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FCC and IC Test report for parts 15.207, 15.209, 15.247, RSS-247, RSS-Gen

Product name	: 95-1300-0200
Applicant	: TMSi BV
FCC ID	: 2A8DA-APEX01
IC	: 28908-APEX01

Test report No. : P000207337 001 Ver 2.00

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.

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 company number for Telefication is: 4173A. The CABID is NL0001.

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	Kiwa Telefication BV
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	31-10-2022	First draft	KK
v1.00	09-12-2022	Final version	KK
v2.00	17-01-2023	Section 1.8, additional remarks has been added	KK

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
15.207 (c)	RSS-Gen 8.8	Conducted spurious emissions on AC mains	3.2	Pass

1 General Description

1.1 Applicant

Client name:	TMSi BV
Address:	Zutphenstraat 57, Oldenzaal Netherlands
Zip code:	7575 EJ
Telephone:	+31 541216643
E-mail:	sake.kroondijk@tmsi.com
Contact name:	Sake Kroondijk

1.2 Manufacturer

Manufacturer name:	TMSi BV
Address:	Zutphenstraat 57, Oldenzaal Netherlands
Zip code:	7575 EJ
Telephone:	+31 541216643
E-mail:	sake.kroondijk@tmsi.com
Contact name:	Sake Kroondijk

1.3 Tested Equipment Under Test (EUT)

Product name:	95-1300-0200
Brand name:	TMSi BV
FCC ID	2A8DA-APEX01
IC	28908-APEX01
Product type:	EEG amplifier
Model(s):	-
Batch and/or serial No.	-
Software version:	1.0
Hardware version:	V2-Rev2
Date of receipt	11-10-2022
Tests started:	21-10-2022
Testing ended:	28-10-2022

1.4 Product specifications of Equipment under test

Tx Frequency:	BLE: 2402 – 2480 MHz
Rx frequency:	BLE: 2402 – 2480 MHz
Antenna type:	Ceramic chip antenna
Antenna gain:	1.86 dBi
Type of modulation:	GFSK
Emission designator	-

Disclaimer: The antenna gain value taken from the data sheet.

1.5 Environmental conditions

Test date	21-10-2022
Ambient temperature	20.7 C°
Humidity	56.3 %

1.6 Measurement standards

- ANSI C63.10:2013

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 §15.209
- FCC Part 15 Subpart C §15.207
- FCC Part 15 Subpart C §15.247
- RSS-Gen Issue 5
- RSS-247 Issue 2

1.8 Observation and remarks

The manufacturer provided test mode firmware to set the EUT to transmit or receive continuously.
The EUT has pre-certified radio module, thus only radiated spurious emissions and AC power line conducted emissions have been tested.
Multi radio assessment has been performed since the EUT has two identical BLE radio module and they can transmit simultaneously. Since the EUT using the pre-certified radio modules with dedicated antenna, RF power values taken from the test report of the radio module (report number RF191225C12-1 with FCC ID: QOQ-GM220P).

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 : Koray Korcum, MSc

Review of test methods and report by:

Name : Roy van Barneveld

The above conclusions have been verified by the following signatory:

Date : 21-02-2023

Name : R. van Barneveld

Function : Test engineer

Signature :

2 Test configuration of the Equipment Under Test

2.1 Test mode

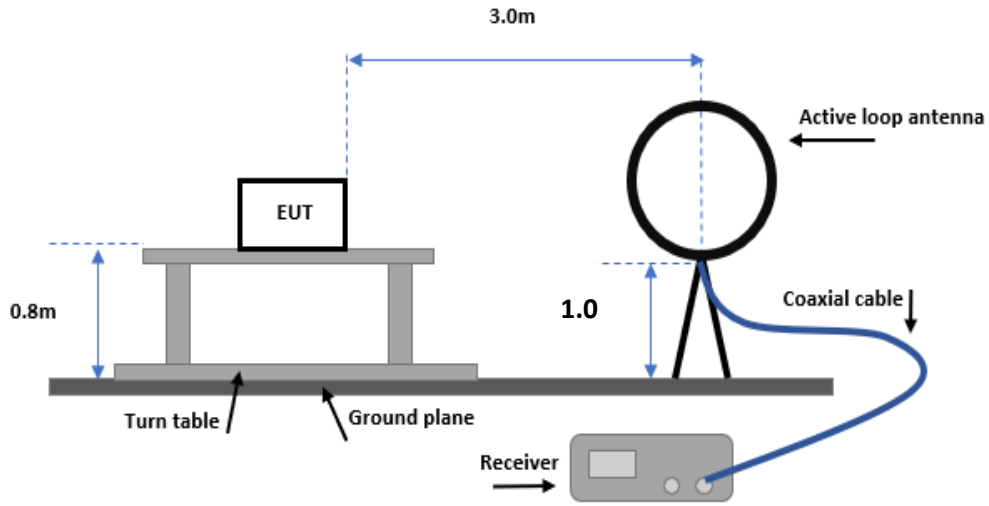
The applicant provided test mode firmware for the EUT, in which it was possible to configure the EUT into different test channels.

2.2 Tested channels and Data rates

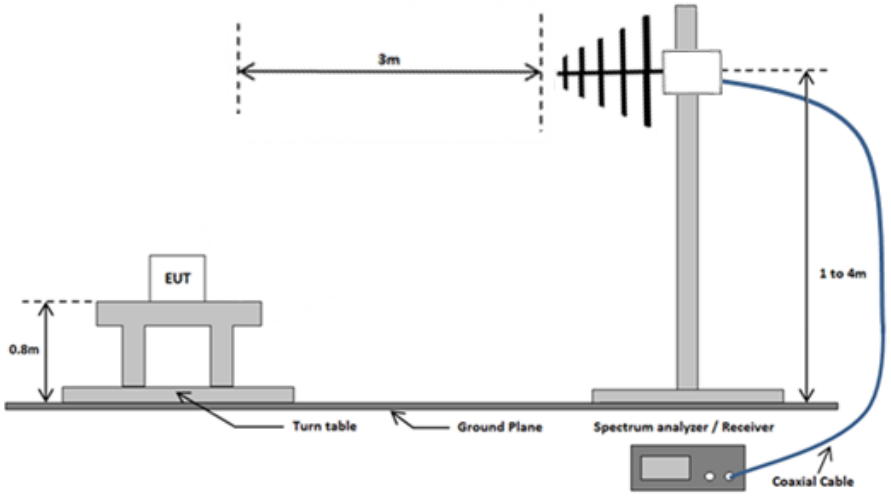
Technology	Channels	Data rate	Frequency (MHz)
BLE	37	1 Mbps	2402
	19	1 Mbps	2440
	39	1 Mbps	2480

2.3 Test setups

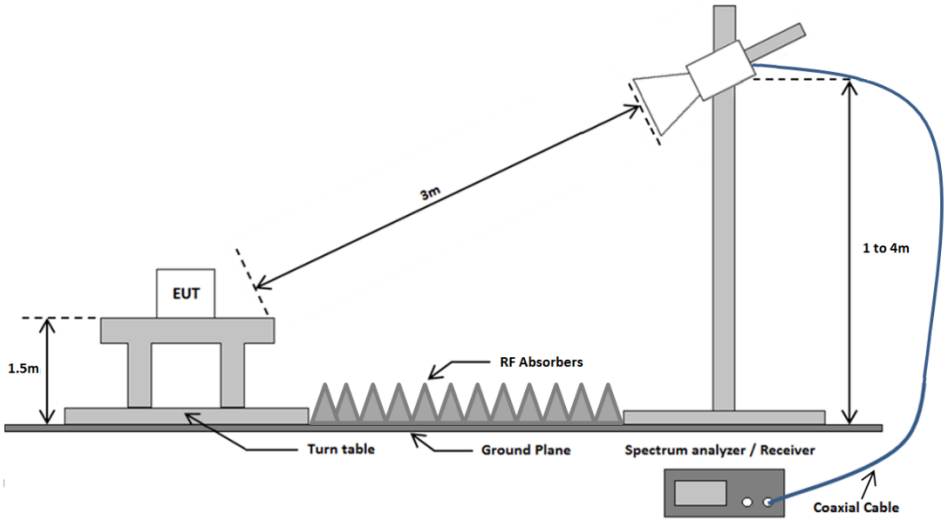
Radiated emissions test setup 9 kHz – 30 MHz



Radiated emissions test setup 30 MHz - 1 GHz

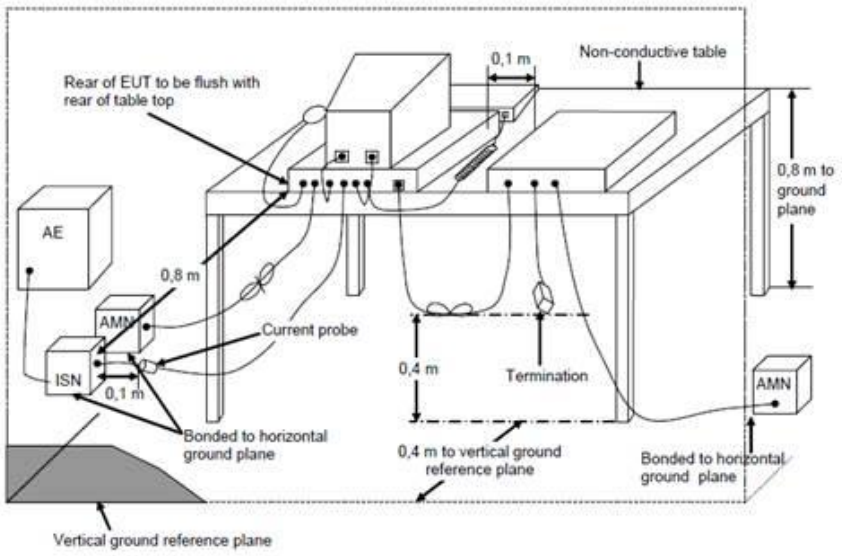


Radiated emissions test setup above 1 GHz



Conducted emissions test setup

Emissions test at AC mains



2.4 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	04-2022	04-2023	3.1, 3.2
Spectrum analyzer	Rohde & Schwarz	FSP40	TE11125	03-2022	03-2023	3.1
3.0 GHz HPF	Wainwright	WHK3.0/18G-10EF	114682	07-2021	07-2024	3.1
Active loop antenna	EMCO	6502	114515	01-2022	01-2024	3.1
Biconical antenna + 6dB attenuator	Schwarzbeck + HP	VHA9103 + 8491A	114436 + 114254	03-2021	03-2024	3.1
Logperiodic antenna	EMCO	3147	114385	03-2021	03-2024	3.1
Horn antenna	EMCO	3115	114607	01-2021	01-2024	3.1
Horn antenna	FLANN-MICROWAVE	20240-25	114518	NA*	NA*	3.1
Preamplifier 1-18 GHz	µComp Nordic	MCNA-40-0010800-25-10P	114690	01-2022	01-2023	3.1
Preamplifier 18-40 GHz	Miteq	JS4-18004000-33-8P	114693	01-2022	01-2023	3.1
Test software	Raditeq	Radimation Version 2021.1.9	TE 02008	--	--	3.1, 3.2
Two line V-network	Rohde & Schwarz	ESH3-Z5	114379	07-2021	07-2022	3.2

*Note: Standard gain horn antennas do not need calibration

2.5 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

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 3m measurement 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 2.4 of this report.

