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FCC and IC Test report for parts 15.109, 15.209, 15.247, RSS-247, RSS-Gen

Product name	: Ambient sensor
Applicant	: Rockwool BV
FCC ID	: 2AUKP-CL002
IC	: 25447-CL002

Test report No. : 200701991 007 Ver 3.00

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).

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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

Revision History

Version	Date	Remarks	By
v0.50	06/04/2021	First draft	K.K.
v1.00	28-05-2021	Initial release version	RvB
V2.00	07-06-2021	Updated EUT information in 1.3	K.K.
V3.00	04-07-2021	Updated chapter 2.4/3.4.5/3.5.4	RvB

Table of Contents

Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.247(d) 15.209 (a) 15.109	RSS-Gen 8.9	Radiated spurious emissions	3.1	Pass
15.247 (a)	RSS-247 5.2(a)	6 dB bandwidth	3.2	Pass
--	RSS-Gen 6.7	99% bandwidth	3.3	Pass
15.247 (b)	RSS-247 5.4 (d)	RF output power	3.4	Pass
15.247 (e)	RSS-247 5.2 (b)	Power spectral density	3.5	Pass
15.247 (d)	RSS-247 5.5	Band edge	3.6	Pass

1 General Description

1.1 Applicant

Client name:	Rockwool BV
Address:	Industrieweg 15, Roermond, The Netherlands
Zip code:	6045 JG
E-mail:	Edwin.dilling@grodan.com
Contact name:	Mr. E. Dilling

1.2 Manufacturer

Client name:	Rockwool BV
Address:	Industrieweg 15, Roermond, The Netherlands
Zip code:	6045 JG
E-mail:	Edwin.dilling@grodan.com
Contact name:	Mr. E. Dilling

1.3 Tested Equipment Under Test (EUT)

Product name:	Ambient Sensor
Brand name:	ROCKWOOL, Grodan, GroSens
FCC ID:	2AUKP-CL002
IC :	25447-CL002
Product type:	Climate Sensor
Model(s):	GS21CL12(tested), GS21CL13
Software version:	--
Hardware version:	--
Date of receipt	11-09-2020
Tests started:	11-09-2020
Testing ended:	26-03-2021

1.4 Product specifications of Equipment under test

Tx Frequency:	BLE: 2400 – 2483.5 MHz
Rx frequency:	BLE: 2400 – 2483.5 MHz
Antenna type	PCB antenna
Antenna Gain:	0 dBi
Type of modulation:	BLE: GFSK
Emission designator	729KF1D

1.5 Environmental conditions

Test date	06-10-2020	01-10-2020	26-03-2021
Ambient temperature	21.2°C	23.9°C	22.7°C
Humidity	36.7%	43.5%	50.3%

1.6 Measurement standards

- ANSI C63.4:2014
- 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 §15.109
- FCC Part 15 Subpart C §15.209
- FCC Part 15 Subpart C §15.247
- RSS-Gen Issue 5
- RSS-247 Issue 2

1.8 Observation and remarks

This report only contains the BLE results. See Kiwa Telefication test reports 200701991 001 and 002 for The other results.

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 tests are performed by:

Name :K. Korcum under supervisor of ing. R. van Barneveld

Review of test methods and report by:

Name : ing. R. van Barneveld

The above conclusions have been verified by the following signatory:

Date : 13-09-2022

Name : Raoul Tolud, MSc

Function : Test Engineer

Signature :

2 Test configuration of the Equipment Under Test

2.1 Test mode

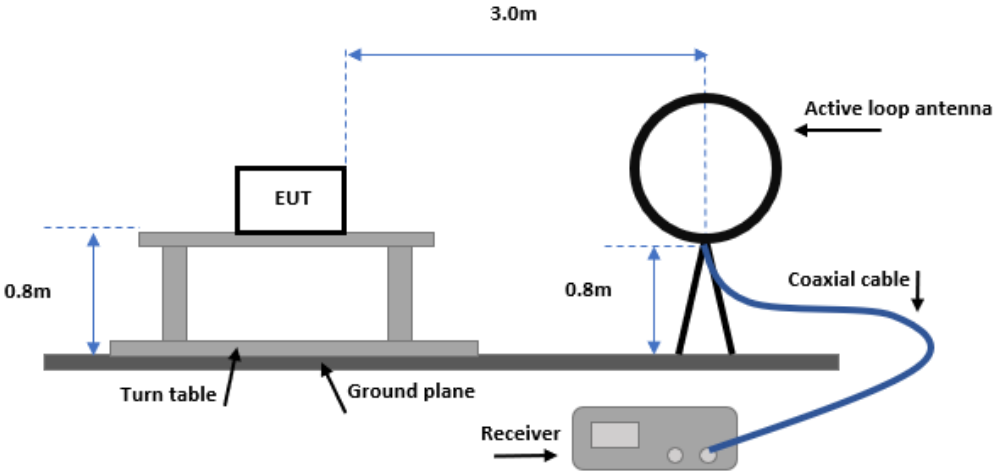
The applicant provided test mode firmware for the BLE radio, in which it was possible to configure the radio to transmit continuously.

2.2 Tested channels and Data rates

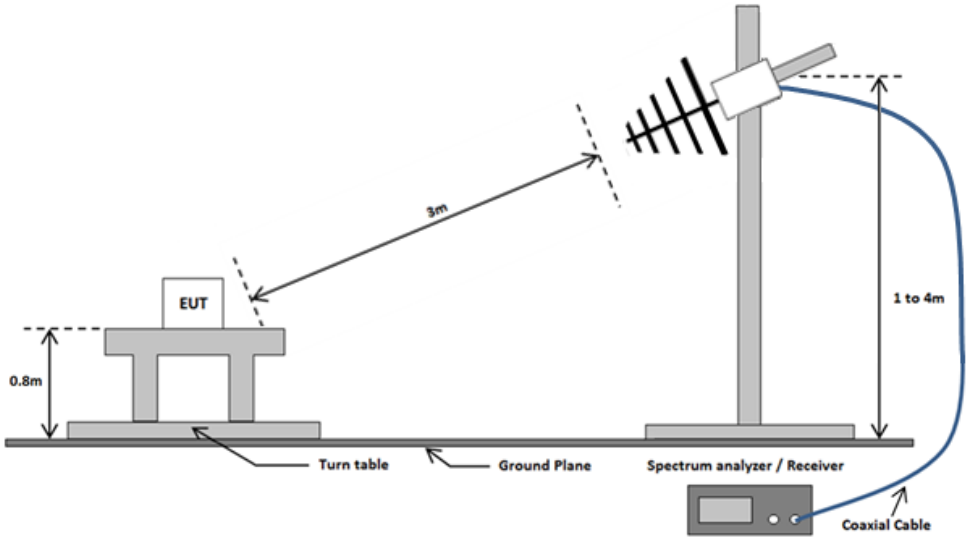
Technology	Channels	Data rate	Frequency (MHz)
Bluetooth Low Energy	1	1 Mbps	2402
	18	1 Mbps	2440
	39	1 Mbps	2480

2.3 Test setups

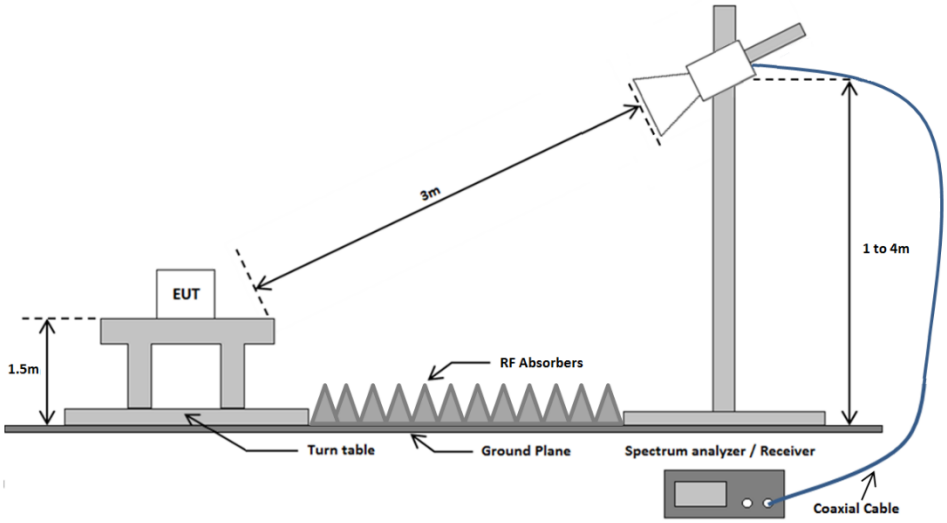
Radiated emissions test setup 9 kHz – 30 MHz



Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



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	01-2022	01-2023	3.1
Spectrum analyzer	Rohde & Schwarz	FSP40	114742	03-2022	03-2023	3.1
Test software	DARE	Radimation	--	--	--	3.1
Spectrum Analyzer	Rohde & Schwarz	FSV40	114527	05-2022	05-2023	3.2 – 3.6
3.0 GHz HPF	Wainwright	WHK3.0/18G-10EF	TE01139	01-2021	01-2024	3.1
Active loop antenna	EMCO	6502	114515	01-2022	01-2024	3.1
Biconilog antenna	Chase	114516	03-2021	03-2024	114516	3.1
Horn antenna	EMCO	3115	114607	01-2021	01-2024	3.1
Preamplifier 1-18 GHz	µComp Nordic	MCNA-40-0010800-25-10P	114690	01-2022	01-2023	3.1
Preamplifier 18-26 GHz	Miteq	JS4-18004000-33-8P	TE11131	01-2022	01-2023	3.1

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: 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
30 MHz to 26.5 GHz: According to ANSI C63.4-2013

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

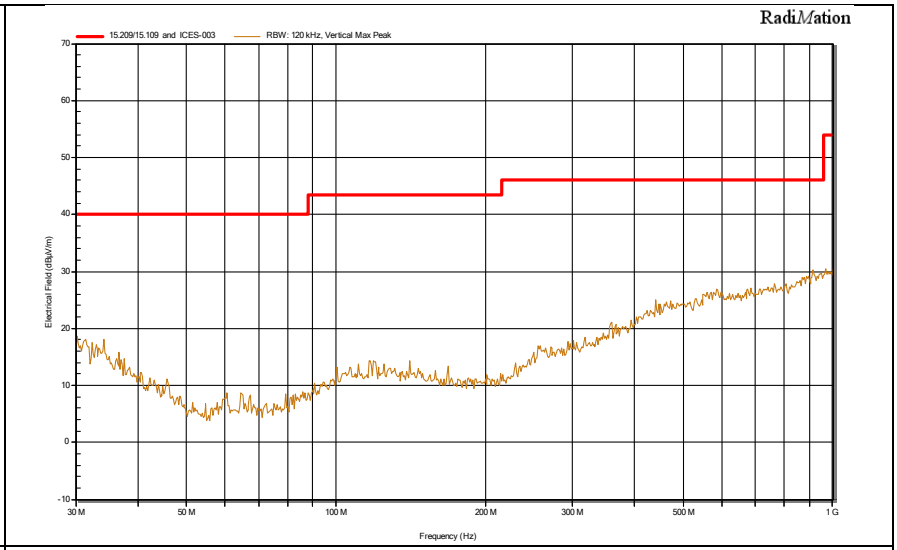
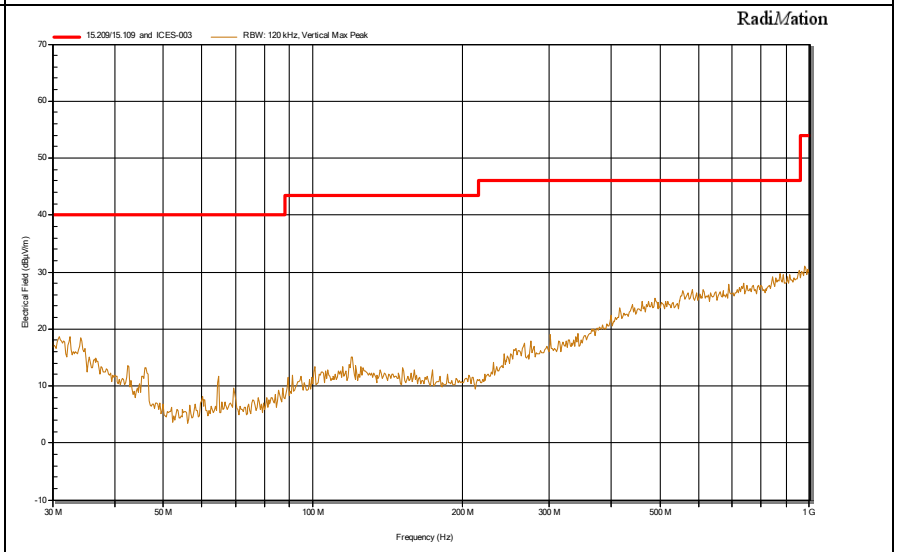
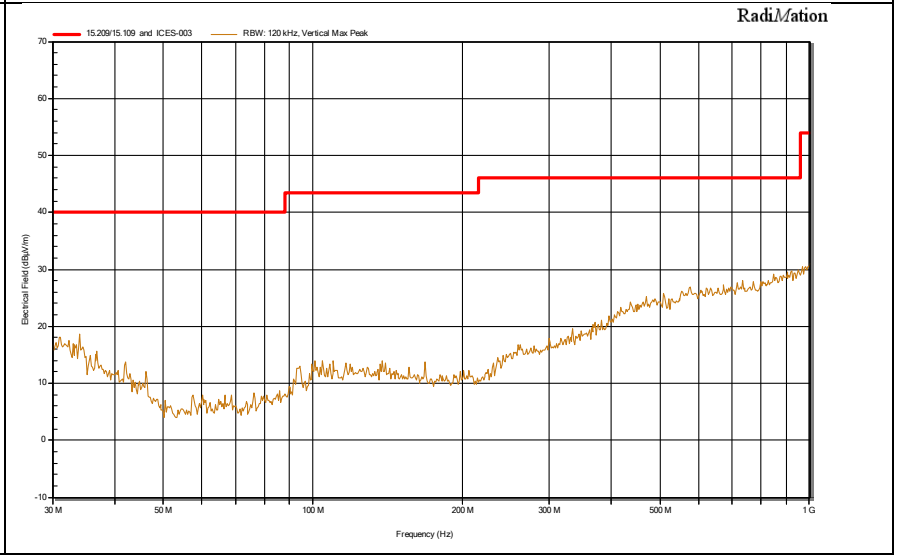
3.1.5 Measurement Uncertainty

