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FCC Test report for parts 22.359, 24.238, 27.53 (Transmitter spurious emissions only)

Product name : iotspot LTE-M

Applicant : iottum B.V.

FCC ID : 2AYAIIEM02

Test report No. : 200101624 001 v1.00

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.

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Documentation

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at 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	13-12-2020	First draft	RvB
v1.00	08-02-2021	Release version	RvB

Table of Contents

Revision History 2
Summary of Test results 4
1 General Description 5
1.1 Applicant 5
1.2 Manufacturer 5
1.3 Tested Equipment Under Test (EUT) 5
1.4 Product specifications of Equipment under test 6
1.5 Environmental conditions 6
1.6 Measurement standards 6
1.7 Applicable standards 6
1.8 Observation and remarks 6
1.9 Conclusions 7
2 Test configuration of the Equipment Under Test 8
2.1 Test mode 8
2.2 Test setups 8
2.3 Equipment used in the test configuration 9
2.4 Sample calculations 9
3 Test results 10
3.1 Radiated spurious emissions 10
3.1.1 Limit 10
3.1.2 Measurement instruments 10
3.1.3 Test setup 10
3.1.4 Test procedure 10
3.1.5 Measurement Uncertainty 10
3.1.6 Notes 10
3.1.7 Plots of the Radiated Spurious Emissions Measurement 11
4 Sample calculations 24

Summary of Test results

FCC	Description	Section in report	Verdict
22.359 24.238 27.53	Radiated spurious emissions	3.1	Pass

1 General Description

1.1 Applicant

Client name:	iottum B.V.
Address	Veemarktkade 8, 5222 AE, 's-Hertogenbosch, The Netherlands.
Zip code:	5221 LC
E-mail:	marnix@iotspot.co
Contact name:	Mr. M. Lankhorst

1.2 Manufacturer

Manufacturer name:	iottum B.V.
Address:	Veemarktkade 8, 5222 AE, 's-Hertogenbosch, The Netherlands.
Zip code:	5221 LC
E-mail:	marnix@iotspot.co
Contact name:	Mr. M. Lankhorst

1.3 Tested Equipment Under Test (EUT)

Product name:	iotspot LTE-M
Brand name:	iotspot
Product type:	iotspot LTE-M is an on-premise, low-voltage powered device that transmits and receives GSM and Bluetooth signals, transmits passive NFC signals and emits LED light
Variant model(s):	--
Software version:	--
Hardware version:	--
Date of receipt:	27-01-2020
Tests started:	20-02-2020
Testing ended:	03-08-2020

1.4 Product specifications of Equipment under test

TX Frequencies:	GSM bands: 850/900, 1800/1900 LTE-M/NB-IOT bands: 2,3,4,5,8,12,13,18,19,20,25
RX frequencies:	GSM bands: 850/900, 1800/1900 LTE-M/NB-IOT bands: 2,3,4,5,8,12,13,18,19,20,25
Antenna gain:	1.5 dBi
Antenna type:	Chip antenna

1.5 Environmental conditions

Test date	20-02-2020	29-07-2020	03-08-2020
Ambient temperature	22.4°C	22.1°C	24.8°C
Humidity	44.8%	36.4%	49.2%

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

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 R. Van Barneveld

Review of test methods and report by:

Name : P. van Wanrooij, BASc

The above conclusions have been verified by the following signatory:

Date : 11-02-2021

Name : P. van Wanrooij

Function : Test Engineer

Signature :

2 Test configuration of the Equipment Under Test

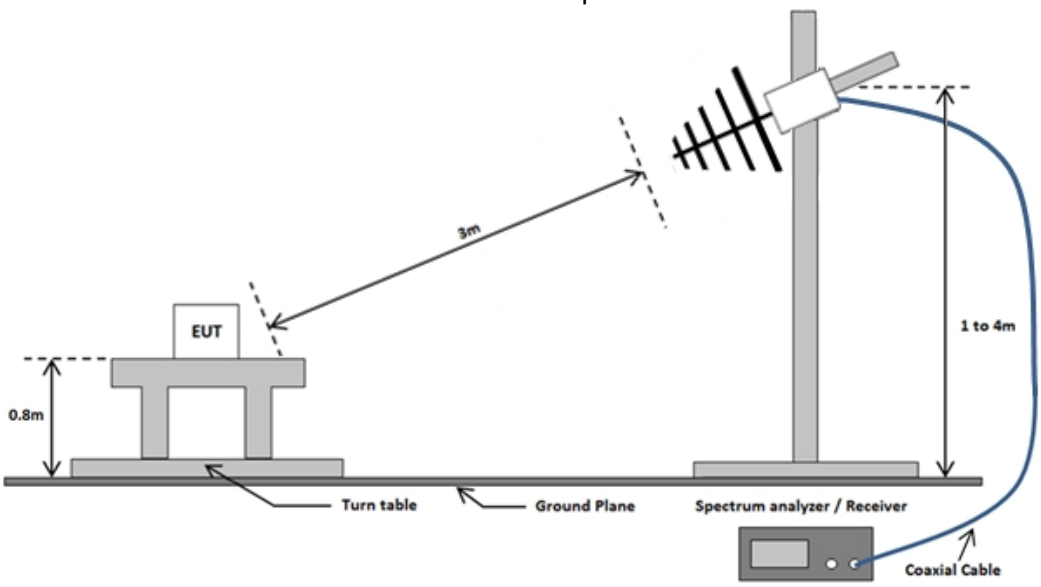
2.1 Test mode

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

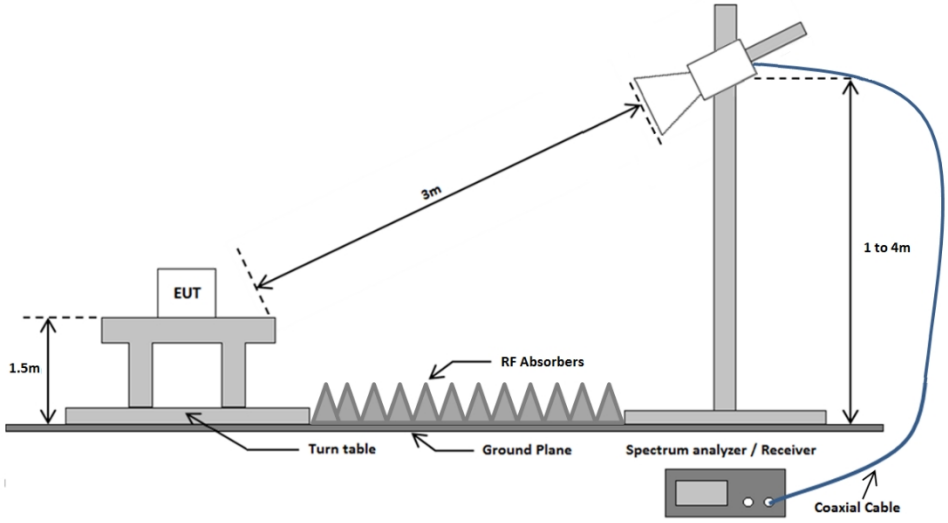
Technology	Band	Uplink Frequency range (MHz)
GSM	850	824.2 – 848.8
	1900	1850.2 – 1909.8
LTE	2	1850 – 1910
	5	824 – 849

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 + 10log(P) dB
P = 23 dBm = 0.2 W

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

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
9 kHz to 30 MHz IRN 027 – Method 1
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	±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

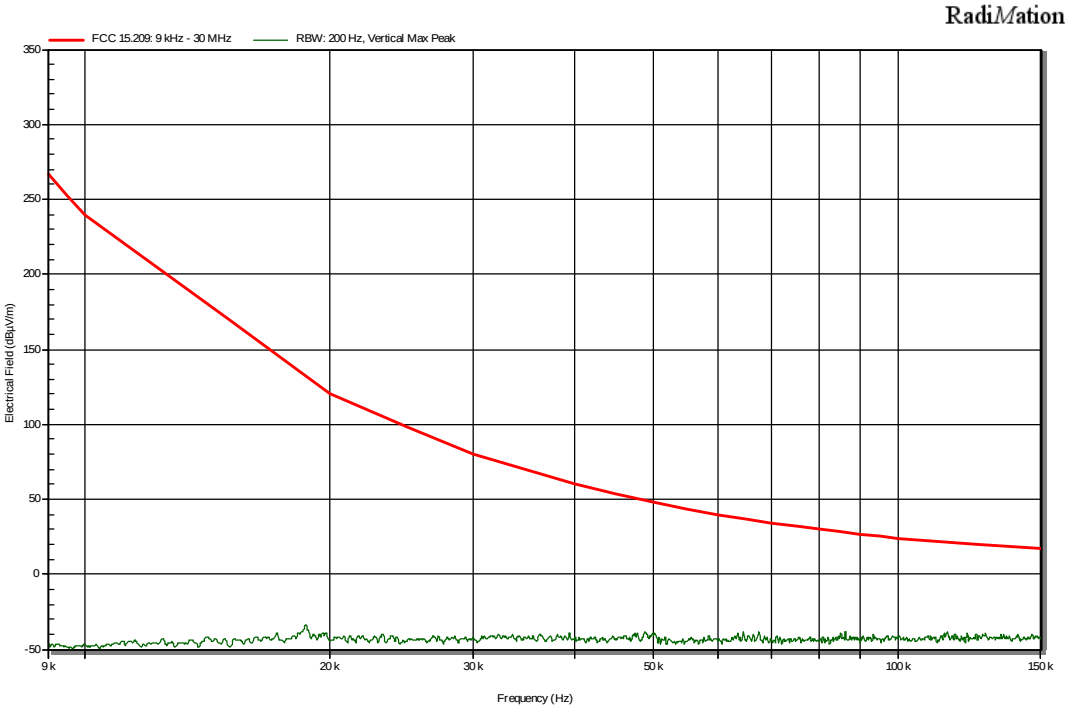
3.1.6 Notes

1. A band reject filter was used in the frequency range 30 MHz to 18 GHz.
2. 9 kHz to 30 MHz only tested on the worst case.

