HCT CO.,LTD
74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea
TEL: +82-31-645-6300 FAX: +82-31-645-6401

# FCC BT REPORT

## FCC Certification

**Applicant Name:**
LG Electronics MobileComm U.S.A., Inc.

**Address:**
1000 Sylvan Avenue, Englewood Cliffs NJ 07632

**Date of Issue:**
September 18, 2015
**Test Site/Location:**
HCT CO., LTD., 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea
**Report No.:** HCT-R-1509-F029
**HCT FRN:** 0005866421

| | |
|---|---|
| **FCC ID** | **: ZNFH650** |
| **APPLICANT** | **: LG Electronics MobileComm U.S.A., Inc.** |

| | |
|---|---|
| **FCC Model(s):** | LG-H650 |
| **EUT Type:** | Cellular/PCS GSM/WCDMA/LTE Phone with WLAN and Bluetooth |
| **Max. RF Output Power:** | 9.503 dBm ( 8.919 mW) |
| **Frequency Range:** | 2402 MHz - 2480 MHz (Bluetooth) |
| **Modulation type** | GFSK(Normal), π/4DQPSK and 8DPSK(EDR) |
| **FCC Classification:** | FCC Part 15 Spread Spectrum Transmitter |
| **FCC Rule Part(s):** | Part 15 subpart C 15.247 |

Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

**HCT CO., LTD.** Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)

**Report prepared by**
**: Kyung Soo Kang**
**Test Engineer of RF Team**

**Approved by**
**: Sang Jun Lee**
**Manager of RF Team**

# Version

| TEST REPORT NO. | DATE | DESCRIPTION |
|---|---|---|
| HCT-R-1509-F029 | September 18, 2015 | - First Approval Report |
| | | |
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# 1. GENERAL INFORMATION

| | |
|---|---|
| **Applicant:** | LG Electronics MobileComm U.S.A., Inc |
| **Address:** | 1000 Sylvan Avenue, Englewood Cliffs NJ 07632 |
| **FCC ID:** | ZNFH650 |
| **EUT Type:** | Cellular/PCS GSM/WCDMA/LTE Phone with WLAN and Bluetooth |
| **Model name(s):** | LG-H650 |
| **Date(s) of Tests:** | August 24, 2015 ~ September 17, 2015 |
| **Place of Tests:** | HCT Co., Ltd.<br>74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea<br>(IC Recognition No. : 5944A-5) |

# 2. EUT DESCRIPTION

| | |
|---|---|
| **FCC Model Name** | LG-H650 |
| **EUT Type** | Cellular/PCS GSM/WCDMA/LTE Phone with WLAN and Bluetooth |
| **Power Supply** | DC 3.8 V |
| **Battery Infomation** | Model: BL-T22<br>Type: Li-ion Battery(Standard) |
| **Frequency Range** | 2402 MHz - 2480 MHz (Bluetooth) |
| **Transmit Power** | 9.503 dBm (8.919 mW) |
| **BT Operating Mode** | Normal, EDR, AFH |
| **Modulation Type** | GFSK(Normal), π/4DQPSK and 8DPSK(EDR) |
| **Modulation Technique** | FHSS |
| **Number of Channels** | 79Channels, Minimum 20 Channels(AFH) |
| **Antenna Specification** | Manufacturer: AT&C<br>Antenna type: INTERNAL<br>ANTENNA Peak Gain : -1.78 dBi |

**※ 15.247 Requirements for Bluetooth transmitter**

▪ This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:

1) This system is hopping pseudo-randomly.

2) Each frequency is used equally on the average by each transmitter.

3) The receiver input bandwidths that match the hopping channel bandwidths of their corresponding transmitters

4) The receiver shifts frequencies in synchronization with the transmitted signals.

▪ 15.247(g): The system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this Section 15.247 should the transmitter be presented with a continuous data (or information) stream.

▪ 15.247(h): The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

# 3. TEST METHODOLOGY

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and FCC Public Notice DA 00-705 dated March 30, 2000 entitled “Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems” were used in the measurement of the

**LG Electronics MobileComm U.S.A., Inc. Cellular/PCS GSM/WCDMA/LTE Phone with WLAN and Bluetooth FCC ID: ZNFH650**

## 3.1 EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

## 3.2 EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

## 3.3 GENERAL TEST PROCEDURES

**Conducted Emissions**

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

**Radiated Emissions**

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013). To record the final measurements, the analyzer detector function was set to CISPR quasi-peak mode and the bandwidth of the spectrum analyzer was set to 120 kHz for frequencies below 1 GHz or 1 MHz for frequencies above 1 GHz. For average measurements above 1 GHz, the analyzer was set to peak detector with a reduced VBW setting(RBW = 1 MHz, VBW = 1/T Hz, where T = Pulse width).

**Conducted Antenna Terminal**

See Section from 7.8.2 to 7.8.8.(ANSI 63.10-2013)

### 3.4 DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
Channel low, mid and high with highest data rate (worst case) is chosen for full testing.

## 4. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipments, which is traceable to recognized national standards.

## 5. FACILITIES AND ACCREDITATIONS

### 5.1 FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22. Detailed description of test facility was submitted to the Commission and accepted dated July 07, 2015 (Registration Number: 90661)

### 5.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

## 6. ANTENNA REQUIREMENTS

**According to FCC 47 CFR §15.203:**

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antennas of this E.U.T are permanently attached.
*The E.U.T Complies with the requirement of §15.203

# 7. SUMMARY OF TEST RESULTS

| Test Description | FCC Part Section(s) | Test Limit | Test Condition | Test Result |
|---|---|---|---|---|
| 20 dB Bandwidth | §15.247(a)(1)(ii) or (iii) | N/A | CONDUCTED | PASS |
| Occupied Bandwidth | N/A | N/A | | N/A |
| Conducted Maximum Peak Output Power | §15.247(b)(1) | < 1 W if ≥ 75 non-overlapping hopping channels used<br>< 0.125 W if < 75 non-overlapping hopping channels used | | PASS |
| Carrier Frequency Separation | §15.247(a)(1) | >25 kHz or<br>>2/3 of the 20dB BW | | PASS |
| Number of Hopping Frequencies | §15.247(a)(1)(iii) | ≥ 15 | | PASS |
| Time of Occupancy | §15.247(a)(1)(iii) | <400 ms | | PASS |
| Conducted Spurious Emissions | §15.247(d) | > 20 dB for<br>all out-of band emissions | | PASS |
| Band Edge(Out of Band Emissions) | §15.247(d) | > 20 dB for<br>all out-of band emissions | | PASS |
| AC Power line Conducted Emissions | §15.207(a) | cf. Section 8.7 | | PASS |
| Radiated Spurious Emissions | §15.247(d), 15.205, 15.209 | cf. Section 8.6.2 | RADIATED | PASS |
| Radiated Restricted Band Edge | §15.247(d), 15.205, 15.209 | cf. Section 8.6.3 | | PASS |

# 8. FCC PART 15.247 REQUIREMENTS

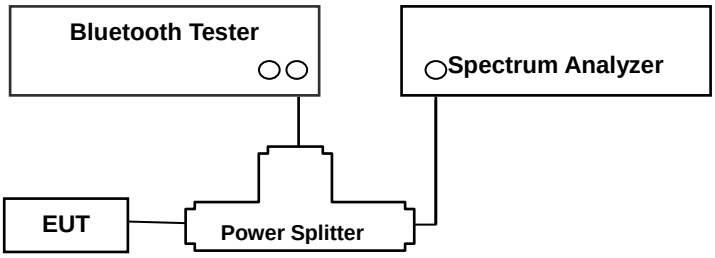
## 8.1 PEAK POWER

### LIMIT

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

1. For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 W. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 W.
2. 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.

### Test Configuration




### TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer. The Spectrum Analyzer is set to the peak detector mode. This test is performed with hopping off.

The Spectrum Analyzer is set to (7.8.5 in ANSI 63.10-2013)

1) Span: approximately 5 times the 20 dB bandwidth, centered on a hopping channel
2) RBW > the 20 dB bandwidth of the emission being measured
3) VBW ≥ RBW
4) Sweep = Auto
5) Detector = Peak
6) Trace = Max hold

### SAMPLE CALCULATION

Output Power = Spectrum Reading Power + Power Splitter loss + Cable loss(2 ea)

= 10 dBm + 6 dB + 1.5 dB = 17.5 dBm

Note :

1. Spectrum reading values are not plot data. The power results in plot is already including the actual values of loss for the splitter and cable combination.
2. Spectrum offset = Power Splitter loss + Cable loss

3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. Actual value of loss for the splitter and cable combination is 6.51 dB at 2402 MHz and is 6.54 dB at 2480 MHz.
   So, 6.5 dB is offset. And the offset gap in the 2.4 GHz range do not affect the conducted peak power final result

**TEST RESULTS**

No non-compliance noted

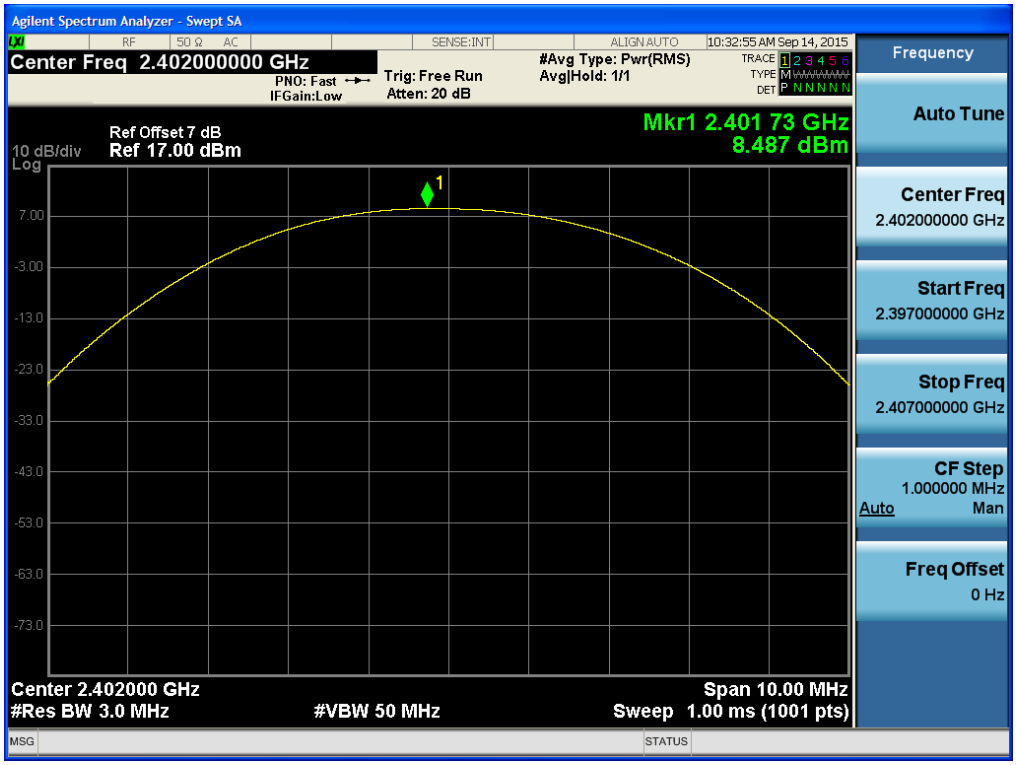
**Test Data**

| Channel | Frequency (MHz) | Output Power (GFSK) | | Limit (mW) | Result |
|---|---|---|---|---|---|
| | | (dBm) | (mW) | | |
| Low | 2402 | 8.487 | 7.058 | 125 | PASS |
| Mid | 2441 | 9.203 | 8.323 | | PASS |
| High | 2480 | 8.973 | 7.894 | | PASS |

| Channel | Frequency (MHz) | Output Power (8DPSK) | | Output Power (π/4DQPSK) | | Limit (mW) | Result |
|---|---|---|---|---|---|---|---|
| | | (dBm) | (mW) | (dBm) | (mW) | | |
| Low | 2402 | 8.829 | 7.637 | 8.606 | 7.254 | 125 | PASS |
| Mid | 2441 | 9.503 | 8.919 | 9.276 | 8.464 | | PASS |
| High | 2480 | 9.244 | 8.402 | 9.046 | 8.028 | | PASS |

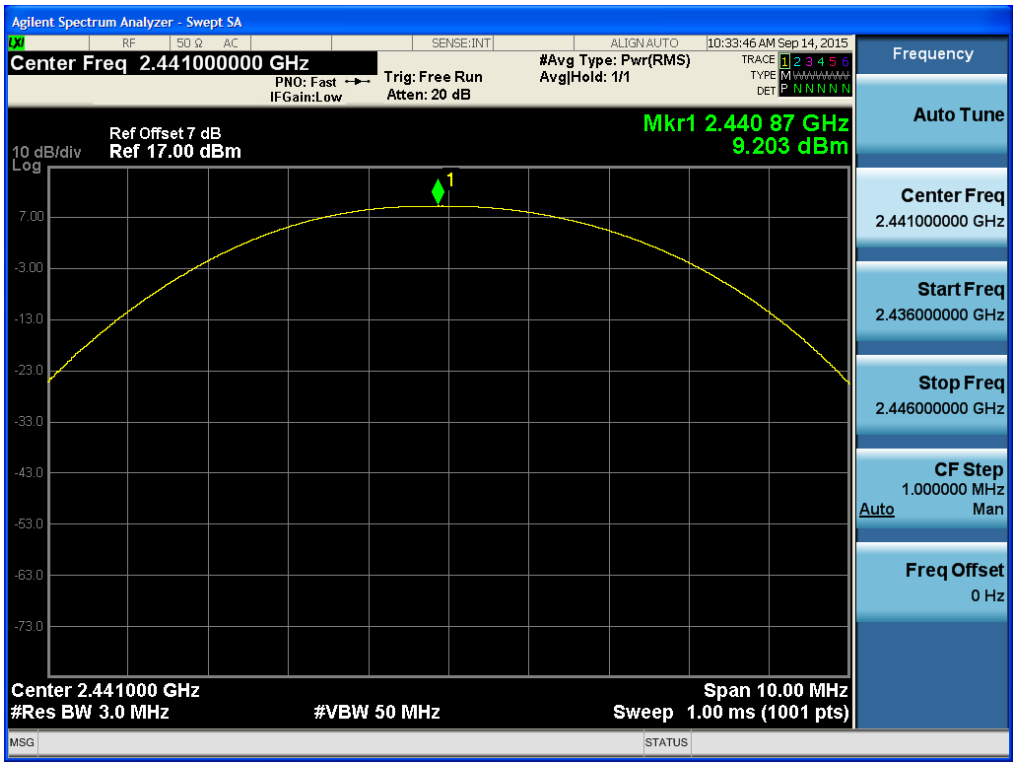
Test Plots (GFSK)

Peak Power (Low-CH)



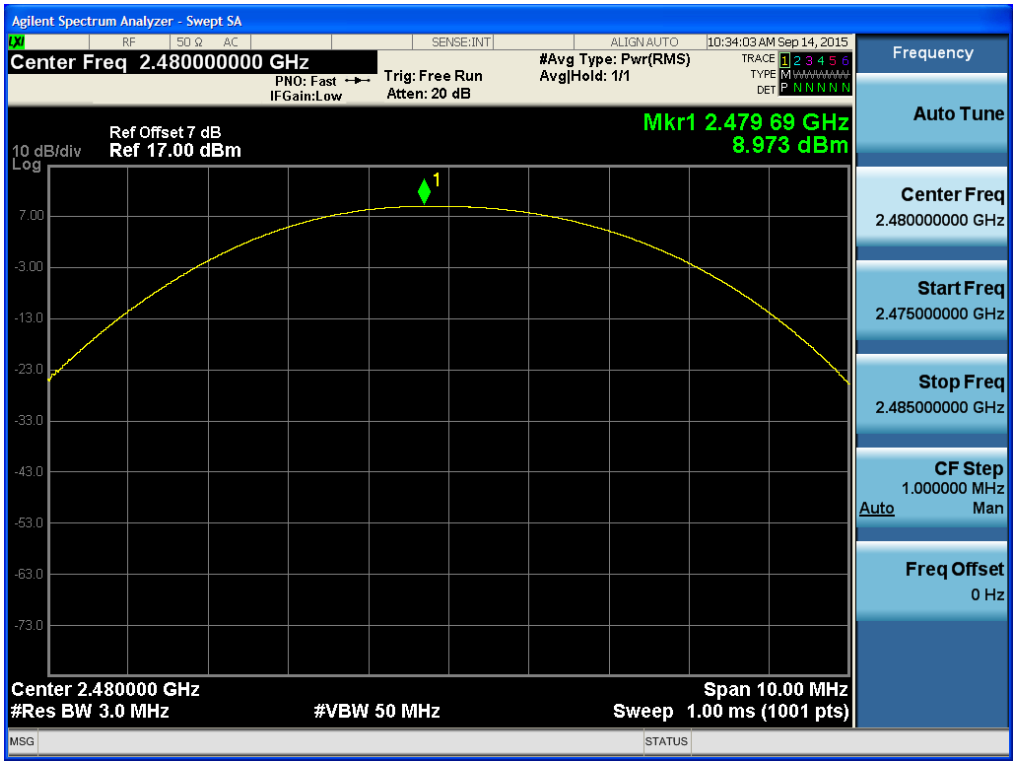

Test Plots (GFSK)

Peak Power (Mid-CH)



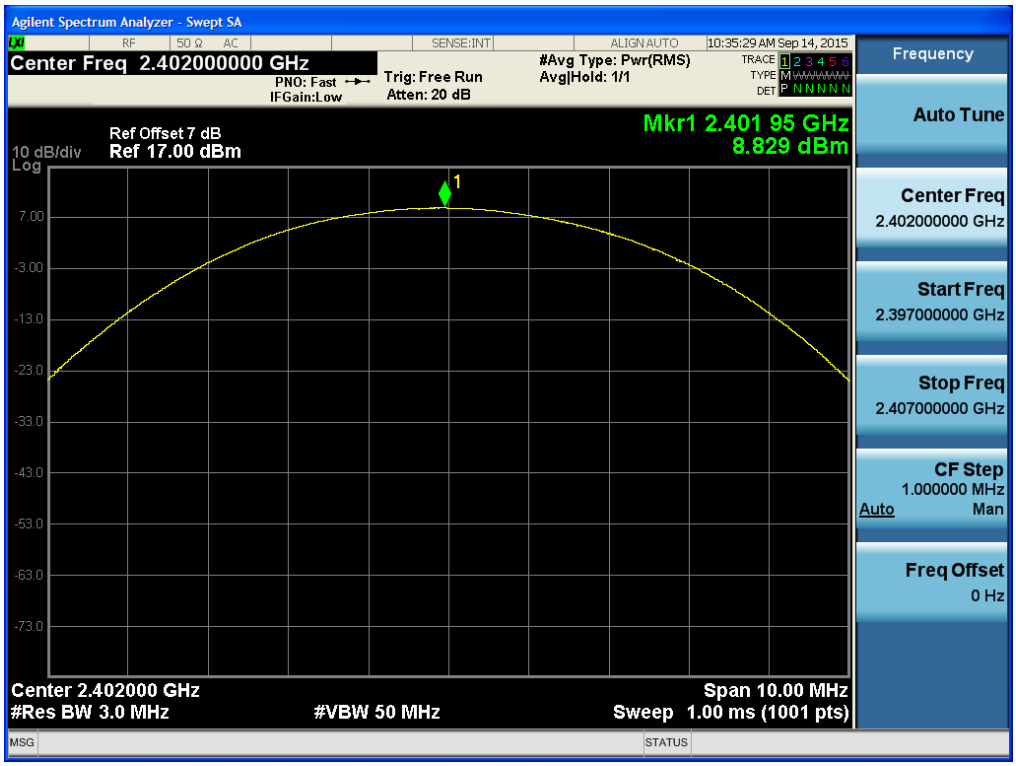
Test Plots (GFSK)

Peak Power (High-CH)

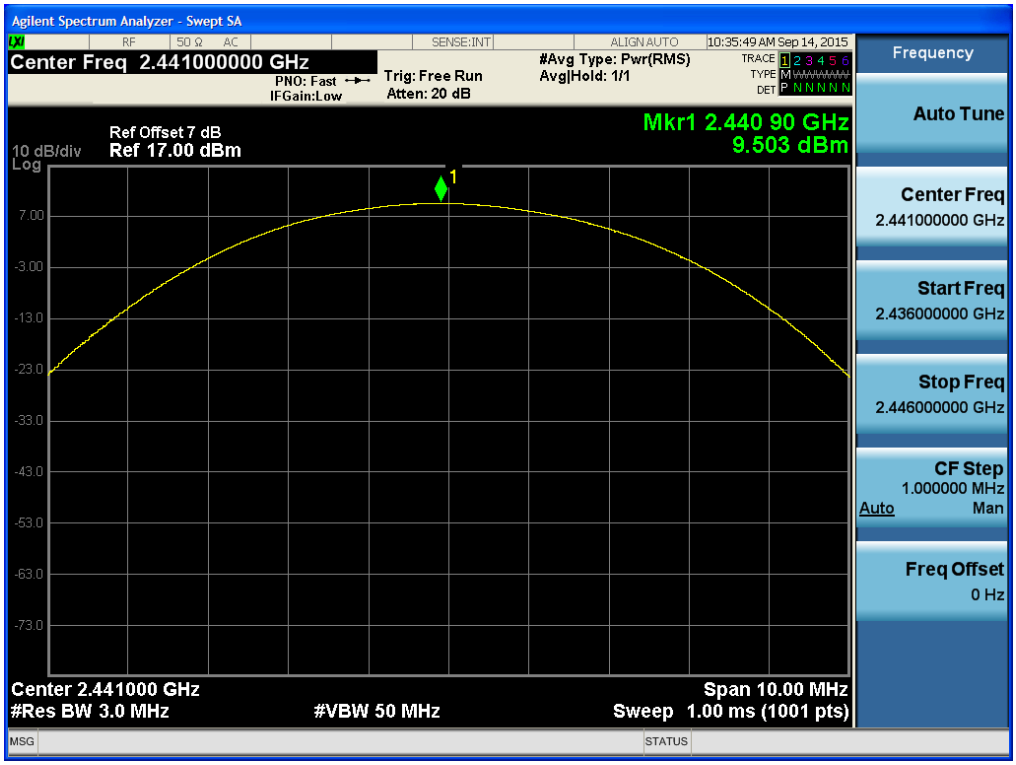



Test Plots (8DPSK)

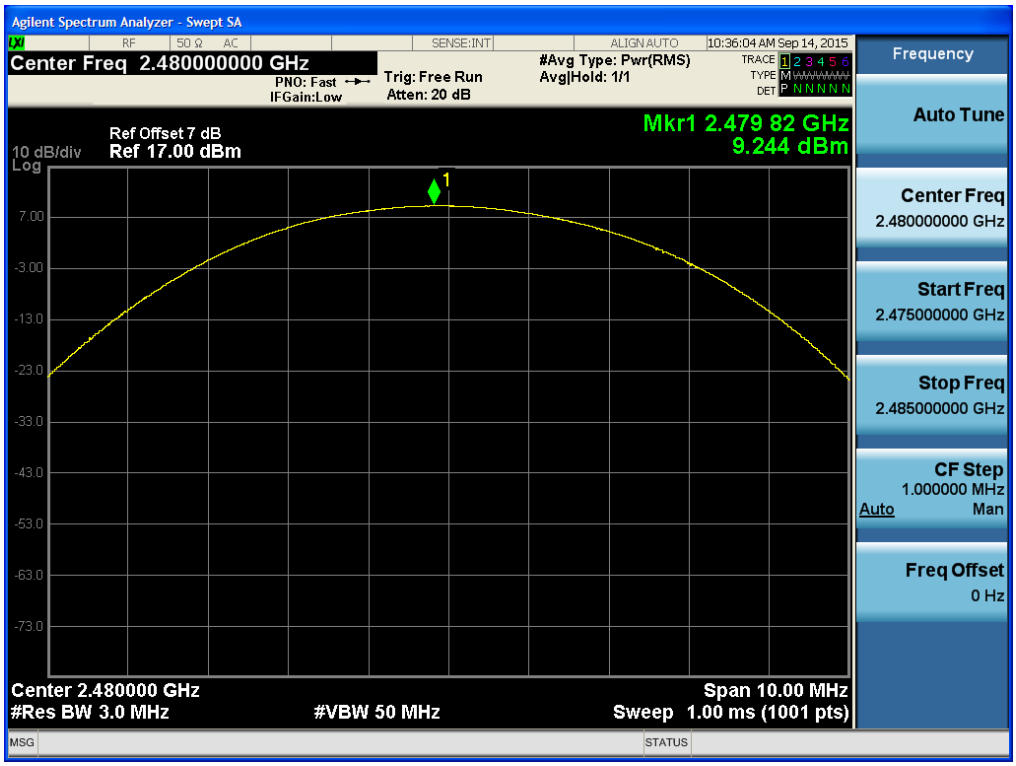
Peak Power (Low-CH)



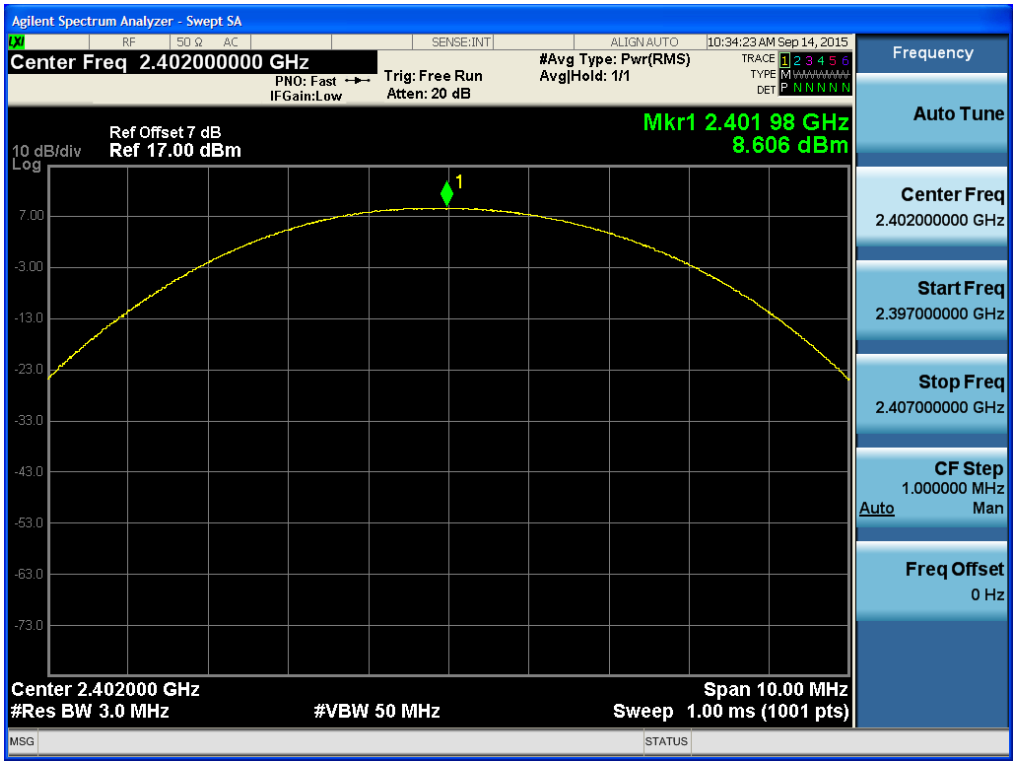
Test Plots (8DPSK)
Peak Power (Mid-CH)



