

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

Product name: **Wireless Rootzone Sensor**
Applicant: **ROCKWOOL B.V. / Grodan**
FCC ID: **2AUKP-RZ001**
IC ID: **25447-RZ001**

Test report No. : 190701370 Ver 1.0

Laboratory information

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Testing Location

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Test Site FCC	NL0001

Revision History

Version	Date	Remarks	By
v0.5	13-08-2019	First draft	PvW
v1.0	29-11-2019	Initial release	PvW

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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
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Zip code: 6045 JG
Telephone: +31 475 353 535
E-mail: Paul.bouwens@grodan.com
Contact name: Mr. P. Bouwens

1.2 Manufacturer

Manufacturer name: ROCKWOOL B.V. / Grodan
Address: Industrieweg 15, Roermond, the Netherlands
Zip code: 6045 JG
Telephone: +31 475 353 535
E-mail: Paul.bouwens@grodan.com
Contact name: Mr. P. Bouwens

1.3 Tested Equipment Under Test (EUT)

Product name: Rootzone sensor
Brand name: Grodan
Product type: Wireless Rootzone Sensor
FCC ID: 2AUKP-RZ001
IC ID: 25447-RZ001
Software version: 1.01
Hardware version: RZ001
Date of receipt: 09-08-2019
Tests started: 09-08-2019
Testing ended: 12-08-2019

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: 6.21 LoRa: 16.8
Antenna type	BLE: PCB antenna LoRa: Straight antenna
Antenna gain (dBi)	BLE: 0.54 LoRa: -0.7
Type of modulation	BLE: GFSK LoRa: CSS
Emission designator BLE	1M79G1D
Emission designator LoRa	768KX1D

1.5 Modification of the Equipment Under Test (EUT)

The manufacturer provided both a radiated sample and a conducted sample for radio testing. The manufacturer disabled simultaneous transmission in order to pass the radiated spurious emission tests. The manufacturer added grounding to the LoRA PCB module.

1.6 Observations and remarks

The equipment contains two separate radios. One radio is used for BLE communication. This radio is part of a module, FCC ID X8WBT840. They use the BT840L-V2 antenna. Only spurious emissions have been tested for this radio, as no modifications were made to the module.

The other radio is used for LoRa communication. This radio is part of a module, FCC ID AU792U13A16858. For LoRa the manufacturer uses an antenna not included in the AU792U13A16858 application.

Results not found in this report can be found in their original application.

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

1.7 Environmental conditions

Test date	09-08-2019	12-08-2019
Ambient temperature	25.6 °C	23.9 °C
Humidity	45.4 %	47.7 %
Ambient pressure	Between 86 and 106 kPa	Between 86 and 106 kPa

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. P.A. Suringa

The above conclusions have been verified by the following signatory:

Date : 29-11-2019

Name : ing. K.A. Roes

Function : Coordinator Radio Laboratory

Signature :



