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The Netherlands
Chamber of Commerce
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FCC Test report for parts 15.207, 15.209, 15.247

Product name	: NOVA
Applicant	: SenseGlove B.V.
FCC ID	: 2A24H-NOVA01

Test report No. : P000023260 001 Ver 2.0

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).

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The Industry Canada company number for Telefication is: 4173A.

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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	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	09-08-2021	First draft	PvW
v1.00	03-12-2021	Initial release	PvW
V2.00	09-03-2022	Added calibration info Updated test procedure	PvW

Table of Contents

Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.247(d) 15.209 (a)	RSS-Gen 8.9	Radiated spurious emissions	3.1	Pass
15.205 (a)	RSS Gen 8.10	Spurious emissions in the restricted bands	3.1	Pass
15.247 (b)	RSS-247 5.4 (d)	RF output power	3.2	Pass
15.207 (c)	RSS-Gen 8.8	AC Power Line Conducted Emissions	3.3	Pass

1 General Description

1.1 Applicant

Client name:	SenseGlove B.V.
Address:	Molengraaffsingel 12, Delft, the Netherlands
Zip code:	2629 JD
Telephone:	0031 0636548263
E-mail:	Johannes@senseglove.com
Contact name:	Mr. Johannes Luijten

1.2 Manufacturer

Manufacturer name:	SenseGlove B.V.
Address:	Molengraaffsingel 12, Delft, the Netherlands
Zip code:	2629 JD
Telephone:	0031 0636548263
E-mail:	Johannes@senseglove.com
Contact name:	Mr. Johannes Luijten

1.3 Tested Equipment Under Test (EUT)

Product name:	NOVA
Brand name:	SenseGlove
FCC ID:	2A24H-NOVA01
Product type:	Wireless haptic and force feedback gloves
Model(s):	--
Batch and/or serial No.	NOVA-DEV1-L
Software version:	--
Hardware version:	--
Date of receipt:	09-08-2021
Tests started:	09-08-2021
Testing ended:	09-08-2021

1.4 Product specifications of Equipment under test

Tx Frequency:	2400 – 2483.5 MHz
Rx frequency:	2400 – 2483.5 MHz
Antenna type:	Meandering PCB antenna
Antenna gain:	3.7 dBi
Type of modulation:	FHSS
Emission designator	1M00F1D

Disclaimer: The antenna gain and operating frequency bands are taken from the module datasheet

1.5 Environmental conditions

Test date	09-08-2021
Ambient temperature	21.2°C
Humidity	60.1%

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 §15.207
- FCC Part 15 Subpart C §15.209
- FCC Part 15 Subpart C §15.247

1.8 Observation and remarks

The EUT contains pre-certified Espressif module ESP32 WROOM-32D.
The EUT only uses the BT 4.0 option of the module, other technologies are disabled for the end user.

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. P.A. Suringa

The above conclusions have been verified by the following signatory:

Date : 10-03-2022

Name : ing. R. van Barneveld

Function : Test Engineer

Signature :

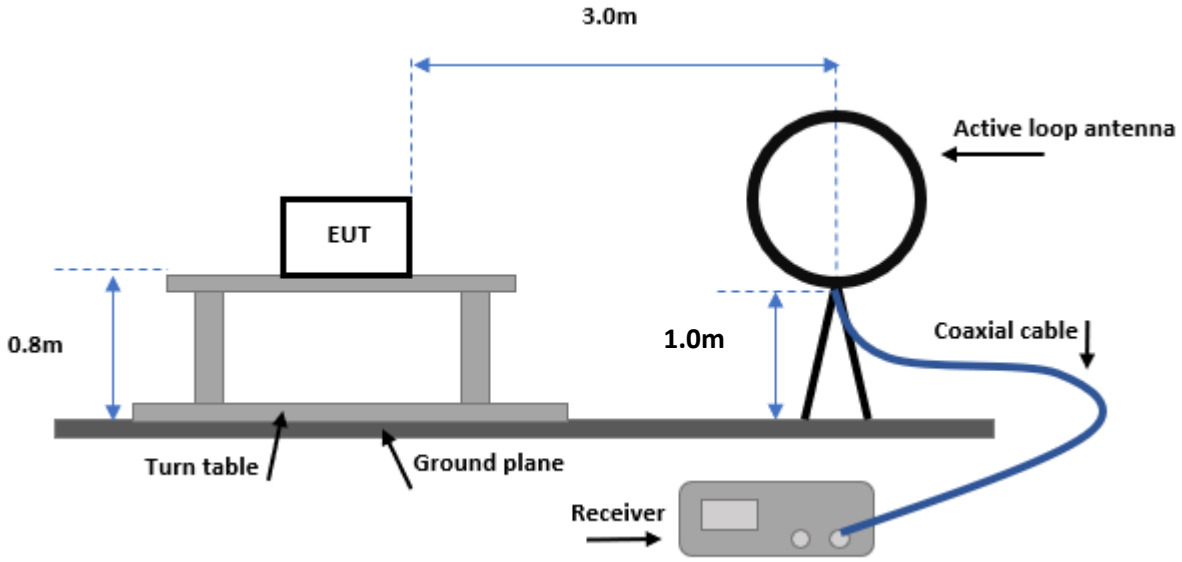
2 Test configuration of the Equipment Under Test

2.1 Test mode

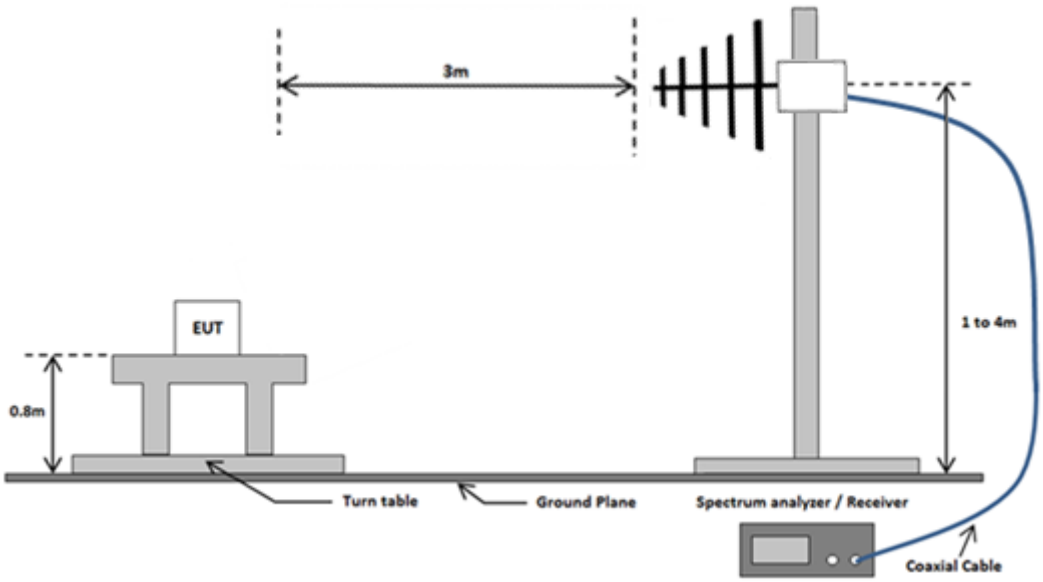
The manufacturer provided a test mode where the transmitter could be set to transmit continuously on a fixed channel. Spurious emissions are tested in the worst case operating mode.

