Test report for

47 CFR Part 15 Subpart C

RSS-247, RSS-Gen

The RvA is signatory to ILAC - MRA

Product name	: BLESTM32VE
Applicant	: Victron Energy
FCC ID	: 2A2XGBLESTM32VE
IC	: 27461-BLESTM32VE

Test report No. : P000301224 004 Ver 3.0

Laboratory information

Accreditation

Kiwa Nederland B.V. complies with the accreditation criteria for test laboratories as laid down in ISO/IEC 17025:2017. The accreditation covers the quality system of the laboratory as well as the specific activities as described in the authorized annex bearing the accreditation number L248 and is granted by the Dutch Council For Accreditation (RvA: Raad voor Accreditatie).

Kiwa Nederland B.V. is designated by the FCC as an Accredited Test Firm for compliance testing of equipment subject to Certification under Parts 15 & 18. The Designation number is: NL0001.

Kiwa Nederland B.V. is a Wireless Device Testing laboratory recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements.
The Industry Canada company number for Kiwa Nederland B.V. is: 4173A. The CABID is NL0001.

Kiwa Nederland B.V. is a registered Conformity Assessment body (CAB) under the Japan-EC MRA (Agreement on Mutual Recognition between Japan and the European Community). The registration number is: 201.

Documentation

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at Kiwa Nederland B.V.

Testing Location

Test Site	Kiwa Nederland B.V.
Test Site location	Wilmersdorf 50 7327 AC Apeldoorn The Netherlands Tel. +31 88998 3393
Test Site FCC	NL0001
CABID	NL0001

Revision History

Version	Date	Remarks	By
v0.50	14-01-2025	First draft	TK
v1.00	07-02-2025	Initial release	TK
V2.00	25-02-2025	Adjustment of hardware release	TK
V3.00	30-04-2025	Updated value of RF power on page 41 from mW to W	TK

Table of Contents

Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.247(d) 15.225(d) 15.209 (a)	RSS-Gen 8.9	Radiated spurious emissions	3.1	Pass
15.205 (a)	RSS Gen 8.10	Spurious emissions in the restricted bands	3.1	Pass
15.247 (a)	RSS-247 5.2(a)	6 dB bandwidth	3.2	Pass
--	RSS-Gen 6.7	99% bandwidth	3.3	Pass
15.247 (b)	RSS-247 5.4 (d)	RF output power	3.4	Pass
15.247 (e)	RSS-247 5.2 (b)	Power spectral density	3.5	Pass
15.247 (d)	RSS-247 5.5	Band edge	3.6	Pass

Decision rule: Pass/Fail decisions are based on measurement results without taking into account measurement uncertainty.

1 General Description

1.1 Applicant

Client name:	Victron Energy B.V.
Address:	De Paal 35
Zip code:	1351 JG Almere
Country:	The Netherlands
Telephone:	+31 36-535 97 00
E-mail:	ngalanos@victronenergy.com

1.2 Manufacturer

Manufacturer name:	Victron Energy B.V.
Address:	De Paal 35
Zip code:	1351 JG Almere
Country:	The Netherlands
Telephone:	+31 36-535 97 00
E-mail:	ngalanos@victronenergy.com

1.3 Tested Equipment Under Test (EUT)

Product name:	BLESTM32VE
Brand name:	Victron Energy
FCC ID:	2A2XGBLESTM32VE
IC:	27461-BLESTM32VE
Product description:	VE Bluetooth module
Variant model(s):	--
Batch and/or serial No.	--
Software version:	v1
Hardware version:	SSC BLE B
Date of receipt:	05-08-2024
Tests started:	12-08-2024
Testing ended:	21-11-2024

1.3.1 Auxiliary items

AUX1

Product name:	Dekra DMM
Product type:	Power supply for EUT
Remarks:	Connects to EUT's auxiliary port

AUX2

Product name:	Notebook
Product type:	Laptop
Remarks:	Connects to EUT's auxiliary micro-USB port, property test lab

1.4 Product specifications of Equipment under test

Tx Frequency:	BLE: 2402-2480MHz
Rx frequency:	BLE: 2402-2480MHz
Occupied channel width:	BLE: 1-2MHz
Antenna type:	BLE: Integrated PCB antenna
Antenna gain:	BLE: 0 dBi
Type of modulation:	BLE: GFSK
Emission designator	BLE: 2M03F1D, 1M01F1D

Disclaimer: The operating frequency bands are declared by the applicant

1.5 Environmental conditions

Normal test conditions:

Temperature (*) : +15°C to +25°C
Relative humidity(*) : 20 % to 75 %

1.6 Measurement standards

- ANSI C63.10:2013
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02

1.7 Applicable standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.207
- FCC Part 15 Subpart C §15.209
- FCC Part 15 Subpart C §15.247
- RSS-Gen Issue 5
- RSS-210 Issue 9
- RSS-247 Issue 3

1.8 Observation and remarks

The EUT is a radio module intended for integration in other devices. The worst case angle for radiated emissions was determined and used for the measurements presented in this report. The EUT does not have an AC mains input or dedicated AC/DC adapter, so no conducted emission measurements were performed. A sample with the integrated antenna removed was provided for conducted tests. The highest internal frequency is the 2480 MHz frequency for BLE. The module supports BLE 1Mbit and 2Mbit an assessment was performed to see which setting is worse for spurious emissions, this was 2Mbit. So, all spurious emissions measurements were performed using 2Mbit.

1.9 Modifications to the EUT (Equipment Under Test)

None

1.10 Conclusions

The sample of the product showed **NO NON-COMPLIANCES** to the specifications stated in paragraph 1.7 of this report.

The results of the test as stated in this report, are exclusively applicable to the product items as identified in this report. Kiwa Nederland B.V. accepts no responsibility for any properties of product items in this test report, which are not supported by the tests as specified in paragraph 1.7 *"Applicable standards".*

All tests are performed by:

Name : Tom Keltjens, BaSc and Paul van Wanrooij, BaSc

Review of test methods and report by:

Name : ing. Maaz. H. Khan

The above conclusions have been verified by the following signatory:

Date : 30-04-2025

Name : P. van Wanrooij

Function : Test Engineer

Signature :

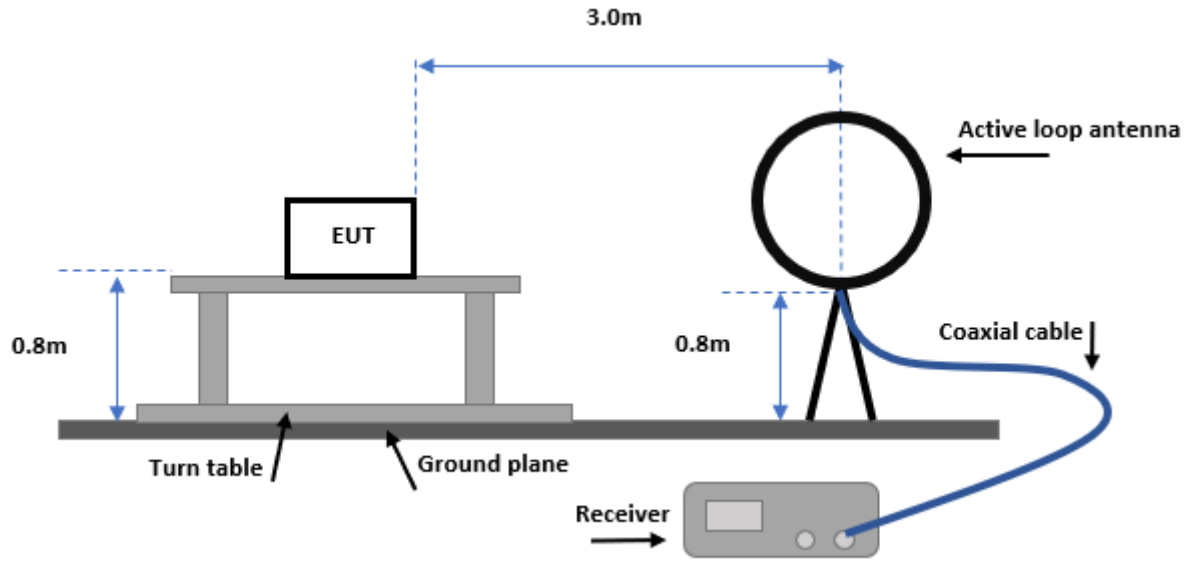
2 Test configuration of the Equipment Under Test

2.1 Test mode

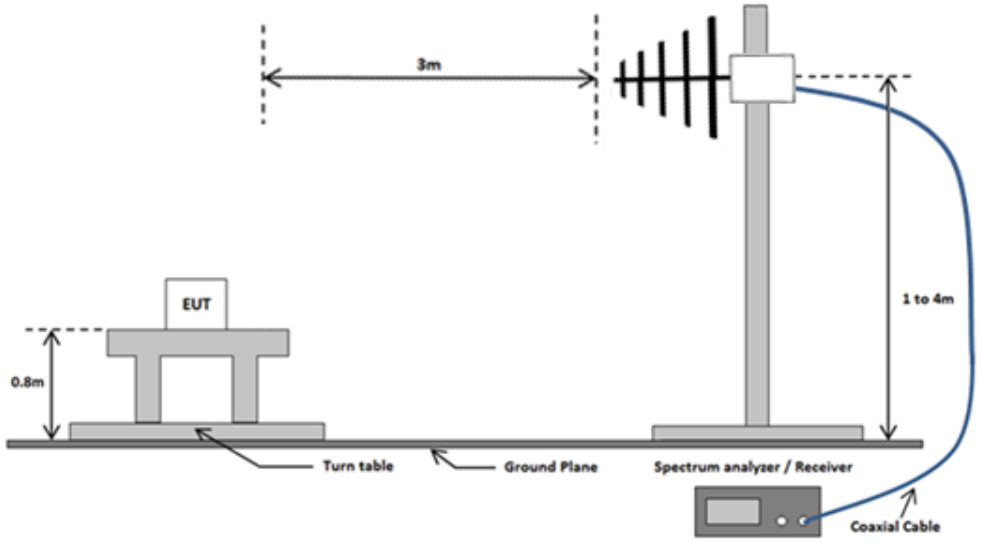
The manufacturer provided a software to set the radio in a specific channel and power level.

2.2 Test setups

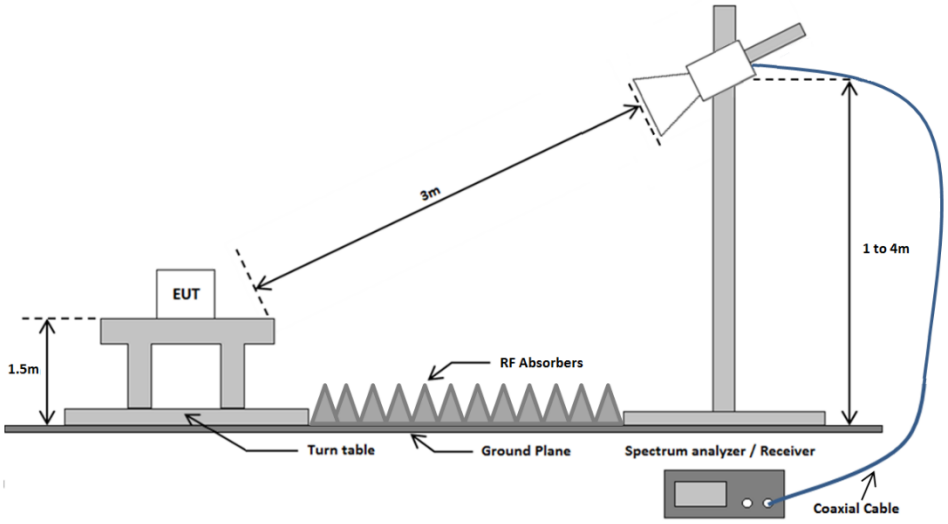
Radiated emissions test setup 9 kHz – 30 MHz



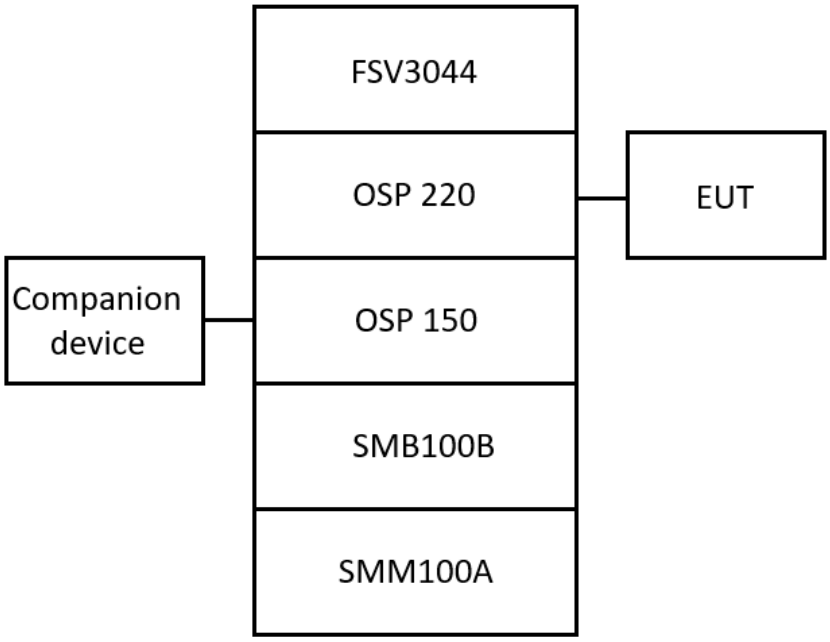
Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



Antenna port conducted tests



List of used cables					
Number	**Function**	**From**	**To**	**Length**	**Remarks**
1	3.3 Vdc power	AUX1	EUT	< 3m	In final product this power input will not be a power line.
2	Communication	AUX2	EUT	< 3m	Only used to set the EUT in a test mode, not part of the final product.

2.3 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Cal. Done date	Cal. due date	Used at Par.
EMI Receiver	Rohde & Schwarz	ESR7	114605	11-2024	11-2025	3.1
Spectrum Analyzer	Rohde & Schwarz	FSV3044	114923	10-2023	10-2025	3.1
3.0 GHz HPF	Wainwright	WHK3.0/18G-10EF	114682	12-2024	12-2025	3.1
Biconical antenna + 6dB attenuator	EMCO	3109	107818	06-2022	06-2025	3.1
Logperiodic antenna	EMCO	3147	114385	02-2021	02-2026	3.1
Horn antenna	EMCO	3115	114607	01-2021	01-2025	3.1
Horn antenna	FLANN-MICROWAVE	20240-25	114518	NA*	NA*	3.1
Preamplifier 1-18 GHz	µComp Nordic	MCNA-40-0010800-25-10P	114771	08-2024	08-2025	3.1
Preamplifier 18-40 GHz	Schwarzbeck	BBV-9721	115026	06-2024	06-2025	3.1
Semi-Anechoic Chamber	ETS Lindgren	SAR	114624	03-2023	03-2026	3.1
Test software	Raditeq	Radimation Version 2023.2.3	--	--	--	3.1

*Note: Standard gain horn antennas do not need calibration
NA= Not Applicable

Description	Manufacturer	Model	ID	Cal. Done date	Cal. due date	Used at Par.
Spectrum analyzer	Rohde & Schwarz	FSV3044	115043	11-2023	11-2025	3.2 – 3.6
Power meter and switch unit	Rohde & Schwarz	OSP220	115042	01-2024	01-2027	3.2 – 3.6
Switch unit	Rohde & Schwarz	OSP150	115041	11-2023	11-2026	3.2 – 3.6
Signal generator	Rohde & Schwarz	SMB100A	115040	11-2023	11-2025	3.2 – 3.6
Vector Signal Generator	Rohde & Schwarz	SMM100A	115039	11-2023	11-2025	3.2 – 3.6

2.4 Sample calculations

All formulas for data conversions and conversion factors are reported in chapter 4 of this test report.

3 Test results

3.1 Radiated spurious emissions

3.1.1 Limit

FCC 15.209(a)

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance(m)
0.009 – 0.490	2400/F(kHz)	20*{log[2400]-log[F(kHz)]}	300*
0.490 – 1.705	24000/F(kHz)	20*{log[24000]-log[F(kHz)]}	30*
1.705 – 30.0	30	29.5	30*
30 -88	100	40	3
88 - 216	150	43,5	3
216-960	200	46	3
Above 960	500	54	3

*Note: Measured values in the plots 9 kHz to 30 MHz corrected to 30m or 300m limit distance according to the method described in ANSI C63.10-2013, clause 6.4

RSS-GEN

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Magnetic field strength (H-Field) (µA/m)	Magnetic field strength (H-Field) (dBµA/m)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance(m)
0.009 – 0.490	6.37/F (kHz)	20*{log[6.37]-log[F(kHz)]}	N.A.	20*{log[6.37] - log[F(kHz)]} + 51.5	300*
0.490 – 1.705	63.7/F (kHz)	20*{log[63.7]-log[F(kHz)]}	N.A.	20*{log[63.7] - log[F(kHz)]} + 51.5	30*
1.705 - 30	0.08	-21.9	N.A.	29.6	30*
30 -88	N.A.	N.A.	100	40	3
88 - 216	N.A.	N.A.	150	43,5	3
216-960	N.A.	N.A.	200	46	3
Above 960	N.A.	N.A.	500	54	3

*Note: Measured values in the plots 9 kHz to 30 MHz corrected to 30m or 300m limit distance according to the method described in ANSI C63.10-2013, clause 6.4.

3.1.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.1.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.1.4 Test procedure

9 kHz – 30 MHz: According to ANSI C63.10-2013, section 6.4
30 MHz to 26.5 GHz: According to ANSI C63.10-2013, section 6.5 and 6.6

9 kHz to 30 MHz: IRN 441 – Method 10
30 MHz to 1 GHz: IRN 441 – Method 1
1 GHz to 18 GHz: IRN 441– Method 2
18 to 26 GHz: IRN 441– Method 3

In case of handheld and/or body-worn equipment, the EUT's orientation (X, Y, Z) was varied in order to ensure that maximum emission amplitudes were attained. In all other cases the associated cabling and the EUT orientation was varied for maximum emissions.

The spectrum was examined from 0.009 MHz to 10 times X GHz, not more than the 10th harmonic of the highest intentional generated frequency (X GHz). Final radiated emission measurements were made at 3m distance.

The 6 highest emission amplitudes relative to the appropriate limit were recorded in this report. Field strength values of radiated emissions at frequencies not listed in the tables are more than 20 dB below the applicable limit.

3.1.5 Measurement Uncertainty

Frequency range	Polarization	Uncertainty
9 kHz – 30 MHz	--	±1.6 dB
30 – 200 MHz	Horizontal	±4.5 dB
	Vertical	±5.4 dB
200 -1000 MHz	Horizontal	±3.6 dB
	Vertical	±4.6 dB
1 – 18 GHz	Horizontal	±5.7 dB
	Vertical	±5.7 dB
18 – 26.5 GHz	Horizontal	±4.9 dB
	Vertical	±4.9 dB

3.1.6 Test results

Low channel
Below 1GHz

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Limit	Status	Angle	Height	Polarization
1	327.604 MHz	31 dBµV/m	28 dBµV/m	46 dBµV/m	Pass	167 degrees	1 m	Vertical
2	537.864 MHz	33.9 dBµV/m	28.4 dBµV/m	46 dBµV/m	Pass	182 degrees	1 m	Vertical
3	394.283 MHz	33 dBµV/m	29.2 dBµV/m	46 dBµV/m	Pass	1 degrees	2.5 m	Vertical
4	393.289 MHz	33.8 dBµV/m	30.6 dBµV/m	46 dBµV/m	Pass	4 degrees	1 m	Horizontal

Above 1GHz

Peak Number	Frequency	Peak	Peak Limit	Average	Average Limit	Status	Angle	Height	Polarization
1	7.205 GHz	58.4 dBµV/m	74 dBµV/m	49.6 dBµV/m	54 dBµV/m	Pass	283 degrees	3.2 m	Horizontal
2	7.208 GHz	54 dBµV/m	74 dBµV/m	42.6 dBµV/m	54 dBµV/m	Pass	18 degrees	3.7 m	Vertical
3	16.818 GHz	61.3 dBµV/m	74 dBµV/m	49.8 dBµV/m	54 dBµV/m	Pass	45 degrees	2.7 m	Horizontal

Mid channel
Below 1GHz

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Limit	Status	Angle	Height	Polarization
1	152.349 MHz	32.8 dBµV/m	30 dBµV/m	43.5 dBµV/m	Pass	222 degrees	1 m	Vertical
1	511.918 MHz	33.8 dBµV/m	27.2 dBµV/m	46 dBµV/m	Pass	116 degrees	1 m	Vertical

Above 1GHz

Peak Number	Frequency	Peak	Peak Limit	Average	Average Limit	Status	Angle	Height	Polarization
1	7.319 GHz	57 dBµV/m	74 dBµV/m	47.9 dBµV/m	54 dBµV/m	Pass	297 degrees	2.7 m	Horizontal
2	7.322 GHz	54.7 dBµV/m	74 dBµV/m	44.3 dBµV/m	54 dBµV/m	Pass	47 degrees	2.7 m	Vertical

High channel
Below 1GHz

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Limit	Status	Angle	Height	Polarization
1	146.651 MHz	32.2 dBµV/m	28.9 dBµV/m	43.5 dBµV/m	Pass	130 degrees	1 m	Vertical
2	67.097 MHz	17.8 dBµV/m	5.7 dBµV/m	40 dBµV/m	Pass	32 degrees	4 m	Horizontal
1	331.217 MHz	29 dBµV/m	23.5 dBµV/m	46 dBµV/m	Pass	221 degrees	1 m	Vertical
2	352.801 MHz	29 dBµV/m	24.1 dBµV/m	46 dBµV/m	Pass	190 degrees	1.5 m	Horizontal
3	540.638 MHz	33.6 dBµV/m	26.7 dBµV/m	46 dBµV/m	Pass	41 degrees	1 m	Vertical

