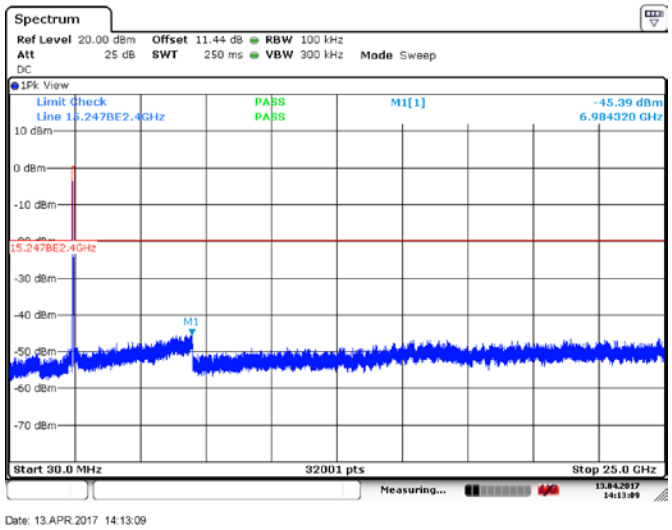


Figure 8.3.16: *Conducted spurious emissions, 2437MHz, 20MHz BW, OFDM/Mbps9*

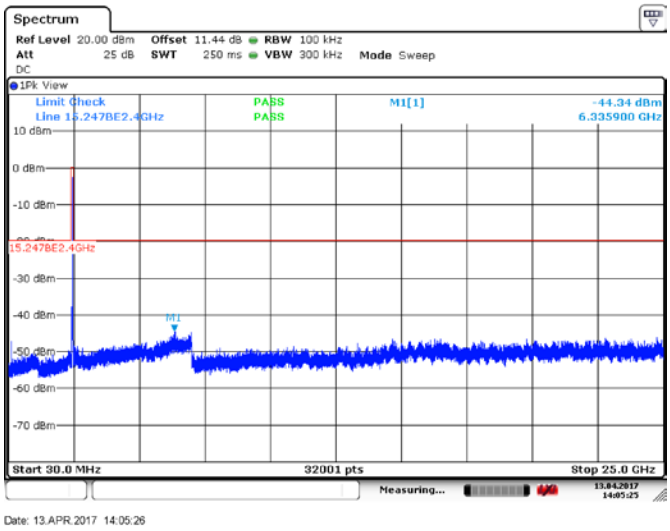


Figure 8.3.17: *Conducted spurious emissions, 2462MHz, 20MHz BW, OFDM/Mbps9*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

8.3.5 Test data – Radiated Spurious Emissions

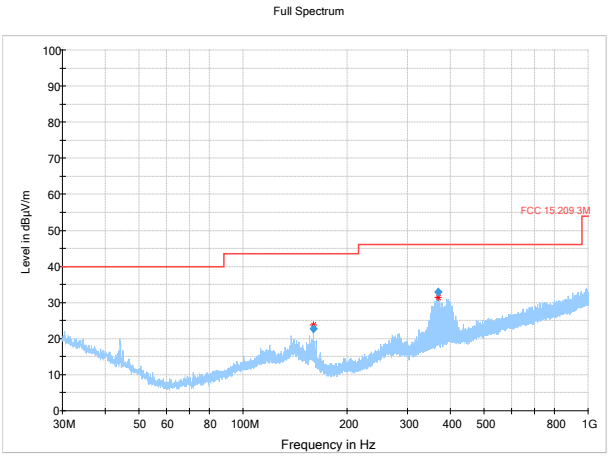


Figure 8.3.18: *Radiated spurious emissions, 2412MHz, 20MHz BW, DSSS/Mbps11, 30-1000MHz*

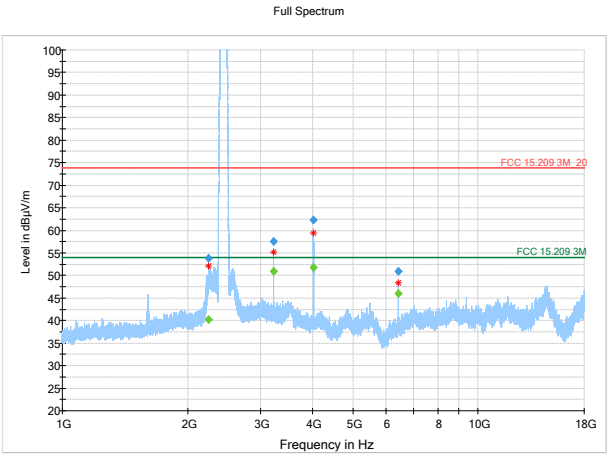


Figure 8.3.19: *Radiated spurious emissions, 2412MHz, 20MHz BW, DSSS/Mbps11, 1-18GHz*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

Table 8.3-4: *Radiated spurious emissions final measurement results, 2412MHz, 20MHz BW, DSSS/Mbps11*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
160.000000	22.80	43.50	20.70	5000.0	120.000	229.3	H	50.0
367.255000	32.81	46.00	13.19	5000.0	120.000	101.6	H	84.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2246.650000	---	40.14	53.90	13.76	5000.0	1000.000	105.1	H	34.0
2246.650000	53.86	---	73.90	20.04	5000.0	1000.000	105.1	H	34.0
3215.950000	---	50.97	53.90	2.93	5000.0	1000.000	121.9	H	278.0
3215.950000	57.55	---	73.90	16.35	5000.0	1000.000	121.9	H	278.0
4019.933333	---	51.82	53.90	2.08	5000.0	1000.000	106.7	H	273.0
4019.933333	62.24	---	73.90	11.66	5000.0	1000.000	106.7	H	273.0
6431.616667	---	46.02	53.90	7.88	5000.0	1000.000	177.8	V	116.0
6431.616667	50.95	---	73.90	22.95	5000.0	1000.000	177.8	V	116.0

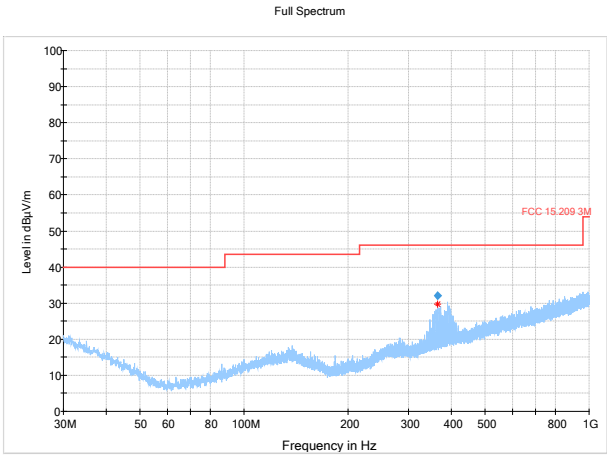


Figure 8.3.20: *Radiated spurious emissions, 2437MHz, 20MHz BW, DSSS/Mbps11, 30-1000MHz*

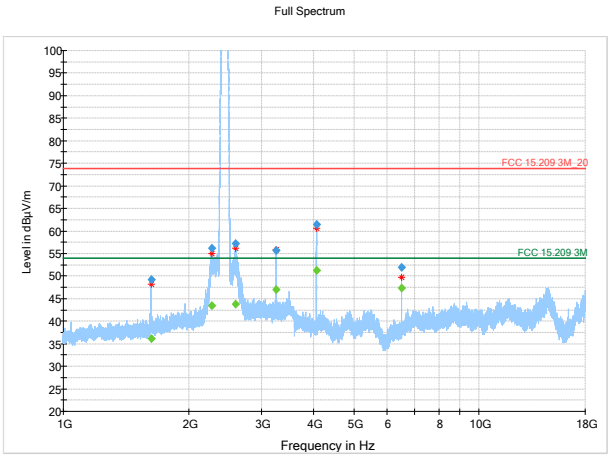


Figure 8.3.21: *Radiated spurious emissions, 2437MHz, 20MHz BW, DSSS/Mbps11, 1-18GHz*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

Table 8.3-5: *Radiated spurious emissions final measurement results, 2437MHz, 20MHz BW, DSSS/Mbps11*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
363.603000	32.05	46.00	13.95	5000.0	120.000	103.2	H	103.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1624.616667	49.28	---	73.90	24.62	5000.0	1000.000	114.6	H	296.0
1624.616667	---	36.10	53.90	17.80	5000.0	1000.000	114.6	H	296.0
2279.116667	---	43.36	53.90	10.54	5000.0	1000.000	135.5	H	190.0
2279.116667	56.20	---	73.90	17.70	5000.0	1000.000	135.5	H	190.0
2599.033333	57.22	---	73.90	16.68	5000.0	1000.000	148.2	H	166.0
2599.033333	---	43.80	53.90	10.10	5000.0	1000.000	148.2	H	166.0
3249.283333	---	47.06	53.90	6.84	5000.0	1000.000	108.6	H	278.0
3249.283333	55.69	---	73.90	18.21	5000.0	1000.000	108.6	H	278.0
4059.983333	---	51.24	53.90	2.66	5000.0	1000.000	119.6	H	275.0
4059.983333	61.50	---	73.90	12.40	5000.0	1000.000	119.6	H	275.0
6498.316667	---	47.26	53.90	6.64	5000.0	1000.000	185.9	V	114.0
6498.316667	51.86	---	73.90	22.04	5000.0	1000.000	185.9	V	114.0

