verify No.480962688830

위변조방지/진위확인
www.docuqr.com

# TEST REPORT

**KCTL Inc.**
65, Sinwon-ro, Yeongtong-gu,
Suwon-si, Gyeonggi-do, 16677, Korea
TEL: 82-31-285-0894 FAX: 82-505-299-8311
www.kctl.co.kr



KCTL

**1. Client**

- Name : TBC Co.,LTD.
- Address : i-115, 38 Wolgok-Gil Gangnae-Myeon, Heungdeok-Gu, Cheongju-Si, Chungcheongbuk-Do, South Korea (28171)
- Date of Receipt : 2017-12-05

**2. Use of Report** : -

**3. Name of Product and Model** : Anykey / AKP-200

**4. Manufacturer and Country of Origin** : TBC Co.,LTD. / Korea

**5. FCC ID** : 2AOHM-AKP-200

**6. Date of Test** : 2018-02-01 to 2018-02-02

**7. Test Standards** : FCC Part 15 Subpart C, 15.247

**8. Test Results** : Refer to the test result in the test report

| | | |
|---|---|---|
| Affirmation | Tested by<br>Name : Dowon Ahn (Signature) | Technical Manager<br>Name : Jongha Choi (Signature) |

2018-02-14

## KCTL Inc.

As a test result of the sample which was submitted from the client, this report does not guarantee the whole product quality. This test report should not be used and copied without a written agreement by KCTL Inc.

REPORT REVISION HISTORY

| Date | Revision | Page No |
|---|---|---|
| 2018-02-02 | Originally issued | - |
| 2018-02-13 | Revised section rule and added test plots, ducy factor | Several pages |
| 2018-02-14 | Included section 3.5 and revised note | 7, 24 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

*This report shall not be reproduced except in full, without the written approval of KCTL Inc. This document may be altered or revised by KCTL Inc. personnel only, and shall be noted in the revision section of the document. Any alteration of this document not carried out by KCTL Inc. will constitute fraud and shall nullify the document.*

# [ Contents ]

**1. Client information ..... 4**
**2. Laboratory information ..... 5**
**3. Description of E.U.T. ..... 6**
3.1 Basic description ..... 6
3.2 General description ..... 6
3.3 Test frequency ..... 7
3.4 Test Voltage ..... 7
**4. Summary of test results ..... 8**
4.1 Standards & results ..... 8
4.2 Uncertainty ..... 8
**5. Test results ..... 9**
5.1 Antenna Requirement ..... 9
5.2 Maximum Peak Output Power ..... 10
5.3 Peak Power Spectral Density ..... 12
5.4 6 dB Bandwidth(DTS Channel Bandwidth) ..... 16
5.5 Spurious Emission, Band Edge, and Restricted bands ..... 21
5.6 Conducted Emission ..... 43
**6. Test equipment used for test ..... 45**

This test report shall not be reproduced, except in full, without the written approval

# 1. Client information

| | |
|---|---|
| **Applicant:** | TBC Co.,LTD. |
| **Address:** | i-115, 38 Wolgok-Gil Gangnae-Myeon, Heungdeok-Gu, Cheongju-Si, Chungcheongbuk-Do, South Korea (28171) |
| **Telephone number:** | +82 10 3466 1748 |
| **Facsimile number:** | +82 3 230 2169 |
| **Contact person:** | Kihyeong Lee / ceo.tbc@gmail.com |

| | |
|---|---|
| **Manufacturer:** | TBC Co.,LTD. |
| **Address:** | i-115, 38 Wolgok-Gil Gangnae-Myeon, Heungdeok-Gu, Cheongju-Si, Chungcheongbuk-Do, South Korea (28171) |

KCTL

# 2. Laboratory information

**Address**

**KCTL Inc.**

65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea

Telephone Number: 82 31 285 0894

Facsimile Number: 82 505 299 8311

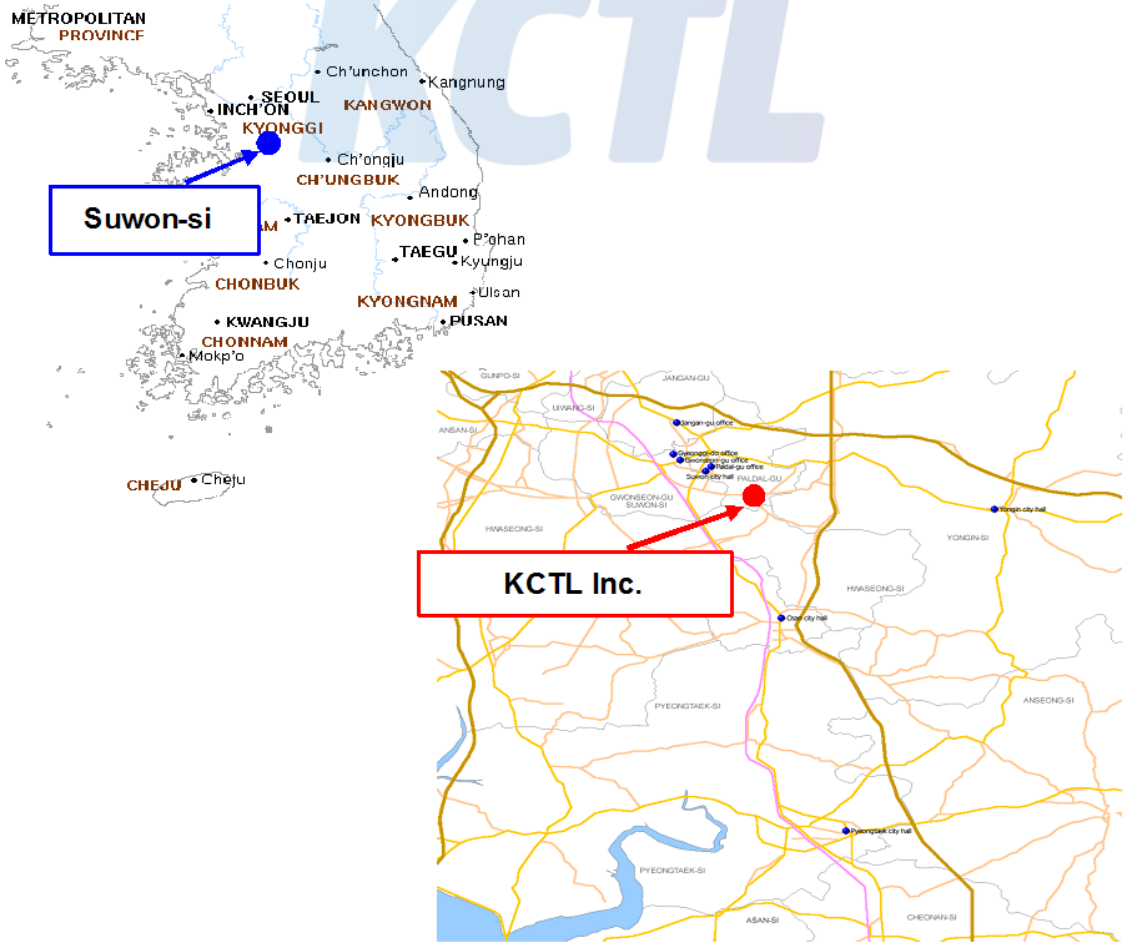
FCC Site Designation No: KR0040, FCC Site Registration No: 687132

VCCI Registration No. : R-3327, G-198, C-3706, T-1849

Industry Canada Registration No. : 8035A

KOLAS NO.: KT231

SITE MAP



# 3. Description of E.U.T.

## 3.1 Basic description

| | |
|---|---|
| Applicant | TBC Co.,LTD. |
| Address of Applicant | i-115, 38 Wolgok-Gil Gangnae-Myeon, Heungdeok-Gu, Cheongju-Si, Chungcheongbuk-Do, South Korea (28171) |
| Manufacturer | TBC Co.,LTD. |
| Address of Manufacturer | i-115, 38 Wolgok-Gil Gangnae-Myeon, Heungdeok-Gu, Cheongju-Si, Chungcheongbuk-Do, South Korea (28171) |
| Type of equipment | Anykey |
| Basic Model | AKP-200 |
| Serial number | N/A |

## 3.2 General description

| | |
|---|---|
| Frequency Range | 2 402 ㎒ ~ 2 480 ㎒ (Bluetooth Low Energy) |
| Type of Modulation | GFSK |
| The number of channels | 40 ch (Bluetooth Low Energy) |
| Type of Antenna | PCB Antenna |
| Antenna Gain | -0.533 dBi |
| Transmit Power | -2.17 dBm |
| Power supply | DC 12 V |
| Product SW/HW version | 1.0 / 2.1 |
| Radio SW/HW version | 1.0 / 2.1 |
| Test SW Version | NRFgo Studio |
| RF power setting in TEST SW | default |

Note : The above EUT information was declared by the manufacturer.

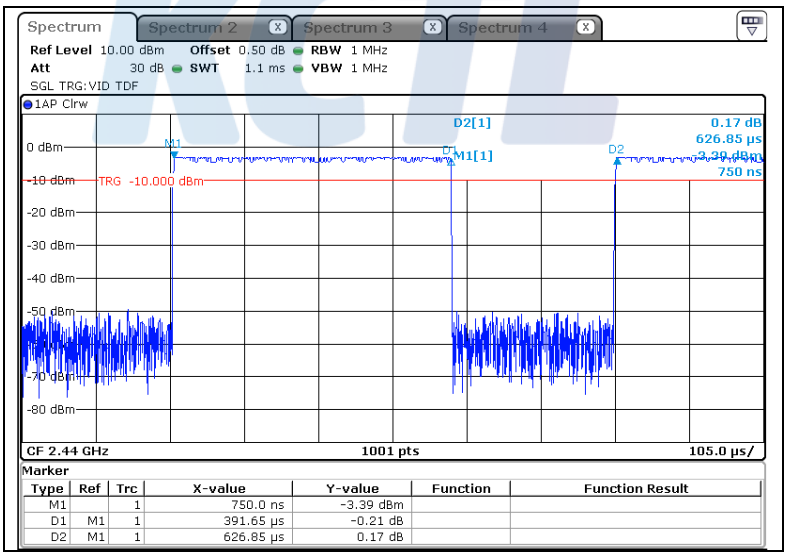
## 3.3 Test frequency

| | Frequency |
|---|---|
| Lowest frequency | 2 402 ㎒ |
| Middle frequency | 2 440 ㎒ |
| Highest frequency | 2 480 ㎒ |

## 3.4 Test Voltage

| Mode | Voltage |
|---|---|
| Nominal voltage | DC 12 V |

## 3.5 Duty Cycle Correction Factor




Note1) : period : 0.626 85 ms, On time : 0.391 65 ms
Note2) : 10 log(1 / x) = 10 log(0.626 85 / 0.391 65) = 2.042 655, x = 0.624 8
Note3) : It is a continuous transmission (duty cycle <=98 %)

# 4. Summary of test results

## 4.1 Standards & results

| FCC Rule Reference | Parameter | Report Section | Test Result |
|---|---|---|---|
| 15.203, 15.247(b)(4) | Antenna Requirement | 5.1 | C |
| 15.247(b)(3) | Maximum Peak Output Power | 5.2 | C |
| 15.247(e) | Peak Power Spectral Density | 5.3 | C |
| 15.247(a)(2) | 6 dB Channel Bandwidth | 5.4 | C |
| - | Occupied Bandwidth | 5.4 | C |
| 15.247(d),15.205(a),15.209(a) | Spurious Emission,<br>Band Edge and Restricted bands | 5.5 | C |
| 15.207(a) | Conducted Emissions | 5.6 | NA2) |

Note1) : C = complies, NC = Not complies, NT = Not tested, NA = Not Applicable
Note2) : This test is not applicable because the EUT falls into the automotive device and it's not to be connected to the public utility(AC) power line.

