



# 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-SRF0002-B</b><br>Page (1) of (51) |                                                     |             |                                            |                                                     |
| <b>1. Client</b><br>◦ Name : DAESUNG ELTEC CO., LTD.<br>◦ Address : 371-6 Gasan Dong Kumcheon Ku, Seoul, 153-023, Korea<br>◦ Date of Receipt : 2018-12-12<br><b>2. Use of Report</b> : -<br><b>3. Name of Product and Model</b> : D-AUDIO / iLX-W650<br><b>4. Manufacturer and Country of Origin</b> : DAESUNG ELTEC CO., LTD. / Korea<br><b>5. FCC ID</b> : QV3ILXW650<br><b>6. IC</b> : 23578-ILXW650<br><b>7. Date of Test</b> : 2018-12-28 to 2019-01-03<br><b>8. Test Standards</b> : FCC Part 15 Subpart C, 15.247<br>IC RSS-247 Issue 2<br>RSS-Gen Issue 5<br><b>9. Test Results</b> : Refer to the test result in the test report                                                                                                                                                                                                               |                                                          |                                                     |             |                                            |                                                     |
| <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%; vertical-align: middle; padding: 5px;">Affirmation</td> <td style="width: 40%; padding: 5px;">           Tested by <br/>           Name : Dokyun Lee (Signature)         </td> <td style="width: 40%; padding: 5px;">           Technical Manager <br/>           Name : Jongha Choi (Signature)         </td> </tr> </table> <div style="text-align: right; margin-top: 20px;">2019-01-24</div> <div style="text-align: center; margin-top: 20px;"> <h2 style="margin: 0;">KCTL Inc.</h2> <p style="margin-top: 20px;">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.</p> </div> |                                                          |                                                     | Affirmation | Tested by<br>Name : Dokyun Lee (Signature) | Technical Manager<br>Name : Jongha Choi (Signature) |
| Affirmation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Tested by<br>Name : Dokyun Lee (Signature)               | Technical Manager<br>Name : Jongha Choi (Signature) |             |                                            |                                                     |

#### Report revision history

| Date       | Revision              | Page No                           |
|------------|-----------------------|-----------------------------------|
| 2019-01-08 | Initial report        | -                                 |
| 2019-01-23 | Updated               | 5,6,9,11,12,14,<br>15,16,19,21,28 |
| 2019-01-24 | Updated limit section | 9,12,15,16,21,<br>22,25,31,32,33  |
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## 1. General information

Client : DAESUNG ELTEC CO., LTD.  
 Address : 371-6 Gasan Dong Kumcheon Ku, Seoul, 153-023, Korea  
 Manufacturer : DAESUNG ELTEC CO., LTD.  
 Address : 371-6 Gasan Dong Kumcheon Ku, Seoul, 153-023, Korea  
 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-2  
                           KOLAS No.: KT231

## 2. Device information

Equipment under test : D-AUDIO  
 Model : iLX-W650  
 Frequency range : 2 402 MHz ~ 2 480 MHz  
 Modulation technique : GFSK,  $\pi/4$ DQPSK, 8DPSK  
 Number of channels : 79 ch  
 Power source : DC 12.00 V  
 Antenna specification : Chip Antenna  
 Software version : V0.901\_1112  
 Hardware version : F019  
 Test device serial No. : RU00029AR81110029

### 2.1. Accessory information

| Equipment | Manufacturer | Model | Serial No. | Power source |
|-----------|--------------|-------|------------|--------------|
| N/A       | -            | -     | -          | -            |

## 2.2. Frequency/channel operations

This device contains the following capabilities:

Bluetooth

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

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.

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

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

|                                                                                                                                                                                                          |                                                                |                                                                                     |
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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.

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#### 4. Summary of tests

| FCC Part section(s)            | IC Rule            | 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       | Number of hopping channel     | Pass         |
| 15.247(a) (iii)                | RSS-247, 5.1 (d)   | Time of occupancy(dwell time) | Pass         |
| 15.205(a),<br>15.209(a)        | RSS-247, 5.5       | Spurious emission             | Pass         |
| 15.247(d),                     | RSS-GEN, 8.9, 8.10 | Band-edge, restricted band    | 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 area test site, adequate comparison measurements were confirmed against 30 m open area test 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 Y 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

## 5. Measurement uncertainty

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

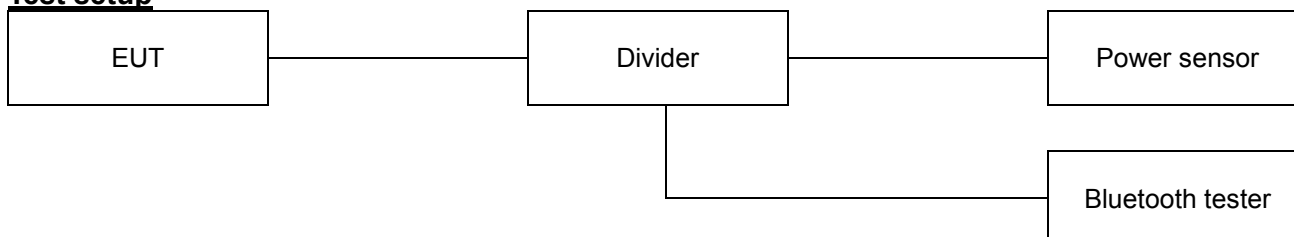
All measurement uncertainty values are shown with a coverage factor of  $k=2$  to indicated a 95 % level of confidence. The measurement data shown herein meets or exceeds the  $U_{\text{CISPR}}$  measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified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

| Parameter                    | Expanded uncertainty( $\pm$ dB) |                    |
|------------------------------|---------------------------------|--------------------|
| Conducted RF power           | 1.44 dB                         |                    |
| Conducted Spurious Emissions | 1.52 dB                         |                    |
| Radiated Spurious Emissions  | 9 kHz ~ 30 MHz:                 | 2.42 dB            |
|                              | 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 |
| Conducted Emissions          | 1 GHz ~ 25 GHz                  | +6.03 dB, -6.05 dB |
|                              | 9 kHz ~ 150 kHz                 | 3.75 dB            |
|                              | 150 kHz ~ 30 MHz                | 3.36 dB            |

## 6. Test results

### 6.1. 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

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

RSS-247, 5.4 (b)

#### 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 ≥ RBW.
- 4) Sweep: Auto.
- 5) Detector function: Peak.

|                                                                                                                                                                                                          |                                                                 |                                                                                     |
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- 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.

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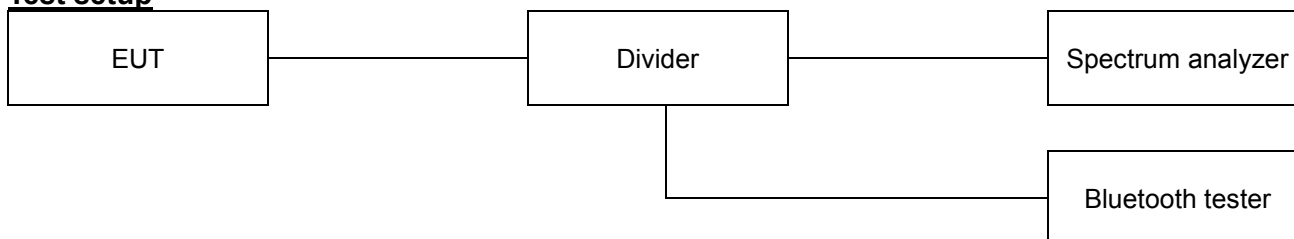
### Test results

| Frequency(MHz) | Data rate(Mbps) | Measured output power(dBm) |         | Limit(dBm) |
|----------------|-----------------|----------------------------|---------|------------|
|                |                 | Peak                       | Average |            |
| 2 402          | 1               | -1.98                      | -5.79   | 30.00      |
| 2 441          | 1               | -2.88                      | -7.28   |            |
| 2 480          | 1               | -3.48                      | -7.39   |            |
| 2 402          | 2               | -0.97                      | -5.49   | 20.97      |
| 2 441          | 2               | -1.58                      | -6.97   |            |
| 2 480          | 2               | -1.88                      | -6.99   |            |
| 2 402          | 3               | -0.97                      | -5.49   | 20.97      |
| 2 441          | 3               | -1.58                      | -6.97   |            |
| 2 480          | 3               | -1.88                      | -6.99   |            |

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## 6.2. Carrier Frequency Separation

### 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.

#### IC

FHSs 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, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.

### Test procedure

ANSI C63.10-2013 - Section 7.8.2

RSS-247, 5.1 (b)

### Test settings

- Span: Wide enough to capture the peaks of two adjacent channels.
- 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.
- Video (or average) bandwidth (VBW)  $\geq$  RBW.
- Sweep: Auto.
- Detector function: Peak.
- Trace: Max hold.
- 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.

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**Test results**

| Frequency(MHz) | Data rate(Mbps) | Carrier frequency separation(MHz) | Limit(MHz) |
|----------------|-----------------|-----------------------------------|------------|
| 2 402          | 1               | 1.001                             | 0.693      |
| 2 441          | 1               | 1.001                             | 0.691      |
| 2 480          | 1               | 1.001                             | 0.693      |
| 2 402          | 3               | 1.001                             | 0.885      |
| 2 441          | 3               | 1.001                             | 0.887      |
| 2 480          | 3               | 1.001                             | 0.889      |

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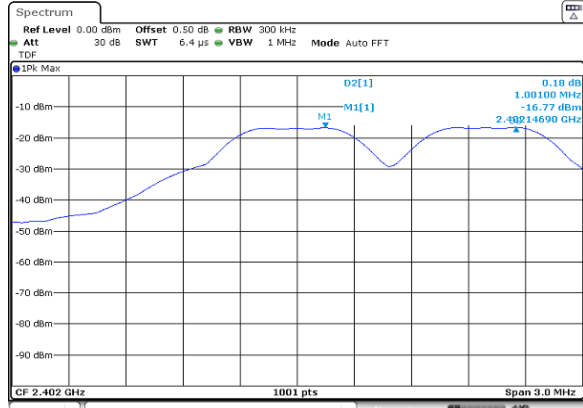
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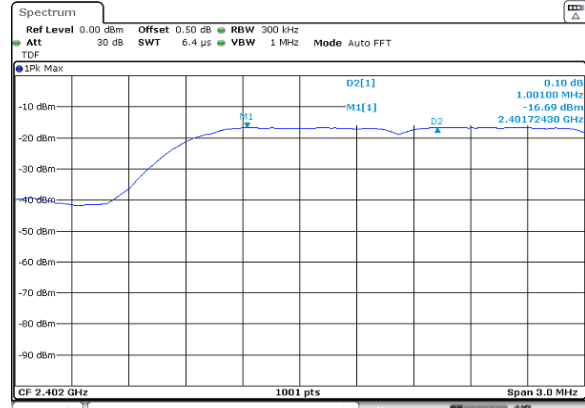
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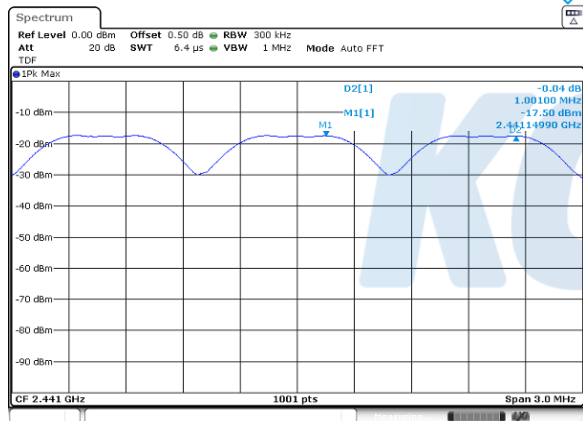
## GFSK



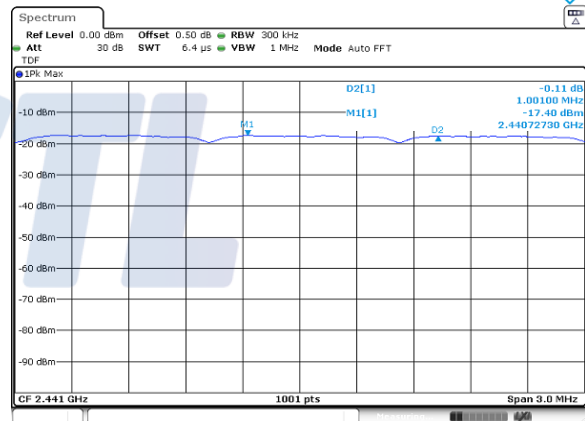
## 8DPSK



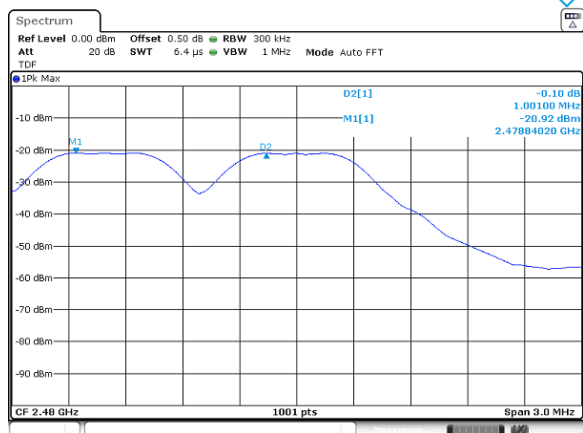
## Lowest Channel



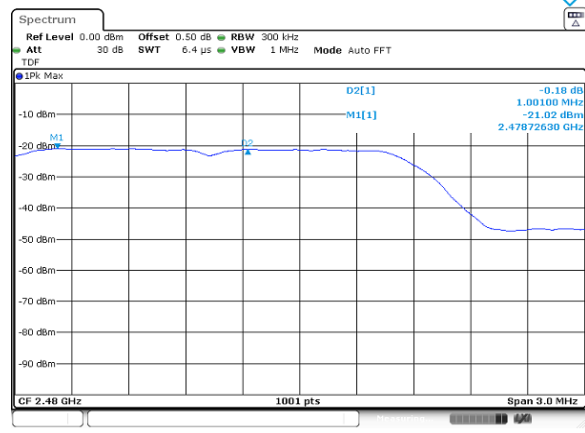
## Lowest Channel



## Middle Channel



## Middle Channel

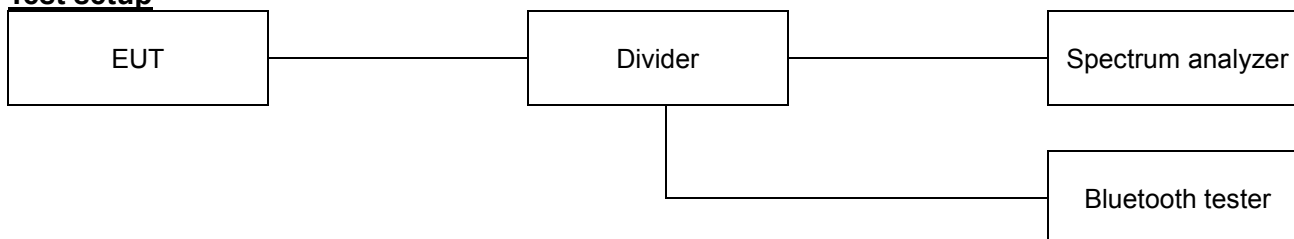


## Highest Channel

## Highest Channel

### 6.3. 20dB Channel Bandwidth (Occupied bandwidth)

#### 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.

#### IC

The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system's radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the "x dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

**Note:** It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

### **Test procedure**

ANSI C63.10-2013 - Section 6.9.2  
RSS-247, 5.1 (a), RSS-GEN, 6.7

### **Test settings**

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.

