

FCC report for parts 15.247, 22.917, 24.238 and 27.53

(Transmitter spurious emissions only)



The RvA is signatory to ILAC - MRA



Product name : Treon Gateway 2

Applicant : Treon

FCC ID : 2AR86GW12

Test report No. : P000319246 007 Ver 2.00

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	15-02-2024	First draft	PS
v1.00	11-03-2024	Final release	PS
V2.00	16-04-2024	Updated versions of some RSS standards in section 1.7 of this report	PS

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Summary of Test results

FCC	ISED	Description	Section in report	Verdict
22.359 24.238 27.53	RSS-132 RSS-133 RSS – 139	Radiated spurious emissions	3.1	Pass
15.247(d)	RSS-Gen § 8.9	Radiated spurious emissions	3.1.9	Pass
15.207(c)	RSS-Gen § 8.8	AC conducted emissions	3.2	Pass

1 General Description

1.1 Applicant

Client name:	Treon Oy
Address:	Visiokatu 3
Zip code:	33720, Tampere FINLAND
Telephone:	+358505507331
E-mail:	certification@treon.fi
Contact name:	Janne Julkunen

1.2 Manufacturer

Manufacturer name:	Treon Oy
Address:	Visiokatu 3
Zip code:	33720, Tampere FINLAND
Telephone:	+358505507331
E-mail:	certification@treon.fi
Contact name:	Janne Julkunen

1.3 Tested Equipment Under Test (EUT)

Product name:	Treon Gateway 2
Brand name:	Treon
Model or type:	Model 1211,variant WP
FCC ID:	2AR86GW12
Product description:	Wireless IoT Gateway
Variant model(s):	Model 1211, Variant BT
Batch and/or serial No.	--
Software version:	V7
Hardware version:	B5.1
Date of receipt	26-06-2023
Tests started:	11-09-2023
Testing ended:	29-01-2024

1.4 Product specifications of Equipment under test

Wi-Fi	
Tx Frequency:	2.412GHz - 2.462 GHz
Rx frequency:	2.412GHz - 2.462 GHz
Antenna type:	Ceramic chip antenna
Antenna gain:	1.05dBi
Type of modulation:	DSSS
Emission designator:	10M0G7D

BLE	
Tx Frequency:	2.402GHz - 2.480 GHz
Rx frequency:	2.402GHz - 2.480 GHz
Antenna type:	Inverted-F antenna on PCB
Antenna gain:	1.59dBi
Type of modulation:	GFSK
Emission designator	1M00G1D

LTE-M	
Bands 2, 4, 5, 12, 13	1850 - 1910 MHz; 1710 – 1755 MHz; 824 – 849 MHz; 699 – 716 MHz; 777 – 787 MHz
Antenna type:	Monopole antenna
Antenna gain:	2dBi
Type of modulation:	QPSK, QAM
Emission designator	20M0W7D

1.5 Environmental conditions

Test date	03-08-2023	08-10-2023	16-11-2023	22-01-2024	24-01-2024
Ambient temperature	21.2°C	18.8°C	20.9°C	21.5°C	20.9°C
Humidity	73%	33.1%	38.8%	17.9%	19.3%

1.6 Measurement standards

- ANSI C63.26:2015

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 §15.247
- FCC Part 22 Subpart C §22.359
- FCC Part 24 Subpart C §24.238
- FCC Part 27 Subpart C §27.53
- RSS-132 Issue 4
- RSS-133 Issue 6, A1
- RSS-139 Issue 4
- RSS-Gen Issue5

1.8 Observation and remarks

The EUT contains a pre-certified cellular module, so only radiated spurious emissions are tested.
Tests are performed on a representative selection of operating frequency bands.

1.9 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. Telefication 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 conducted tests are performed by:

Name : ing P.A Suringa

Review of test methods and report by:

Name : ing R. van Barneveld

The above conclusions have been verified by the following signatory:

Date : 22-05-2024

Name : ing. R. van Barneveld

Function : Test Engineer

Signature :

A handwritten signature in blue ink, consisting of a stylized 'R' followed by several horizontal strokes.

2 Test configuration of the Equipment Under Test

2.1 Test mode

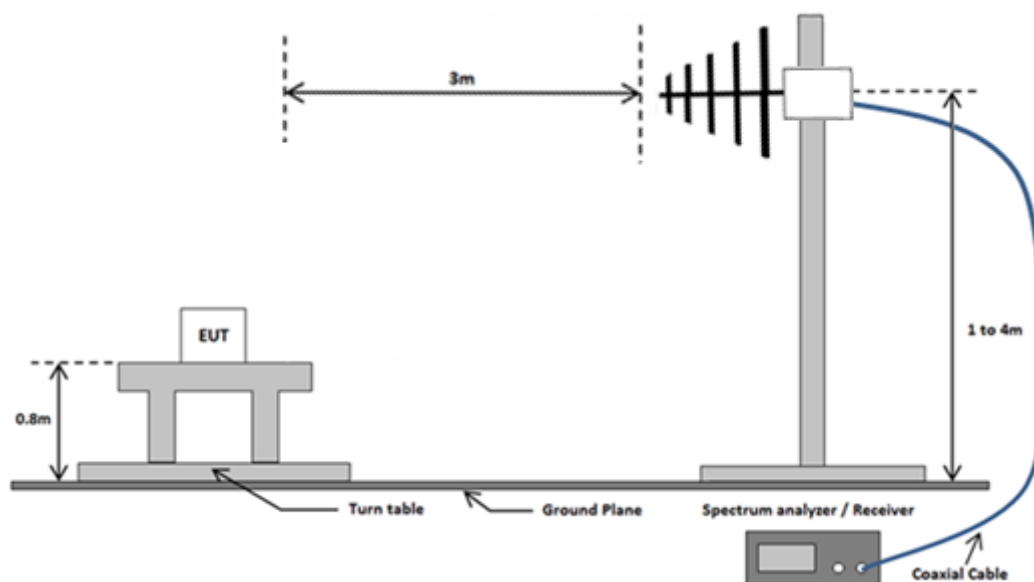
The equipment is configured to connect to a radio communication tester which keeps the transmitter continuously active and transmitting during testing.

Tested channels/bands

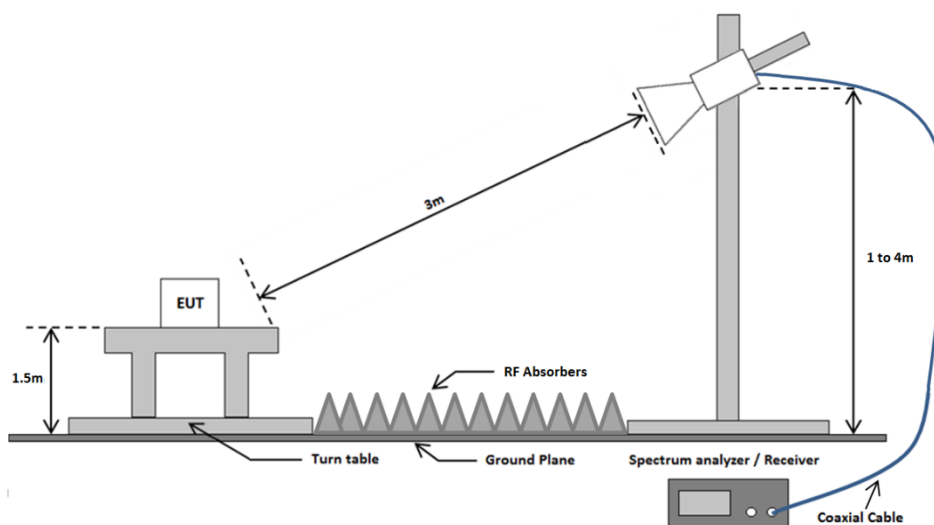
Technology	Band	Channels (MHz)	Frequency range (MHz)
LTE-M	2	1855 1863 1871	1850 – 1910
	4	1712 1734 1753	1710 -1785
	5	829 836.5 844	824 – 849
	12	701 707.5 714	699 - 716
	13	782	777-787

2.2 Test setups

Radiated emissions test setup 30 MHz - 1 GHz

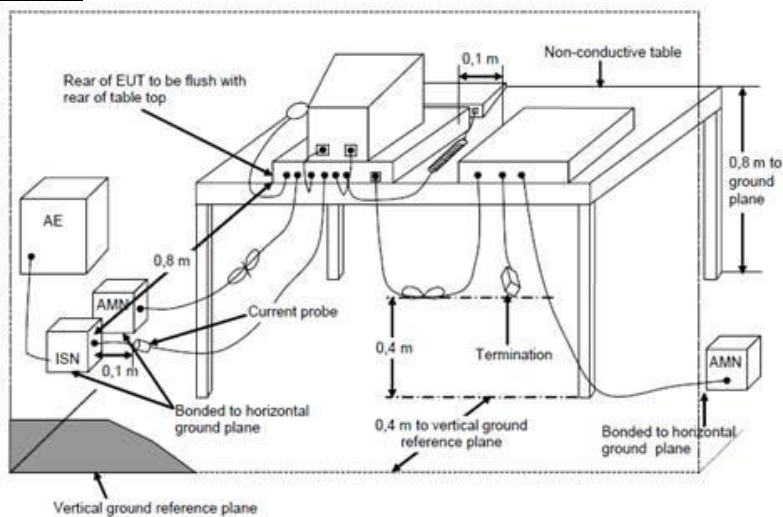


Radiated emissions test setup above 1 GHz



Conducted emissions test setup

Emissions test at AC mains



2.3 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Cal done date	Cal due date	Used at Par.
Spectrum analyzer	Rohde & Schwarz	FSV	114923	10-2023	10-2025	3.1
EMI Receiver	Rohde & Schwarz	ESCI	114161	01-2023	01-2024	3.2
Measurement receiver	Rohde & Schwarz	ESR7	114870	09-2022	09-2024	3.1
Biconical antenna (+ 6 dB atten.)	Schwarzbeck	BBA 9106 + VHA 9103	114436	03-2021	03-2024	3.1
Horn antenna	EMCO	3115	114607	01-2021	01-2024	3.1
Preamplifier	µComp	MCNA-40-001080	114771	05-2022	05-2024	3.1
Semi-Anechoic room	ETS Lindgren	SAR	114624	03-2023	03-2026	3.1
Preamplifier	MITEQ	JS4-18004000-33-8P	TE 11131	01-2023	01-2024	3.1
Horn antenna	Flann Microwave	20240-25	114518	NA*	NA*	3.1
Log periodic antenna	EMCO	3147	114436	03-2021	03-2024	3.1
Radio communication tester	Rohde & Schwarz	CMW-290	114428	NA	NA	3.1
Test software	DARE	Radimation Version 2023.2.3	--	--	--	3.1
LTE band 5 reject filter	Wainwright	WRCG 824/894 – 809/914	--	--	--	3.1
LTE band 2 reject filter	Wainwright	WRCG 1845/1880 - 1830/1895	--	--	--	3.1
LTE band 4 reject filter	Wainwright	WRCG 1710/1755-1535/1928	--	--	--	3.1
2.4 GHz high pass filter	Wainwright	WHK3.0/18G-10EF	114682	09-2021	09-2024	3.1.9
LISN /Two line V-network	Rohde & Schwarz	ENV 216	114379	11-2023	11-2024	3.2

*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

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10\log(P)$ dB

$P = 23 \text{ dBm} = 0.2 \text{ W}$

$$\text{limit} = 23 \text{ dBm} - [43 + 10 * \log_{10}(0.2)] \text{ dB} = -13 \text{ dBm}$$

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

30 MHz to 26.5 GHz: According to ANSI C63.26-2015 section 5.5.2

30 MHz to 1 GHz: IRN 026 – Method 1

1 GHz to 18 GHz: IRN 026 – Method 2

18 to 26.5 GHz: IRN 026 – Method 3

3.1.5 Measurement Uncertainty

Frequency range	Polarization	Uncertainty
30 – 250 MHz	Hor. & Vert.	±6.3 dB
250 -1000 MHz	Hor. & Vert.	±4.5 dB
1 – 18 GHz	Hor. & Vert.	±5.4 dB
18 – 26.5 GHz	Hor. & Vert.	±4.1 dB

3.1.6 Results of the radiated spurious emissions measurement

1-18 GHz LTE Band 2 (plots 3q, 3r)

Frequency	Peak	Average Limit	Average	Height	Polarization
3.741 GHz	66.4 dB μ V/m	82.2 dB μ V/m	50.4 dB μ V/m	2 m	Horizontal

1-18 GHz LTE Band 4 (plots 4o, 4p)

Frequency	Peak	Average limit	Height	Polarization
3.505 GHz	74.6 dB μ V/m	82.2 dB μ V/m	1.5 m	Horizontal
1.752 GHz (Note)	98.3 dB μ V/m	NA	2 m	Horizontal

Note: represents fundamental carrier

1-18 GHz LTE Band 12 high ch (plots 5f, 5g)

Frequency	Peak (dB μ V/m)	Average limit (dB μ V/m)	Height	Polarization
2.858 GHz	60.5	82.2	3 m	Horizontal
2.143 GHz	74.7	82.2	1 m	Vertical
4.855 GHz	52.4	82.2	1 m	Vertical
3.572 GHz	59.8	82.2	2.5 m	Horizontal
1.429 GHz	64.3	82.2	3 m	Horizontal

0.25 – 1 GHz LTE Band 13 (plots 5h, 5i)

Frequency	Peak	Height	Polarization
778.281 MHz	101.3 dB μ V/m	2 m	Vertical
786.438 MHz	106.7 dB μ V/m	2 m	Vertical

Note: measured peaks in band 13 represent fundamental signal in 10 MHz bandwidth; no limit is applicable

1 -18 GHz LTE Band 2 + BLE (plots 5l, 5m)

Frequency	Peak (dBμV/m)	Peak Limit (dBμV/m)	Average (dBμV/m)	Average limit (dBμV/m)	Height	Polariza- tion
3.873 GHz	45.8	82.2	38.5	54	2.5 m	Vertical
3.742 GHz	49.1	82.2	49.7	54	2.5 m	Vertical
1.869 GHz	56	82.2	49.8	54	4 m	Horizontal
2.934 GHz	53.4	82.2	53.4	54	1.5 m	Vertical
(Note)						

Note: intermodulation (third order) product of the simultaneous transmission

30 – 250 MHz LTE Band 5 + BLE (plots 5n, 5o)

Frequency	Peak	Height	Quasi-Peak	Quasi Peak Limit (dBμV/m)	Polarization
42.94 MHz	39.3 dBμV/m	3.5 m	34.7 dBμV/m	40	Vertical
43.489 MHz	39.8 dBμV/m	3.5 m	35 dBμV/m	40	Vertical
33.478 MHz	40.2 dBμV/m	3 m	33.1 dBμV/m	40	Vertical
110.766 MHz	34.5 dBμV/m	1.7 m	26.7 dBμV/m	43.5	Horizontal
108.786 MHz	41 dBμV/m	1.8 m	34.6 dBμV/m	43.5	Horizontal
32.622 MHz	40.3 dBμV/m	3.3 m	34.4 dBμV/m	40	Vertical

0.25 – 1 GHz LTE Band 5 + BLE (plots 5p, 5q)

Frequency	Peak	Height	Quasi-Peak	Quasi Peak Limit	Polarization
625 MHz	36 dBμV/m	2 m	--	46 dBμV/m	Vertical
500.038 MHz	44.8 dBμV/m	1 m	43.3 dBμV/m	46 dBμV/m	Vertical
750.063 MHz	33.7 dBμV/m	1 m	--	46 dBμV/m	Horizontal
374.969 MHz	33.6 dBμV/m	1.5 m	--	46 dBμV/m	Vertical

1 – 18 GHz WLAN + BLE (plots 5x, 5y)

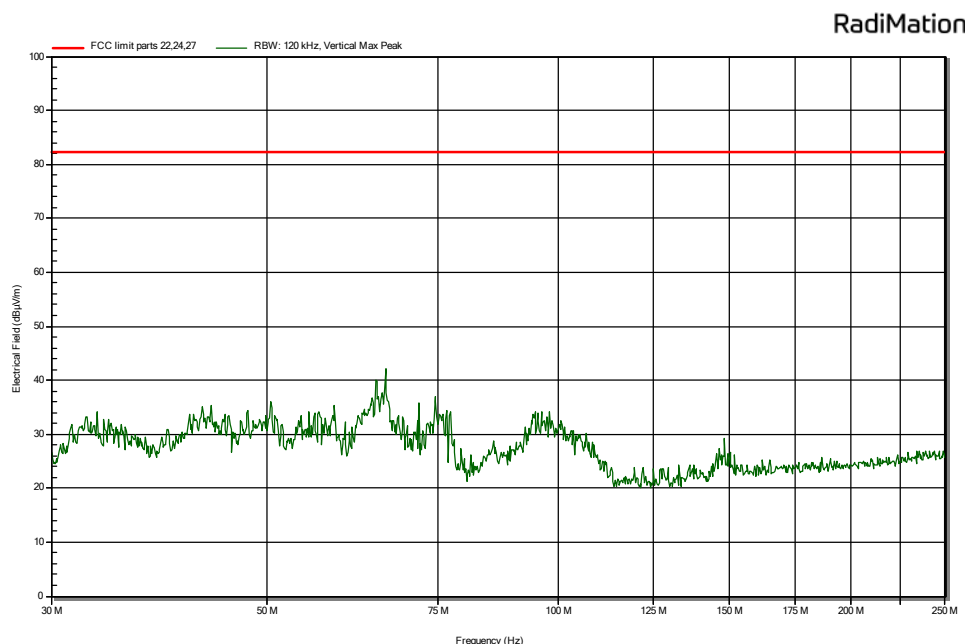
Frequency	Peak	Peak Limit	Average	Average limit	Height	Polarization
2.411 GHz	46.7 dB μ V/m	74 dB μ V/m	39 dB μ V/m	54 dB μ V/m	3.5 m	Vertical

Remark: emission peak represents the fundamental frequency and is therefore not subject to the limit

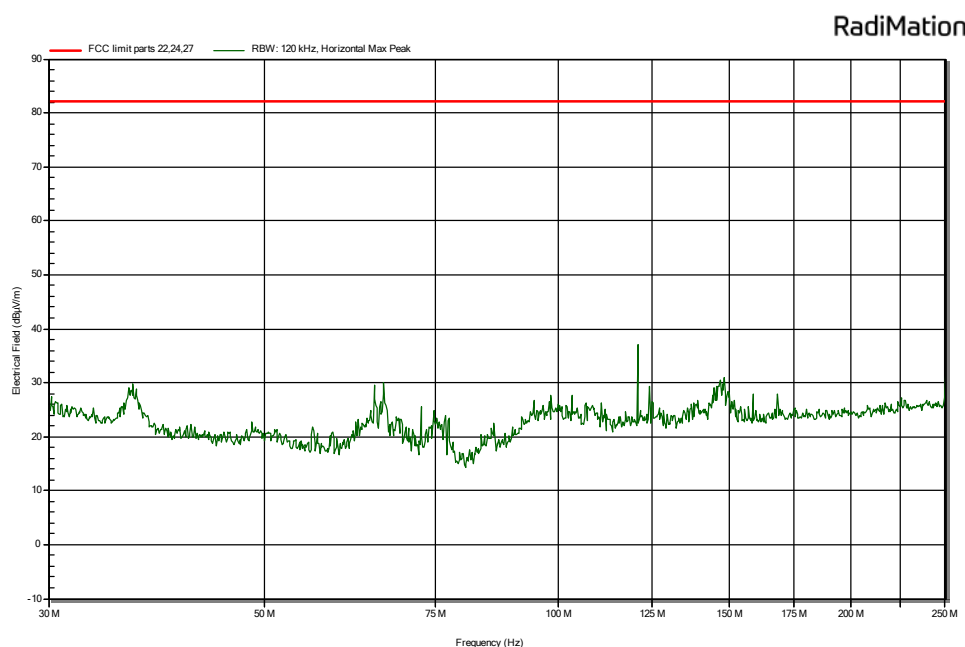
3.1.7 Plots of the Radiated Spurious Emissions Measurement

LTE-M

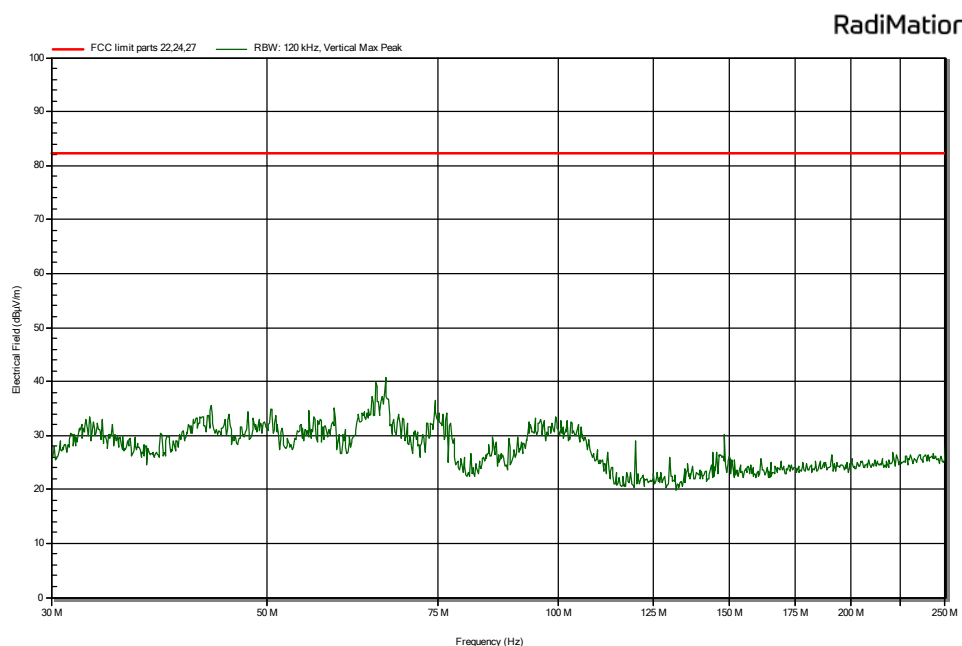
30 -250 MHz



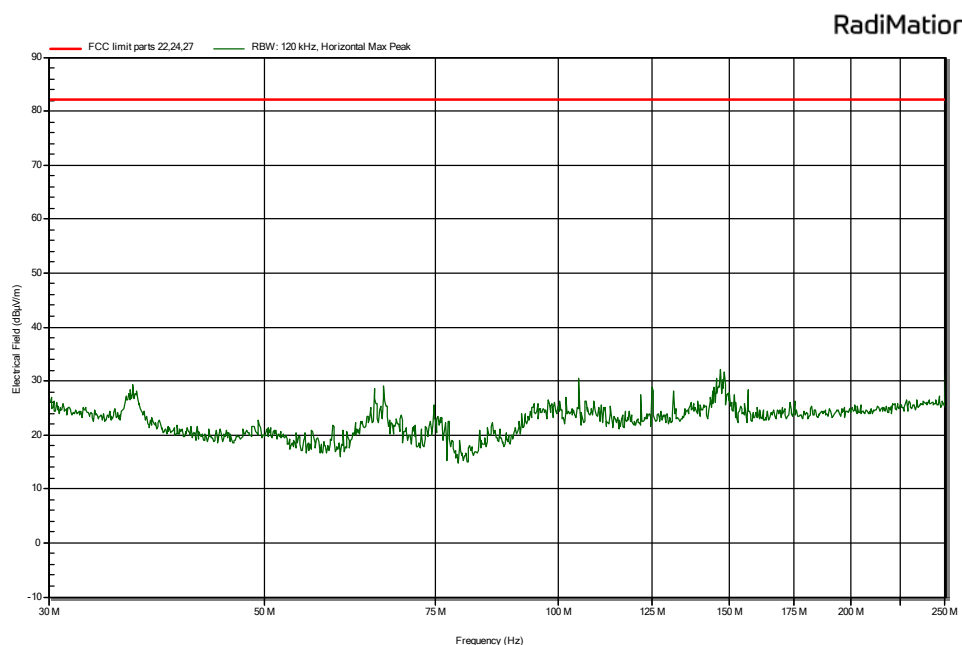
Plot 3m: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(peak values shown) Band 2 Low channel



