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Test report

FCC-15.247 and RSS-247 Radius RBT-002 BTLE #320139

Date of issue: December 19, 2016

Applicant: Radius Networks, Inc.

Product: Locator Tent

Model: RBT-002

FCC ID: 2ABYU-RBT002 IC Registration number: 12010A-RBT002

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

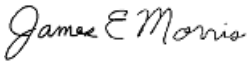
  Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

- 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	Jim Morris, EMC/Wireless Manager
Review date	December 19, 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

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Radius Networks, Inc.
Address	3255 Grace Street NW
City	Washington DC
Province/State	Washington DC
Postal/Zip code	20007
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	Not applicable[1]
§15.31(e)	Variation of power source	Pass[2]
§15.203	Antenna requirement	Pass[3]
§15.205	Restricted bands of operation	Pass

Notes: [1] Battery Operated.

[2] Fresh batteries used for all radiated testing. 3V DC supply used for all RF conducted testing.

[3] 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[1]
7.1.3	Receiver conducted emission limits	Not applicable[1]
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Not applicable[2]
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] Battery Operated.

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	December 8, 2016
Nemko sample ID number	#1 - #15

3.2 EUT information

Product name	Locator Tent
Model	RBT-002
Model variant	N/A
Serial number	N/A
FCC ID	2ABYU-RBT002
IC Registration Number	12010A-RBT002

3.3 Technical information

Applicant IC company number	12010A
IC UPN number	RBT002
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	2.52mW (Conducted) 1.26mW each module.
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	713.9
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	GFSK
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, Units @ distance	50.7 dBµV/m @ 3m AVG, 59.1 dBµV/m @ 3m Peak
Power requirements	3V Replaceable Battery
Antenna information	1.5 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

The RBT-002 Locator Tent is a Bluetooth Smart™ equipped location tracking token for use by major quick service and fast casual restaurants to provide on-time, table-level accurate meal delivery services. As a component of the Radius Networks in-venue location tracking system, individual locator tents can be tracked as they are moved within store, restaurant or other physical venue.

The functional purpose of the RBT-002 Locator Tent is to transmit a message, in the form of a Bluetooth Smart non-connectable advertisement, containing a unique identifier to an array of receivers that are distributed throughout a venue such as a store or restaurant. As a user carrying an RBT-002 Locator Tent moves throughout the venue. The transmitted messages that are received by the receiver array are analyzed by a central processor to determine the user's location in the venue.

Each RBT-002 is equipped with dual Bluetooth Smart transmitters for redundancy and load sharing. Each transmitter will be operating at a minimum transmission interval of 250ms with a transmit time of 300us for each transmitted message. The resulting combined duty cycle for both transmitters is 0.72%.

The RBT-002 Locator Tent is powered by two CR-2032 lithium coin cell batteries, providing over 12 months of continuous service without the need for recharging or battery replacement. As part of an on-going service arrangement, tents are generally replaced on an annual basis. None of internal components or batteries of the Locator Tent are intended to be user serviceable.

Operational properties of the dual Bluetooth Smart transmitters, including transmission frequencies and power levels, are fixed at the factory and are not modifiable by the end customer.

3.5 EUT exercise details

A test version of firmware was implemented that allows different RF channels to be in different EUT. EUT is set to fixed channel test mode with modulation and 100% duty cycle. As only the 3 advertising channels are used, only 2402/2426/2480MHz are selected.

3.6 EUT setup diagram

Setup Photo in separate exhibit for confidentiality reason

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

Setup Photo in separate exhibit for confidentiality reason

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

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
EUT Case / Module Holder	Radius Network	RBT-002	N/A
Modules with antenna	EM Microelectronic	EMBC01	N/a
Modules with temporary RF connector	EM Microelectronic	EMBC01	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

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.
3V DC Battery

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
E1019	Two Line V-Network	Rohde & Schwarz	ENV216	101045	15-Jun-2017
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

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	December 12, 2016	Temperature	22 °C
Test engineer	Feng You	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	59 %

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	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	660.7	500	160.7
	2426	713.9	500	213.9
	2480	696.7	500	196.7