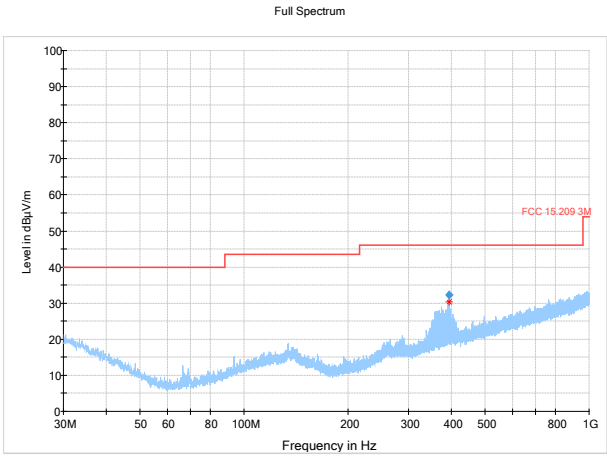


Figure 8.3.22: *Radiated spurious emissions, 2462MHz, 20MHz BW, DSSS/Mbps11, 30-1000MHz*

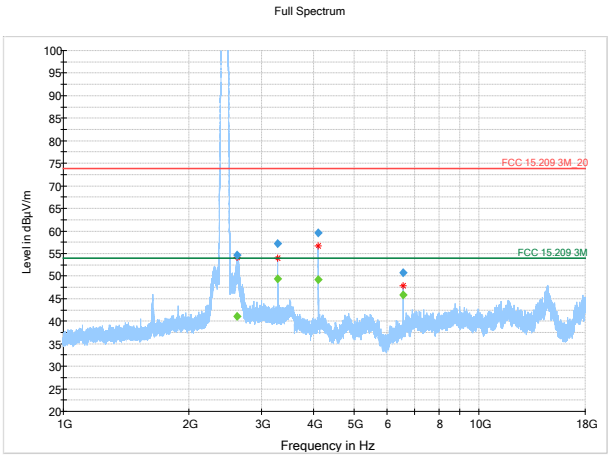


Figure 8.3.23: *Radiated spurious emissions, 2462MHz, 20MHz BW, DSSS/Mbps11, 1-18GHz*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

Table 8.3-6: *Radiated spurious emissions final measurement results, 2462MHz, 20MHz BW, DSSS/Mbps11*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
392.509000	32.26	46.00	13.74	5000.0	120.000	100.0	H	111.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2616.383333	54.60	---	73.90	19.30	5000.0	1000.000	196.7	H	140.0
2616.383333	---	41.10	53.90	12.80	5000.0	1000.000	196.7	H	140.0
3282.300000	57.17	---	73.90	16.73	5000.0	1000.000	106.1	H	274.0
3282.300000	---	49.41	53.90	4.49	5000.0	1000.000	106.1	H	274.0
4101.883333	---	49.16	53.90	4.74	5000.0	1000.000	118.0	H	272.0
4101.883333	59.65	---	73.90	14.25	5000.0	1000.000	118.0	H	272.0
6565.016667	---	45.86	53.90	8.04	5000.0	1000.000	182.8	V	116.0
6565.016667	50.67	---	73.90	23.23	5000.0	1000.000	182.8	V	116.0

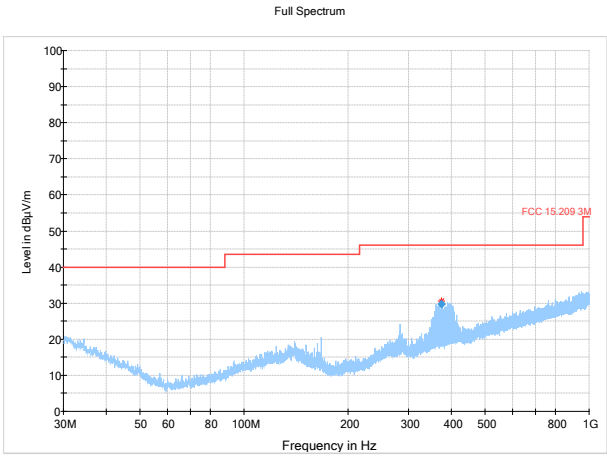


Figure 8.3.24: *Radiated spurious emissions, 2412MHz, 20MHz BW, OFDM/Mbps9, 30-1000MHz*

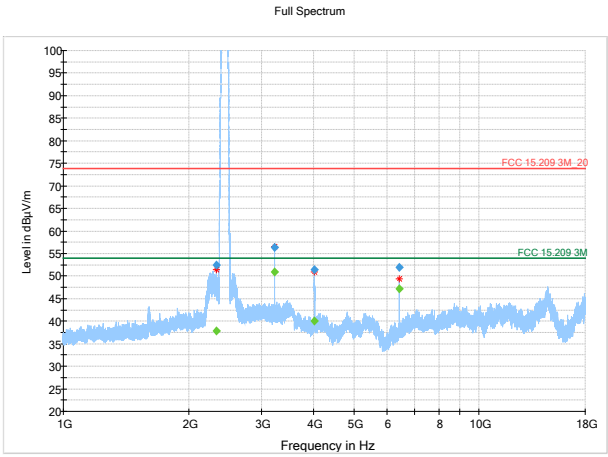


Figure 8.3.25: *Radiated spurious emissions, 2412MHz, 20MHz BW, OFDM/Mbps9, 1-18GHz*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

Table 8.3-7: *Radiated spurious emissions final measurement results, 2412MHz, 20MHz BW, OFDM/Mbps9*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
374.315500	29.79	46.00	16.21	5000.0	120.000	101.7	H	100.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2334.316667	52.44	---	73.90	21.46	5000.0	1000.000	200.4	H	174.0
2334.316667	---	37.87	53.90	16.03	5000.0	1000.000	200.4	H	174.0
3215.950000	56.31	---	73.90	17.59	5000.0	1000.000	131.3	H	274.0
3215.950000	---	50.97	53.90	2.93	5000.0	1000.000	131.3	H	274.0
4021.633333	---	39.98	53.90	13.92	5000.0	1000.000	163.3	V	10.0
4021.633333	51.41	---	73.90	22.49	5000.0	1000.000	163.3	V	10.0
6431.616667	---	47.25	53.90	6.65	5000.0	1000.000	200.1	V	114.0
6431.616667	51.93	---	73.90	21.97	5000.0	1000.000	200.1	V	114.0

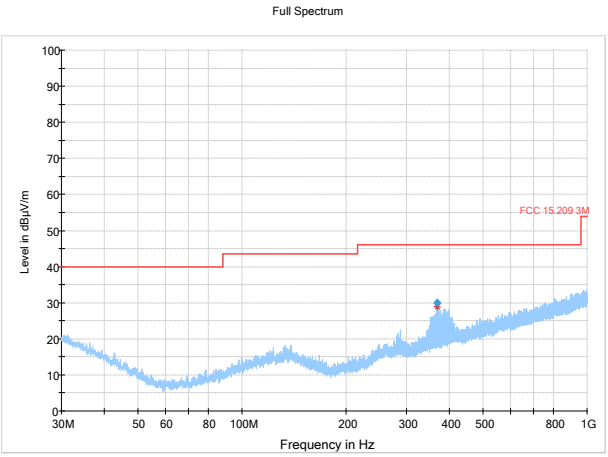


Figure 8.3.26: *Radiated spurious emissions, 2437MHz, 20MHz BW, OFDM/Mbps9, 30-1000MHz*

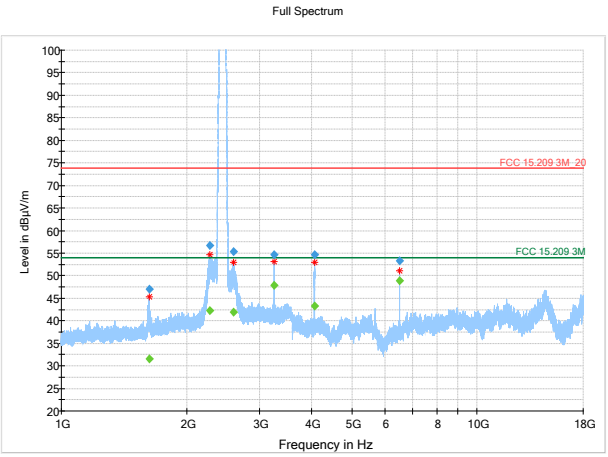


Figure 8.3.27: *Radiated spurious emissions, 2437MHz, 20MHz BW, OFDM/Mbps9, 1-18GHz*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

Table 8.3-8: *Radiated spurious emissions final measurement results, 2437MHz, 20MHz BW, OFDM/Mbps9*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
367.280500	30.02	46.00	15.98	5000.0	120.000	102.7	H	125.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1629.583333	46.92	---	73.90	26.98	5000.0	1000.000	231.6	H	297.0
1629.583333	---	31.52	53.90	22.38	5000.0	1000.000	231.6	H	297.0
2277.800000	56.76	---	73.90	17.14	5000.0	1000.000	156.6	H	317.0
2277.800000	---	42.28	53.90	11.62	5000.0	1000.000	156.6	H	317.0
2592.116667	---	41.95	53.90	11.95	5000.0	1000.000	219.6	H	165.0
2592.116667	55.27	---	73.90	18.63	5000.0	1000.000	219.6	H	165.0
3249.366667	---	47.85	53.90	6.05	5000.0	1000.000	131.8	H	345.0
3249.366667	54.57	---	73.90	19.33	5000.0	1000.000	131.8	H	345.0
4063.183333	---	43.28	53.90	10.62	5000.0	1000.000	125.0	H	272.0
4063.183333	54.62	---	73.90	19.28	5000.0	1000.000	125.0	H	272.0
6498.316667	---	48.92	53.90	4.98	5000.0	1000.000	158.4	V	116.0
6498.316667	53.31	---	73.90	20.59	5000.0	1000.000	158.4	V	116.0

