# RF TEST REPORT

| | | |
|---|---|---|
| Test item | : | Mobile Computer |
| Model No. | : | FCC: NAUTIZ X8<br>IC: 14248 |
| Order No. | : | DEMC1407-02978, DEMC1407-02987 |
| Date of receipt | : | 2014-07-21 |
| Test duration | : | 2014-07-29 ~ 2014-08-20 |
| Date of issue | : | 2014-10-21 |
| Use of report | : | FCC & IC Original Grant |

Applicant : Handheld Group AB
Kinnegatan 17, 53133 Lidköping Sweden

Test laboratory : DT&C Co., Ltd.
42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 449-935

| | | |
|---|---|---|
| Test specification | : | FCC Part 15 Subpart C.247<br>RSS-210 Issue 8: 2010 |
| Test environment | : | See appended test report |
| Test result | : | ☒ Pass ☐ Fail |



Tested by:

Engineer
HyunSu Son

Reviewed by:

Technical Manager
HongHee Lee

# Test Report Version

| Test Report No. | Date | Description |
|---|---|---|
| DRTFCC1410-1319 | Oct. 21, 2014 | Initial issue |
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# 1.General Information

## 1.1. Testing Laboratory

### DT&C Co., Ltd.

FCC test site number 678747 & IC Site number 5470A-1
42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 449-935
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Telephone : + 82-31-321-2664
FAX : + 82-31-321-1664

## 1.2. Details of Applicant

Applicant : Handheld Group AB
Address : Kinnegatan 17, 53133 Lidköping Sweden
Contact person : Jerker Hellström
Phone No. : +46 510 54 71 70

## 1.3. Description of EUT

| | |
|---|---|
| **EUT** | Mobile Computer |
| **Model Name** | FCC: NAUTIZ X8<br>IC: 14248 |
| **Serial Number** | Identical prototype |
| **Power Supply** | DC 3.7 V |
| **Frequency Range** | 2402 MHz ~ 2480 MHz |
| **Modulation Technique** | GFSK, π/4-DQPSK, 8DPSK |
| **Number of Channels** | 79 |
| **Antenna Type** | Internal Antenna |
| **Antenna Gain** | PK : 2.915 dBi |

## 1.4. Declaration by the manufacturer

- NA

## 1.5. Information about the FHSS characteristics:

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:
  A) The hopping sequence is pseudorandom
  B) All channels are used equally on average
  C) The receiver input bandwidth equals the transmit bandwidth
  D) The receiver hops in sequence with the transmit signal
- 15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.
- 15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate its channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.
- 15.247(h): The EUT employs Adaptive Frequency Hopping (AFH) which identifies sources of interference namely devices operating in 802.11 WLAN and excludes them from the list of available channels. The process of re-mapping reduces the number of test channels from 79 channels to a minimum number of 20 channels.

## 1.6. Test Equipment List

| Type | Manufacturer | Model | Cal.Date (yy/mm/dd) | Next.Cal.Date (yy/mm/dd) | S/N |
|---|---|---|---|---|---|
| Spectrum Analyzer | Agilent | E4440A | 13/10/24 | 14/10/24 | US45303051 |
| MXA Signal Analyzer | Agilent | N9020A | 14/03/28 | 15/03/28 | MY50200816 |
| Bluetooth Tester | TESCOM | TC-3000B | 14/06/26 | 15/06/26 | 3000B640046 |
| Dynamic Measurement DC Source | Agilent | 66332A | 14/02/07 | 15/02/07 | GB37470190 |
| Vector Signal Generator | Rohde Schwarz | SMBV100A | 14/01/07 | 15/01/07 | 255571 |
| Signal Generator | Rohde Schwarz | SMF100A | 14/07/01 | 15/07/01 | 102341 |
| Multimeter | HP | 34401A | 14/02/27 | 15/02/27 | 3146A13475 |
| 50W 10dB ATT | SMAJK | SMAJK-50-10 | 13/10/23 | 14/10/23 | 3-50-10 |
| Power Splitter | Anritsu | K241B | 13/10/22 | 14/10/22 | 1701102 |
| PreAmplifier | Agilent | 8449B | 14/02/27 | 15/02/27 | 3008A00370 |
| Amplifier | HP | 8447E | 14/01/08 | 15/01/08 | 2945A02865 |
| High-pass filter | Wainwright Instruments | WHKX3.0 | 14/01/07 | 15/01/07 | 12 |
| Loop Antenna | Schwarzbeck | FMZB1513 | 14/04/29 | 16/04/29 | 1513-128 |
| BILOG ANTENNA | SCHAFFNER | CBL6112B | 12/11/06 | 14/11/06 | 2737 |
| Double-Ridged Guide Antenna | ETS-LINDGREN | 3117 | 14/05/12 | 16/05/12 | 00140394 |
| HORN ANT | A.H.Systems | SAS-574 | 13/03/20 | 15/03/20 | 154 |
| EMI TEST RECEIVER | Rohde Schwarz | ESU | 14/01/08 | 15/01/08 | 100014 |
| EMI TEST RECEIVER | Rohde Schwarz | ESCI7 | 14/02/27 | 15/02/27 | 100910 |
| CVCF | EM TEST | ENTWAVE 60-400 | 14/05/26 | 15/05/26 | P1311115470 |
| LISN | SCHWARZBECK | NNLK8121 | 14/08/18 | 15/08/18 | NNLK8121-580 |
| PULSE LIMITER | Rohde Schwarz | ESH3-Z2 | 14/01/08 | 15/01/08 | 101334 |
| Thermohygrometer | BODYCOM | BJ5478 | 14/05/13 | 15/05/13 | 120612-2 |

## 1.7. Summary of Test Results

| FCC Part RSS-210 & GEN | Parameter | Limit (Using in 2400~ 2483.5MHz) | Test Condition | Status Note 1 |
|---|---|---|---|---|
| 15.247(a) RSS-210(A8.1) | Carrier Frequency Separation | >= 20dB BW or >= Two-Thirds of the 20dB BW | Conducted | C |
| | Number of Hopping Frequencies | >= 15 hops | | C |
| | 20 dB Bandwidth | None | | C |
| | Dwell Time | =< 0.4 seconds | | C |
| 15.247(b) RSS-210(A8.4) | Transmitter Output Power | =< 1Watt , if CHs >= 75 Others =<0.125W | | C |
| 15.247(d) RSS-210(A8.5) | Band-edge | The radiated emission to any 100 kHz of out-band shall be at least 20dB below the highest in-band spectral density. | | C |
| | Conducted Spurious Emissions | | | C |
| RSS Gen | Occupied Bandwidth (99 %) | RSS-Gen(4.6.1) | | C |
| 15.205 15.209 RSS-210(A8.5) | RadiatedEmissions | FCC 15.209 Limits | Radiated | C Note 2 |
| 15.207 RSS-Gen(7.2.4) | AC Conducted Emissions | FCC 15.207 Limits | AC Line Conducted | C |
| 15.203 RSS-Gen(7.1.2) | Antenna Requirements | FCC 15.203 | - | C |

Note 1: C=Comply NC=Not Comply NT=Not Tested NA=Not Applicable

Note 2:The sample was tested according to the following specification:

ANSI C63.10-2009

## 1.8 Conclusion of worst-case and operation mode

The EUT has three type of modulation (GFSK, π/4DQPSK and 8DPSK).

Therefore all applicable requirements were tested with all the modulations.

The field strength of spurious emission was measured in three orthogonal EUT positions(X-axis, Y-axis and Z-axis).

Tested frequency information,

- Hopping Function: Enable

| | TXFrequency(MHz) | RX Frequency(MHz) |
|---|---|---|
| **Hopping Band** | 2402 ~ 2480 | 2402 ~ 2480 |

- Hopping Function: Disable

| | TXFrequency(MHz) | RX Frequency(MHz) |
|---|---|---|
| **Lowest Channel** | 2402 | 2402 |
| **Middle Channel** | 2441 | 2441 |
| **Highest Channel** | 2480 | 2480 |

# 2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

## 2.1. Test Setup

Refer to the APPENDIX I.

## 2.2. Limit

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

According to § 15.209(a), except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table

| Frequency (MHz) | Limit (uV/m) | Measurement Distance (meter) |
|---|---|---|
| 0.009 – 0.490 | 2400/F(KHz) | 300 |
| 0.490 – 1.705 | 24000/F(KHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |
| 30 ~ 88 | 100 ** | 3 |
| 88 ~ 216 | 150 ** | 3 |
| 216 ~ 960 | 200 ** | 3 |
| Above 960 | 500 | 3 |

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

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

| MHz | MHz | MHz | MHz | GHz | GHz |
|---|---|---|---|---|---|
| 0.009 ~ 0.110 | 8.41425 ~ 8.41475 | 108 ~ 121.94 | 1300 ~ 1427 | 4.5 ~ 5.15 | 14.47 ~ 14.5 |
| 0.495 ~ 0.505 | 12.29 ~ 12.293 | 123 ~ 138 | 1435 ~ 1626.5 | 5.35 ~ 5.46 | 15.35 ~ 16.2 |
| 2.1735 ~ 2.1905 | 12.51975 ~ 12.52025 | 149.9 ~ 150.05 | 1645.5 ~ 1646.5 | 7.25 ~ 7.75 | 17.7 ~ 21.4 |
| 4.125 ~ 4.128 | 12.57675 ~ 12.57725 | 156.52475 ~ | 1660 ~ 1710 | 8.025 ~ 8.5 | 22.01 ~ 23.12 |
| 4.17725 ~ 4.17775 | 13.36 ~ 13.41 | 156.52525 | 1718.8 ~ 1722.2 | 9.0 ~ 9.2 | 23.6 ~ 24.0 |
| 4.20725 ~ 4.20775 | 16.42 ~ 16.423 | 156.7 ~ 156.9 | 2200 ~ 2300 | 9.3 ~ 9.5 | 31.2 ~ 31.8 |
| 6.215 ~ 6.218 | 16.69475 ~ 16.69525 | 162.0125 ~ 167.17 | 2310 ~ 2390 | 10.6 ~ 12.7 | 36.43 ~ 36.5 |
| 6.26775 ~ 6.26825 | 16.80425 ~ 16.80475 | 167.72 ~ 173.2 | 2483.5 ~ 2500 | 13.25 ~ 13.4 | Above 38.6 |
| 6.31175 ~ 6.31225 | 25.5 ~ 25.67 | 240 ~ 285 | 2655 ~ 2900 | | |
| 8.291 ~ 8.294 | 37.5 ~ 38.25 | 322 ~ 335.4 | 3260 ~ 3267 | | |
| 8.362 ~ 8.366 | 73 ~ 74.6 | 399.90 ~ 410 | 3332 ~ 3339 | | |
| 8.37625 ~ 8.38675 | 74.8 ~ 75.2 | 608 ~ 614 | 3345.8 ~ 3358 | | |
| | | 960 ~ 1240 | 3600 ~ 4400 | | |

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 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, 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.

## 2.3. Test Procedures

Radiated emissions from the EUT were measured according to the ANSI C63.10:2009

### 2.3.1. Test Procedures for Radiated Spurious Emissions

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference-receiving antenna.
3. For measurements above 1GHz absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1GHz, the absorbers are removed.
4. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
5. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
6. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
7. If the emission level of the EUT in peak mode was 10㏈lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10㏈margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE 1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120㎑for Quasi-peak detection (QP) at frequency below 1㎓.

NOTE 2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1㎒for Peak detection and frequency above 1㎓.

NOTE 3. The resolution bandwidth of test receiver/spectrum analyzer is 1㎒and the video bandwidth is 1㎑ for Average detection (AV) at frequency above 1㎓.

### 2.3.2. Test Procedures for Conducted Spurious Emissions

1.The transmitter output was connected to the spectrum analyzer.
2.The **reference level** of the fundamental frequency was measured with the spectrum analyzer using RBW=100 ㎑, VBW=300 ㎑.
3. The conducted spurious emission was tested each ranges were set as below.

**Frequency range: 9 KHz ~ 30 MHz**
**RBW= 100kHz, VBW= 300kHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT: 40001**

**Frequency range: 30 MHz ~ 10 GHz, 10 GHz~25 GHz**
**RBW= 1MHz, VBW= 3MHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT: 40001**

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

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 KHz, VBW = 300KHz, SAPN = 100 MHz and BINS = 2001 to get accurate emission level within 100 KHz BW.

Also the path loss for conducted measurement setup was used as described on the Appendix I of this test report.

## 2.4. Test Results

Ambient temperature : 22°C
Relative humidity : 34%

### 2.4.1. Radiated Emission

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

▪ Lowest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2389.12 | X | H | PK | 50.40 | -0.07 | NA | NA | 50.33 | 74.00 | 23.67 |
| 2389.12 | X | H | AV | 37.69 | -0.07 | NA | NA | 37.62 | 54.00 | 16.38 |
| 4803.97 | X | H | PK | 44.88 | 6.63 | NA | NA | 51.51 | 74.00 | 22.49 |
| 4803.15 | X | H | AV | 32.23 | 6.63 | NA | NA | 38.86 | 54.00 | 15.14 |

▪ Middle Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4882.27 | X | H | PK | 45.39 | 6.80 | NA | NA | 52.19 | 74.00 | 21.81 |
| 4882.06 | X | H | AV | 33.59 | 6.80 | NA | NA | 40.39 | 54.00 | 13.61 |

▪ Highest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2484.26 | X | H | PK | 50.24 | 0.35 | NA | NA | 50.59 | 74.00 | 23.41 |
| 2484.16 | X | H | AV | 38.30 | 0.35 | NA | NA | 38.65 | 54.00 | 15.35 |
| 4959.96 | X | H | PK | 45.81 | 6.97 | NA | NA | 52.78 | 74.00 | 21.22 |
| 4959.91 | X | H | AV | 33.87 | 6.97 | NA | NA | 40.84 | 54.00 | 13.16 |

▪ Hopping Mode

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2389.32 | X | H | PK | 50.62 | -0.07 | N/A | N/A | 50.55 | 74.00 | 23.45 |
| 2389.40 | X | H | AV | 37.83 | -0.07 | N/A | N/A | 37.76 | 54.00 | 16.24 |
| 2484.31 | X | H | PK | 50.44 | 0.35 | N/A | N/A | 50.79 | 74.00 | 23.21 |
| 2484.20 | X | H | AV | 38.57 | 0.35 | N/A | N/A | 38.92 | 54.00 | 15.08 |

**Note.**

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.
2. Above listed point data is the worst case data.
3. Sample Calculation.
   Margin = Limit – Result/Result = Reading + T.F + D.C.F./ T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
4. D.C.F Calculation. (D.C.F. = Duty Cycle Correction Factor)
   - Time to cycle through all channels= $\Delta t = T_{[ms]}$ X 20minimum hopping channels , where T = pulse width
   - 100ms / $\Delta t_{[ms]}$ = H -> Round up to next highest integer, to account for worst case, H'
   - The Worst Case Dwell Time = $T_{[ms]}$ x H'
   - D.C.F = 20 x Log(The Worst Case Dwell Time / 100ms) dB

## 9kHz ~ 25GHz Data(Modulation: *π/4DQPSK*)

▪ Lowest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2381.19 | X | H | PK | 58.10 | -0.07 | N/A | NA | 58.03 | 74.00 | 15.97 |
| 2380.94 | X | H | AV | 37.38 | -0.07 | N/A | NA | 37.31 | 54.00 | 16.69 |
| 4804.23 | X | H | PK | 45.36 | 6.63 | N/A | NA | 51.99 | 74.00 | 22.01 |
| 4960.34 | X | H | AV | 33.17 | 6.63 | N/A | NA | 39.80 | 54.00 | 14.20 |

▪ Middle Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4882.04 | X | H | PK | 45.61 | 6.80 | NA | NA | 52.41 | 74.00 | 21.59 |
| 4882.23 | X | H | AV | 33.34 | 6.80 | NA | NA | 40.14 | 54.00 | 13.86 |

▪ Highest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2487.25 | X | H | PK | 58.55 | 0.35 | N/A | NA | 58.90 | 74.00 | 15.10 |
| 2483.52 | X | H | AV | 40.45 | 0.35 | N/A | NA | 40.80 | 54.00 | 13.20 |
| 4959.78 | X | H | PK | 45.23 | 6.97 | N/A | NA | 52.20 | 74.00 | 21.80 |
| 4959.68 | X | H | AV | 33.23 | 6.97 | N/A | NA | 40.20 | 54.00 | 13.80 |

▪ Hopping Mode

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2381.22 | X | H | PK | 58.40 | -0.07 | N/A | N/A | 58.33 | 74.00 | 15.67 |
| 2381.14 | X | H | AV | 37.53 | -0.07 | N/A | N/A | 37.46 | 54.00 | 16.54 |
| 2487.32 | X | H | PK | 58.74 | 0.35 | N/A | N/A | 59.09 | 74.00 | 14.91 |
| 2483.44 | X | H | AV | 40.81 | 0.35 | N/A | N/A | 41.16 | 54.00 | 12.84 |

**Note.**

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.
2. Above listed point data is the worst case data.
3. Sample Calculation.
   Margin = Limit – Result / Result = Reading + T.F + D.C.F. / T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
4. D.C.F Calculation. (D.C.F. = Duty Cycle Correction Factor)
   - Time to cycle through all channels= $\Delta t = T_{[ms]}$ X 20minimum hopping channels , where T = pulse width
   - 100ms / $\Delta t_{[ms]}$ = H -> Round up to next highest integer, to account for worst case, H'
   - The Worst Case Dwell Time = $T_{[ms]}$ x H'
   - D.C.F = 20 x Log(The Worst Case Dwell Time / 100ms) dB

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

▪ Lowest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2381.14 | X | H | PK | 57.07 | -0.07 | N/A | NA | 57.00 | 74.00 | 17.00 |
| 2381.74 | X | H | AV | 37.33 | -0.07 | N/A | NA | 37.26 | 54.00 | 16.74 |
| 4959.99 | X | H | PK | 45.11 | 6.63 | N/A | NA | 51.74 | 74.00 | 22.26 |
| 4960.36 | X | H | AV | 33.43 | 6.63 | N/A | NA | 40.06 | 54.00 | 13.94 |

▪ Middle Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4882.01 | X | H | PK | 45.23 | 6.80 | NA | NA | 52.03 | 74.00 | 21.97 |
| 4881.55 | X | H | AV | 33.77 | 6.80 | NA | NA | 40.57 | 54.00 | 13.43 |

▪ Highest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2487.23 | X | H | PK | 57.14 | 0.35 | N/A | NA | 57.49 | 74.00 | 16.51 |
| 2483.52 | X | H | AV | 40.27 | 0.35 | N/A | NA | 40.62 | 54.00 | 13.38 |
| 4959.99 | X | H | PK | 45.11 | 6.97 | N/A | NA | 52.08 | 74.00 | 21.92 |
| 4960.36 | X | H | AV | 33.43 | 6.97 | N/A | NA | 40.40 | 54.00 | 13.60 |

▪ Hopping Mode

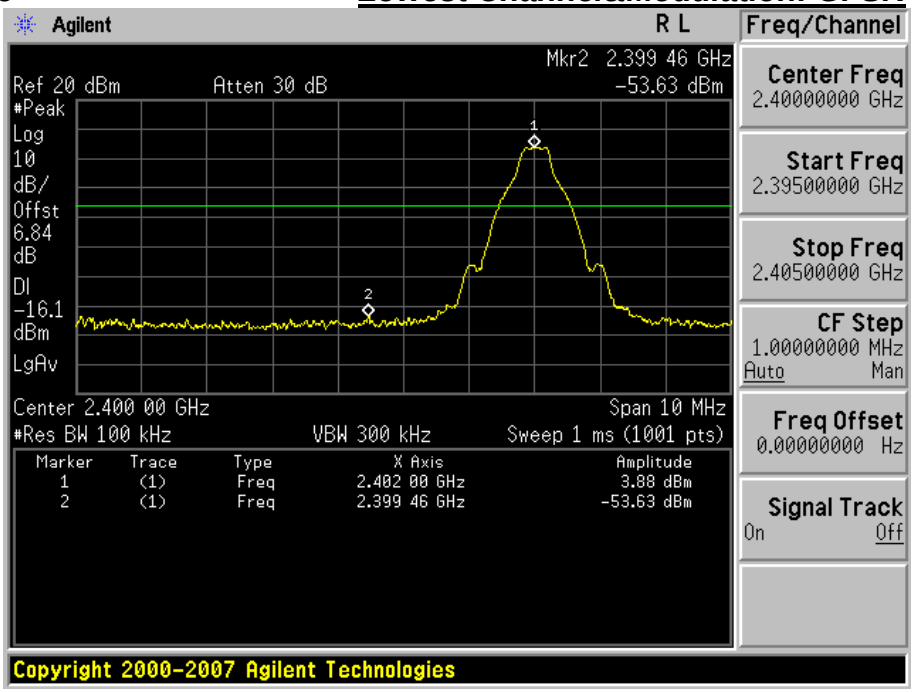
| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2381.36 | X | H | PK | 57.11 | -0.07 | N/A | N/A | 57.04 | 74.00 | 16.96 |
| 2381.57 | X | H | AV | 37.56 | -0.07 | N/A | N/A | 37.49 | 54.00 | 16.51 |
| 2487.46 | X | H | PK | 57.30 | 0.35 | N/A | N/A | 57.65 | 74.00 | 16.35 |
| 2483.42 | X | H | AV | 40.44 | 0.35 | N/A | N/A | 40.79 | 54.00 | 13.21 |

**Note.**

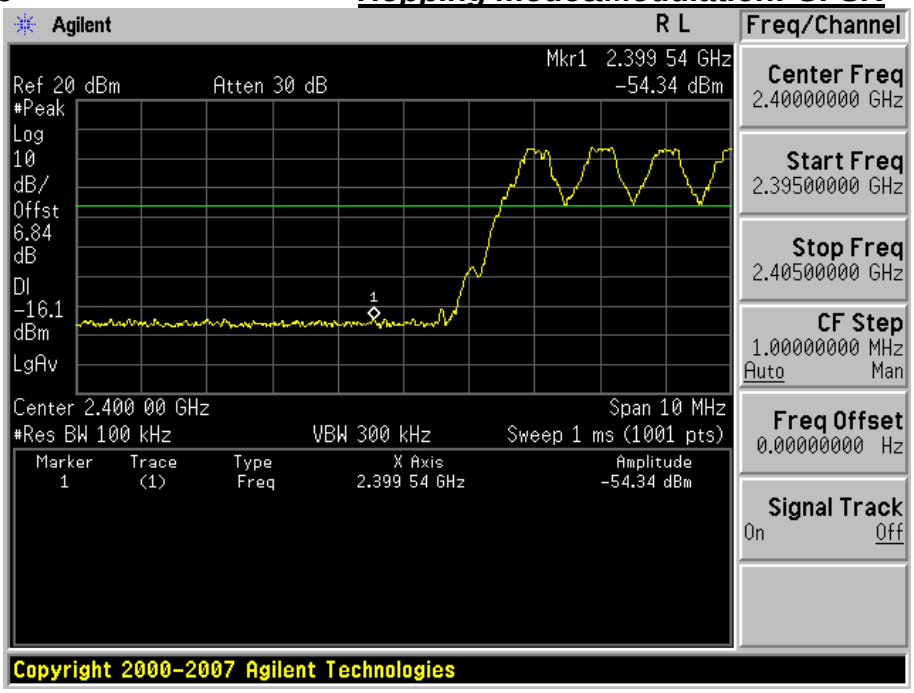
1. No other spurious and harmonic emissions were found greater than listed emissions on above table.
2. Above listed point data is the worst case data.
3. Sample Calculation.
   Margin = Limit – Result / Result = Reading + T.F + D.C.F. / T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
4. D.C.F Calculation. (D.C.F. = Duty Cycle Correction Factor)
   - Time to cycle through all channels= $\Delta t = T_{[ms]}$ X 20minimum hopping channels , where T = pulse width
   - 100ms / $\Delta t_{[ms]}$ = H -> Round up to next highest integer, to account for worst case, H'
   - The Worst Case Dwell Time = $T_{[ms]}$ x H'
   - D.C.F = 20 x Log(The Worst Case Dwell Time / 100ms) dB

### 2.4.2. Conducted Spurious Emissions

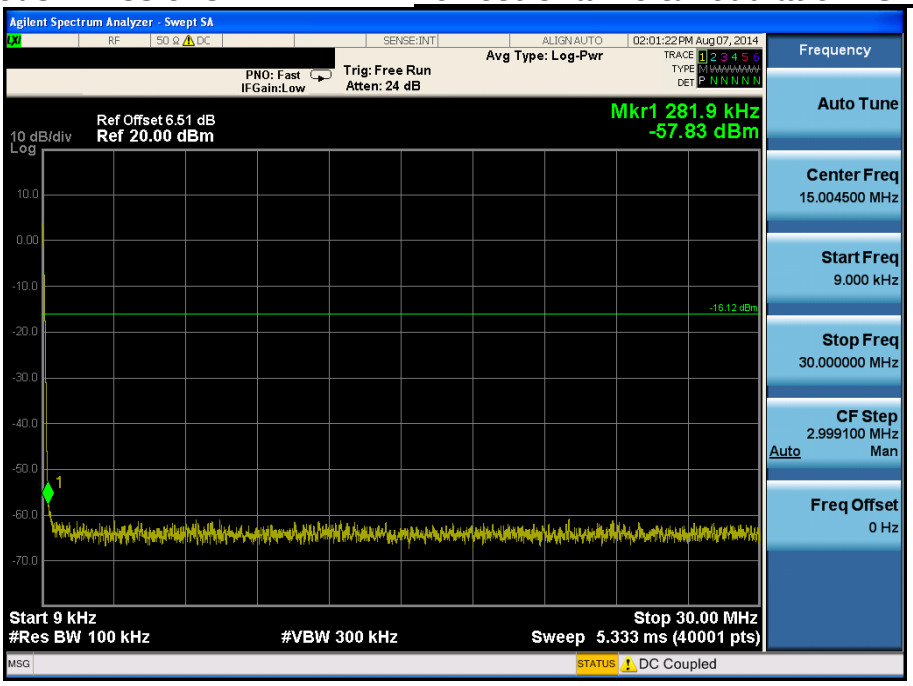
**Low Band-edge** ***Lowest Channel&Modulation: GFSK***

