

Test report

366446 – TRFWL

Date of issue: February 1, 2019

Applicant:

Creacheer, Inc.

Product:

Wearable Bluetooth Device for Measuring Body Position and Gestures

Model:

Creacheer One

FCC ID: 2AQRCCR1

IC Registration number: 24183-CR1

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 (DTSSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices

Test location

Company name	Nemko USA, Inc.
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City	Carlsbad
Province	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
Site number	FCC: US5058; IC: 2040B-3

Tested by	Martha Espinoza, Wireless Engineer
Tester signature	
Reviewed by	Chip Fleury, Wireless and Certification Supervisor
Review date	March 6, 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 contained in this report are within Nemko USA's ISO/IEC 17025 accreditation.

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Table of contents

Table of contents	3
Section 1. Report summary	4
1.1 Applicant and manufacturer	4
1.2 Test specifications	4
1.3 Test methods	4
1.4 Statement of compliance	4
1.5 Exclusions	4
1.6 Test report revision history	4
Section 2. Summary of test results	5
2.1 FCC Part 15 Subpart C, general requirements test results	5
2.2 FCC Part 15 Subpart C, intentional radiators test results	5
2.3 IC RSS-GEN, Issue 5, test results	5
2.4 IC RSS-247, Issue 2, test results	6
Section 3. Equipment under test (EUT) details	7
3.1 Sample information	7
3.2 EUT information	7
3.3 Technical information	7
3.4 Antenna technical information	8
3.5 Product description and theory of operation	9
3.6 EUT exercise details	9
3.7 EUT setup diagram	9
3.8 EUT sub assemblies	9
Section 4. Engineering considerations	10
4.1 Modifications incorporated in the EUT	10
4.2 Technical judgment	10
4.3 Deviations from laboratory tests procedures	10
Section 5. Test conditions	11
5.1 Atmospheric conditions	11
5.2 Power supply range	11
Section 6. Measurement uncertainty	12
6.1 Uncertainty of measurement	12
Section 7. Test equipment	13
7.1 Test equipment list	13
Section 8. Test Data	14
8.1 FCC 15.247(a) (2) and RSS-247 5.2(a) Minimum 6 dB bandwidth	14
8.2 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and EIRP requirements	16
8.3 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions	18
8.4 FCC 15.247(e) and RSS-247 5.2(b) Power Spectrum Density	36
Section 9. Block diagrams of test set-ups	38
9.1 Radiated emissions set-up – Below 1GHz	38
9.2 Radiated emissions set-up – Above 1GHz	39

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Creacheer, Inc
Address	10360 Reserve Dr # 101
City	San Diego
Province/State	California
Postal/Zip code	92127
Country	USA

1.2 Test specifications

FCC 47 CFR Part 15, Sub-part 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
366446-TRFWL	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
§15.31(e)	Variation of power source	Not applicable
§15.203	Antenna requirement	Pass ²
§15.205	Restricted bands of operation	Pass

Notes: ¹ EUT is battery powered and has no direct connection to the AC mains.

² The EUT uses trace antennas 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 5, test results

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable ¹
7.4	Receiver conducted emission limits	Not applicable ¹
8.8	Power Line Conducted Emissions Limits for License-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 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

² EUT is battery powered 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 EIRP 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	January 28, 2019
Nemko sample ID number	366446

3.2 EUT information

Product name	Creacheer ONE
Model	CR1
Model variant	N/A
Serial number	Engineering sample (5106)
FCC ID	2AQRCCR1
IC Registration Number	24183-CR1

3.3 Technical information

Applicant IC company number	24183
IC UPN number	CR1
All used IC test site(s) Reg. number	N/A
RSS number and Issue number	RSS-247, Issue 2, February 2017
Frequency band	2400-2483.5 MHz
Frequency Min (MHz)	2402
Frequency Max (MHz)	2480
RF power Min (W), Conducted	0.0011
RF power Max (W), Conducted	0.00114
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	730.000
Measured BW (kHz) (99%)	1068.3
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	GFSK
Emission classification (F1D, G1D, D1D)	F1D
Transmitter spurious, Units @ distance	52.690 dBμV/m @ 3m Peak / 45.990 dBμV/m @ 3m Average
Power requirements	3.2 – 4.2 VDC (5 V during recharge), Max Current 100 mA
Antenna information	PCB Antenna, peak gain is -5.51 dBi and XY plane The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

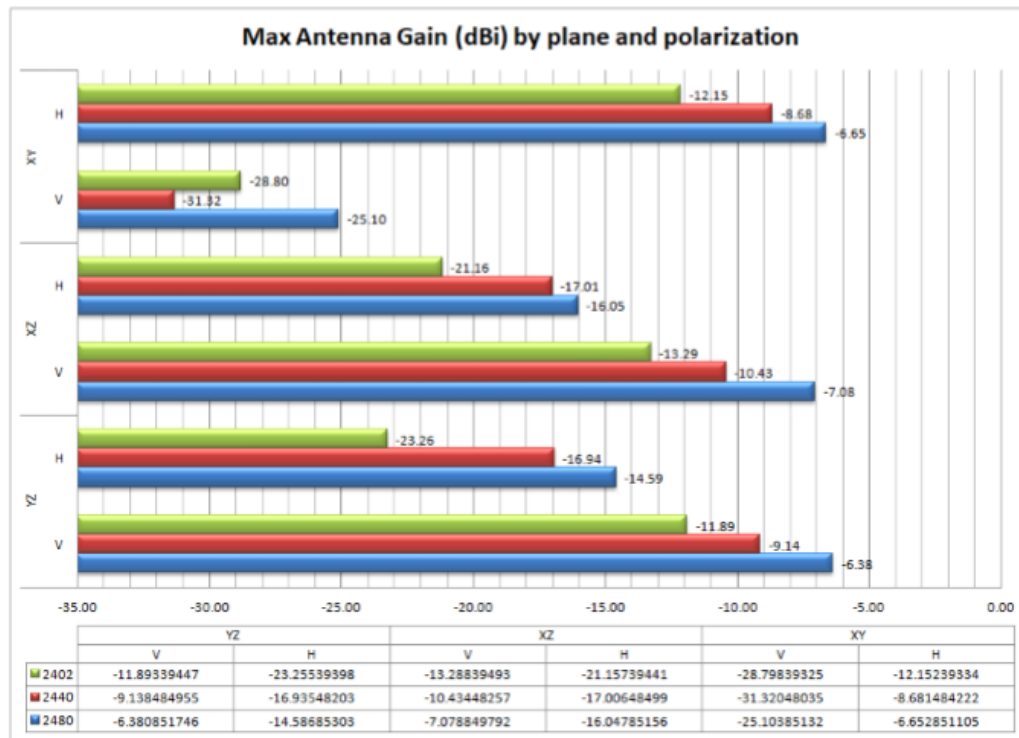
3.4 Antenna technical information

The maximum antenna gain declared by manufacturer was -5.51 dBi. The measurements and calculus in this document were done considering this information.

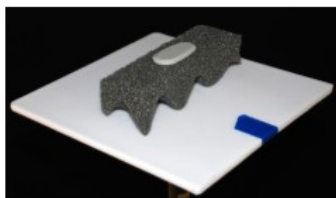
Radiated Measurements

The Creacheer sensor was positioned on the rotation table in 3 various planes (XY, XZ and YZ), and horizontal and vertical gains were measured at all 3 frequencies.

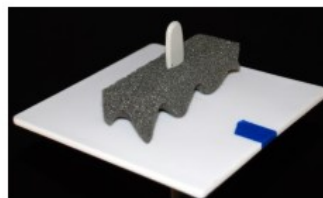
Results are summarized below, followed by the polar plots.



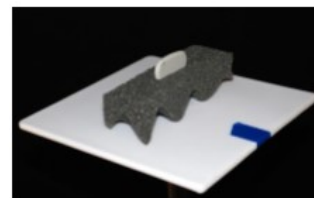
The maximum antenna gain is $-6.38 \text{ dBi} + 0.87 \text{ dB}$ tolerance = **-5.51 dBi**



XY Plane



XZ Plane



YZ Plane

* Blue marker on white platform points at receiving antenna

** Device charging pads face the receiving antenna (except in the case of XY plane where they point directly up in the positive Z direction)

The maximum gain was found in the YZ plane, so, the measurements were done in that physical position.

3.5 Product description and theory of operation

The Equipment Under Test (EUT) is a multifunctional wearable Bluetooth device (Model: CR1) for the consumer health and wellness market. The product functionality includes, body position monitoring, body motion monitoring, gesture detection, haptic alerting and intercommunication with associated computing devices (BLE connection to your smartphone). The EUT incorporates a low power radio operating in the 2400-2483.5 MHz ISM band.

3.6 EUT exercise details

A modes list was provided by manufacturer where the number of taps is indicating for getting the desired mode.

- 1) Radio off
- 2) TX CW -2402
- 3) TX CW - 2440
- 4) TX CW - 2480
- 5) TX Modulate – 2402
- 6) TX Modulate – 2440
- 7) TX Modulate – 2480
- 8) RX – 2402
- 9) RX – 2440
- 10) RX - 2480

The device blinks the LED to indicate the newly started operation (eg, 4 blinks = TX CW on 2480 MHz).

The number 5, 6 and 7 were used for the measurements done in this report. The EUT was fixed in a single modulation for each channel: GFSK and a data rate of 1 Mb/s (according to the declared by manufacturer). RF conducted test was performed on unit with a temporary RF output port (50Ω SMA before antenna). The losses caused by this temporary arrangement, were considered when a compensate factor was introducing for all the measurements done during the process.

3.7 EUT setup diagram

Setup Photo in separate exhibit

Figure 3.7-1: Radiated Emissions Test Setup – below 1GHz

Setup Photo in separate exhibit

Figure 3.7-2: Radiated Emissions Test Setup – above 1GHz

3.8 EUT sub assemblies

Table 3.8-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
Recharge dock	Creacheer	N/A	Engineering sample (1001)

Table 3.8-2: EUT support equipment

Description	Brand name	Model/Part number	Serial number
AC-DC Converter	Hongge	TX-0501000-AC102	N/A
Ipod touch	Apple	A1574	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 $\pm 5\%$, 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

Equipment	Manufacturer	Model no.	Asset no.	Cal Date	Next cal.
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1121	05-25-2018	05-25-2020
Antenna, Bilog	Schaffner-Chase	CBL6111C	E1480	12-05-2018	12-05-2019
Antenna, Horn	ETS	3117-PA	E1139	01-26-2018	01-26-2020
Antenna, Horn	Sage Millimeter Inc.	SAR-2309-42-S2	E1143	02-13-2018	02-13-2019
Power Amplifier	Sage Millimeter Inc.	SBL-1834034030-KFKF	E1174	NCR	NCR
Signal Analyzer	Rohde & Schwarz	FSV40	E1120	08-24-2018	08-24-2019
EMC Test Receiver	Rohde & Schwarz	ESCI7	E1026	05-23-2017	05-23-2019
Two Line V-Network	Rohde & Schwarz	ENV216	E1019	07-10-2018	07-10-2019

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.