2.2 Test setups

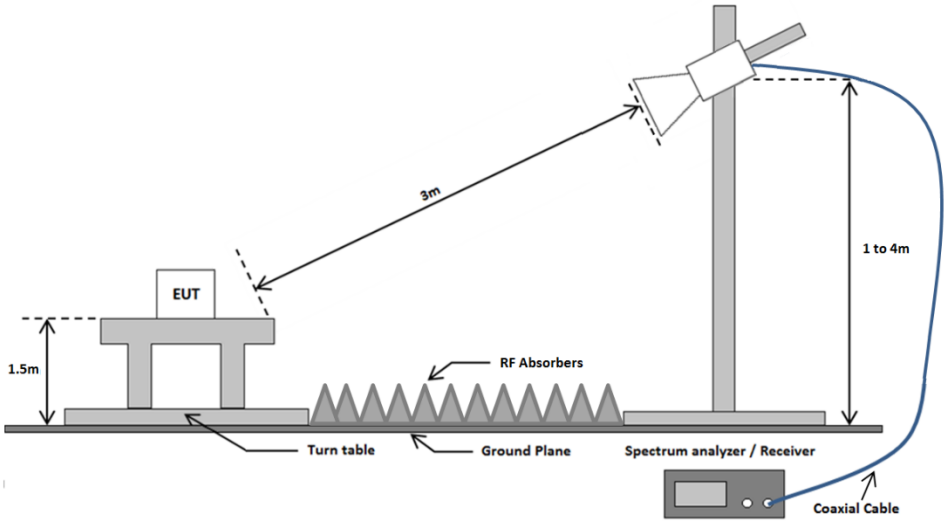
Radiated emissions test setup 9 kHz – 30 MHz



Radiated emissions test setup 30 MHz - 1 GHz

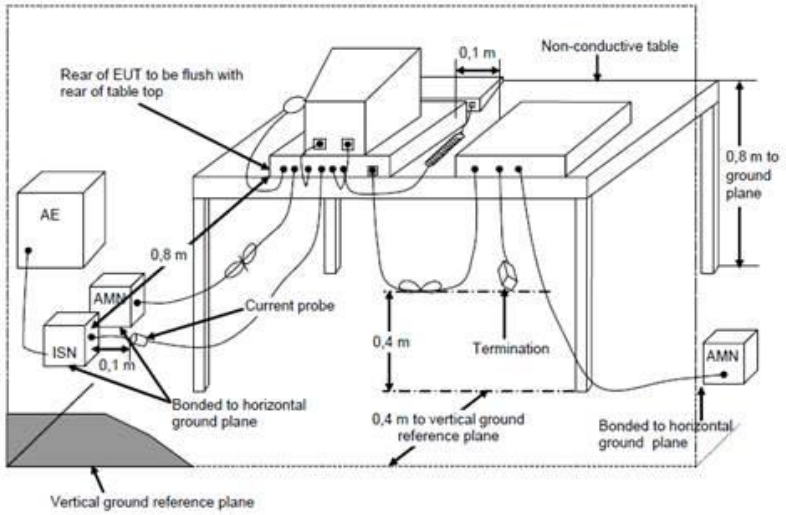


Radiated emissions test setup above 1 GHz



Conducted emissions test setup

Emissions test at AC mains



2.3 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Used at Par.	Cal. Date	Cal. Due date
EMI Receiver	Rohde & Schwarz	ESCI	TE11128	3.3	02-2021	02-2022
EMI Receiver	Rohde & Schwarz	ESR7	TE01220	3.1	02-2022	02-2023
Spectrum analyzer	Rohde & Schwarz	FSP40	TE11125	3.1; 3.2	03-2020	03-2022
3.0 GHz HPF	Wainwright	WHK3.0/18G-10EF	TE01140	3.1	09-2021	09-2024
Active loop antenna	EMCO	6502	TE11171	3.1	01-2021	01-2024
Biconilog antenna	Chase	CBL6112A	TE00967	3.1	03-2021	03-2024
Horn antenna	EMCO	3115	TE00531	3.1; 3.2	01-2021	01-2024
Preamplifier 1-18 GHz	µComp Nordic	MCNA-40-0010800-25-10P	TE11175	3.1; 3.2	01-2022	01-2023
Horn antenna	FLANN-MICROWAVE	20240-25	TE 00818	3.1	NA	NA
Preamplifier 18-26 GHz	Miteq	JS4-18004000-33-8P	TE 11131	3.1	01-2022	01-2023
Test software	DARE	Radimation Version 2021.1.9	--	3.1 – 3.3	NA	NA
Green 7 m cable for antenna	Micro Coax	FB142A1070002020	114691	3.1	NA	NA

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

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: Limit lines in the plots 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 2.3 of this report.

3.1.3 Test setup

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

3.1.4 Test procedure

9 kHz – 30 MHz: According to ANSI C63.10-2013, section 6.4
30 MHz to 1 GHz: According to ANSI C63.10-2013, section 6.5
1 GHz to 26.5 GHz: According to ANSI C63.10-2013, section 6.6

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

The EUT is investigated in X, Y and Z orientations to find the orientation of highest emissions prior to measuring the radiated spurious emissions.

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 Measured peaks

9 kHz – 30 MHz

No peaks are reported as all measured peaks are more than 20 dB below the applicable limit

30 – 1000 MHz, low channel

Peak Number	Frequency	Peak	Peak Limit	Status
1	265,467 MHz	33,3 dBµV/m	46 dBµV/m	Pass
2	237,337 MHz	32 dBµV/m	46 dBµV/m	Pass
3	232,196 MHz	32,5 dBµV/m	46 dBµV/m	Pass
4	220,799 MHz	30,5 dBµV/m	46 dBµV/m	Pass
5	376,29 MHz	29,9 dBµV/m	46 dBµV/m	Pass
6	190,05 MHz	26,1 dBµV/m	43,5 dBµV/m	Pass

1-18 GHz, low channel

Peak number	Frequency (MHz)	Peak (dBµV/m)	Average (dBµV/m)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Status	Polarization
1	4804,122	48,3	42,9	74	54	Pass	Vertical
2	3202,656	47,4	43,2	74	54	Pass	Vertical

1 – 18 GHz, mid channel

Peak Number	Frequency	Average (dBµV/m)	Average Limit (dBµV/m)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Status	Polarization
1	17,885 GHz	44,3	54	56,5	74	Pass	Horizontal
2	17,911 GHz	43,9	54	56,1	74	Pass	Vertical
3	17,896 GHz	44,3	54	56,1	74	Pass	Vertical
4	17,792 GHz	43,4	54	55,8	74	Pass	Vertical
5	18 GHz	43,1	54	56,1	74	Pass	Vertical
6	4,88 GHz	40,9	54	47,9	74	Pass	Vertical

1-18 GHz, high channel

Peak Number	Frequency	Peak (dBµV/m)	Peak Limit (dBµV/m)	Average (dBµV/m)	Average Limit (dBµV/m)	Status	Polarization
1	2,48 GHz	48	74	46,1	54	Pass	Vertical
2	4,96 GHz	52,9	74	50,1	54	Pass	Horizontal

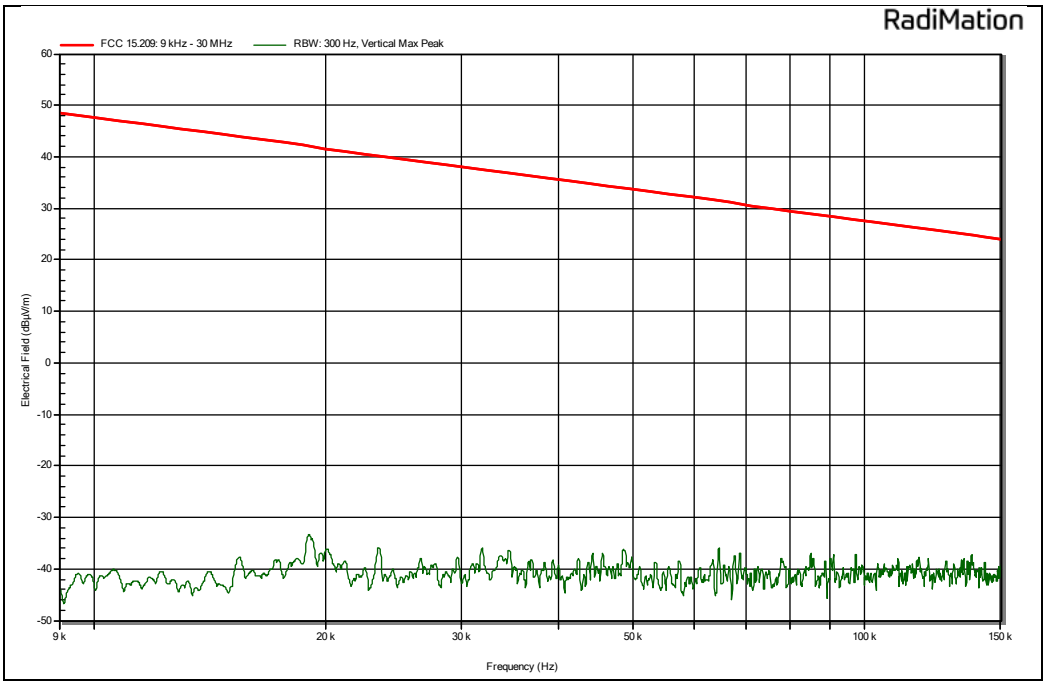
18 – 26 GHz, low channel

Peak Number	Frequency	Average (dBµV/m)	Average Limit (dBµV/m)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Status	Polarization
1	25,762 GHz	45,9 µµV/m	54	57,3	74	Pass	Horizontal
2	25,745 GHz	47,1	54	57,4	74	Pass	Horizontal
3	25,635 GHz	46,7	54	57,4	74	Pass	Horizontal
4	24,668 GHz	48,1	54	57,6	74	Pass	Vertical
5	25,755 GHz	46,6	54	57,2	74	Pass	Vertical
6	25,591 GHz	46	54	57,4	74	Pass	Vertical

