# FCC CFR47 PART 15 SUBPART C
# CERTIFICATION
# TEST REPORT

**FOR**

**BROADCOM USB BLUETOOTH MODULE**

**MODEL NUMBER: BCM92045MD**

**FCC ID: QDS-BRCM1021**

**REPORT NUMBER: 05U3907-1B**

**ISSUE DATE: FEBRUARY 7, 2006**

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**LAB CODE:200065-0**

Revision History

| Rev. | Issue Date | Revisions | Revised By |
|---|---|---|---|
| A | 1/27/06 | Initial Issue | Thu |
| B | 02/07/06 | Added MPE calculations for both 8PSK and GFSK modulations | Thu |
| | | Added limit table for section 7.1.2 & 7.2.2 hopping frequency separation | Thu |
| | | Revised the alternative power limit from 1W to 125mW for section 7.1.5 | Thu |

# TABLE OF CONTENTS

# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** Broadcom Corp.
190 Mathilda Place
Sunnyvale, CA 94086, USA

**EUT DESCRIPTION:** Broadcom USB Bluetooth Module

**MODEL:** BCM92045MD

**SERIAL NUMBER:** #1062183 - RF Conducted unit; #1062187 - Radiated emission unit

**DATE TESTED:** January 11 to 13, 2006

| APPLICABLE STANDARDS | |
|---|---|
| **STANDARD** | **TEST RESULTS** |
| FCC PART 15 SUBPART C | NO NON-COMPLIANCE NOTED |

Compliance Certification Services, Inc. tested the above equipment in accordance with the requirements set forth in the above standards. 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 Compliance Certification Services and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Compliance Certification Services will constitute fraud and shall nullify the document. No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.

Approved & Released For CCS By: Tested By:

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# 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2003, FCC CFR 47 Part 2 and FCC CFR 47 Part 15.

# 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 561F Monterey Road, Morgan Hill, California, USA. The sites are constructed in conformance with the requirements of ANSI C63.4, ANSI C63.7 and CISPR Publication 22. All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

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. MEASUREMENT UNCERTAINTY

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

| PARAMETER | UNCERTAINTY |
|---|---|
| Radiated Emission, 30 to 200 MHz | +/- 3.3 dB |
| Radiated Emission, 200 to 1000 MHz | +4.5 / -2.9 dB |
| Radiated Emission, 1000 to 2000 MHz | +4.5 / -2.9 dB |
| Power Line Conducted Emission | +/- 2.9 dB |

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

# 5. EQUIPMENT UNDER TEST

## 5.1. DESCRIPTION OF EUT

The EUT is a USB Bluetooth module operating in the 2400-2483.5 MHz band.

The radio module is manufactured by BROADCOM CORPORATION.

## 5.2. MAXIMUM OUTPUT POWER

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

GFSK 2400 to 2483.5 MHz Authorized Band

| Frequency Range (MHz) | Output Power (dBm) | Output Power (mW) |
|---|---|---|
| 2402 - 2480 | 4.33 | 2.71 |

8PSK 2400 to 2483.5 MHz Authorized Band

| Frequency Range (MHz) | Output Power (dBm) | Output Power (mW) |
|---|---|---|
| 2402 - 2480 | 6.33 | 4.30 |

## 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an Ethertronics (PCB antenna) with a maximum gain of –1.34 dBi.

## 5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was Widcomm_V 4.0.1.400.

The EUT driver software installed in the laptop support equipment during testing was Broadcom Bluetool, rev. 0.8.5.8.

The test utility software used during testing was HCI Control: USB0.

## 5.5. WORST-CASE CONFIGURATION AND MODE

The worst-case channel is determined as the channel with the highest output power. The highest measured output power was at 2480 MHz for both GFSK and 8PSK modulations.

X, Y and Z polarization positions were investigated, and X position was determined as the worst-case position.

## 5.6. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

| PERIPHERAL SUPPORT EQUIPMENT LIST | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number** | **FCC ID** |
| Laptop | DELL | INSPERON 630m | 02/20/3145 | N/A |
| USB Converter | BROADCOM | 3P3V | 1059200 | N/A |
| AC/DC Adapter | DELL | PA-1900-02D | CN09125-48010-35Q | N/A |

