**FCC CFR47 PART 15 SUBPART C**
**INDUSTRY CANADA RSS-210 ISSUE 7**

# CERTIFICATION TEST REPORT

**FOR**

**3G/UNLICENSED WIRELESS HUB**

**MODEL NUMBER: QWH-HUB-V1.0A**

**FCC ID: J9C2NET**
**IC: 2723A-2NET**

**REPORT NUMBER: 11U114082-2, Revision A**

**ISSUE DATE: December 09, 2011**

*Prepared for*
**QUALCOMM INCORPORATED**
**5775 MOREHOUSE DRIVE**
**SAN DEIGO, CA 92121-1714**

*Prepared by*
**COMPLIANCE CERTIFICATION SERVICES (UL CCS)**
**47173 BENICIA STREET**
**FREMONT, CA 94538, U.S.A.**
**TEL: (510) 771-1000**
**FAX: (510) 661-0888**

NVLAP LAB CODE 200065-0

Revision History

| Rev. | Issue Date | Revisions | Revised By |
|---|---|---|---|
| -- | 11/30/11 | Initial Issue | F. Ibrahim |
| A | 12/09/11 | Revised section 5.2 | F. Ibrahim |

# TABLE OF CONTENTS

**1. ATTESTATION OF TEST RESULTS ..... 5**

**2. TEST METHODOLOGY ..... 6**

**3. FACILITIES AND ACCREDITATION ..... 6**

**4. CALIBRATION AND UNCERTAINTY ..... 6**

*4.1. MEASURING INSTRUMENT CALIBRATION ..... 6*

*4.2. SAMPLE CALCULATION ..... 6*

*4.3. MEASUREMENT UNCERTAINTY ..... 6*

**5. EQUIPMENT UNDER TEST ..... 7**

*5.1. DESCRIPTION OF EUT ..... 7*

*5.2. MAXIMUM OUTPUT POWER ..... 7*

*5.3. DESCRIPTION OF AVAILABLE ANTENNAS ..... 7*

*5.4. SOFTWARE AND FIRMWARE ..... 7*

*5.5. WORST-CASE CONFIGURATION AND MODE ..... 7*

*5.6. DESCRIPTION OF TEST SETUP ..... 8*

**6. TEST AND MEASUREMENT EQUIPMENT ..... 11**

**7. ANTENNA PORT TEST RESULTS ..... 12**

*7.1. BASIC DATA RATE GFSK MODULATION ..... 12*

7.1.1. 20 dB AND 99% BANDWIDTH ..... 12

7.1.2. HOPPING FREQUENCY SEPARATION ..... 19

7.1.3. NUMBER OF HOPPING CHANNELS ..... 21

7.1.4. AVERAGE TIME OF OCCUPANCY ..... 26

7.1.5. OUTPUT POWER ..... 33

7.1.6. AVERAGE POWER ..... 37

7.1.7. CONDUCTED SPURIOUS EMISSIONS ..... 38

*7.2. ENHANCED DATA RATE 8PSK MODULATION ..... 47*

7.2.1. 20 dB AND 99% BANDWIDTH ..... 47

7.2.2. HOPPING FREQUENCY SEPARATION ..... 54

7.2.3. NUMBER OF HOPPING CHANNELS ..... 56

7.2.4. AVERAGE TIME OF OCCUPANCY ..... 61

7.2.5. OUTPUT POWER ..... 68

7.2.6. AVERAGE POWER ..... 72

7.2.7. CONDUCTED SPURIOUS EMISSIONS ..... 73

**8. RADIATED TEST RESULTS ..... 82**

*8.1. LIMITS AND PROCEDURE ..... 82*

*8.2. TRANSMITTER ABOVE 1 GHz ..... 83*

8.2.1. BASIC DATA RATE GFSK MODULATION ..... 83

8.2.2. ENHANCED DATA RATE 8PSK MODULATION ..... 92

*8.3. RECEIVER ABOVE 1 GHz ..... 101*

*8.4. WORST-CASE BELOW 1 GHz ..... 102*

**9. AC POWER LINE CONDUCTED EMISSIONS ..... 105**

**10. MAXIMUM PERMISSIBLE EXPOSURE ..... 109**

**11. SETUP PHOTOS ..... 113**

# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** QUALCOMM INCORPORATED
5775 MOREHOUSE DRIVE
SAN DEIGO, CA 92121-1714

**EUT DESCRIPTION:** 3G/UNLICENSED WIRELESS HUB

**MODEL:** QWH-HUB-V1.0A

**SERIAL NUMBER:** DEV D26001, VALC00100000145

**DATE TESTED:** NOVEMBER 17-21, 2011

| APPLICABLE STANDARDS | |
|---|---|
| **STANDARD** | **TEST RESULTS** |
| CFR 47 Part 15 Subpart C | Pass |
| INDUSTRY CANADA RSS-210 Issue 7 Annex 8 | Pass |
| INDUSTRY CANADA RSS-GEN Issue 3 | Pass |

Compliance Certification Services (UL CCS) tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL CCS based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL CCS will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For UL CCS By:

FRANK IBRAHIM
EMC SUPERVISOR
UL CCS

Tested By:

STEVE AGUILAR
EMC TECHNICIAN
UL CCS

# 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2009, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 2, and RSS-210 Issue 7.

# 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

UL CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://www.ccsemc.com.

# 4. CALIBRATION AND UNCERTAINTY

## 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

## 4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

## 4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| PARAMETER | UNCERTAINTY |
|---|---|
| Conducted Disturbance, 0.15 to 30 MHz | 3.52 dB |
| Radiated Disturbance, 30 to 1000 MHz | 4.94 dB |

Uncertainty figures are valid to a confidence level of 95%.

# 5. EQUIPMENT UNDER TEST

## 5.1. DESCRIPTION OF EUT

The EUT is a 3G/ Unlicensed Wireless Hub with WLAN and Bluetooth.

The radio module is manufactured by Qualcomm.

## 5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

| Frequency Range (MHz) | Mode | Output Power (dBm) | Output Power (mW) |
|---|---|---|---|
| 2402 - 2480 | Basic GFSK | 7.45 | 5.56 |
| 2402 - 2480 | Enhanced 8PSK | 7.26 | 5.32 |

## 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an internal PIFA antenna, with a maximum gain of 3.8 dBi.

## 5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was btContTx., rev. 11-2-2011.

## 5.5. WORST-CASE CONFIGURATION AND MODE

The worst-case channel is determined as the channel with the highest output power.

Radiated emissions below 1 GHz and power line conducted emissions were performed with the EUT set to the channel with highest output power.

For the fundamental investigation, since the EUT is a portable device that has three orientations; X, Y and Z orientations have been investigated and the worst case was found to be at Z orientation.

## 5.6. DESCRIPTION OF TEST SETUP

**SUPPORT EQUIPMENT**

| PERIPHERAL SUPPORT EQUIPMENT LIST | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number** | **FCC ID** |
| Laptop w/ power supply | HP Compaq | 6910P | CND8143DGD | -- |

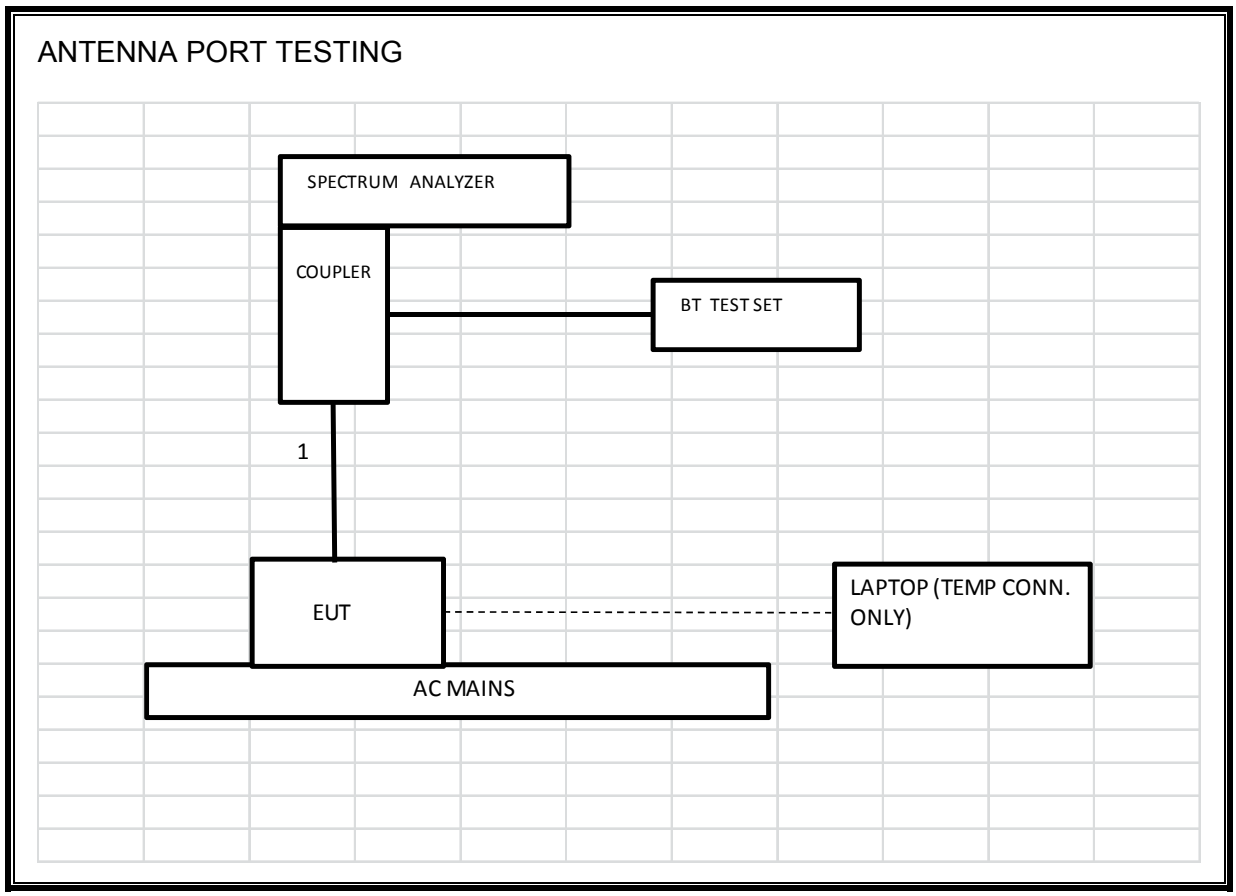
**I/O CABLES**

| I/O CABLE LIST | | | | | | |
|---|---|---|---|---|---|---|
| **Cable No.** | **Port** | **# of Identical Ports** | **Connector Type** | **Cable Type** | **Cable Length** | **Remarks** |
| 1 | BT RF out | 1 | SMA | Shieldied | 60 cm | Testing only. Port not part of final product. |
| 2 | AC | 2 | AC PLUG (US) | Unshielded | 1.8m | AC extenison cord |

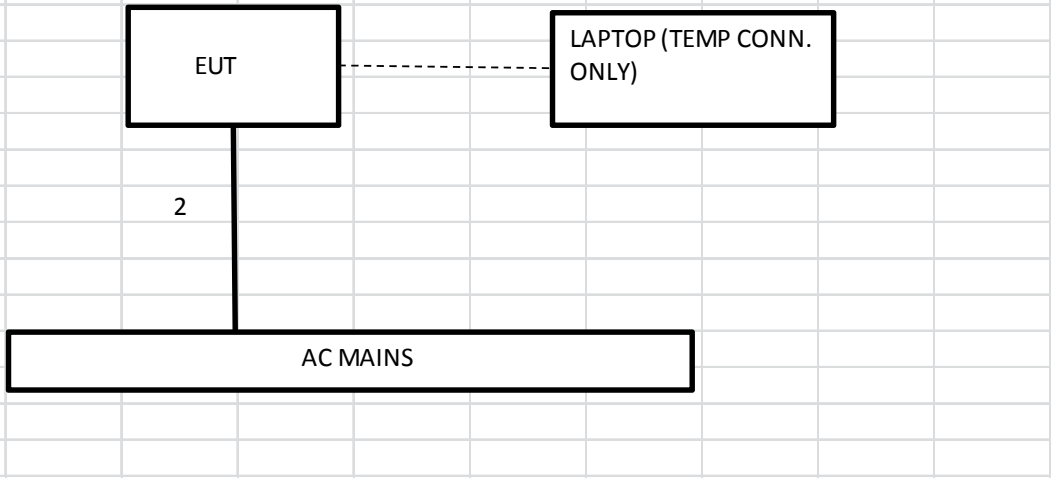
**TEST SETUP**

The EUT is set to transmit in Blue tooth mode either by using a Bluetooth Test Set or temporarily connecting a laptop via a USB cable to enter the appropriate command in the DOS CMD window.

**SETUP DIAGRAM FOR TESTS**



RADIATED EMISSIONS TESTS



# 6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

| TEST EQUIPMENT LIST | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Asset** | **Cal Due** |
| Spectrum Analyzer, 26.5 GHz | Agilent / HP | E4440A | C01176 | 08/04/12 |
| P-Seies single channel Power Meter | Agilent / HP | N1911A | 1260847C | 08/04/12 |
| Spectrum Analyzer, 44 GHz | Agilent / HP | E4446A | C00986 | 12/17/11 |
| Bi Directional coupler | RF Lambda | RFDC5M06G15 | -- | -- |
| P-Seies single channel Power Meter | Agilent / HP | N1911A | N/A | 08/04/12 |
| Preamplifier, 26.5 GHz | Agilent / HP | 8449B | C01052 | 06/13/12 |
| Preamplifier, 1300 MHz | Agilent / HP | 8447D | C01048 | 07/16/12 |
| BiLog Antenna | ETS | 3117 | C01005 | 07/25/12 |
| Antenna, Horn, 18 GHz | EMCO | 3115 | C00945 | 06/26/12 |
| PSA | Agilent | E4440A | T129 | 04/28/12 |
| Power meter | Agilent | E4416A | PPM3 | 03/22/12 |
| Power Sensor | Agilent | E9327A | T233 | 03/22/12 |
| LISN, 30 MHz | FCC | LISN-50/250-25-2 | N02625 | 11/15/12 |
| LISN, 10 kHz ~ 30 MHz | Solar | 8012-50-R-24-BNC | N02481 | 11/16/12 |
| EMI Test Receiver | R&S | ESC17 | 10000741 | 07/02/12 |
| Antenna, Horn, 26.5 GHz | ARA | SWH-28 | C01015 | 10/06/12 |

# 7. ANTENNA PORT TEST RESULTS

## 7.1. BASIC DATA RATE GFSK MODULATION

### 7.1.1. 20 dB AND 99% BANDWIDTH

**LIMIT**

None; for reporting purposes only.

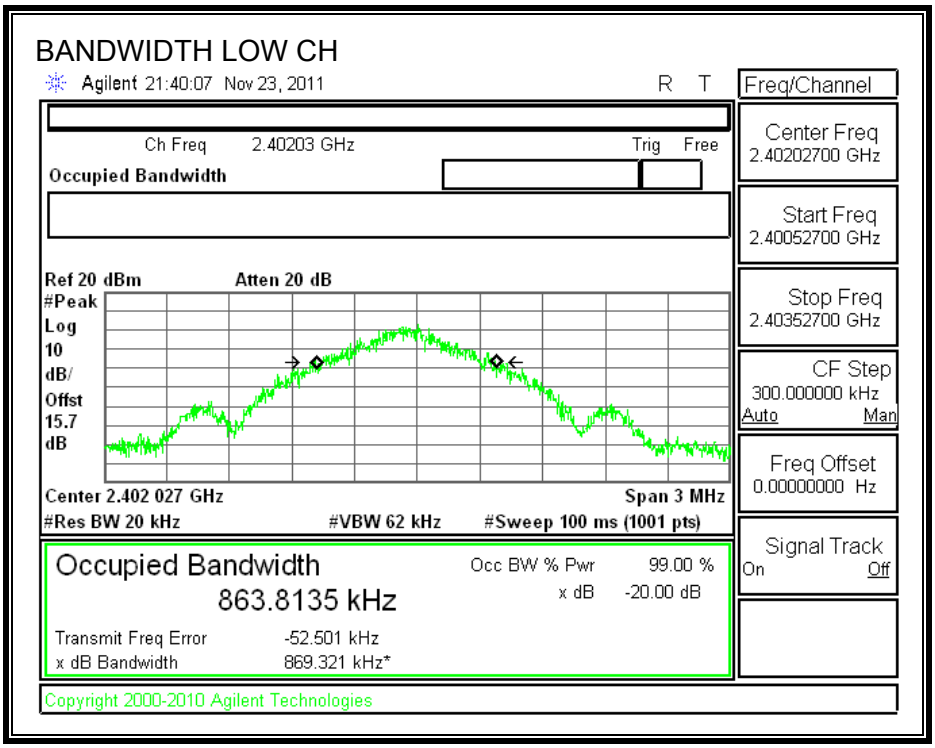
**TEST PROCEDURE**

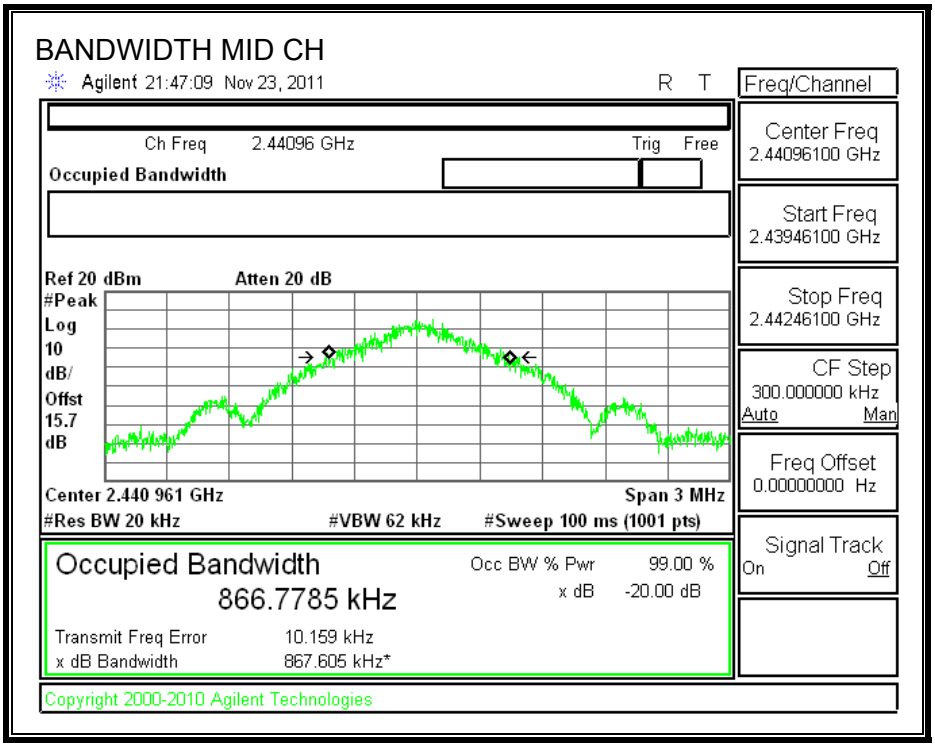
The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

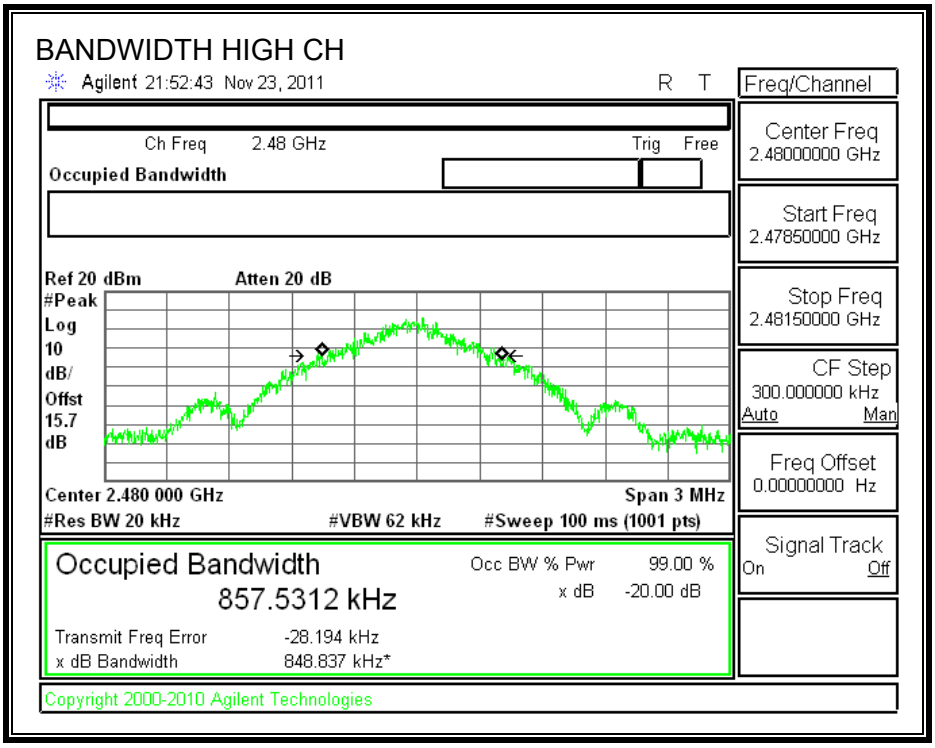
**RESULTS**

| Channel | Frequency (MHz) | 20 dB Bandwidth (kHz) | 99% Bandwidth (kHz) |
|---|---|---|---|
| Low | 2402 | 869.321 | 854.9906 |
| Middle | 2441 | 867.605 | 857.273 |
| High | 2480 | 848.837 | 839.0326 |

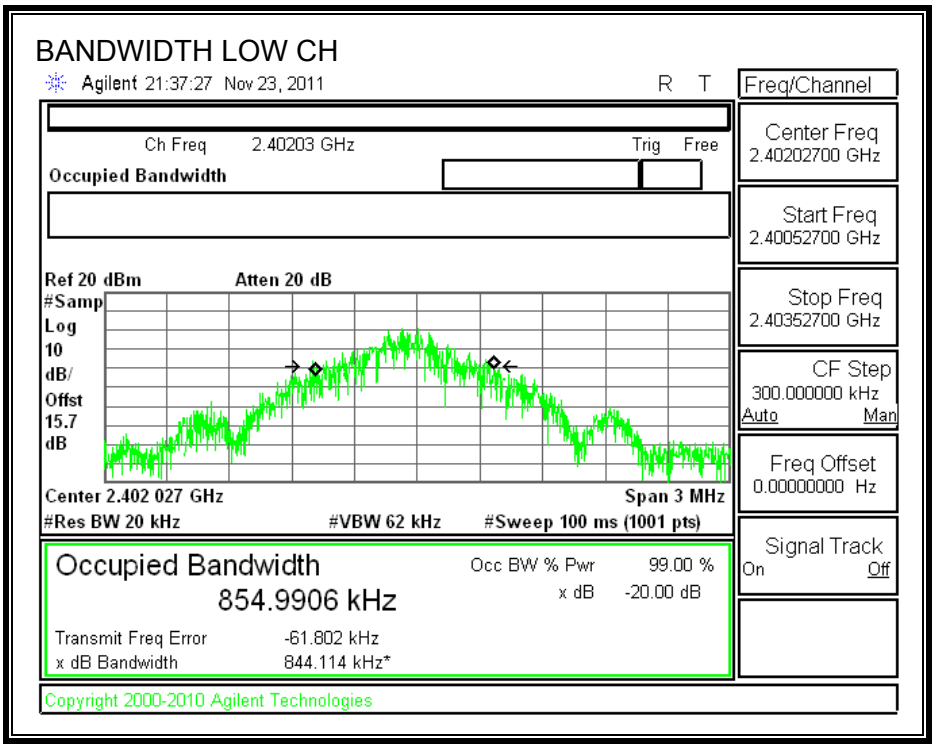
**20 dB BANDWIDTH**

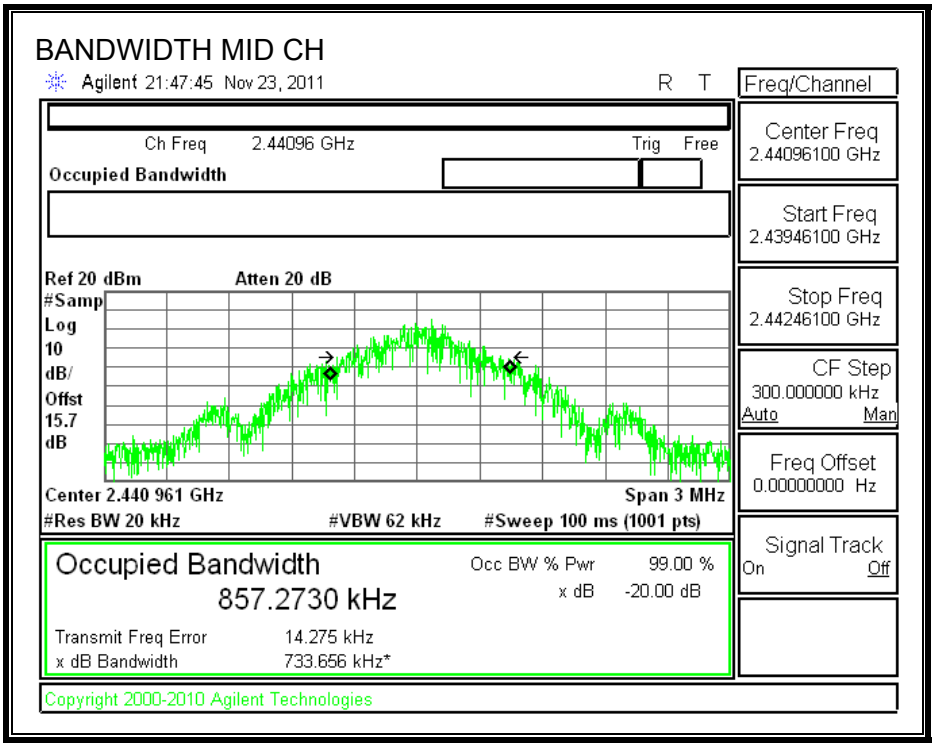


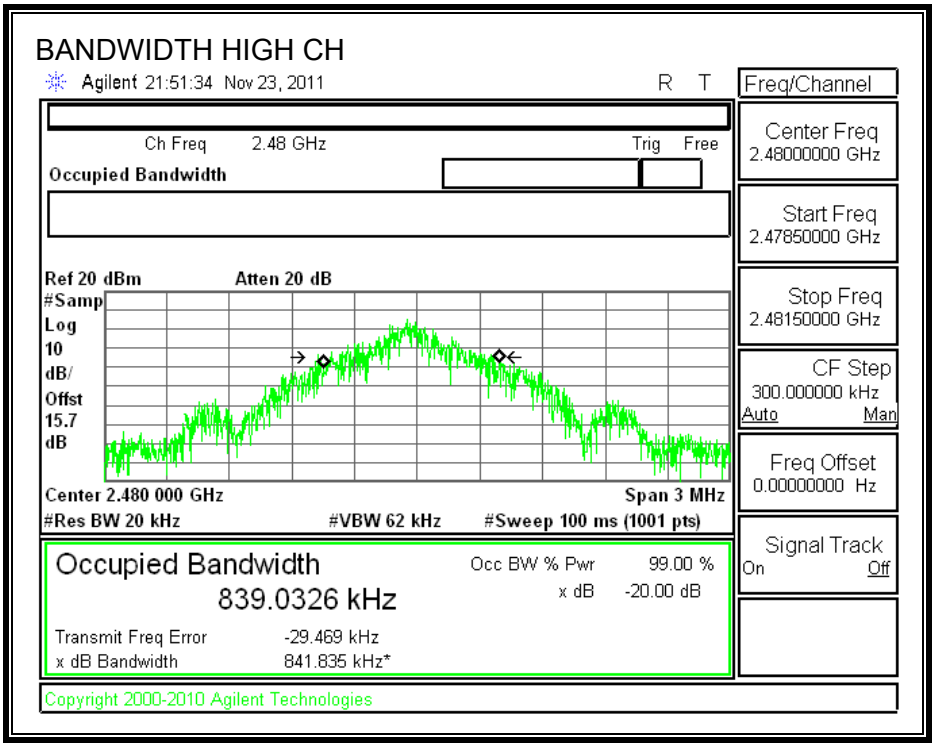




**99% BANDWIDTH**







## 7.1.2. HOPPING FREQUENCY SEPARATION

**LIMIT**

FCC §15.247 (a) (1)

IC RSS-210 A8.1 (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hoping channel, whichever is greater.

