

# 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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### Documentation

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### Testing Location

|                    |                                                                                                       |
|--------------------|-------------------------------------------------------------------------------------------------------|
| Test Site          | Telefication BV                                                                                       |
| Test Site location | Edisonstraat 12a<br>6902 PK Zevenaar<br>The Netherlands<br><br>Tel. +31889983600<br>Fax. +31316583189 |
| 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                                               |
| Address:      | Industrieweg 15, Roermond, the Netherlands                           |
| Zip code:     | 6045 JG                                                              |
| Telephone:    | +31 475 353 535                                                      |
| E-mail:       | <a href="mailto:Paul.bouwens@grodan.com">Paul.bouwens@grodan.com</a> |
| 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:            | <a href="mailto:Paul.bouwens@grodan.com">Paul.bouwens@grodan.com</a> |
| 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<br>2400 – 2483.5                 |
| RX frequency range (MHz)              | 2400 – 2483.5                              |
| Maximum output power to antenna (dBm) | BLE: 6.21<br>LoRa: 16.8                    |
| Antenna type                          | BLE: PCB antenna<br>LoRa: Straight antenna |
| Antenna gain (dBi)                    | BLE: 0.54<br>LoRa: -0.7                    |
| Type of modulation                    | BLE: GFSK<br>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

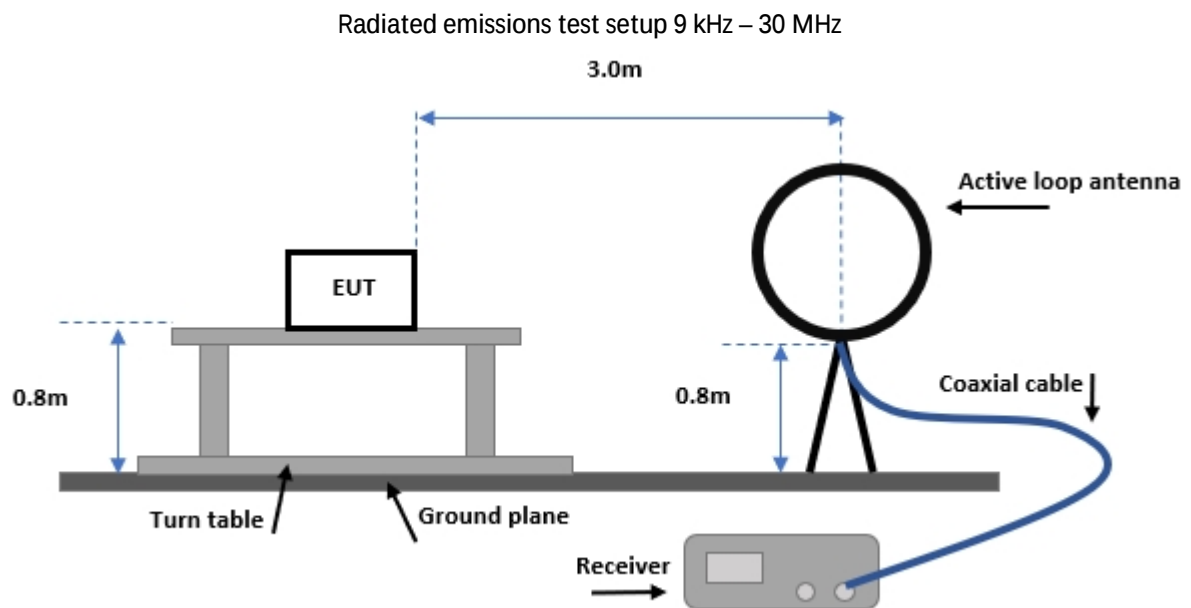
### 2.1 Test mode

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

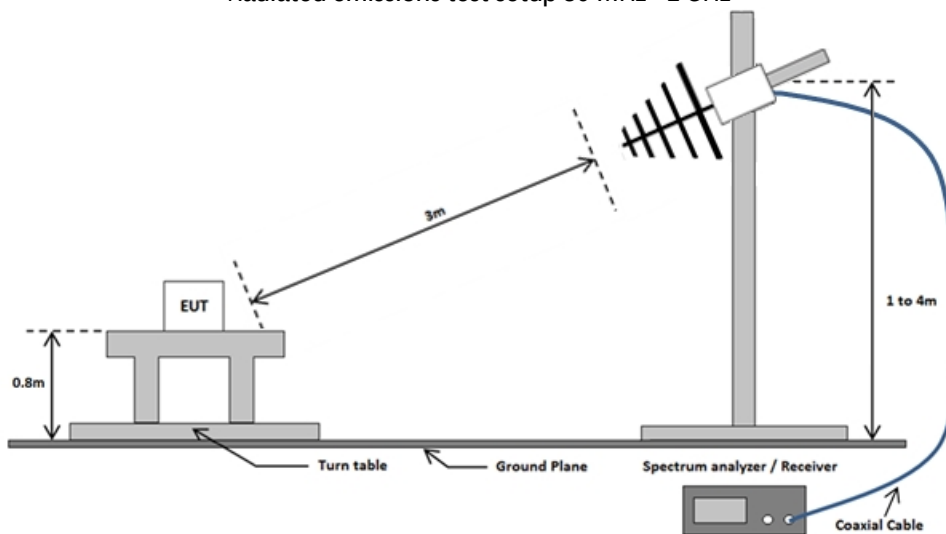
### 2.2 Tested channels and Data rates

| 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           |

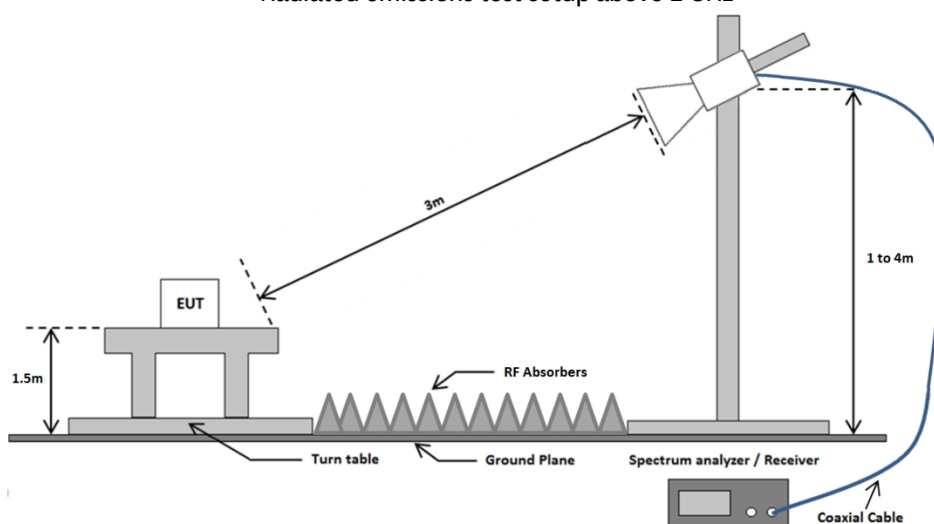
### 2.3 Test setups



### 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 (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 | 744.0               |
|                 | 5              | 909.2           | 12.5 kbps | 732.3               |
|                 | 8              | 914.2           | 12.5 kbps | 693.8               |
| Uncertainty     | $\pm 36.2$ 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.

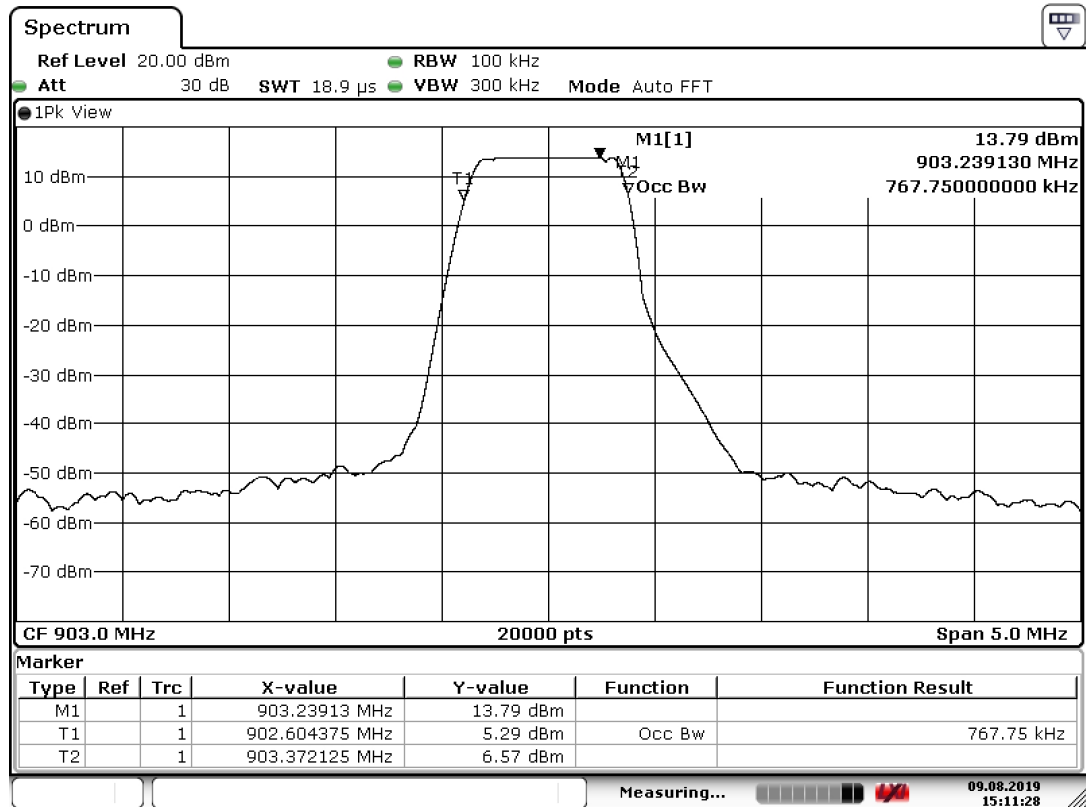
### 3.2.5 Test results of the 99% occupied bandwidth measurement

| 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     | $\pm 12$ kHz |                 |           |                     |

