Test report for

47 CFR Part 15 Subpart C

RSS-247, RSS-Gen

The RvA is signatory to ILAC - MRA

Product name	: Tacx Alpine
Applicant	: Tacx bv.
FCC ID	: IPH-04820
IC	: 1792A-04820

Test report No. : P000396038 001 Ver 1.00

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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Documentation

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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	02-12-2024	First draft	AWM
v1.00	10-03-2025	Initial release	AWM

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 5.2(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
15.207 (c)	RSS-Gen 8.8	AC power-line conducted emissions	3.7	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:	Tacx bv.
Address:	de Boeg 2
Zip code:	2343 HK Oegstgeest the Netherlands
Telephone:	071 7999292
E-mail:	richard@tacx.nl
Contact name:	Richard Kockelkoren

1.2 Manufacturer

Manufacturer name:	Garmin International, Inc.
Address:	1200 E. 151st
Zip code:	KS 66062 Olathe, United States
Telephone:	+1 9134401946
E-mail:	ben.karsak@garmin.com
Contact name:	Ben Karsak

1.3 Tested Equipment Under Test (EUT)

Product name:	Tacx, Alpine
Brand name:	GARMIN
FCC ID:	IPH-04820
IC:	1792A-04820
Product description:	Slope simulator for indoor cycling trainer
Variant model(s):	--
Batch and/or serial No.	A04820
Software version:	006-B4562-00-4
Hardware version:	012-04820-09-A
Date of receipt:	12-08-2024
Tests started:	12-08-2024
Testing ended:	20-11-2024

1.3.1 Auxiliary items

AUX1

Product name:	Notebook
Brand name:	Dell
Product type:	Laptop
Model:	Latitude 7490
Remarks:	Connects to EUT for programming the device into another test mode

1.4 Product specifications of Equipment under test

Tx Frequency:	BLE: 2400-2483.5 MHz ANT+: 2400-2483.5 MHz
Rx frequency:	BLE: 2400-2483.5 MHz ANT+: 2400-2483.5 MHz
Occupied channel width:	1.055 MHz (1Mbps), 2.040 MHz (2Mbps), 910 kHz (ANT+)
Antenna type:	PCB trace
Antenna gain:	5 dBi
Type of modulation:	GFSK
Emission designator	BLE: 1M05F1D (1 Mbit) 2M04F1D (2 Mbit) ANT+: 910KF1D

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 80 %

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 Device has extra programming PCB for testing purposes, which is not in the end product. For the frequency range 30 MHz-230 MHz the USB cable for applying correct test frequency, which is not applied in end product, is not terminated correctly causing wide band noise within the frequency range (see plots 3a and 3b BLE 1 Mbps and BLE 2 Mbps). For this reason ferrites were applied on this cable during further testing.

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 : dr.ir. G. Geers
Ing. M.H. Khan

Review of test methods and report by:

Name : ing. R. van Barneveld.

The above conclusions have been verified by the following signatory:

Date : 04-04-2025

Name : P. van Wanrooij

Function : Test Engineer

Signature :

2 Test configuration of the Equipment Under Test

2.1 Test mode

The applicant provided test mode firmware for the BLE radio, in which it was possible to configure the radio to transmit continuously. The 2400 – 2483.5 MHz radio has been tested in standby mode.

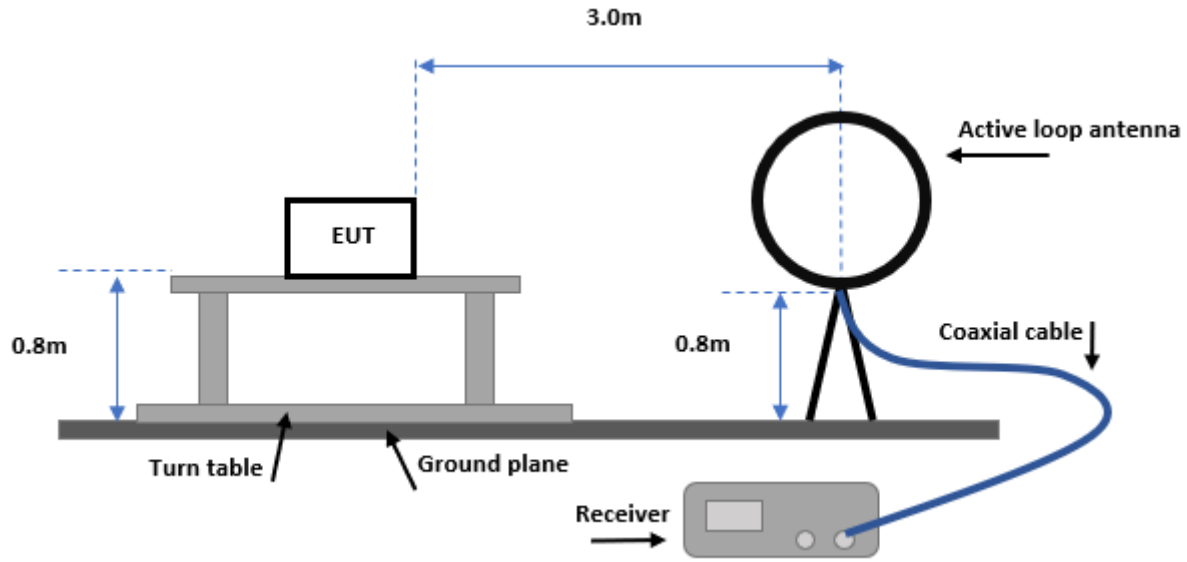
Technology	Channels	Data rate	Frequency (MHz)
BLE	37	1 Mbps	2402
	17	1 Mbps	2440
	39	1 Mbps	2480

Technology	Channels	Data rate	Frequency (MHz)
BLE	37	2 Mbps	2402
	17	2 Mbps	2440
	39	2 Mbps	2480

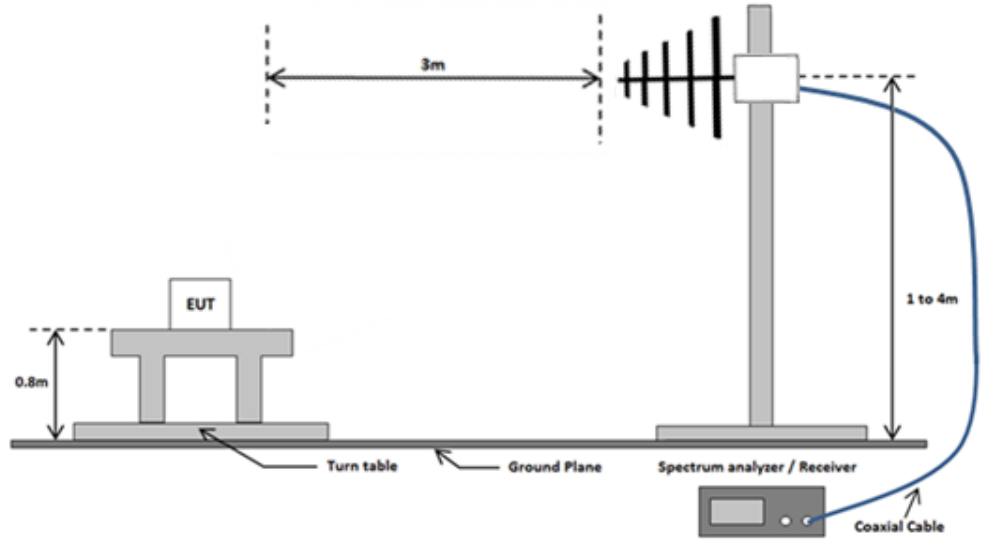
Technology	Channels	Data rate	Frequency (MHz)
ANT+	1	1 Mbps	2457

2.2 Test setups

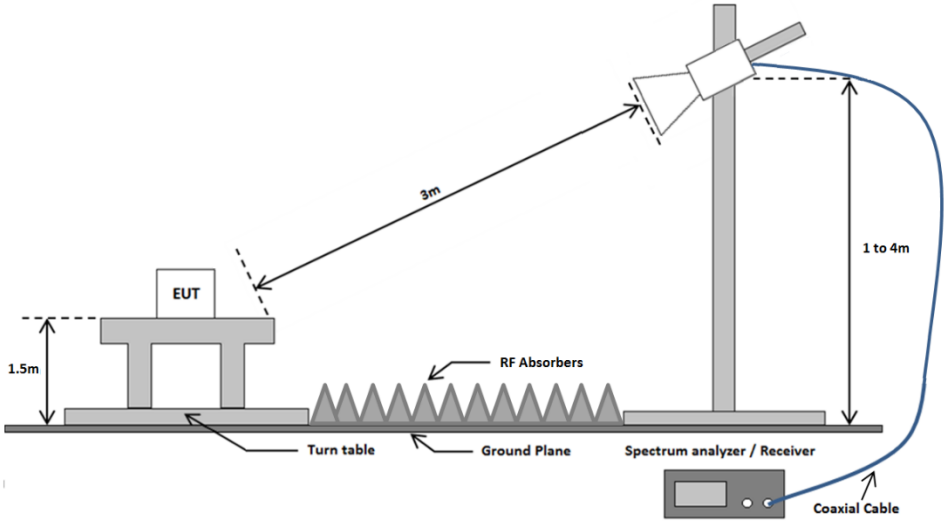
Radiated emissions test setup 9 kHz – 30 MHz



Radiated emissions test setup 30 MHz - 1 GHz

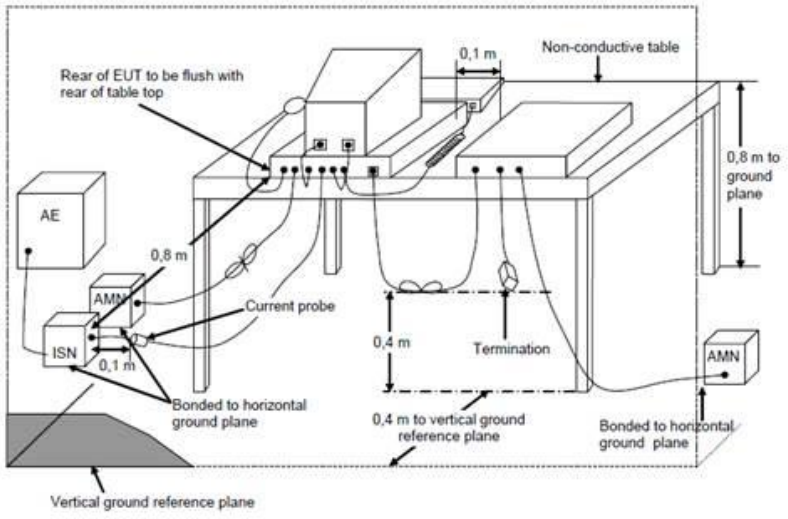


Radiated emissions test setup above 1 GHz



AC Power line conducted emissions test setup

Emissions test at AC mains



List of used cables					
Number	**Function**	**From**	**To**	**Length**	**Remarks**
1	AC Power	mains 120Vac 60 Hz	EUT	< 3m	-
2	USB programming cable	EUT	AUX 2	< 3m	Is for testing purposes, the EUT will not be sold with a programming function.

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	114534	07-2024	07-2025	3.1
Spectrum Analyzer	Rohde & Schwarz	FSV3044	114923	10-2023	10-2025	3.1
3.0 GHz HPF	Wainwright	WHK3.0/18G-10EF	114682	09-2021	09-2024	3.1
Active loop antenna	EMCO	6502	114515	01-2022	01-2025	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	01-2025	01-2028	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
RF cable	Berkenhoff	RG214	114628	--	--	3.1
Antenna Cable	Carlisle	FB142A107	114691	--	--	3.1
Test software	Raditeq	Radimation Version 2023.2.3	--	--	--	3.1
LISN /Two line V-network	Rohde & Schwarz	ENV 216	114379	11-2023	11-2025	3.7

*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 9
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

9 kHz -30 MHz

Channel	Frequency [kHz]	Peak [dBµV/m]	Quasi-Peak [dBµV/m]	Quasi-Peak Limit [dBµV/m]	Polarization
ANT +	555.723	-4,3	-8.6	32,7	Perpendicular
ANT+	16395	4.2	-3.7	29,5	Perpendicular

30 MHz-250 MHz

Channel	Frequency [MHz]	Peak [dBµV/m]	Quasi-Peak [dBµV/m]	Quasi-Peak Limit [dBµV/m]	Polarization
ANT+	31.351	30.7	18,7	40	Vertical
ANT+	42.679	34.1	24.8	40	Vertical
BLE Low (1Mbps)	50.049	40.1	31.2	40	Vertical
BLE Low (1Mbps)	52.175	43.2	32.3	40	Vertical
BLE Low (1Mbps)	54.074	45.5	37.4	40	Vertical
BLE Low (1Mbps)	55.11	46.4	38.4	40	Vertical
BLE Low (1Mbps)	56.211	44.8	35.5	40	Vertical
BLE Low (1Mbps)	58.485	43.7	34.2	40	Vertical
BLE Low (1Mbps)	59.542	43.1	34.7	40	Vertical
BLE Low (1Mbps)	61.856	38.6	29.6	40	Vertical
ANT+	63.806	37	27.3	40	Vertical
BLE Mid (1Mbps)	66.97	33.8	25	40	Vertical
BLE High (2Mbps)	69.996	34.3	32.3	40	Vertical
BLE Mid (2Mbps)	70.003	35.6	32.1	40	Vertical
ANT+	73.172	37.3	26	40	Vertical
BLE Low (1Mbps)	105.984	39.3	28.6	43.5	Vertical

ANT+	114.385	40.4	31.2	43.5	Vertical
BLE Mid (2Mbps)	114.489	39.7	29.8	43.5	Vertical
BLE Mid (1Mbps)	117.028	36	22.9	43.5	Vertical
BLE High (2Mbps)	118.034	37	25.7	43.5	Vertical
ANT+	134.419	40.5	30.8	43.5	Vertical
ANT+	246.929	36.5	23.7	46	Horizontal

250 MHz-1000 MHz

Channel	Frequency [MHz]	Peak [dBµV/m]	Quasi-Peak [dBµV/m]	Quasi-Peak Limit [dBµV/m]	Polarization
ANT+	252.945	33.9	22	46	Horizontal
BLE High (1Mbps)	256.506	37.1	20.6	46	Horizontal
BLE Low (1Mbps)	261.594	32.8	17.1	46	Horizontal
ANT+	359.872	31.2	16.9	46	Horizontal
ANT+	399.854	36.2	29.9	46	Horizontal
ANT+	463.071	30.5	17.5	46	Vertical
BLE Mid (1Mbps)	956.702	43	31.1	46	Vertical
BLE Low (1Mbps)	972.548	42.7	31.2	54	Vertical
ANT+	979.196	33.9	21	54	Horizontal

1-18 GHz

Channel	Frequency [GHz]	Peak [dBµV/m]	Peak Limit [dBµV/m]	Average [dBµV/m]	Average Limit [dBµV/m]	Polarization
ANT+	7.324	53.1	74	44.3	54	Vertical
BLE Low (1Mbps)	7.205	52.6	74	44.9	54	Vertical

BLE Mid (1Mbps)	7.32	52.3	74	44.9	54	Horizontal
BLE Mid (1Mbps)	7.32	53.6	74	44.3	54	Vertical
BLE High (1Mbps)	7.439	53.7	74	44.1	54	Horizontal
BLE Low (2Mbps)	7.439	53.6	74	46.4	54	Horizontal
BLE Mid (2Mbps)	7.320	52.8	74	44.1	54	Vertical
BLE High (2Mbps)	7.439	53.9	74	44.6	54	Horizontal

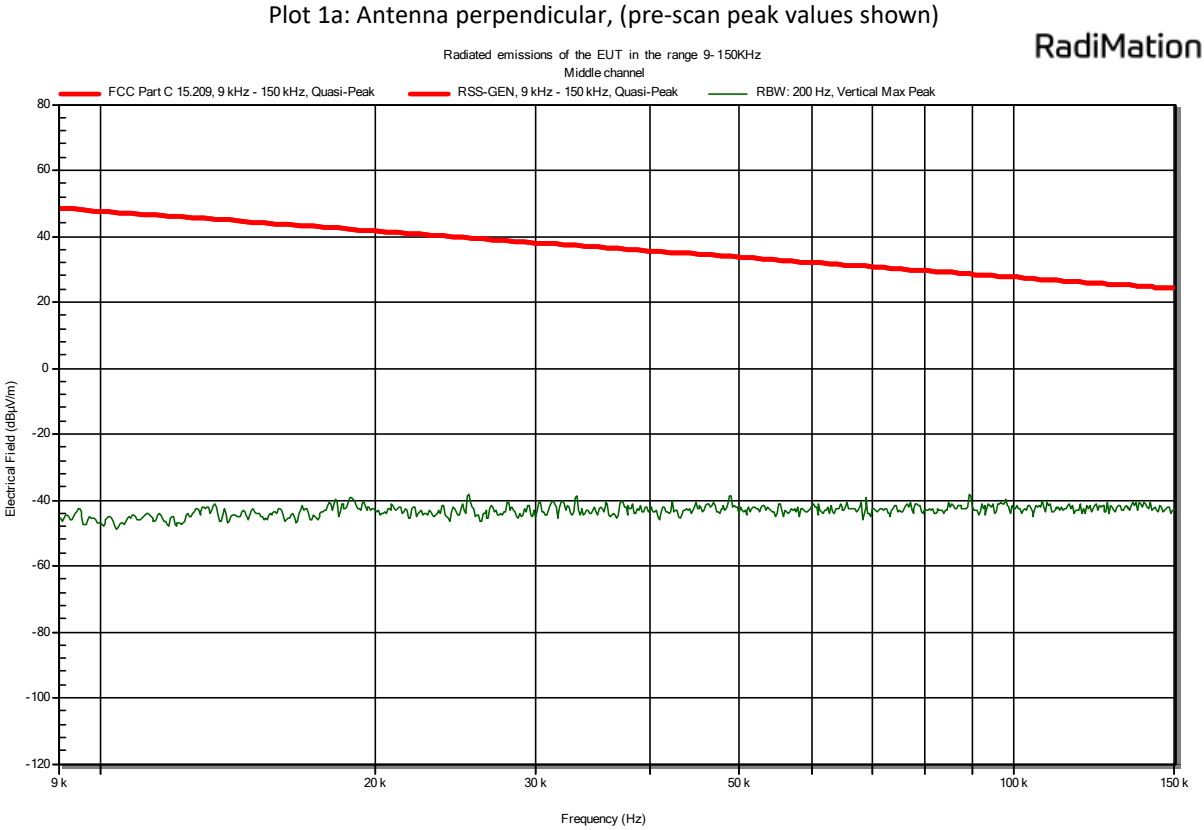
18-26.5 GHz

Channel	Frequency [GHz]	Peak [dBµV/m]	Peak Limit [dBµV/m]	Average [dBµV/m]	Average Limit [dBµV/m]	Polarization
BLE High (1Mbps)	23.44	54.5	74	42.2	54	Vertical
ANT+	23.468	54	74	41.9	54	Vertical
BLE Low (1Mbps)	24.063	53.7	74	42.2	54	Vertical
BLE Low (1Mbps)	24.992	53.5	74	41.4	54	Horizontal
BLE Low (1Mbps)	25.676	54.8	74	42,3	54	Vertical
ANT+	25.837	54.9	74	42.6	54	Vertical
BLE Low (1Mbps)	25.947	54.1	74	41.9	54	Horizontal
ANT+	26.142	54.2	74	42.5	54	Horizontal
BLE Low (1Mbps)	26.423	55.2	74	42.9	54	Horizontal
ANT+	26.474	55.2	74	43.3	54	Vertical

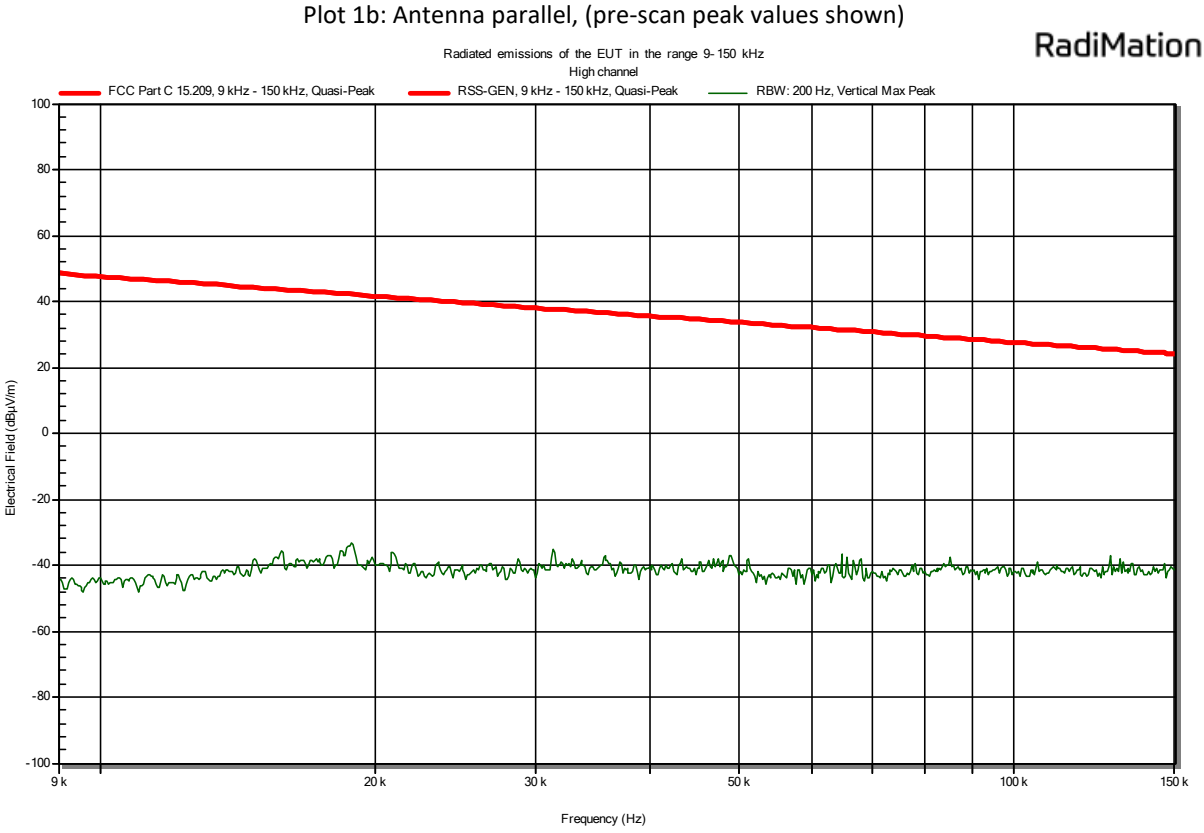
The results of the radiated emission tests are depicted in the tables above. A selection of plots is provided on the next pages

3.1.7 Plots of the Radiated Spurious Emissions Measurement BLE 1 Mbps

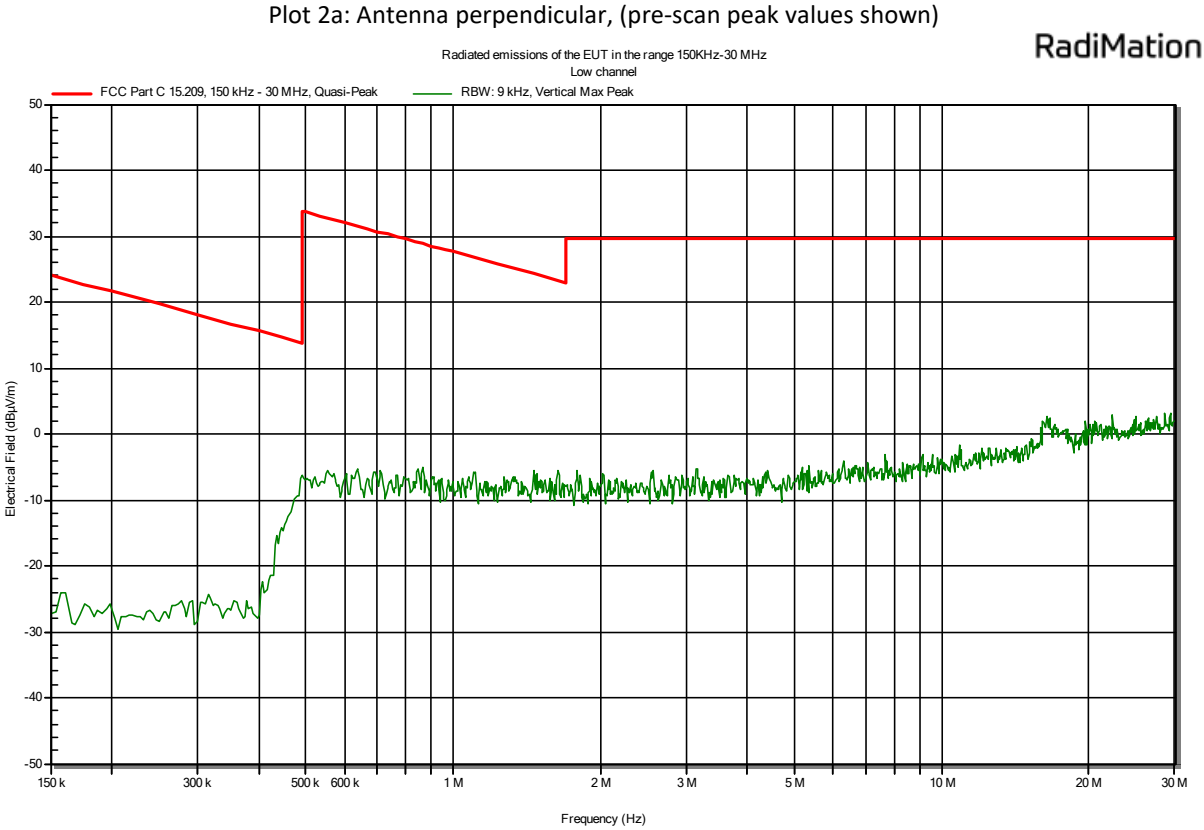
Plot 1a: Antenna perpendicular, (pre-scan peak values shown)



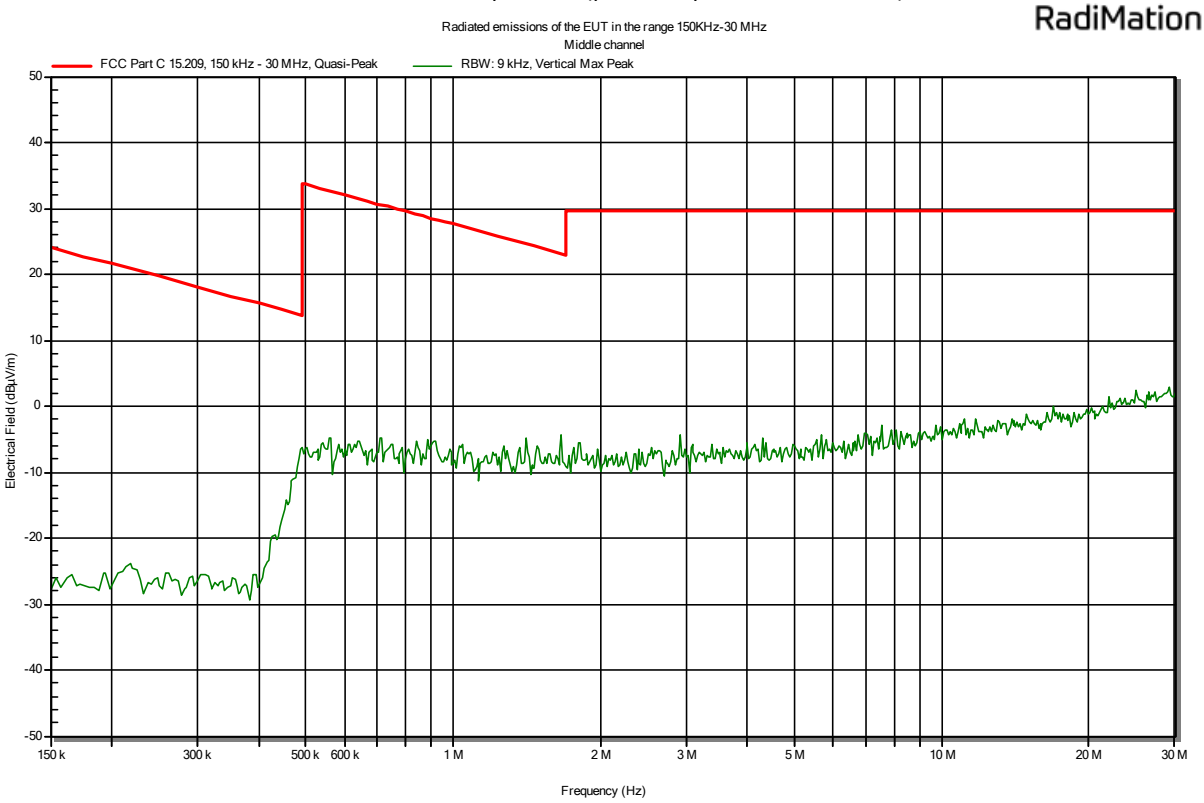
Plot 1b: Antenna parallel, (pre-scan peak values shown)



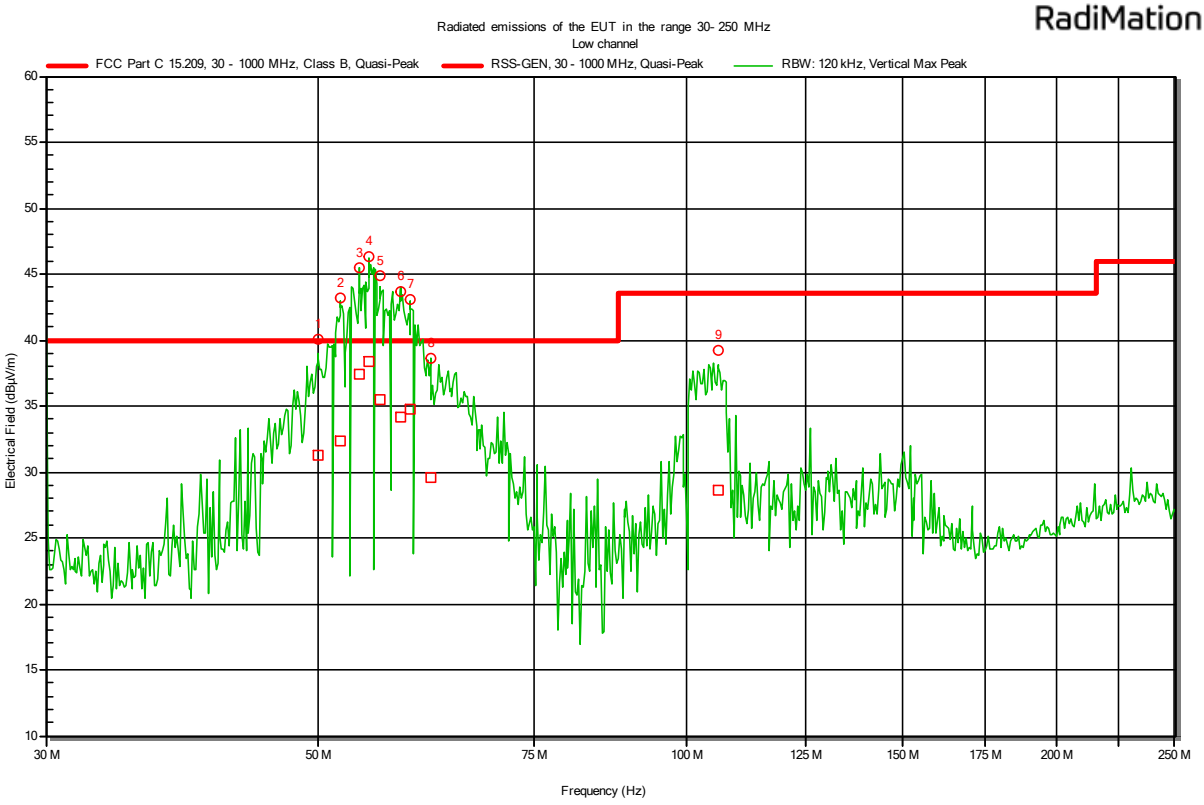
Plot 2a: Antenna perpendicular, (pre-scan peak values shown)



Plot 2b: Antenna parallel, (pre-scan peak values shown)

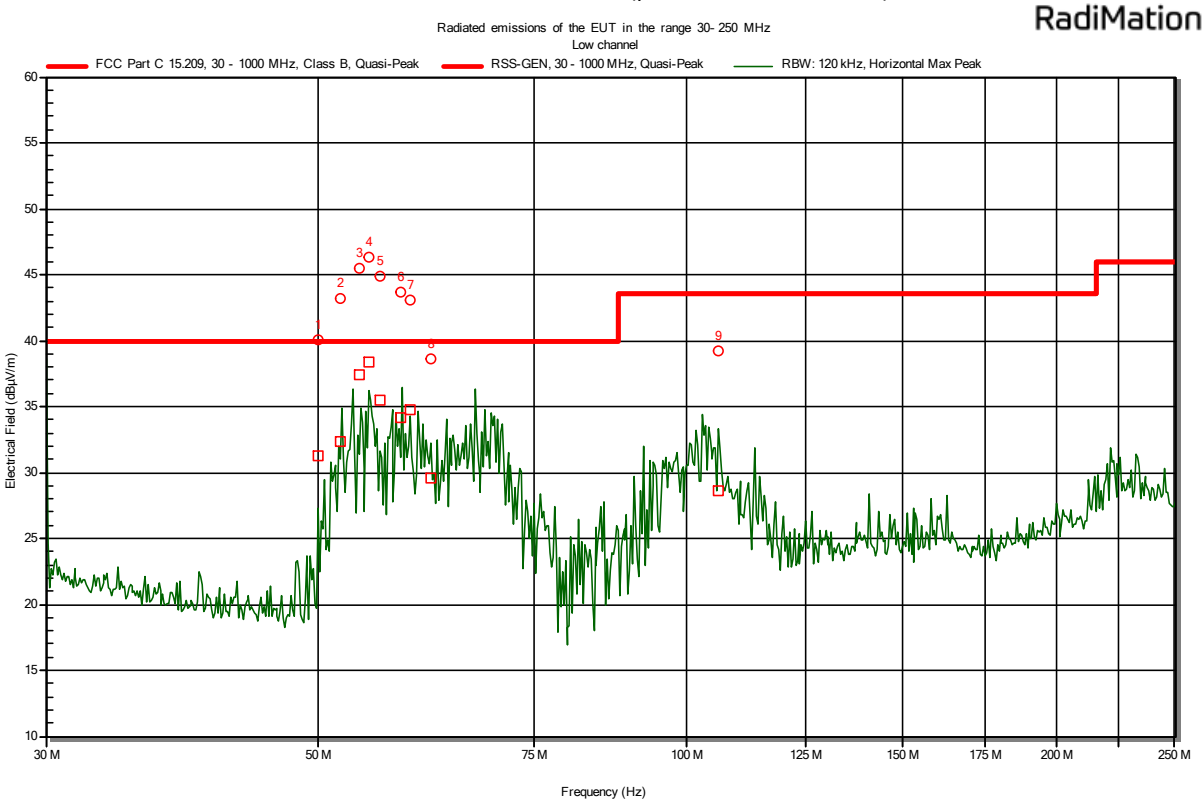


Plot 3a: Antenna vertical, (pre-scan values shown)



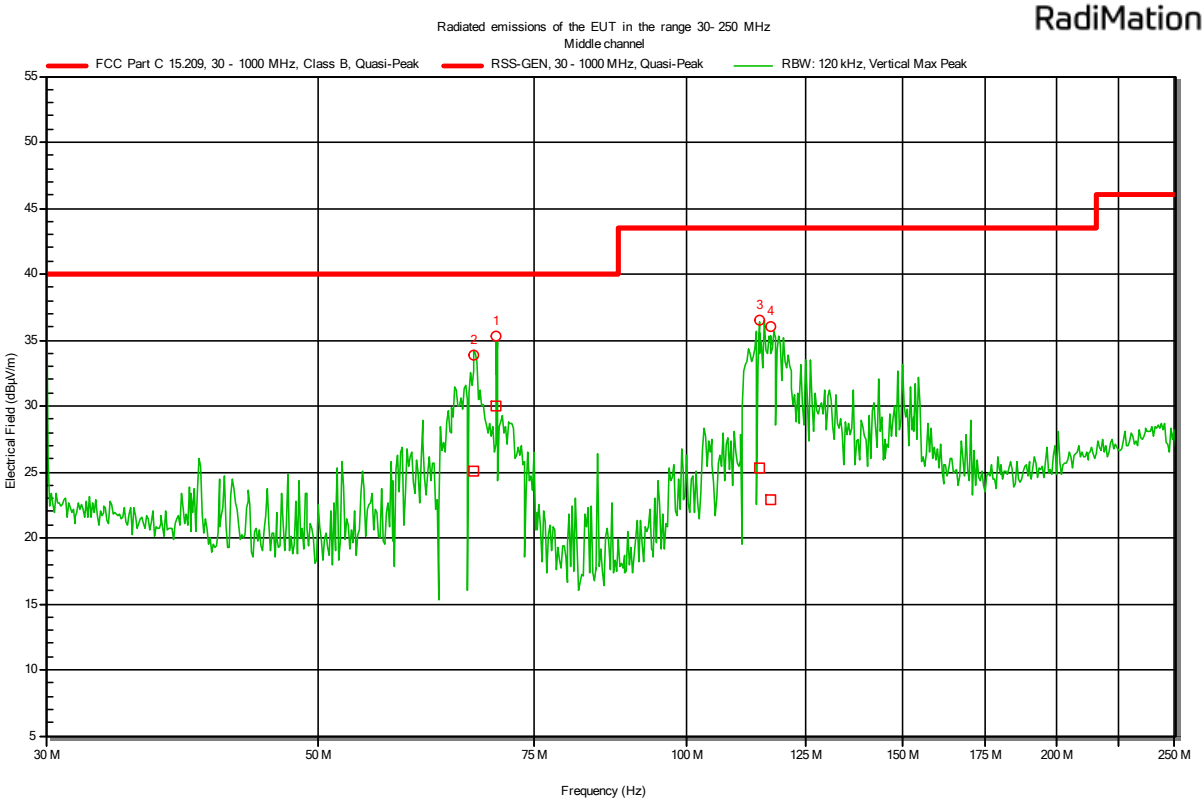
Note: The USB programming cable is not terminated correctly, which causes wide band noise.

