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Test report

356174-TRFWLEMCR1

Date of issue: March 20, 2019

Applicant:
EM Microelectronic US Inc.

Product:
BT Radio Beacon

Model:
EMBP01

Variants:
EMBP00, EMBP02, EMBP03

FCC ID:
2ACQR-EMBP0

IC:
12155A-EMBP0

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 License-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-3

Tested by	Andres Martinez, Wireless Engineer
Reviewed by	Chip Fleury, Wireless and Certification Supervisor.
Review date	April 8, 2019
Reviewer signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko USA's ISO/IEC 17025 accreditation.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	EM Microelectronic US Inc
Address	5475 Mark Dabling Boulevard, Suite 200
City	Colorado Springs
Province/State	CO
Postal/Zip code	80918-3848
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 License-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
TRF	Original report issued
R1	Changed output power to conducted

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
§15.205	Restricted bands of operation	Pass

Notes:

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	Pass
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Pass
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

2.3 IC RSS-GEN, Issue 5, test results

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Pass
7.4	Receiver conducted emission limits	Pass
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Not applicable[1]
8.10	Restricted Frequency Bands	Pass

Notes: [1] EUT is powered from an USB Port and has no direct connection to the AC mains.

2.4 IC RSS-247, Issue 2, test results

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

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	November 1, 2018
Nemko sample ID number	362141

3.2 EUT information

Product name	BT Radio Beacon
Model	EMBP01 (see note)
Model variant	EMBP00, EMBP02, EMBP03
Serial number	N/A
FCC ID	2ACQR-EMBP0
IC Registration Number	12155A-EMBP0

NOTE: After a quick scan on all four models the EMBP01 was chosen for testing the RF characteristics as it appeared to have a slightly increased power output.

3.3 Technical information

Applicant IC company number	12155A
IC UPN number	EMBP0
All used IC test site(s) Reg. number	2040B
RSS number and Issue number	RSS-247, Issue 2, February 2017
Frequency band	2.4-2.4835Ghz
Frequency Min (MHz)	2402
Frequency Max (MHz)	2480
RF power Min (W), Conducted	0.00013
RF power Max (W), Conducted	0.00038
Field strength, Units @ distance	N/A
Measured BW (kHz) (99%)	1060 kHz
Calculated BW (kHz), as per TRC-43	GFSK
Type of modulation	F1D
Emission classification (F1D, G1D, D1D)	N/A
Transmitter spurious, Units @ distance	3V battery
Power requirements	Integrated PCB IFA
Antenna information	1.5 dBi

3.4 Product description and theory of operation

The EMBP0x is a high-performance, customizable Bluetooth V5.0 low energy proximity beacon with an accelerometer for advanced functionality. The small and rugged EMBP0x comes fully encapsulated with a resin-based polymer for protection against dust and liquids and reliable use in harsh environmental conditions. The beacon has been optimized for low-cost and ease of use.

The EMBP0x is compatible with major beacon formats including iBeacon™, Eddystone™, AltBeacon™, and trackable with proprietary systems such as the Quuppa Intelligent Locating System™. The beacon is fully customizable over the air or in manufacturing. For example, the following parameters can be easily modified:

- Packet types, including custom packet type
- Device name, address, manufacturer name, model number, HW/SW revision
- UUID, Major/Minor ID, UID or URL
- Beacon interval
- Transmitter output power
- Accelerometer function and sensitivity

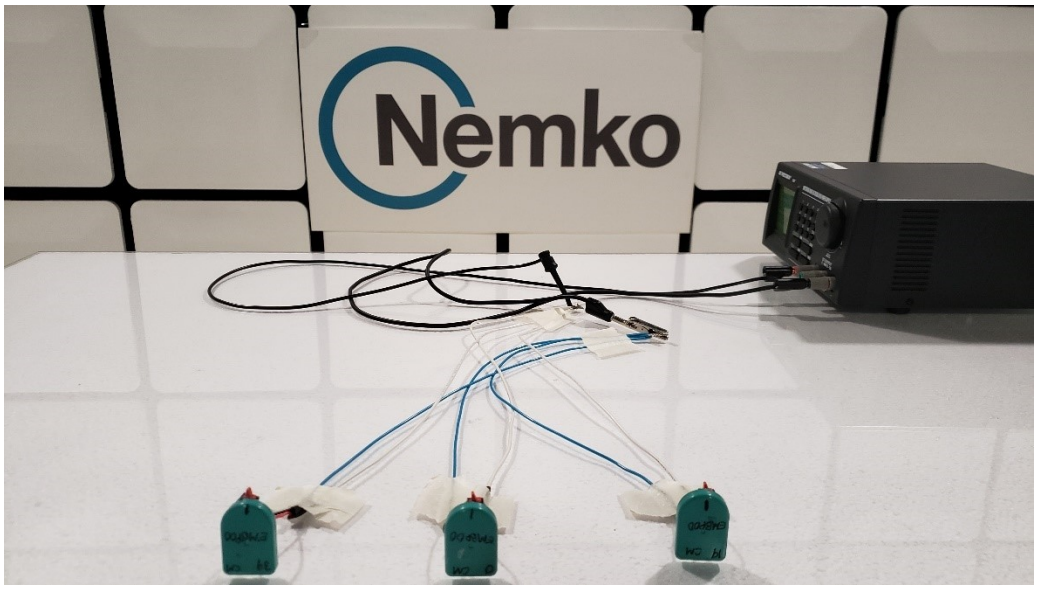
EMBP0x description above is representative of EMBP00, 01, 02 and 03 Models

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.