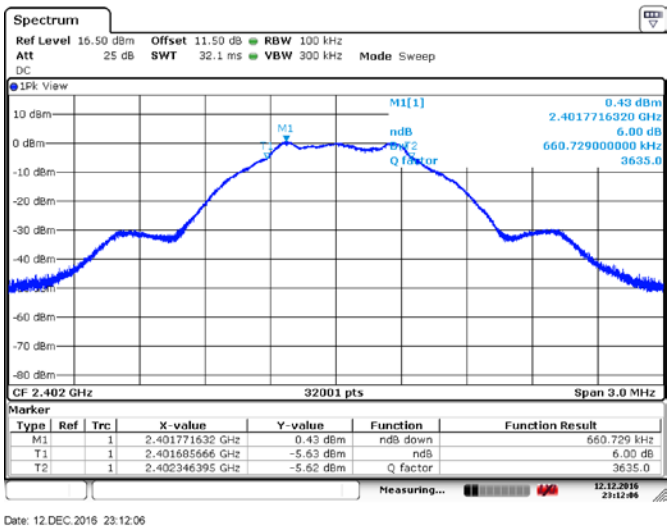


Figure 8.1-1: *6 dB bandwidth, 2402MHz*

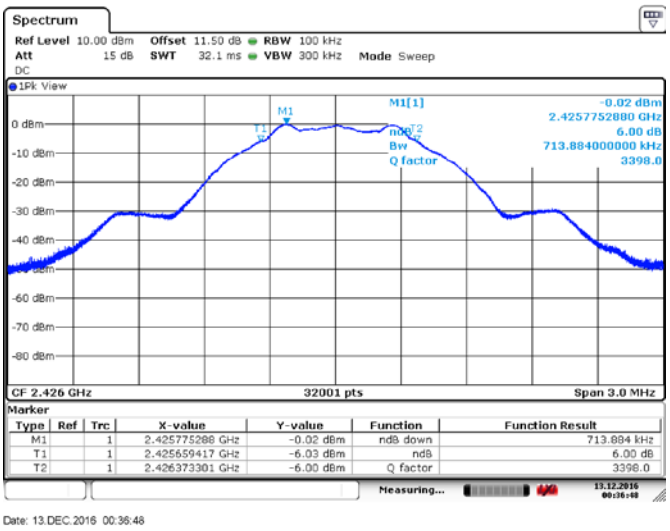


Figure 8.1-2: *6 dB bandwidth, 2426MHz*

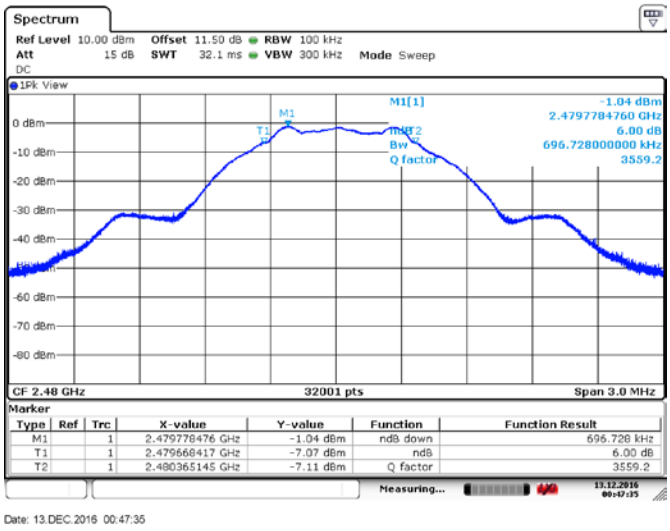


Figure 8.1-3: *6 dB bandwidth, 2480MHz*

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	December 12, 2016	Temperature	22 °C
Test engineer	Feng You	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	59 %

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*

Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
	Measured	Limit					
2402	1	30	29	1.5	2.5	36	33.5
2426	0.46	30	29.54	1.5	1.96	36	34.04
2480	-0.54	30	30.54	1.5	0.96	36	35.04

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		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

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	December 13, 2016	Temperature	22 °C
Test engineer	Feng You	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	54 %