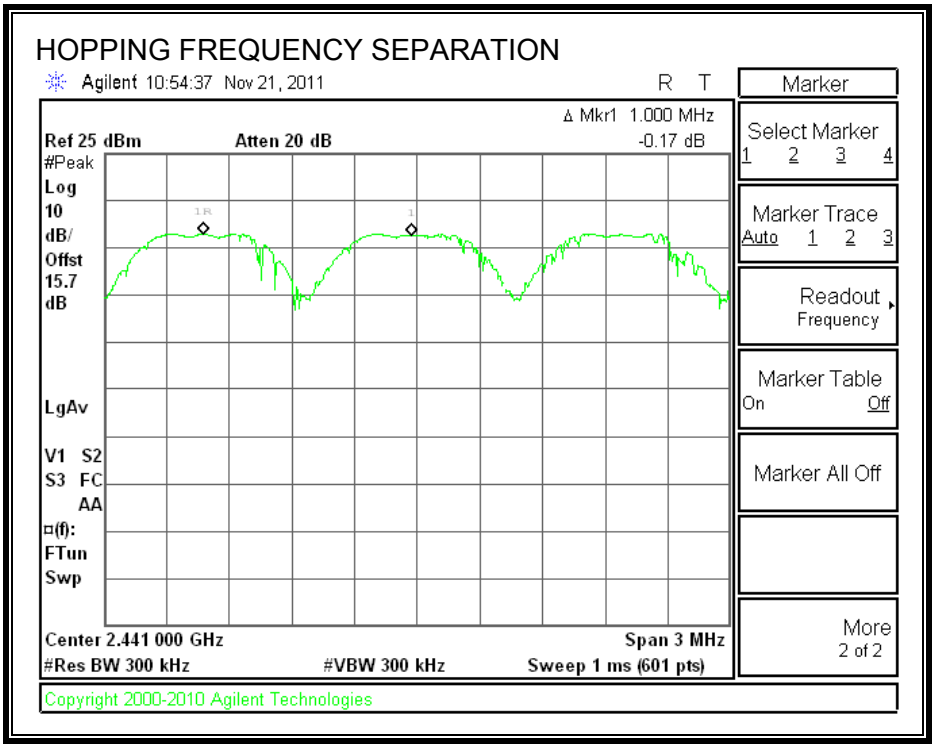
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

## RESULTS

## HOPPING FREQUENCY SEPARATION



## 7.1.3. NUMBER OF HOPPING CHANNELS

**LIMIT**

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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

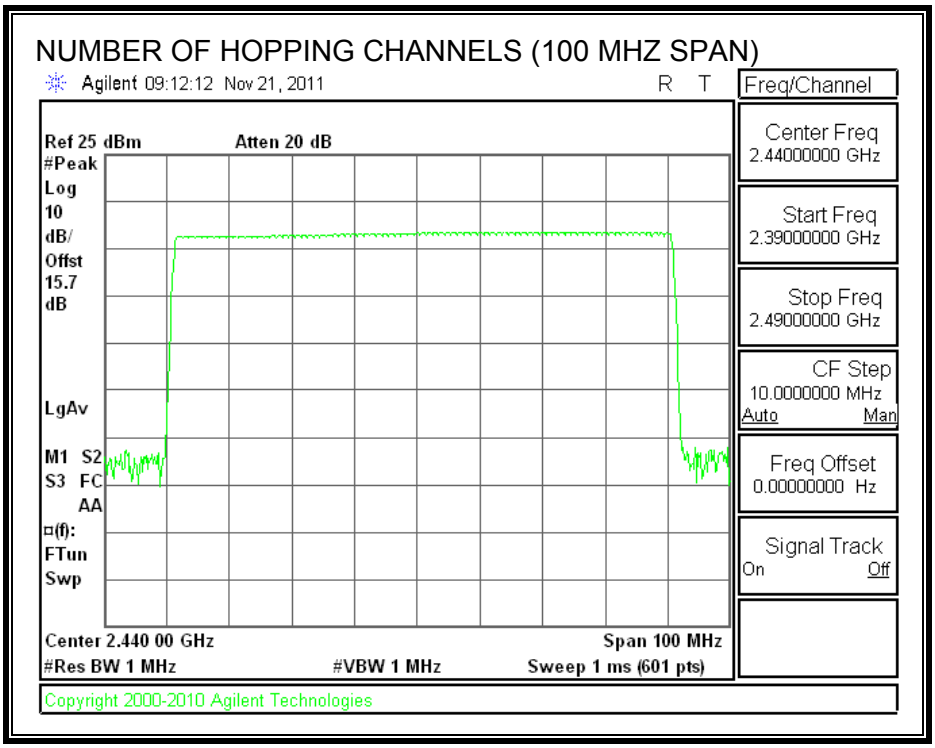
**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

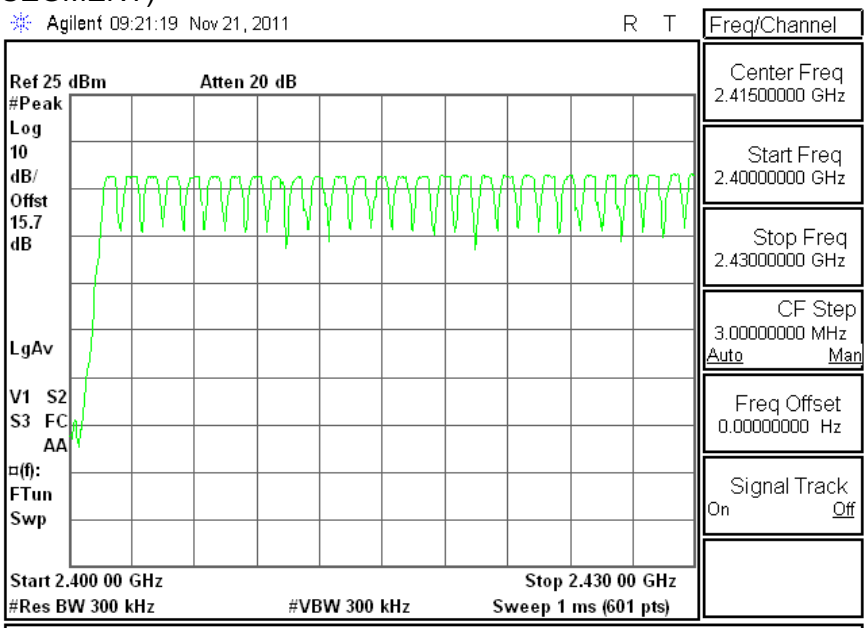
**RESULTS**

79 Channels observed.

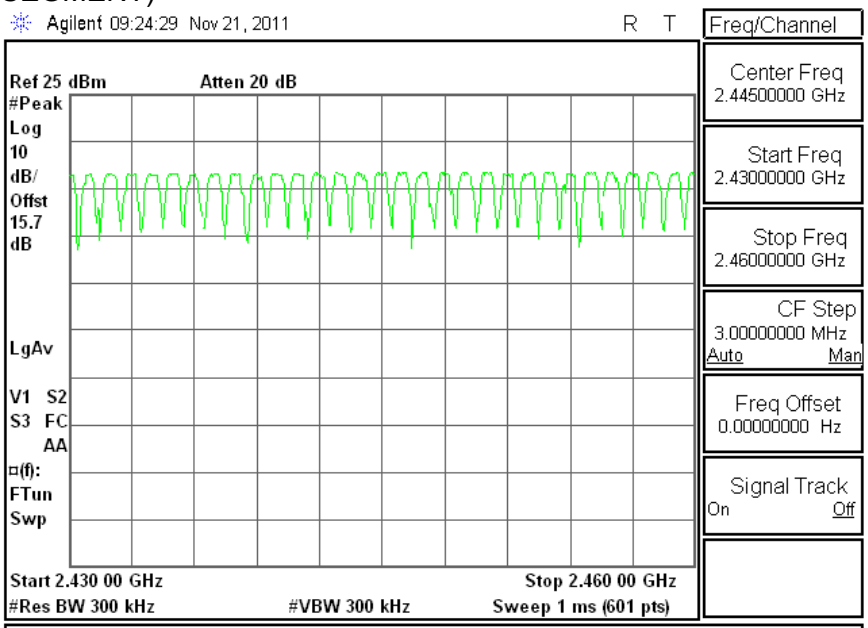
**NUMBER OF HOPPING CHANNELS**



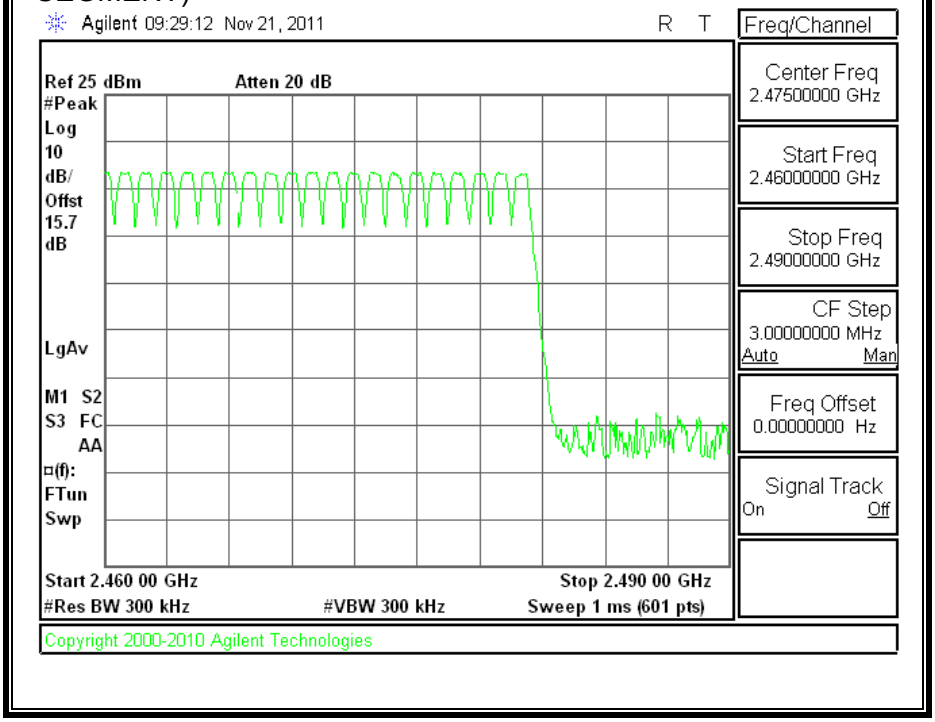
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, SECOND SEGMENT)



NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, THIRD SEGMENT)



## 7.1.4. AVERAGE TIME OF OCCUPANCY

**LIMIT**

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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.

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

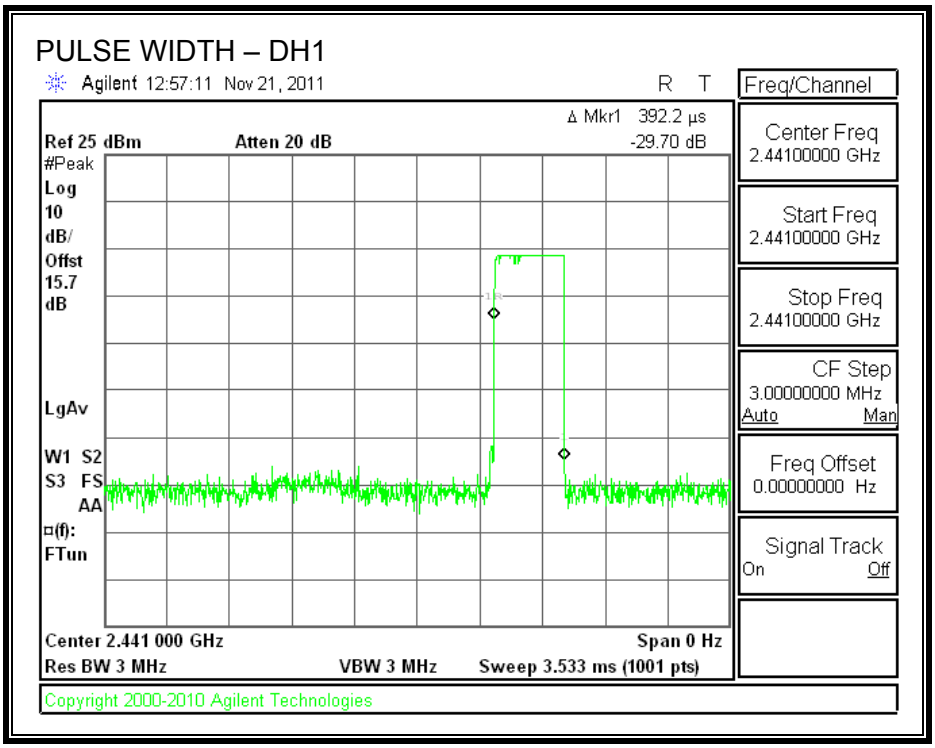
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

**RESULTS**

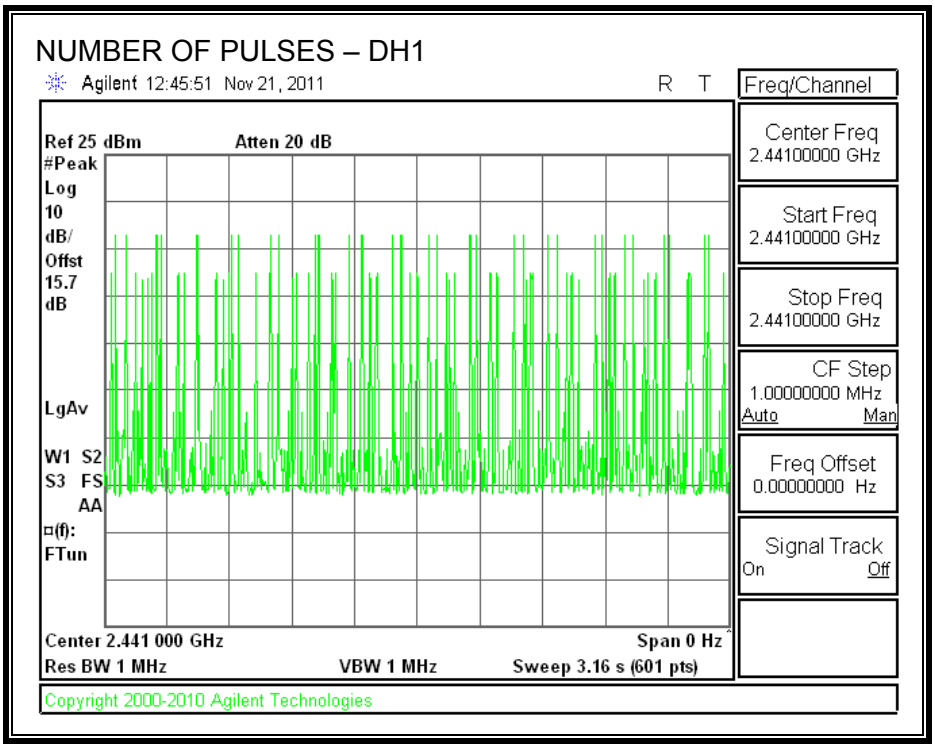
GFSK Mode

| DH Packet | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of (sec) | Limit (sec) | Margin (sec) |
|---|---|---|---|---|---|
| DH1 | 0.3922 | 37 | 0.1451 | 0.4 | -0.2549 |
| DH3 | 1.661 | 16 | 0.2658 | 0.4 | -0.1342 |
| DH5 | 2.917 | 10 | 0.2917 | 0.4 | -0.1083 |

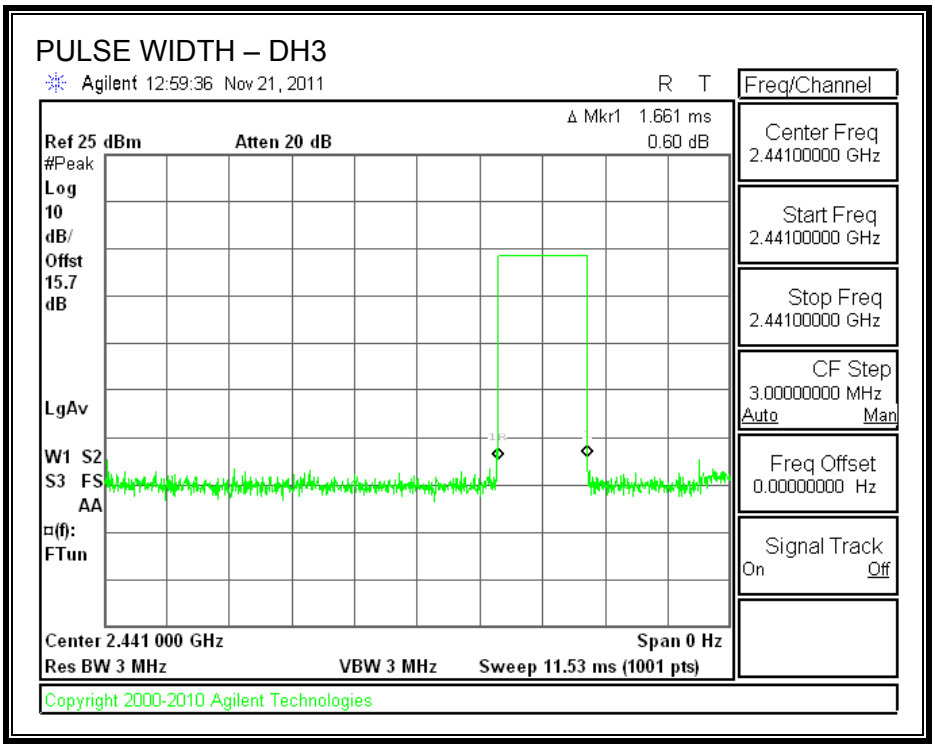
**PULSE WIDTH - DH1**



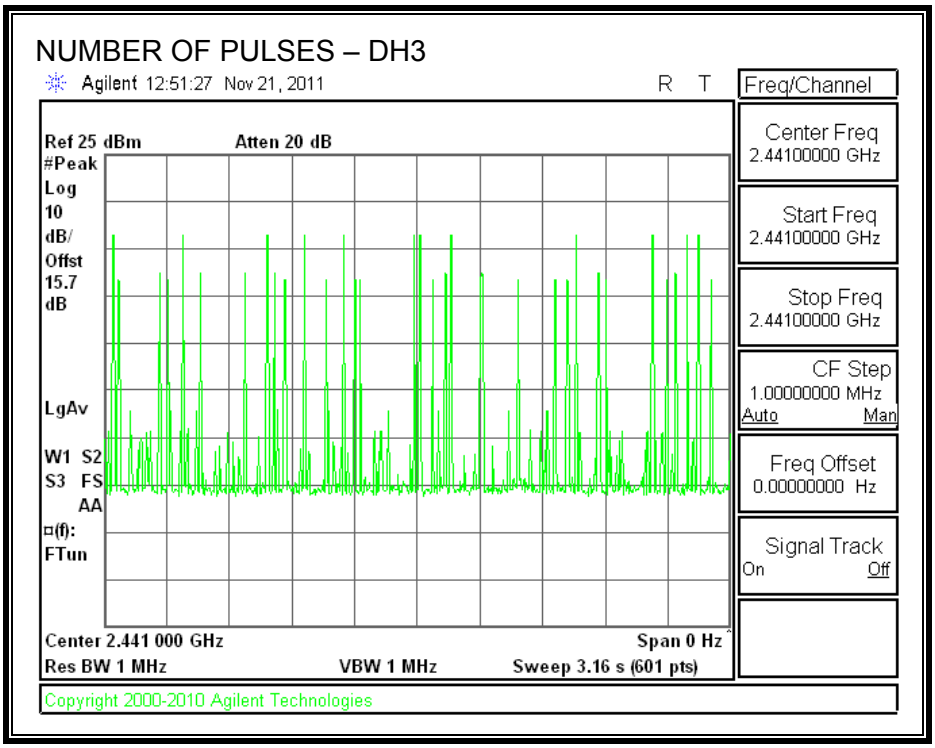
**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1**



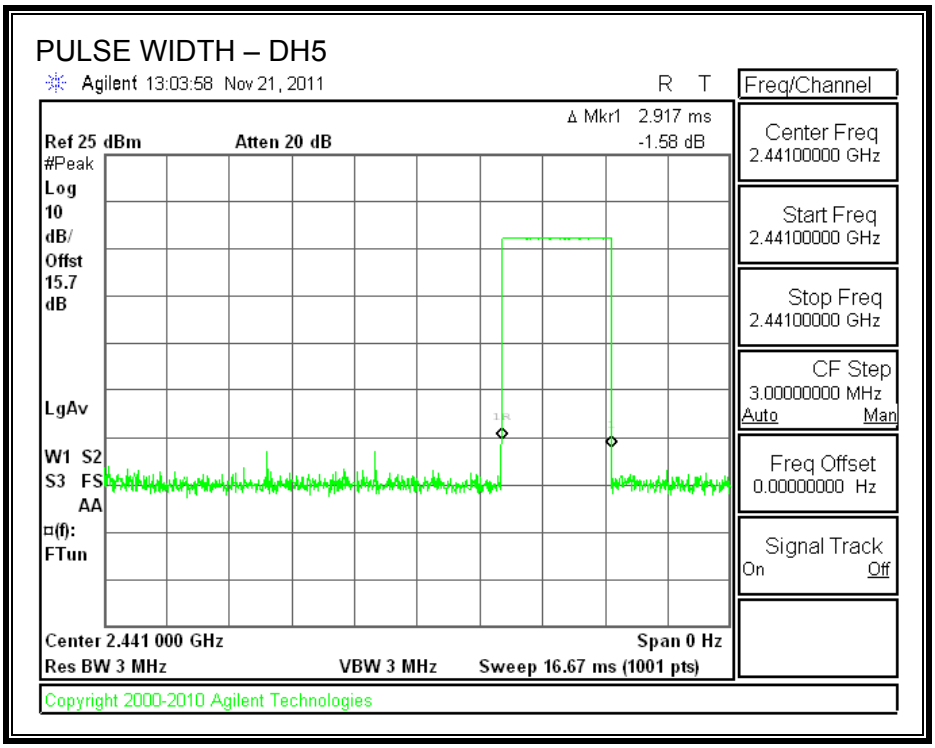
**PULSE WIDTH – DH3**



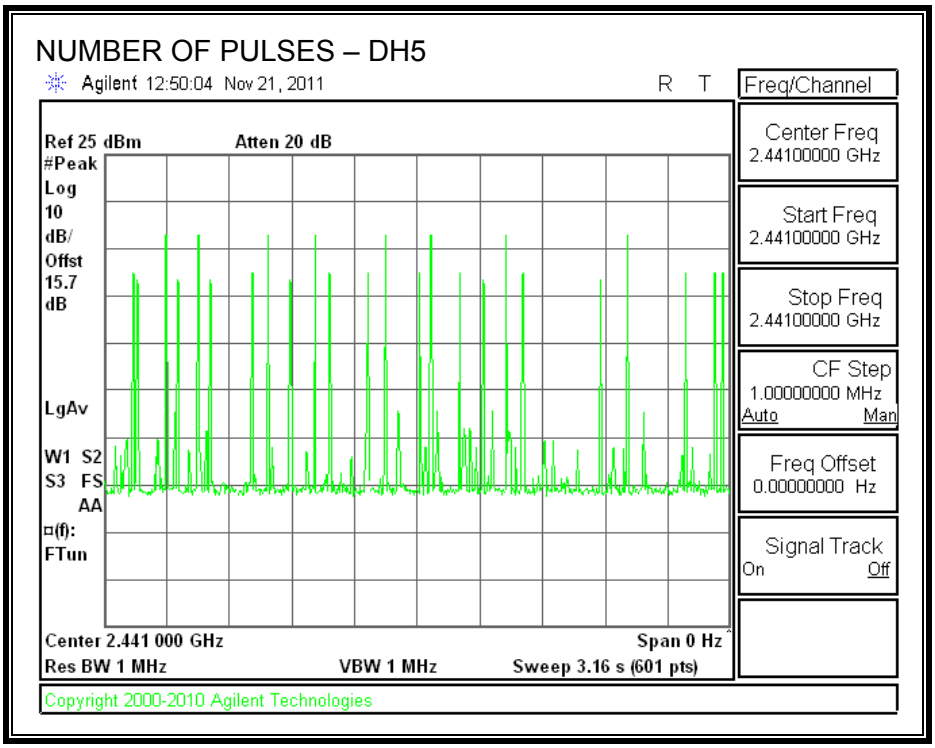
**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3**



**PULSE WIDTH – DH5**



**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5**



### 7.1.5. OUTPUT POWER

**LIMIT**

§15.247 (b) (1)

RSS-210 Issue 7 Clause A8.4

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm.

