

FCC and IC Test Report for Parts 15.247, and RSS-247, RSS Gen (DTS)

Product name : SWORD Health Motion tracker Alfa
Applicant : SWORD Health S.A.
FCC ID : 2AQ4A-AA1
ISED ID : 24618-AA1

Test report No. :180700049 002 v1.00

Laboratory information

Accreditation

Telefication complies with the accreditation criteria for test laboratories as laid down in ISO/IEC 17025:2005. 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

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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	05-08-2018	First draft version	RvB
v1.00	02-08-2019	Release version	RvB

Table of Contents

Revision History	2
Summary of Test results.....	5
1 General Description.....	6
1.1 Applicant.....	6
1.2 Manufacturer	6
1.3 Tested Equipment Under Test (EUT)	6
1.4 Product specifications of Equipment under test	7
1.5 Modification of the Equipment Under Test (EUT).....	7
1.6 Observations and remarks.....	7
1.7 Environmental conditions.....	7
1.8 Measurement standards	7
1.9 Applicable standards	7
1.10 Conclusions.....	8
2 Test configuration of the Equipment Under Test	9
2.1 Test mode	9
2.2 Tested channels and Data rates	9
2.3 Conducted Test setup.....	9
2.4 Radiated Test setup	10
2.5 Equipment used in the test configuration	11
2.6 Sample calculation.....	11
3 Test results	12
3.1 6dB bandwidth Measurement.....	12
3.1.1 Limit.....	12
3.1.2 Measurement instruments	12
3.1.3 Test setup.....	12
3.1.4 Test procedure	12
3.1.5 Test Results of the 6 dB bandwidth Measurement.....	12
3.1.6 Plots of the 6 dB bandwidth Measurement	13
3.2 99% Occupied Bandwidth.....	14
3.2.1 Limit.....	14
3.2.2 Measurement instruments	14
3.2.3 Test setup.....	14
3.2.4 Test procedure	14
3.2.5 Test results of the 99% Occupied Bandwidth Measurement.....	14
3.2.6 Plots of the 99% Occupied Bandwidth Measurement	15
3.3 Output Power Measurement	16
3.3.1 Limit.....	16

3.3.2	Measurement instruments	16
3.3.3	Test setup	16
3.3.4	Test procedure	16
3.3.5	Test results of Output Power Measurement	16
3.3.6	Plots of Peak Output Power Measurement	17
3.4	Power Spectral Density	18
3.4.1	Limit	18
3.4.2	Measurement instruments	18
3.4.3	Test setup	18
3.4.4	Test procedure	18
3.4.5	Test results of Power Spectral Density Measurement	18
3.4.6	Plots of the Power Spectral Density Measurements	19
3.5	Conducted Spurious Emissions Measurement	20
3.5.1	Limit	20
3.5.2	Measurement instruments	20
3.5.3	Test setup	20
3.5.4	Test procedure	20
3.5.5	Plots of the Conducted Spurious Emissions Measurement	20
3.5.6	Measurement Uncertainty	20
3.6	Band edge emissions in the authorized band	24
3.6.1	Limit	24
3.6.2	Measurement instruments	24
3.6.3	Test setup	24
3.6.4	Test procedure	24
3.6.5	Test results of band edge measurements	24
3.6.6	Measurement Uncertainty	24
3.6.7	Plots of the band edge measurements	25
3.7	Radiated Spurious Emissions Measurement	26
3.7.1	Limit	26
3.7.2	Measurement instruments	26
3.7.3	Test setup	26
3.7.4	Test procedure	26
3.7.5	Notes	26
3.7.6	Plots of the Radiated Spurious Emissions	27
3.7.7	Measurement Uncertainty	33

Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.247 (a)	RSS 247 5.2 (1)	6dB Bandwidth	3.1	Pass
--	RSS GEN 6.7	Occupied Bandwidth	3.2	Pass
15.247 (b)	RSS 247 5.4 (2)	RF Output Power	3.3	Pass
15.247 (e)	RSS 247 5.2 (2)	Power Spectral Density	3.4	Pass
15.247 (d)	RSS 247 5.5	Conducted Spurious emissions	3..5	Pass
15.247 (d)	RSS 247 5.5	Band Edge emission in the authorized band	3.6	Pass
15.209 (a)	RSS-247 5.4	Radiated Spurious emissions	3.7	Pass
15.205 (a)	RSS Gen 8.10	Spurious emissions in the restricted bands	3.7	Pass

1 General Description

1.1 Applicant

Client name:	SWORD Health S.A.
Address	Rua Sá da Bandeira, 651, Porto, Portugal
Contact name:	Ms. S. Francisco
E-mail:	Sara@swordhealth.com

1.2 Manufacturer

Client name:	SWORD Health S.A.
Address	Rua Sá da Bandeira, 651, Porto, Portugal
Contact name:	Ms. S. Francisco
E-mail:	<u>Sara@swordhealth.com</u>

1.3 Tested Equipment Under Test (EUT)

Product name:	SWORD Health Motion Tracker Alfa
Brand name:	SWORD Health Motion Trackers
Product type:	Inertial sensor for motion tracking
FCC ID:	2AQ4A-AA1
IC ID:	24618-AA1
Model(s):	Alfa
Software version:	1.3.0
Hardware version:	1.0
Date of receipt	17-07-2018
Tests started:	17-07-2018
Testing ended:	27-07-2018

1.4 Product specifications of Equipment under test

TX Frequency range (MHz):	2402 - 2480
RX frequency range (MHz):	2402 - 2480
Maximum output power to the antenna(dBm):	-2.27
Antenna type :	Chip
Antenna Gain:	2.6 dBi
Type of modulation:	GFSK
Emission designator:	642KF1D

1.5 Modification of the Equipment Under Test (EUT)

None.

1.6 Observations and remarks

The EUT is a motion tracking device that uses an IMU to gather data and transmit that data wirelessly via the Bluetooth 4.2 radio. The applicant provided test mode firmware for the EUT, with which it was possible to configure the EUT into different test. Using a Python script called "DTM". Version 1.

1.7 Environmental conditions

Test date	23-07-2018	25-07-2018
Ambient temperature	26.3 °C	25.3 °C
Humidity	43.7 %	47. 5%

1.8 Measurement standards

- ANSI C63.10:2013

1.9 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 §15.247, §15.209, §15.205
- RSS-247 Issue 2, RSS-GEN Issue 5

1.10 Conclusions

The sample of the product showed NO NON-COMPLIANCES to the specifications stated in paragraph 1.9 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 1.9 "*Applicable standards*".

All tests are performed by:

Name : ing. R. van Barneveld

Review of test methods and report by:

Name : ing P.A. Suringa

The above conclusions have been verified by the following signatory:

Date : 02-08-2019

Name : ing. K.A. Roes

Function : Coordinator Wireless & EMC

Signature :



2 Test configuration of the Equipment Under Test

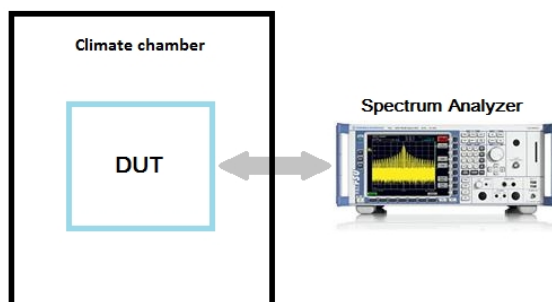
2.1 Test mode

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

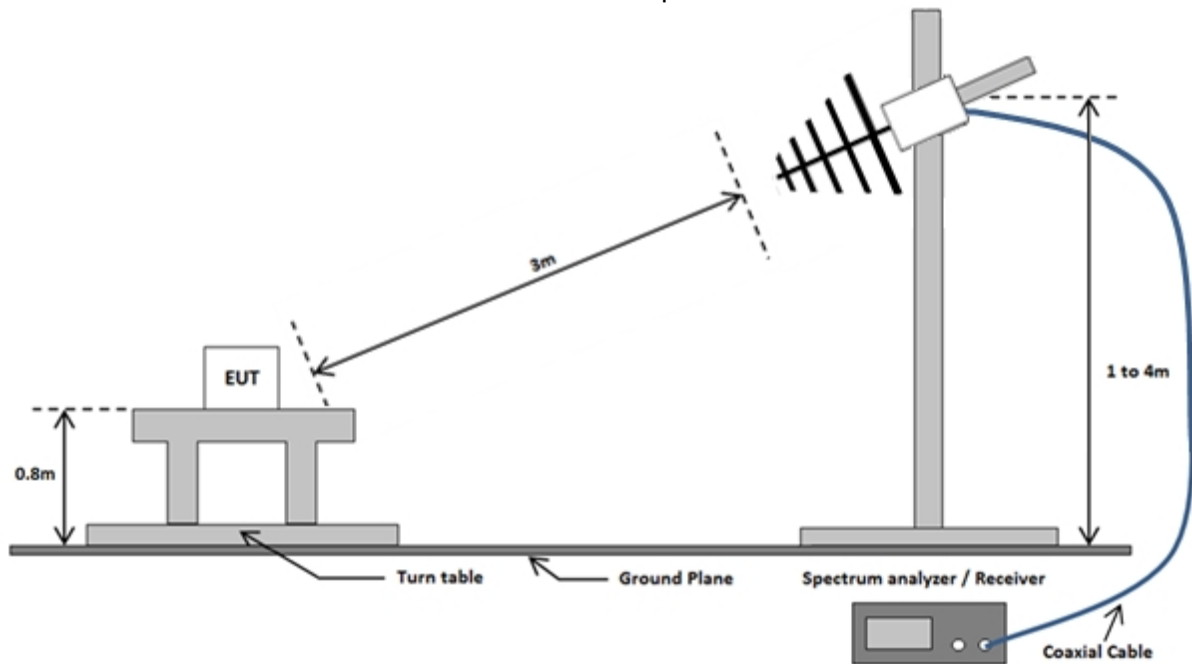
Technology	Channels	Data rate	Frequency (MHz)
Bluetooth Low Energy	37	1 Mbps	2402
	17	1 Mbps	2440
	39	1 Mbps	2480