Three units were evaluated each one transmitted on a separate 2.4GHz channel (2402, 2440, 2480MHz)

3.6 EUT setup diagram



3.7 EUT sub assemblies

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	FCC ID
Low-Energy Proximity Beacon with Accelerometer	EM Microelectronics	EMBP01	2ACQR-EMBP0

Table 3.7-2: Support Equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop Computer	Dell	Inspiron 15	MSIP-RMM-CEI-P39F001	N/A

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

None.

4.2 Technical judgment

None.

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

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

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

5.2 Power supply range

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

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

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

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1120	1 yr.	07-28-2019
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1121	1 yr.	04-28-2019
Antenna, Bilog	Schaffner-Chase	CBL6111C	E1480	1 yr.	11-28-2019
Antenna, Horn	ETS	3117-PA	E1139	2 yr.	01-25-2020
Antenna, Horn	Sage	SAR-2309-42-S2	E1143	2 yr.	03-05-2020
Spectrum Analyzer	Rohde & Schwarz	FSV40	E1120	1 yr.	07-27-2019
Signal Generator	Rohde & Schwarz	SMB 100A	E1128	1 yr.	09-13-2019
High-pass filter	Wainwright Instruments GMBH	WHKX12-2493-2770-18000-60SS	N/A	N/A	Verified with FSV40
USB RF Power Sensor	ETS – Lindgren	7002-006	E1061	1 yr.	04-16-2019
Manual variable attenuator/1 dB step/10 dB step	JFW Industries	50SDV100-967	54912	N/A	Cal Not Required
Directional Coupler, Dual	Narda	3022	73393	N/A	Cal Not Required
Manual Step Attenuator, 0-9 dB, DC-18 GHz	API Weinschel	AF9009-9-31	26509	N/A	Cal Not Required

Section 8. Test Data

8.1 FCC 15.247(a) (2) and RSS-247 5.2(a) 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 (a) The minimum 6 dB bandwidth shall be 500 kHz.

IC RSS-GEN:
6.7 Occupied bandwidth (or 99% emissions bandwidth)

8.1.2 Test summary

Test date	March 12, 2019	Temperature	20 °C
Test engineer	Andres Martinez	Air pressure	1007 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	10 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	762.82	500	262.82
	2440	775.64	500	275.64
	2480	766.02	500	266.02

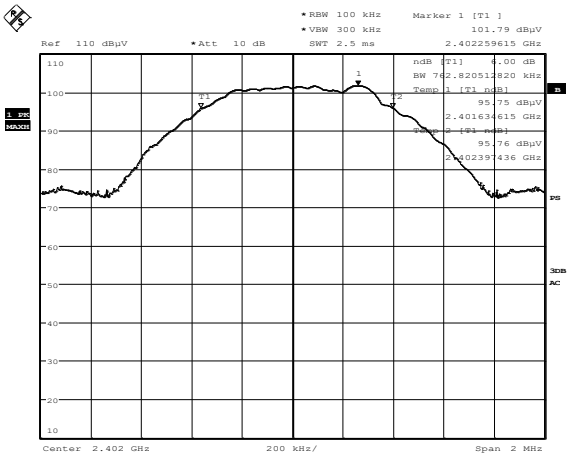


Figure 8.1-1: 6 dB bandwidth @ 2402MHz

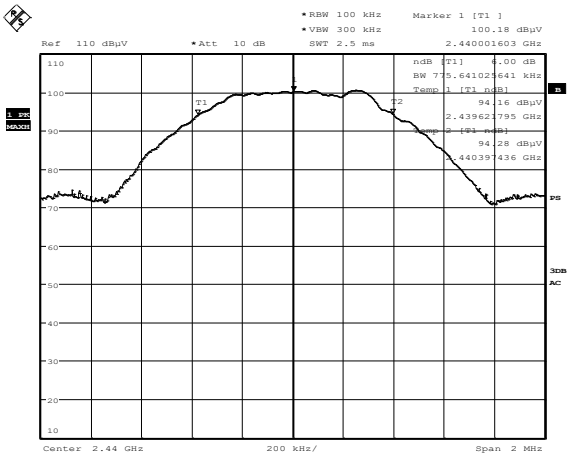


Figure 8.1-2: 6 dB bandwidth @ 2440MHz

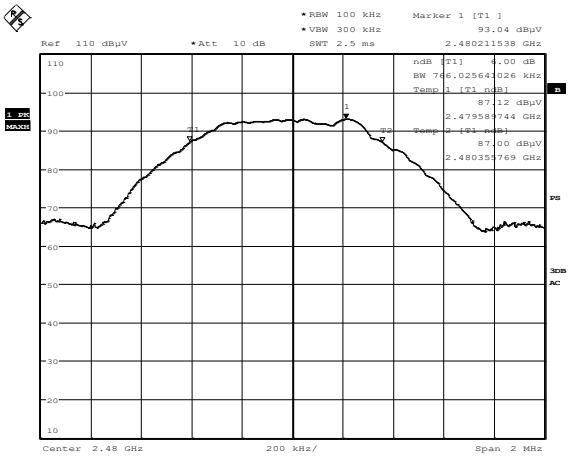


Figure 8.1-3: 6 dB bandwidth @ 2480MHz

Table 8.1-2: 99% bandwidth results

Modulation	Frequency, MHz	99% bandwidth, MHz	Limit, kHz	Margin, kHz
GFSK	2402	1.0608	-	-
	2440	1.0576	-	-
	2480	1.0608	-	-