3.1.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.1.4 Test procedure

Prior to running the measurements, the EUT has been investigated in the X, Y and Z dimensions to determine the worst case configuration for spurious emissions.

9 kHz – 30 MHz: According to ANSI C63.10-2013, section 5.4.2 and 8.2.3
30 MHz to 26.5 GHz: According to ANSI C63.10-2013, section 8.3

9 kHz to 30 MHz: IRN 026 – Method 10
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
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 Peak tables of the radiated spurious emissions measurement

Measured peaks Horizontal 30 – 1000 MHz Low channel

Frequency (MHz)	Polarization	Height (m)	Quasi-Peak (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Difference (dB)
263,994	Horizontal	1,2	36,3	46	-9,7
268,992	Vertical	1,7	22,3	46	-23,7
308,567	Horizontal	1	37	46	-9,0

Measured peaks Horizontal 30 – 1000 MHz Middle channel

Frequency (MHz)	Polarization	Height (m)	Quasi-Peak (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Difference (dB)
263,994	Horizontal	1,2	37,4	46	-8,6
263,982	Vertical	1,2	26,2	46	-19,8

Measured peaks Vertical 30 – 1000 MHz Low channel

Frequency (MHz)	Polarization	Height (m)	Quasi-Peak (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Difference (dB)
44,231	Vertical	1	32,5	40	-7,5
44,649	Vertical	1	35,7	40	-4,3
47,993	Vertical	1	38,7	40	-1,3

Measured peaks Vertical 30 – 1000 MHz Middle channel

Frequency (MHz)	Polarization	Height (m)	Quasi-Peak (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Difference (dB)
54,748	Vertical	1	27,3	40	-12,7
69,576	Vertical	1,2	15,2	40	-24,8
54,29	Vertical	1	27	40	-13,0

Measured peaks Horizontal 30 – 1000 MHz High channel

Frequency (MHz)	Polarization	Height (m)	Quasi-Peak (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Difference (dB)
54,48	Vertical	1,8	25,7	40	-14,3
104,738	Vertical	1	19,5	43,5	-24,0
121,615	Vertical	1	14,1	43,5	-29,4

Measured peaks Horizontal 1 – 18 GHz Low channel

Frequency (MHz)	Polarization	Height (m)	Peak (dBµV/m)	Average (dBµV/m)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Difference (dB)	Average Difference (dB)
7205	Horizontal	1	46	33,9	74	54	-28,0	-20,1

Measured peaks Horizontal 1 – 18 GHz Middle channel

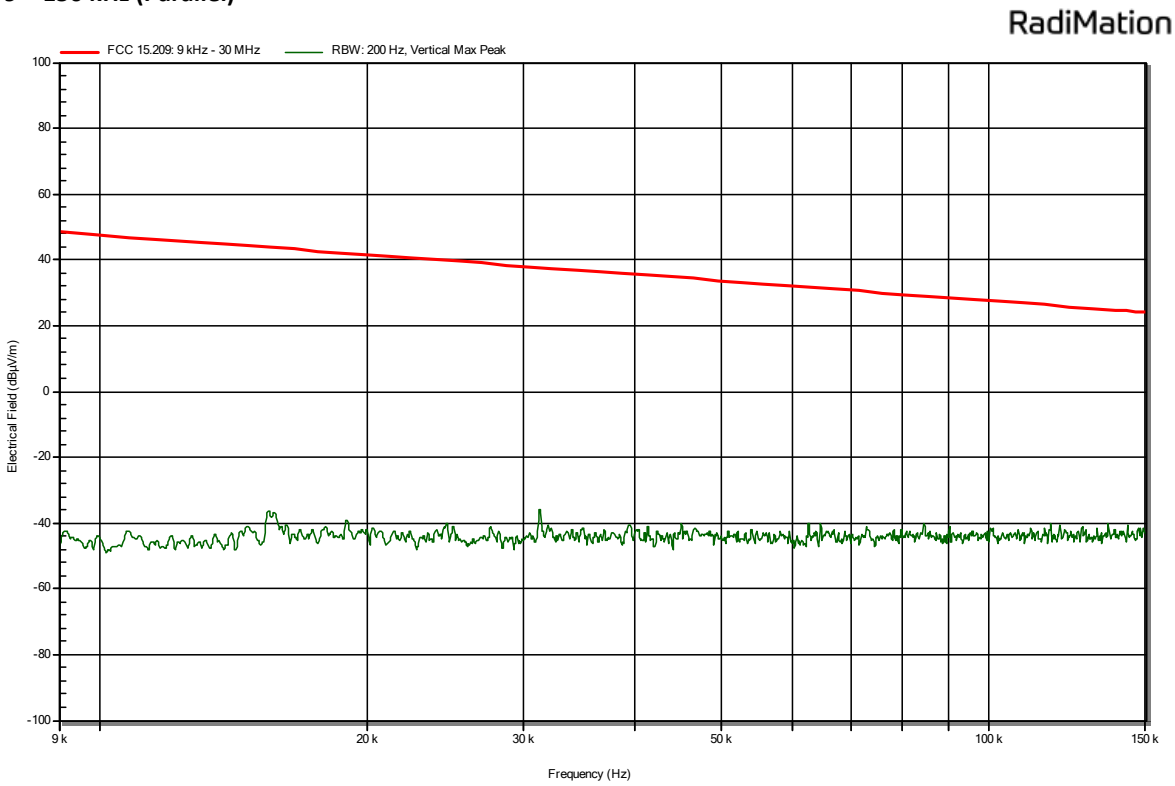
Frequency (MHz)	Polarization	Height (m)	Peak (dBµV/m)	Average (dBµV/m)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Difference (dB)	Average Difference (dB)
7319,75	Horizontal	2	46,9	35,2	74	54	-27,1	-18,8

Measured peaks Horizontal 1 – 18 GHz High channel

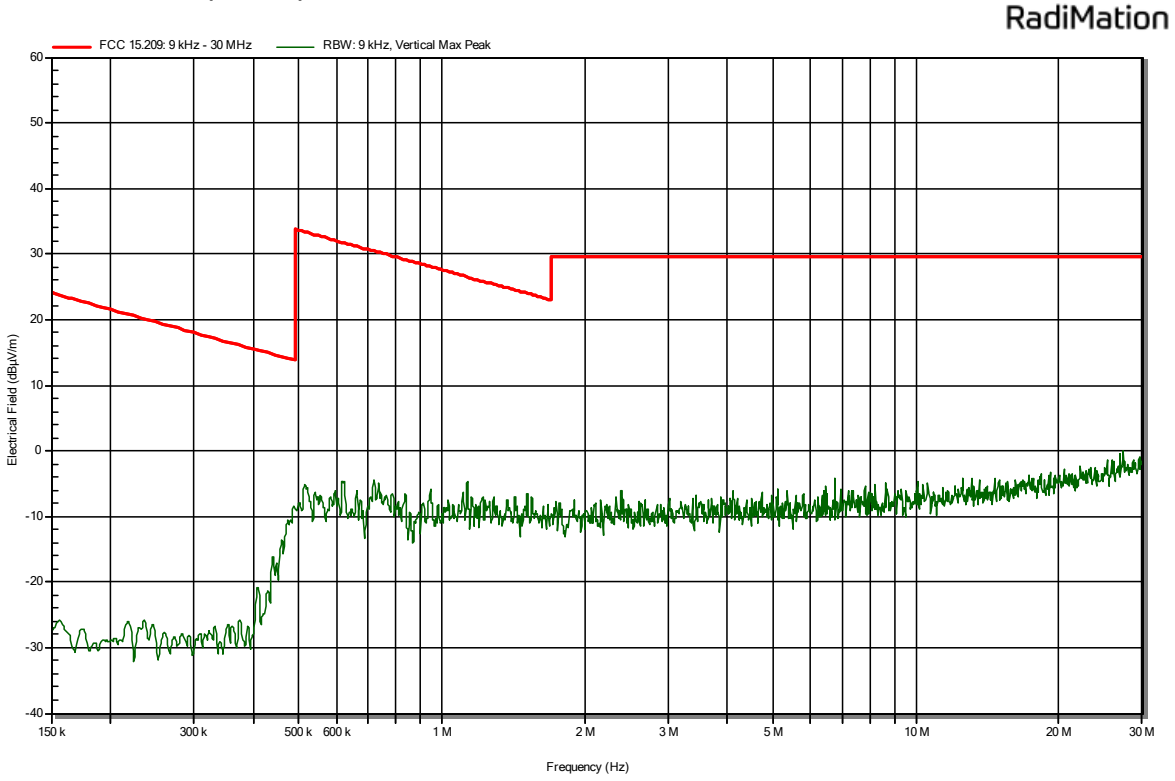
Frequency (MHz)	Polarization	Height (m)	Peak (dBµV/m)	Average (dBµV/m)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Difference (dB)	Average Difference (dB)
7440,875	Horizontal	4	47,3	34	74	54	-26,7	-20,0

