



# TEST REPORT

|                                                                                                                                                                                                                       |                                    |                                                        |                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------------|------------------------------------------|
| <b>KCTL Inc.</b><br>65, Sinwon-ro, Yeongtong-gu,<br>Suwon-si, Gyeonggi-do, 16677, Korea<br>TEL: 82-31-285-0894 FAX: 82-505-299-8311<br><a href="http://www.kctl.co.kr">www.kctl.co.kr</a>                             |                                    | Report No.:<br><b>KR19-SRF0144</b><br>Page (1) of (52) |                                          |
| <b>1. Client</b><br>◦ Name : EM-Tech Co., Ltd.<br>◦ Address : 40, Changwon-daero 1144beon-gil, Seongsan-gu, Changwon-si, Gyeonsangnam-do, 51539, Korea<br>◦ Date of Receipt : 2019-07-24                              |                                    |                                                        |                                          |
| <b>2. Use of Report</b> : -                                                                                                                                                                                           |                                    |                                                        |                                          |
| <b>3. Name of Product and Model</b> : Wearable Wireless Speaker/ SP-A7W                                                                                                                                               |                                    |                                                        |                                          |
| <b>4. Manufacturer and Country of Origin</b> : EM-TECH VIETNAM CO., LTD / VIETNAM                                                                                                                                     |                                    |                                                        |                                          |
| <b>5. FCC ID</b> : 2AOIKSP-A7W                                                                                                                                                                                        |                                    |                                                        |                                          |
| <b>6. IC Certification</b> : 25200-SPA7W                                                                                                                                                                              |                                    |                                                        |                                          |
| <b>7. Date of Test</b> : 2019-09-17 to 2019-09-19                                                                                                                                                                     |                                    |                                                        |                                          |
| <b>8. Test Standards</b> : FCC Part 15 Subpart C, 15.247<br>RSS-247 Issue 2 February 2017<br>RSS-Gen Issue 5 March 2019                                                                                               |                                    |                                                        |                                          |
| <b>9. Test Results</b> : Refer to the test result in the test report                                                                                                                                                  |                                    |                                                        |                                          |
| Affirmation                                                                                                                                                                                                           | Tested by<br>Name : Myeongjun Kwon |                                                        | Technical Manager<br>Name : Jaehyong Lee |
|                                                                                                                                                                                                                       |                                    |                                                        | 2019-09-23                               |
| <b>KCTL Inc.</b>                                                                                                                                                                                                      |                                    |                                                        |                                          |
| 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. |                                    |                                                        |                                          |



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## 1. General information

Client : EM-Tech Co., Ltd.  
 Address : 40, Changwon-daero 1144beon-gil, Seongsan-gu, Changwon-si,  
 Gyeongsangnam-do, 51539, Korea  
 Manufacturer : EM-TECH VIETNAM CO., LTD  
 Address : Yen phong industrials zone Bac ninh province, Vietnam  
 Laboratory : KCTL Inc.  
 Address : 65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea  
 Accreditations : 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

## 2. Device information

Equipment under test : Wearable Wireless Speaker  
 Model : SP-A7W  
 Frequency range : 2 402 MHz ~ 2 480 MHz  
 Modulation technique : GFSK,  $\pi/4$ -DQPSK, 8DPSK  
 Number of channels : 79 ch  
 Power source : DC 3.70 V  
 Antenna specification : Chip Antenna  
 Antenna gain : 5.06 dBi  
 Software version : 1.0  
 Hardware version : 1.0  
 Test device serial No. : N/A  
 Operation temperature : -10 °C ~ 50 °C

## 2.1. Frequency/channel operations

This device contains the following capabilities:

Bluetooth(BDR/EDR)

| Ch. | Frequency (MHz) |
|-----|-----------------|
| 00  | 2 402           |
| .   | .               |
| 39  | 2 441           |
| .   | .               |
| 78  | 2 480           |

Table 2.1.1. Bluetooth (BDR/EDR) mode

15.247 Requirements for Bluetooth transmitter:

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:
  - 1) This system is hopping pseudo-randomly.
  - 2) Each frequency is used equally on the average by each transmitter.
  - 3) The receiver input bandwidths that match the hopping channel bandwidths of their corresponding transmitters
  - 4) The receiver shifts frequencies in synchronization with the transmitted signals.
- 15.247(g): The system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this Section 15.247 should the transmitter be presented with a continuous data (or information) stream.
- 15.247(h): The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

### **3. Antenna requirement**

Requirement of FCC part 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 provisions of this section.

Requirement of RSS-Gen Section 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

- The transmitter has permanently attached Chip Antenna (internal antenna) on board.
- The EUT Complies with the requirement of §15.203, §15.247.

#### 4. Summary of tests

| FCC Part section(s)            | IC Rule Reference                  | Parameter                    | Test results |
|--------------------------------|------------------------------------|------------------------------|--------------|
| 15.247(b)(1),(4)               | RSS-247, 5.4 (b)                   | Maximum peak output power    | Pass         |
| 15.247(a)(1)                   | RSS-247, 5.1 (b)                   | Carrier frequency separation | Pass         |
| 15.247(a)(1)                   | RSS-247, 5.1 (a)                   | 20dB channel bandwidth       | Pass         |
| -                              | RSS-Gen, 6.7                       | Occupied bandwidth           | Pass         |
| 15.247(a)(iii)<br>15.247(b)(1) | RSS-247, 5.1(d)                    | Number of hopping channel    | Pass         |
| 15.247(a) (iii)                | RSS-247, 5.1 (d)                   | Time of occupancy(dwel time) | Pass         |
| 15.205(a),<br>15.209(a)        | RSS-247, 5.5<br>RSS-Gen, 8.9, 8.10 | Spurious emission            | Pass         |
| 15.247(d),                     |                                    | Band-edge, restricted band   | Pass         |
| 15.207                         | RSS-Gen 8.8                        | Conducted Emissions          | Pass         |

#### Notes:

1. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2. According to exploratory test no any obvious emission were detected from 9 kHz to 30 MHz. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.
3. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z. It was determined that X orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in X orientation
4. The test procedure(s) in this report were performed in accordance as following.
  - ♦ ANSI C63.10-2013
  - ♦ KDB 558074 D01 v05r02

## 5. Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of  $k=2$  to indicate a 95 % level of confidence. The measurement data shown herein meets or exceeds the  $U_{\text{CISPR}}$  measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified limits to determine compliance.

| Parameter                    | Expanded uncertainty ( $\pm$ ) |         |
|------------------------------|--------------------------------|---------|
| Conducted RF power           | 1.76 dB                        |         |
| Conducted spurious emissions | 4.03 dB                        |         |
| Radiated spurious emissions  | 9 kHz ~ 30 MHz:                | 2.28 dB |
|                              | 30 MHz ~ 300 MHz               | 4.98 dB |
|                              | 300 MHz ~ 1 000 MHz            | 5.14 dB |
|                              | 1 GHz ~ 6 GHz                  | 6.70 dB |
|                              | Above 6 GHz                    | 6.60 dB |
| Conducted emissions          | 9 kHz ~ 150 kHz                | 3.66 dB |
|                              | 150 kHz ~ 30 MHz               | 3.26 dB |



**6. Measurement results explanation example**

The offset level is set in the spectrum analyzer to compensate the RF cable loss factor between EUT conducted output port and spectrum analyzer.

With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

| Frequency (MHz) | Factor(dB) | Frequency (MHz) | Factor(dB) |
|-----------------|------------|-----------------|------------|
| 30              | 5.85       | 10 000          | 8.17       |
| 100             | 5.95       | 11 000          | 8.18       |
| 200             | 6.03       | 12 000          | 8.39       |
| 300             | 6.13       | 13 000          | 8.90       |
| 400             | 6.17       | 14 000          | 9.37       |
| 500             | 6.94       | 15 000          | 9.59       |
| 600             | 6.29       | 16 000          | 9.70       |
| 700             | 6.36       | 17 000          | 9.76       |
| 800             | 6.41       | 18 000          | 10.18      |
| 900             | 6.46       | 19 000          | 10.88      |
| 1 000           | 6.50       | 20 000          | 10.88      |
| 2 000           | 6.81       | 21 000          | 10.42      |
| 3 000           | 7.02       | 22 000          | 10.99      |
| 4 000           | 7.23       | 23 000          | 11.48      |
| 5 000           | 7.47       | 24 000          | 11.06      |
| 6 000           | 7.78       | 25 000          | 11.80      |
| 7 000           | 7.96       | 26 000          | 11.02      |
| 8 000           | 8.23       | 26 500          | 11.56      |
| 9 000           | 8.06       |                 |            |

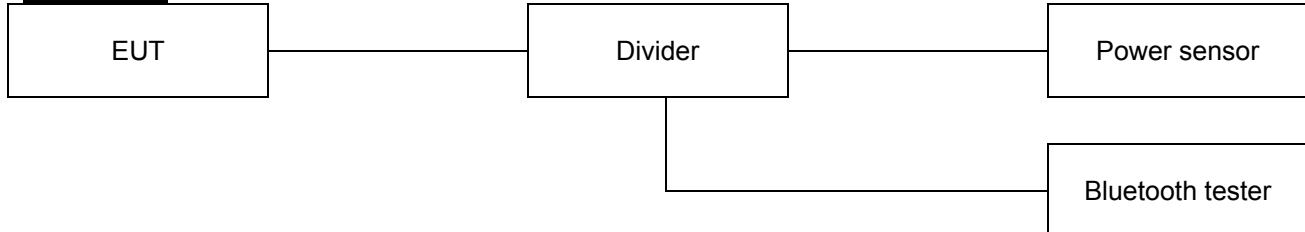
**Note.**

Offset(dB) = RF cable loss(dB) + Power Divider(dB)

## 7. Test results

### 7.1. Maximum peak output power

#### Test setup



#### Limit

##### FCC

According to §15.247(a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

According to §15.247(b)(1), for frequency hopping systems operating in the 2 400-2 483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725-5 850 MHz band: 1 watt. For all other frequency hopping systems in the 2 400-2 483.5 MHz band: 0.125 watts.

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.

##### IC

According to RSS-247 5.4(b), for FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels.

The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

#### Test procedure

ANSI C63.10-2013 - Section 7.8.5

**Test settings**

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

Use the following spectrum analyzer settings:

- 1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
- 2) RBW > 20 dB bandwidth of the emission being measured.
- 3) VBW  $\geq$  RBW.
- 4) Sweep: Auto.
- 5) Detector function: Peak.
- 6) Trace: Max hold.
- 7) Allow trace to stabilize.

**Notes:**

A peak responding power sensor is used, where the power sensor system video bandwidth is greater than the occupied bandwidth of the EUT.

**KCTL**

### Test results

| Frequency<br>(MHz) | Data rate<br>(Mbps) | Conducted output<br>power<br>(dBm) |         | Conducted<br>Power<br>Limit<br>(dBm) | Ant.<br>Gain<br>(dBi) | Max. e.i.r.p.<br>(dB m) |         | Max.<br>e.i.r.p.<br>Limit<br>(dBm) |
|--------------------|---------------------|------------------------------------|---------|--------------------------------------|-----------------------|-------------------------|---------|------------------------------------|
|                    |                     | Peak                               | Average |                                      |                       | Peak                    | Average |                                    |
| 2 402              | 1                   | -1.86                              | -3.65   | 20.97                                | 5.06                  | 3.20                    | 1.41    | 36.02                              |
| 2 441              | 1                   | -1.46                              | -3.20   |                                      | 5.06                  | 3.60                    | 1.86    |                                    |
| 2 480              | 1                   | -2.96                              | -4.60   |                                      | 5.06                  | 2.10                    | 0.46    |                                    |
| 2 402              | 2                   | 1.25                               | -2.64   | 20.97                                | 5.06                  | 6.31                    | 2.42    | 36.02                              |
| 2 441              | 2                   | 1.85                               | -2.03   |                                      | 5.06                  | 6.91                    | 3.03    |                                    |
| 2 480              | 2                   | 0.45                               | -3.30   |                                      | 5.06                  | 5.51                    | 1.76    |                                    |
| 2 402              | 3                   | 1.75                               | -2.62   | 20.97                                | 5.06                  | 6.81                    | 2.44    | 36.02                              |
| 2 441              | 3                   | 2.35                               | -1.96   |                                      | 5.06                  | 7.41                    | 3.10    |                                    |
| 2 480              | 3                   | 1.15                               | -3.13   |                                      | 5.06                  | 6.21                    | 1.93    |                                    |

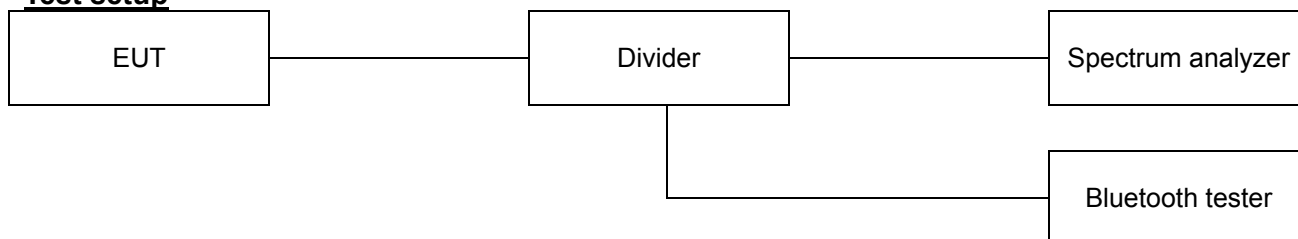
### Notes:

1. e.i.r.p. Calculation: e.i.r.p. (dB m) = Conducted output power (dB m) + Antenna gain (dB i)



## 7.2. Carrier frequency separation

### Test setup



### Limit

According to §15.247(a)(1) and RSS-247 5.1(b), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

### Test procedure

ANSI C63.10-2013 - Section 7.8.2

### Test settings

- a) Span: Wide enough to capture the peaks of two adjacent channels.
- b) RBW: Start with the RBW set to approximately 30 % of the channel spacing; adjust as necessary to best identify the center of each individual channel.
- c) Video (or average) bandwidth (VBW)  $\geq$  RBW.
- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.
- g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the 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](http://www.kctl.co.kr)