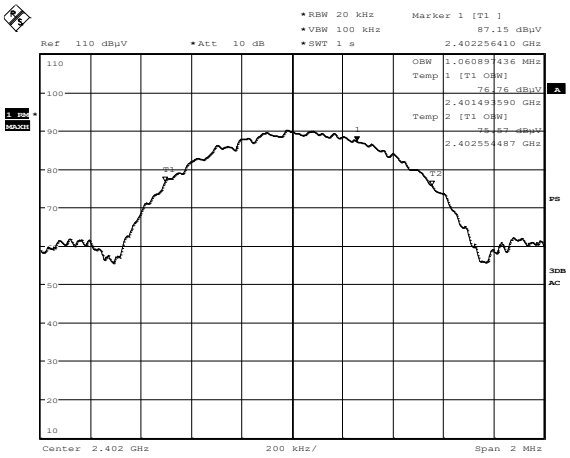


Figure 8.1-4: 99% bandwidth, Data Rate 250Kb/s

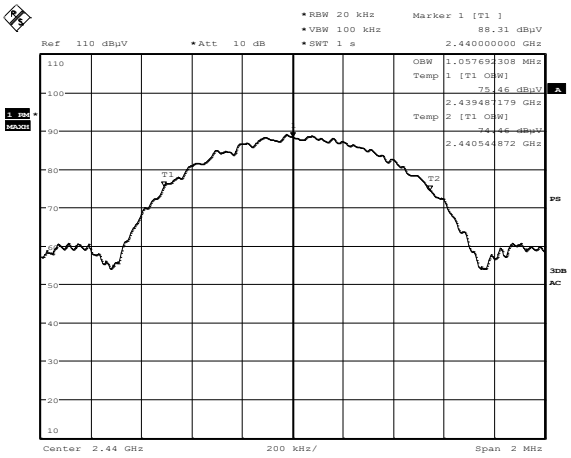


Figure 8.1-5: 99% bandwidth, Data Rate 1Mb/s

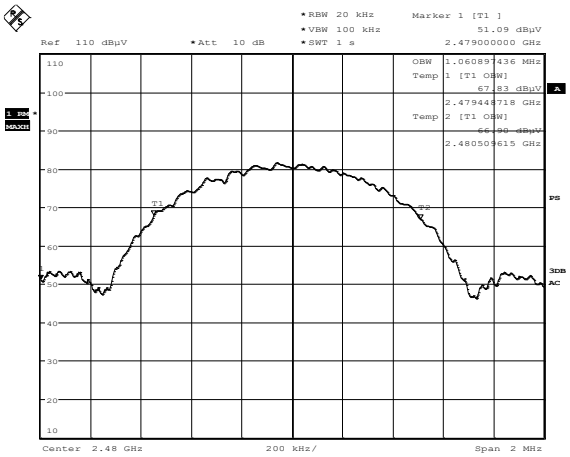


Figure 8.1-6: 99% bandwidth, Data Rate 2Mb/s

8.2 FCC 15.247(b) and RSS-247 5.4 (d) 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 Isotopically Radiated Power (E.I.R.P.) Requirements

(d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 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	March 13, 2019	Temperature	20 °C
Test engineer	Andres Martinez	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	51 %

8.2.3 Observations, settings and special notes

Peak Conducted Power Measured
Spectrum analyzer settings:

Resolution bandwidth	≥ Channel BW (1MHz)
Video bandwidth	≥ 3 × RBW (3MHz)
Frequency span	≥ 3 x RBW (3MHz)
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