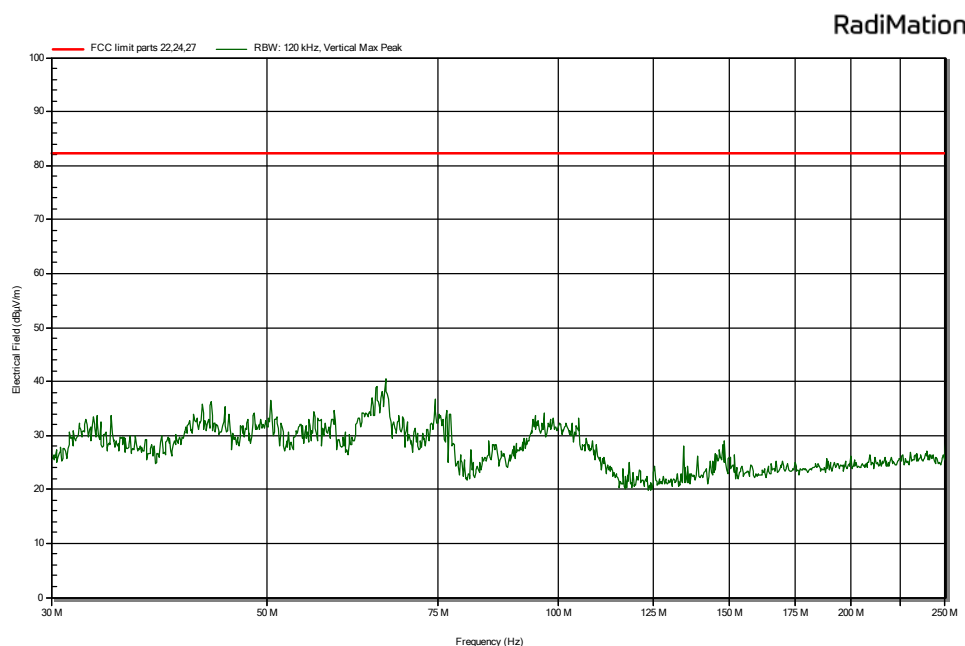
Plot 3n: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(peak values shown) Band 2 Low channel



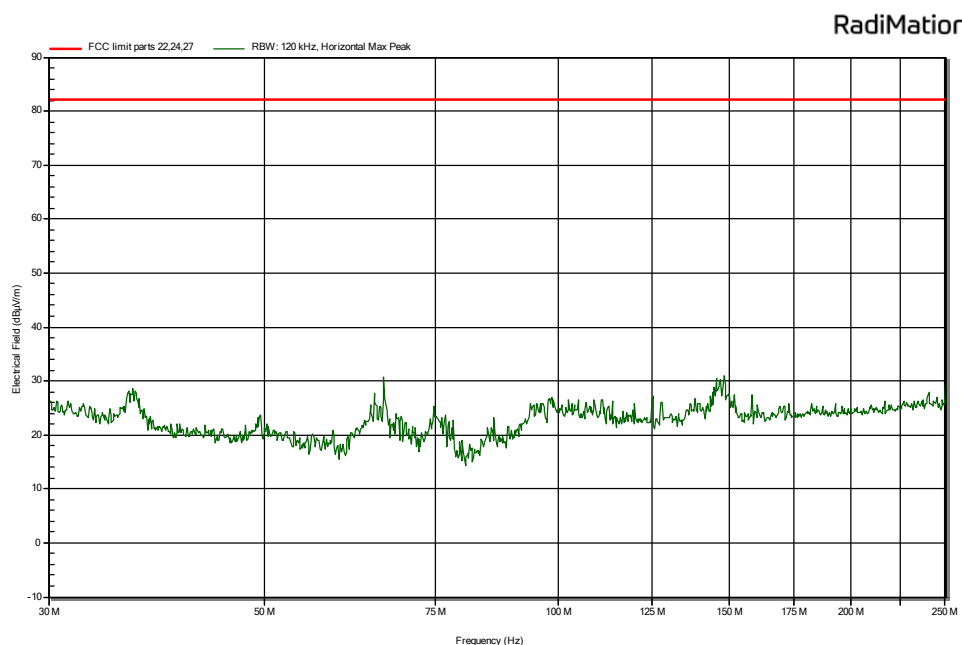
Plot 3m: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(peak values shown) Band 2 Mid channel



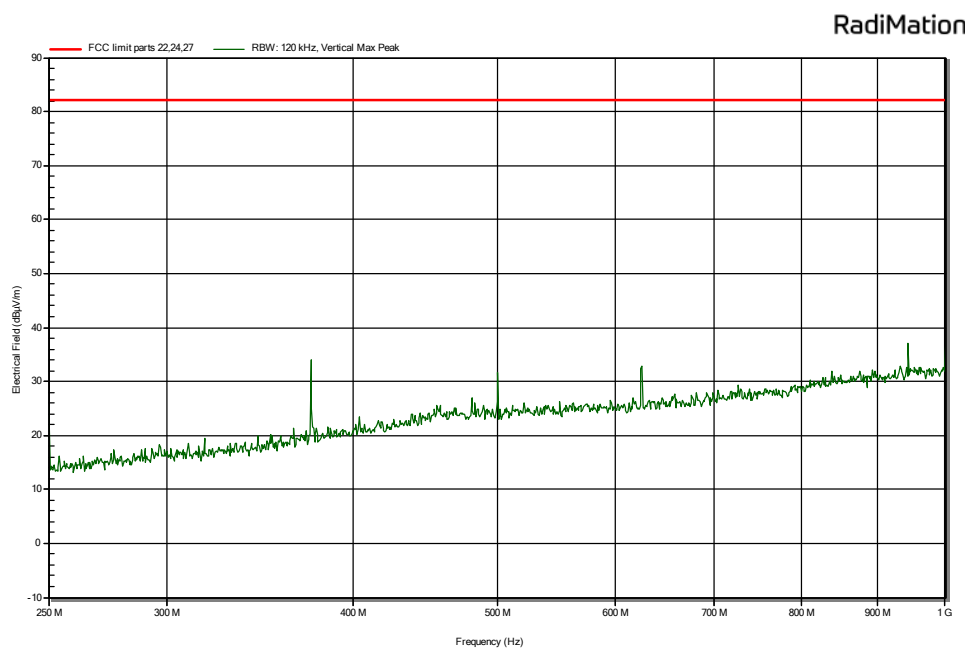
Plot 3n: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(peak values shown) Band 2 Mid channel



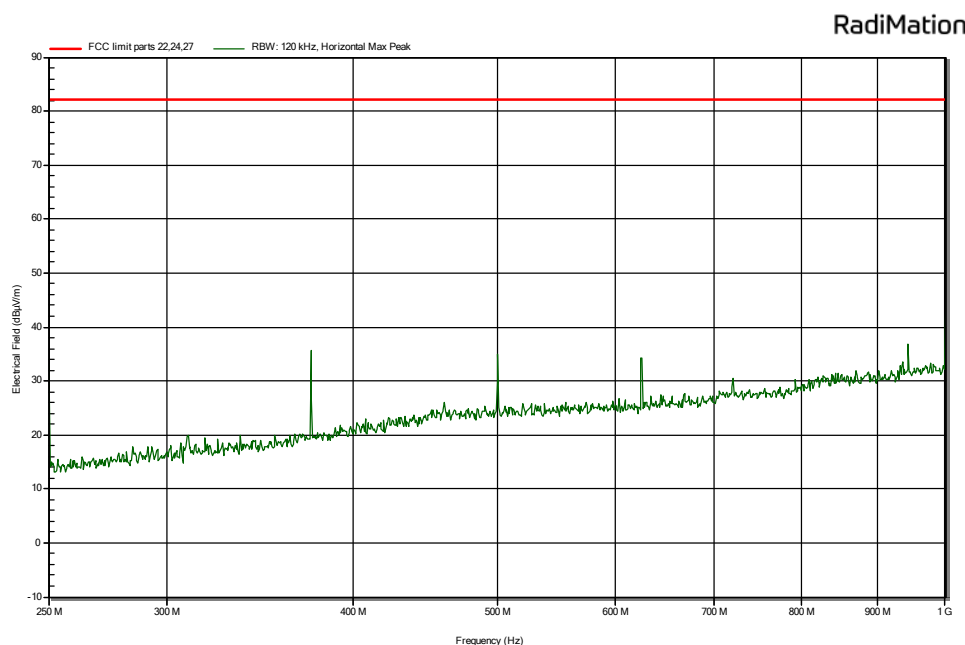
Plot 3m: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(peak values shown) Band 2 High channel



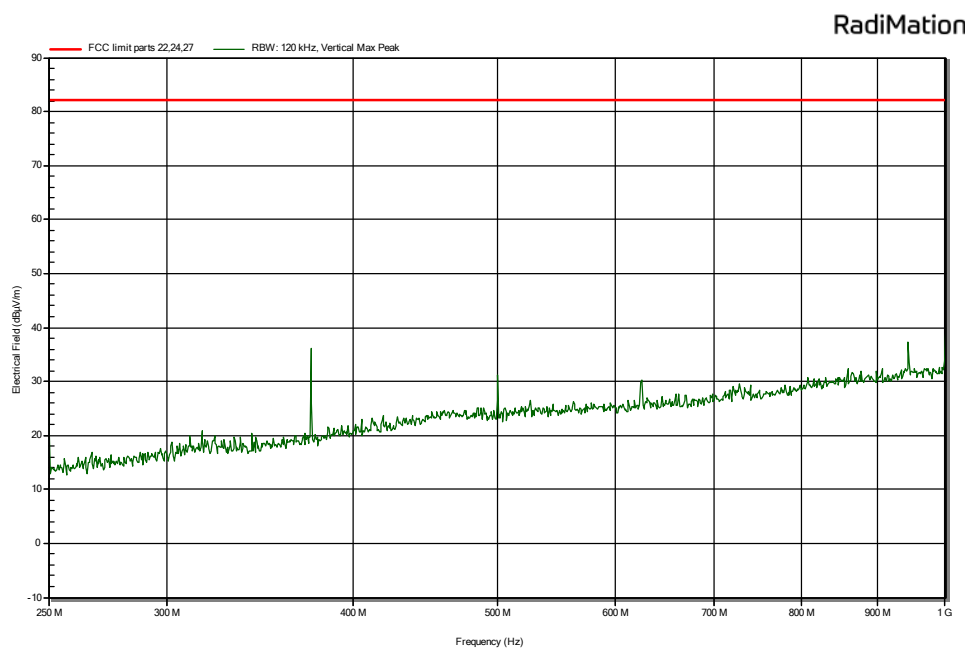
Plot 3n: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(peak values shown) Band 2 High channel



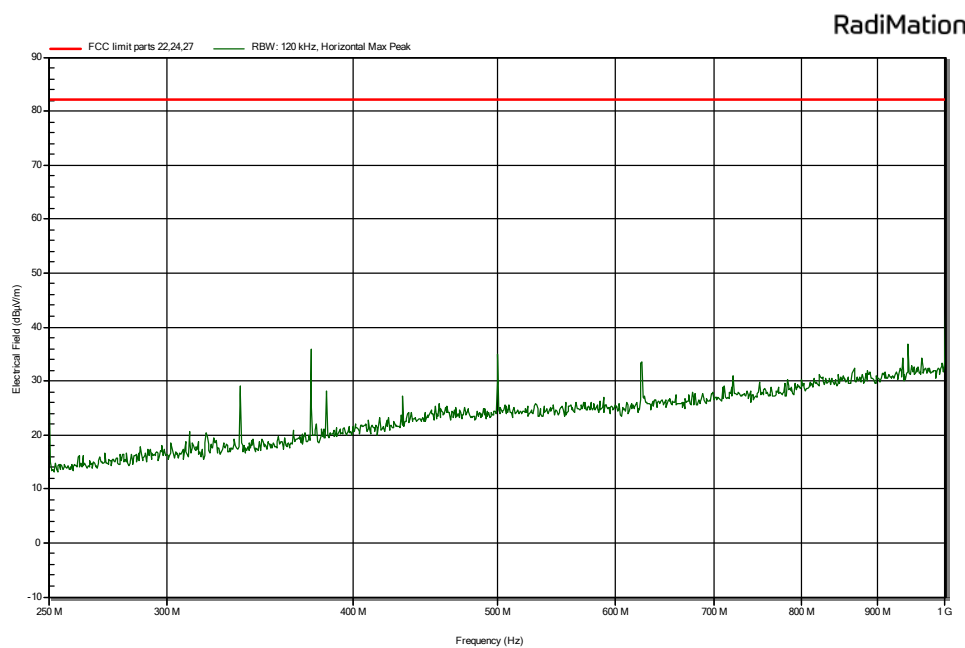
Plot 3m: radiated emissions of the EUT, Antenna vertical, in the range 0.25 - 1 GHz
(peak values shown) Band 2 Low channel



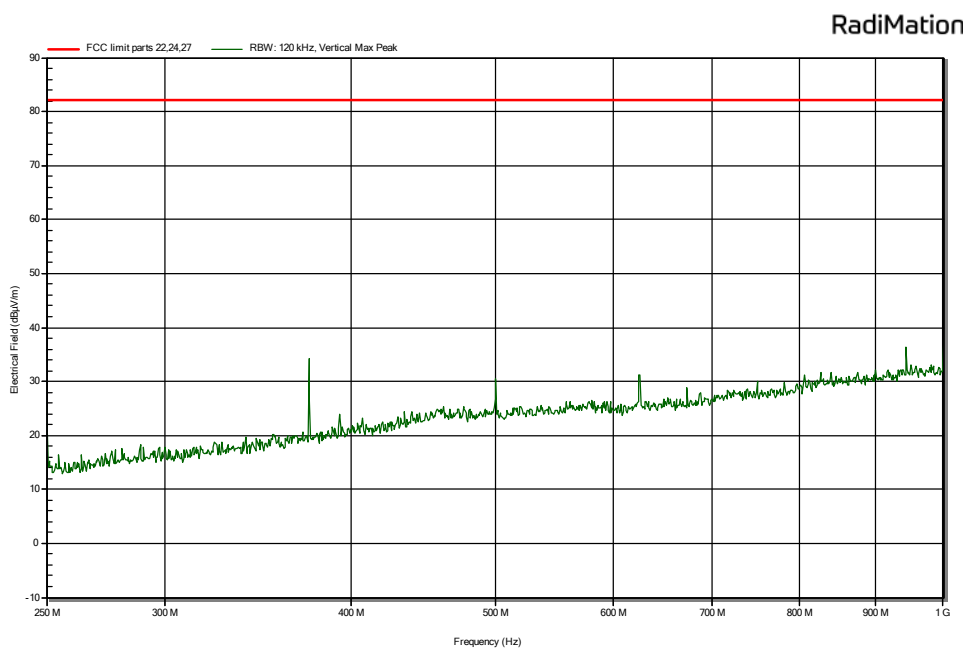
Plot 3n: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 - 1 GHz
(peak values shown) Band 2 Low channel



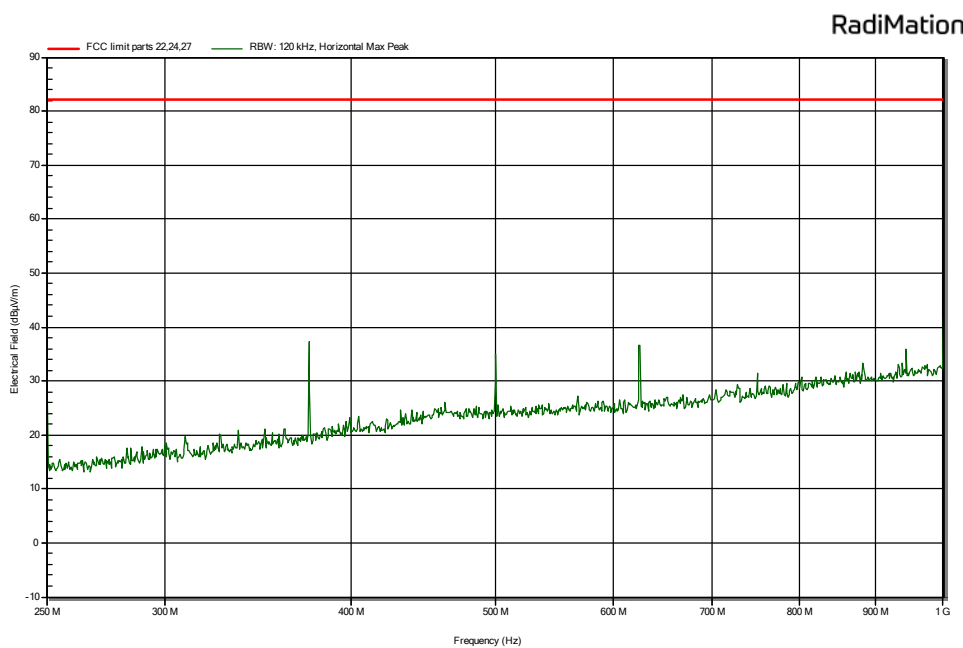
Plot 3m: radiated emissions of the EUT, Antenna vertical, in the range 0.25 - 1 GHz
(peak values shown) Band 2 Mid channel



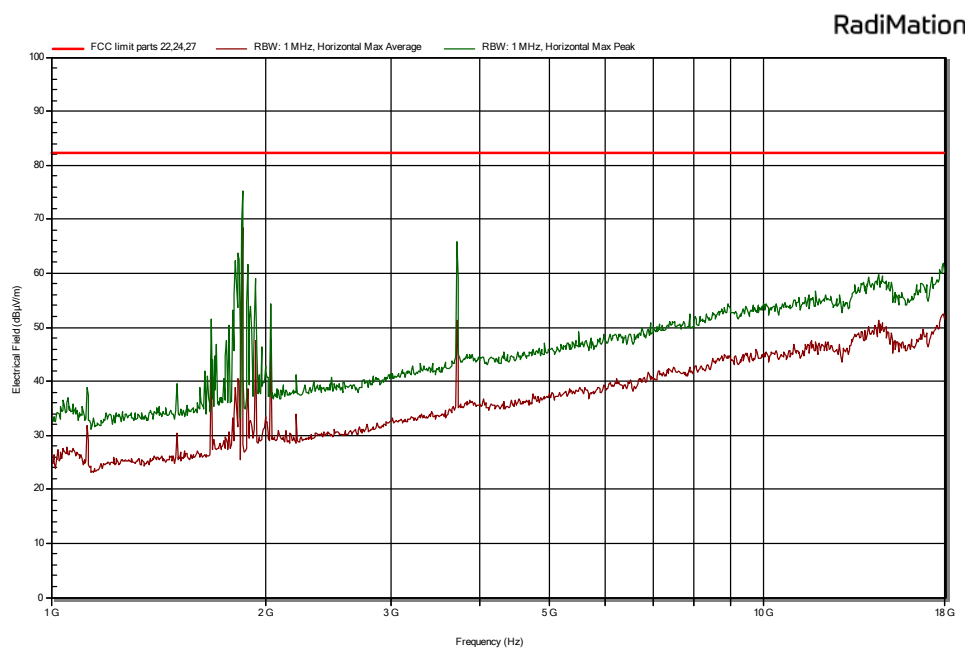
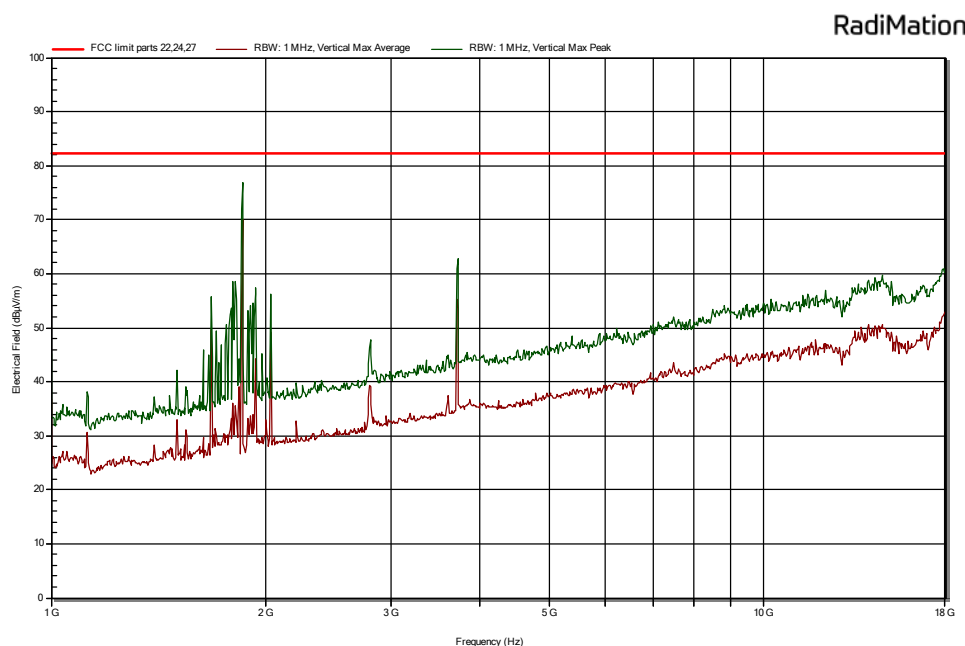
Plot 3n: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 - 1 GHz
(peak values shown) Band 2 Mid channel



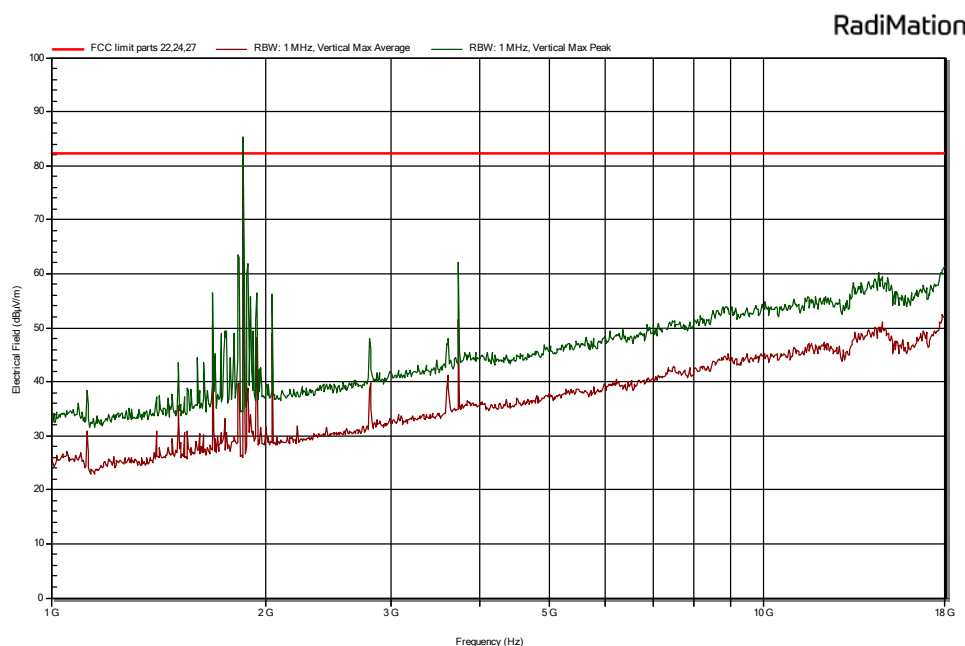
Plot 3m: radiated emissions of the EUT, Antenna vertical, in the range 0.25 - 1 GHz
(peak values shown) Band 2 High channel



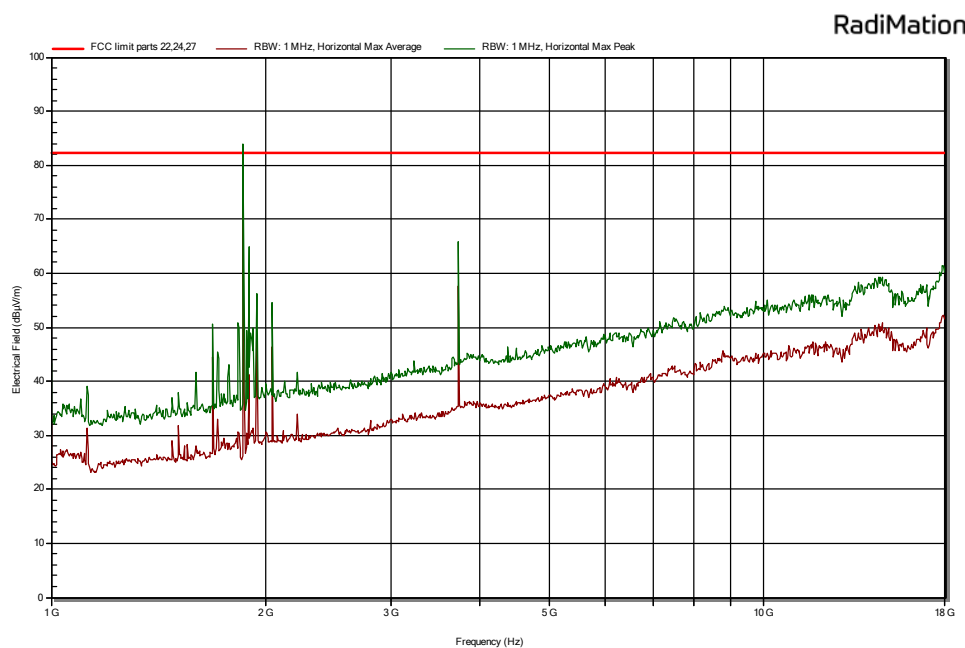
Plot 3n: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 - 1 GHz
(peak values shown) Band 2 High channel



Note: A LTE band 2 reject filter was used.