2 Test configuration of the Equipment Under Test

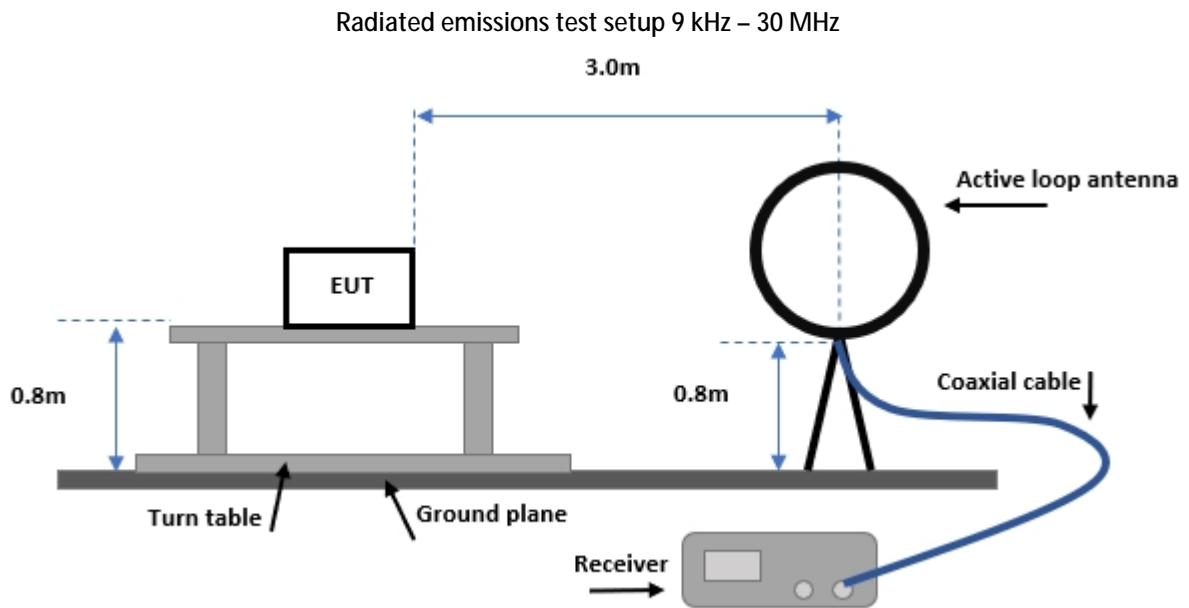
2.1 Test mode

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

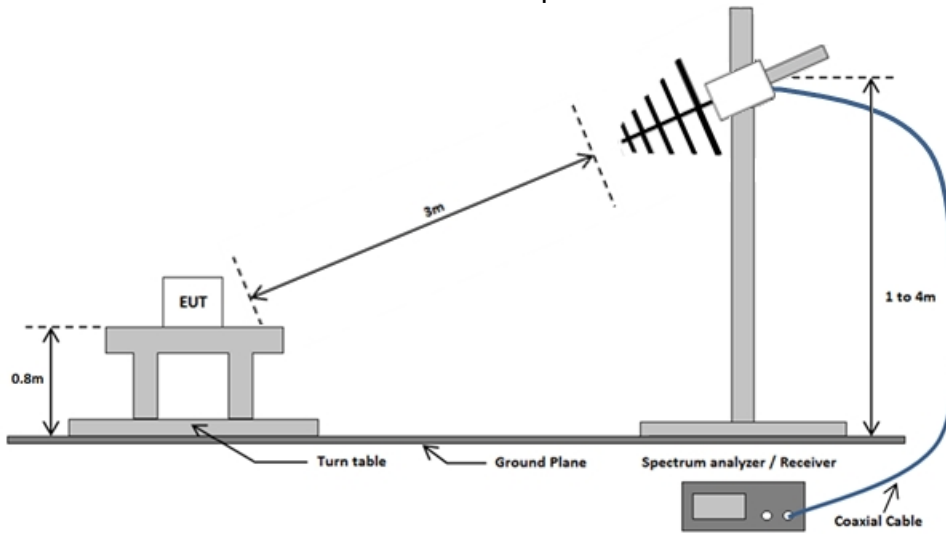
2.2 Tested channels and Data rates

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

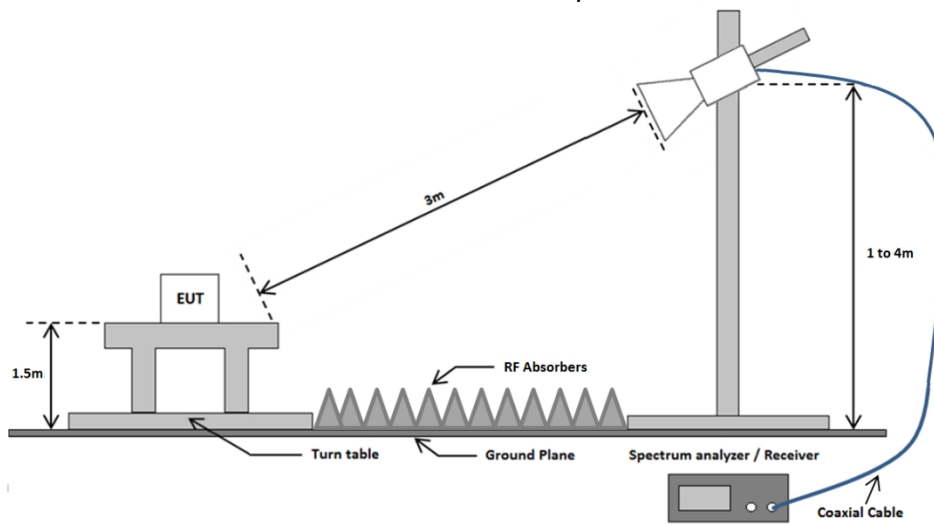
2.3 Test setups



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
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 (dB μ V/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	744.0
	5	909.2	12.5 kbps	732.3
	8	914.2	12.5 kbps	693.8
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.

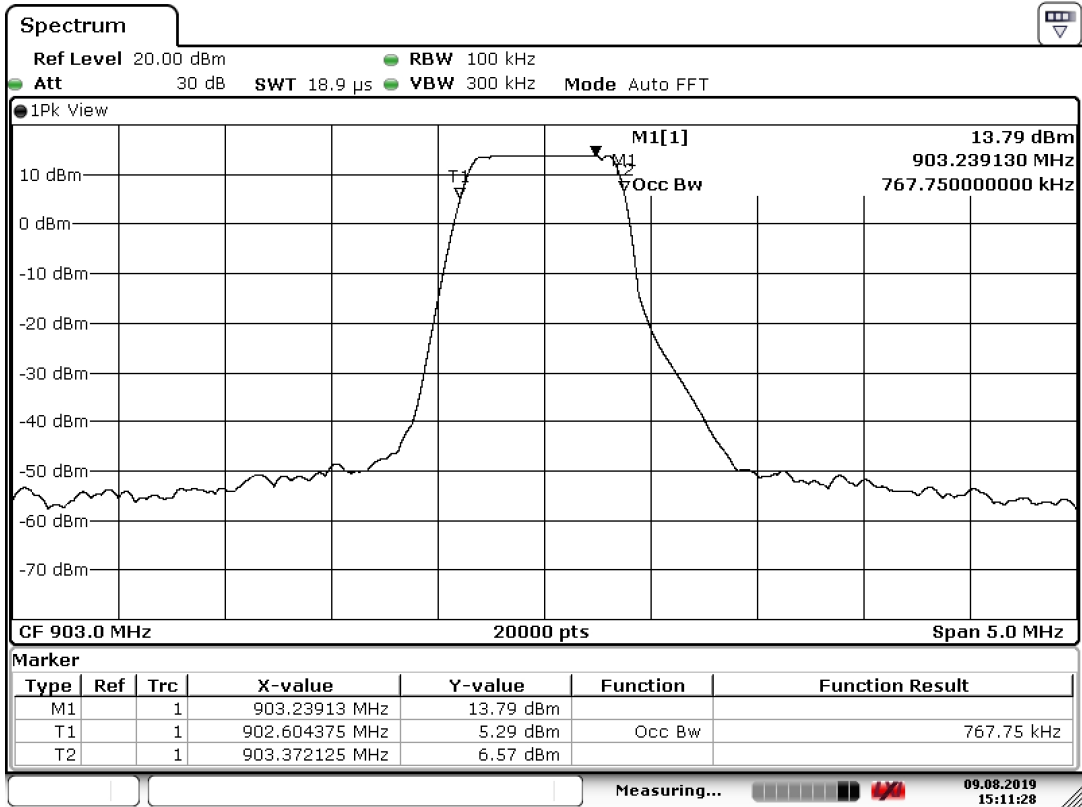
3.2.5 Test results of the 99% occupied bandwidth measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
LoRa	1	903.0	12.5 kbps	767.8
	5	909.2	12.5 kbps	711.5
	8	914.2	12.5 kbps	701.8
Uncertainty	± 12 kHz			

