

FCC and IC Test report for parts
22.359, 24.238, 27.53
RSS-Gen, RSS-130, RSS-132, RSS-133 RSS-139,
(Transmitter spurious emissions only)

Product name : TC-1
Applicant : Nilfisk A/S
FCC ID : 2AVNE-TC1
IC ID : 25476-TC1

Test report No. : 200100533 016 Ver 1.0

Laboratory information

Accreditation

Telefication 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 L021 and is granted on 30 November 1990 by the Dutch Council For Accreditation (RvA: Raad voor Accreditatie).

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

Telefication is a Wireless Device Testing laboratory recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements.

The Industry Canada registration number for the 3 meter test chamber of Telefication is: 4173A-1.

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

Documentation

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

Testing Location

Test Site	Telefication BV
Test Site location	Edisonstraat 12a 6902 PK Zevenaar The Netherlands Tel. +31316583180 Fax. +31316583189
Test Site FCC	NL0001

Revision History

Version	Date	Remarks	By
v0.50	29-09-2020	First draft	PvW
v1.00	14-12-2020	Initial Release	PvW

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Summary of Test results

FCC	ISED	Description	Section in report	Verdict
22.359 24.238 27.53	RSS-Gen RSS-130 RSS-132 RSS-133 RSS-139	Radiated spurious emissions	3.1	Pass

1 General Description

1.1 Applicant

Client name: Nilfisk A/S
Address: Kornmarksvej 1, Broendby
Zip code: DK-2605, Denmark
Telephone: +45 30654609
E-mail: Lars.stagsted.hansen@nilfisk.com
Contact name: Mr. Lars Stagsted Hansen

1.2 Manufacturer

Manufacturer name: Nilfisk A/S
Address: Kornmarksvej 1, Broendby
Zip code: DK-2605, Denmark
Telephone: +45 30654609
E-mail: Lars.stagsted.hansen@nilfisk.com
Contact name: Mr. Lars Stagsted Hansen

1.3 Tested Equipment Under Test (EUT)

Product name: TC-1
Brand name: Nilfisk A/S
FCC ID: 2AVNE-TC1
IC ID: 25476-TC1
Product type: Telemetry IoT Module
Model(s): --
Batch and/or serial No. --
Software version: Rev 01.xxx
Hardware version: Rev D.x.x
Date of receipt: 20-05-2020
Tests started: 30-07-2020
Testing ended: 31-07-2020

1.4 Product specifications of Equipment under test

Tx Frequency:	Device operates within approved frequencies overlapping with the following cellular bands: GSM 1800 DCS UP LTE 10,AWS-1+ UP LTE 3,1800+ UP LTE 4,AWS-1 UP LTE 66,AWS-3 UP UMTS CH 10 UP UMTS CH 3 UP UMTS CH 4 UP
Rx frequency:	Device operates within approved frequencies overlapping with the following cellular bands: GSM 1800 DCS UP LTE 10,AWS-1+ UP LTE 3,1800+ UP LTE 4,AWS-1 UP LTE 66,AWS-3 UP UMTS CH 10 UP UMTS CH 3 UP UMTS CH 4 UP
Antenna type:	Patch antenna
Type of modulation:	According to GSM/LTE specs

1.5 Environmental conditions

Test date	30-07-2020	31-07-2020
Ambient temperature	29.2°C	29.8°C
Humidity	33.2%	31.9%

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 22 Subpart C §22.359
- FCC Part 24 Subpart C §24.238
- FCC Part 27 Subpart C §27.53
- RSS-Gen Issue 5
- RSS-130 Issue 2
- RSS-132 Issue 3
- RSS-133 Issue 6, A1
- RSS-139 Issue 3

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 : P. van Wanrooij, BASc

Review of test methods and report by:

Name : ing. R. van Barneveld

The above conclusions have been verified by the following signatory:

Date : 15-12-2020

Name : ing P.A. Suringa

Function : Senior Test Engineer

Signature :



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.

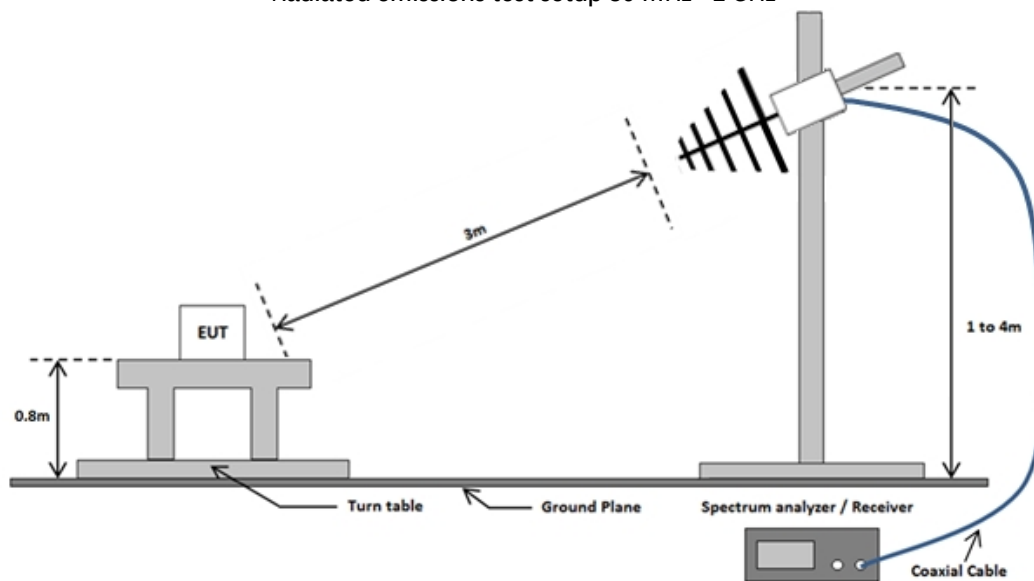
The EUT also contains a BLE radio, it was not possible to disable this transmitter during emission testing of the cellular radio.

Tested channels/bands

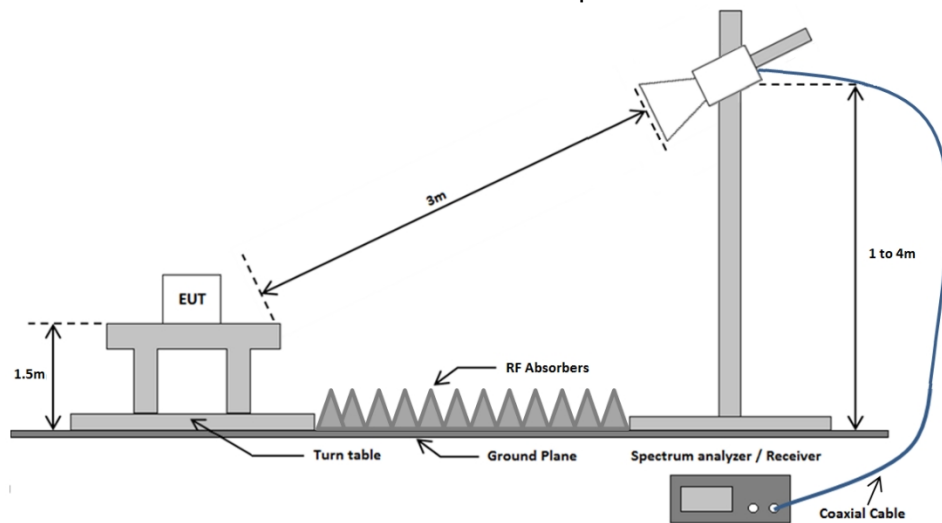
Technology	Band	Uplink Frequency range (MHz)
GSM	850	824.2 – 848.8
	1900	1850.2 – 1909.8
LTE	2	1850 – 1910
	5	824 – 849

2.2 Test setups

Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



2.3 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Used at Par.
Spectrum analyzer	Rohde & Schwarz	FSP40	TE 11125	3.1
Measurement receiver	Rohde & Schwarz	ESR7	TE 01220	3.1
Biconilog antenna	Chase	CBL6112A	TE 00967	3.1
Horn antenna	EMCO	3115	TE 00531	3.1
Preamplifier	μComp	MCNA-40-001080	TE 11175	3.1
Semi-Anechoic room	COMTEST	SAR	TE 00861	3.1
Active loop antenna	EMCO	9112-2710	TE 11171	3.1
Preamplifier	MITEQ	JS4-18004000-33-8P	TE 11131	3.1
Horn antenna	Flann Microwave	20240-25	TE 00818	3.1
Radio communication tester	Rohde & Schwarz	CMW-500	TE 01286	3.1
Radio communication tester	Rohde & Schwarz	CMU-200	TE 01166	3.1

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 C63.4-2014, section 8.3

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 – 200 MHz	Horizontal	$\pm 4.5 \text{ dB}$
	Vertical	$\pm 5.4 \text{ dB}$
200 -1000 MHz	Horizontal	$\pm 3.6 \text{ dB}$
	Vertical	$\pm 4.6 \text{ dB}$
1 – 18 GHz	Horizontal	$\pm 5.7 \text{ dB}$
	Vertical	$\pm 5.7 \text{ dB}$
18 – 26.5 GHz	Horizontal	$\pm 4.9 \text{ dB}$
	Vertical	$\pm 4.9 \text{ dB}$