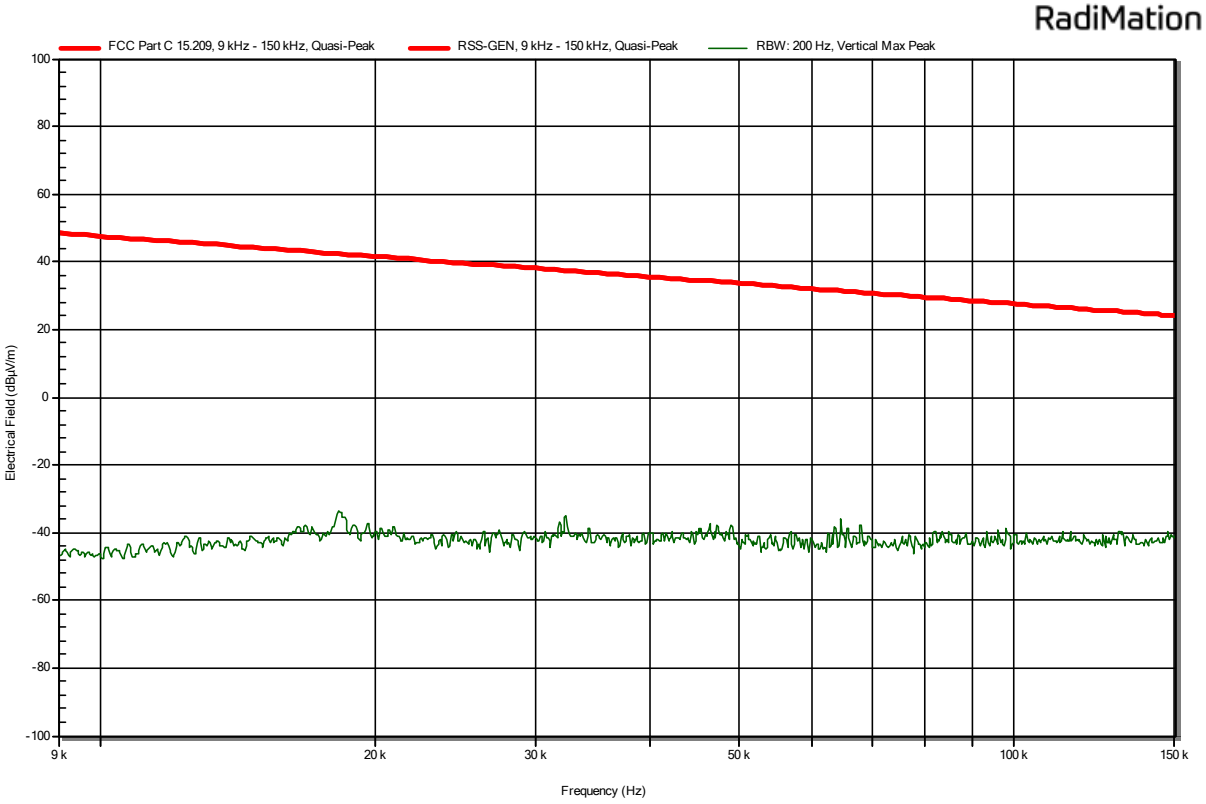
Above 1GHz

Peak Number	Frequency	Peak	Peak Limit	Average	Average Limit	Status	Angle	Height	Polarization
1	7.439 GHz	56.6 dBµV/m	74 dBµV/m	47.3 dBµV/m	54 dBµV/m	Pass	197 degrees	3.2 m	Horizontal

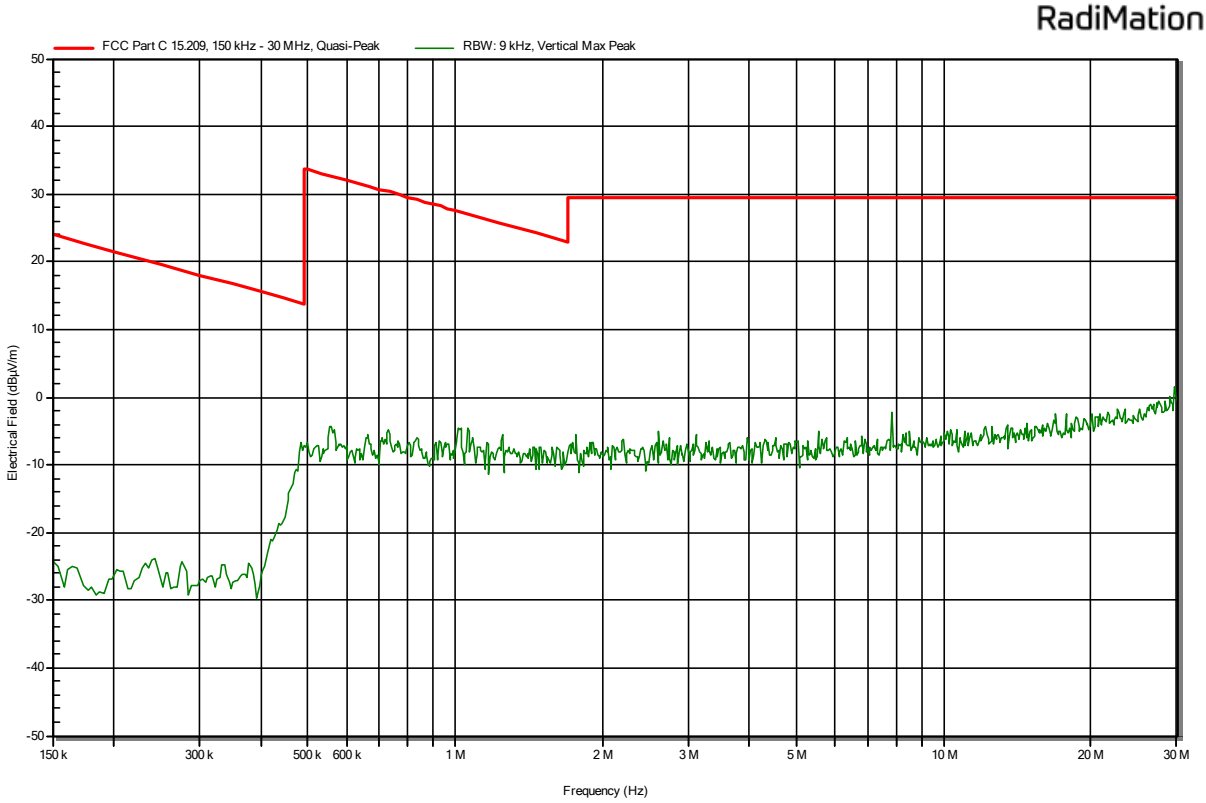
The results of the radiated emission tests are depicted in the table above. A selection of plots is provided on the next pages.

3.1.7 Plots of the Radiated Spurious Emissions Measurement

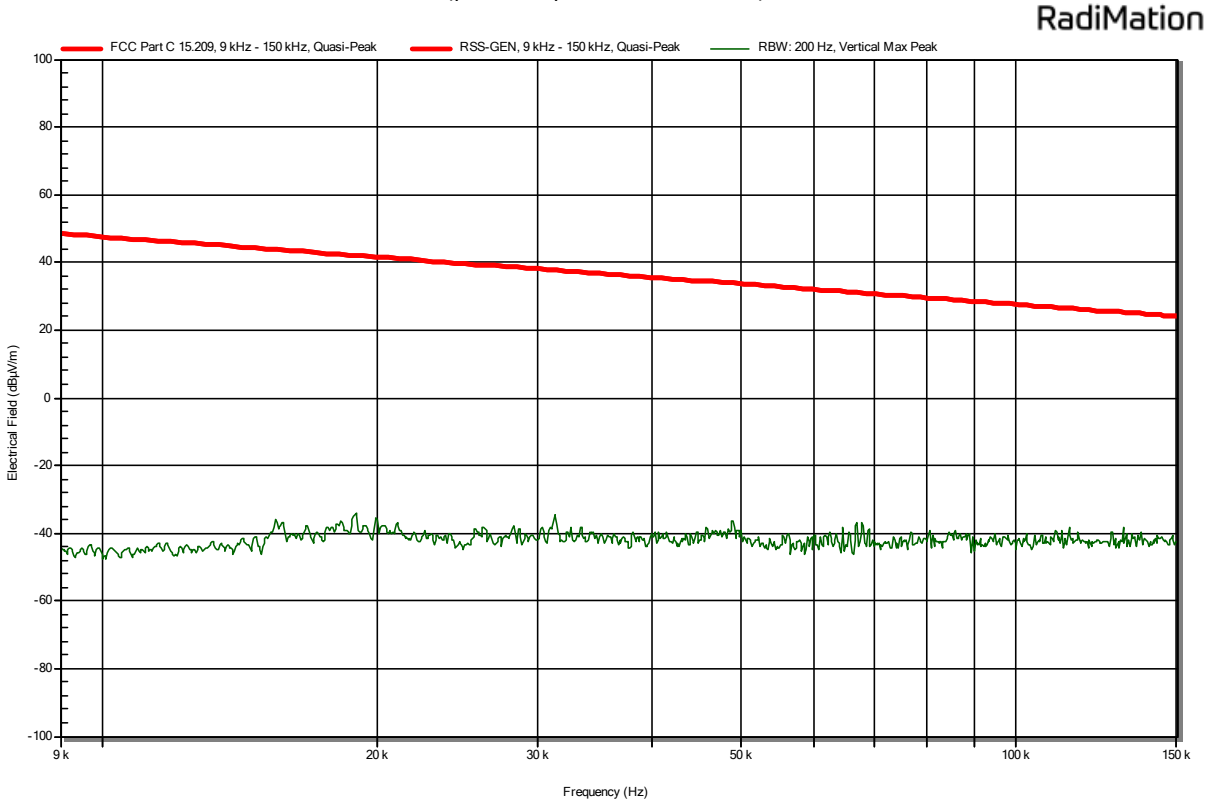
Plot 1a: radiated emissions of the EUT, Antenna perpendicular, in the range 9 – 150KHz
(pre-scan peak values shown)



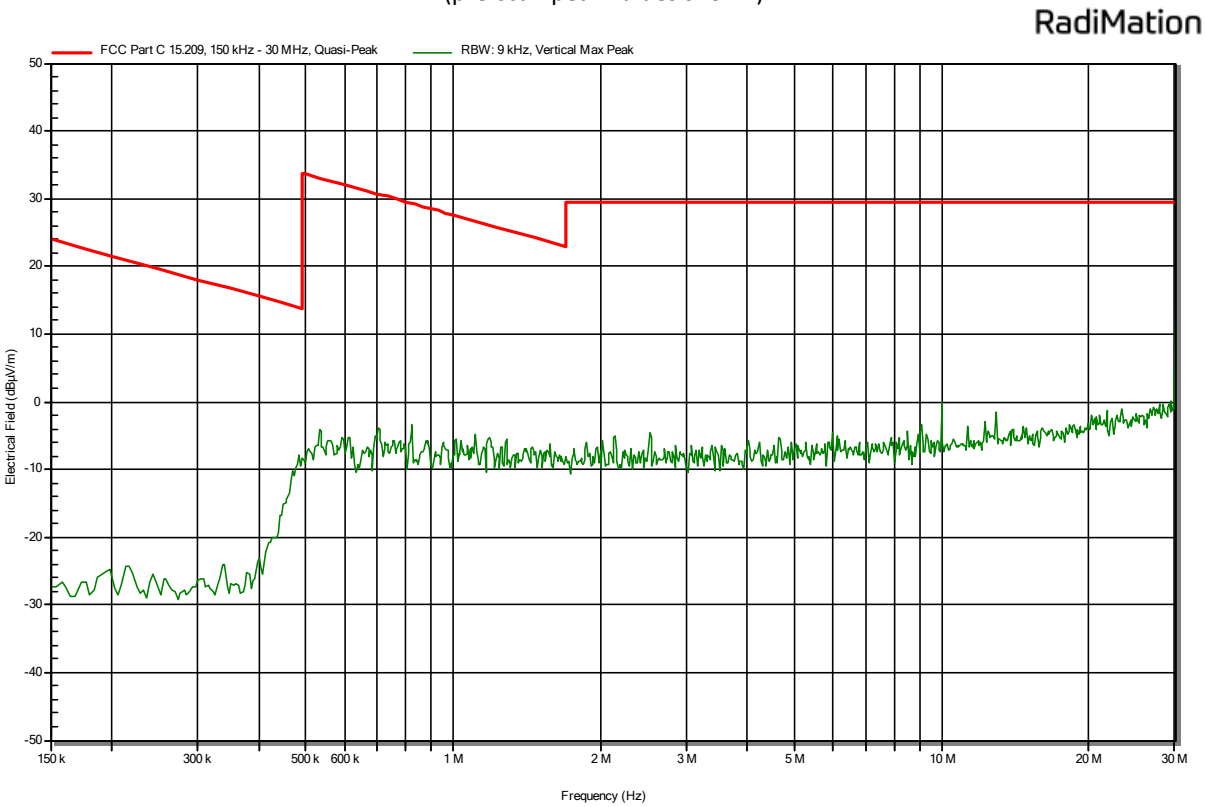
Plot 1b: radiated emissions of the EUT, Antenna parallel, in the range 9 – 150KHz
(pre-scan peak values shown)



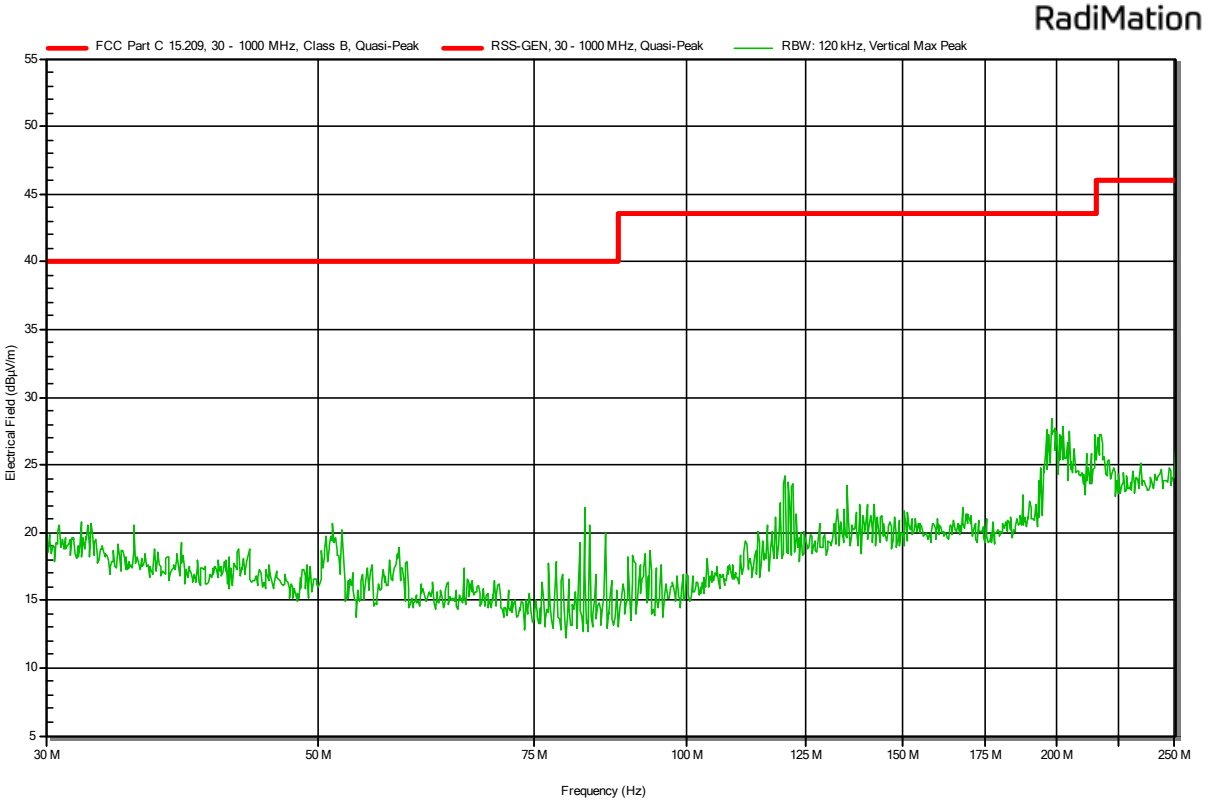
Plot 2a: radiated emissions of the EUT, Antenna perpendicular, in the range 150KHz-30 MHz
(pre-scan peak values shown)



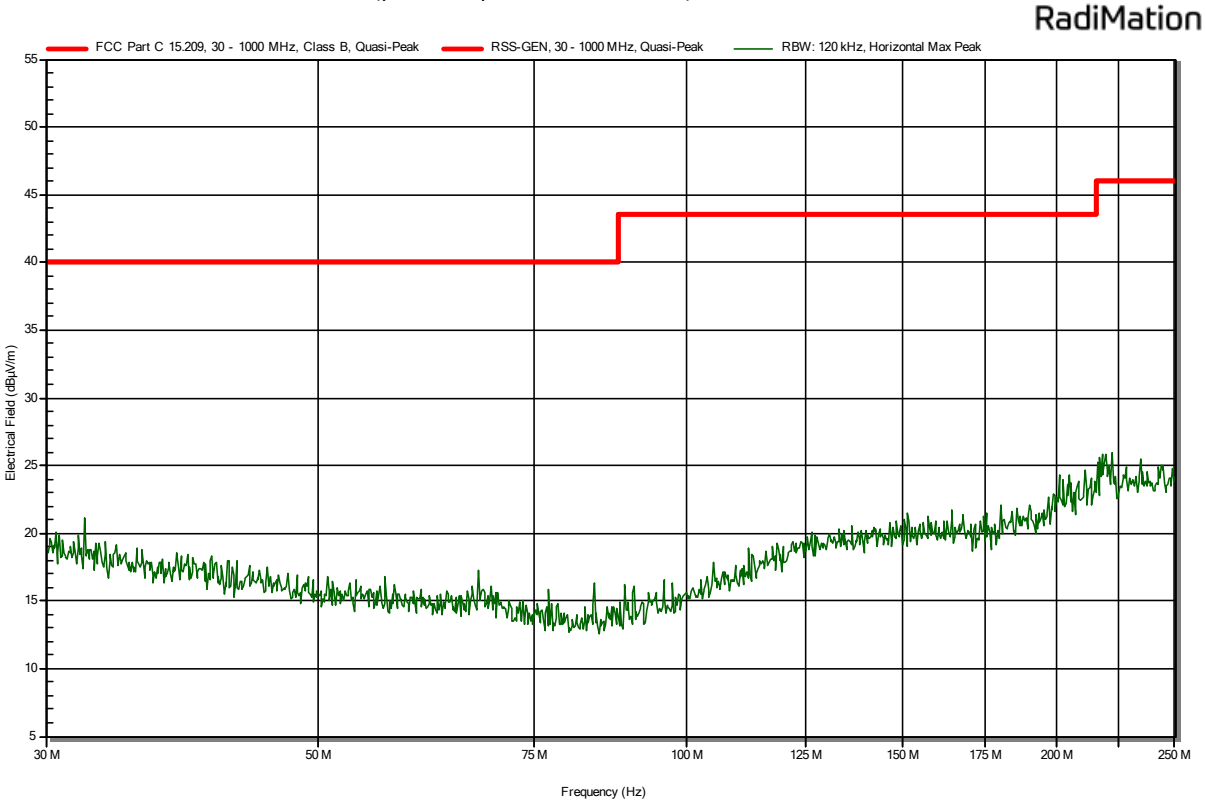
Plot 2b: radiated emissions of the EUT, Antenna parallel, in the range 150KHz-30 MHz
(pre-scan peak values shown)



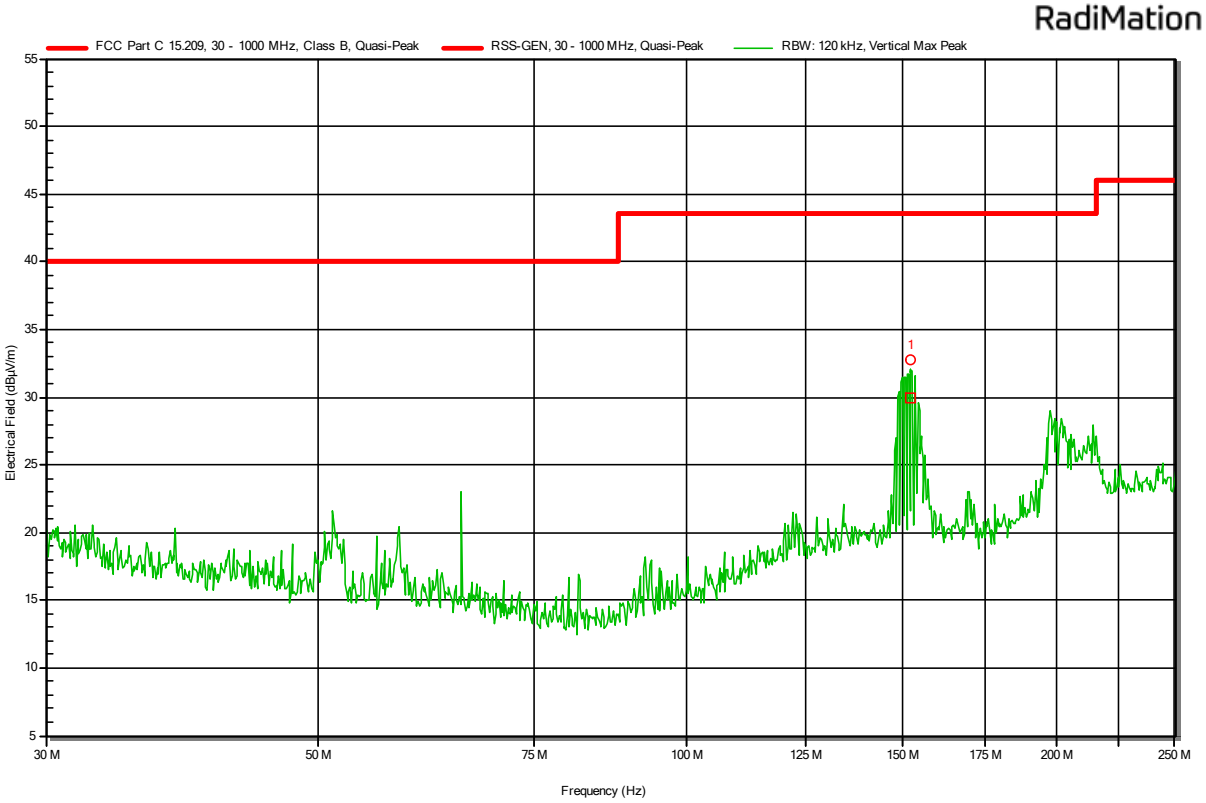
Plot 3a: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(pre-scan peak values shown) Low channel