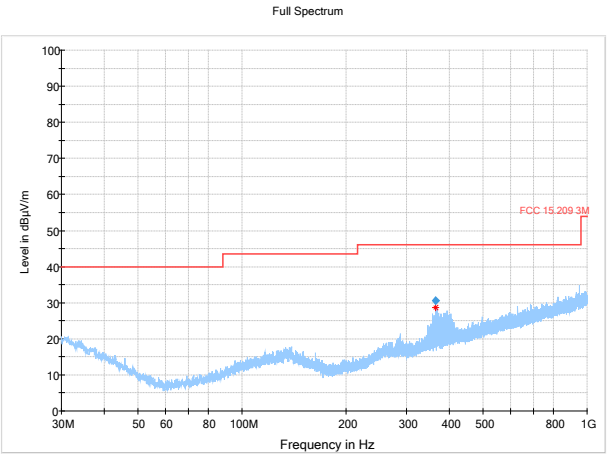


Figure 8.3.28: *Radiated spurious emissions, 2462MHz, 20MHz BW, OFDM/Mbps9, 30-1000MHz*

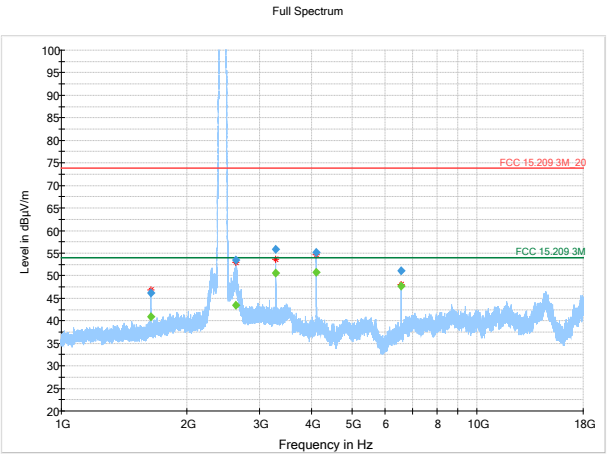


Figure 8.3.29: *Radiated spurious emissions, 2462MHz, 20MHz BW, OFDM/Mbps9, 1-18GHz*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

Table 8.3-9: *Radiated spurious emissions final measurement results, 2462MHz, 20MHz BW, OFDM/Mbps9*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
363.611500	30.62	46.00	15.38	5000.0	120.000	111.5	H	104.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1641.366667	46.14	---	73.90	27.76	5000.0	1000.000	143.5	H	302.0
1641.366667	---	40.94	53.90	12.96	5000.0	1000.000	143.5	H	302.0
2623.933333	---	43.40	53.90	10.50	5000.0	1000.000	213.3	H	168.0
2623.933333	53.46	---	73.90	20.44	5000.0	1000.000	213.3	H	168.0
3282.616667	55.78	---	73.90	18.12	5000.0	1000.000	143.4	H	353.0
3282.616667	---	50.55	53.90	3.35	5000.0	1000.000	143.4	H	353.0
4102.033333	---	50.72	53.90	3.18	5000.0	1000.000	134.1	H	320.0
4102.033333	55.20	---	73.90	18.70	5000.0	1000.000	134.1	H	320.0
6565.016667	---	47.74	53.90	6.16	5000.0	1000.000	147.7	V	116.0
6565.016667	51.04	---	73.90	22.86	5000.0	1000.000	147.7	V	116.0

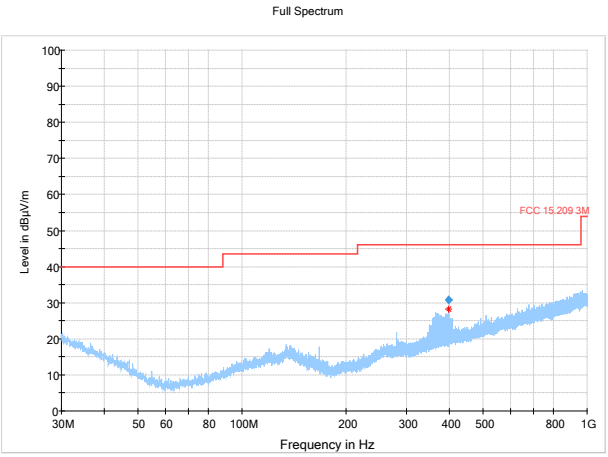


Figure 8.3.30: *Radiated spurious emissions, Wi-Fi (2412MHz, 20MHz BW, DSSS/Mbps11), and ANT 2456MHz, 30-1000MHz*

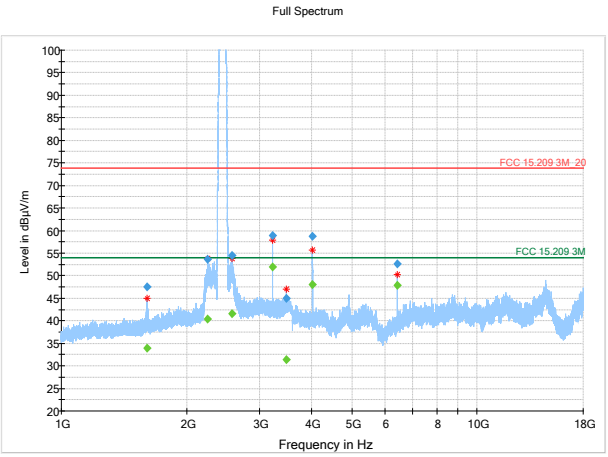


Figure 8.3.31: *Radiated spurious emissions, Wi-Fi (2412MHz, 20MHz BW, DSSS/Mbps11), and ANT 2456MHz, 1-18GHz*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

Table 8.3-10: *Radiated spurious emissions final measurement results, Wi-Fi (2412MHz, 20MHz BW, DSSS/Mbps11), and ANT 2456MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
396.186500	30.68	46.00	15.32	5000.0	120.000	101.9	H	115.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1607.800000	---	33.96	53.90	19.94	5000.0	1000.000	185.1	H	307.0
1607.800000	47.53	---	73.90	26.37	5000.0	1000.000	185.1	H	307.0
2246.233333	53.66	---	73.90	20.24	5000.0	1000.000	189.4	H	36.0
2246.233333	---	40.39	53.90	13.51	5000.0	1000.000	189.4	H	36.0
2572.783333	54.48	---	73.90	19.42	5000.0	1000.000	153.7	H	146.0
2572.783333	---	41.50	53.90	12.40	5000.0	1000.000	153.7	H	146.0
3215.966667	---	51.97	53.90	1.93	5000.0	1000.000	130.7	H	343.0
3215.966667	58.82	---	73.90	15.08	5000.0	1000.000	130.7	H	343.0
3482.433333	---	31.42	53.90	22.48	5000.0	1000.000	135.4	H	173.0
3482.433333	44.89	---	73.90	29.01	5000.0	1000.000	135.4	H	173.0
4019.933333	---	48.04	53.90	5.86	5000.0	1000.000	133.7	H	324.0
4019.933333	58.71	---	73.90	15.19	5000.0	1000.000	133.7	H	324.0
6431.616667	---	47.87	53.90	6.03	5000.0	1000.000	151.7	V	119.0
6431.616667	52.64	---	73.90	21.26	5000.0	1000.000	151.7	V	119.0

8.3.6 Test data – Radiated Spurious Emissions at Band Edge in Restricted Band

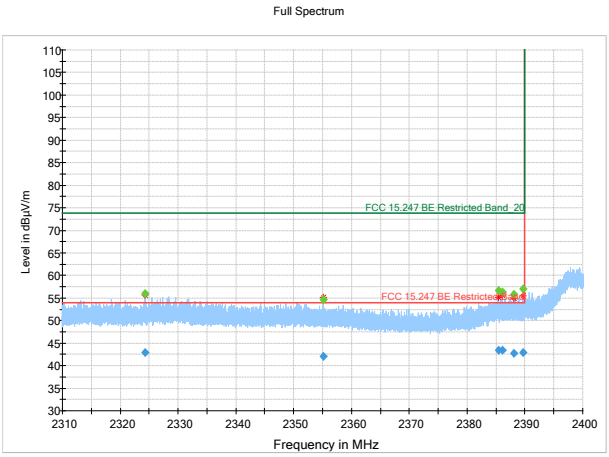


Figure 8.3.32: *Radiated Band Edge, 2412MHz, 20MHz BW, DSSS/Mbps11*

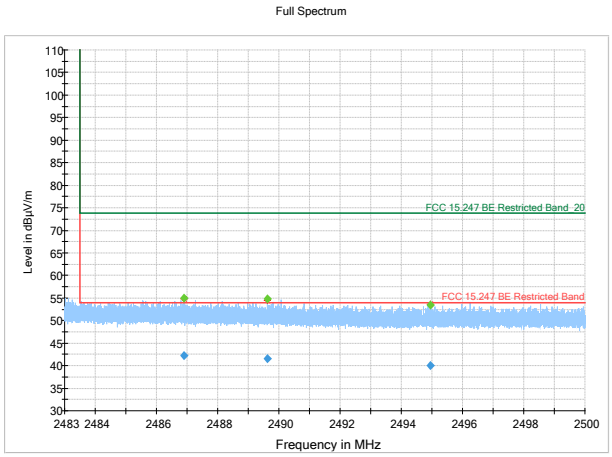


Figure 8.3.33: *Radiated Band Edge, 2462MHz, 20MHz BW, DSSS/Mbps11*

Table 8.3-11: *Radiated Band Edge final measurement results, 2412MHz, 20MHz BW, DSSS/Mbps11*