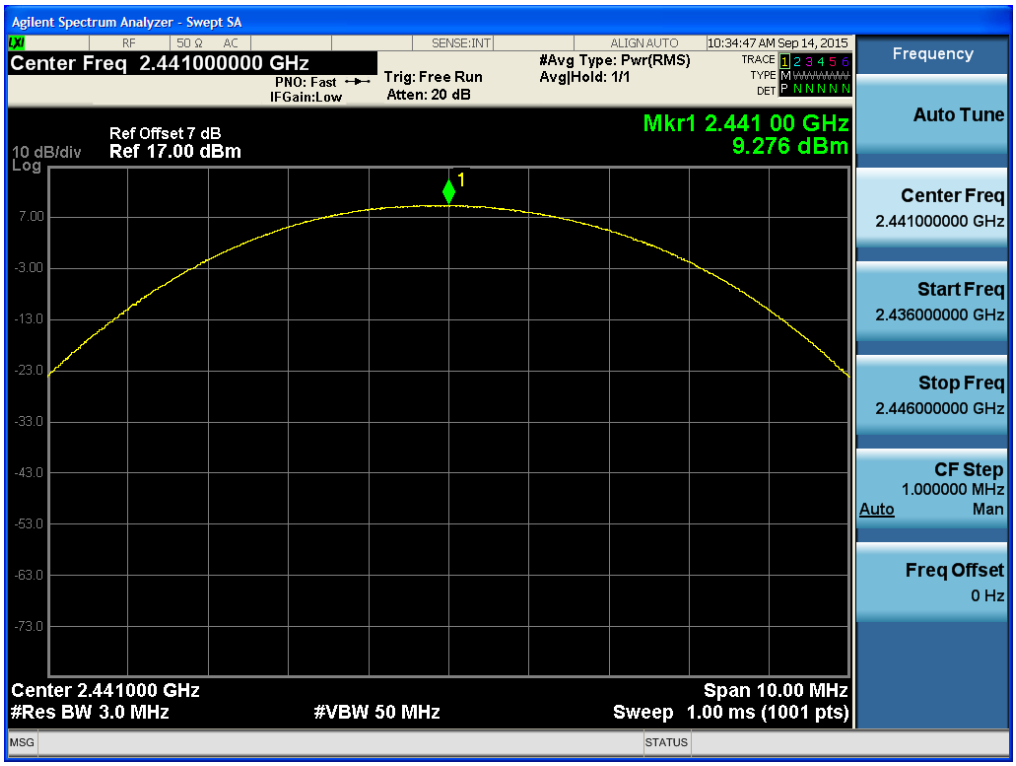

Test Plots (8DPSK)
Peak Power (High-CH)



Test Plots (π/4DQPSK)
Peak Power (Low-CH)

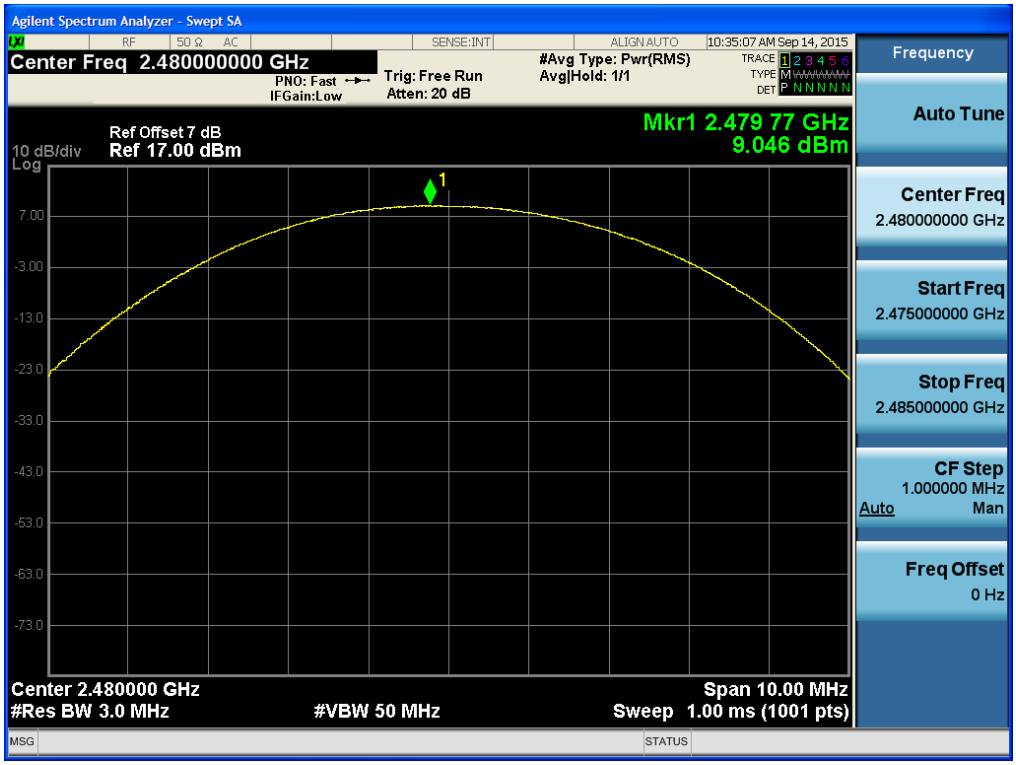



Test Plots (π/4DQPSK)
Peak Power (Mid-CH)



Test Plots (π/4DQPSK)

Peak Power (High-CH)

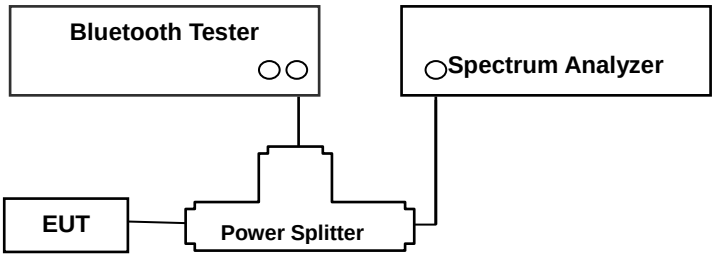


## 8.2 BAND EDGES

### LIMIT

According to §15.247(d), in any 100 kHz 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 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

### Test Configuration




### TEST PROCEDURE

**This test is performed with hopping off and hopping on.**

The Spectrum Analyzer is set to (6.10.4 in ANSI 63.10-2013)

1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.
3) Attenuation: Auto (at least 10 dB preferred).
4) Sweep time: Coupled.
5) RBW: 100 kHz
6) VBW: 300 kHz
7) Detector: Peak
8) Trace: Max hold

**TEST RESULTS**

See attached.

Note :

1. The results in plot is already including the actual values of loss for the splitter and cable combination.
2. Spectrum offset = Power Splitter loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. Actual value of loss for the splitter and cable combination is 6.51 dB at 2402 MHz and is 6.54 dB at 2480 MHz. So, 6.5 dB is offset. And the offset gap in the 2.4 GHz range do not affect the band edge measurement final result.

**Test Data**

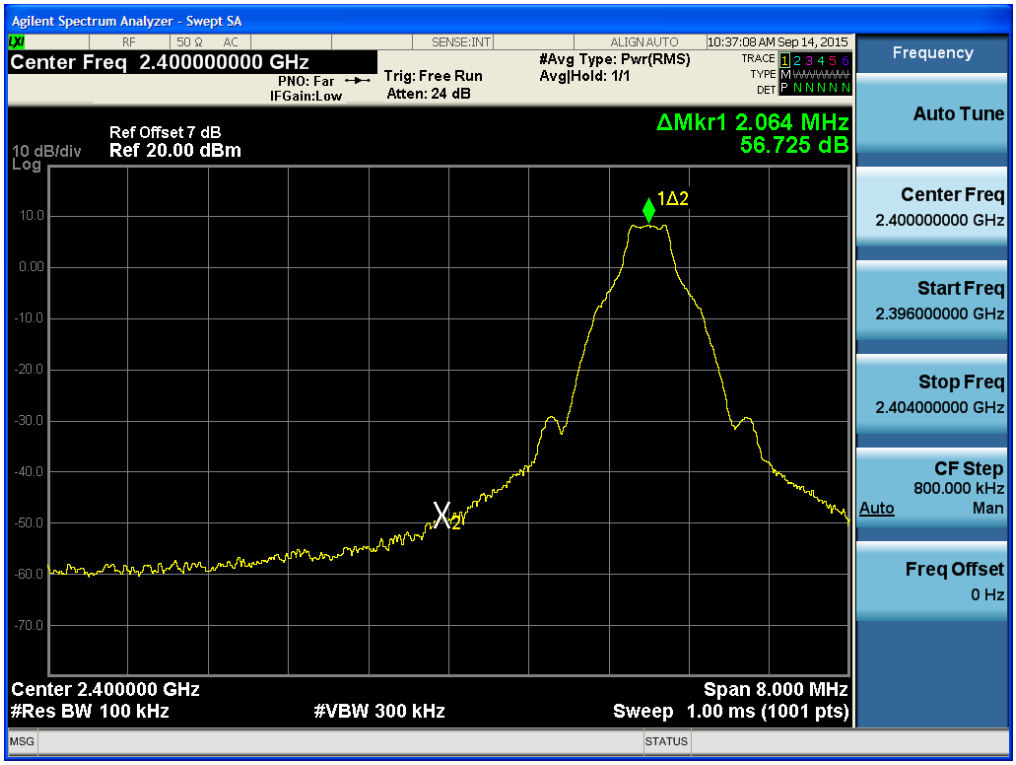
- Without hopping

| Outside Frequency Band | GFSK (dB) | 8DPSK (dB) | π/4DQPSK (dB) | Limit (dBc) | Margin GFSK (dBc) | Margin 8DPSK (dBc) | Margin π/4DQPSK (dBc) | Result |
|---|---|---|---|---|---|---|---|---|
| Lower | 56.725 | 54.571 | 55.318 | 20 | 36.725 | 34.571 | 35.318 | PASS |
| Upper | 64.666 | 63.243 | 63.155 | | 44.666 | 43.243 | 43.155 | PASS |

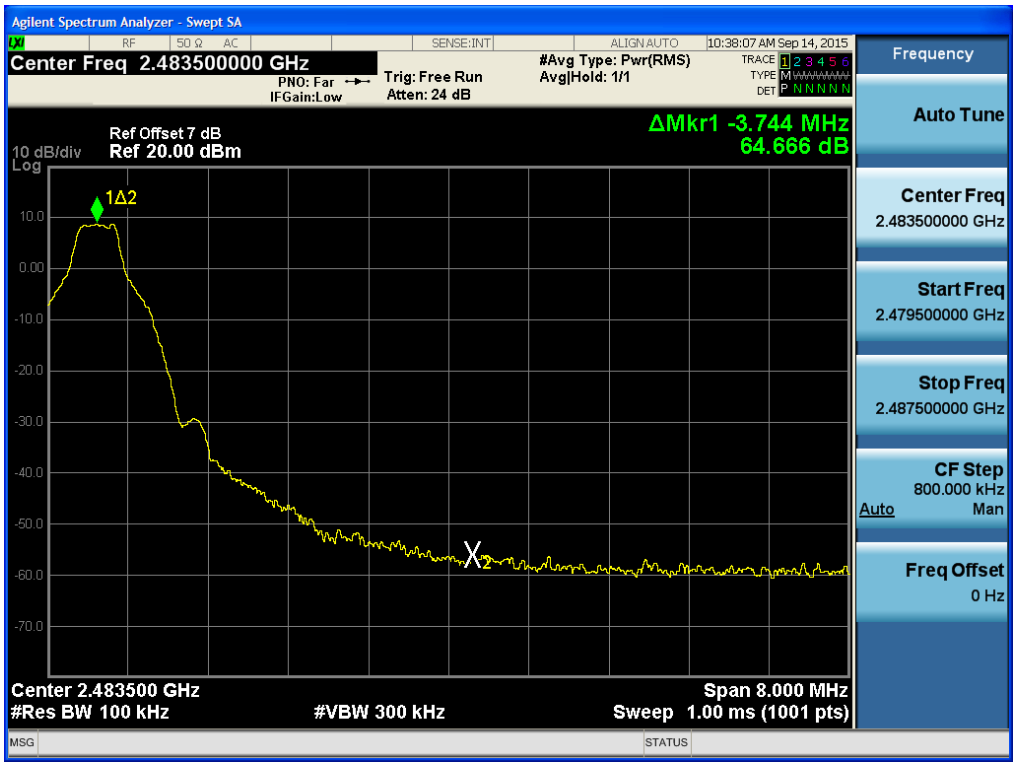
- With hopping

| Outside Frequency Band | GFSK (dB) | 8DPSK (dB) | π/4DQPSK (dB) | Limit (dBc) | Margin GFSK (dBc) | Margin 8DPSK (dBc) | Margin π/4DQPSK (dBc) | Result |
|---|---|---|---|---|---|---|---|---|
| Lower | 59.432 | 56.808 | 57.981 | 20 | 39.432 | 36.808 | 37.981 | PASS |
| Upper | 65.698 | 65.409 | 63.323 | | 45.698 | 45.409 | 43.323 | PASS |

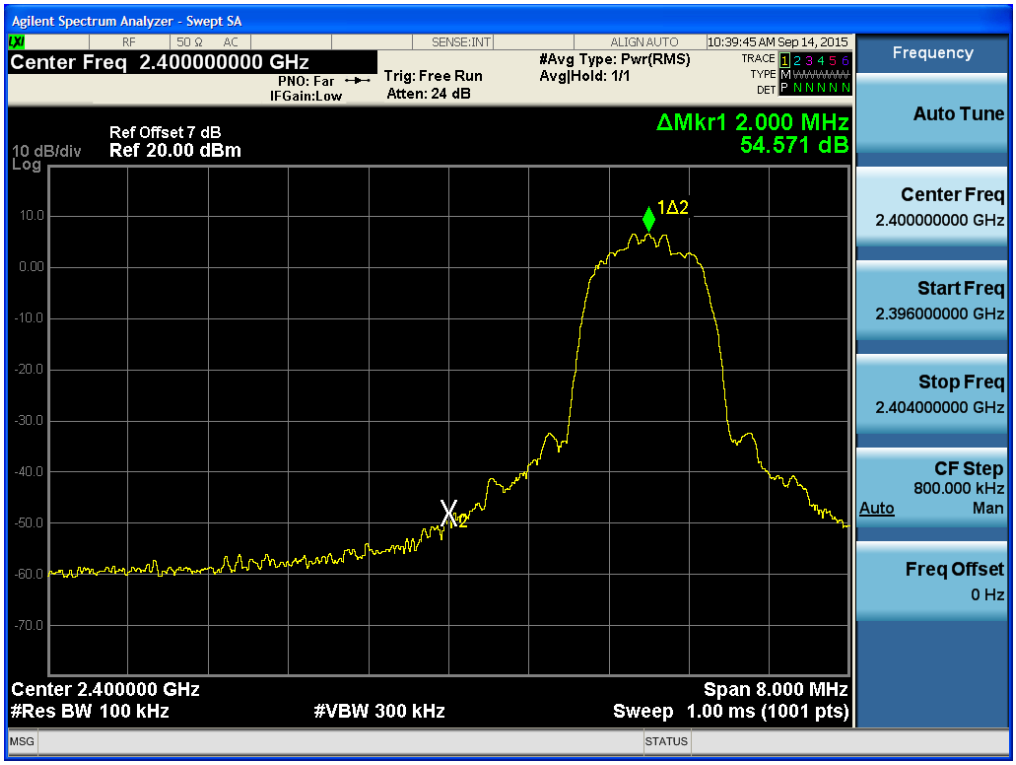
Test Plots without hopping (GFSK)
Band Edges (Low-CH)



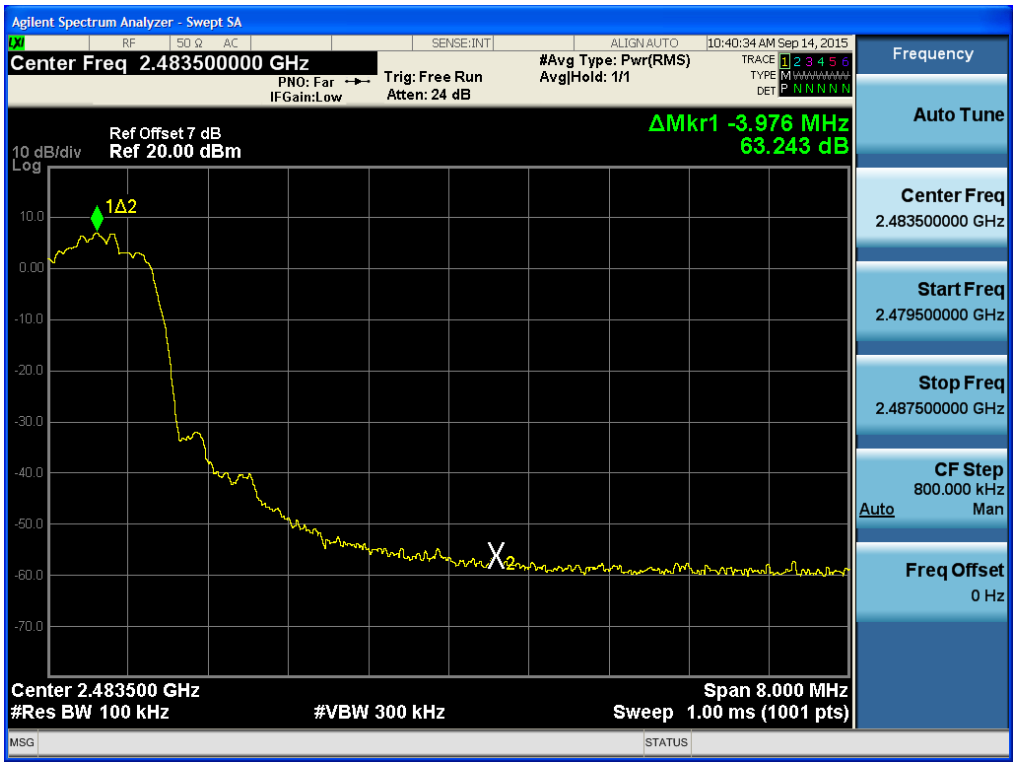

Test Plots without hopping (GFSK)
Band Edges (High-CH)



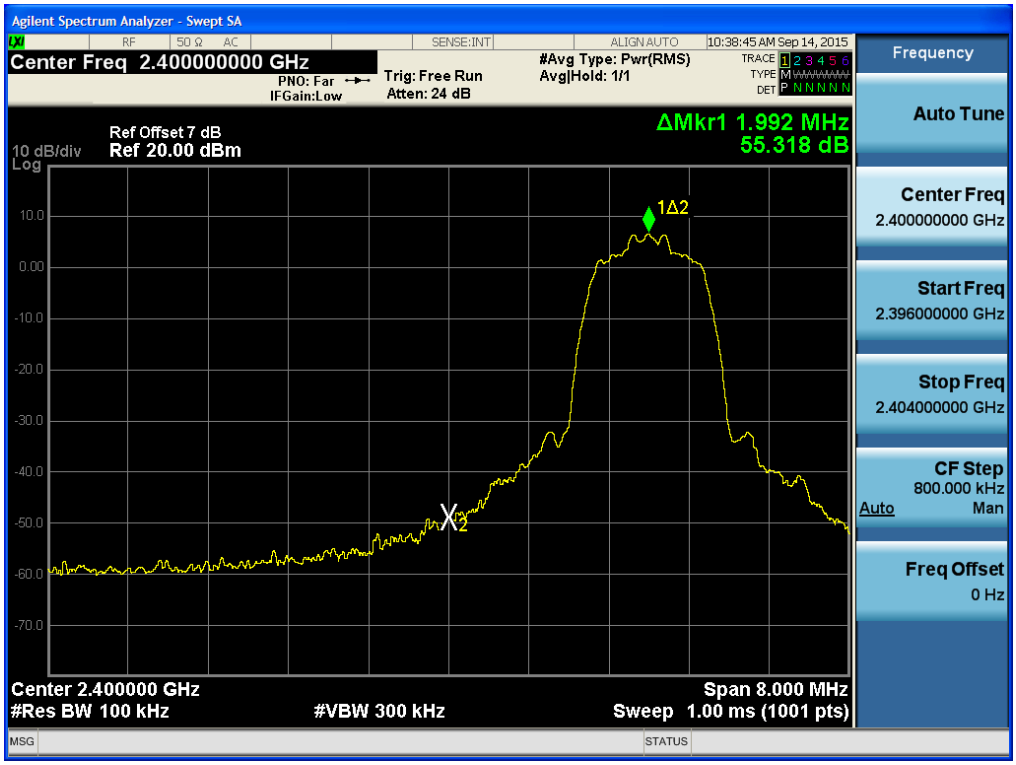
Test Plots without hopping (8DPSK)
Band Edges (Low-CH)



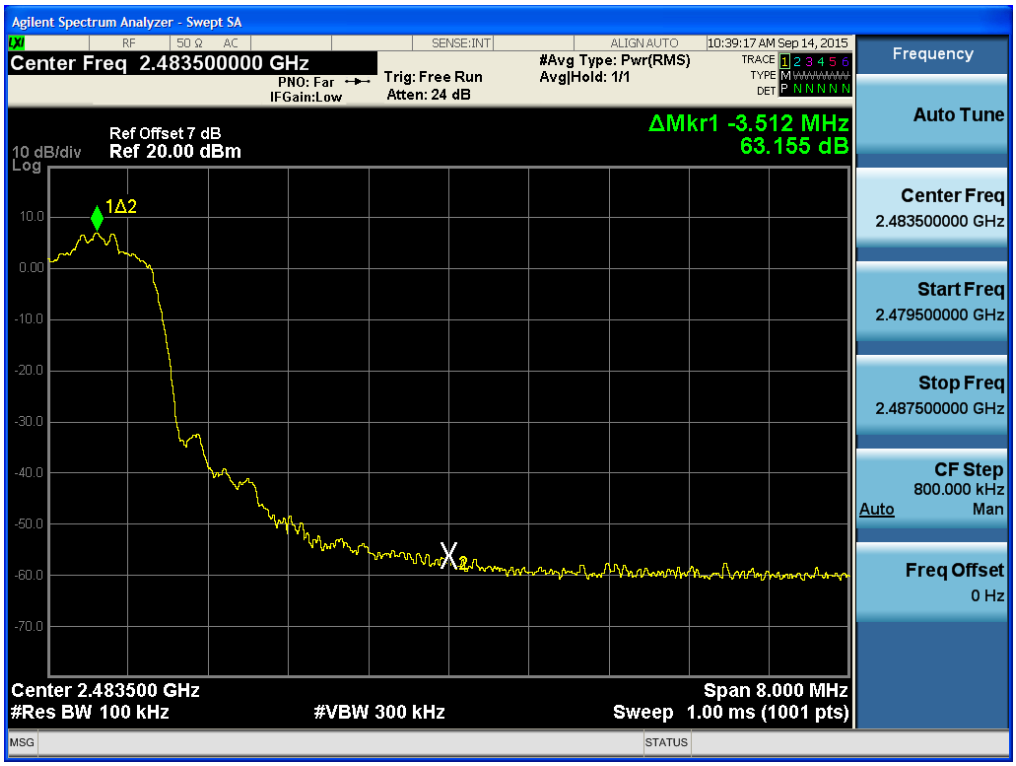

Test Plots without hopping (8DPSK)
Band Edges (High-CH)



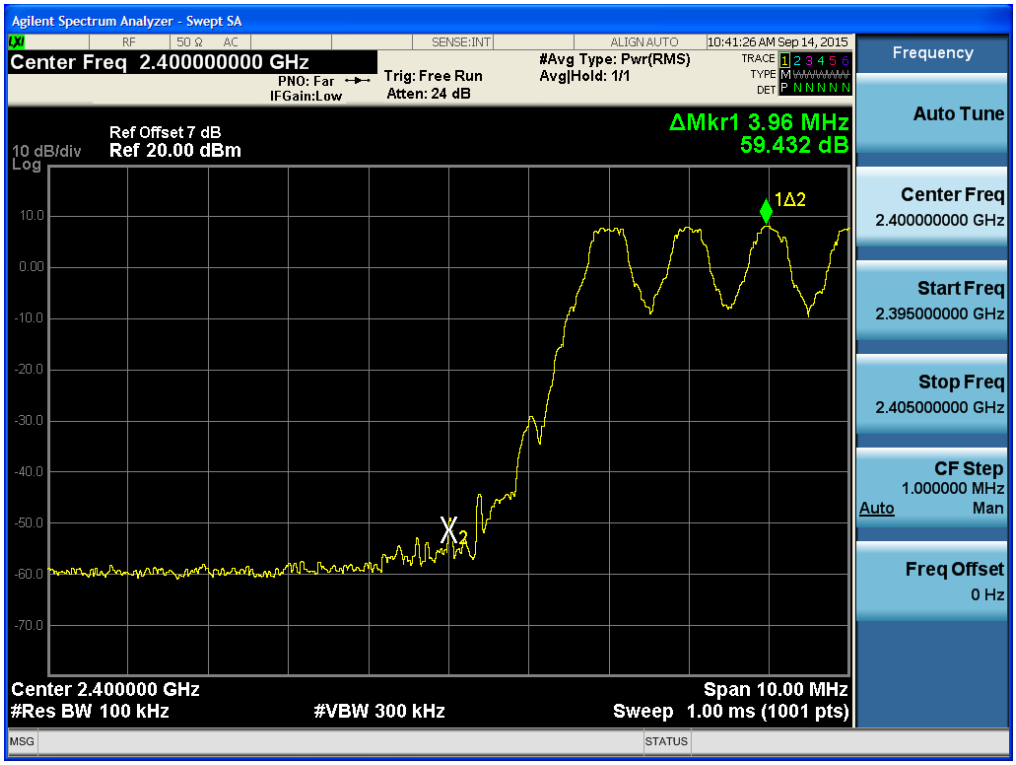
Test Plots without hopping (π/4DQPSK)
Band Edges (Low-CH)



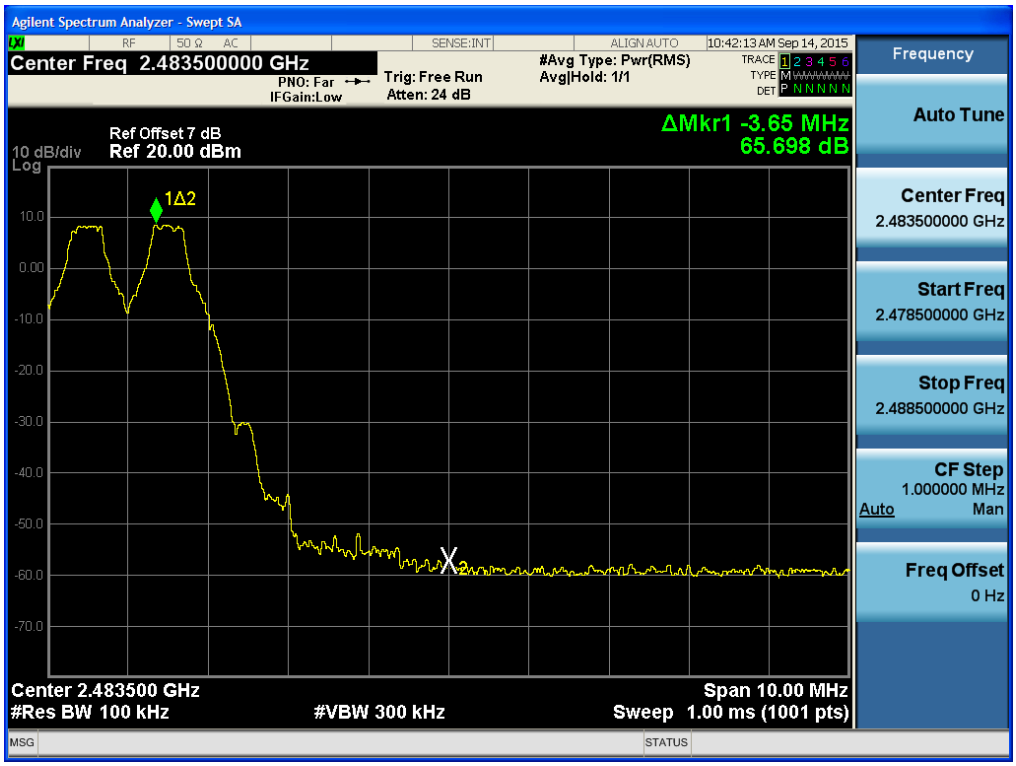

Test Plots without hopping (π/4DQPSK)
Band Edges (High-CH)



