# Certificate of Test

**NCT Co., Ltd.**
211-71, Geumgok-ro, Hwaseong-si,
Gyeonggi-do, 18511, Korea
(Tel: +82-31-323-6070 / Fax: +82-31-323-6071)



Your business' success starts with NCT

1. **Client**
   - ○ Name : SystemBase Co.,Ltd.
   - ○ Address : Daerung Post Tower-1 16F, 288, Digital-ro, Guro-gu, Seoul, Republic of Korea
   - ○ Date of Receipt : 2020-01-10

2. **Use of Report :** FCC Approval

3. **Test Sample**
   - ○ Description / FCC ID : Bluetooth Serial Adaptor / PRO-WCS-232V6

4. **Date of Test :** 2020-01-28 ~ 2020-02-21

5. **Test method used :** FCC Part 15 Subpart C 15.247

6. **Testing Environment :**
   - ○ Temperature: (25 ± 5) °C, Humidity: Less than 75 % R.H.
   - * Unless specified otherwise in the individual methods, the tests were conducted on ambient conditions.

7. **Test Results :** Refer to the test results

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
This Test Report cannot be reproduced, except in full
This test report is prepared according to the requirements of ISO / IEC 17025.

| | | |
|---|---|---|
| Affirmation | **Tested by**<br>Jong-Myoung, Shin (signature) | **Technical Manager**<br>Kyung-Taek, Lee (signature) |

**March 02, 2020**

**NCT CO., LTD.** (seal)

## Table of contents

# 1. General Information's

## 1.1 Test Performed

| | | |
|---|---|---|
| Laboratory | : | NCT Co., Ltd. |
| Address | : | 211-71, Geumgok-ro, Hwaseong-si, Gyeonggi-do, 18511, Korea |
| Telephone | : | +82-31-323-6070 |
| Facsimile | : | +82-31-323-6071 |
| FCC Designation No. | : | KR0166 |
| FCC Registration Number | : | 409631 |

# 2. Information's about Test Item

## 2.1 Applicant Information

| | | |
|---|---|---|
| Company name | : | SystemBase Co.,Ltd. |
| Address | : | Daerung Post Tower-1 16F, 288, Digital-ro, Guro-gu, Seoul, Republic of Korea |
| Telephone / Facsimile | : | +82-2-855-0501 / +82-2-855-0580 |

## 2.2 Equipment Under Test (EUT) description

| | | |
|---|---|---|
| Test item particulars | : | Bluetooth Serial Adaptor |
| Model and/or type reference | : | WCS-232 V6.0 |
| Additional model name | : | BT-232 V6.0 |
| Serial number | : | Identification |
| Antenna type and gain | : | Dipole Antenna with Max gain : 5.37 dBi (M/N: R-AN2400-1901RS) |
| | | Dipole Antenna with Max gain : 3.09 dBi (M/N: R-AN2400-5801RS) |
| | | Dipole Antenna with Max gain : 1.40 dBi (M/N: AN2400-3306RS) |
| Date (s) of performance of tests: | : | 2020-01-28 ~ 2020-02-05 |
| Date of receipt of test item | : | 2020-01-10 |
| EUT condition | : | Pre-production, not damaged |
| Number of channel | : | 79 |
| EUT Power Source | : | DC 3.7 V |
| Type of Modulation | : | Basic Mode(GFSK), EDR Mode(Pi/4 DQPSK, 8DPSK) |
| FirmWare version | : | 1.0 |
| Hardware version | : | 1.0 |
| Test software name(version) | : | CSR BlueSuite_BlueTest3(2.6.2) |

## 2.3 Tested Frequency

| Test Mode | Test frequency (㎒) | | |
|---|---|---|---|
| | Low frequency | Middle frequency | High frequency |
| GFSK | 2 402 | 2 442 | 2 480 |
| Pi/4 DQPSK | 2 402 | 2 442 | 2 480 |
| 8DPSK | 2 402 | 2 442 | 2 480 |

## 2.4 Worst-Case

| | |
|---|---|
| BDR | GFSK(DH5) |
| EDR | 8DPSK(3-DH5) |

Note: The power measurement has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates.



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# 3. Test Report

## 3.1 Test Summary

| Applied | Test Items | Clause | Test Condition | Result |
|---|---|---|---|---|
| ☒ | Antenna Requirement | 15.203 | Conducted | C |
| ☒ | 20 dB Channel Bandwidth | 15.247(a) | | C |
| ☒ | Number of Hopping Frequencies | 15.247(a) | | C |
| ☒ | Time of Occupancy (Dwell Time) | 15.247(a) | | C |
| ☒ | Carrier Frequencies Separation | 15.247(a) | | C |
| ☒ | Peak Output Power | 15.247(b) | | C |
| ☒ | Conducted Spurious Emission | 15.247(d) | | C |
| ☒ | Radiated Spurious Emission | 15.247(d)<br>15.205 & 15.209 | Radiated | C |
| ☒ | Conducted Emissions | 15.207 | AC Line Conducted | C |

*Note 1*: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

The sample was tested according to the following specification: ANSI C63.10:2013

Compliance was determined by specification limits of the applicable standard according to customer requirements.

## 3.2 Test Report Version

| Test Report No. | Date | Description |
|---|---|---|
| NW2003-F001 | 2020-03-02 | Initial issue |
| | | |
| | | |



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## 3.3 Transmitter Requirements

### 3.3.1 Antenna Requirement

Accoding to §15.203 An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Accoding to §15.247(b)(4) e 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.

#### 3.3.1.1 Result

Complies
(The transmitter has a Dipole Antenna. The directional peak gain of the antenna is 5.37 dBi.)


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## 3.3.2 20 dB Channel Bandwidth

### 3.3.2.1 Test Setup

Refer to the APPENDIX I.

### 3.3.2.2 Limit

Limit : Not Applicable

### 3.3.2.3 Test Procedure

1. The 20 dB bandwidth were measured with a spectrum analyzer connected to RF antenna Connector (conducted measurement) while EUT was operating in transmit mode. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.

2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using below setting:
   RBW = 1% to 5% of the 20 dB BW
   VBW ≥ 3 × RBW
   Span = between two times and five times the 20 dB bandwidth
   Sweep = auto
   Detector function = peak
   Trace = max hold

### 3.3.2.4 Test Result

| Test Mode | Test Frequency | 20 dB Bandwidth (MHz) |
|---|---|---|
| GFSK | Low | 0.876 |
| | Middle | 0.872 |
| | High | 0.876 |
| 8DPSK | Low | 1.264 |
| | Middle | 1.216 |
| | High | 1.212 |


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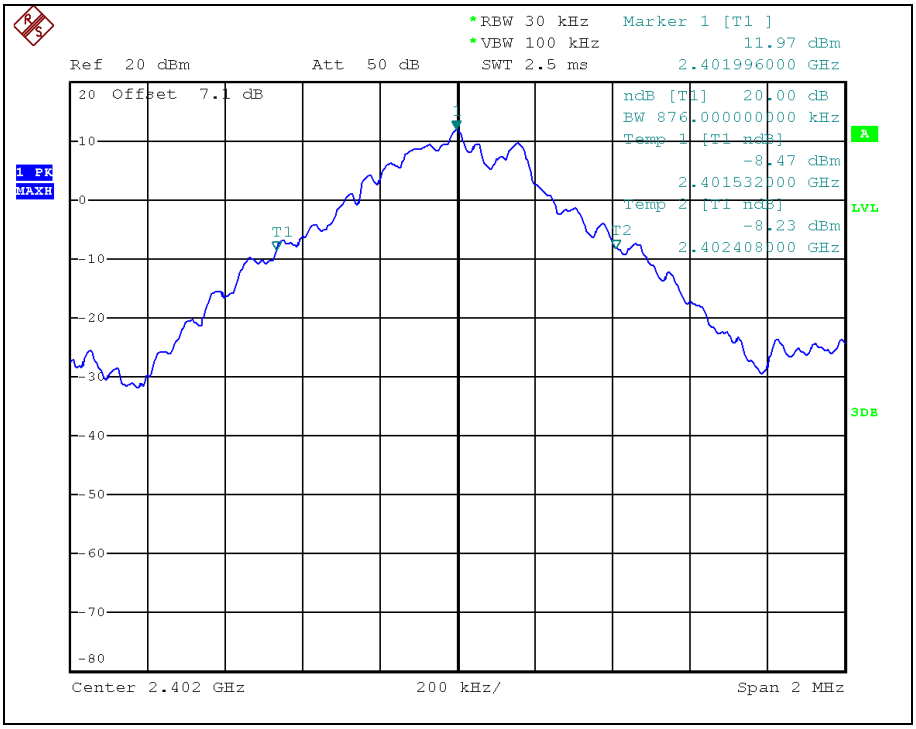
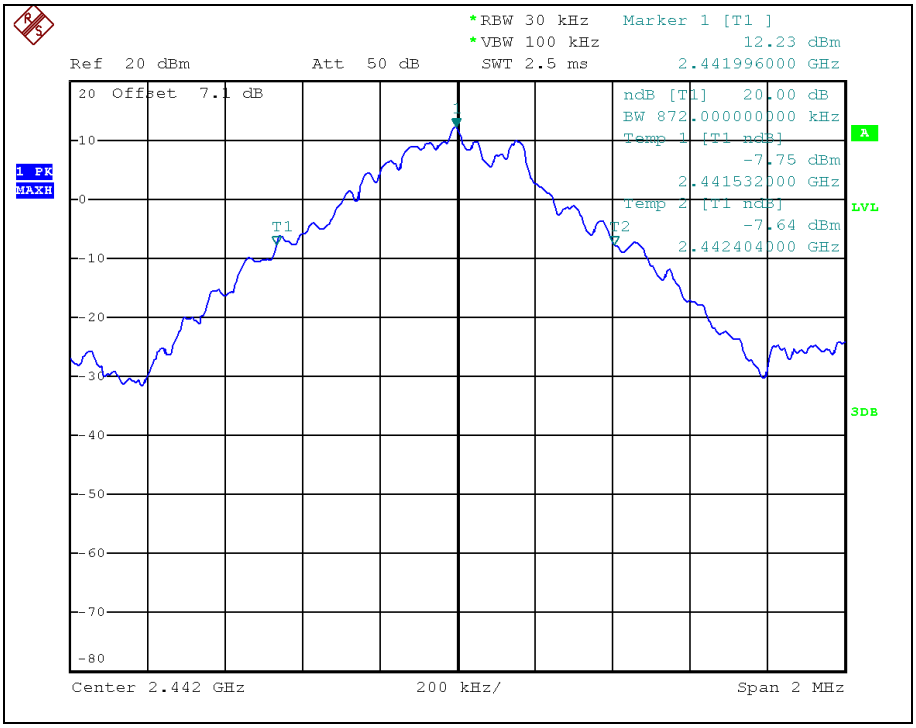
### 3.3.2.5 Test Plot

**GFSK _ Low frequency** **20 dB Bandwidth**




**GFSK _ Middle frequency** **20 dB Bandwidth**



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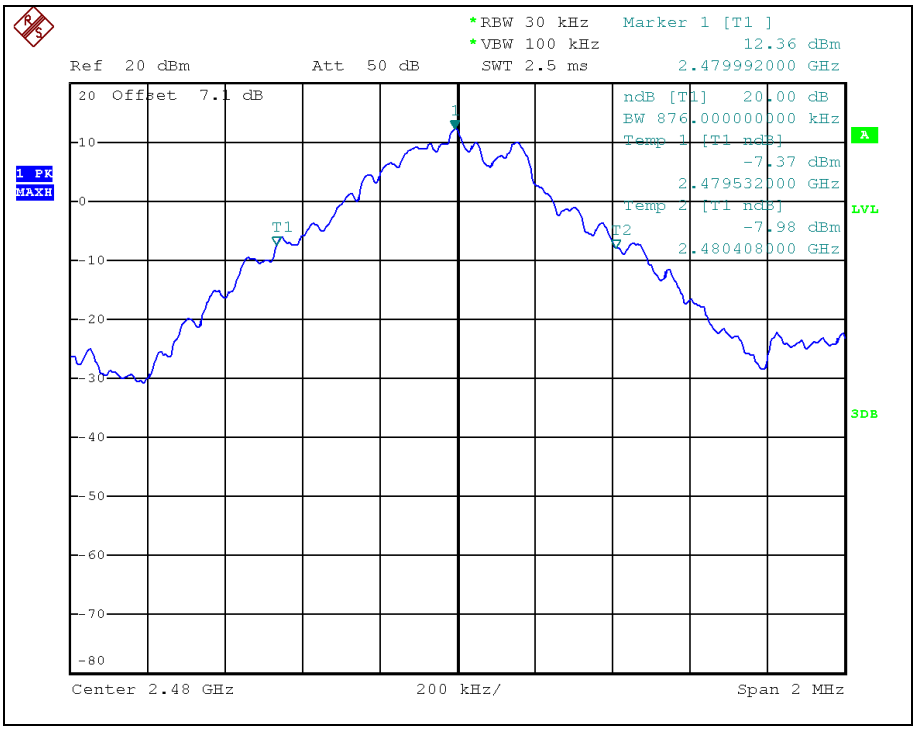
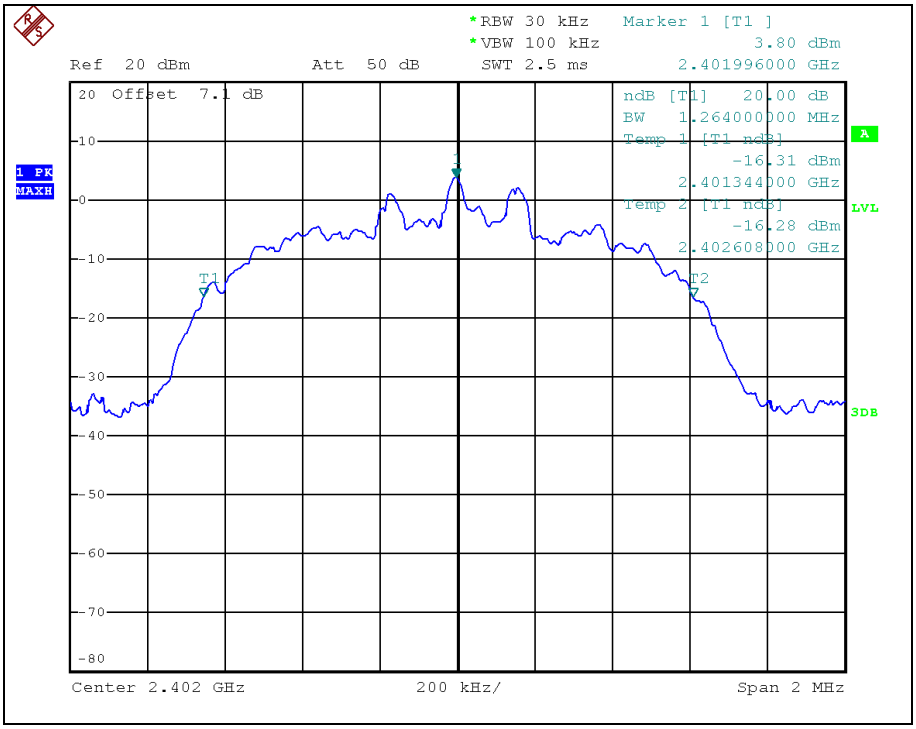
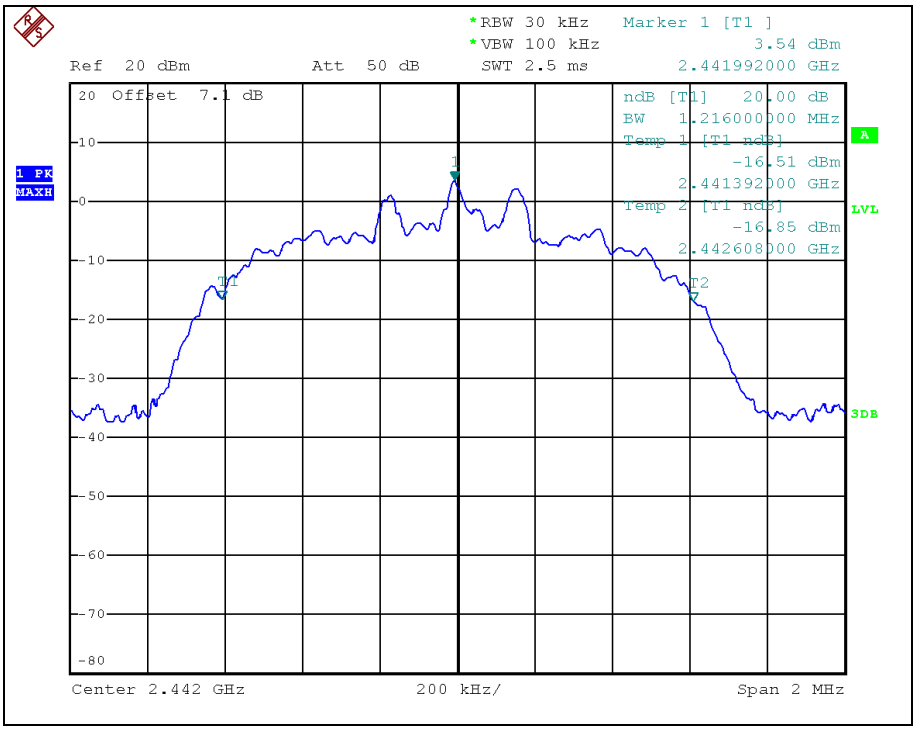
**GFSK _ High frequency** **20 dB Bandwidth**



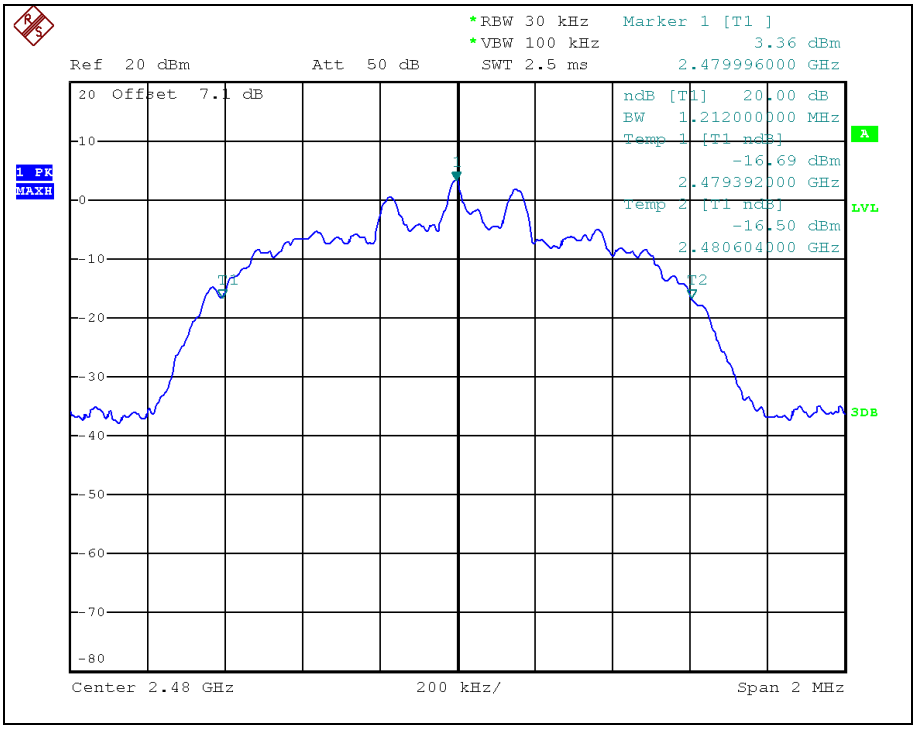

**8DPSK _ Low frequency** **20 dB Bandwidth**



**8DPSK _ Middle frequency** **20 dB Bandwidth**




**8DPSK _ High frequency** **20 dB Bandwidth**



## 3.3.3 Number of Hopping Frequencies

### 3.3.3.1 Test Setup

Refer to the APPENDIX I.