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2324.346000	---	55.94	73.90	17.96	1000.0	1000.000	185.2	H	44.0
2324.346000	42.88	---	53.90	11.02	1000.0	1000.000	185.2	H	44.0
2355.075000	---	54.67	73.90	19.23	1000.0	1000.000	169.0	H	46.0
2355.075000	42.14	---	53.90	11.76	1000.0	1000.000	169.0	H	46.0
2385.378000	---	56.70	73.90	17.20	1000.0	1000.000	203.3	H	38.0
2385.378000	43.41	---	53.90	10.49	1000.0	1000.000	203.3	H	38.0
2386.038000	---	56.31	73.90	17.59	1000.0	1000.000	156.0	H	37.0
2386.038000	43.40	---	53.90	10.50	1000.0	1000.000	156.0	H	37.0
2388.036000	---	55.79	73.90	18.11	1000.0	1000.000	151.2	H	34.0
2388.036000	42.80	---	53.90	11.10	1000.0	1000.000	151.2	H	34.0
2389.713000	---	57.02	73.90	16.88	1000.0	1000.000	172.0	H	37.0
2389.713000	42.98	---	53.90	10.92	1000.0	1000.000	172.0	H	37.0

Table 8.3-12: *Radiated Band Edge final measurement results, 2462MHz, 20MHz BW, DSSS/Mbps11*

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2486.898667	---	54.89	73.90	19.01	1000.0	1000.000	131.3	H	152.0
2486.898667	42.29	---	53.90	11.61	1000.0	1000.000	131.3	H	152.0
2489.623200	---	54.79	73.90	19.11	1000.0	1000.000	104.3	H	149.0
2489.623200	41.58	---	53.90	12.32	1000.0	1000.000	104.3	H	149.0
2494.962333	---	53.43	73.90	20.47	1000.0	1000.000	120.2	H	183.0
2494.962333	40.01	---	53.90	13.89	1000.0	1000.000	120.2	H	183.0

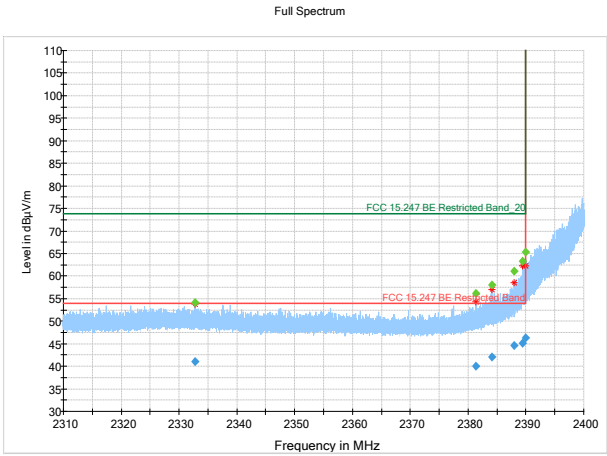


Figure 8.3.34: *Radiated Band Edge, 2412MHz, 20MHz BW, OFDM/Mbps9*

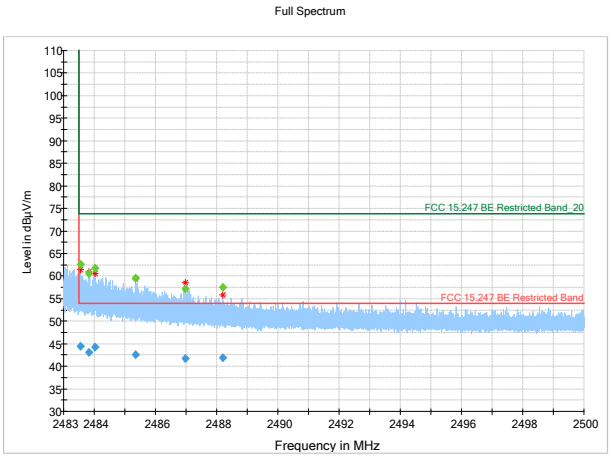


Figure 8.3.35: *Radiated Band Edge, 2462MHz, 20MHz BW, OFDM/Mbps9*

Table 8.3-13: *Radiated Band Edge final measurement results, 2412MHz, 20MHz BW, OFDM/Mbps9*

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2332.827000	---	54.13	73.90	19.77	1000.0	1000.000	209.2	H	163.0
2332.827000	41.01	---	53.90	12.89	1000.0	1000.000	209.2	H	163.0
2381.337000	---	56.11	73.90	17.79	1000.0	1000.000	111.5	H	156.0
2381.337000	40.09	---	53.90	13.81	1000.0	1000.000	111.5	H	156.0
2384.169000	42.07	---	53.90	11.83	1000.0	1000.000	197.6	H	156.0
2384.169000	---	57.98	73.90	15.92	1000.0	1000.000	197.6	H	156.0
2387.970000	44.55	---	53.90	9.35	1000.0	1000.000	175.4	H	38.0
2387.970000	---	61.12	73.90	12.78	1000.0	1000.000	175.4	H	38.0
2389.413000	45.05	---	53.90	8.85	1000.0	1000.000	143.1	H	322.0
2389.413000	---	63.36	73.90	10.54	1000.0	1000.000	143.1	H	322.0
2389.980000	46.37	---	53.90	7.53	1000.0	1000.000	165.3	H	327.0
2389.980000	---	65.25	73.90	8.65	1000.0	1000.000	165.3	H	327.0

Table 8.3-14: *Radiated Band Edge final measurement results, 2462MHz, 20MHz BW, OFDM/Mbps9*

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2483.550800	44.47	---	53.90	9.43	1000.0	1000.000	164.4	H	146.0
2483.550800	---	62.67	73.90	11.23	1000.0	1000.000	164.4	H	146.0
2483.817700	43.12	---	53.90	10.78	1000.0	1000.000	131.8	H	330.0
2483.817700	---	60.54	73.90	13.36	1000.0	1000.000	131.8	H	330.0
2484.026233	44.32	---	53.90	9.58	1000.0	1000.000	180.6	H	150.0
2484.026233	---	61.69	73.90	12.21	1000.0	1000.000	180.6	H	150.0
2485.339200	42.53	---	53.90	11.37	1000.0	1000.000	124.3	H	31.0
2485.339200	---	59.62	73.90	14.28	1000.0	1000.000	124.3	H	31.0
2486.962700	41.67	---	53.90	12.23	1000.0	1000.000	131.3	H	145.0
2486.962700	---	57.23	73.90	16.67	1000.0	1000.000	131.3	H	145.0
2488.208233	41.89	---	53.90	12.01	1000.0	1000.000	202.3	H	150.0
2488.208233	---	57.59	73.90	16.31	1000.0	1000.000	202.3	H	150.0

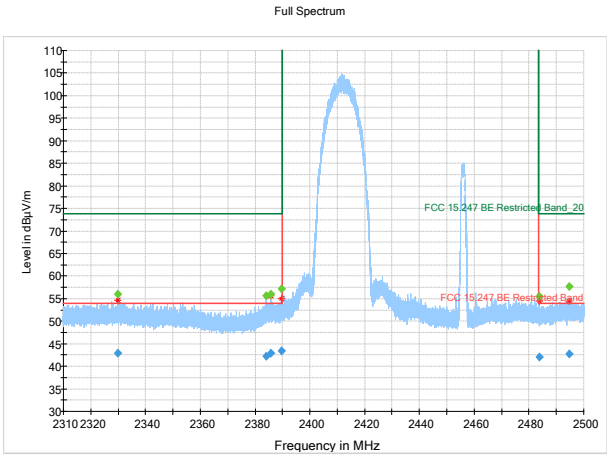


Figure 8.3.36: *Radiated Band Edge, Wi-Fi (2412MHz, 20MHz BW, DSSS/Mbps11), and ANT 2456MHz*

Table 8.3-15: *Radiated Band Edge final measurement results, Wi-Fi (2412MHz, 20MHz BW, DSSS/Mbps11), and ANT 2456MHz*

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2329.867667	42.90	---	53.90	11.00	1000.0	1000.000	182.8	H	46.0
2329.867667	---	55.94	73.90	17.96	1000.0	1000.000	182.8	H	46.0
2384.182333	42.21	---	53.90	11.69	1000.0	1000.000	141.5	H	42.0
2384.182333	---	55.63	73.90	18.27	1000.0	1000.000	141.5	H	42.0
2385.651667	42.95	---	53.90	10.95	1000.0	1000.000	149.8	H	34.0
2385.651667	---	55.91	73.90	17.99	1000.0	1000.000	149.8	H	34.0
2389.698667	43.48	---	53.90	10.42	1000.0	1000.000	188.4	H	38.0
2389.698667	---	57.10	73.90	16.80	1000.0	1000.000	188.4	H	38.0
483.824667	---	55.44	73.90	18.46	1000.0	1000.000	213.4	H	146.0
2483.824667	42.12	---	53.90	11.78	1000.0	1000.000	213.4	H	146.0
2494.730667	---	57.67	73.90	16.23	1000.0	1000.000	151.0	H	38.0
2494.730667	42.66	---	53.90	11.24	1000.0	1000.000	151.0	H	38.0

8.4 FCC 15.247(e) and RSS-247 5.2(2) Power Spectrum Density

8.4.1 Definitions and limits

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

8.4.2 Test summary

Test date	April 12, 2017	Temperature	21 °C
Test engineer	Feng You	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	55 %

8.4.3 Observations, settings and special notes

3kHz RBW

Per ANSI 63.10-2013 5.6.2.2

c) In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.