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**KCTL****Test results**

| Frequency(MHz) | Data rate(Mbps) | Carrier frequency separation(MHz) | Limit(MHz) |
|----------------|-----------------|-----------------------------------|------------|
| 2 402          | 1               | 1.004                             | 0.639      |
| 2 441          | 1               | 1.007                             | 0.637      |
| 2 480          | 1               | 0.998                             | 0.639      |
| 2 402          | 3               | 1.046                             | 0.867      |
| 2 441          | 3               | 1.184                             | 0.867      |
| 2 480          | 3               | 1.061                             | 0.860      |

**KCTL**

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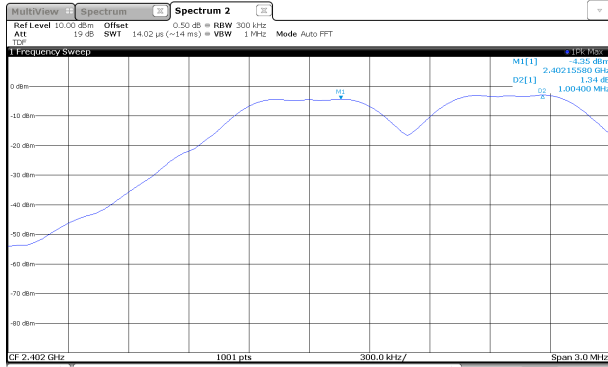
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Suwon-si, Gyeonggi-do, 16677, Korea  
TEL: 82-31-285-0894 FAX: 82-505-299-8311  
[www.kctl.co.kr](http://www.kctl.co.kr)

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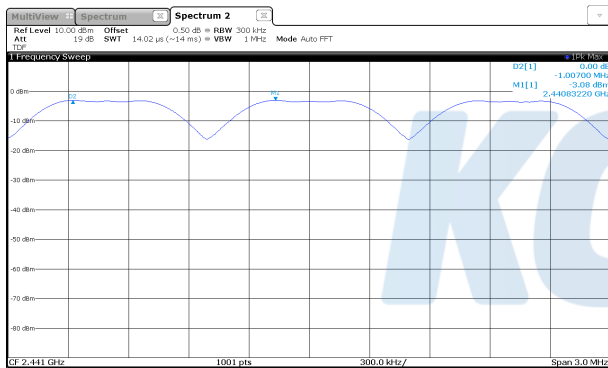
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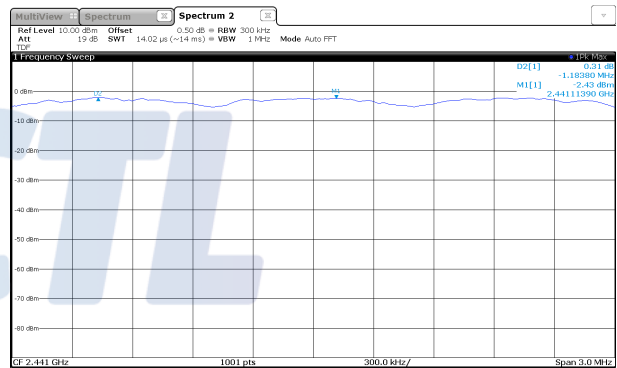
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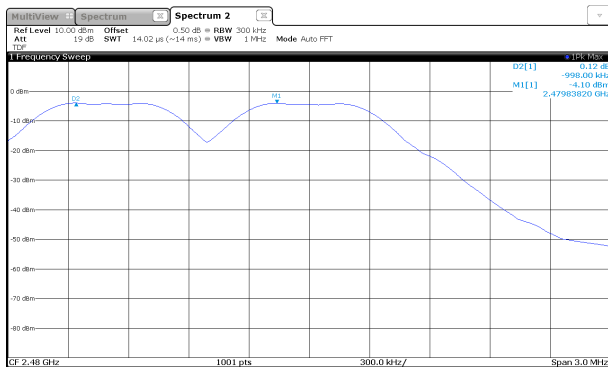
## GFSK / Mid ch.



## 8DPSK / Mid ch.



## GFSK / High ch.

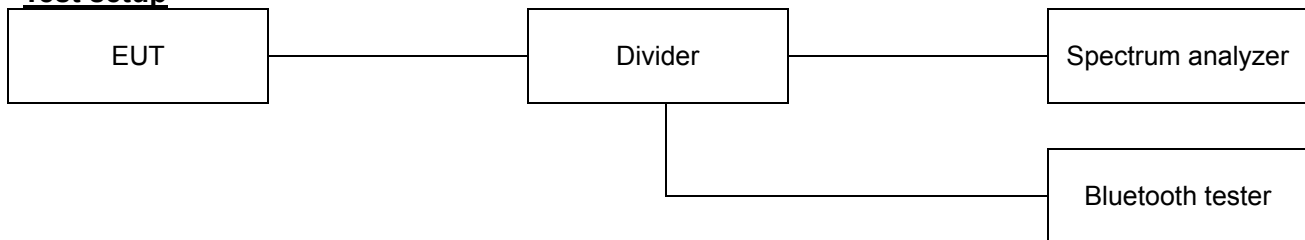


## 8DPSK / High ch.



### 7.3. 20dB channel bandwidth (Occupied bandwidth)

#### Test setup



#### Limit

According to §15.247(a)(1) and RSS-247 5.1(a), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

#### Test procedure

ANSI C63.10-2013 - Section 6.9.2

#### Test settings

##### 20dB channel bandwidth and Occupied bandwidth

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are -6 dB, -20 dB, and -26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this subclause, the ratio is designated by “-xx dB.” The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the “-xx dB” bandwidth; other requirements might specify that the “-xx dB” bandwidth be entirely contained within the authorized or designated frequency band.

- The spectrum analyzer center frequency is set to the nominal EUT channel center frequency.
- Span: Two times and five times the OBW.
- RBW = 1 % to 5 % of the OBW and VBW ≥ 3 x RBW
- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “-xx dB down” requirement; that is, if the requirement calls for measuring the -20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.
- Detector: peak
- Trace mode: max hold.
- Allow the trace to stabilize.
- Determine the “-xx dB down amplitude” using ((reference value) - xx). Alternatively, this calculation may be made by using the marker-delta function of the instrument.
- If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow

the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).

- k) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “-xx dB down amplitude” determined in step h). If a marker is below this “-xx dB down amplitude” value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the “-xx dB down amplitude” determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

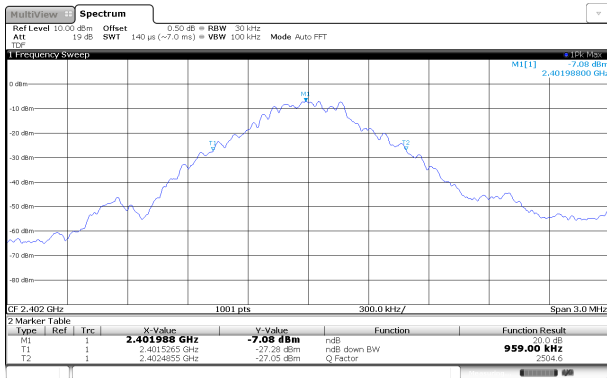
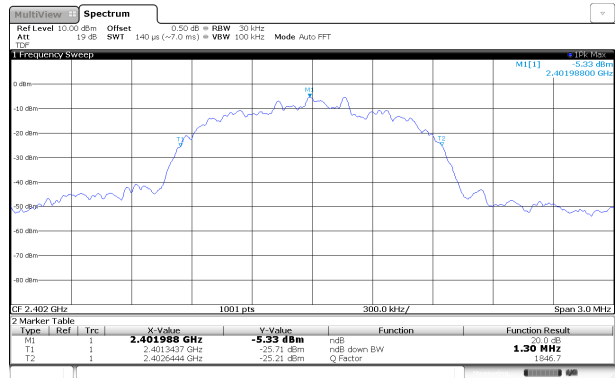
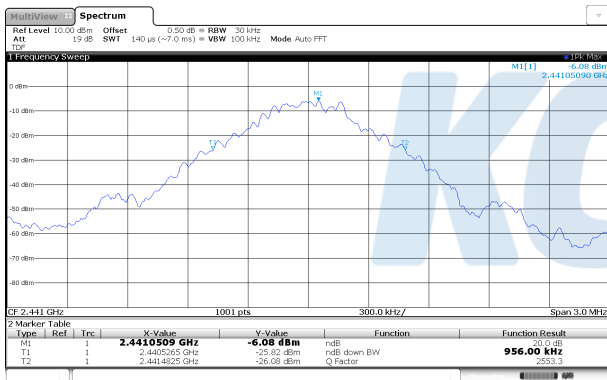
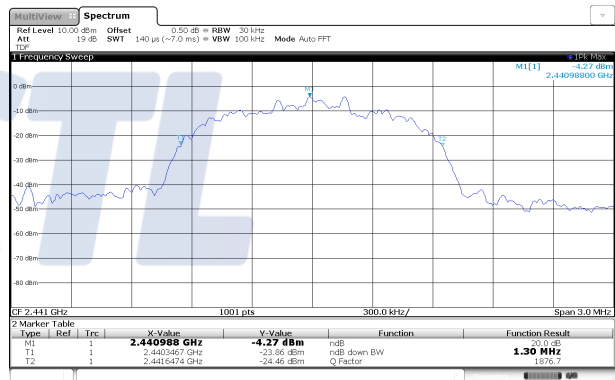
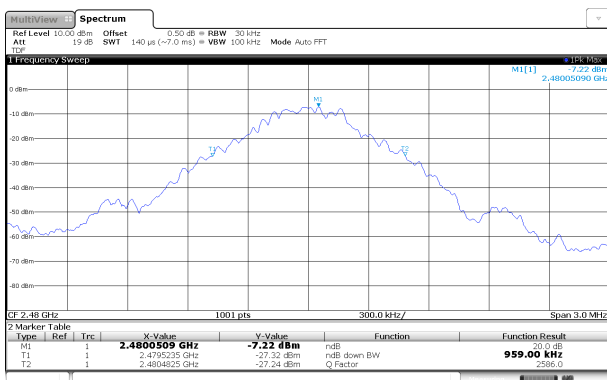
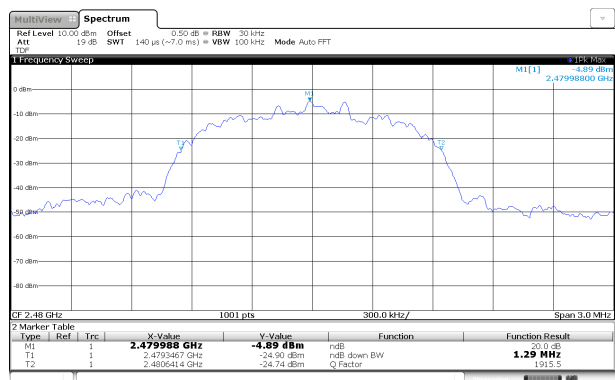
### **Test results**

#### **20 dB Bandwidth**

| Frequency(MHz) | Data rate (Mbps) | 20 dB Bandwidth (MHz) | Minimum Bandwidth (MHz) |
|----------------|------------------|-----------------------|-------------------------|
| 2 402          | 1                | 0.959                 | 0.5                     |
| 2 441          | 1                | 0.956                 |                         |
| 2 480          | 1                | 0.959                 |                         |
| 2 402          | 3                | 1.300                 |                         |
| 2 441          | 3                | 1.300                 |                         |
| 2 480          | 3                | 1.290                 |                         |

#### **99% Bandwidth**

| Frequency(MHz) | Data rate (Mbps) | 99% bandwidth(MHz) |
|----------------|------------------|--------------------|
| 2 402          | 1                | 0.881              |
| 2 441          | 1                | 0.879              |
| 2 480          | 1                | 0.876              |
| 2 402          | 3                | 1.170              |
| 2 441          | 3                | 1.171              |
| 2 480          | 3                | 1.165              |

**20 dB bandwidth****GFSK / Low ch.****8DPSK / Low ch.****GFSK / Mid ch.****8DPSK / Mid ch.****GFSK / High ch.****8DPSK / High ch.**

# 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](http://www.kctl.co.kr)

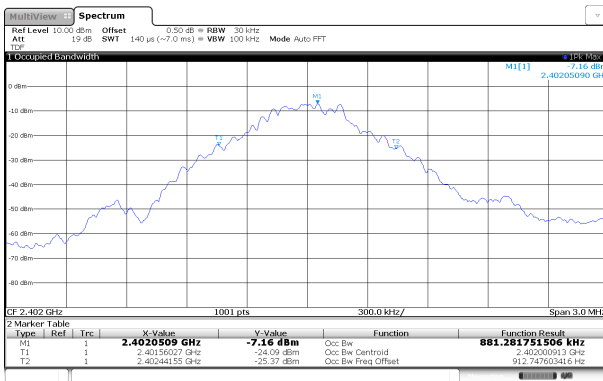
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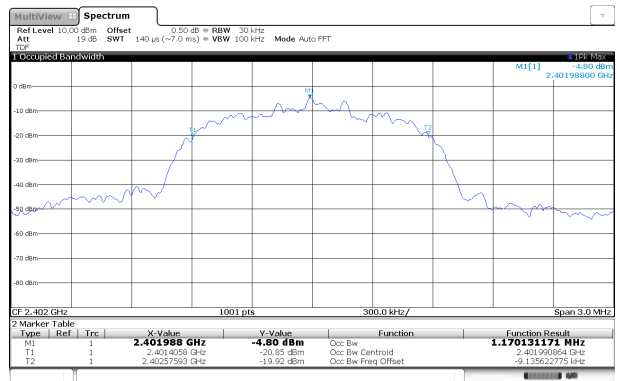


## 99 % bandwidth

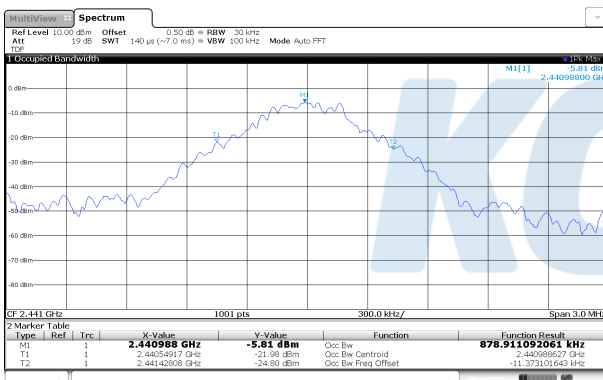
### GFSK / Low ch.