8.1.2 Test summary

Test date	January 28, 2019	Temperature	22 °C
Test engineer	Martha Espinoza	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	30 %

8.1.3 Observations, settings and special notes

Spectrum analyzer settings:

Resolution bandwidth	100 kHz
Video bandwidth	$\geq 3 \times \text{RBW}$
Frequency span	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	730.000	500	230.000
	2440	715.000	500	215.000
	2480	725.000	500	225.000

8.1.4 Test data, continued

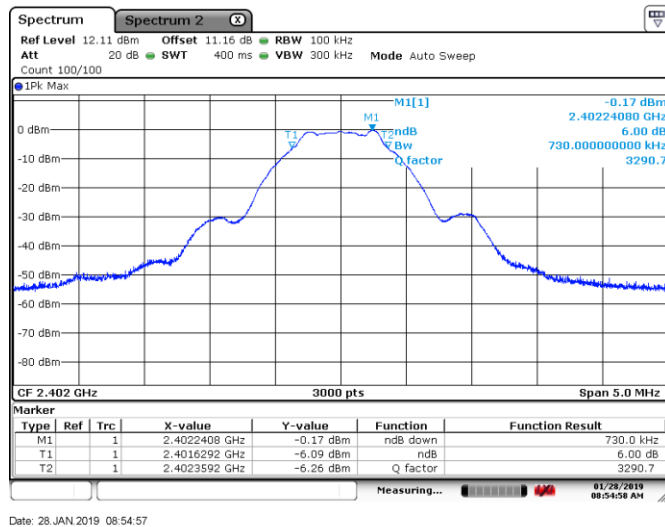


Figure 8.1-1: 6 dB bandwidth, Low CH

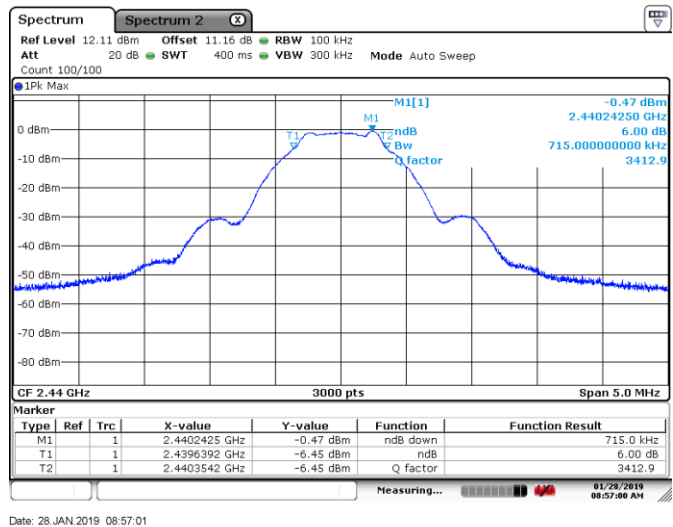


Figure 8.1-2: 6 dB bandwidth, Mid CH

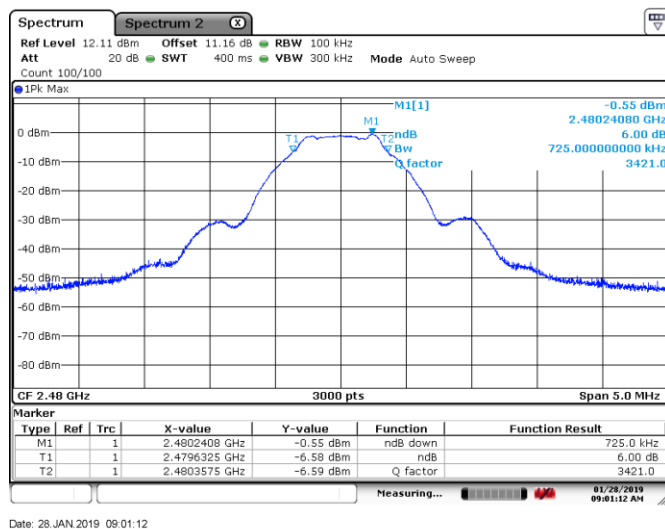


Figure 8.1-3: 6 dB bandwidth, High CH

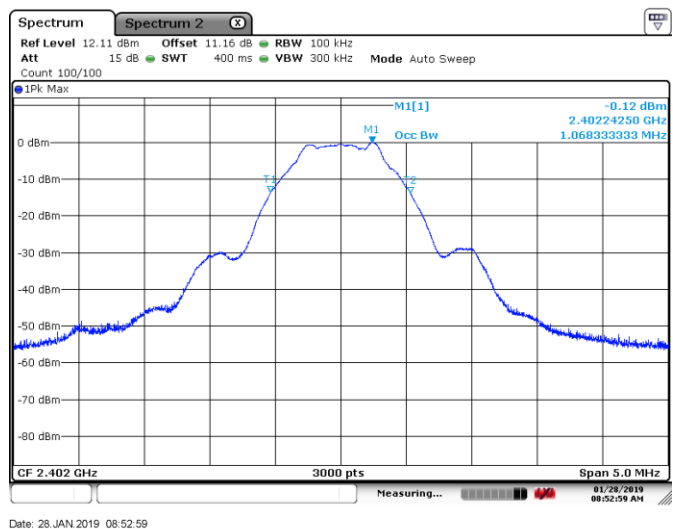


Figure 8.1-4: 99% OBW, Low CH (representative)

Table 8.1-2: 99% OBW bandwidth results

Modulation	Frequency, MHz	99% OBW, MHz
GFSK	2402	1.068
	2440	1.065
	2480	1.068

8.2 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and EIRP 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 1 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

- (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 EIRP 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 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 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	January 28, 2019	Temperature	22 °C
Test engineer	Martha Espinoza	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	30 %

8.2.3 Observations, settings and special notes

Peak Conducted Power Measured

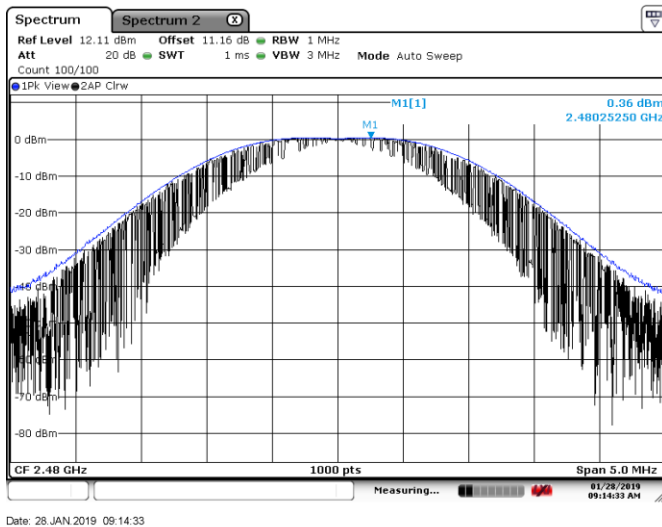
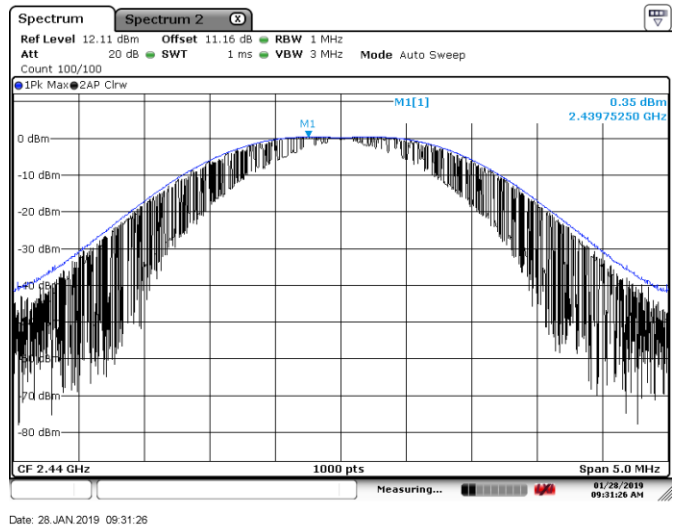
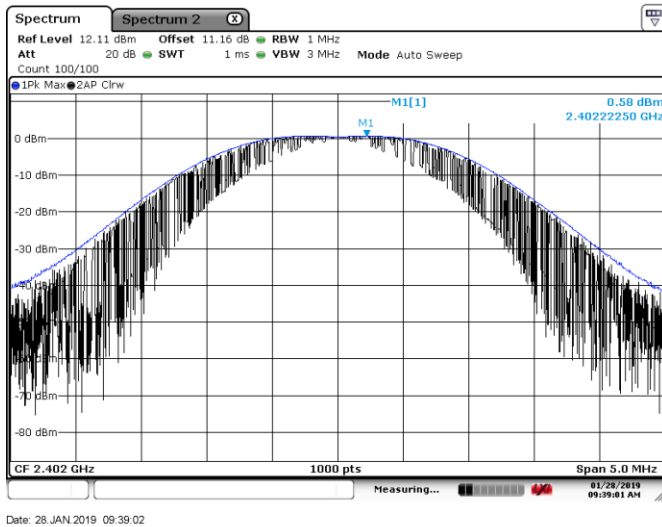
Spectrum analyzer settings:

Resolution bandwidth	≥ Channel BW (1 MHz)
Video bandwidth	≥ 3 × RBW (3 MHz)
Frequency span	≥ 3 × RBW (5 MHz)
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: Output power measurements results

Modulation	Frequency, MHz	Conducted output power, dBm		Margin, dB	Max Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		Measured	Limit					
GFSK	2402	0.58	30	29.42	-5.51	-4.93	36	40.93
	2440	0.35	30	29.65	-5.51	-5.16	36	41.16
	2480	0.36	30	29.64	-5.51	-5.15	36	41.15



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

8.3.1 Definitions and limits continued

Note: Certain frequency bands listed in Table 8.3-2 and above 38.6 GHz are designated for low-power license-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	January 28, 2019	Temperature	22 °C
Test engineer	Martha Espinoza	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	30 %

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.
The EUT was investigated for worst case emissions before final test results

Spectrum analyzer settings for conducted spurious emissions measurements:

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

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

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

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

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

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

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

8.3.4 Test data

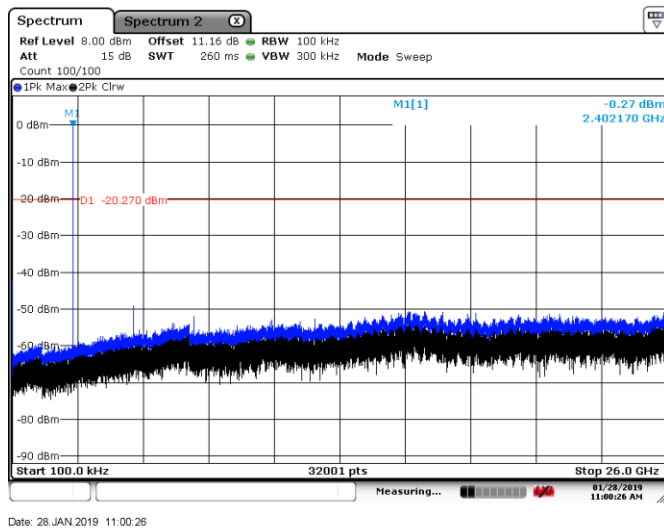


Figure 8.3.1: Conducted spurious emissions, low channel

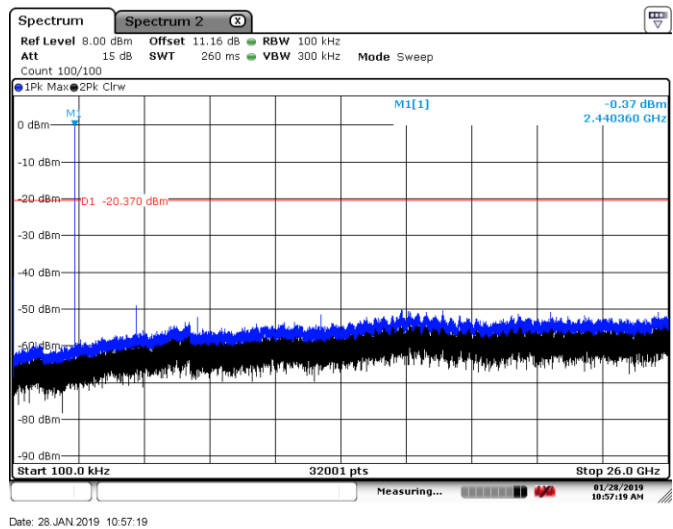


Figure 8.3.2: Conducted spurious emissions, mid channel

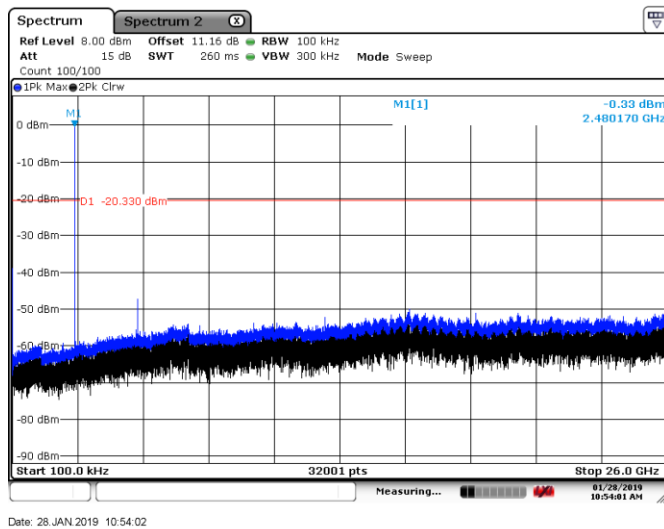


Figure 8.3.3: Conducted spurious emissions, high channel

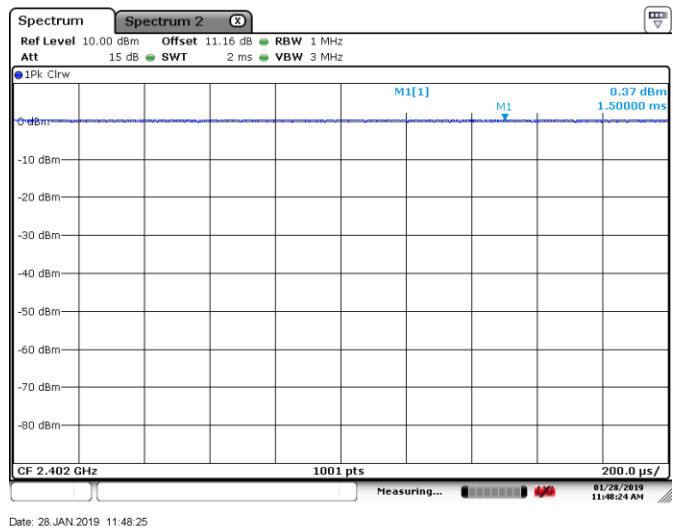


Figure 8.3.4: 2ms sweep, low channel 100% Duty cycle

Note: Peaks within 2400-2483.5MHz are transmitter fundamentals.

8.3.4 Test data, continued

DUTY CYCLE

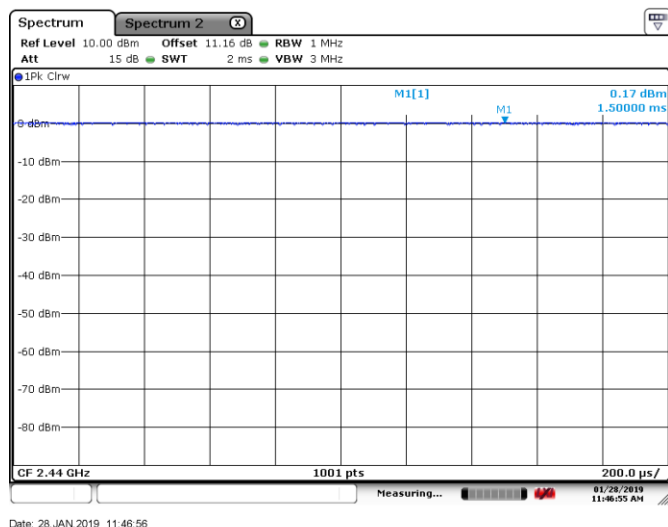


Figure 8.3.5: 2ms sweep, middle channel 100% Duty cycle

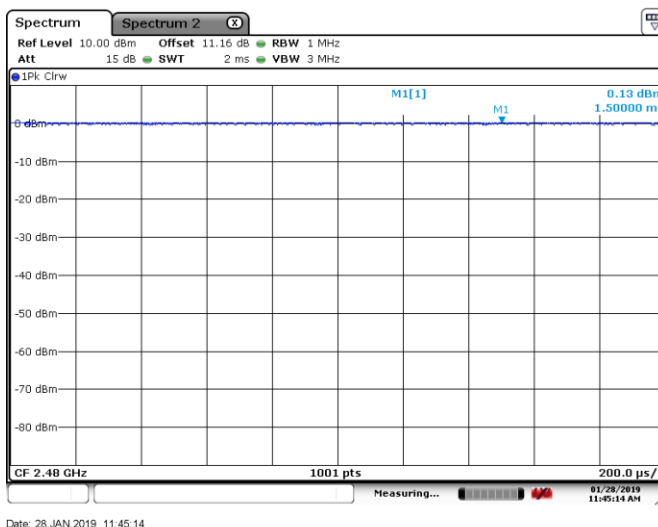


Figure 8.3.6: 2ms sweep, high channel 100% Duty cycle

BANDEDGE MEASUREMENTS

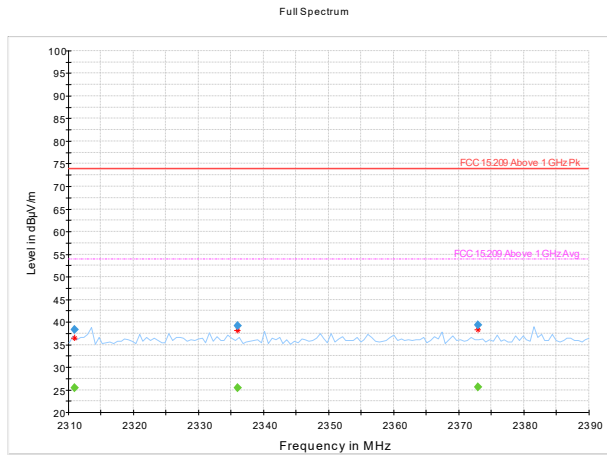


Figure 8.3.7: Low band edge(2310-2390), restrictive bands.

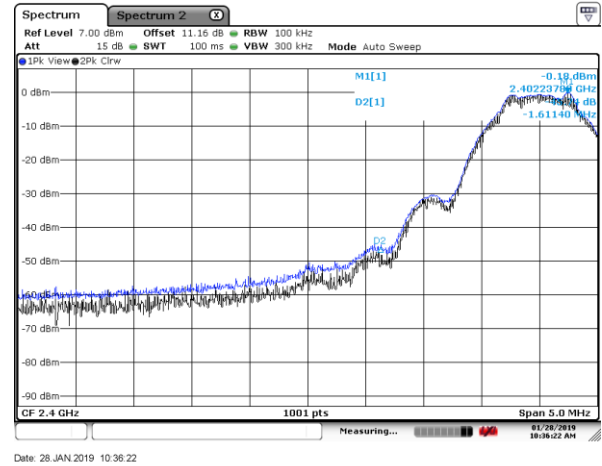


Figure 8.3.8: Low band edge (2390-2400). Non- Restrictive bands.
(Emissions at least 20 dB below Fundamental)

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas Time (s)	BW (MHz)
2310.90000	38.30	---	73.90	35.60	5.0	1.00
2310.90000	---	25.37	53.90	28.53	5.0	1.00
2335.96666	39.11	---	73.90	34.79	5.0	1.00
2335.96666	---	25.45	53.90	28.45	5.0	1.00
2372.93333	39.33	---	73.90	34.57	5.0	1.00
2372.93333	---	25.62	53.90	28.28	5.0	1.00

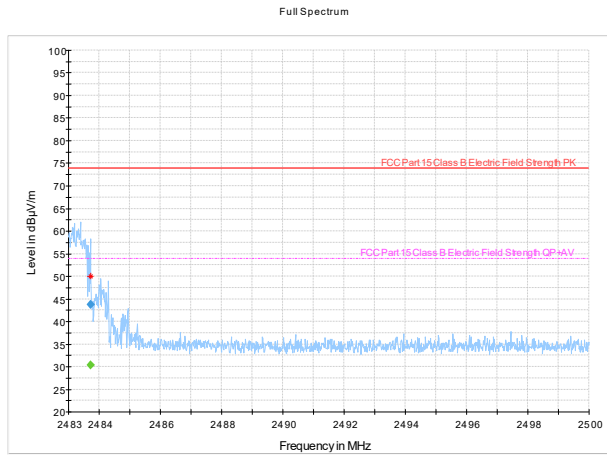


Figure 8.3.9: High band edge(2483-2500), restrictive bands.