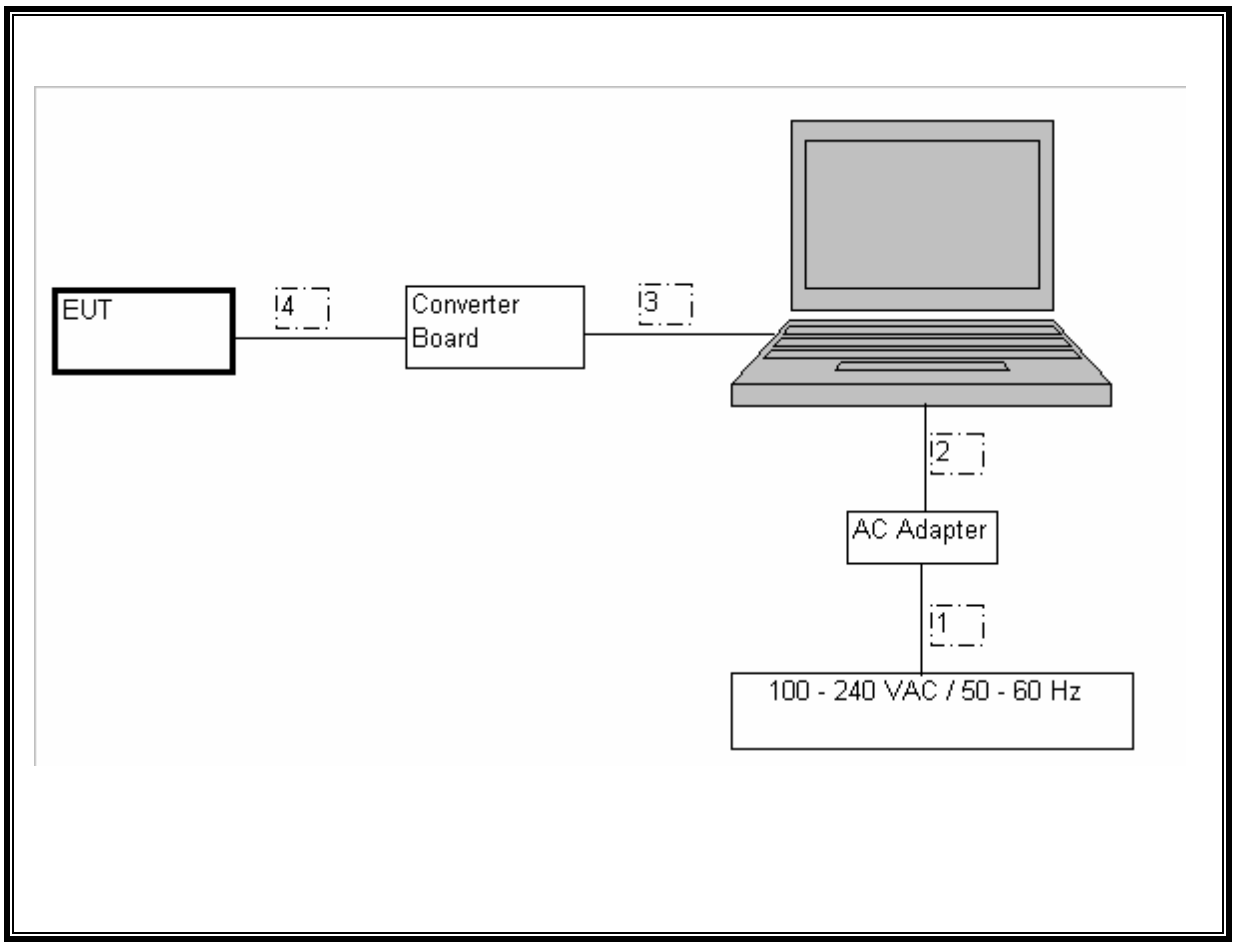
### I/O CABLES

| I/O CABLE LIST | | | | | | |
|---|---|---|---|---|---|---|
| **Cable No.** | **Port** | **# of Identical Ports** | **Connector Type** | **Cable Type** | **Cable Length** | **Remarks** |
| 1 | AC | 1 | US 115V | Un-shielded | 1m | N/A |
| 2 | DC | 1 | DC Plug | Un-shielded | 15m | N/A |
| 3 | USB | 1 | USB | Shielded | 1.5m | N/A |
| 4 | BT | 1 | Paralell | Un-shielded | .3m | N/A |

### TEST SETUP

The EUT was connected to the host laptop via a converter board. Test software exercised the radio card.

**SETUP DIAGRAM FOR 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** | **Serial Number** | **Cal Due** |
| EMI Test Receiver | R & S | ESHS 20 | 827129/006 | 10/22/2006 |
| Site A Line Stabilizer / Conditioner | Tripplite | LC-1800a | A0051681 | CNR |
| LISN, 10 kHz ~ 30 MHz | FCC | LISN-50/250-25-2 | 2023 | 08/30/2006 |
| LISN, 10 kHz ~ 30 MHz | Solar | 8012-50-R-24-BNC | 8379443 | 10/21/2006 |
| Spectrum Analyzer, 26.5 GHz | HP | 8593EM | 3710A00205 | 01/06/2007 |
| Antenna, Horn 1 ~ 18 GHz | EMCO | 3117 | 29310 | 09/12/2006 |
| Antenna, Horn 18 ~ 26 GHz | ARA | SWH-28 | 1007 | 02/24/2006 |
| Line Filter | Lindgren | LMF-3489 | 497 | N.C.R. |
| Preamplifier, 1 ~ 26.5 GHz | HP | 8449B | 3008A00369 | 08/17/2006 |
| Peak Power Meter | Agilent | E4416A | GB41291160 | 02/09/2006 |
| Peak / Average Power Sensor | Agilent | E9327A | US40440755 | 02/10/2006 |
| 30MHz---- 2Ghz | Sunol Sciences | JB1 Antenna | A121003 | 09/15/2006 |
| 4.0 High Pass Filter | Micro Tronics | HPM13351 | 3 | N/A |
| Spectrum Analyzer 20 Hz ~ 44 GHz | Agilent | E4446A | MY43360112 | 06/16/2006 |
| 2.4-2.5 Band Reject Filter | Micro Tronics | N/A | 1 | N/A |

# 7. LIMITS AND RESULTS

## 7.1. ANTENNA PORT CHANNEL TESTS FOR EUT WITH 8PSK MODULATION

### 7.1.1. 20 dB BANDWIDTH

**LIMIT**

None; for reporting purposes only.