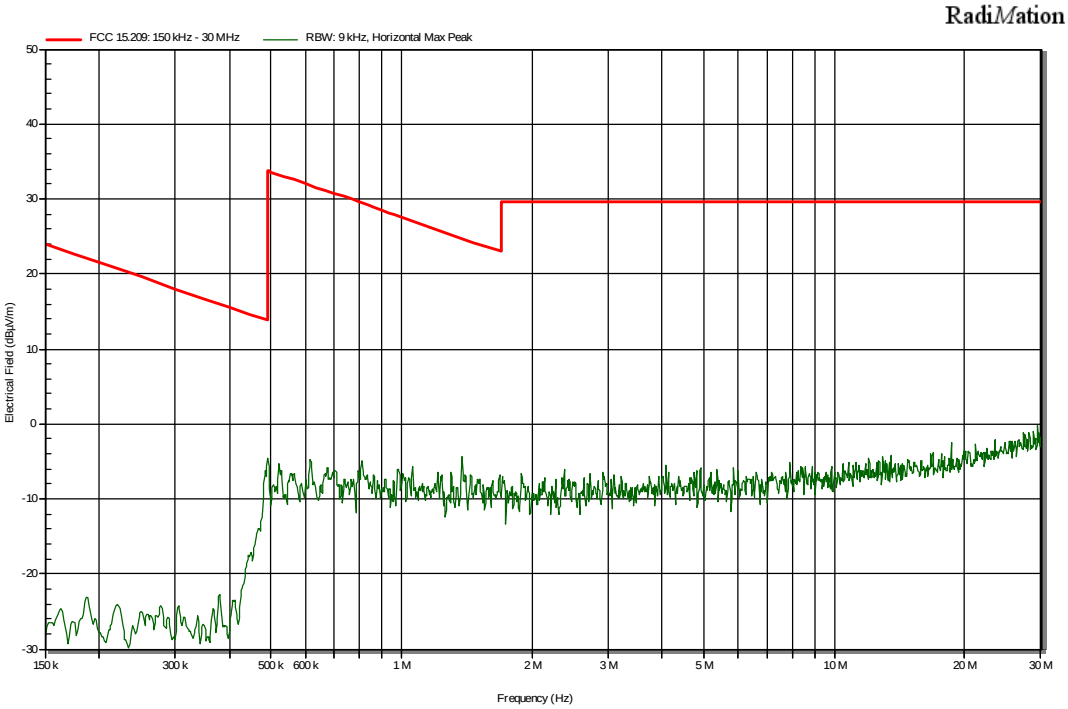
3.1.7 Plots of the Radiated Spurious Emissions Measurement