3.1.7 Plots of the Radiated Spurious Emissions Measurement

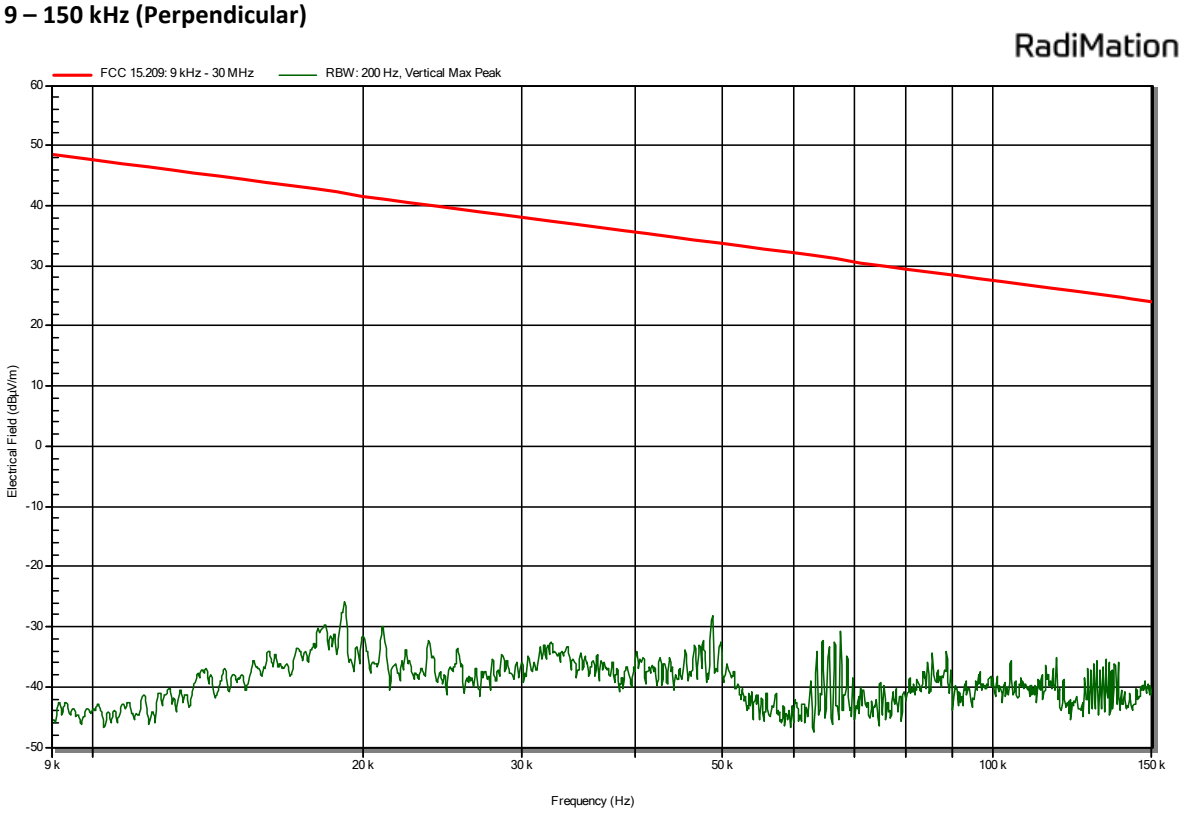
9 – 150 kHz (Parallel)



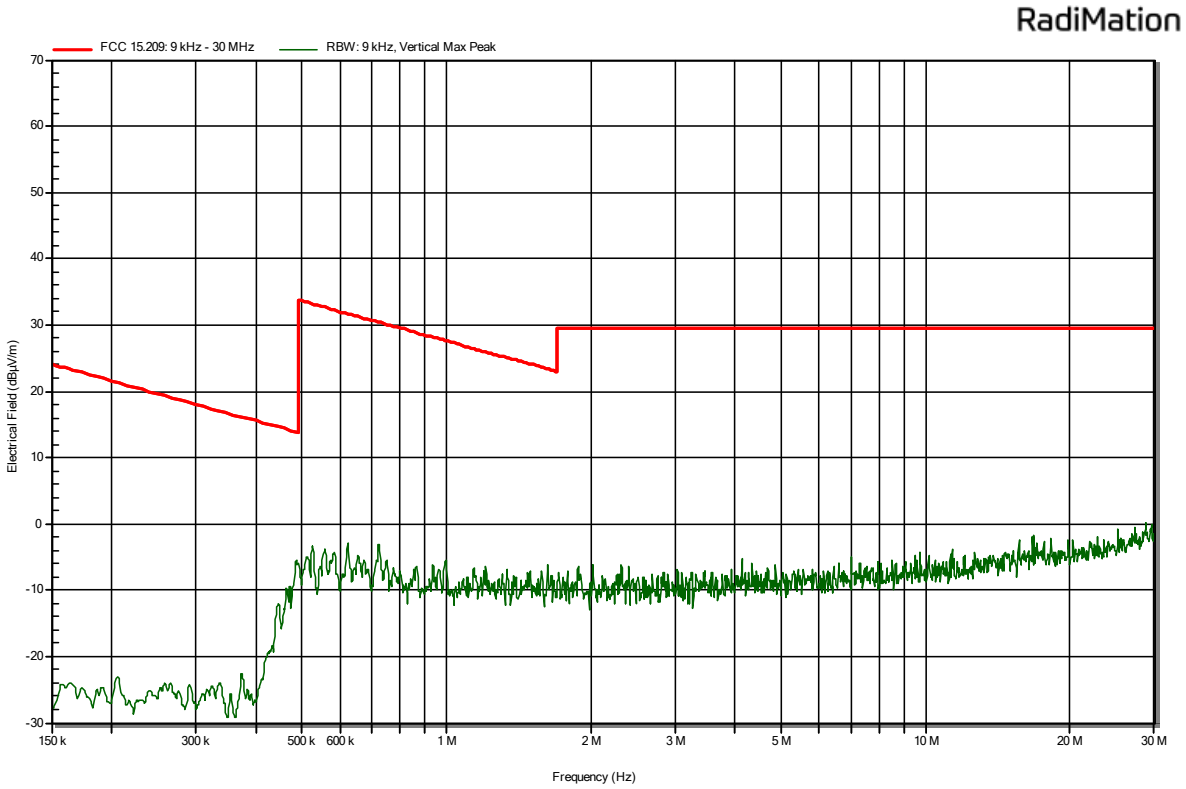
150 kHz – 30 MHz (Parallel)



9 – 150 kHz (Perpendicular)

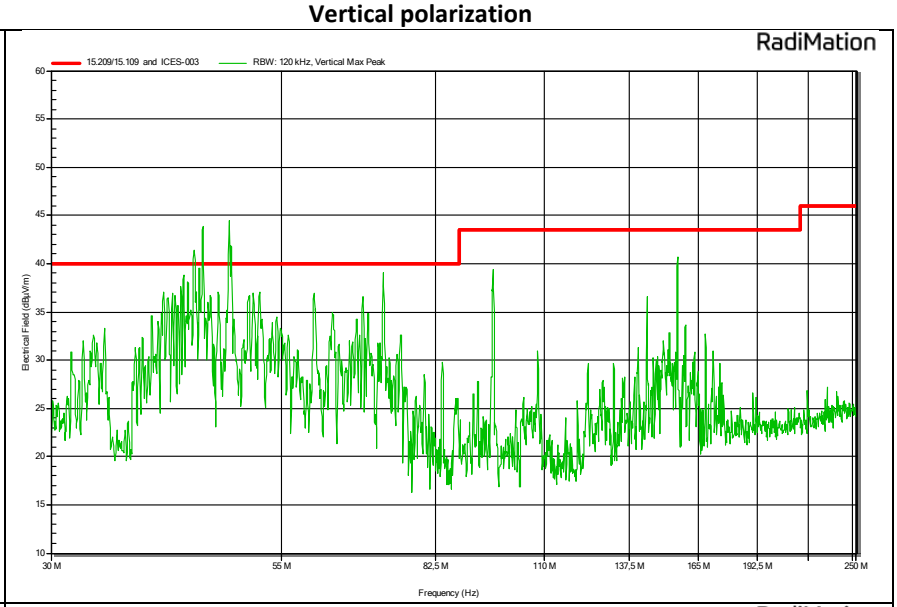
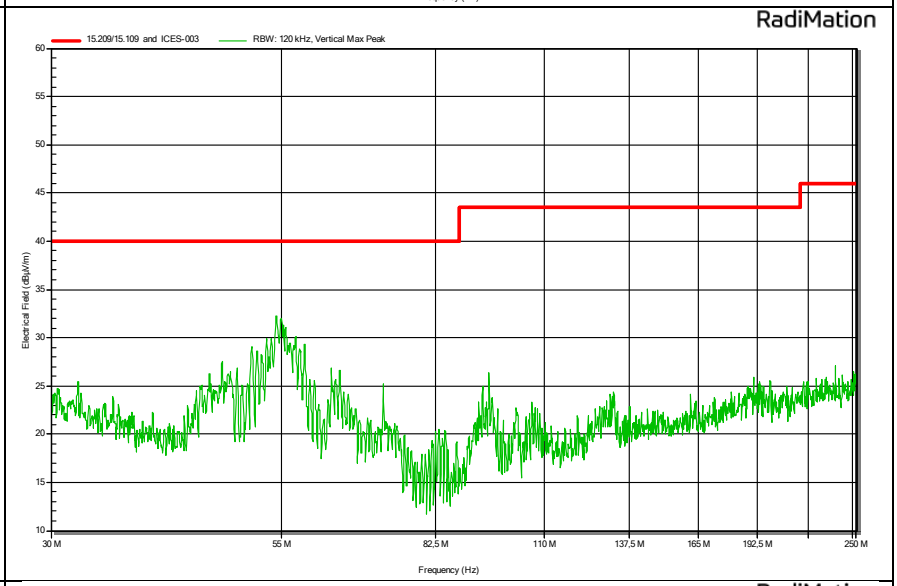
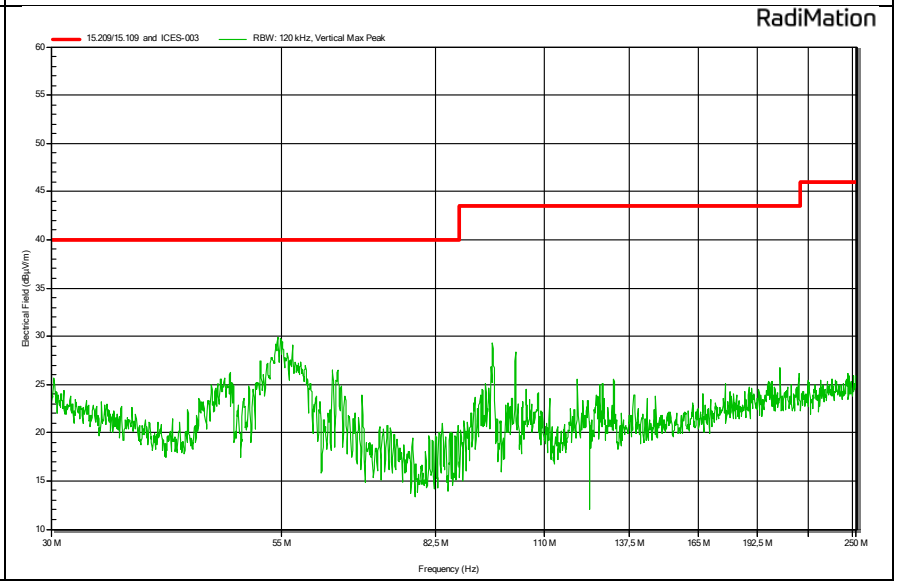


150 kHz – 30 MHz (Perpendicular)