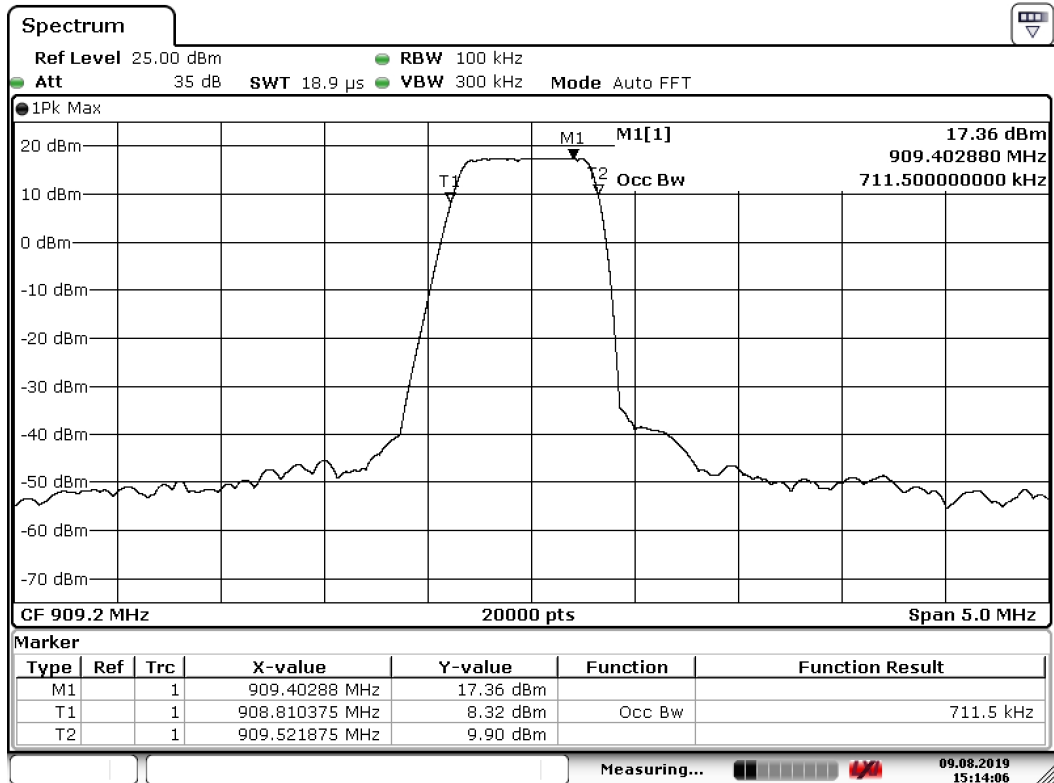
BLE: see module test report

3.2.6 Plots of the 99% occupied bandwidth measurement

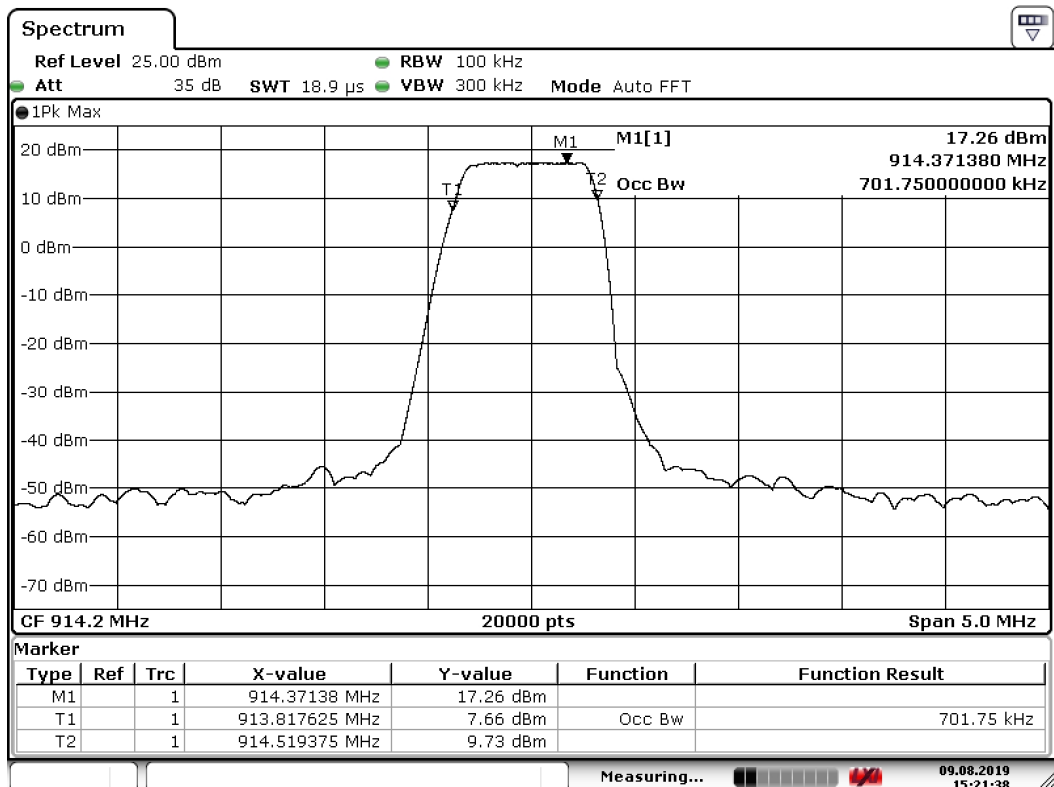
Channel 1



Channel 5



Channel 8



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	16.10
	5	909.2	12.5 kbps	15.83
	8	914.2	12.5 kbps	15.21
Uncertainty	±0.71 dB			

BLE: See module test report

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/3 kHz (dBm)
Bluetooth Low Energy	37	2402	1 Mbps	5.07
	18	2440	1 Mbps	4.99
	39	2480	1 Mbps	3.14
Uncertainty	±2 dB			

BLE: 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 ($\mu\text{V}/\text{m}$)	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

3.5.2 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 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.