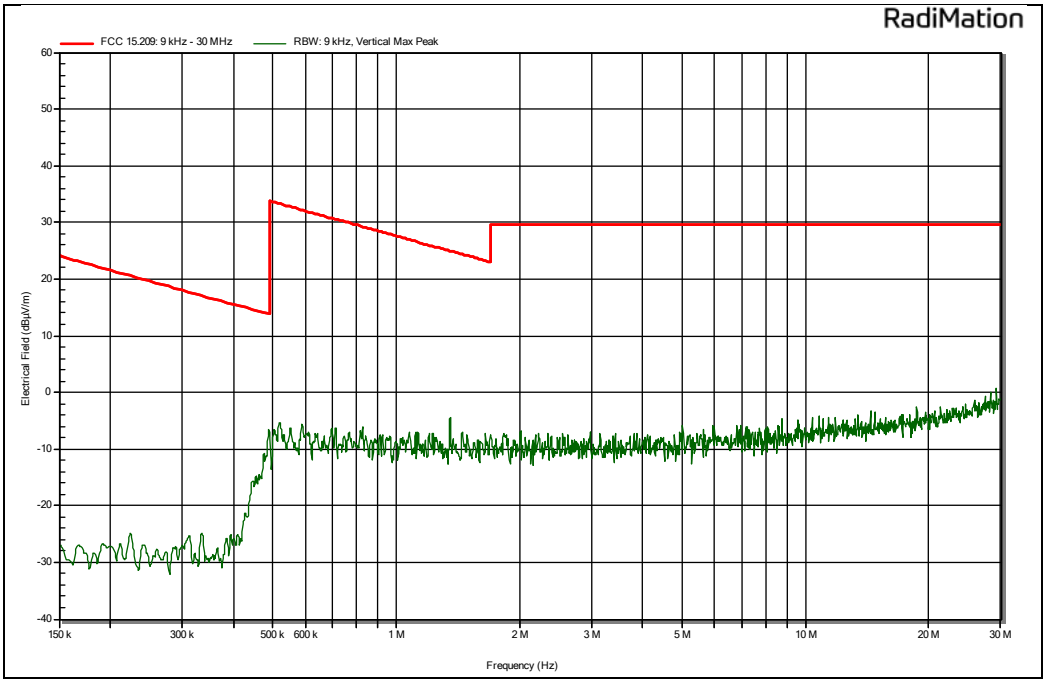
3.1.7 Plots of the Radiated Spurious Emissions