Plot 3b: Antenna horizontal, (pre-scan values shown)

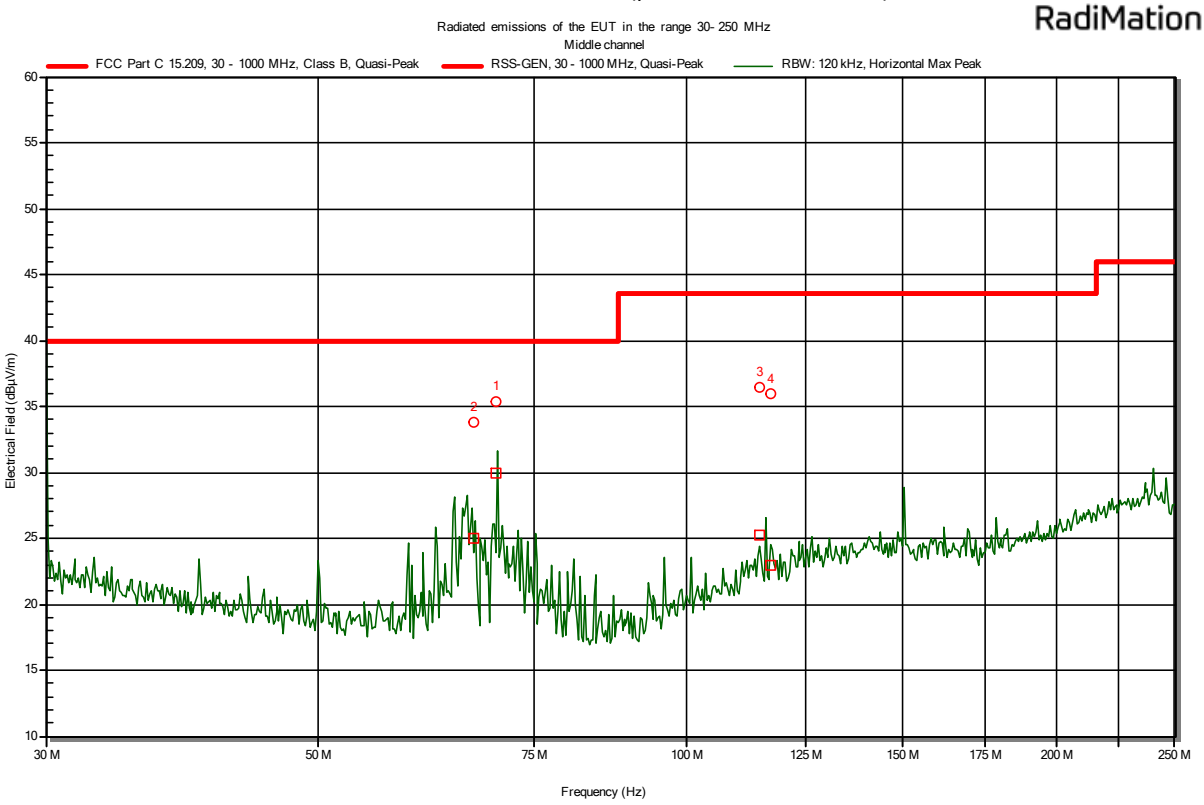


Note: The USB programming cable is not terminated correctly, which causes wide band noise.

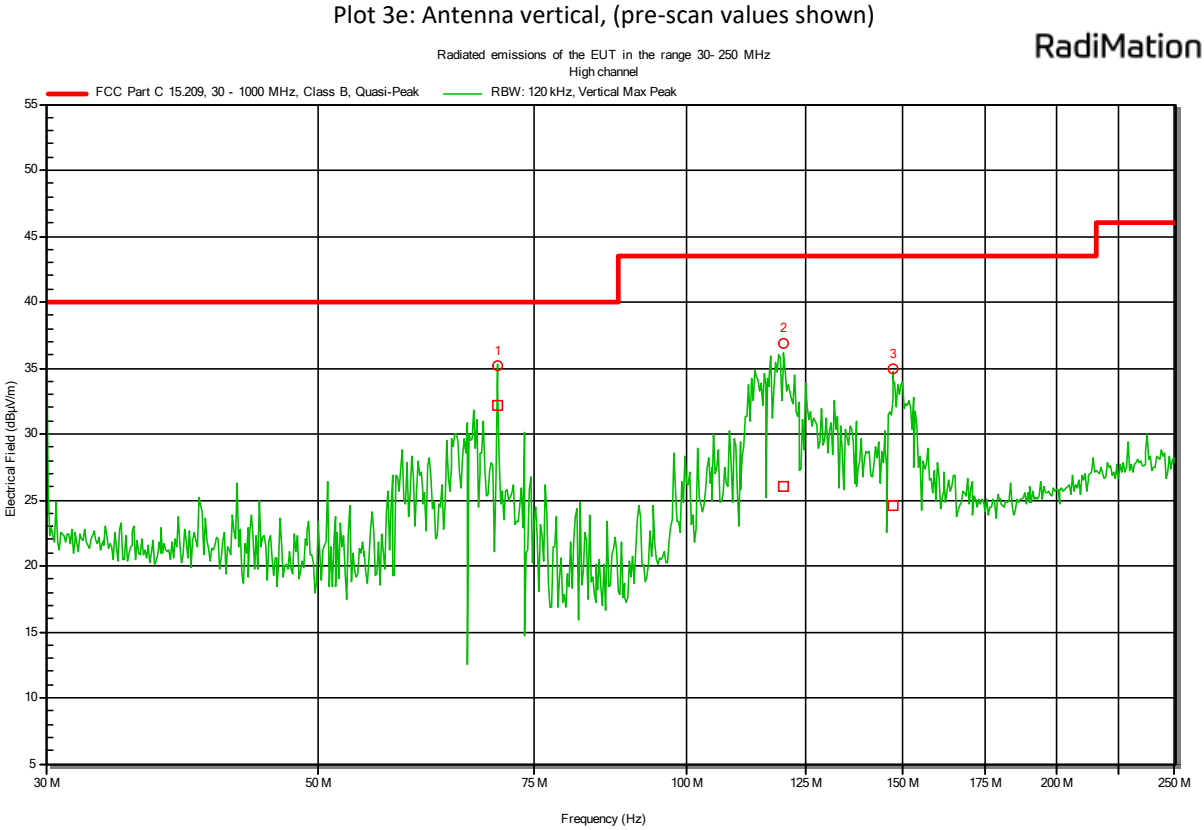
Plot 3c: Antenna vertical, (pre-scan values shown)



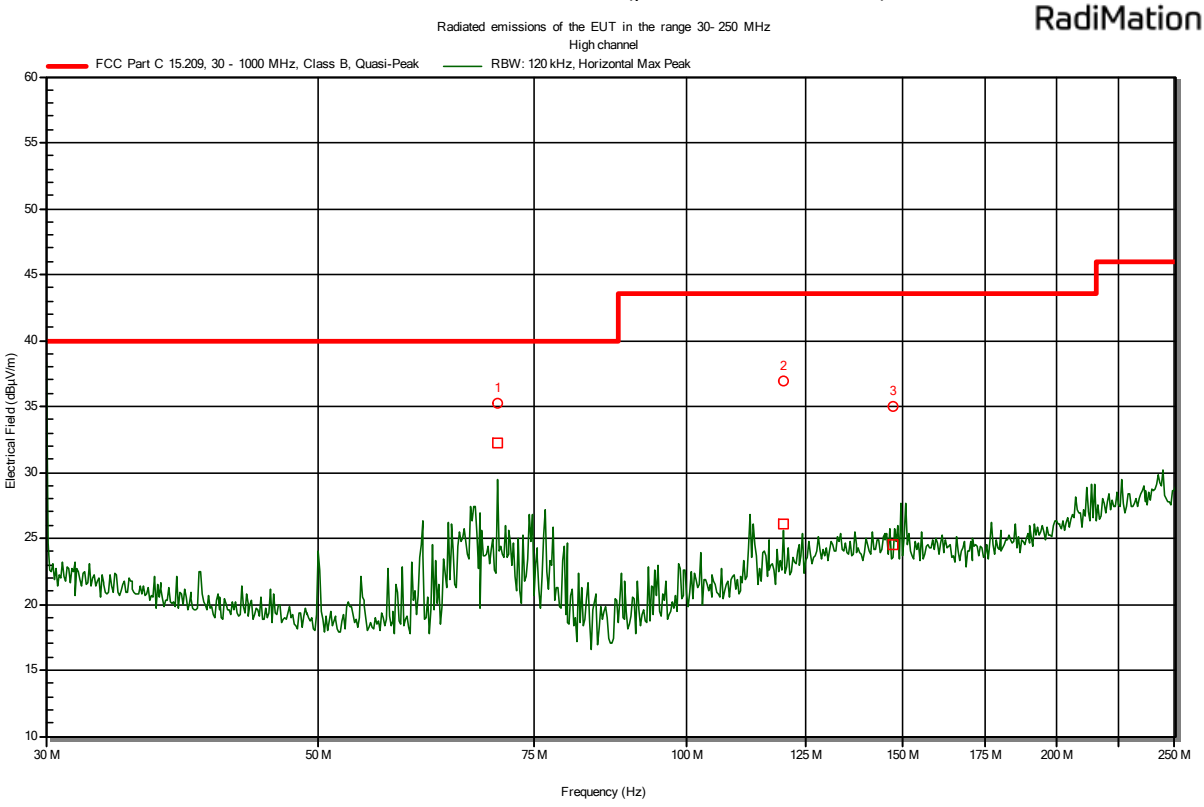
Plot 3d: Antenna horizontal, (pre-scan values shown)



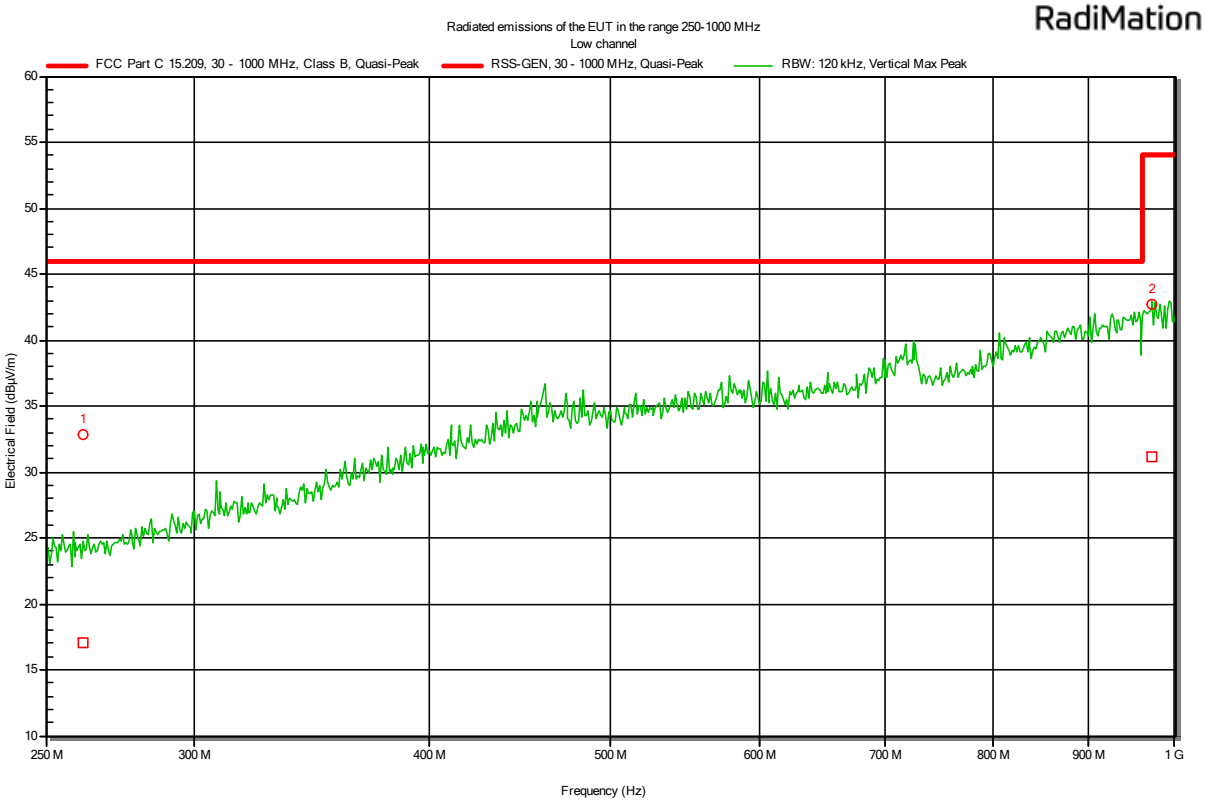
Plot 3e: Antenna vertical, (pre-scan values shown)



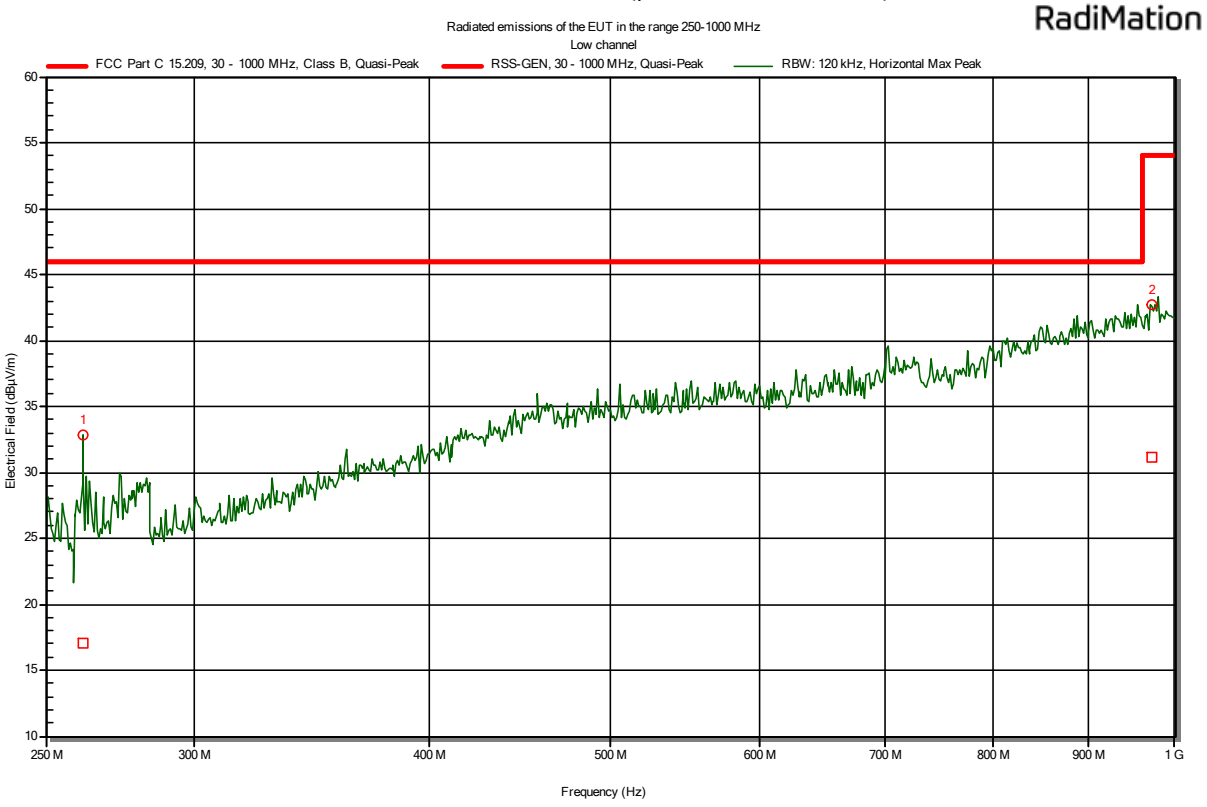
Plot 3f: Antenna horizontal, (pre-scan values shown)



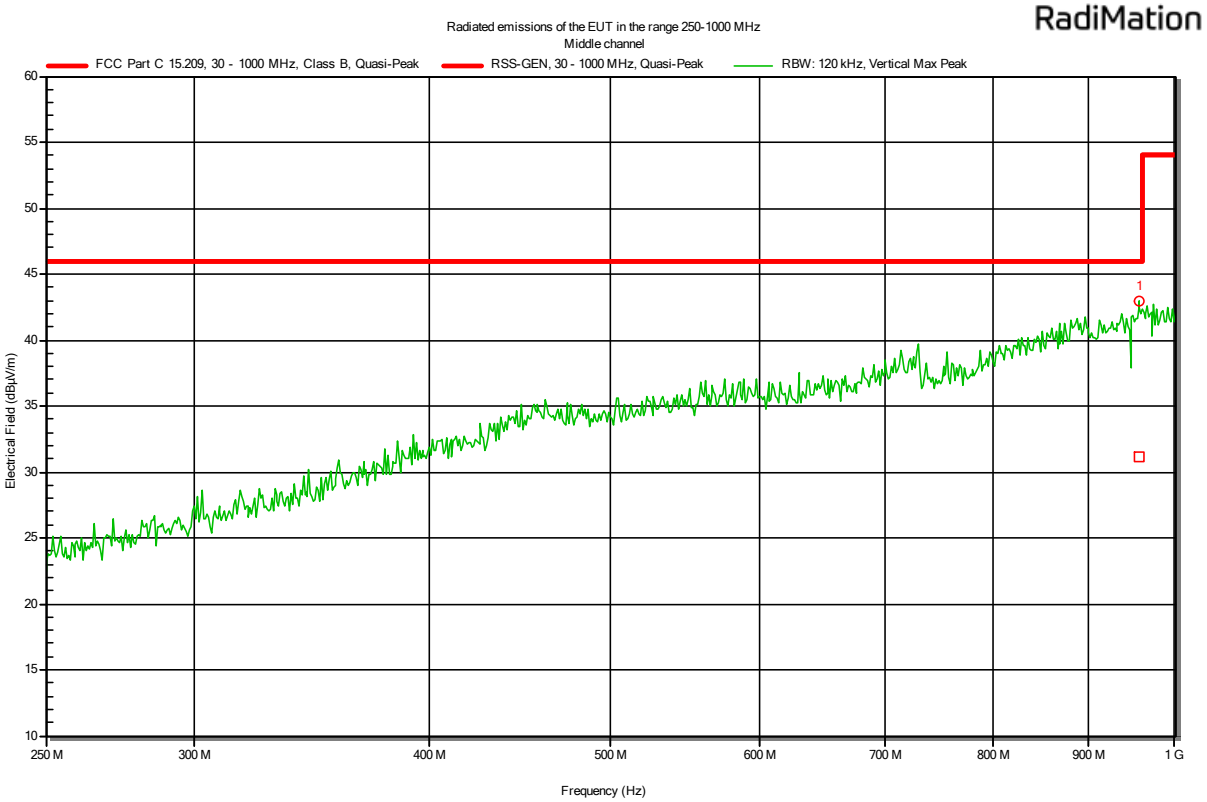
Plot 4a: Antenna vertical, (pre-scan values shown)



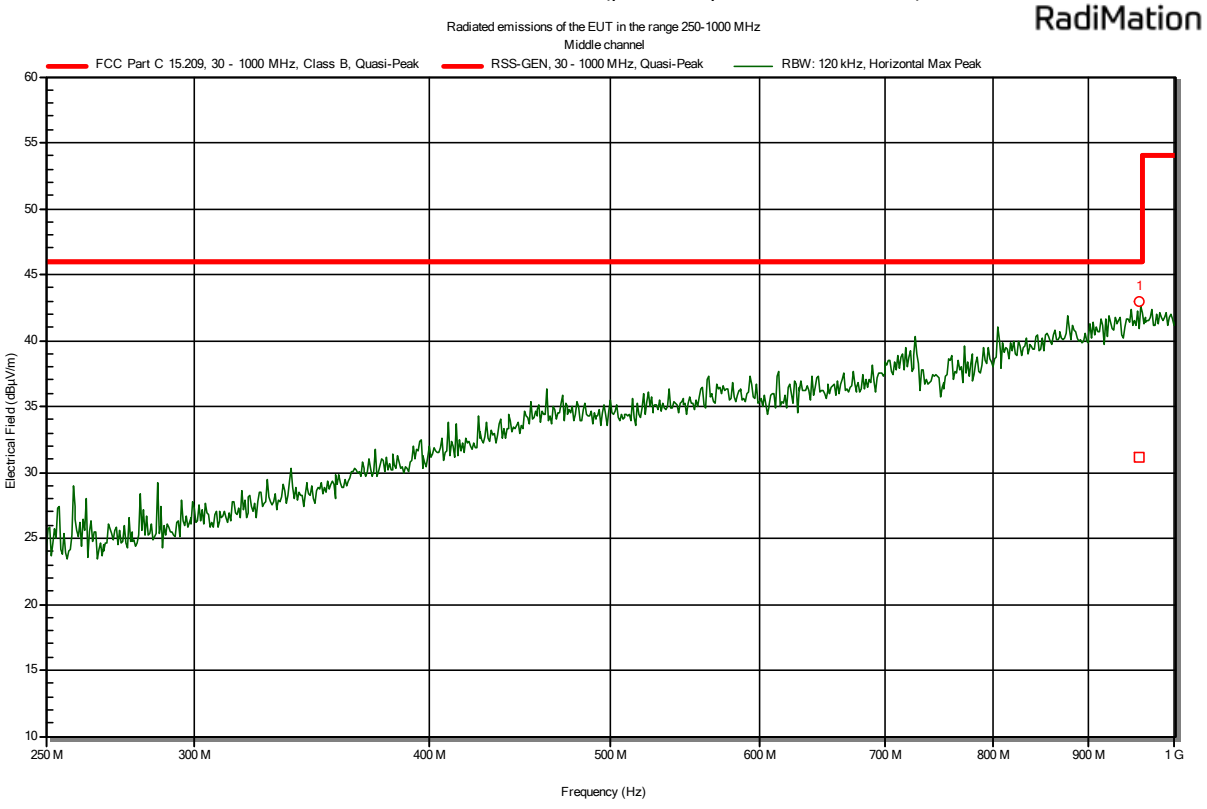
Plot 4b: Antenna horizontal, (pre-scan values shown)



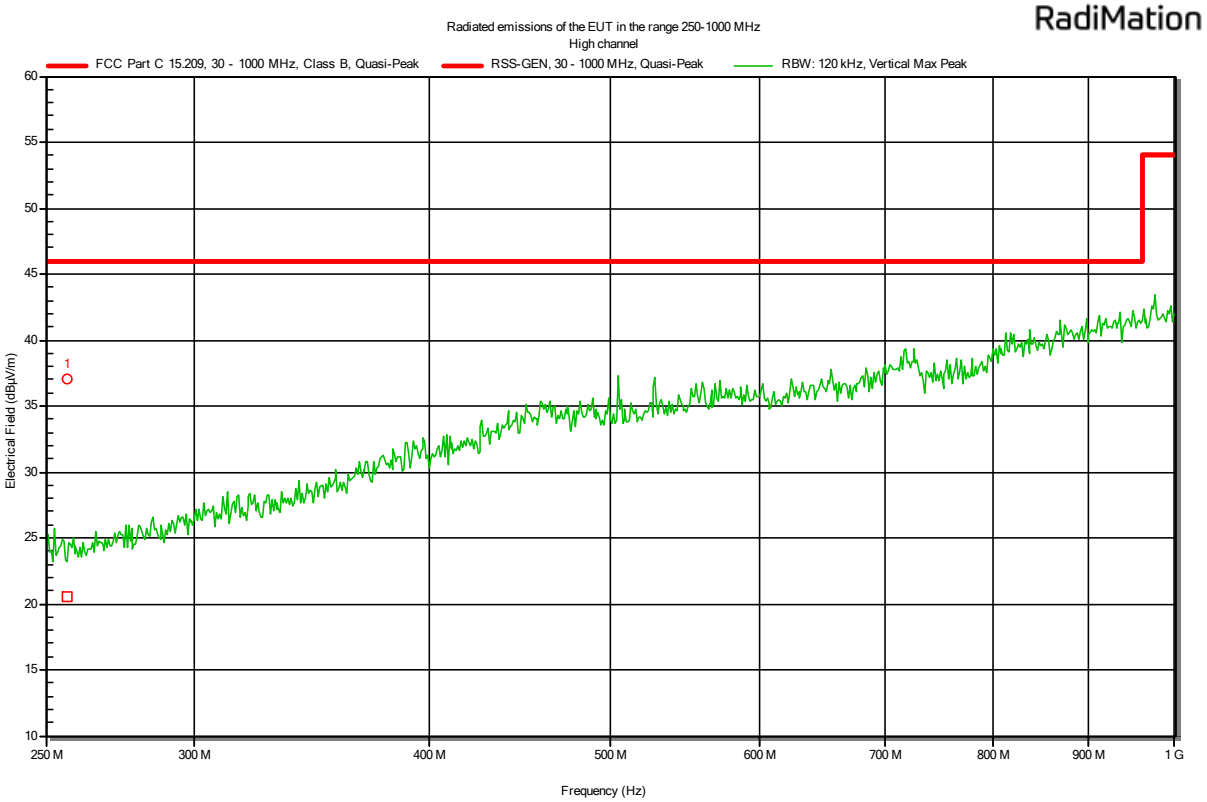
Plot 4c: Antenna vertical, (pre-scan peak values shown)



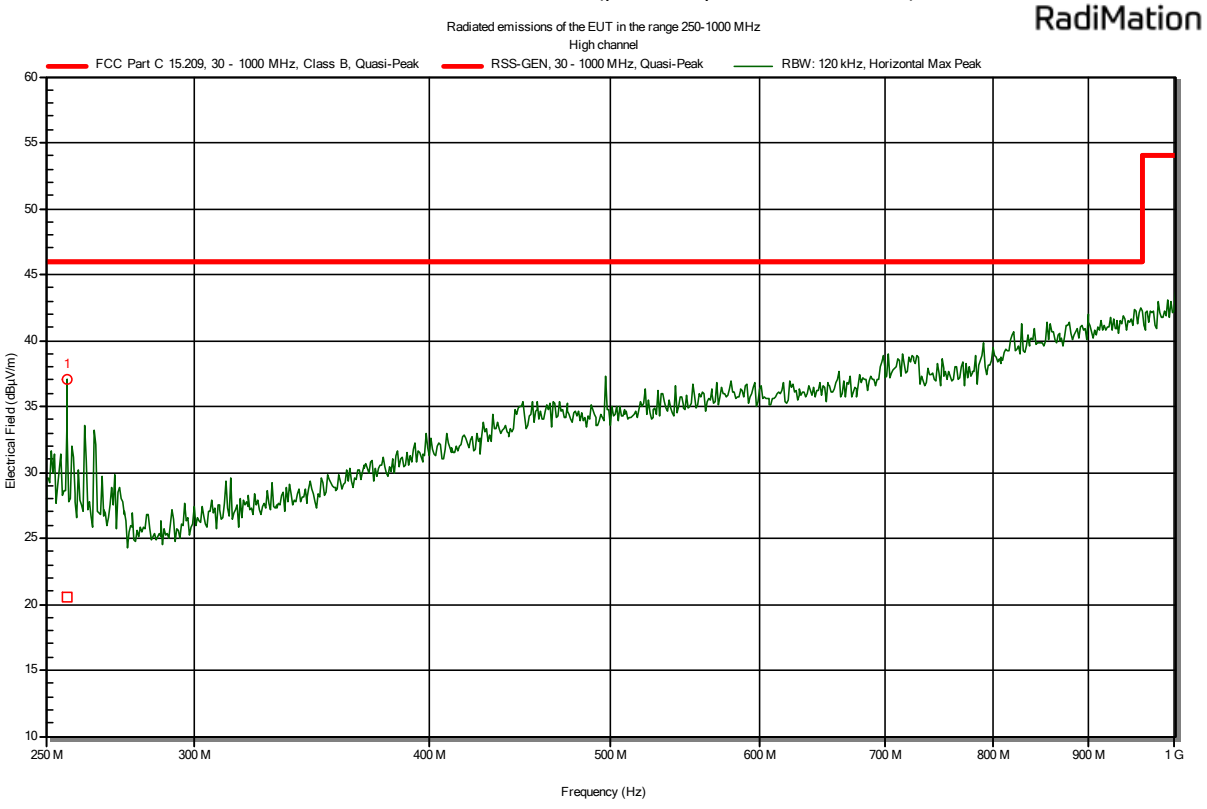
Plot 4d: Antenna horizontal, (pre-scan peak values shown)



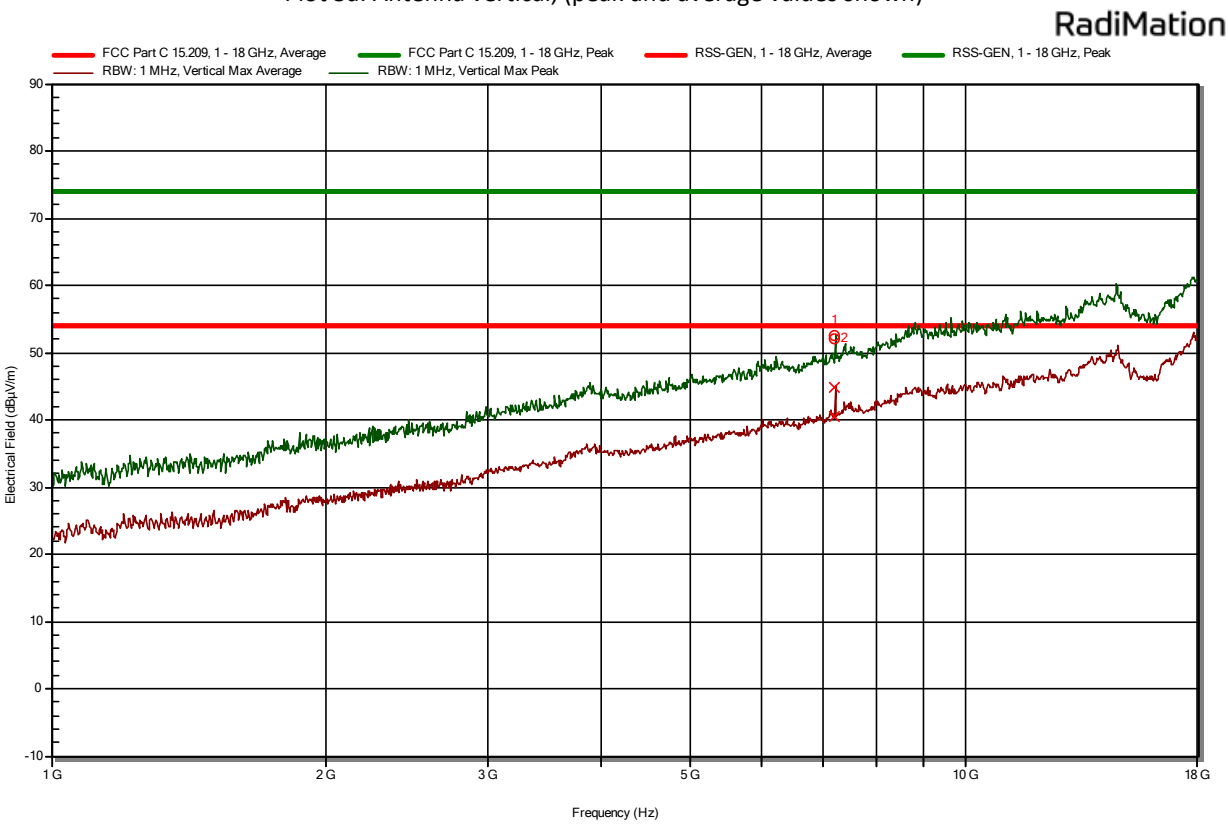
Plot 4e: Antenna vertical, (pre-scan peak values shown)



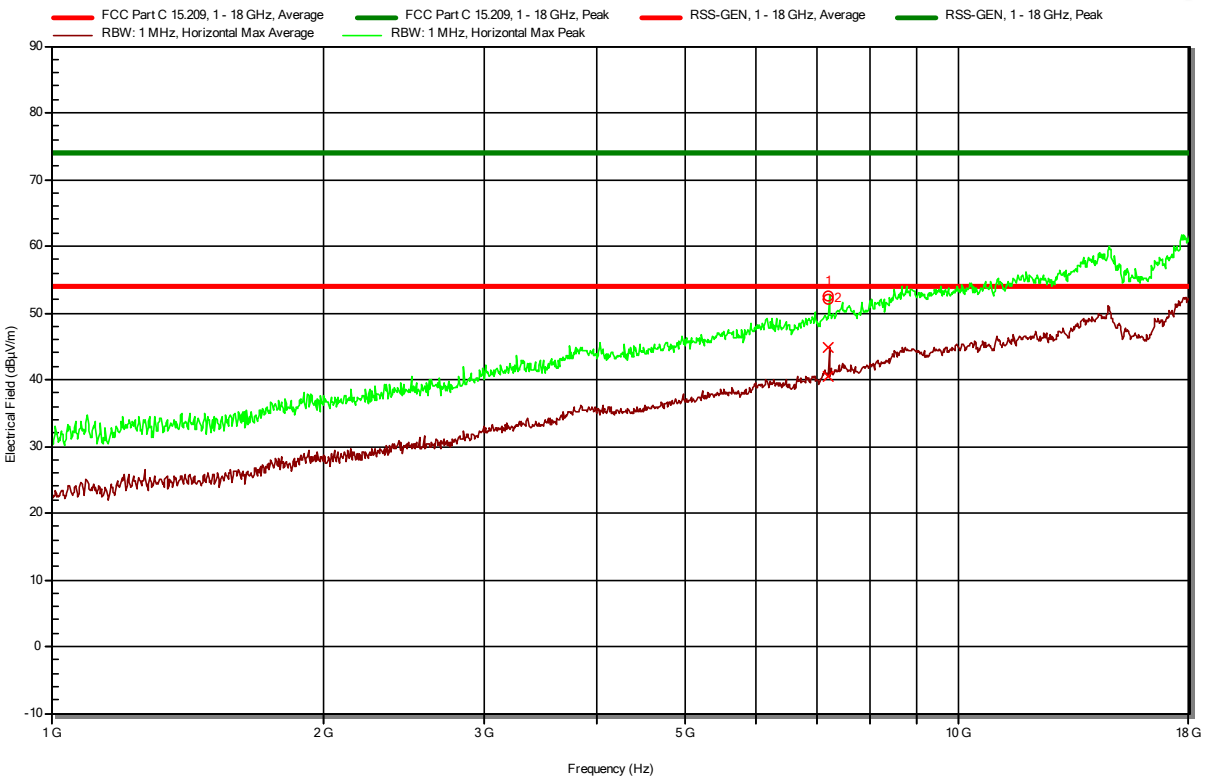
Plot 4f: Antenna horizontal, (pre-scan peak values shown)