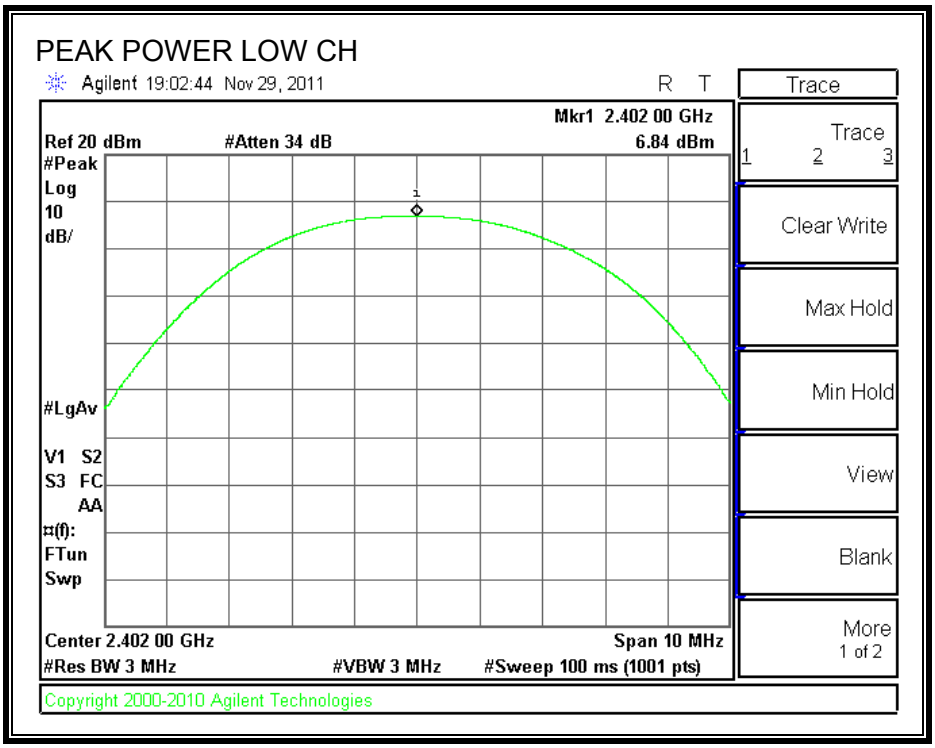
**TEST PROCEDURE**

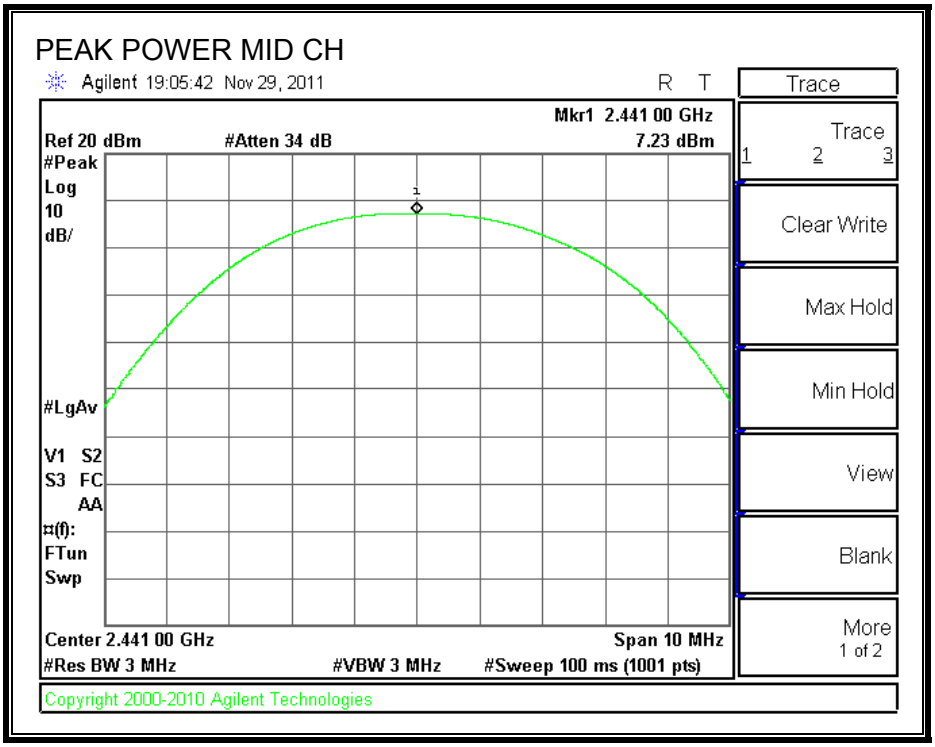
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

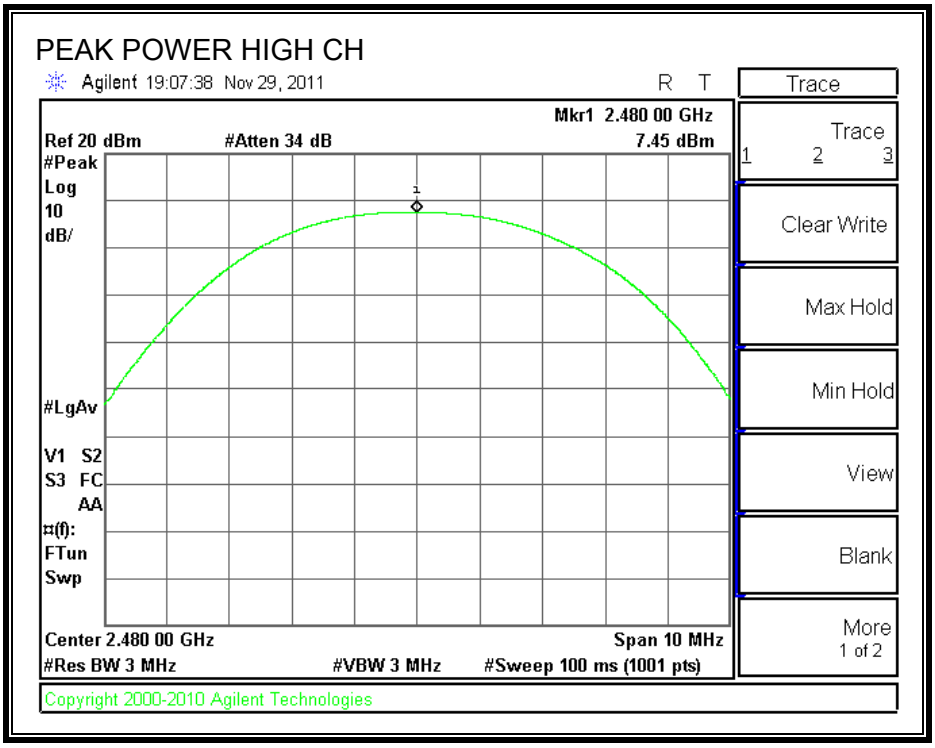
**RESULTS**

| Channel | Frequency (MHz) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 6.84 | 30 | -23.16 |
| Middle | 2441 | 7.23 | 30 | -22.77 |
| High | 2480 | 7.45 | 30 | -22.55 |

**OUTPUT POWER**







### 7.1.6. AVERAGE POWER

**LIMIT**

None; for reporting purposes only.

**TEST PROCEDURE**

The transmitter output is connected to a power meter.

**RESULTS**

The cable assembly insertion loss of 15.71 dB (including coupler and cable) was entered as an offset in the power meter to allow for direct reading of power.

| Channel | Frequency (MHz) | Average Power (dBm) |
|---|---|---|
| Low | 2402 | 6.38 |
| Middle | 2441 | 7.01 |
| High | 2480 | 7.22 |

## 7.1.7. CONDUCTED SPURIOUS EMISSIONS

**LIMITS**

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

**TEST PROCEDURE**

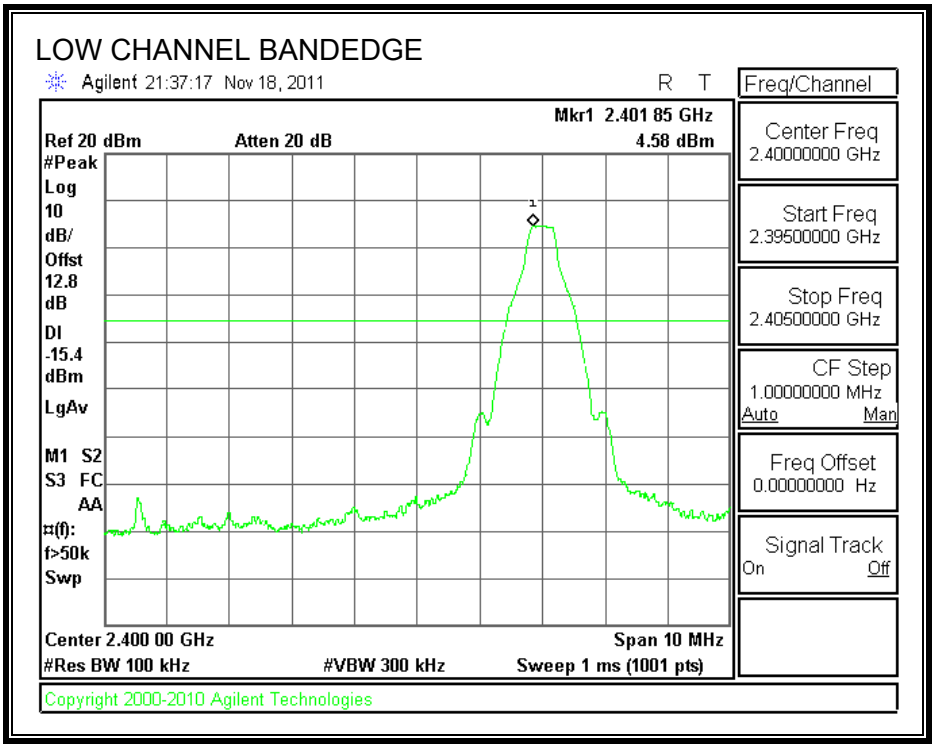
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

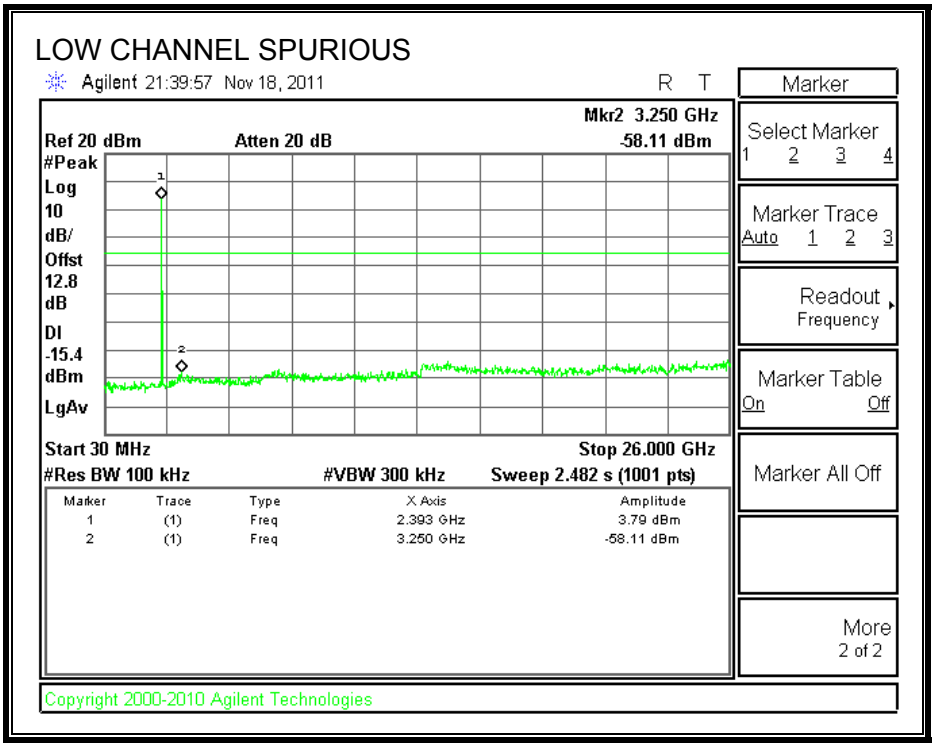
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

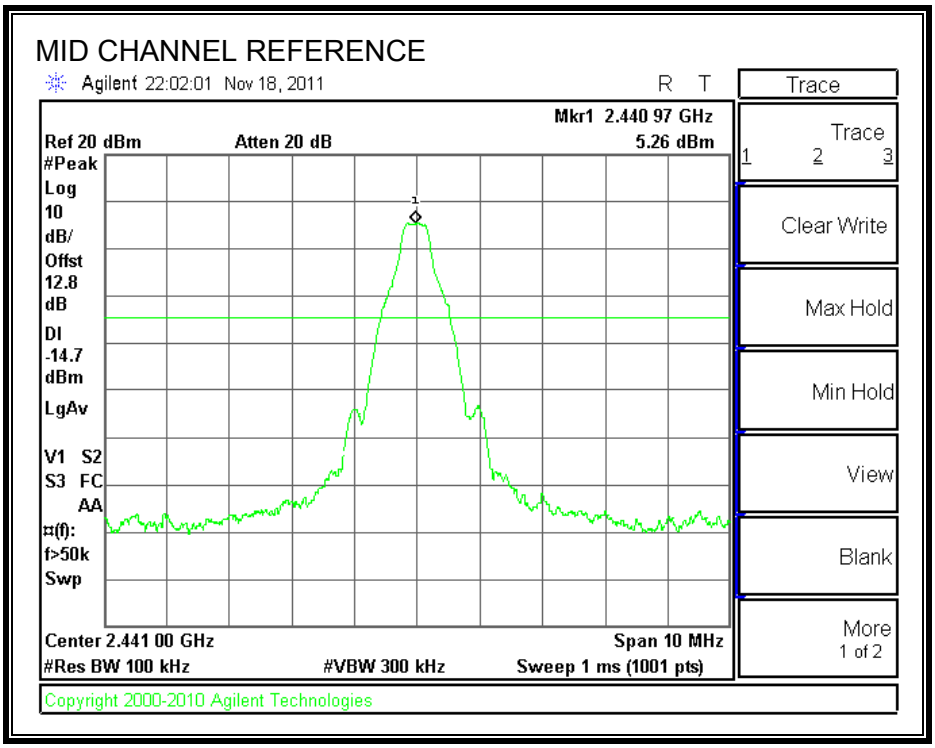
## RESULTS

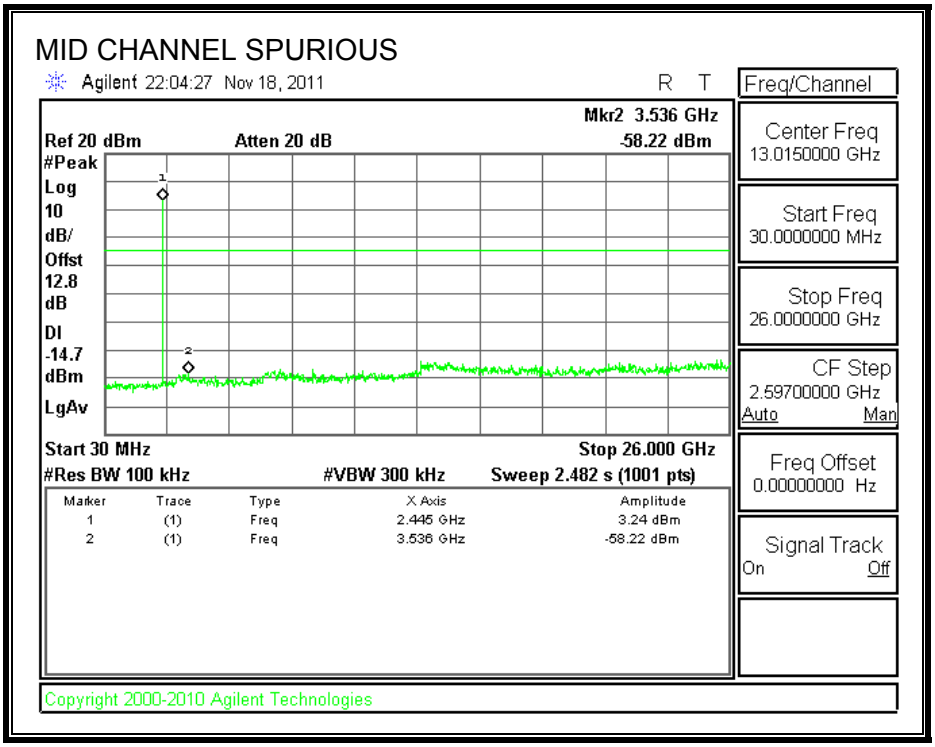
## SPURIOUS EMISSIONS, LOW CHANNEL



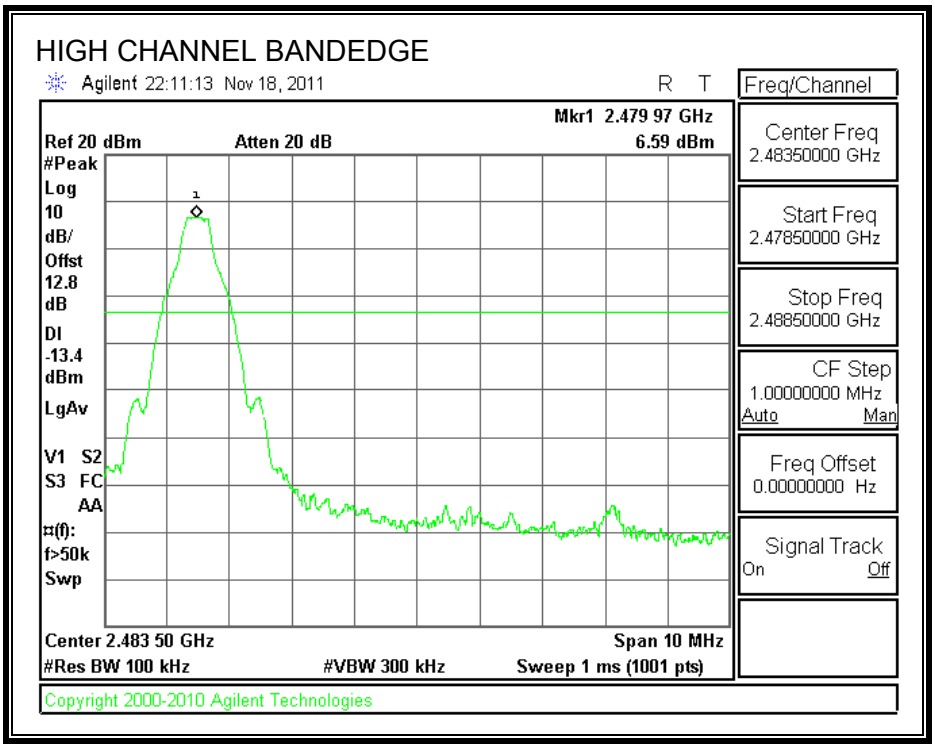


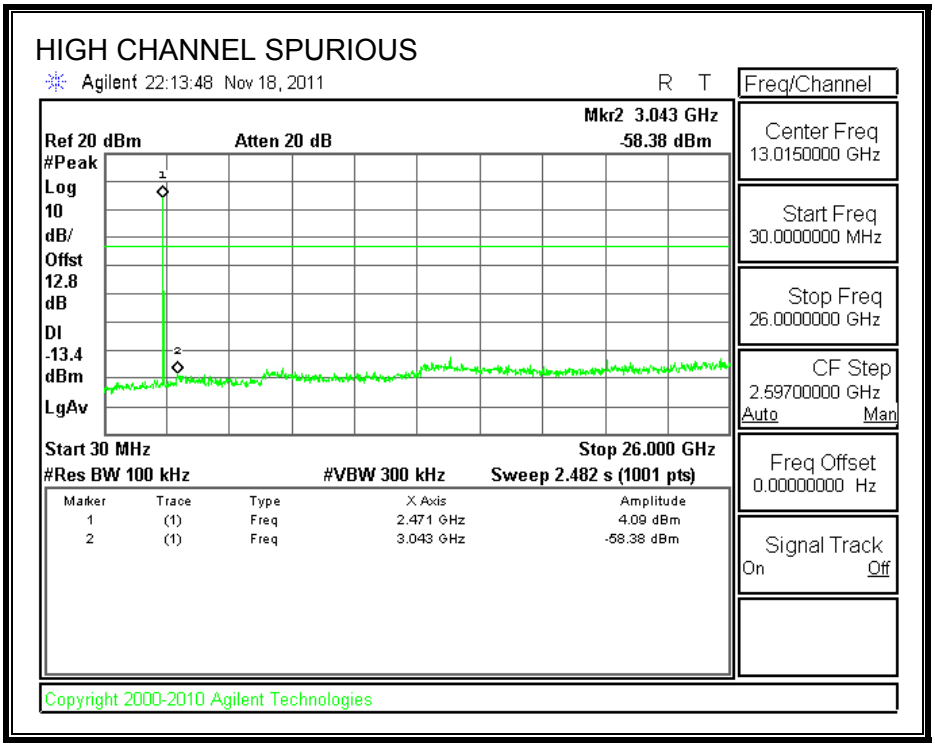
**SPURIOUS EMISSIONS, MID CHANNEL**



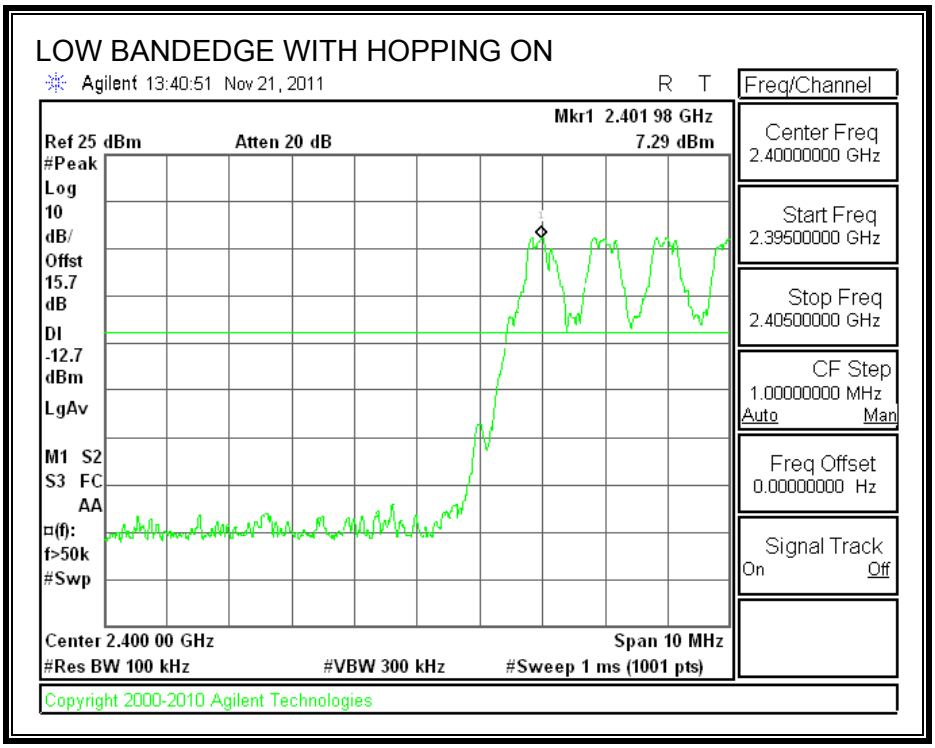


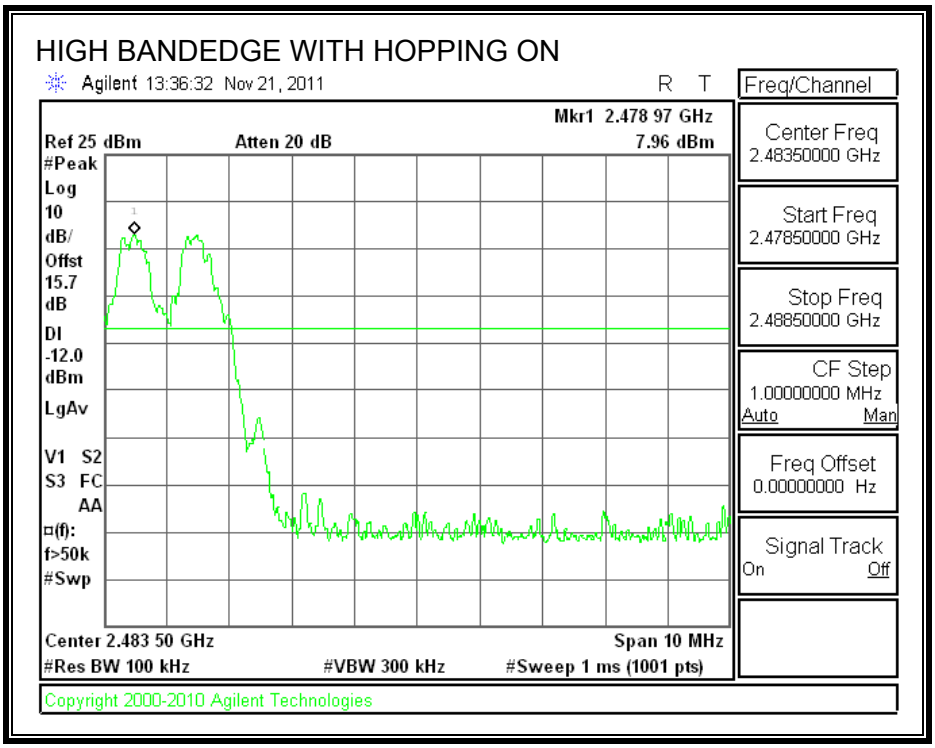
**SPURIOUS EMISSIONS, HIGH CHANNEL**





**SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**





## 7.2. ENHANCED DATA RATE 8PSK MODULATION

### 7.2.1. 20 dB AND 99% BANDWIDTH

**LIMIT**

None; for reporting purposes only.