- a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency.  
Span: Two times and five times the OBW.
- b)  $RBW = 1\%$  to  $5\%$  of the OBW and  $VBW \geq 3 \times RBW$
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- d) 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.
- e) Detector: peak
- f) Trace mode: max hold.
- g) Allow the trace to stabilize.
- h) 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.
- i) 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).
- j) 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.

#### **Occupied bandwidth (or 99% emission bandwidth)**

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the “x dB bandwidth” is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

**Note:** It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

### Test results

| Frequency(MHz) | Data rate(Mbps) | 20 dB bandwidth(MHz) | 99 % bandwidth(MHz) |
|----------------|-----------------|----------------------|---------------------|
| 2 402          | 1               | 1.040                | 0.896               |
| 2 441          | 1               | 1.037                | 0.899               |
| 2 480          | 1               | 1.040                | 0.905               |
| 2 402          | 3               | 1.328                | 1.181               |
| 2 441          | 3               | 1.331                | 1.184               |
| 2 480          | 3               | 1.334                | 1.184               |

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

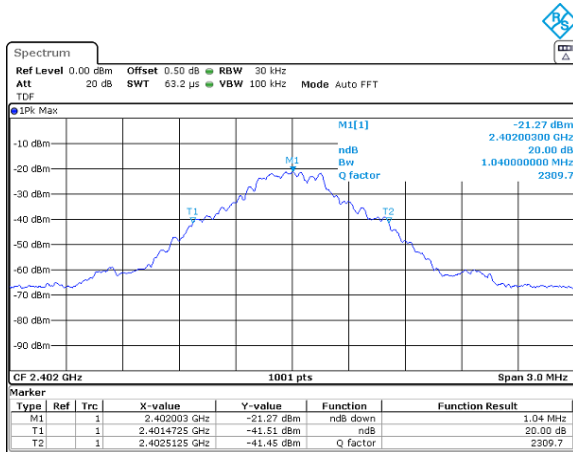
Report No.:  
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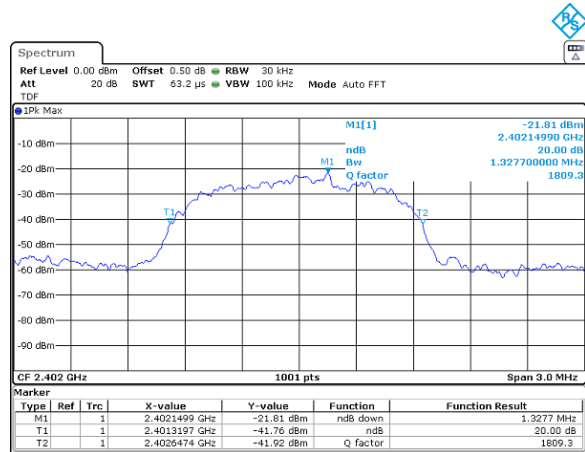


## 20 dB bandwidth(MHz)

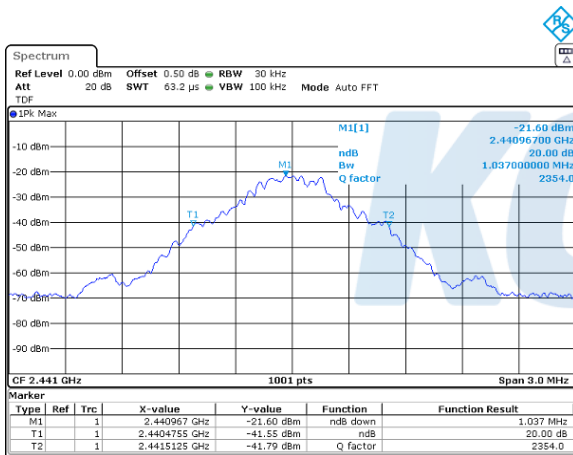
### GFSK



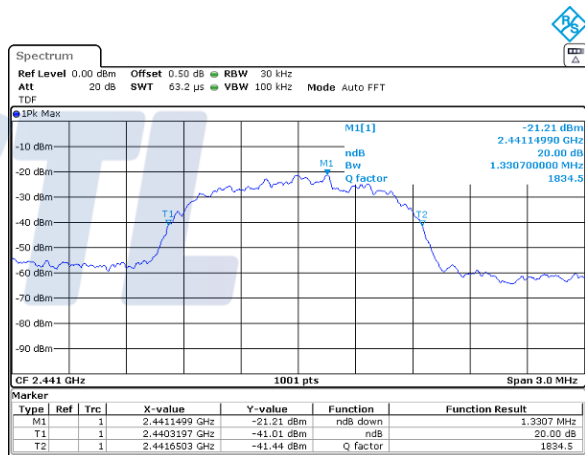
### 8DPSK



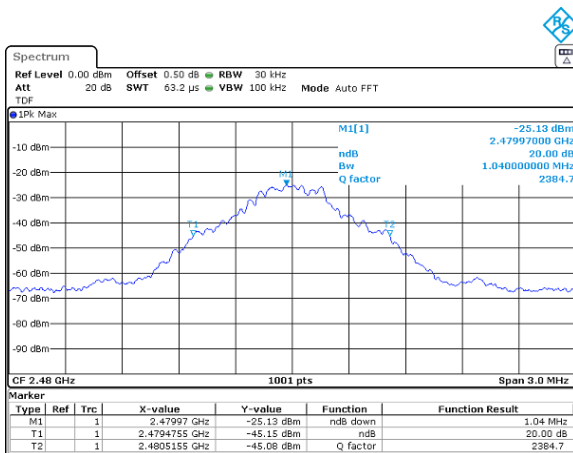
### 2 402 MHz



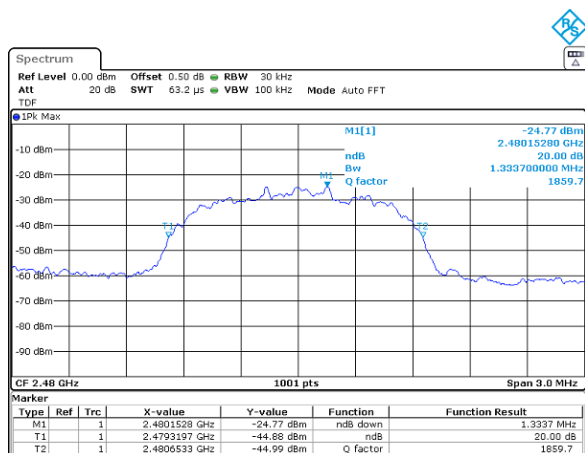
### 2 402 MHz



### 2 441 MHz



### 2 441 MHz



### 2 480 MHz

### 2 480 MHz

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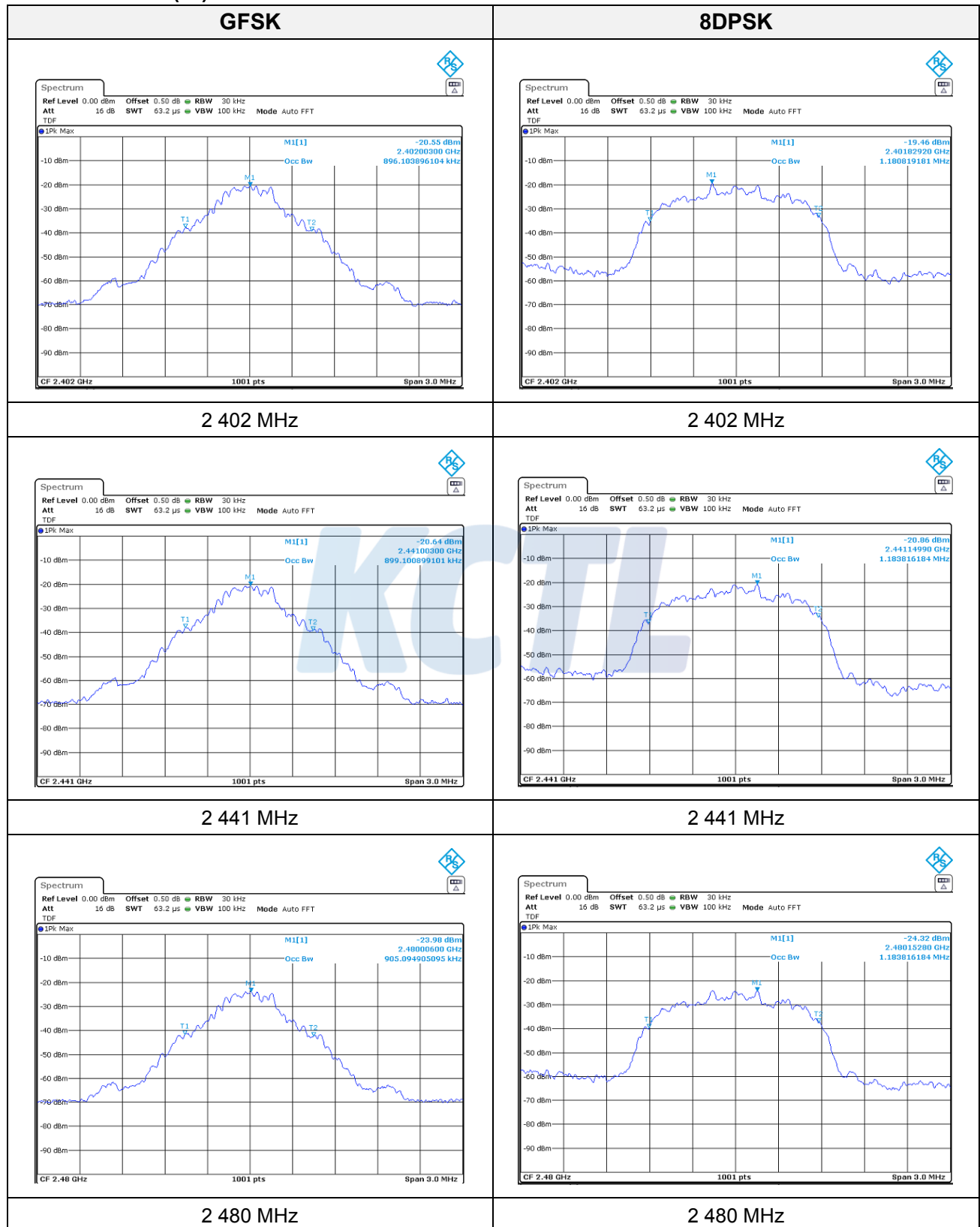
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## 99 % bandwidth(MHz)

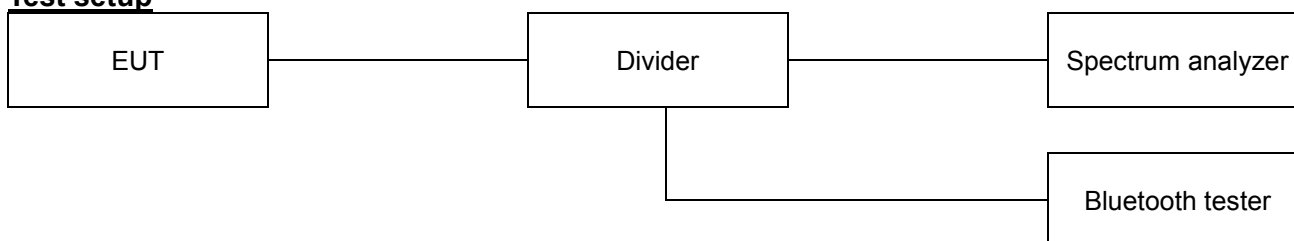


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## 6.4. Number of Hopping Channels

### Test setup



### Limit FCC

According to §15.247(a)(1)(iii), Frequency hopping systems in the 2 400-2 483.5 MHz band shall use at least 15 channels.

### IC

FHSs employ a spread spectrum technology in which the carrier is modulated with coded information in a conventional manner, causing a conventional spreading of the radio frequency (RF) energy around the carrier frequency. The carrier frequency is not fixed, but changes at fixed intervals under the direction of a coded sequence.

FHSs are not required to employ all available hopping frequencies during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the requirements in this section in case the transmitter is presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of frequency hopping equipment and must distribute its transmissions over the minimum number of hopping channels specified in this section.

Incorporation of intelligence into an FHS that enables it to recognize other users of the band and to avoid occupied frequencies is permitted provided that the FHS does it individually and independently chooses or adapts its hopset. The coordination of FHSs in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

The following applies to FHSs in each of the three bands:

- The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system's radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
- FHSs 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, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.