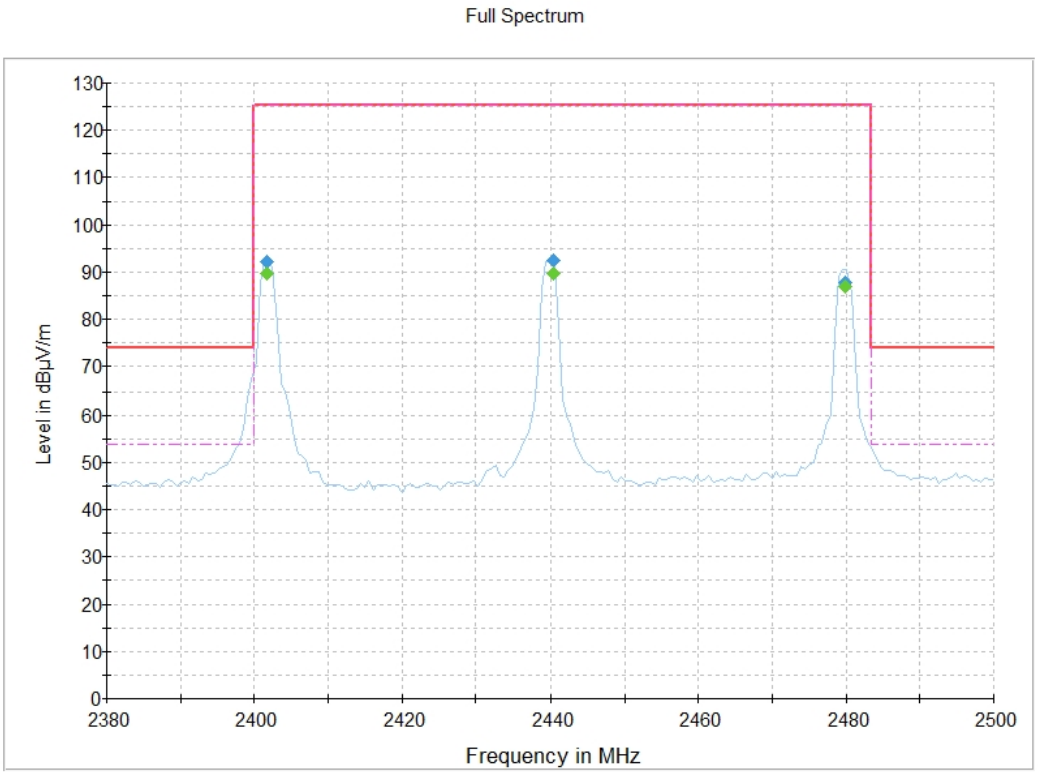


Figure 8.2-1: Output power measurements plot.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2401.733333	92.32	---	125.23	32.91	5000.0	1000.000	134.0	V	92.0	1.7
2401.733333	---	89.81	125.23	35.42	5000.0	1000.000	134.0	V	92.0	1.7
2440.333333	92.51	---	125.23	32.72	5000.0	1000.000	120.0	V	50.0	1.8
2440.333333	---	89.66	125.23	35.57	5000.0	1000.000	120.0	V	50.0	1.8
2479.933333	---	87.01	125.23	38.22	5000.0	1000.000	200.0	V	79.0	1.9
2479.933333	87.81	---	125.23	37.42	5000.0	1000.000	200.0	V	79.0	1.9

Table 8.2-1: Output power measurements results

Note: 125dBµV/m limit is equivalent to the FCC and IC power level of 1W.

Table 8.2-2: Conducted Output Power

Modulation	Frequency, MHz	dBµV/m	dBm (reading)*	Integral Antenna (dBi)	Conducted** output power (dBm)	Conducted Power (W)	Limit (dBm)	Margin, kHz
GFSK	2402	92.32	-2.88	1.5	-4.38	0.00036	30	262.82
	2440	92.51	-2.69	1.5	-4.19	0.00038	30	275.64
	2480	87.81	-7.42	1.5	-8.92	0.00013	30	266.02

* Equation used for conversion: P(dBm) = E(dBµV/m) – 95.2

** Conducted output power was derived from P(dBm) - antenna gain (1.5dBi)

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(d), the attenuation required shall be 30 dB instead of 20 db. Attenuation below the general field strength limits specified in RSS-Gen is not required.

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

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

Table 8.3-2: 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

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	March 13, 2019	Temperature	20 °C
Test engineer	Andres Martinez	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	51 %

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.
Antenna 0 path was selected for most radiated test cases as worst case.

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:	3 MHz
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

8.3.4 Test data

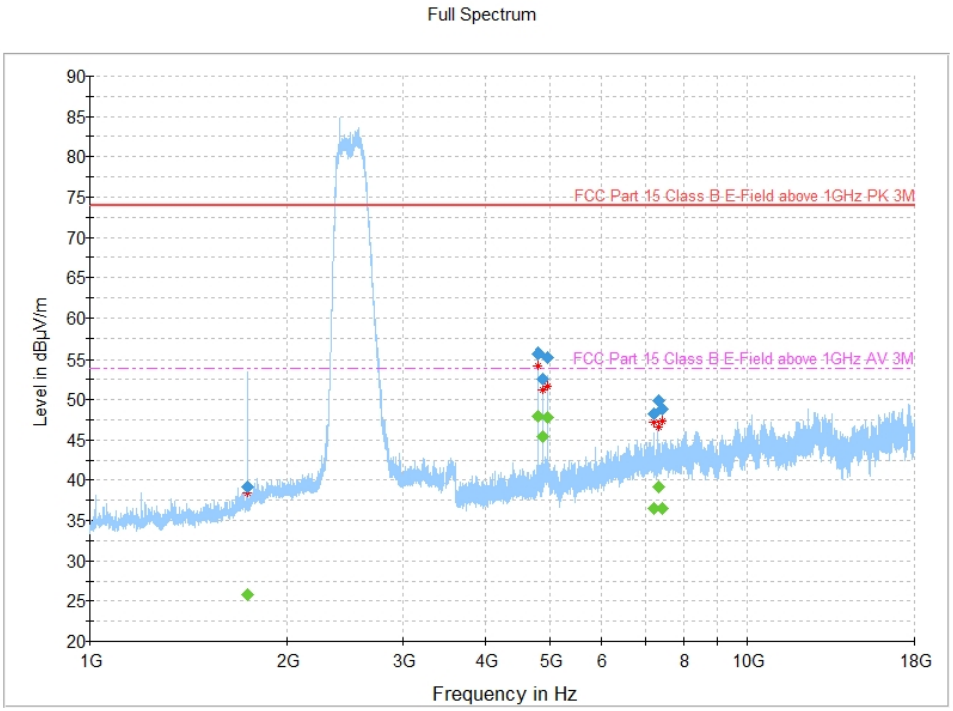


Figure 8.3-1: Spurious (out-of-band) emissions plot.