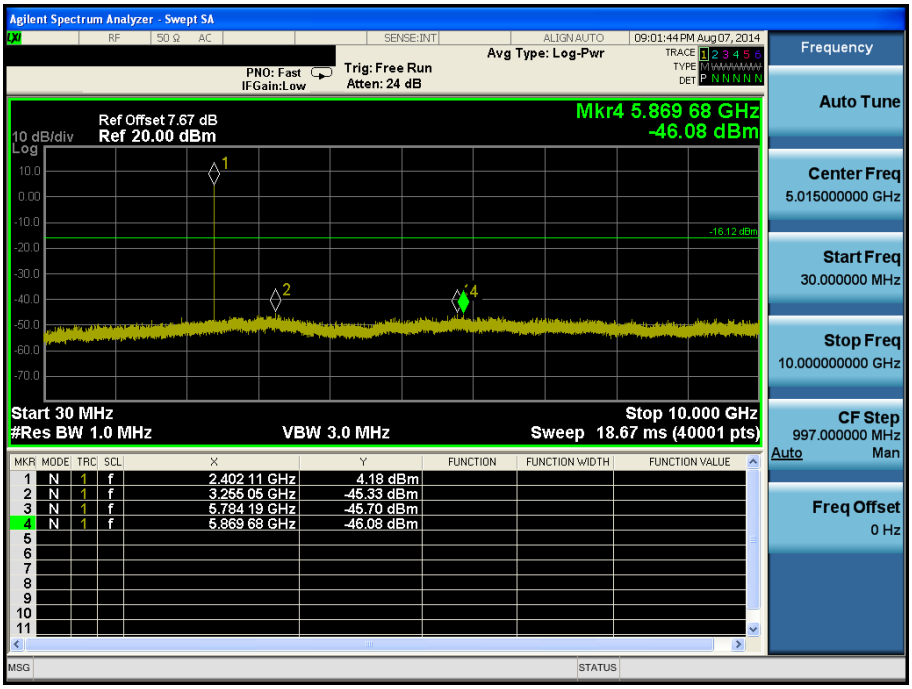



**Low Band-edge** ***Hopping mode&Modulation: GFSK***

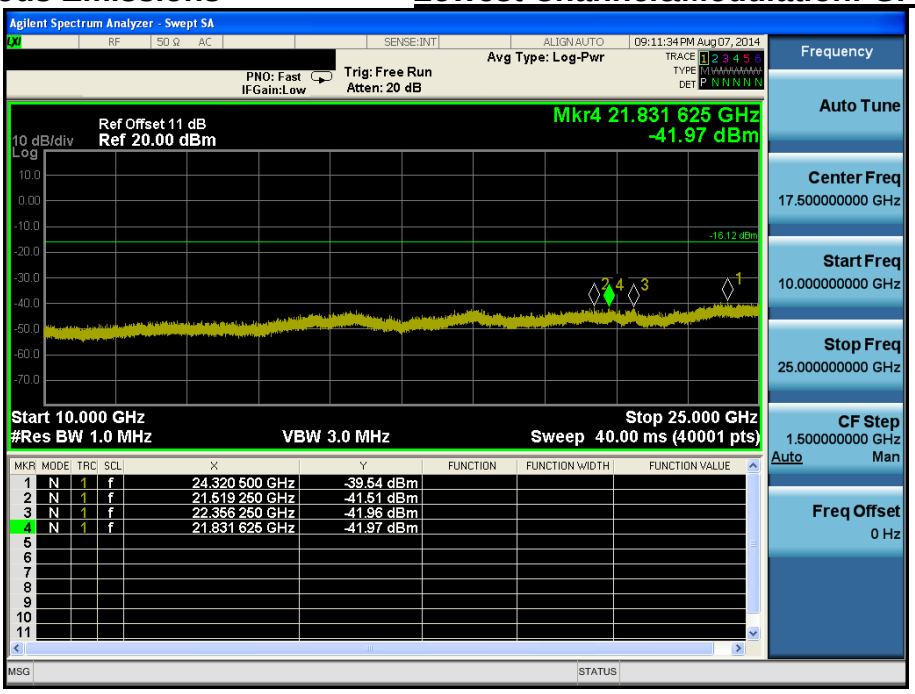


## Conducted Spurious Emissions *Lowest Channel&Modulation: GFSK*

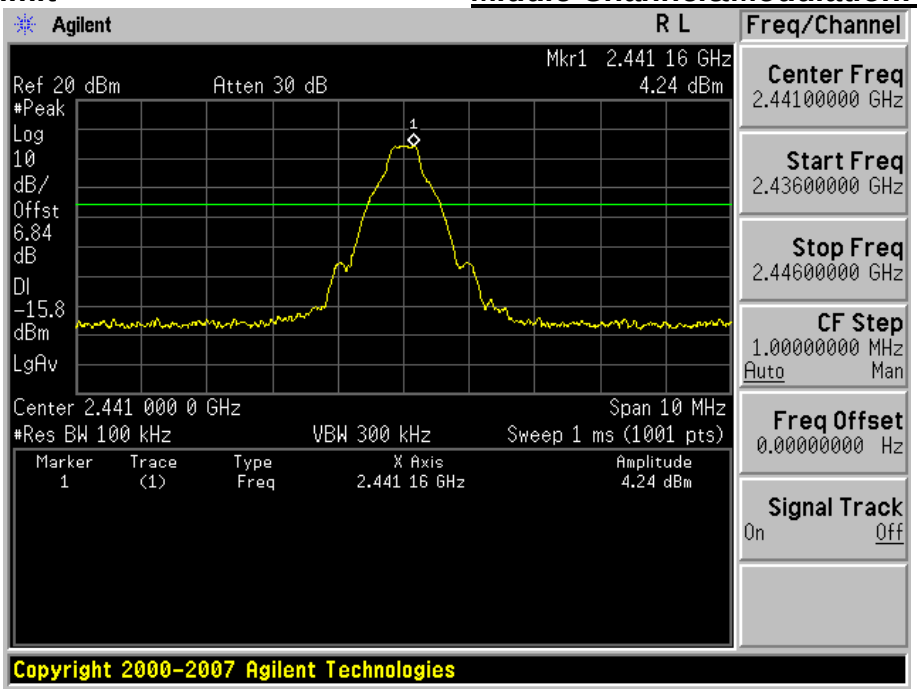


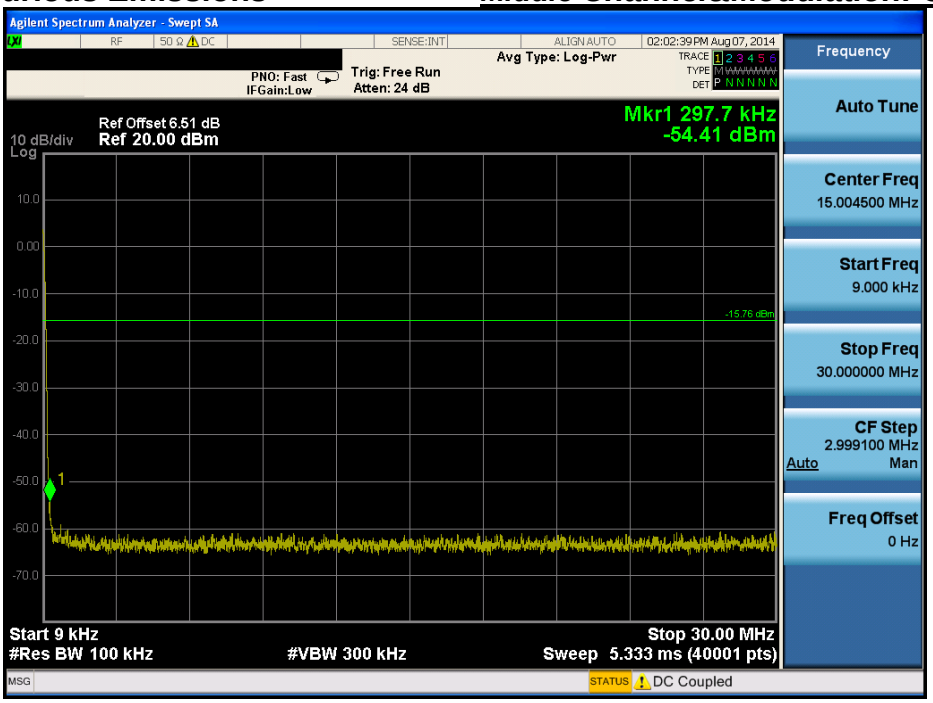
## Conducted Spurious Emissions ***Lowest Channel&Modulation: GFSK***



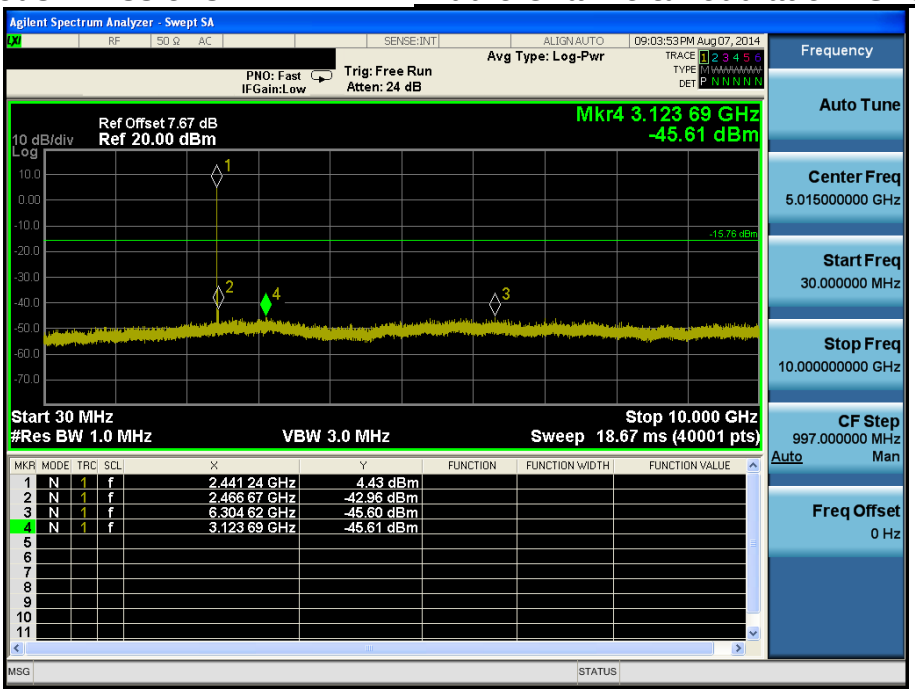
**Reference for limit** ***Middle Channel&Modulation: GFSK***

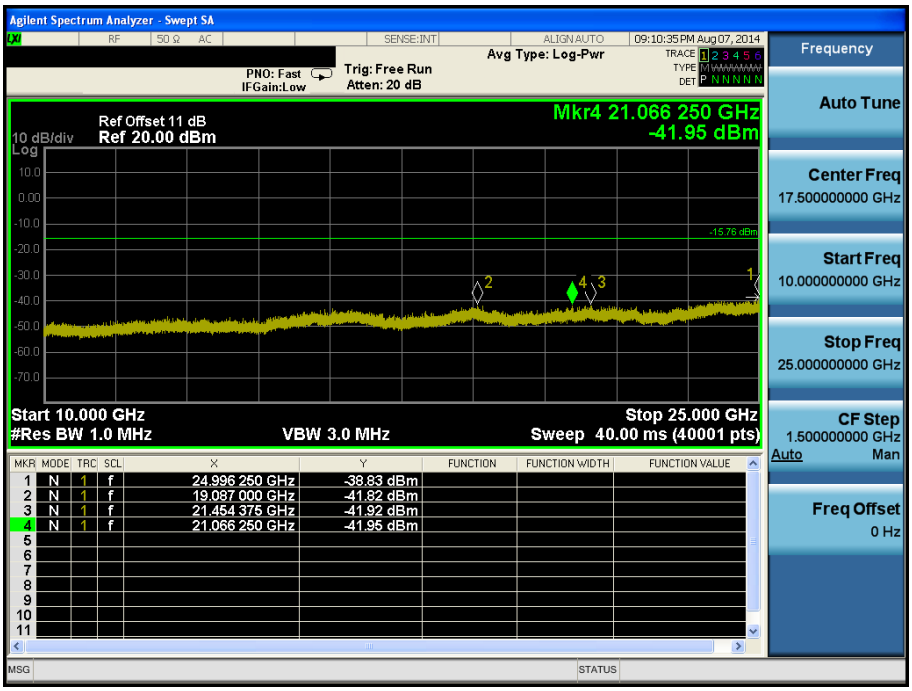



**Conducted Spurious Emissions** ***Middle Channel&Modulation: GFSK***

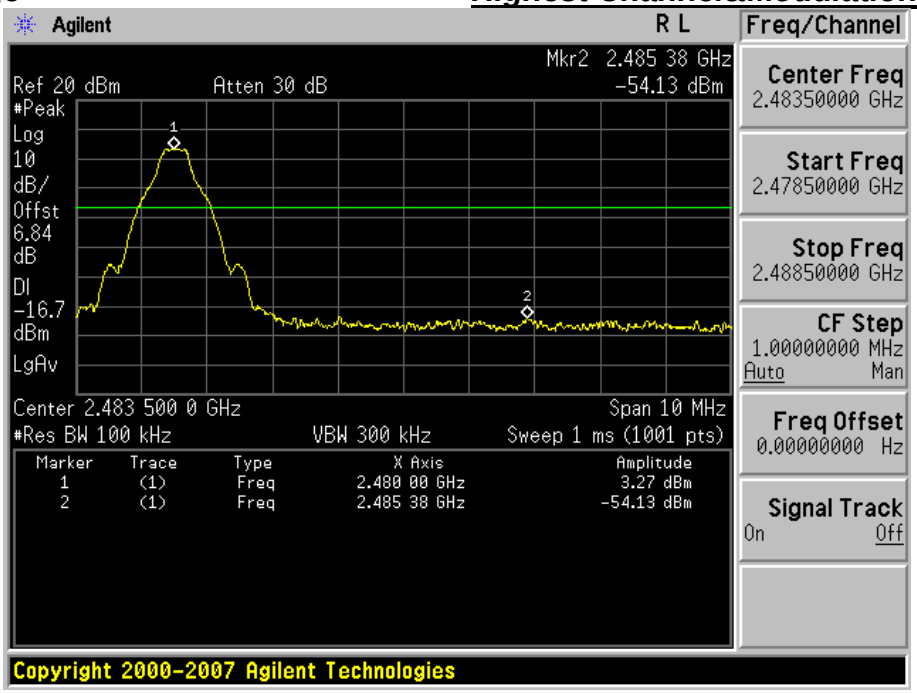


## Conducted Spurious Emissions *Middle Channel&Modulation: GFSK*

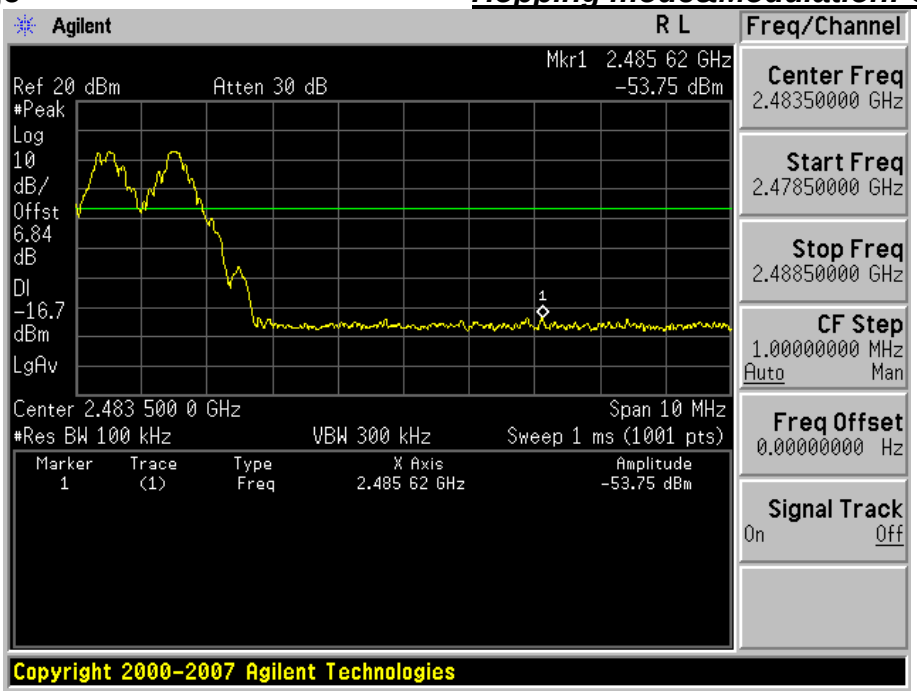


**High Band-edge** ***Highest Channel&Modulation: GFSK***

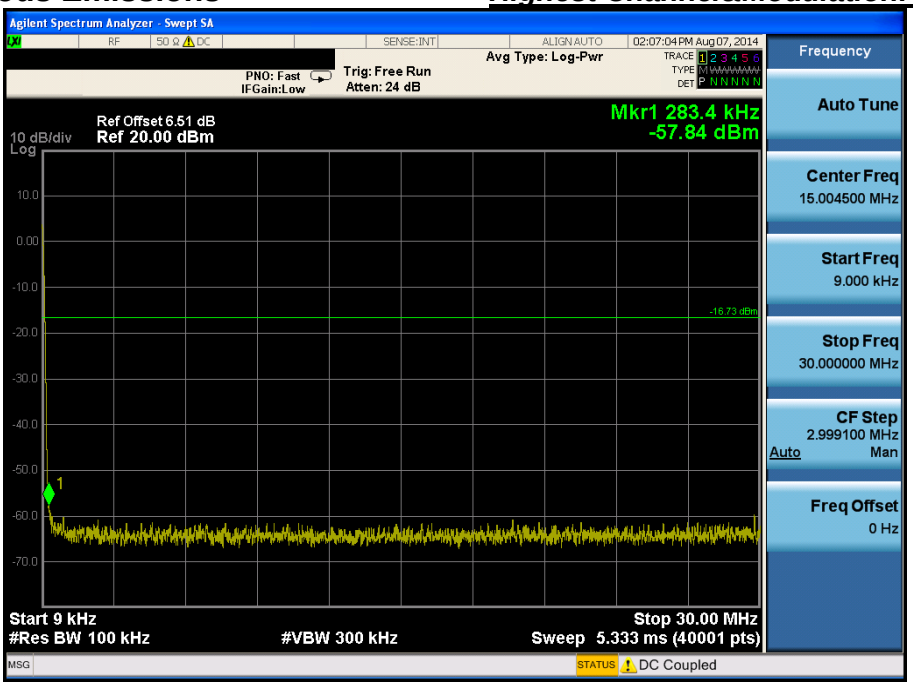


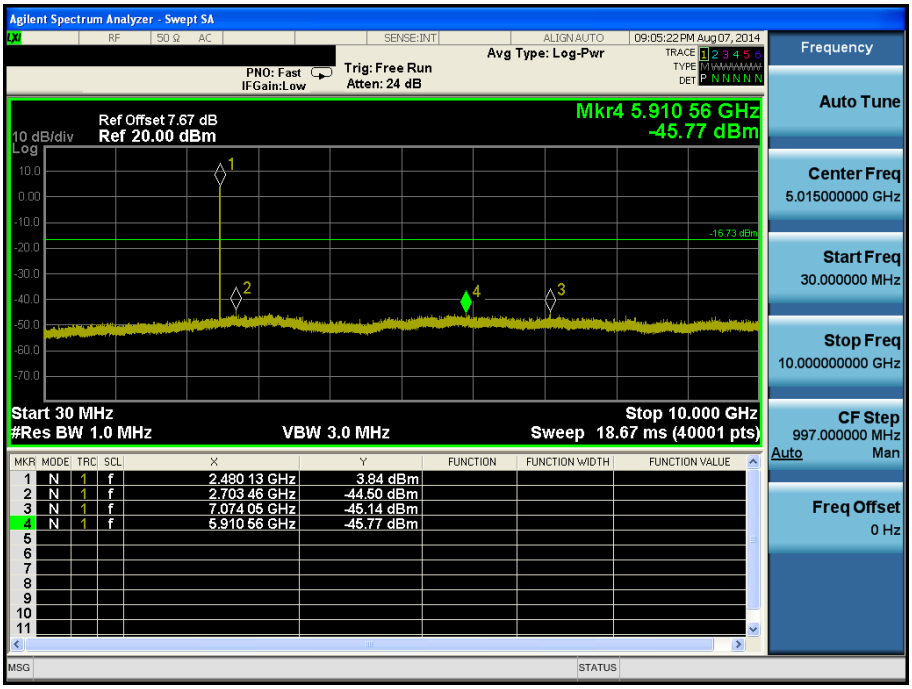

**High Band-edge** ***Hopping mode&Modulation: GFSK***



## Conducted Spurious Emissions

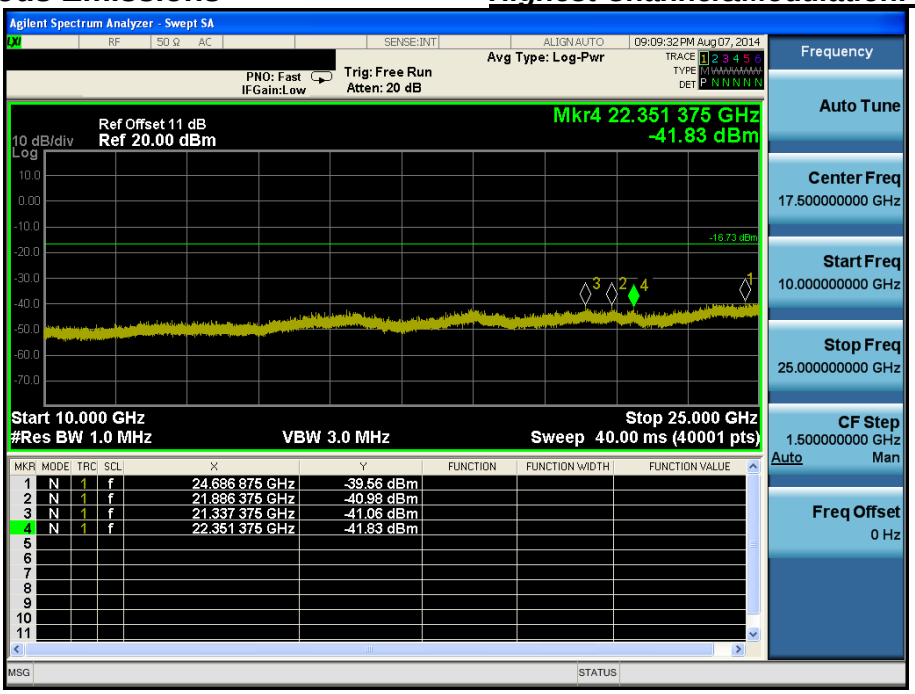
***Highest Channel&Modulation: GFSK***



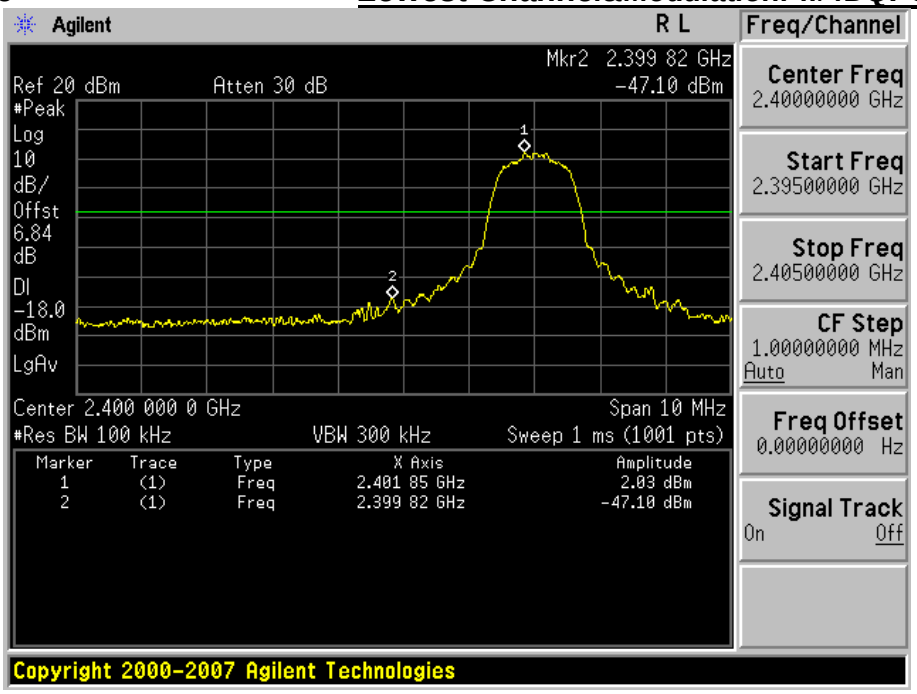



## Conducted Spurious Emissions

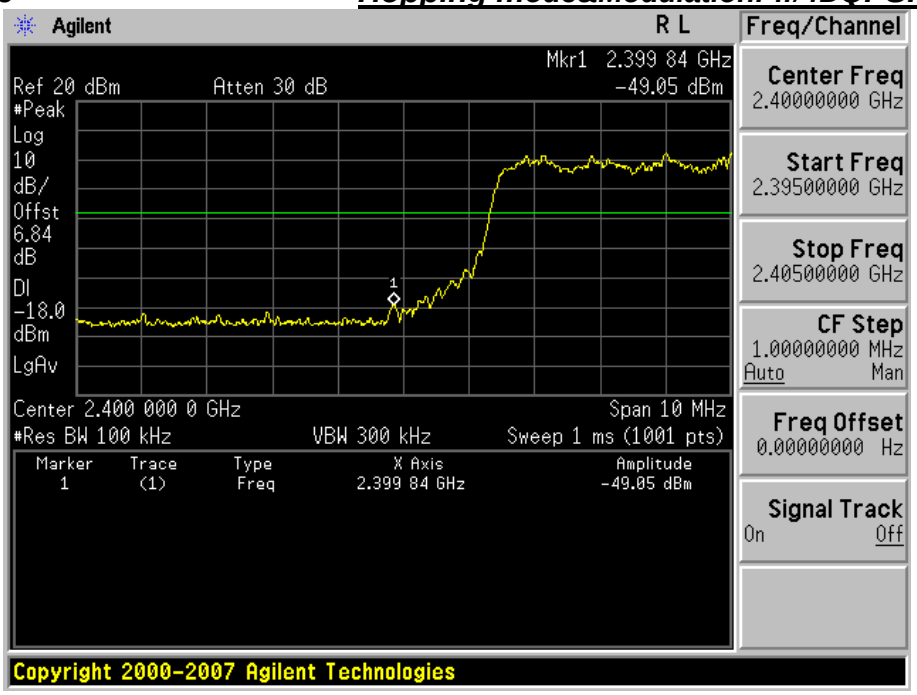
***Highest Channel&Modulation: GFSK***



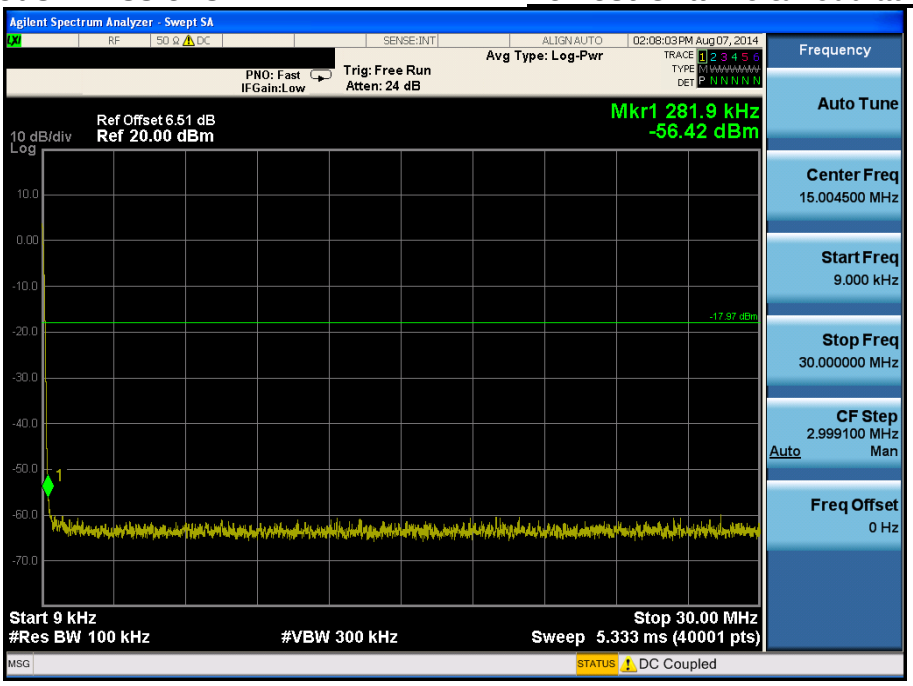
**Low Band-edge** ***Lowest Channel&Modulation: π/4DQPSK***