### 3.3.3.2 Limit

Limit : >= 15 hops

### 3.3.3.3 Test Procedure

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.
To get higher resolution, two frequency ranges for FH mode within the 2400 ~ 2483.5 ㎒ were examined.

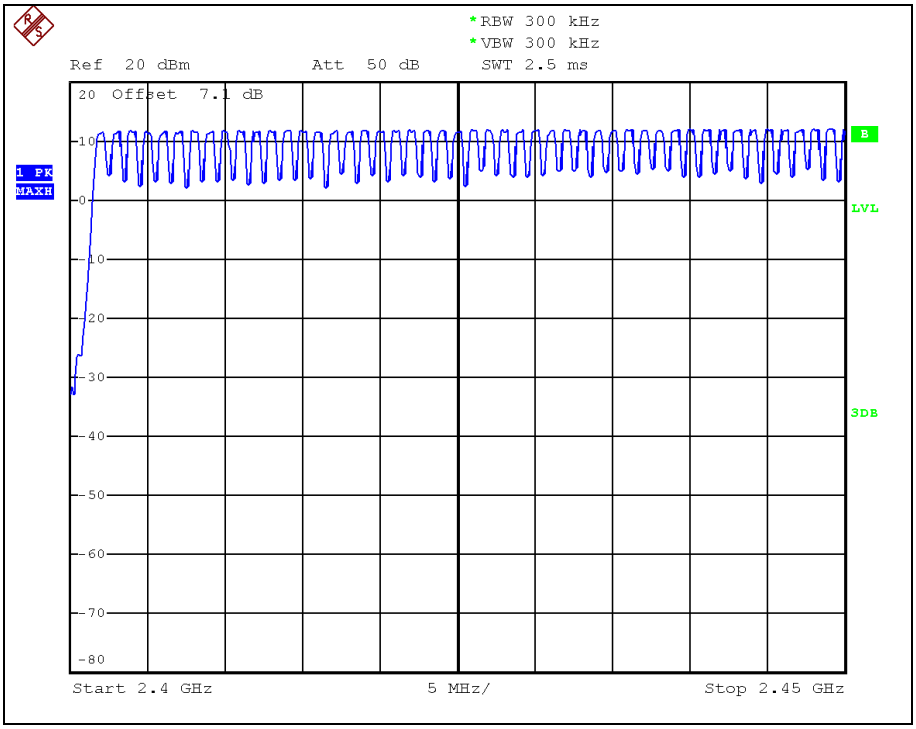
The spectrum analyzer is set to:
Span = 50 ㎒
RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 ㏈ bandwidth, whichever is smaller.
VBW ≥ RBW
Sweep = Auto
Detector = Peak
Trace = Max hold

### 3.3.3.4 Test Result

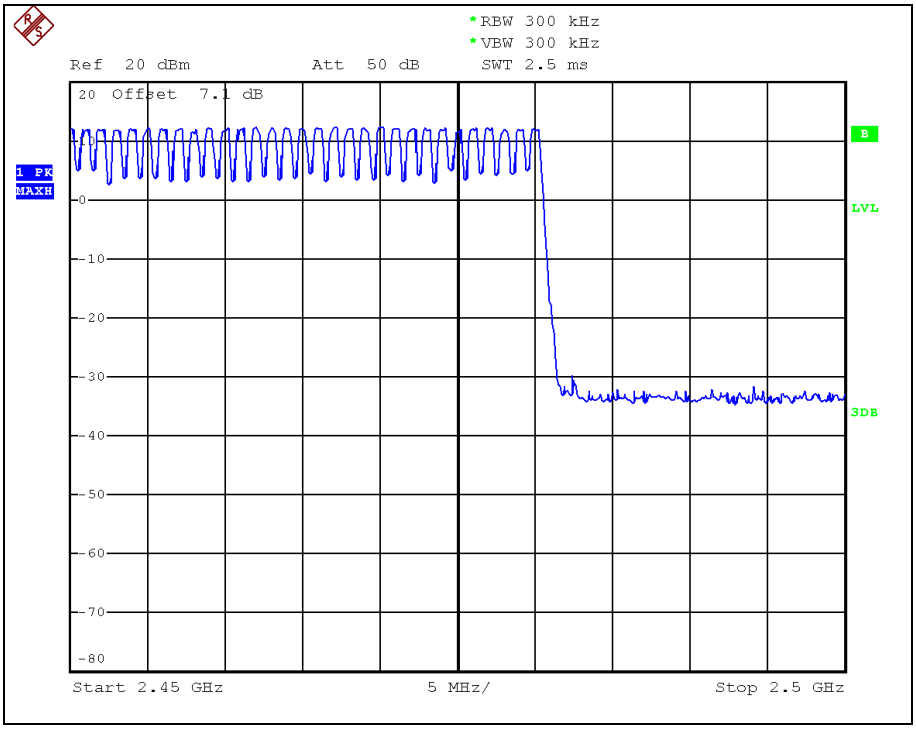
| Test Mode | Number of Hopping Channels |
|---|---|
| **GFSK** | 79 |
| **8DPSK** | 79 |

### 3.3.3.5 Test Plot

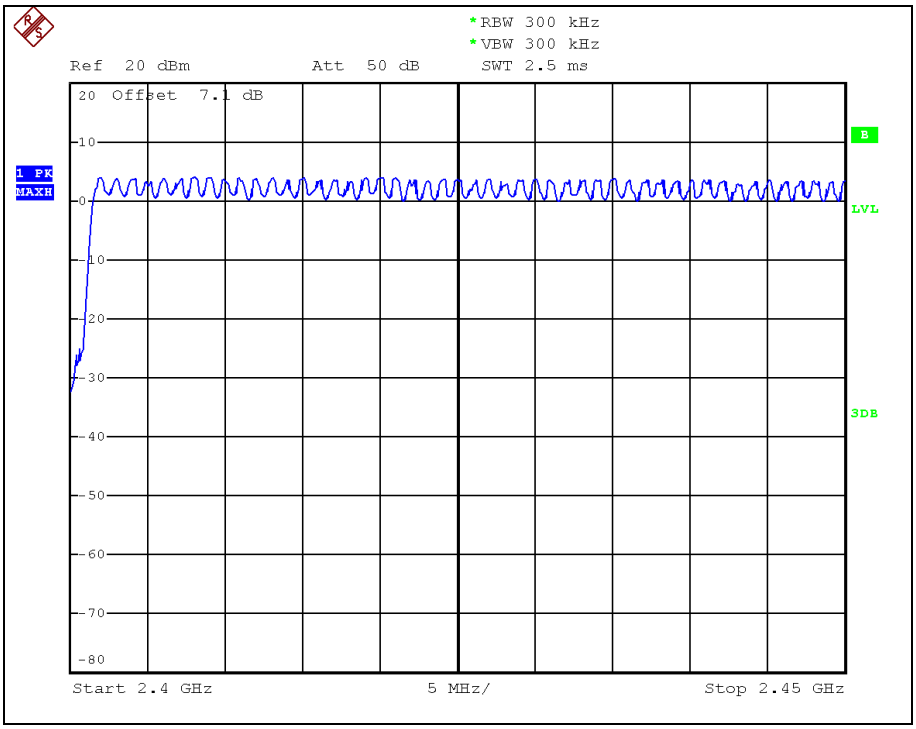
**GFSK _ Hopping Mode** **Number of Hopping Frequencies**



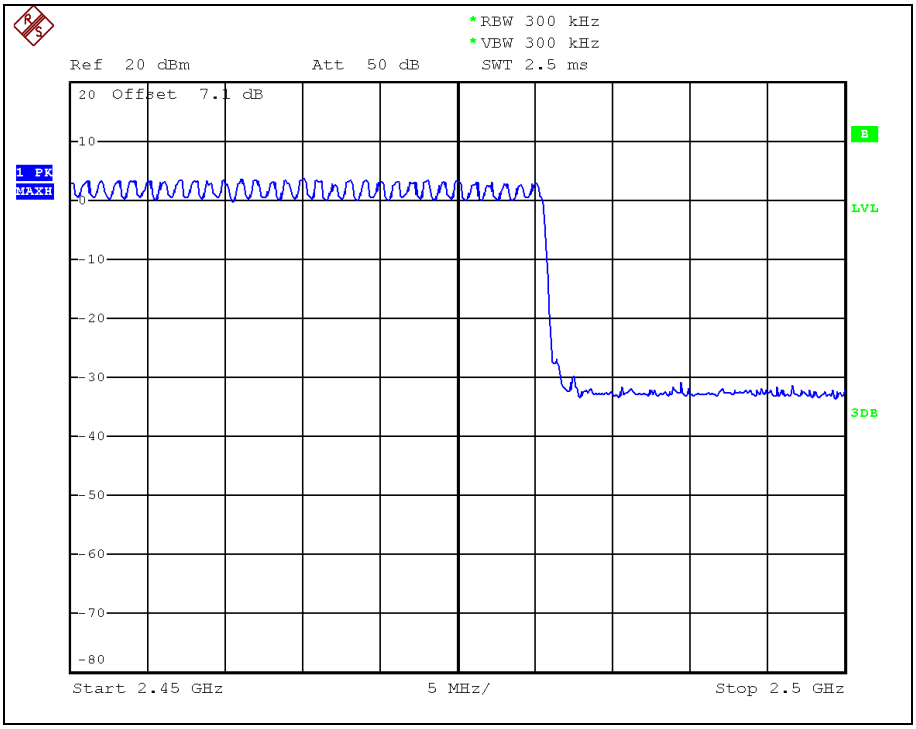

**GFSK _ Hopping Mode** **Number of Hopping Frequencies**



**8DPSK _ Hopping Mode** **Number of Hopping Frequencies**




**8DPSK _ Hopping Mode** **Number of Hopping Frequencies**



## 3.3.4 Time of Occupancy (Dwell Time)

### 3.3.4.1 Test Setup

Refer to the APPENDIX I.

### 3.3.4.2 Limit

The maximum permissible time of occupancy is 400 ms within a period of 400 ms multiplied by the number of hopping channels employed.

### 3.3.4.3 Test Procedure

The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to:
Center frequency = 2442 ㎒ Span = zero
RBW = 1 ㎒ (RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel)
VBW ≥ RBW Detector = Peak
Trace = Max hold

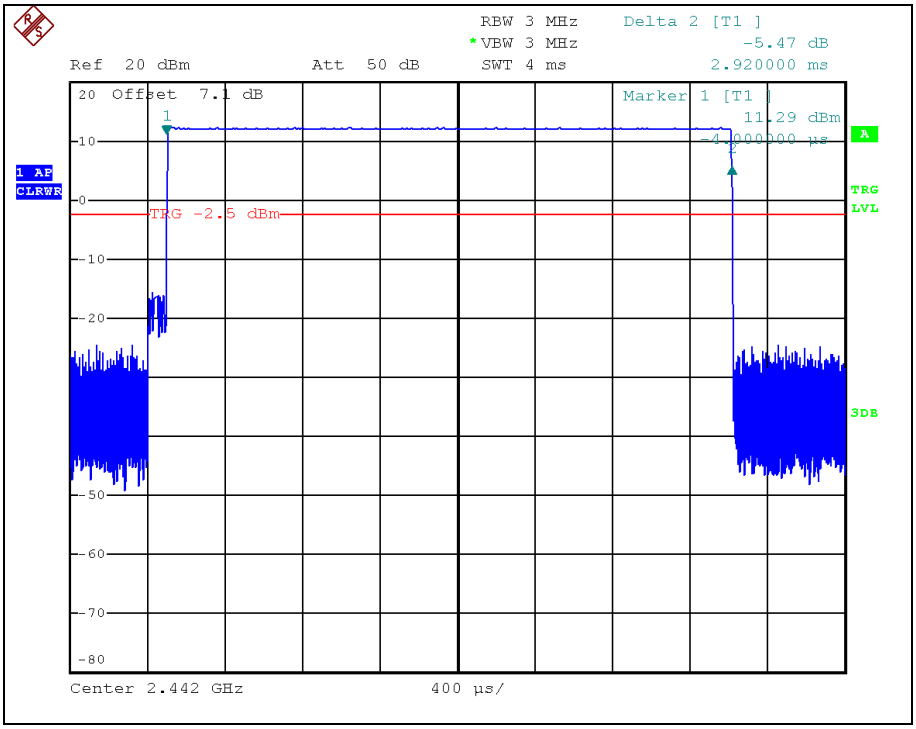
### 3.3.4.4 Test Result

| Test Mode | Number of Hopping Channels | Burst On Time (ms) | Result (sec) | Limit (sec) |
|---|---|---|---|---|
| **GFSK (non-AFH)** | 79 | 2.920 | 0.31 | 0.40 |
| **GFSK (AFH)** | 20 | 2.920 | 0.16 | 0.40 |
| **8DPSK (non-AFH)** | 79 | 2.944 | 0.31 | 0.40 |
| **8DPSK (AFH)** | 20 | 2.944 | 0.16 | 0.40 |

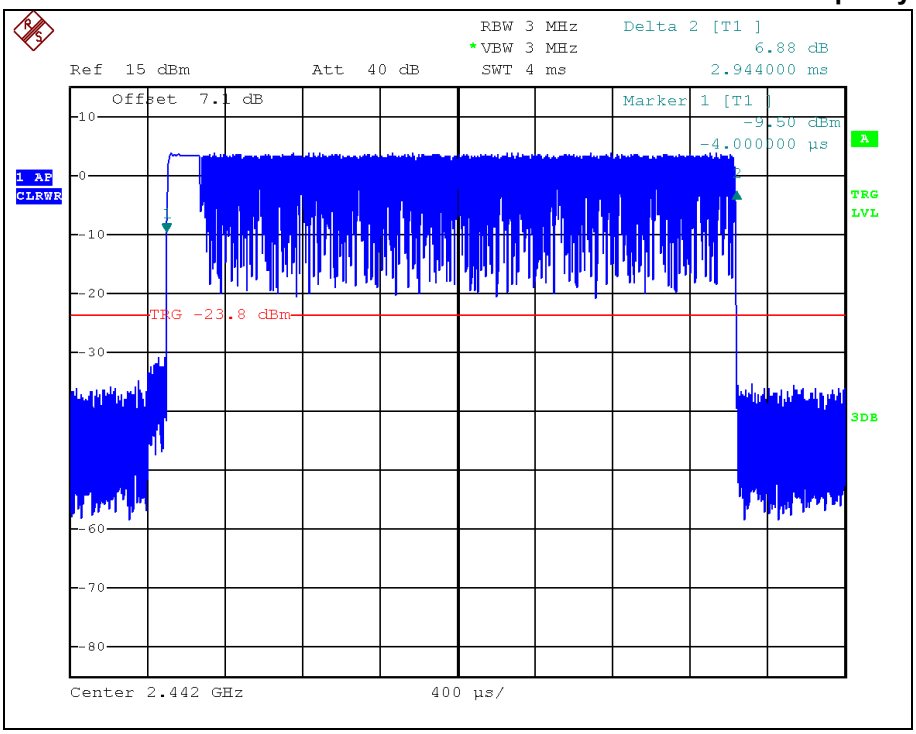
Note: Dwell Time = 0.4 x Hopping channel x Burst On Time x ((Hopping rate / Time slots) / Hopping channel)
- Time slots for DH5 = 6 slots ( TX = 5 slot / RX = 1 slot)
- Hopping Rate = 1600 for FH mode & 800 for AFH mode

### 3.3.4.5 Test Plot

**GFSK** **Time of Occupancy**




**8DPSK** **Time of Occupancy**



## 3.3.5 Carrier Frequencies Separation

### 3.3.5.1 Test Setup

Refer to the APPENDIX I.

### 3.3.5.2 Limit

Limit : ≥ 25 ㎑ or ≥ Two-Thirds of the 20 ㏈ BW whichever is greater.

### 3.3.5.3 Test Procedure

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.
After the trace being stable, the reading value between the peaks of the adjacent channels using the marker delta function was recorded as the measurement results.

