Test report for

15.247 (DTS), 15.209 and 15.207

RSS-247, RSS-Gen

The RvA is signatory to ILAC - MRA

Product name	: RF Module 2.4 GHz
Applicant	: Tyro Remotes B.V.
FCC ID	: SQL- FS2400
IC	: 30985-FS2400

Test report No. : P000394196 001 Ver 4.0

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).

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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.

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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	08/08/24	First draft	LFD
v1.00	12/08/24	Initial release	LFD
V2.00	13/08/2024	Added SMA Antenna Spurious Emissions	LFD
V3.00	20/11/2024	Added verification results with a second testfixture and added feedback	RvB
V4.00	09/01/2025	Fixed typo’s in chapter 3.2 and 3.3.6	RvB

Table of Contents

Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.247(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 5.1(a)	20 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 (d)	RSS-247 5.5	Band edge	3.5	Pass
15.207 (c)	RSS-Gen 8.8	AC power-line conducted emissions	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:	Tyro Remotes
Address:	Bedrijvenpark Twente 299
Zip code:	7602 KK Almelo Netherlands
Telephone:	+31 612734017
E-mail:	j.nijkrake@tyroremotes.eu
Contact name:	John Nijkrake

1.2 Manufacturer

Manufacturer name:	Tyro Remotes
Address:	Bedrijvenpark Twente 299
Zip code:	7602 KK Almelo Netherlands
Telephone:	+31 612734017
E-mail:	j.nijkrake@tyroremotes.eu
Contact name:	John Nijkrake

1.3 Tested Equipment Under Test (EUT)

Product name:	Feasycom 2.4 GHz radio module
Brand name:	Feasycom
FCC ID:	SQL- FS2400
IC:	30985-FS2400
Product description:	2.4 GHz radio module
Variant model(s):	FS2400
Batch and/or serial No.	Not Applicable
Software version:	5.4.2
Hardware version:	R1.2
Date of receipt:	25/04/2024
Tests started:	01/05/2024
Testing ended:	12/06/2024

1.3.1 Auxiliary items

AUX1

Product name:	EUT test fixture 1
Product type:	AC/DC Adaptor
Remarks:	Connects to EUT

AUX2

Product name:	EUT test fixture 2
Product type:	AC/DC Adaptor
Remarks:	Connects to EUT

1.4 Product specifications of Equipment under test

Tx Frequency:	2402 – 2480 MHz
Rx frequency:	2402 – 2480 MHz
Occupied channel width:	1 and 2 MHz
Antenna type:	SMA Antenna / PCB Antenna
Antenna gain:	3.2 dBi / 2.9 dBi
Type of modulation:	GFSK
Emission designator	1M03G1D / 2M05G1D

Disclaimer: The operating frequency bands are declared by the applicant

1.5 Environmental conditions

Normal test conditions:

Temperature (*) : +15°C to +35°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-247 Issue 3

1.8 Observation and remarks

0 Ohm SMD resistor removed for conducted testing to avoid a power split.
Two antennas tested: PCB integrated antenna and an external SMA antenna.

1.9 Modifications to the EUT (Equipment Under Test)

No structural modifications.

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 : L. Fonseca Dias

Review of test methods and report by:

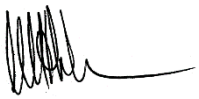
Name : P. van Wanrooij, BASc

The above conclusions have been verified by the following signatory:

Date : 13-01-2025

Name : ing. M.H. Khan

Function : Test Engineer

Signature : 

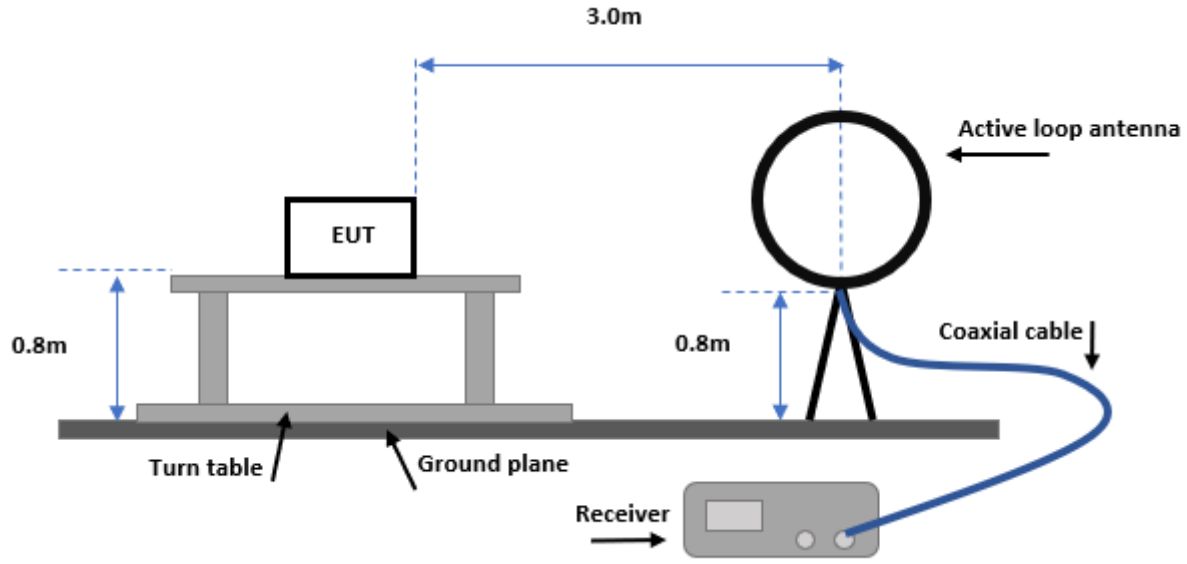
2 Test configuration of the Equipment Under Test

2.1 Test mode

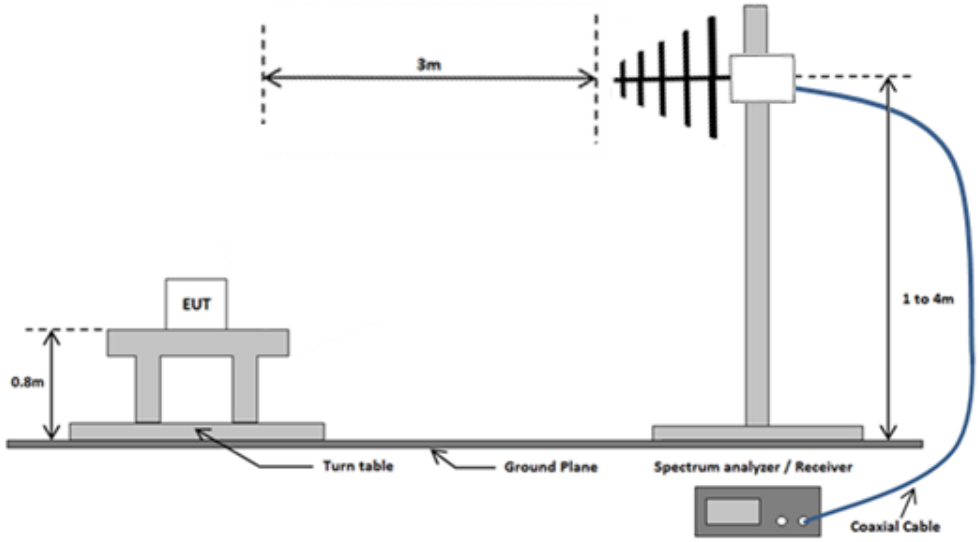
EUT operating at test mode with continuous transmission of modulated signal for subparts 20X.and on idle mode for 10X.

2.2 Test setups

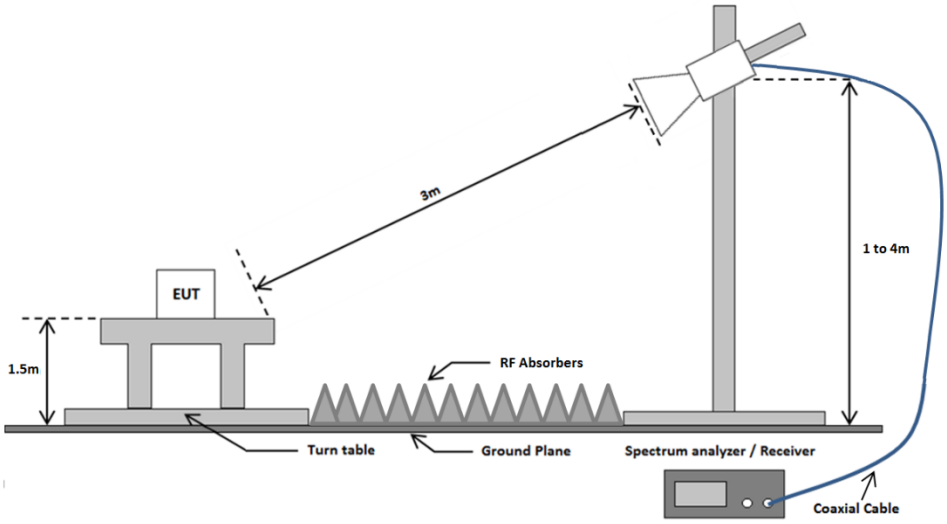
Radiated emissions test setup 9 kHz – 30 MHz



Radiated emissions test setup 30 MHz - 1 GHz

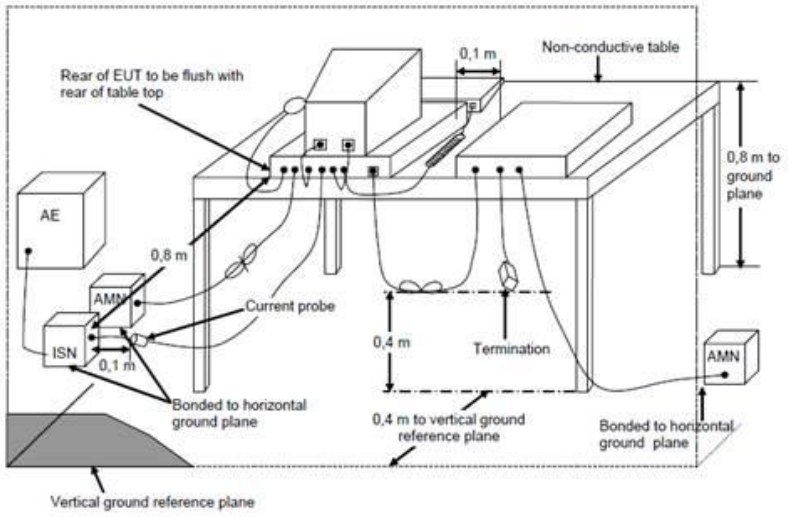


Radiated emissions test setup above 1 GHz



AC Power line conducted emissions test setup

Emissions test at AC mains



Antenna port conducted tests

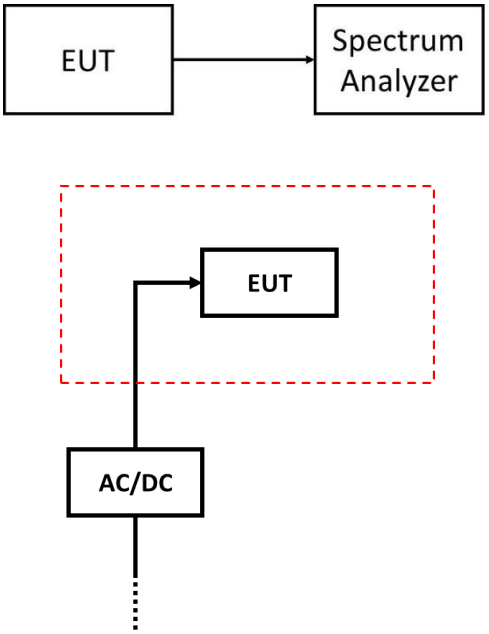


Figure 1. EUT and auxiliary setup

List of used cables					
Number	**Function**	**From**	**To**	**Length**	**Remarks**
1	AC Power	mains 120Vac 60 Hz	AUX1	< 3m	-
2	24 Vdc power	AUX1	EUT	< 3m	-

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	114870	09-2022	09-2024	3.6
EMI Receiver	Rohde & Schwarz	ESR7	114605	07-2022	07-2024	3.1
Spectrum Analyzer	Rohde & Schwarz	FSV3044	114923	10-2023	10-2025	3.1
3.0 GHz HPF	Wainwright	WHK3.0/18G-10EF	114682	09-2021	09-2024	3.1
Biconical antenna + 6dB attenuator	EMCO	3146	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	07-2024	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, 3.6
LISN /Two line V-network	Rohde & Schwarz	ENV 216	114379	11-2023	11-2025	3.6
Spectrum Analyzer	Rohde & Schwarz	FSV3044	115043	03-2022	10-2024	3.2, 3.3, 3.4, 3.5
Switch	Rohde & Schwarz	OSP220	115042	01-2024	01-2027	3.2, 3.3, 3.4, 3.5
Switch	Rohde & Schwarz	OSP150	115041	11-2023	11-2026	3.2, 3.3, 3.4, 3.5

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

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

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 – 13.11 14.01 – 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

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

External Antenna:

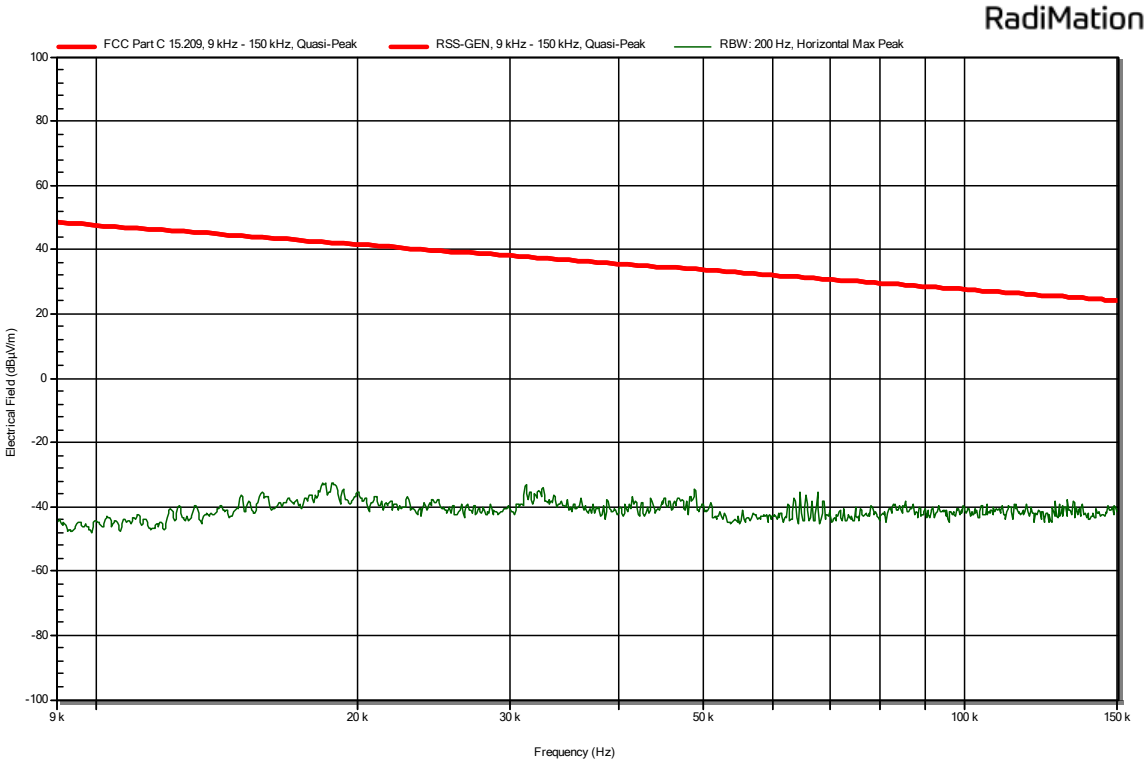
Frequency (MHz)	Peak (dBµV/m)	Quasi-Peak (dBµV/m)	QP Limit (dBµV/m)	Channel	Height (m)	Polarization	Status
42.467	42.5	37.5	40	Mid	1.3	Vertical	Pass
43.467	40.6	37.1	40	Low	1	Vertical	Pass
48.024	45.4	39.1	40	Mid	1	Vertical	Pass
57.016	26.7	18.2	40	Mid	1.8	Vertical	Pass
59.912	27	17.2	40	Low	1.3	Vertical	Pass
67.403	36.9	16.7	40	High	1.8	Vertical	Pass
68.269	34.3	17.7	40	Mid	1.8	Vertical	Pass
74.847	37.9	32.4	40	Low	1	Vertical	Pass

Internal Antenna:

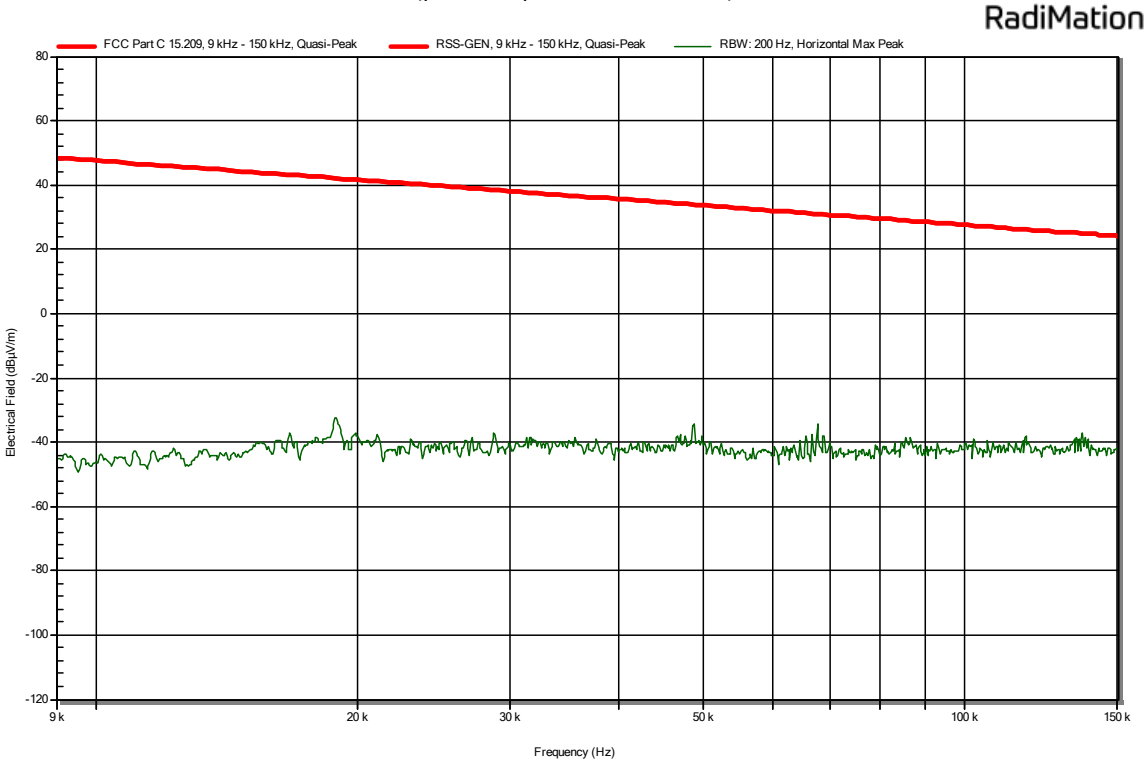
Frequency (MHz)	Peak (dBµV/m)	Quasi-Peak (dBµV/m)	QP Limit (dBµV/m)	Channel	Height (m)	Polarization	Status
30.23	40.3	23.4	40	Low	1.8	Vertical	Pass
42.368	39.4	36.2	40	Low	1	Vertical	Pass
43.573	40.4	37.1	40	Low	1	Vertical	Pass
46.991	39.2	33.7	40	Low	1	Vertical	Pass
50.635	34.7	26.6	40	Mid	1.3	Vertical	Pass
66.856	33	11.3	40	Mid	2.7	Horizontal	Pass
67.303	34	14.4	40	Mid	2.2	Vertical	Pass
92.974	35.4	30.9	43.5	Low	1	Vertical	Pass

The results of the radiated emission tests are depicted in the tables above. A selection of plots is provided on the next pages.
No High-pass filter was used on the internal antenna 1 – 18 GHz tests to show the carrier in the 3 channels.

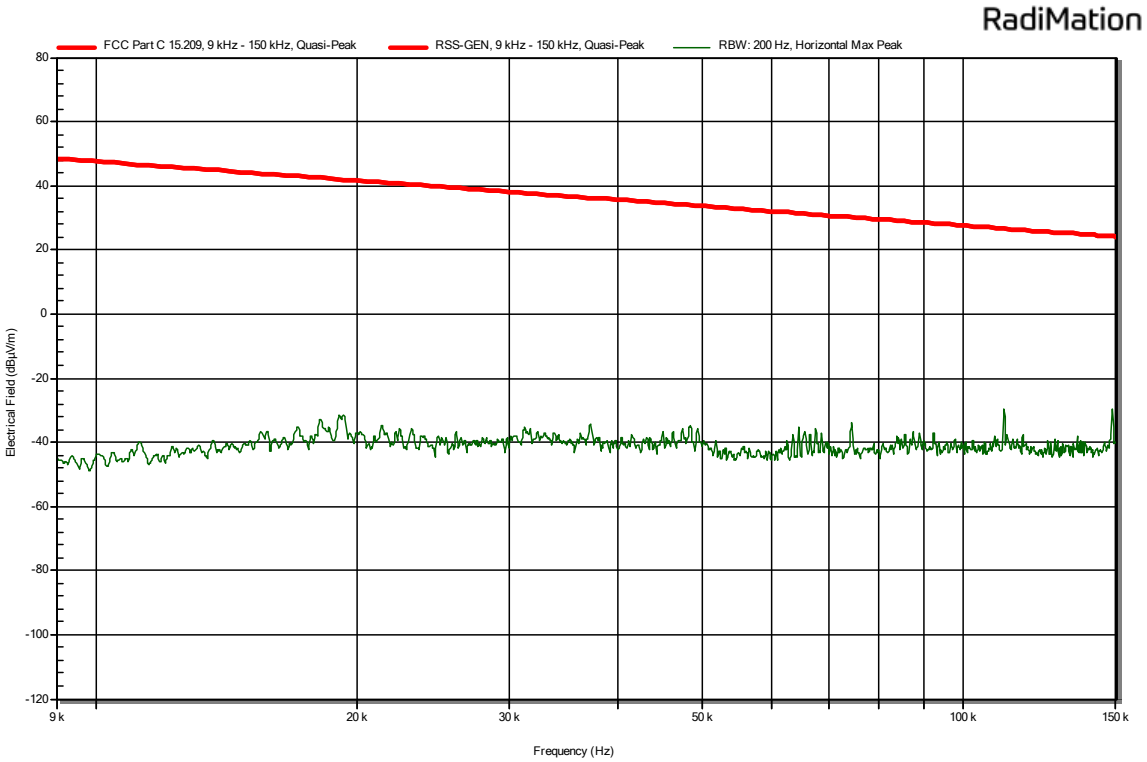
3.1.7 Plots of the Radiated Spurious Emissions Measurement



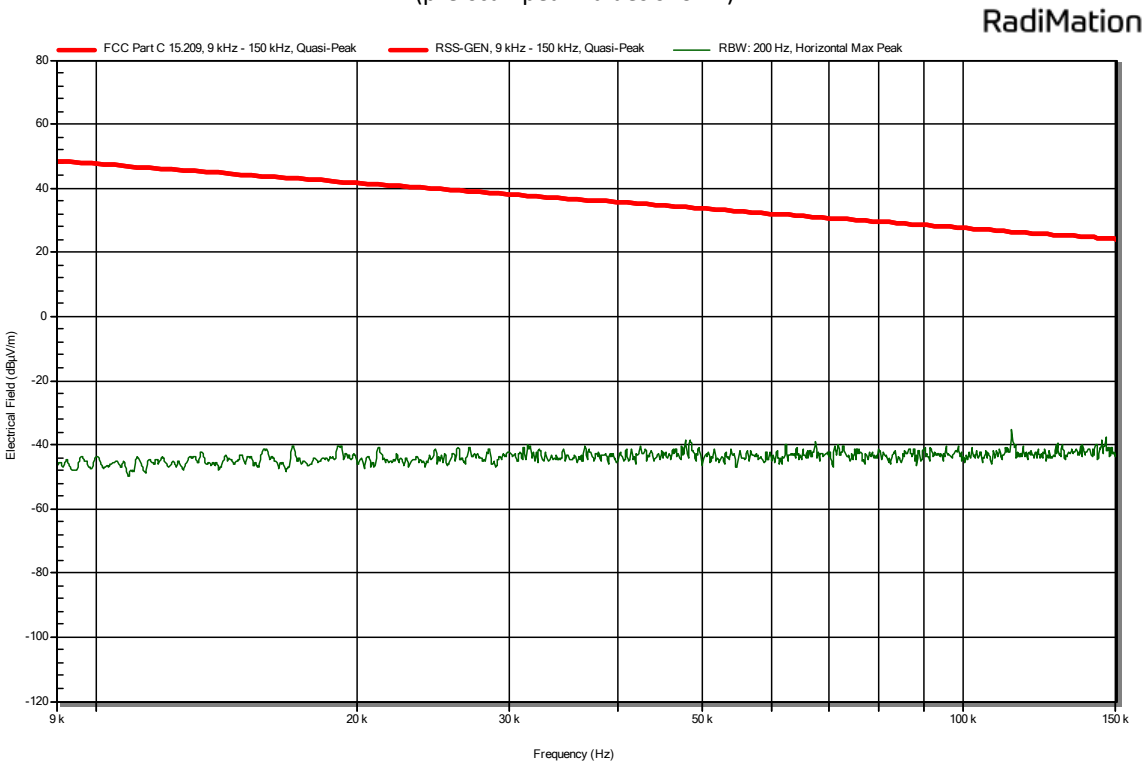
Plot 1: radiated emissions of the EUT (External Antenna), Antenna perpendicular, in the range 9 – 150KHz (pre-scan peak values shown)



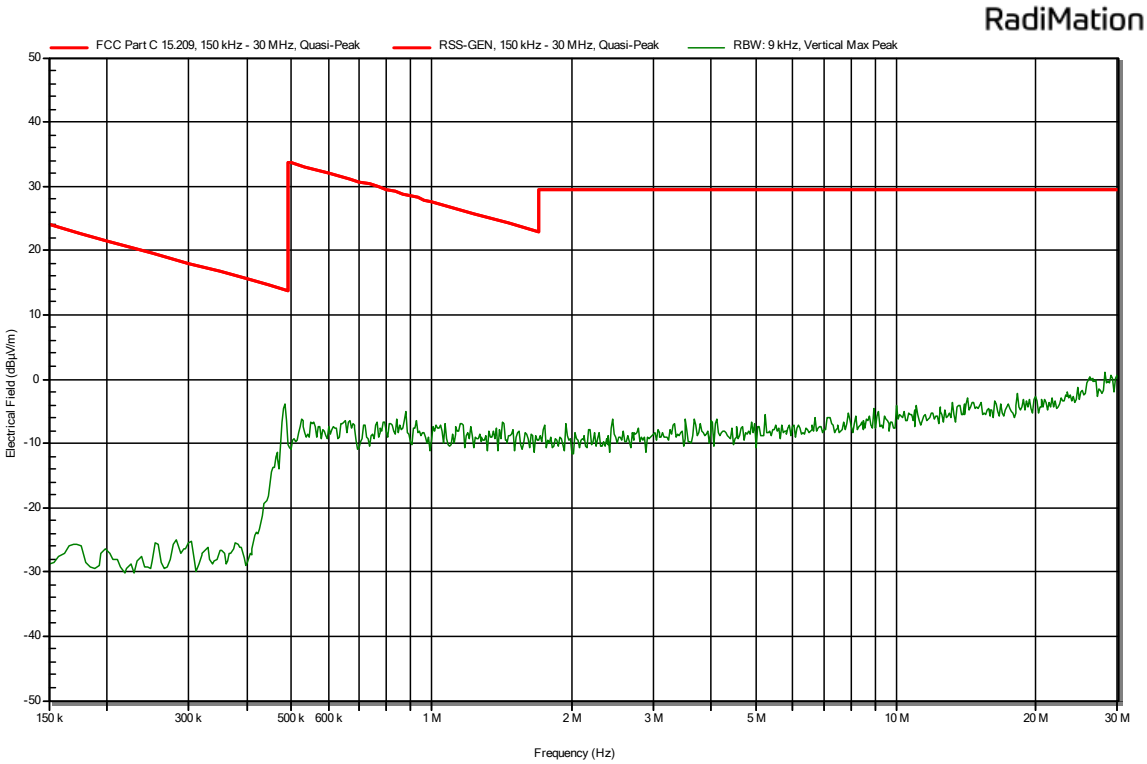
Plot 2: radiated emissions of the EUT (External Antenna), Antenna parallel, in the range 9 – 150KHz (pre-scan peak values shown)