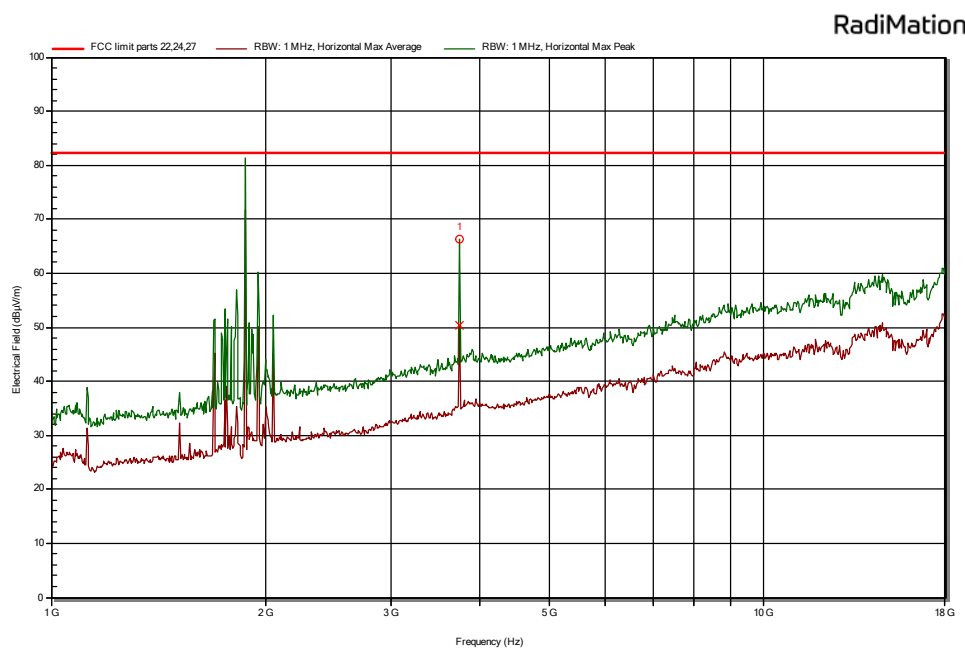
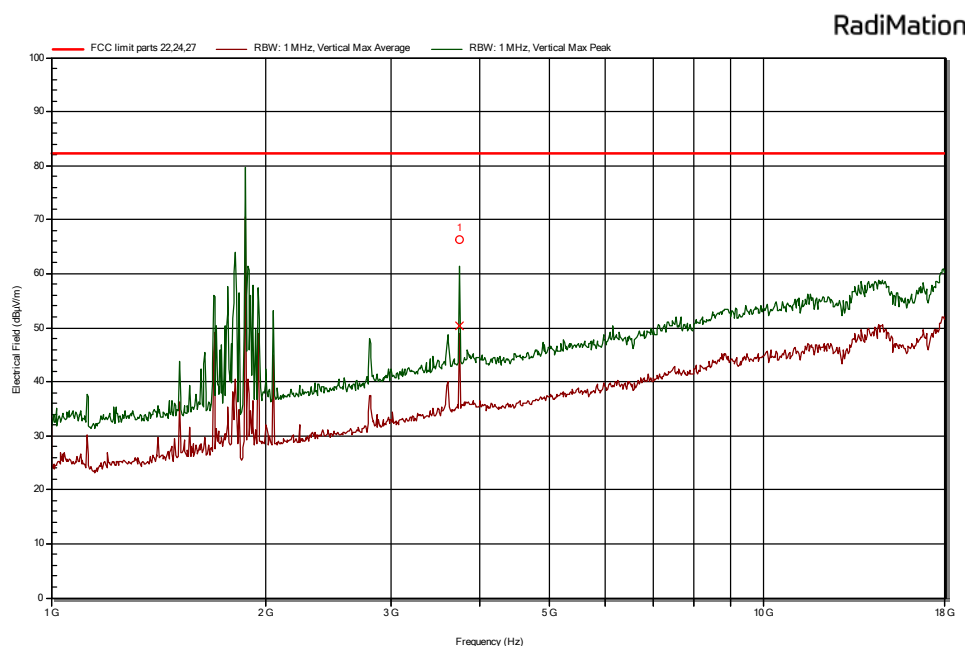


Plot 3o: radiated emissions of the EUT, Antenna vertical, in the range 1 – 18 GHz
(peak and average values shown) Band 2 Mid channel

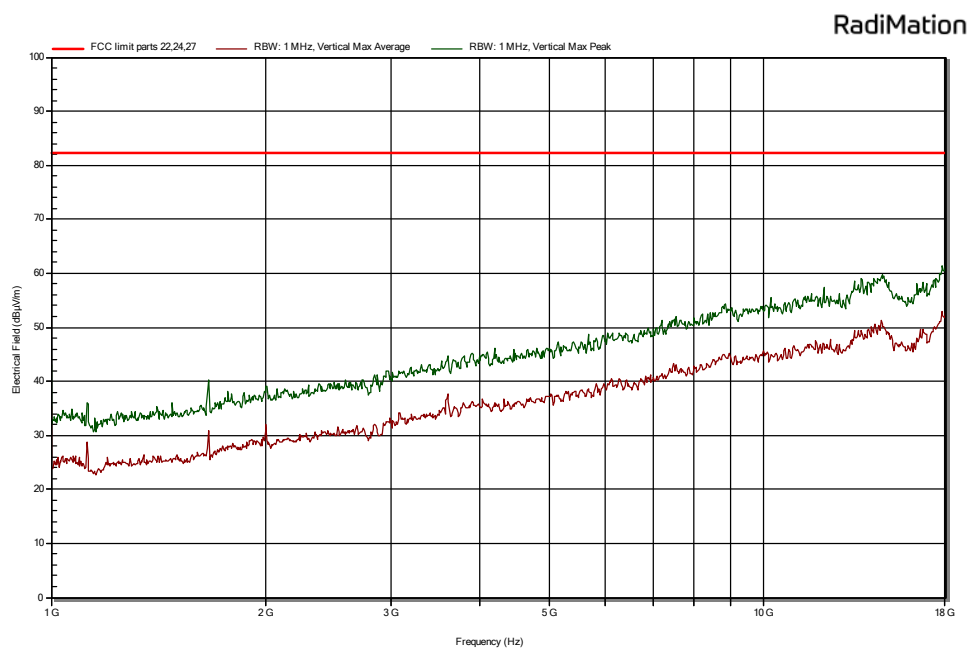


Plot 3p: radiated emissions of the EUT, Antenna horizontal, in the range 1 – 18 GHz
(peak and average values shown) Band 2 Mid channel

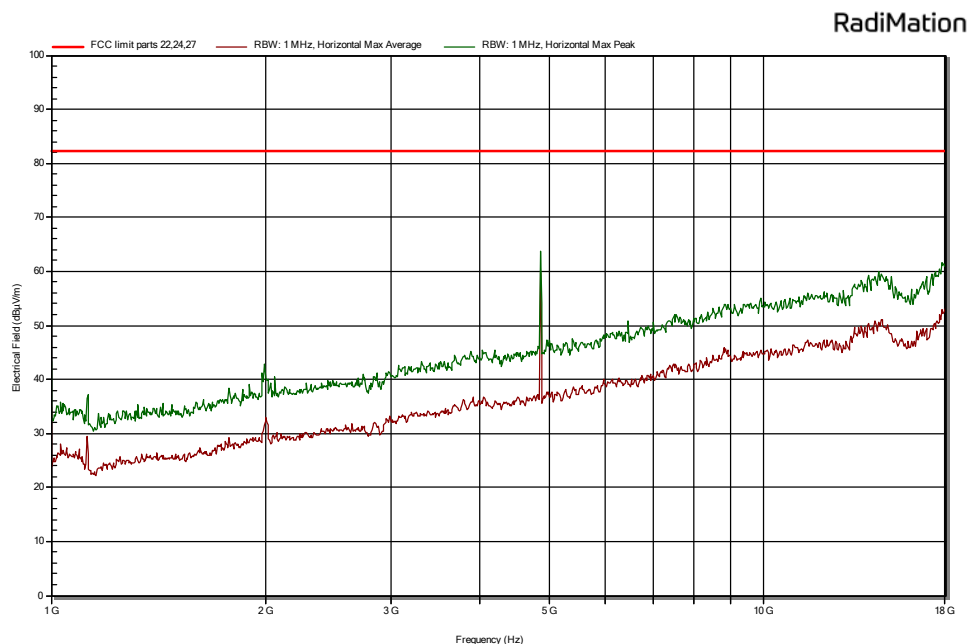
Note: A LTE band 2 reject filter was used



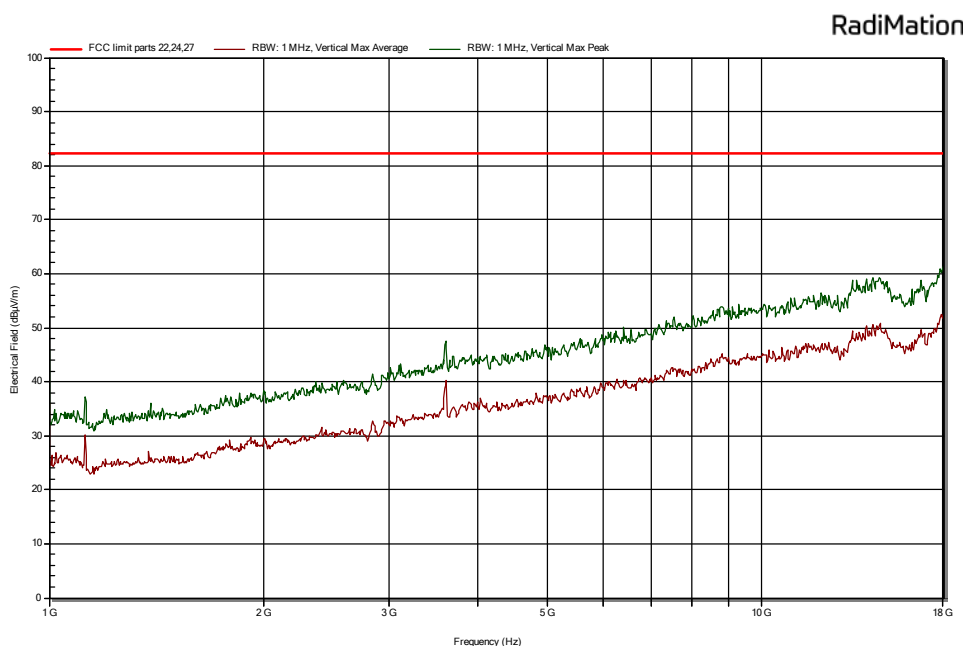
Note: A LTE band 2 reject filter was used



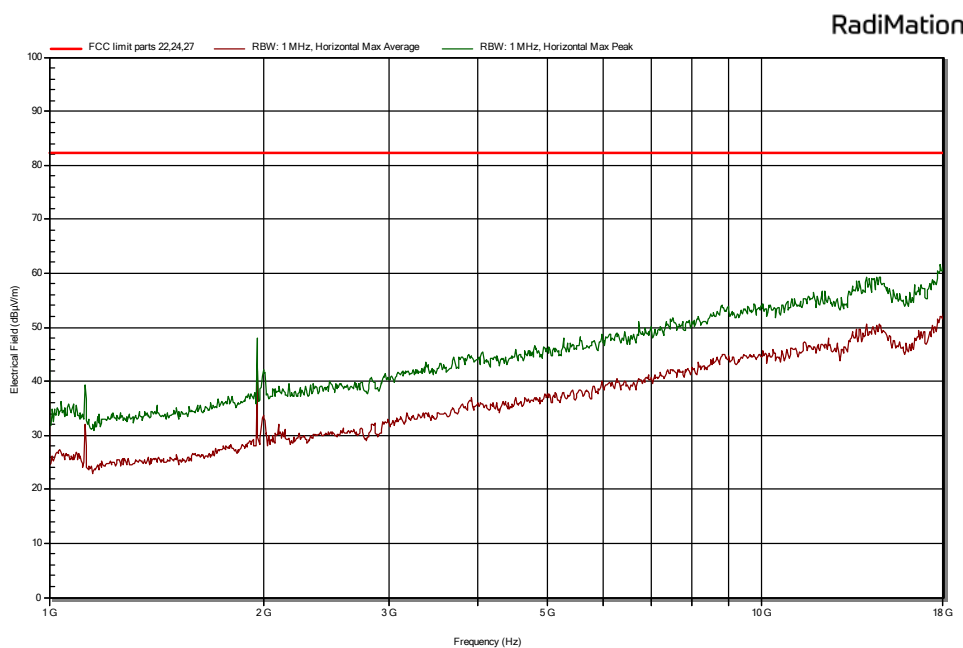
Plot 3s: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 5 Low channel



Plot 3t: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 5 Low channel
Note: A LTE band 5 reject filter was used

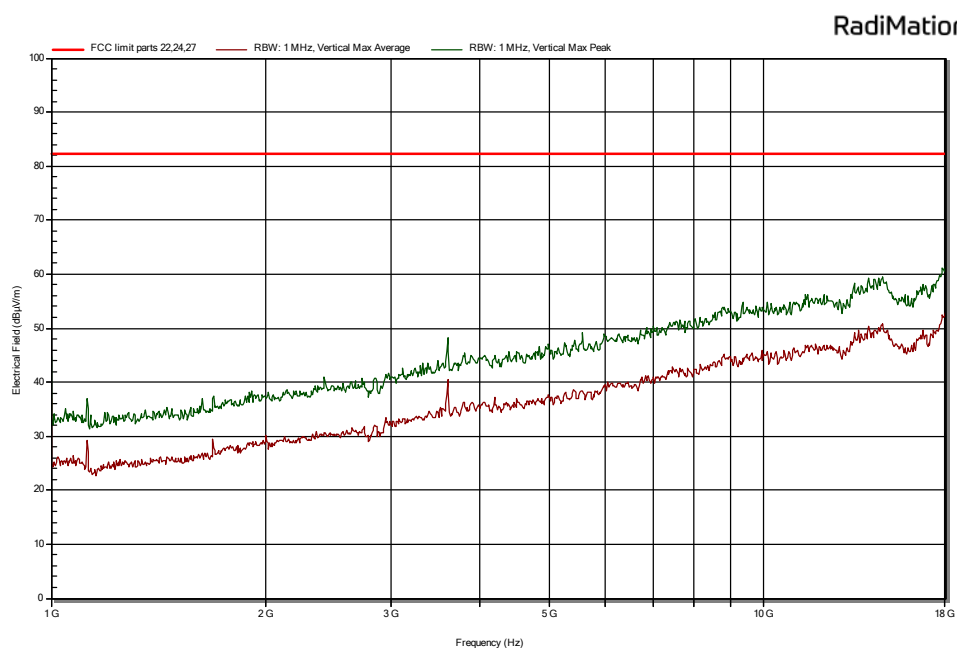


Plot 3u: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 5 Mid channel

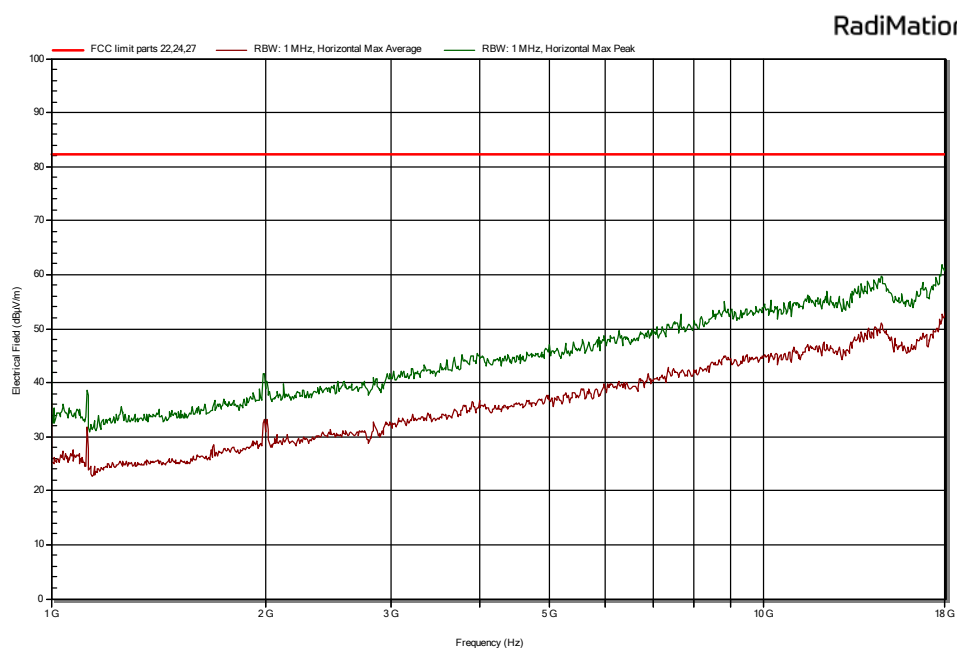


Plot 3t: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 5 Mid channel

Note: A LTE band 5 reject filter was used



Plot 3v: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 5 High channel

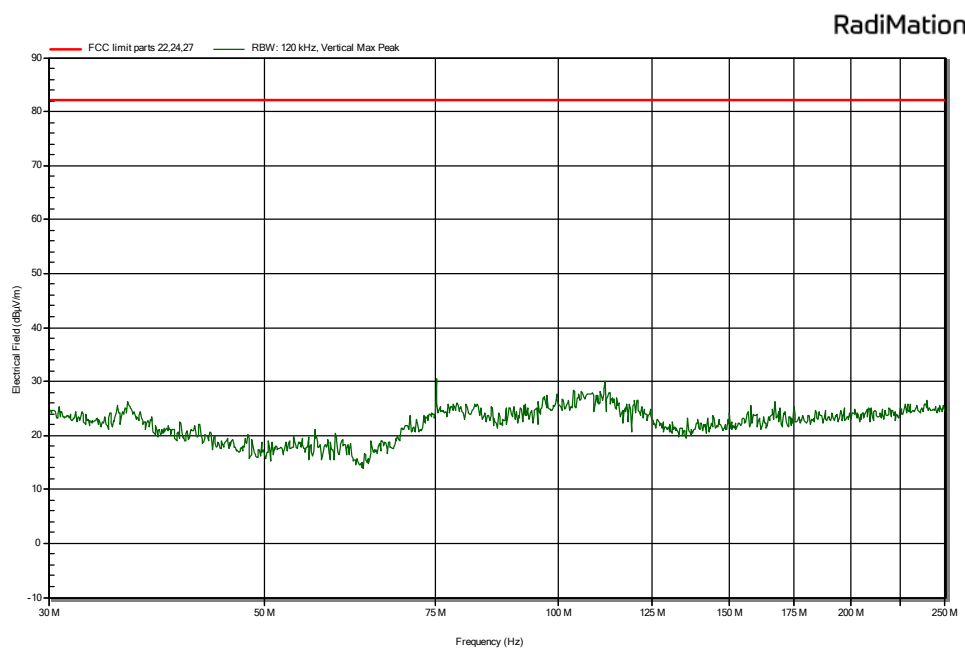


Plot 3w: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 5 High channel

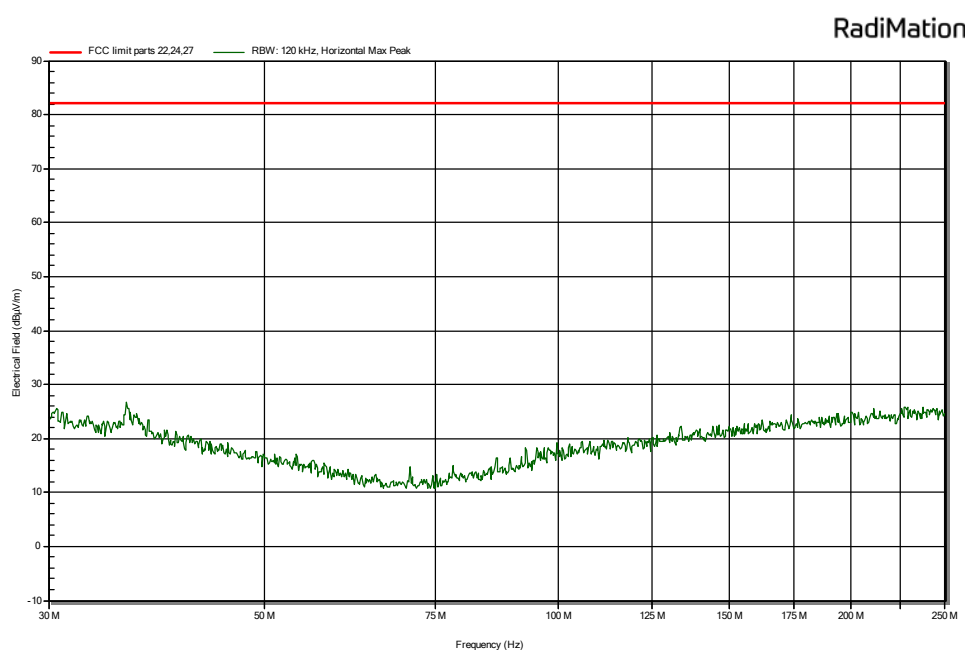
Note: A LTE band 5 reject filter was used

Remark: in the preceding 12 LTE plots the following conversion formula is valid: $E_{dB\mu V/m} = EIRP_{dBm} + 95.2_{dB}$