The spectrum analyzer is set to:
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.
VBW ≥ RBW
Sweep = Auto
Detector = Peak
Trace = Max hold

### 3.3.5.4 Test Result

| Test Mode | Test Frequency | Carrier Frequencies Separation (㎑) | Min. Limit (㎑) |
|---|---|---|---|
| GFSK | Low | 1.008 | 0.584 |
| | Middle | 0.996 | 0.581 |
| | High | 1.002 | 0.584 |
| 8DPSK | Low | 1.002 | 0.843 |
| | Middle | 1.002 | 0.811 |
| | High | 1.002 | 0.808 |

Note: Limit(㎑) = Test Result of 20 ㏈ BW * 2/3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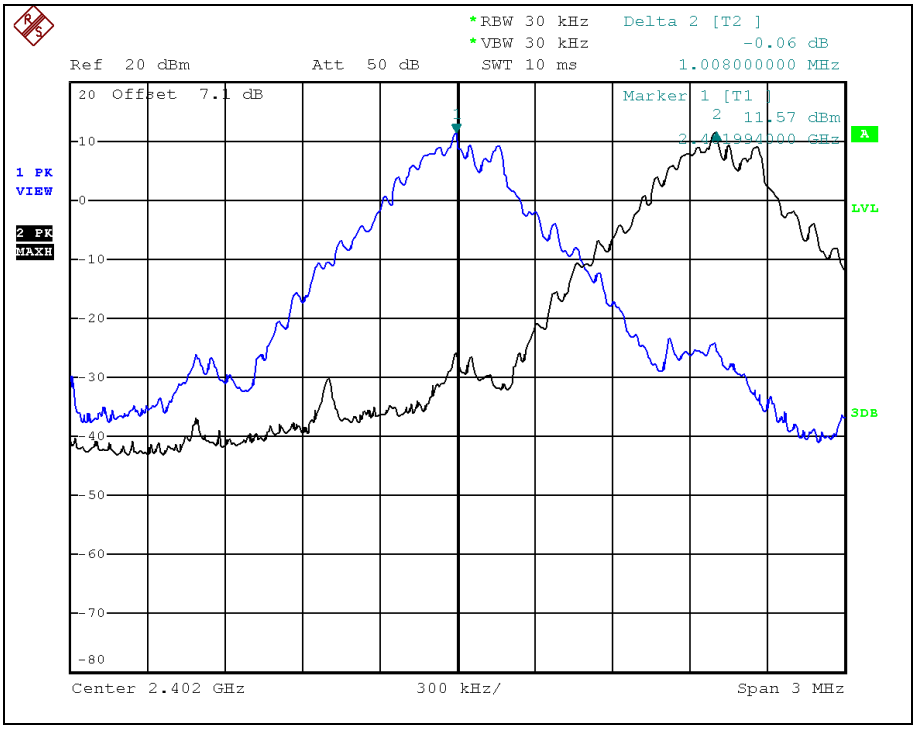
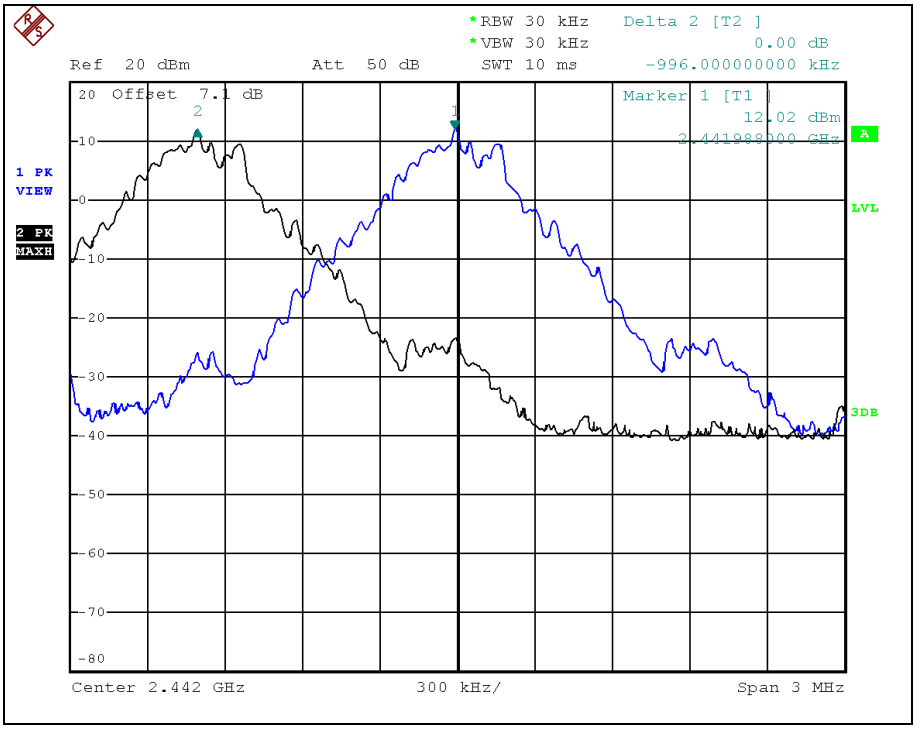
### 3.3.5.5 Test Plot

**GFSK _ Low frequency** **Carrier Frequency Separation**




**GFSK _ Middle frequency** **Carrier Frequency Separation**



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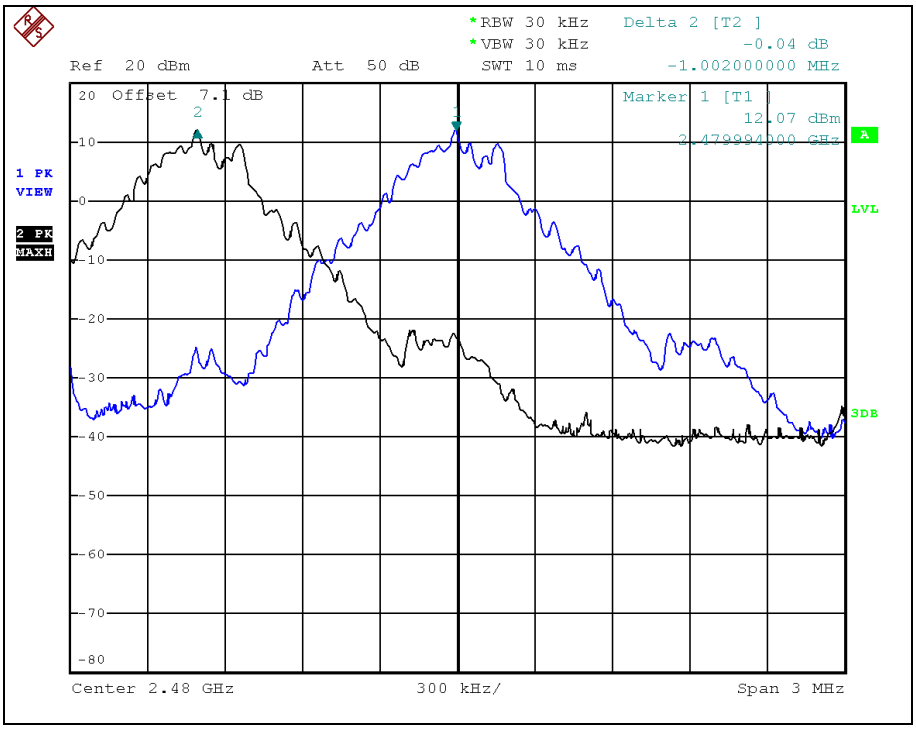
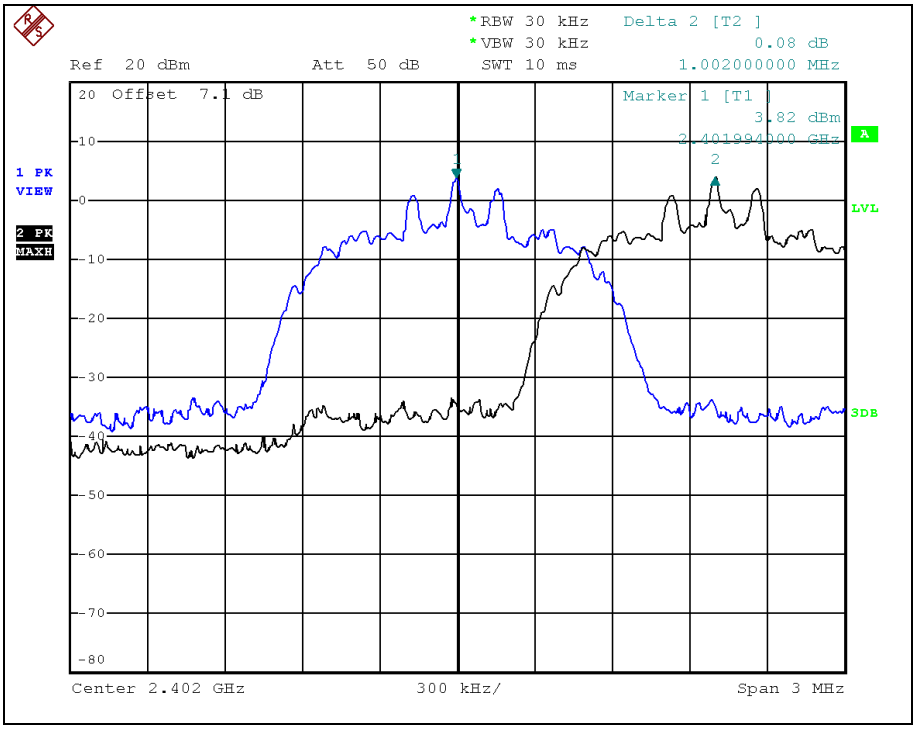
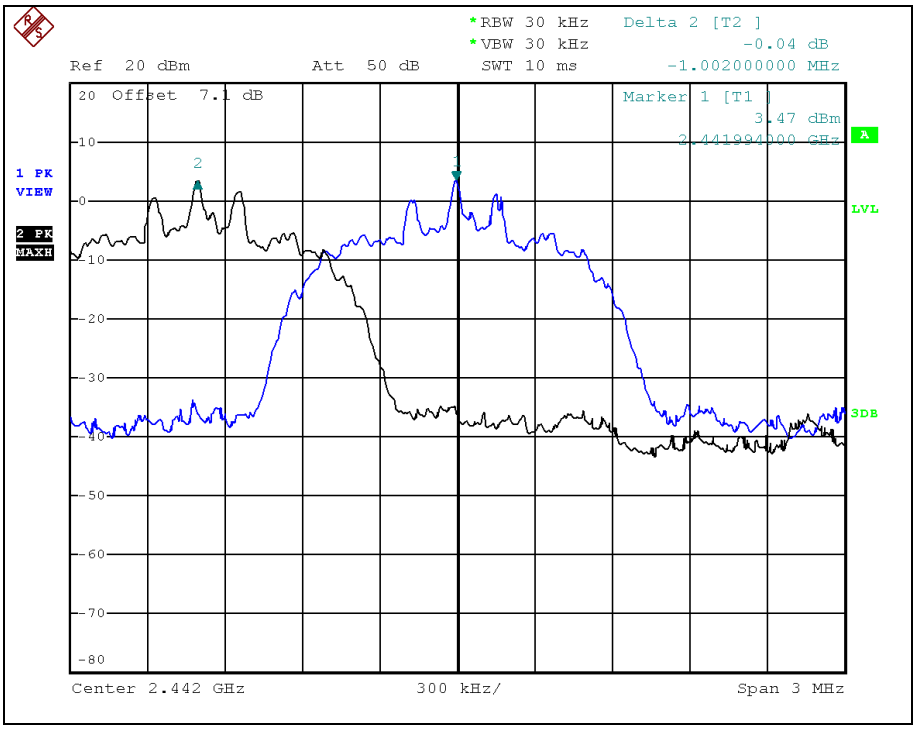
**GFSK _ High frequency** **Carrier Frequency Separation**



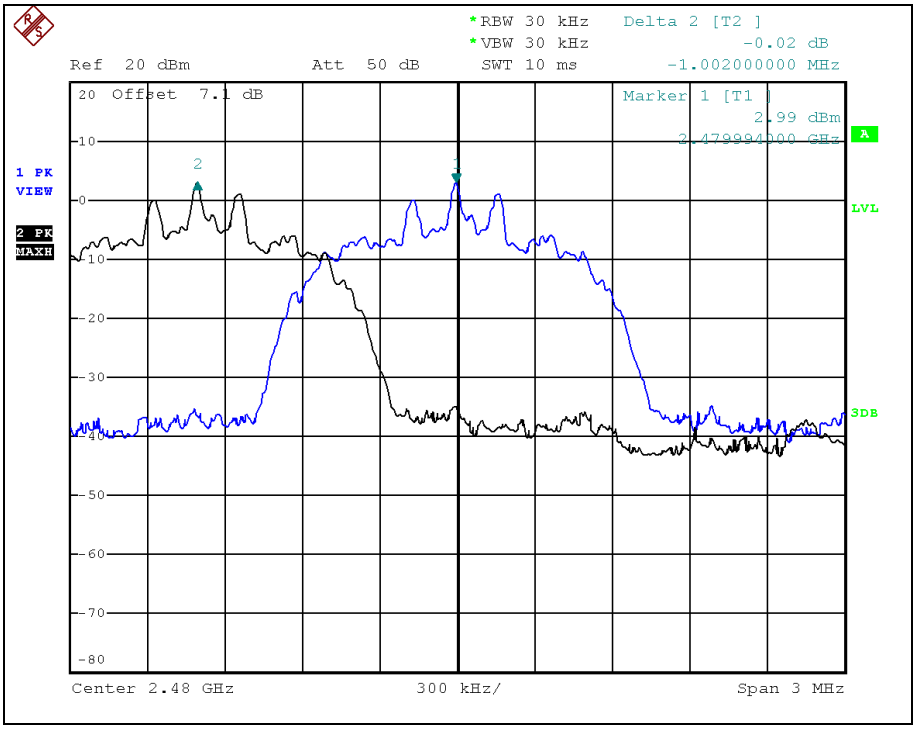

**8DPSK _ Low frequency** **Carrier Frequency Separation**



**8DPSK _ Middle frequency** **Carrier Frequency Separation**




**8DPSK _ High frequency** **Carrier Frequency Separation**



## 3.3.6 Peak Output Power

### 3.3.6.1 Test Setup

Refer to the APPENDIX I.

### 3.3.6.2 Limit

The maximum peak output power of the intentional radiator shall not exceed the following:

1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-thirds of the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.
2. §15.247(b)(1), For frequency hopping systems operating in the 2400 – 2483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725 – 5805 ㎒ band: 1 Watt. For all other frequency hopping systems in the 2400-2483.5 ㎒ band: 0.125 watts.

### 3.3.6.3 Test Procedure

1. The RF output power was measured with a spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, a spectrum analyzer was used to record the shape of the transmit signal.
2. The peak output power of the fundamental frequency was measured with the spectrum analyzer using;
   Span = approximately 5 times of the 20 ㏈ bandwidth, centered on a hopping channel
   RBW ≥ 20 ㏈ BW
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold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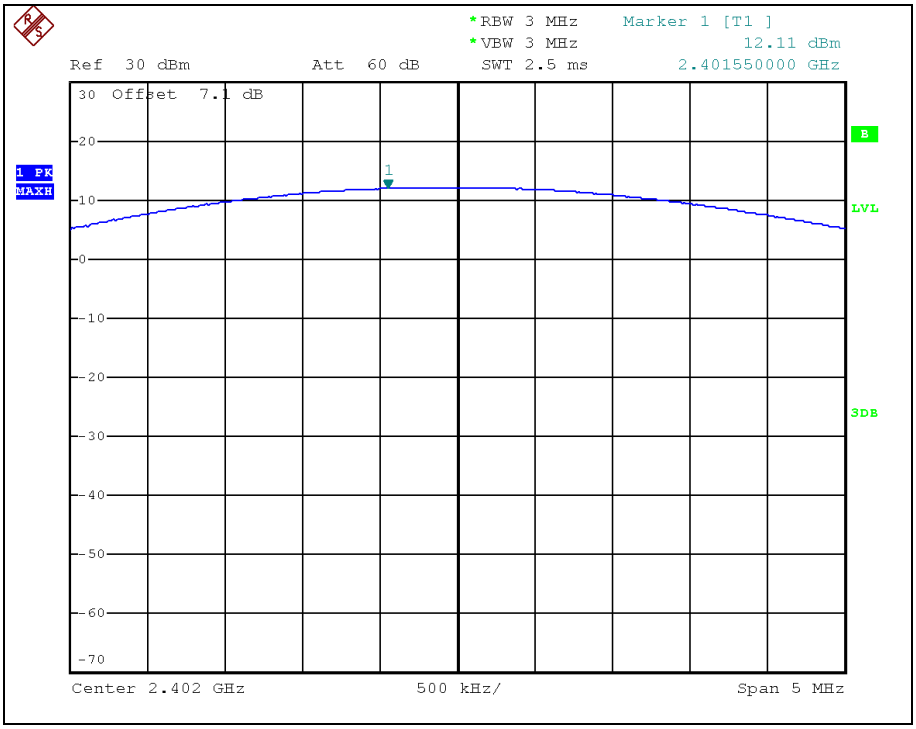
### 3.3.6.4 Test Result

| Test Mode | Test Frequency | Peak Output Power | | Frame Average Power | |
|---|---|---|---|---|---|
| | | dBm | mW | dBm | mW |
| GFSK | Low | 12.11 | 16.26 | 11.67 | 14.69 |
| | Middle | 12.37 | 17.26 | 11.92 | 15.56 |
| | High | **12.94** | **19.68** | 12.23 | 16.71 |
| Pi/4 DQPSK | Low | 4.26 | 2.67 | 2.87 | 1.94 |
| | Middle | 3.77 | 2.38 | 2.20 | 1.66 |
| | High | 3.58 | 2.28 | 2.05 | 1.60 |
| 8DPSK | Low | 4.64 | 2.91 | 2.96 | 1.98 |
| | Middle | 4.22 | 2.64 | 2.29 | 1.69 |
| | High | 4.08 | 2.56 | 2.15 | 1.64 |

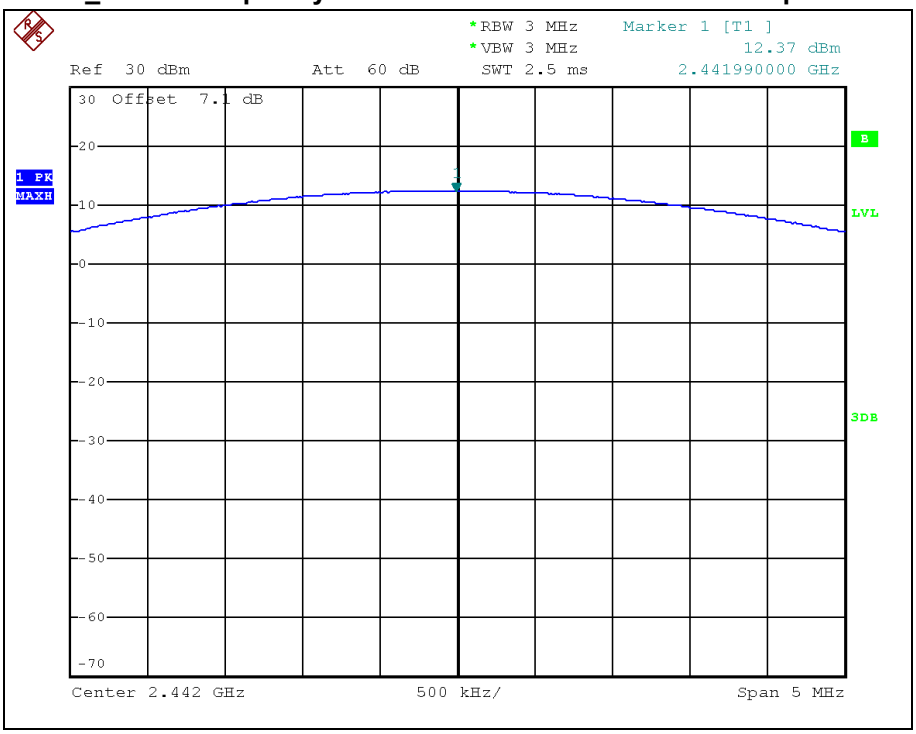
Note1: Frame Average Power was tested using an average power meter for reference only.