8.4.4 Test data

Table 8.4-1: *Power Spectrum Density*

Frequency,	Channel Bandwidth,	Modulation	Data Rate,	Measured PSD@3kHz	Limit	Margin	Antenna gain	EIRP,	EIRP limit,	EIRP margin
MHz	MHz		Mbps	dBm	dBm	dB	dBi	dBm	dBm	dB
2412	20	1	DSSS/BPSK	-14.51	8.00	22.51	1.6	-12.91	14	26.91
2437	20	1	DSSS/BPSK	-13.26	8.00	21.26	1.6	-11.66	14	25.66
2462	20	1	DSSS/BPSK	-13.99	8.00	21.99	1.6	-12.39	14	26.39
2412	20	11	DSS/CCK	-13.55	8.00	21.55	1.6	-11.95	14	25.95
2437	20	11	DSS/CCK	-12.03	8.00	20.03	1.6	-10.43	14	24.43
2462	20	11	DSS/CCK	-12.35	8.00	20.35	1.6	-10.75	14	24.75
2412	20	6	OFDM/BPSK	-19.49	8.00	27.49	1.6	-17.89	14	31.89
2437	20	6	OFDM/BPSK	-14.93	8.00	22.93	1.6	-13.33	14	27.33
2462	20	6	OFDM/BPSK	-19.44	8.00	27.44	1.6	-17.84	14	31.84
2412	20	9	OFDM/BPSK	-19.25	8.00	27.25	1.6	-17.65	14	31.65
2437	20	9	OFDM/BPSK	-15.34	8.00	23.34	1.6	-13.74	14	27.74
2462	20	9	OFDM/BPSK	-18.92	8.00	26.92	1.6	-17.32	14	31.32