3.1.6 Results of the radiated spurious emissions measurement

GSM 850

Peak Number	Frequency	Peak	Peak Limit	Status	Polarization
1	3,247 GHz	-61,5 dBm	-13,0 dBm	Pass	Horizontal

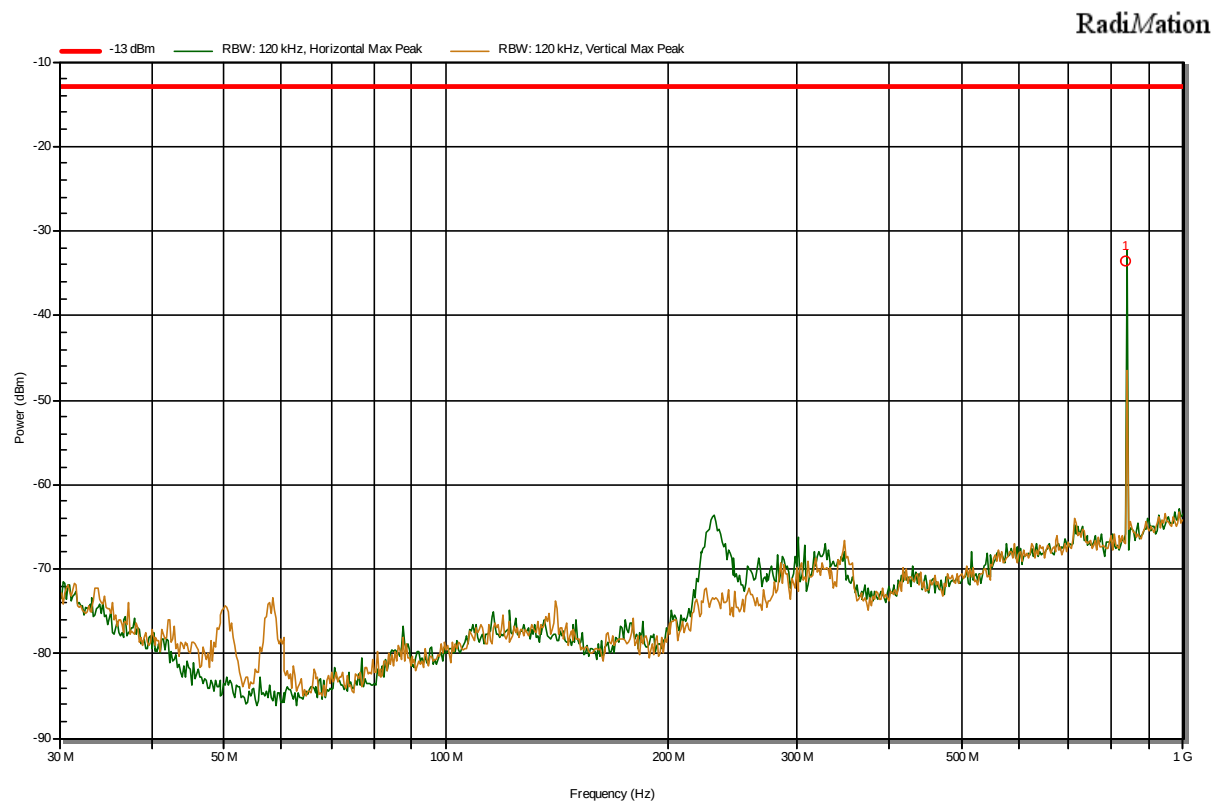
GSM 1900

Peak Number	Frequency	Peak	Peak Limit	Status	Polarization
1	3,74 GHz	-46,5 dBm	-13,0 dBm	Pass	Horizontal

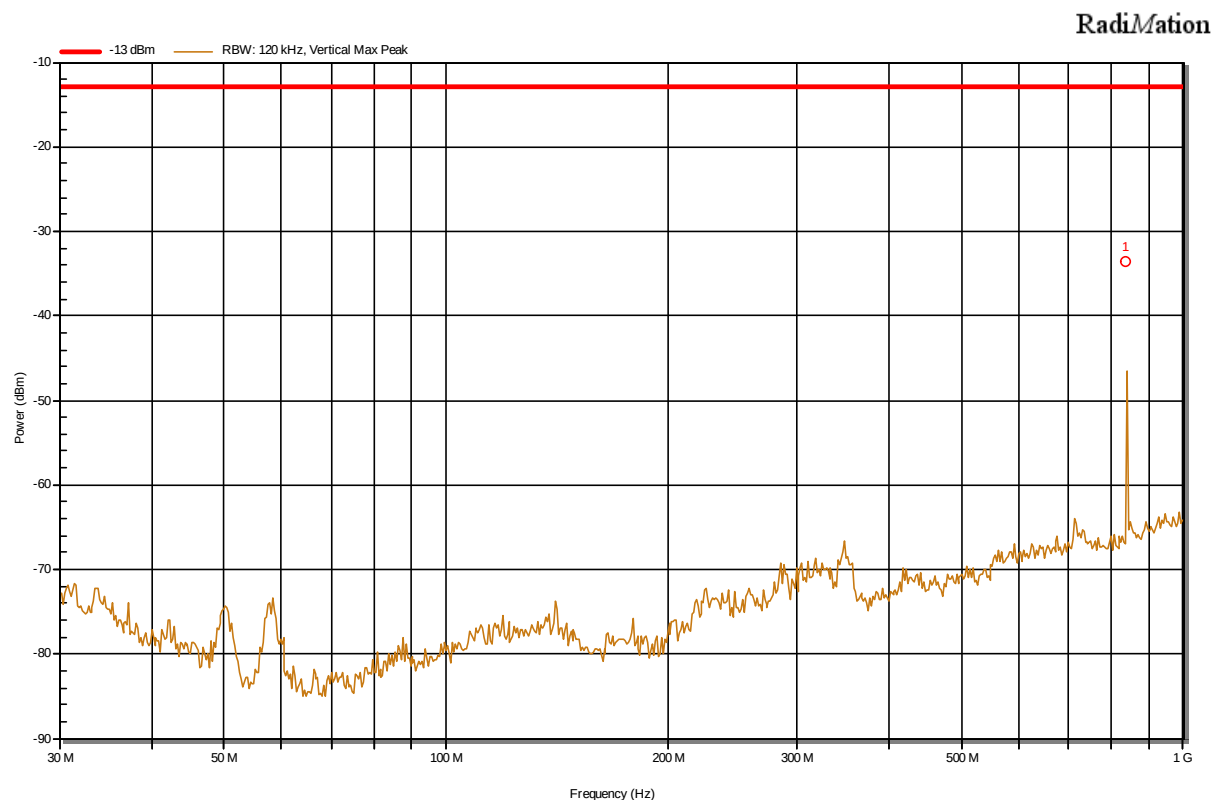
3.1.7 Plots of the Radiated Spurious Emissions Measurement (LTE Band 5)