2.3 Conducted Test setup

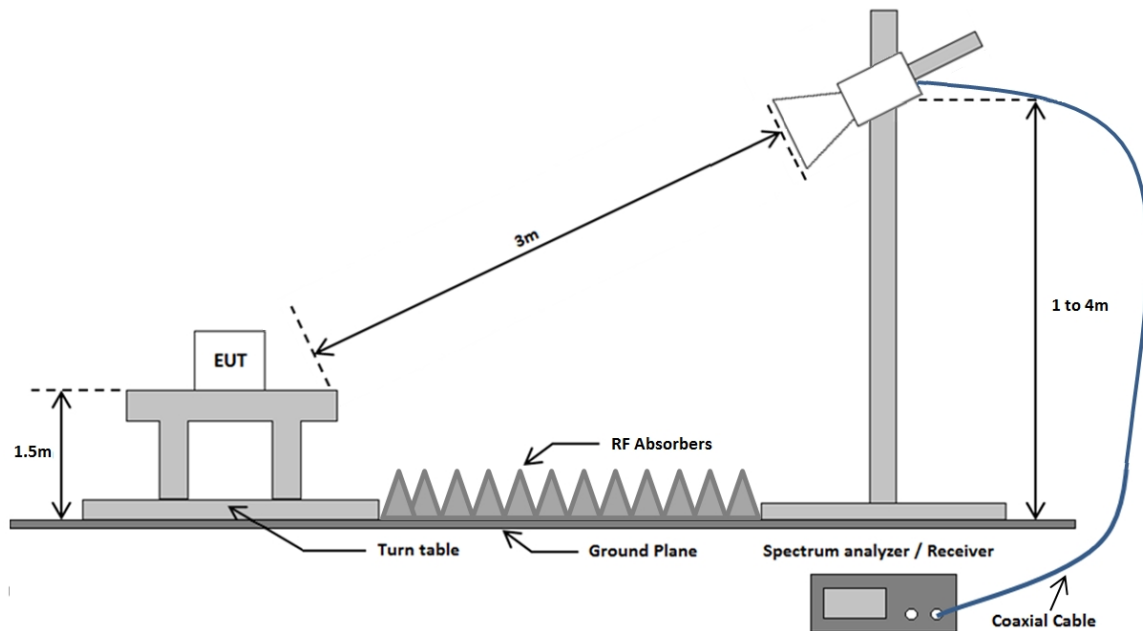


2.4 Radiated Test setup

Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



2.5 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Used at Par.
Spectrum Analyzer	Rohde & Schwarz	FSV40	TE01269	3.1 – 3.6
EMI Receiver	Rohde & Schwarz	ESR7	TE01220	3.7
Spectrum Analyzer	Rohde & Schwarz	FSP40	TE11125	3.7
SAC Chamber	Comtest Engineering BV	-	TE00861	3.7
Horn Antenna	EMCO The Electro – Mechanics Co	3115	TE00531	3.7
Biconilog Antenna	Chase	CBL6112A	TE00967	3.7
Radimation software	DARE	2016.2.8	--	3.7
Pre-amplifier	Miteq	JF4-18004000-30-8P-A1	TE11131	3.7
Pre-amplifier	Miteq	AFS42-041001800-28-10	TE11132	3.7

2.6 Sample calculation

Field Strength Measurement example:

Frequency (GHz)	Polarization	Height(m)	Peak (dBμV/m)
1.884	vertical	2	38

The following relation applies:

$$E \text{ (dB}\mu\text{V/m)} = U \text{ (dB}\mu\text{V)} + AF \text{ (dB/m)} - G \text{ (dB)} + CL \text{ (dB)}$$

Where:

E = Electric field strength

U = Measuring receiver voltage

AF = Antenna factor

G = Gain of the pre-amplifier

CL = Cable loss

$$(38 = 47.2 + 27.8 - 39.6 + 2.6)$$

3 Test results

3.1 6dB bandwidth Measurement

3.1.1 Limit

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

3.1.2 Measurement instruments

The measurement instruments are listed in chapter 2.5 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

Tests according to ANSI C63.10.

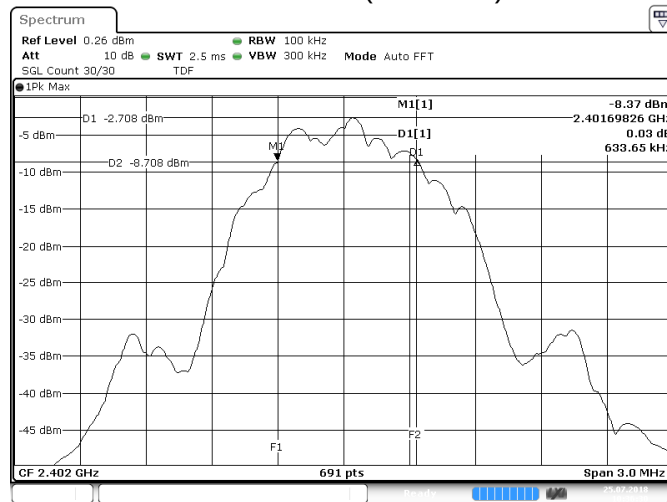
IRN 017 - Occupied bandwidth (Hz), method 3.

3.1.5 Test Results of the 6 dB bandwidth Measurement

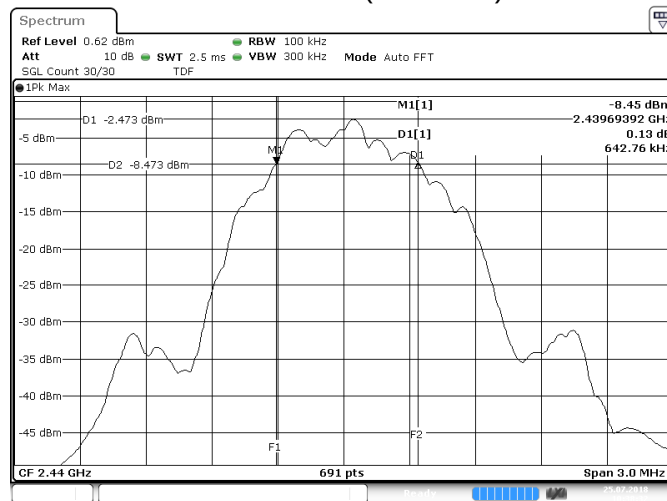
Technology Std.	Channel	Frequency (MHz)	Data rate	6dB bandwidth (kHz)
Bluetooth Low Energy	37	2402	1 Mbps	633.65
	17	2440	1 Mbps	642.76
	39	2480	1 Mbps	633.65
Uncertainty	± 58 kHz			

3.1.6 Plots of the 6 dB bandwidth Measurement

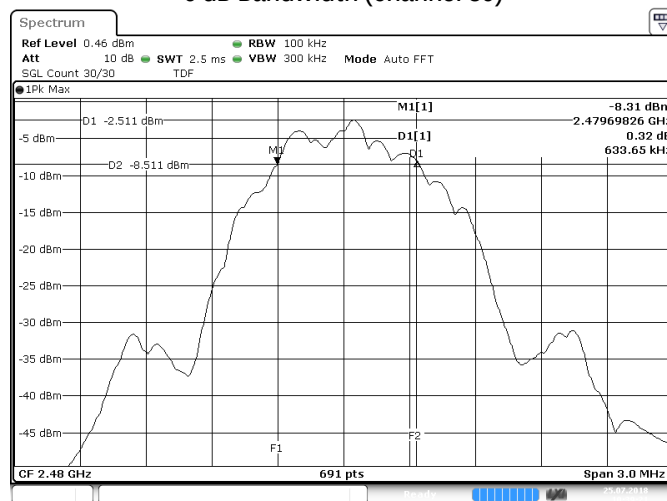
6 dB Bandwidth (Channel 37)



6 dB Bandwidth (Channel 17)



6 dB Bandwidth (Channel 39)



3.2 99% Occupied Bandwidth

3.2.1 Limit

According to RSS-Gen 6.6

3.2.2 Measurement instruments

The measurement instruments are listed in chapter 2.5 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

- 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 $\geq 3 \times$ 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.