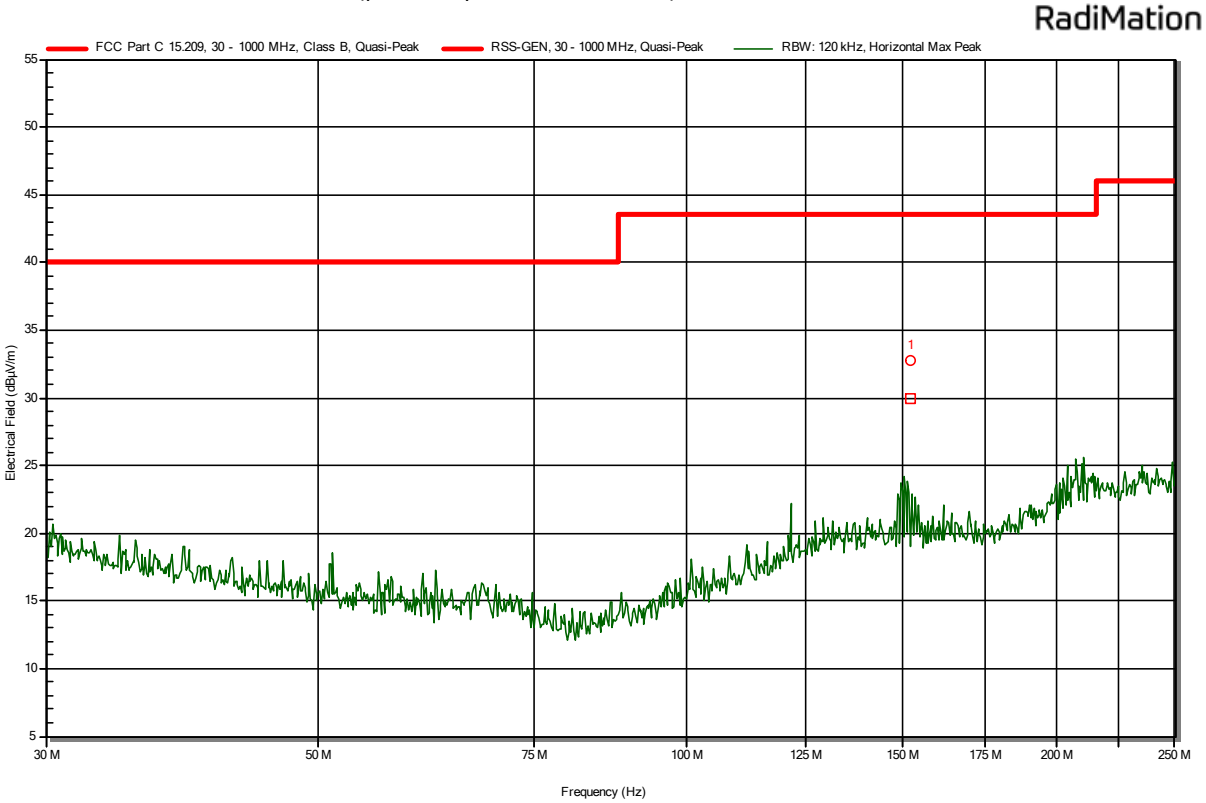
Plot 3b: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(pre-scan peak values shown) Low channel



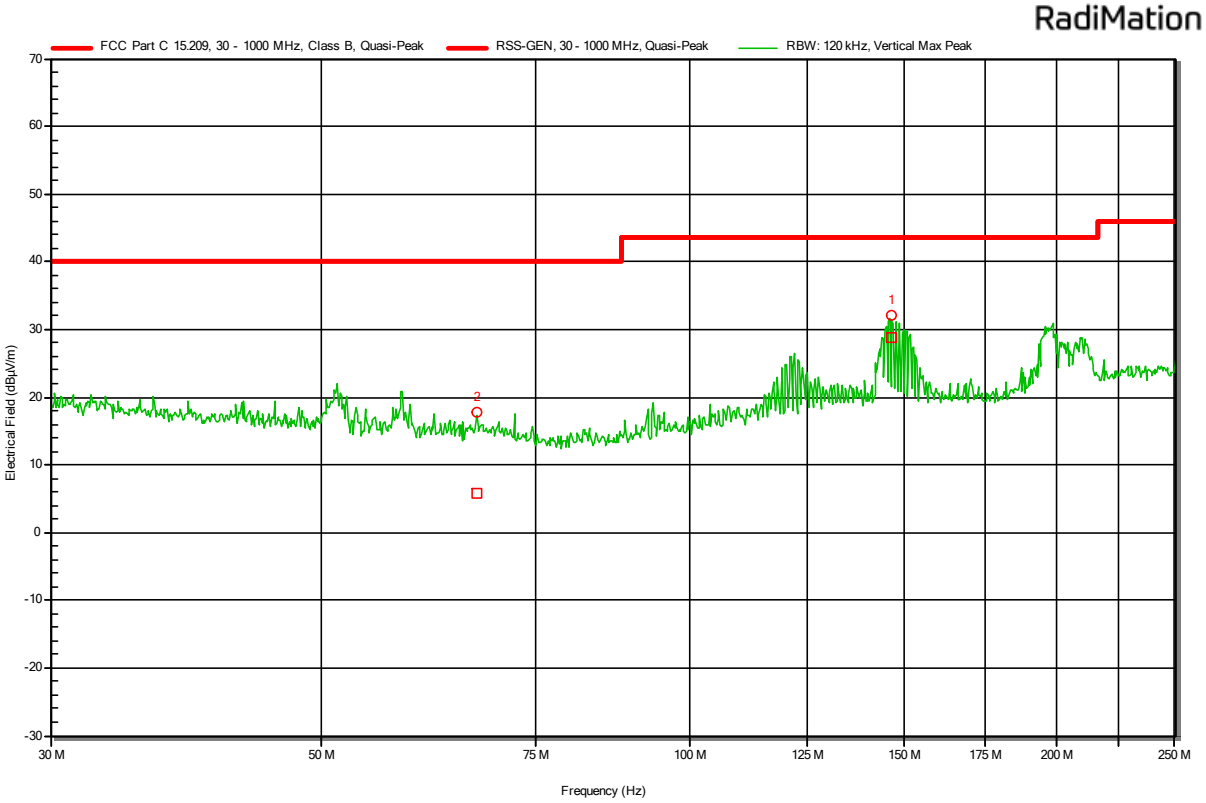
Plot 3c: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(pre-scan peak values shown) Middle channel



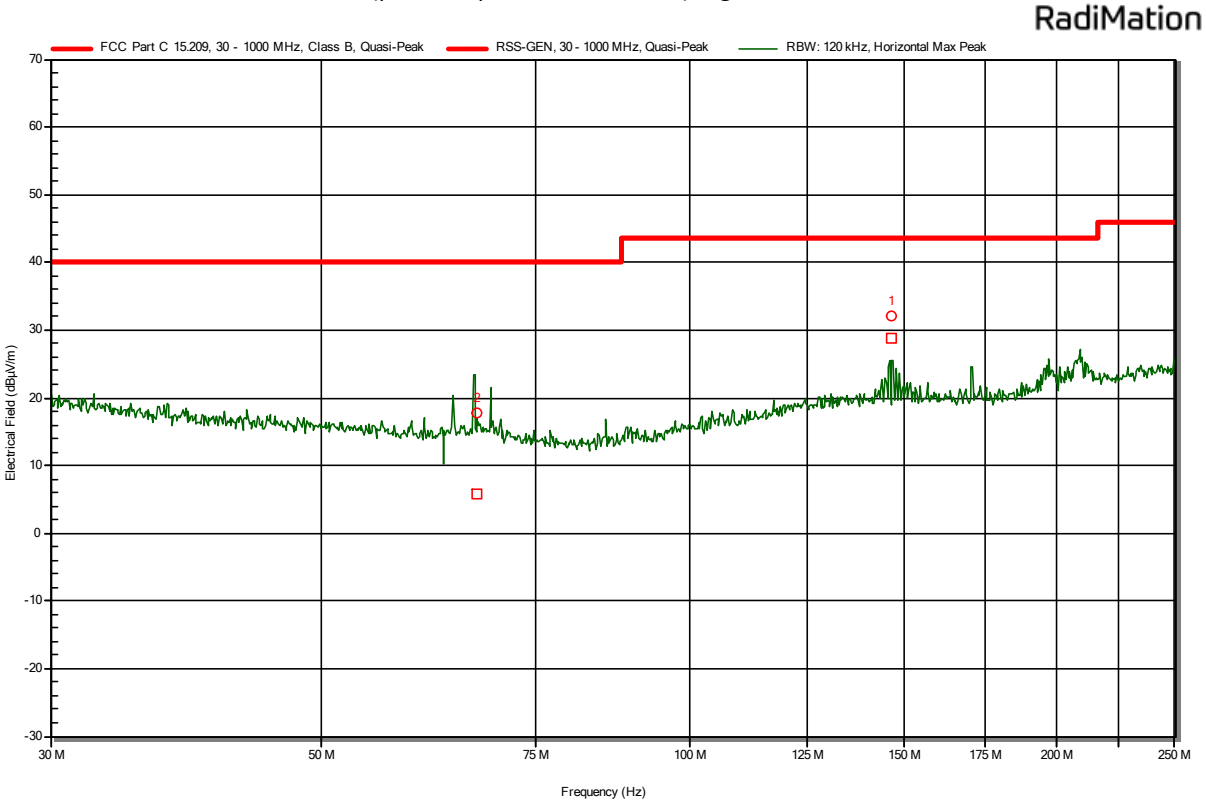
Plot 3d: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(pre-scan peak values shown) Middle channel



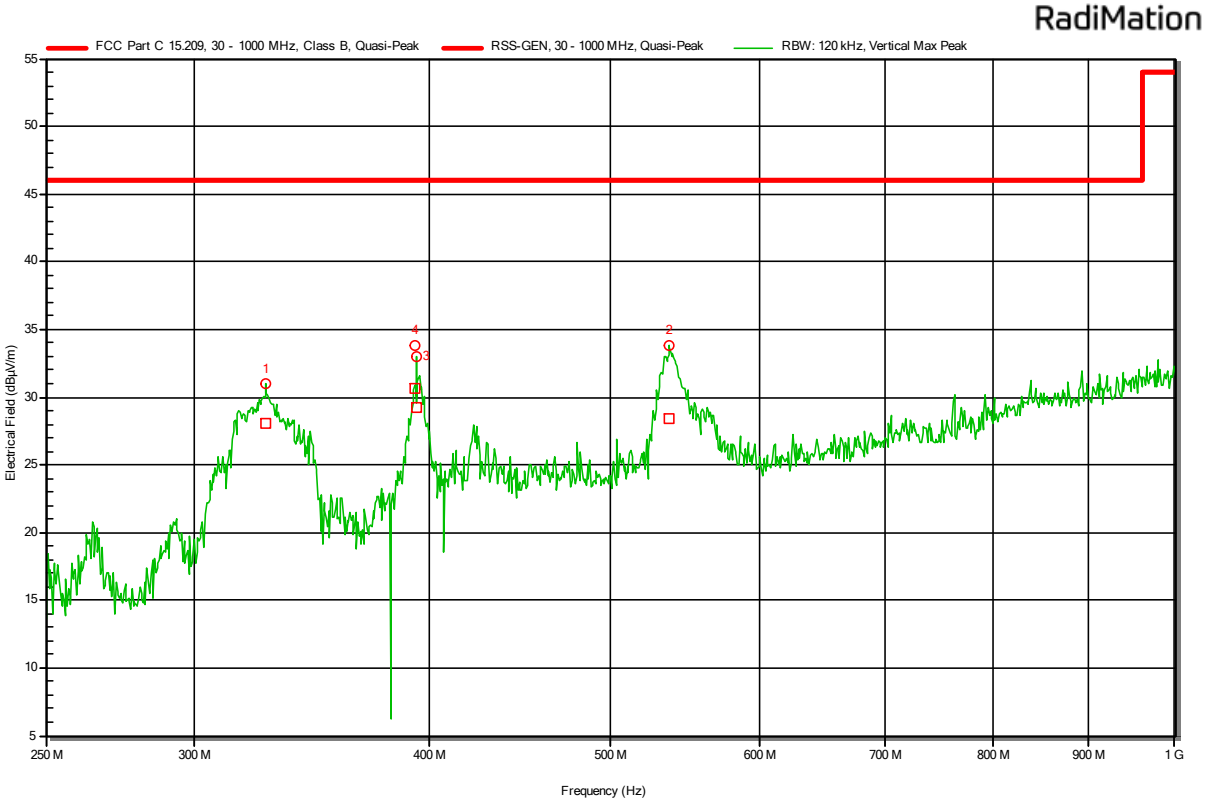
Plot 3e: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(pre-scan peak values shown) High channel



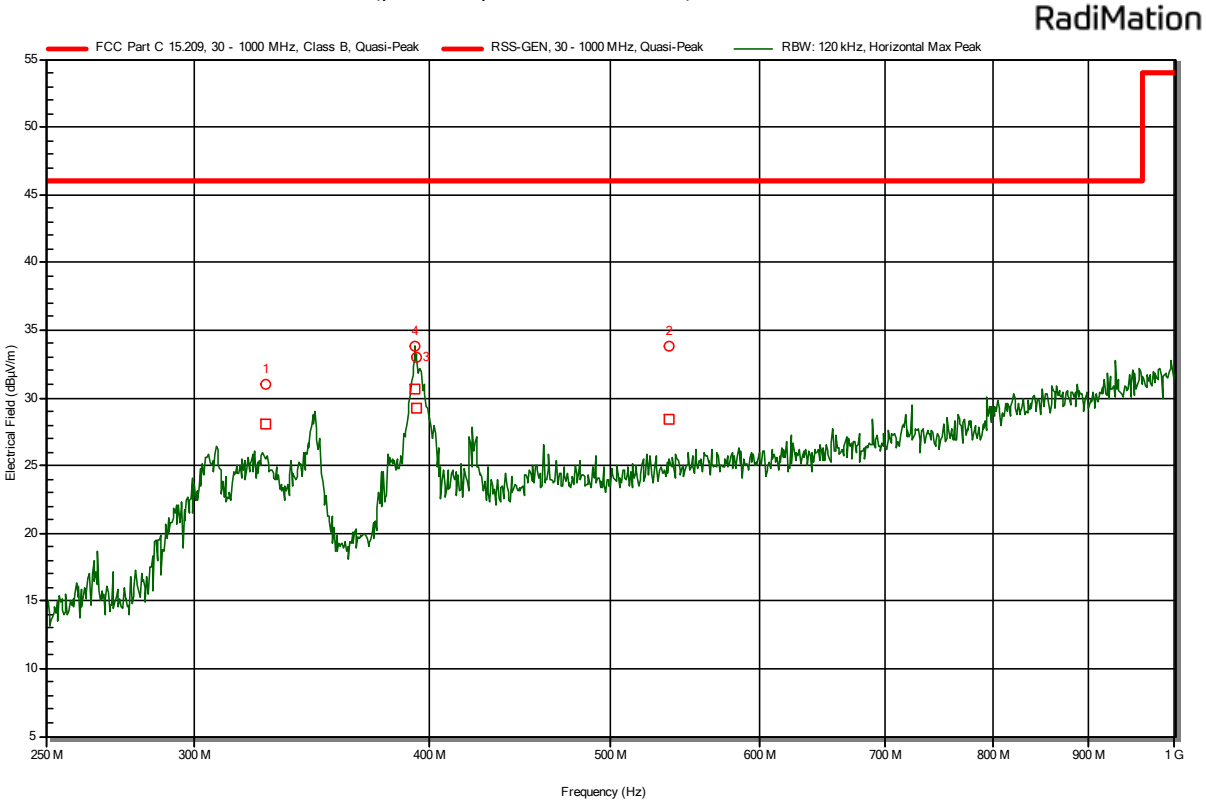
Plot 3f: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(pre-scan peak values shown) High channel



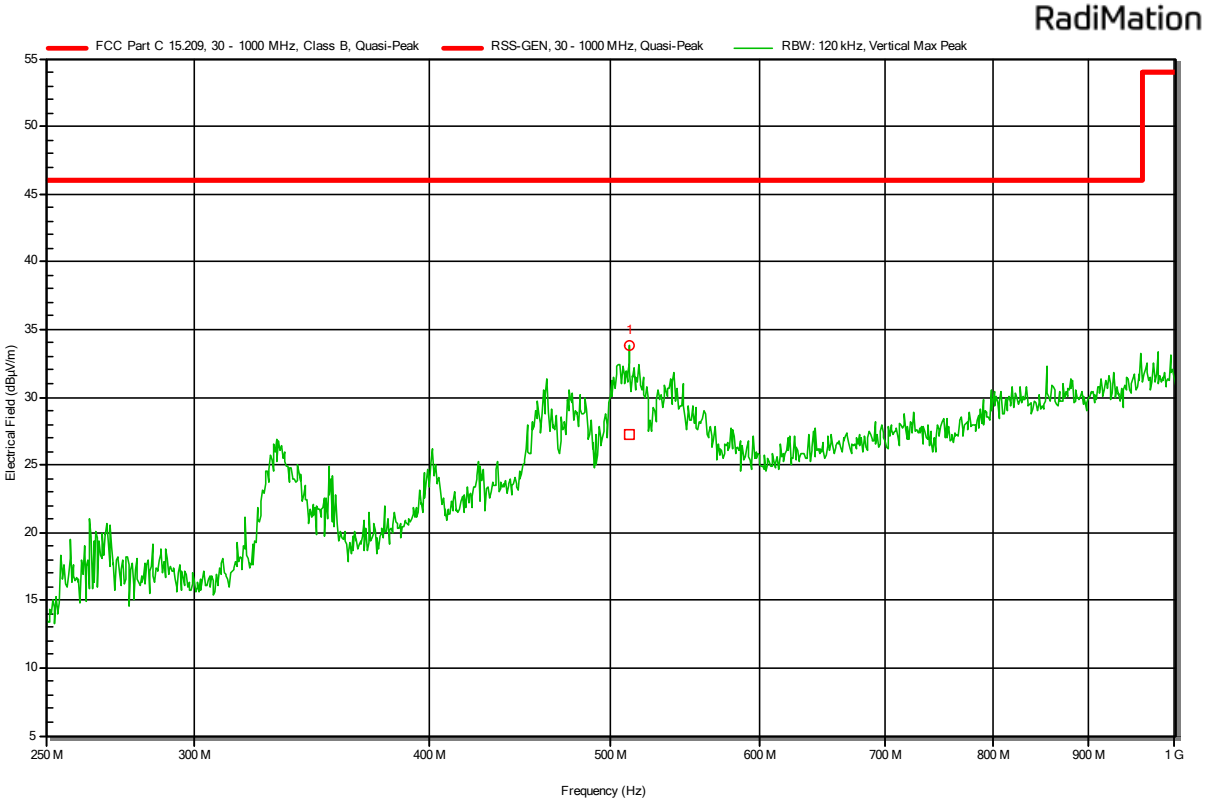
Plot 4a: radiated emissions of the EUT, Antenna vertical, in the range 250-1000 MHz
(pre-scan peak values shown) Low channel



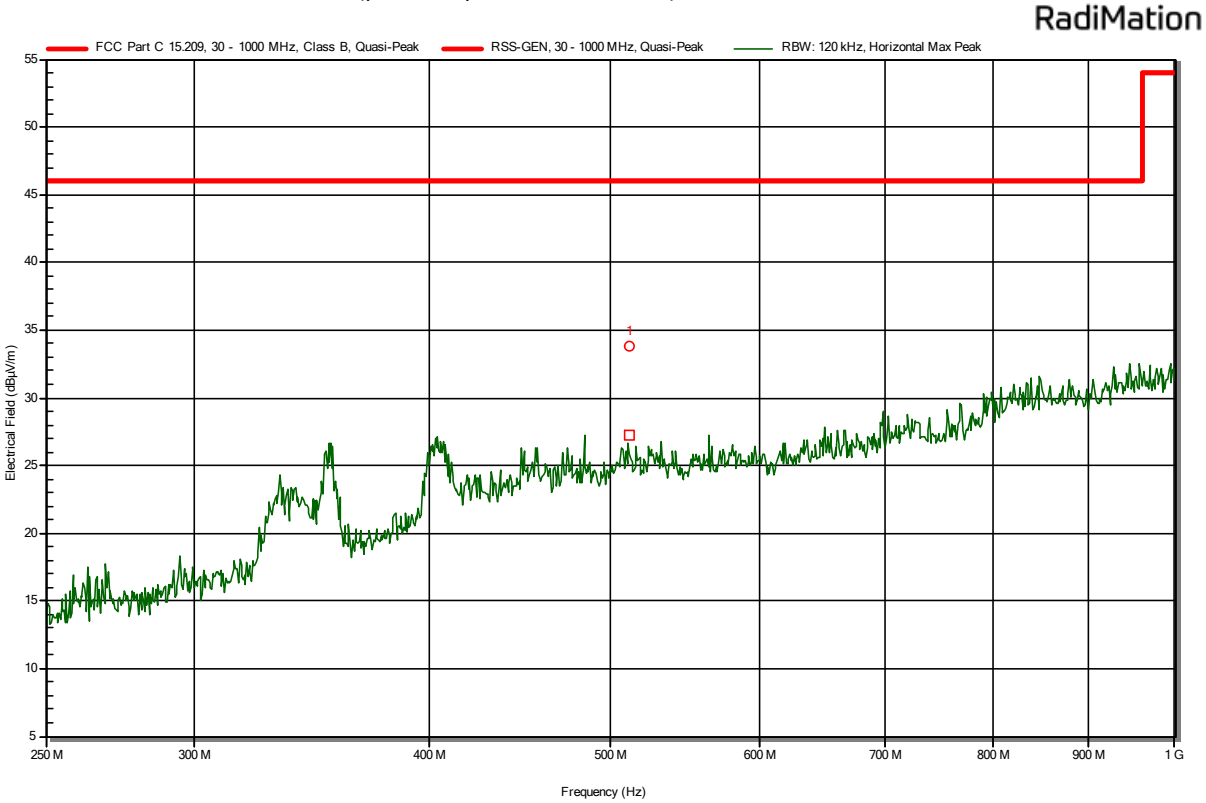
Plot 4b: radiated emissions of the EUT, Antenna horizontal, in the range 250-1000 MHz
(pre-scan peak values shown) Low channel



