

## **2.4 GHz Bluetooth Radio Test Report (FHSS)**

**For  
CP-8821 IP Phone with**

**2.4GHz / 5.0GHz Wi-Fi Radio 802.11a/ac/b/g/n + Bluetooth v3.0**

**FCC ID:** LDK88211296  
**IC ID:** 2461B-88211296

**Against the following Specifications:**

**47 CFR 15.247**

**47 CFR 15.209**

**47 CFR 15.205**

**RSS-Gen issue 4**

**RSS-247 issue 1**

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**Revision:** See EDCS

This report replaces any previously entered test report under EDCS – **875270**. This test report has been electronically authorized and archived using the CISCO Engineering Document Control system. Test Report Template EDCS# 1526148



**SECTION 1: OVERVIEW ..... 3**

1.1 TEST SUMMARY ..... 3

**SECTION 2: ASSESSMENT INFORMATION ..... 5**

2.1 GENERAL ..... 5

2.2 UNITS OF MEASUREMENT ..... 5

2.3 DATE OF TESTING (INITIAL SAMPLE RECEIPT DATE TO LAST DATE OF TESTING) ..... 7

2.4 REPORT ISSUE DATE ..... 7

2.5 TESTING FACILITIES ..... 7

2.6 EQUIPMENT ASSESSED (EUT) ..... 7

2.7 EUT DESCRIPTION ..... 8

**SECTION 3: RESULT SUMMARY ..... 9**

**SECTION 4: SAMPLE DETAILS ..... 11**

4.1 SAMPLE DETAILS ..... 11

4.2 ANTENNA INFORMATION ..... 11

4.3 MODE OF OPERATION DETAILS ..... 11

4.4 TEST MODE, MODULATION AND DATA PACKET TYPE DESCRIPTION ..... 11

**APPENDIX A: CONDUCTED TEST RESULTS ..... 12**

**A.1 20DB BANDWIDTH ..... 12**

A.1.1 LIMITS ..... 12

A.1.2 TEST PROCEDURE ..... 12

A.1.3 20DB BANDWIDTH DATA TABLE ..... 13

A.1.4 20DB BANDWIDTH GRAPHICAL TEST RESULTS ..... 13

**A.2 MAXIMUM PEAK CONDUCTED OUTPUT POWER ..... 23**

A.2.1 LIMITS ..... 23

A.2.3 TEST PROCEDURE ..... 23

A.2.4 MAXIMUM PEAK CONDUCTED OUTPUT POWER DATA TABLE ..... 24

A.2.5 MAXIMUM PEAK CONDUCTED OUTPUT POWER GRAPHICAL TEST RESULTS ..... 28

**A.3 CARRIER FREQUENCY SEPARATION ..... 37**

A.3.1 LIMITS ..... 37

A.3.2 TEST PROCEDURE ..... 37

A.3.3 CARRIER FREQUENCY SEPARATION DATA TABLE ..... 37

A.3.4 CARRIER FREQUENCY SEPARATION GRAPHICAL RESULTS ..... 38

**A.4 NUMBER OF HOPPING FREQUENCIES ..... 39**

A.4.1 LIMITS ..... 39

A.4.2 TEST PROCEDURES ..... 39

A.4.3 NUMBER OF HOPPING FREQUENCIES DATA TABLE ..... 39

A.4.3 NUMBER OF HOPPING FREQUENCIES GRAPHICAL TEST RESULTS ..... 40

**A.5 AVERAGE TIME OF OCCUPANCY ..... 41**

A.5.1 LIMITS ..... 41

A.5.2 TEST PROCEDURE ..... 41



A.5.3	AVERAGE TIME OF OCCUPANCY AND DWELL TIME DATA TABLE .....	42
A.5.4	AVERAGE TIME OF OCCUPANCY, DWELL TIME GRAPHICAL TEST RESULTS & CALCULATION .....	43
<b>A.6</b>	<b>CONDUCTED BAND EDGE .....</b>	<b>52</b>
A.6.1	LIMITS .....	52
A.6.2	TEST PROCEDURE .....	52
A.6.3	CONDUCTED BAND EDGE GRAPHICAL TEST RESULTS .....	53
<b>A.7</b>	<b>RESTRICTED BANDS .....</b>	<b>59</b>
A.7.1	LIMITS .....	59
A.7.2	TEST PROCEDURE .....	59
A.7.3	RESTRICTED BANDS TEST DATA .....	60
A.7.4	RESTRICTED BANDS GRAPHICAL TEST RESULTS.....	61
<b>APPENDIX B:</b>	<b>RADIATED TEST RESULTS .....</b>	<b>63</b>
<b>B.1</b>	<b>TRANSMITTER SPURIOUS EMISSIONS &amp; RESTRICTED BANDS .....</b>	<b>63</b>
B.1.1	LIMITS .....	64
B.1.2	TEST PROCEDURE .....	65
B.1.3	TRANSMITTER RADIATED SPURIOUS EMISSIONS GRAPHICAL DATA RESULTS .....	66
<b>B.2</b>	<b>RECEIVER SPURIOUS EMISSIONS .....</b>	<b>73</b>
B.2.1	LIMITS .....	73
B.2.2	TEST PROCEDURE .....	74
B.2.3	RECEIVER SPURIOUS EMISSIONS GRAPHICAL DATA RESULTS .....	75
<b>B.3</b>	<b>AC POWER LINE CONDUCTED EMISSIONS .....</b>	<b>77</b>
B.3.1	LIMITS .....	77
B.3.2	TEST PROCEDURE .....	78
B.3.3	RECORDED TEST DATA AND GRAPHICAL TEST RESULTS.....	80
<b>APPENDIX C:</b>	<b>LIST OF TEST EQUIPMENT USED TO PERFORM THE TEST .....</b>	<b>82</b>
<b>APPENDIX D:</b>	<b>ABBREVIATION KEY AND DEFINITIONS .....</b>	<b>83</b>
<b>APPENDIX E:</b>	<b>SOFTWARE USED TO PERFORM TESTING .....</b>	<b>84</b>
<b>APPENDIX F:</b>	<b>TEST PROCEDURES .....</b>	<b>85</b>
<b>APPENDIX G:</b>	<b>SCOPE OF ACCREDITATION (A2LA CERTIFICATE NUMBER 1178-01).....</b>	<b>86</b>
<b>APPENDIX H:</b>	<b>TEST ASSESSMENT PLAN.....</b>	<b>87</b>
<b>APPENDIX I:</b>	<b>WORST CASE JUSTIFICATION .....</b>	<b>87</b>

## **Section 1: Overview**

### **1.1 Test Summary**

**The samples were assessed against the tests detailed in section 3 under the requirements of the following specifications:**



Specifications
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FCC 15.247 RSS-247 Issue 1: May 2015 RSS-Gen Issue 4: Nov 2015
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**Notes:** Measurements were made in accordance with FCC docket #: DA 00-0705, ET docket 96-8 measurement method of spurious emission tolerance to the International Telecommunication Union (ITU) Recommendation SM329.

## **Section 2: Assessment Information**

### **2.1 General**

This report contains an assessment of an apparatus against Radio Standards based upon tests carried out on the samples submitted. The testing was performed by and for the use of Cisco systems Inc:

With regard to this assessment, the following points should be noted:

- a) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.
- b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.
- c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).
- d) All testing was performed under the following environmental conditions:
  - Temperature 15°C to 35°C (54°F to 95°F)
  - Atmospheric Pressure 860mbar to 1060mbar (25.4" to 31.3")
  - Humidity 10% to 75\*%
- e) All AC testing was performed at one or more of the following supply voltages:
  - 110V 60 Hz (+/-20%)

### **2.2 Units of Measurement**

The units of measurements defined in the appendices are reported in specific terms, which are test dependent. Where radiated measurements are concerned these are defined at a particular distance. Basic voltage measurements are defined in units of [dBuV]

As an example, the basic calculation for all measurements is as follows:

Emission level [dBuV] = Indicated voltage level [dBuV] + Cable Loss [dB] + Other correction factors [dB]

The combinations of correction factors are dependent upon the exact test configurations [see test equipment lists for further details] and may include:-

Antenna Factors, Pre Amplifier Gain, LISN Loss, Pulse Limiter Loss and Filter Insertion Loss..

Note: to convert the results from dBuV/m to uV/m use the following formula:-

Level in uV/m = Common Antilogarithm [(X dBuV/m)/20] = Y uV/m

### **Measurement Uncertainty Values**



voltage and power measurements	± 2 dB
conducted EIRP measurements	± 1.4 dB
radiated measurements	± 3.2 dB
frequency measurements	± 2.4 10 <sup>-7</sup>
temperature measurements	± 0.54°.
humidity measurements	± 2.3%
DC and low frequency measurements	± 2.5%.

Where relevant measurement uncertainty levels have been estimated for tests performed on the apparatus. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

**Radiated emissions (expanded uncertainty, confidence interval 95%)**

30 MHz - 300 MHz	+/- 3.8 dB
300 MHz - 1000 MHz	+/- 4.3 dB
1 GHz - 10 GHz	+/- 4.0 dB
10 GHz - 18GHz	+/- 8.2 dB
18GHz - 26.5GHz	+/- 4.1 dB
26.5GHz - 40GHz	+/- 3.9 dB

**Conducted emissions (expanded uncertainty, confidence interval 95%)**

30 MHz – 40GHz	+/- 0.38 dB
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A product is considered to comply with a requirement if the nominal measured value is below the limit line. The product is considered to not be in compliance in case the nominal measured value is above the limit line.

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**2.3 Date of testing (Initial sample receipt date to last date of testing)**

September 08 2015 to June 27, 2016

**2.4 Report Issue Date**

Cisco uses an electronic system to issue, store and control the revision of test reports. This system is called the Engineering Document Control System (EDCS). The actual report issue date is embedded into the original file on EDCS. Any copies of this report, either electronic or paper, that are not on EDCS must be considered uncontrolled

**2.5 Testing facilities**

This assessment was performed by:

**Testing Laboratories**

Cisco Systems, Inc.  
125 West Tasman Drive (Building P)  
San Jose, CA 95134  
USA

**Headquarters**

Cisco Systems, Inc.  
170 West Tasman Drive  
San Jose, CA 95134  
USA

**Registration Numbers for Industry Canada**

Cisco System Site	Address	Site Identifier
Building P, 10m Chamber	125 West Tasman Dr San Jose, CA 95134	Company #: 2461N-2
Building P, 5m Chamber	125 West Tasman Dr San Jose, CA 95134	Company #: 2461N-1
Building I, 5m Chamber	285 W. Tasman Drive San Jose, California 95134	Company #: 2461M-1
Building N, 5m Chamber	125 Rio Robles San Jose, California 95134	Company #: 6111A

**Test Engineer**

Dann Le

**2.6 Equipment Assessed (EUT)**

CP-8821

## 2.7 EUT Description

The **CP-8821** is the next generation IP Phone with Wi-Fi (802.11a/ac/b/g/n) and Bluetooth module support. The specification is applied to IEEE802.11a/ac/b/g/n + Bluetooth Basic rate/ EDR

Here is a brief summary of the Heracles hardware:

- IEEE 802.11 a/b/g/n/ac compliant wireless LAN
- USB 2.0/OTG interface (Shared with docking connector)
- 2.4-inch TFT LCD display, with 240 x 320 pixels, 16M colors
- Capacitive standard 12-key backlit keypad, 2 soft keys, volume and ringer control hard keys, mute hard key, speakerphone hard key, push-to-talk hard key, dedicated end call button (shared with power-on and off function) and send/dial button, 5-way joystick/navigation keys
- 512MB LPDDR2 RAM, 4GB eMMC flash storage, version4.41
- 2020 mAh removable standard battery
- Ring, Wireless low signal, battery condition and MWI LED
- Shared antenna for 802.11a/b/g/n/ac and Bluetooth Basic rate /EDR.
- Separate ringer and voice speaker
- 3.5 mm headset interface
- Vibrate alert support
- Two Digital Microphone & Two loud speaker Interface
- Audio codec support, MP3, WAV, AAC etc.
- IP67 certified water and dust proof.





### Section 3: Result Summary

#### Conducted emissions

Basic Standard	Technical Requirements / Details	Result
FCC 15.247 RSS-247	<b>20 dB Bandwidth:</b> The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped, between upper and Lower Frequency from top carrier (dBc) down.	Pass
FCC 15.247 RSS-247	<b>Maximum Peak Conducted Output Power:</b> 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 watt. For all other frequency Hopping systems in the 2400-2483.5 MHz band: 0.125 Watt.	Pass
FCC 15.247 RSS-247	<b>Carrier Frequency Separation:</b> For frequency hopping systems according to a hopping channel carrier Frequencies that are separated by 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.	Pass
FCC 15.247 RSS-247	<b>No. of Hopping Frequencies / Time Occupancy:</b> Frequency hopping systems in the 2400-2483.5 MHz band shall use at Least 15 Channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of Hopping channels employed.	Pass
FCC 15.247 RSS-247	<b>Conducted Band-Edge:</b> 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	Pass
FCC15.247/15.205 RSS-Gen 8.10	<b>Restricted band:</b> Unwanted emissions falling within the restricted bands, as defined in FCC 15.205 (a) and RSS-Gen 6.13 must also comply with the radiated emission limits specified in FCC 15.209 (a) and RSS-Gen 8.10	Pass

#### Conducted emissions (continue)



Basic Standard	Technical Requirements / Details	Result
<p><b>FCC15.207</b></p> <p><b>RSS-Gen 8.8</b></p>	<p><b>AC Power Line Conducted Emissions:</b>  <b>FCC:</b> (a) Except as shown in paragraphs (b) and (c) of this section, 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 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).  <b>RSS:</b> Except when the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply, either directly or indirectly (such as with battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits table 3 shown in section 8.8</p>	<p><b>Pass</b></p>

**Radiated Emissions**

Basic Standard	Technical Requirements / Details	Result
<p><b>FCC15.209/205</b></p> <p><b>RSS-Gen6.13/8.10</b></p>	<p><b>TX Spurious Emissions and Restricted Bands:</b>  The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the table specified in the table in FCC§15.209(a) and in RSS-Gen 8.9.</p>	<p><b>Pass</b></p>
<p><b>RSS-Gen 5.0</b></p>	<p><b>RX Spurious Emissions:</b>  Receivers are required to comply with the limits of spurious emissions as set out in this section. Receiver emission measurements are to be performed as per the normative test method referenced in Section 3.</p>	<p><b>Pass</b></p>



## Section 4: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing. Please also refer to the “Justification for worst Case test Configuration” section of this report for further details on the selection of EUT samples.

### 4.1 Sample Details

Sample No.	Equipment Details	Manufacturer	Hardware Rev.	Firmware Rev.	Software Rev.	Serial Number
S01 (Radiated)	CP-8821	Cisco Systems, Inc.	01	Sip8821.10-3-2HER-157 dev	Rootfs8821.10-3-2HER-157-dev	FCH192180BK
S02 (Conducted)	CP-8821	Cisco Systems, Inc.	01	Sip8821.10-2-1-HE1-3.1-diagnostics	Sip8821.10-2-1-HE1-3.1-diagnostics	FCH18528TEU

### 4.2 Antenna Information

The following antennas are supported by this product series.

Frequency (MHz)	Part Number	Antenna Type	Antenna Gain (dBi)
2400-2483.5	Internal	Monopole	2.4

### 4.3 Mode of Operation Details

Mode#	Description	Comments
1	Diagnostic	Diagnostic version allows to do conducted testing at antenna port of EUT. Image version : <b>Sip8821.10-2-1-HE1-3.1-diagnostics</b>

Measurements were made in accordance with

- ANSI C63.10:2013,
- Public Notice #: DA 00-0705

### 4.4 Test Mode, Modulation and Data Packet Type Description

Test Mode	Modulation	Data Packet
A	GFSK	DH1
B	$\pi/4$ -DQPSK	2-DH3
C	8-DPSK	3-DH1
<b>Note1:</b> Table above represents the worst case scenarios for all modulation and data packet type combinations.		

## **Appendix A: Conducted Test Results**

### **A.1 20dB Bandwidth**

The 20 dB emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 20 dB below the maximum in-band spectral density of the modulated signal

#### **A.1.1 Limits**

FCC 15.247, RSS- 247 5.1(1)

There is no limit for 20 dB bandwidth.

#### **A.1.2 Test Procedure**

Step 1:

- Edit the spectrum analyzer settings according to the parameters below.
  - Center Frequency: frequency under test
  - Span: approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
  - RBW:  $\geq 1\%$  of the 20 dB bandwidth
  - VBW:  $\geq$  RBW
  - Sweep: Auto Couple
  - Ref Level: 10dB (or higher if required)
  - Attenuation: 20dB (if required)
  - Detector: Peak
  - Trace Mode: Max Hold

Step 2:

- The EUT is set in a transmitter mode at its maximum data rate. Allow the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission. Then use the marker-normal function to place at the 20 dB down on one side of the emission. Reset with the marker-delta function and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. Record data.