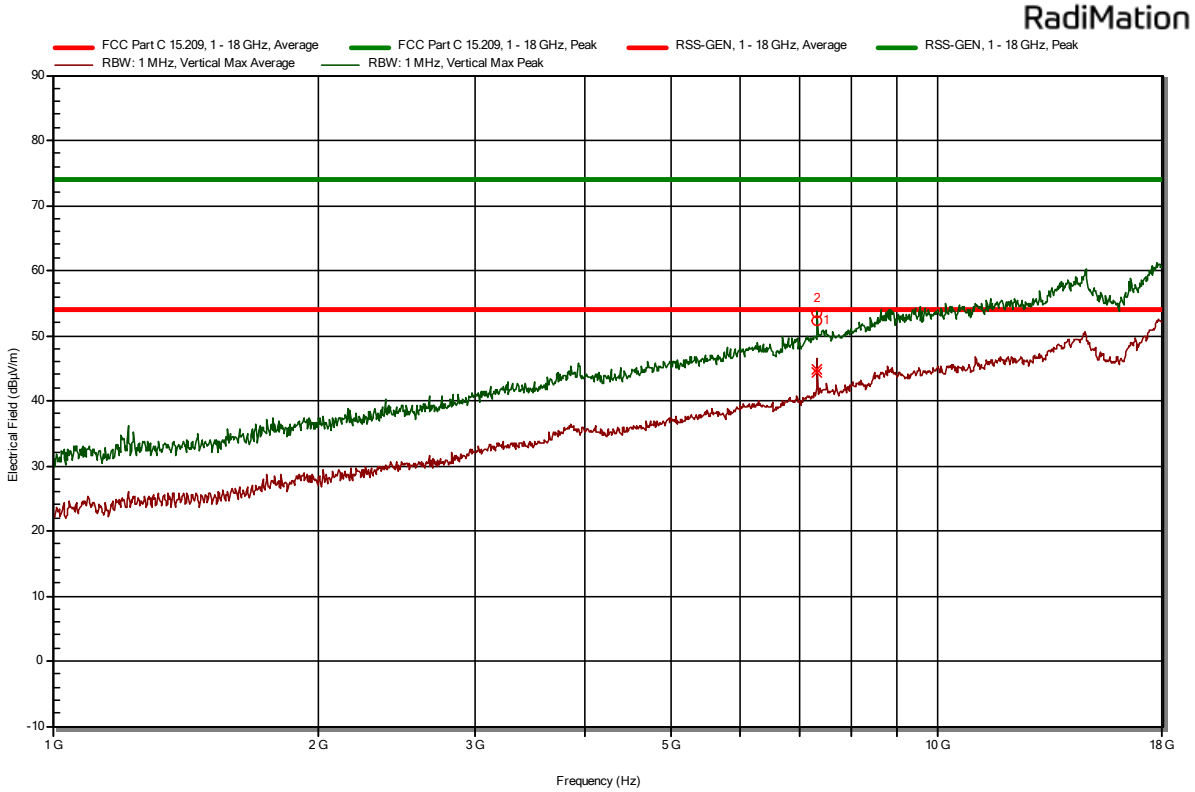
Plot 5a: Antenna vertical, (peak and average values shown)



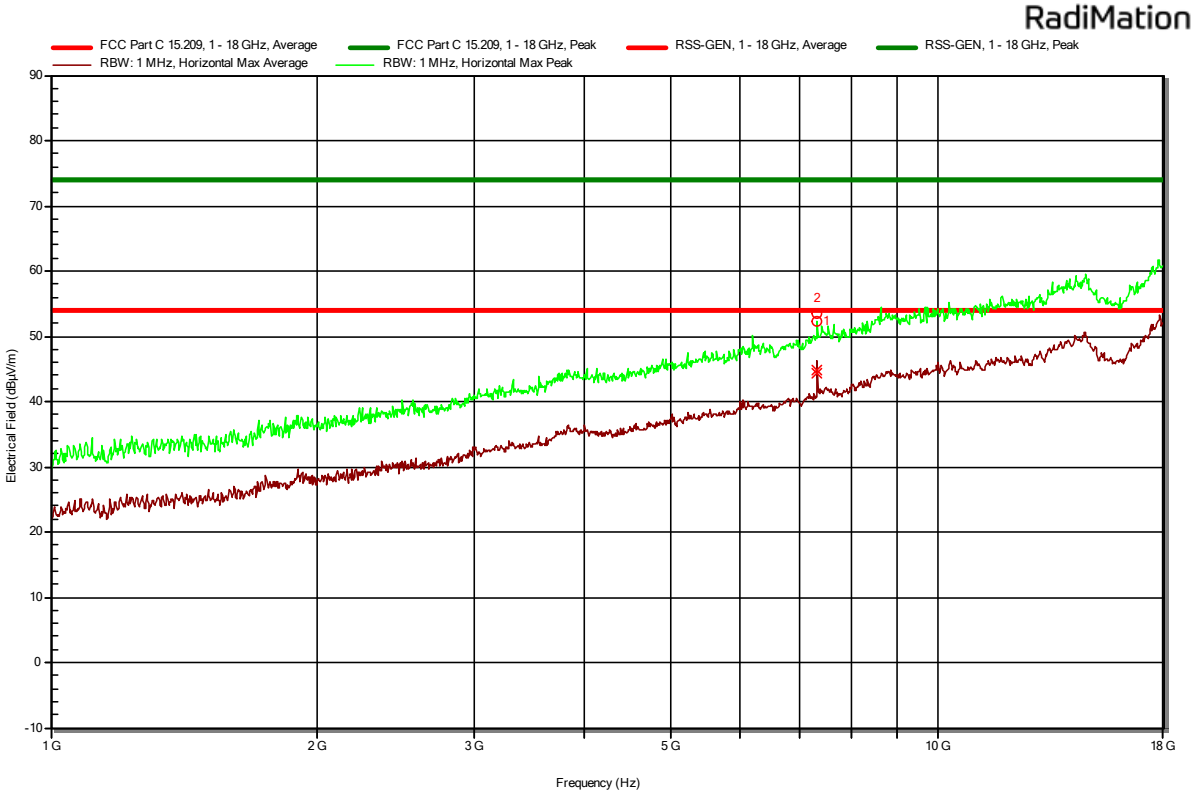
Plot 5b: Antenna horizontal, (peak and average values shown)



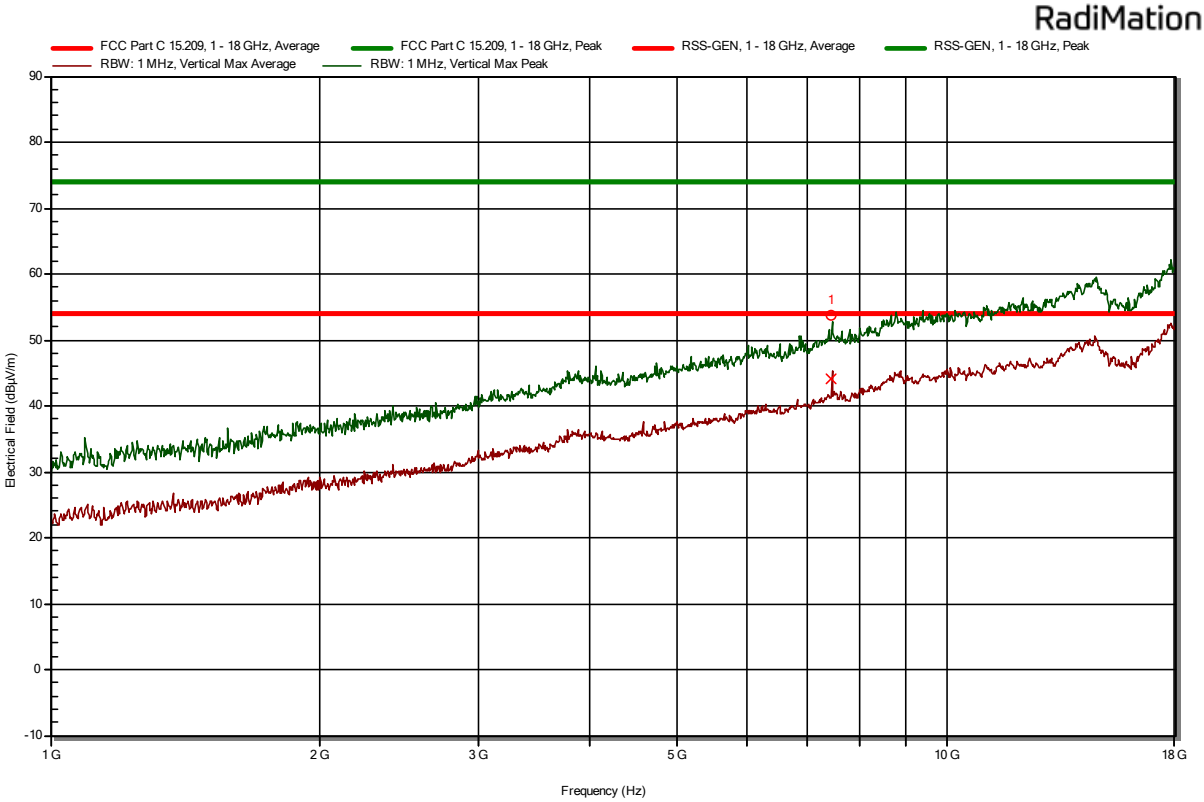
Plot 5c: Antenna vertical, (peak and average values shown)



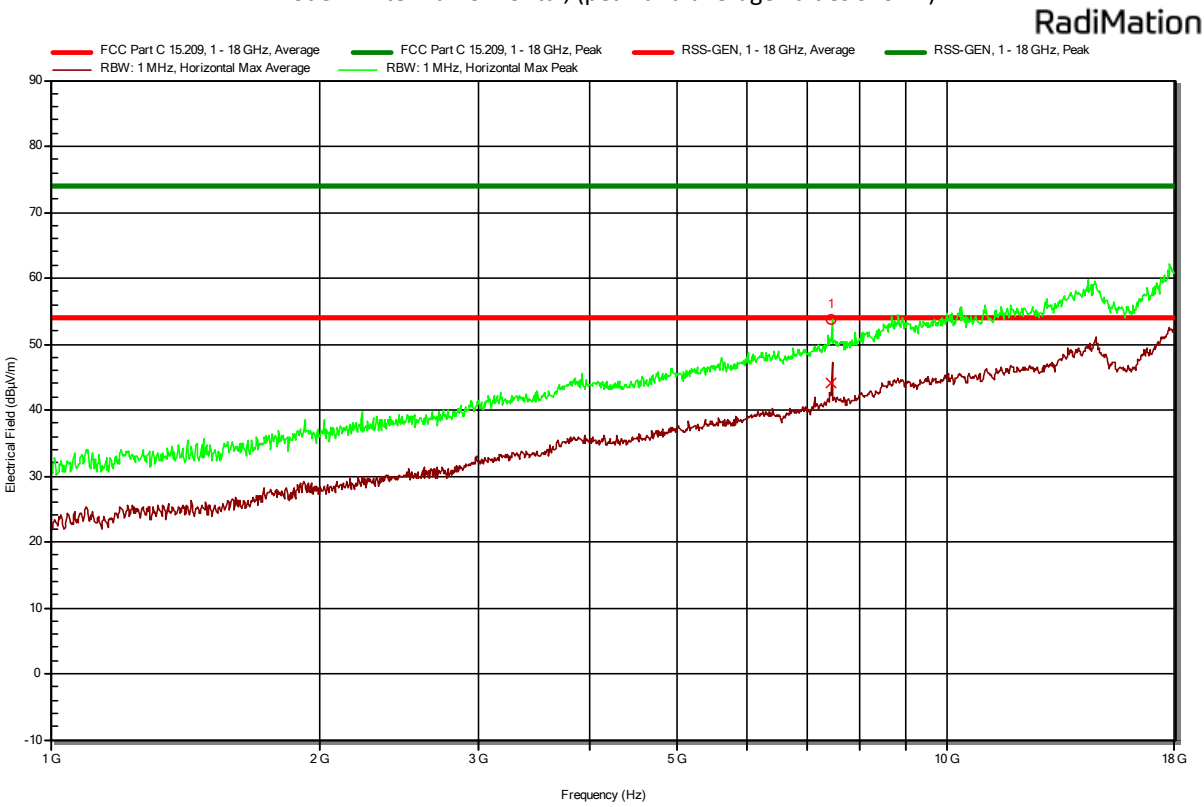
Plot 5d: Antenna horizontal, (peak and average values shown)



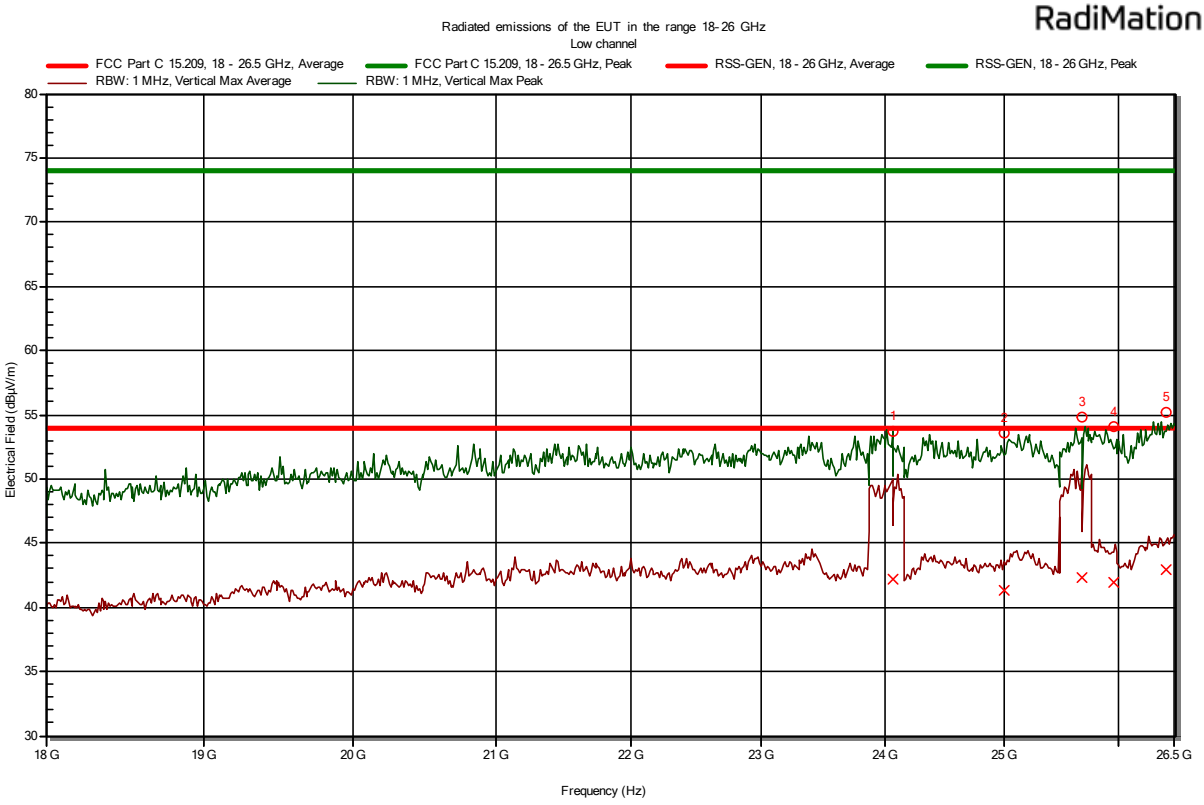
Plot 5e: Antenna vertical, (peak and average values shown)



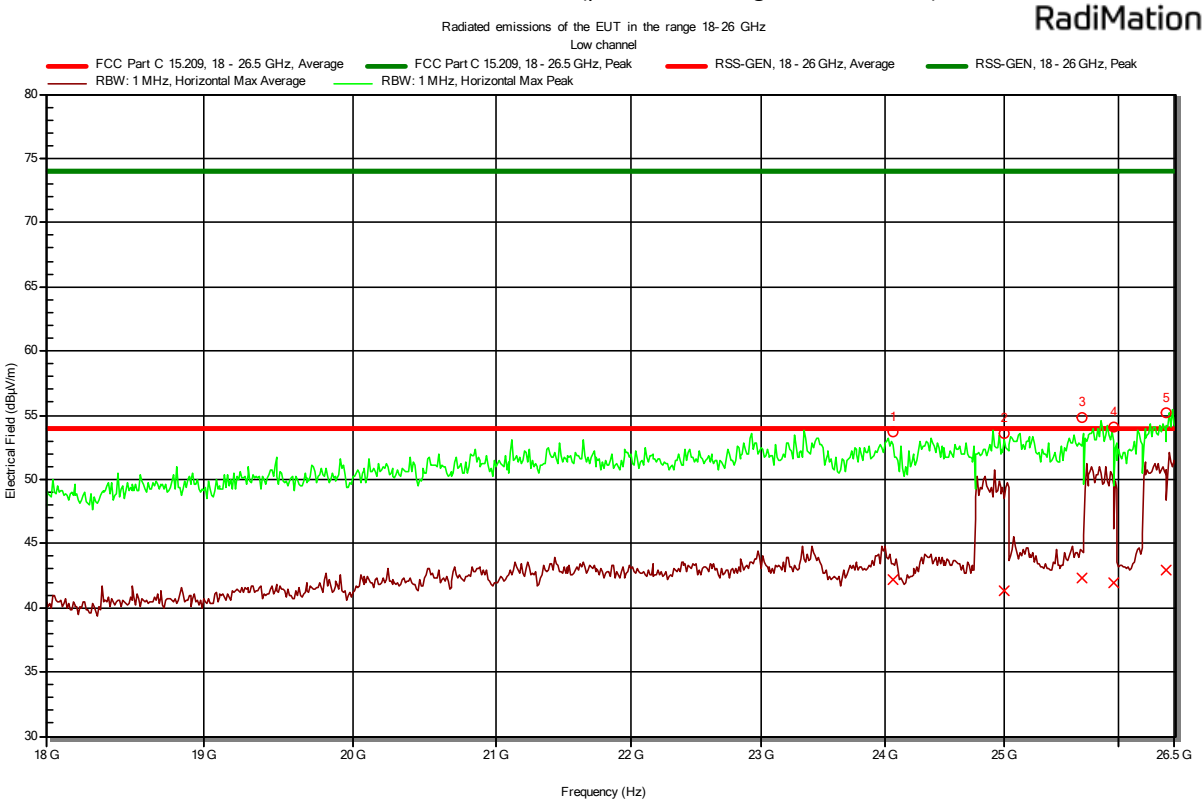
Plot 5f: Antenna horizontal, (peak and average values shown)



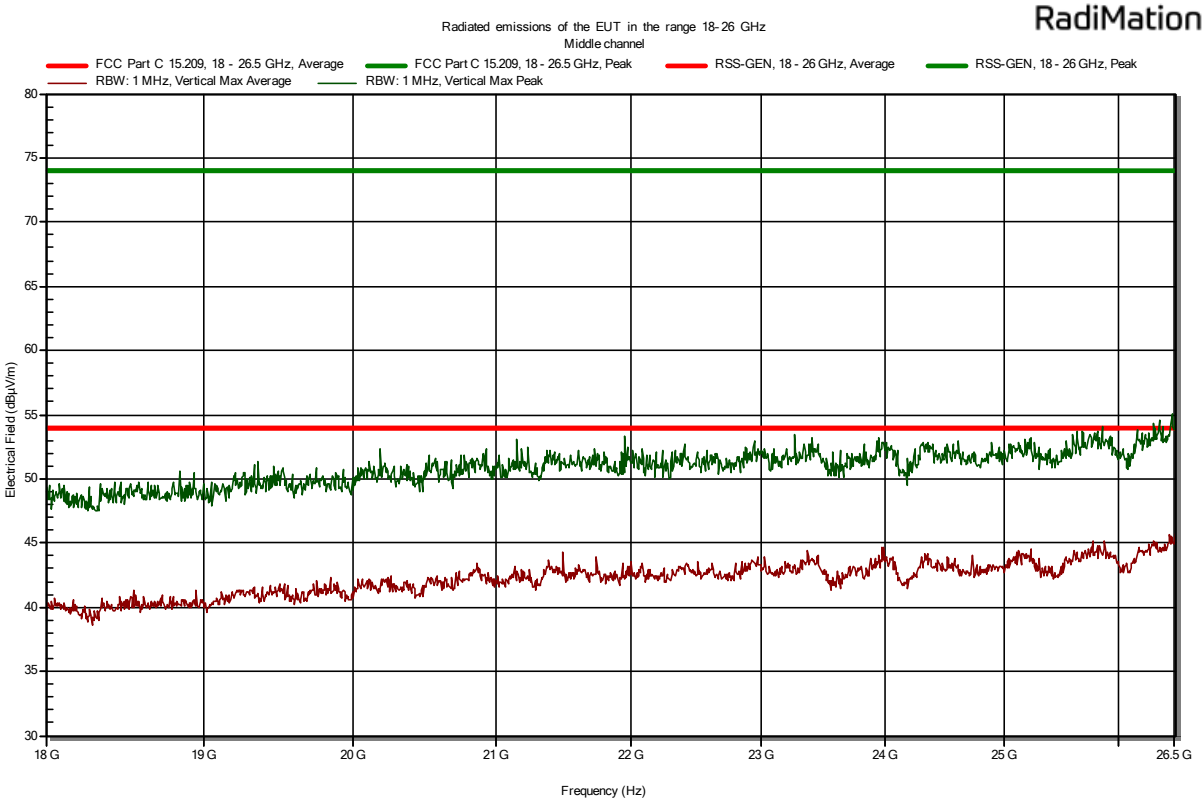
Plot 6a: Antenna vertical, (peak and average values shown)



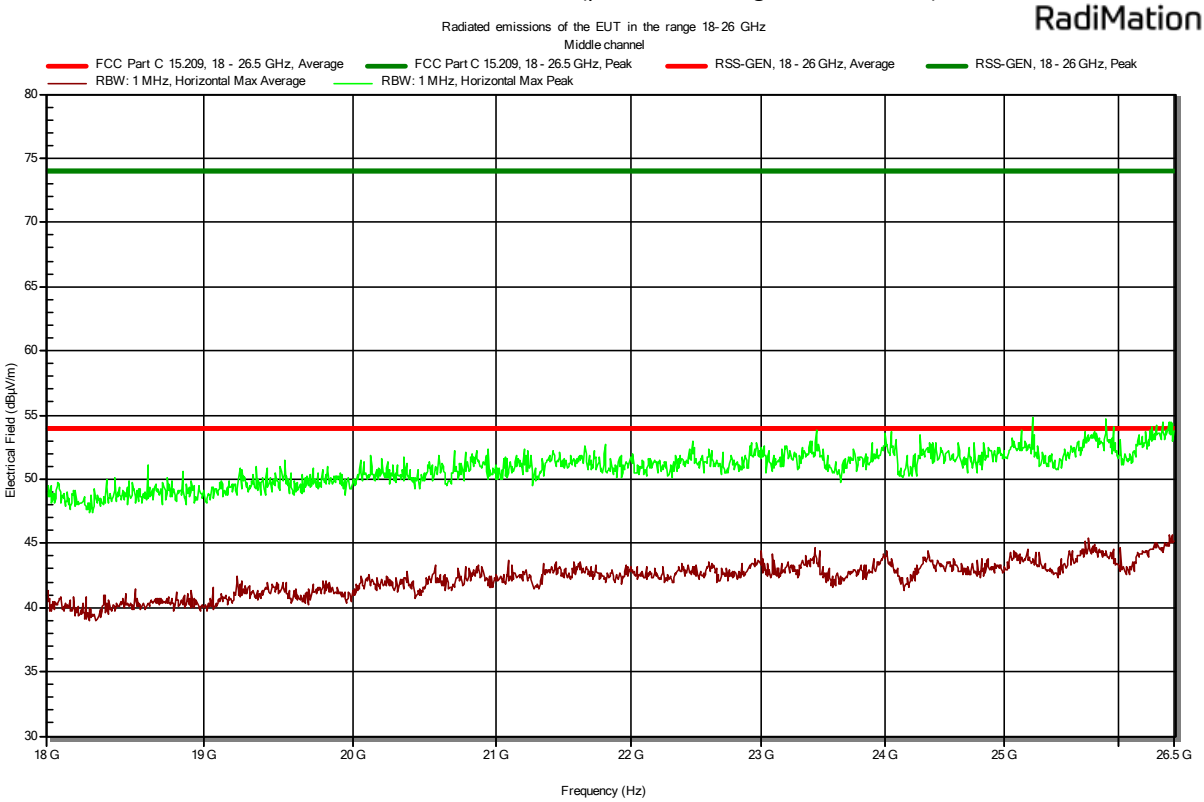
Plot 6b: Antenna horizontal, (peak and average values shown)



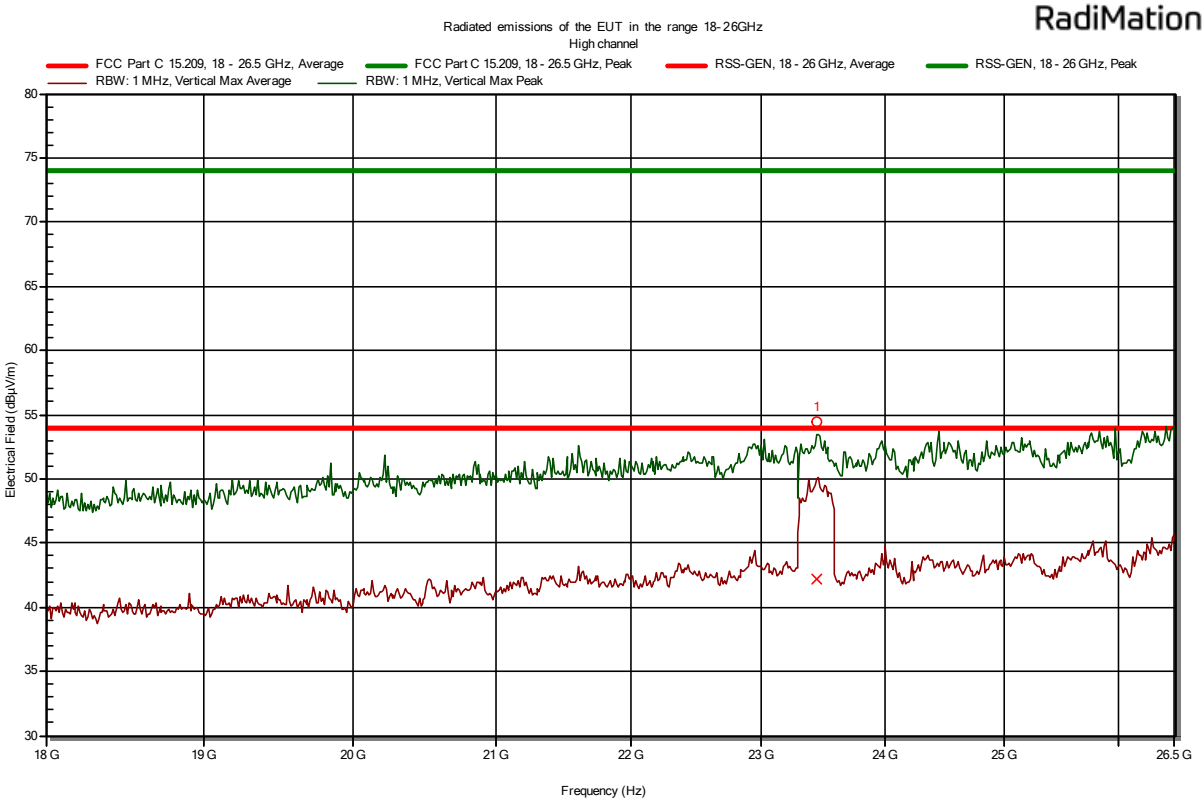
Plot 6c: Antenna vertical, (peak and average values shown)



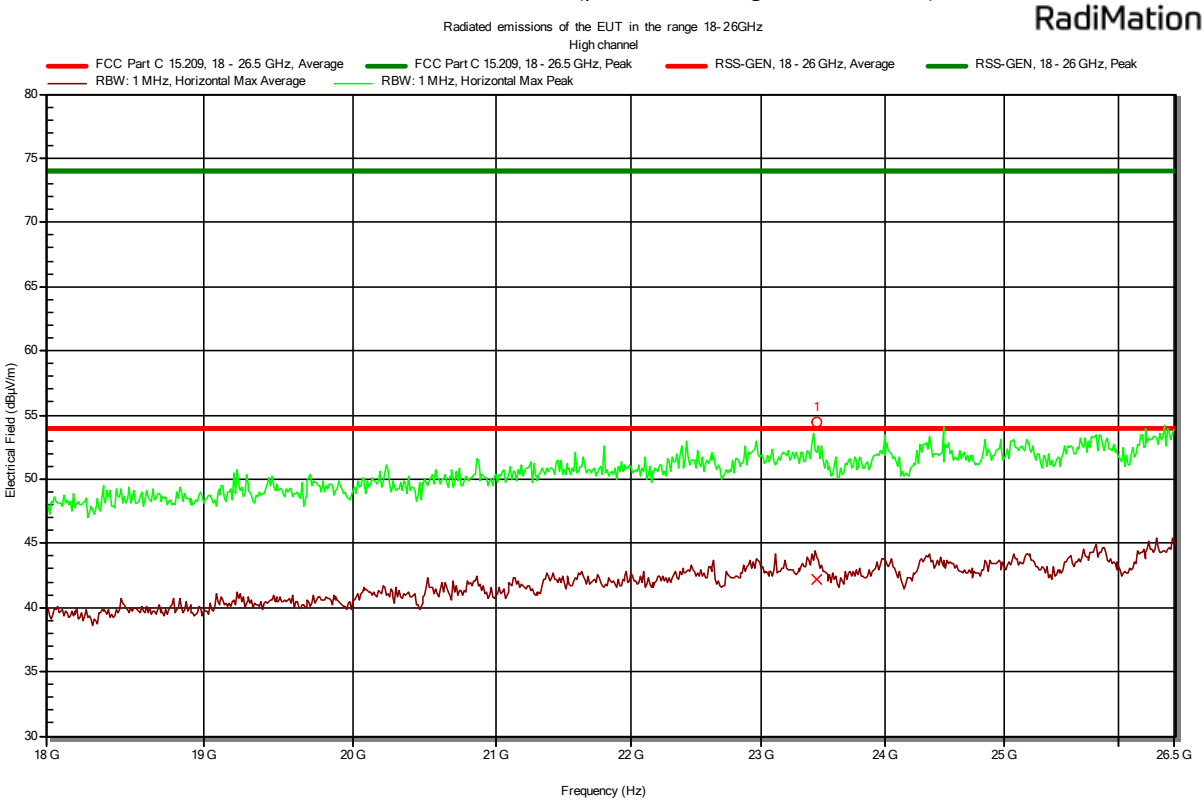
Plot 6d: Antenna horizontal, (peak and average values shown)



Plot 6e: Antenna vertical, (peak and average values shown)

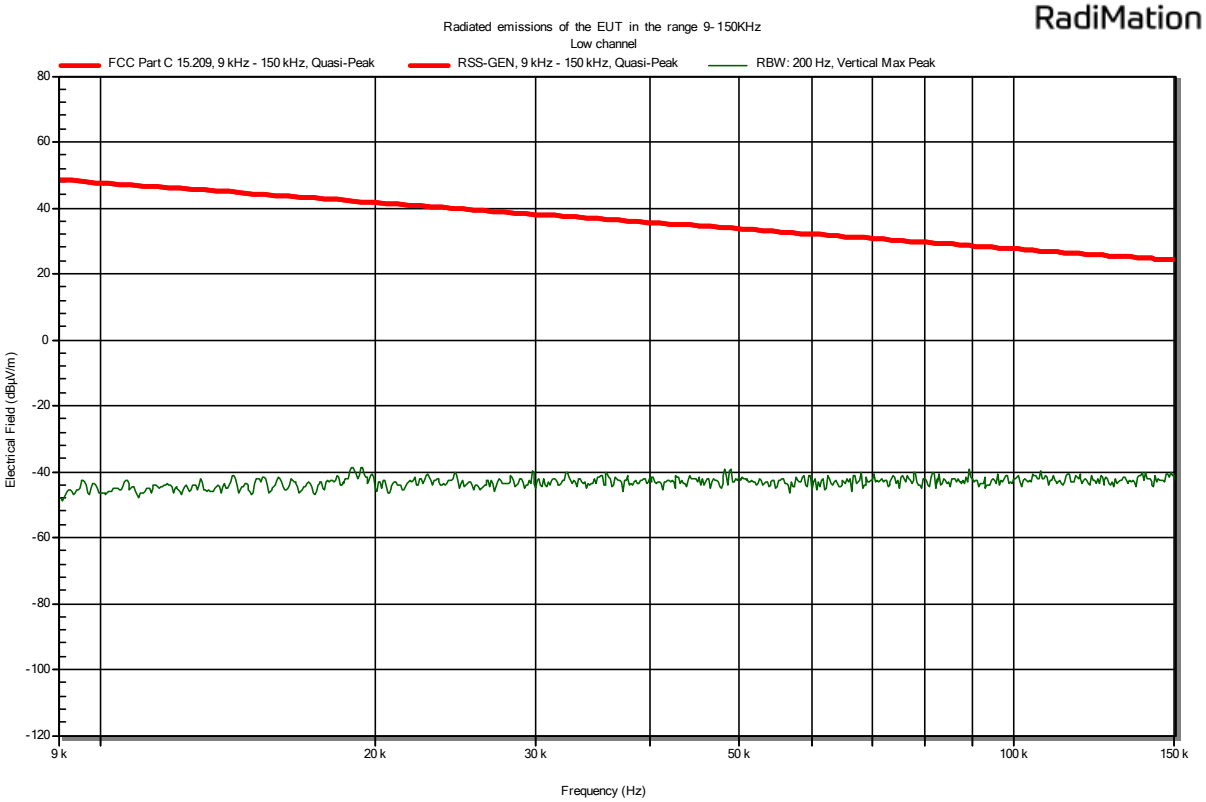


Plot 6f: Antenna horizontal, (peak and average values shown)