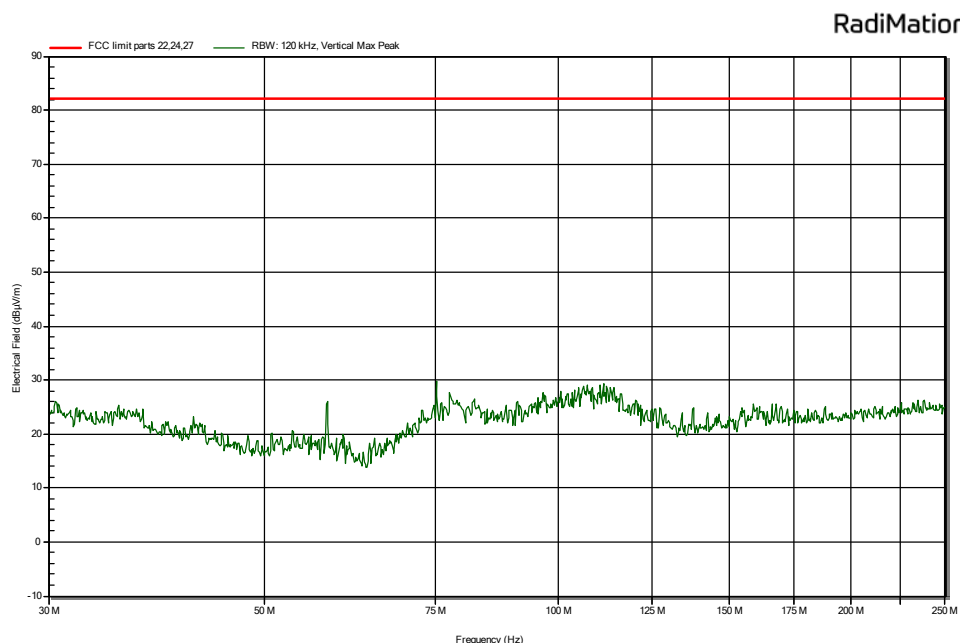
Band 4



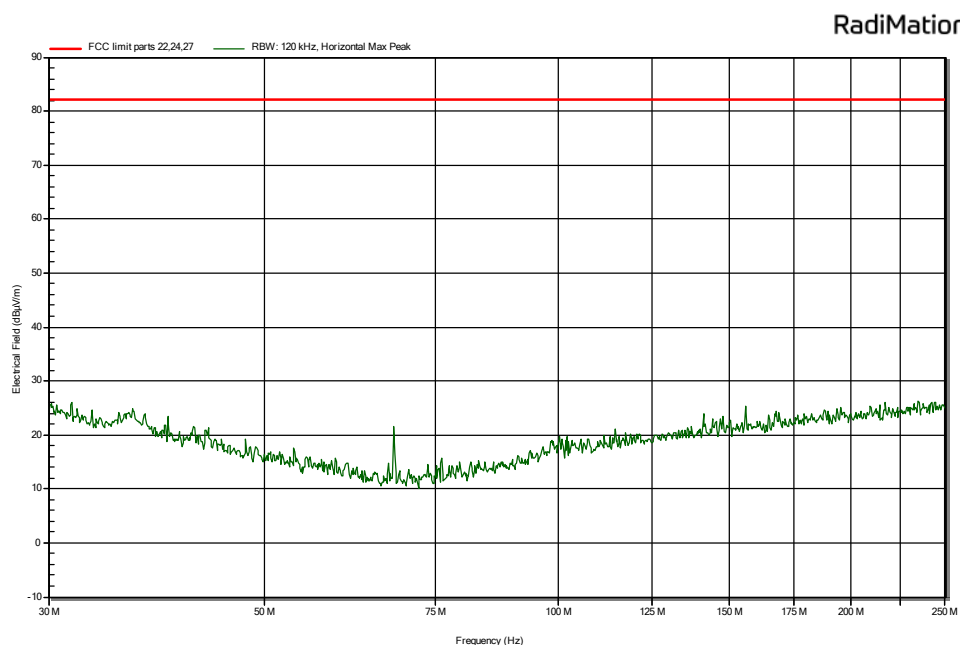
Plot 3x: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(peak values shown) Band 4 Low channel



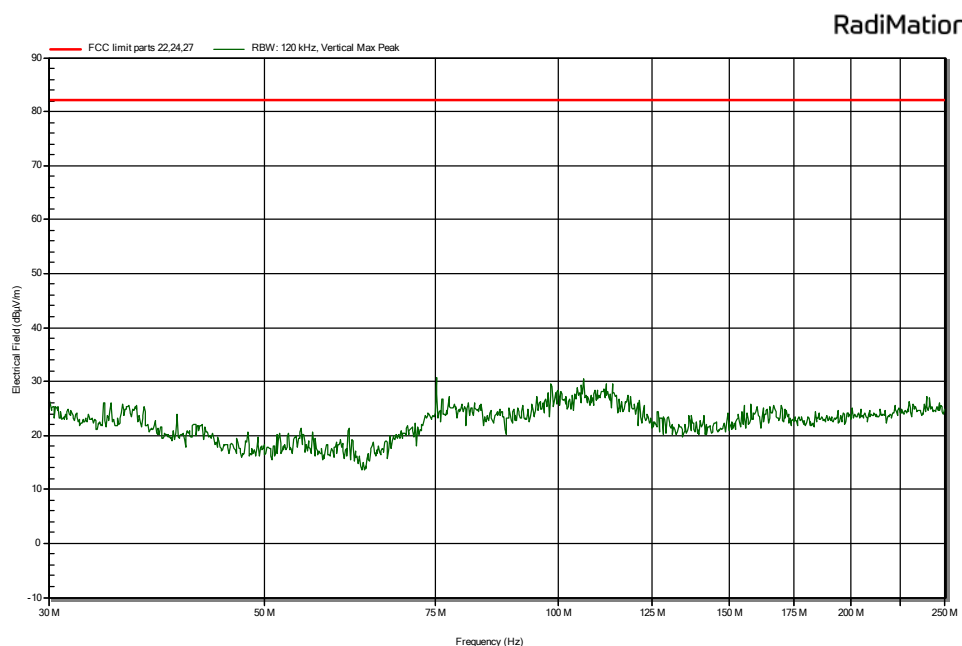
Plot 3y: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(peak values shown) Band 4 Low channel



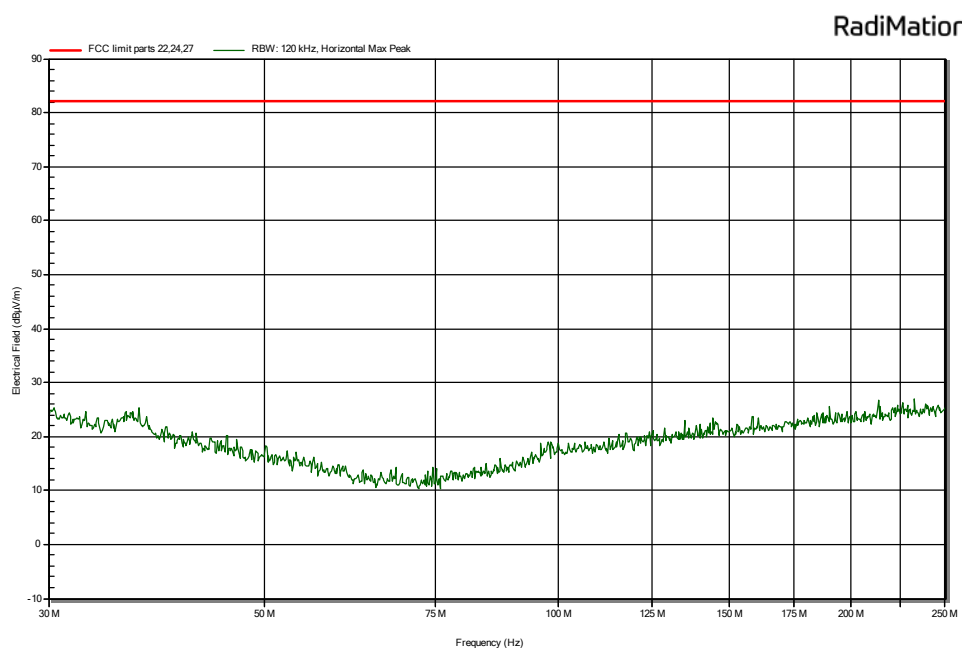
Plot 3z: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(peak values shown) Band 4 Mid channel



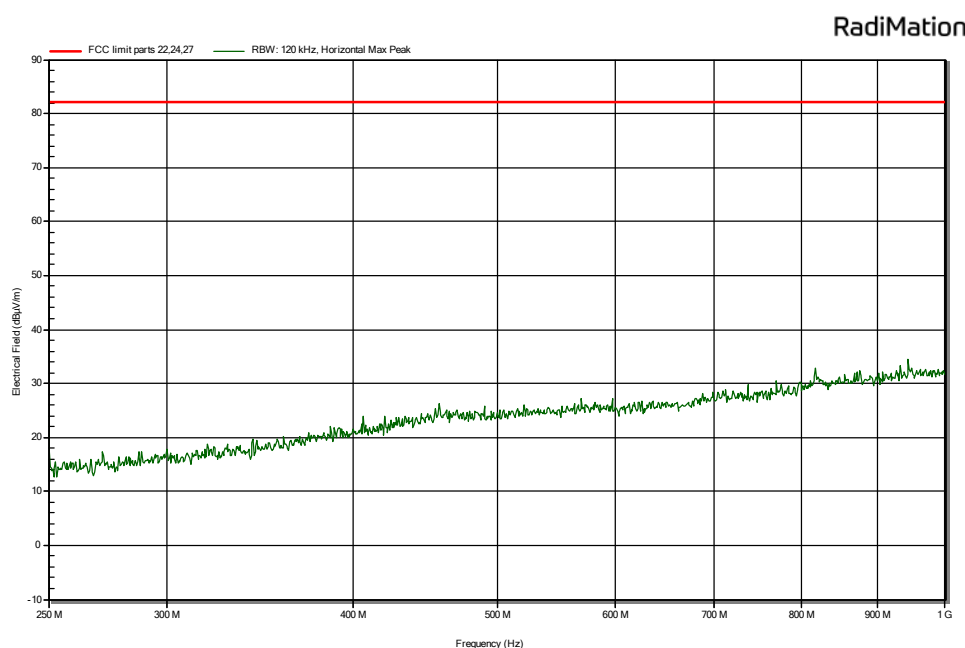
Plot 4a: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(peak values shown) Band 4 Mid channel



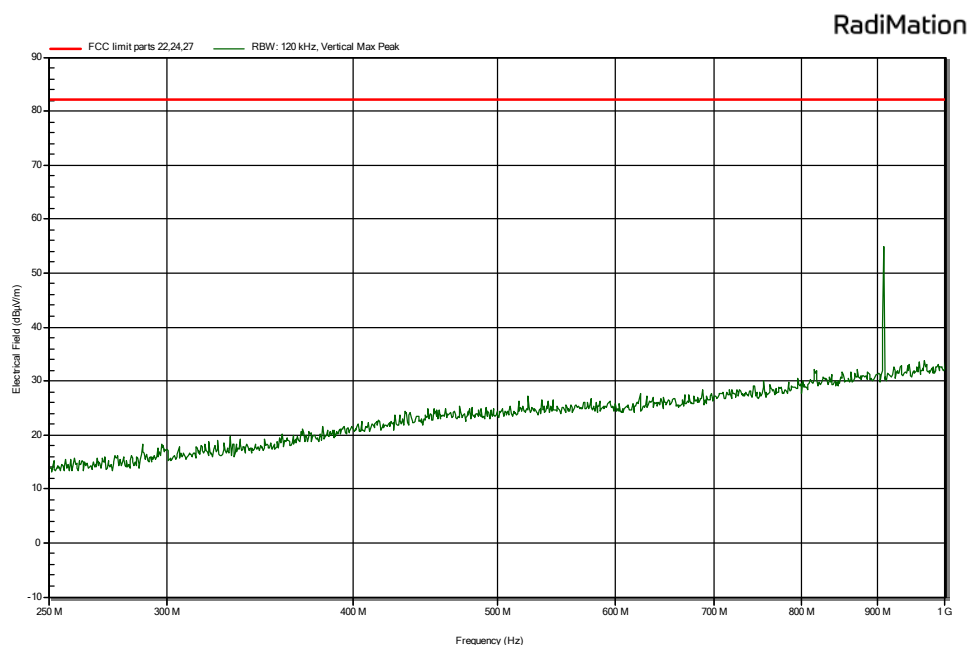
Plot 4b: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz (peak values shown) Band 4 High channel



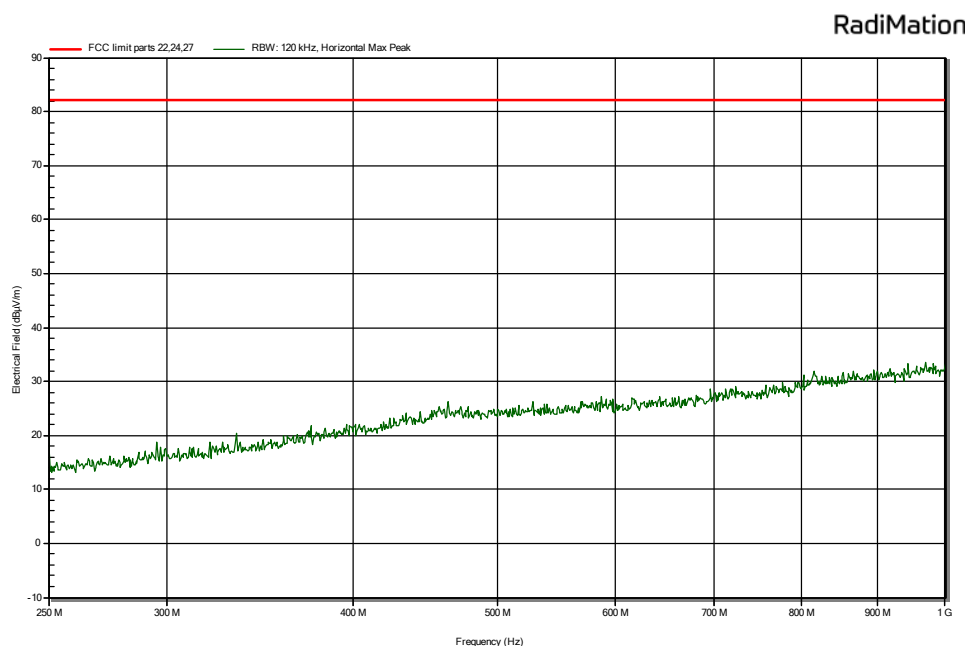
Plot 4c: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz (peak values shown) Band 4 High channel



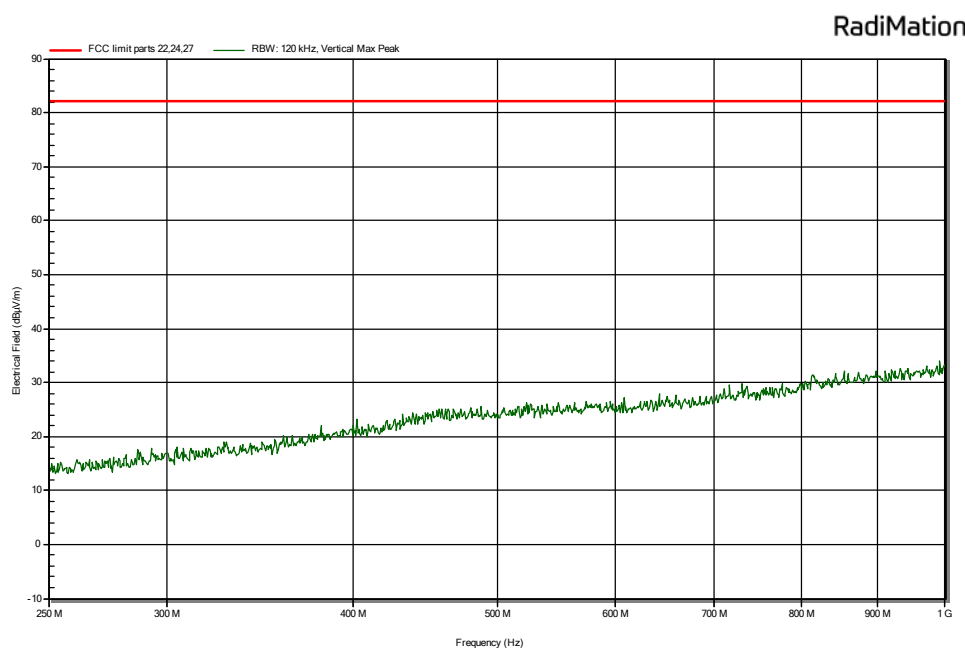
Plot 4d: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 – 1 GHz
(peak values shown) Band 4 Low channel



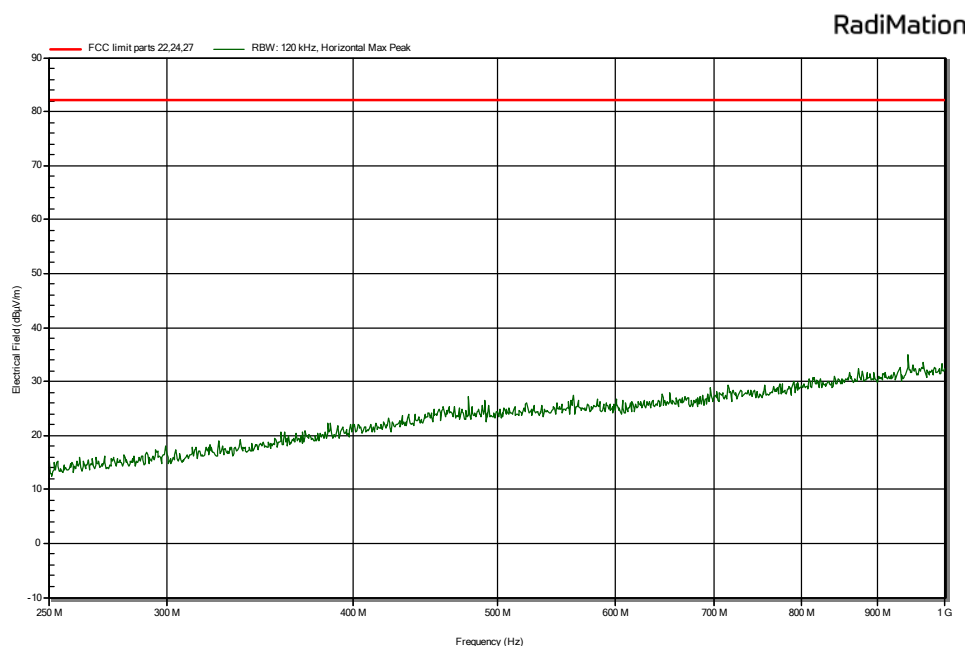
Plot 4e: radiated emissions of the EUT, Antenna vertical, in the range 0.25 – 1 GHz
(peak values shown) Band 4 Low channel



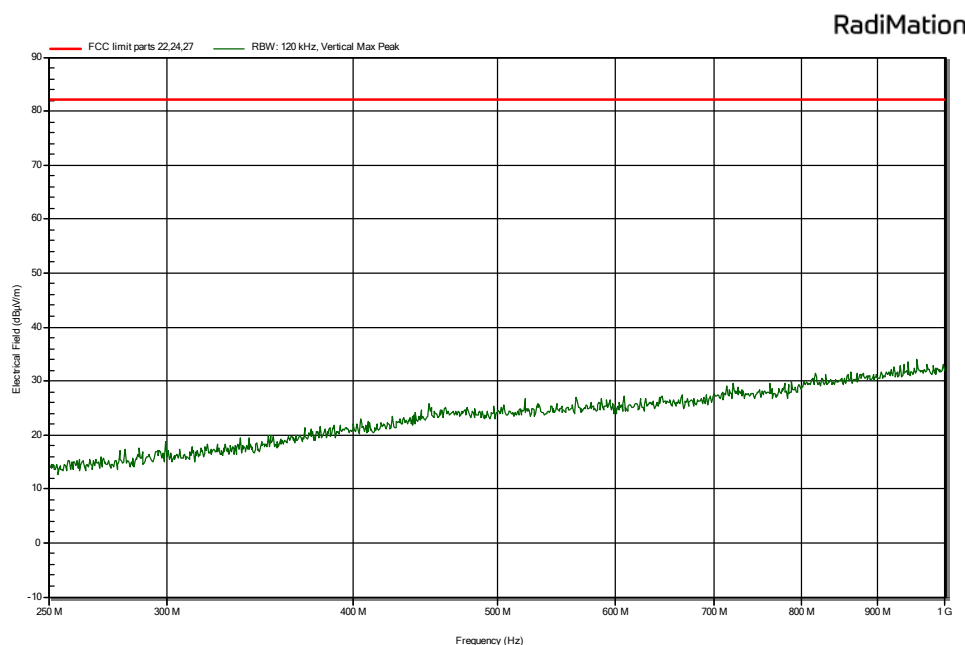
Plot 4f: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 – 1 GHz
(peak values shown) Band 4 Middle channel



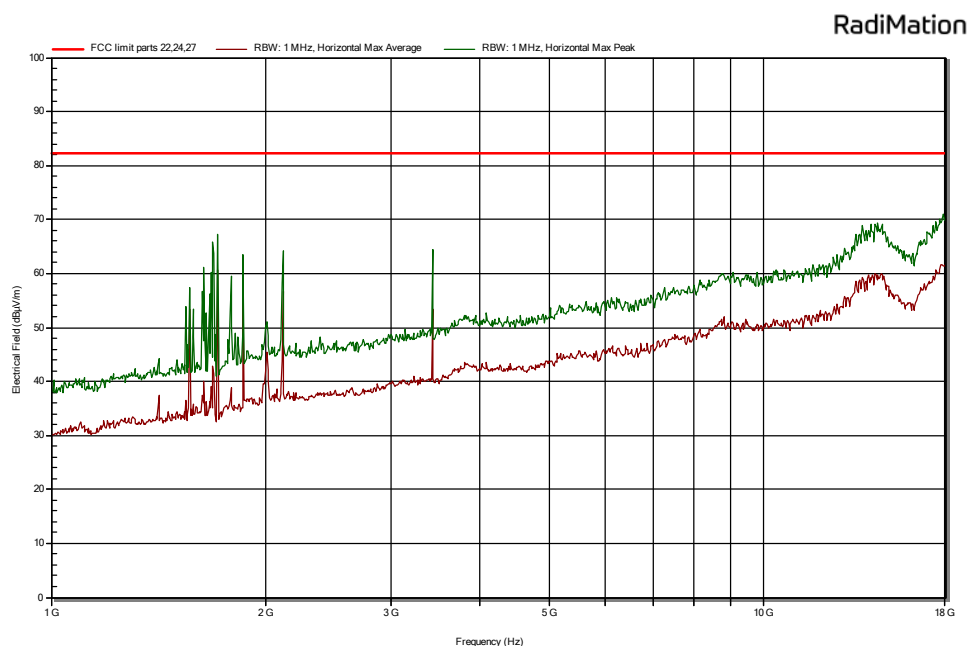
Plot 4g: radiated emissions of the EUT, Antenna vertical, in the range 0.25 – 1 GHz
(peak values shown) Band 4 Middle channel