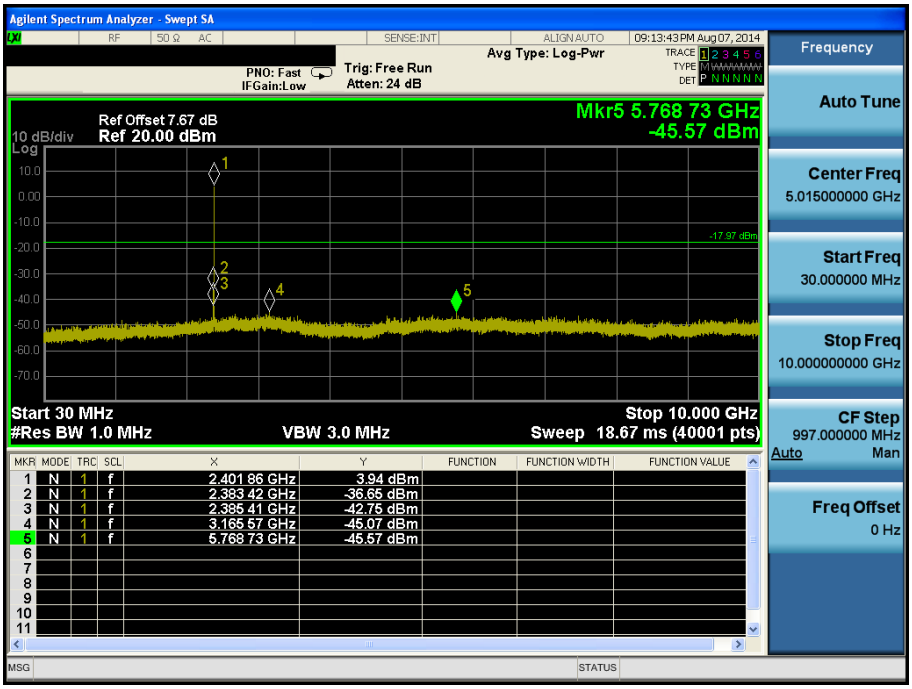



**Low Band-edge** ***Hopping mode&Modulation: π/4DQPSK***



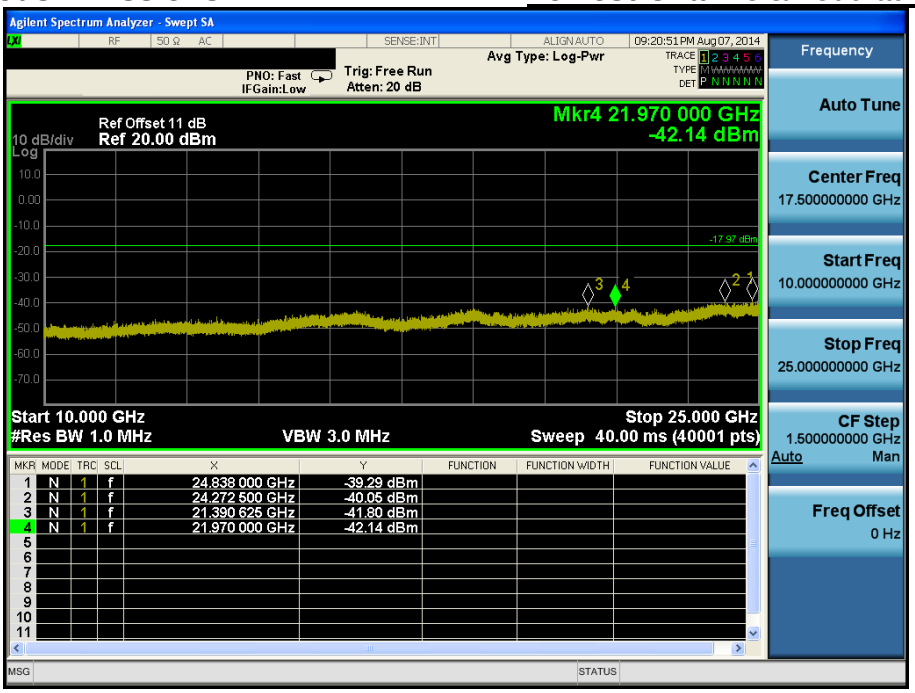
## Conducted Spurious Emissions *Lowest Channel&Modulation:π/4DQPSK*



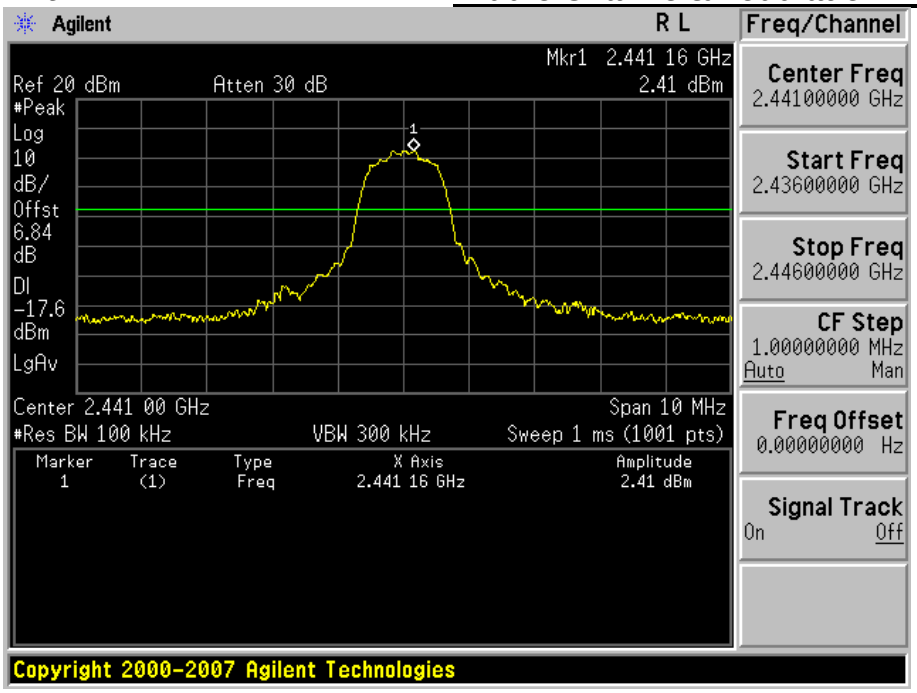



## Conducted Spurious Emissions

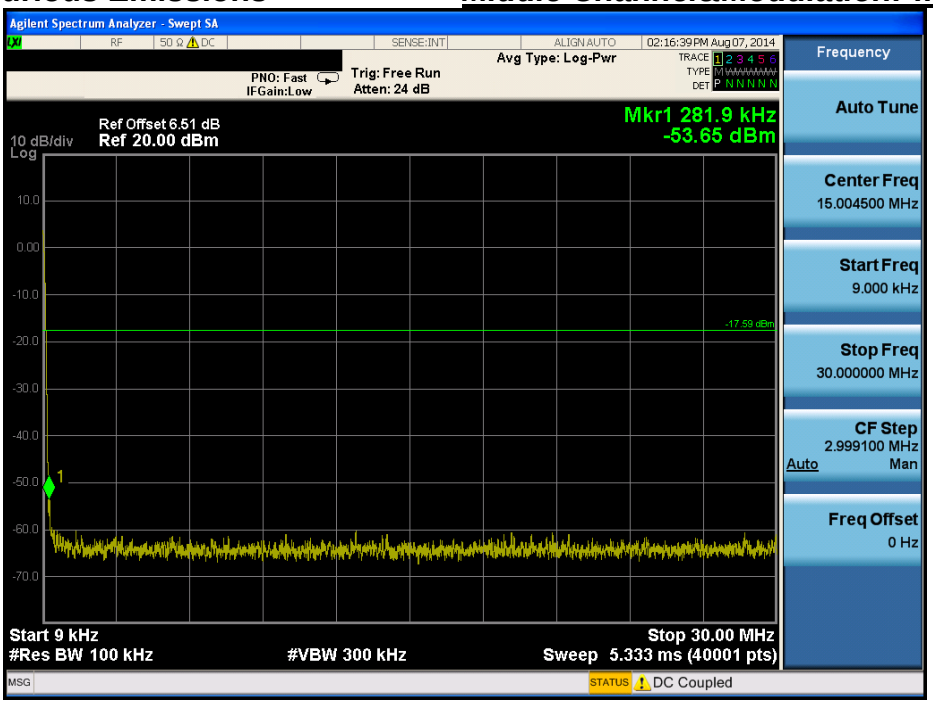
***Lowest Channel&Modulation:π/4DQPSK***



**Reference for limit** ***Middle Channel&Modulation: π/4DQPSK***

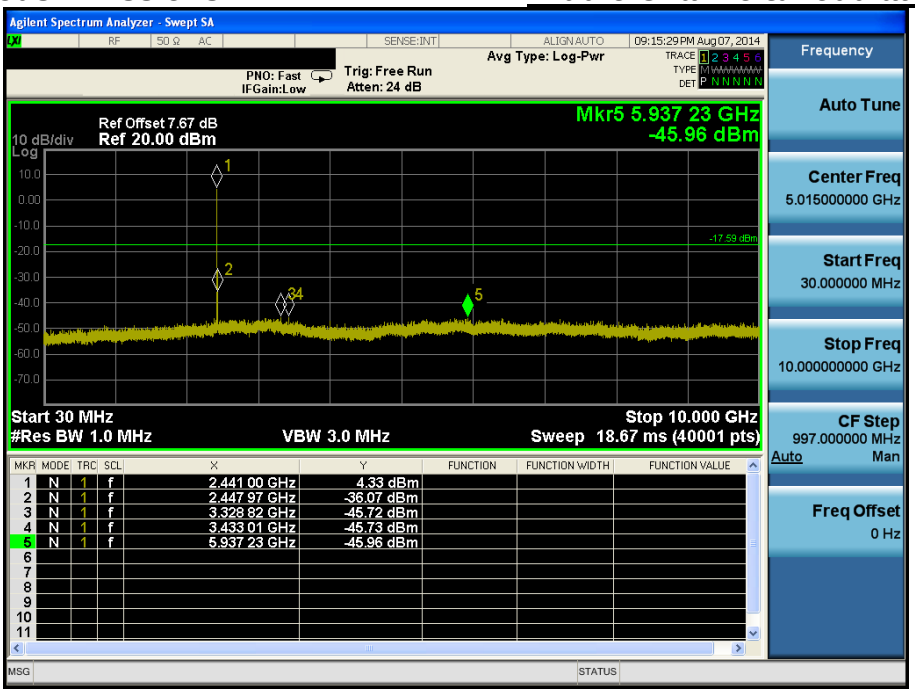


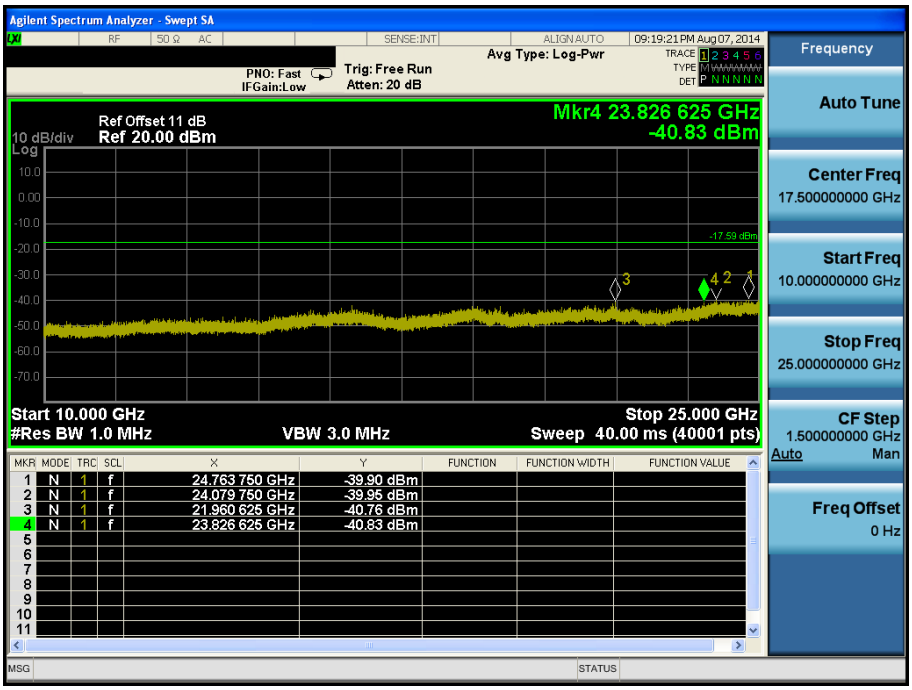

**Conducted Spurious Emissions** ***Middle Channel&Modulation: π/4DQPSK***



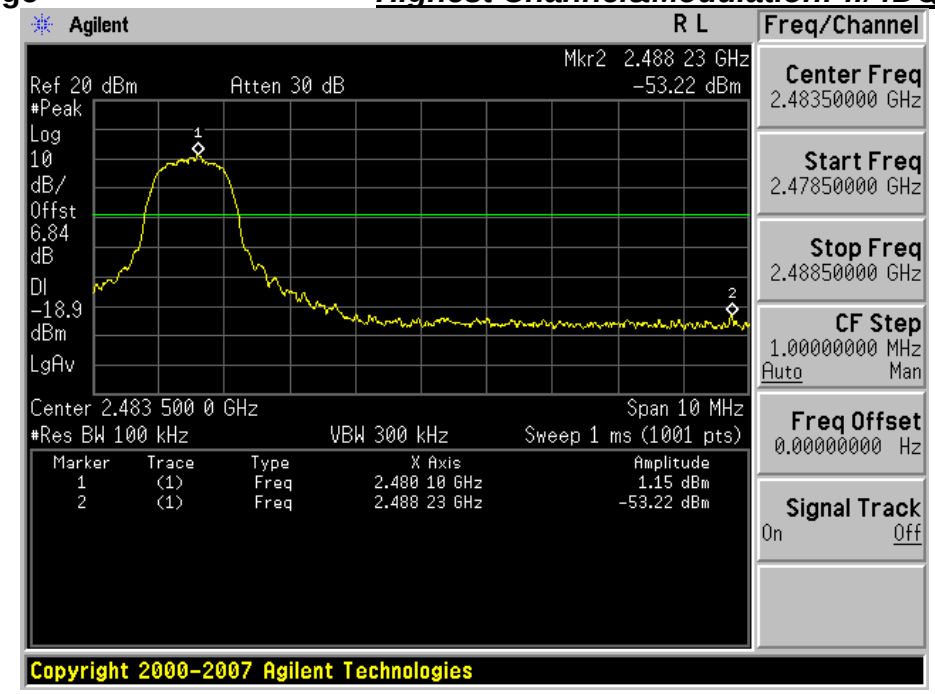
## Conducted Spurious Emissions

***Middle Channel&Modulation: π/4DQPSK***

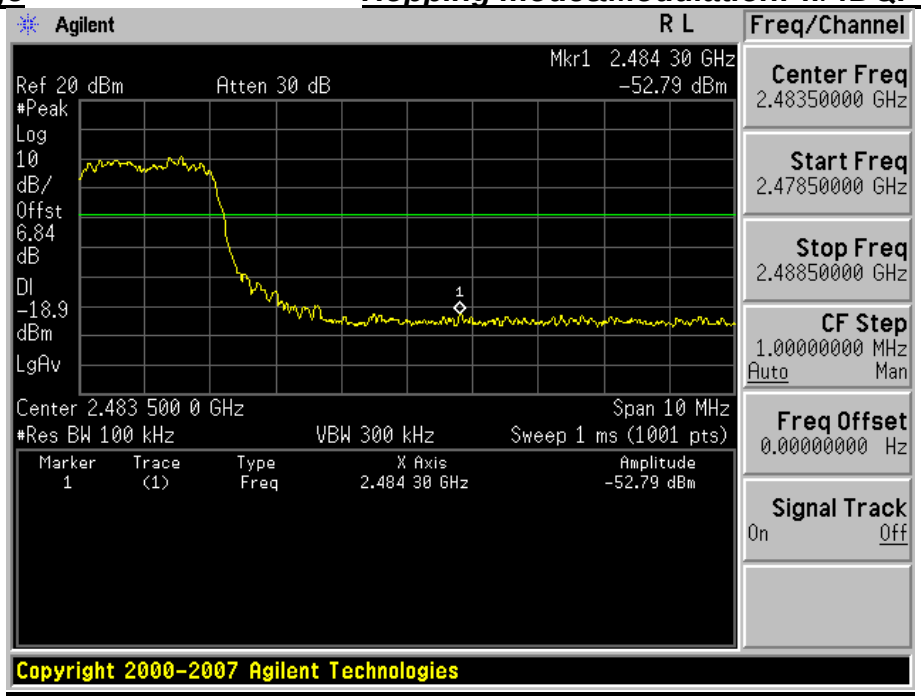


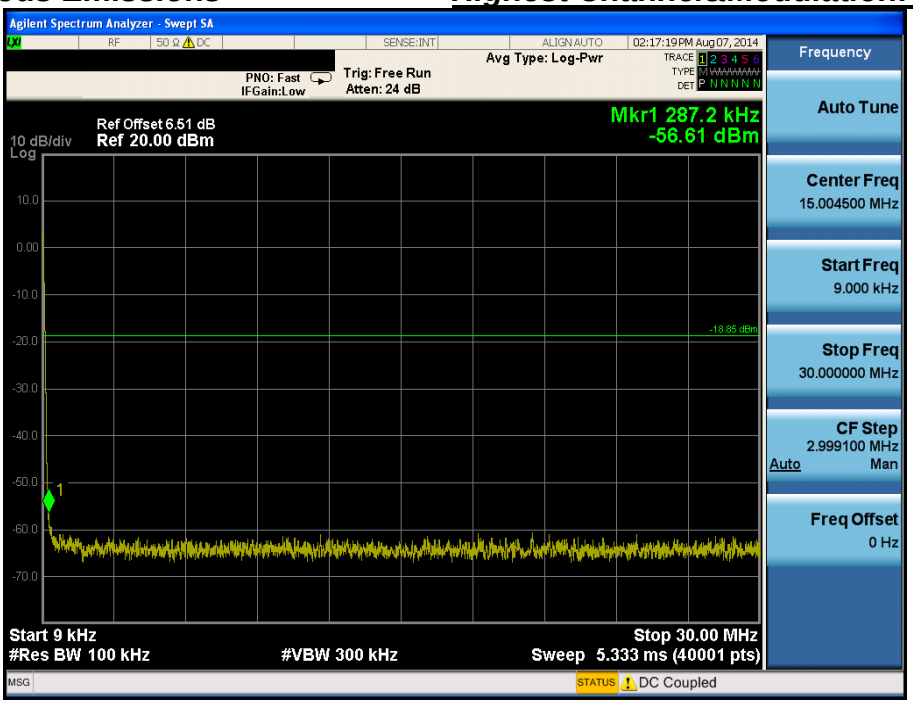
**High Band-edge** ***Highest Channel&Modulation: π/4DQPSK***

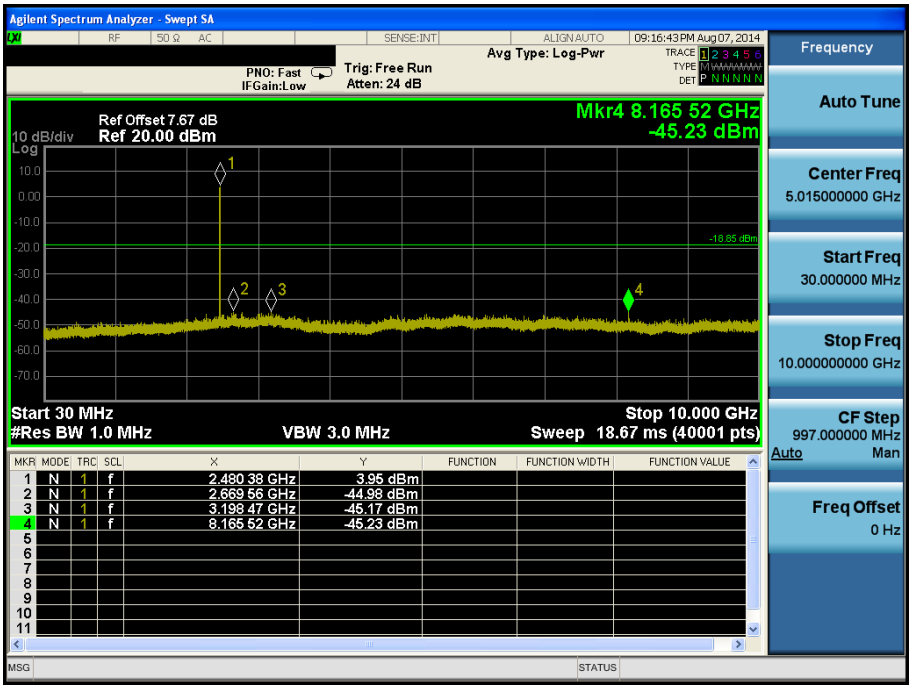



***High Band-edge*** ***Hopping mode&Modulation: π/4DQPSK***

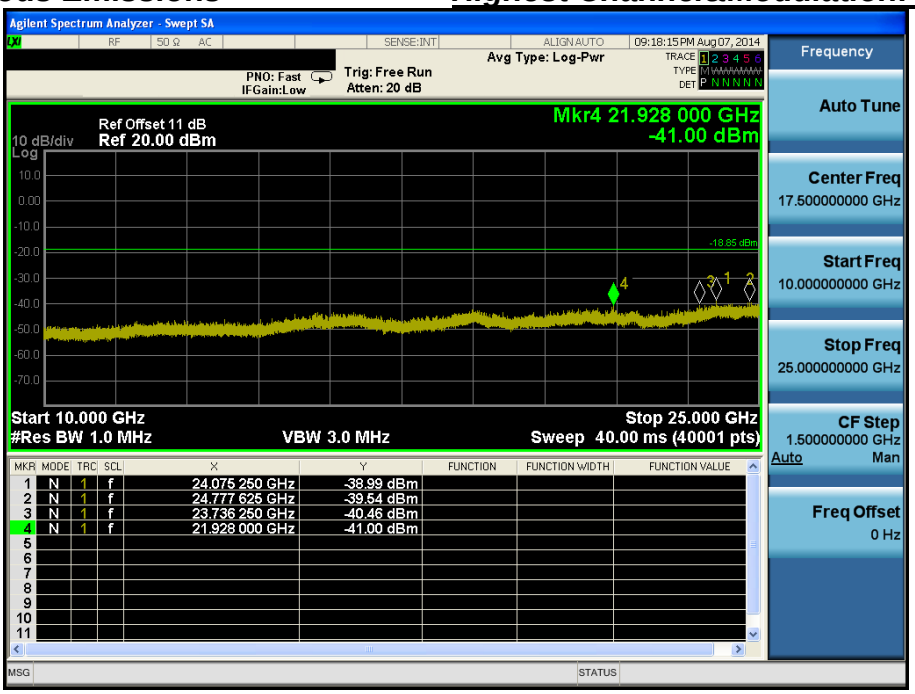


## Conducted Spurious Emissions *Highest Channel&Modulation: π/4DQPSK*

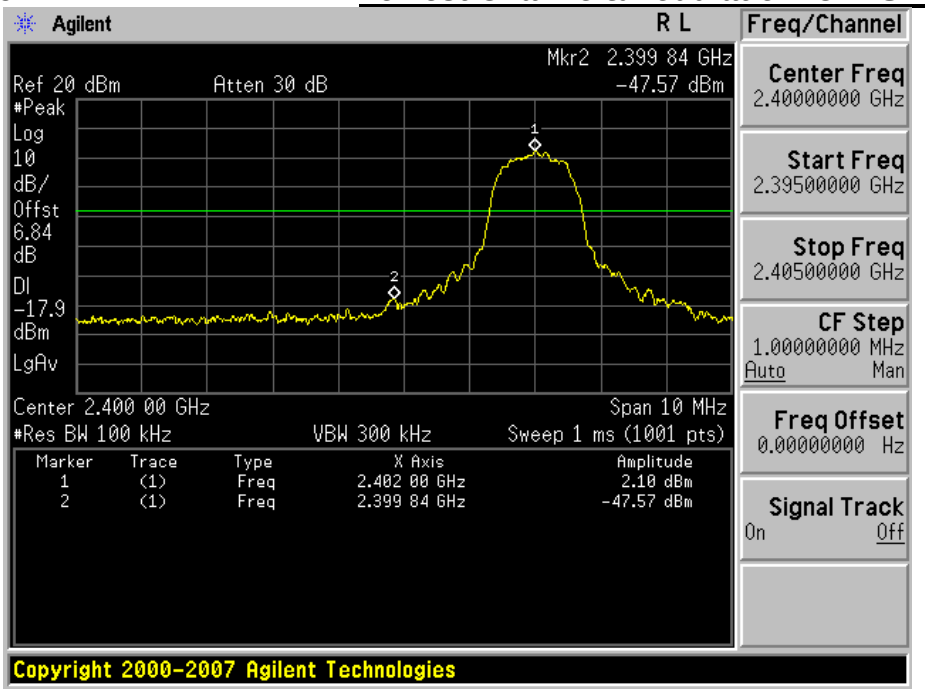


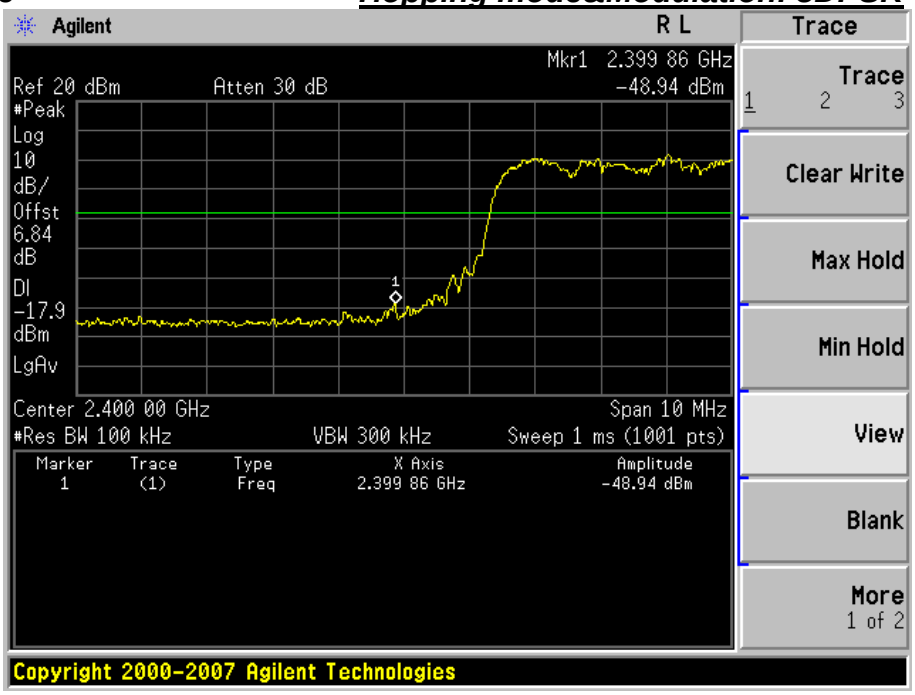
## Conducted Spurious Emissions ***Highest Channel&Modulation: π/4DQPSK***



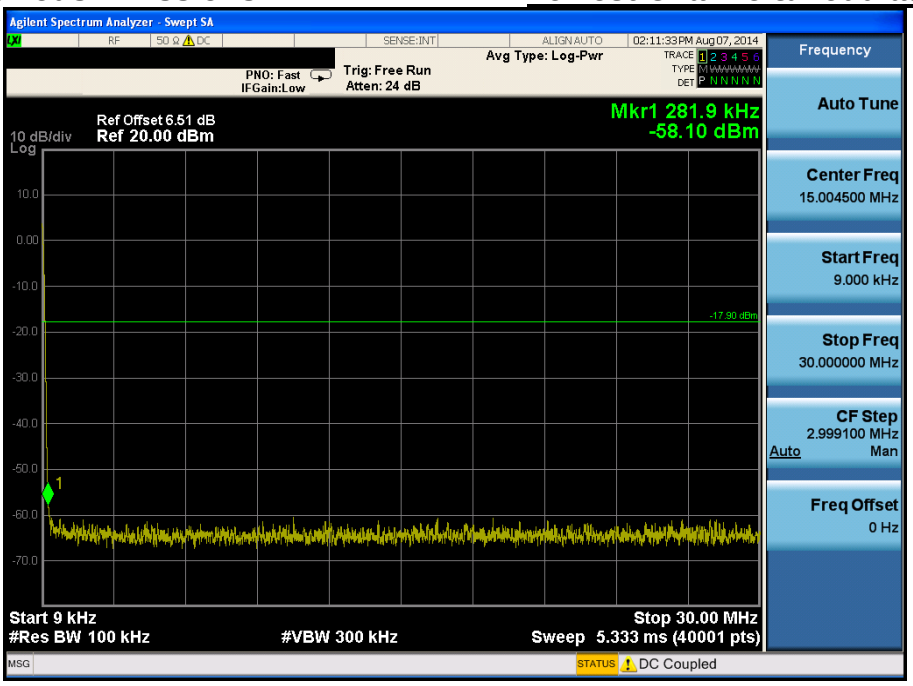
**Low Band-edge** ***Lowest Channel&Modulation: 8DPSK***

