

FCC and IC Test Report for Parts 15.247, 15.209 (DTS) and RSS-247, RSS Gen

Product name: **Wireless Climate Sensor**
Applicant: **ROCKWOOL B.V. / Grodan**
FCC ID: **2AUKP-CLC001**
IC ID: **25447-CLC001**

Test report No. : 190800839 Ver 2.0

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).

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 registration number for the 3 meter test chamber of Telefication is: 4173A-1.

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	Telefication BV
Test Site location	Edisonstraat 12a 6902 PK Zevenaar The Netherlands Tel. +31889983600 Fax. +31316583189
Test Site FCC	NL0001

Revision History

Version	Date	Remarks	By
v0.5	05-11-2019	First draft	PvW
v1.0	29-11-2019	Initial release	PvW
v2.0	09-12-2019	Updated BLE RF power in clause 1.4	PvW

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 Test setups.....	9
2.4 Equipment used in the test configuration.....	11
2.5 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
3.2 99% Occupied Bandwidth.....	13
3.2.1 Limit.....	13
3.2.2 Measurement instruments	13
3.2.3 Test setup.....	13
3.2.4 Test procedure	13
3.2.5 Test results of the 99% occupied bandwidth measurement.....	13
3.2.6 Plots of the 99% occupied bandwidth measurement	14
3.3 Output Power Measurement	17
3.3.1 Limit.....	17
3.3.2 Measurement instruments	17
3.3.3 Test setup.....	17

3.3.4	Test procedure	17
3.3.5	Test results of 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
3.5	Radiated Spurious Emissions Measurement	19
3.5.1	Limit.....	19
3.5.2	Measurement instruments	19
3.5.3	Test setup.....	19
3.5.4	Test procedure	19
3.5.5	Notes	19
3.5.6	Plots of the BLE Radiated Spurious Emissions.....	20
3.5.7	Plots of the LoRa Radiated Spurious Emissions.....	26
3.5.8	Measurement Uncertainty.....	30
3.6	Other requirements.....	31
3.6.1	Band edge power	31
3.6.2	Channel dwell time.....	31
3.6.3	Minimum number of hopping channels and hopping sequence	31
3.6.4	Specific hopping requirements	31

Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.247 (a)	RSS-247 5.2(a)	6dB Bandwidth	3.1	Pass
--	RSS-Gen 6.7	99% Bandwidth	3.2	Pass
15.247 (b)	RSS-247 5.1 (b)	RF output power	3.3	Pass
15.247 (e)	RSS-247 5.2 (b)	Power spectral density	3.4	Pass
15.209 (a)	RSS-247 5.4	Radiated Spurious emissions	3.5	Pass
15.205 (a)	RSS Gen 8.10	Spurious emissions in the restricted bands	3.5	Pass

1 General Description

1.1 Applicant

Client name:	ROCKWOOL B.V. / Grodan
Address:	Industrieweg 15, Roermond, the Netherlands
Zip code:	6045 JG
Telephone:	+31 475 353846
E-mail:	Paul.bouwens@grodan.com
Contact name:	Mr. Paul Bouwens

1.2 Manufacturer

Manufacturer name:	ROCKWOOL B.V. / Grodan
Address:	Industrieweg 15, Roermond, the Netherlands
Zip code:	6045 JG
Telephone:	+31 475 353846
E-mail:	Paul.bouwens@grodan.com
Contact name:	Mr. Paul Bouwens

1.3 Tested Equipment Under Test (EUT)

Product name:	Wireless Climate Sensor
Brand name:	Grodan
Product type:	Wireless Climate Sensor with CO2
Variant models:	Climate Sensor HT + CO2 – M/US Climate Sensor HT – M/US
FCC ID:	2AUKP-CLC001
IC ID	25447-CLC001
Software version:	1.01
Hardware version:	CLC001 CL001
Date of receipt:	12-09-2019
Tests started:	12-09-2019
Testing ended:	28-10-2019

1.4 Product specifications of Equipment under test

TX Frequency range (MHz)	902 – 915 2400 – 2483.5
RX frequency range (MHz)	2400 – 2483.5
Maximum output power to antenna (dBm)	BLE: -15.0 LoRa: 14.82
Antenna type	BLE: PCB antenna LoRa: Meandering PCB antenna
Antenna gain (dBi)	BLE: 0.54 LoRa: 4.0
Type of modulation	BLE: GFSK LoRa: CSS
Emission designator BLE	1M79G1D
Emission designator LoRa	576KX1D

1.5 Modification of the Equipment Under Test (EUT)

None.

1.6 Observations and remarks

The manufacturer has declared that the BLE and LoRa radios will not transmit simultaneously.

1.7 Environmental conditions

Test date	12-09-2019	13-09-2019	28-10-2019
Ambient temperature	23.1 °C	23.1 °C	21.9 °C
Humidity	47.8 %	47.7 %	45.2 %

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
- 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 : P. van Wanrooij, BASc

Review of test methods and report by:

Name : ing. R. van Barneveld

The above conclusions have been verified by the following signatory:

Date : 12-12-2019

Name : ing. K.A. Roes

Function : Coordinator Radio Laboratory

Signature :



2 Test configuration of the Equipment Under Test

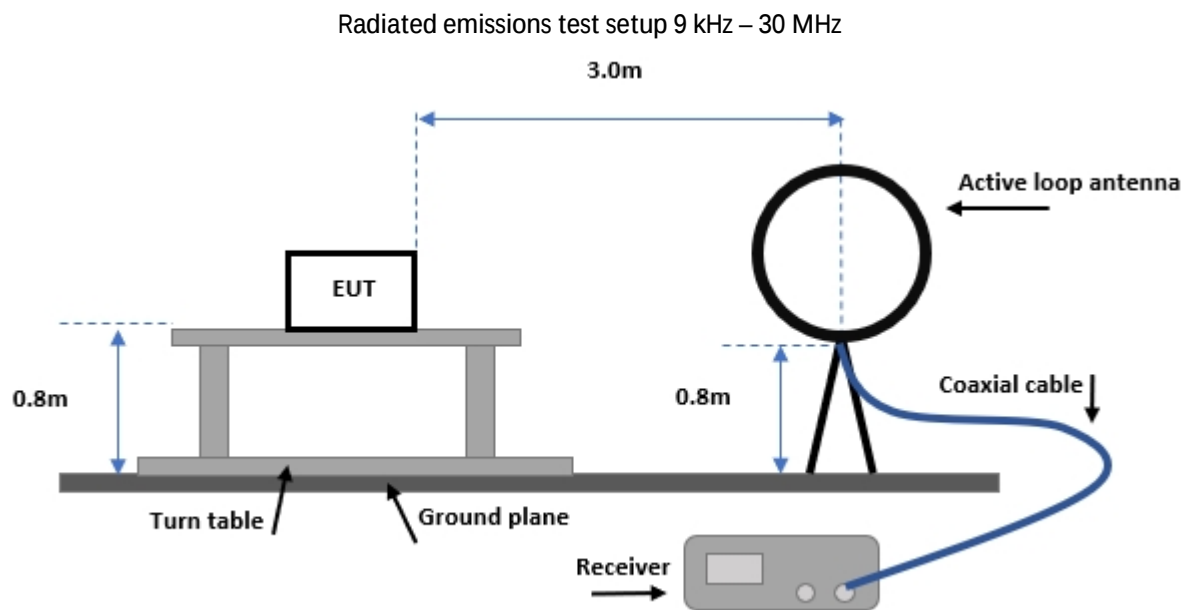
2.1 Test mode

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

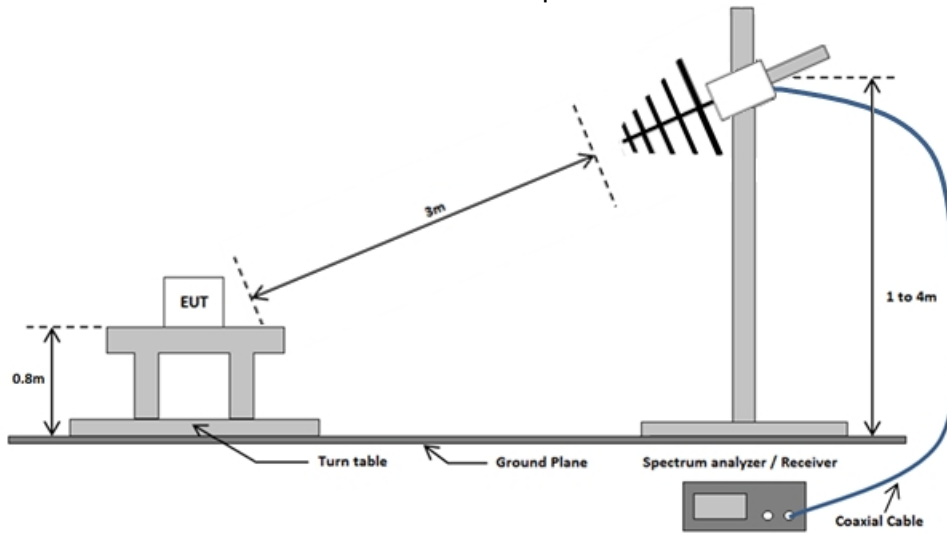
2.2 Tested channels and Data rates

Technology	Channels	Data rate	Frequency (MHz)
Bluetooth Low Energy	37 (Low)	1 Mbps	2402
	18 (Mid)	1 Mbps	2440
	39 (High)	1 Mbps	2480
LoRa	1 (low)	12.5 kbps	903.0
	5 (mid)	12.5 kbps	909.2
	8 (high)	12.5 kbps	914.2
LoRa	0 (low)	1.76 kbps	902.3
	31 (mid)	1.76 kbps	908.6
	63 (high)	1.76 kbps	914.9