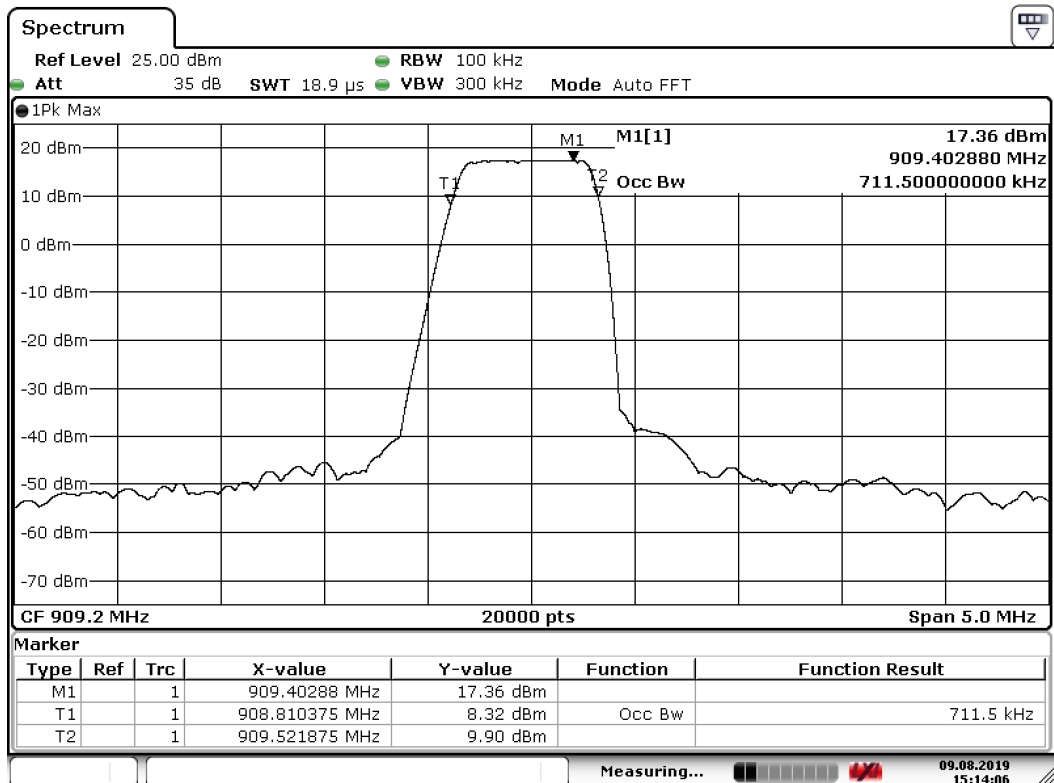
BLE: see module test report

### 3.2.6 Plots of the 99% occupied bandwidth measurement

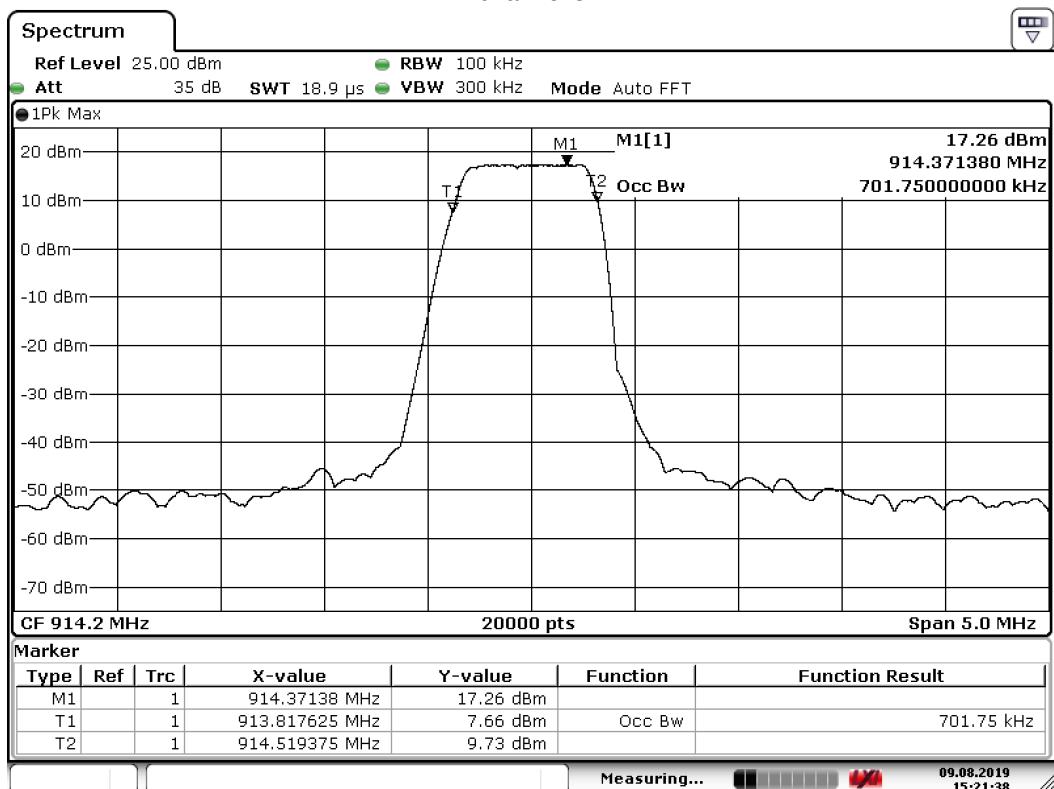
Channel 1



## 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 ( $\mu\text{V/m}$ ) | 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 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.

