



# **FCC CFR47 Part 15 Subpart C ISED RSS-247 Certification Test Report**

**For the**

|                  |                                   |
|------------------|-----------------------------------|
| <b>Product</b>   | <b>: Digital Door Lock</b>        |
| <b>Model</b>     | <b>: CDL-107U</b>                 |
| <b>FCC ID</b>    | <b>: CCECDL-107U</b>              |
| <b>ISED ID</b>   | <b>: 22254-CDL107U</b>            |
| <b>Applicant</b> | <b>: COMMAX Co., Ltd.</b>         |
| <b>FCC Rule</b>  | <b>: CFR 47 Part 15 Subpart C</b> |
| <b>ISED Rule</b> | <b>: RSS-247 Issue 2</b>          |

We hereby certify that the above product has been tested by us with the listed rules and found in compliance with the regulation. The test data and results are issued on the test report no. **TR-W1903-001**

Signature

A handwritten signature in black ink, appearing to read 'Choi, Yeong-min', written over a horizontal line.

Choi, Yeong-min / Technical Manager

Date: 2019-03-05

**Test Laboratory: ENG Co., Ltd.**

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Report No.: TR-W1903-001

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gongjam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

Report Form\_01 (Rev.0)

# FCC/ISED CERTIFICATION TEST REPORT

**Project Number** : EA1902C-008  
**Test Report Number** : TR-W1903-001  
**Type of Equipment** : Digital Door Lock  
**Model Name** : CDL-107U  
**FCC ID** : CCECDL-107U  
**ISED ID** : 22254-CDL107U  
**Multiple Model Name** : N/A  
**Applicant** : COMMAX Co., Ltd.  
**Address** : 494 Dunchon-Daero, Jungwon-Gu, Seongnam-si, Gyeonggi-do,  
South Korea  
**Manufacturer** : COMMAX Co., Ltd.  
**Address** : 494 Dunchon-Daero, Jungwon-Gu, Seongnam-si, Gyeonggi-do,  
South Korea  
**Regulation** : FCC Part 15 Subpart C Section 15.247, ISED RSS-247 Issue2  
**Total page of Report** : 42 Pages  
**Date of Receipt** : 2019-01-24  
**Date of Issue** : 2019-03-05  
**Test Result** : PASS

This test report only contains the result of a single test of the sample supplied for the examination.  
 It is not a generally valid assessment of the features of the respective products of the mass-production.

|             |                                     |                                                                                      |            |
|-------------|-------------------------------------|--------------------------------------------------------------------------------------|------------|
| Prepared by | Song, In-young / Senior Engineer    |  | 2019-03-05 |
|             |                                     | Signature                                                                            | Date       |
| Reviewed by | Choi, Yeong-min / Technical Manager |  | 2019-03-05 |
|             |                                     | Signature                                                                            | Date       |

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### Release Control Record

| Issue Report No. | Issued Date | Details/Revisions |
|------------------|-------------|-------------------|
| TR-W1903-001     | 2019-03-05  | Initial Release   |
| -                | -           | -                 |

## 1. TEST SUMMARY

### 1.1 Regulations and results

The sample submitted for evaluation (Hereafter referred to as the EUT) has been tested in accordance with the following regulations or standards.

| FCC Reference Section  | ISED Reference Section     | Description                              | P | F | N.T. | Note   |
|------------------------|----------------------------|------------------------------------------|---|---|------|--------|
| 15.247(a)(2)           | RSS-247 5.2 a)             | 6 dB Bandwidth<br>Occupied Bandwidth     | P |   |      |        |
| 15.247(b)(3)           | RSS-247 5.4 d)             | Maximum peak output power                | P |   |      |        |
| 15.247(d)              | RSS-247 5.5                | Band Edge<br>Conducted spurious emission | P |   |      |        |
| 15.247(e)              | RSS-247 5.2 b)             | Power spectral density                   | P |   |      |        |
| 15.205(a)<br>15.209(a) | RSS 247 5.5<br>RSS-GEN 8.9 | Radiated spurious emissions              | P |   |      |        |
| 15.207(a)              | RSS GEN 8.8                | AC power line conducted emissions        |   |   | N.T. | Note 1 |

#### Remark:

P means Passed

F means Failed

N.T. means Not Tested

**Note1.** The EUT is operated by battery only. (used manganese dry cell as type AA)

### 1.2 Test Methodology

The tests mentioned in clause 1.1 in this test report were performed according to FCC CFR 47 Part 2, CFR 47 Part 15 and ANSI C63.10-2013, and RSS-Gen Issue 4, KDB 558074 D01DTS Meas. Guidance v04: Measurement Procedure PK is used for power measurement.

### 1.3 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

### 1.4 Purpose of the test

The test was performed to determine whether the equipment under test fulfills the requirements of the regulation stated in FCC Part 15 Subpart C Section 15.247, RGG-Gen and RSS-247

## 1.5 Test Facility

The measurement facilities are located at 135-60 Gyeongchung-daero, Gonjam-eup, Gwangju-si, Gyeonggi-do 12813, Korea. Description details of test facilities were submitted to the FCC and IC, designated by the RRA (Radio Research Agency), and accredited by Korea and accredited by KOLAS (Korea Laboratory Accreditation Scheme) in Korea according to the requirement of ISO 17025.

| Laboratory Qualification                   | Registration No. | Mark                                                                                |
|--------------------------------------------|------------------|-------------------------------------------------------------------------------------|
| FCC                                        | KR0160           |  |
| ISED(Canada)                               | IC 12721A        |  |
| RRA                                        | KR0160           |  |
| Korean Agency for Technology and Standards | KT733            |  |

## 2. EUT (Equipment Under Test) INFORMATION

### 2.1 General Description

The COMMAX Co., Ltd., Model CDL-107U (referred to as the EUT in this report) is a Digital Door Lock. The EUT is a device for transferring Bluetooth signal to a Smart phone through wireless communication. The product specification described herein was obtained from product data sheet or user's manual.

|                                |                                                                                             |
|--------------------------------|---------------------------------------------------------------------------------------------|
| Operating Frequency            | 2 402 ~ 2 480 MHz                                                                           |
| Kind of Class                  | DXT- Digital Transmission System                                                            |
| Max. RF Output Power           | - 6.65 dBm                                                                                  |
| Modulation Types               | Bluetooth Low Energy (GFSK)                                                                 |
| Number of Channels             | 40 CH                                                                                       |
| Channel Bandwidth              | 2 MHz                                                                                       |
| Generated or used Freq. in EUT | 32.768 kHz, 13.56 MHz, 16 MHz, 32 MHz                                                       |
| Type of Antenna                | <input checked="" type="checkbox"/> Integrated Type <input type="checkbox"/> Dedicated Type |
| Antenna Gain                   | -7.45 dBi                                                                                   |
| Operating Temperature          | - 25 °C ~ + 50 °C                                                                           |
| Normal Test Voltage            | DC 6.0 V                                                                                    |
| Electrical Rating              | DC 6.0 V                                                                                    |
| Test SW Version                | nRFgo Studio Version: 1.21.2.10                                                             |
| RF power setting in TEST SW    | N/A                                                                                         |
| Software Version               | 1.0                                                                                         |
| Hardware Version               | 1.0                                                                                         |

## 2.2 Available channel number and frequency

| Operating Mode: Bluetooth LE, 2 MHz Channel Spacing |                |         |                |         |                |
|-----------------------------------------------------|----------------|---------|----------------|---------|----------------|
| Channel                                             | Frequency(MHz) | Channel | Frequency(MHz) | Channel | Frequency(MHz) |
| 0                                                   | 2 402          | 14      | 2 430          | 28      | 2 458          |
| 1                                                   | 2 404          | 15      | 2 432          | 29      | 2 460          |
| 2                                                   | 2 406          | 16      | 2 434          | 30      | 2 462          |
| 3                                                   | 2 408          | 17      | 2 436          | 31      | 2 464          |
| 4                                                   | 2 410          | 18      | 2 438          | 32      | 2 466          |
| 5                                                   | 2 412          | 19      | 2 440          | 33      | 2 468          |
| 6                                                   | 2 414          | 20      | 2 442          | 34      | 2 470          |
| 7                                                   | 2 416          | 21      | 2 444          | 35      | 2 472          |
| 8                                                   | 2 418          | 22      | 2 446          | 36      | 2 474          |
| 9                                                   | 2 420          | 23      | 2 448          | 37      | 2 476          |
| 10                                                  | 2 422          | 24      | 2 450          | 38      | 2 478          |
| 11                                                  | 2 424          | 25      | 2 452          | 39      | 2 480          |
| 12                                                  | 2 426          | 26      | 2 454          |         |                |
| 13                                                  | 2 428          | 27      | 2 456          |         |                |

## 2.3 Additional Model

None

### 3. TEST CONDITION

#### 3.1 Equipment Used During Test

The following peripheral devices and/or interface cables were connected during the measurement:

| Description             | Model No. | Serial No.    | Manufacturer.    |
|-------------------------|-----------|---------------|------------------|
| Digital Door Lock (EUT) | CDL-107U  | N/A           | COMMAX Co., Ltd. |
| Test Jig                | FT232     | N/A           | N/A              |
| Notebook PC             | E5470     | ZU10190-15008 | DELL             |
| Adapter for Notebook PC | LA65NM130 | N/A           | DELL             |

#### 3.2 Mode of operation during the test

Software used to control the EUT for staying in continuous transmitting mode is programmed.

The used modulation type for the testing is GFSK.

#### 3.3 Preliminary Testing for Worst case configuration

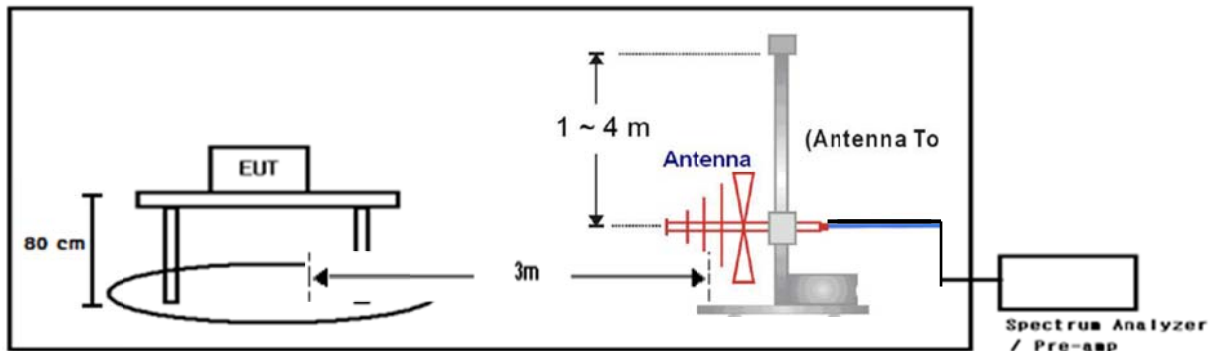
For finding worst case configuration and operating mode, preliminary testing was performed and radiated emission and conducted emission tests were performed with the EUT set to transmit and receive at the channel with the highest output power as worst case scenario. Since the EUT is a fixed type device, all spurious emission tests were performed in one axis direction.

Based on preliminary testing following operating modes were selected for the final test as listed below.

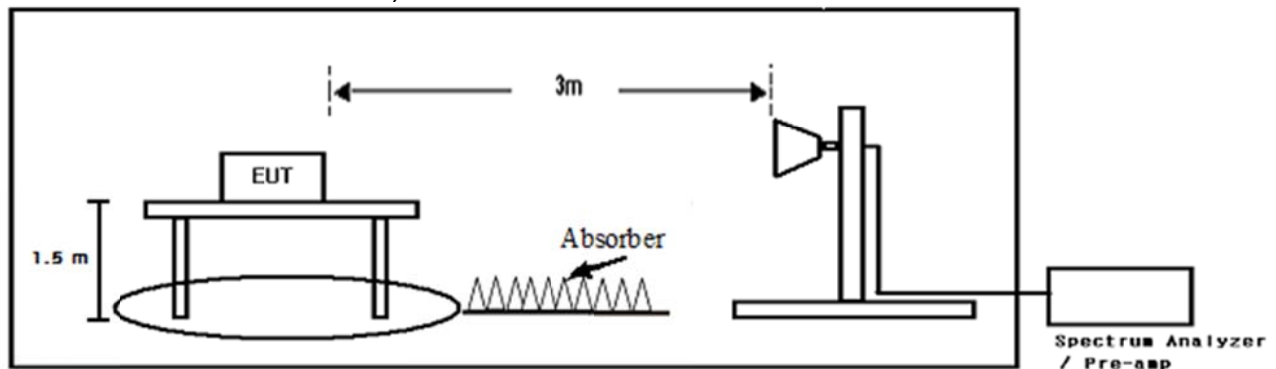
##### 3.3.1 Test Channel and Frequency

| Operating Mode       | Test Channel   | Frequency |
|----------------------|----------------|-----------|
| Bluetooth Low Energy | Low Channel    | 2 402 MHz |
|                      | Middle Channel | 2 440 MHz |
|                      | High Channel   | 2 480 MHz |

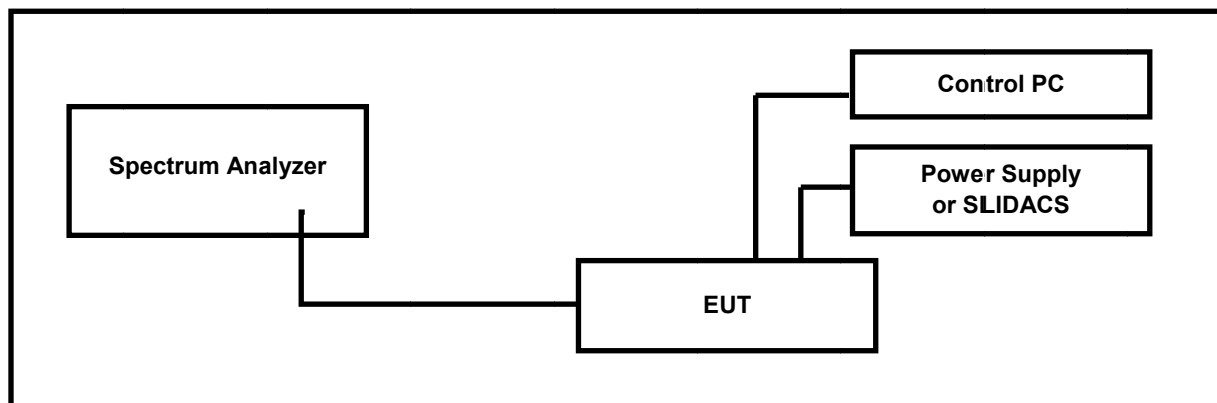
### 3.3 Test Setup Drawing (Radiated Test below 1 GHz)



### (Radiated Test above 1 GHz)



### (Conducted Test)



### 3.4 EUT Modifications

- No EMC Relevant Modifications were performed by this test laboratory.

#### 4. ANTENNA REQUIREMENT

According to FCC CFR 47 Part 15 section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provision of this section.

##### 4.1 Antenna Description

| Frequency Band (GHz) | Antenna Type        | Max Peak Gain (dBi) | Connector Type |
|----------------------|---------------------|---------------------|----------------|
| 2.4                  | PCB Pattern Antenna | - 7.45              | -              |

##### 4.2 Conclusion

The antenna connector type of the EUT is PCB Pattern Antenna, so the EUT met the requirement.

## 5. TEST RESULT

### 5.1 6 dB Bandwidth

#### 5.1.1 Limit

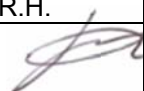
The minimum 6 dB bandwidth shall be at least 500 kHz acc to Section 15.247 (a) (2), and RSS-247 5.2 (a).

