# TEST REPORT

| KCTL Inc.<br>65, Sinwon-ro, Yeongtong-gu,<br>Suwon-si, Gyeonggi-do, 443-390, Korea<br>TEL: 82 70 5008 1021<br>FAX: 82 505 299 8311 | Report No.: KCTL15-FR0024<br><br>Page( 1 ) / ( 60 ) Pages | KCTL<br>http://www.kctl.co.kr |
|---|---|---|

**1. Applicant**

| | |
|---|---|
| Name: | Hyundai Mobis Co., Ltd. |
| Address: | 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, Korea |

**2. Sample Description:**

| | |
|---|---|
| FCC ID: | TQ8-AC110F6GG |
| Type of equipment: | DIGITAL CAR AUDIO SYSTEM |
| Basic Model: | AC110F6GG |
| Variant Model: | AC110F6GN, AC110F6GE, AC110F6GL, AC111F6GE, AC111F6GG, AC112F6GG, AC110F6CG |
| **3. Date of Test:** | August 24 ~ August 26, 2015 |
| **4. Test method used:** | FCC Part 15 Subpart C 15.247 |

**5. Test Results**

| | |
|---|---|
| Test Item: | Refer to page 7 |
| Result: | Refer to page 8 ~ page 51 |
| Measurement Uncertainty: | Refer to page 7 |

This result shown in this report refer only to the sample(s) tested unless otherwise stated.

| | | |
|---|---|---|
| Affirmation | Tested by<br><br>Name: YOO, YOUNG BIN | Technical Manager<br><br>Name: SON, MIN GI |

2015. 08. 31

**KCTL Inc.** Testing Laboratory

# [ Contents ]

# 1. Client information

| | |
|---|---|
| **Applicant:** | Hyundai Mobis Co., Ltd. |
| **Address:** | 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, Korea |
| **Telephone number:** | +81-31-260-2707 |
| **Facsimile number:** | +81-31-899-1788 |
| **Contact person:** | Choi Seung Hoon/ csh@mobis.co.kr |

| | |
|---|---|
| **Manufacturer:** | Hyundai Mobis Co., Ltd. |
| **Address:** | 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, Korea |

# 2. Laboratory information

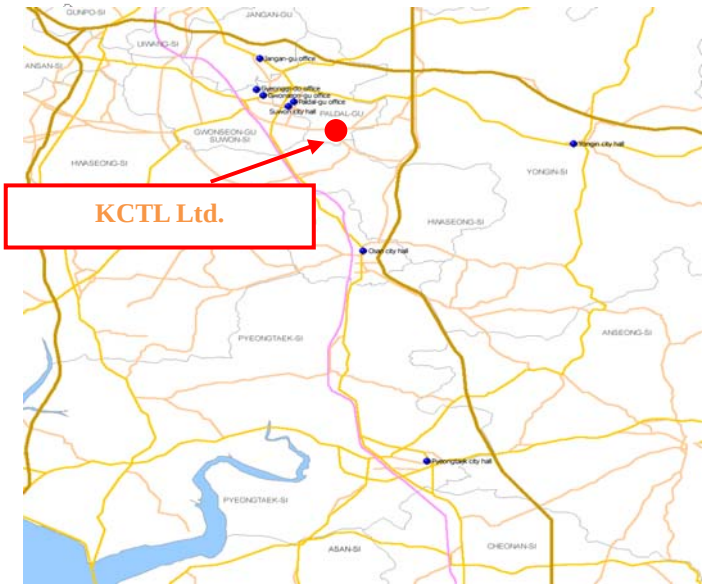
## Address

**KCTL Ltd.**
65 Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea
Telephone Number: 82-70-5008-1016  Facsimile Number: 82-505-299-8311

## Certificate

KOLAS No.: 231
FCC Site Designation No: KR0040
FCC Site Registration No: 687132
VCCI Site Registration No.: R-3327, G-198, C-3706, T-1849
IC Site Registration No.:8035A-2

## SITE MAP

# 3. Description of E.U.T.

## 3.1 Basic description

| | |
|---|---|
| Applicant: | Hyundai Mobis Co., Ltd. |
| Address of Applicant | 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, Korea |
| Manufacturer | Hyundai Mobis Co., Ltd. |
| Address of Manufacturer | 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, Korea |
| Type of equipment | DIGITAL CAR AUDIO SYSTEM |
| Basic Model | AC110F6GG |
| Variant Model | AC110F6GN, AC110F6GE, AC110F6GL, AC111F6GE, AC111F6GG, AC112F6GG, AC110F6CG |
| Serial number | N/A |

* Variant model names are different only for the marketing area.

## 3.2 General description

| | |
|---|---|
| Frequency Range | 2 402 ㎒ ~ 2 480 ㎒ |
| Type of Modulation | GFSK, π/4DQPSK, 8DPSK |
| Number of Channels | 79 ch |
| Type of Antenna | Chip Antenna |
| Antenna Gain | 3.85 ㏈i |
| Transmit Power | 4.51 ㏈m |
| Power supply | DC 12 V |
| Product SW/HW version | 1.0 |
| Radio SW/HW version | 1.0 |
| Test SW Version | CSR Bluesuite 2.6.0 |
| RF power setting in TEST SW | EXT250, Int63 |

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

## 3.3 Test frequency

| | Frequency |
|---|---|
| Low frequency | 2 402 ㎒ |
| Middle frequency | 2 441 ㎒ |
| High frequency | 2 480 ㎒ |

## 3.4 Test Voltage

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

**※ 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.

# 4. Summary of test results

## 4.1 Standards & results

| FCC Rule | IC Rule | Parameter | Report Section | Test Result |
|---|---|---|---|---|
| 15.203, 15.247(b)(4) | - | Antenna Requirement | 5.1 | C |
| 15.247(b)(1), (4) | RSS-210, A8.4(2) | Maximum Peak Output Power | 5.2 | C |
| 15.247(a)(1) | RSS-210, A8.1(b) | Carrier Frequency Separation | 5.3 | C |
| 15.247(a)(1) | RSS-210, A8.1(a) RSS-GEN, 6.6 | 20dB Channel Bandwidth | 5.4 | C |
| - | RSS-GEN, 6.6 | Occupied Bandwidth | 5.4 | C |
| 15.247(a)(iii) 15.247(b)(1) | RSS-210, A8.1(d) | Nunber of Hopping Channel | 5.5 | C |
| 15.247(a) (iii) | RSS-210, A8.1(d) | Time of Occupancy(Dwell Time) | 5.6 | C |
| 15.247(d), 15.205(a), 15.209(a) | RSS-210, A8.5 RSS-GEN, 8.9, 10 | Spurious Emission, BandEdge, Restricted Band | 5.7 | C |
| 15.207(a) | RSS-GEN, 8.8 | Conducted Emissions | - | N/A1) |

Note: C=complies
NC= Not complies
NT=Not tested
NA=Not Applicable

N/A1) : This test is not applicable because the EUT falls into the automotive device and it's not to be connected to the public utility(AC) power line.

* The method of measurement used to test this DSS device is FCC Public Notice DA 00-705
* The general test methods used to test on this device are ANSI C63.10:2013

## 4.2 Uncertainty

| Measurement Item | Expanded Uncertainty U = KUc (K = 2) | |
|---|---|---|
| Conducted RF power | ± 1.30 dB | |
| Conducted Spurious Emissions | ± 1.52 dB | |
| Radiated Spurious Emissions | 30 ㎒ ~ 300 ㎒: | + 4.94 dB, - 5.06 dB |
| | | + 4.93 dB, - 5.05 dB |
| | 300 ㎒ ~ 1 000 ㎒: | + 4.97 dB, - 5.08 dB |
| | | + 4.84 dB, - 4.96 dB |
| | 1 ㎓ ~ 25 ㎓: | + 6.03 dB, - 6.05 dB |
| Conducted Emissions | 9 ㎑ ~ 150 ㎑: | ± 3.75 dB |
| | 150 ㎑ ~ 30 ㎒: | ± 3.36 dB |

# 5. Test results

## 5.1 Antenna Requirement

### 5.1.1 Regulation

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

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

### 5.1.2 Result

-Complied

The transmitter has a Chip antenna. The directional gain of the antenna is 3.85 dBi.

## 5.2 Maximum Peak Output Power

### 5.2.1 Regulation

According to §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 ㎽.

According to §15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5 ㎒ band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 ㎒ band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 ㎒ 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 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

### 5.2.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument (spectrum analyzer) using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester and make sure the spectrum analyzer is operated in its linear range.
4. Set the spectrum analyzer as follows: Span = approximately 5 times the 20 ㏈ bandwidth, centered on a hopping channel RBW > the 20 ㏈ bandwidth of the emission being measured VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Measure the highest amplitude appearing on spectral display and record the level to calculate results.
6. Repeat above procedures until all frequencies measured were complete.

## 5.2.3 Test Result

## - Complied

* GFSK

| Channel | Frequency (㎒) | Result (dBm) | Limit (dBm) | Margin (dB) | Avarage Power (dBm) |
|---|---|---|---|---|---|
| Low | 2 402 | 1.87 | 30.00 | 28.13 | 0.91 |
| Middle | 2 441 | 2.83 | 30.00 | 27.17 | 1.62 |
| High | 2 480 | 3.62 | 30.00 | 26.38 | 1.52 |

* π/4DQPSK

| Channel | Frequency (㎒) | Result (dBm) | Limit (dBm) | Margin (dB) | Avarage Power (dBm) |
|---|---|---|---|---|---|
| Low | 2 402 | 3.09 | 20.97 | 17.88 | 0.64 |
| Middle | 2 441 | 3.83 | 20.97 | 17.14 | 0.84 |
| High | 2 480 | 4.31 | 20.97 | 16.66 | 0.18 |

* 8DPSK

| Channel | Frequency (㎒) | Result (dBm) | Limit (dBm) | Margin (dB) | Avarage Power (dBm) |
|---|---|---|---|---|---|
| Low | 2 402 | 3.27 | 20.97 | 17.70 | 0.64 |
| Middle | 2 441 | 3.95 | 20.97 | 17.02 | 0.84 |
| High | 2 480 | 4.51 | 20.97 | 16.46 | 0.17 |

NOTE:

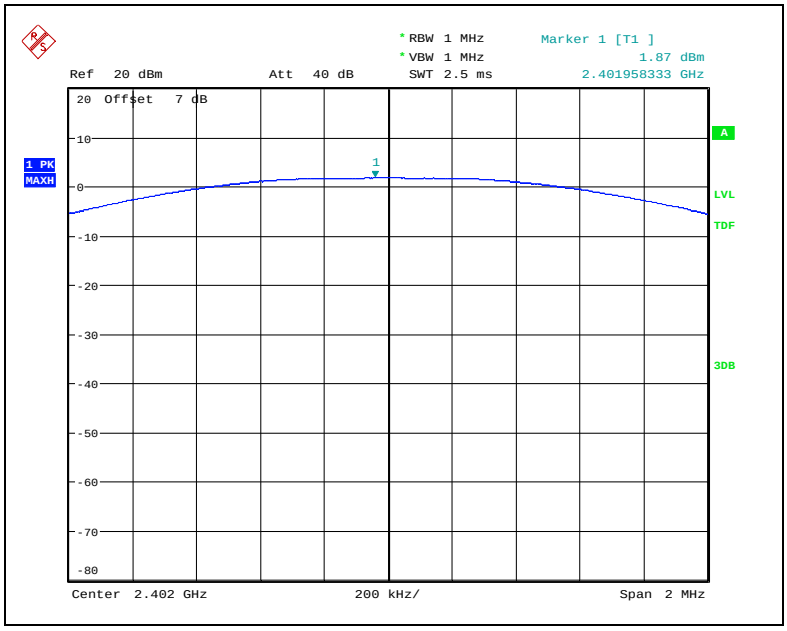
1. Since the directional gain of the Chip antenna declared by the manufacturer ($G_{ANT}$ = 3.85 dBi) does not exceed 6.0 dBi, there was no need to reduce the output power.
2. We took the insertion loss of the cable loss into consideration within the measuring instrument.

## 5.2.4 Test Plot

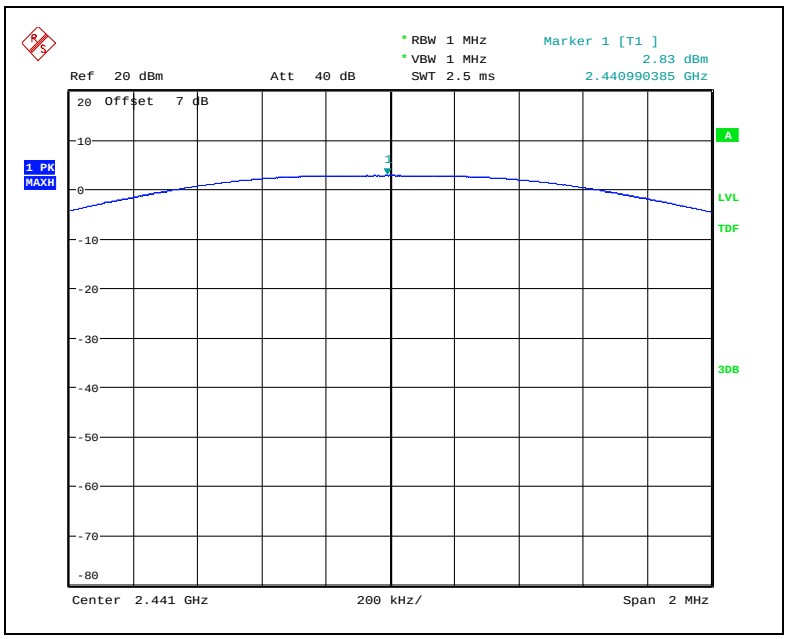
Figure 1. Plot of the Maximum Peak Output Power (Conducted)

*** GFSK**

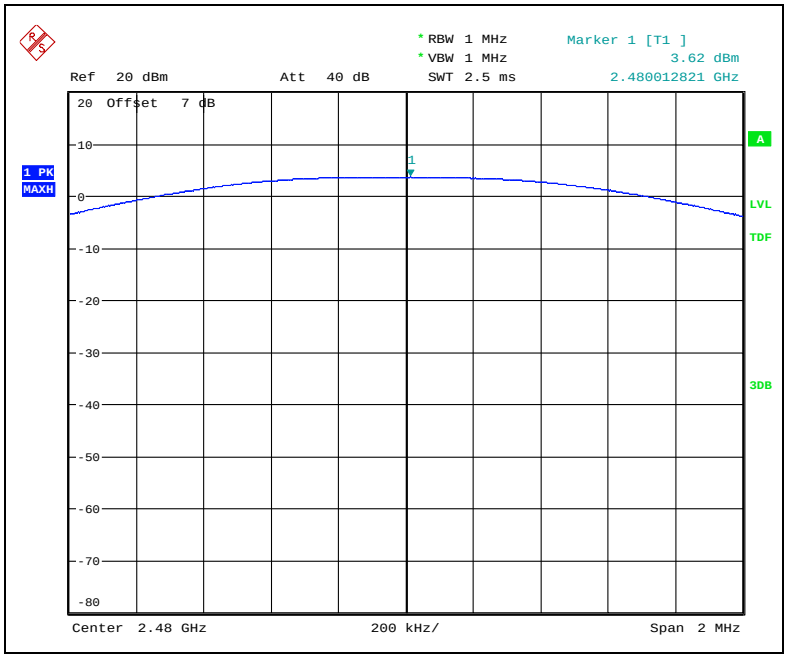
Lowest Channel( 2 402 ㎒)




Middle Channel (2 441 ㎒)

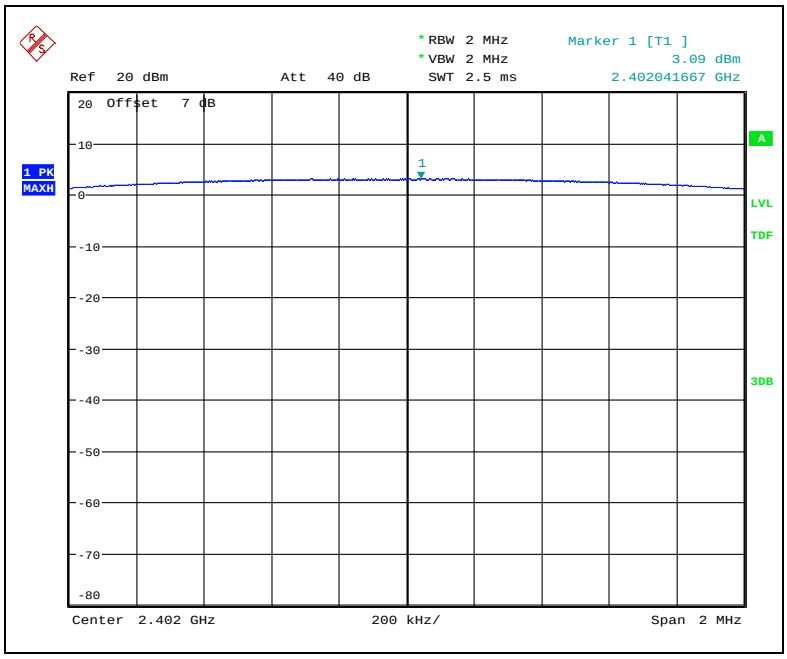


Highest Channel ( 2 480 ㎒)