### 3.3.6.5 Test Plot

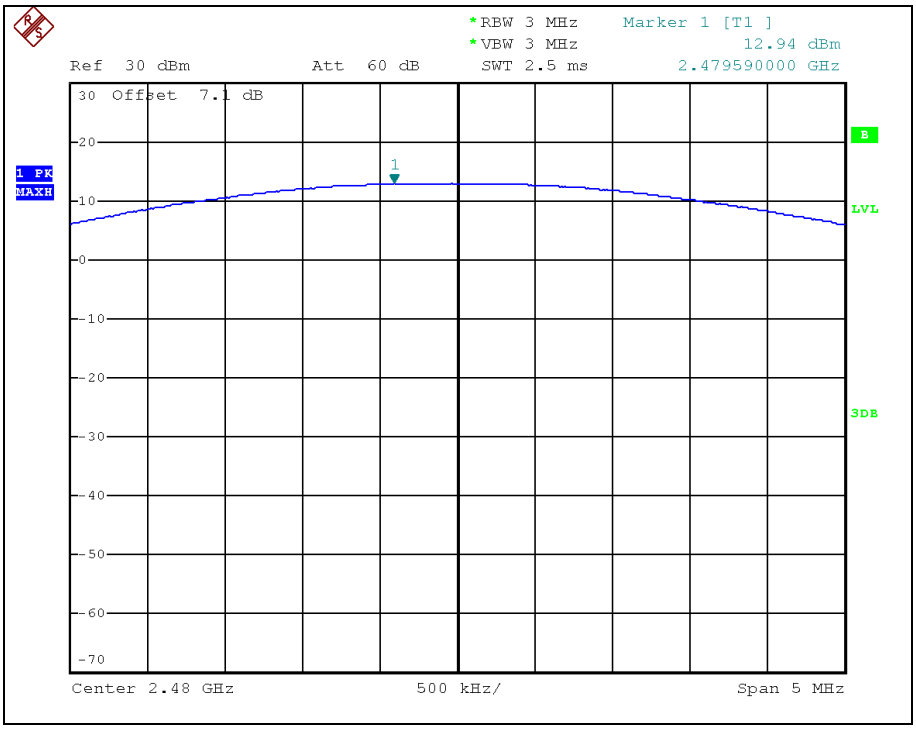
**GFSK _ Low frequency** **Peak Output Power**



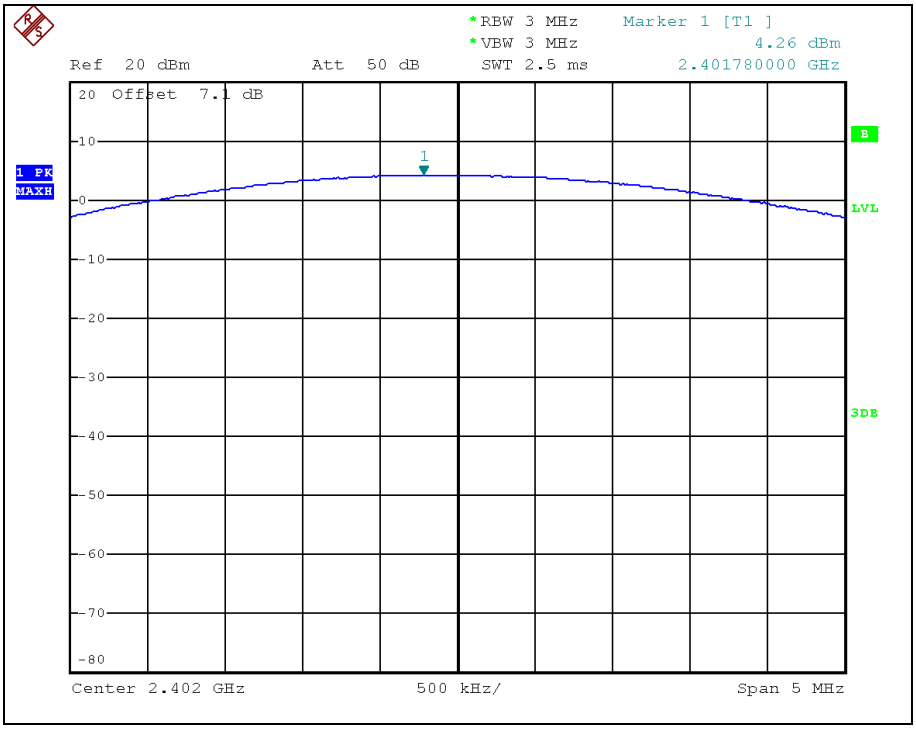

**GFSK _ Middle frequency** **Peak Output Power**



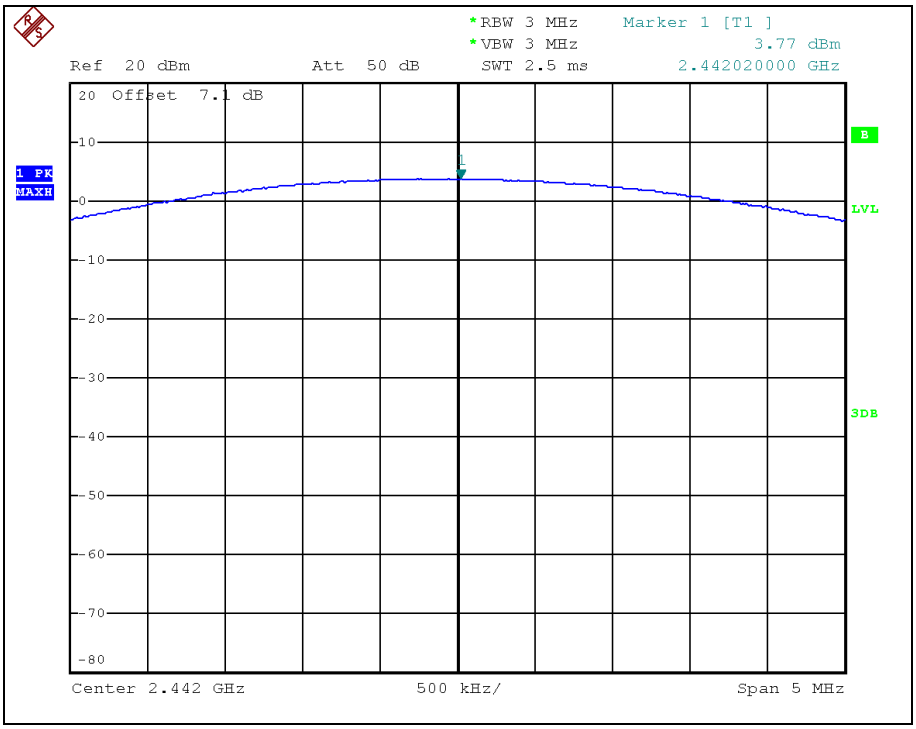
**GFSK _ High frequency** **Peak Output Power**



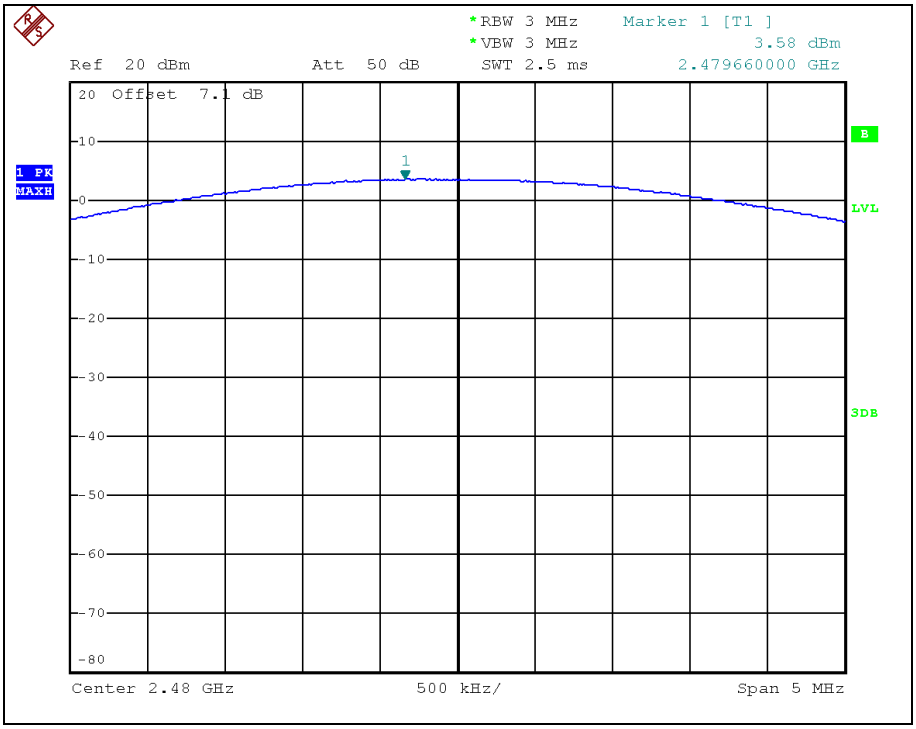

**Pi/4 DQPSK _ Low frequency** **Peak Output Power**



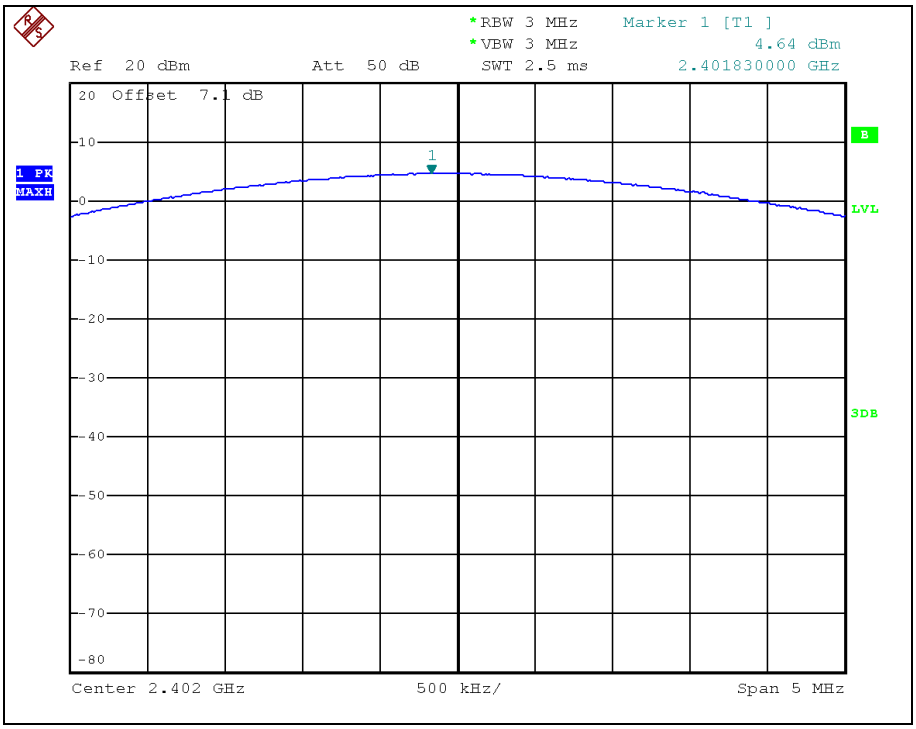
**Pi/4 DQPSK _ Middle frequency** **Peak Output Power**



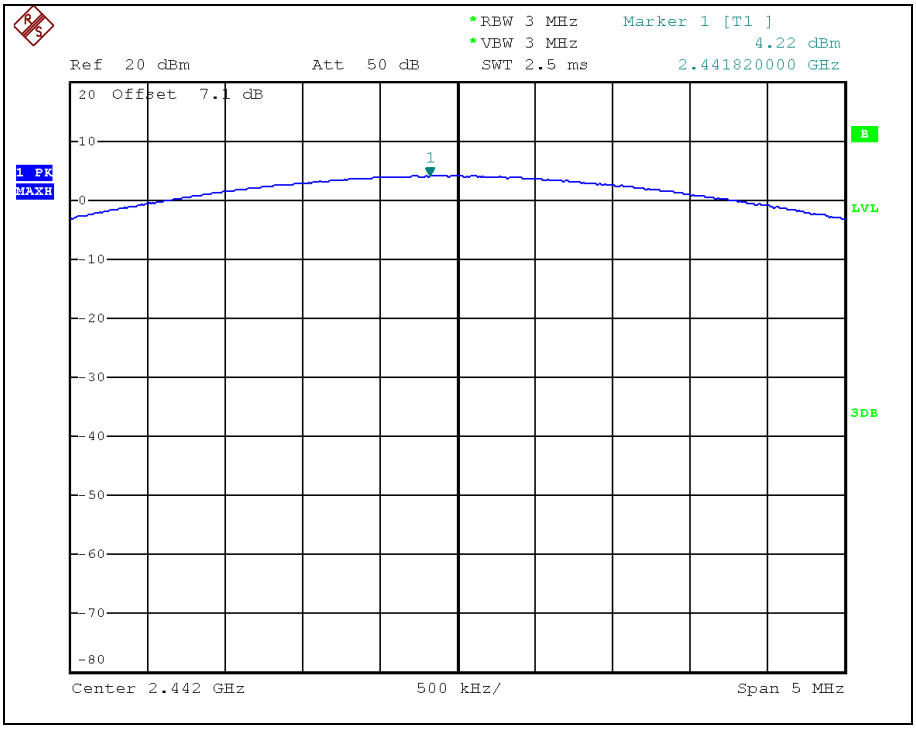

**Pi/4 DQPSK _ High frequency** **Peak Output Power**



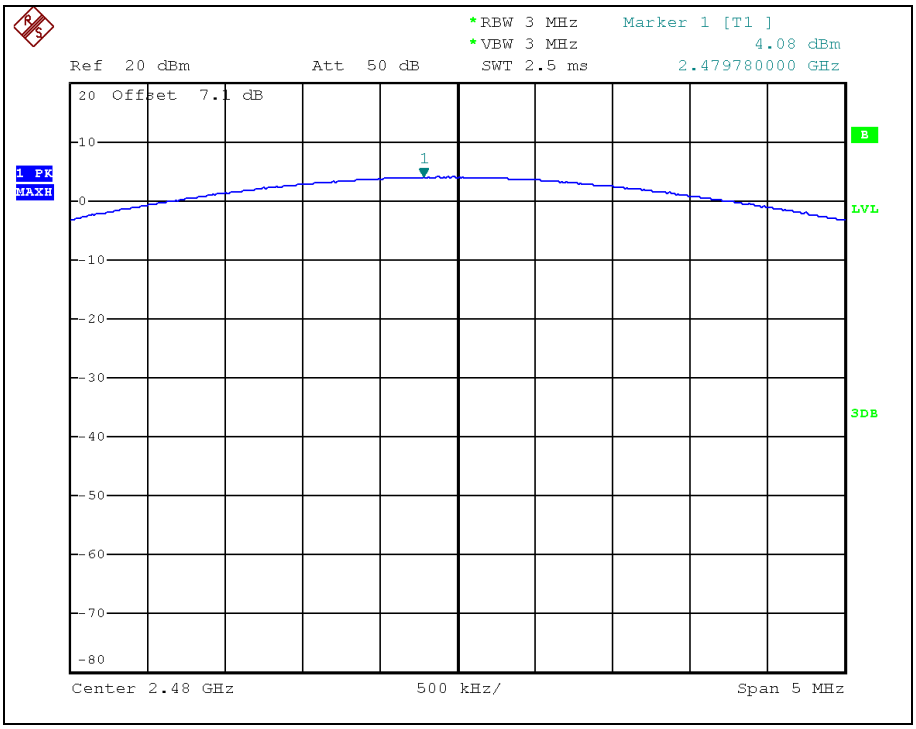
**8DPSK _ Low frequency** **Peak Output Power**




**8DPSK _ Middle frequency** **Peak Output Power**



**8DPSK _ High frequency** **Peak Output Power**



## 3.3.7 TX Radiated Spurious Emission and Conducted Spurious Emission

### 3.3.7.1 Test Setup

Refer to the APPENDIX I.