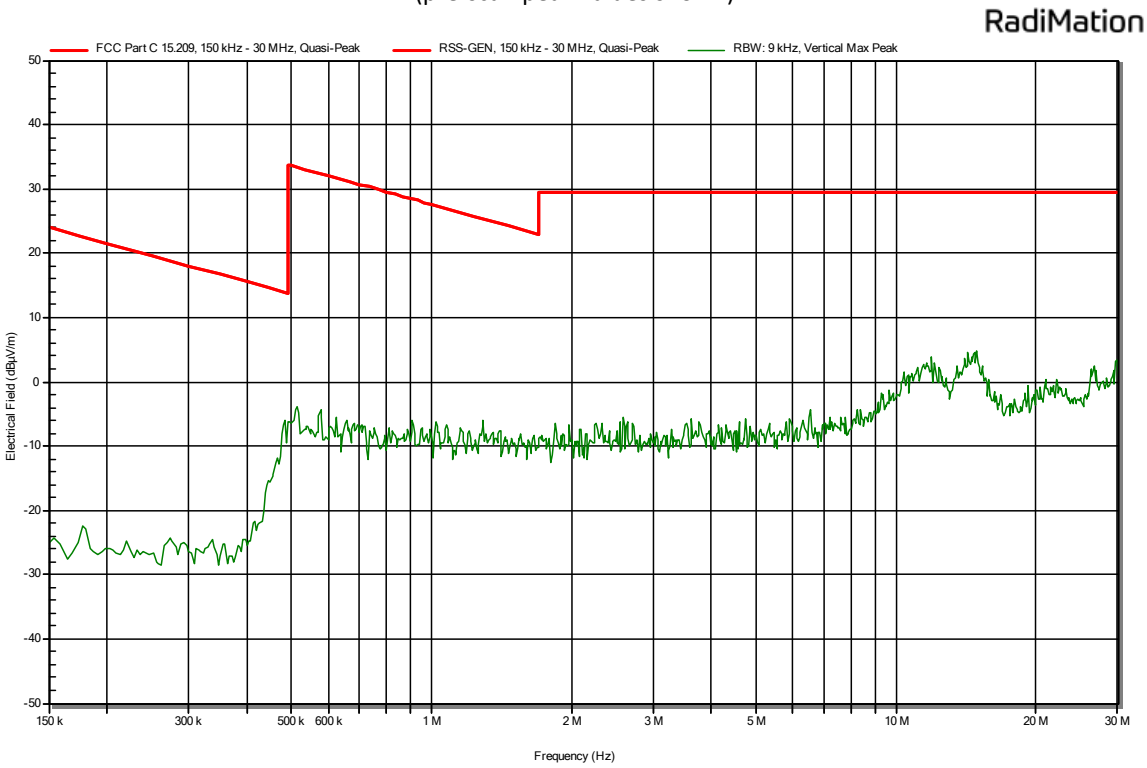
Plot 3: radiated emissions of the EUT (Internal Antenna), Antenna perpendicular, in the range 9 – 150KHz (pre-scan peak values shown)



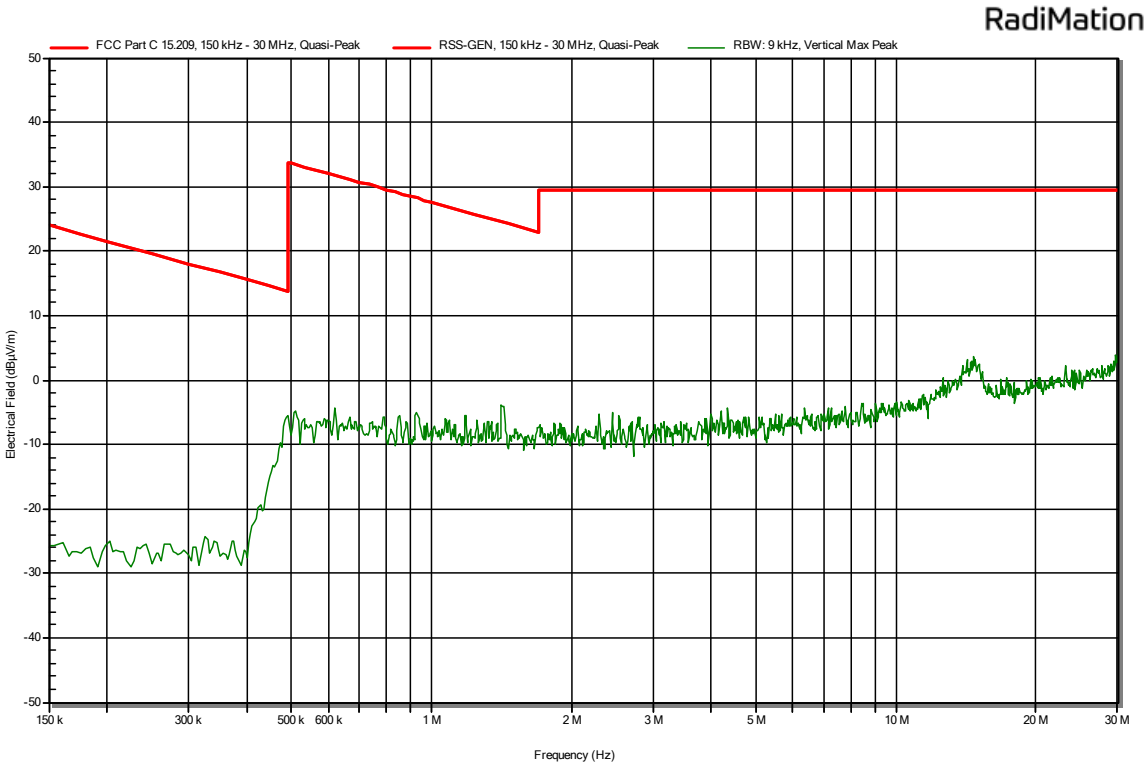
Plot 4: radiated emissions of the EUT (Internal Antenna), Antenna parallel, in the range 9 – 150KHz (pre-scan peak values shown)



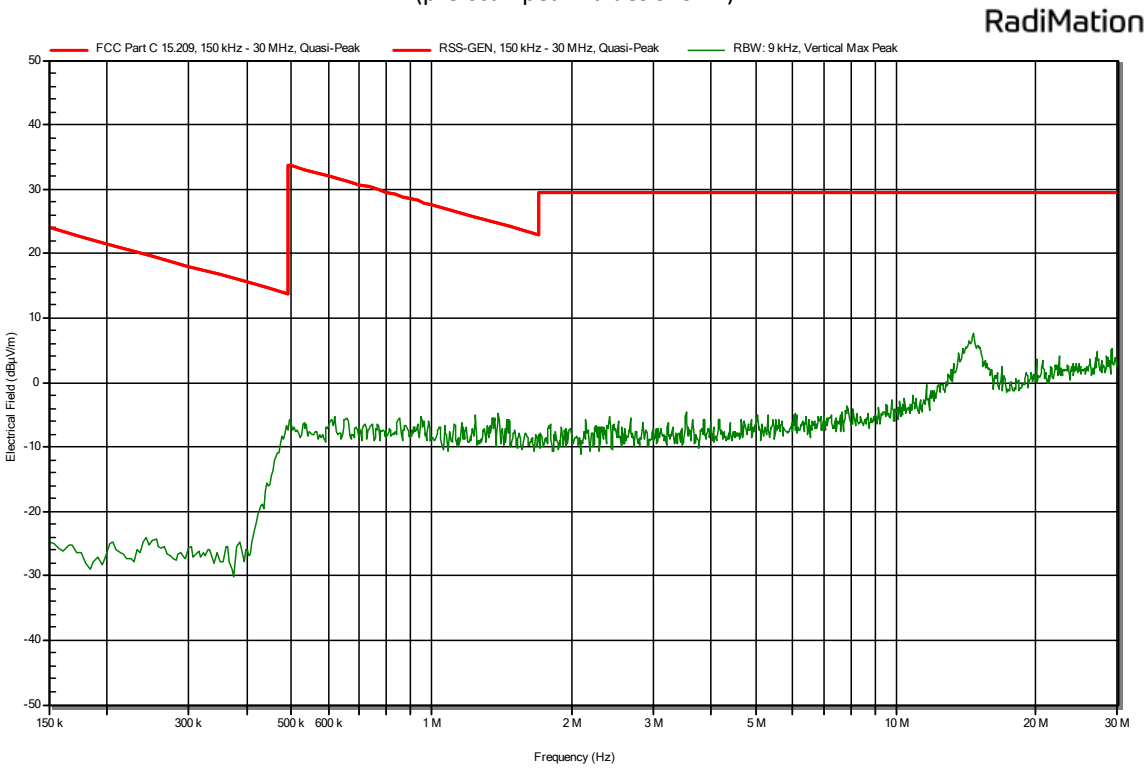
Plot 5: radiated emissions of the EUT (External Antenna), Antenna perpendicular, in the range 150KHz-30 MHz (pre-scan peak values shown)



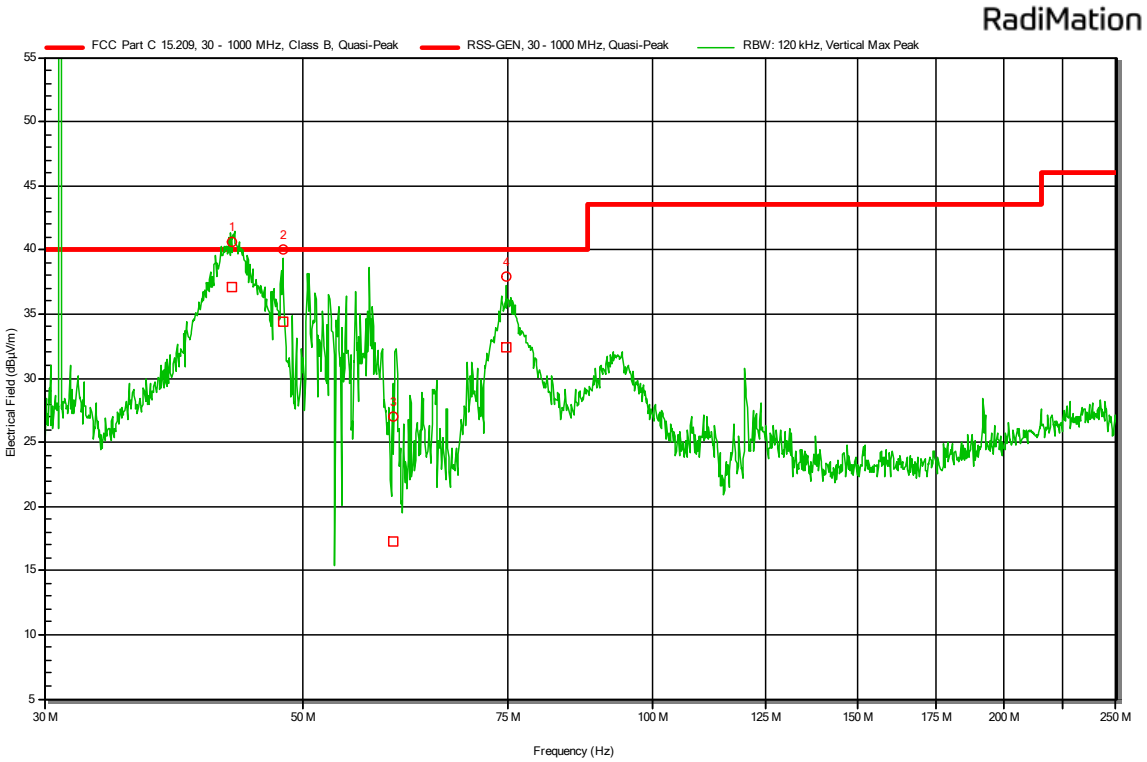
Plot 6: radiated emissions of the EUT (External Antenna), Antenna parallel, in the range 150KHz-30 MHz (pre-scan peak values shown)



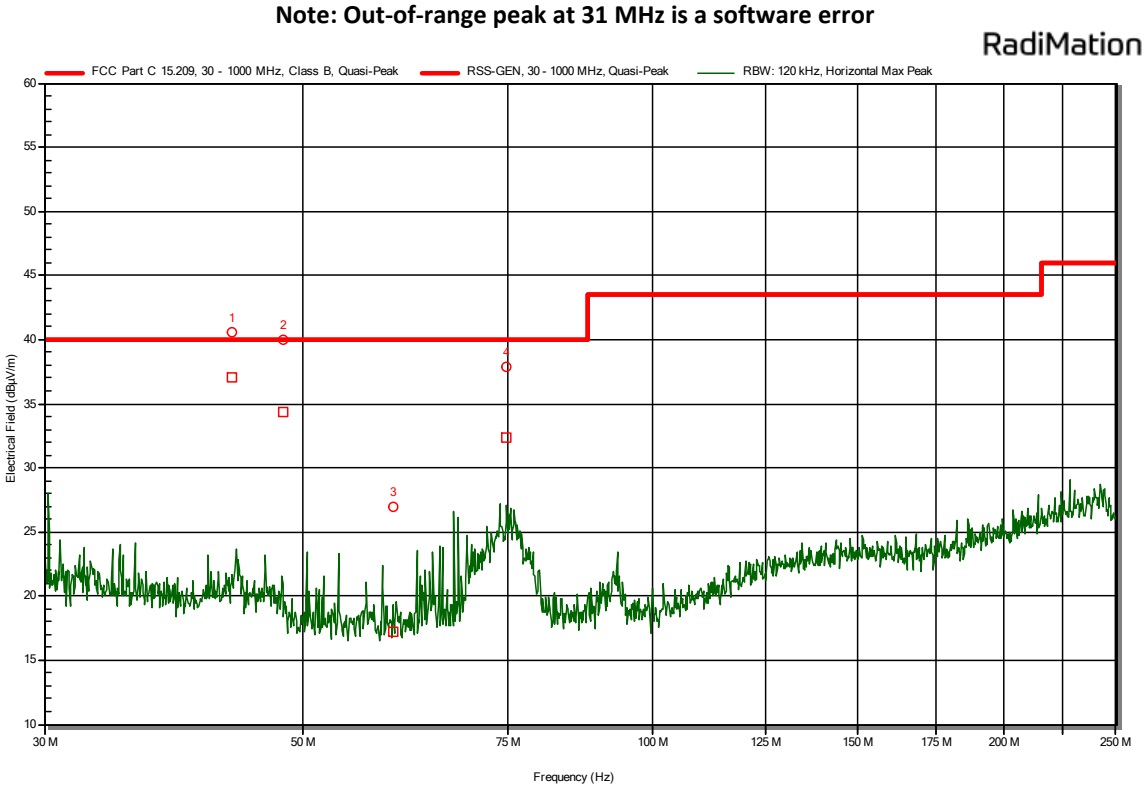
Plot 7: radiated emissions of the EUT (Internal Antenna), Antenna perpendicular, in the range 150KHz-30 MHz (pre-scan peak values shown)



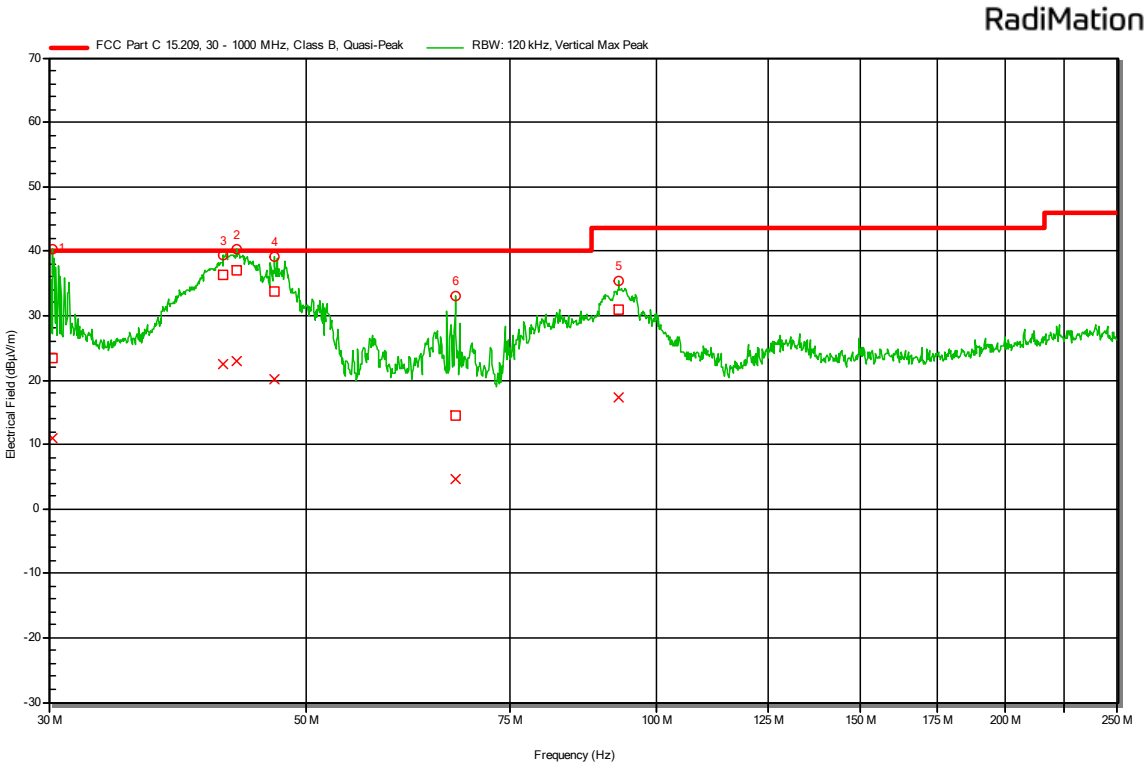
Plot 8: radiated emissions of the EUT (Internal Antenna), Antenna parallel, in the range 150KHz-30 MHz (pre-scan peak values shown)



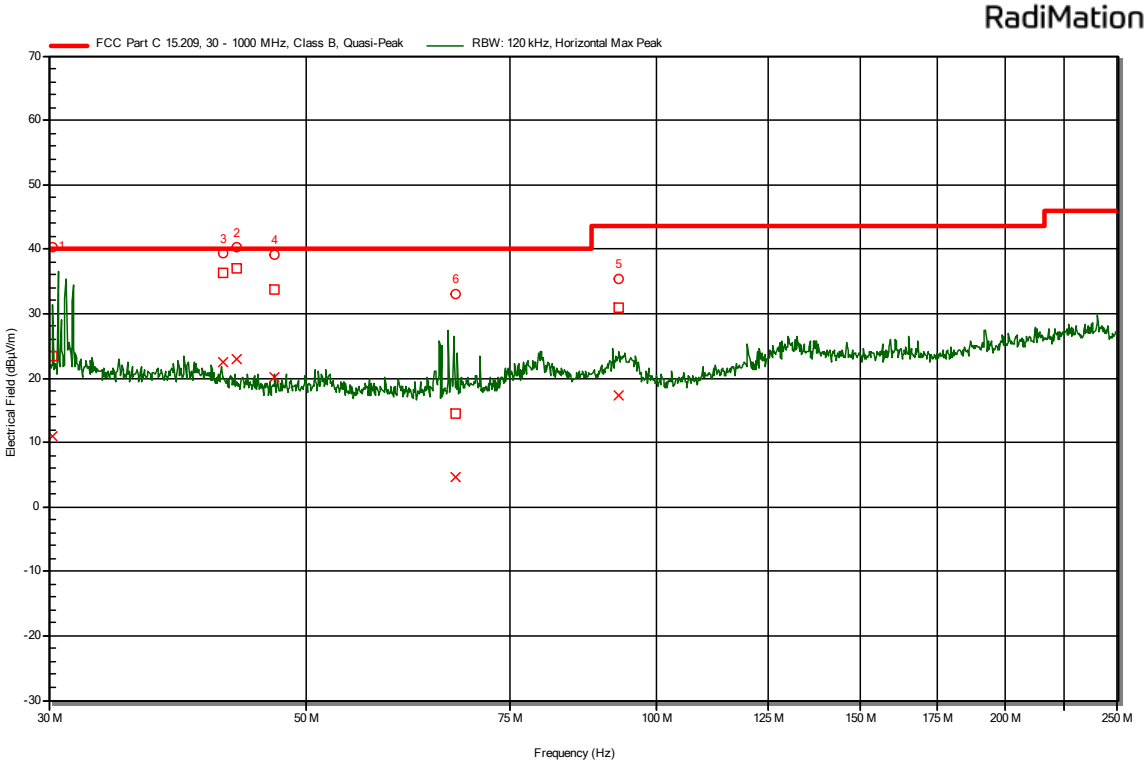
Plot 9: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 30 – 250 MHz (pre-scan peak values shown)
Low channel
Note: Out-of-range peak at 31 MHz is a software error



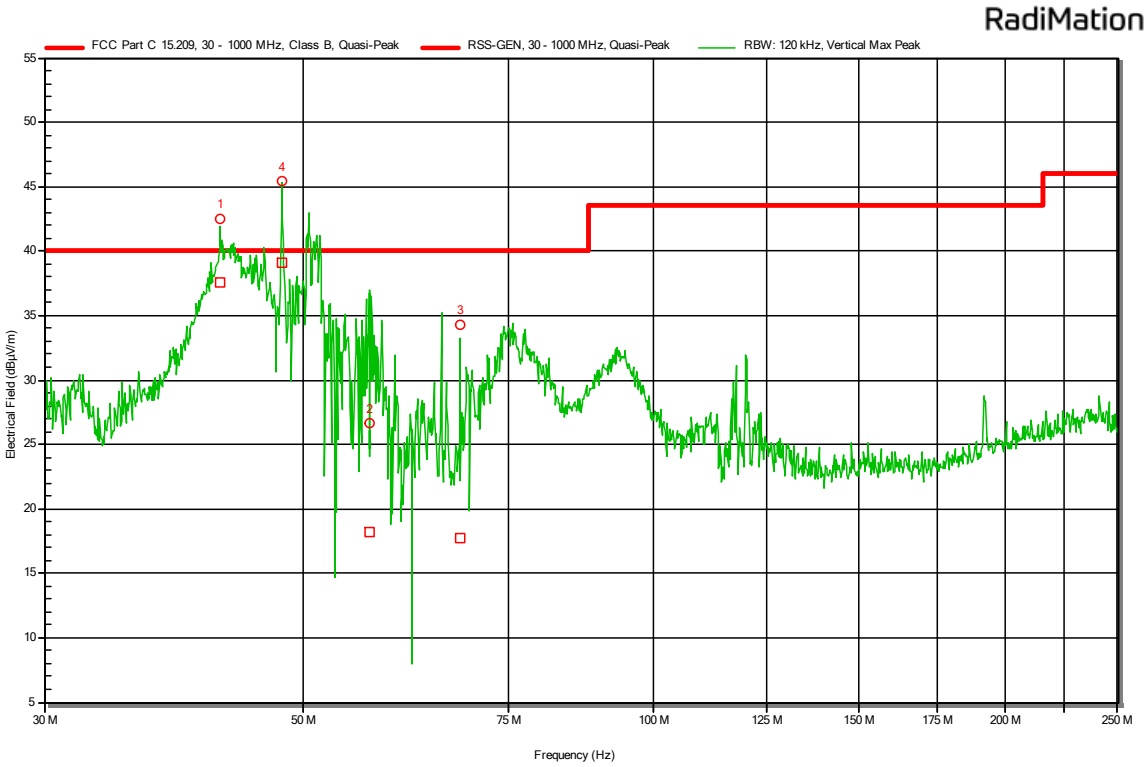
Plot 10: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 30 – 250 MHz (pre-scan peak values shown)
Low channel



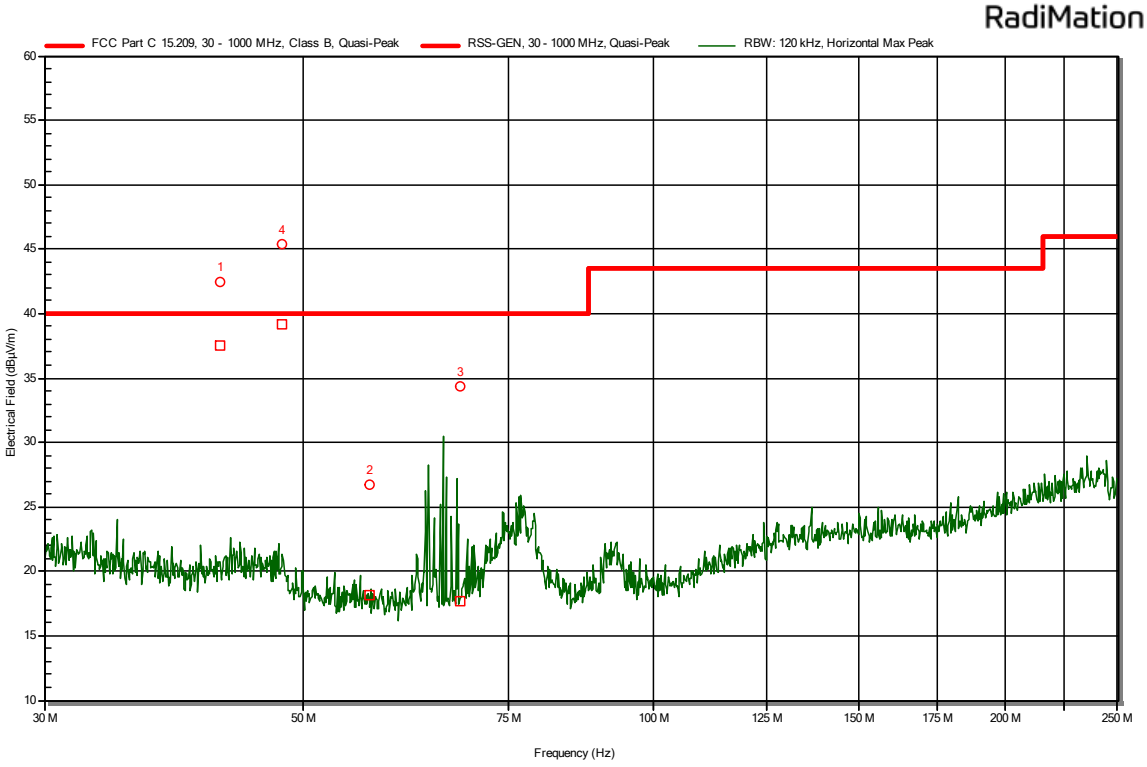
Plot 11: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 30 – 250 MHz (pre-scan peak values shown)
Low channel



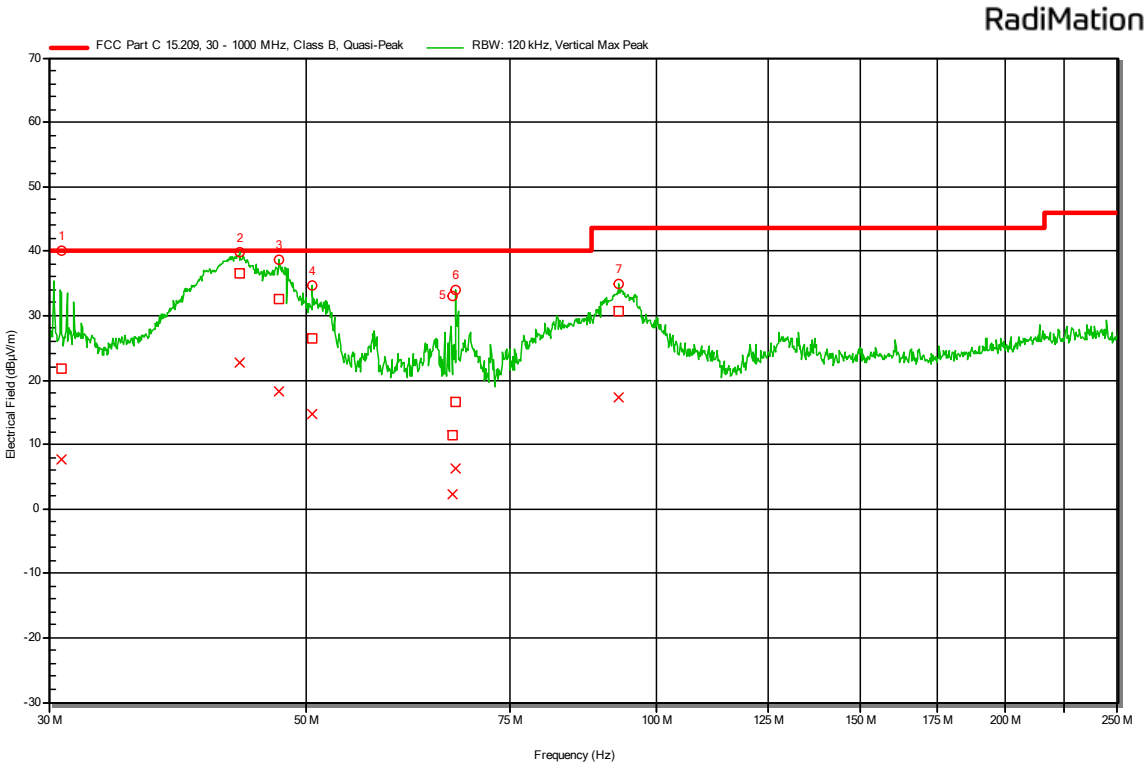
Plot 12: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 30 – 250 MHz (pre-scan peak values shown)
Low channel