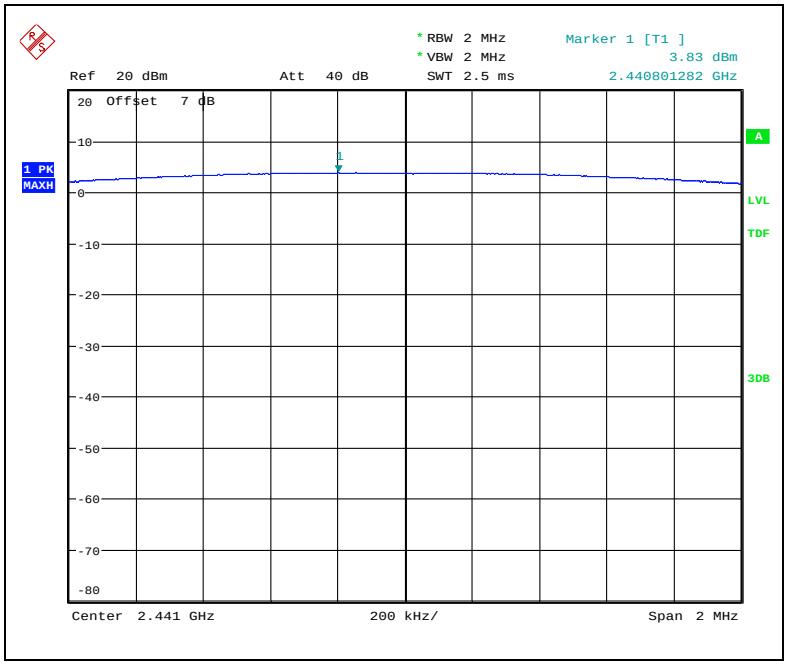



*** π/4DQPSK**

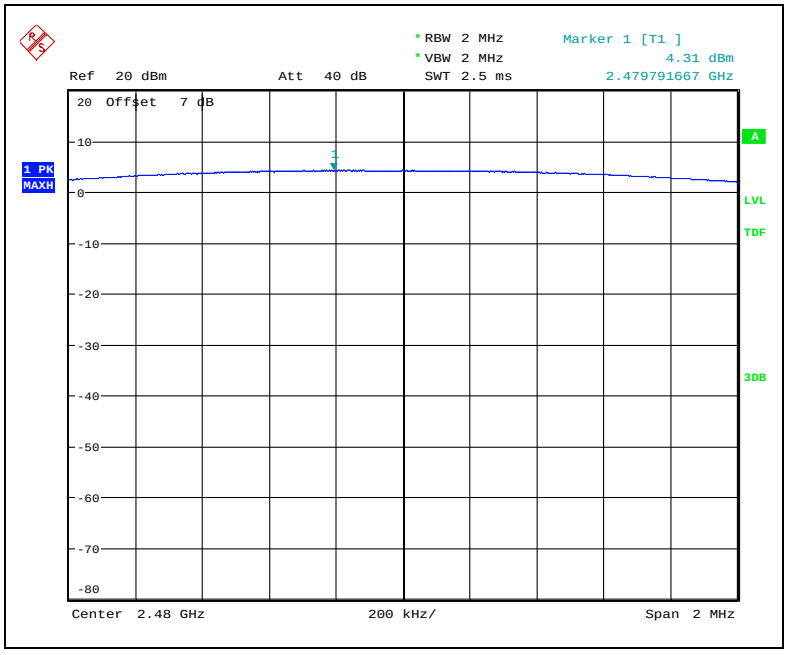
Lowest Channel( 2 402 ㎒)



Middle Channel (2 441 ㎒)

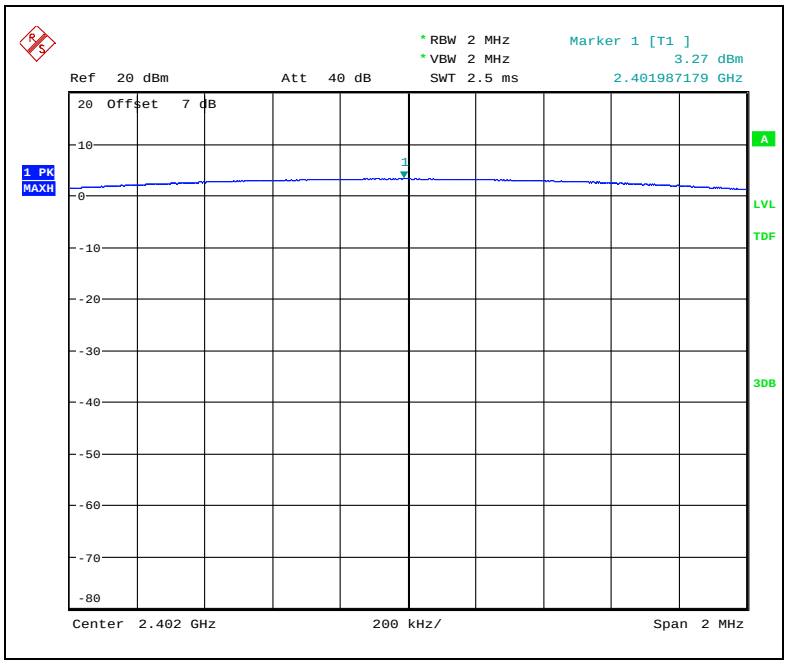



Highest Channel ( 2 480 ㎒)

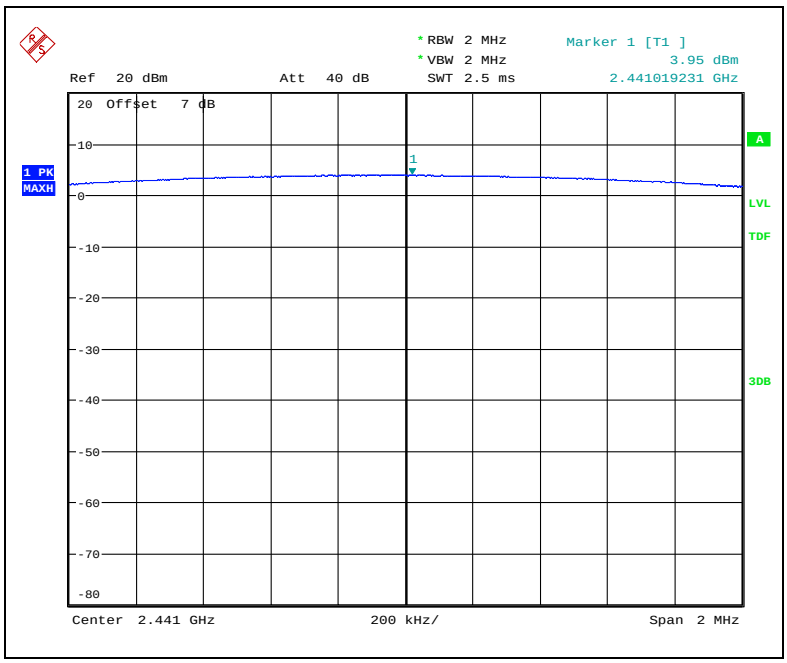


*** 8DPSK**

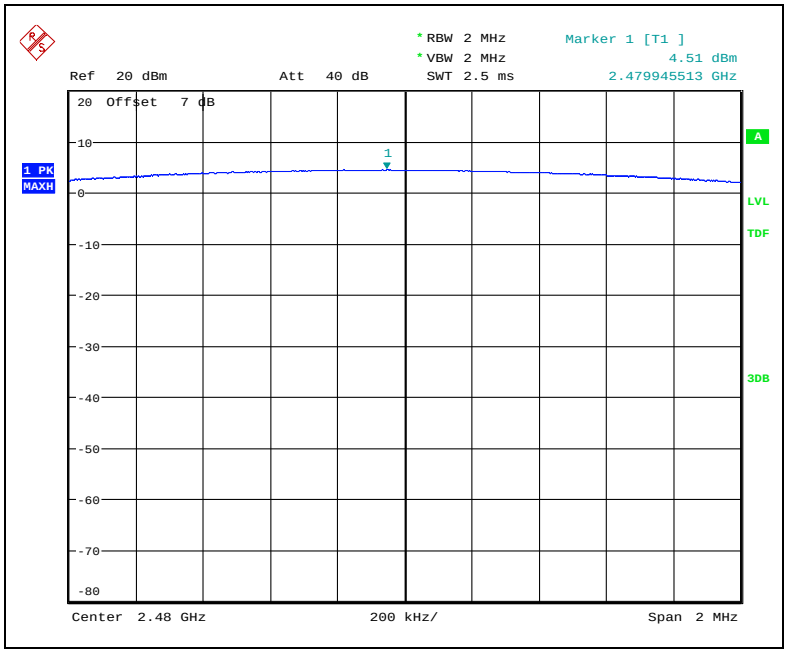
Lowest Channel( 2 402 ㎒)




Middle Channel (2 441 ㎒)



Highest Channel ( 2 480 ㎒)



## 5.3 Carrier Frequency Separation

### 5.3.1 Regulation

According to §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 ㎽.

### 5.3.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester.
4. Set the spectrum analyzer as follows: Span = wide enough to capture the peaks of two adjacent channels Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span Video (or Average) Bandwidth (VBW) ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Measure the separation between the peaks of the adjacent channels using the marker-delta function.
6. Repeat above procedures until all frequencies measured were complete.

### 5.3.3 Test Result

- Complied

*** GFSK**

| Operating Mode | Carrier frequency separation (㎒) | Limit |
|---|---|---|
| Hopping | 1.000 | ≥25 ㎑ or 20 ㏈ bandwidth |

*** π/4DQPSK**

| Operating Mode | Carrier frequency separation (㎒) | Limit |
|---|---|---|
| Hopping | 1.009 | ≥25 ㎑ or two-thirds of the 20 ㏈ bandwidth |

*** 8DPSK**

| Operating Mode | Carrier frequency separation (㎒) | Limit |
|---|---|---|
| Hopping | 1.004 | ≥25 ㎑ or two-thirds of the 20 ㏈ bandwidth |

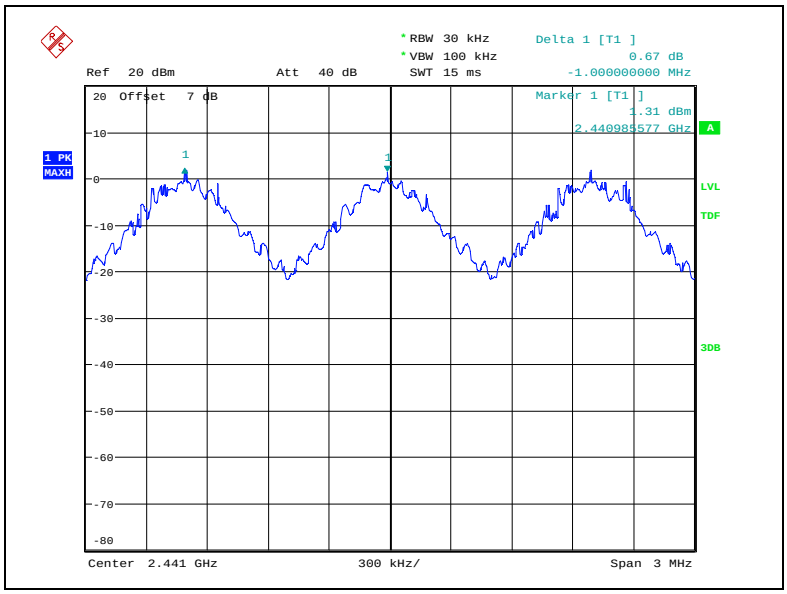
NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

## 5.3.4 Test Plot

Figure 2.Plot of the Carrier Frequency Separation (Conducted)

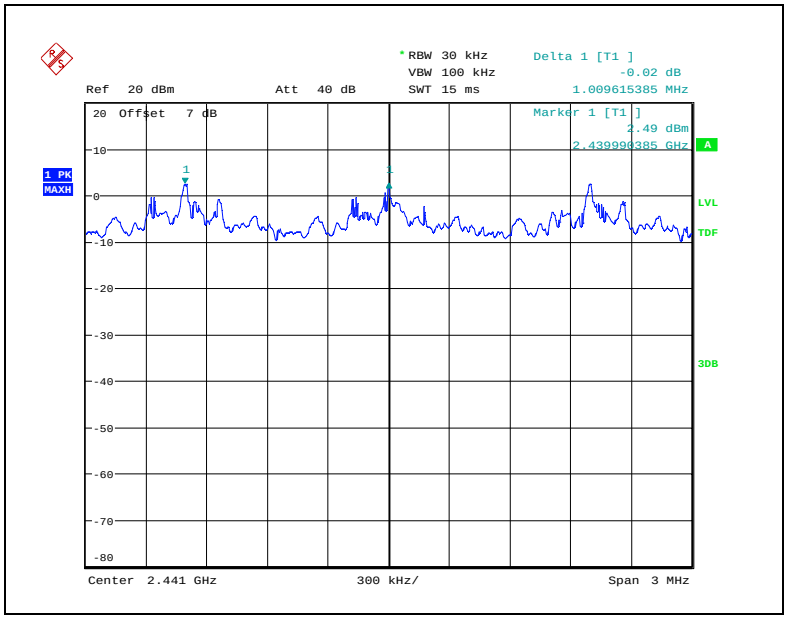
*** GFSK**

Middle Channel (2 441 ㎒)



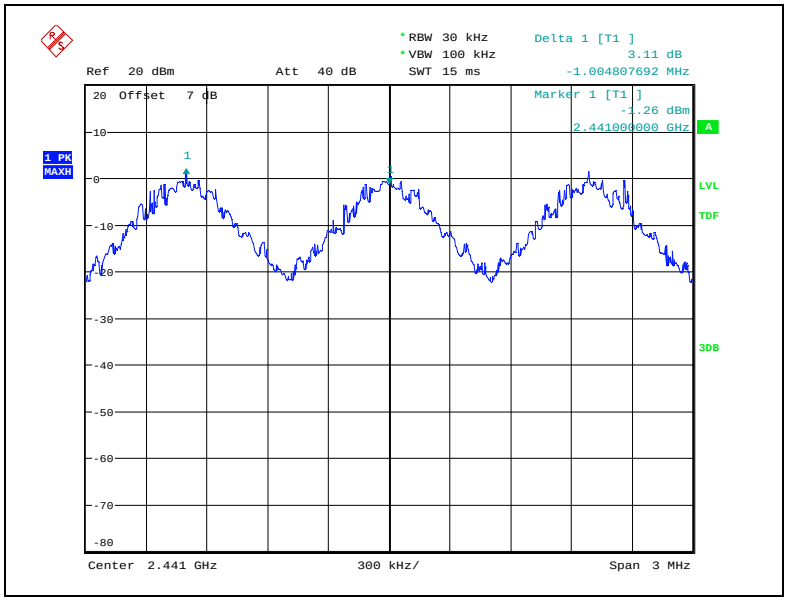

*** π/4DQPSK**

Middle Channel (2 441 ㎒)



*** 8DPSK**

Middle Channel (2 441 ㎒)



## 5.4 20 dB Channel Bandwidth

### 5.4.1 Regulation

According to §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 ㎽

### 5.4.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester and make sure the spectrum analyzer is operated in its linear range.
4. Set the spectrum analyzer as follows: Span = approximately 2 to 3 times the 20 ㏈ bandwidth, centered on a hopping channel RBW ≥ 1% of the 20 ㏈ bandwidth VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Set a reference level on it equal to the highest peak value.
6. Measure the frequency difference of two frequencies that were attenuated 20 ㏈ from the reference level. Record the frequency difference as the emission bandwidth.
7. Repeat above procedures until all frequencies measured were complete..