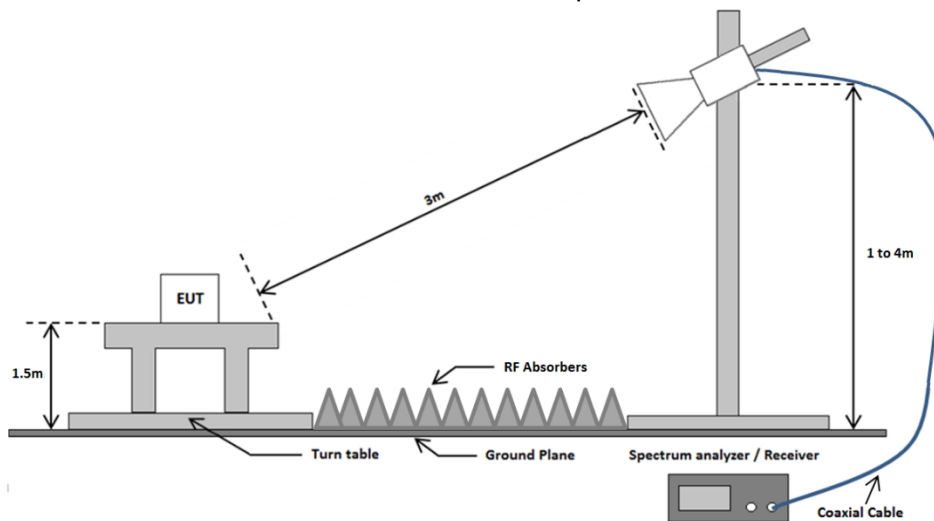
2.3 Test setups



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	Used at Par.
Spectrum Analyzer	Rohde & Schwarz	FSP40	TE11125	3.5
Spectrum Analyzer	Rohde & Schwarz	ESR7	TE01220	3.1 - 3.5
Biconilog Antenna	Chase	CBL6112A	TE00967	3.5
Horn Antenna	EMCO The Electro – Mechanics Co	3115	TE00531	3.5
Horn Antenna	Flann Microwave	20240-25	TE00818	3.5
SAC Chamber	Comtest Engineering BV	-	TE00861	3.5
Band reject filter	5N45-2441/T83-0/0	WHK3.0/18G-10EF	TE00932	3.5
Active loop antenna	EMCO	6502	113188	3.5
Pre-amplifier	Miteq	Js4-18004000-30-8P-A1	TE11131	3.5
Software	DARE Instruments	Radimation 2019.1.8	--	3.5

2.5 Sample calculation

Field Strength Measurement example:

Frequency (GHz)	Polarization	Height(m)	Peak (dBμV/m)
1.804	Horizontal	2	45.9

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

$$(45.9 = 41.52 + 36.1 - 37.42 + 5.7)$$

3 Test results

3.1 6dB bandwidth Measurement

3.1.1 Limit

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

LoRa: No requirement.

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

Tests according to ANSI C63.10.

IRN 017 - Occupied bandwidth (Hz) Method 4 – DTS Bandwidth.

3.1.5 Test Results of the 6 dB bandwidth Measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	6dB bandwidth (kHz)
LoRa	1	903.0	12.5 kbps	512.3
	5	909.2	12.5 kbps	523.9
	8	914.2	12.5 kbps	535.5
LoRa	0	902.3	1.76 kbps	125.2
	31	908.6	1.76 kbps	125.9
	63	914.9	1.76 kbps	125.2
Uncertainty	± 36.2 kHz			

BLE: See module test report

3.2 99% Occupied Bandwidth

3.2.1 Limit

According to RSS-Gen 6.7.

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

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 $\geq$ 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.

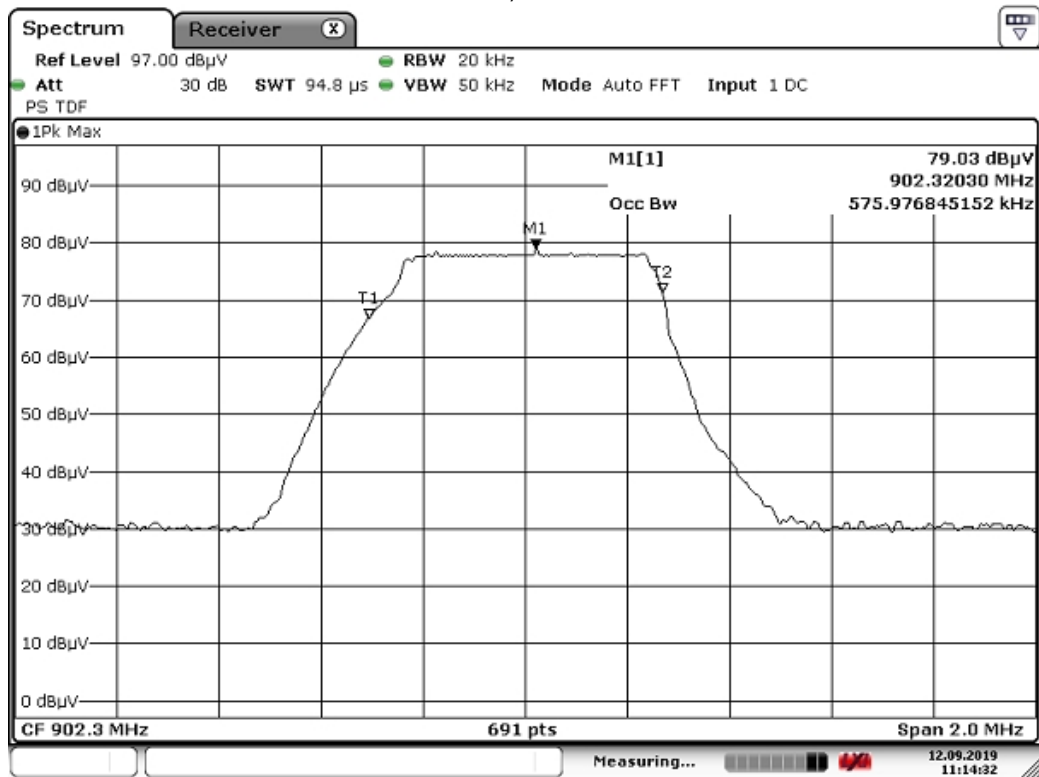
3.2.5 Test results of the 99% occupied bandwidth measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
LoRa	1	903.0	12.5 kbps	576.0
	5	909.2	12.5 kbps	576.0
	8	914.2	12.5 kbps	564.4
LoRa	0	902.3	1.76 kbps	124.5
	31	908.6	1.76 kbps	124.8
	63	914.9	1.76 kbps	125.2
Uncertainty	± 12 kHz			