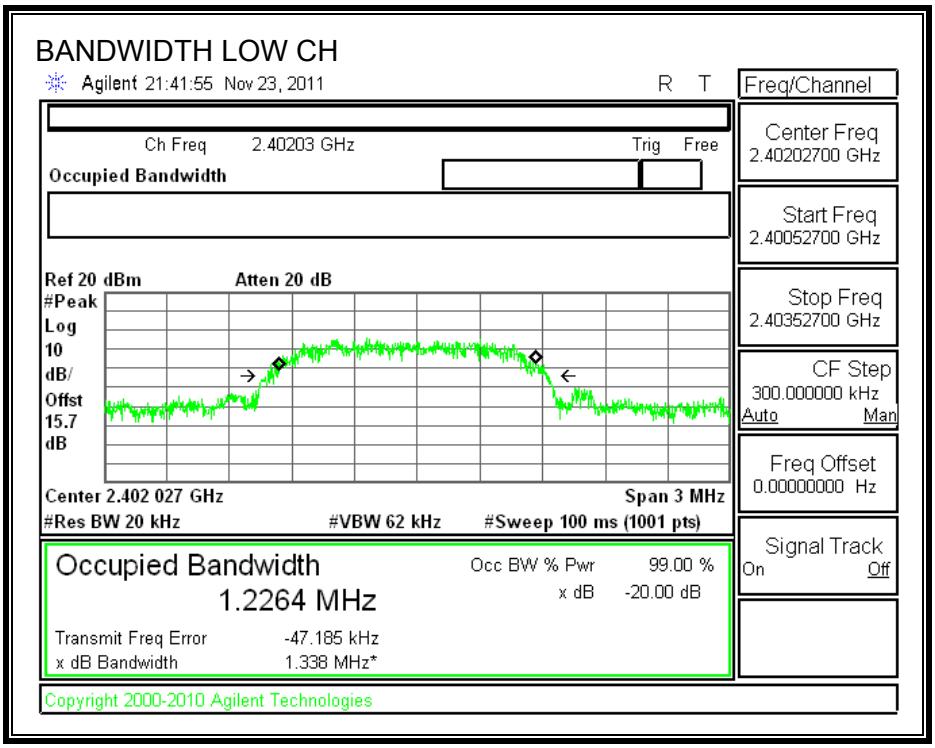
**TEST PROCEDURE**

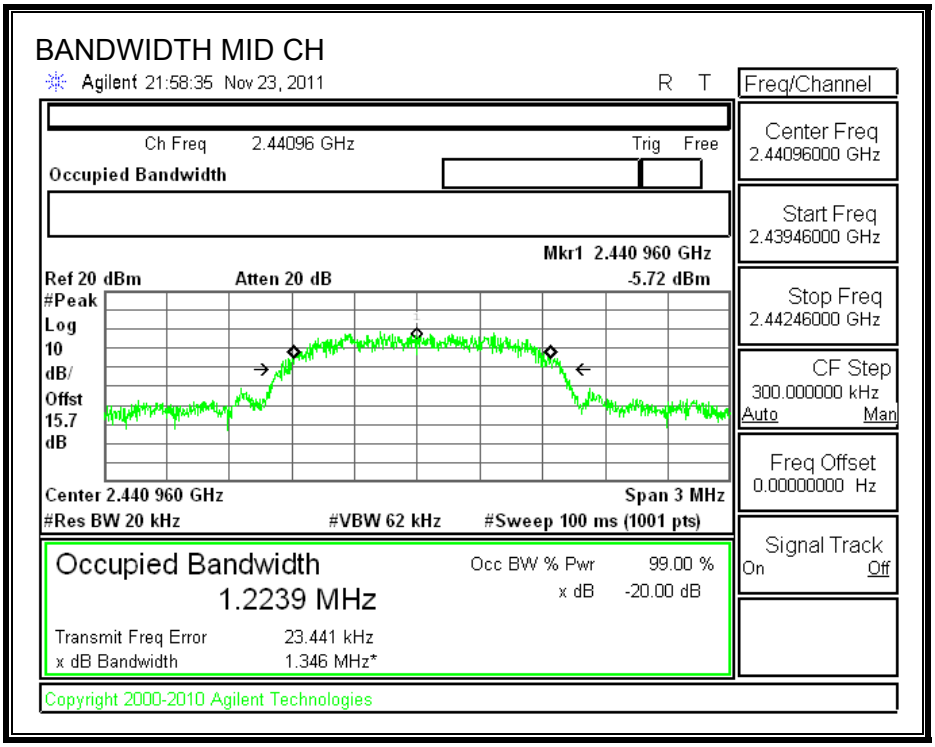
The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

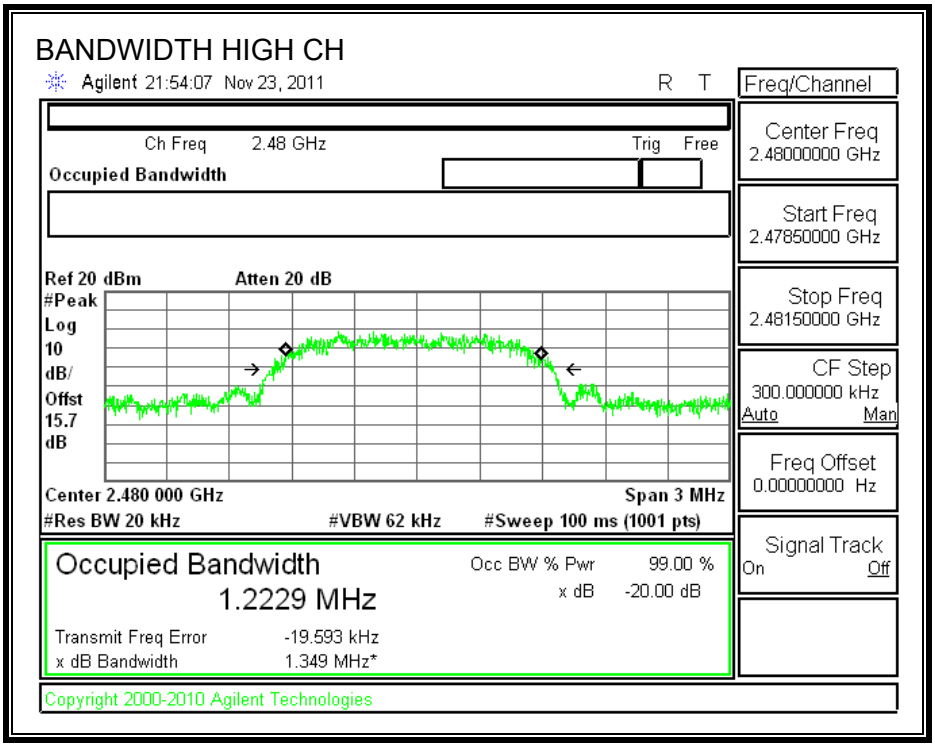
**RESULTS**

| Channel | Frequency (MHz) | 20 dB Bandwidth (kHz) | 99% Bandwidth (kHz) |
|---|---|---|---|
| Low | 2402 | 1338 | 1223.5 |
| Middle | 2441 | 1346 | 1217.2 |
| High | 2480 | 1349 | 1199.3 |

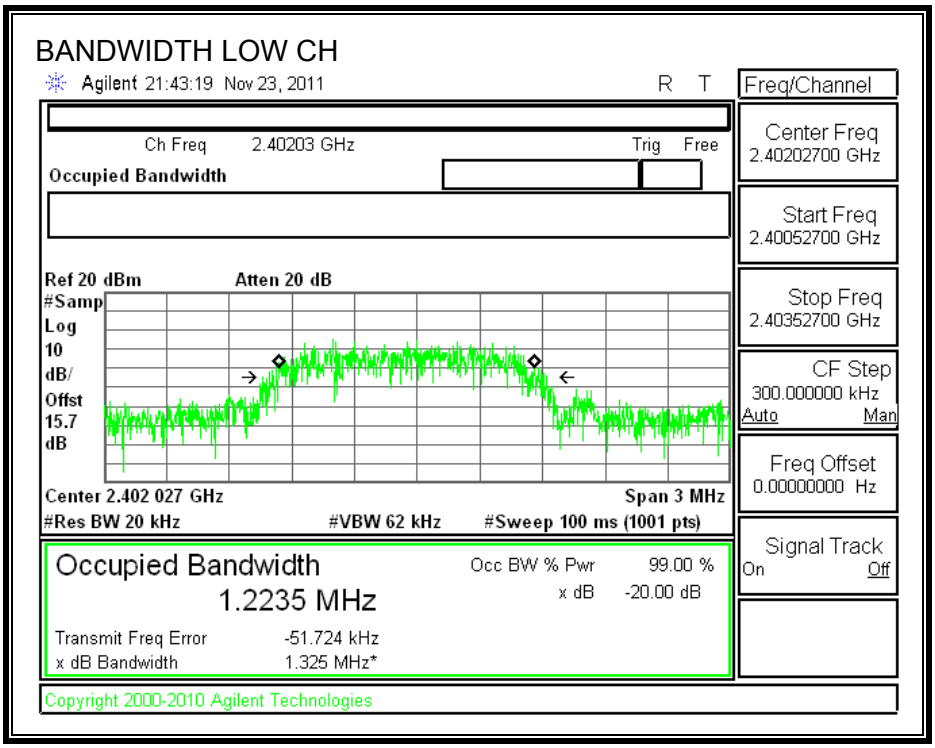
**20 dB BANDWIDTH**

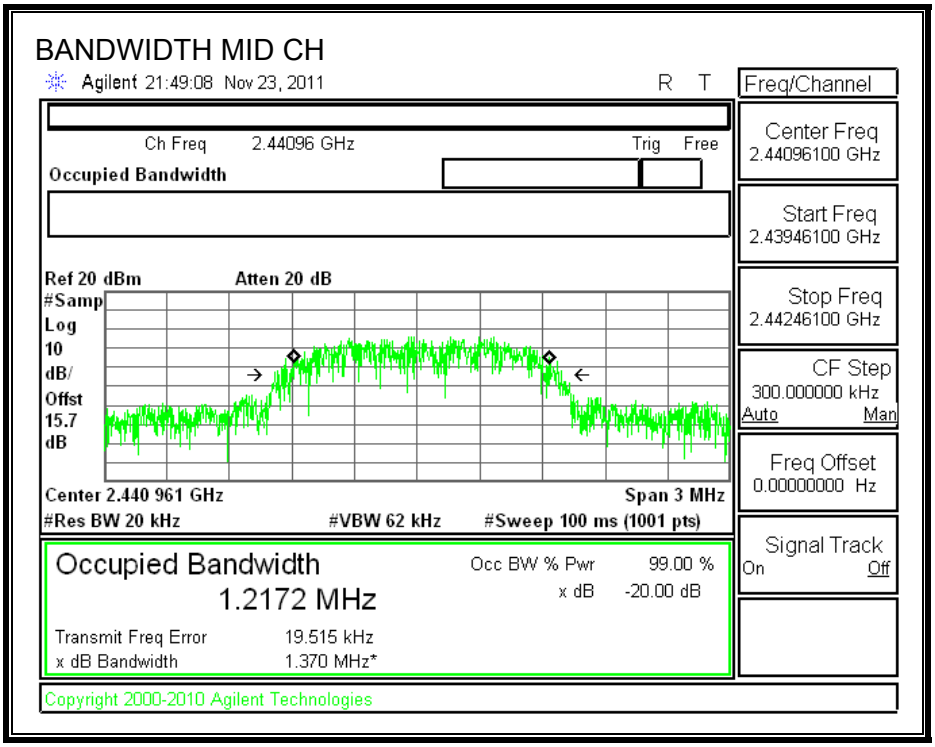


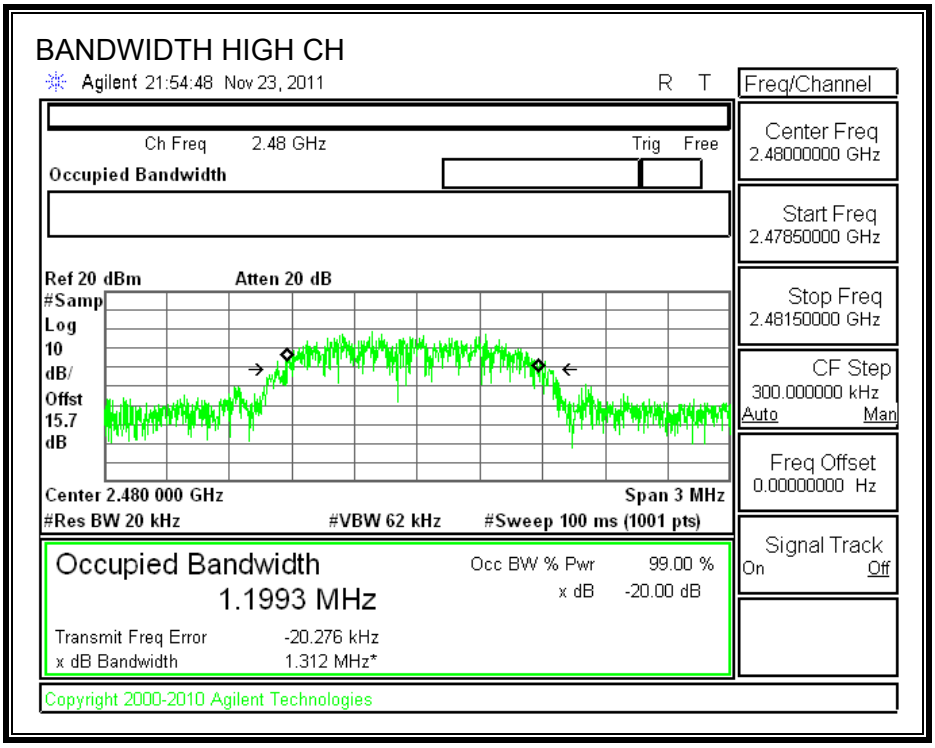




**99% BANDWIDTH**







## 7.2.2. HOPPING FREQUENCY SEPARATION

**LIMIT**

FCC §15.247 (a) (1)

IC RSS-210 A8.1 (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hoping channel, whichever is greater.

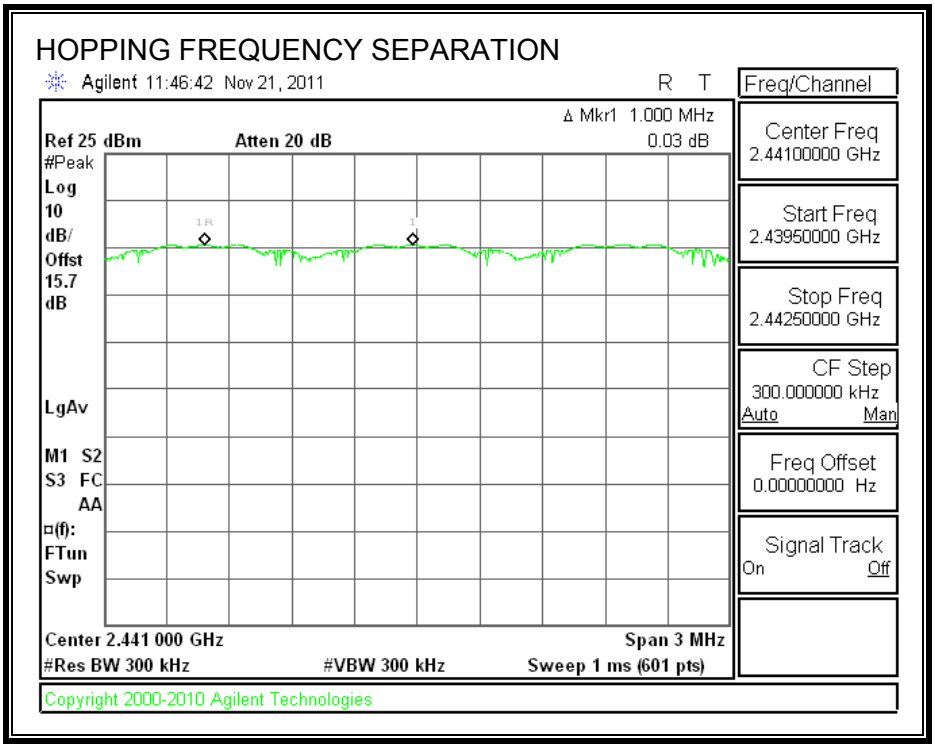
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

## RESULTS

## HOPPING FREQUENCY SEPARATION



## 7.2.3. NUMBER OF HOPPING CHANNELS

**LIMIT**

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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

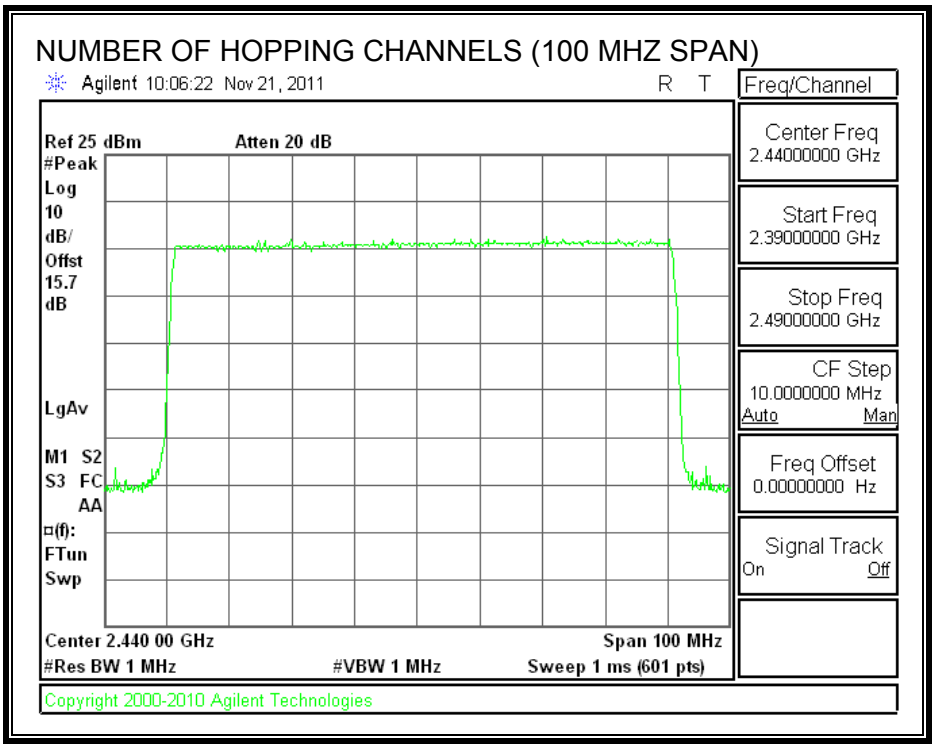
**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

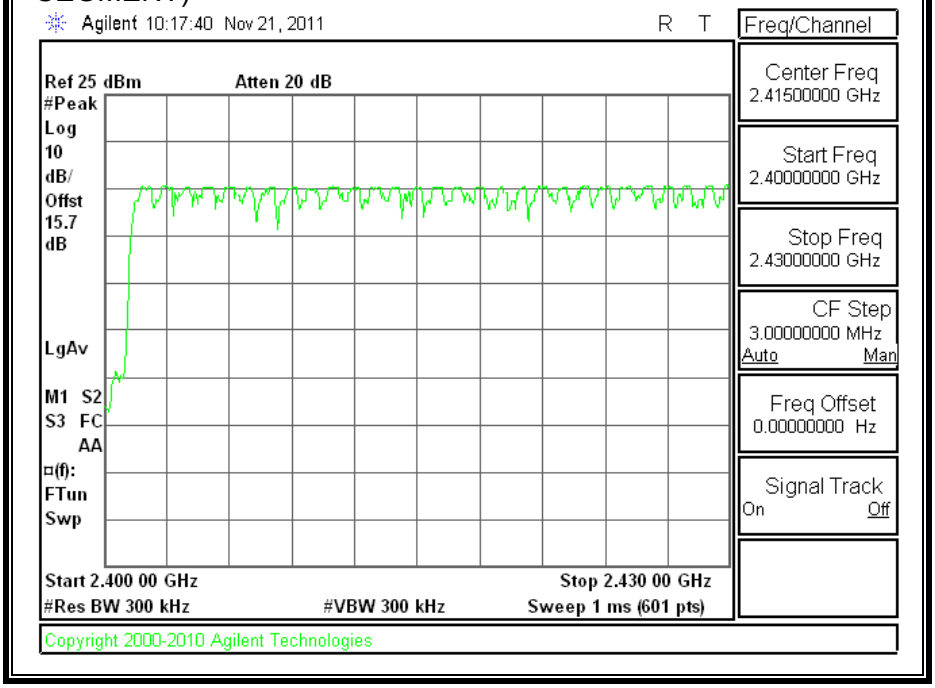
**RESULTS**

79 Channels observed.

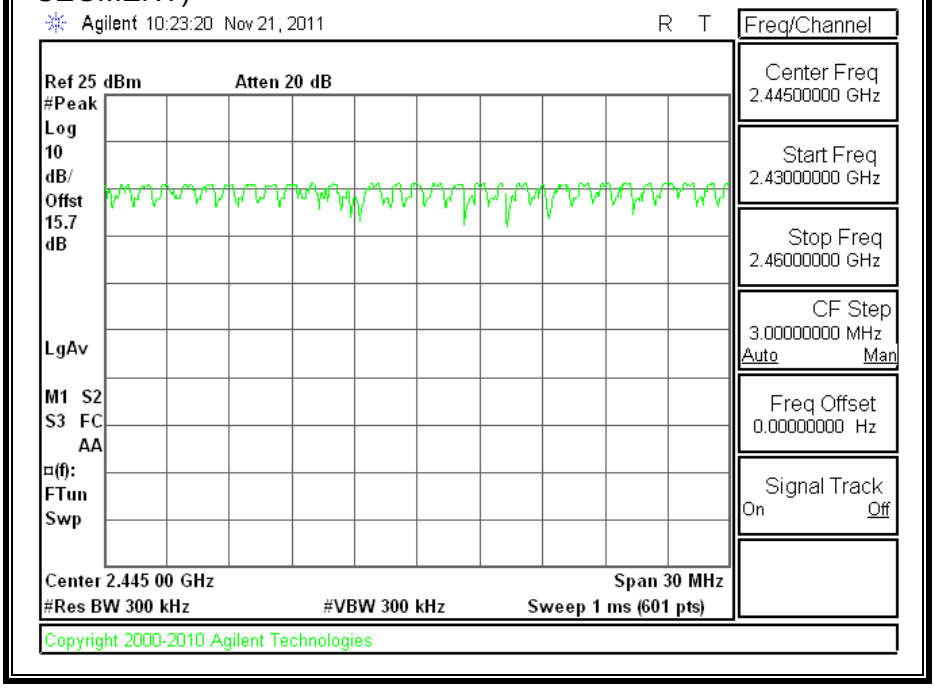
**NUMBER OF HOPPING CHANNELS**



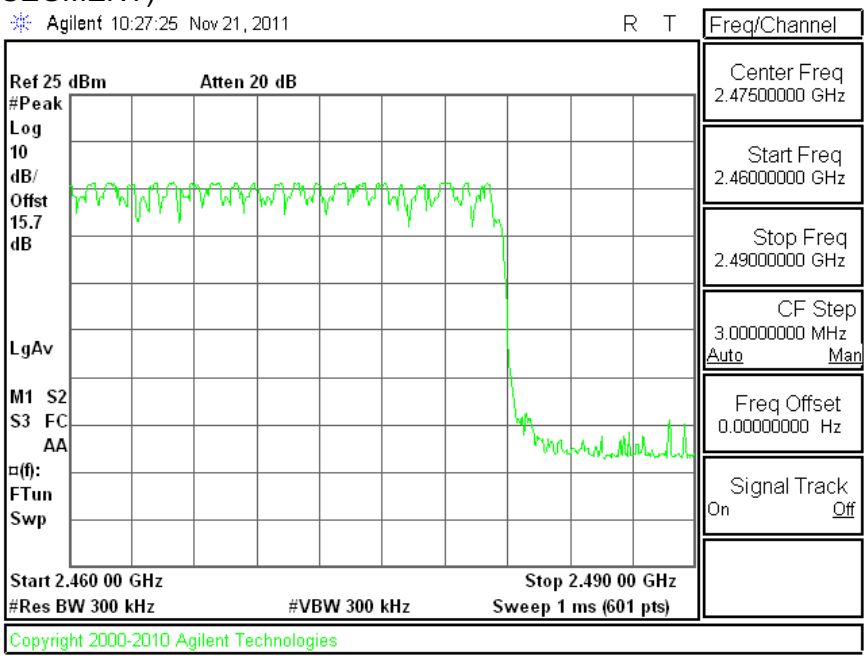
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, SECOND SEGMENT)



NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, THIRD SEGMENT)



## 7.2.4. AVERAGE TIME OF OCCUPANCY

**LIMIT**

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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.