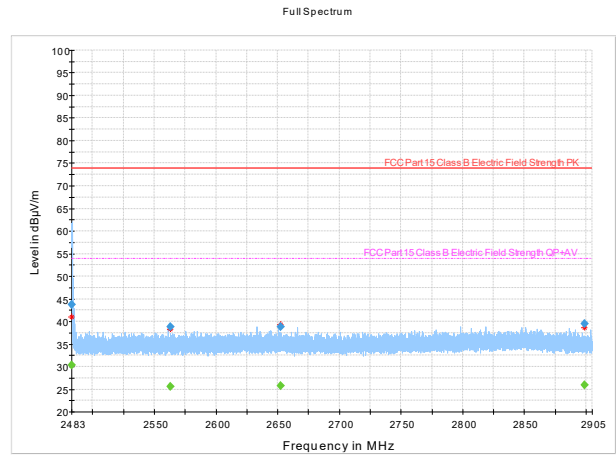


Figure 8.3.10: High band edge (2655-2900). Restrictive bands.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2483.717400	---	30.27	53.90	23.63
2483.717400	43.69	---	73.90	30.21
2484.200000	39.11	---	73.90	34.79
2484.200000	---	26.04	53.90	27.86

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2899.056867	39.44	---	73.90	34.46
2899.056867	---	25.91	53.90	27.99

8.3.5 Test data, continued

RADIATED EMISSIONS REQUIREMENTS

Full Spectrum

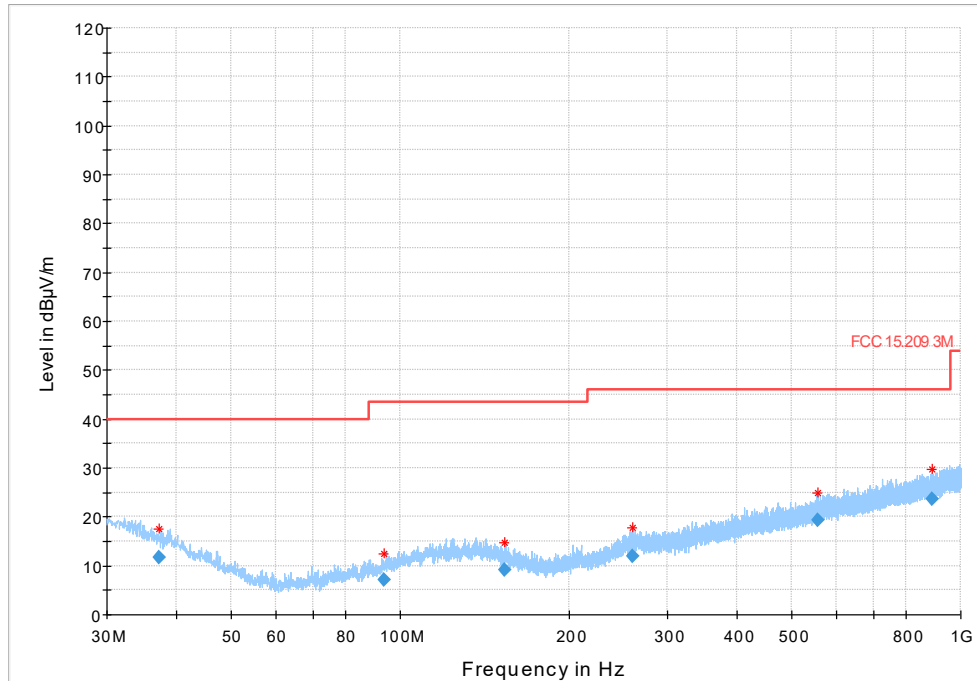


Figure 8.3.11: Radiated spurious emissions, low channel, 30-1000MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
37.240500	11.57	40.00	28.43	5000.0	120.000	397.5	V	1.0	16.6
93.759500	7.06	43.50	36.44	5000.0	120.000	126.7	H	25.0	10.7
153.526000	9.07	43.50	34.43	5000.0	120.000	121.4	V	16.0	13.1
259.704000	12.07	46.00	33.93	5000.0	120.000	343.7	V	194.0	16.0
556.294000	19.23	46.00	26.77	5000.0	120.000	348.3	H	85.0	22.5
887.769000	23.55	46.00	22.45	5000.0	120.000	214.8	H	1.0	26.9

Table 8.3-4: Radiated spurious emissions results, low channel from 30 to 1000 MHz

Note: No considerable EUT emissions were observed

8.3.6 Test data, continued

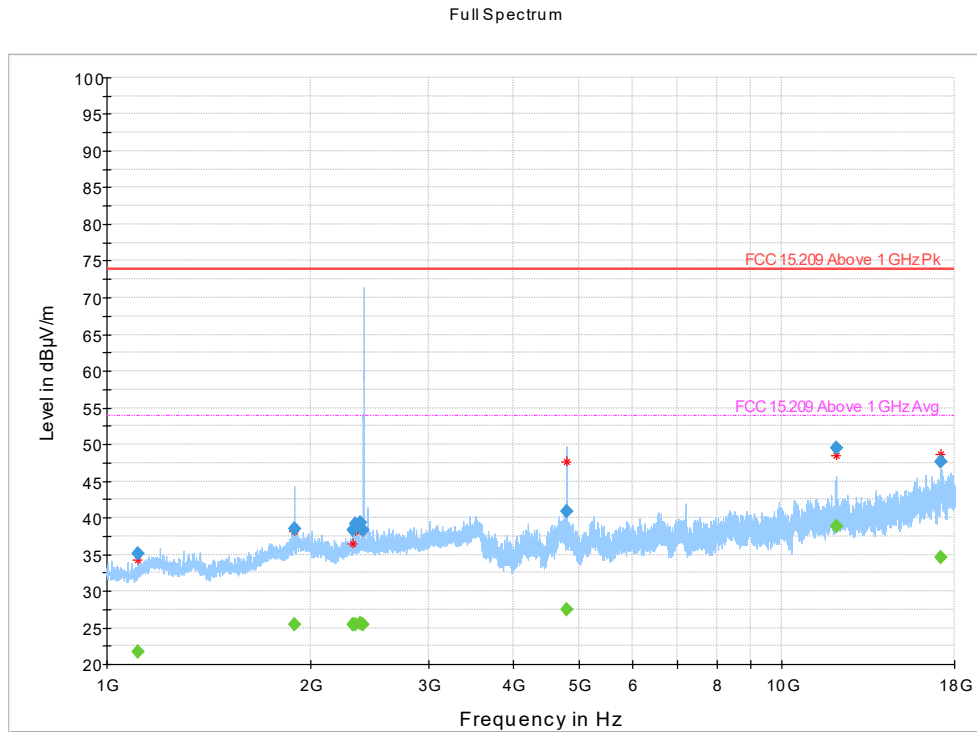


Figure 8.3.10: Radiated spurious emissions, low channel, from 1 to 18 GHz

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)
1113.000000	---	21.67	53.90	32.23	5000.0	1000.000	209.2	H	267.0	-14.3
1113.000000	35.08	---	73.90	38.82	5000.0	1000.000	209.2	H	267.0	-14.3
1895.833333	38.46	---	73.90	35.44	5000.0	1000.000	386.6	V	263.0	-10.7
1895.833333	---	25.34	53.90	28.56	5000.0	1000.000	386.6	V	263.0	-10.7
2310.900000	38.30	---	73.90	35.60	5000.0	1000.000	159.5	H	102.0	-10.1
2310.900000	---	25.37	53.90	28.53	5000.0	1000.000	159.5	H	102.0	-10.1
2335.966667	39.11	---	73.90	34.79	5000.0	1000.000	213.9	H	125.0	-10.0
2335.966667	---	25.45	53.90	28.45	5000.0	1000.000	213.9	H	125.0	-10.0
2372.933333	39.33	---	73.90	34.57	5000.0	1000.000	154.9	H	146.0	-9.8
2372.933333	---	25.62	53.90	28.28	5000.0	1000.000	154.9	H	146.0	-9.8
2392.533333	---	25.49	53.90	28.41	5000.0	1000.000	397.3	H	0.0	-9.8
2392.533333	38.27	---	73.90	35.63	5000.0	1000.000	397.3	H	0.0	-9.8
4796.300000	---	27.54	53.90	26.36	5000.0	1000.000	286.7	V	16.0	-2.0
4796.300000	40.80	---	73.90	33.10	5000.0	1000.000	286.7	V	16.0	-2.0
12008.866667	---	38.82	53.90	15.08	5000.0	1000.000	209.4	V	0.0	4.2
12008.866667	49.43	---	73.90	24.47	5000.0	1000.000	209.4	V	0.0	4.2
17216.333333	---	34.50	53.90	19.40	5000.0	1000.000	379.1	H	148.0	12.2
17216.333333	47.68	---	73.90	26.22	5000.0	1000.000	379.1	H	148.0	12.2