**A.1.3 20dB Bandwidth Data Table**

20dB Bandwidth		
Packet Type	Frequency (MHz)	20dB BW (KHz)
<b>Modulation type : GFSK</b>		
DH5	2402	935 KHz
	2441	935 KHz
	2480	930 KHz
DH3	2402	930 KHz
	2441	935 KHz
	2480	930 KHz
DH1	2402	930 KHz
	2441	935 KHz
	2480	935 KHz
<b>Modulation type : <math>\pi/4</math>-DQPSK</b>		
2-DH5	2402	1340 KHz
	2441	1335 KHz
	2480	1335 KHz
2-DH3	2402	1340 KHz
	2441	1340 KHz
	2480	1345 KHz
2-DH1	2402	1350 KHz
	2441	1315 KHz
	2480	1350 KHz
<b>Modulation type : 8-DPSK</b>		
3-DH5	2402	1290 KHz
	2441	1315 KHz
	2480	1300 KHz
3-DH3	2402	1325 KHz
	2441	1320 KHz
	2480	1285 KHz
3-DH1	2402	1290 KHz
	2441	1315 KHz
	2480	1320 KHz

**A.1.4 20dB Bandwidth Graphical Test Results**

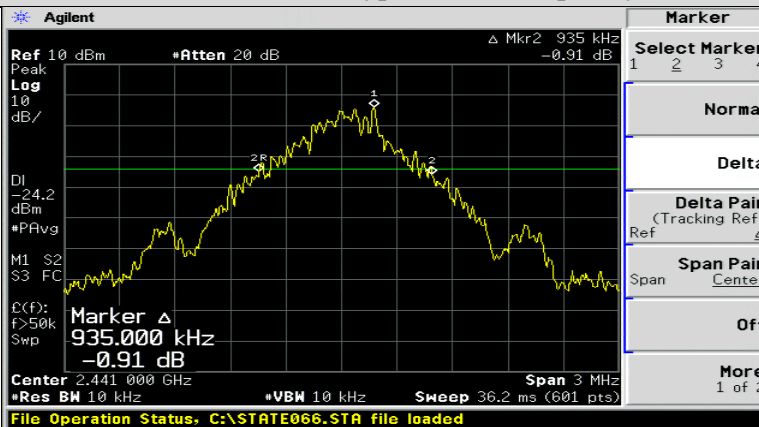


20dB Bandwidth Graphical Test Results

Modulation : GFSK / Packet Type: DH5 / Frequency: 2402 MHz



Modulation: GFSK / Packet Type: DH5 / Frequency: 2441 MHz

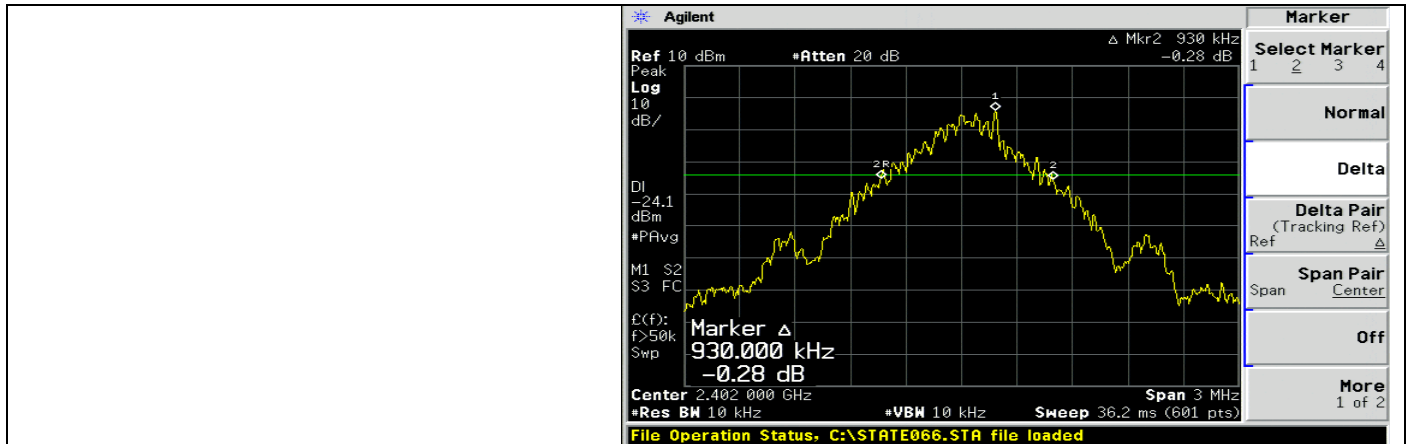


Modulation: GFSK / Packet Type: DH5 / Frequency: 2480 MHz

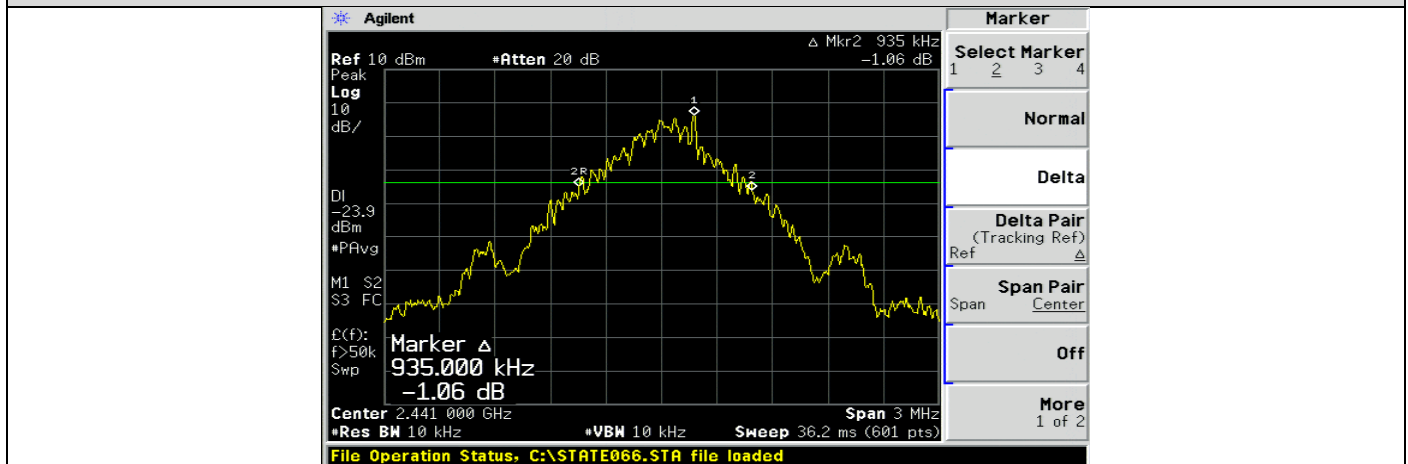


20dB Bandwidth Graphical Test Results

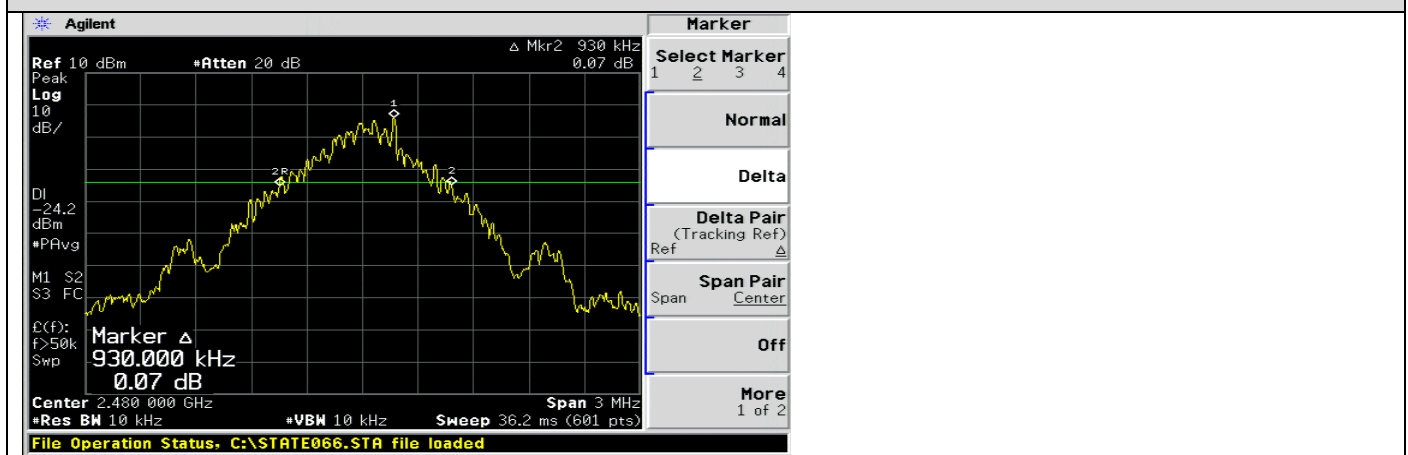
Modulation : GFSK / Packet Type: DH3 / Frequency: 2402 MHz



Modulation : GFSK / Packet Type: DH3 / Frequency: 2441 MHz

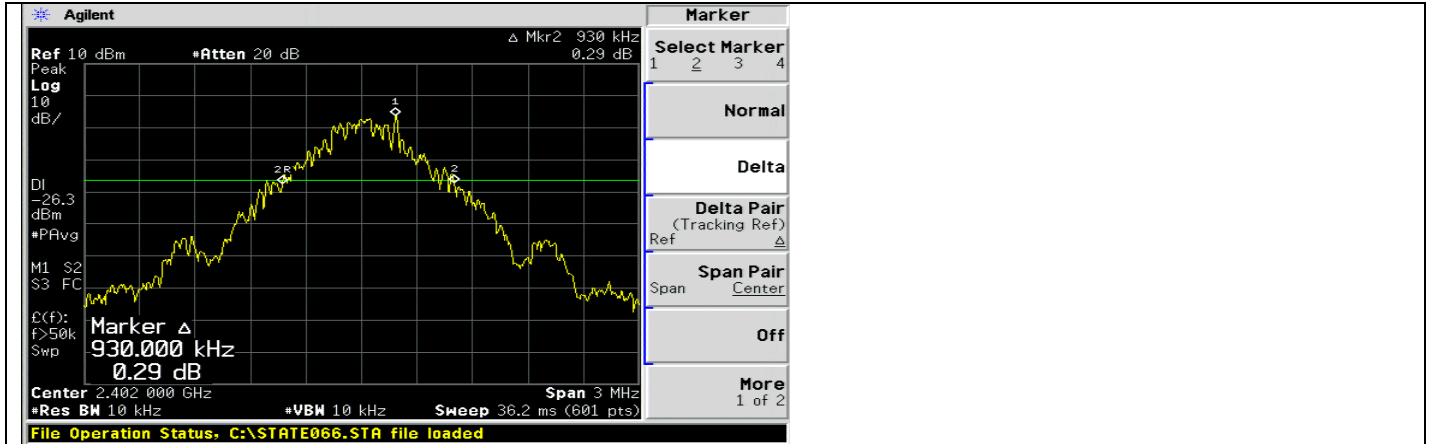


Modulation : GFSK / Packet Type: DH3 / Frequency: 2480 MHz



20dB Bandwidth Graphical Test Results

Modulation : GFSK / Packet Type: DH1 / Frequency: 2402 MHz



Modulation : GFSK / Packet Type: DH1 / Frequency: 2441 MHz



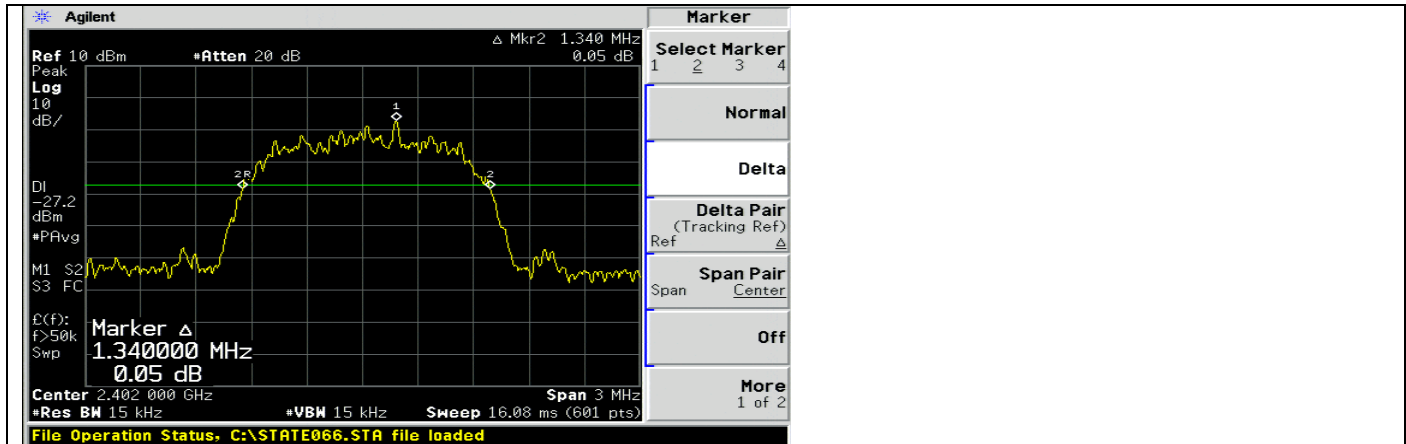
Modulation : GFSK / Packet Type: DH1 / Frequency: 2480 MHz



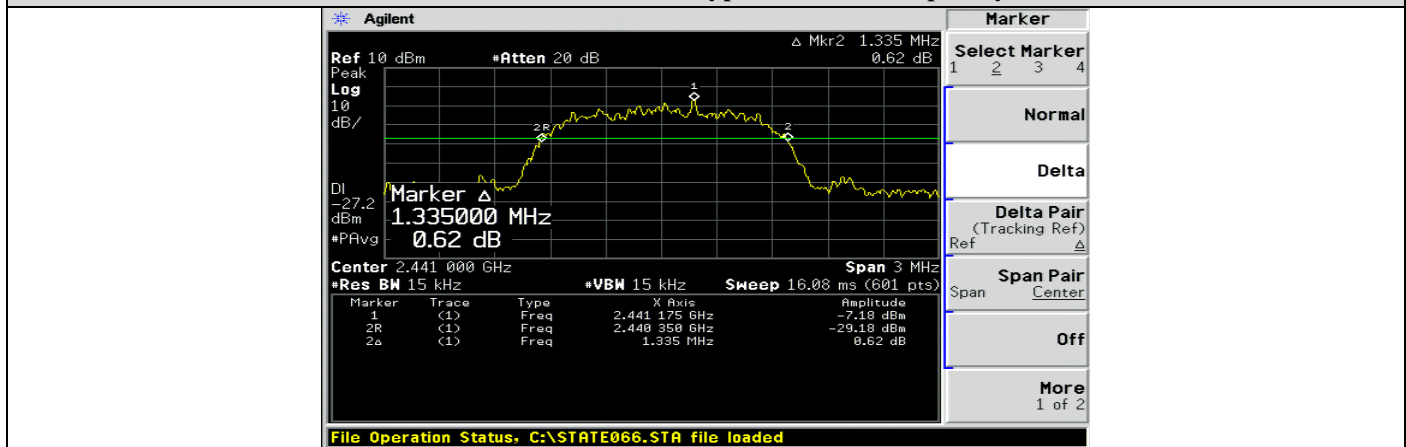
20dB Bandwidth Graphical Test Results

Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH5 / Frequency: 2402 MHz

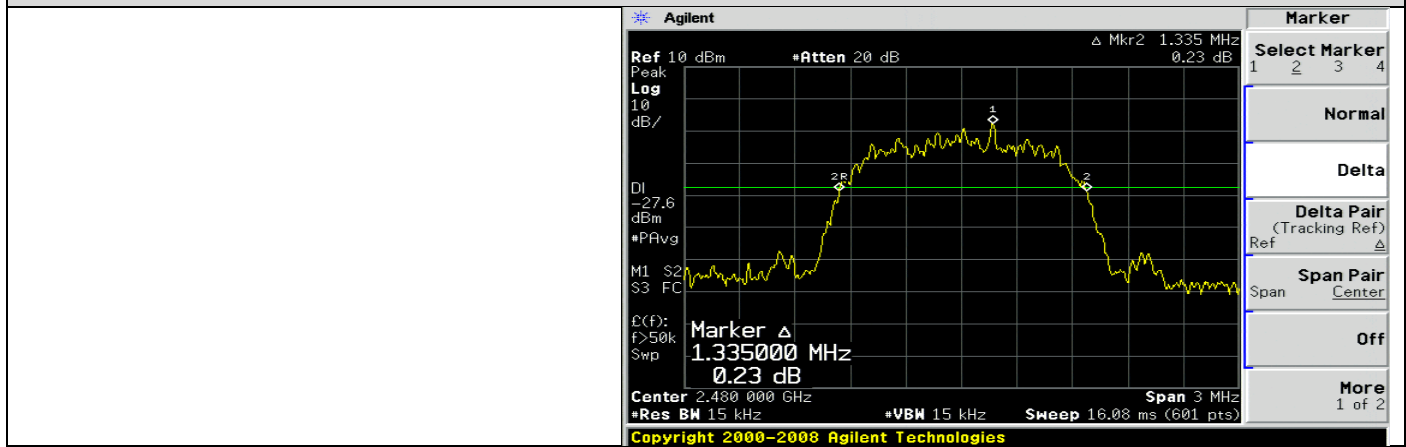




Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH5 / Frequency: 2441 MHz

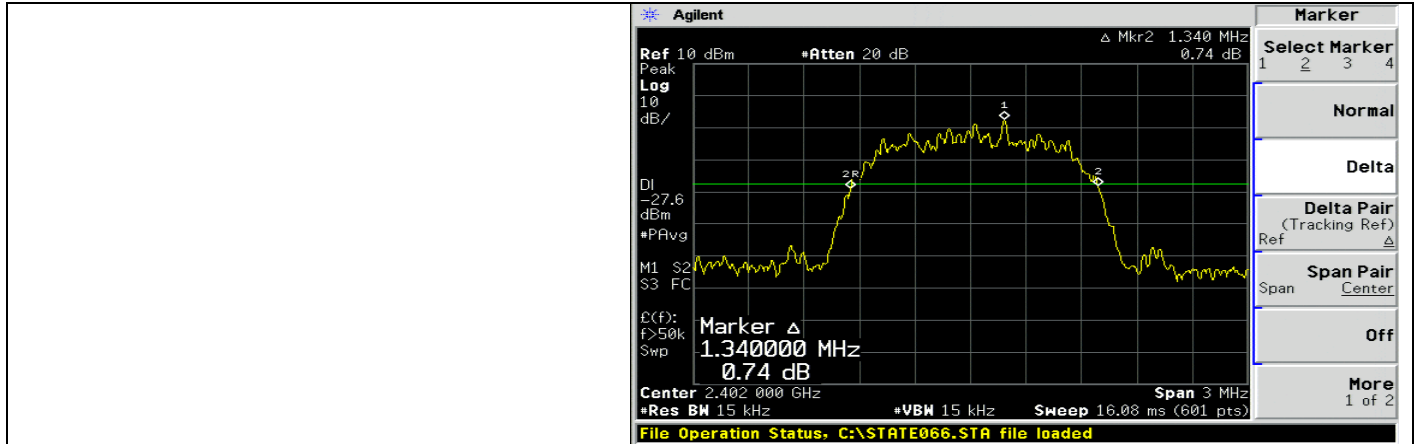


Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH5 / Frequency: 2480 MHz

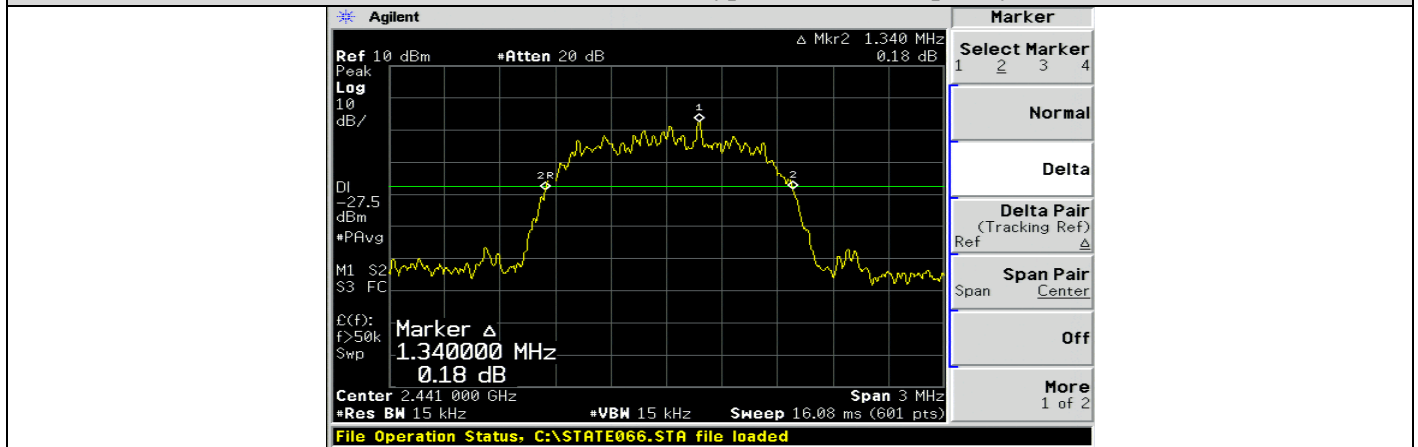


20dB Bandwidth Graphical Test Results

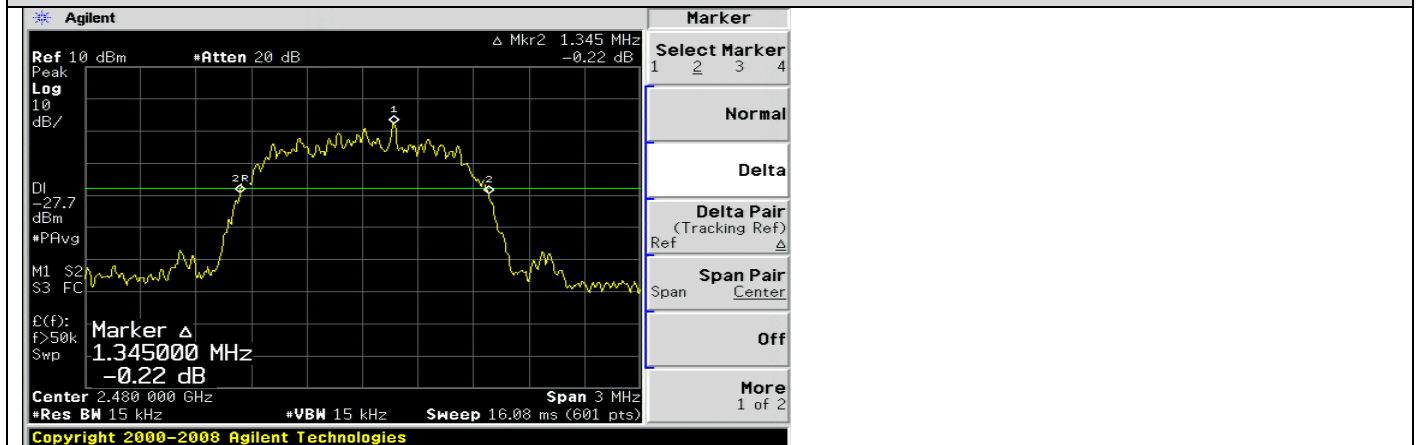
Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH3 / Frequency: 2402 MHz



Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH3 / Frequency: 2441 MHz

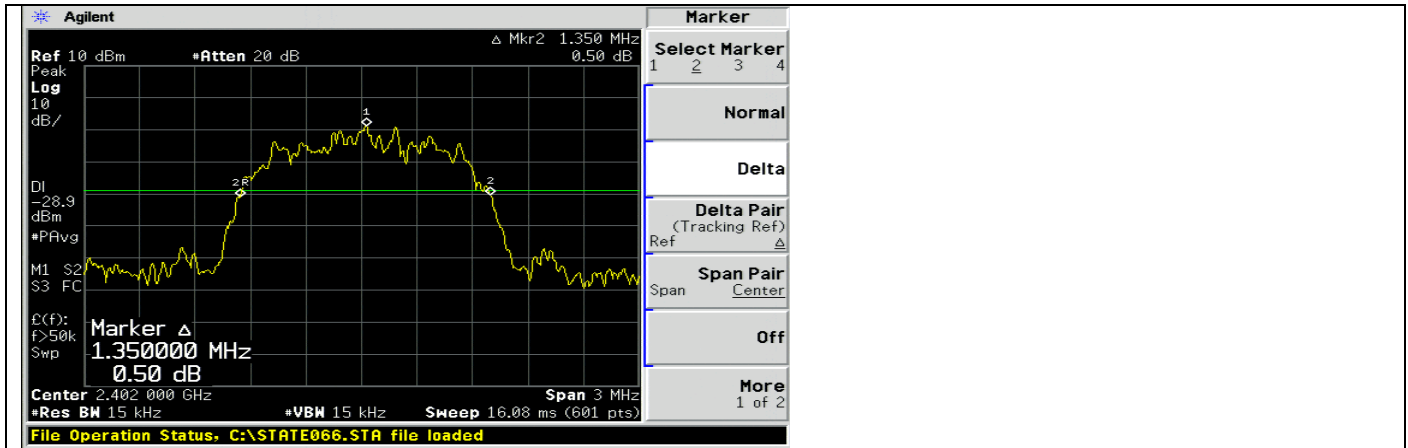


Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH3 / Frequency: 2480 MHz

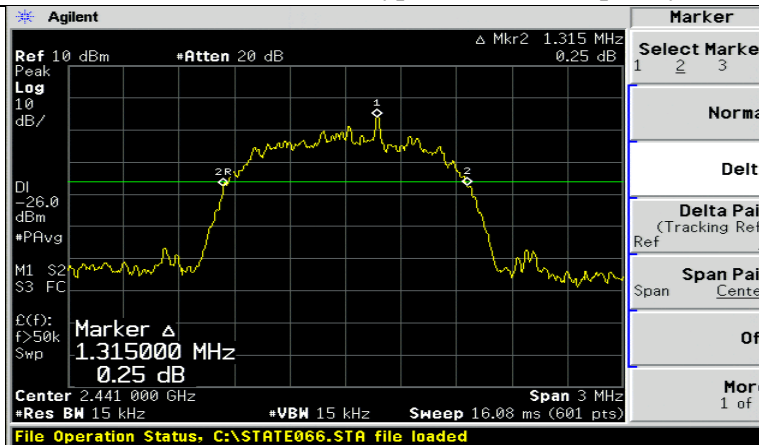


20dB Bandwidth Graphical Test Results

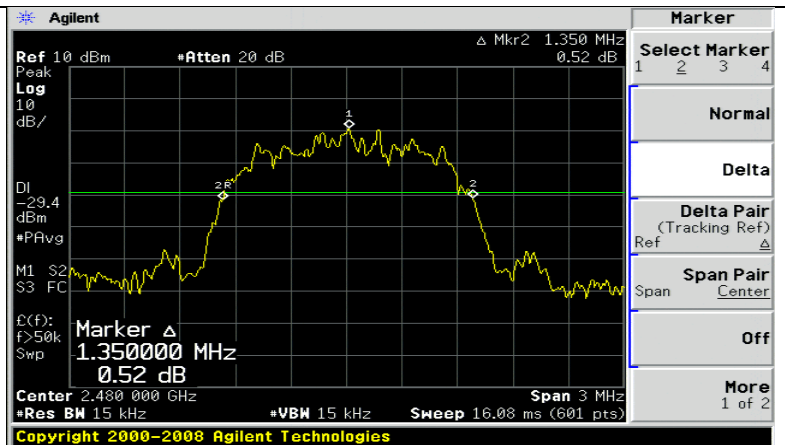
Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH1 / Frequency: 2402 MHz



Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH1 / Frequency: 2441 MHz

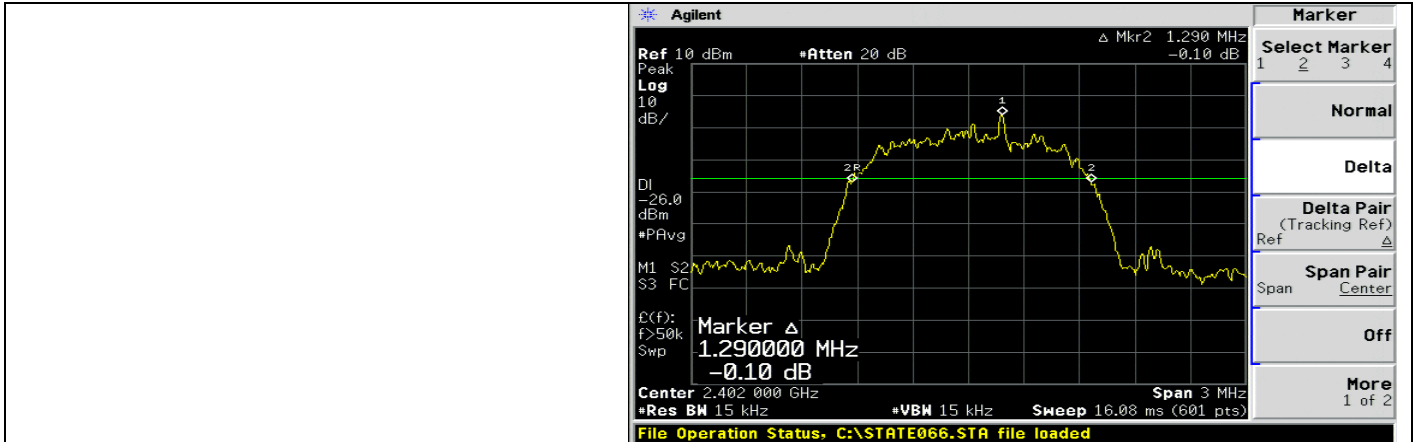


Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH1 / Frequency: 2480 MHz

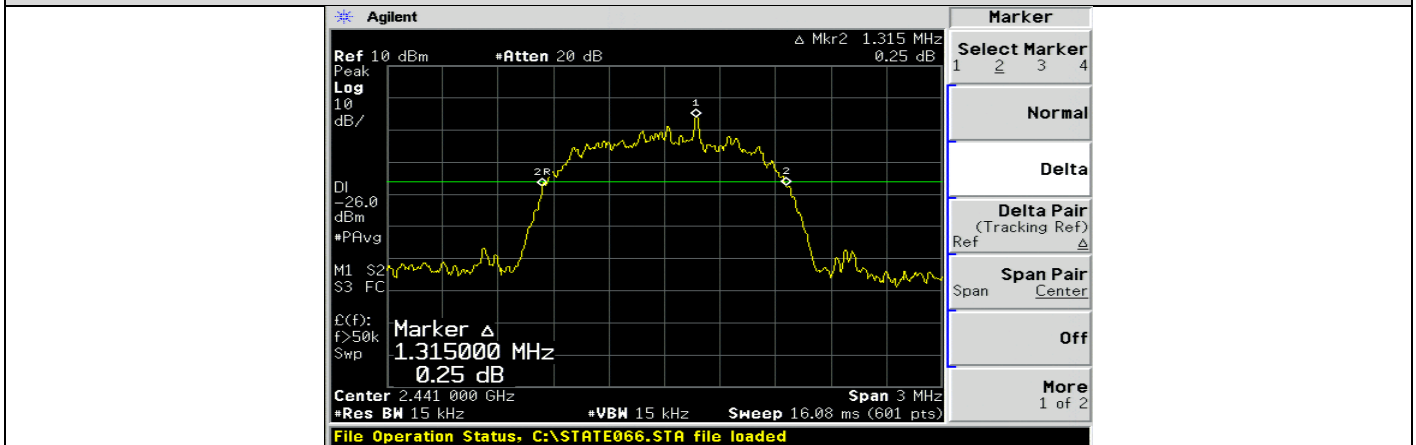


20dB Bandwidth Graphical Test Results

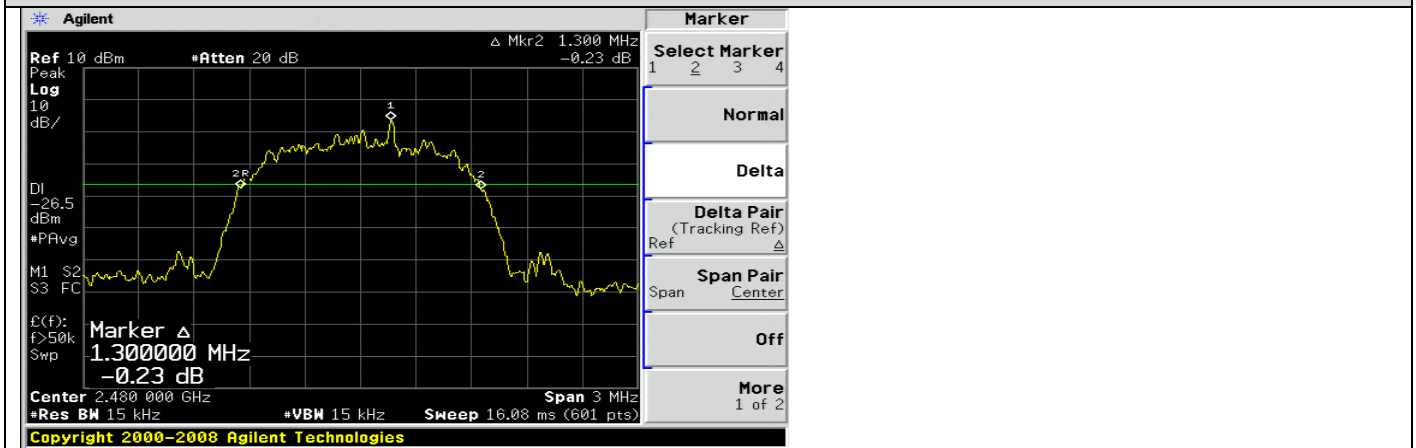
Modulation : 8DPSK / Packet Type: 3-DH5 / Frequency: 2402 MHz



Modulation : 8DPSK / Packet Type: 3-DH5 / Frequency: 2441 MHz



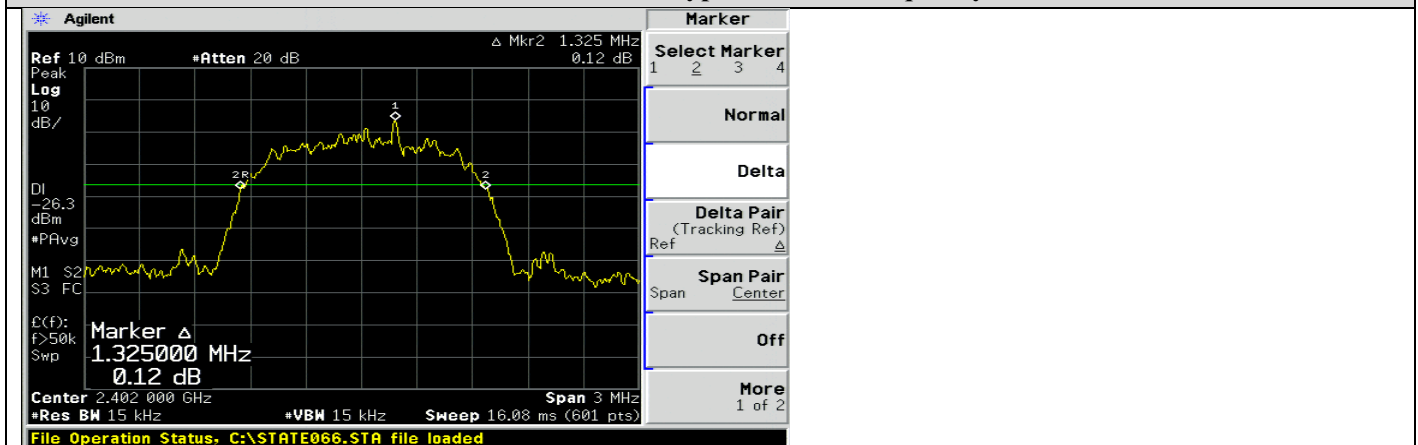
Modulation : 8DPSK / Packet Type: 3-DH5 / Frequency: 2480 MHz



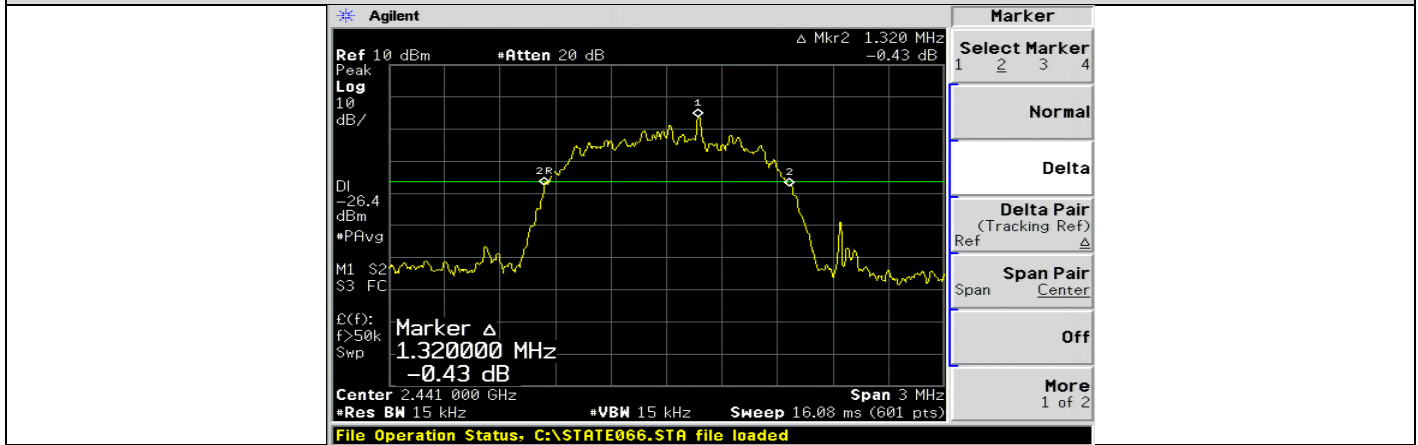


20dB Bandwidth Graphical Test Results

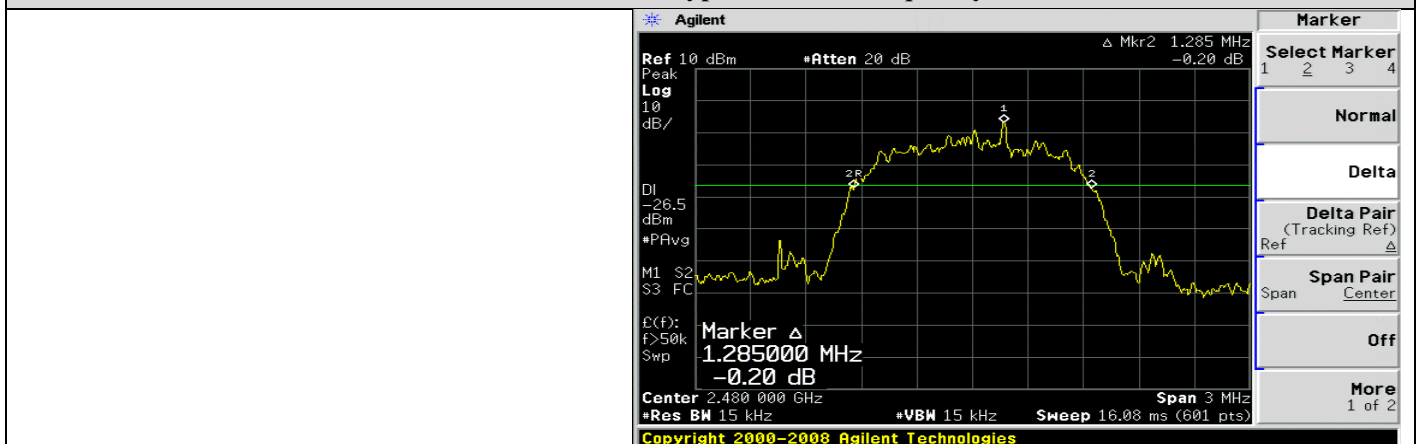
Modulation : 8DPSK / Packet Type: 3-DH3 / Frequency: 2402 MHz



