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Test report

FCC-15.247 and RSS-247 BLE #314207

Date of issue: September 14, 2016

Applicant: Vita-Mix Manufacturing Corporation

Product: Household Food Preparing Machine

Model: VM0185 Model Variant: Different shells and faceplates

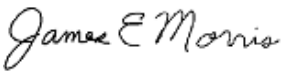
FCC ID: 2AJEHVM0185 IC Registration number: 21814-VM0185

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
  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

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
Site number	FCC: US5058; IC: 2040B

Tested by	Feng You, Sr. Wireless Engineer
Reviewed by	James Morris
Review date	September 15, 2016
Reviewer signature	

Limits of responsibility

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

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Vita-Mix Manufacturing Corporation
Address	8615 Usher Road
City	Cleveland
Province/State	OH
Postal/Zip code	44138
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 1	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

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 Antennas are located within the protective cover of EUT on PCB.

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	August 4, 2016
Nemko sample ID number	314207 #1/#2/#3/#4/#5

3.2 EUT information

Product name	Household Food Preparing Machine
Model	VM0185
Model variant	With different shells and faceplates
Serial number	BETA_02_68, BETA_06_94, N/A
FCC ID	2AJEHVM0185
IC Registration Number	21814-VM0185

3.3 Technical information

Applicant IC company number	21814
IC UPN number	VM0185
All used IC test site(s) Reg. number	2040B
RSS number and Issue number	RSS-247, Issue 1, May 2015
Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2402
Frequency Max (MHz)	2480
RF power Min (W), Conducted/ERP/EIRP	N/A
RF power Max (W), Conducted/ERP/EIRP	0.00102 (Conducted)
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	933.4
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	GFSK
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, Units @ distance	40.4 dBµV/m @ 3m AVG, 53.4 dBµV/m @ 3m Peak
Power requirements	120V AC 60Hz
Antenna information	0 dBi gain antenna on PCB. The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

Household Food Preparing Machine using Bluetooth LE interface for download menu. It also has 13.56MHz NFC reader to register container (NFC in separate report).

The wireless board modified with RF connector was used for RF conducted test. All other test cases were performed with normal unit with USB to UART connector.

3.5 EUT exercise details

A test version of firmware was implemented that allows the different RF modes/channels to be sequenced through. EUT is set to fixed channel test mode with external PC using USB to UART cable to control channels and modes.

3.6 EUT setup diagram

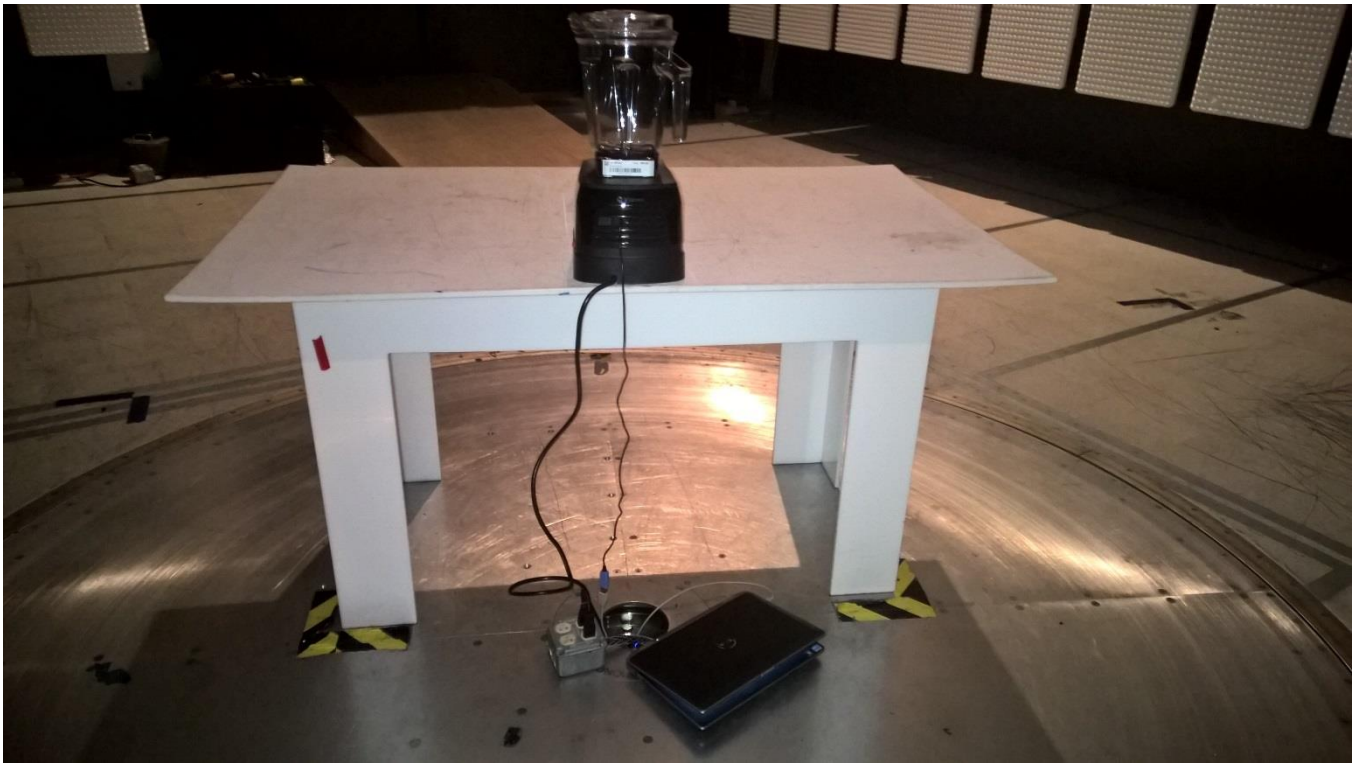


Figure 3.6-1: *Radiated Emissions Test Setup – below 1GHz*

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

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

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Household Food Preparing Machine – BLE on, NFC off	Vita-Mix	VM0185	BETA_06_94
Household Food Preparing Machine – BLE on, NFC on	Vita-Mix	VM0185	BETA_02_68
64oz Food Container	Vita-Mix	061XXX	BETA_03_67
Metal Shell	Vita-Mix	117257	N/A
Wireless Board with RF Connector, BLE on	Vita-Max	100116 Rev E23	N/A

Table 3.7-2: *Support Equipement*

Description	Brand name	Model/Part number	Serial number
Test Laptop	Dell	Latitude E6430	N/A
Laptop Power Supply	Dell	LA 130 PM1Z1	N/A
Test Laptop	Lenovo	0047	N/A
Laptop Power Supply	Lenovo	PA-1300-12	N/A
USB to TTL Serial Cable	Adafruit	954	N/A

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

The following modifications were performed by client:
USB to UART cable connected to wireless board through opening on plastic case. (for test mode control purpose only)

4.2 Technical judgment

1. All required test cases for BLE were performed with BLE on and NFC off.
2. Radiated emissions was also performed in worst case channel with BLE and NFC on at the same time – no problem with colocation.
3. Radiated emissions was also performed in worst case channel with BLE and NFC on at the same time (same unit in (2) replaced with Metal Shell) – no negative effect.