## 5.4.3 Test Result

- Complied

| Mode | Channel | 20 dB Channel Bandwidth(㎒) | Occupied Bandwidth (99 % BW)(㎒) |
|---|---|---|---|
| GFSK | Low | 0.887 | 0.875 |
| | Middle | 0.875 | 0.868 |
| | High | 0.878 | 0.868 |
| π/4DQPSK | Low | 1.288 | 1.195 |
| | Middle | 1.266 | 1.185 |
| | High | 1.266 | 1.176 |
| 8DPSK | Low | 1.304 | 1.217 |
| | Middle | 1.294 | 1.205 |
| | High | 1.294 | 1.189 |

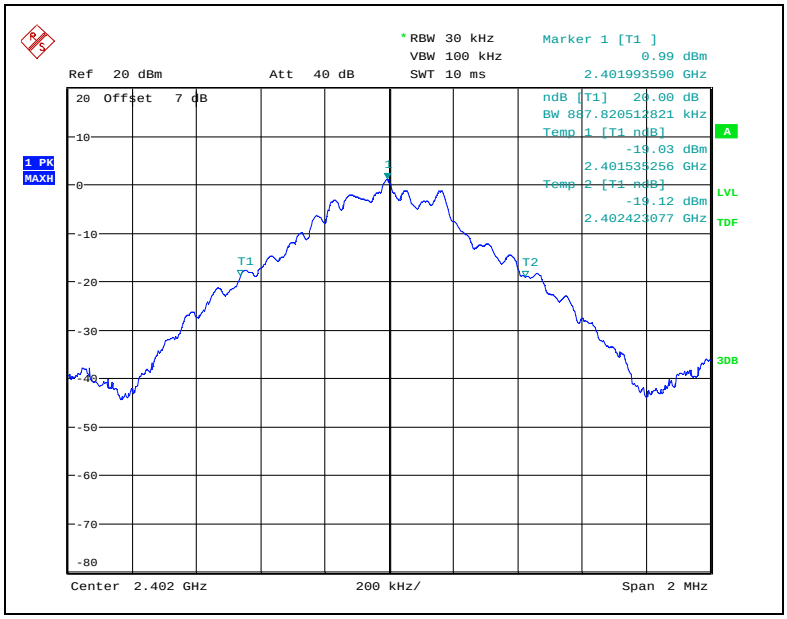
NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

## 5.4.4 Test Plot

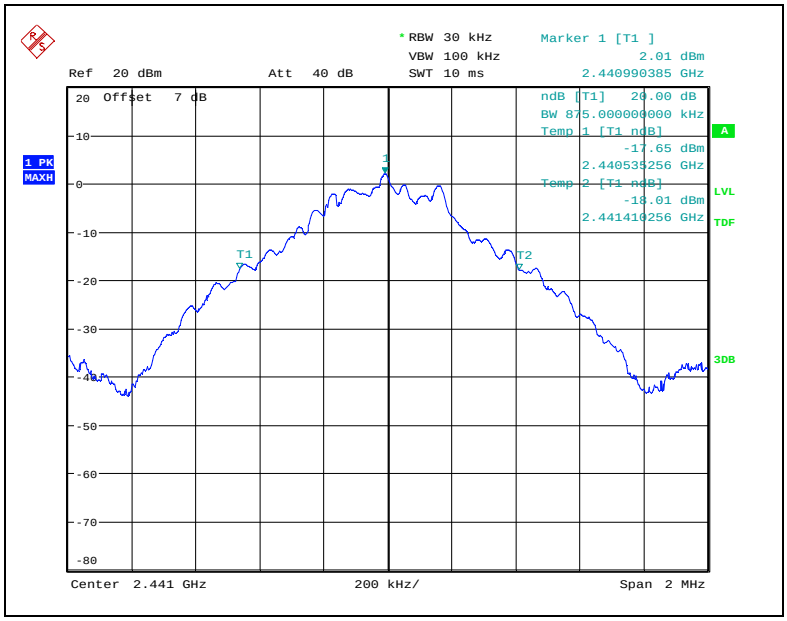
Figure 3.Plot of the 20 dB Channel Bandwidth / Occupied Bandwidth (Conducted)

*** GFSK (20 dB Channel Bandwidth)**

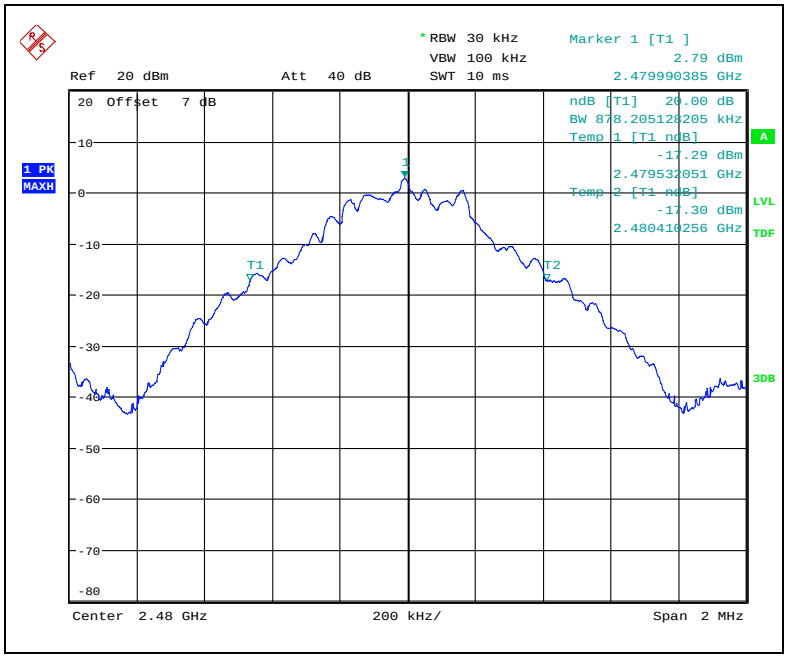
Lowest Channel( 2 402 ㎒)




Middle Channel (2 441 ㎒)

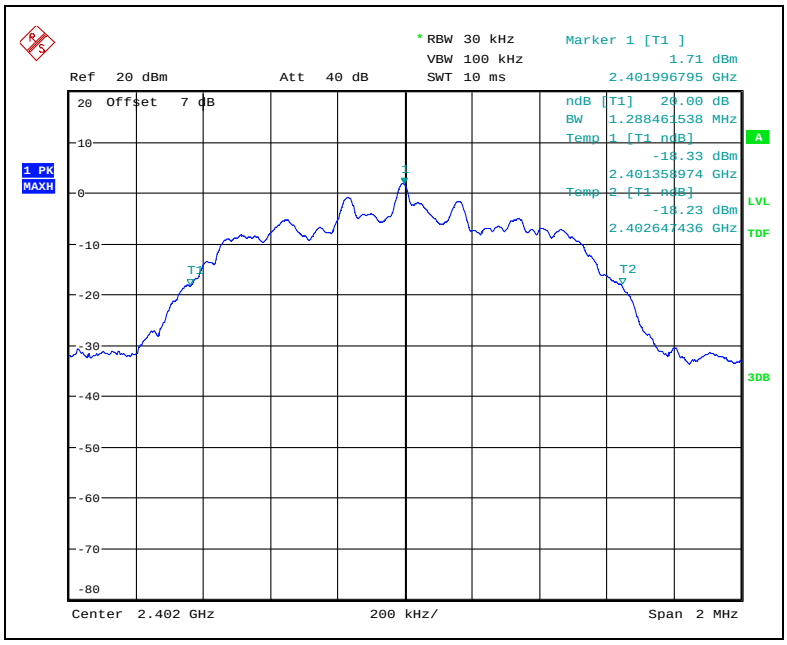


Highest Channel ( 2 480 ㎒)

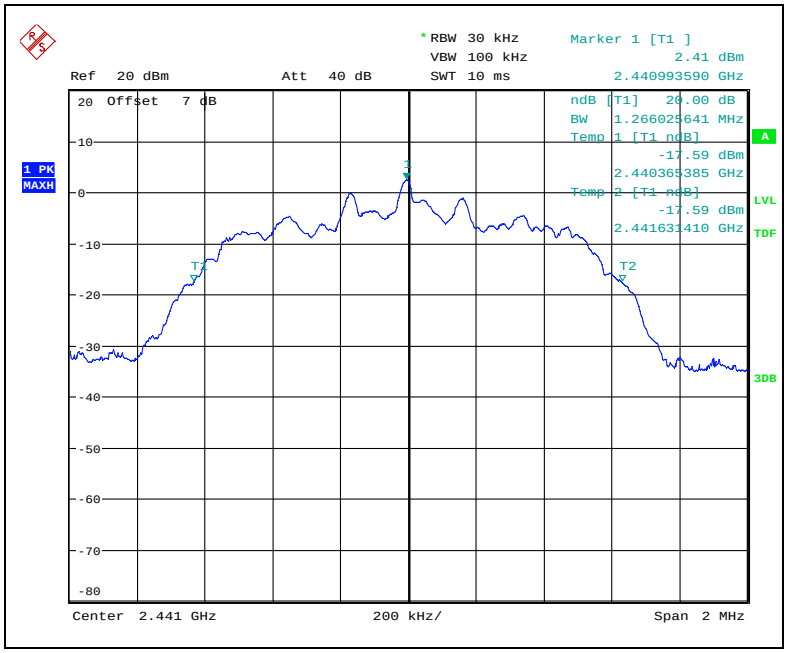



*** π/4DQPSK (20 dB Channel Bandwidth)**

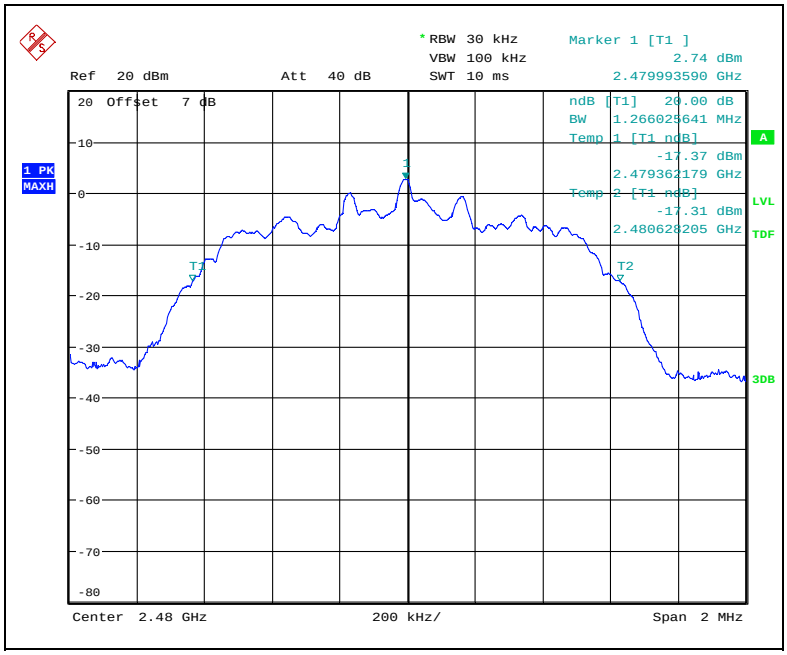
Lowest Channel( 2 402 ㎒)



Middle Channel (2 441 ㎒)

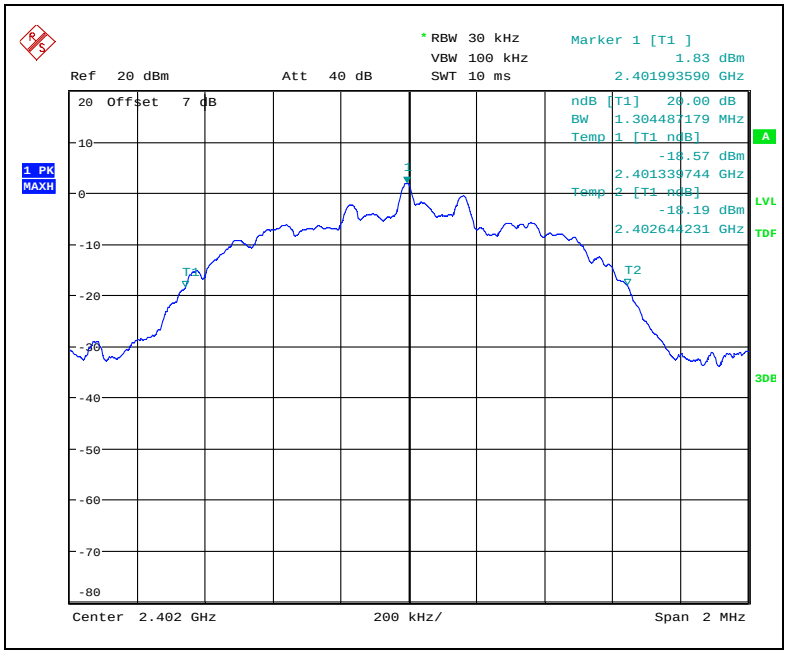



Highest Channel ( 2 480 ㎒)

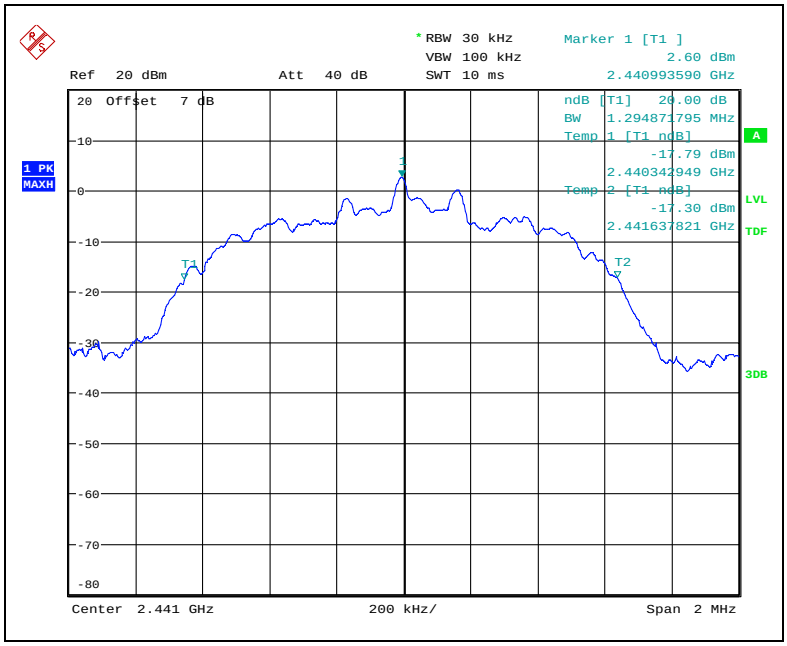


*** 8DPSK (20 dB Channel Bandwidth)**

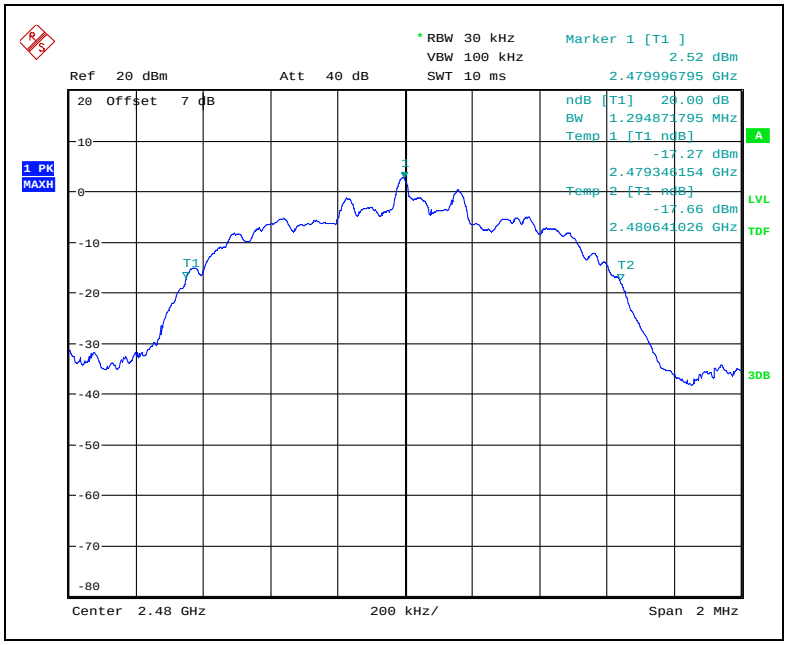
Lowest Channel( 2 402 ㎒)




Middle Channel (2 441 ㎒)

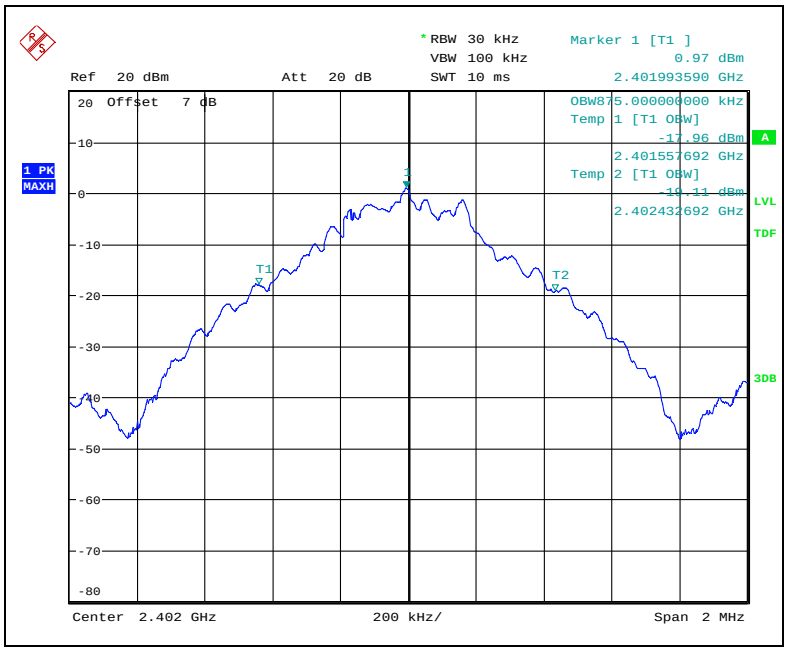


Highest Channel ( 2 480 ㎒)