#### 5.1.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v04: 8.1 Option 1

The transmitter output is connected to a spectrum analyzer with the RBW set to 100 kHz, VBW  $\geq 3 \times$  RBW, peak detector and max hold.

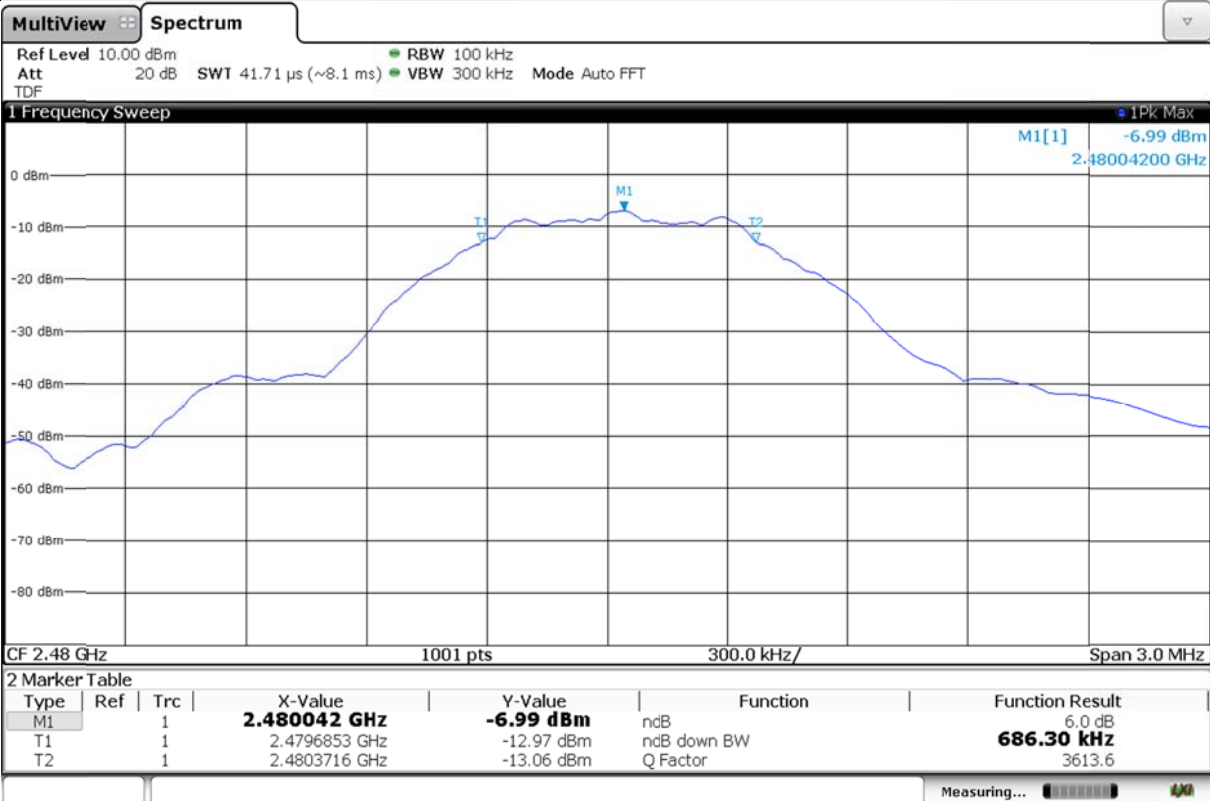
#### 5.1.3 Test Data

|                              |                 |                      |                                                                                                 |
|------------------------------|-----------------|----------------------|-------------------------------------------------------------------------------------------------|
| Date of Test                 | 2019-02-19      | Temperature          | (21.2 $\pm$ 1.0) °C                                                                             |
|                              |                 | Relative humidity    | (46.6 $\pm$ 3.0) % R.H.                                                                         |
| <b>Test Result</b>           | <b>PASS</b>     | Tested by            | Do-heon Kim  |
| Operating Mode: Bluetooth LE |                 |                      |                                                                                                 |
| Channel                      | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz)                                                                             |
| Low                          | 2 402           | 0.66                 | 0.5                                                                                             |
| Middle                       | 2 440           | 0.68                 |                                                                                                 |
| High                         | 2 480           | 0.69                 |                                                                                                 |

## 5.1.4 Test Plots



# Operating Mode: Bluetooth LE (High Channel)



## 5.2 99 % Bandwidth

### 5.2.1 Limit

Not applicable. For reporting purpose only.

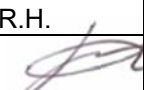
### 5.2.2 Method of Measurement

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1 % to 5 % of the OBW.

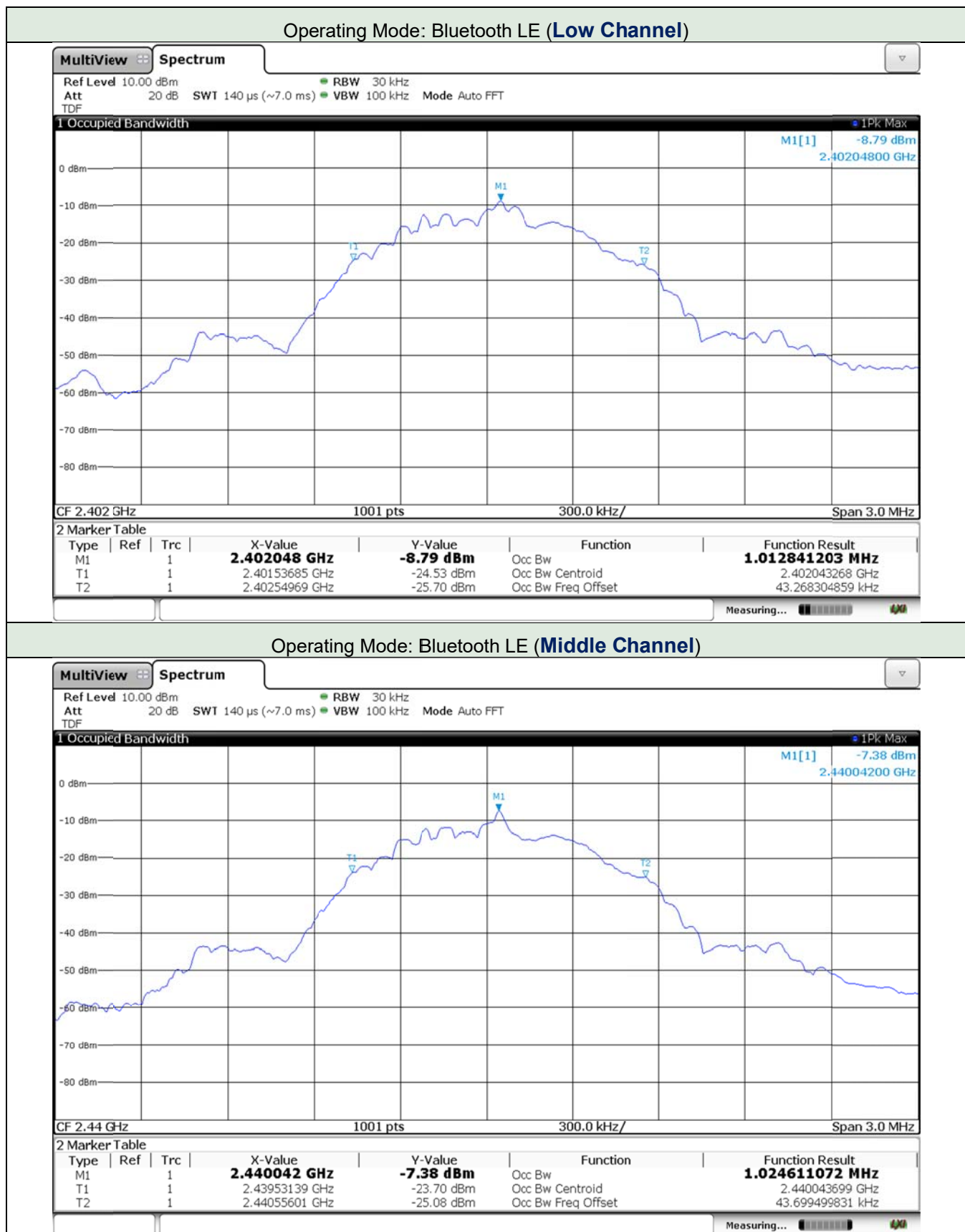
The span is set to capture all products of the modulation process, including the emission skirts.

The VBW is set to 3 times the RBW. The sweep time is coupled and peak detection and max hold mode is used. The spectrum analyzer internal 99% bandwidth function is utilized.

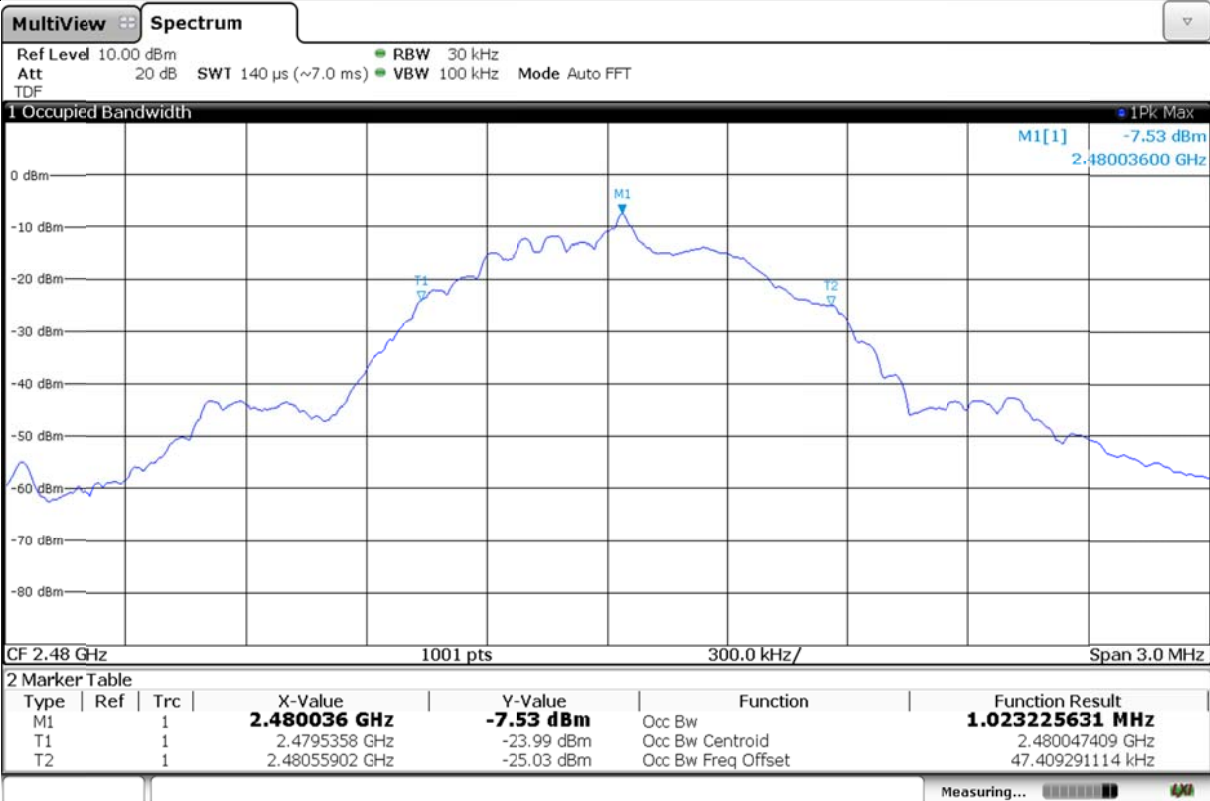
### 5.2.3 Test Data

|                                |                 |                   |                                                                                                 |
|--------------------------------|-----------------|-------------------|-------------------------------------------------------------------------------------------------|
| Date of Test                   | 2019-02-19      | Temperature       | (21.2 ± 1.0) °C                                                                                 |
|                                |                 | Relative humidity | (46.6 ± 3.0) % R.H.                                                                             |
| <b>Test Result</b>             | <b>PASS</b>     | Tested by         | Do-heon Kim  |
| Operational Mode: Bluetooth LE |                 |                   |                                                                                                 |
| Channel                        | Frequency (MHz) |                   | 99 % Bandwidth (MHz)                                                                            |
| Low                            | 2 402           |                   | 1.01                                                                                            |
| Middle                         | 2 440           |                   | 1.03                                                                                            |
| High                           | 2 480           |                   | 1.02                                                                                            |

## 5.2.4 Test Plots



# Operating Mode: Bluetooth LE (High Channel)



## 5.3 Maximum Peak Output Power

### 5.3.1 Limit

Acc. To section 15.247 and RSS-247 5.4 d), For system using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 5.3.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v04: 9.1.1 RBW  $\geq$  DTS bandwidth

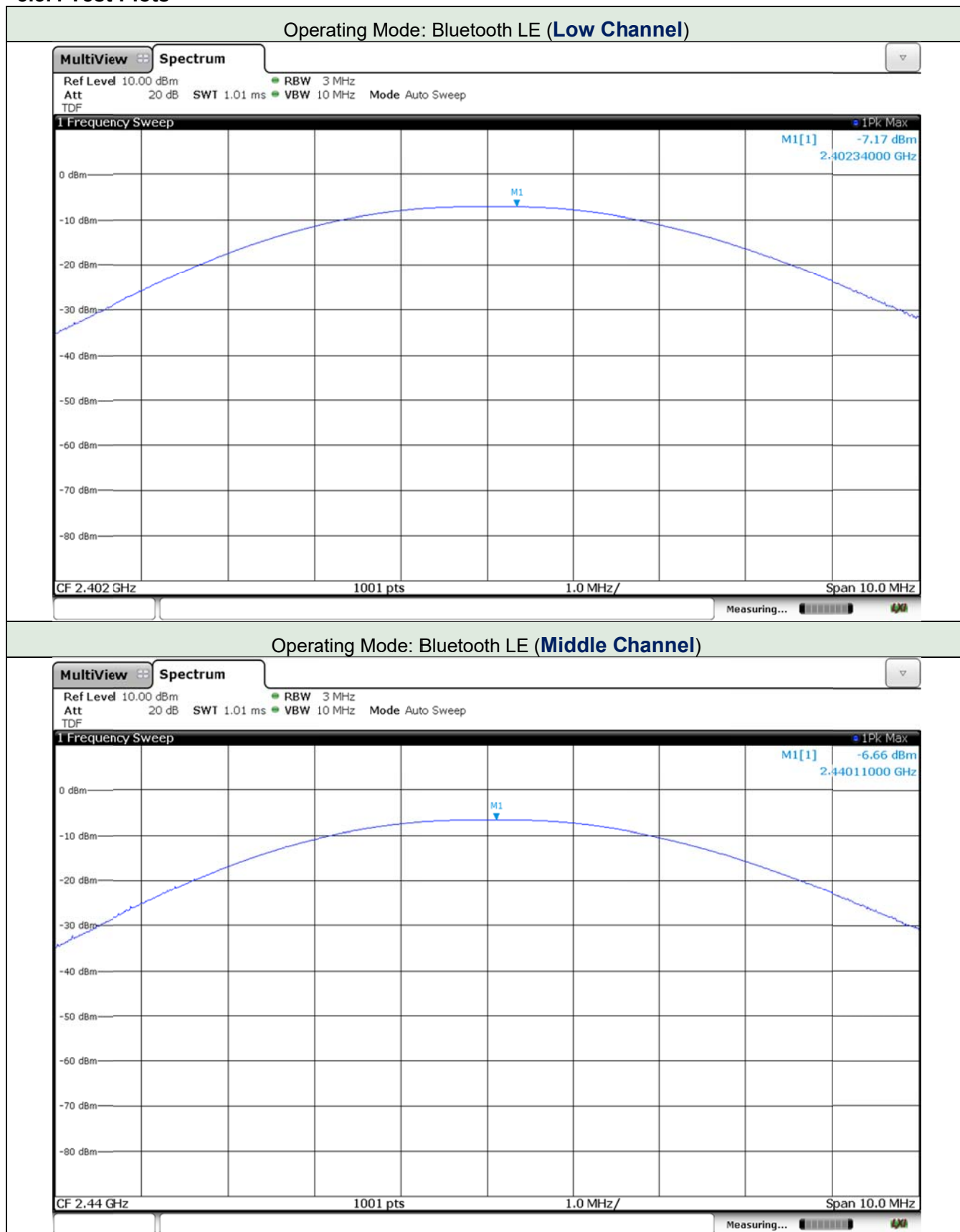
The cable assembly insertion loss was entered as an offset in the spectrum analyzer to allow for direct reading of power.