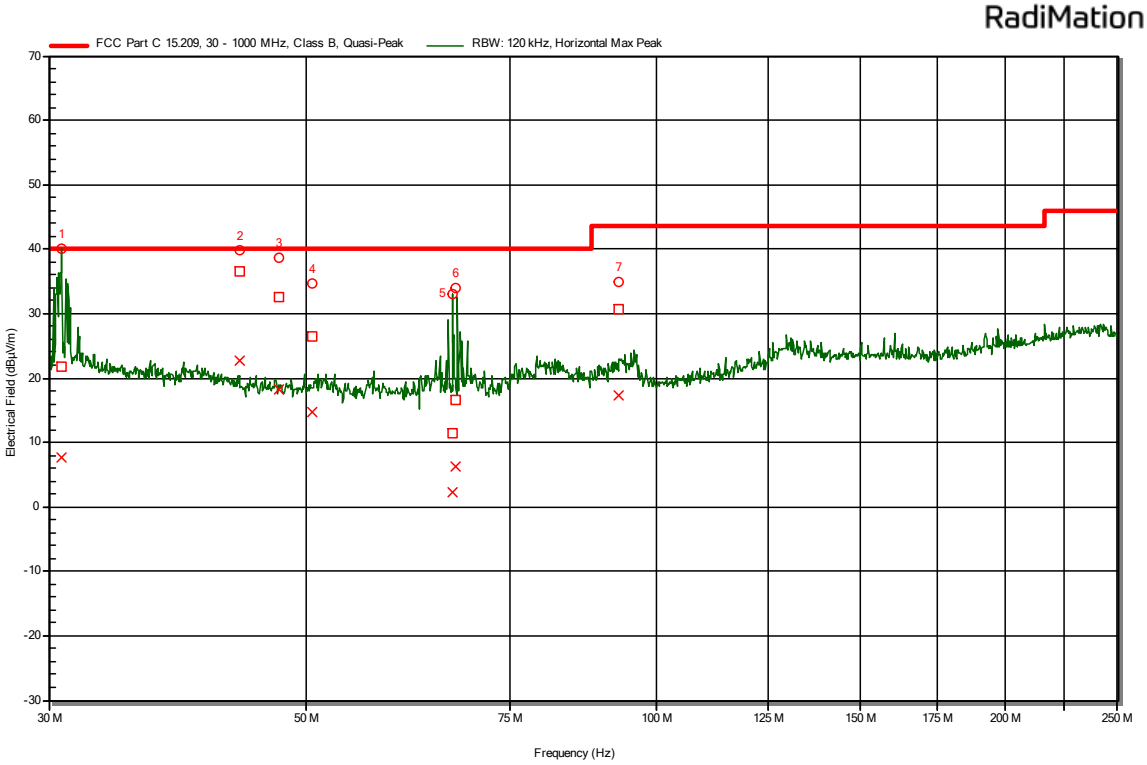
Plot 13: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 30 – 250 MHz (pre-scan peak values shown)
Middle channel



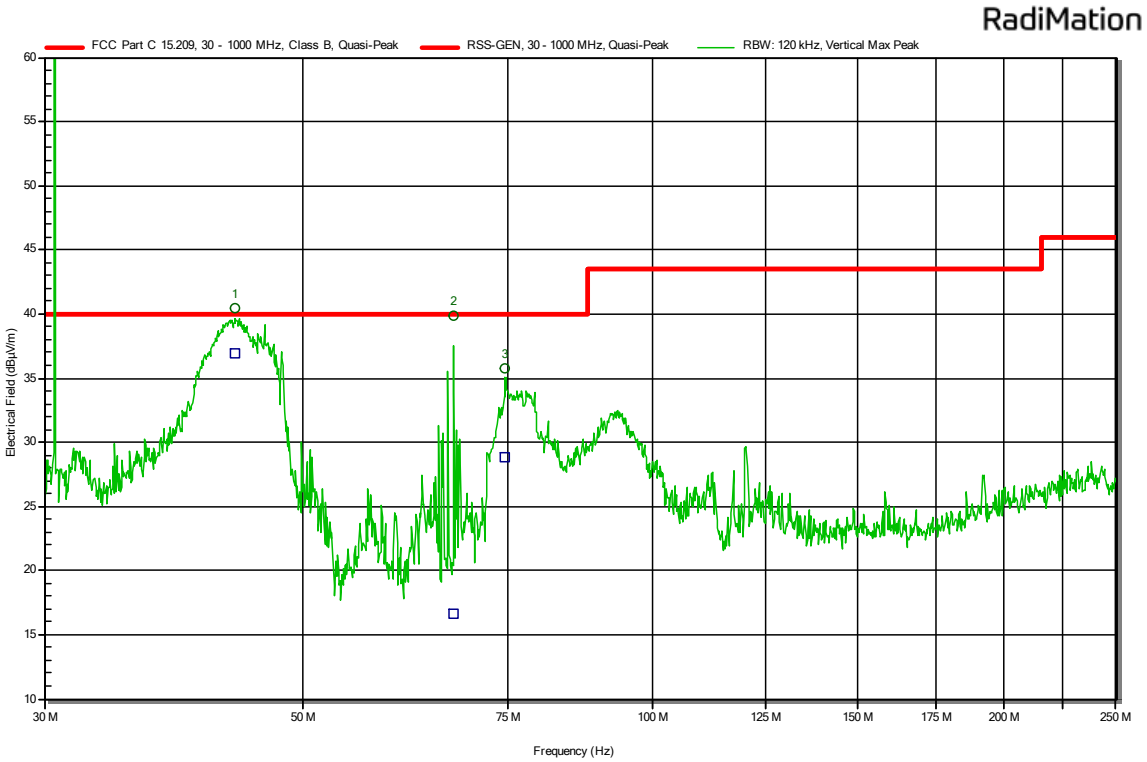
Plot 14: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 30 – 250 MHz (pre-scan peak values shown)
Middle channel



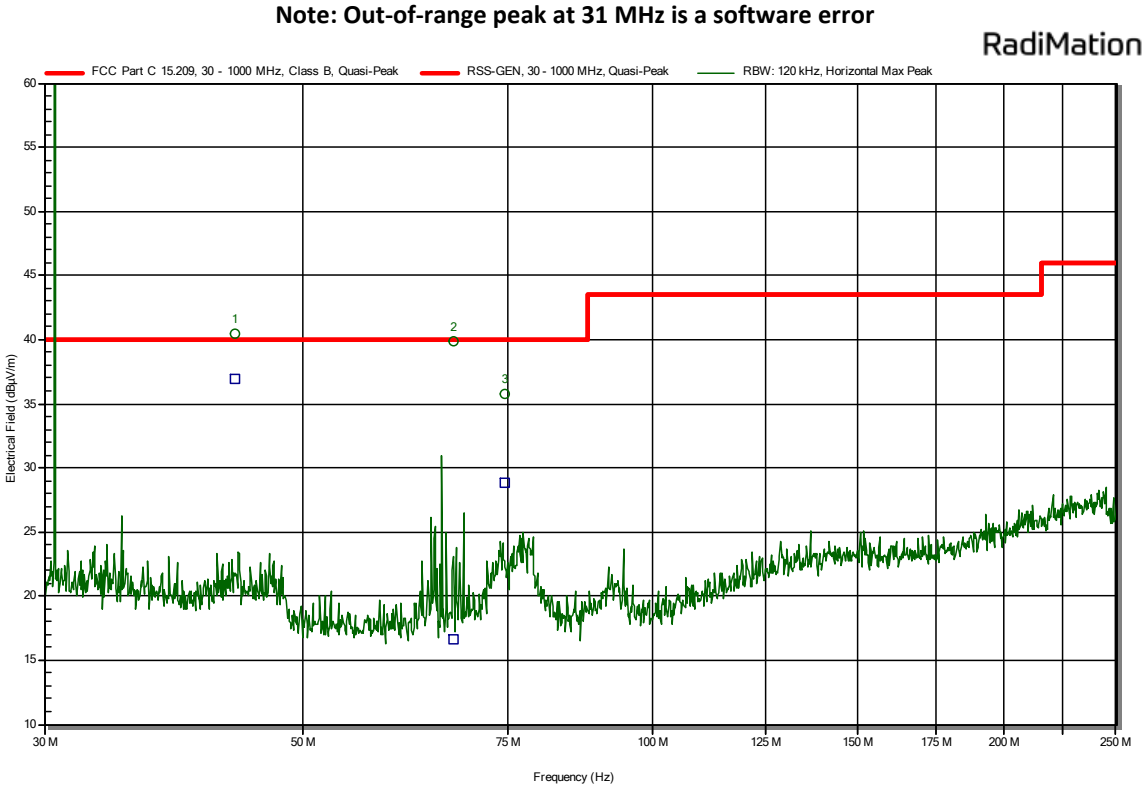
Plot 15: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 30 – 250 MHz (pre-scan peak values shown)
Middle channel



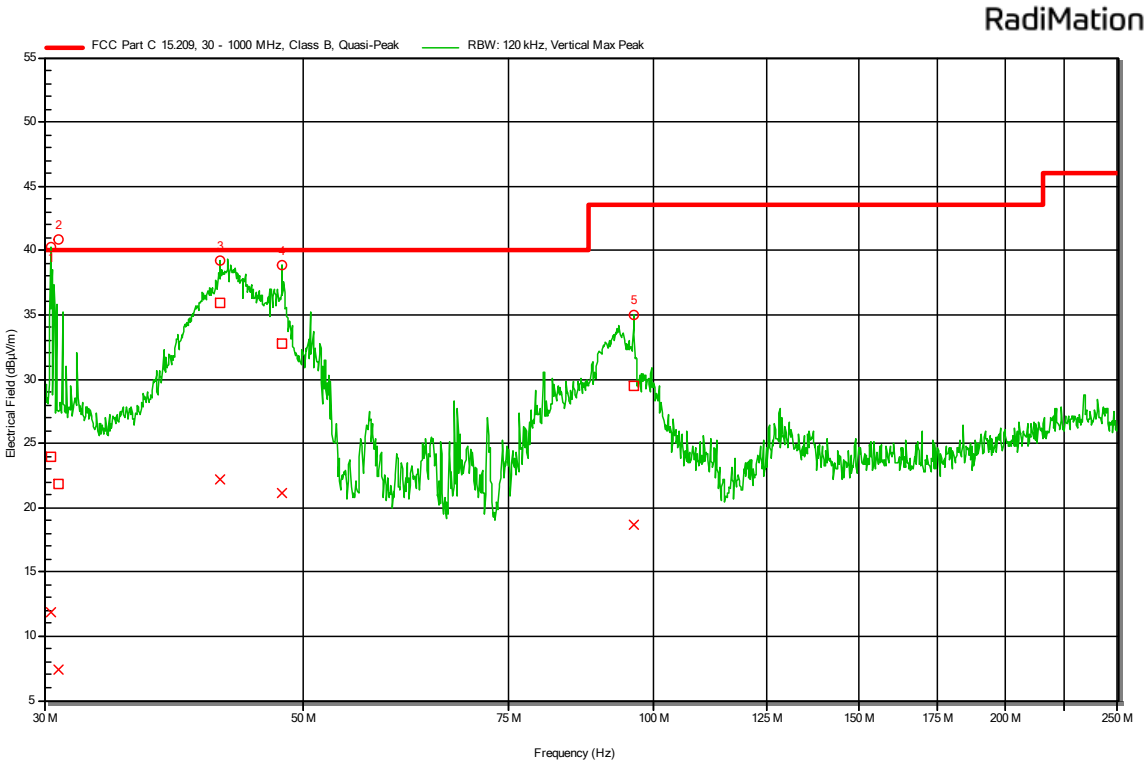
Plot 16: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 30 – 250 MHz (pre-scan peak values shown)
Middle channel



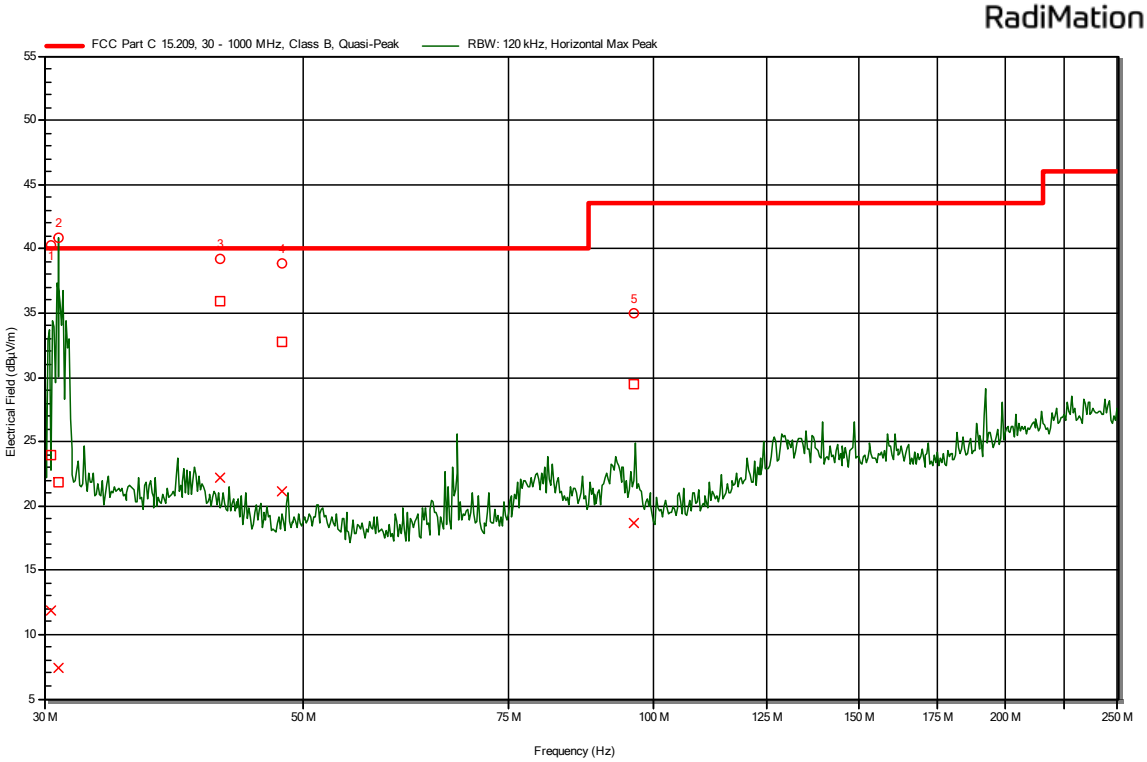
Plot 17: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 30 – 250 MHz (pre-scan peak values shown)
High channel
Note: Out-of-range peak at 31 MHz is a software error



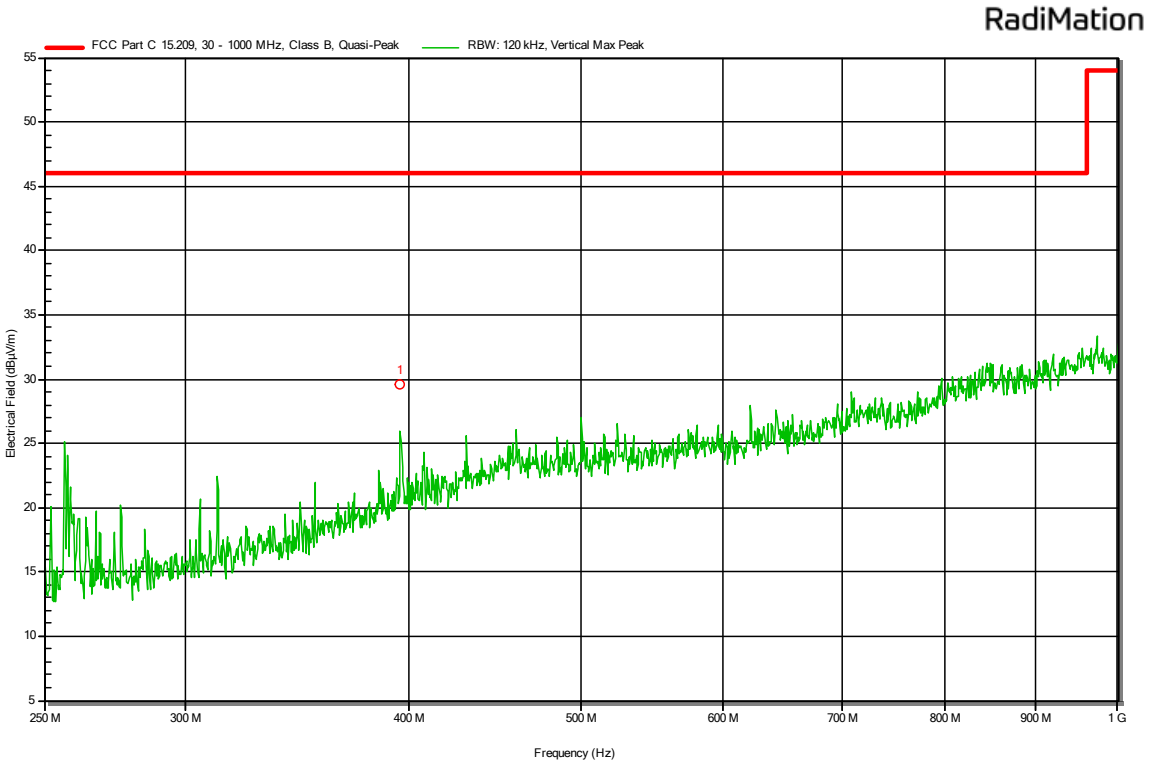
Plot 18: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 30 – 250 MHz (pre-scan peak values shown)
High channel
Note: Out-of-range peak at 31 MHz is a software error



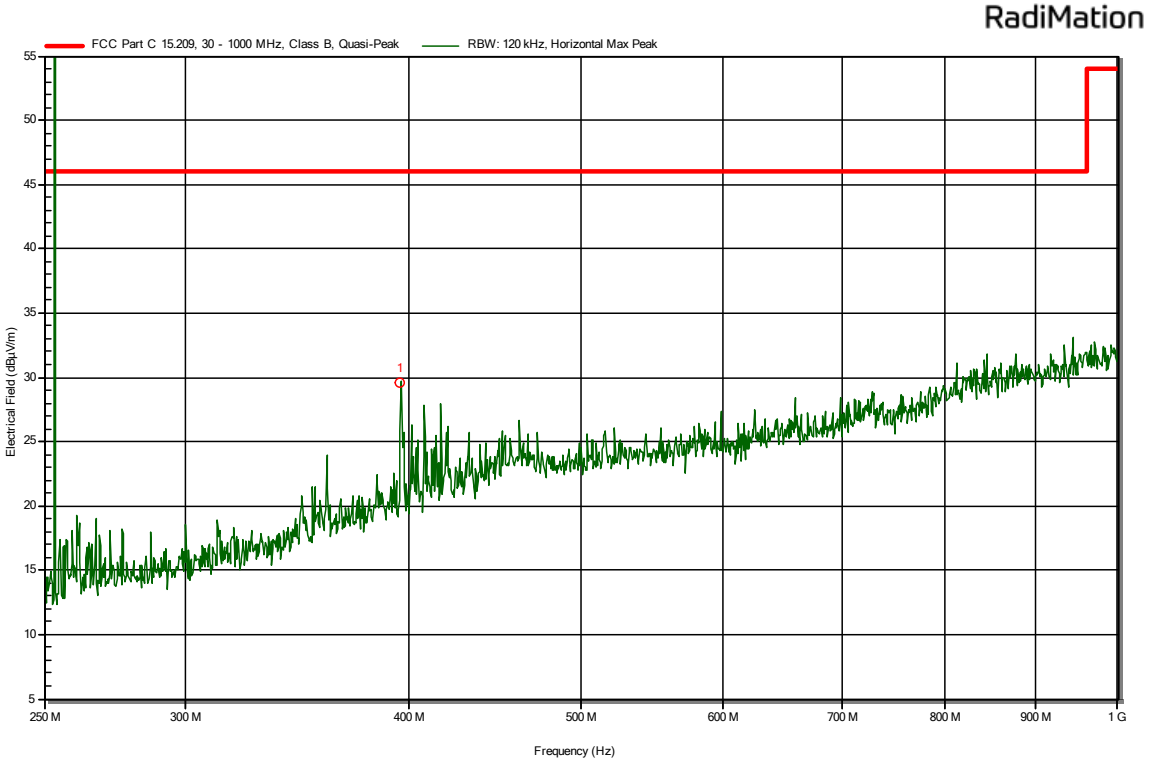
Plot 19: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 30 – 250 MHz (pre-scan peak values shown)
High channel



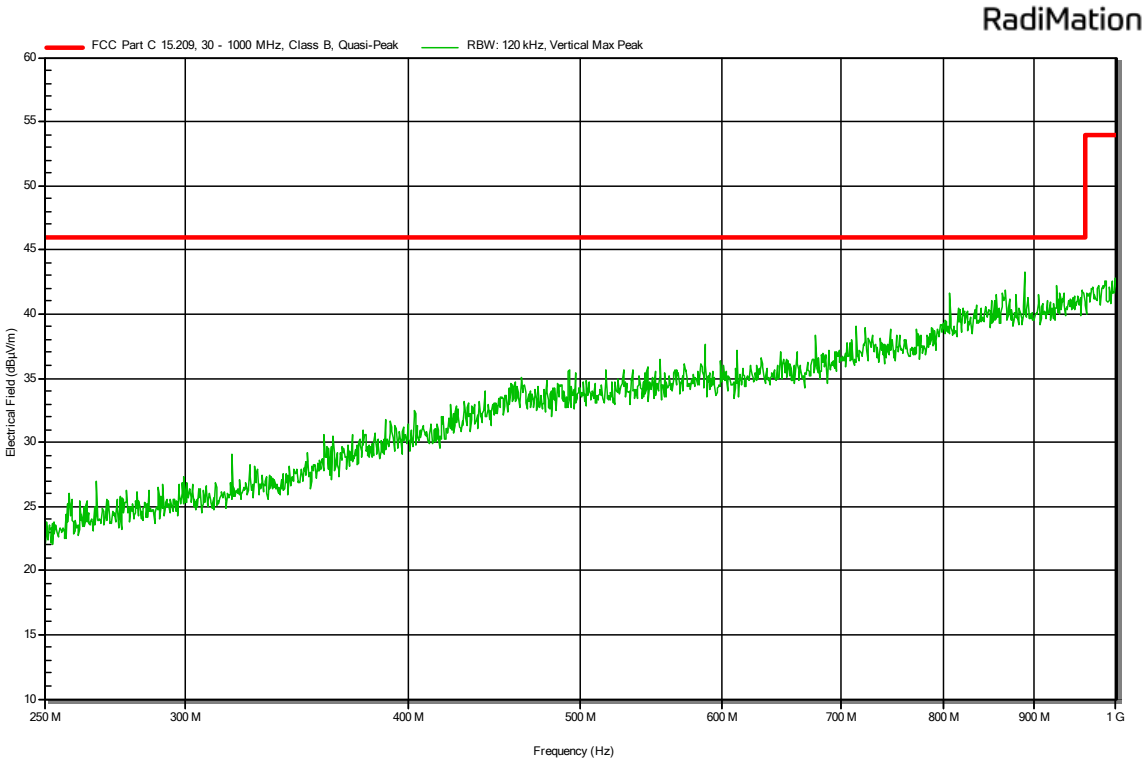
Plot 20: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 30 – 250 MHz (pre-scan peak values shown)
High channel



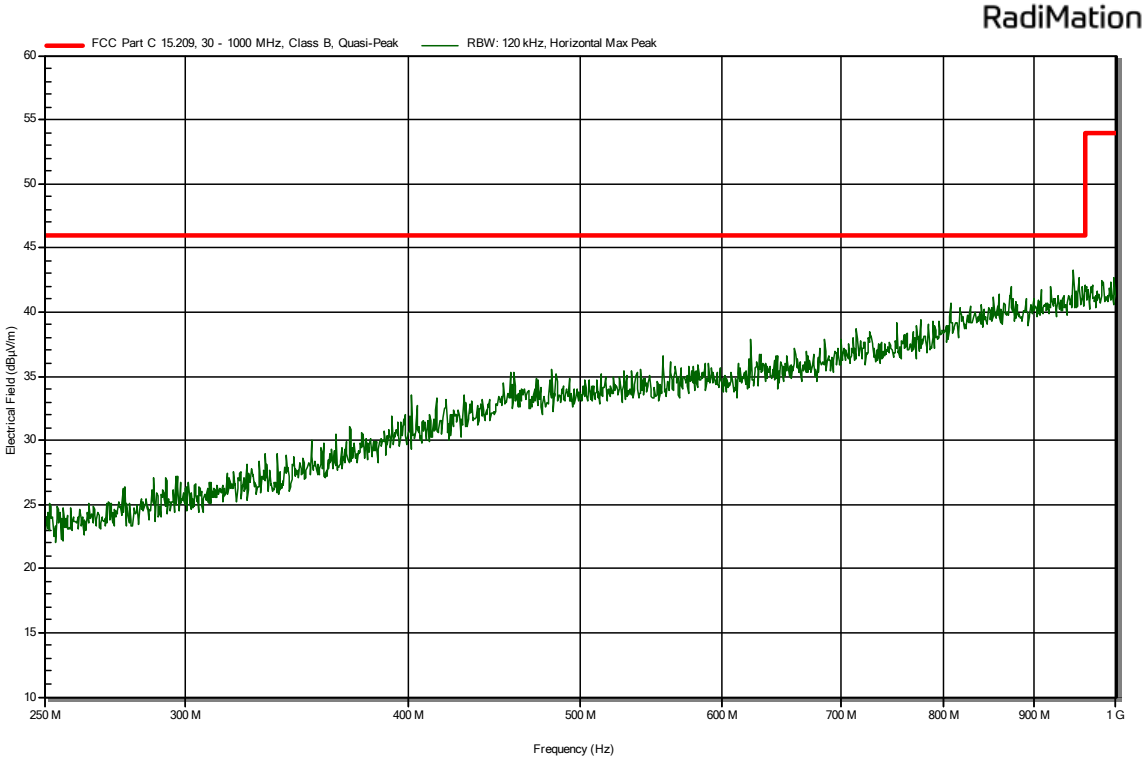
Plot 21: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 250-1000 MHz (pre-scan peak values shown)
Low channel



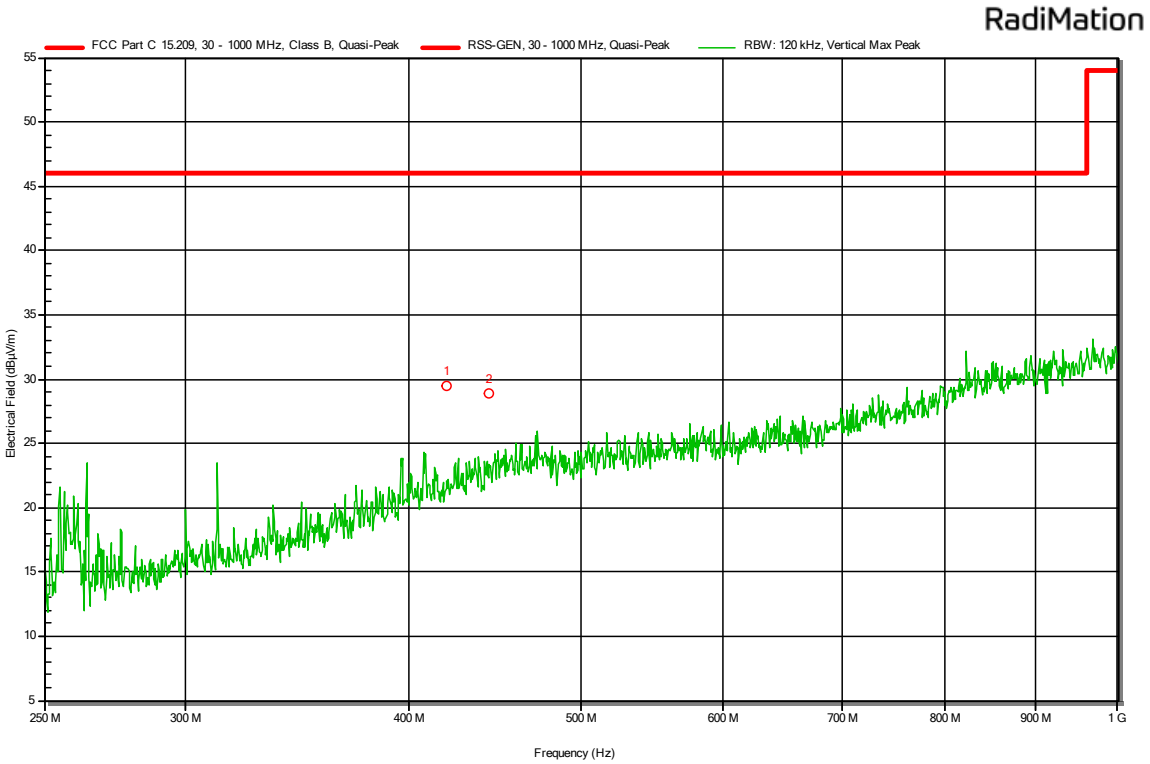
Plot 22: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 250-1000 MHz (pre-scan peak values shown)
Low channel
Note: Out-of-range peak at 251 MHz is a software error



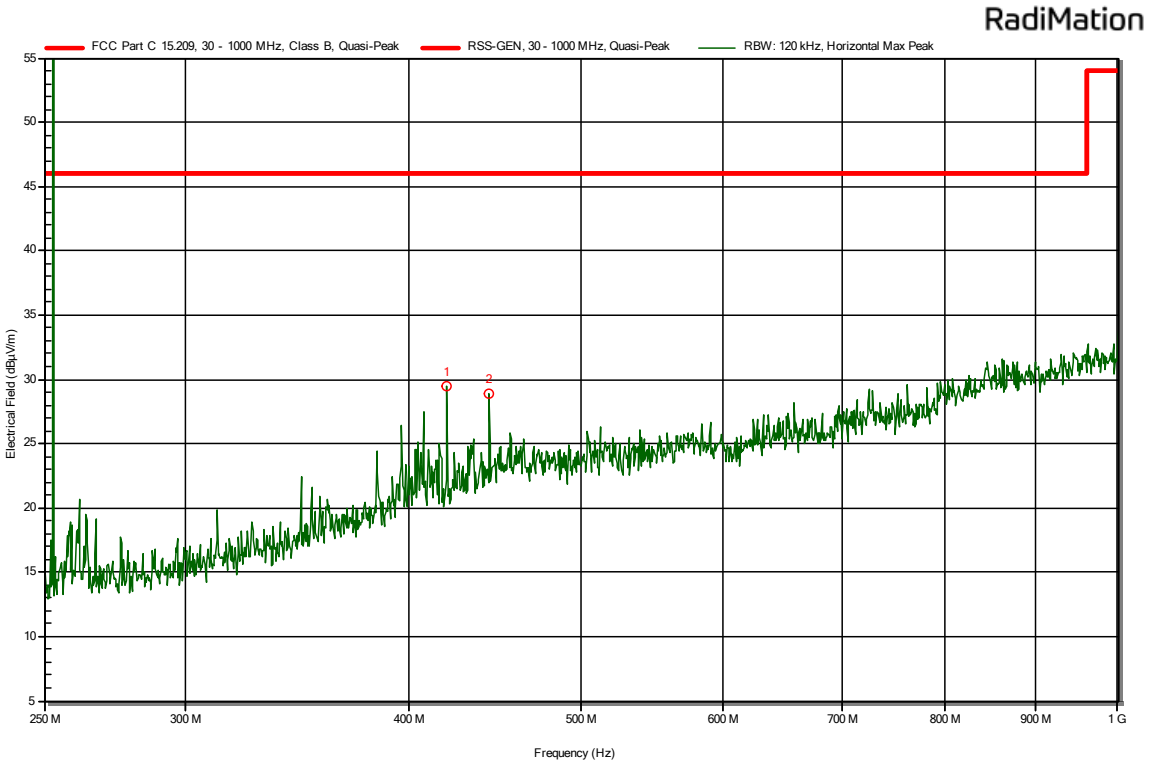
Plot 23: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 250-1000 MHz (pre-scan peak values shown)
Low channel