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

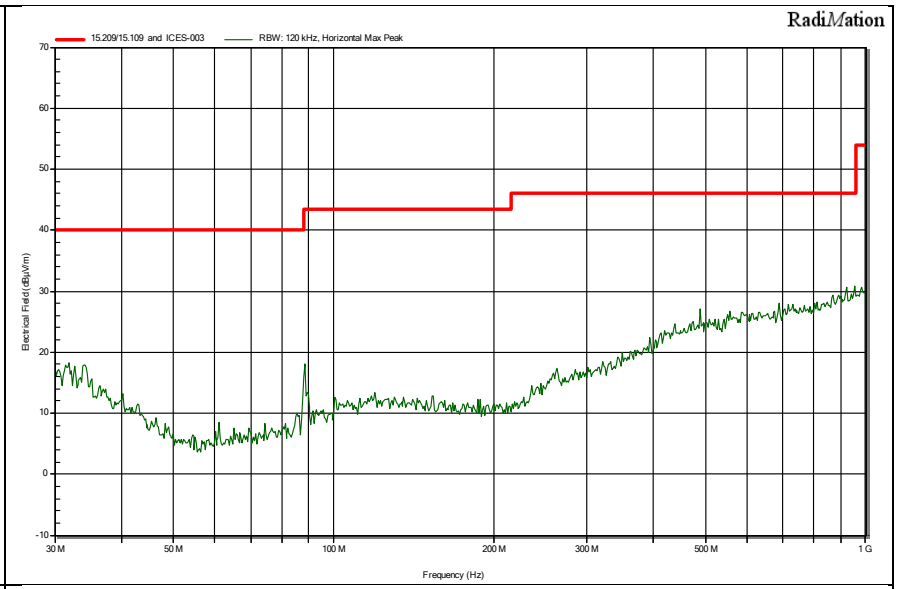
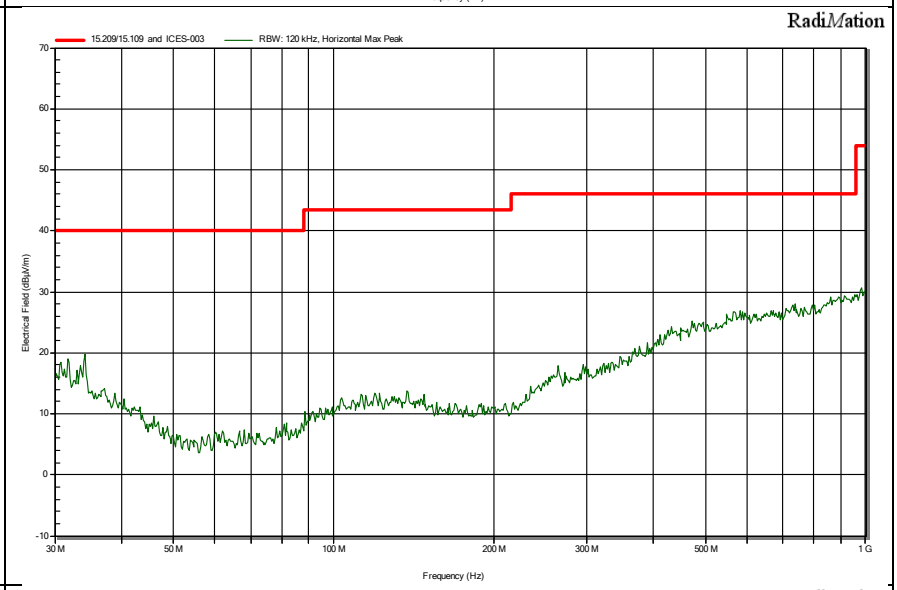
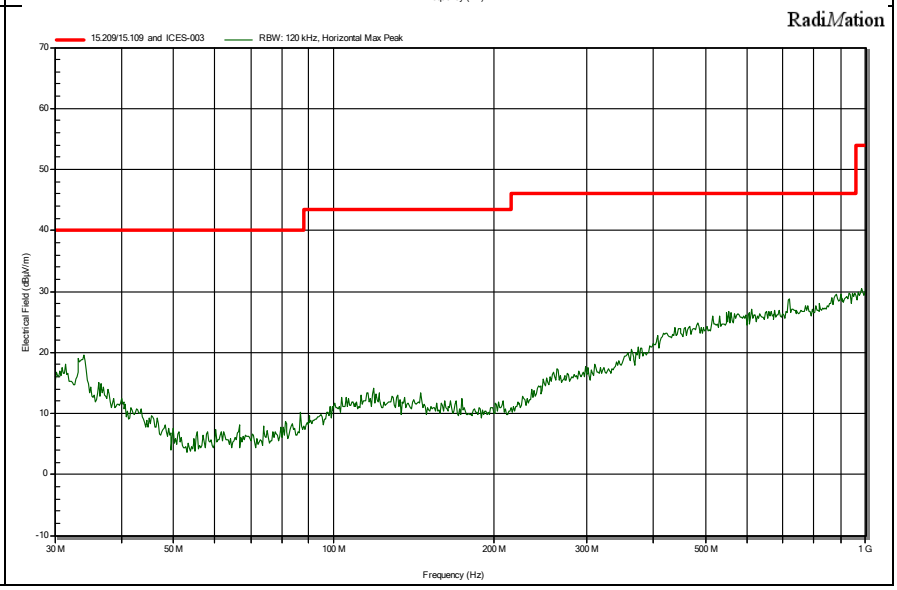
Note: in the 1- 18 GHz frequency range high pass filter was used.

3.1.6 Plots of the Radiated Spurious Emissions Measurement

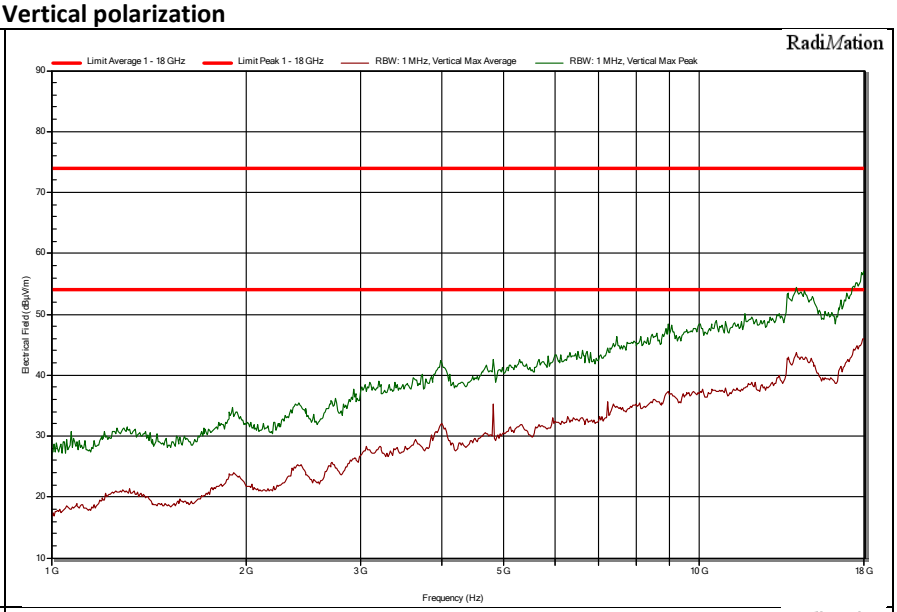
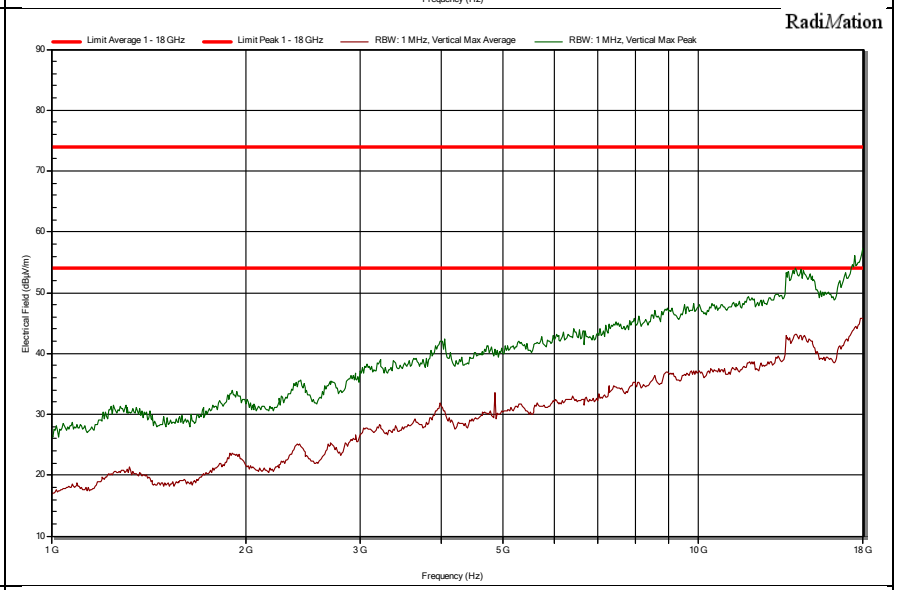
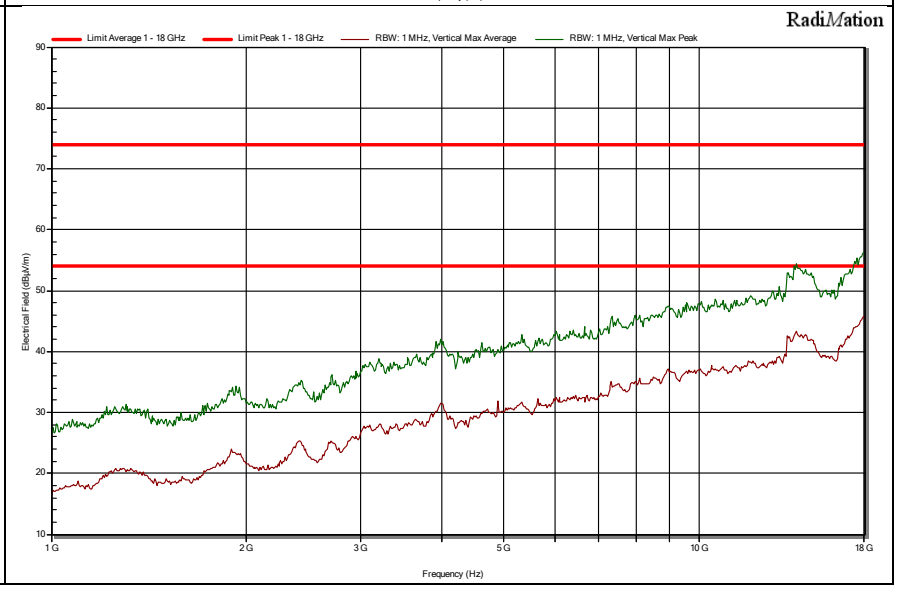
30 MHz to 1 GHz Vertical polarization