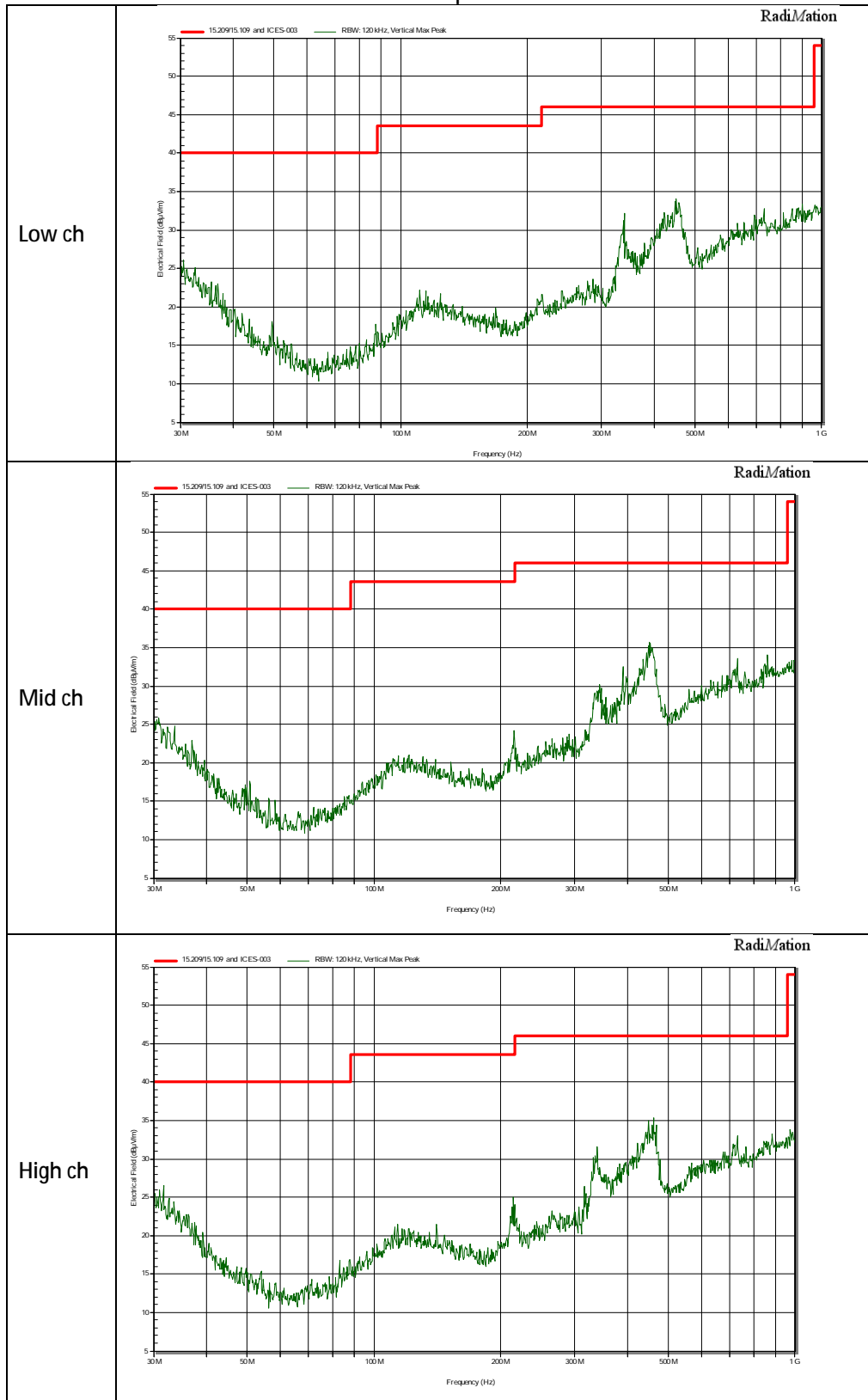
3.5.5 Notes

- 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

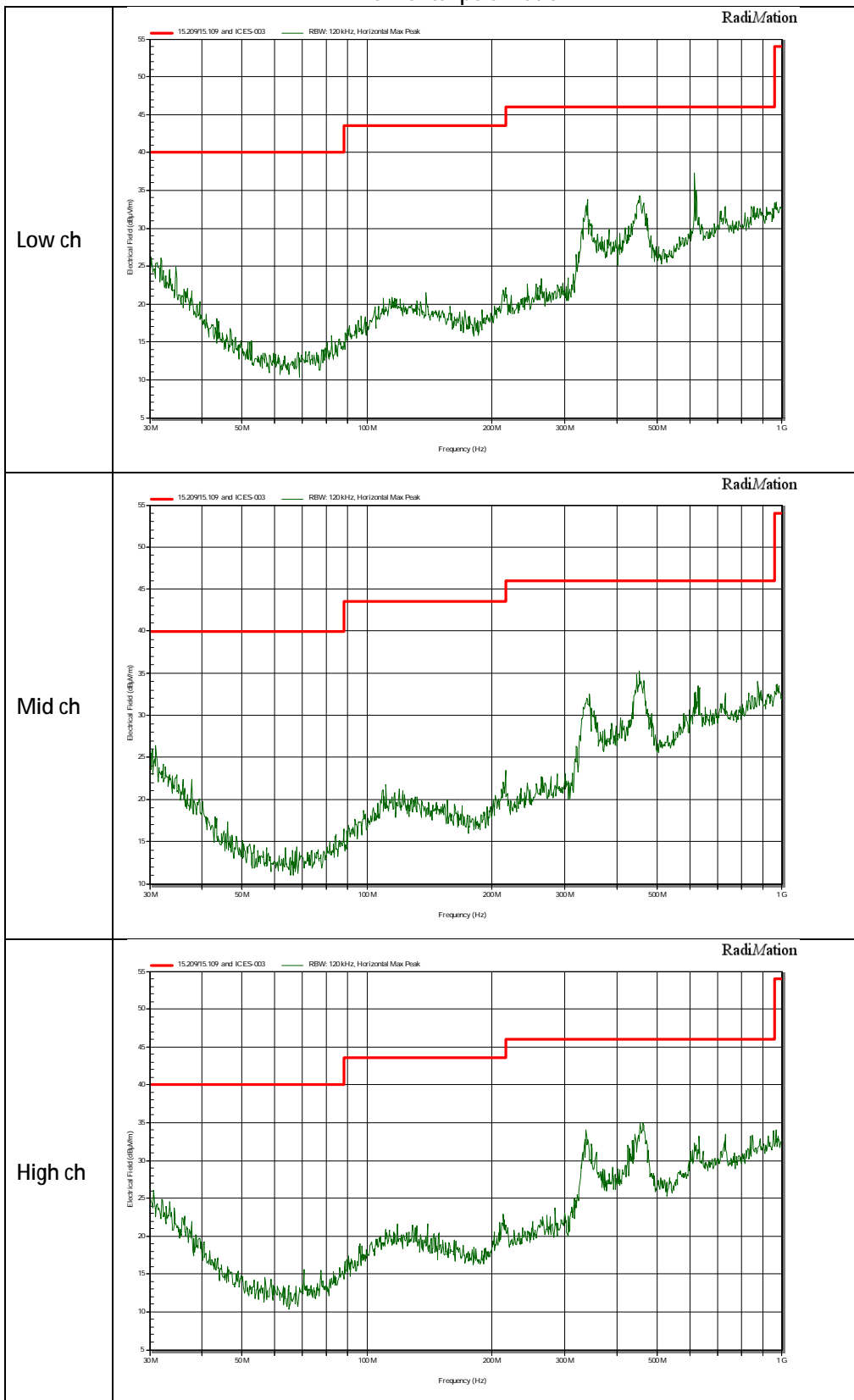
30 MHz to 1 GHz