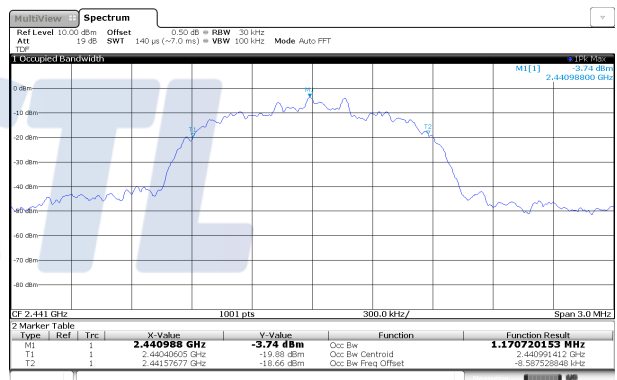
### 8DPSK / Low ch.



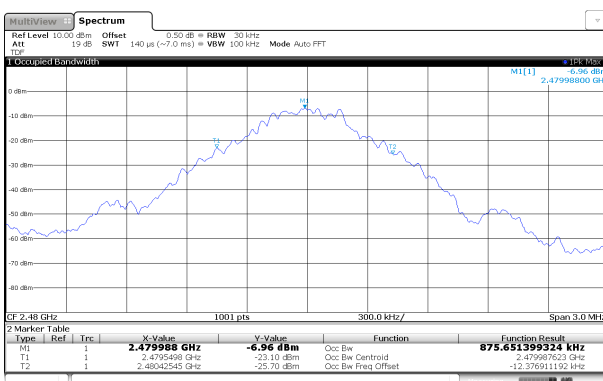
### GFSK / Mid ch.



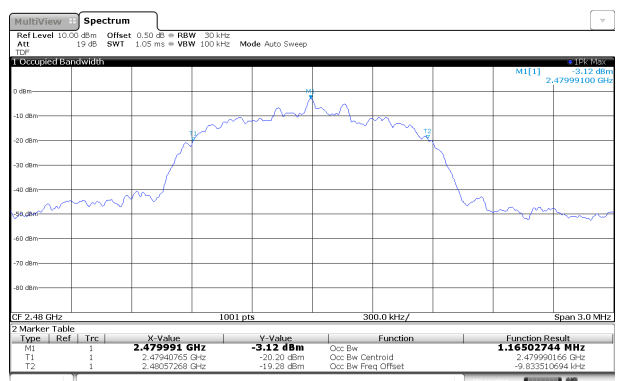
### 8DPSK / Mid ch.



### GFSK / High ch.



### 8DPSK / High ch.

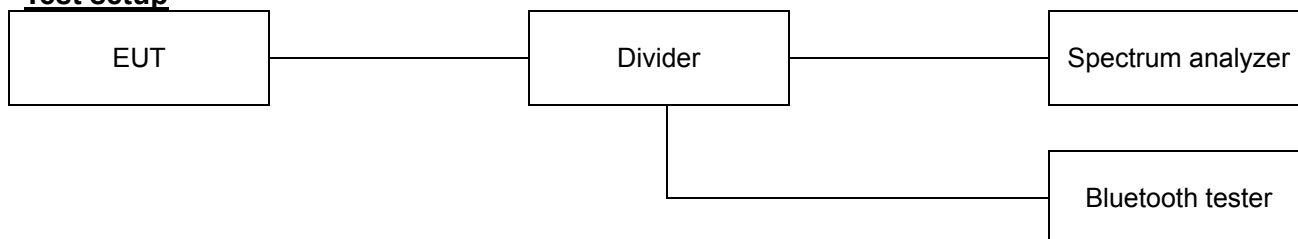


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KCTL-TIR001-003/2

## 7.4. Number of hopping channels

### Test setup



### Limit

According to §15.247(a)(1)(iii) and RSS-247 5.1(d), frequency hopping systems in the 2 400-2 483.5 MHz band shall use at least 15 channels.

### Test procedure

ANSI C63.10-2013 - Section 7.8.3

### Test settings

- a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
- b) RBW: To identify clearly the individual channels, set the RBW to less than 30 % of the channel spacing or the 20 dB bandwidth, whichever is smaller.
- c) VBW  $\geq$  RBW.
- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.
- g) Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

### Test results

| Mode           | Number of hopping channel | Limit     |
|----------------|---------------------------|-----------|
| GFSK           | 79                        | $\geq 15$ |
| $\pi/4$ -DQPSK | 79                        | $\geq 15$ |
| 8DPSK          | 79                        | $\geq 15$ |

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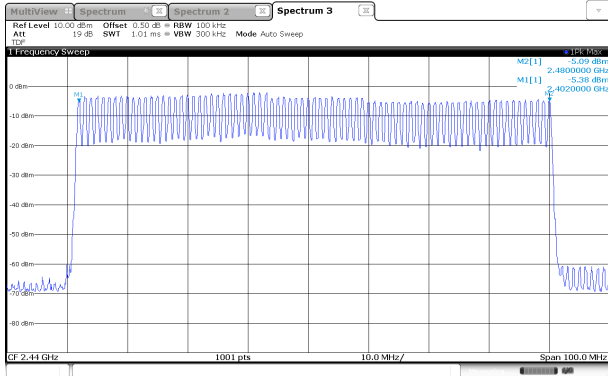
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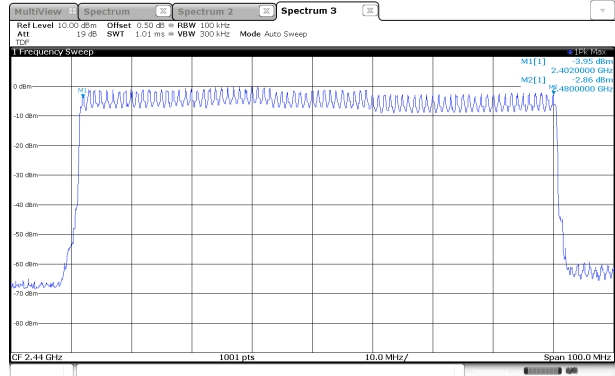
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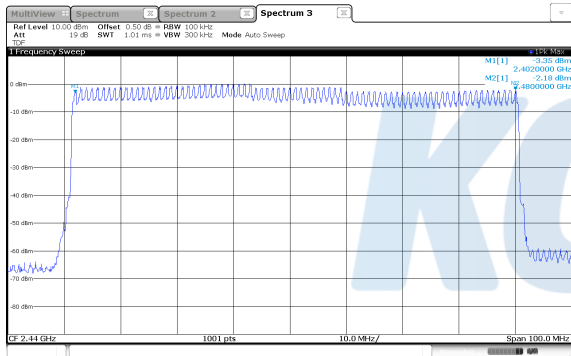
## GFSK



## $\pi/4$ -DQPSK



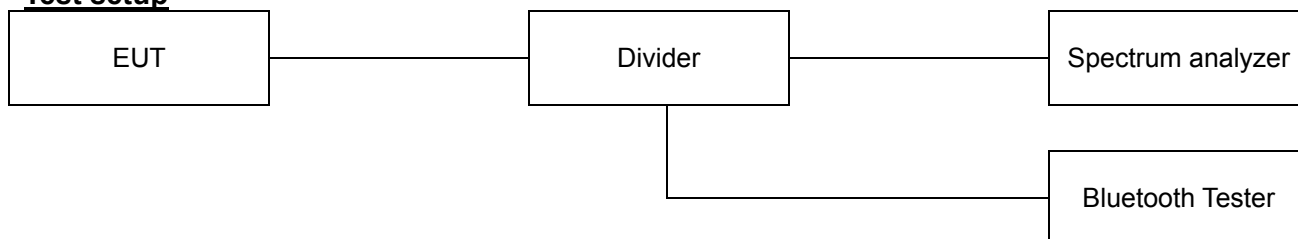
## 8DPSK



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## 7.5. Time of occupancy(Dwell time)

### Test setup



### Limit

According to §15.247(a)(1)(iii) and RSS-247 5.1(d), frequency hopping systems in the 2 400-2 483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

### Test procedure

ANSI C63.10-2013 - Section 7.8.4

### Test settings

- Span: Zero span, centered on a hopping channel.
- RBW  $\leq$  channel spacing and  $\gg 1 / T$ , where T is the expected dwell time per channel.
- Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
- Detector function: Peak.
- Trace: Max hold.
- Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

**Test results****- Non-AFH**

| Modulation | Frequency (MHz) | Pulse Width (ms) | Hopping rate (hop/s) | Number of Channels | Result (s) | Limit (s) |
|------------|-----------------|------------------|----------------------|--------------------|------------|-----------|
| DH1        | 2 441           | 0.378            | 800.000              | 79                 | 0.121      | 0.400     |
| DH3        | 2 441           | 1.636            | 400.000              | 79                 | 0.262      | 0.400     |
| DH5        | 2 441           | 2.884            | 266.667              | 79                 | 0.308      | 0.400     |
| 2-DH1      | 2 441           | 0.397            | 800.000              | 79                 | 0.127      | 0.400     |
| 2-DH3      | 2 441           | 1.652            | 400.000              | 79                 | 0.264      | 0.400     |
| 2-DH5      | 2 441           | 2.891            | 266.667              | 79                 | 0.308      | 0.400     |
| 3-DH1      | 2 441           | 0.397            | 800.000              | 79                 | 0.127      | 0.400     |
| 3-DH3      | 2 441           | 1.648            | 400.000              | 79                 | 0.264      | 0.400     |
| 3-DH5      | 2 441           | 2.898            | 266.667              | 79                 | 0.309      | 0.400     |

**- AFH**

| Modulation | Frequency (MHz) | Pulse Width (ms) | Hopping rate (hop/s) | Number of Channels | Result (s) | Limit (s) |
|------------|-----------------|------------------|----------------------|--------------------|------------|-----------|
| DH1        | 2 441           | 0.378            | 400.000              | 20                 | 0.060      | 0.400     |
| DH3        | 2 441           | 1.636            | 200.000              | 20                 | 0.131      | 0.400     |
| DH5        | 2 441           | 2.884            | 133.333              | 20                 | 0.154      | 0.400     |
| 2-DH1      | 2 441           | 0.397            | 400.000              | 20                 | 0.064      | 0.400     |
| 2-DH3      | 2 441           | 1.652            | 200.000              | 20                 | 0.132      | 0.400     |
| 2-DH5      | 2 441           | 2.891            | 133.333              | 20                 | 0.155      | 0.400     |
| 3-DH1      | 2 441           | 0.397            | 400.000              | 20                 | 0.064      | 0.400     |
| 3-DH3      | 2 441           | 1.648            | 200.000              | 20                 | 0.132      | 0.400     |
| 3-DH5      | 2 441           | 2.898            | 133.333              | 20                 | 0.155      | 0.400     |

**Notes:**

## 1. Non-AFH

- Period Time: 0.4 sec x 79 channels = 31.6 sec
- Result (s)= (Hopping rate (hop/s/slot) / 79 channels) x 31.6 sec x Pulse width (ms)

## 2. AFH

- Period Time: 0.4 sec x 20 channels = 8 sec
- Result (s)= (Hopping rate (hop/s/slot) / 20 channels) x 8 sec x Pulse width (ms)

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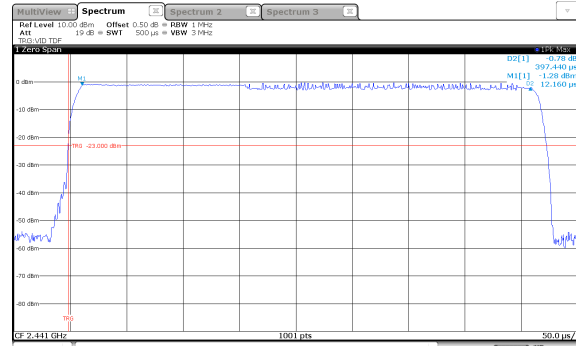
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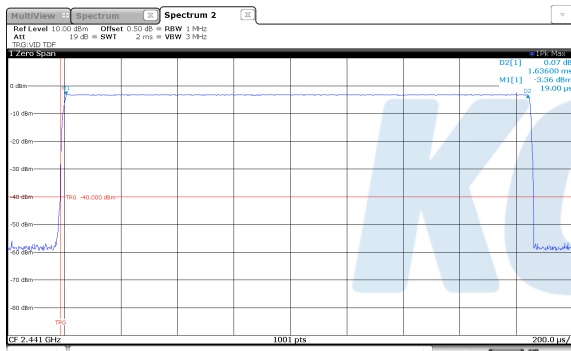
## GFSK / DH1