GSM900

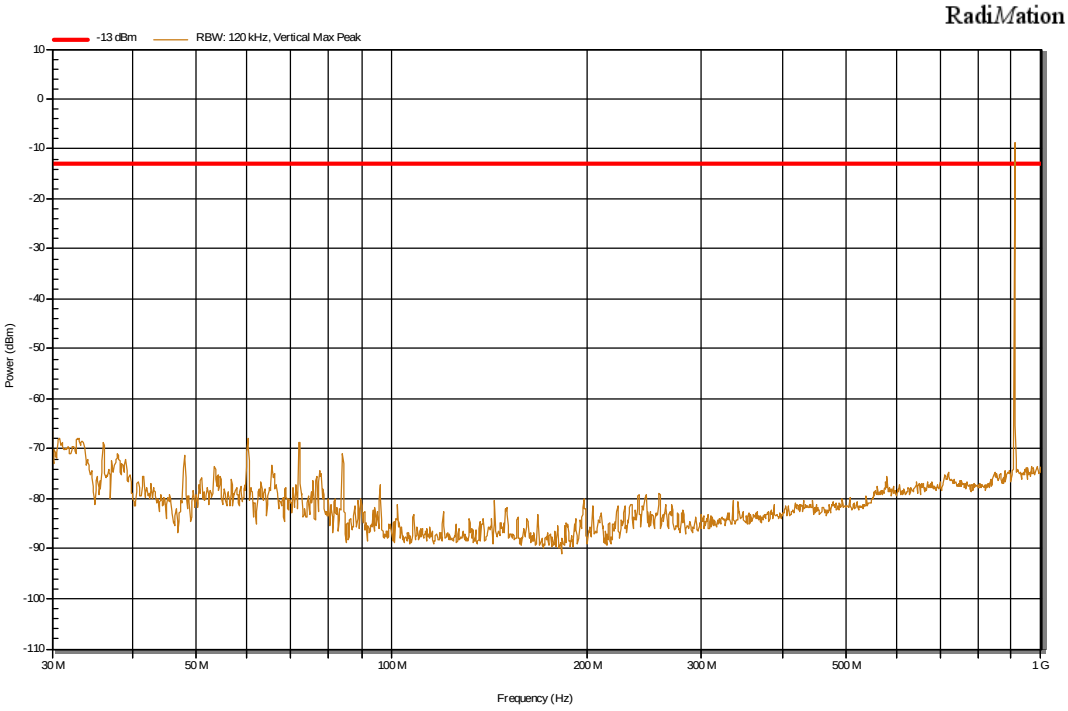
9kHz - 150 kHz



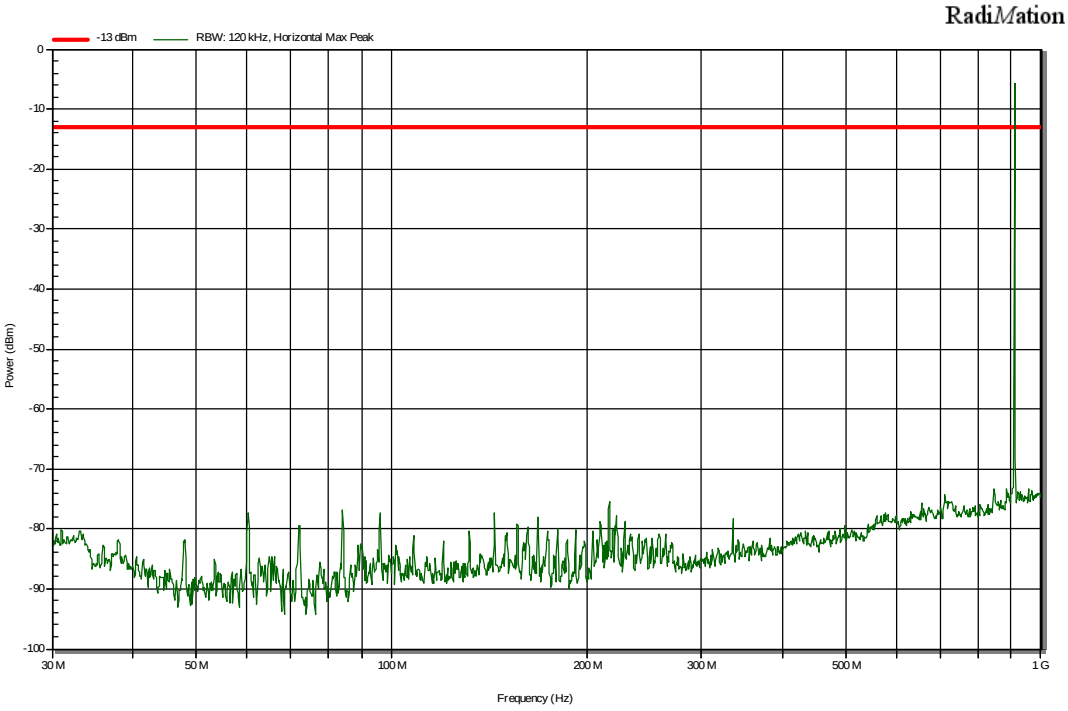
150 kHz – 30 MHz



GSM900
30-1000 MHz
Vertical

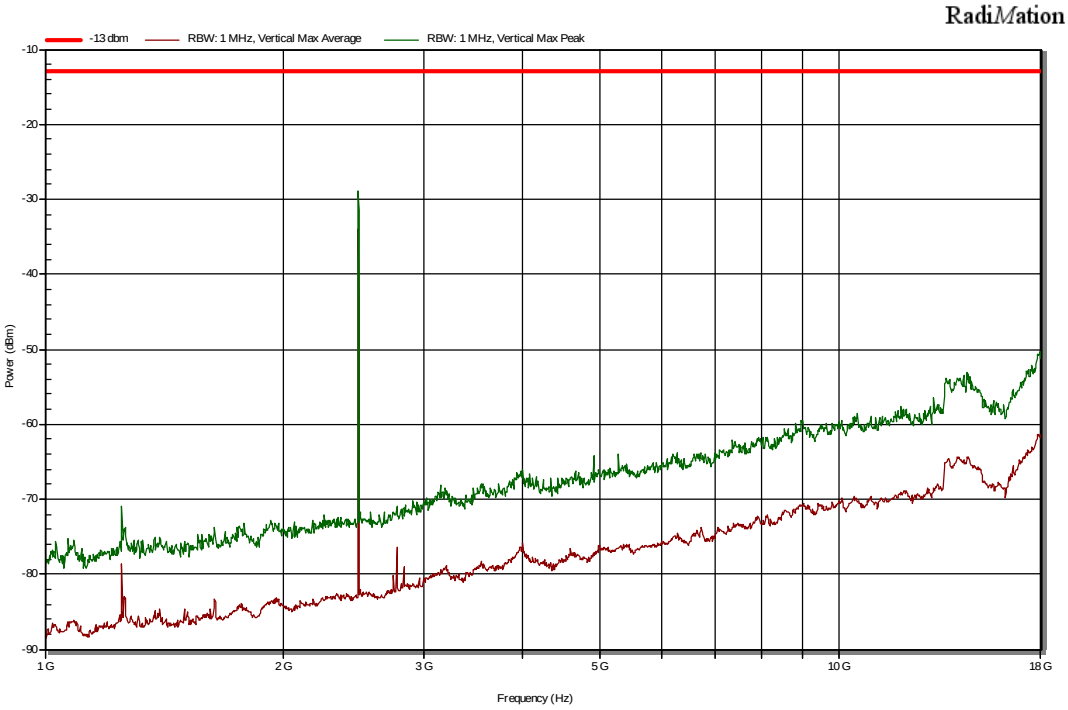


Horizontal



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

1 – 18 GHz
Vertical



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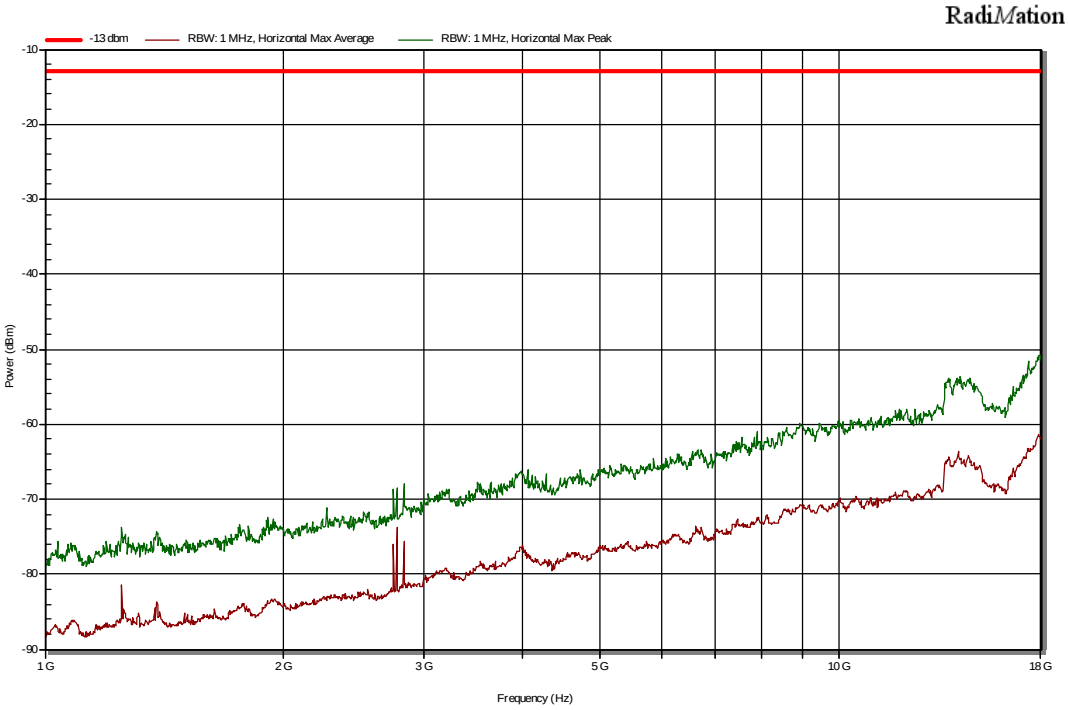
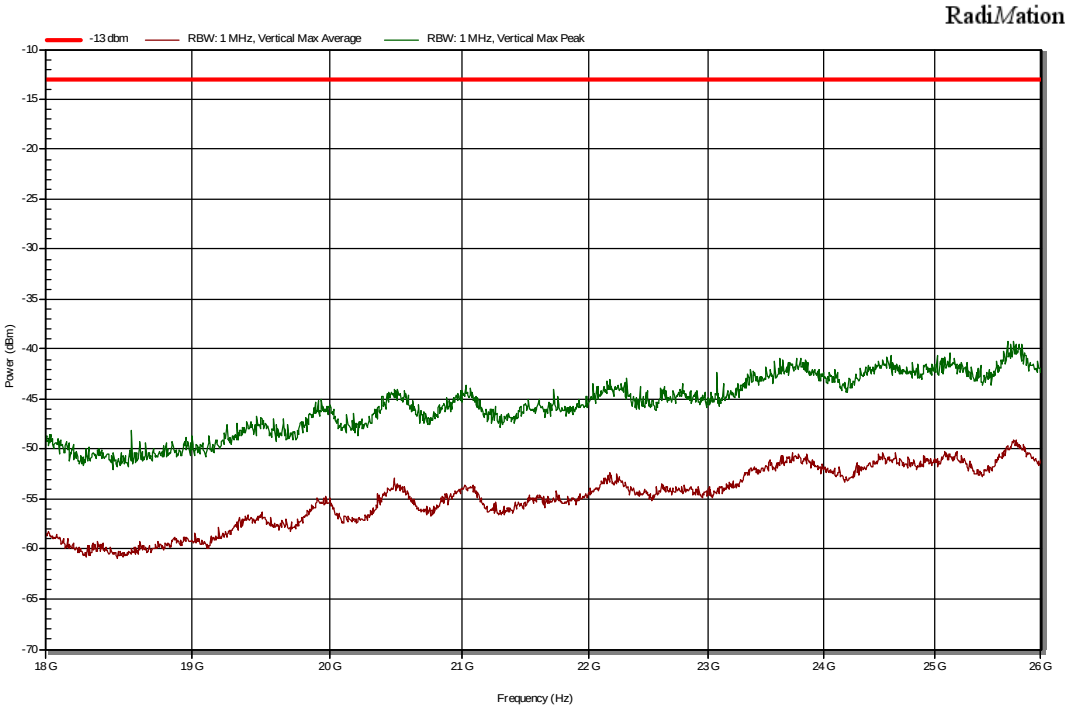