- c) For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds

### **Test procedure**

ANSI C63.10-2013 - Section 7.8.3

RSS-247, 5.1

### **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                        | ≥15   |
| $\pi/4$ DQPSK | 79                        | ≥15   |
| 8DPSK         | 79                        | ≥15   |

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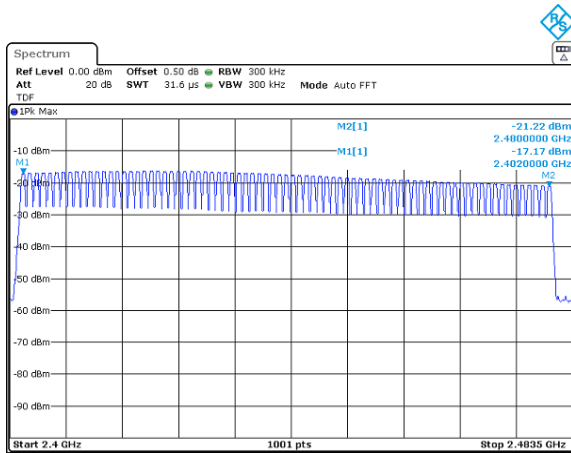
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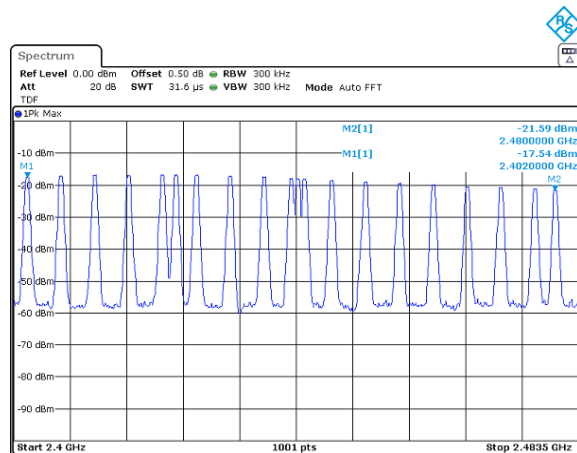
Page (24) of (51)



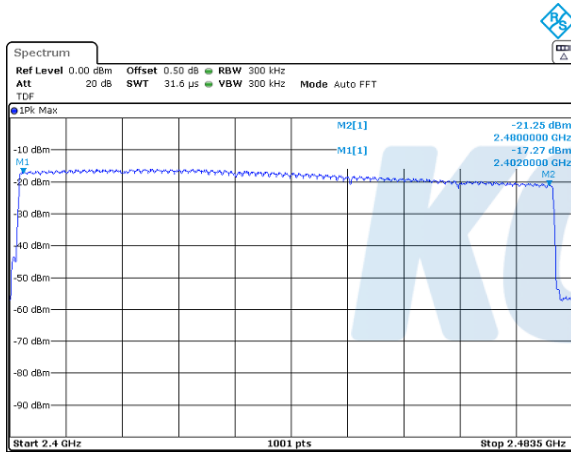
## Non-AFH



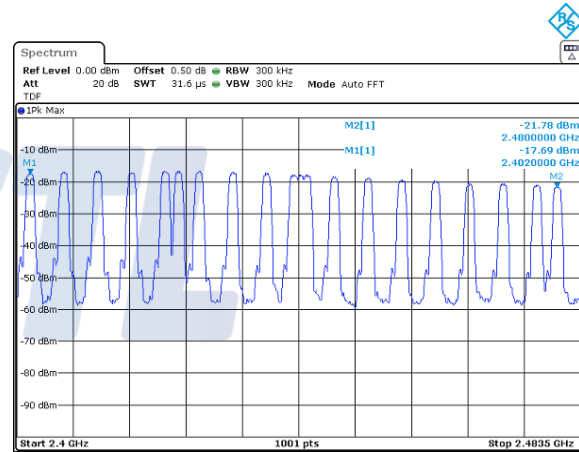
## AFH



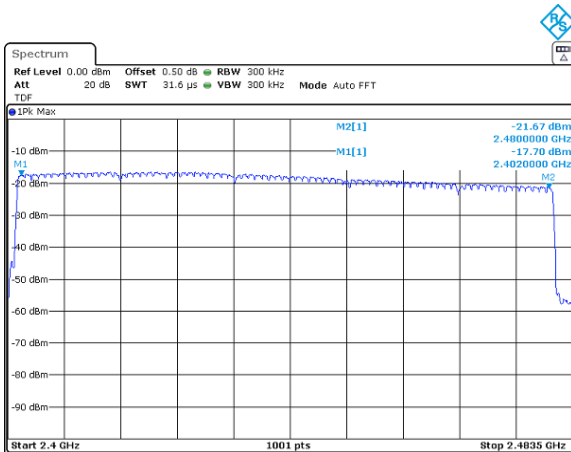
## GFSK



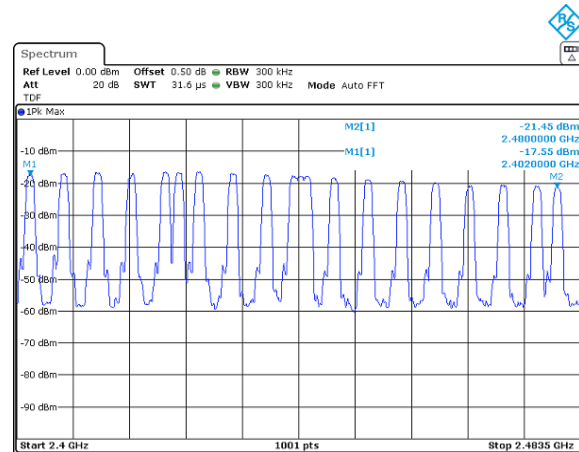
## GFSK



## $\pi/4$ DQPSK



## $\pi/4$ DQPSK

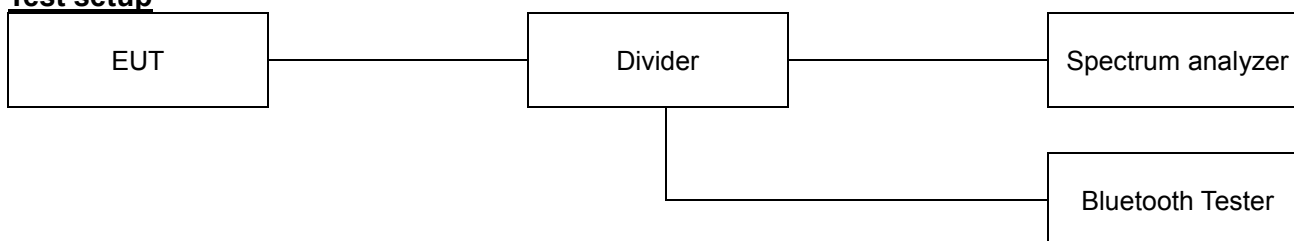


## 8DPSK

## 8DPSK

## 6.5. Time of Occupancy(Dwell Time)

### Test setup



### Limit FCC

According to §15.247(a)(1)(iii), 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.

### IC

FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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.

Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

### Test procedure

ANSI C63.10-2013 - Section 7.8.4

RSS-247, 5.1 (d)

### 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] | Reading [ms] | Hopping rate [hop/s] | Number of Channels | Result [s] | Limit [s] |
|------------|-----------------|--------------|----------------------|--------------------|------------|-----------|
| DH1        | 2 441           | 0.382        | 800.000              | 79                 | 0.122      | 0.400     |
| DH3        | 2 441           | 1.633        | 400.000              | 79                 | 0.261      | 0.400     |
| DH5        | 2 441           | 2.884        | 266.667              | 79                 | 0.308      | 0.400     |
| 2-DH1      | 2 441           | 0.388        | 800.000              | 79                 | 0.124      | 0.400     |
| 2-DH3      | 2 441           | 1.641        | 400.000              | 79                 | 0.263      | 0.400     |
| 2-DH5      | 2 441           | 2.891        | 266.667              | 79                 | 0.308      | 0.400     |
| 3-DH1      | 2 441           | 0.389        | 800.000              | 79                 | 0.124      | 0.400     |
| 3-DH3      | 2 441           | 1.634        | 400.000              | 79                 | 0.261      | 0.400     |
| 3-DH5      | 2 441           | 2.882        | 266.667              | 79                 | 0.307      | 0.400     |

**- AFH**

| Modulation | Frequency [MHz] | Reading [ms] | Hopping rate [hop/s] | Number of Channels | Result [s] | Limit [s] |
|------------|-----------------|--------------|----------------------|--------------------|------------|-----------|
| DH1        | 2 441           | 0.382        | 400.000              | 20                 | 0.061      | 0.400     |
| DH3        | 2 441           | 1.638        | 200.000              | 20                 | 0.131      | 0.400     |
| DH5        | 2 441           | 2.883        | 133.333              | 20                 | 0.154      | 0.400     |
| 2-DH1      | 2 441           | 0.388        | 400.000              | 20                 | 0.062      | 0.400     |
| 2-DH3      | 2 441           | 1.641        | 200.000              | 20                 | 0.131      | 0.400     |
| 2-DH5      | 2 441           | 2.882        | 133.333              | 20                 | 0.154      | 0.400     |
| 3-DH1      | 2 441           | 0.388        | 400.000              | 20                 | 0.062      | 0.400     |
| 3-DH3      | 2 441           | 1.641        | 200.000              | 20                 | 0.131      | 0.400     |
| 3-DH5      | 2 441           | 2.890        | 133.333              | 20                 | 0.154      | 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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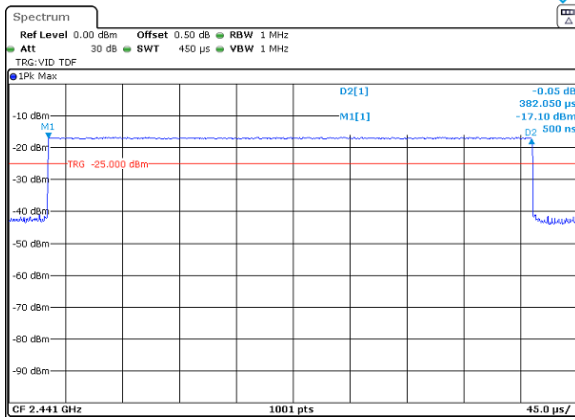
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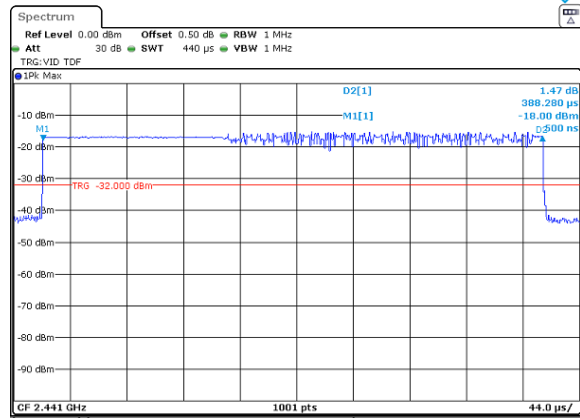
Page (27) of (51)



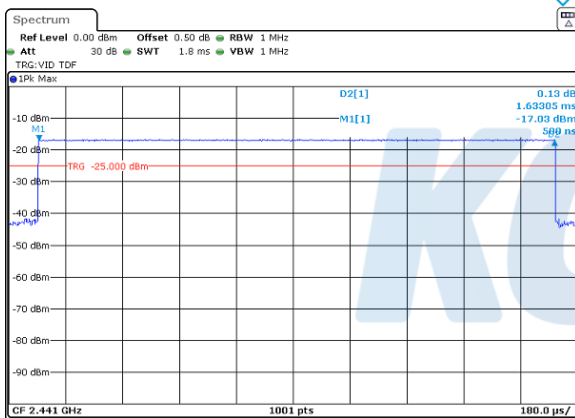
## Non-AFH(GFSK)



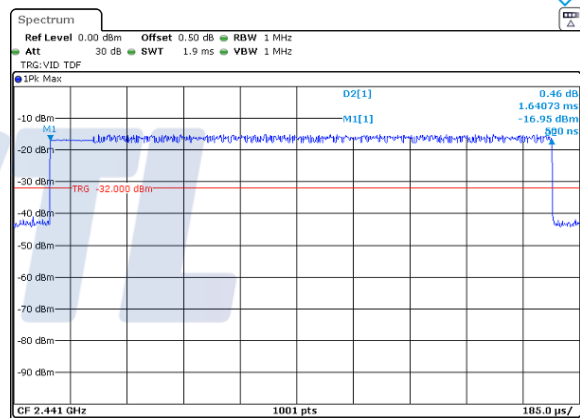
## Non-AFH( $\pi/4$ DQPSK)