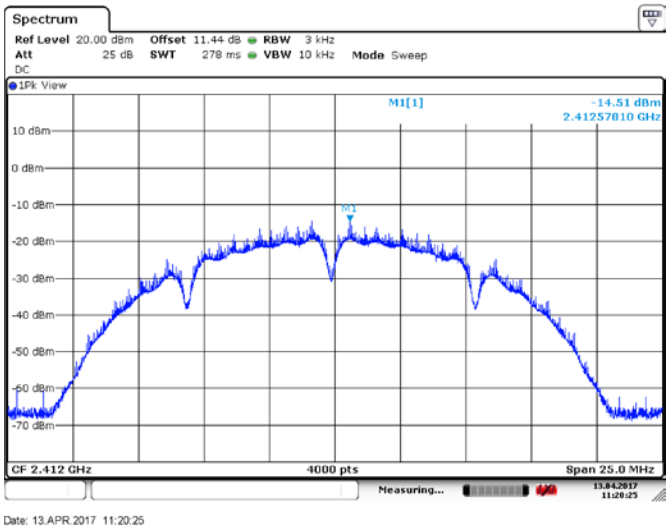


Figure 8.4.1: *Power Spectrum Density, 2412MHz, 20MHz BW, DSSS/Mbps1*

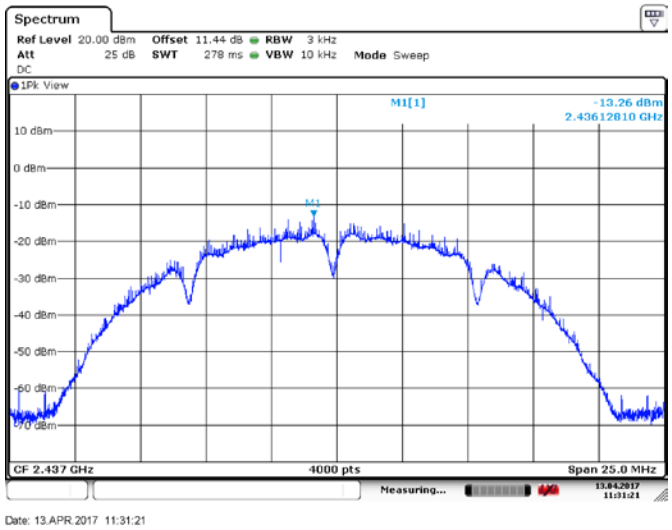


Figure 8.4.2: *Power Spectrum Density, 2437MHz, 20MHz BW, DSSS/Mbps1*

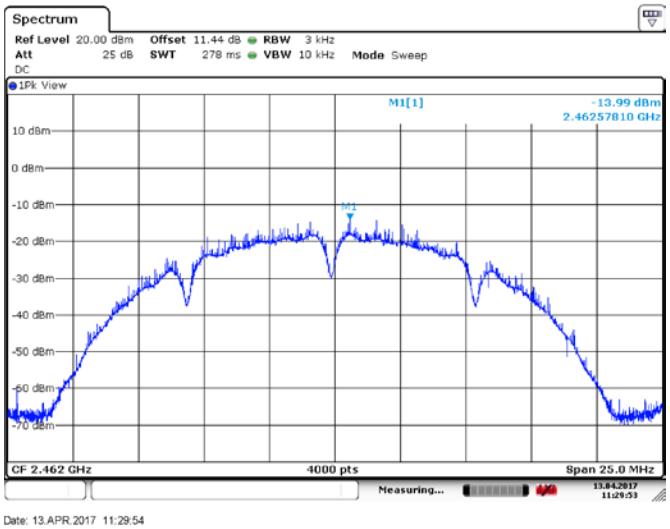


Figure 8.4.3: *Power Spectrum Density, 2462MHz, 20MHz BW, DSSS/Mbps1*

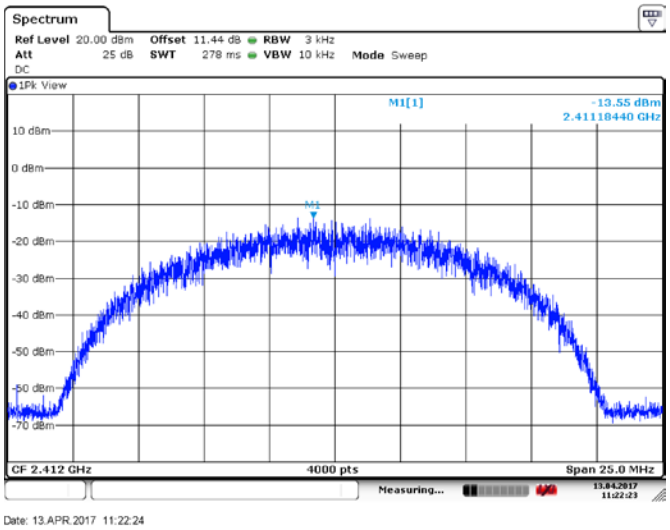


Figure 8.4.4: *Power Spectrum Density, 2412MHz, 20MHz BW, DSSS/Mbps11*

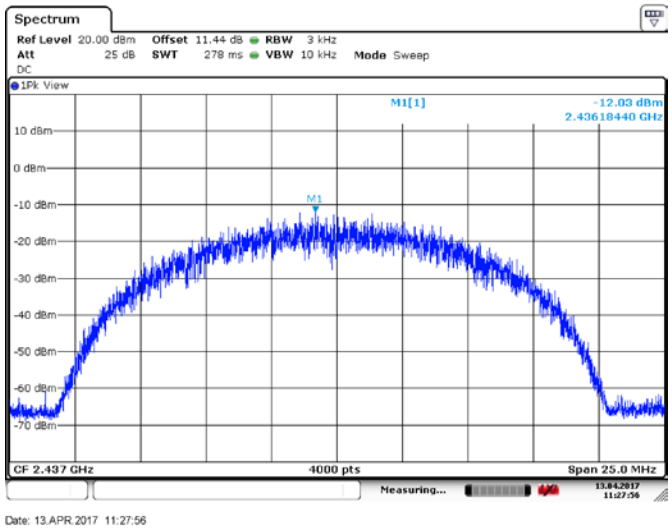


Figure 8.4.5: *Power Spectrum Density, 2437MHz, 20MHz BW, DSSS/Mbps11*

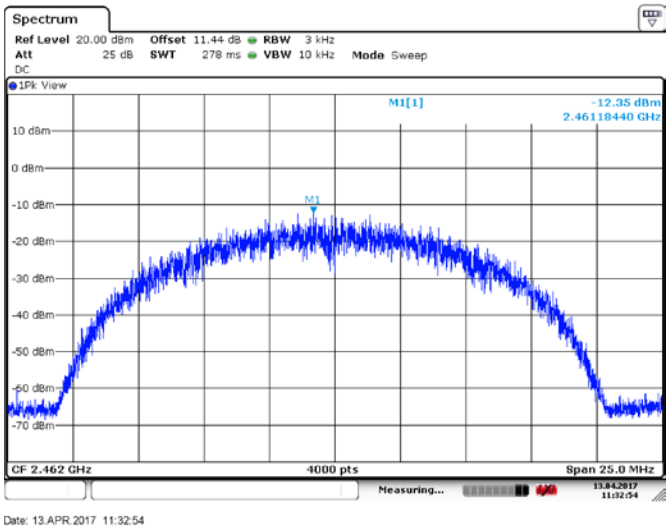


Figure 8.4.6: *Power Spectrum Density, 2462MHz, 20MHz BW, DSSS/Mbps11*

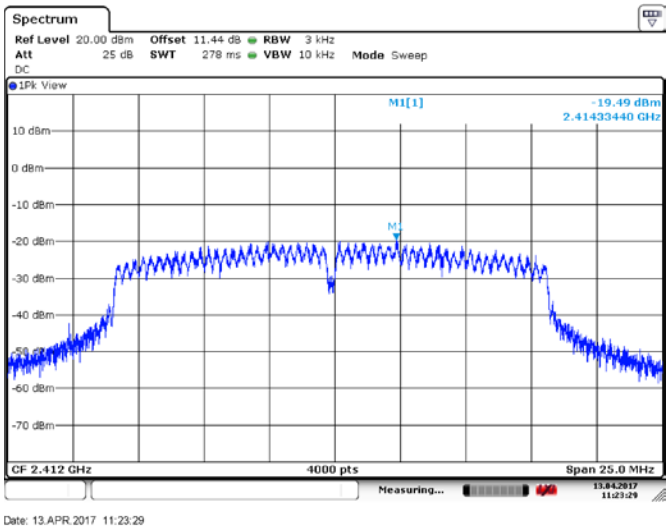


Figure 8.4.7: *Power Spectrum Density, 2412MHz, 20MHz BW, OFDM/Mbps6*

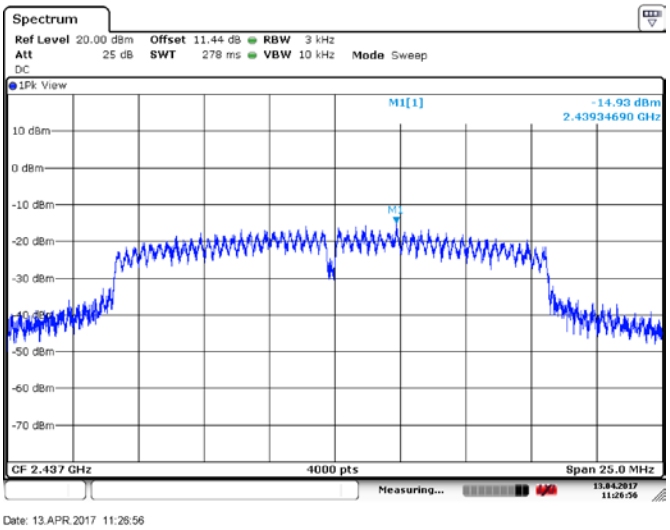


Figure 8.4.8: *Power Spectrum Density, 2437MHz, 20MHz BW, OFDM/Mbps6*

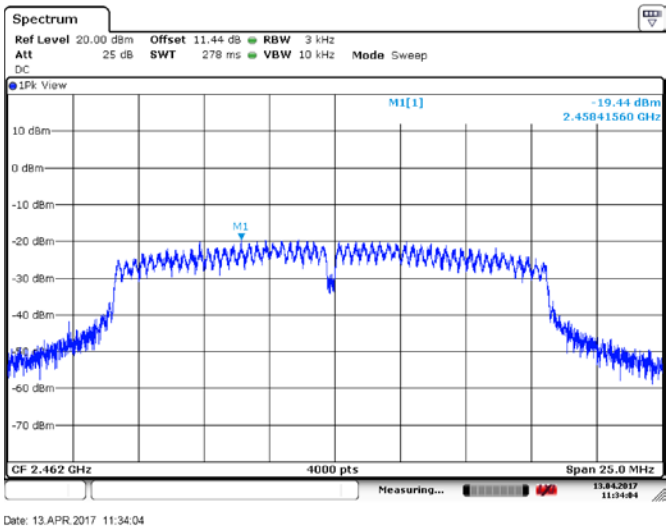
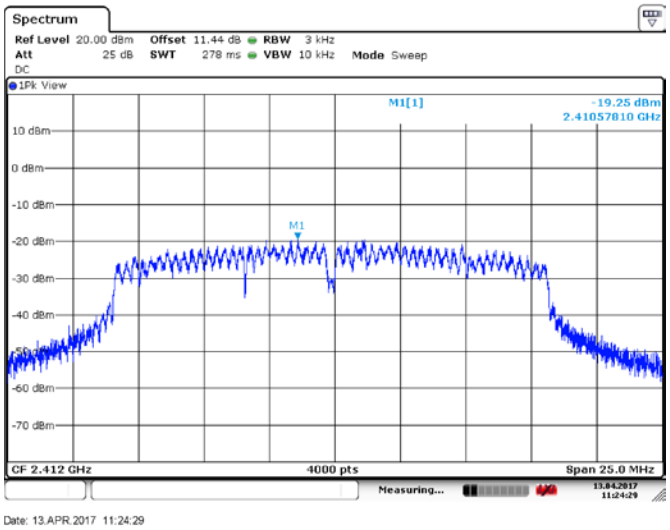
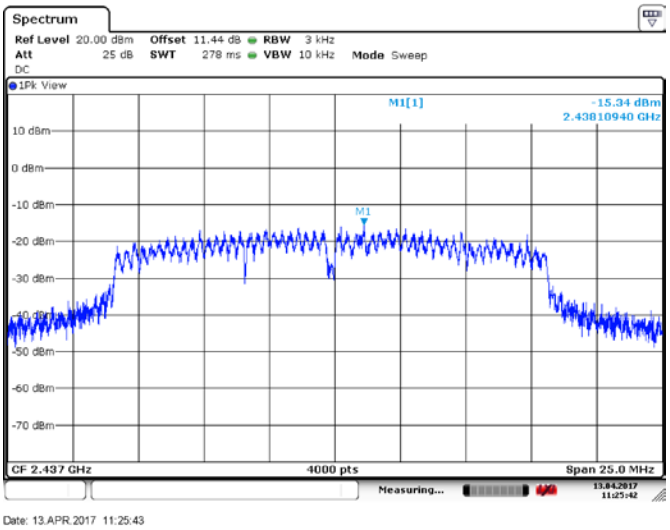


Figure 8.4.9: *Power Spectrum Density, 2462MHz, 20MHz BW, OFDM/Mbps6*



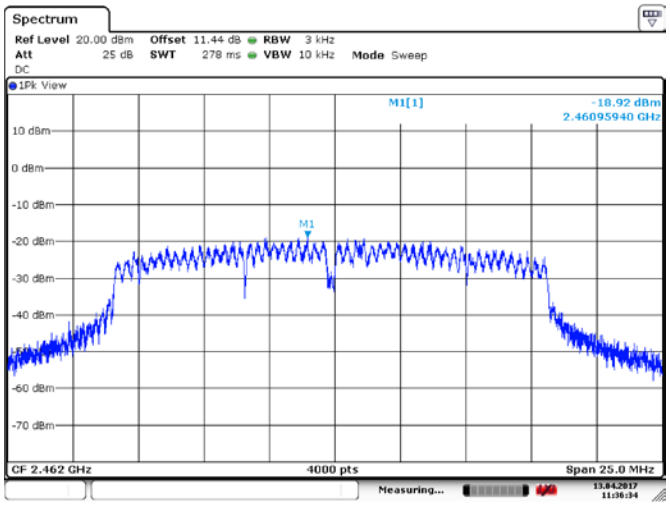
Date: 13.APR.2017 11:24:29

Figure 8.4.10: *Power Spectrum Density, 2412MHz, 20MHz BW, OFDM/Mbps9*



Date: 13.APR.2017 11:25:43

Figure 8.4.11: *Power Spectrum Density, 2437MHz, 20MHz BW, OFDM/Mbps9*



Date: 13.APR.2017 11:36:35

Figure 8.4.12: *Power Spectrum Density, 2462MHz, 20MHz BW, OFDM/Mbps9*

8.5 FCC 15.207(a) AC power line conducted emissions limits

8.5.1 Definitions and limits

Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 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.

The conducted emissions shall be measured with a 50 Ω/50 µH line impedance stabilization network (LISN).

Table 8.5-1: *Conducted emissions limit*

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

Note: * - Decreases with the logarithm of the frequency.