9 kHz to 150 kHz

Parallel

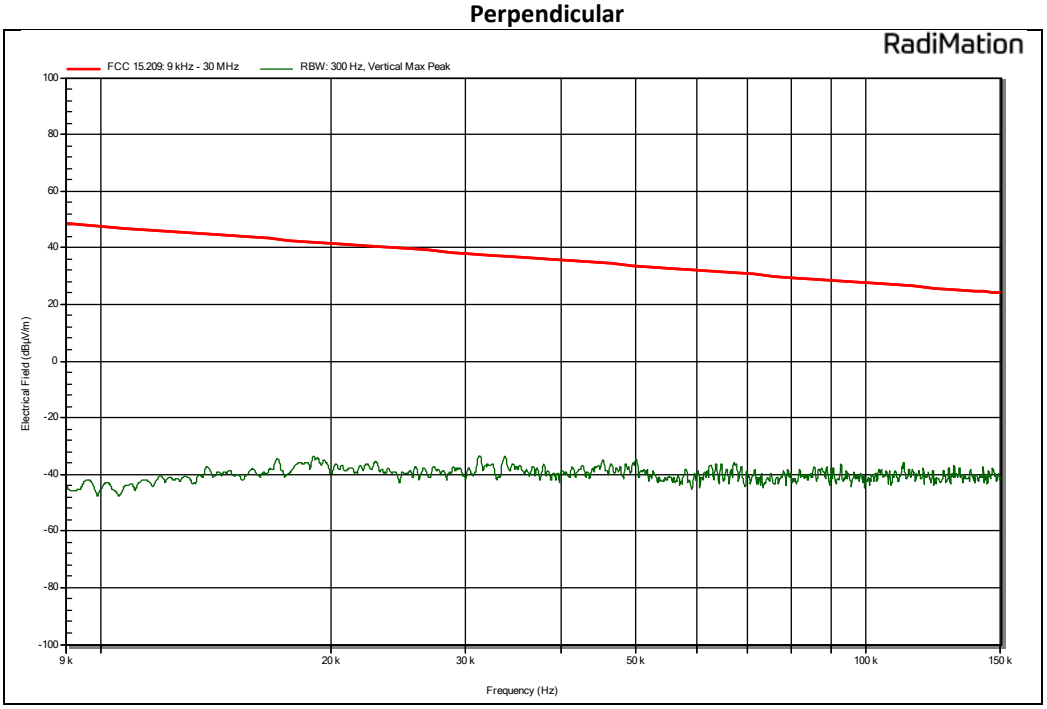


150 kHz to 30 MHz

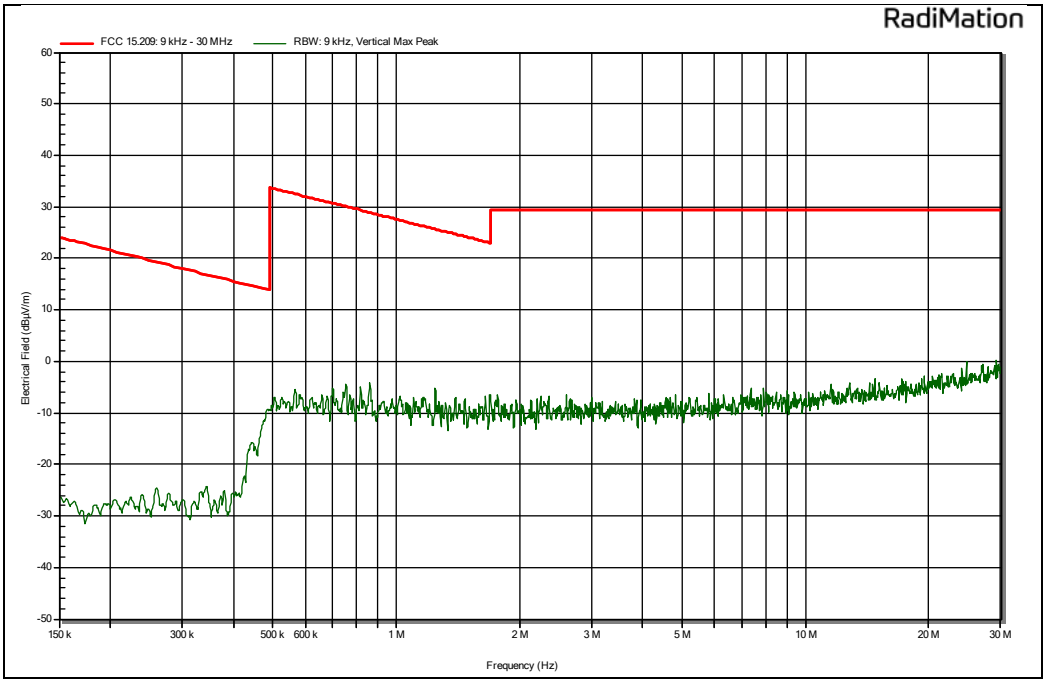


9 kHz to 150 kHz

Perpendicular

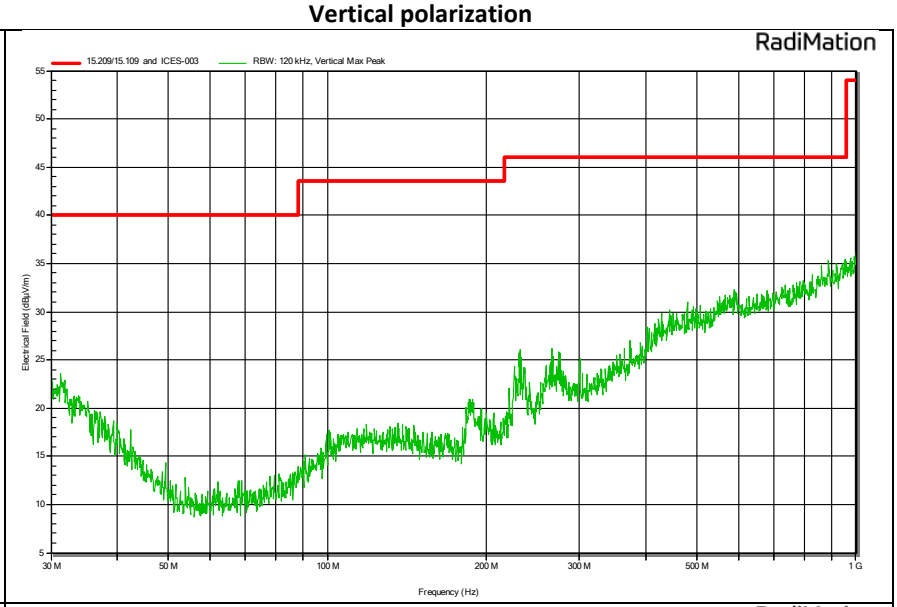
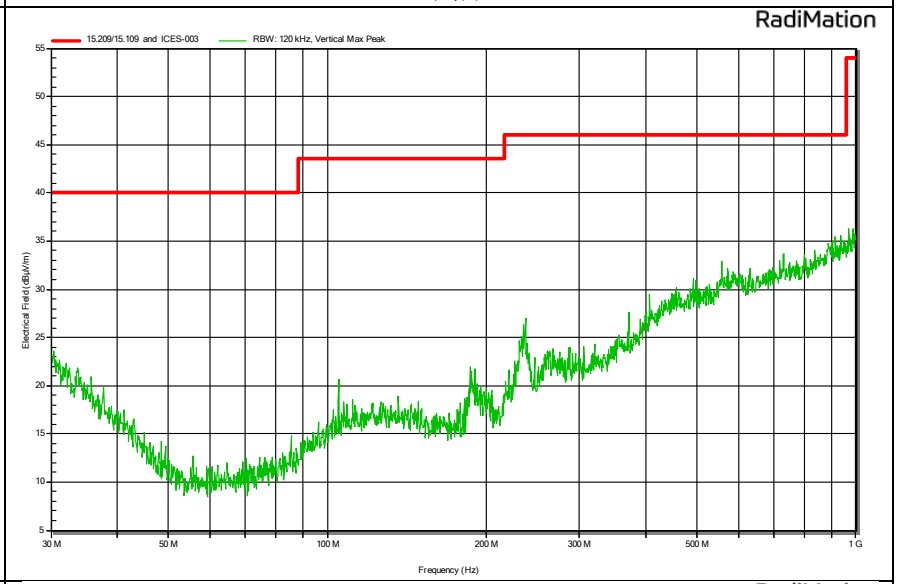
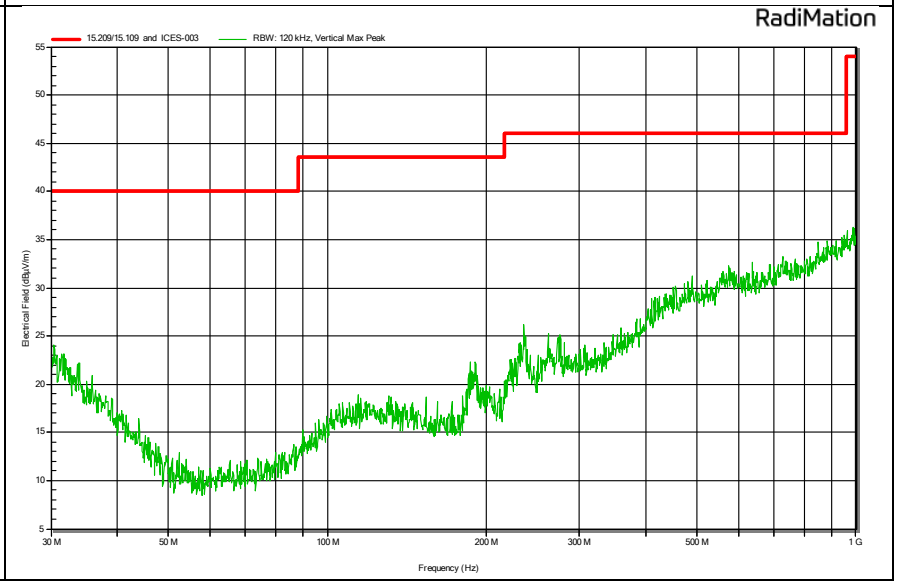