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

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
529	Antenna, DRWG	EMCO	3115	2505	01-Feb-2017
815	Multimeter	Fluke	111	78130066	02-Feb-2017
N106	Thermometer	FLUKE	50D	78620042	10-Aug-2016
E1013	DRG Horn (Small)	EMCO	3116	00119488	18-Nov-2016
E1019	Two Line V-Network	Rohde & Schwarz	ENV216	101045	15-Jun-2017
E1026	EMI Test Receiver 9kHz to 7GHz	Rohde & Schwarz	ESCI 7	100800	17-Mar-2017
S1043	Variac (Variable Transformer) 3kVA, Input 110/220VAC @ 4.8/12A	Shanghai China	TDGC	N/A	VOU
1733	Antenna, Active Loop	EMCO	6507	45939	21-Oct-2016
1763	Antenna, Bilog	Schaffner	CBL 6111D	22926	02-Oct-2016
1839	Environmental Chamber (Temperature only)	Tenney	T-14	14	VOU
E1120	Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101395	25-May-2017
E1121	EMI Test Receiver	Rohde & Schwarz	ESU 40	100064	28-Apr-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	August 9, 2016	Temperature	23 °C
Test engineer	Feng You	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	63 %

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	1–5 % of Channel BW (no wider than 100 kHz)
Video bandwidth	≥3 × RBW
Frequency span	1.5 MHz
Detector mode	Peak
Trace mode	Max Hold

8.1.4 Test data

Table 8.1-1: *6 dB bandwidth results*

Modulation	Frequency, MHz	6dB bandwidth, kHz	Limit, kHz	Margin, kHz
GFSK	2402	904.5	500	404.5
	2440	933.4	500	433.4
	2480	824.9	500	324.9

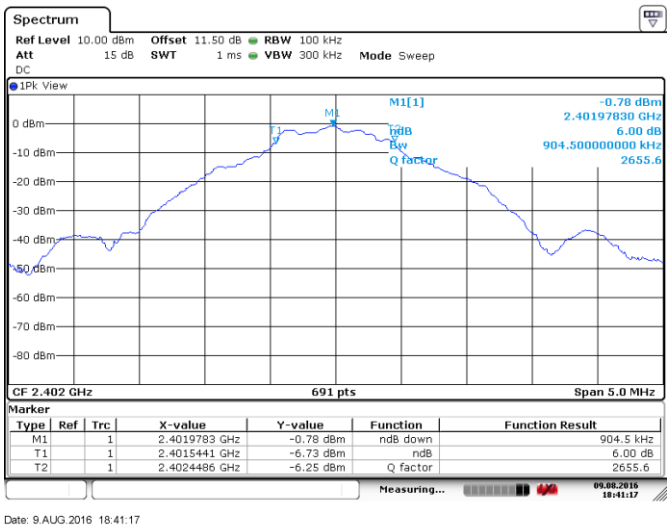


Figure 8.1-1: *6 dB bandwidth, 2402MHz*

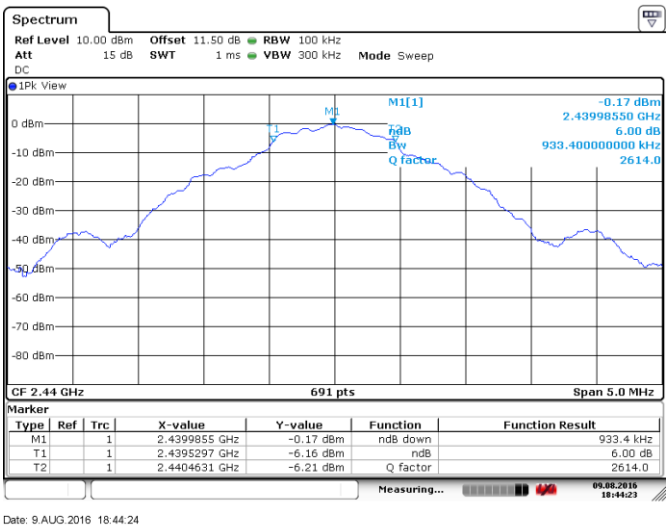


Figure 8.1-2: *6 dB bandwidth, 2440MHz*

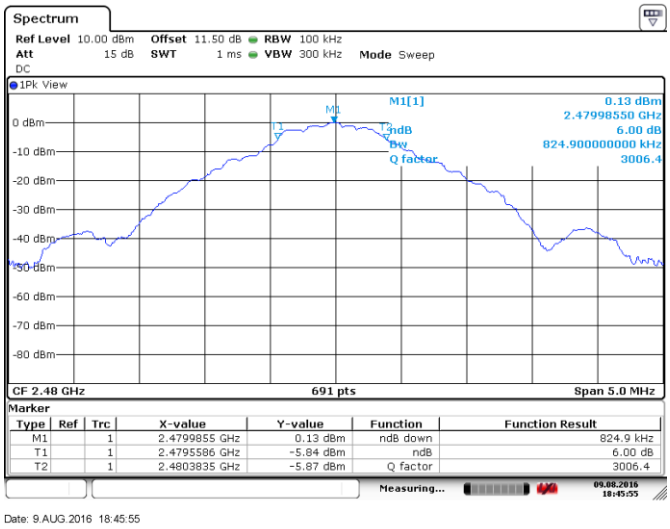


Figure 8.1-3: *6 dB bandwidth, 2480MHz*

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	August 9, 2016	Temperature	23 °C
Test engineer	Feng You	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	63 %

8.2.3 Observations, settings and special notes

Peak Conducted Power Measured
Spectrum analyser settings:

Resolution bandwidth	≥ Channel BW (3MHz)
Video bandwidth	≥ 3 × RBW (10MHz)
Frequency span	≥ 3 x RBW (10MHz)
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *Output power measurements results*

Power Source	Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		Measured	Limit					
120V AC	2402	-0.81	30	30.81	0	-0.81	36	36.81
	2440	-0.18	30	30.18	0	-0.18	36	36.18
	2480	0.09	30	29.91	0	0.09	36	35.91
108V AC	2402	-0.8	30	30.8	0	-0.8	36	36.8
	2440	-0.18	30	30.18	0	-0.18	36	36.18
	2480	0.08	30	29.92	0	0.08	36	35.92
132V AC	2402	-0.81	30	30.81	0	-0.81	36	36.81
	2440	-0.18	30	30.18	0	-0.18	36	36.18
	2480	0.09	30	29.91	0	0.09	36	35.91

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	Field strength of emissions 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	August 9, 2016	Temperature	23 °C
Test engineer	Feng You	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	63 %

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.

Spectrum analyser settings for conducted spurious emissions measurements:

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

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

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

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

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

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

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

8.3.4 Test data

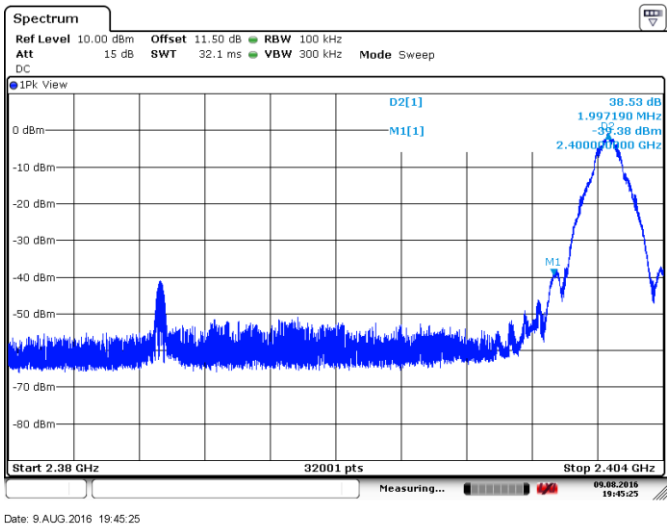


Figure 8.3-1: *Bandedge Measurement, low channel*

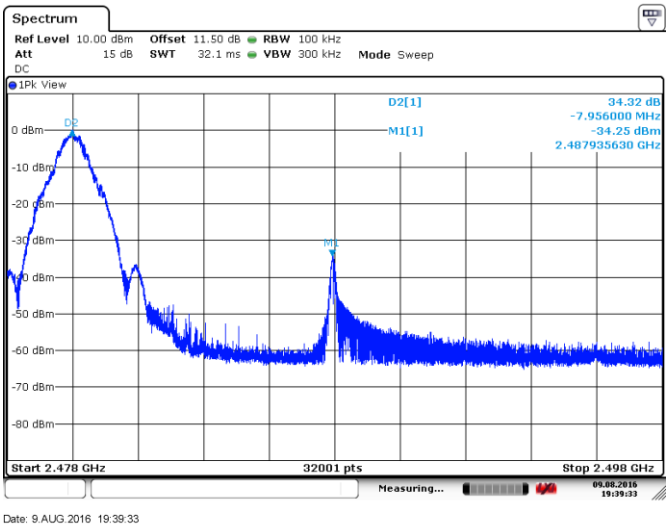


Figure 8.3-2: *Bandedge Measurement, high channel*

Table 8.3 4: Reference PSD in 100kHz

Modulation	Frequency, MHz	PSD dBm/100kHz
GFSK	2402	-0.8
	2440	-0.18
	2480	-0.07

Table 8.3 5: Bandedge Results

Modulation	Frequency, MHz	Highest Peak, dBc	Limit, dBc	Margin, dB
GFSK	2402	38.53	20	18.53
	2480	34.32	20	14.32

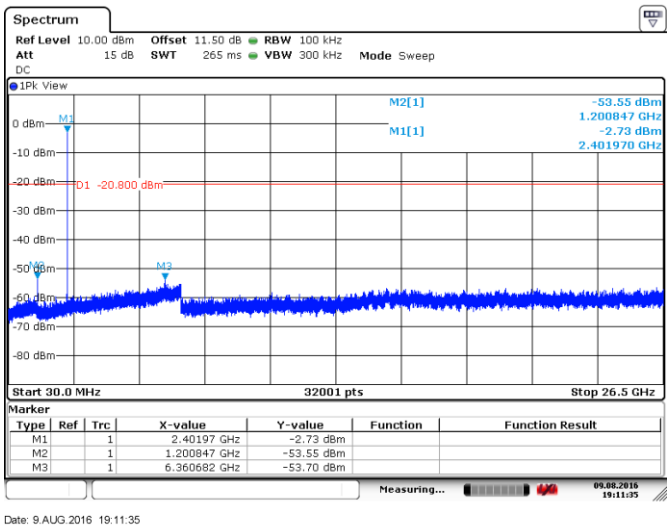


Figure 8.3-3: *Conducted spurious emissions, low channel*

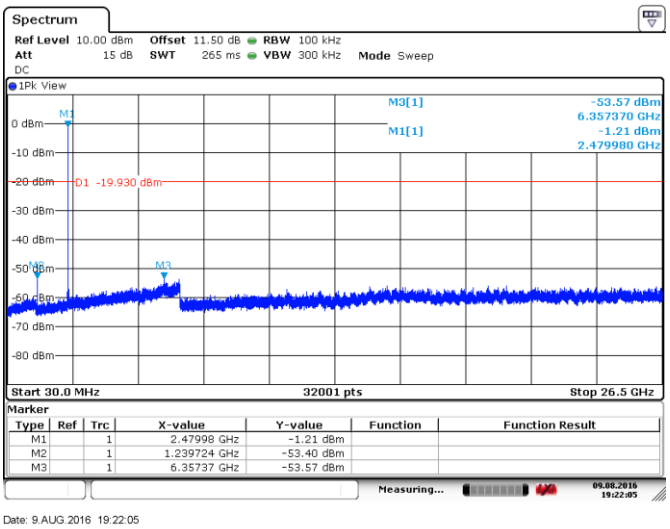


Figure 8.3-4: *Conducted spurious emissions, high channel*

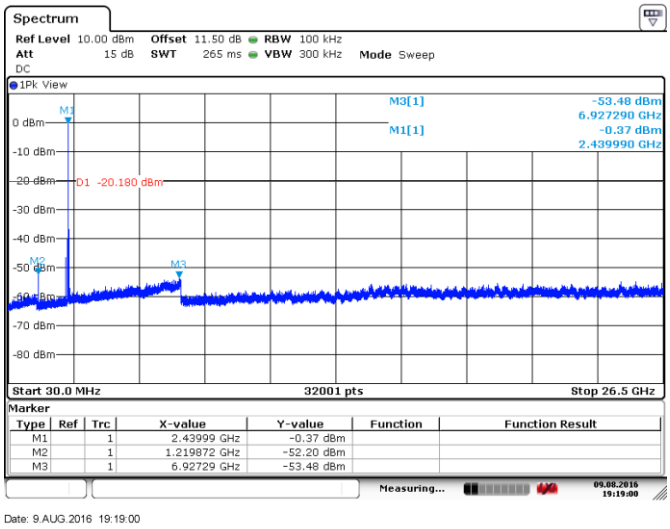


Figure 8.3-5: *Conducted spurious emissions, mid channel*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