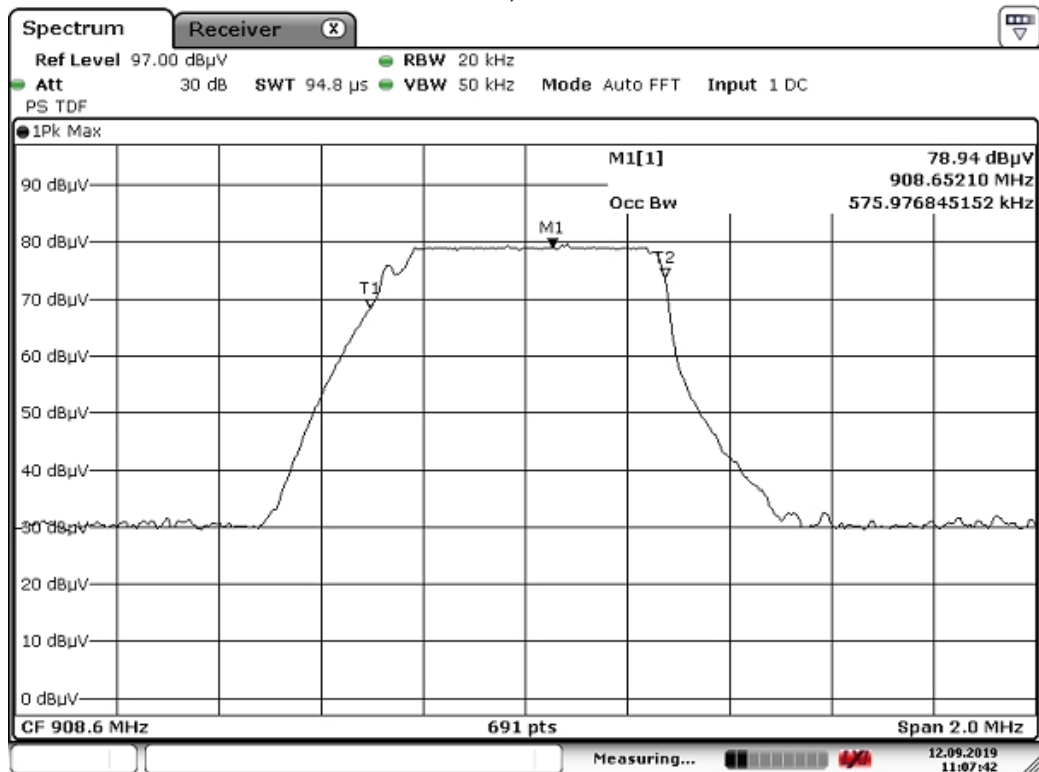
BLE: see module test report

3.2.6 Plots of the 99% occupied bandwidth measurement

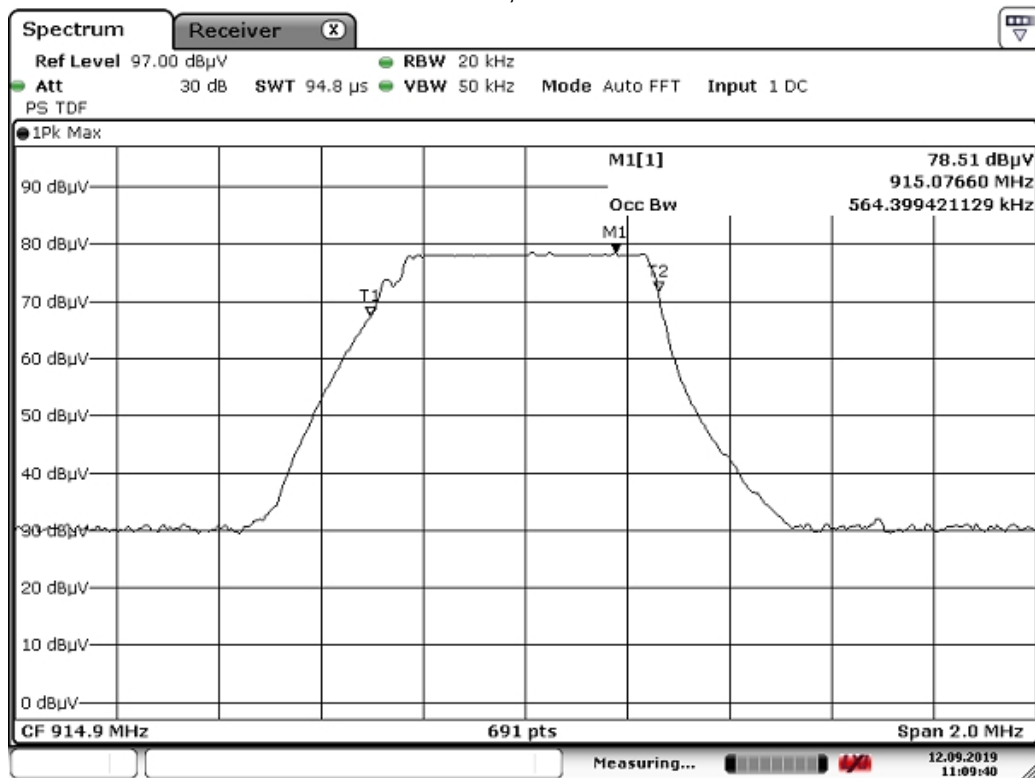
500 kHz, channel 1



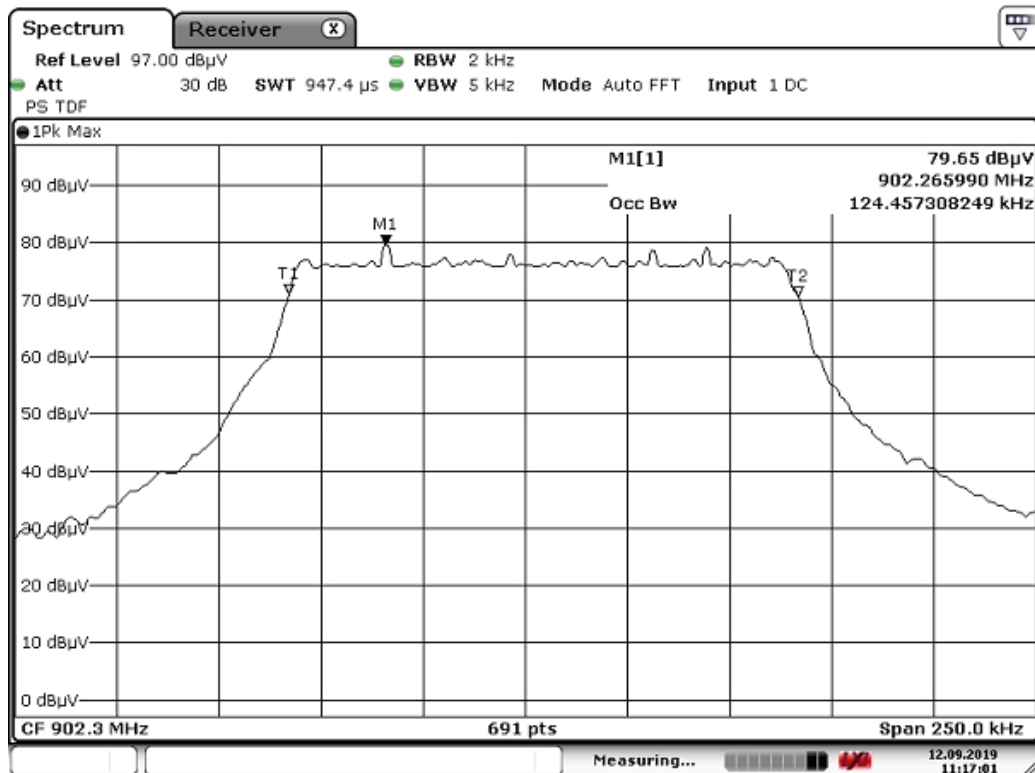
500 kHz, channel 5



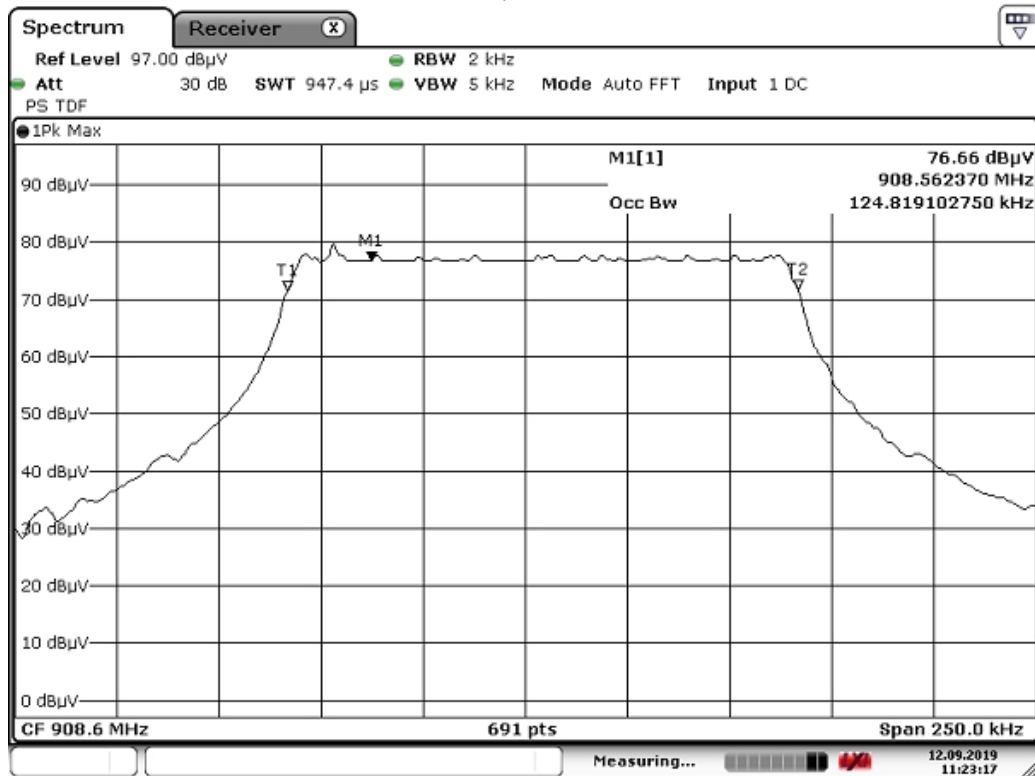
500 kHz, channel 8



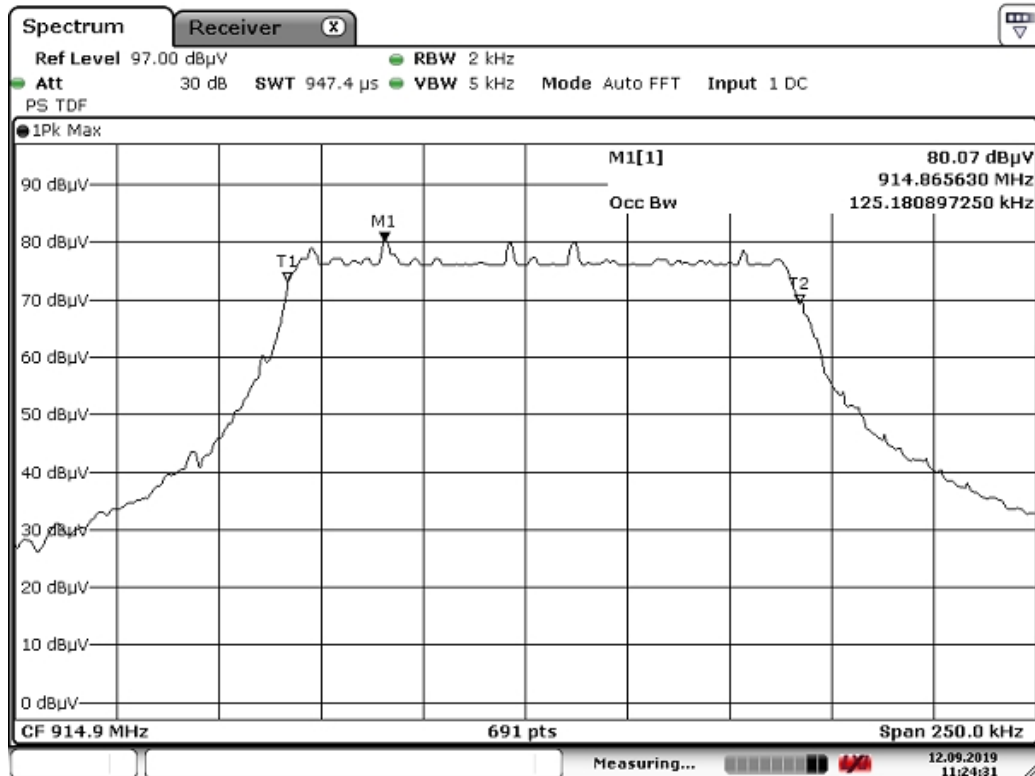
125 kHz, channel 0



125 kHz, channel 31



125 kHz, channel 63



3.3 Output Power Measurement

3.3.1 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.

3.3.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 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

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.

3.3.5 Test results of Output Power Measurement

Technology Std.	Channel	Peak method		Peak output power (dBm)
		Frequency (MHz)	Data rate	
LoRa	1	903.0	12.5 kbps	10.8 ¹
	5	909.2	12.5 kbps	10.8 ¹
	8	914.2	12.5 kbps	10.7 ¹
BLE	37	2402	1 Mbps	-15.3 ²
	18	2440	1 Mbps	-15.9 ²
	39	2480	1 Mbps	-15.0 ²
Uncertainty	±0.71 dB			

Note 1: peak output power for LoRa is the same for 125 kHz data rate and 500 kHz data rate.

Note 2: peak output power measured radiated and converted to conducted by subtracting the antenna gain.

$$P_{\text{conducted}} \text{ (dBm)} = P_{\text{radiated}} \text{ (dBm)} - \text{Gain (dBi)}.$$

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 2.4 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

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).