Note: The general test methods used to test this device is ANSI C63.10:2013

## 4.2 Uncertainty

| Measurement Item | Expanded Uncertainty<br>U = *k*Uc (*k* = 2) | |
|---|---|---|
| Conducted RF power | 1.44 dB | |
| Conducted Spurious Emissions | 1.52 dB | |
| Radiated Spurious Emissions | 30 MHz ~ 300 MHz: | +4.94 dB, -5.06 dB |
| | | +4.93 dB, -5.05 dB |
| | 300 MHz ~ 1 000 MHz: | +4.97 dB, -5.08 dB |
| | | +4.84 dB, -4.96 dB |
| | 1 GHz ~ 25 GHz: | +6.03 dB, -6.05 dB |
| Conducted Emissions | 9 kHz ~ 150 kHz: | 3.75 dB |
| | 150 kHz ~ 30 MHz: | 3.36 dB |

# 5. Test results

## 5.1 Antenna Requirement

### 5.1.1 Regulation

According to §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 provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

And according to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 5.1.2 Result

### - Complied

The transmitter has permanently attached PCB Antenna (internal antenna) on board.

## 5.2 Maximum Peak Output Power

### 5.2.1 Regulation

According to §15.247(b)(3), For systems using digital modulation in the 902-928 ㎒, 2 400-2 483.5 ㎒, and 5 725-5 850 ㎒ bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

### 5.2.2 Measurement Procedure

These test measurement settings are specified in section 9.0 of 558074 D01 DTS Meas Guidance.

#### 5.2.2.1 PKPM1 Peak-reading power meter method

The maximum peak conducted output power may be measured using a broadband peak RF power meter.
The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

## 5.2.3 Test Result

## - Complied

| Channel | Frequency [㎒] | Result [dBm] | Limit [dBm] | Margin [dB] | Average Power [dBm] |
|---|---|---|---|---|---|
| Lowest | 2 402 | -2.27 | 30.00 | 32.27 | -4.82 |
| Middle | 2 440 | -2.17 | 30.00 | 32.17 | -4.82 |
| Highest | 2 480 | -2.27 | 30.00 | 32.27 | -4.78 |

-NOTE:
1. We took the insertion loss of the cable loss into consideration within the measuring instrument. (Cable loss + Attenuator)
2. It was measured by peak power sensor.

This test report shall not be reproduced, except in full, without the written approval

## 5.3 Peak Power Spectral Density

### 5.3.1 Regulation

According to §15.247(e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 ㎑ band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

### 5.3.2 Measurement Procedure

These test measurement settings are specified in section 10.0 of 558074 D01 DTS Meas Guidance.

#### 5.3.2.1 Method PKPSD (peak PSD)

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

1) Set analyzer center frequency to DTS channel center frequency.

2) Set the span to 1.5 times the DTS bandwidth.

3) Set the RBW to: 3 ㎑ ≤ RBW ≤ 100 ㎑.

4) Set the VBW ≥ 3 x RBW.

5) Detector = peak.

6) Sweep time = auto couple.

7) Trace mode = max hold.

8) Allow trace to fully stabilize.

9) Use the peak marker function to determine the maximum amplitude level within the RBW.

10) If measured value exceeds limit, reduce RBW (no less than 3 ㎑) and repeat.

## 5.3.3 Test Result

## - Complied

| Channel | Frequency [㎒] | Result (RBW=3 ㎑) [dB m/3 ㎑] | Limit [dBm/3 ㎑] | Margin [dB] |
|---|---|---|---|---|
| Lowest | 2 402 | -18.23 | 8.00 | 26.23 |
| Middle | 2 440 | -18.73 | 8.00 | 26.73 |
| Highest | 2 480 | -17.64 | 8.00 | 25.64 |

-NOTE:

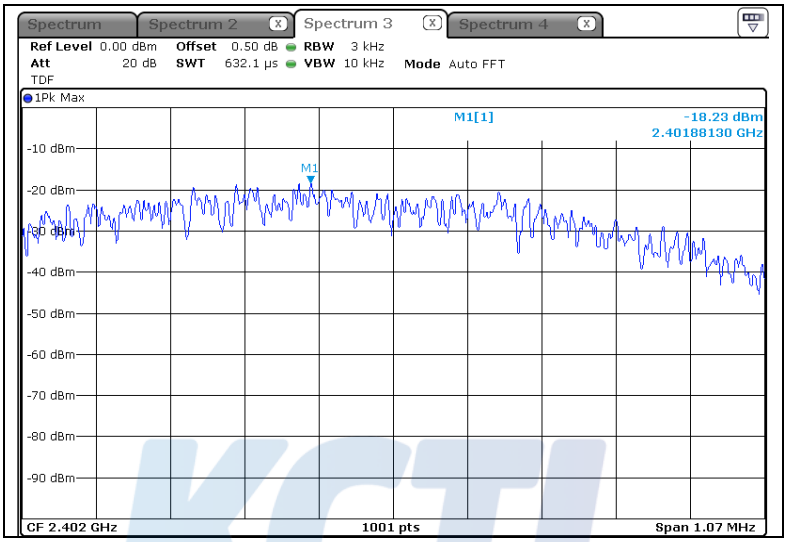
1. We took the insertion loss of the cable loss into consideration within the measuring instrument.

KCTL

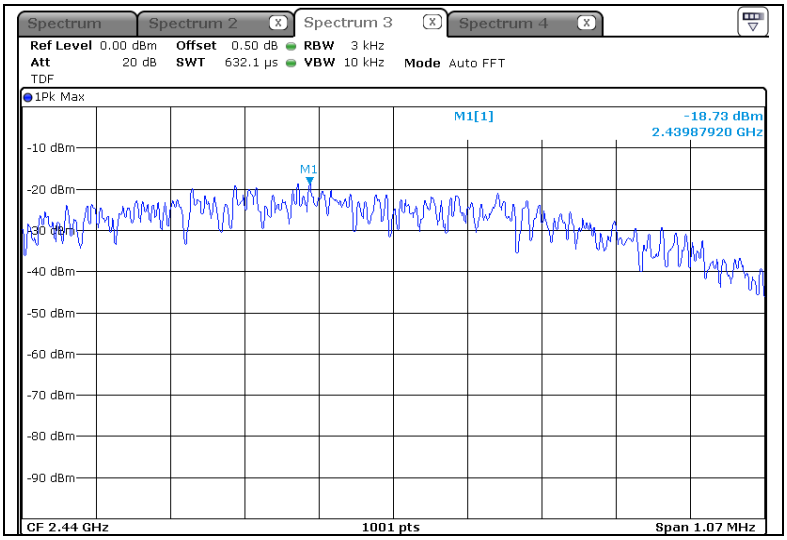
## 5.3.4 Test Plot

Figure 1. Plot of the Power Density

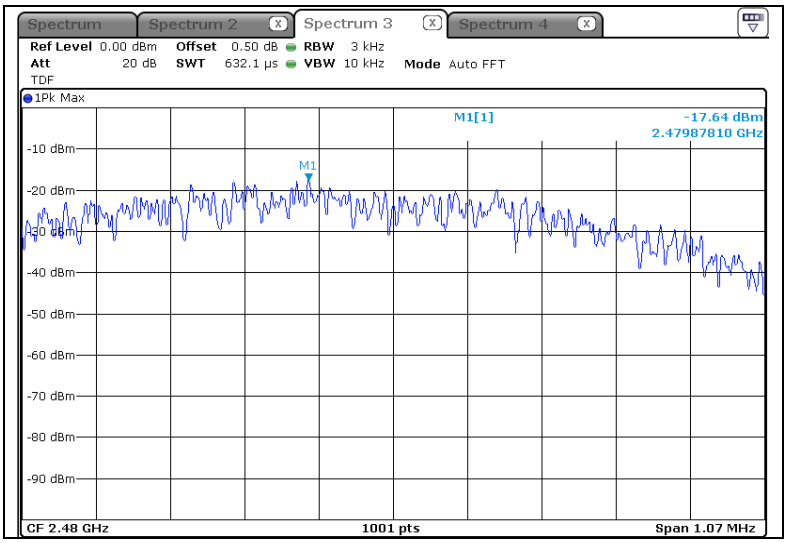
Lowest Channel (2 402 ㎒)




Middle Channel (2 440 ㎒)



Highest Channel (2 480 ㎒)



## 5.4 6 dB Bandwidth(DTS Channel Bandwidth)

### 5.4.1 Regulation

According to §15.247(a)(2) Systems using digital modulation techniques may operate in the 902–928 ㎒, 2 400–2 483.5 ㎒, and 5 725–5 850 ㎒ bands. The minimum 6 ㏈ bandwidth shall be at least 500 ㎑.

### 5.4.2 Measurement Procedure

These test measurement settings are specified in section 8.0 of 558074 D01 DTS Meas Guidance.

#### 5.4.2.1 DTS Channel Bandwidth Measurement Procedure-Option 2

The automatic bandwidth measurement capability of an instrument may be employed using the X ㏈ bandwidth mode with X set to 6 ㏈, if the functionality described above (i.e., RBW = 100 ㎑, VBW ≥ 3 x RBW, peak detector with maximum hold) is implemented by the instrumentation function.
When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 ㏈.

## 5.4.3 Test Result

## - Complied

| Channel | Frequency [㎒] | 6 ㏈ Bandwidth [㎒] | Min. Limit [㎒] | Occupied Bandwidth (99 % BW) [㎒] |
|---|---|---|---|---|
| Lowest | 2 402 | 0.71 | 0.50 | 1.07 |
| Middle | 2 440 | 0.72 | 0.50 | 1.08 |
| Highest | 2 480 | 0.71 | 0.50 | 1.08 |

-NOTE:

1. We took the insertion loss of the cable loss into consideration within the measuring instrument.

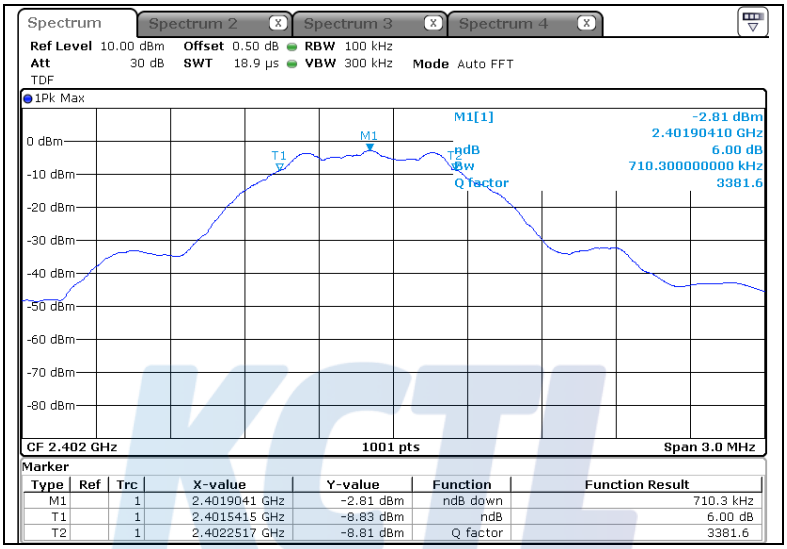
This test report shall not be reproduced, except in full, without the written approval