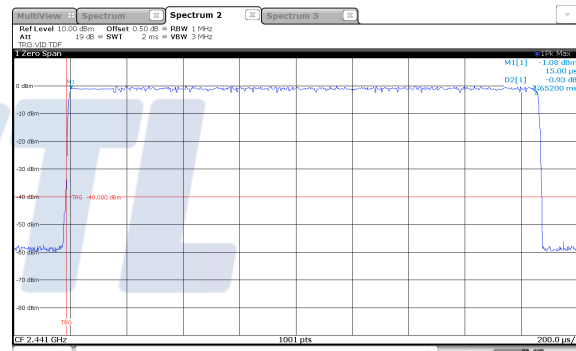
## $\pi/4$ -DQPSK / 2-DH1



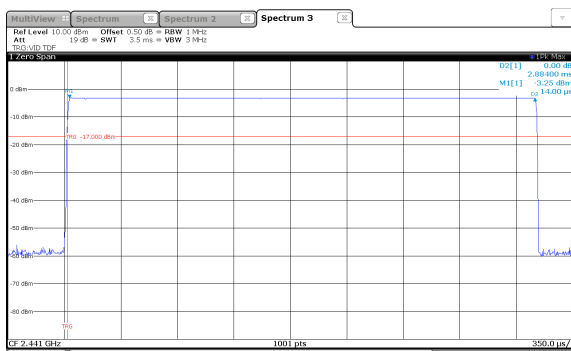
## GFSK / DH3



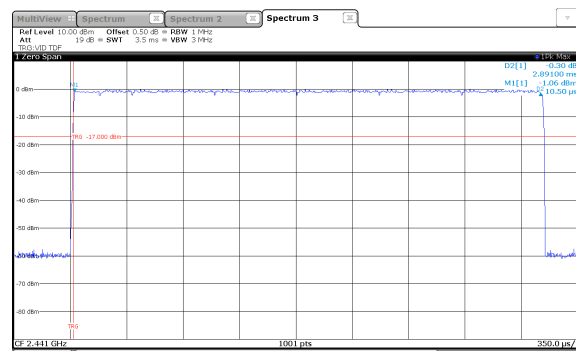
## $\pi/4$ -DQPSK / 2-DH3



## GFSK / DH5



## $\pi/4$ -DQPSK / 2-DH5



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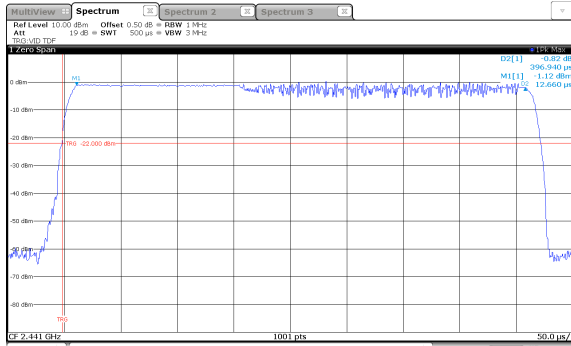
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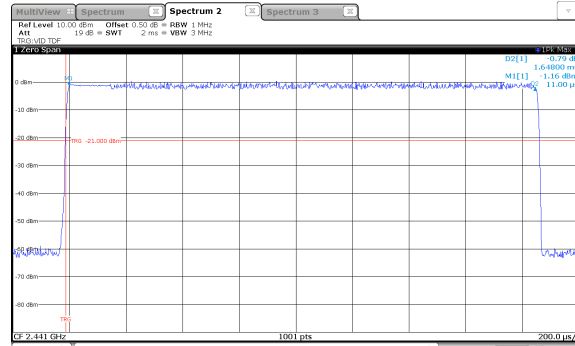
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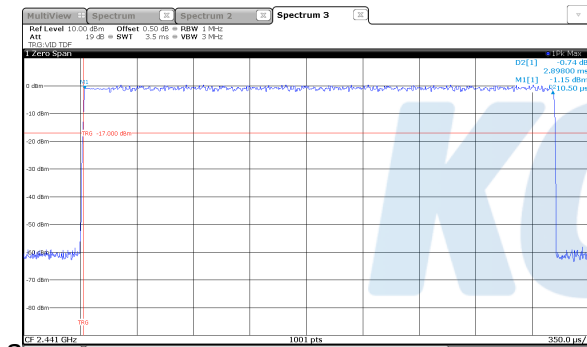
## 8DPSK / 3-DH1



## 8DPSK / 3-DH3



## 8DPSK / 3-DH5

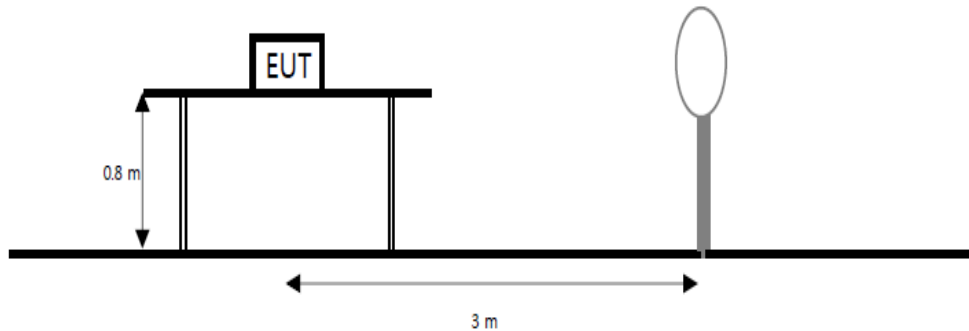


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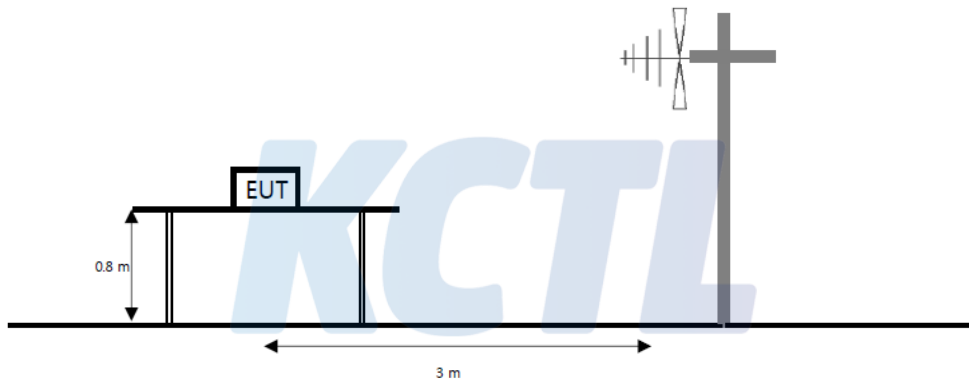
## 7.6. Radiated spurious emissions & band edge

### Test setup

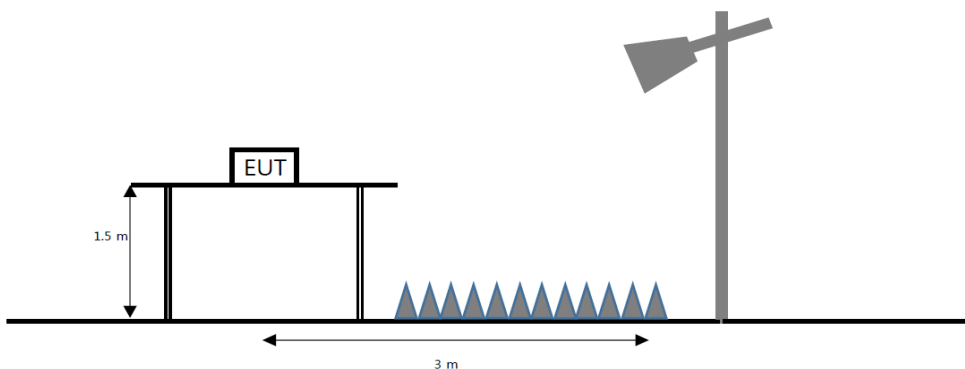
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz emissions, whichever is lower.



### Limit

According to section 15.209(a), RSS-Gen(8.9) except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency (MHz) | Field strength ( $\mu\text{V}/\text{m}$ ) | Measurement distance (m) |
|-----------------|-------------------------------------------|--------------------------|
| 0.009 - 0.490   | 2 400/F(kHz)                              | 300                      |
| 0.490 - 1.705   | 24 000/F(kHz)                             | 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 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., Section 15.231 and 15.241.

According to section 15.205(a) and (b), RSS-Gen(8.10) only spurious emissions are permitted in any of the frequency bands listed below:

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

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

According to section 15.407(b), undesirable emission limits. Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz

For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.

For transmitters operating in the 5.725-5.85 GHz band: All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

**KCTL**

**Test procedure**

ANSI C63.10-2013 Section 12.7.7.2, 12.7.5, 12.7.6  
KDB 789033 D02 v02r01 – Section G

**Test settings****Peak field strength measurements**

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = as specified in table
3. VBW  $\geq$  (3 $\times$ RBW)
4. Detector = peak
5. Sweep time = auto
6. Trace mode = max hold
7. Allow sweeps to continue until the trace stabilizes

**Table. RBW as a function of frequency**

| Frequency           | RBW                |
|---------------------|--------------------|
| 9 kHz to 150 kHz    | 200 Hz to 300 Hz   |
| 0.15 MHz to 30 MHz  | 9 kHz to 10 kHz    |
| 30 MHz to 1 000 MHz | 100 kHz to 120 kHz |
| > 1 000 MHz         | 1 MHz              |

**Average field strength measurements****Trace averaging with continuous EUT transmission at full power**

If the EUT can be configured or modified to transmit continuously ( $D \geq 98\%$ ), then the average emission levels shall be measured using the following method (with EUT transmitting continuously):

1. RBW = 1 MHz (unless otherwise specified).
2. VBW  $\geq$  (3 $\times$ RBW).
3. Detector = RMS (power averaging), if  $[\text{span} / (\# \text{ of points in sweep})] \leq (\text{RBW} / 2)$ . Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
4. Averaging type = power (i.e., rms):
  - 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
  - 2) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
5. Sweep time = auto.
6. Perform a trace average of at least 100 traces.

**Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction**

If continuous transmission of the EUT ( $D \geq 98\%$ ) cannot be achieved and the duty cycle is constant (duty cycle variations are less than  $\pm 2\%$ ), then the following procedure shall be used:

1. The EUT shall be configured to operate at the maximum achievable duty cycle.
2. Measure the duty cycle D of the transmitter output signal as described in 11.6.
3. RBW = 1 MHz (unless otherwise specified).
4. VBW  $\geq$  [3  $\times$  RBW].
5. Detector = RMS (power averaging), if  $[\text{span} / (\# \text{ of points in sweep})] \leq (\text{RBW} / 2)$ . Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this

condition cannot be satisfied, then the detector mode shall be set to peak.

6. Averaging type = power (i.e., rms):
  - 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
  - 2) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
7. Sweep time = auto.
8. Perform a trace average of at least 100 traces.
9. A correction factor shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
  - 1) If power averaging (rms) mode was used in step f), then the applicable correction factor is  $[10 \log (1 / D)]$ , where D is the duty cycle.
  - 2) If linear voltage averaging mode was used in step f), then the applicable correction factor is  $[20 \log (1 / D)]$ , where D is the duty cycle.
  - 3) If a specific emission is demonstrated to be continuous ( $D \geq 98\%$ ) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

**Notes:**

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1 kHz ( $\geq 1/T$ ) for Average detection (AV) at frequency above 1 GHz. (where T = pulse width)
2.  $f < 30$  MHz, extrapolation factor of 40 dB/decade of distance.  $F_d = 40 \log(D_m/D_s)$   
 $f \geq 30$  MHz, extrapolation factor of 20 dB/decade of distance.  $F_d = 20 \log(D_m/D_s)$   
 Where:  
 $F_d$  = Distance factor in dB  
 $D_m$  = Measurement distance in meters  
 $D_s$  = Specification distance in meters
3. Factors(dB) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or  $F_d$ (dB)
4. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
5. Average test would be performed if the peak result were greater than the average limit.
6. <sup>1)</sup> means restricted band.
7. According to part 15.31(f)(2), an extrapolation factor of 40 dB/decade is applied because measured distance of radiated emission is 3 m.
8. Below 30 MHz frequency range, In order to search for the worst result, all orientations about parallel, perpendicular, and ground-parallel were investigated then reported. when the emission level was higher than 20 dB of the limit, then the following statement shall be made: "No spurious emissions were detected within 20 dB of the limit."

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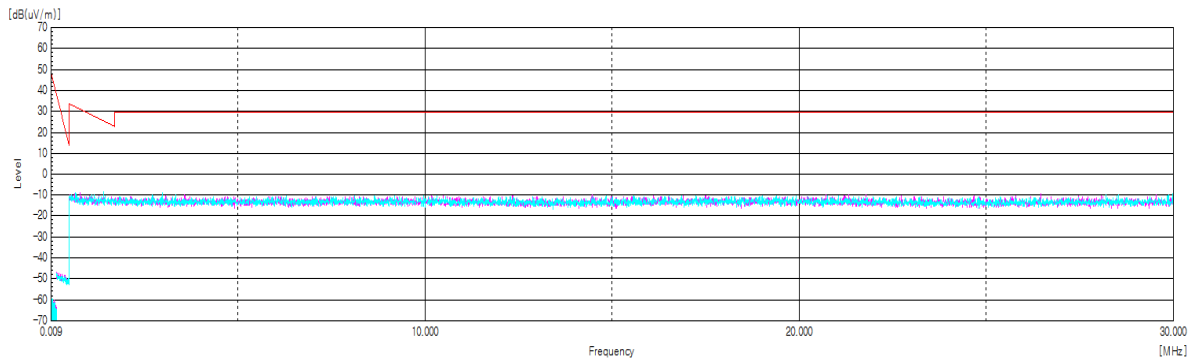
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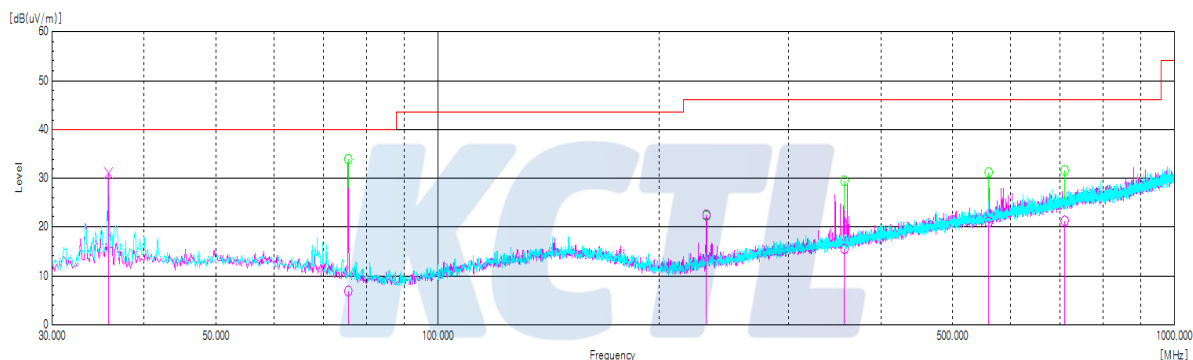
**KCTL****Test results (Below 30 MHz) – Worst case: 8DPSK Middle frequency**

| Frequency                                                      | Pol.  | Reading        | Cable Loss | Amp Gain | Antenna Factor | DCCF | Result           | Limit            | Margin |
|----------------------------------------------------------------|-------|----------------|------------|----------|----------------|------|------------------|------------------|--------|
| (MHz)                                                          | (V/H) | (dB( $\mu$ V)) | (dB)       | (dB)     | (dB)           | (dB) | (dB( $\mu$ V/m)) | (dB( $\mu$ V/m)) | (dB)   |
| No spurious emissions were detected within 20 dB of the limit. |       |                |            |          |                |      |                  |                  |        |