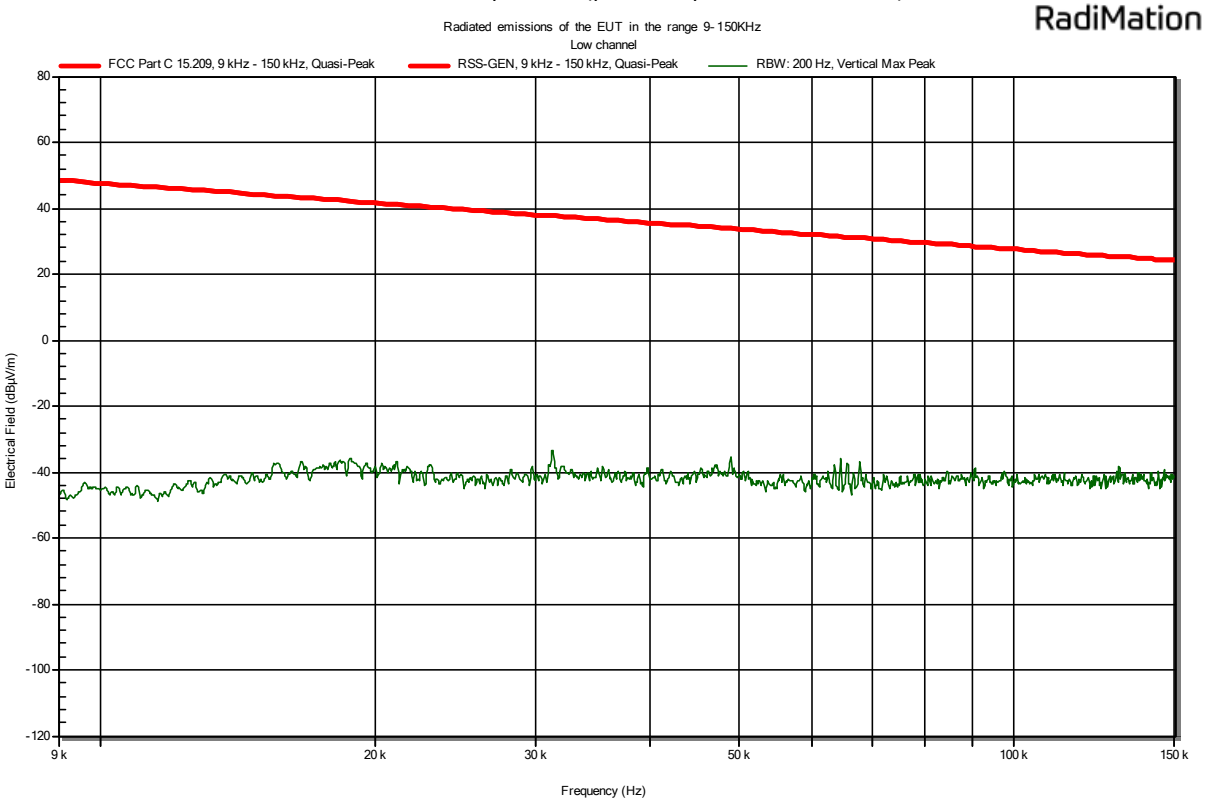


3.1.8 Plots of the Radiated Spurious Emissions Measurement BLE 2 Mbps

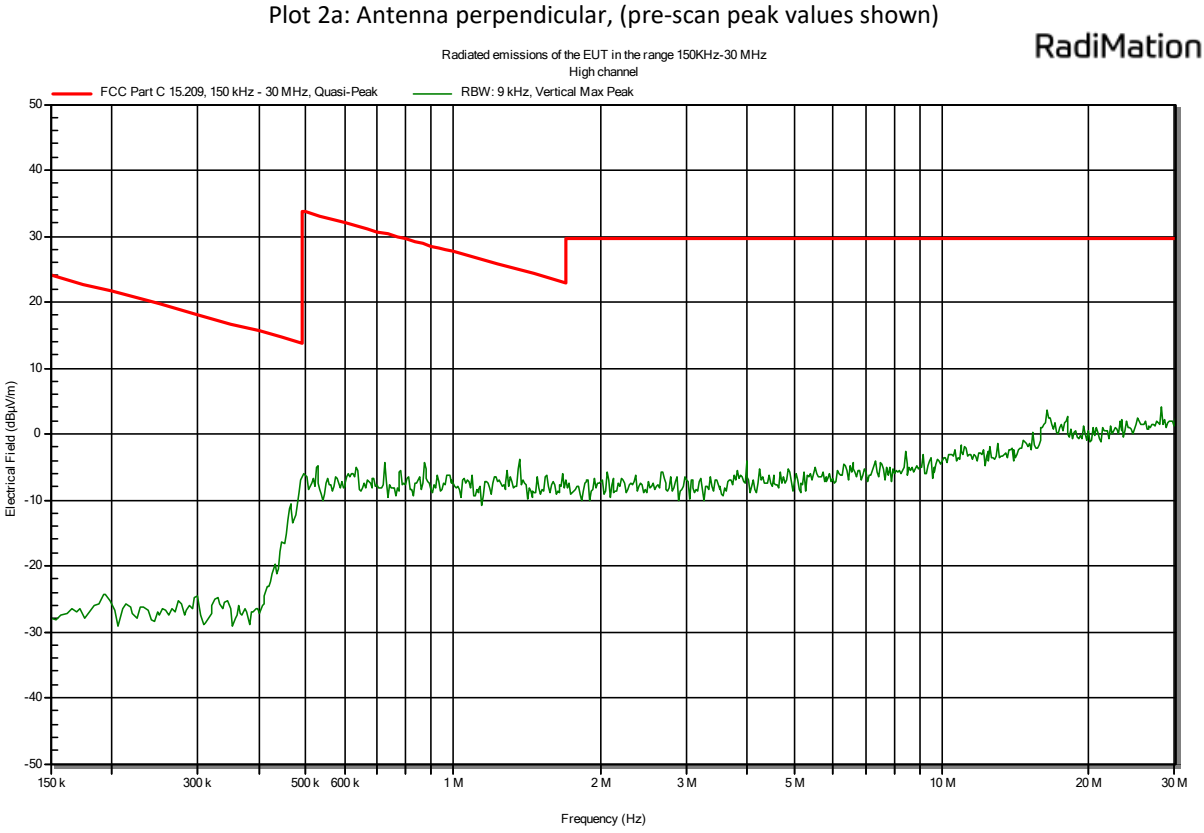
Plot 1a: Antenna perpendicular, (pre-scan peak values shown)



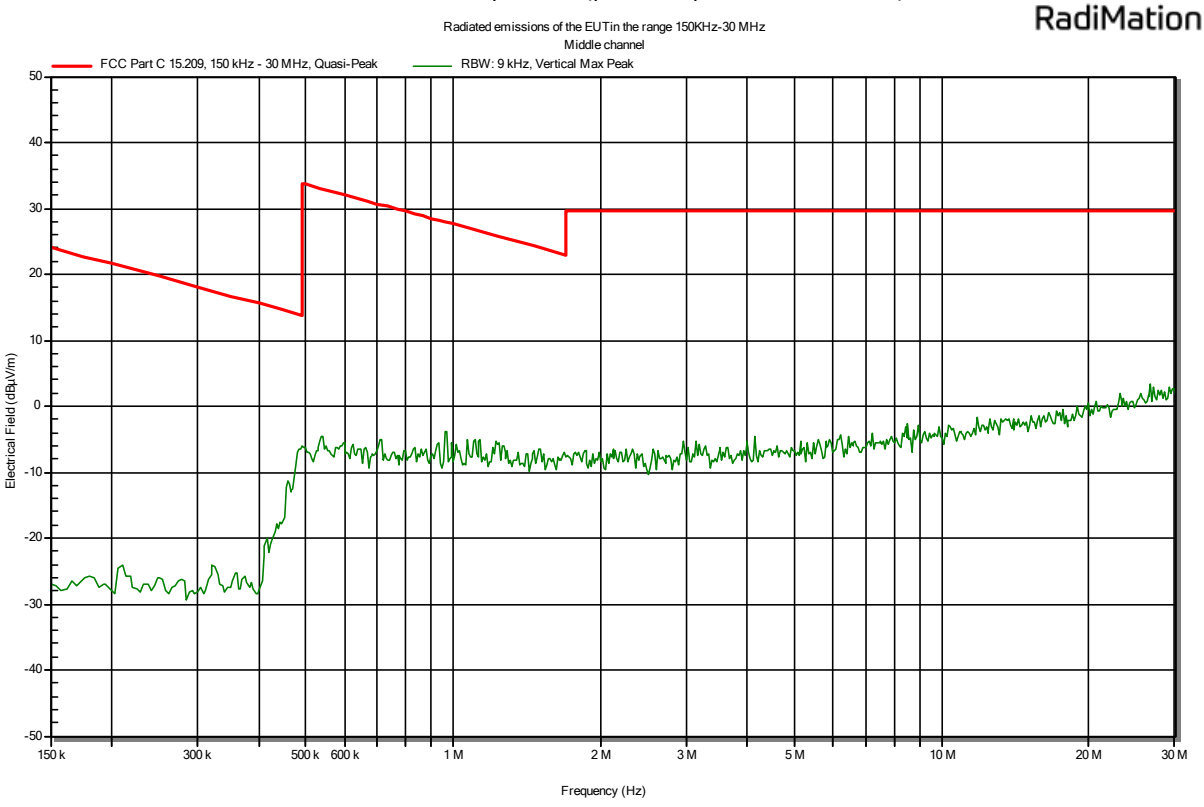
Plot 1b: Antenna parallel, (pre-scan peak values shown)



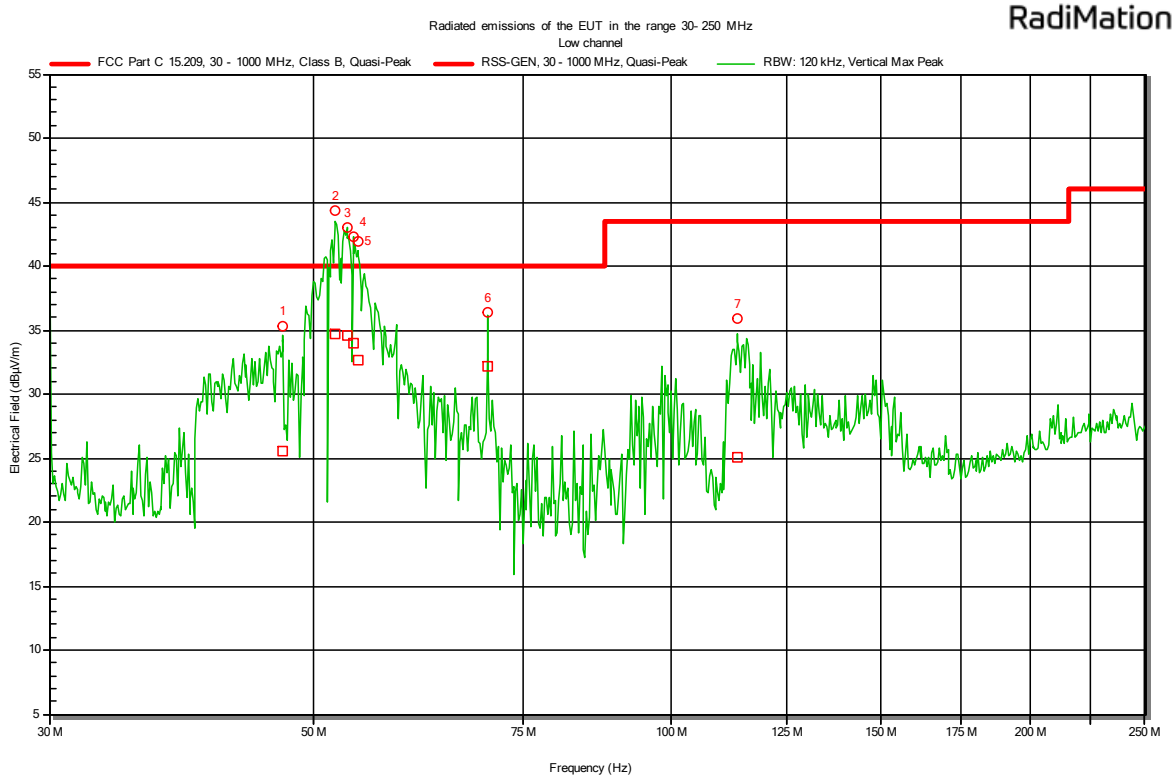
Plot 2a: Antenna perpendicular, (pre-scan peak values shown)



Plot 2b: Antenna parallel, (pre-scan peak values shown)

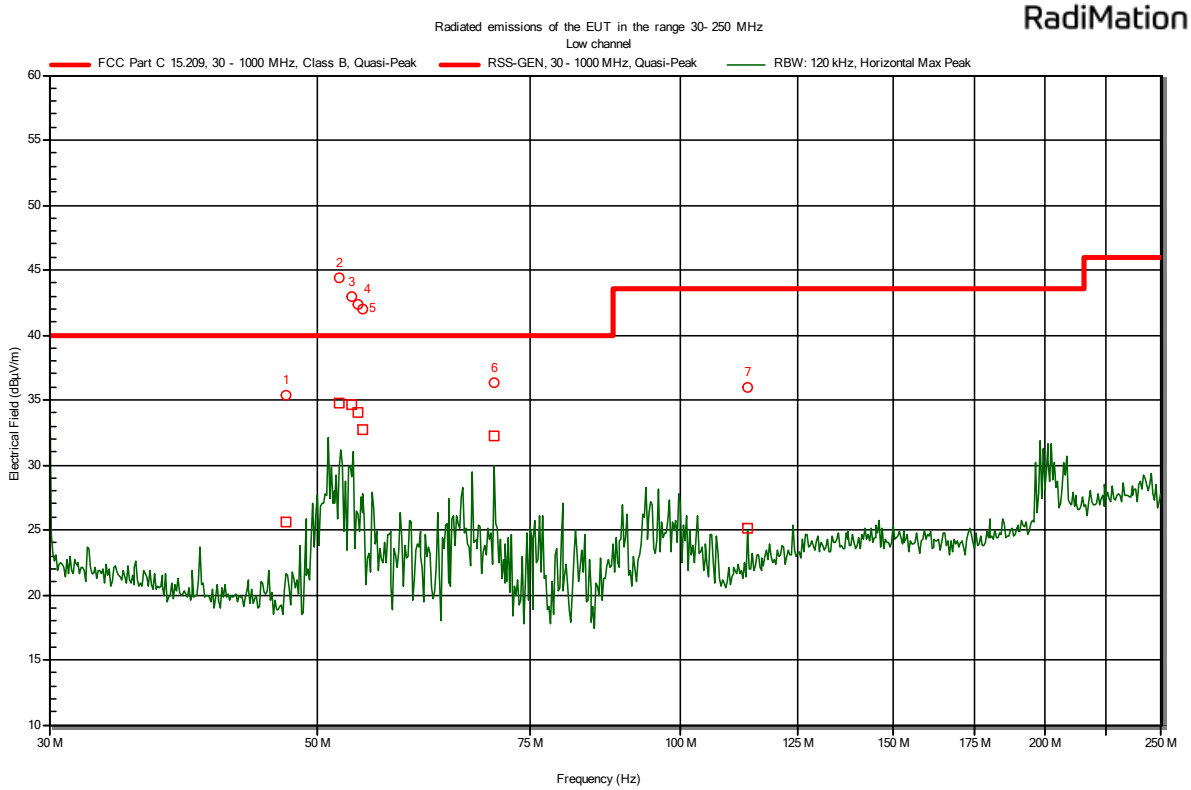


Plot 3a: Antenna vertical, (pre-scan peak values shown)



Note: The USB programming cable is not terminated correctly, which causes wide band noise for which in all other measurements a ferrite was applied on the cable.

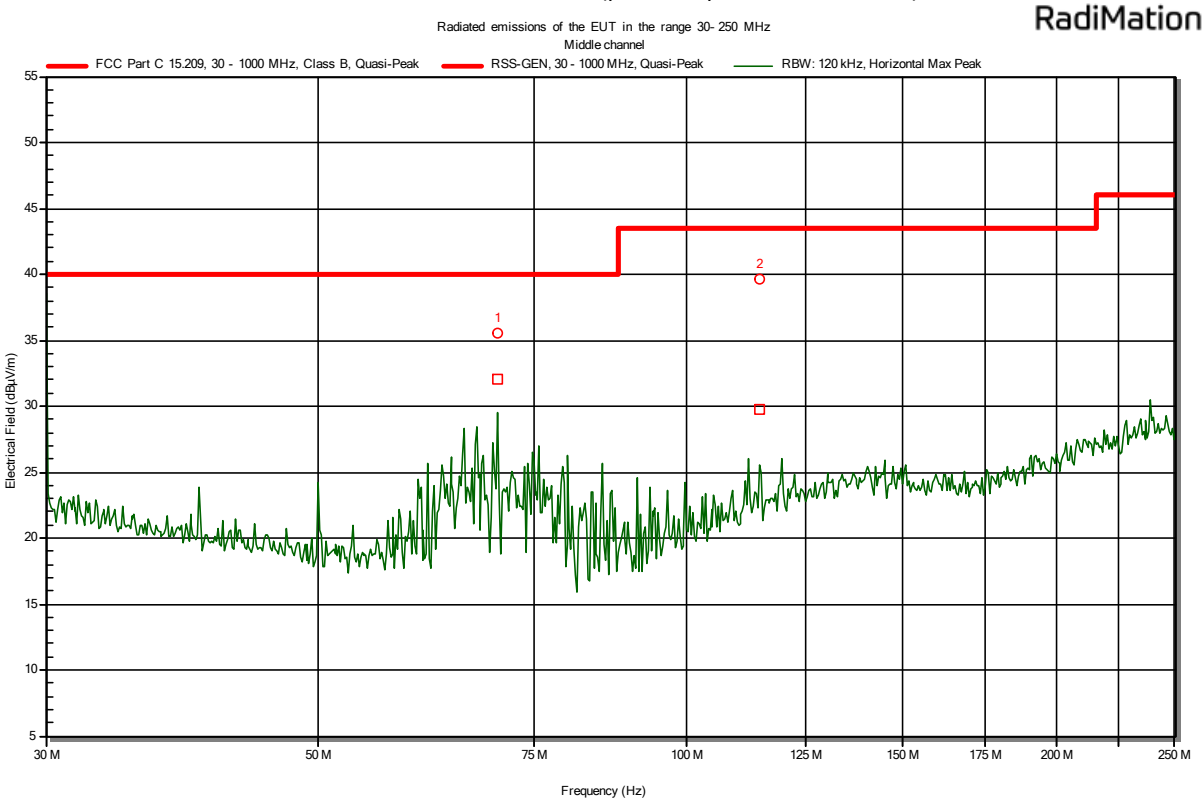
Plot 3b: Antenna horizontal, (pre-scan peak values shown)



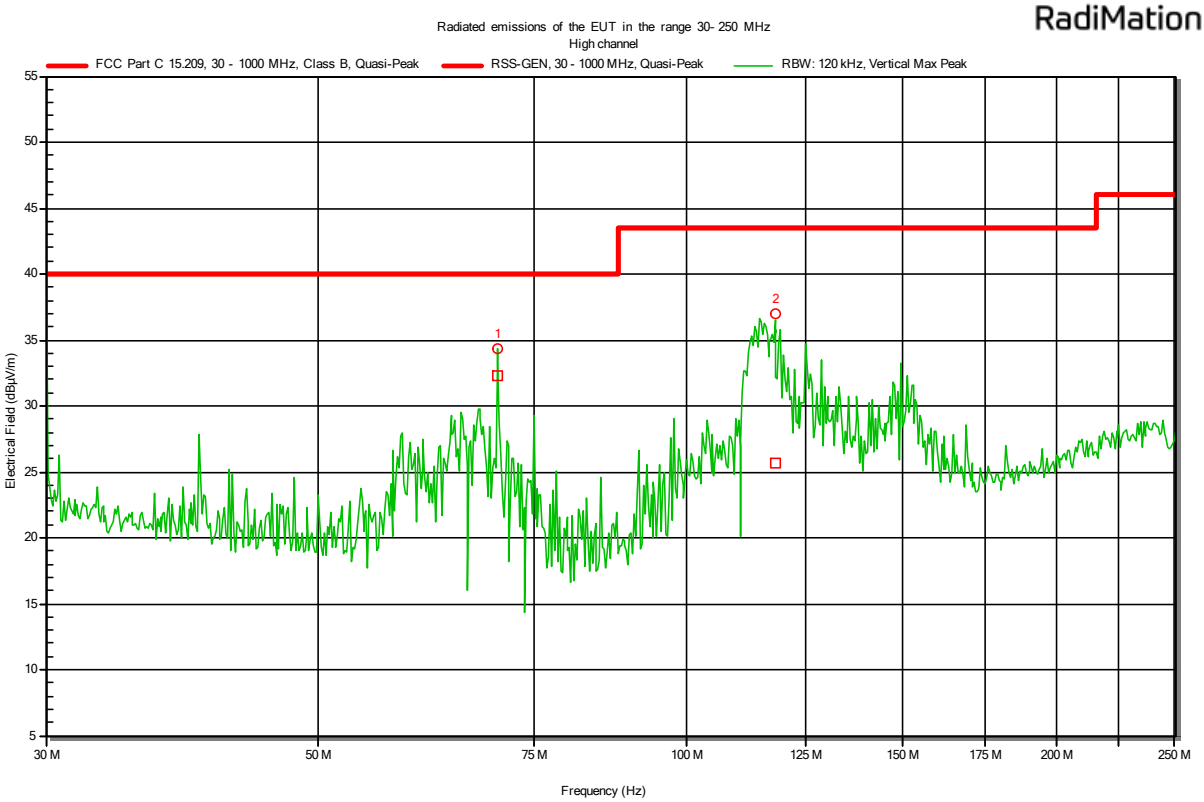
Note: The USB programming cable is not terminated correctly, which causes wide band noise for which in all other measurements a ferrite was applied on the cable.

Plot 3c: Antenna vertical, (pre-scan peak values shown)

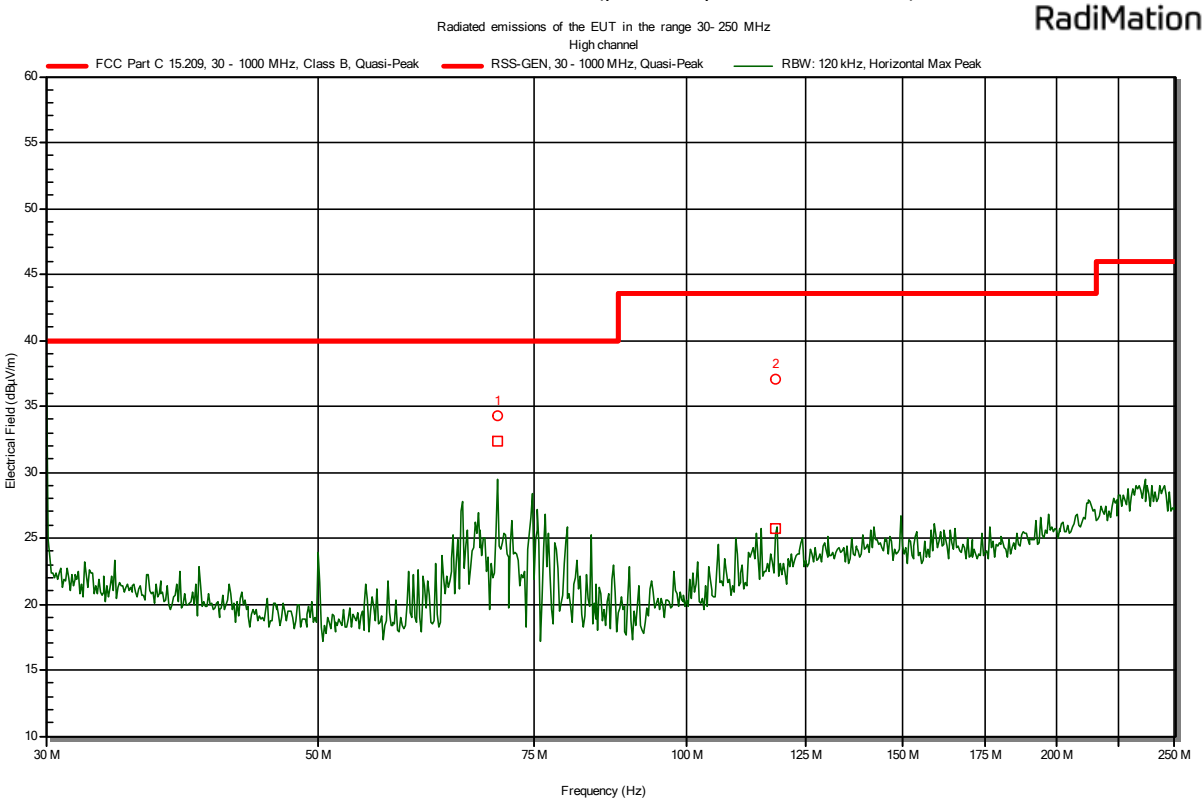
Plot 3d: Antenna horizontal, (pre-scan peak values shown)



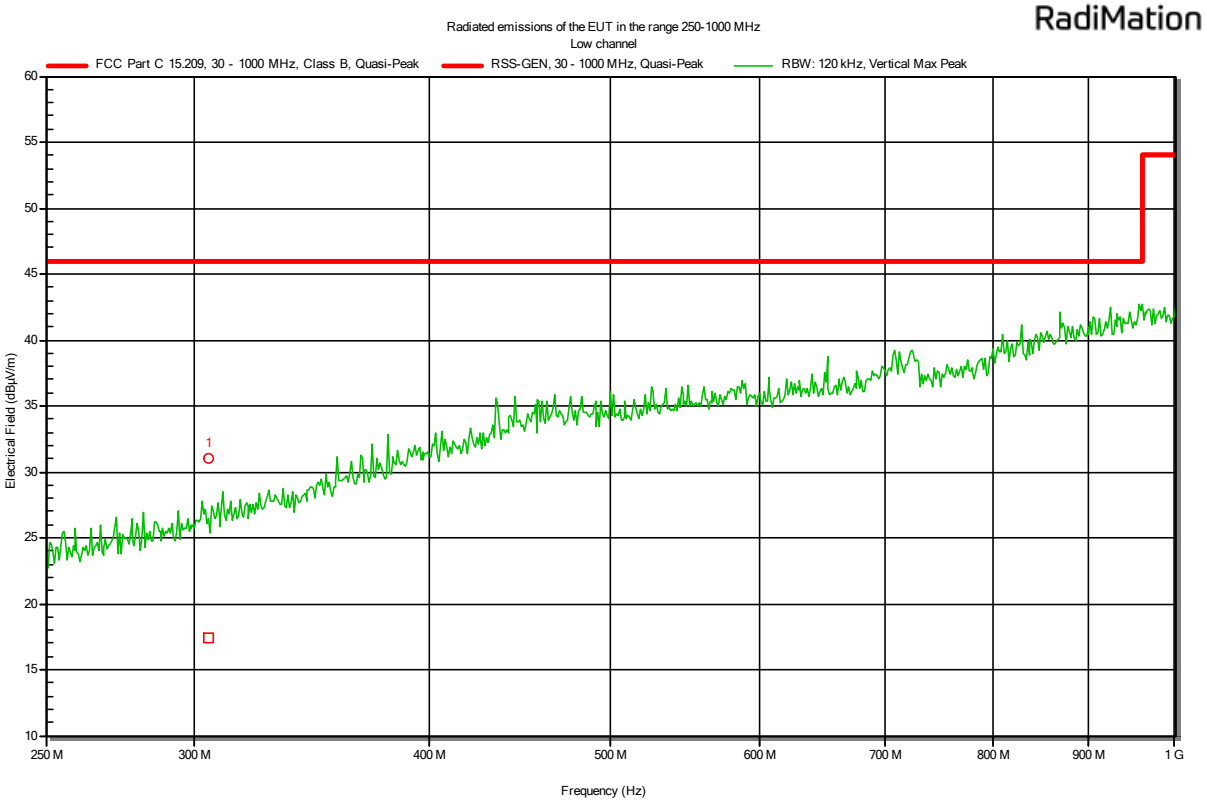
Plot 3e: Antenna vertical, (pre-scan peak values shown)



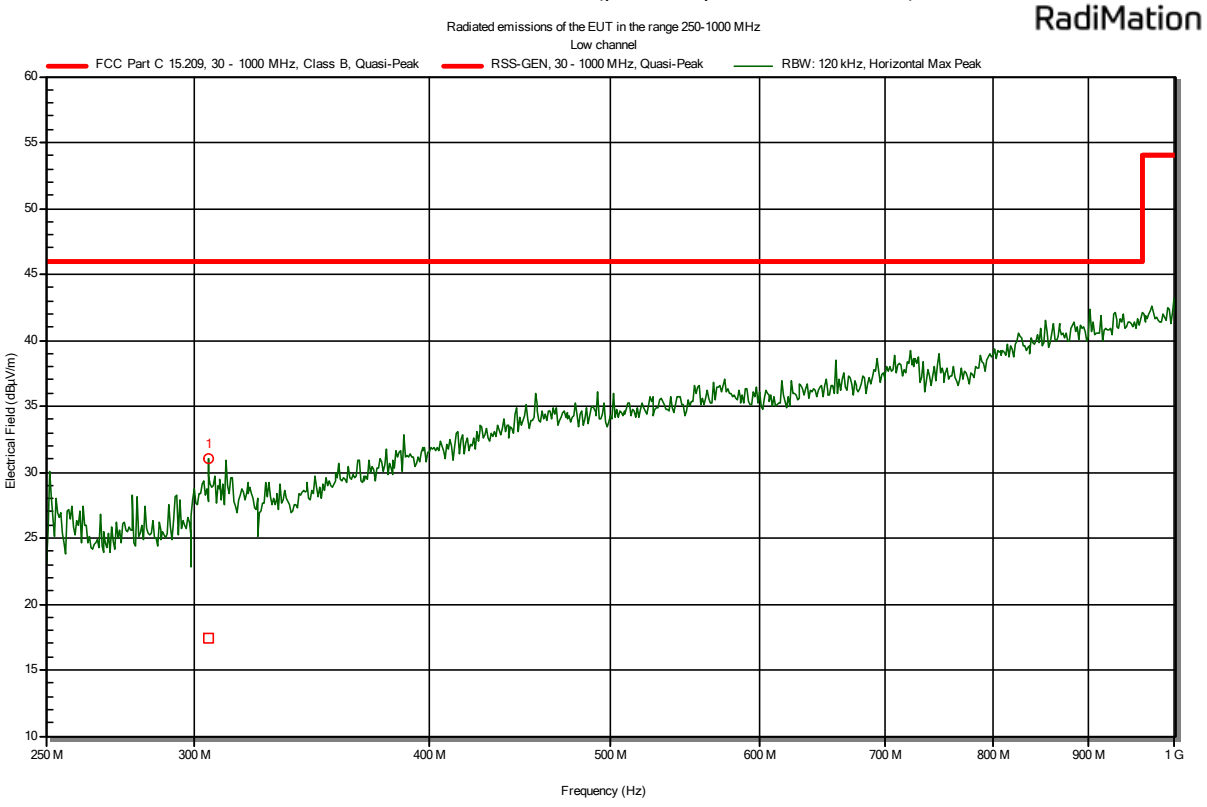
Plot 3f: Antenna horizontal, (pre-scan peak values shown)



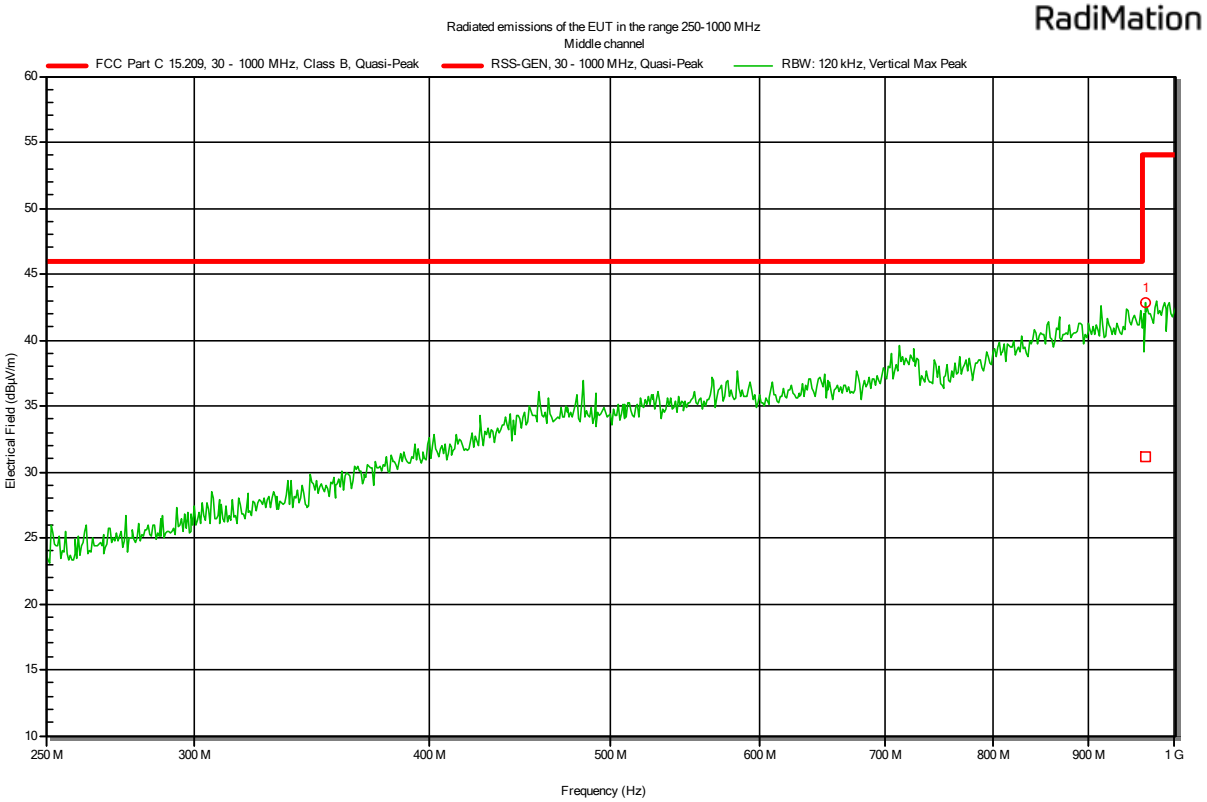
Plot 4a: Antenna vertical, (pre-scan peak values shown)



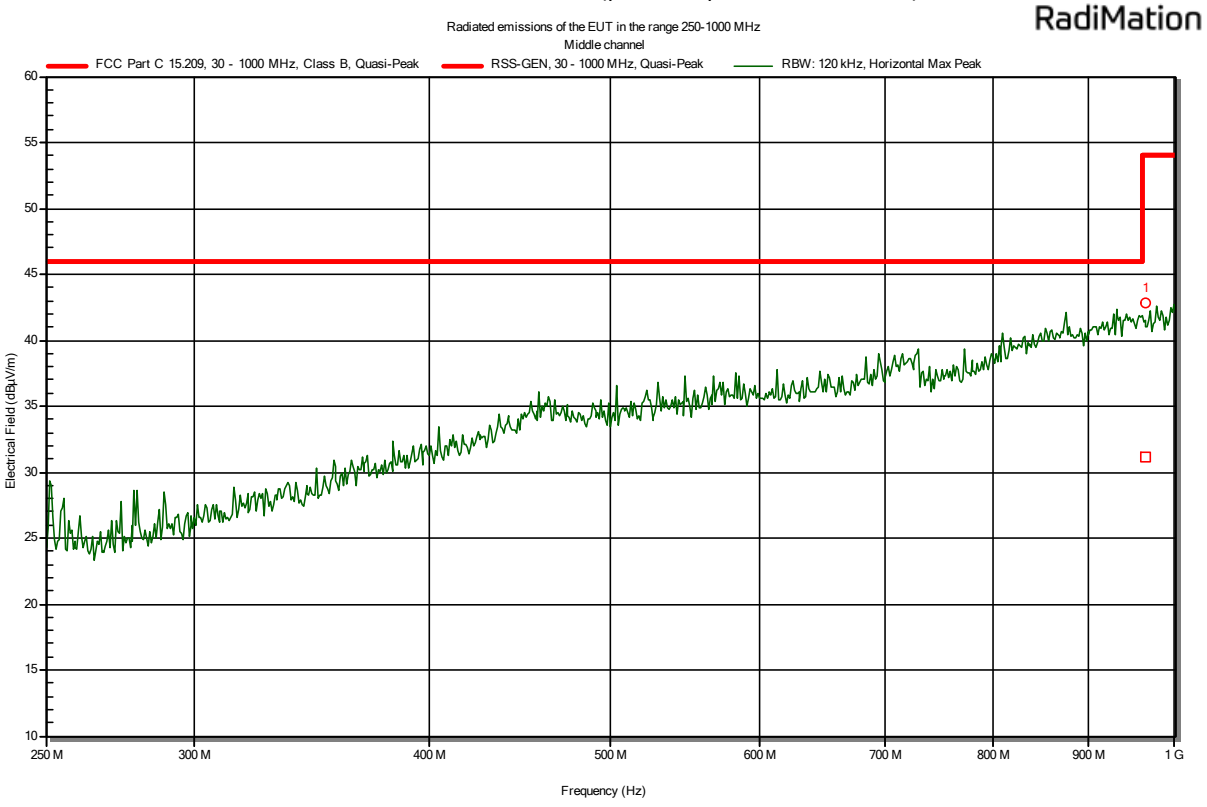
Plot 4b Antenna horizontal, (pre-scan peak values shown)