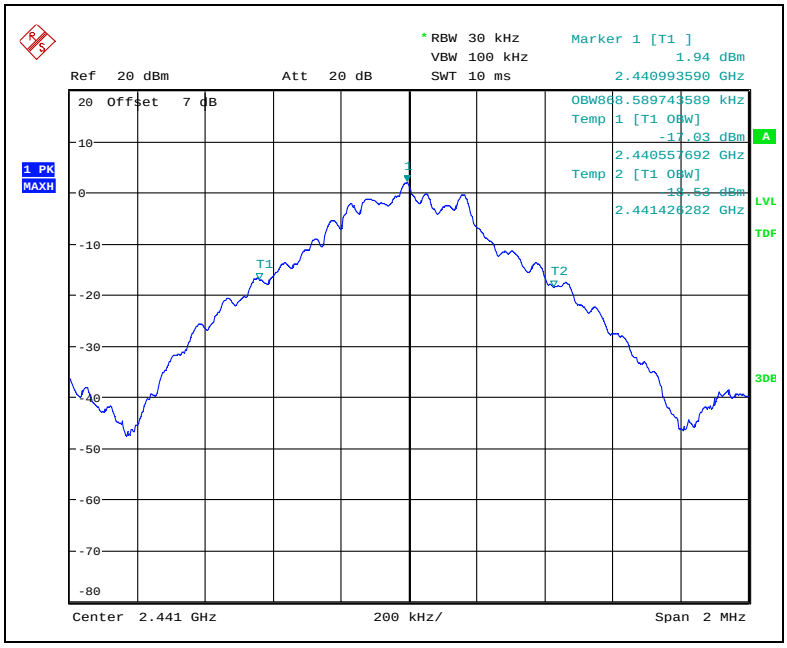



*** GFSK (Occupied Bandwidth)**

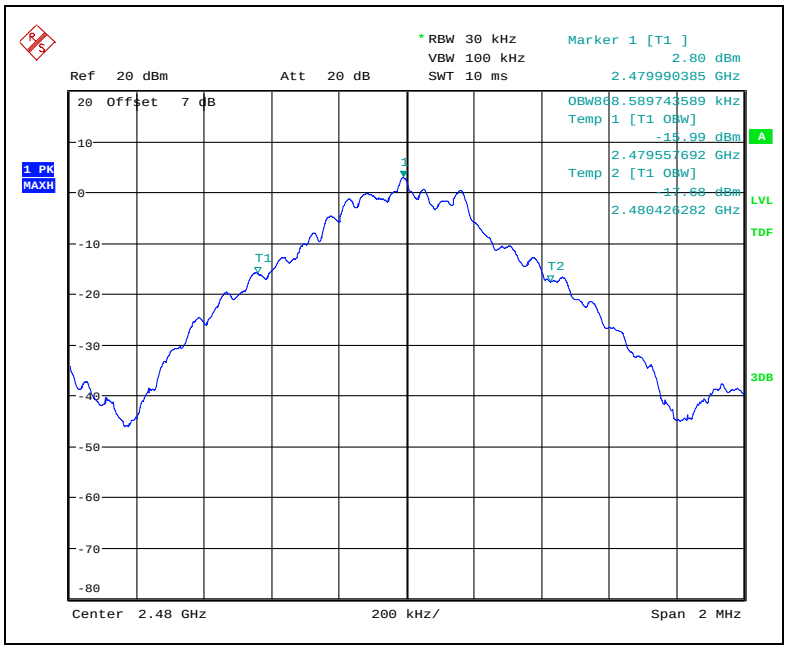
Lowest Channel( 2 402 ㎒)



Middle Channel (2 441 ㎒)

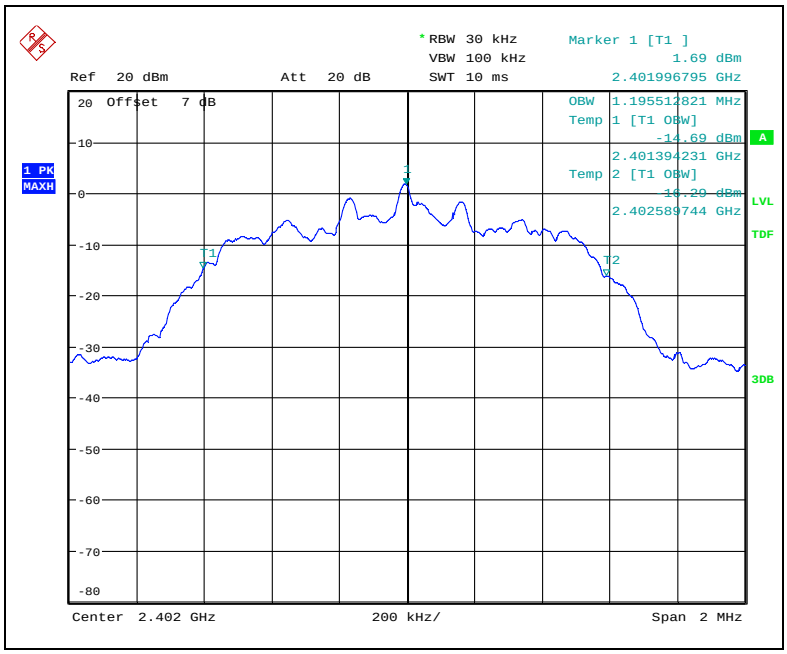



Highest Channel ( 2 480 ㎒)

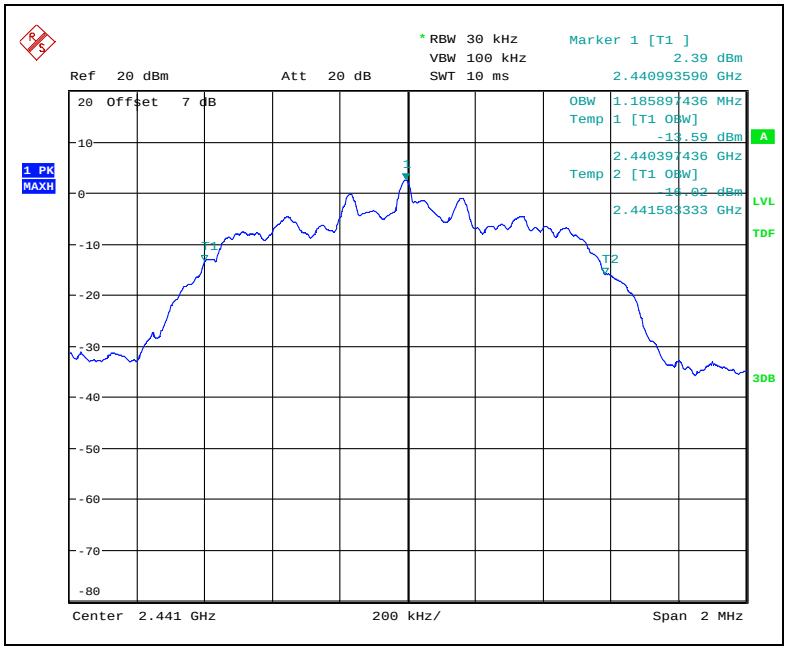


*** π/4DQPSK (Occupied Bandwidth)**

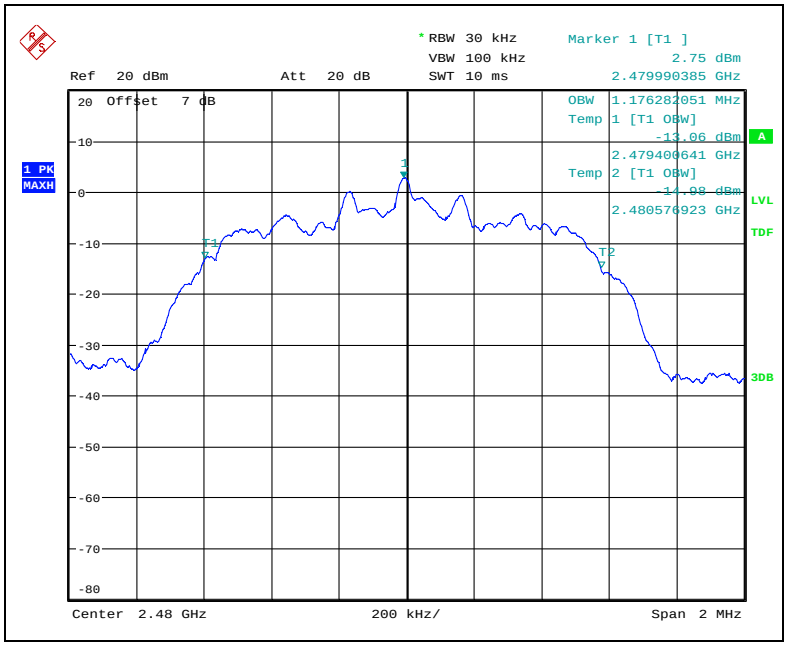
Lowest Channel( 2 402 ㎒)




Middle Channel (2 441 ㎒)

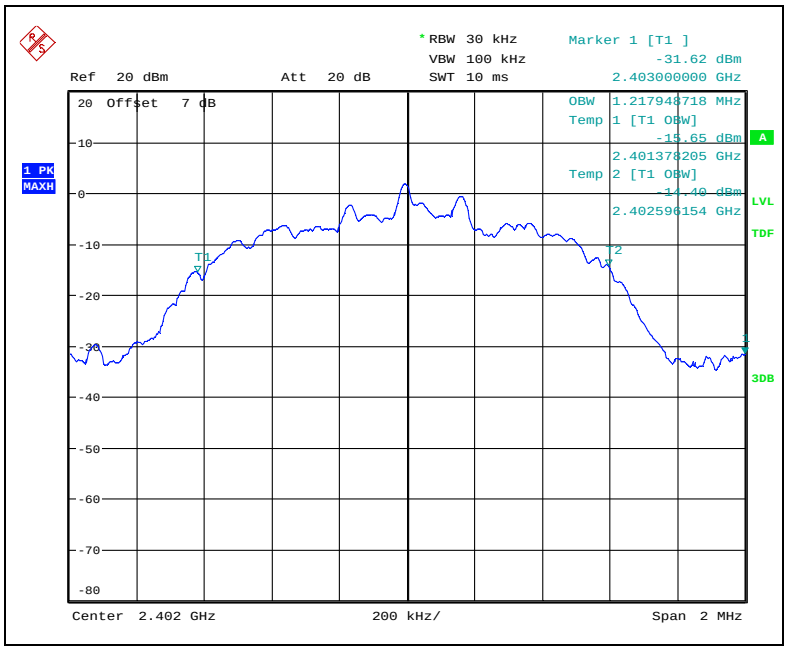


Highest Channel ( 2 480 ㎒)

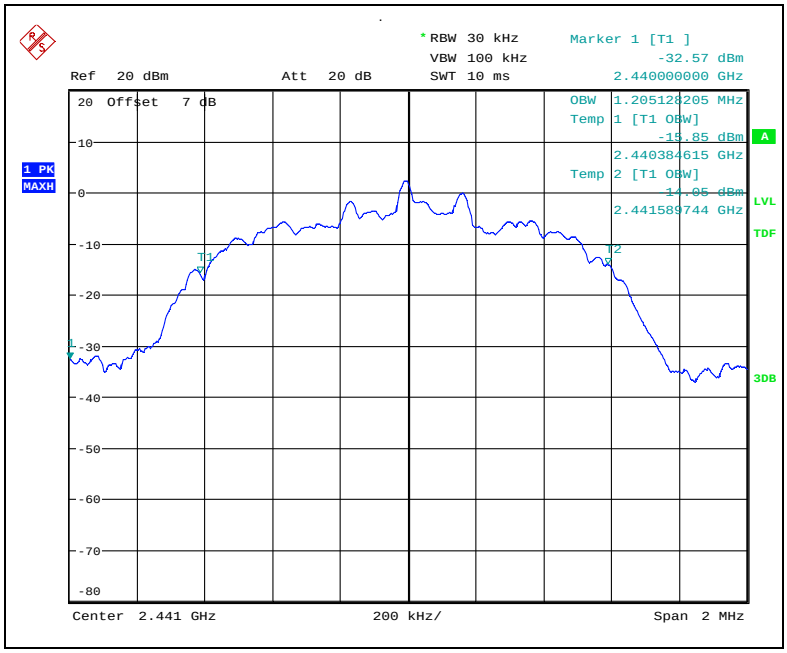



*** 8DPSK (Occupied Bandwidth)**

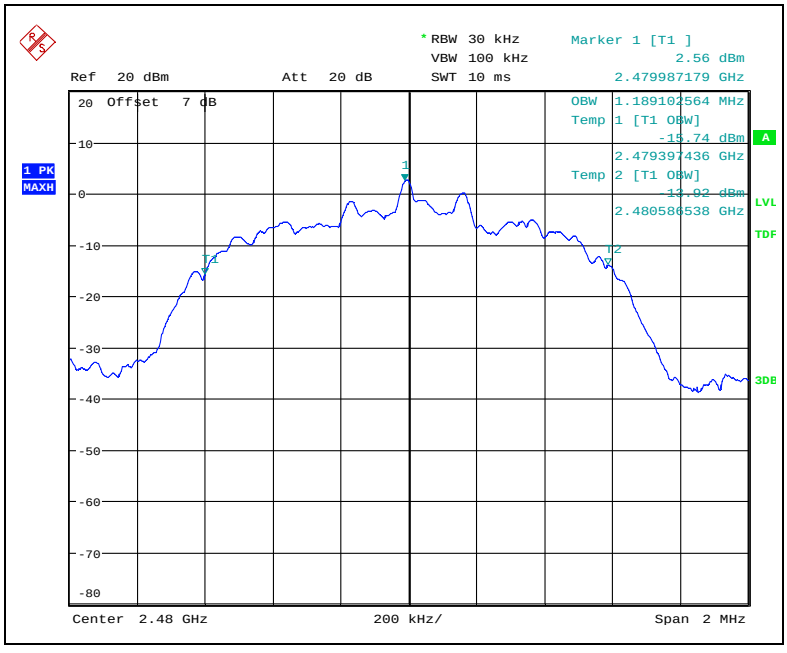
Lowest Channel( 2 402 ㎒)



Middle Channel (2 441 ㎒)




Highest Channel ( 2 480 ㎒)



## 5.5 Number of Hopping Channels

### 5.5.1 Regulation

According to §15.247(a)(1)(iii), Frequency hopping systems in the 2400-2483.5 ㎒ 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. According to §15.247(b)(1), For frequency hopping systems operating in the 2400-2483.5 ㎒ band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 ㎒ band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 ㎒ band: 0.125 watts.

### 5.5.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set the hopping function enabled by controlling it via UART interface or Bluetooth tester.
4. Set the spectrum analyzer as follows: Span = the frequency band of operation RBW ≥ 1% of the span VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Record the number of hopping channels.

## 5.5.3 Test Result

- Complied

| Mode | Frequency | Number of hopping channel | Limit |
|---|---|---|---|
| GFSK | 2 402 – 2 480 ㎒ | 79 | ≥15 |
| π/4DQPSK | 2 402 – 2 480 ㎒ | 79 | ≥15 |
| 8DPSK | 2 402 – 2 480 ㎒ | 79 | ≥15 |

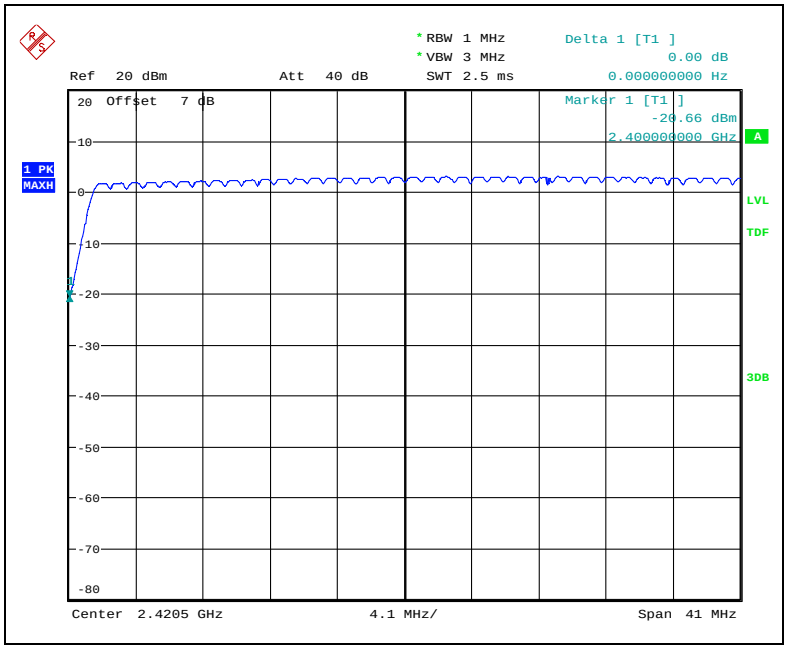
NOTE:

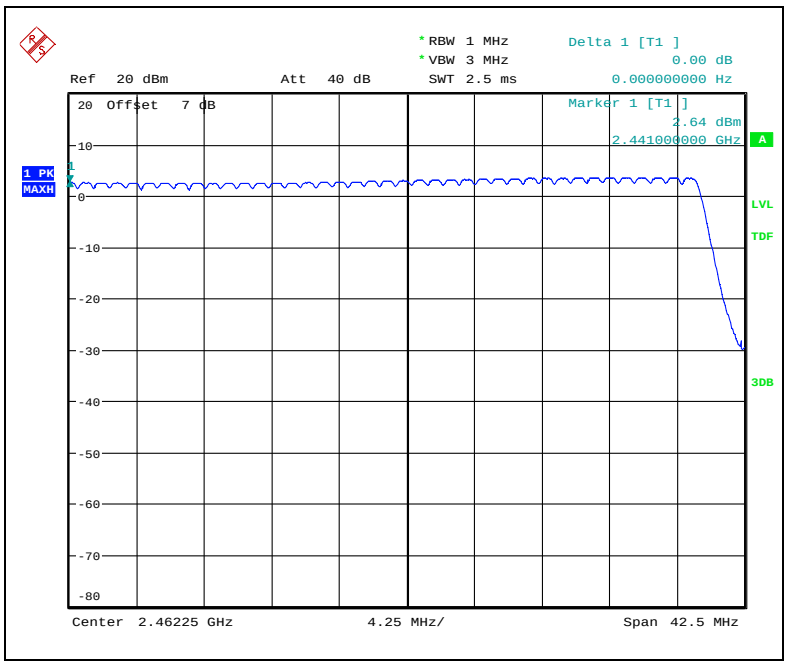
1. We took the insertion loss of the cable loss into consideration within the measuring instrument.
2. Measurement is made with EUT operating in hopping mode between 79 channels providing a worse case scenario as compared to AFH mode hopping between 20 channels.