30 – 1000 MHz

Horizontal

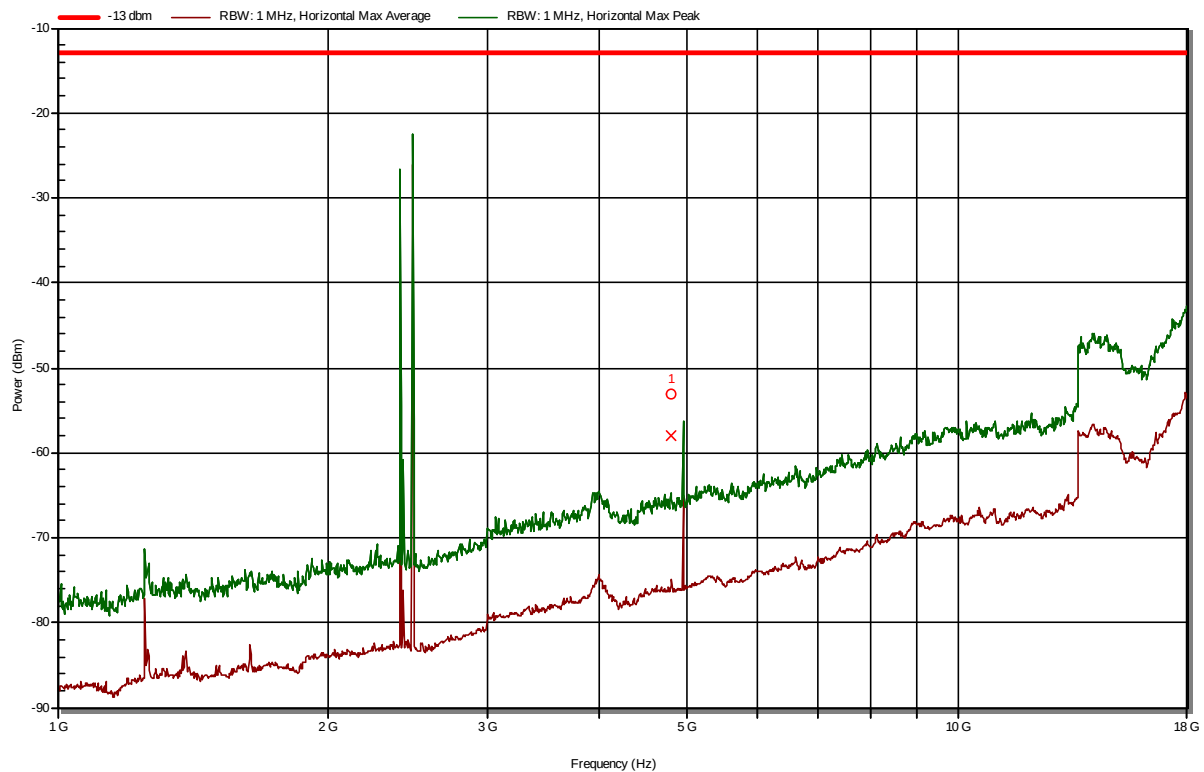


Vertical



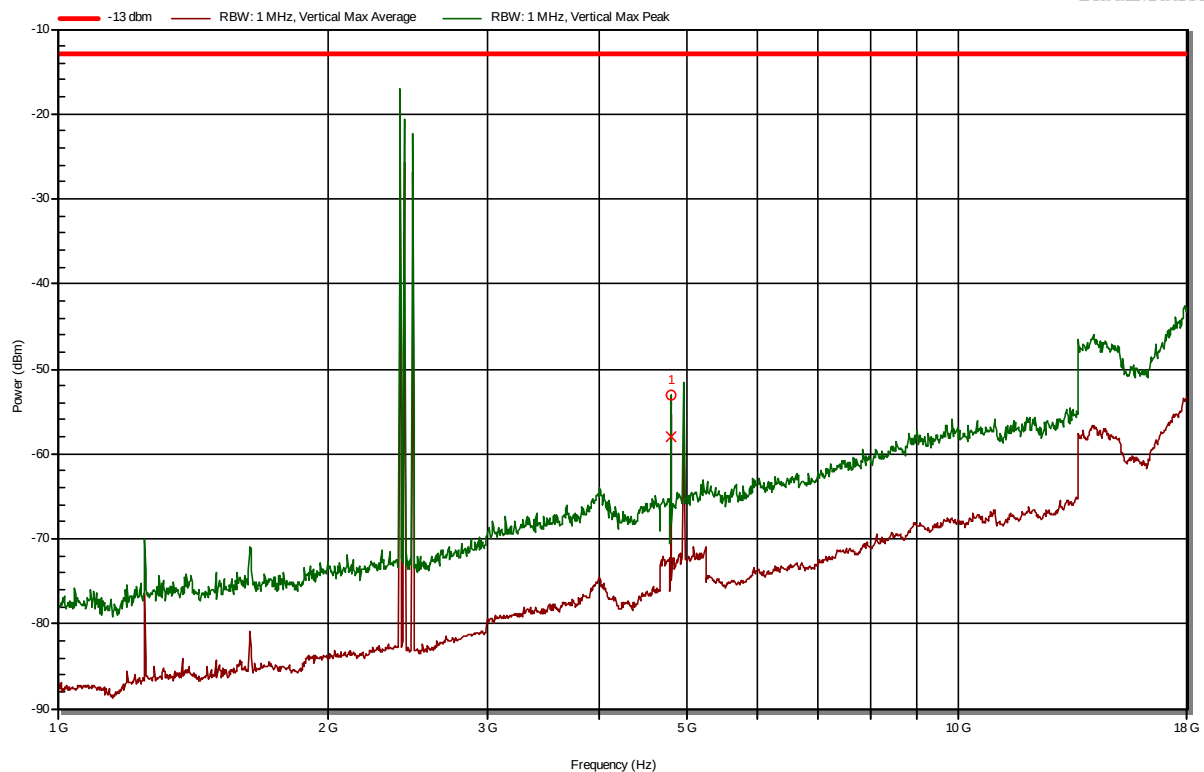
1 – 18 GHz
Horizontal

RadiMation



Vertical

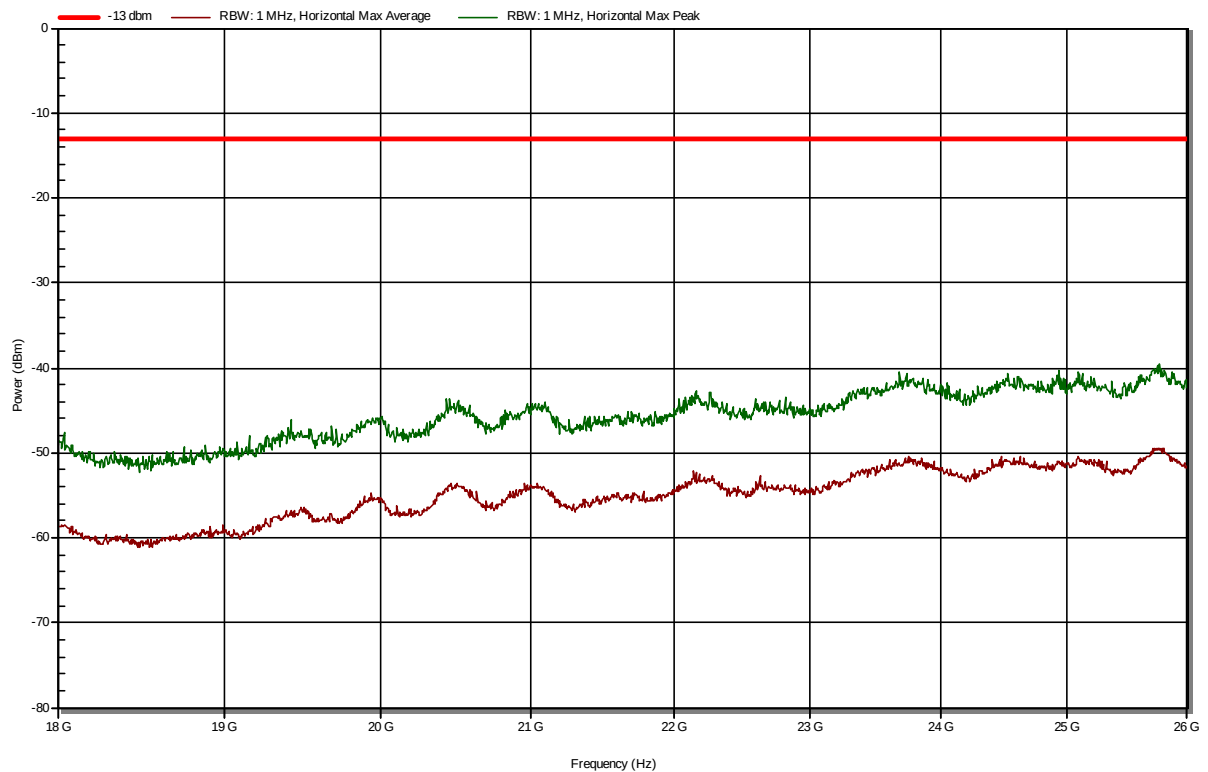
RadiMation



Note: The peaks in the 2400 – 2483.5 MHz range are transmitted by the BLE radio and are not subject to the limit.