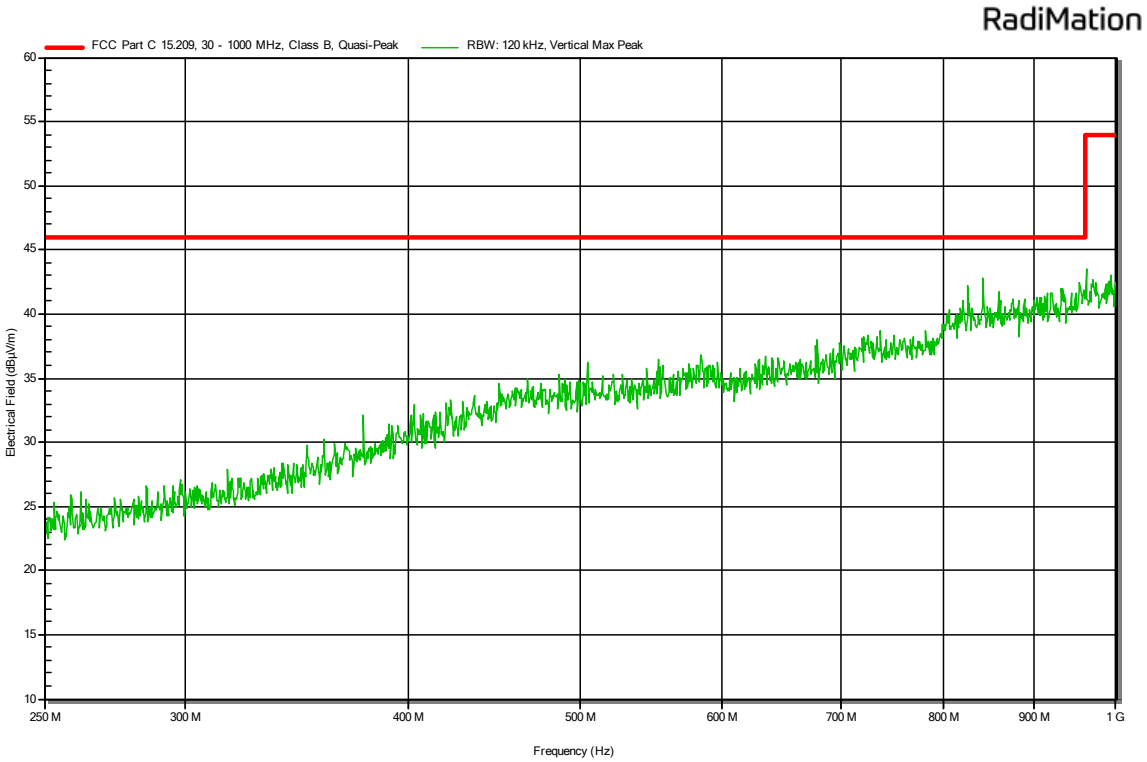
Plot 24: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 250-1000 MHz (pre-scan peak values shown)
Low channel



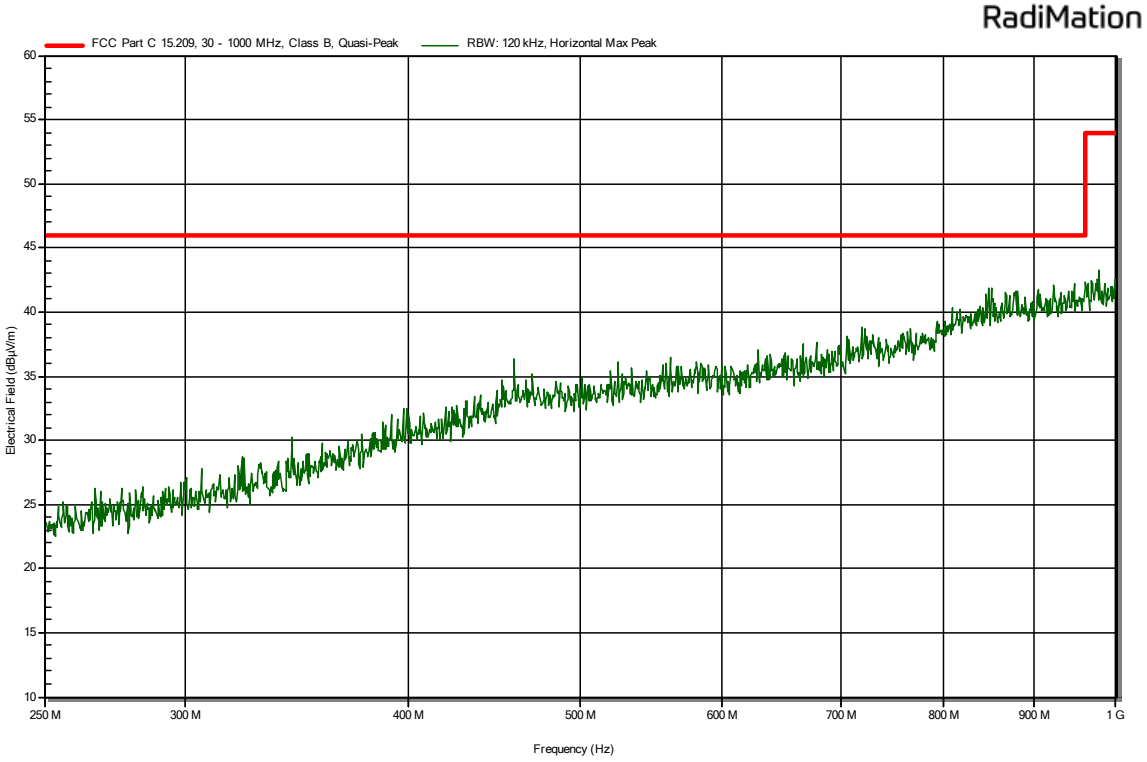
Plot 25: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 250-1000 MHz (pre-scan peak values shown)
Middle channel



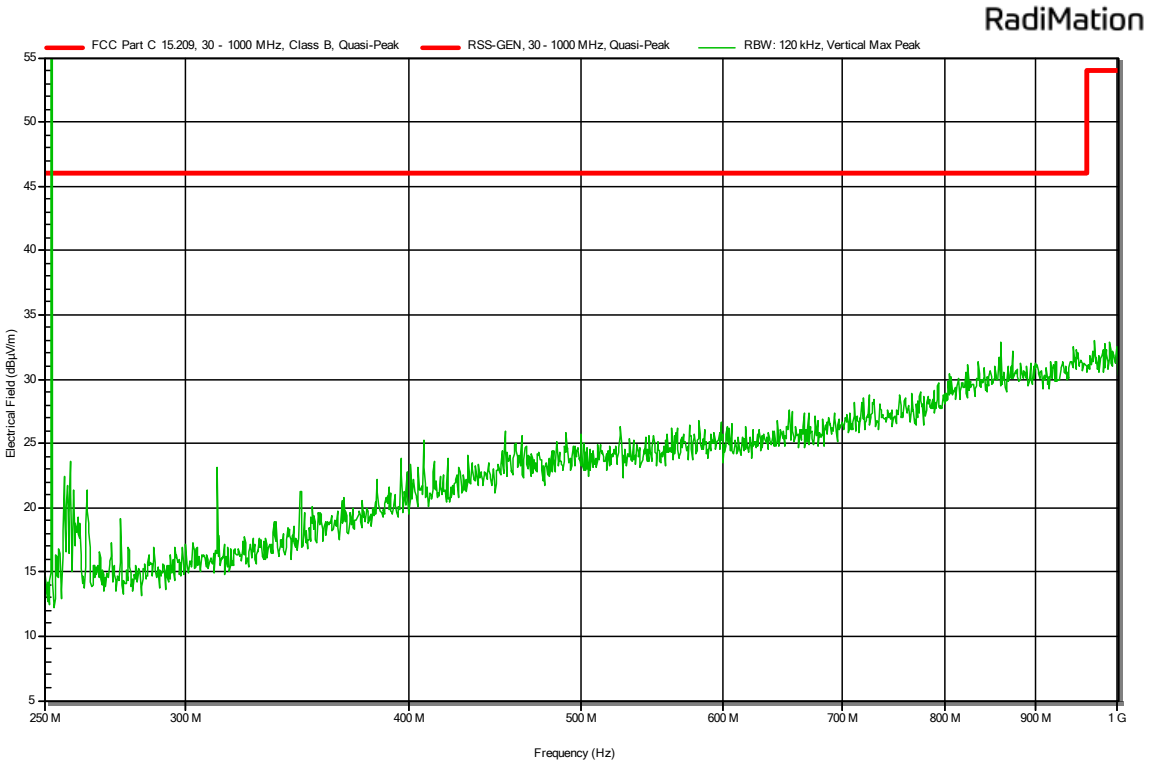
Plot 26: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 250-1000 MHz (pre-scan peak values shown)
Middle channel
Note: Out-of-range peak at 251 MHz is a software error



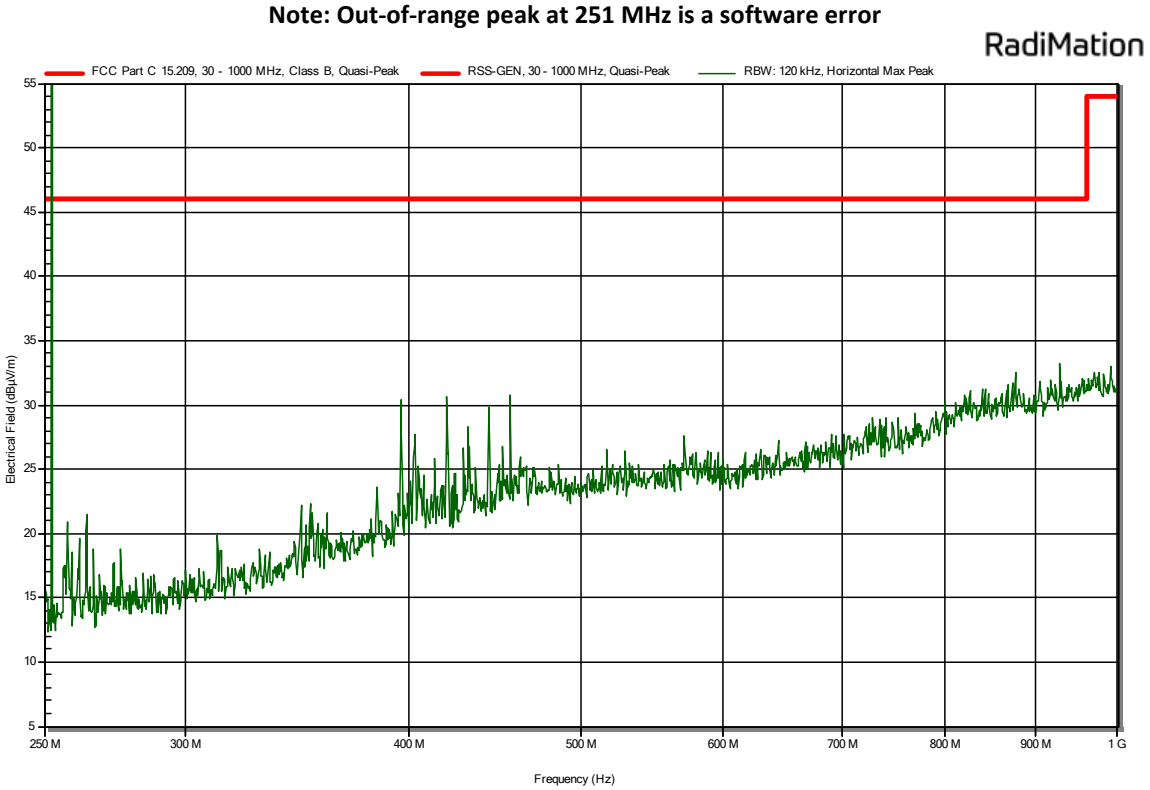
Plot 27: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 250-1000 MHz (pre-scan peak values shown)
Middle channel



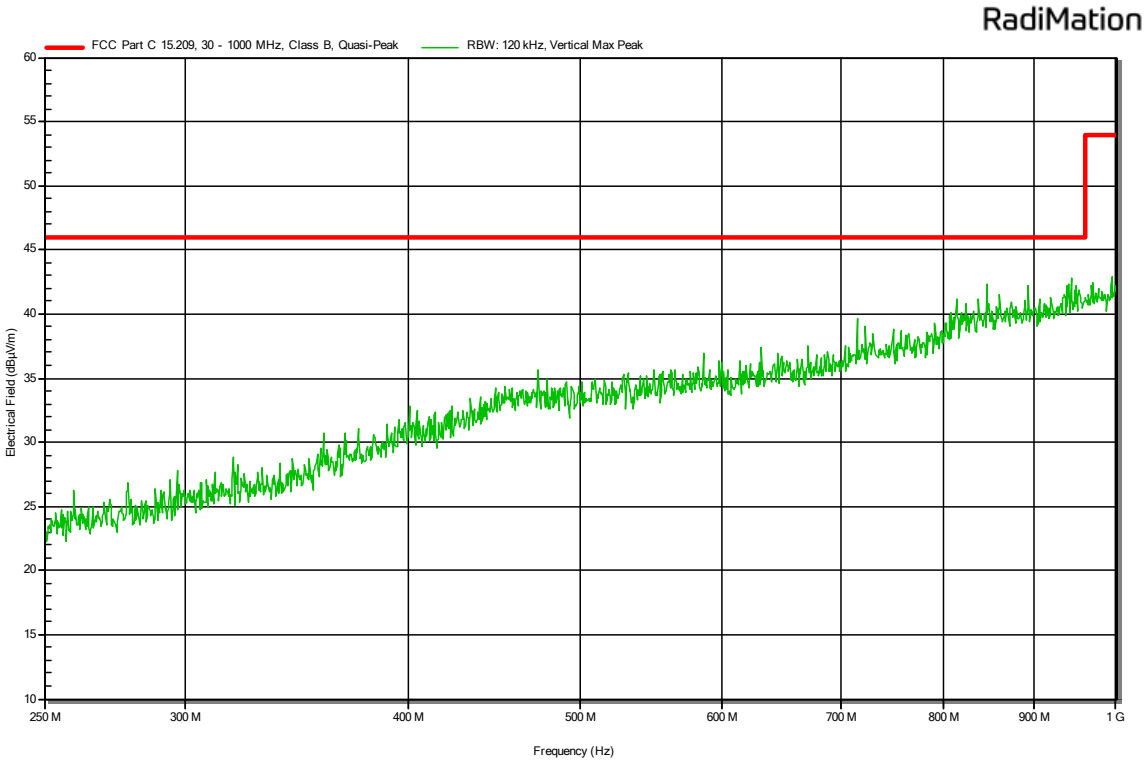
Plot 28: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 250-1000 MHz (pre-scan peak values shown)
Middle channel



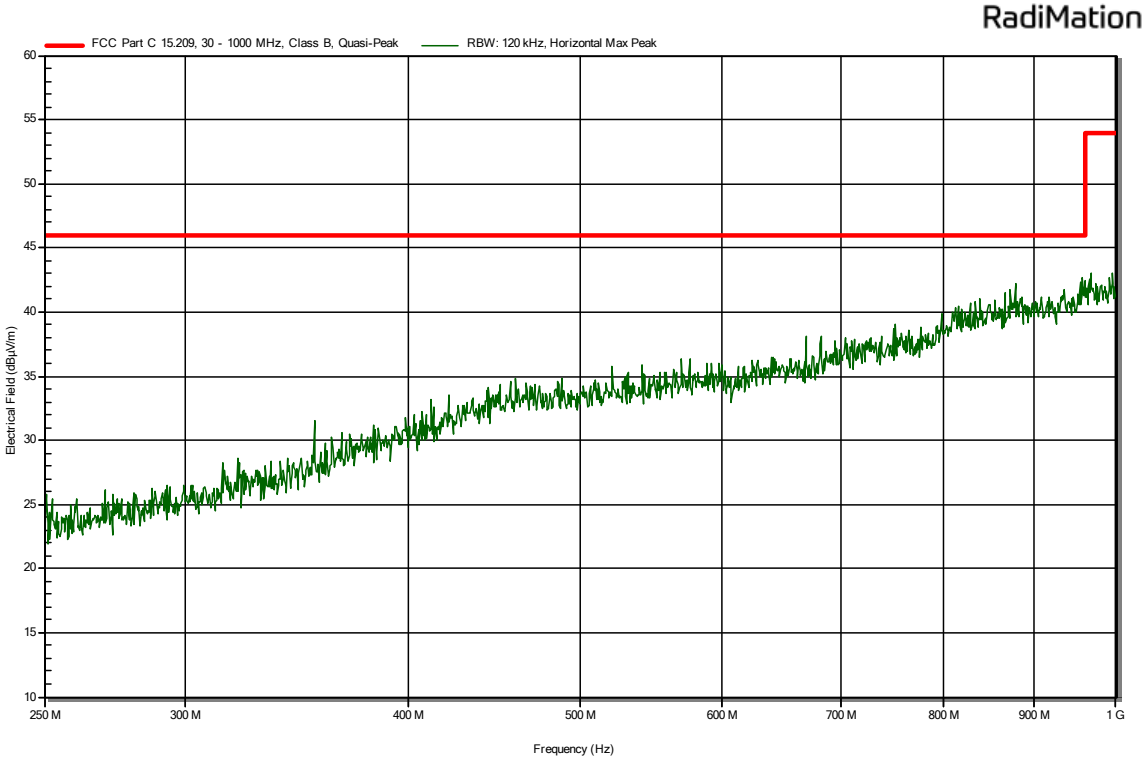
Plot 29: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 250-1000 MHz (pre-scan peak values shown)
High channel
Note: Out-of-range peak at 251 MHz is a software error



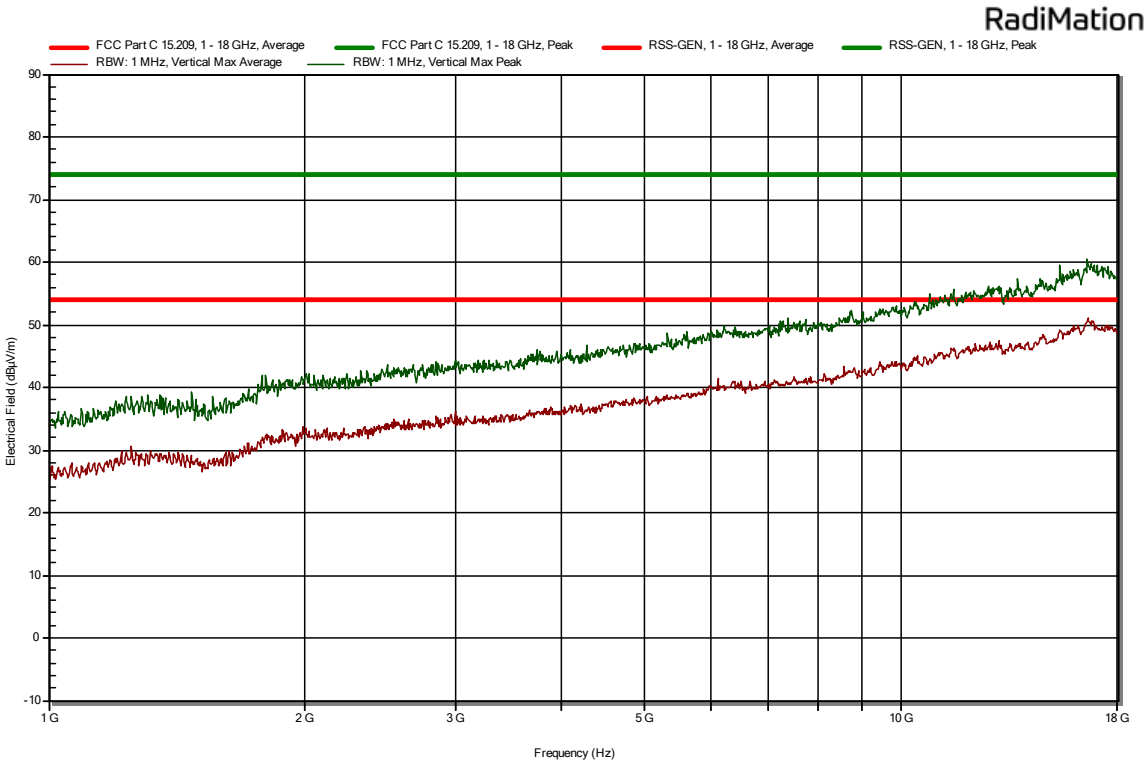
Plot 30: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 250-1000 MHz (pre-scan peak values shown)
High channel
Note: Out-of-range peak at 251 MHz is a software error



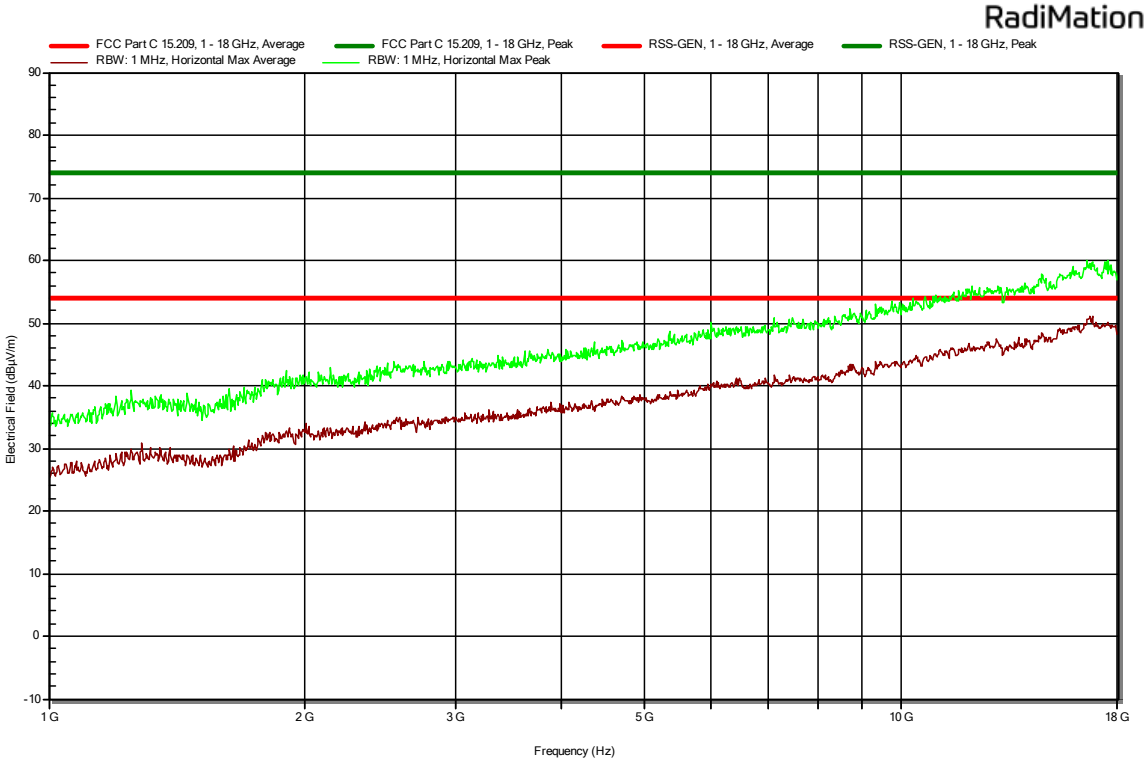
Plot 31: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 250-1000 MHz (pre-scan peak values shown)
High channel



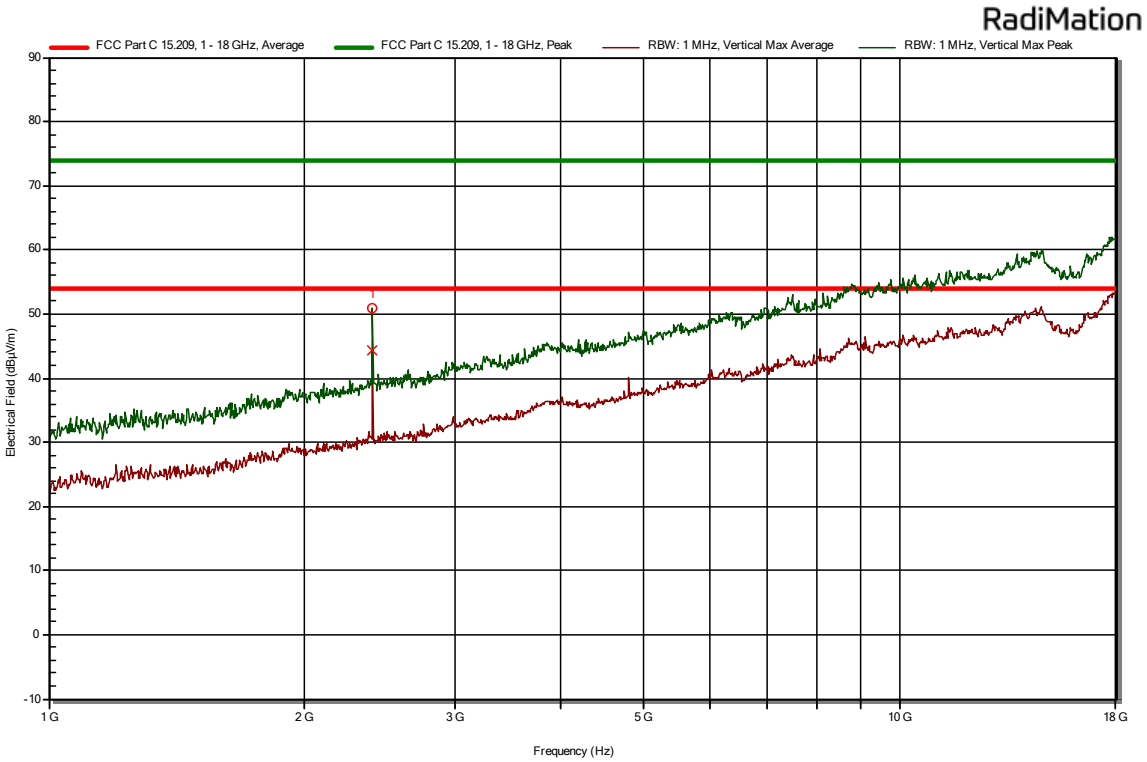
Plot 32: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 250-1000 MHz (pre-scan peak values shown)
High channel



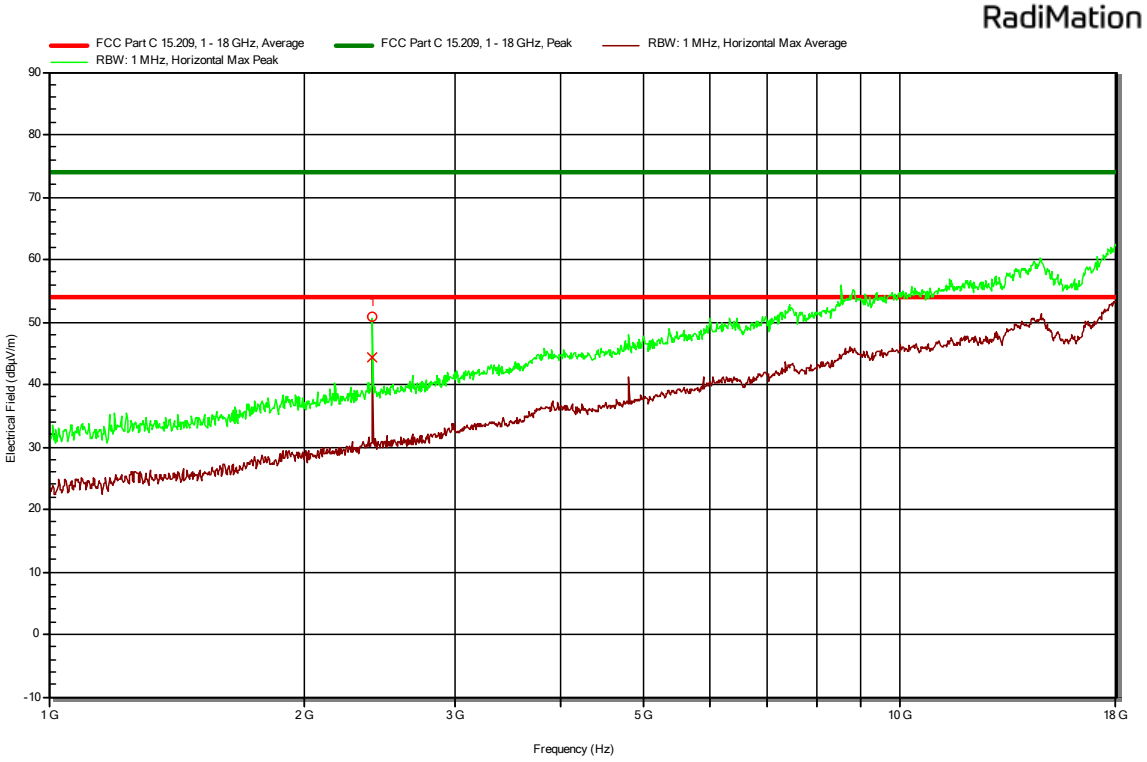
Plot 33: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 1 – 18 GHz (peak and average values shown)
Low channel