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

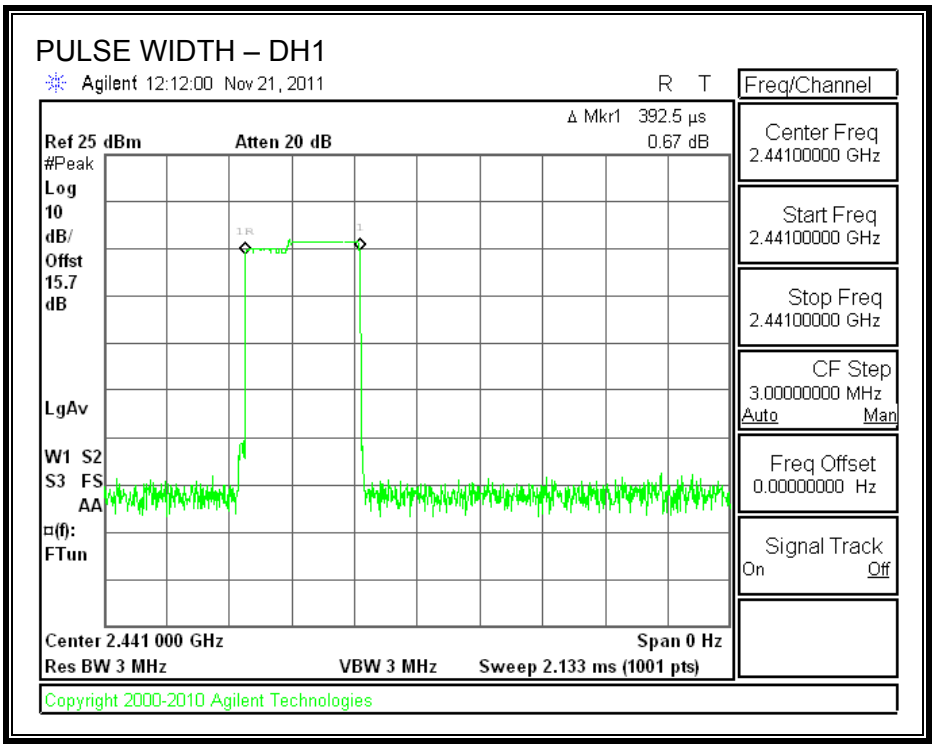
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

**RESULTS**

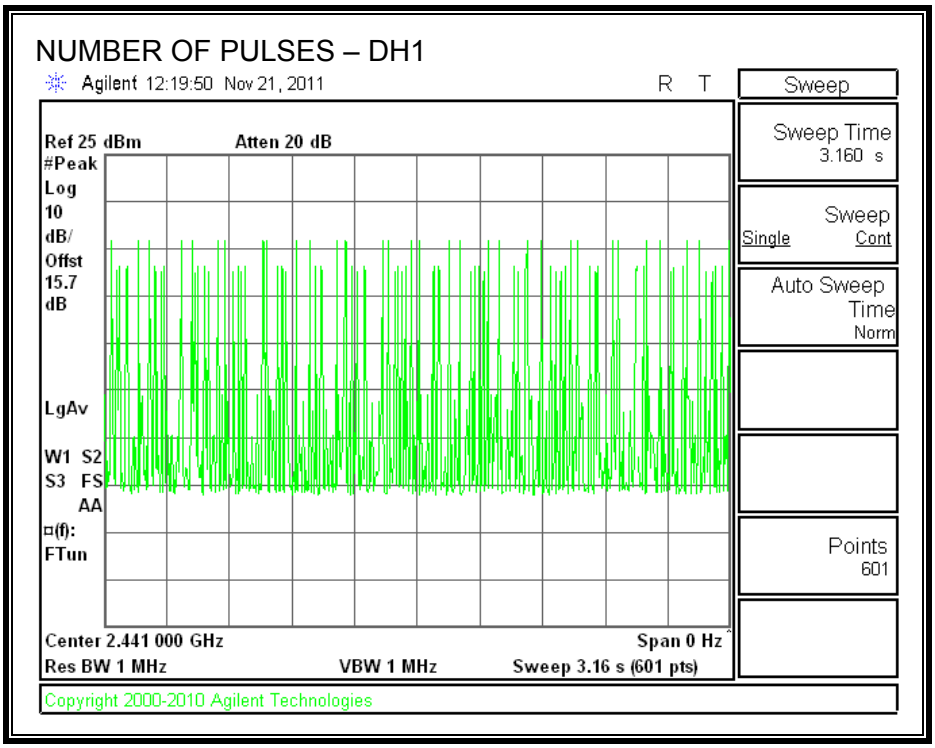
8PSK (EDR) Mode

| DH Packet | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of (sec) | Limit (sec) | Margin (sec) |
|---|---|---|---|---|---|
| DH1 | 0.3925 | 33 | 0.1295 | 0.4 | -0.2705 |
| DH3 | 1.6830 | 17 | 0.2861 | 0.4 | -0.1139 |
| DH5 | 2.9260 | 12 | 0.3511 | 0.4 | -0.0489 |

**PULSE WIDTH - DH1**

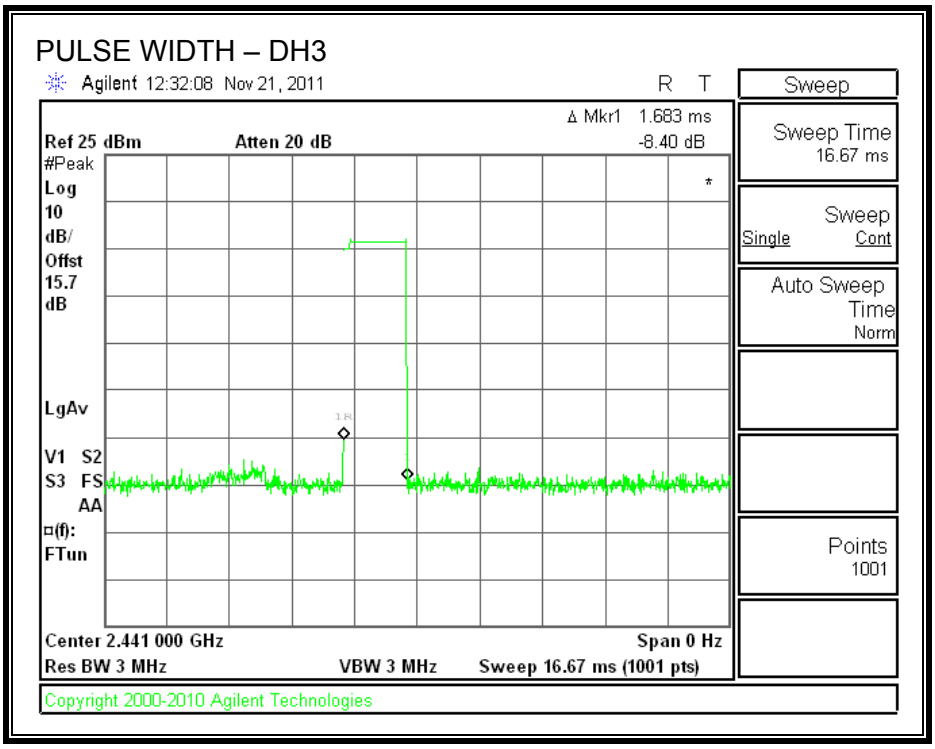


**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1**

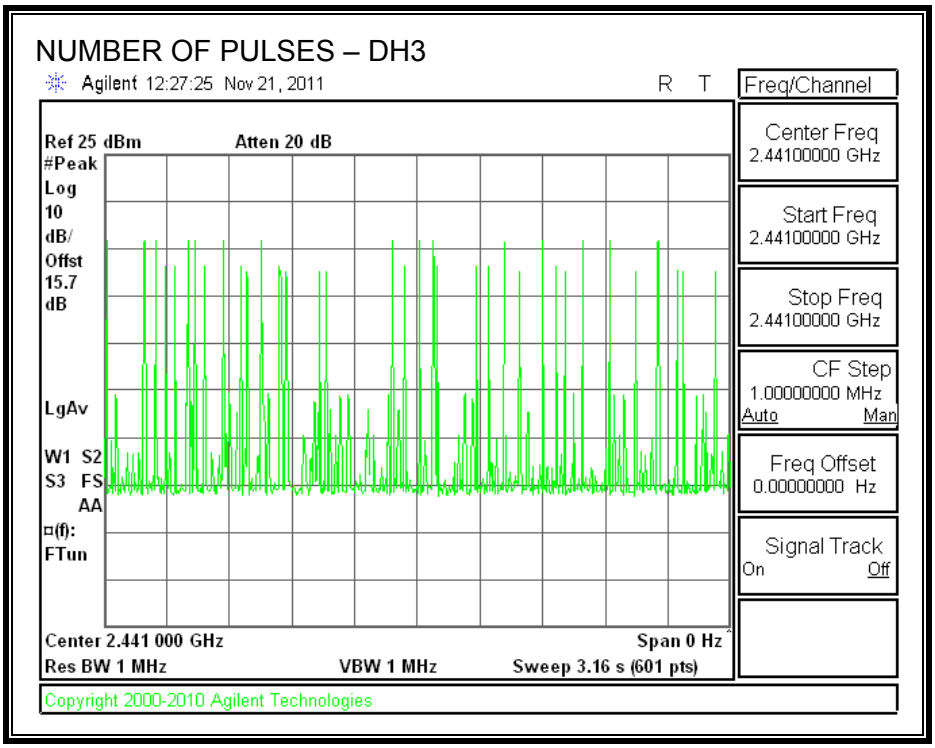



**33**

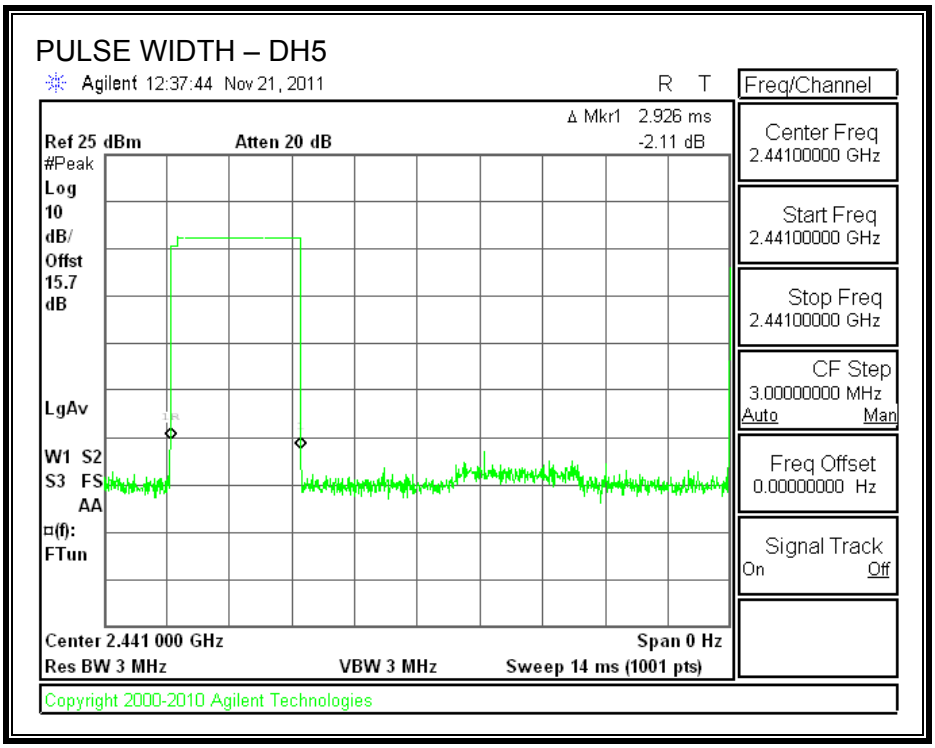
**PULSE WIDTH – DH3**



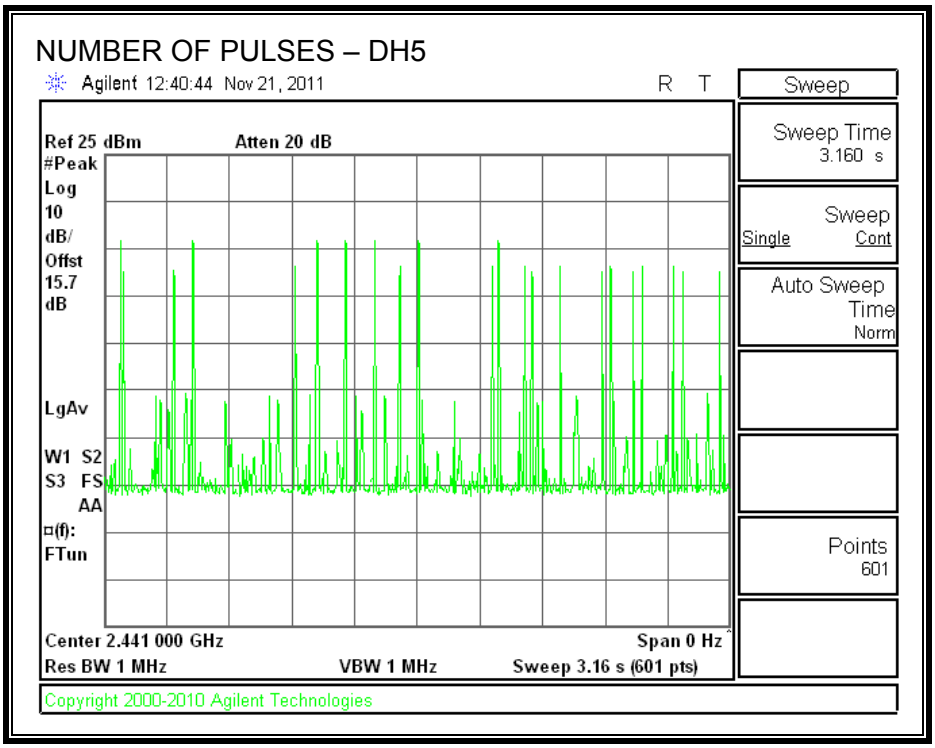
**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3**



**PULSE WIDTH – DH5**



**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5**



### 7.2.5. OUTPUT POWER

**LIMIT**

§15.247 (b) (1)

RSS-210 Issue 7 Clause A8.4

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm.

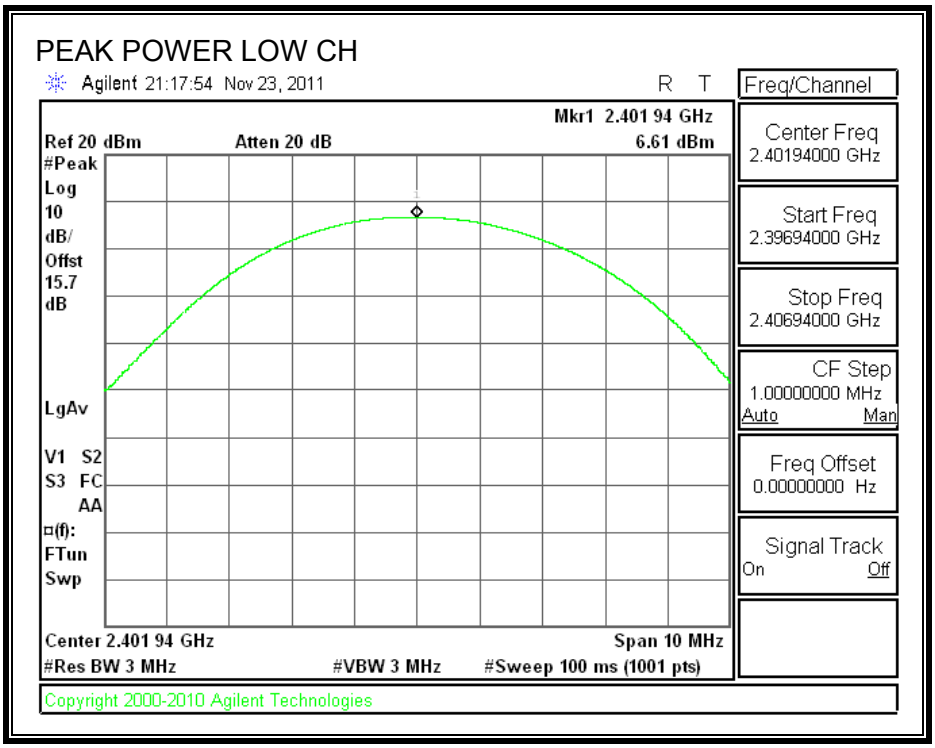
**TEST PROCEDURE**

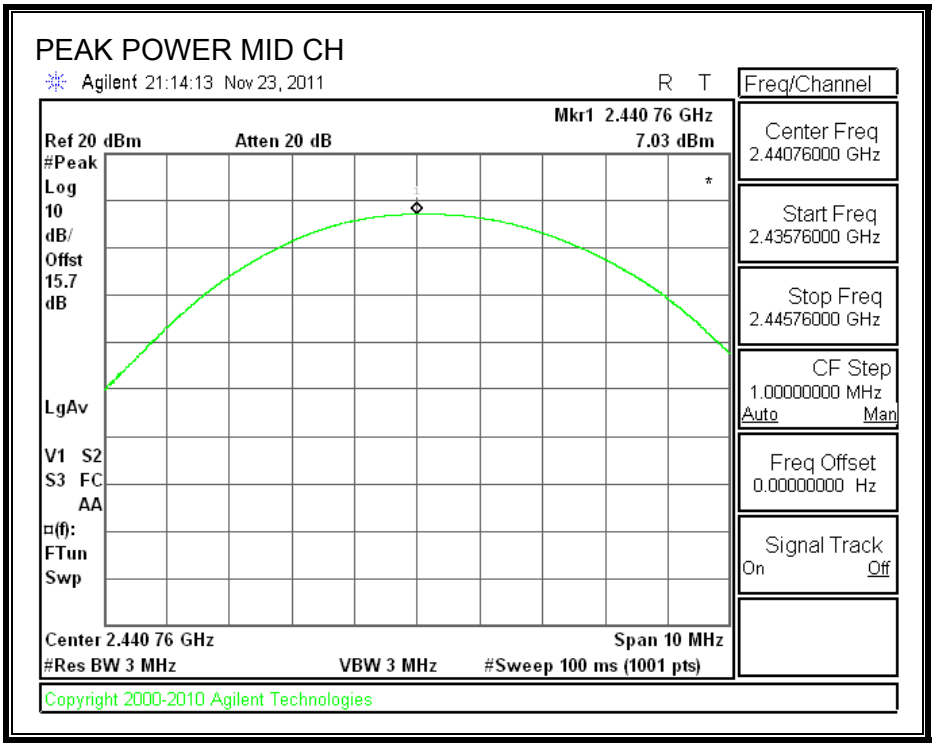
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

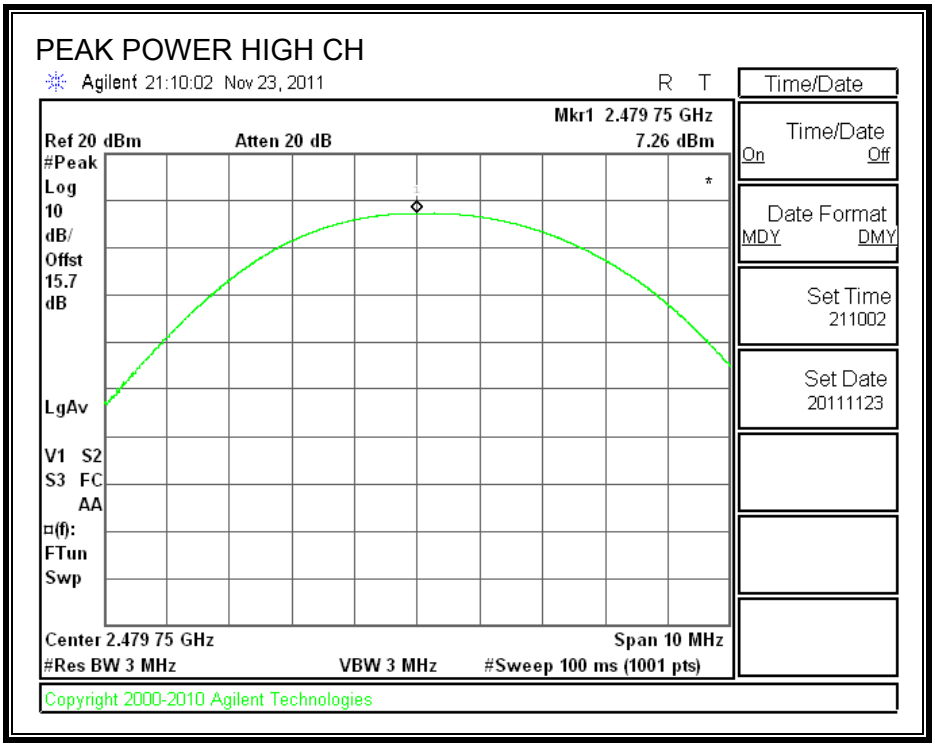
**RESULTS**

| Channel | Frequency (MHz) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 6.61 | 30 | -23.39 |
| Middle | 2441 | 7.03 | 30 | -22.97 |
| High | 2480 | 7.26 | 30 | -22.74 |

**OUTPUT POWER**







## 7.2.6. AVERAGE POWER

**LIMIT**

None; for reporting purposes only.

**TEST PROCEDURE**

The transmitter output is connected to a power meter.

**RESULTS**

The cable assembly insertion loss of 15.71 dB (including coupler and cable) was entered as an offset in the power meter to allow for direct reading of power.

.

| Channel | Frequency (MHz) | Average Power (dBm) |
|---|---|---|
| Low | 2402 | 4.20 |
| Middle | 2441 | 5.22 |
| High | 2480 | 5.21 |

## 7.2.7. CONDUCTED SPURIOUS EMISSIONS

**LIMITS**

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

**TEST PROCEDURE**

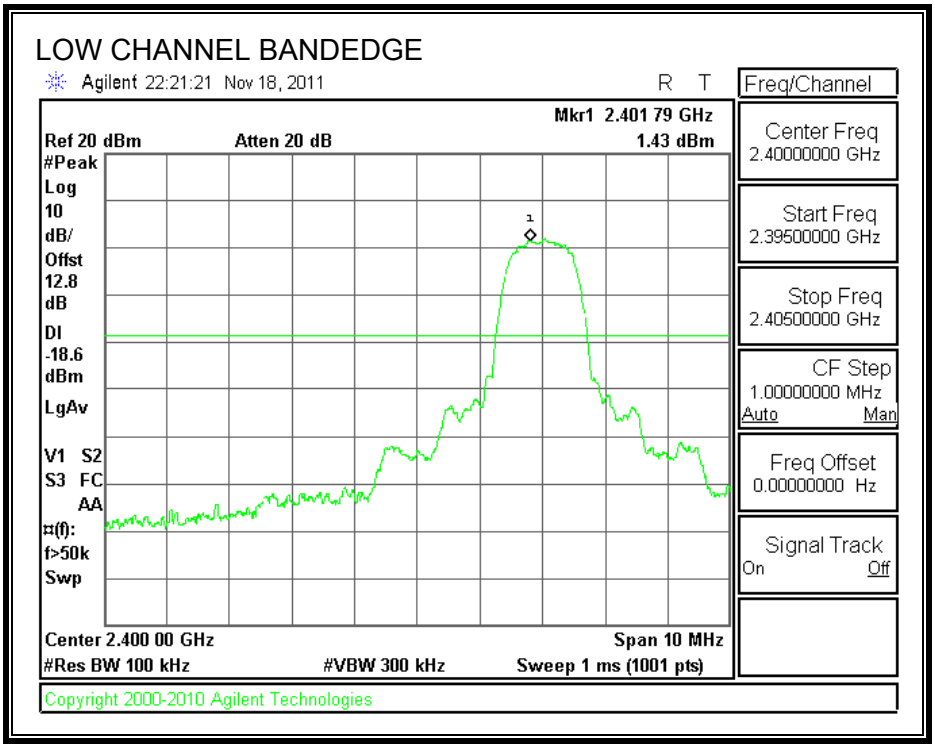
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

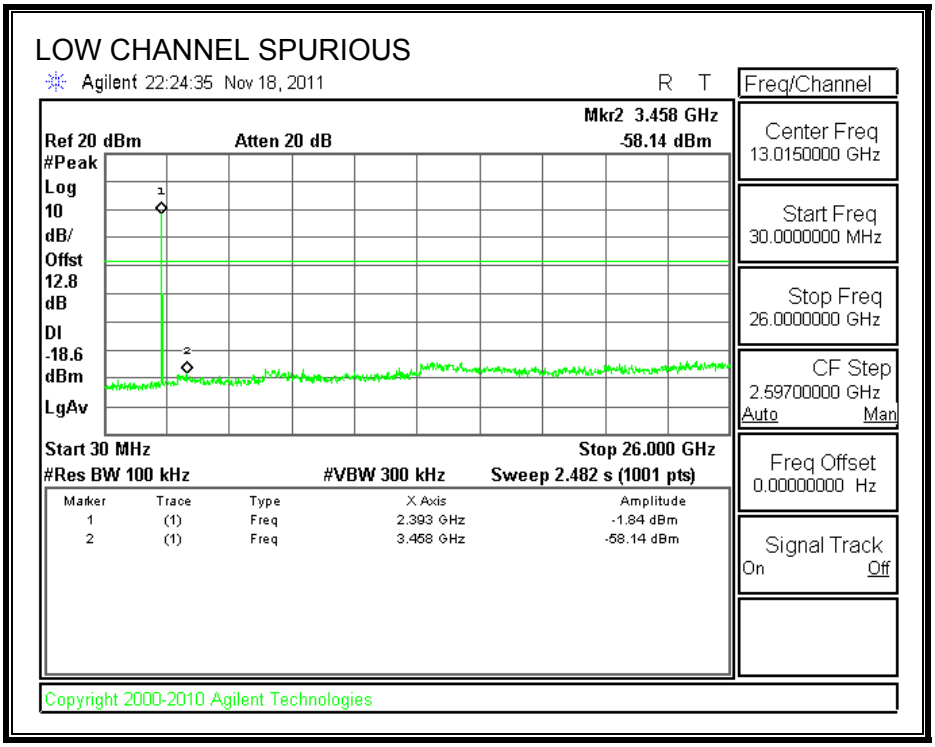
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