18-26 GHz
Vertical



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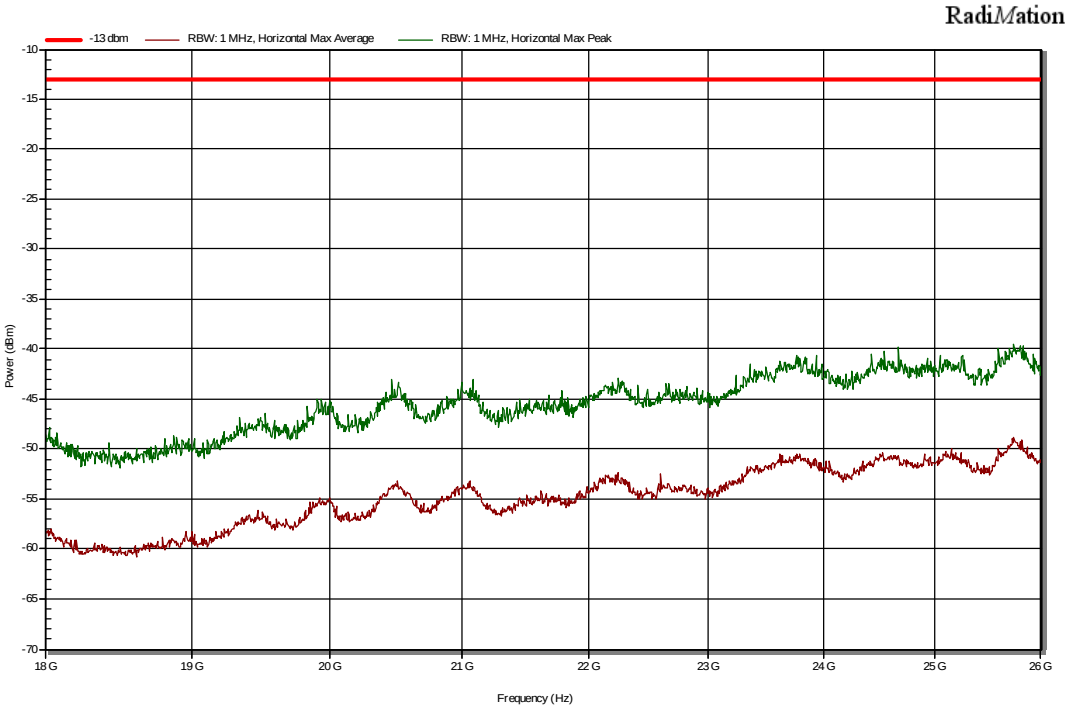
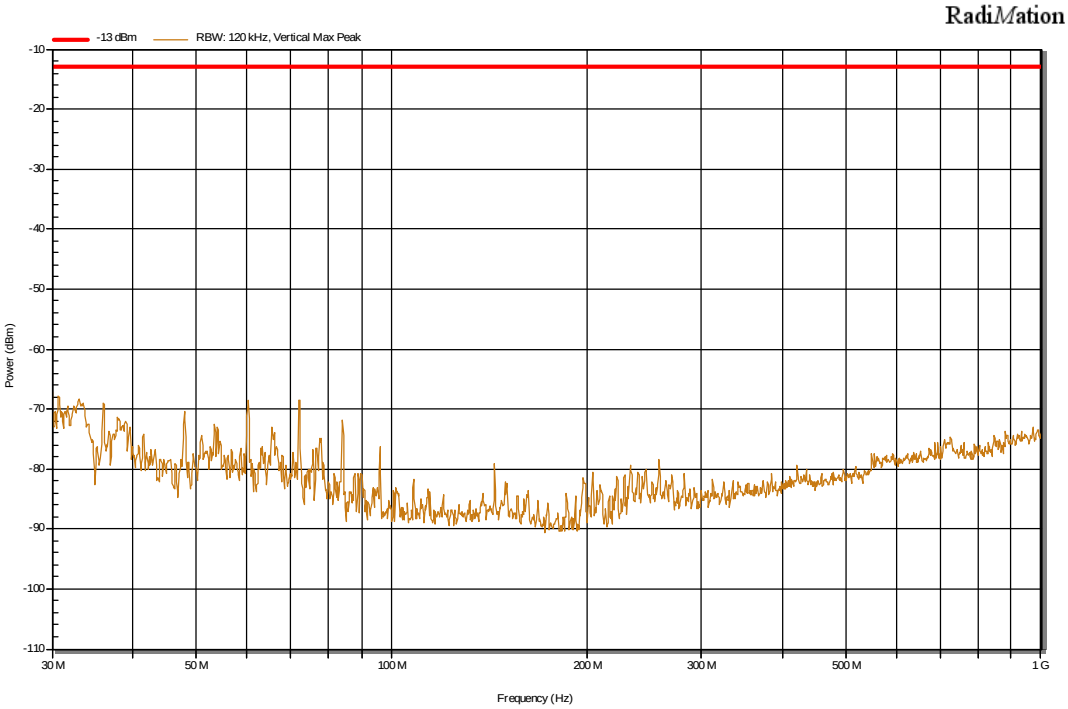


DCS1800
30-1000 MHz
Vertical



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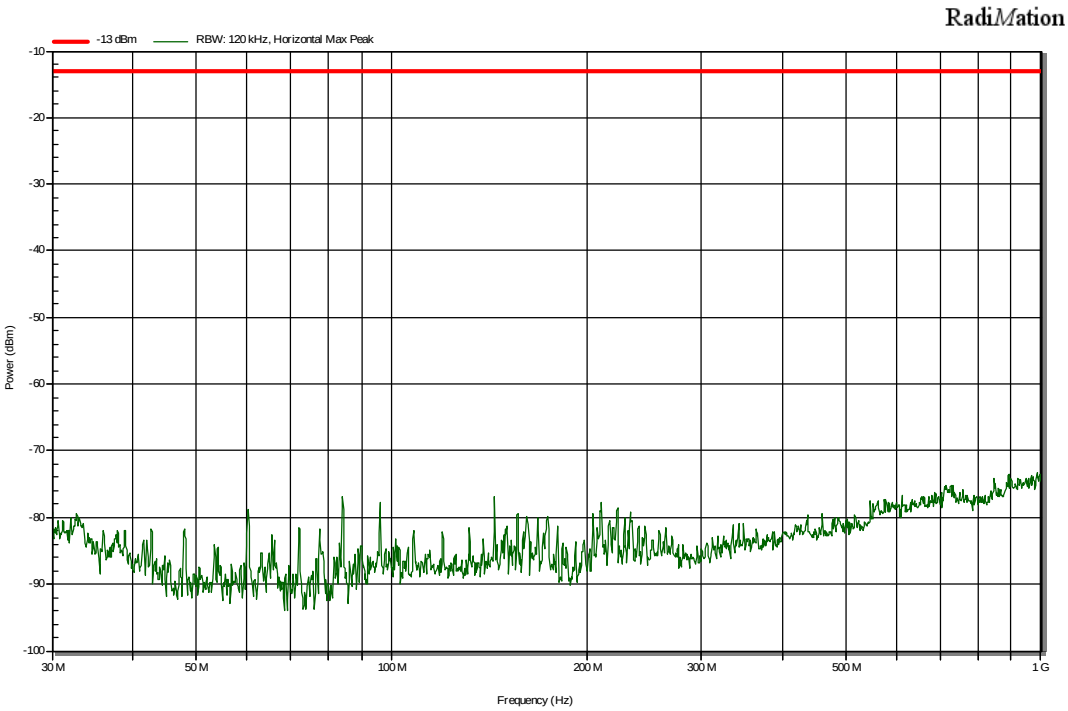
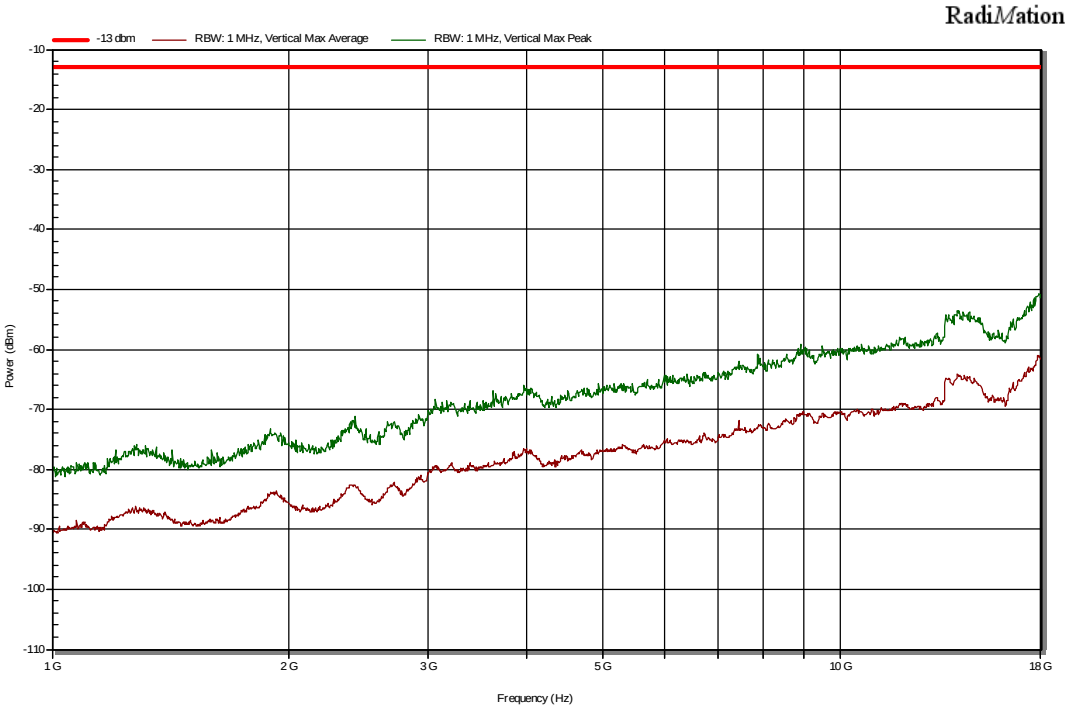
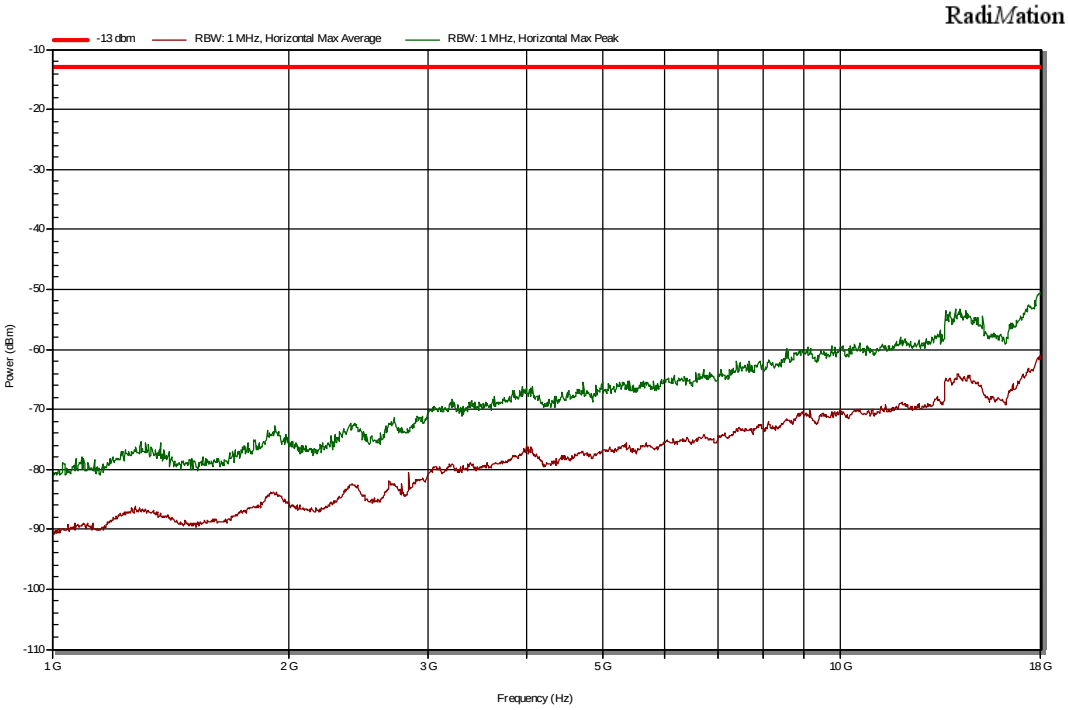