Test Plots with hopping (GFSK)
Band Edges (Low-CH)

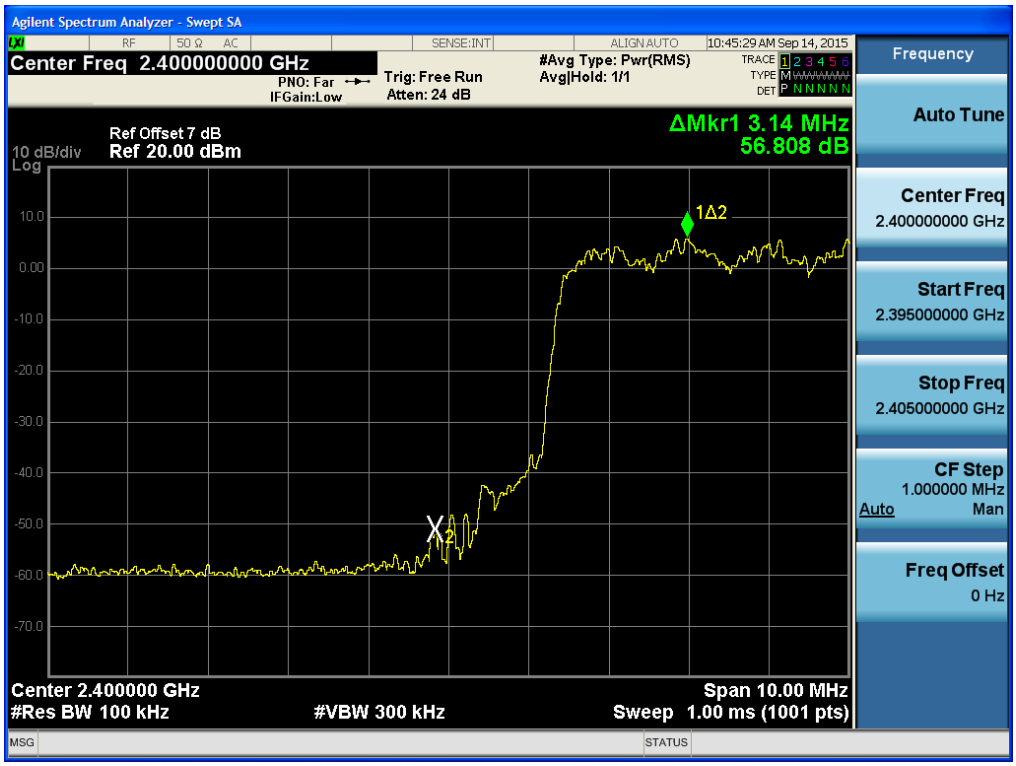



Test Plots with hopping (GFSK)
Band Edges (High-CH)



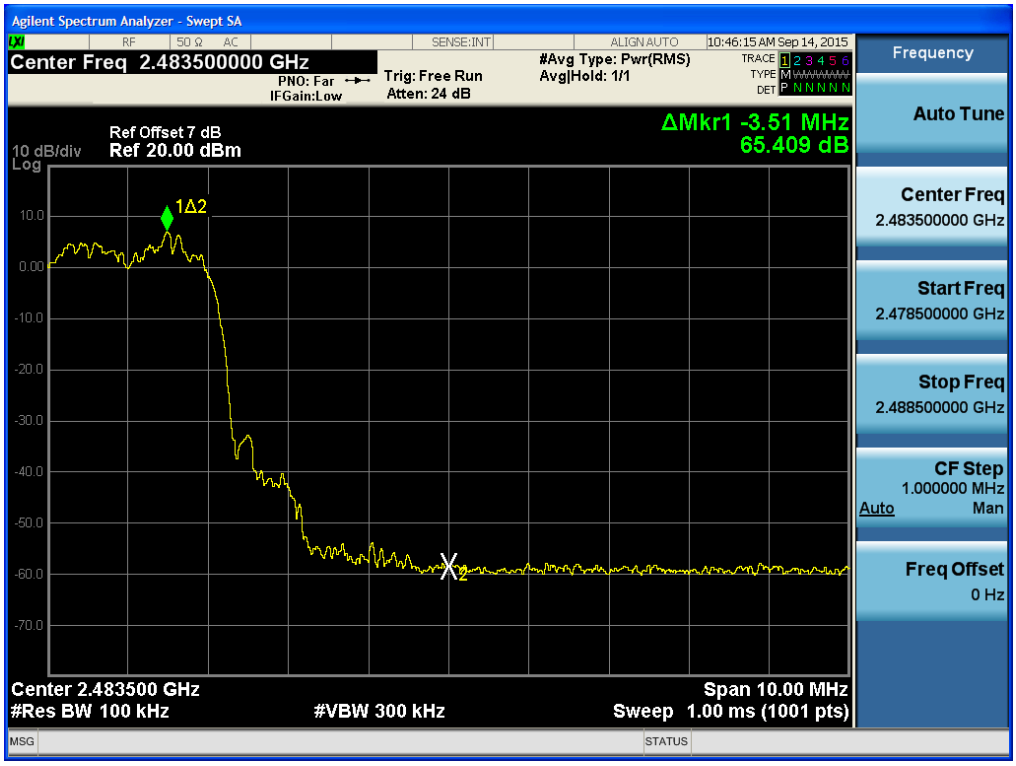
Test Plots with hopping (8DPSK)

Band Edges (Low-CH)

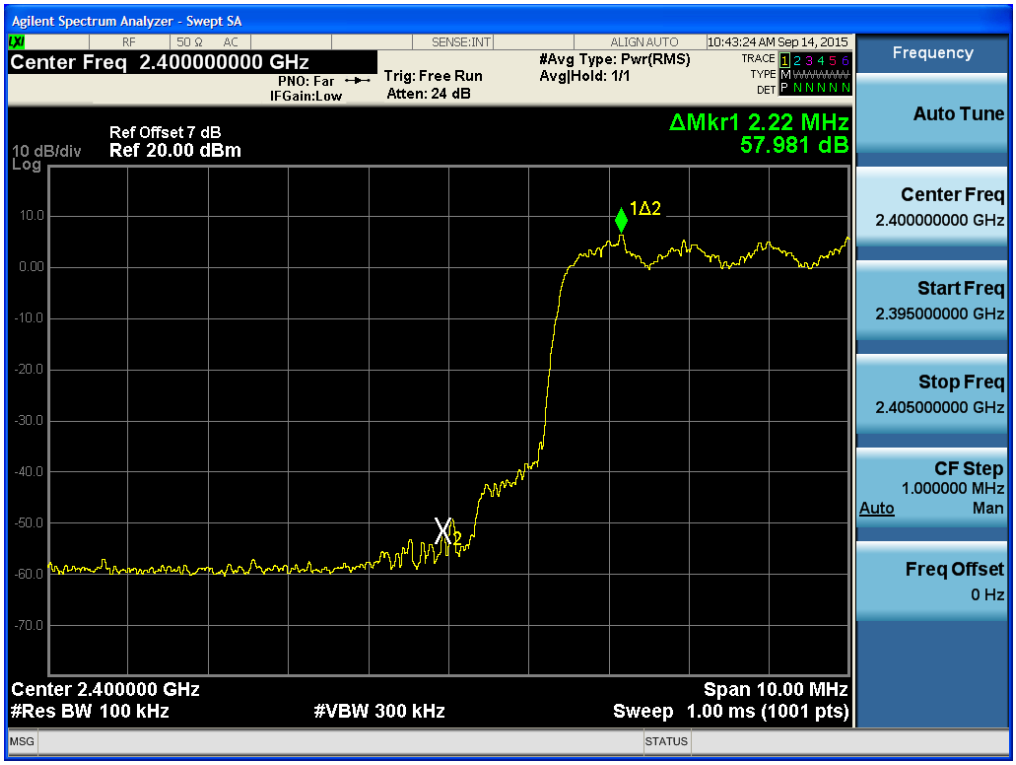



Test Plots with hopping (8DPSK)

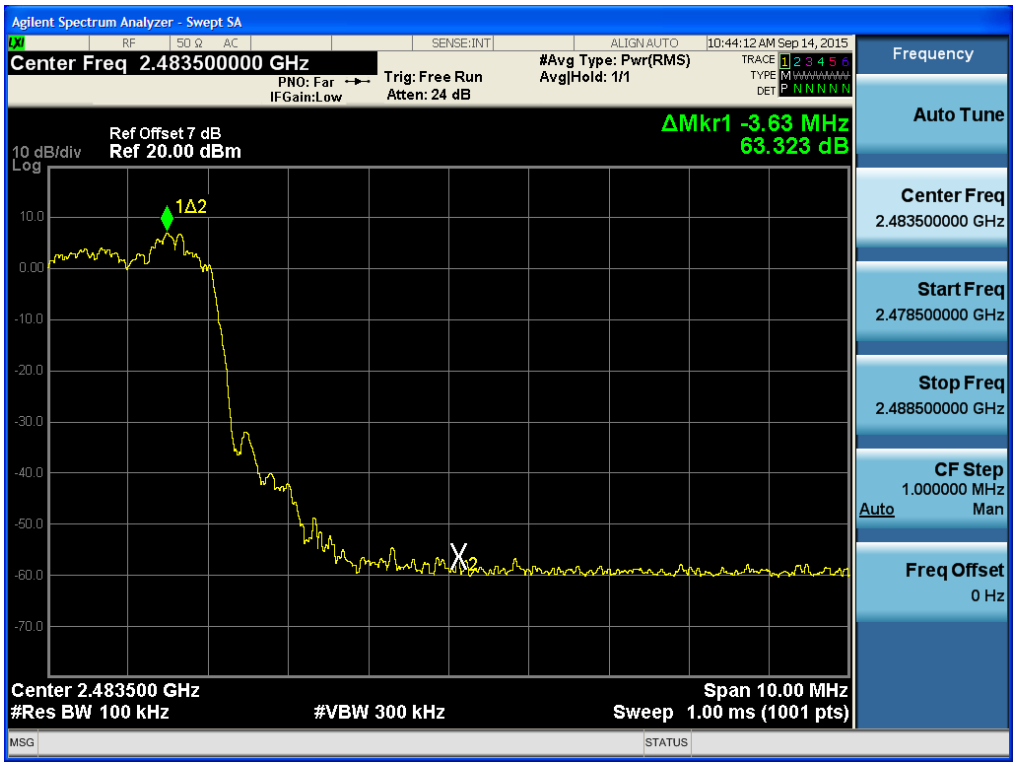
Band Edges (High-CH)



Test Plots with hopping (π/4DQPSK)
Band Edges (Low-CH)




Test Plots with hopping (π/4DQPSK)
Band Edges (High-CH)

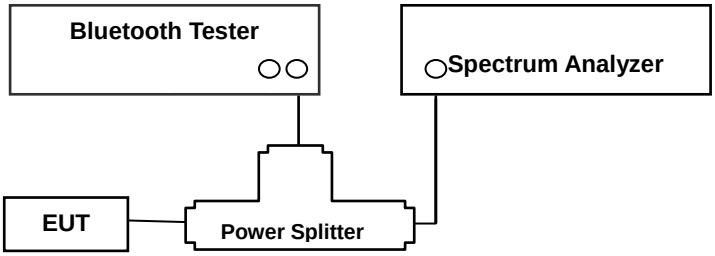


## 8.3 FREQUENCY SEPARATION / OCCUPIED BANDWIDTH (99% BW)

### LIMIT

According to §15.247(a)(1), Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

### Test Configuration




### TEST PROCEDURE

The Channel Separation test is performed with hopping on. And the 20 dB Bandwidth test is performed with hopping off.

The Spectrum Analyzer is set to (7.8.2 in ANSI 63.10-2013)

1) Span: Wide enough to capture the peaks of two adjacent channels
2) 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.
3) VBW ≥ RBW
4) Sweep: Auto
5) Detector: Peak
6) Trace: Max hold
7) All the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

### TEST RESULTS

No non-compliance noted

**Test Data**

| Channel Separation (kHz) | | | 20dB Bandwidth (kHz) | | | | Limit (kHz) | Result |
|---|---|---|---|---|---|---|---|---|
| GFSK | 8DPSK | π/4DQPSK | Channel | GFSK | 8DPSK | π/4DQPSK | | |
| 1002 | 999 | 996 | Low CH | 947.1 | 1280.0 | 1281.0 | >25 or >2/3 of the 20dB BW | Pass |
| | | | Middle CH | 968.1 | 1299.0 | 1288.0 | | |
| | | | High CH | 967.8 | 1298.0 | 1288.0 | | |

**Occupied Bandwidth (99% BW )**

| 99% BW (kHz) | | | |
|---|---|---|---|
| Channel | GFSK | 8DPSK | π/4DQPSK |
| Low CH | 870.38 | 1159.30 | 1164.60 |
| Middle CH | 893.62 | 1171.80 | 1169.90 |
| High CH | 894.76 | 1171.10 | 1165.00 |

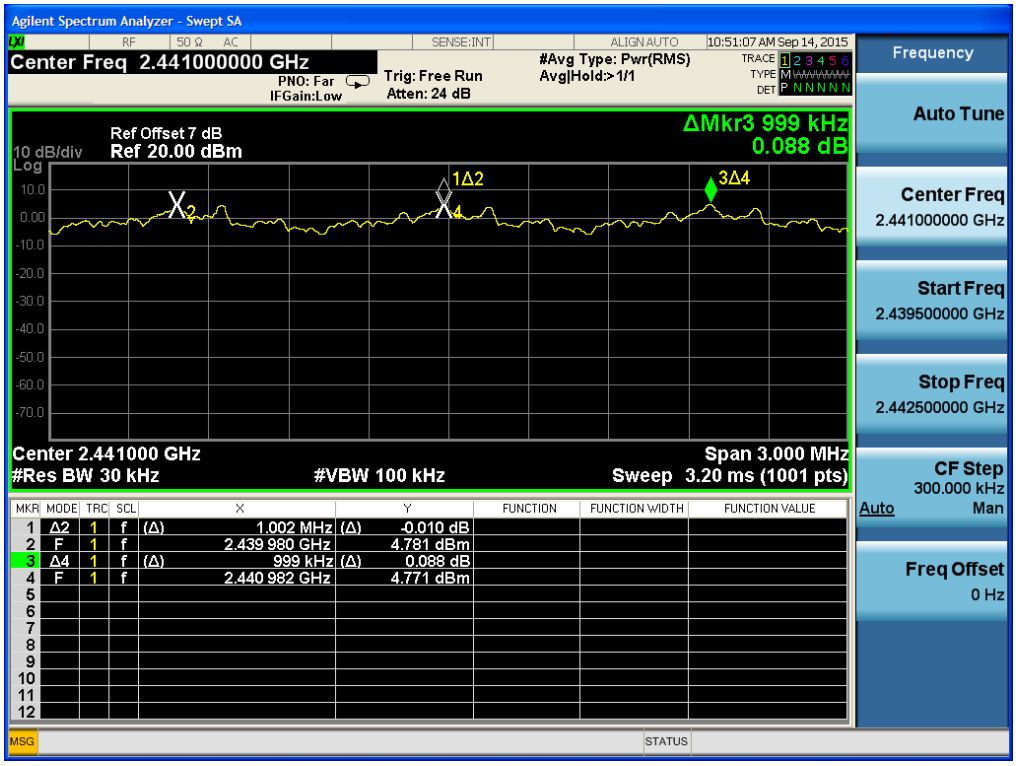
Note : We can not know what use channel in AFH mode. So, we can not test in AFH mode. Also, if the test performs some channel in AFH mode, the test result is not different with normal mode.

Test Plots (GFSK)

Channel Separation

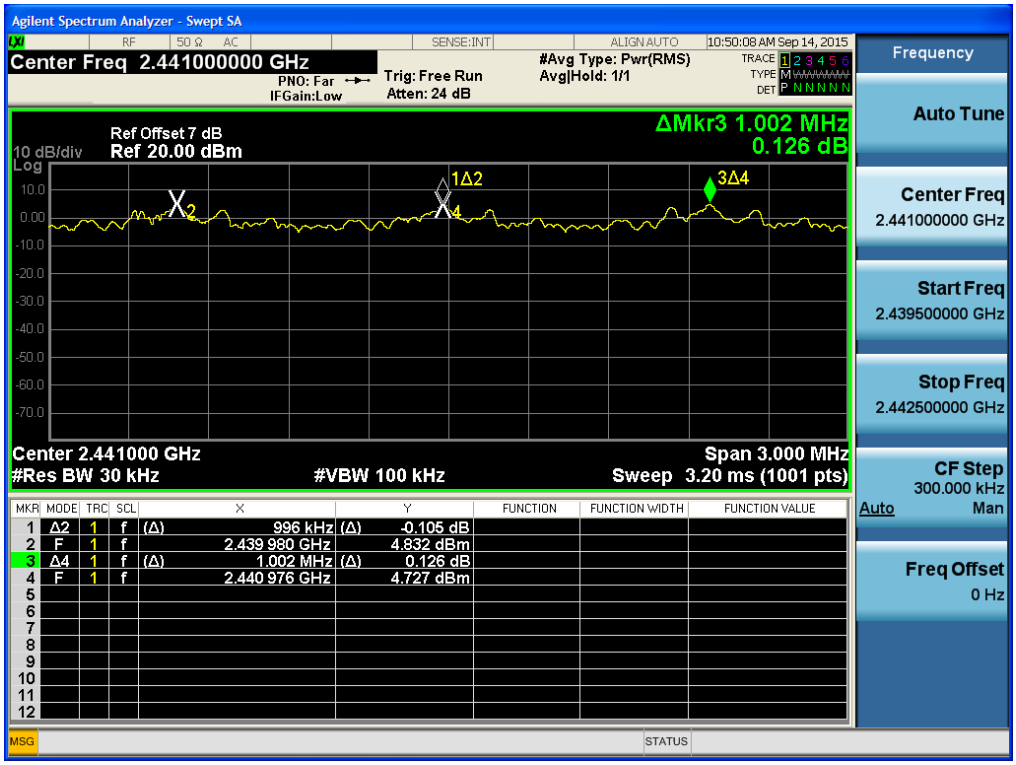

Test Plots (8DPSK)

Channel Separation



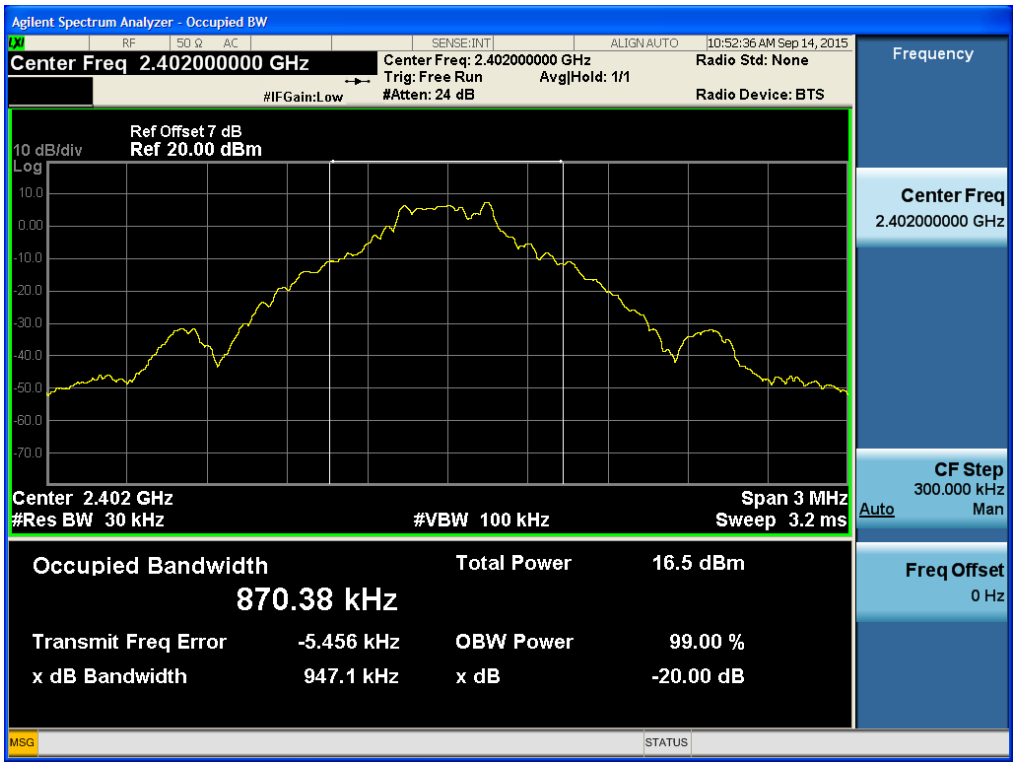
Test Plots (π/4DQPSK)

Channel Separation



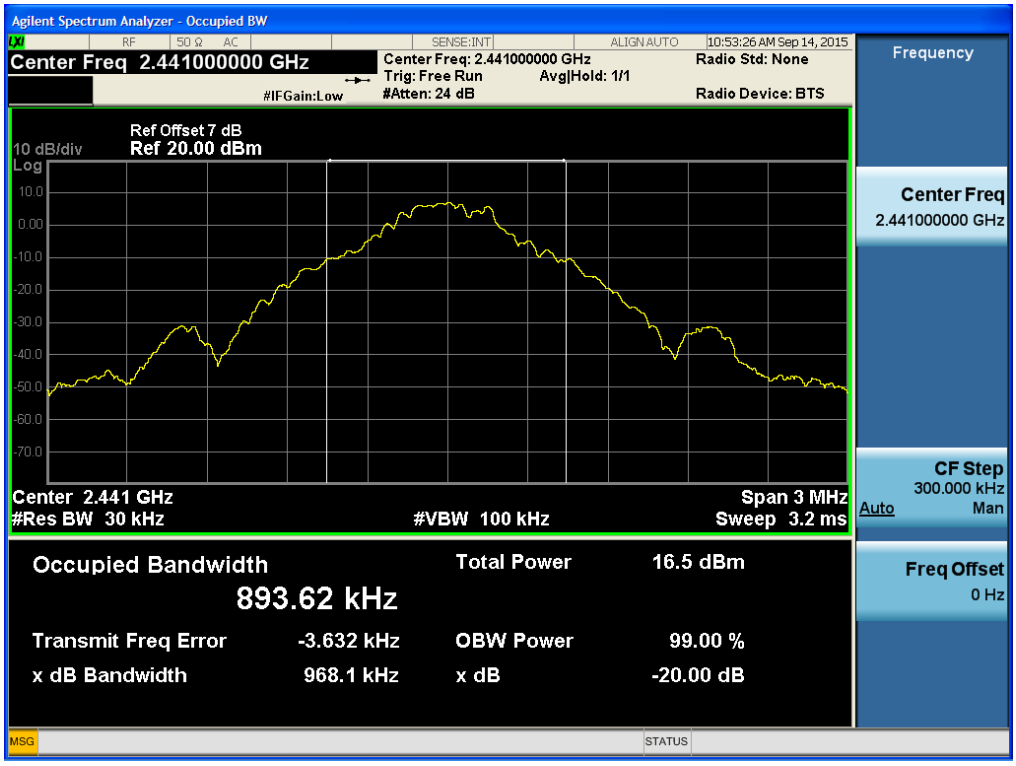
Test Plots (GFSK)

20 dB Bandwidth & Occupied Bandwidth (Low-CH)



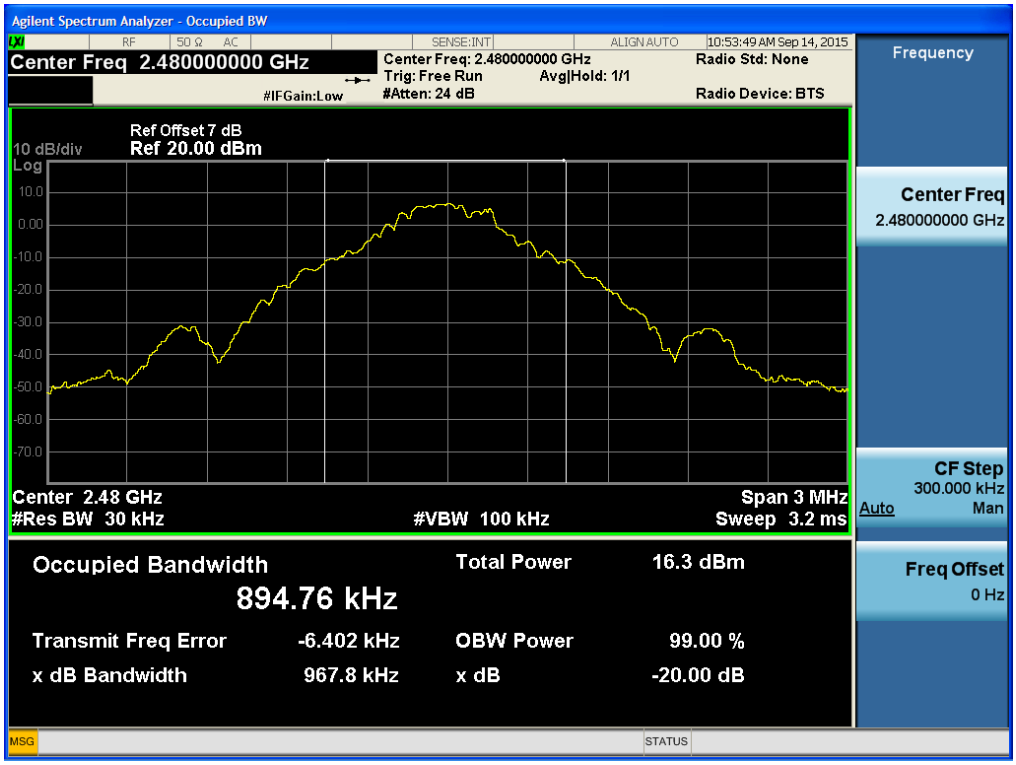

Test Plots (GFSK)

20 dB Bandwidth & Occupied Bandwidth (Mid-CH)