### 3.3.7.2 Limit

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

According to § 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 (㎒) | Limit (uV/m) | Measurement Distance (meter) |
|---|---|---|
| 0.009 ~ 0.490 | 2400/F (㎑) | 300 |
| 0.490 ~ 1705 | 24000/F (㎑) | 30 |
| 1705 ~ 30.0 | 30 | 30 |
| 30 ~ 88 | 100 ** | 3 |
| 88 ~ 216 | 150 ** | 3 |
| 216 ~ 960 | 200 ** | 3 |
| Above 960 | 500 | 3 |

** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 - 72 ㎒, 76 - 88 ㎒, 174 - 216 ㎒ or 470 – 806 ㎒. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

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

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.009 ~ 0.110 | 16.42 ~ 16.423 | 399.90 ~ 410 | 4.5 ~ 5.15 |
| 0.495 ~ 0.505 | 16.69475 ~ 16.69525 | 608 ~ 614 | 5.35 ~ 5.46 |
| 2.1735 ~ 2.1905 | 16.80425 ~ 16.80475 | 960 ~ 1240 | 7.25 ~ 7.75 |
| 4.125 ~ 4.128 | 25.5 ~ 25.67 | 1300 ~ 1427 | 8.025 ~ 8.5 |
| 4.17725 ~ 4.17775 | 37.5 ~ 38. | 1435 ~ 1626.5 | 9.0 ~ 9.2 |
| 4.20725 ~ 4.20775 | 25 73 ~ 74.6 | 1645.5 ~ 1646.5 | 9.3 ~ 9.5 |
| 4.17725 ~ 4.17775 | 74.8 ~ 75.2 | 1660 ~ 1710 | 10.6 ~ 12.7 |
| 6.215 ~ 6.218 | 108 ~ 121.94 | 1718.8 ~ 1722.2 | 13.25 ~ 13.4 |
| 6.26775 ~ 6.26825 | 149.9 ~ 150.05 | 2200 ~ 2300 | 14.47 ~ 14.5 |
| 6.31175 ~ 6.31225 | 156.52475 ~ 156.52525 | 2310 ~ 2390 | 15.35 ~ 16.2 |
| 8.291 ~ 8.294 | 156.7 ~ 156.9 | 2483.5 ~ 2500 | 17.7 ~ 21.4 |
| 8.362 ~ 8.366 | 162.0125 ~ 167.17 | 2690 ~ 2900 | 22.01 ~ 23.12 |
| 8.37625 ~ 8.38675 | 3345.8 ~ 3358 | 3260 ~ 3267 | 23.6 ~ 24.0 |
| 8.41425 ~ 8.41475 | 3600 ~ 4400 | 3332 ~ 3339 | 31.2 ~ 31.8 |
| 12.51975 ~ 12.52025 | 3345.8 ~ 3358 | 240 ~ 285 | 36.43 ~ 36.5 |
| 12.57675 ~ 12.57725 | 3600 ~ 4400 | 322 ~ 335.4 | Above 38.6 |
| 13.36 ~ 13.41 | | | |

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 ㎒, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 ㎒, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

### 3.3.7.3 Test Procedure for Radiated Spurious Emission

1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 ㎓, the table height is 80 cm. For emission measurements above 1 ㎓, the table height is 1.5 m. The table was rotated 360 degrees to determine the position of the highest radiation.

2. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 1 or 3 meter away from the interference-receiving antenna.

3. For measurements above 1㎓ absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1 ㎓, the absorbers are removed.

4. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

5. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.

6. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

7. If the emission level of the EUT in peak mode was 10 ㏈ lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 ㏈ margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

**Measurement Instrument Setting**

1. Frequency Range: Below 1㎓
   RBW = 100 or 120 ㎑, VBW = 3 x RBW, Detector = Peak or Quasi Peak

2. Frequency Range: Above 1 ㎓

   Peak Measurement
   RBW = 1 ㎒, VBW = 3 ㎒, Detector = Peak, Sweep time = Auto,
   Trace mode = Max Hold until the trace stabilizes

   Average Measurement
   RBW = 1㎒, VBW ≥ 1/T, Detector = Peak, Sweep Time = Auto,
   Trace Mode = Max Hold until the trace stabilizes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### 3.3.7.4 Test Procedure for Conducted Spurious Emission

1. The transmitter output was connected to the spectrum analyzer.

2. The reference level of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 ㎑, VBW = 300 ㎑.

3. The conducted spurious emission was tested each ranges were set as below.
   Frequency range: 30 ㎒ ~ 26.5 ㎓
   RBW = 1 ㎒, VBW = 3 ㎒, SWEEP TIME = AUTO, DETECTOR = PEAK,
   TRACE = MAX HOLD

   LIMIT LINE = 20 ㏈ below of the reference level of above measurement procedure Step 2. (RBW = 100 ㎑, VBW = 300 ㎑)



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### 3.3.7.5 Test Result

**9 ㎑ ~ 25 ㎓ Data (Modulation: GFSK)**

- Low frequency

| Frequency | Reading | | Pol. | Factor | DCCF | Limits | | Result | | Margin | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (dB uV/m) | | | (dB) | (dB) | (dB uV/m) | | (dB uV/m) | | (dB) | |
| (㎒) | AV / Peak | | | | | AV / Peak | | AV / Peak | | AV / Peak | |
| 4 804.00 | N/A | 56.19 | H | -9.0 | -24.67 | 54.0 | 74.0 | 22.5 | 47.2 | 31.5 | 26.8 |
| 7 206.00 | N/A | 50.79 | V | -0.5 | -24.67 | 54.0 | 74.0 | 25.6 | 50.3 | 28.4 | 23.7 |
| 9 608.00 | N/A | 53.42 | V | 0.7 | -24.67 | 54.0 | 74.0 | 29.5 | 54.1 | 24.5 | 19.9 |

- Middle frequency

| Frequency | Reading | | Pol. | Factor | DCCF | Limits | | Result | | Margin | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (dB uV/m) | | | (dB) | (dB) | (dB uV/m) | | (dB uV/m) | | (dB) | |
| (㎒) | AV / Peak | | | | | AV / Peak | | AV / Peak | | AV / Peak | |
| 4 884.00 | N/A | 57.16 | H | -8.9 | -24.67 | 54.0 | 74.0 | 23.6 | 48.3 | 30.4 | 25.7 |
| 7 326.00 | N/A | 51.06 | V | -0.4 | -24.67 | 54.0 | 74.0 | 26.0 | 50.6 | 28.0 | 23.4 |
| 9 768.00 | N/A | 57.53 | V | 1.2 | -24.67 | 54.0 | 74.0 | 34.0 | 58.7 | 20.0 | 15.3 |

- High frequency

| Frequency | Reading | | Pol. | Factor | DCCF | Limits | | Result | | Margin | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (dB uV/m) | | | (dB) | (dB) | (dB uV/m) | | (dB uV/m) | | (dB) | |
| (㎒) | AV / Peak | | | | | AV / Peak | | AV / Peak | | AV / Peak | |
| 4 960.00 | N/A | 58.12 | H | -9.0 | -24.67 | 54.0 | 74.0 | 24.5 | 49.1 | 29.5 | 24.9 |
| 7 440.00 | N/A | 51.34 | V | -0.1 | -24.67 | 54.0 | 74.0 | 26.5 | 51.2 | 27.5 | 22.8 |
| 9 920.00 | N/A | 58.83 | V | 1.4 | -24.67 | 54.0 | 74.0 | 35.5 | 60.2 | 18.5 | 13.8 |

Note 1: The radiated emissions were inverstigated 9 ㎑ to 25 ㎓. And no other spurious and harmonic emissions were found above listed frequencies.
Note 2: DCCF(Duty Cycle Correction Factor)
- Time to cycle through all channels = Δt = T [ms] X 20 minimum hopping channels, where T = pulse width = 2.92 ms
- 100 ms / Δt [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / ( 2.92 X 20 ) = 1.71 ≒ 2
- The Worst Case Dwell Time = T [ms] x H' = 2.92 ms X 2 = 5.84 ms
- DCCF = 20 x log(The Worst Case Dwell Time / 100 ms) ㏈ = 20 x log( 5.84 / 100 ) = -24.67 ㏈

Note 3: Sample Calculation.
Margin = Limit – Result / Peak Result = Peak Reading + TF / Average Result = Peak Reading + TF + DCCF
TF = Ant factor + Cable Loss + Filter Loss – Amp Gain

**9 ㎑ ~ 25 ㎓ Data (Modulation: 8DPSK)**

- Low frequency

| Frequency | Reading | | Pol. | Factor | DCCF | Limits | | Result | | Margin | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (dB uV/m) | | | (dB) | (dB) | (dB uV/m) | | (dB uV/m) | | (dB) | |
| (㎒) | AV / Peak | | | | | AV / Peak | | AV / Peak | | AV / Peak | |
| 4 804.00 | N/A | 52.56 | H | -9.0 | -24.67 | 54.0 | 74.0 | 18.9 | 43.6 | 35.1 | 30.4 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

- Middle frequency

| Frequency | Reading | | Pol. | Factor | DCCF | Limits | | Result | | Margin | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (dB uV/m) | | | (dB) | (dB) | (dB uV/m) | | (dB uV/m) | | (dB) | |
| (㎒) | AV / Peak | | | | | AV / Peak | | AV / Peak | | AV / Peak | |
| 4 884.00 | N/A | 51.41 | H | -8.9 | -24.67 | 54.0 | 74.0 | 17.9 | 42.5 | 36.1 | 31.5 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

- High frequency

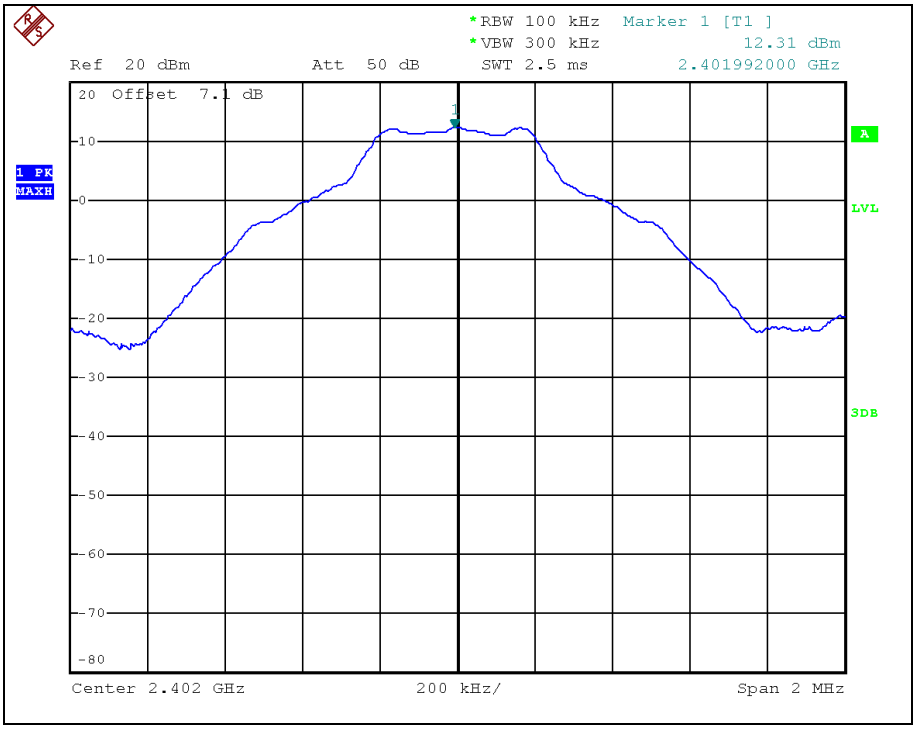
| Frequency | Reading | | Pol. | Factor | DCCF | Limits | | Result | | Margin | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (dB uV/m) | | | (dB) | (dB) | (dB uV/m) | | (dB uV/m) | | (dB) | |
| (㎒) | AV / Peak | | | | | AV / Peak | | AV / Peak | | AV / Peak | |
| 4 960.00 | N/A | 50.10 | H | -9.0 | -24.67 | 54.0 | 74.0 | 16.4 | 41.1 | 37.6 | 32.9 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Note 1: The radiated emissions were inverstigated 9 ㎑ to 25 ㎓. And no other spurious and harmonic emissions were found above listed frequencies.
Note 2: DCCF(Duty Cycle Correction Factor)
- Time to cycle through all channels = ∆t = T [ms] X 20 minimum hopping channels, where T = pulse width = 2.92 ms
- 100 ms / ∆t [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / ( 2.92 X 20 ) = 1.71 ≒ 2
- The Worst Case Dwell Time = T [ms] x H' = 2.92 ms X 2 = 5.84 ms
- DCCF = 20 x log(The Worst Case Dwell Time / 100 ms) ㏈ = 20 x log( 5.84 / 100 ) = -24.67 ㏈

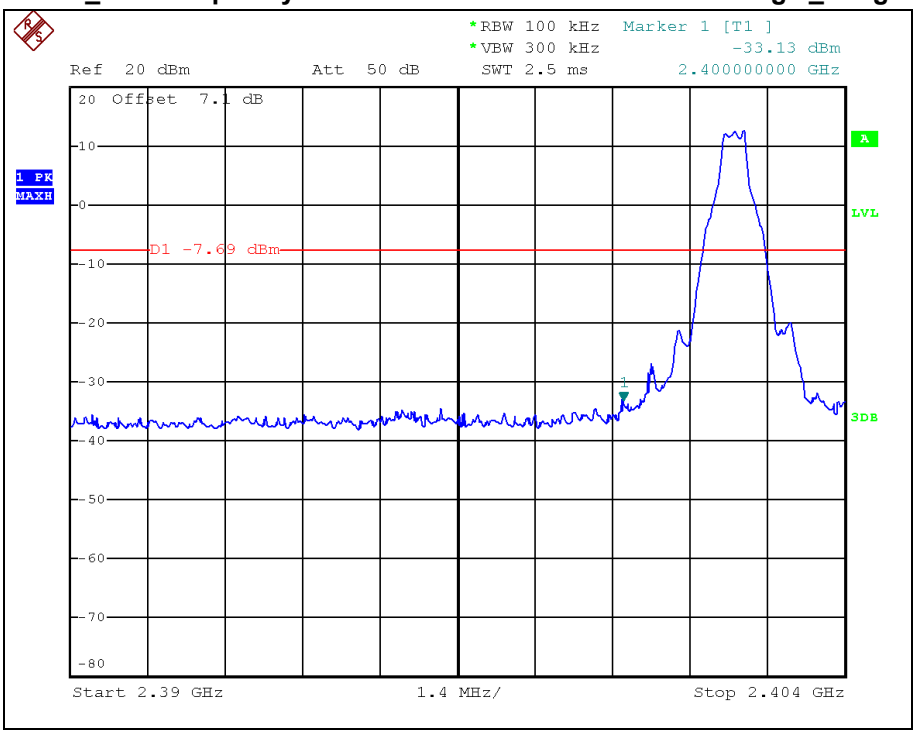
Note 3: Sample Calculation.
Margin = Limit – Result / Peak Result = Peak Reading + TF / Average Result = Peak Reading + TF + DCCF
TF = Ant factor + Cable Loss + Filter Loss – Amp Gain