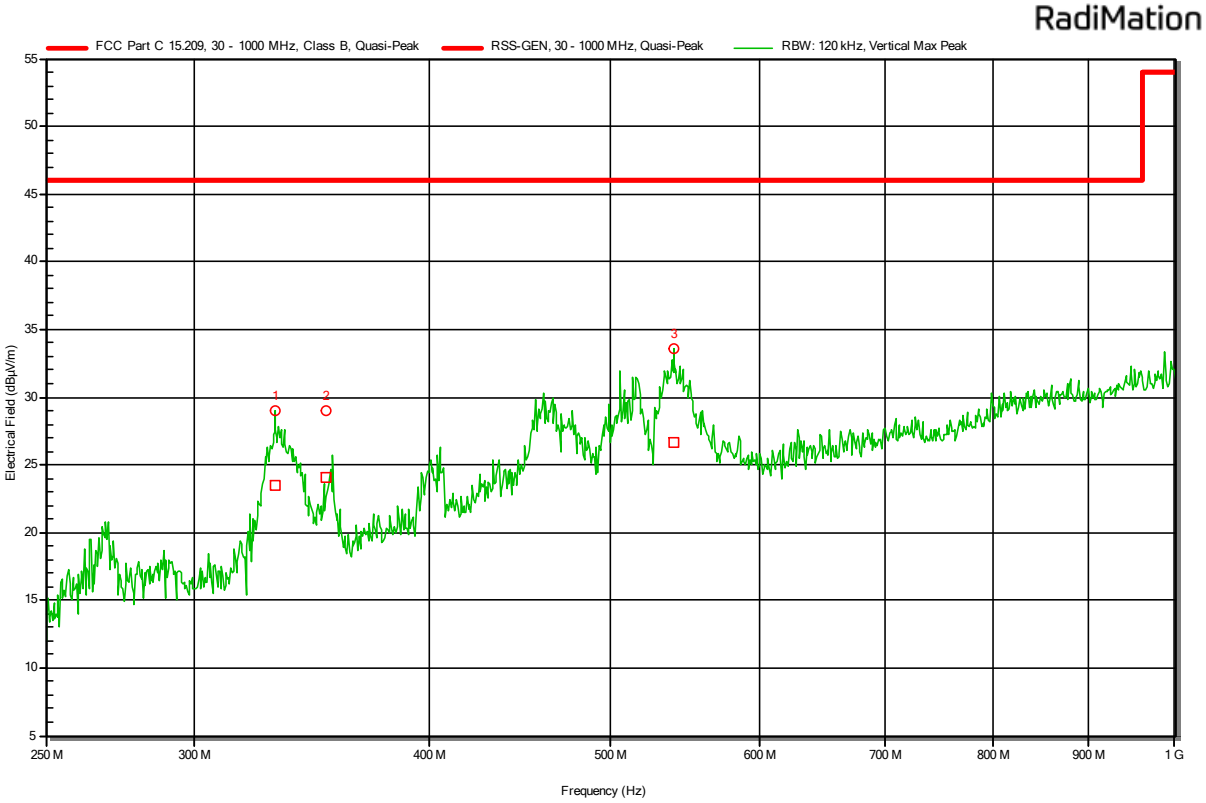
Plot 4c: radiated emissions of the EUT, Antenna vertical, in the range 250-1000 MHz
(pre-scan peak values shown) Middle channel



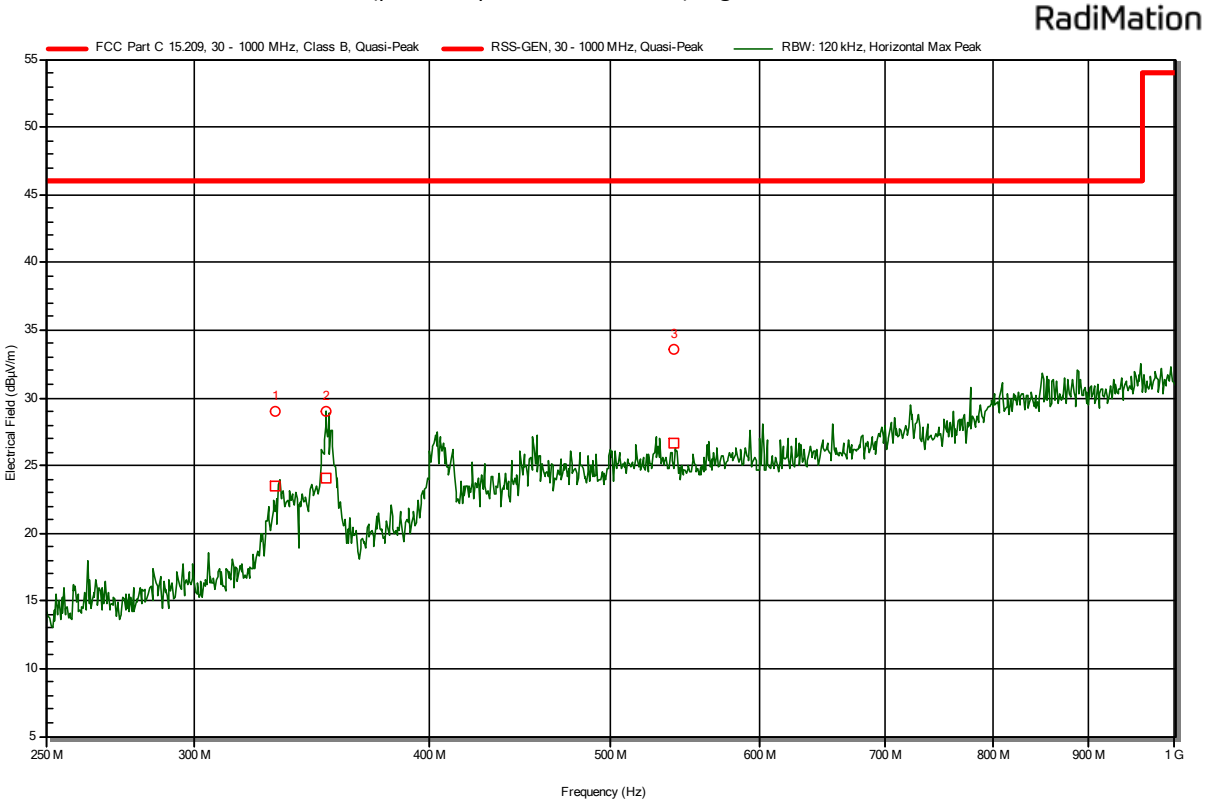
Plot 4d: radiated emissions of the EUT, Antenna horizontal, in the range 250-1000 MHz
(pre-scan peak values shown) Middle channel



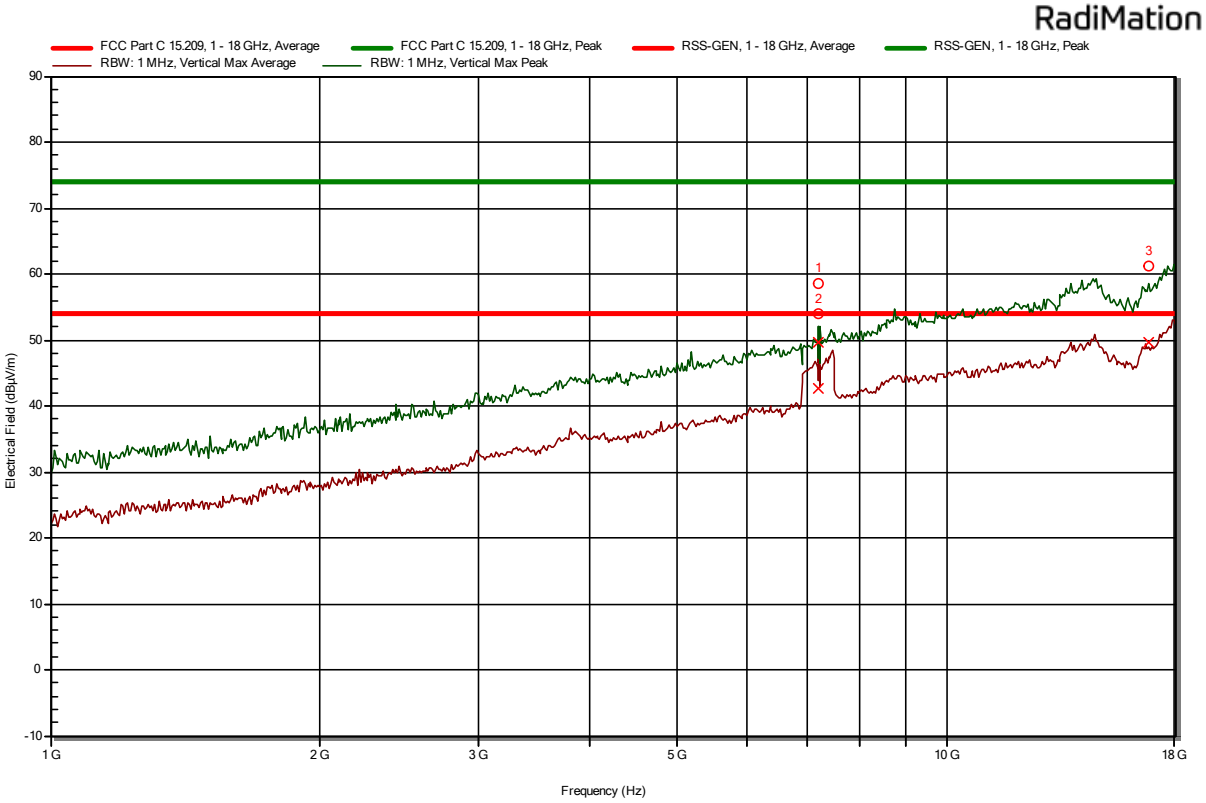
Plot 4e: radiated emissions of the EUT, Antenna vertical, in the range 250-1000 MHz
(pre-scan peak values shown) High channel



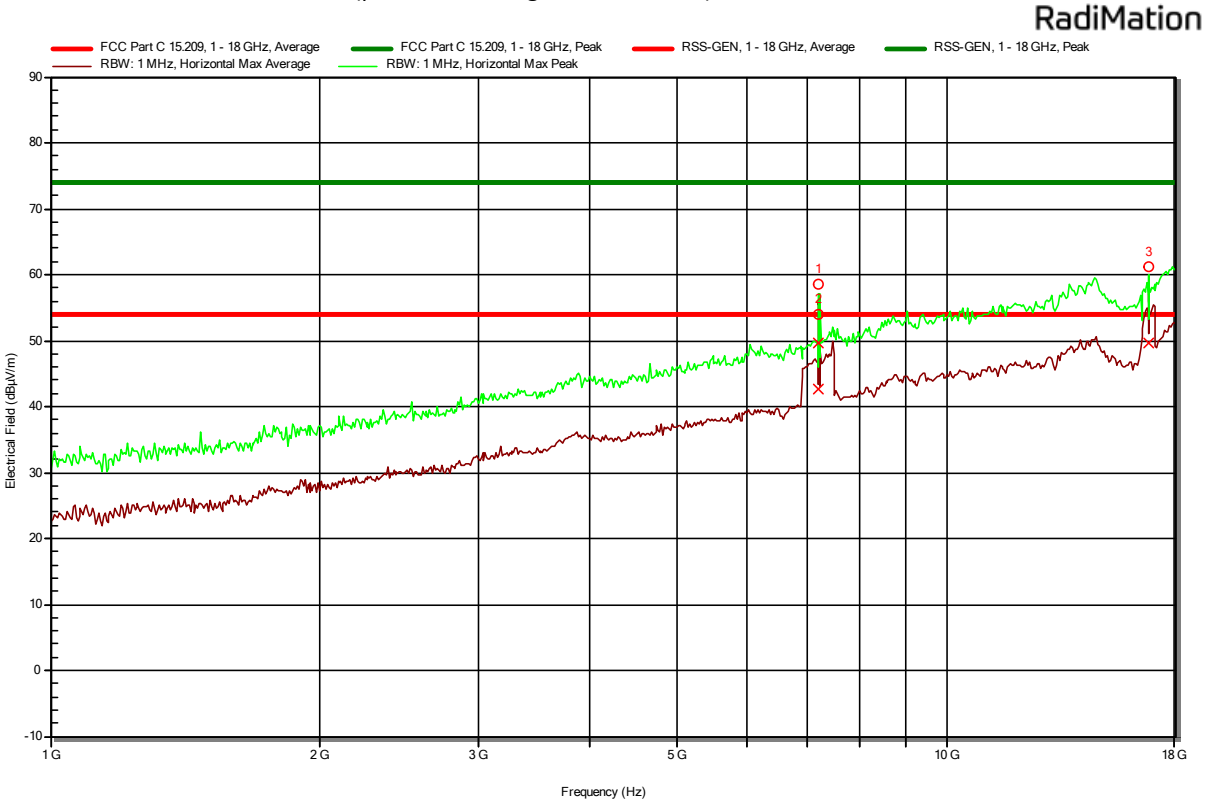
Plot 4f: radiated emissions of the EUT, Antenna horizontal, in the range 250-1000 MHz
(pre-scan peak values shown) High channel



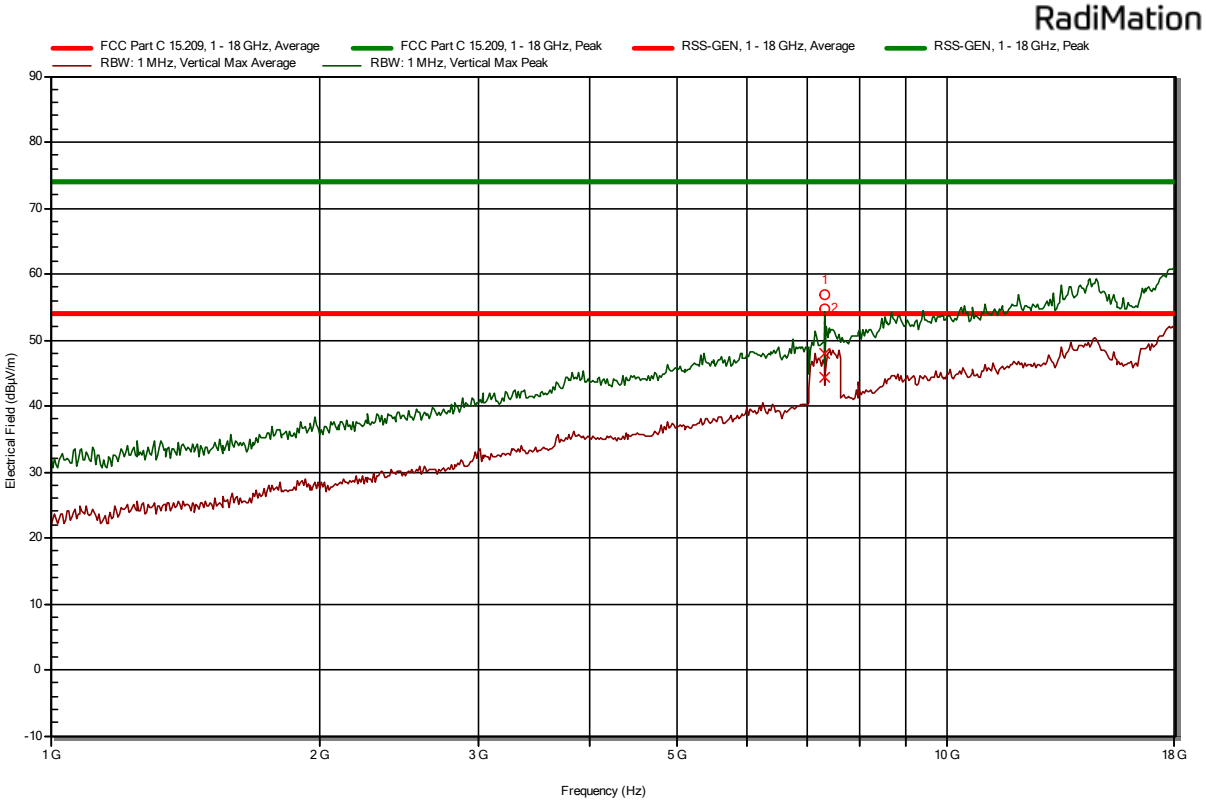
Plot 5a: radiated emissions of the EUT, Antenna vertical, in the range 1 – 18 GHz
(peak and average values shown) Low channel



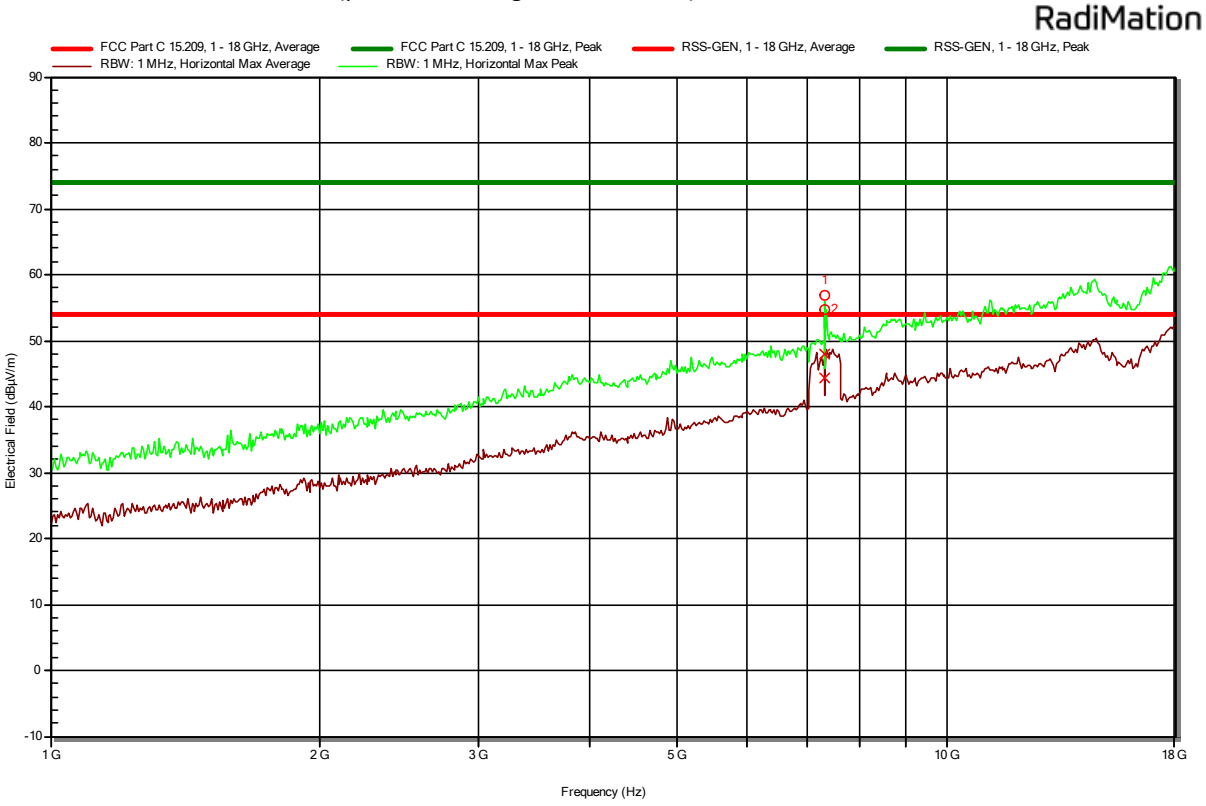
Plot 5b: radiated emissions of the EUT, Antenna horizontal, in the range 1 – 18 GHz
(peak and average values shown) Low channel



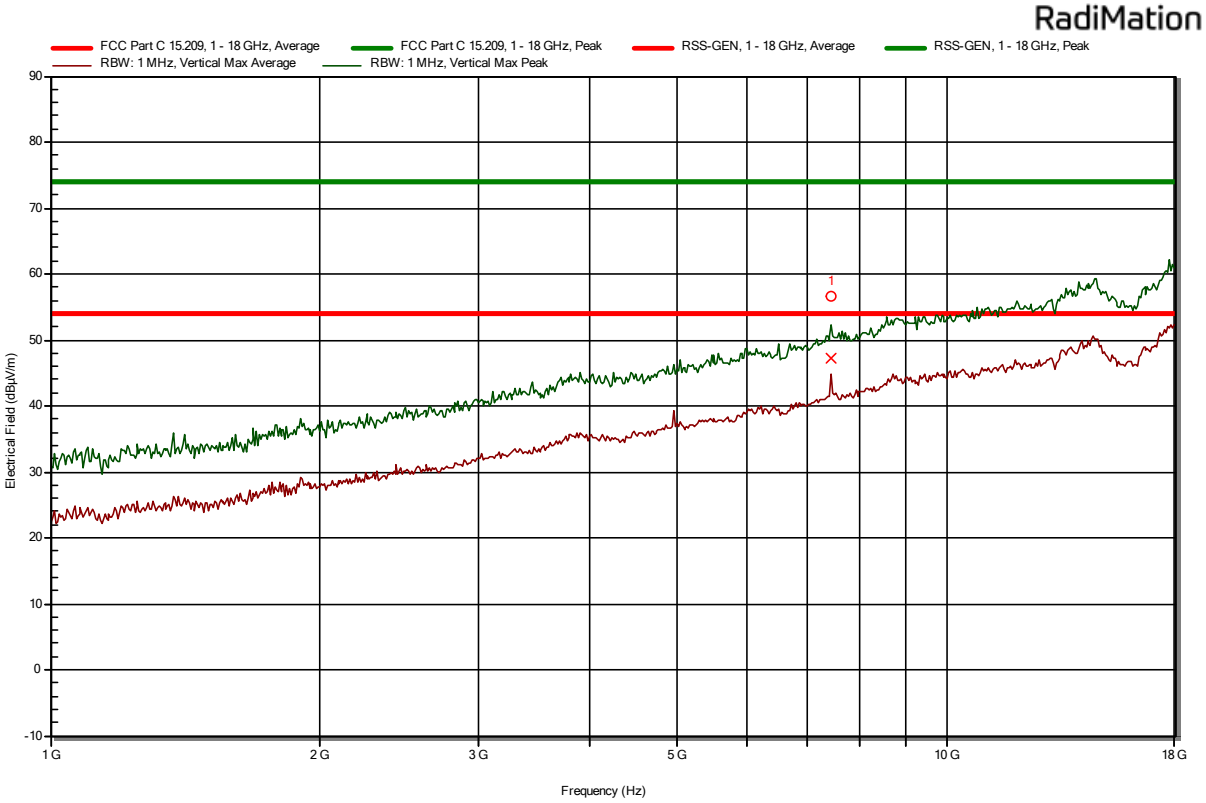
Plot 5c: radiated emissions of the EUT, Antenna vertical, in the range 1 – 18 GHz
(peak and average values shown) Middle channel