Modulation : 8DPSK / Packet Type: 3-DH3 / Frequency: 2441 MHz



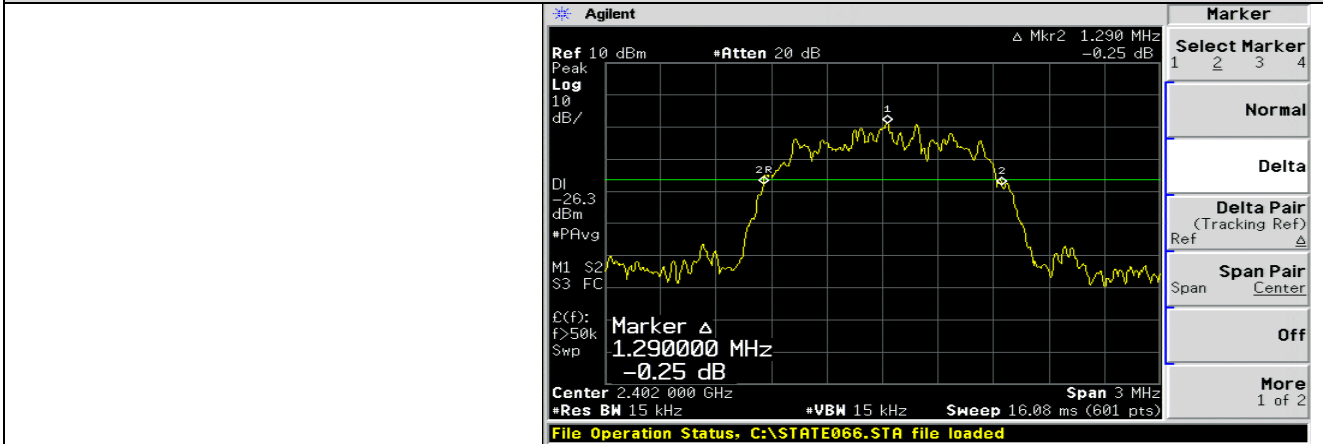
Modulation : 8DPSK / Packet Type: 3-DH3 / Frequency: 2480 MHz



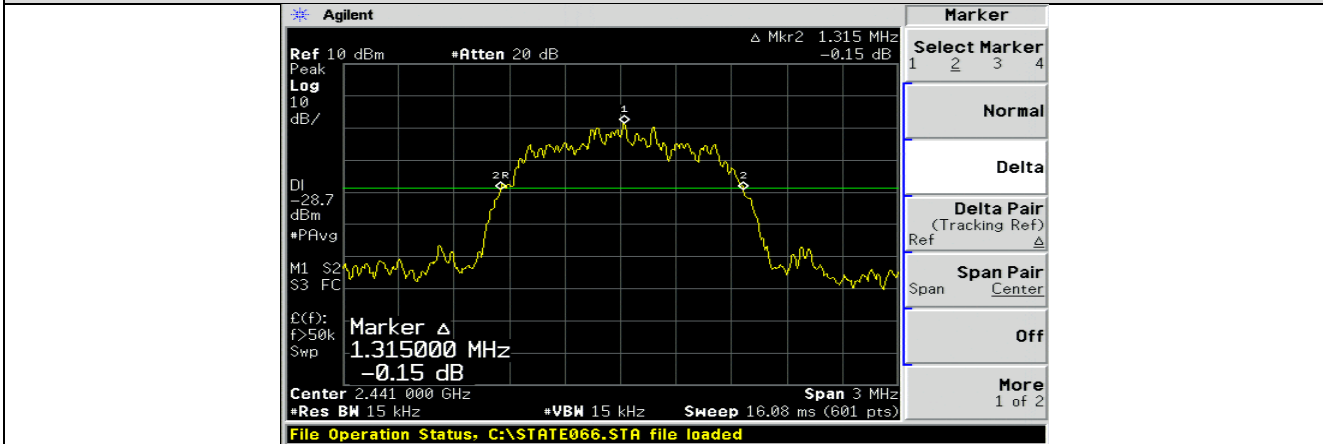
20dB Bandwidth Graphical Test Results



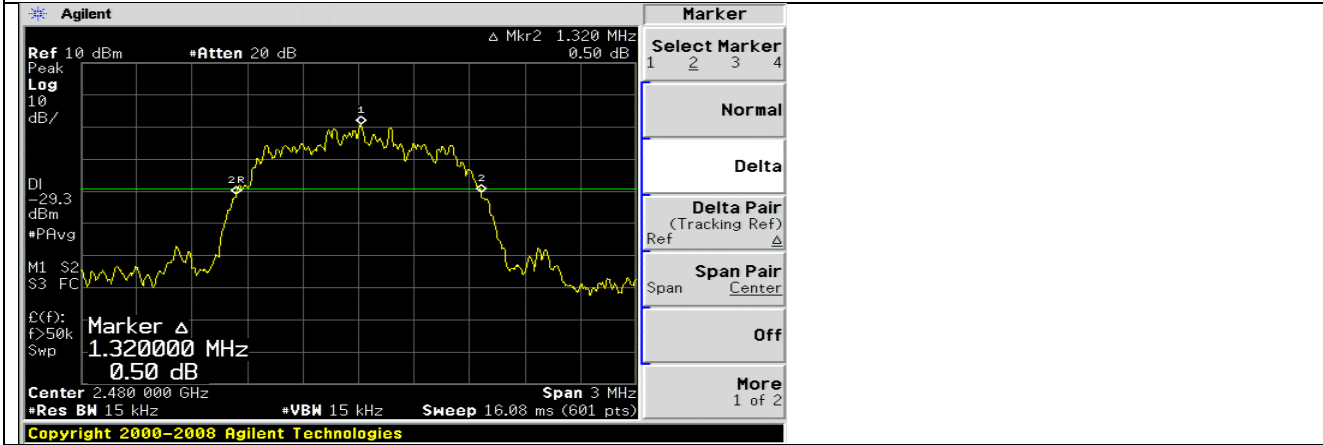
**Modulation : 8DPSK / Packet Type: 3-DH1 / Frequency: 2402 MHz**



**Modulation : 8DPSK / Packet Type: 3-DH1 / Frequency: 2441 MHz**



**Modulation : 8DPSK / Packet Type: 3-DH1 / Frequency: 2480 MHz**



## **A.2 Maximum Peak Conducted Output Power**

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth. However, when a filter with adequate width is not available, an integrated method utilizing a peak detector is acceptable.

### **A.2.1 Limits**

#### **FCC 15.247 (b) (3)**

The maximum conducted output power of the intentional radiator for systems using frequency hopping systems in the 2400-2483.5MHz band shall not exceed 1 Watt (30dBm). If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### **RSS 247 5.4 (2)**

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels

### **A.2.3 Test Procedure**

Refer to Public Notice DA 00-705

- Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
- RBW > the 20 dB bandwidth of the emission being measured
- VBW  $\geq$  RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission.





**A.2.4 Maximum Peak Conducted Output Power Data Table**

<b>Modulation</b>	<b>GFSK</b>	<b>Maximum Peak Conducted Output Power &amp; E.I.R.P</b>				
<b>Packet type:</b>	DH5					
<b>Transmit Chains:</b>	1					
<b>Data Rate:</b>	1 Mbps					
<b>Frequency (MHz)</b>	<b>Peak Conducted Output Power (dBm)</b>	<b>Peak Conducted Power Limit (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>E.I.R.P (dBm)</b>	<b>E.I.R.P Limit (dBm)</b>	<b>Result</b>
2402	6.54	30	2.4	8.94	36	Pass
2441	<b>6.91</b>	30	2.4	<b>9.31</b>	36	Pass
2480	6.59	30	2.4	8.99	36	Pass

<b>Modulation</b>	<b>GFSK</b>	<b>Maximum Peak Conducted Output Power &amp; E.I.R.P</b>				
<b>Packet type:</b>	DH3					
<b>Transmit Chains:</b>	1					
<b>Data Rate:</b>	1 Mbps					
<b>Frequency (MHz)</b>	<b>Peak Conducted Output Power (dBm)</b>	<b>Peak Conducted Power Limit (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>E.I.R.P (dBm)</b>	<b>E.I.R.P Limit (dBm)</b>	<b>Result</b>
2402	6.54	30	2.4	8.94	36	Pass
2441	<b>6.94</b>	30	2.4	<b>9.34</b>	36	Pass
2480	6.65	30	2.4	9.05	36	Pass





Modulation	GFSK	Maximum Peak Conducted Output Power & E.I.R.P				
Packet type:	DH1					
Transmit Chains:	1					
Data Rate:	1 Mbps					
Frequency (MHz)	Peak Conducted Output Power (dBm)	Peak Conducted Power Limit (dBm)	Antenna Gain (dBi)	E.I.R.P (dBm)	E.I.R.P Limit (dBm)	Result
2402	5.34	30	2.4	7.74	36	Pass
2441	5.75	30	2.4	8.15	36	Pass
2480	5.52	30	2.4	7.92	36	Pass
Modulation	$\pi/4$ DQPSK	Maximum Peak Conducted Output Power & E.I.R.P				
Packet type:	2-DH5					
Transmit Chains:	1					
Data Rate:	2 Mbps					
Frequency (MHz)	Peak Conducted Output Power (dBm)	Peak Conducted Power Limit (dBm)	Antenna Gain (dBi)	E.I.R.P (dBm)	E.I.R.P Limit (dBm)	Result
2402	5.10	30	2.4	7.50	36	Pass
2441	5.22	30	2.4	7.62	36	Pass
2480	4.70	30	2.4	7.10	36	Pass



<b>Modulation</b>	$\pi/4$ DQPSK	<b>Maximum Peak Conducted Output Power &amp; E.I.R.P</b>				
<b>Packet type:</b>	2- DH3					
<b>Transmit Chains:</b>	1					
<b>Data Rate:</b>	2 MBps					
<b>Frequency (MHz)</b>	<b>Peak Conducted Output Power (dBm)</b>	<b>Peak Conducted Power Limit (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>E.I.R.P (dBm)</b>	<b>E.I.R.P Limit (dBm)</b>	<b>Result</b>
2402	5.00	30	2.4	7.40	36	Pass
2441	5.16	30	2.4	7.56	36	Pass
2480	4.65	30	2.4	7.05	36	Pass

<b>Modulation</b>	$\pi/4$ DQPSK	<b>Maximum Peak Conducted Output Power &amp; E.I.R.P</b>				
<b>Packet type:</b>	2-DH1					
<b>Transmit Chains:</b>	1					
<b>Data Rate:</b>	2 MBps					
<b>Frequency (MHz)</b>	<b>Peak Conducted Output Power (dBm)</b>	<b>Peak Conducted Power Limit (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>E.I.R.P (dBm)</b>	<b>E.I.R.P Limit (dBm)</b>	<b>Result</b>
2402	4.06	30	2.4	6.46	36	Pass
2441	4.16	30	2.4	6.56	36	Pass
2480	3.65	30	2.4	6.05	36	Pass

<b>Modulation</b>	8-DPSK	<b>Maximum Peak Conducted Output Power &amp; E.I.R.P</b>				
<b>Packet type:</b>	3-DH5					
<b>Transmit Chains:</b>	1					
<b>Data Rate:</b>	1 MBps					
<b>Frequency (MHz)</b>	<b>Peak Conducted Output Power (dBm)</b>	<b>Peak Conducted Power Limit (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>E.I.R.P (dBm)</b>	<b>E.I.R.P Limit (dBm)</b>	<b>Result</b>
2402	4.48	30	2.4	6.88	36	Pass
2441	4.60	30	2.4	7.00	36	Pass
2480	4.12	30	2.4	6.52	36	Pass

<b>Modulation</b>	8-DPSK	<b>Maximum Peak Conducted Output Power &amp; E.I.R.P</b>				
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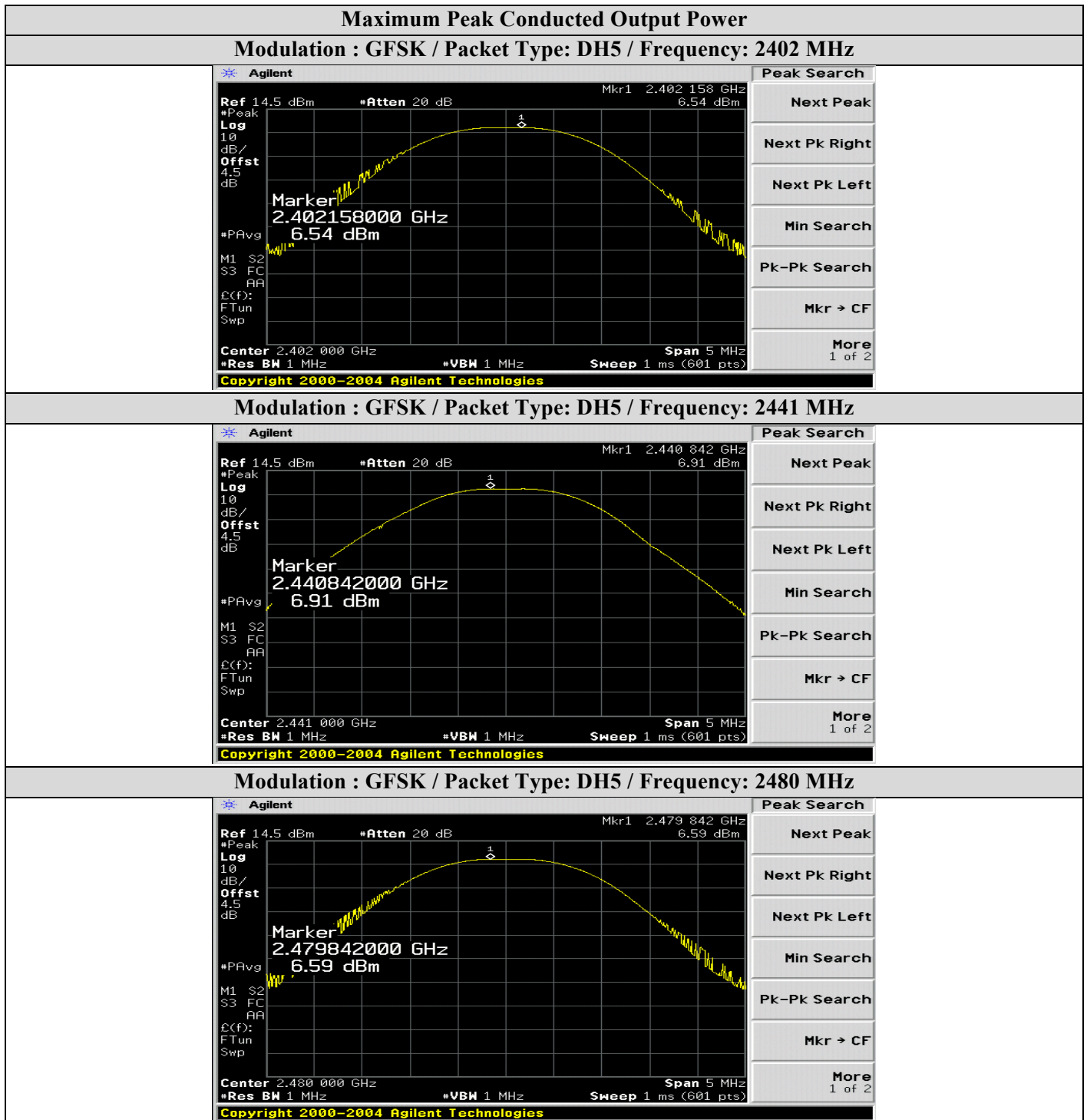
<b>Packet type:</b>	<b>3-DH3</b>					
<b>Transmit Chains:</b>	1					
<b>Data Rate:</b>	3 MBps					
<b>Frequency (MHz)</b>	<b>Peak Conducted Output Power (dBm)</b>	<b>Peak Conducted Power Limit (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>E.I.R.P (dBm)</b>	<b>E.I.R.P Limit (dBm)</b>	<b>Result</b>
2402	4.48	30	2.4	6.88	36	Pass
2441	<b>4.62</b>	30	2.4	7.02	36	Pass
2480	4.10	30	2.4	6.50	36	Pass

<b>Modulation</b>	<b>8-DPSK</b>					
<b>Packet type:</b>	3-DH1	<b>Maximum Peak Conducted Output Power &amp; E.I.R.P</b>				
<b>Transmit Chains:</b>	1					
<b>Data Rate:</b>	3 MBps					
<b>Frequency (MHz)</b>	<b>Peak Conducted Output Power (dBm)</b>	<b>Peak Conducted Power Limit (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>E.I.R.P (dBm)</b>	<b>E.I.R.P Limit (dBm)</b>	<b>Result</b>
2402	4.55	30	2.4	6.95	36	Pass
2441	<b>4.64</b>	30	2.4	<b>7.04</b>	36	Pass
2480	4.20	30	2.4	6.60	36	Pass

**Note:** Worst case is determined as the modulation with Highest Output Power.  
 Worst cases emissions to be determined as GFSK / DH-3



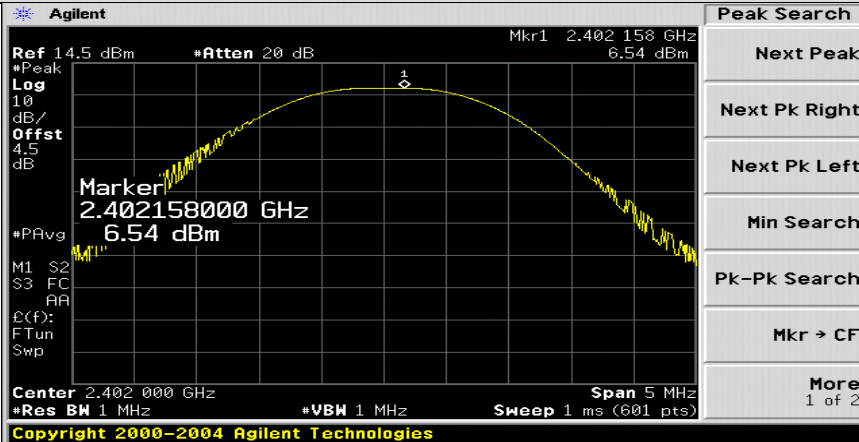
**A.2.5 Maximum Peak Conducted Output Power Graphical Test Results**



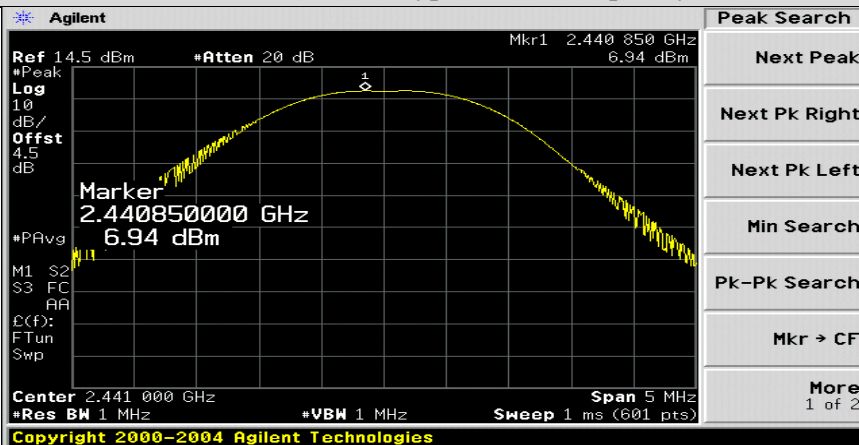


**Maximum Peak Conducted Output Power**

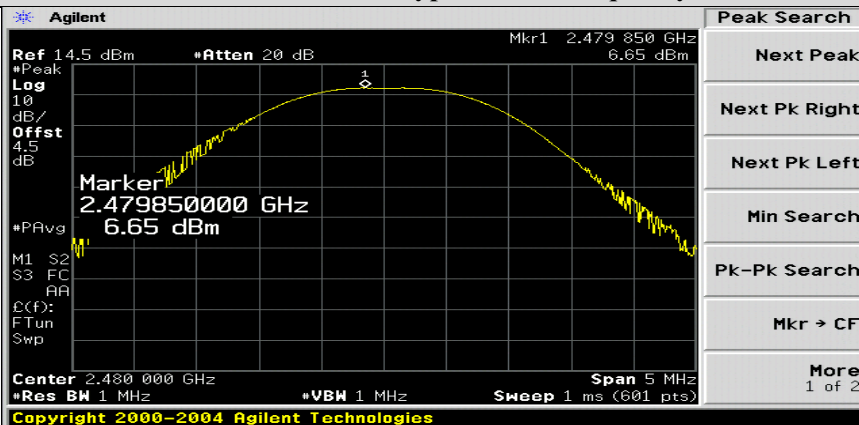
**Modulation : GFSK / Packet Type: DH3 / Frequency: 2402 MHz**