Table 8.3-5: Radiated spurious emissions results, low channel from 1 to 18 GHz

Note: No considerable EUT emissions were observed

8.3.7 Test data, continued

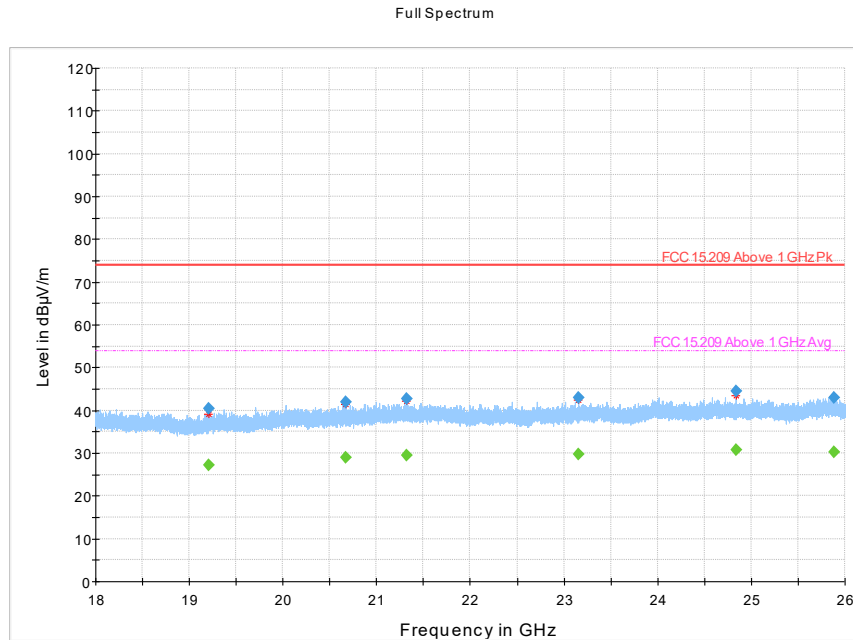


Figure 8.3.12: Radiated spurious emissions, low channel, 18 – 26 GHz

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)
19205.500000	40.33	---	73.90	33.57	5000.0	1000.000	114.1	H	23.0	1.0
19205.500000	---	27.27	53.90	26.63	5000.0	1000.000	114.1	H	23.0	1.0
20664.833333	---	28.86	53.90	25.04	5000.0	1000.000	112.0	V	23.0	2.0
20664.833333	42.07	---	73.90	31.83	5000.0	1000.000	112.0	V	23.0	2.0
21323.366667	---	29.60	53.90	24.30	5000.0	1000.000	114.5	H	-1.0	2.8
21323.366667	42.66	---	73.90	31.24	5000.0	1000.000	114.5	H	-1.0	2.8
23153.366667	---	29.72	53.90	24.18	5000.0	1000.000	139.1	V	264.0	2.5
23153.366667	42.99	---	73.90	30.91	5000.0	1000.000	139.1	V	264.0	2.5
24840.033333	---	30.75	53.90	23.15	5000.0	1000.000	125.0	V	23.0	3.5
24840.033333	44.44	---	73.90	29.46	5000.0	1000.000	125.0	V	23.0	3.5
25881.100000	42.97	---	73.90	30.93	5000.0	1000.000	119.5	H	126.0	3.7
25881.100000	---	30.14	53.90	23.76	5000.0	1000.000	119.5	H	126.0	3.7

Table 8.3-6: Radiated spurious emissions results, low channel from 18 to 26 GHz

Note: No considerable EUT emissions were observed

8.3.4 Test data, continued

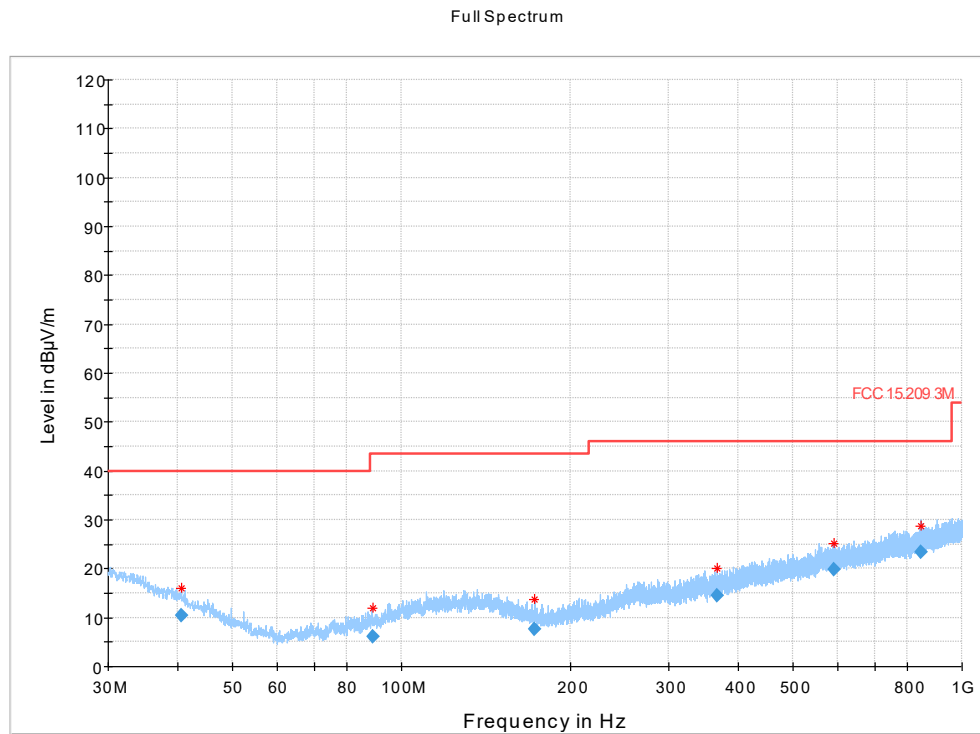


Figure 8.3.12: Radiated spurious emissions, middle channel, 30-1000MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.503500	10.51	40.00	29.49	5000.0	120.000	205.5	H	145.0	14.8
88.953500	6.16	43.50	37.34	5000.0	120.000	115.0	V	358.0	10.0
172.792000	7.65	43.50	35.85	5000.0	120.000	320.0	V	93.0	11.7
366.279000	14.43	46.00	31.57	5000.0	120.000	393.9	V	0.0	18.1
591.900500	19.76	46.00	26.24	5000.0	120.000	143.6	V	206.0	23.0
845.958500	23.38	46.00	22.62	5000.0	120.000	311.3	V	17.0	26.8

Table 8.3-7: Radiated spurious emissions results, middle channel from 30 to 1000 MHz

Note: No considerable EUT emissions were observed

8.3.5 Test data, continued

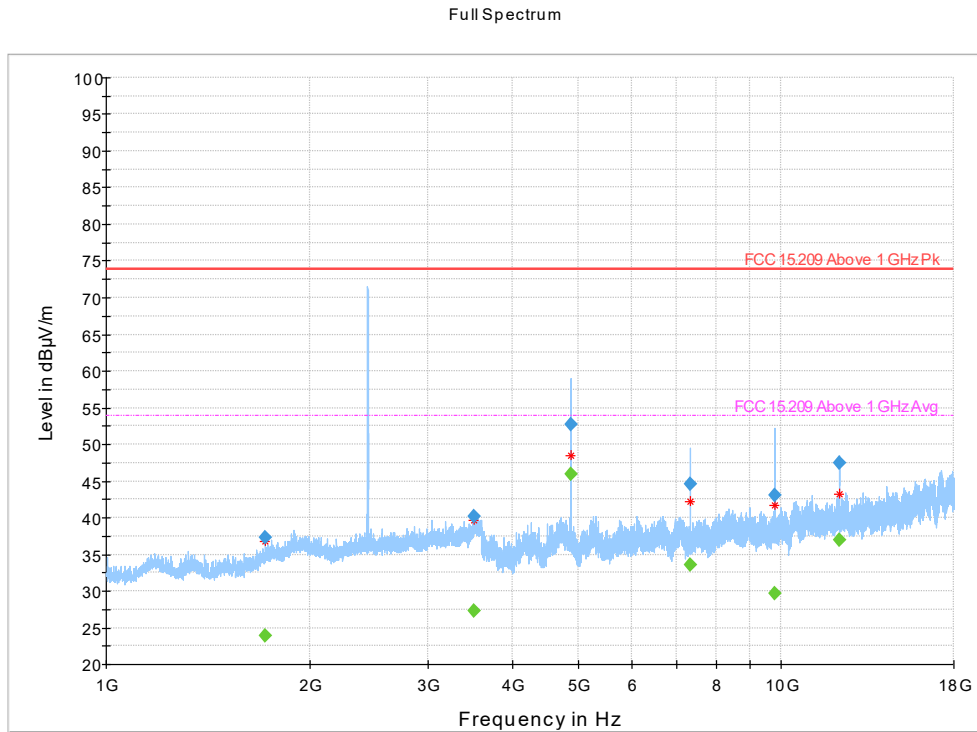


Figure 8.3.13: Radiated spurious emissions, middle channel, 1-18 GHz

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)
1722.300000	37.26	---	73.90	36.64	5000.0	1000.000	120.5	H	255.0	-12.4
1722.300000	---	23.97	53.90	29.93	5000.0	1000.000	120.5	H	255.0	-12.4
3511.233333	---	27.21	53.90	26.69	5000.0	1000.000	269.7	V	124.0	-6.0
3511.233333	40.19	---	73.90	33.71	5000.0	1000.000	269.7	V	124.0	-6.0
4880.400000	52.69	---	73.90	21.21	5000.0	1000.000	100.0	V	79.0	-2.2
4880.400000	---	45.99	53.90	7.91	5000.0	1000.000	100.0	V	79.0	-2.2
7319.600000	44.59	---	73.90	29.31	5000.0	1000.000	99.9	V	72.0	0.0
7319.600000	---	33.58	53.90	20.32	5000.0	1000.000	99.9	V	72.0	0.0
9760.866667	42.99	---	73.90	30.91	5000.0	1000.000	111.5	V	72.0	2.8
9760.866667	---	29.68	53.90	24.22	5000.0	1000.000	111.5	V	72.0	2.8
12199.066667	47.53	---	73.90	26.37	5000.0	1000.000	187.3	V	176.0	4.8
12199.066667	---	36.96	53.90	16.94	5000.0	1000.000	187.3	V	176.0	4.8

Table 8.3-8: Radiated spurious emissions results, middle channel from 1 to 18 GHz