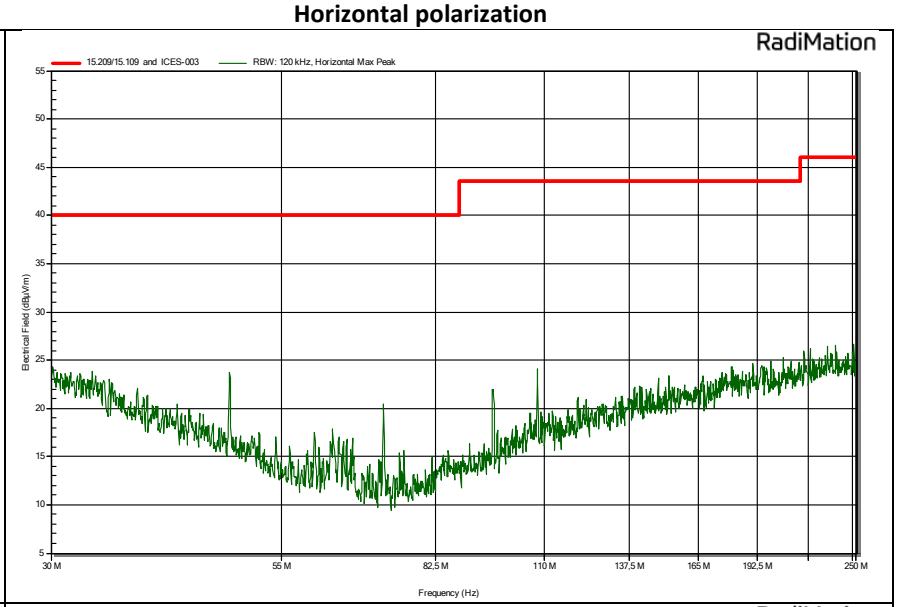
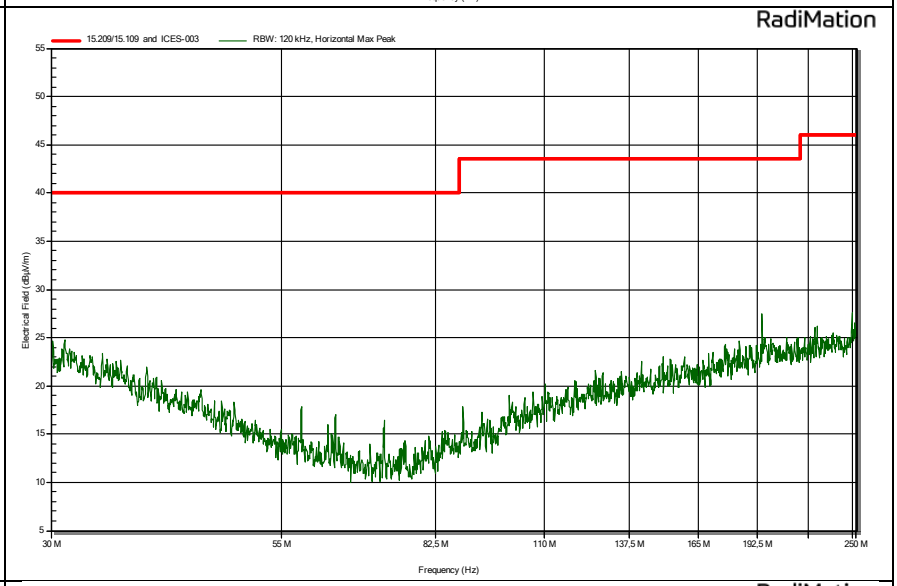
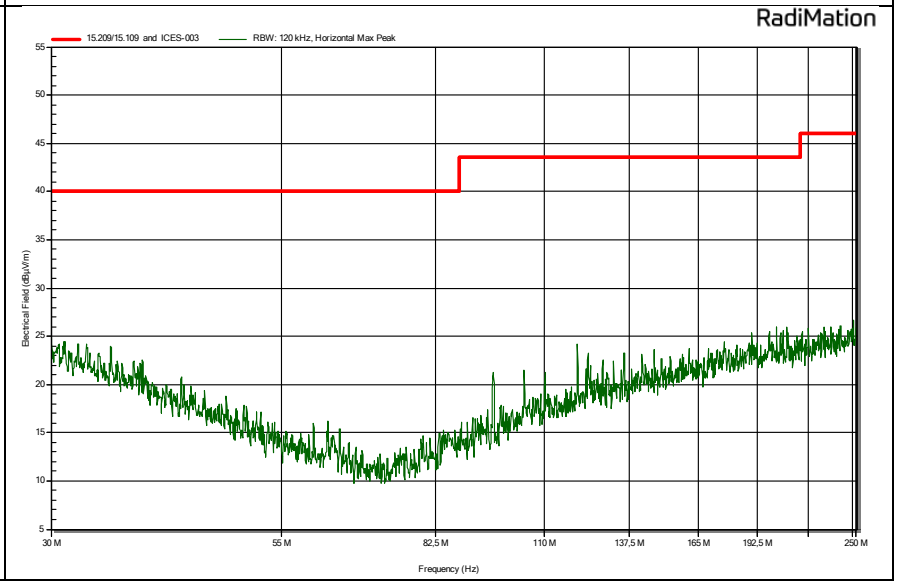
30 MHz to 250 MHz

Vertical polarization

Low ch	
Mid ch	
High ch	

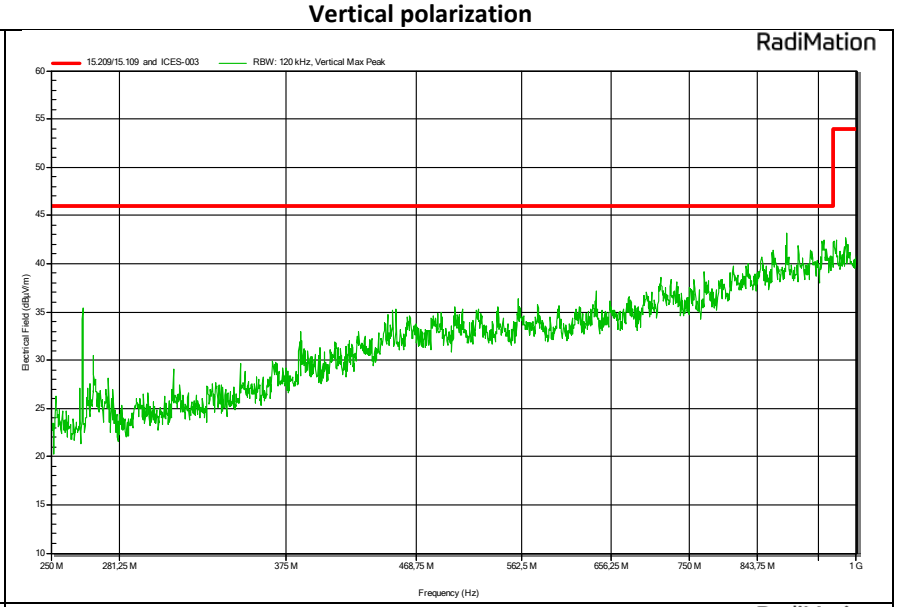
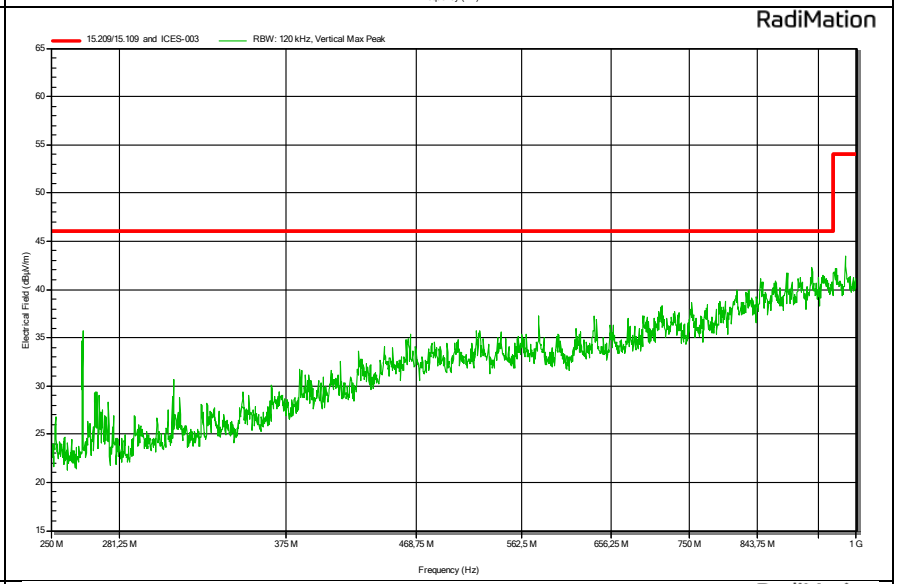
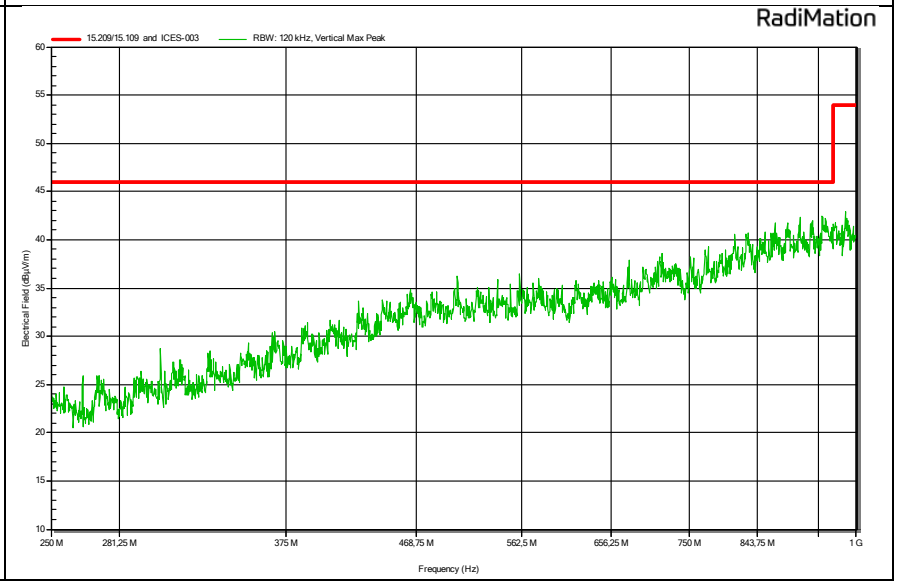
30 MHz to 250 MHz