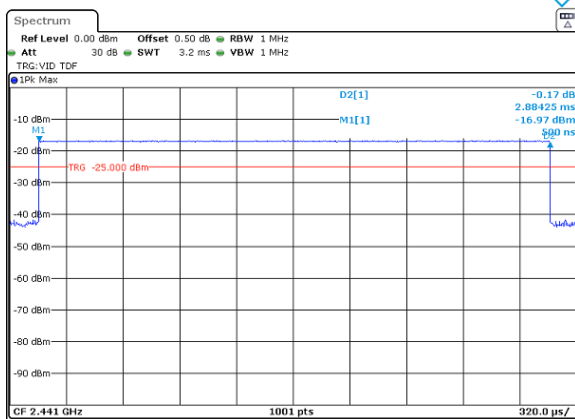
## DH1



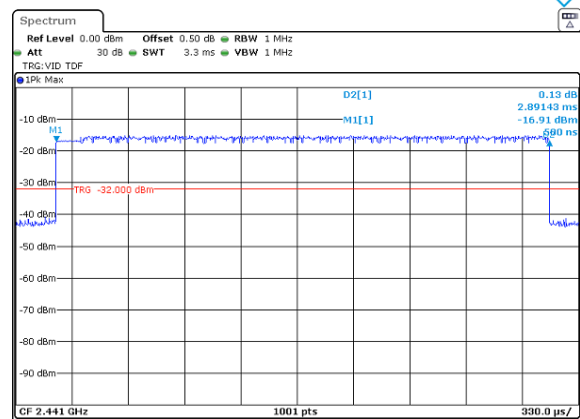
## 2-DH1



## DH3



## 2-DH3



## DH5

## 2-DH5

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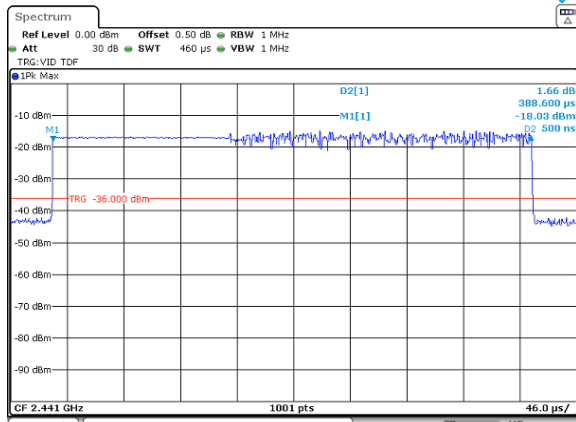
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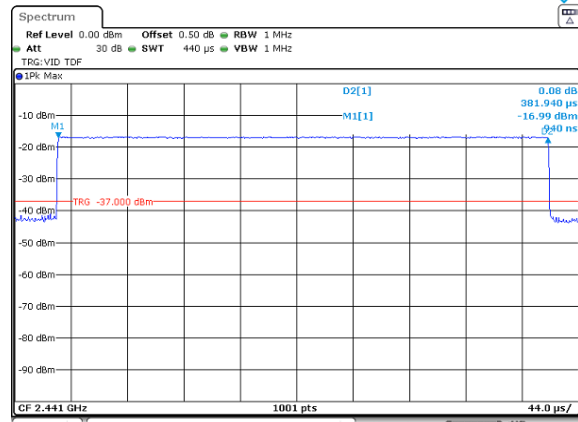
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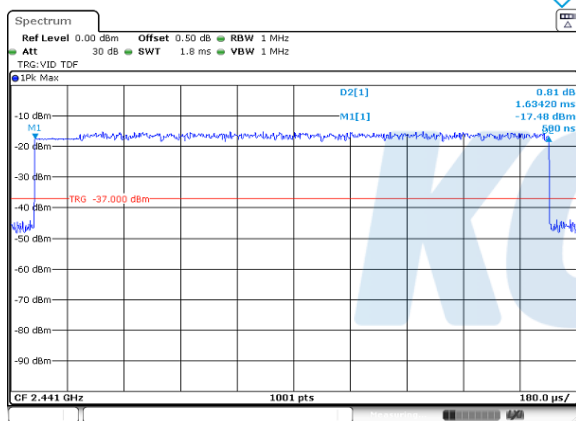
## Non-AFH(8DPSK)



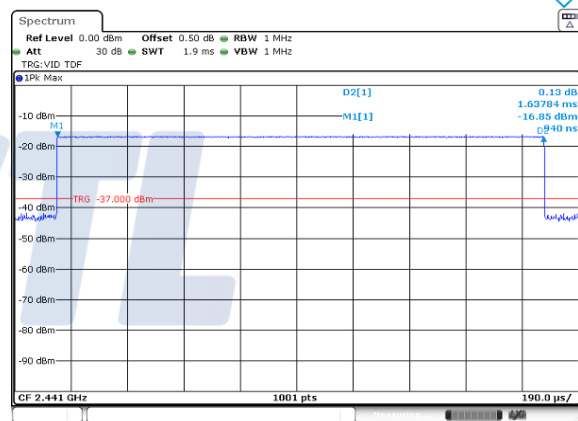
## AFH(GFSK)



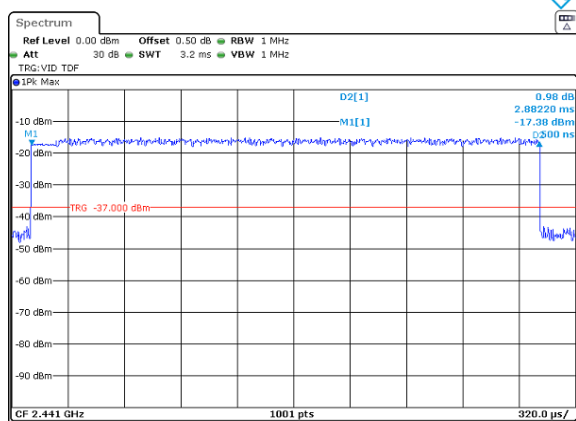
## 3-DH1



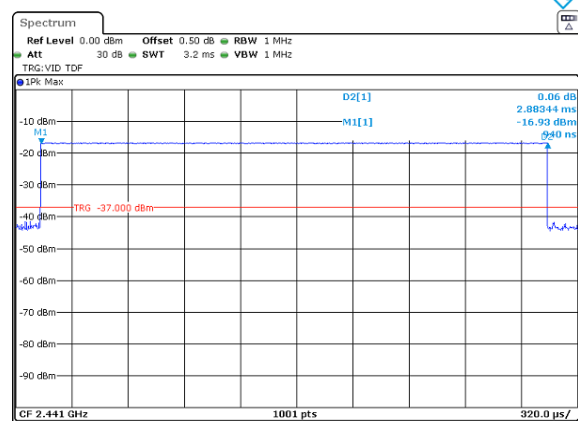
## DH1



## 3-DH3



## DH3



## 3-DH5



## DH5



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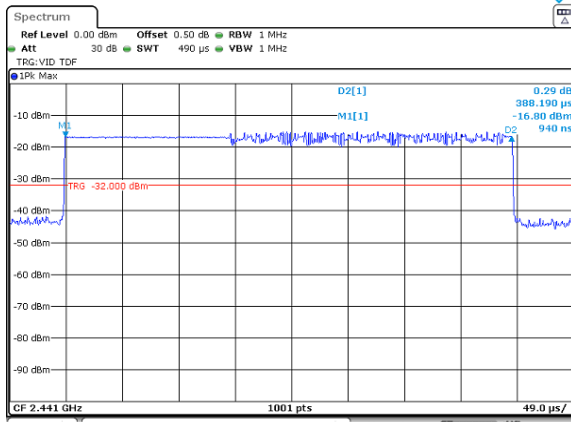
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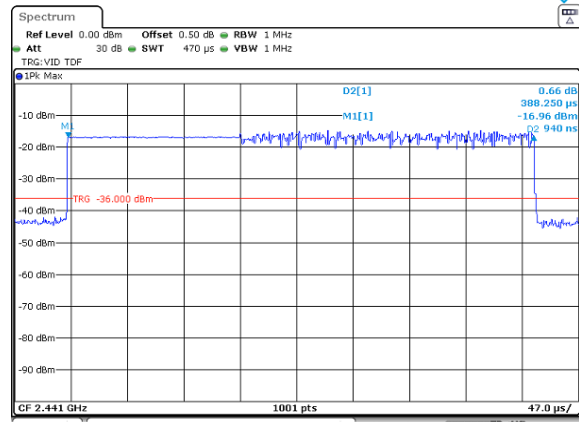
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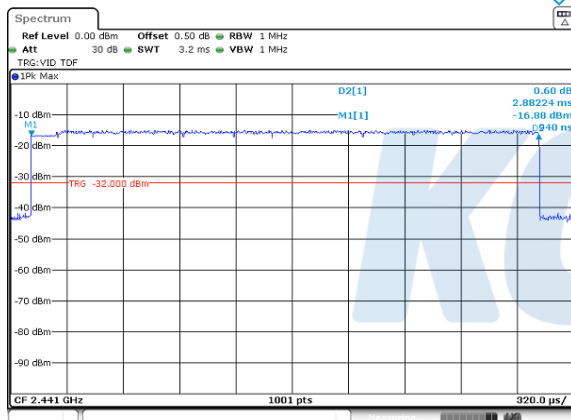
## AFH( $\pi/4$ DQPSK)



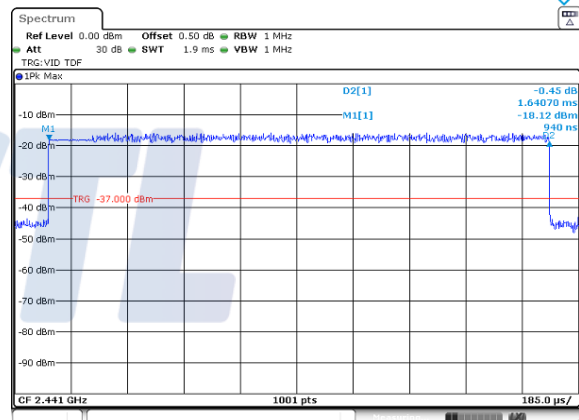
## AFH(8DPSK)



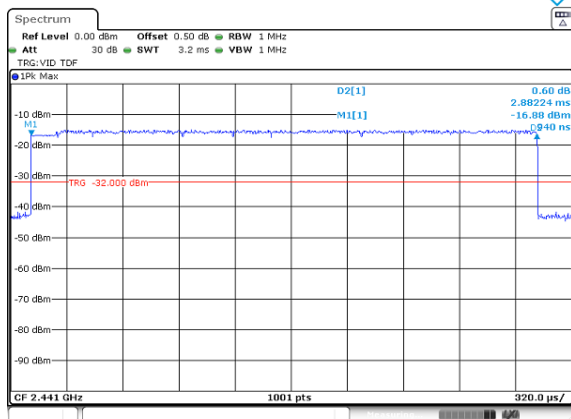
## 2-DH1



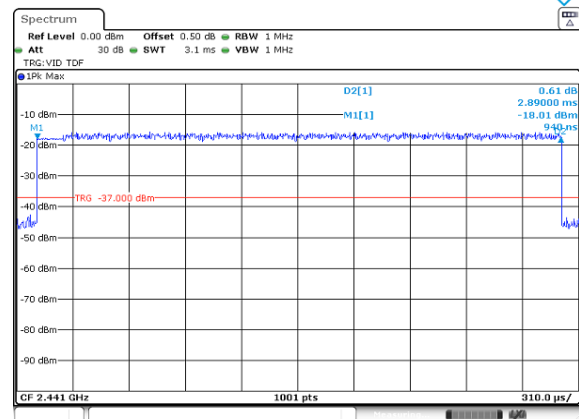
## 3-DH1



## 2-DH3



## 3-DH3



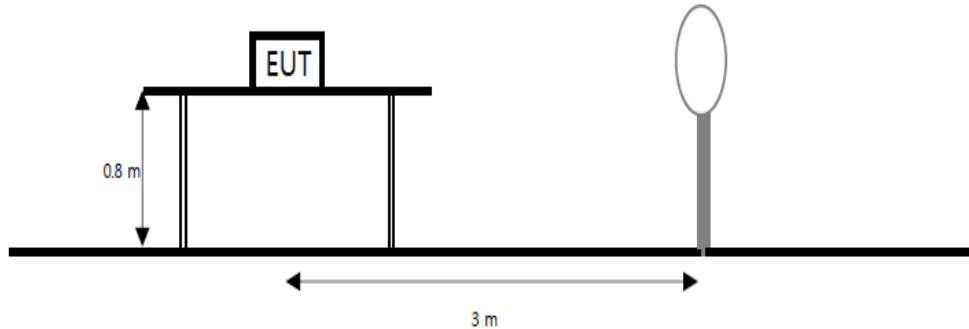
## 2-DH5

## 3-DH5

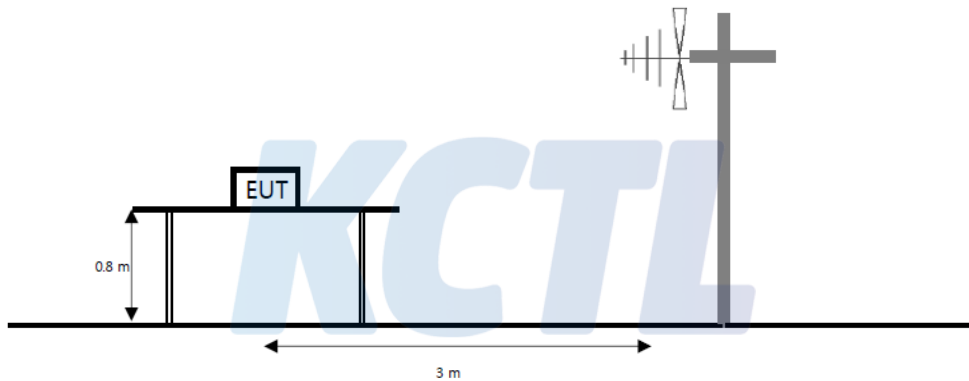
## 6.6. Radiated spurious emissions & band edge

### Test setup

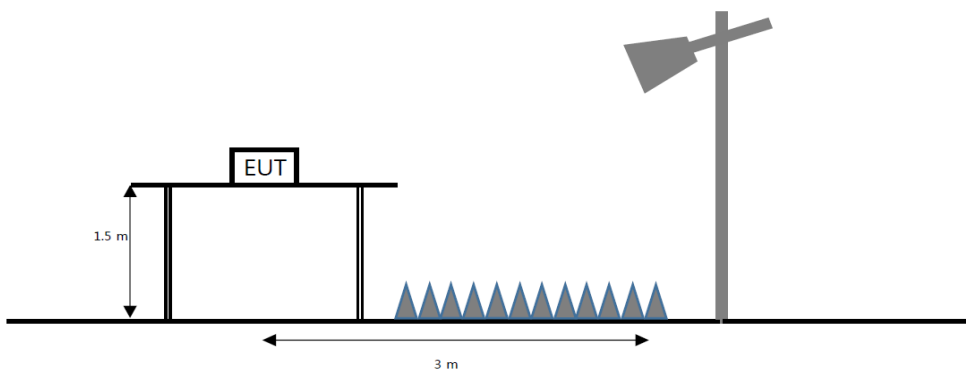
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions



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 FCC**

According to section 15.209(a), 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 ( $\mu V/m$ ) | 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), 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  | 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.