**Horizontal/Vertical****KCTL**

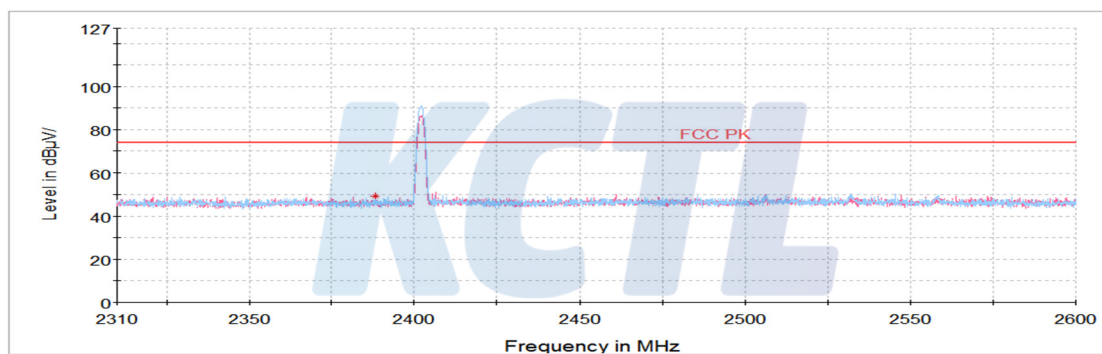
**Test results (Below 1 000 MHz) – Worst case: 8DPSK Middle frequency**

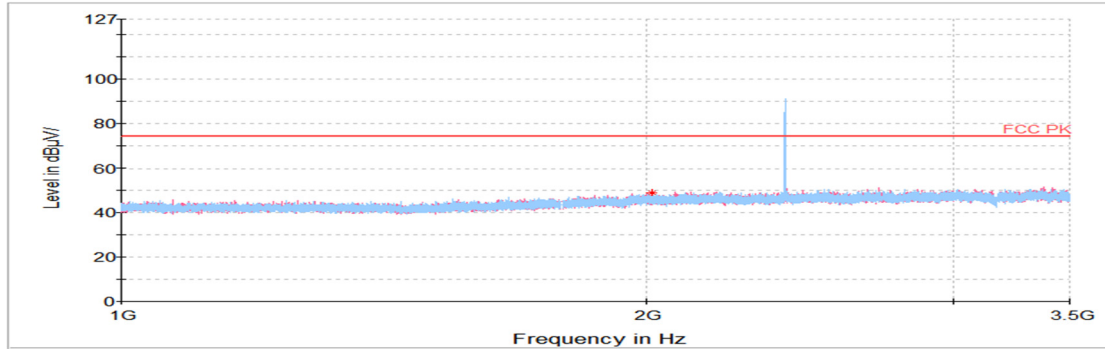
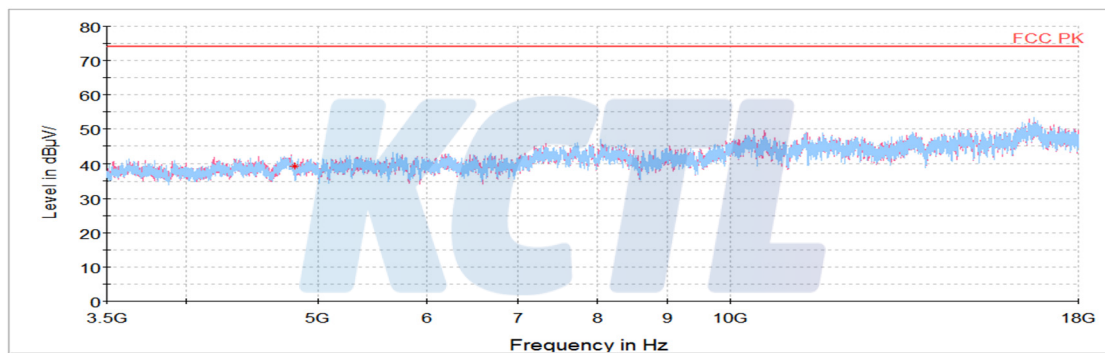
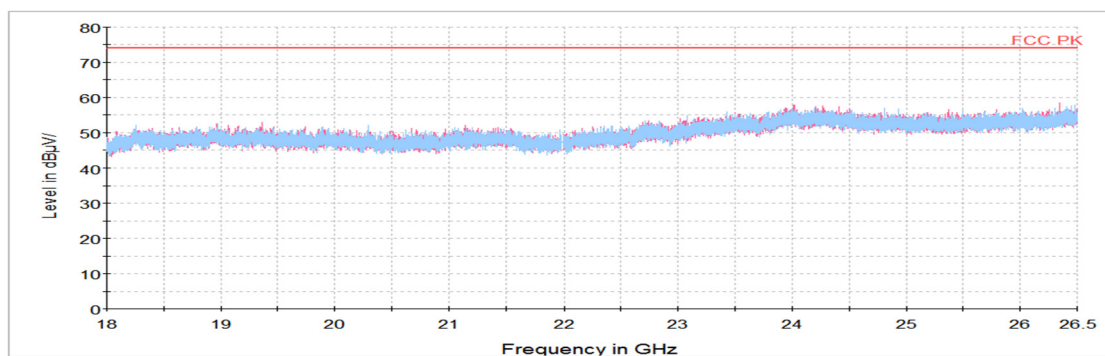
| Frequency            | Pol.  | Reading        | Ant. Factor | Amp. + Cable | DCCF | Result           | Limit            | Margin |
|----------------------|-------|----------------|-------------|--------------|------|------------------|------------------|--------|
| (MHz)                | (V/H) | (dB( $\mu$ V)) | (dB)        | (dB)         | (dB) | (dB( $\mu$ V/m)) | (dB( $\mu$ V/m)) | (dB)   |
| Quasi peak data      |       |                |             |              |      |                  |                  |        |
| 35.82                | V     | 44.30          | 17.56       | -30.87       | -    | 30.99            | 40.00            | 9.01   |
| 75.71                | H     | 21.60          | 15.26       | -30.23       | -    | 6.63             | 40.00            | 33.37  |
| 232.00               | H     | 33.70          | 16.98       | -28.68       | -    | 22.00            | 46.00            | 24.00  |
| 356.28 <sup>1)</sup> | H     | 22.40          | 20.49       | -27.82       | -    | 15.07            | 46.00            | 30.93  |
| 560.23               | H     | 22.70          | 24.51       | -26.71       | -    | 20.50            | 46.00            | 25.50  |
| 709.12               | H     | 19.60          | 26.90       | -25.90       | -    | 20.60            | 46.00            | 25.40  |

**Horizontal/Vertical**

**Test results (Above 1 000 MHz)****GFSK****Low Channel**

| Frequency                                                      | Pol.  | Reading  | Ant. Factor | Amp. + Cable | DCCF | Result     | Limit      | Margin |
|----------------------------------------------------------------|-------|----------|-------------|--------------|------|------------|------------|--------|
| (MHz)                                                          | (V/H) | (dB(μV)) | (dB)        | (dB)         | (dB) | (dB(μV/m)) | (dB(μV/m)) | (dB)   |
| <b>Peak data</b>                                               |       |          |             |              |      |            |            |        |
| 2 388.36 <sup>1)</sup>                                         | H     | 66.14    | 32.01       | -48.80       | -    | 49.35      | 74.00      | 24.65  |
| 4 803.64 <sup>1)</sup>                                         | V     | 58.50    | 33.78       | -53.12       | -    | 39.16      | 74.00      | 34.84  |
| <b>Average Data</b>                                            |       |          |             |              |      |            |            |        |
| No spurious emissions were detected within 20 dB of the limit. |       |          |             |              |      |            |            |        |

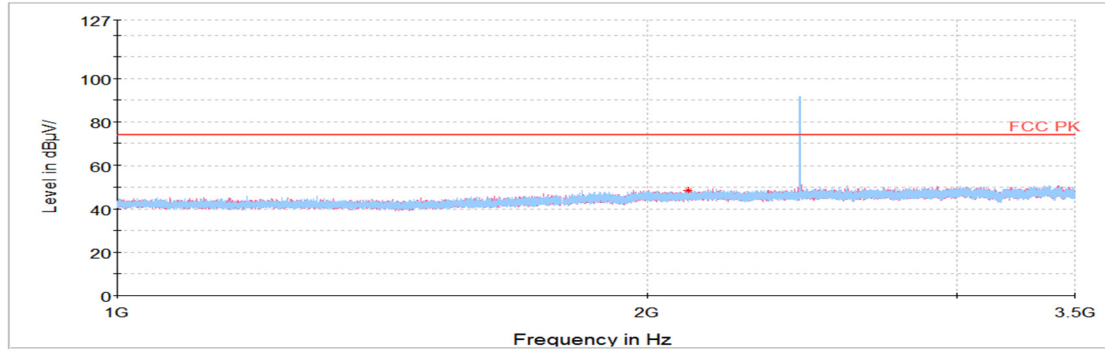
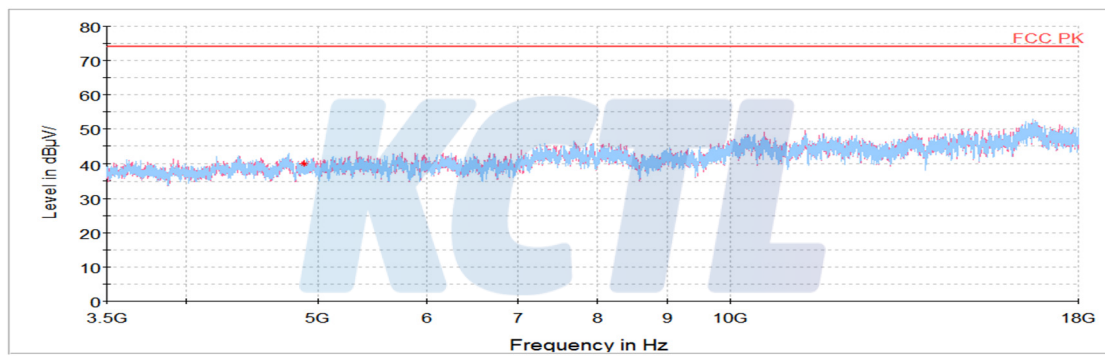
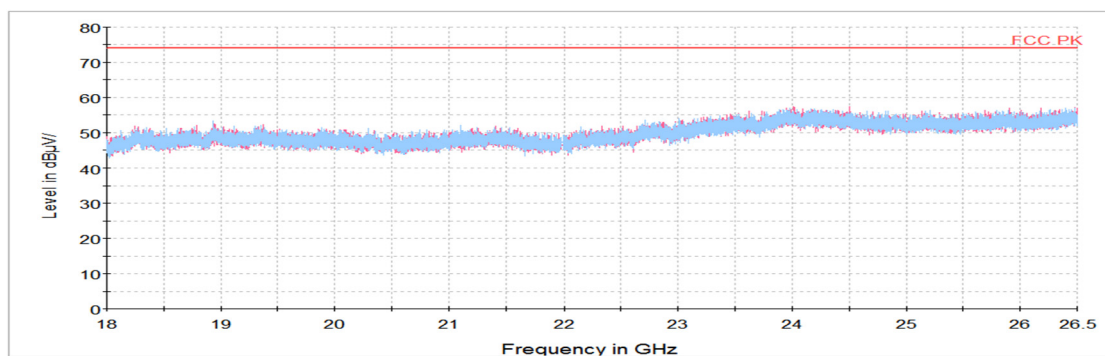
**Horizontal/Vertical for Band-edge**

**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

### Middle Channel

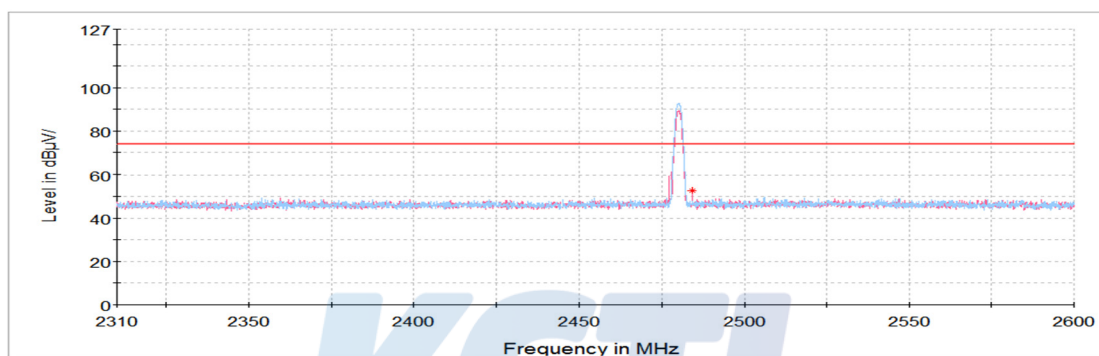
| Frequency                                                      | Pol.  | Reading         | Ant. Factor | Amp. + Cable | DCCF | Result            | Limit             | Margin |
|----------------------------------------------------------------|-------|-----------------|-------------|--------------|------|-------------------|-------------------|--------|
| (MHz)                                                          | (V/H) | (dB( $\mu V$ )) | (dB)        | (dB)         | (dB) | (dB( $\mu V/m$ )) | (dB( $\mu V/m$ )) | (dB)   |
| <b>Peak data</b>                                               |       |                 |             |              |      |                   |                   |        |
| 4 880.22 <sup>1)</sup>                                         | H     | 60.72           | 33.83       | -54.56       | -    | 39.99             | 74.00             | 34.01  |
| <b>Average Data</b>                                            |       |                 |             |              |      |                   |                   |        |
| No spurious emissions were detected within 20 dB of the limit. |       |                 |             |              |      |                   |                   |        |