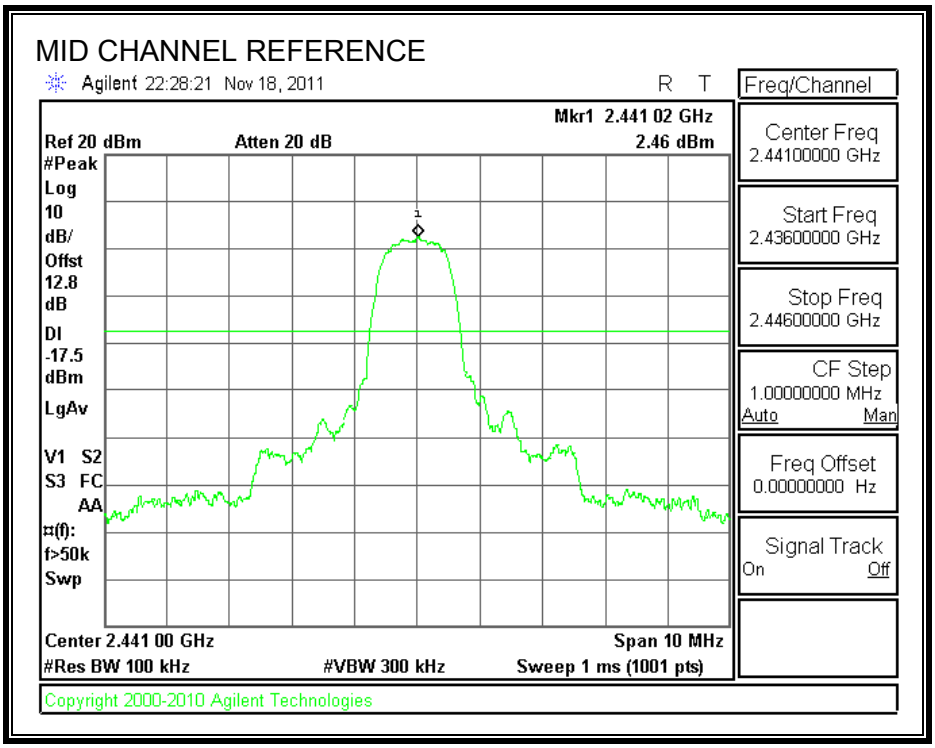
## RESULTS

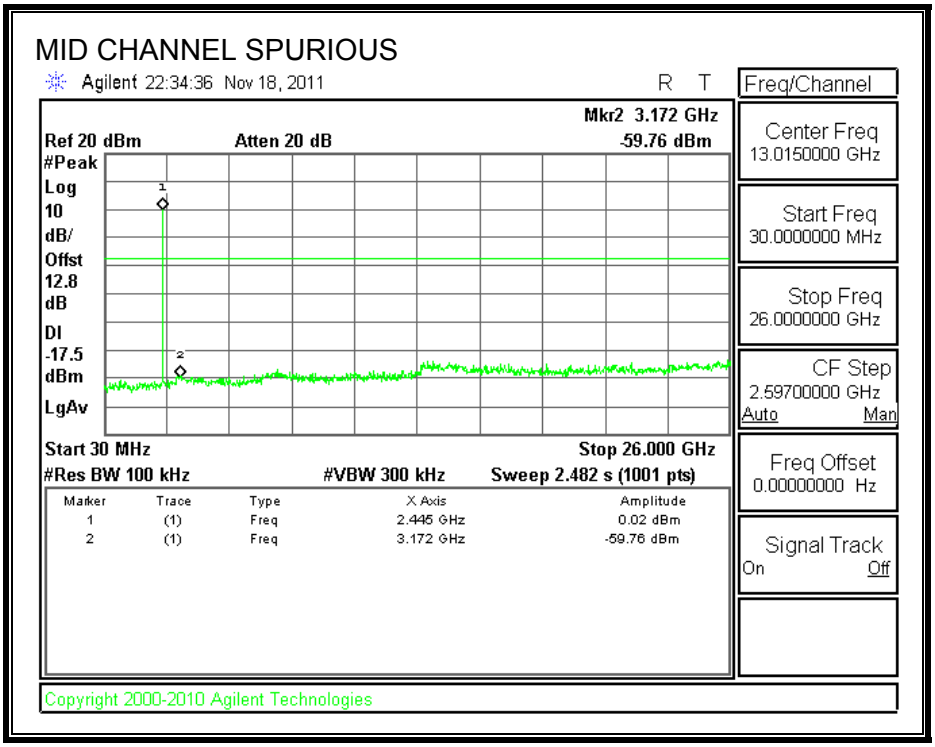
## SPURIOUS EMISSIONS, LOW CHANNEL



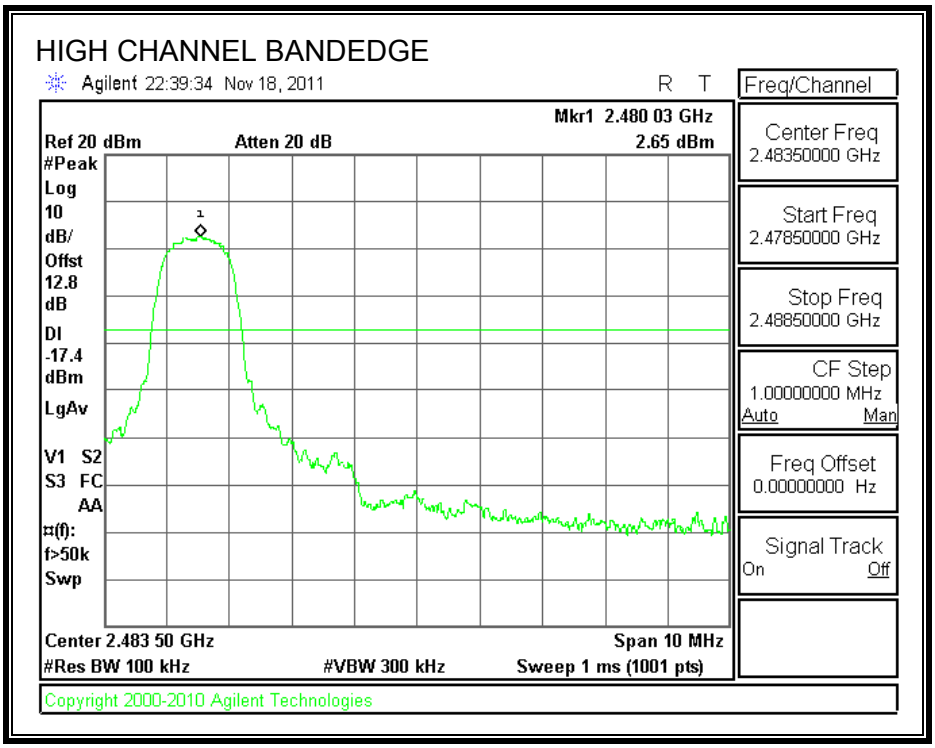


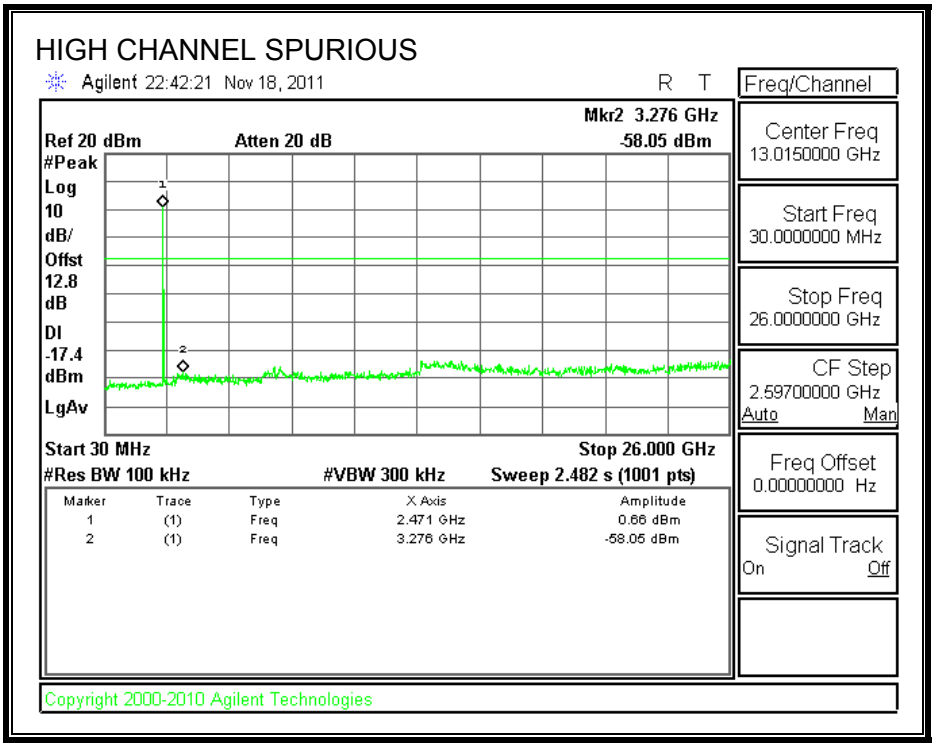
**SPURIOUS EMISSIONS, MID CHANNEL**



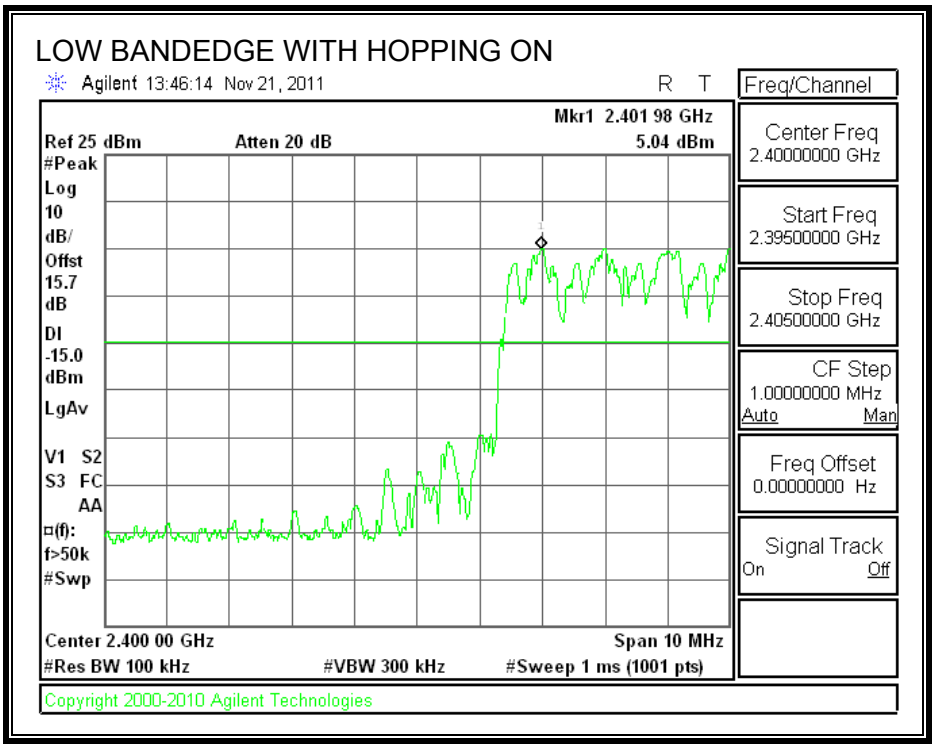


**SPURIOUS EMISSIONS, HIGH CHANNEL**

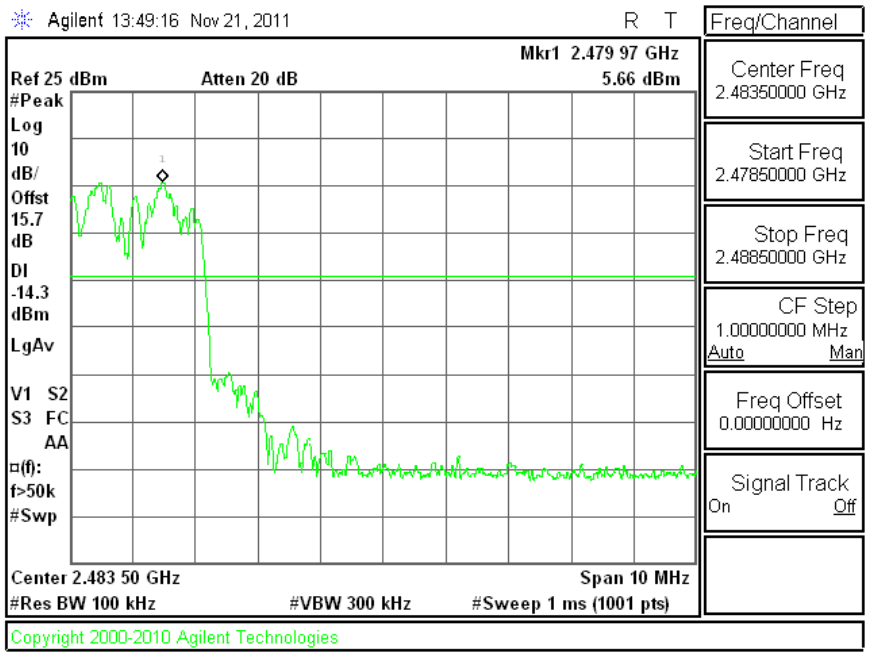




**SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



HIGH BANDEDGE WITH HOPPING ON



# 8. RADIATED TEST RESULTS

## 8.1. LIMITS AND PROCEDURE

**LIMITS**

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

IC RSS-GEN Clause 6 (Receiver)

| Frequency Range (MHz) | Field Strength Limit (uV/m) at 3 m | Field Strength Limit (dBuV/m) at 3 m |
|---|---|---|
| 30 - 88 | 100 | 40 |
| 88 - 216 | 150 | 43.5 |
| 216 - 960 | 200 | 46 |
| Above 960 | 500 | 54 |

**TEST PROCEDURE**

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

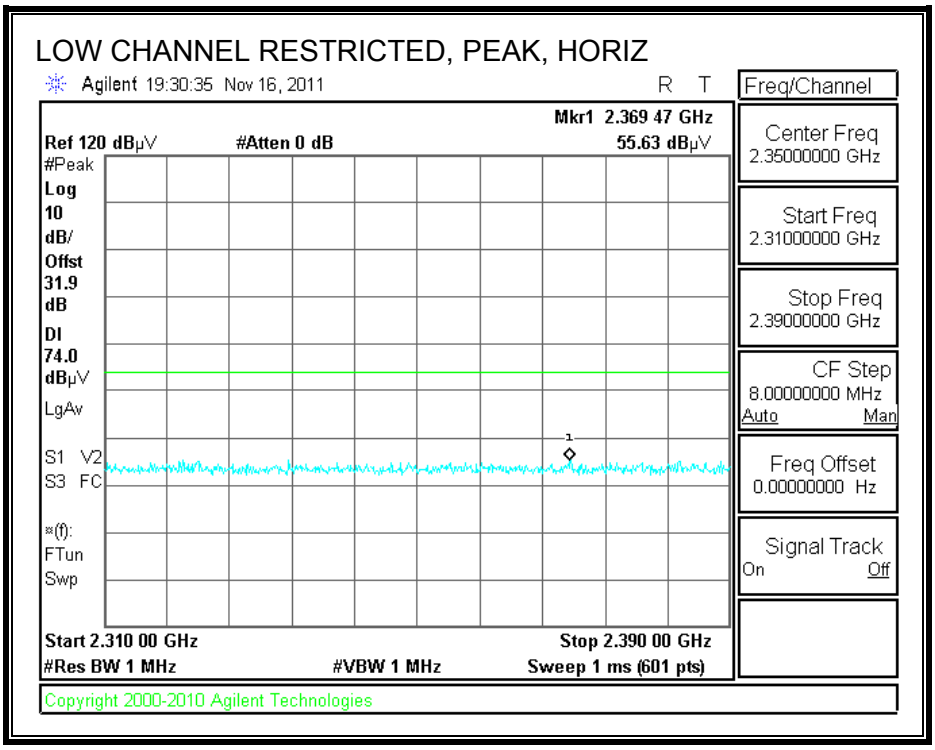
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

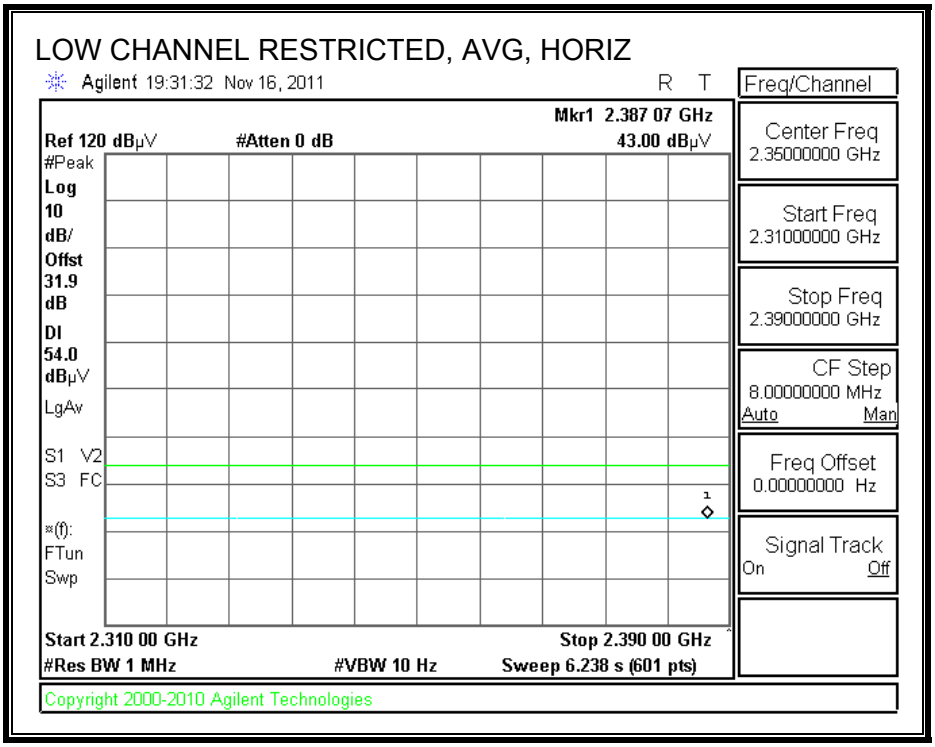
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

## 8.2. TRANSMITTER ABOVE 1 GHz

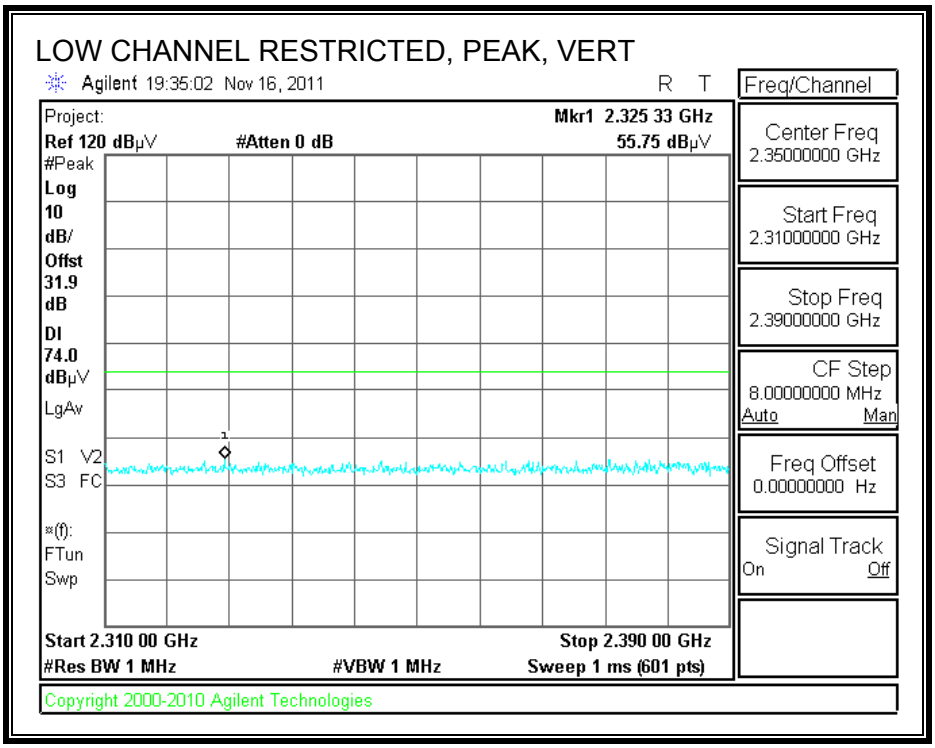
### 8.2.1. BASIC DATA RATE GFSK MODULATION

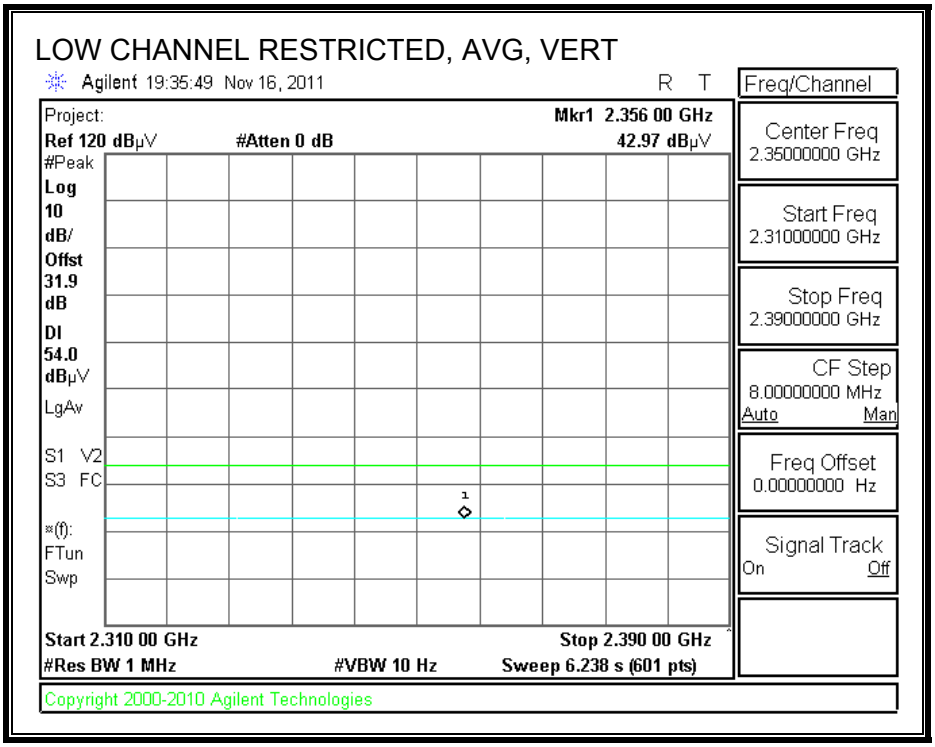
**RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)**



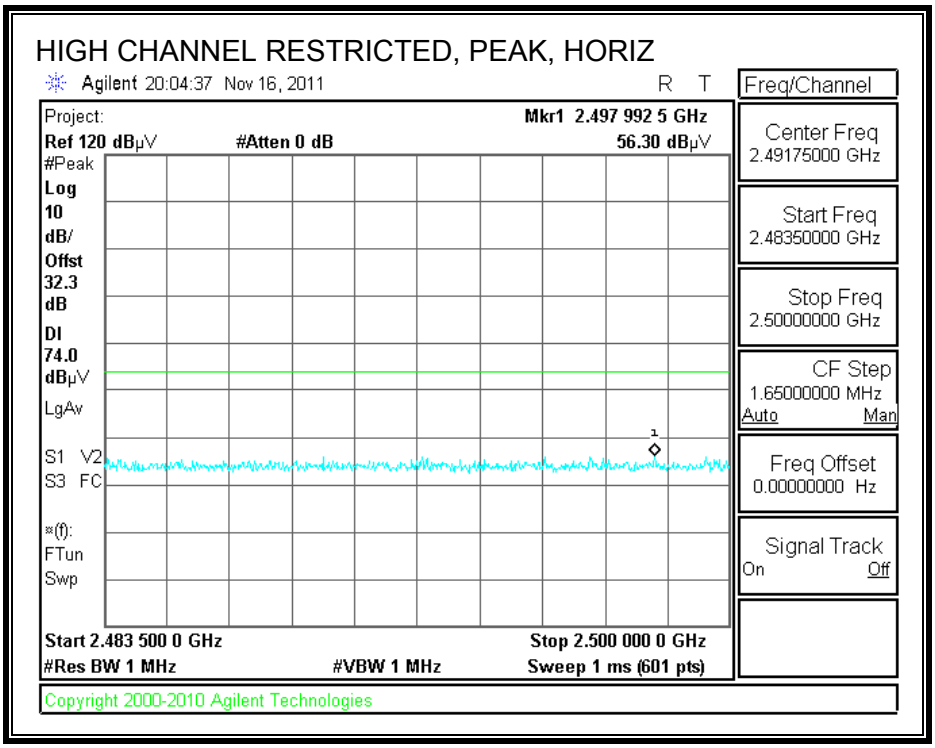


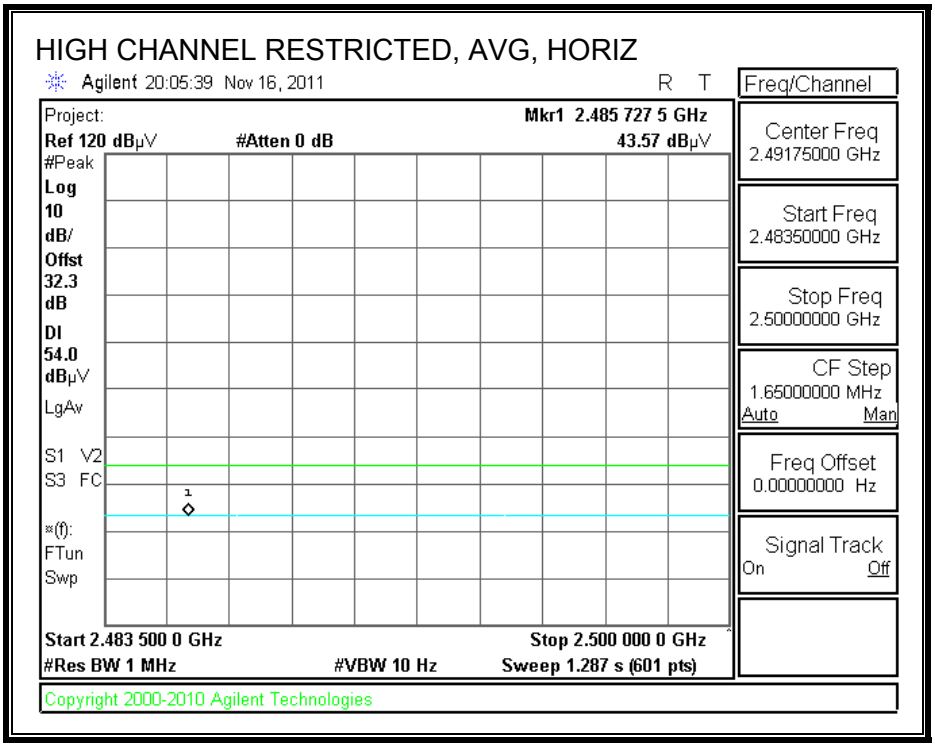
**RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**