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The RBW is set to 1% to 3% of the 20 dB bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled.

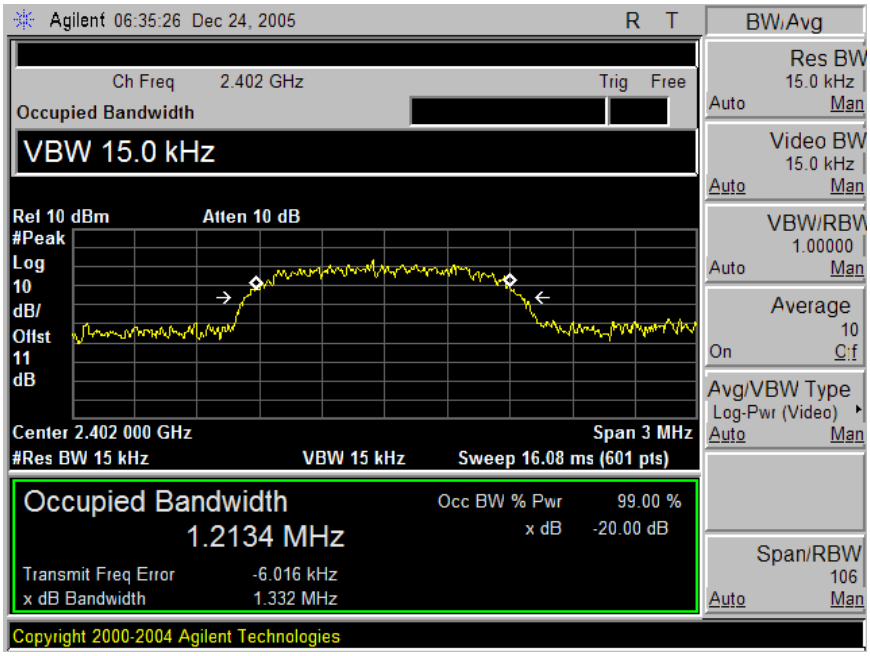
**RESULTS**

No non-compliance noted:

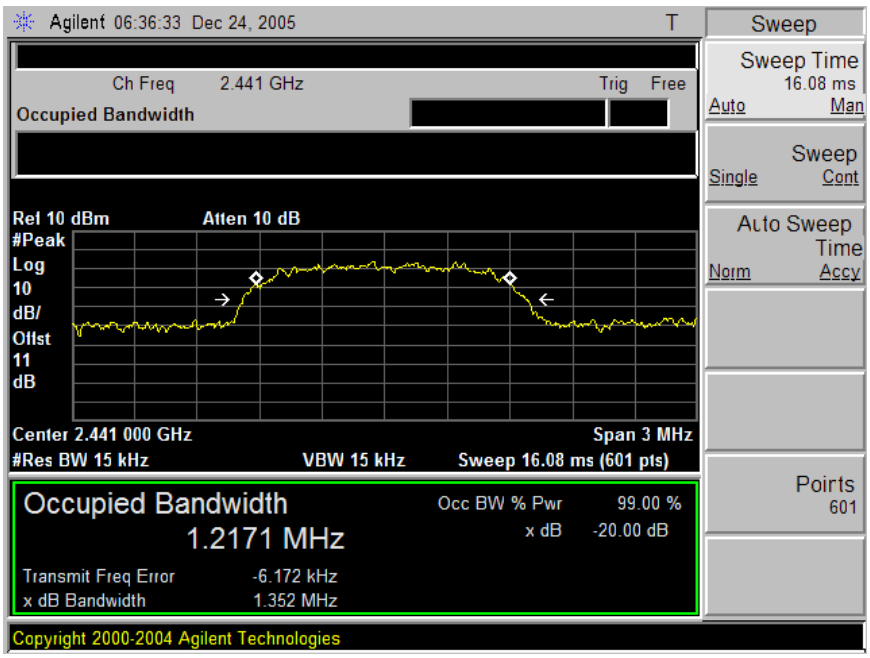
| Channel | Frequency (MHz) | 20 dB Bandwidth (kHz) |
|---|---|---|
| Low | 2402 | 1332 |
| Middle | 2441 | 1352 |
| High | 2480 | 1353 |