## 5.4.4 Test Plot

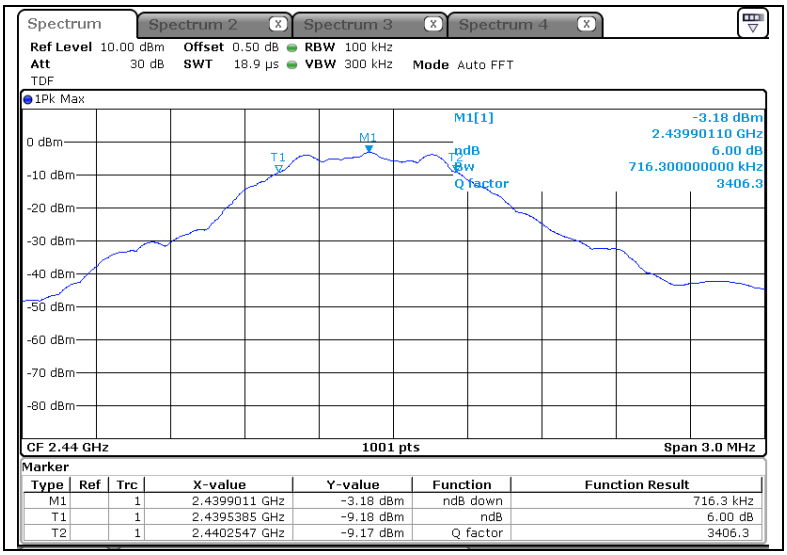
Figure 2. Plot of the 6㏈ Bandwidth & Occupied Bandwidth

**- 6 ㏈ Bandwidth**

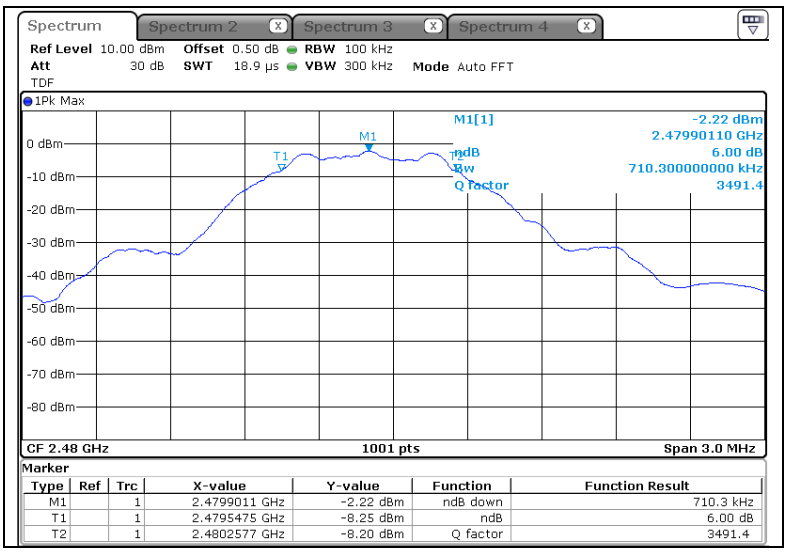
Lowest Channel (2 402 ㎒)




Middle Channel (2 440 ㎒)

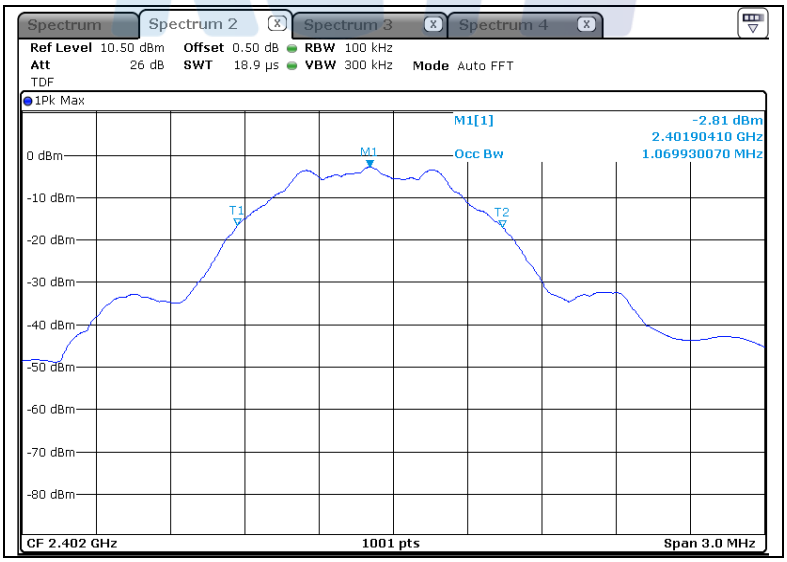


Highest Channel (2 480 ㎒)

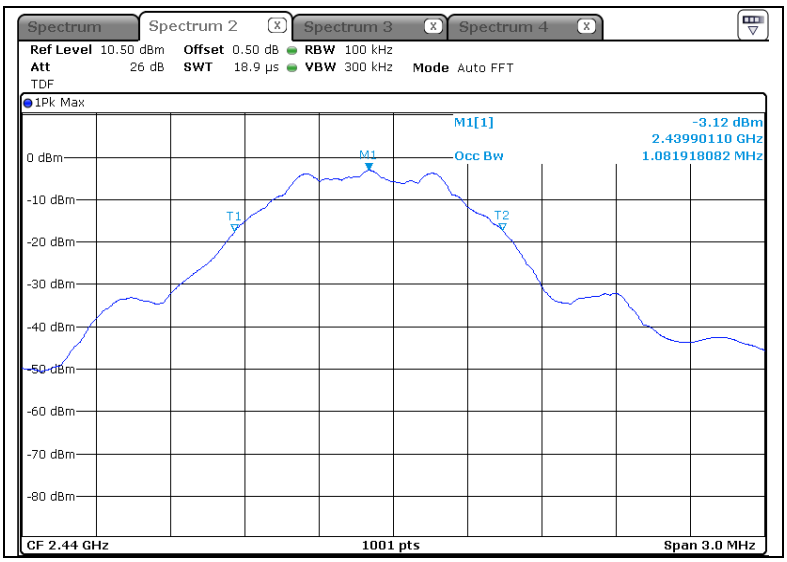



**- OBW**

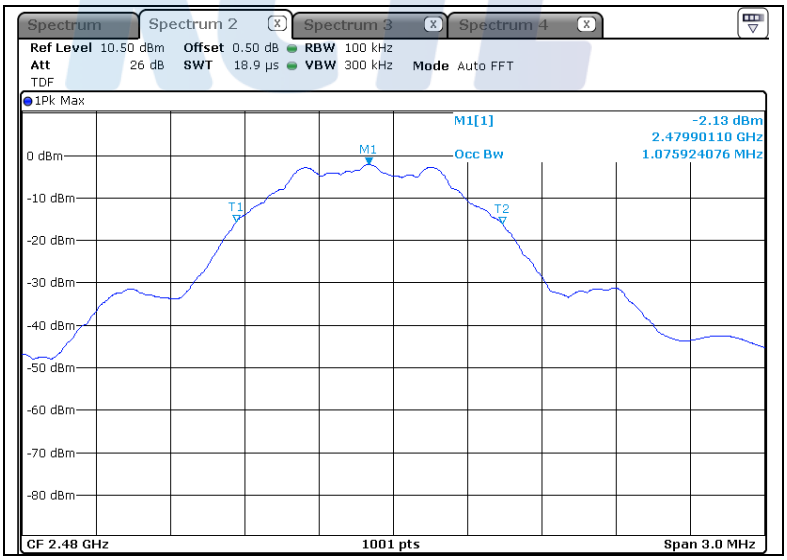
Lowest Channel (2 402 ㎒)



Middle Channel (2 440 ㎒)




Highest Channel (2 480 ㎒)



## 5.5 Spurious Emission, Band Edge, and Restricted bands

### 5.5.1 Regulation

According to §15.247(d), in any 100 ㎑ 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 ㏈ below that in the 100 ㎑ 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 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

According to §15.209(a), Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall notexceed the field strength levels specified in the following table:

| Frequency (㎒) | Field strength (㎛/m) | Measurement distance (m) |
|---|---|---|
| 0.009 - 0.490 | 2 400/F(㎑) | 300 |
| 0.490 - 1.705 | 24 000/F(㎑) | 30 |
| 1.705 - 30 | 30 | 30 |
| 30 - 88 | 100** | 3 |
| 88 - 216 | 150** | 3 |
| 216 - 960 | 200** | 3 |
| Above 960 | 500 | 3 |

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 ㎒, 76–88 ㎒, 174–216 ㎒ or 470–806 ㎒. However, operation within these frequency bands is permItted under other sections of this part, e.g., §15.231 and 15.241.

According to § 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.009 - 0.110<br>0.495 - 0.505<br>2.173 5 - 2.190 5<br>4.125 - 4.128<br>4.177 25 - 4.177 75<br>4.207 25 - 4.207 75<br>6.215 - 6.218<br>6.267 75 - 6.268 25<br>6.311 75 - 6.312 25<br>8.291 - 8.294<br>8.362 - 8.366<br>8.376 25 - 8.386 75<br>8.414 25 - 8.414 75<br>12.29 - 12.293<br>12.519 75 - 12.520 25<br>12.576 75 - 12.577 25<br>13.36 - 13.41 | 16.42 - 16.423<br>16.694 75 - 16.695 25<br>16.804 25 - 16.804 75<br>25.5 - 25.67<br>37.5 - 38.25<br>73 - 74.6<br>74.8 - 75.2<br>108 - 121.94<br>123 - 138<br>149.9 - 150.05<br>156.524 75 - 156.525 25<br>156.7 - 156.9<br>162.012 5 - 167.17<br>167.72 - 173.2<br>240 - 285<br>322 - 335.4 | 399.9 - 410<br>608 - 614<br>960 – 1 240<br>1 300 – 1 427<br>1 435 – 1 626.5<br>1 645.5 – 1 646.5<br>1 660 – 1 710<br>1 718.8 – 1 722.2<br>2 200 – 2 300<br>2 310 – 2 390<br>2 483.5 – 2 500<br>2 690 – 2 900<br>3 260 – 3 267<br>3 332 – 3 339<br>3 345.8 – 3 358<br>3 600 – 4 400 | 4.5 - 5.15<br>5.35 - 5.46<br>7.25 - 7.75<br>8.025 - 8.5<br>9.0 - 9.2<br>9.3 - 9.5<br>10.6 - 12.7<br>13.25 - 13.4<br>14.47 - 14.5<br>15.35 - 16.2<br>17.7 - 21.4<br>22.01 - 23.12<br>23.6 - 24.0<br>31.2 - 31.8<br>36.43 - 36.5<br>Above 38.6 |

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

## 5.5.2Measurement Procedure

### 5.5.2.1 Band-edge Compliance of RF Conducted Emissions

#### 5.5.2.1.1 Reference Level Measurement

Establish a reference level by using the following procedure:

1) Set instrument center frequency to DTS channel center frequency.
2) Set the span to ≥ 1.5 times the DTS bandwidth.
3) Set the RBW = 100 ㎑.
4) Set the VBW ≥ 3 x RBW.
5) Detector = peak.
6) Sweep time = auto couple.
7) Trace mode = max hold.
8) Allow trace to fully stabilize.
9) Use the peak marker function to determine the maximum PSD level.

#### 5.5.2.1.2 Emissions Level Measurement

1) Set the center frequency and span to encompass frequency range to be measured.
2) Set the RBW = 100 ㎑.
3) Set the VBW ≥ 3 x RBW.
4) Detector = peak.
5) Ensure that the number of measurement points ≥ span/RBW
6) Sweep time = auto couple.
7) Trace mode = max hold.
8) Allow trace to fully stabilize.
9) Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

## 5.5.2.2 Conducted Spurious Emissions

Set the spectrum analyzer as follows:

1) Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic.
   Typically, several plots are required to cover this entire span.
2) RBW = 100 ㎑
3) VBW ≥ RBW
4) Sweep = auto
5) Detector function = peak
6) Trace = max hold
7) Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
8) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specifiedbandwidth.

## 5.5.2.3 Radiated Spurious Emissions

1) The preliminary and final rdiated measurements were performed to determine the frequency producing the maximum emissions in at a 10m semi-anechoic chamber. The EUT was tested at a distance 3 meters.
2) The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360˚.
3) The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 ㎑ to 30 ㎒ using the loop antenna, and from 30 to 1 000 ㎒ using the Bi-Log antenna, and from 1 000 ㎒ to 26 500 ㎒ using the horn antenna.
4) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.
5) The 0.8m height is for below 1 G testing, and 1.5m is for above 1G testing.