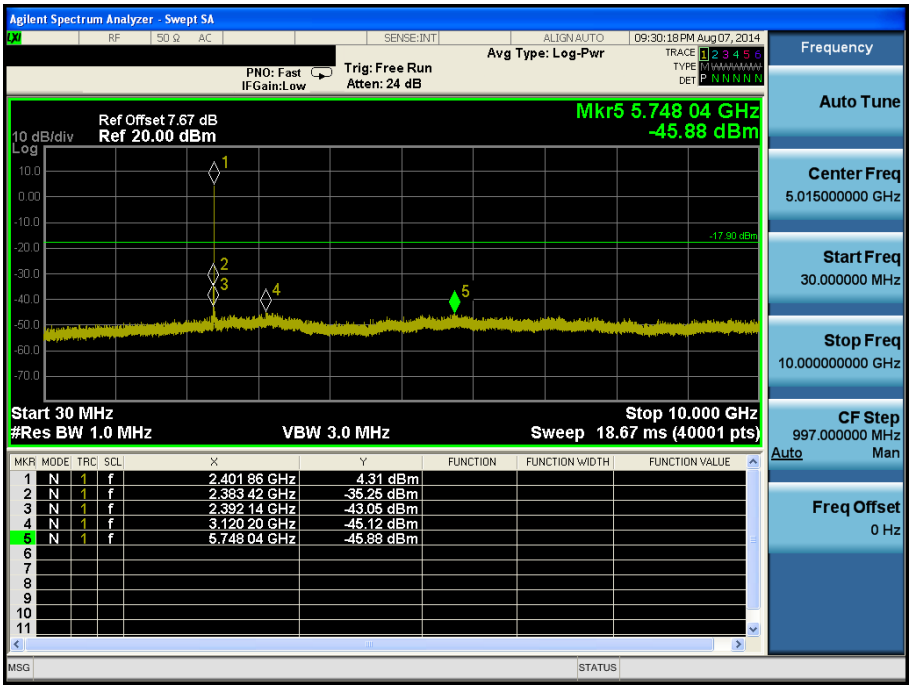



**Low Band-edge** ***Hopping mode&Modulation: 8DPSK***



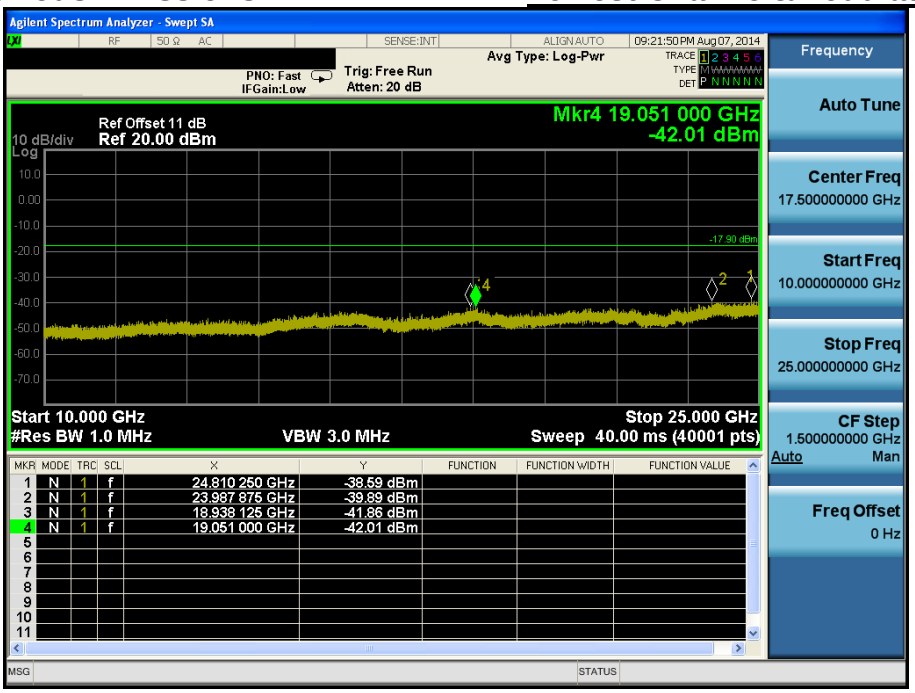
## Conducted Spurious Emissions *Lowest Channel&Modulation: 8DPSK*



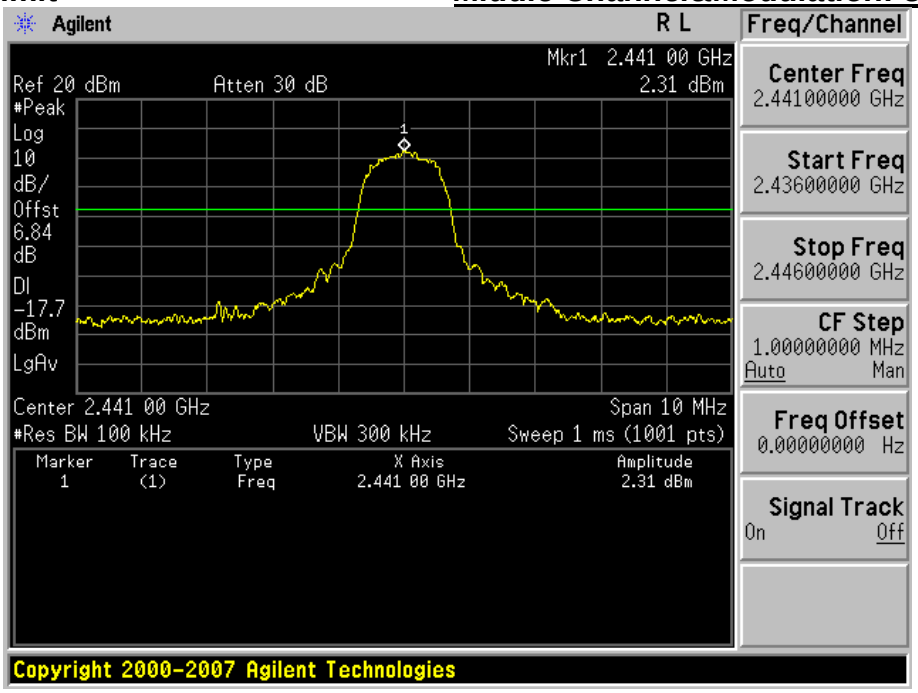



## Conducted Spurious Emissions

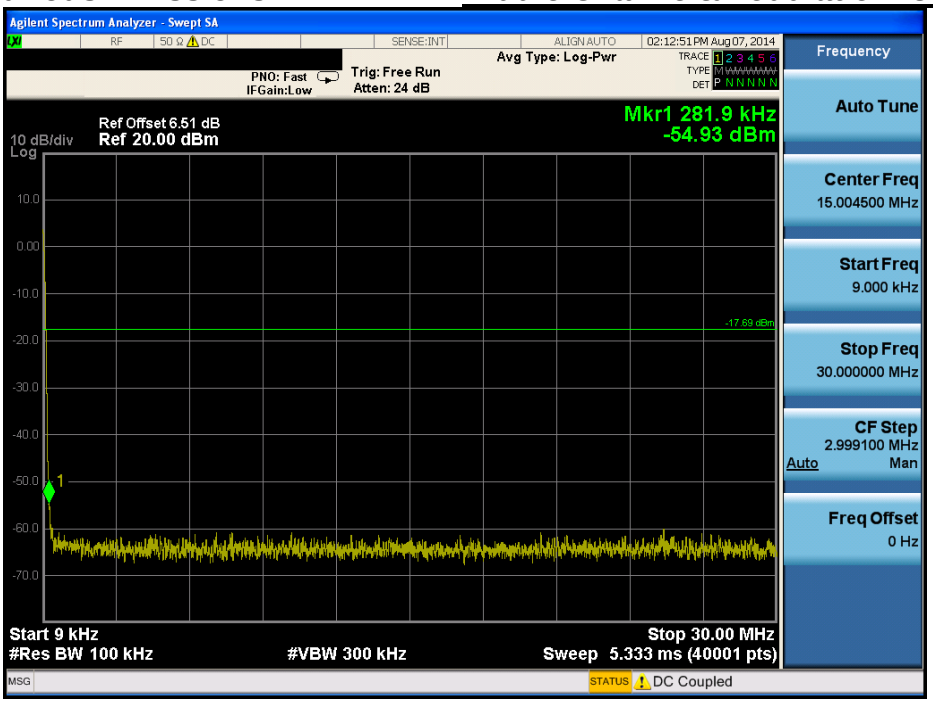
***Lowest Channel&Modulation: 8DPSK***



**Reference for limit** ***Middle Channel&Modulation: 8DPSK***

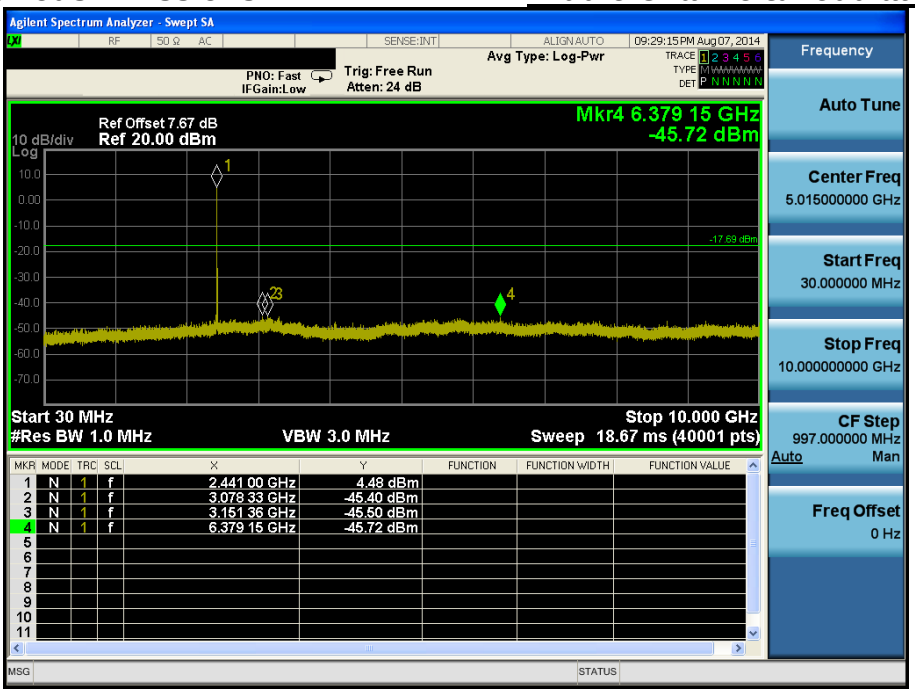


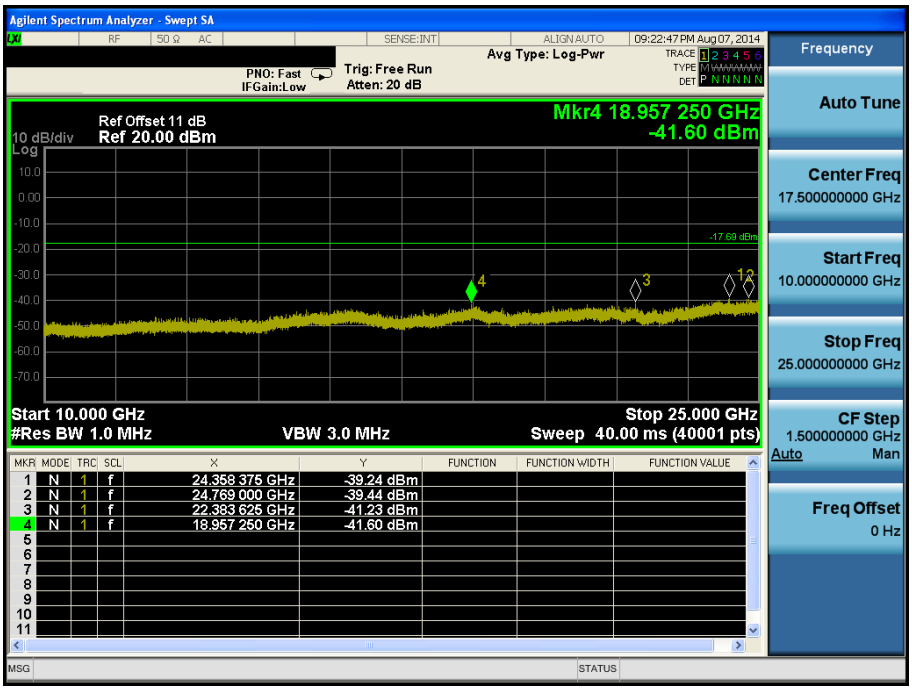

**Conducted Spurious Emissions** ***Middle Channel&Modulation: 8DPSK***



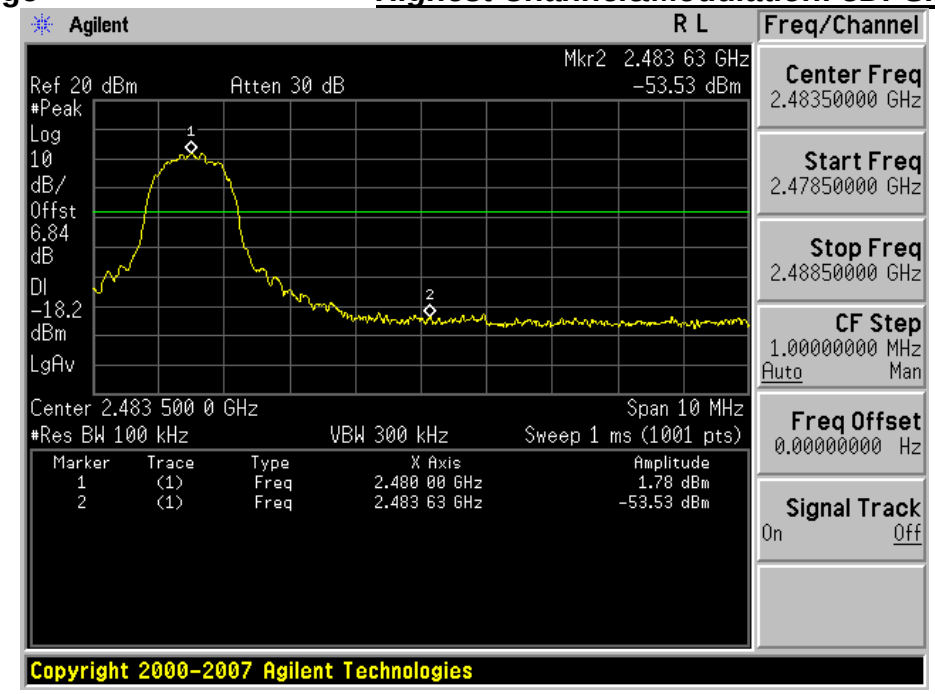
## Conducted Spurious Emissions

***Middle Channel&Modulation: 8DPSK***

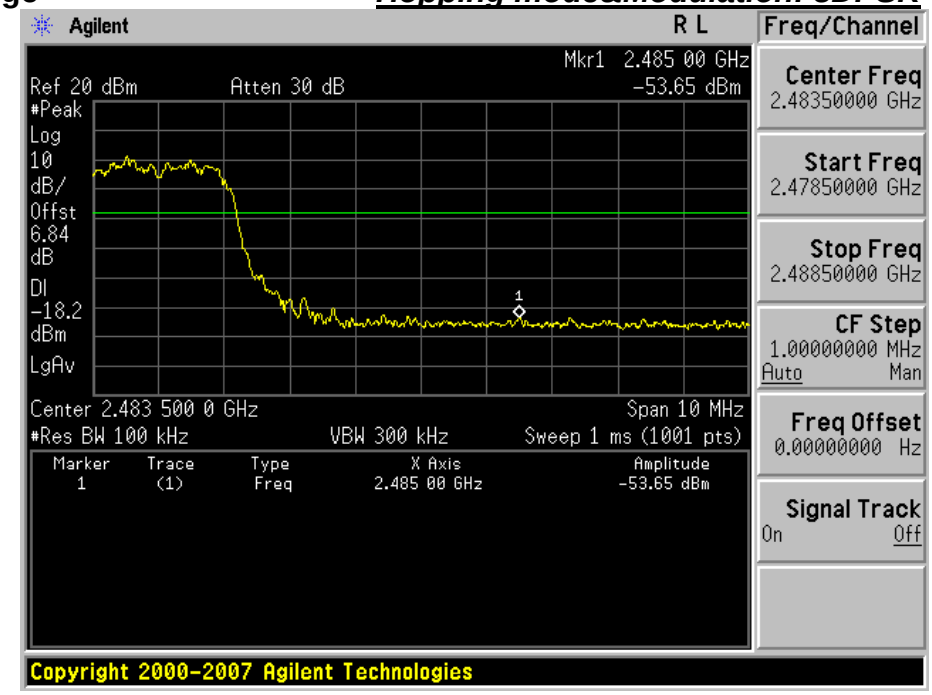


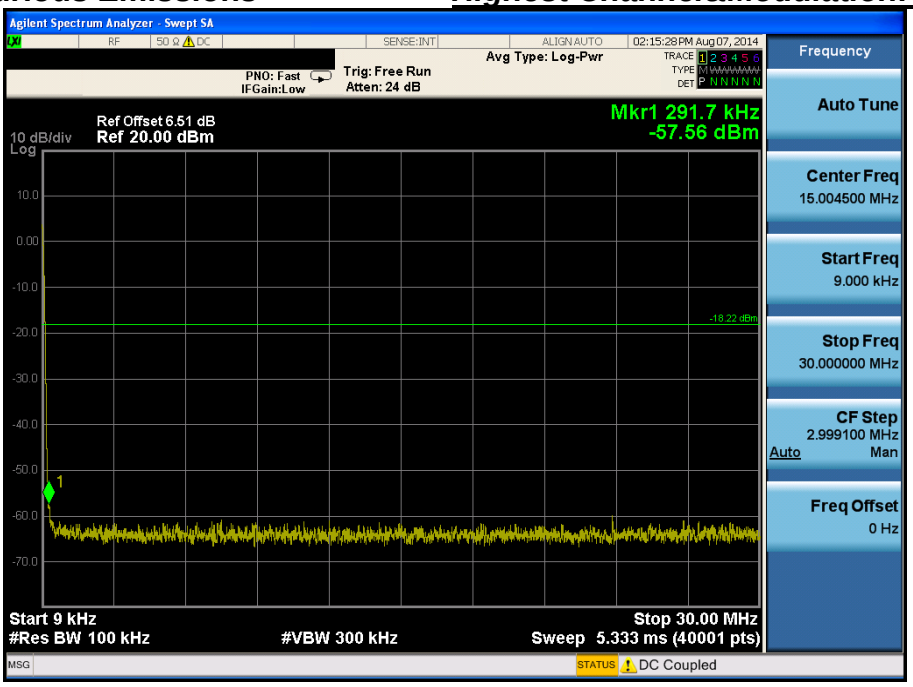
**High Band-edge** ***Highest Channel&Modulation: 8DPSK***

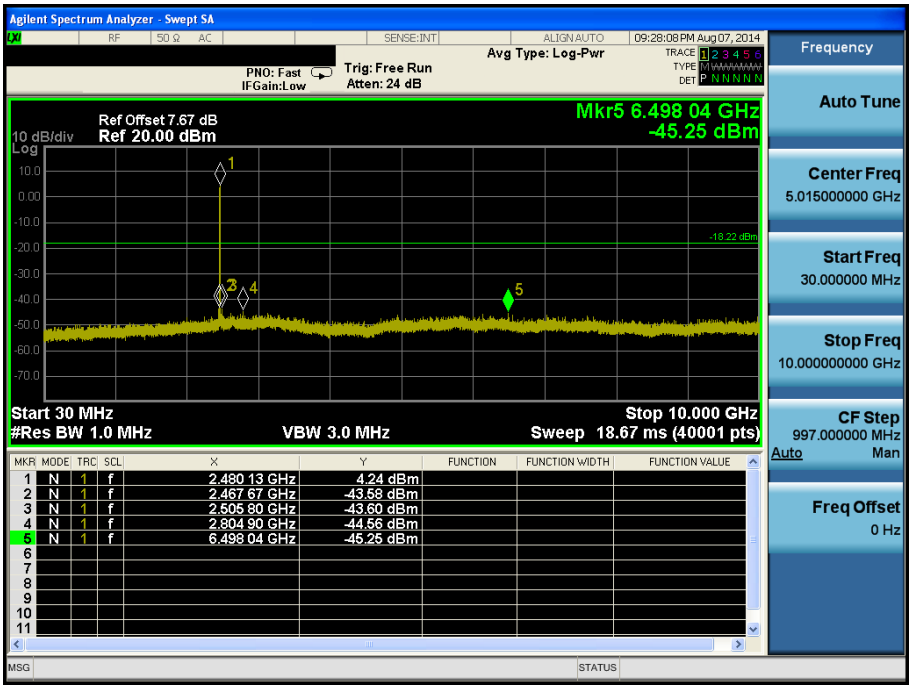



**High Band-edge** ***Hopping mode&Modulation: 8DPSK***

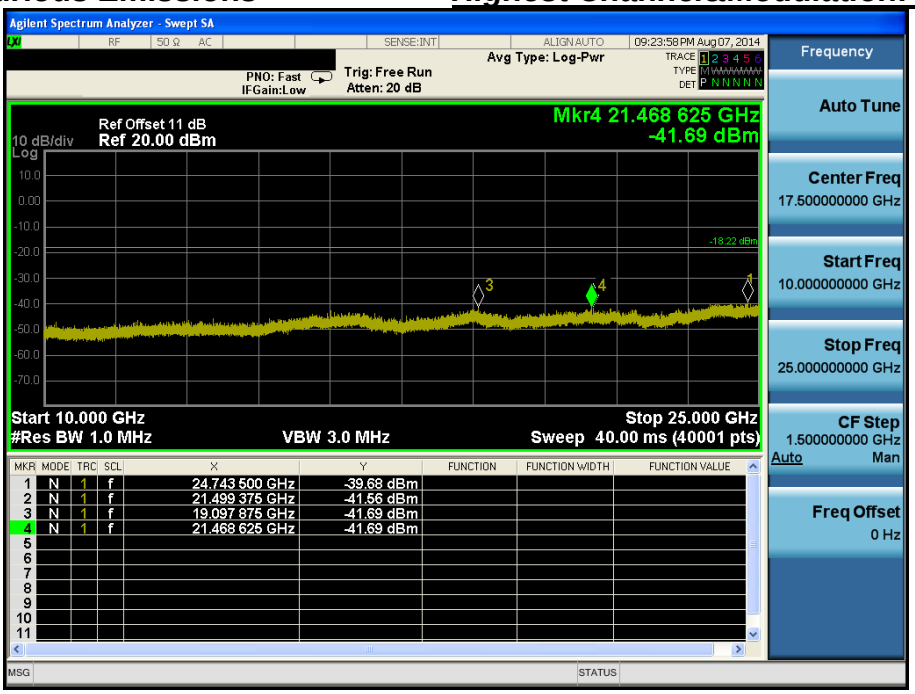


## Conducted Spurious Emissions ***Highest Channel&Modulation: 8DPSK***



## Conducted Spurious Emissions *Highest Channel&Modulation: 8DPSK*



# 3. Carrier Frequency Separation

## 3.1.Test Setup

Refer to the APPENDIX I.

## 3.2. Limit

Limit: ≥ 20dB BW or ≥Two-Thirds of the 20dB BW

**- Procedure:**

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

The spectrum analyzer is set to:

Span = wide enough to capture the peaks of two adjacent channels
RBW = 1% of the span
Sweep = auto
VBW = ≥ RBW
Detector function = peak
Trace = max hold

**- Measurement Data: Comply**

**- FH mode**

| Hopping Mode | Test Mode | Peak of adjacent Channel (MHz) | Peak of center channel (MHz) | Test Result (MHz) |
|---|---|---|---|---|
| Enable | GFSK | 2441.009 | 2442.011 | 1.002 |
| | π/4-DQPSK | 2440.997 | 2439.998 | 0.999 |
| | 8DPSK | 2441.003 | 2442.002 | 0.999 |

**- AFH mode**

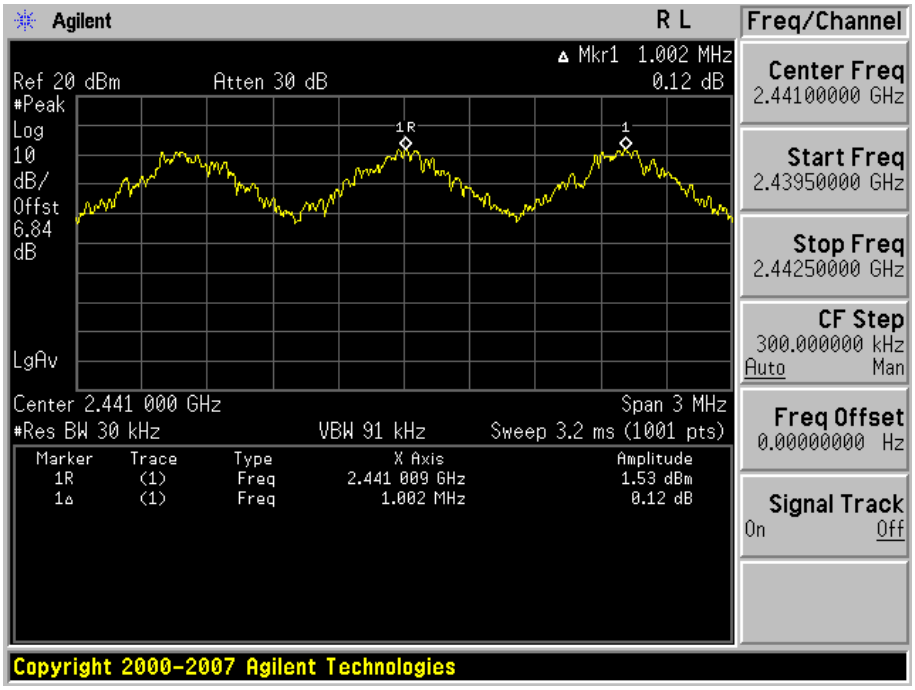
| Hopping Mode | Test Mode | Peak of adjacent Channel (MHz) | Peak of center channel (MHz) | Test Result (MHz) |
|---|---|---|---|---|
| Enable | GFSK | 2411.012 | 2412.014 | 1.002 |
| | π/4-DQPSK | 2411.000 | 2411.999 | 0.999 |
| | 8DPSK | 2411.003 | 2412.008 | 1.005 |

Note 1: See next pages for actual measured spectrum plots.