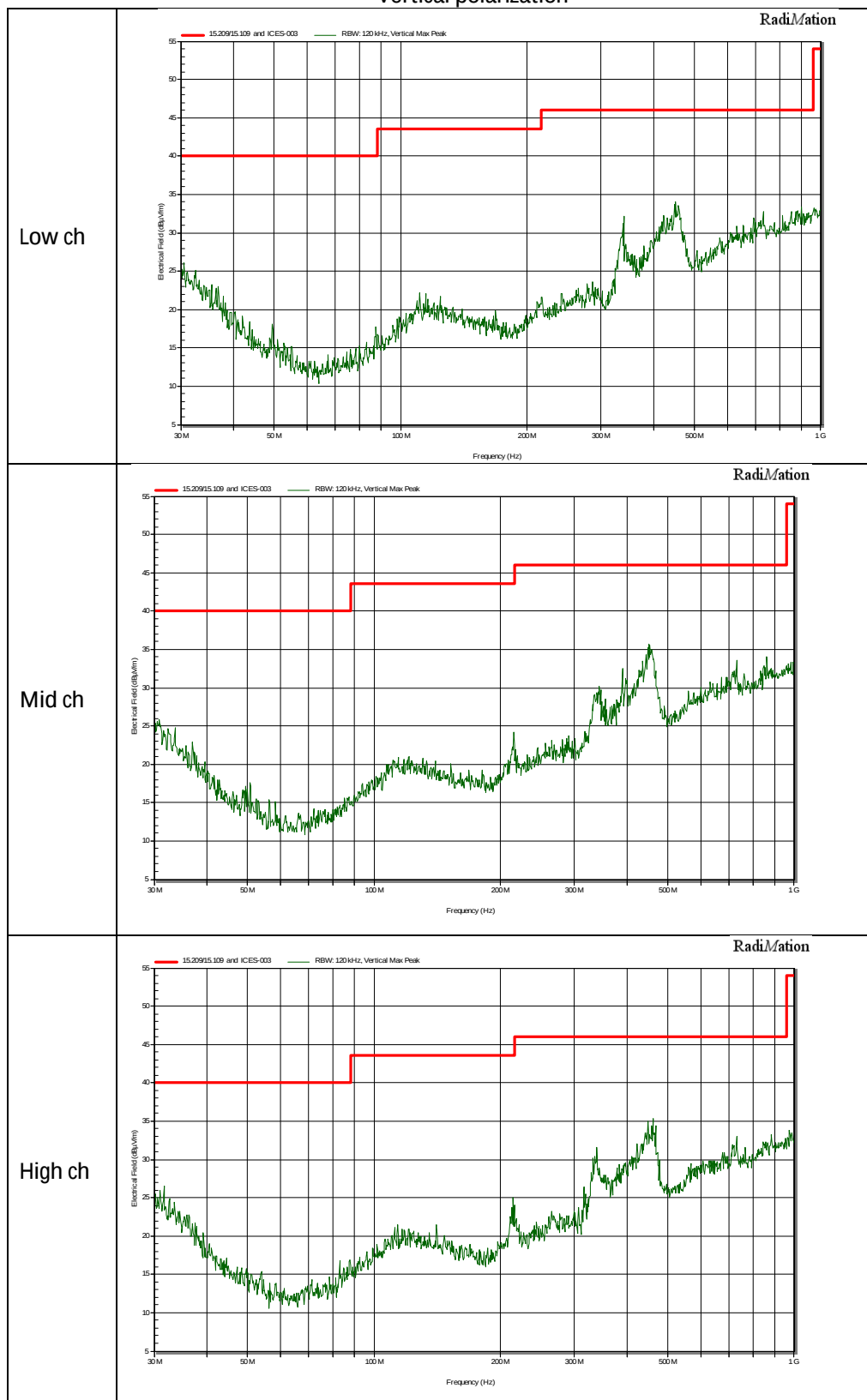
#### 3.5.5 Notes

- 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

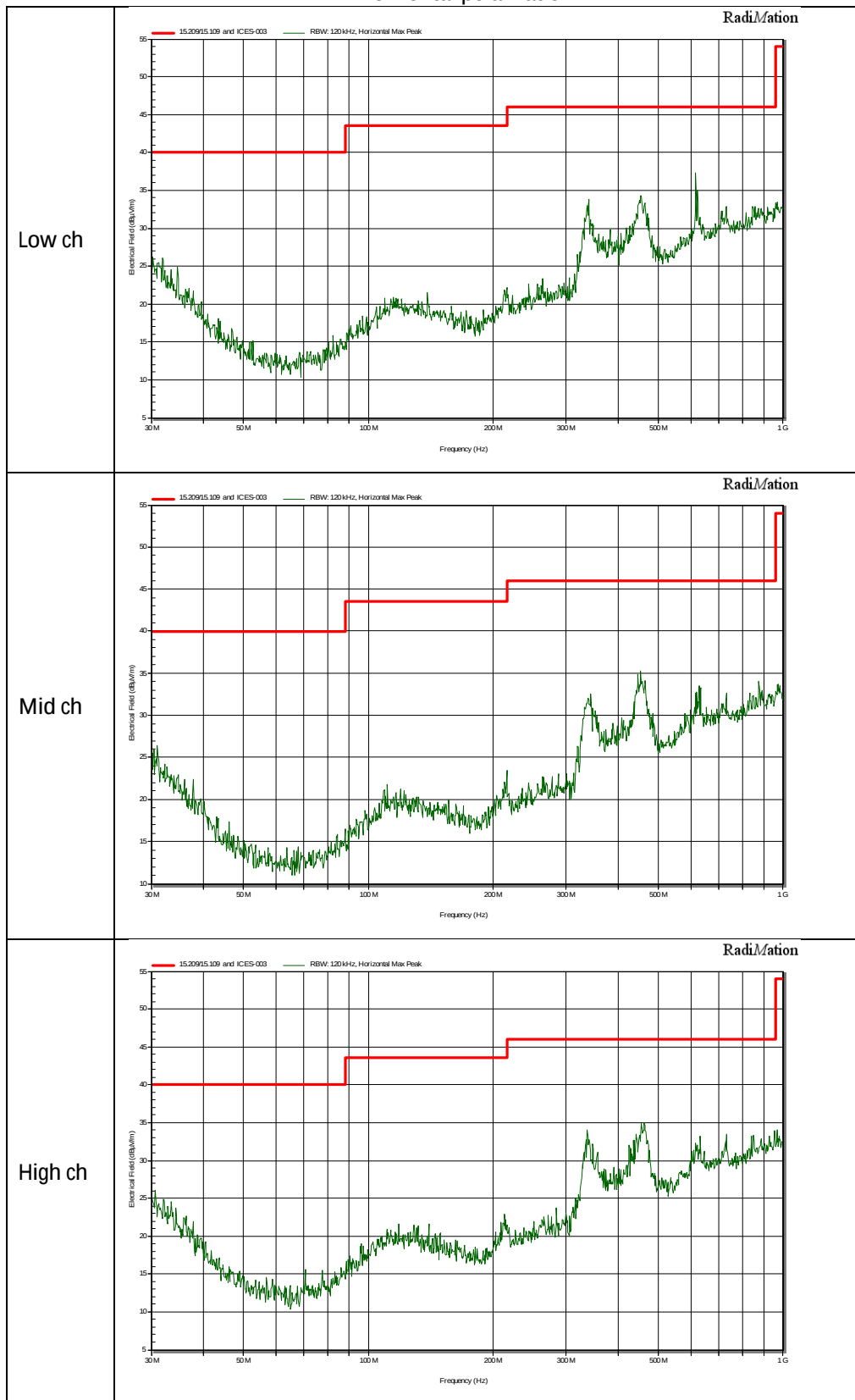
30 MHz to 1 GHz

Vertical polarization



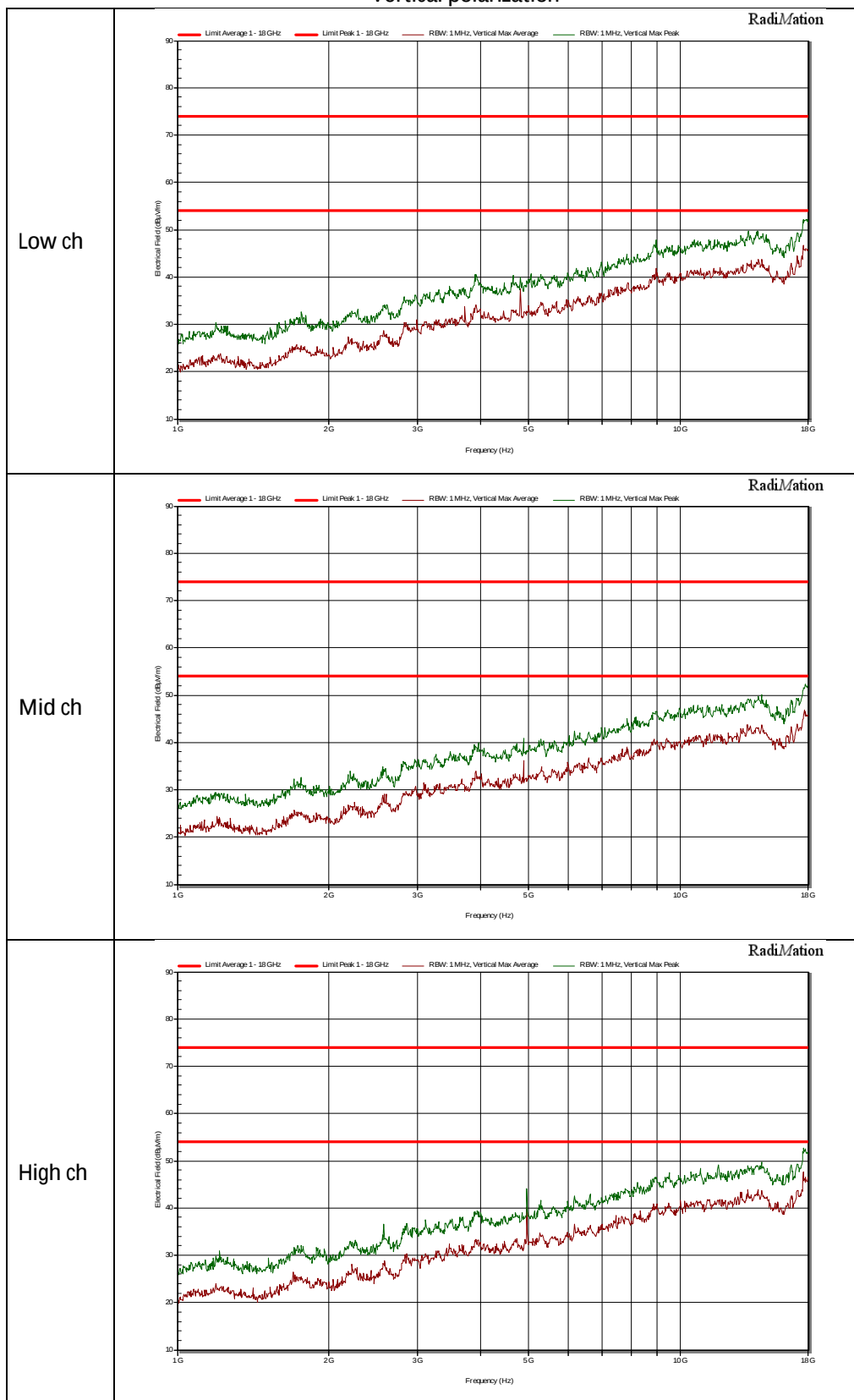
30 MHz to 1 GHz

Horizontal polarization



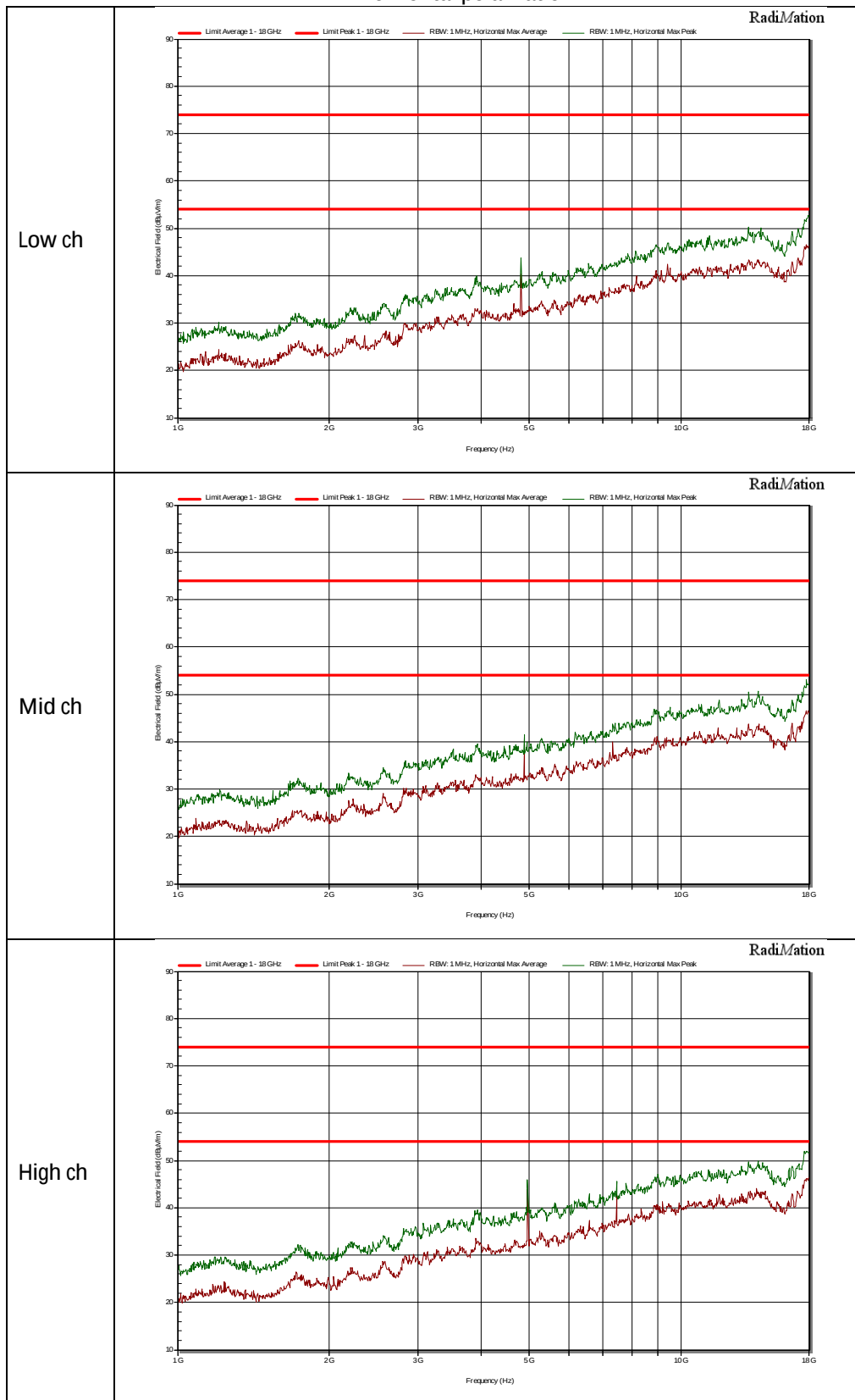