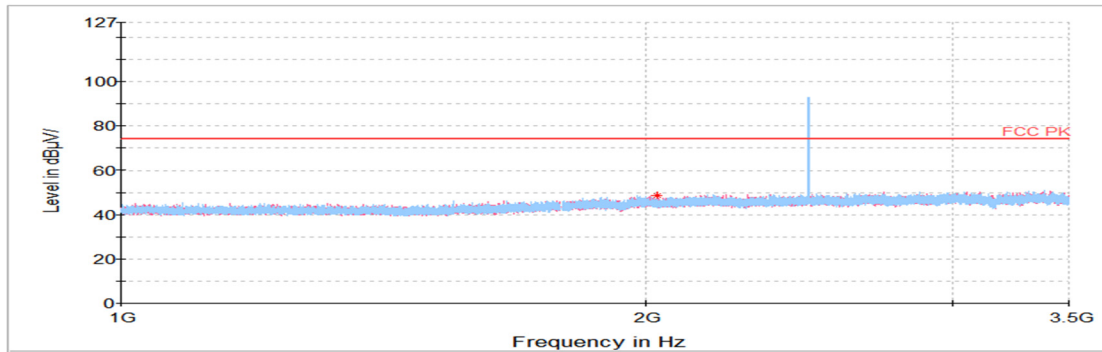
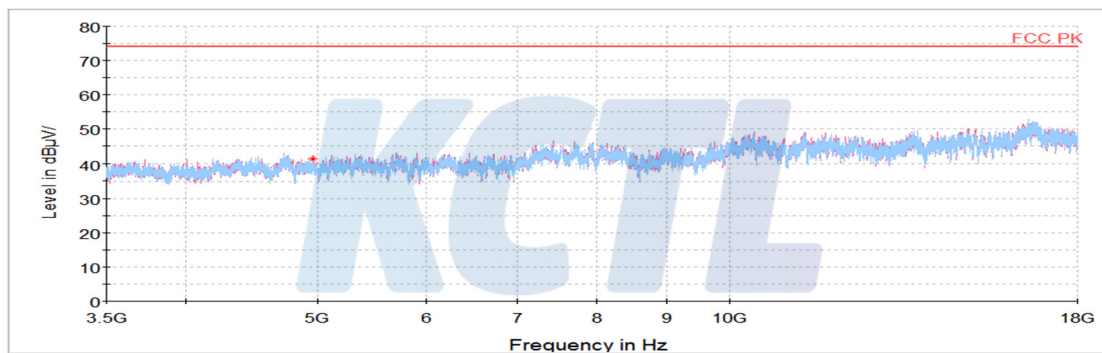
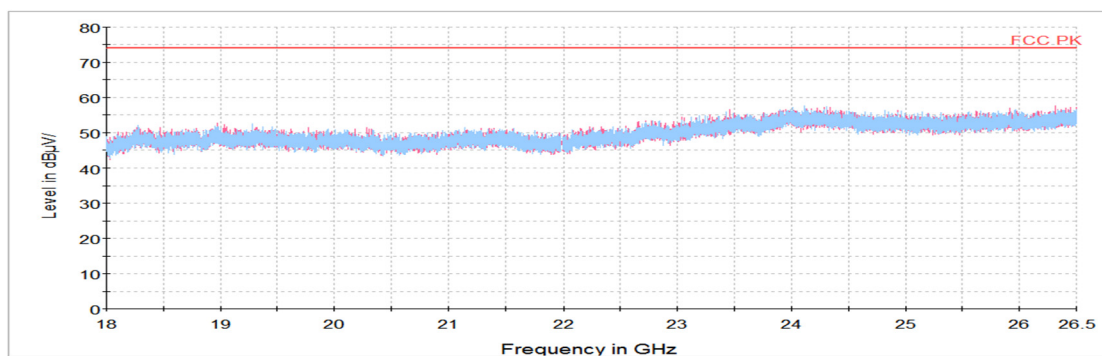
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**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

**High Channel**

| Frequency              | Pol.  | Reading        | Ant. Factor | Amp. + Cable | DCCF | Result           | Limit            | Margin |
|------------------------|-------|----------------|-------------|--------------|------|------------------|------------------|--------|
| (MHz)                  | (V/H) | (dB( $\mu$ V)) | (dB)        | (dB)         | (dB) | (dB( $\mu$ V/m)) | (dB( $\mu$ V/m)) | (dB)   |
| <b>Peak data</b>       |       |                |             |              |      |                  |                  |        |
| 2 484.56 <sup>1)</sup> | V     | 68.92          | 32.09       | -48.19       | -    | 52.82            | 74.00            | 21.18  |
| 4 962.69 <sup>1)</sup> | V     | 62.05          | 33.88       | -54.58       | -    | 41.35            | 74.00            | 32.65  |
| <b>Average Data</b>    |       |                |             |              |      |                  |                  |        |

**Horizontal/Vertical for Band-edge**

**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

**KCTL Inc.**

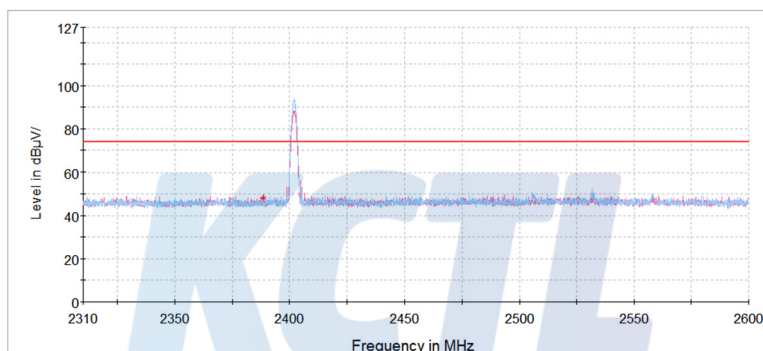
65, Sinwon-ro, Yeongtong-gu,  
Suwon-si, Gyeonggi-do, 16677, Korea  
TEL: 82-31-285-0894 FAX: 82-505-299-8311  
[www.kctl.co.kr](http://www.kctl.co.kr)

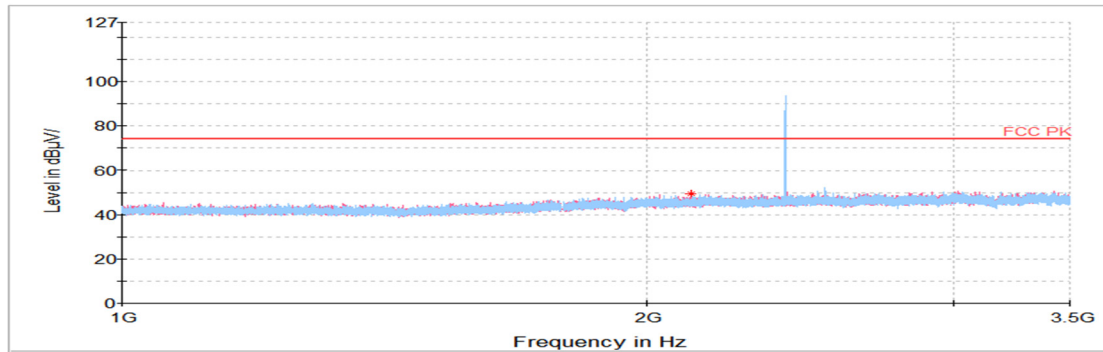
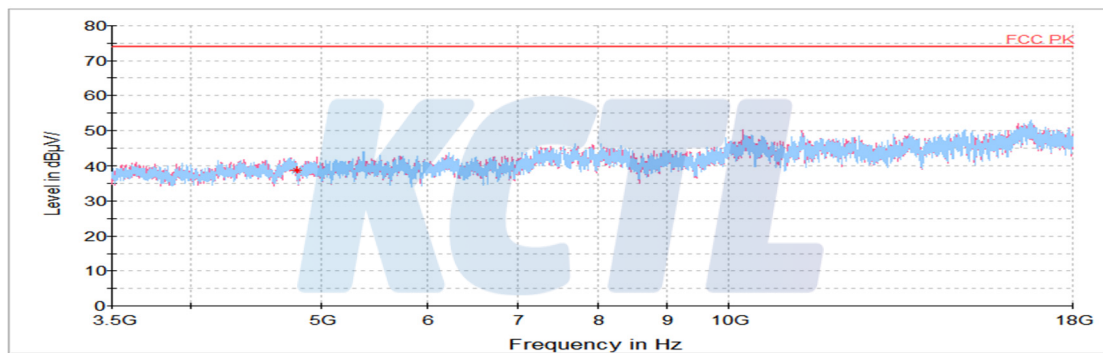
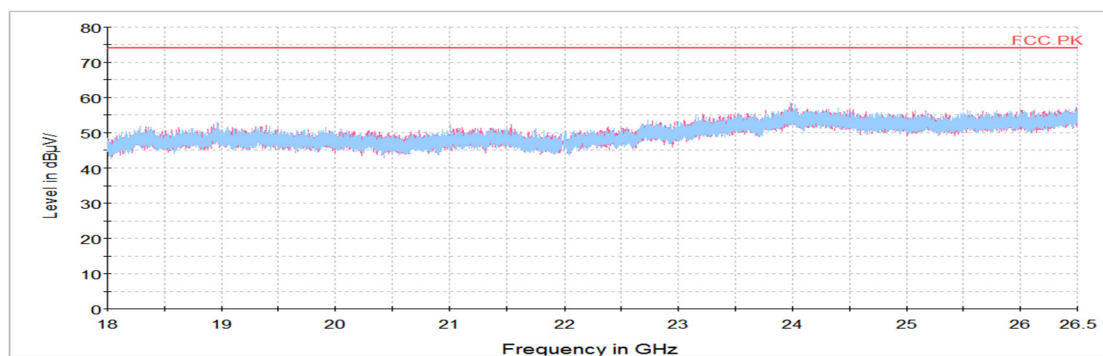
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**KCTL****8DPSK****Low Channel**

| Frequency                                                      | Pol.  | Reading         | Ant. Factor | Amp. + Cable | DCCF | Result            | Limit             | Margin |
|----------------------------------------------------------------|-------|-----------------|-------------|--------------|------|-------------------|-------------------|--------|
| (MHz)                                                          | (V/H) | (dB( $\mu V$ )) | (dB)        | (dB)         | (dB) | (dB( $\mu V/m$ )) | (dB( $\mu V/m$ )) | (dB)   |
| <b>Peak data</b>                                               |       |                 |             |              |      |                   |                   |        |
| 2 388.67 <sup>1)</sup>                                         | H     | 65.09           | 32.01       | -48.79       | -    | 48.31             | 74.00             | 25.69  |
| 4 804.09 <sup>1)</sup>                                         | V     | 57.85           | 33.78       | -53.13       | -    | 38.50             | 74.00             | 35.50  |
| <b>Average Data</b>                                            |       |                 |             |              |      |                   |                   |        |
| No spurious emissions were detected within 20 dB of the limit. |       |                 |             |              |      |                   |                   |        |

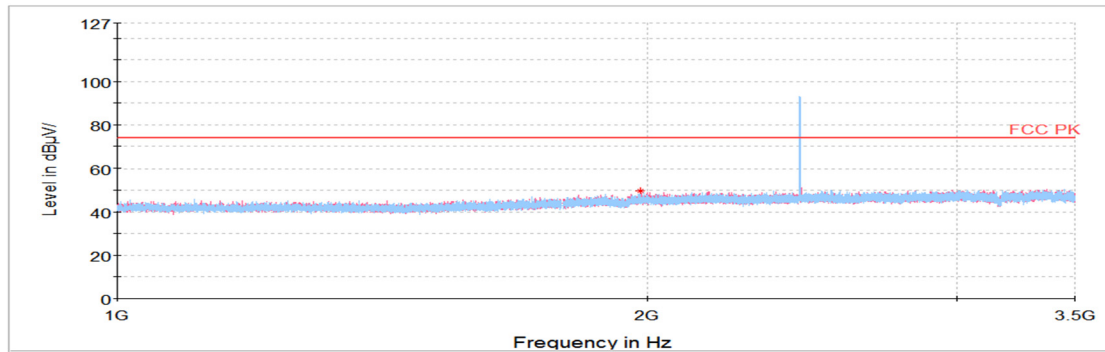
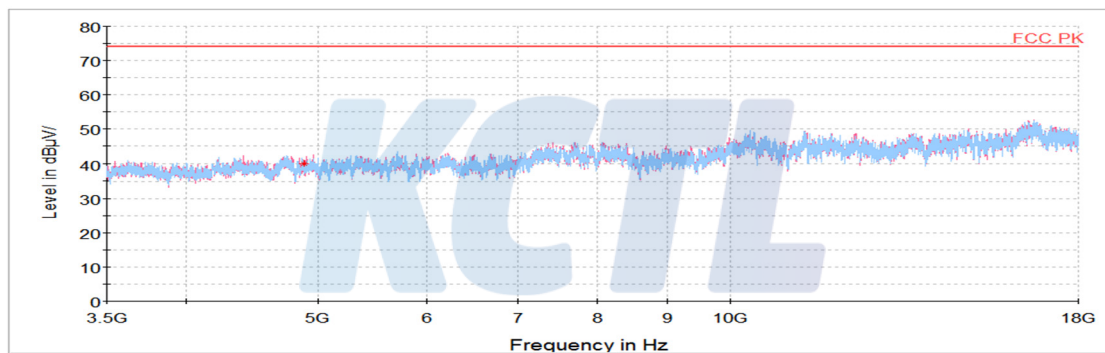
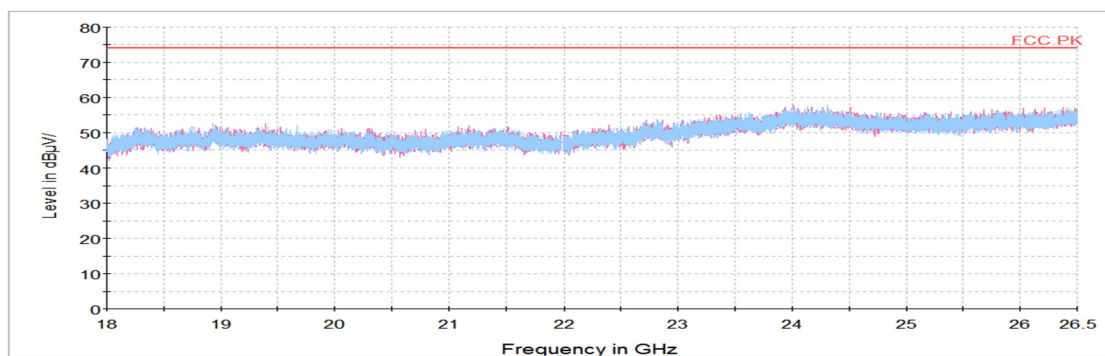
**Horizontal/Vertical for Band-edge**