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

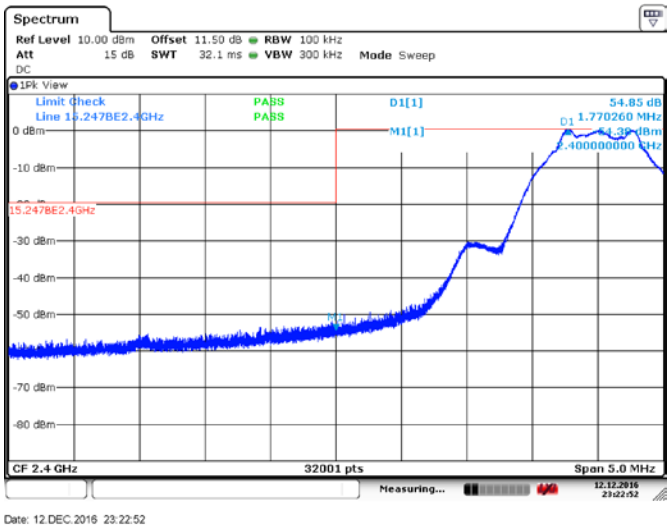


Figure 8.3.1: *Bandedge Measurement, low channel*

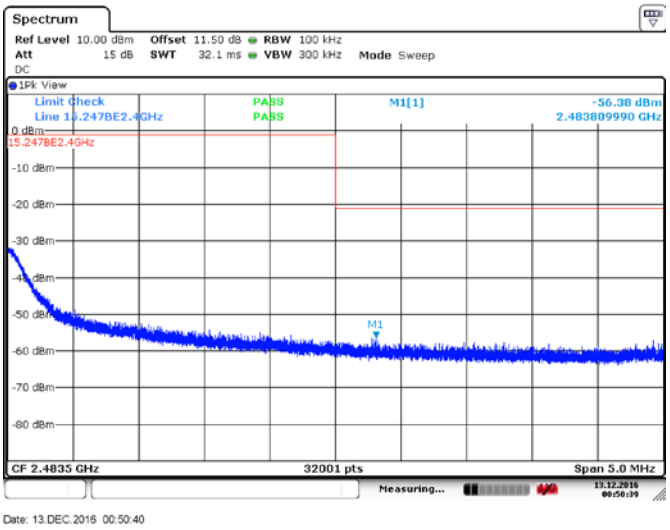


Figure 8.3.2: *Bandedge Measurement, high channel*

***Table 8.3-4*: Reference PSD in 100kHz**

Modulation	Frequency, MHz	PSD dBm/100kHz
GFSK	2402	0.43
	2426	-0.02
	2480	-1.04

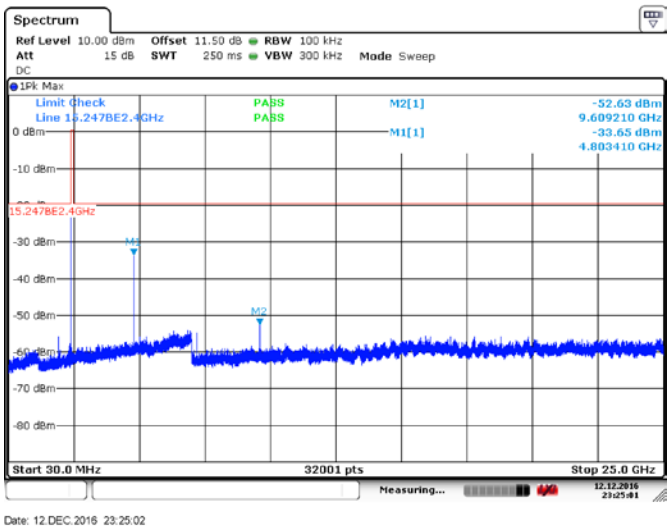


Figure 8.3.3: *Conducted spurious emissions, low channel*

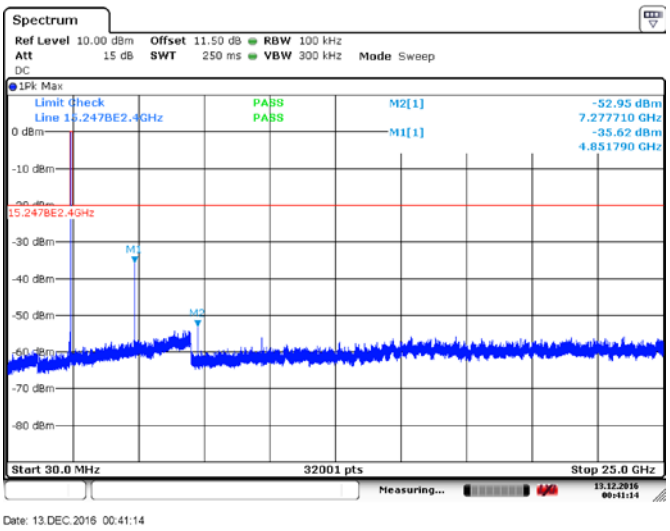


Figure 8.3.4: *Conducted spurious emissions, mid channel*

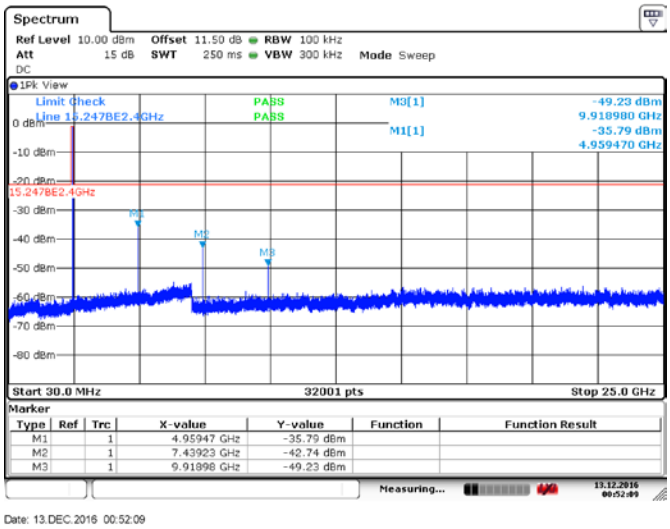


Figure 8.3.5: *Conducted spurious emissions, high channel*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