Note: No considerable EUT emissions were observed

8.3.4 Test data, continued

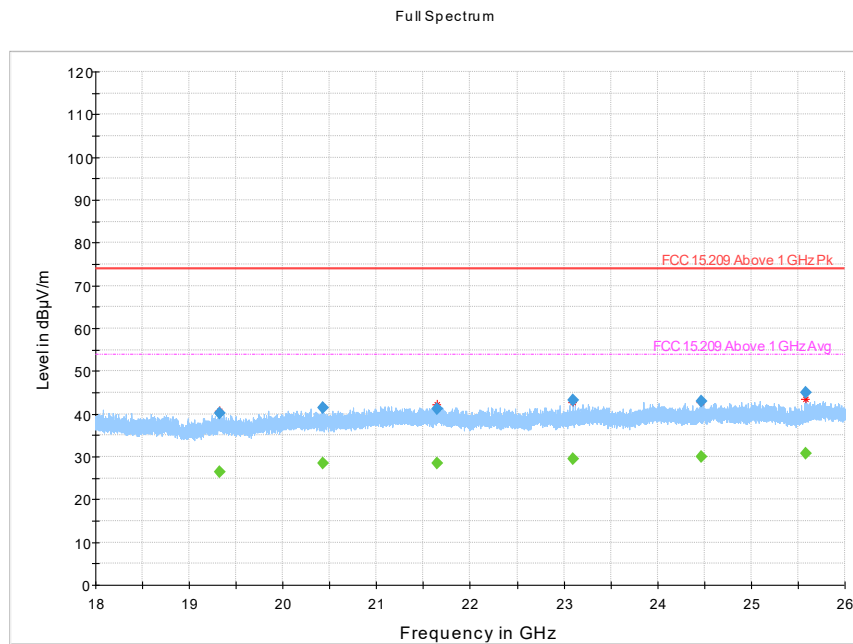


Figure 8.3.14: Radiated spurious emissions, middle channel, 18 – 26 GHz

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)
19320.966667	40.06	---	73.90	33.84	5000.0	1000.000	117.6	H	313.0	1.0
19320.966667	---	26.44	53.90	27.46	5000.0	1000.000	117.6	H	313.0	1.0
20421.900000	41.50	---	73.90	32.40	5000.0	1000.000	175.0	V	3.0	2.3
20421.900000	---	28.43	53.90	25.47	5000.0	1000.000	175.0	V	3.0	2.3
21649.366667	41.07	---	73.90	32.83	5000.0	1000.000	159.3	V	113.0	2.5
21649.366667	---	28.56	53.90	25.34	5000.0	1000.000	159.3	V	113.0	2.5
23095.100000	43.34	---	73.90	30.56	5000.0	1000.000	108.3	V	296.0	2.5
23095.100000	---	29.45	53.90	24.45	5000.0	1000.000	108.3	V	296.0	2.5
24468.033333	43.03	---	73.90	30.87	5000.0	1000.000	149.9	H	27.0	2.8
24468.033333	---	30.00	53.90	23.90	5000.0	1000.000	149.9	H	27.0	2.8
25579.633333	44.92	---	73.90	28.98	5000.0	1000.000	125.0	H	164.0	3.6
25579.633333	---	30.64	53.90	23.26	5000.0	1000.000	125.0	H	164.0	3.6

Table 8.3-9: Radiated spurious emissions results, middle channel from 18 to 26 GHz

Note: No considerable EUT emissions were observed

8.3.4 Test data, continued

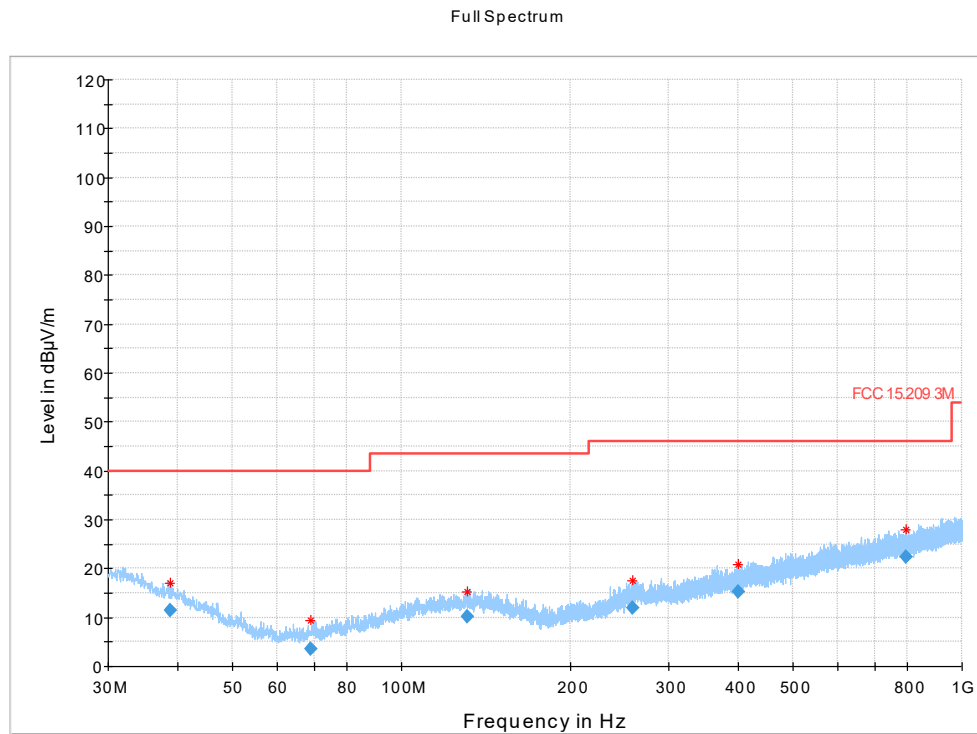


Figure 8.3.15: Radiated spurious emissions, high channel, 30-1000MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.670500	11.52	40.00	28.48	5000.0	120.000	203.4	H	1.0	15.8
68.996000	3.60	40.00	36.40	5000.0	120.000	201.3	H	115.0	7.5
131.062500	10.10	43.50	33.40	5000.0	120.000	330.5	V	351.0	13.7
259.043000	12.00	46.00	34.00	5000.0	120.000	268.0	V	207.0	15.9
399.082000	15.38	46.00	30.62	5000.0	120.000	150.9	V	335.0	19.1
795.261500	22.28	46.00	23.72	5000.0	120.000	343.6	V	184.0	25.6

Table 8.3-10: Radiated spurious emissions results, high channel from 30 to 1000 MHz

Note: No considerable EUT emissions were observed

8.3.5 Test data, continued

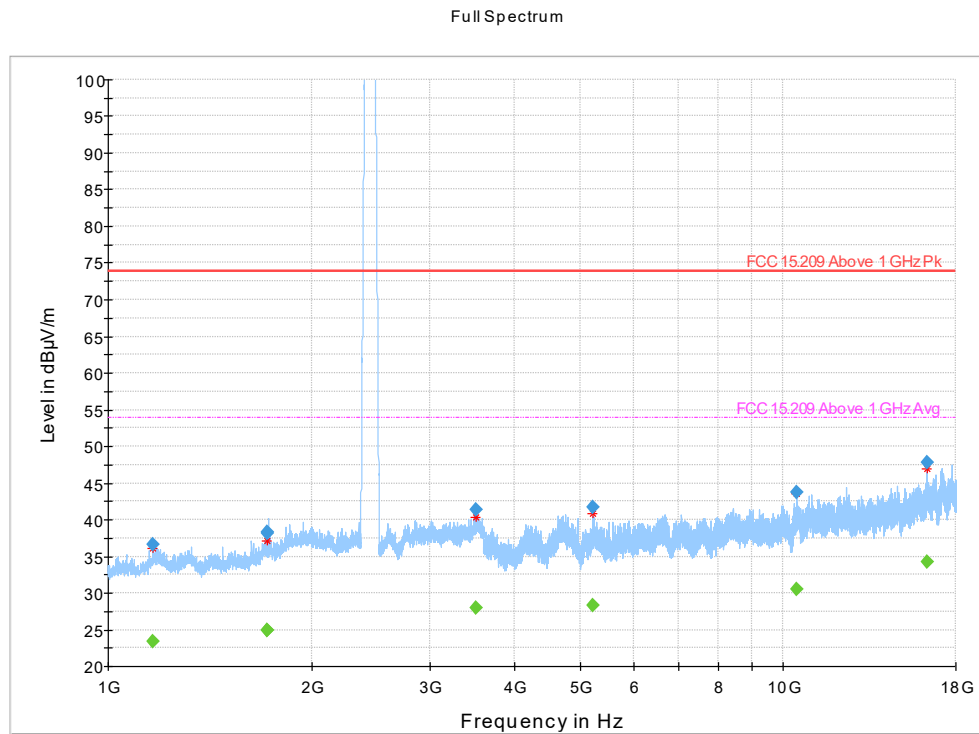


Figure 8.3.16: Radiated spurious emissions, high channel, 1-18 GHz

Note: To frequency range from 1 to 18 GHz a band rejection filter was added for avoiding the pre-amplifier saturation. The losses associated to this passive device, was corrected.

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)
1163.800000	36.62	---	73.90	37.28	5000.0	1000.000	266.4	V	286.0	-13.2
1163.800000	---	23.32	53.90	30.58	5000.0	1000.000	266.4	V	286.0	-13.2
1721.966667	38.15	---	73.90	35.75	5000.0	1000.000	235.8	V	0.0	-11.7
1721.966667	38.31	---	73.90	35.59	5000.0	1000.000	235.8	V	0.0	-11.7
1721.966667	---	24.86	53.90	29.04	5000.0	1000.000	235.8	V	0.0	-11.7
1721.966667	---	24.86	53.90	29.04	5000.0	1000.000	235.8	V	0.0	-11.7
3504.700000	41.32	---	73.90	32.58	5000.0	1000.000	410.0	H	72.0	-5.4
3504.700000	---	27.94	53.90	25.96	5000.0	1000.000	410.0	H	72.0	-5.4
5230.700000	---	28.28	53.90	25.62	5000.0	1000.000	286.5	V	255.0	-1.8
5230.700000	41.65	---	73.90	32.25	5000.0	1000.000	286.5	V	255.0	-1.8
10452.066667	---	30.53	53.90	23.37	5000.0	1000.000	373.3	H	0.0	4.0
10452.066667	43.72	---	73.90	30.18	5000.0	1000.000	373.3	H	0.0	4.0
16335.666667	---	34.20	53.90	19.70	5000.0	1000.000	276.6	H	0.0	10.9
16335.666667	47.74	---	73.90	26.16	5000.0	1000.000	276.6	H	0.0	10.9