1 GHz to 18 GHz

Vertical polarization



1 GHz to 18 GHz

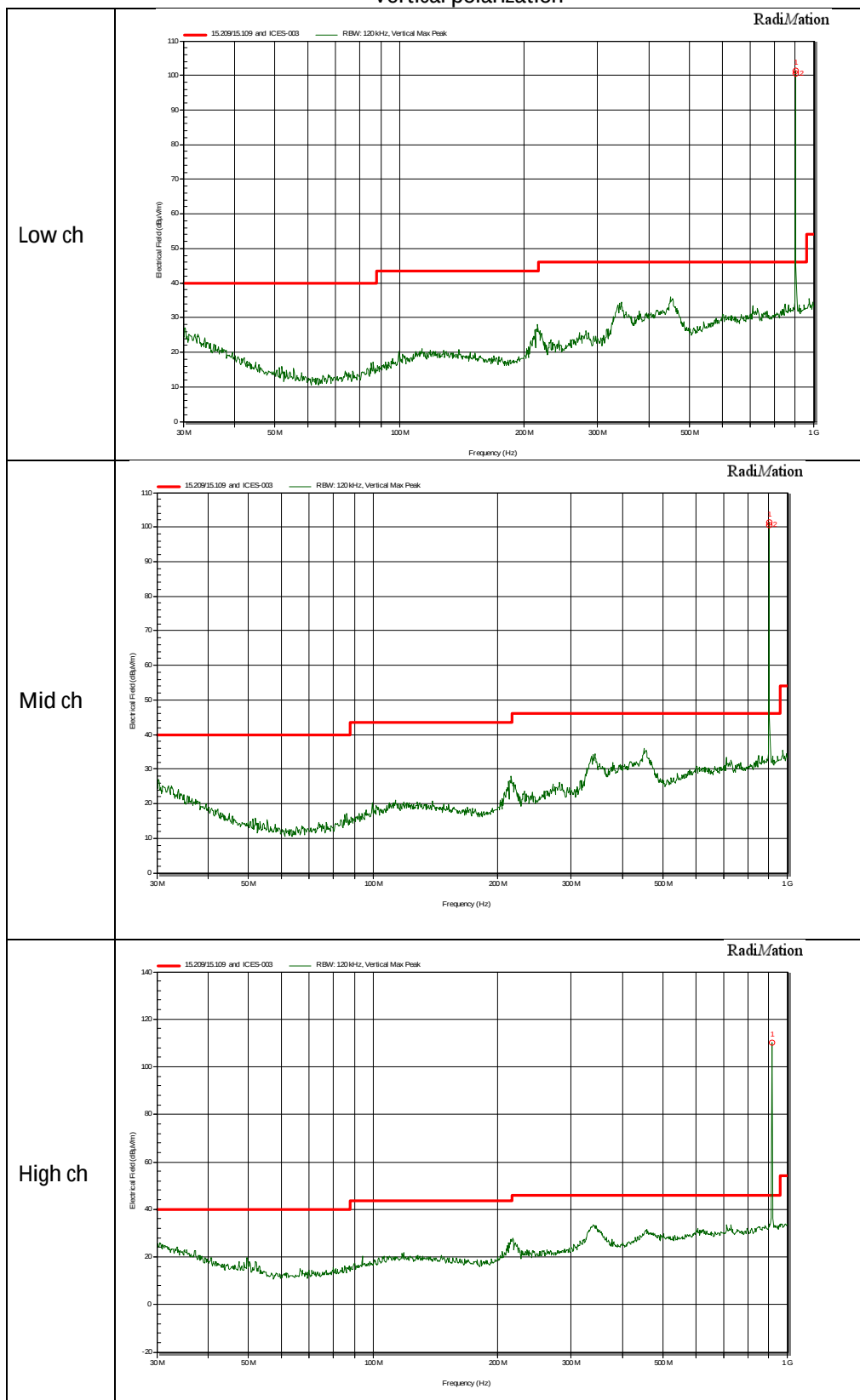
Horizontal polarization



### 3.5.7 Plots of the LoRa Radiated Spurious Emissions

30 MHz to 1 GHz

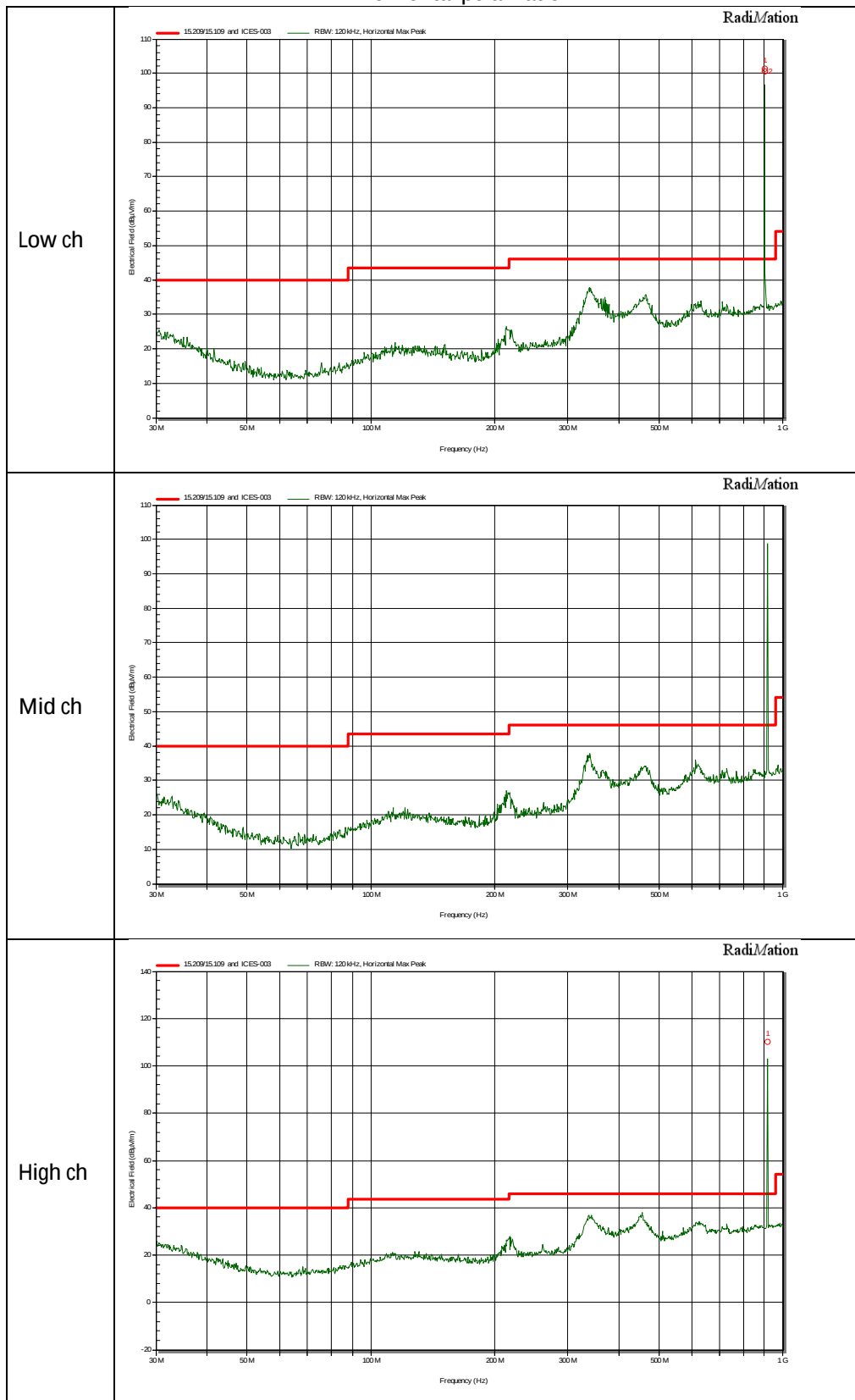
Vertical polarization



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