Low ch	
Mid ch	
High ch	

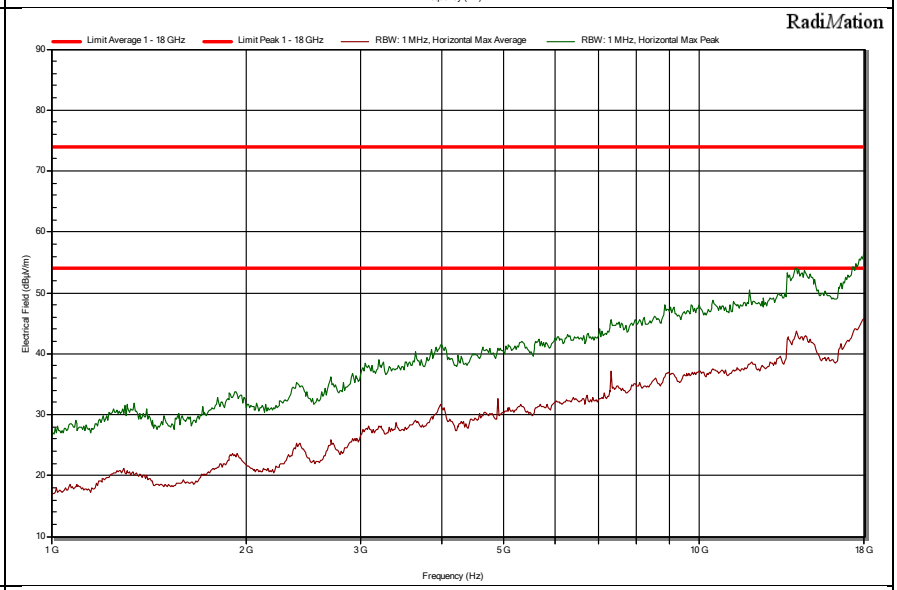
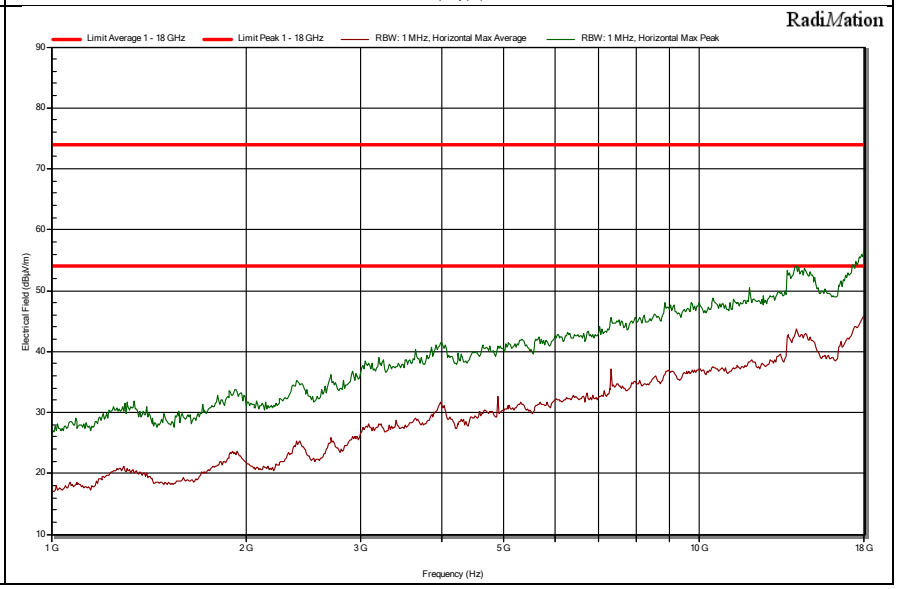
30 MHz to 1 GHz Horizontal polarization

Low ch	
Mid ch	
High ch	

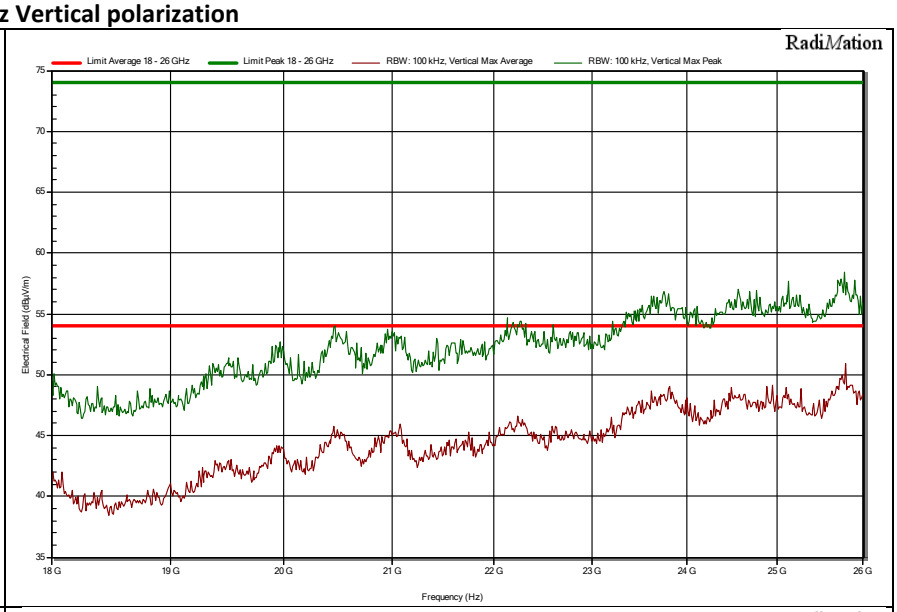
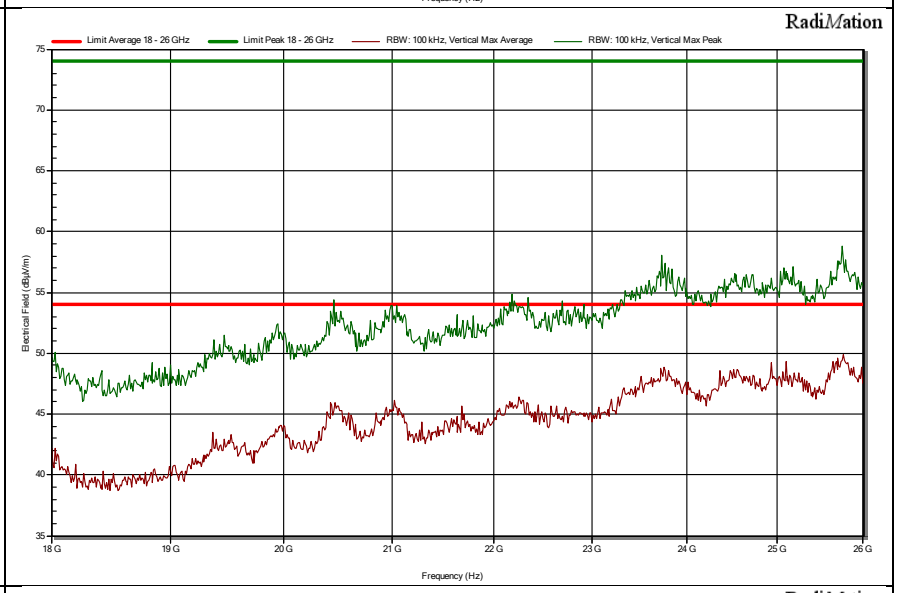
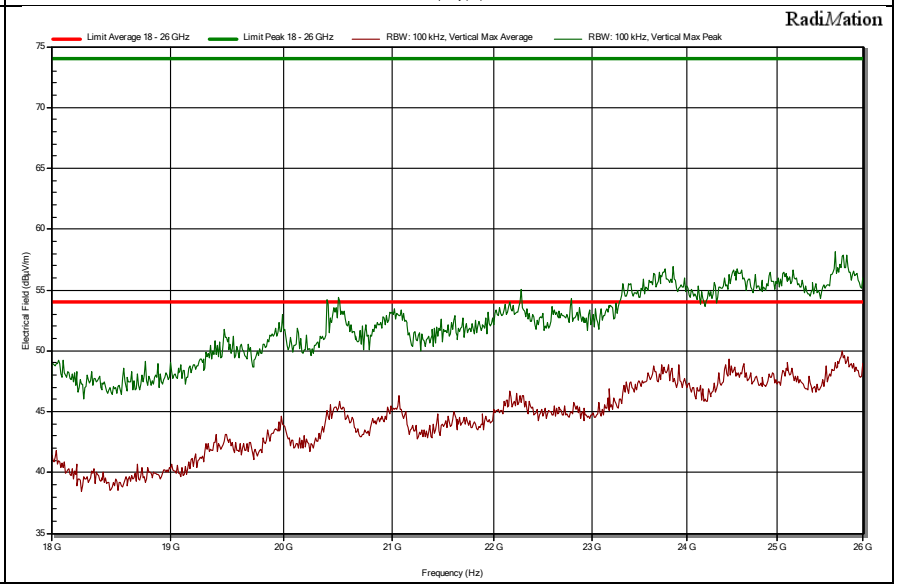
1 GHz to 18 GHz Vertical polarization