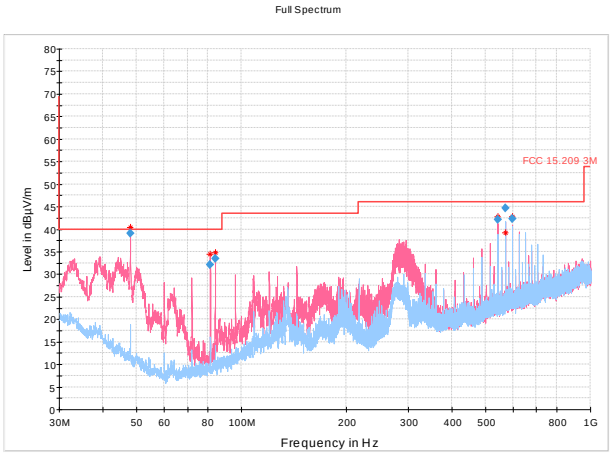


Figure 8.3-6: *Radiated spurious emissions, low channel, 30-1000MHz*

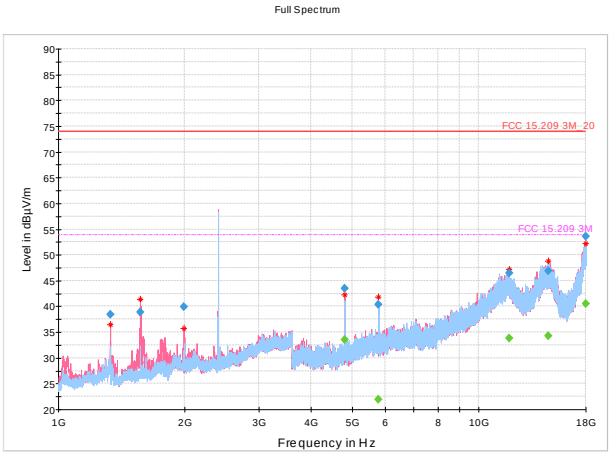


Figure 8.3-7: *Radiated spurious emissions, low channel, 1-18GHz*

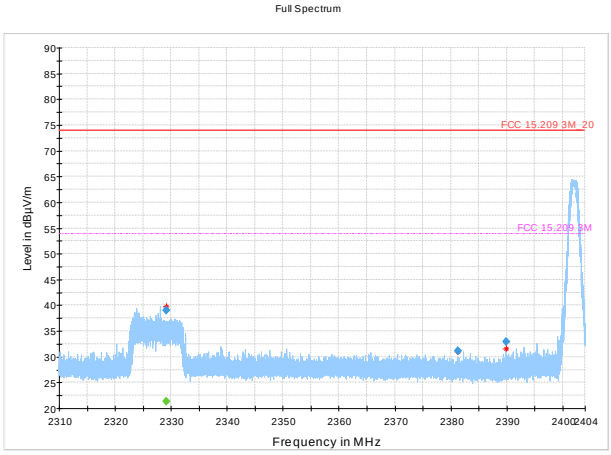


Figure 8.3-7b: *Radiated spurious emissions, low channel, Near Bandedge*

Table 8.3-6: *Radiated field strength measurement results for low channel 2402MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
47.993500	39.07	40.00	0.93	1000.0	120.000	105.4	V	23.0
81.361500	32.17	40.00	7.83	1000.0	120.000	120.1	V	0.0
84.020500	33.45	40.00	6.55	1000.0	120.000	108.7	V	355.0
542.402500	42.17	46.00	3.83	1000.0	120.000	110.3	V	0.0
569.514000	44.61	46.00	1.39	1000.0	120.000	126.2	H	316.0
596.634000	42.33	46.00	3.67	1000.0	120.000	158.0	V	82.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1329.5000	---	16.88	53.90	37.02	1000.0	1000.000	196.4	V	179.0
1329.5000	38.46	---	73.90	35.44	1000.0	1000.000	196.4	V	179.0
1567.1000	---	17.13	53.90	36.77	1000.0	1000.000	166.8	V	242.0
1567.1000	38.90	---	73.90	35.00	1000.0	1000.000	166.8	V	242.0
1993.6333	39.92	---	73.90	33.98	1000.0	1000.000	143.2	V	170.0
1993.6333	---	19.09	53.90	34.81	1000.0	1000.000	143.2	V	170.0
4803.2000	---	33.53	53.90	20.37	1000.0	1000.000	159.7	V	36.0
4803.2000	43.53	---	73.90	30.37	1000.0	1000.000	159.7	V	36.0
5779.0000	40.36	---	73.90	33.54	1000.0	1000.000	219.7	H	51.0
5779.0000	---	21.99	53.90	31.91	1000.0	1000.000	219.7	H	51.0
11829.100	46.51	---	73.90	27.39	1000.0	1000.000	138.4	H	336.0
11829.100	---	33.86	53.90	20.04	1000.0	1000.000	138.4	H	336.0
14645.100	---	34.21	53.90	19.69	1000.0	1000.000	109.5	V	96.0
14645.100	46.90	---	73.90	27.00	1000.0	1000.000	109.5	V	96.0
17994.433	53.53	---	73.90	20.37	1000.0	1000.000	168.8	V	155.0
17994.433	---	40.44	53.90	13.46	1000.0	1000.000	168.8	V	155.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2329.1106	---	21.39	53.90	32.51	1000.0	1000.000	138.9	H	285.0
2329.1106	38.96	---	73.90	34.94	1000.0	1000.000	138.9	H	285.0
2381.2358	---	17.57	53.90	36.33	1000.0	1000.000	104.0	V	79.0
2381.2358	31.15	---	73.90	42.75	1000.0	1000.000	104.0	V	79.0
2389.9590	---	18.43	53.90	35.47	1000.0	1000.000	112.2	V	301.0
2389.9590	32.91	---	73.90	40.99	1000.0	1000.000	112.2	V	301.0

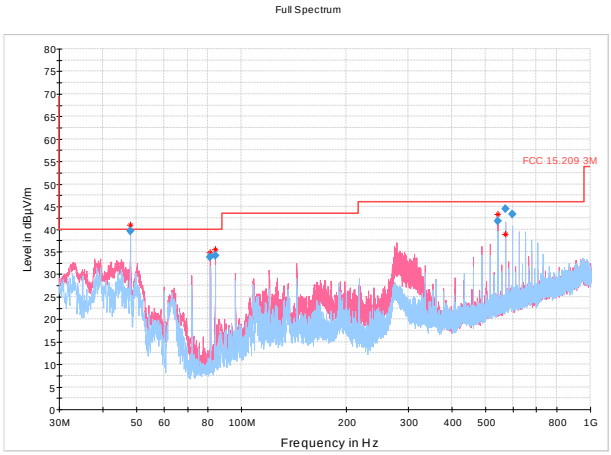


Figure 8.3-8: *Radiated spurious emissions, mid channel, 30-1000MHz*

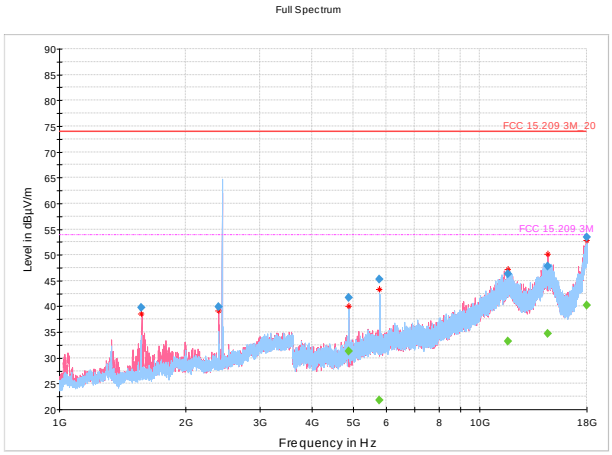


Figure 8.3-8: *Radiated spurious emissions, mid channel, 1-18GHz*

Table 8.3-7: *Radiated field strength measurement results for mid channel 2440MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
47.993500	39.56	40.00	0.44	1000.0	120.000	100.0	V	68.0
81.361500	33.75	40.00	6.25	1000.0	120.000	124.0	V	340.0
84.020500	34.18	40.00	5.82	1000.0	120.000	100.0	V	332.0
542.402500	41.76	46.00	4.24	1000.0	120.000	112.6	V	0.0
569.514000	44.42	46.00	1.58	1000.0	120.000	123.3	H	315.0
596.634000	43.32	46.00	2.68	1000.0	120.000	118.8	H	308.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1565.8666	39.84	---	73.90	34.06	1000.0	1000.000	163.2	V	247.0
1565.8666	---	17.39	53.90	36.51	1000.0	1000.000	163.2	V	247.0
2394.6333	39.87	---	73.90	34.03	1000.0	1000.000	155.9	V	20.0
2394.6333	---	17.39	53.90	36.51	1000.0	1000.000	155.9	V	20.0
4879.2000	---	31.28	53.90	22.62	1000.0	1000.000	162.5	H	32.0
4879.2000	41.71	---	73.90	32.19	1000.0	1000.000	162.5	H	32.0
5781.5666	45.22	---	73.90	28.68	1000.0	1000.000	160.5	H	101.0
5781.5666	---	21.85	53.90	32.05	1000.0	1000.000	160.5	H	101.0
11676.566	46.27	---	73.90	27.63	1000.0	1000.000	219.9	H	30.0
11676.566	---	33.28	53.90	20.62	1000.0	1000.000	219.9	H	30.0
14543.533	47.76	---	73.90	26.14	1000.0	1000.000	201.6	V	150.0
14543.533	---	34.66	53.90	19.24	1000.0	1000.000	201.6	V	150.0
17997.800	53.40	---	73.90	20.50	1000.0	1000.000	218.9	V	109.0
17997.800	---	40.14	53.90	13.76	1000.0	1000.000	218.9	V	109.0