Note

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 ㎓.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 3 ㎒ for Average detection (AV) at frequency above 1 ㎓. (Detector = RMS, Averaging type = power)
   In case of duty cycle less than 98%, a duty cycle correction factor has to be added to the measurement result.

## - KDB 414788

RADIATED EMISSION TEST SITES FOR MEASUREMENTS FROM 9 kHz TO 30 MHz

The test site requirements of Section 15.31(d) apply for part 15 device radiated emission measurements at frequencies below 30 MHz. Site validation requirements for radiated emission measurements below 30 MHz have not been established. However, ANSI C63 standards provide general criteria for test sites used to make measurements in the 9 kHz to 30 MHz frequency range. For example, Subclause 5.2 of ANSI C63.10-2013 states that “radiated emission test sites below 30 MHz shall be free from metal objects, buried pipes, and any objects that can affect radiated measurements. An alternative test site that can demonstrate equivalence to a test site as described in the preceding sentence shall be accepted for the purposes of this standard.”

Therefore, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30 MHz if characterized so that the measurements correspond to those obtained at an open-field test site. Site characterization shall be obtained by other means such as performing measurements at an alternative test site and comparing to measurement results obtained at an open-field test site. Statistical analysis of the measurement data from several similar devices may be required to show correlation between the measurements from the alternative test site and the open-field test site. Test laboratories wishing to make radiated emission measurements below 30 MHz using other than an open-field site must document evidence of correlation between the alternative site and an open-field test site and make it available to the Commission upon request and for review during a laboratory accreditation assessment.

For Part 18 equipment, Section 2.1 of FCC Measurement Procedure MP-5 also permits the use of test sites other than an open-field test site only if it can be shown that the results obtained at such a location are correlated with those made at an open-field test site. Sufficient tests shall be made to demonstrate that the alternative test site produces results that correlate with the results of tests made at an open-field test site.

## 5.5.3 Test Result

## - Complied

1. Conducted Spurious Emissions was shown in figure 3.
   Note: We took the insertion loss of the cable into consideration within the measuring instrument.
2. Measured value of the Field strength of spurious Emissions (Radiated)
3. It tested x,y and z – 3 axis each, mentioned only worst case data at this report.

**- Below 1 ㎓ data (worst-case)**

**Middle Channel (2 440 ㎒)**

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(μV)] | Cable Loss [dB] | Amp Gain [dB] | Antenna Factor [dB] | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|---|
| **Quasi-Peak DATA. Emissions below 30 ㎒** | | | | | | | | | | |
| 7.52 | 9 | V | 38.80 | 0.58 | -32.68 | 19.70 | -12.40 | 26.40 | 69.50 | 43.10 |
| 24.47 | 9 | H | 39.00 | 1.37 | -32.68 | 19.21 | -12.10 | 26.90 | 69.50 | 42.60 |
| **Quasi-Peak DATA. Emissions below 1 ㎓** | | | | | | | | | | |
| 47.34 | 120 | V | 35.31 | 1.41 | -30.43 | 15.28 | -13.74 | 21.57 | 40.00 | 18.43 |
| 49.52 | 120 | V | 30.54 | 1.45 | -29.38 | 14.23 | -13.70 | 16.84 | 40.00 | 23.16 |
| 122.39 | 120 | H | 40.11 | 2.38 | -37.76 | 18.18 | -17.20 | 22.91 | 43.50 | 20.59 |
| 146.64 | 120 | H | 34.98 | 2.63 | -38.20 | 16.90 | -18.67 | 16.31 | 43.50 | 27.19 |
| 183.50 | 120 | V | 32.22 | 3.01 | -34.38 | 14.69 | -16.68 | 15.54 | 43.50 | 27.96 |
| 433.16 | 120 | H | 31.08 | 5.56 | -14.03 | -0.29 | -8.76 | 22.32 | 46.00 | 23.68 |

Note. Factor = Cable loss + Amp gain + Antenna factor

## - Above 1 ㎓ data

### Lowest Channel (2 402 ㎒)

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Cable Loss [dB] | Amp Gain [dB] | Antenna Factor [dB] | Factor [dB] | DCCF [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Peak DATA. Emissions above 1 ㎓** | | | | | | | | | | | |
| 1 715.78 | 1 000 | H | 72.24 | 3.15 | -60.29 | 26.66 | -30.48 | - | 41.76 | 74.00 | 32.24 |
| 2 337.81 1) | 1 000 | H | 67.57 | 3.67 | -59.25 | 28.44 | -27.14 | - | 40.43 | 74.00 | 33.57 |
| 2 824.06 1) | 1 000 | V | 67.46 | 4.01 | -59.65 | 29.37 | -26.27 | - | 41.19 | 74.00 | 32.81 |
| 4 804.09 2) | 1 000 | H | 74.11 | 5.34 | -59.20 | 32.80 | -21.06 | - | 53.05 | 74.00 | 20.95 |
| 7 205.20 2) | 1 000 | V | 75.22 | 6.71 | -59.86 | 35.91 | -17.24 | - | 57.99 | 74.00 | 16.01 |
| 19 971.47 1) | 1 000 | V | 45.88 | 11.40 | -48.75 | 44.20 | 6.85 | - | 52.72 | 74.00 | 21.28 |
| 26 102.63 | 1 000 | H | 43.19 | 13.70 | -46.67 | 45.70 | 12.73 | - | 55.92 | 74.00 | 18.08 |
| **Average DATA. Emissions above 1 ㎓** | | | | | | | | | | | |
| 2 337.81 1) | 1 000 | H | 63.11 | 3.67 | -59.25 | 28.44 | -27.14 | 2.04 | 36.01 | 54.00 | 15.95 |
| 2 824.06 1) | 1 000 | V | 55.03 | 4.01 | -59.65 | 29.37 | -26.27 | 2.04 | 28.76 | 54.00 | 23.20 |
| 4 804.09 2) | 1 000 | H | 68.57 | 5.34 | -59.20 | 32.80 | -21.06 | 2.04 | 47.51 | 54.00 | 4.45 |
| 19 971.47 1) | 1 000 | V | 36.77 | 11.40 | -48.75 | 44.20 | 6.85 | 2.04 | 43.62 | 54.00 | 8.34 |

Note. Factor = Cable loss + Amp. Gain + Antenna factor
1) Restricted band
2) Harmonic

### Middle Channel (2 440 ㎒)

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Cable Loss [dB] | Amp Gain [dB] | Antenna Factor [dB] | Factor [dB] | DCCF [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Peak DATA. Emissions above 1 ㎓** | | | | | | | | | | | |
| 1 253.52 | 1 000 | V | 70.34 | 2.71 | -60.91 | 24.81 | -33.39 | - | 36.95 | 74.00 | 37.05 |
| 3 005.16 | 1 000 | V | 69.09 | 4.14 | -59.11 | 29.71 | -25.26 | - | 43.83 | 74.00 | 30.17 |
| 4 879.31 1) | 1 000 | H | 74.55 | 5.39 | -59.36 | 32.84 | -21.13 | - | 53.42 | 74.00 | 20.58 |
| 7 319.28 1) | 1 000 | H | 75.75 | 6.76 | -60.26 | 36.02 | -17.48 | - | 58.27 | 74.00 | 15.73 |
| 21 355.91 | 1 000 | V | 45.39 | 11.90 | -49.31 | 44.90 | 7.49 | - | 52.88 | 74.00 | 21.12 |
| 26 305.83 | 1 000 | V | 40.29 | 13.70 | -46.72 | 45.60 | 12.58 | - | 52.86 | 74.00 | 21.14 |
| **Average DATA. Emissions above 1 ㎓** | | | | | | | | | | | |
| 4 879.31 1) | 1 000 | H | 69.38 | 5.39 | -59.36 | 32.84 | -21.13 | 2.04 | 48.25 | 54.00 | 3.71 |
| 7 319.28 1) | 1 000 | H | 66.75 | 6.76 | -60.26 | 36.02 | -17.48 | 2.04 | 51.80 | 54.00 | 2.69 |
| 21 355.91 | 1 000 | V | 34.79 | 11.90 | -49.31 | 44.90 | 7.49 | 2.04 | 42.28 | 54.00 | 9.68 |

Note. Factor = Cable loss + Amp. Gain + Antenna factor
1) Harmonic

**Highest Channel (2 480 ㎒)**

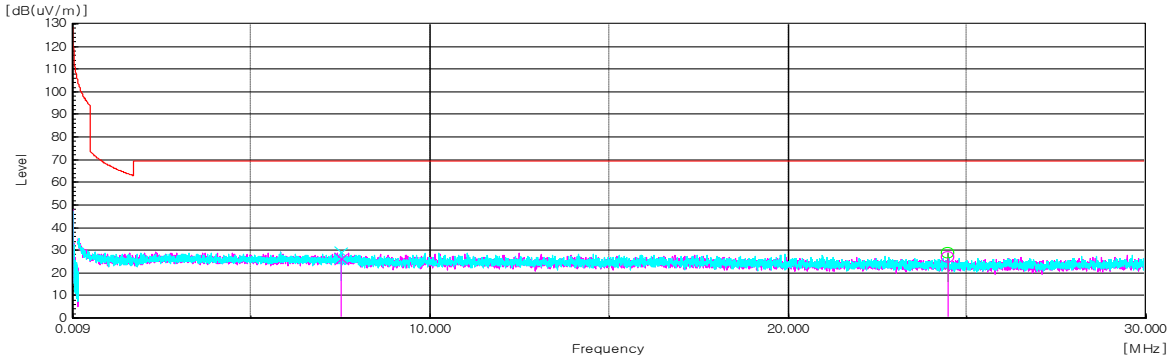
| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Cable Loss [dB] | Amp Gain [dB] | Antenna Factor [dB] | Factor [dB] | DCCF [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Peak DATA. Emissions above 1 ㎓** | | | | | | | | | | | |
| 1 728.05 | 1 000 | H | 69.95 | 3.17 | -60.28 | 26.71 | -30.40 | - | 39.56 | 74.00 | 34.44 |
| 2 483.51 1) | 1 000 | H | 77.04 | 3.77 | -59.21 | 28.72 | -26.72 | - | 50.32 | 74.00 | 23.68 |
| 3 468.05 | 1 000 | V | 69.46 | 4.44 | -60.08 | 30.96 | -24.68 | - | 44.78 | 74.00 | 29.22 |
| 4 959.52 2) | 1 000 | H | 73.56 | 5.44 | -59.40 | 32.88 | -21.08 | - | 52.47 | 74.00 | 21.53 |
| 7 439.22 2) | 1 000 | H | 76.70 | 6.81 | -60.68 | 36.14 | -17.73 | - | 58.97 | 74.00 | 15.03 |
| 23 653.30 | 1 000 | V | 44.53 | 12.60 | -48.78 | 45.10 | 8.92 | - | 53.44 | 74.00 | 20.56 |
| 26 052.95 | 1 000 | H | 42.68 | 13.70 | -46.63 | 45.70 | 12.77 | - | 55.45 | 74.00 | 18.55 |
| **Average DATA. Emissions above 1 ㎓** | | | | | | | | | | | |
| 2 483.51 1) | 1 000 | H | 62.71 | 3.77 | -59.21 | 28.72 | -26.72 | 2.04 | 35.99 | 54.00 | 15.97 |
| 4 959.52 2) | 1 000 | H | 70.26 | 5.44 | -59.40 | 32.88 | -21.08 | 2.04 | 49.18 | 54.00 | 2.78 |
| 7 439.22 2) | 1 000 | H | 69.76 | 6.81 | -60.68 | 36.14 | -17.73 | 2.04 | 52.03 | 54.00 | 2.56 |
| 23 653.30 | 1 000 | V | 34.63 | 12.60 | -48.78 | 45.10 | 8.92 | 2.04 | 43.55 | 54.00 | 8.41 |