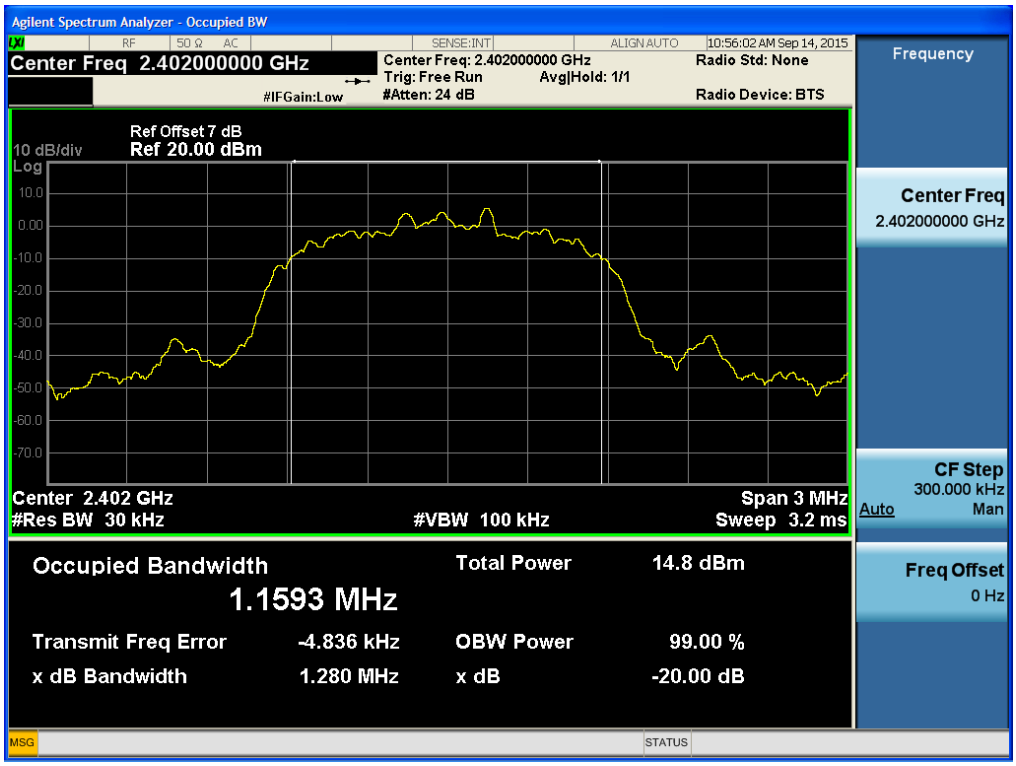
Test Plots (GFSK)

20 dB Bandwidth & Occupied Bandwidth (High-CH)



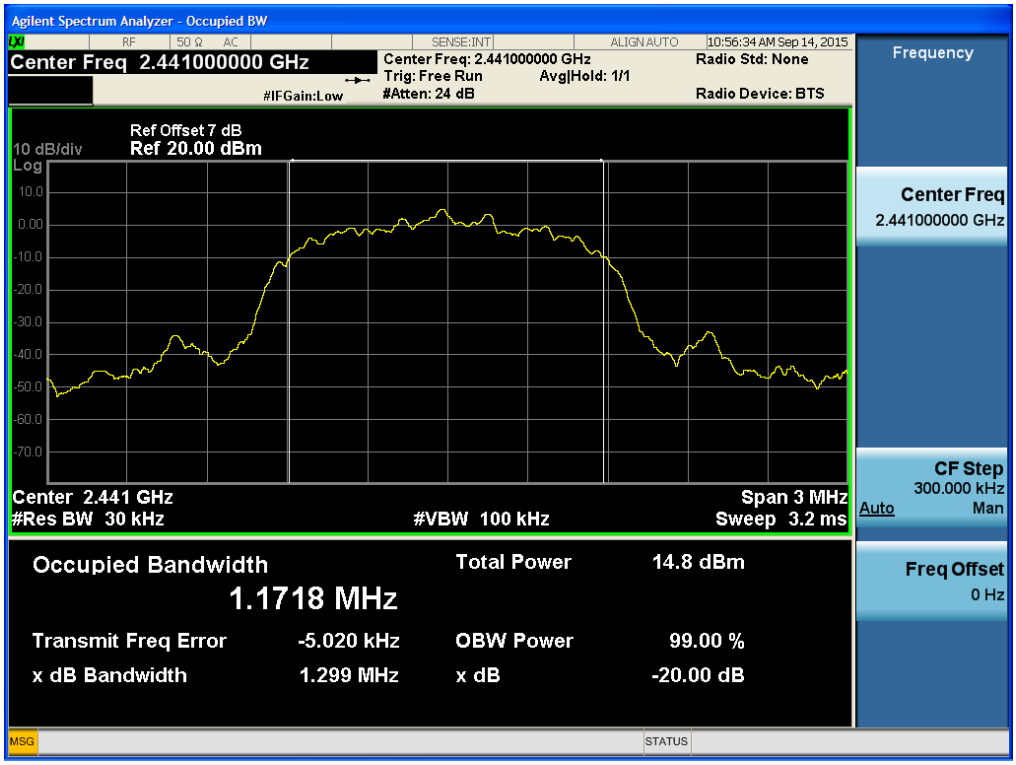

Test Plots (8DPSK)

20 dB Bandwidth & Occupied Bandwidth (Low-CH)



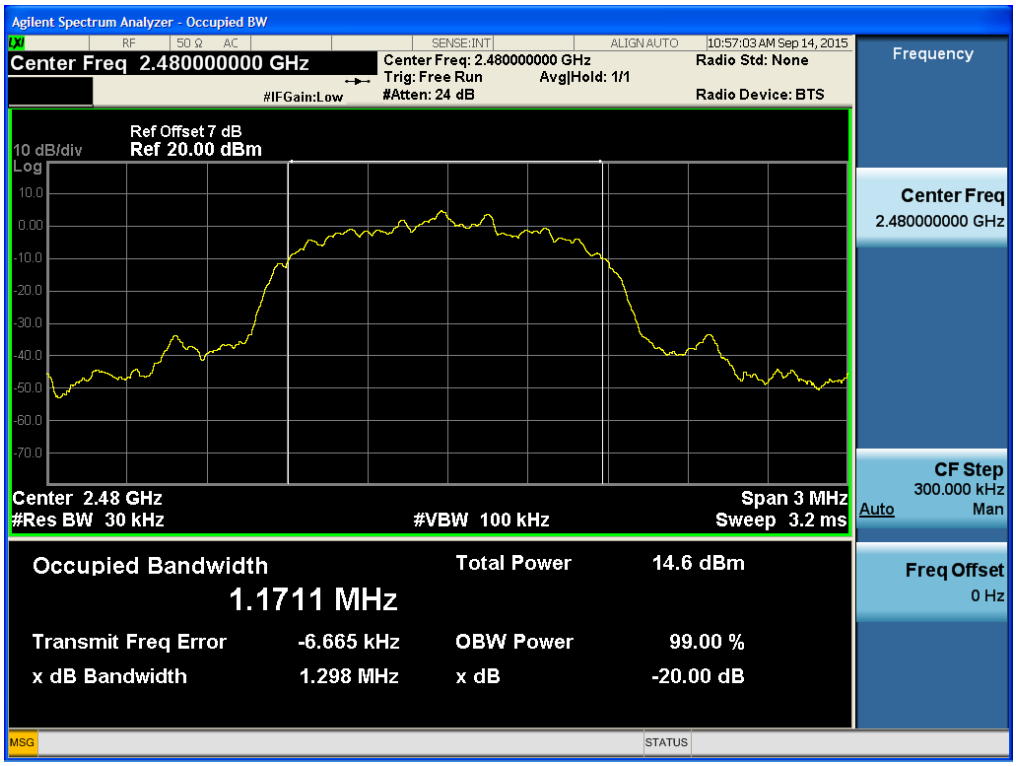
Test Plots (8DPSK)

20 dB Bandwidth & Occupied Bandwidth (Mid-CH)



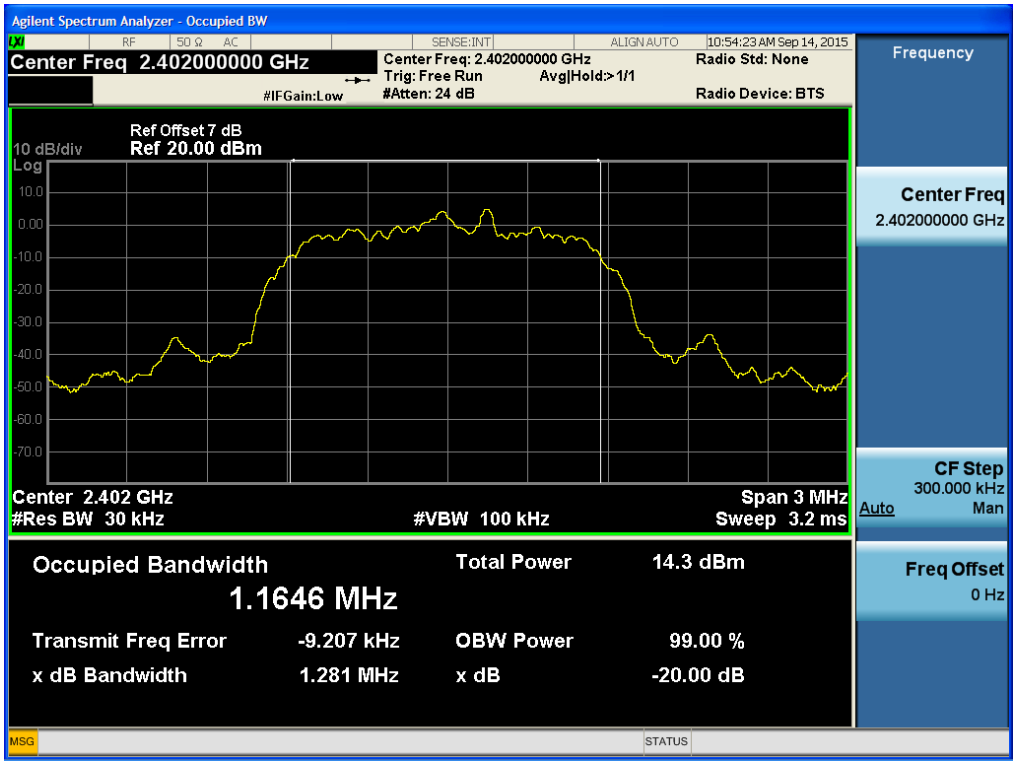

Test Plots (8DPSK)

20 dB Bandwidth & Occupied Bandwidth (High-CH)



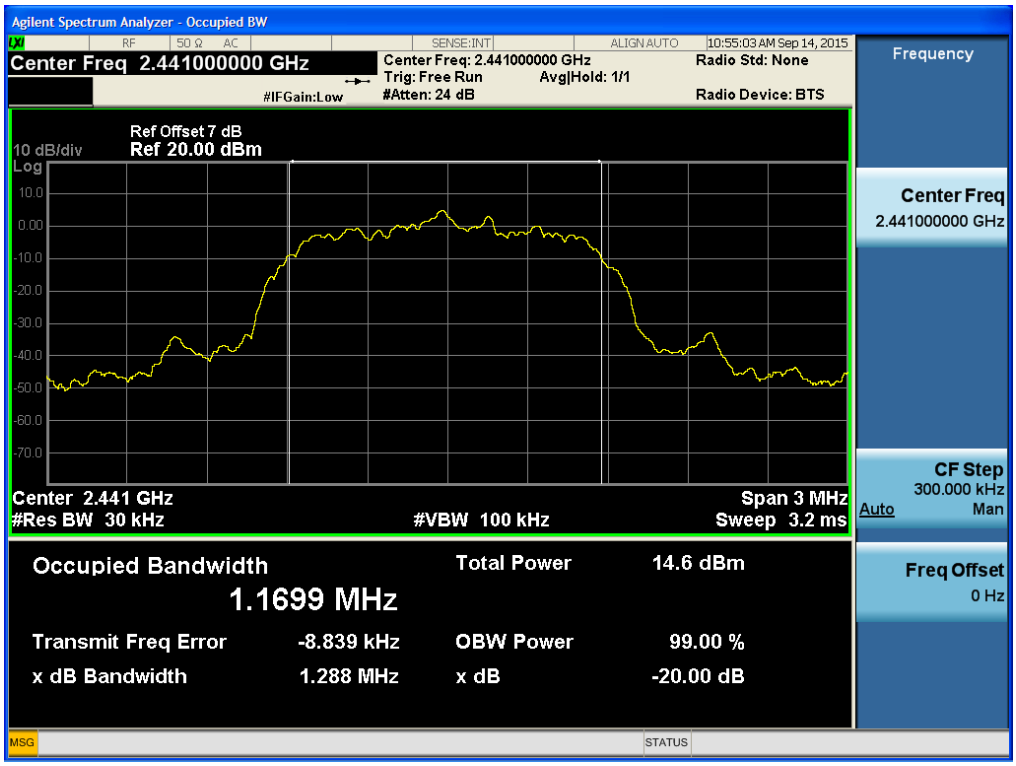
Test Plots (π/4DQPSK)

20 dB Bandwidth & Occupied Bandwidth (Low-CH)



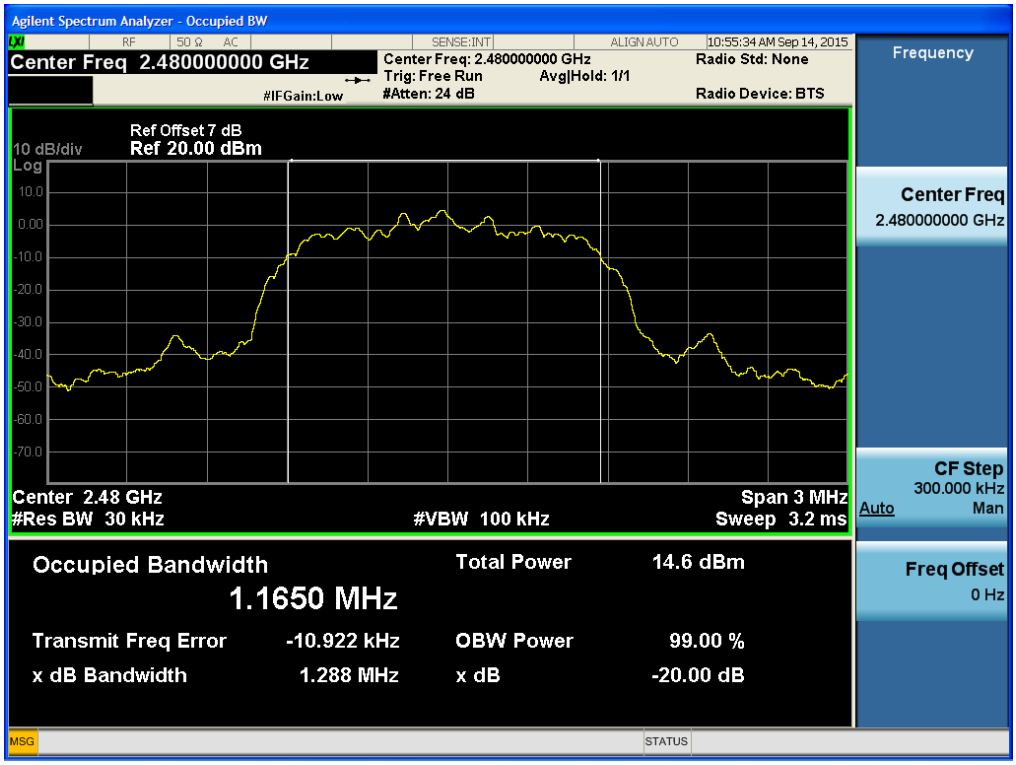

Test Plots (π/4DQPSK)

20 dB Bandwidth & Occupied Bandwidth (Mid-CH)



Test Plots (π/4DQPSK)

20 dB Bandwidth & Occupied Bandwidth (High-CH)

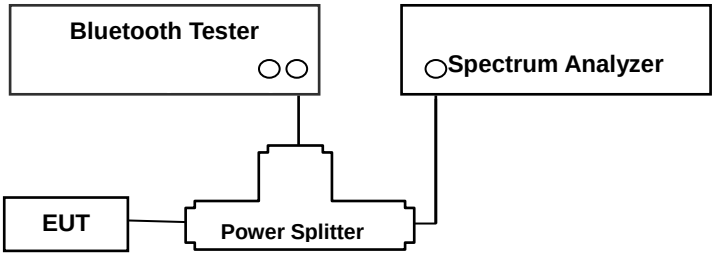


## 8.4 NUMBER OF HOPPING FREQUENCY

**LIMIT**

According to §15.247(a)(1)(iii), Frequency hopping systems operating in the 2400 MHz ~ 2483.5 MHz bands shall use at least 15 hopping frequencies.

**Test Configuration**




**TEST PROCEDURE**

The Bluetooth frequency hopping function of the EUT was enabled.

The Spectrum Analyzer is set to (7.8.3 in ANSI 63.10-2013)

1) Span: the frequency band of operation
2) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3) VBW ≥ RBW
4) Sweep: Auto
5) Detector: Peak
6) Trace: Max hold
7) Allow the trace to stabilize.

**TEST RESULTS**

No non-compliance noted

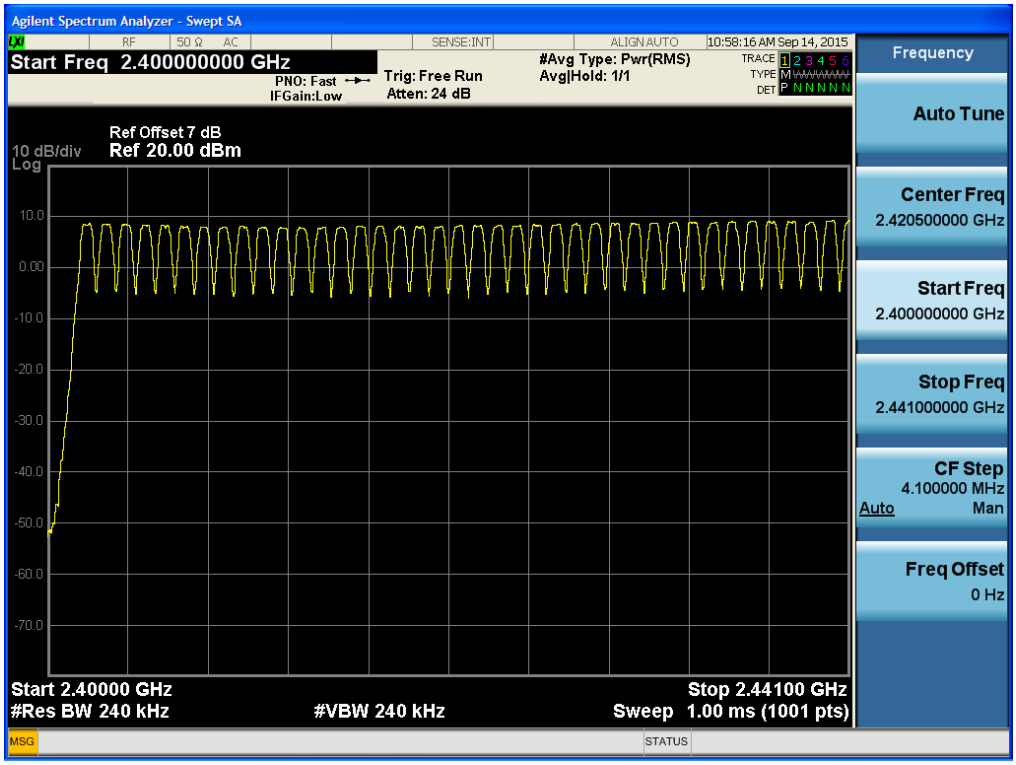
**Test Data**

| Result (No. of CH) | | | Limit | Result |
|---|---|---|---|---|
| GFSK | 8DPSK | π/4DQPSK | | |
| 79 | 79 | 79 | ≥15 | Pass |

**Note : In case of AFH mode, minimum number of hopping channels is 20.**

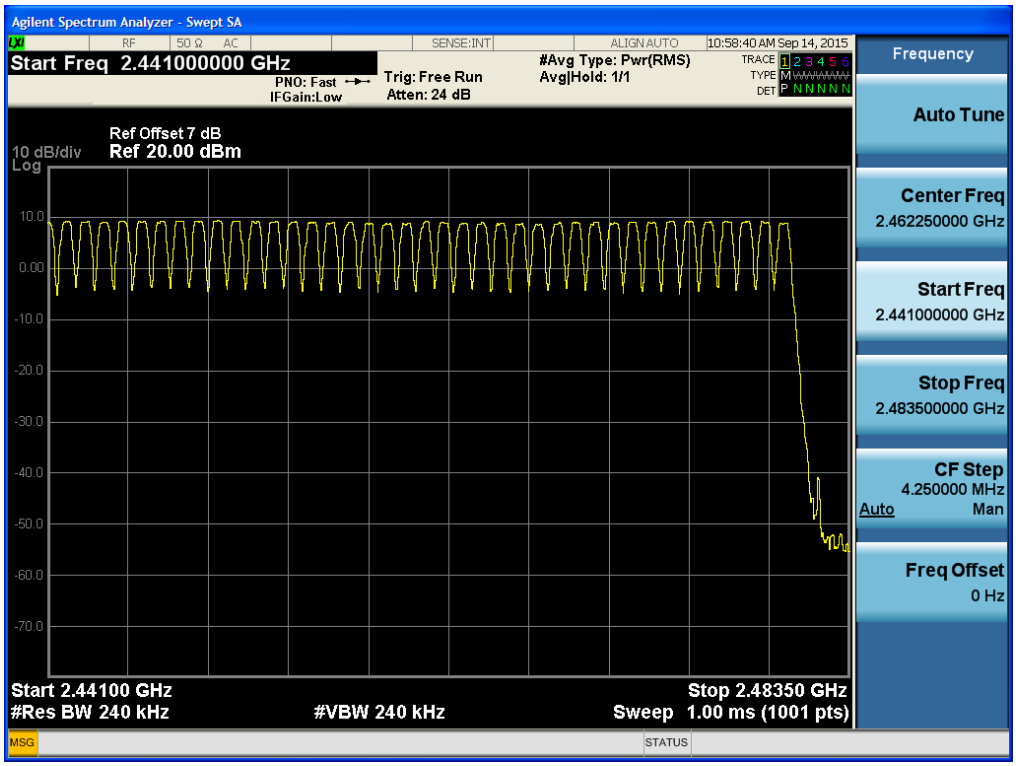
Test Plots (GFSK)

Number of Channels (2.4 GHz - 2.441 GHz)



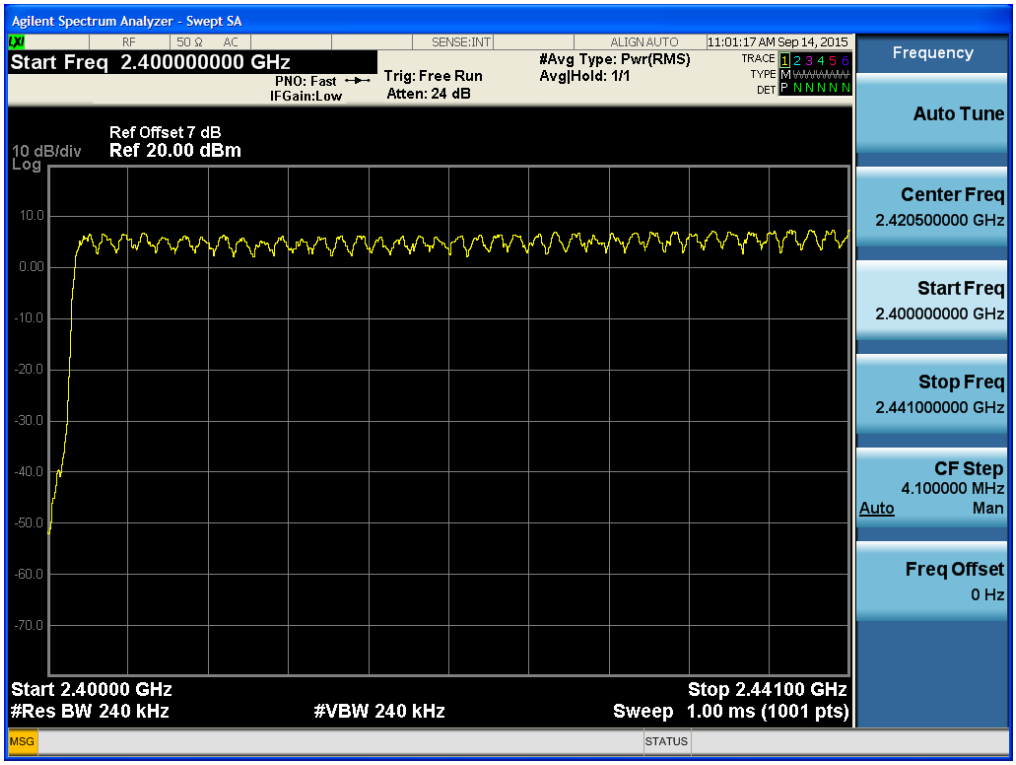

Test Plots (GFSK)

Number of Channels (2.441 GHz - 2.4835 GHz)



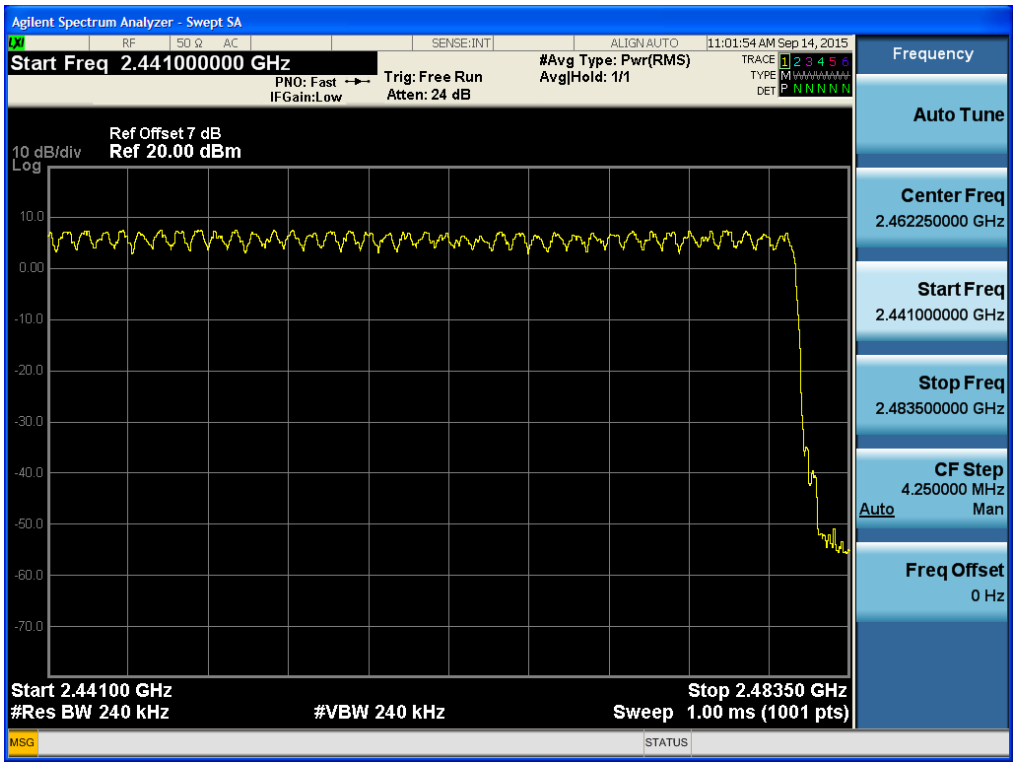
Test Plots (8DPSK)

Number of Channels (2.4 GHz - 2.441 GHz)