Low ch	
Mid ch	
High ch	

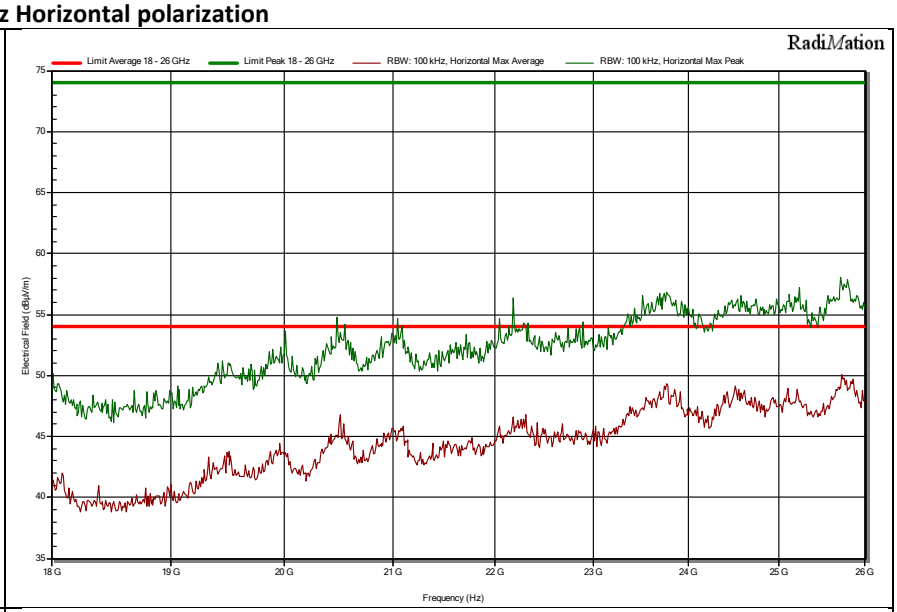
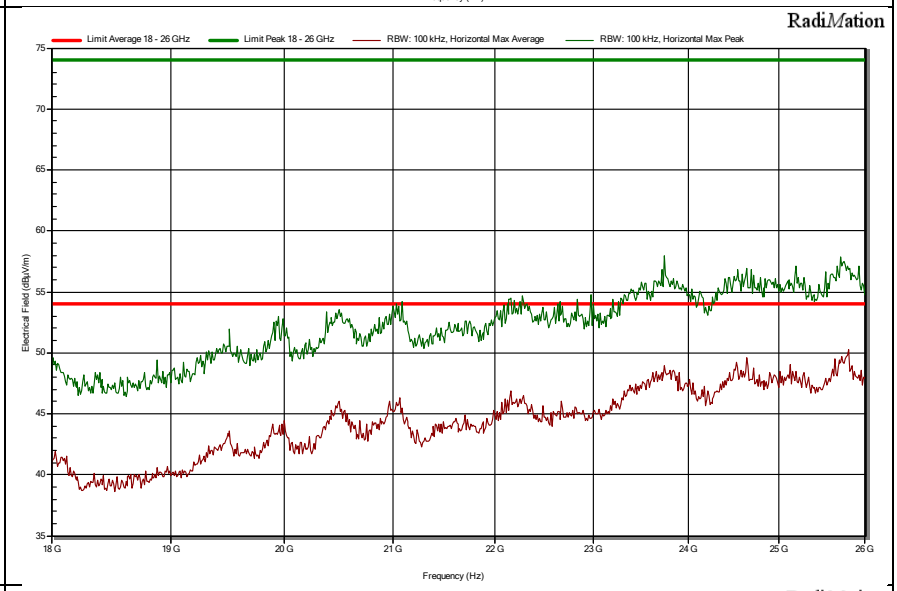
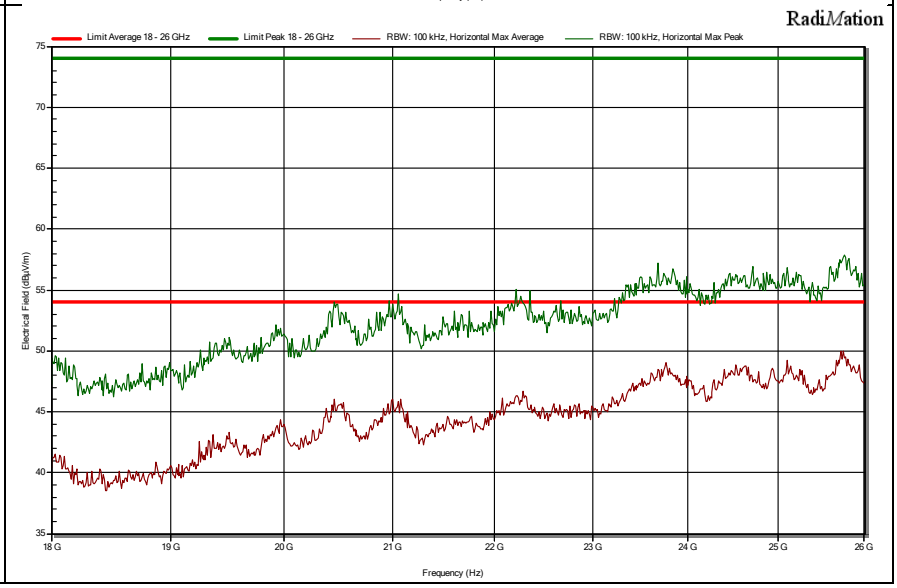
1 GHz to 18 GHz Horizontal polarization

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 6dB bandwidth Measurement

3.2.1 Limit

The minimum 6 dB Bandwidth shall be at least 500 kHz.

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

Tests according to ANSI C63.10
IRN 017 - Occupied bandwidth (Hz) Method 4 – DTS Bandwidth.

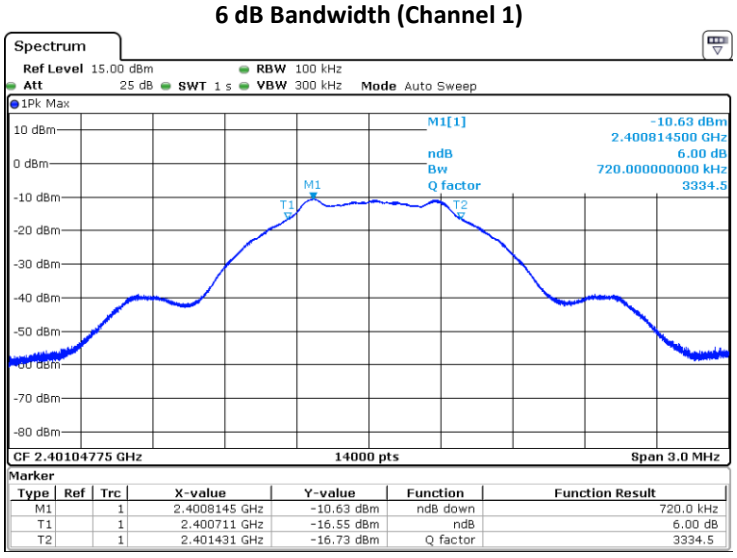
3.2.5 Test Results of the 6 dB bandwidth Measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	6dB bandwidth (kHz)
Bluetooth Low energy	1	2402	1 Mbps	720
	18	2440	1 Mbps	729
	39	2480	1 Mbps	714
Uncertainty	± 36.2 kHz			

3.2.6 Plots of the 6 dB bandwidth measurement

See the next page.