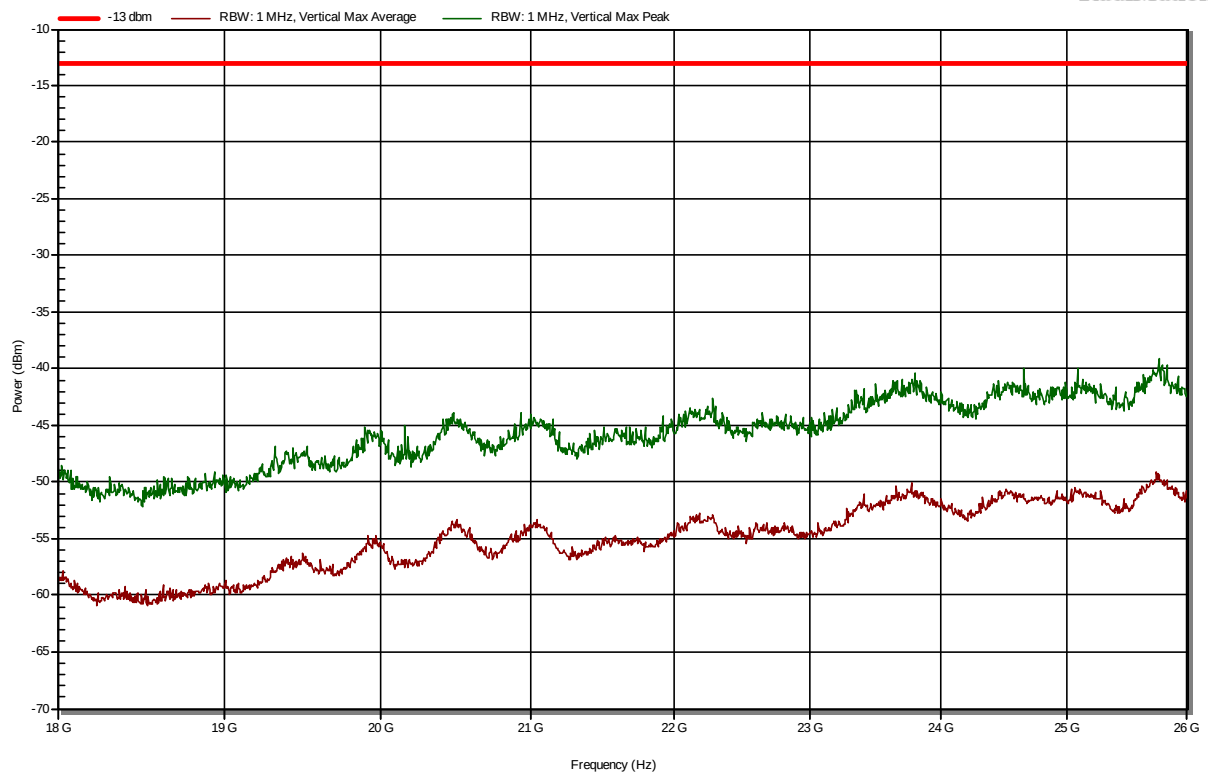
18 – 26 GHz Horizontal

RadiMation



Vertical

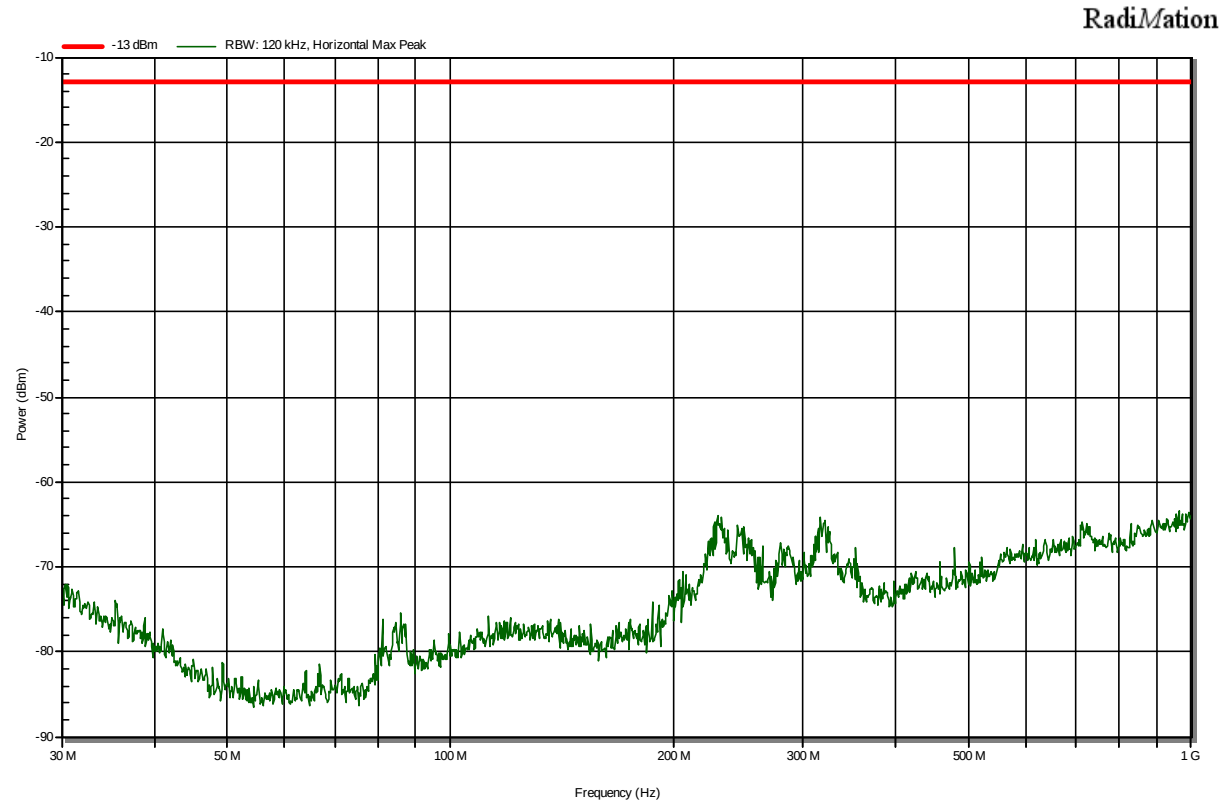
RadiMation



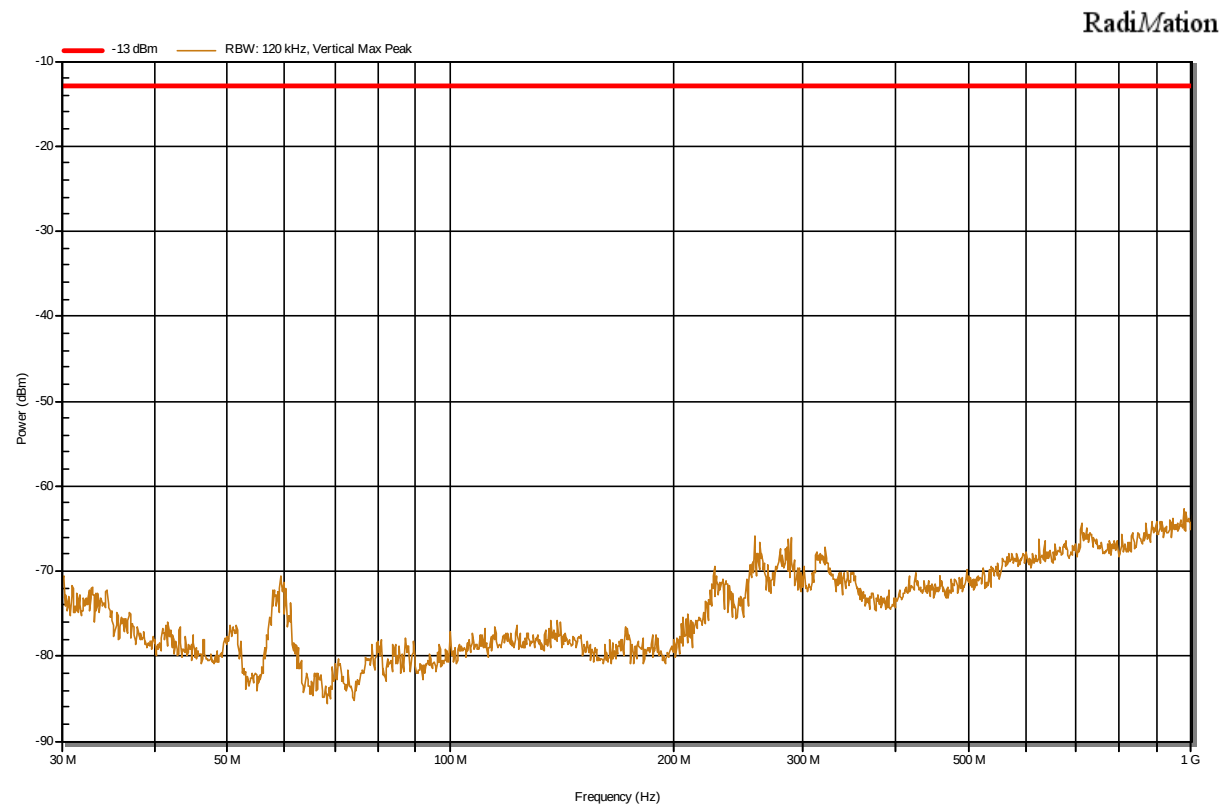
3.1.8 Plots of the Radiated Spurious Emissions Measurement (LTE Band 2)