**Modulation : GFSK / Packet Type: DH3 / Frequency: 2441 MHz**



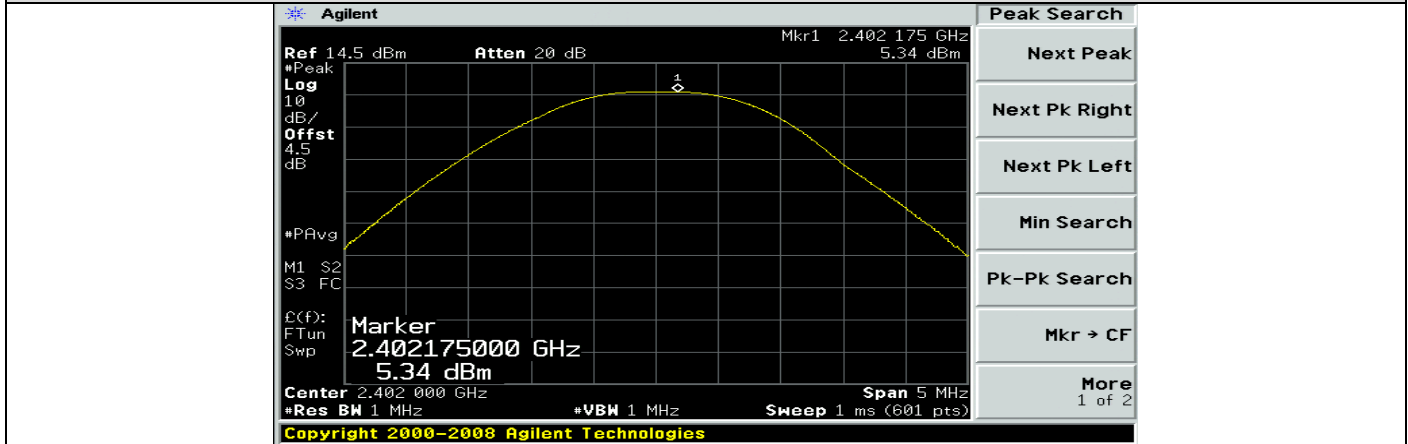
**Modulation : GFSK / Packet Type: DH3 / Frequency: 2480 MHz**



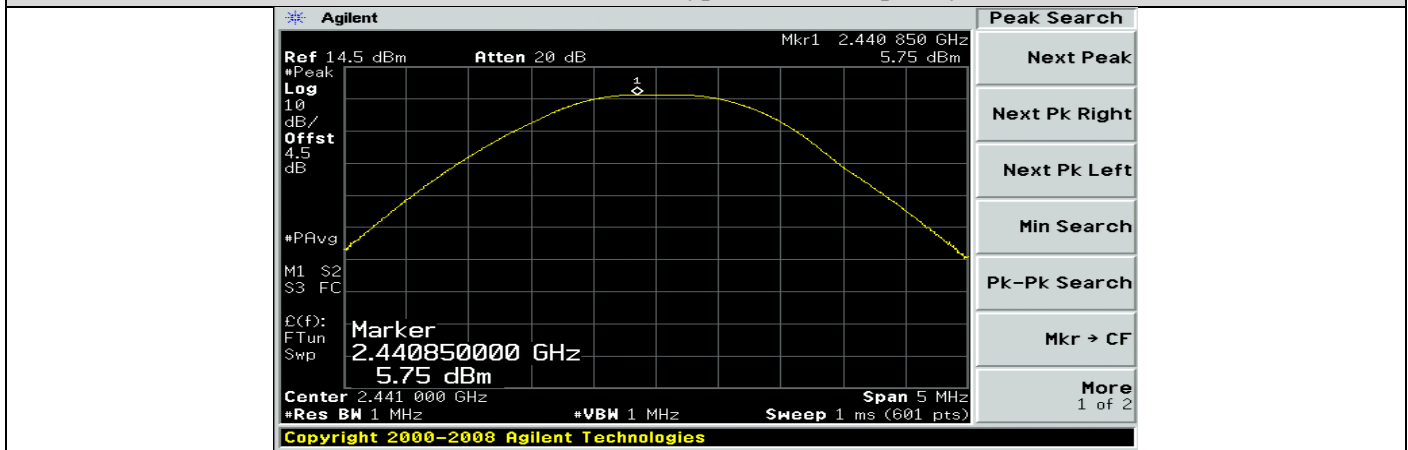
**Maximum Peak Conducted Output Power**



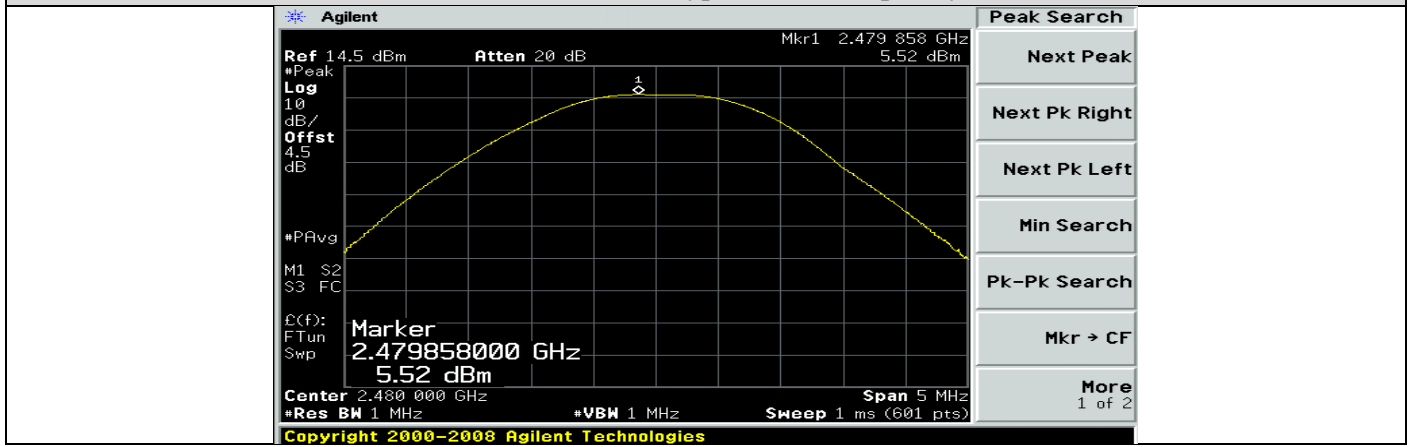
**Modulation : GFSK / Packet Type: DH1 / Frequency: 2402 MHz**



**Modulation : GFSK / Packet Type: DH1 / Frequency: 2441 MHz**

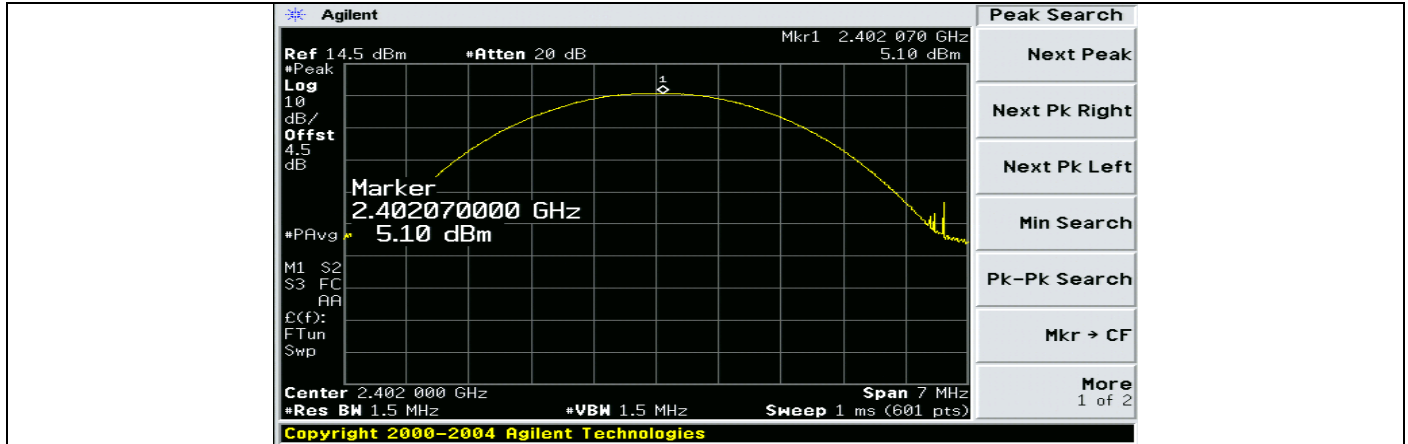


**Modulation : GFSK / Packet Type: DH1 / Frequency: 2480 MHz**

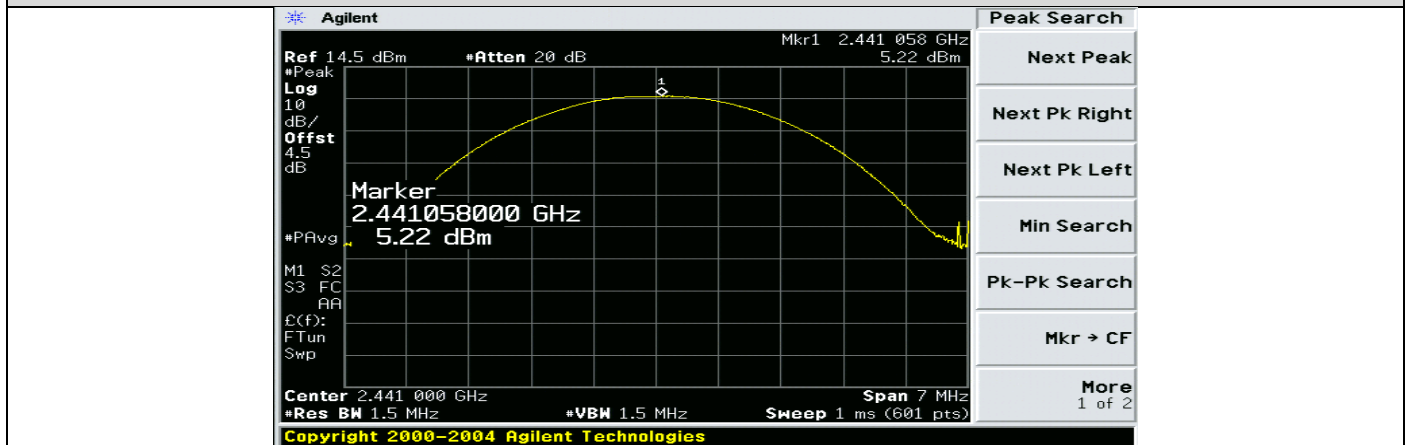


**Maximum Peak Conducted Output Power**

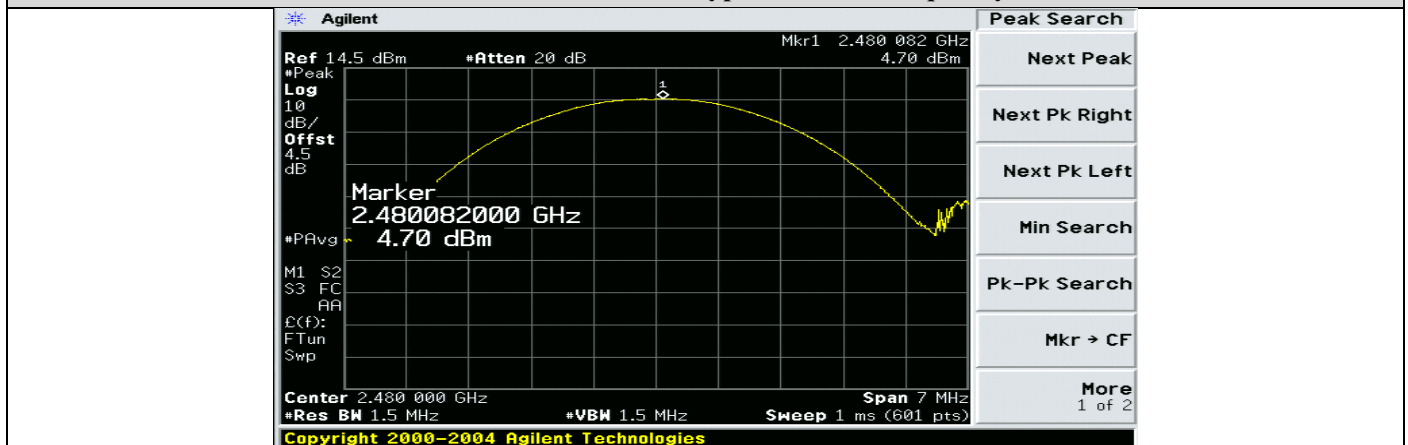
**Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH5 / Frequency: 2402 MHz**



Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH5 / Frequency: 2441 MHz

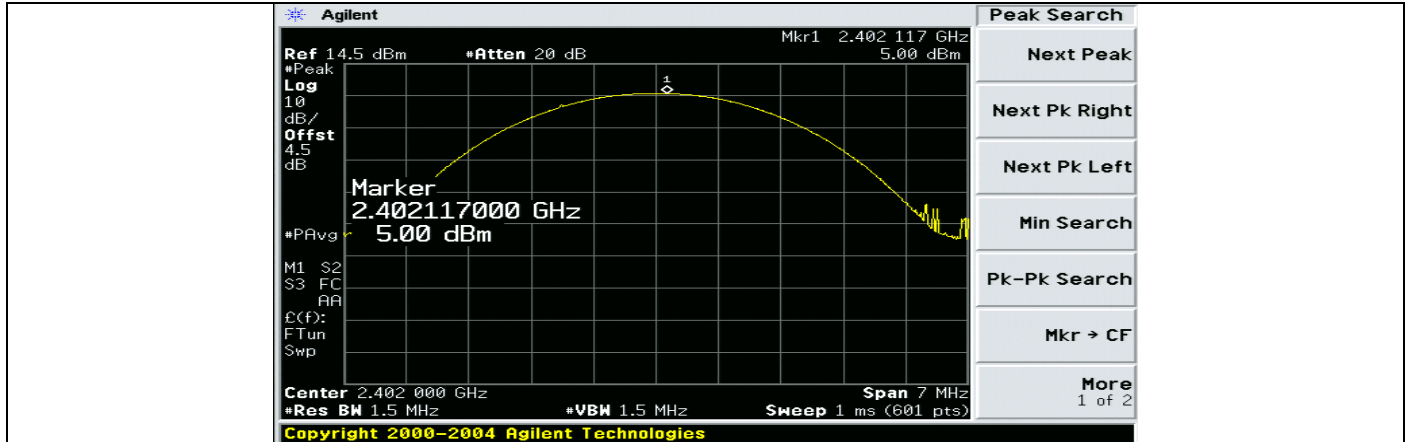


Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH5 / Frequency: 2480 MHz

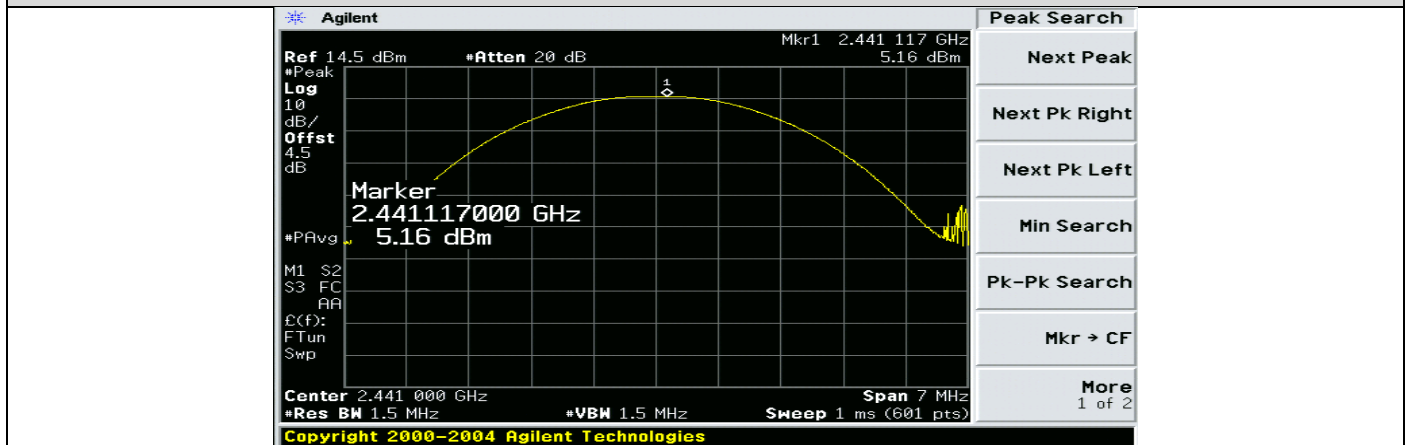


Maximum Peak Conducted Output Power

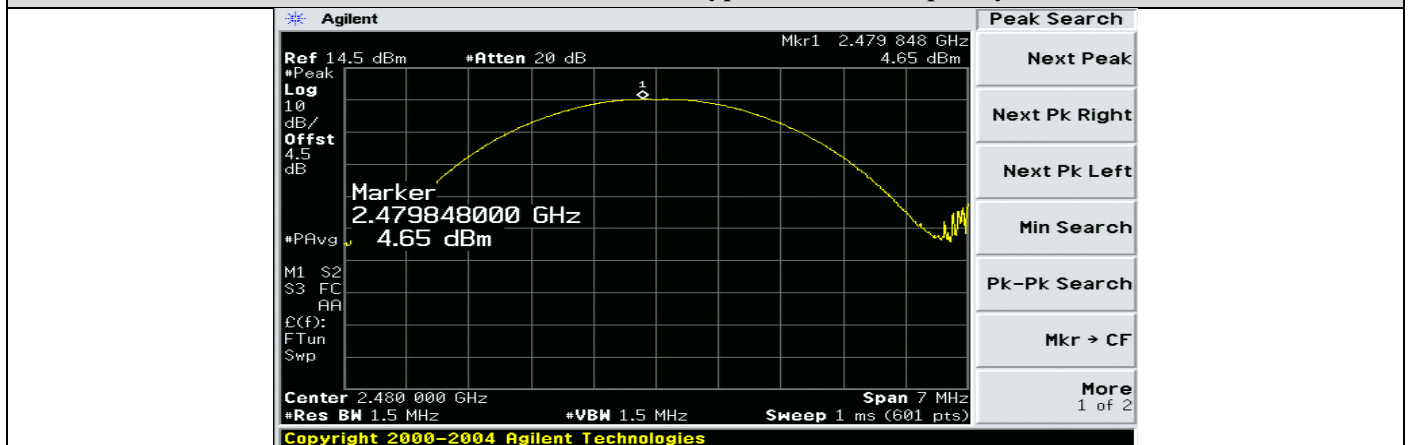
Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH3 / Frequency: 2402 MHz



Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH3 / Frequency: 2441 MHz



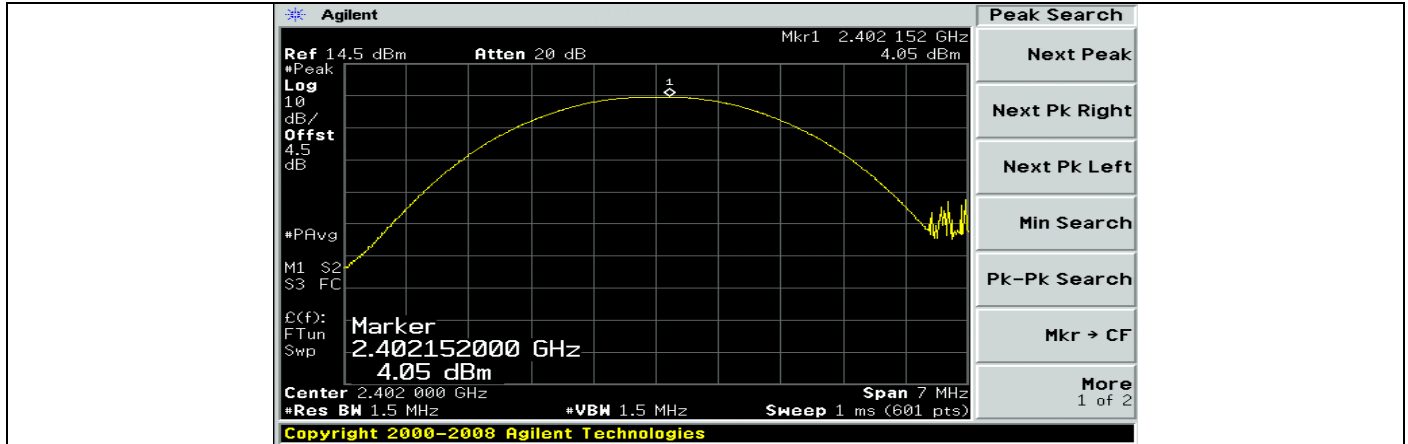
Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH3 / Frequency: 2480 MHz



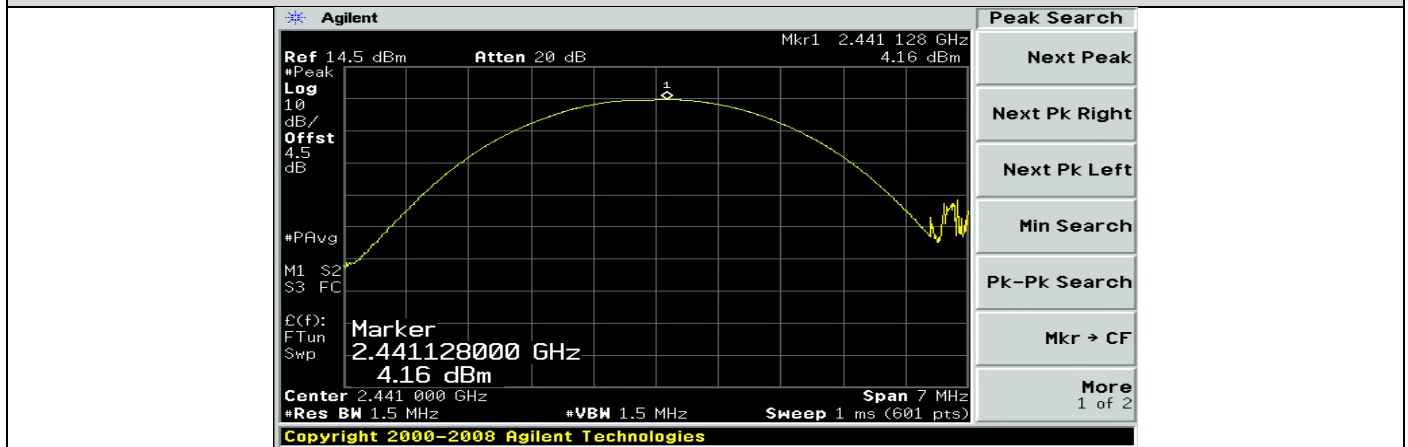
Maximum Peak Conducted Output Power

Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH1 / Frequency: 2402 MHz

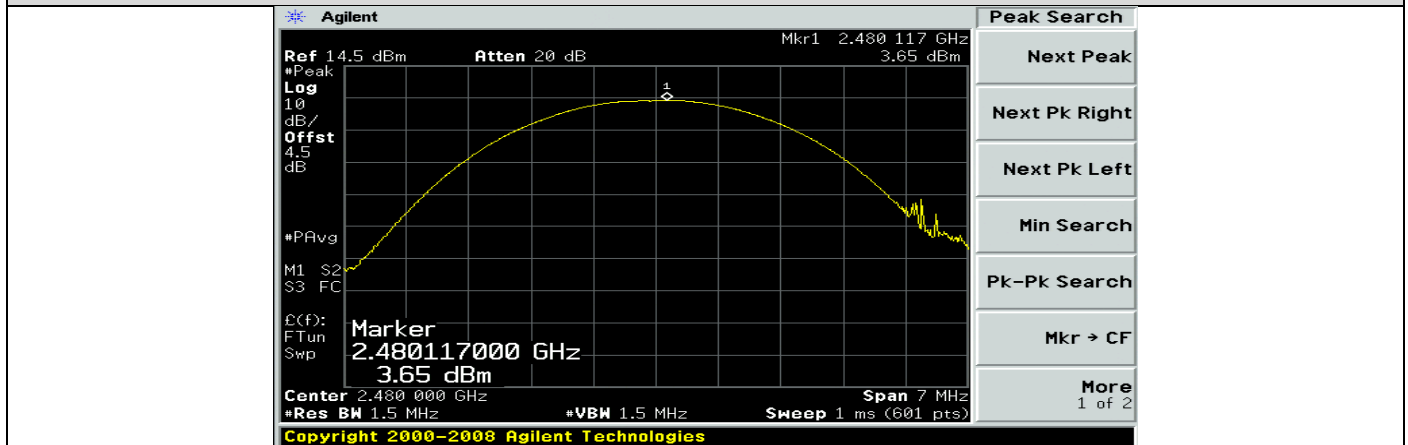




Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH1 / Frequency: 2441 MHz

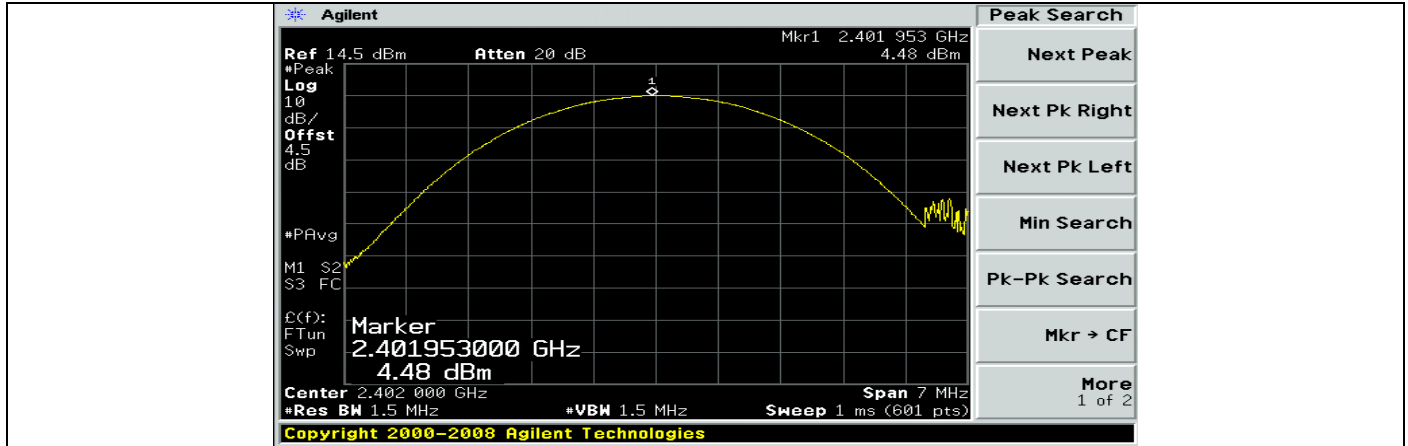


Modulation :  $\pi/4$  DQPSK / Packet Type: 2-DH1 / Frequency: 2480 MHz

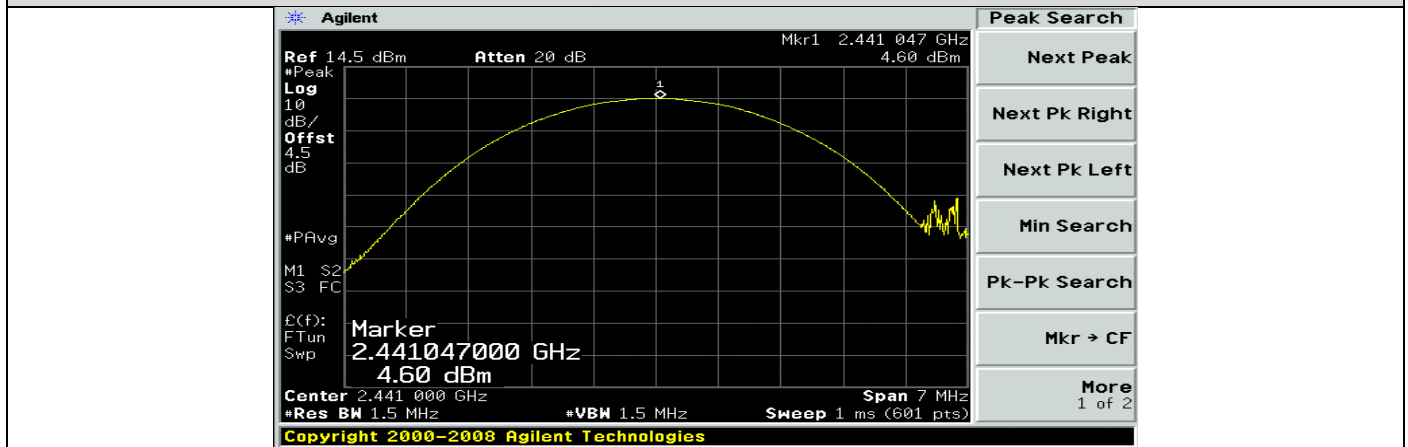


Maximum Peak Conducted Output Power

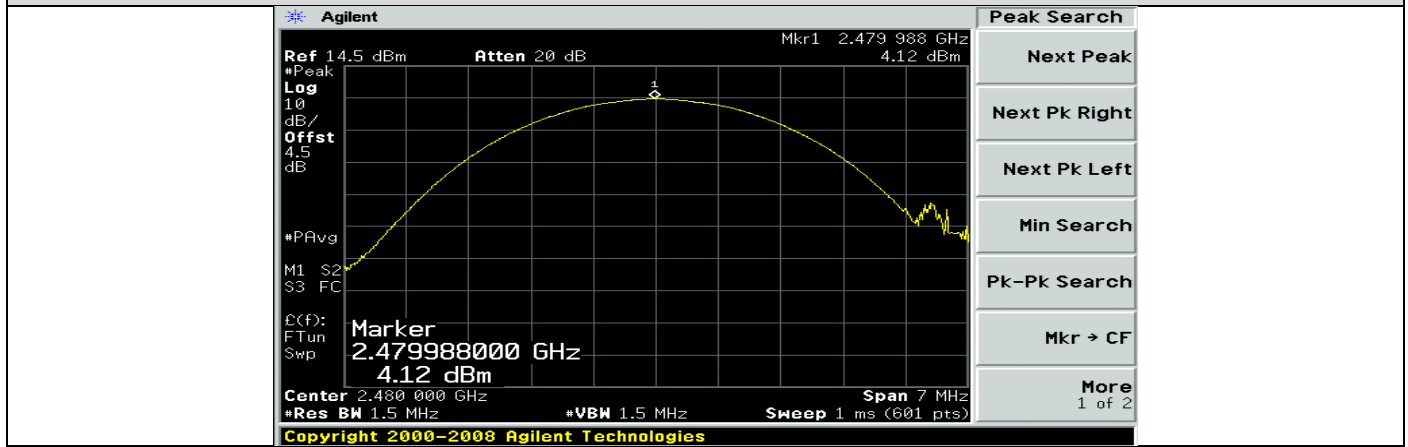
Modulation : 8DPSK / Packet Type: 3-DH5 / Frequency: 2402 MHz



**Modulation : 8DPSK / Packet Type: 3-DH5 / Frequency: 2441 MHz**

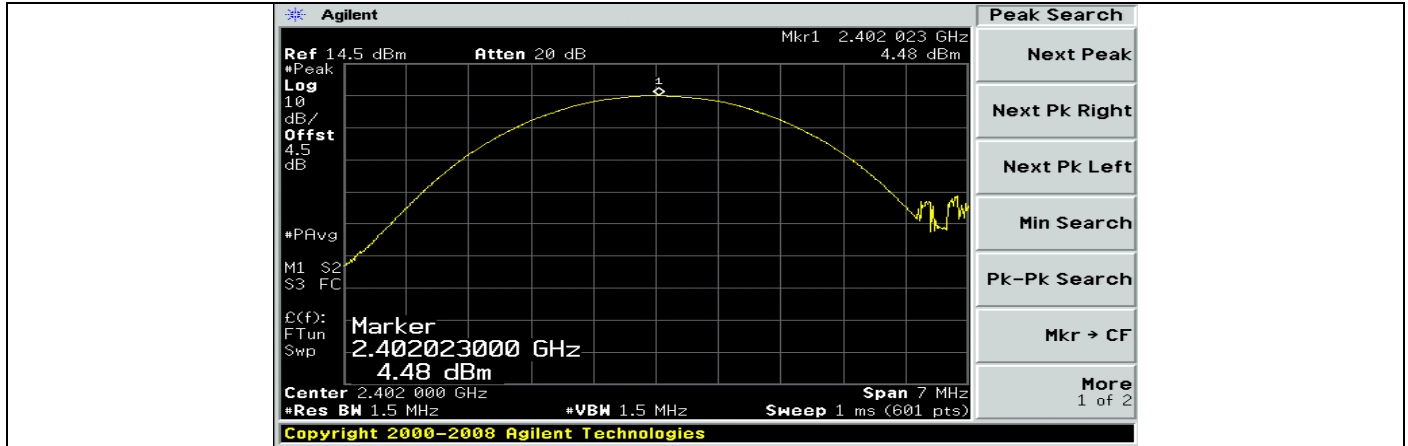


**Modulation : 8DPSK / Packet Type: 3-DH5 / Frequency: 2480 MHz**

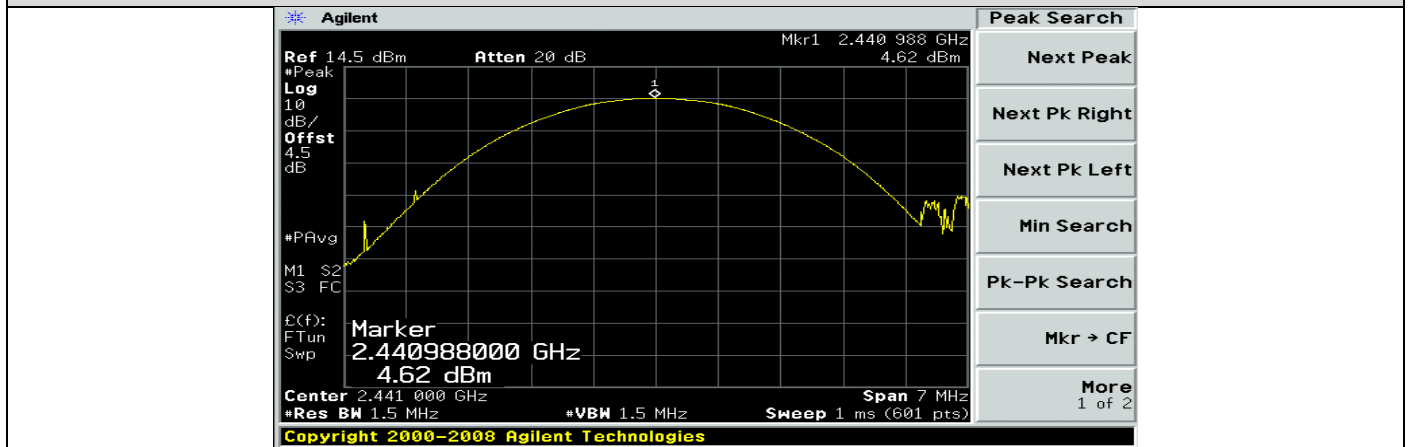


**Maximum Peak Conducted Output Power**

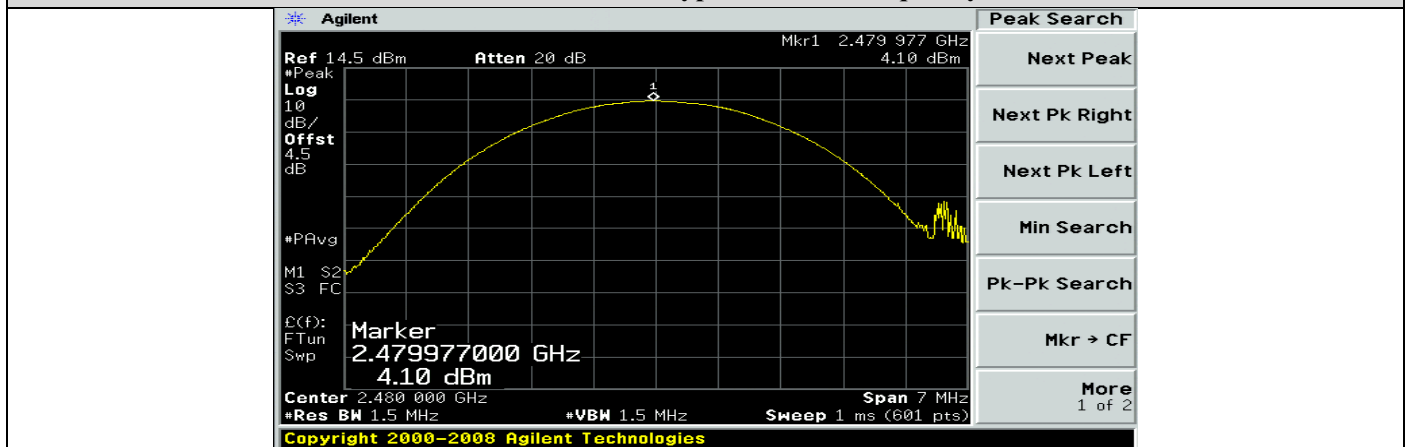
**Modulation : 8DPSK / Packet Type: 3-DH3 / Frequency: 2402 MHz**