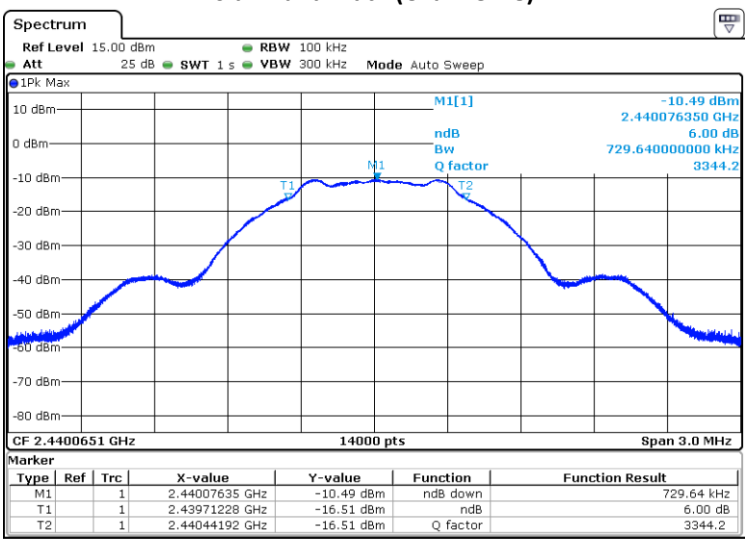
6 dB Bandwidth (Channel 1)



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4008145 GHz	-10.63 dBm	ndB down	720.0 kHz
T1		1	2.400711 GHz	-16.55 dBm	ndB	6.00 dB
T2		1	2.401431 GHz	-16.73 dBm	Q factor	3334.5

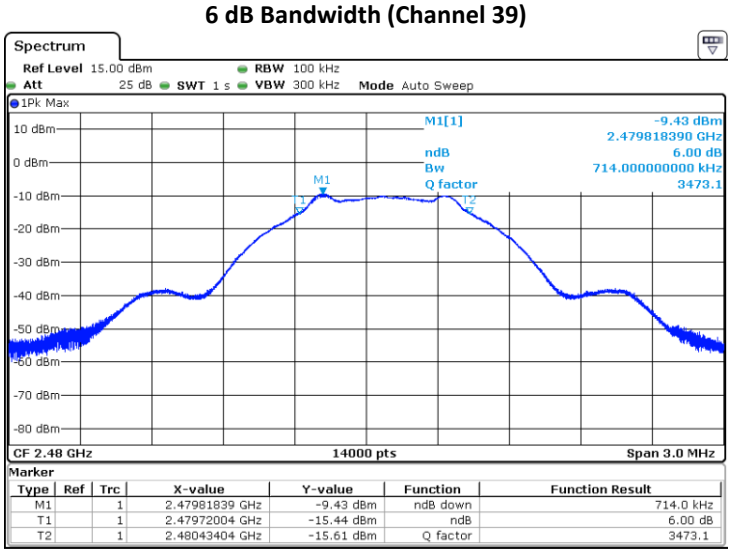
6 dB Bandwidth (Channel 18)



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.44007635 GHz	-10.49 dBm	ndB down	729.64 kHz
T1		1	2.43971228 GHz	-16.51 dBm	ndB	6.00 dB
T2		1	2.44044192 GHz	-16.51 dBm	Q factor	3344.2

6 dB Bandwidth (Channel 39)



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47981839 GHz	-9.43 dBm	ndB down	714.0 kHz
T1		1	2.47972004 GHz	-15.44 dBm	ndB	6.00 dB
T2		1	2.48043404 GHz	-15.61 dBm	Q factor	3473.1

3.3 99% Occupied Bandwidth

3.3.1 Limit

According to RSS-Gen 6.7

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

IRN 017 - Occupied bandwidth (Hz) Method 1 – XX % power bandwidth.

1. Set the centre frequency to the nominal EUT channel centre frequency
2. Set span = 1.5 times to 0.5 times the Occupied Bandwidth
3. Set VBW ≥ 3x RBW
4. Video averaging is not permitted. Where practical, detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

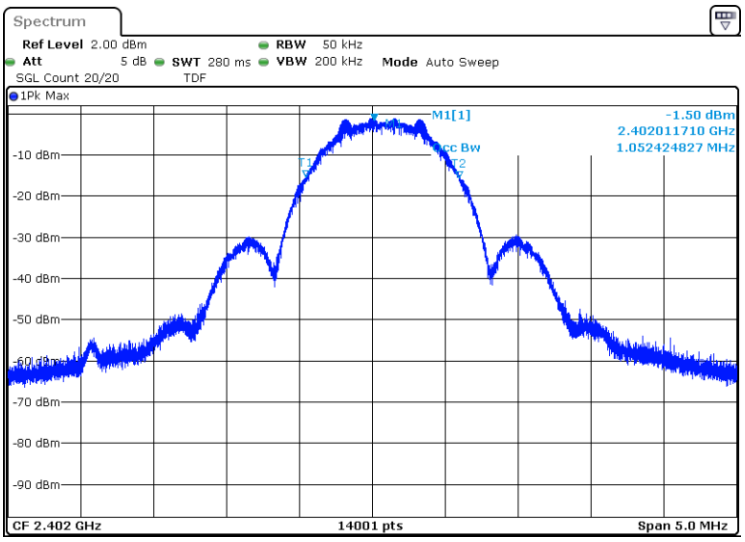
3.3.5 Test results of the 99% occupied bandwidth measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Bluetooth Low energy	1	2402	1 Mbps	1052
	18	2440	1 Mbps	1055
	39	2480	1 Mbps	1058
Uncertainty	± 36.2 kHz			

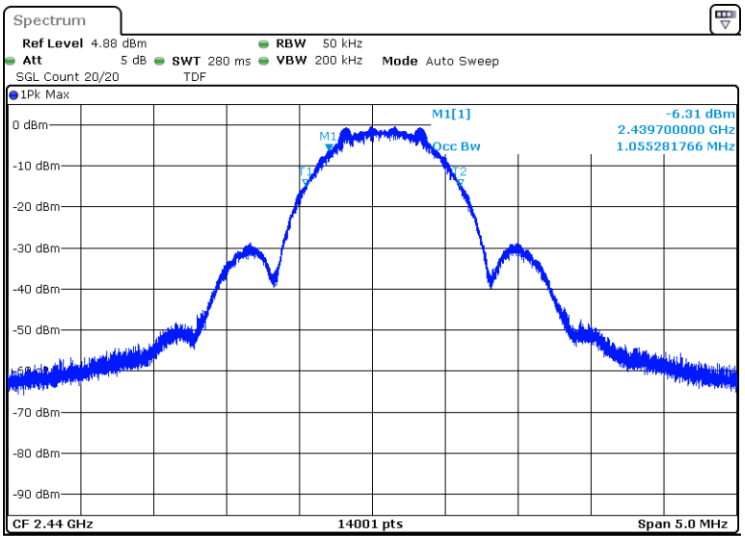
3.3.6 Plots of the 99% occupied bandwidth measurement

See the next page.

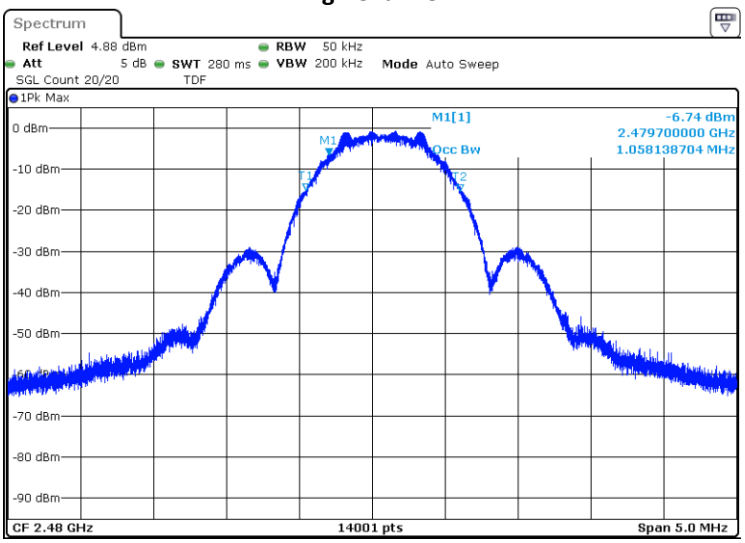
Low Channel



Mid Channel



High Channel



3.4 Output Power Measurement

3.4.1 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.