Vertical polarization



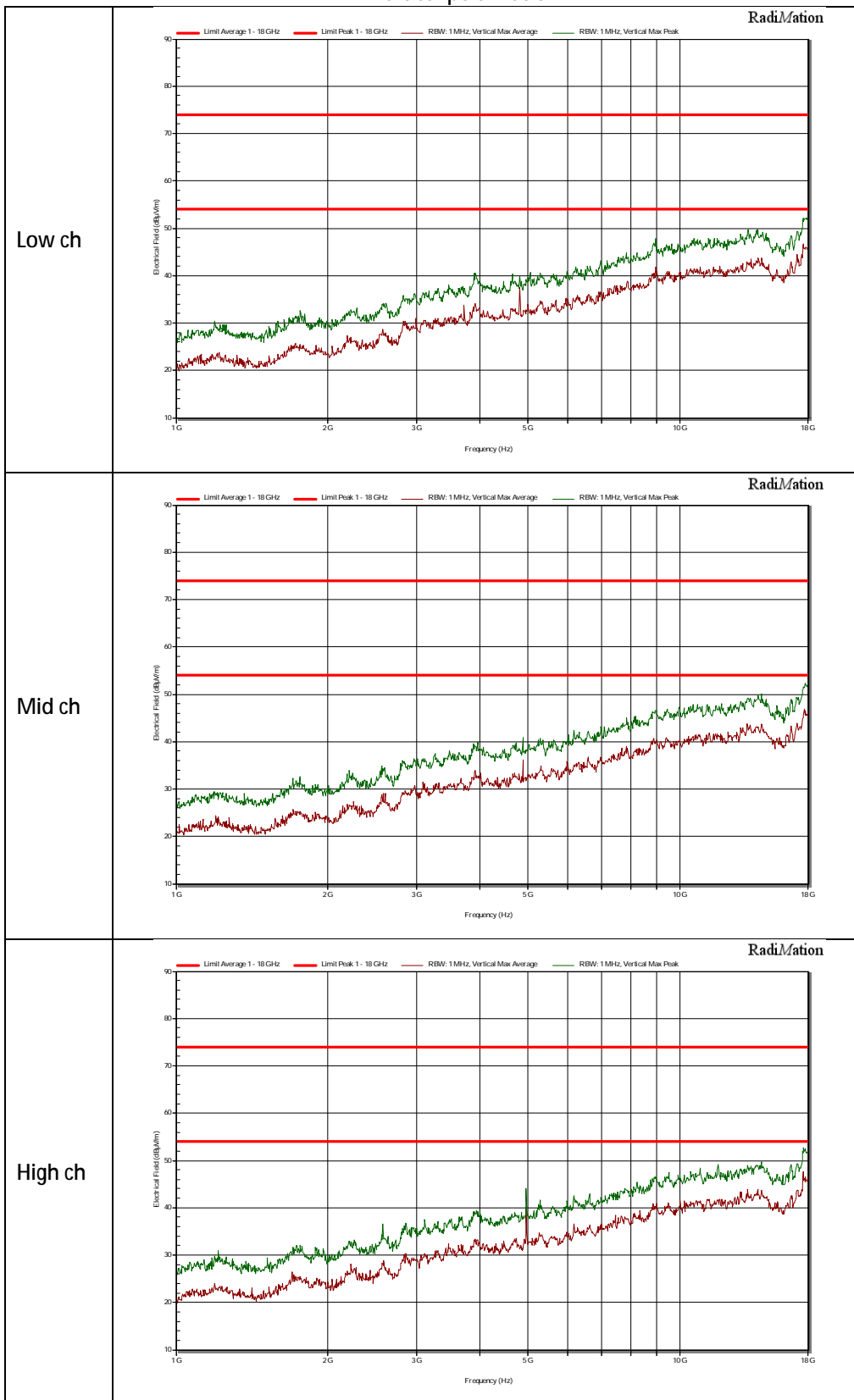
30 MHz to 1 GHz

Horizontal polarization



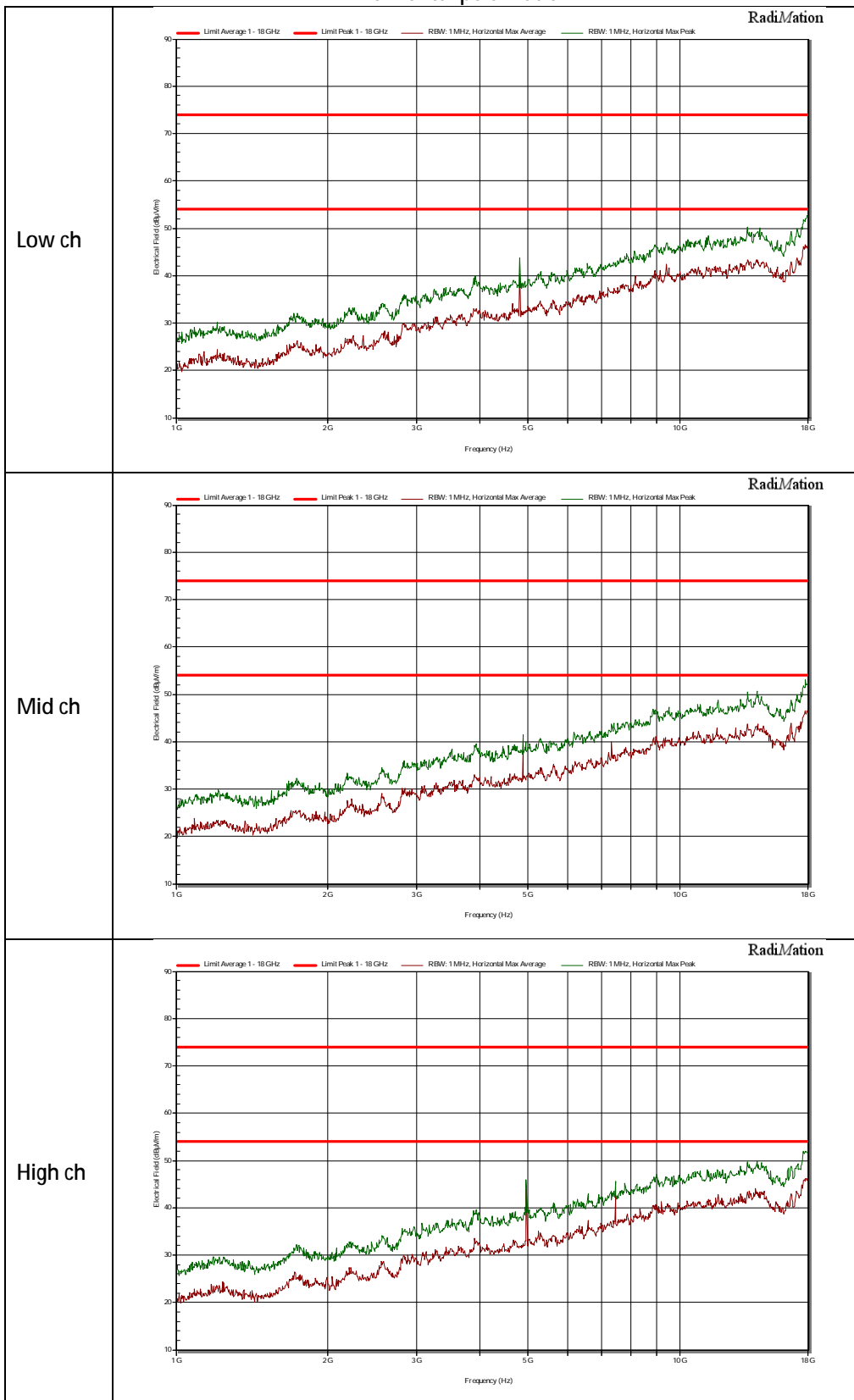
1 GHz to 18 GHz