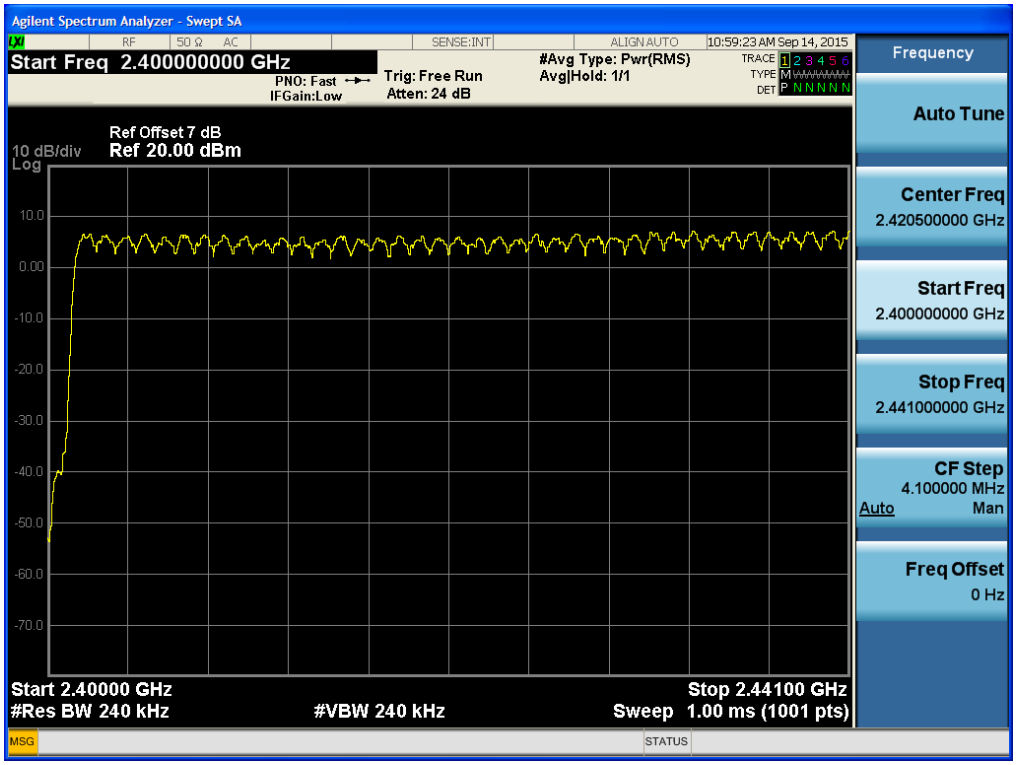

Test Plots (8DPSK)

Number of Channels (2.441 GHz - 2.4835 GHz)



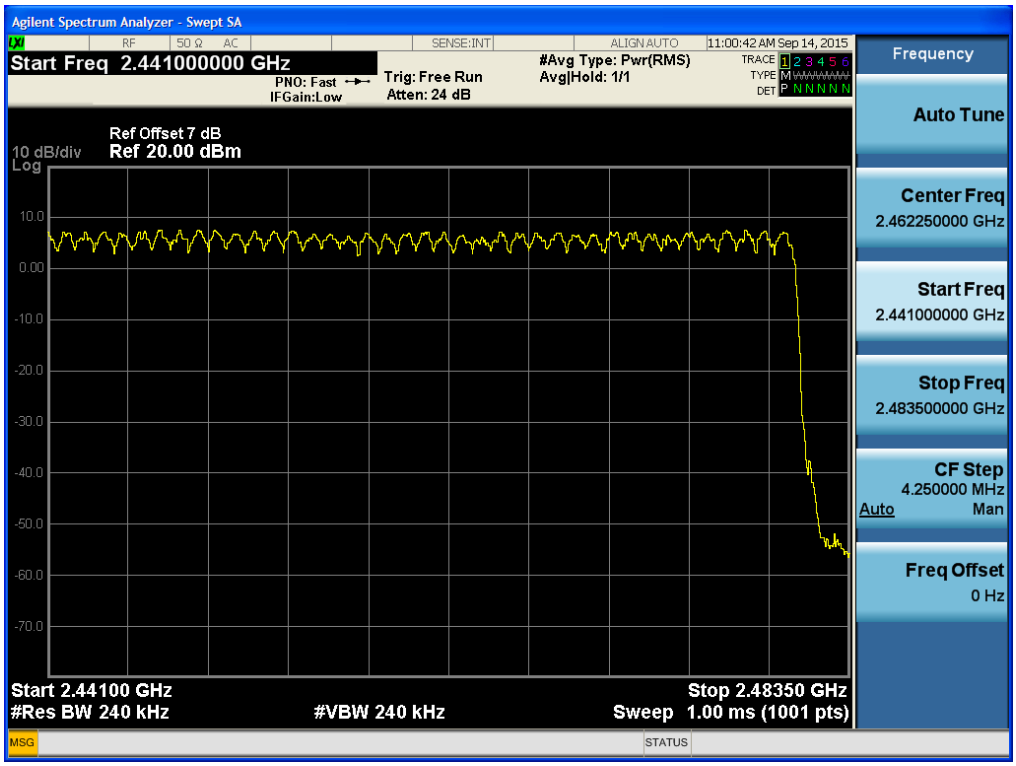
Test Plots (π/4DQPSK)

Number of Channels (2.4 GHz - 2.441 GHz)




Test Plots (π/4DQPSK)

Number of Channels (2.441 GHz - 2.4835 GHz)

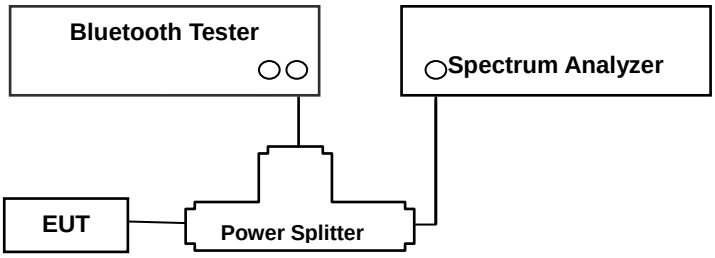


## 8.5 TIME OF OCCUPANCY (DWELL TIME)

**LIMIT**

According to §15.247(a)(1)(iii), Frequency hopping systems operating in the 2400 MHz ~ 2483.5 MHz bands. The average time of occupancy on any channels shall not greater than 0.4 s within a period 0.4 s multiplied by the number of hopping channels employed.

**Test Configuration**




**TEST PROCEDURE**

This test is performed with hopping off.

EUT was set to transmit the longest packet type (DH5)

The Spectrum Analyzer is set to (7.8.4 in ANSI 63.10-2013)

1) Span: Zero span, centered on a hopping channel
2) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
3) Sweep = as necessary to capture the entire dwell time per hopping channel
4) Detector: Peak
5) Trace: Max hold

The marker-delta function was used to determine the dwell time.

**Normal Mode / EDR Mode**

**DH 5**(The longest packet type for GFSK)

CH Mid : 2.890 * (1600/6)/79 * 31.6 = 308.27 (ms)

**2-DH 5**(The longest packet type for π/4DQPSK)

CH Mid : 2.890 * (1600/6)/79 * 31.6 = 308.27 (ms)

**3-DH 5**(The longest packet type for 8DPSK)

CH Mid : 2.890 * (1600/6)/79 * 31.6 = 308.27 (ms)

**AFH Mode**

**DH 5**(The longest packet type for GFSK)

CH Mid : 2.890 * (800/6)/20 * 8.0 = 154.13 (ms)

**2-DH 5**(The longest packet type for π/4DQPSK)

CH Mid : 2.890 * (800/6)/20 * 8.0 = 154.13 (ms)

**3-DH 5**(The longest packet type for 8DPSK)

CH Mid : 2.890 * (800/6)/20 * 8.0 = 154.13 (ms)

Note :

A DH5 Packet need 5 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/6 hops per second with 79 channels. So the system have each channel 3.3755 times per second and so for 31.6 seconds the system have 106.7 times of appearance. Each tx-time per appearance of DH5 is 2.892 ms.

Dwell time = Tx-time * 106.7

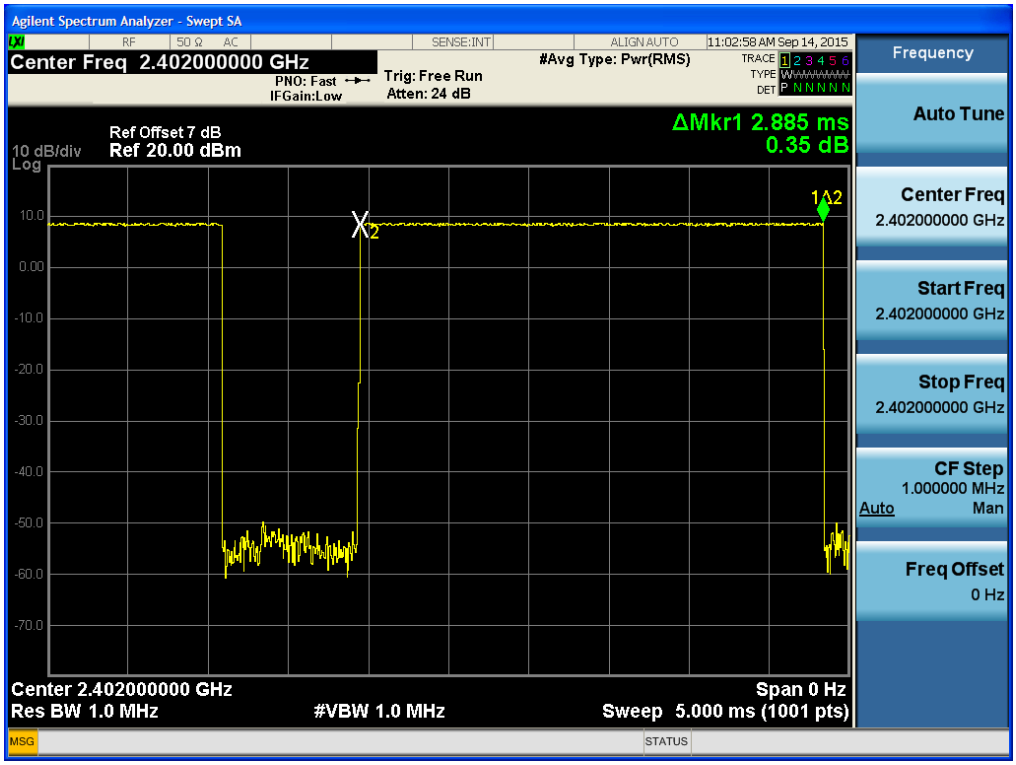
**TEST RESULTS**

See the table.

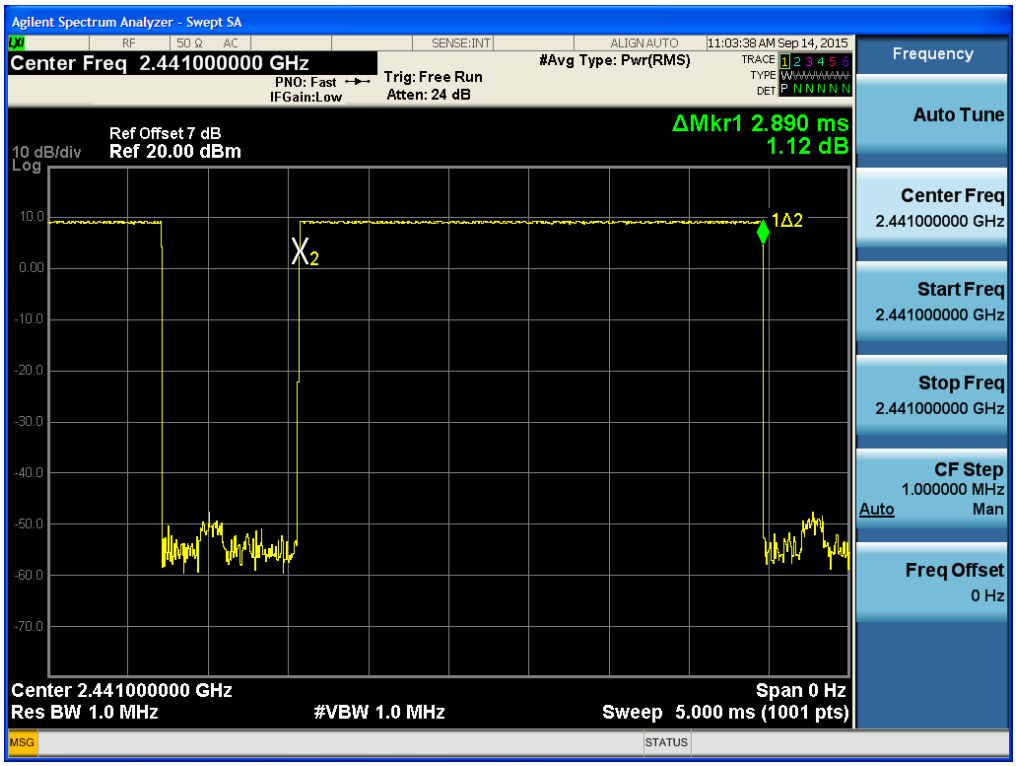
| | Channel | GFSK | 8DPSK | π/4DQPSK |
|---|---|---|---|---|
| Pulse Time (ms) | Low | 2.885 | 2.890 | 2.890 |
| | Mid | 2.890 | 2.890 | 2.890 |
| | High | 2.885 | 2.890 | 2.885 |

| | Channel | GFSK | 8DPSK | π/4DQPSK | Period Time (s) | Limit (ms) | Result |
|---|---|---|---|---|---|---|---|
| Total of Dwell (ms) | Low | 307.73 | 308.27 | 308.27 | 31.6 | 400 | PASS |
| | Mid | 308.27 | 308.27 | 308.27 | 31.6 | | PASS |
| | High | 307.73 | 308.27 | 307.73 | 31.6 | | PASS |

Test Plots (GFSK)
Dwell Time (Low-CH)

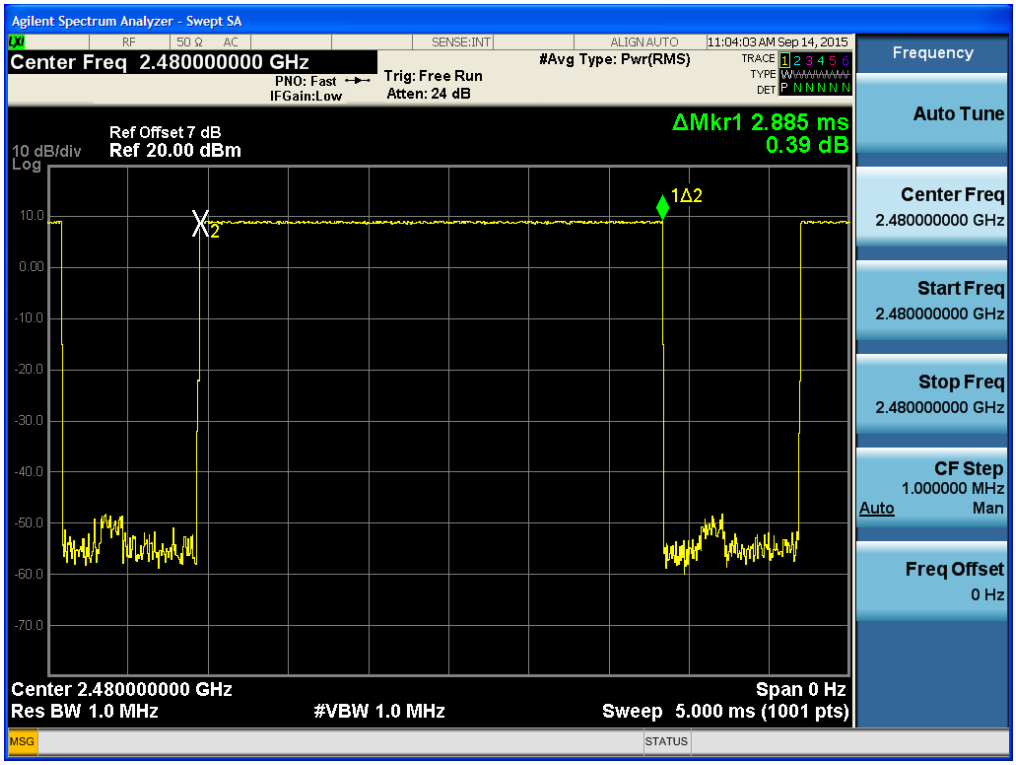



Test Plots (GFSK)
Dwell Time (Mid-CH)



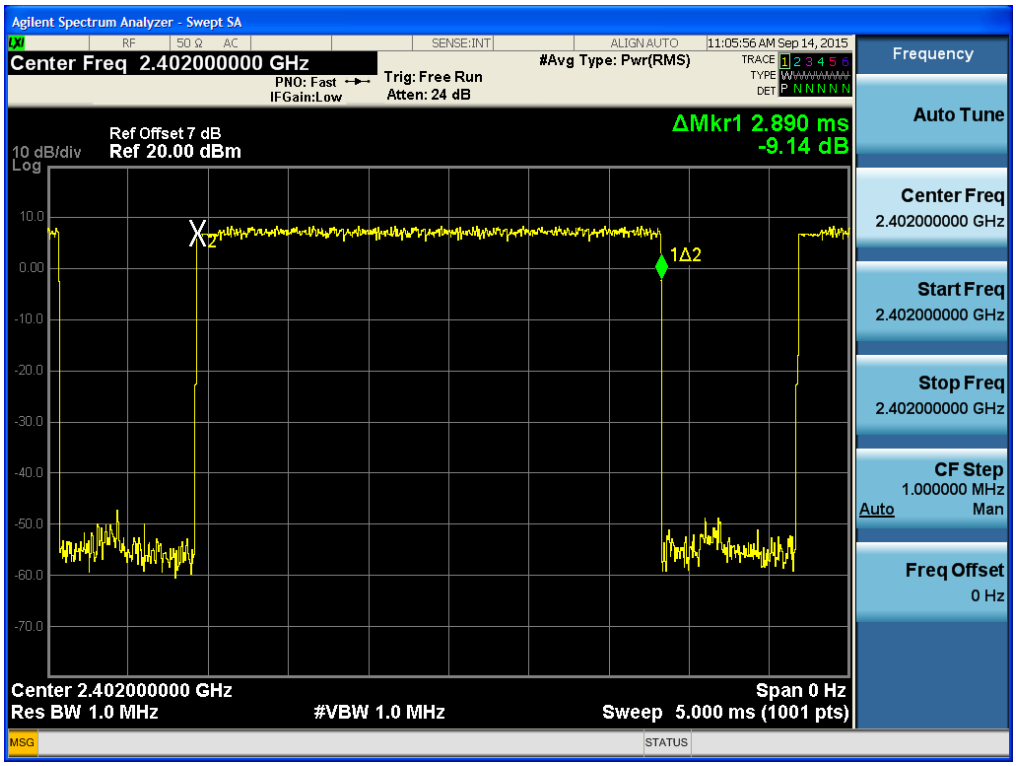
Test Plots (GFSK)

Dwell Time (High-CH)

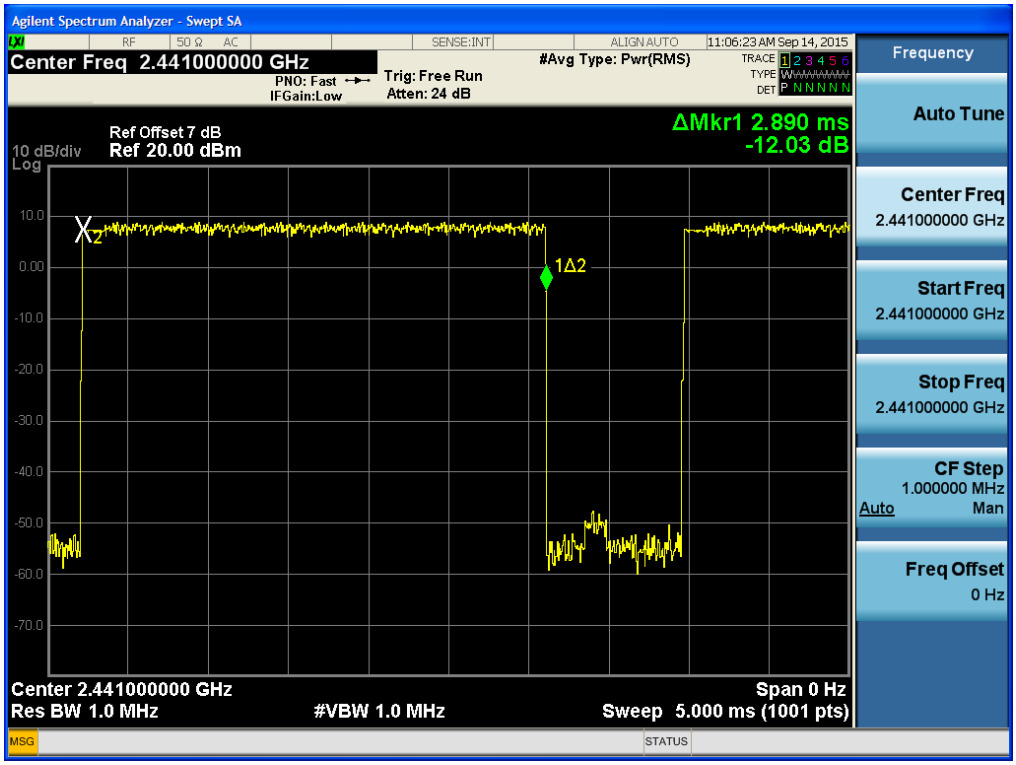



Test Plots (8DPSK)

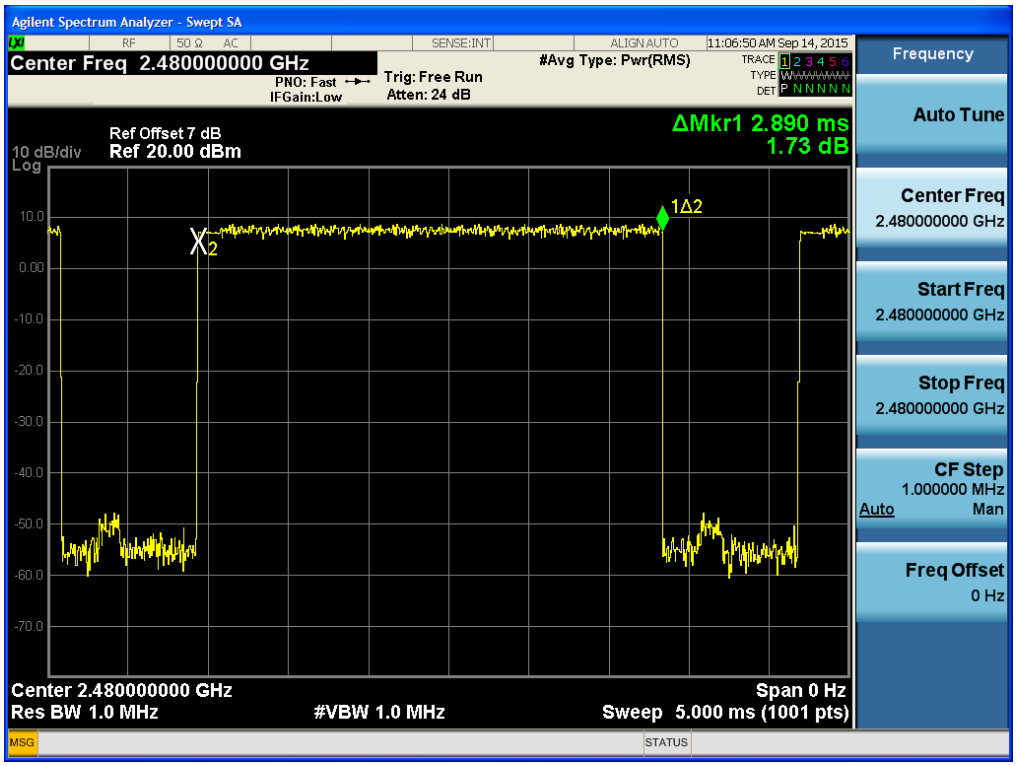
Dwell Time (Low-CH)



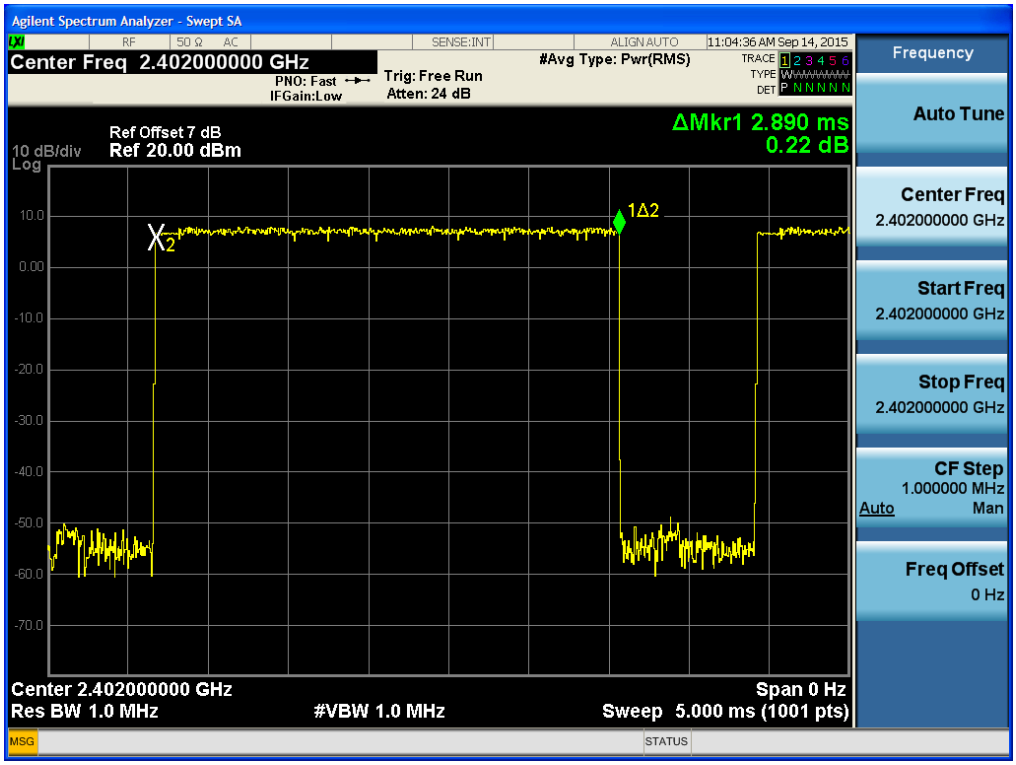
Test Plots (8DPSK)
Dwell Time (Mid-CH)



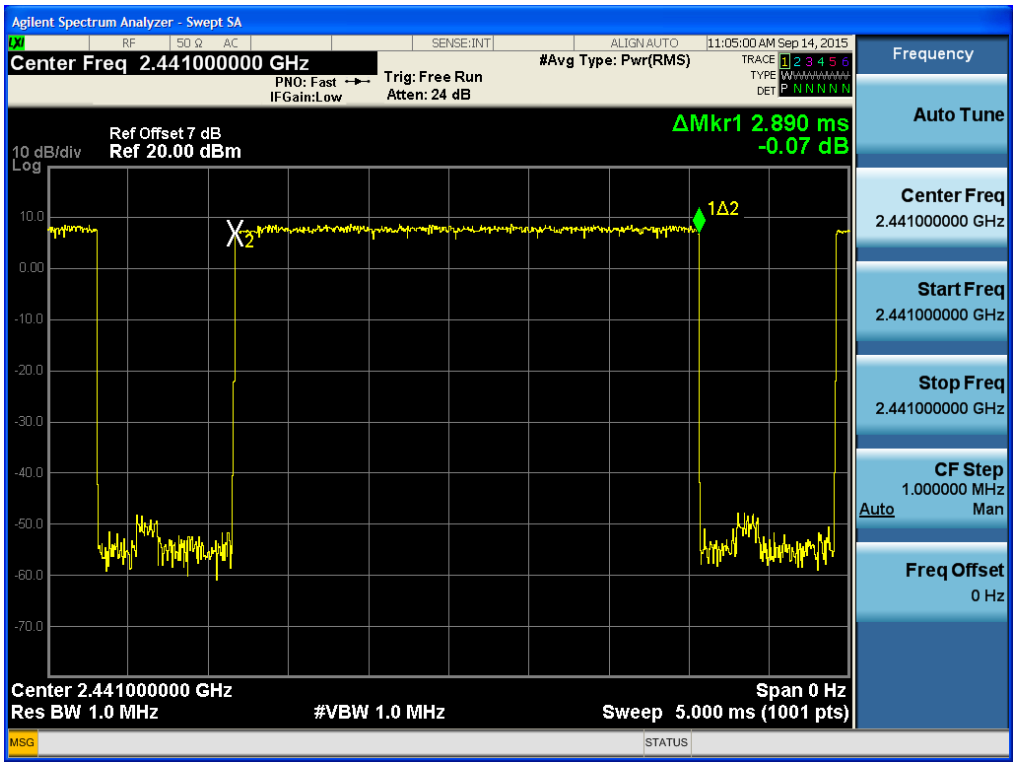

Test Plots (8DPSK)
Dwell Time (High-CH)