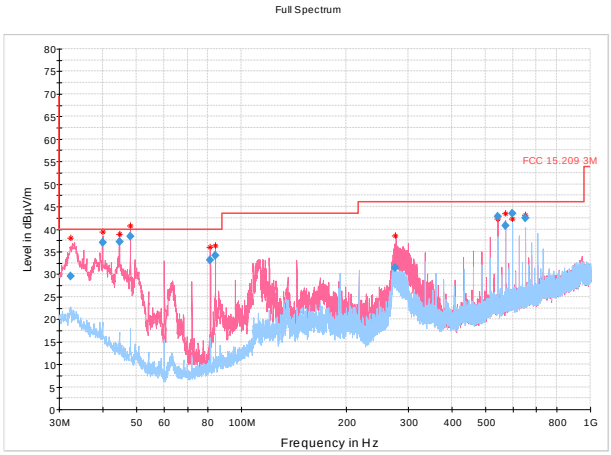


Figure 8.3-10: *Radiated spurious emissions, high channel, 30-1000MHz*

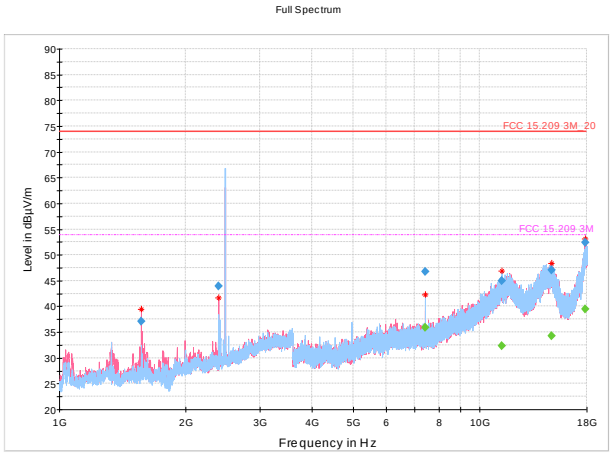


Figure 8.3-11: *Radiated spurious emissions, high channel, 1-18GHz*

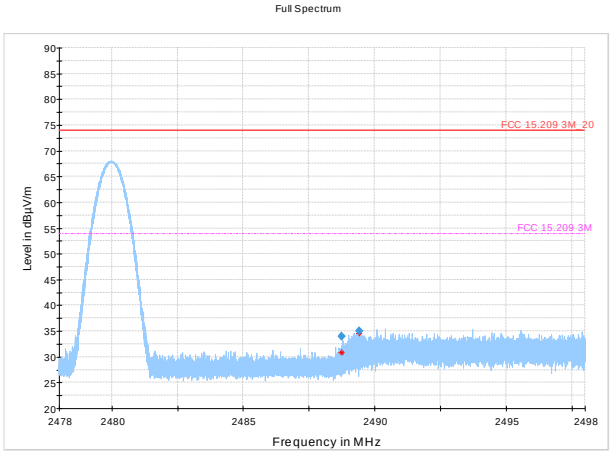


Figure 8.3-11b: *Radiated spurious emissions, high channel, Near Bandedge*

Table 8.3-8: *Radiated field strength measurement results for high channel 2480MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
32.404500	29.56	40.00	10.44	1000.0	120.000	167.4	V	204.0
39.991000	37.04	40.00	2.96	1000.0	120.000	108.7	V	174.0
44.687000	37.12	40.00	2.88	1000.0	120.000	111.3	V	108.0
47.993500	38.45	40.00	1.55	1000.0	120.000	108.3	V	200.0
81.361500	33.15	40.00	6.85	1000.0	120.000	108.9	V	331.0
84.020500	34.21	40.00	5.79	1000.0	120.000	108.0	V	335.0
276.111000	31.38	46.00	14.62	1000.0	120.000	105.3	V	213.0
542.402500	42.73	46.00	3.27	1000.0	120.000	109.9	V	0.0
569.514000	40.71	46.00	5.29	1000.0	120.000	265.3	V	17.0
596.634000	43.52	46.00	2.48	1000.0	120.000	110.1	H	320.0
650.897000	42.47	46.00	3.53	1000.0	120.000	115.2	H	30.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1564.6333	---	16.24	53.90	37.66	1000.0	1000.000	160.1	V	35.0
1564.6333	37.05	---	73.90	36.85	1000.0	1000.000	160.1	V	35.0
2391.3666	---	18.05	53.90	35.85	1000.0	1000.000	140.8	V	330.0
2391.3666	43.93	---	73.90	29.97	1000.0	1000.000	140.8	V	330.0
7440.0333	46.74	---	73.90	27.16	1000.0	1000.000	193.4	H	-5.0
7440.0333	---	35.95	53.90	17.95	1000.0	1000.000	193.4	H	-5.0
11295.033	44.94	---	73.90	28.96	1000.0	1000.000	139.9	H	168.0
11295.033	---	32.30	53.90	21.60	1000.0	1000.000	139.9	H	168.0
14863.733	---	34.21	53.90	19.69	1000.0	1000.000	184.7	H	1.0
14863.733	47.09	---	73.90	26.81	1000.0	1000.000	184.7	H	1.0
17829.033	---	39.45	53.90	14.45	1000.0	1000.000	155.3	V	355.0
17829.033	52.35	---	73.90	21.55	1000.0	1000.000	155.3	V	355.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2488.7306	---	18.44	53.90	35.46	1000.0	1000.000	138.0	H	321.0
2488.7306	34.00	---	73.90	39.90	1000.0	1000.000	138.0	H	321.0
2489.4113	---	19.67	53.90	34.23	1000.0	1000.000	160.2	V	142.0
2489.4113	35.05	---	73.90	38.85	1000.0	1000.000	160.2	V	142.0