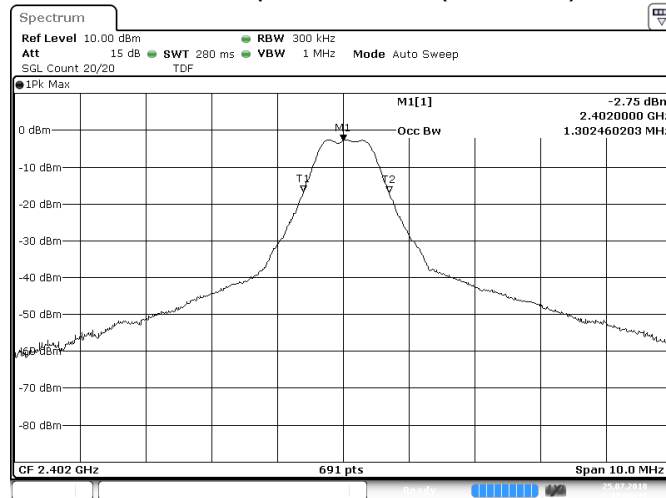
IRN 017 - Occupied bandwidth (Hz), method 1

3.2.5 Test results of the 99% Occupied Bandwidth Measurement

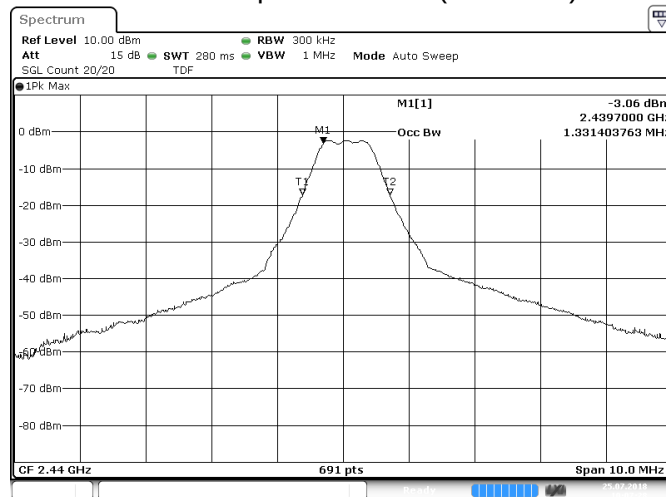
Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (MHz)
Bluetooth Low Energy	37	2402	1 Mbps	1.302
	17	2440	1 Mbps	1.331
	39	2480	1 Mbps	1.331
Uncertainty	± 362 kHz			

3.2.6 Plots of the 99% Occupied Bandwidth Measurement

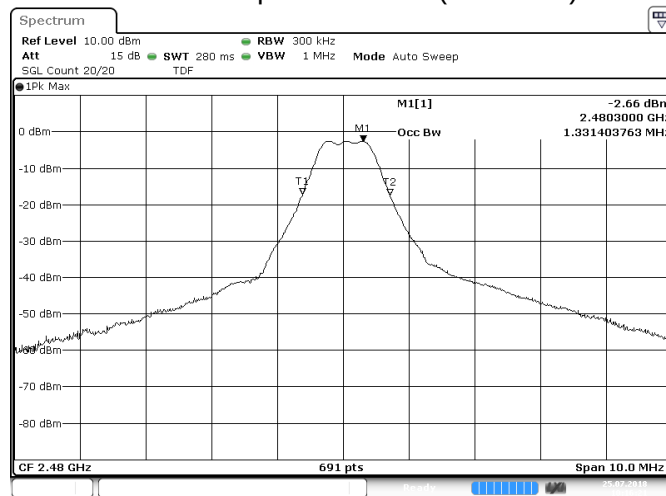
BLE 99% Occupied Bandwidth (Channel 37)



BLE 99% Occupied Bandwidth (Channel 17)



BLE 99% Occupied Bandwidth (Channel 39)



3.3 Output Power Measurement

3.3.1 Limit

For systems using digital modulation in the 2400-2483.5 MHz band, 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.

3.3.2 Measurement instruments

The measurement instruments are listed in chapter 2.5 of this report.

3.3.3 Test setup

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

3.3.4 Test procedure

Tests according to ANSI C63.10.

IRN 014- RF Power (W), method 10.

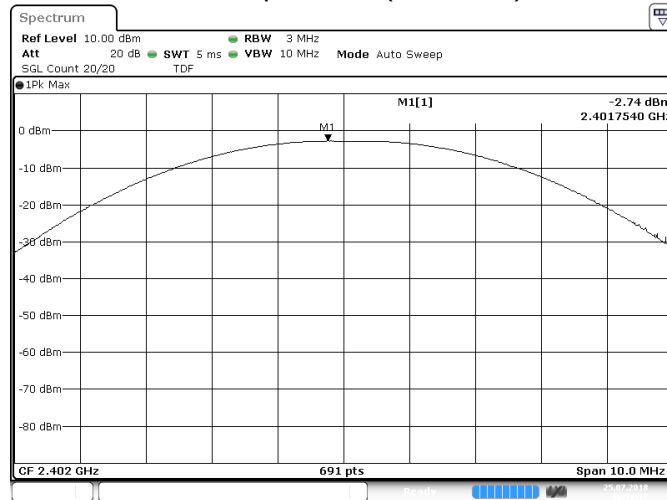
3.3.5 Test results of Output Power Measurement

Technology Std.	Peak method			
	Channels	Frequency (MHz)	Data rate	Peak output power (dBm)
Bluetooth Low Energy	37	2402	1 Mbps	-0.14
	17	2440	1 Mbps	0.33
	39	2480	1 Mbps	0.14
Uncertainty	± 0.9 dB			

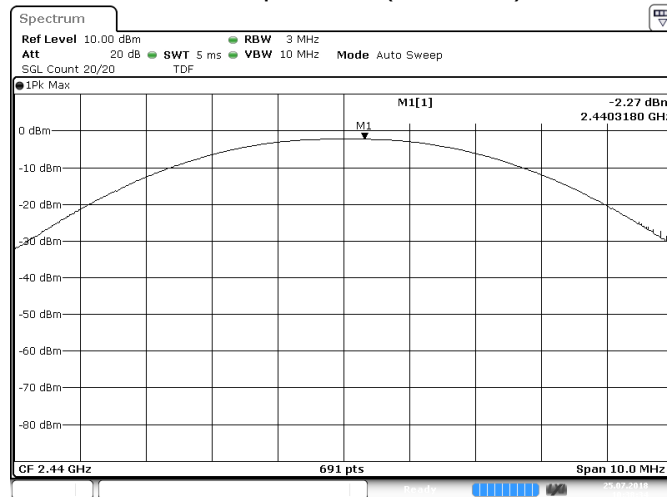
Note: Measurements were performed conducted. (Pout (dBm)+ant. Gain(dBi)=EIRP (dBm).

3.3.6 Plots of Peak Output Power Measurement

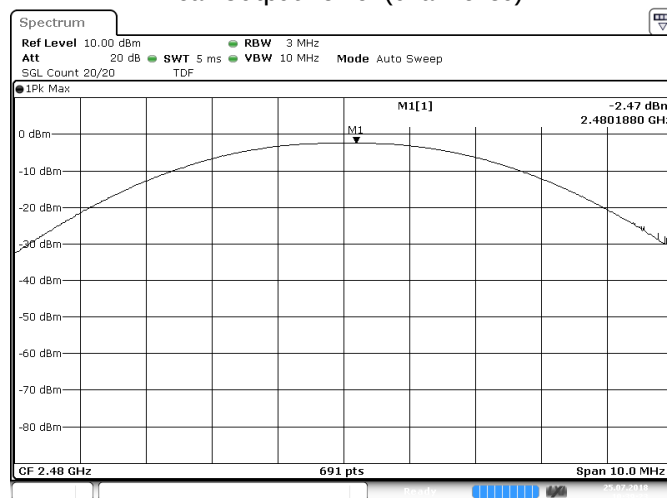
Peak Output Power (Channel 37)



Peak Output Power (Channel 17)



Peak Output Power (Channel 39)



3.4 Power Spectral Density

3.4.1 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.

3.4.2 Measurement instruments

The measurement instruments are listed in chapter 2.5 of this report.

3.4.3 Test setup

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

3.4.4 Test procedure

Tests according to ANSI C63.10.

IRN 030 - Power Spectral Density (W vs. Hz), method 5.