### **IC**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates

compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

**Table 5- General field strength limits at frequencies above 30 MHz**

| Frequency(MHz) | Field strength<br>( $\mu\text{V/m}$ at 3 m) |
|----------------|---------------------------------------------|
| 30 to 88       | 100                                         |
| 88 to 216      | 150                                         |
| 216 to 960     | 200                                         |
| Above 960      | 500                                         |

**Table 6- General field strength limits at frequencies below 30 MHz**

| Frequency                 | Magnetic field strength (H-Field)<br>( $\mu\text{A/m}$ ) | Measurement<br>distance(m) |
|---------------------------|----------------------------------------------------------|----------------------------|
| 9 – 490 kHz <sup>1)</sup> | 6.37/F (F in kHz)                                        | 300                        |
| 490 – 1705 kHz            | 63.7/F (F in kHz)                                        | 30                         |
| 1.705 - 30 MHz            | 0.08                                                     | 30                         |

**Note 1:** The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:

- The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD).
- Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.
- Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

**Table 7- Restricted frequency bands\***

| MHz                 | MHz                   | GHz           |
|---------------------|-----------------------|---------------|
| 0.090 - 0.110       | 149.9 - 150.05        | 9.0 - 9.2     |
| 0.495 - 0.505       | 156.52475 - 156.52525 | 9.3 - 9.5     |
| 2.1735 - 2.1905     | 156.7 - 156.9         | 10.6 - 12.7   |
| 3.020 - 3.026       | 162.0125 - 167.17     | 13.25 - 13.4  |
| 4.125 - 4.128       | 167.72 - 173.2        | 14.47 - 14.5  |
| 4.17725 - 4.17775   | 240 - 285             | 15.35 - 16.2  |
| 4.20725 - 4.20775   | 322 - 335.4           | 17.7 - 21.4   |
| 5.677 - 5.683       | 399.9 - 410           | 22.01 - 23.12 |
| 6.215 - 6.218       | 608 - 614             | 23.6 - 24.0   |
| 6.26775 - 6.26825   | 960 - 1427            | 31.2 - 31.8   |
| 6.31175 - 6.31225   | 1435 - 1626.5         | 36.43 - 36.5  |
| 8.291 - 8.294       | 1645.5 - 1646.5       | Above 38.6    |
| 8.362 - 8.366       | 1660 - 1710           |               |
| 8.37625 - 8.38675   | 1718.8 - 1722.2       |               |
| 8.41425 - 8.41475   | 2200 - 2300           |               |
| 12.29 - 12.293      | 2310 - 2390           |               |
| 12.51975 - 12.52025 | 2483.5 - 2500         |               |
| 12.57675 - 12.57725 | 2655 - 2900           |               |
| 13.36 - 13.41       | 3260 - 3267           |               |
| 16.42 - 16.423      | 3332 - 3339           |               |
| 16.69475 - 16.69525 | 3345.8 - 3358         |               |
| 16.80425 - 16.80475 | 3500 - 4400           |               |
| 25.5 - 25.67        | 4500 - 5150           |               |
| 37.5 - 38.25        | 5350 - 5460           |               |
| 73 - 74.6           | 7250 - 7750           |               |
| 74.8 - 75.2         | 8025 - 8500           |               |
| 108 - 138           | --                    |               |

\* Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

**Test procedure**

ANSI C63.10-2013

RSS-247, 5.5, RSS-GEN, 8.9, 8.10

**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**

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1 MHz
3. VBW = 1/T  $\geq$  1 Hz
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace was allowed to run for at least 50 times(1/duty cycle) traces

**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> mean is restricted band.  
<sup>2)</sup> mean is bandedge.

**Duty cycle correction factor calculation:**

According to 7.5 Procedure for determining the average value of pulsed emissions

Duty Cycle Correction Factor Calculation

- Worst case : AFH mode
- Channel hop rate = 800 hops/second
- Hopping rate for DH5 mode = 800 hops/second / 5 (6 slots for DH5) = 133.33 hops/second
- Time per channel hop = 1 / 133.33 hops/second = 7.50 ms
- Time to cycle through all channels = 7.50 x 20 channels(AFH mode) = 150 ms
- Number of times transmitter hits on one channel = 100 ms / Time to cycle through all channels [ms]  
= 100 ms / 150 ms = 1 time
- Worst case Dwell time = 7.5 ms
- Duty Cycle Correction Factor =  $20\log(7.5 \text{ ms}/100 \text{ ms}) = -22.5 \text{ dB}$

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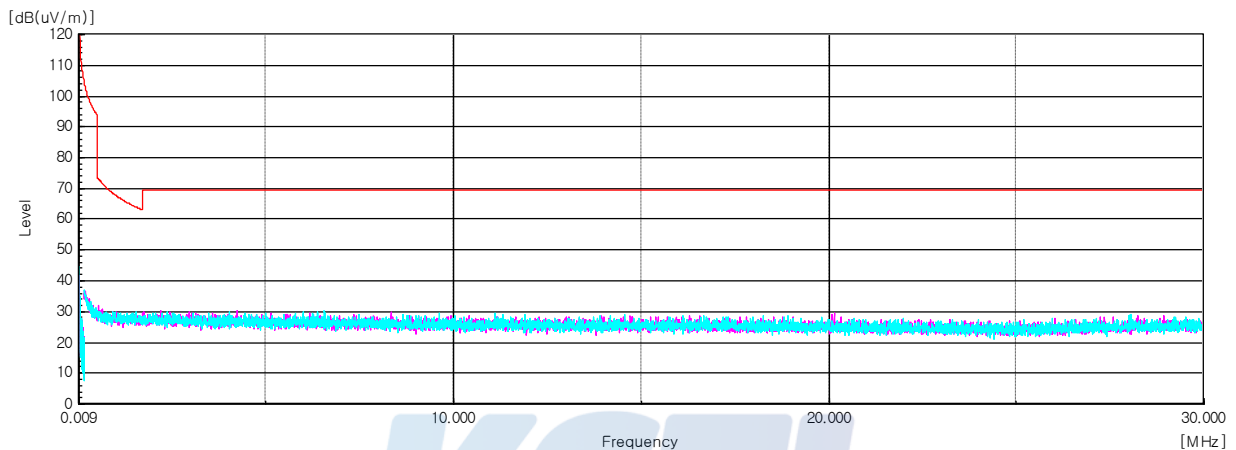
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Report No.:  
KR19-SRF0002-B

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

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

**Horizontal/Vertical**

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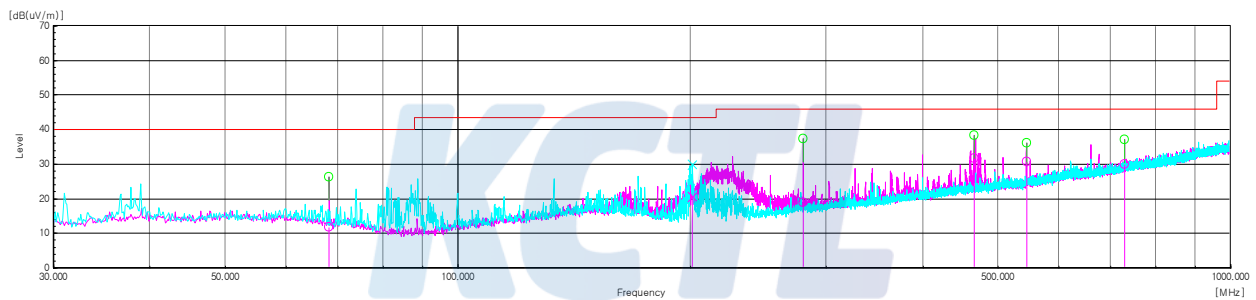
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**KCTL****Test results (Below 1 000 MHz) –Worst case: 8DPSK High frequency**

| Frequency       | Pol.  | Reading  | Cable Loss | Amp Gain | Antenna Factor | DCCF | Result     | Limit      | Margin |
|-----------------|-------|----------|------------|----------|----------------|------|------------|------------|--------|
| [MHz]           | [V/H] | [dB(μV)] | [dB]       | [dB]     | [dB]           | [dB] | [dB(μV/m)] | [dB(μV/m)] | [dB]   |
| Quasi Peak data |       |          |            |          |                |      |            |            |        |
| 68.19           | H     | 25.00    | 1.72       | -27.38   | 12.46          | -    | 11.80      | 40.00      | 28.20  |
| 201.33          | V     | 33.00    | 3.13       | -30.91   | 15.38          | -    | 20.60      | 43.50      | 22.90  |
| 280.02          | H     | 27.40    | 3.73       | -30.93   | 18.80          | -    | 19.00      | 46.00      | 27.00  |
| 465.29          | H     | 34.30    | 4.94       | -30.28   | 22.74          | -    | 31.70      | 46.00      | 14.30  |
| 544.22          | H     | 31.70    | 5.39       | -30.16   | 23.87          | -    | 30.80      | 46.00      | 15.20  |
| 728.64          | H     | 26.50    | 6.31       | -28.11   | 25.20          | -    | 29.90      | 46.00      | 16.10  |

**Horizontal/Vertical**

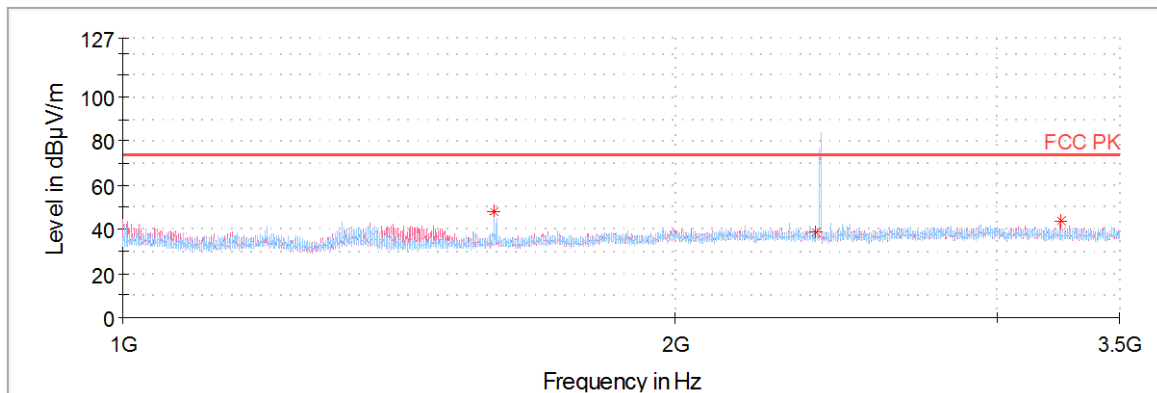
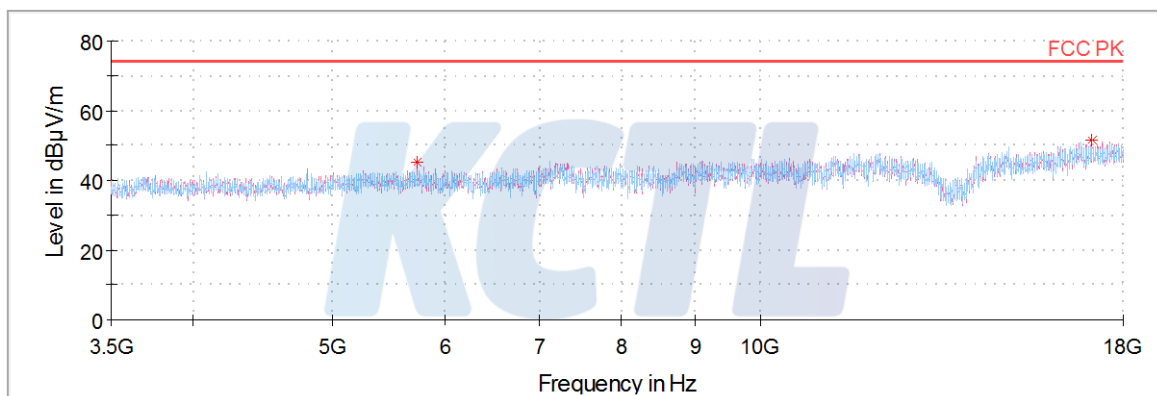
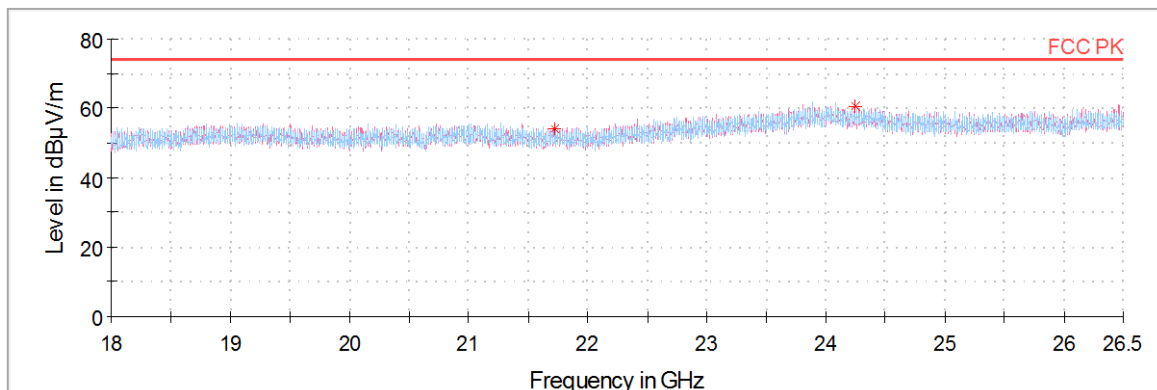
## Test results (Above 1 000 MHz)

### GFSK

#### Low Channel

| Frequency                                                      | Pol.  | Reading  | Cable Loss | Amp Gain | Antenna Factor | DCCF | Result     | Limit      | Margin |
|----------------------------------------------------------------|-------|----------|------------|----------|----------------|------|------------|------------|--------|
| [MHz]                                                          | [V/H] | [dB(μV)] | [dB]       | [dB]     | [dB]           | [dB] | [dB(μV/m)] | [dB(μV/m)] | [dB]   |
| <b>Peak data</b>                                               |       |          |            |          |                |      |            |            |        |
| 1 594.24 <sup>1)</sup>                                         | V     | 79.97    | 3.04       | -60.66   | 26.18          | -    | 48.53      | 74.00      | 25.47  |
| 2 389.06 <sup>2)</sup>                                         | V     | 66.11    | 3.70       | -59.68   | 28.54          | -    | 38.67      | 74.00      | 35.33  |
| 21 725.20                                                      | V     | 46.36    | 12.00      | -49.24   | 45.00          | -    | 54.12      | 74.00      | 19.88  |
| 24 233.78                                                      | H     | 45.84    | 12.80      | -43.05   | 45.10          | -    | 60.69      | 74.00      | 13.31  |
| <b>Average Data</b>                                            |       |          |            |          |                |      |            |            |        |
| No spurious emissions were detected within 20 dB of the limit. |       |          |            |          |                |      |            |            |        |