Note: From 2.4GHz to 2.4835GHz a 2.4GHz Notch filter was used as it can be seen in the emissions plot it.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1738.400000	---	25.78	53.90	28.12	5000.0	1000.000	123.0	H	304.0	-10.7
1738.400000	39.21	---	73.90	34.69	5000.0	1000.000	123.0	H	304.0	-10.7
4804.633333	---	47.89	53.90	6.01	5000.0	1000.000	118.0	V	336.0	-2.0
4804.633333	55.73	---	73.90	18.17	5000.0	1000.000	118.0	V	336.0	-2.0
4880.400000	52.50	---	73.90	21.40	5000.0	1000.000	139.0	V	326.0	-1.9
4880.400000	---	45.36	53.90	8.54	5000.0	1000.000	139.0	V	326.0	-1.9
4960.466667	55.26	---	73.90	18.64	5000.0	1000.000	133.0	V	228.0	-1.3
4960.466667	---	47.83	53.90	6.07	5000.0	1000.000	133.0	V	228.0	-1.3
7206.500000	---	36.51	53.90	17.39	5000.0	1000.000	122.0	V	0.0	2.4
7206.500000	48.30	---	73.90	25.60	5000.0	1000.000	122.0	V	0.0	2.4
7319.500000	49.81	---	73.90	24.09	5000.0	1000.000	158.0	V	313.0	2.6
7319.500000	---	39.13	53.90	14.77	5000.0	1000.000	158.0	V	313.0	2.6
7440.366667	48.86	---	73.90	25.04	5000.0	1000.000	145.0	V	16.0	3.6
7440.366667	---	36.50	53.90	17.40	5000.0	1000.000	145.0	V	16.0	3.6

Table 8.3-4: Spurious (out-of-band) emissions data.