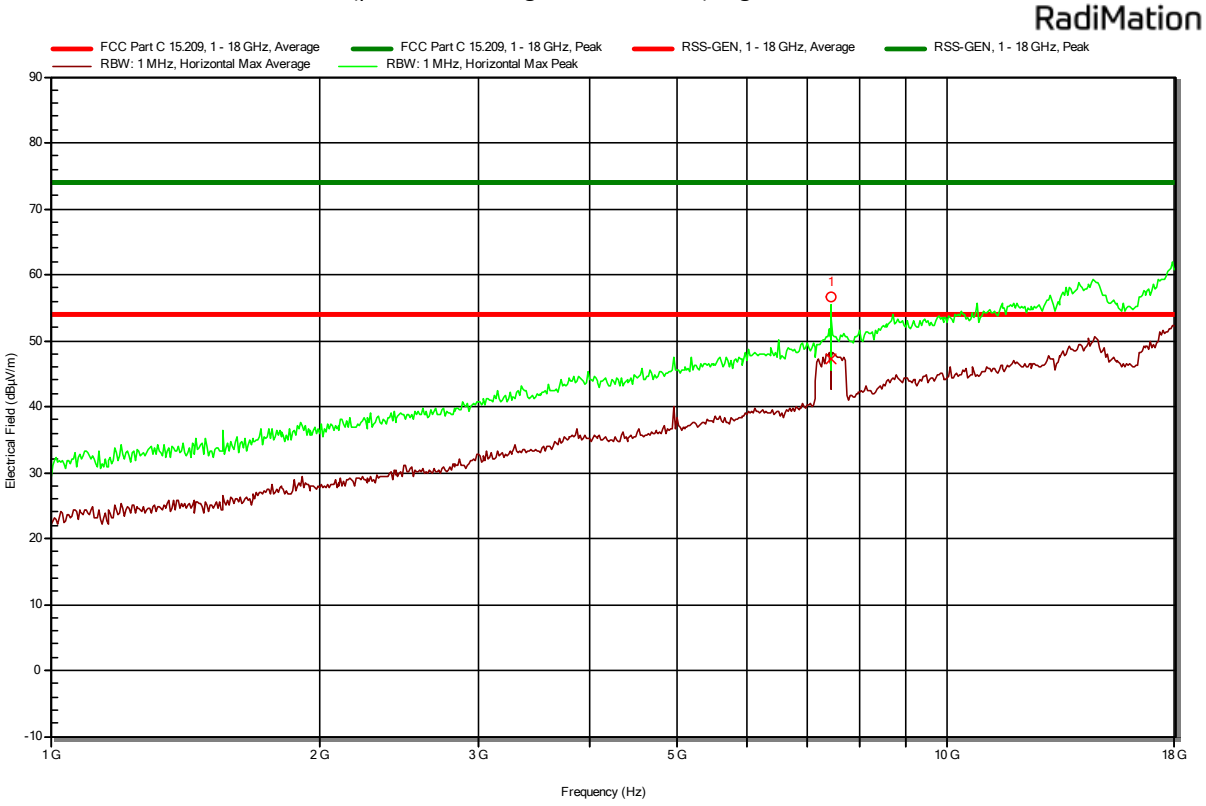
Plot 5d: radiated emissions of the EUT, Antenna horizontal, in the range 1 – 18 GHz
(peak and average values shown) Middle channel



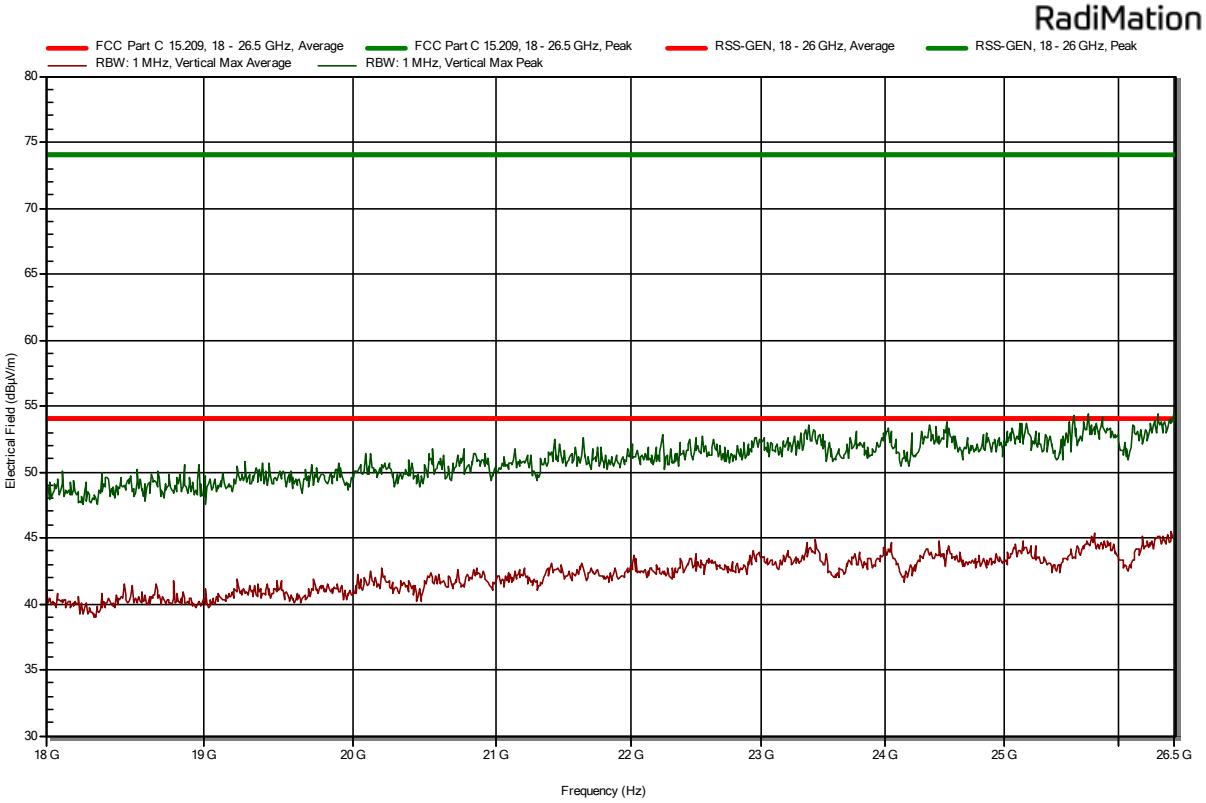
Plot 5e: radiated emissions of the EUT, Antenna vertical, in the range 1 – 18 GHz
(peak and average values shown) High channel



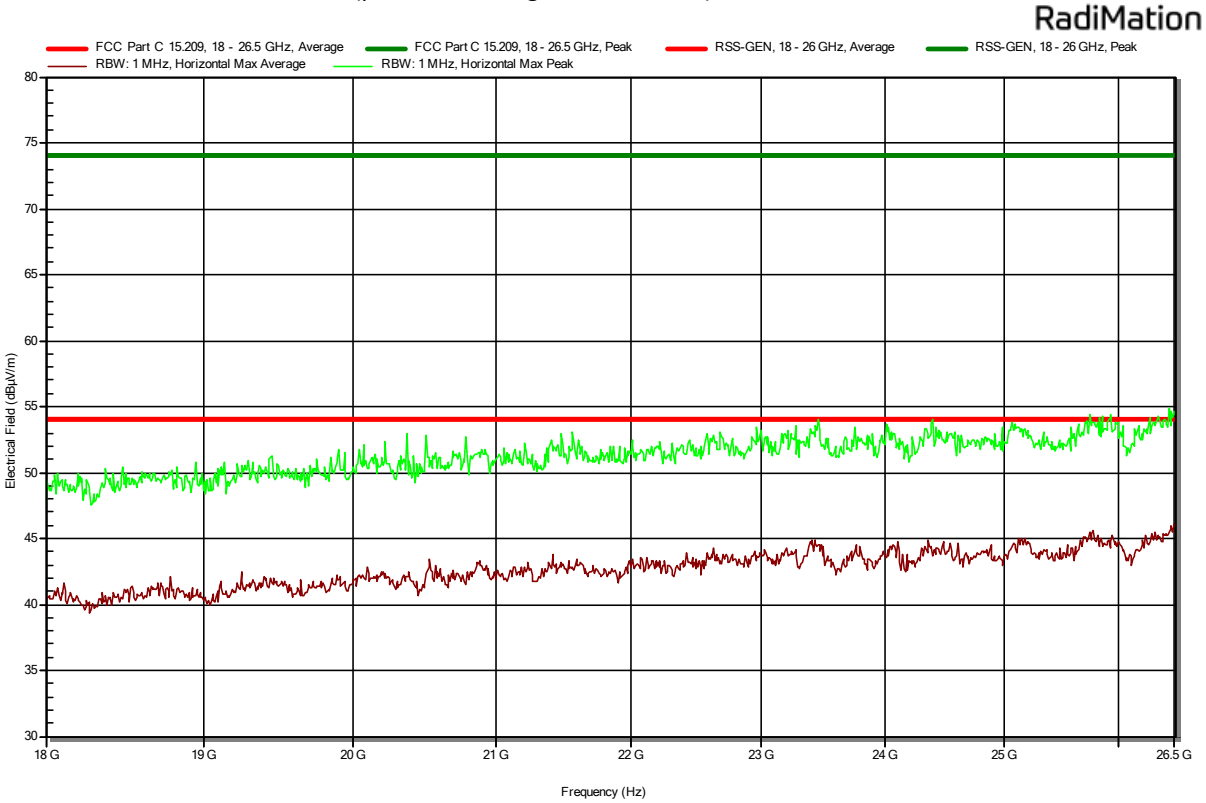
Plot 5f: radiated emissions of the EUT, Antenna horizontal, in the range 1 – 18 GHz
(peak and average values shown) High channel



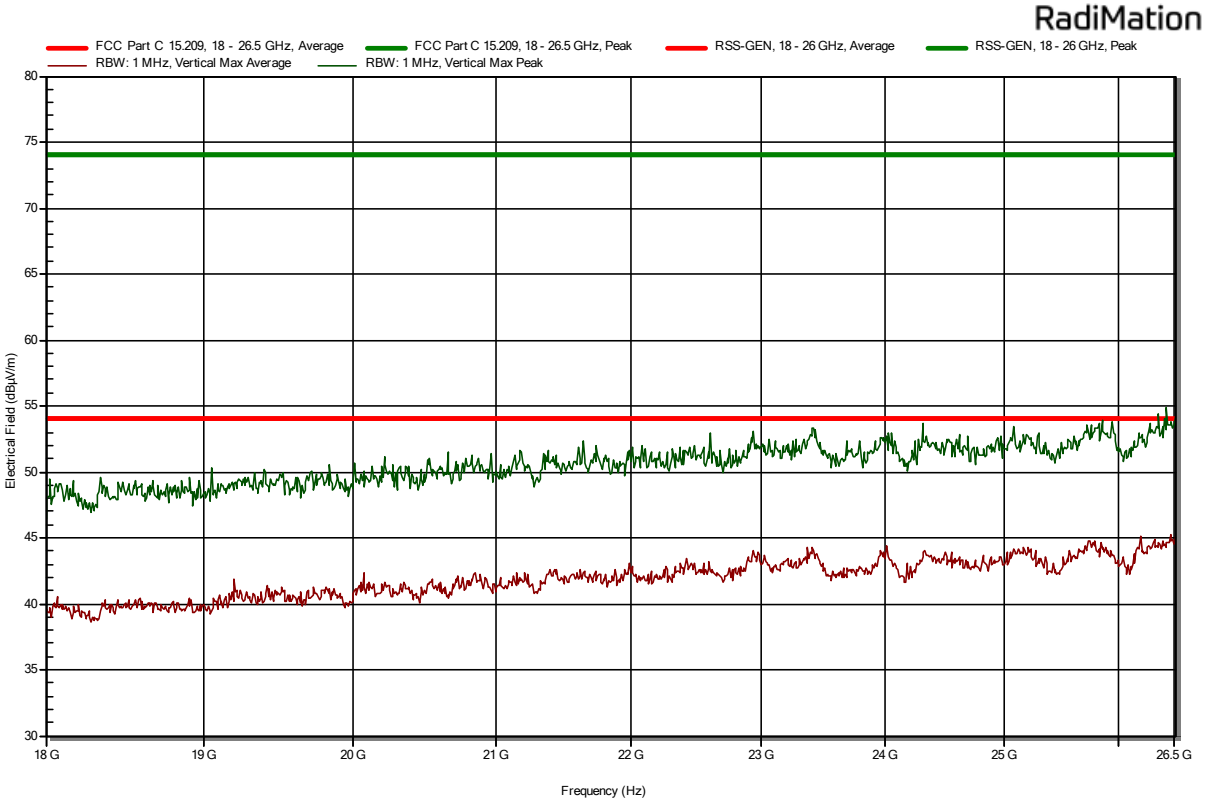
Plot 6a: radiated emissions of the EUT, Antenna vertical, in the range 18 – 26 GHz
(peak and average values shown) Low channel



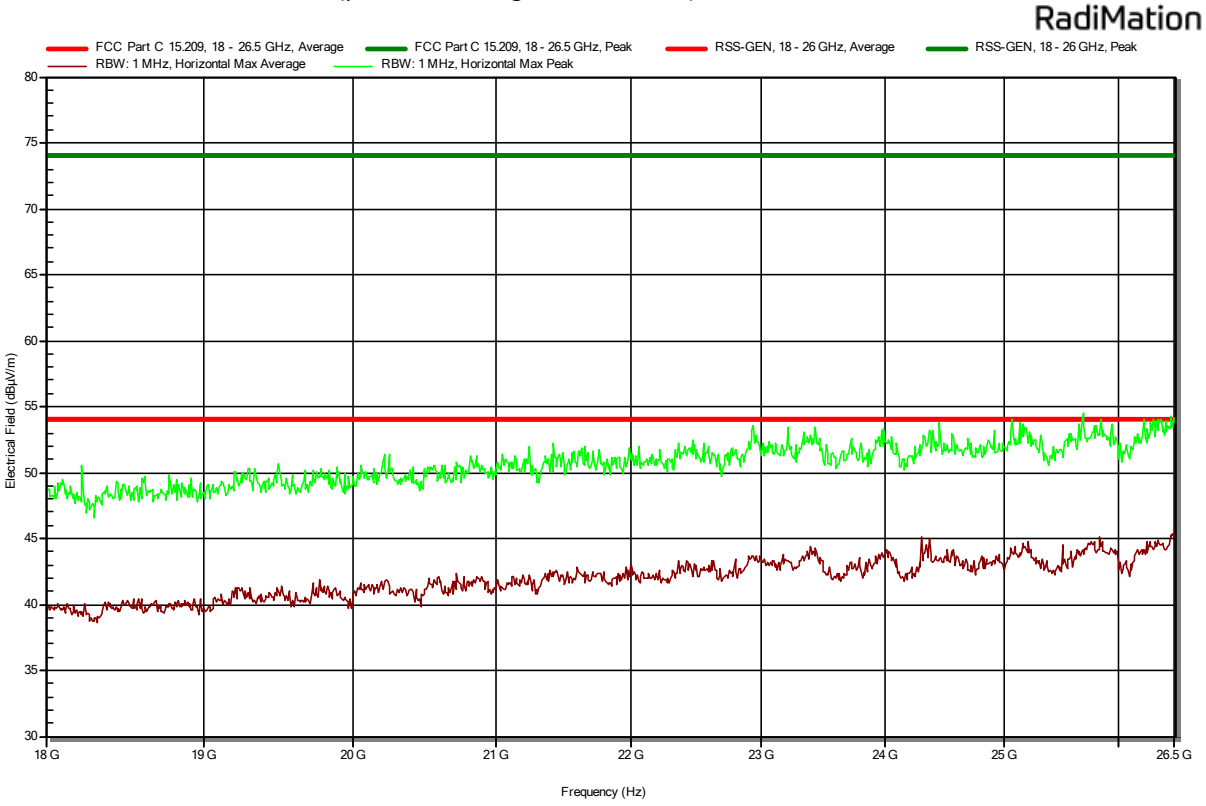
Plot 6b: radiated emissions of the EUT, Antenna horizontal, in the range 18 – 26GHz
(peak and average values shown) Low channel



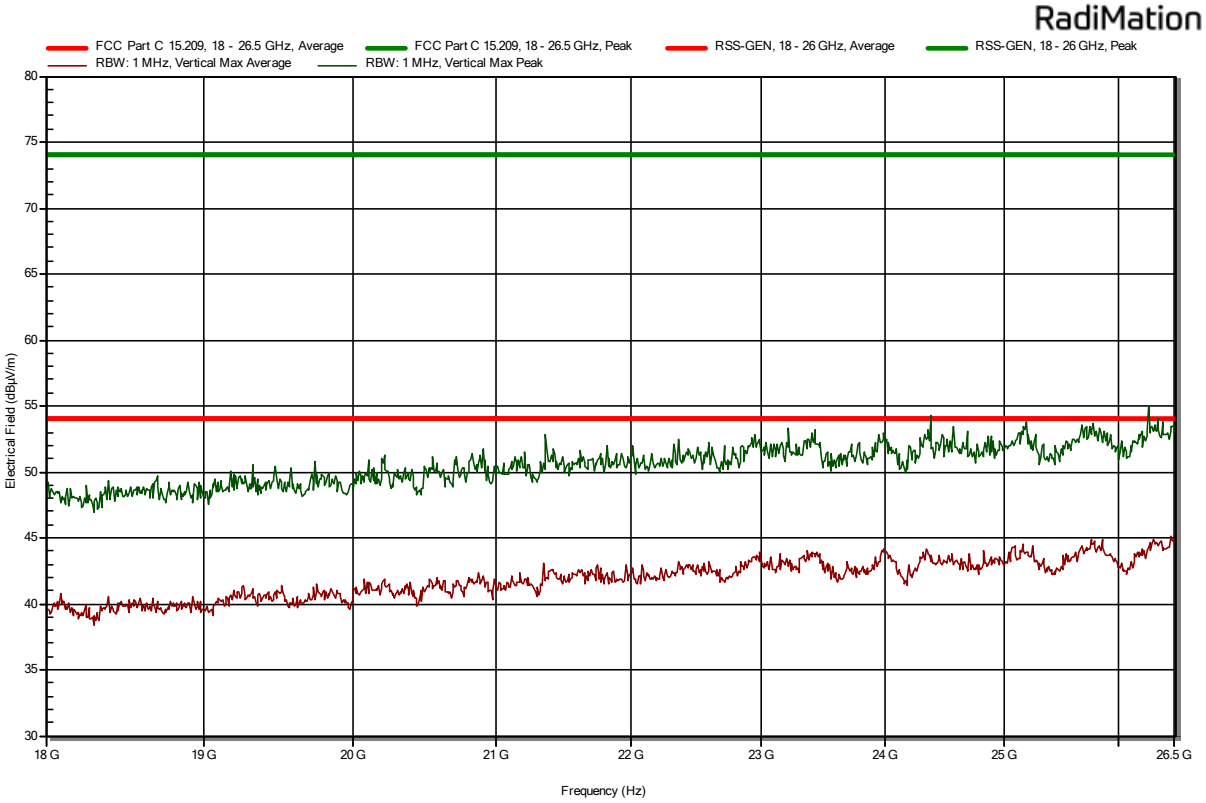
Plot 6c: radiated emissions of the EUT, Antenna vertical, in the range 18 – 26GHz
(peak and average values shown) Middle channel



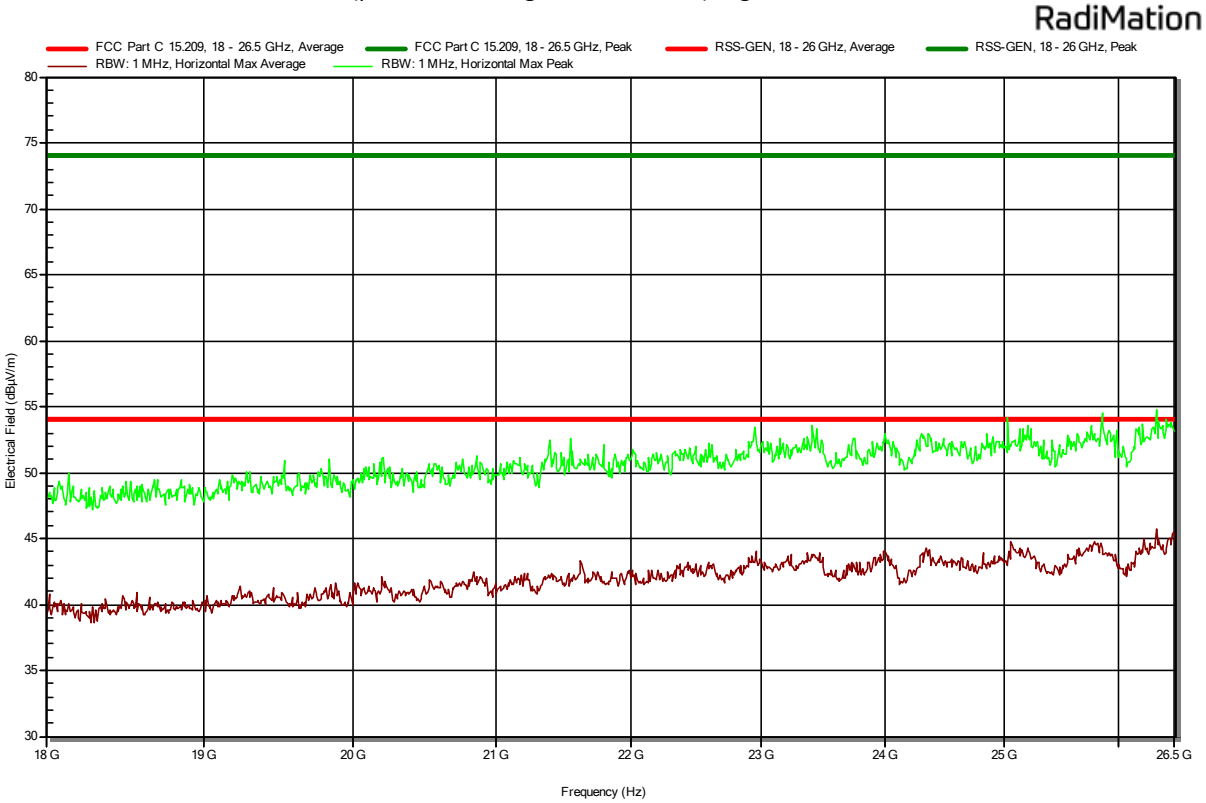
Plot 6d: radiated emissions of the EUT, Antenna horizontal, in the range 18 – 26GHz
(peak and average values shown) Middle channel



Plot 6e: radiated emissions of the EUT, Antenna vertical, in the range 18 – 26GHz
(peak and average values shown) High channel



Plot 6f: radiated emissions of the EUT, Antenna horizontal, in the range 18 – 26 GHz
(peak and average values shown) High channel



3.2 6dB bandwidth Measurement

3.2.1 Limit

The minimum 6 dB Bandwidth shall be at least 500 kHz.