150 kHz to 30 MHz



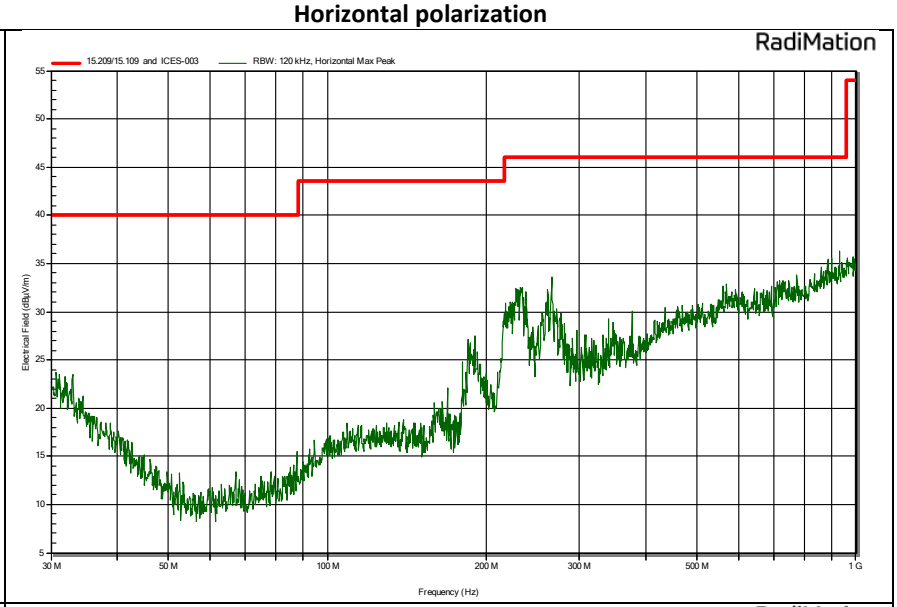
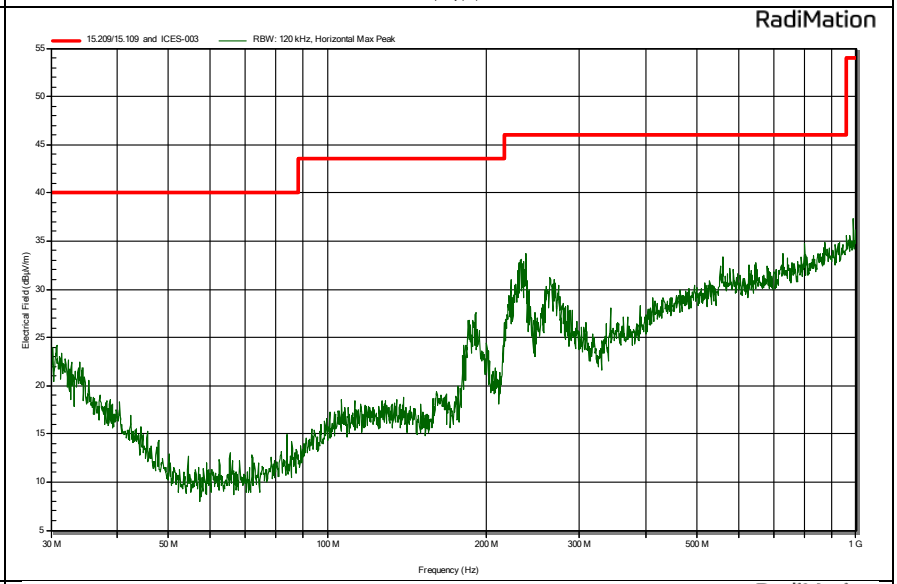
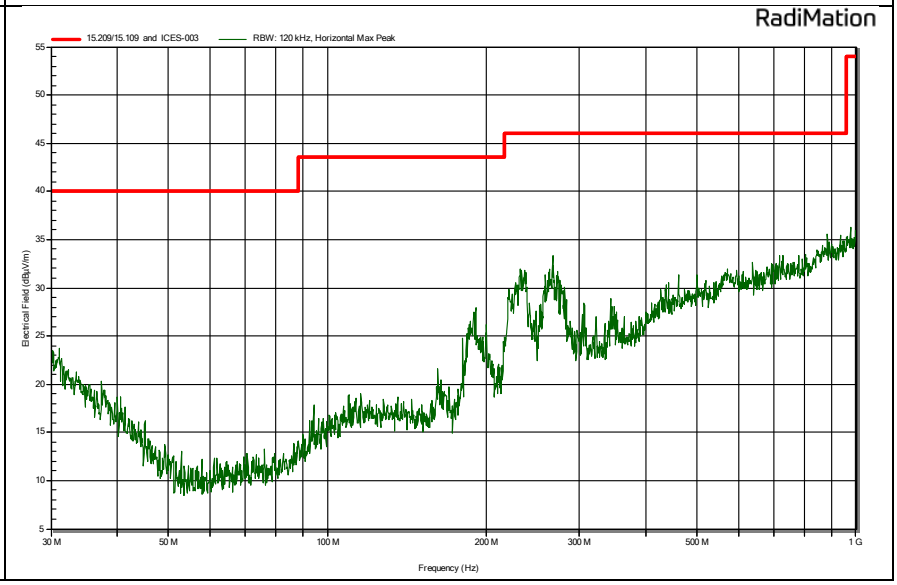
30 MHz to 1 GHz