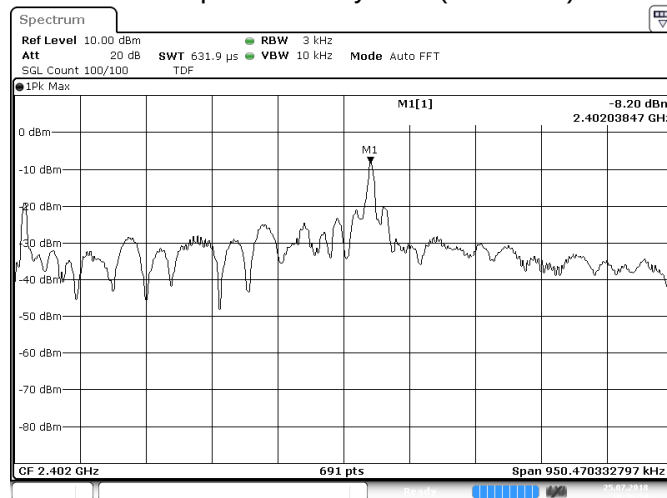
3.4.5 Test results of Power Spectral Density Measurement

Technology Std.	Channels	Frequency (MHz)	Data rate	PSD/3 kHz (dBm)
Bluetooth Low Energy	37	2402	1 Mbps	-5.6
	17	2440	1 Mbps	-5.11
	39	2480	1 Mbps	-5.31
Uncertainty	±0.63 dB			

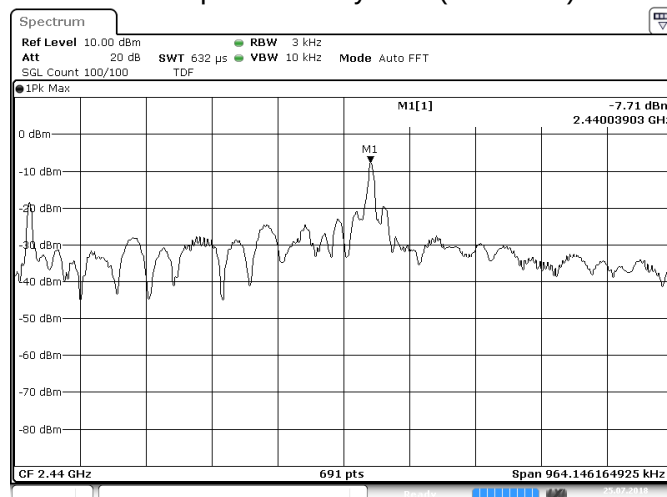
Note: Measurements were performed conducted. (Pout (dBm)+ant. Gain(dBi)=EIRP (dBm).

3.4.6 Plots of the Power Spectral Density Measurements

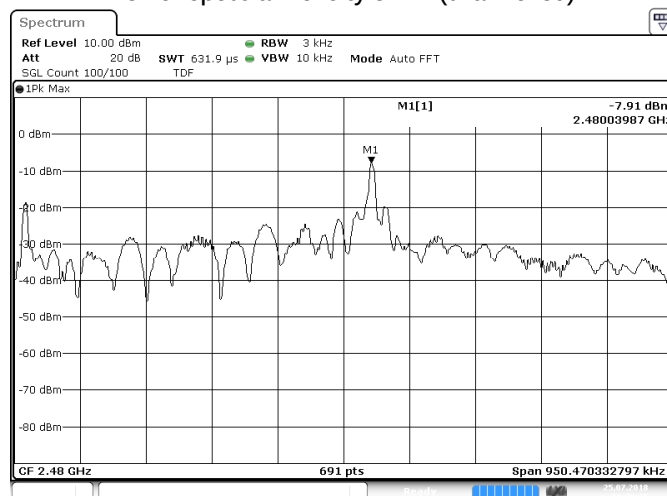
Power Spectral Density 3 kHz (channel 37)



Power Spectral Density 3 kHz (channel 17)



Power Spectral Density 3 kHz (channel 39)



3.5 Conducted Spurious Emissions Measurement

3.5.1 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the RF power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power.

3.5.2 Measurement instruments

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

3.5.3 Test setup

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

3.5.4 Test procedure

Tests according to ANSI C63.10.

IRN 016 - Spurious emission (W), methode 11.

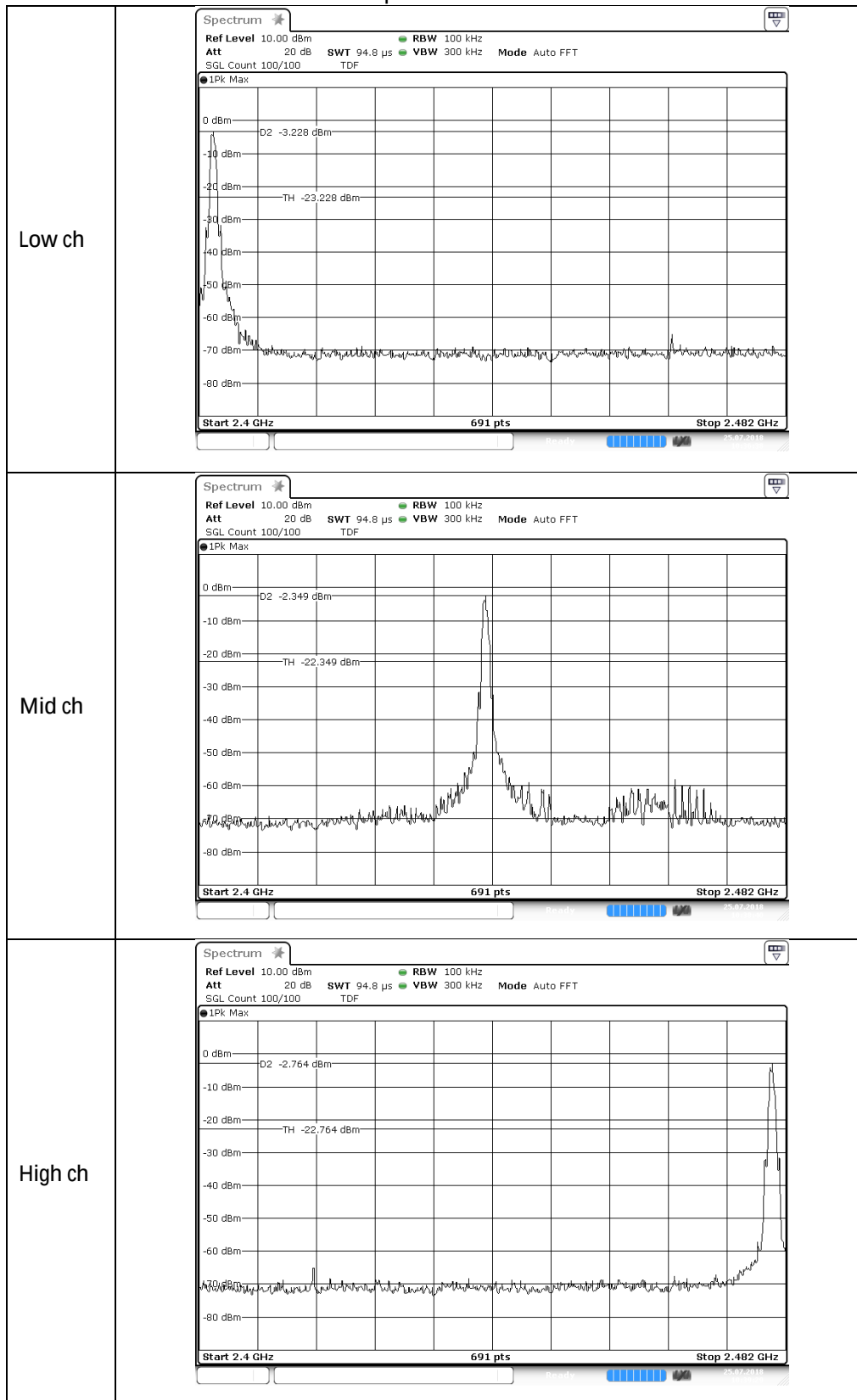
3.5.5 Plots of the Conducted Spurious Emissions Measurement

See next page.