## 5.5.4 Test Plot

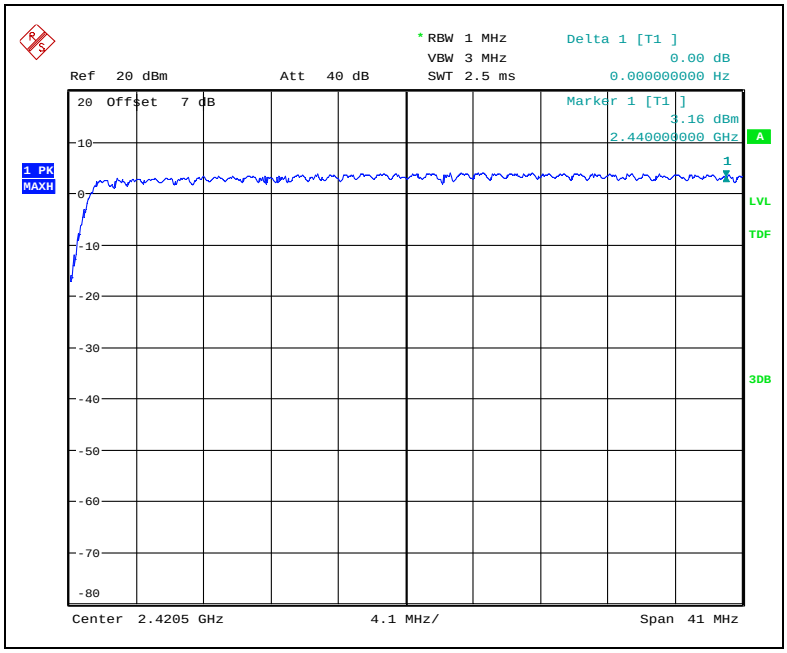
Figure 4. Plot of the Number of Hopping Channels (Conducted)

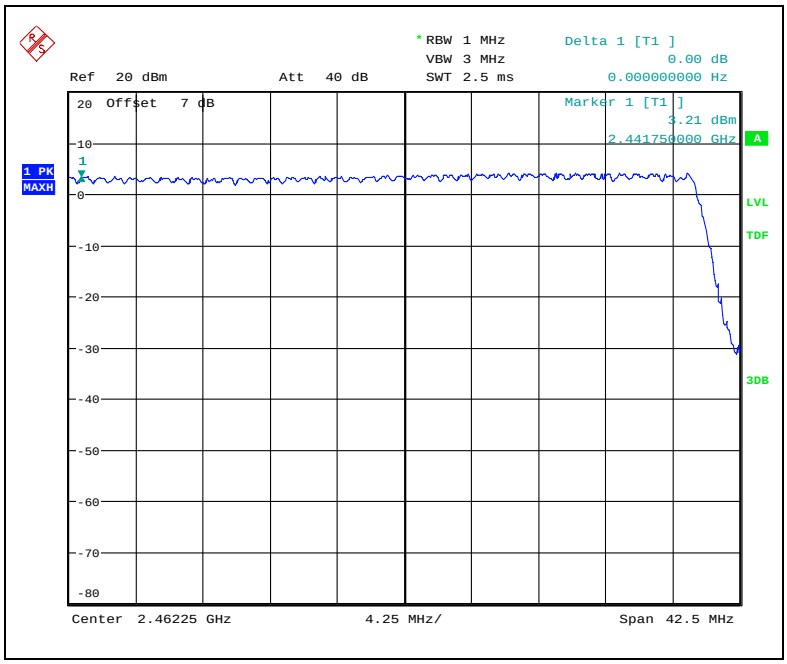
*** GFSK**



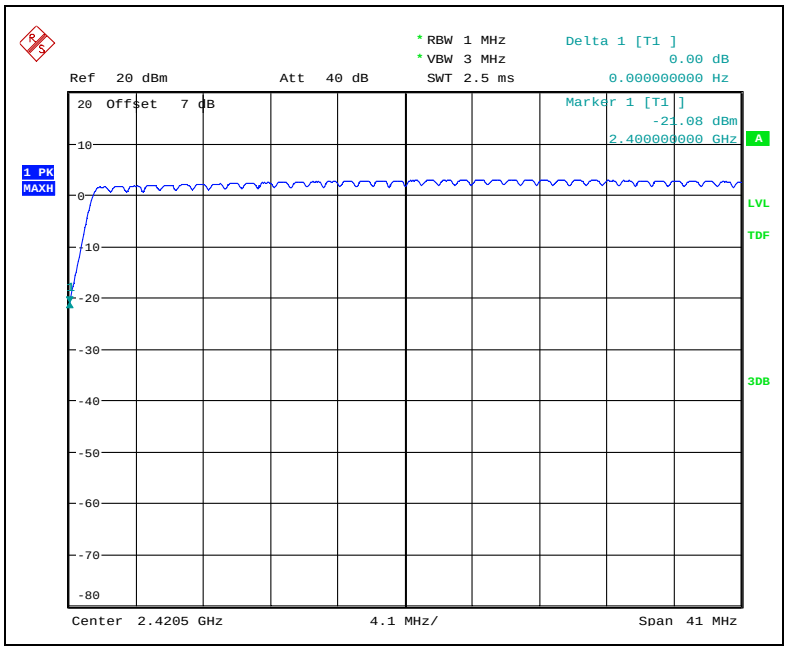



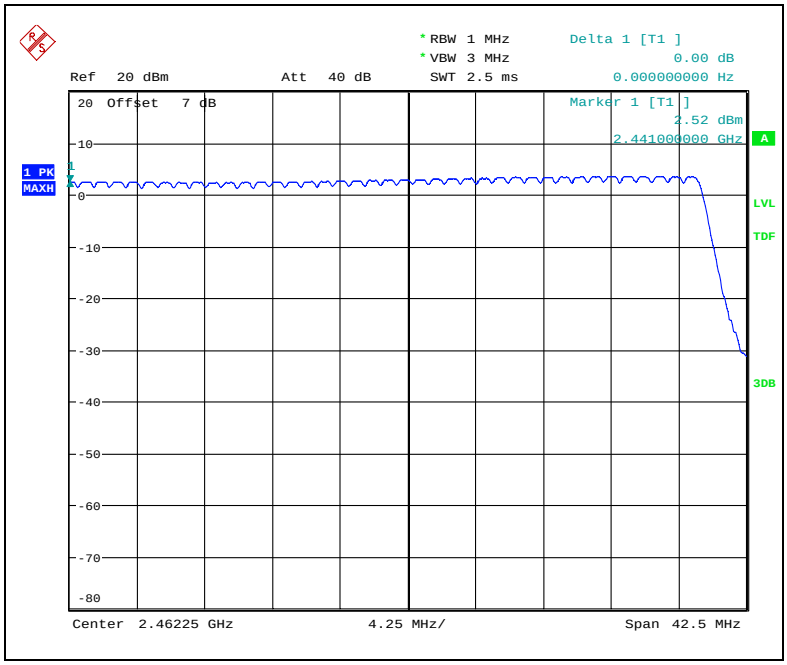
*** π/4DQPSK**



*** 8DPSK**



## 5.6 Time of Occupancy(Dwell Time)

### 5.6.1 Regulation

According to §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 ㎒ 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.

### 5.6.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester.
4. Set the spectrum analyzer as follows: Span = zero span, centered on a hopping channel RBW = 1 ㎒ VBW ≥ RBW Sweep = as necessary to capture the entire dwell time per hopping channel Detector function = peak Trace = max hold
5. Measure the dwell time using the marker-delta function.
6. Repeat above procedures until all frequencies measured were complete.
7. Repeat this test for different modes of operation (e.g., data rate, modulation format, etc.), if applicable.

## 5.6.3 Test Result

- Complied

| Hopping mode | Modulation | Packet Type | Reading[㎳] | Hopping rate [hop/s] | Number of Channels | Actual[s] | Limit[s] |
|---|---|---|---|---|---|---|---|
| Non-AFH | GFSK | DH1 | 0.394 | 800.000 | 79 | 0.126 | 0.40 |
| | | DH3 | 1.648 | 400.000 | 79 | 0.264 | 0.40 |
| | | DH5 | 2.904 | 266.667 | 79 | 0.310 | 0.40 |
| | π/4DQPSK | 2-DH1 | 0.408 | 800.000 | 79 | 0.131 | 0.40 |
| | | 2-DH3 | 1.659 | 400.000 | 79 | 0.265 | 0.40 |
| | | 2-DH5 | 2.910 | 266.667 | 79 | 0.310 | 0.40 |
| | 8DPSK | 3-DH1 | 0.406 | 800.000 | 79 | 0.130 | 0.40 |
| | | 3-DH3 | 1.659 | 400.000 | 79 | 0.265 | 0.40 |
| | | 3-DH5 | 2.904 | 266.667 | 79 | 0.310 | 0.40 |
| AFH | GFSK | DH1 | 0.394 | 400.000 | 20 | 0.063 | 0.40 |
| | | DH3 | 1.648 | 200.000 | 20 | 0.132 | 0.40 |
| | | DH5 | 2.904 | 133.333 | 20 | 0.155 | 0.40 |
| | π/4DQPSK | 2-DH1 | 0.408 | 400.000 | 20 | 0.065 | 0.40 |
| | | 2-DH3 | 1.659 | 200.000 | 20 | 0.133 | 0.40 |
| | | 2-DH5 | 2.910 | 133.333 | 20 | 0.155 | 0.40 |
| | 8DPSK | 3-DH1 | 0.406 | 400.000 | 20 | 0.065 | 0.40 |
| | | 3-DH3 | 1.659 | 200.000 | 20 | 0.133 | 0.40 |
| | | 3-DH5 | 2.904 | 133.333 | 20 | 0.155 | 0.40 |

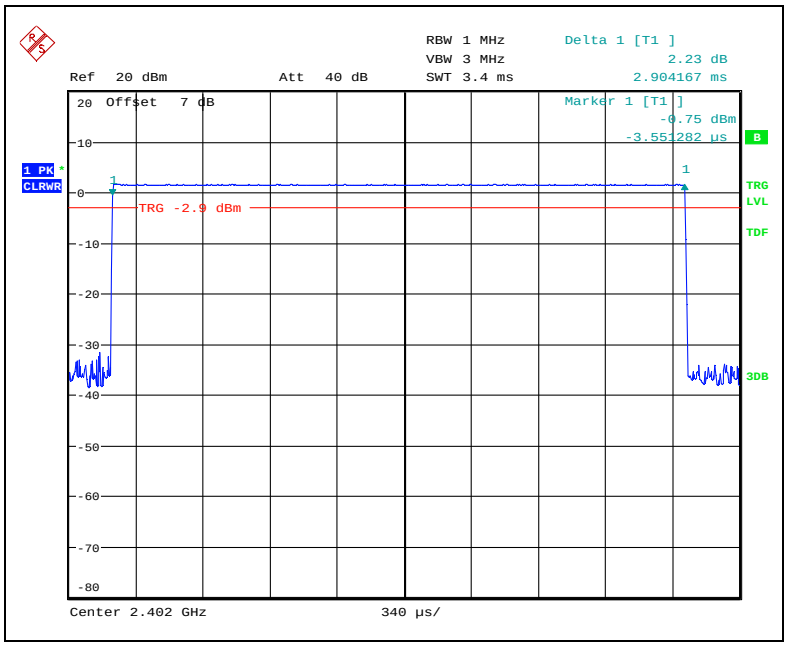
NOTE 1. Non AFH
Actual = Reading × (Hopping rate / Number of channels) × Test period
Hopping rate = 1 600/time slot
Test period = 0.4 [seconds / channel] × 79 [channel] = 31.6 [seconds]
2. AFH
Actual = Reading × (Hopping rate / Number of channels) × Test period
Hopping rate = 800/time slot
Test period = 0.4 [seconds / channel] × 20 [channel] = 8 [seconds]

## 5.6.4 Test Plot

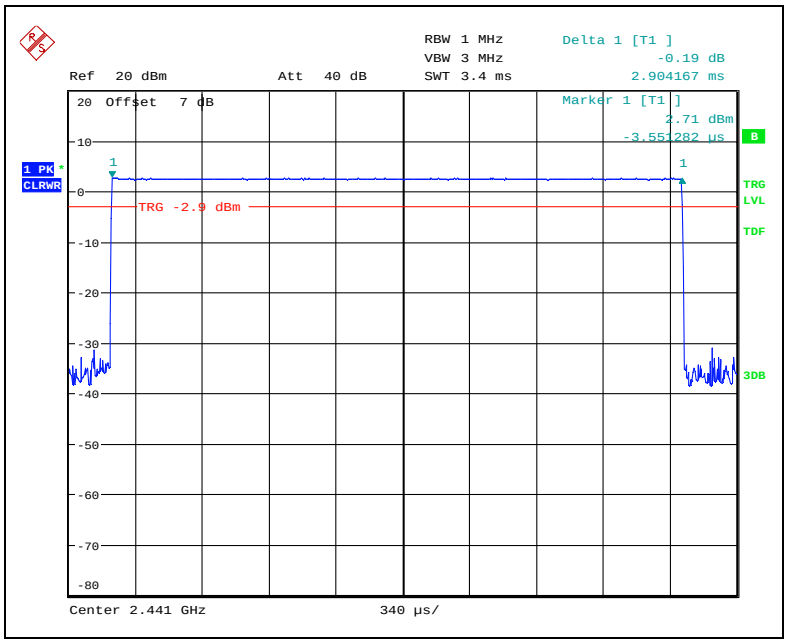
Figure 5. Plot of the Time of Occupancy (Conducted)

*** GFSK**

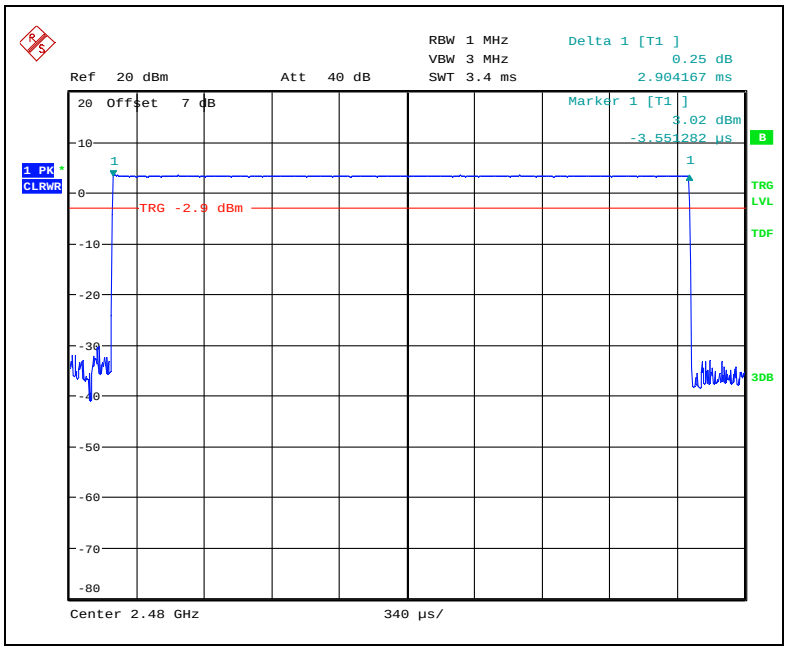
Lowest Channel( 2 402 ㎒)




Middle Channel (2 441 ㎒)

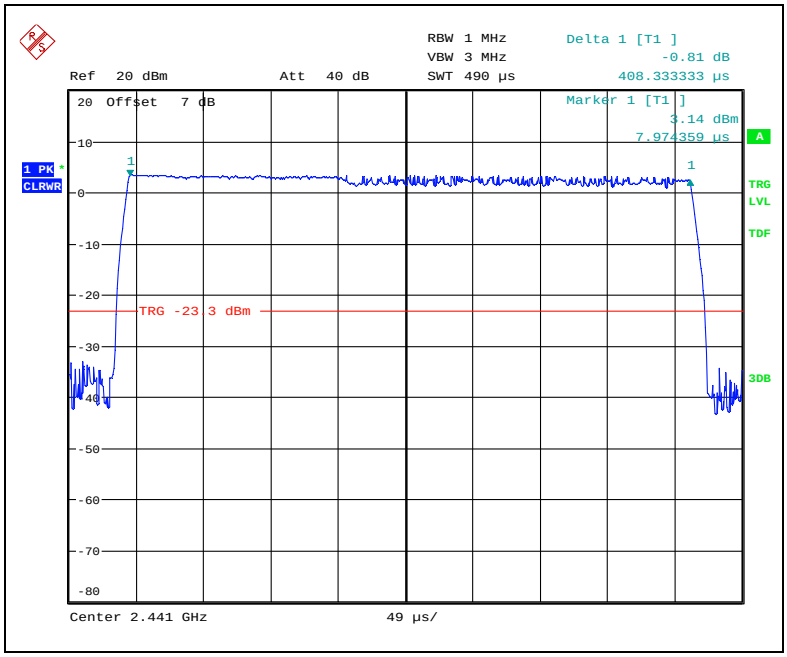


Highest Channel ( 2 480 ㎒)