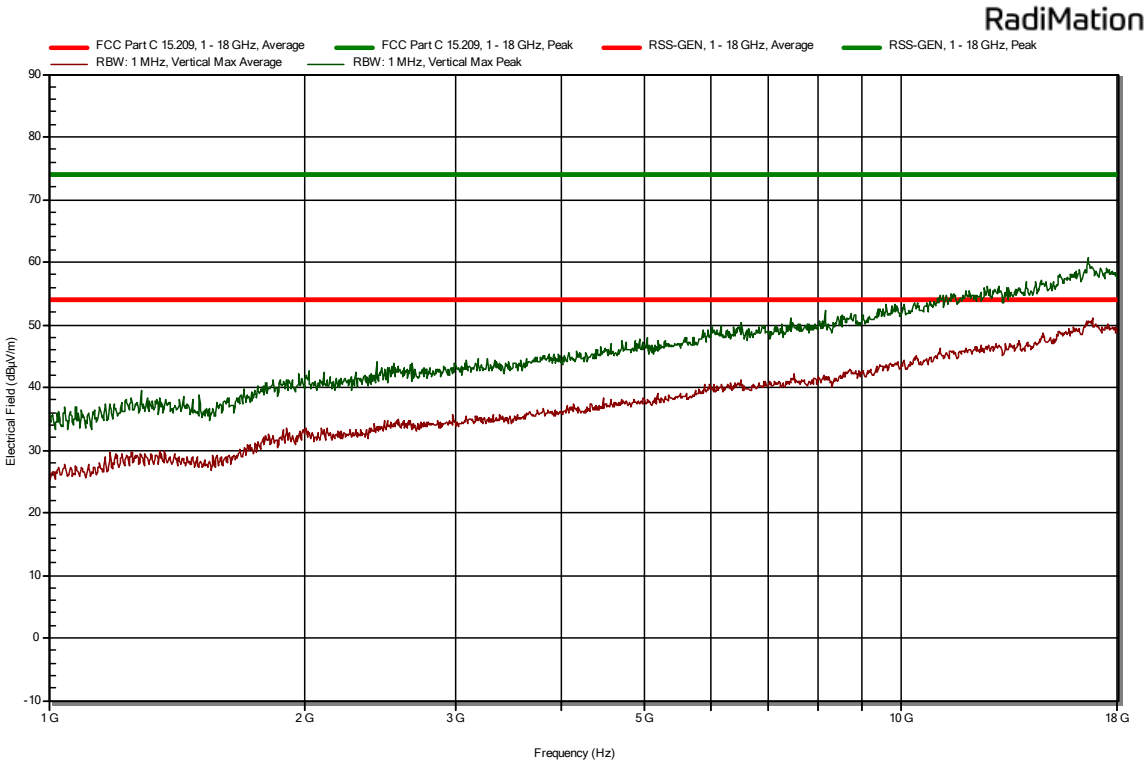
Plot 34: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 1 – 18 GHz (peak and average values shown)
Low channel



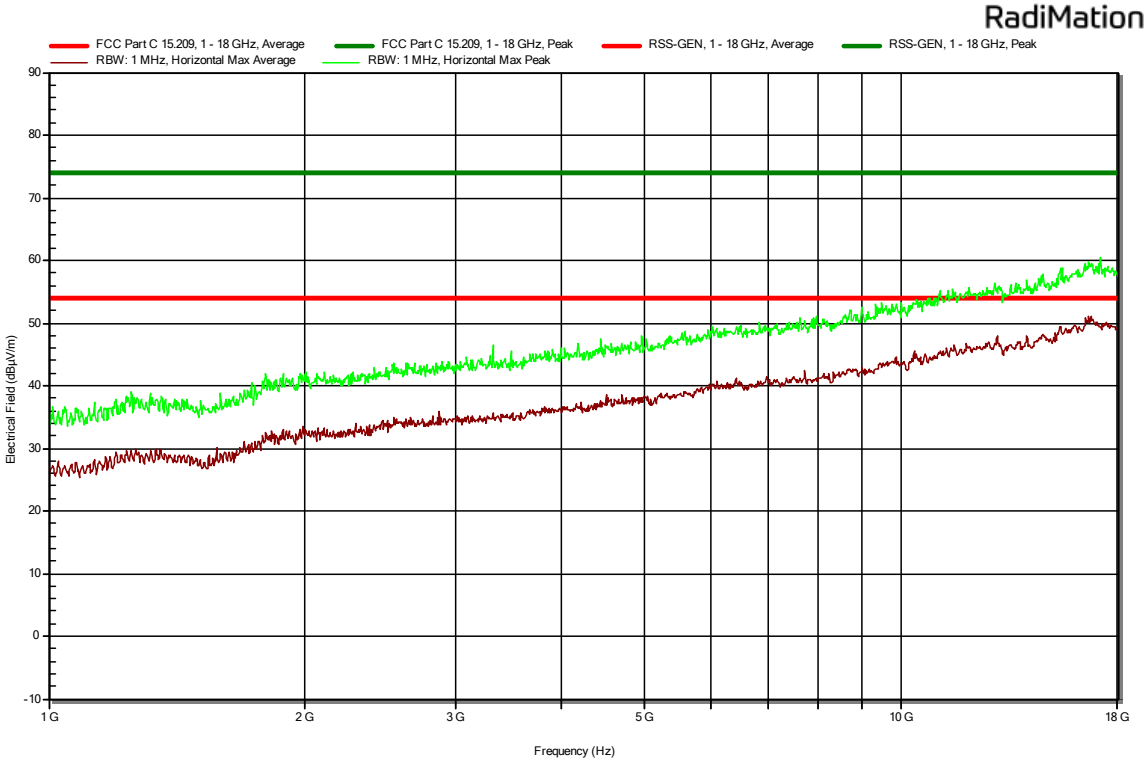
Plot 35: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 1 – 18 GHz (peak and average values shown)
Low channel



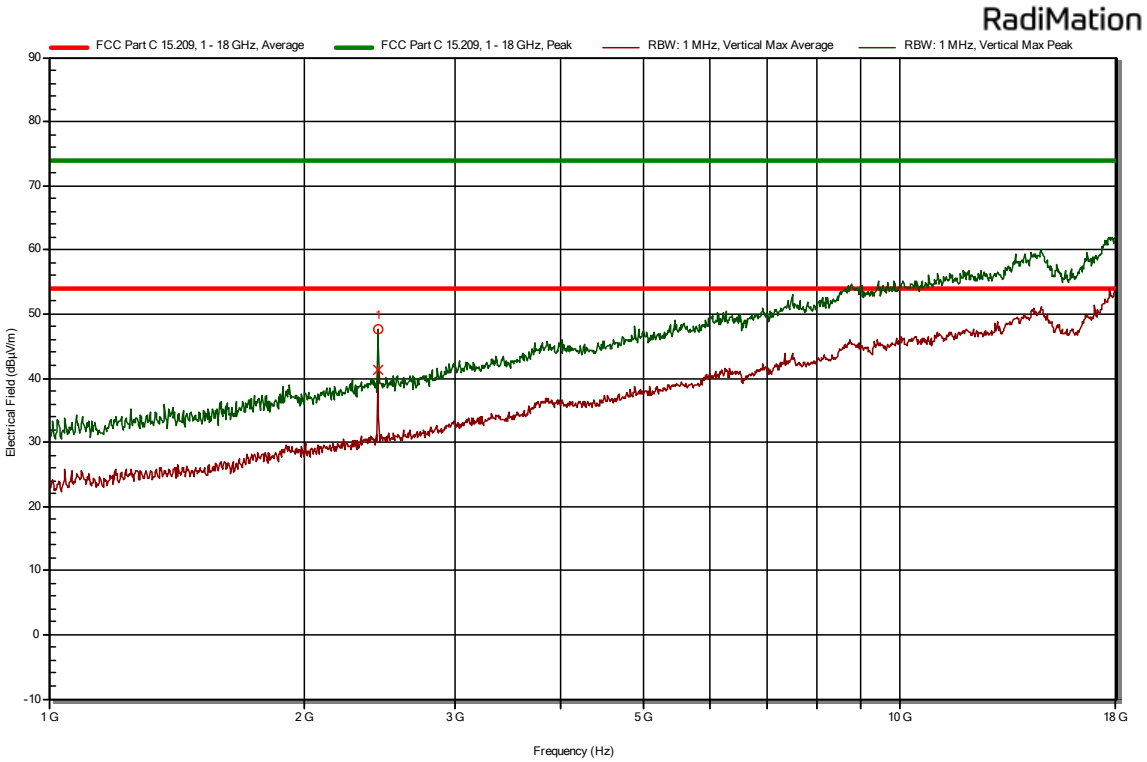
Plot 36: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 1 – 18 GHz (peak and average values shown)
Low channel



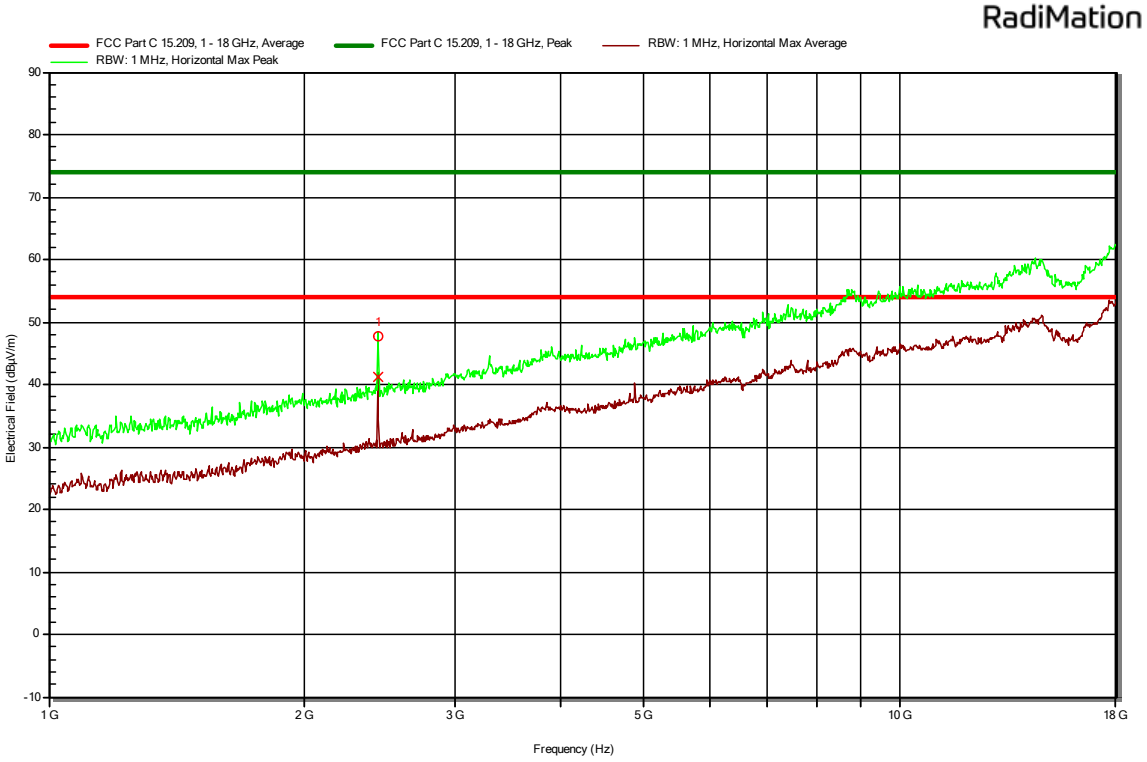
Plot 37: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 1 – 18 GHz (peak and average values shown)
Middle channel



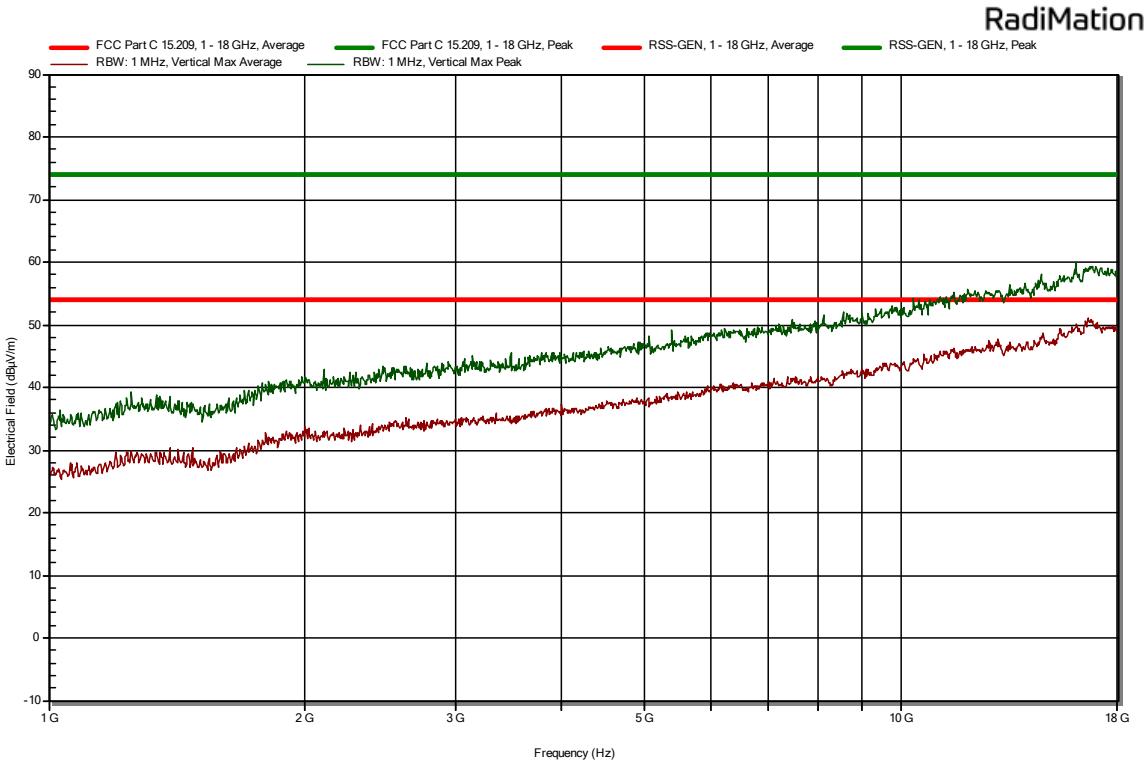
Plot 38: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 1 – 18 GHz (peak and average values shown)
Middle channel



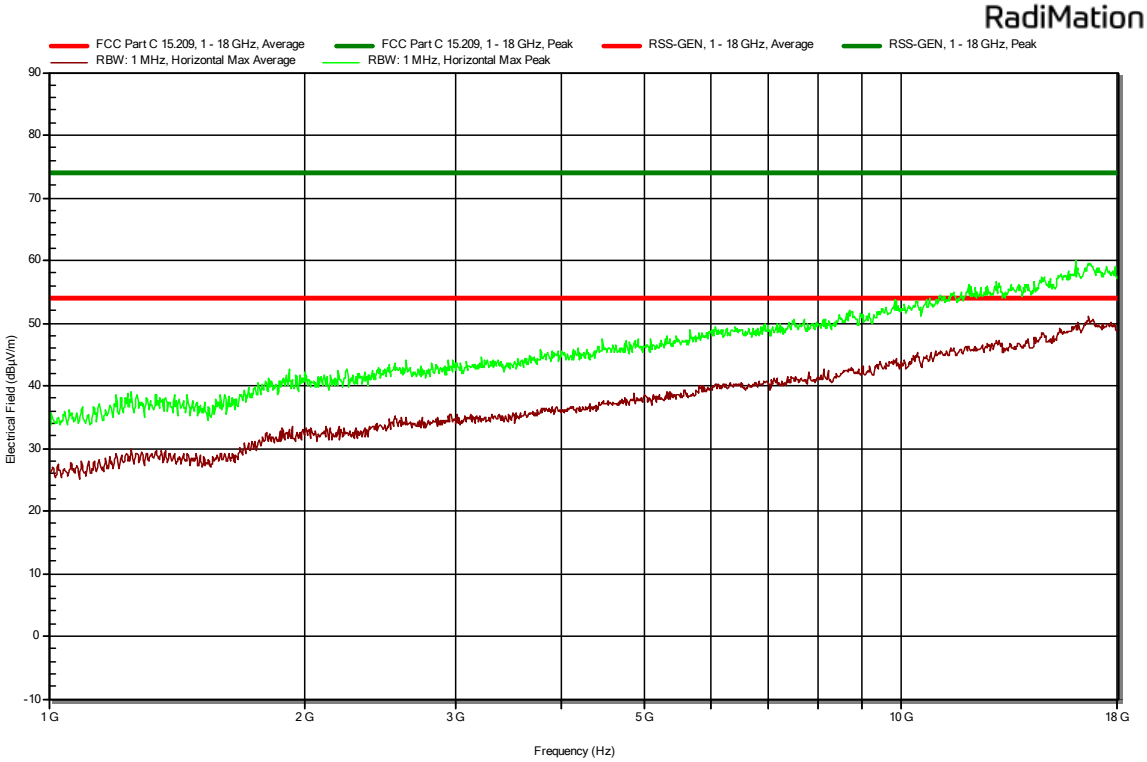
Plot 39: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 1 – 18 GHz (peak and average values shown)
Middle channel



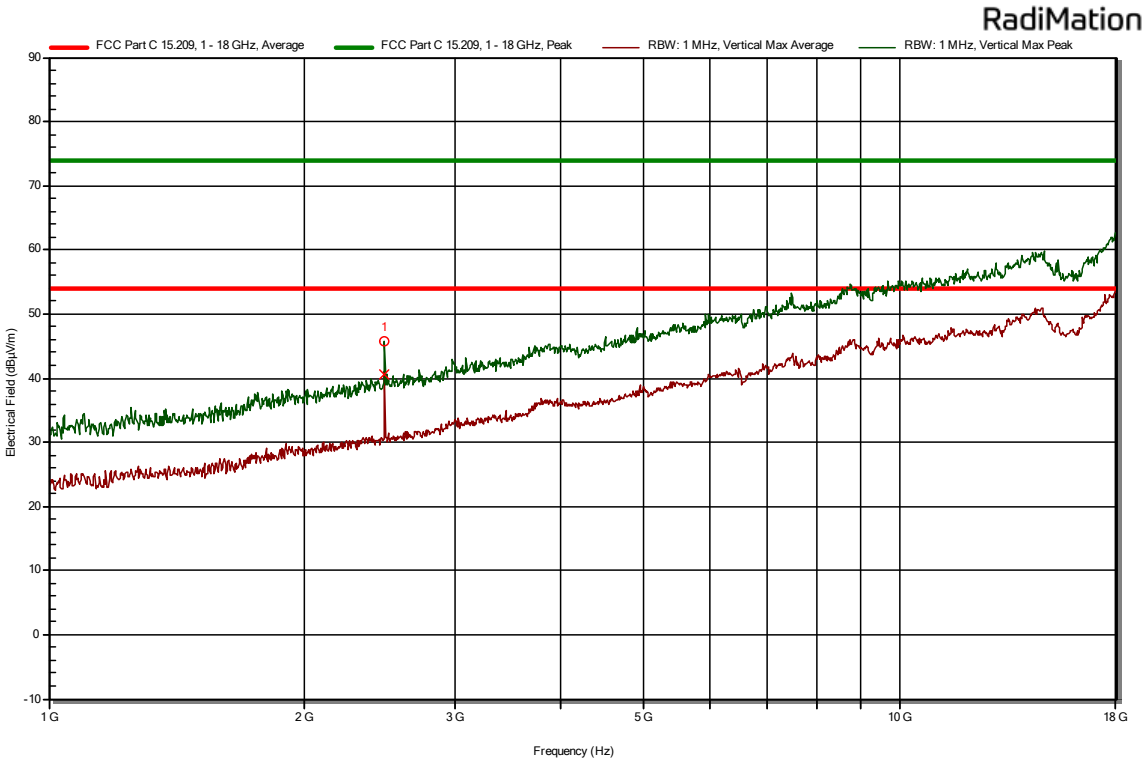
Plot 40: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 1 – 18 GHz (peak and average values shown)
Middle channel



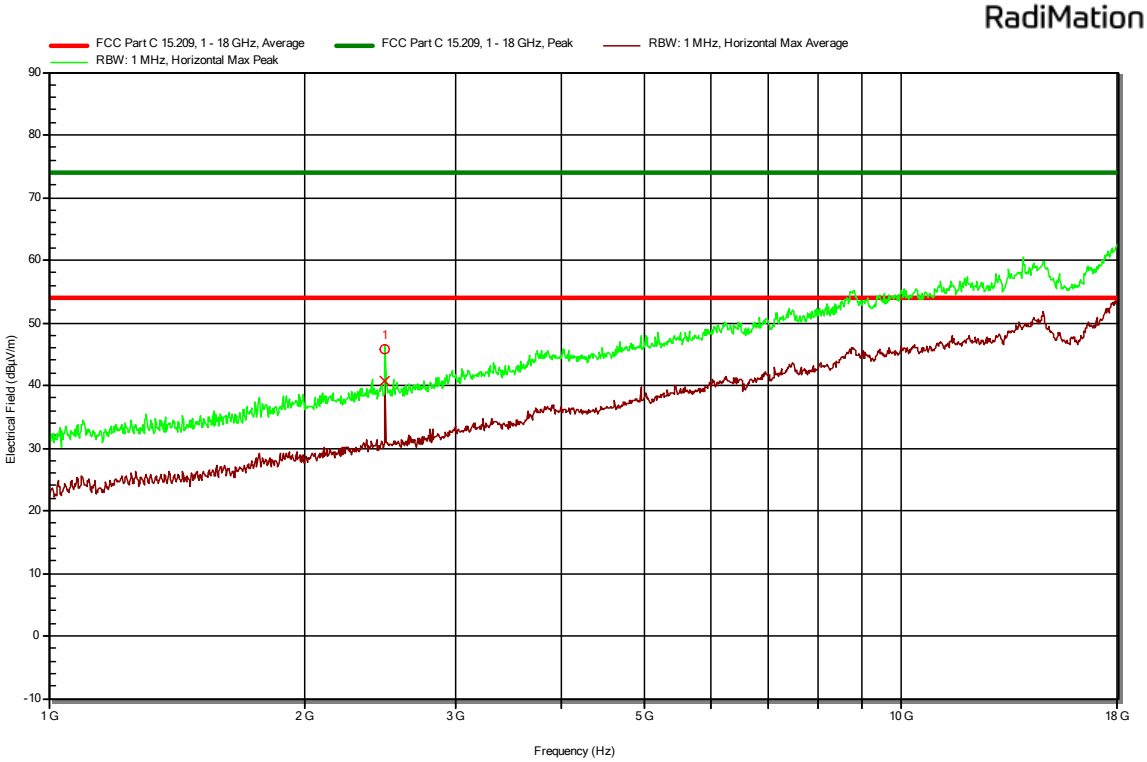
Plot 41: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 1 – 18 GHz (peak and average values shown)
High channel



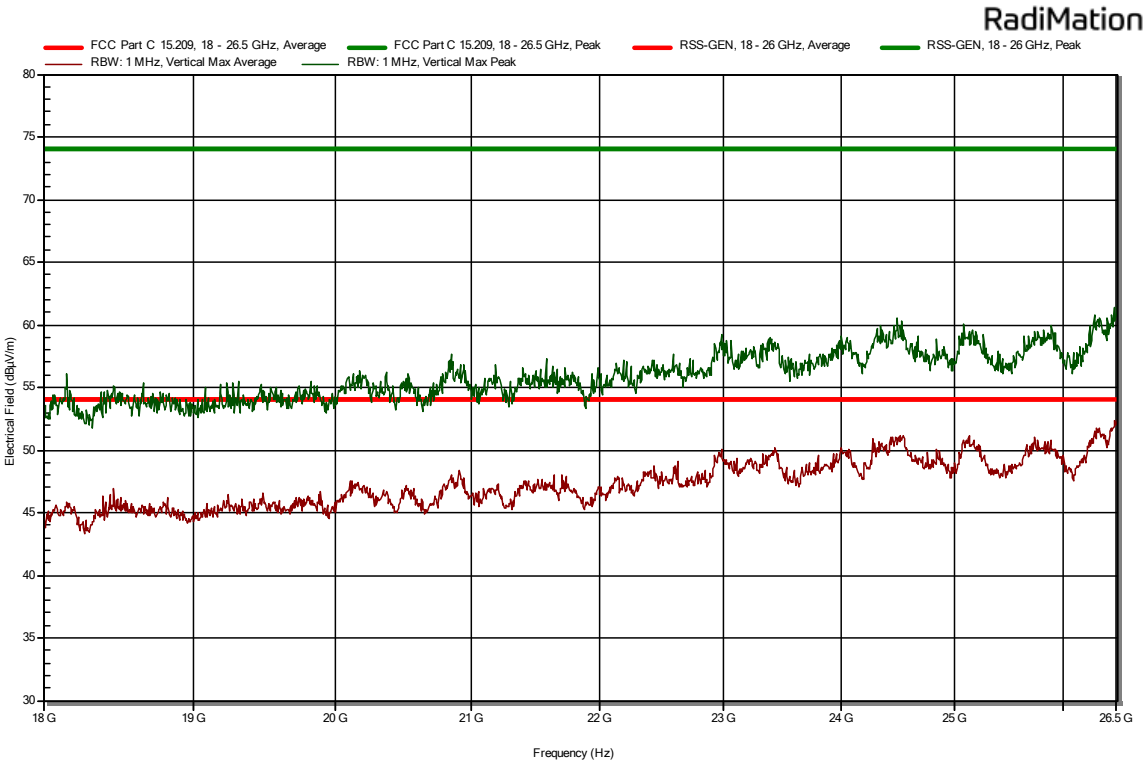
Plot 42: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 1 – 18 GHz (peak and average values shown)
High channel



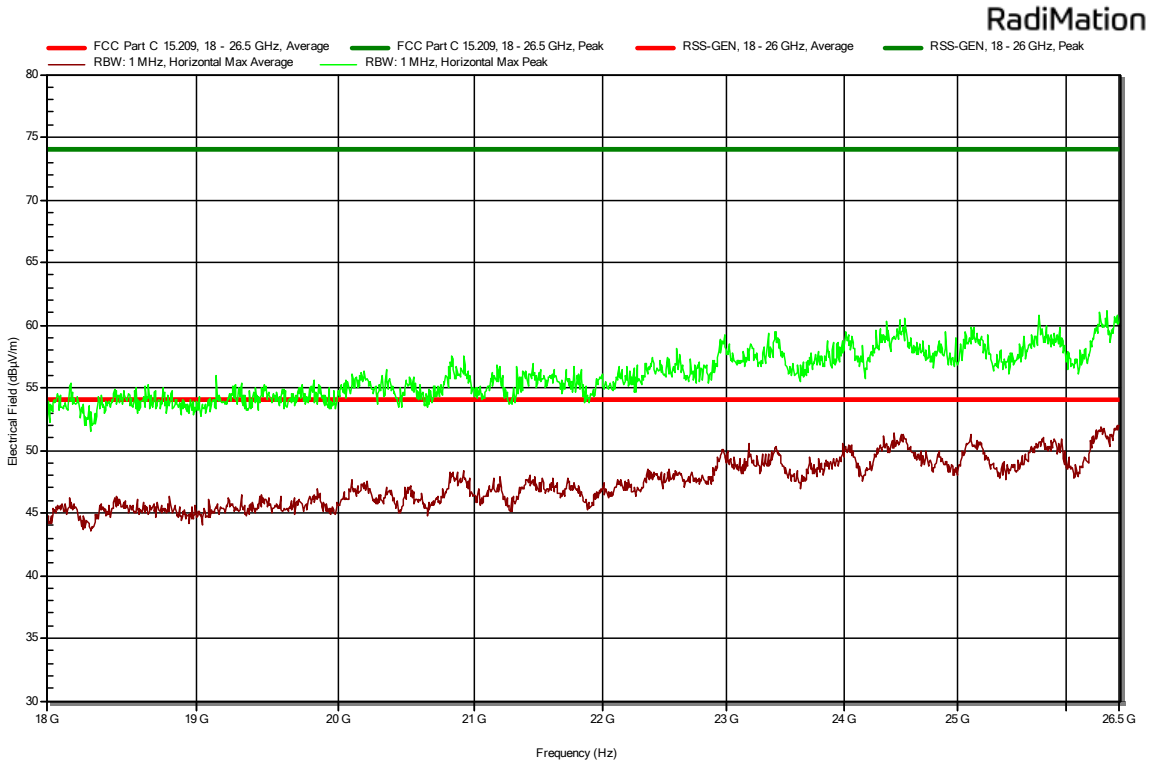
Plot 43: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 1 – 18 GHz (peak and average values shown)
High channel