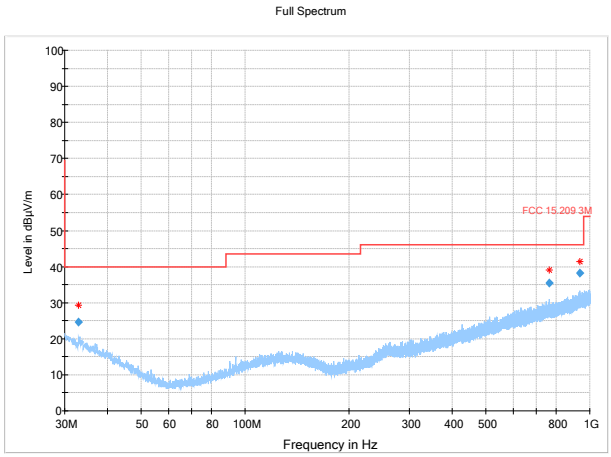


Figure 8.3.6: *Radiated spurious emissions, low channel, 30-1000MHz*

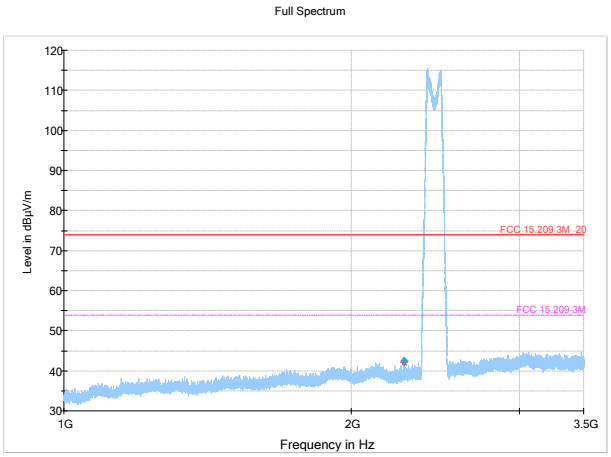


Figure 8.3.7: *Radiated spurious emissions, low channel, 1-3.5GHz*

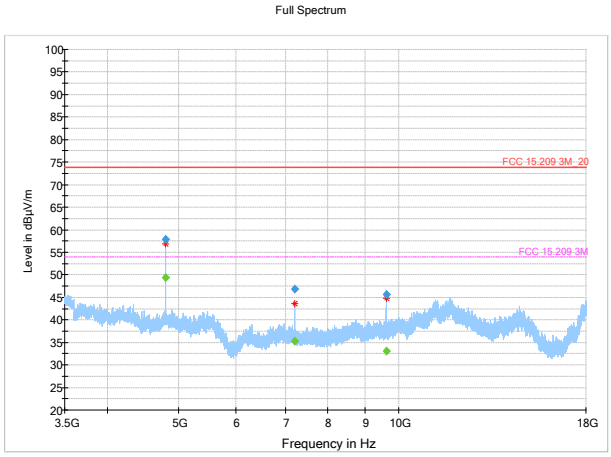


Figure 8.3.8: *Radiated spurious emissions, low channel, 3.5-18MHz*

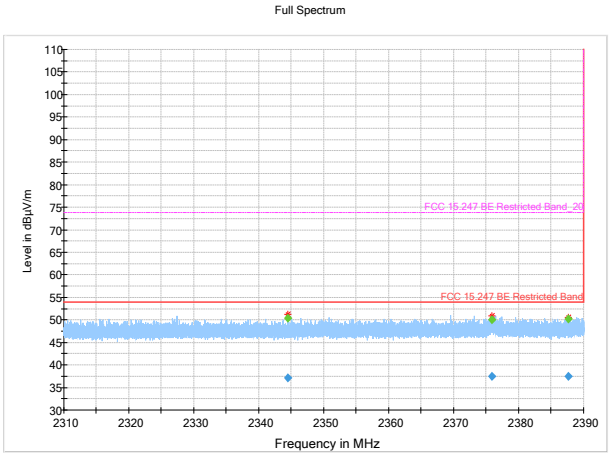


Figure 8.3.9: *Radiated spurious emissions, low bandedge*

Table 8.3-5: *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)
32.912500	24.69	40.00	15.31	1000.0	120.000	129.2	H	290.0
764.022000	35.52	46.00	10.48	1000.0	120.000	198.7	H	218.0
937.140500	38.12	46.00	7.88	1000.0	120.000	131.2	H	203.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2271.200000	---	28.81	53.90	25.09	1000.0	1000.000	345.6	V	302.0
2271.200000	42.43	---	73.90	31.47	1000.0	1000.000	345.6	V	302.0
4803.516667	---	49.39	53.90	4.51	1000.0	1000.000	153.5	H	52.0
4803.516667	57.93	---	73.90	15.97	1000.0	1000.000	153.5	H	52.0
7206.800000	---	35.31	53.90	18.59	1000.0	1000.000	125.0	H	46.0
7206.800000	46.76	---	73.90	27.14	1000.0	1000.000	125.0	H	46.0
9608.966667	---	33.06	53.90	20.84	1000.0	1000.000	159.8	H	82.0
9608.966667	45.69	---	73.90	28.21	1000.0	1000.000	159.8	H	82.0
2344.498667	50.38		73.90	23.52	1000.0	1000.000	259.0	H	93.0
2344.498667		37.14	53.90	16.76	1000.0	1000.000	259.0	H	93.0
2375.869333		37.44	53.90	16.46	1000.0	1000.000	158.0	V	295.0
2375.869333	50.08		73.90	23.82	1000.0	1000.000	158.0	V	295.0
2387.594667		37.51	53.90	16.39	1000.0	1000.000	189.3	V	326.0
2387.594667	50.27		73.90	23.63	1000.0	1000.000	189.3	V	326.0

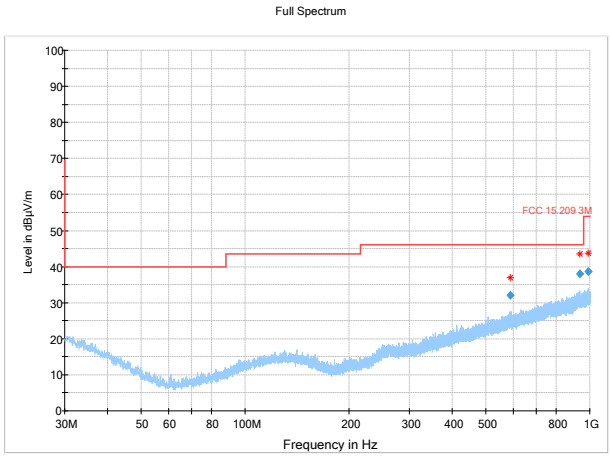


Figure 8.3.10: *Radiated spurious emissions, mid channel, 30-1000MHz*

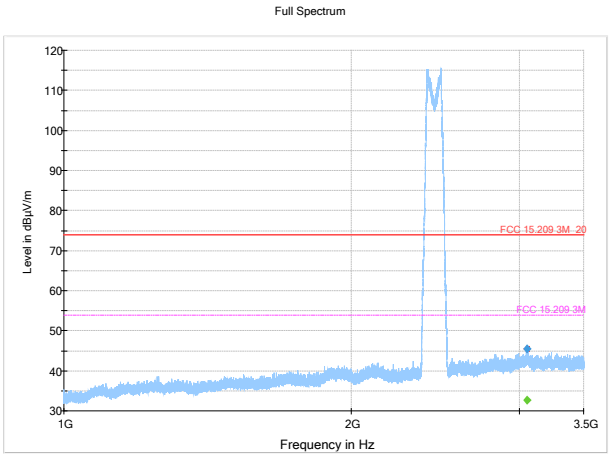


Figure 8.3.11: *Radiated spurious emissions, mid channel, 1-3.5GHz*

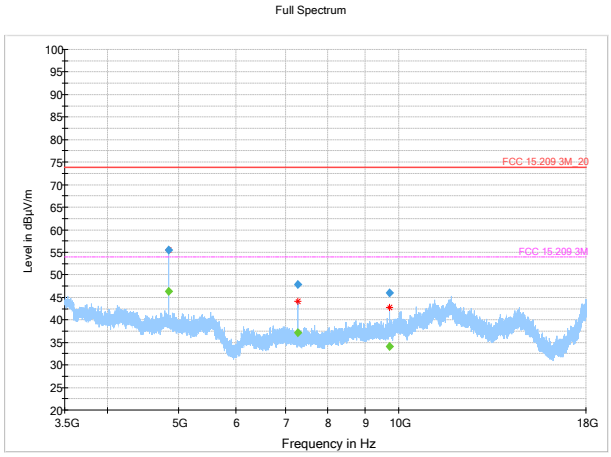


Figure 8.3.12: *Radiated spurious emissions, mid channel, 3.5-18MHz*

***Table 8.3-6**: 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)
587.145000	32.10	46.00	13.90	1000.0	120.000	376.3	H	53.0
937.464000	38.10	46.00	7.90	1000.0	120.000	314.2	H	22.0
988.285000	38.73	53.90	15.17	1000.0	120.000	256.3	H	66.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
3056.416667	---	32.73	53.90	21.17	1000.0	1000.000	347.7	H	248.0
3056.416667	45.46	---	73.90	28.44	1000.0	1000.000	347.7	H	248.0
4852.483333	55.49	---	73.90	18.41	1000.0	1000.000	198.8	H	206.0
4852.483333	---	46.36	53.90	7.54	1000.0	1000.000	198.8	H	206.0
7278.650000	47.82	---	73.90	26.08	1000.0	1000.000	140.3	H	160.0
7278.650000	---	37.11	53.90	16.79	1000.0	1000.000	140.3	H	160.0
9704.900000	---	34.05	53.90	19.85	1000.0	1000.000	201.0	H	352.0
9704.900000	45.98	---	73.90	27.92	1000.0	1000.000	201.0	H	352.0