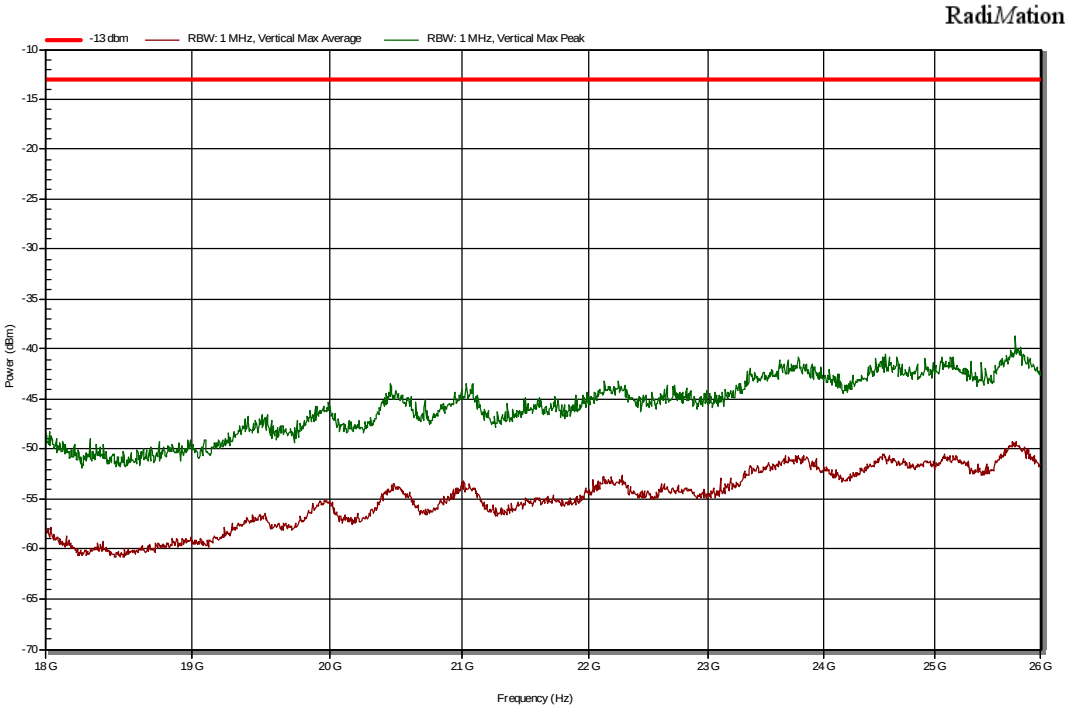
1 – 18 GHz
Vertical



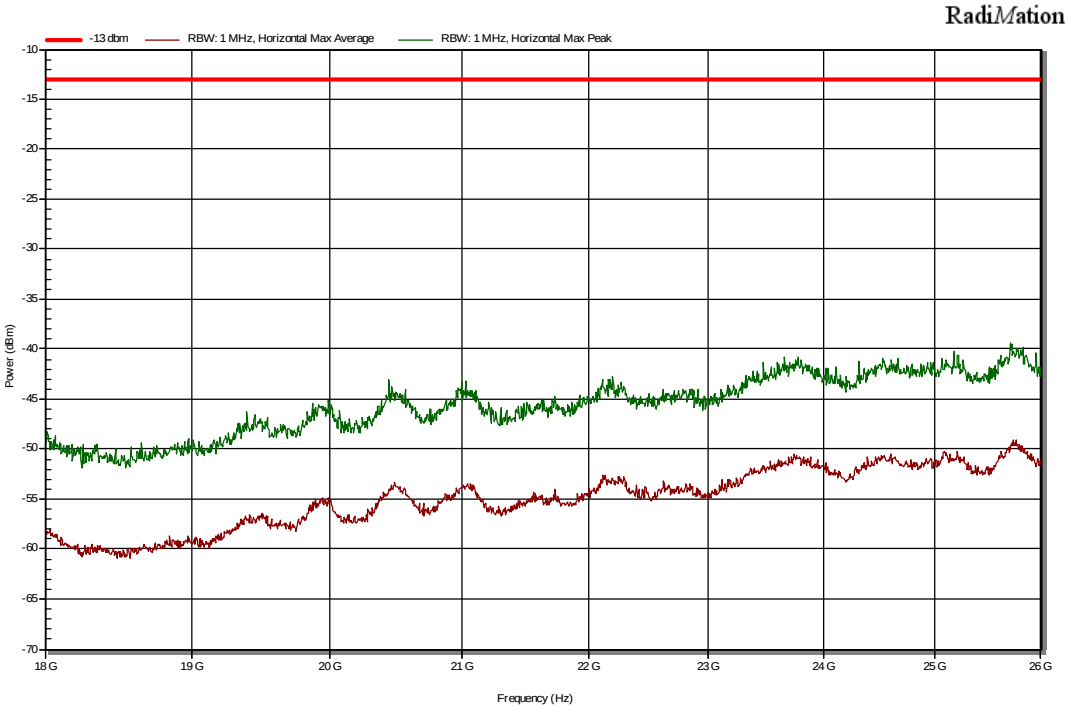
Horizontal



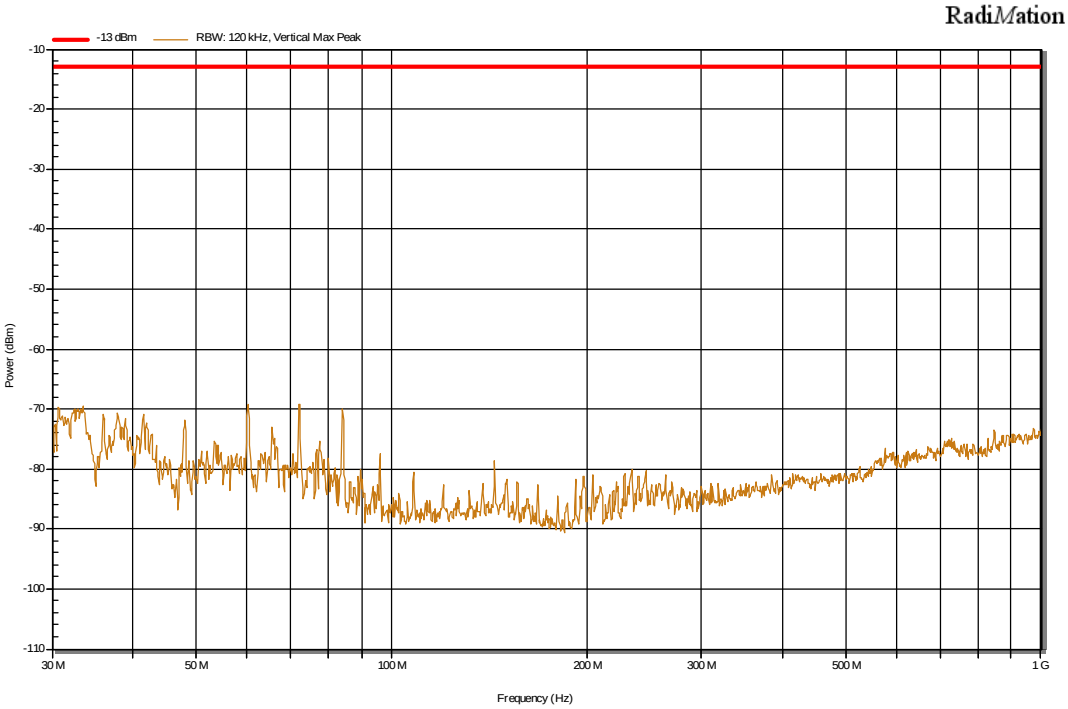
18-26 GHz
Vertical



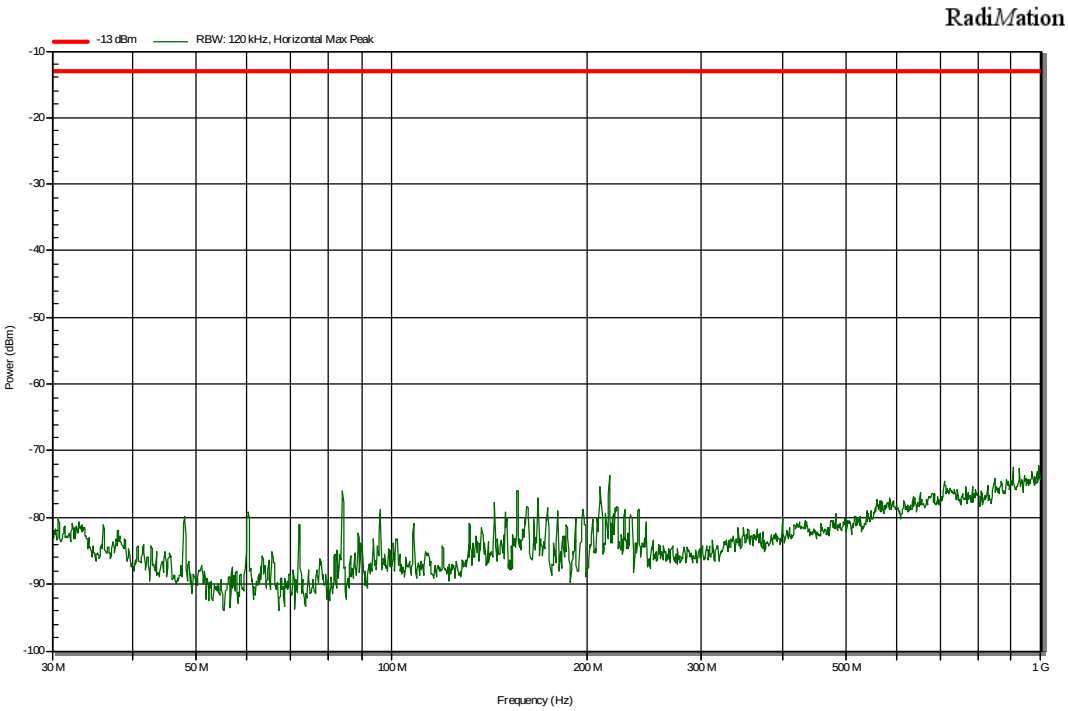
Horizontal