30-1000 MHz

Horizontal

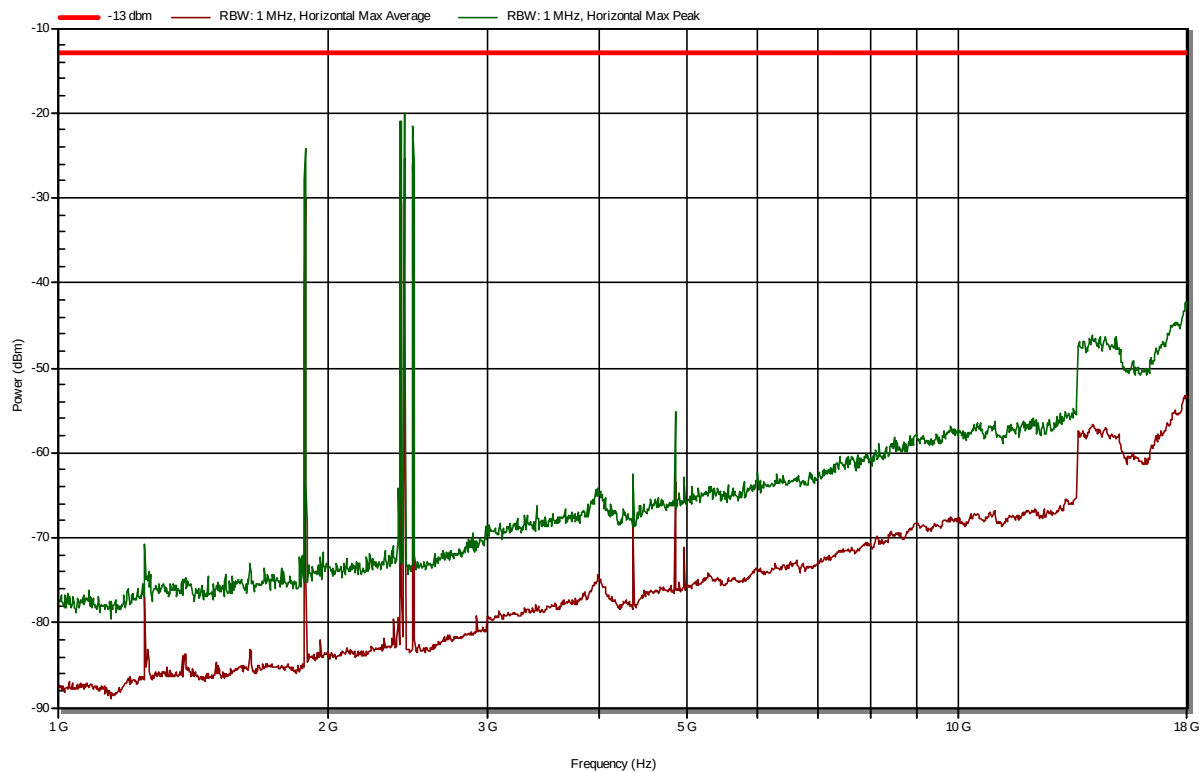


Vertical



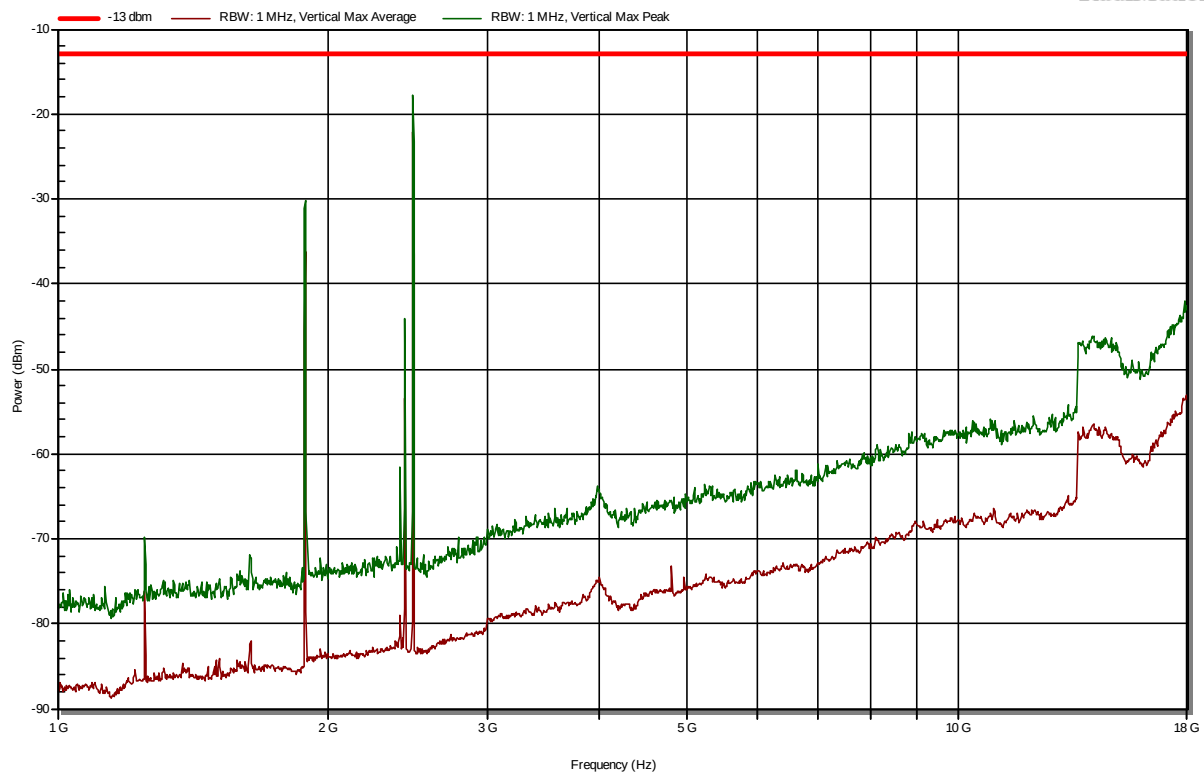
1 – 18 GHz Horizontal

RadiMation



Vertical

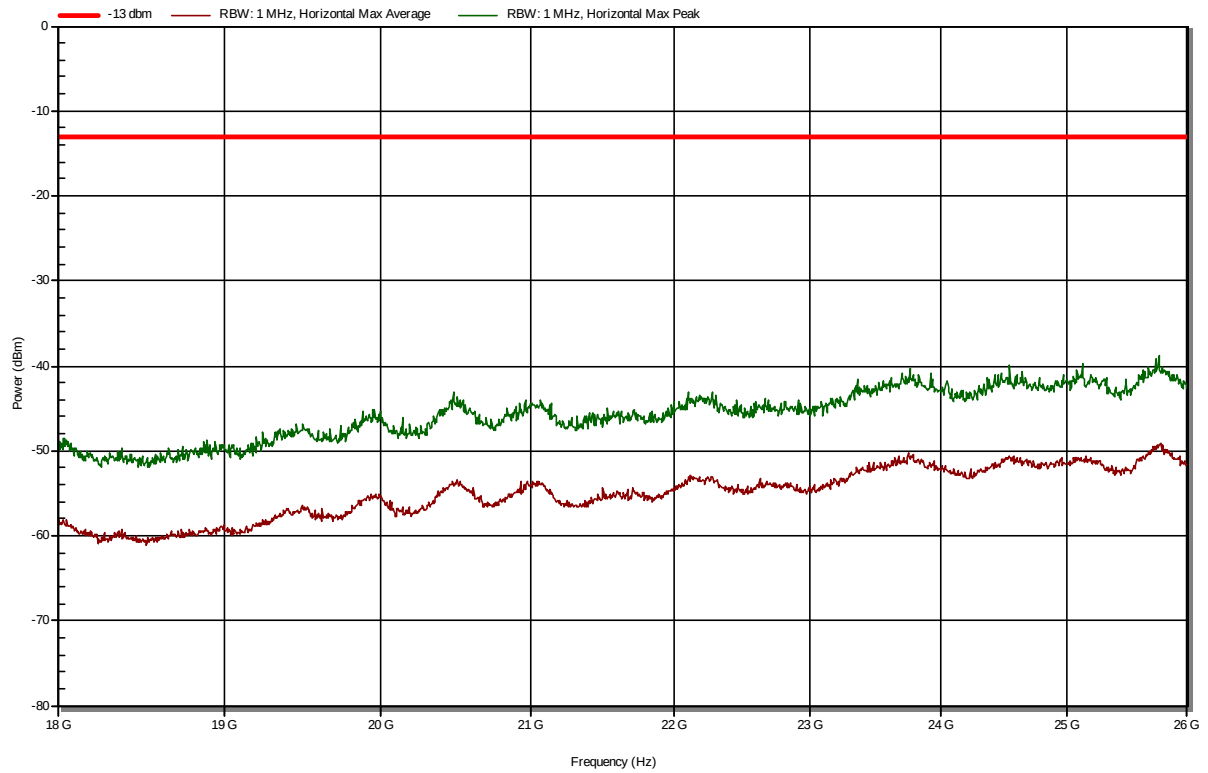
RadiMation



Note: The peaks in the 2400 – 2483.5 MHz range are transmitted by the BLE radio and are not subject to the limit. The peak at 1900 MHz is the transmission frequency and is not subject to the limit.