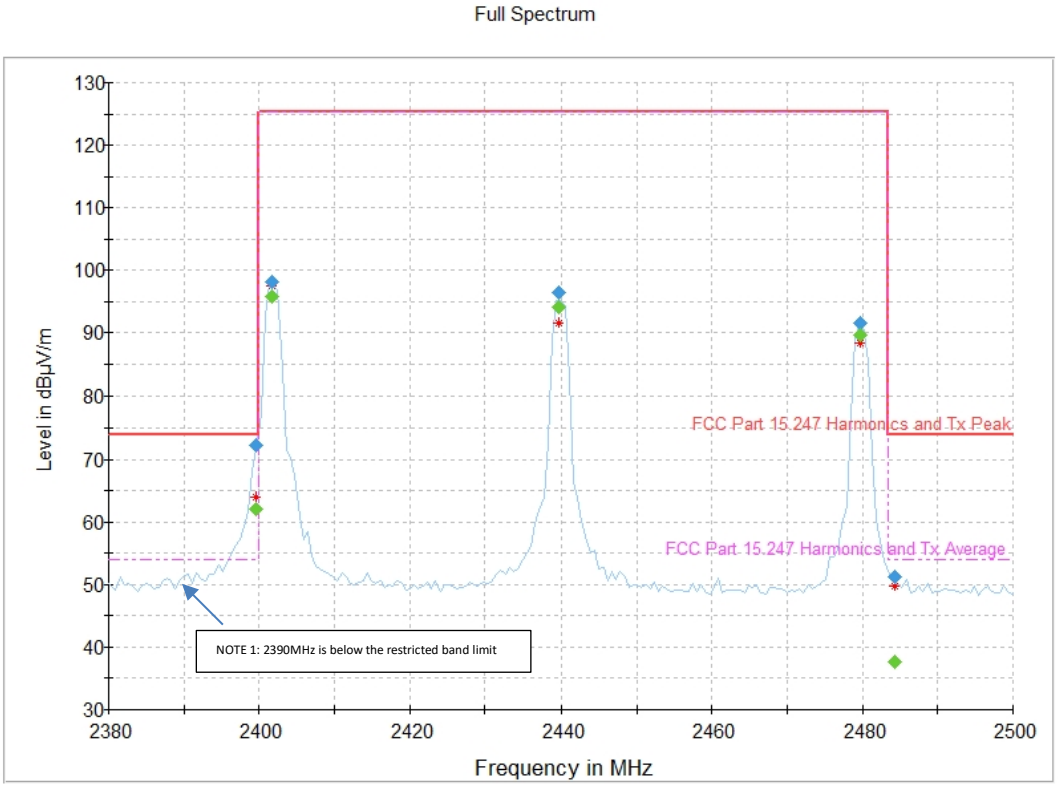


Figure 8.3-2: Band-edges emissions plot.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
(Note 2)2399.533333	---	62.15	75.76	13.61	5000.0	1000.000	108.0	V	0.0	1.7
2399.533333	72.25	---	78.24	5.99	5000.0	1000.000	108.0	V	0.0	1.7
2401.733333	---	95.76	125.23	29.47	5000.0	1000.000	106.0	V	1.0	1.7
2401.733333	98.24	---	125.23	26.99	5000.0	1000.000	106.0	V	1.0	1.7
2439.733333	96.41	---	125.23	28.82	5000.0	1000.000	118.0	V	52.0	1.8
2439.733333	---	94.05	125.23	31.18	5000.0	1000.000	118.0	V	52.0	1.8
2479.766667	91.47	---	125.23	33.76	5000.0	1000.000	151.0	V	40.0	1.9
2479.766667	---	89.70	125.23	35.53	5000.0	1000.000	151.0	V	40.0	1.9
2484.233333	---	37.71	53.90	16.19	5000.0	1000.000	190.0	V	4.0	2.0
2484.233333	51.14	---	73.90	22.76	5000.0	1000.000	190.0	V	4.0	2.0

Table 8.3-5: Band-edges emissions data

Note 1: The plot clearly shows the emission at 2390MHz it under the Restricted Band limit.

Note 2: The EUT at the 2400MHz band edge requirement is 20dB down from the fundamental. The plot demonstrates a passing condition

8.4 FCC 15.247(e) and RSS-247 5.2(b) 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	March 13, 2019	Temperature	20 °C
Test engineer	Andres Martinez	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	51 %

8.4.3 Observations, settings and special notes

Power output is less than 8dbm therefor PSD complies.

Note: The measurement was made as a Radiated test with a resolution bandwidth of 1MHz. The peak output power levels were then adjusted to reflect the equivalent dBm reading for the dBµV/m at 3 meters. The device PSD even utilizing a 1MHz band with was below the required Limit

Equation used for conversion: P(dBm) = E(dBµV/m) – 95.2

8.4.4 Test data

Table 8.4-1: Power Spectrum Density

Modulation	Frequency, MHz	Radiated PSD@3kHz, dBm		Margin, dB
		Measured	Limit	
GFSK	2402	-2.88	8	10.88
	2440	-2.69	8	10.69
	2480	-7.42	8	15.39