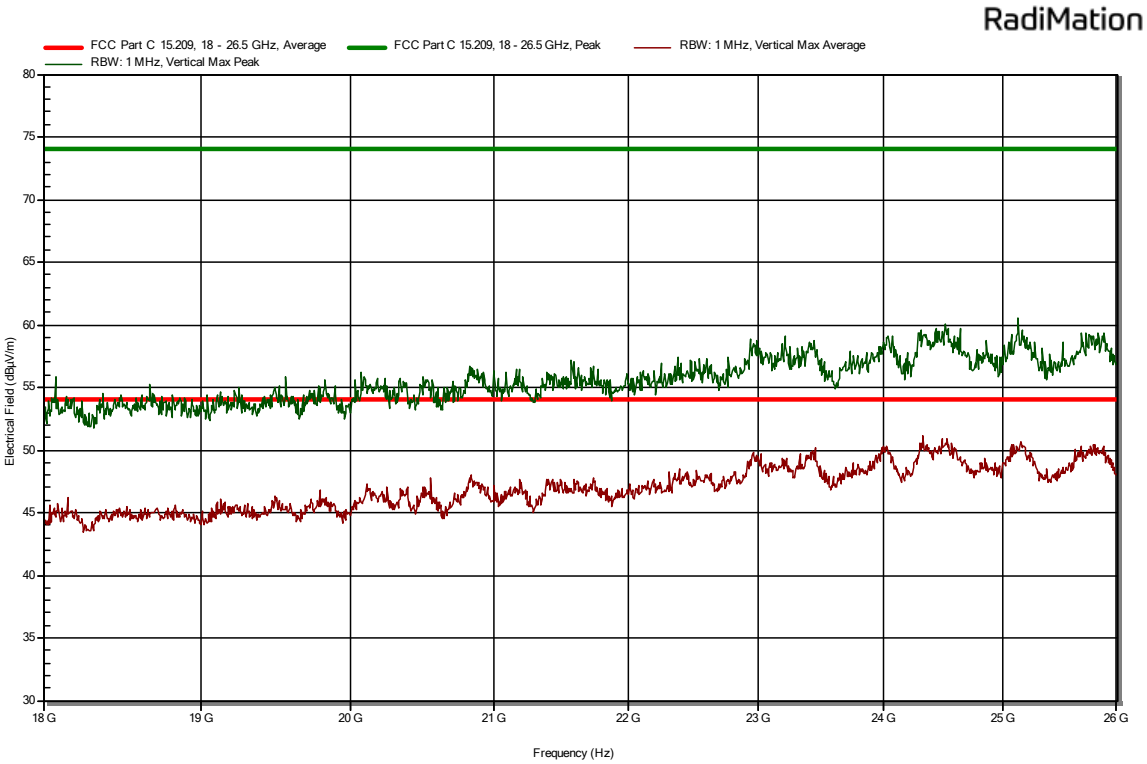
Plot 44: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 1 – 18 GHz (peak and average values shown)
High channel



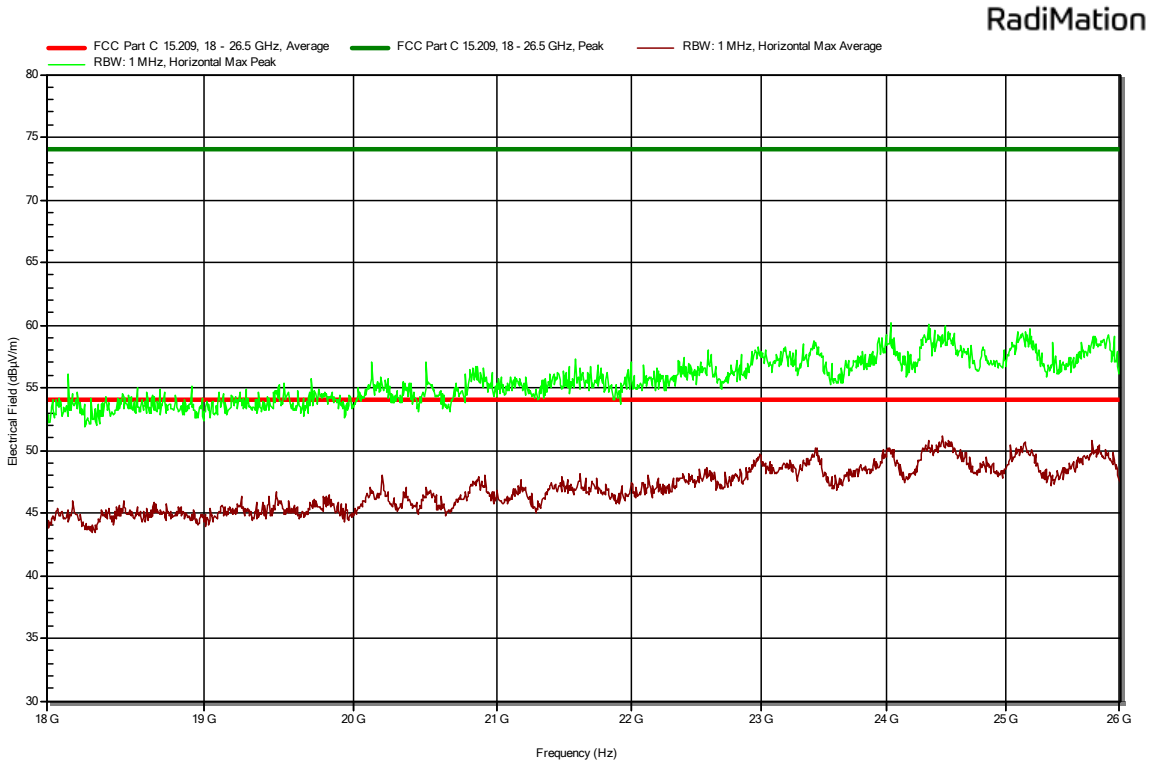
Plot 45: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 18 – 26 GHz (peak and average values shown)
Low channel



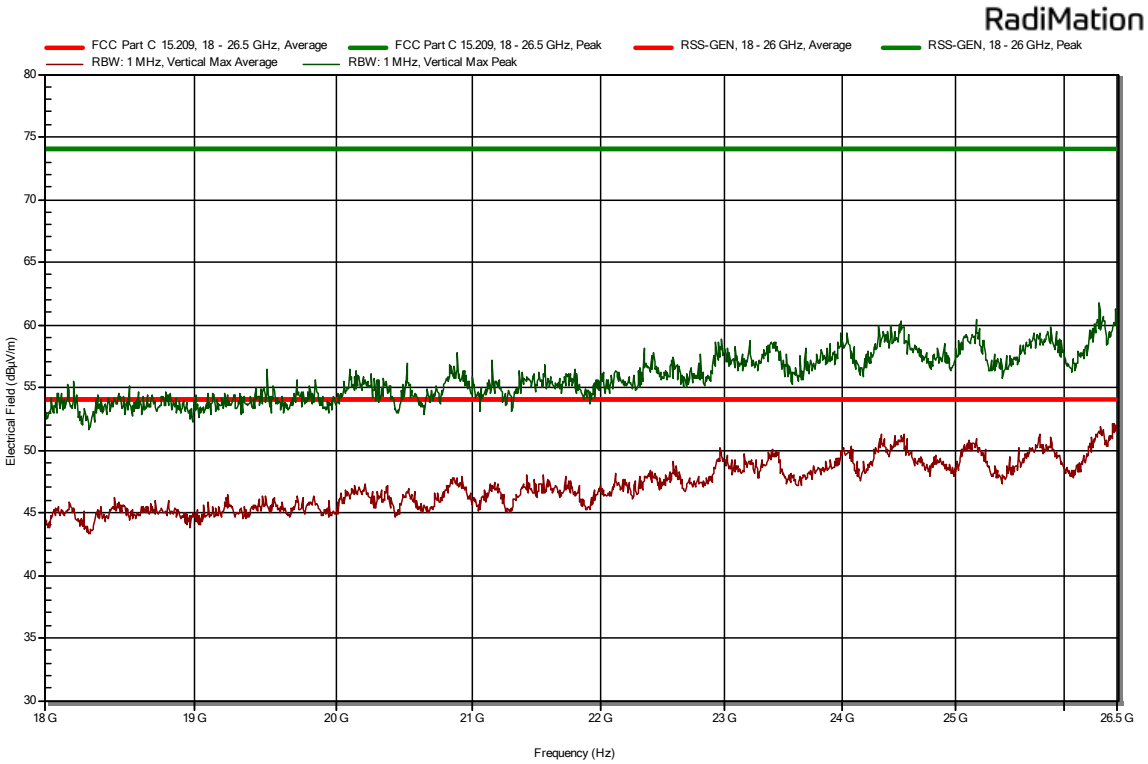
Plot 46: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 18 – 26GHz (peak and average values shown)
Low channel



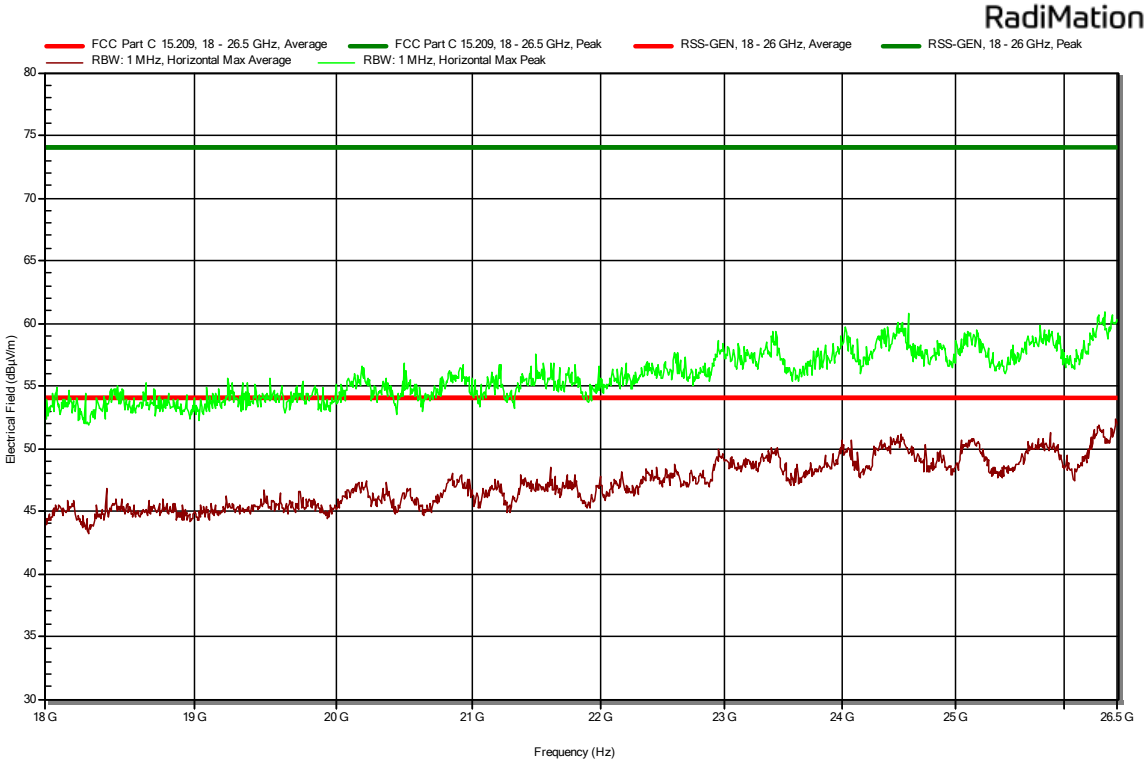
Plot 47: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 18 – 26 GHz (peak and average values shown)
Low channel



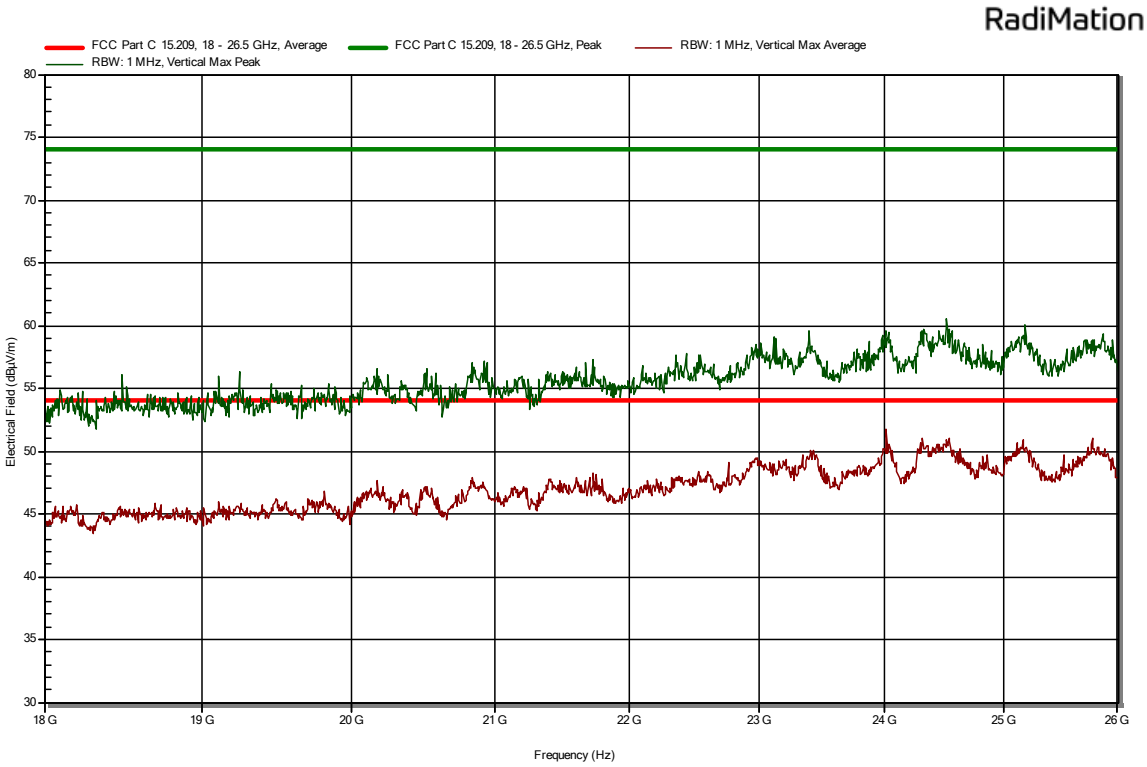
Plot 48: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 18 – 26GHz (peak and average values shown)
Low channel



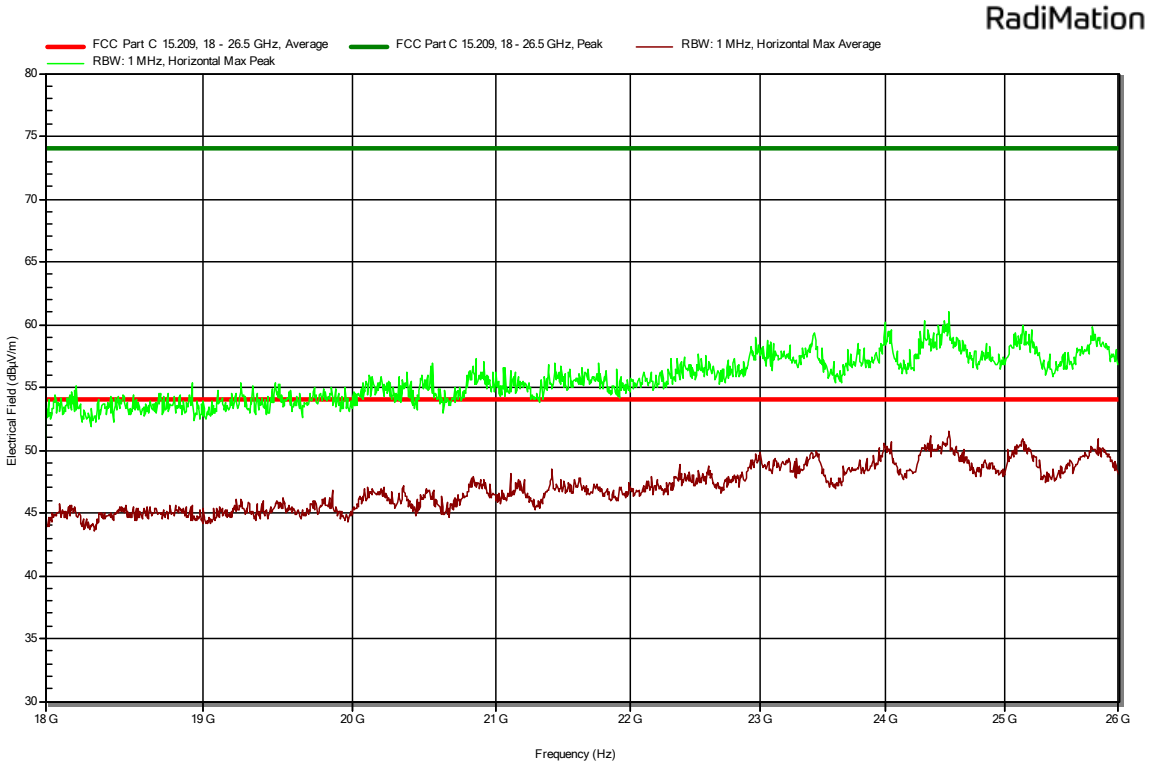
Plot 49: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 18 – 26GHz (peak and average values shown)
Middle channel



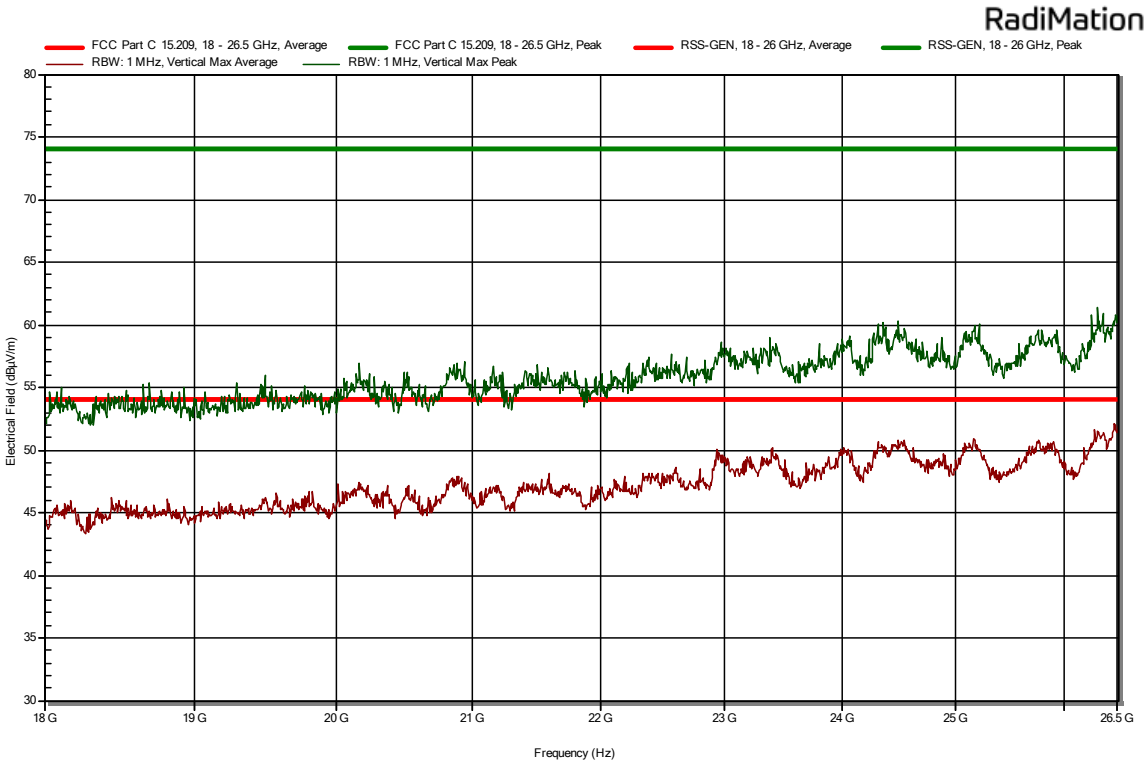
Plot 50: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 18 – 26GHz (peak and average values shown)
Middle channel



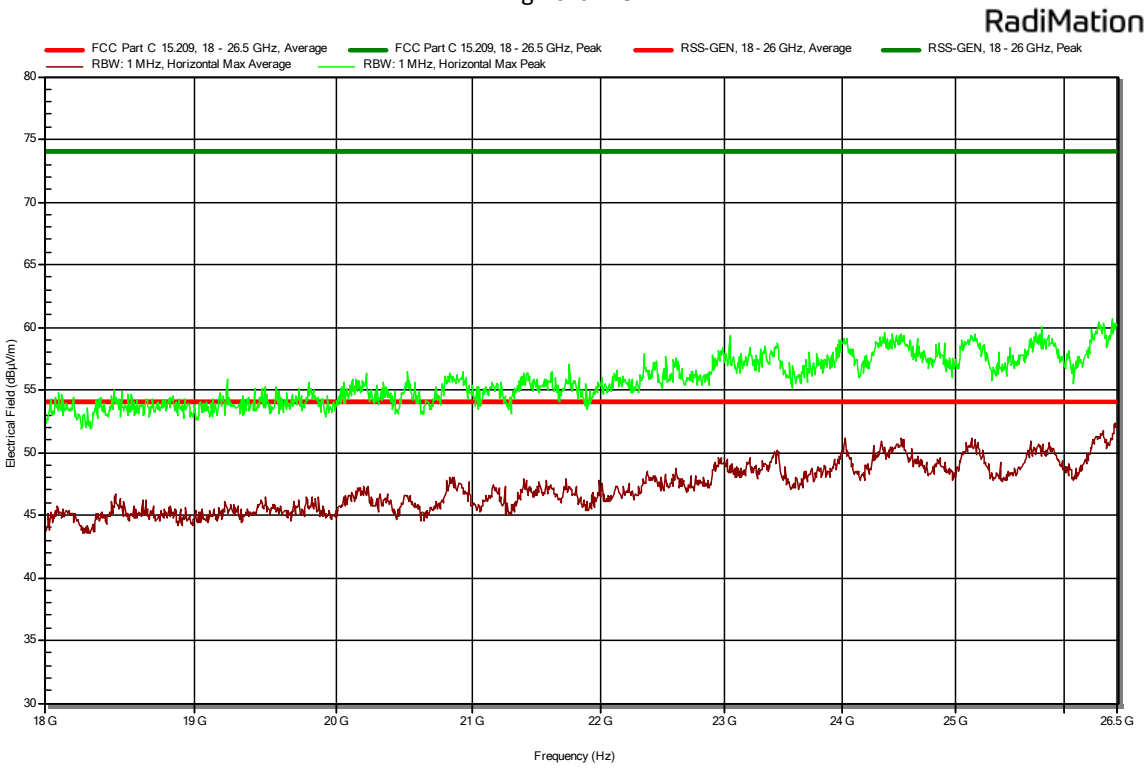
Plot 51: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 18 – 26GHz (peak and average values shown)
Middle channel



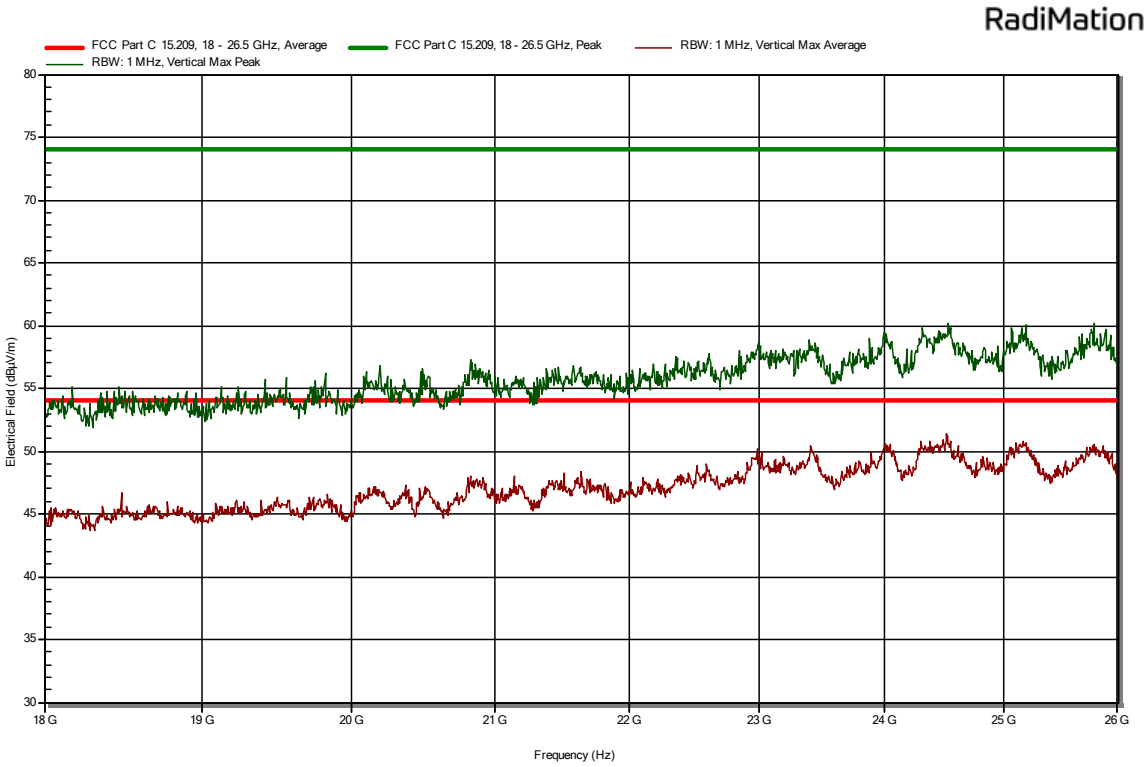
Plot 52: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 18 – 26GHz (peak and average values shown)
Middle channel



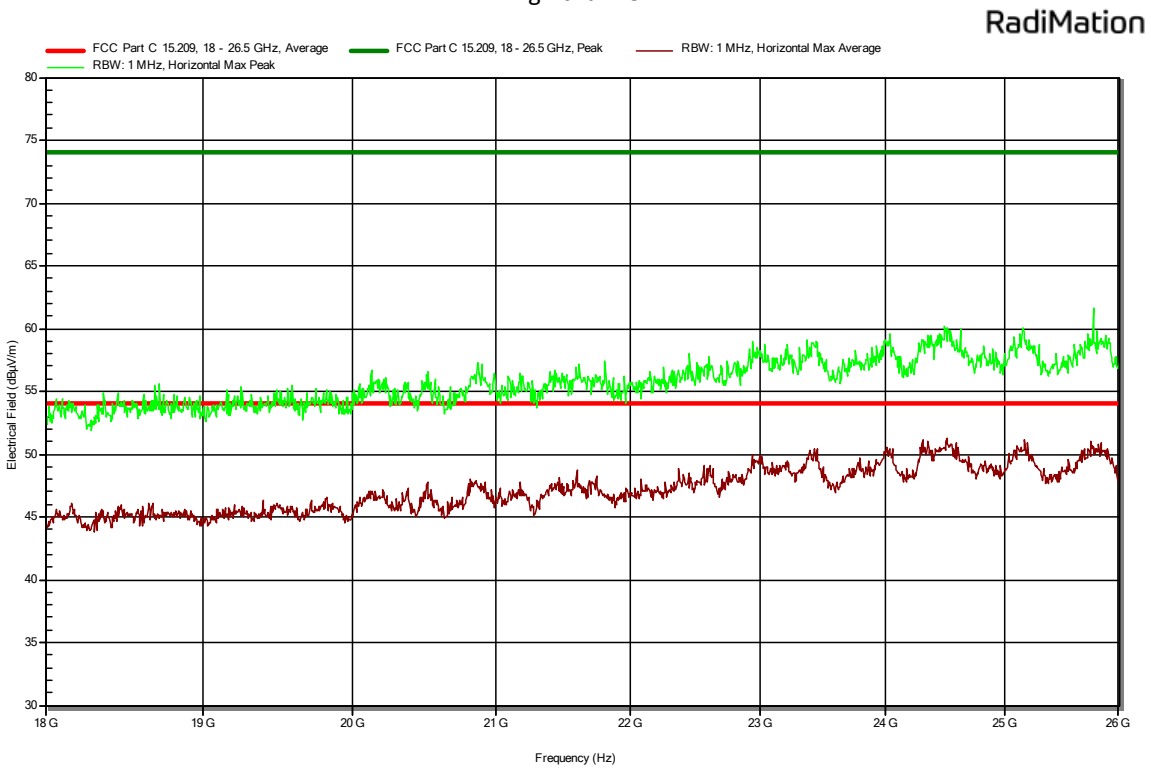
Plot 53: radiated emissions of the EUT (External Antenna), Antenna vertical, in the range 18 – 26GHz (peak and average values shown)
High channel



Plot 54: radiated emissions of the EUT (External Antenna), Antenna horizontal, in the range 18 – 26 GHz (peak and average values shown)
High channel