**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

### Middle Channel

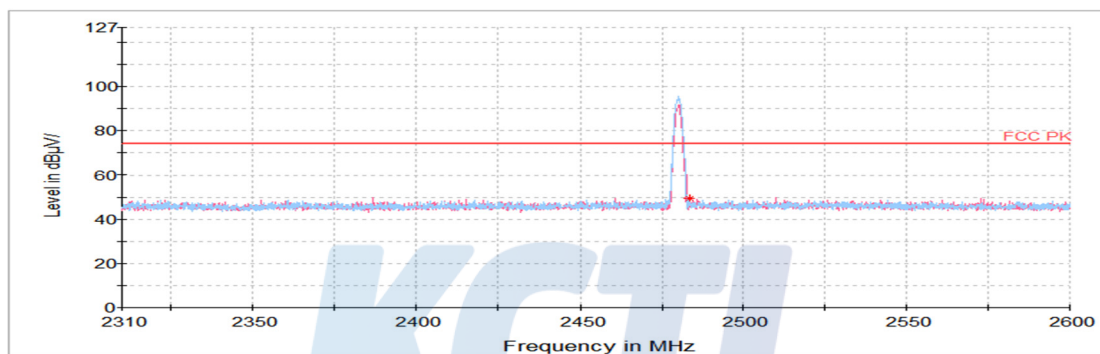
| Frequency                                                      | Pol.  | Reading         | Ant. Factor | Amp. + Cable | DCCF | Result            | Limit             | Margin |
|----------------------------------------------------------------|-------|-----------------|-------------|--------------|------|-------------------|-------------------|--------|
| (MHz)                                                          | (V/H) | (dB( $\mu V$ )) | (dB)        | (dB)         | (dB) | (dB( $\mu V/m$ )) | (dB( $\mu V/m$ )) | (dB)   |
| <b>Peak data</b>                                               |       |                 |             |              |      |                   |                   |        |
| 4 879.31 <sup>1)</sup>                                         | H     | 60.49           | 33.83       | -54.54       | -    | 39.78             | 74.00             | 34.22  |
| <b>Average Data</b>                                            |       |                 |             |              |      |                   |                   |        |
| No spurious emissions were detected within 20 dB of the limit. |       |                 |             |              |      |                   |                   |        |

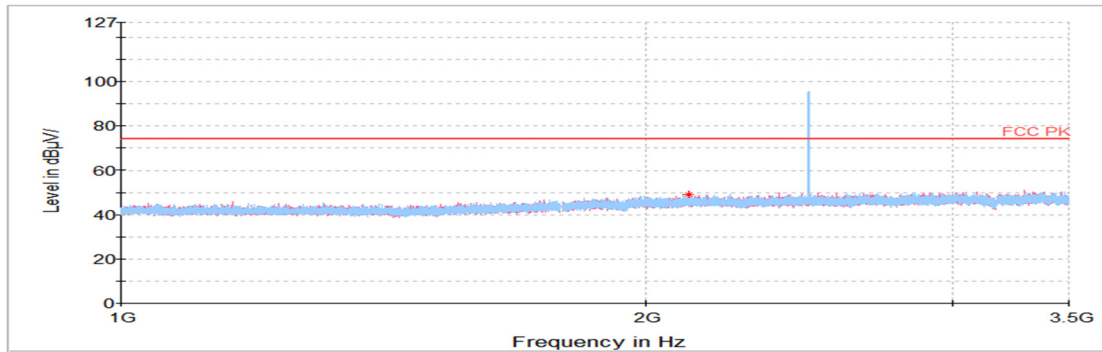
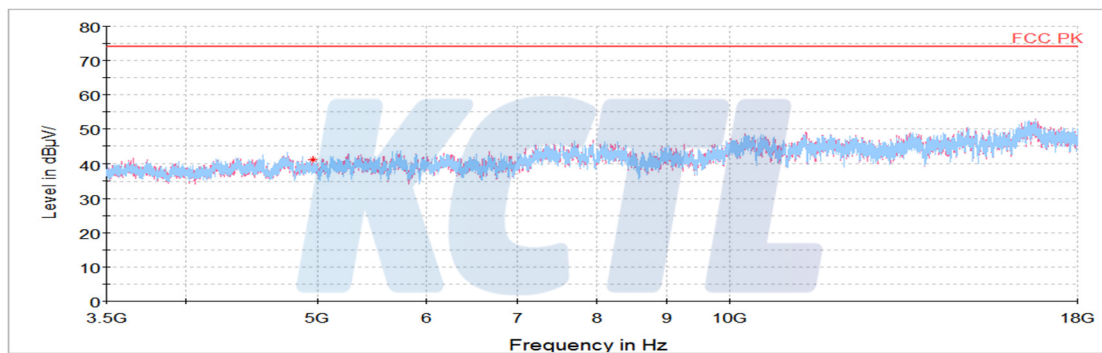
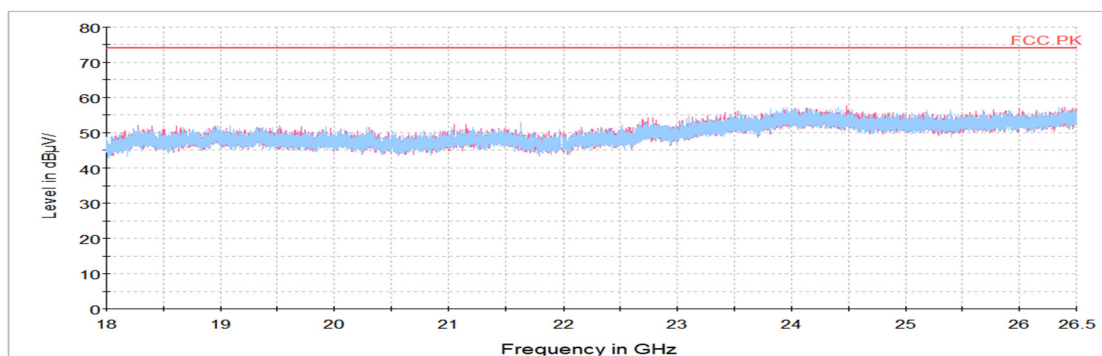
*KCTL*

**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

**High Channel**

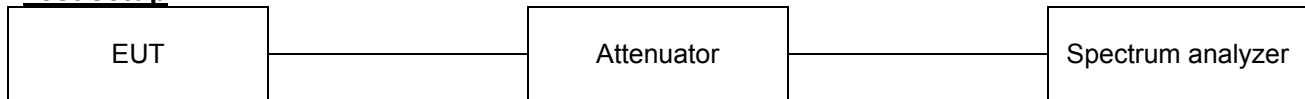
| Frequency                                                      | Pol.  | Reading        | Ant. Factor | Amp. + Cable | DCCF | Result           | Limit            | Margin |
|----------------------------------------------------------------|-------|----------------|-------------|--------------|------|------------------|------------------|--------|
| (MHz)                                                          | (V/H) | (dB( $\mu$ V)) | (dB)        | (dB)         | (dB) | (dB( $\mu$ V/m)) | (dB( $\mu$ V/m)) | (dB)   |
| <b>Peak data</b>                                               |       |                |             |              |      |                  |                  |        |
| 2 483.59 <sup>1)</sup>                                         | H     | 65.71          | 32.09       | -48.19       | -    | 49.61            | 74.00            | 24.39  |
| 4 959.06 <sup>1)</sup>                                         | H     | 61.77          | 33.88       | -54.6        | -    | 41.05            | 74.00            | 32.95  |
| <b>Average Data</b>                                            |       |                |             |              |      |                  |                  |        |
| No spurious emissions were detected within 20 dB of the limit. |       |                |             |              |      |                  |                  |        |

**Horizontal/Vertical for Band-edge**

**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

## 7.7. Conducted Spurious Emission

### Test setup



### Limit

According to §15.247(d), RSS-247(5.5), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operation, 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 averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation specified in §15.209(a) is not required. In addition, radiated emission limits specified in §15.209(a) (see §15.205(c)).

Limit : 20 dBc

### Test procedure

ANSI C63.10-2013 - Section 11.11.3, 14.3.3

KDB 558074 D01 v05 - Section 8.5

KDB 662911 D01 v02r01 – section (E)(3)(b)

### Test settings

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 10<sup>th</sup> harmonic.  
Typically, several plots are required to cover this entire span.
- 2) RBW = 100 kHz
- 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 specified bandwidth.

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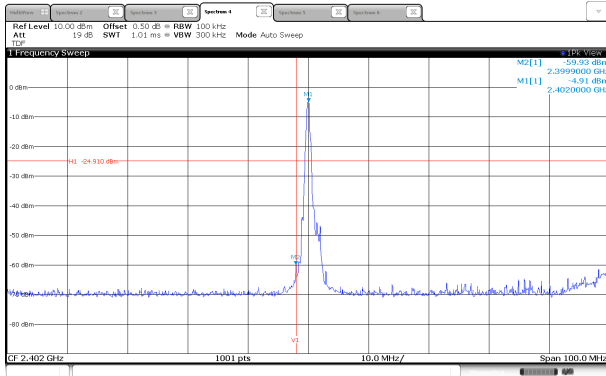
# KCTL

## Test results

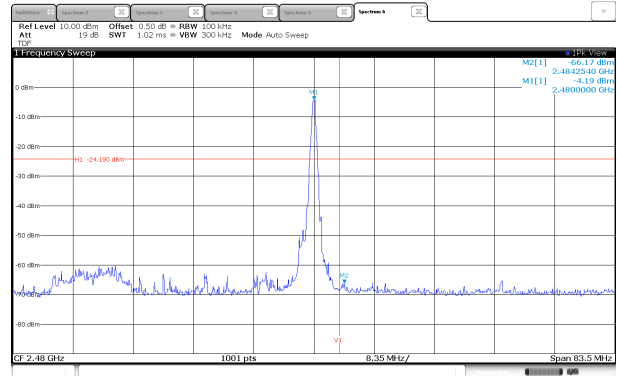
Test mode : GFSK

## Band-edge

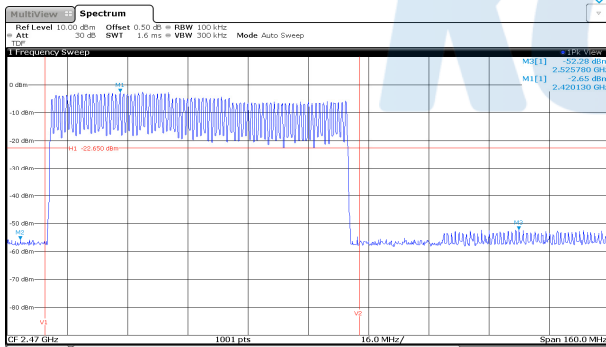
### Low ch.



### High ch.



### With Hopping



Blank

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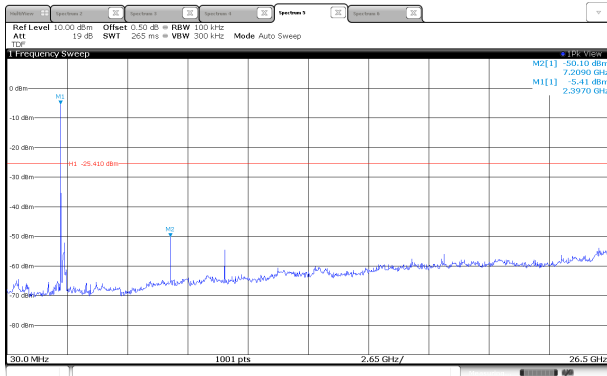
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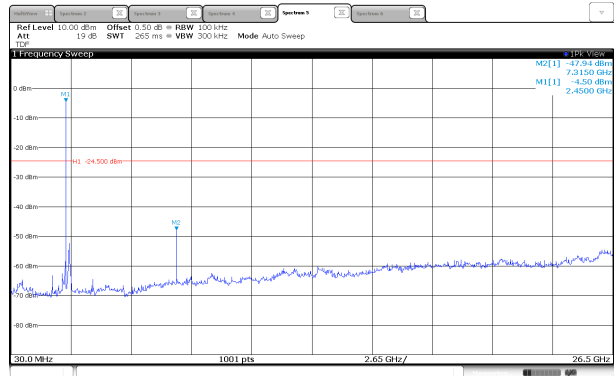
# KCTL

## Conducted emission

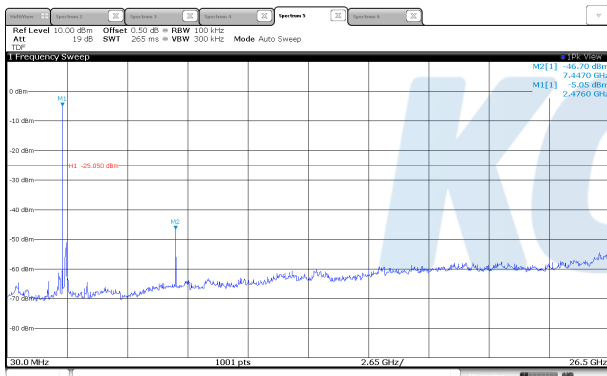
### Low ch.