Test Plots (π/4DQPSK)
Dwell Time (Low-CH)

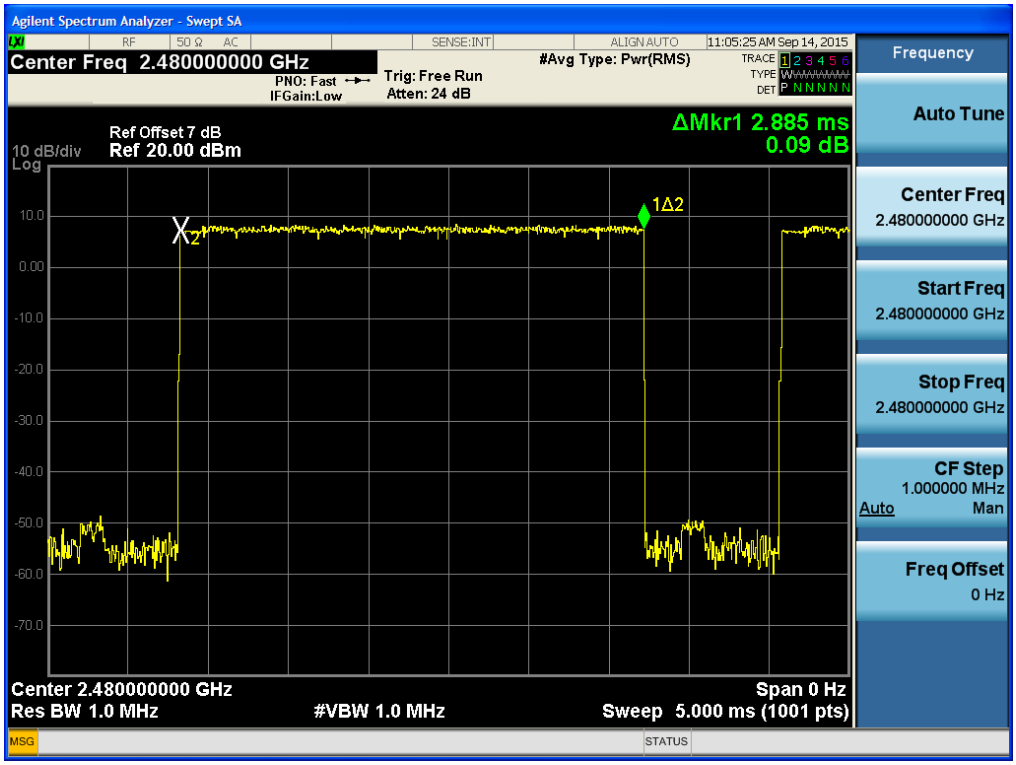



Test Plots (π/4DQPSK)
Dwell Time (Mid-CH)



Test Plots (π/4DQPSK)

Dwell Time (High-CH)



## 8.6 SPURIOUS EMISSIONS

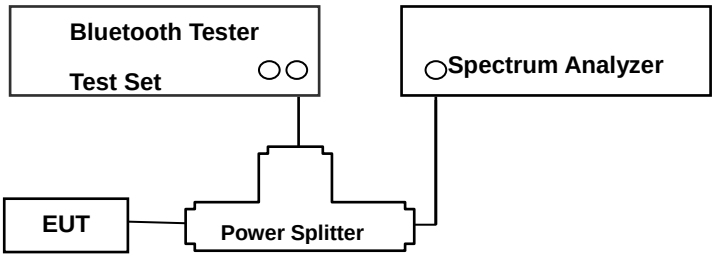
### 8.6.1 CONDUCTED SPURIOUS EMISSIONS

**Test Requirements and limit, §15.247(d)**

In any 100 kHz 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 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power 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 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

**Limit : 20 dBc**

**Test Configuration**




**TEST PROCEDURE**

Conducted RF measurements of the transmitter output were made to confirm that the EUT antenna port conducted emissions meet the specified limit and to identify any spurious signals that require further investigation or measurements on the radiated emissions site.

The transmitter output is connected to the spectrum analyzer.

The Spectrum Analyzer is set to (7.8.8 in ANSI 63.10-2013)

1) Span: 30 MHz to 10 times the operating frequency in GHz.
2) RBW: 100 kHz
3) VBW: 300 kHz
4) Sweep: Coupled
5) Detector: Peak

Measurements are made over the 30 MHz to 26 GHz range with the transmitter set to the lowest, middle, and highest channels.

This test is performed with hopping off.

## TEST RESULTS

No non-compliance noted.

Note : In order to simplify the report, attached plots were only the worst case channel and data rate.

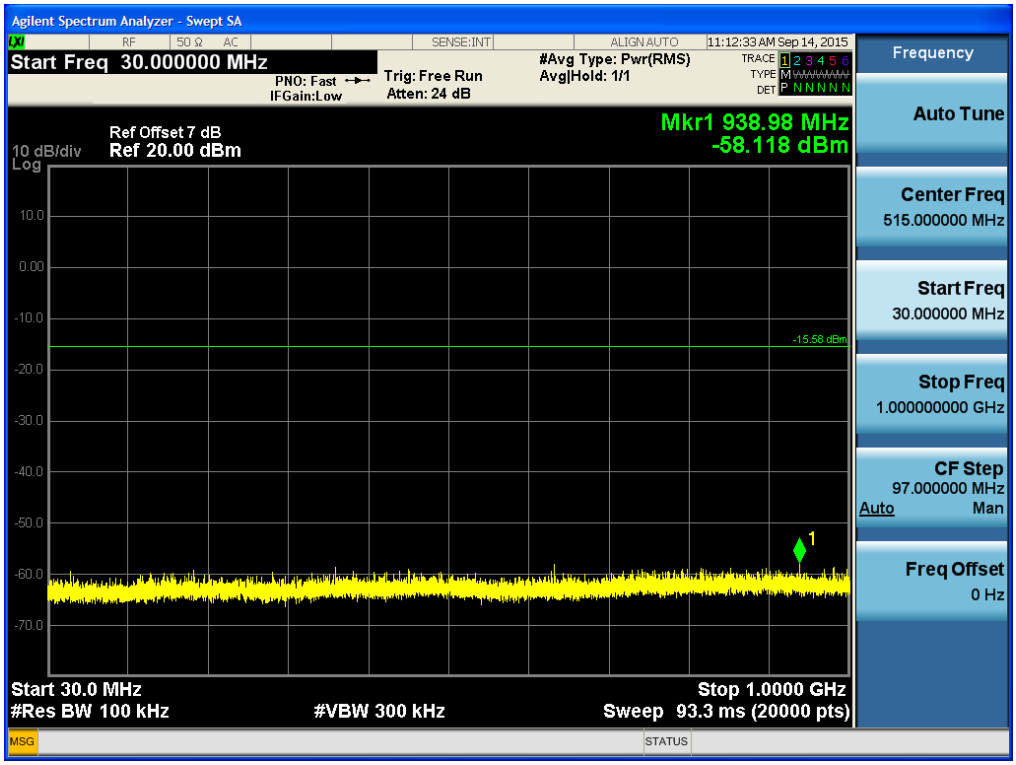
## FACTORS FOR FREQUENCY

| Freq(MHz) | Factor(dB) |
|---|---|
| 30 | 10.01 |
| 100 | 10.02 |
| 200 | 10.10 |
| 300 | 10.09 |
| 400 | 10.13 |
| 500 | 10.21 |
| 600 | 10.13 |
| 700 | 10.31 |
| 800 | 10.18 |
| 900 | 10.30 |
| 1000 | 10.17 |
| 2000 | 8.53 |
| 2400* | 6.51 |
| 2500* | 6.54 |
| 3000 | 8.59 |
| 4000 | 10.02 |
| 5000 | 9.88 |
| 6000 | 5.70 |
| 7000 | 10.21 |
| 8000 | 6.13 |
| 9000 | 8.79 |
| 10000 | 12.46 |
| 11000 | 8.11 |
| 12000 | 9.52 |
| 13000 | 8.98 |
| 14000 | 8.13 |
| 15000 | 11.82 |
| 16000 | 6.92 |
| 17000 | 13.23 |
| 18000 | 10.25 |
| 19000 | 10.28 |
| 20000 | 9.10 |
| 21000 | 10.94 |
| 22000 | 11.54 |
| 23000 | 8.81 |
| 24000 | 11.71 |
| 25000 | 9.37 |
| 26000 | 9.34 |

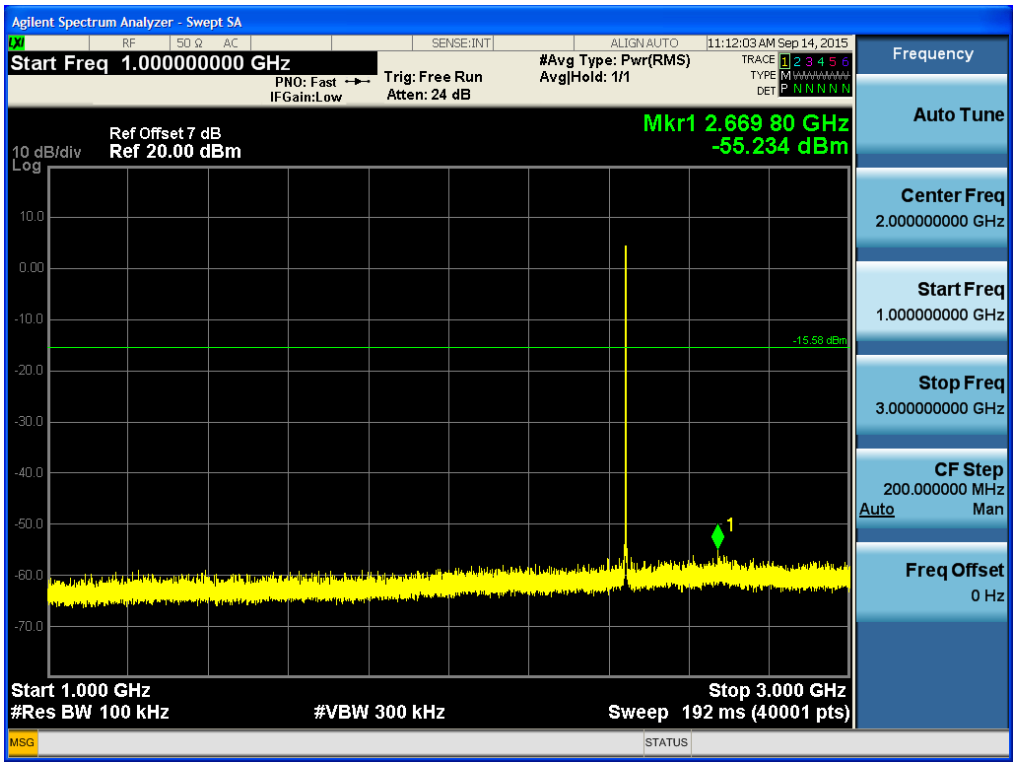
Note : 1. '*' is fundamental frequency range.

2. Factor = Cable loss + Splitter loss

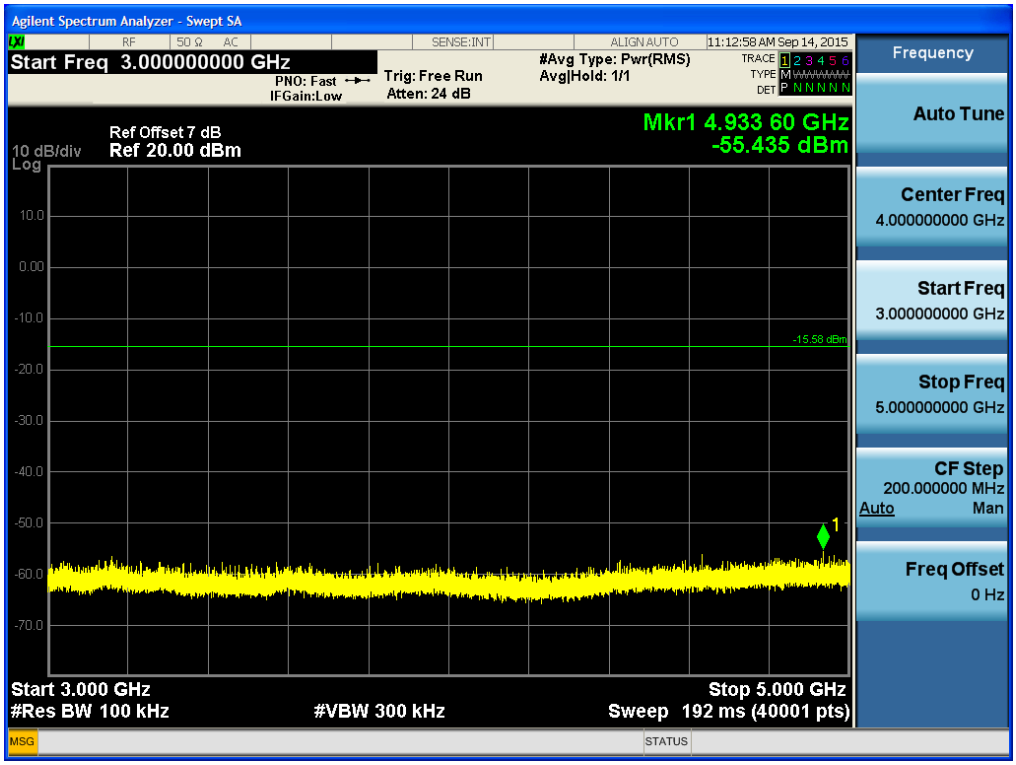
Test Plots (8DPSK)- 30 MHz - 1 GHz
Spurious Emission (Mid-CH)



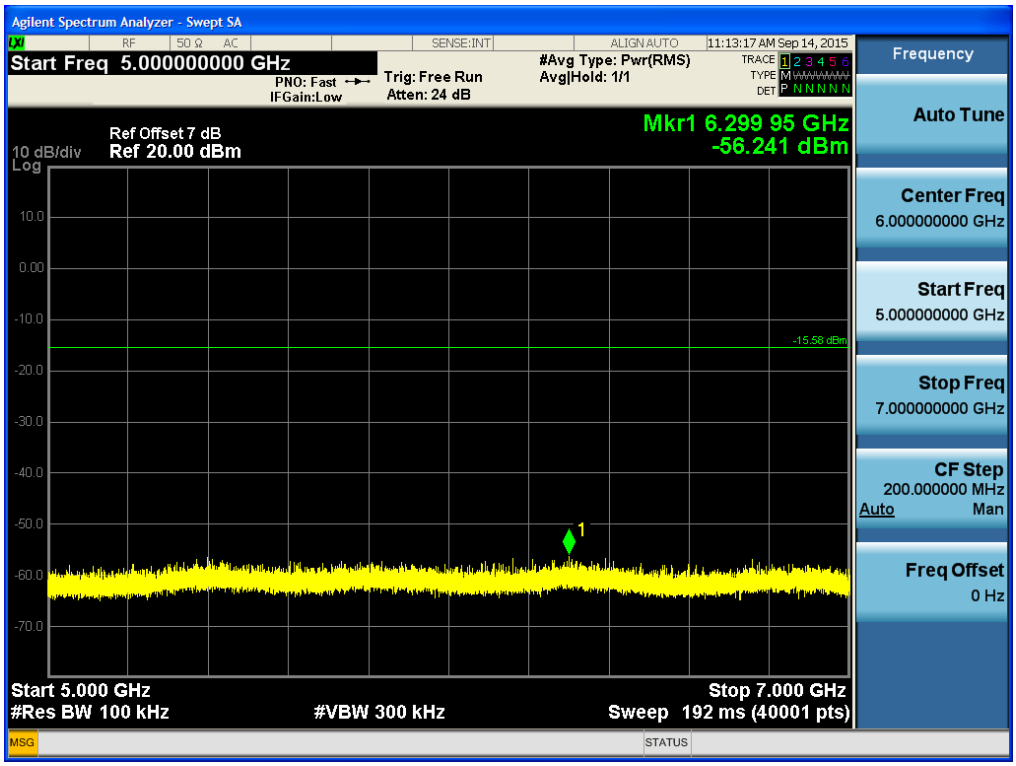

Test Plots (8DPSK)- 1 GHz – 3 GHz
Spurious Emission (Mid-CH)



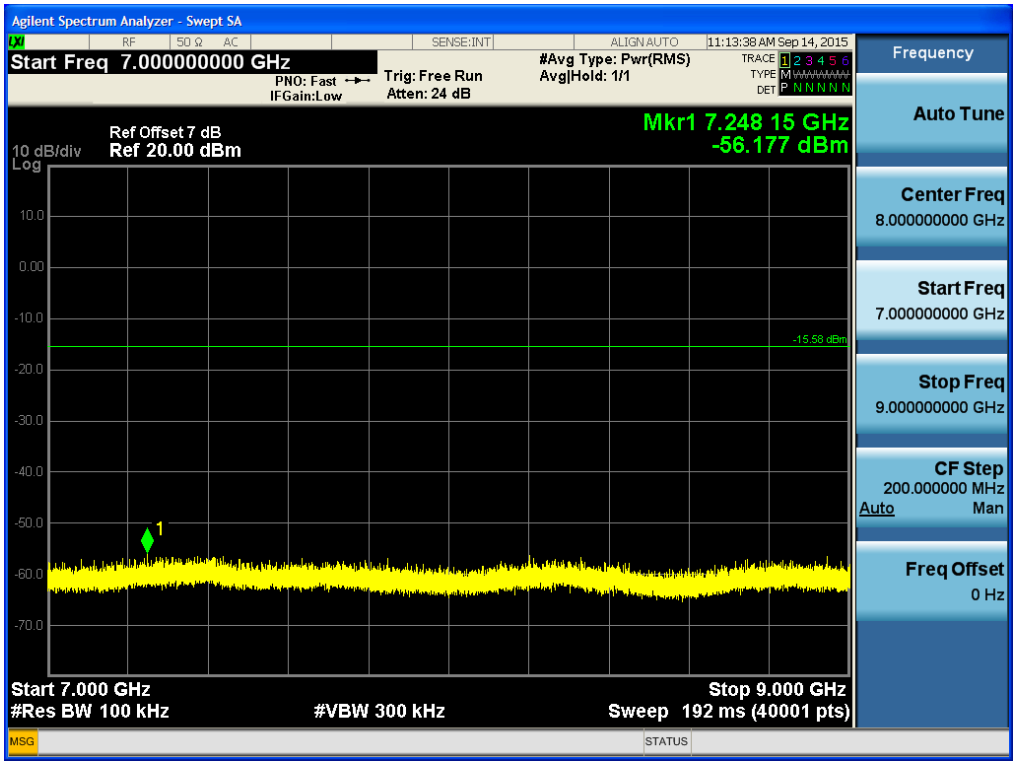
Test Plots (8DPSK)- 3 GHz - 5 GHz
Spurious Emission (Mid-CH)



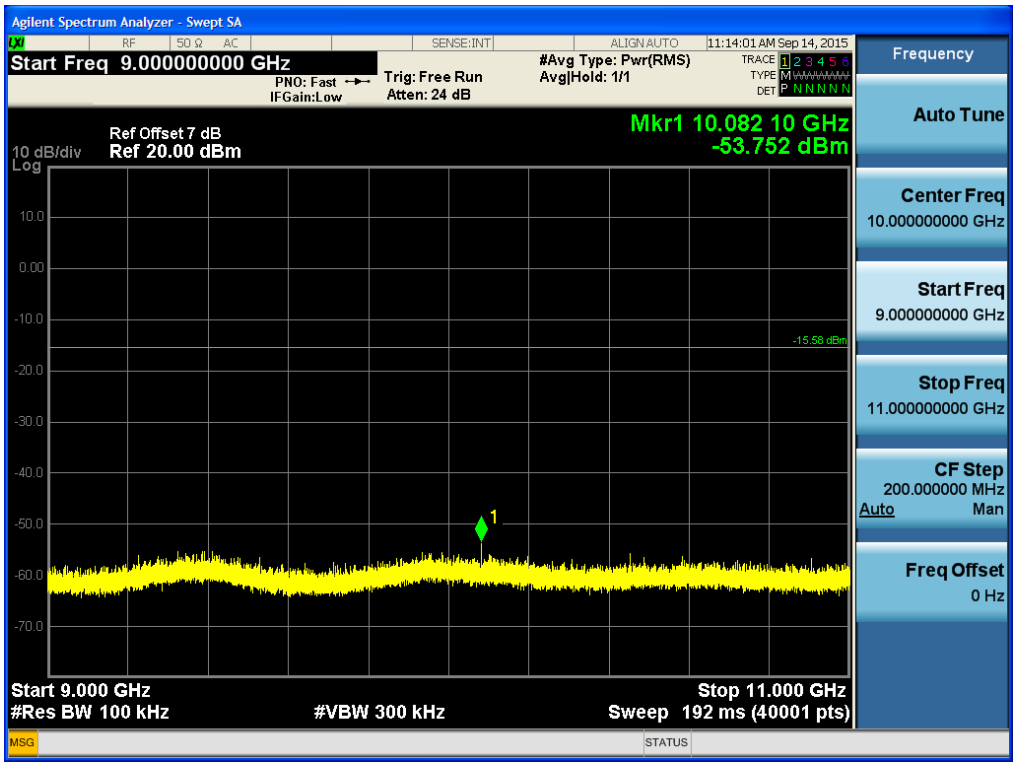

Test Plots (8DPSK)- 5 GHz - 7 GHz
Spurious Emission (Mid-CH)



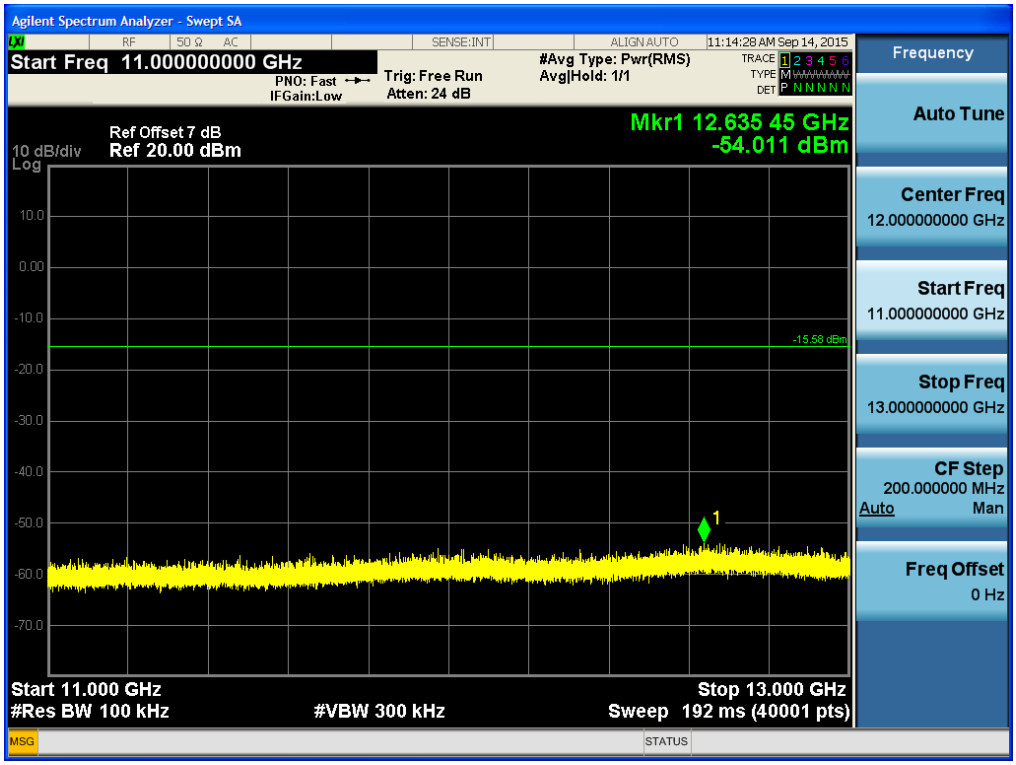
Test Plots (8DPSK)- 7 GHz - 9 GHz
Spurious Emission (Mid-CH)



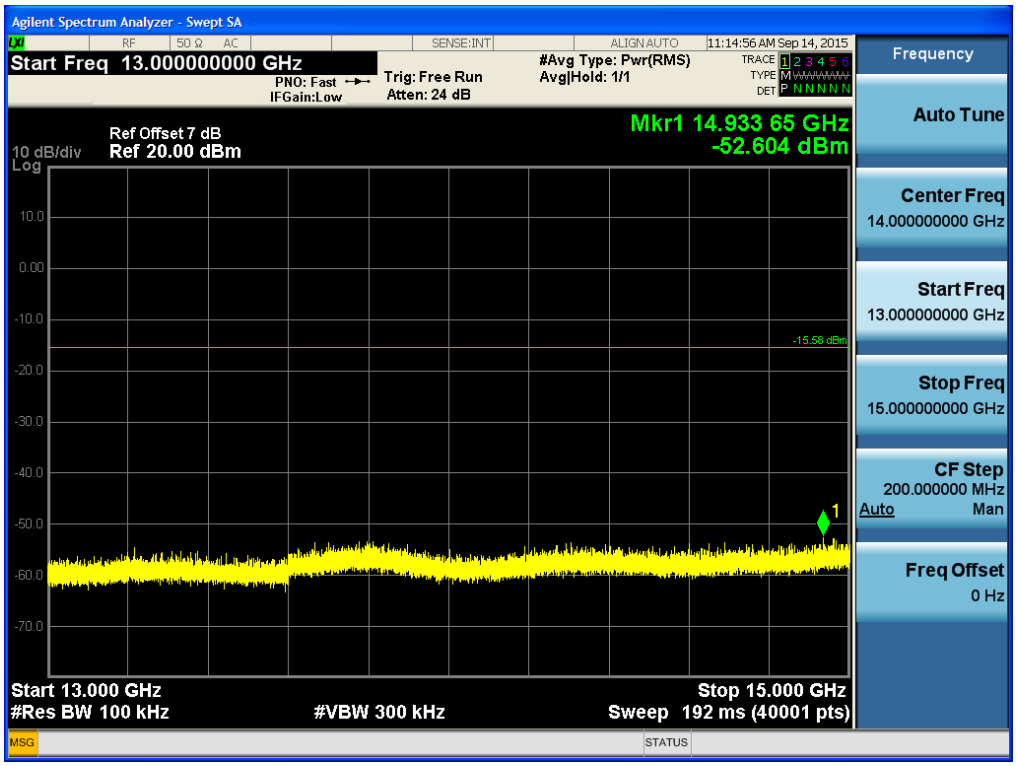

Test Plots(8DPSK)- 9 GHz - 11 GHz
Spurious Emission (Mid-CH)