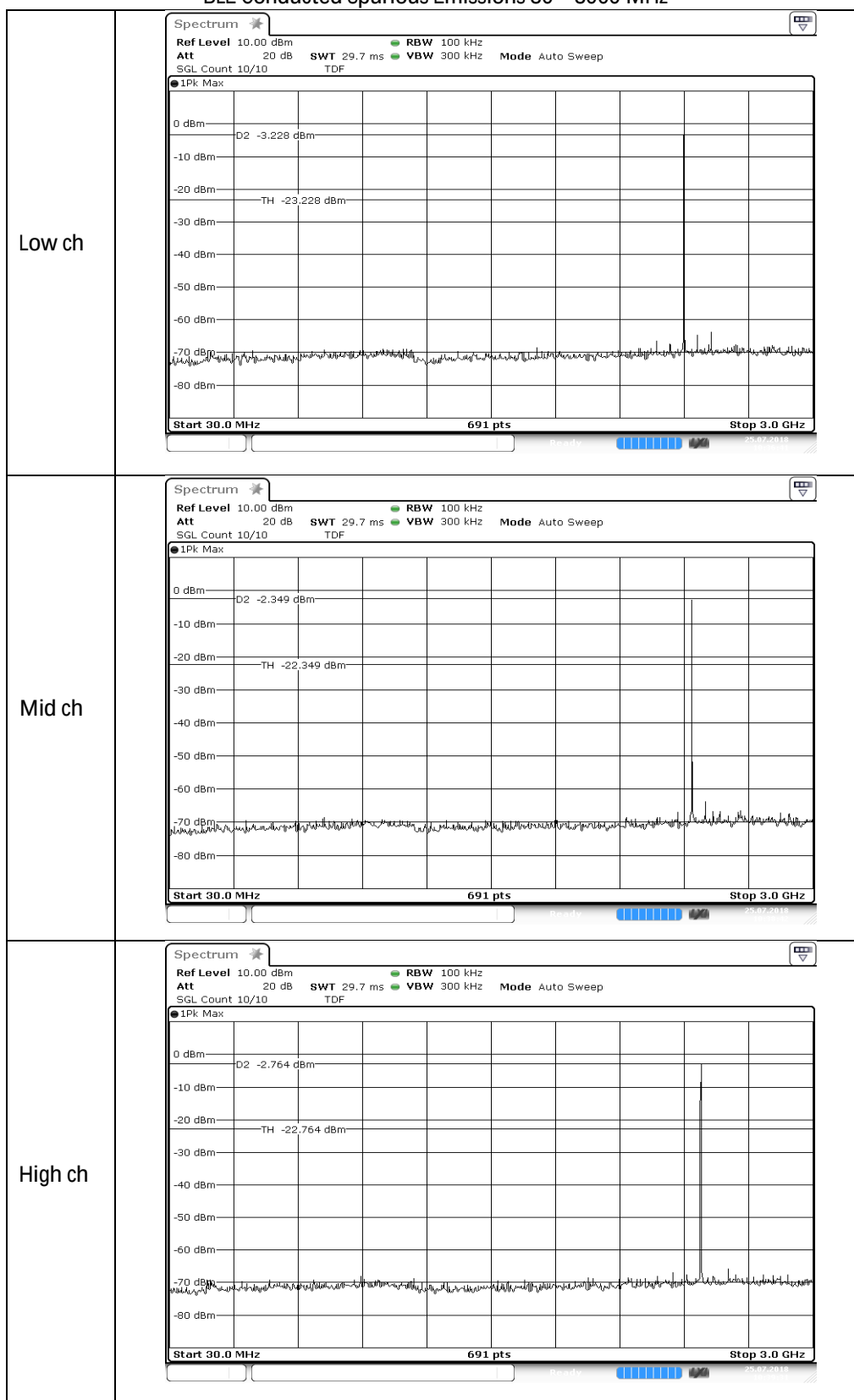
3.5.6 Measurement Uncertainty

< 1 GHz	1.27 dB
≥ 1 GHz	2.53 dB

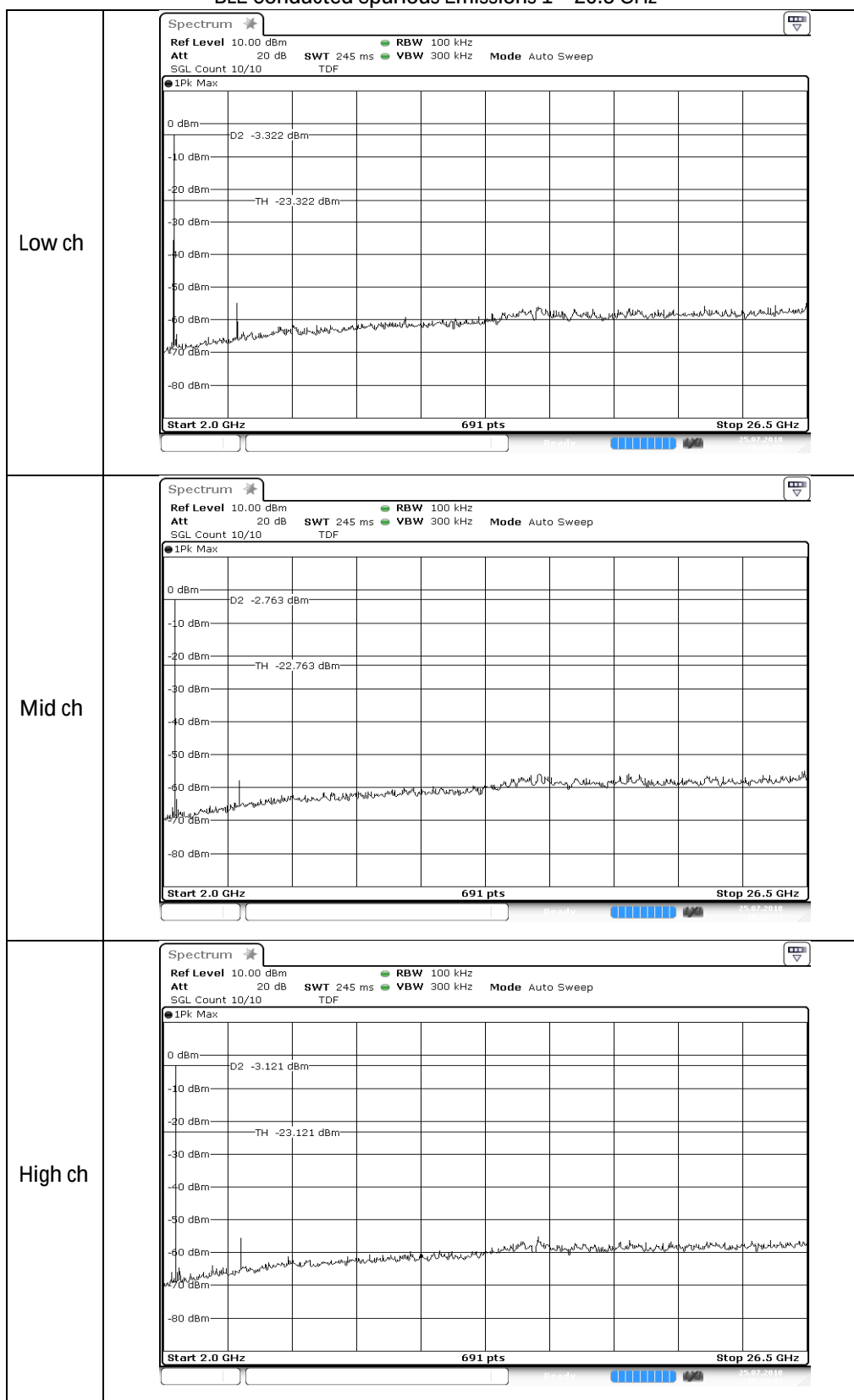
BLE Conducted Spurious Emissions Fundamental level



BLE Conducted Spurious Emissions 30 – 3000 MHz



BLE Conducted Spurious Emissions 1 – 26.5 GHz



3.6 Band edge emissions in the authorized band

3.6.1 Limit

At least 20 dB attenuation in a 100 kHz bandwidth relative to the highest fundamental channel power spectral density in 100 kHz.

3.6.2 Measurement instruments

The measurement instruments are listed in chapter 2.5 of this report.

3.6.3 Test setup

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

3.6.4 Test procedure

Tests according to ANSI C63.10.

IRN 026 - Radiated electrical disturbance (V per m), method 5.

3.6.5 Test results of band edge measurements

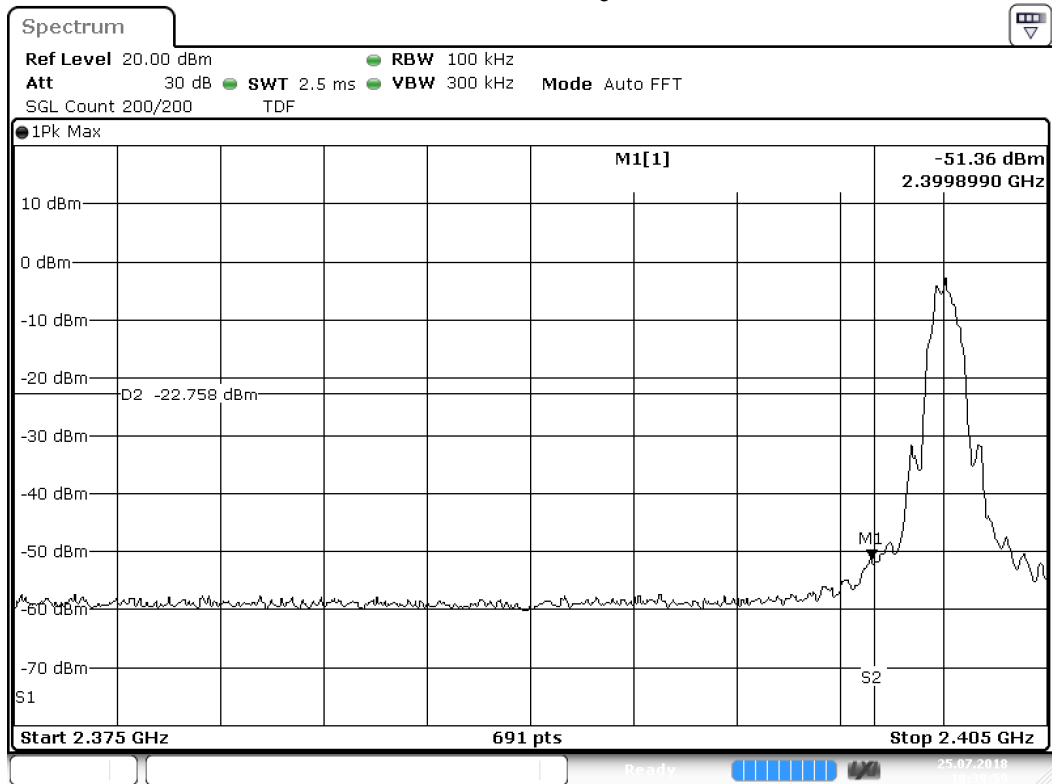
Peak method				
Technology Std.	Channels	Frequency (MHz)	Data rate	Attenuation (dB)
Bluetooth Low Energy	37	2402	1 Mbps	-51.36
	39	2480	1 Mbps	-53.89
Uncertainty	+/- 1.7 dB			