### 5.3.3 Test Data for Output Power

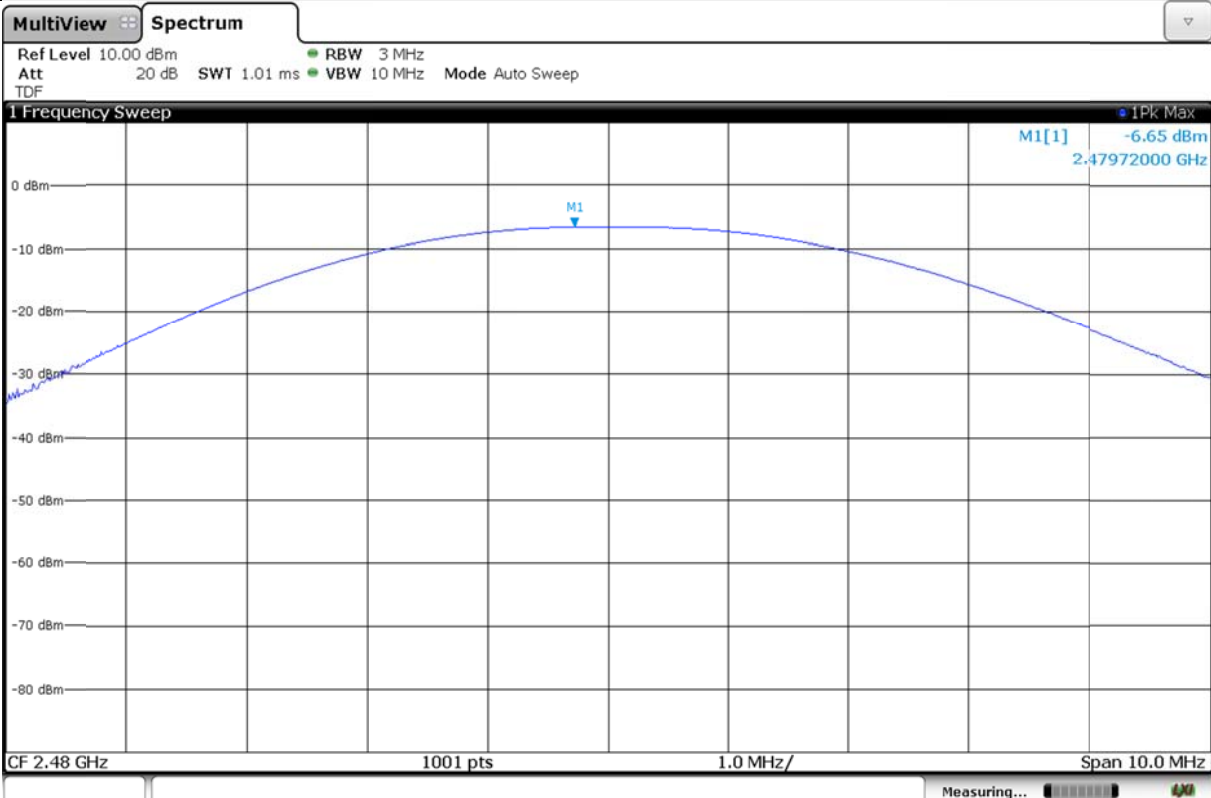
|                              |                 |                      |                                                                                                  |             |
|------------------------------|-----------------|----------------------|--------------------------------------------------------------------------------------------------|-------------|
| Date of Test                 | 2019-02-19      | Temperature          | (21.2 ± 1.0) °C                                                                                  |             |
|                              |                 | Relative humidity    | (46.6 ± 3.0) % R.H.                                                                              |             |
| <b>Test Result</b>           | <b>PASS</b>     | Tested by            | Do-heon Kim  |             |
| Operating Mode: Bluetooth LE |                 |                      |                                                                                                  |             |
| Channel                      | Frequency (MHz) | Measured Value (dBm) | Limit (dBm)                                                                                      | Margin (dB) |
| Low                          | 2 402           | -7.17                | 30                                                                                               | 37.17       |
| Middle                       | 2 440           | -6.66                |                                                                                                  | 36.66       |
| High                         | 2 480           | -6.65                |                                                                                                  | 36.65       |

Remark. Margin = Limit – Measured Value

### 5.3.4 Test Plots



Operating Mode: Bluetooth LE (High Channel)



## 5.4 Peak Power Spectral Density

### 5.4.1 Limit

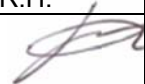
Acc. To section 15.247 and RSS-247 5.2 b), the power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### 5.4.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v04: 10.2 Method PKPSD (peak PSD).

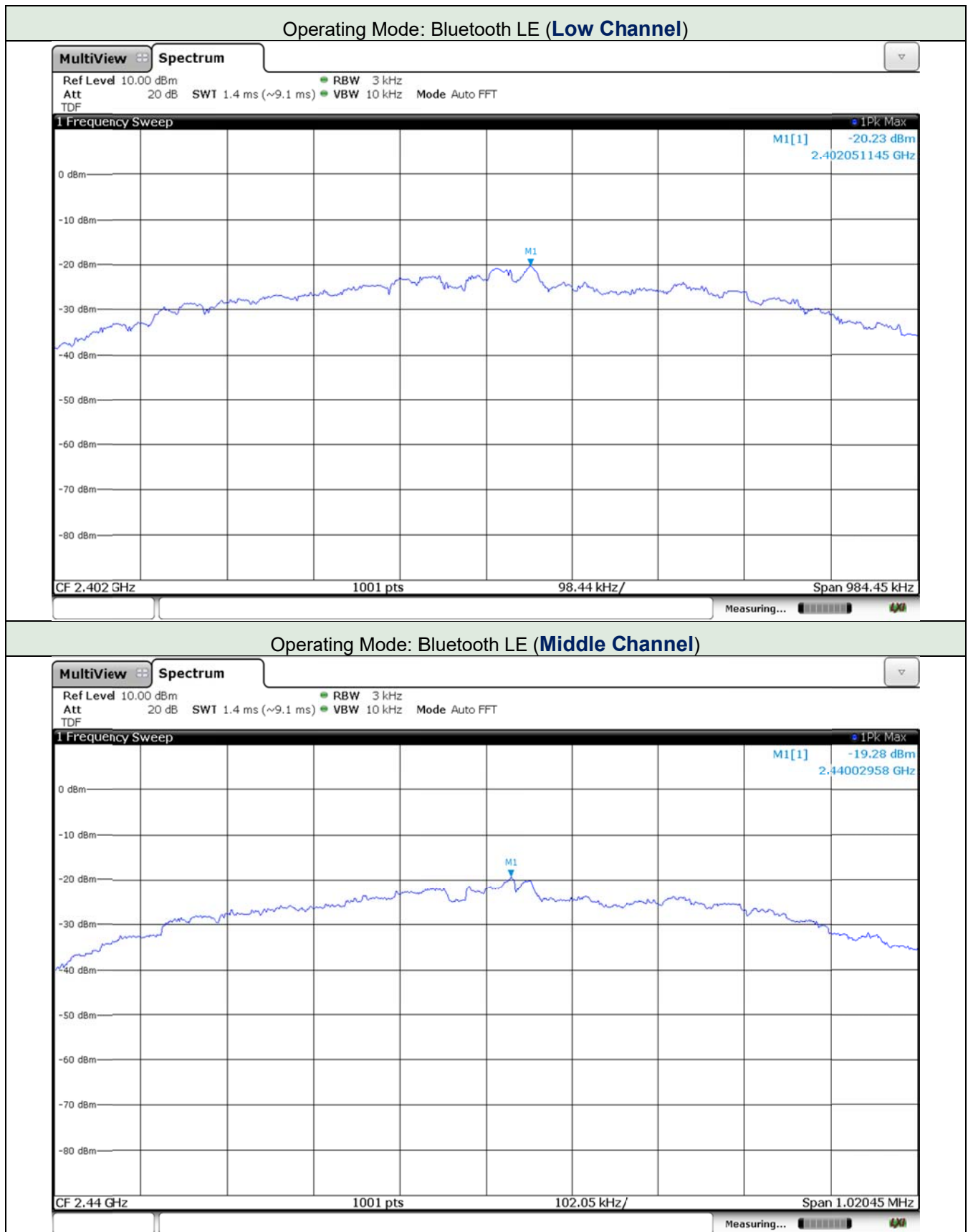
The transmitter output is connected to a spectrum analyzer with the RBW set from 3 kHz to 100 kHz,  
VBW  $\geq$  3 X RBW, peak detector and max hold.

### 5.4.3 Test Data

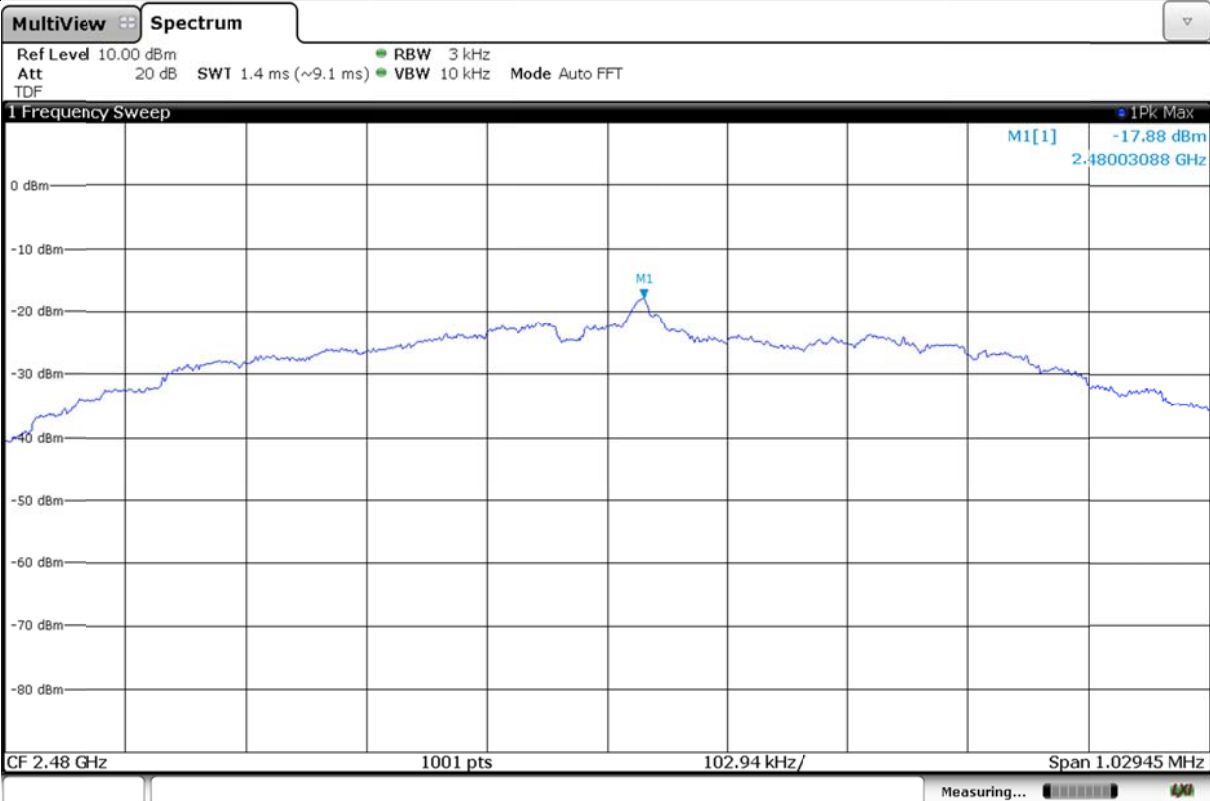
|                              |                 |                      |                   |                                                                                                 |
|------------------------------|-----------------|----------------------|-------------------|-------------------------------------------------------------------------------------------------|
| Date of Test                 |                 | 2019-02-19           | Temperature       | (21.2 ± 1.0) °C                                                                                 |
|                              |                 |                      | Relative humidity | (46.6 ± 3.0) % R.H.                                                                             |
| Test Result                  |                 | PASS                 | Tested by         | Do-heon Kim  |
| Operating Mode: Bluetooth LE |                 |                      |                   |                                                                                                 |
| Channel                      | Frequency (MHz) | Measured Value (dBm) | Limit (dBm)       | Margin (dB)                                                                                     |
| Low                          | 2 402           | -20.23               | 8                 | 28.23                                                                                           |
| Middle                       | 2 440           | -19.28               |                   | 27.28                                                                                           |
| High                         | 2 480           | -17.88               |                   | 25.88                                                                                           |

Remark. Margin = Limit – Measured Value

## 5.4.4 Test Plots



Operating Mode: Bluetooth LE (High Channel)



## 5.5 Out of Band Emission

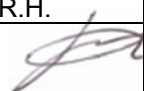
### 5.5.1 Limit

Acc. To section 15.247(d) and RSS-247 5.5, In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in 15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))

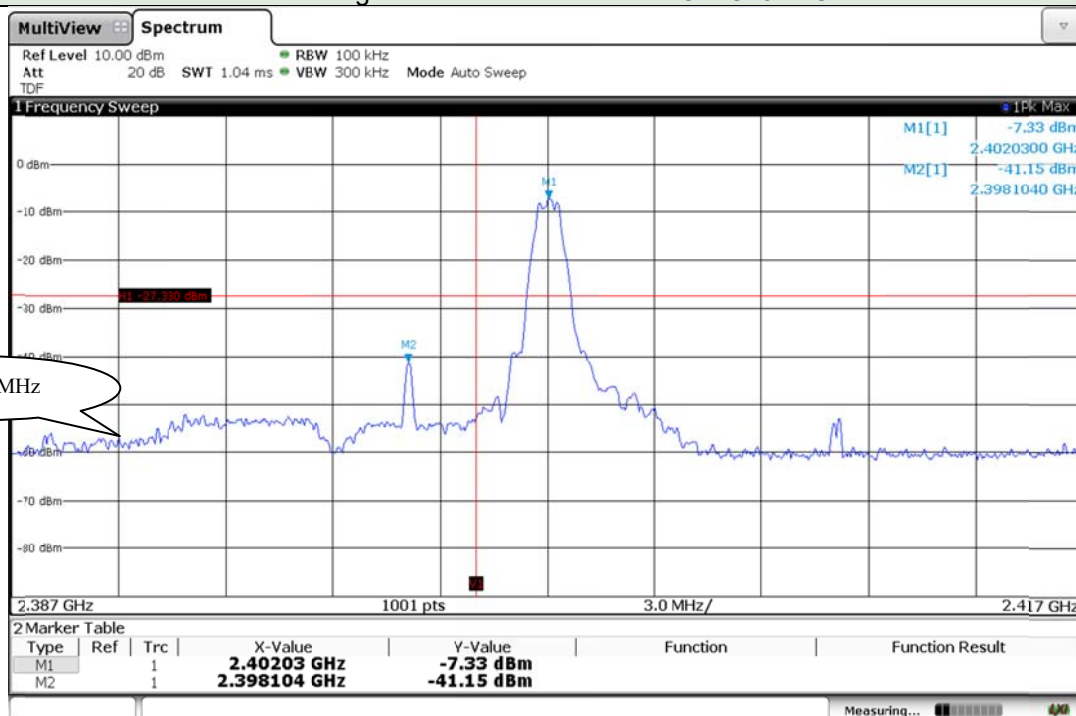
### 5.5.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v04: 11.0 Emissions in non-restricted frequency bands. The transmitter output is connected to a spectrum analyzer with the RBW set to 100 kHz, VBW  $\geq 3 \times$  RBW, peak detector and max hold. Measurements utilizing these settings are made of the in-band reference level, band-edge (where measurements to the general radiated limits will not be made) and out-of-band emissions.