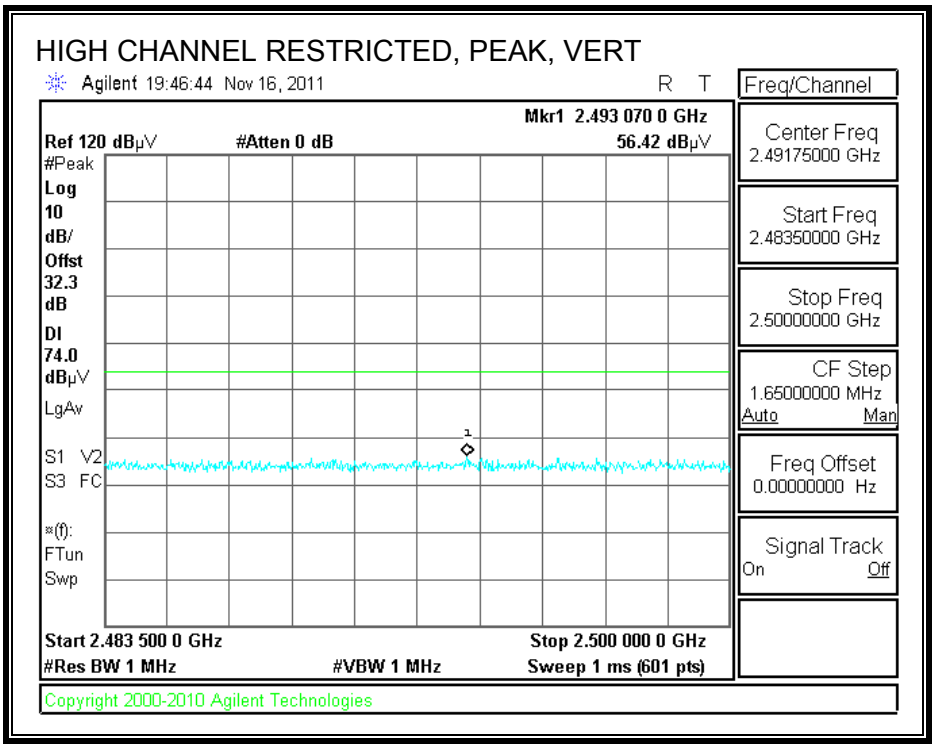


**RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**

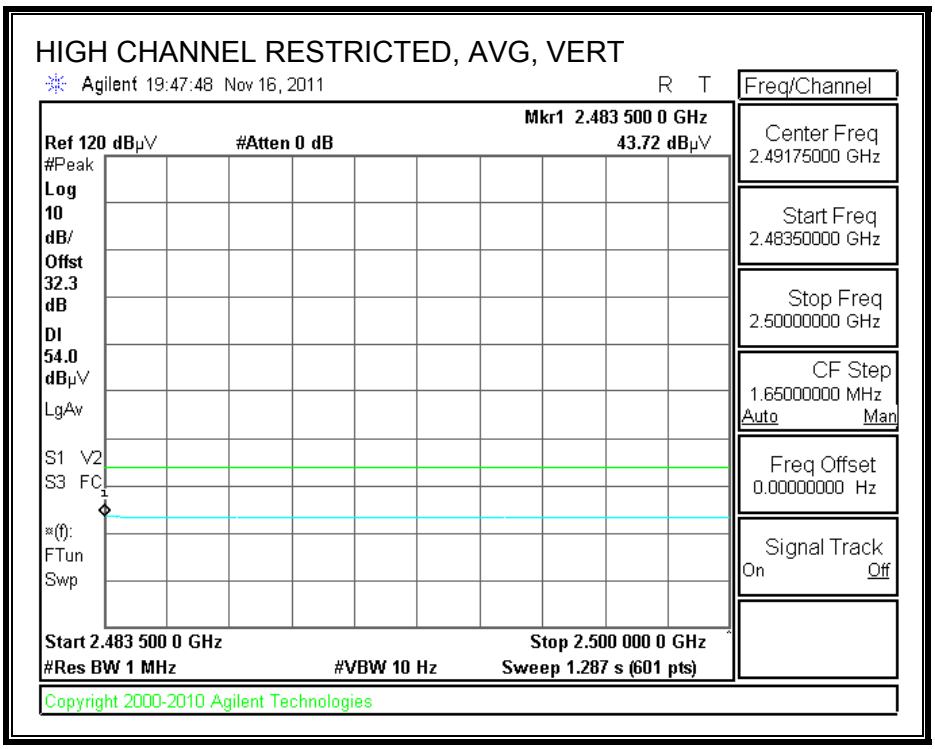




**RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)**



HIGH CHANNEL RESTRICTED, AVG, VERT



## HARMONICS AND SPURIOUS EMISSIONS

**High Frequency Measurement**
**Compliance Certification Services, Fremont 5m Chamber-B**

**Company:** QualComm
**Project #:** 11U14082
**Date:** 11/16/2011
**Test Engineer:** Thanh Nguyen
**Configuration:** EUT StandAlone
**Mode:** Transmit GFSK Mode

**Test Equipment:**

| Horn 1-18GHz | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz | Limit |
|---|---|---|---|---|
| T59; S/N: 3245 @3m | T145 Agilent 3008A0056 | | T125; ARA 18-26GHz; S/N:1007 | FCC 15.205 |

Hi Frequency Cables

| 3' cable 22807700 | 12' cable 22807600 | 20' cable 22807500 | HPF | Reject Filter |
|---|---|---|---|---|
| 3' cable 22807700 | 12' cable 22807600 | 20' cable 22807500 | | R_001 |

**Peak Measurements**
RBW=VBW=1MHz
**Average Measurements**
RBW=1MHz ; VBW=10Hz

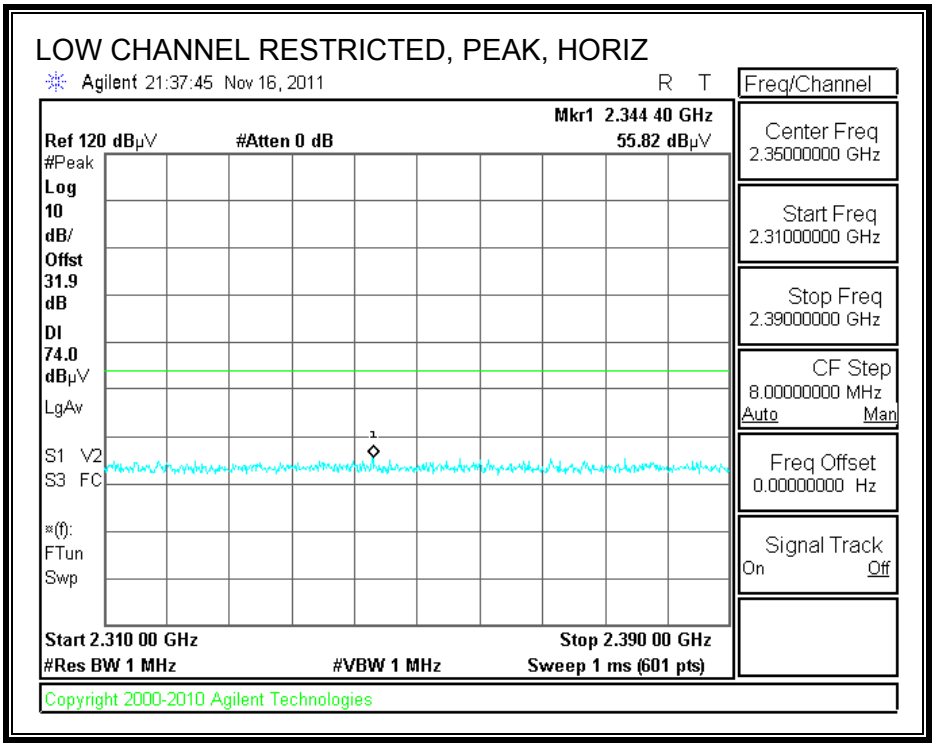
| f GHz | Dist (m) | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | Fltr dB | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes (V/H) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low Ch | | | | | | | | | | | | | | | |
| 4.804 | 3.0 | 38.7 | 26.3 | 33.1 | 6.3 | -34.8 | 0.0 | 0.0 | 43.3 | 30.9 | 74 | 54 | -30.7 | -23.1 | Noise floor/V |
| 4.804 | 3.0 | 38.5 | 26.4 | 33.1 | 6.3 | -34.8 | 0.0 | 0.0 | 43.1 | 31.0 | 74 | 54 | -30.9 | -23.0 | Noise floor/H |
| Mid Ch | | | | | | | | | | | | | | | |
| 4.882 | 3.0 | 37.9 | 25.0 | 33.2 | 6.3 | -34.8 | 0.0 | 0.0 | 42.6 | 29.7 | 74 | 54 | -31.4 | -24.3 | Noise floor/V |
| 4.882 | 3.0 | 38.0 | 25.0 | 33.2 | 6.3 | -34.8 | 0.0 | 0.0 | 42.7 | 29.8 | 74 | 54 | -31.3 | -24.2 | Noise floor/H |
| High Ch | | | | | | | | | | | | | | | |
| 4.962 | 3.0 | 38.8 | 25.3 | 33.3 | 6.4 | -34.8 | 0.0 | 0.0 | 43.7 | 30.2 | 74 | 54 | -30.3 | -23.8 | Noise floor/V |
| 4.962 | 3.0 | 38.9 | 25.3 | 33.3 | 6.4 | -34.8 | 0.0 | 0.0 | 43.8 | 30.2 | 74 | 54 | -30.2 | -23.8 | Noise floor/H |

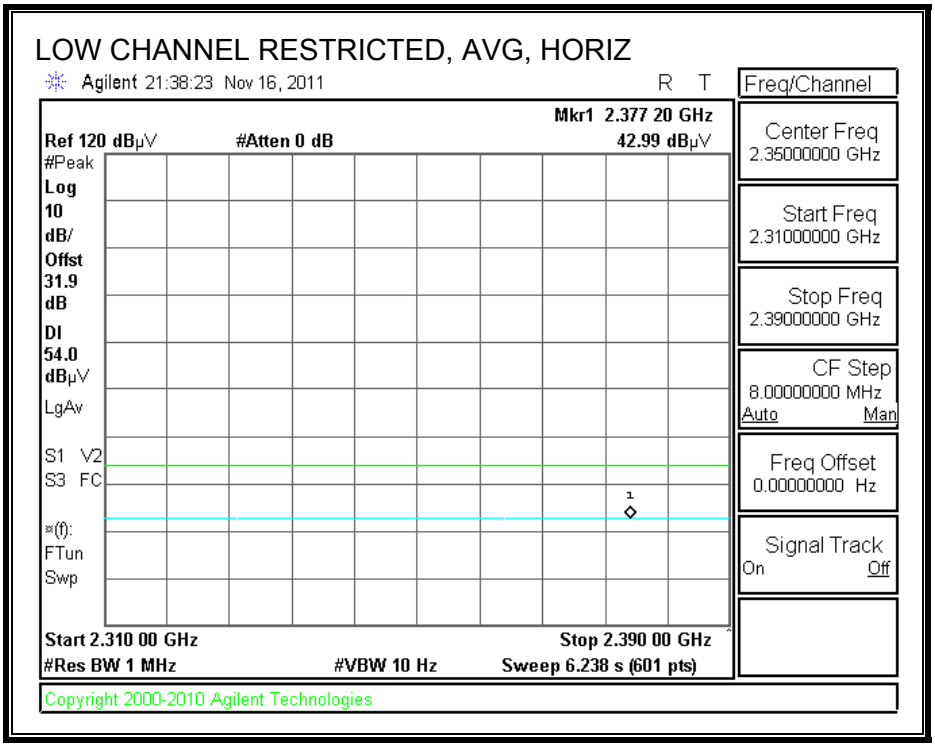
Rev. 07.08.11

| | | | | | |
|---|---|---|---|---|---|
| f | Measurement Frequency | Amp | Preamp Gain | Avg Lim | Average Field Strength Limit |
| Dist | Distance to Antenna | D Corr | Distance Correct to 3 meters | Pk Lim | Peak Field Strength Limit |
| Read | Analyzer Reading | Avg | Average Field Strength @ 3 m | Avg Mar | Margin vs. Average Limit |
| AF | Antenna Factor | Peak | Calculated Peak Field Strength | Pk Mar | Margin vs. Peak Limit |
| CL | Cable Loss | HPF | High Pass Filter | | |

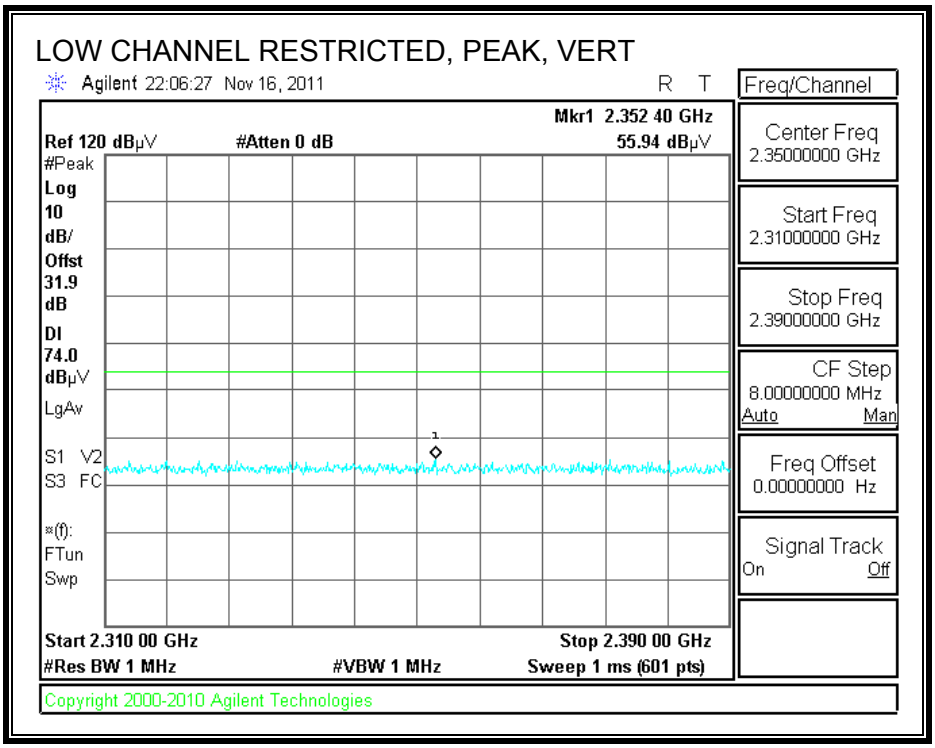
## 8.2.2. ENHANCED DATA RATE 8PSK MODULATION

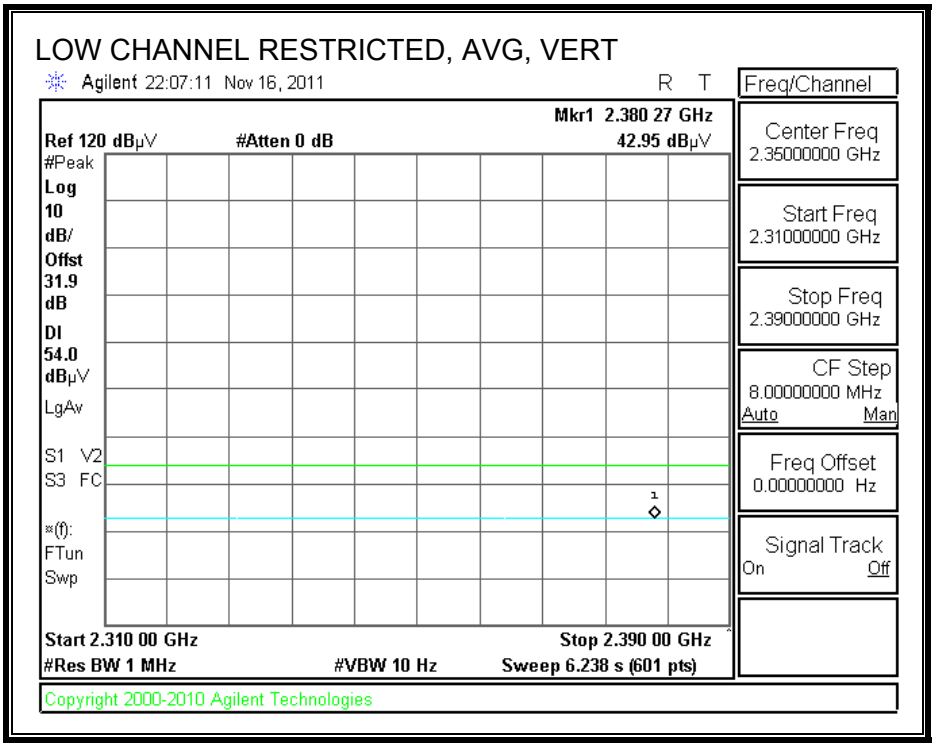
**RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)**



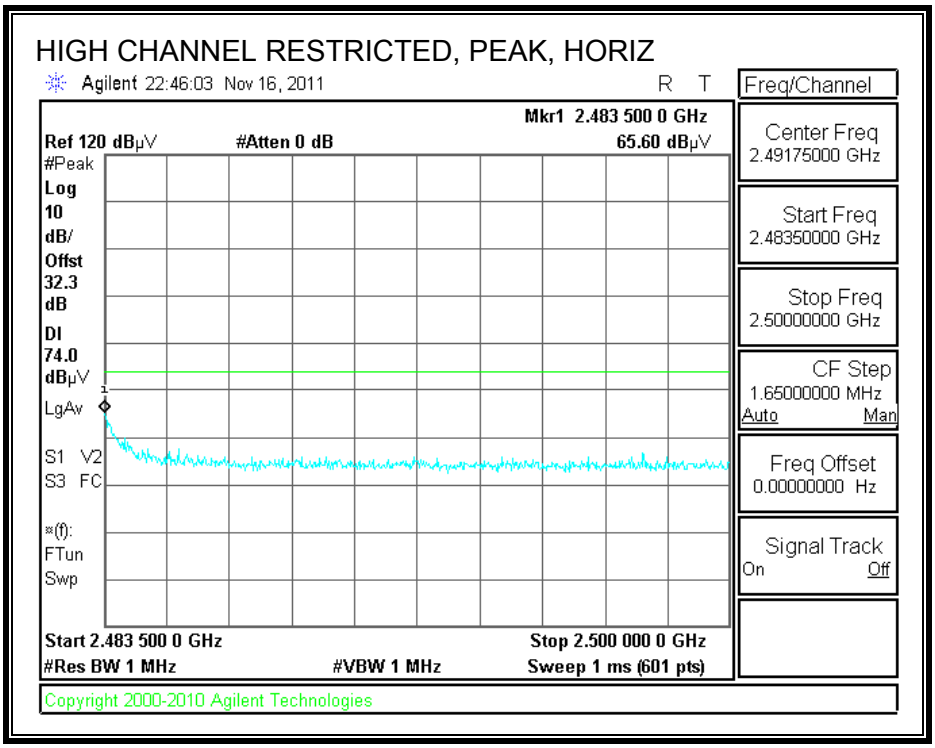


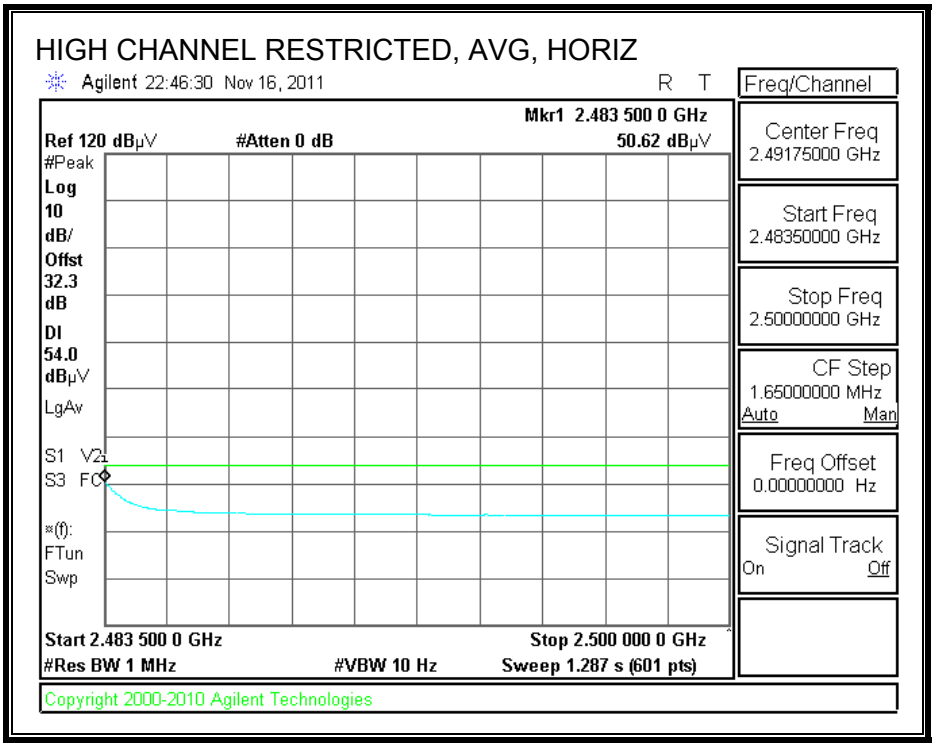
**RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**



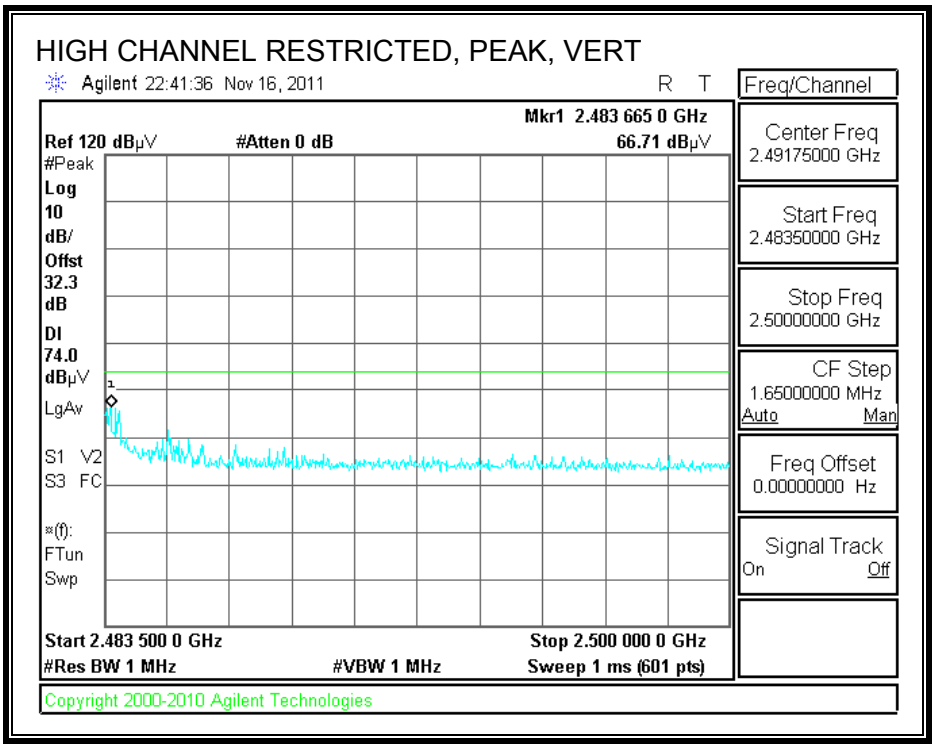


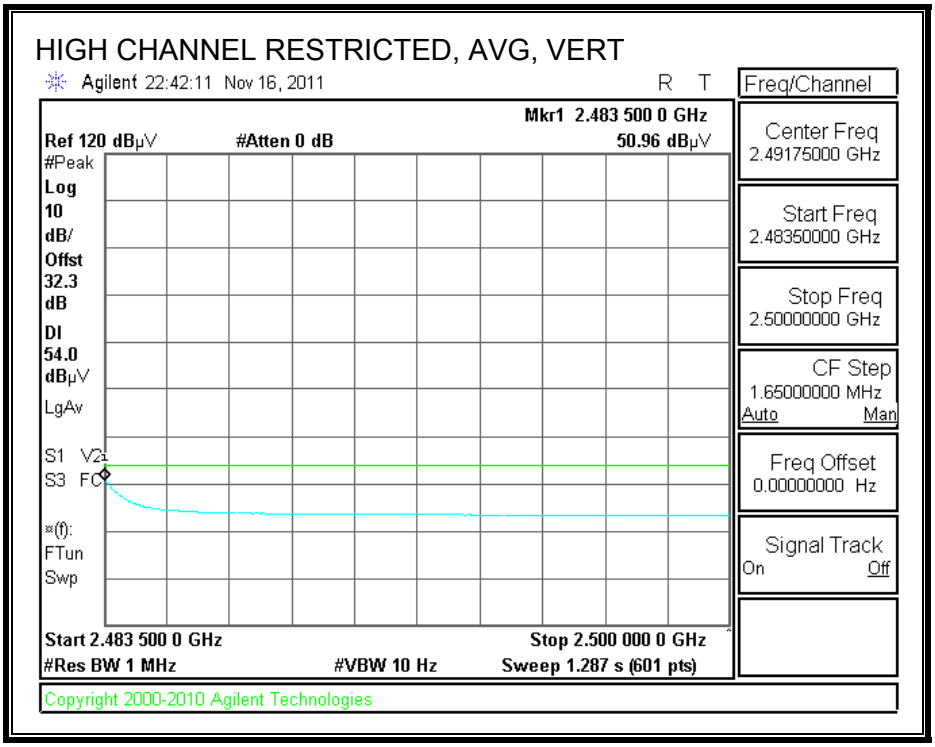
**RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**





**RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)**





## HARMONICS AND SPURIOUS EMISSIONS

**High Frequency Measurement**
**Compliance Certification Services, Fremont 5m Chamber-B**

**Company:** QualComm
**Project #:** 11U14082
**Date:** 11/17/2011
**Test Engineer:** Thanh Nguyen
**Configuration:** EUT StandAlone
**Mode:** Transmit 8PSK Mode

**Test Equipment:**

| Horn 1-18GHz | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz | Limit |
|---|---|---|---|---|
| T59; S/N: 3245 @3m | T145 Agilent 3008A0056 | | T125; ARA 18-26GHz; S/N:1007 | FCC 15.205 |

Hi Frequency Cables

| 3' cable 22807700 | 12' cable 22807600 | 20' cable 22807500 | HPF | Reject Filter |
|---|---|---|---|---|
| 3' cable 22807700 | 12' cable 22807600 | 20' cable 22807500 | | R_001 |

**Peak Measurements**
RBW=VBW=1MHz
**Average Measurements**
RBW=1MHz ; VBW=10Hz

| f GHz | Dist (m) | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | Fltr dB | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes (V/H) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low Ch | | | | | | | | | | | | | | | |
| 4.804 | 3.0 | 38.2 | 26.4 | 33.1 | 6.3 | -34.8 | 0.0 | 0.0 | 42.8 | 31.0 | 74 | 54 | -31.2 | -23.0 | Noise floor/V |
| 4.804 | 3.0 | 38.5 | 26.5 | 33.1 | 6.3 | -34.8 | 0.0 | 0.0 | 43.1 | 31.1 | 74 | 54 | -30.9 | -22.9 | Noise floor/H |
| Mid Ch | | | | | | | | | | | | | | | |
| 4.882 | 3.0 | 38.3 | 25.8 | 33.2 | 6.3 | -34.8 | 0.0 | 0.0 | 43.0 | 30.5 | 74 | 54 | -31.0 | -23.5 | Noise floor/V |
| 4.882 | 3.0 | 38.5 | 25.3 | 33.2 | 6.3 | -34.8 | 0.0 | 0.0 | 43.2 | 30.1 | 74 | 54 | -30.8 | -23.9 | Noise floor/H |
| High Ch | | | | | | | | | | | | | | | |
| 4.962 | 3.0 | 38.5 | 25.5 | 33.3 | 6.4 | -34.8 | 0.0 | 0.0 | 43.4 | 30.4 | 74 | 54 | -30.6 | -23.6 | Noise floor/V |
| 4.962 | 3.0 | 38.5 | 25.5 | 33.3 | 6.4 | -34.8 | 0.0 | 0.0 | 43.4 | 30.4 | 74 | 54 | -30.6 | -23.6 | Noise floor/H |