**20 dB BANDWIDTH**

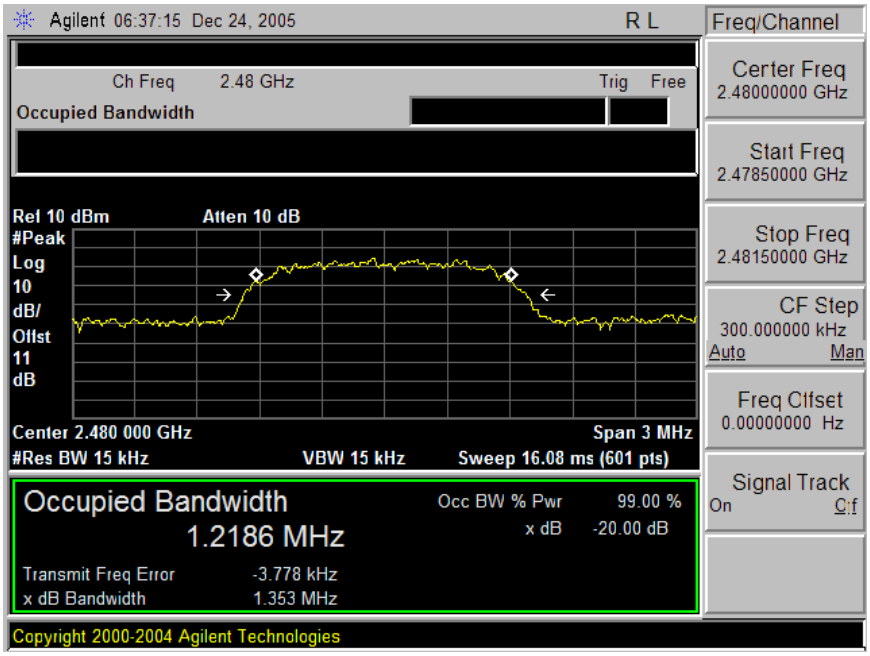
20 dB BANDWIDTH LOW CH



20 dB BANDWIDTH MID CH



20 dB BANDWIDTH HIGH CH



## 7.1.2. HOPPING FREQUENCY SEPARATION

**LIMIT**

§15.247 (a) (1) 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 100 kHz and the VBW is set to 100 kHz. The sweep time is coupled.

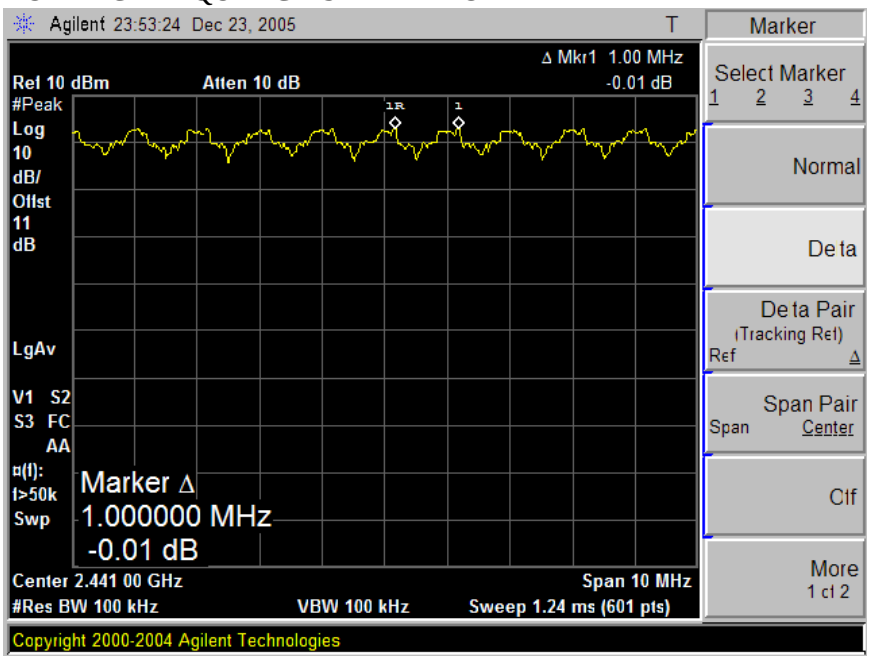
**RESULTS**

No non-compliance noted:

| Modulation | Frequency (MHz) | Hopping Separation (kHz) | Minimum of 25kHz or Two-Thirds of 20 dB (kHz) | Margin (kHz) |
|---|---|---|---|---|
| 8PSK | 2441 | 1000 | 902 | 98 |

**HOPPING FREQUENCY SEPARATION**

HOPPING FREQUENCY SEPARATION



## 7.1.3. NUMBER OF HOPPING CHANNELS

**LIMIT**

§15.247 (a) (1) (iii) 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 1 % of the span. The analyzer is set to Max Hold.

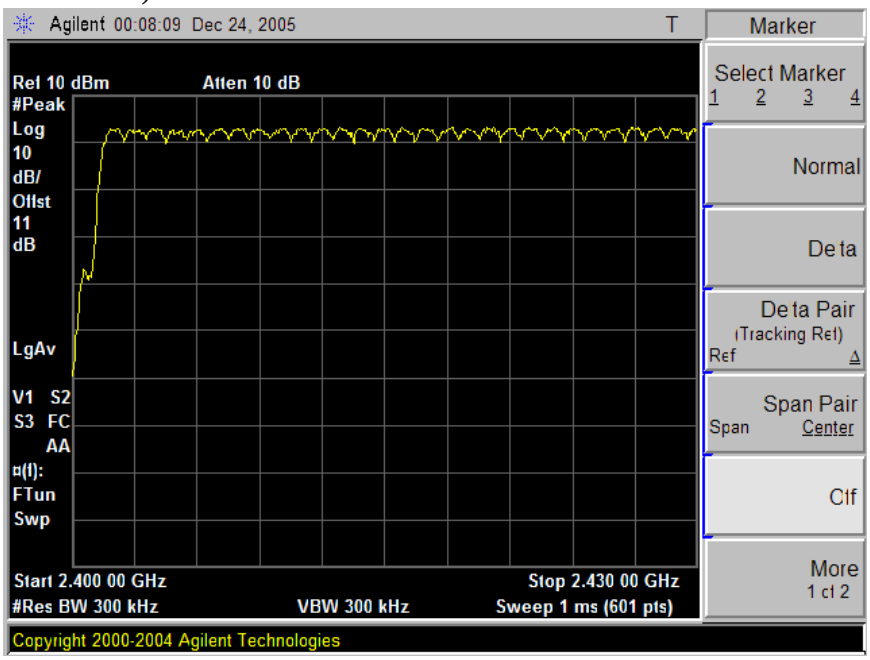
**RESULTS**

No non-compliance noted:

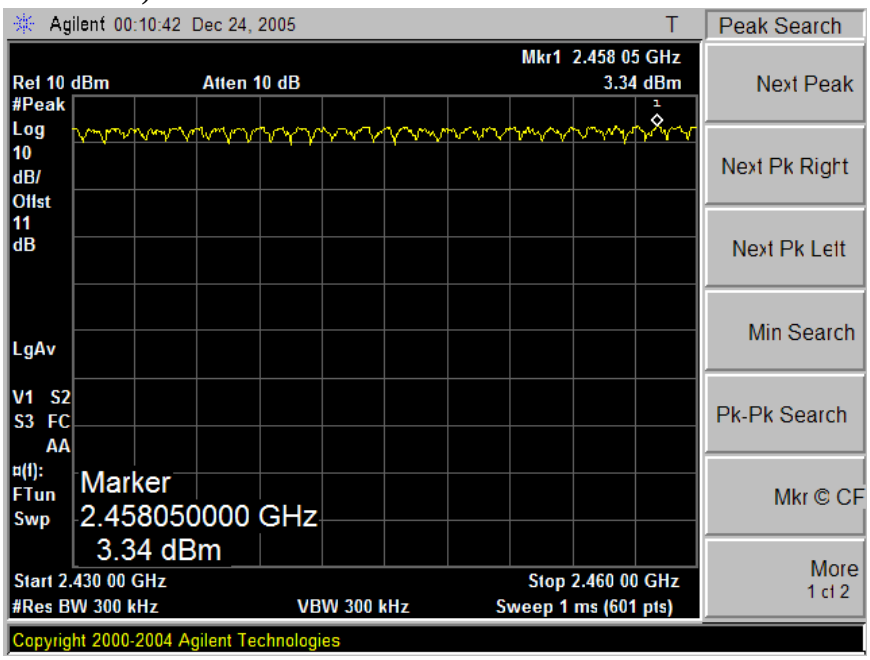
79 Channels observed.

## NUMBER OF HOPPING CHANNELS

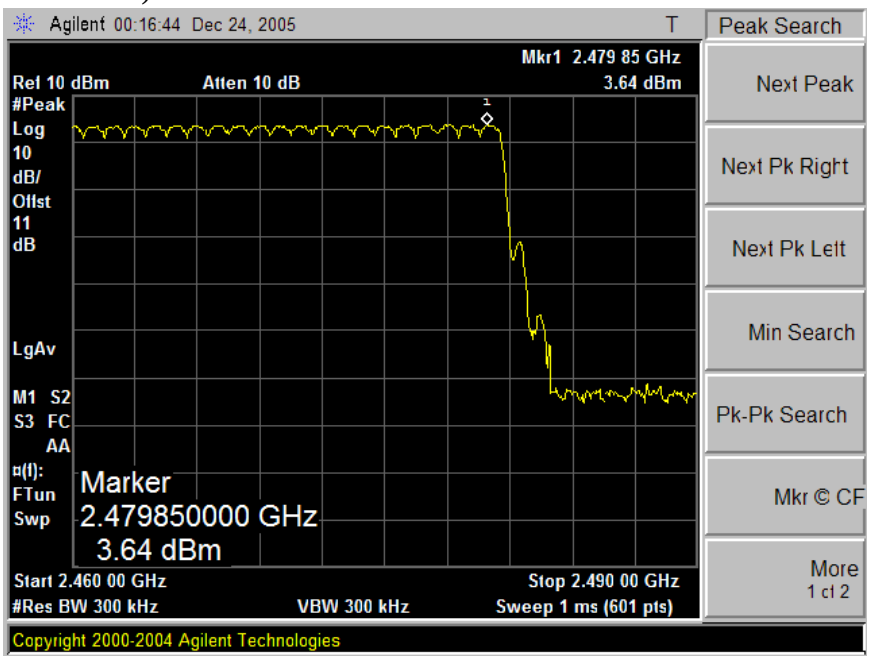
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



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**

§15.247 (a) (1) (iii) Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping 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.