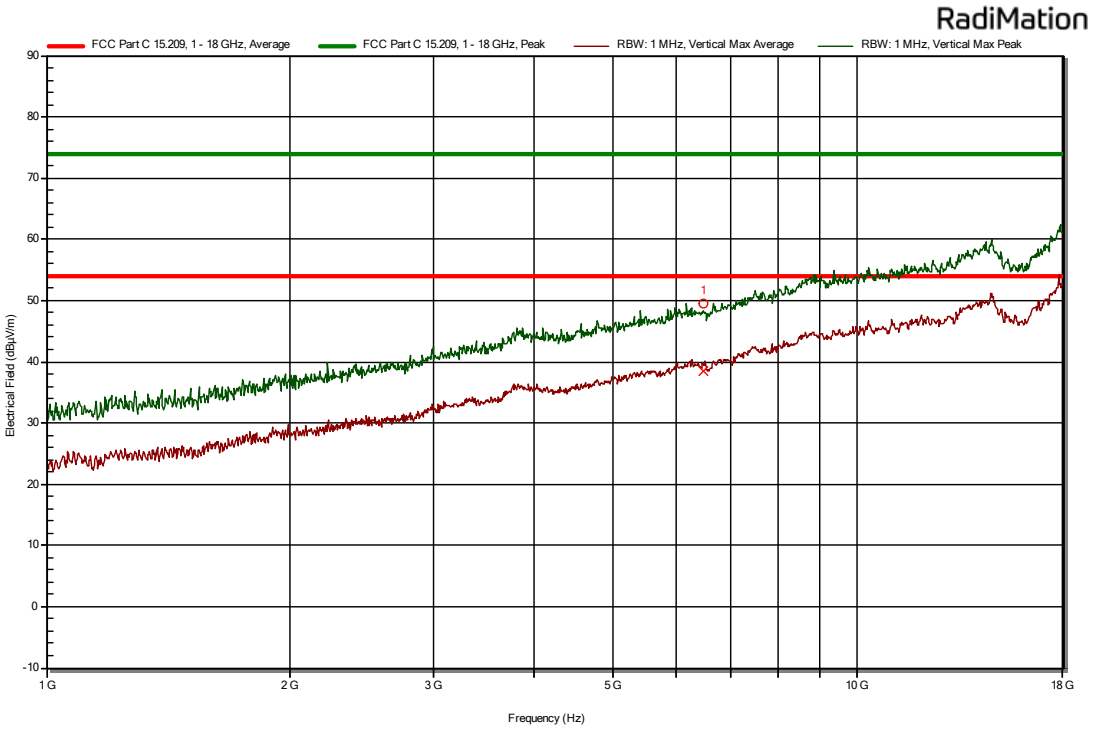


Plot 55: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 18 – 26GHz (peak and average values shown)
High channel

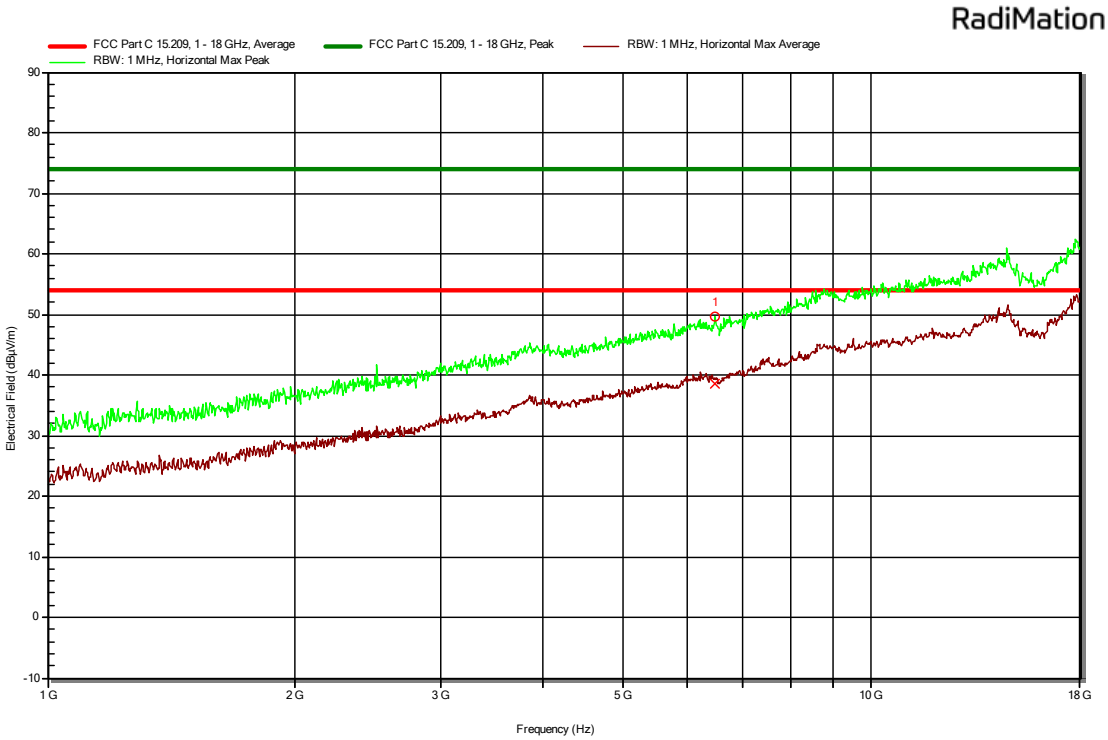


Plot 56: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 18 – 26 GHz (peak and average values shown)
High channel

Verification results with EUT in host 2.



Plot 57: radiated emissions of the EUT (Internal Antenna), Antenna vertical, in the range 1 - 18 GHz (peak and average values shown)
Low channel



Plot 58: radiated emissions of the EUT (Internal Antenna), Antenna horizontal, in the range 1 - 18 GHz (peak and average values shown)
Low channel
Note: no peaks found, only noise floor shown

3.2 6 dB 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

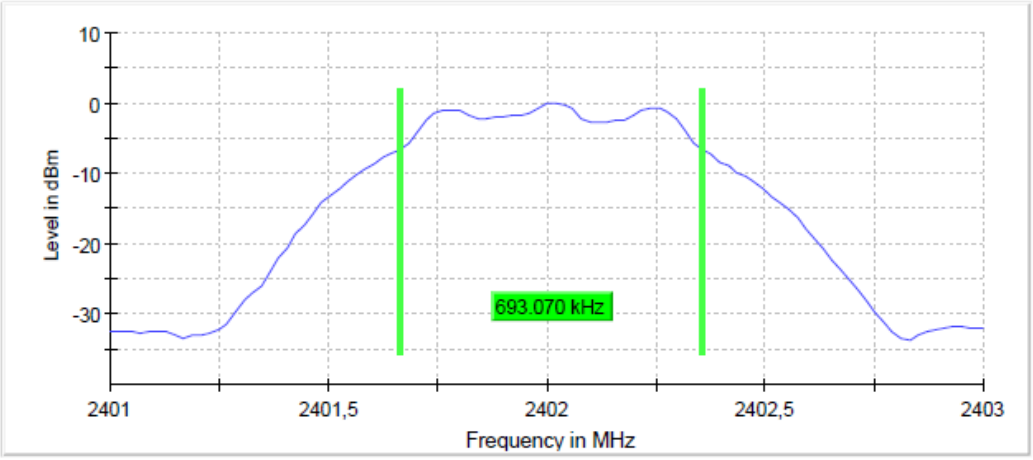
Technology Std.	Channel	Frequency (MHz)	Data rate	6 dB bandwidth (kHz)
Bluetooth Low energy	1	2402	1 Mbps	693.07
	18	2440	1 Mbps	693.07
	39	2480	1 Mbps	693.07
Uncertainty	± 36.2 kHz			

Note: plots are provided on the next page.

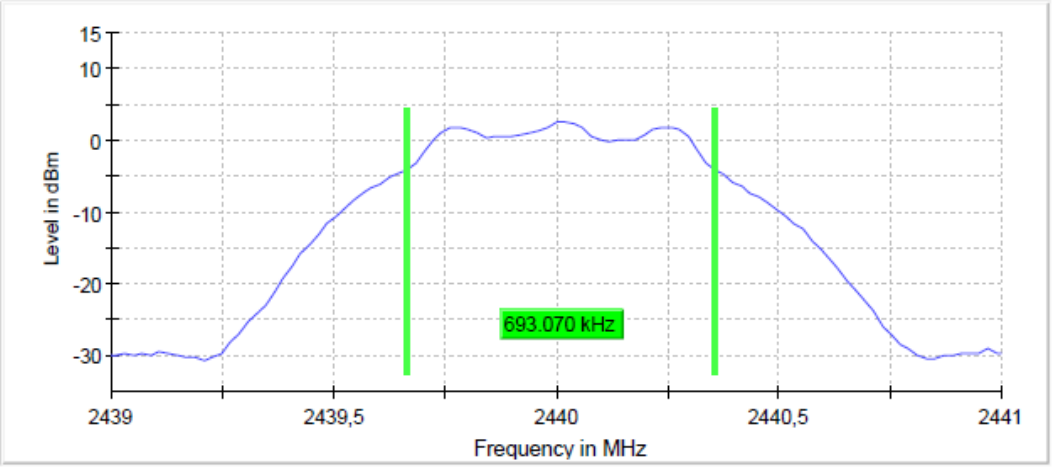
Technology Std.	Channel	Frequency (MHz)	Data rate	6 dB bandwidth (MHz)
Bluetooth Low energy	1	2402	2 Mbps	1.148
	18	2440	2 Mbps	1.148
	39	2480	2 Mbps	1.148
Uncertainty	± 36.2 kHz			

Note: plots are provided on the next page.

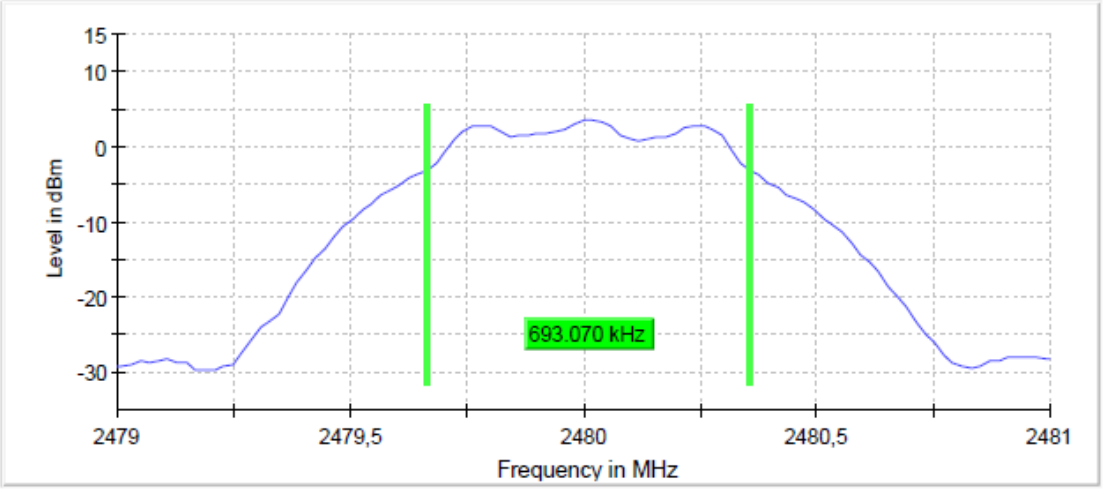
3.2.6 Plots of the 6 dB bandwidth



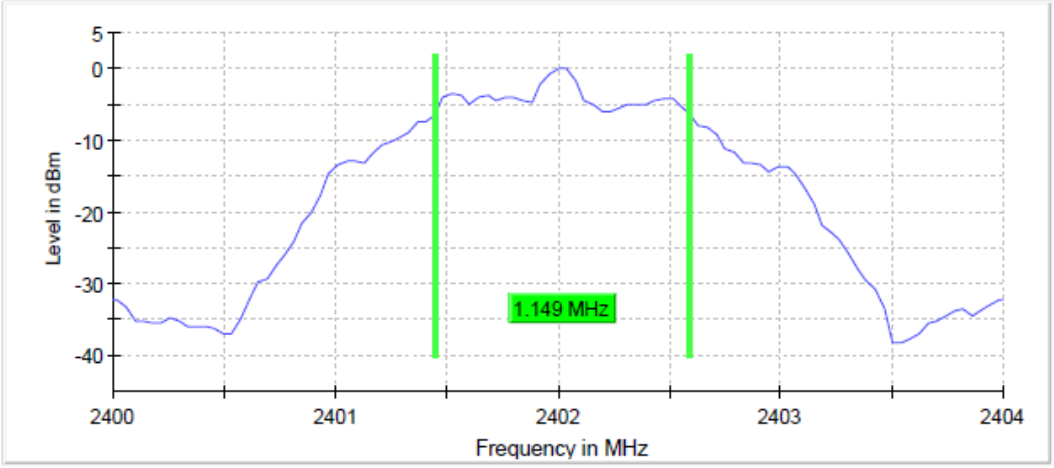
Plot 57: 6 dB Bandwidth of the EUT at 1Mbps
Low channel



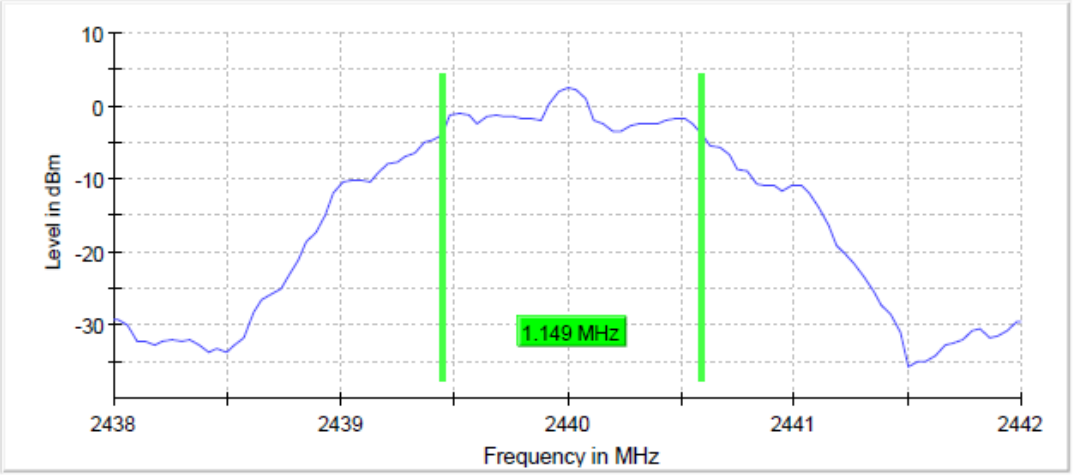
Plot 58: 6 dB Bandwidth of the EUT at 1Mbps
Mid channel



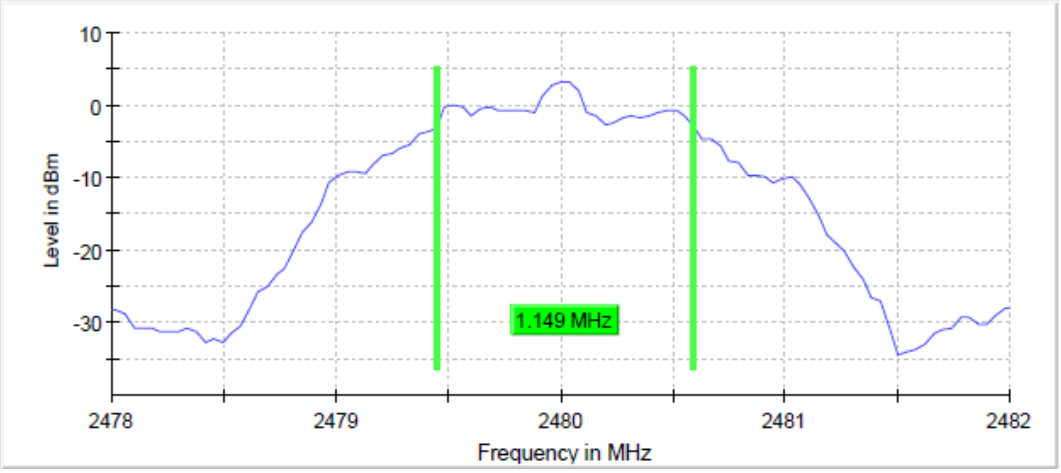
Plot 59: 6 dB Bandwidth of the EUT at 1Mbps
High channel



Plot 60: 6 dB Bandwidth of the EUT at 2Mbps
Low channel



Plot 61: 6 dB Bandwidth of the EUT at 2Mbps
Mid channel



Plot 62: 6 dB Bandwidth of the EUT at 2Mbps
High channel

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

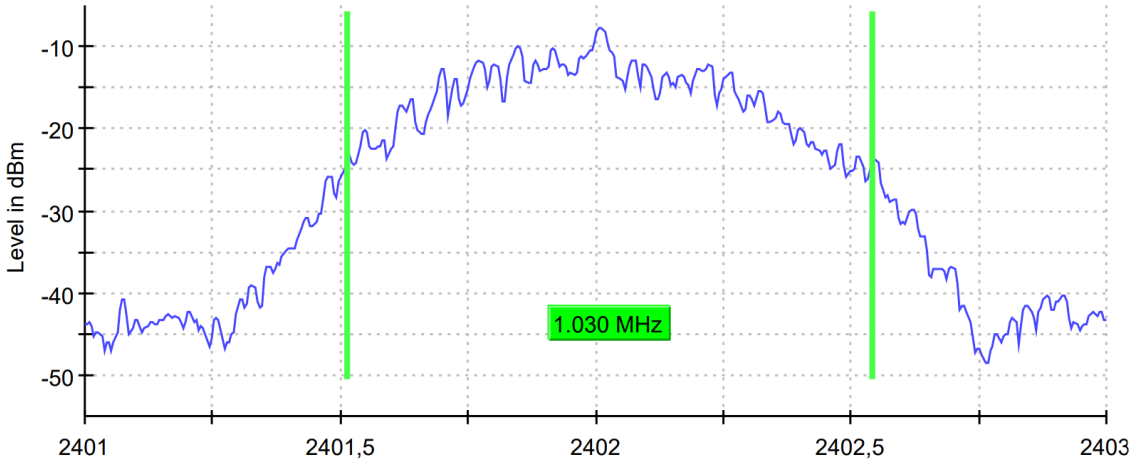
Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Bluetooth Low energy	1	2402	1 Mbps	1030
	18	2440	1 Mbps	1025
	39	2480	1 Mbps	1025
Uncertainty	± 36.2 kHz			

Note: plots are provided on the next page.

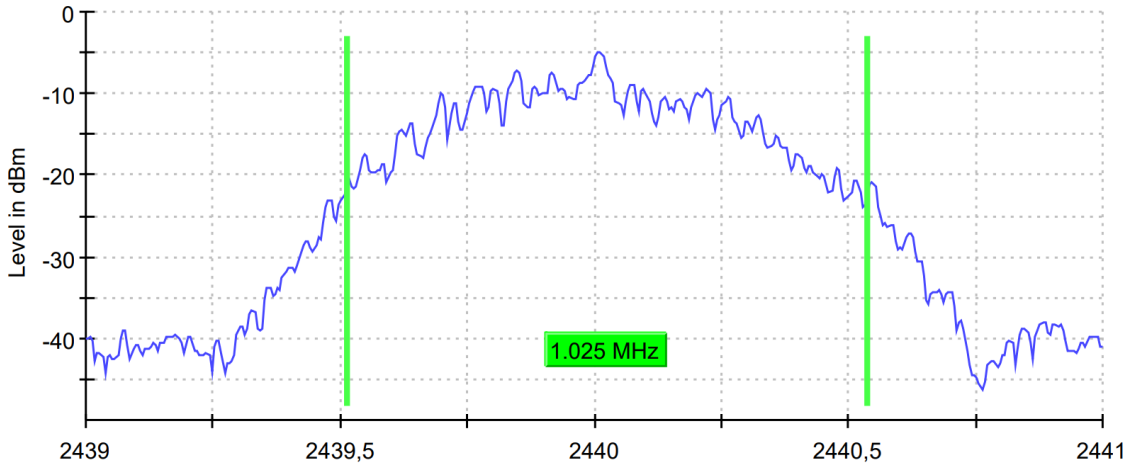
Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Bluetooth Low energy	1	2402	2 Mbps	2050
	18	2440	2 Mbps	2050
	39	2480	2 Mbps	2050
Uncertainty	± 36.2 kHz			

Note: plots are provided on the next page.

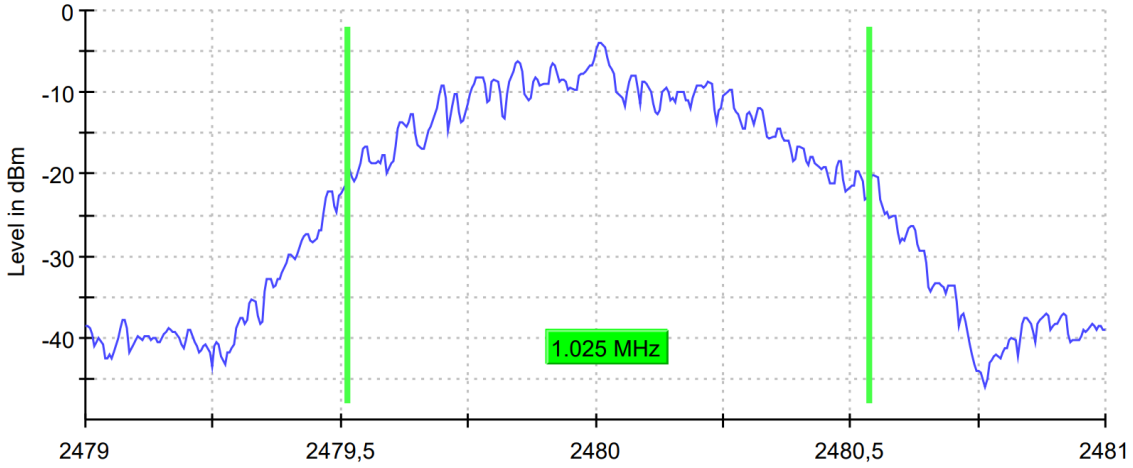
3.3.6 Plots of the 99% occupied bandwidth measurement



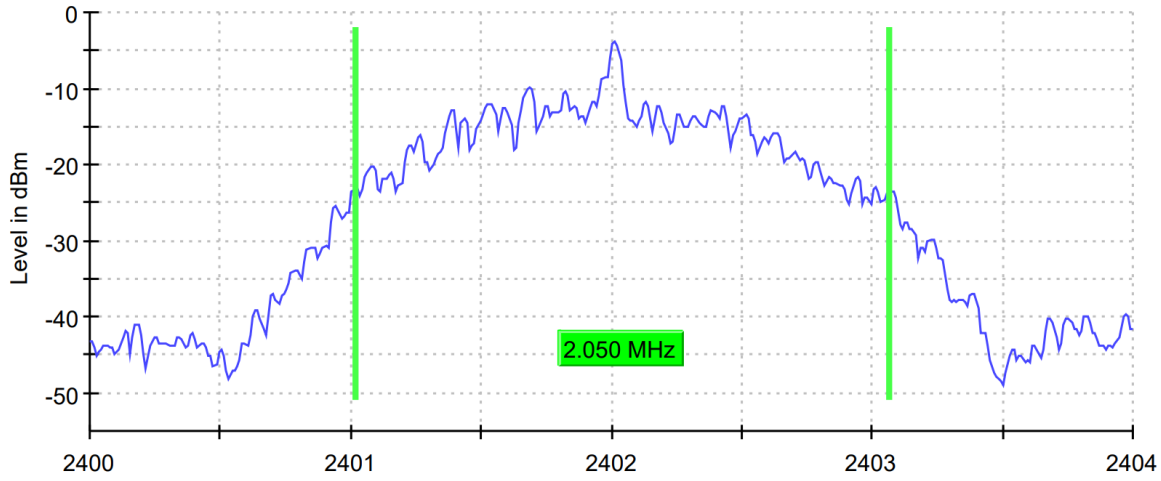
Plot 63: 99% Occupied Bandwidth of the EUT at 1Mbps
Low channel



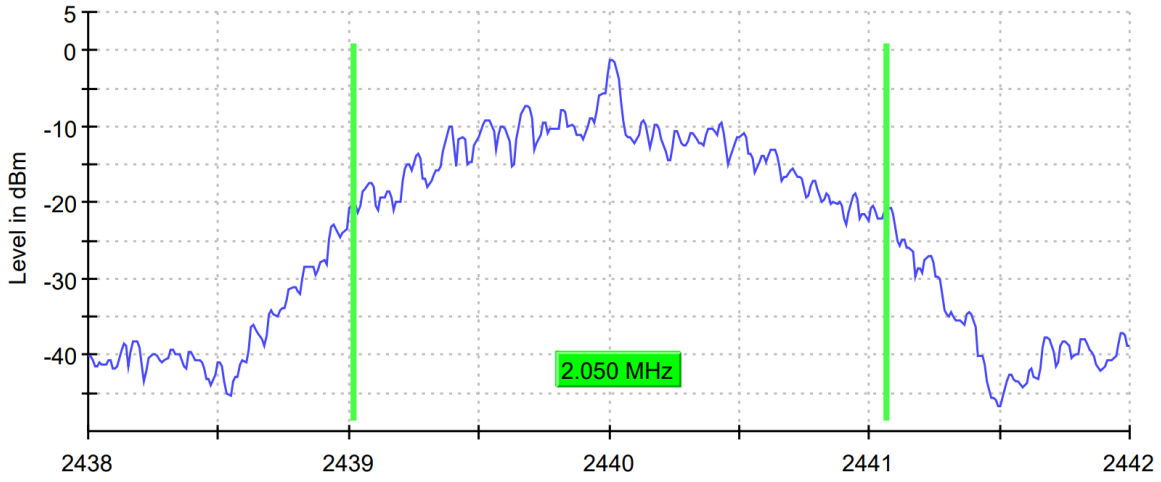
Plot 64: 99% Occupied Bandwidth of the EUT at 1Mbps
Mid channel



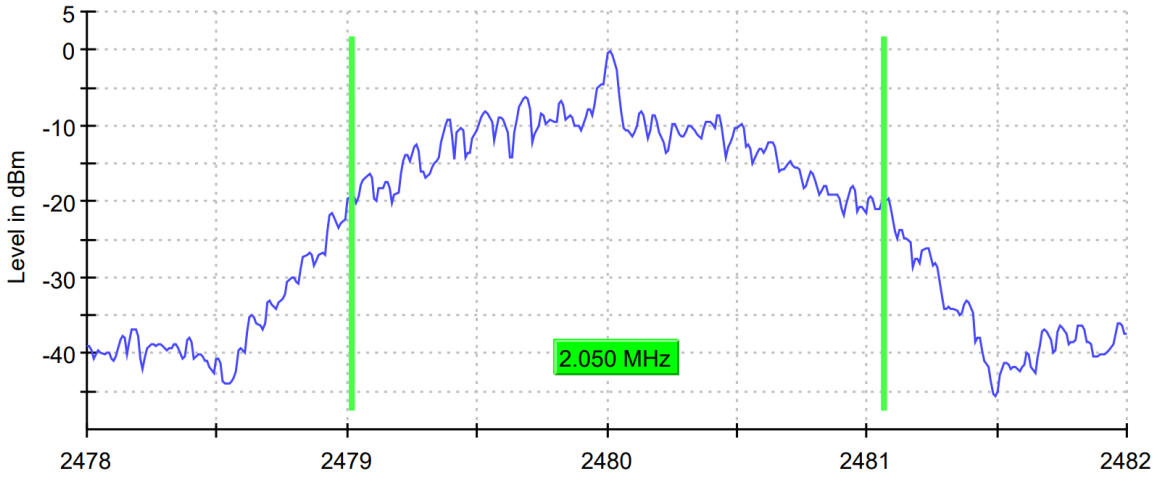
Plot 65: 99% Occupied Bandwidth of the EUT at 1Mbps
High channel



Plot 66: 99% Occupied Bandwidth of the EUT at 2Mbps
Low channel



Plot 67: 99% Occupied Bandwidth of the EUT at 2Mbps
Mid channel



Plot 68: 99% Occupied Bandwidth of the EUT at 2Mbps
High channel

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 12 – Peak Method according to ANSI C63.10.