### 3.3.7.6 Test Plot for Conducted Spurious Emission

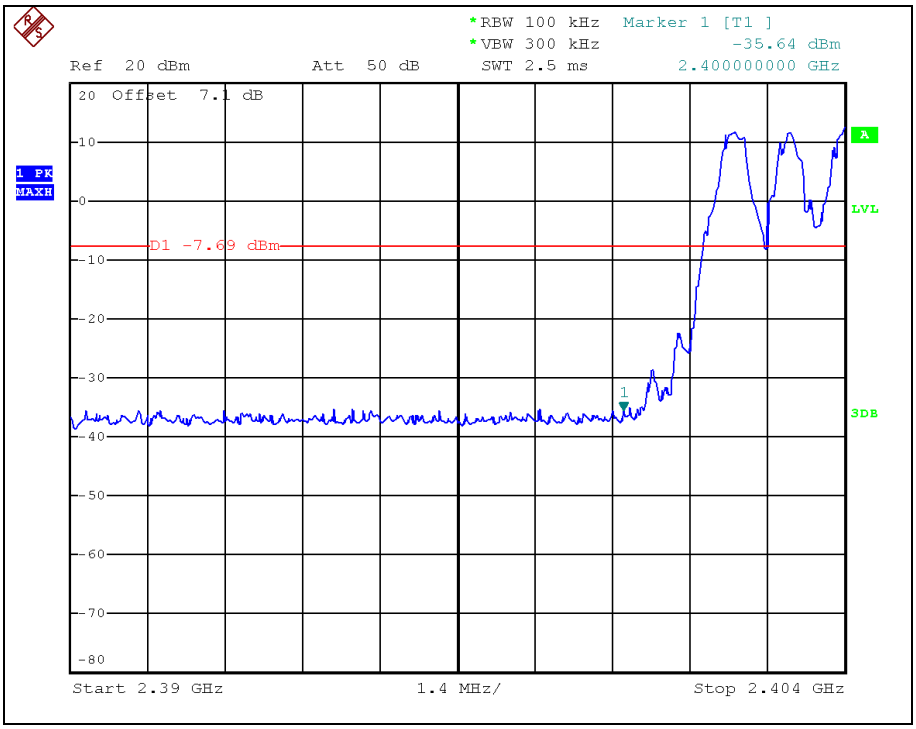
**GFSK _ Low frequency** **Reference**



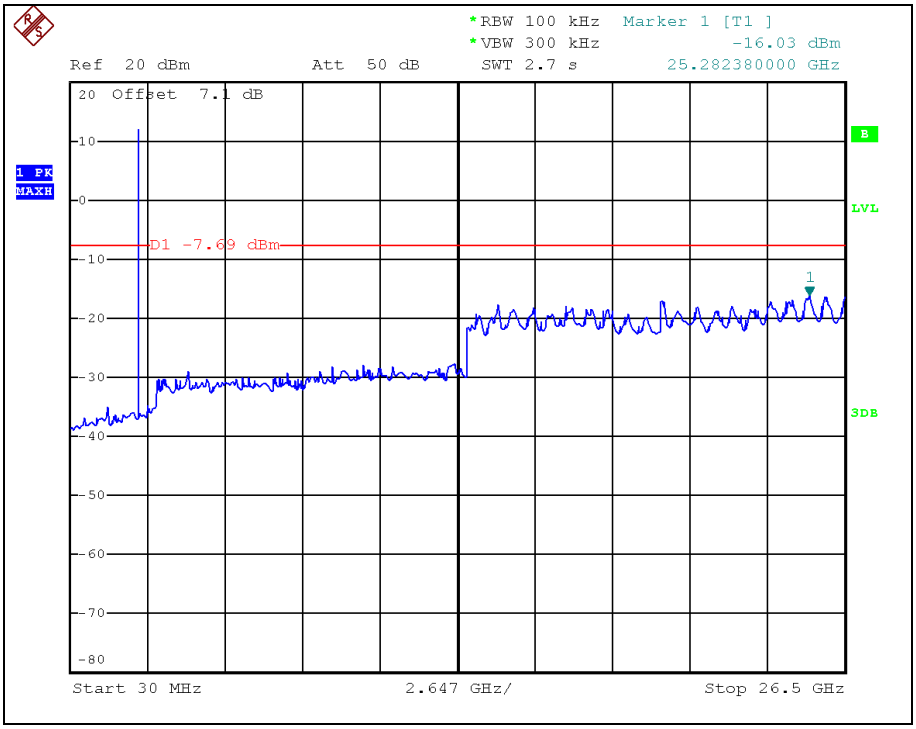

**GFSK _ Low frequency** **Bandedge _ Single**



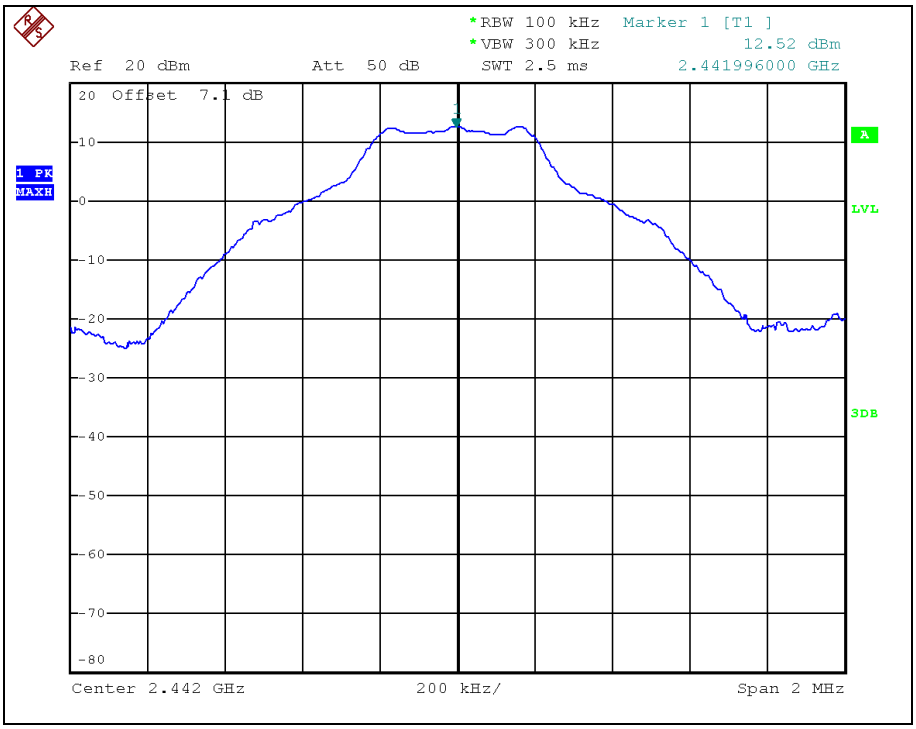
**GFSK _ Low frequency** **Bandedge _ Hopping**



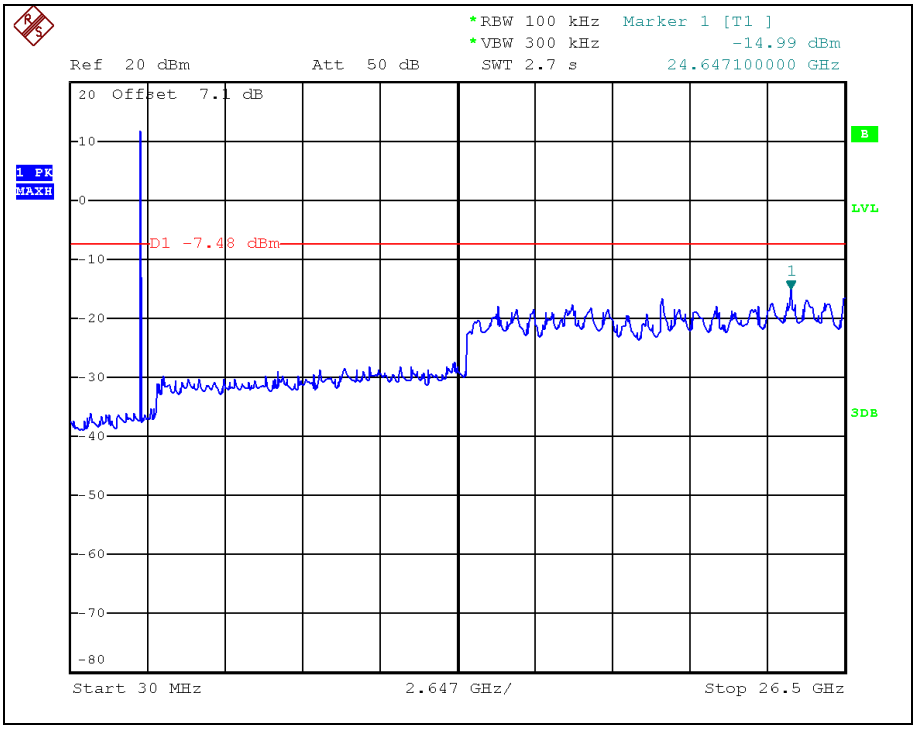

**GFSK _ Low frequency** **Spurious**



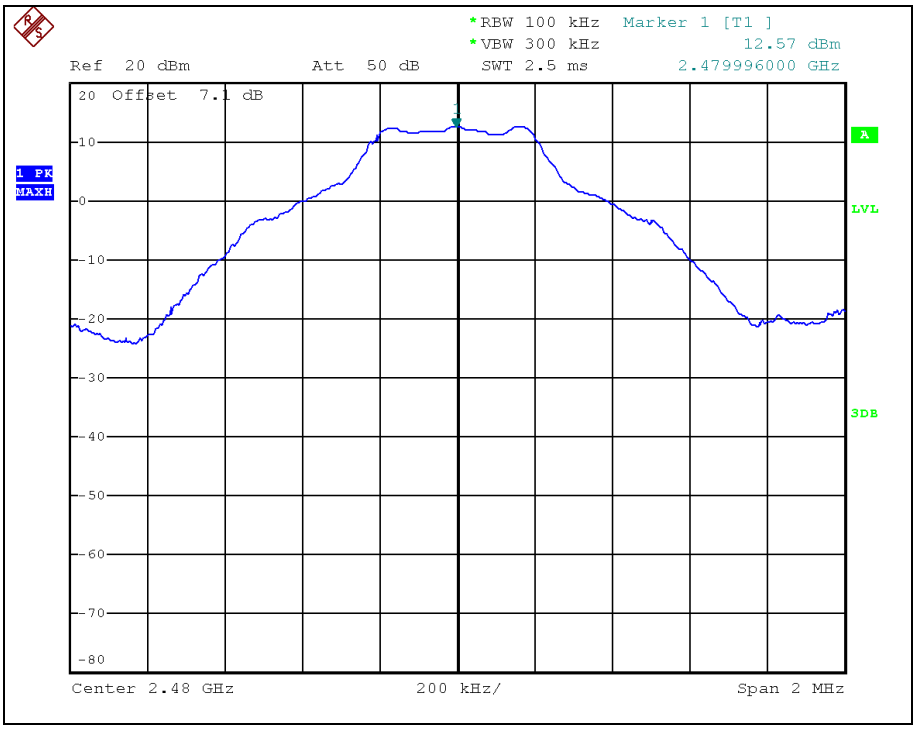
**GFSK _ Middle frequency** **Reference**



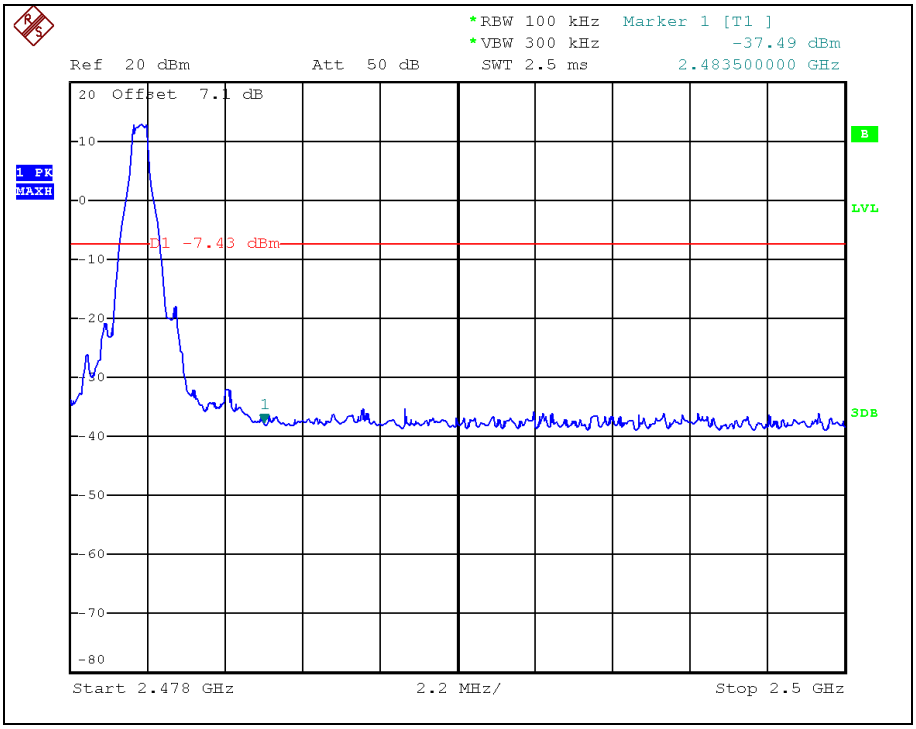

**GFSK _ Middle frequency** **Spurious**



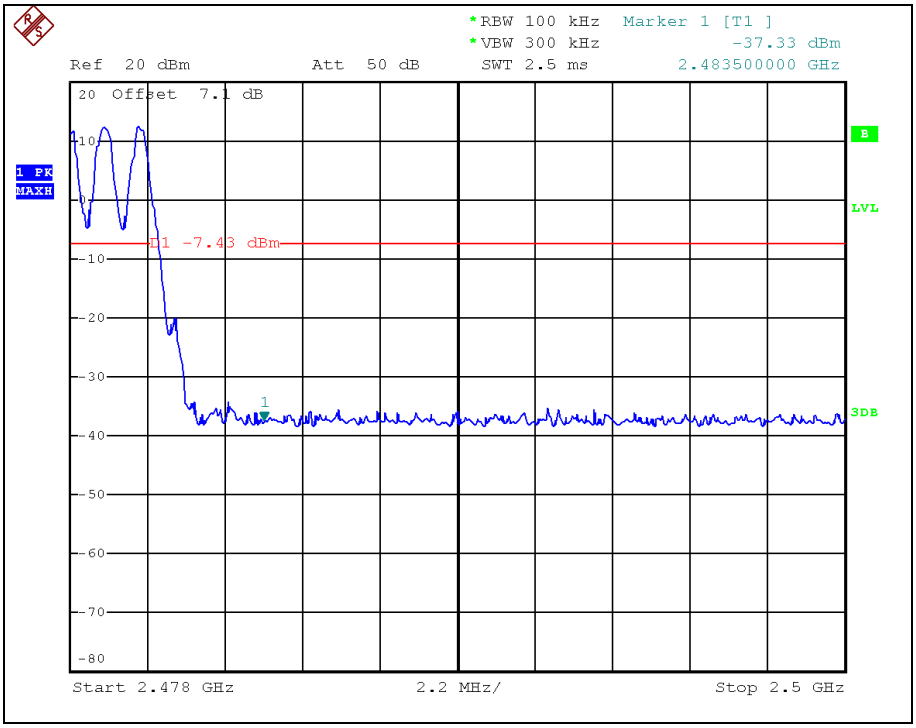
**GFSK _ High frequency** **Reference**



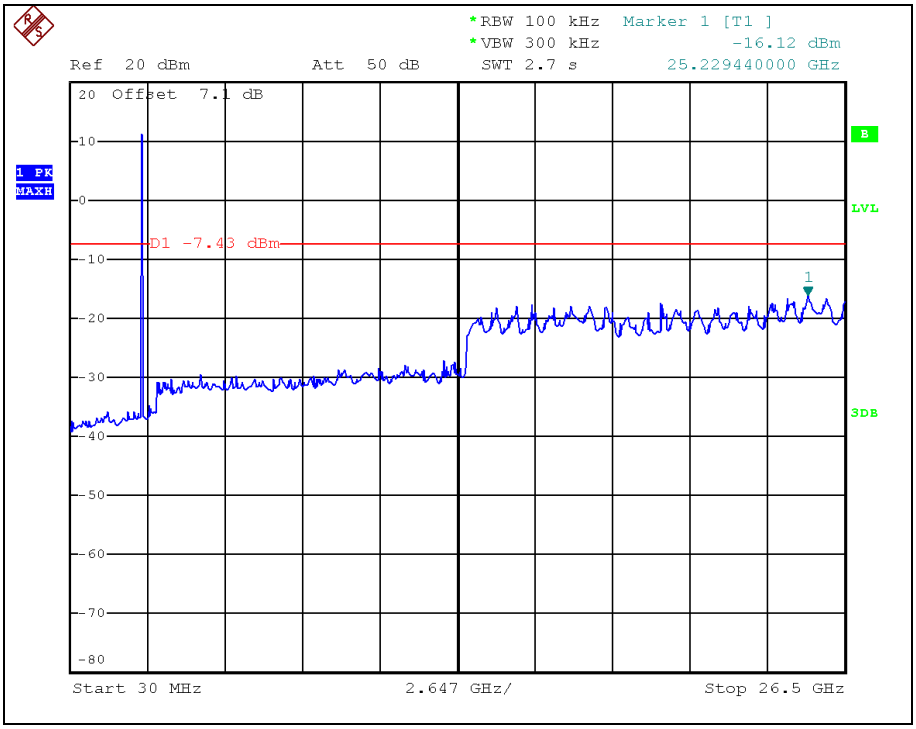

**GFSK _ High frequency** **Bandedge _ Single**



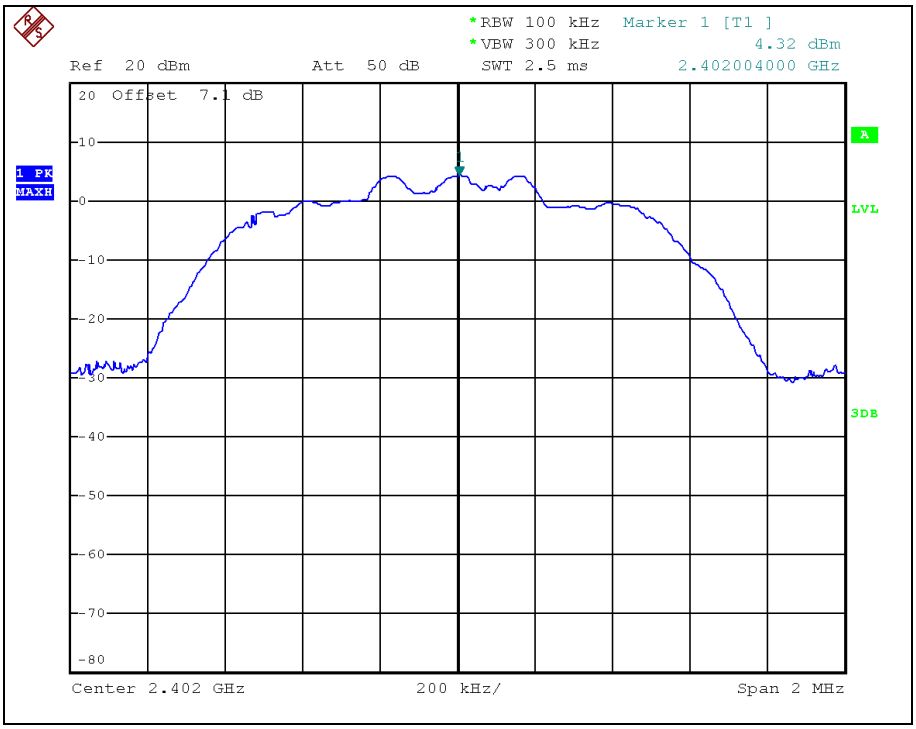
**GFSK _ High frequency** **Bandedge _ Hopping**