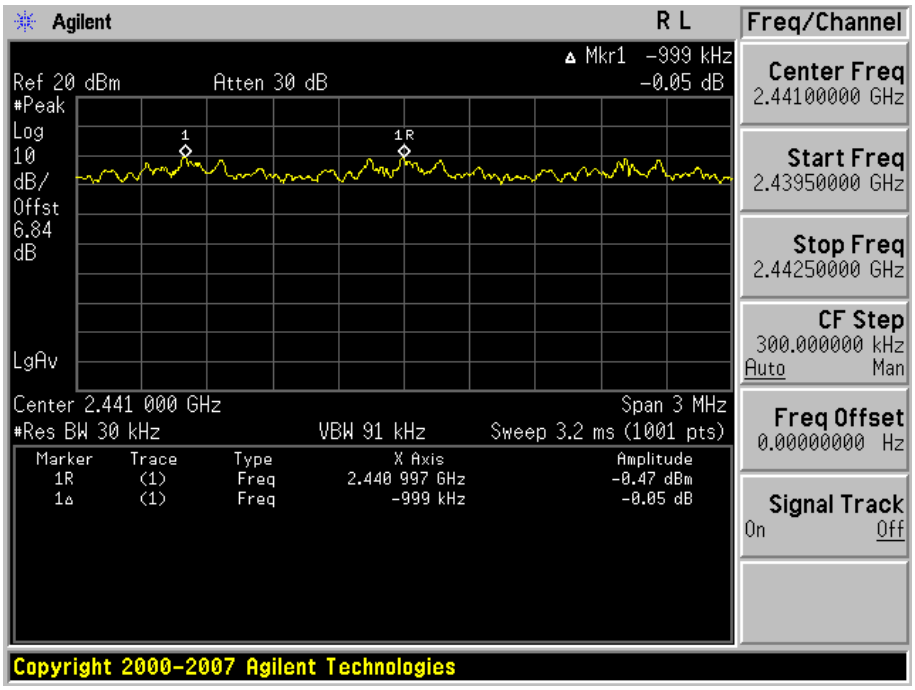
- **Minimum Standard:**

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
Alternatively, frequency hopping systems operating in the 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, provided the systems operate with an output power no greater than 125 mW

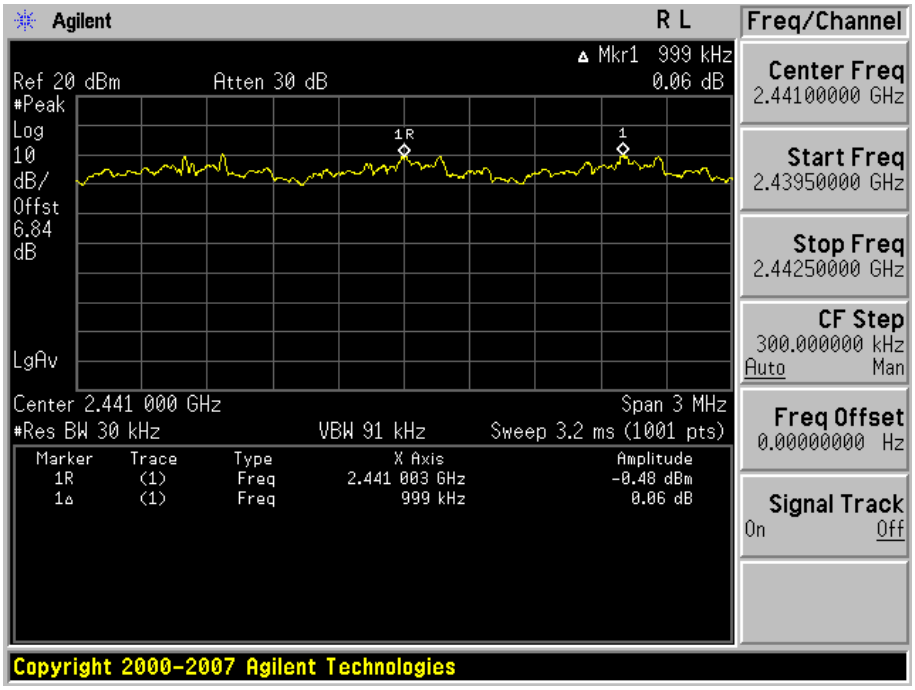
## Carrier Frequency Separation (FH) *Hopping mode: Enable&GFSK*



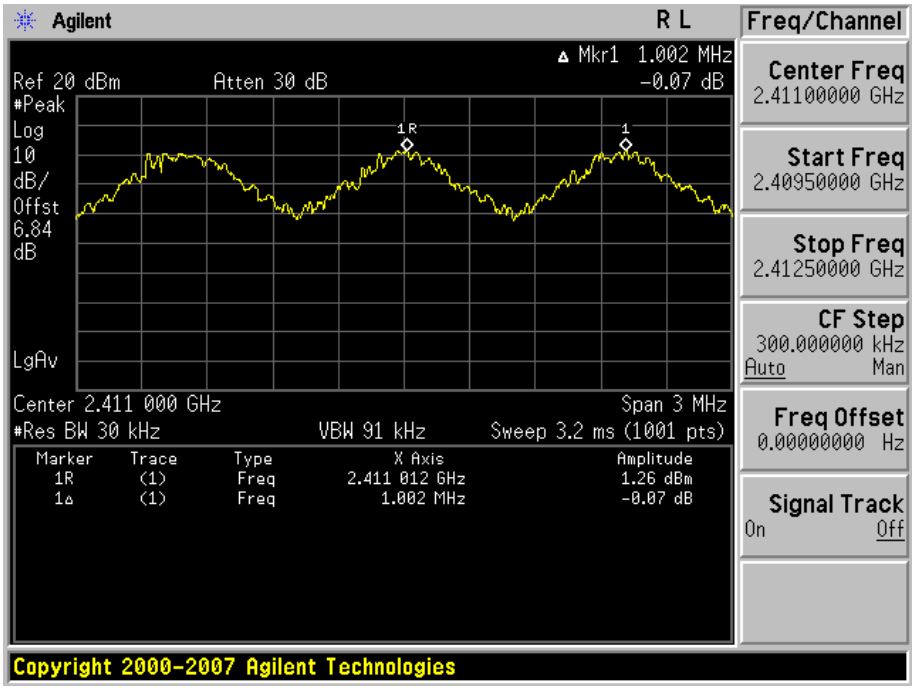

## Carrier Frequency Separation (FH) *Hopping mode: Enable&π/4-DQPSK*



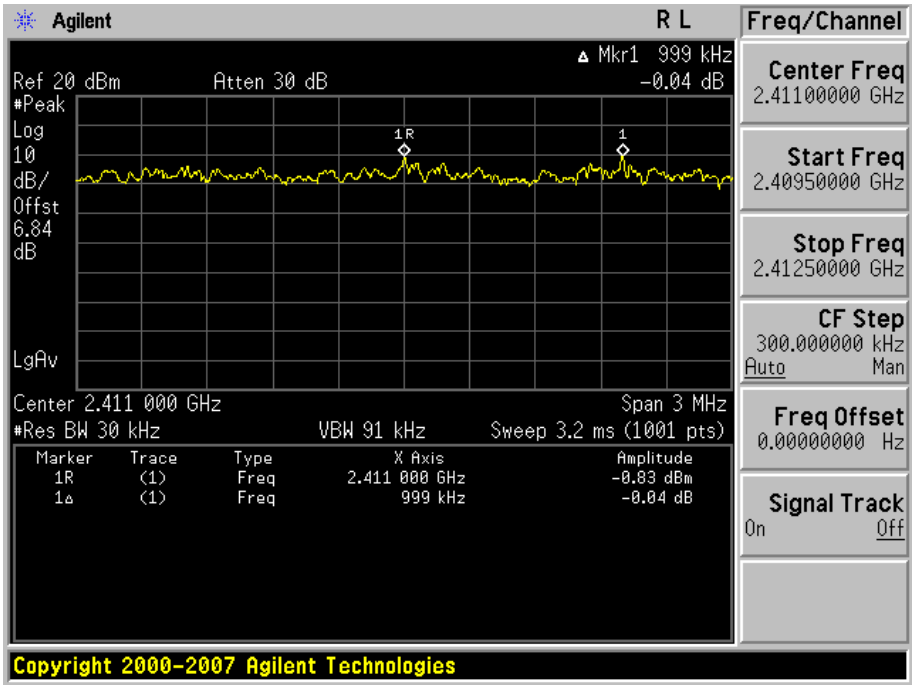
## Carrier Frequency Separation (FH) ***Hopping mode: Enable&8DPSK***



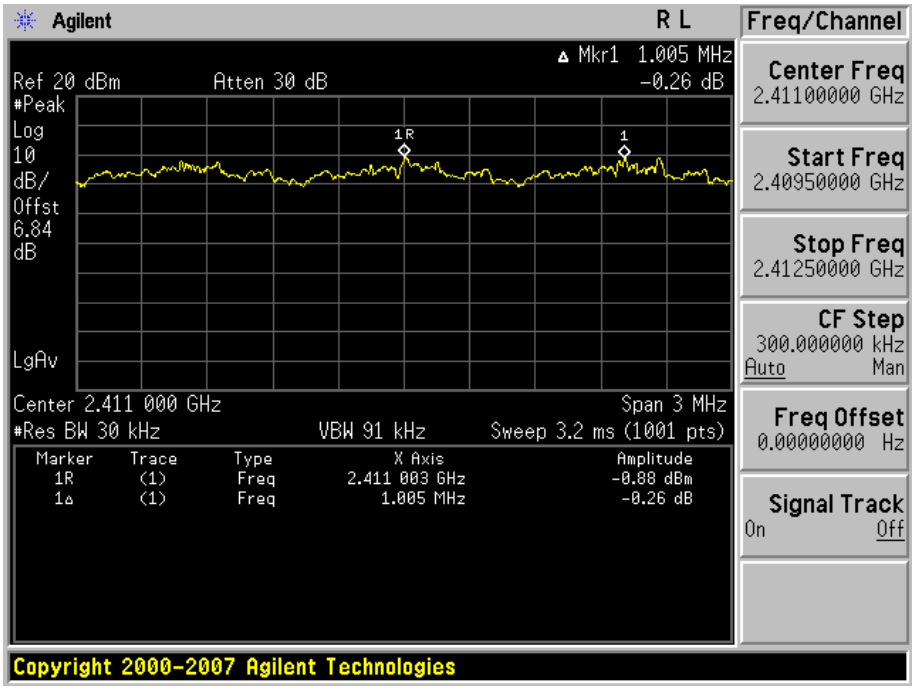
## Carrier Frequency Separation (AFH) ***Hopping mode: Enable&GFSK***




## Carrier Frequency Separation (AFH) ***Hopping mode: Enable&π/4-DQPSK***



## Carrier Frequency Separation (AFH) ***Hopping mode: Enable&8DPSK***



# 4.Number of Hopping Frequencies

## 4.1.Test Setup

Refer to the APPENDIX I.

## 4.2. Limit

Limit: >= 15 hops

**- Procedure:**

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

The spectrum analyzer is set to:

Span = 50MHz  Plot 1: Start Frequency = 2391.5MHz,  Stop Frequency = 2441.5 MHz
Plot 2: Start Frequency = 2441.5MHz,  Stop Frequency = 2491.5 MHz

RBW = 1% of the span or more  Sweep = auto
VBW = ≥ RBW  Detector function = peak
Trace = max hold

- **Measurement Data: Comply**

**- FH mode**

| Hopping mode | Test mode | Test Result (Total Hops) |
|---|---|---|
| Enable | GFSK | 79 |
| | π/4-DQPSK | 79 |
| | 8DPSK | 79 |

**- AFH mode**

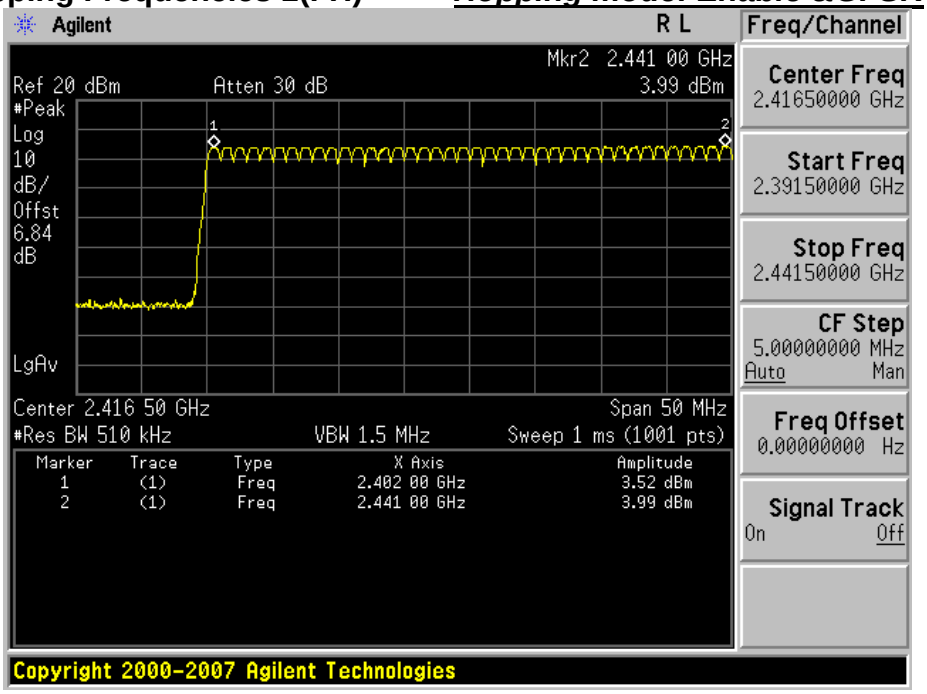
| Hopping mode | Test mode | Test Result (Total Hops) |
|---|---|---|
| Enable | GFSK | 20 |
| | π/4-DQPSK | 20 |
| | 8DPSK | 20 |

Note 1: See next pages for actual measured spectrum plots.

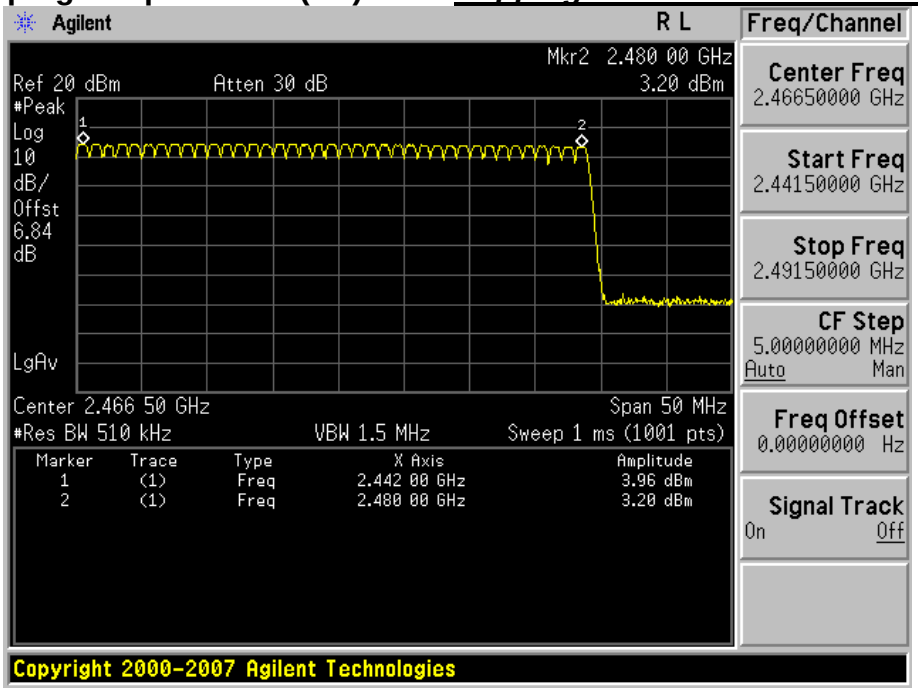
**- Minimum Standard:**

| |
|---|
| At least 15 hopes |

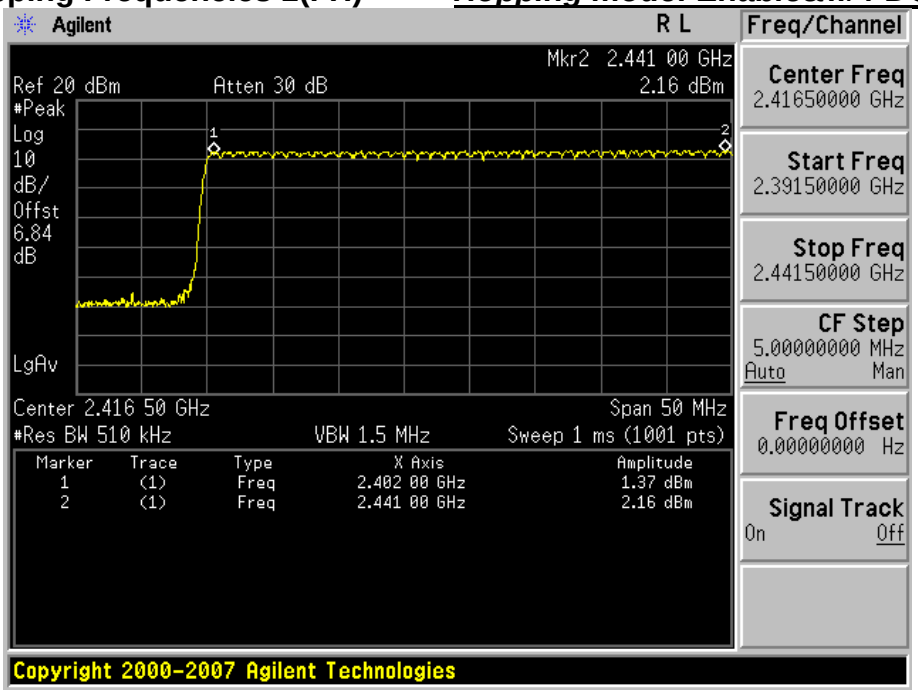
**Number of Hopping Frequencies 1(FH)** ***Hopping mode: Enable &GFSK***



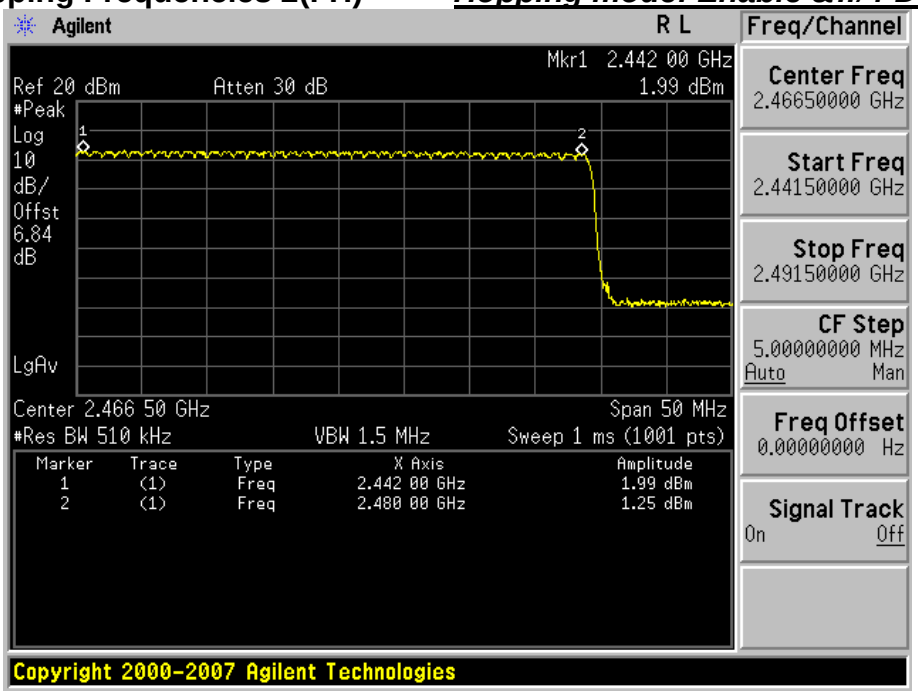

**Number of Hopping Frequencies 2(FH)** ***Hopping mode: Enable & GFSK***



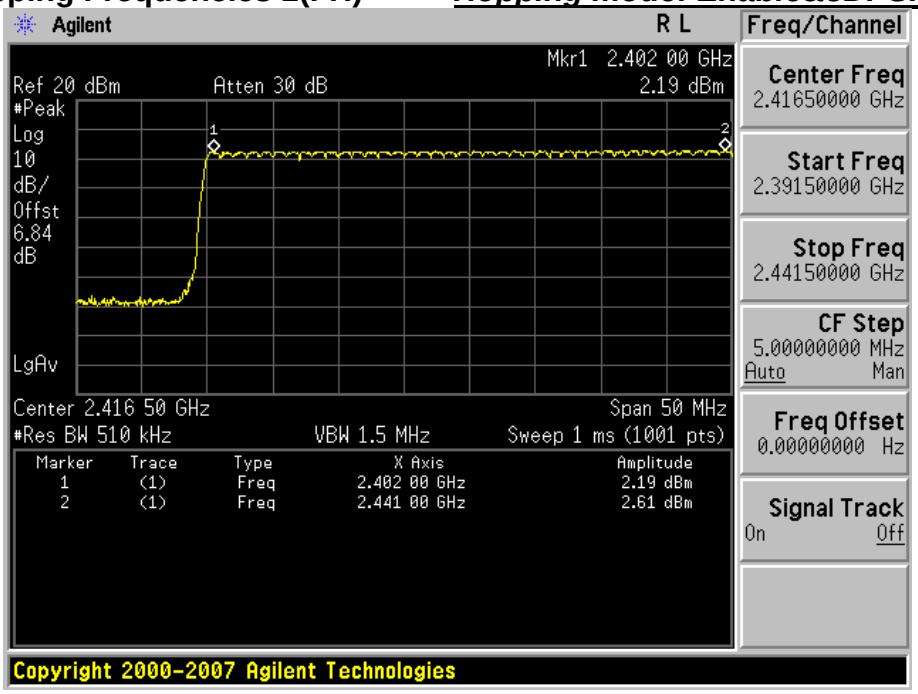
**Number of Hopping Frequencies 1(FH)** ***Hopping mode: Enable&π/4-DQPSK***



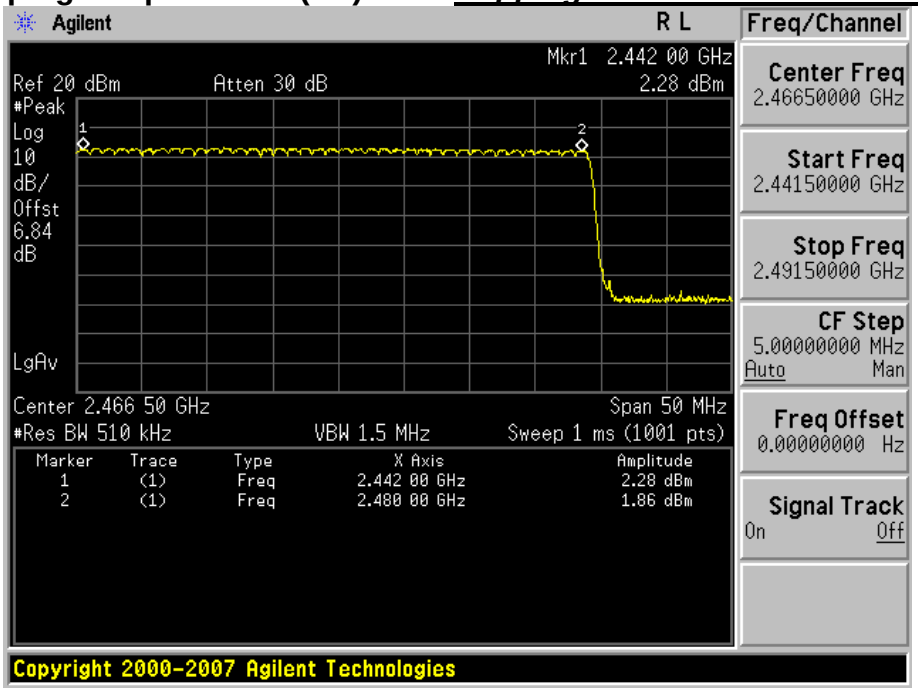

**Number of Hopping Frequencies 2(FH)** ***Hopping mode: Enable &π/4-DQPSK***



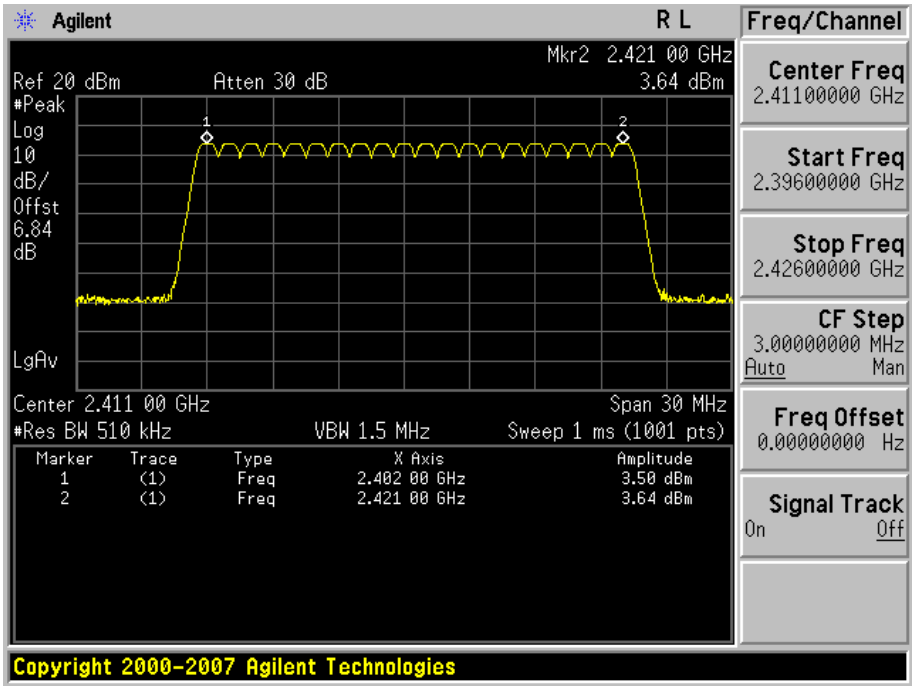
**Number of Hopping Frequencies 1(FH)** ***Hopping mode: Enable&8DPSK***



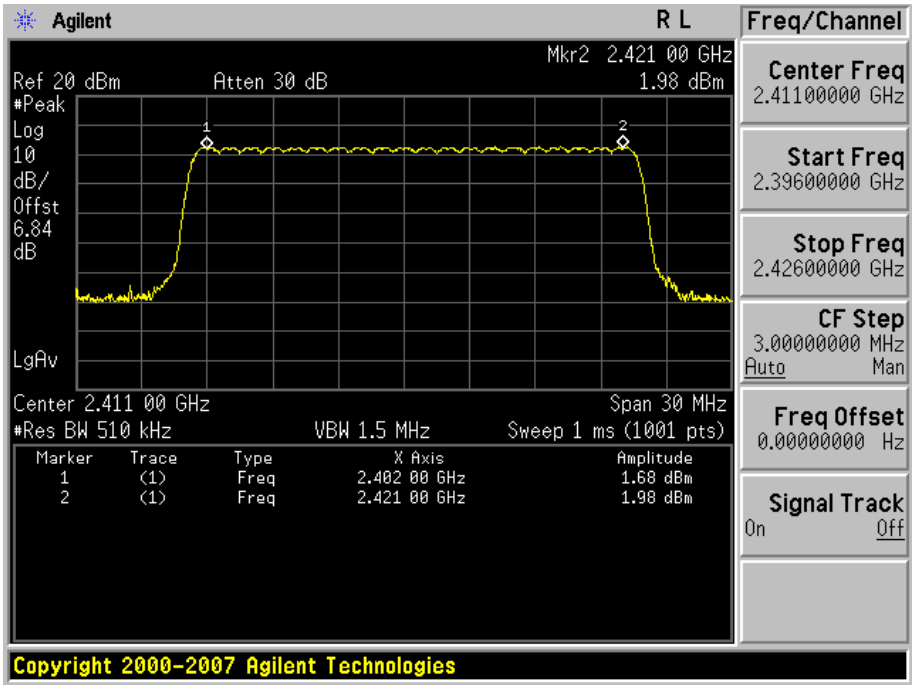

**Number of Hopping Frequencies 2(FH)** ***Hopping mode: Enable & 8DPSK***



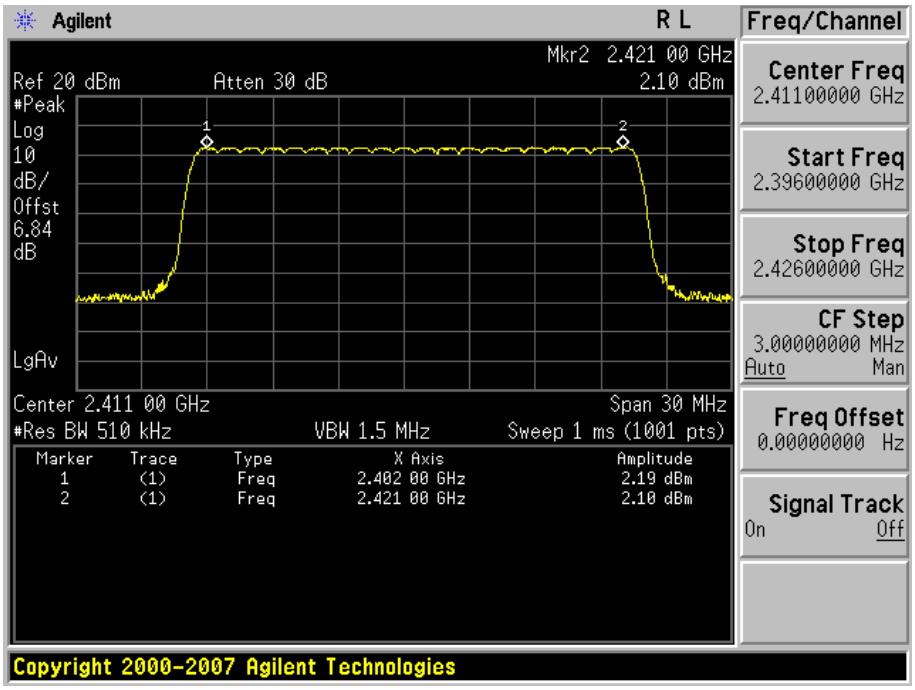
**Number of Hopping Frequencies 1(AFH)** ***Hopping mode: Enable &GFSK***




**Number of Hopping Frequencies 1(AFH)** ***Hopping mode: Enable &π/4-DQPSK***



**Number of Hopping Frequencies 1(AFH)** ***Hopping mode: Enable & 8DPSK***



# 5. 20dBc BW

## 5.1. Test Setup

Refer to the APPENDIX I.