**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.

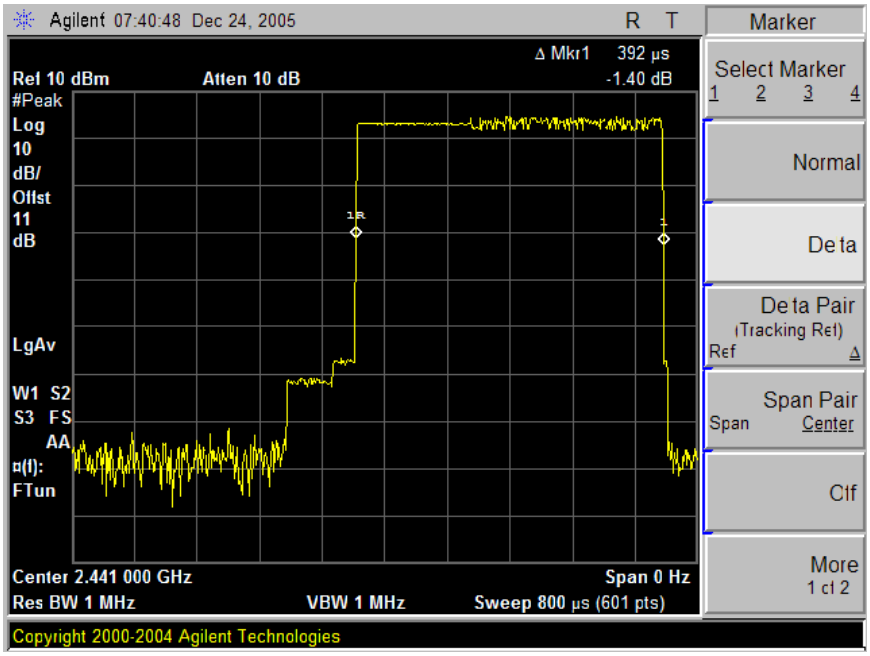
**RESULTS**

No non-compliance noted:

| DH Packet | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
|---|---|---|---|---|---|
| 1 | 0.392 | 32 | 0.125 | 0.4 | 0.275 |
| 3 | 1.645 | 16 | 0.263 | 0.4 | 0.137 |
| 5 | 2.892 | 13 | 0.376 | 0.4 | 0.024 |

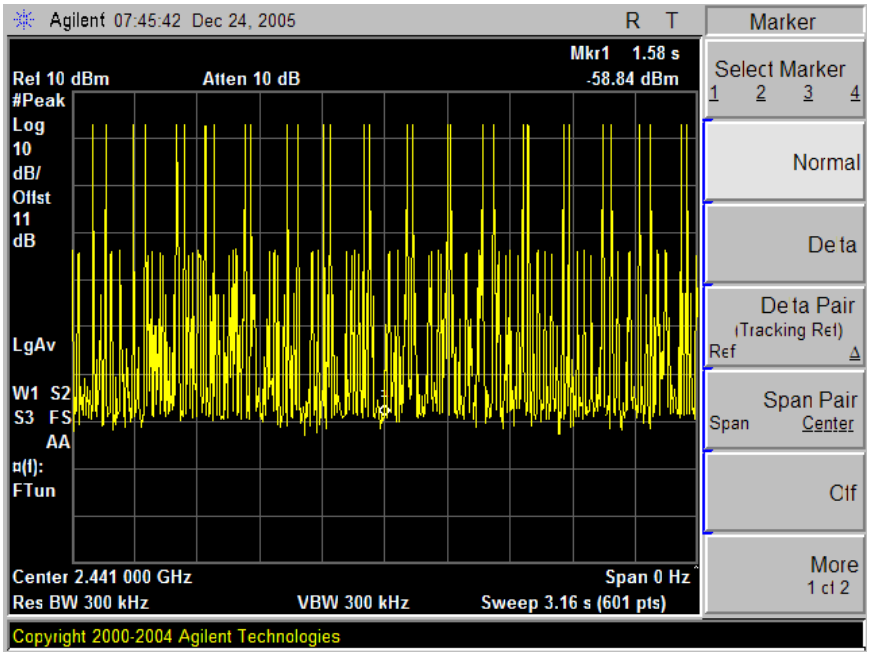
**PULSE WIDTH (DH1 PACKET TYPE)**

PULSE WIDTH



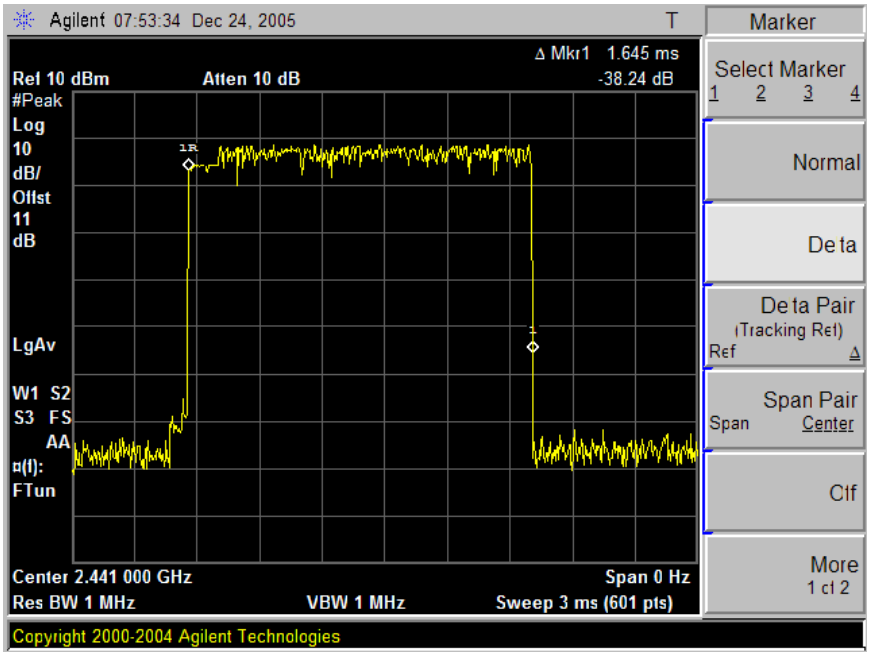
## NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD