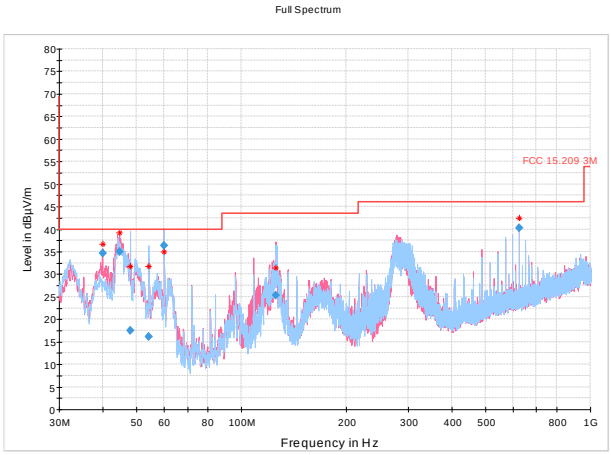


Figure 8.3-12: *Radiated spurious emissions, BLE mid channel, 30-1000MHz*

Both BLE and NFC on

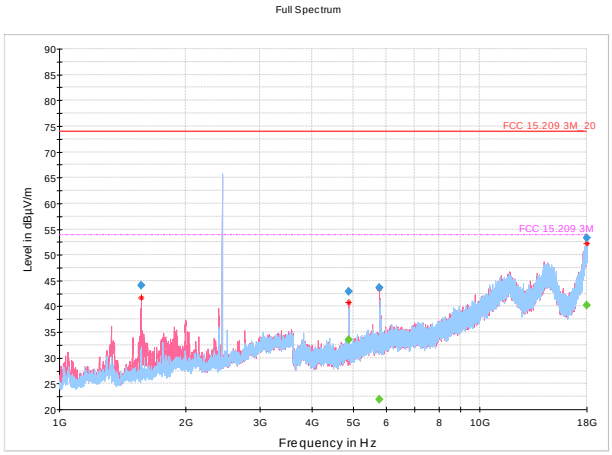


Figure 8.3-13: *Radiated spurious emissions, BLE mid channel, 1-18GHz*

Both BLE and NFC on

Table 8.3-9: *Radiated field strength measurement results for mid channel 2440MHz, BLE and NFC*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
39.991000	34.62	40.00	5.38	1000.0	120.000	100.0	V	11.0
44.695500	34.92	40.00	5.08	1000.0	120.000	112.3	V	122.0
47.993500	17.52	40.00	22.48	1000.0	120.000	142.2	H	215.0
54.241500	16.08	40.00	23.92	1000.0	120.000	140.0	H	0.0
60.013000	36.42	40.00	3.58	1000.0	120.000	122.9	V	71.0
125.665000	25.39	43.50	18.11	1000.0	120.000	105.4	V	-1.0
623.785500	40.17	46.00	5.83	1000.0	120.000	116.2	H	124.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1563.9333	44.01	---	73.90	29.89	1000.0	1000.000	150.9	V	121.0
1563.9333	---	19.76	53.90	34.14	1000.0	1000.000	150.9	V	121.0
4880.6333	42.82	---	73.90	31.08	1000.0	1000.000	103.9	V	29.0
4880.6333	---	33.56	53.90	20.34	1000.0	1000.000	103.9	V	29.0
5786.5333	43.62	---	73.90	30.28	1000.0	1000.000	172.1	V	28.0
5786.5333	---	21.88	53.90	32.02	1000.0	1000.000	172.1	V	28.0
17995.400	53.31	---	73.90	20.59	1000.0	1000.000	113.1	V	80.0
17995.400	---	40.25	53.90	13.65	1000.0	1000.000	113.1	V	80.0

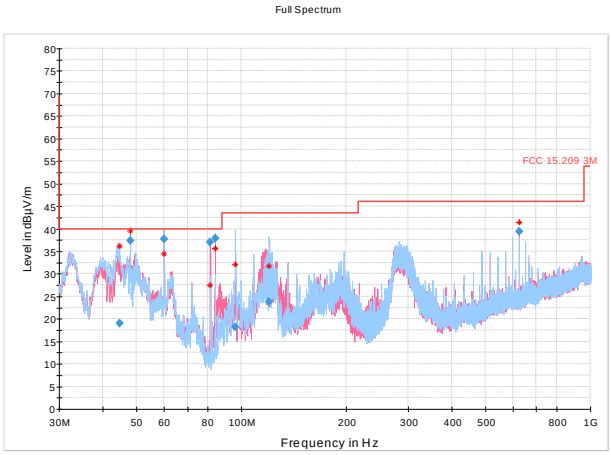


Figure 8.3-14: *Radiated spurious emissions, BLE mid channel, 30-1000MHz*

Both BLE and NFC on, with Metal Shell

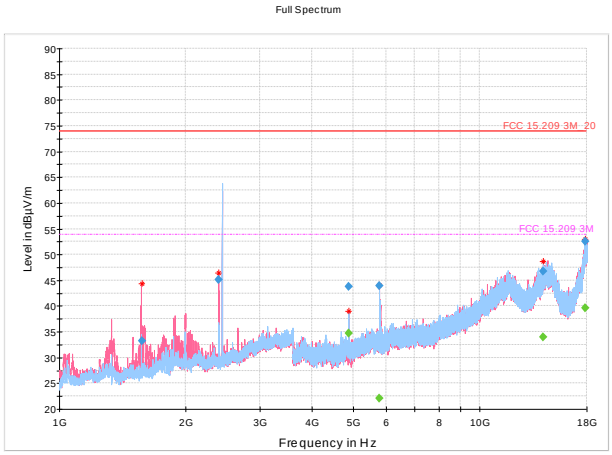


Figure 8.3-15: *Radiated spurious emissions, BLE mid channel, 1-18GHz*

Both BLE and NFC on, with Metal Shell

Table 8.3-10: *Radiated field strength measurement results for mid channel 2440MHz, BLE and NFC, with Metal Shell*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
44.682000	19.07	40.00	20.93	1000.0	120.000	387.3	H	106.0
48.033500	37.36	40.00	2.64	1000.0	120.000	111.4	V	164.0
60.013000	37.76	40.00	2.24	1000.0	120.000	100.0	V	337.0
81.353000	37.01	40.00	2.99	1000.0	120.000	126.2	V	339.0
84.020500	37.95	40.00	2.05	1000.0	120.000	108.8	V	351.0
96.048500	18.15	43.50	25.35	1000.0	120.000	157.5	H	317.0
120.056000	23.78	43.50	19.72	1000.0	120.000	277.3	H	10.0
623.785500	39.48	46.00	6.52	1000.0	120.000	103.9	V	106.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1572.5666	---	16.05	53.90	37.86	1000.0	1000.000	117.7	V	104.0
1572.5666	33.28	---	73.90	40.62	1000.0	1000.000	117.7	V	104.0
2391.4666	---	18.24	53.90	35.66	1000.0	1000.000	106.4	V	36.0
2391.4666	45.05	---	73.90	28.85	1000.0	1000.000	106.4	V	36.0
4880.5666	---	34.72	53.90	19.18	1000.0	1000.000	105.5	H	215.0
4880.5666	43.76	---	73.90	30.14	1000.0	1000.000	105.5	H	215.0
5776.9333	---	22.10	53.90	31.80	1000.0	1000.000	126.8	V	64.0
5776.9333	43.91	---	73.90	29.99	1000.0	1000.000	126.8	V	64.0
14169.900	46.78	---	73.90	27.12	1000.0	1000.000	266.3	H	188.0
14169.900	---	33.91	53.90	19.99	1000.0	1000.000	266.3	H	188.0
17826.666	52.49	---	73.90	21.41	1000.0	1000.000	232.8	H	113.0
17826.666	---	39.60	53.90	14.30	1000.0	1000.000	232.8	H	113.0

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	August 9, 2016	Temperature	23 °C
Test engineer	Feng You	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	63 %