8.5.2 Test summary

Test date	April 18, 2017	Temperature	21 °C
Test engineer	Feng You	Air pressure	1008 mbar
Verdict	Pass	Relative humidity	65 %

8.5.3 Observations, settings and special notes

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

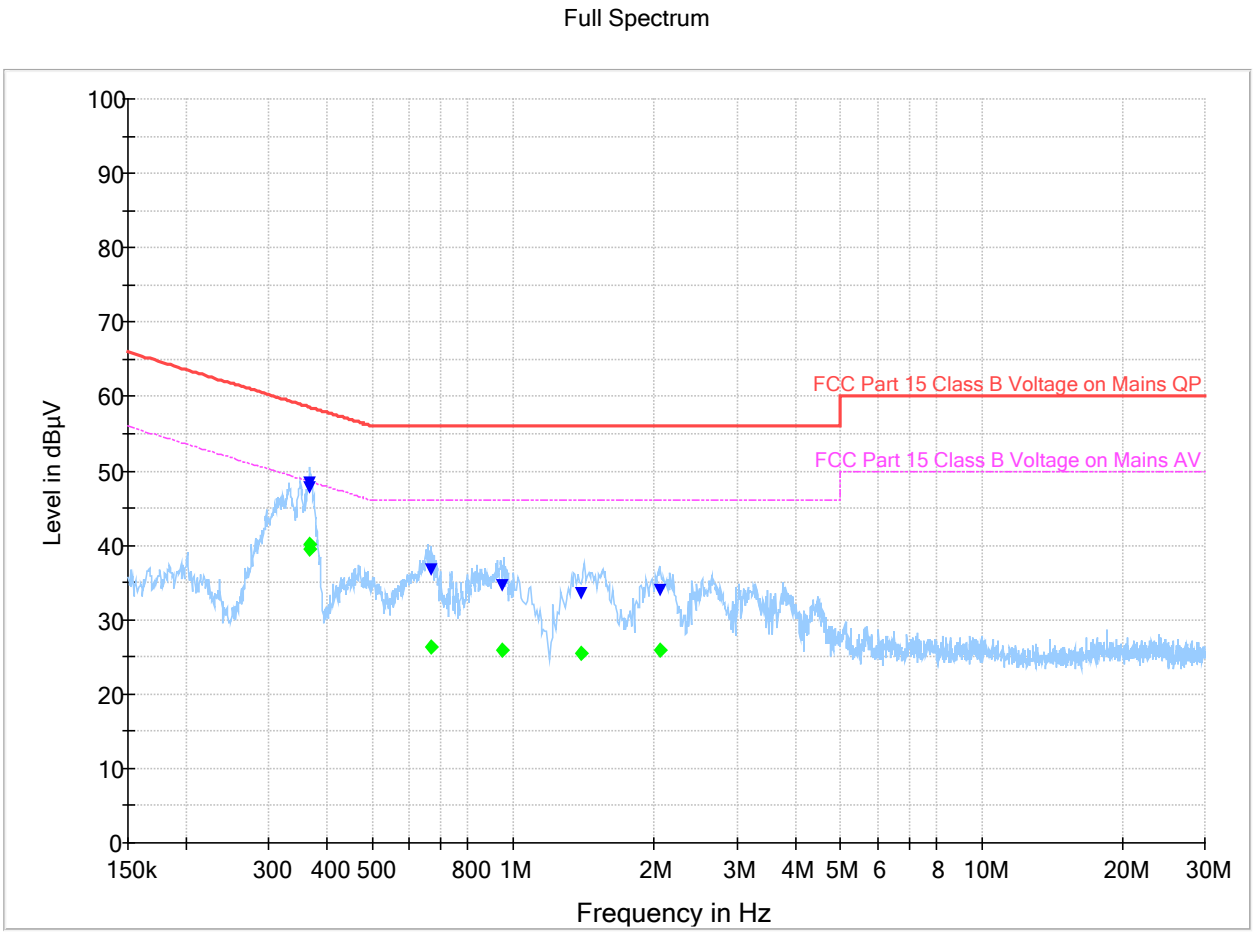
A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Highest output power modes were selected.

Test receiver settings:

Frequency span	150 kHz to 30 MHz
Detector mode	Peak and Average (preview mode); Quasi-Peak (final measurements)
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold
Measurement time	1000 ms

8.5.4 Test data – 2437MHz TX, 20MHz BW, OFDM/Mbps9

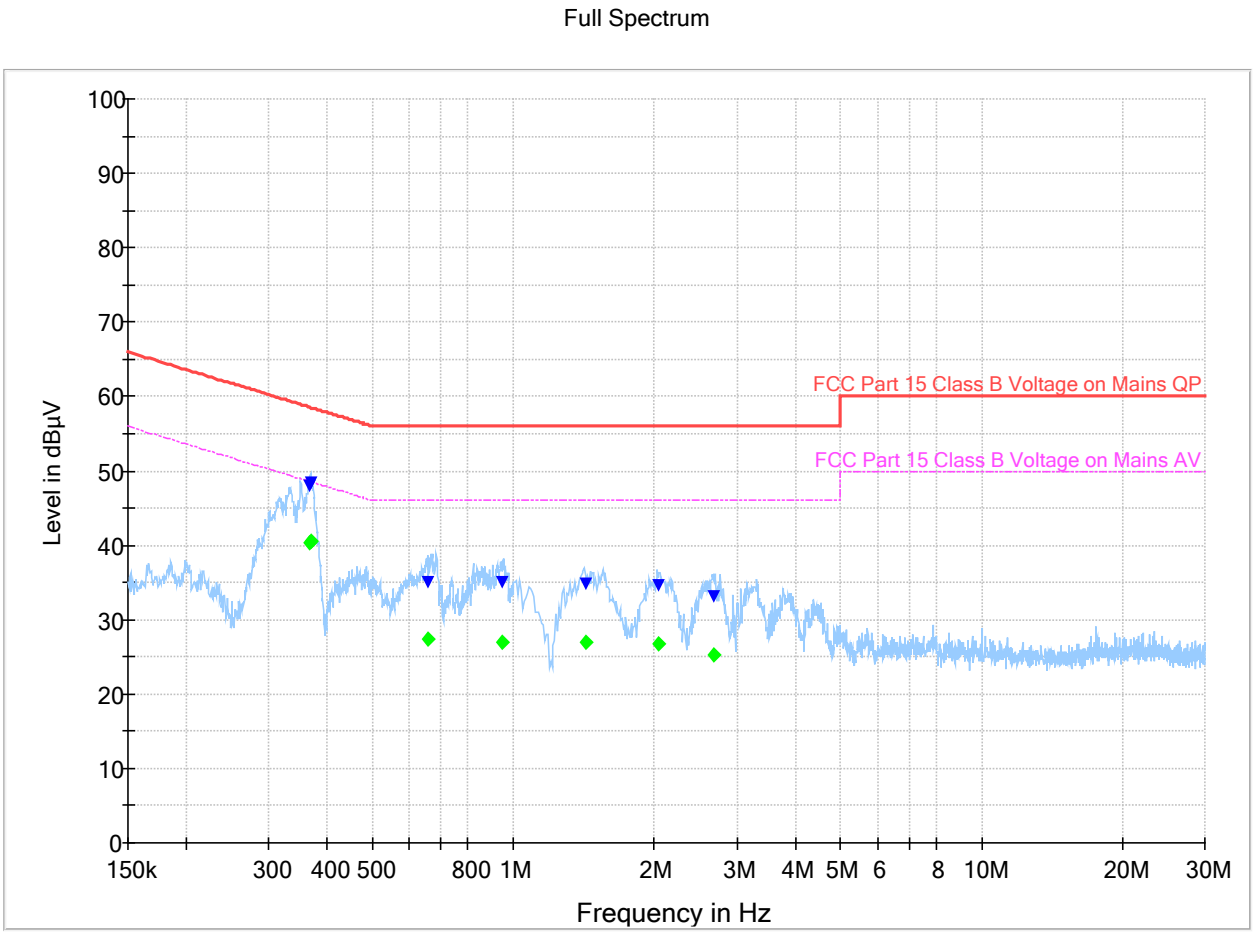


Plot 8.5-1: *Conducted emissions scan*

Table 8.5-2: *Quasi-Peak and Average conducted emissions results*

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter
0.365734	47.79	---	58.60	10.81	10000.0	9.000	L1	ON
0.365734	---	39.57	48.60	9.02	10000.0	9.000	L1	ON
0.366663	48.30	---	58.58	10.27	10000.0	9.000	L1	ON
0.366663	---	40.06	48.58	8.52	10000.0	9.000	L1	ON
0.667313	---	26.39	46.00	19.61	10000.0	9.000	L1	ON
0.667313	36.67	---	56.00	19.33	10000.0	9.000	L1	ON
0.942904	---	25.83	46.00	20.17	10000.0	9.000	L1	ON
0.942904	34.61	---	56.00	21.39	10000.0	9.000	L1	ON
1.399834	---	25.41	46.00	20.59	10000.0	9.000	L1	ON
1.399834	33.50	---	56.00	22.50	10000.0	9.000	L1	ON
2.053100	---	25.82	46.00	20.18	10000.0	9.000	L1	ON
2.053100	34.03	---	56.00	21.97	10000.0	9.000	L1	ON