Horizontal polarization

Low ch	
Mid ch	
High ch	

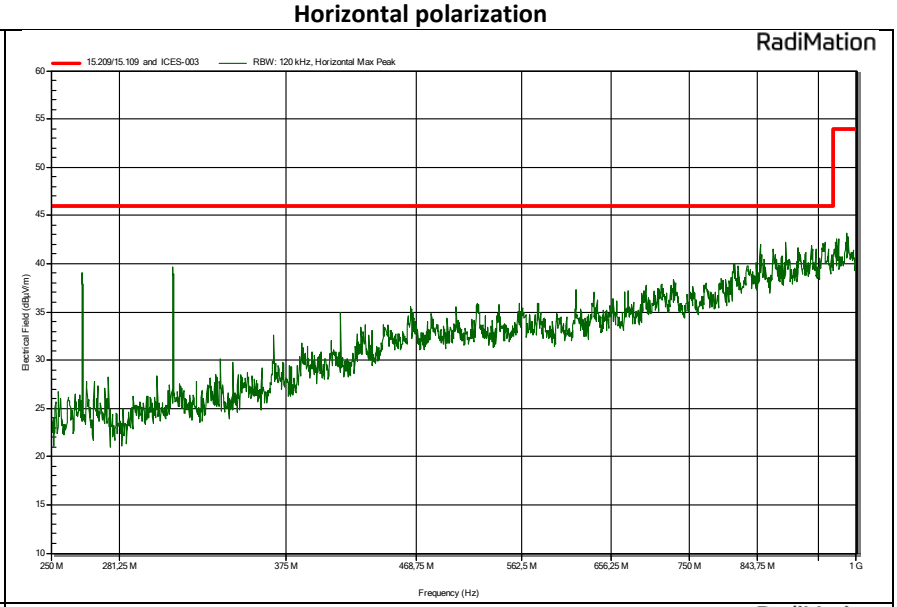
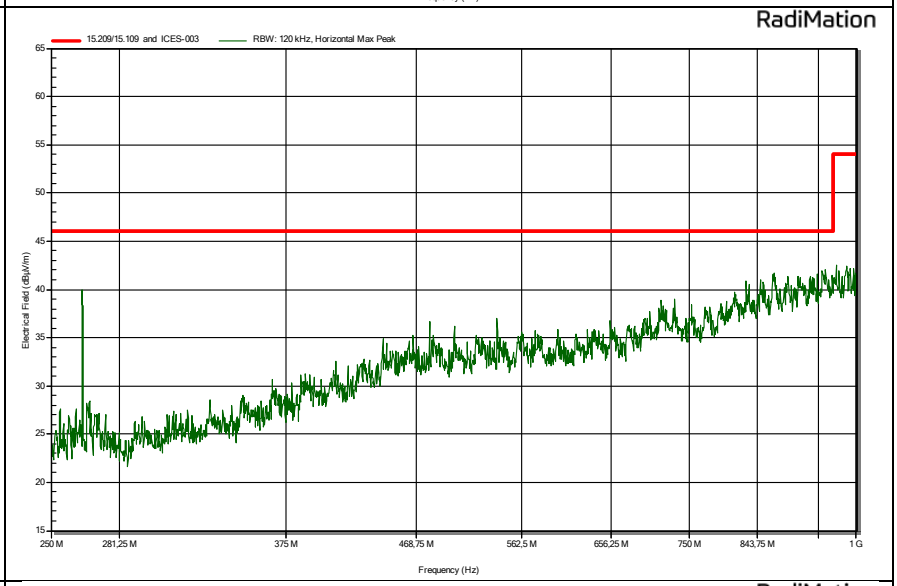
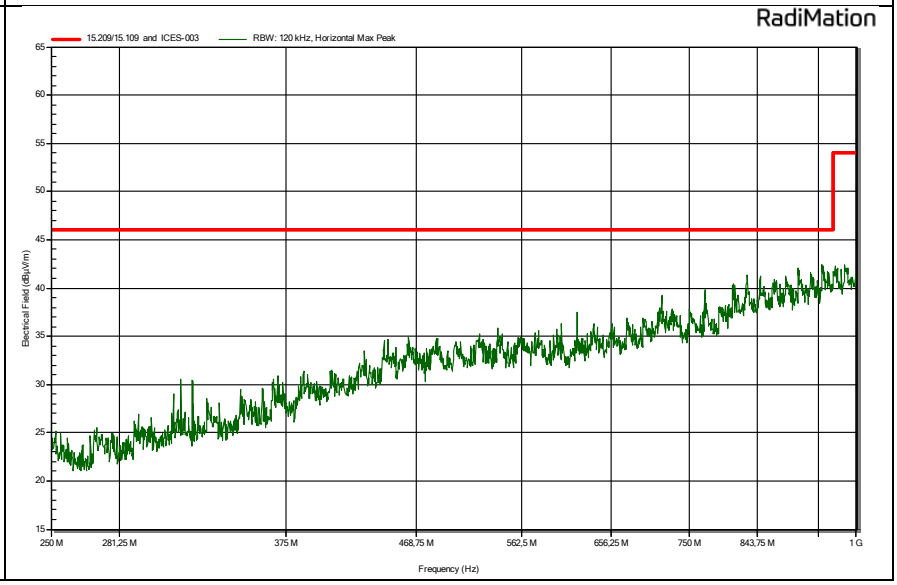
250 MHz to 1 GHz

Vertical polarization

Low ch	
Mid ch	
High ch	

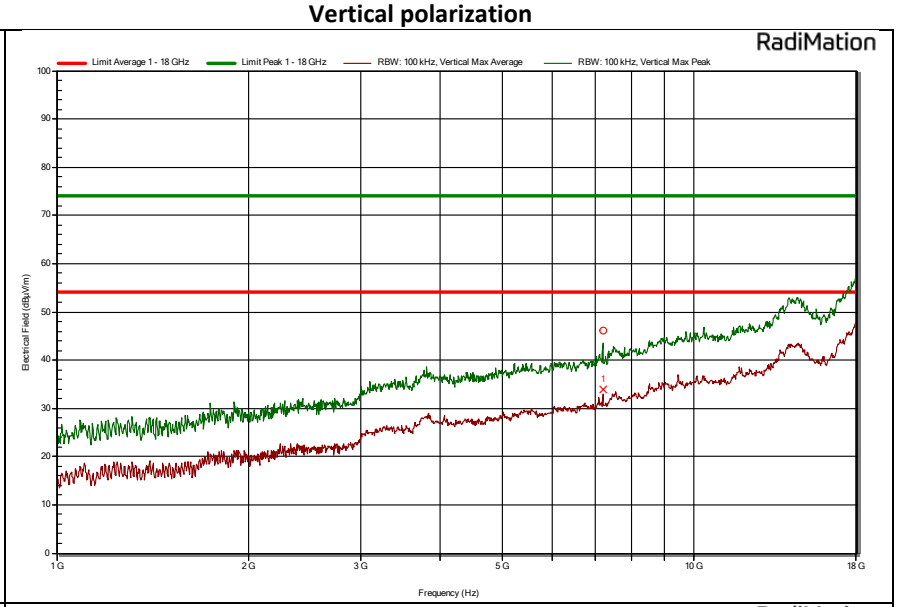
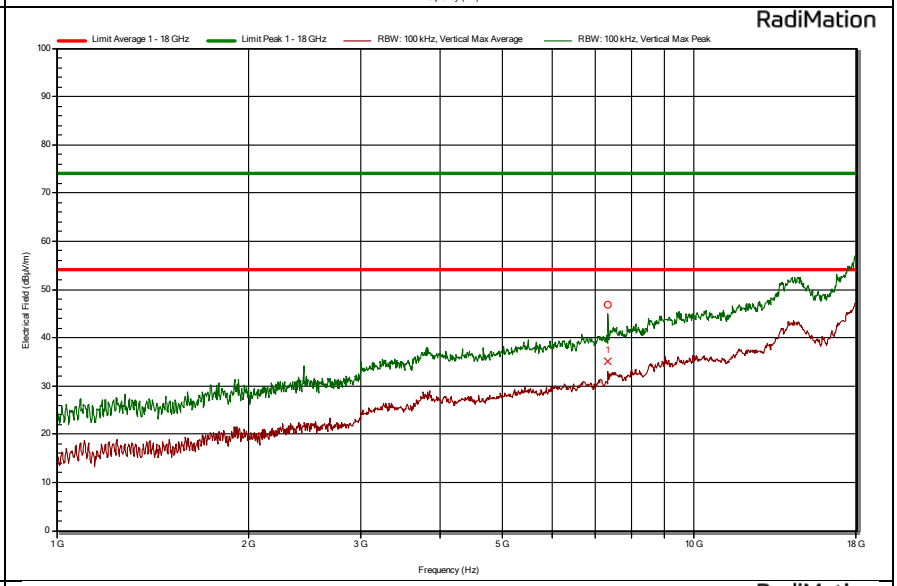
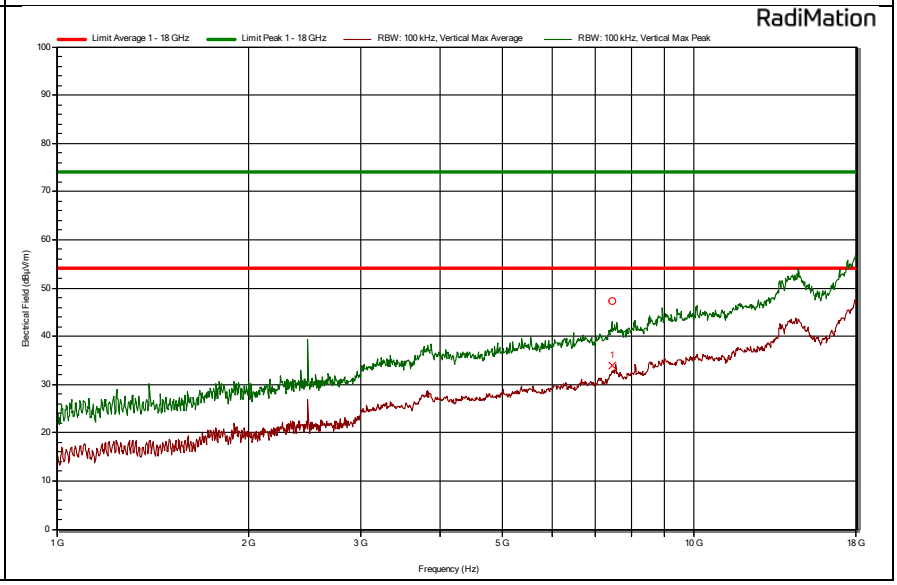
250 MHz to 1 GHz