8.4.3 Observations, settings and special notes

3kHz RBW

8.4.4 Test data

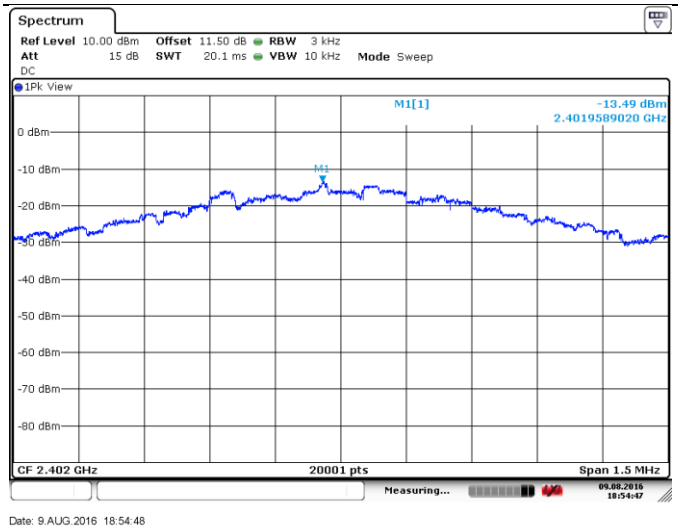


Diagram 8.4-1: *Power Spectrum Density,, 2402MHz*

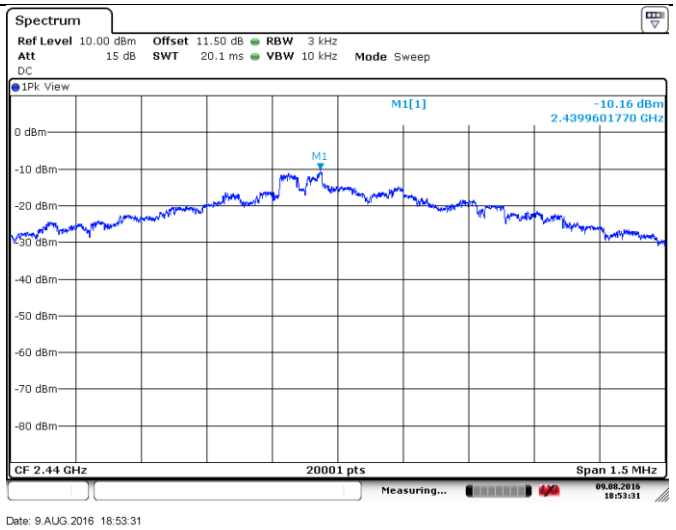


Diagram 8.4-2: *Power Spectrum Density,, 2440MHz*

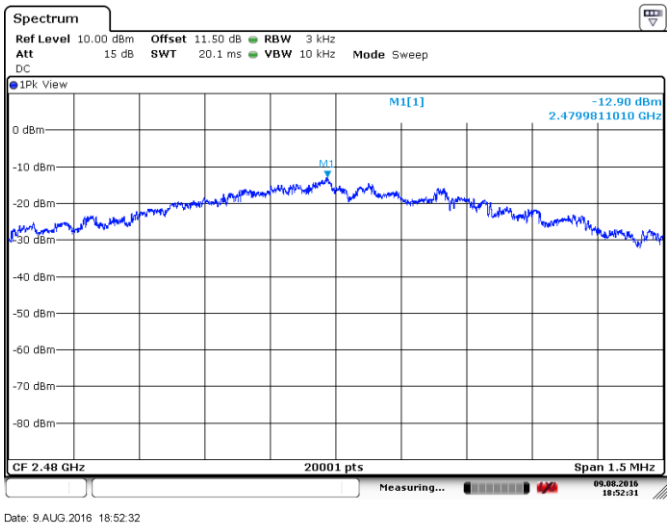


Diagram 8.4-3: *Power Spectrum Density,, 2480MHz*

Table 8.4-1: *Power Spectrum Density*

Power Source	Frequency, MHz	Conducted PSD@3kHz, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		Measured	Limit					
120V AC	2402	-13.49	8	21.49	0	-13.49	14	27.49
	2440	-10.16	8	18.16	0	-10.16	14	24.16
	2480	-12.9	8	20.9	0	-12.9	14	26.9

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	August 8, 2016	Temperature	23 °C
Test engineer	Feng You	Air pressure	999 mbar
Verdict	Pass	Relative humidity	63 %

8.5.3 Observations, settings and special notes

This is tested with both BLE and NFC on, BLE in mid CH 2440MHz.

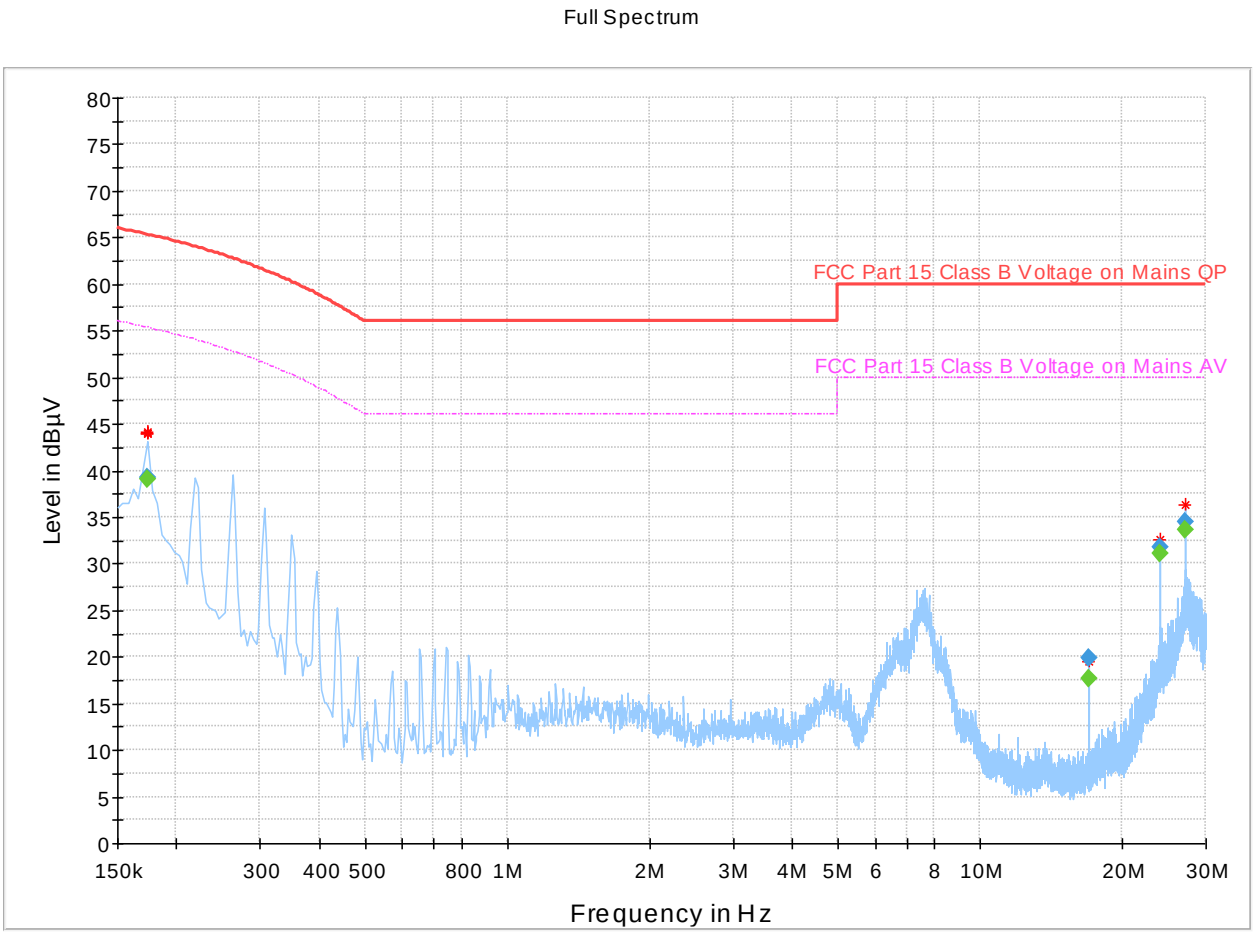
The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

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.