3.4.5 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	37	2402	1 Mbps	-35.0
	18	2440	1 Mbps	-33.8
	39	2480	1 Mbps	-34.2
Uncertainty	±2 dB			

LoRa: See module test report

3.5 Radiated Spurious Emissions Measurement

3.5.1 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	$2400/F(\text{kHz})$	300
0.490 – 1.705	$24000/F(\text{kHz})$	30
1.705 - 30	30	30
30 -88	100	3
88 - 216	150	3
216-960	200	3
Above 960	500	3

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

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.

Other details are according to KDB Publication 558074 V05, sections 11.3 and 12.1.

IRN 027 – Radiated magnetic disturbance (A per m) Method 1 – 9 kHz – 30 MHz.

IRN 026 - Radiated electrical disturbance (V per m) Method 1 – 30 MHz – 1 GHz in SAR.

IRN 026 - Radiated electrical disturbance (V per m) Method 2 – 1 - 18 GHz in SAR.

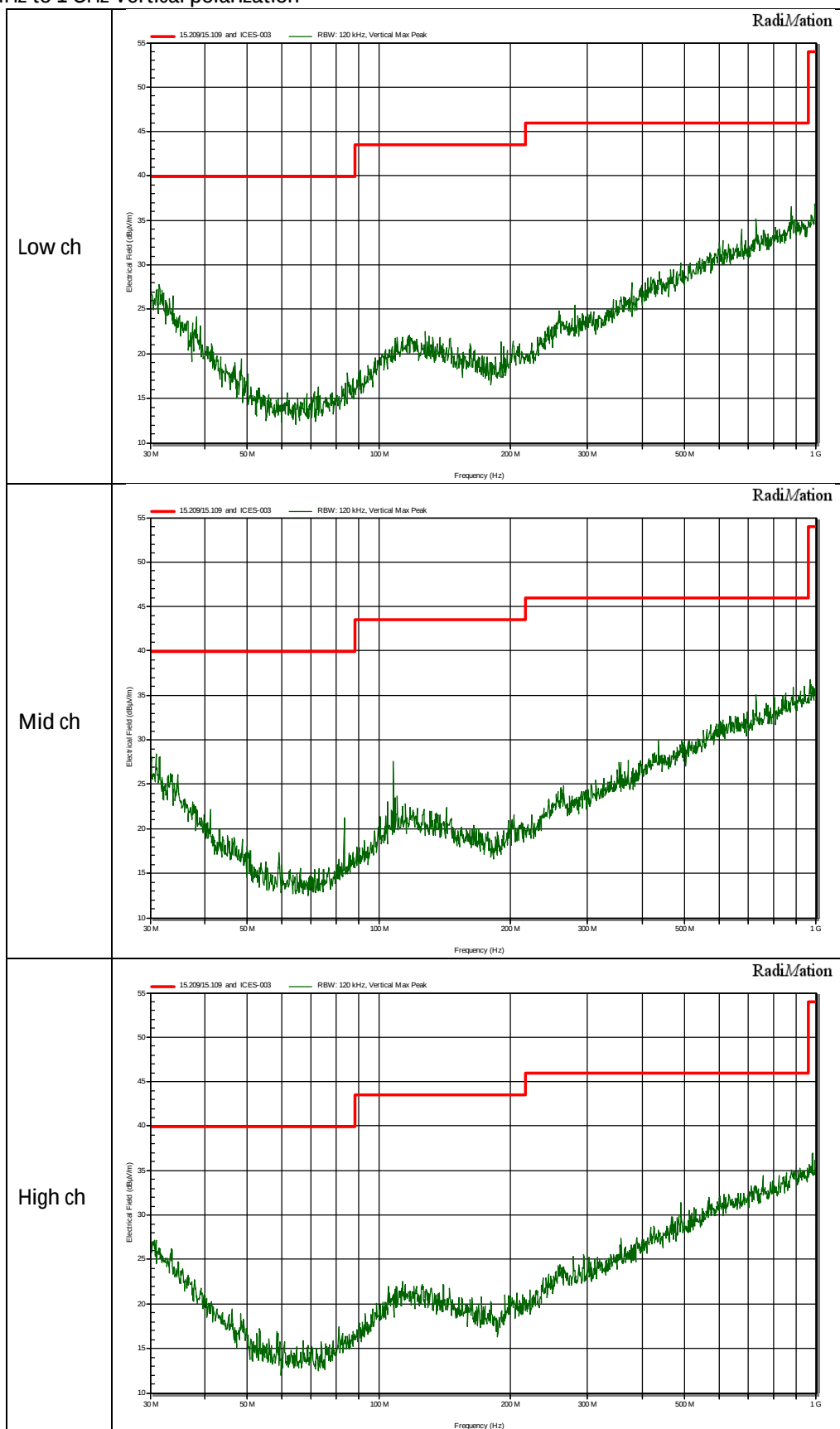
IRN 026 - Radiated electrical disturbance (V per m) Method 3 – 18 - 26.5 GHz in SAR.

3.5.5 Notes

- In the frequency range of 1 – 26 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.
- All emissions in the 9 kHz – 30 MHz range are more than 20 dB below the limit so these results are not reported.
- No peaks were measured in the 18 – 26.5 GHz frequency range so these results are not reported.
- The peak exceeding the spurious limits in the 902 – 928 MHz frequency band in the 30 – 1000 MHz plots is the transmission frequency, and therefore not subject to the limit.