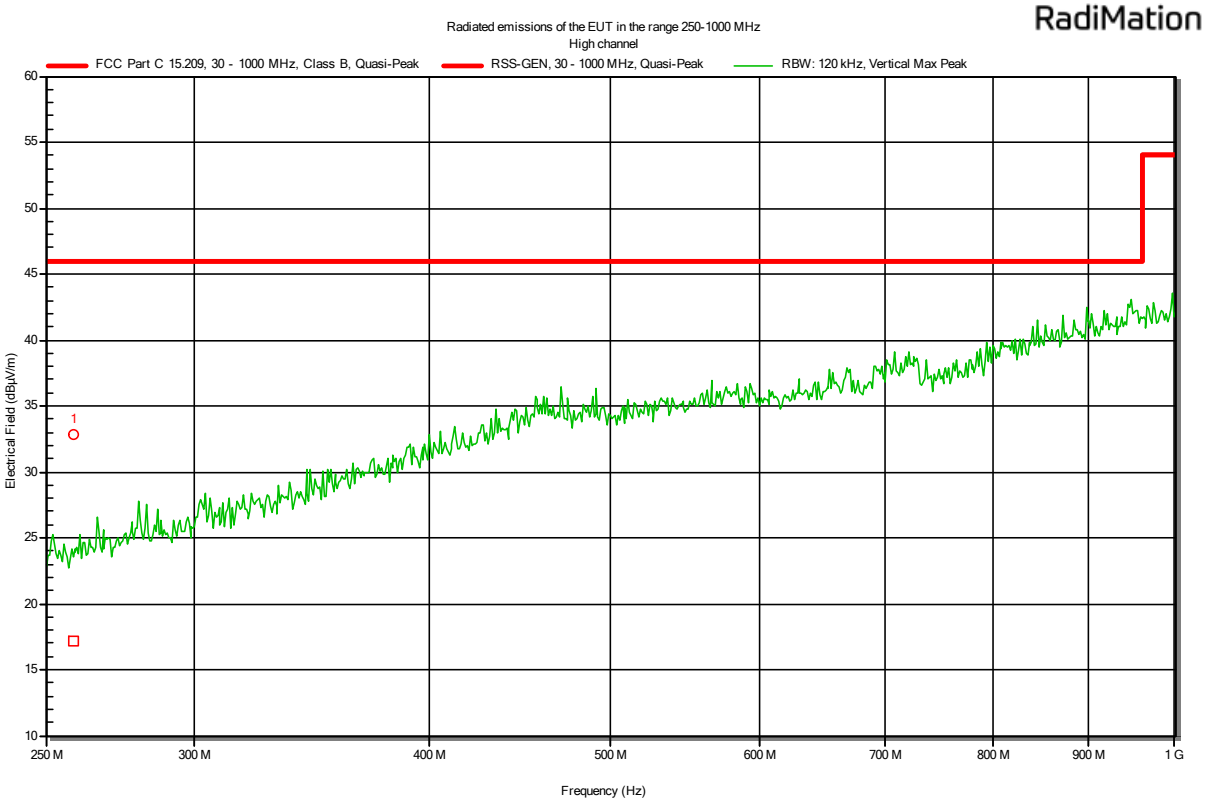
Plot 4c: Antenna vertical, (pre-scan peak values shown)



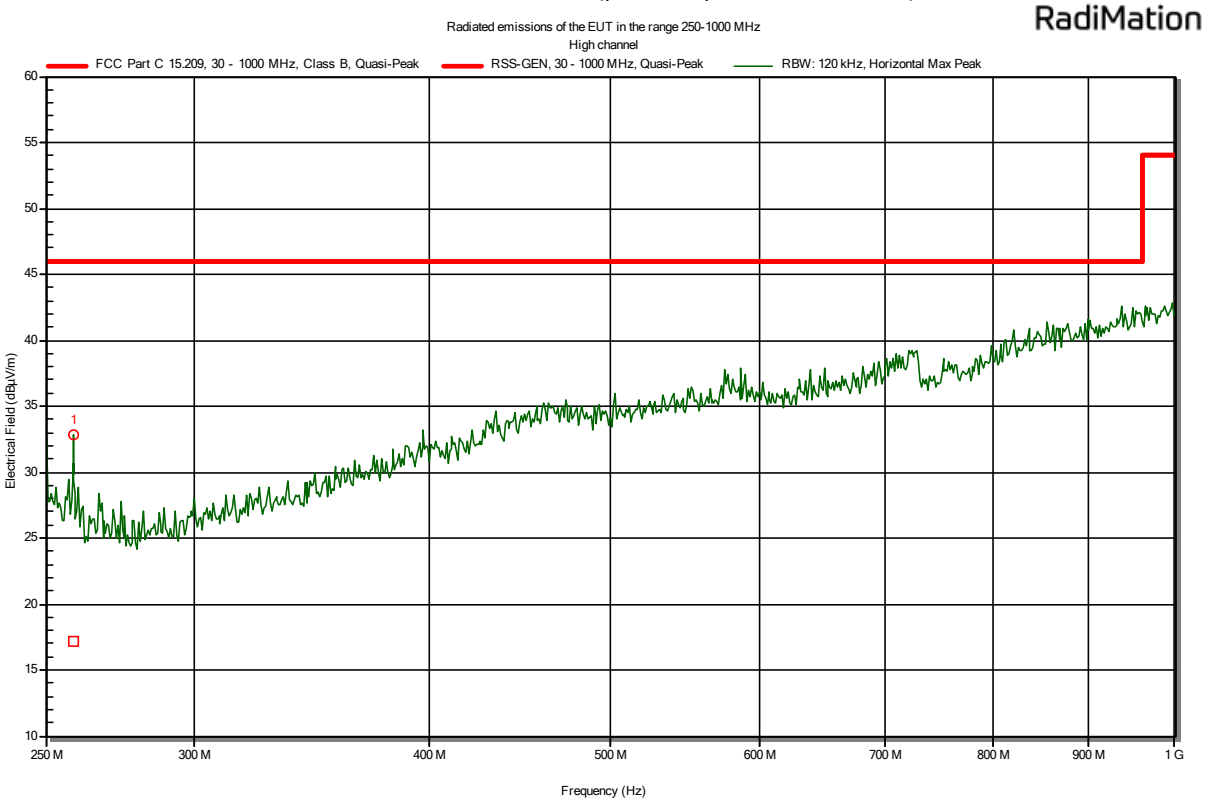
Plot 4d: Antenna horizontal, (pre-scan peak values shown)



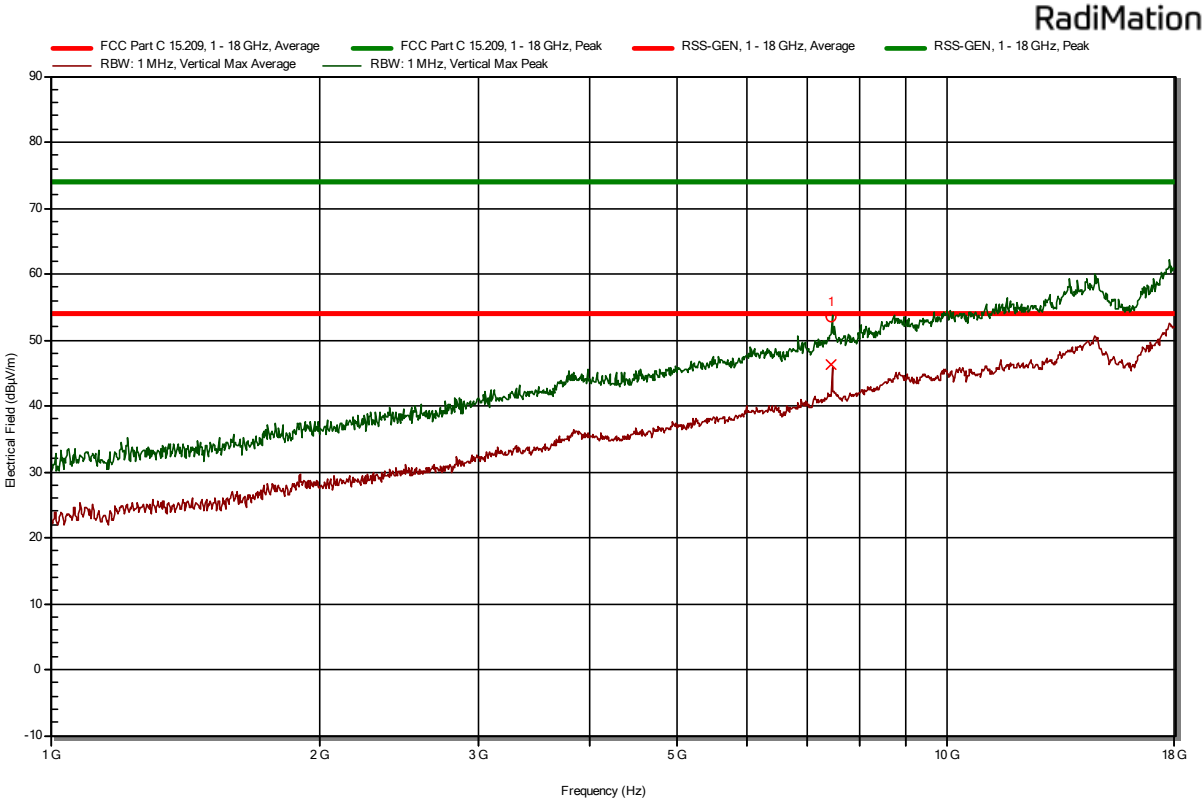
Plot 4e: Antenna vertical, (pre-scan peak values shown)



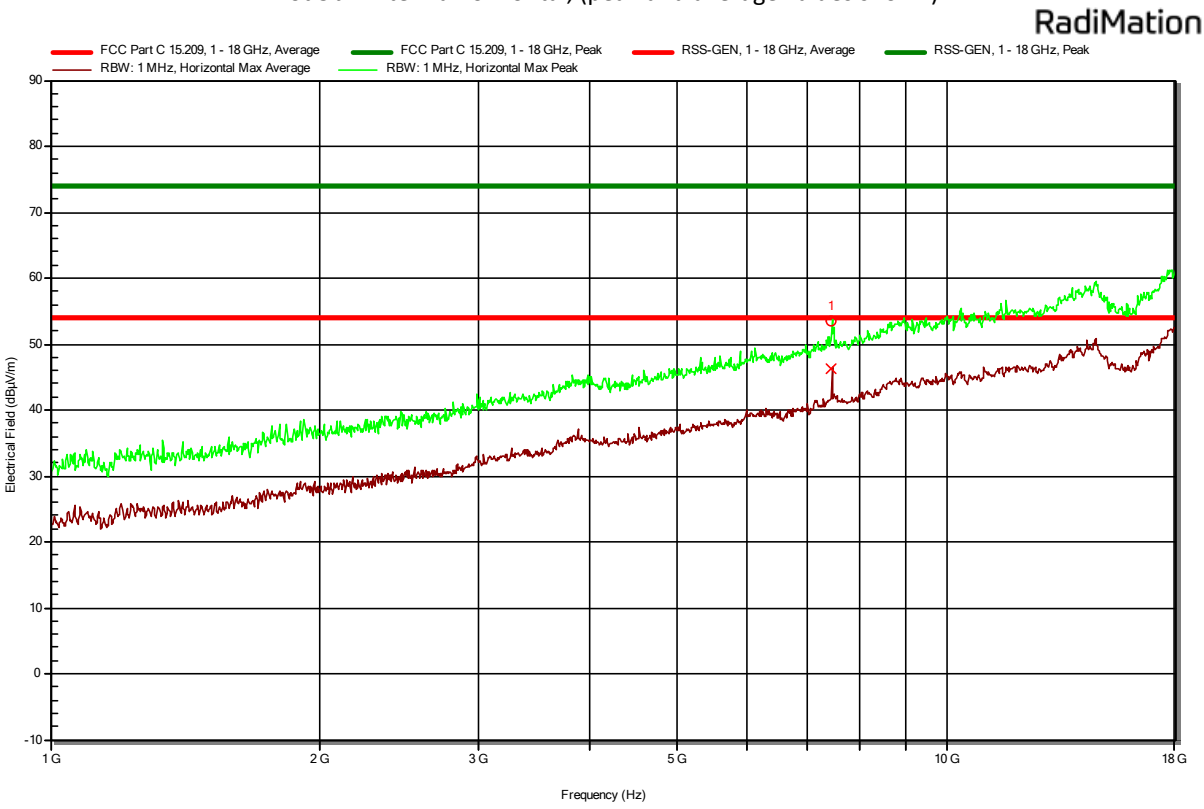
Plot 4f: Antenna horizontal, (pre-scan peak values shown)



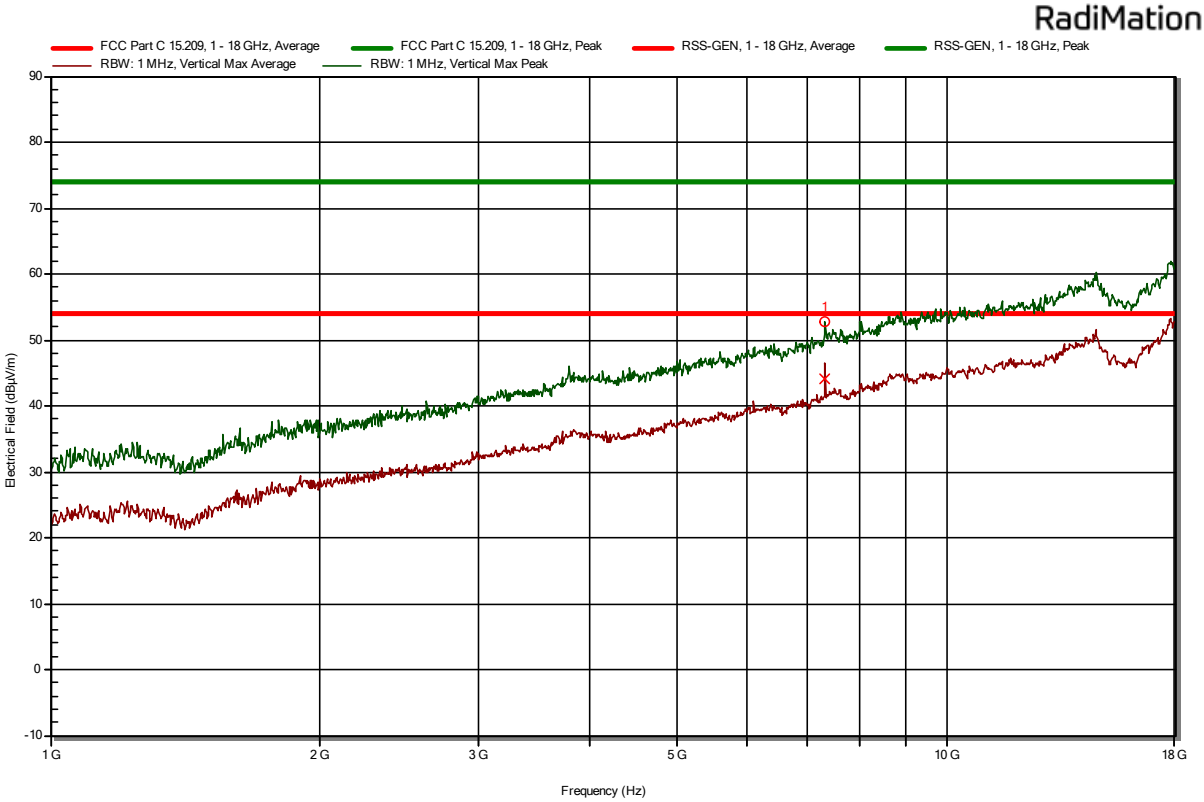
Plot 5a: Antenna vertical, (peak and average values shown)



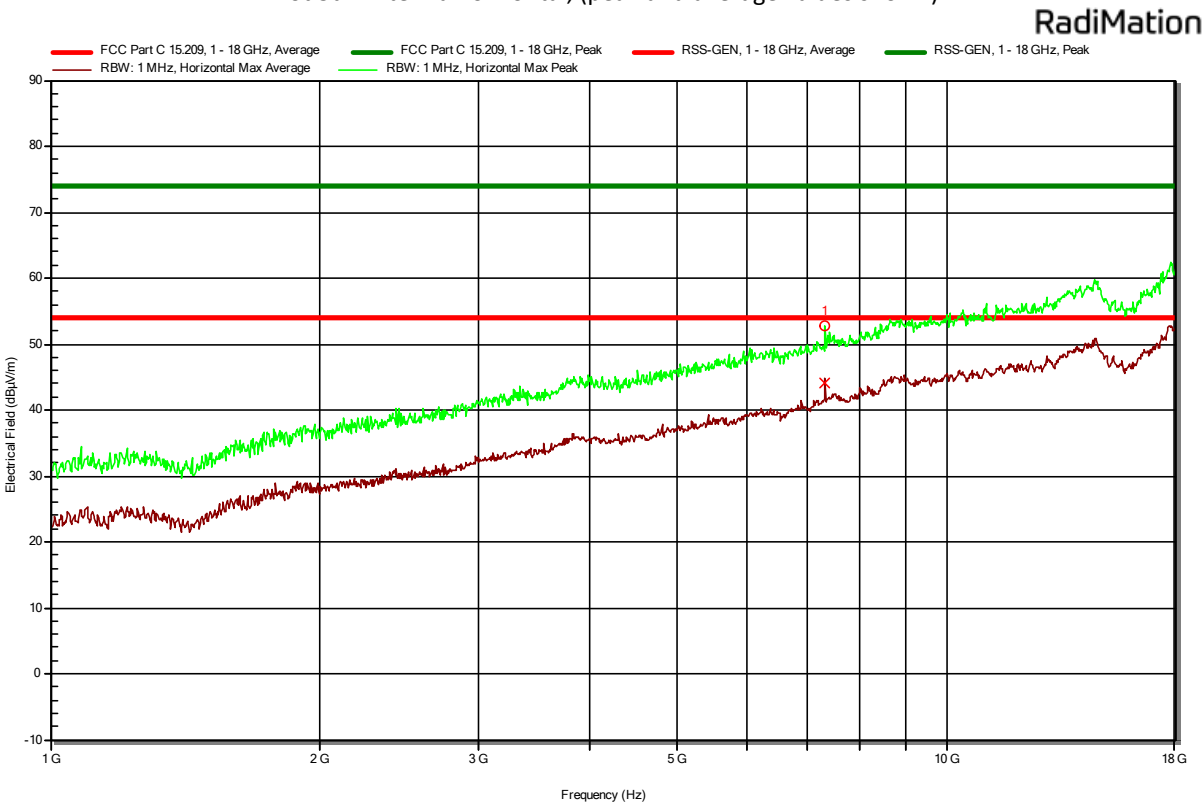
Plot 5b: Antenna horizontal, (peak and average values shown)



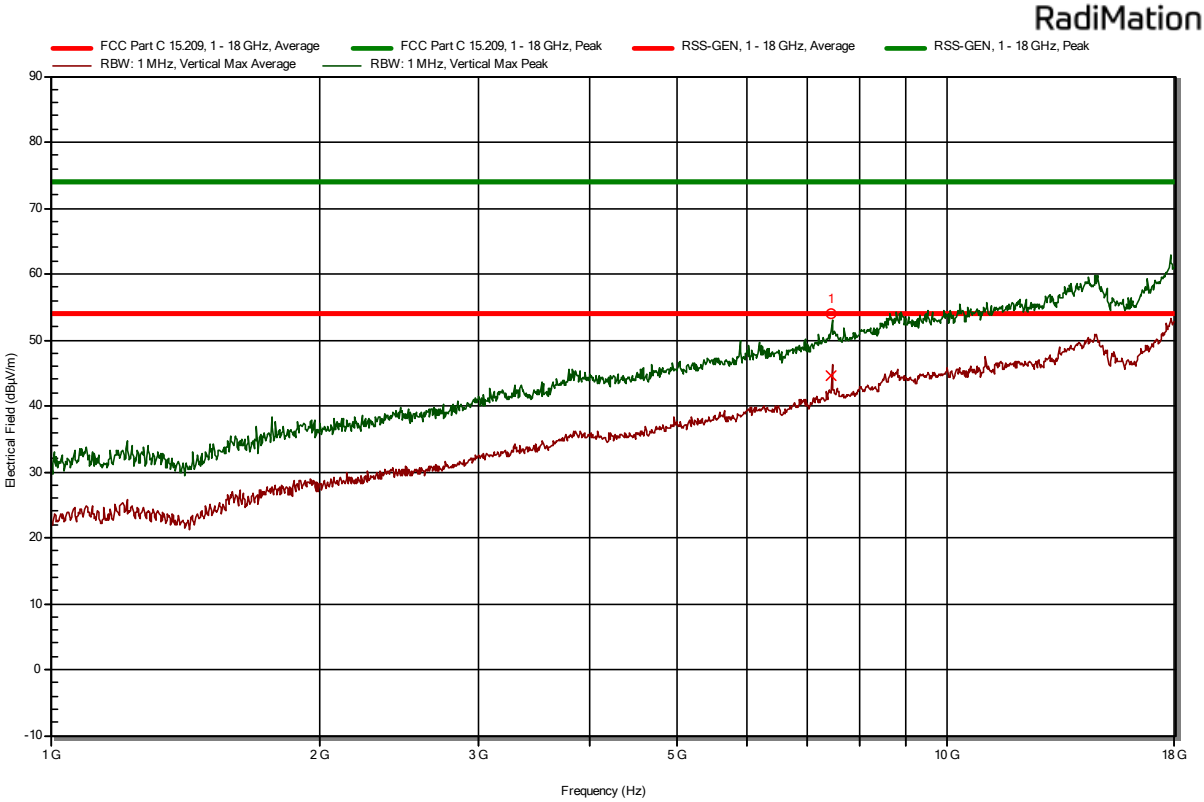
Plot 5c: Antenna vertical, (peak and average values shown)



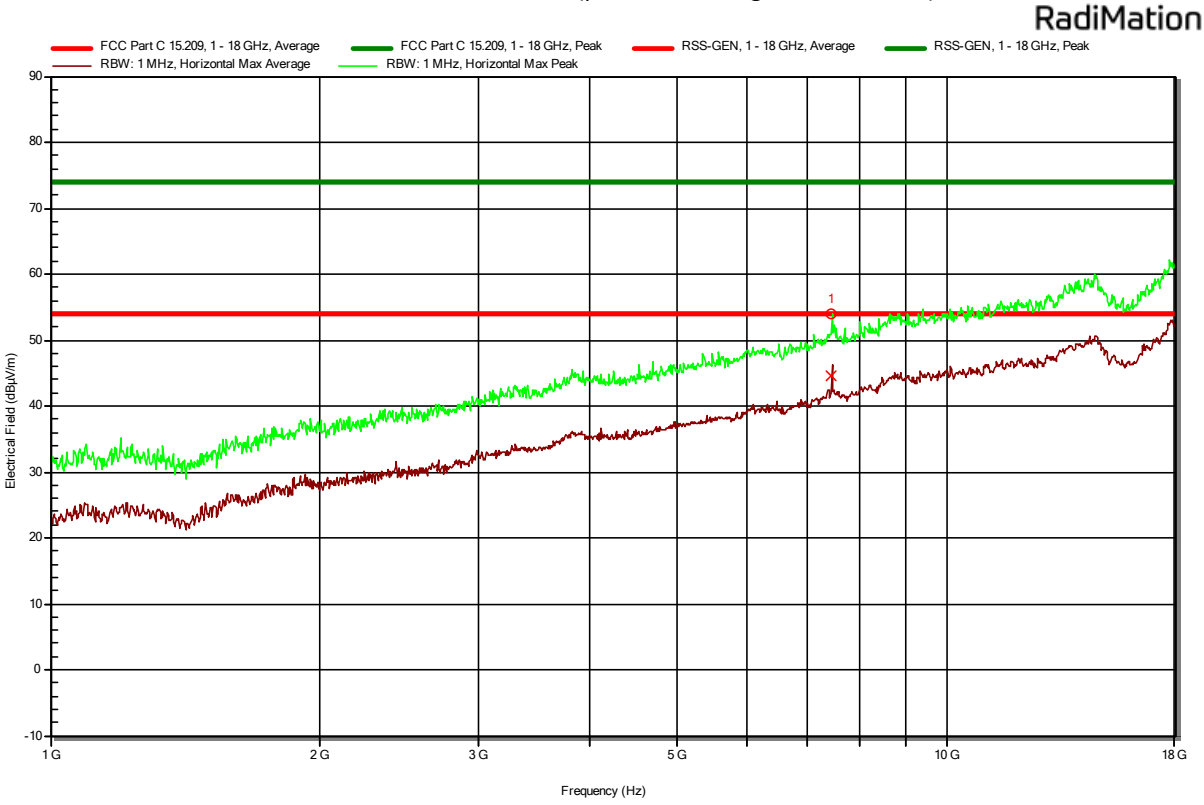
Plot 5d: Antenna horizontal, (peak and average values shown)



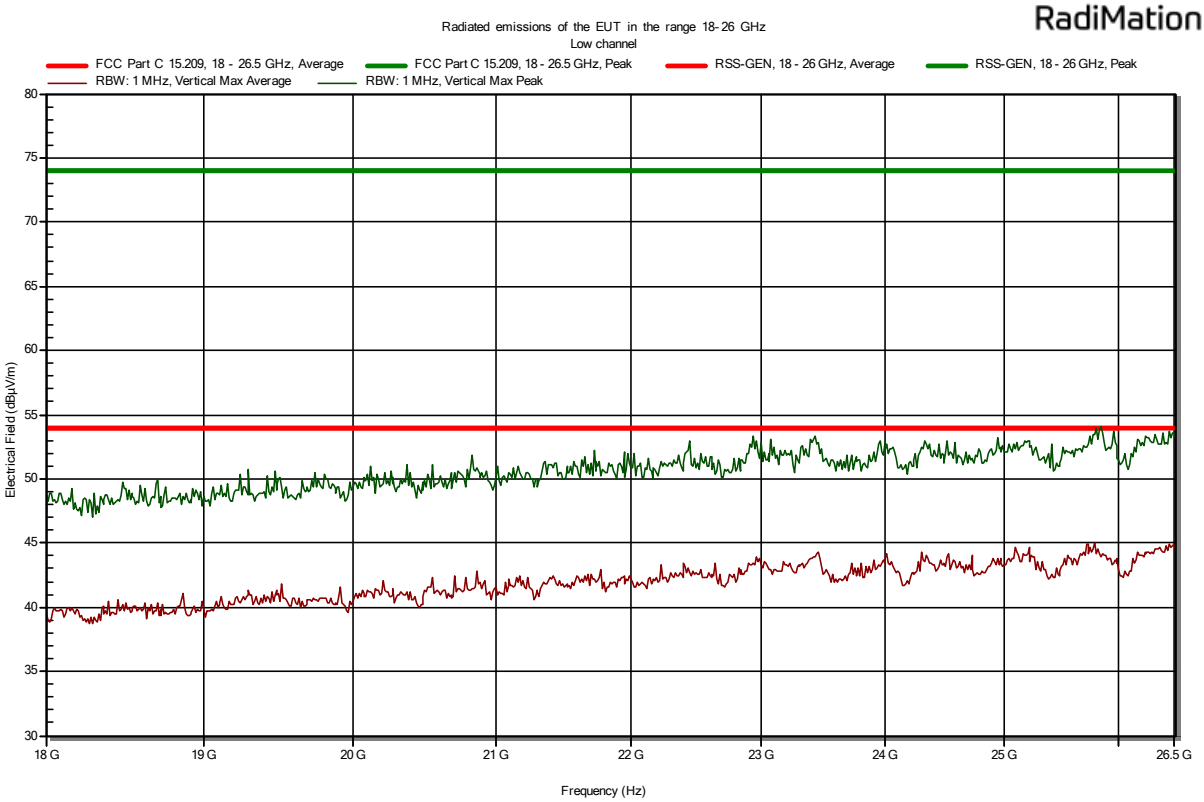
Plot 5e: Antenna vertical, (peak and average values shown)



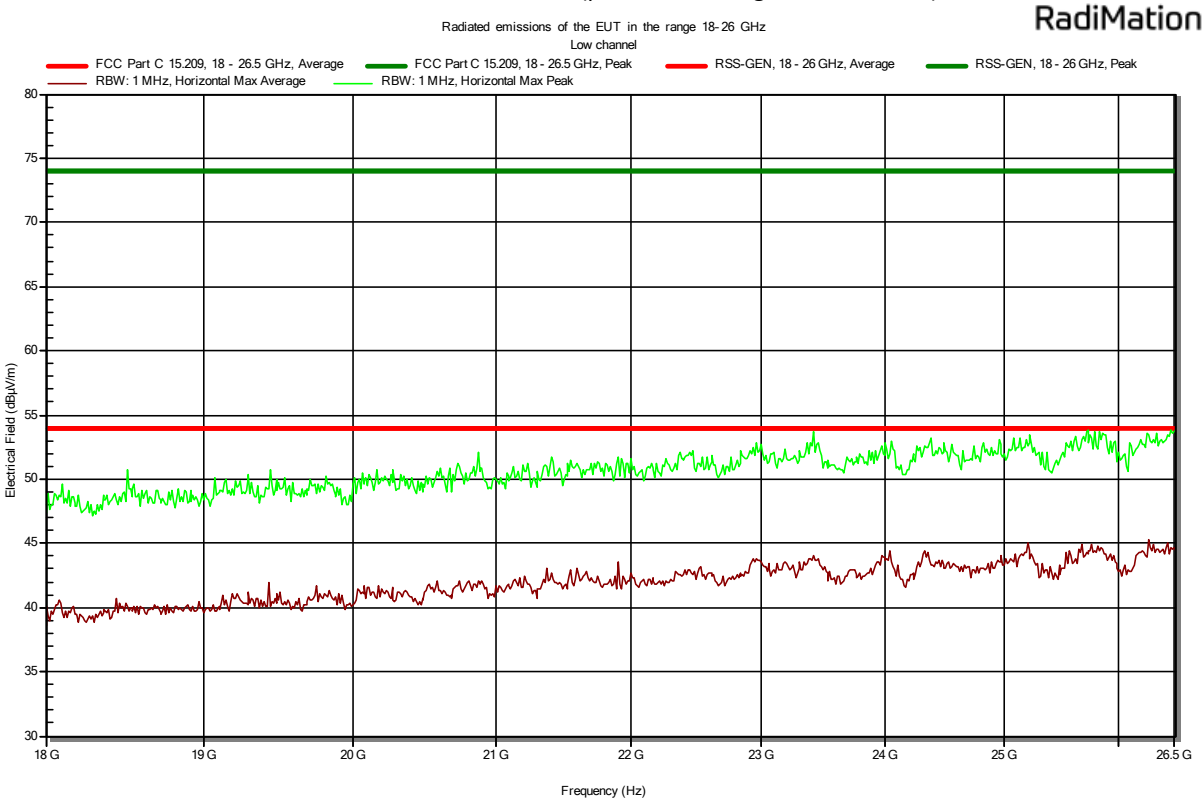
Plot 5f: Antenna horizontal, (peak and average values shown)



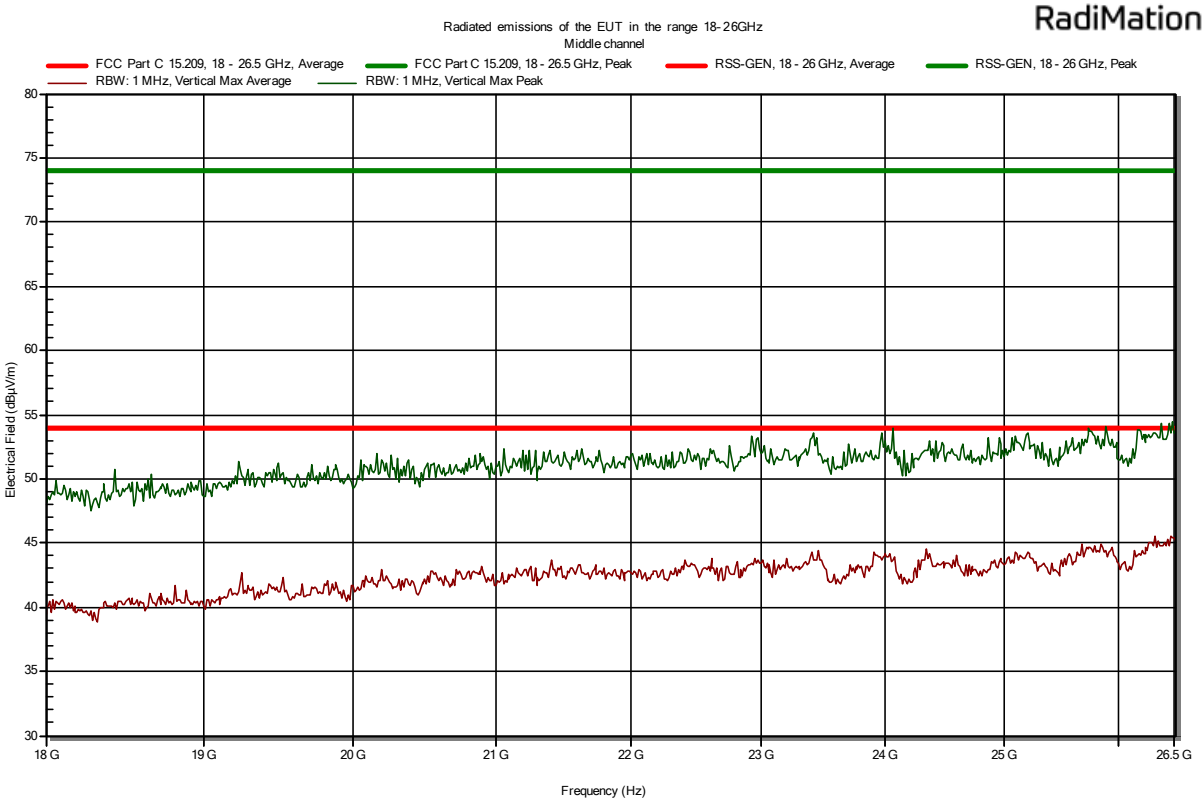
Plot 6a: Antenna vertical, (peak and average values shown)