3.4.5 Test results of Output Power Measurement

External Antenna:

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	1	2402	1Mbps	-0.257	0.0009	0.0020
	18	2440	1Mbps	2.302	0.0017	0.0035
	39	2480	1Mbps	3.435	0.0022	0.0046
Uncertainty				±0.71 dB		

Note: plots are provided on the next page

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	1	2402	2Mbps	-0.614	0.0009	0.0018
	18	2440	2Mbps	1.977	0.0016	0.0033
	39	2480	2Mbps	3.102	0.0020	0.0043
Uncertainty				±0.71 dB		

Note: plots are provided on the next page

Internal Antenna:

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	1	2402	1Mbps	-0.257	0.0009	0.0018
	18	2440	1Mbps	2.302	0.0017	0.0033
	39	2480	1Mbps	3.435	0.0022	0.0043
Uncertainty				±0.71 dB		

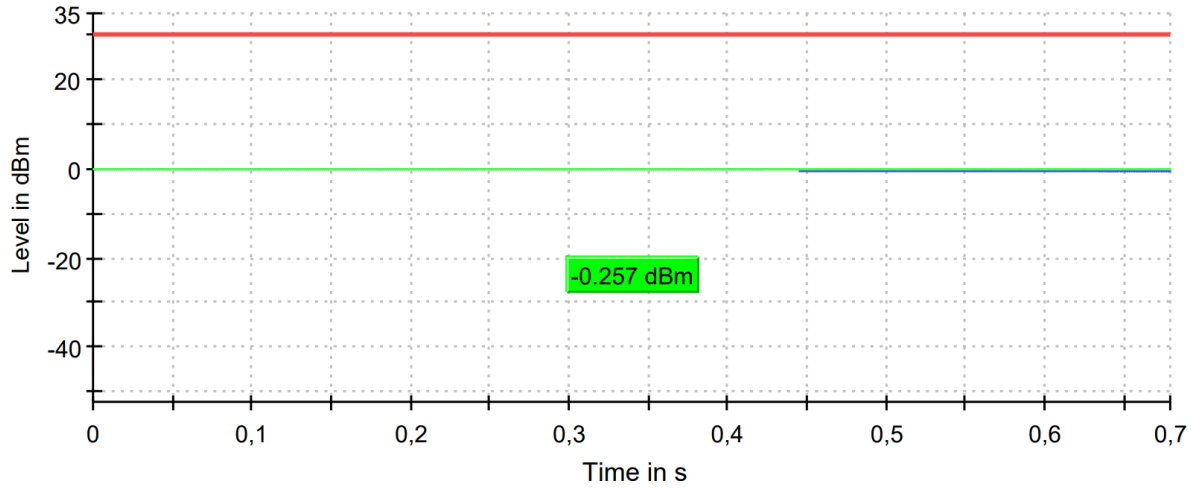
Note: plots are provided on the next page

Peak method

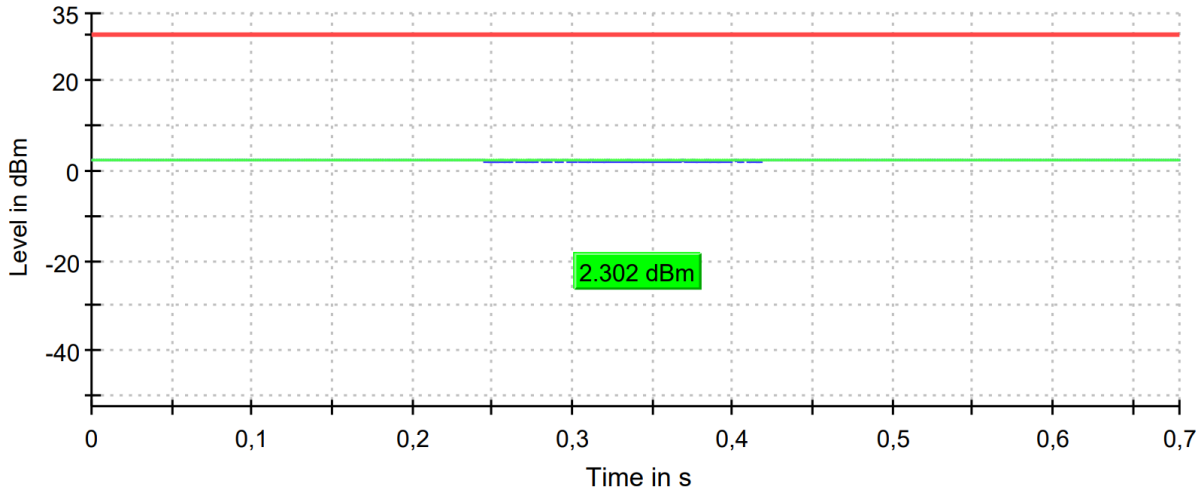
Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power conducted (dBm)	Peak output power conducted (W)	Peak output power EIRP (W)
Bluetooth Low energy	1	2402	2Mbps	-0.614	0.0009	0.0017
	18	2440	2Mbps	1.977	0.0016	0.0031
	39	2480	2Mbps	3.102	0.0020	0.0040
Uncertainty				±0.71 dB		

Note: plots are provided on the next page

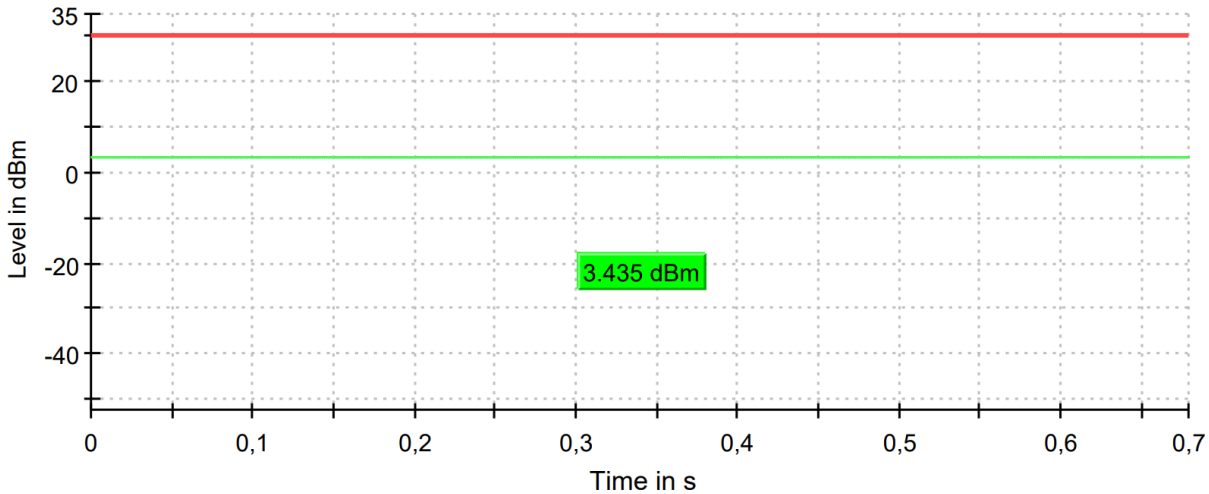
3.4.6 Plots of the Output power



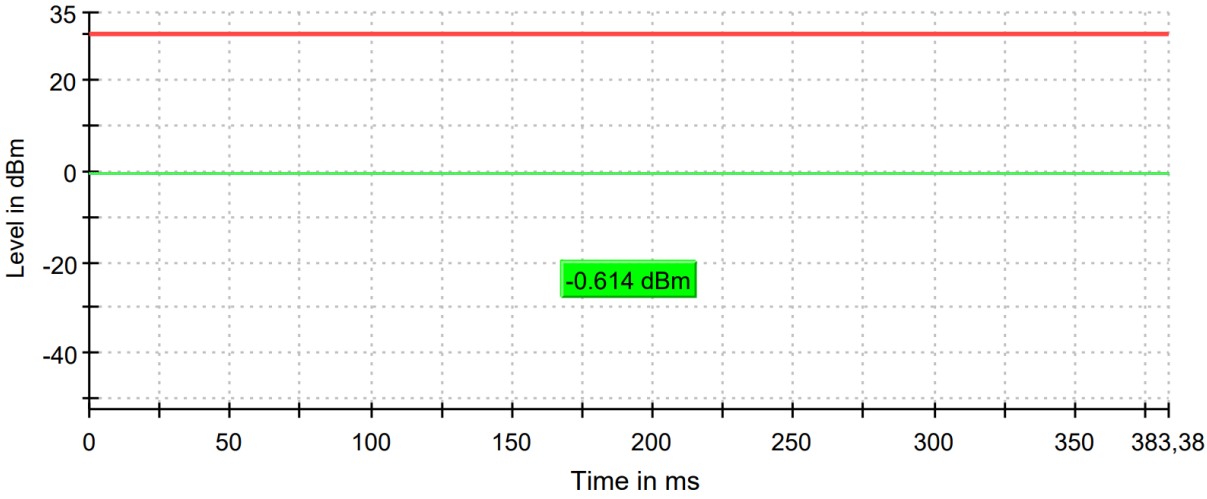
Plot 69: Conducted Output Power of the EUT at 1Mbps
Low channel



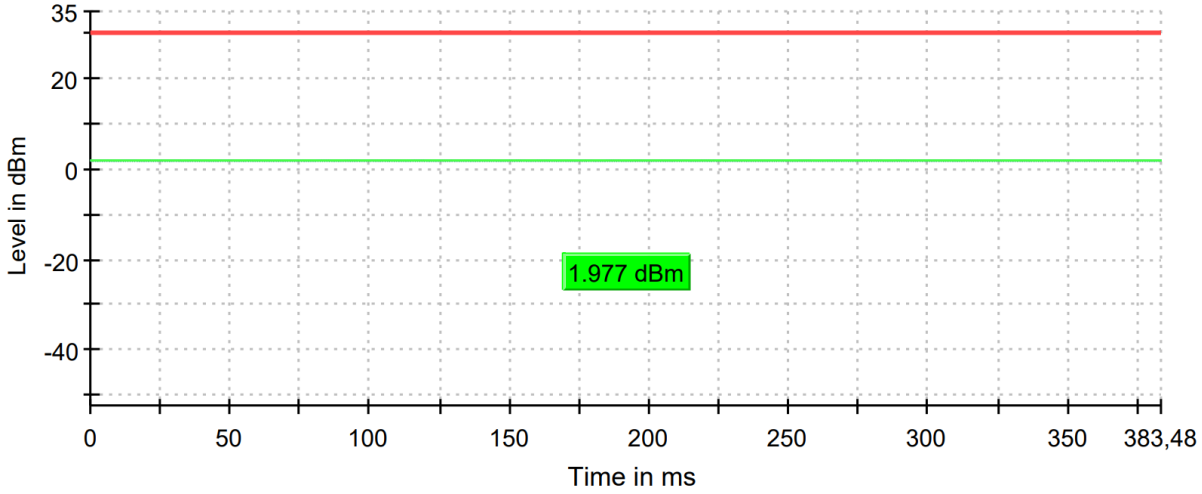
Plot 70: Conducted Output Power of the EUT at 1Mbps
Mid channel



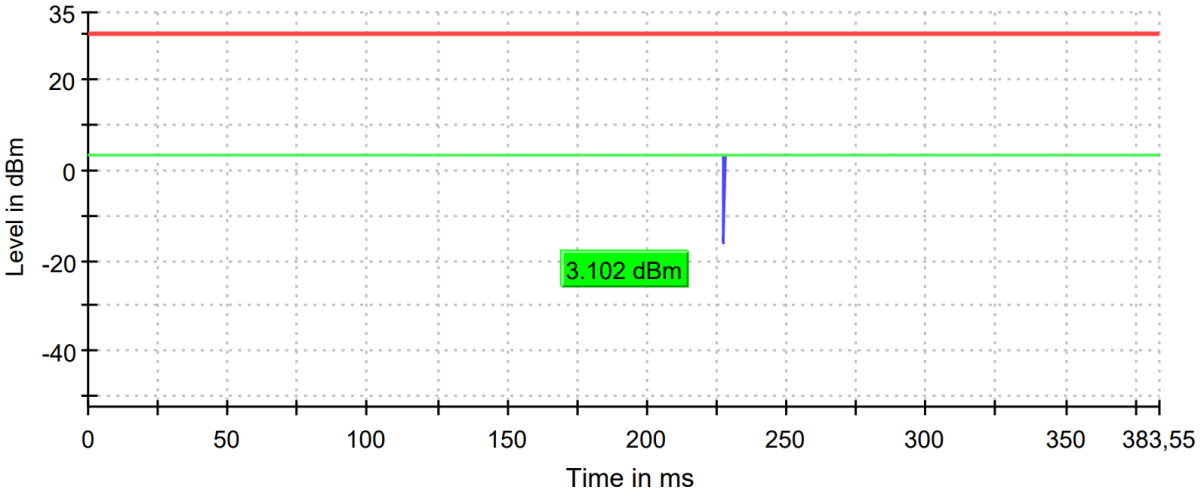
Plot 71: Conducted Output Power of the EUT at 1Mbps
High channel



Plot 72: Conducted Output Power of the EUT at 2Mbps
Low channel



Plot 73: Conducted Output Power of the EUT at 2Mbps
Mid channel



Plot 74: Conducted Output Power of the EUT at 2Mbps
High channel

3.5 Band edge Measurement

3.5.1 Limit

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

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. Antenna port conducted.

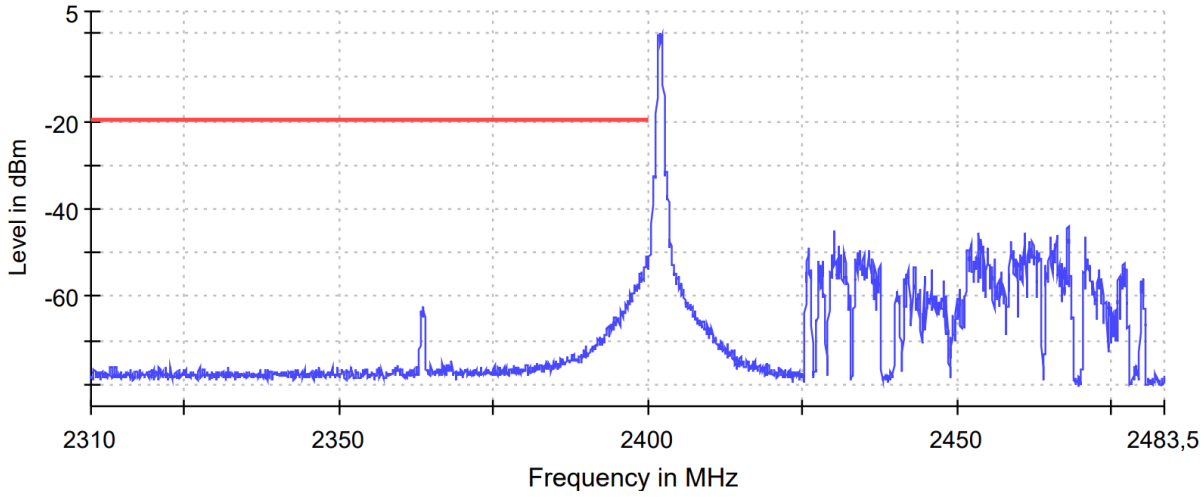
3.5.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02, section 8.7.
IRN 415 – Method 13 – Spurious emissions at the Authorized band edge (relative method).

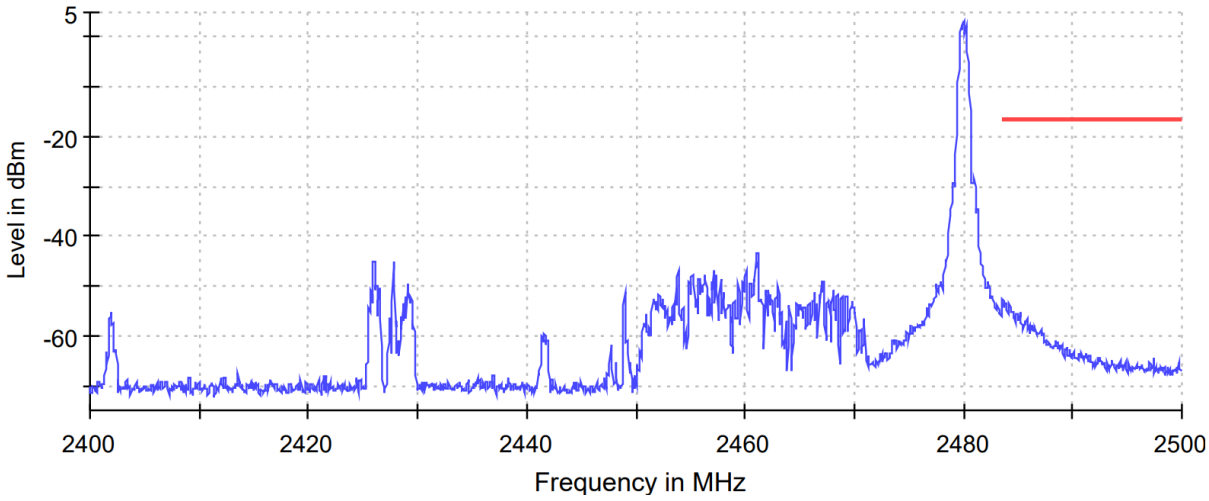
3.5.5 Measurement Uncertainty

± 5.7 dB.(radiated)

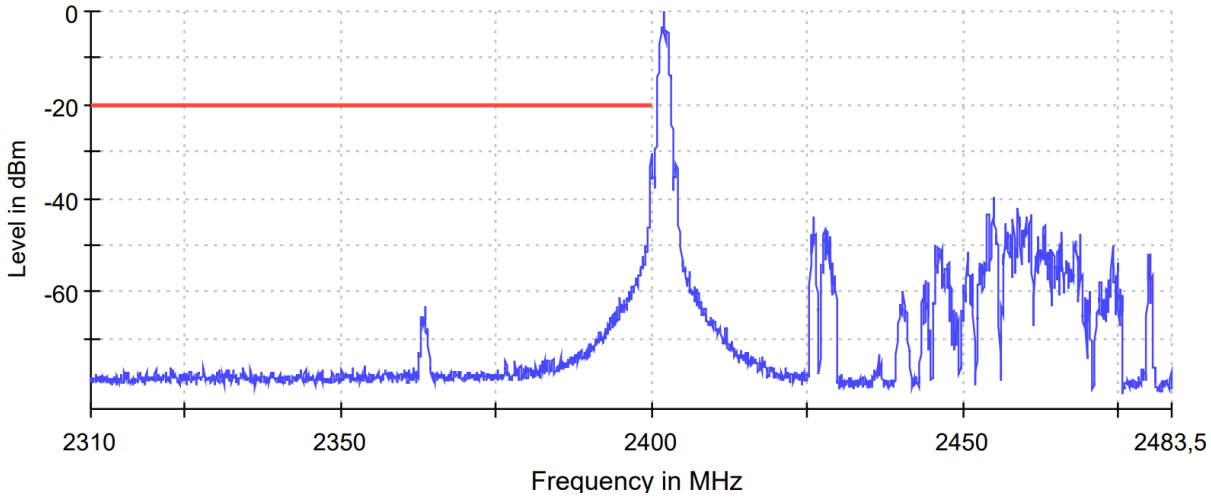
3.5.6 Plots of the Band edge Measurements



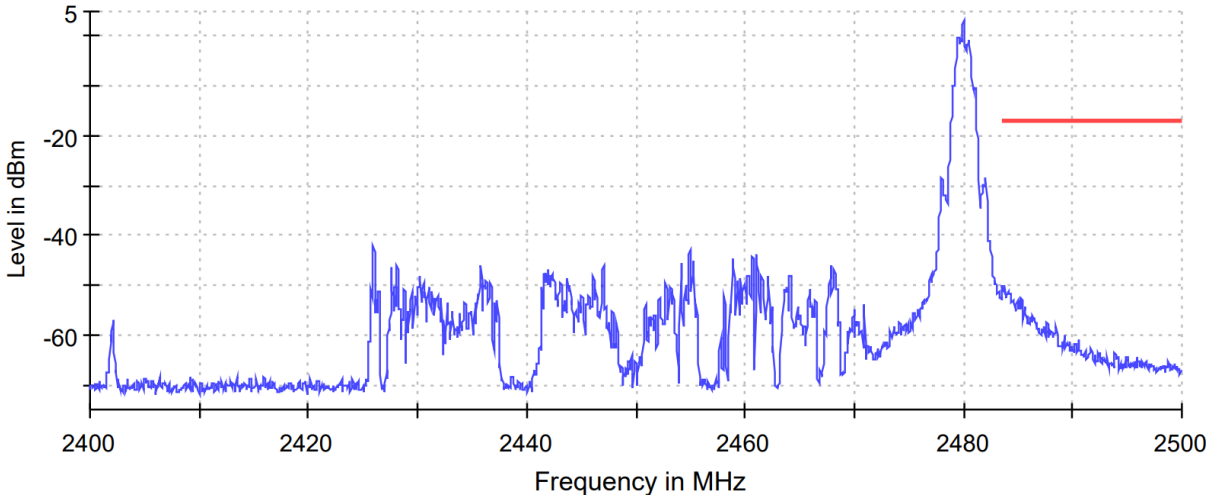
Plot 75: Lower band edge at 1Mbps (Channel 1)



Plot 76: Upper band edge at 1Mbps (Channel 39)



Plot 77: Lower band edge at 2Mbps (Channel 1)



Plot 78: Upper band edge at 2Mbps (Channel 39)

3.6 AC Power-line conducted emissions

3.6.1 Limit

According to 15.207 (a), (c)

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

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.

3.6.4 Test procedure

According to ANSI C63.10-2020 Section 6.2
IRN 439 – Method 1

3.6.5 Measurement uncertainty

+/- 3.6 dB

3.6.6 AC Power Line Conducted emission data of the EUT, results

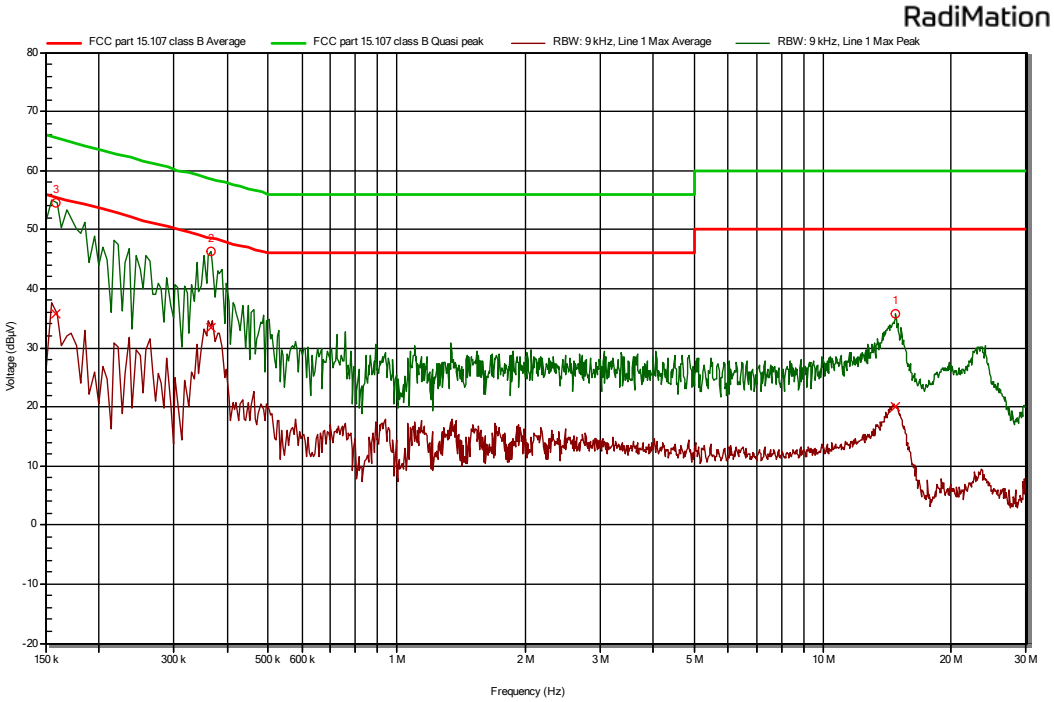
Phase

Peak Number	Frequency	Peak	Status	Average	Average Limit
1	14,757 MHz	35,7 dBµV	Pass	20,1 dBµV	50 dBµV
2	366 kHz	46,4 dBµV	Pass	33,5 dBµV	48,6 dBµV
3	159 kHz	54,6 dBµV	Pass	35,7 dBµV	55,5 dBµV

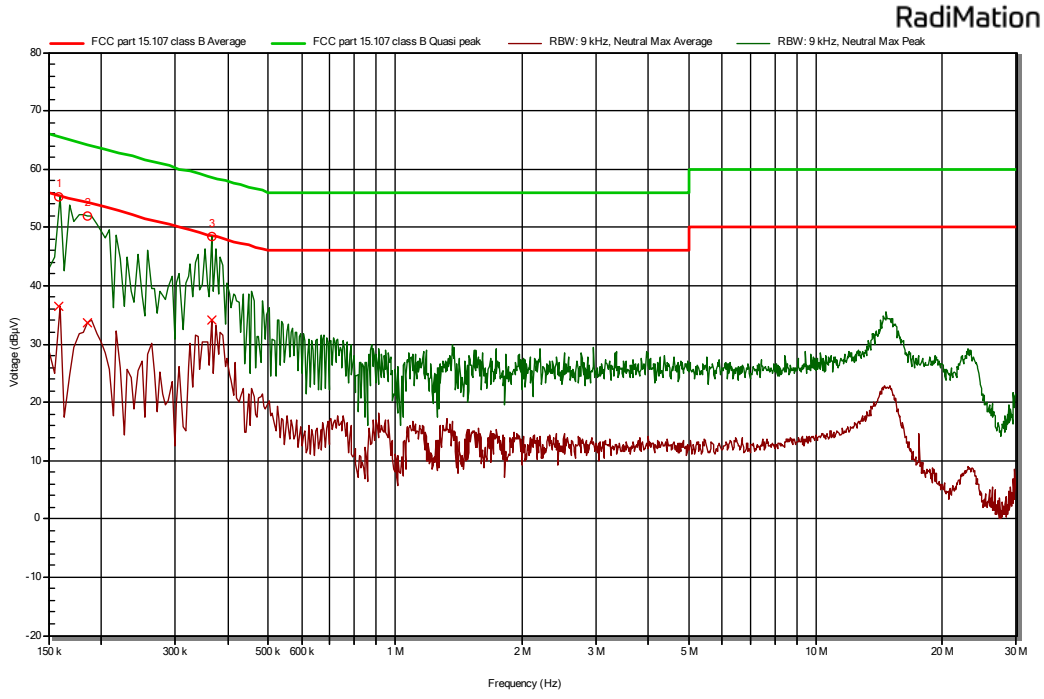
Neutral

Peak Number	Frequency	Peak	Status	Average	Average Limit
1	159 kHz	55,3 dBµV	Pass	36,4 dBµV	55,5 dBµV
2	186 kHz	52 dBµV	Pass	33,6 dBµV	54,2 dBµV
3	366 kHz	48,4 dBµV	Pass	34,1 dBµV	48,6 dBµV

3.6.7 Plots of the AC mains conducted spurious measurement



Plot 79: Pre-scan plot with peak detector of the AC Power-line Conducted emissions on **Phase**



Plot 80: Pre-scan plot with peak detector of the AC Power-line Conducted emissions on **Neutral**

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 (dB/Ωm) 114515 EMCO 6505 S/N:9112-2710	CL (dB) SAR cable	Corr. (dB)
0,009	-32,35	0,7	-31,65
0,01	-33,16	0,05	-33,11
0,02	-37,56	0,07	-37,49
0,03	-39,29	0,1	-39,19
0,04	-40,11	0,1	-40,01
0,1	-41,27	0,1	-41,17
0,2	-41,48	0,1	-41,38
0,5	-41,58	0,1	-41,48
1	-41,62	0,2	-41,42
3	-41,6	0,2	-41,4
5	-41,65	0,3	-41,35
10	-42,11	0,6	-41,51
15	-42,88	0,9	-41,98
20	-43,78	1	-42,78
25	-44,85	0,7	-44,15
27	-45,36	1,2	-44,16
30	-46,25	1	-45,25

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: 114436** **VHA 9103 + BBA 9106** **SN: 9856**	**Cable loss (dB)** **Id: SAR cable**	**Corr. (dB)**
30	18.6	0.68	19.28
100	10.4	1.15	11.55
150	14.8	1.41	16.21
200	16.0	1.63	17.63
250	16.9	1.93	18.83

Frequency (MHz)	**Gain (dBi)** **ID: 114385** **EMCO LPDA** **SN: 9856**	**Cable loss (dB)** **Id: SAR cable**	**Corr. (dB)**
250	11.8	1.93	13.73
300	13	2.12	15.12
350	15.6	2.2	17.8
400	17.1	2.29	19.39
450	17.3	2.53	19.83
500	17.7	2.67	20.37
550	18.4	2.9	21.3
600	19.2	3.02	22.22
650	19.7	3.09	22.79
700	20.3	3.22	23.52
750	21.4	3.56	24.96
800	22	3.69	25.69
900	22.1	3.81	25.91
950	22.6	3.91	26.51
1000	22.5	4.3	26.8

Frequency (MHz)	AF (dB/m) Kiwa ID: 114607 Emco 3115 SN: 9412-4377	Gain (dB) Kiwa ID: 114693 Miteq JS4-18004000-30-8P-A1	Cable loss (dB) TE 01315	Corr. (dB)
1000	23,6	40,4	2,0	66
1500	25,1	40,5	2,4	68
2000	27,1	40,5	2,7	70,3
2500	28,6	40,7	3,2	72,5
3000	30,5	40,7	3,2	74,4
3500	31,2	40,7	3,4	75,3
4000	32,7	40,9	4,9	78,5
4500	32,4	40,9	4,4	77,7
5000	33,2	40,7	4,6	78,5
5500	34,0	40,5	4,5	79
6000	34,6	40,0	5,2	79,8
6500	34,3	39,4	5,9	79,6
7000	35,2	38,6	5,7	79,5
7500	36,4	39,2	5,9	81,5
8000	37,0	38,9	6,3	82,2
8500	37,5	38,4	6,4	82,3
9000	38,1	37,4	6,5	82
9500	37,8	37,0	7,1	81,9
10000	38,2	36,5	7,3	82
10500	38,1	36,7	7,6	82,4
11000	38,3	36,9	8,3	83,5
11500	38,5	37,6	8,1	84,2
12000	39,1	38,3	8,4	85,8
12500	38,7	38,5	8,3	85,5
13000	39,2	38,9	9,2	87,3
13500	40,5	40,2	8,3	89
14000	41,1	40,0	8,2	89,3
14500	41,4	40,1	8,2	89,7
15000	40,2	41,4	8,3	89,9
15500	37,9	41,4	8,6	87,9
16000	37,5	42,8	9,2	89,5
16500	38,6	42,3	8,8	89,7
17000	41,1	43,1	9,4	93,6
17500	42,7	43,2	9,4	95,3
18000	44,0	44,2	9,8	98

Frequency (MHz)	AF (dB/m) Kiwa ID: 114518 Flann 20240-25 SN: 163703	Gain (dB) Kiwa ID:114693 Miteq JS4-18004000-30-8P-A1	Cable loss (dB) TE 01315	Corr. (dB)
18000	31,3	26,2	9,8	67,3
19000	31,5	26,1	9,6	67,2
20000	31,7	25,9	11	68,6
21000	31,9	24,3	10,7	66,9
22000	32,1	18,3	10,5	60,9
23000	32,2	18,9	10,8	61,9
24000	32,3	23,6	11,4	67,3
25000	32,4	24,5	11,6	68,5
26000	32,5	25,3	11,7	69,5

<< END OF REPORT>>