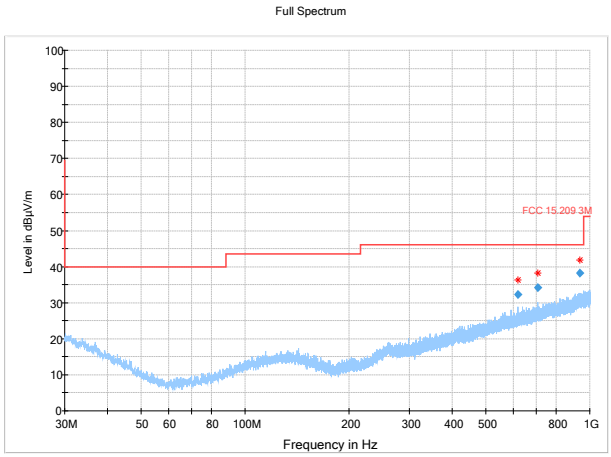


Figure 8.3.13: *Radiated spurious emissions, high channel, 30-1000MHz*

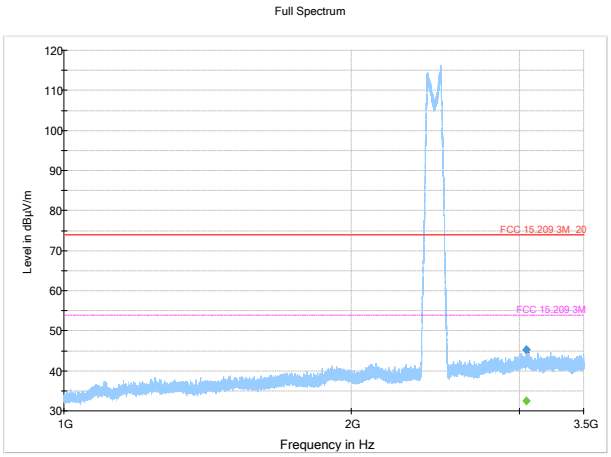


Figure 8.3.14: *Radiated spurious emissions, high channel, 1-3.5GHz*

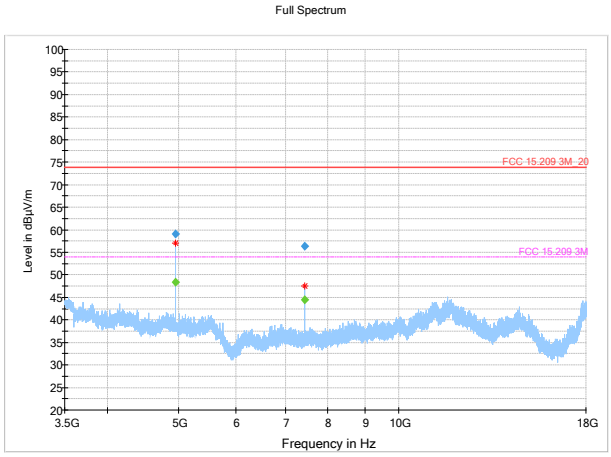


Figure 8.3.15: *Radiated spurious emissions, high channel, 3.5-18MHz*

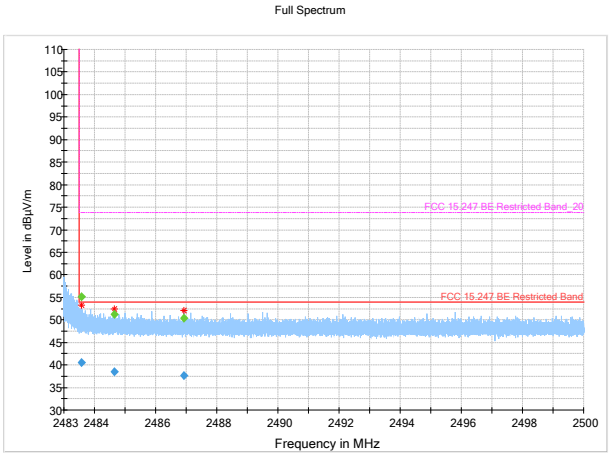


Figure 8.3.16: *Radiated spurious emissions, high bandedge*

***Table 8.3-7**: 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)
619.277500	32.37	46.00	13.63	1000.0	120.000	264.0	V	280.0
707.744000	34.21	46.00	11.79	1000.0	120.000	308.0	V	79.0
937.435000	38.15	46.00	7.85	1000.0	120.000	140.0	H	204.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
3049.183333	---	32.57	53.90	21.33	1000.0	1000.000	389.9	V	289.0
3049.183333	45.31	---	73.90	28.59	1000.0	1000.000	389.9	V	289.0
4960.583333	---	48.33	53.90	5.57	1000.0	1000.000	218.7	H	355.0
4960.583333	59.05	---	73.90	14.85	1000.0	1000.000	218.7	H	355.0
7439.450000	---	44.42	53.90	9.48	1000.0	1000.000	175.3	H	14.0
7439.450000	56.39	---	73.90	17.51	1000.0	1000.000	175.3	H	14.0
2483.569500	40.57	---	53.90	13.33	1000.0	1000.000	183.3	H	67.0
2483.569500	55.16		73.90	18.74	1000.0	1000.000	183.3	H	67.0
2484.639367		38.58	53.90	15.32	1000.0	1000.000	162.3	H	224.0
2484.639367	51.21		73.90	22.69	1000.0	1000.000	162.3	H	224.0
2486.930400	50.44		73.90	23.46	1000.0	1000.000	121.2	V	149.0
2486.930400		37.68	53.90	16.22	1000.0	1000.000	121.2	V	149.0

2 modules set to different channels (1 to 2402MHz, 1 to 2426MHz)