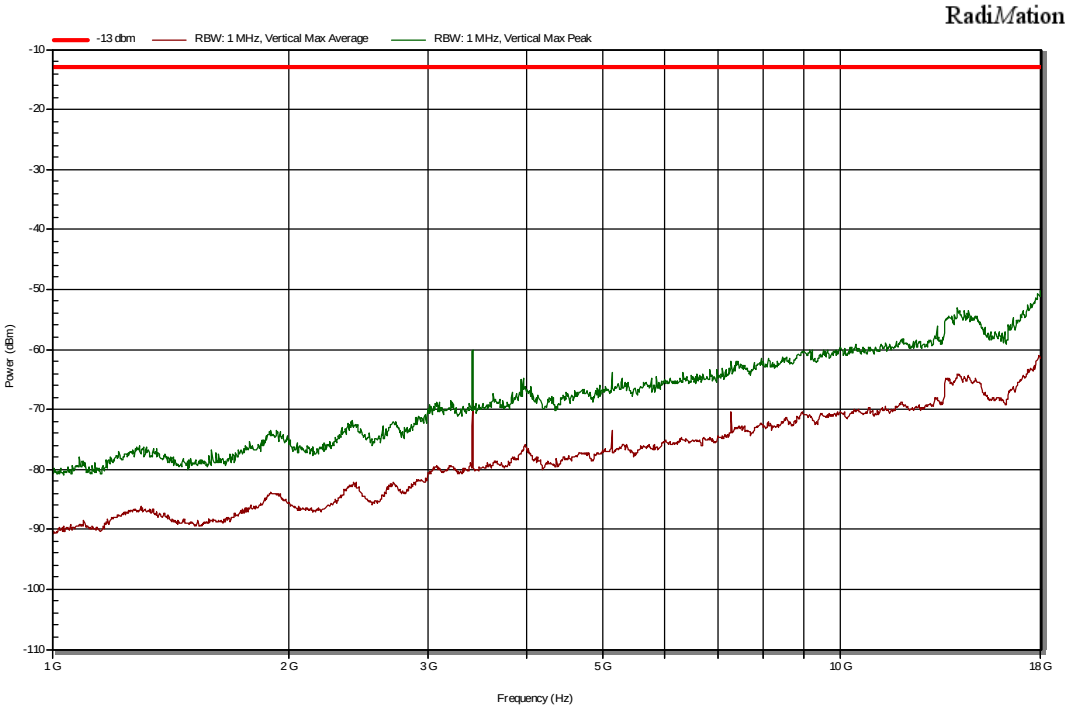
LTE Band 3
30-1000 MHz
Vertical



Horizontal



1 – 18 GHz
Vertical



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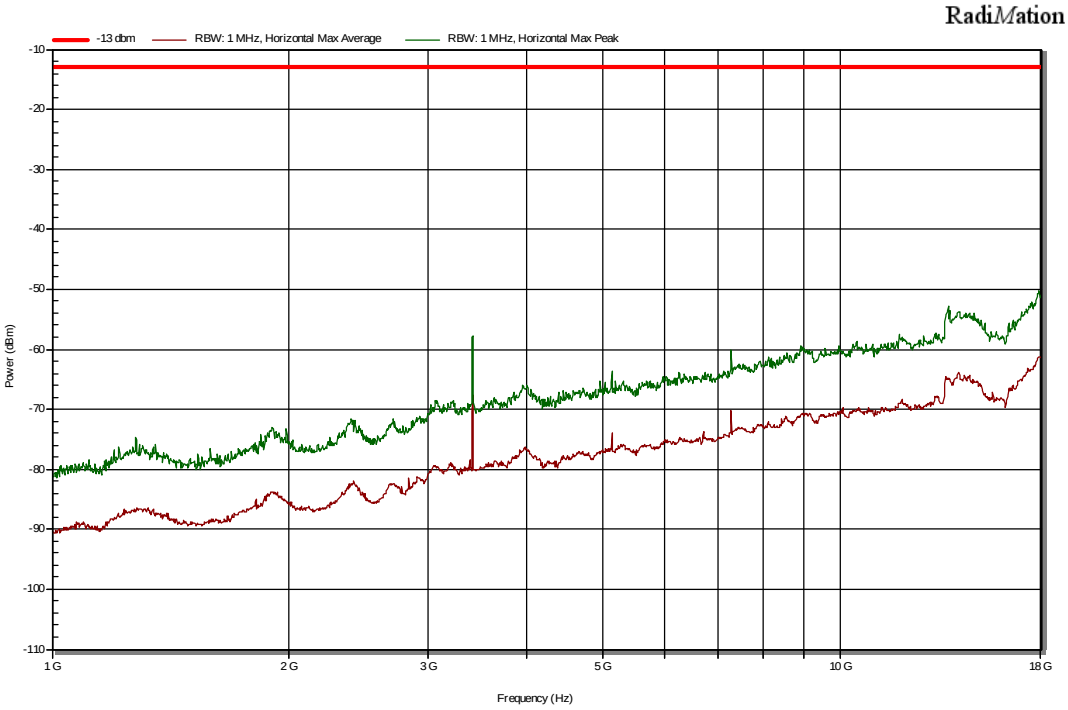
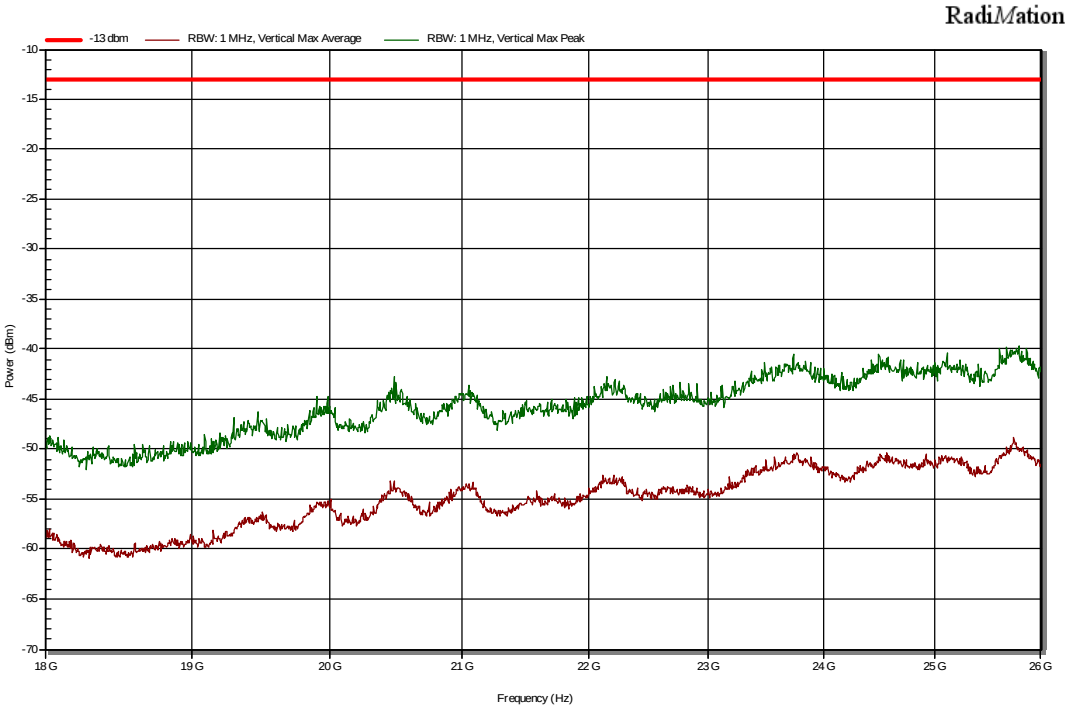