Horizontal polarization

Low ch	
Mid ch	
High ch	

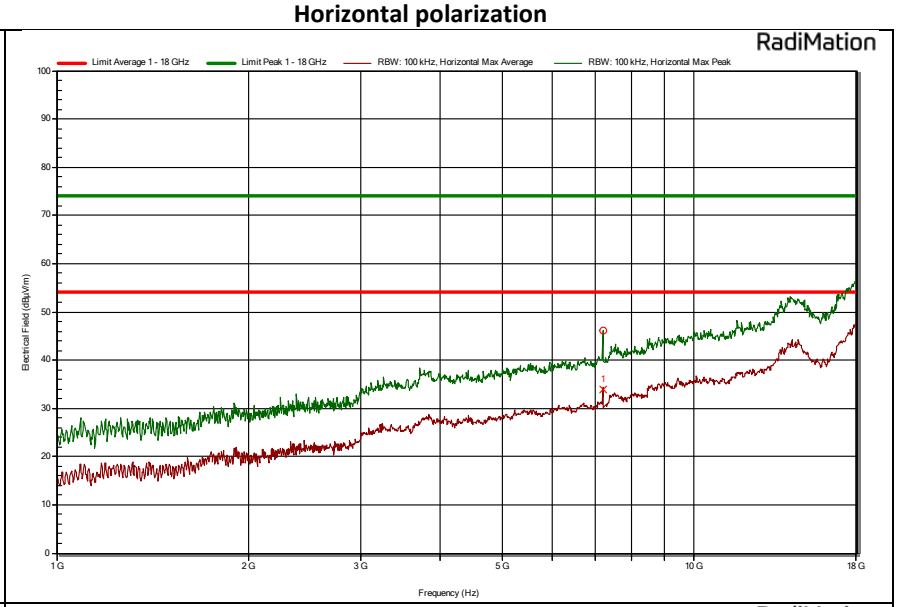
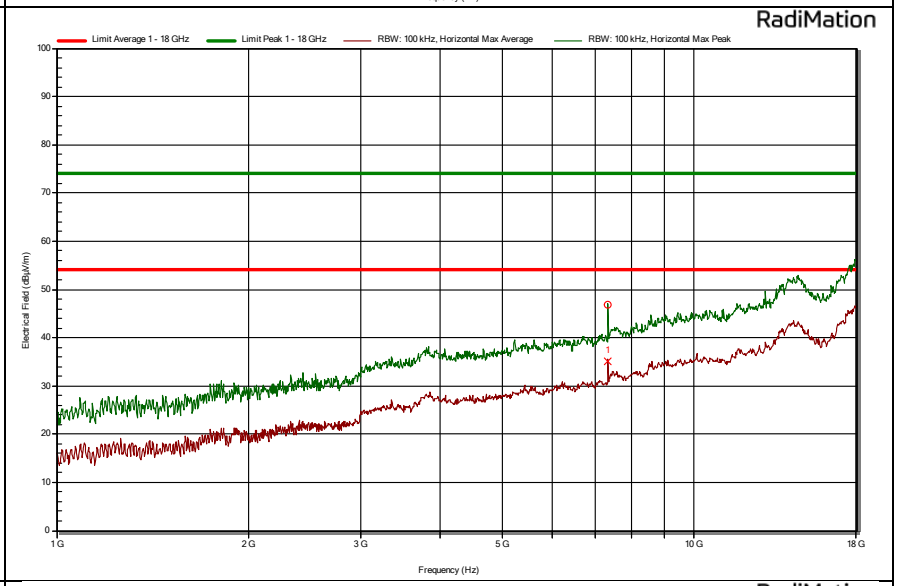
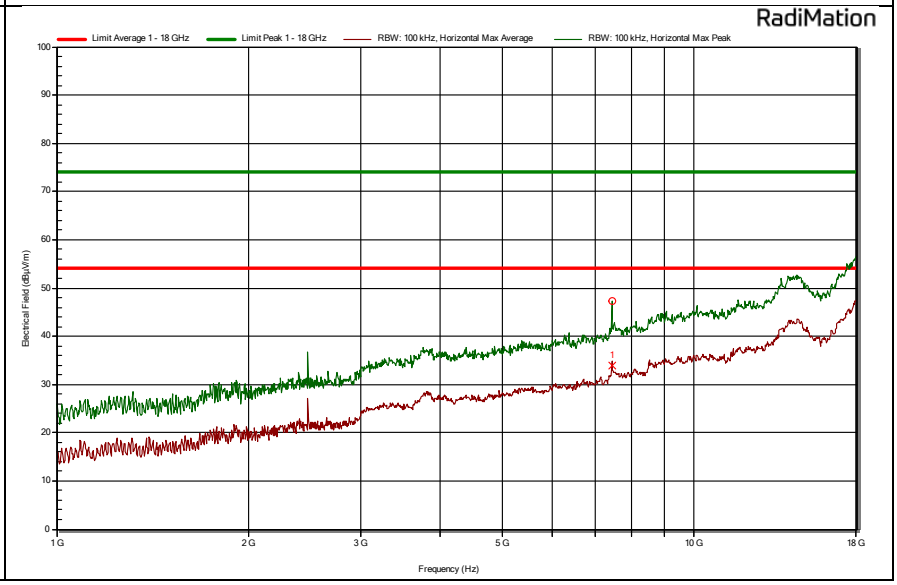
1 GHz to 18 GHz

Vertical polarization

Low ch	
Mid ch	
High ch	

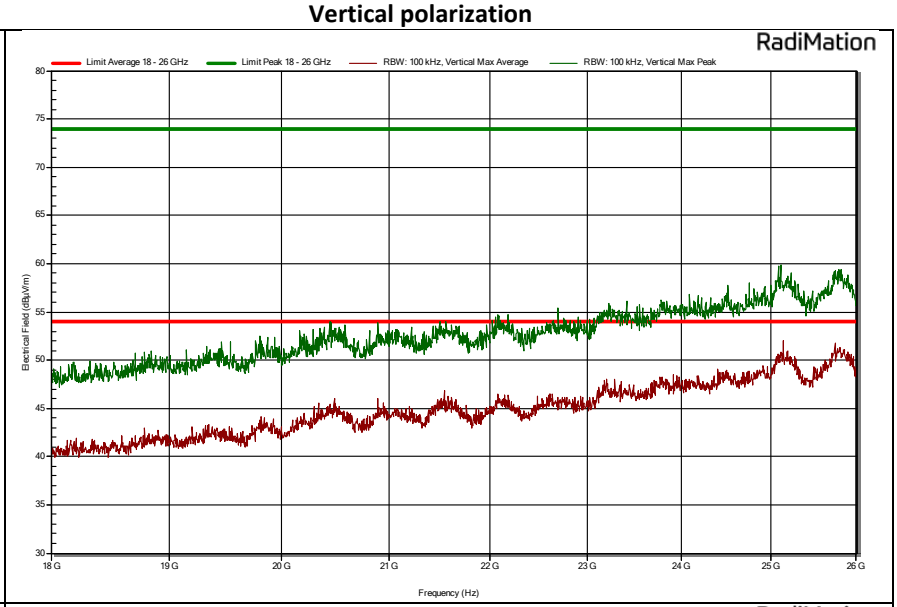
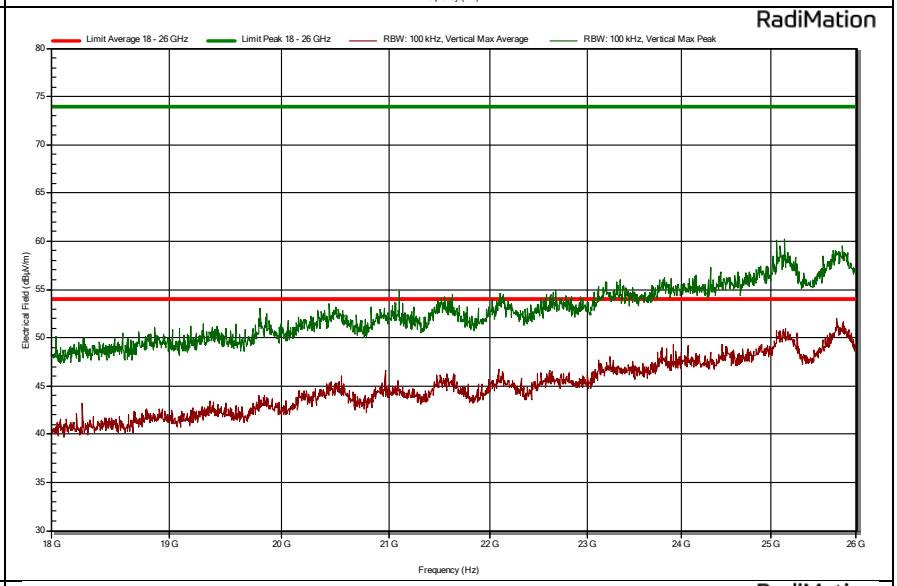
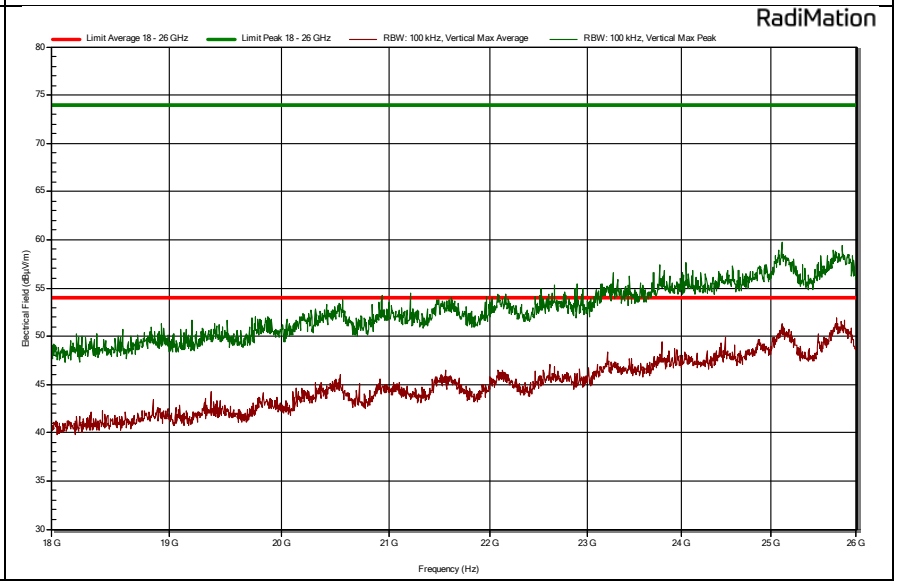
1 GHz to 18 GHz