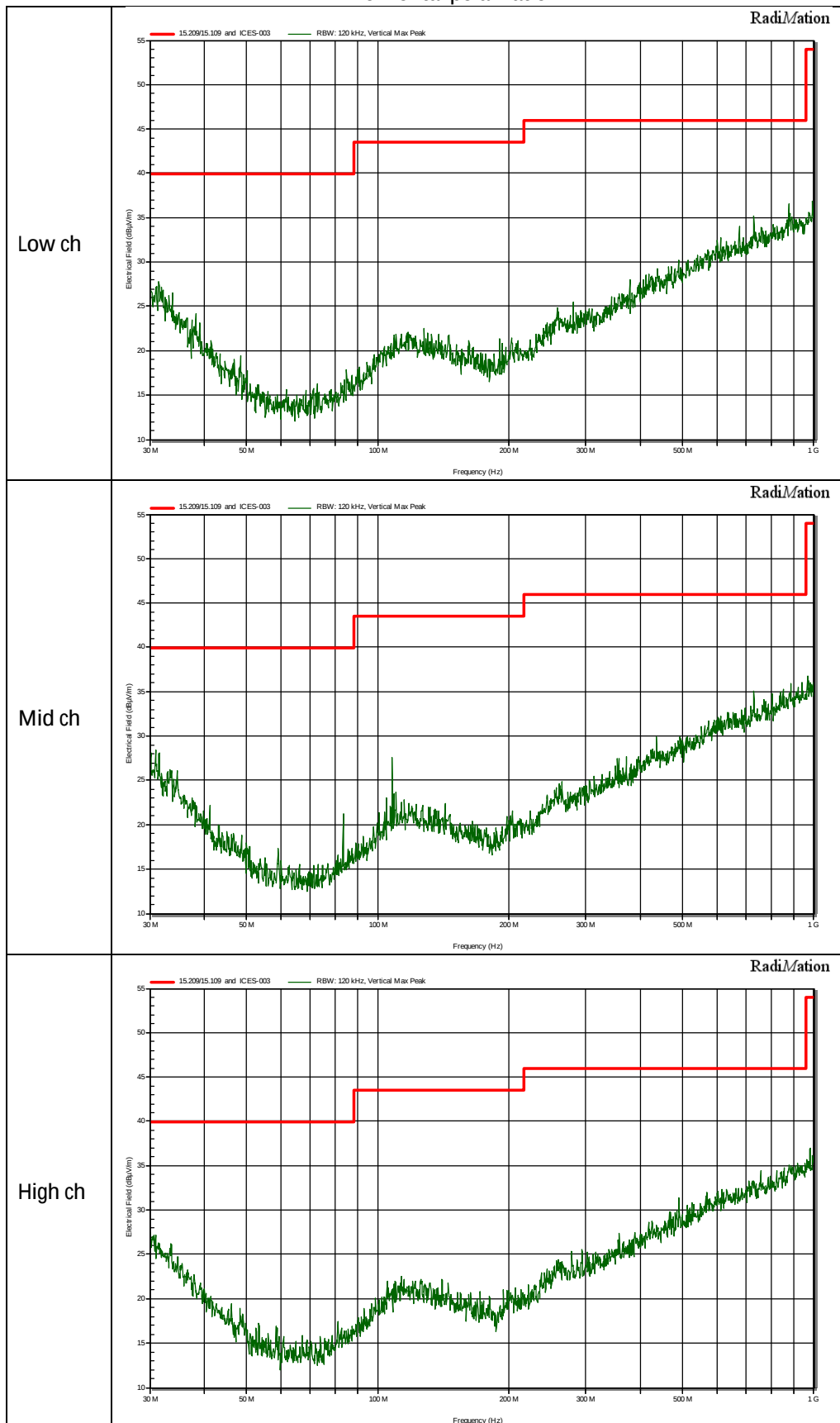
3.5.6 Plots of the BLE Radiated Spurious Emissions