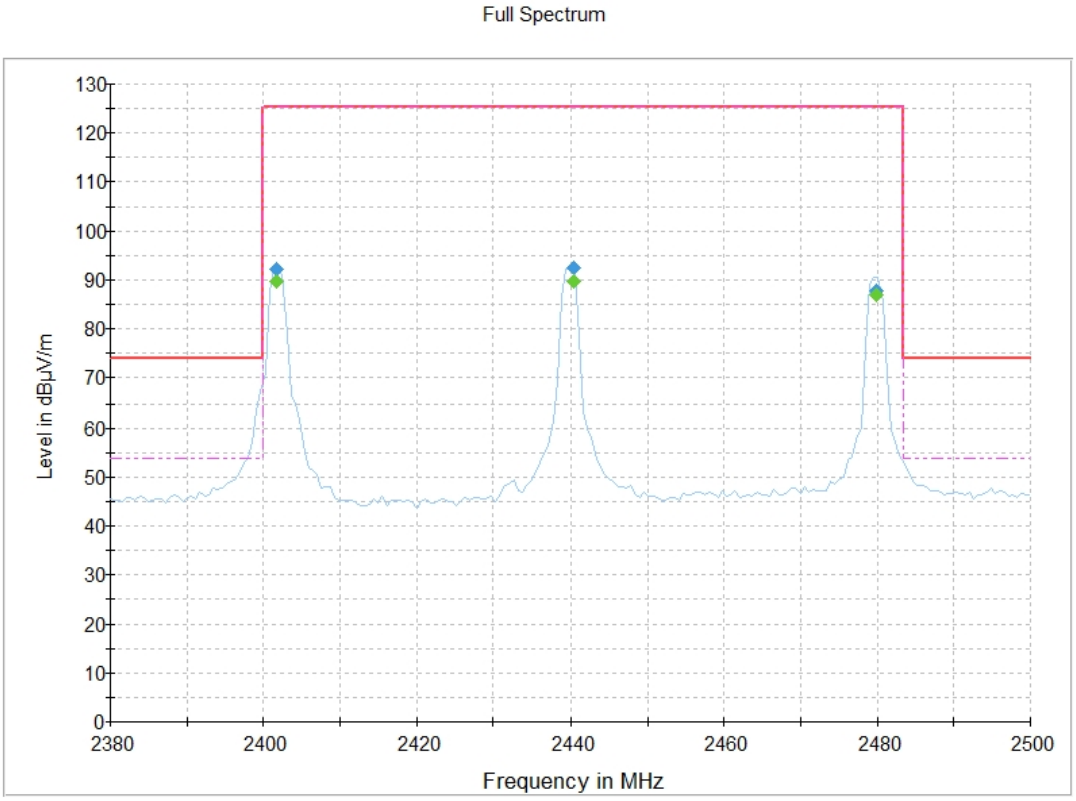


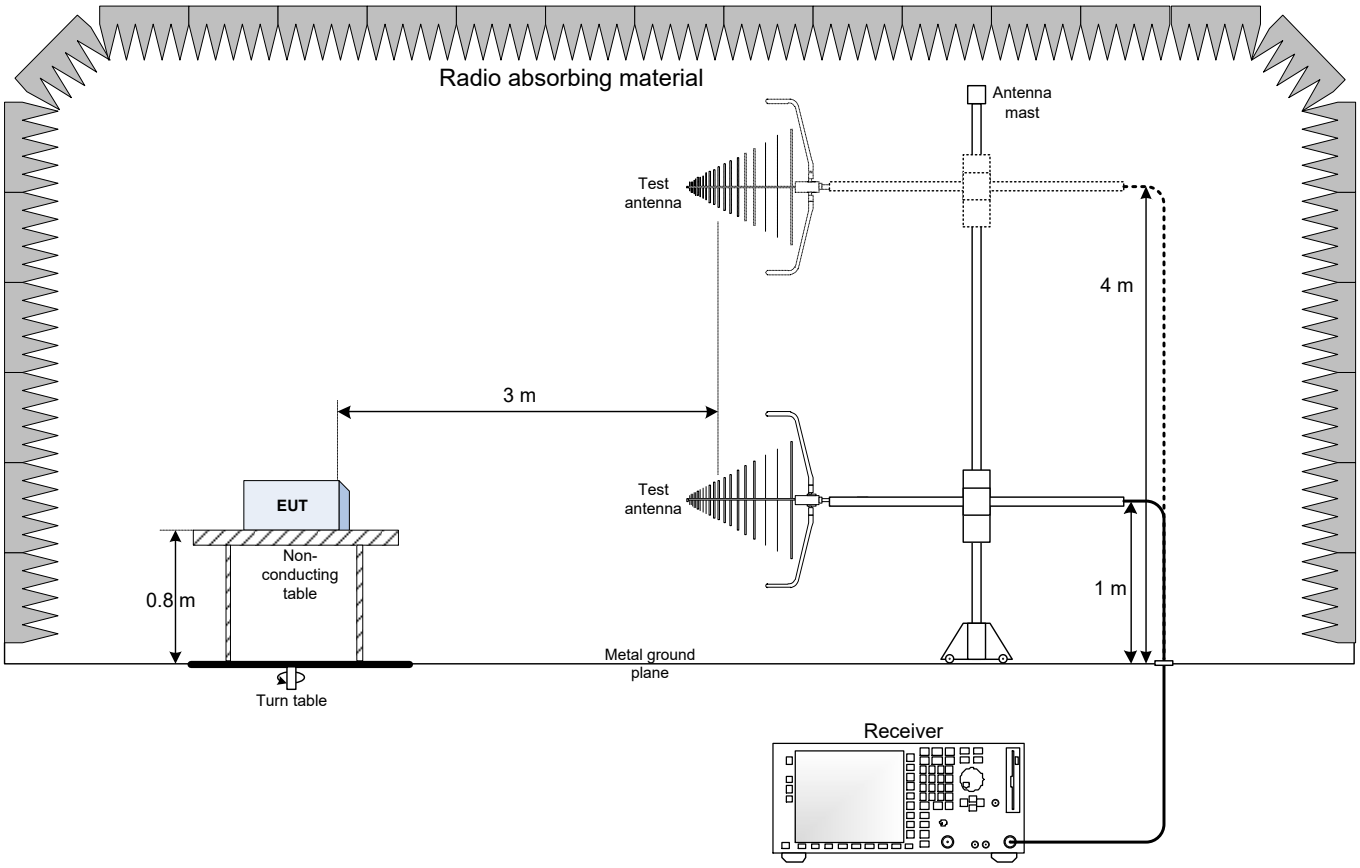
Figure 8.4-1: Power Spectrum Density plot.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2401.733333	92.32	---	125.23	32.91	5000.0	1000.000	134.0	V	92.0	1.7
2401.733333	---	89.81	125.23	35.42	5000.0	1000.000	134.0	V	92.0	1.7
2440.333333	92.51	---	125.23	32.72	5000.0	1000.000	120.0	V	50.0	1.8
2440.333333	---	89.66	125.23	35.57	5000.0	1000.000	120.0	V	50.0	1.8
2479.933333	---	87.01	125.23	38.22	5000.0	1000.000	200.0	V	79.0	1.9
2479.933333	87.81	---	125.23	37.42	5000.0	1000.000	200.0	V	79.0	1.9