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



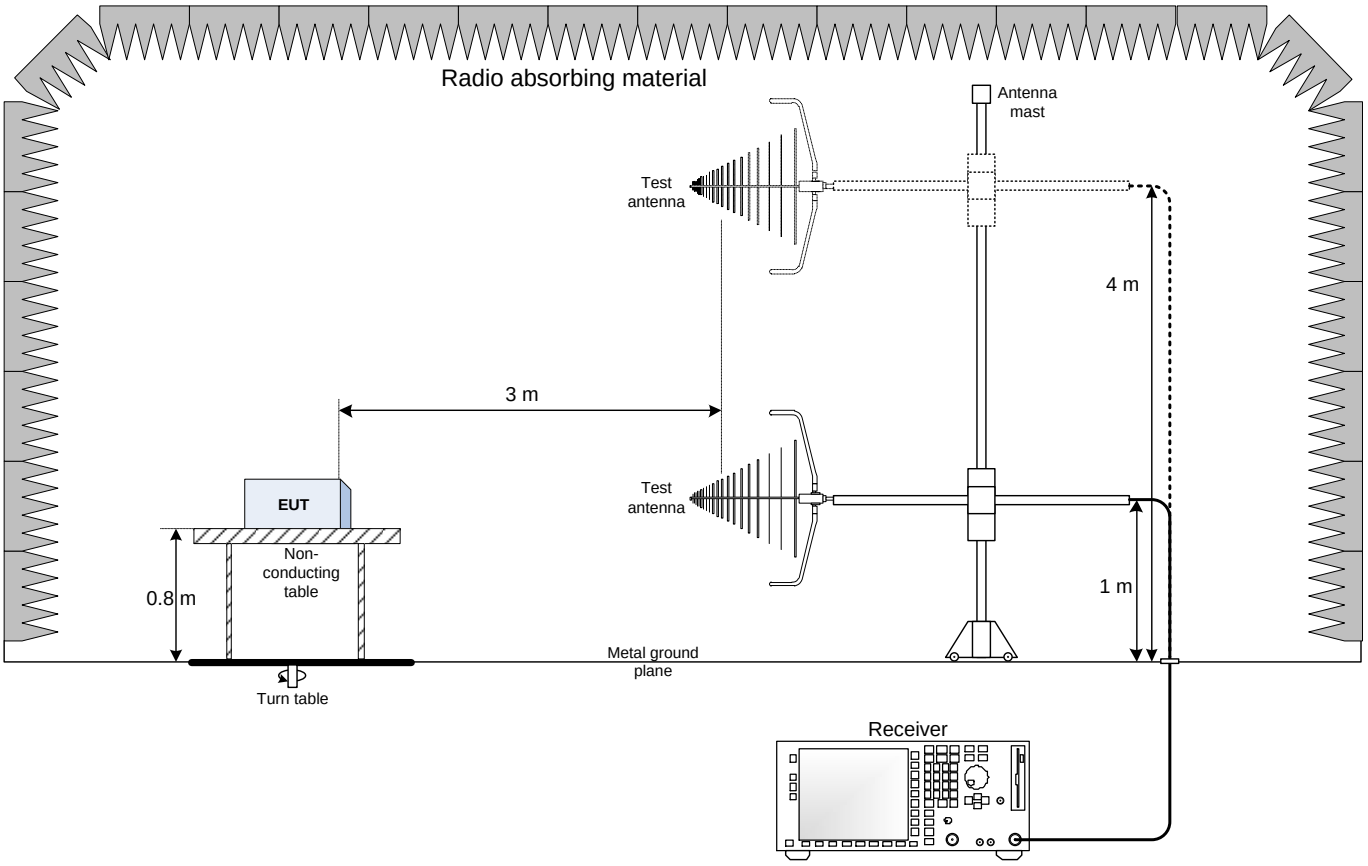
Plot 8.5-1: *Conducted emissions*

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

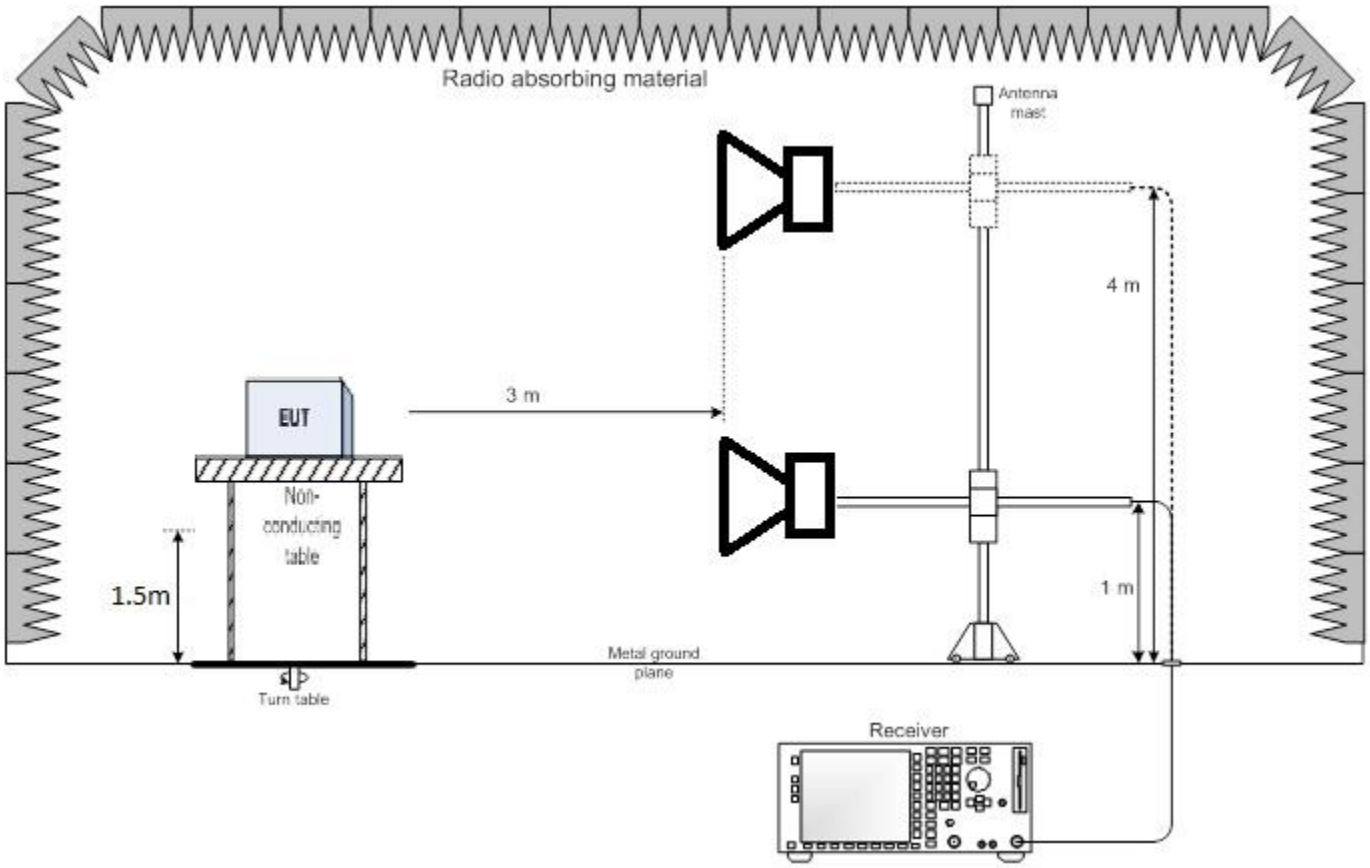
Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line
0.174000	---	39.03	55.31	16.28	1000.0	9.000	N
0.174000	39.20	---	65.31	26.11	1000.0	9.000	N
17.032000	19.92	---	60.00	40.08	1000.0	9.000	L1
17.032000	---	17.67	50.00	32.33	1000.0	9.000	L1
24.004000	---	31.06	50.00	18.94	1000.0	9.000	N
24.004000	31.73	---	60.00	28.27	1000.0	9.000	N
27.120000	34.44	---	60.00	25.56	1000.0	9.000	L1
27.120000	---	33.70	50.00	16.30	1000.0	9.000	L1

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