## 5.2. Limit

Limit: Not Applicable

## 5.3. Test Procedure

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

2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW ≥ 1% of the 20 dB bandwidth, VBW ≥RBW, Span = 3㎒.

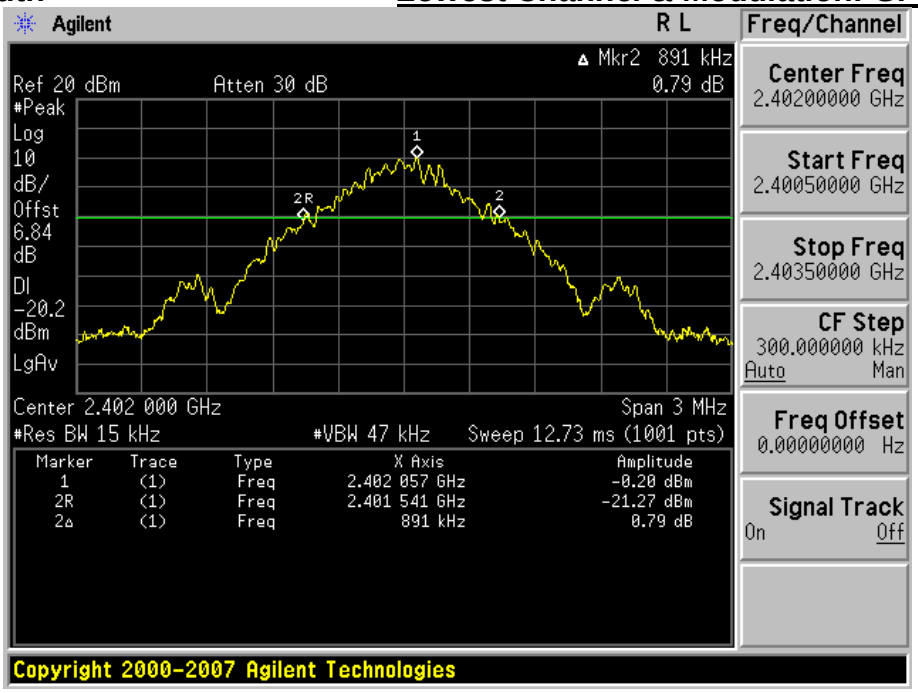
## 5.4. Test Results

Ambient temperature : 23°C
Relative humidity : 39%

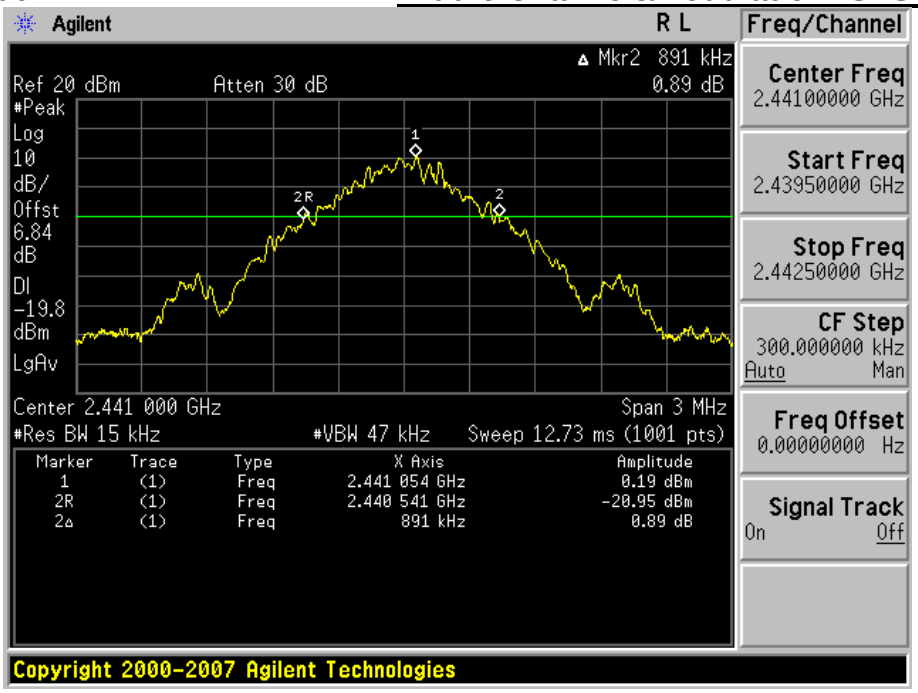
| Modulation | Tested Channel | 20dBc BW (MHz) |
|---|---|---|
| ***GFSK*** | **Lowest** | 0.891 |
| | **Middle** | 0.891 |
| | **Highest** | 0.891 |
| ***π/4DQPSK*** | **Lowest** | 1.344 |
| | **Middle** | 1.332 |
| | **Highest** | 1.341 |
| ***8DPSK*** | **Lowest** | 1.341 |
| | **Middle** | 1.323 |
| | **Highest** | 1.308 |

Note 1: See next pages for actual measured spectrum plots.

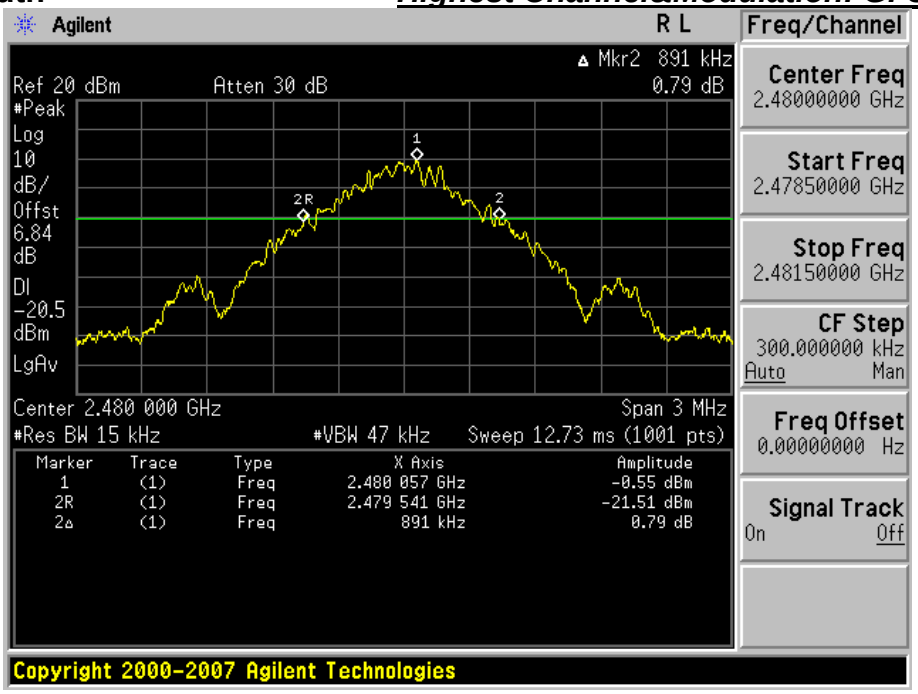
**20dBc Bandwidth** ***Lowest Channel & Modulation: GFSK***



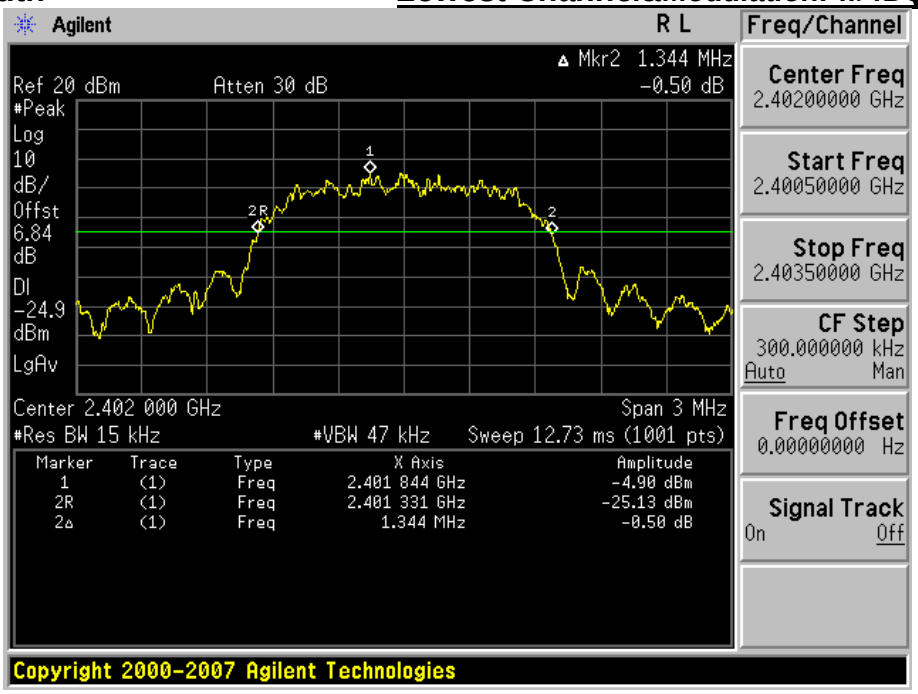

**20dBc Bandwidth** ***Middle Channel&Modulation: GFSK***



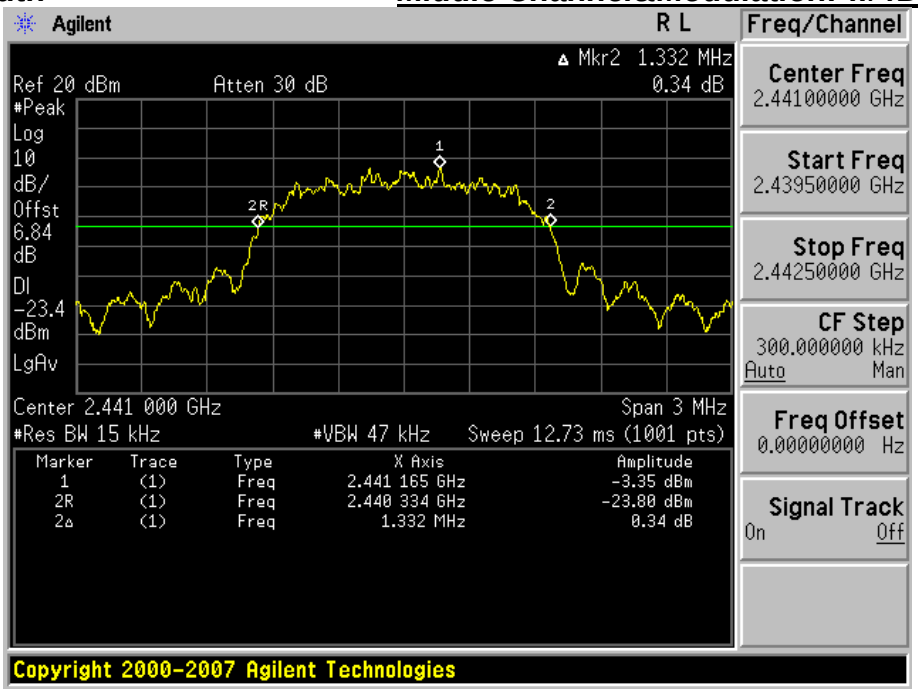
**20dBc Bandwidth** ***Highest Channel&Modulation: GFSK***



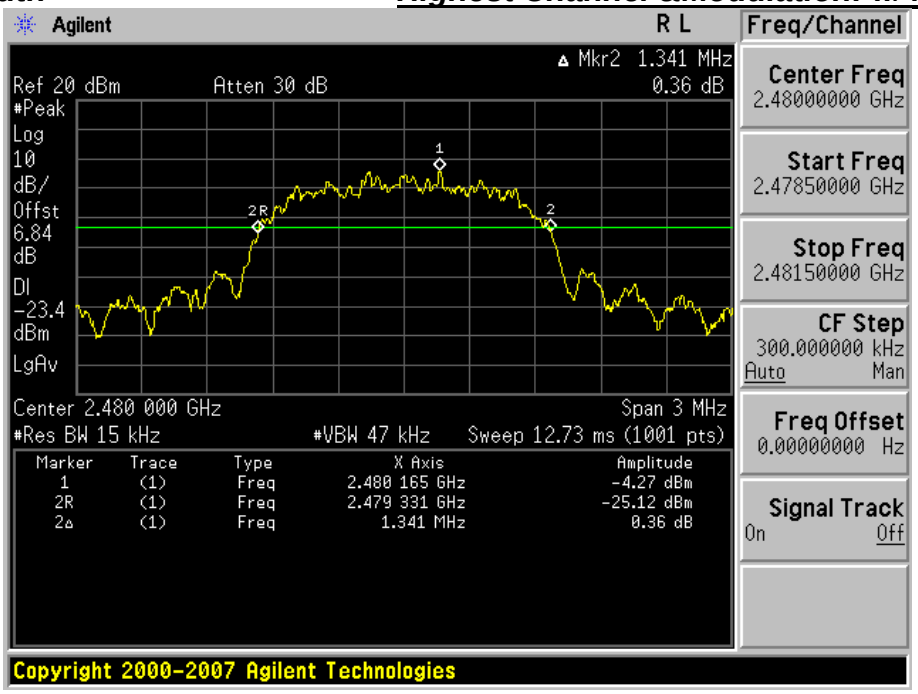

**20dBc Bandwidth** ***Lowest Channel&Modulation: π/4DQPSK***



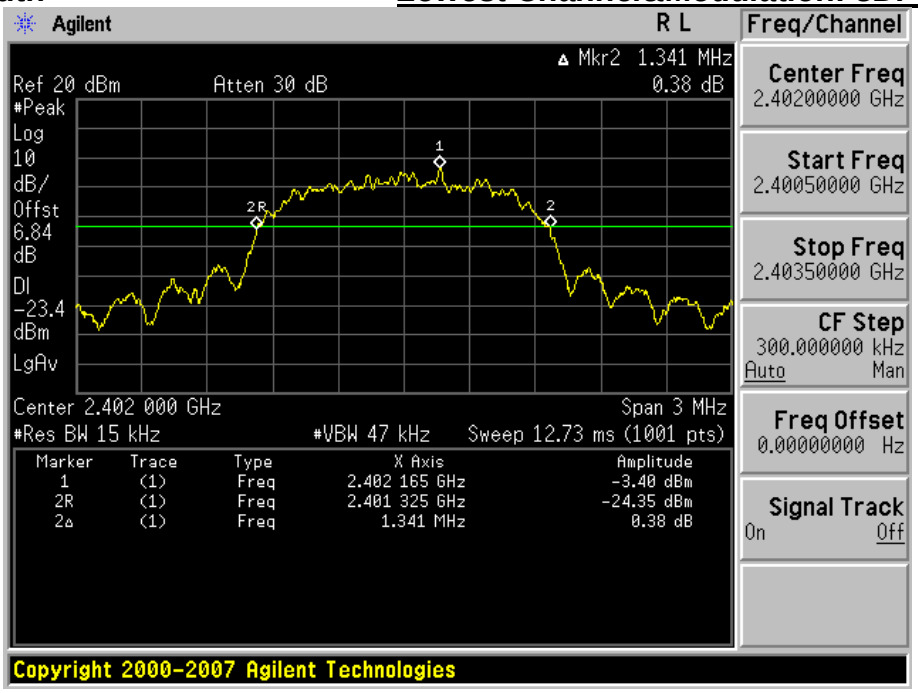
**20dBc Bandwidth** ***Middle Channel&Modulation: π/4DQPSK***



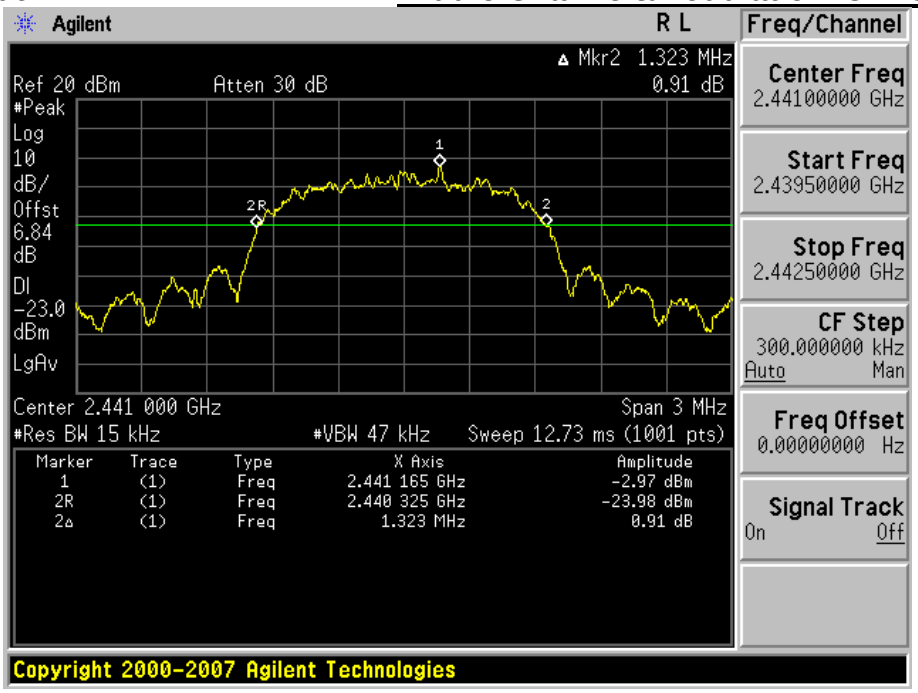

**20dBc Bandwidth** ***Highest Channel &Modulation: π/4DQPSK***



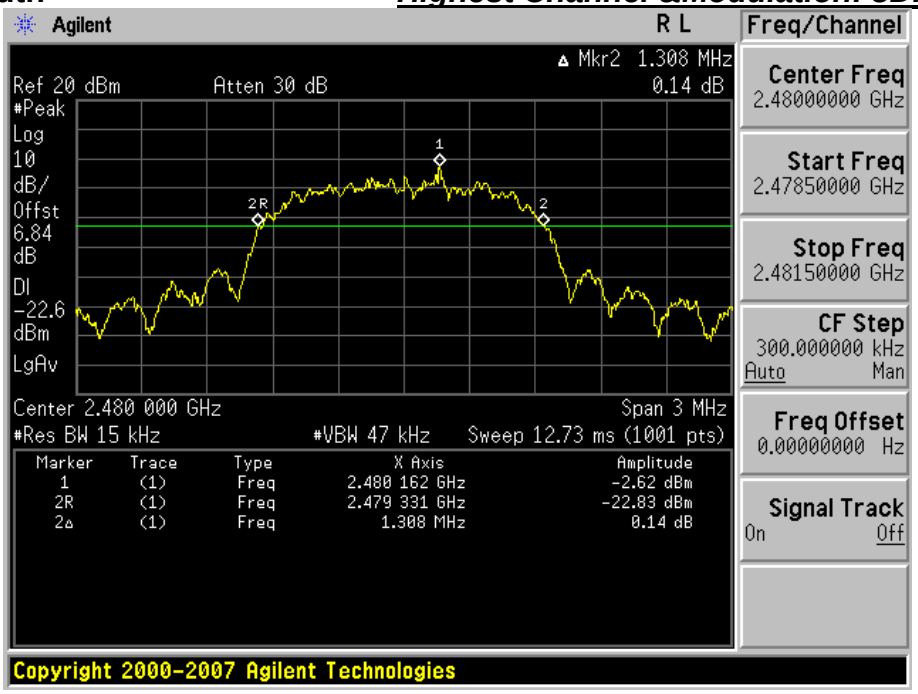
**20dBc Bandwidth** ***Lowest Channel&Modulation: 8DPSK***




**20dBc Bandwidth** ***Middle Channel&Modulation: 8DPSK***



**20dBc Bandwidth** ***Highest Channel &Modulation: 8DPSK***



# 6. Time of Occupancy (Dwell Time)

## 6.1. Test Setup

Refer to the APPENDIX I.

## 6.2. Limit

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

## 6.3. Test Procedure

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

The spectrum analyzer is set to:

Center frequency = 2441 MHz
Span = zero
RBW = 1 MHz
VBW = ≥ RBW
Trace = max hold
Detector function = peak

## 6.4. Test Results

Ambient temperature : 22°C
Relative humidity : 36 %

**- FH mode**

| Hopping mode | Packet Type | Number of hopping Channels | Burst On Time (ms) | Period (ms) | Test Result (sec) |
|---|---|---|---|---|---|
| Enable | DH 5 | 79 | 2.880 | 3.750 | 0.307 |
| | 2 DH 5 | 79 | 2.880 | 3.750 | 0.307 |
| | 3 DH 5 | 79 | 2.880 | 3.750 | 0.307 |

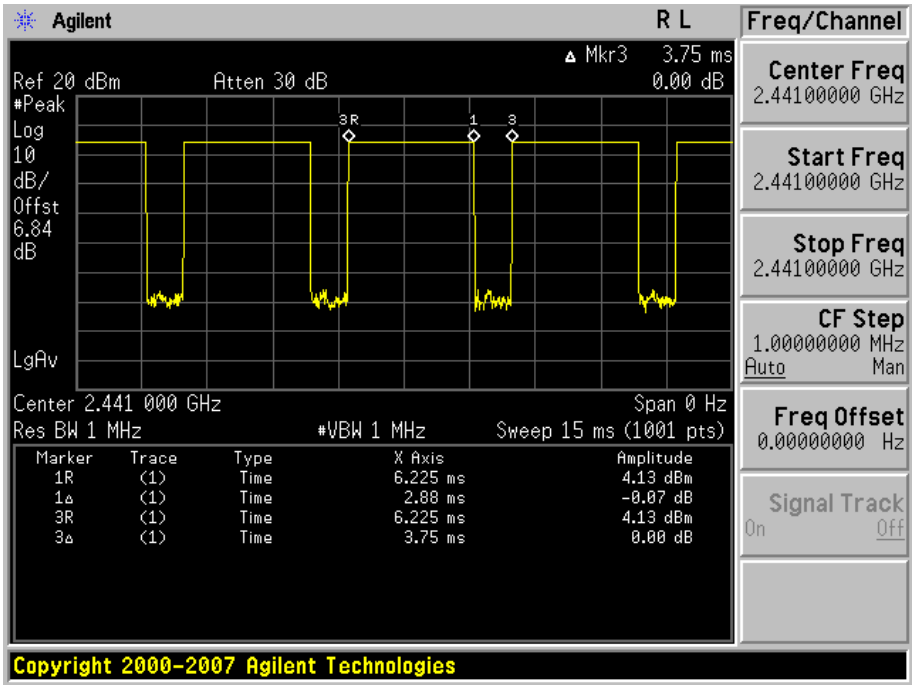
**- AFH mode**

| Hopping mode | Packet Type | Number of hopping Channels | Burst On Time (ms) | Period (ms) | Test Result (sec) |
|---|---|---|---|---|---|
| Enable | DH 5 | 20 | 2.880 | 3.750 | 0.154 |
| | 2 DH 5 | 20 | 2.880 | 3.750 | 0.154 |
| | 3 DH 5 | 20 | 2.880 | 3.750 | 0.154 |

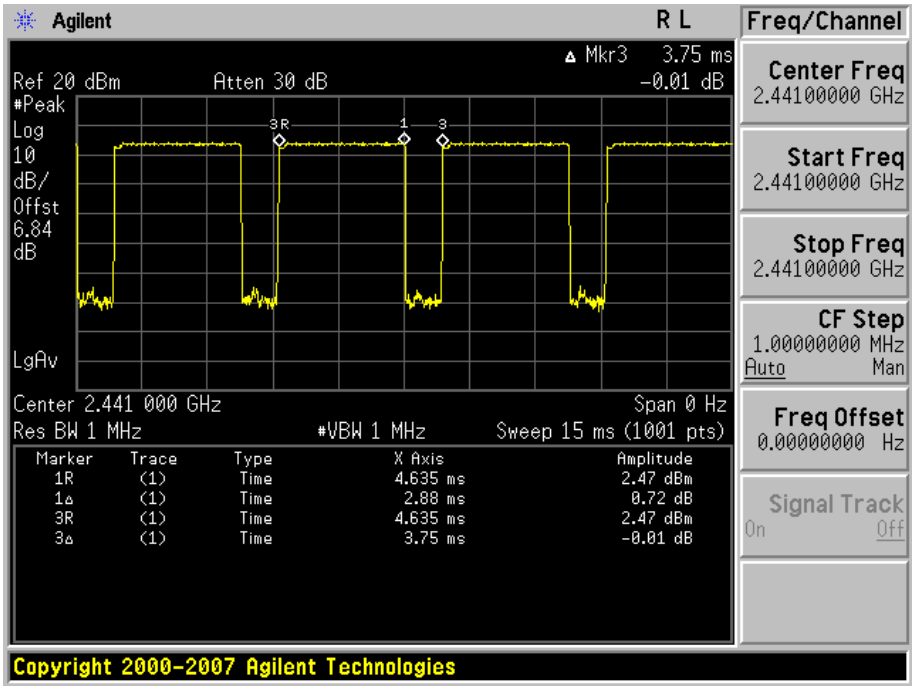
Note 1: Dwell Time = 0.4 × Hopping channel × Burst ON time × ((Hopping rate ÷ Time slots) ÷ Hopping channel)
- Time slots for DH5 = 6 slots(TX = 5 slot / RX = 1 slot)
- Hopping Rate = 1600 for FH mode & 800 for AFH mode

Note 2: See next pages for actual measured spectrum plots.