3.2.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.2.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.2.4 Test procedure

According to ANSI C63.10, section 6.9
IRN 404 - Occupied bandwidth (Hz) Method 4 – DTS Bandwidth.

3.2.5 Test Results of the 6 dB bandwidth Measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	6dB bandwidth (kHz)
Bluetooth Low energy	37	2402	1 Mbps	712.872
	17	2440	1 Mbps	712.872
	39	2480	1 Mbps	712.872
Uncertainty	± 36.2 kHz			

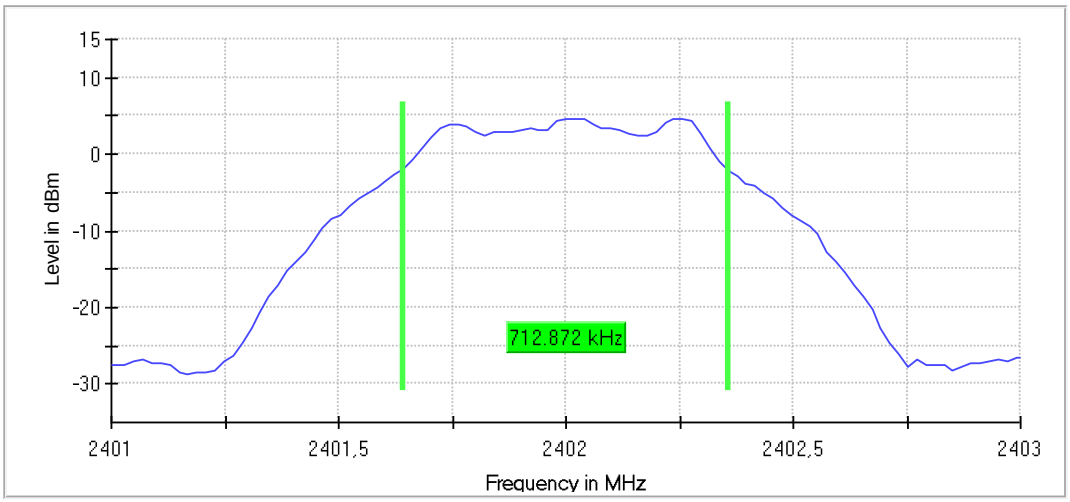
Technology Std.	Channel	Frequency (MHz)	Data rate	6dB bandwidth (kHz)
Bluetooth Low energy	37	2402	2 Mbps	1227.722
	17	2440	2 Mbps	1227.722
	39	2480	2 Mbps	1188.118
Uncertainty	± 36.2 kHz			

Note: plots are provided on the next page.

3.2.6 Plots of the 6 dB bandwidth

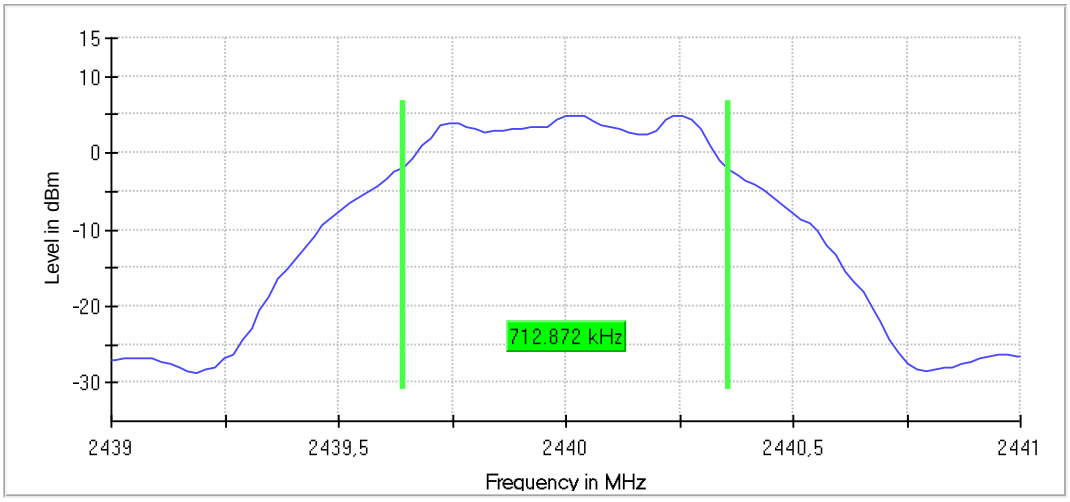
Channel 37 - 1 Mbps

6 dB Bandwidth



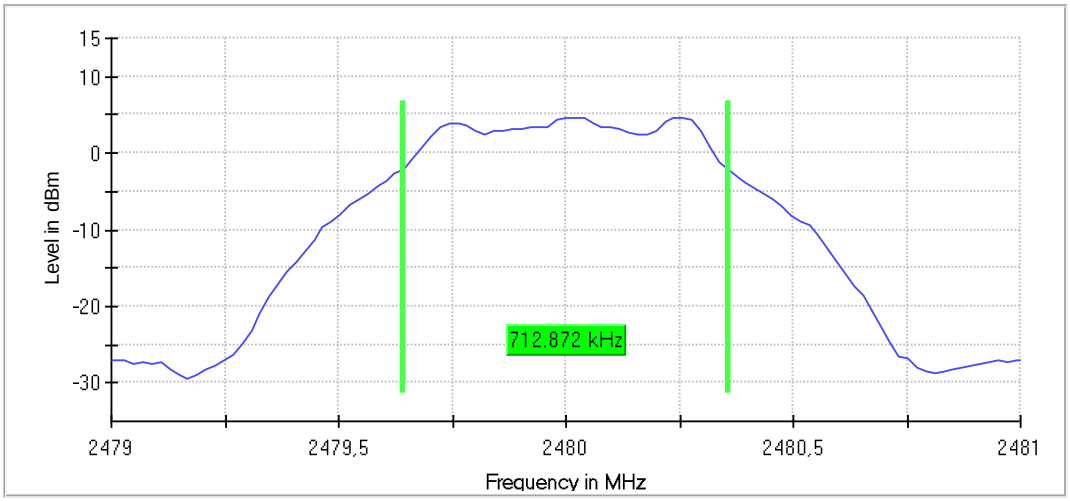
Channel 17 - 1 Mbps

6 dB Bandwidth



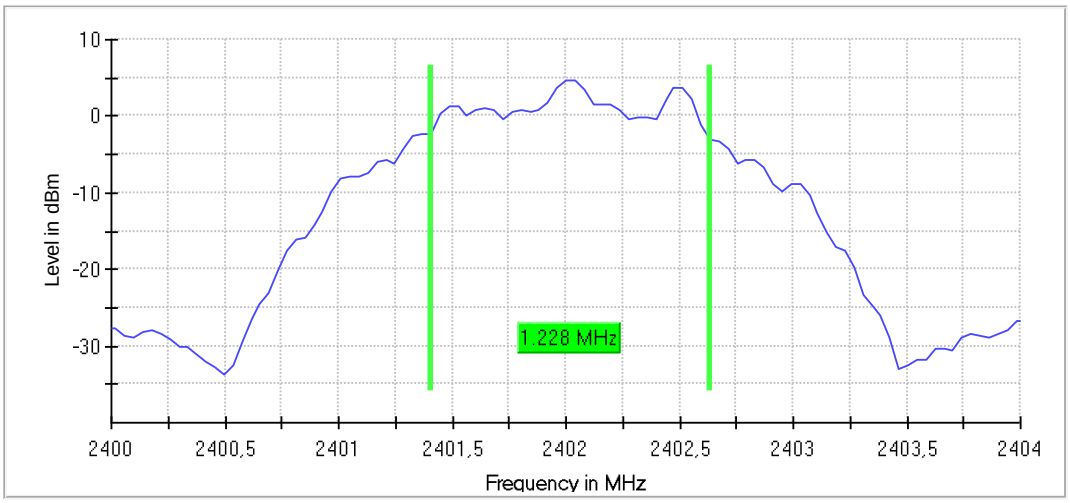
Channel 39 - 1 Mbps

6 dB Bandwidth



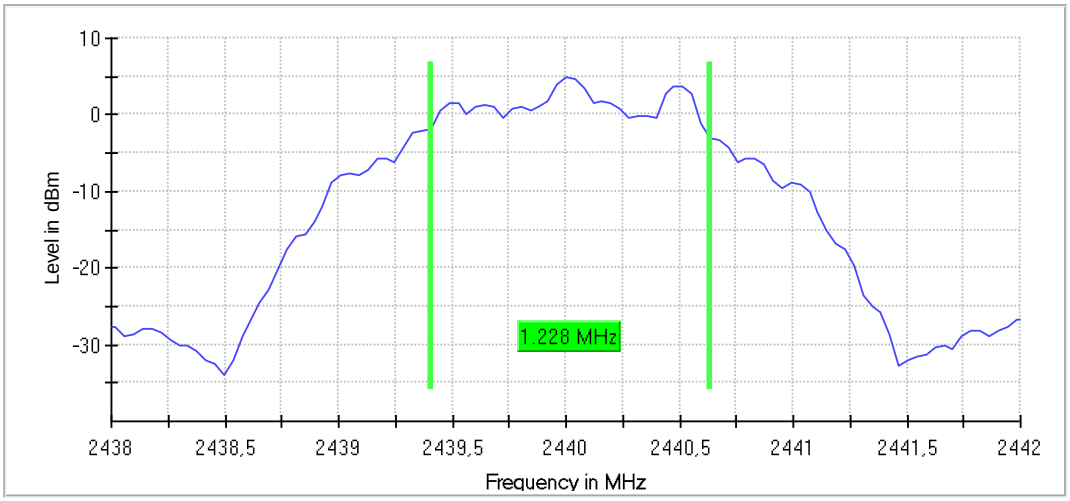
Channel 37 - 2 Mbps

6 dB Bandwidth



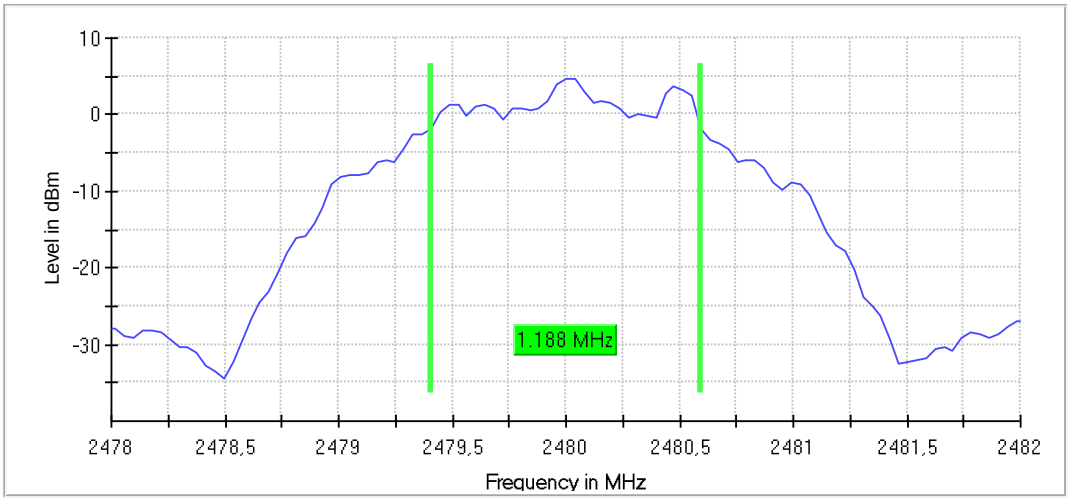
Channel 17 - 2 Mbps

6 dB Bandwidth



Channel 39 - 2 Mbps

6 dB Bandwidth



3.3 99% Occupied Bandwidth

3.3.1 Limit

According to RSS-Gen 6.7

3.3.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.3.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.3.4 Test procedure

According to ANSI C63.10, section 6.9
IRN 404 - Occupied bandwidth (Hz) Method 1 – XX % power bandwidth.

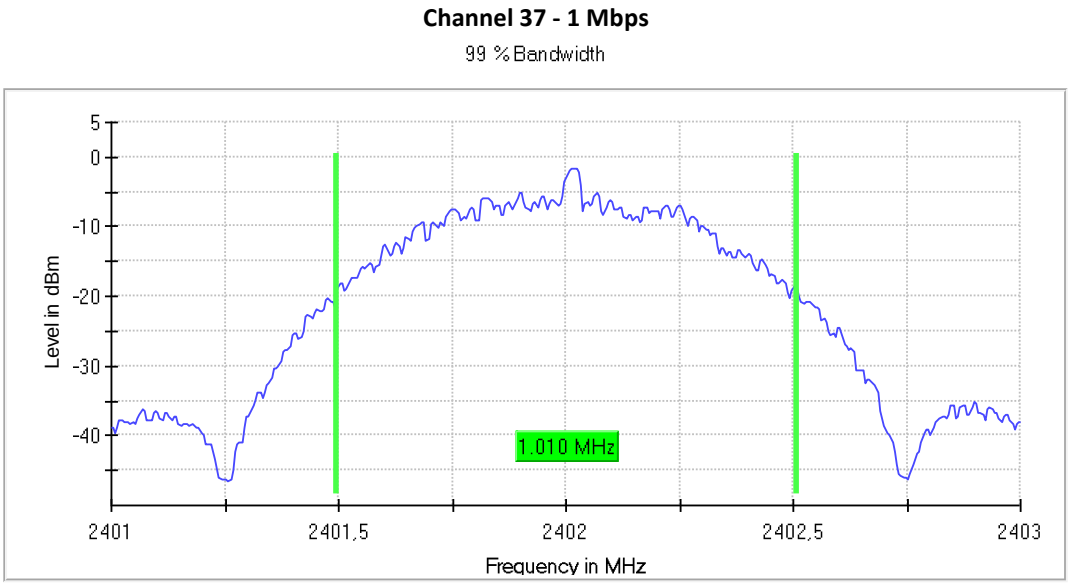
3.3.5 Test results of the 99% occupied bandwidth measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Bluetooth Low energy	37	2402	1 Mbps	1010.0
	17	2440	1 Mbps	1010.0
	39	2480	1 Mbps	1005.0
Uncertainty	± 12 kHz			

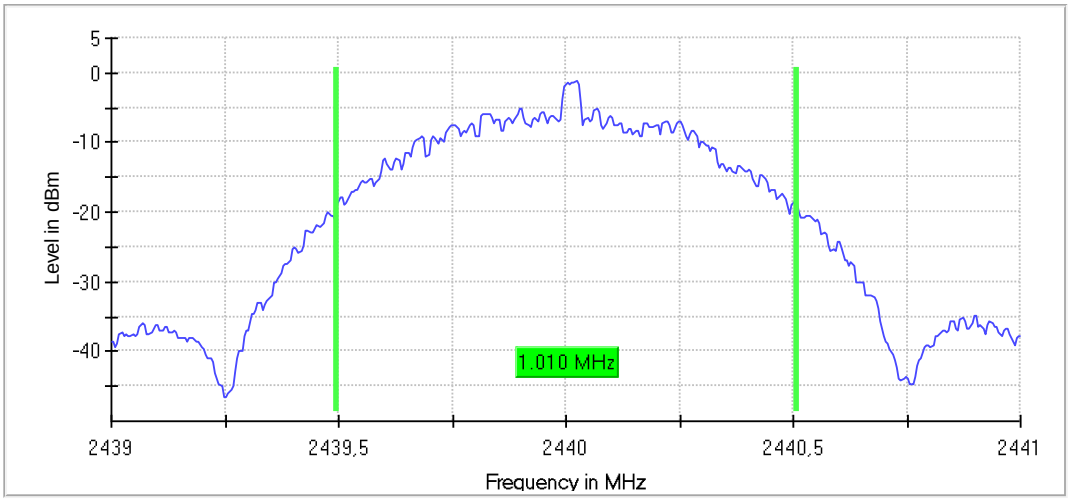
Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Bluetooth Low energy	37	2402	2 Mbps	2030.0
	17	2440	2 Mbps	2020.0
	39	2480	2 Mbps	2010.0
Uncertainty	± 12 kHz			

3.3.6 Plots of the 99% occupied bandwidth measurement

Channel 37 - 1 Mbps

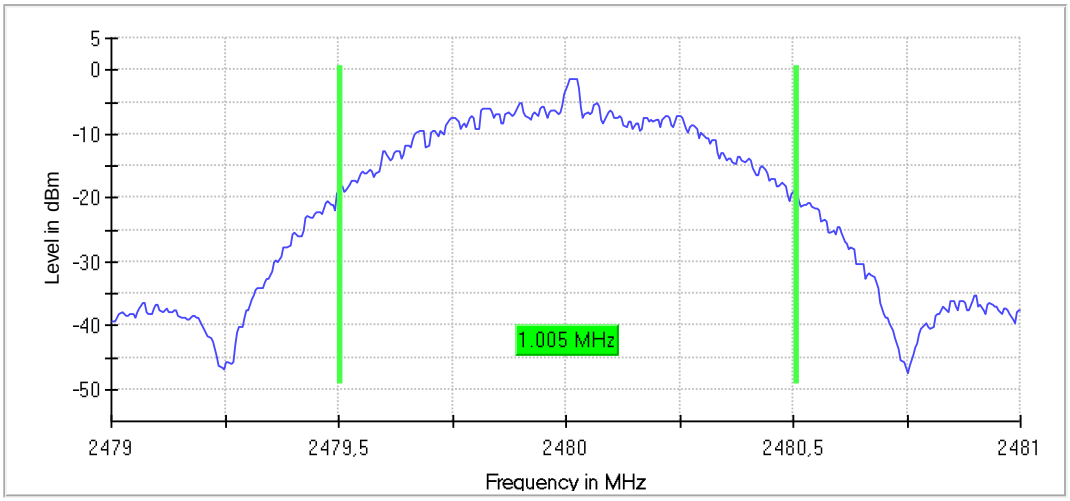


Channel 17 - 1 Mbps



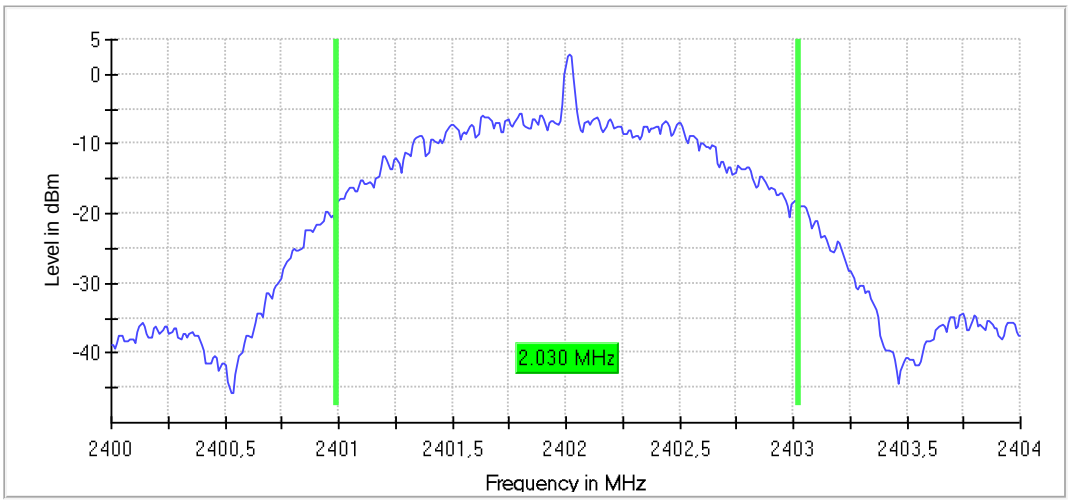
Channel 39 - 1 Mbps

99 % Bandwidth



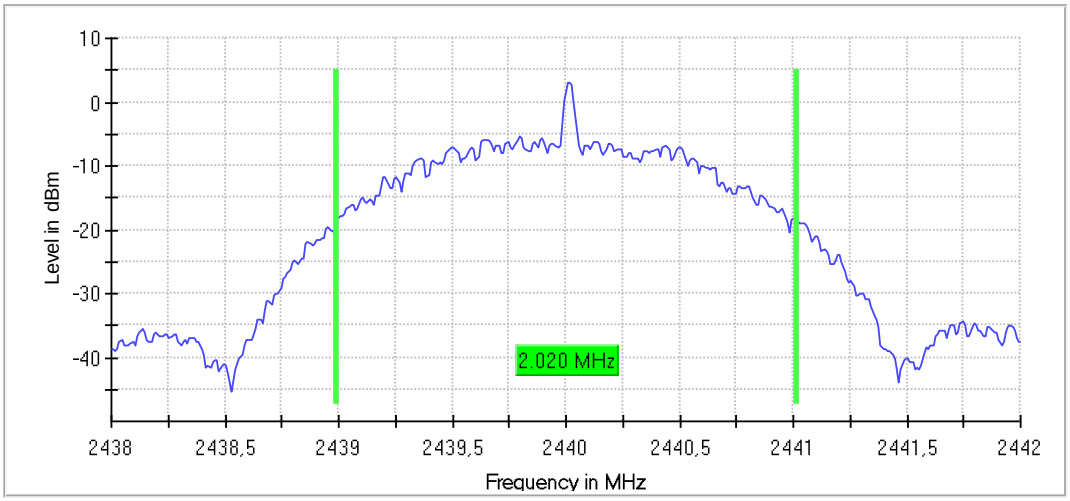
Channel 37 - 2 Mbps

99 % Bandwidth



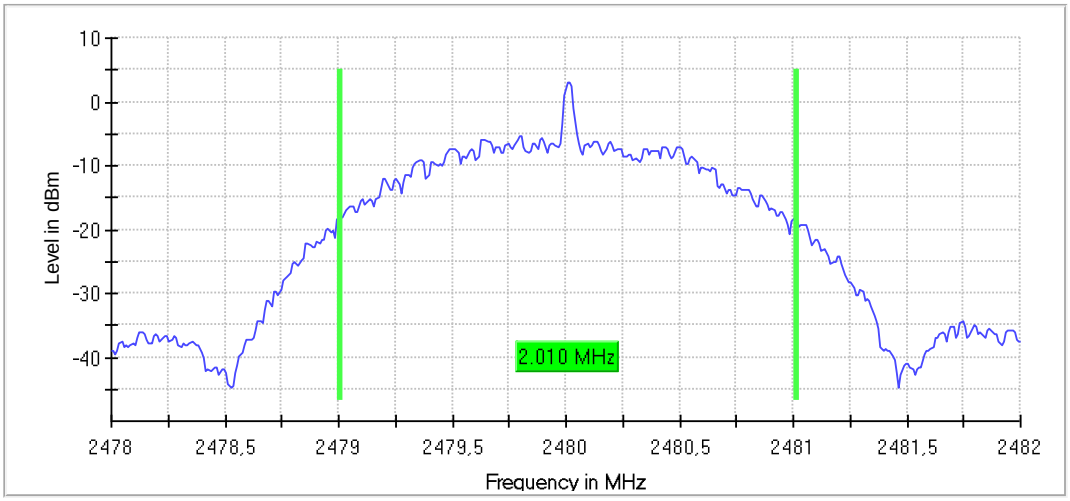
Channel 17 - 2 Mbps

99 % Bandwidth



Channel 39 - 2 Mbps

99 % Bandwidth



3.4 Output Power Measurement

3.4.1 Limit

FCC: For systems using digital modulation in the 2400-2483.5 MHz, the limit for the peak output power is 1W (30 dBm). If transmitting antenna of directional gain greater than 6 dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point to point operation, the limit has to be reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

RSS: 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. The e.i.r.p. shall not exceed 4W

3.4.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.4.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.4.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02.
IRN 402 - RF power (W) - Method 1 – AVGSA (DTS) according to ANSI C63.10.