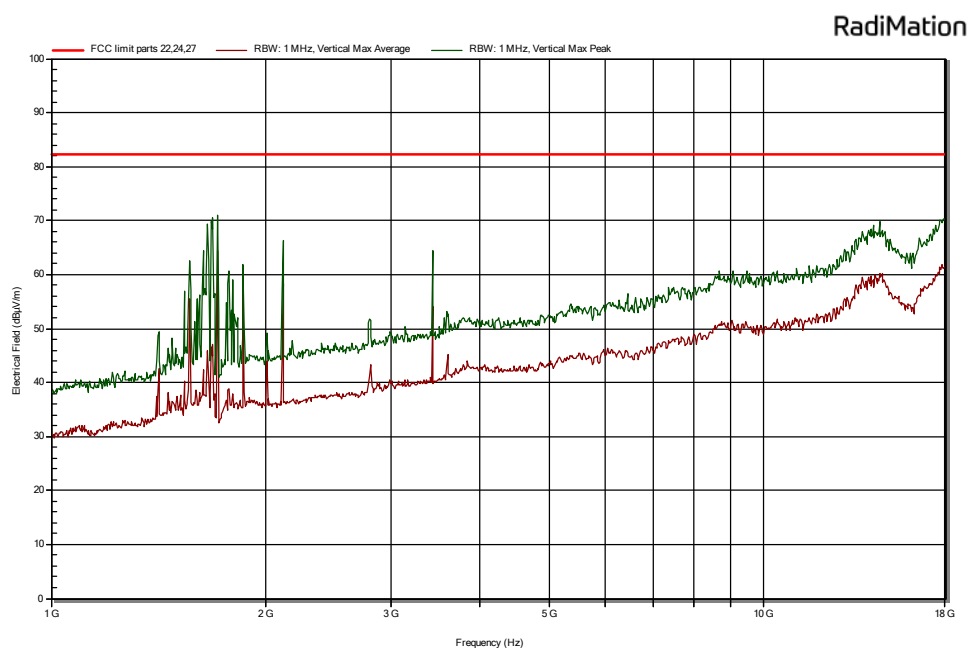
Plot 4h: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 – 1 GHz
(peak values shown) Band 4 High channel



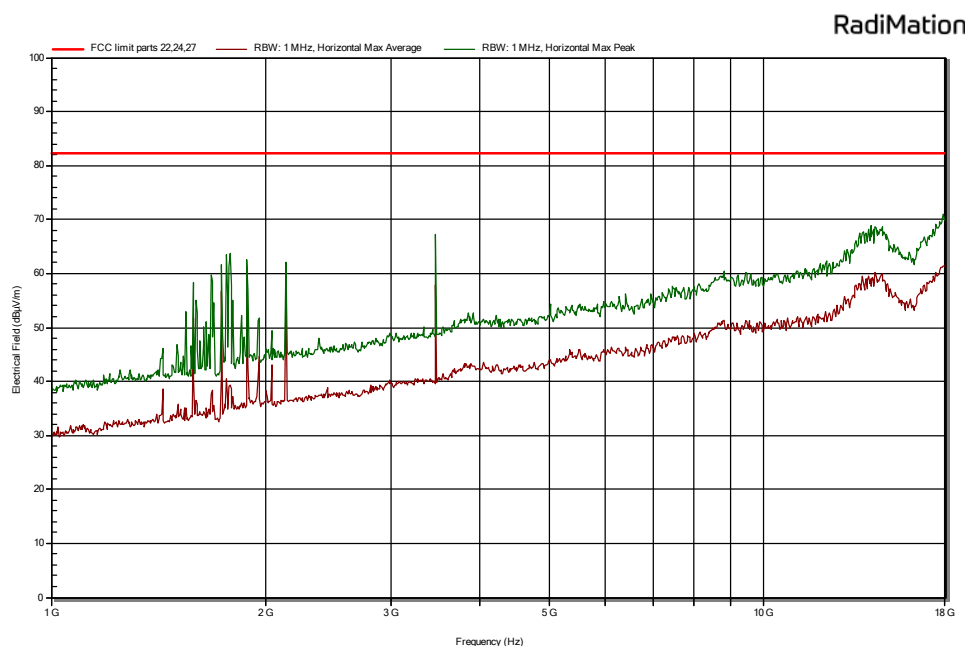
Plot 4i: radiated emissions of the EUT, Antenna vertical, in the range 0.25 – 1 GHz
(peak values shown) Band 4 High channel



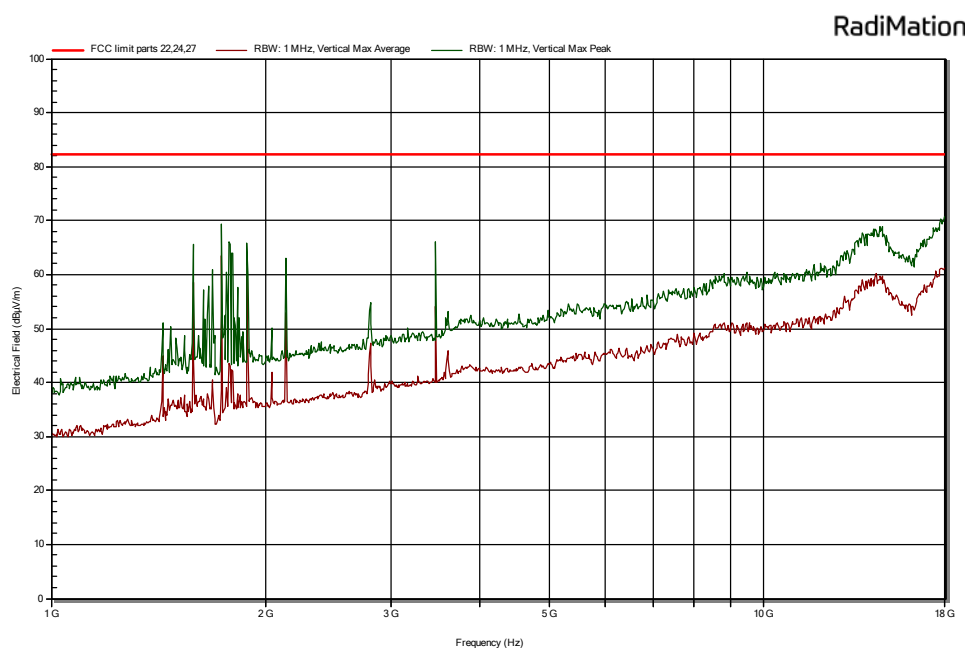
Plot 4j: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 4 Low channel



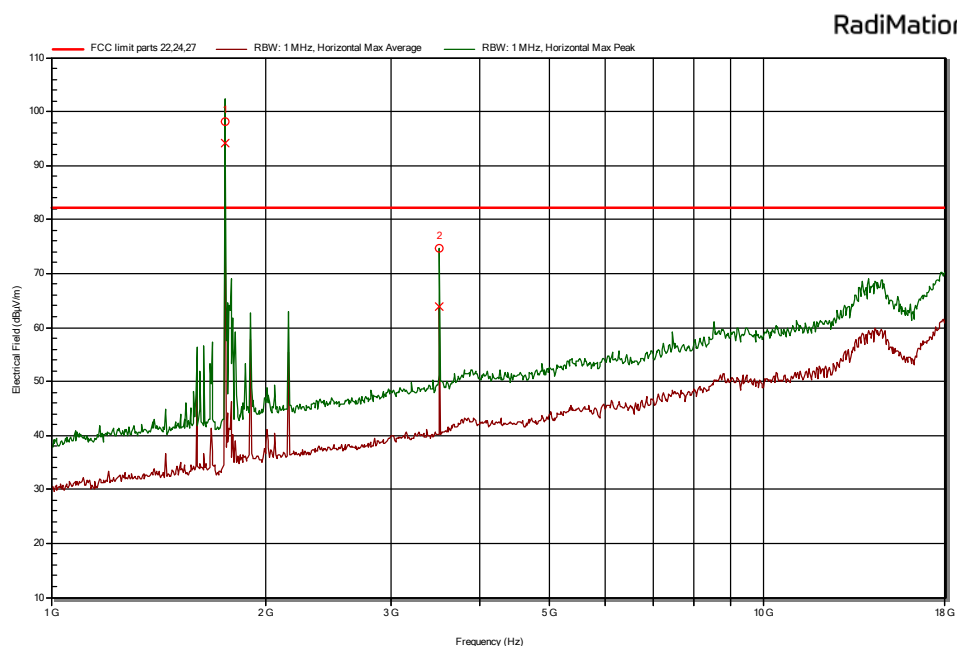
Plot 4k: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 4 Low channel
Note: A LTE band 4 reject filter was used



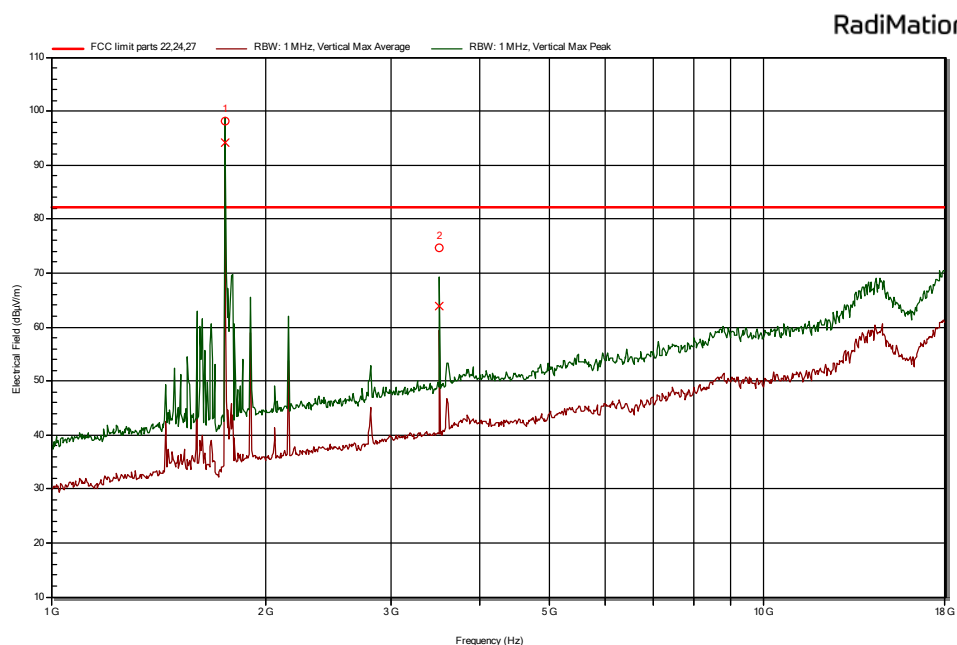
Plot 4m: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 4 Middle channel



Plot 4n: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 4 Middle channel
Note: A LTE band 4 reject filter was used



Plot 4o: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 4 High channel

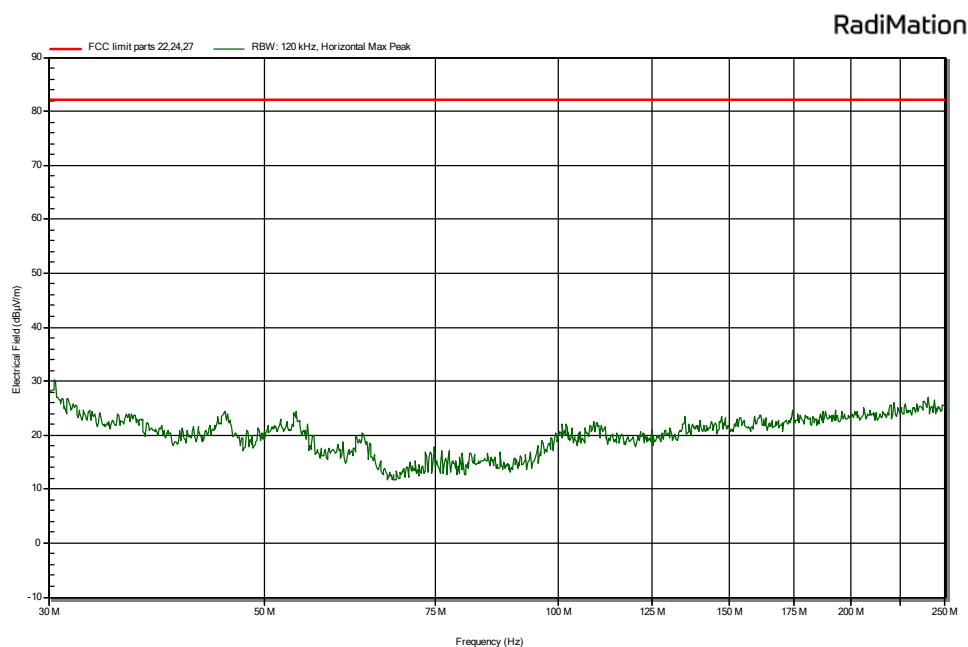


Plot 4p: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 4 High channel

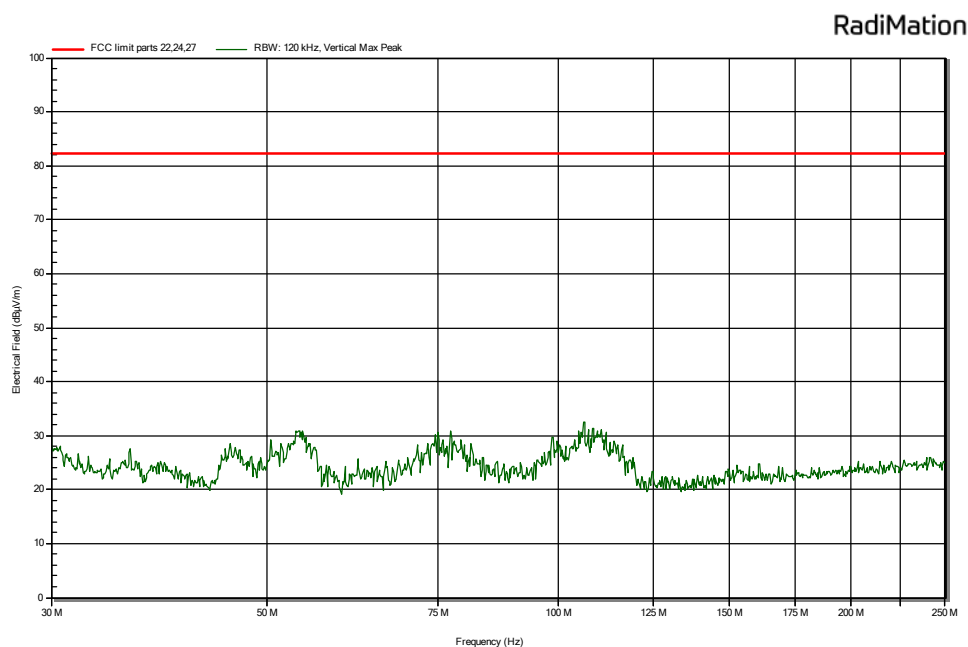
Note: A LTE band 4 reject filter was used

Note: the highest peak seen in the plots above is the fundamental frequency and therefore not subject to the limit.

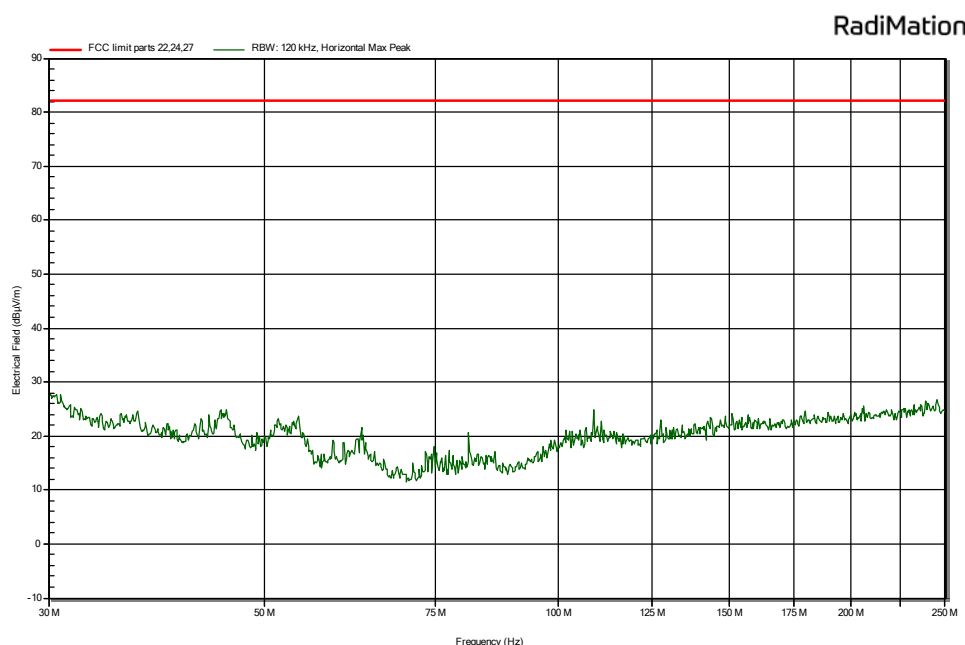
Band 12



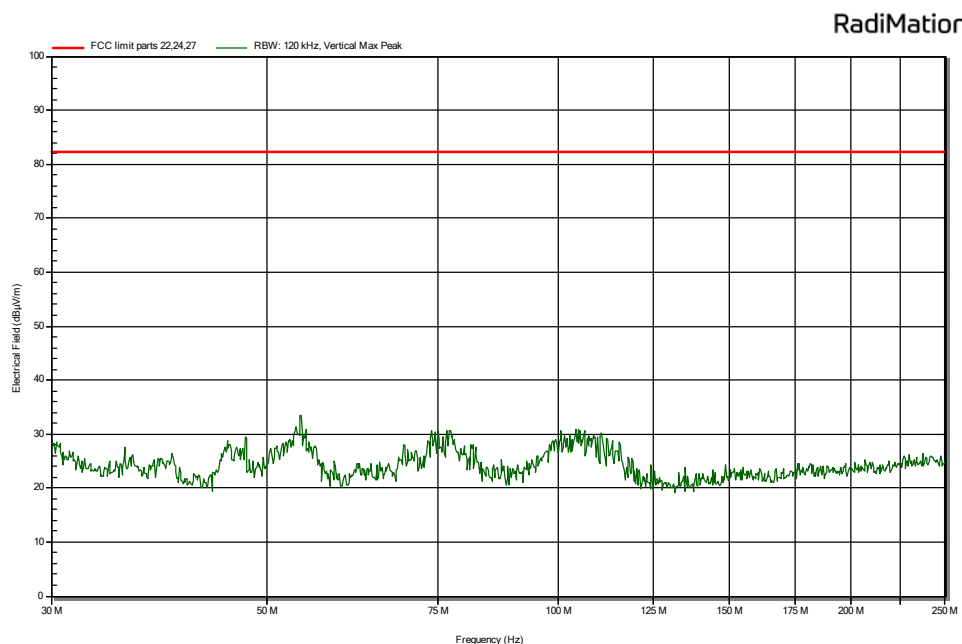
Plot 4q: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz (peak values shown) Band 12 Low channel



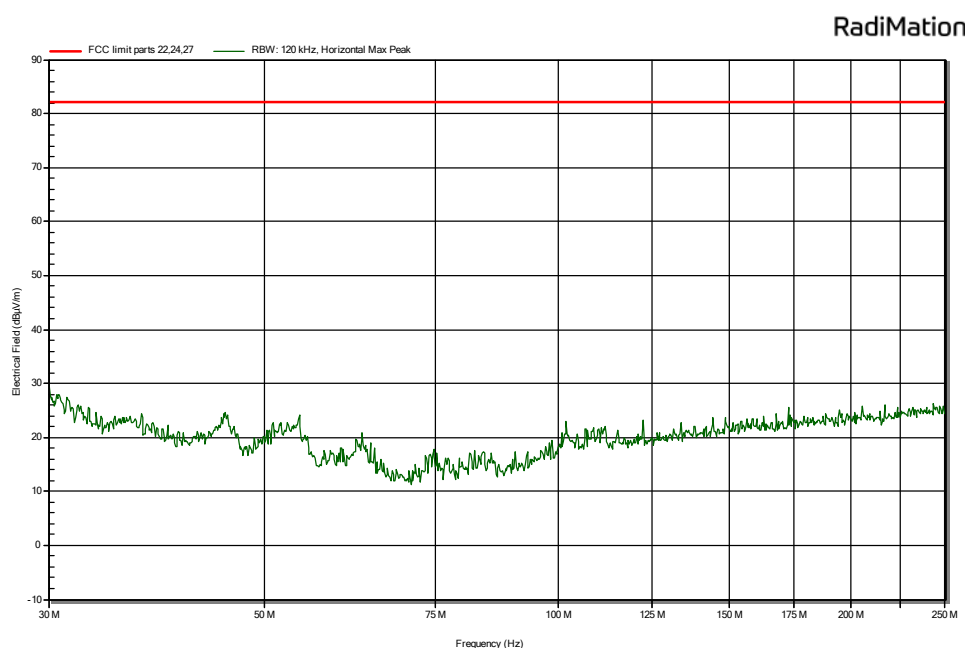
Plot 4r: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz (peak values shown) Band 12 Low channel



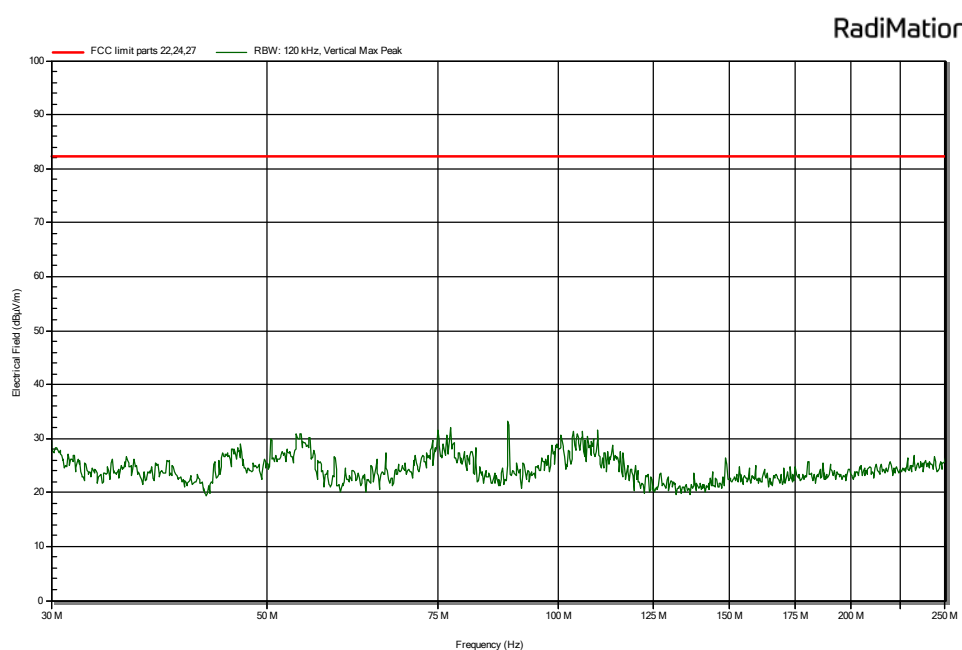
Plot 4s: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(peak values shown) Band 12 Middle channel



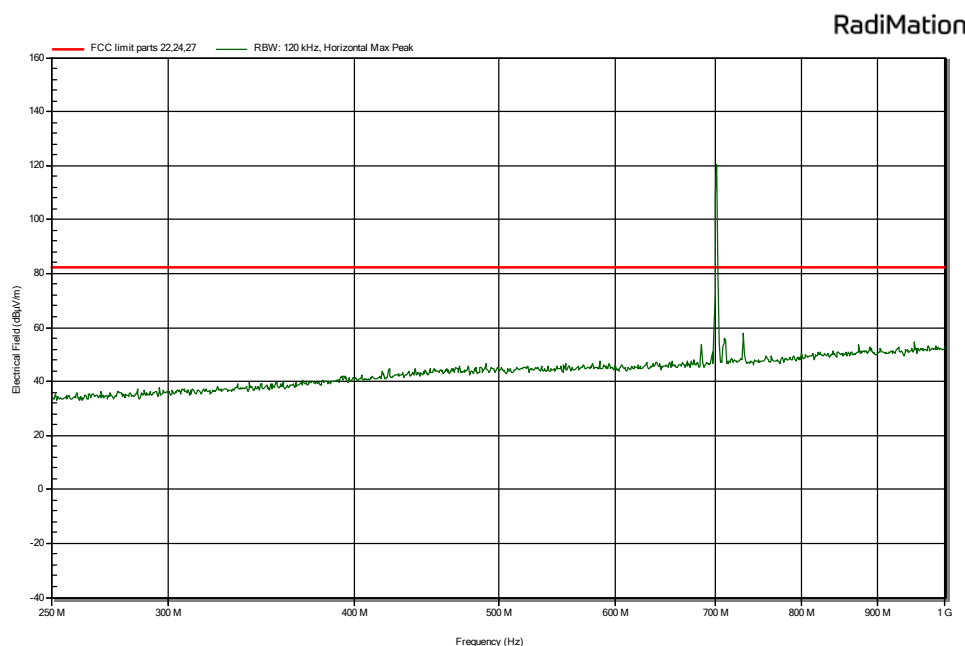
Plot 4s: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(peak values shown) Band 12 Middle channel