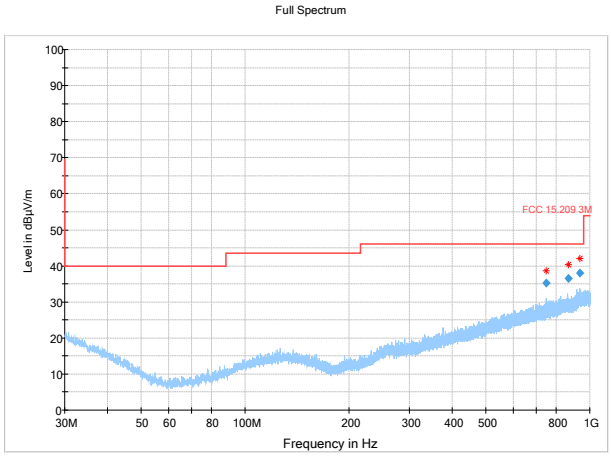


Figure 8.3.17: *Radiated spurious emissions, low + mid channel, 30-1000MHz*

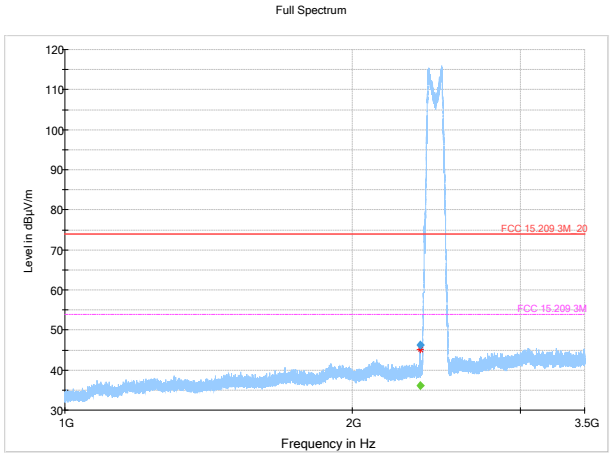


Figure 8.3.18: *Radiated spurious emissions, low + mid channel, 1-3.5GHz*

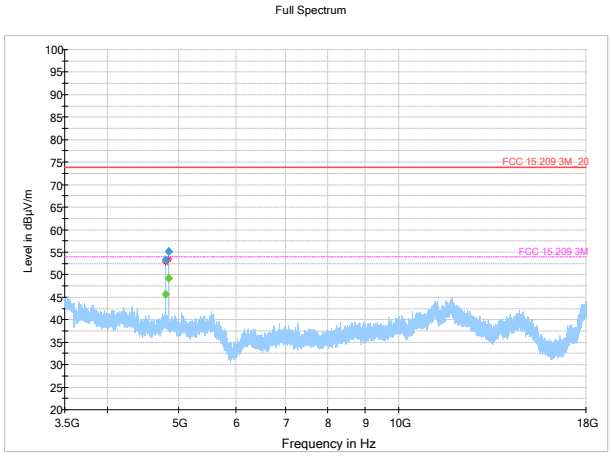


Figure 8.3.19: *Radiated spurious emissions, low + mid channel, 3.5-18MHz*

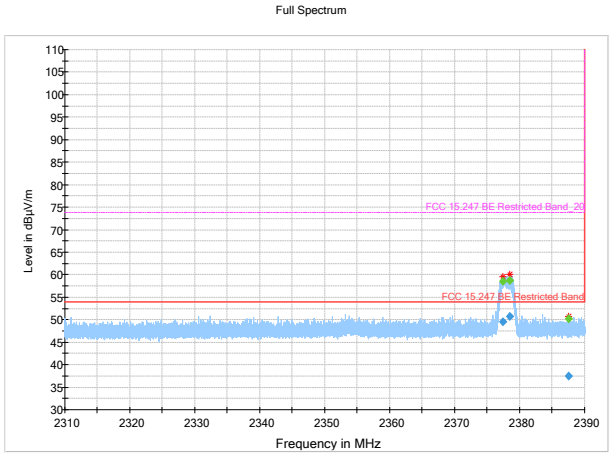


Figure 8.3.20: *Radiated spurious emissions, low bandedge*

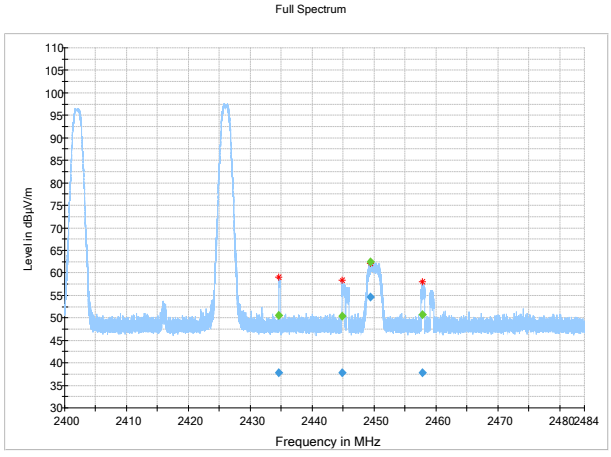


Figure 8.3.21: *Radiated spurious emissions, low + mid channel, Inband Intermodulation*

Table 8.3-8: *Radiated field strength measurement results for low + mid channel 2402MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
746.861500	35.14	46.00	10.86	1000.0	120.000	375.7	H	322.0
864.851000	36.59	46.00	9.41	1000.0	120.000	332.0	V	103.0
934.132000	38.08	46.00	7.92	1000.0	120.000	365.4	V	186.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2353.916667	---	36.08	53.90	17.82	1000.0	1000.000	211.5	H	282.0
2353.916667	46.33	---	73.90	27.57	1000.0	1000.000	211.5	H	282.0
4804.550000	53.33	---	73.90	20.57	1000.0	1000.000	191.7	H	217.0
4804.550000	---	45.59	53.90	8.31	1000.0	1000.000	191.7	H	217.0
4851.600000	55.19	---	73.90	18.71	1000.0	1000.000	148.7	H	42.0
4851.600000	---	49.27	53.90	4.63	1000.0	1000.000	148.7	H	42.0
2377.373333	58.57	---	73.90	15.33	1000.0	1000.000	161.3	H	293.0
2377.373333	---	49.46	53.90	4.44	1000.0	1000.000	161.3	H	293.0
2378.450667	58.66	---	73.90	15.24	1000.0	1000.000	197.5	H	300.0
2378.450667		50.66	53.90	3.24	1000.0	1000.000	197.5	H	300.0
2387.525333	50.20	---	73.90	23.70	1000.0	1000.000	151.1	V	256.0
2387.525333	---	37.50	53.90	16.40	1000.0	1000.000	151.1	V	256.0