3.4.5 Test results of Output Power Measurement

Peak method

Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power conducted (dBm)	Peak output power conducted (W)	Peak output power EIRP (W)
Bluetooth Low Energy	37	2402	1 Mbps	4.8	0.003	0.003
	17	2440	1 Mbps	4.8	0.003	0.003
	39	2480	1 Mbps	4.7	0.003	0.003
Uncertainty				±0.71 dB		

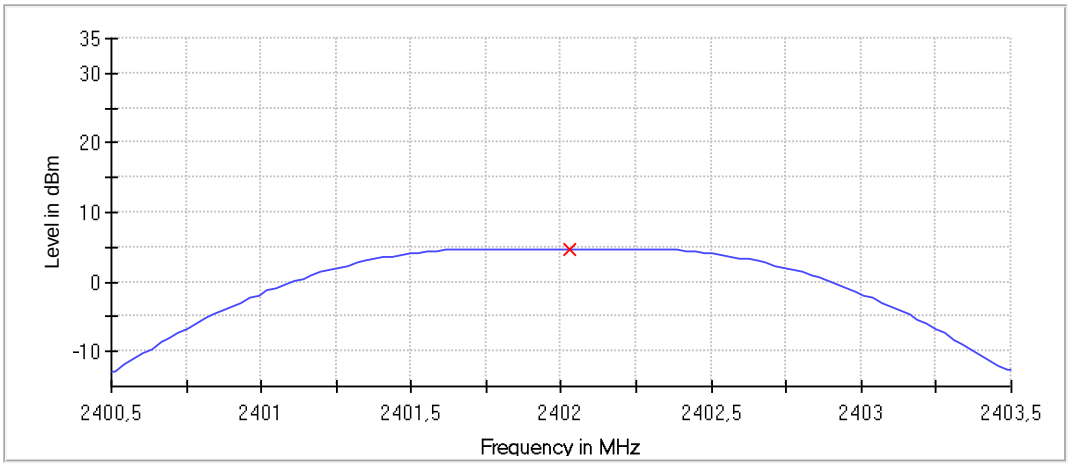
Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power conducted (dBm)	Peak output power conducted (W)	Peak output power EIRP (W)
Bluetooth Low Energy	37	2402	2 Mbps	4.8	0.003	0.003
	17	2440	2 Mbps	4.9	0.003	0.003
	39	2480	2 Mbps	4.7	0.003	0.003
Uncertainty				±0.71 dB		

Note: plots are provided on the next page

3.4.6 Plots of the Output power

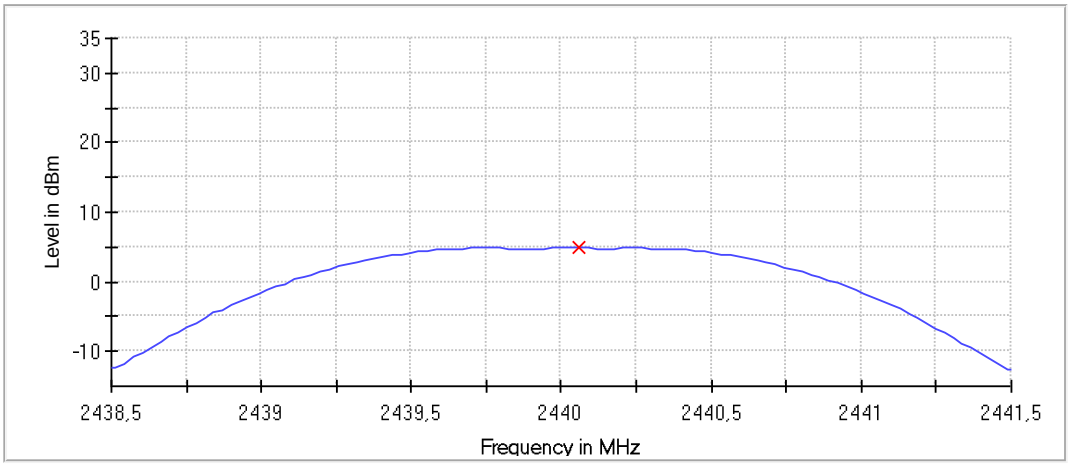
Channel 1 - 37 Mbps

Peak Power



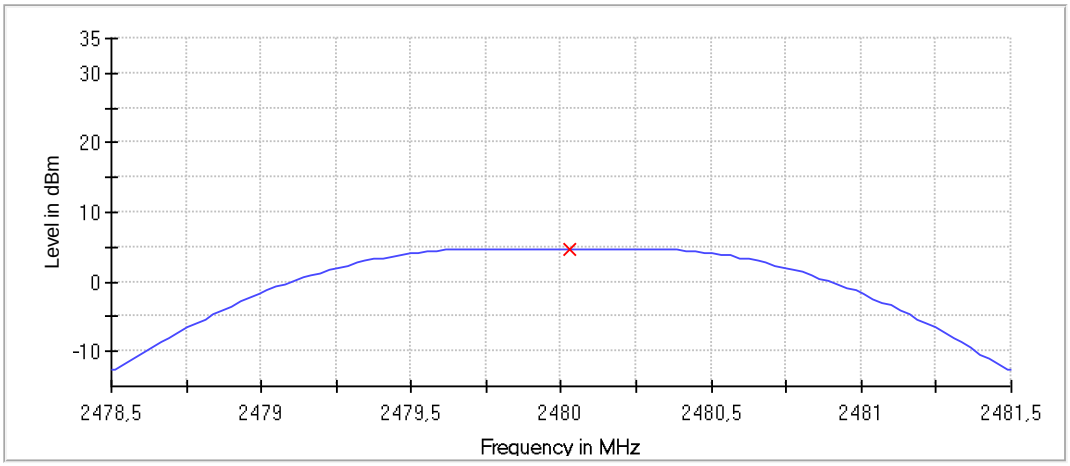
Channel 17 - 37 Mbps

Peak Power



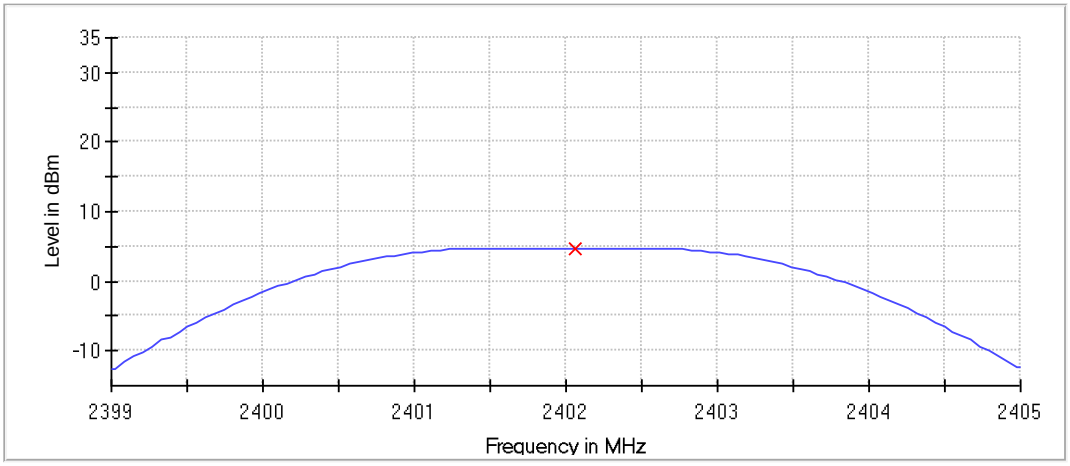
Channel 39 - 1 Mbps

Peak Power



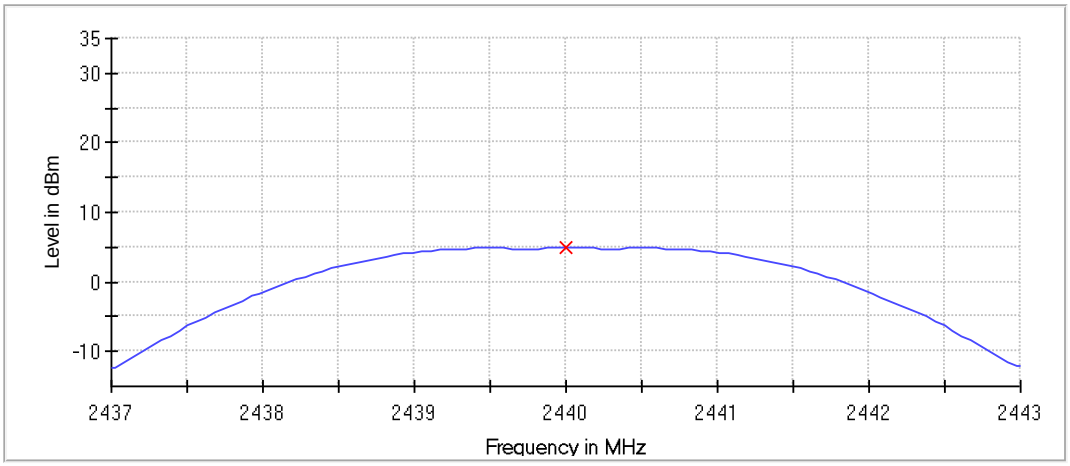
Channel 37 - 2 Mbps

Peak Power



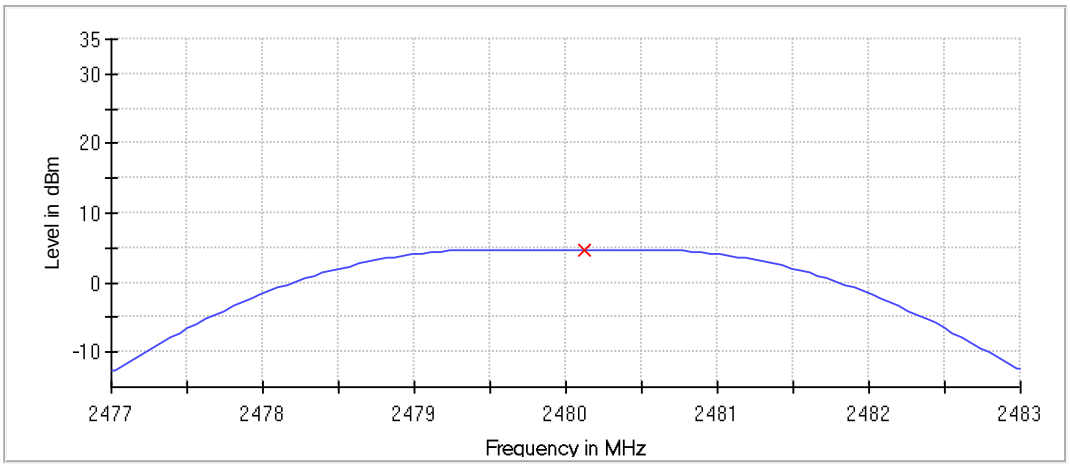
Channel 17 - 2 Mbps

Peak Power



Channel 39 - 2 Mbps

Peak Power



3.5 Power Spectral Density

3.5.1 Limit

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band at any time interval of continuous transmission.

3.5.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.5.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.5.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02.
IRN 412 - Spectral power density (W per n.Hz) - Method 5 – Peak method PKPSD (PSD in 3 kHz band)

3.5.5 Test results of Power Spectral Density Measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	PSD conducted (dBm/3 kHz)	Limit (conducted) (dBm/3kHz)
Bluetooth Low Energy	37	2402	1 Mbps	-1.442	8
	17	2440	1 Mbps	-1.155	8
	39	2480	1 Mbps	-1.413	8
Uncertainty	±2 dB				

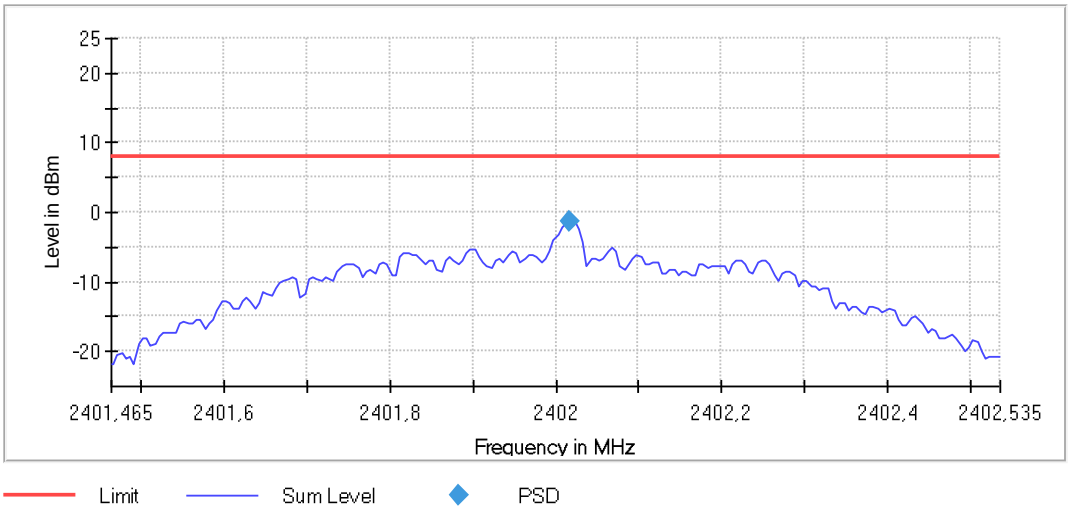
Technology Std.	Channel	Frequency (MHz)	Data rate	PSD conducted (dBm/3 kHz)	Limit (conducted) (dBm/3kHz)
Bluetooth Low Energy	37	2402	2 Mbps	-1.180	8
	17	2440	2 Mbps	-1.409	8
	39	2480	2 Mbps	-1.174	8
Uncertainty	±2 dB				