3.4.2 Measurement instruments

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

3.4.3 Test setup

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

3.4.4 Test procedure

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

IRN 014 - RF power (W) - Method 1 – AVGSA (DTS) according to ANSI C63.10.

3.4.5 Test results of Output Power Measurement

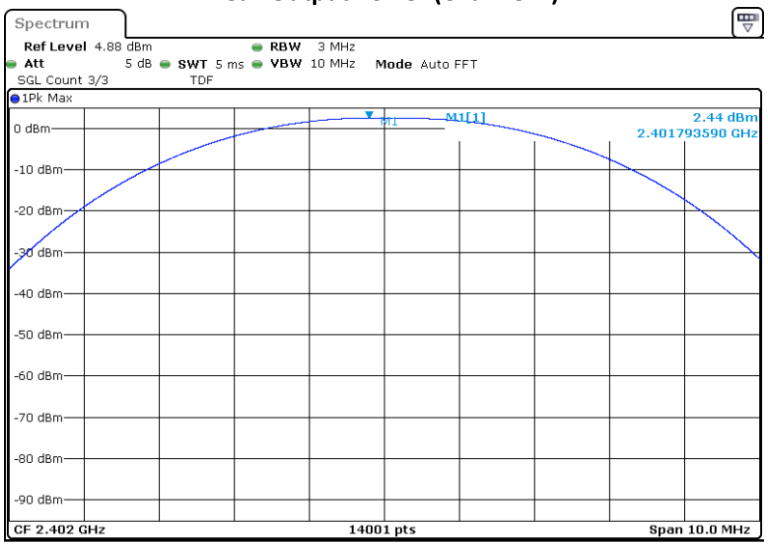
Peak method

Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power (dBm)
Bluetooth Low Energy	1	2402	1 Mbps	2.44
	18	2440	1 Mbps	2.72
	39	2480	1 Mbps	2.39
Uncertainty	±0.71 dB			

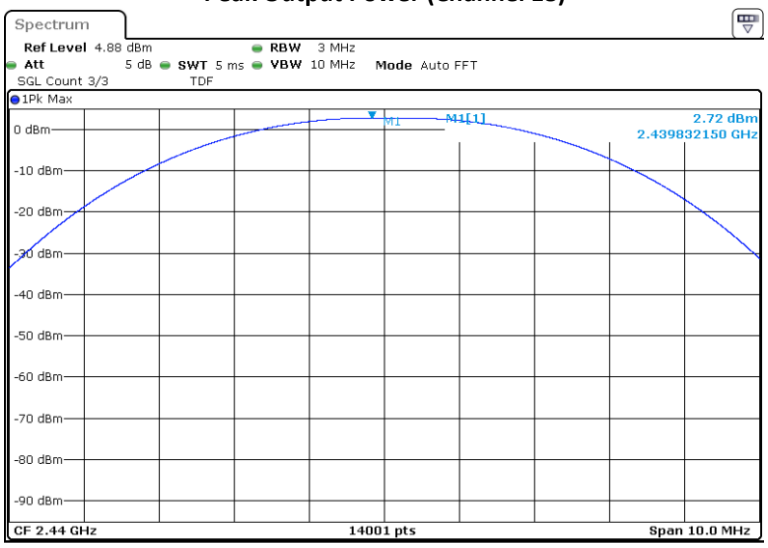
3.4.6 Plots of Peak Output Power Measurement

See the next page.

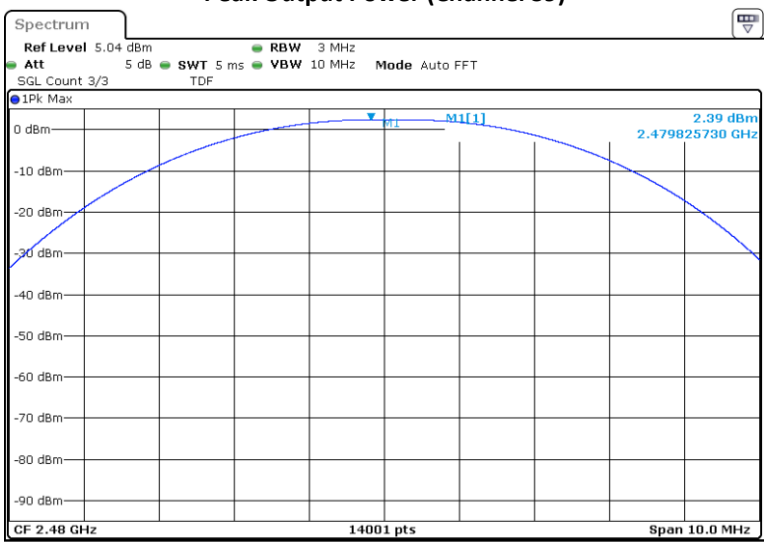
Peak Output Power (Channel 1)



Peak Output Power (Channel 18)



Peak Output Power (Channel 39)



3.5 Power Spectral Density

3.5.1 Limit

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band at any time interval of continuous transmission.

3.5.2 Measurement instruments

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

3.5.3 Test setup

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

3.5.4 Test procedure

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

IRN 030 - Spectral power density (W per n.Hz) - Method 5 – Peak method PKPSD (PSD in 3 kHz band)

3.5.5 Test results of Power Spectral Density Measurement

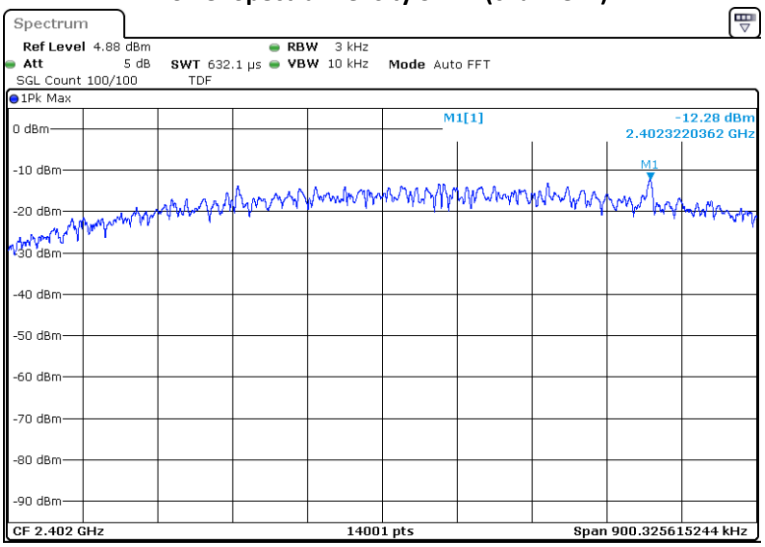
Peak Power spectral density

Technology Std.	Channel	Frequency (MHz)	Data rate	PSD (dBm/3 kHz)
Bluetooth Low Energy	1	2402	1 Mbps	-12.28
	18	2440	1 Mbps	-11.95
	39	2480	1 Mbps	-12.30
Uncertainty	±0.71 dB			

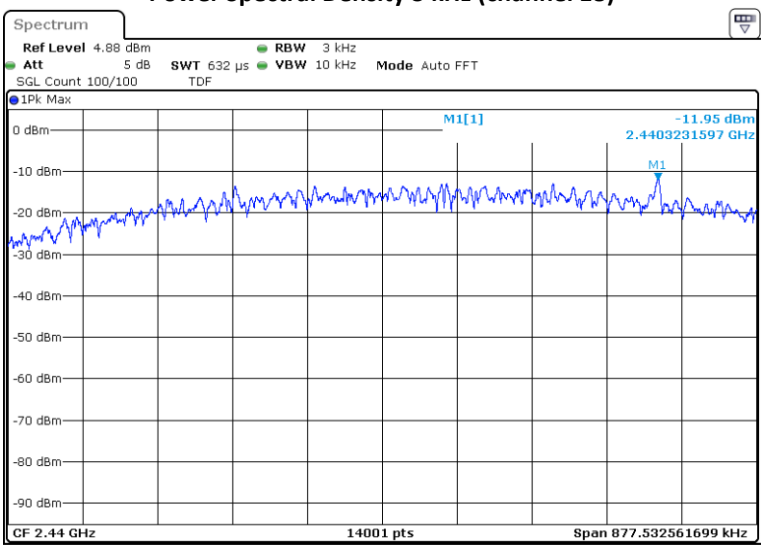
3.5.6 Plots of the Power Spectral Density Measurements

See the next page.