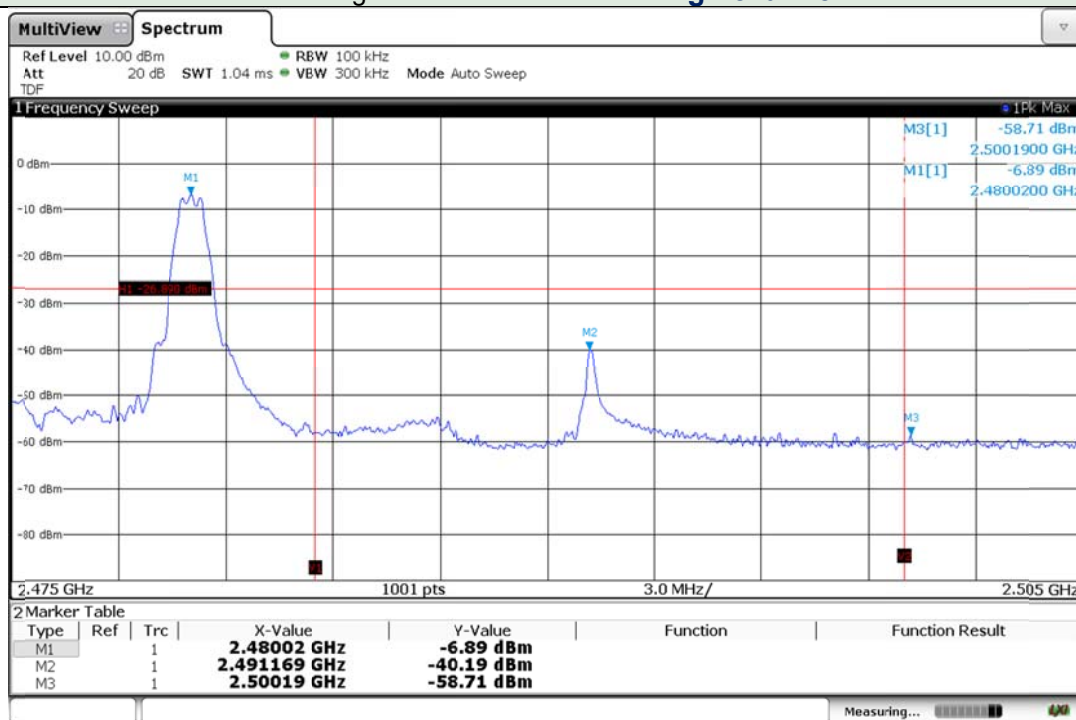
### 5.5.3 Test Data for Operating mode: Bluetooth LE

|                    |             |                   |                                                                                                 |
|--------------------|-------------|-------------------|-------------------------------------------------------------------------------------------------|
| Date of Test       | 2019-02-19  | Temperature       | (21.2 ± 1.0) °C                                                                                 |
|                    |             | Relative humidity | (46.6 ± 3.0) % R.H.                                                                             |
| <b>Test Result</b> | <b>PASS</b> | Tested by         | Do-heon Kim  |

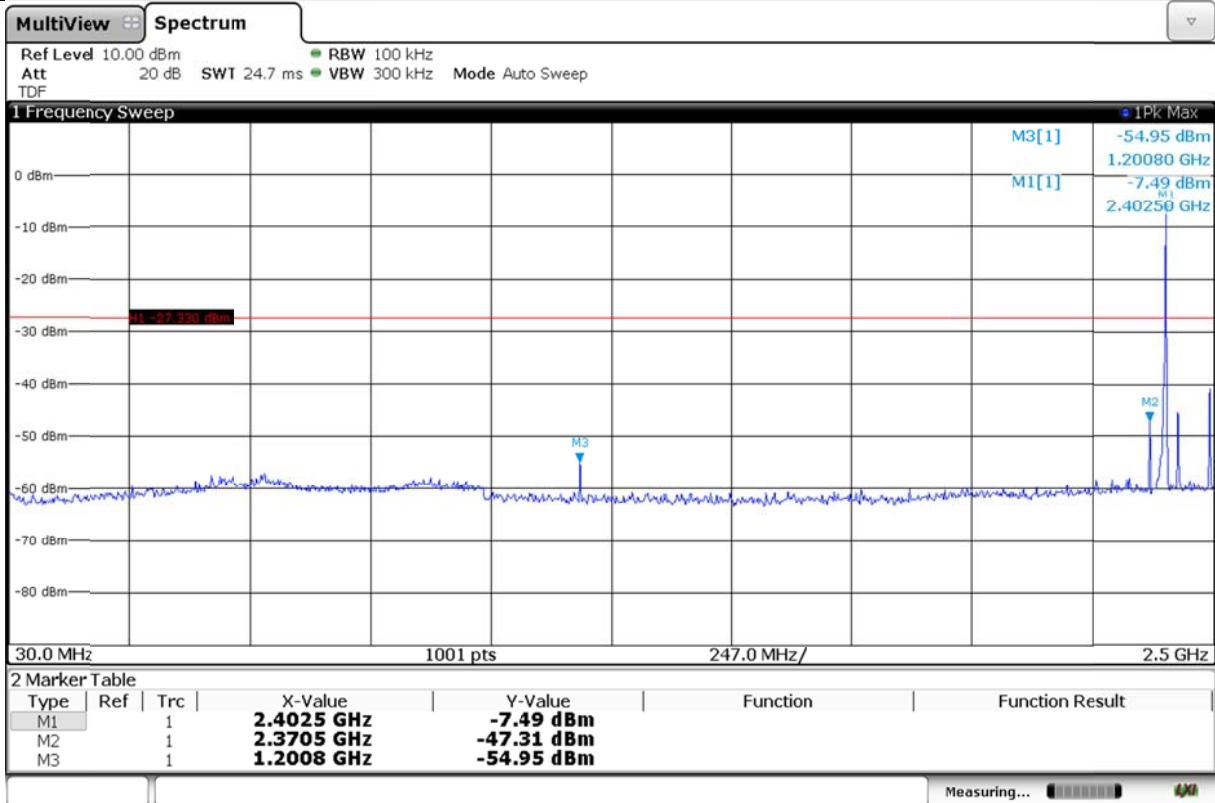
#### Band-edge and Restricted band – Low channel



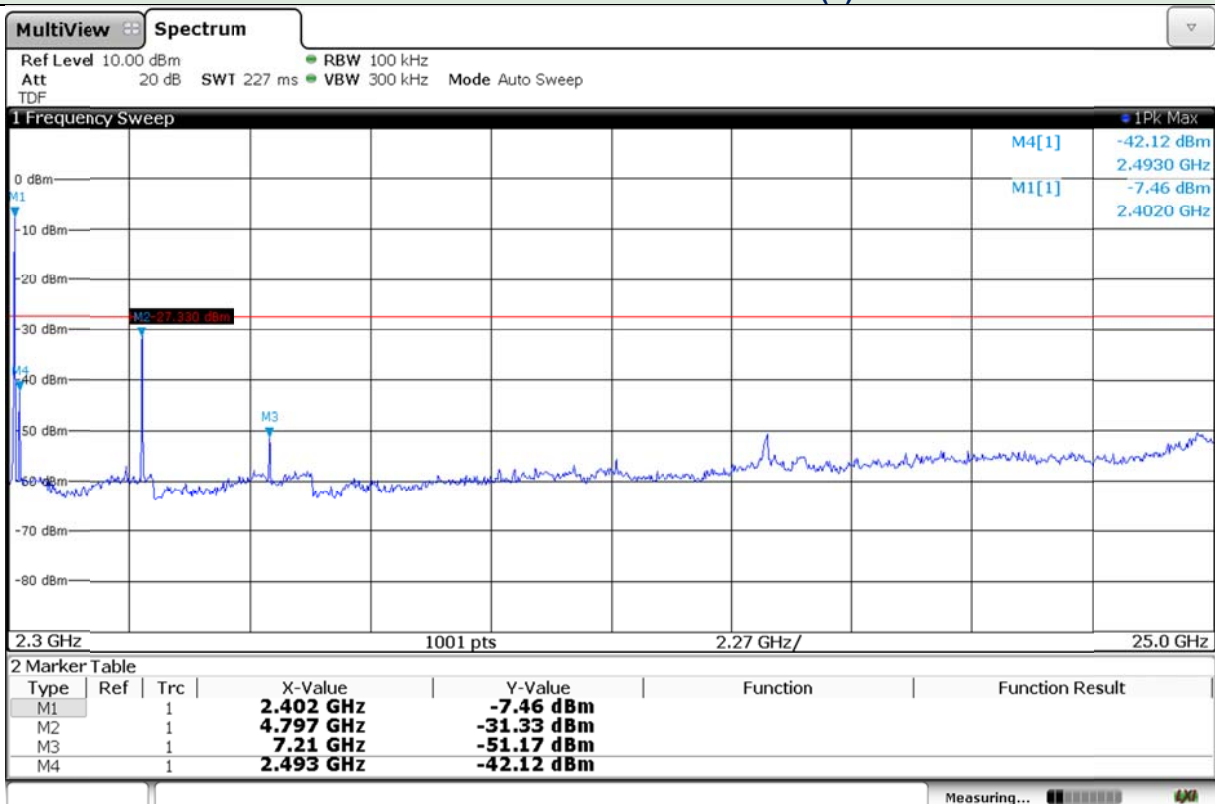
#### Band-edge and Restricted band – High channel



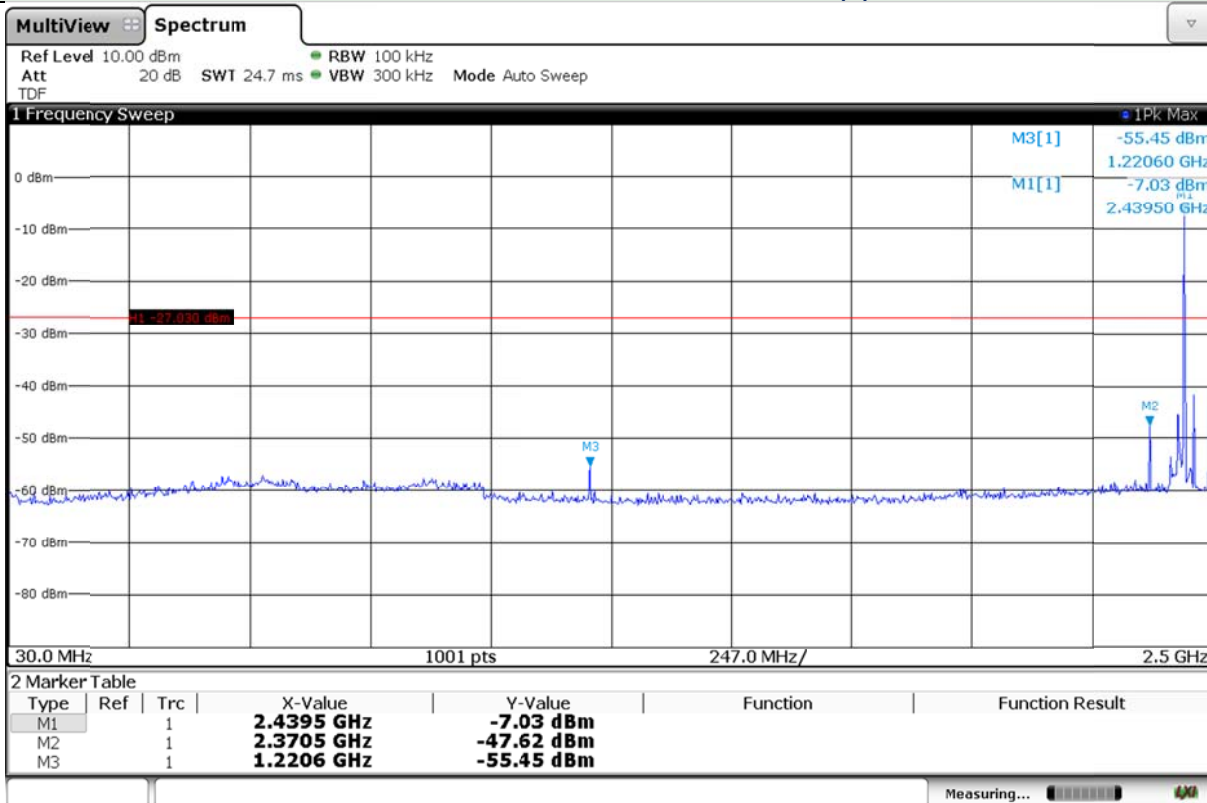
### Non-restricted band – Low Channel (1)



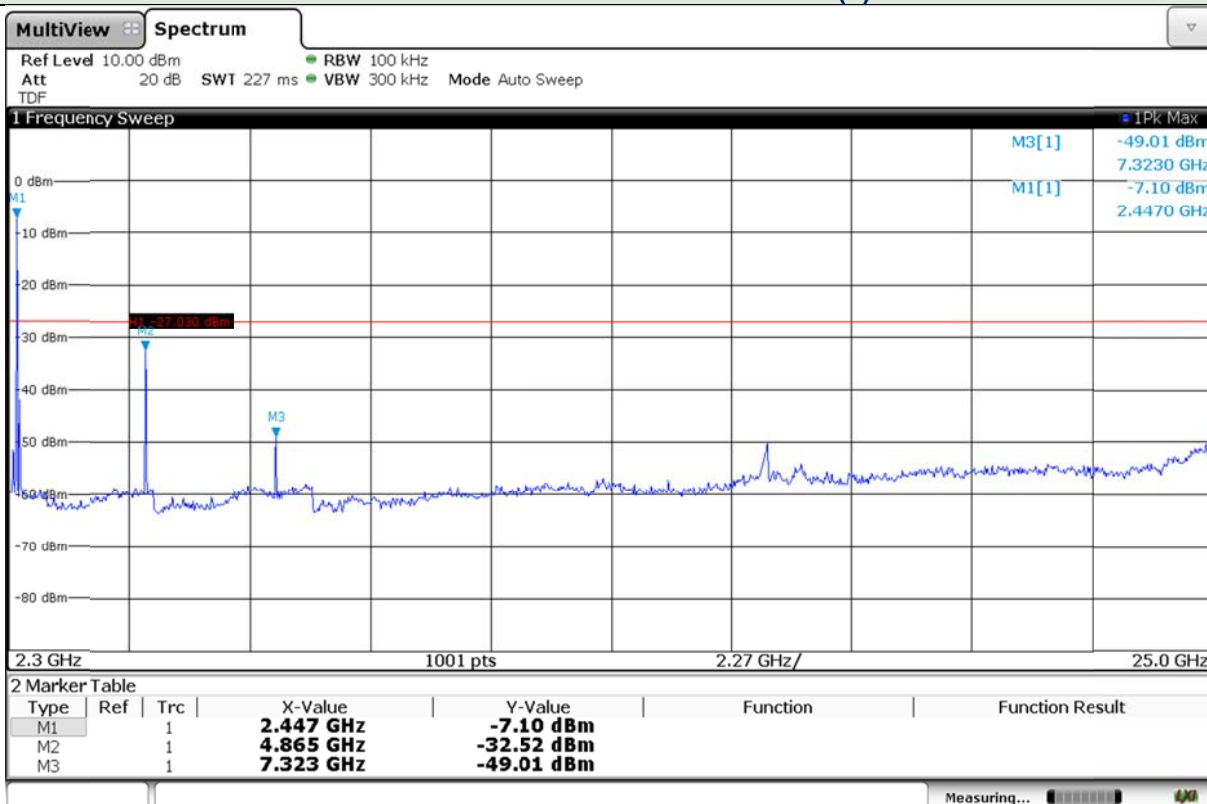
### Non-restricted band – Low Channel (2)