Vertical polarization

Low ch	
Mid ch	
High ch	

30 MHz to 1 GHz

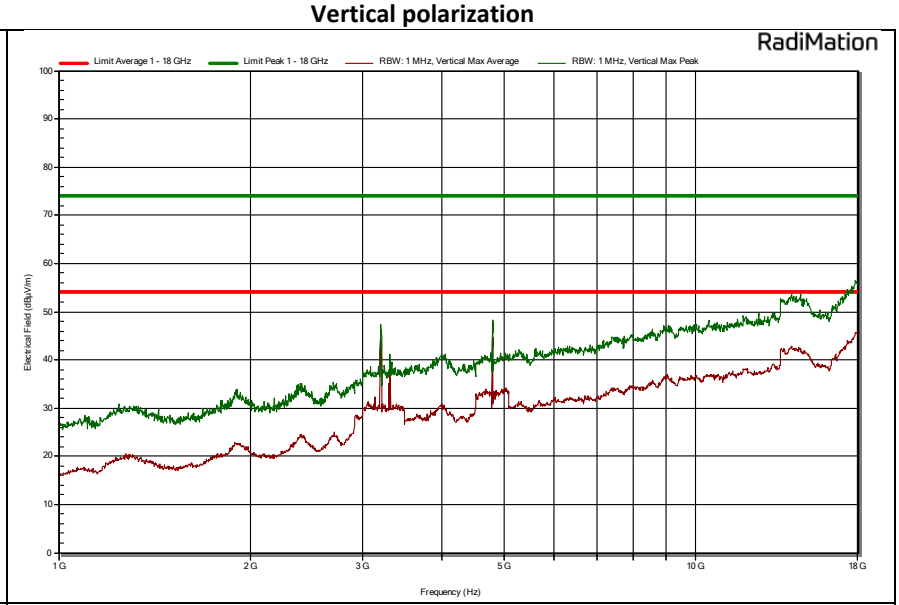
Horizontal polarization

Low ch	
Mid ch	
High ch	

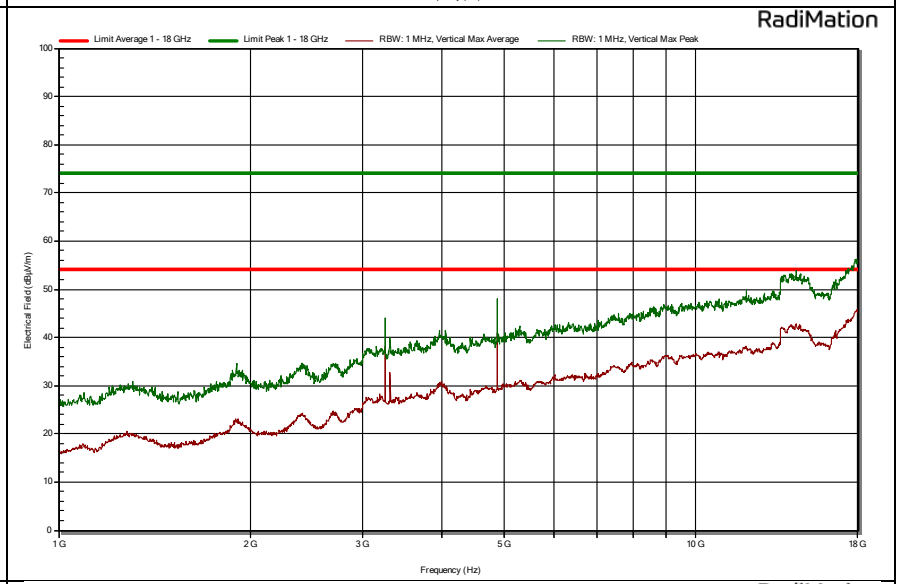
1 GHz to 18 GHz

Vertical polarization

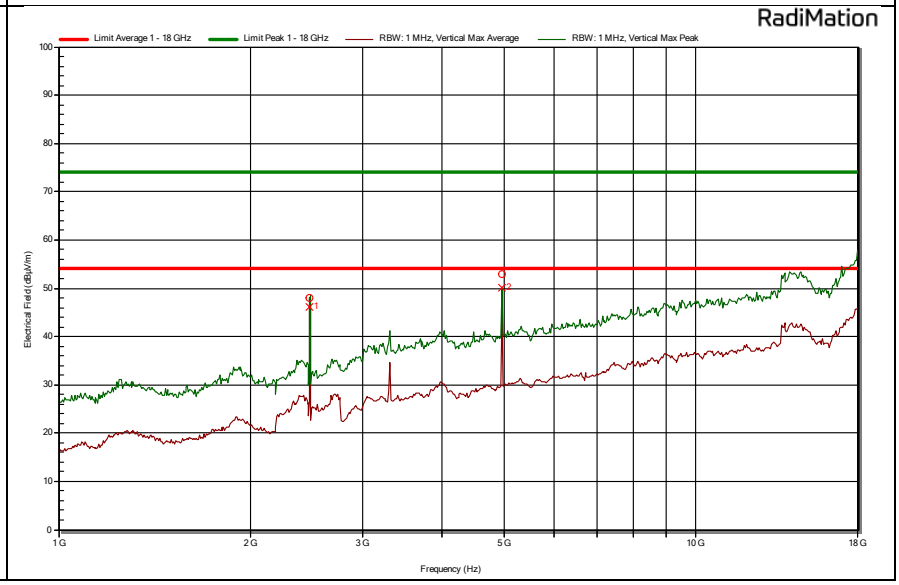
Low ch



Mid ch

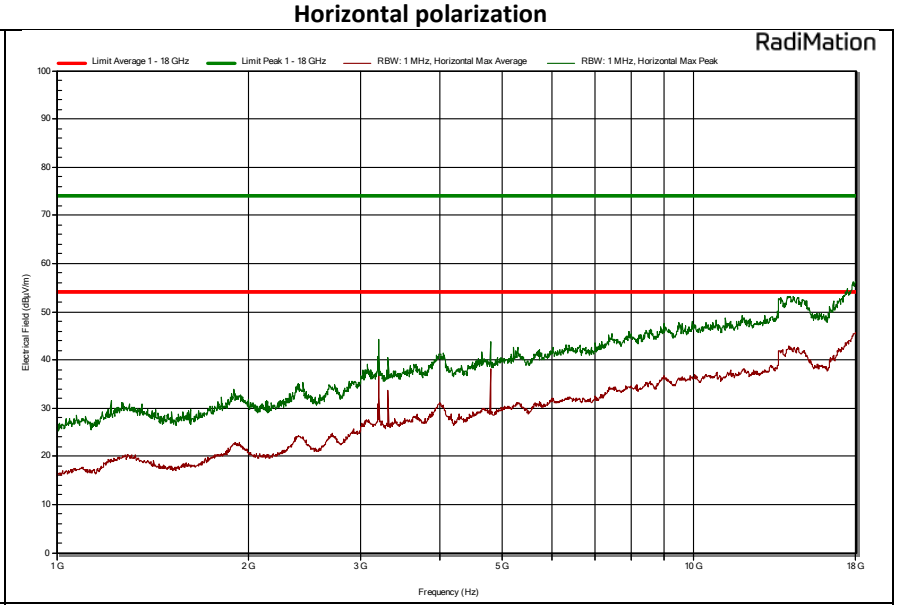
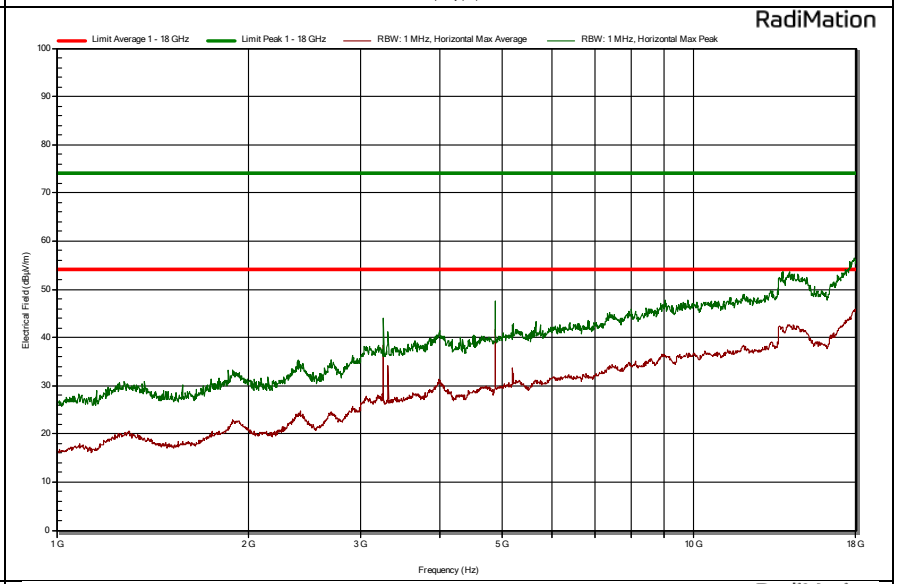
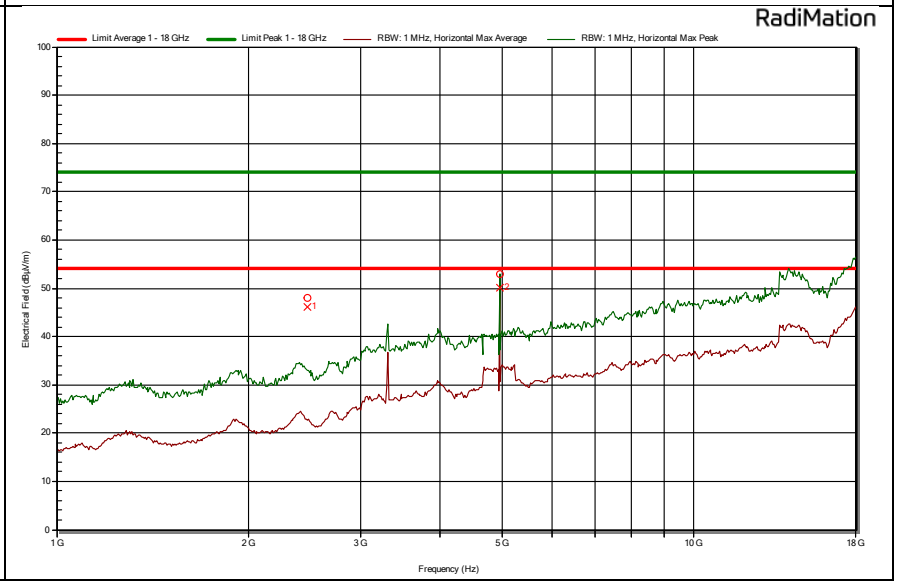


High ch



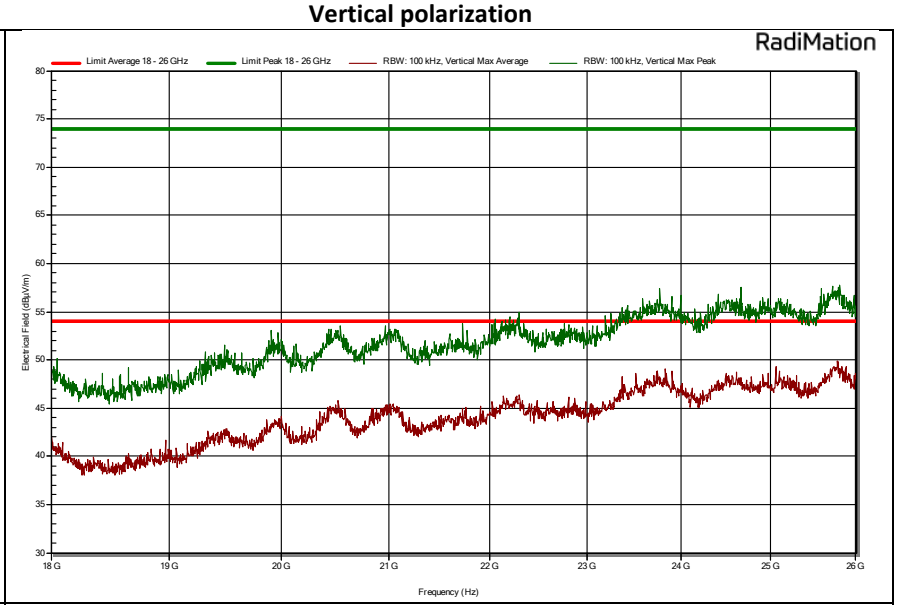
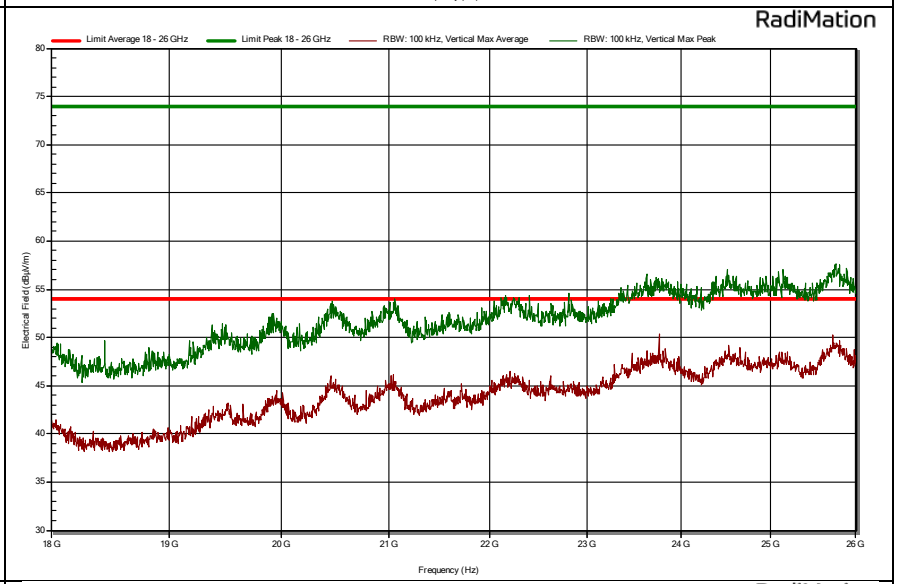
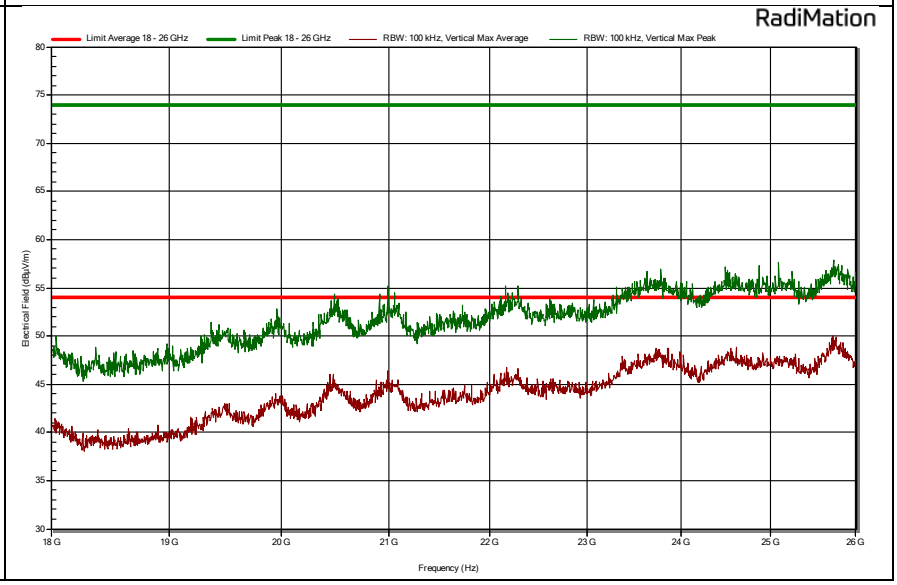
1 GHz to 18 GHz