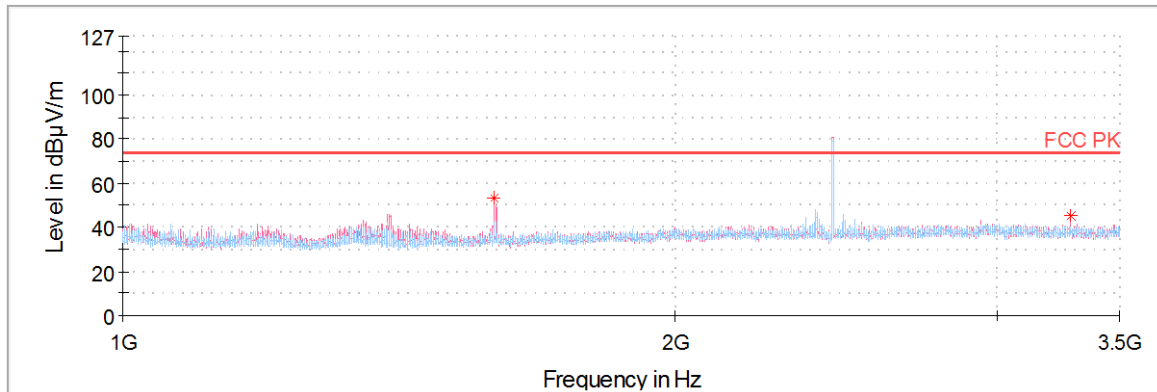
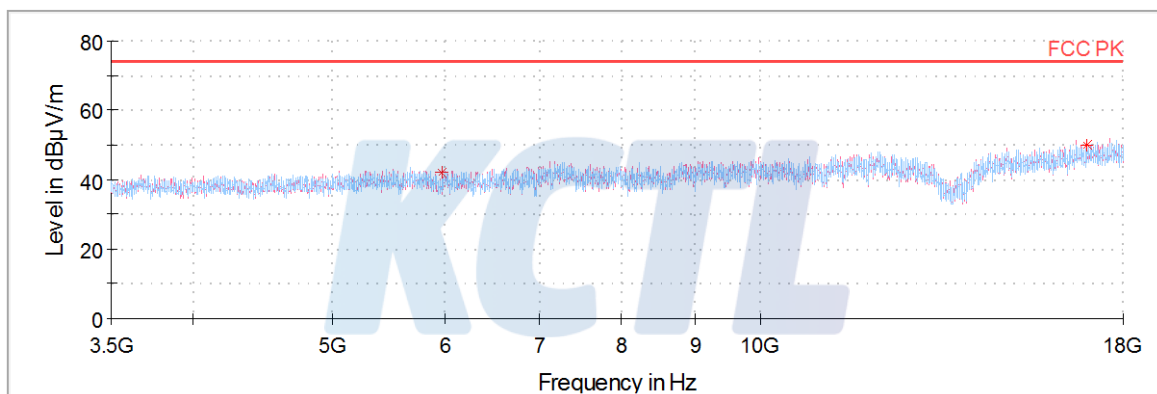
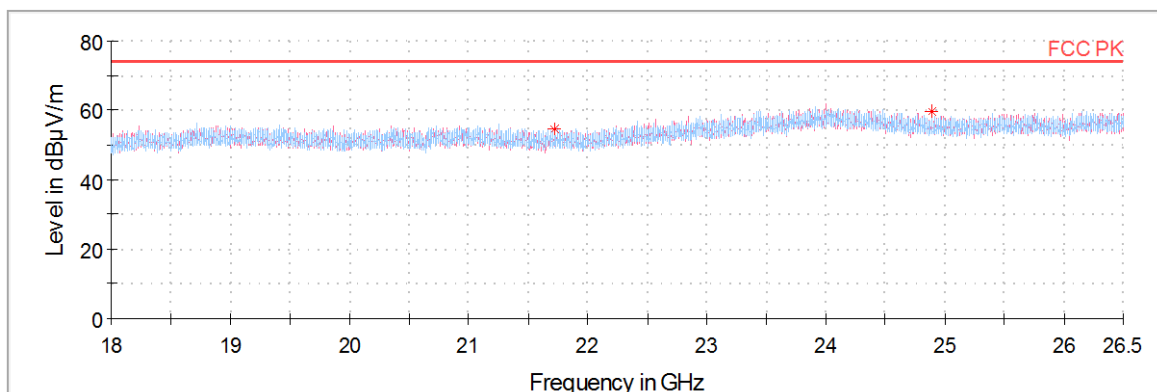


**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

### Middle Channel

| Frequency                                                      | Pol.  | Reading  | Cable Loss | Amp Gain | Antenna Factor | DCCF | Result     | Limit      | Margin |
|----------------------------------------------------------------|-------|----------|------------|----------|----------------|------|------------|------------|--------|
| [MHz]                                                          | [V/H] | [dB(μV)] | [dB]       | [dB]     | [dB]           | [dB] | [dB(μV/m)] | [dB(μV/m)] | [dB]   |
| <b>Peak data</b>                                               |       |          |            |          |                |      |            |            |        |
| 1 596.86 <sup>1)</sup>                                         | V     | 84.54    | 3.04       | -60.68   | 26.19          | -    | 53.09      | 74.00      | 20.91  |
| 21 700.76                                                      | V     | 46.87    | 12.00      | -49.24   | 45.00          | -    | 54.63      | 74.00      | 19.37  |
| 24 922.10                                                      | H     | 45.68    | 12.80      | -44.23   | 45.20          | -    | 59.45      | 74.00      | 14.55  |
| <b>Average Data</b>                                            |       |          |            |          |                |      |            |            |        |
| No spurious emissions were detected within 20 dB of the limit. |       |          |            |          |                |      |            |            |        |

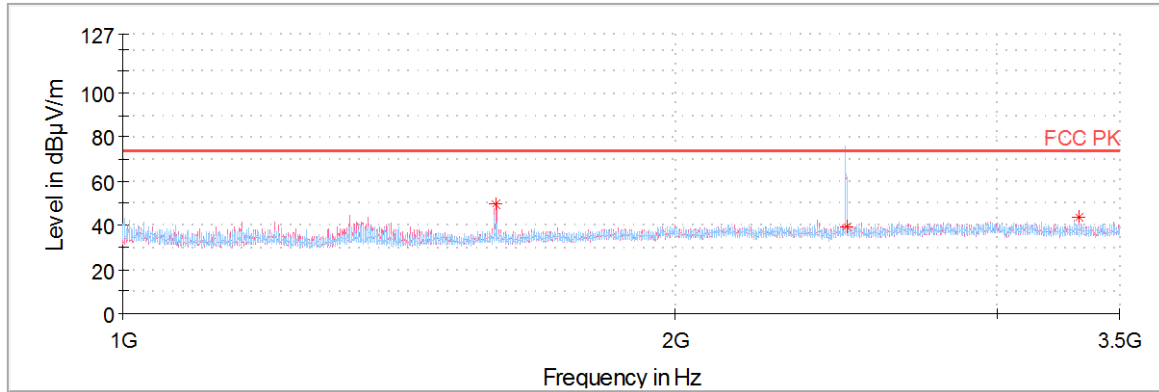
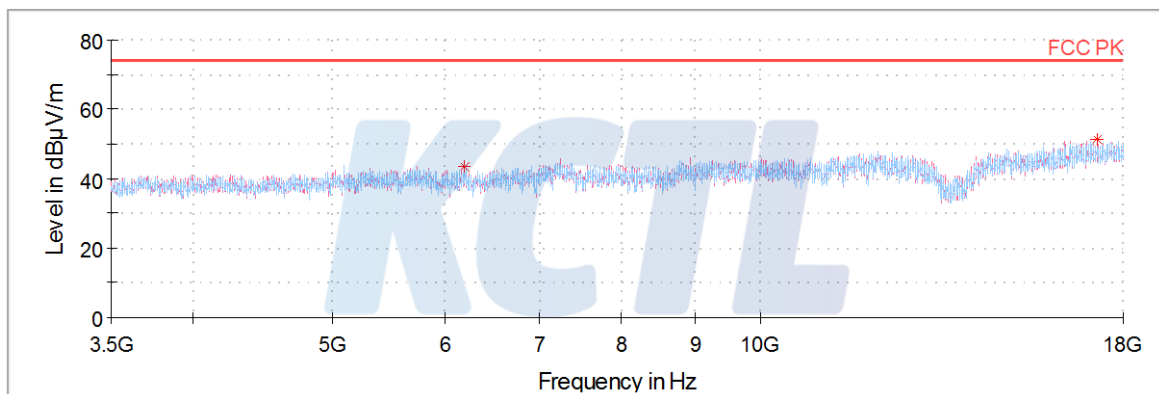
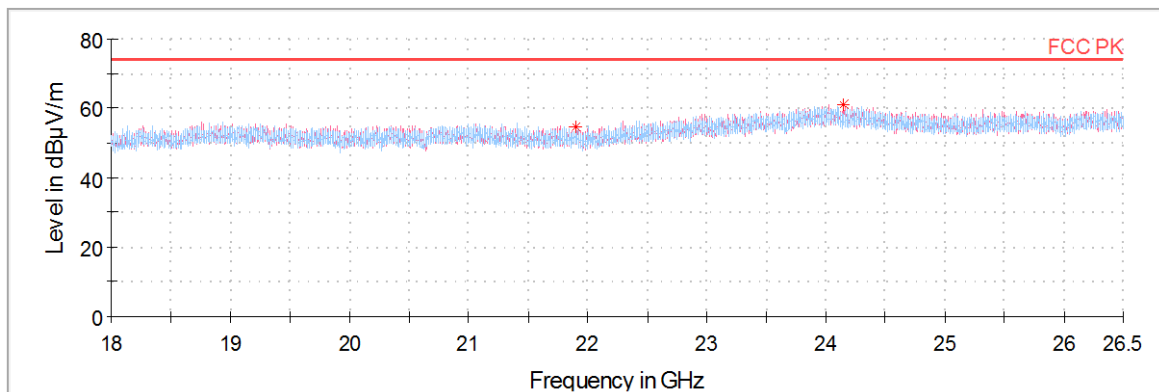
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**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

## High Channel

| Frequency                                                      | Pol.  | Reading  | Cable Loss | Amp Gain | Antenna Factor | DCCF | Result     | Limit      | Margin |
|----------------------------------------------------------------|-------|----------|------------|----------|----------------|------|------------|------------|--------|
| [MHz]                                                          | [V/H] | [dB(μV)] | [dB]       | [dB]     | [dB]           | [dB] | [dB(μV/m)] | [dB(μV/m)] | [dB]   |
| <b>Peak data</b>                                               |       |          |            |          |                |      |            |            |        |
| 1 597.12 <sup>1)</sup>                                         | V     | 81.36    | 3.04       | -60.64   | 26.19          | -    | 49.95      | 74.00      | 24.05  |
| 2 484.45 <sup>2)</sup>                                         | H     | 66.66    | 3.77       | -59.57   | 28.72          | -    | 39.58      | 74.00      | 34.42  |
| 21 916.70                                                      | H     | 47.06    | 12.10      | -49.46   | 45.00          | -    | 54.70      | 74.00      | 19.30  |
| 24 136.72                                                      | V     | 46.02    | 12.80      | -42.91   | 45.10          | -    | 61.01      | 74.00      | 12.99  |
| <b>Average Data</b>                                            |       |          |            |          |                |      |            |            |        |
| No spurious emissions were detected within 20 dB of the limit. |       |          |            |          |                |      |            |            |        |

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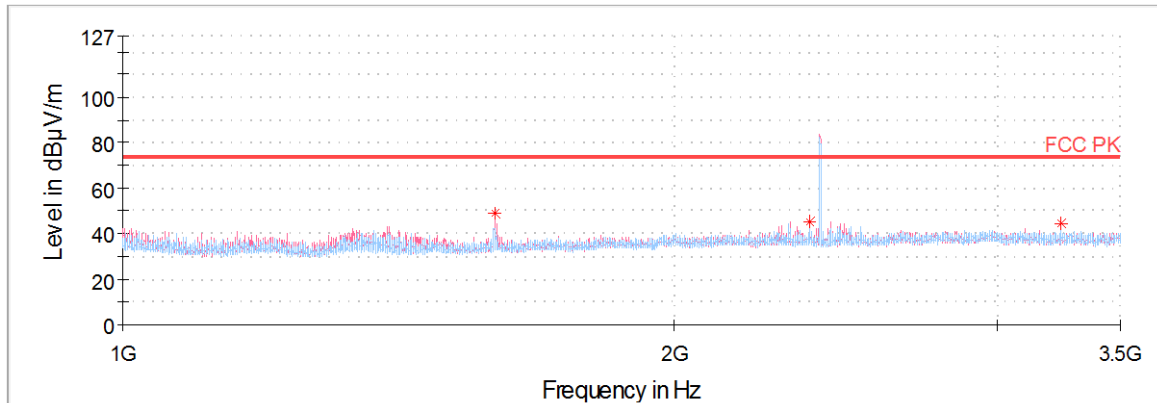
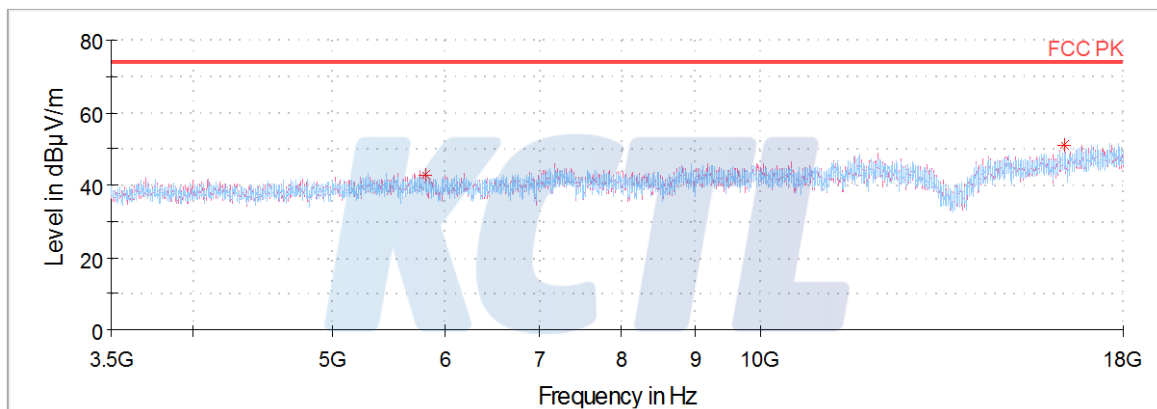
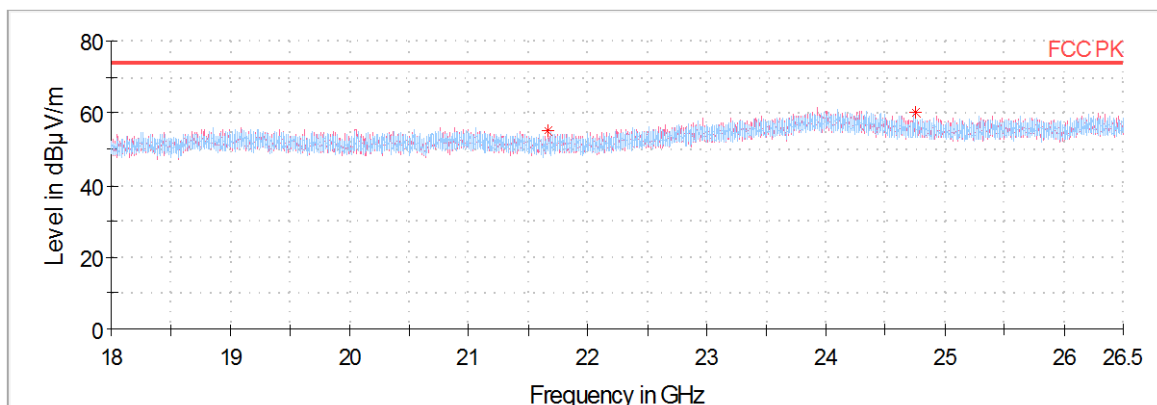
**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