8.5.5 Test data – Wi-Fi 2437MHz TX 20MHz BW, OFDM/Mbps9), and ANT 2456MHz



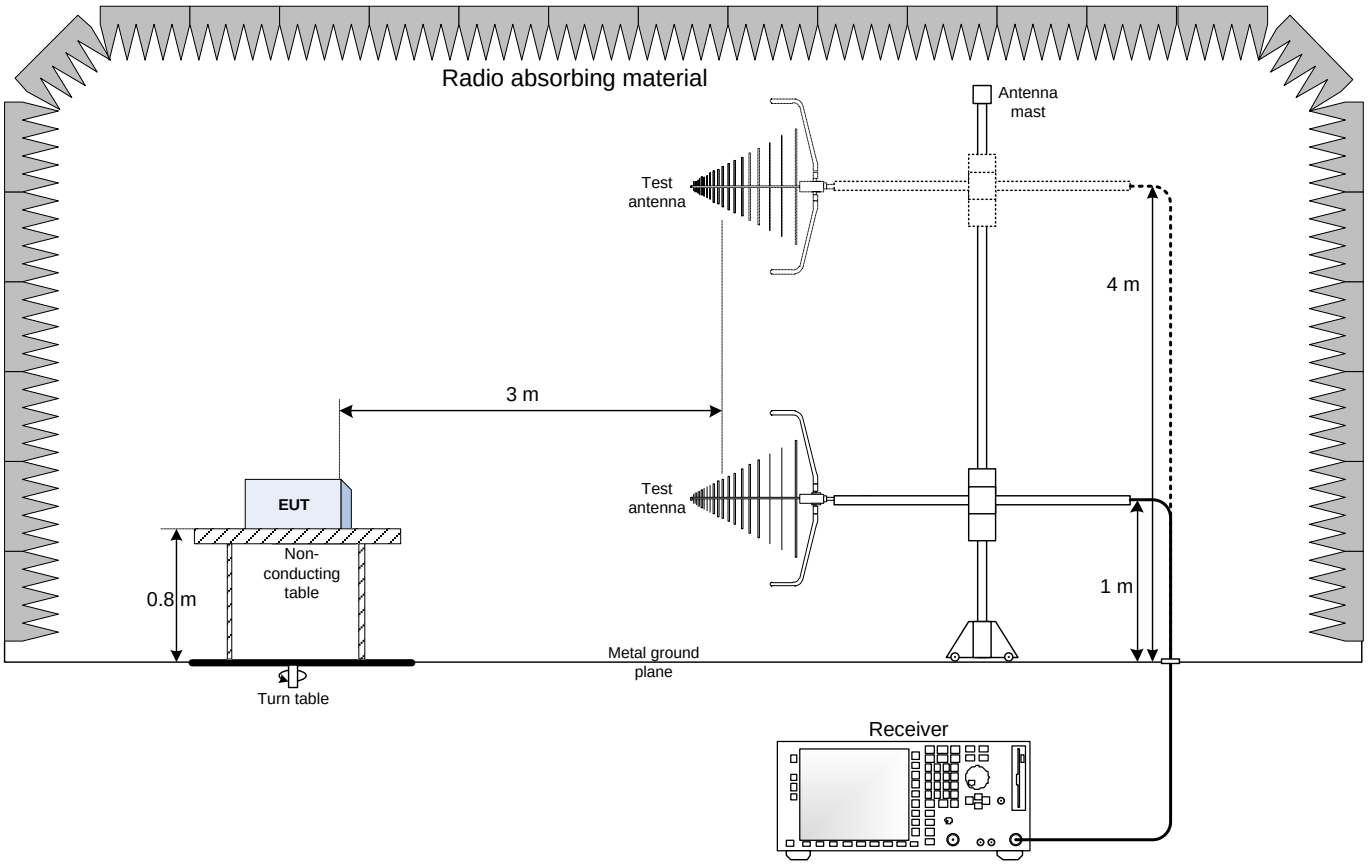
Plot 8.5-2: *Conducted emissions scan*

Table 8.5-3: *Quasi-Peak and Average conducted emissions results*

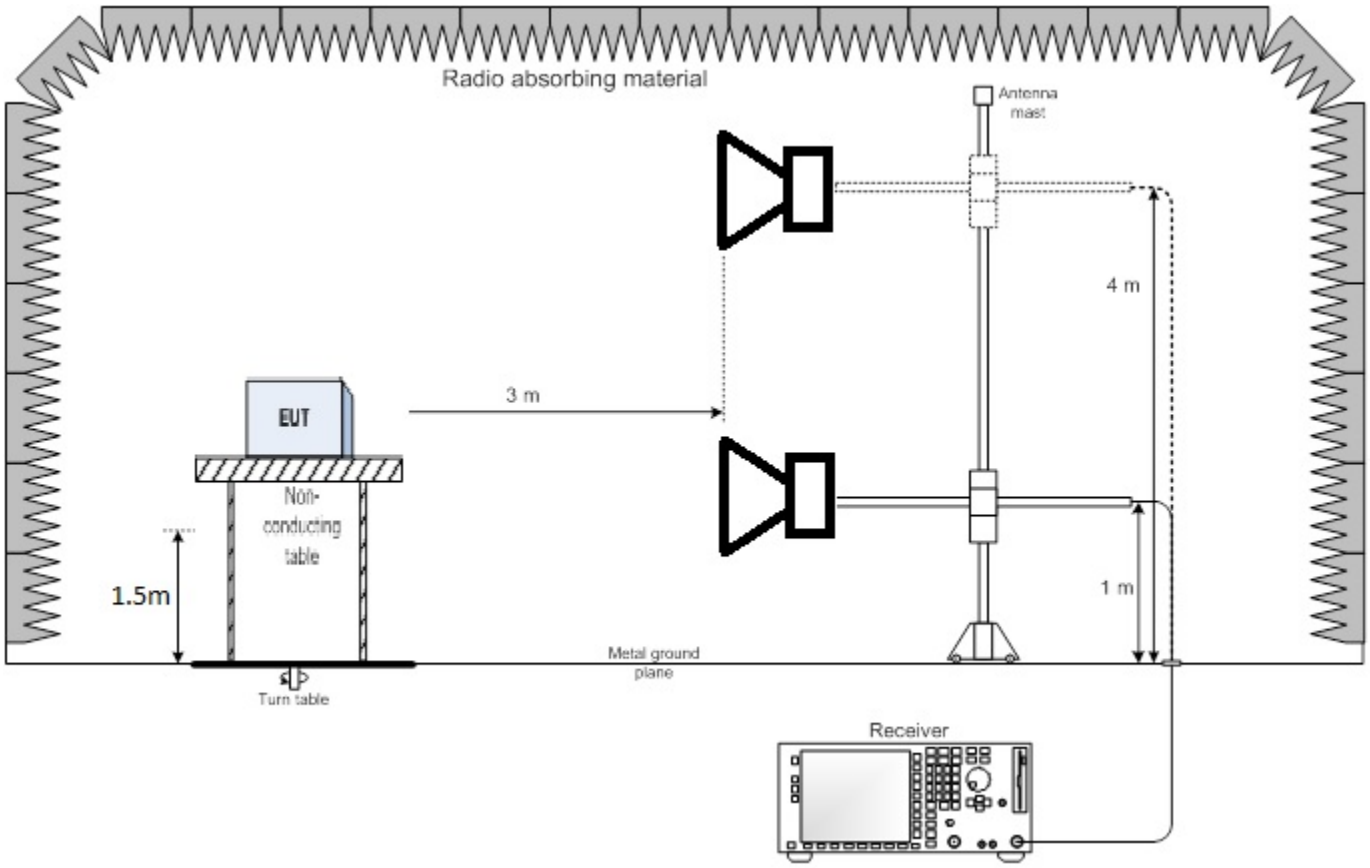
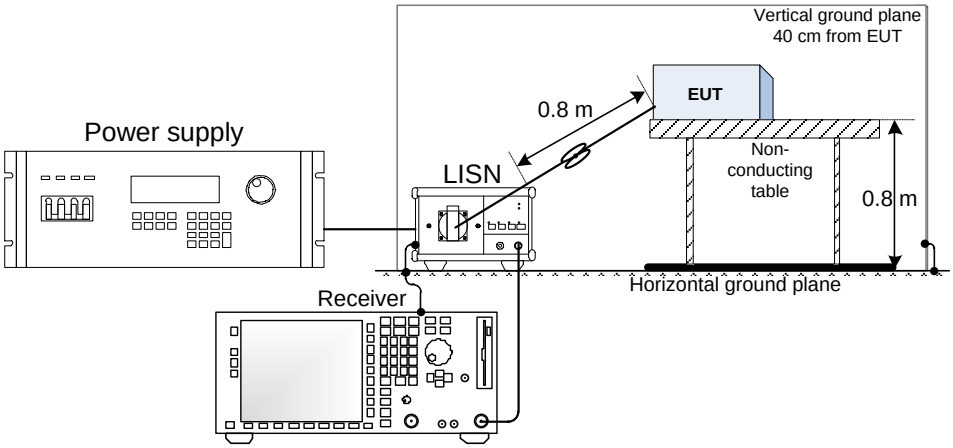
Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter
0.367136	47.90	---	58.57	10.67	10000.0	9.000	L1	ON
0.367136	---	40.37	48.57	8.20	10000.0	9.000	L1	ON
0.368768	48.40	---	58.53	10.12	10000.0	9.000	L1	ON
0.368768	---	40.61	48.53	7.92	10000.0	9.000	L1	ON
0.657341	---	27.32	46.00	18.68	10000.0	9.000	L1	ON
0.657341	35.00	---	56.00	21.00	10000.0	9.000	L1	ON
0.942904	---	26.88	46.00	19.12	10000.0	9.000	L1	ON
0.942904	35.08	---	56.00	20.92	10000.0	9.000	L1	ON
1.423834	---	26.94	46.00	19.06	10000.0	9.000	L1	ON
1.423834	34.85	---	56.00	21.15	10000.0	9.000	L1	ON
2.041052	---	26.84	46.00	19.16	10000.0	9.000	L1	ON
2.041052	34.61	---	56.00	21.39	10000.0	9.000	L1	ON
2.682319	---	25.34	46.00	20.66	10000.0	9.000	L1	ON
2.682319	33.04	---	56.00	22.96	10000.0	9.000	L1	ON

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up – Below 1GHz



9.2 Radiated emissions set-up – Above 1GHz



9.3 Conducted emissions set-up