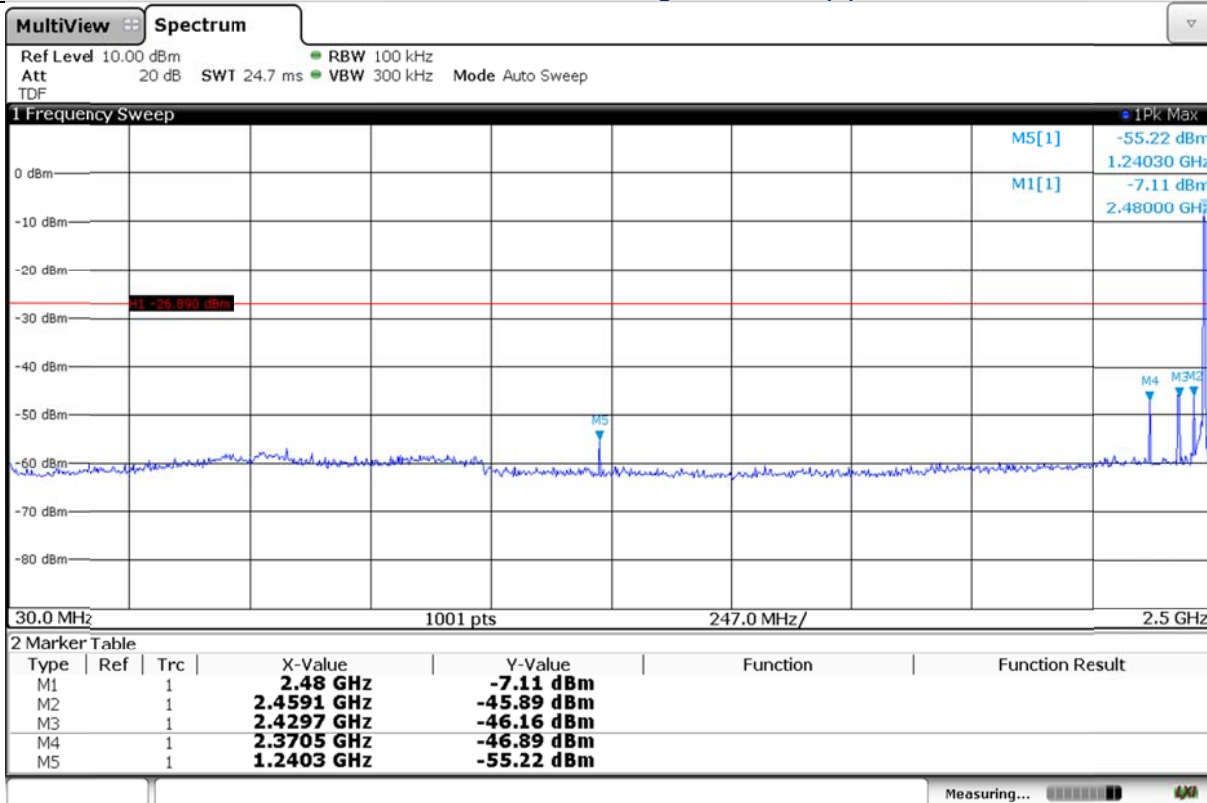
### Non-restricted band – Middle Channel (1)



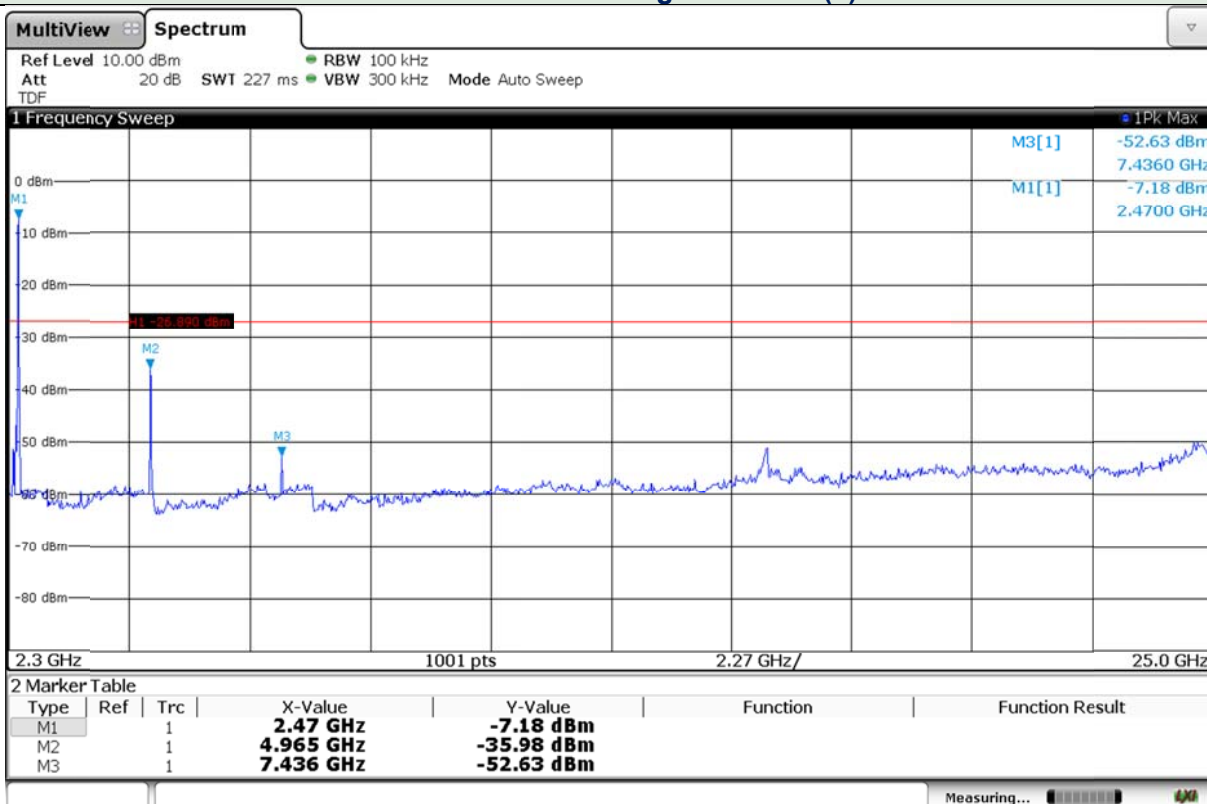
### Non-restricted band – Middle Channel (2)



## Non-restricted band – High Channel (1)



## Non-restricted band – High Channel (2)



## 5.6 Radiated Emission

### 5.6.1 Limit

Acc. To section 15.205, 15.209, and RSS-Gen 8.9, following table shall be applied.

| Frequency Range (MHz) | Field Strength Limit (uV/m) at 3 m | Field Strength Limit (dBuV/m) at 3 m |
|-----------------------|------------------------------------|--------------------------------------|
| 30 – 88               | 100                                | 40                                   |
| 88 – 216              | 150                                | 43.5                                 |
| 216 – 960             | 200                                | 46                                   |
| Above 960             | 500                                | 24                                   |

### 5.6.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v04: 12.1 Radiated emission measurements.

The radiated emissions measurements were on 3 m, semi-anechoic chamber. The EUT and other support equipment were placed on a non-conductive table 80 cm for below 1 GHz and 1.5 m for above 1 GHz above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

The frequency spectrum from 30 MHz to 25 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

For measurement below 1 GHz, the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For peak emission measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz and for average measurement, resolution bandwidth is set to 1 MHz; and the video bandwidth is set to 10 Hz, when duty cycle is more than 98 %. If duty cycle is less than 98 %, the video bandwidth is set to  $\geq 1/T$ , where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz. The spectrum from 30 MHz to 25 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band.

### 5.6.3 Test Site Requirement for KDB 414788 D01

Acc. to KDB 414788 D01 Radiated Test Site v01, Semi Anechoic Chamber (SAC) shall be verified test results below 30 MHz with Open Area Test Site (OATS), so we compared test results between the measurements from our SAC and an OATS and found test results almost same, so we **declare test result for below 30 MHz from our SAC is valid and met the requirement acc. to KDB 414788 D01 Radiated Test Site v01.**

### 5.6.4 Measurement Uncertainty

Measurement uncertainties were not taken into account and following uncertainty levels have been estimated for tests performed on the apparatus. The measurement uncertainties are given with at least 95 % confidence.

| Frequency Range | Uncertainty | Frequency Range | Uncertainty |
|-----------------|-------------|-----------------|-------------|
| 9 kHz ~ 30 MHz  | ± 2.1 dB    | 30 MHz ~ 1 GHz  | ± 4.8 dB    |
| 1 GHz ~ 18 GHz  | ± 5.0 dB    | 18 GHz ~25 GHz  | ± 5.3 dB    |

### 5.6.5 Sample Calculated Example

At 80 MHz

Limit = 40.0 dBuV/m

Result (dBuV/m)

= Receiver Reading (dBuV) + Antenna Factor (dB/m) - Pre-amplifier Gain (dB) + Cable Loss (dB) = 30