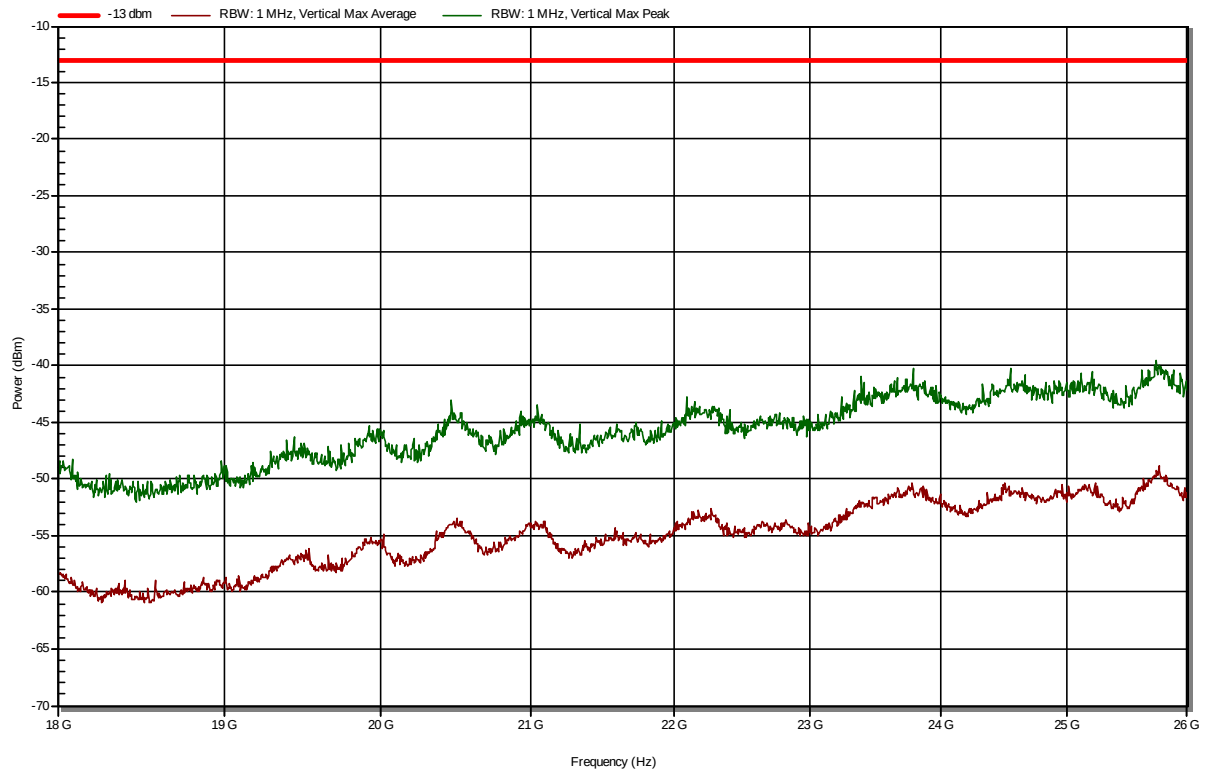
18-26 GHz
Horizontal

RadiMation



Vertical

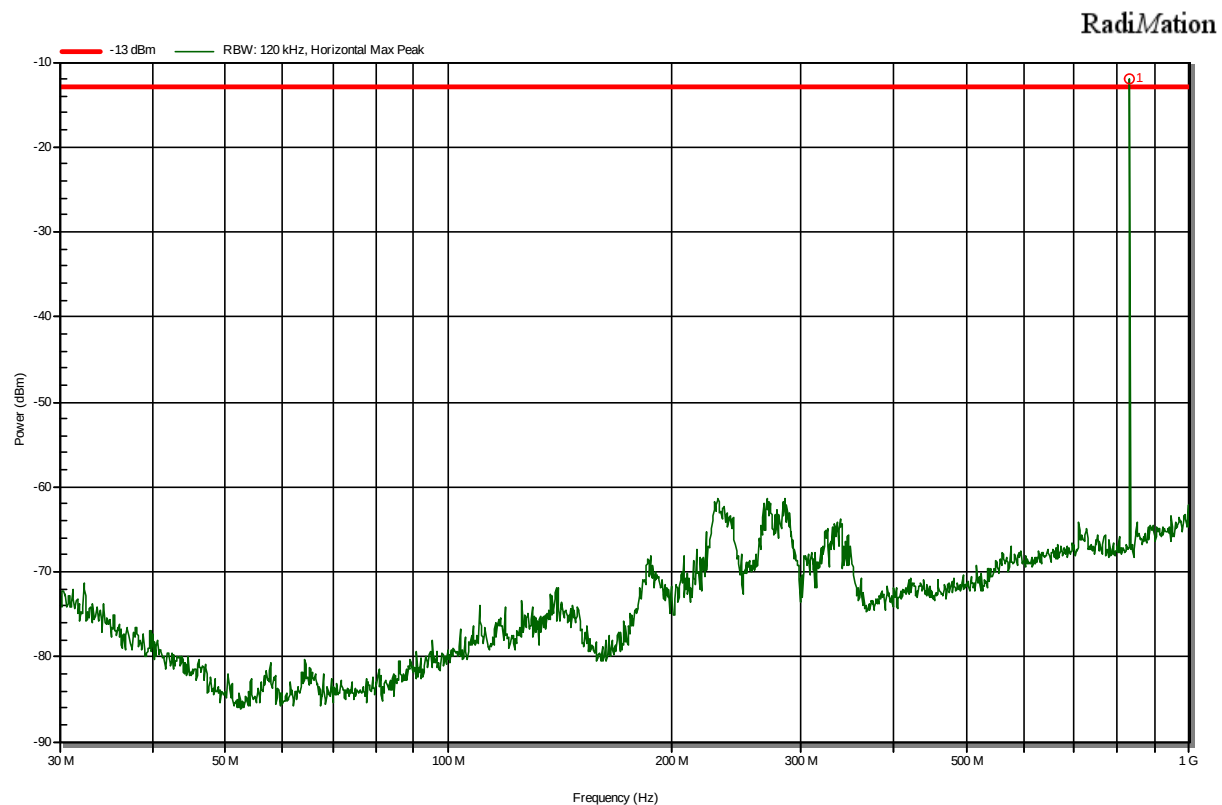
RadiMation



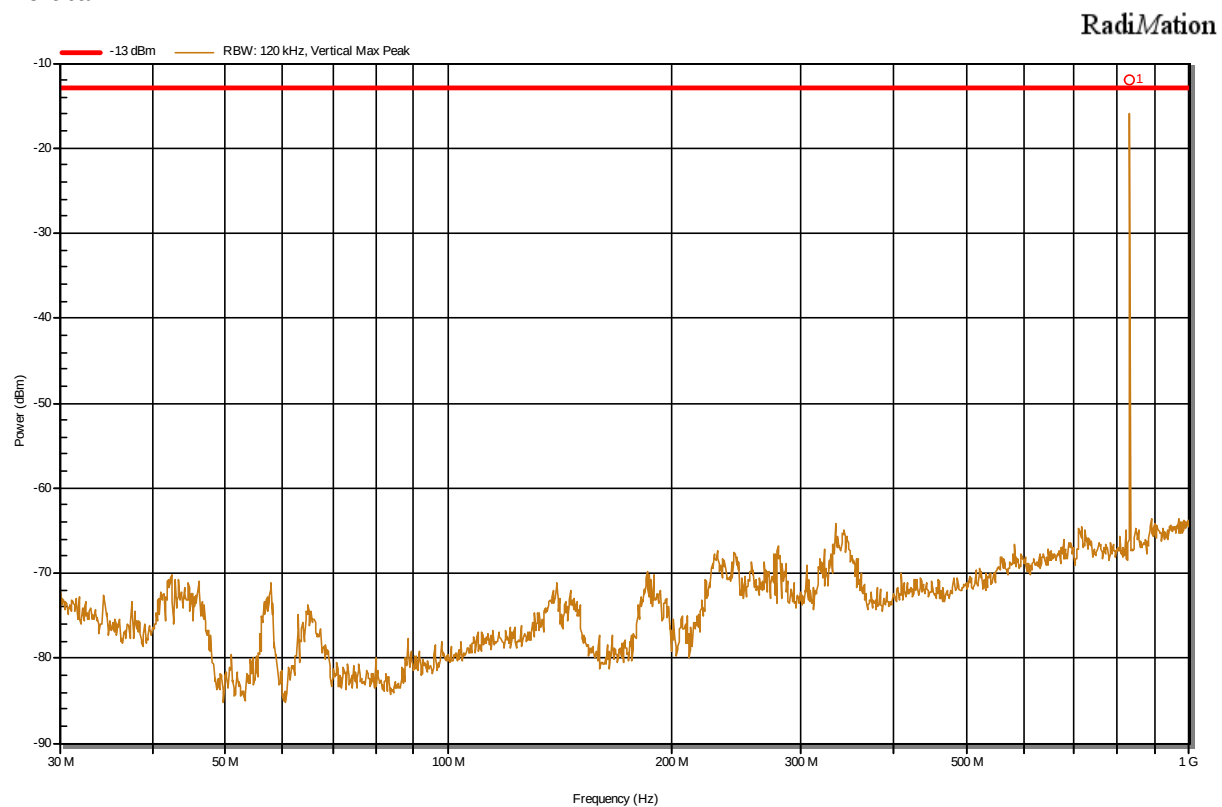
3.1.9 Plots of the Radiated Spurious Emissions Measurement (GSM 850)