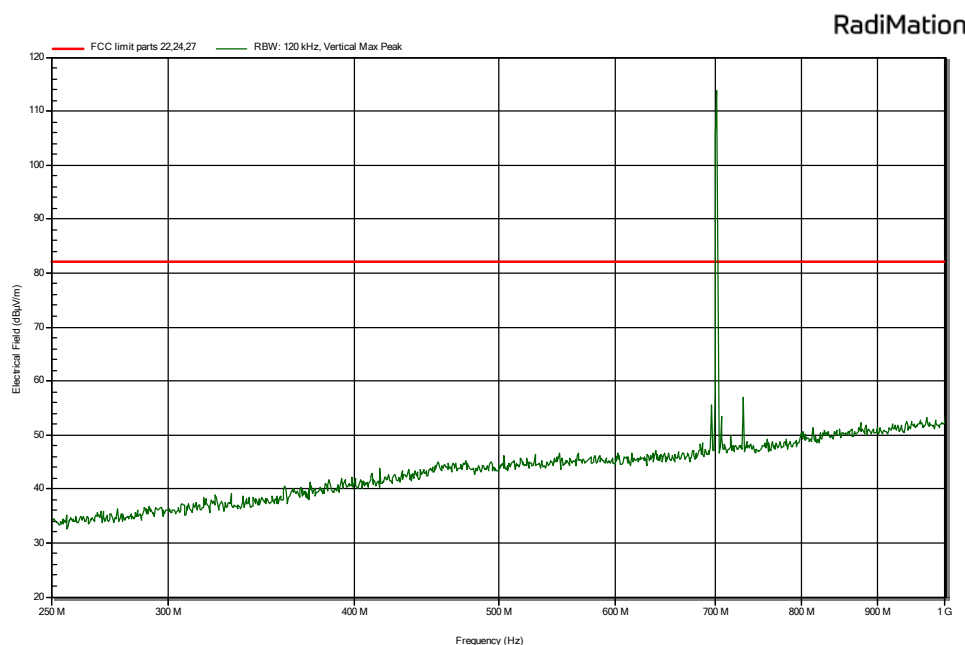
Plot 4t: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(peak values shown) Band 12 High channel



Plot 4u: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(peak values shown) Band 12 High channel

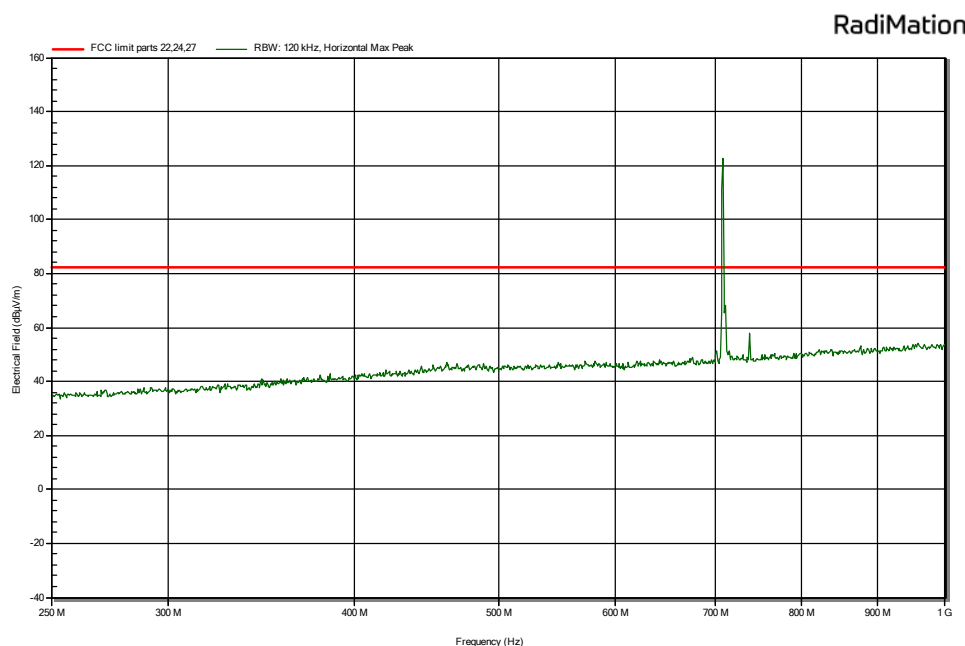


Plot 4v: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 – 1 GHz
(peak values shown) Band 12 Low channel

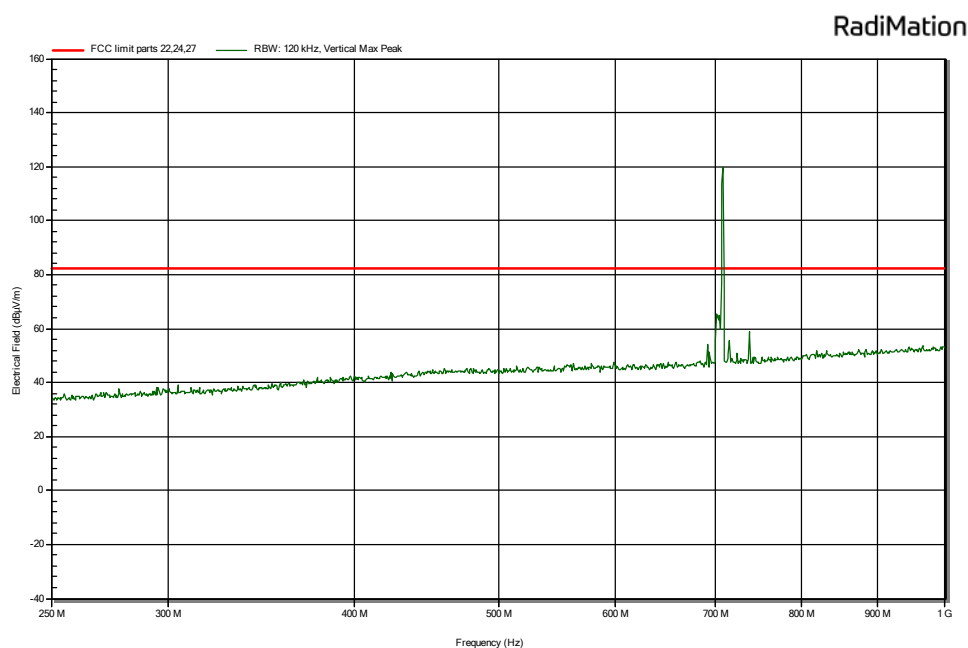


Plot 4w: radiated emissions of the EUT, Antenna vertical, in the range 0.25 – 1 GHz
(peak values shown) Band 12 Low channel

Note: the highest peak seen in the plots above is the fundamental frequency and therefore not subject to the limit.

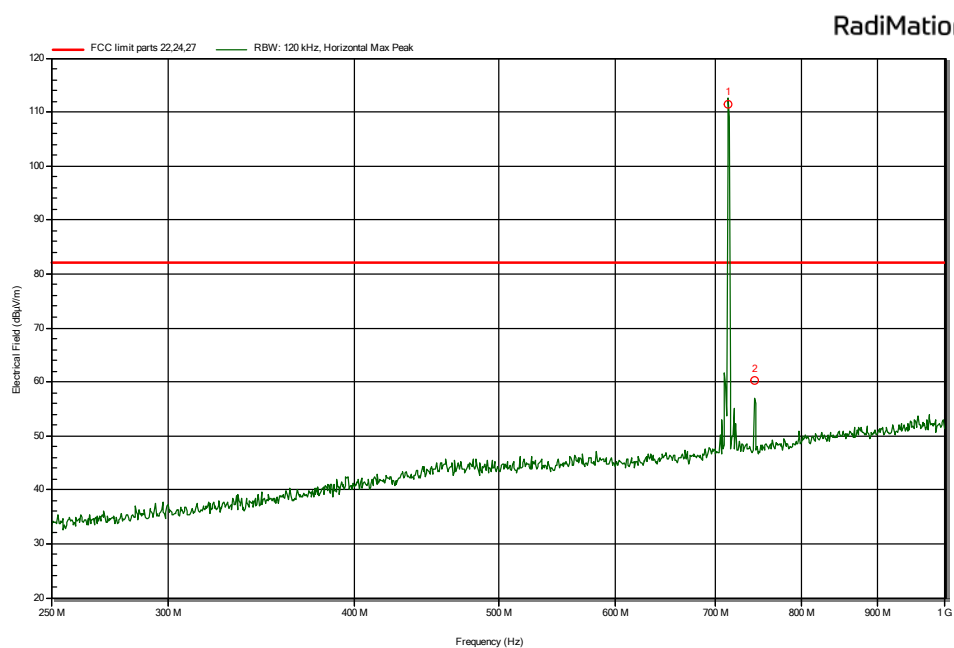


Plot 4x: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 – 1 GHz
(peak values shown) Band 12 Middle channel

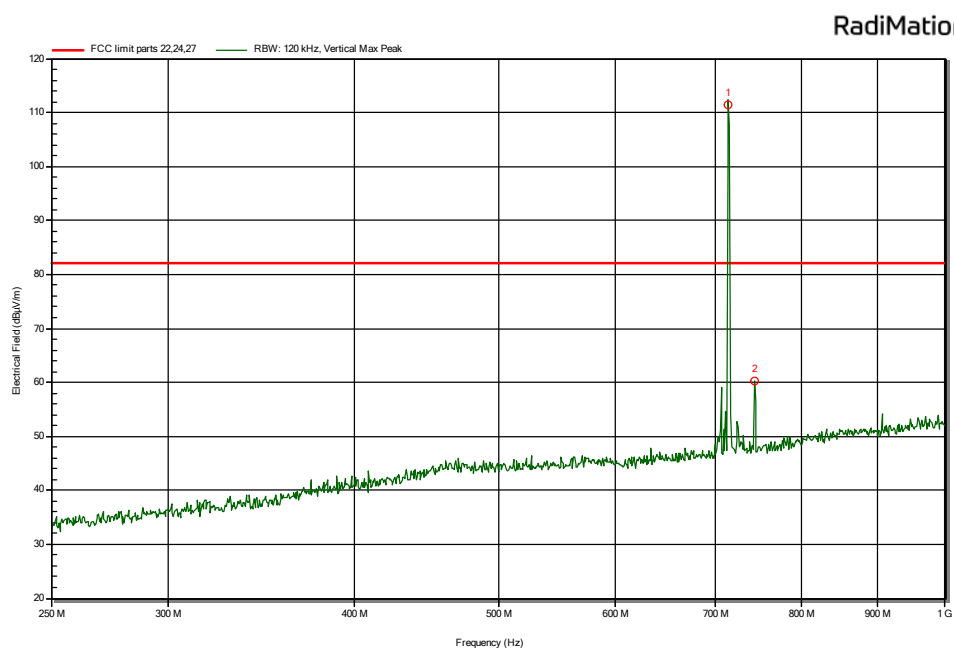


Plot 4y: radiated emissions of the EUT, Antenna vertical, in the range 0.25 – 1 GHz
(peak values shown) Band 12 Middle channel

Note: the highest peak seen in the plots above is the fundamental frequency and therefore not subject to the limit.

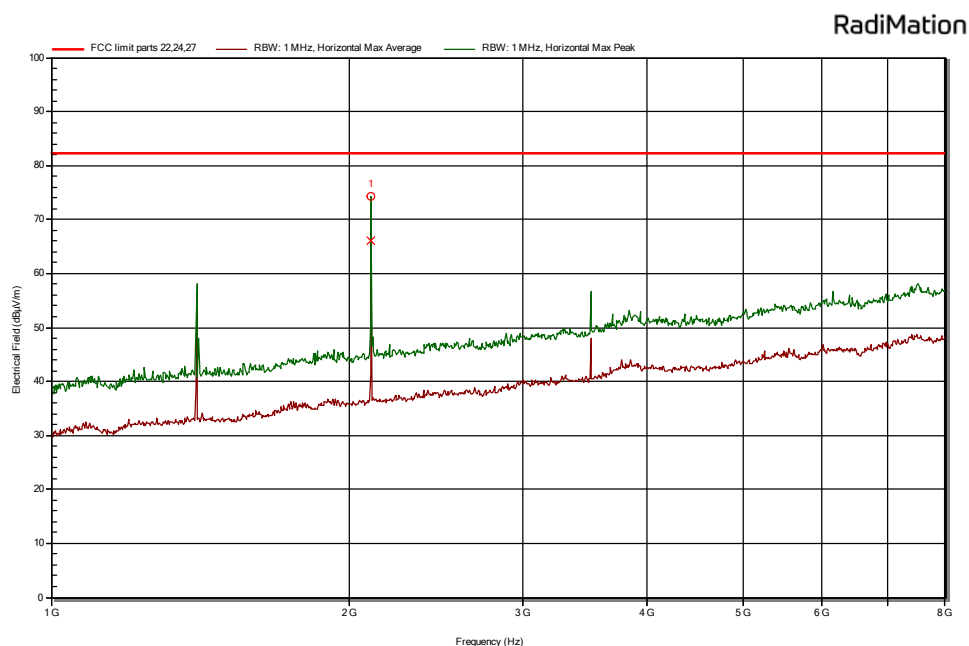


Plot 4z: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 – 1 GHz
(peak values shown) Band 12 High channel

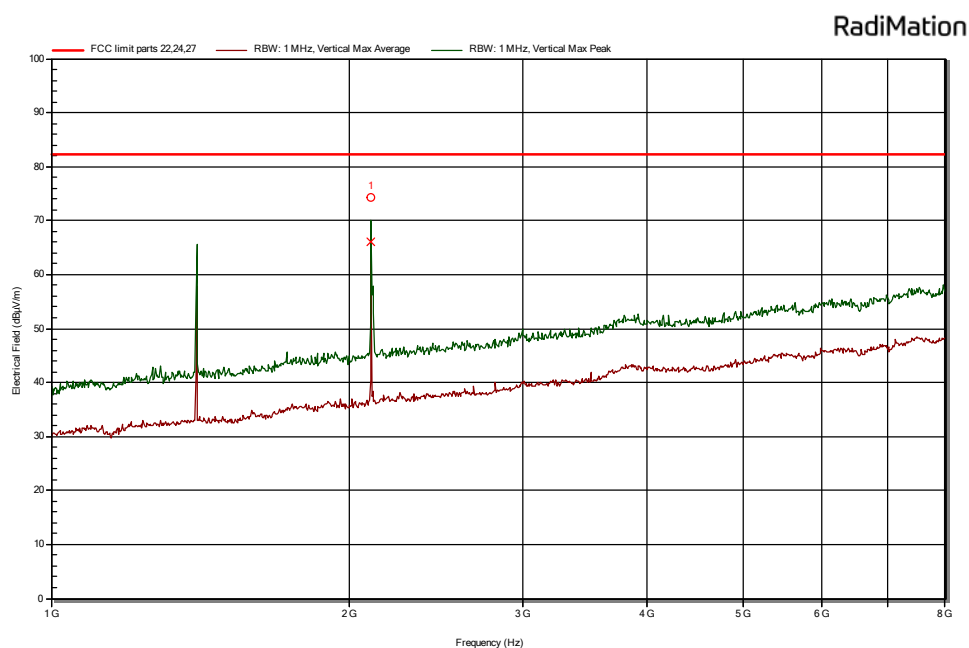


Plot 5a: radiated emissions of the EUT, Antenna vertical, in the range 0.25 – 1 GHz
(peak values shown) Band 12 High channel

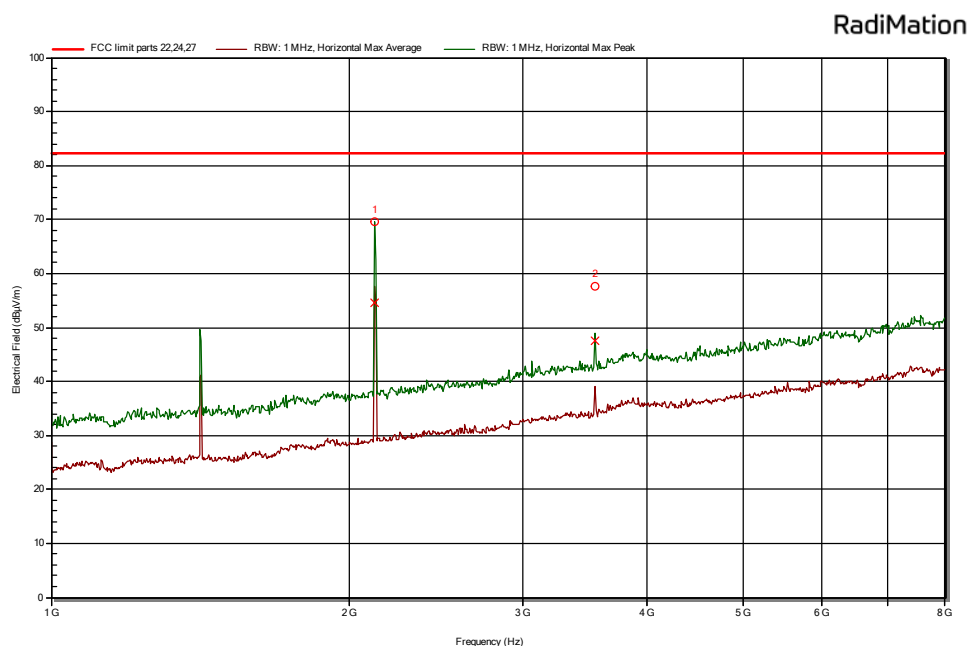
Note: the highest peak seen in the plots above is the fundamental frequency and therefore not subject to the limit.



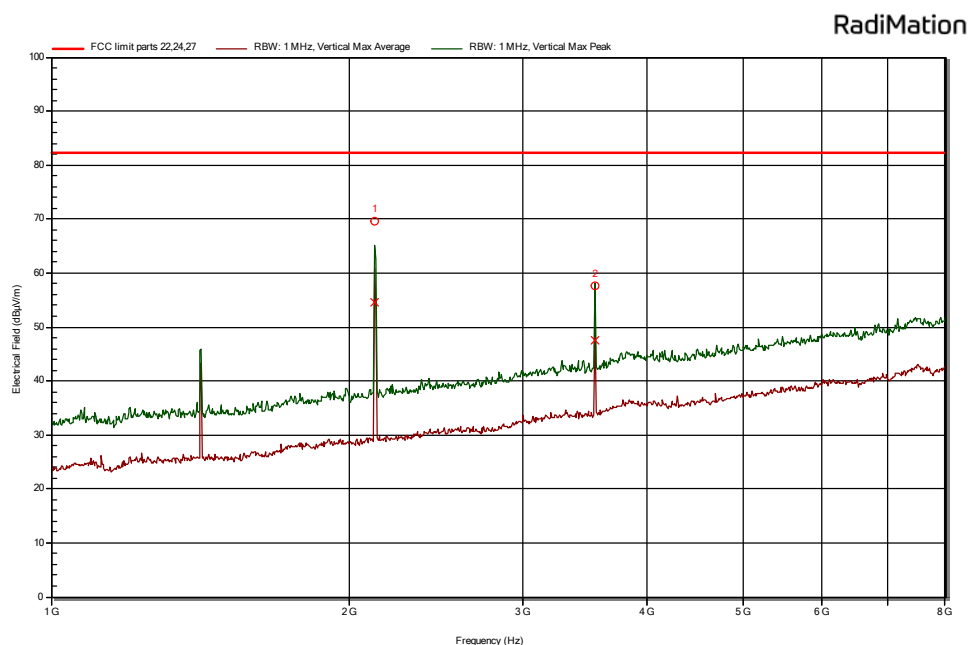
Plot 5b: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 12 Low channel



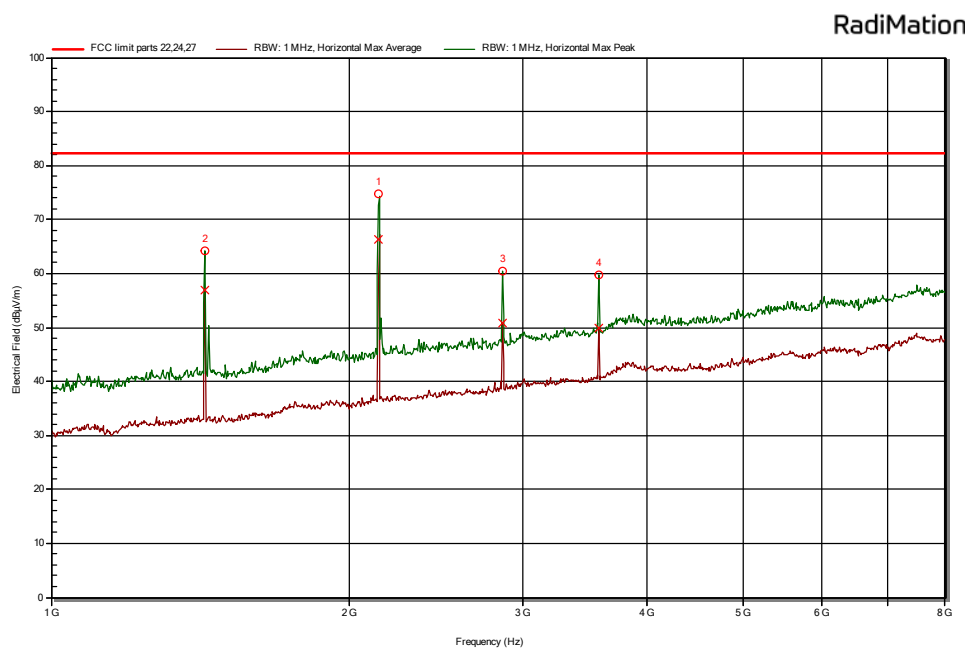
Plot 5c: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 12 Low channel



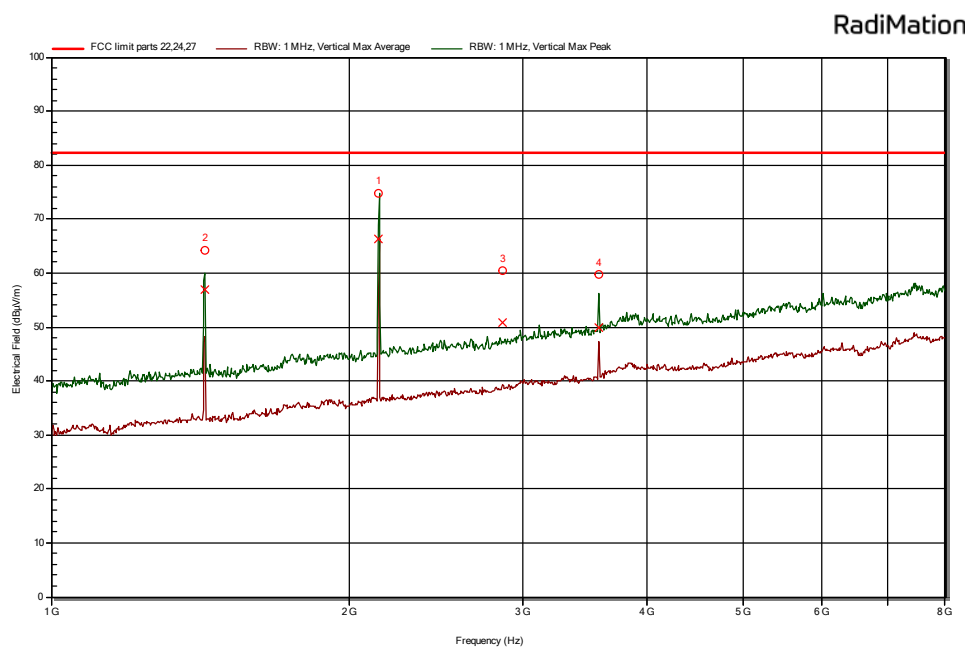
Plot 5d: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 12 Mid channel