Vertical polarization



1 GHz to 18 GHz

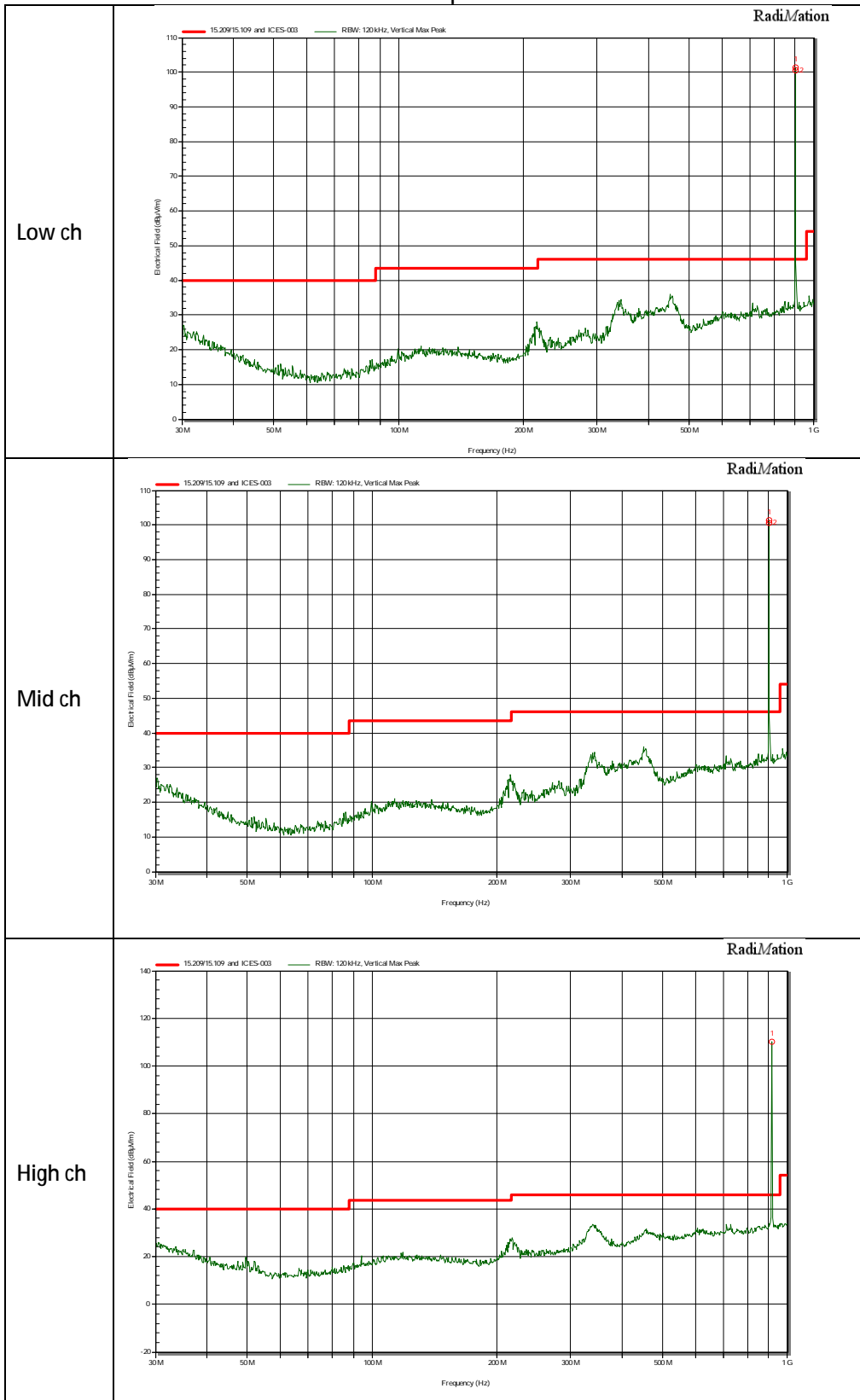
Horizontal polarization



3.5.7 Plots of the LoRa Radiated Spurious Emissions

30 MHz to 1 GHz