## 8DPSK

### Low Channel

| Frequency                                                      | Pol.  | Reading  | Cable Loss | Amp Gain | Antenna Factor | DCCF | Result     | Limit      | Margin |
|----------------------------------------------------------------|-------|----------|------------|----------|----------------|------|------------|------------|--------|
| [MHz]                                                          | [V/H] | [dB(μV)] | [dB]       | [dB]     | [dB]           | [dB] | [dB(μV/m)] | [dB(μV/m)] | [dB]   |
| <b>Peak data</b>                                               |       |          |            |          |                |      |            |            |        |
| 1 596.27 <sup>1)</sup>                                         | V     | 80.34    | 3.04       | -60.67   | 26.19          | -    | 48.90      | 74.00      | 25.10  |
| 2 369.22 <sup>2)</sup>                                         | V     | 72.61    | 3.69       | -59.69   | 28.50          | -    | 45.11      | 74.00      | 28.89  |
| 24 674.36                                                      | V     | 47.23    | 12.00      | -49.21   | 45.00          | -    | 55.02      | 74.00      | 18.98  |
| 24 785.45                                                      | H     | 46.24    | 12.80      | -43.90   | 45.10          | -    | 60.24      | 74.00      | 13.76  |
| <b>Average Data</b>                                            |       |          |            |          |                |      |            |            |        |
| No spurious emissions were detected within 20 dB of the limit. |       |          |            |          |                |      |            |            |        |

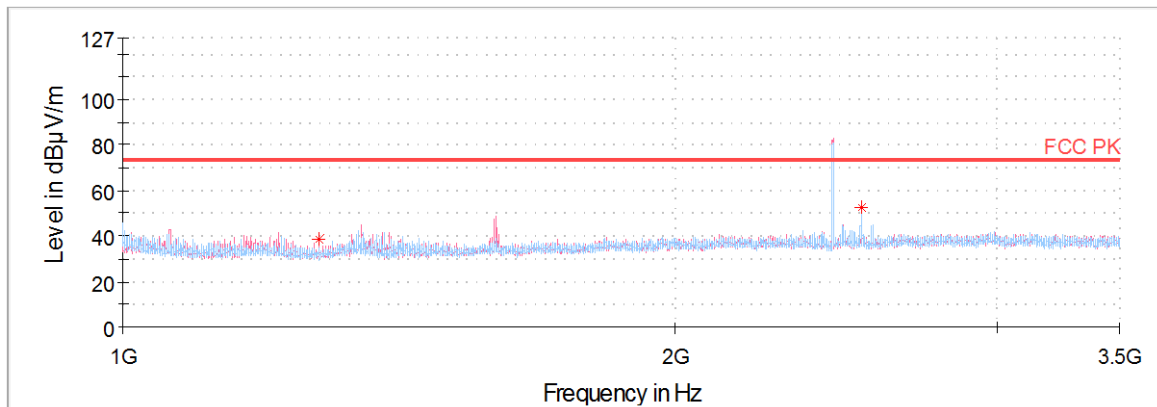
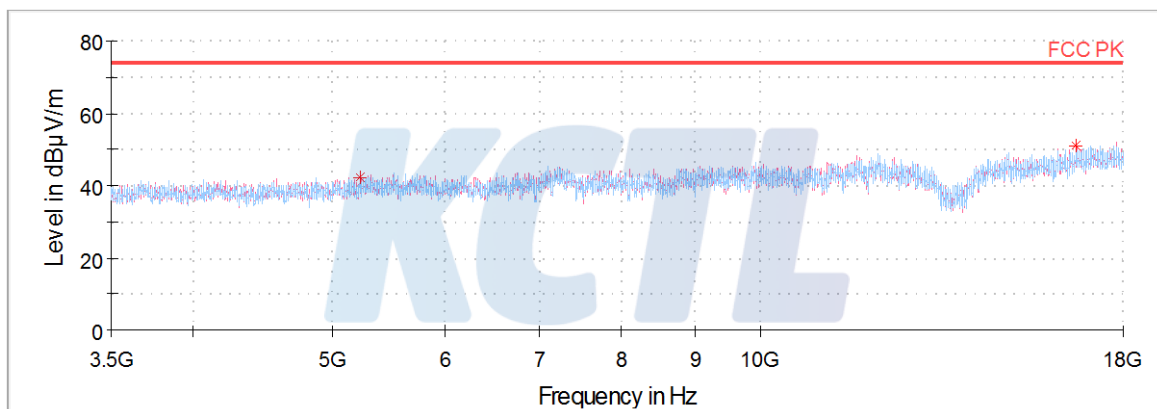
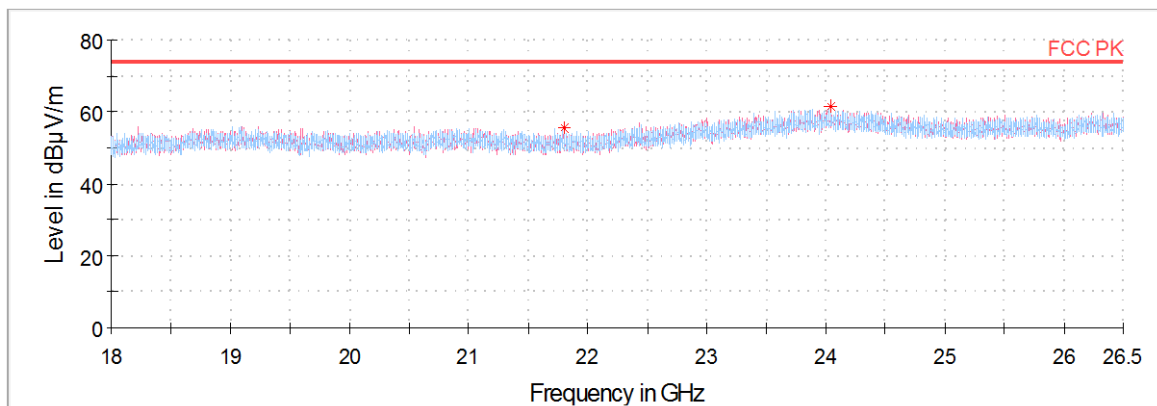
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**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

### Middle Channel

| Frequency                                                      | Pol.  | Reading  | Cable Loss | Amp Gain | Antenna Factor | DCCF | Result     | Limit      | Margin |
|----------------------------------------------------------------|-------|----------|------------|----------|----------------|------|------------|------------|--------|
| [MHz]                                                          | [V/H] | [dB(μV)] | [dB]       | [dB]     | [dB]           | [dB] | [dB(μV/m)] | [dB(μV/m)] | [dB]   |
| <b>Peak data</b>                                               |       |          |            |          |                |      |            |            |        |
| 21 805.81                                                      | H     | 47.78    | 12.10      | -49.39   | 45.00          | -    | 55.49      | 74.00      | 18.51  |
| 24 039.09                                                      | H     | 46.18    | 12.80      | -42.61   | 45.00          | -    | 61.37      | 74.00      | 12.63  |
| <b>Average Data</b>                                            |       |          |            |          |                |      |            |            |        |
| No spurious emissions were detected within 20 dB of the limit. |       |          |            |          |                |      |            |            |        |

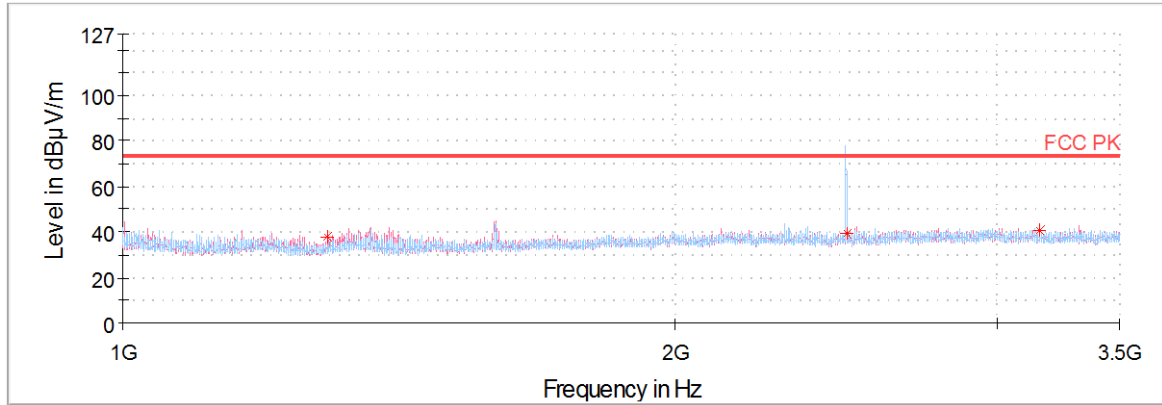
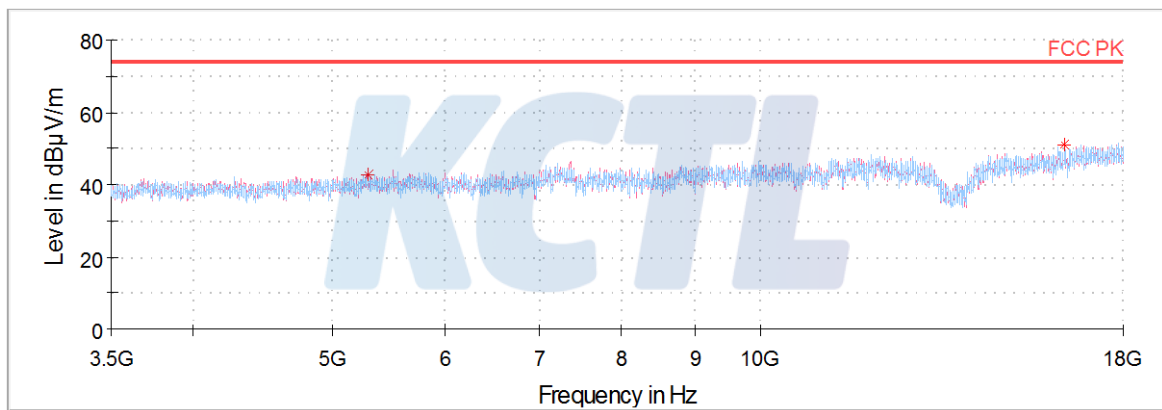
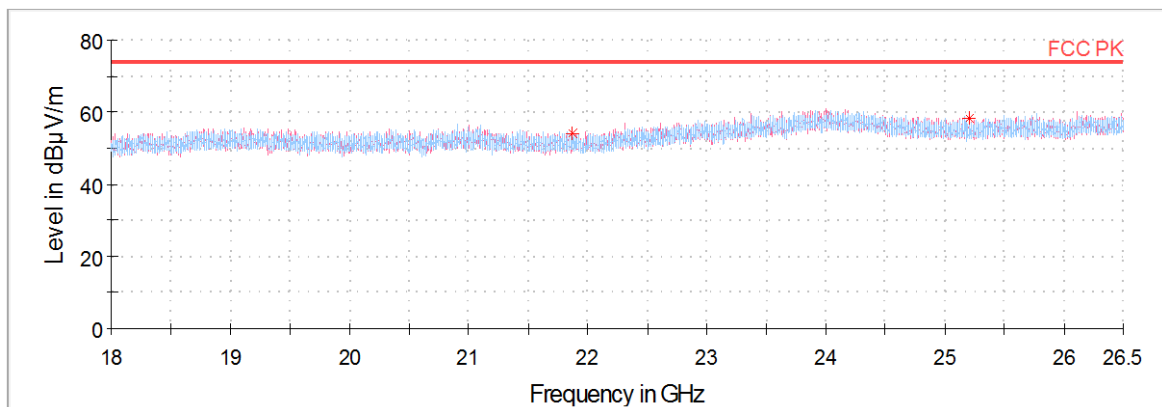
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**Horizontal/Vertical for 1 GHz ~ 3.5 GHz****Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

## High Channel

| Frequency                                                      | Pol.  | Reading  | Cable Loss | Amp Gain | Antenna Factor | DCCF | Result     | Limit      | Margin |
|----------------------------------------------------------------|-------|----------|------------|----------|----------------|------|------------|------------|--------|
| [MHz]                                                          | [V/H] | [dB(μV)] | [dB]       | [dB]     | [dB]           | [dB] | [dB(μV/m)] | [dB(μV/m)] | [dB]   |
| <b>Peak data</b>                                               |       |          |            |          |                |      |            |            |        |
| 2 485.31 <sup>2)</sup>                                         | H     | 66.44    | 3.77       | -59.56   | 28.72          | -    | 39.37      | 74.00      | 34.63  |
| 21 885.39                                                      | V     | 46.38    | 12.10      | -49.44   | 45.00          | -    | 54.04      | 74.00      | 19.96  |
| 25 202.33                                                      | H     | 44.27    | 13.00      | -44.31   | 45.30          | -    | 58.26      | 74.00      | 15.74  |
| <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**