Note: plots are provided on the next page

3.5.6 Plots of the Power Spectral Density

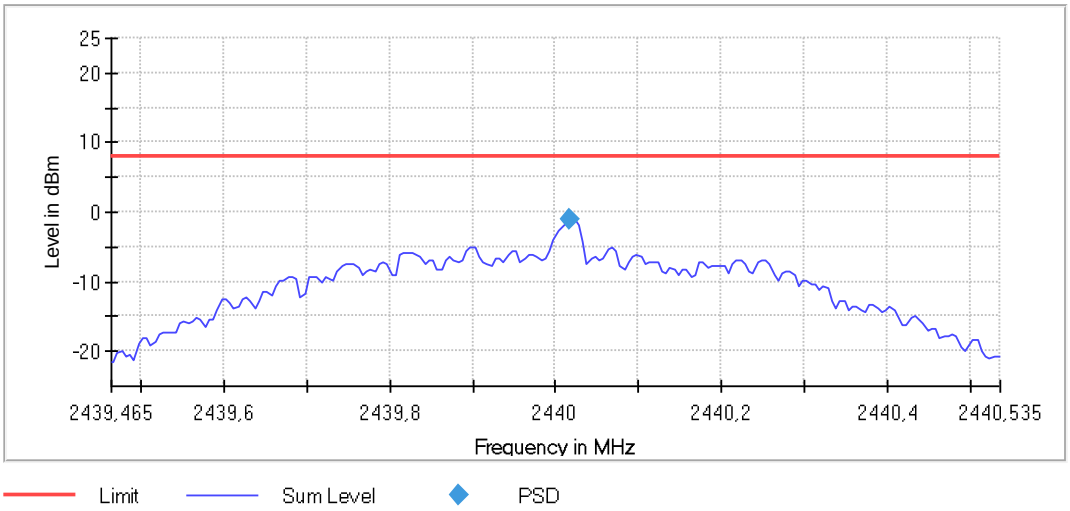
Channel 37 - 1 Mbps

Peak Power Spectral Density



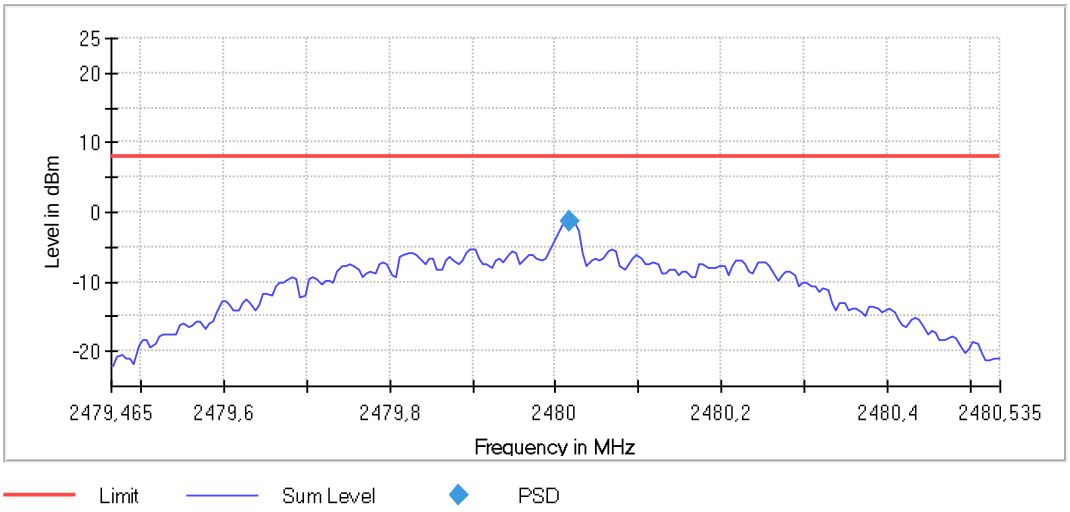
Channel 17 - 1 Mbps

Peak Power Spectral Density



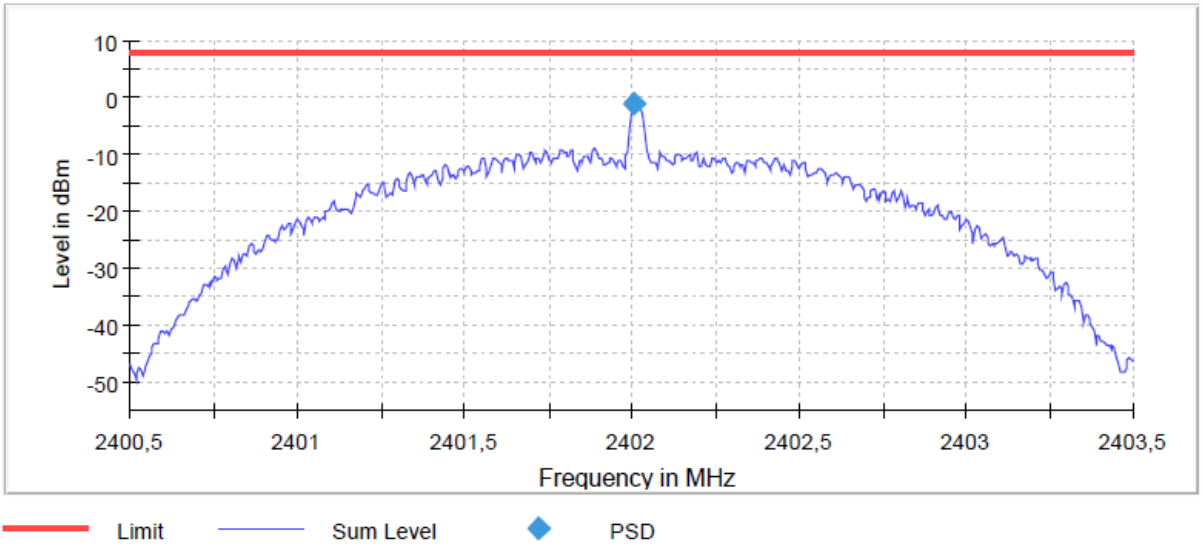
Channel 39 - 1 Mbps

Peak Power Spectral Density

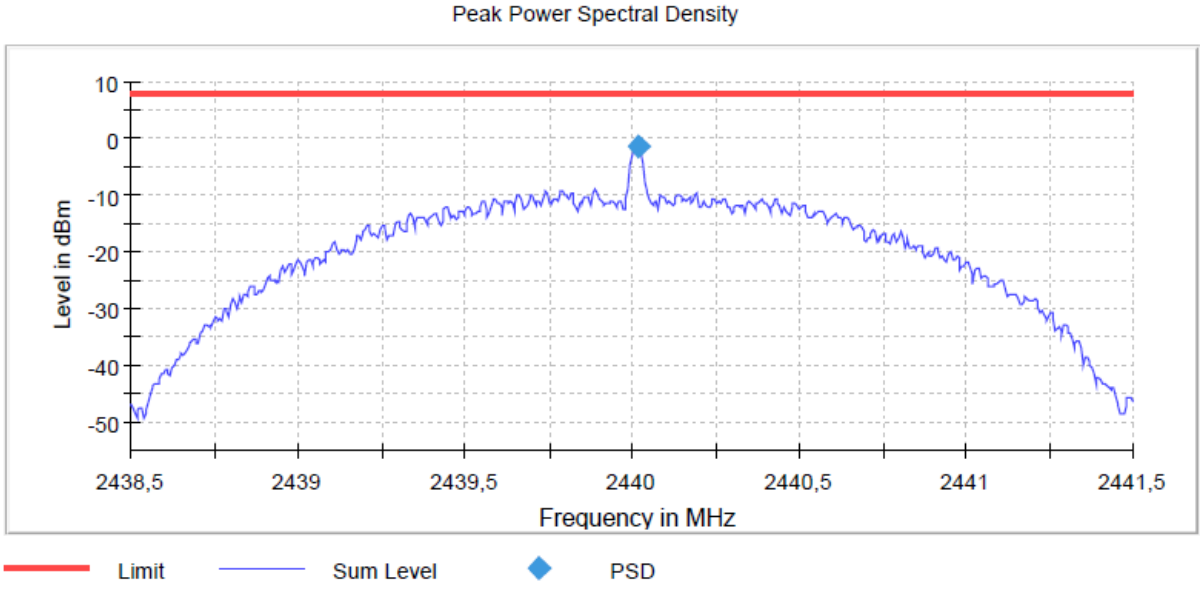


Channel 37 - 2 Mbps

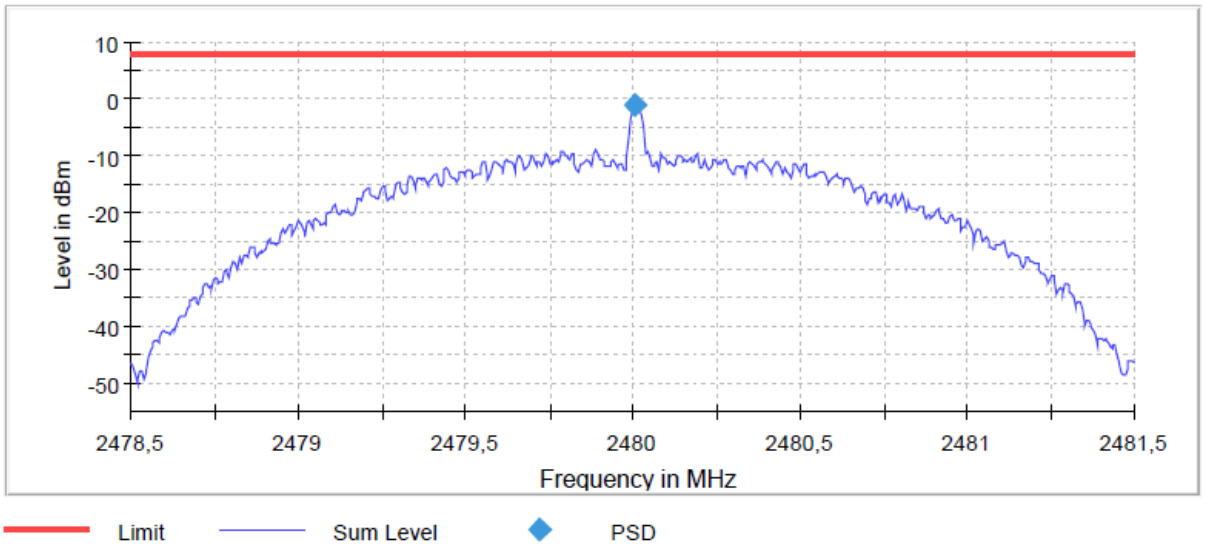
Peak Power Spectral Density



Channel 17 - 2 Mbps



Channel 39 - 2 Mbps



3.6 Band edge Measurement

3.6.1 Limit

Band edge:
At the edge of the authorized band the RF power shall be at least 20 dB down.

3.6.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.6.3 Test setup

The test setup is as shown in chapter 2.2 of this report. Antenna port conducted

3.6.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02, section 8.7.
IRN 441 - Radiated electrical disturbance (V per m) Method 6 – Radiated electrical disturbance at the Authorized band edge.

3.6.5 Measurement results

Channel 37 - 1 Mbps

Frequency	Level	Margin	Limit	Result
MHz	dBm	dB	dBm	
2399.575000	-52.6	37.4	-15.2	PASS
2399.525000	-52.6	37.4	-15.2	PASS
2399.975000	-52.7	37.5	-15.2	PASS
2399.925000	-53.0	37.8	-15.2	PASS
2399.875000	-53.2	37.9	-15.2	PASS
2399.625000	-53.5	38.3	-15.2	PASS
2399.825000	-53.8	38.5	-15.2	PASS
2398.975000	-53.9	38.6	-15.2	PASS
2399.775000	-53.9	38.6	-15.2	PASS
2398.925000	-54.0	38.8	-15.2	PASS
2399.475000	-54.1	38.9	-15.2	PASS
2399.725000	-54.8	39.6	-15.2	PASS
2399.675000	-54.8	39.6	-15.2	PASS
2399.175000	-55.0	39.8	-15.2	PASS
2399.325000	-55.1	39.9	-15.2	PASS

Channel 39 - 1 Mbps

Frequency	Level	Margin	Limit	Result
MHz	dBm	dB	dBm	
2483.575000	-54.4	38.9	-15.5	PASS
2483.525000	-55.2	39.7	-15.5	PASS
2483.725000	-56.2	40.7	-15.5	PASS
2483.925000	-56.4	40.9	-15.5	PASS
2483.775000	-56.4	40.9	-15.5	PASS
2483.825000	-56.4	40.9	-15.5	PASS
2483.875000	-56.5	41.0	-15.5	PASS
2483.625000	-56.5	41.0	-15.5	PASS
2483.675000	-56.8	41.3	-15.5	PASS
2484.125000	-57.0	41.5	-15.5	PASS
2484.075000	-57.0	41.5	-15.5	PASS

Frequency	Level	Margin	Limit	Result
MHz	dBm	dB	dBm	
2483.975000	-57.0	41.5	-15.5	PASS
2484.225000	-57.1	41.6	-15.5	PASS
2484.025000	-57.3	41.8	-15.5	PASS
2484.325000	-57.4	41.9	-15.5	PASS

Channel 37 - 2 Mbps

Frequency	Level	Margin	Limit	Result
MHz	dBm	dB	dBm	
2399.975000	-25.8	10.6	-15.2	PASS
2399.925000	-30.4	15.2	-15.2	PASS
2399.875000	-32.8	17.6	-15.2	PASS
2399.825000	-33.3	18.1	-15.2	PASS
2399.775000	-35.1	19.9	-15.2	PASS
2399.725000	-38.5	23.3	-15.2	PASS
2399.675000	-40.6	25.4	-15.2	PASS
2399.625000	-41.9	26.7	-15.2	PASS
2399.575000	-42.8	27.6	-15.2	PASS
2399.525000	-45.0	29.8	-15.2	PASS
2399.475000	-46.7	31.5	-15.2	PASS
2399.425000	-48.8	33.6	-15.2	PASS
2399.375000	-49.1	33.9	-15.2	PASS
2399.275000	-49.9	34.7	-15.2	PASS
2399.325000	-50.2	35.0	-15.2	PASS

Channel 39 - 2 Mbps

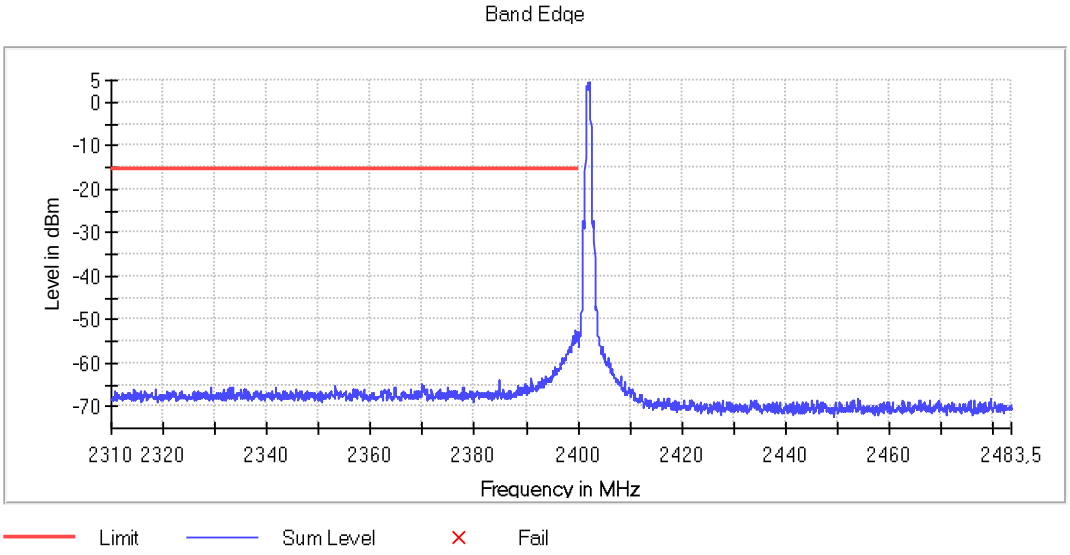
Frequency	Level	Margin	Limit	Result
MHz	dBm	dB	dBm	
2483.525000	-55.2	39.7	-15.5	PASS
2483.725000	-55.6	40.1	-15.5	PASS
2483.675000	-55.8	40.4	-15.5	PASS
2483.875000	-56.2	40.8	-15.5	PASS
2483.825000	-56.3	40.8	-15.5	PASS
2483.575000	-56.9	41.5	-15.5	PASS
2483.625000	-57.2	41.8	-15.5	PASS
2483.925000	-57.5	42.0	-15.5	PASS
2485.125000	-57.5	42.1	-15.5	PASS
2483.775000	-57.6	42.2	-15.5	PASS
2483.975000	-57.6	42.2	-15.5	PASS
2484.025000	-57.7	42.3	-15.5	PASS
2484.925000	-57.8	42.4	-15.5	PASS
2484.975000	-57.9	42.4	-15.5	PASS
2484.075000	-58.0	42.5	-15.5	PASS

3.6.6 Measurement Uncertainty

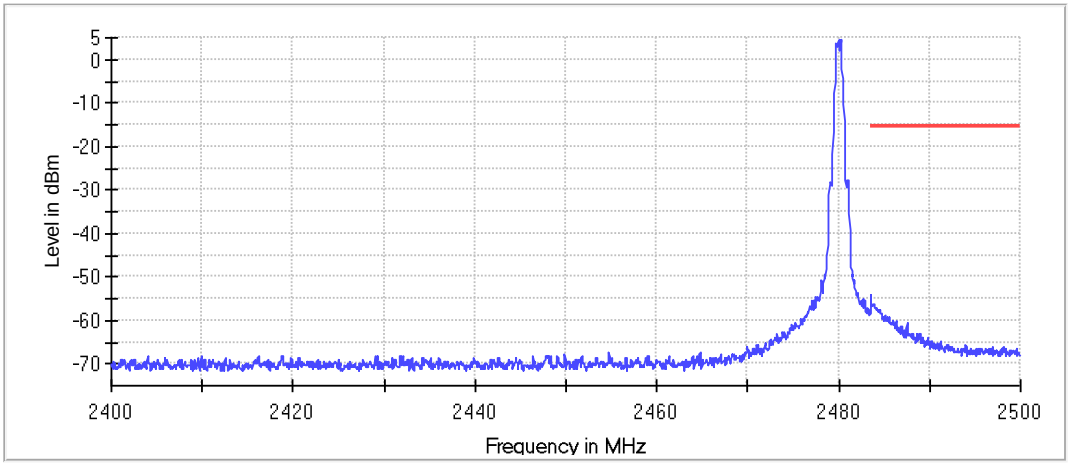
± 2 dB.(Conducted)

3.6.7 Plots of the Band edge Measurements

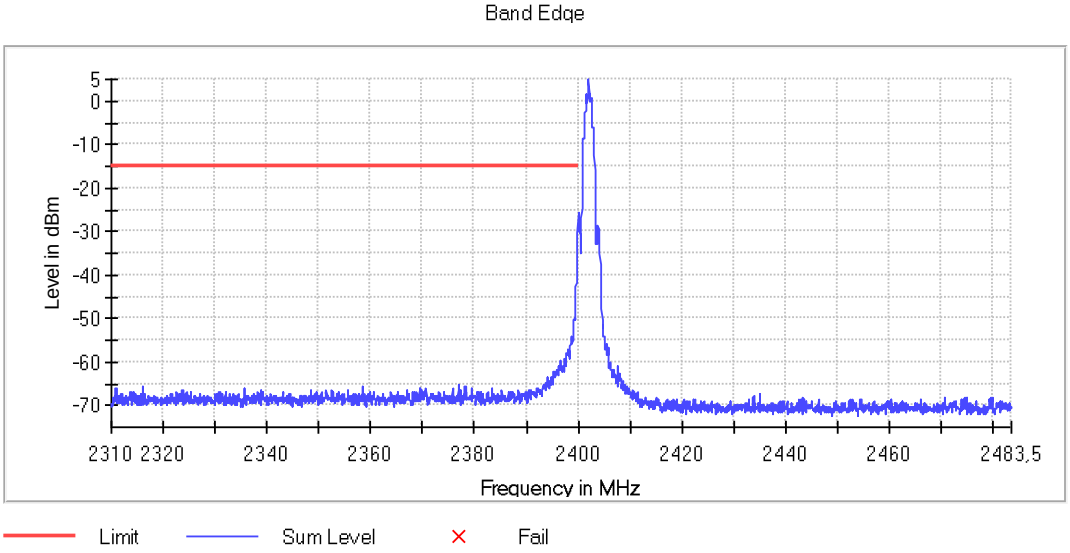
BLE Lower band edge (Channel 37) – 1 Mbps



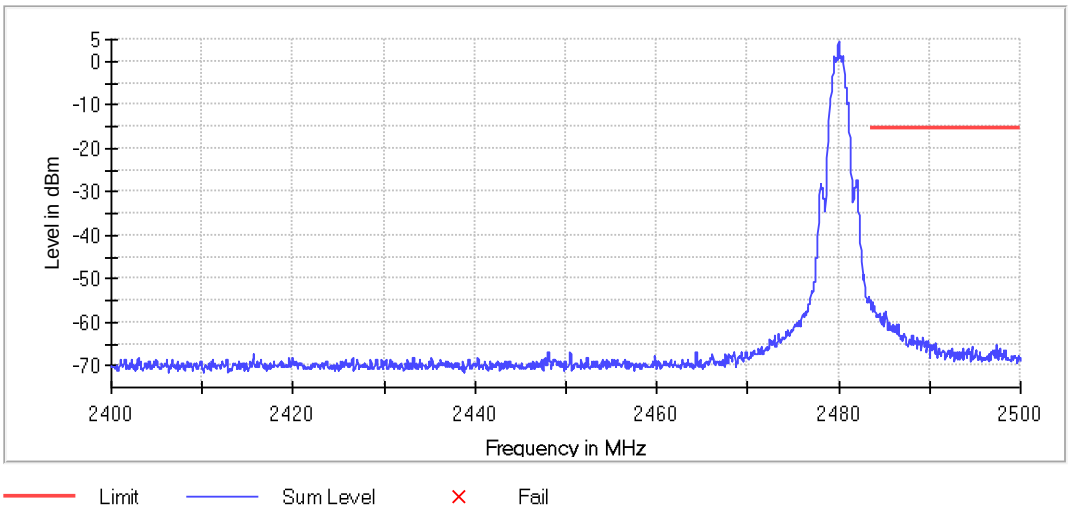
BLE Upper band edge (Channel 39) – 1 Mbps



BLE Lower band edge (Channel 37) – 2 Mbps



BLE Upper band edge (Channel 39) – 2 Mbps



4 Sample calculations

All formulas for data conversions and conversion factors are reported in this chapter.

Conducted emission Measurement:

U_{lisn} (dBµV) = U (dBµV) + Corr. (dB)

Where:
U = Measuring receiver voltage
LISN insertion loss = Voltage division factor of LISN
Corr. = sum of single correction factors of used LISN, cables and pulse limiter.
Linear interpolation will be used for frequencies in between the values in the table.

Frequency (MHz)	Voltage division LISN (db)	Cable loss (dB)	Corr. (dB)
	114379 SN: 230000813 Rohde & Schwarz ENV 216	**TE 11134**	
0,15	9.7	0.02	9.72
0,2	9.68	0.03	9.71
0,3	9.68	0.03	9.71
0,5	9.69	0.08	9.77
0,7	9.69	0.25	9.94
0,8	9.69	0.25	9.94
1	9.68	0.11	9.79
2	9.7	0.15	9.85
3	9.71	0.21	9.92
5	9.72	0.21	9.93
7	9.76	0.25	10.01
8	9.77	0.25	10.02
10	9.77	0.29	10.06
15	9.84	0.34	10.18
20	9.88	0.37	10.25
25	9.97	0.43	10.4
30	10.08	0.45	10.53

Magnetic field strength measurement:

$$H\left[dB\left(\mu\frac{A}{m}\right)\right] = V[dB(\mu V)] + L_c[dB] + AF^H[\frac{dB}{\Omega m}]$$

Where:
H is the magnetic field strength (to be compared to the limit)
V is the voltage level measured by the receiver or spectrum analyzer
L_C is the cable loss
AF^H is the magnetic antenna factor

Frequency (MHz)	AF 114515 EMCO 6505 S/N:9112-2710	300m to 3m and 30m to 3m correction	CL (dB) SAR cable	Corr. (dB)
0.009	18.49	104.956	0.7	-85.8
0.01	17.64	104.041	0.05	-86.4
0.02	13.23	98.02	0.07	-84.7
0.03	11.65	94.498	0.1	-82.7
0.04	10.97	91.999	0.1	-80.9
0.1	10.14	84.041	0.1	-73.8
0.2	10.01	78.02	0.1	-67.9
0.5	9.95	50.061	0.1	-40
1	9.91	44.041	0.2	-33.9
3	9.93	34.498	0.2	-24.4
5	9.93	30.061	0.3	-19.8
10	9.75	24.041	0.6	-13.7
15	9.29	20.519	0.9	-10.3
20	8.57	18.02	1	-8.5
25	7.55	16.082	0.7	-7.8
27	7.01	15.413	1.2	-7.2
30	6.03	14.498	1	-7.5

Field Strength Measurement:

E (dBµV/m) = U(dBµV) + AF (dB/m) + Corr. (dB)

Where:
E = Electric field strength
U = Measuring receiver voltage
AF = Antenna factor
CL = Cable loss

Corr. = sum of single correction factors of used cable and amplifier (if applicable).
Linear interpolation will be used for frequencies in between the values in the table.
Tables shows an extract of the values.

Frequency (MHz)	AF (dB/m) ID: 107818 EMCO 3109	Cable loss (dB) Id: 114928	Attenuator ID:114525 Hewlett Packet	Corr. (dB)
30	13.5	1.8	6	21.3
100	9.2	2.7	6	17.9
150	12.6	3.2	6	21.8
200	13.6	3.6	6	23.2
250	15.2	4.3	6	25.5

Frequency (MHz)	AF (dB/m) ID: 114385 EMCO LPDA	Cable loss (dB) Id: 114928	Corr. (dB)
250	11.8	4.3	16.1
300	13	5.1	18.1
350	14.2	5.8	20.0
400	15.6	7.3	22.9
450	17.1	7.9	25.0
500	17.3	8.0	25.3
550	17.7	8.0	25.7
600	18.4	7.7	26.1
650	19.2	7.5	26.7
700	19.7	7.7	27.4
750	20.3	7.9	28.2
800	21.4	8.2	29.6
850	22.0	8.7	30.7
900	22.1	8.9	31.0
950	22.6	9.2	31.8
1000	22.5	9.6	32.1

Frequency (MHz)	AF (dB/m) 114607 Emco 3115 SN: 9412-4377	Gain (dB) 114690 µComp Nordic MCNA-40-0010800-25-10P	Cable loss (dB) 114691	Corr. (dB)
1000	23.6	45.1	2.1	-19.4
2000	27.1	44.7	3.3	-14.3
3000	30.5	44.2	4.2	-9.5
4000	32.7	43.5	4.9	-5.9
5000	33.2	43.1	5.6	-4.3
6000	34.6	43.0	6.3	-2.1
7000	35.2	42.9	6.4	-1.3
8000	37.0	43.3	7.2	0.9
9000	38.1	43.3	7.9	2.7
10000	38.2	43.0	8.2	3.4
11000	38.3	42.9	8.7	4.1
12000	39.1	42.6	9.0	5.5
13000	39.2	43.6	9.8	5.4
14000	41.1	44.3	9.7	6.5
15000	40.2	44.4	10.4	6.2
16000	37.5	44.3	10.8	4.0
17000	41.1	44.5	11.4	8.0
18000	44.0	44.9	11.4	10.5

Frequency (MHz)	AF (dB/m) Kiwa ID: 114518 Flann 20240-25 SN: 163703	Gain (dB) Kiwa ID: Schwarzbeck BBV 9721	Cable loss (dB) 114691	Corr. (dB)
18000	31.3	34.5	11.4	8.2
19000	31.5	34.9	11.2	7.8
20000	31.7	34.1	11.6	9.2
21000	31.9	33.6	12.1	10.4
22000	32.1	33.6	12.4	10.9
23000	32.2	33.3	13.6	12.5
24000	32.3	32.3	13.5	13.5
25000	32.4	33.0	13.4	12.8
26000	32.5	32.9	13.7	13.3

<< END OF REPORT>>