30 MHz to 1 GHz Vertical polarization



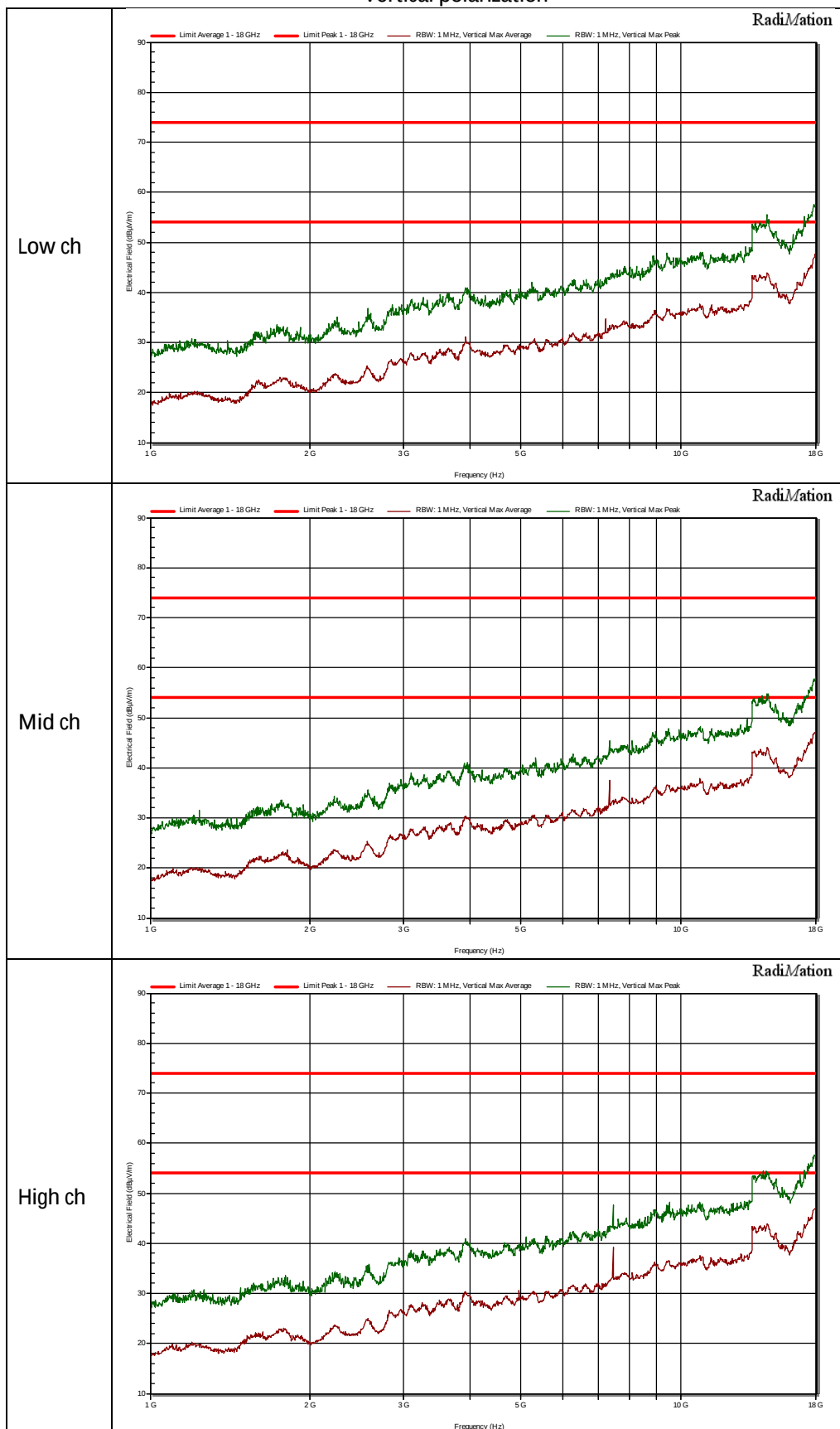
30 MHz to 1 GHz

Horizontal polarization



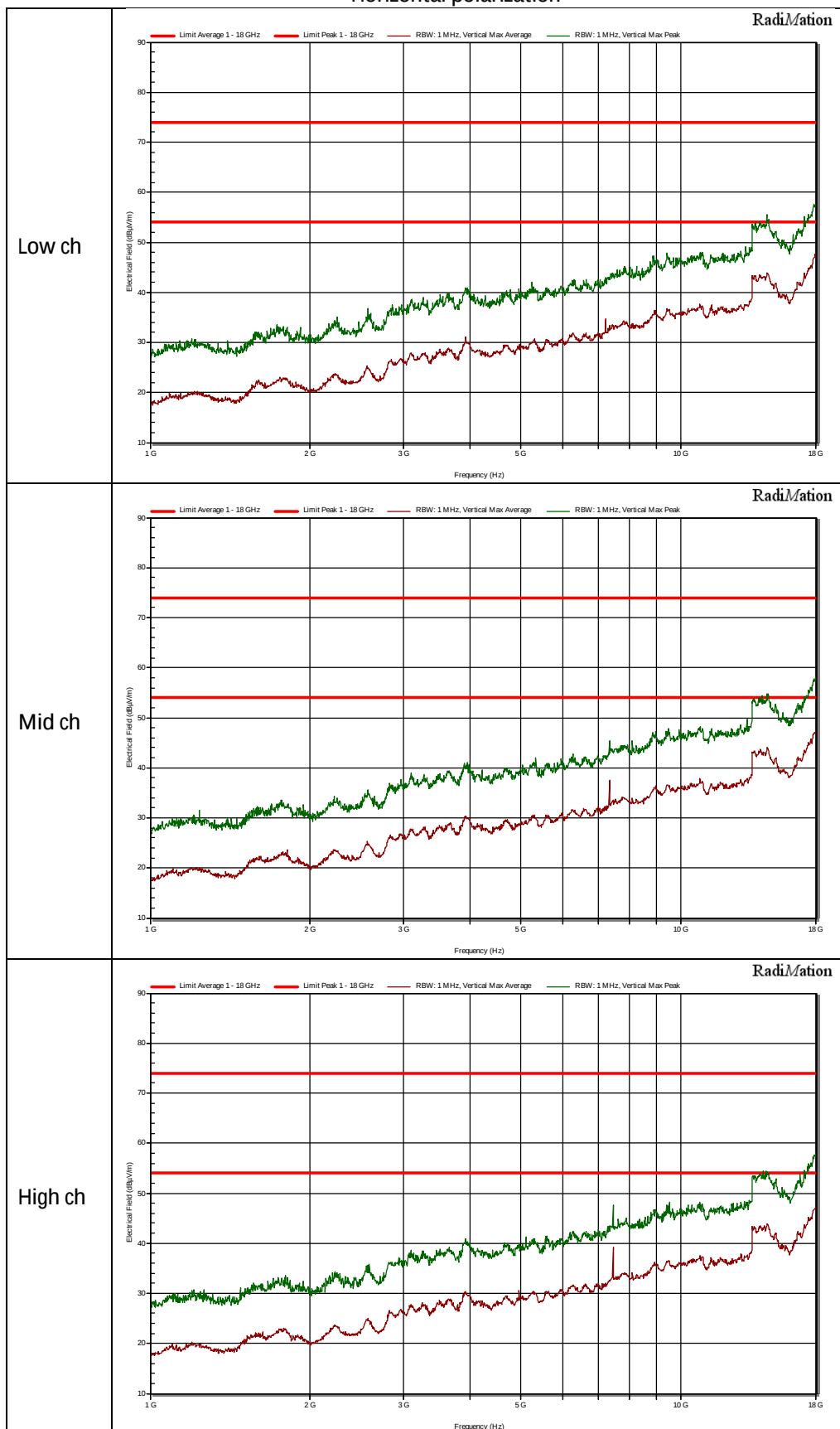
1 GHz to 18 GHz

Vertical polarization



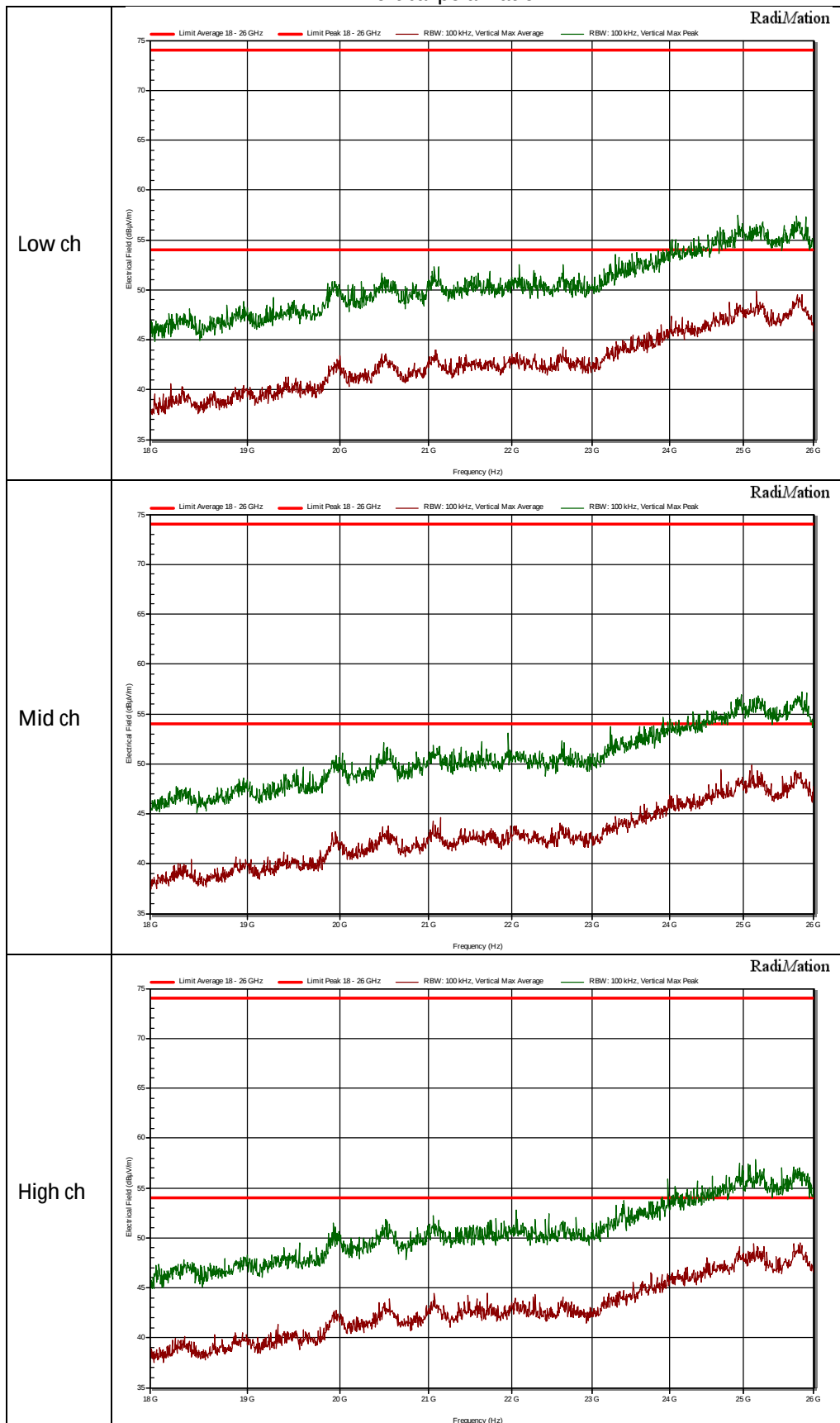
1 GHz to 18 GHz

Horizontal polarization



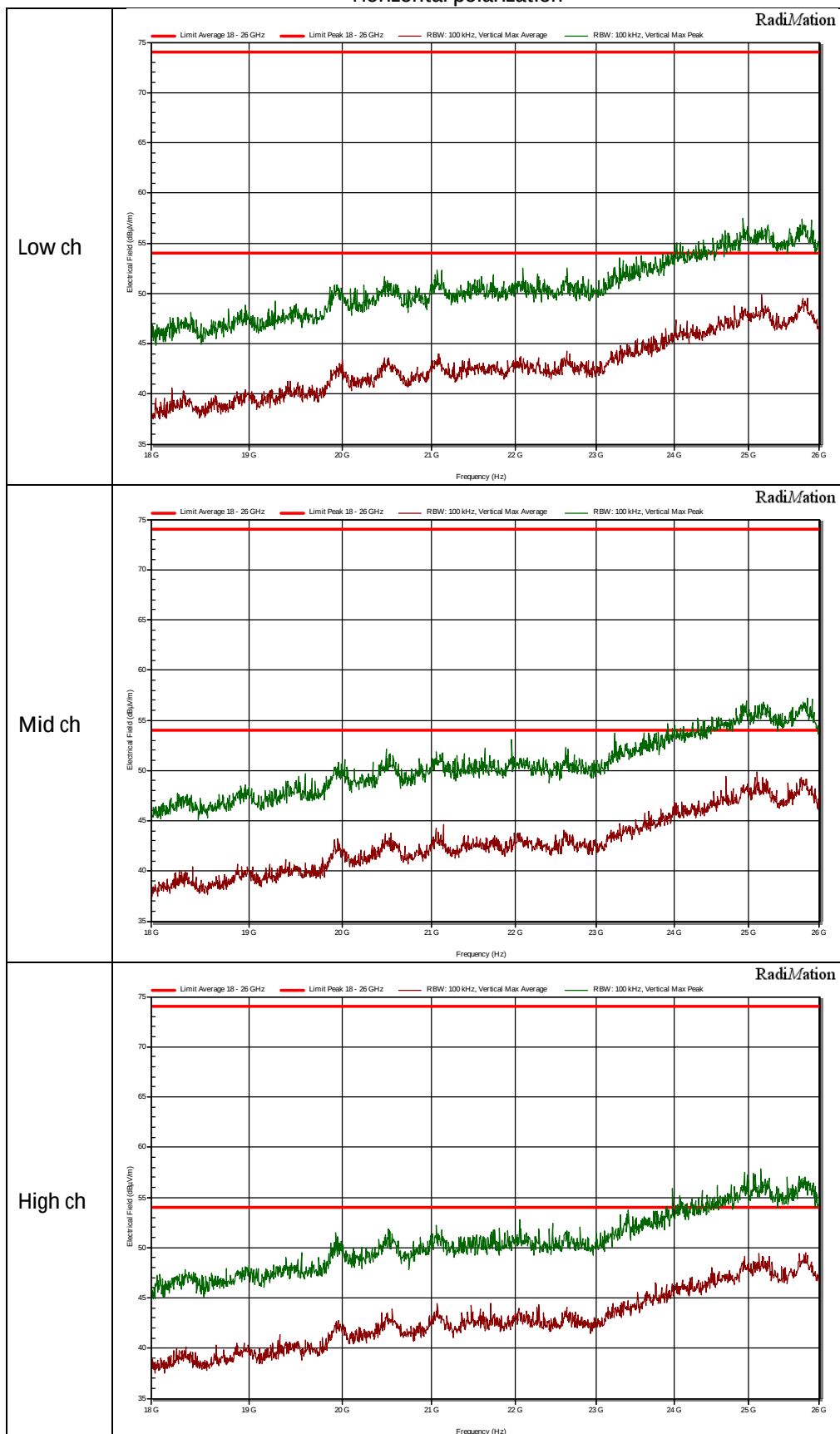
18 GHz to 26 GHz