30-1000 MHz

Horizontal

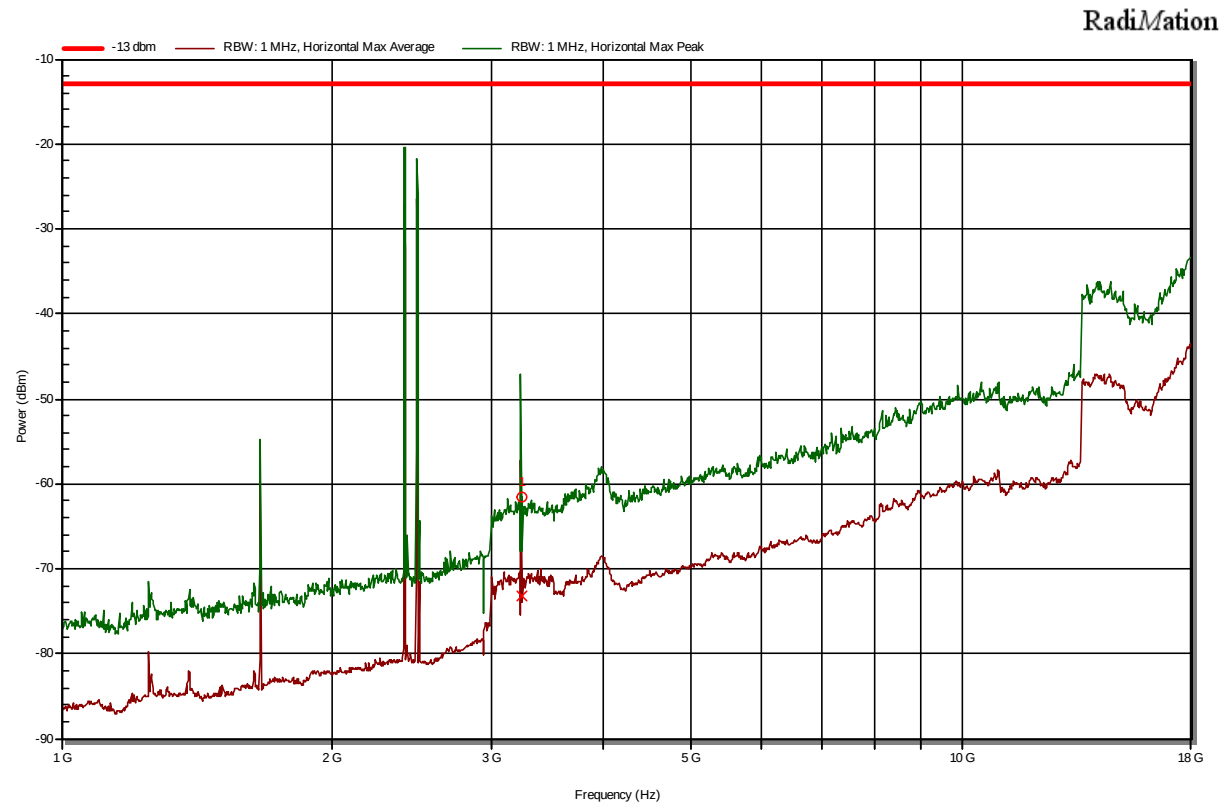


Vertical

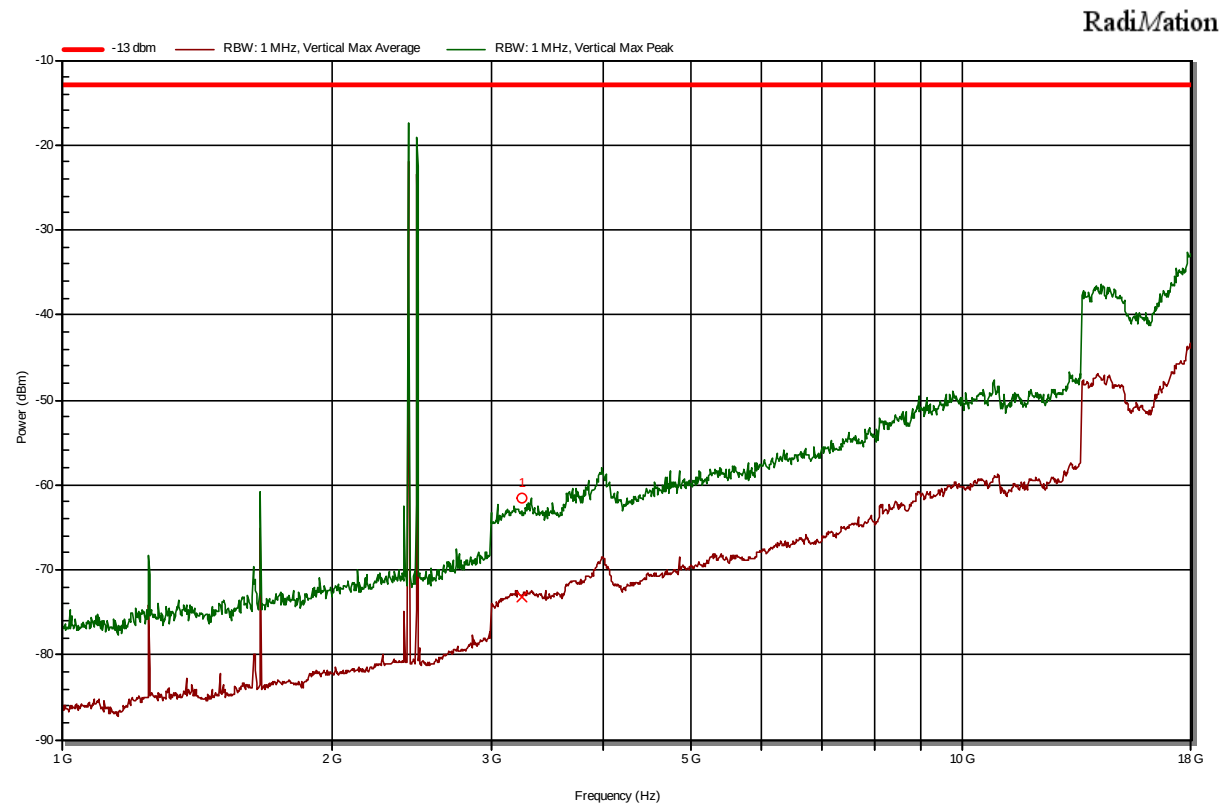


Note: The peak at 840 MHz is the transmission frequency and is not subject to the limit.

1 – 18 GHz
Horizontal



Vertical

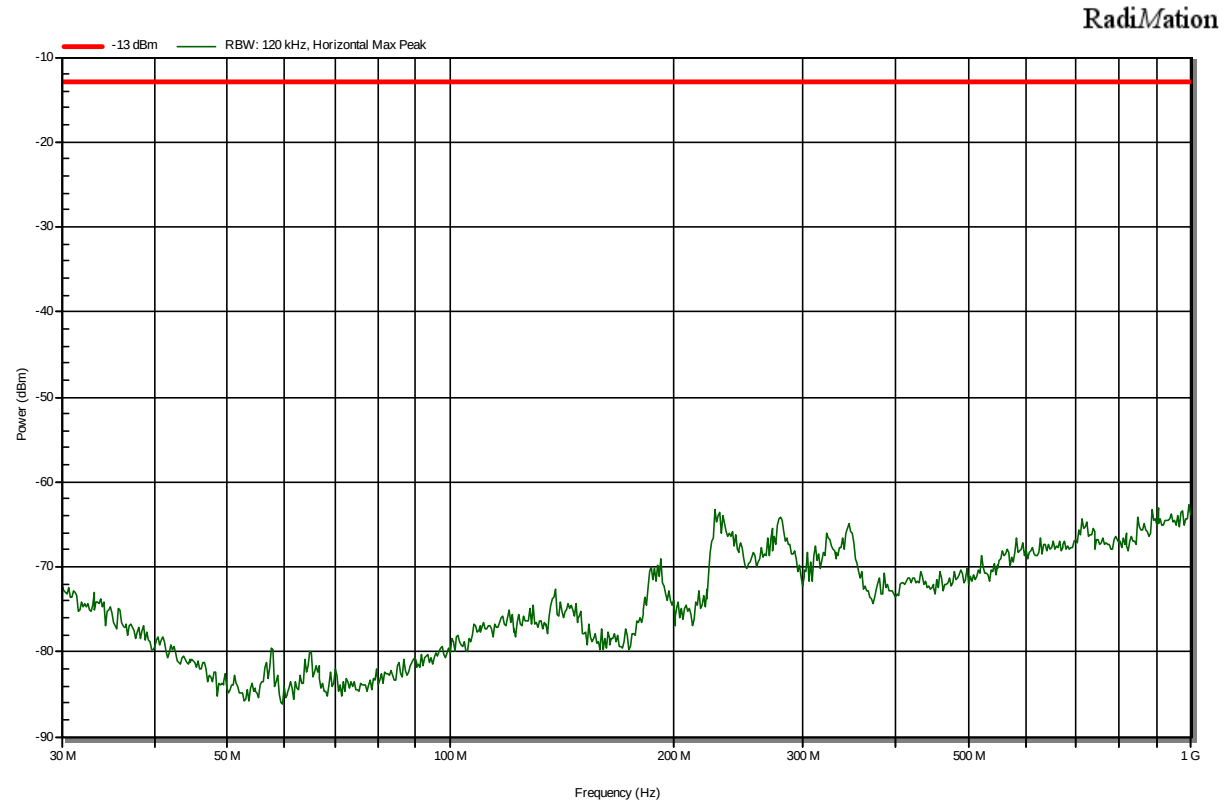


Note: The peaks in the 2400 – 2483.5 MHz range are transmitted by the BLE radio and are not subject to the limit.