Horizontal polarization

Low ch	
Mid ch	
High ch	

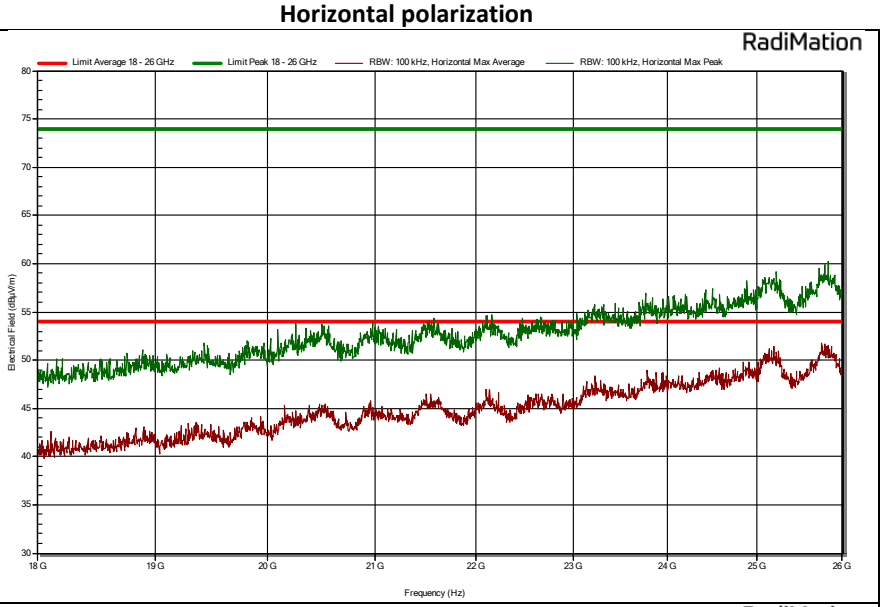
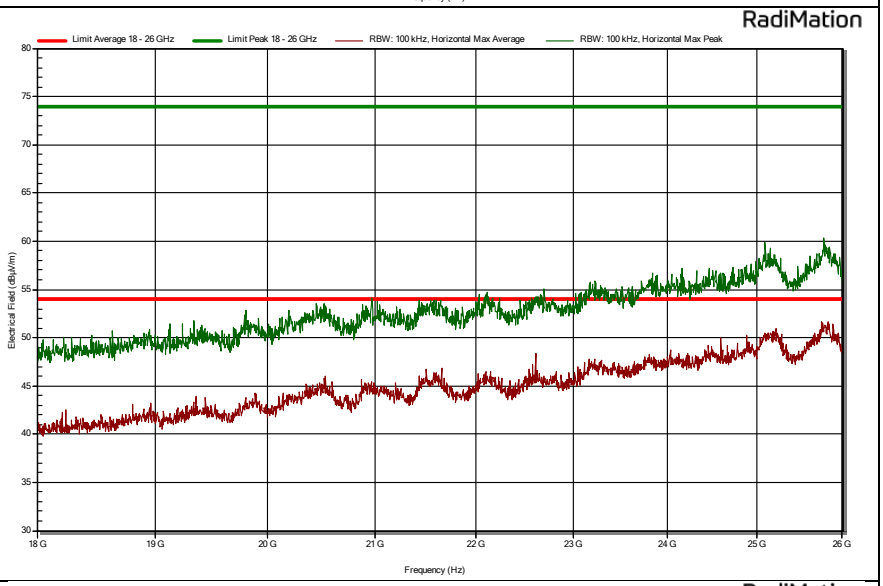
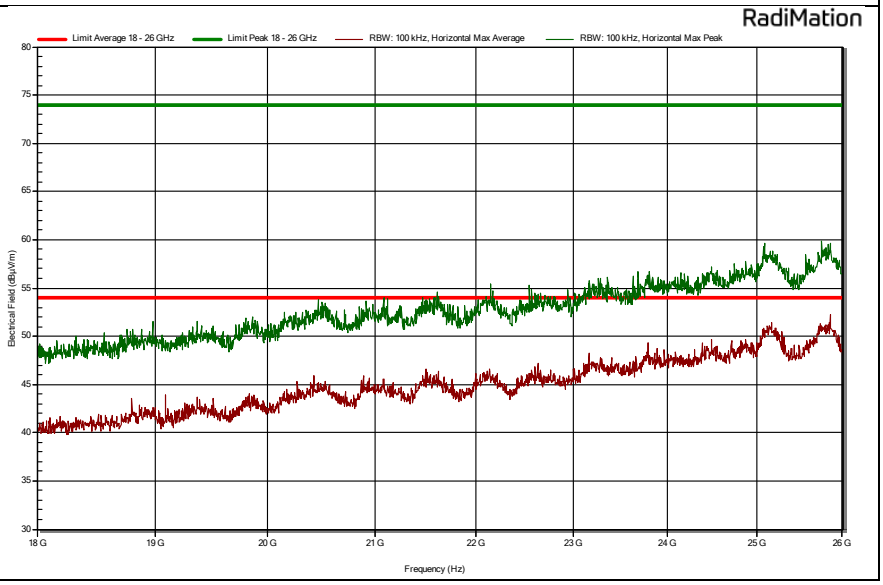
18 GHz to 26 GHz

Vertical polarization

Low ch	
Mid ch	
High ch	

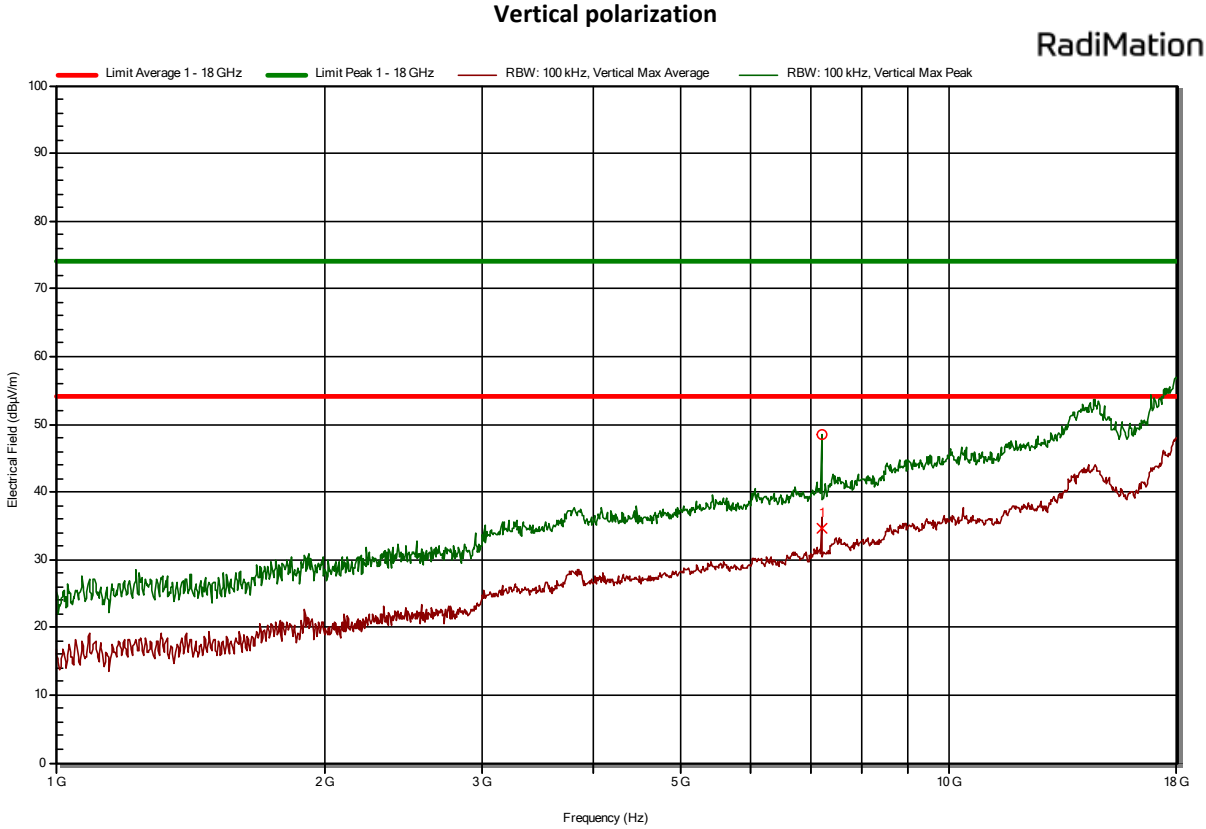
18 GHz to 26 GHz

Horizontal polarization

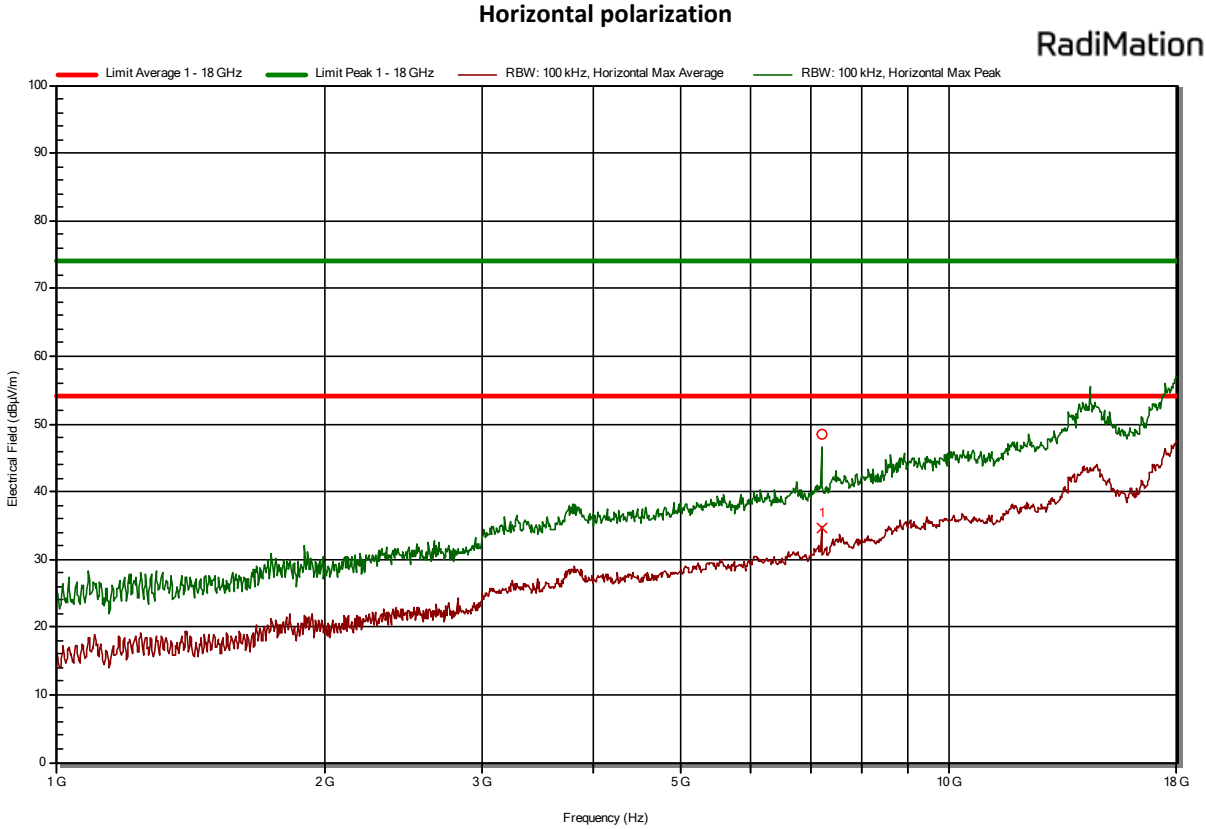
Low ch	
Mid ch	
High ch	

Multi radio

Vertical polarization



Horizontal polarization



3.2 AC power line 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 (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.