Vertical polarization



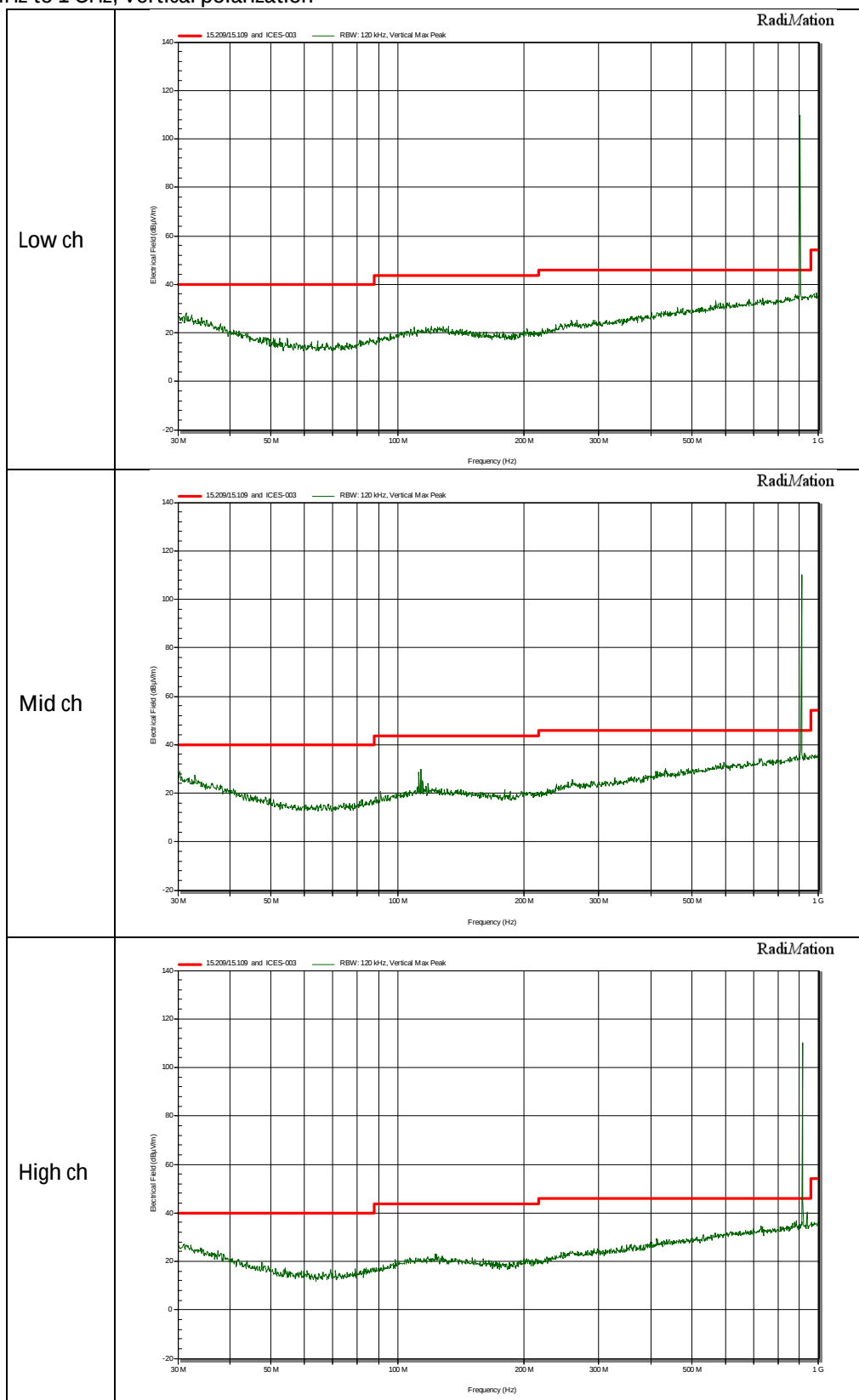
18 GHz to 26 GHz

Horizontal polarization



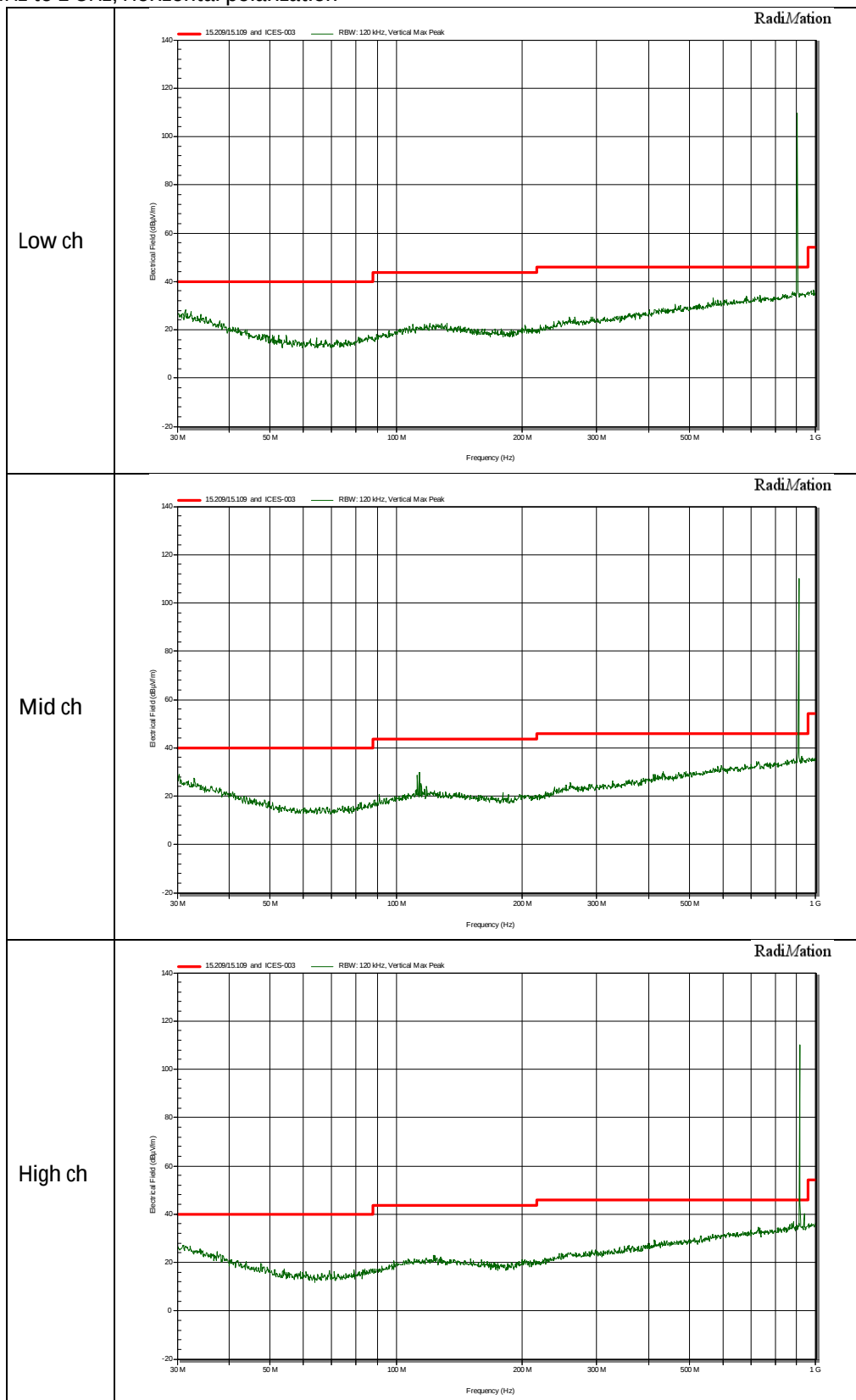
3.5.7 Plots of the LoRa Radiated Spurious Emissions

30 MHz to 1 GHz, Vertical polarization



Note: The peak in the 900-928 MHz range is the transmission frequency and not subject to the spurious limit.