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Report No.:  
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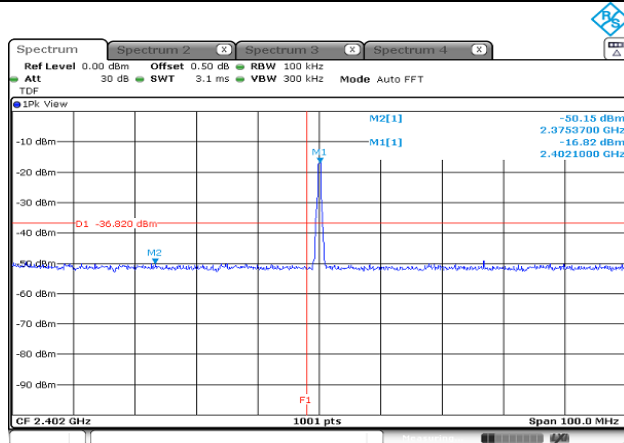
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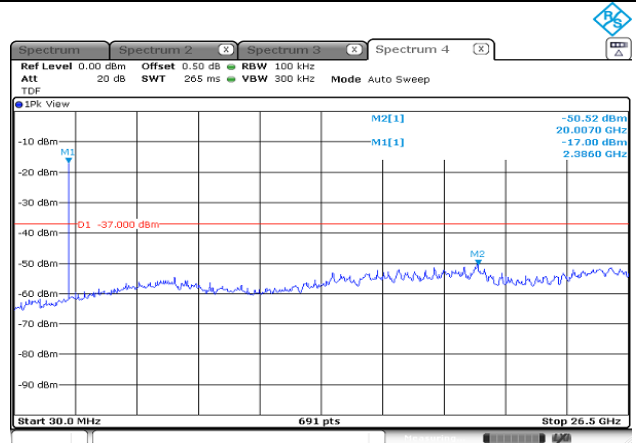
## Test results

### GFSK

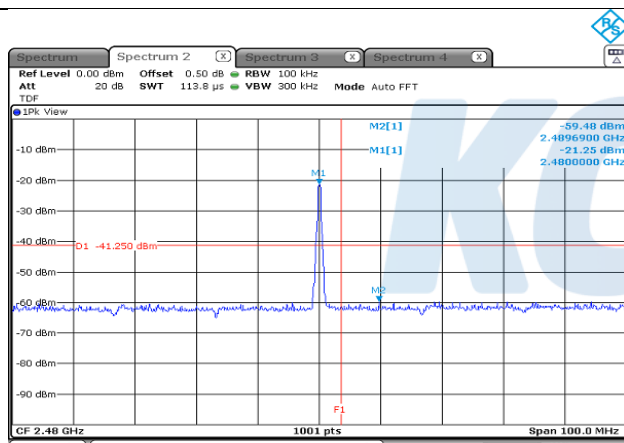
#### Conducted bandedge



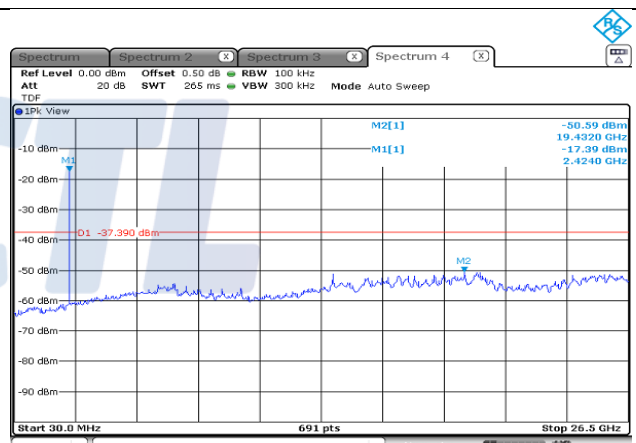
#### Conducted spurious



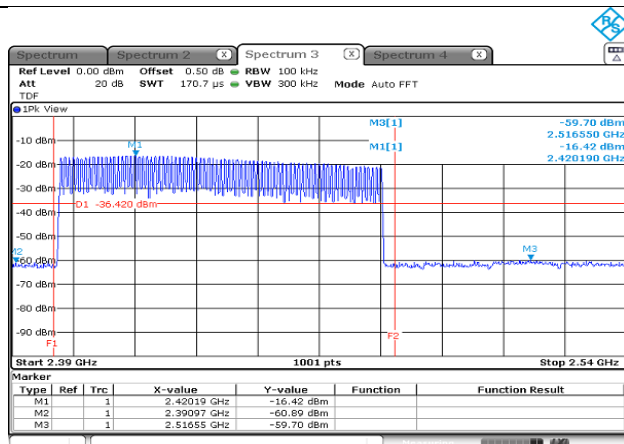
#### Lowest



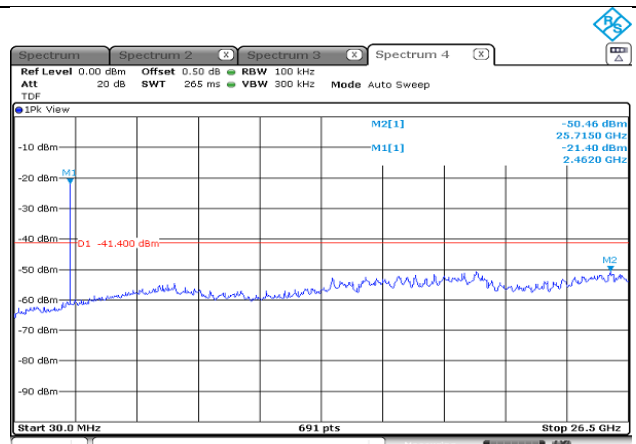
#### Lowest



#### Highest



#### Middle



#### With Hopping Band-edge

#### Highest

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Suwon-si, Gyeonggi-do, 16677, Korea  
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Report No.:  
KR19-SRF0002-B

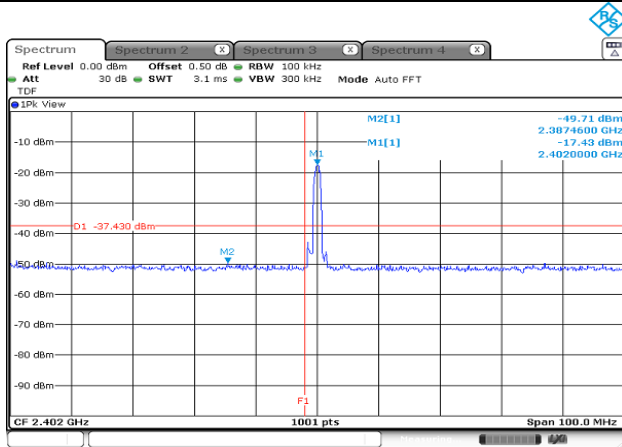
Page (50) of (51)



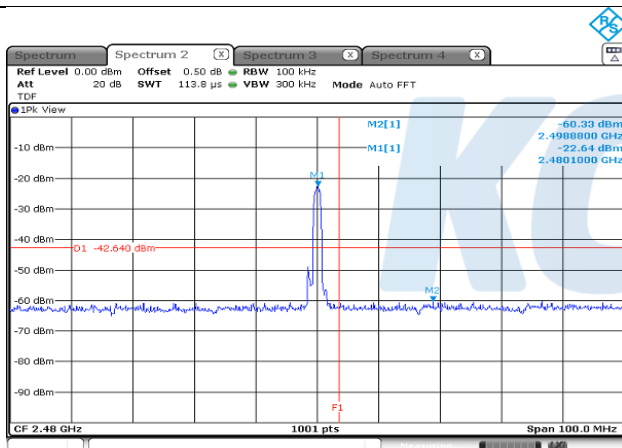
## Test results

### 8DPSK

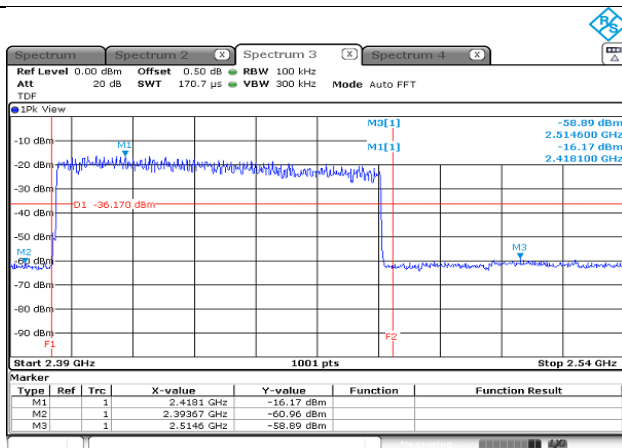
#### Conducted bandedge



Lowest

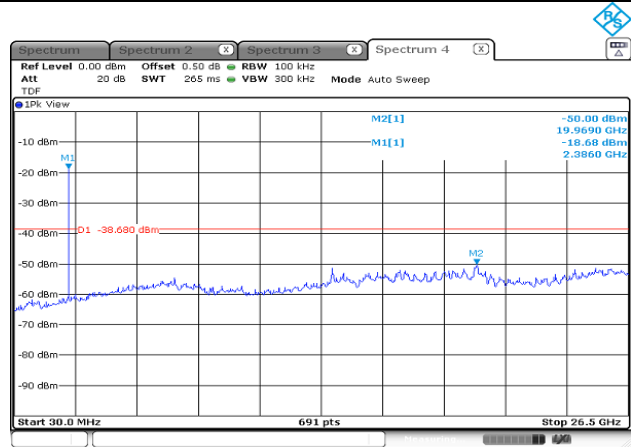


Highest

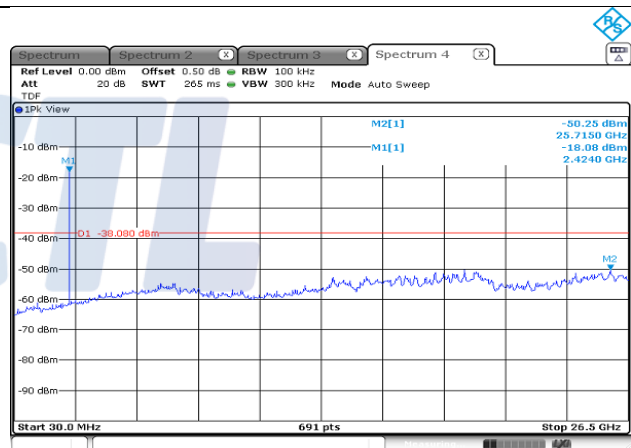


With Hopping Band-edge

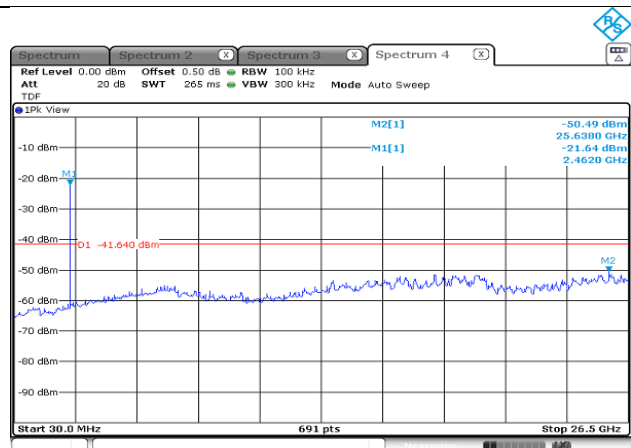
#### Conducted spurious



Lowest



Middle



Highest

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## 7. Measurement equipment

| Equipment Name             | Manufacturer                 | Model No.                                     | Serial No.  | Next Cal. Date |
|----------------------------|------------------------------|-----------------------------------------------|-------------|----------------|
| Spectrum Analyzer          | R & S                        | FSV30                                         | 100914      | 19.09.10       |
| Wideband Power Sensor      | R & S                        | NRP-Z81                                       | 102398      | 19.01.31       |
| DC Power Supply            | AGILENT                      | E3632A                                        | MY40018781  | 19.05.14       |
| Bluetooth Tester           | TESCOM                       | TC-3000C                                      | 3000C000270 | 19.08.02       |
| Power Divider              | Aeroflex/<br>Weinschel, Inc. | 1580-1                                        | RZ184       | 19.08.02       |
| ATTENUATOR                 | R & S                        | DNF<br>Dämpfungsglied<br>10 dB in<br>N-50 Ohm | 31212       | 19.05.14       |
| EMI TEST RECEIVER          | R & S                        | ESCI                                          | 100732      | 19.08.23       |
| Bi-Log Antenna             | SCHWARZBECK                  | VULB 9168                                     | 440         | 19.10.23       |
| Amplifier                  | SONOMA<br>INSTRUMENT         | 310N                                          | 186280      | 19.04.05       |
| ATTENUATOR                 | Weinschel<br>ENGINEERING     | 1                                             | AE7348      | 19.05.14       |
| Horn antenna               | ETS.lindgren                 | 3116                                          | 00086632    | 19.04.20       |
| Horn antenna               | ETS.lindgren                 | 3117                                          | 161225      | 19.05.18       |
| AMPLIFIER                  | L-3 Narda-MITEQ              | AMF-7D-0100180<br>0-22-10P                    | 2003683     | 19.05.15       |
| AMPLIFIER                  | L-3 Narda-MITEQ              | JS44-18004000-33<br>-8P                       | 2000997     | 19.08.02       |
| LOOP Antenna               | R & S                        | HFH2-Z2                                       | 892665/035  | 19.01.25       |
| 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 | 19.05.14       |
| Vector Signal<br>Generator | R & S                        | SMBV100A                                      | 257566      | 19.01.05       |
| Signal Generator           | R & S                        | SMR40                                         | 100007      | 19.05.15       |
| Cable Assembly             | RadiAll                      | 2301761768000PJ                               | 1724.659    | -              |
| Cable Assembly             | gigalane                     | RG-400                                        | -           | -              |
| Cable Assembly             | HUER+SUHNER                  | SUCOFLEX 104                                  | MY4342/4    | -              |

**End of test report**