**Modulation : 8DPSK / Packet Type: 3-DH3 / Frequency: 2441 MHz**

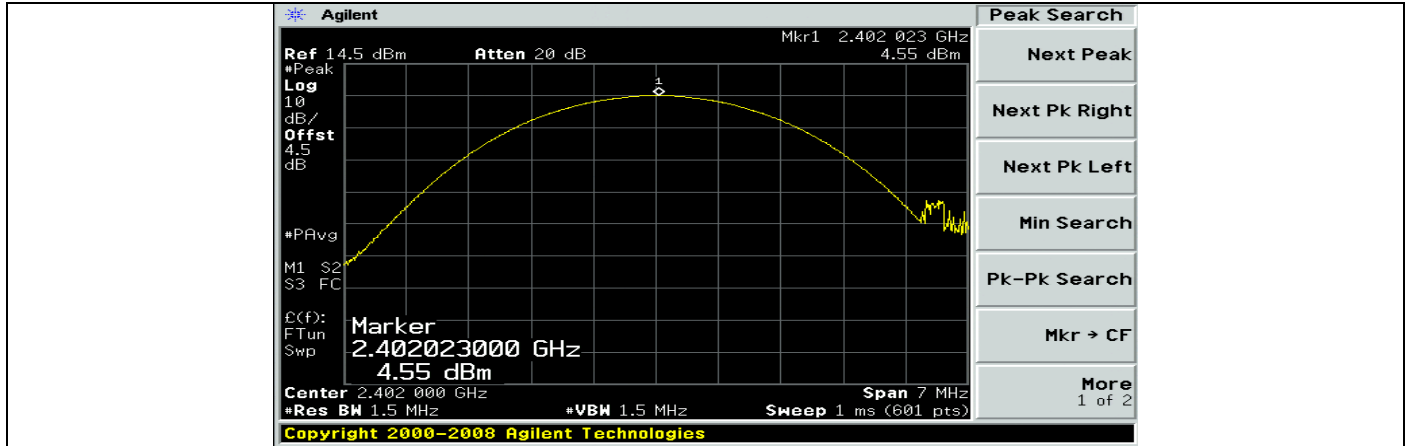


**Modulation : 8DPSK / Packet Type: 3-DH3 / Frequency: 2480 MHz**

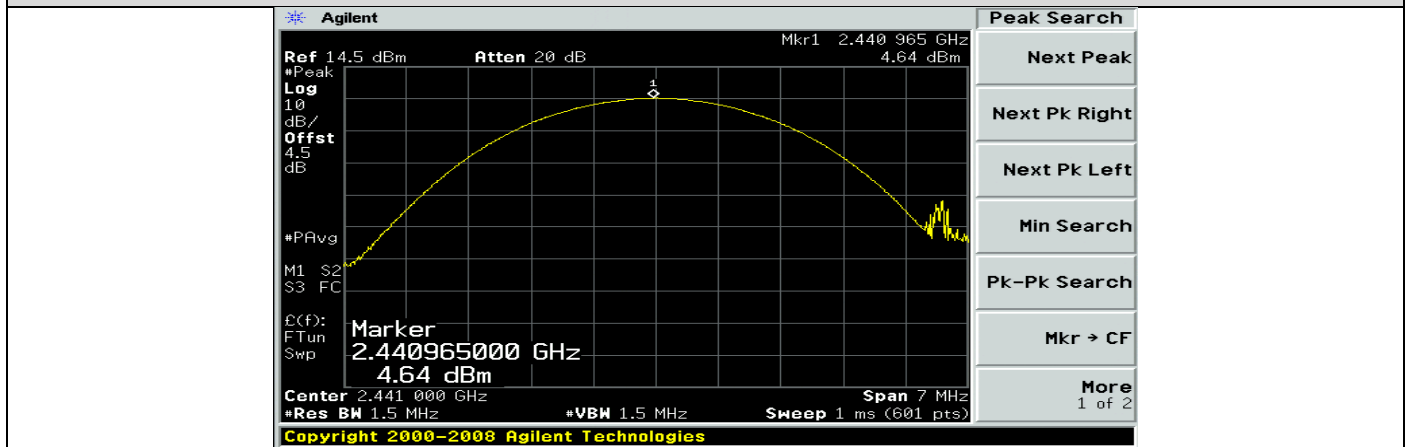


**Maximum Peak Conducted Output Power**

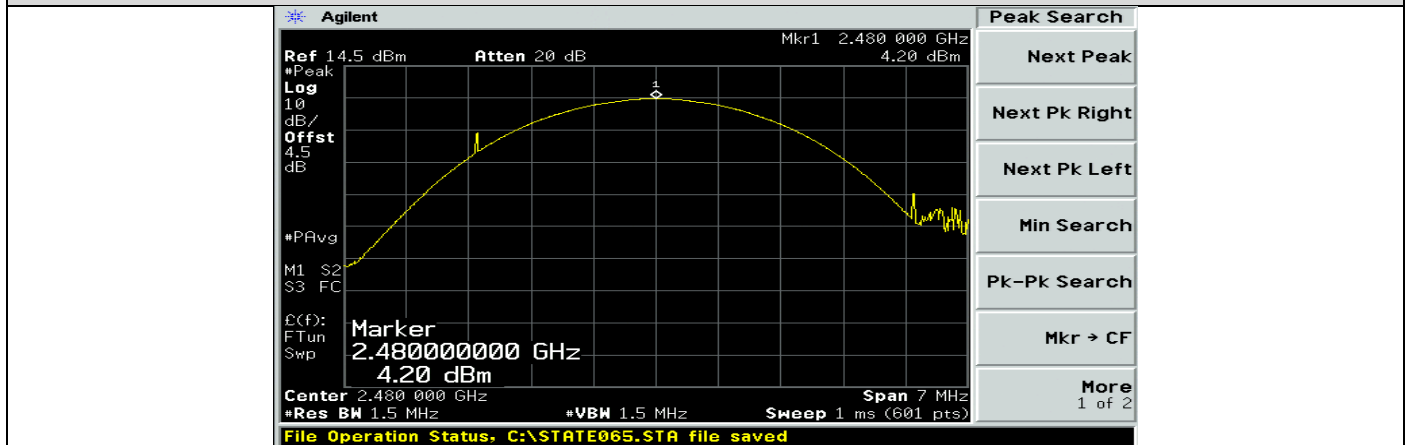
**Modulation : 8DPSK / Packet Type: 3-DH1 / Frequency: 2402 MHz**



Modulation : 8DPSK / Packet Type: 3-DH1 / Frequency: 2441 MHz



Modulation : 8DPSK / Packet Type: 3-DH1 / Frequency: 2480 MHz



### A.3 Carrier Frequency Separation

#### A.3.1 Limits

FCC 15.247(a) (1) & & RSS-247 5.1(2)

For frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel frequencies that are separated by 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternately, frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the system operates with an output power no greater than 125 mW.

#### A.3.2 Test Procedure

Refer Public Notice DA 00-705

The EUT must have its hopping function enabled. Use the following spectrum analyzer Settings:

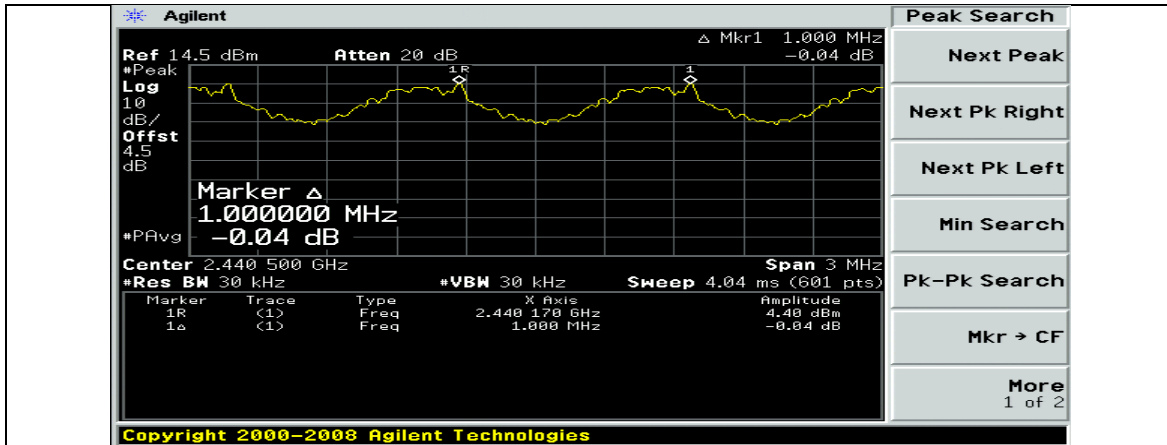
- Span = wide enough to capture the peaks of two adjacent channels
- Resolution (or IF) Bandwidth (RBW) > 1% of the span
- Video (or Average) Bandwidth (VBW) > RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

#### A.3.3 Carrier Frequency Separation Data Table

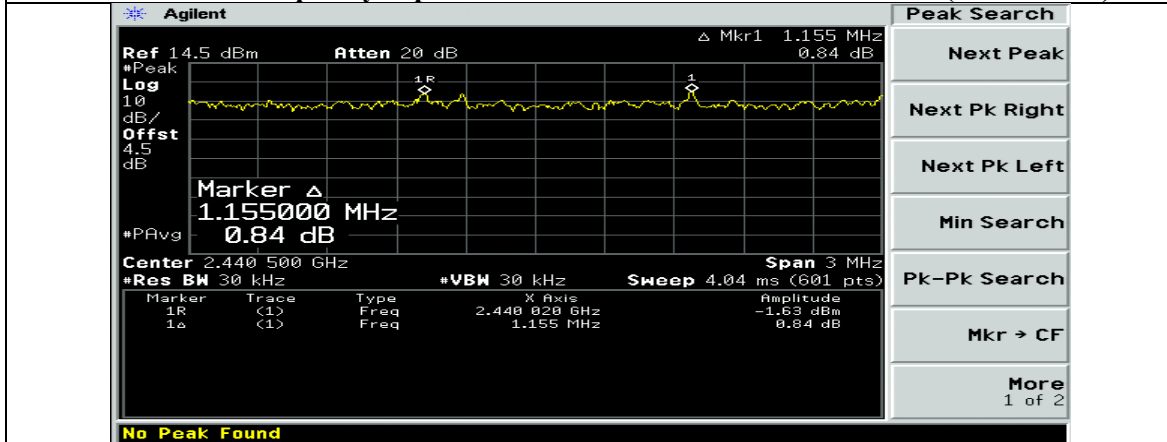
Frequency (MHz)	Modulation Systems	Carrier Frequency Separation (KHz)	Limits (KHz)	Results
2440 & 2441	GFSK	1000.00	935	Pass
2440 & 2441	$\pi/4$ DQPSK	1155.00	900	Pass
2440 & 2441	8- DPSK	990.00	882	Pass



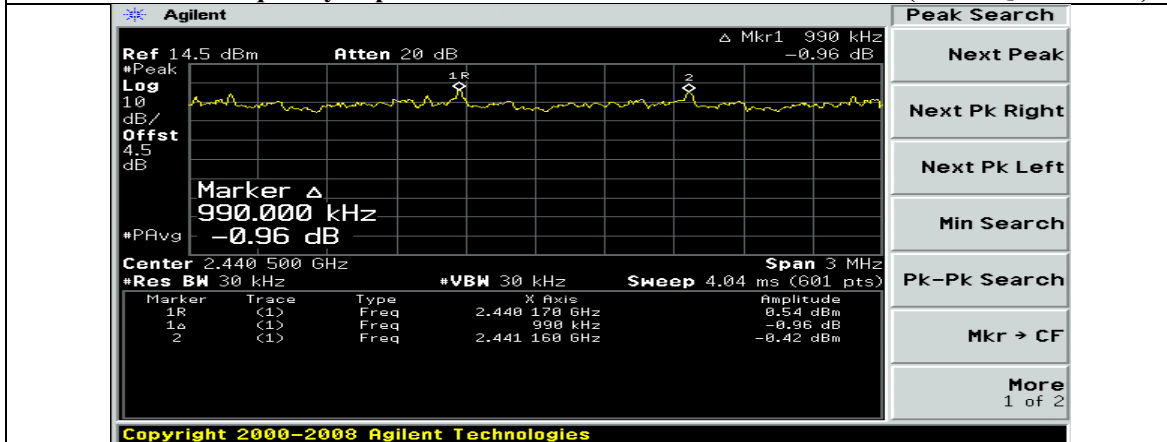
A.3.4 Carrier Frequency Separation Graphical Results



Title: Carrier Frequency Separation between 2440 MHz & 2441 MHz (GFSK-DH5)



Title: Carrier Frequency Separation between 2440 MHz & 2441 MHz (Pi/4 DQPSK-DH5)



Title: Carrier Frequency Separation between 2440 MHz & 2441 MHz (8-DPSK-DH5)



## **A.4 Number of Hopping Frequencies**

### **A.4.1 Limits**

FCC 15.247(a) (iii) & RSS-247 (5.1) (4)

Frequency hopping systems operating in the band 2400-2483.5MHz shall use at least 15 hopping channels.

### **A.4.2 Test Procedures**

Refer to Public Notice DA 00-705

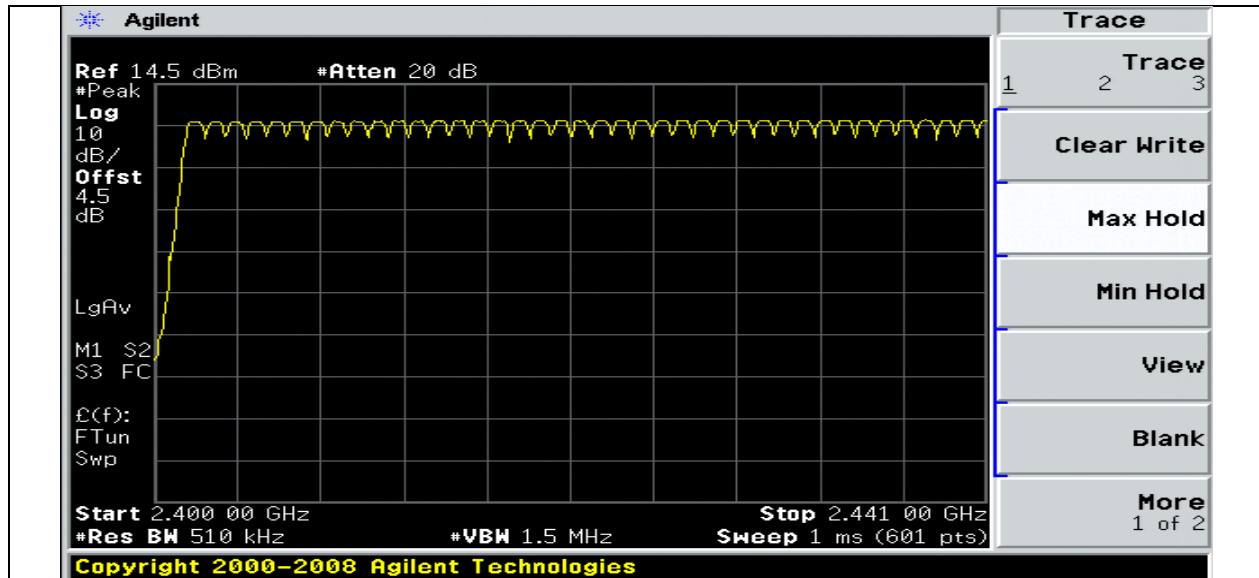
The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

- Span = the frequency band of operation
- RBW > 1% of the span
- VBW > RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize
- It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies.

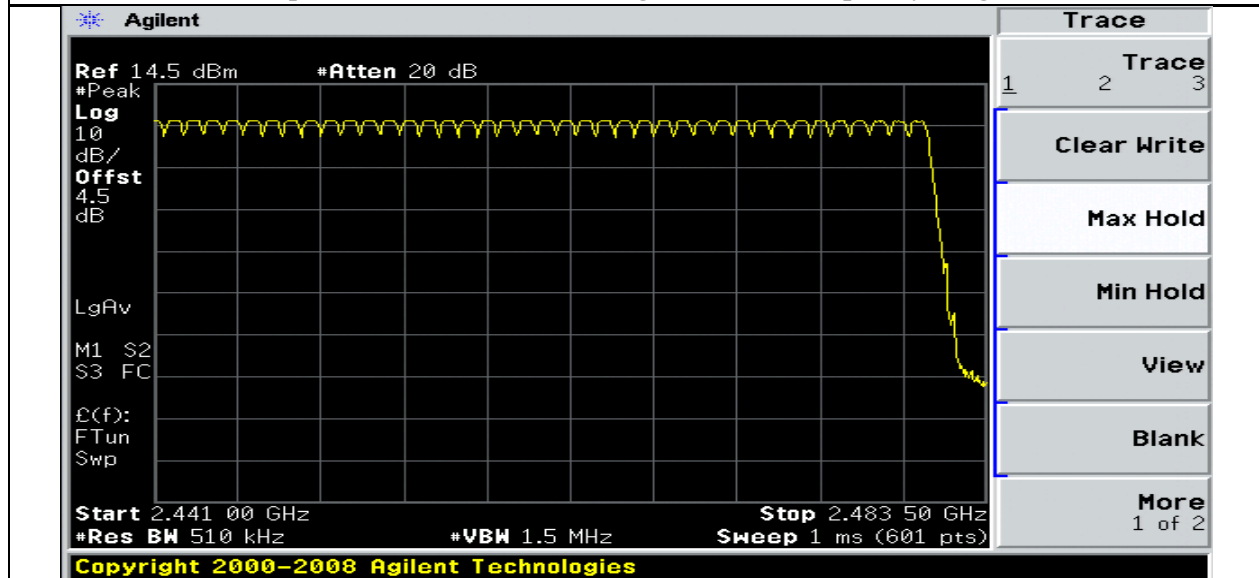
### **A.4.3 Number of Hopping Frequencies Data Table**

<b>Frequency (MHz)</b>	<b>Total No. of Channels</b>	<b>Limits</b>	<b>Results</b>
2400 – 2483.5	79	$\geq 15$	Pass
<b>Total number of hopping frequencies in the 2400-2483.5MHz Band = 79 Channels</b>			

**A.4.3 Number of Hopping Frequencies Graphical Test Results**



Title: Total No. of Hops Channels = 39.5 for 1<sup>st</sup> segment in the frequency range 2400-2440MHz



Title: Total No. of Hops Channels = 39.5 for 2<sup>nd</sup> segment in the frequency range 2441-2483.5MHz



## **A.5 Average Time of Occupancy**

### **A.5.1 Limits**

FCC 15.247 (a) (iii) & RSS-247 (5.1) (4)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

### **A.5.2 Test Procedure**

Refer to Public Notice DA 00 705

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

- Span = zero span, centered on a hopping channel
- RBW = 1 MHz
- VBW  $\geq$  RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector function = peak
- Trace = max hold
- If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation

The total sweep time is  $0.4(79) = 31.6$  seconds.

Due to the number of hops in the 31.6s sweep we determined to reduce the sweep time to 15.80, count the number of hops and multiply by 2. The total number of hops will be multiplied by the measured time of one pulse.