Plot 5e: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 12 Mid channel

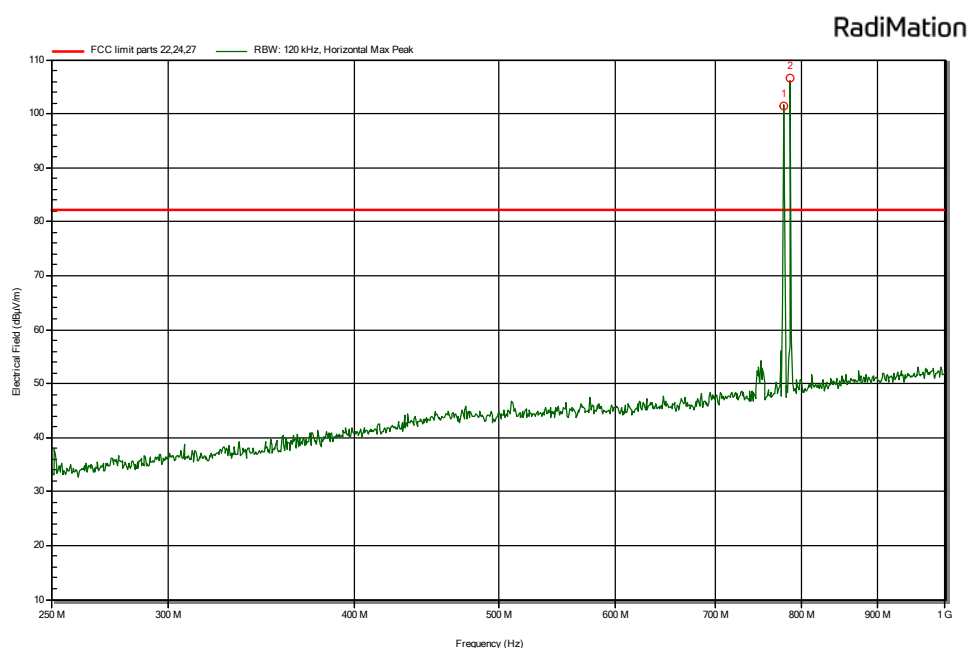


Plot 5f: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 12 High channel

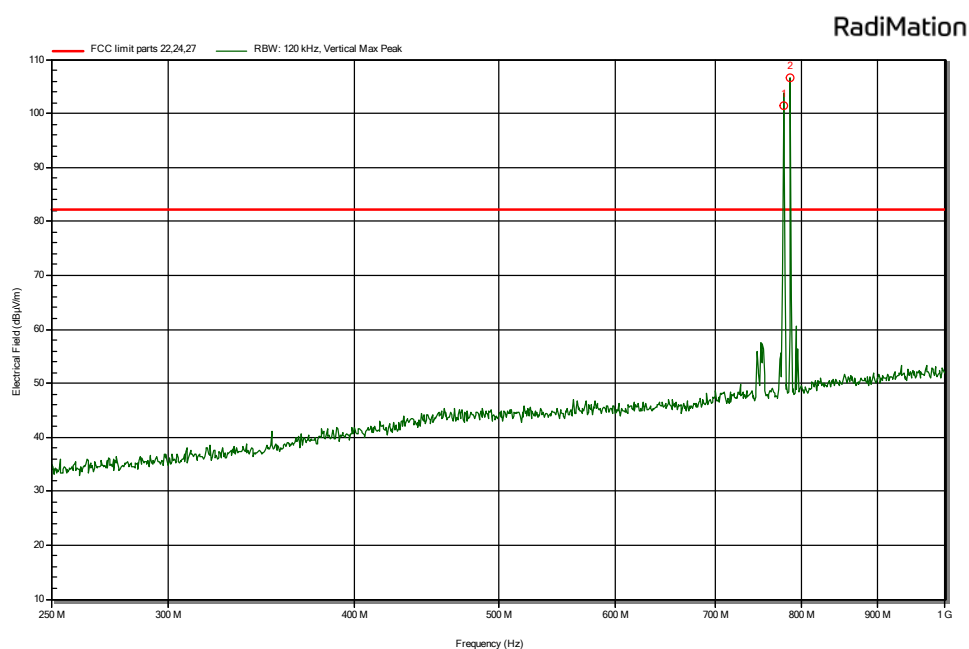


Plot 5g: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 12 High channel

Band 13

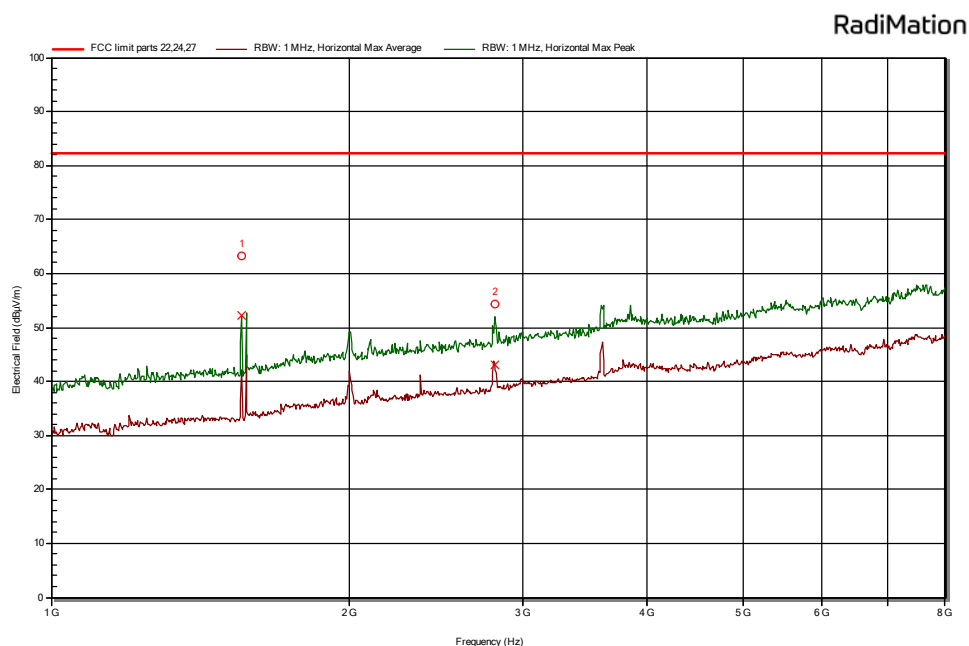


Plot 5h: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 – 1 GHz
(peak values shown) Band 13

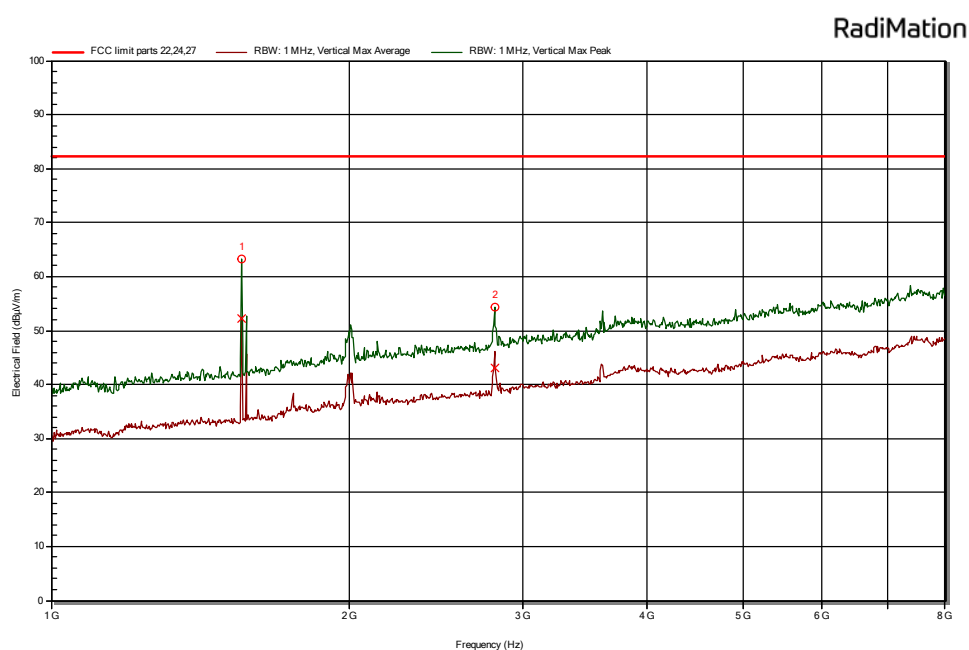


Plot 5i: radiated emissions of the EUT, Antenna vertical, in the range 0.25 – 1 GHz
(peak values shown) Band 13

Note: the highest peaks seen in the plots above is the fundamental frequency and therefore not subject to the limit.

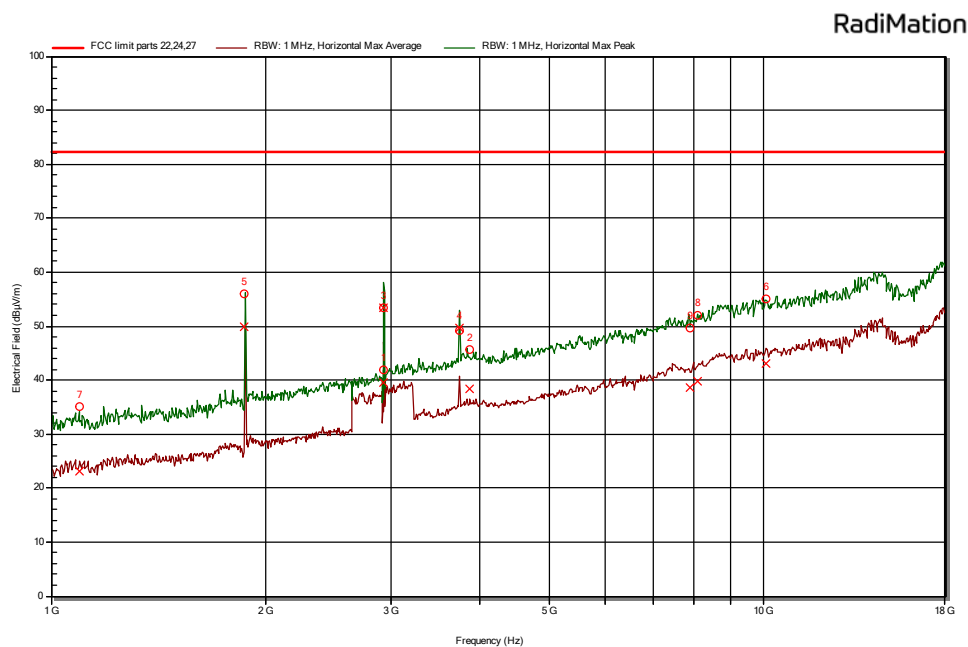


Plot 5j: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 13

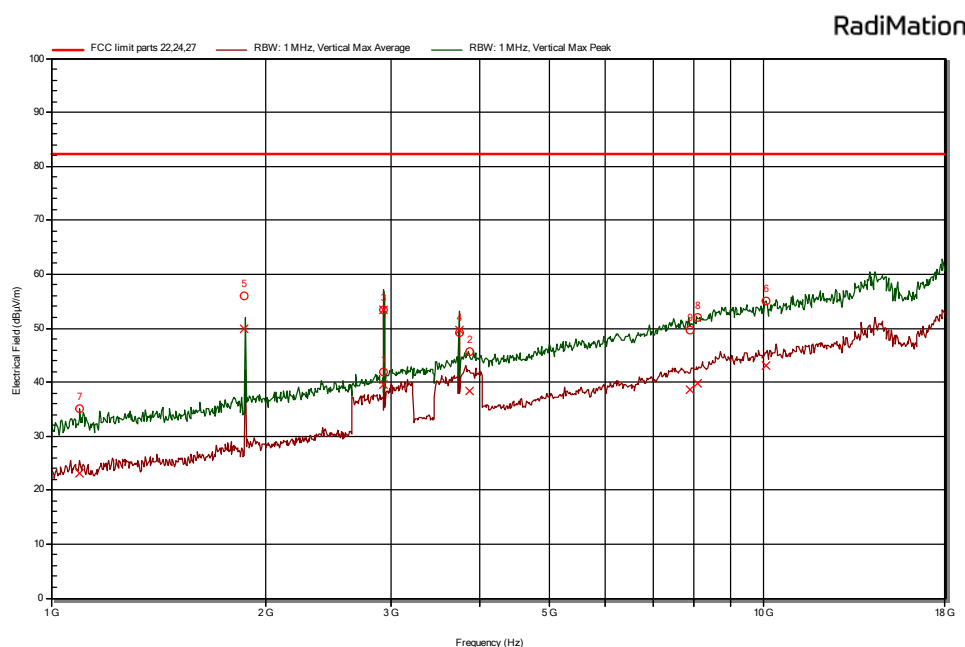


Plot 5k: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 13

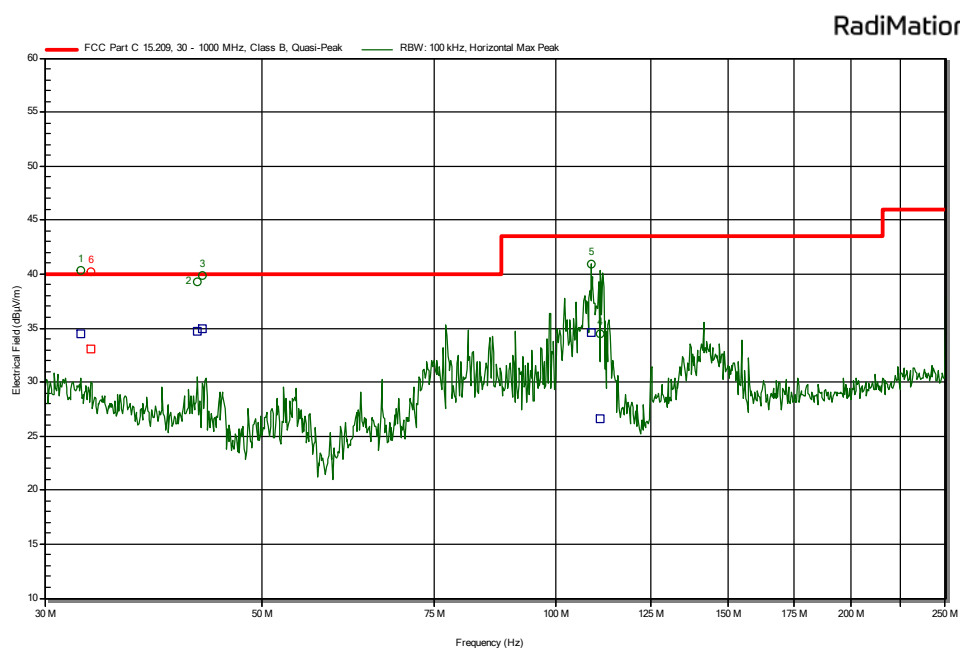
3.1.8 Plots of the simultaneous transmissions (LTE-M + BLE) measurements



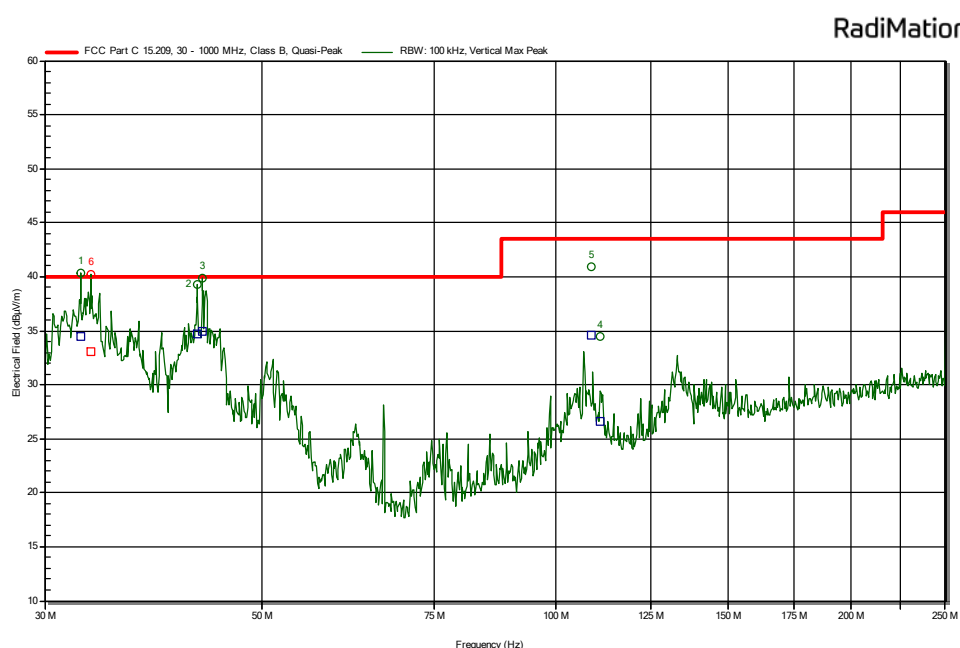
Plot 5l: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 2 + BLE



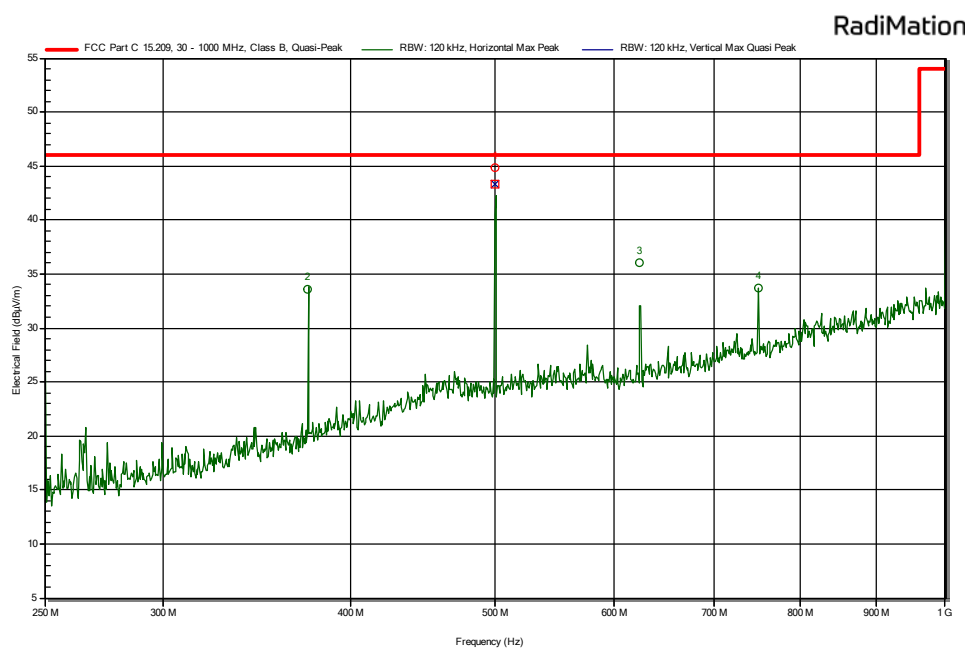
Plot 5m: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 2 + BLE



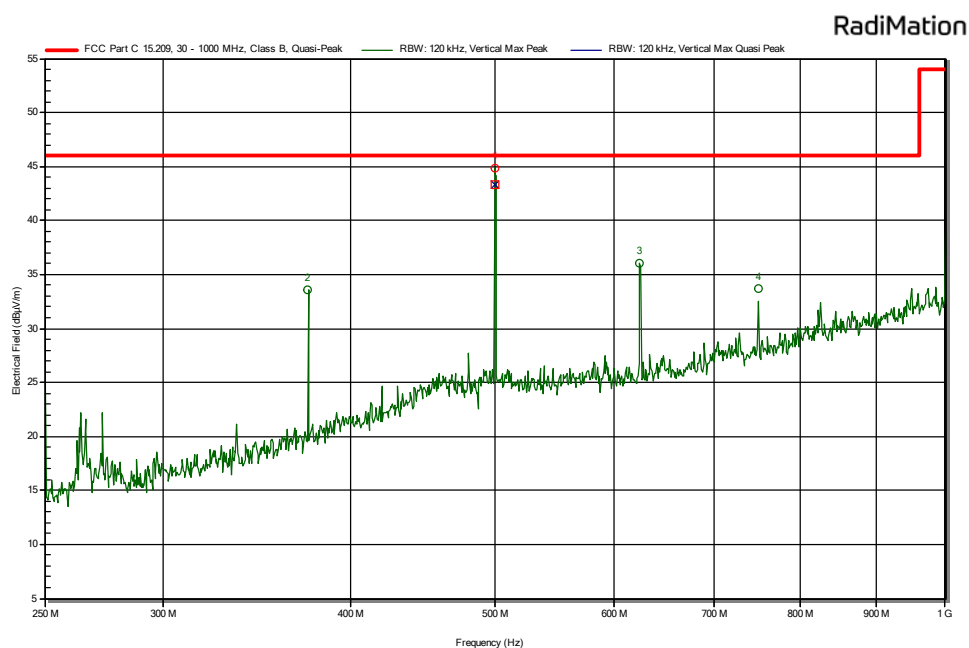
Plot 5n: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz
(peak values shown) Band 5 + BLE



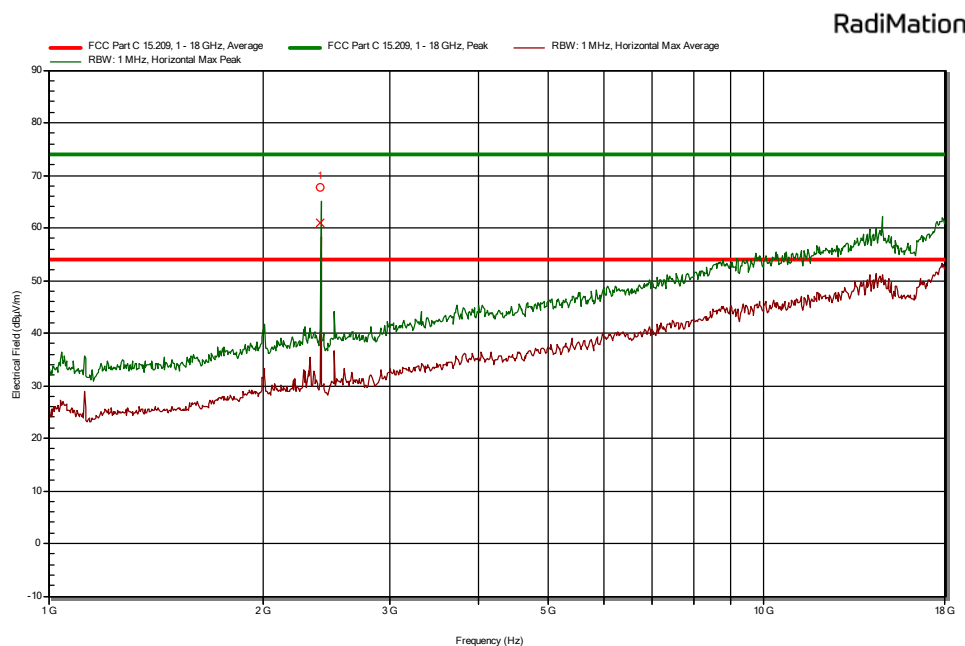
Plot 5o: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz
(peak values shown) Band 5 + BLE