Table 8.3-11: Radiated spurious emissions results, high channel from 1 to 18 GHz

Note: No considerable EUT emissions were observed

8.3.4 Test data, continued

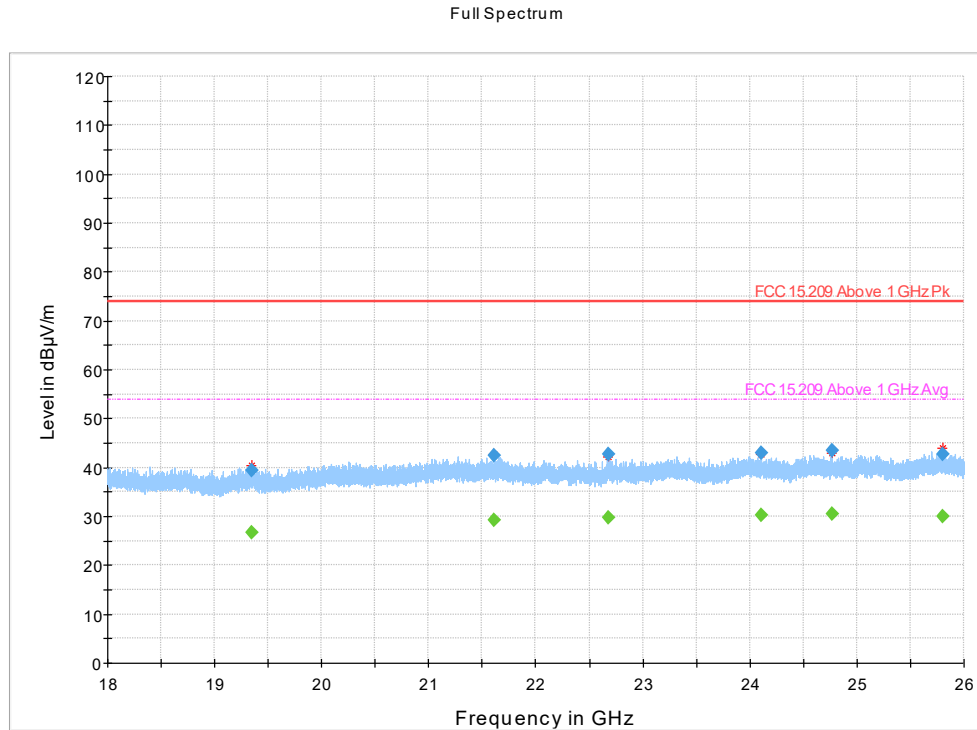


Figure 8.3.13: Radiated spurious emissions, high channel, 18 - 26 GHz

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)
19347.900000	---	26.59	53.90	27.31	5000.0	1000.000	115.2	H	276.0	1.0
19347.900000	39.49	---	73.90	34.41	5000.0	1000.000	115.2	H	276.0	1.0
21611.900000	---	29.19	53.90	24.71	5000.0	1000.000	125.0	V	114.0	2.5
21611.900000	42.33	---	73.90	31.57	5000.0	1000.000	125.0	V	114.0	2.5
22683.900000	---	29.67	53.90	24.23	5000.0	1000.000	163.0	H	107.0	2.4
22683.900000	42.82	---	73.90	31.08	5000.0	1000.000	163.0	H	107.0	2.4
24107.900000	---	30.13	53.90	23.77	5000.0	1000.000	100.0	V	285.0	2.9
24107.900000	42.87	---	73.90	31.03	5000.0	1000.000	100.0	V	285.0	2.9
24766.300000	43.57	---	73.90	30.33	5000.0	1000.000	125.0	H	243.0	3.6
24766.300000	---	30.48	53.90	23.42	5000.0	1000.000	125.0	H	243.0	3.6
25807.633333	42.74	---	73.90	31.16	5000.0	1000.000	116.2	H	165.0	3.8
25807.633333	---	29.96	53.90	23.94	5000.0	1000.000	116.2	H	165.0	3.8

Table 8.3-12: Radiated spurious emissions results, high channel from 18 to 26 GHz

Note: No considerable EUT emissions were observed

8.3.5 Test data, continued

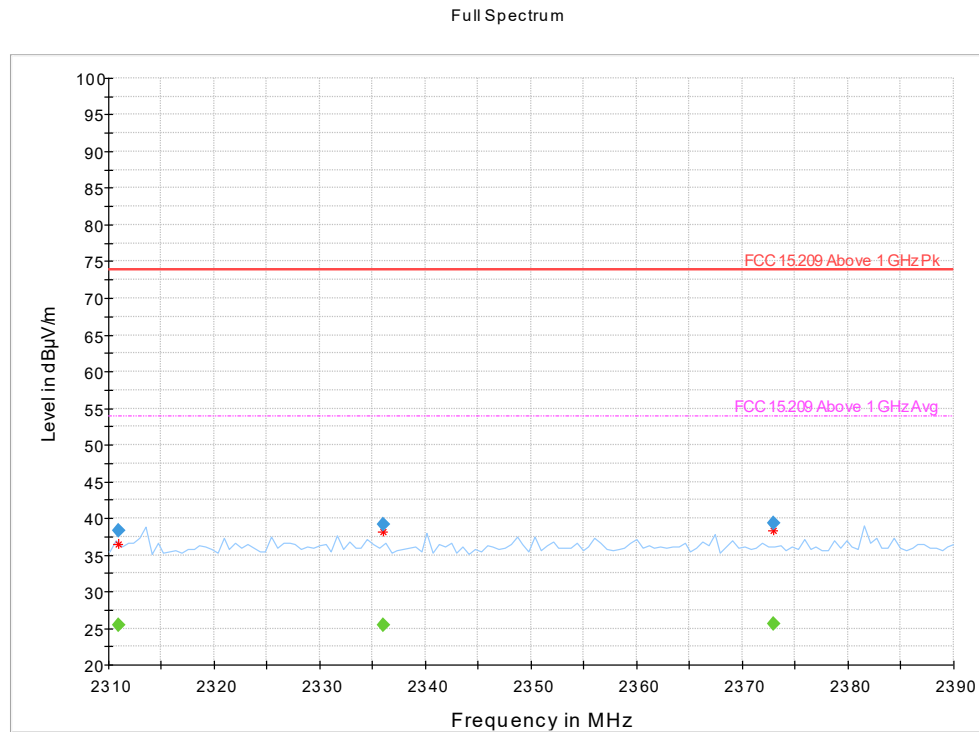


Figure 8.3.18: Radiated low band edge, FCC and IC restrictive frequency bands from 2310 to 2390 MHz

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)
2310.900000	38.30	---	73.90	35.60	5000.0	1000.000	159.5	H	102.0	-10.1
2310.900000	---	25.37	53.90	28.53	5000.0	1000.000	159.5	H	102.0	-10.1
2335.966667	39.11	---	73.90	34.79	5000.0	1000.000	213.9	H	125.0	-10.0
2335.966667	---	25.45	53.90	28.45	5000.0	1000.000	213.9	H	125.0	-10.0
2372.933333	39.33	---	73.90	34.57	5000.0	1000.000	154.9	H	146.0	-9.8
2372.933333	---	25.62	53.90	28.28	5000.0	1000.000	154.9	H	146.0	-9.8

Table 8.3.13: Radiated low band edge results, FCC and IC restrictive frequency bands from 2310 to 2390 MHz

Note: No considerable EUT emissions were observed

8.3.6 Test data, continued

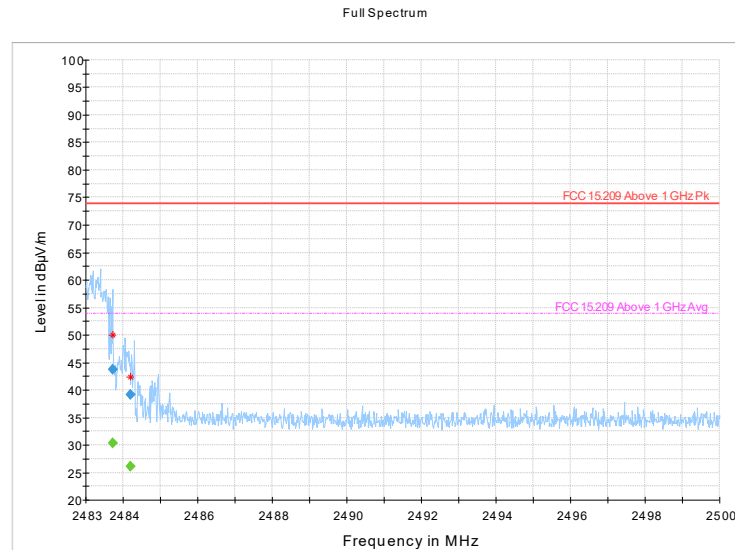


Figure 8.3.19: Radiated high band edge, FCC restrictive frequency bands from 2483.5 to 2500 MHz.

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)
2483.717400	---	30.27	53.90	23.63	5000.0	1000.000	145.0	V	63.0	-9.5
2483.717400	43.69	---	73.90	30.21	5000.0	1000.000	145.0	V	63.0	-9.5
2484.200000	39.11	---	73.90	34.79	5000.0	1000.000	346.5	H	301.0	-9.5
2484.200000	---	26.04	53.90	27.86	5000.0	1000.000	346.5	H	301.0	-9.5

Figure 8.3.14: Radiated high band edge, FCC restrictive frequency bands from 2483.5 to 2500 MHz.

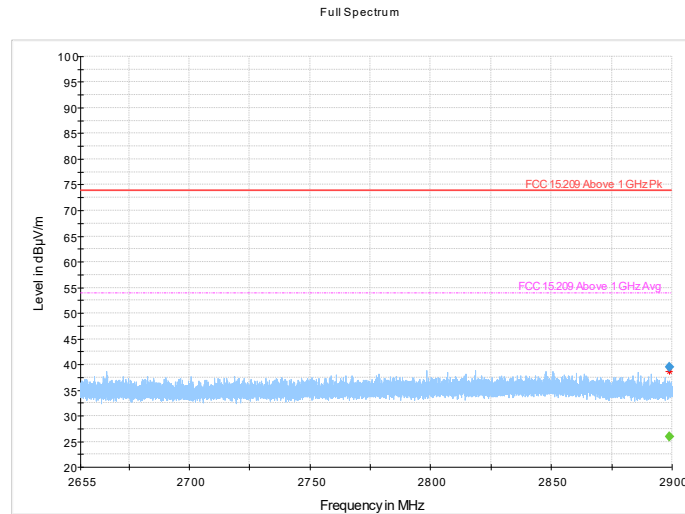


Figure 8.3.20: Radiated high band edge, IC restrictive frequency bands from 2655 to 2900 MHz.

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)
2899.056867	39.44	---	73.90	34.46	5000.0	1000.000	346.7	H	274.0	-8.3
2899.056867	---	25.91	53.90	27.99	5000.0	1000.000	346.7	H	274.0	-8.3

Figure 8.3.15: Radiated high band edge, IC restrictive frequency bands from 2655 to 2900 MHz.