18-26 GHz
Vertical



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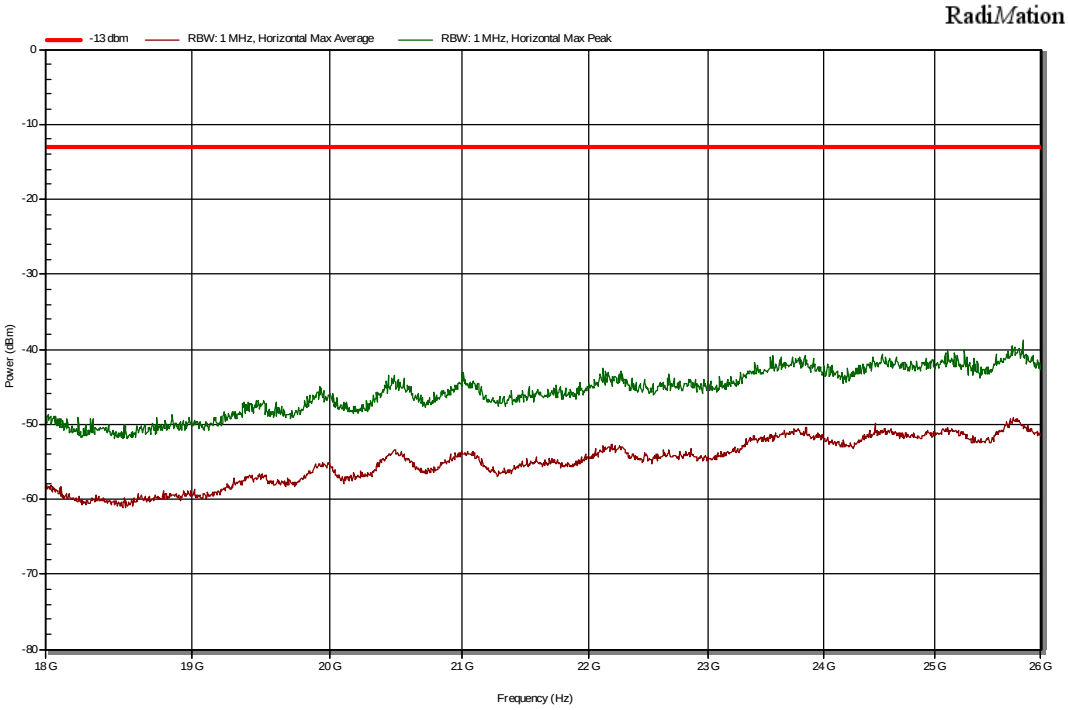
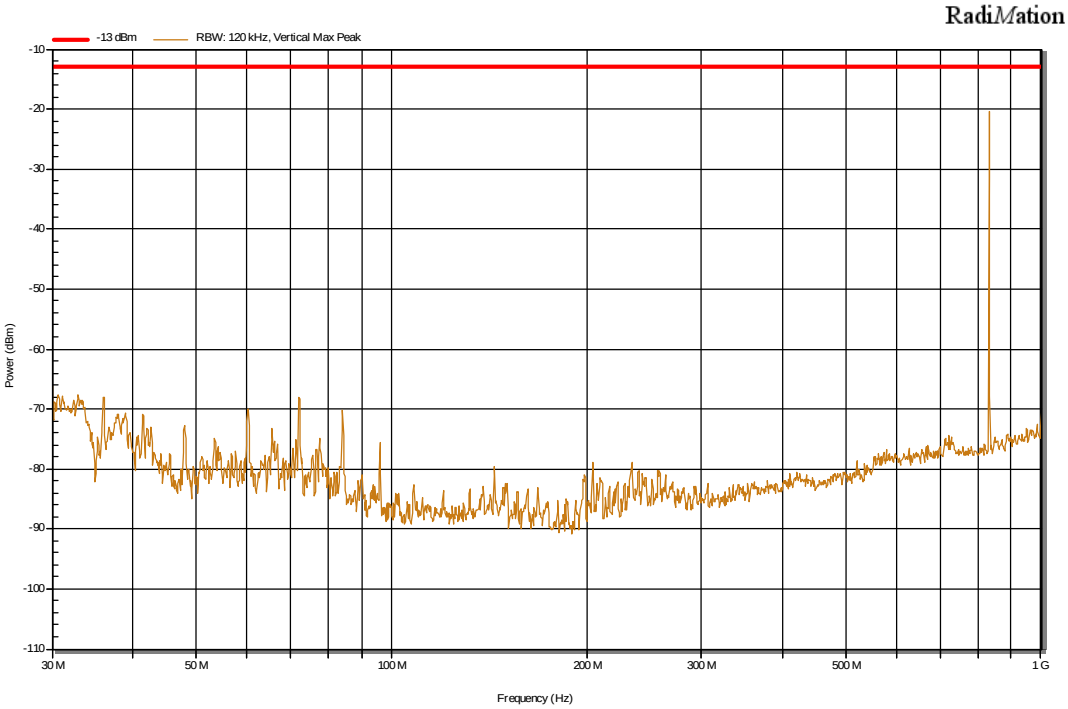