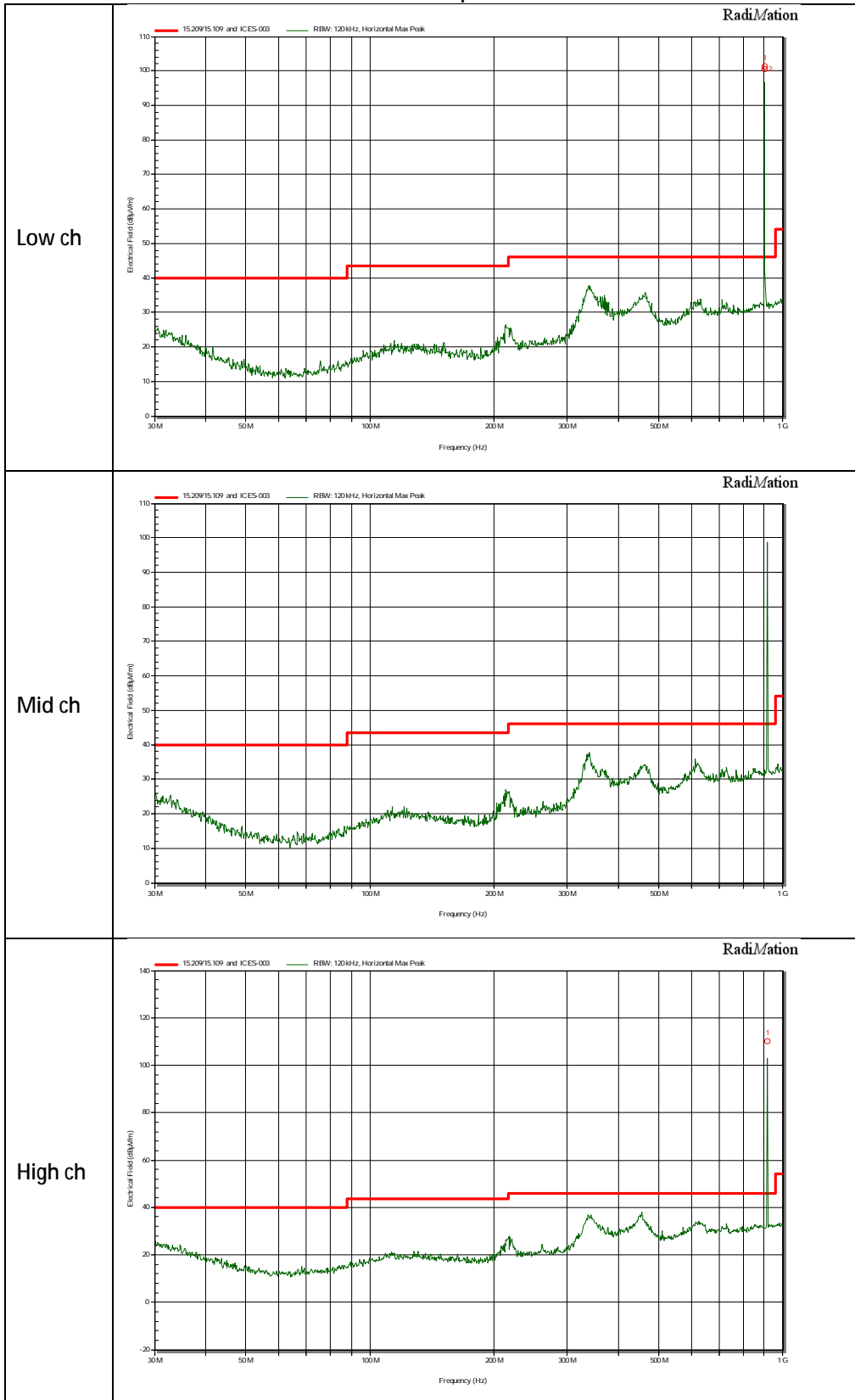
Vertical polarization



Note: the peak at 900 MHz is the transmission frequency and is not subject to the spurious limit