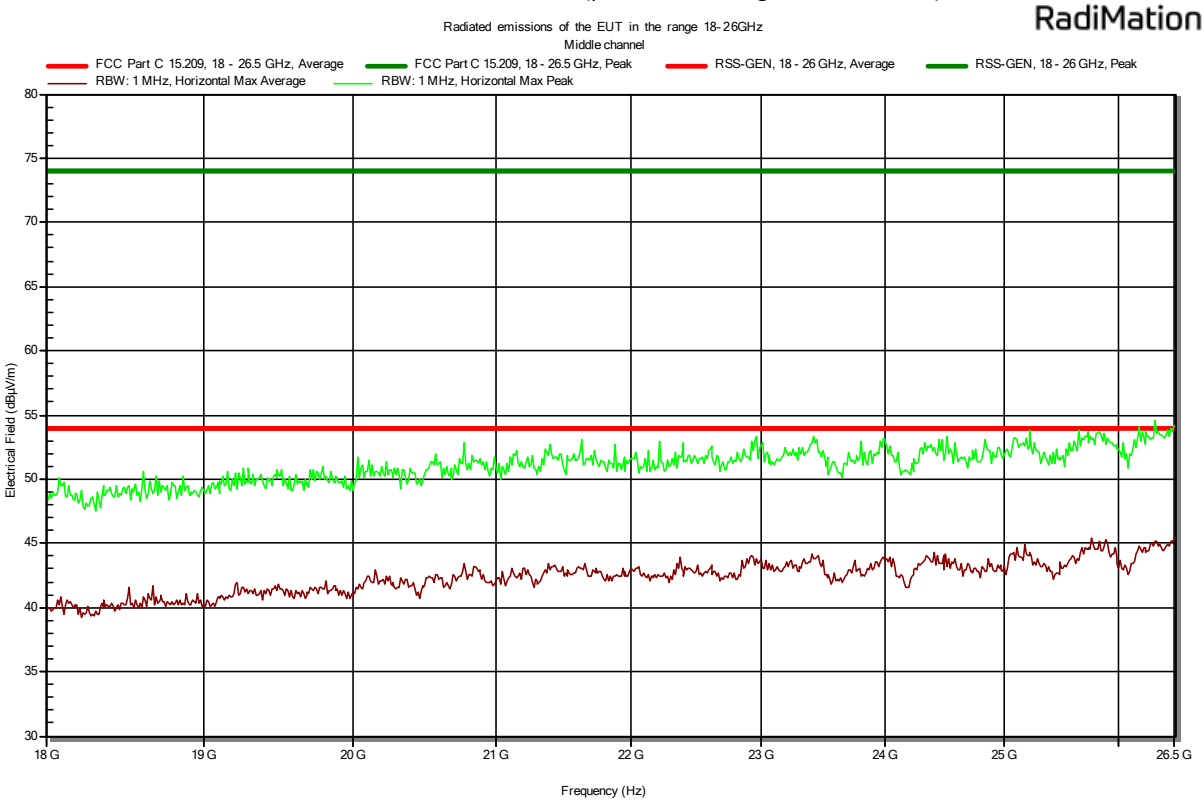
Plot 6b: Antenna horizontal, (peak and average values shown)



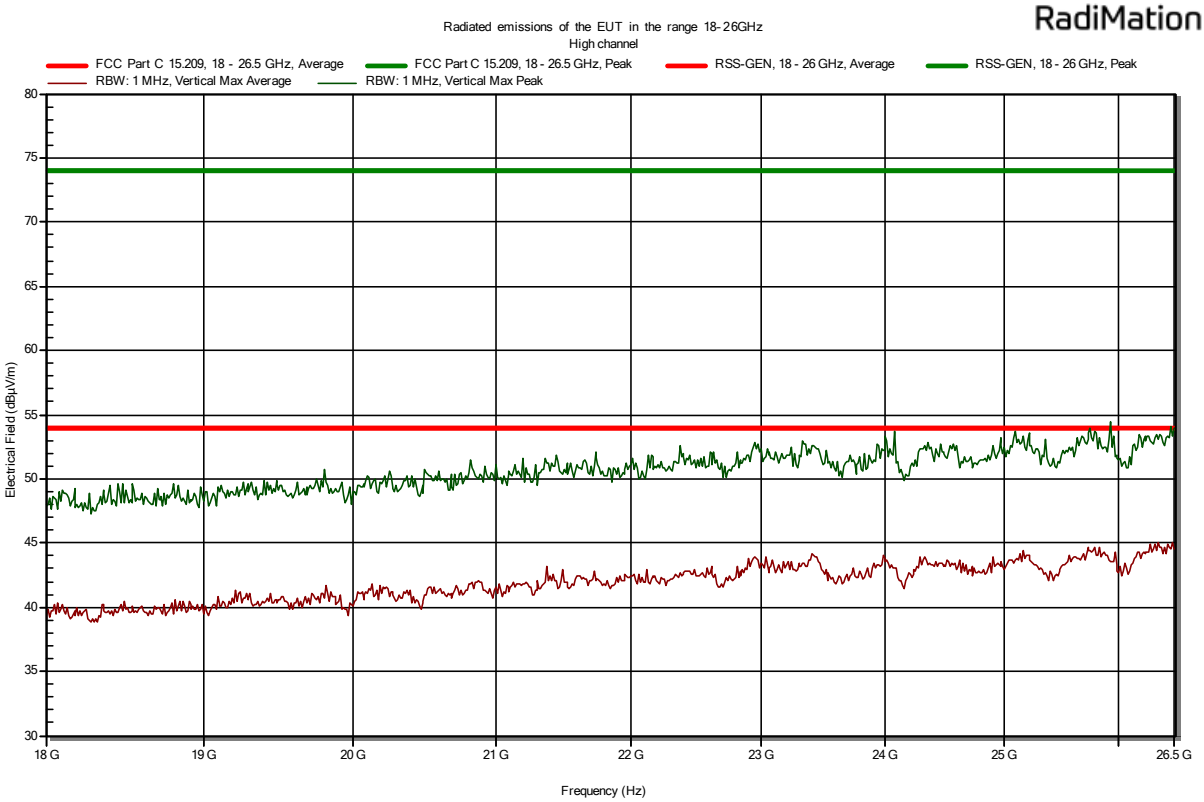
Plot 6c: Antenna vertical, (peak and average values shown)



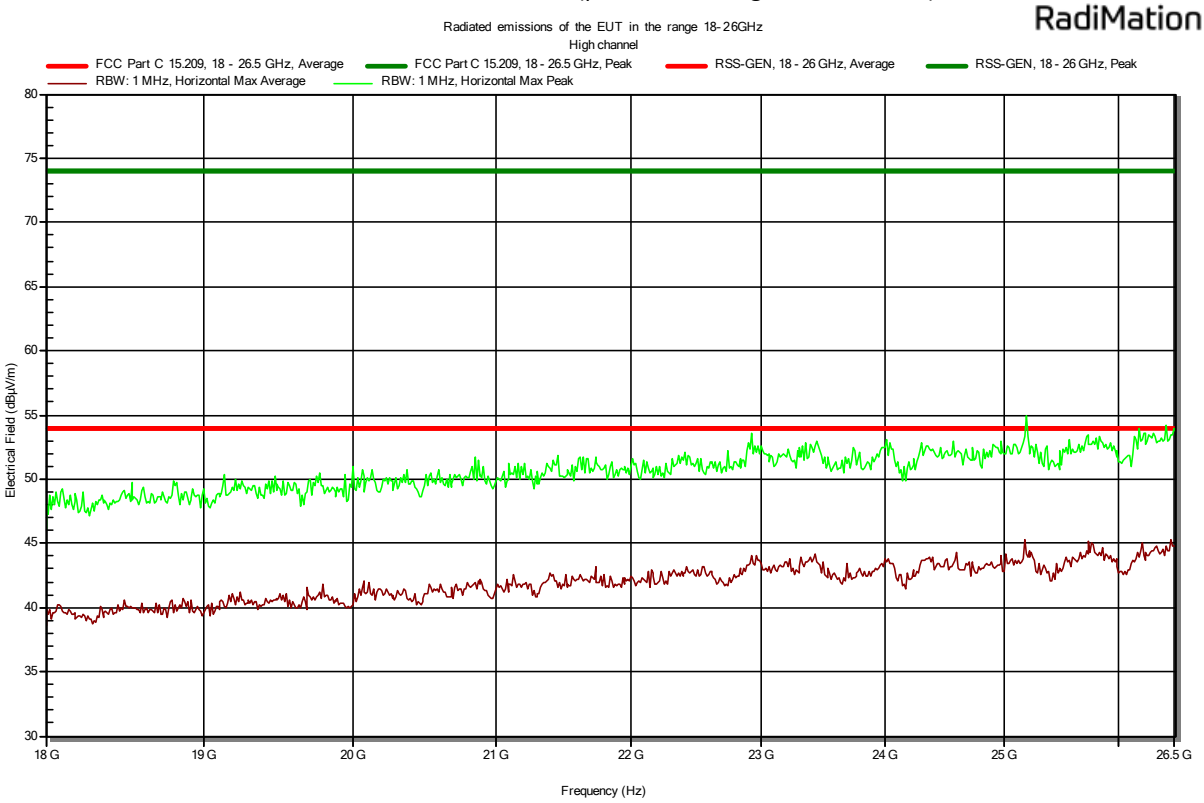
Plot 6d:, Antenna horizontal, (peak and average values shown)



Plot 6e: Antenna vertical, (peak and average values shown)

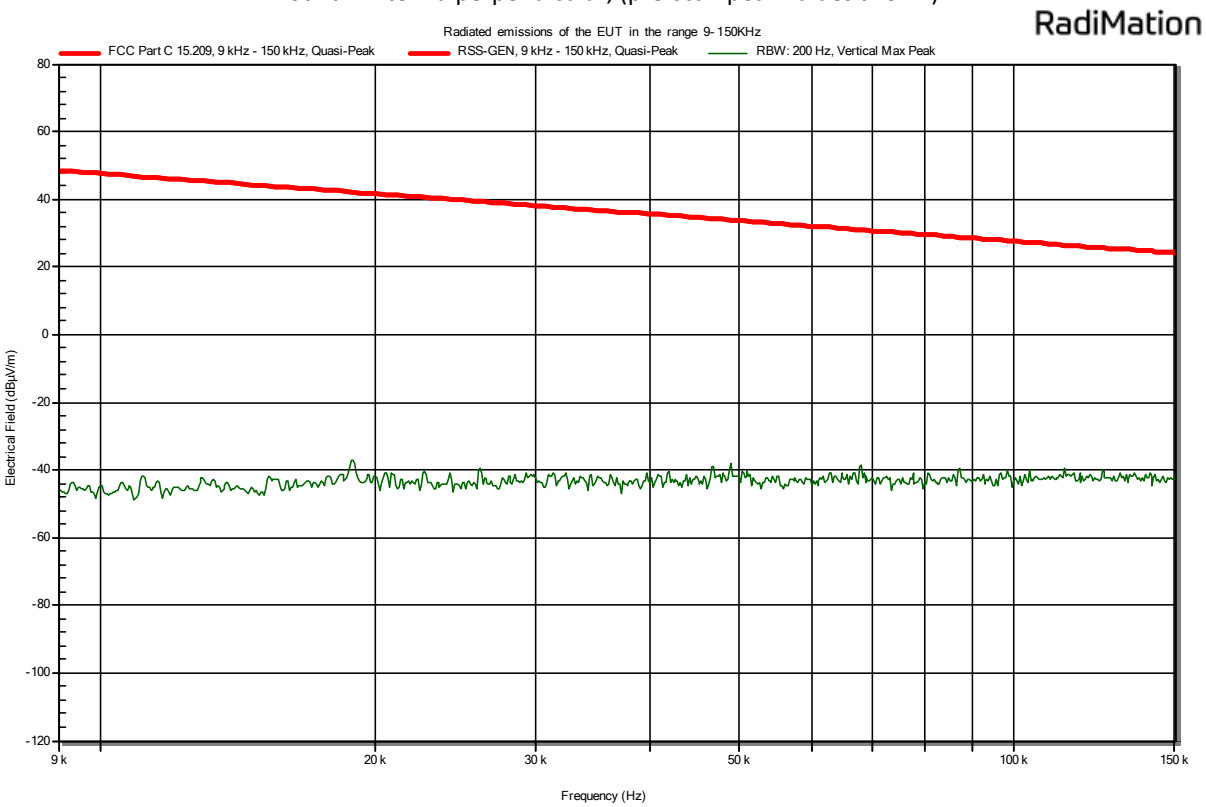


Plot 6f: Antenna horizontal, (peak and average values shown)

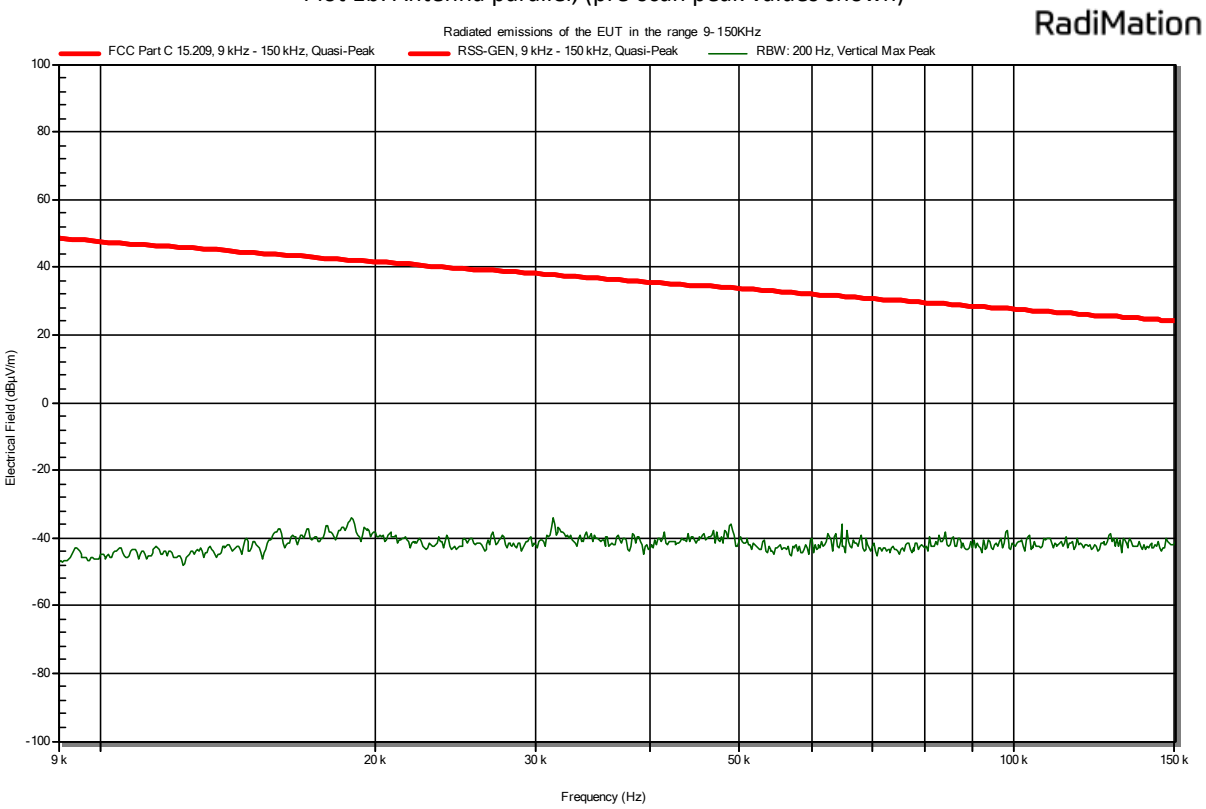


3.1.9 Plots of the Radiated Spurious Emissions Measurement ANT+

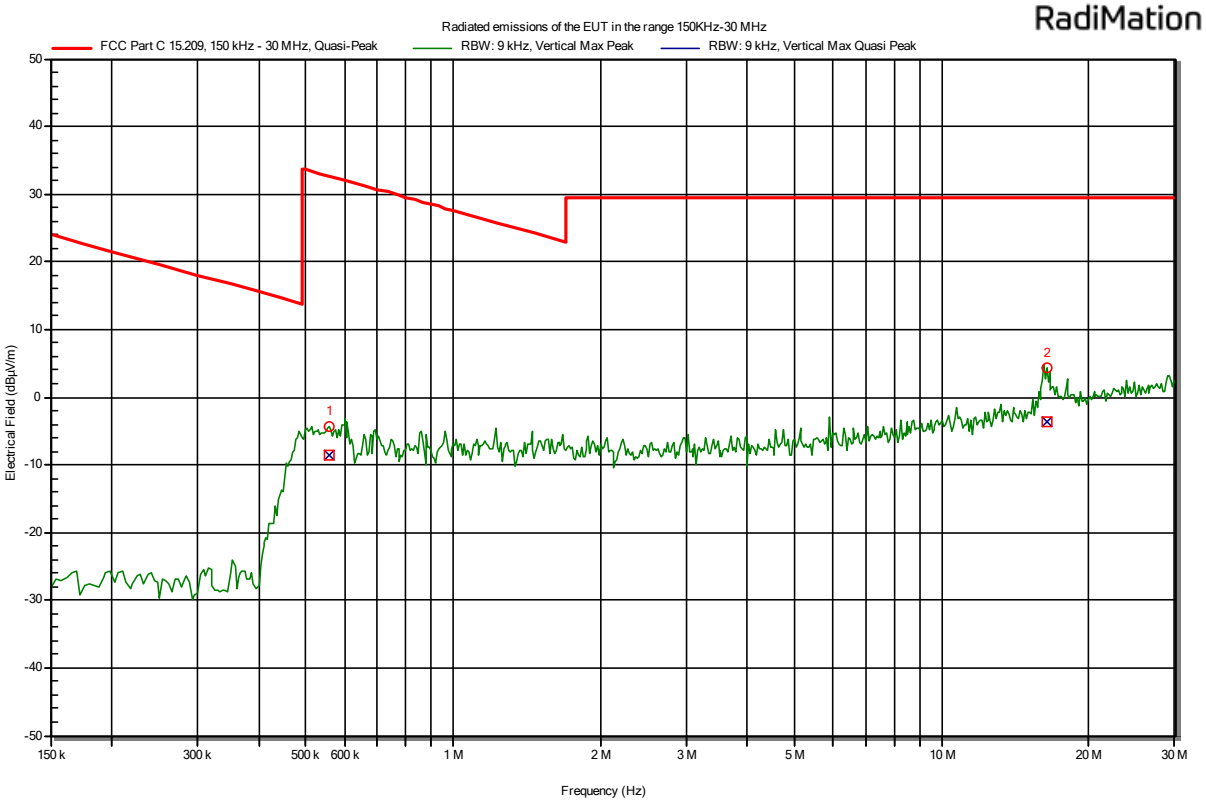
Plot 1a: Antenna perpendicular, (pre-scan peak values shown)



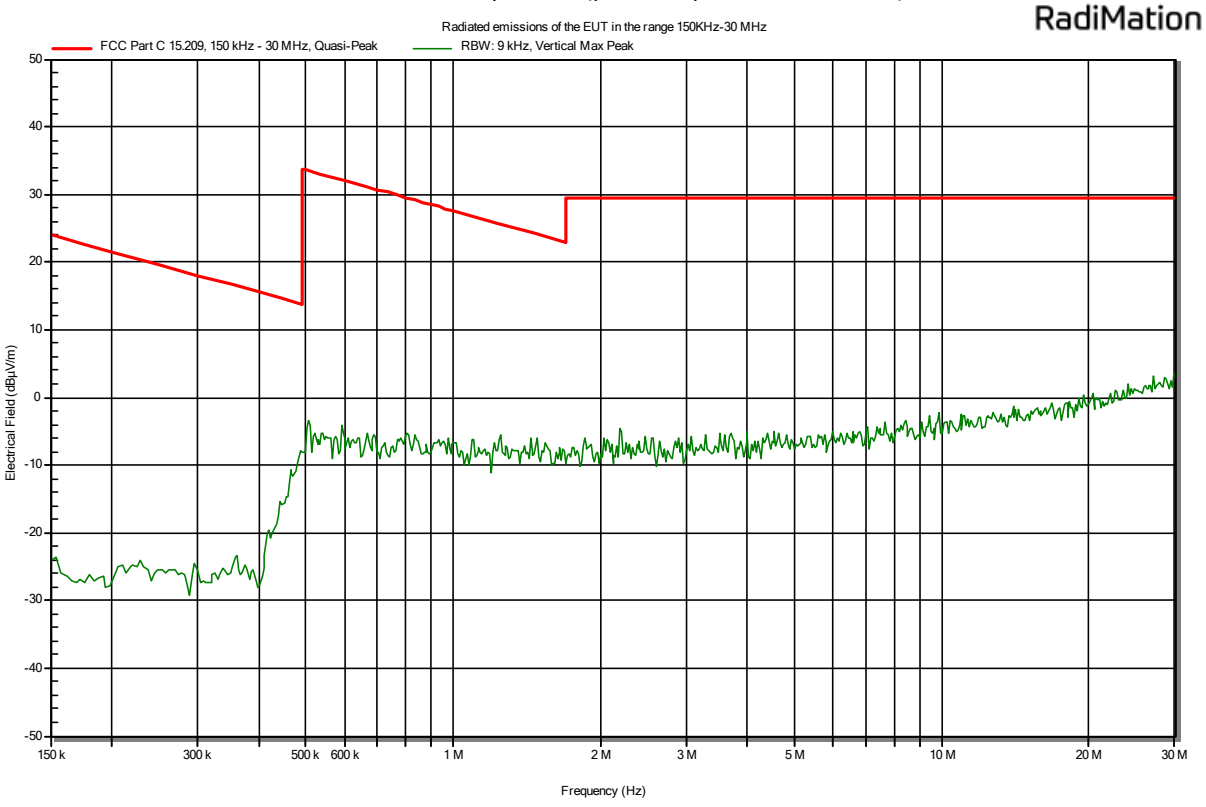
Plot 1b: Antenna parallel, (pre-scan peak values shown)



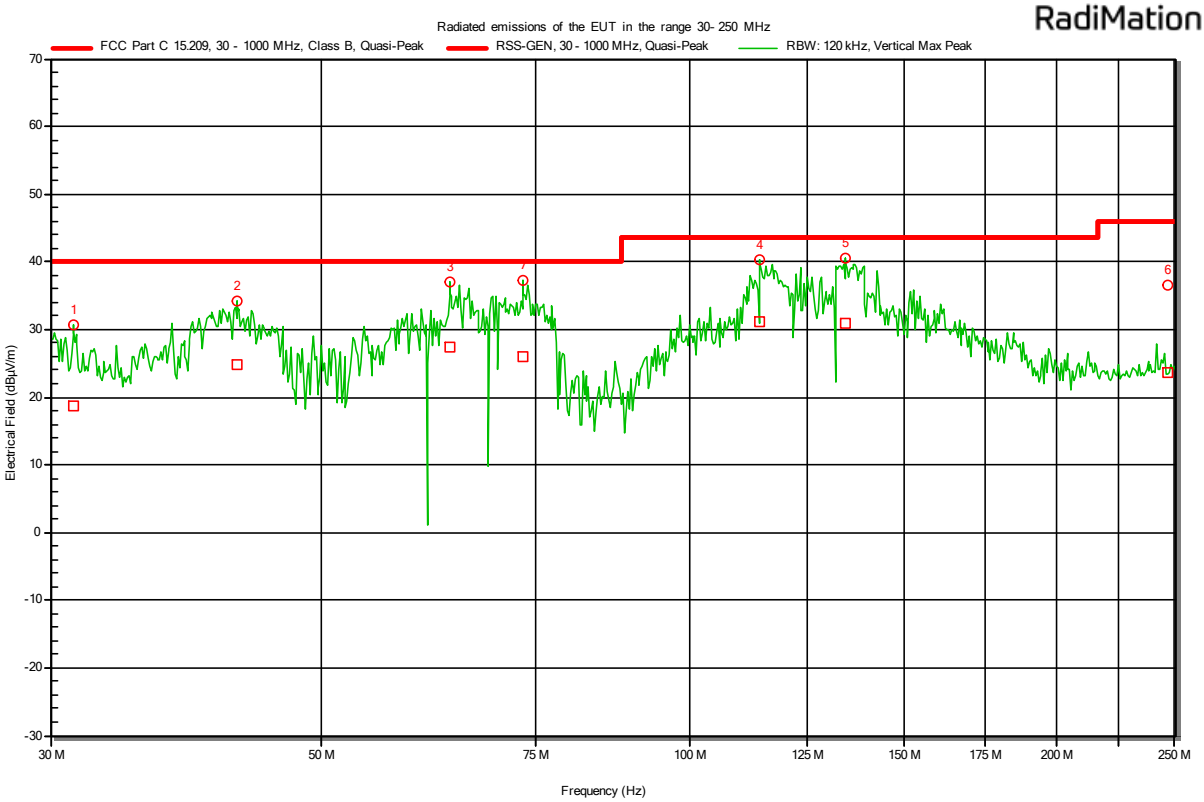
Plot 2a: Antenna perpendicular,(pre-scan peak values shown)



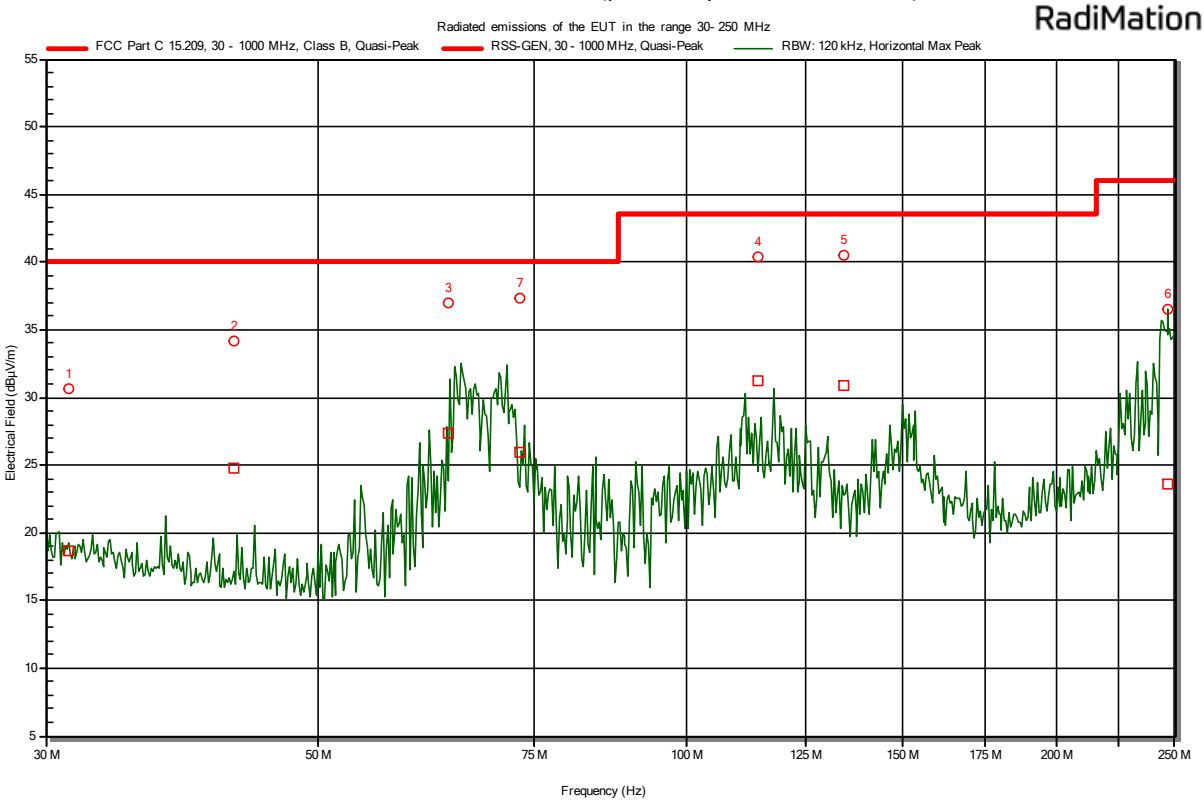
Plot 2b: Antenna parallel, (pre-scan peak values shown)



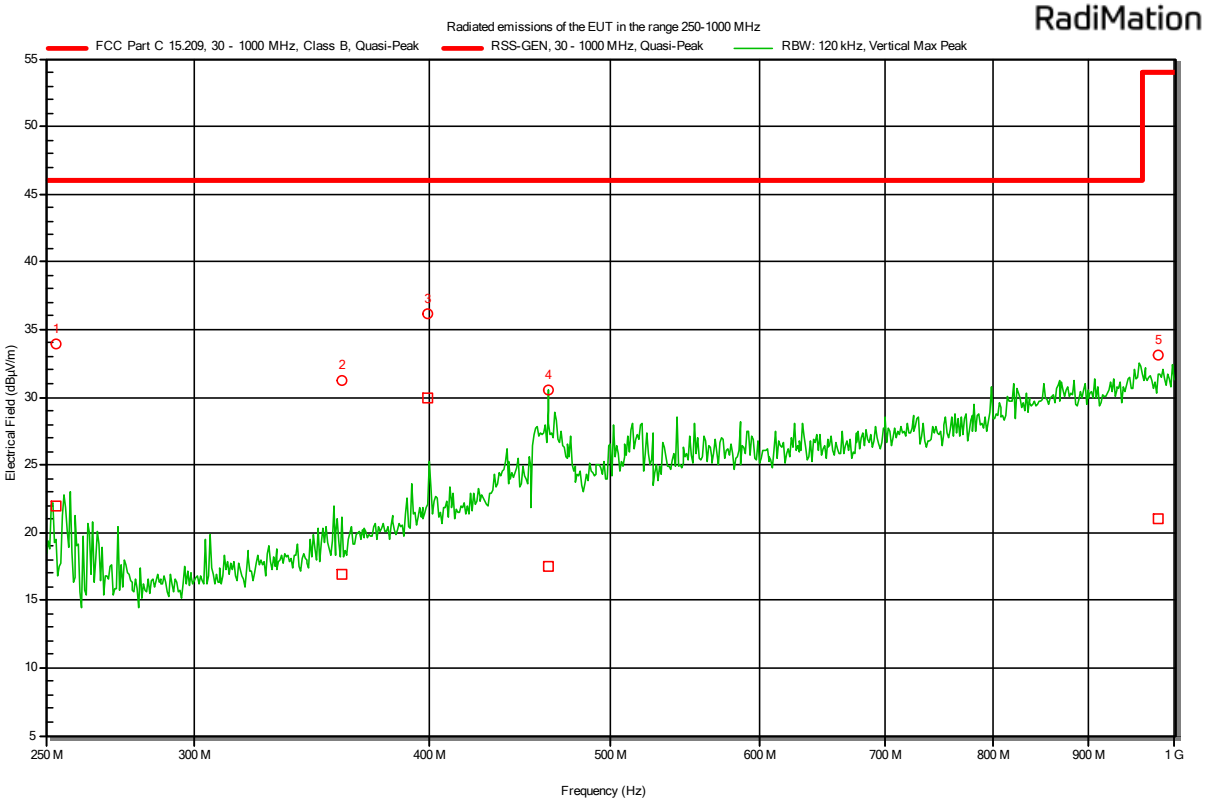
Plot 3a: Antenna vertical, (pre-scan peak values shown)



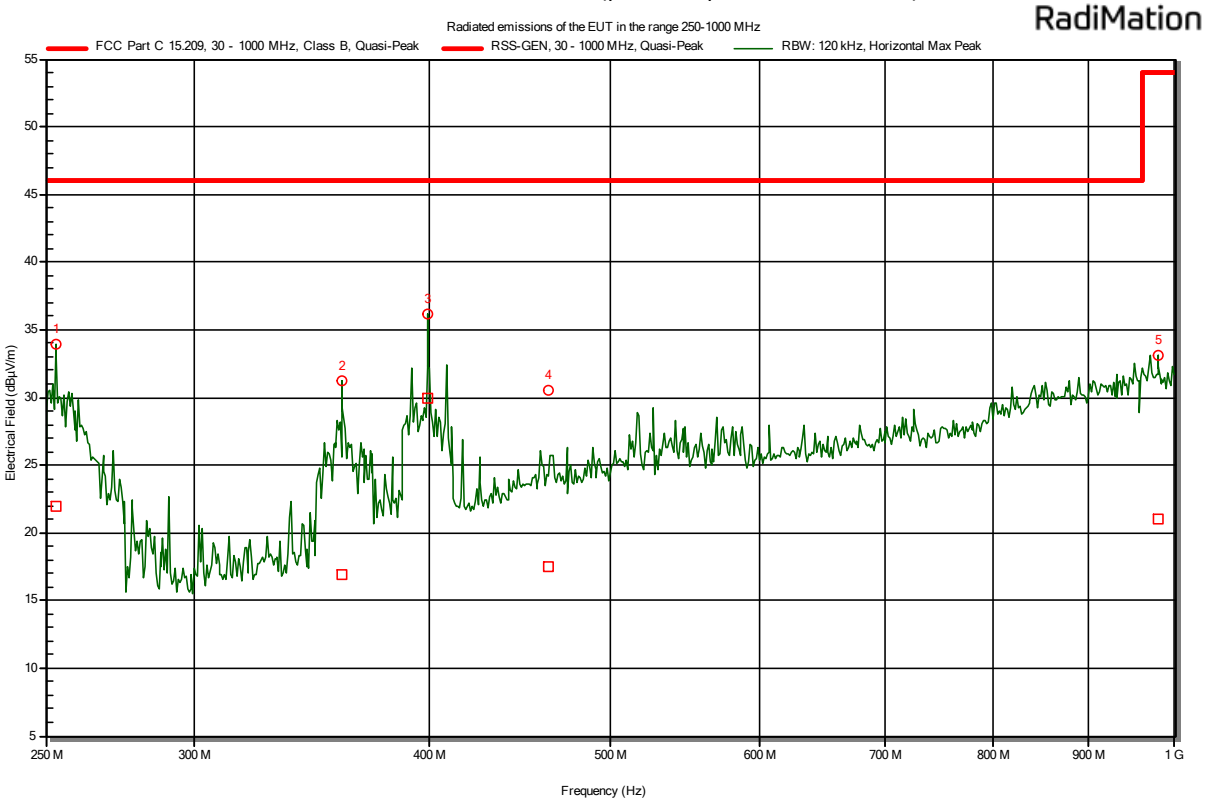
Plot 3b: Antenna horizontal, (pre-scan peak values shown)



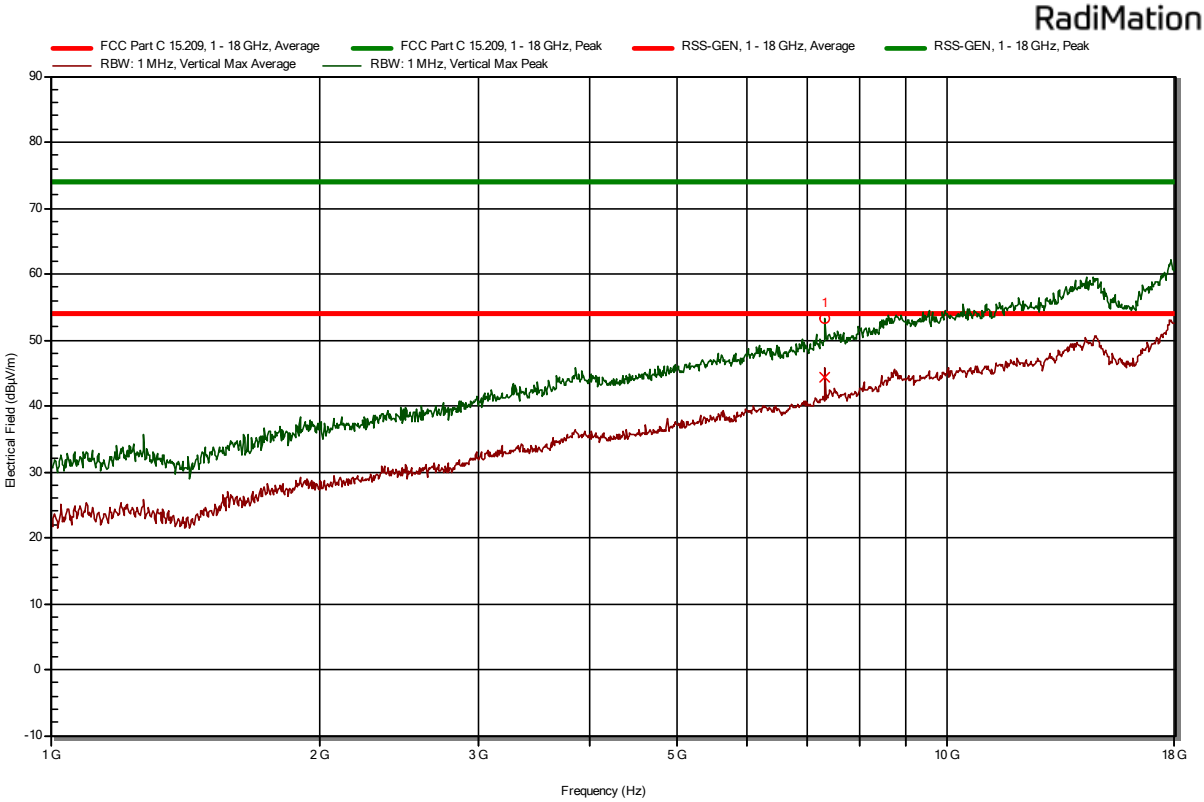
Plot 4a: Antenna vertical (pre-scan peak values shown)