Note. Factor = Cable loss + Amp. Gain + Antenna factor
1) Restricted band
2) Harmonic

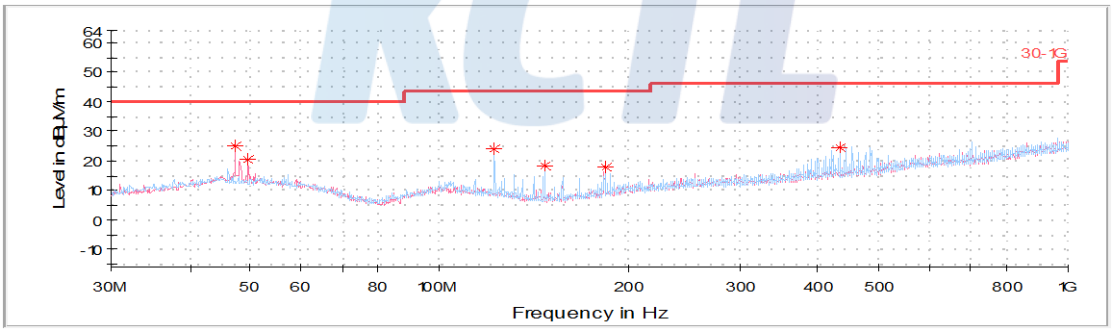
## 5.5.4.1 Test Plot

Figure 3. Plot of the Spurious Emissions (Radiated)

**- 9 ㎑ ~ 30 ㎒ data**

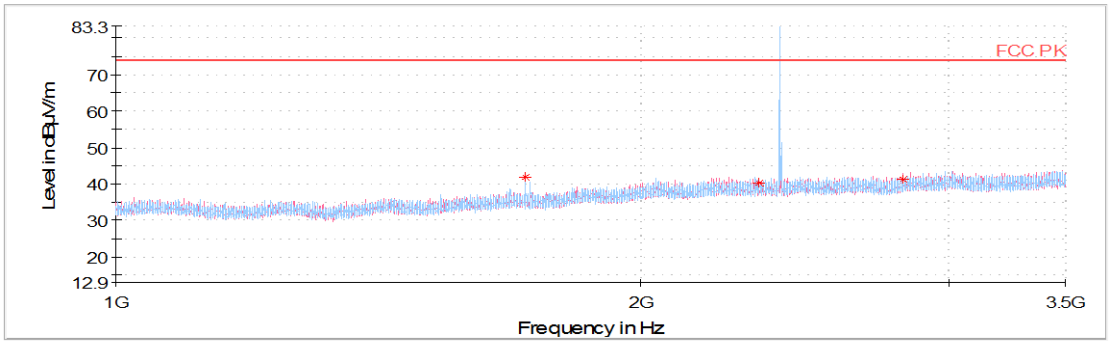



**- 30 ㎒ ~ 1 ㎓ data**

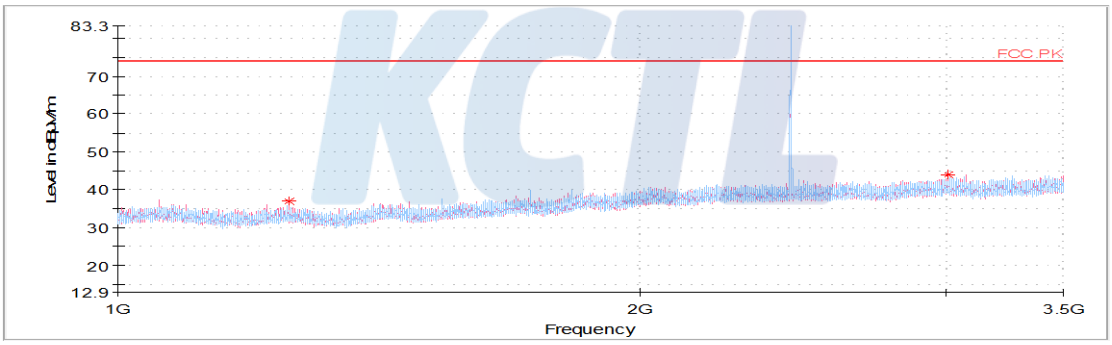


**- 1 ㎓ ~ 3.5 ㎓ data**

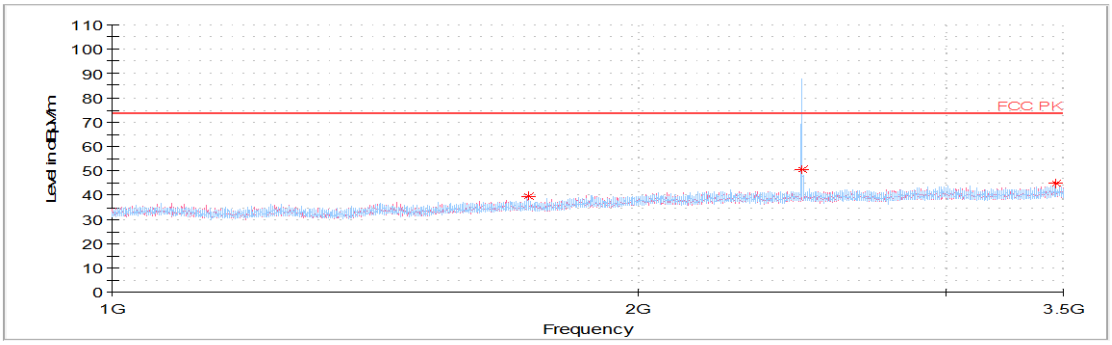
Lowest Channel (2 402 ㎒)




Middle Channel (2 440 ㎒)

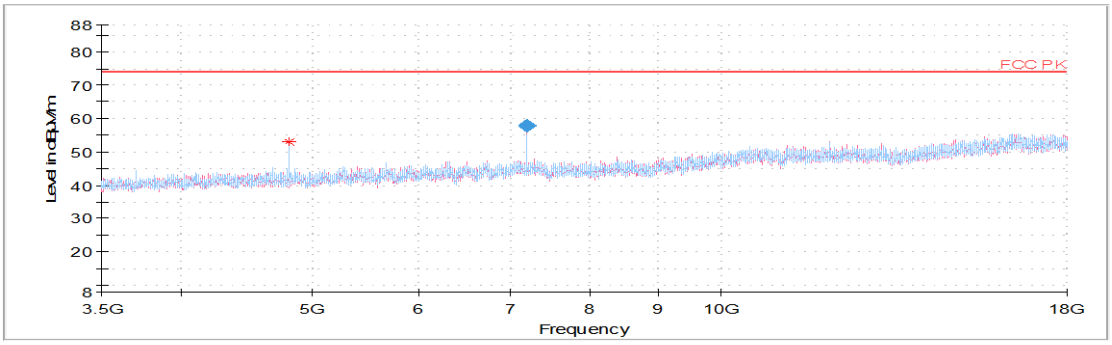



Highest Channel (2 480 ㎒)

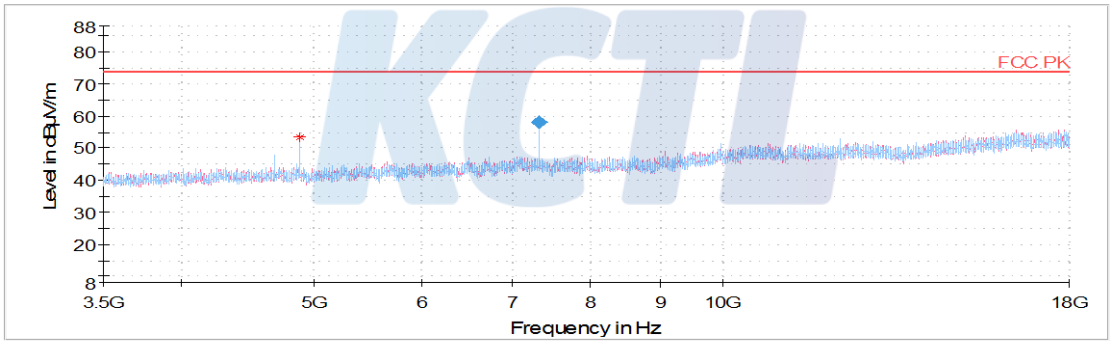


**- 3.5 ㎓ ~ 18 ㎓ data**

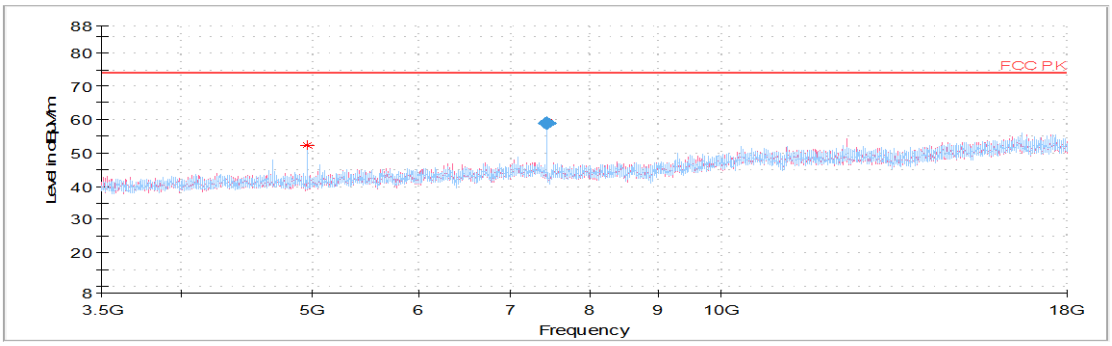
Lowest Channel (2 402 ㎒)




Middle Channel (2 440 ㎒)

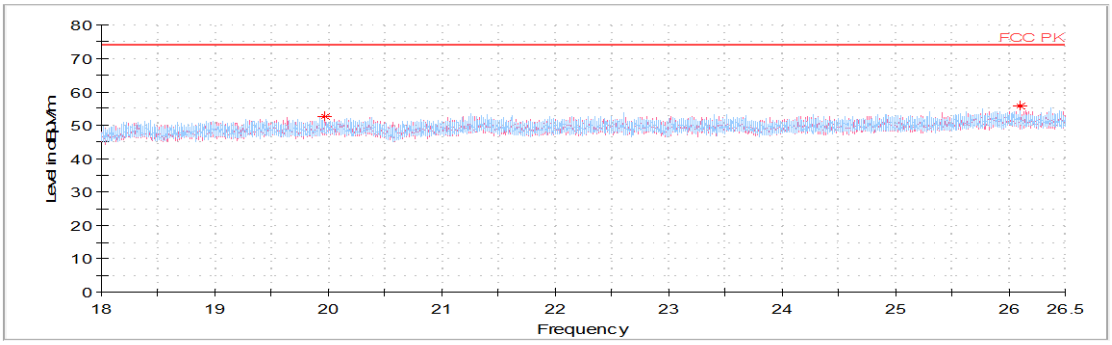



Highest Channel (2 480 ㎒)