Note: No considerable EUT emissions were observed

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	January 28, 2019	Temperature	22 °C
Test engineer	Martha Espinoza	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	30 %

8.4.3 Observations, settings and special notes

100kHz RBW

8.4.4 Test data

Table 8.4-1: Power Spectrum Density

Modulation	Frequency, MHz	Conducted PSD@50kHz, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		Measured	Limit					
GFSK	2402	-0.16	8	8.16	-5.51	-5.67	14	19.67
	2440	-0.46	8	8.46	-5.51	-5.97	14	19.97
	2480	-0.62	8	8.62	-5.51	-6.13	14	20.13

8.4.1 Test data, continued

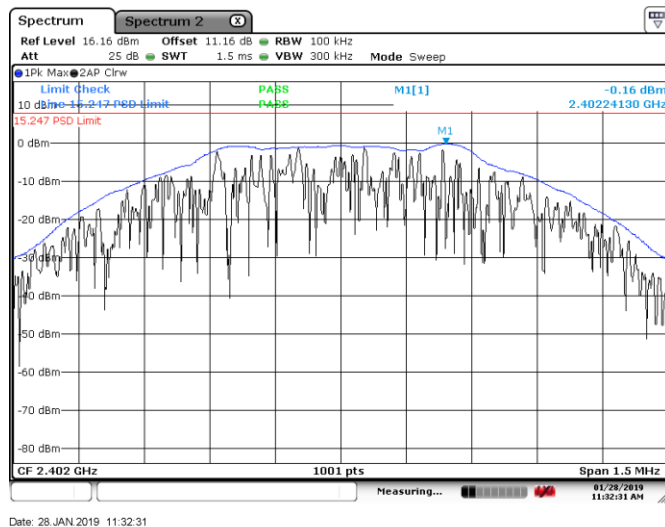


Figure 8.4-1: PSD, Low CH

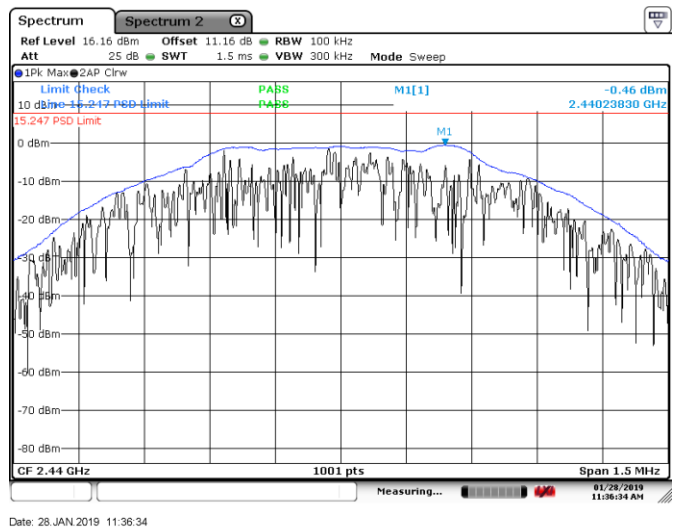


Figure 8.4-2: PSD, Mid CH

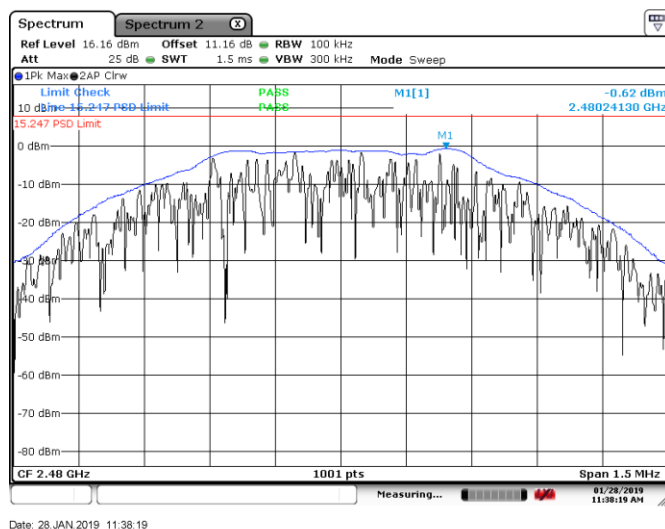
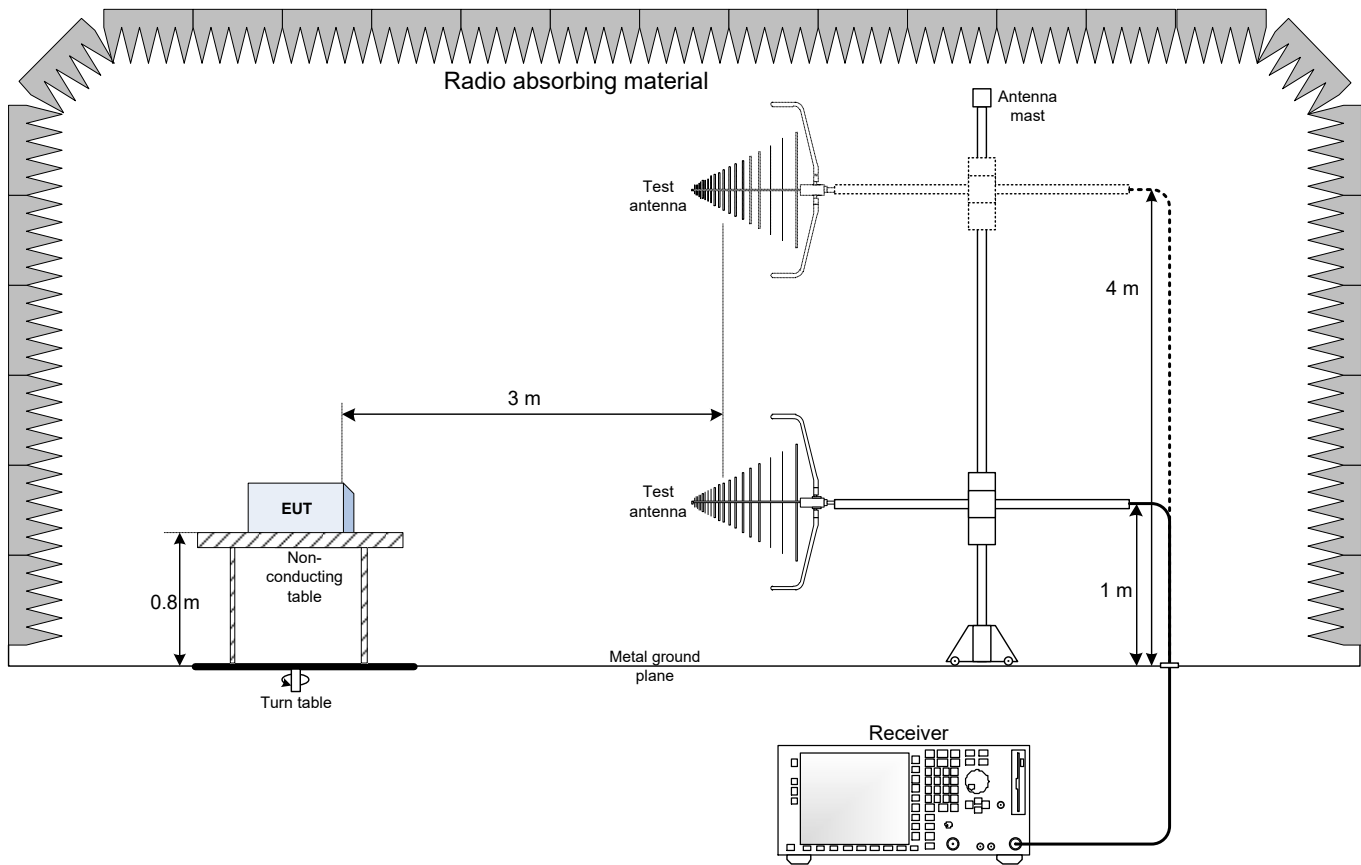


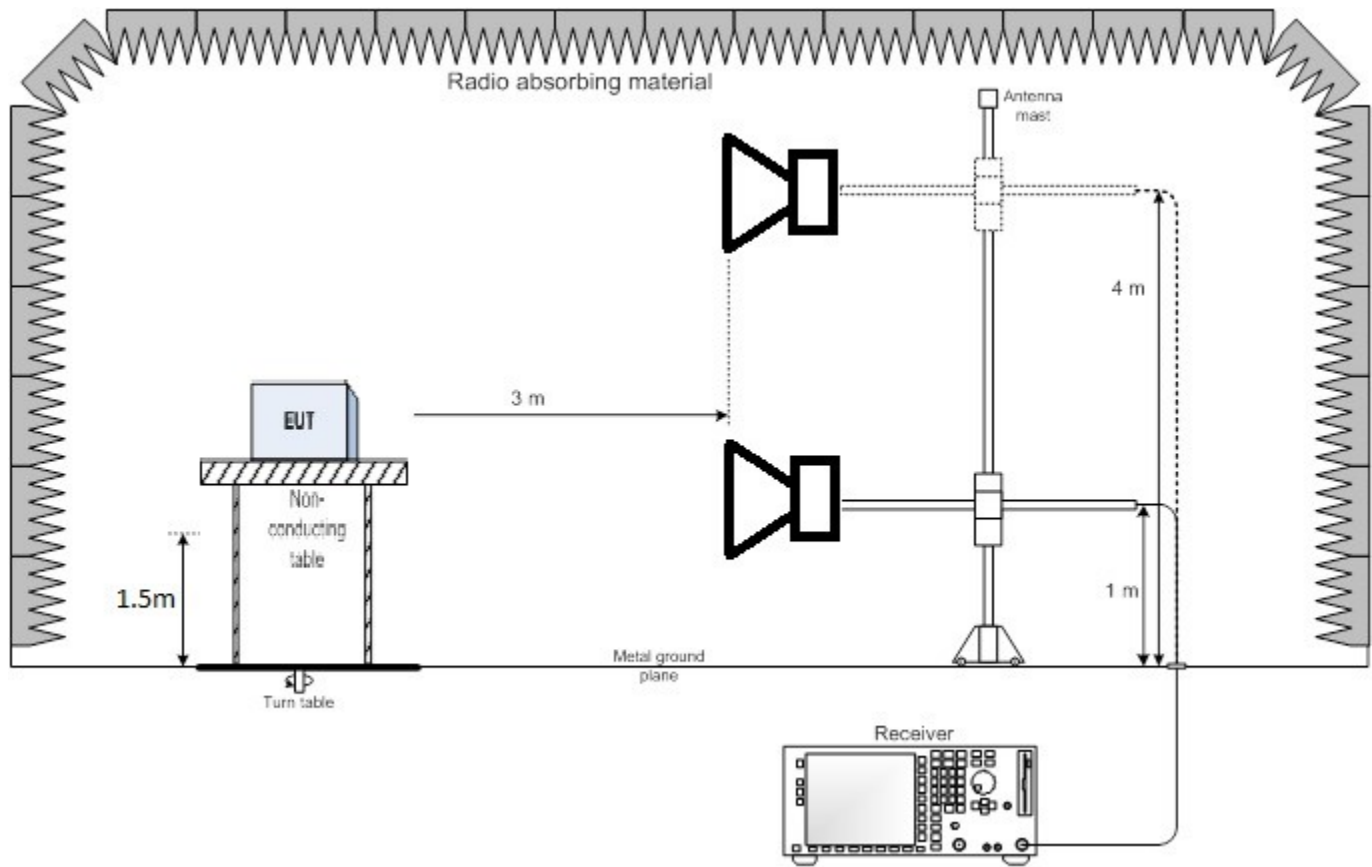
Figure 8.4-3: PSD, High CH

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up – Below 1GHz



9.2 Radiated emissions set-up – Above 1GHz



Thank you for choosing