3.2.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.2.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.2.4 Test procedure

According to ANSI C63.10: 2013
IRN 029 – Method 1

3.2.5 Peak table of the AC power line emission measurement

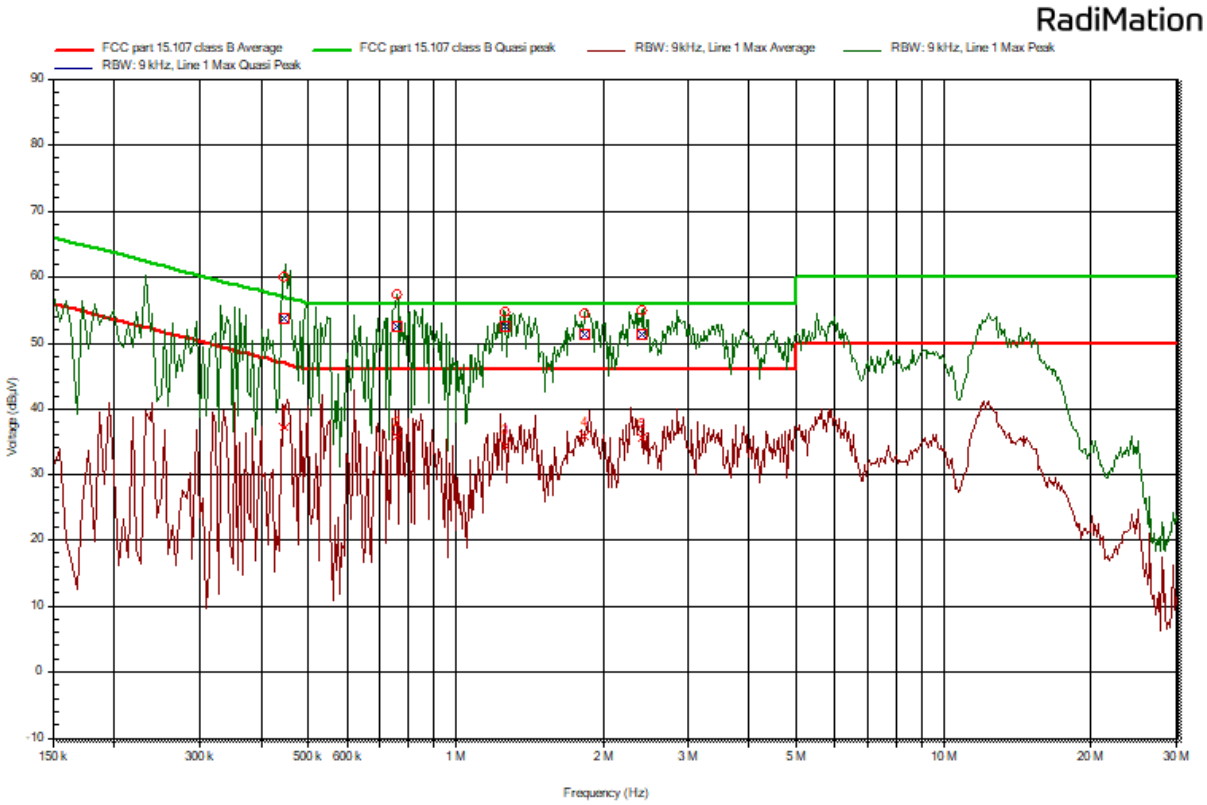
See next page.

3.2.6 Measurement uncertainty

+/- 3.6 dB

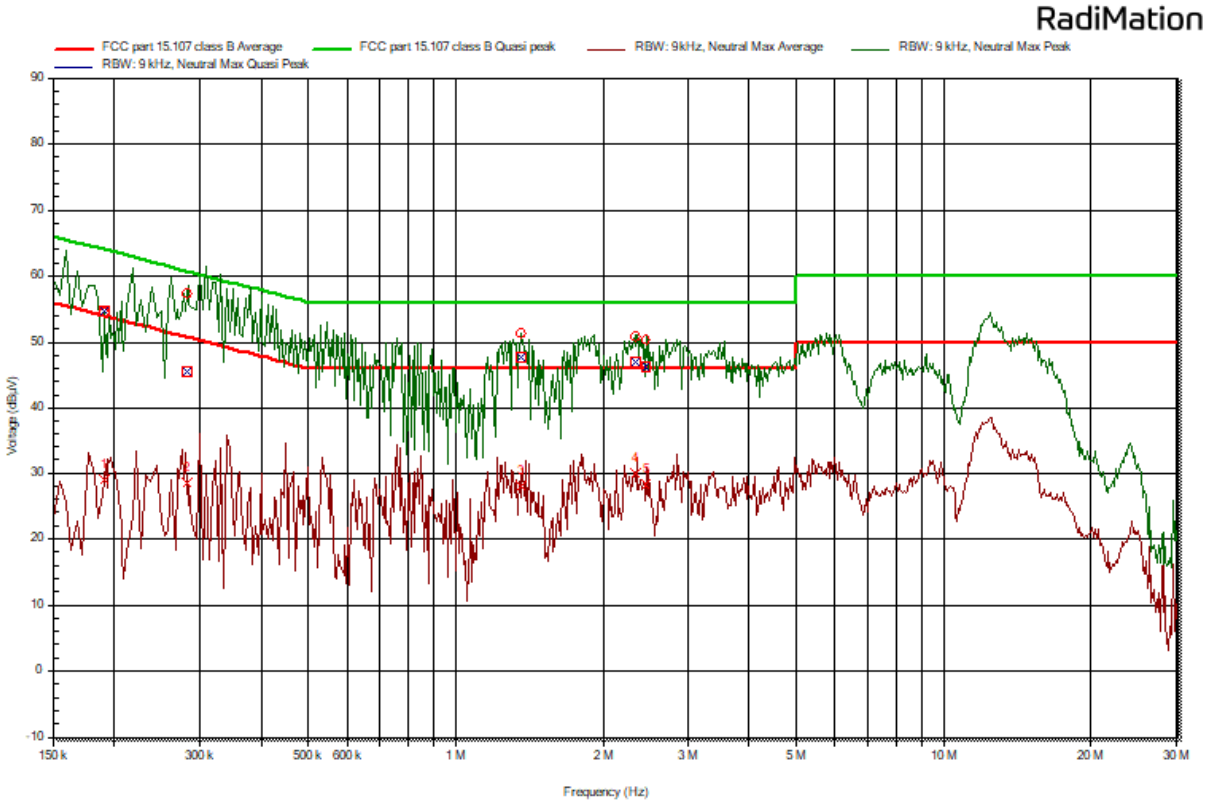
3.2.7 Plots of the AC mains conducted spurious measurement

Phase



Frequency	Peak	Average	Average Limit	Quasi-Peak	Quasi-Peak Limit	Status
444,3 kHz	59,9 dBµV	37,1 dBµV	47 dBµV	53,6 dBµV	57 dBµV	Pass
755,7 kHz	57,3 dBµV	35,7 dBµV	46 dBµV	52,4 dBµV	56 dBµV	Pass
1,261 MHz	54,8 dBµV	34,3 dBµV	46 dBµV	52,6 dBµV	56 dBµV	Pass
1,837 MHz	54,4 dBµV	35,7 dBµV	46 dBµV	51,3 dBµV	56 dBµV	Pass
2,401 MHz	54,9 dBµV	35,4 dBµV	46 dBµV	51,2 dBµV	56 dBµV	Pass

Neutral



Frequency	Peak	Average	Average Limit	Quasi-Peak	Quasi-Peak Limit	Status
190,95 kHz	54,4 dBµV	29 dBµV	54 dBµV	54,7 dBµV	64 dBµV	Pass
283,2 kHz	57,2 dBµV	28,5 dBµV	50,7 dBµV	45,5 dBµV	60,7 dBµV	Pass
1,36 MHz	51,4 dBµV	28 dBµV	46 dBµV	47,6 dBµV	56 dBµV	Pass
2,338 MHz	50,8 dBµV	29,8 dBµV	46 dBµV	47 dBµV	56 dBµV	Pass
2,449 MHz	50,5 dBµV	28,1 dBµV	46 dBµV	46,3 dBµV	56 dBµV	Pass

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 Rohde & Schwarz ENV216	**TE 11134**	
0,15	9.6	0,02	9.62
0,3	9.6	0,03	9.63
0,5	9.6	0,08	9.68
0,7	9.7	0,25	9.95
1	9.6	0,11	9.71
3	9.6	0,21	9.81
5	9.6	0,21	9.81
7	9.7	0,25	9.95
10	9.7	0,29	9.99
15	9.7	0,34	10.04
20	9.8	0,37	10.17
22	9.6	0,39	9.99
24	9.6	0,43	10.03
30	9.6	0,45	10.05

Magnetic field strength measurement:

$$H\left[dB\left(\mu\frac{A}{m}\right)\right] = V[dB(\mu V)] + L_c[dB] + AF^H[\frac{dB}{\Omega m}]$$

Where:
H is the magnetic field strength (to be compared to the limit)
V is the voltage level measured by the receiver or spectrum analyzer
L_C is the cable loss
AF^H is the magnetic antenna factor

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

Field Strength Measurement:

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

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

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

Frequency (Mhz)	**AF (dB/m)**	**Cable loss (dB)**	**Corr. (dB)**
	Id: 114436 Schwarzbeck VHA9103+BBA9106 SN: 9856	**Id: SAR cable**	
30	18,64	0,68	19,32
100	10,43	1,15	11,58
150	14,76	1,41	16,17
200	16,04	1,63	17,67
250	16,89	1,93	18,82

Frequency (Mhz)	**AF (dB/m)**	**Cable loss (dB)**	**Corr. (dB)**
	Id: 114385 EMCO 3147 SN: 9104-1031	**Id: SAR cable**	
250	11,8	1,93	13,73
300	13	2,12	15,12
350	14,2	2,2	16,4
400	15,6	2,29	17,89
450	17,1	2,53	19,63
500	17,3	2,67	19,97
550	17,7	2,9	20,6
600	18,4	3,02	21,42
650	19,2	3,09	22,29
700	19,7	3,22	22,92
750	20,3	3,56	23,86
800	21,4	3,69	25,09
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) TE 00531 Emco 3115 SN: 9412-4377	Gain (dB) TE 11132 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) TE 00818 Flann 20240-25 SN: 163703	Gain (dB) TE 11131 Miteq JS4-18004000-30-8P-A1	Cable loss (dB) TE 01315	Corr. (dB)
18000	31,3	26,2	9,8	67,3
19000	31,5	26,1	9,6	67,2
20000	31,7	25,9	11	68,6
21000	31,9	24,3	10,7	66,9
22000	32,1	18,3	10,5	60,9
23000	32,2	18,9	10,8	61,9
24000	32,3	23,6	11,4	67,3
25000	32,4	24,5	11,6	68,5
26000	32,5	25,3	11,7	69,5

< End of Report >