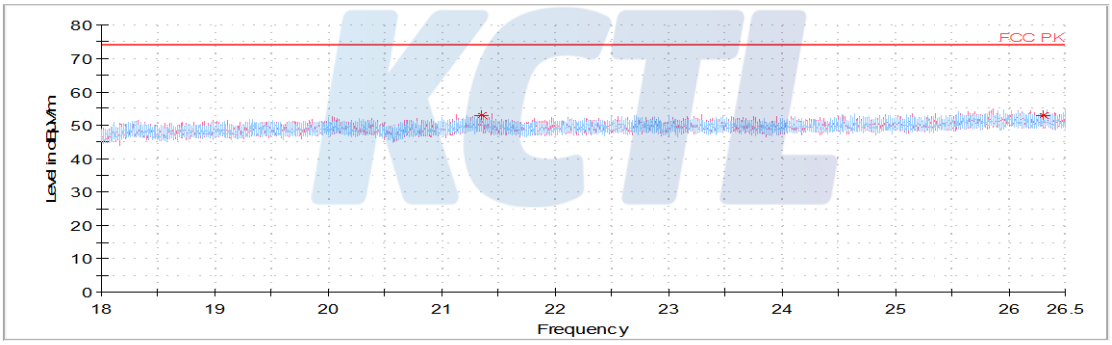


**- 18 ㎓ ~ 26.5 ㎓ data**

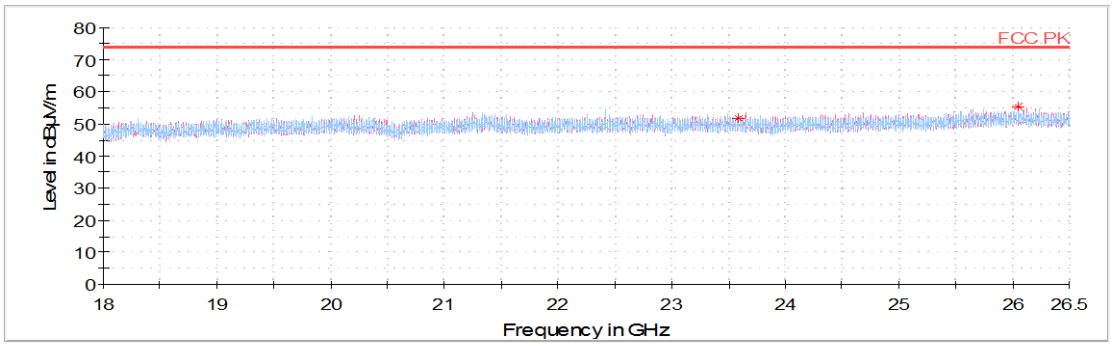
Lowest Channel (2 402 ㎒)




Middle Channel (2 440 ㎒)



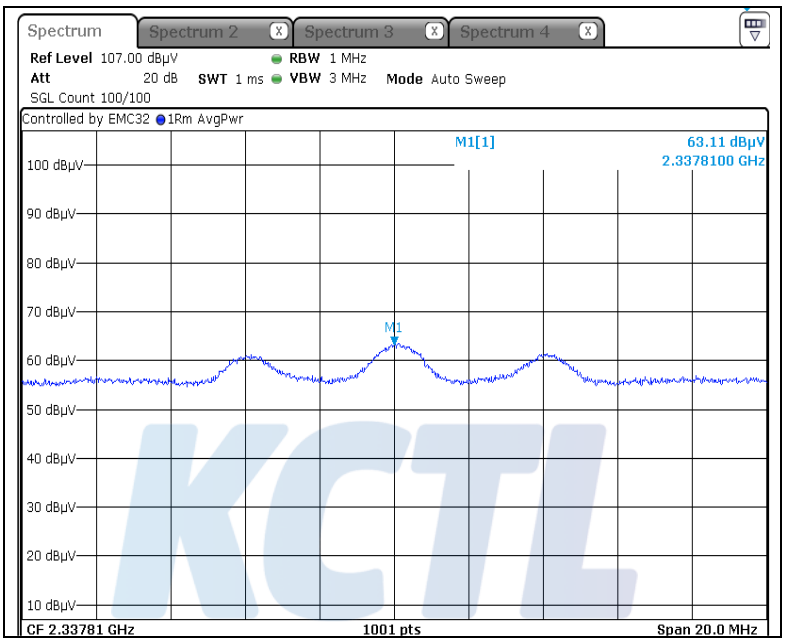

Highest Channel (2 480 ㎒)

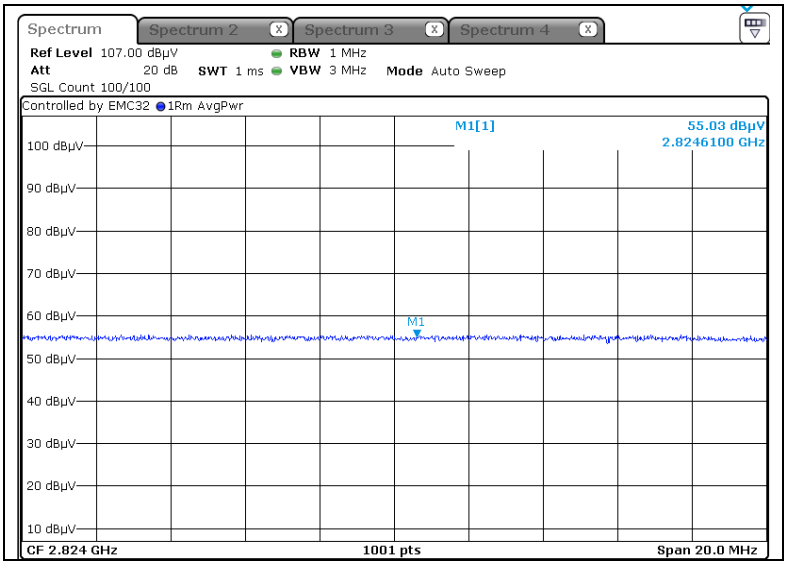


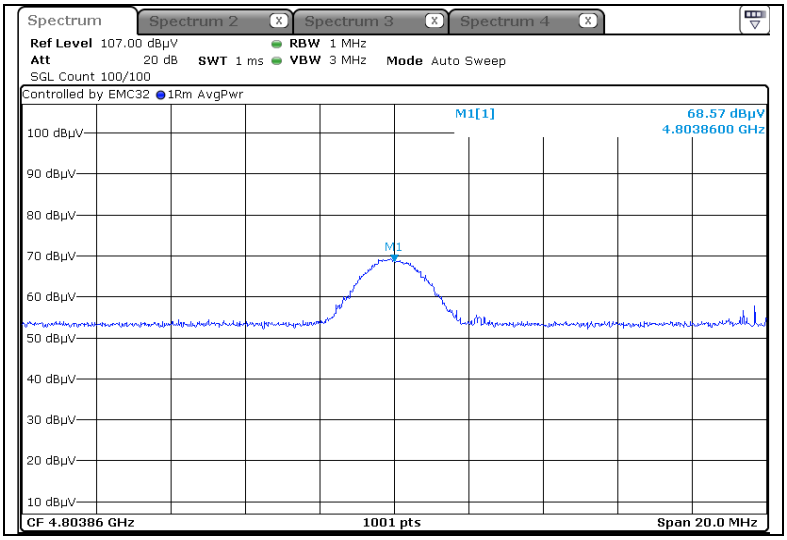
## 5.5.4.2 Test Plot

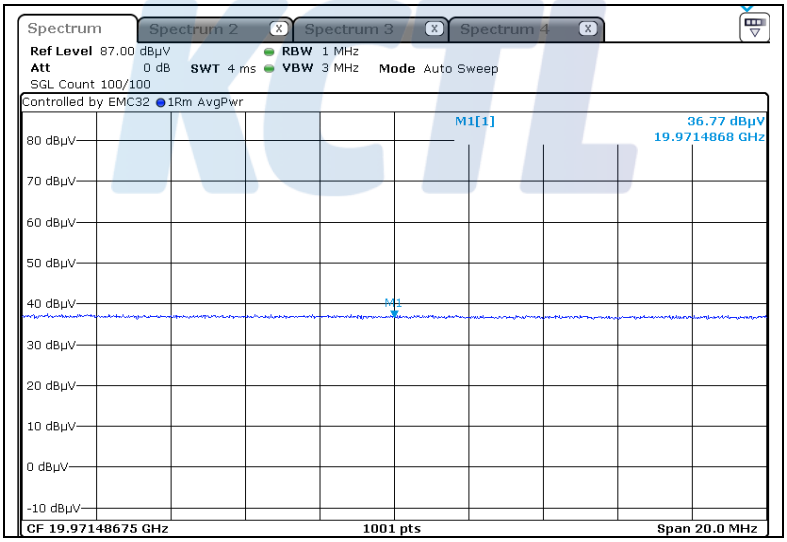
Figure 4. Plot of the average data emissions (Radiated)

Lowest Channel (2 402 ㎒)

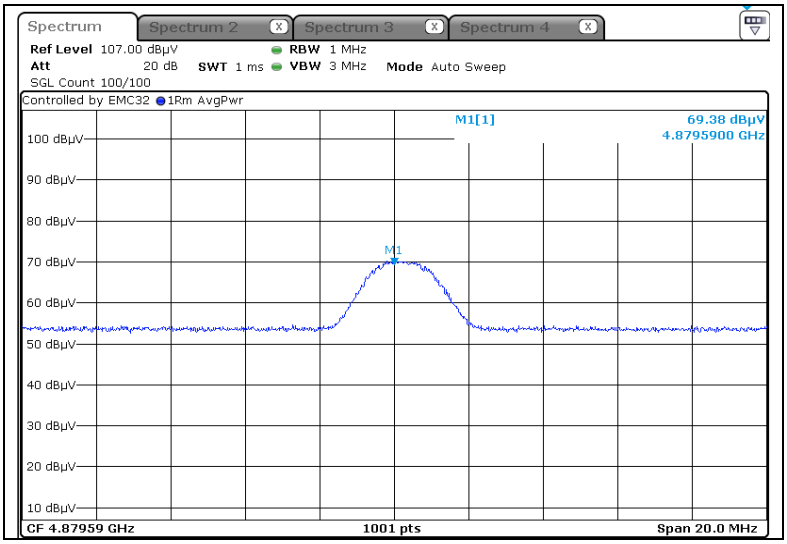


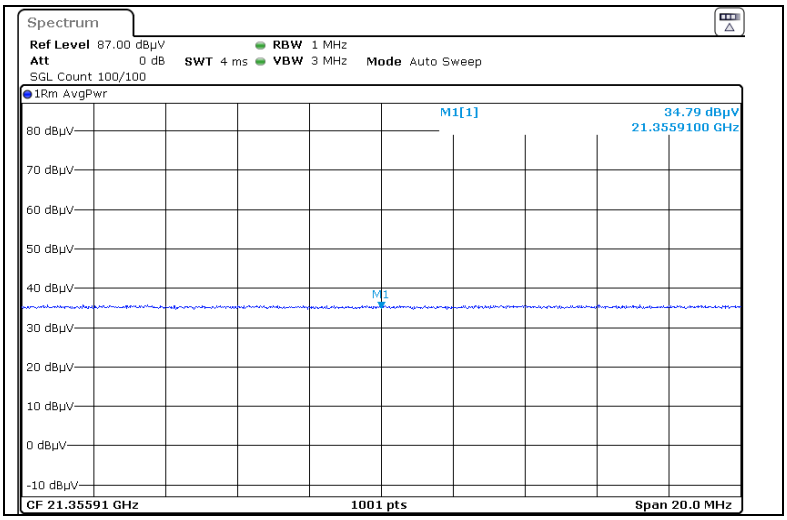




Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 107.00 dBµV
RBW 1 MHz
Att 20 dB
SWT 1 ms
VBW 3 MHz
Mode Auto Sweep
SGL Count 100/100
Controlled by EMC32
1Rm AvgPwr
M1[1]
68.57 dBµV
4.8038600 GHz
100 dBµV
90 dBµV
80 dBµV
70 dBµV
60 dBµV
50 dBµV
40 dBµV
30 dBµV
20 dBµV
10 dBµV
M1
CF 4.80386 GHz
1001 pts
Span 20.0 MHz