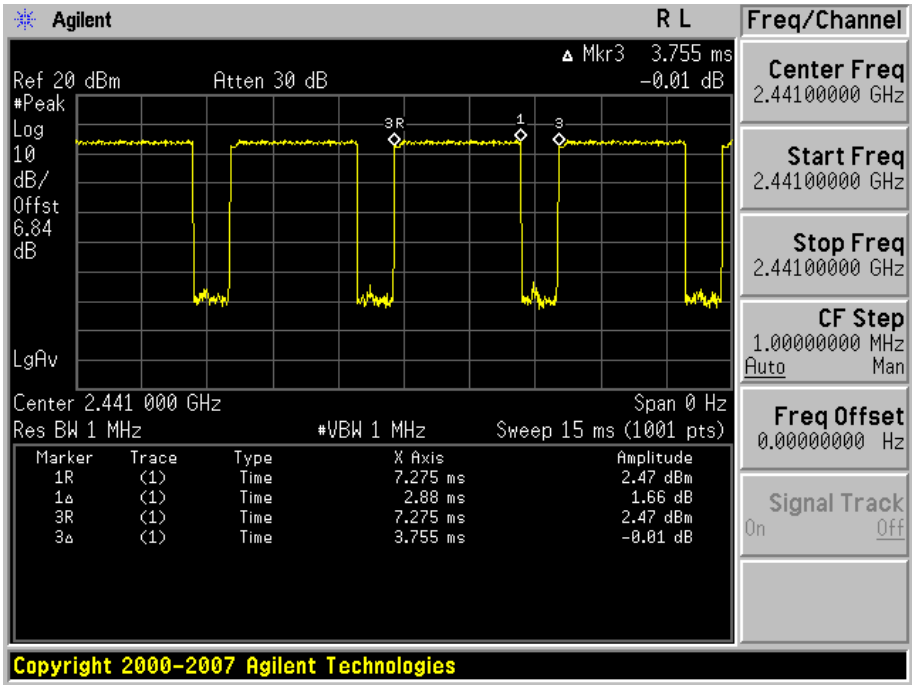
**Time of Occupancy (FH)** ***Hopping mode: Enable&GFSK***



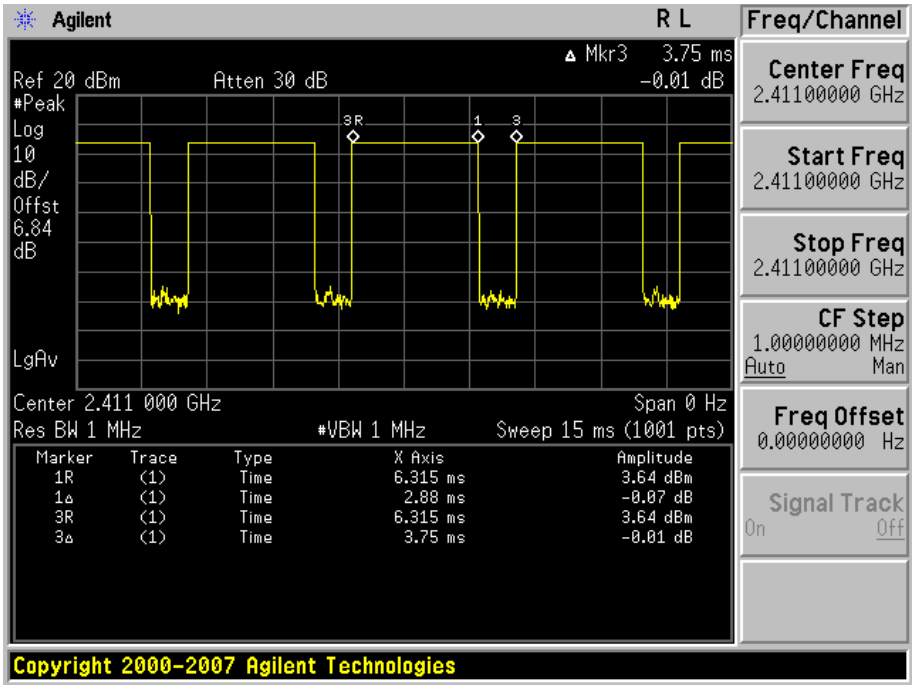

**Time of Occupancy (FH)** ***Hopping mode: Enable&π/4-DQPSK***



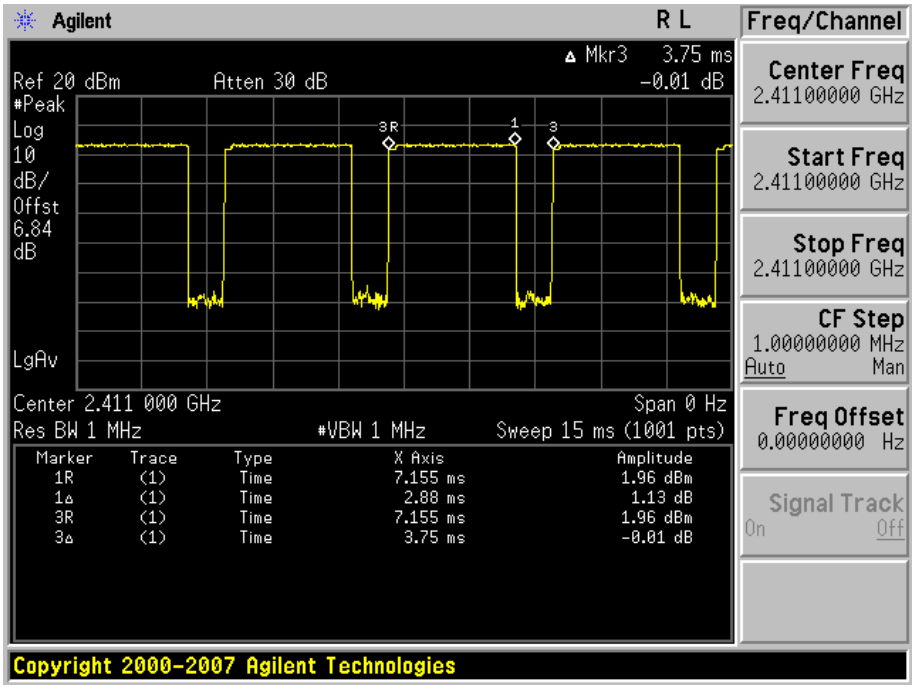
**Time of Occupancy (FH)** ***Hopping mode: Enable&8DPSK***



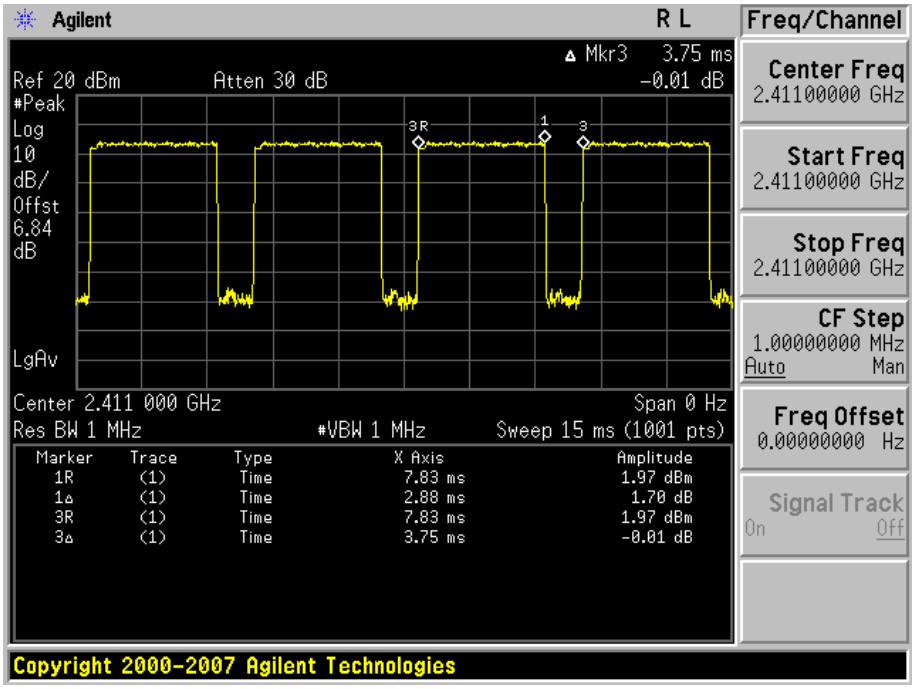
**Time of Occupancy (AFH)** ***Hopping mode: Enable&GFSK***




**Time of Occupancy (AFH)** ***Hopping mode: Enable&π/4-DQPSK***



**Time of Occupancy (AFH)** ***Hopping mode: Enable&8DPSK***



# 7. Maximum Peak Output Power Measurement

## 7.1. Test Setup

Refer to the APPENDIX I.

## 7.2. Limit

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

1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

2. §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 ㎒ band: 1 Watt.

## 7.3. Test Procedure

1. The RF power output was measured with a Spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.

2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using ;
   Span = approximately 5 times of the 20 ㏈bandwidth, centered on a hopping channel
   RBW ≥ 20㏈BW
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold

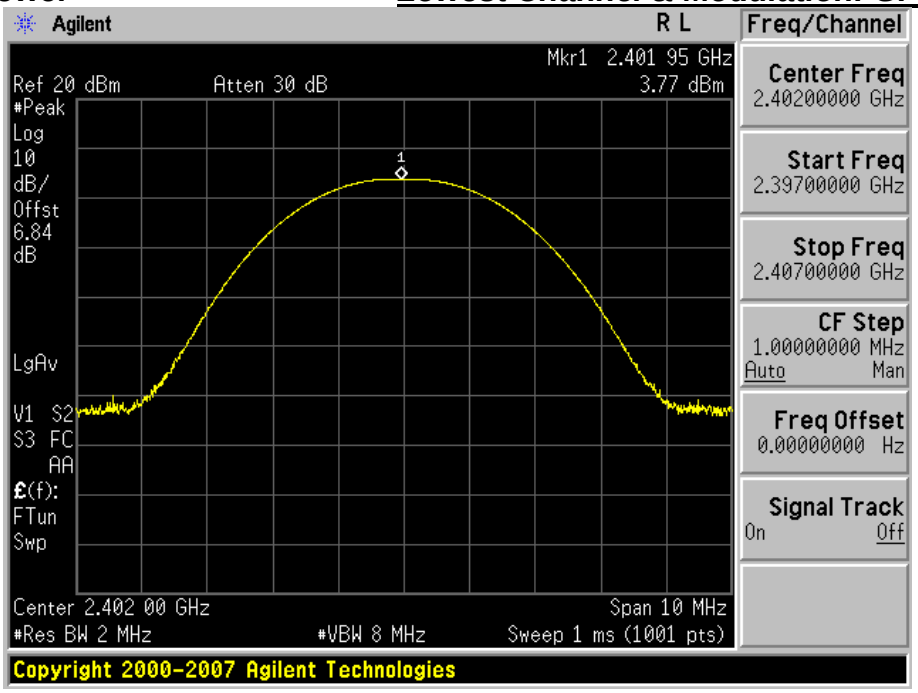
## 7.4. Test Results

Ambient temperature : 22°C
Relative humidity : 36 %

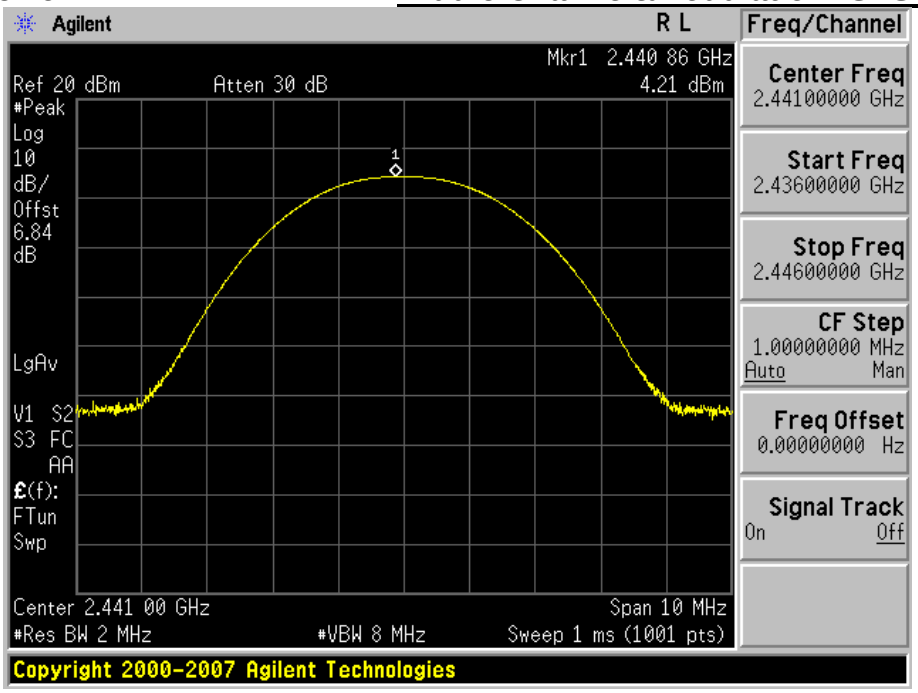
| Modulation | Tested Channel | Peak Output Power | |
|---|---|---|---|
| | | dBm | mW |
| ***GFSK*** | **Lowest** | 3.77 | 2.382 |
| | **Middle** | 4.21 | 2.636 |
| | **Highest** | 3.46 | 2.218 |
| ***π/4DQPSK*** | **Lowest** | 4.20 | 2.630 |
| | **Middle** | 4.68 | 2.938 |
| | **Highest** | 3.94 | 2.477 |
| ***8DPSK*** | **Lowest** | 4.80 | 3.020 |
| | **Middle** | **5.28** | **3.373** |
| | **Highest** | 4.54 | 2.844 |

Note 1: See next pages for actual measured spectrum plots.

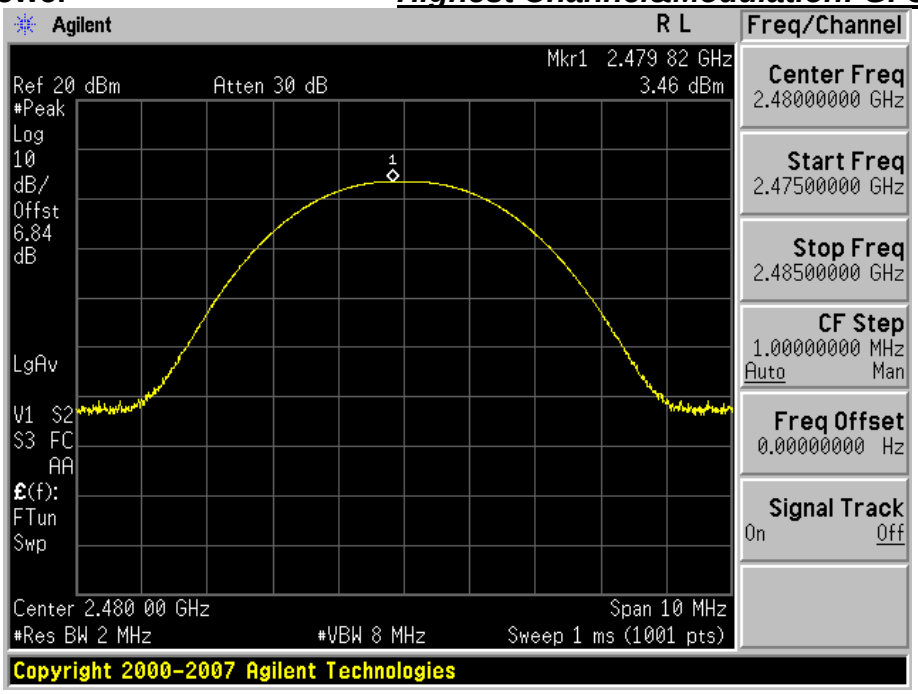
**Peak Output Power** ***Lowest Channel & Modulation: GFSK***



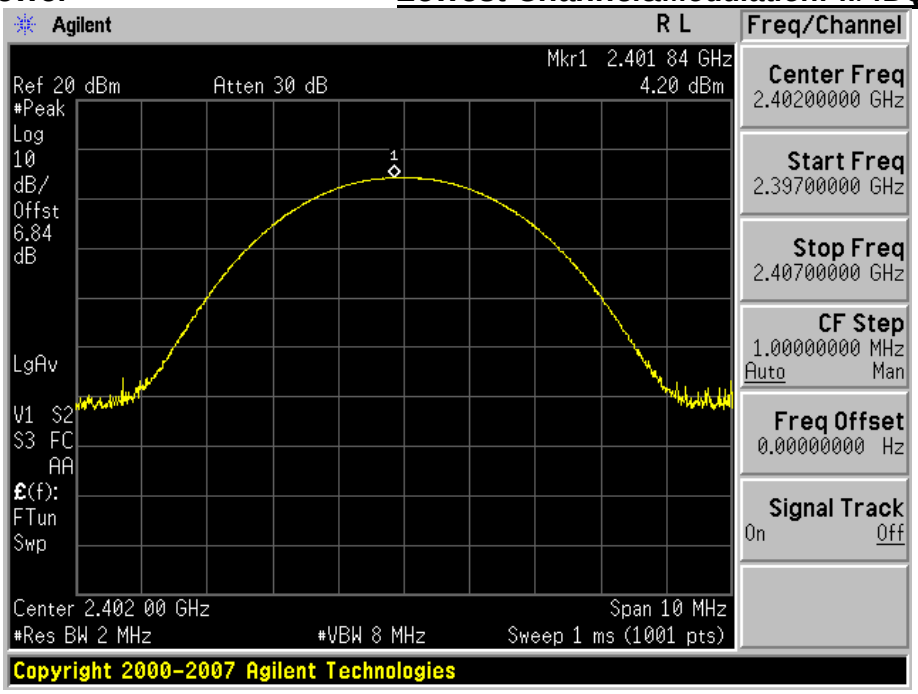

**Peak Output Power** ***Middle Channel&Modulation: GFSK***



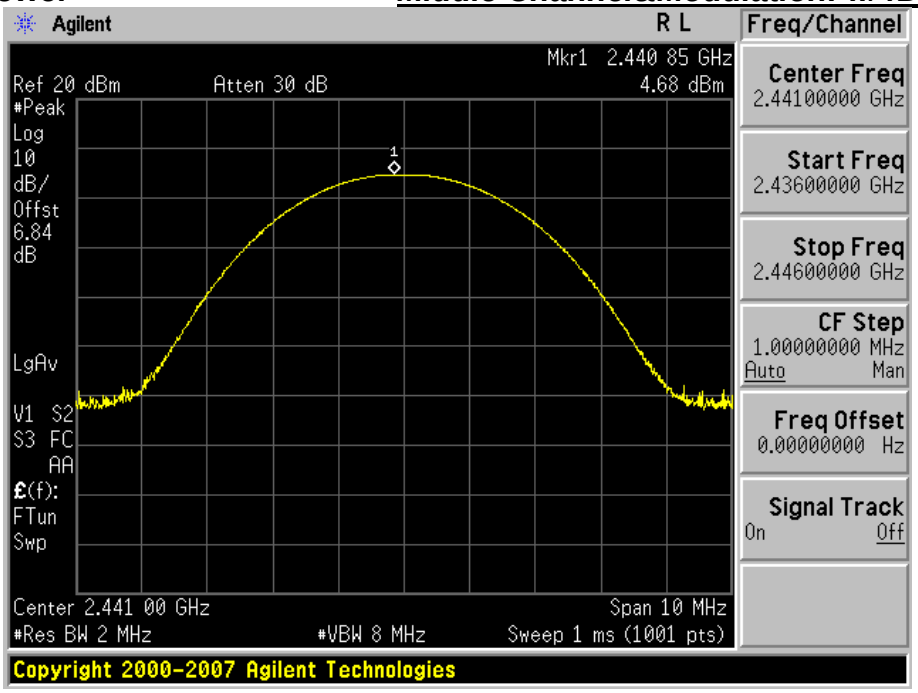
**Peak Output Power** ***Highest Channel&Modulation: GFSK***



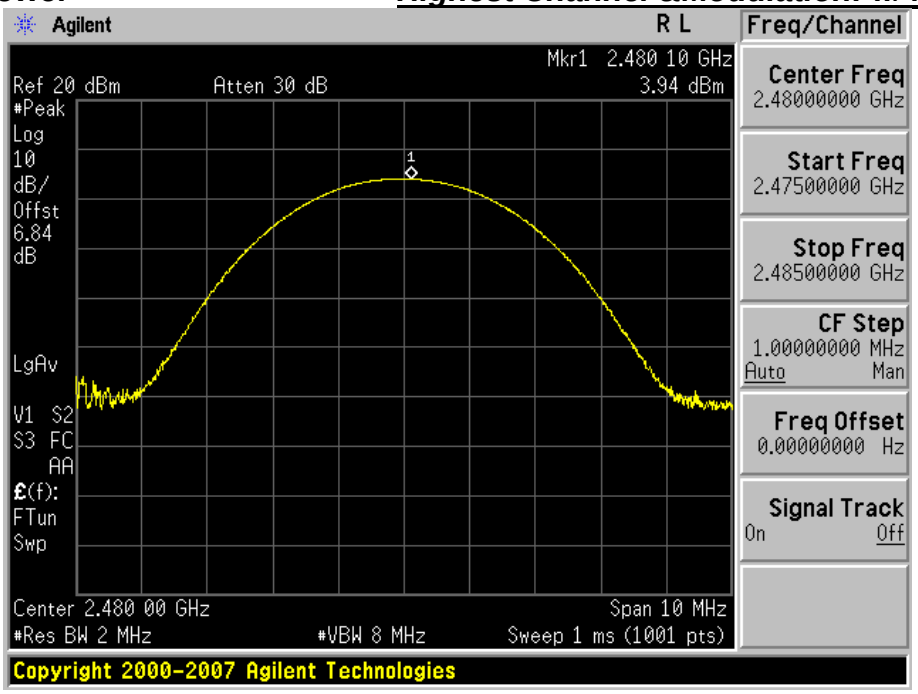

**Peak Output Power** ***Lowest Channel&Modulation: π/4DQPSK***



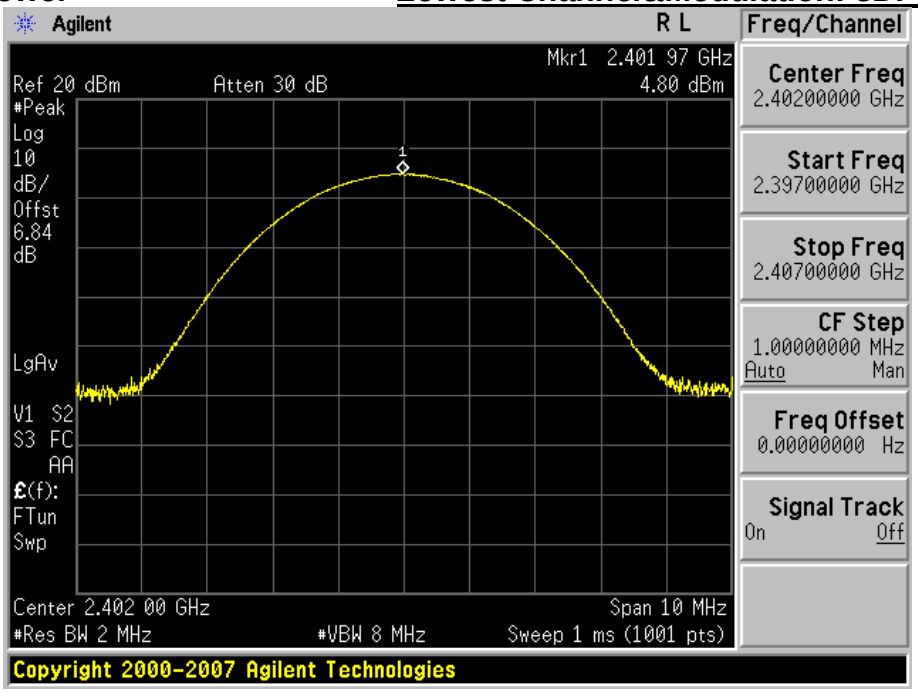
**Peak Output Power** ***Middle Channel&Modulation: π/4DQPSK***



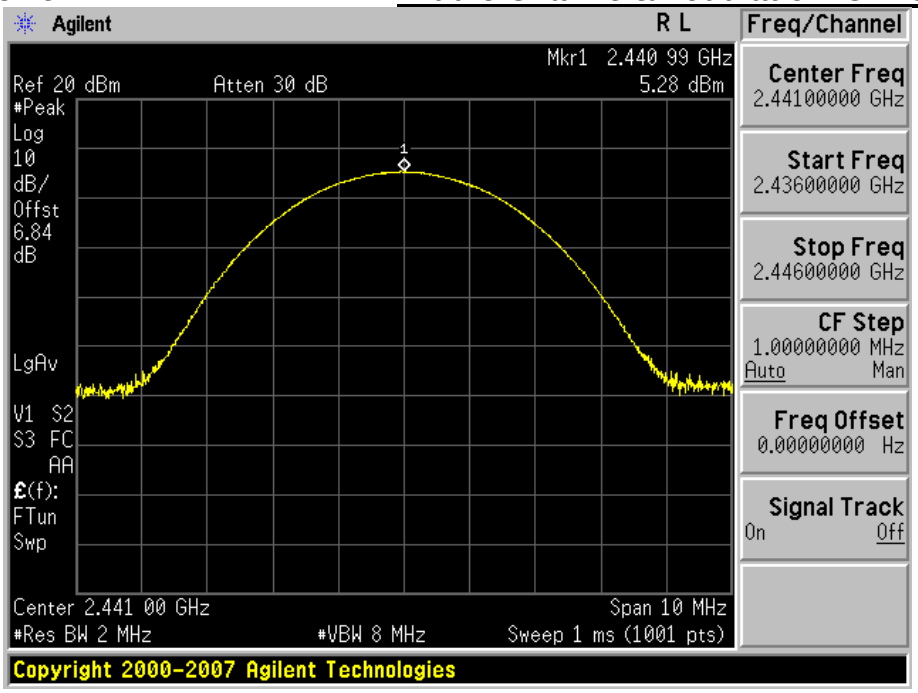

**Peak Output Power** ***Highest Channel &Modulation: π/4DQPSK***



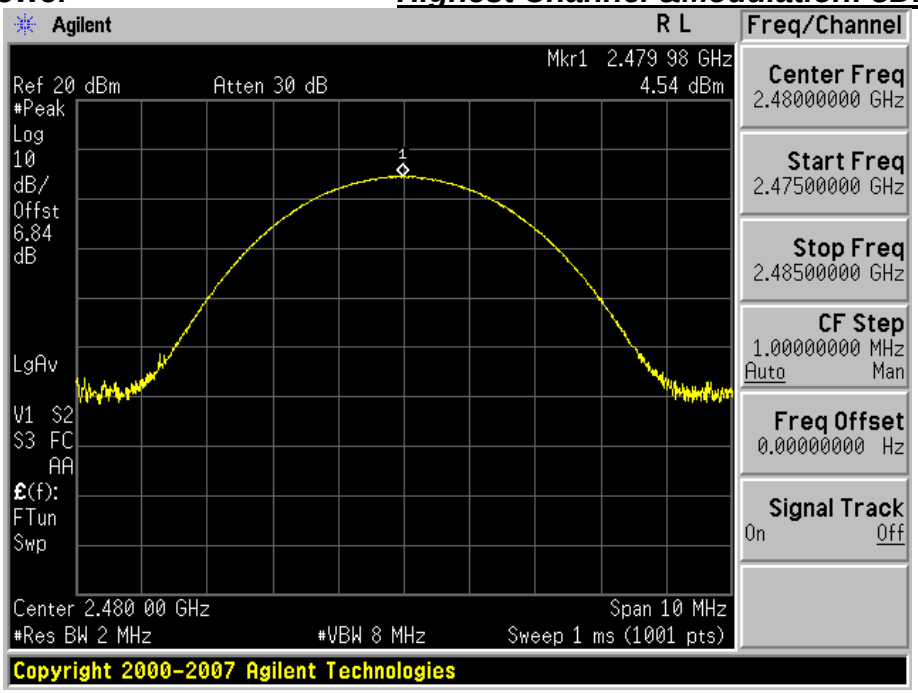
**Peak Output Power** ***Lowest Channel&Modulation: 8DPSK***




**Peak Output Power** ***Middle Channel&Modulation: 8DPSK***



**Peak Output Power** ***Highest Channel &Modulation: 8DPSK***



# 8. Transmitter AC Power Line Conducted Emission

## 8.1. Test Setup

Refer to test setup photo.