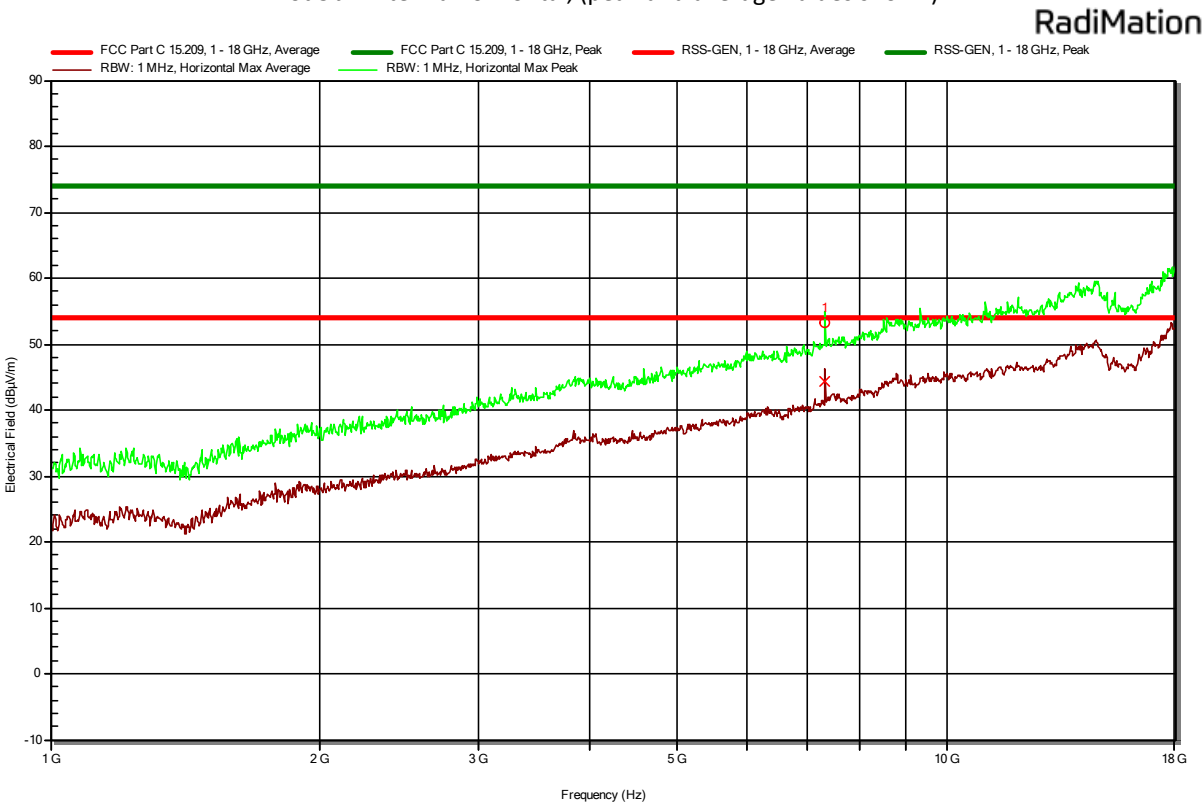
Plot 4b: Antenna horizontal, (pre-scan peak values shown)



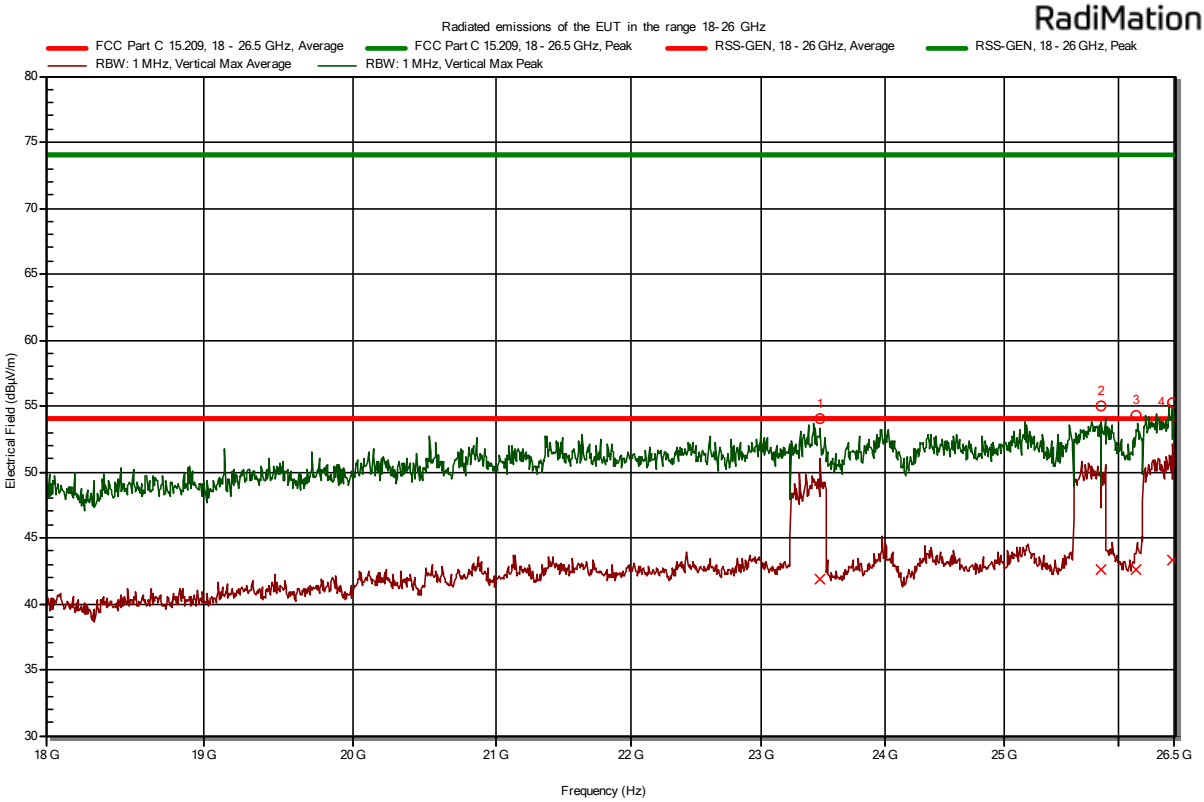
Plot 5a: Antenna vertical, (peak and average values shown)



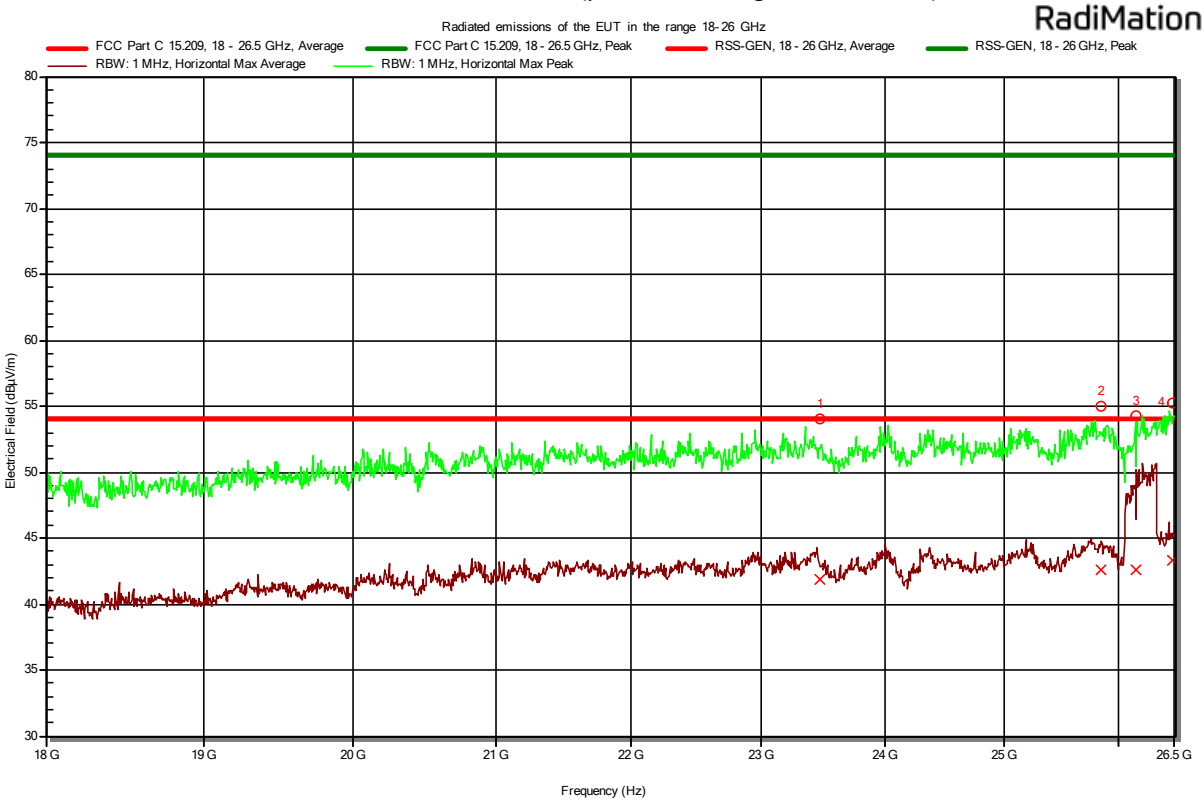
Plot 5b: Antenna horizontal, (peak and average values shown)



Plot 6a: Antenna vertical, (peak and average values shown)



Plot 6b: Antenna horizontal, (peak and average values shown)



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	1	2402	1 Mbps	732.674
	18	2440	1 Mbps	732.674
	39	2480	1 Mbps	732.674
Uncertainty	± 36.2 kHz			

Technology Std.	Channel	Frequency (MHz)	Data rate	6dB bandwidth (kHz)
Bluetooth Low energy	1	2402	2 Mbps	1228
	18	2440	2 Mbps	1228
	39	2480	2 Mbps	1228
Uncertainty	± 36.2 kHz			

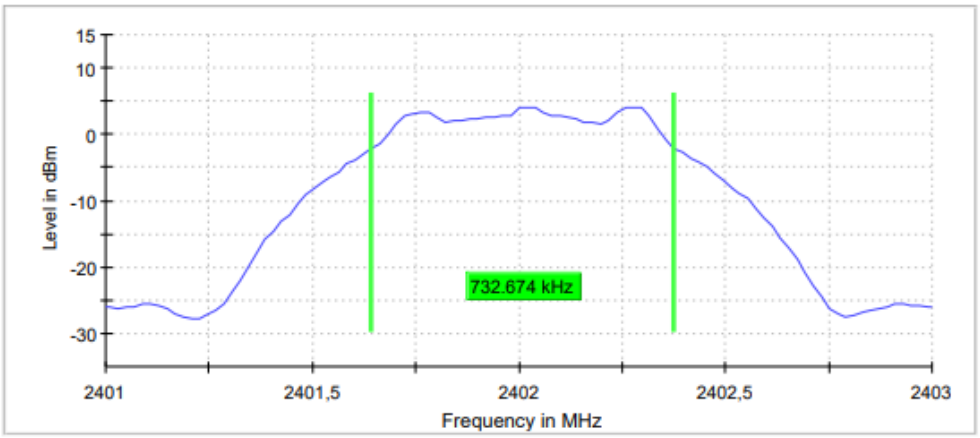
Technology Std.	Channel	Frequency (MHz)	Data rate	6dB bandwidth (kHz)
ANT+	1	2457	1 Mbps	554.456
Uncertainty	± 36.2 kHz			

Note: plots are provided on the next page.

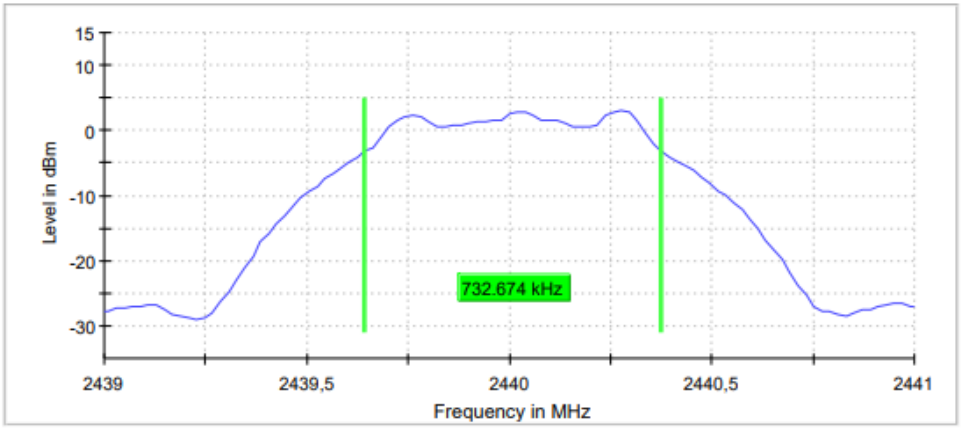
3.2.6 Plots of the 6 dB bandwidth

BLE 1 MBps

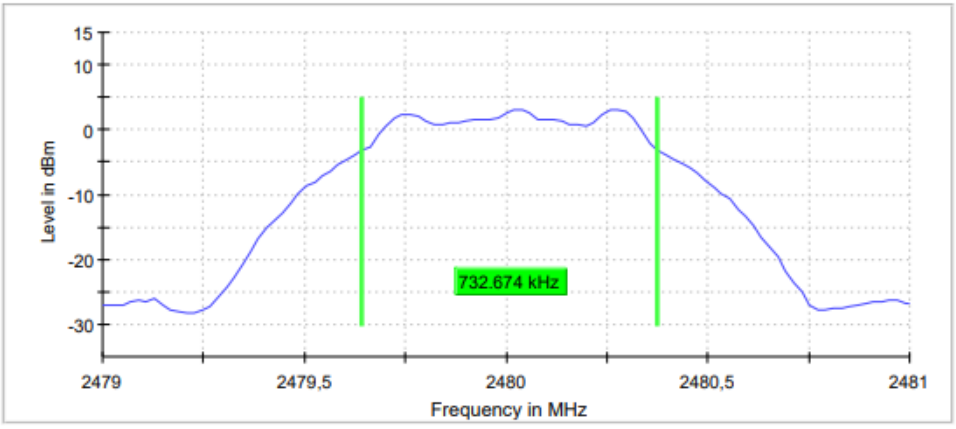
Channel 1



Channel 18

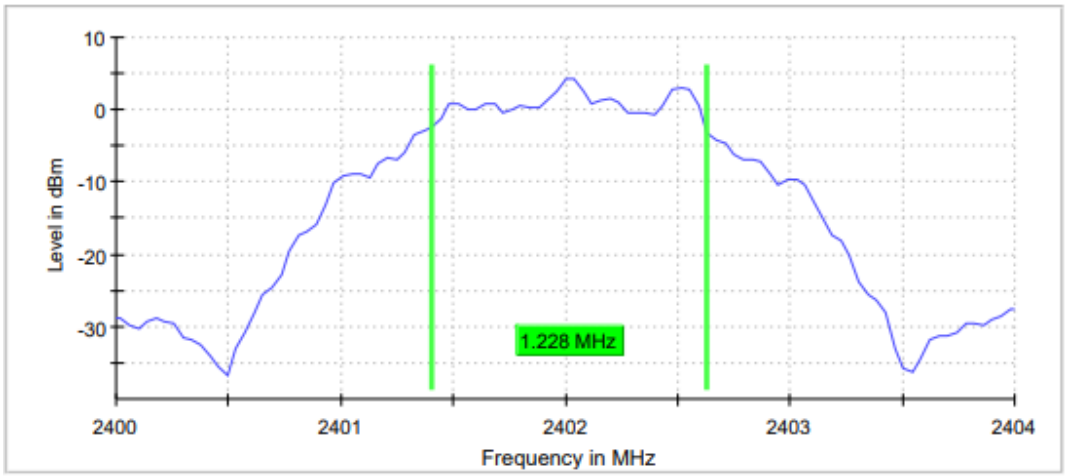


Channel 39

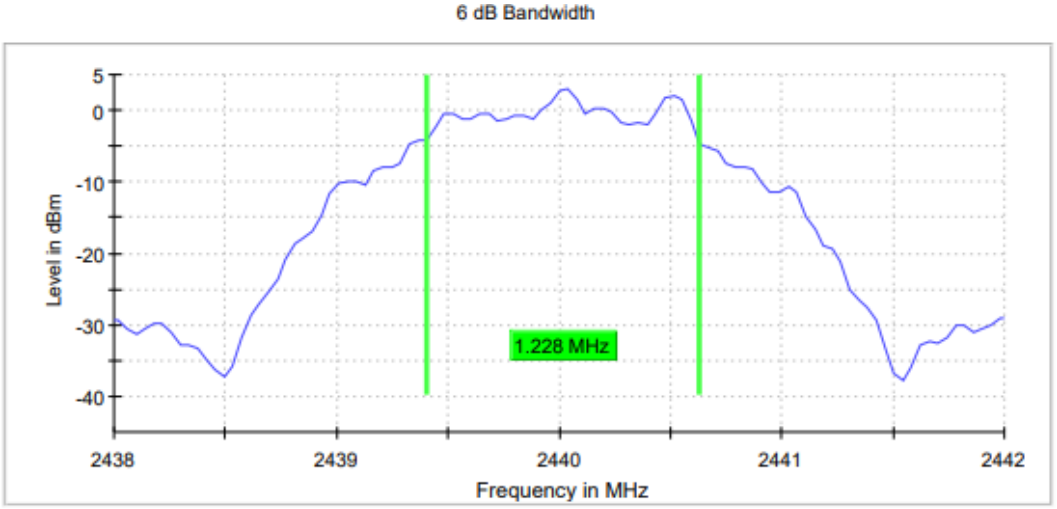


BLE 2 Mbps

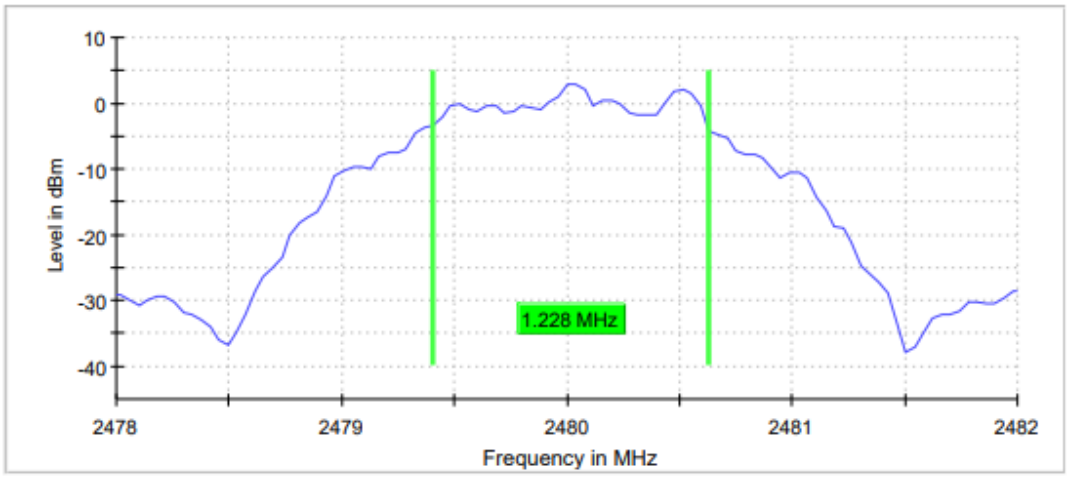
Channel 1



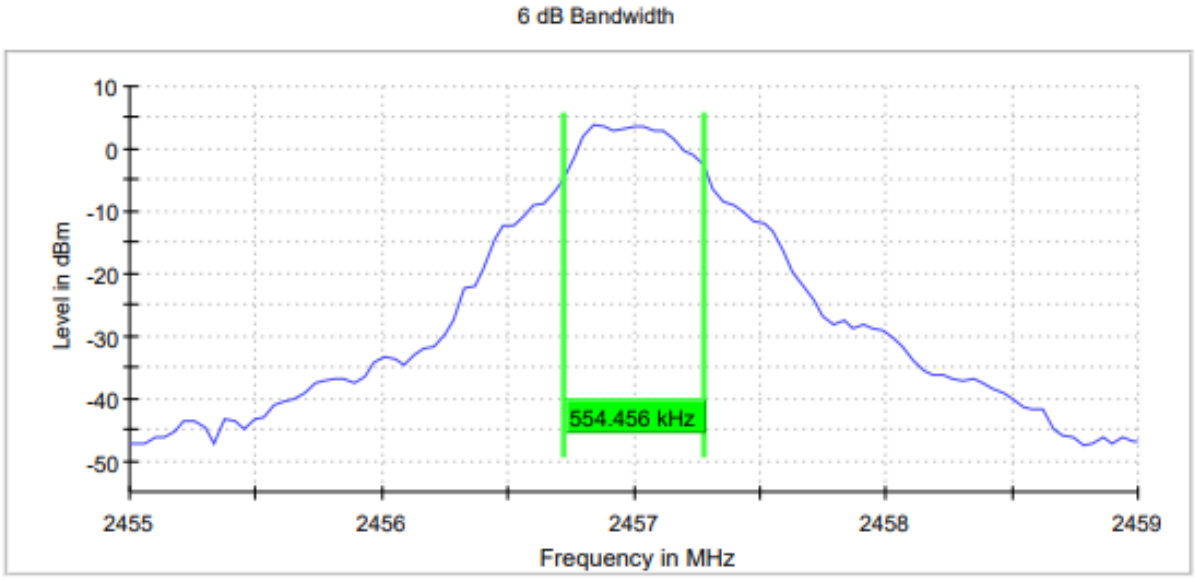
Channel 18



Channel 39



ANT+


6 dB Bandwidth
10
0
-10
-20
-30
-40
-50
Level in dBm
554.456 kHz
2455
2456
2457
2458
2459
Frequency in MHz

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	1050
	18	2440	1 Mbps	1050
	39	2480	1 Mbps	1055
Uncertainty	± 12 kHz			

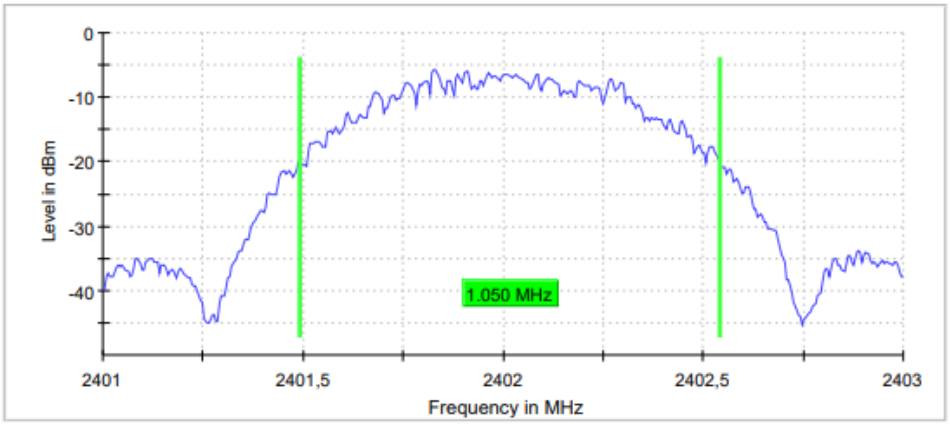
Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Bluetooth Low energy	1	2402	2 Mbps	2020
	18	2440	2 Mbps	2020
	39	2480	2 Mbps	2040
Uncertainty	± 12 kHz			

Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
ANT+	1	2457	2 Mbps	910
Uncertainty	± 12 kHz			

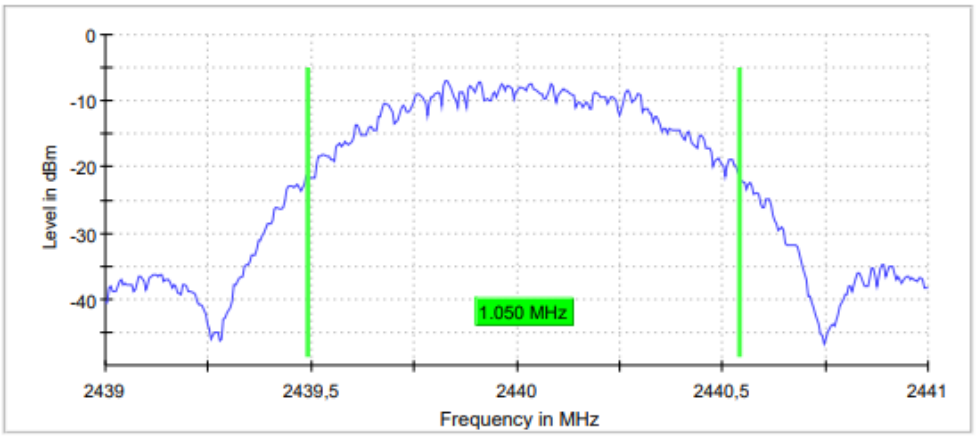
3.3.6 Plots of the 99% occupied bandwidth measurement

BLE 1Mbps

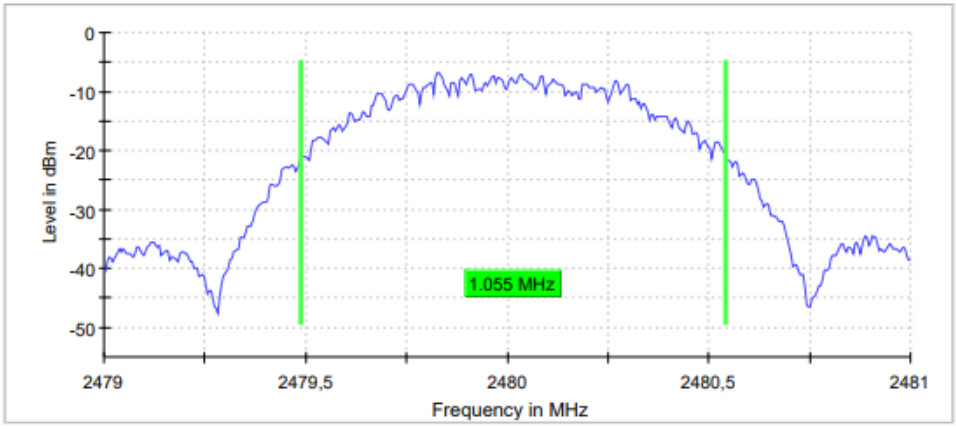
Channel 1



Channel 18

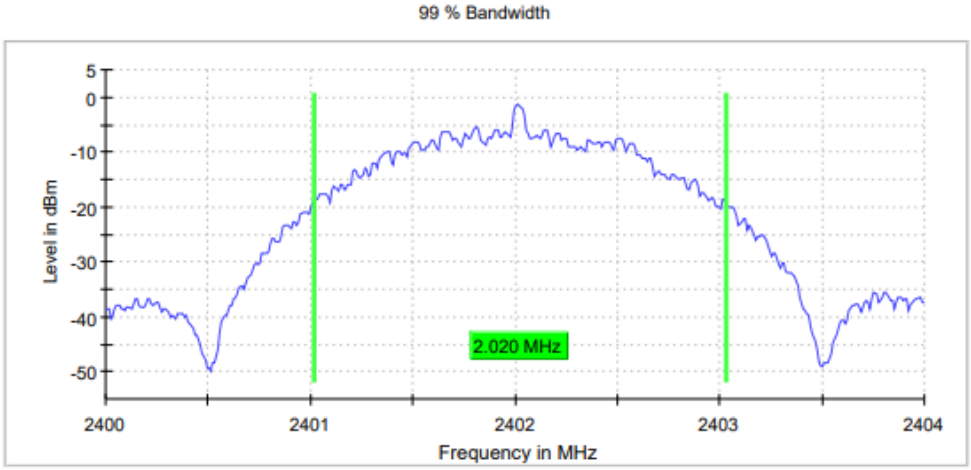


Channel 39

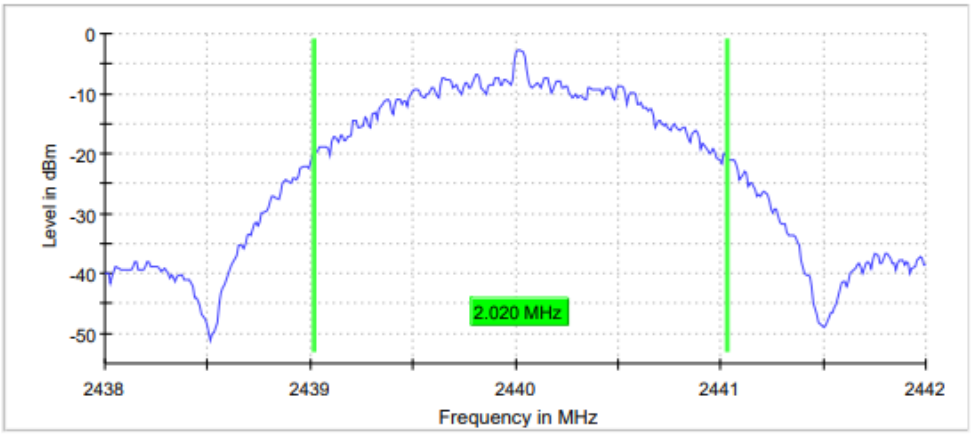


BLE 2Mbps

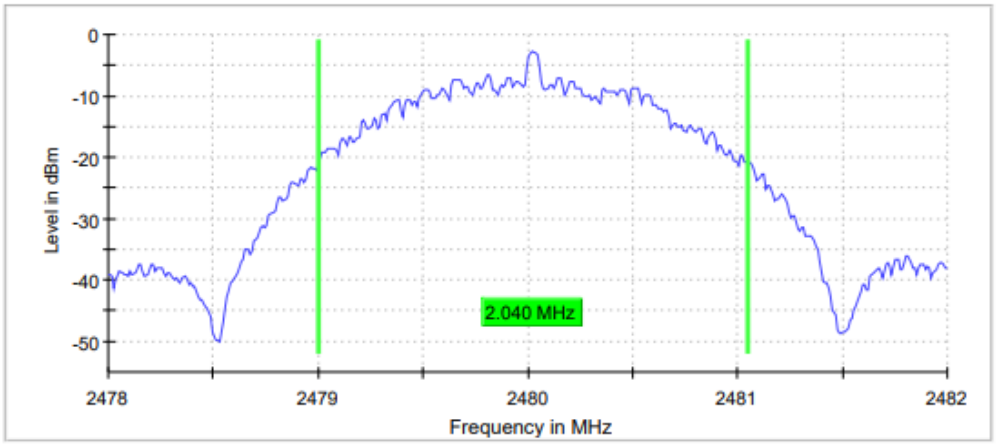
Channel 1



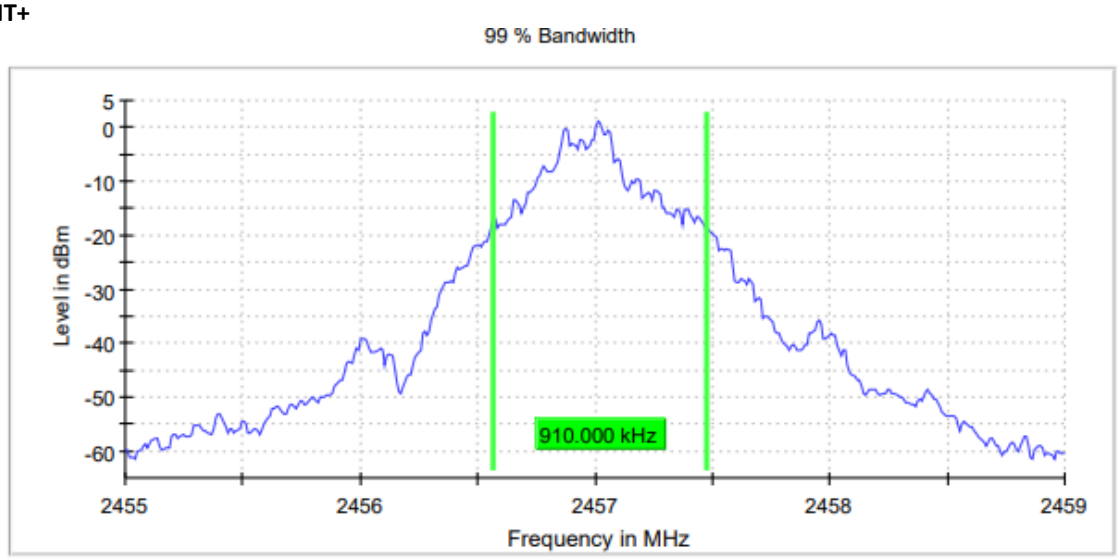
Channel 18



Channel 39



ANT+


99 % Bandwidth
5
0
-10
-20
-30
-40
-50
-60
Level in dBm
910.000 kHz
2455
2456
2457
2458
2459
Frequency in MHz

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	1	2402	1 Mbps	4.65	0.00292	0.00922
	18	2440	1 Mbps	3.44	0.00221	0.00698
	39	2480	1 Mbps	3.57	0.00228	0.00719
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	1	2402	2 Mbps	4.64	0.00291	0.00920
	18	2440	2 Mbps	3.43	0.00220	0.00696
	39	2480	2 Mbps	3.54	0.00226	0.00714
Uncertainty				±0.71 dB		

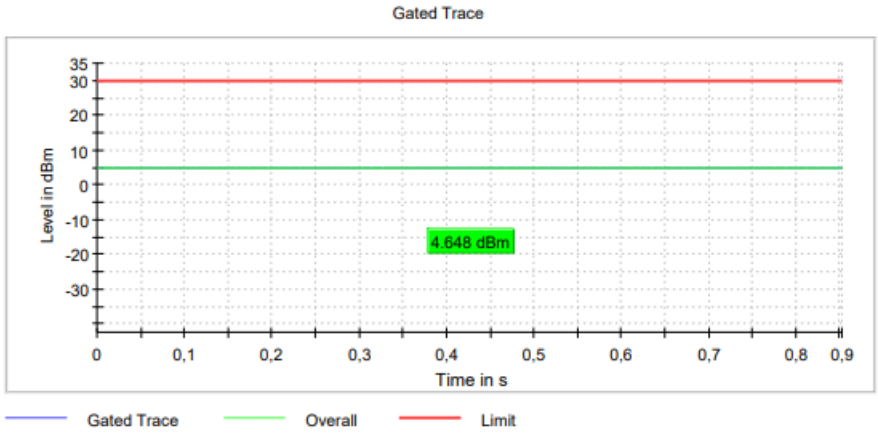
Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power conducted (dBm)	Peak output power conducted (W)	Peak output power EIRP (W)
ANT+	1	2457	1 Mbps	5.0	0.00316	0.01000
Uncertainty				±0.71 dB		