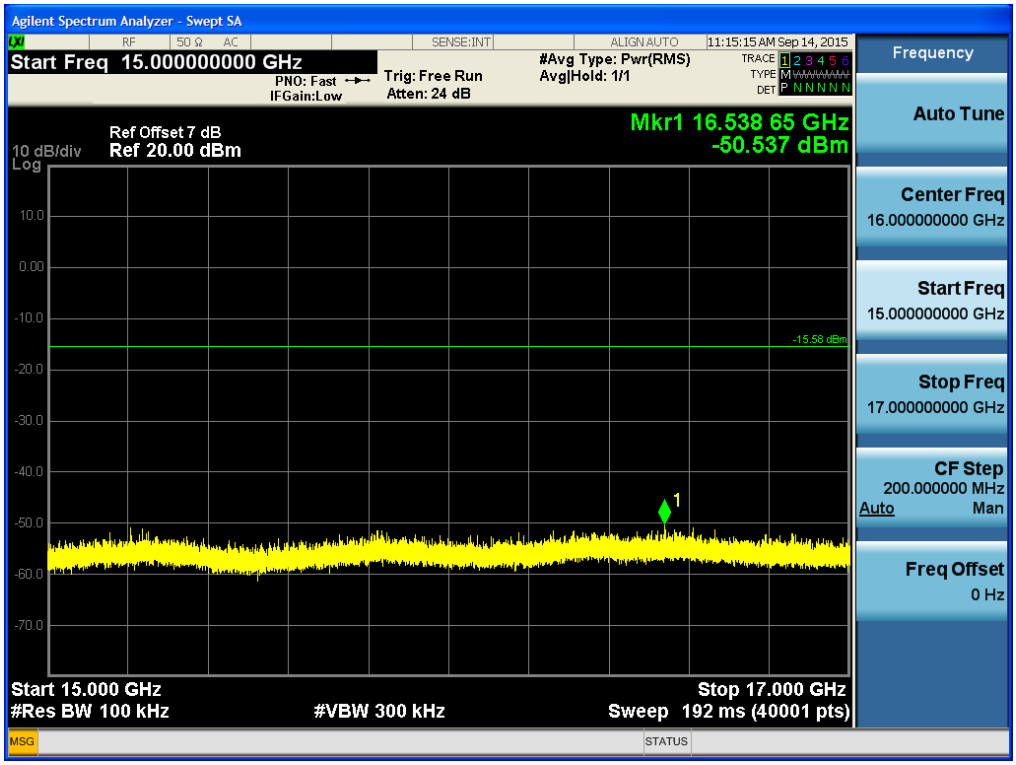
Test Plots (8DPSK)- 11 GHz - 13 GHz
Spurious Emission (Mid-CH)



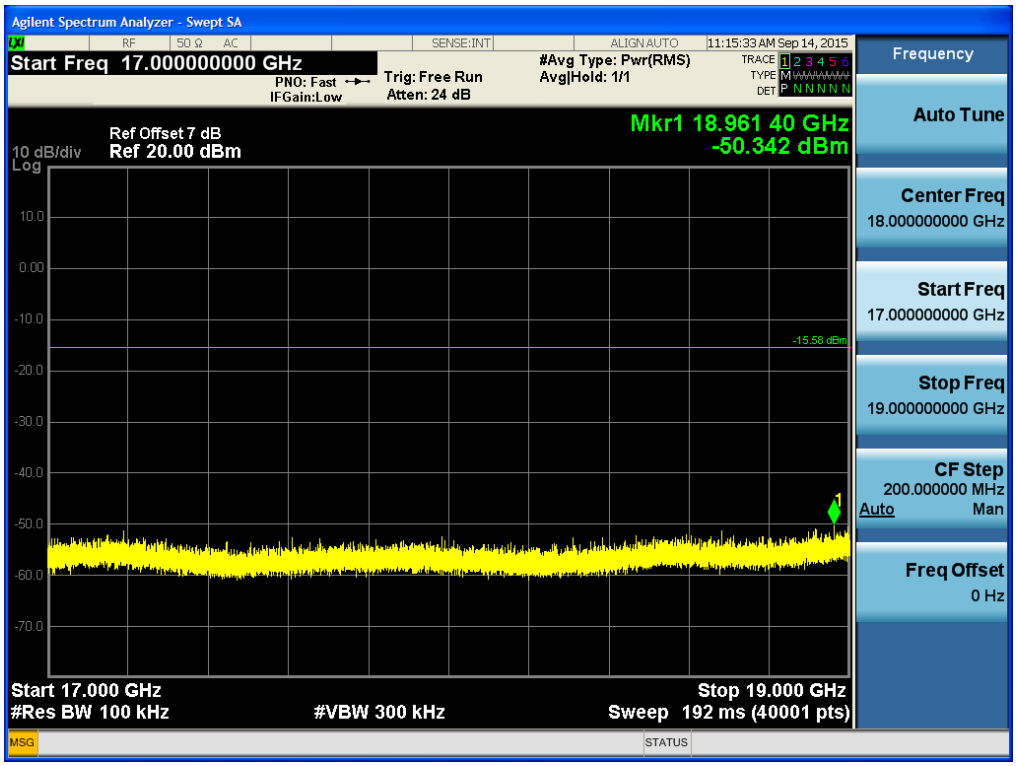

Test Plots (8DPSK)- 13 GHz – 15 GHz
Spurious Emission (Mid-CH)



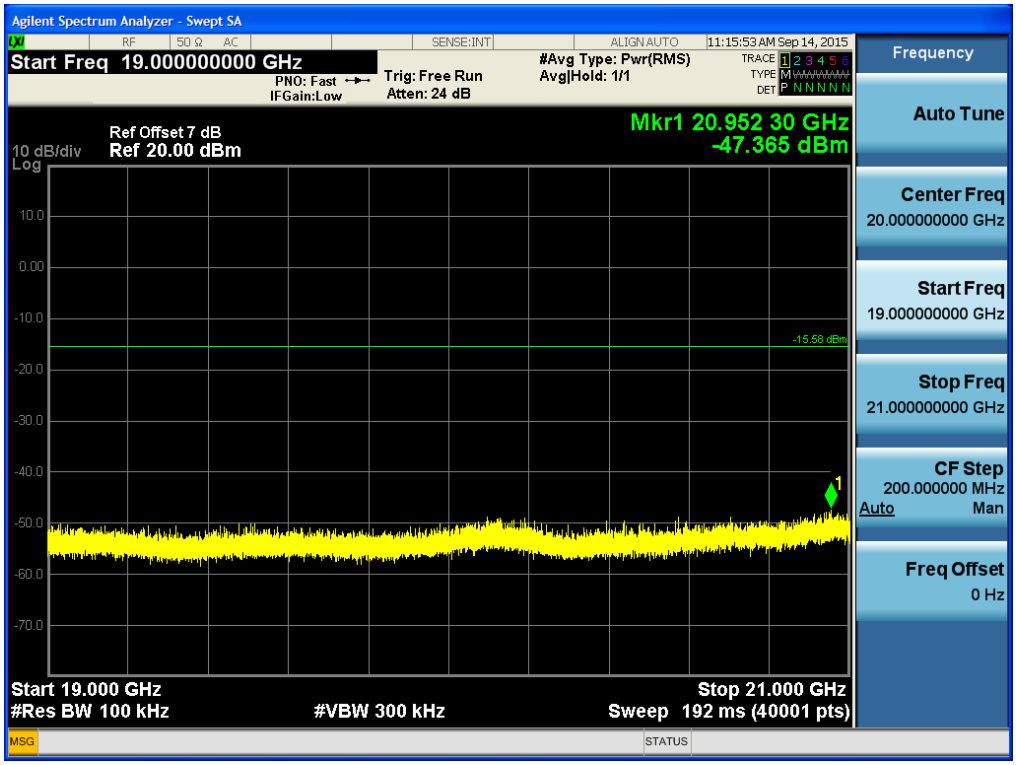
Test Plots (8DPSK)– 15 GHz - 17 GHz
Spurious Emission (Mid-CH)



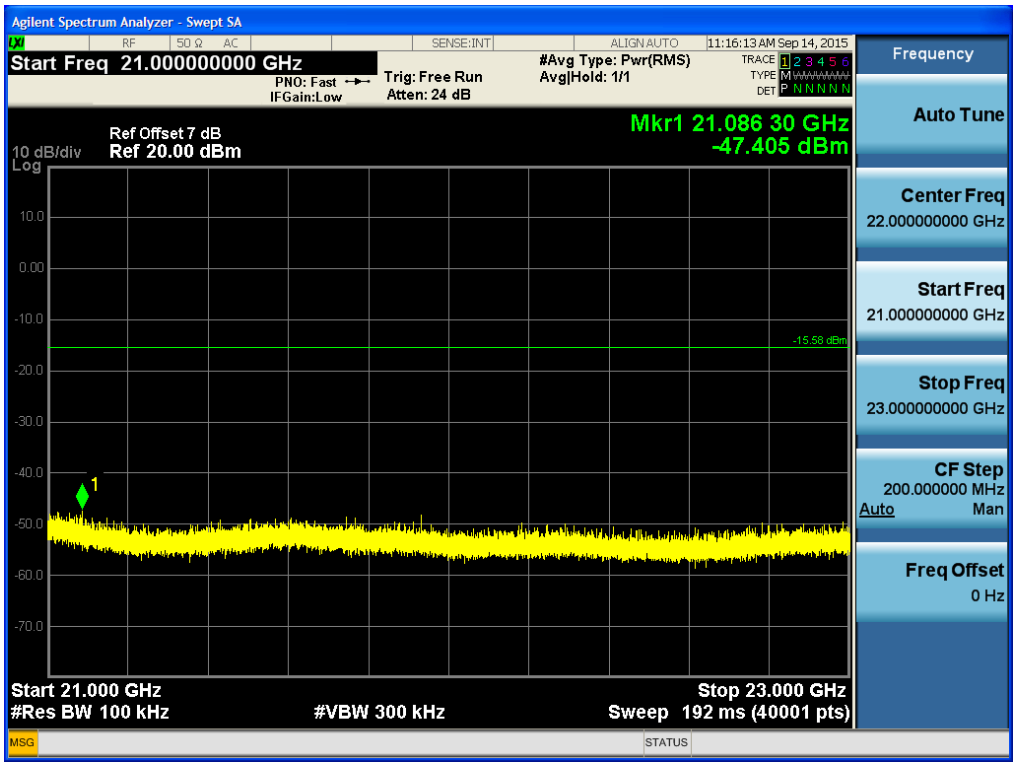

Test Plots(8DPSK)- 17 GHz - 19 GHz
Spurious Emission (Mid-CH)



Test Plots (8DPSK)- 19 GHz - 21 GHz
Spurious Emission (Mid-CH)

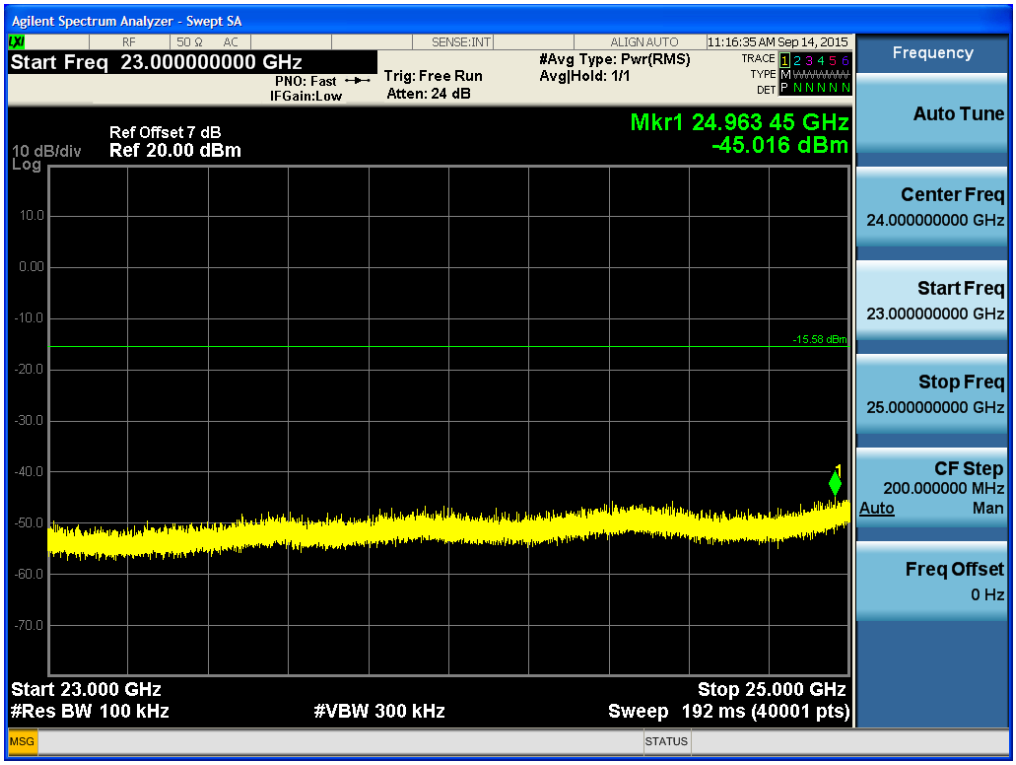



Test Plots (8DPSK)- 21 GHz - 23 GHz
Spurious Emission (Mid-CH)



Test Plots (8DPSK)- 23 GHz - 25 GHz

Spurious Emission (Mid-CH)



### 8.6.2 RADIATED SPURIOUS EMISSIONS

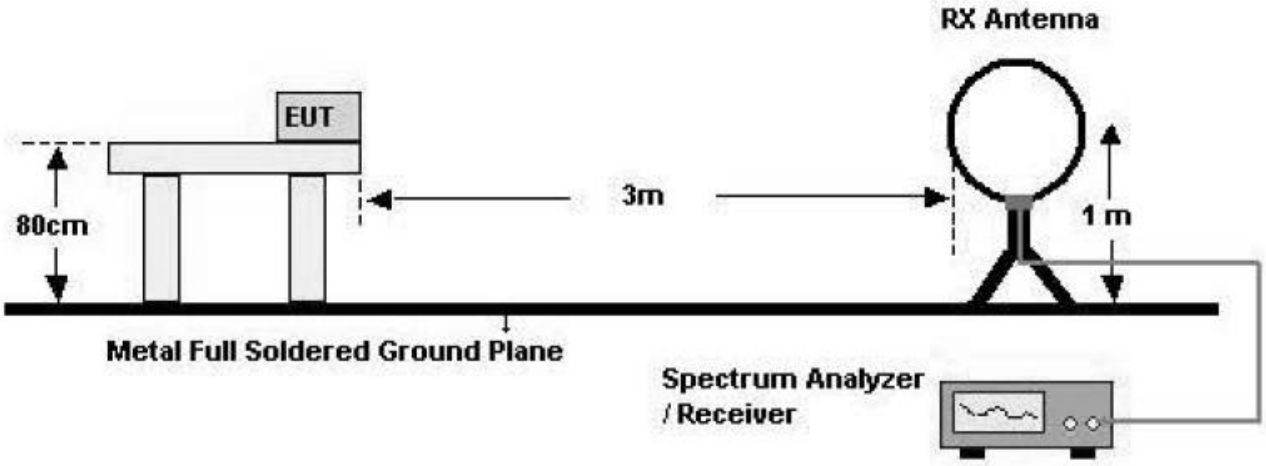
**LIMIT : §15.205, §15.209**

1. 20dBc in any 100kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

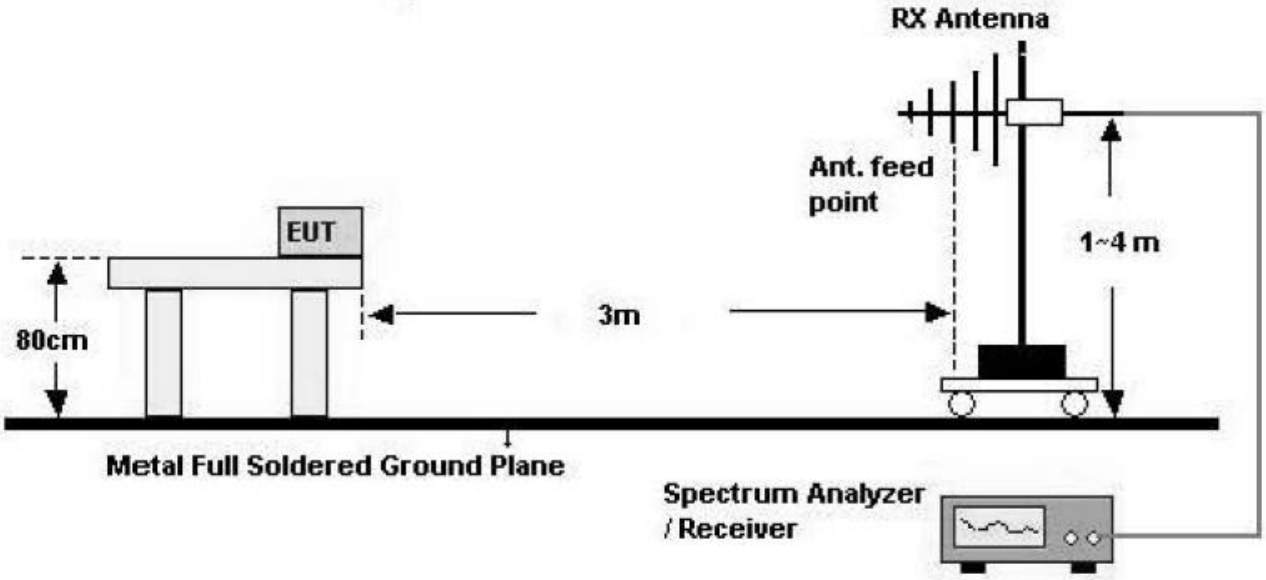
| Frequency (MHz) | Field Strength (uV/m) | Measurement Distance (m) |
|---|---|---|
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30 | 30 | 30 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

**Test Configuration**

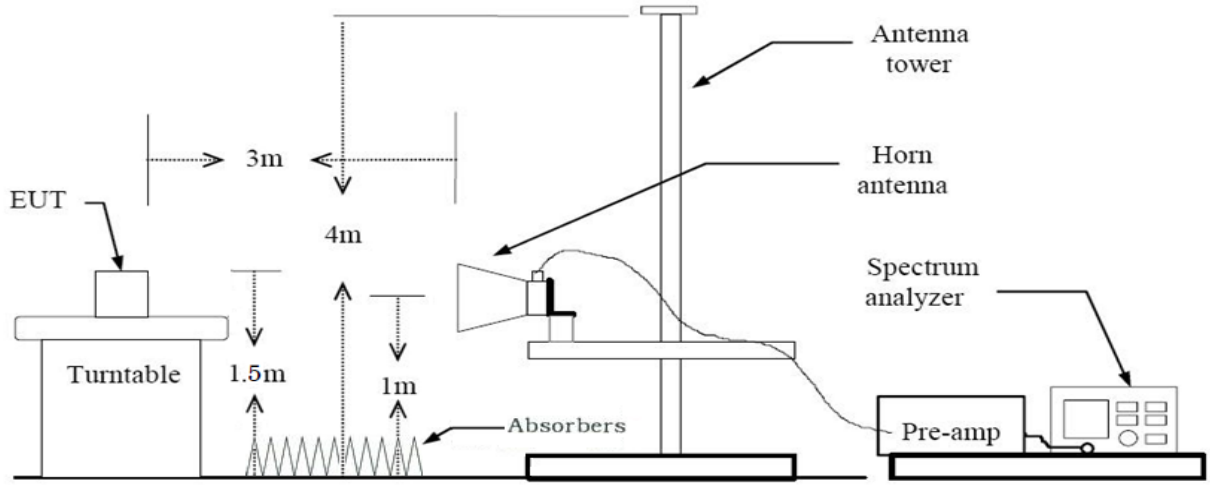
**Below 30 MHz**




**30 MHz - 1 GHz**



**Above 1 GHz**




**TEST PROCEDURE**

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. Spectrum Setting

   a. Peak: 1 GHz – 25 GHz, RBW = 1 MHz, VBW ≥3*RBW

   b. Average: 1 GHz – 25 GHz, RBW = 1 MHz, VBW ≥ 1/τ Hz, where τ = pulse width in seconds.

Note :

1. We are performed the RSE and radiated band edge using standard radiated method.
2. The duty cycle factor for BT mode.

| BT Mode | $T_{on}$ (ms) | VBW(1/T) (Hz) | The actual setting value of VBW (Hz) |
|---|---|---|---|
| | 2.890 | 346 | 1000 |

**TEST RESULTS**

**9 kHz – 30MHz**

**Operation Mode:** Normal Mode

| Frequency | Reading | Ant. factor | Cable loss | Ant. POL | Total | Limit | Margin |
|---|---|---|---|---|---|---|---|
| ㎒ | dB㎶ | dB /m | dB | (H/V) | dB㎶/m | dB㎶/m | dB |
| No Critical peaks found | | | | | | | |

**Notes:**

1. Measuring frequencies from 9 kHz to the 30MHz.
2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
3. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
5. This test is performed with hopping off.
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

**TEST RESULTS**

**Below 1 GHz**

**Operation Mode:** Normal Mode

| Frequency | Reading | Ant. factor | Cable loss | Ant. POL | Total | Limit | Margin |
|---|---|---|---|---|---|---|---|
| ㎒ | dB㎶ | dB /m | dB | (H/V) | dB㎶/m | dB㎶/m | dB |
| No Critical peaks found | | | | | | | |

**Notes:**

1. Measuring frequencies from 30 MHz to the 1 GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
3. This test is performed with hopping off.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Above 1 GHz

Operation Mode: CH Low(GFSK)

| Frequency [MHz] | Reading DBuV | ※A.F+CL-AMP GAIN [dB] | ANT. POL [H/V] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|
| 4804 | 51.78 | 1.38 | V | 53.16 | 73.98 | 20.82 | PK |
| 4804 | 39.98 | 1.38 | V | 41.36 | 53.98 | 12.62 | AV |
| 7206 | 49.28 | 8.56 | V | 57.84 | 73.98 | 16.14 | PK |
| 7206 | 37.11 | 8.56 | V | 45.67 | 53.98 | 8.31 | AV |
| 4804 | 52.60 | 1.38 | H | 53.98 | 73.98 | 20.00 | PK |
| 4804 | 42.07 | 1.38 | H | 43.45 | 53.98 | 10.53 | AV |
| 7206 | 49.39 | 8.56 | H | 57.95 | 73.98 | 16.03 | PK |
| 7206 | 37.13 | 8.56 | H | 45.69 | 53.98 | 8.29 | AV |

Operation Mode: CH Low(8DPSK)

| Frequency [MHz] | Reading DBuV | ※A.F+CL-AMP GAIN [dB] | ANT. POL [H/V] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|
| 4804 | 50.13 | 1.38 | V | 51.51 | 73.98 | 22.47 | PK |
| 4804 | 38.48 | 1.38 | V | 39.86 | 53.98 | 14.12 | AV |
| 7206 | 48.54 | 8.56 | V | 57.1 | 73.98 | 16.88 | PK |
| 7206 | 37.16 | 8.56 | V | 45.72 | 53.98 | 8.26 | AV |
| 4804 | 51.13 | 1.38 | H | 52.51 | 73.98 | 21.47 | PK |
| 4804 | 39.40 | 1.38 | H | 40.78 | 53.98 | 13.20 | AV |
| 7206 | 48.62 | 8.56 | H | 57.18 | 73.98 | 16.80 | PK |
| 7206 | 37.22 | 8.56 | H | 45.78 | 53.98 | 8.20 | AV |

Operation Mode: CH Low(π/4DQPSK)

| Frequency [MHz] | Reading DBuV | ※A.F+CL-AMP GAIN [dB] | ANT. POL [H/V] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|
| 4804 | 50.06 | 1.38 | V | 51.44 | 73.98 | 22.54 | PK |
| 4804 | 38.52 | 1.38 | V | 39.9 | 53.98 | 14.08 | AV |
| 7206 | 49.14 | 8.56 | V | 57.7 | 73.98 | 16.28 | PK |
| 7206 | 37.16 | 8.56 | V | 45.72 | 53.98 | 8.26 | AV |
| 4804 | 51.10 | 1.38 | H | 52.48 | 73.98 | 21.50 | PK |
| 4804 | 39.67 | 1.38 | H | 41.05 | 53.98 | 12.93 | AV |
| 7206 | 49.28 | 8.56 | H | 57.84 | 73.98 | 16.14 | PK |
| 7206 | 37.17 | 8.56 | H | 45.73 | 53.98 | 8.25 | AV |

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP GAIN: AMPLIFIER GAIN

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000 MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
5. Spectrum setting:
   a. Peak Setting 1 GHz – 25 GHz, RBW = 1 MHz, VBW = 3 MHz.
   b. Average Setting 1 GHz – 25 GHz, RBW = 1 MHz, VBW ≥ 1/τ Hz, where τ = pulse width in seconds.
   We performed using a reduced video BW method was done with the analyzer in linear mode.
6. FYI : Duty Cycle Correction Factor (79 channel hopping)
   a. Time to cycle through all channels= Δ t= τ [ms] x 79 channels = 229.100 ms, where τ = pulse width
   b. 100 ms/ Δt [ms] = *H* → Round up to next highest integer, *H ' =1*
   c. Worst Case Dwell Time = τ [ms] x *H '* = 2.900 ms
   d. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100ms) dB = -30.752 dB
7. Duty Cycle Correction Factor(AFH mode – minimum channel number case - 20 channels)
   a. Time to cycle through all channels= Δ t= τ [ms] x 20 channels = 58.00 ms, where τ = pulse width
   b. 100 ms/ Δt [ms] = *H* → Round up to next highest integer, *H ' = 2*

c. Worst Case Dwell Time = τ [ms] x *H* ' = 5.800 ms

d. Duty Cycle Correction(AFH) = 20log (Worst Case Dwell Time/ 100ms) dB = -24.7314 dB

e. We applied DCCF in the test result which hopping channel number is 20.

8. We have done Normal Mode and EDR Mode test.
9. This test is performed with hopping off.
10. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Operation Mode: CH Mid(GFSK)

| Frequency [MHz] | Reading DBuV | ※A.F+CL-AMP GAIN [dB] | ANT. POL [H/V] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|
| 4882 | 49.10 | 1.71 | V | 50.81 | 73.98 | 23.17 | PK |
| 4882 | 37.69 | 1.71 | V | 39.4 | 53.98 | 14.58 | AV |
| 7323 | 49.13 | 8.65 | V | 57.78 | 73.98 | 16.20 | PK |
| 7323 | 36.70 | 8.65 | V | 45.35 | 53.98 | 8.63 | AV |
| 4882 | 49.65 | 1.71 | H | 51.36 | 73.98 | 22.62 | PK |
| 4882 | 38.80 | 1.71 | H | 40.51 | 53.98 | 13.47 | AV |
| 7323 | 49.05 | 8.65 | H | 57.7 | 73.98 | 16.28 | PK |
| 7323 | 36.74 | 8.65 | H | 45.39 | 53.98 | 8.59 | AV |

Operation Mode: CH Mid(8DPSK)

| Frequency [MHz] | Reading DBuV | ※A.F+CL-AMP GAIN [dB] | ANT. POL [H/V] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|
| 4882 | 49.17 | 1.71 | V | 50.88 | 73.98 | 23.10 | PK |
| 4882 | 37.38 | 1.71 | V | 39.09 | 53.98 | 14.89 | AV |
| 7323 | 49.23 | 8.65 | V | 57.88 | 73.98 | 16.10 | PK |
| 7323 | 36.72 | 8.65 | V | 45.37 | 53.98 | 8.61 | AV |
| 4882 | 49.24 | 1.71 | H | 50.95 | 73.98 | 23.03 | PK |
| 4882 | 37.46 | 1.71 | H | 39.17 | 53.98 | 14.81 | AV |
| 7323 | 49.15 | 8.65 | H | 57.8 | 73.98 | 16.18 | PK |
| 7323 | 36.69 | 8.65 | H | 45.34 | 53.98 | 8.64 | AV |

Operation Mode: CH Mid(π/4DQPSK)

| Frequency [MHz] | Reading DBuV | ※A.F+CL-AMP GAIN [dB] | ANT. POL [H/V] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|
| 4882 | 49.69 | 1.71 | V | 51.4 | 73.98 | 22.58 | PK |
| 4882 | 37.36 | 1.71 | V | 39.07 | 53.98 | 14.91 | AV |
| 7323 | 49.05 | 8.65 | V | 57.7 | 73.98 | 16.28 | PK |
| 7323 | 36.73 | 8.65 | V | 45.38 | 53.98 | 8.60 | AV |
| 4882 | 49.87 | 1.71 | H | 51.58 | 73.98 | 22.40 | PK |
| 4882 | 37.43 | 1.71 | H | 39.14 | 53.98 | 14.84 | AV |
| 7323 | 49.10 | 8.65 | H | 57.75 | 73.98 | 16.23 | PK |
| 7323 | 36.71 | 8.65 | H | 45.36 | 53.98 | 8.62 | AV |

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP GAIN: AMPLIFIER GAIN

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000 MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
5. Spectrum setting:
   a. Peak Setting 1 GHz – 25 GHz, RBW = 1 MHz, VBW = 3 MHz.
   b. Average Setting 1 GHz – 25 GHz, RBW = 1 MHz, VBW ≥ 1/τ Hz, where τ = pulse width in seconds.
   We performed using a reduced video BW method was done with the analyzer in linear mode.
6. FYI : Duty Cycle Correction Factor (79 channel hopping)
   a. Time to cycle through all channels= Δ t= τ [ms] x 79 channels = 229.100 ms, where τ = pulse width
   b. 100 ms/ Δt [ms] = *H* → Round up to next highest integer, *H ' =1*
   c. Worst Case Dwell Time = τ [ms] x *H '* = 2.900 ms
   d. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100ms) dB = -30.752 dB
7. Duty Cycle Correction Factor(AFH mode – minimum channel number case - 20 channels)
   a. Time to cycle through all channels= Δ t= τ [ms] x 20 channels = 58.00 ms, where τ = pulse width
   b. 100 ms/ Δt [ms] = *H* → Round up to next highest integer, *H ' = 2*

c. Worst Case Dwell Time = τ [ms] x *H* ' = 5.800 ms

d. Duty Cycle Correction(AFH) = 20log (Worst Case Dwell Time/ 100ms) dB = -24.7314 dB

e. We applied DCCF in the test result which hopping channel number is 20.