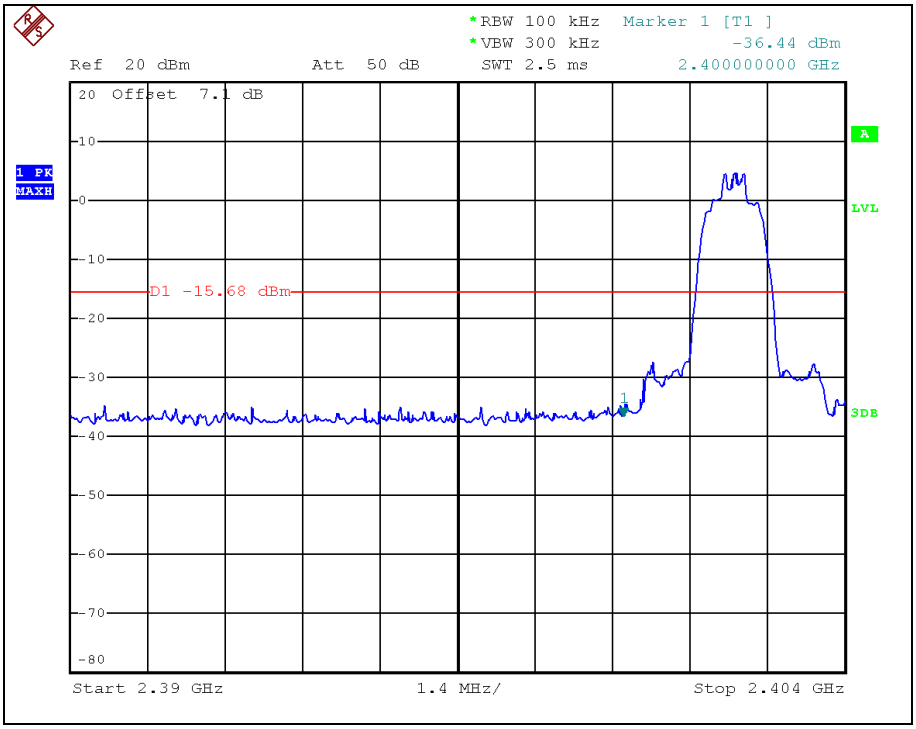

**GFSK _ High frequency** **Spurious**



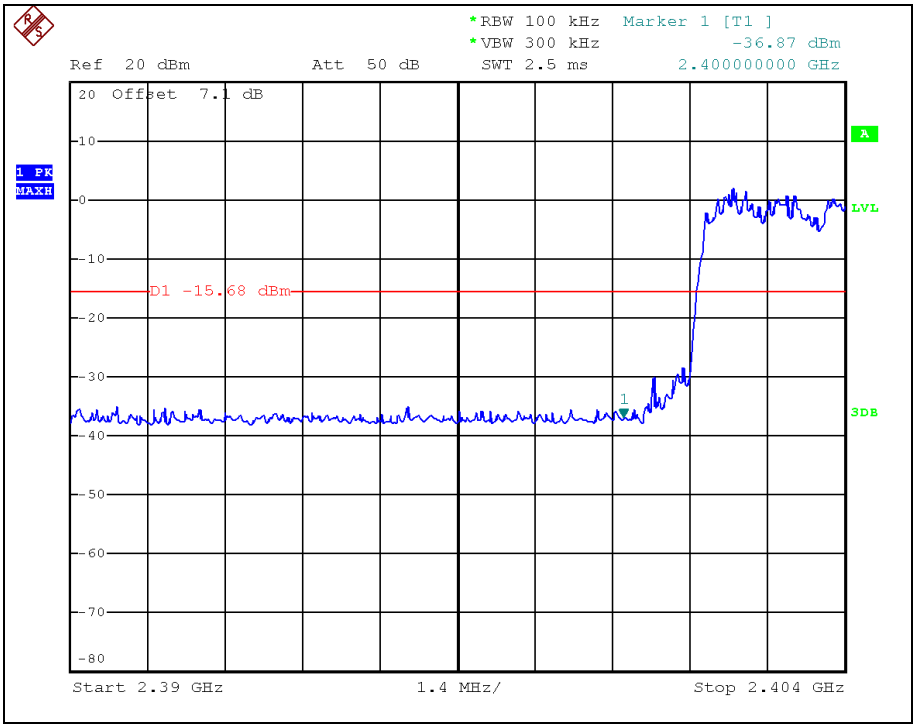
**8DPSK _ Low frequency** **Reference**



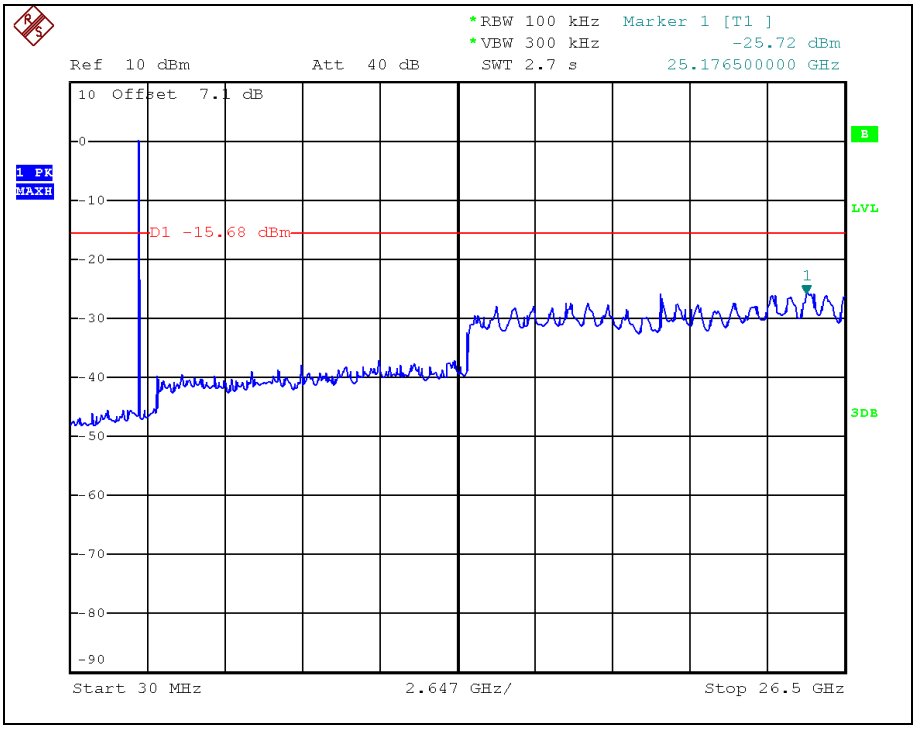

**8DPSK _ Low frequency** **Bandedge _ Single**



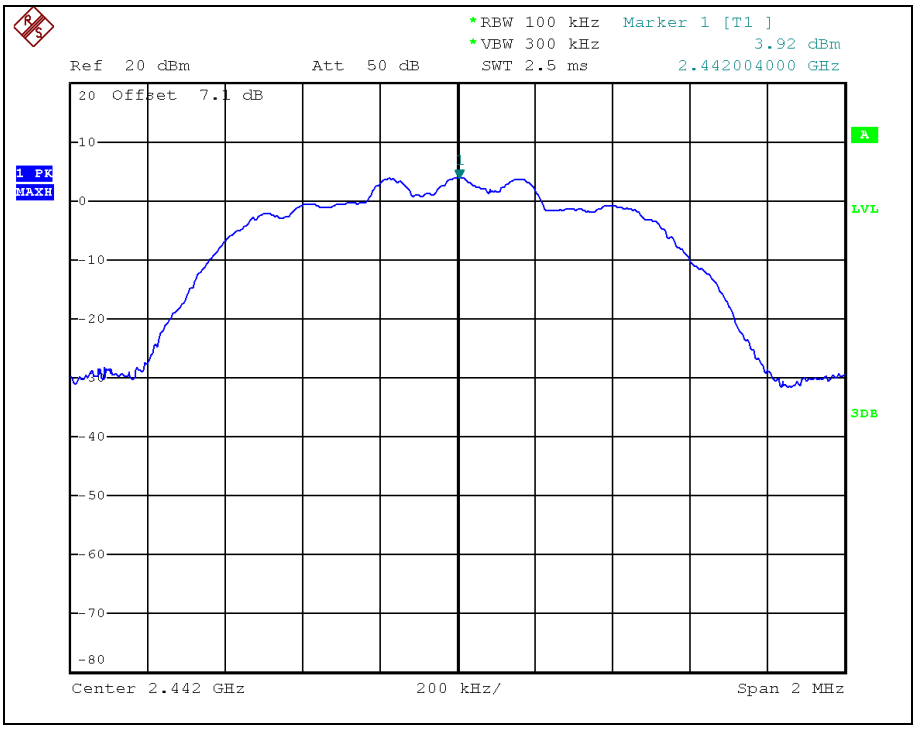
**8DPSK _ Low frequency** **Bandedge _ Hopping**



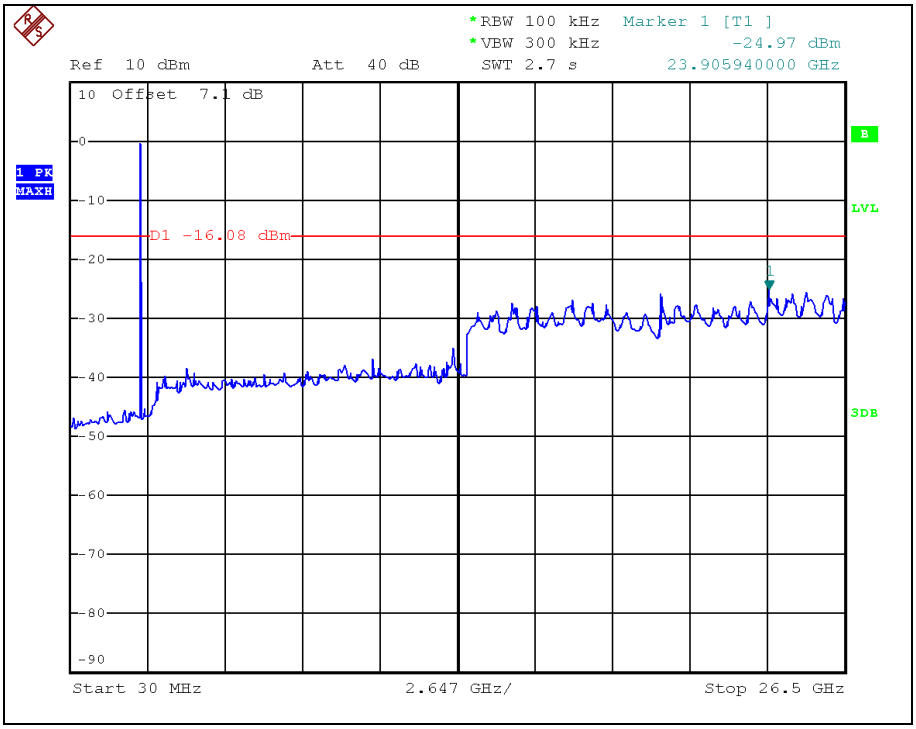

**8DPSK _ Low frequency** **Spurious**



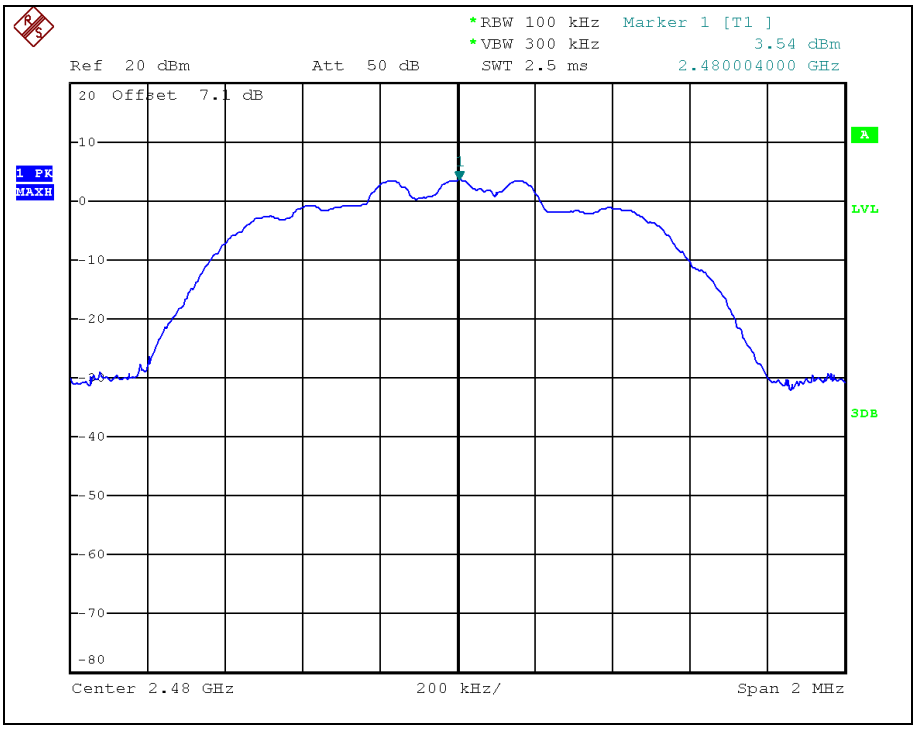
**8DPSK _ Middle frequency** **Reference**



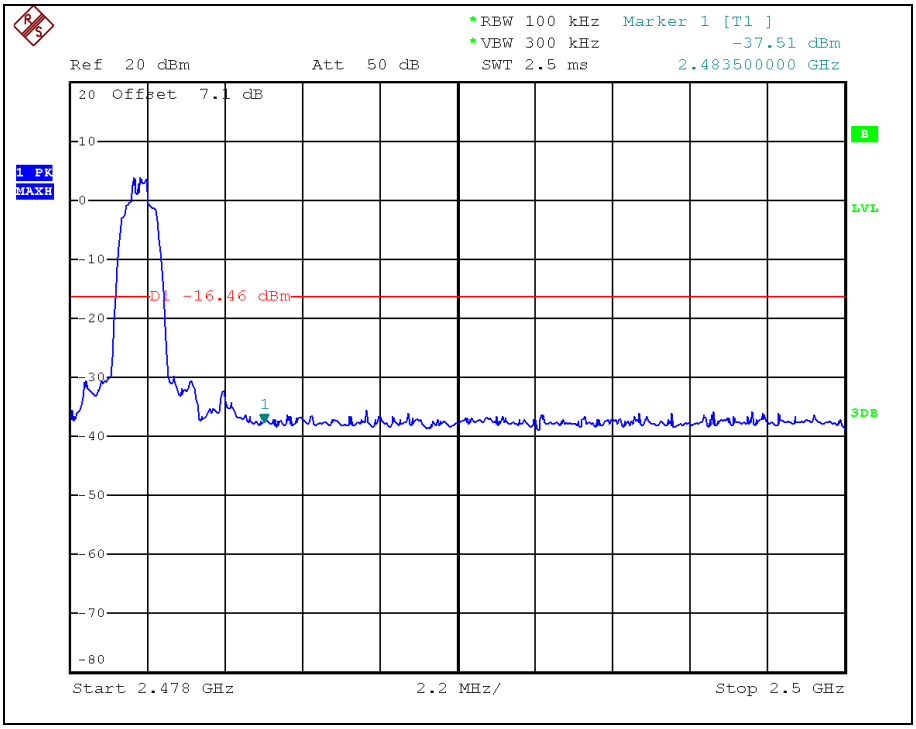

**8DPSK _ Middle frequency** **Spurious**



**8DPSK _ High frequency** **Reference**




**8DPSK _ High frequency** **Bandedge _ Single**



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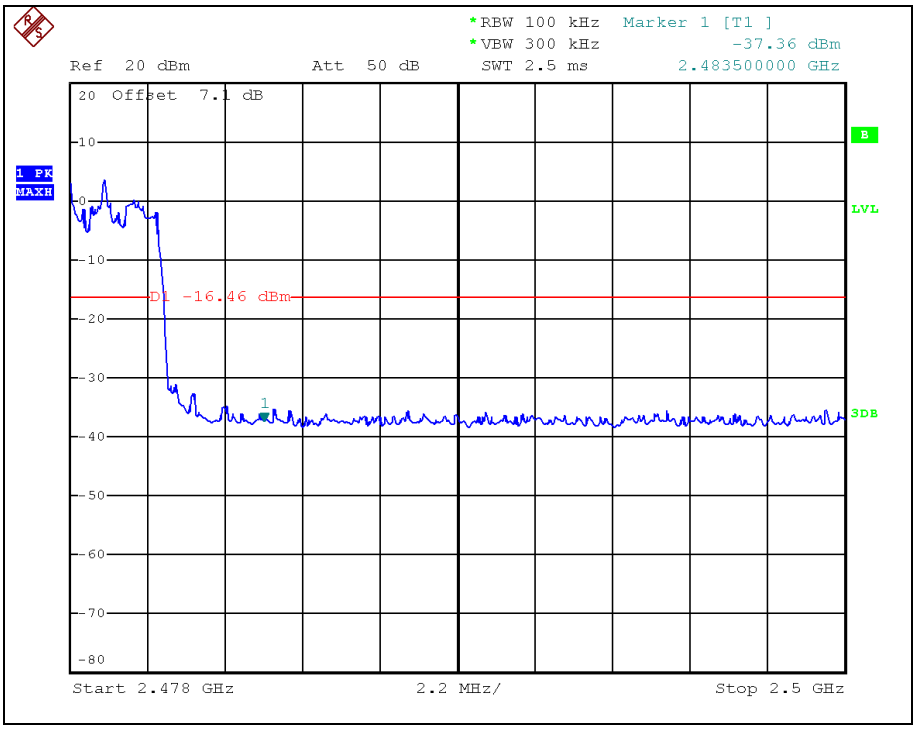
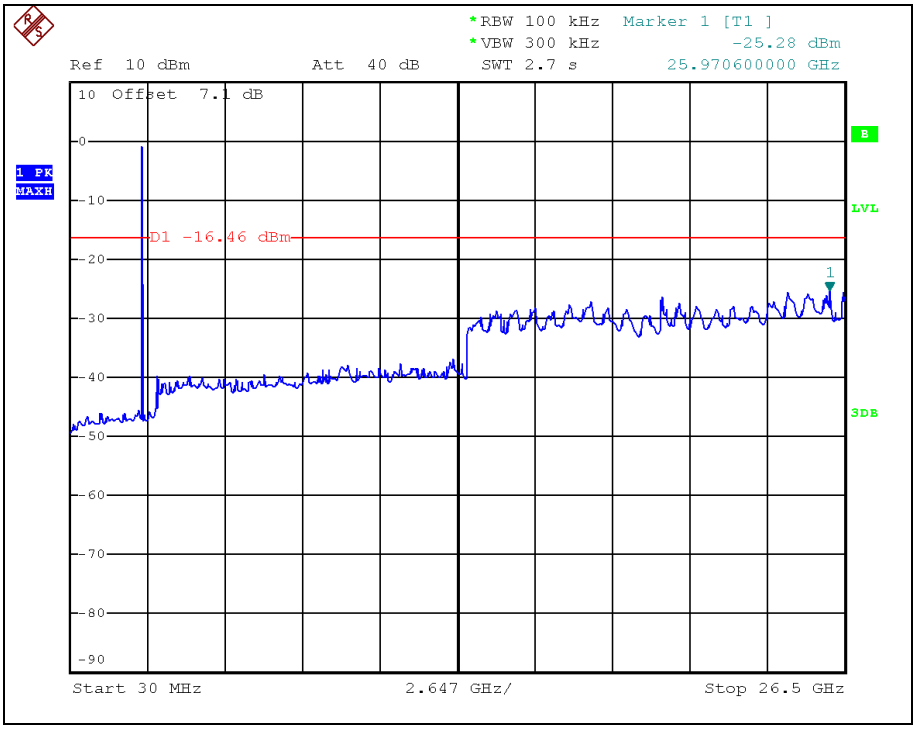
**8DPSK _ High frequency** **Bandedge _ Hopping**




**8DPSK _ High frequency** **Spurious**



## 3.3.8 Conducted Emission

### 3.3.8.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

### 3.3.8.2 Limit

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network (LISN).
Compliance with the provision of this paragraph shall 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 frequency ranges.

| Frequency Range (㎒) | Conducted Limit (dBuV) | |
|---|---|---|
| | Quasi-Peak | Average |
| 0.15 ~ 0.5 | 66 to 56 * | 56 to 46 * |
| 0.5 ~ 5 | 56 | 46 |
| 5 ~ 30 | 60 | 50 |

* Decreases with the logarithm of the frequency

### 3.3.8.3 Test Procedure

Conducted emissions from the EUT were measured according to the ANSI C63.10.