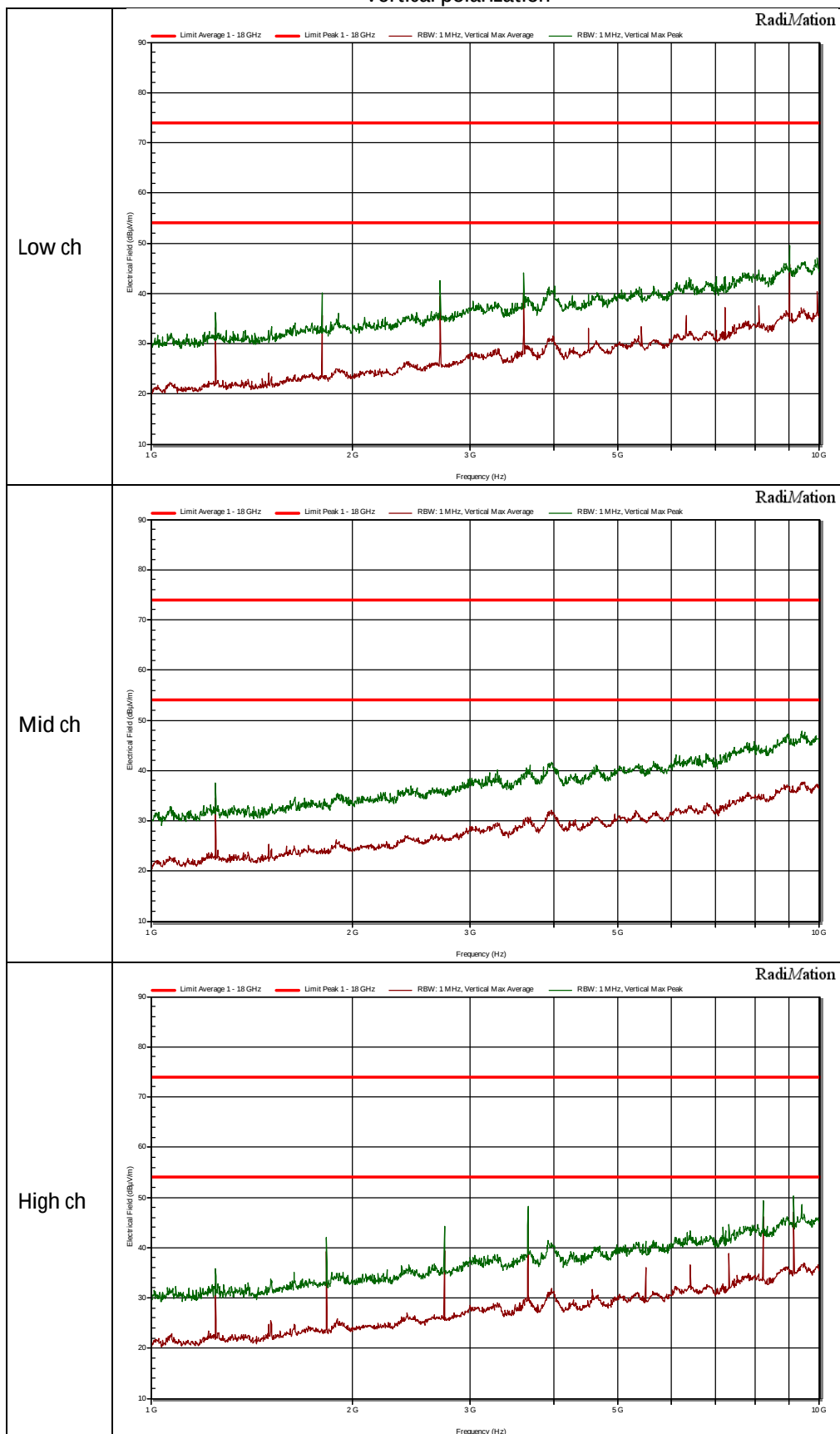
30 MHz to 1 GHz, Horizontal polarization



Note: The peak in the 900-928 MHz range is the transmission frequency and not subject to the spurious limit.

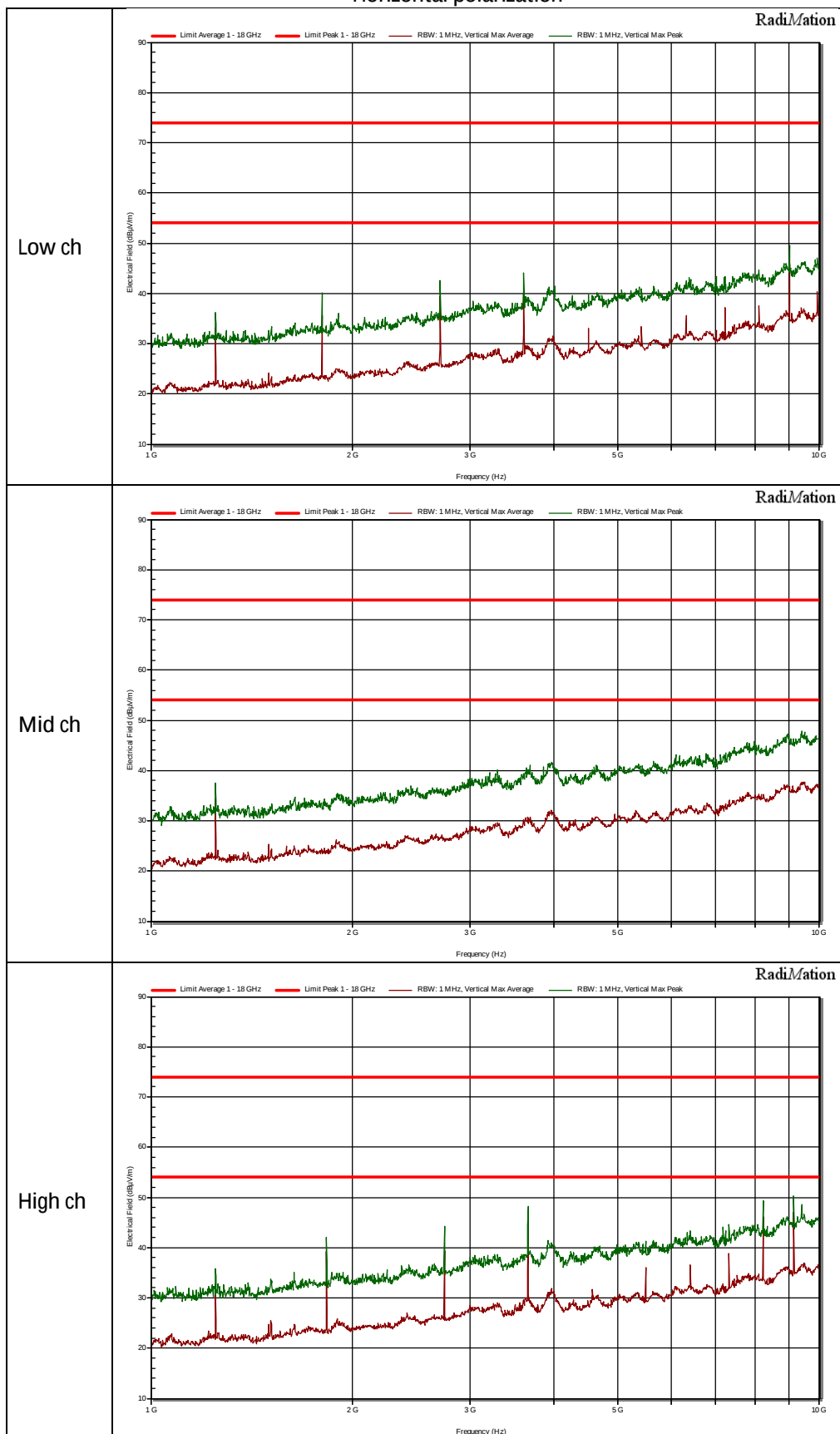
1 GHz to 10 GHz

Vertical polarization



1 GHz to 10 GHz

Horizontal polarization



3.5.8 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

3.6 Other requirements

3.6.1 Band edge power

BLE: See module test report.

LoRa: See module test report.

3.6.2 Channel dwell time

BLE: Not applicable.

LoRa: See module test report.

3.6.3 Minimum number of hopping channels and hopping sequence

BLE: Not applicable.

LoRa: See module test report.

3.6.4 Specific hopping requirements

BLE: Not applicable.

LoRa: See module test report.