8. We have done Normal Mode and EDR Mode test.
9. This test is performed with hopping off.
10. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Operation Mode: CH High(GFSK)

| Frequency [MHz] | Reading DBuV | ※A.F+CL-AMP GAIN [dB] | ANT. POL [H/V] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|
| 4960 | 48.51 | 2.03 | V | 50.54 | 73.98 | 23.44 | PK |
| 4960 | 36.49 | 2.03 | V | 38.52 | 53.98 | 15.46 | AV |
| 7440 | 49.28 | 9.15 | V | 58.43 | 73.98 | 15.55 | PK |
| 7440 | 37.60 | 9.15 | V | 46.75 | 53.98 | 7.23 | AV |
| 4960 | 48.19 | 2.03 | H | 50.22 | 73.98 | 23.76 | PK |
| 4960 | 36.63 | 2.03 | H | 38.66 | 53.98 | 15.32 | AV |
| 7440 | 49.31 | 9.15 | H | 58.46 | 73.98 | 15.52 | PK |
| 7440 | 37.56 | 9.15 | H | 46.71 | 53.98 | 7.27 | AV |

Operation Mode: CH High(8DPSK)

| Frequency [MHz] | Reading DBuV | ※A.F+CL-AMP GAIN [dB] | ANT. POL [H/V] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|
| 4960 | 49.31 | 2.03 | V | 51.34 | 73.98 | 22.64 | PK |
| 4960 | 36.38 | 2.03 | V | 38.41 | 53.98 | 15.57 | AV |
| 7440 | 49.35 | 9.15 | V | 58.5 | 73.98 | 15.48 | PK |
| 7440 | 37.56 | 9.15 | V | 46.71 | 53.98 | 7.27 | AV |
| 4960 | 49.18 | 2.03 | H | 51.21 | 73.98 | 22.77 | PK |
| 4960 | 36.41 | 2.03 | H | 38.44 | 53.98 | 15.54 | AV |
| 7440 | 49.40 | 9.15 | H | 58.55 | 73.98 | 15.43 | PK |
| 7440 | 37.52 | 9.15 | H | 46.67 | 53.98 | 7.31 | AV |

Operation Mode**:** CH High (π/4DQPSK)

| Frequency [MHz] | Reading DBuV | ※A.F+CL-AMP GAIN [dB] | ANT. POL [H/V] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|
| 4960 | 48.35 | 2.03 | V | 50.38 | 73.98 | 23.60 | PK |
| 4960 | 36.39 | 2.03 | V | 38.42 | 53.98 | 15.56 | AV |
| 7440 | 49.24 | 9.15 | V | 58.39 | 73.98 | 15.59 | PK |
| 7440 | 37.55 | 9.15 | V | 46.7 | 53.98 | 7.28 | AV |
| 4960 | 48.39 | 2.03 | H | 50.42 | 73.98 | 23.56 | PK |
| 4960 | 36.47 | 2.03 | H | 38.5 | 53.98 | 15.48 | AV |
| 7440 | 49.38 | 9.15 | H | 58.53 | 73.98 | 15.45 | PK |
| 7440 | 37.53 | 9.15 | H | 46.68 | 53.98 | 7.30 | AV |

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP GAIN: AMPLIFIER GAIN

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000 MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
5. Spectrum setting:
   a. Peak Setting 1 GHz – 25 GHz, RBW = 1 MHz, VBW = 3 MHz.
   b. Average Setting 1 GHz – 25 GHz, RBW = 1 MHz, VBW ≥ 1/τ Hz, where τ = pulse width in seconds. We performed using a reduced video BW method was done with the analyzer in linear mode.
6. FYI : Duty Cycle Correction Factor (79 channel hopping)
   a. Time to cycle through all channels= Δ t= τ [ms] x 79 channels = 229.100 ms, where τ = pulse width
   b. 100 ms/ Δt [ms] = *H* → Round up to next highest integer, *H ' =1*
   c. Worst Case Dwell Time = τ [ms] x *H '* = 2.900 ms
   d. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100ms) dB = -30.752 dB
7. Duty Cycle Correction Factor(AFH mode – minimum channel number case - 20 channels)
   a. Time to cycle through all channels= Δ t= τ [ms] x 20 channels = 58.00 ms, where τ = pulse width
   b. 100 ms/ Δt [ms] = *H* → Round up to next highest integer, *H ' = 2*
   c. Worst Case Dwell Time = τ [ms] x *H '* = 5.800 ms

d. Duty Cycle Correction(AFH) = 20log (Worst Case Dwell Time/ 100ms) dB = -24.7314 dB

e. We applied DCCF in the test result which hopping channel number is 20.

8. We have done Normal Mode and EDR Mode test.
9. This test is performed with hopping off.
10. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

### 8.6.3 RADIATED RESTRICTED BAND EDGES

**Test Requirements and limit, §15.247(d), §15.205, §15.209**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. 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).

| | |
|---|---|
| Operation Mode | Normal(GFSK) |
| Operating Frequency | 2402 MHz, 2480 MHz |
| Channel No | CH 0, CH 78 |

| Frequency [MHz] | Reading dBuV | ※ A.F.+CL [dB] | Ant. Pol. [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|---|
| 2390.0 | 25.26 | 33.50 | H | 0 | 58.76 | 73.98 | 15.22 | PK |
| 2390.0 | 13.60 | 33.50 | H | -24.73 | 22.37 | 53.98 | 31.61 | AV |
| 2390.0 | 25.43 | 33.50 | V | 0 | 58.93 | 73.98 | 15.05 | PK |
| 2390.0 | 13.60 | 33.50 | V | -24.73 | 22.37 | 53.98 | 31.61 | AV |
| 2483.5 | 37.42 | 33.55 | H | 0 | 70.97 | 73.98 | 3.01 | PK |
| 2483.5 | 32.00 | 33.55 | H | -24.73 | 40.82 | 53.98 | 13.16 | AV |
| 2483.5 | 36.11 | 33.55 | V | 0 | 69.66 | 73.98 | 4.32 | PK |
| 2483.5 | 29.20 | 33.55 | V | -24.73 | 38.02 | 53.98 | 15.96 | AV |

Operation Mode EDR(8DPSK)

Operating Frequency 2402 MHz , 2480 MHz

Channel No CH 0, CH 78

| Frequency [MHz] | Reading dBuV | ※ A.F.+CL [dB] | Ant. Pol. [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|---|
| 2390.0 | 25.43 | 33.50 | H | 0 | 58.93 | 73.98 | 15.05 | PK |
| 2390.0 | 13.56 | 33.50 | H | -24.73 | 22.33 | 53.98 | 31.65 | AV |
| 2390.0 | 25.38 | 33.50 | V | 0 | 58.88 | 73.98 | 15.10 | PK |
| 2390.0 | 13.53 | 33.50 | V | -24.73 | 22.30 | 53.98 | 31.68 | AV |
| 2483.5 | 37.27 | 33.55 | H | 0 | 70.82 | 73.98 | 3.16 | PK |
| 2483.5 | 28.90 | 33.55 | H | -24.73 | 37.72 | 53.98 | 16.26 | AV |
| 2483.5 | 36.13 | 33.55 | V | 0 | 69.68 | 73.98 | 4.30 | PK |
| 2483.5 | 27.90 | 33.55 | V | -24.73 | 36.72 | 53.98 | 17.26 | AV |

Operation Mode EDR(π/4DQPSK)

Operating Frequency 2402 MHz , 2480 MHz

Channel No CH 0, CH 78

| Frequency [MHz] | Reading dBuV | ※ A.F.+CL [dB] | Ant. Pol. [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Measurement Type |
|---|---|---|---|---|---|---|---|---|
| 2390.0 | 25.91 | 33.50 | H | 0 | 59.41 | 73.98 | 14.57 | PK |
| 2390.0 | 13.50 | 33.50 | H | -24.73 | 22.27 | 53.98 | 31.71 | AV |
| 2390.0 | 25.50 | 33.50 | V | 0 | 59.00 | 73.98 | 14.98 | PK |
| 2390.0 | 13.50 | 33.50 | V | -24.73 | 22.27 | 53.98 | 31.71 | AV |
| 2483.5 | 37.38 | 33.55 | H | 0 | 70.93 | 73.98 | 3.05 | PK |
| 2483.5 | 28.70 | 33.55 | H | -24.73 | 37.52 | 53.98 | 16.46 | AV |
| 2483.5 | 36.04 | 33.55 | V | 0 | 69.59 | 73.98 | 4.39 | PK |
| 2483.5 | 27.70 | 33.55 | V | -24.73 | 36.52 | 53.98 | 17.46 | AV |

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP GAIN: AMPLIFIER GAIN

**Notes:**

1. Frequency range of measurement = 2483.5 MHz ~ 2500 MHz
2. Total = Reading Value + Antenna Factor + Cable Loss + Duty Cycle Correction Factor
3. Spectrum setting:
   a. Peak Setting 1 GHz – 25 GHz, RBW = 1 MHz, VBW = 3 MHz.
   b. Average Setting 1 GHz – 25 GHz, RBW = 1 MHz, VBW ≥ 1/τ Hz, where τ = pulse width in seconds.
   We performed using a reduced video BW method was done with the analyzer in linear mode.
4. FYI : Duty Cycle Correction Factor (79 channel hopping)
   a. Time to cycle through all channels= Δ t= τ [ms] x 79 channels = 229.100 ms, where τ = pulse width
   b. 100 ms/ Δt [ms] = *H* → Round up to next highest integer, *H ' =1*
   c. Worst Case Dwell Time = τ [ms] x *H '* = 2.900 ms
   d. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100ms) dB = -30.752 dB
5. Duty Cycle Correction Factor(AFH mode – minimum channel number case - 20 channels)
   a. Time to cycle through all channels= Δ t= τ [ms] x 20 channels = 58.00 ms, where τ = pulse width
   b. 100 ms/ Δt [ms] = *H* → Round up to next highest integer, *H ' = 2*
   c. Worst Case Dwell Time = τ [ms] x *H '* = 5.800 ms
   d. Duty Cycle Correction(AFH) = 20log (Worst Case Dwell Time/ 100ms) dB = -24.7314 dB
   e. We applied DCCF in the test result which hopping channel number is 20.
6. We have done Normal Mode, EDR Mode.
7. This test is performed with hopping off.
8. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

## 8.7 POWERLINE CONDUCTED EMISSIONS

### LIMIT

For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolt (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

| Frequency Range (MHz) | Limits (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56 | 56 to 46 |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

### Test Configuration

See test photographs attached in Appendix 1 for the actual connections between EUT and support equipment.

### TEST PROCEDURE

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

### Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

## ▣ RESULT PLOTS

**Conducted Emissions (Line 1)**

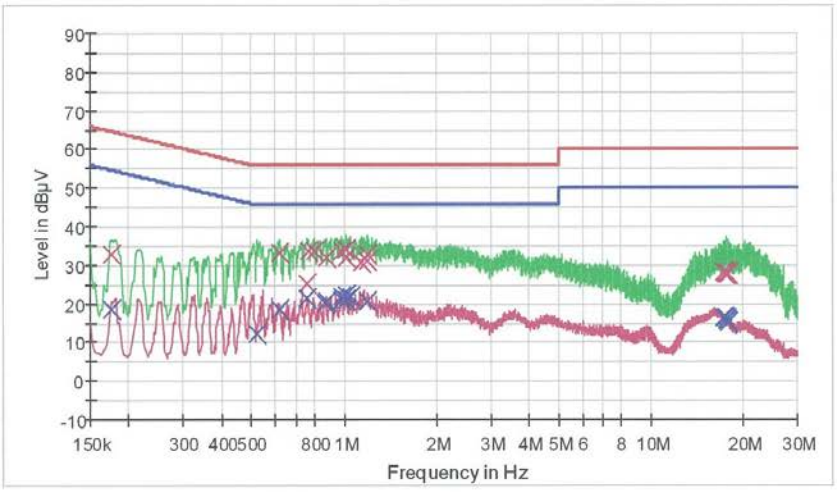
BT N 1 / 2

# HCT TEST Report

### Common Information

| | |
|---|---|
| EUT: | LG-H650 |
| Manufacturer: | LG |
| Test Site: | SHIELD ROOM |
| Operating Conditions: | BT MODE |
| Operator Name: | KS KANG |

FCC CLASS B




### Final Result 1

| Frequency (MHz) | QuasiPeak (dBµV) | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|
| 0.176000 | 32.8 | 9.000 | Off | N | 9.6 | 31.9 | 64.7 |
| 0.618000 | 33.3 | 9.000 | Off | N | 9.6 | 22.7 | 56.0 |
| 0.758000 | 25.4 | 9.000 | Off | N | 9.7 | 30.6 | 56.0 |
| 0.764000 | 33.6 | 9.000 | Off | N | 9.7 | 22.4 | 56.0 |
| 0.798000 | 33.8 | 9.000 | Off | N | 9.7 | 22.2 | 56.0 |
| 0.876000 | 32.2 | 9.000 | Off | N | 9.7 | 23.8 | 56.0 |
| 0.980000 | 33.9 | 9.000 | Off | N | 9.7 | 22.1 | 56.0 |
| 1.016000 | 34.0 | 9.000 | Off | N | 9.7 | 22.0 | 56.0 |
| 1.022000 | 32.0 | 9.000 | Off | N | 9.7 | 24.0 | 56.0 |
| 1.142000 | 30.9 | 9.000 | Off | N | 9.7 | 25.1 | 56.0 |
| 1.190000 | 31.0 | 9.000 | Off | N | 9.7 | 25.0 | 56.0 |
| 1.196000 | 32.7 | 9.000 | Off | N | 9.7 | 23.3 | 56.0 |
| 17.294000 | 28.2 | 9.000 | Off | N | 10.2 | 31.8 | 60.0 |
| 17.368000 | 28.0 | 9.000 | Off | N | 10.2 | 32.0 | 60.0 |
| 17.522000 | 28.4 | 9.000 | Off | N | 10.2 | 31.6 | 60.0 |
| 17.600000 | 27.8 | 9.000 | Off | N | 10.2 | 32.2 | 60.0 |

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BT N 2 / 2

| Frequency (MHz) | QuasiPeak (dBµV) | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|
| 17.634000 | 28.0 | 9.000 | Off | N | 10.2 | 32.0 | 60.0 |
| 17.836000 | 27.9 | 9.000 | Off | N | 10.2 | 32.1 | 60.0 |

## Final Result 2

| Frequency (MHz) | CAverage (dBµV) | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|
| 0.176000 | 18.4 | 9.000 | Off | N | 9.6 | 36.3 | 54.7 |
| 0.522000 | 12.5 | 9.000 | Off | N | 9.6 | 33.5 | 46.0 |
| 0.618000 | 18.7 | 9.000 | Off | N | 9.6 | 27.3 | 46.0 |
| 0.758000 | 21.3 | 9.000 | Off | N | 9.7 | 24.7 | 46.0 |
| 0.864000 | 20.2 | 9.000 | Off | N | 9.7 | 25.8 | 46.0 |
| 0.876000 | 20.7 | 9.000 | Off | N | 9.7 | 25.3 | 46.0 |
| 0.980000 | 21.9 | 9.000 | Off | N | 9.7 | 24.1 | 46.0 |
| 0.984000 | 21.2 | 9.000 | Off | N | 9.7 | 24.8 | 46.0 |
| 1.016000 | 22.2 | 9.000 | Off | N | 9.7 | 23.8 | 46.0 |
| 1.022000 | 21.0 | 9.000 | Off | N | 9.7 | 25.0 | 46.0 |
| 1.050000 | 22.1 | 9.000 | Off | N | 9.7 | 23.9 | 46.0 |
| 1.190000 | 20.8 | 9.000 | Off | N | 9.7 | 25.2 | 46.0 |
| 17.294000 | 16.5 | 9.000 | Off | N | 10.2 | 33.5 | 50.0 |
| 17.368000 | 16.4 | 9.000 | Off | N | 10.2 | 33.6 | 50.0 |
| 17.522000 | 16.2 | 9.000 | Off | N | 10.2 | 33.8 | 50.0 |
| 17.600000 | 15.7 | 9.000 | Off | N | 10.2 | 34.3 | 50.0 |
| 17.634000 | 15.7 | 9.000 | Off | N | 10.2 | 34.3 | 50.0 |
| 17.836000 | 15.3 | 9.000 | Off | N | 10.2 | 34.7 | 50.0 |

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**Conducted Emissions (Line 2)**

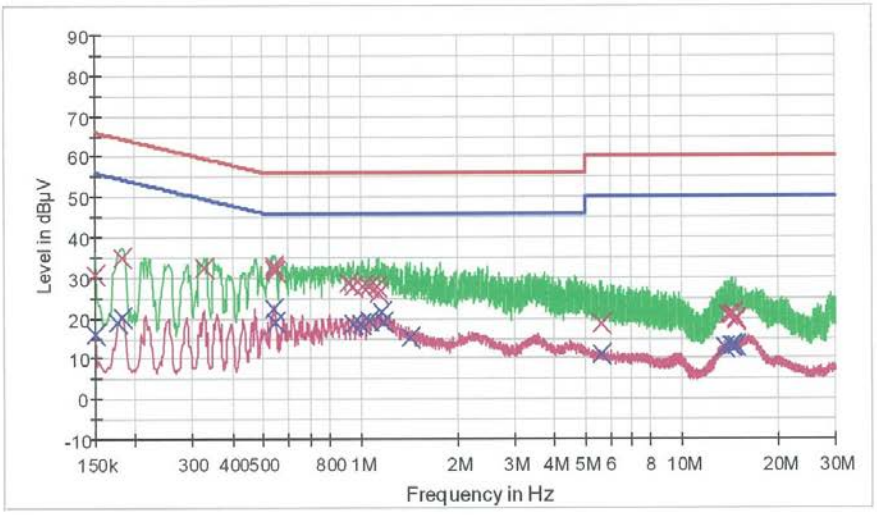
EMI Auto Test(10) 1 / 2

# HCT TEST Report

## Common Information

| | |
|---|---|
| EUT: | LG-H650 |
| Manufacturer: | LG |
| Test Site: | SHIELD ROOM |
| Operating Conditions: | BT MODE |
| Operator Name: | KS KANG |

FCC CLASS B




FCC CLASS B_QP
Preview Result 2-AVG
FCC CLASS B_ AV
Final Result 1-QPK
Preview Result 1-PK+
Final Result 2-CAV

## Final Result 1

| Frequency (MHz) | QuasiPeak (dBµV) | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|
| 0.150000 | 31.0 | 9.000 | Off | L1 | 9.6 | 35.0 | 66.0 |
| 0.182000 | 35.0 | 9.000 | Off | L1 | 9.6 | 29.4 | 64.4 |
| 0.326000 | 32.3 | 9.000 | Off | L1 | 9.6 | 27.3 | 59.6 |
| 0.538000 | 32.2 | 9.000 | Off | L1 | 9.7 | 23.8 | 56.0 |
| 0.542000 | 33.0 | 9.000 | Off | L1 | 9.7 | 23.0 | 56.0 |
| 0.548000 | 31.7 | 9.000 | Off | L1 | 9.7 | 24.3 | 56.0 |
| 0.922000 | 28.8 | 9.000 | Off | L1 | 9.7 | 27.2 | 56.0 |
| 0.952000 | 27.8 | 9.000 | Off | L1 | 9.7 | 28.2 | 56.0 |
| 1.012000 | 27.9 | 9.000 | Off | L1 | 9.7 | 28.1 | 56.0 |
| 1.058000 | 27.9 | 9.000 | Off | L1 | 9.7 | 28.1 | 56.0 |
| 1.126000 | 27.9 | 9.000 | Off | L1 | 9.7 | 28.1 | 56.0 |
| 1.138000 | 26.3 | 9.000 | Off | L1 | 9.7 | 29.7 | 56.0 |
| 5.632000 | 18.4 | 9.000 | Off | L1 | 9.9 | 41.6 | 60.0 |
| 13.914000 | 20.9 | 9.000 | Off | L1 | 10.1 | 39.1 | 60.0 |
| 14.176000 | 20.8 | 9.000 | Off | L1 | 10.1 | 39.2 | 60.0 |
| 14.404000 | 21.2 | 9.000 | Off | L1 | 10.1 | 38.8 | 60.0 |

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EMI Auto Test(10) 2 / 2

| Frequency (MHz) | QuasiPeak (dBµV) | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|
| 14.636000 | 20.0 | 9.000 | Off | L1 | 10.1 | 40.0 | 60.0 |
| 14.668000 | 19.5 | 9.000 | Off | L1 | 10.1 | 40.5 | 60.0 |

## Final Result 2

| Frequency (MHz) | CAverage (dBµV) | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|
| 0.150000 | 16.1 | 9.000 | Off | L1 | 9.6 | 39.9 | 56.0 |
| 0.176000 | 19.0 | 9.000 | Off | L1 | 9.6 | 35.7 | 54.7 |
| 0.182000 | 20.4 | 9.000 | Off | L1 | 9.6 | 34.0 | 54.4 |
| 0.538000 | 22.3 | 9.000 | Off | L1 | 9.7 | 23.7 | 46.0 |
| 0.542000 | 22.6 | 9.000 | Off | L1 | 9.7 | 23.4 | 46.0 |
| 0.548000 | 18.9 | 9.000 | Off | L1 | 9.7 | 27.1 | 46.0 |
| 0.952000 | 18.4 | 9.000 | Off | L1 | 9.7 | 27.6 | 46.0 |
| 1.008000 | 18.6 | 9.000 | Off | L1 | 9.7 | 27.4 | 46.0 |
| 1.058000 | 19.5 | 9.000 | Off | L1 | 9.7 | 26.5 | 46.0 |
| 1.162000 | 21.3 | 9.000 | Off | L1 | 9.7 | 24.7 | 46.0 |
| 1.176000 | 19.0 | 9.000 | Off | L1 | 9.7 | 27.0 | 46.0 |
| 1.428000 | 15.2 | 9.000 | Off | L1 | 9.7 | 30.8 | 46.0 |
| 5.632000 | 11.1 | 9.000 | Off | L1 | 9.9 | 38.9 | 50.0 |
| 13.632000 | 12.7 | 9.000 | Off | L1 | 10.1 | 37.3 | 50.0 |
| 14.176000 | 13.3 | 9.000 | Off | L1 | 10.1 | 36.8 | 50.0 |
| 14.404000 | 13.2 | 9.000 | Off | L1 | 10.1 | 36.8 | 50.0 |
| 14.636000 | 13.0 | 9.000 | Off | L1 | 10.1 | 37.0 | 50.0 |
| 14.668000 | 12.9 | 9.000 | Off | L1 | 10.1 | 37.1 | 50.0 |

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# 9. LIST OF TEST EQUIPMENT

## 9.1 LIST OF TEST EQUIPMENT(Conducted Test)

| Manufacturer | Model / Equipment | Calibration Date | Calibration Interval | Serial No. |
|---|---|---|---|---|
| Rohde & Schwarz | ENV216/ LISN | 01/13/2015 | Annual | 100073 |
| Agilent | E4440A/ Spectrum Analyzer | 03/18/2015 | Annual | US45303008 |
| Agilent | N9020A / SIGNAL ANALYZER | 06/30/2015 | Annual | MY51110085 |
| Agilent | N9020A / SIGNAL ANALYZER | 07/02/2015 | Annual | MY50510304 |
| Agilent | N1911A/Power Meter | 07/09/2015 | Annual | MY45100523 |
| Agilent | N1921A /POWER SENSOR | 07/09/2015 | Annual | MY45241059 |
| Agilent | 87300B/Directional Coupler | 12/08/2014 | Annual | 3116A03621 |
| Hewlett Packard | 11667B / Power Splitter | 04/30/2015 | Annual | 11275 |
| ITECH | IT6720 / DC POWER SUPPLY | 11/04/2014 | Annual | 010002156287001199 |
| Agilent | 8493C / Attenuator(10 dB) | 07/21/2015 | Annual | 07560 |
| Rohde & Schwarz | CBT / BLUETOOTH TESTER | 04/06/2015 | Annual | 100422 |

## 9.2 LIST OF TEST EQUIPMENT(Radiated Test)

| Manufacturer | Model / Equipment | Calibration Date | Calibration Interval | Serial No. |
|---|---|---|---|---|
| Schwarzbeck | VULB 9160/ TRILOG Antenna | 10/10/2014 | Biennial | 3368 |
| HD | MA240/ Antenna Position Tower | N/A | N/A | 556 |
| EMCO | 1050/ Turn Table | N/A | N/A | 114 |
| HD GmbH | HD 100/ Controller | N/A | N/A | 13 |
| HD GmbH | KMS 560/ SlideBar | N/A | N/A | 12 |
| CERNEX | CBL18265035 / POWER AMP | 07/27/2015 | Annual | 22966 |
| Schwarzbeck | BBHA 9120D/ Horn Antenna | 05/07/2015 | Biennial | 937 |
| Schwarzbeck | BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz) | 04/30/2015 | Biennial | BBHA9170124 |
| Rohde & Schwarz | FSP / Spectrum Analyzer | 10/23/2014 | Annual | 836650/016 |
| Wainwright Instrument | WHF3.0/18G-10EF / High Pass Filter | 06/28/2015 | Annual | 8 |
| Wainwright Instrument | WRCJ2400/2483.5-2370/2520-60/14SS / Band Reject Filter | 06/15/2015 | Annual | 1 |
| Rohde & Schwarz | LOOP ANTENNA | 09/03/2014 | Biennial | 1513-175 |
| CERNEX | CBL06185030 / POWER AMP | 07/21/2015 | Annual | 22965 |
| CERNEX | CBLU1183540 / POWER AMP | 07/21/2015 | Annual | 22964 |
| Rohde & Schwarz | CBT / BLUETOOTH TESTER | 04/06/2015 | Annual | 100422 |