Horizontal polarization

Low ch	
Mid ch	
High ch	

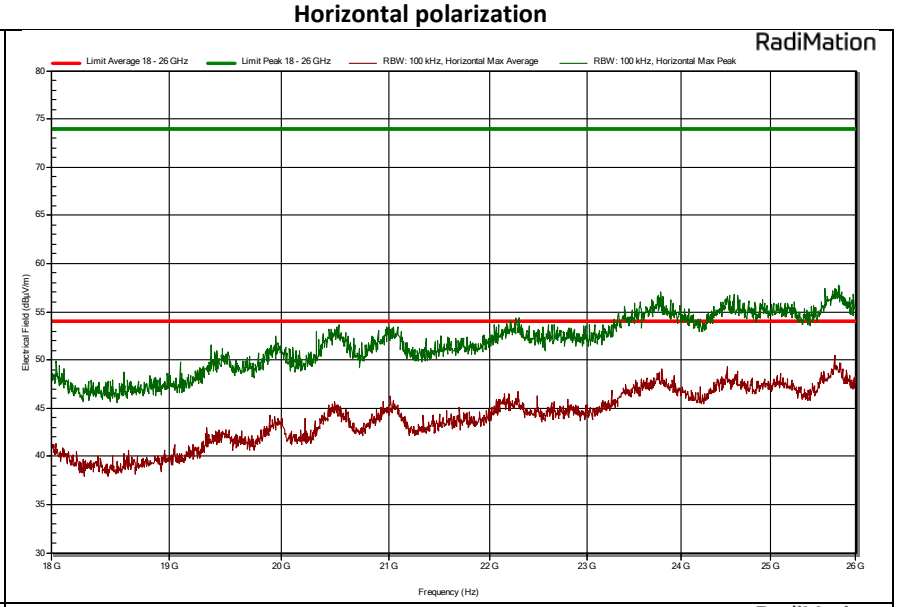
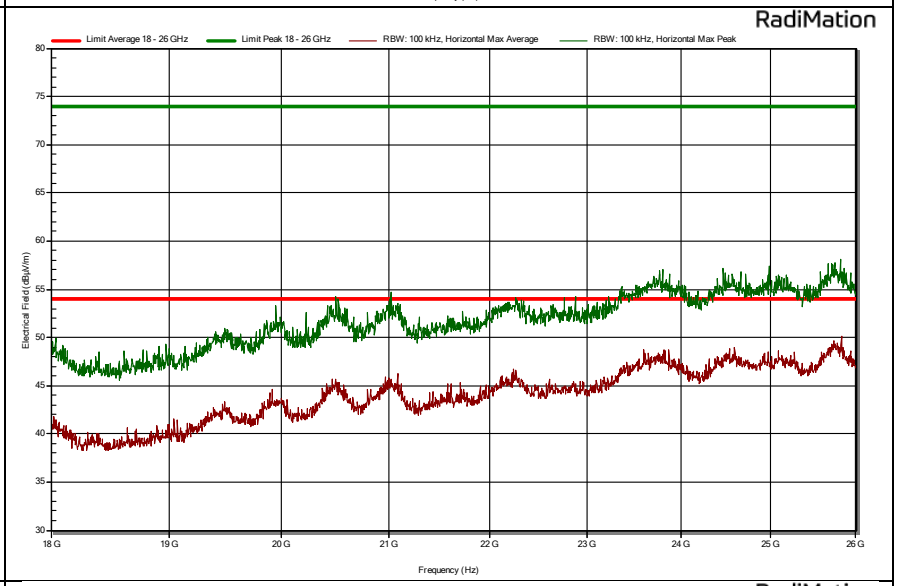
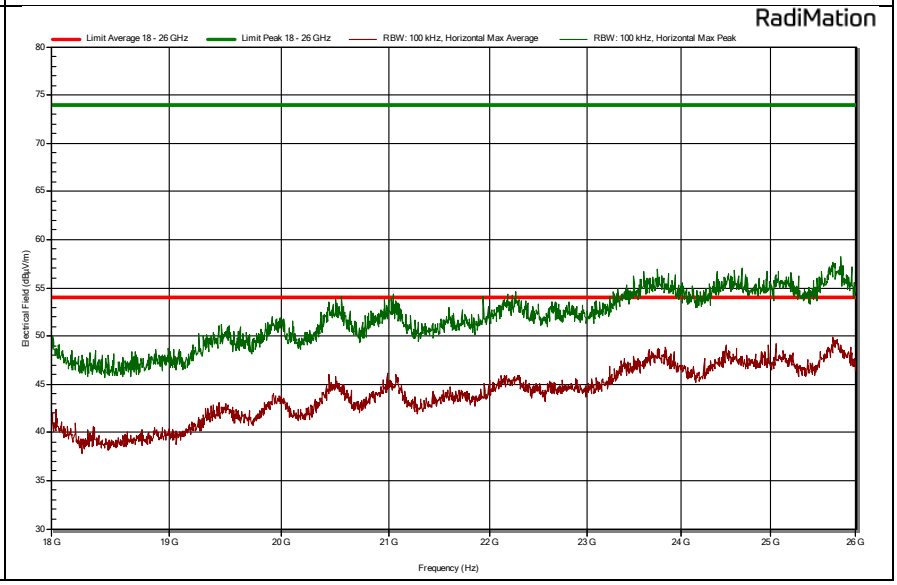
18 GHz to 26 GHz

Vertical polarization

Low ch	
Mid ch	
High ch	

18 GHz to 26 GHz

Horizontal polarization

Low ch	
Mid ch	
High ch	

3.2 Output Power Measurement

3.2.1 Limit

For systems using digital modulation in the 2400-2483.5 MHz, the limit for the peak output power is 30 dBm. If transmitting antenna of directional gain greater than 6 dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point to point operation, the limit has to be reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

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

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05.