30 MHz to 1 GHz

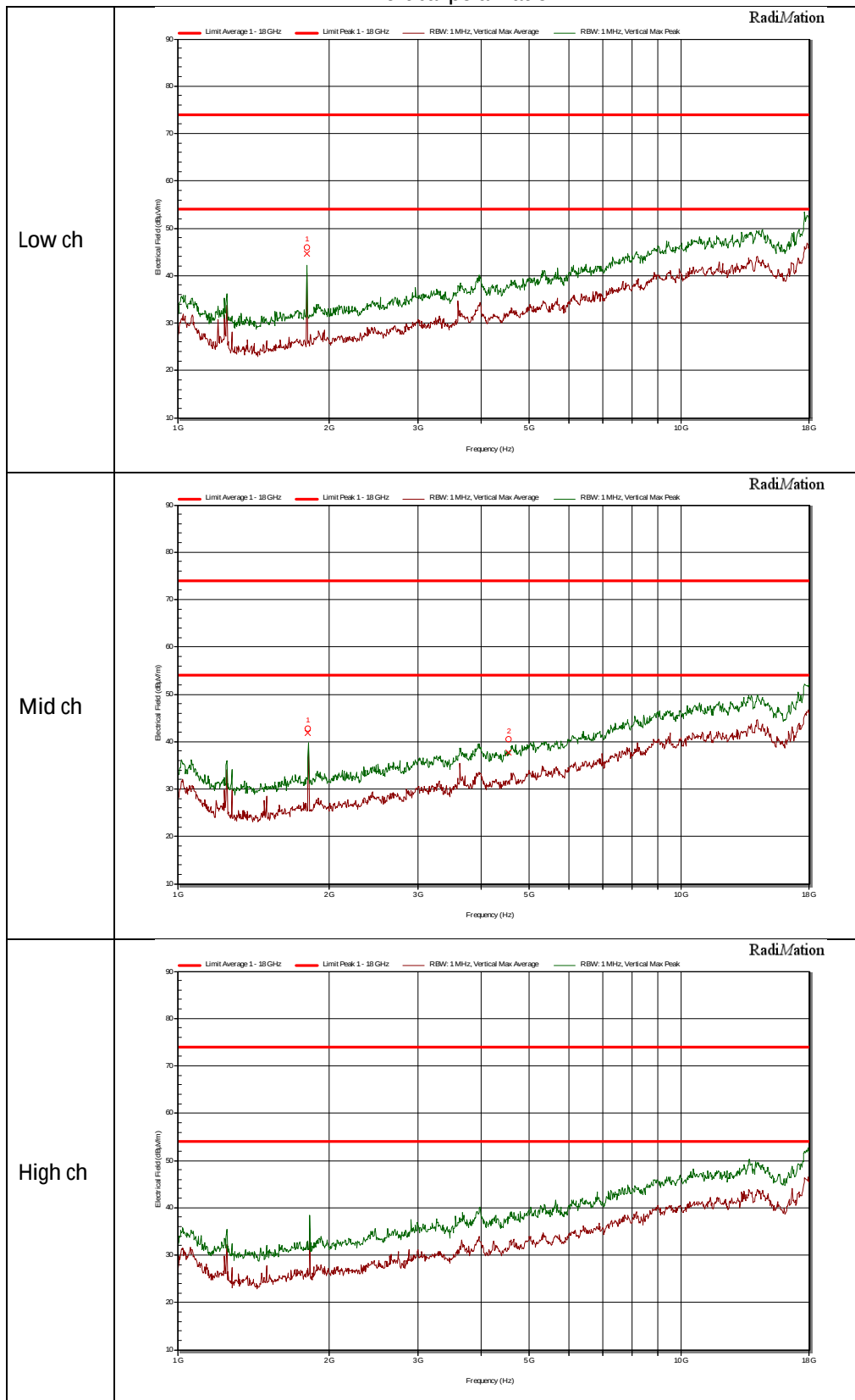
Horizontal polarization



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

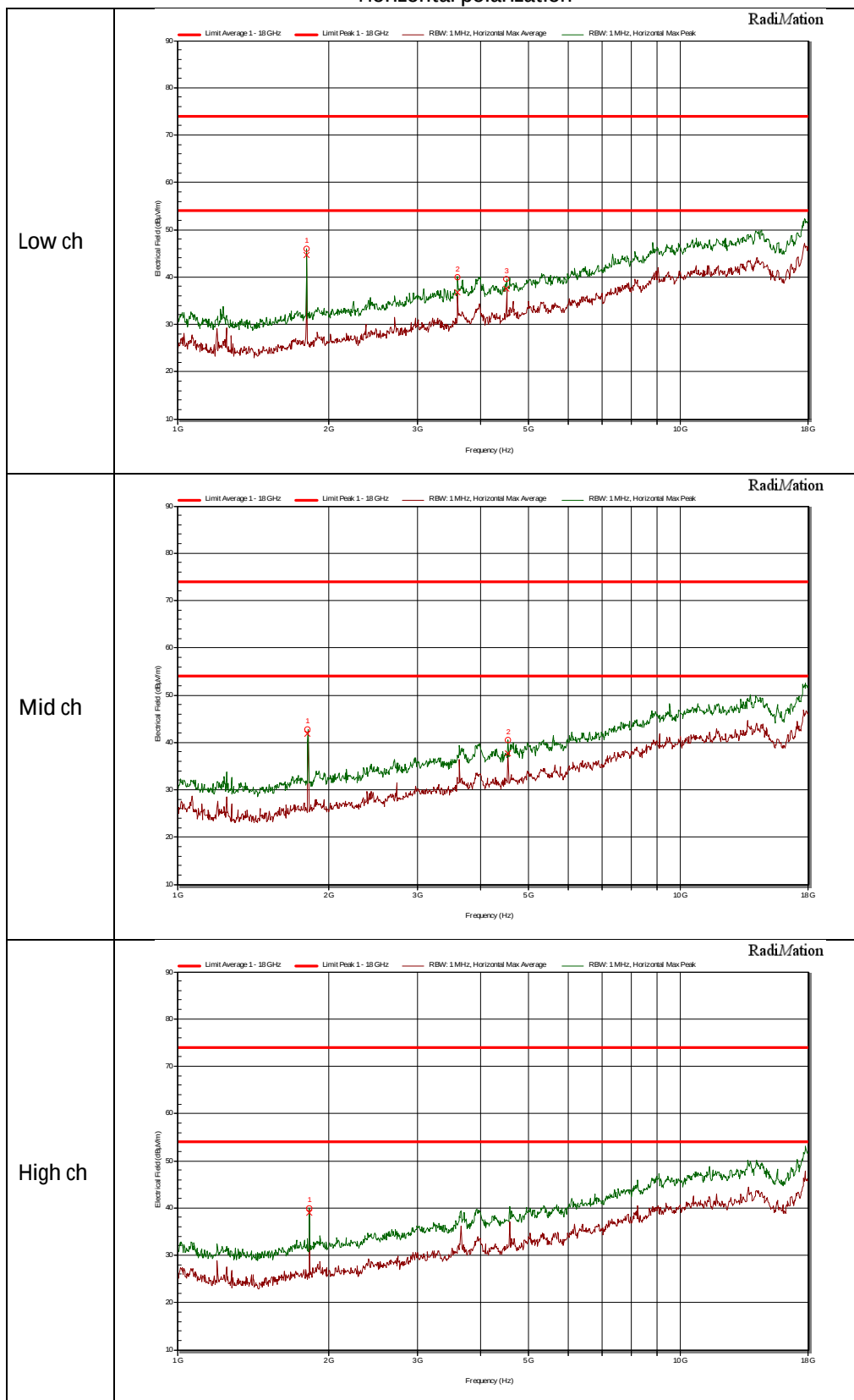
1 GHz to 18 GHz

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 $\mu$ V/m | 74 dB $\mu$ V/m | 44,6 dB $\mu$ V/m | 54 dB $\mu$ V/m | Horizontal   |
| Low     | 3,609 GHz | 40 dB $\mu$ V/m   | 74 dB $\mu$ V/m | 36,8 dB $\mu$ V/m | 54 dB $\mu$ V/m | Horizontal   |
| Low     | 4,512 GHz | 39,5 dB $\mu$ V/m | 74 dB $\mu$ V/m | 37,6 dB $\mu$ V/m | 54 dB $\mu$ V/m | Horizontal   |

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

| Channel | Frequency | Peak            | Peak Limit      | Average         | Average Limit   | Polarization |
|---------|-----------|-----------------|-----------------|-----------------|-----------------|--------------|
| High    | 1,83 GHz  | 40 dB $\mu$ V/m | 74 dB $\mu$ V/m | 39 dB $\mu$ V/m | 54 dB $\mu$ 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.