1. The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

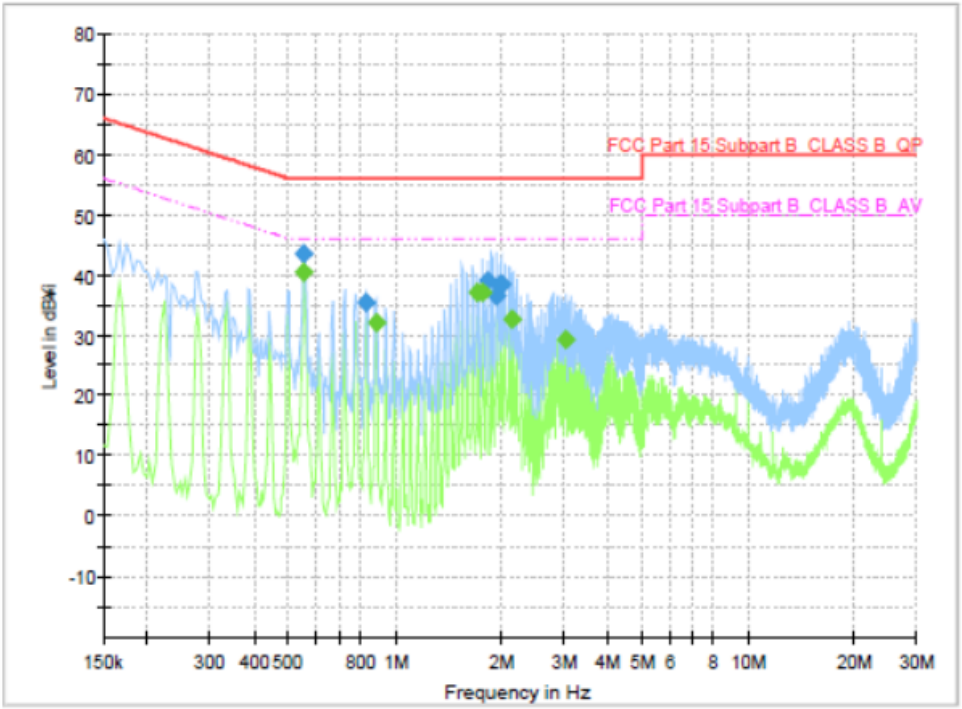
### 3.3.8.4 Test Result

- **AC Line Conducted Emission (Graph)**

# Test Report

## Common Information

| | |
|---|---|
| Test Model: | WCS-232 V6.0 |
| Test Standard: | FCC Part 15 Subpart B |
| Test Mode: | Bluetooth |
| Test Conditions: | AC 120 V, 60 Hz / 23.5 'C, 31.6 % R.H. |
| Operator Name: | JongMyoung, Shin |
| Comment: | LINE |
| Order Number: | - |




## Final Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|
| 0.552000 | --- | 40.46 | 46.00 | 5.54 | 1000.0 | 9.000 | L1 | 0.2 |
| 0.552000 | 43.40 | --- | 56.00 | 12.60 | 1000.0 | 9.000 | L1 | 0.2 |
| 0.828000 | 35.55 | --- | 56.00 | 20.45 | 1000.0 | 9.000 | L1 | 0.2 |
| 0.884000 | --- | 32.05 | 46.00 | 13.95 | 1000.0 | 9.000 | L1 | 0.2 |
| 1.716000 | --- | 37.01 | 46.00 | 8.99 | 1000.0 | 9.000 | L1 | 0.2 |
| 1.768000 | --- | 37.18 | 46.00 | 8.82 | 1000.0 | 9.000 | L1 | 0.2 |
| 1.828000 | 39.18 | --- | 56.00 | 16.82 | 1000.0 | 9.000 | L1 | 0.2 |
| 1.940000 | 36.60 | --- | 56.00 | 19.40 | 1000.0 | 9.000 | L1 | 0.3 |
| 1.992000 | 38.19 | --- | 56.00 | 17.81 | 1000.0 | 9.000 | L1 | 0.3 |
| 1.996000 | 38.61 | --- | 56.00 | 17.39 | 1000.0 | 9.000 | L1 | 0.3 |
| 2.156000 | --- | 32.55 | 46.00 | 13.45 | 1000.0 | 9.000 | L1 | 0.3 |
| 3.044000 | --- | 29.29 | 46.00 | 16.71 | 1000.0 | 9.000 | L1 | 0.3 |



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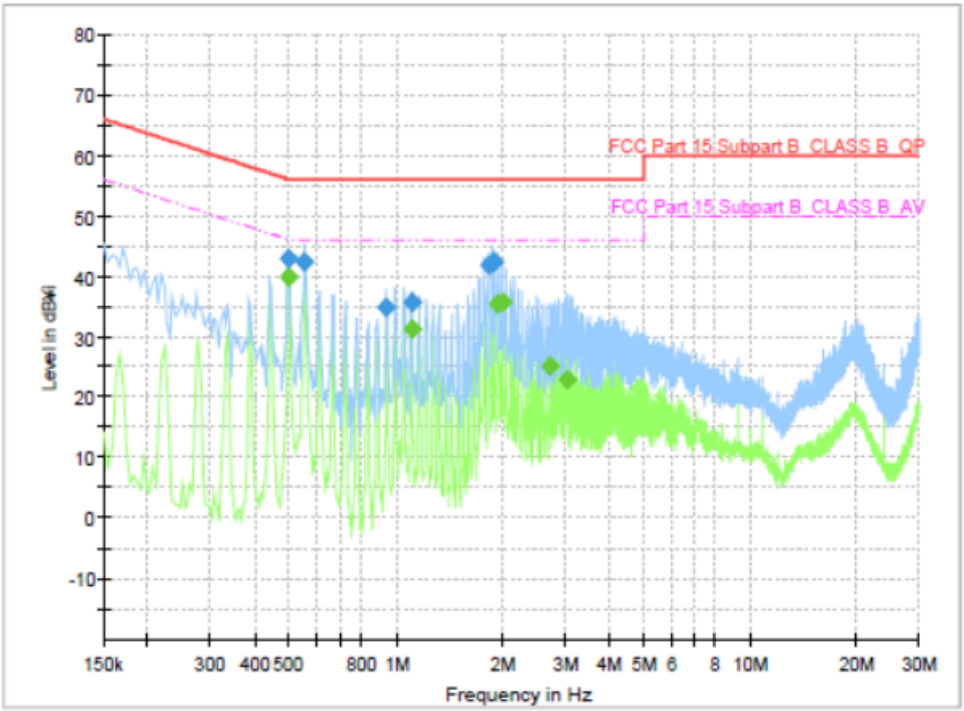
# Test Report

## Common Information

| | |
|---|---|
| Test Model: | WCS-232 V6.0 |
| Test Standard: | FCC Part 15 Subpart B |
| Test Mode: | Bluetooth |
| Test Conditions: | AC 120 V, 60 Hz / 23.5 'C, 31.6 % R.H. |
| Operator Name: | JongMyoung, Shin |
| Comment: | NEUTRAL |
| Order Number: | - |




## Final Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|
| 0.500000 | 43.03 | --- | 56.00 | 12.97 | 1000.0 | 9.000 | N | 0.1 |
| 0.500000 | --- | 39.88 | 46.00 | 6.12 | 1000.0 | 9.000 | N | 0.1 |
| 0.552000 | 42.27 | --- | 56.00 | 13.73 | 1000.0 | 9.000 | N | 0.2 |
| 0.940000 | 34.87 | --- | 56.00 | 21.13 | 1000.0 | 9.000 | N | 0.2 |
| 1.108000 | 35.75 | --- | 56.00 | 20.25 | 1000.0 | 9.000 | N | 0.2 |
| 1.108000 | --- | 31.17 | 46.00 | 14.83 | 1000.0 | 9.000 | N | 0.2 |
| 1.828000 | 41.81 | --- | 56.00 | 14.19 | 1000.0 | 9.000 | N | 0.2 |
| 1.884000 | 42.26 | --- | 56.00 | 13.74 | 1000.0 | 9.000 | N | 0.3 |
| 1.940000 | --- | 35.32 | 46.00 | 10.68 | 1000.0 | 9.000 | N | 0.3 |
| 1.996000 | --- | 35.69 | 46.00 | 10.31 | 1000.0 | 9.000 | N | 0.3 |
| 2.720000 | --- | 25.09 | 46.00 | 20.91 | 1000.0 | 9.000 | N | 0.3 |
| 3.044000 | --- | 22.77 | 46.00 | 23.23 | 1000.0 | 9.000 | N | 0.3 |

# APPENDIX I

## TEST SETUP



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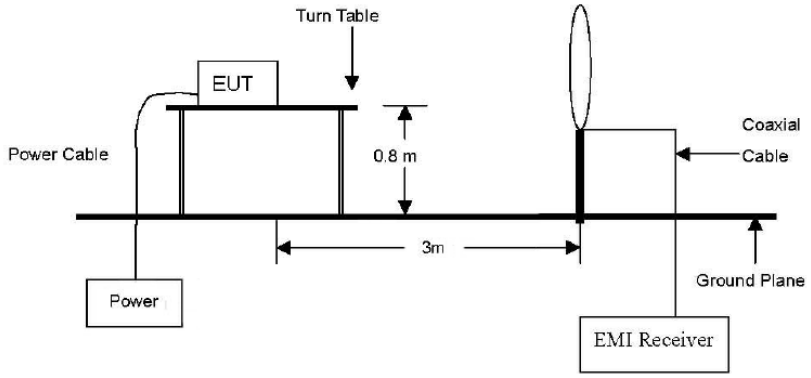
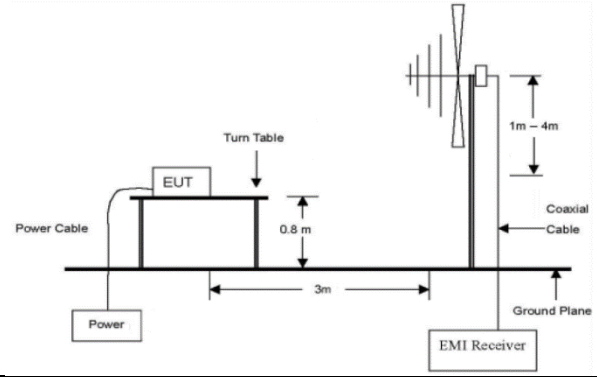
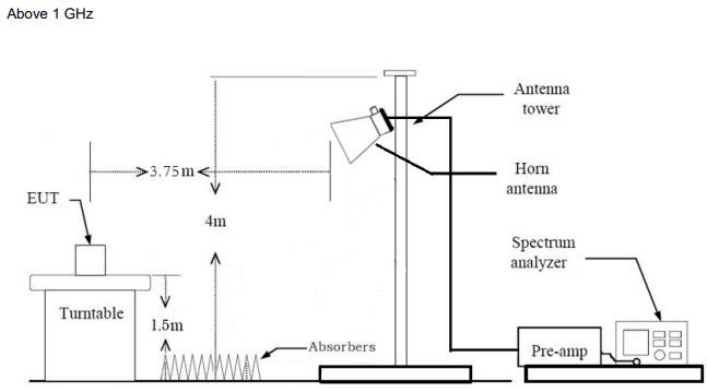
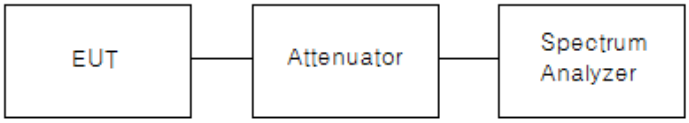
- Radiated Measurement

| | |
|---|---|
| **below 30 ㎒** |  |
| **below 1 ㎓** |  |
| **above 1 ㎓** |  |

- Conducted Measurement

| | |
|---|---|
| **Conducted** |  |

# APPENDIX II

## TEST EQUIPMENT USED FOR TESTS



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| | Description | Manufacturer | Serial No. | Model No. | Cal. Date | Next Cal. Date |
|---|---|---|---|---|---|---|
| 1 | SPECTRUM ANALYZER | R&S | 100250 | FSU26 | 2019-09-23 | 2020-09-23 |
| 2 | SPECTRUM ANALYZER | R&S | 100617 | FSP40 | 2019-03-11 | 2020-03-11 |
| 3 | USB Power sensor | Agilent | MY52500002 | U2021XA | 2019-03-11 | 2020-03-11 |
| 4 | Humi./Baro/Temp. data recorder | Lutron | 38420 | MHB-382SD | 2019-11-18 | 2020-11-18 |
| 5 | Temperature & humidity cabinet | TERCHY | 1060906 | MHCB-64AZDA | 2019-12-09 | 2020-12-09 |
| 6 | 8360B SERIES SWEPT SIGNAL GENERATOR | HP | 3614A00312 | 83640B | 2019-11-22 | 2020-11-22 |
| 7 | Vector SG | R&S | 255563 | SMBV100A | 2019-03-11 | 2020-03-11 |
| 8 | Power supply | GWInstsk | EH120798 | PST-3202 | 2019-03-11 | 2020-03-11 |
| 9 | Triple Output DC Power Supply | Agilent | MY40038816 | E3631A | 2019-03-11 | 2020-03-11 |
| 10 | Multi-meter | HP | 3146A5998 | 34401A | 2019-03-11 | 2020-03-11 |
| 11 | ATTENUATOR | Agilent | 08259 | 8493C | 2019-03-13 | 2020-03-13 |
| 12 | POWER DIVIDER | Agilent | 11664 | 11636B | 2019-03-13 | 2020-03-13 |
| 13 | POWER DIVIDER | Agilent | 51623 | 11636B | 2019-04-11 | 2020-04-11 |
| 14 | STEP ATTENUATOR | HP | 2852A00842 | 8495D | 2019-03-13 | 2020-03-13 |
| 15 | TRILOG BroadBand Antenna | Schwarzbeck | 01027 | VULB 9168 | 2019-06-17 | 2020-06-17 |
| 16 | TRILOG BroadBand Antenna | Schwarzbeck | 01029 | VULB 9168 | 2019-06-20 | 2020-06-20 |
| 17 | Double Ridged BroadBand Horn Antenna | Schwarzbeck | 02087 | BBHA 9120D | 2019-07-26 | 2020-07-26 |
| 18 | Double Ridged BroadBand Horn Antenna | Schwarzbeck | 02086 | BBHA 9120D | 2019-07-26 | 2020-07-26 |
| 19 | BroadBand Horn Antenna | Schwarzbeck | 00938 | BBHA 9170 | 2019-07-10 | 2020-07-10 |
| 20 | BroadBand Horn Antenna | Schwarzbeck | 00937 | BBHA 9170 | 2019-07-10 | 2020-07-10 |
| 21 | Amplifier | TESTEK | 190007-L | TK-PA18H | 2019-05-29 | 2020-05-29 |
| 22 | Amplifier | TESTEK | 190008-L | TK-PA1840H | 2019-06-03 | 2020-06-03 |
| 23 | Open Switch and Control Platform | R&S | 101375 | OSP220 | N/A | N/A |
| 24 | LOOP-ANTENNA | Schwarzbeck | 00124 | FMZB1519 B | 2019-06-27 | 2020-06-27 |
| 25 | LISN | Schwarzbeck | 00984 | NSLK 8127 | 2019-06-20 | 2020-06-20 |
| 26 | EMI Test Receiver | R&S | 102116 | ESRP3 | 2019-07-24 | 2020-07-24 |