Note: plots are provided on the next page

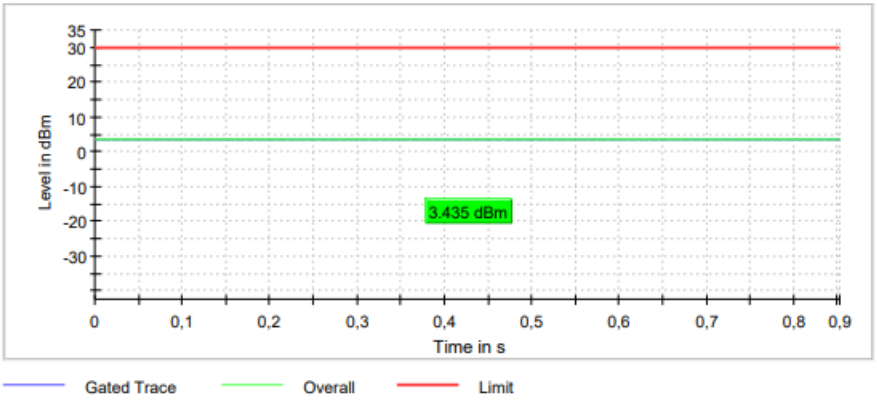
3.4.6 Plots of the Output power

BLE 1 Mbps

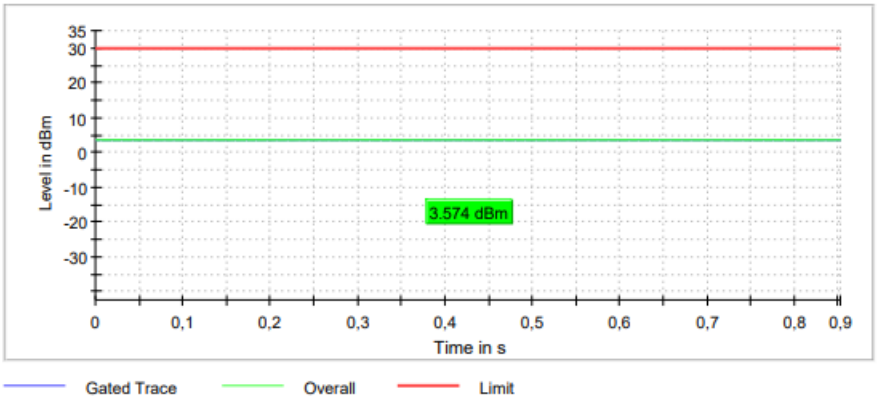
Channel 1



Channel 18

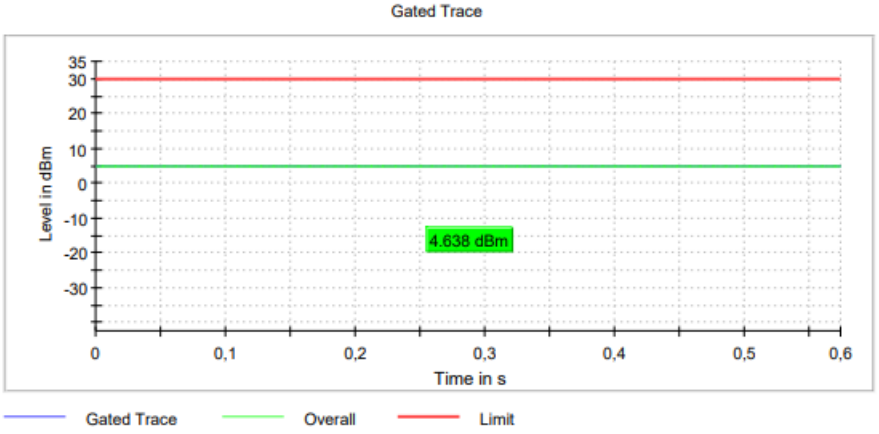


Channel 39

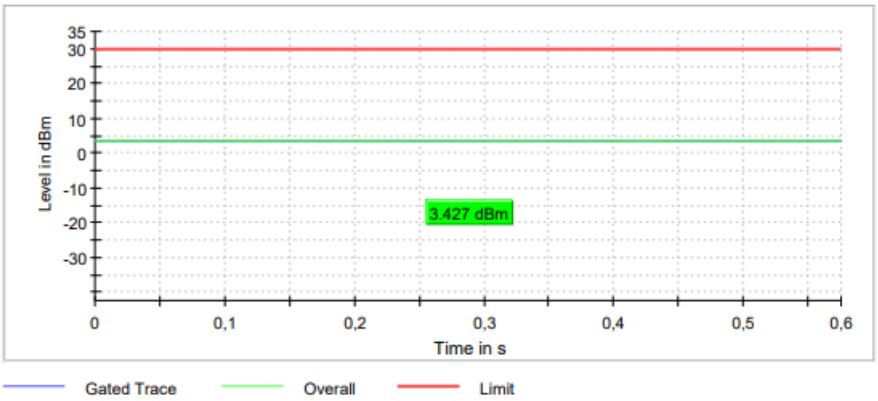


BLE 2 Mbps

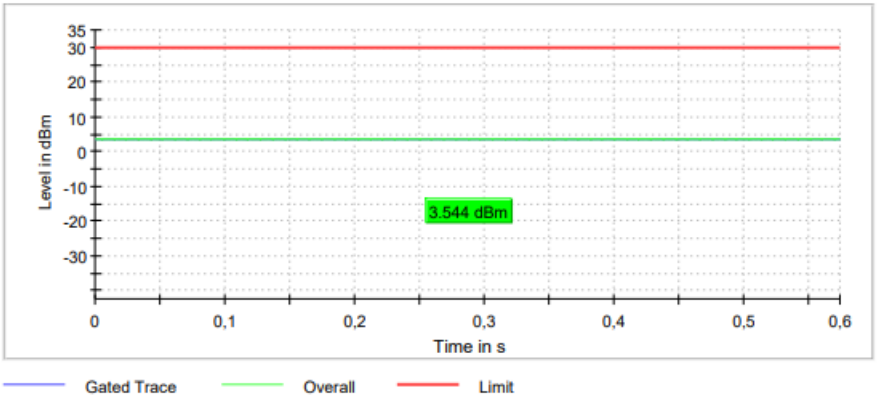
Channel 1



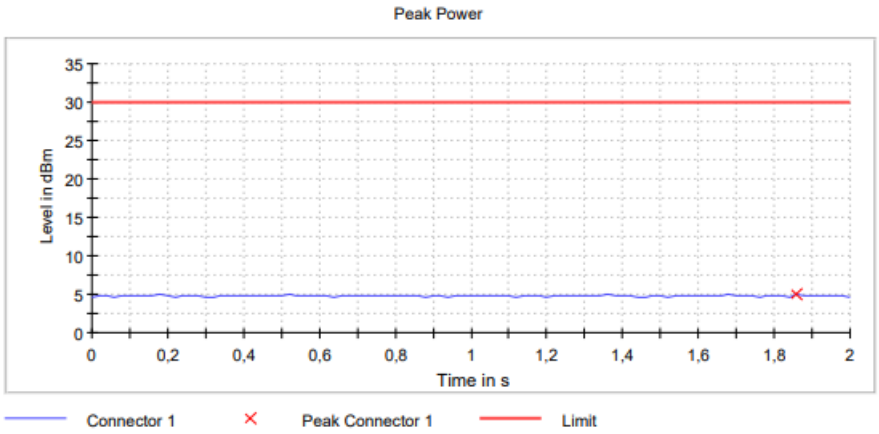
Channel 18



Channel 39



ANT+


Peak Power
Level in dBm
35
30
25
20
15
10
5
0
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
2
Time in s
Connector 1
Peak Connector 1
Limit

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	1	2402	1 Mbps	-5.670	8
	18	2440	1 Mbps	-6.960	8
	39	2480	1 Mbps	-6.865	8
Uncertainty	±2 dB				

Technology Std.	Channel	Frequency (MHz)	Data rate	PSD conducted (dBm/3 kHz)	Limit (conducted) (dBm/3kHz)
Bluetooth Low Energy	1	2402	2 Mbps	-6.543	8
	18	2440	2 Mbps	-8.198	8
	39	2480	2 Mbps	-8.400	8
Uncertainty	±2 dB				

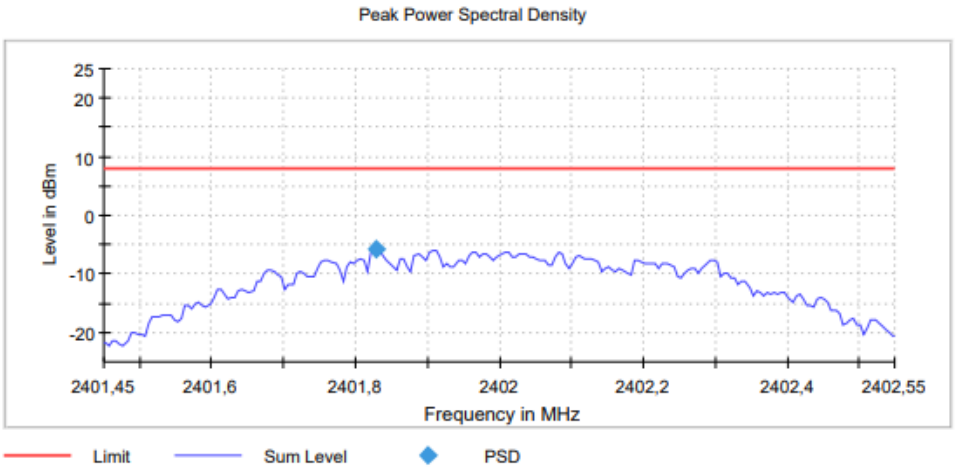
Technology Std.	Channel	Frequency (MHz)	Data rate	PSD conducted (dBm/3 kHz)	Limit (conducted) (dBm/3kHz)
ANT+	1	2457	1 Mbps	-3.094	8
Uncertainty	±2 dB				

Note: plots are provided on the next page

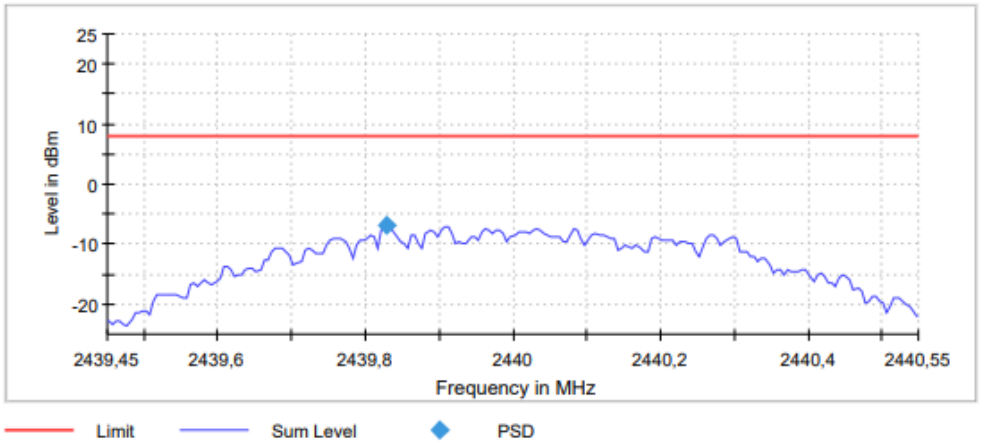
3.5.6 Plots of the Power Spectral Density

BLE 1Mbps

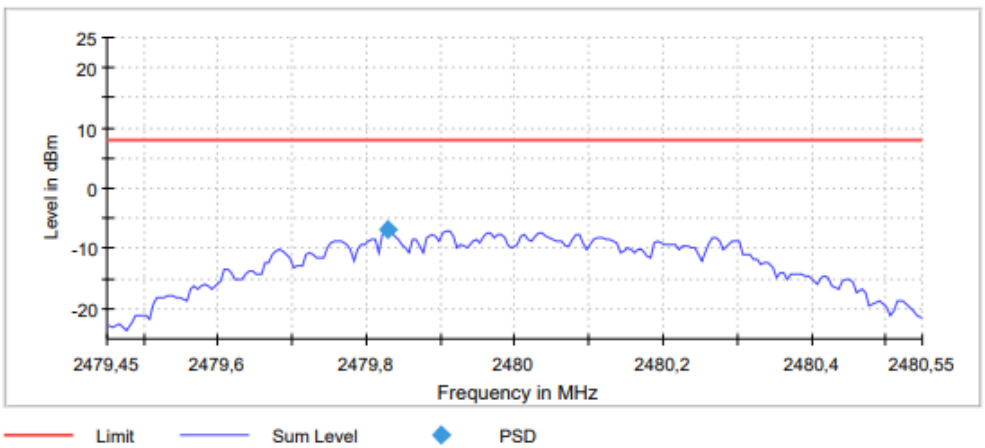
Channel 1



Channel 18

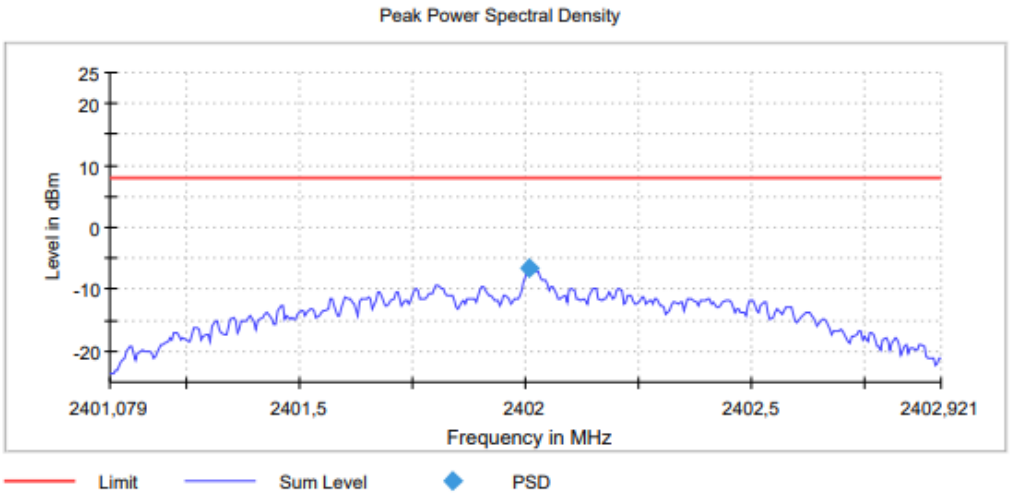


Channel 39

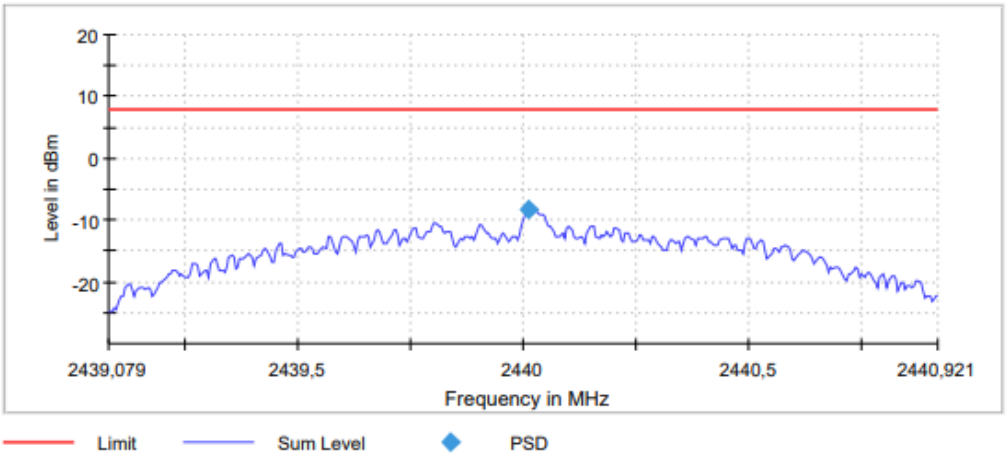


BLE 2Mbps

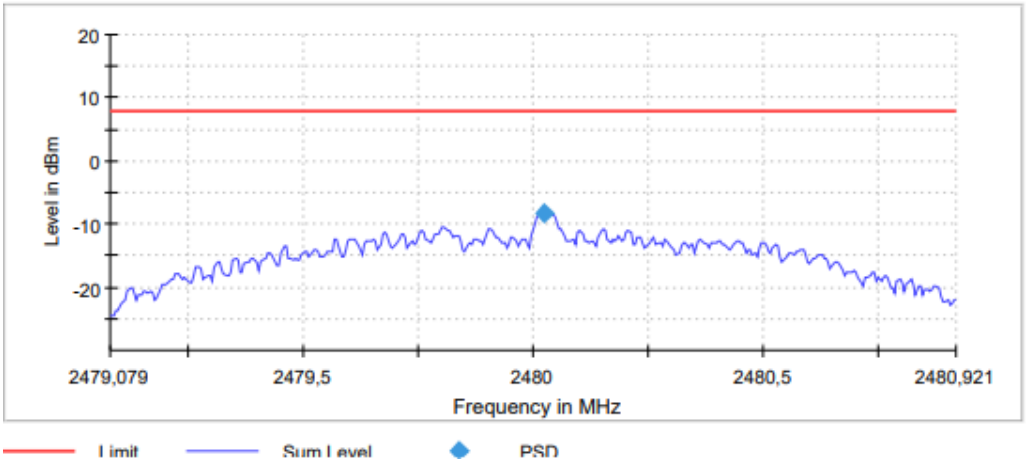
Channel 1



Channel 18

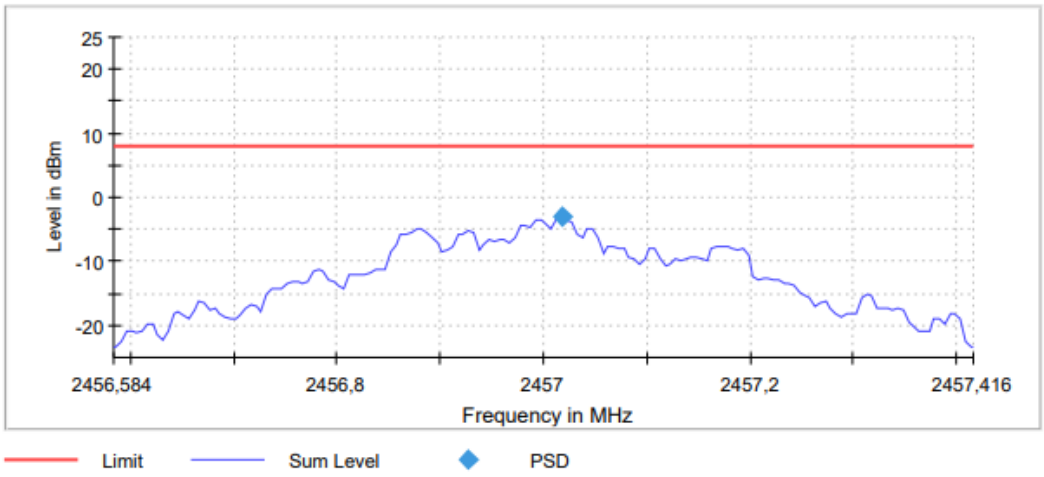


Channel 39



ANT+

Peak Power Spectral Density



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.

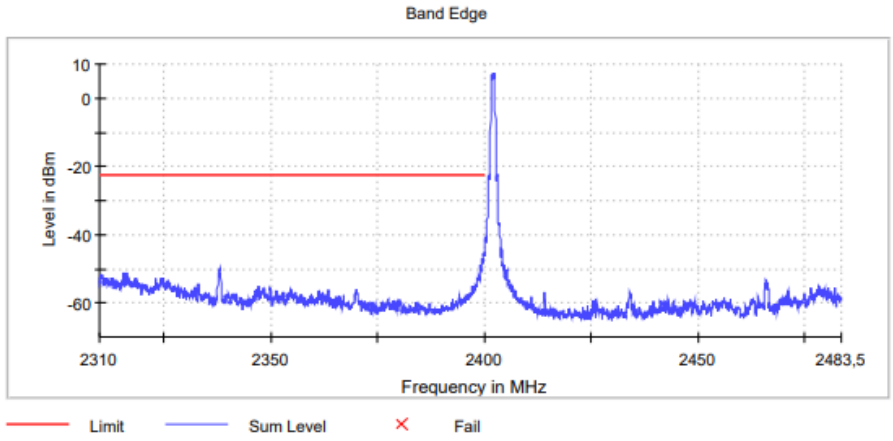
3.6.5 Measurement Uncertainty

± 5.7 dB.(radiated)

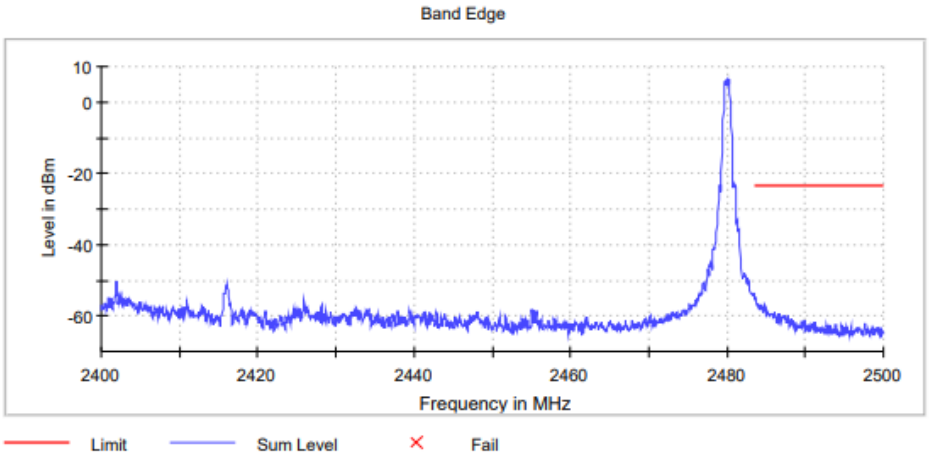
3.6.6 Plots of the Band edge Measurements

BLE 1Mbps

BLE Lower band edge (Channel 1)

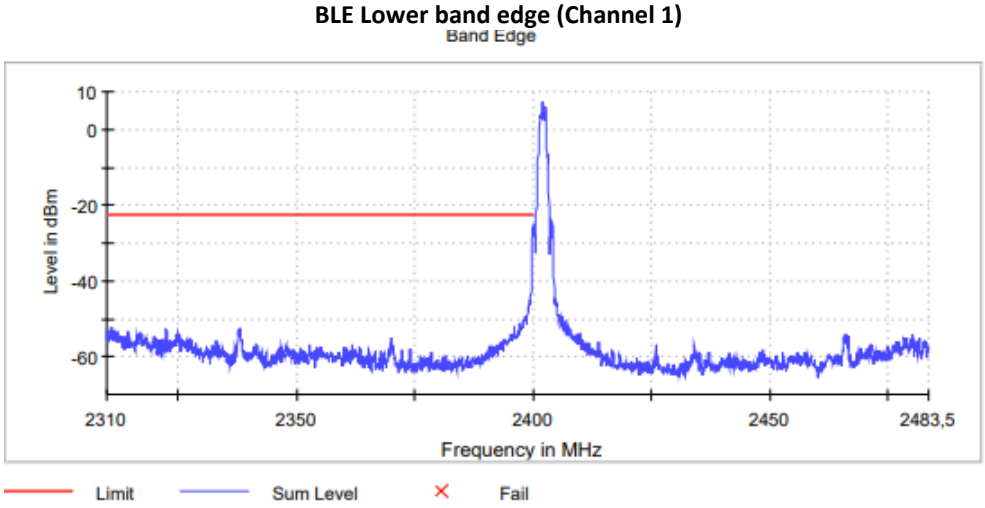


BLE Upper band edge (Channel 39)

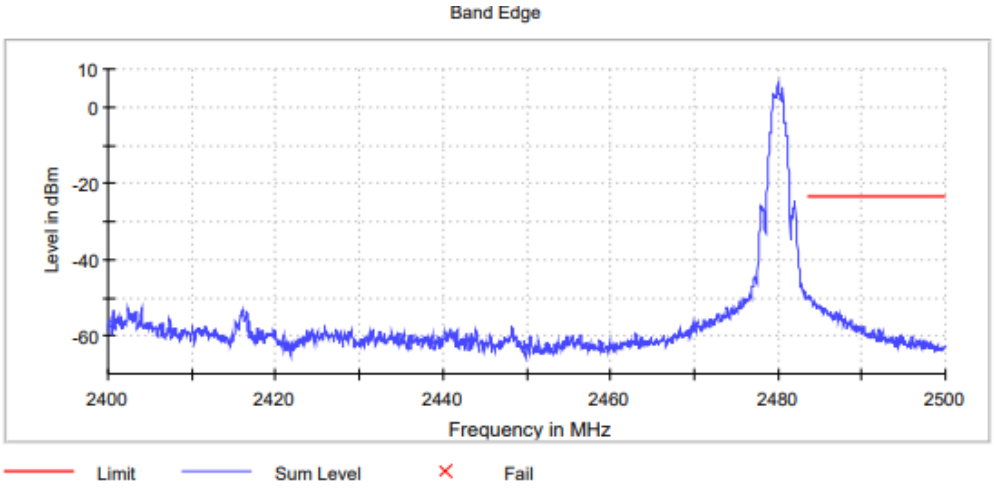


BLE 2Mbps

BLE Lower band edge (Channel 1)

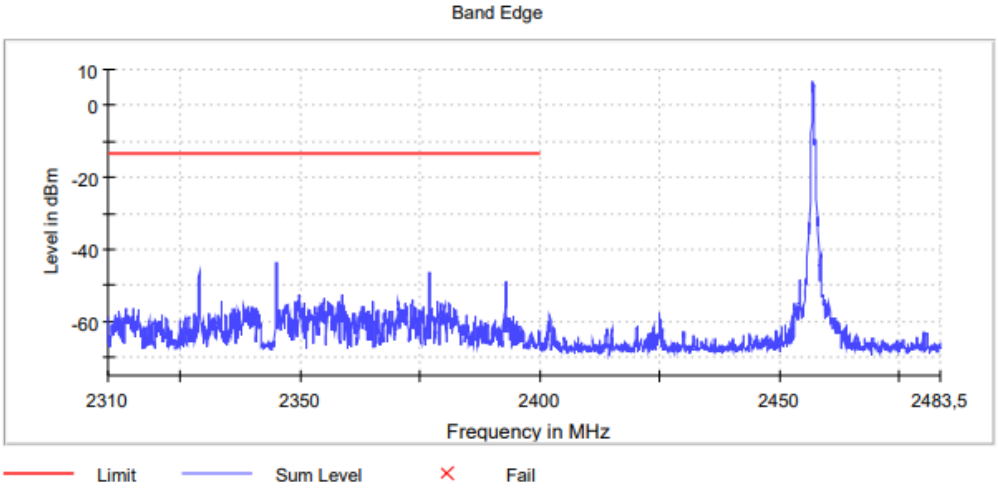


BLE Upper band edge (Channel 39)

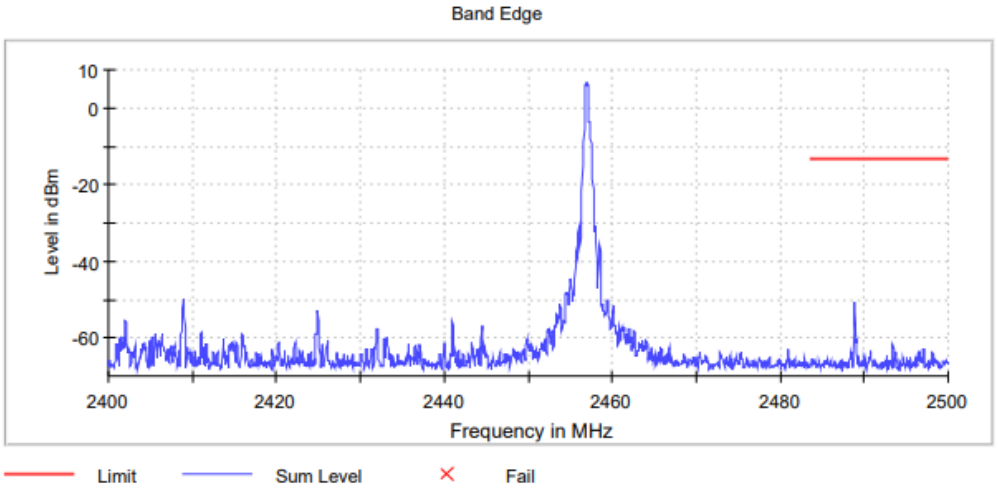


ANT+

Lower band edge



Upper band edge



3.7 AC Power-line conducted emissions

3.7.1 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.

3.7.2 Measurement instruments

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

3.7.3 Test setup

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

3.7.4 Test procedure

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

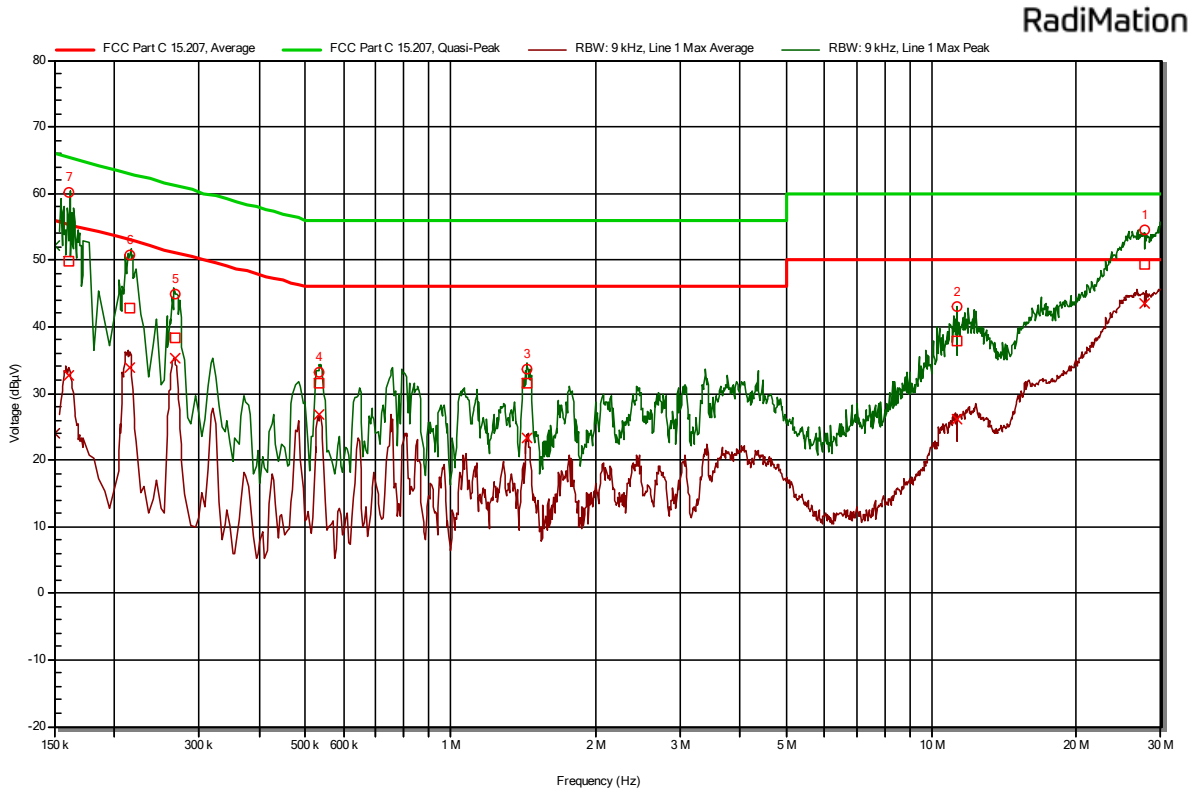
3.7.5 Measurement uncertainty

+/- 3.6 dB

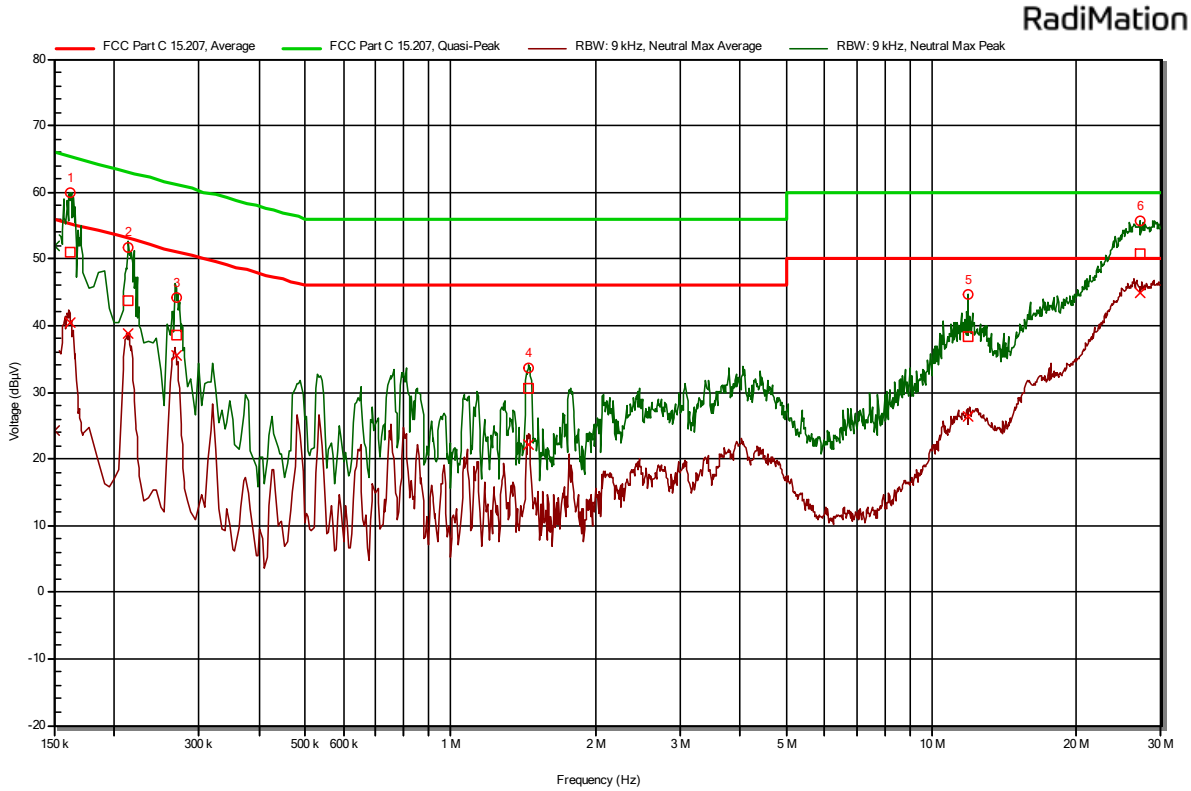
3.7.6 AC Power Line Conducted emission data of the EUT, results

Frequency	Peak	Peak Limit	Average	Average Limit	Quasi-Peak	Quasi-Peak Limit	LISN
267.9 kHz	44.9 dBµV	61.2 dBµV	35.2 dBµV	51.2 dBµV	38.4 dBµV	61.2 dBµV	Line 1
216.15 kHz	50.8 dBµV	63 dBµV	33.8 dBµV	53 dBµV	42.9 dBµV	63 dBµV	Line 1
161.25 kHz	60.3 dBµV	65.4 dBµV	32.8 dBµV	55.4 dBµV	49.8 dBµV	65.4 dBµV	Line 1
162.6 kHz	59.8 dBµV	65.3 dBµV	40.3 dBµV	55.3 dBµV	51.1 dBµV	65.3 dBµV	Neutral
214.35 kHz	51.8 dBµV	63 dBµV	38.9 dBµV	53 dBµV	43.7 dBµV	63 dBµV	Neutral
269.25 kHz	44.3 dBµV	61.1 dBµV	35.6 dBµV	51.1 dBµV	38.5 dBµV	61.1 dBµV	Neutral

3.7.7 Plots of the AC mains conducted spurious measurement



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



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) + CL(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.

E (dBµV/m) = U(dBµV) + Corr(dB)

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

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