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	December 12, 2016	Temperature	22 °C
Test engineer	Feng You	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	59 %

8.4.3 Observations, settings and special notes

3kHz RBW

8.4.4 Test data

Table 8.4-1: *Power Spectrum Density*

Frequency, MHz	Conducted PSD@3kHz, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
	Measured	Limit					
2402	-13.73	8	21.73	1.5	-12.23	14	26.23
2426	-14.16	8	22.16	1.5	-12.66	14	26.66
2480	-15.34	8	23.34	1.5	-13.84	14	27.84

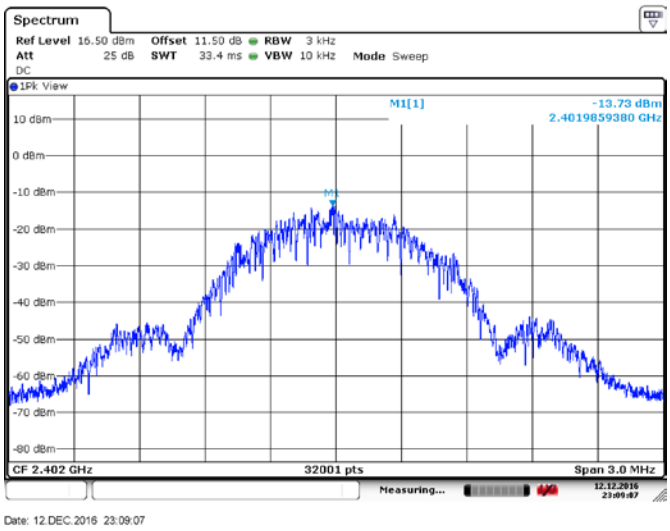


Figure 8.4-1: *Power Spectrum Density @ 3kHz, 2402MHz*

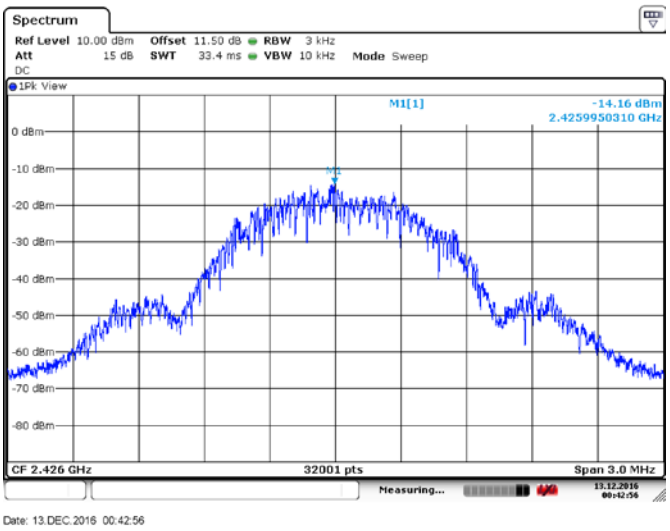


Figure 8.4-2: *Power Spectrum Density @ 3kHz, 2426MHz*

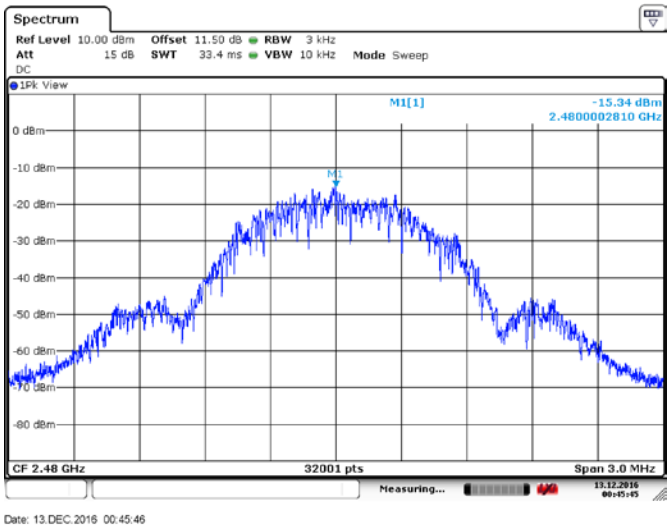
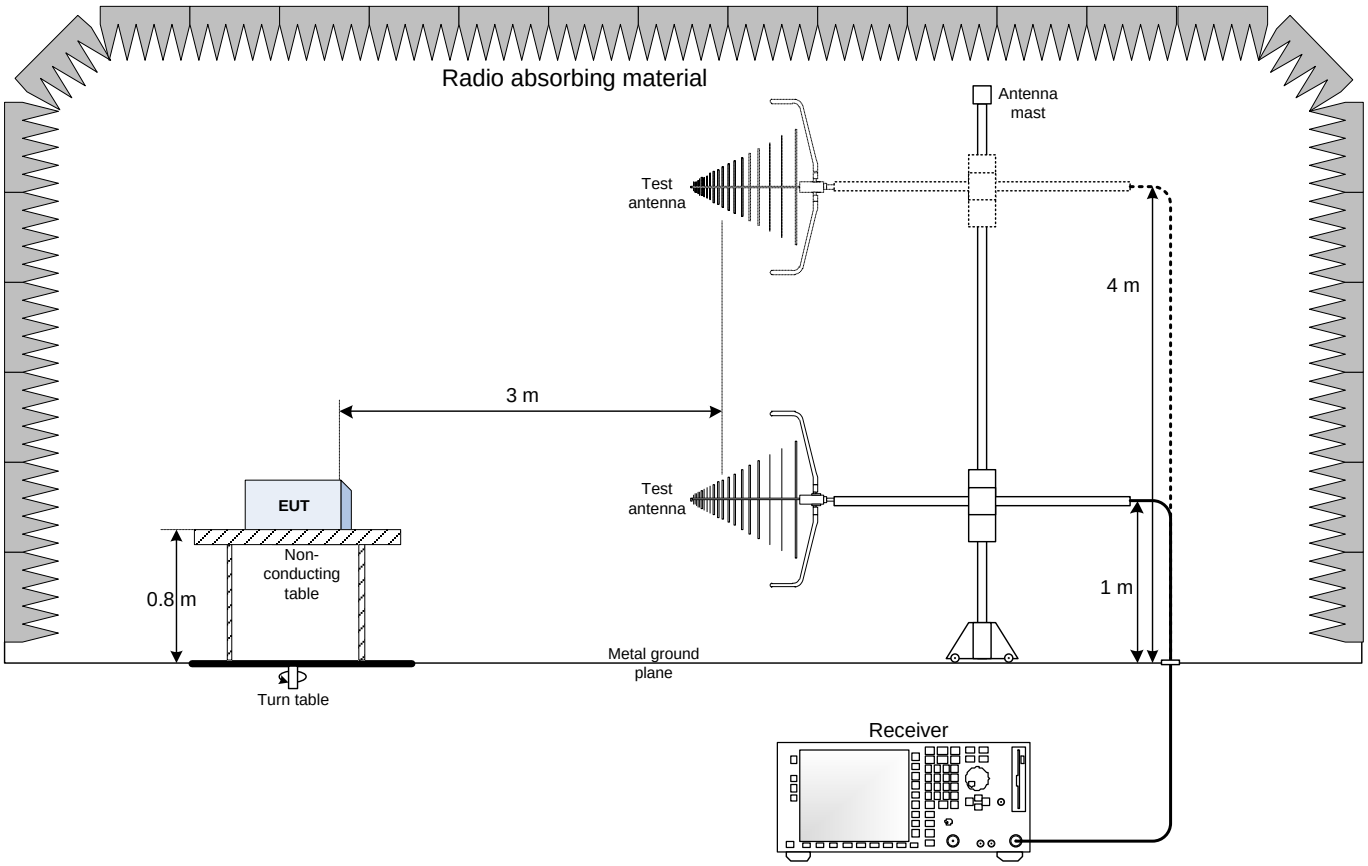