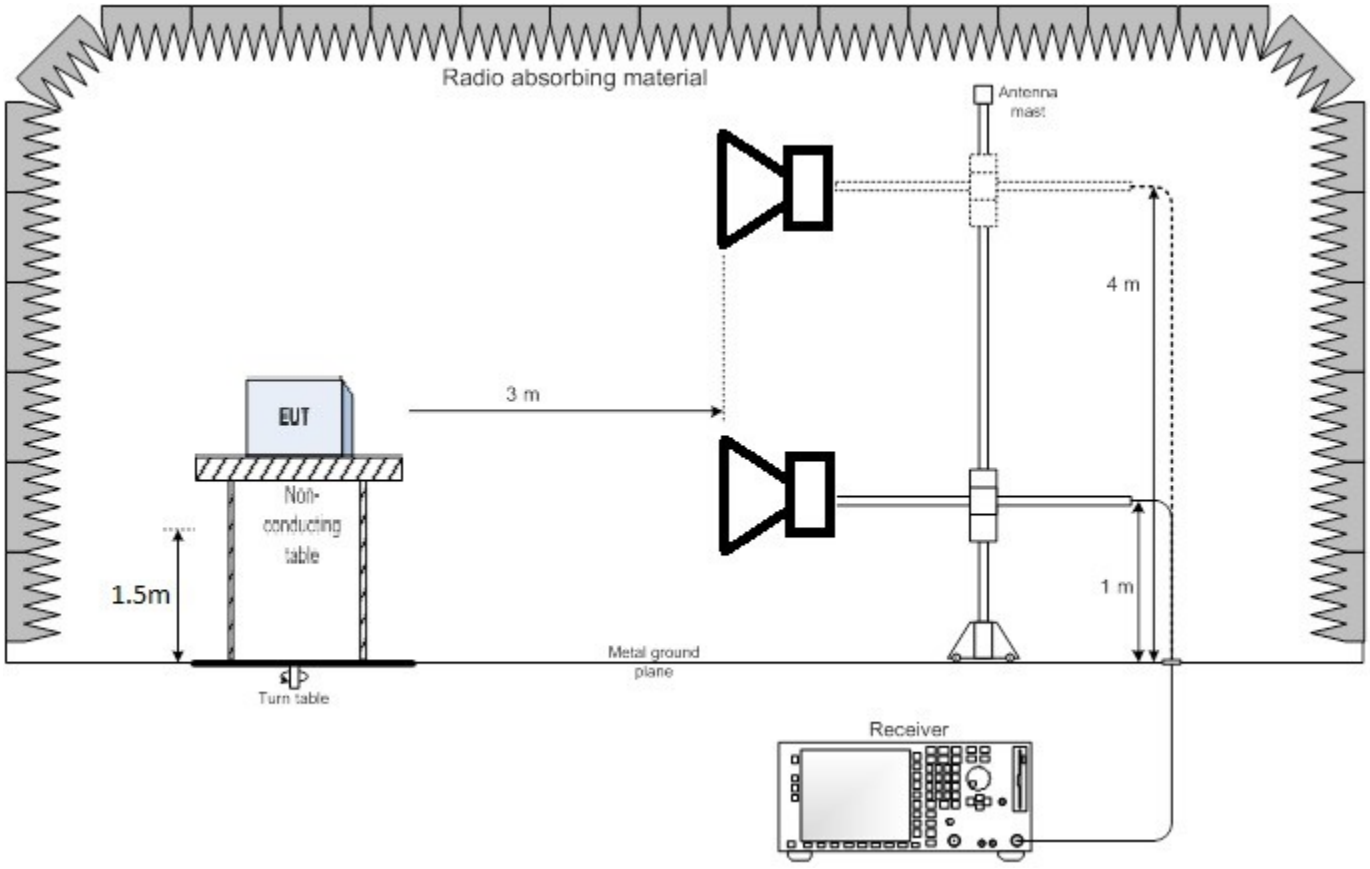
Table 8.4-2: Power Spectrum Density data.

Section 9. Block diagrams of test set-ups

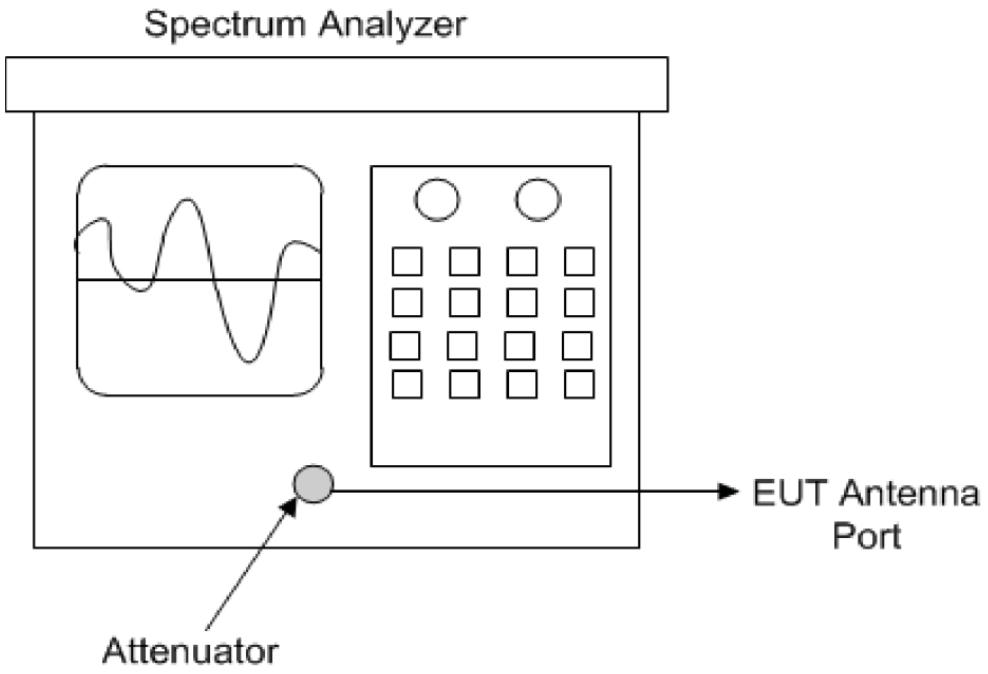
9.1 Radiated emissions set-up – Below 1GHz



9.2 Radiated emissions set-up – Above 1GHz



9.3 Antenna Port Conducted emissions set-up –



Thank you for choosing