### Mid ch.



### High ch.



Blank

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Report No.:  
KR19-SRF0144

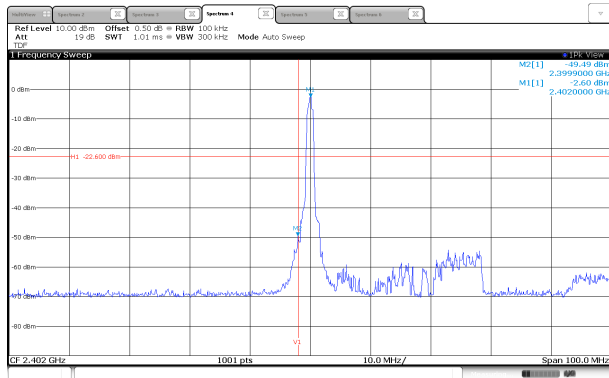
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# KCTL

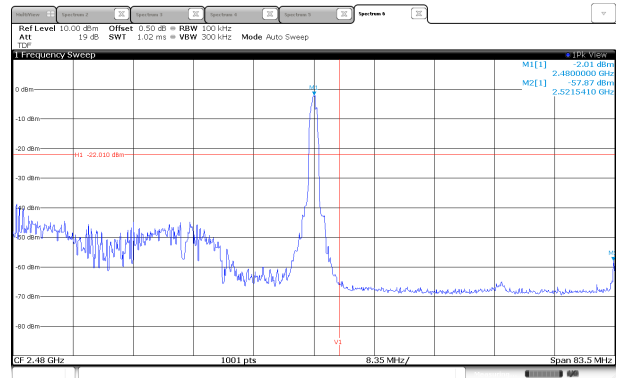
Test mode : 8DPSK

## Band edge

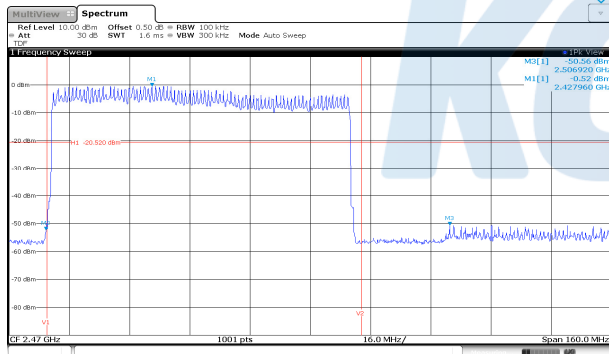
### Low ch.



### High ch.



### With Hopping



Blank

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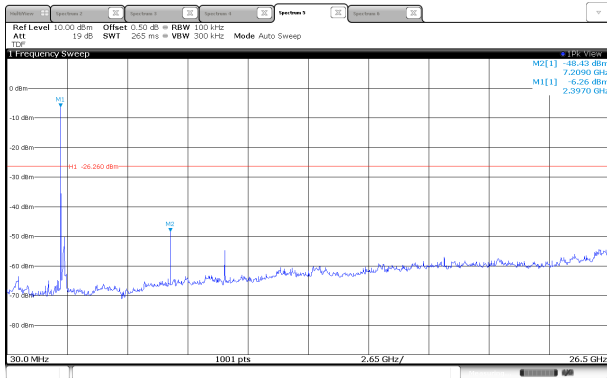
Report No.:  
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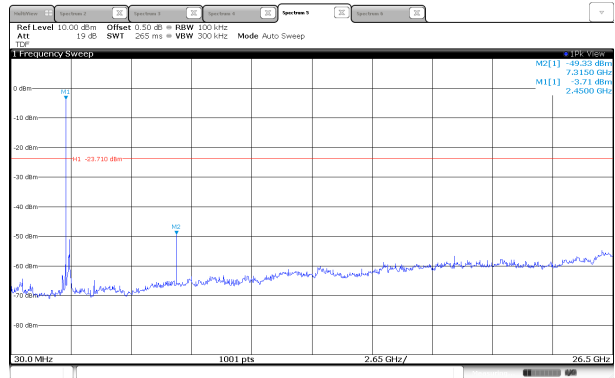
# KCTL

## Conducted emission

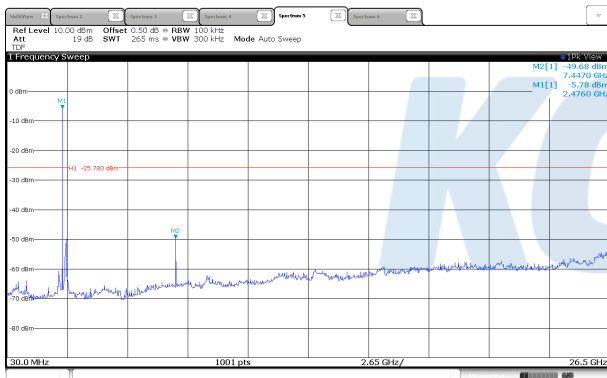
### Low ch.



### Mid ch.



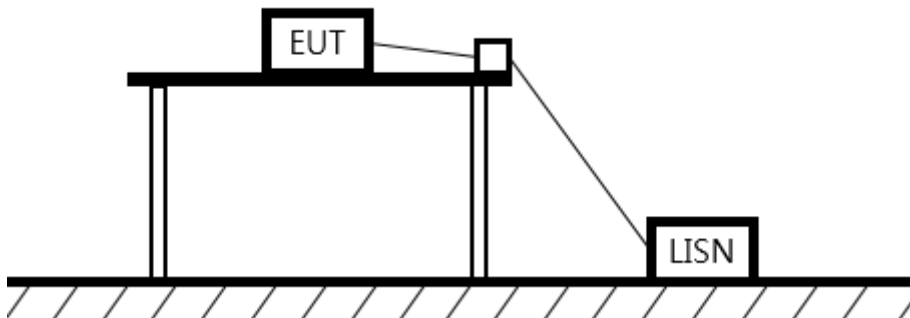
### High ch.



Blank

## 7.8. AC Conducted emission

### Test setup



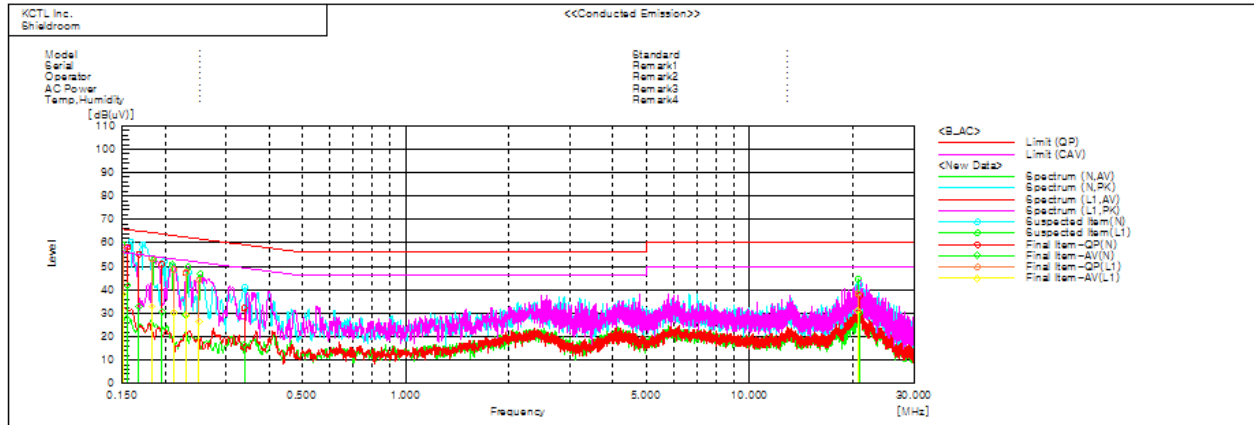
### Limit

According to 15.207(a) and RSS-Gen(8.8), 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 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall be on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

| Frequency of Emission (MHz) | Conducted limit (dBμV/m) |          |
|-----------------------------|--------------------------|----------|
|                             | Quasi-peak               | Average  |
| 0.15 – 0.50                 | 66 - 56*                 | 56 - 46* |
| 0.50 – 5.00                 | 56                       | 46       |
| 5.00 – 30.0                 | 60                       | 50       |

### Measurement procedure

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm 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 in the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
5. The measurements were made with the detector set to peak amplitude within a bandwidth of 10 kHz or to quasi-peak and average within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

**Test results****Worst case: 8DPSK / Middle frequency****Final Result**

| --- N Phase --- |           |          |          |      |          |          |          |          |        |
|-----------------|-----------|----------|----------|------|----------|----------|----------|----------|--------|
| No.             | Frequency | Reading  | Reading  | o.f  | Result   | Result   | Limit    | Limit    | Margin |
|                 | [MHz]     | QP       | CAV      |      | QP       | CAV      | QP       | AV       |        |
|                 |           | [dB(μV)] | [dB(μV)] |      | [dB(μV)] | [dB(μV)] | [dB(μV)] | [dB(μV)] | [dB]   |
| 1               | 0.15525   | 48.3     | 31.8     | 9.9  | 58.2     | 41.7     | 65.7     | 55.7     | 7.5    |
| 2               | 0.1674    | 45.2     | 22.5     | 10.1 | 55.3     | 32.6     | 65.1     | 55.1     | 9.8    |
| 3               | 0.19518   | 40.9     | 20.5     | 10.0 | 50.9     | 30.5     | 63.8     | 53.8     | 12.9   |
| 4               | 0.22943   | 37.5     | 19.6     | 9.7  | 47.2     | 29.3     | 62.5     | 52.5     | 15.3   |
| 5               | 0.33908   | 22.3     | 6.7      | 9.8  | 32.1     | 16.5     | 59.2     | 49.2     | 27.1   |
| 6               | 20.89668  | 27.5     | 20.4     | 10.0 | 37.5     | 30.4     | 60.0     | 50.0     | 22.5   |

| --- L1 Phase --- |           |          |          |      |          |          |          |          |        |
|------------------|-----------|----------|----------|------|----------|----------|----------|----------|--------|
| No.              | Frequency | Reading  | Reading  | o.f  | Result   | Result   | Limit    | Limit    | Margin |
|                  |           | QP       | CAV      |      | QP       | CAV      | QP       | AV       |        |
|                  |           | [dB(μV)] | [dB(μV)] |      | [dB(μV)] | [dB(μV)] | [dB(μV)] | [dB(μV)] | [dB]   |
| 1                | 0.15039   | 47.3     | 28.5     | 9.8  | 57.1     | 38.3     | 66.0     | 56.0     | 8.9    |
| 2                | 0.1827    | 43.1     | 22.7     | 10.1 | 53.2     | 32.8     | 64.4     | 54.4     | 11.2   |
| 3                | 0.21172   | 38.8     | 20.4     | 9.9  | 48.7     | 30.3     | 63.1     | 53.1     | 14.4   |
| 4                | 0.22997   | 37.6     | 19.4     | 9.8  | 47.4     | 29.3     | 62.5     | 52.5     | 15.1   |
| 5                | 0.25042   | 34.4     | 16.6     | 9.7  | 44.1     | 26.3     | 61.7     | 51.7     | 17.6   |
| 6                | 20.67355  | 28.2     | 21.0     | 10.2 | 38.4     | 31.2     | 60.0     | 50.0     | 21.6   |

## 8. Measurement equipment

| Equipment Name              | Manufacturer         | Model No.                                     | Serial No.  | Next Cal. Date |
|-----------------------------|----------------------|-----------------------------------------------|-------------|----------------|
| Spectrum Analyzer           | R&S                  | FSW50                                         | 101013      | 20.05.13       |
| Spectrum Analyzer           | R&S                  | FSV40                                         | 100988      | 20.01.04       |
| Bluetooth Tester            | TESCOM               | TC-3000C                                      | 3000C000270 | 20.07.31       |
| Power Divider               | AGILENT              | 11636B                                        | 54456       | 20.01.08       |
| Wideband Power Sensor       | R&S                  | NRP-Z81                                       | 102398      | 20.01.25       |
| ATTENUATOR                  | R&S                  | DNF<br>Dämpfungsglied<br>10 dB in<br>N-50 Ohm | 31212       | 20.05.13       |
| EMI TEST RECEIVER           | R&S                  | ESCI7                                         | 100732      | 20.08.22       |
| Bi-Log Antenna              | SCHWARZBECK          | VULB 9168                                     | 583         | 20.05.04       |
| Amplifier                   | SONOMA<br>INSTRUMENT | 310N                                          | 284608      | 20.08.22       |
| COAXIAL FIXED<br>ATTENUATOR | Agilent              | 8491B-003                                     | 2708A18758  | 20.05.04       |
| Horn antenna                | ETS.lindgren         | 3116                                          | 00086632    | 20.02.15       |
| Horn antenna                | ETS.lindgren         | 3117                                          | 155787      | 19.10.23       |
| Broadband<br>PreAmplifier   | SCHWARZBECK          | BBV9718                                       | 216         | 20.07.30       |
| AMPLIFIER                   | L-3 Narda-MITEQ      | AMF-7D-01001800<br>-22-10P                    | 2031196     | 20.02.21       |
| AMPLIFIER                   | L-3 Narda-MITEQ      | JS44-18004000-33<br>-8P                       | 2000997     | 20.08.01       |
| LOOP Antenna                | R&S                  | HFH2-Z2                                       | 100355      | 20.08.24       |
| Antenna Mast                | Innco Systems        | MA4640-XP-ET                                  | -           | -              |
| Turn Table                  | Innco Systems        | DT2000                                        | 79          | -              |
| Antenna Mast                | Innco Systems        | MA4000-EP                                     | 303         | -              |
| Turn Table                  | Innco Systems        | DT2000                                        | 79          | -              |
| Highpass Filter             | WT                   | WT-A1698-HS                                   | WT160411001 | 20.05.14       |
| TWO-LINE V -<br>NETWORK     | R&S                  | ENV216                                        | 101358      | 20.04.05       |
| EMI TEST RECEIVER           | R&S                  | ESCI                                          | 100001      | 20.08.22       |
| Vector Signal<br>Generator  | R&S                  | SMBV100A                                      | 257566      | 20.01.04       |
| Signal Generator            | R&S                  | SMB100A                                       | 176206      | 20.01.25       |
| Cable Assembly              | HUBER+SUHNER         | SUCOFLEX 102                                  | 38488/2     | -              |
| Cable Assembly              | Radiall              | 2301762000PJ                                  | 1724.66     | -              |
| Cable Assembly              | HUER+SUHNER          | SUCOFLEX 104                                  | MY4342/4    | -              |

**End of test report**