IRN 014 - RF power (W) - Method 10

3.2.5 Test results of Output Power Measurement

Peak method

Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power (dBm)
Bluetooth	0	2402	1 Mbps	-6.5
	38	2440	1 Mbps	-7.9
	78	2480	1 Mbps	-3.4
Uncertainty	±5.27 dB			

3.3 AC Power Line Conducted Emissions

3.3.1 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.

3.3.2 Measurement instruments

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

3.3.3 Test setup

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

3.3.4 Test procedure

According to ANSI C63.10-2013, section 6.2
IRN 029 – Method 1
The EUT is powered by a rechargeable battery which can be charged with DC by connecting to any device with a powered USB port, so AC Power Line Conducted Emissions have been measured on a dedicated AC/DC adapter.

3.3.5 Test results of the AC Power Line Conducted Emissions

Neutral

Peak Number	Frequency	Average	Average Limit	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Status	Average Status
1	897,9 kHz	45,2 dBµV	46 dBµV	49,8 dBµV	56 dBµV	Pass	Pass

Phase

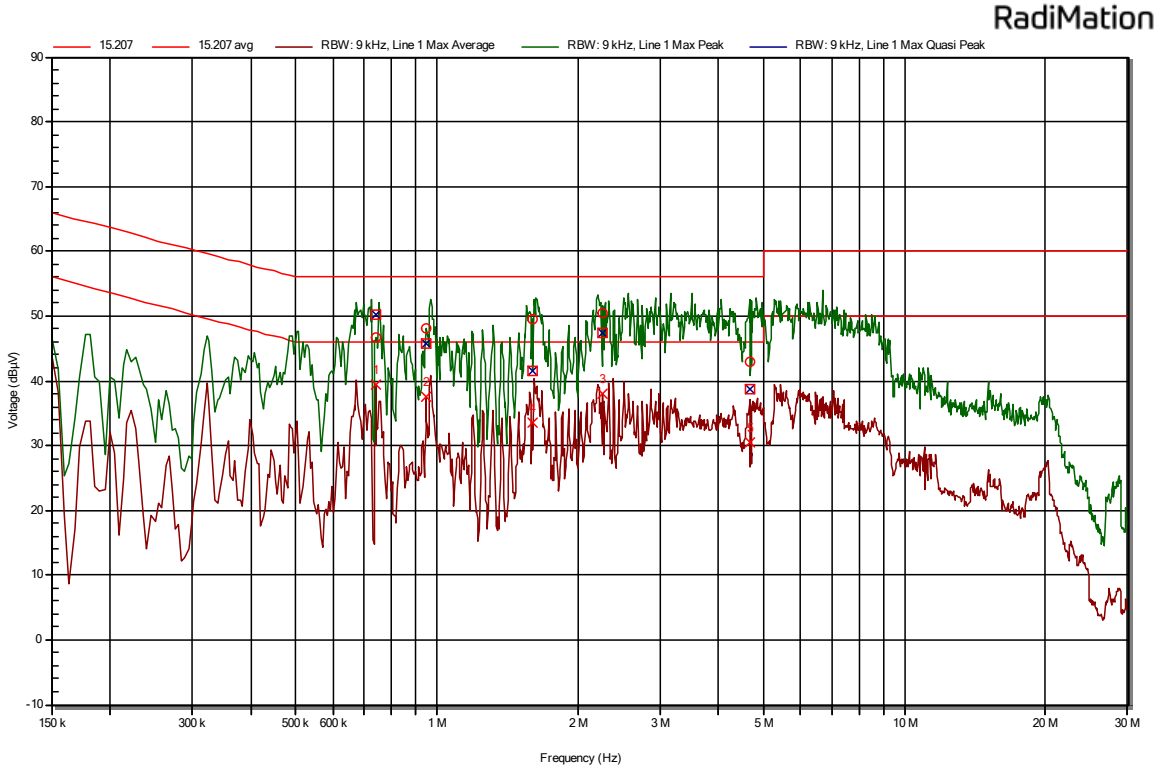
Peak Number	Frequency	Average	Average Limit	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Status	Average Status
1	741,75 kHz	39,5 dBµV	46 dBµV	50,1 dBµV	56 dBµV	Pass	Pass
2	948,75 kHz	37,6 dBµV	46 dBµV	45,6 dBµV	56 dBµV	Pass	Pass
3	2,263 MHz	37,9 dBµV	46 dBµV	47,3 dBµV	56 dBµV	Pass	Pass
4	1,601 MHz	33,7 dBµV	46 dBµV	41,6 dBµV	56 dBµV	Pass	Pass
5	4,689 MHz	30,5 dBµV	46 dBµV	38,8 dBµV	56 dBµV	Pass	Pass

3.3.6 Measurement uncertainty

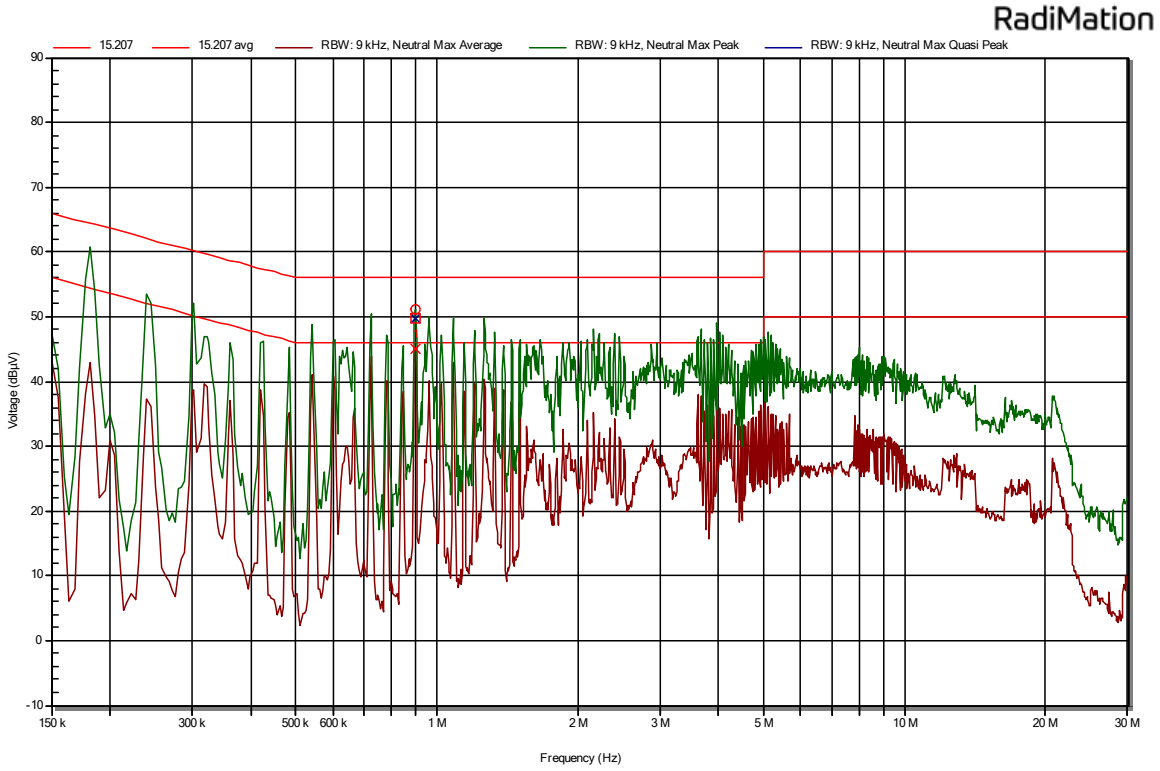
+/- 3.6 dB

3.3.7 Plots of the AC Power Line Conducted Emissions

Phase



Neutral



4 Sample calculations

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

Conducted emission Measurement:

U_{lisn} (dBµV) = U (dBµV) + Corr. (dB)

Where:
U = Measuring receiver voltage
LISN insertion loss = Voltage division factor of LISN
Corr. = sum of single correction factors of used LISN, cables and pulse limiter.
Linear interpolation will be used for frequencies in between the values in the table.

Frequency (Mhz)	**Voltage division LISN (db)**	**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:

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)** **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) 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 00531 Emco 3115 SN: 9412-4377	Gain (dB) TE 11132 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