LTE band 20
30-1000 MHz
Vertical



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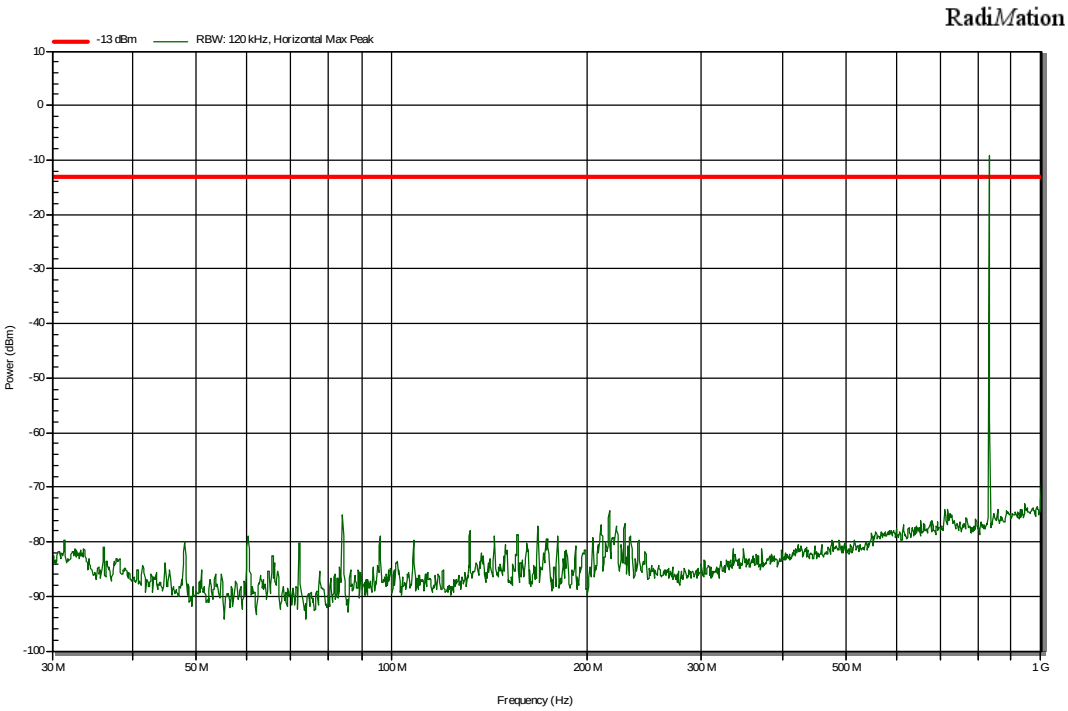
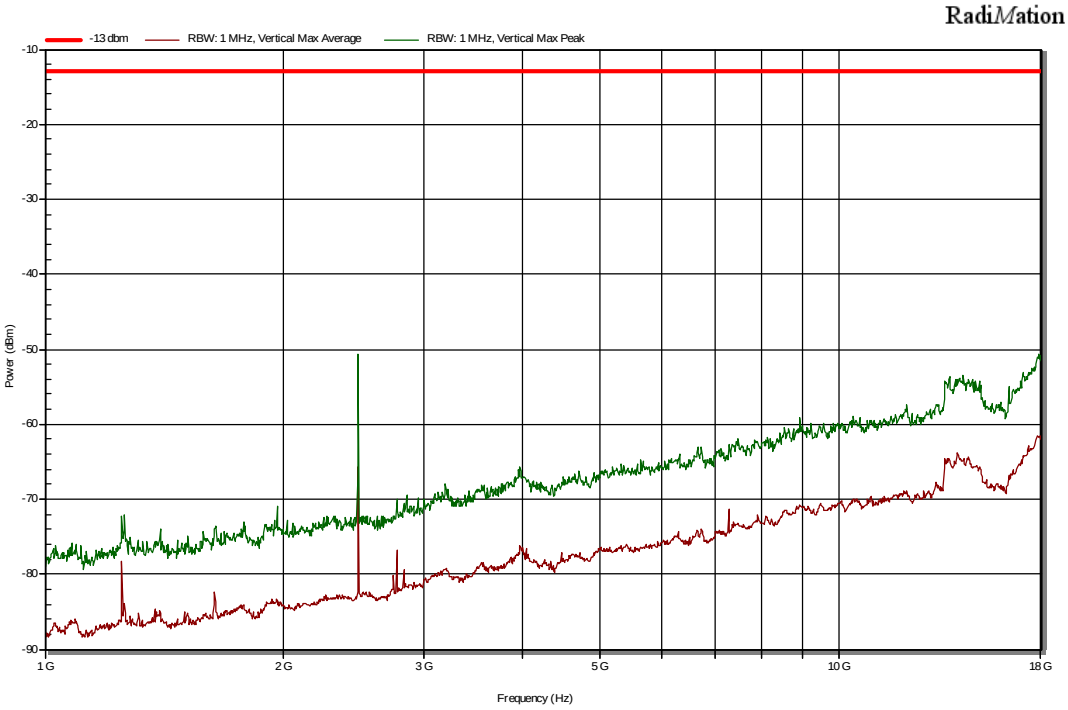
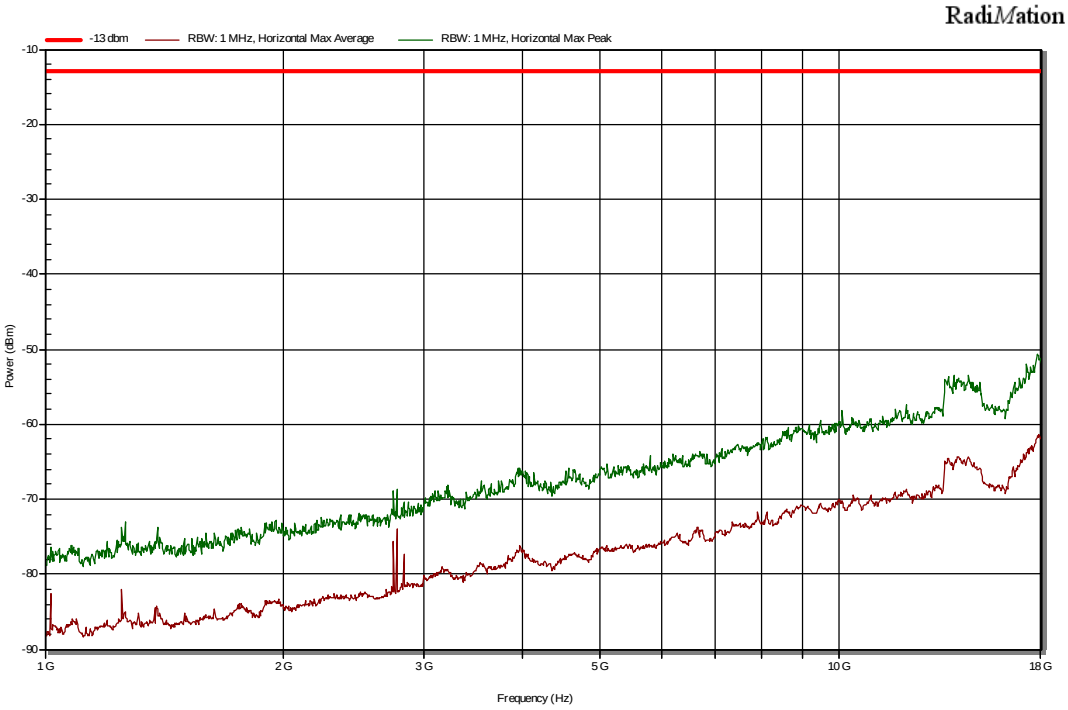


Note: the peak seen in the plots is the fundamental frequency and is not subject to the limit shown in the plots.

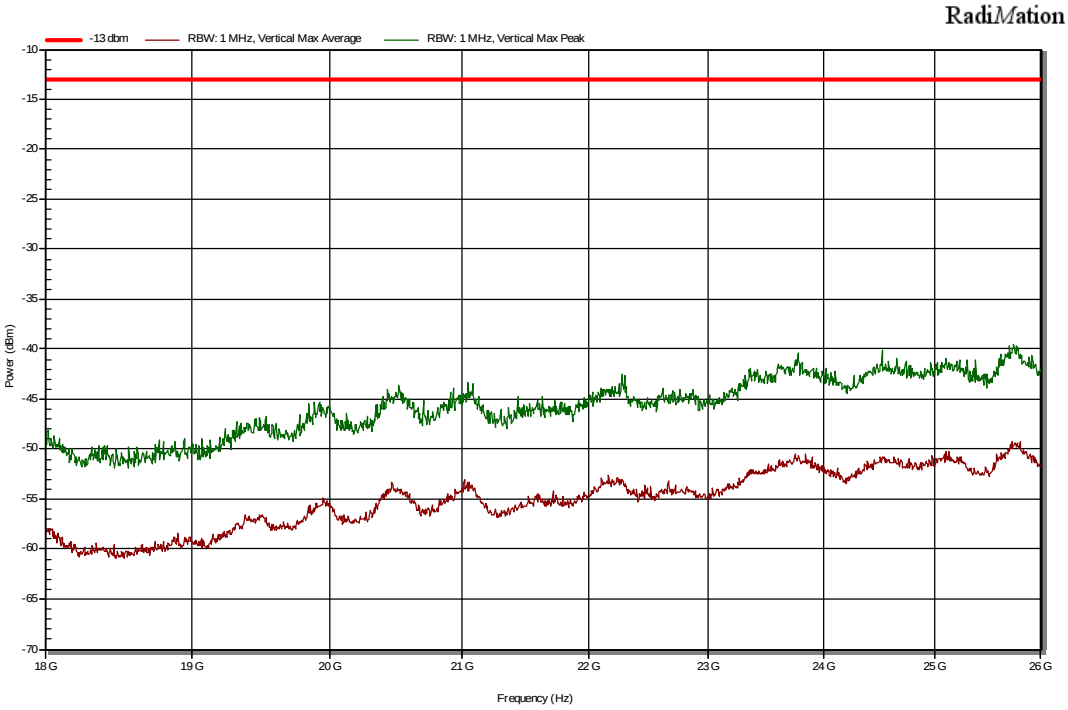
1 – 18 GHz
Vertical



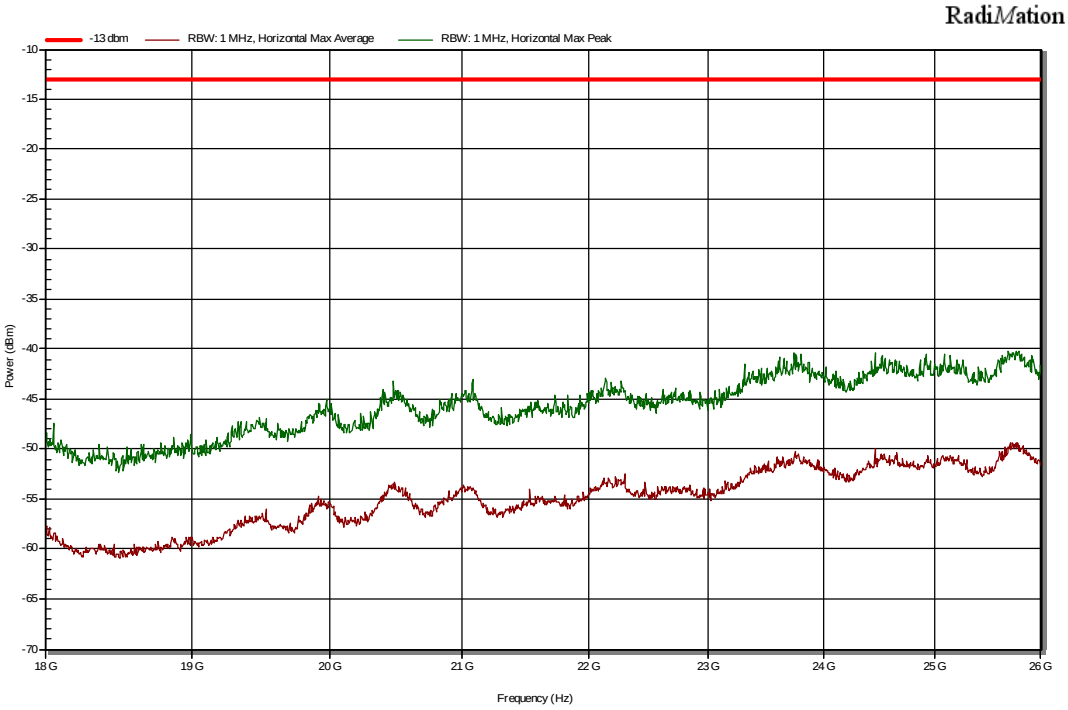
Horizontal



18-26 GHz
Vertical



Horizontal



4 Sample calculations

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

Conducted emission Measurement (see chapter 3.9):

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

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

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

Frequency (Mhz)	AF (dB/m)	Cable loss (dB)	Corr. (dB)
	TE 00967 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