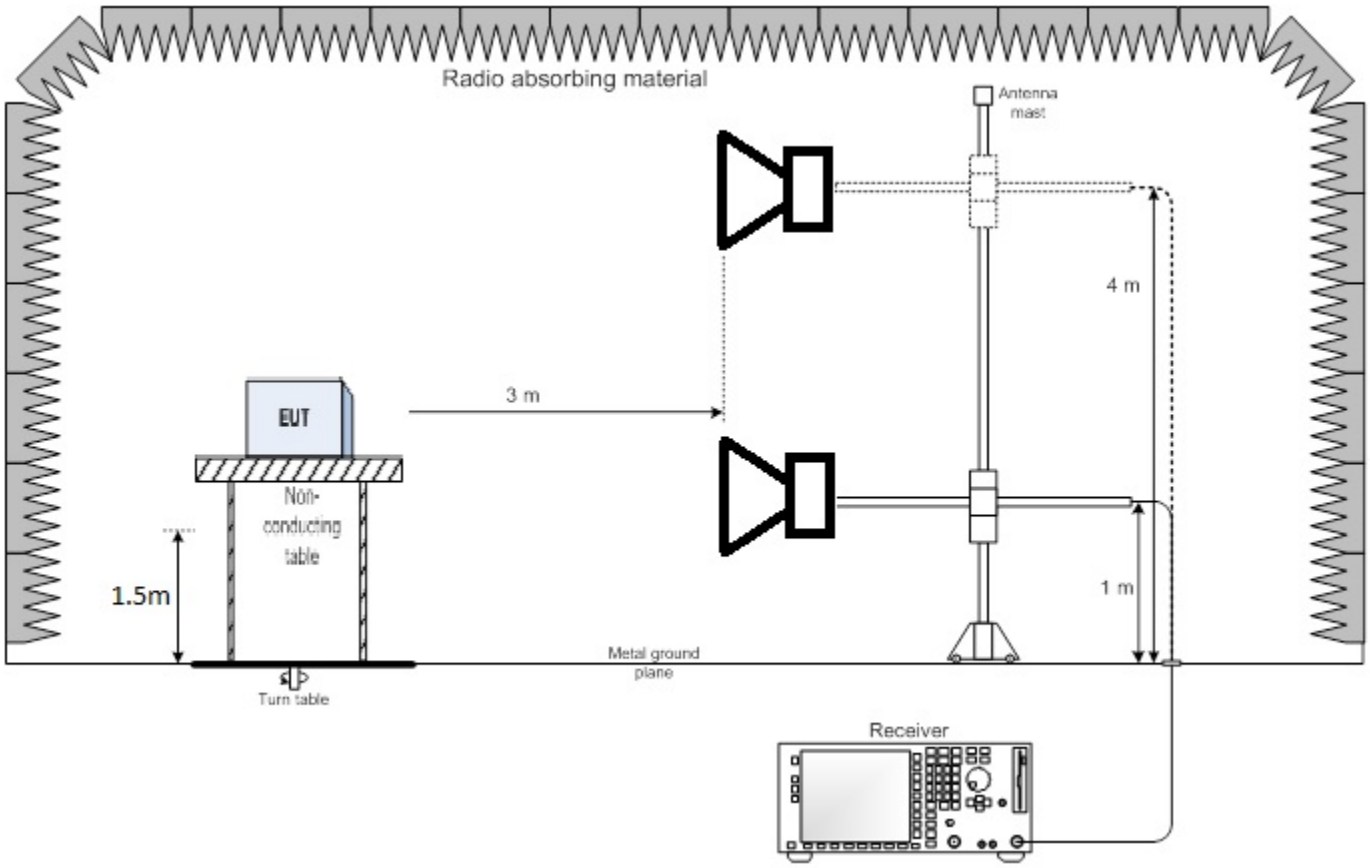
Figure 8.4-3: *Power Spectrum Density @ 3kHz, 2480MHz*

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