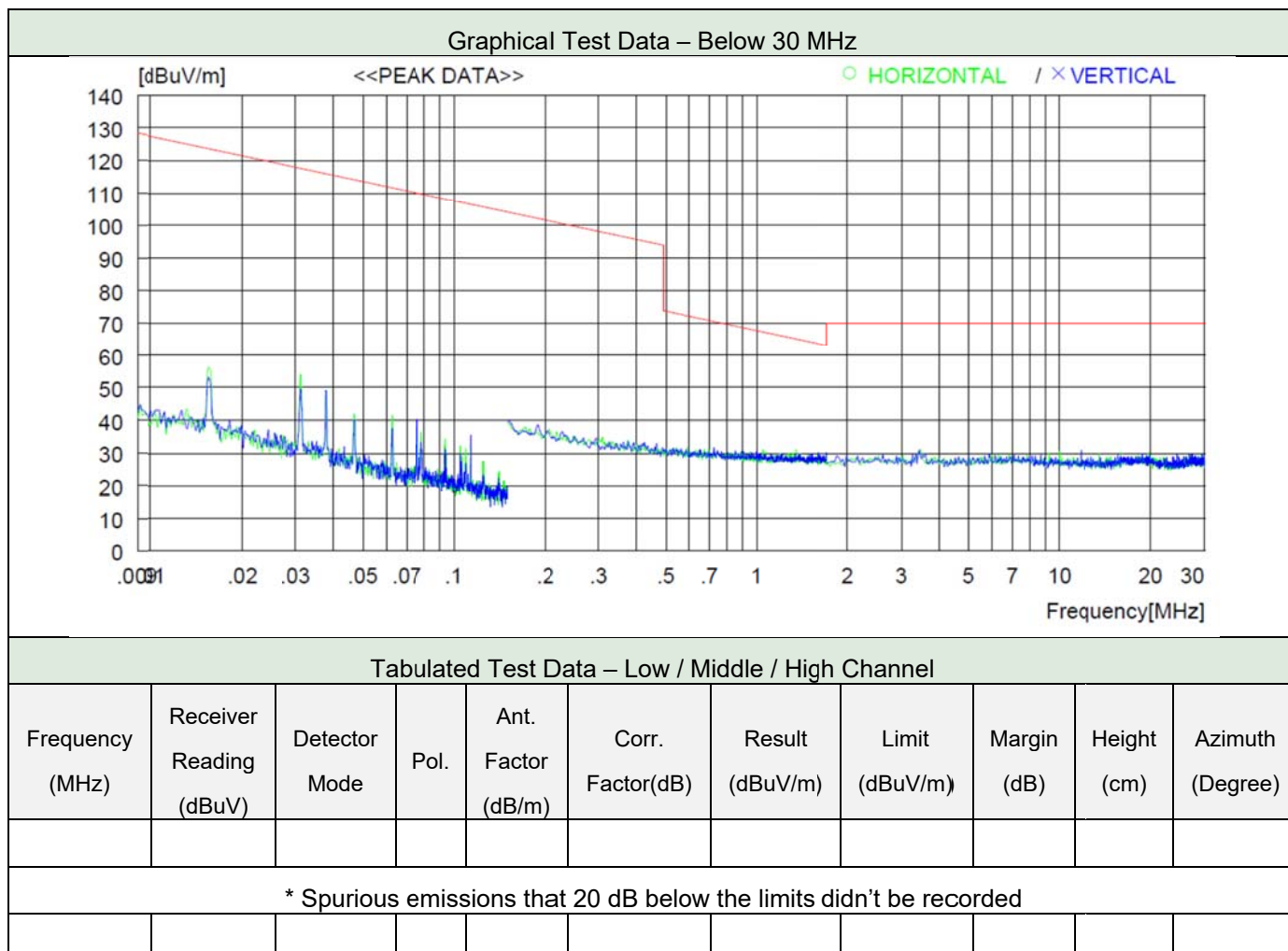
Margin = Limit – Result = 40 – 30 = 10

so the EUT has 10.0 dB margin at 80 MHz

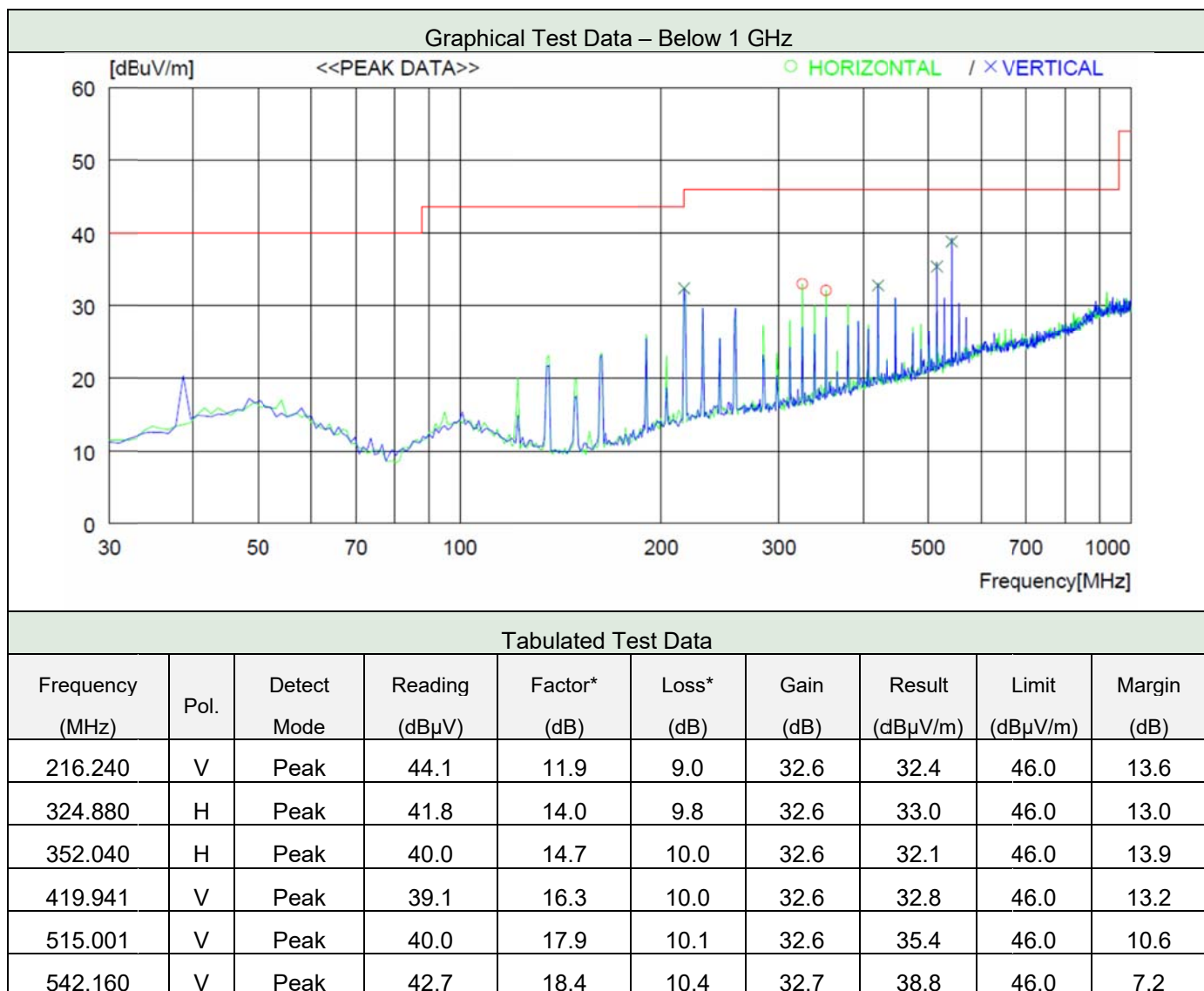
## 5.6.6 Test Data

|                             |               |                   |                     |                                                                                                 |                      |  |
|-----------------------------|---------------|-------------------|---------------------|-------------------------------------------------------------------------------------------------|----------------------|--|
| Date of Test                | 2019-02-14    | Temperature       | (22.6 ± 2.7) °C     |                                                                                                 |                      |  |
|                             |               | Relative humidity | (46.3 ± 5.9) % R.H. |                                                                                                 |                      |  |
| Measurement Frequency Range |               | 9 kHz ~ 25 GHz    |                     |                                                                                                 |                      |  |
| Test Result                 | PASS          | Tested By         |                     | Do-heon Kim  |                      |  |
| Frequency range             | Detector Mode | Resolution BW     | Video BW            | Video Filtering                                                                                 | Measurement distance |  |
| Below 30 MHz                | Peak or Q.P.  | 9 kHz             | 100 kHz             | -                                                                                               | 3 m                  |  |
| 30 MHz ~ 1 000 MHz          | Peak or Q.P.  | 100 kHz           | 300 kHz             | -                                                                                               | 3 m                  |  |
| Above 1 GHz                 | Peak          | 1 MHz             | 3 MHz               |                                                                                                 | 3 m                  |  |
|                             | Average       | 1 MHz             | 3 MHz               |                                                                                                 | 3 m                  |  |

### 5.6.6.1 Test Data below 30 MHz



## 5.6.6.2 Test Data from 30 MHz to 1 GHz



Note: "H" means Horizontal polarity, "V" means Vertical polarity.

GFSK lowest channel is worst case configuration, so test data is reported for lowest channel only.

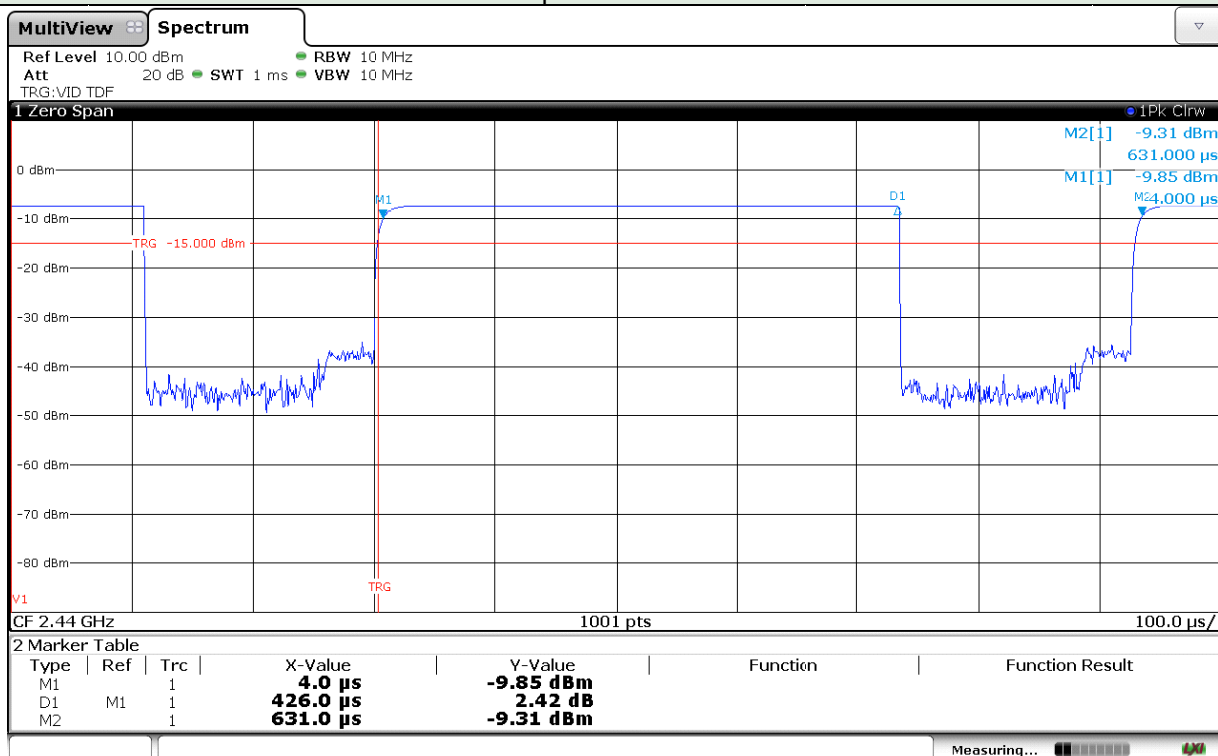
Quasi-peak measurements are omitted because the peak data meets the limit.

### 5.6.6.3 Test Data above 1 GHz

#### 5.6.6.3.1 Duty Cycle

|                      |               |                   |                                                                                                 |
|----------------------|---------------|-------------------|-------------------------------------------------------------------------------------------------|
| Date of Test         | 2019-02-14    | Temperature       | (22.6 ± 2.7) °C                                                                                 |
|                      |               | Relative humidity | (46.3 ± 5.9) % R.H.                                                                             |
| Measurement Distance | 3 m           | Tested By         | Do-heon Kim  |
| Detector Mode        | Resolution BW | Video BW          | Sweep Time                                                                                      |
| PEAK                 | 1 MHz         | 3 MHz             | Auto                                                                                            |
| AVERAGE              | 1 MHz         | 3 MHz             | Auto                                                                                            |

#### Graphical Test Data



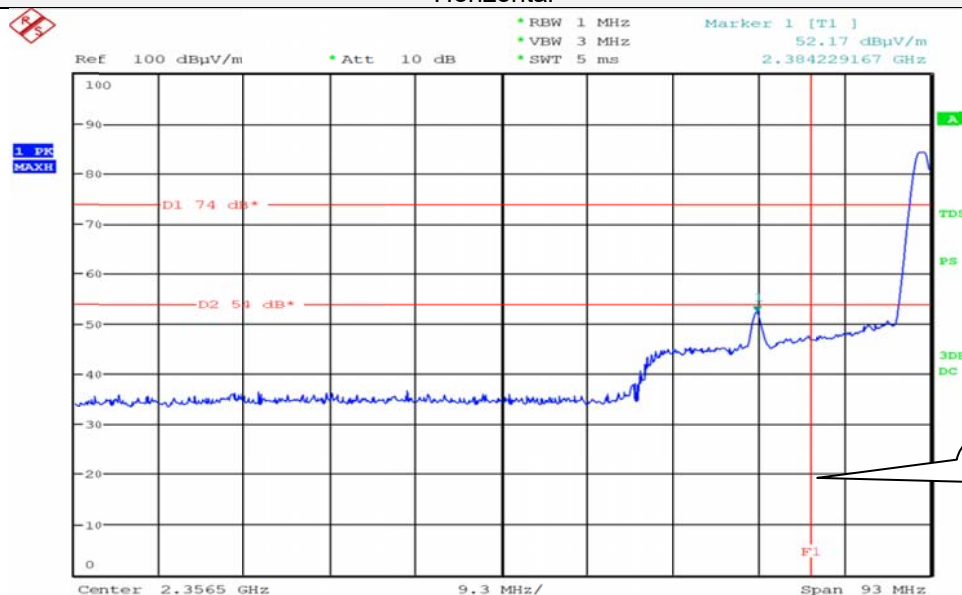
#### Tabulated Test Data

| Operating Mode | On Time (μs) | On + Off Time (μs) | Duty Cycle (%) | Duty Factor (dB) |
|----------------|--------------|--------------------|----------------|------------------|
| Bluetooth LE   | 426.0        | 631.0              | 67.51          | 1.71             |

### 5.6.6.3.2 Test Data for Band edge (Restricted band)

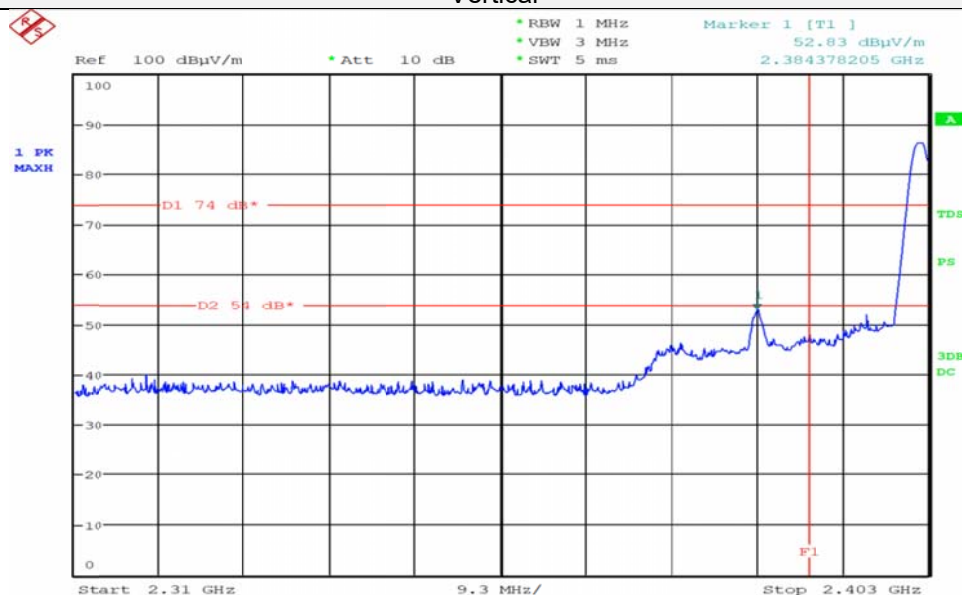
#### Graphical Test Data – Low Channel (Peak)

##### Horizontal



F1 = 2 390 MHz

##### Vertical



#### Tabulated Test Data – Low Channel

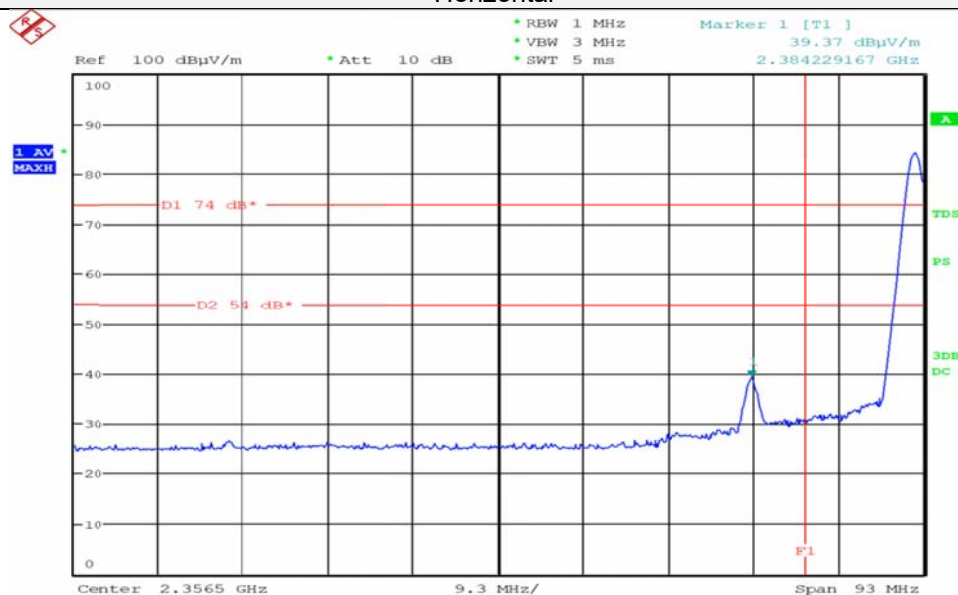
| Freq.<br>(MHz) | Detector<br>Mode | Pol. | Measured<br>Value<br>(dBuV/m) | Duty<br>Factor<br>(dB) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Height<br>(cm) | Azimuth<br>(Deg) |
|----------------|------------------|------|-------------------------------|------------------------|--------------------|-------------------|----------------|----------------|------------------|
| 2 384.2        | Peak             | H    | 52.17                         | -                      | 52.17              | 74.00             | 21.83          | 100            | 130              |
| 2 384.4        | Peak             | V    | 52.83                         | -                      | 52.83              | 74.00             | 21.17          | 100            | 240              |

**NOTE:** “H” means Horizontal polarity, “V” means Vertical polarity.

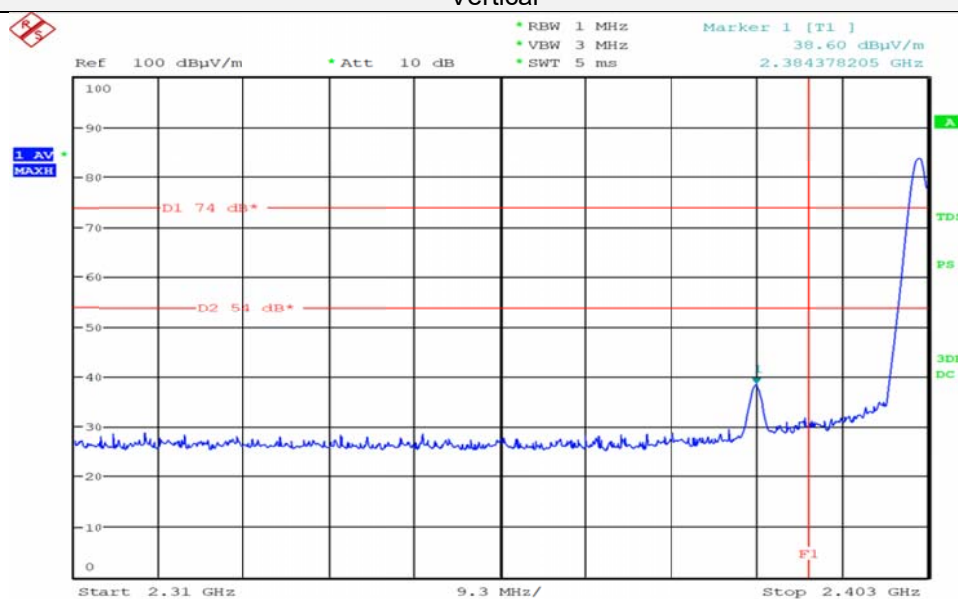
Measured Value = Receiver reading + Antenna Factor + Cable Loss - Pre-amplifier Gain