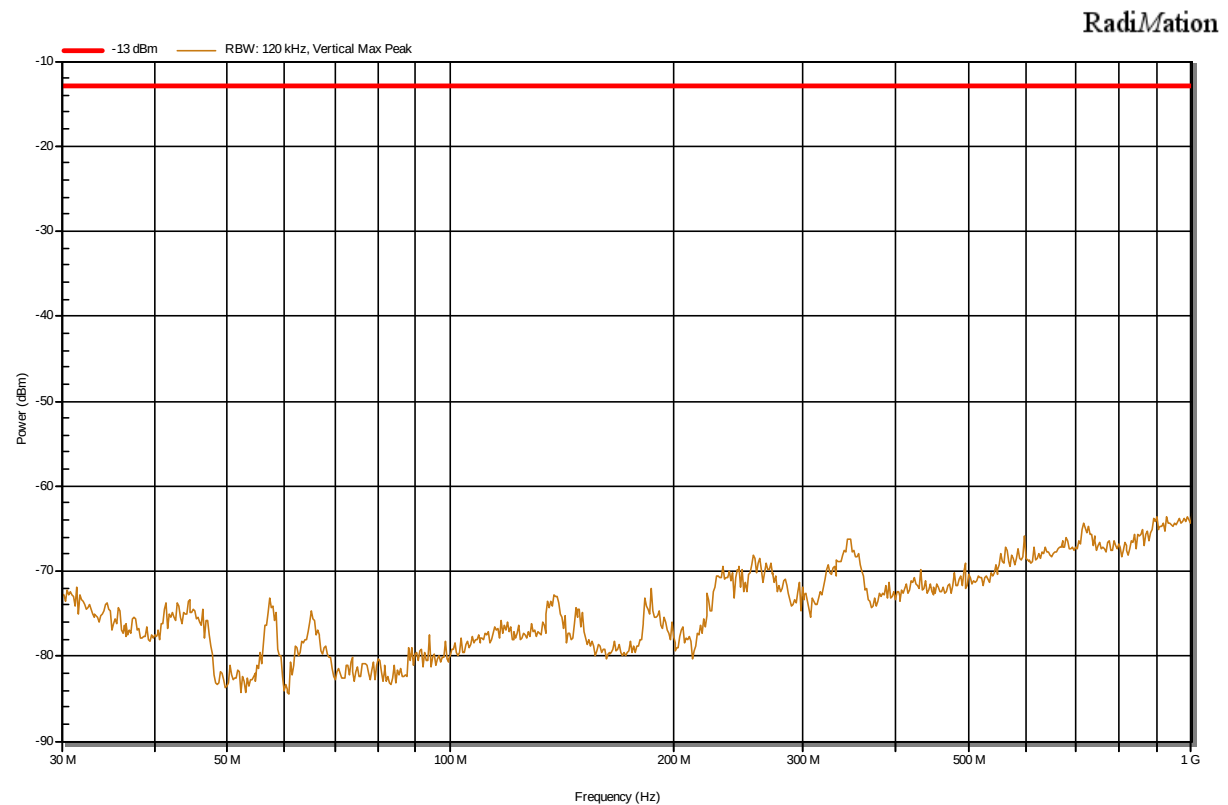
3.1.10 Plots of the Radiated Spurious Emissions Measurement (GSM 1900)

30 – 1000 MHz

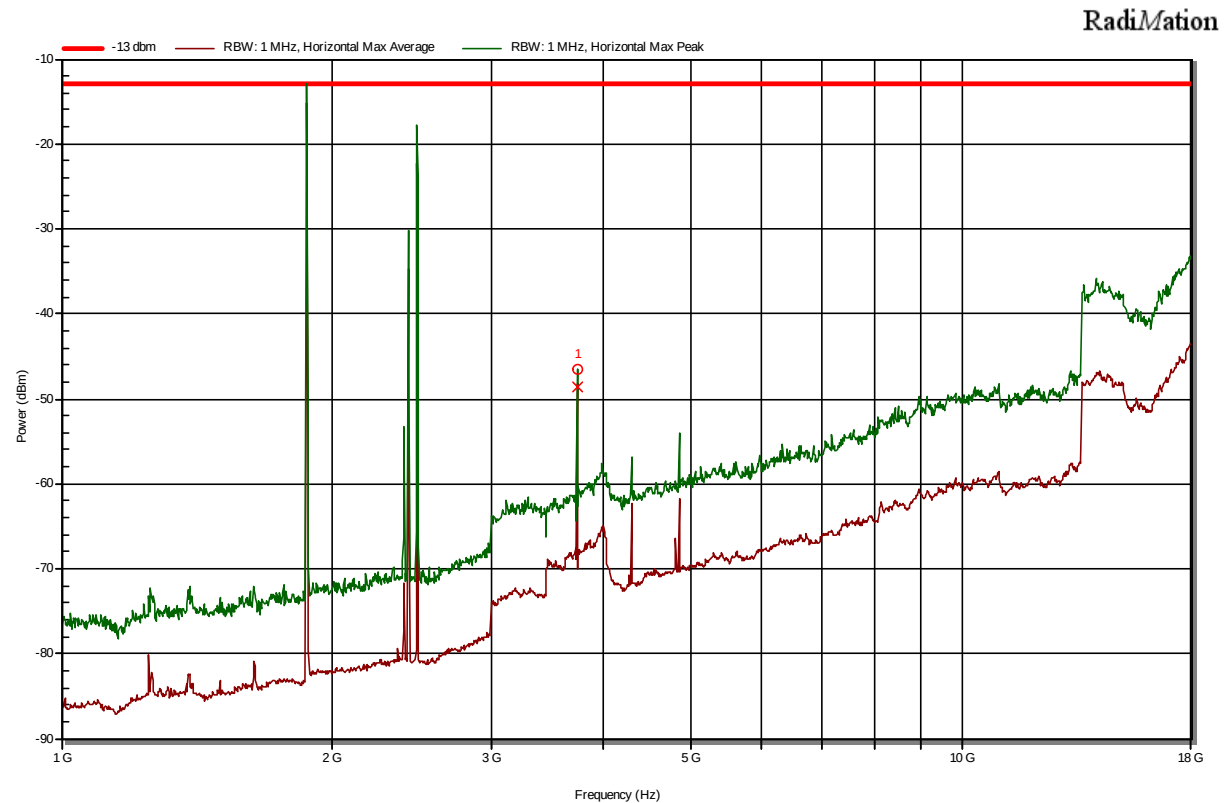
Horizontal



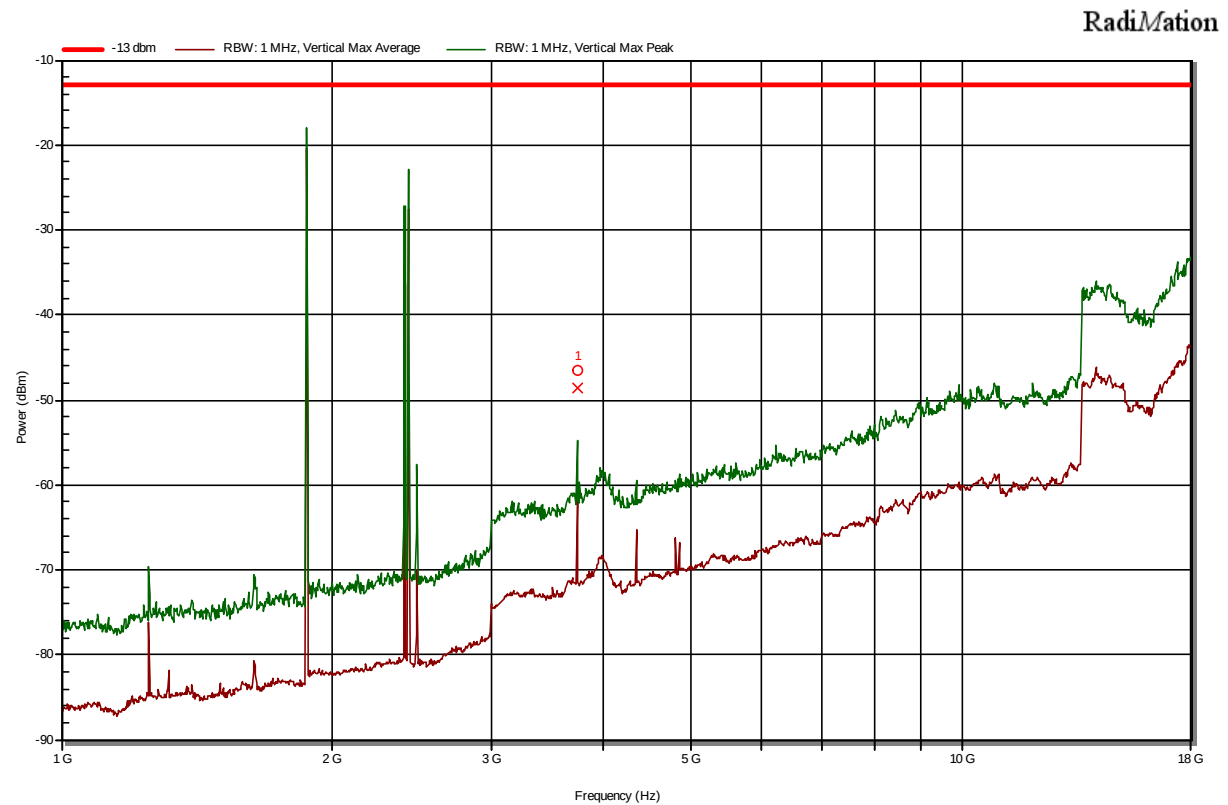
Vertical



1 – 18 GHz Horizontal



Vertical



Note: The peaks in the 2400 – 2483.5 MHz range are transmitted by the BLE radio and are not subject to the limit. The peak at 1870 MHz is the transmission frequency and is not subject to the limit.

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)
	TE 00208 SN: 892785/004 Rohde & Schwarz ESH3-Z5	TE 00756 SN: 5SM03153 Rohde & Schwarz ESH3-Z2	TE 11134	
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) TE 00967 Chase CBL6112A SN: 2308	Cable loss (dB) Id: SAR cable	Corr. (dB)
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