3.6.6 Measurement Uncertainty

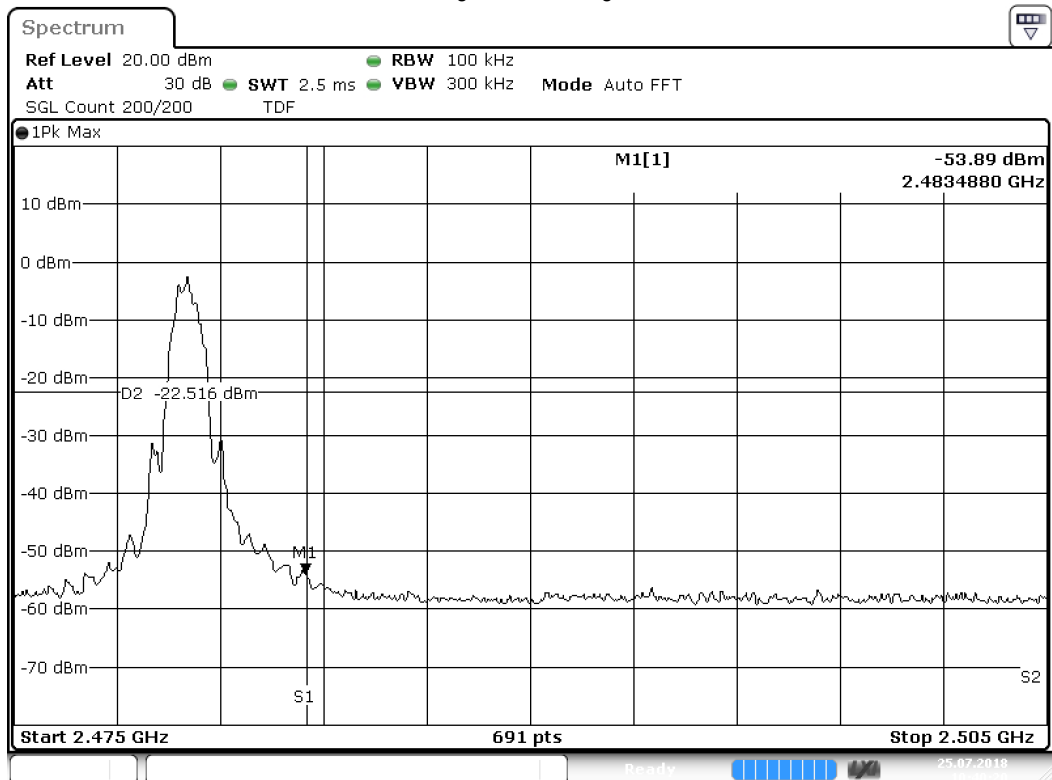
≥ 1 GHz	2.53 dB
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3.6.7 Plots of the band edge measurements

Lower band edge



Higher band edge



3.7 Radiated Spurious Emissions Measurement

3.7.1 Limit

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

15.209

Frequency (MHz)	Field strength ($\mu\text{V/m}$)	Measurement distance(m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 - 30	30	30
30 -88	100	3
88 - 216	150	3
216-960	200	3
Above 960	500	3

3.7.2 Measurement instruments

The measurement instruments are listed in chapter 2.5 of this report.

3.7.3 Test setup

The test setup is as shown in chapter 2.4 of this report.

3.7.4 Test procedure

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz.

Radiated emission limits in these three bands are based on measurements employing an average detector.

Tests according to ANSI C63.10.

IRN 026 - Radiated electrical disturbance (V per m), method 1/2/3.

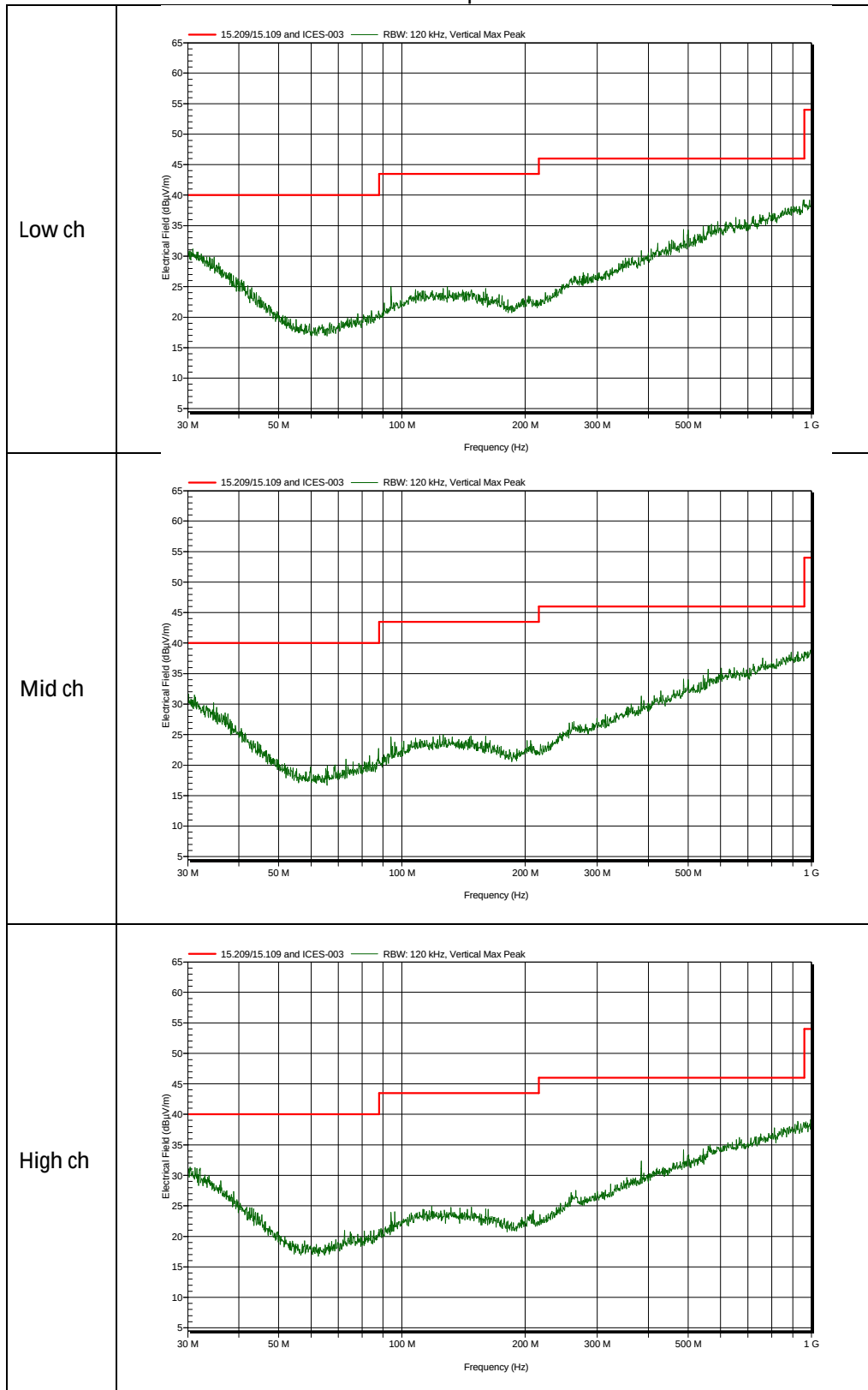
3.7.5 Notes

- In the frequency range of 1 – 18 GHz the green trace is measured using a peak detector and the red trace is measured using an average detector. The top limit line represent the peak limit and the bottom limit represents the average limit
- The peaks seen in the 1 – 18 GHz frequency range, are the fundamental frequencies and are therefore not subject to the limit.