Example: Number of Hops in 15.80s = 80. Total Number of Hops in 31.6s =  $80(2) = 160$   
Single Pulse Width = 0.001s. Time of Occupancy =  $160(0.001) = 0.160$ s

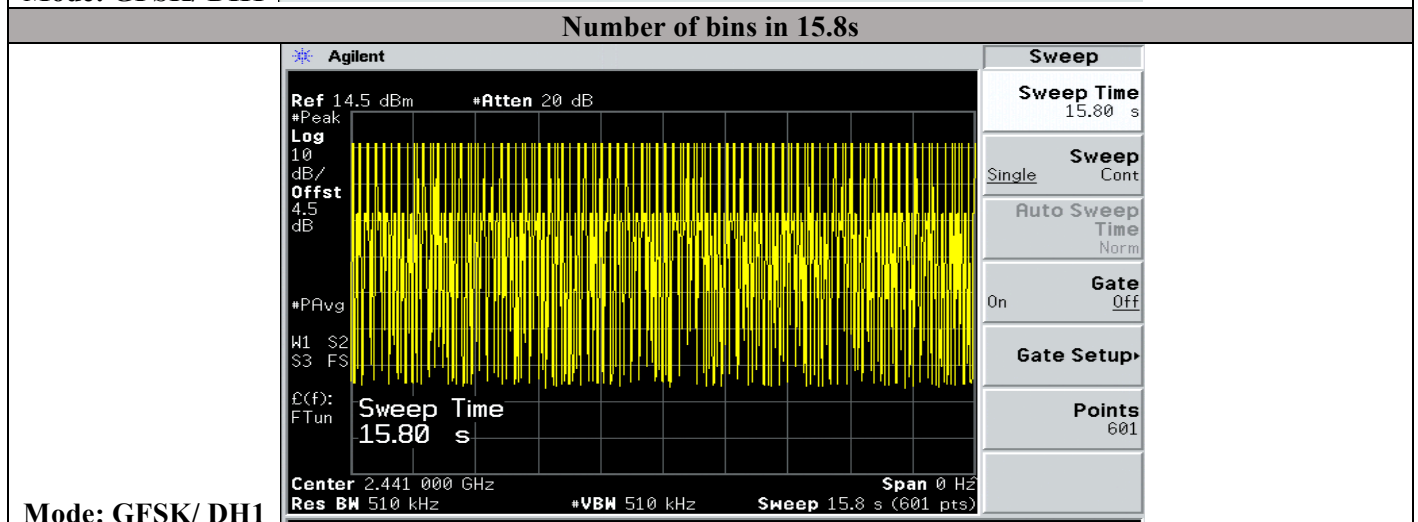
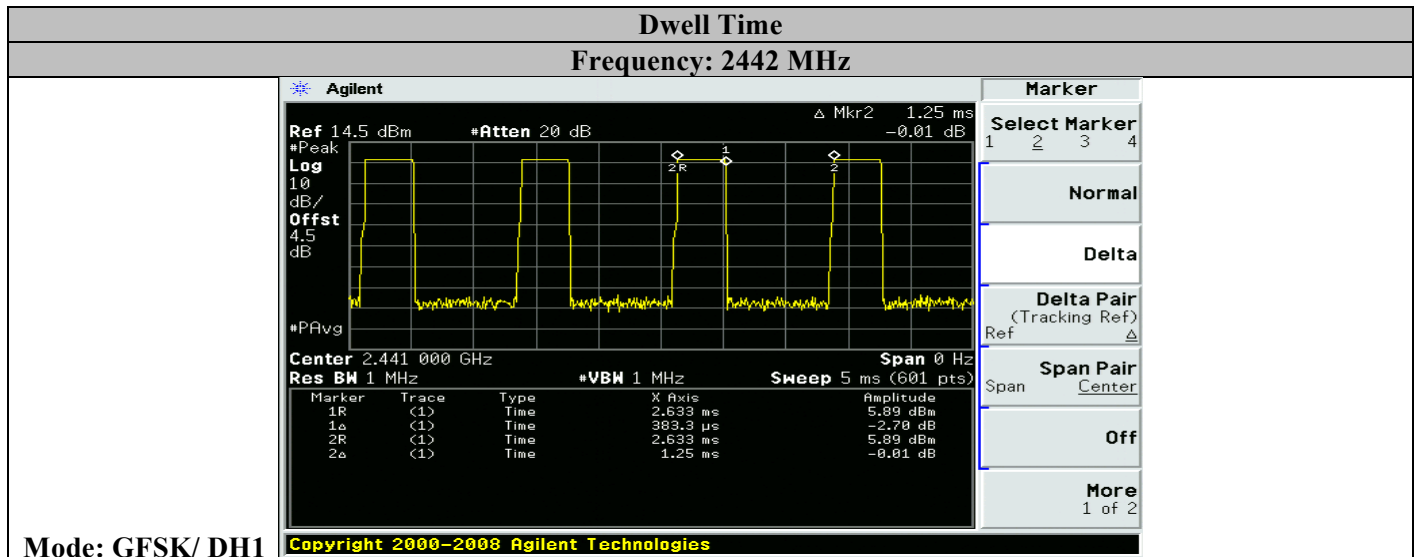


**A.5.3 Average Time of Occupancy and Dwell Time Data table**

<b>Frequency (MHz)</b>	<b>Packet Type</b>	<b>Dwell Time (ms)</b>	<b>Time Occupancy (ms)</b>	<b>Limits (ms)</b>	<b>Results</b>
2441	DH1	0.383	111.07	400	Pass
2441	DH3	1.65	264.0	400	Pass
2441	DH5	2.883	288.3	400	Pass
2441	2-DH1	0.3917	116.816	400	Pass
2441	2-DH3	1.65	260.8	400	Pass
2441	2-DH5	2.9	235.586	400	Pass
2441	3-DH1	0.3917	113.68	400	Pass
2441	3-DH3	1.63	270.6	400	Pass
2441	3-DH5	2.873	266.8	400	Pass



**A.5.4 Average Time of Occupancy, Dwell Time Graphical Test Results & Calculation**



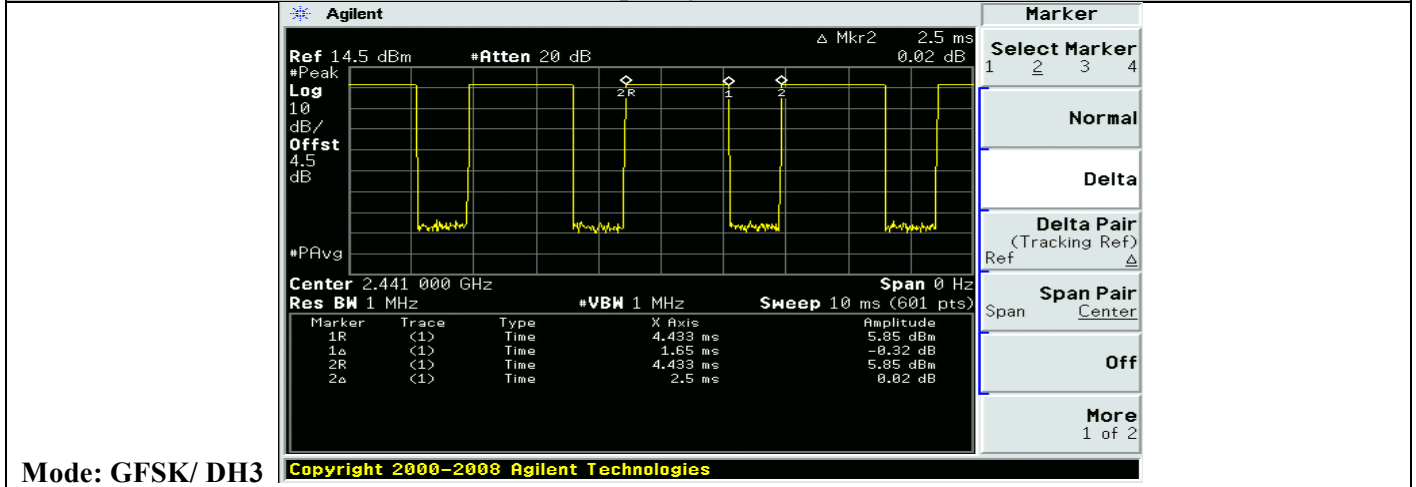
**Average Time of Occupancy Calculation**

Mode: GFSK/ DH1

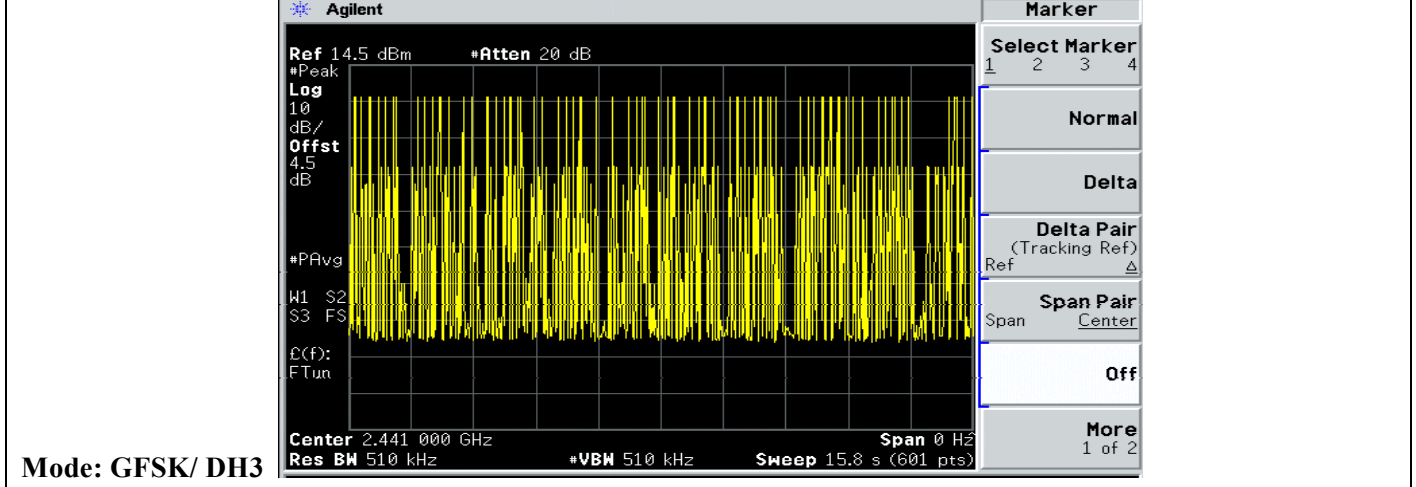
Dwell Time = **0.383ms**  
 Total bins in 15.8 s = 145  
 Max. Allowed time = 0.4 s x No. of available channels = 0.4s x 79 = 31.6s  
 Total bins in 31.6s = 145 (in 15.8s) x 2 = 290 bins  
 Total time occupancy (in 31.6s) = 290 x 0.383ms = **111.07ms** or 0.111s



**Dwell Time**  
**Frequency: 2441 MHz**



**Number of bins in 15.8s**



Mode: GFSK/ DH3

Dwell Time = 1.65ms  
 Total bins in 15.8 s = 80  
 Max. Allowed time = 0.4 s x No. of available channels = 0.4s x 79 = 31.6s  
 Total bins in 31.6s = 80 (in 15.8s) x 2 = 160 bins  
 Total time occupancy (in 31.6s) = 160 x 1.65ms = **264ms** or 0.264s



**Dwell Time**  
**Frequency: 2442 MHz**

Agilent  
 Ref 14.5 dBm #Atten 20 dB Δ Mkr2 3.75 ms  
 #Peak 0.02 dB  
 Log 10 dB/Offst 4.5 dB  
 #PAvg  
 Center 2.441 000 GHz Span 0 Hz  
 Res BW 1 MHz #VBW 1 MHz Sweep 10 ms (601 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	1.917 ms	5.93 dBm
1Δ	(1)	Time	2.883 ms	-0.09 dB
2R	(1)	Time	1.917 ms	5.93 dBm
2Δ	(1)	Time	3.75 ms	0.02 dB

**Marker**

Select Marker  
 1 2 3 4

Normal

Delta

Delta Pair  
 (Tracking Ref)  
 Ref Δ

Span Pair  
 Span Center

Off

More  
 1 of 2

Mode: GFSK/ DH5 Copyright 2000-2008 Agilent Technologies

**Number of bins in 15.8s**

Agilent  
 Ref 14.5 dBm #Atten 20 dB  
 #Peak  
 Log 10 dB/Offst 4.5 dB  
 #PAvg  
 W1 S2  
 S3 FS  
 Sweep Time  
 15.80 s  
 Center 2.441 000 GHz Span 0 Hz  
 Res BW 510 kHz #VBW 510 kHz Sweep 15.8 s (601 pts)

**Sweep**

Sweep Time  
 15.80 s

Single Sweep Cont

Auto Sweep Time Norm

On Gate Off

Gate Setup

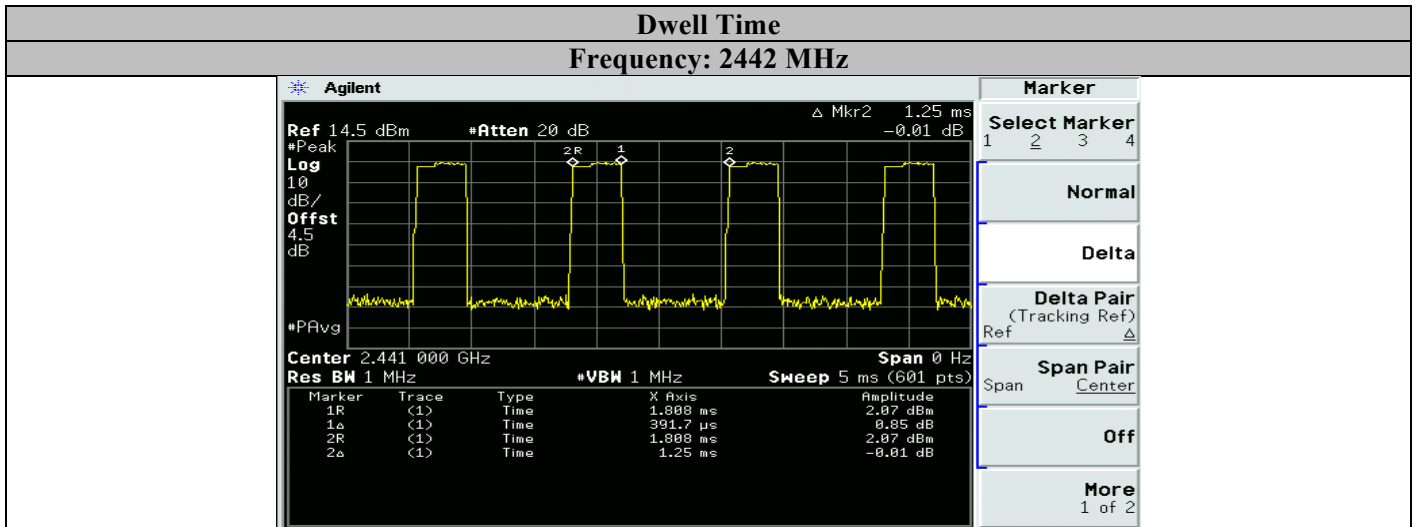
Points  
 601

Mode: GFSK/ DH5

**Average Time of Occupancy Calculation**

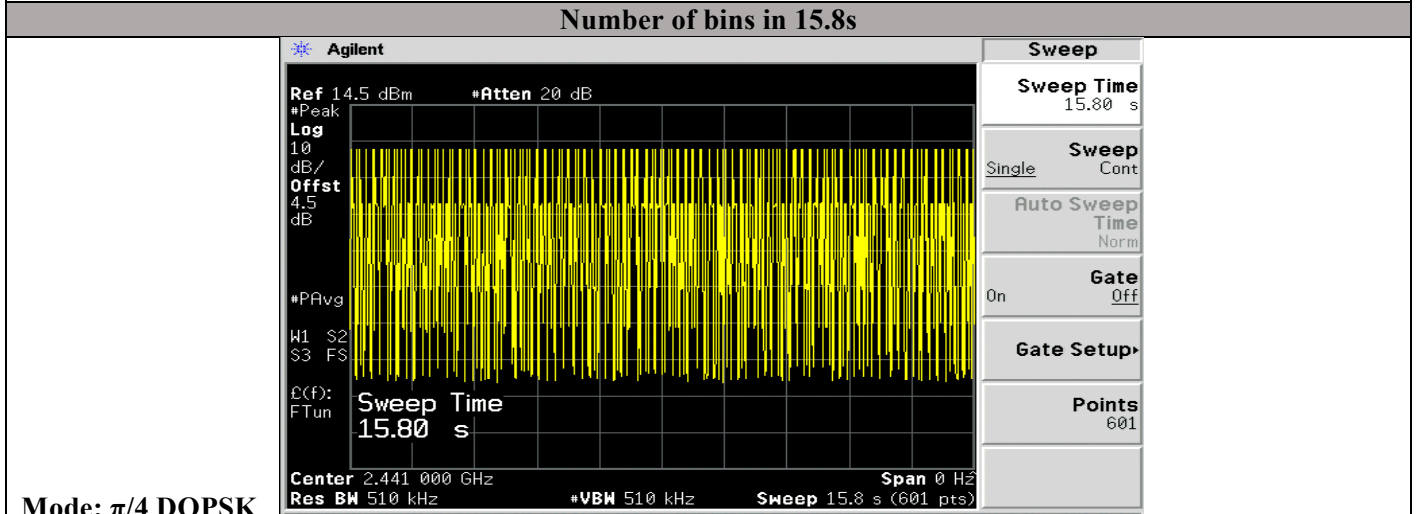
Mode: GFSK/ DH5

Dwell Time = **2.883 ms**  
 Total bins in 15.8s = 50  
 Max. Allowed time = 0.4 s x No. of available channels = 0.4s x 79 = 31.6s  
 Total bins in 31.6s = 50 (in 15.8s) x 2 = 100 bins  
 Total time occupancy (in 31.6s) = 100 x 2.883ms = **288.3ms** or 0.2883s



Mode:  $\pi/4$  DQPSK

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Mode:  $\pi/4$  DQPSK

**Average Time of Occupancy Calculation**

<b>Mode/Packet Type</b>	Dwell Time = <b>0.392</b>
$\pi/4$ DQPSK/ 2-DH1	Total bins in 15.8 s = 145
	Max. Allowed time = 0.4 s x No. of available channels = 0.4s x 79 = 31.6s
	Total bins in 31.6s = 145 (in 15.8s) x 2 = 290 bins
	Total time occupancy (in 31.6s) = 290 x 0.392ms = <b>113.68ms</b> or 0.1136s



**Dwell Time**  
**Frequency: 2441 MHz**

Agilent  
 Ref 14.5 dBm #Atten 20 dB  
 #Peak 10 dB/Offst 4.5 dB  
 #PAvg  
 Center 2.441 000 GHz Span 0 Hz  
 Res BW 1 MHz #VBW 1 MHz Sweep 10 ms (601 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	3.7 ms	1.96 dBm
1a	(1)	Time	1.65 ms	0.55 dB
2R	(1)	Time	3.7 ms	1.96 dBm
2a	(1)	Time	2.5 ms	-0.02 dB

**Marker**

Select Marker  
 1 2 3 4

Normal

Delta

Delta Pair  
 (Tracking Ref)  
 Ref Δ

Span Pair  
 Span Center

Off

More  
 1 of 2

Mode:  $\pi/4$  DQPSK Copyright 2000-2008 Agilent Technologies

**Number of bins in 15.8s**

Agilent  
 Ref 14.5 dBm #Atten 20 dB  
 #Peak 10 dB/Offst 4.5 dB  
 #PAvg  
 W1 S2  
 S3 FS  
 E(f):  
 FTun  
 Sweep Time  
 15.80 s  
 Center 2.441 000 GHz Span 0 Hz  
 Res BW 510 kHz #VBW 510 kHz Sweep 15.8 s (601 pts)

**Sweep**

Sweep Time  
 15.80 s

Single Sweep Cont

Auto Sweep Time Norm

Gate On Off

Gate Setup

Points  
 601

Mode:  $\pi/4$  DQPSK

**Average Time of Occupancy Calculation**

<b>Mode/Packet Type</b>	Dwell Time = <b>1.65ms</b>
	Total bins in 15.8 s = 82
	Max. Allowed time = 0.4 s x No. of available channels = 0.4s x 79 = 31.6s
	Total bins in 31.6s = 82 (in 15.8s) x 2 = 164 bins
	Total time occupancy (in 31.6s) = 164 x 1.65ms = <b>270.6ms</b> or 0.2706s