## 8.2. Limit

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

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

* Decreases with the logarithm of the frequency

## 8.3. Test Procedures

Conducted emissions from the EUT were measured according to the ANSI C63.10-2009

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

## 8.4. Test Results

**AC Line Conducted Emissions (Graph)**&Modulation: ***GFSK***

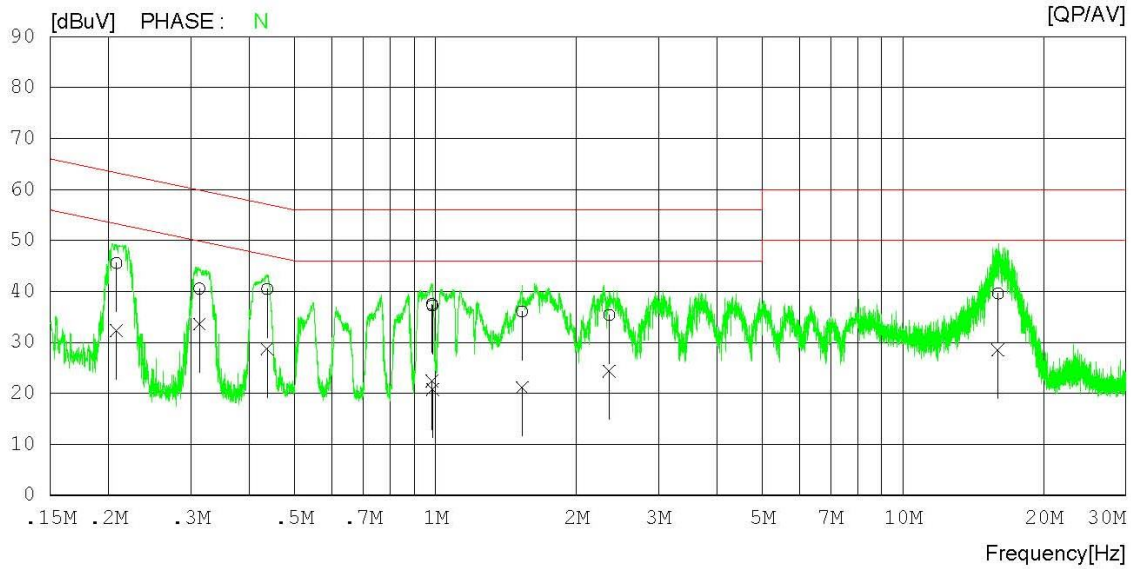
# Results of Conducted Emission

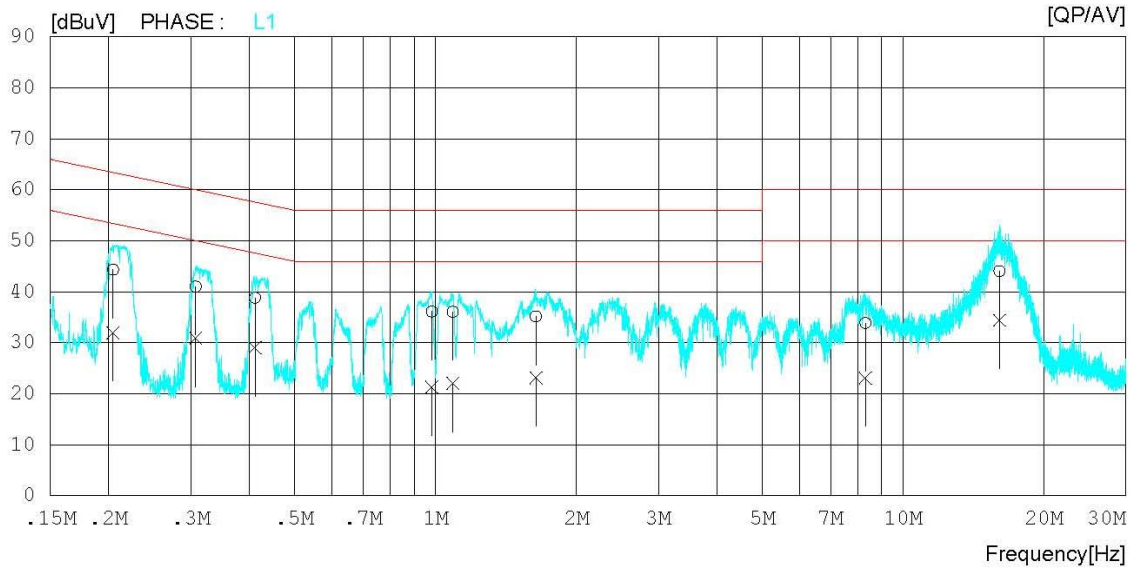
Date : 2014-08-20

| | | | | | |
|---|---|---|---|---|---|
| Model No. | : | NAUTIZ X8 | Referrence No | : | |
| Type | : | | Power Supply | : | 120V 60Hz |
| Serial No. | : | | Temp/Humi. | : | 21'C 39 % R.H |
| Test Condition | : | BT | Operator | : | H.S SON |

Memo : Hopping Mode

LIMIT : FCC P15.207 QP
FCC P15.207 AV



**AC Line Conducted Emissions (List)**&Modulation: ***GFSK***

# Results of Conducted Emission

Date : 2014-08-20

| | | | | | |
|---|---|---|---|---|---|
| Model No. | : | NAUTIZ X8 | Referrence No. | : | |
| Type | : | | Power Supply | : | 120V 60Hz |
| Serial No. | : | | Temp/Humi. | : | 21'C 39 % R.H |
| Test Condition | : | BT | Operator | : | H.S.SON |

Memo : Hopping Mode

LIMIT : FCC P15.207 QP
FCC P15.207 AV

| NO | FREQ | READING QP | READING AV | C.FACTOR | RESULT QP | RESULT AV | LIMIT QP | LIMIT AV | MARGIN QP | MARGIN AV | PHASE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | [MHz] | [dBuV] | [dBuV] | [dB] | [dBuV] | [dBuV] | [dBuV] | [dBuV] | [dBuV] | [dBuV] | |
| 1 | 0.20774 | 35.6 | 22.4 | 9.9 | 45.5 | 32.3 | 63.3 | 53.3 | 17.8 | 21.0 | N |
| 2 | 0.31244 | 30.6 | 23.7 | 9.9 | 40.5 | 33.6 | 59.9 | 49.9 | 19.4 | 16.3 | N |
| 3 | 0.43637 | 30.5 | 18.8 | 9.9 | 40.4 | 28.7 | 57.1 | 47.1 | 16.7 | 18.4 | N |
| 4 | 0.98250 | 27.6 | 12.5 | 9.9 | 37.5 | 22.4 | 56.0 | 46.0 | 18.5 | 23.6 | N |
| 5 | 0.98500 | 27.3 | 10.9 | 9.9 | 37.2 | 20.8 | 56.0 | 46.0 | 18.8 | 25.2 | N |
| 6 | 1.53100 | 26.1 | 11.1 | 10.0 | 36.1 | 21.1 | 56.0 | 46.0 | 19.9 | 24.9 | N |
| 7 | 2.35280 | 25.4 | 14.4 | 10.0 | 35.4 | 24.4 | 56.0 | 46.0 | 20.6 | 21.6 | N |
| 8 | 15.97160 | 29.3 | 18.2 | 10.3 | 39.6 | 28.5 | 60.0 | 50.0 | 20.4 | 21.5 | N |
| 9 | 0.20423 | 34.4 | 22.1 | 9.9 | 44.3 | 32.0 | 63.4 | 53.4 | 19.1 | 21.4 | L1 |
| 10 | 0.30702 | 31.1 | 21.0 | 9.9 | 41.0 | 30.9 | 60.1 | 50.1 | 19.1 | 19.2 | L1 |
| 11 | 0.41093 | 28.9 | 19.1 | 9.9 | 38.8 | 29.0 | 57.6 | 47.6 | 18.8 | 18.6 | L1 |
| 12 | 0.98230 | 26.2 | 11.4 | 9.9 | 36.1 | 21.3 | 56.0 | 46.0 | 19.9 | 24.7 | L1 |
| 13 | 1.08880 | 26.2 | 12.1 | 9.9 | 36.1 | 22.0 | 56.0 | 46.0 | 19.9 | 24.0 | L1 |
| 14 | 1.63960 | 25.2 | 13.1 | 10.0 | 35.2 | 23.1 | 56.0 | 46.0 | 20.8 | 22.9 | L1 |
| 15 | 8.31260 | 23.7 | 12.9 | 10.2 | 33.9 | 23.1 | 60.0 | 50.0 | 26.1 | 26.9 | L1 |
| 16 | 16.08180 | 33.8 | 24.1 | 10.3 | 44.1 | 34.4 | 60.0 | 50.0 | 15.9 | 15.6 | L1 |

# 9. Antenna Requirement

▣ **Procedure:**

Describe how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT.

▣ **Conclusion: Comply**

**The internal antenna is attached on the main PCB using the special spring tension. (Refer to Internal Photo file.)**

▣ **Minimum Standard:**

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.

# 10. Occupied Bandwidth (99%)

**- Procedure: (RSS-Gen Issue 3)**
- The 99% power bandwidth was measured with a calibrated spectrum analyzer.
- Spectrum analyzer plots are included on the following pages.

**- Measurement Data: Comply**

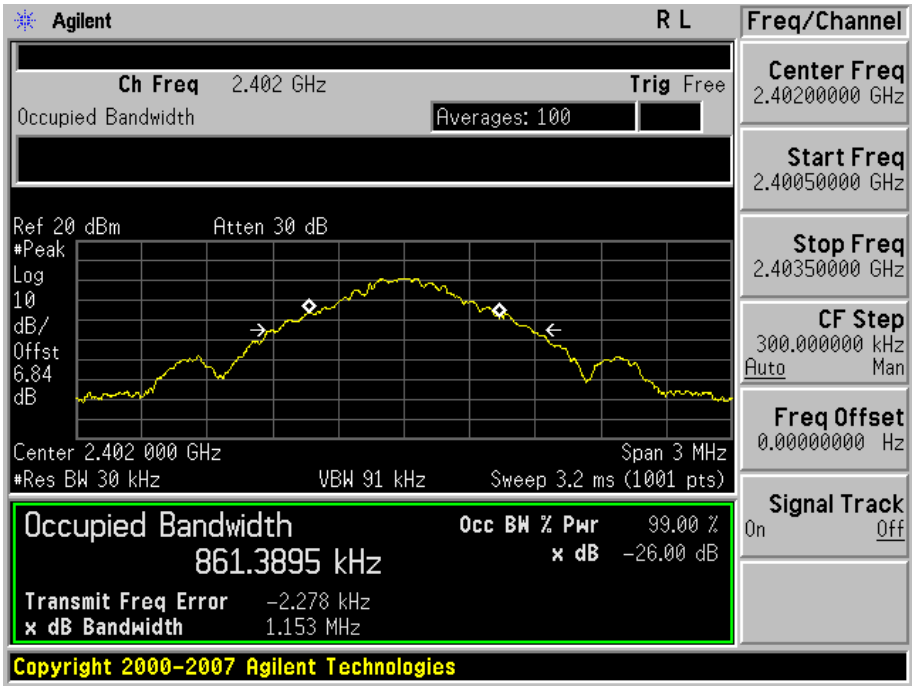
| Test Mode | Tested Channel | Test Results (MHz) |
|---|---|---|
| GFSK | Lowest | 0.861 |
| | Middle | 0.853 |
| | Highest | 0.854 |
| π/4-DQPSK | Lowest | 1.196 |
| | Middle | 1.200 |
| | Highest | 1.203 |
| 8DPSK | Lowest | 1.205 |
| | Middle | 1.215 |
| | Highest | 1.218 |

Note 1: See next pages for actual measured spectrum plots.

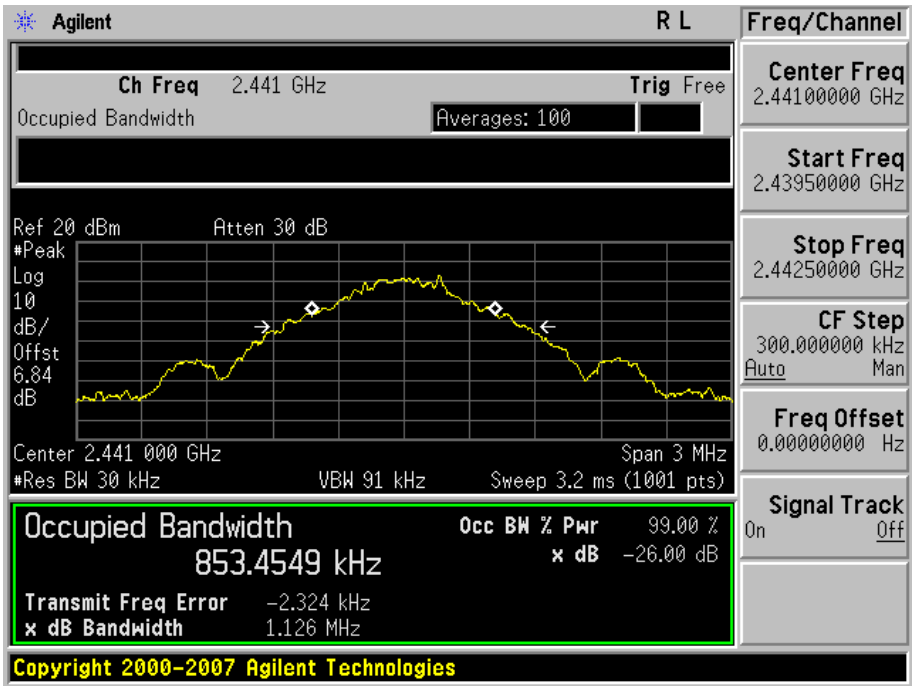
- **Minimum Standard:**

| |
|---|
| NA |

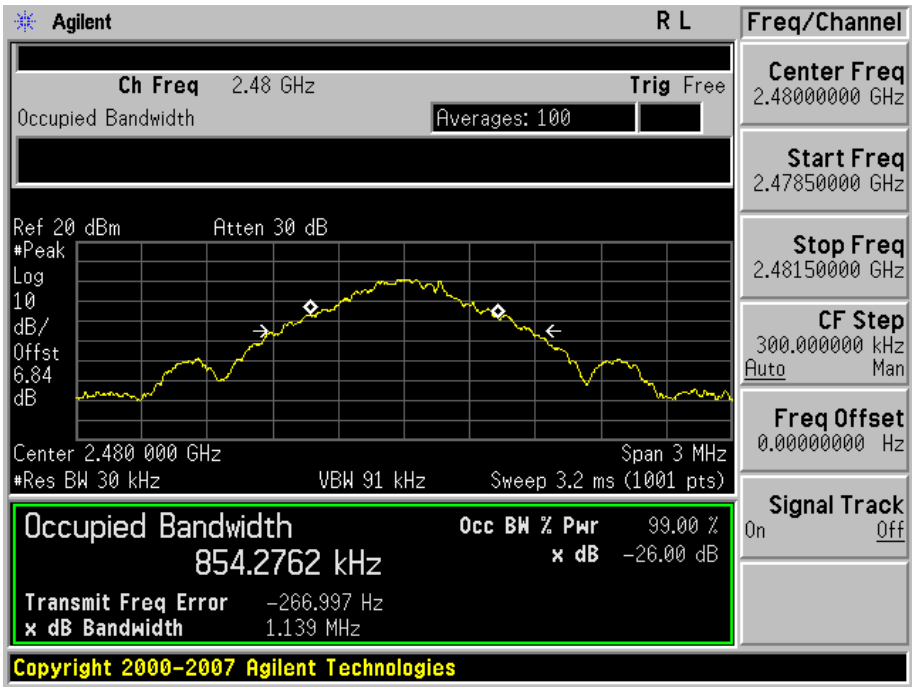
**Occupied Bandwidth (99%)** Lowest Frequency & GFSK



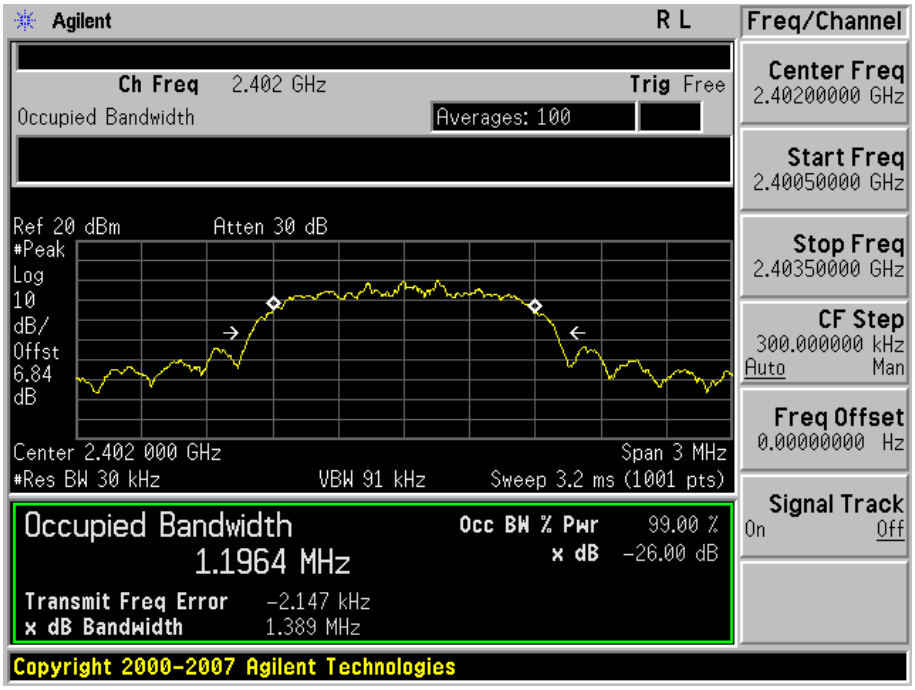

**Occupied Bandwidth (99%)** Middle Frequency & GFSK



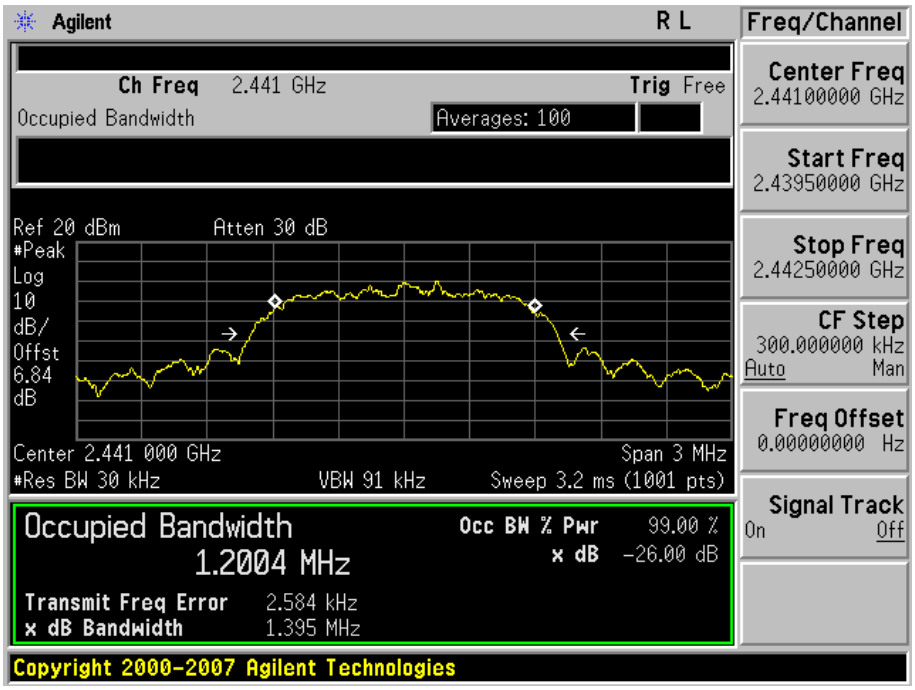
**Occupied Bandwidth (99%)** Highest Frequency & GFSK



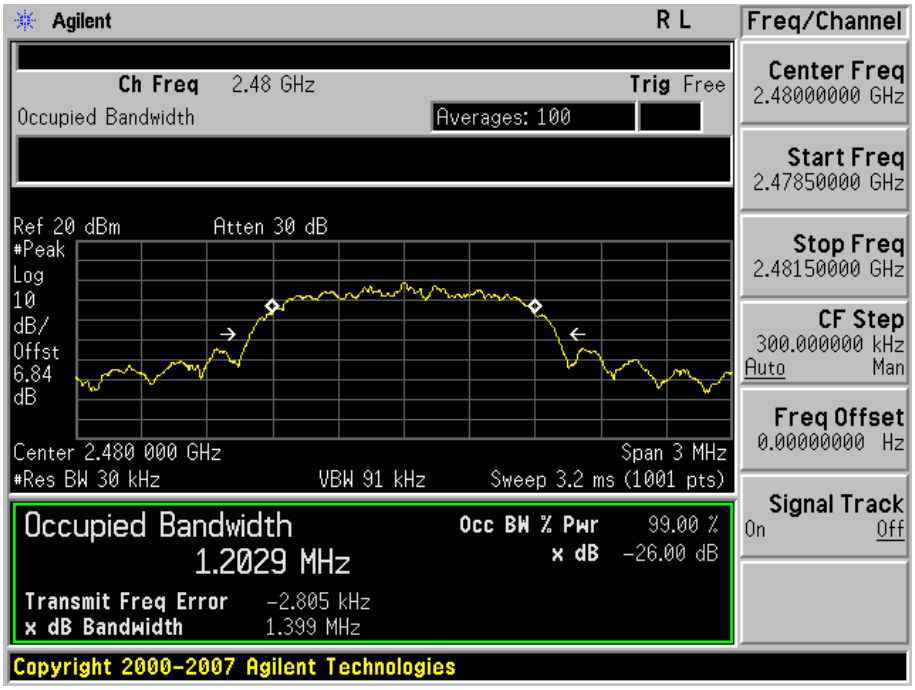
**Occupied Bandwidth (99%)** Lowest Frequency & π/4-DQPSK



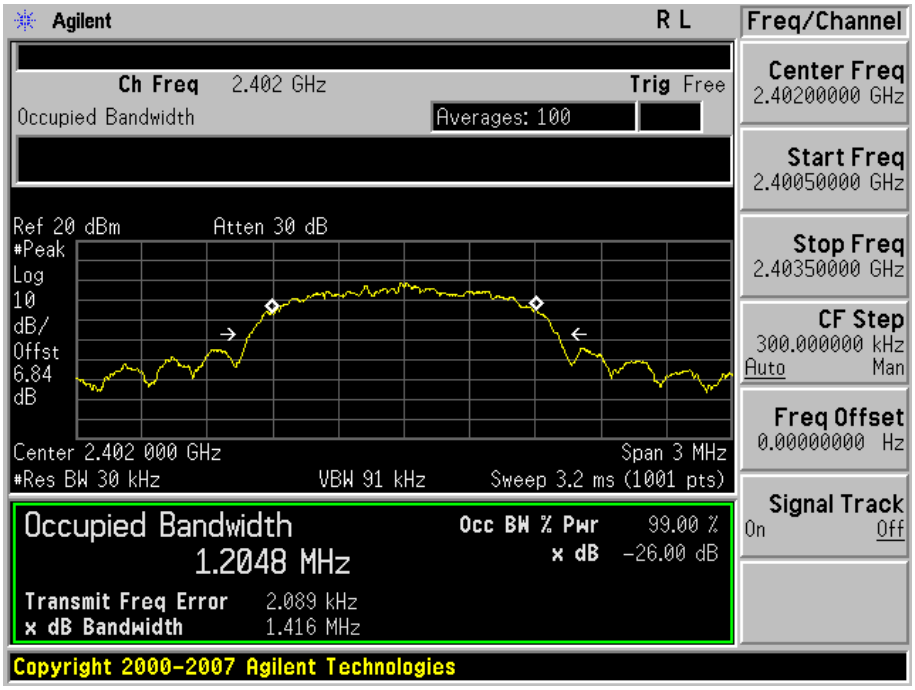

**Occupied Bandwidth (99%)** Middle Frequency & π/4-DQPSK



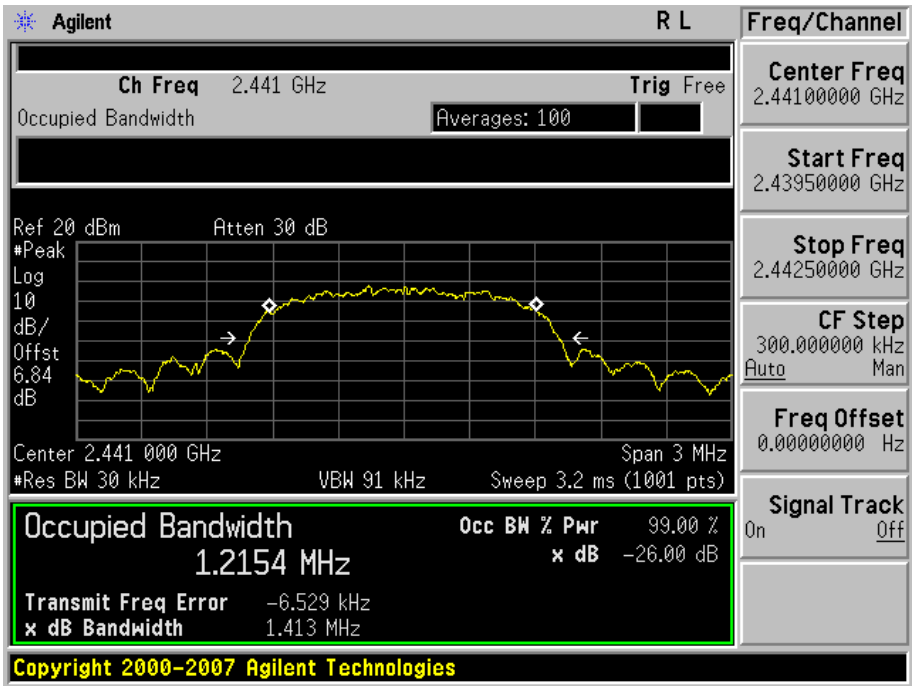
**Occupied Bandwidth (99%)** Highest Frequency & π/4-DQPSK



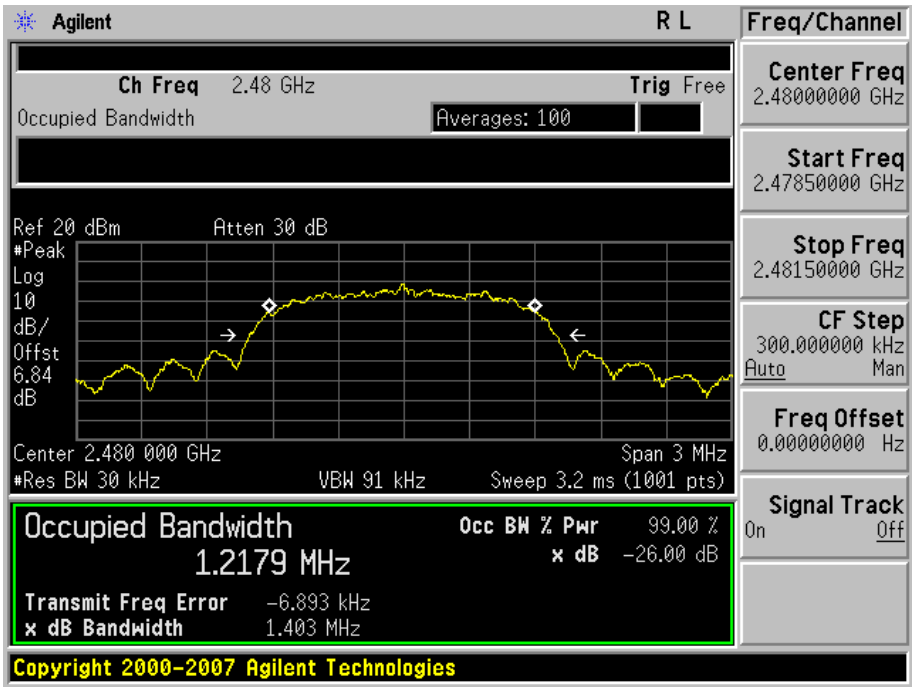
**Occupied Bandwidth (99%)** Lowest Frequency & 8DPSK




**Occupied Bandwidth (99%)** Middle Frequency & 8DPSK



**Occupied Bandwidth (99%)** Highest Frequency & 8DPSK

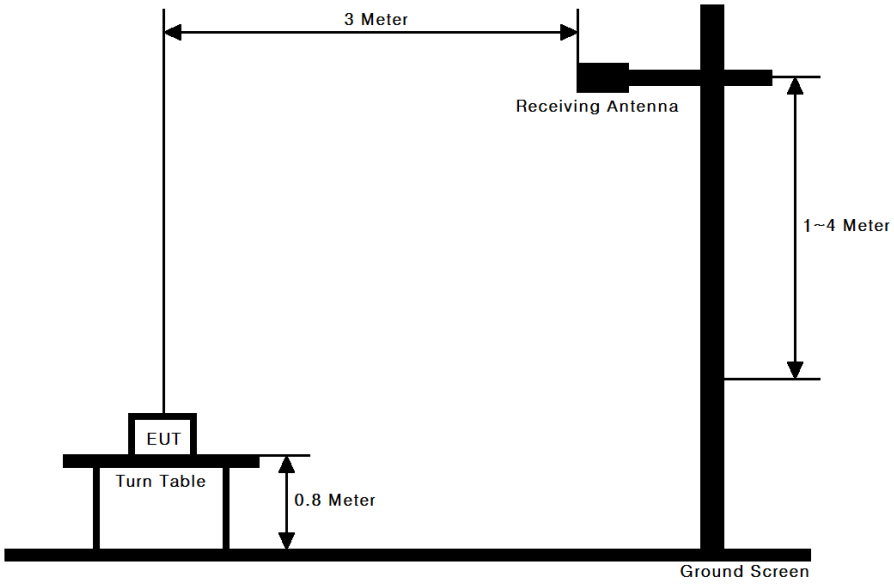


# APPENDIX I

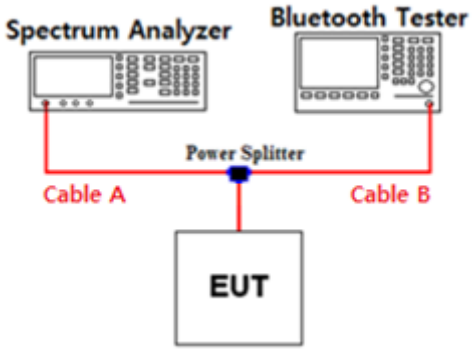
## Test set up Diagrams&Path lossInformation

### ▪Radiated Measurement

The diagram below shows the test setup that is utilized to make the measurements for emission from 9kHz to 25GHz Emissions.




### ▪Conducted Measurement




**Path loss information**

| Frequency (GHz) | Path Loss (dB) | Frequency (GHz) | Path Loss (dB) |
|---|---|---|---|
| 0.03 | 6.51 | 15 | 8.55 |
| 1 | 6.69 | 20 | 9.53 |
| 2.402 & 2.441 & 2.480 | 6.84 | 25 | 11.00 |
| 5 | 7.13 | - | - |
| 10 | 7.69 | - | - |

Note. 1: The path loss from EUT to Spectrum analyzer were measured and used for test.
Path loss ( = S/A's Correction factor) = Cable A + Power splitter