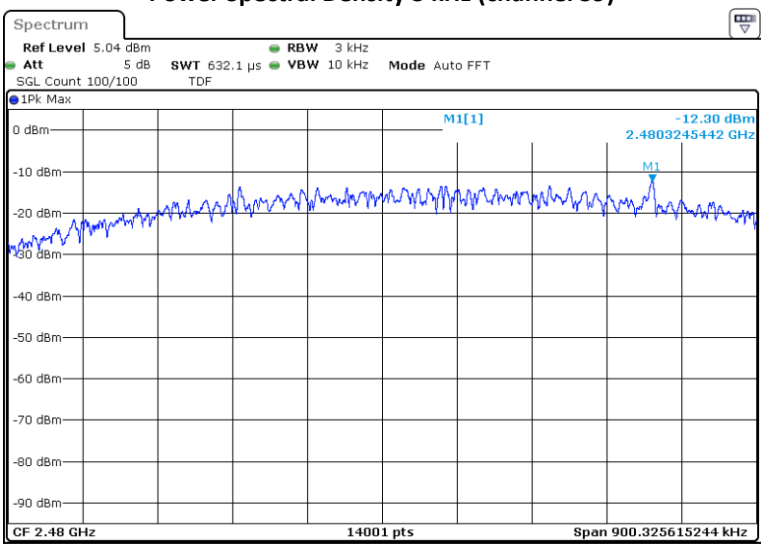
Power Spectral Density 3 kHz (channel 1)



Power Spectral Density 3 kHz (channel 18)



Power Spectral Density 3 kHz (channel 39)



3.6 Band edge Measurement

3.6.1 Limit

Band edge:
At the edge of the authorized band the RF power shall be at least 20 dB down.

3.6.2 Measurement instruments

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

3.6.3 Test setup

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

3.6.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05, sections 11.3 and 12.1. IRN 026 - Radiated electrical disturbance (V per m) Method 6 – Radiated electrical disturbance at the Authorized band edge.

3.6.5 Measurement Uncertainty

± 5.7 dB.

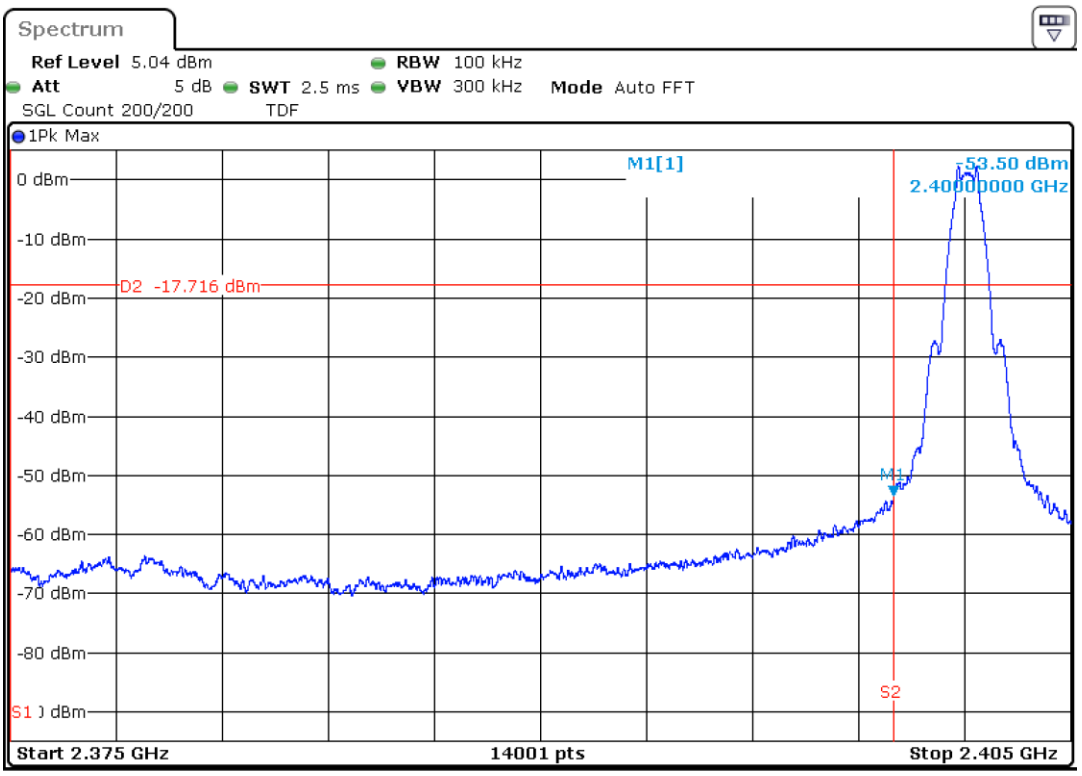
3.6.6 Results of the Band edge Measurements

Technology Std.	Channels	Frequency (MHz)	Data rate	20 dB down (dB)	Limit (dBm)
Bluetooth Low Energy	1	2402	1Mbps	-53.50	-17.72
	39	2408	1 Mbps	-58.69	-17.84
Uncertainty	±2 dB				

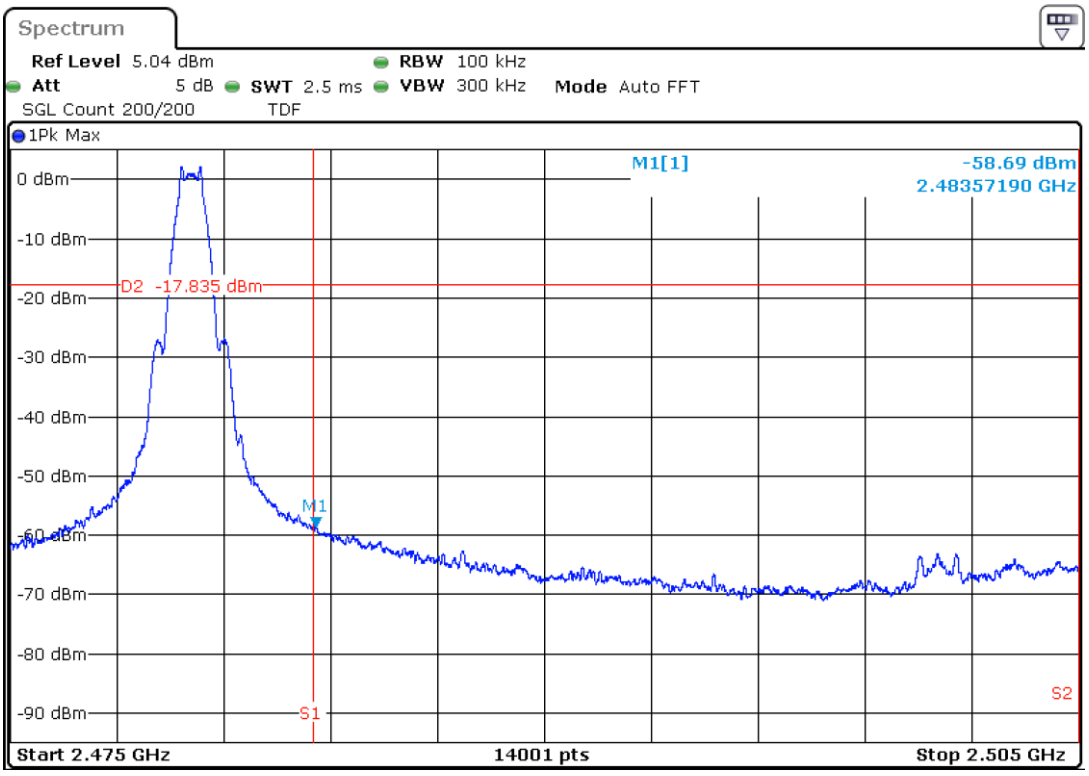
3.6.7 Plots of the Band edge Measurements

See next page

BLE Lower band edge (Channel 1)



BLE Upper band edge (Channel 39)



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