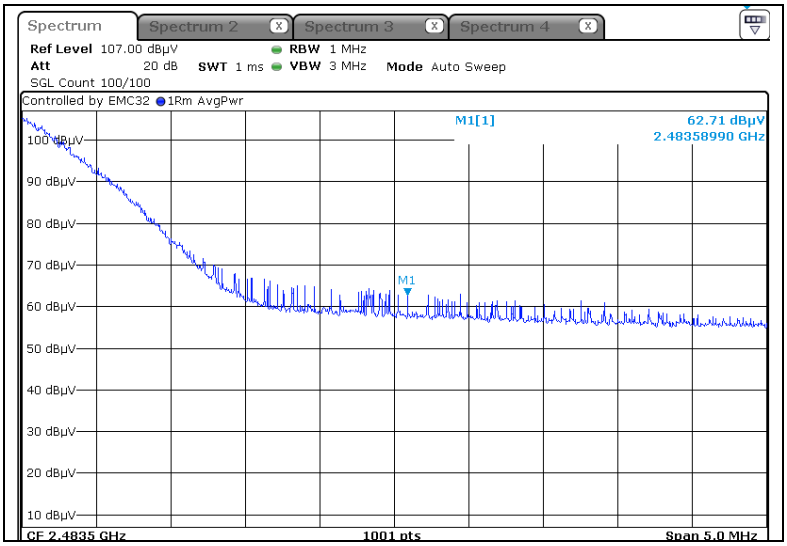

Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 87.00 dBµV
RBW 1 MHz
Att 0 dB
SWT 4 ms
VBW 3 MHz
Mode Auto Sweep
SGL Count 100/100
Controlled by EMC32
1Rm AvgPwr
M1[1]
36.77 dBµV
19.9714868 GHz
80 dBµV
70 dBµV
60 dBµV
50 dBµV
40 dBµV
30 dBµV
20 dBµV
10 dBµV
0 dBµV
-10 dBµV
M1
CF 19.97148675 GHz
1001 pts
Span 20.0 MHz

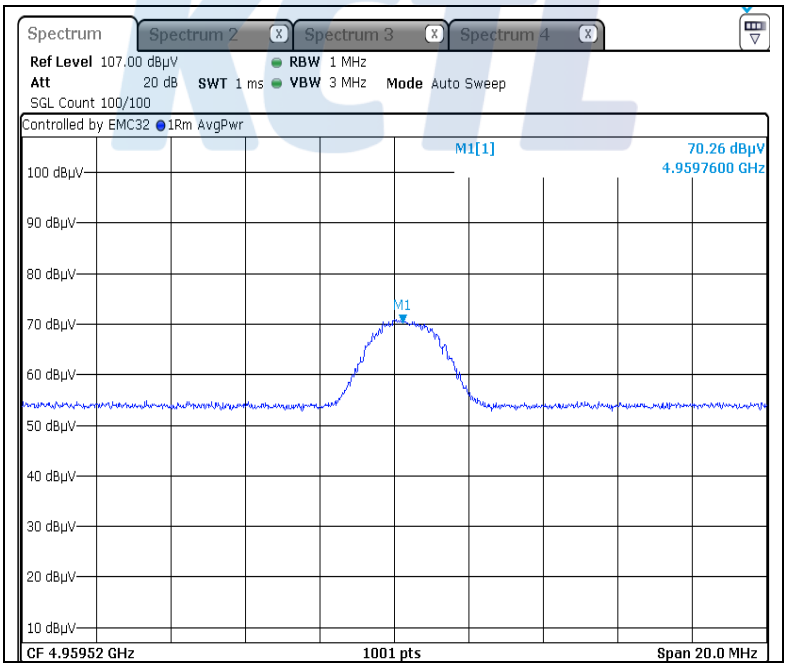
Middle Channel (2 440 ㎒)

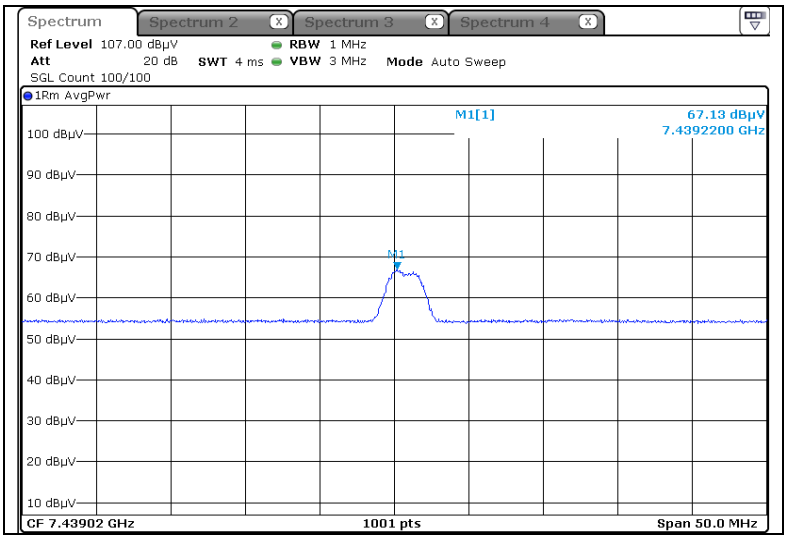


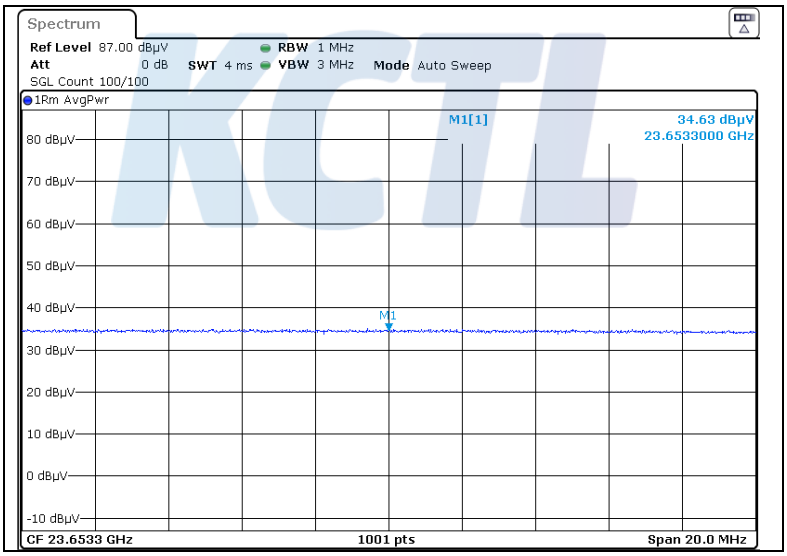

Spectrum
Ref Level 87.00 dBµV
Att 0 dB
SWT 4 ms
RBW 1 MHz
VBW 3 MHz
Mode Auto Sweep
SGL Count 100/100
1Rm AvgPwr
M1[1]
34.79 dBµV
21.3559100 GHz
80 dBµV
70 dBµV
60 dBµV
50 dBµV
40 dBµV
30 dBµV
20 dBµV
10 dBµV
0 dBµV
-10 dBµV
M1
CF 21.35591 GHz
1001 pts
Span 20.0 MHz

Highest Channel (2 480 ㎒)




Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 107.00 dBµV
Att 20 dB
SWT 4 ms
RBW 1 MHz
VBW 3 MHz
Mode Auto Sweep
SGL Count 100/100
1Rm AvgPwr
M1[1]
67.13 dBµV
7.4392200 GHz
100 dBµV
90 dBµV
80 dBµV
70 dBµV
60 dBµV
50 dBµV
40 dBµV
30 dBµV
20 dBµV
10 dBµV
M1
CF 7.43902 GHz
1001 pts
Span 50.0 MHz

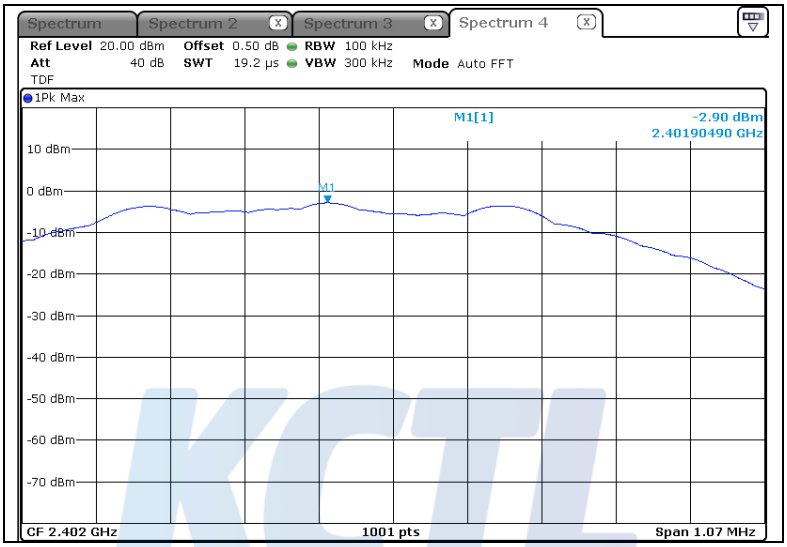

Spectrum
Ref Level 87.00 dBµV
Att 0 dB
SWT 4 ms
RBW 1 MHz
VBW 3 MHz
Mode Auto Sweep
SGL Count 100/100
1Rm AvgPwr
M1[1]
34.63 dBµV
23.6533000 GHz
80 dBµV
70 dBµV
60 dBµV
50 dBµV
40 dBµV
30 dBµV
20 dBµV
10 dBµV
0 dBµV
-10 dBµV
M1
CF 23.6533 GHz
1001 pts
Span 20.0 MHz

## 5.5.5 Test Plot

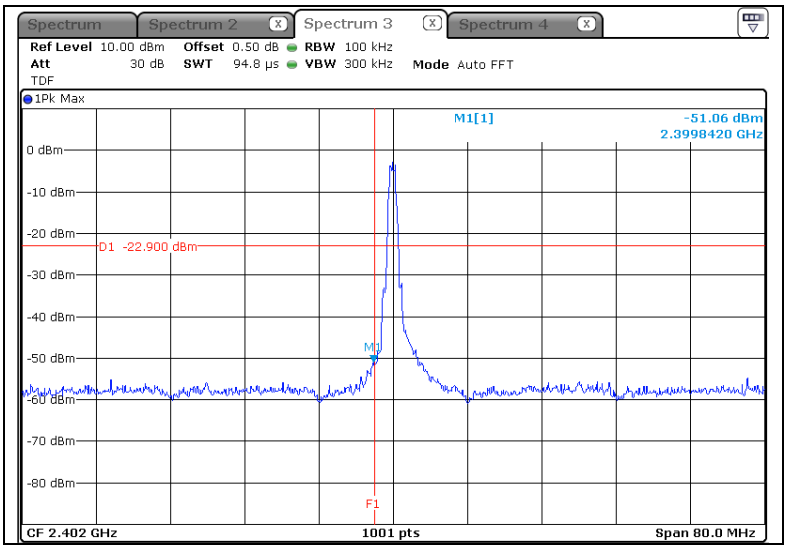
Figure 5. Plot of the Band-edge & Conducted Spurious Emissions (Conducted)

Lowest Channel (2 402 ㎒)