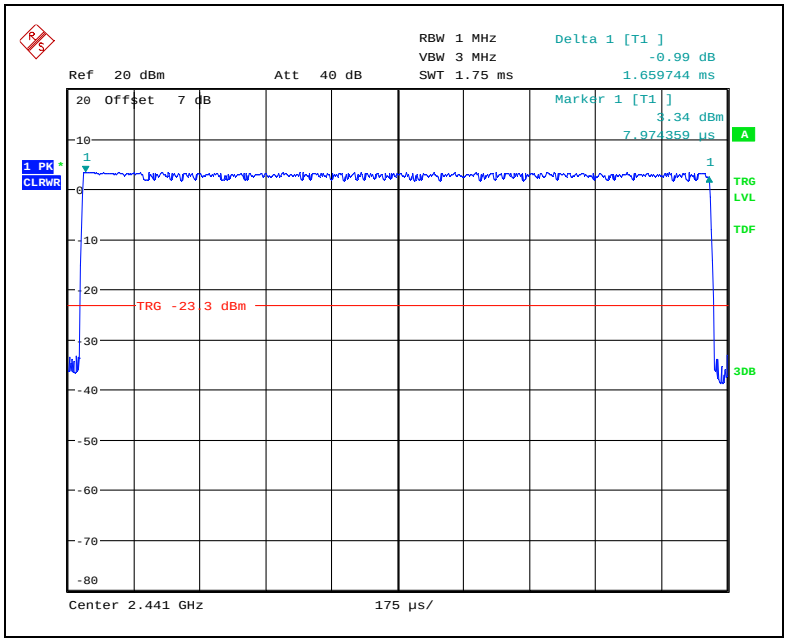



*** 8DPSK**

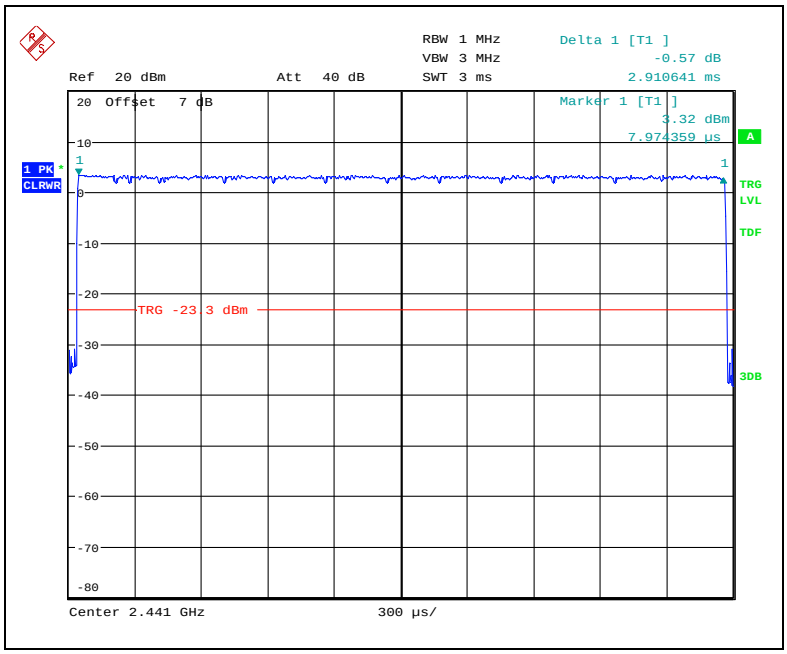
Lowest Channel( 2 402 ㎒)



Middle Channel (2 441 ㎒)

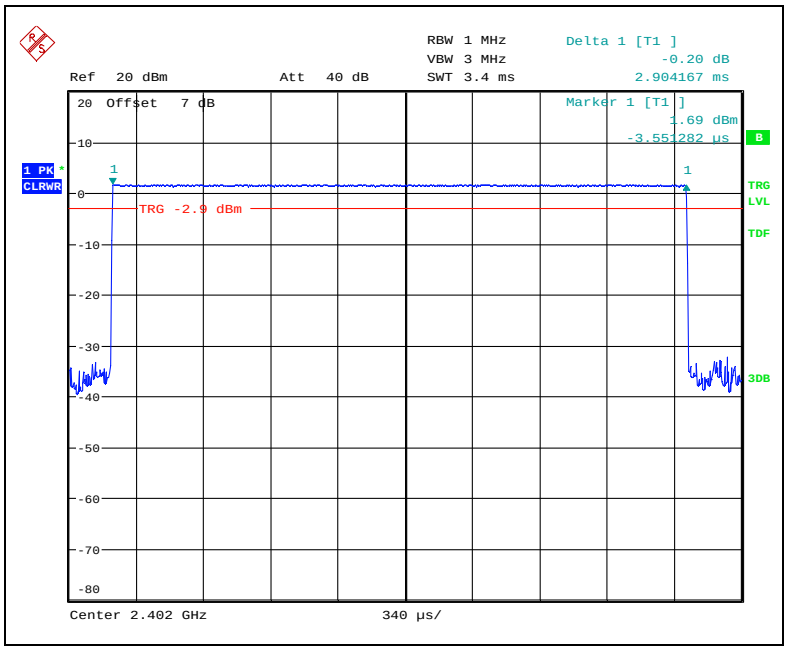



Highest Channel ( 2 480 ㎒)

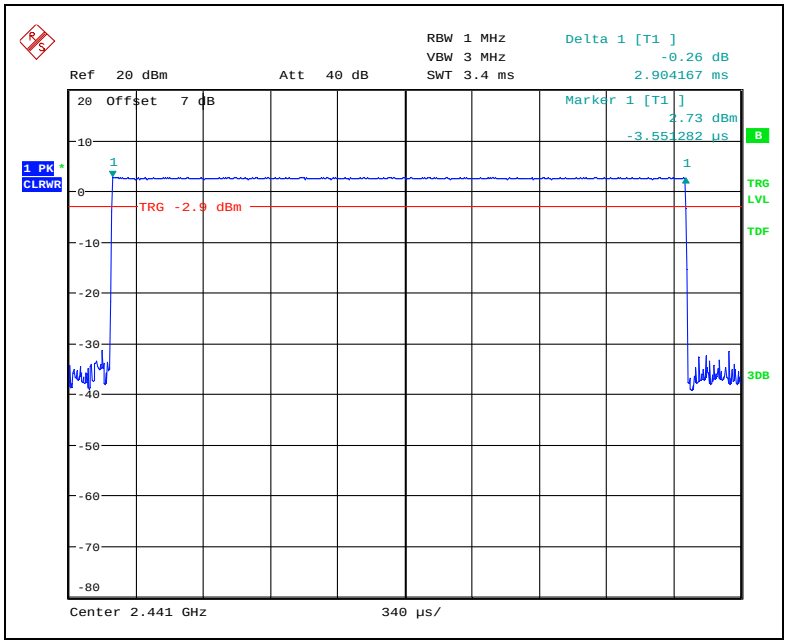


*** 8DPSK**

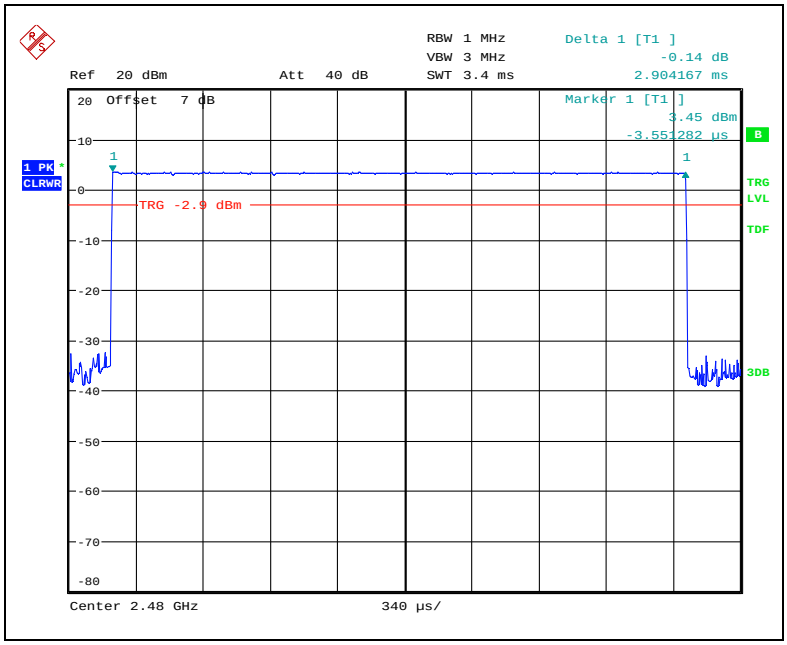
Lowest Channel( 2 402 ㎒)




Middle Channel (2 441 ㎒)



Highest Channel ( 2 480 ㎒)



## 5.7 Spurious Emission, Band edge and Restricted bands

### 5.7.1 Regulation

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

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

| Frequency (㎒) | Field strength (㎶/m) | Measurement distance (m) |
|---|---|---|
| 0.009 - 0.490 | 2400/F(㎑) | 300 |
| 0.490 -1.705 | 24000/F(㎑) | 30 |
| 1.705 – 30 | 30 | 30 |
| 30 - 88 | 100** | 3 |
| 88 - 216 | 150** | 3 |
| 216 - 960 | 200** | 3 |
| Above 960 | 500 | 3 |

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

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

| ㎒ | ㎒ | ㎒ | ㎓ |
|---|---|---|---|
| 0.009 - 0.110 | 16.42 - 16.423 | 399.9 - 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 - 38.25 | 1435 - 1626.5 | 9.0 - 9.2 |
| 4.20725 - 4.20775 | 73 - 74.6 | 1645.5 - 1646.5 | 9.3 - 9.5 |
| 6.215 - 6.218 | 74.8 - 75.2 | 1660 - 1710 | 10.6 - 12.7 |
| 6.26775 - 6.26825 | 108 - 121.94 | 1718.8 - 1722.2 | 13.25 - 13.4 |
| 6.31175 - 6.31225 | 123 - 138 | 2200 - 2300 | 14.47 - 14.5 |
| 8.291 - 8.294 | 149.9 - 150.05 | 2310 - 2390 | 15.35 - 16.2 |
| 8.362 - 8.366 | 156.52475 - 156.52525 | 2483.5 - 2500 | 17.7 - 21.4 |
| 8.37625 - 8.38675 | 156.7 - 156.9 | 2690 - 2900 | 22.01 - 23.12 |
| 8.41425 - 8.41475 | 162.0125 - 167.17 | 3260 - 3267 | 23.6 - 24.0 |
| 12.29 - 12.293 | 167.72 - 173.2 | 3332 - 3339 | 31.2 - 31.8 |
| 12.51975 - 12.52025 | 240 - 285 | 3345.8 - 3358 | 36.43 - 36.5 |
| 12.57675 - 12.57725 | 322 - 335.4 | 3600 - 4400 | 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.

## 5.7.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1) Band-edge Compliance of RF Conducted Emissions

1. Set the spectrum analyzer as follows:
   Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
   RBW ≥ 1% of the span
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. Allow the trace to stabilize. Set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
3. Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

2) Spurious RF Conducted Emissions:

1. Set the spectrum analyzer as follows:
   Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
   RBW = 100 ㎑
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
   a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
3. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

3) Spurious Radiated Emissions:

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.
2. The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.
3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 ㎑ to 30 ㎒ using the loop antenna, and from 30 to 1000 ㎒ using the TRILOG broadband antenna, and from 1000 ㎒ to 26500 ㎒ using the horn antenna.
4. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
5. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

Note

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 ㎓.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 10 ㎐ for Average detection (AV) at frequency above 1㎓.

## 5.7.3 Test Result

## - Complied

1. Band edge compliance of RF Conducted Emissions was shown in figure 6.
2. Measured value of the Field strength of spurious Emissions (Radiated)
3. It tested x,y and z – 3 axis each, mentioned only worst case data at this report.

*** Below 1 ㎓ data (Worst-case: π/4DQPSK)**

**π/4DQPSK_Highest channel (2 480 ㎒)**

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Factor [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| **Quasi-Peak DATA. Emissions below 30 ㎒** | | | | | | | |
| Below 30.00 | Not Detected | - | - | - | - | - | - |
| **Quasi-Peak DATA. Emissions below 1 ㎓** | | | | | | | |
| 36.68 | 120 | V | 29.7 | -23.9 | 5.8 | 40.0 | 34.2 |
| 108.83 | 120 | V | 36.5 | -23.7 | 12.8 | 43.5 | 30.7 |
| 360.01 | 120 | H | 49.2 | -18.3 | 30.9 | 46.0 | 15.1 |
| Above 400.00 | **Not Detected** | - | - | - | - | - | - |

*** Above 1 ㎓ data**

**GFSK _Low channel (2 402 ㎒)**

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Factor [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| **Peak DATA. Emissions above 1 ㎓** | | | | | | | |
| *2 322.71 | 1 000 | H | 48.0 | 0.1 | 48.1 | 74.0 | 25.9 |
| Above 3 000.00 | **Not Detected** | - | - | - | - | - | - |
| **Average DATA. Emissions above 1 ㎓** | | | | | | | |
| *2 322.71 | 1 000 | H | 36.5 | 0.1 | 36.6 | 54.0 | 17.4 |
| Above 3 000.00 | **Not Detected** | - | - | - | - | - | - |

* This Asterisk means restricted band.

**GFSK _Middle channel (2 441 ㎒)**

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Factor [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| **Peak DATA. Emissions above 1 ㎓** | | | | | | | |
| - | **Not Detected** | - | - | - | - | - | - |
| **Average DATA. Emissions above 1 ㎓** | | | | | | | |
| - | **Not Detected** | - | - | - | - | - | - |

**GFSK _High channel (2 480 ㎒)**

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Factor [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| **Peak DATA. Emissions above 1 ㎓** | | | | | | | |
| 2 463.10 | 1 000 | H | 50.4 | 0.6 | 51.0 | 74.0 | 23.0 |
| *2 484.49 | 1 000 | H | 50.7 | 0.7 | 51.4 | 74.0 | 22.6 |
| Above 3 000.00 | **Not Detected** | - | - | - | - | - | - |
| **Average DATA. Emissions above 1 ㎓** | | | | | | | |
| 2 463.10 | 1 000 | H | 36.4 | 0.6 | 37.0 | 54.0 | 17.0 |
| *2 484.49 | 1 000 | H | 36.7 | 0.7 | 37.4 | 54.0 | 16.6 |
| Above 3 000.00 | **Not Detected** | - | - | - | - | - | - |

* This Asterisk means restricted band.

**8DPSK _Low channel (2 402 ㎒)**

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Factor [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| **Peak DATA. Emissions above 1 ㎓** | | | | | | | |
| *2 320.08 | 1 000 | H | 48.3 | 0.1 | 48.4 | 74.0 | 25.6 |
| Above 3 000.00 | **Not Detected** | - | - | - | - | - | - |
| **Average DATA. Emissions above 1 ㎓** | | | | | | | |
| *2 320.08 | 1 000 | H | 36.1 | 0.1 | 36.2 | 54.0 | 17.8 |
| Above 3 000.00 | **Not Detected** | | | | | | |

**8DPSK _Middle channel (2 441 ㎒)**

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Factor [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| **Peak DATA. Emissions above 1 ㎓** | | | | | | | |
| - | **Not Detected** | - | - | - | - | - | - |
| **Average DATA. Emissions above 1 ㎓** | | | | | | | |
| - | **Not Detected** | - | - | - | - | - | - |

**8DPSK _High channel (2 480 ㎒)**

| Frequency [㎒] | Receiver Bandwidth [㎑] | Pol. [V/H] | Reading [dB(㎶)] | Factor [dB] | Result [dB(㎶/m)] | Limit [dB(㎶/m)] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| **Peak DATA. Emissions above 1 ㎓** | | | | | | | |
| *2 483.57 | 1 000 | H | 50.5 | 0.7 | 51.2 | 74.0 | 22.8 |
| Above 3 000.00 | **Not Detected** | - | - | - | - | - | - |
| **Average DATA. Emissions above 1 ㎓** | | | | | | | |
| *2 483.57 | 1 000 | H | 40.5 | 0.7 | 41.2 | 54.0 | 12.8 |
| Above 3 000.00 | **Not Detected** | | | | | | |

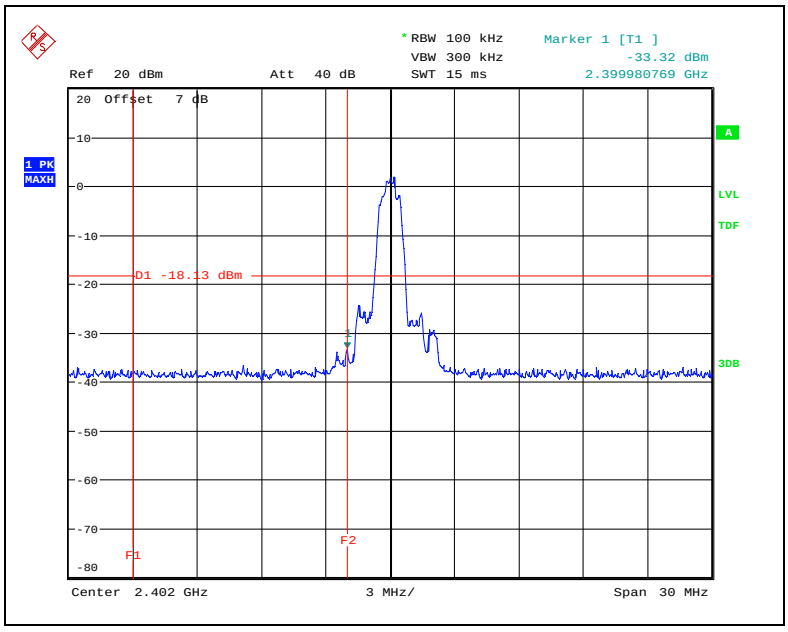
* This Asterisk means restricted band.