## Graphical Test Data – Low Channel (Average)

### Horizontal



### Vertical



### Tabulated Test Data – Low Channel

| Freq.<br>(MHz) | Detector<br>Mode | Pol. | Measured<br>Value<br>(dBuV/m) | Duty<br>Factor<br>(dB) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Height<br>(cm) | Azimuth<br>(Deg) |
|----------------|------------------|------|-------------------------------|------------------------|--------------------|-------------------|----------------|----------------|------------------|
| 2 384.2        | Average          | H    | 39.37                         | 1.71                   | 41.08              | 54.00             | 12.92          | 100            | 130              |
| 2 384.4        | Average          | V    | 38.60                         | 1.71                   | 40.31              | 54.00             | 13.69          | 100            | 240              |

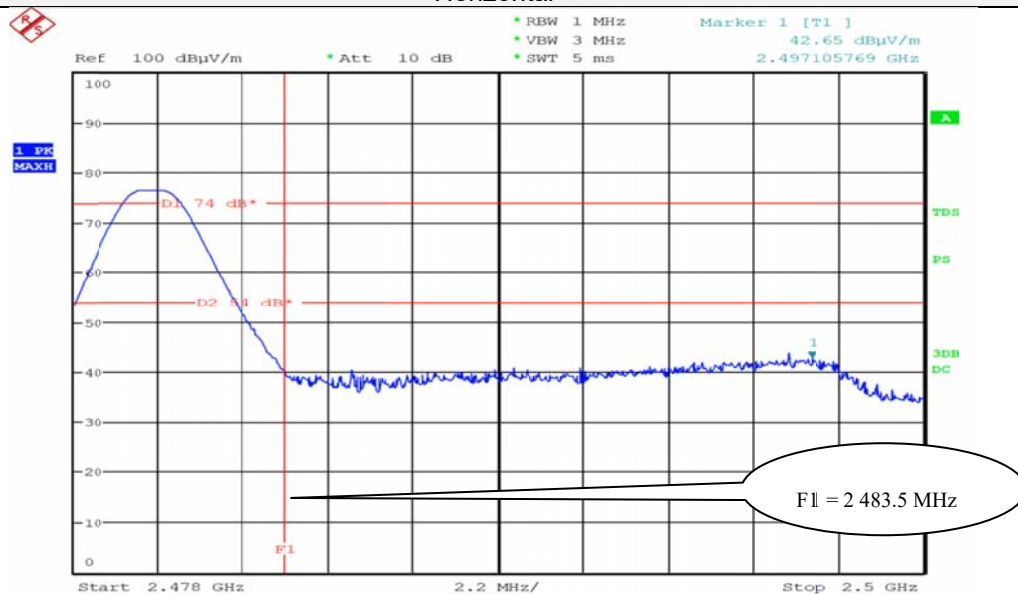
**NOTE:** “H” means Horizontal polarity, “V” means Vertical polarity.

Measured Value = Receiver reading + Antenna Factor + Cable Loss - Pre-amplifier Gain

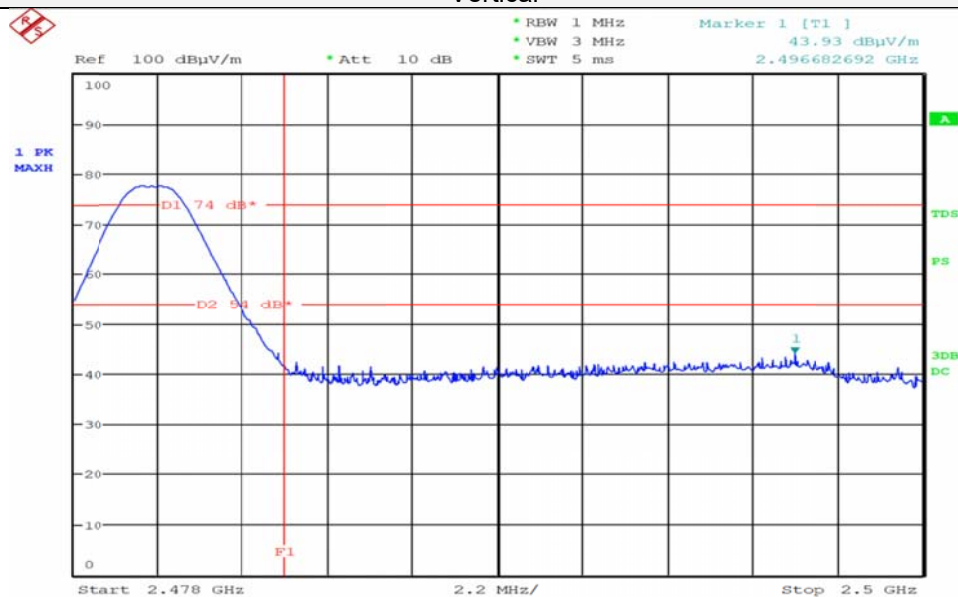
Result = Measured Value + Duty Factor

### Graphical Test Data – High Channel (Peak)

#### Horizontal



#### Vertical



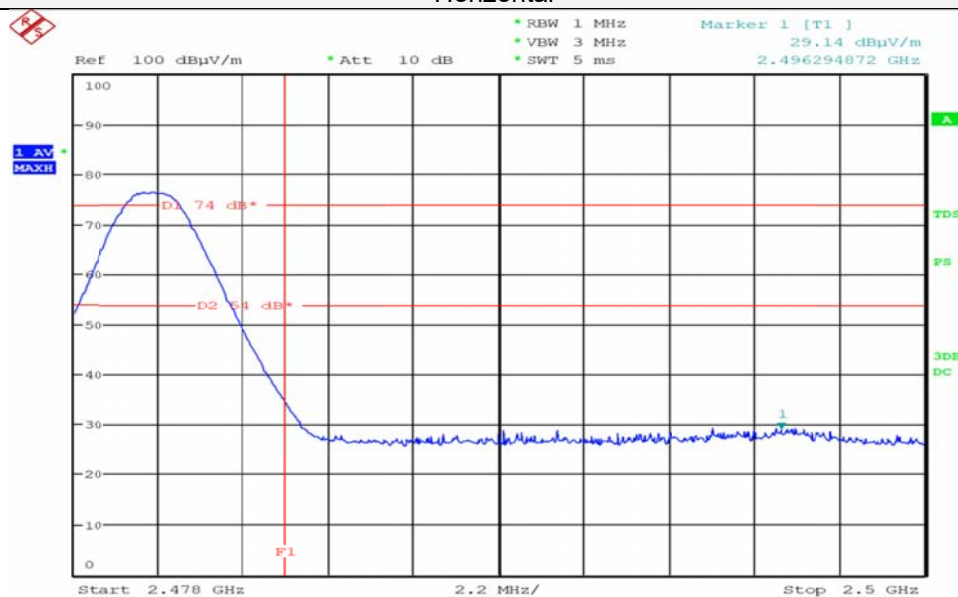
### Tabulated Test Data – High Channel

| Freq. (MHz) | Detector Mode | Pol. | Measured Value (dBuV/m) | Duty Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Height (cm) | Azimuth (Deg) |
|-------------|---------------|------|-------------------------|------------------|-----------------|----------------|-------------|-------------|---------------|
| 2497.1      | Peak          | H    | 42.65                   | -                | 42.65           | 74.00          | 31.35       | 100         | 140           |
| 2496.7      | Peak          | V    | 43.93                   | -                | 43.93           | 74.00          | 30.07       | 100         | 230           |

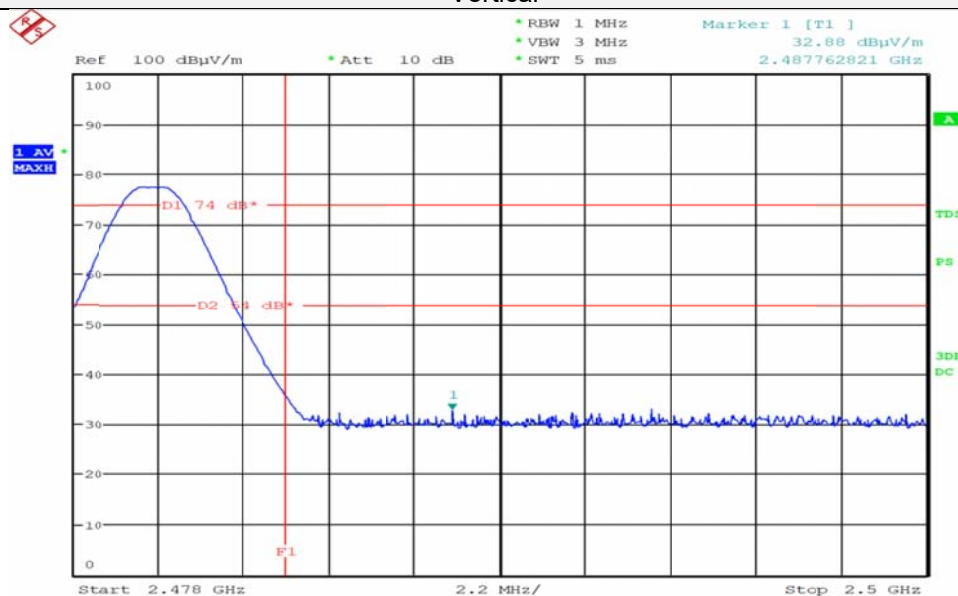
**NOTE:** "H" means Horizontal polarity, "V" means Vertical polarity.

## Graphical Test Data – High Channel (Average)

### Horizontal



### Vertical



### Tabulated Test Data – High Channel

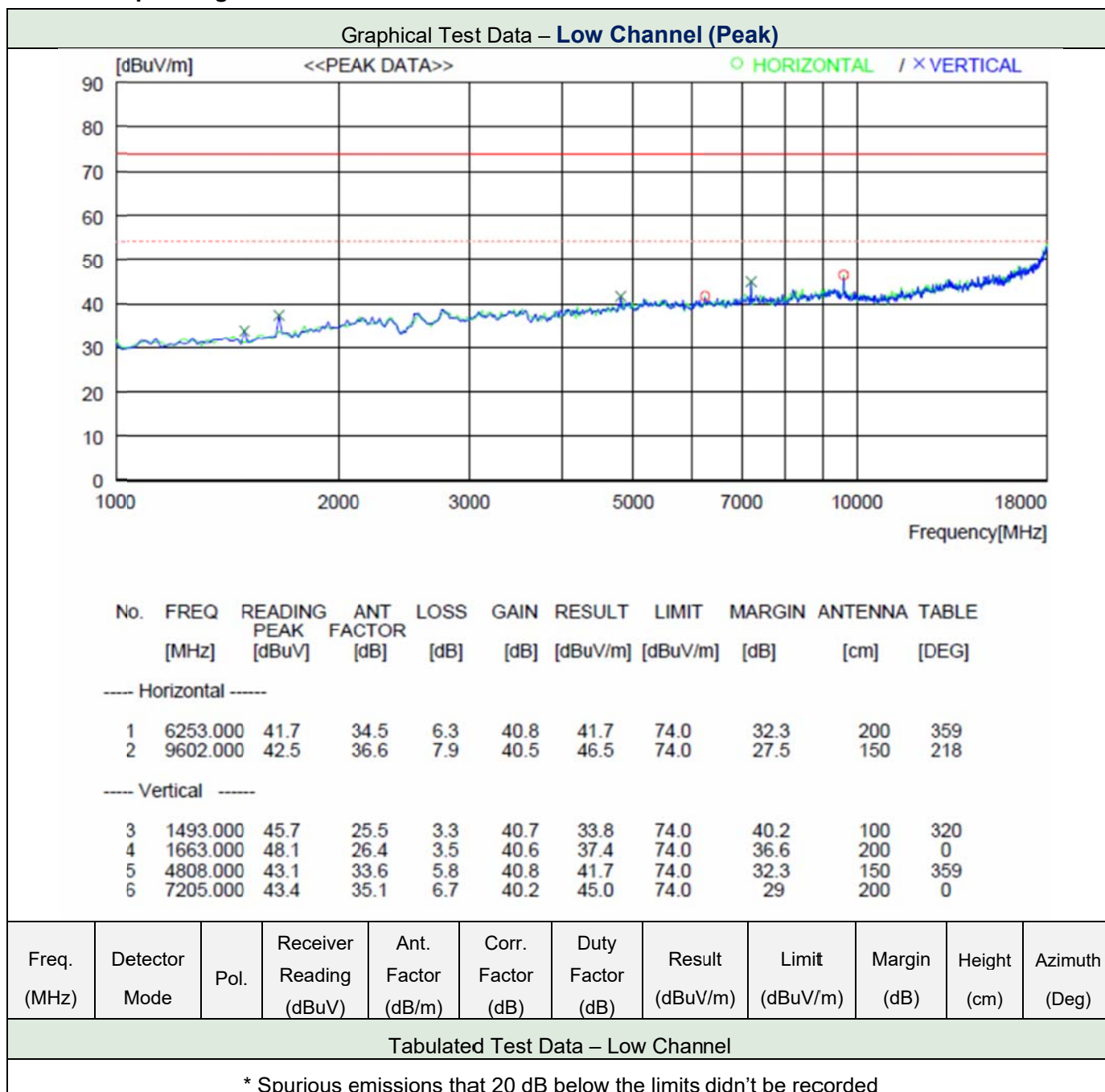
| Freq.<br>(MHz) | Detector<br>Mode | Pol. | Measured<br>Value<br>(dBuV/m) | Duty<br>Factor<br>(dB) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Height<br>(cm) | Azimuth<br>(Deg) |
|----------------|------------------|------|-------------------------------|------------------------|--------------------|-------------------|----------------|----------------|------------------|
| 2 496.3        | Average          | H    | 29.14                         | 1.71                   | 30.85              | 54.00             | 23.15          | 100            | 140              |
| 2 487.8        | Average          | V    | 32.88                         | 1.71                   | 34.59              | 54.00             | 19.41          | 100            | 230              |

**NOTE:** “H” means Horizontal polarity, “V” means Vertical polarity.

Result = Measured Value + Duty Factor

## 5.6.6.4 Test Data for Harmonic & Spurious emission (1 GHz to 18 GHz)

### 5.6.6.4.1 Operating mode: Bluetooth LE



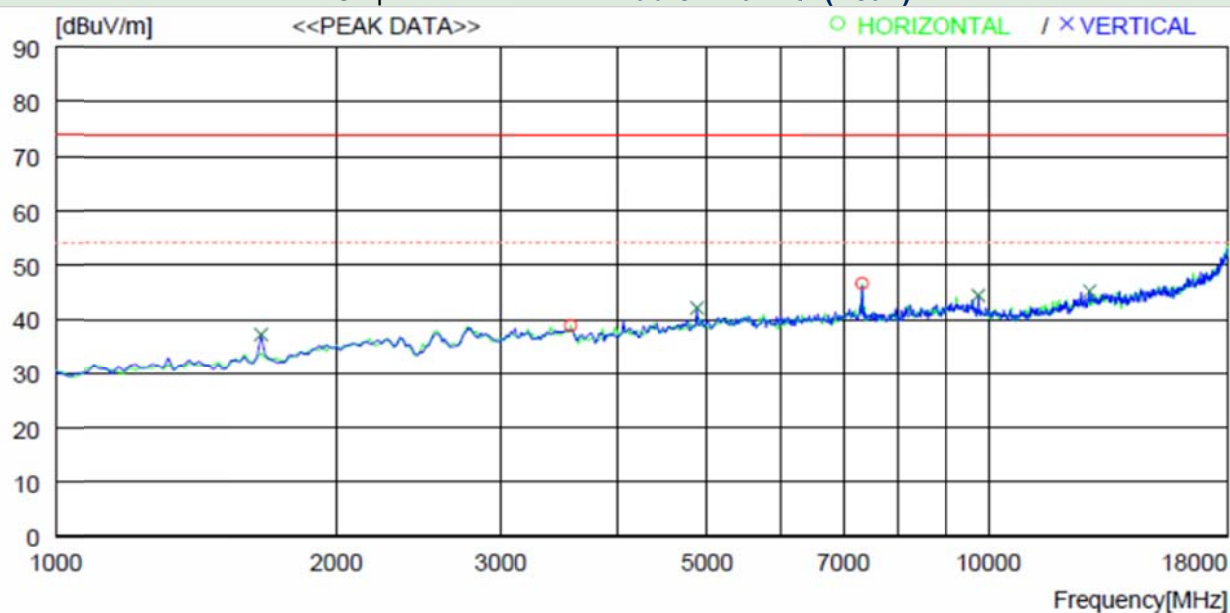
Note. "H" means Horizontal polarity, "V" means Vertical polarity.

Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit – Result

### Graphical Test Data – Middle Channel (Peak)



| No.                  | FREQ<br>[MHz] | READING<br>PEAK<br>[dBuV] | ANT<br>FACTOR<br>[dB] | LOSS<br>[dB] | GAIN<br>[dB] | RESULT<br>[dBuV/m] | LIMIT<br>[dBuV/m] | MARGIN<br>[dB] | ANTENNA<br>[cm] | TABLE<br>[DEG] |
|----------------------|---------------|---------------------------|-----------------------|--------------|--------------|--------------------|-------------------|----------------|-----------------|----------------|
| ---- Horizontal ---- |               |                           |                       |              |              |                    |                   |                |                 |                |
| 1                    | 3567.000      | 43.1                      | 31.7                  | 4.9          | 40.8         | 38.9               | 74.0              | 35.1           | 150             | 52             |
| 2                    | 7324.000      | 44.9                      | 35.2                  | 6.7          | 40.2         | 46.6               | 74.0              | 27.4           | 150             | 0              |
| ---- Vertical ----   |               |                           |                       |              |              |                    |                   |                |                 |                |
| 3                    | 1663.000      | 47.9                      | 26.4                  | 3.5          | 40.6         | 37.2               | 74.0              | 36.8           | 200             | 320            |
| 4                    | 4876.000      | 43.3                      | 33.7                  | 5.8          | 40.7         | 42.1               | 74.0              | 31.9           | 150             | 184            |
| 5                    | 9755.000      | 40.6                      | 36.7                  | 7.9          | 40.8         | 44.4               | 74.0              | 29.6           | 150             | 359            |
| 6                    | 12832.000     | 39.5                      | 37.4                  | 9.2          | 40.9         | 45.2               | 74.0              | 28.8           | 150             | 359            |

| Freq.<br>(MHz) | Detector<br>Mode | Pol. | Receiver<br>Reading<br>(dBuV) | Ant.<br>Factor<br>(dB/m) | Corr.<br>Factor<br>(dB) | Duty<br>Factor<br>(dB) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Height<br>(cm) | Azimuth<br>(Deg) |
|----------------|------------------|------|-------------------------------|--------------------------|-------------------------|------------------------|--------------------|-------------------|----------------|----------------|------------------|
|----------------|------------------|------|-------------------------------|--------------------------|-------------------------|------------------------|--------------------|-------------------|----------------|----------------|------------------|

### Tabulated Test Data – Middle Channel

\* Spurious emissions that 20 dB below the limits didn't be recorded

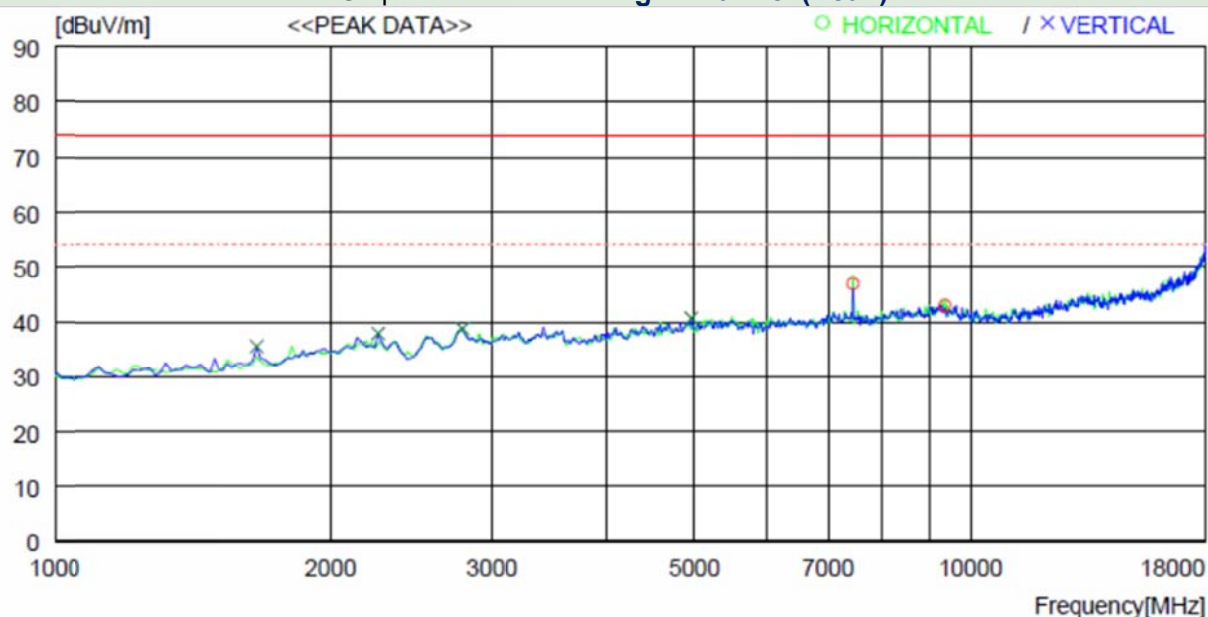
Note. "H" means Horizontal polarity, "V" means Vertical polarity.

Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit - Result

### Graphical Test Data – High Channel (Peak)



| No.                  | FREQ<br>[MHz] | READING<br>PEAK<br>[dBuV] | ANT<br>FACTOR<br>[dB] | LOSS<br>[dB] | GAIN<br>[dB] | RESULT<br>[dBuV/m] | LIMIT<br>[dBuV/m] | MARGIN<br>[dB] | ANTENNA<br>[cm] | TABLE<br>[DEG] |
|----------------------|---------------|---------------------------|-----------------------|--------------|--------------|--------------------|-------------------|----------------|-----------------|----------------|
| ---- Horizontal ---- |               |                           |                       |              |              |                    |                   |                |                 |                |
| 1                    | 7443.000      | 46.7                      | 35.3                  | 5.7          | 40.7         | 47.0               | 74.0              | 27             | 200             | 359            |
| 2                    | 9381.000      | 40.0                      | 36.6                  | 6.7          | 40.3         | 43.0               | 74.0              | 31             | 100             | 359            |
| ---- Vertical ----   |               |                           |                       |              |              |                    |                   |                |                 |                |
| 3                    | 1663.000      | 46.2                      | 26.4                  | 3.5          | 40.6         | 35.5               | 74.0              | 38.5           | 200             | 0              |
| 4                    | 2258.000      | 44.3                      | 28.5                  | 5.7          | 40.6         | 37.9               | 74.0              | 36.1           | 150             | 188            |
| 5                    | 2785.000      | 43.2                      | 29.7                  | 6.6          | 40.7         | 38.8               | 74.0              | 35.2           | 200             | 0              |
| 6                    | 4961.000      | 41.9                      | 33.8                  | 5.7          | 40.7         | 40.7               | 74.0              | 33.3           | 100             | 147            |

| Freq.<br>(MHz) | Detector<br>Mode | Pol. | Receiver<br>Reading<br>(dBuV) | Ant.<br>Factor<br>(dB/m) | Corr.<br>Factor<br>(dB) | Duty<br>Factor<br>(dB) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Height<br>(cm) | Azimuth<br>(Deg) |
|----------------|------------------|------|-------------------------------|--------------------------|-------------------------|------------------------|--------------------|-------------------|----------------|----------------|------------------|
|----------------|------------------|------|-------------------------------|--------------------------|-------------------------|------------------------|--------------------|-------------------|----------------|----------------|------------------|

### Tabulated Test Data – High Channel

\* Spurious emissions that 20 dB below the limits didn't be recorded

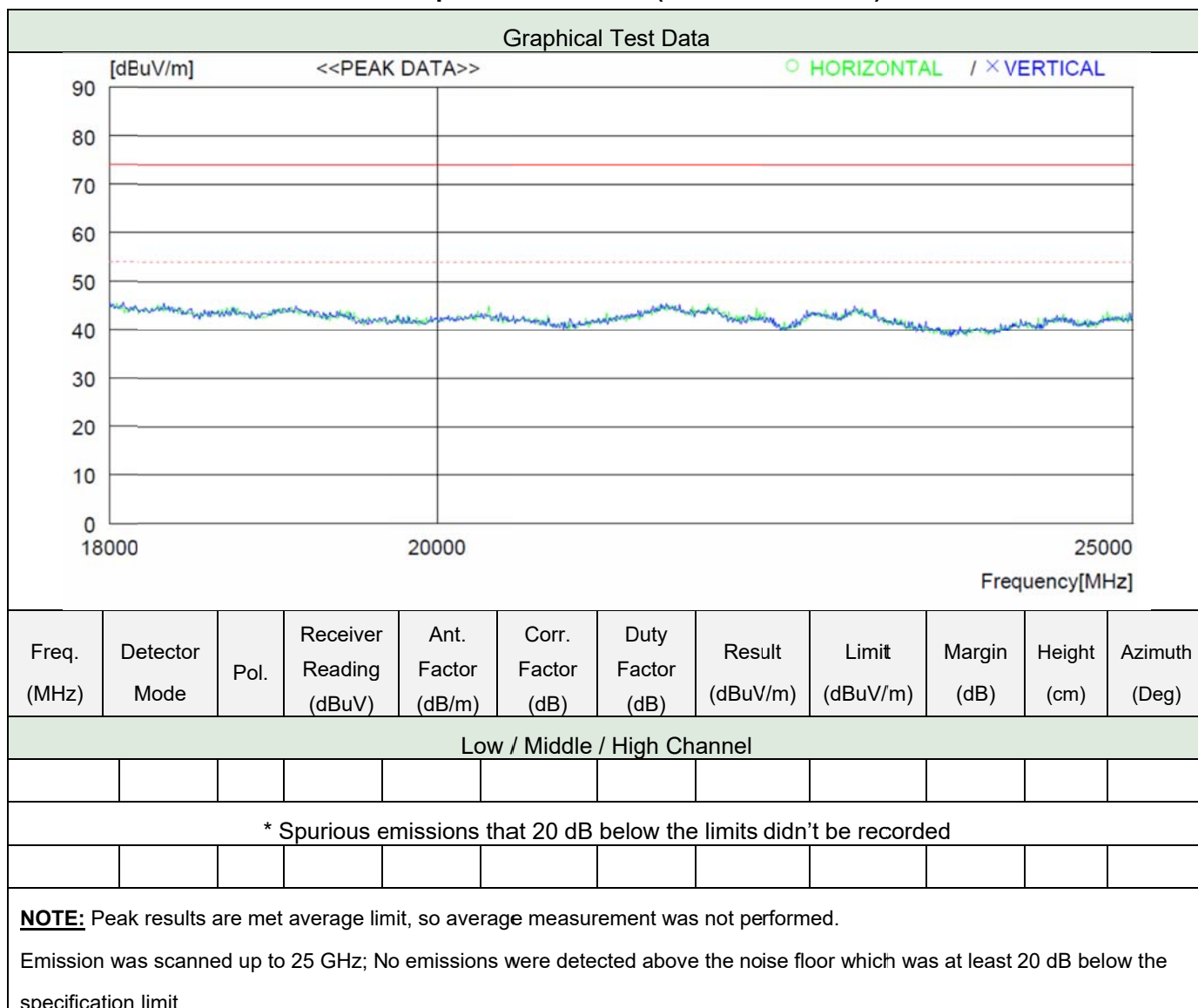
Note. "H" means Horizontal polarity, "V" means Vertical polarity.

Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit - Result

### 5.6.6.5 Test Data for Harmonic & Spurious emission (18 GHz to 25 GHz)



Note. "H" means Horizontal polarity, "V" means Vertical polarity.

Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit - Result

## Appendix I – Test Instrumentation

| Description                | Model No.    | Serial No.            | Manufacturer.     | Due for Cal. Date | Cal. Interval |
|----------------------------|--------------|-----------------------|-------------------|-------------------|---------------|
| Signal & Spectrum Analyzer | FSW 43       | 100578                | Rohde & Schwarz   | 2019-04-26        | 1 Y           |
| Attenuator                 | 56-10        | 58769                 | WEINSCHTEL        | 2020-01-22        | 1 Y           |
| Test Receiver              | ESU 26       | 100303                | Rohde & Schwarz   | 2020-01-18        | 1 Y           |
| Loop Antenna               | HFH2-Z2      | 100341                | Rohde & Schwarz   | 2019-04-21        | 2 Y           |
| TRILOG Broadband Antenna   | VULB9163     | 9163.799              | Schwarzbeck       | 2019-09-14        | 2 Y           |
| Horn Antenna               | HF 907       | 102426                | Rohde & Schwarz   | 2021-01-11        | 2 Y           |
| Horn Antenna               | BBHA 9170    | BBHA 9170 #783        | Schwarzbeck       | 2020-11-28        | 2 Y           |
| Notch Filter               | BRM50702     | G318                  | MICRO-TRONICS     | 2019-11-08        | 1 Y           |
| Attenuator                 | 6dB          | 272.4110.50           | Rohde & Schwarz   | 2020-01-18        | 1 Y           |
| Pre-Amplifier              | 310N         | 344015                | Sonoma Instrument | 2020-01-18        | 1 Y           |
| Pre-Amplifier              | SCU 18D      | 19006450              | Rohde & Schwarz   | 2019-04-24        | 1 Y           |
| Pre-Amplifier              | CBL18265035  | 28706                 | CERNEX            | 2019-03-29        | 1 Y           |
| Turn Table                 | DT3000-3t    | 1310814               | INNCO SYSTEM      | N/A               | N/A           |
| Antenna Master             | MA4000-EP    | 4600814               | INNCO SYSTEM      | N/A               | N/A           |
| Antenna Master             | MA4000-XP-ET | -                     | INNCO SYSTEM      | N/A               | N/A           |
| Camera Controller          | HDCon4102    | 6531445048            | PONTIS            | N/A               | N/A           |
| CO3000 Controller          | Co3000-4Port | CO3000/806/34130814/L | INNCO SYSTEM      | N/A               | N/A           |
| CO3000 Controller          | Co3000-4Port | CO3000/807/34130814/L | INNCO SYSTEM      | N/A               | N/A           |

The measuring equipment utilized to perform the tests documented in this test report has been calibrated in accordance with manufacturer's recommendations, and is traceable to recognized national standards.