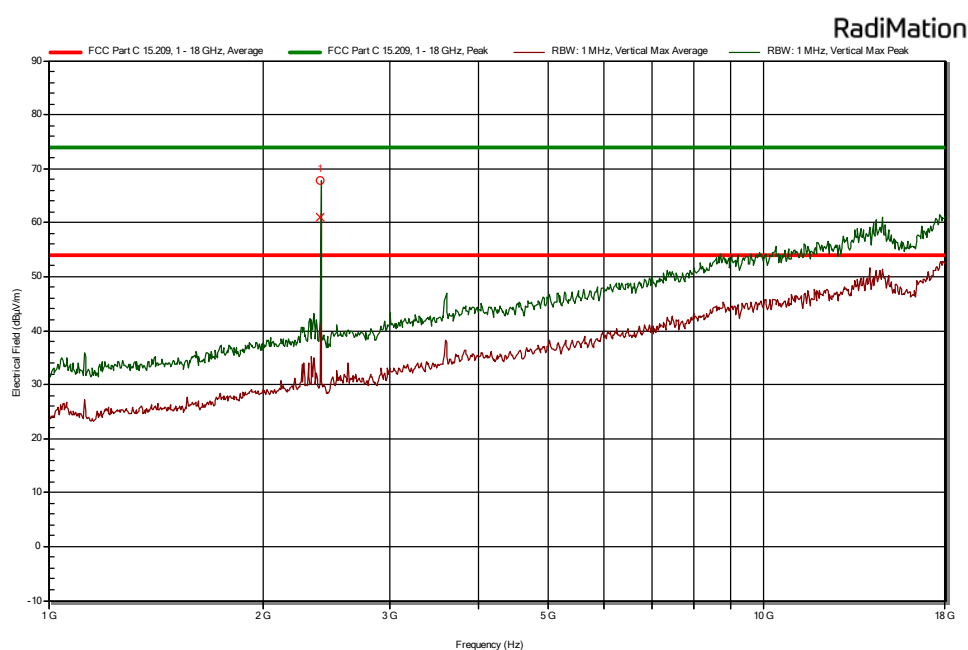
Plot 5p: radiated emissions of the EUT, Antenna horizontal, in the range 0.25 – 1 GHz
(peak values shown) Band 5 + BLE



Plot 5q: radiated emissions of the EUT, Antenna vertical, in the range 0.25 – 1 GHz
(peak values shown) Band 5 + BLE

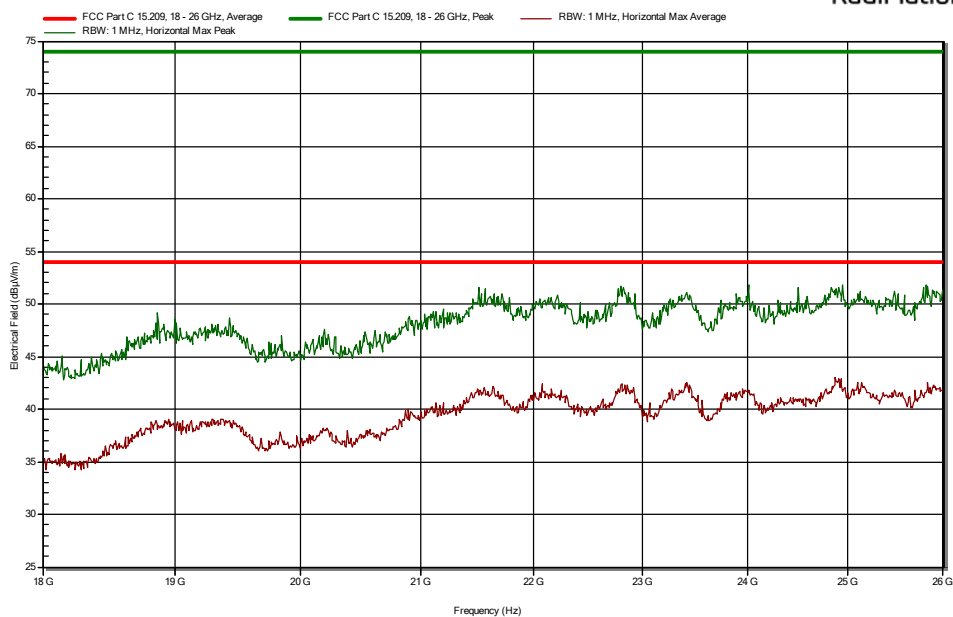


Plot 5r: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) Band 5 + BLE



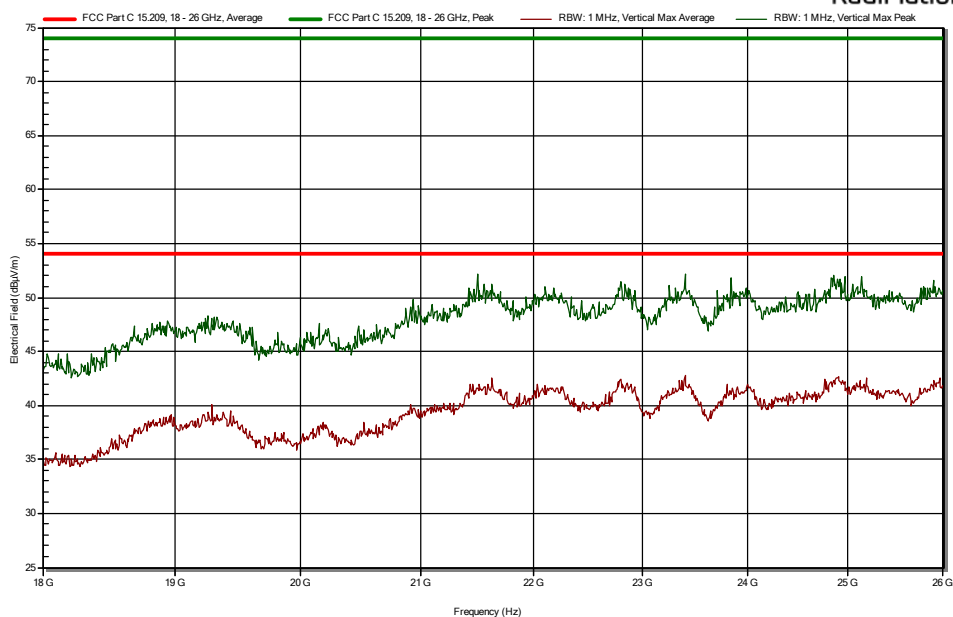
Plot 5s: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) Band 5 + BLE

RadiMation

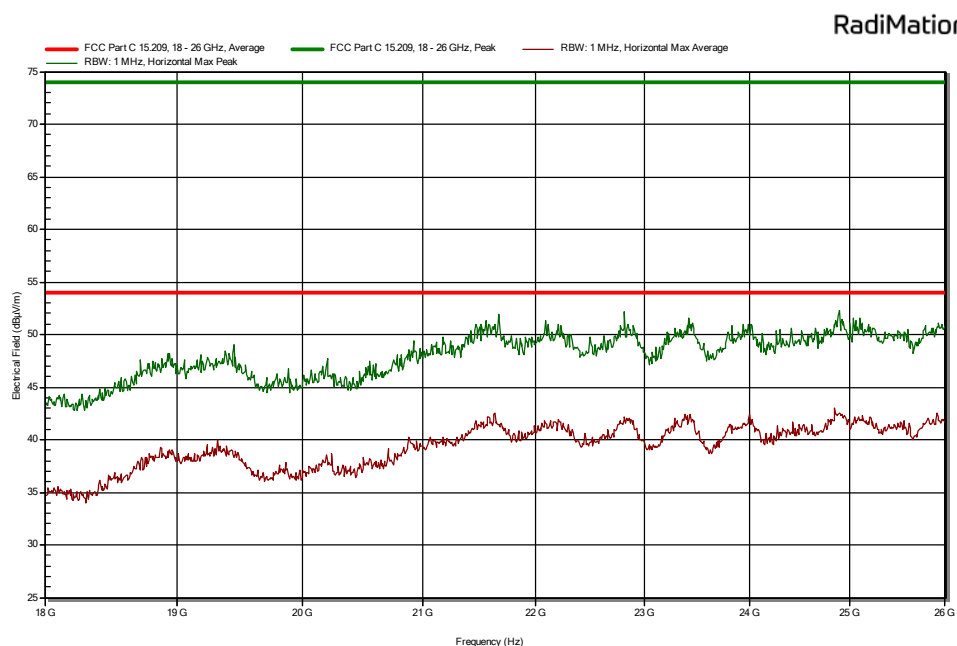


Plot 5t: radiated emissions of the EUT, Antenna horizontal in the range 18 – 26 GHz (peak and average values shown) Band 2 + BLE

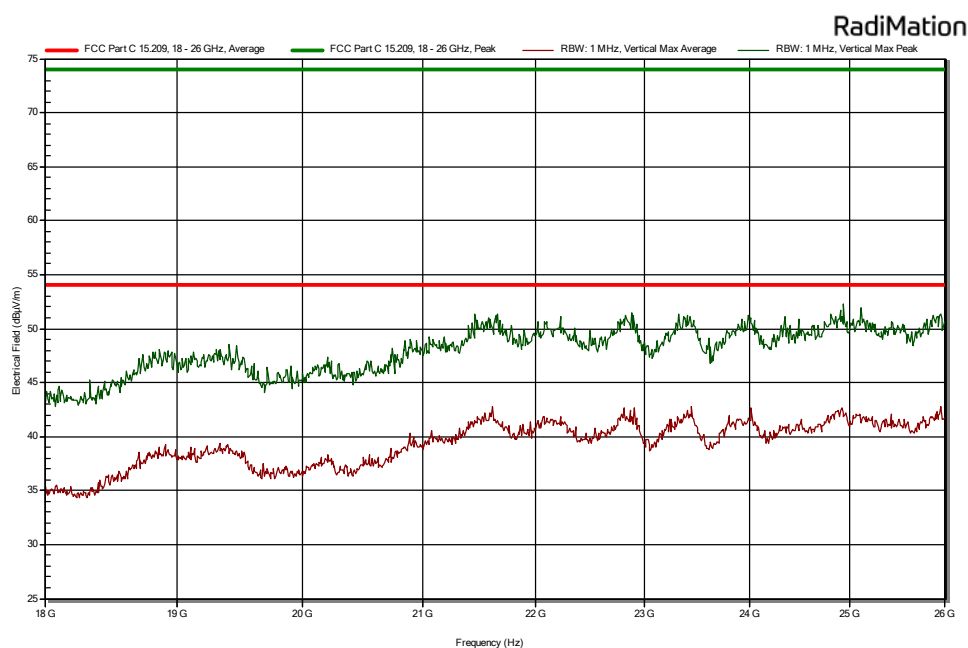
RadiMation



Plot 5u: radiated emissions of the EUT, Antenna vertical in the range 18 – 26 GHz (peak and average values shown) Band 2 + BLE

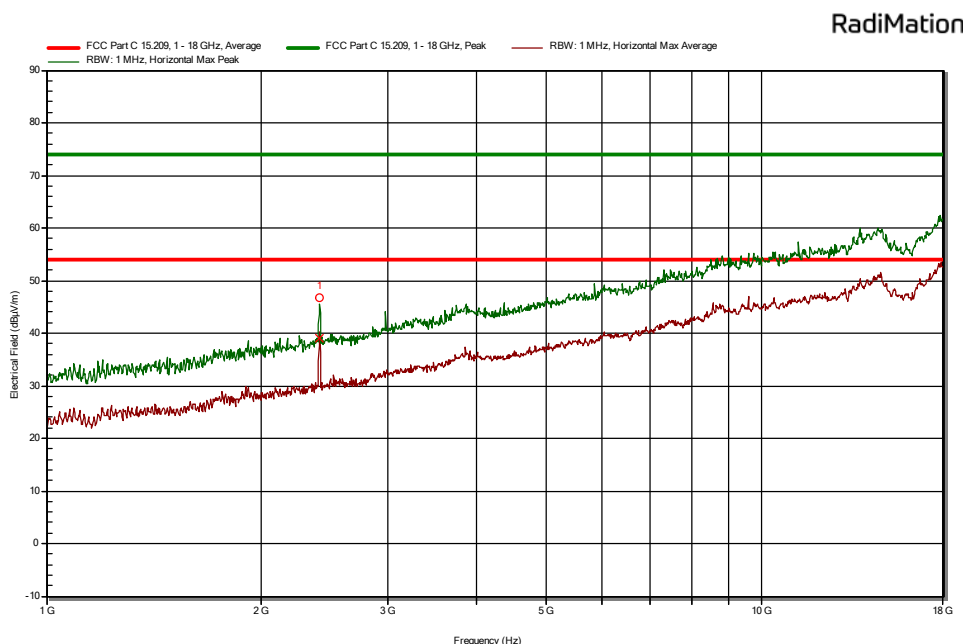


Plot 5v: radiated emissions of the EUT, Antenna horizontal in the range 18 – 26 GHz
(peak and average values shown) Band 5 + BLE

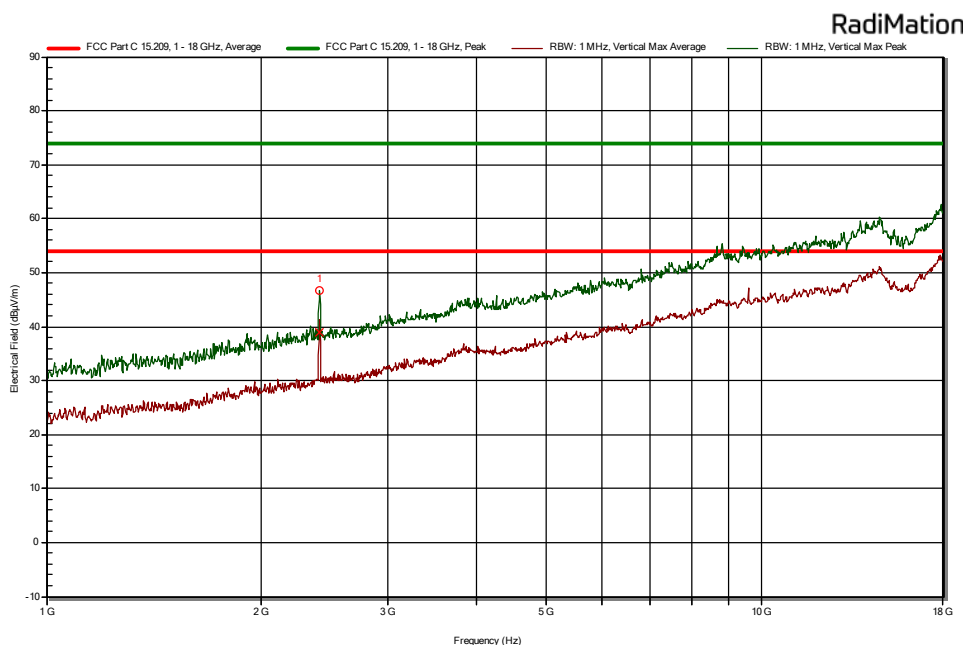


Plot 5w: radiated emissions of the EUT, Antenna vertical in the range 18 – 26 GHz
(peak and average values shown) Band 5 + BLE

3.1.9 Plots of the simultaneous transmissions (WLAN + BLE) measurements



Plot 5x: radiated emissions of the EUT, Antenna horizontal in the range 1 – 18 GHz
(peak and average values shown) WLAN + BLE



Plot 5y: radiated emissions of the EUT, Antenna vertical in the range 1 – 18 GHz
(peak and average values shown) WLAN + BLE
Note: a 2.4 GHz high pass filter was used.

3.2 Conducted emissions

3.2.1 Limit

According to 15.207 (c)

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 (dB μ V)	
	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.

3.2.2 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 C63.4: 2014, section 13.3

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3.2.5 Test results and plots of the AC mains conducted measurement

Phase

Frequency	Peak	Average	Average Limit	Status
190.5 kHz	43.3 dB μ V	25.4	54 dB μ V	Pass
285 kHz	40.3 dB μ V	22.2	50.7 dB μ V	Pass
388.5 kHz	41 dB μ V	36.7	48.1 dB μ V	Pass
159 kHz	46.4 dB μ V	28.8	55.5 dB μ V	Pass
172.5 kHz	45.3 dB μ V	28.8	54.8 dB μ V	Pass
217.5 kHz	41 dB μ V	28.1	52.9 dB μ V	Pass

Neutral

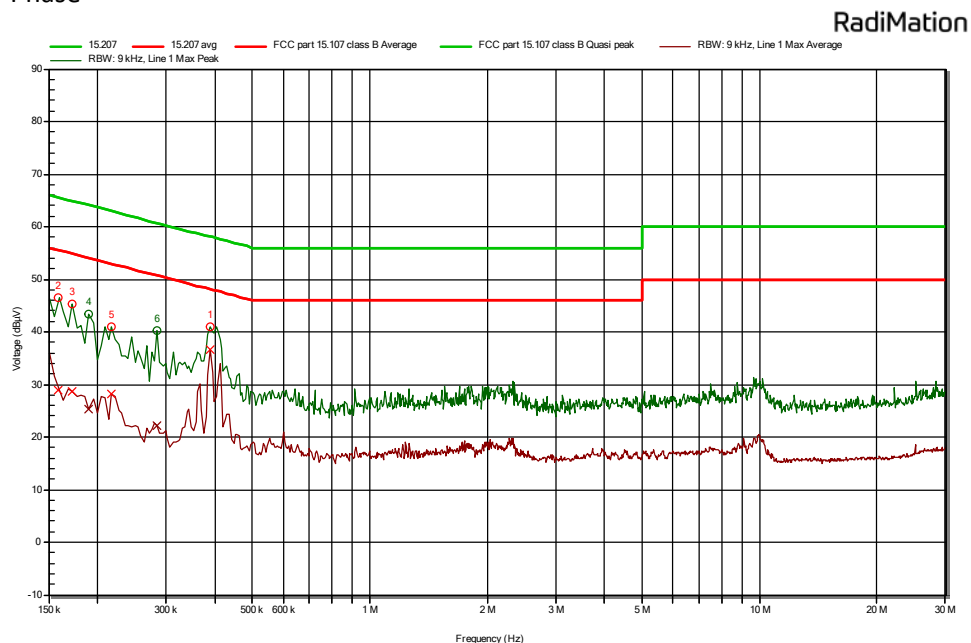
Frequency	Peak	Average	Average Limit	Status
393 kHz	38.8 dB μ V	27.2	48 dB μ V	Pass
154.5 kHz	47.4 dB μ V	30.2	55.8 dB μ V	Pass
186 kHz	42.2 dB μ V	22.5	54.2 dB μ V	Pass
195 kHz	41.7 dB μ V	25.2	53.8 dB μ V	Pass
208.5 kHz	39.7 dB μ V	23.0	53.3 dB μ V	Pass
226.5 kHz	37.6 dB μ V	23.0	52.6 dB μ V	Pass

3.2.6 Measurement uncertainty

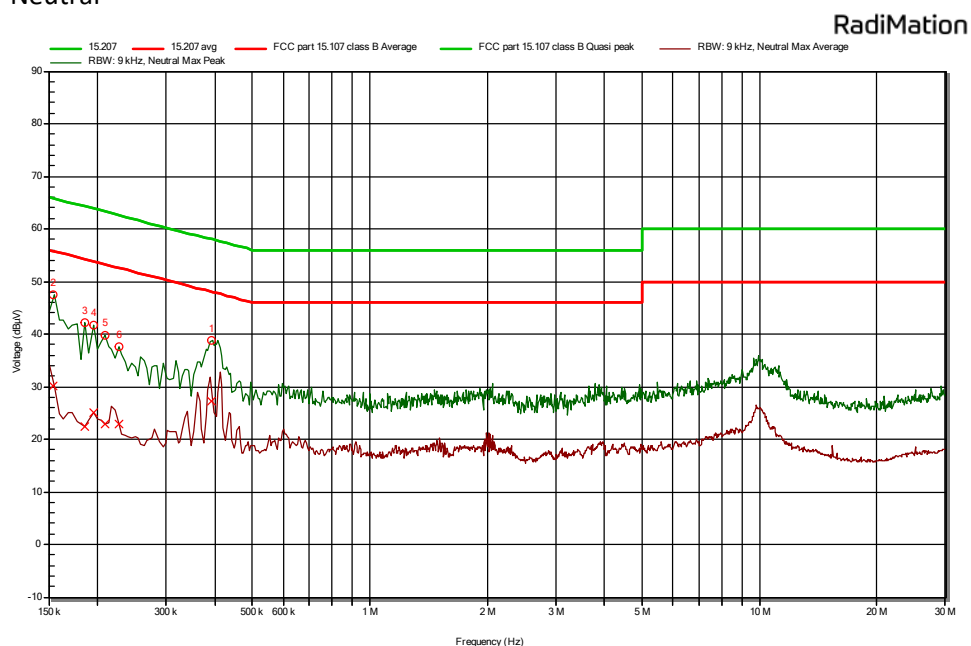
+/- 3.6 dB

3.2.7 Plots of the AC mains conducted spurious measurement

Phase



Neutral



4 Sample calculations

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

Conducted emission Measurement (see chapter 3.9):

$$U_{\text{lisn}} (\text{dB}\mu\text{V}) = U (\text{dB}\mu\text{V}) + \text{Corr. (dB)}$$

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)	Insertion Loss Pulse limiter (dB)	Cable loss (dB)	Corr. (dB)
	Kiwa ID 114159 SN: 892785/004 Rohde & Schwarz ESH3-Z5	Kiwa ID 114160 SN: 5SM03153 Rohde & Schwarz ESH3-Z2	-	
0,15	0,09	9,87	0,02	9,98
0,2	0,1	9,87	0,03	10
0,3	0,1	9,87	0,03	10
0,5	0,1	9,87	0,08	10,05
0,7	0,12	9,87	0,25	10,24
0,8	0,12	9,87	0,25	10,24
1	0,13	9,87	0,11	10,11
2	0,16	9,87	0,15	10,18
3	0,19	9,87	0,21	10,27
5	0,26	9,88	0,21	10,35
7	0,36	9,89	0,25	10,5
8	0,39	9,89	0,25	10,53
10	0,46	9,91	0,29	10,66
15	0,77	9,93	0,34	11,04
20	0,95	9,96	0,37	11,28
25	1,12	9,99	0,43	11,54
30	1,1	10,04	0,45	11,59

Field Strength Measurement (see chapter 3.3):

$$E \text{ (dB}\mu\text{V/m)} = U \text{ (dB}\mu\text{V)} + AF \text{ (dB/m)} + \text{Corr. (dB)}$$

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)	Cable loss (dB)	Corr. (dB)
	Kiwa ID 114516 Chase CBL6112A SN: 2308	Id: SAR cable	
30	18,6	0,68	19,28
100	10,7	1,15	11,85
150	10,6	1,41	12,01
200	9,3	1,63	10,93
250	12,6	1,93	14,53
300	13,3	2,12	15,42
350	14,6	2,2	16,8
400	15,5	2,29	17,79
450	16,9	2,53	19,43
500	17,5	2,67	20,17
550	18,4	2,9	21,3
600	18,8	3,02	21,82
650	19,2	3,09	22,29
700	19	3,22	22,22
750	19,8	3,56	23,36
800	19,7	3,69	23,39
900	20,4	3,81	24,21
950	20,8	3,91	24,71
1000	21,2	4,3	25,5

Frequency (Mhz)	AF (dB/m)	Gain (dB)	Cable loss (dB)	Corr. (dB)
	TE 00531 Emco 3115 SN: 9412-4377	TE 11132 Miteq JS4-18004000-30-8P-A1	TE 01315	
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)	Gain (dB)	Cable loss (dB)	Corr. (dB)
	TE 00531 Emco 3115 SN: 9412-4377	TE 11132 Miteq JS4-18004000-30-8P-A1	TE 01315	
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