30 MHz to 1 GHz

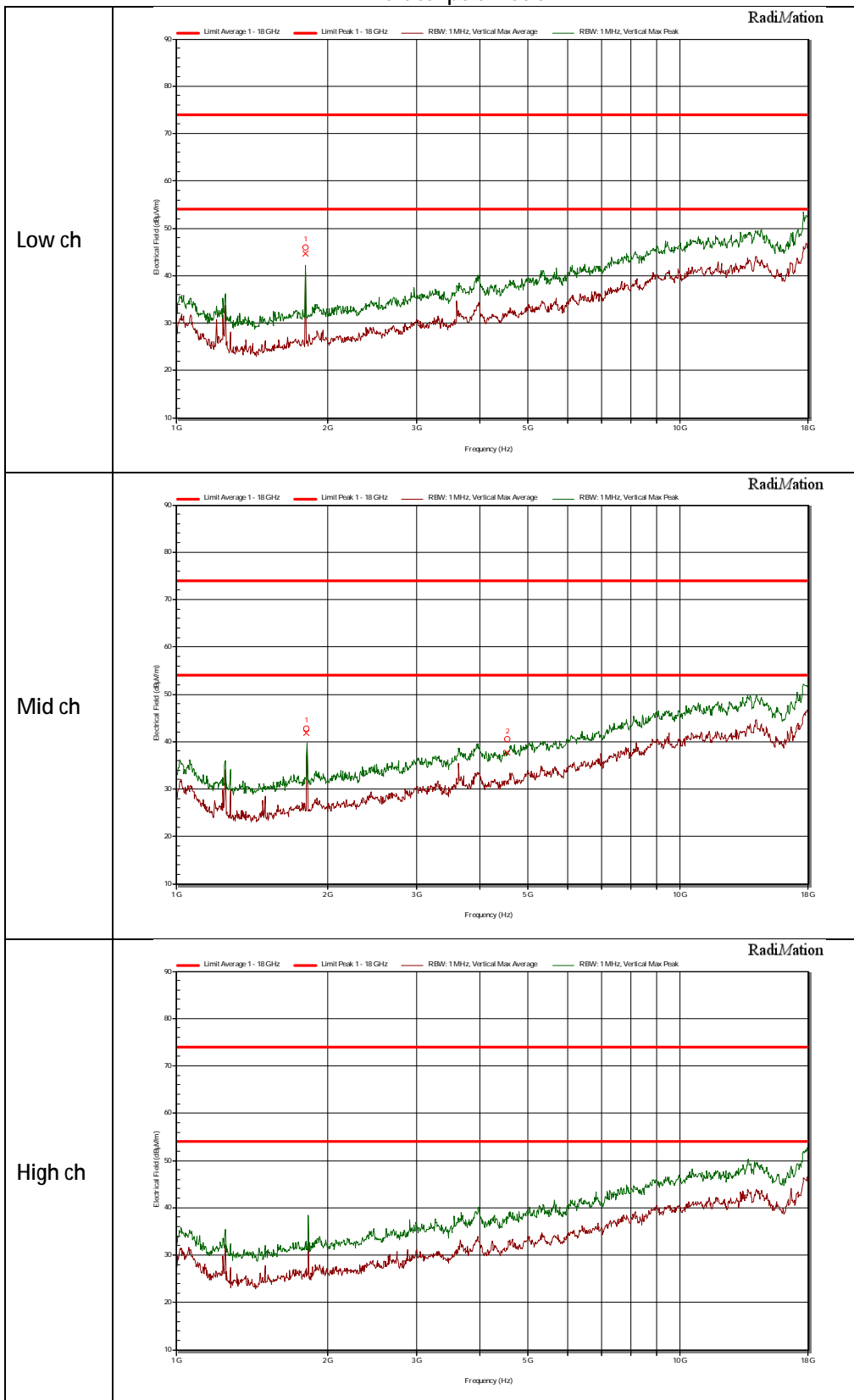
Horizontal polarization



Note: the peak at 900 MHz is the transmission frequency and is not subject to the spurious limit

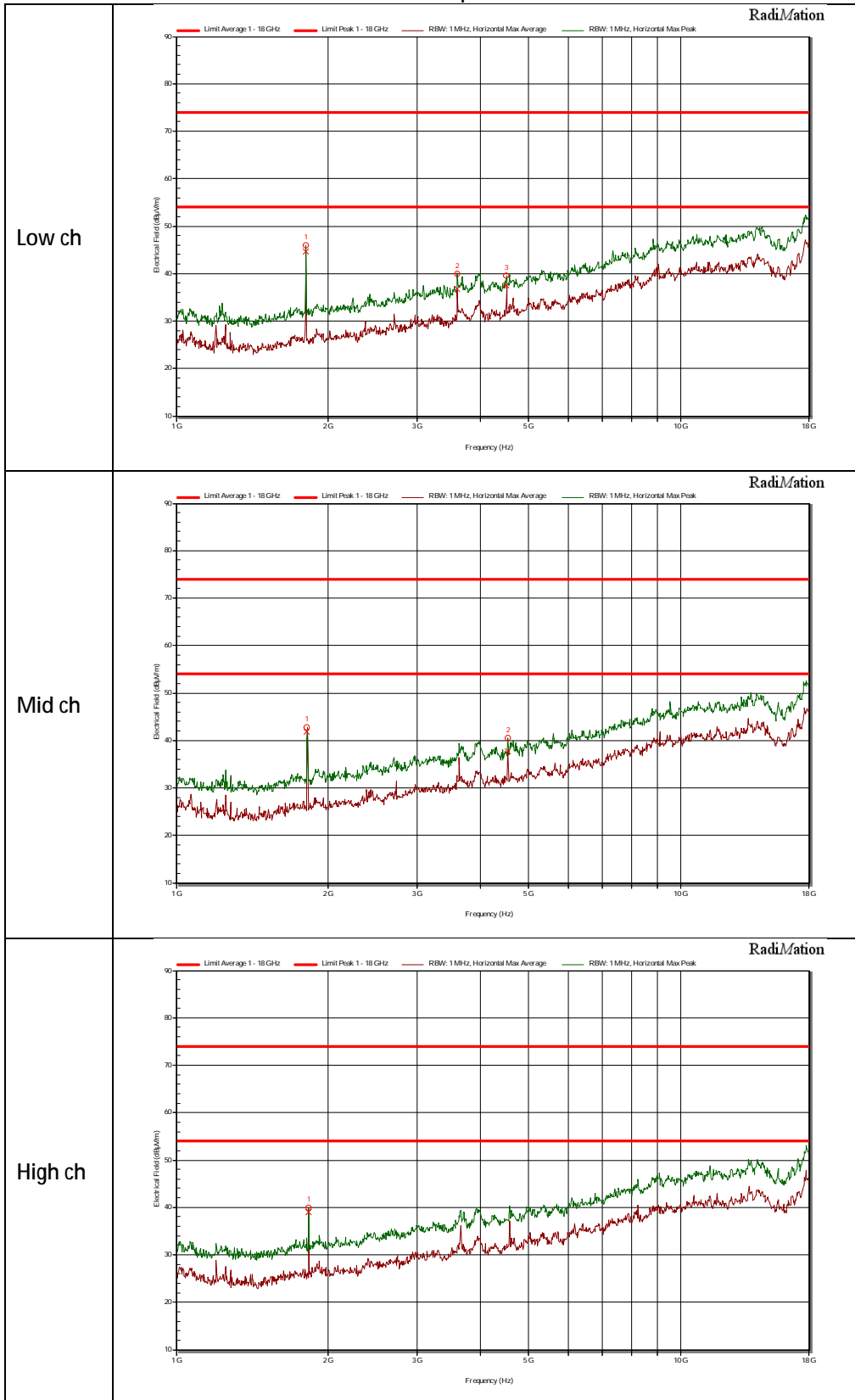
1 GHz to 18 GHz

Vertical polarization



1 GHz to 18 GHz

Horizontal polarization



Measured peaks LoRa spurious emissions

Channel	Frequency	Peak	Peak Limit	Average	Average Limit	Polarization
Low	1,804 GHz	45,9 dB μ V/m	74 dB μ V/m	44,6 dB μ V/m	54 dB μ V/m	Horizontal
Low	3,609 GHz	40 dB μ V/m	74 dB μ V/m	36,8 dB μ V/m	54 dB μ V/m	Horizontal
Low	4,512 GHz	39,5 dB μ V/m	74 dB μ V/m	37,6 dB μ V/m	54 dB μ V/m	Horizontal

Channel	Frequency	Peak	Peak Limit	Average	Average Limit	Polarization
Mid	1,817 GHz	42,9 dB μ V/m	74 dB μ V/m	41,9 dB μ V/m	54 dB μ V/m	Horizontal
Mid	4,543 GHz	40,5 dB μ V/m	74 dB μ V/m	37,6 dB μ V/m	54 dB μ V/m	Horizontal

Channel	Frequency	Peak	Peak Limit	Average	Average Limit	Polarization
High	1,83 GHz	40 dB μ V/m	74 dB μ V/m	39 dB μ V/m	54 dB μ V/m	Horizontal

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.