## 5.7.4 Test Plot

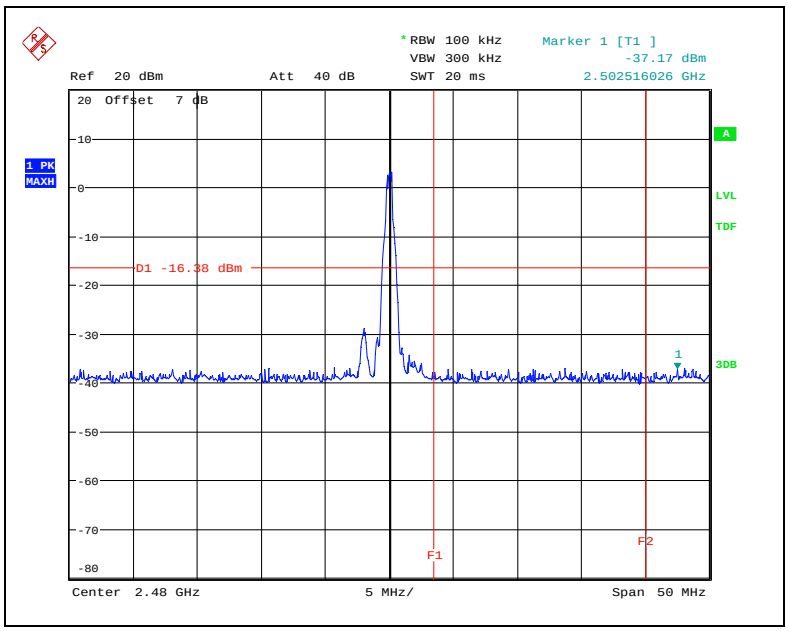
Figure 6. Plot of the Band Edge (Conducted)

*** GFSK (Without hopping)**

Lowest Channel( 2 402 ㎒)

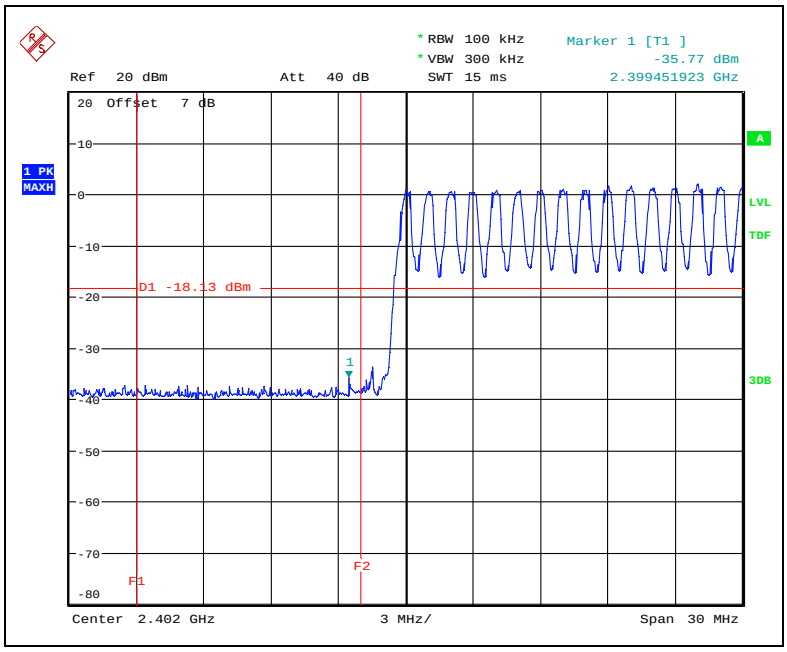



Highest Channel (2 480 ㎒)

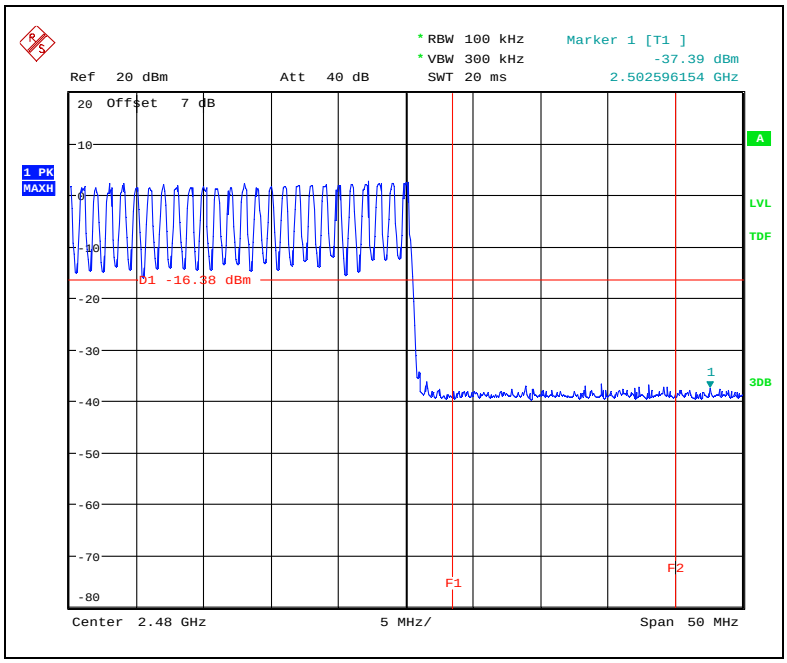


*** GFSK (With hopping)**

Lowest Channel( 2 402 ㎒)

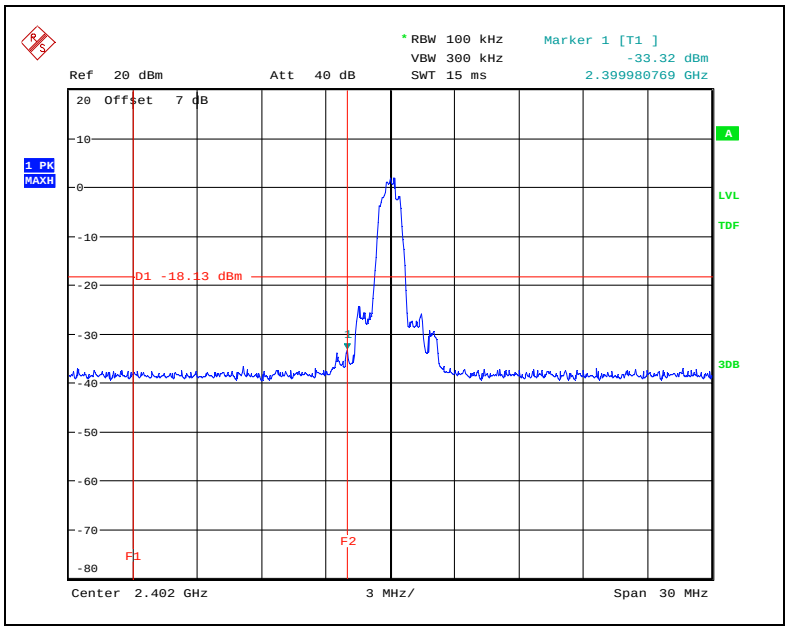



Highest Channel (2 480 ㎒)

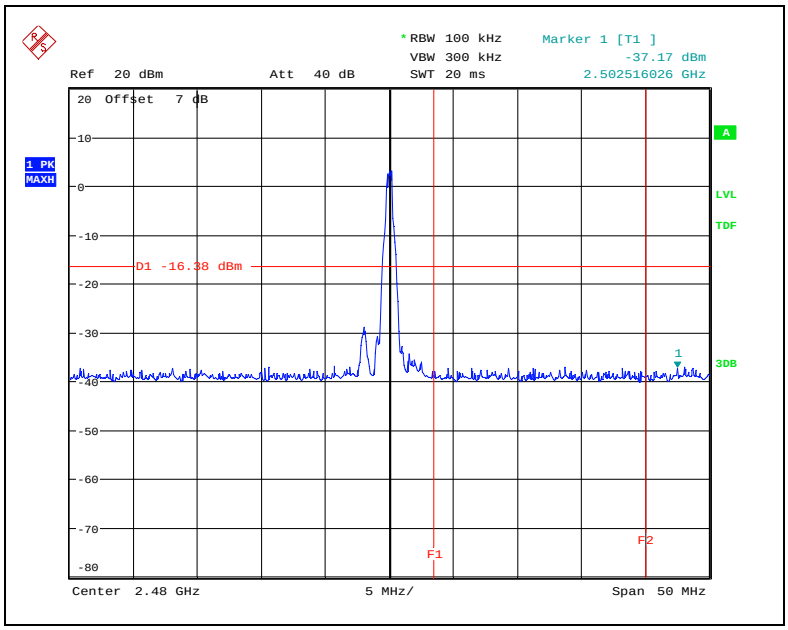


*** GFSK (Without hopping)**

Lowest Channel( 2 402 ㎒)

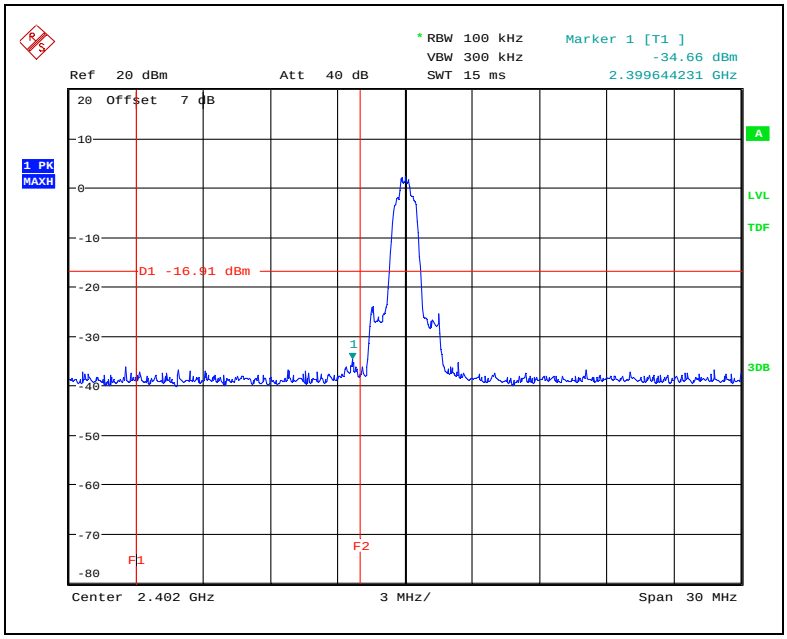



Highest Channel (2 480 ㎒)

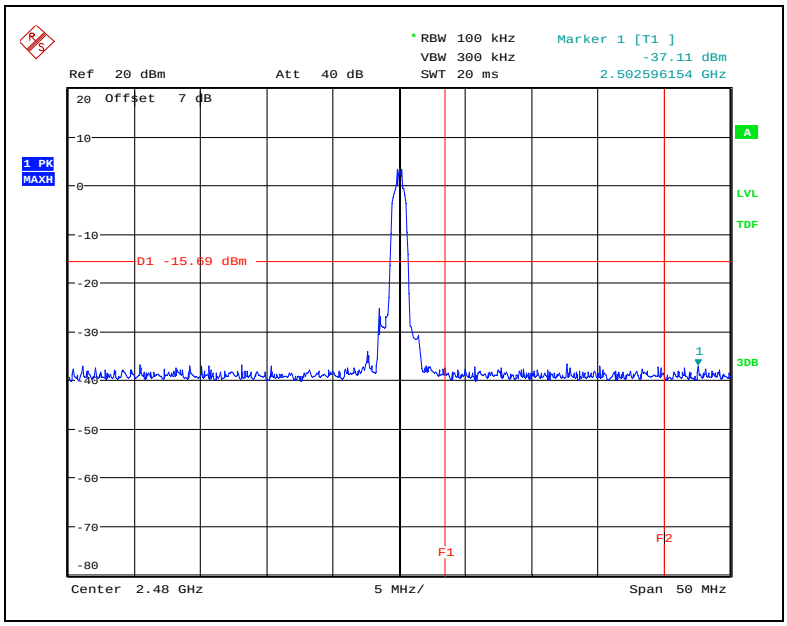


*** π/4DQPSK (With hopping)**

Lowest Channel( 2 402 ㎒)

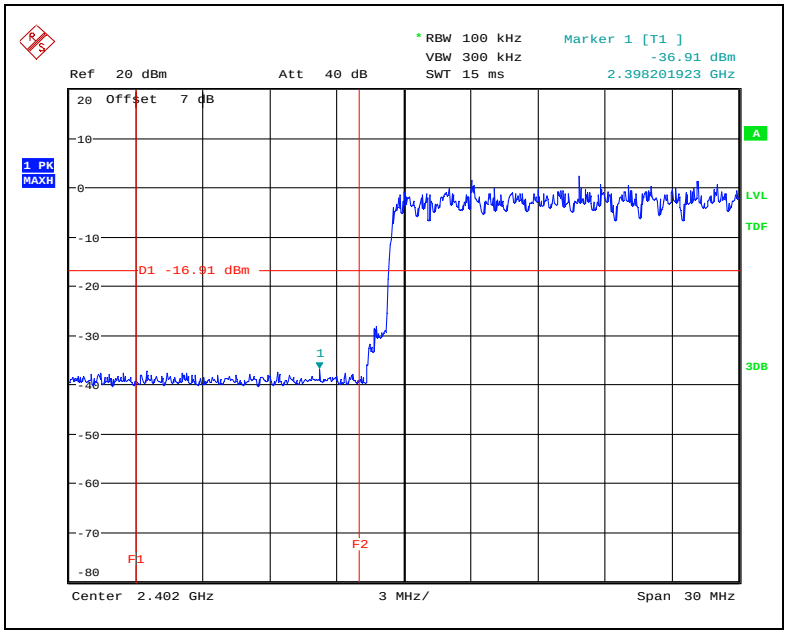



Highest Channel (2 480 ㎒)

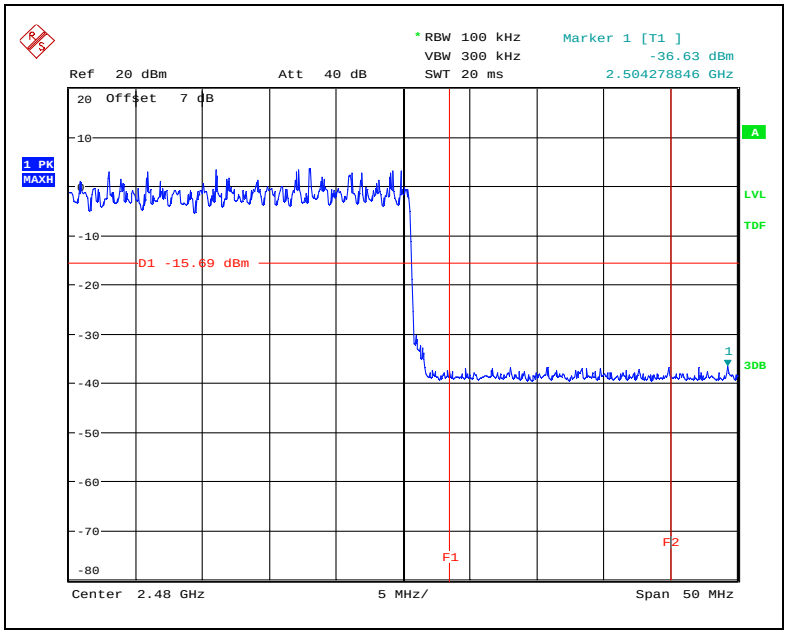


*** π/4DQPSK (Without hopping)**

Lowest Channel( 2 402 ㎒)

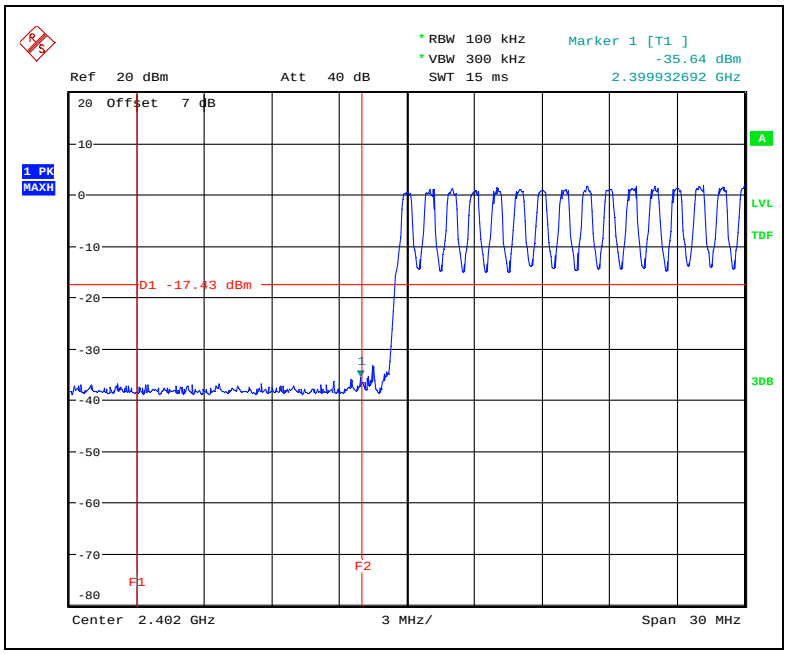



Highest Channel (2 480 ㎒)