3.7.6 Plots of the Radiated Spurious Emissions

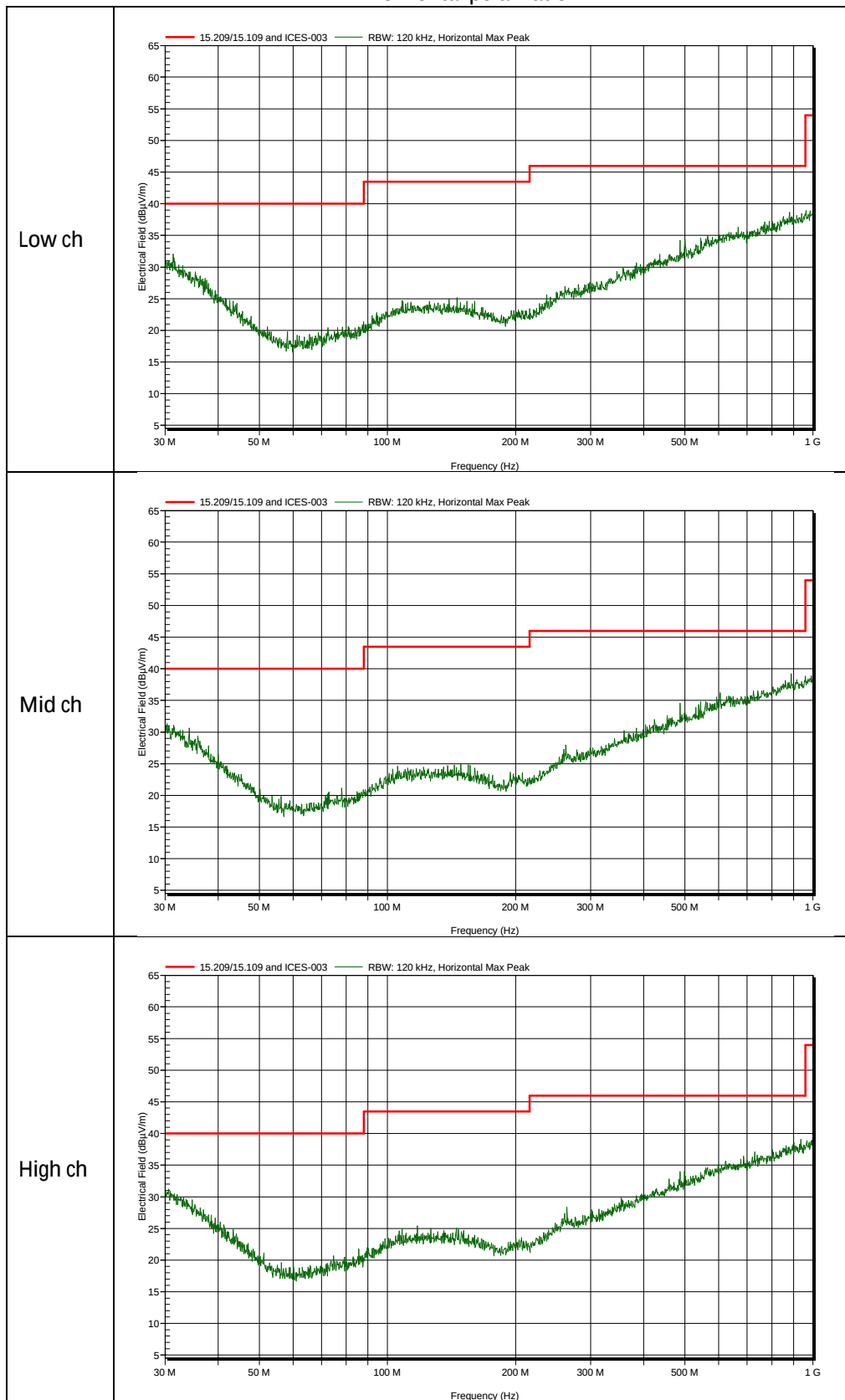
30 MHz to 1 GHz

Vertical polarization



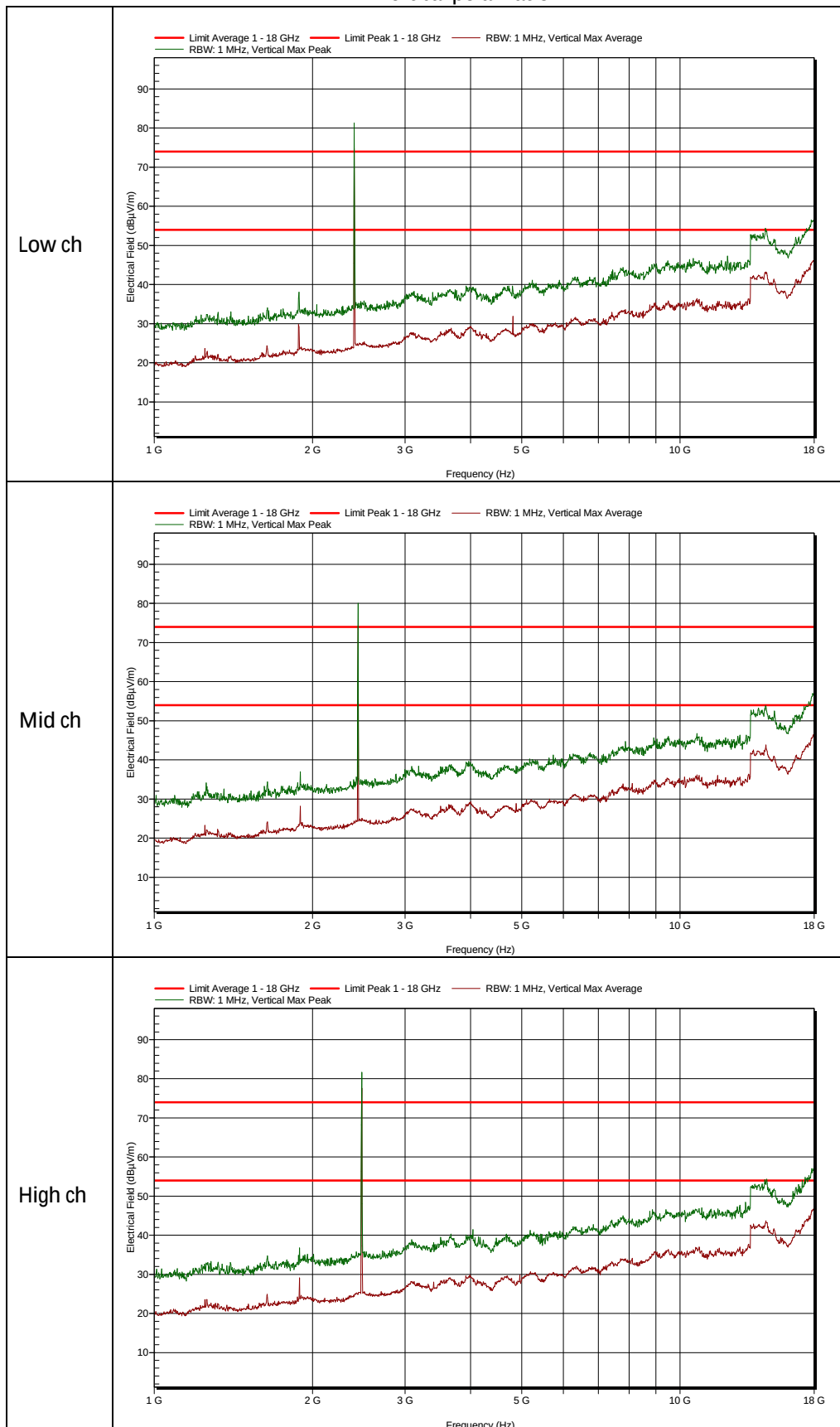
30 MHz to 1 GHz

Horizontal polarization



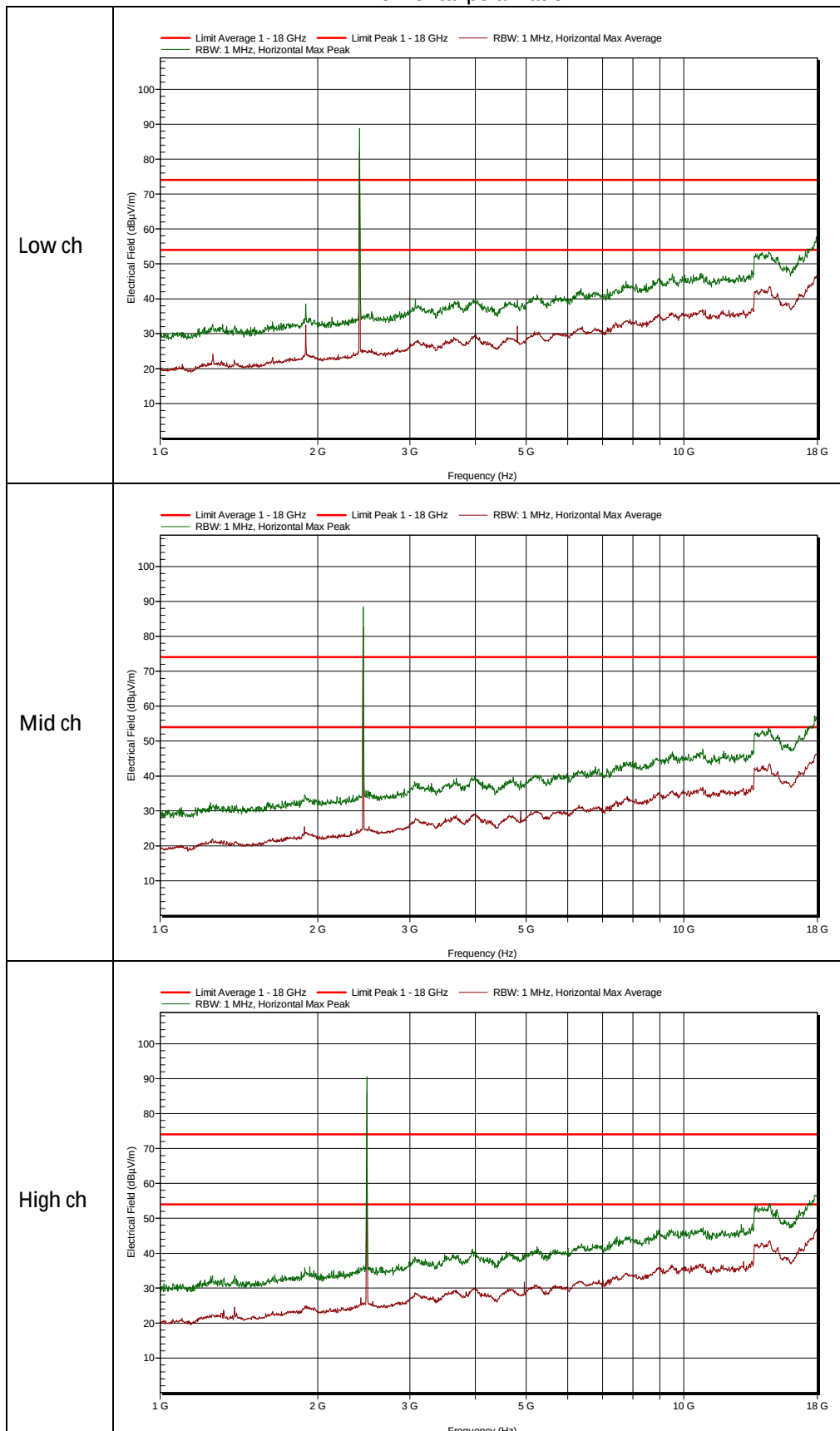
1 GHz to 18 GHz

Vertical polarization



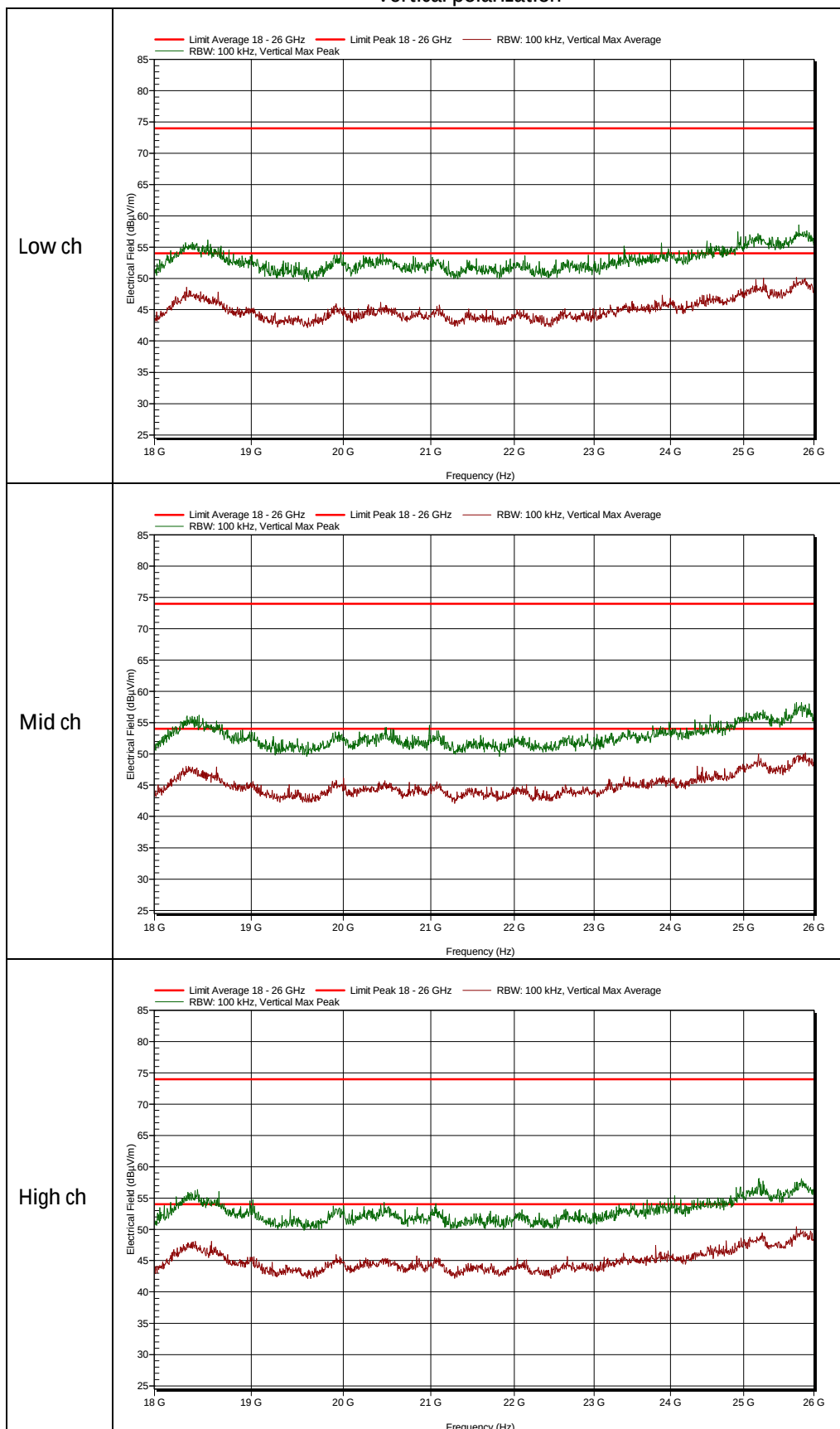
1 GHz to 18 GHz

Horizontal polarization



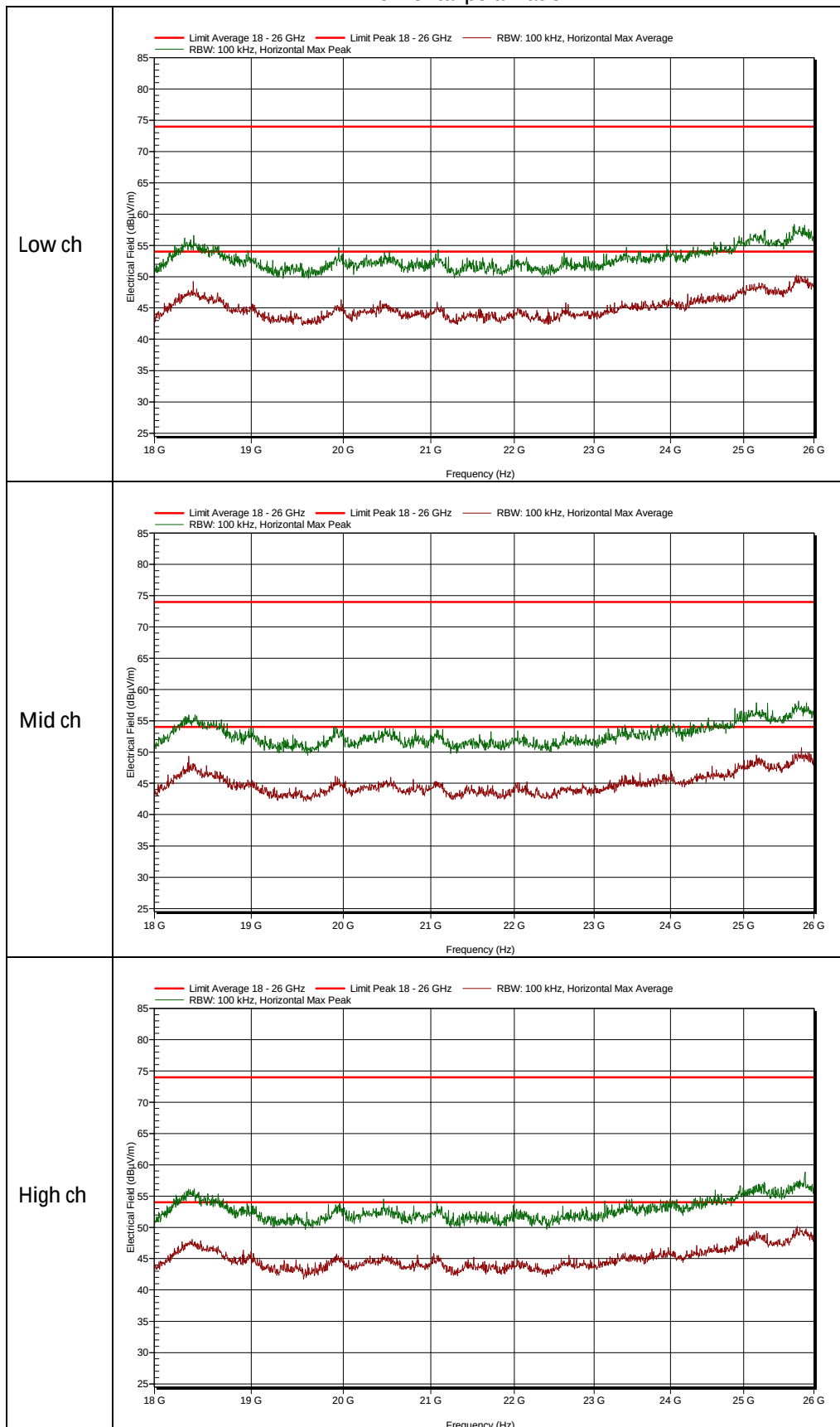
18 GHz to 26 GHz

Vertical polarization



18 GHz to 26 GHz

Horizontal polarization



3.7.7 Measurement Uncertainty

Measurement uncertainty Radiated emissions below 1 GHz

Horizontal polarization	
30 – 200 MHz	4.5 dB
200 – 1000 MHz	3.6 dB
Vertical polarization	
30 – 200 MHz	5.4 dB
200 – 1000 MHz	4.6 dB

Measurement uncertainty Radiated emissions above 1 GHz

1000- 18000 MHz	5.7 dB
18000 – 26000 MHz	3.9 dB