Rev. 07.08.11

| | | | | | |
|---|---|---|---|---|---|
| f | Measurement Frequency | Amp | Preamp Gain | Avg Lim | Average Field Strength Limit |
| Dist | Distance to Antenna | D Corr | Distance Correct to 3 meters | Pk Lim | Peak Field Strength Limit |
| Read | Analyzer Reading | Avg | Average Field Strength @ 3 m | Avg Mar | Margin vs. Average Limit |
| AF | Antenna Factor | Peak | Calculated Peak Field Strength | Pk Mar | Margin vs. Peak Limit |
| CL | Cable Loss | HPF | High Pass Filter | | |

## 8.3. RECEIVER ABOVE 1 GHz

**High Frequency Measurement**
**Compliance Certification Services, Fremont 5m Chamber-B**

**Company:** QualComm
**Project #:** 11U14082
**Date:** 11/18/2011
**Test Engineer:** Thanh Nguyen
**Configuration:** EUT StandAlone
**Mode:** Receive Mode

**Test Equipment:**

| Horn 1-18GHz | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz | Limit |
|---|---|---|---|---|
| T59; S/N: 3245 @3m | T145 Agilent 3008A0056 | | | RX RSS 210 |

Hi Frequency Cables

| 3' cable 22807700 | 12' cable 22807600 | 20' cable 22807500 | HPF | Reject Filter |
|---|---|---|---|---|
| 3' cable 22807700 | 12' cable 22807600 | 20' cable 22807500 | | |

**Peak Measurements**
RBW=VBW=1MHz
**Average Measurements**
RBW=1MHz ; VBW=10Hz

| f GHz | Dist (m) | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | Fltr dB | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes (V/H) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Low Ch** | | | | | | | | | | | | | | | |
| 4.804 | 3.0 | 38.7 | 26.3 | 33.1 | 6.3 | -34.8 | 0.0 | 0.0 | 43.3 | 30.9 | 74 | 54 | -30.7 | -23.1 | Noise floor/V |
| 4.804 | 3.0 | 38.5 | 26.4 | 33.1 | 6.3 | -34.8 | 0.0 | 0.0 | 43.1 | 31.0 | 74 | 54 | -30.9 | -23.0 | Noise floor/H |
| **Mid Ch** | | | | | | | | | | | | | | | |
| 4.882 | 3.0 | 37.9 | 25.0 | 33.2 | 6.3 | -34.8 | 0.0 | 0.0 | 42.6 | 29.7 | 74 | 54 | -31.4 | -24.3 | Noise floor/V |
| 4.882 | 3.0 | 38.0 | 25.0 | 33.2 | 6.3 | -34.8 | 0.0 | 0.0 | 42.7 | 29.8 | 74 | 54 | -31.3 | -24.2 | Noise floor/H |
| **High Ch** | | | | | | | | | | | | | | | |
| 4.962 | 3.0 | 38.8 | 25.3 | 33.3 | 6.4 | -34.8 | 0.0 | 0.0 | 43.7 | 30.2 | 74 | 54 | -30.3 | -23.8 | Noise floor/V |
| 4.962 | 3.0 | 38.9 | 25.3 | 33.3 | 6.4 | -34.8 | 0.0 | 0.0 | 43.8 | 30.2 | 74 | 54 | -30.2 | -23.8 | Noise floor/H |

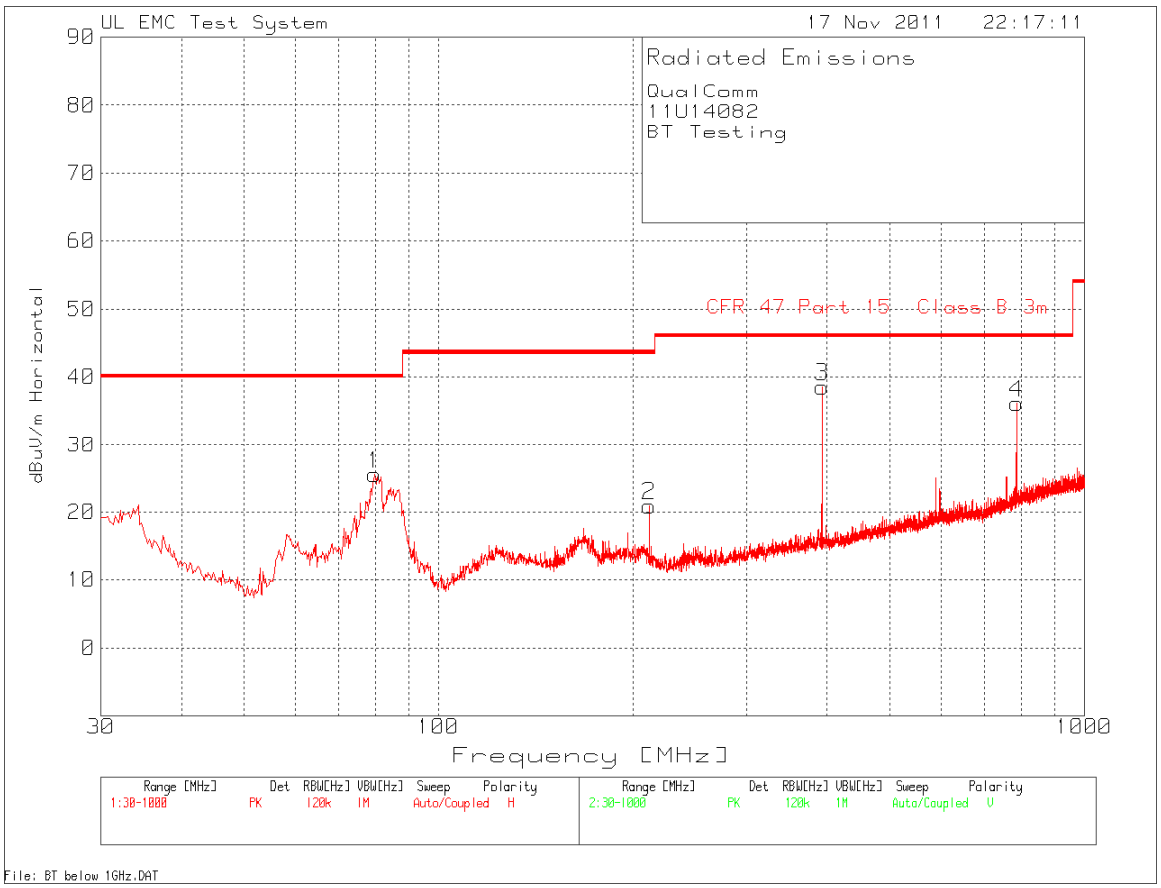
Rev. 07.08.11

| | | | | | |
|---|---|---|---|---|---|
| f | Measurement Frequency | Amp | Preamp Gain | Avg Lim | Average Field Strength Limit |
| Dist | Distance to Antenna | D Corr | Distance Correct to 3 meters | Pk Lim | Peak Field Strength Limit |
| Read | Analyzer Reading | Avg | Average Field Strength @ 3 m | Avg Mar | Margin vs. Average Limit |
| AF | Antenna Factor | Peak | Calculated Peak Field Strength | Pk Mar | Margin vs. Peak Limit |
| CL | Cable Loss | HPF | High Pass Filter | | |

## 8.4. WORST-CASE BELOW 1 GHz

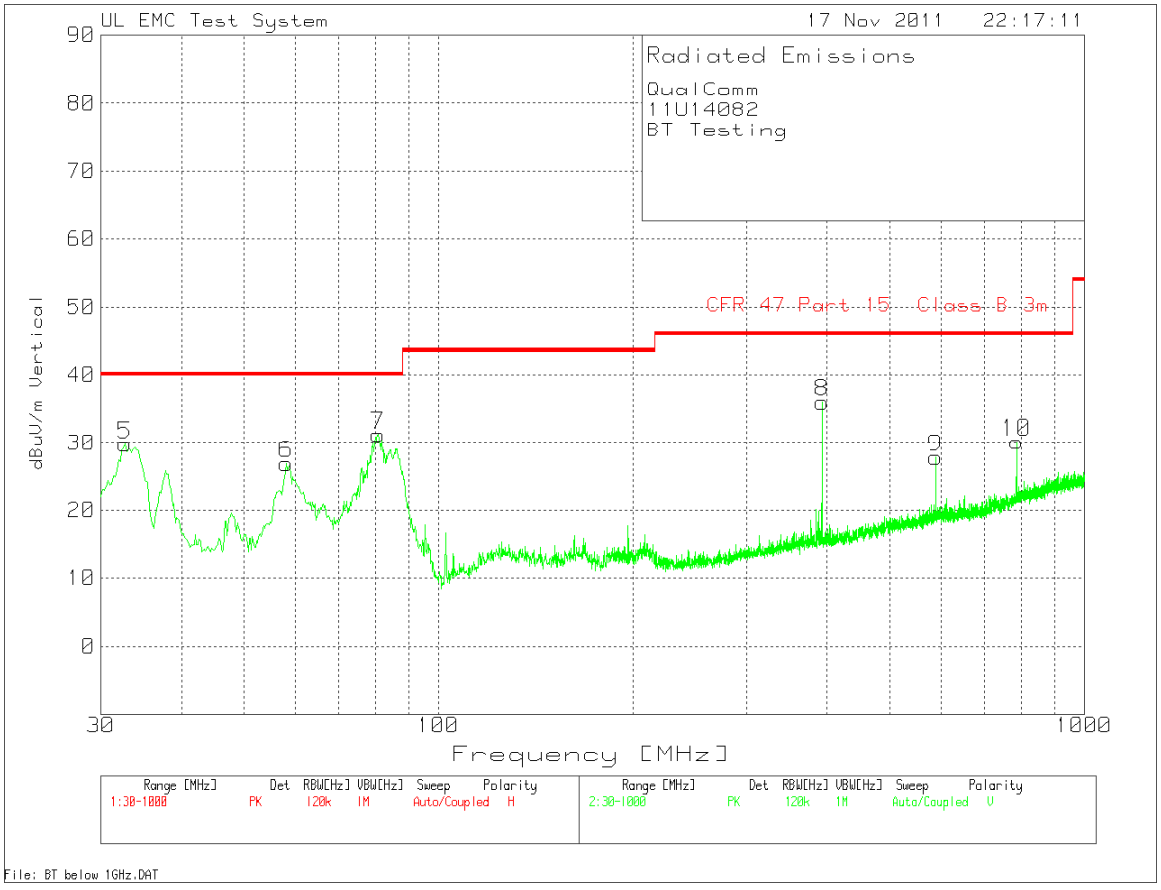
**SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)**

HORIZONTAL PLOT



**SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, VERTICAL)**

VERTICAL PLOT



**EMISSIONS DATA**

QualComm
Project: 11U14082 Qualcomm
Date: Nov. 17, 2011
Tested by: T. Nguyen
BT Testing

Range: 1 30 - 1000MHz

| Test Frequency | Meter Reading | Detector | Preamp factor [dB] | Bilog factor [dB] | Corrected dBuV/m | CFR 47 Part 15 Class B 3m | Margin | Height [cm] | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| 79.6243 | 44.63 | PK | -27.1 | 8 | 25.53 | 40 | -14.47 | 175 | Horz |
| 212.2142 | 34.73 | PK | -25.7 | 11.9 | 20.93 | 43.5 | -22.57 | 175 | Horz |
| 392.6839 | 49.27 | PK | -25.6 | 14.9 | 38.57 | 46 | -7.43 | 94 | Horz |
| 785.6075 | 40.25 | PK | -24.7 | 20.6 | 36.15 | 46 | -9.85 | 94 | Horz |

Range: 2 30 - 1000MHz

| Test Frequency | Meter Reading | Detector | Preamp factor [dB] | Bilog factor [dB] | Corrected dBuV/m | CFR 47 Part 15 Class B 3m | Margin | Height [cm] | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| 32.7138 | 38.54 | PK | -27.5 | 18.7 | 29.74 | 40 | -10.26 | 99 | Vert |
| 58.1075 | 45.89 | PK | -27.2 | 8.2 | 26.89 | 40 | -13.11 | 99 | Vert |
| 80.5935 | 50.29 | PK | -27 | 7.9 | 31.19 | 40 | -8.81 | 176 | Vert |
| 392.6839 | 46.7 | PK | -25.6 | 14.9 | 36 | 46 | -10 | 99 | Vert |
| 589.0488 | 35.21 | PK | -25.7 | 18.3 | 27.81 | 46 | -18.19 | 99 | Vert |
| 785.6075 | 34.21 | PK | -24.7 | 20.6 | 30.11 | 46 | -15.89 | 176 | Vert |

PK - Peak detector
QP - Quasi-Peak detector

Note: cable loss is already included in this data sheet.

# 9. AC POWER LINE CONDUCTED EMISSIONS

**LIMITS**

FCC §15.207 (a)

RSS-Gen 7.2.2

| Frequency of Emission (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.

**TEST PROCEDURE**

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.4.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

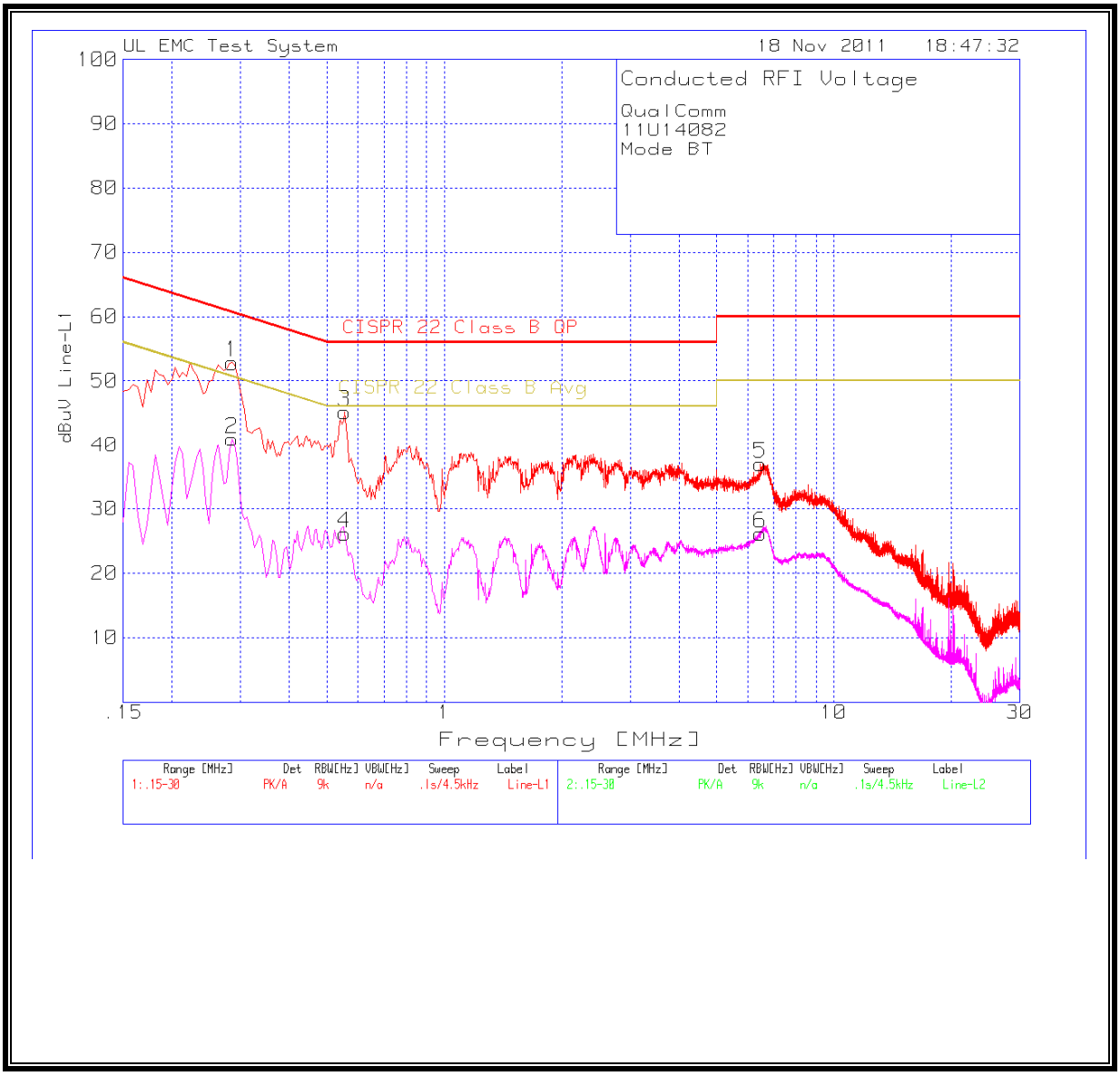
Line conducted data is recorded for both NEUTRAL and HOT lines.

**RESULTS**

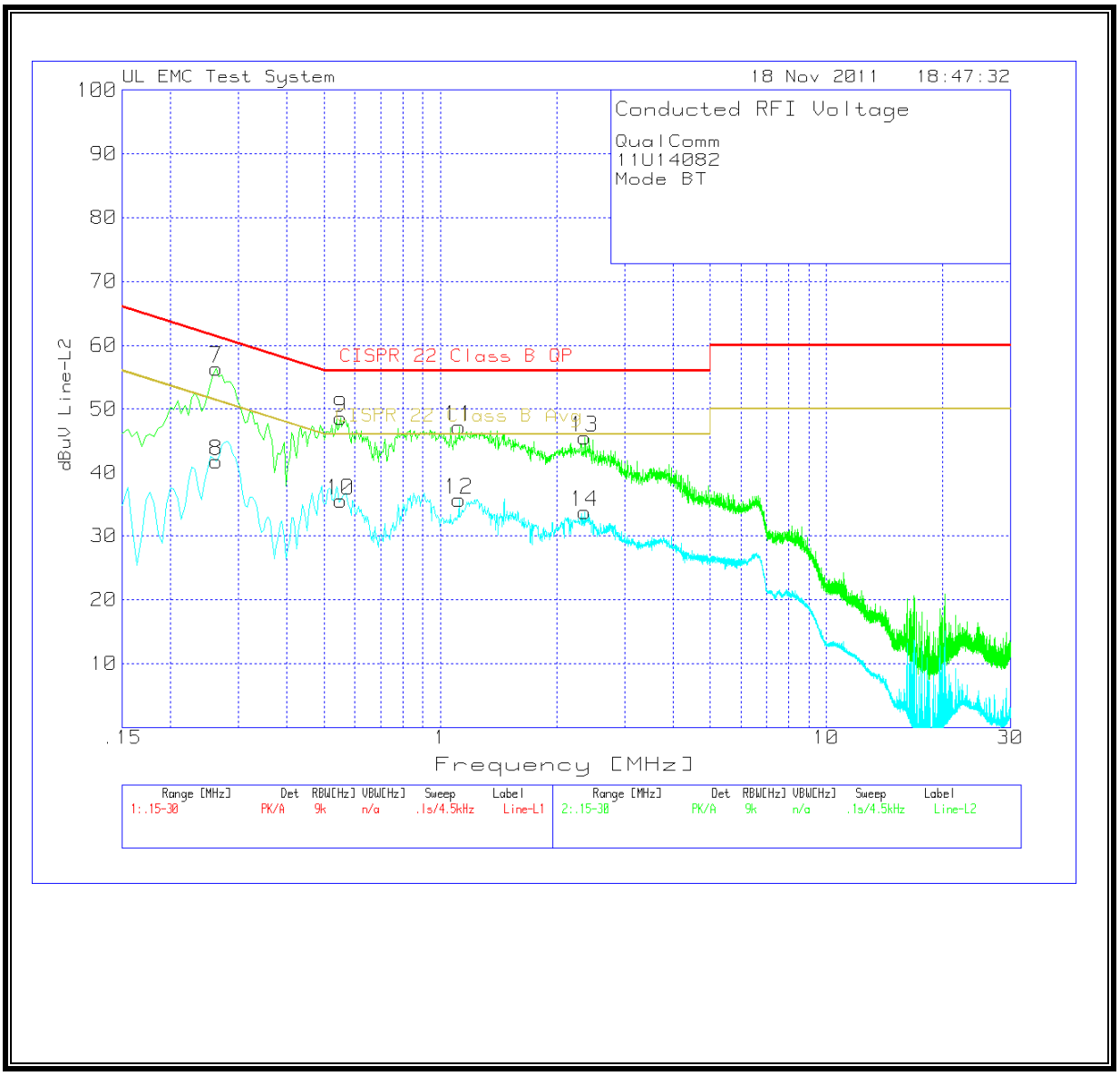
**6 WORST EMISSIONS**

| QualComm | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11U14082 | | | | | | | | |
| Mode BT | | | | | | | | |
| | | | | | | | | |
| Line-L1 .15 - 30MHz | | | | | | | | |
| | | | | | | | | |
| Test Freq. (MHz) | Meter Reading | Detector | LISN [dB] | Correct Reading (dBuVolts) | Class B Quasi-peak Limit | Quasi-Peak Margin | Class B Average Limit | Average Margin |
| 0.285 | 52.01 | PK | 0.8 | 52.81 | 60.7 | -7.89 | | |
| 0.285 | 40.17 | Av | 0.8 | 40.97 | 60.7 | -19.73 | 50.7 | -9.73 |
| 0.555 | 44.74 | PK | 0.4 | 45.14 | 56 | -10.86 | | |
| 0.555 | 25.74 | Av | 0.4 | 26.14 | 56 | -29.86 | 46 | -19.86 |
| 6.477 | 36.7 | PK | 0.3 | 37 | 60 | -23 | | |
| 6.477 | 25.87 | Av | 0.3 | 26.17 | 60 | -33.83 | 50 | -23.83 |
| | | | | | | | | |
| Line-L2 .15 - 30MHz | | | | | | | | |
| | | | | | | | | |
| Test Freq. (MHz) | Meter Reading | Detector | LISN [dB] | Correct Reading (dBuVolts) | Class B Quasi-peak Limit | Quasi-Peak Margin | Class B Average Limit | Average Margin |
| 0.2625 | 55.5 | PK | 0.9 | 56.4 | 61.4 | -5 | | |
| 0.2625 | 40.97 | Av | 0.9 | 41.87 | 61.4 | -19.53 | 51.4 | -9.53 |
| 0.5505 | 48.2 | PK | 0.4 | 48.6 | 56 | -7.4 | | |
| 0.5505 | 35.09 | Av | 0.4 | 35.49 | 56 | -20.51 | 46 | -10.51 |
| 1.1175 | 46.9 | PK | 0.3 | 47.2 | 56 | -8.8 | | |
| 1.1175 | 35.39 | Av | 0.3 | 35.69 | 56 | -20.31 | 46 | -10.31 |
| 2.3685 | 45.25 | PK | 0.3 | 45.55 | 56 | -10.45 | | |
| 2.3685 | 33.38 | Av | 0.3 | 33.68 | 56 | -22.32 | 46 | -12.32 |
| | | | | | | | | |

**LINE 1 RESULTS**



**LINE 2 RESULTS**



# 10. MAXIMUM PERMISSIBLE EXPOSURE

**FCC RULES**

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density ($mW/cm^2$) | Averaging time (minutes) |
|---|---|---|---|---|
| (A) Limits for Occupational/Controlled Exposures | | | | |
| 0.3–3.0 | 614 | 1.63 | *(100) | 6 |
| 3.0–30 | 1842/f | 4.89/f | *($900/f^2$) | 6 |
| 30–300 | 61.4 | 0.163 | 1.0 | 6 |
| 300–1500 | | | f/300 | 6 |
| 1500–100,000 | | | 5 | 6 |
| (B) Limits for General Population/Uncontrolled Exposure | | | | |
| 0.3–1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34–30 | 824/f | 2.19/f | *($180/f^2$) | 30 |

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density ($mW/cm^2$) | Averaging time (minutes) |
|---|---|---|---|---|
| 30–300 | 27.5 | 0.073 | 0.2 | 30 |
| 300–1500 | | | f/1500 | 30 |
| 1500–100,000 | | | 1.0 | 30 |

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

**IC RULES**

IC Safety Code 6, Section 2.2.1 (a) A person other than an RF and microwave exposed worker shall not be exposed to electromagnetic radiation in a frequency band listed in Column 1 of Table 5, if the field strength exceeds the value given in Column 2 or 3 of Table 5, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of Table 5, when averaged spatially and over time.

**Table 5**
**Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)**

| 1 Frequency (MHz) | 2 Electric Field Strength; rms (V/m) | 3 Magnetic Field Strength; rms (A/m) | 4 Power Density ($W/m^2$) | 5 Averaging Time (min) |
|---|---|---|---|---|
| 0.003–1 | 280 | 2.19 | | 6 |
| 1–10 | $280/f$ | $2.19/f$ | | 6 |
| 10–30 | 28 | $2.19/f$ | | 6 |
| 30–300 | 28 | 0.073 | 2* | 6 |
| 300–1 500 | $1.585f^{0.5}$ | $0.0042f^{0.5}$ | $f/150$ | 6 |
| 1 500–15 000 | 61.4 | 0.163 | 10 | 6 |
| 15 000–150 000 | 61.4 | 0.163 | 10 | $616\,000/f^{1.2}$ |
| 150 000–300 000 | $0.158f^{0.5}$ | $4.21 \times 10^{-4}f^{0.5}$ | $6.67 \times 10^{-5}f$ | $616\,000/f^{1.2}$ |

* Power density limit is applicable at frequencies greater than 100 MHz.

**Notes:** 1. Frequency, $f$, is in MHz.
2. A power density of 10 $W/m^2$ is equivalent to 1 $mW/cm^2$.
3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

**EQUATIONS**

Power density is given by:

S = EIRP / (4 * Pi * D^2)

where

S = Power density in W/m^2
EIRP = Equivalent Isotropic Radiated Power in W
D = Separation distance in m

Power density in units of W/m^2 is converted to units of mWc/m^2 by dividing by 10.

Distance is given by:

D = SQRT (EIRP / (4 * Pi * S))

where

D = Separation distance in m
EIRP = Equivalent Isotropic Radiated Power in W
S = Power density in W/m^2

In the table(s) below, Power and Gain are entered in units of dBm and dBi respectively and conversions to linear forms are used for the calculations.

**LIMITS**

From FCC §1.1310 Table 1 (B), the maximum value of S = 1.0 mW/cm^2

From IC Safety Code 6, Section 2.2 Table 5 Column 4, S = 10 W/m^2

**RESULTS**

| Band | Mode | Separation Distance (m) | Output AV Power (dBm) | Antenna Gain (dBi) | IC Power Density (W/m^2) | FCC Power Density (mW/cm^2) |
|---|---|---|---|---|---|---|
| 2.4 GHz | Bluetooth | 0.20 | 7.22 | 3.80 | 0.03 | 0.003 |