*** 8DPSK (With hopping)**

Lowest Channel( 2 402 ㎒)




Highest Channel (2 480 ㎒)

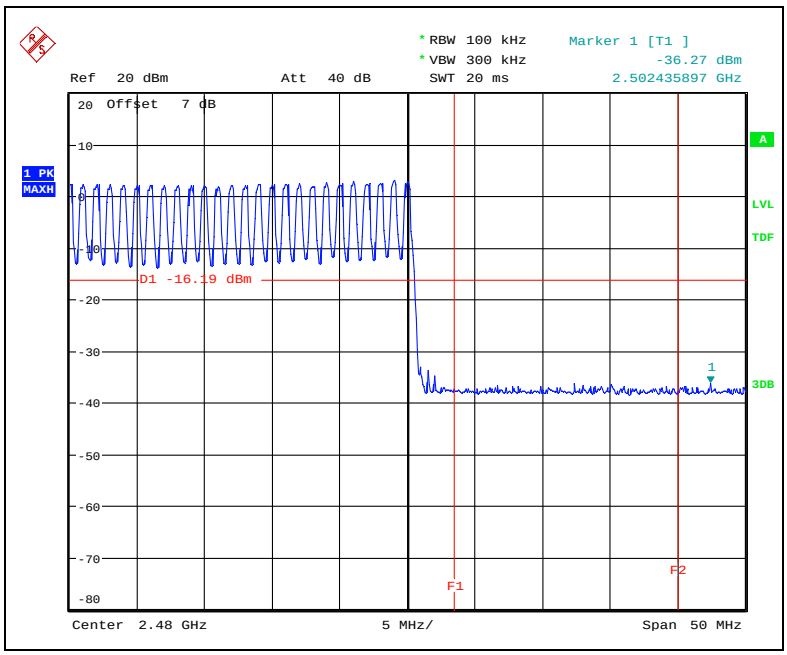
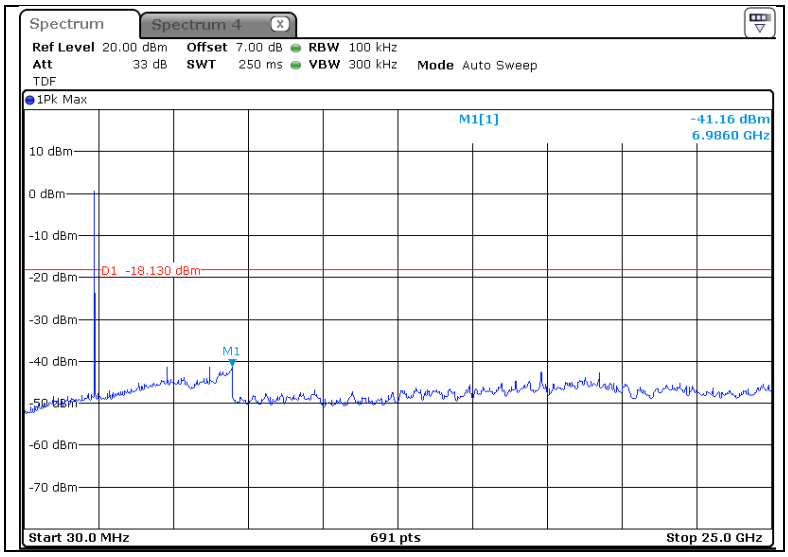


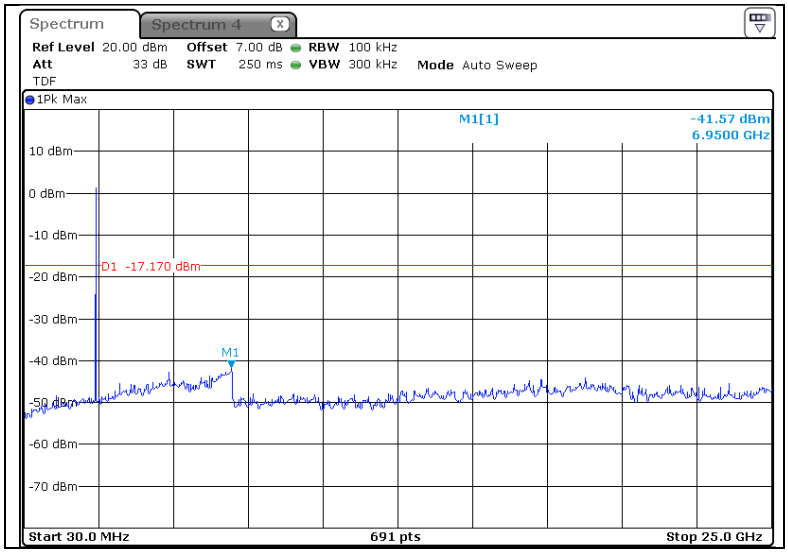
Figure 7. Plot of the Spurious RF conducted emissions

*** GFSK**

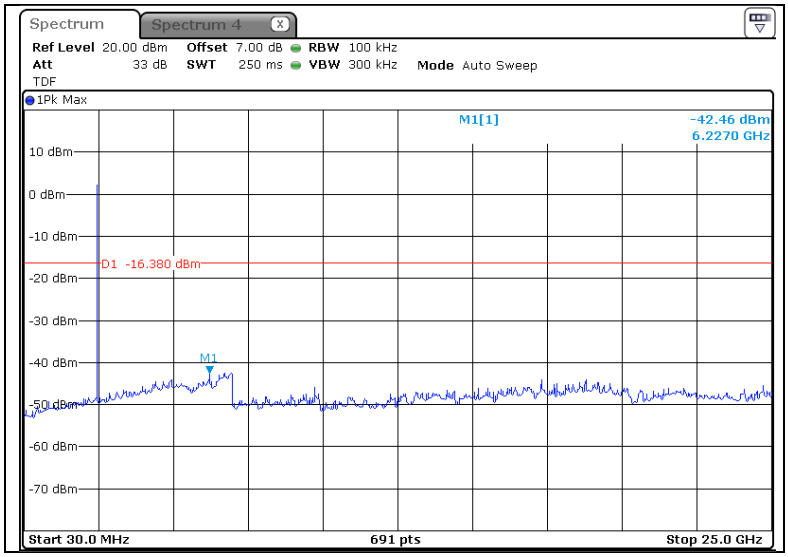
Lowest Channel ( 2 402 ㎒)




Middle Channel (2 441 ㎒)

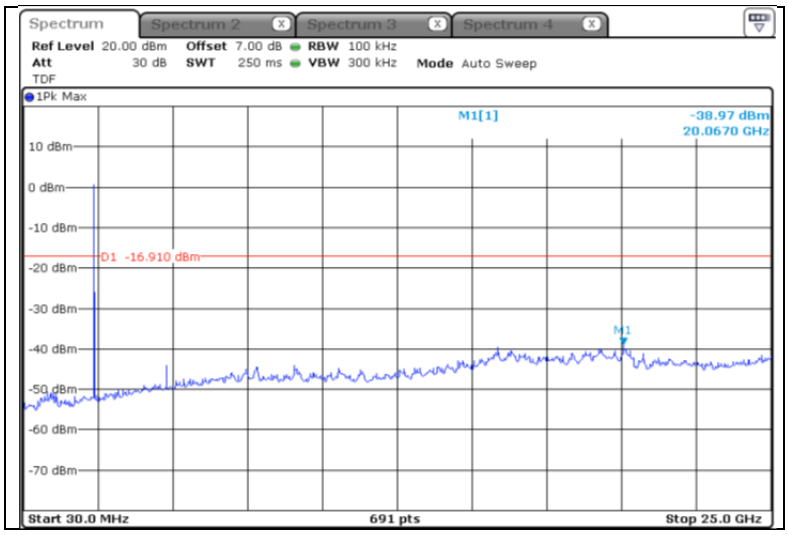


Highest Channel ( 2 480 ㎒)

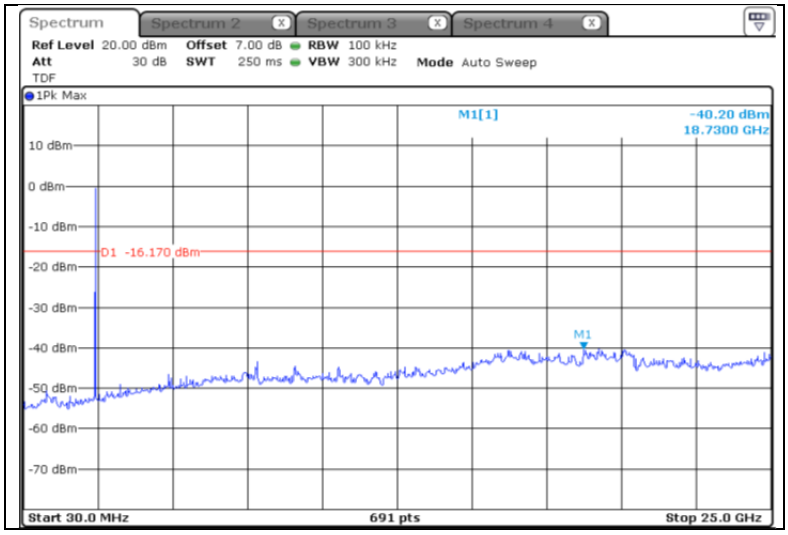



*** 8DPSK**

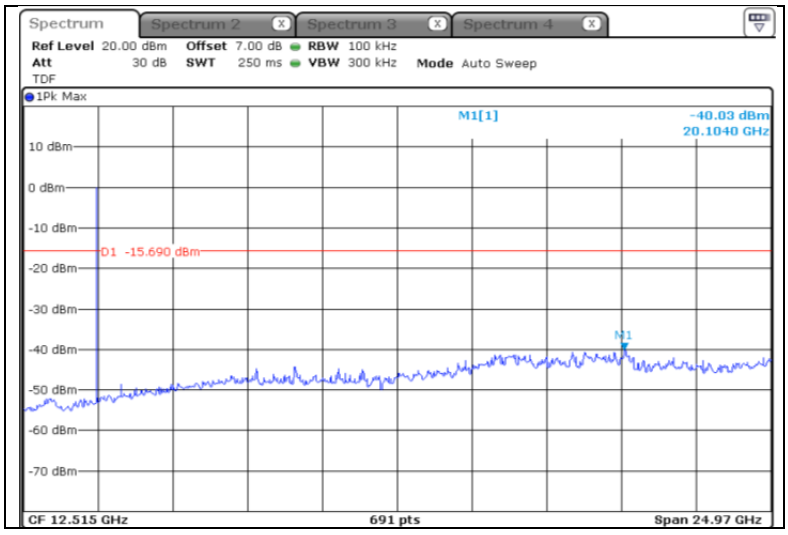
Lowest Channel ( 2 402 ㎒)



Middle Channel (2 441 ㎒)

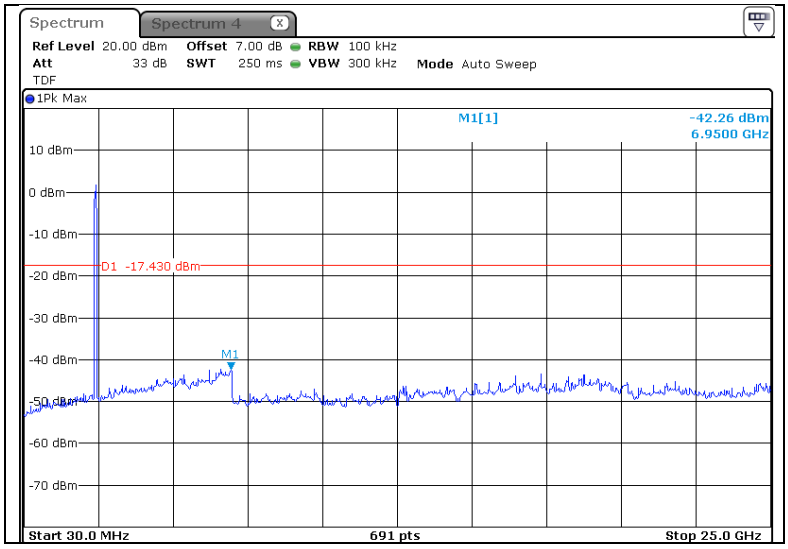



Highest Channel ( 2 480 ㎒)

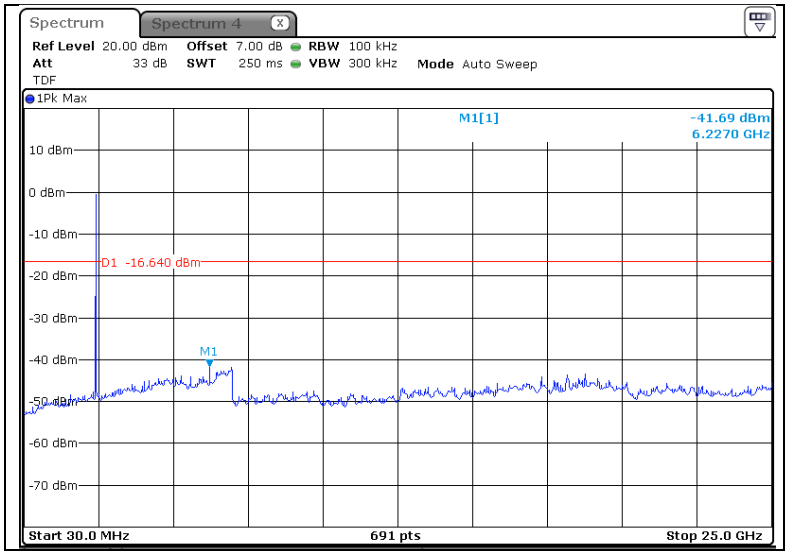


*** 8DPSK**

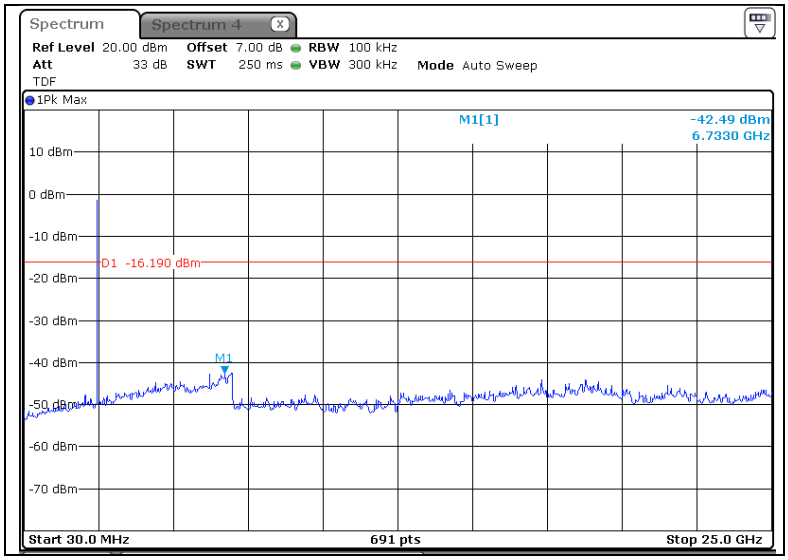
Lowest Channel ( 2 402 ㎒)




Middle Channel (2 441 ㎒)



Highest Channel ( 2 480 ㎒)



# 6. Test equipment used for test

| | Description | Manufacturer | Model No. | Serial No. | Next Cal Date. |
|---|---|---|---|---|---|
| ■ | Spectrum Analyzer | R&S | FSV30 | 101437 | 15.12.11 |
| ■ | Spectrum Analyzer | R&S | FSG13 | 100051 | 16.02.03 |
| ■ | Wideband Power Sensor | R&S | NRP-Z81 | 100677 | 16.01.26 |
| ■ | DC Power Supply | AGILENT | E3632A | MY40004399 | 16.01.06 |
| ■ | Loop Antenna | R&S | HFH2-Z2 | 861971/003 | 17.03.03 |
| ■ | Bi-Log Antenna | SCHWARZBECK | VULB9163 | 552 | 16.06.14 |
| ■ | Horn Antenna | SCHWARZBECK | 3117 | 155787 | 16.02.05 |
| ■ | Horn Antenna | ETS.lindgren | 3116 | 86632 | 15.10.20 |
| ■ | Amplifier | SONOMA INSTRUMENT | 310 | 293004 | 15.09.25 |
| ■ | Emi Test Receiver | R&S | ESCI | 101078 | 16.02.16 |
| ■ | Broadband Preamplifier | SCHWARZBECK | BBV9721 | 2 | 16.05.19 |
| ■ | Broadband Preamplifier | SCHWARZBECK | BBV9718 | 9718-233 | 16.04.13 |
| ■ | Power Divider | Aeroflex/ Weinschel,Inc | 1580-1 | NX380 | 16.08.02 |
| ■ | Attenuator | HP | 8494A | 2631A09825 | 15.10.14 |
| ■ | Attenuator | HP | 8496A | 3308A16640 | 15.10.14 |
| ■ | Highpass Filter | Wainwright Instruments GmbH | WHKX3.0/ 18G-12SS | 44 | 16.02.02 |
| ■ | Antenna Mast | Innco Systems | MA4000-EP | - | - |
| ■ | Turn Table | Innco Systems | DT2000 | - | - |