**Reference**

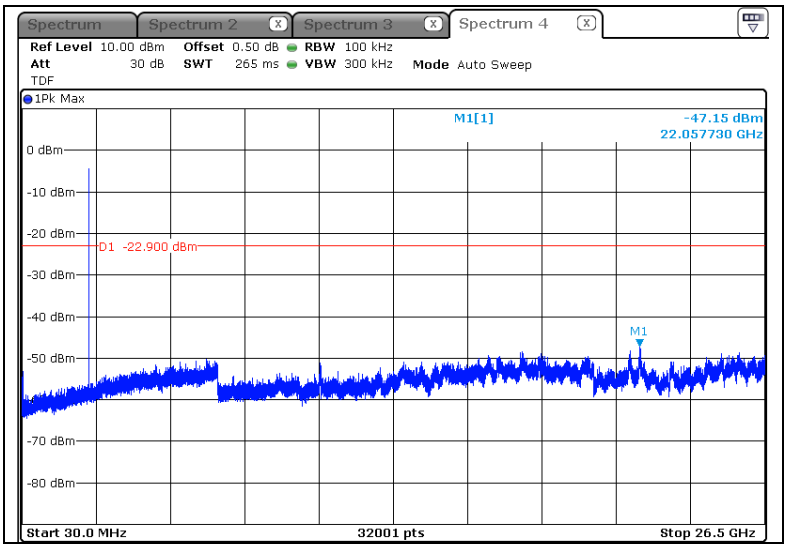



**Band-edge**



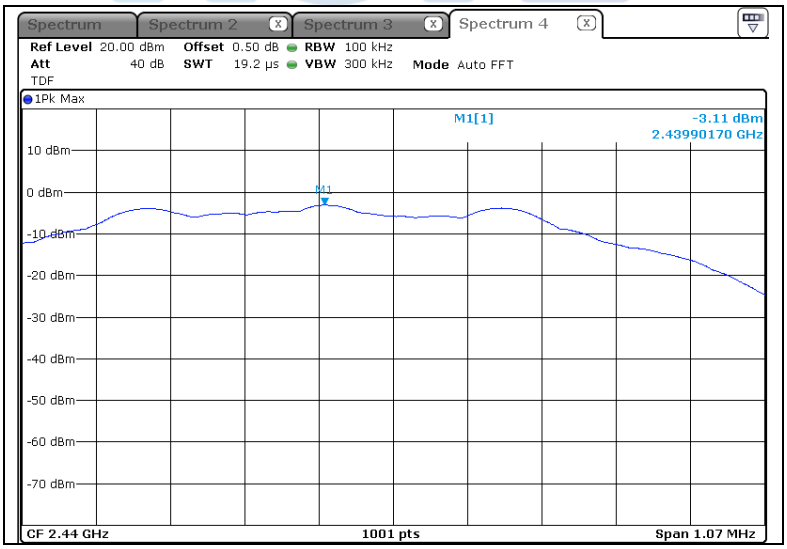

Result of 2 400.0 ㎒

## Conducted Spurious Emissions

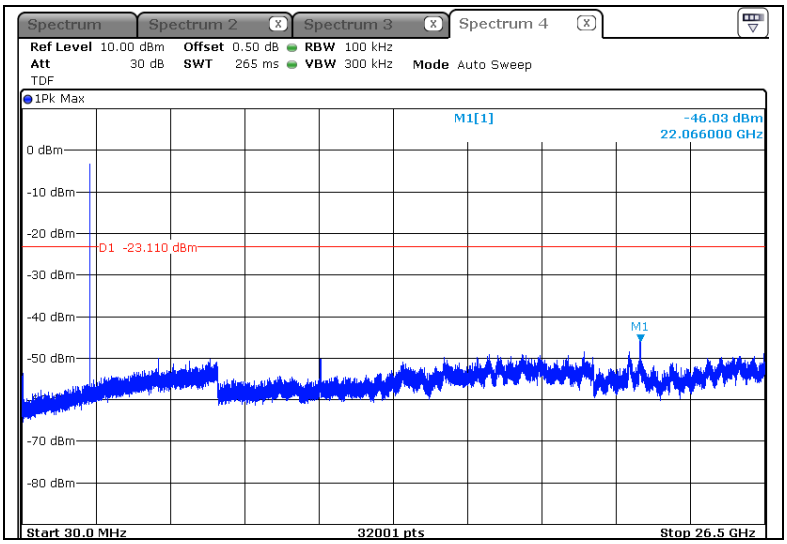



Middle Channel (2 440 ㎒)

## Reference

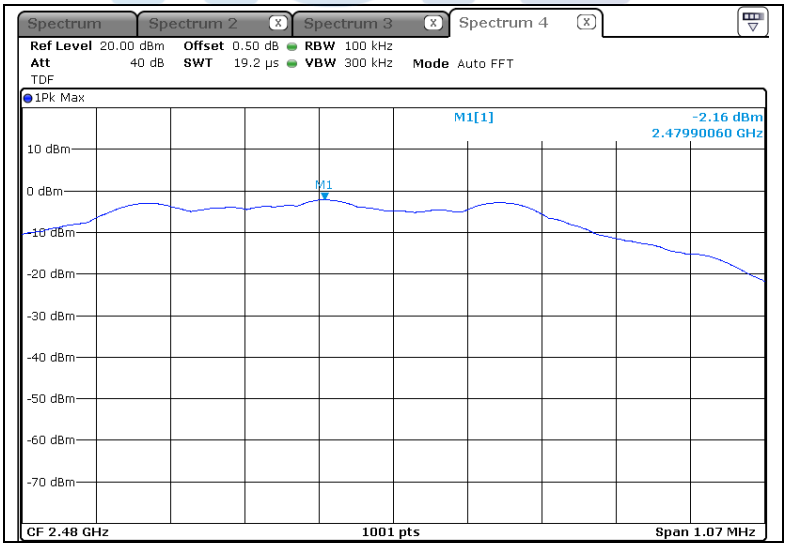


## Conducted Spurious Emissions

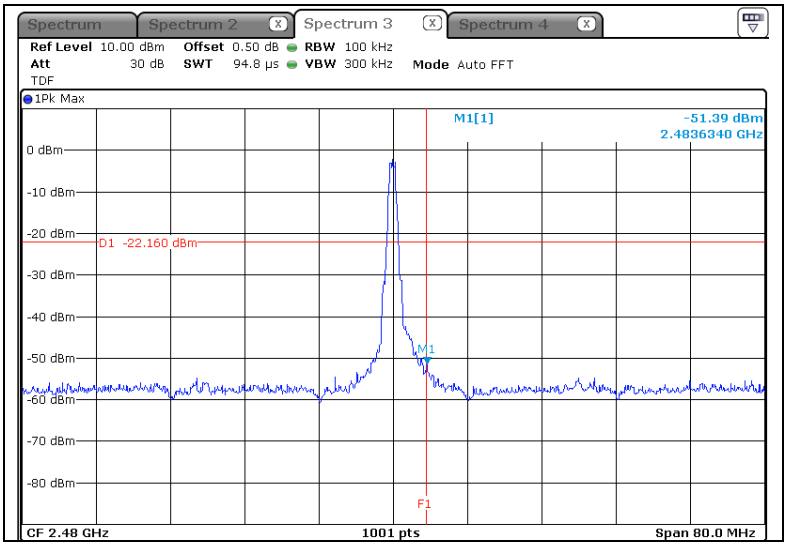



Highest Channel (2 480 ㎒)

## Reference

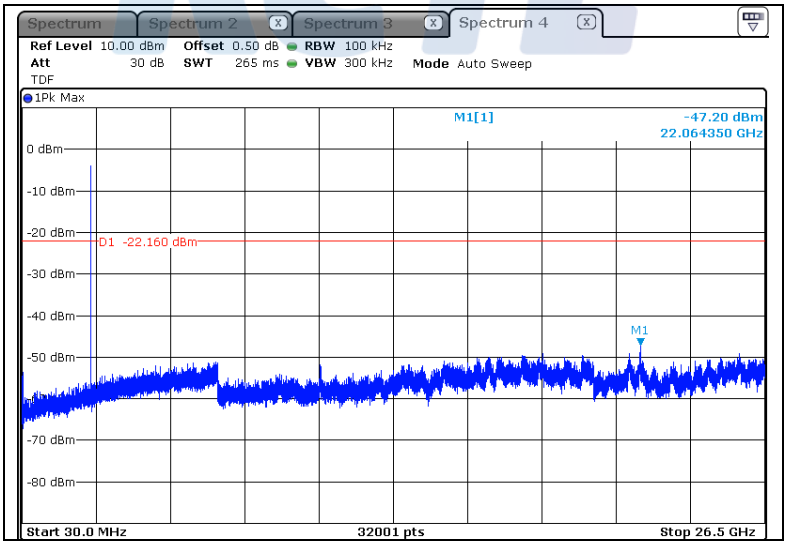


## Band-edge




Result of 2 483.5 ㎒

## Conducted Spurious Emissions



## 5.6 Conducted Emission

### 5.6.1 Regulation

According to §15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

| Frequency of emission (㎒) | Conducted limit (㏈㎶) | |
|---|---|---|
| | Qausi-peak | Average |
| 0.15 – 0.5 | 66 to 56 * | 56 to 46 * |
| 0.5 – 5 | 56 | 46 |
| 5 – 30 | 60 | 50 |

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

### 5.6.2 Measurement Procedure

1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 ㎝ in which is located 40 ㎝ away from the vertical wall and 1.5m away from the side wall of the shielded room.

2) Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.

3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.

4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 ㎒ to 30 ㎒.

5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 ㎑ or to QUASI-PEAK and AVERAGE within a bandwidth of 9 ㎑. The EUT was in transmitting mode during the measurements.

### 5.6.3 Test Result

**Result: NA :** This test is not applicable because the EUT falls into the automotive device and it's not to be connected to the public utility(AC) power line.

# 6. Test equipment used for test

| | Equipment Name | Manufacturer | Model No. | Serial No. | Next Cal. Date |
|---|---|---|---|---|---|
| ■ | SPECTRUM ANALYZER | R&S | FSV30 | 100806 | 18.08.01 |
| ■ | DC Power Supply | AGILENT | E3632A | MY40016393 | 18.12.21 |
| ■ | SIGNAL GENERATOR | R&S | SMR40 | 100007 | 18.05.15 |
| ■ | WIDEBAND POWER SENSOR | R&S | NRP-Z81 | 102398 | 19.01.31 |
| ■ | Attenuator | Weinschel ENGINEERING | 21-10 | 0007 | 19.01.31 |
| ■ | Vector Signal Generator | R&S | SMBV100A | 257566 | 19.01.05 |
| ■ | Cable Assembly | Radiall | 2301762000PJ | 1724.66 | - |
| ■ | Cable Assembly | RadiAll | 2301761768000PJ | 17.30.38 | - |
| ■ | Cable Assembly | Gigalane | RF-400 | - | - |
| ■ | Loop Antenna | R&S | HFH2-Z2 | 100355 | 18.03.03 |
| ■ | EMI Test Receiver | R&S | ESCI7 | 100732 | 18.08.24 |
| ■ | Amplifier | SONOMA | 310N | 344922 | 18.08.25 |
| ■ | Antenna Mast | MA4000-EP | Innco Systems | 303 | - |
| ■ | Turn Table | DT2000 | Innco Systems | 79 | - |
| ■ | Spectrum Analyzer | R&S | FSV40 | 100988 | 19.01.05 |
| ■ | Antenna Mast | Innco Systems | MA4640-XP-ET | - | - |
| ■ | Turn Table | DT2000 | Innco Systems | 79 | - |
| ■ | Bi-Log Antenna | SCHWARZBECK | VULB9163 | 552 | 18.05.10 |
| ■ | ATTENUATOR | HP | 8491B | 22891 | 18.08.24 |
| ■ | Amplifier | SONOMA | 310N | 186280 | 18.04.06 |
| ■ | Horn Antenna | ETS.lindgren | 3117 | 00155757 | 18.10.20 |
| ■ | Horn Antenna | ETS.lindgren | 3116 | 00086635 | 18.04.25 |
| ■ | Amplifier | L-3 Narda-MITEQ | AMF-7D-01001800-22-10P | 2003683 | 18.06.12 |
| ■ | Amplifier | L-3 Narda-MITEQ | JS44-18004000-33-8P | 2000997 | 18.08.09 |
| ■ | High Pass Filter | WT | WT-A1698-HS | WT160411001 | 18.05.15 |

This test report shall not be reproduced, except in full, without the written approval