NUMBER OF PULSES



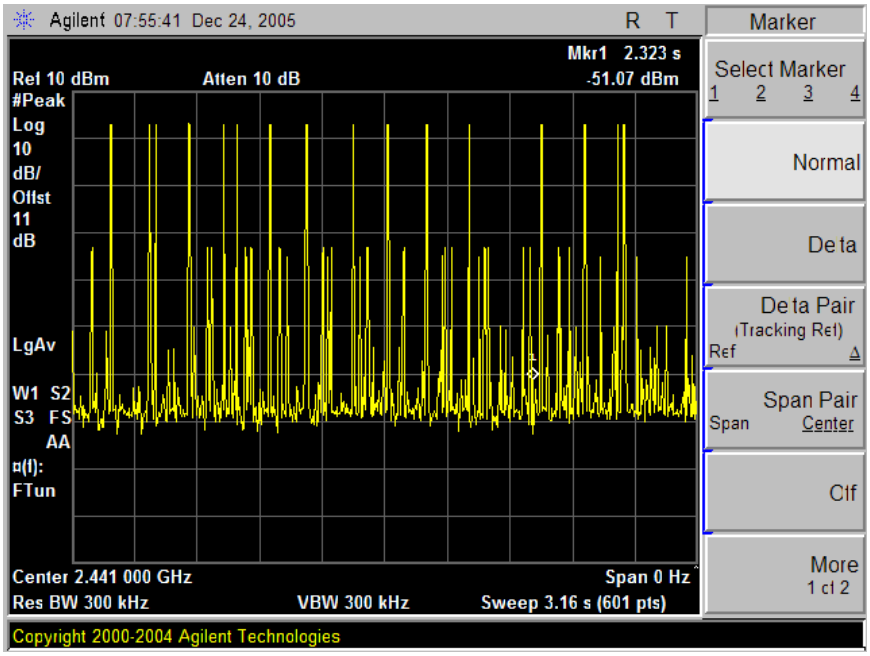
**PULSE WIDTH (DH3 PACKET TYPE)**

PULSE WIDTH



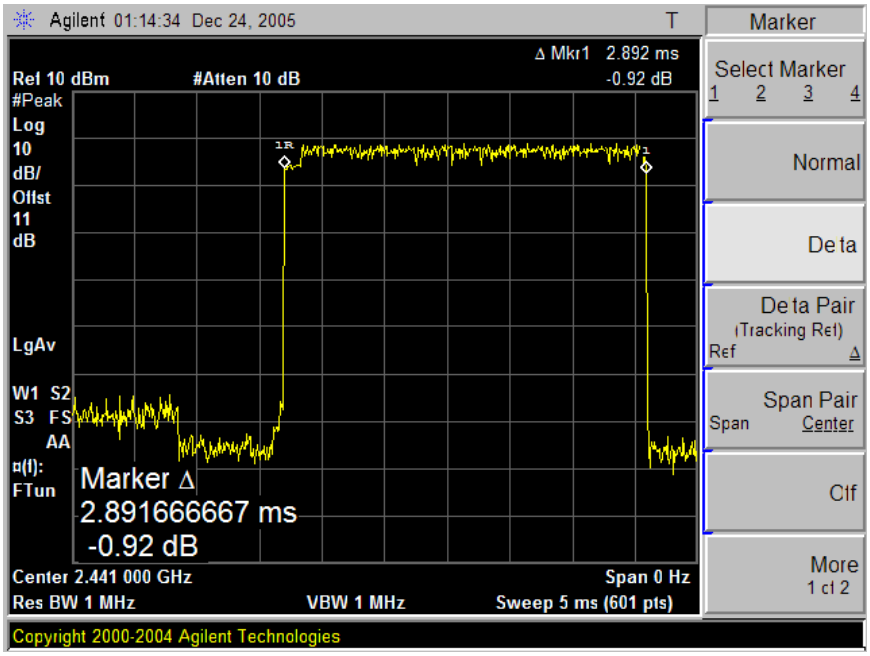
## NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD

NUMBER OF PULSES



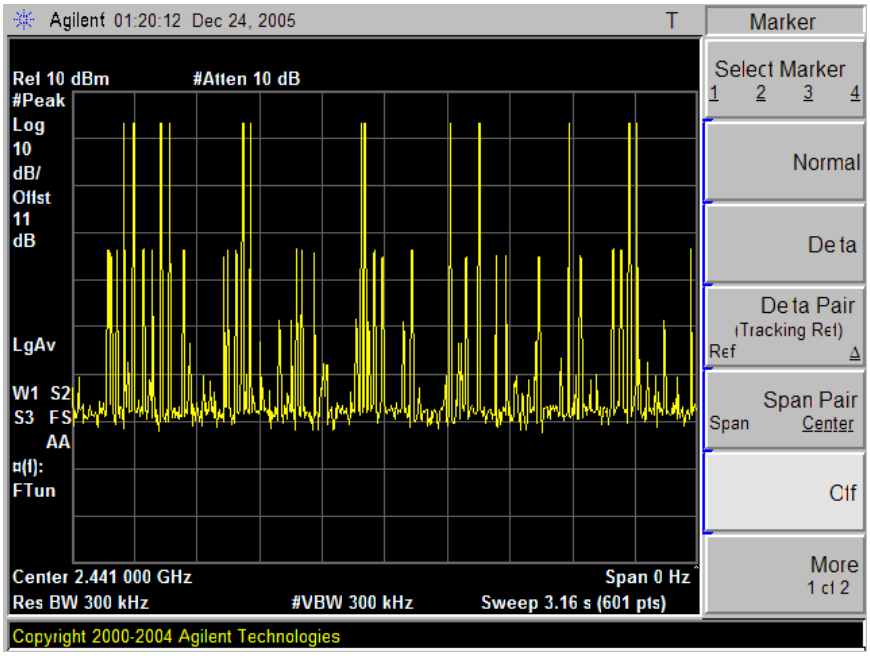
**PULSE WIDTH (DH5 PACKET TYPE)**

PULSE WIDTH



## NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD

NUMBER OF PULSES



## 7.1.5. PEAK OUTPUT POWER

**PEAK POWER LIMIT**

§15.247 (b) The maximum peak output power of the intentional radiator shall not exceed the following:

§15.247 (b) (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

§15.247 (b) (4) Except as shown in paragraphs (b)(3) (i), (ii) and (iii) of this section, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1) or (b)(2) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The maximum antenna gain is –1.34 dBi, therefore the limit is 20.97 dBm.

**TEST PROCEDURE**

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

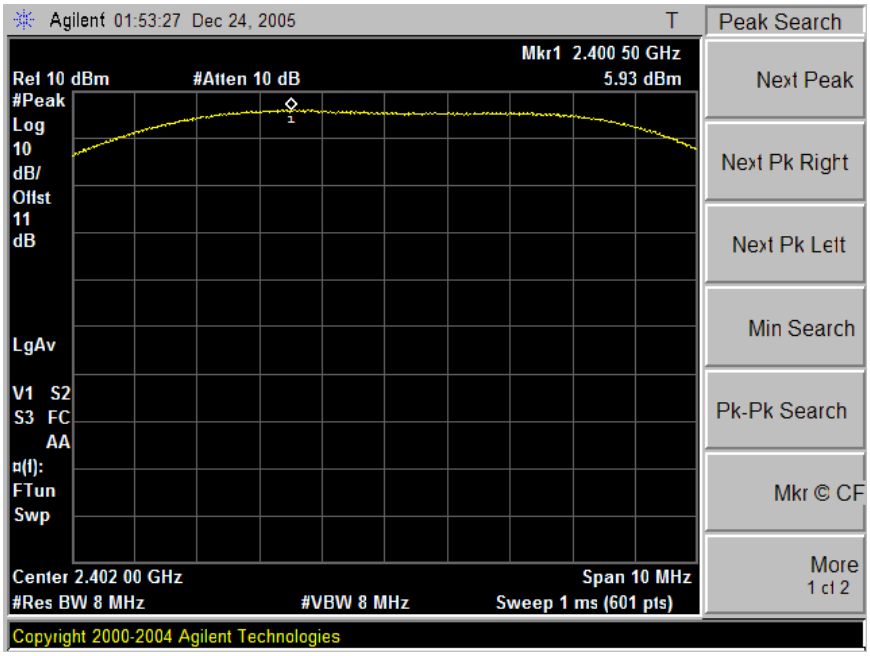
**RESULTS**

No non-compliance noted:

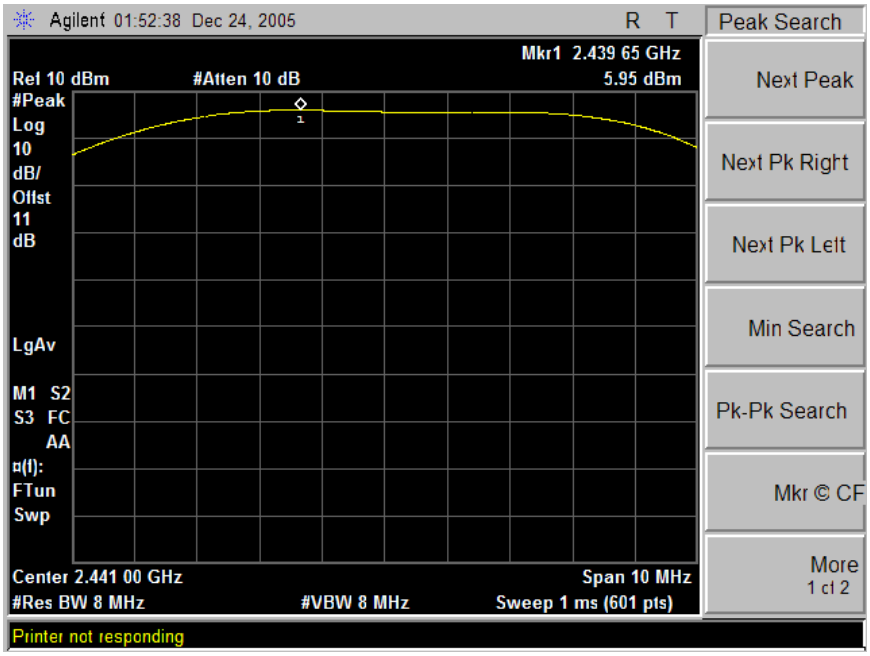
| Channel | Frequency (MHz) | Peak Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 5.93 | 20.97 | -15.04 |
| Middle | 2441 | 5.95 | 20.97 | -15.02 |
| High | 2480 | 6.33 | 20.97 | -14.64 |

**OUTPUT POWER**

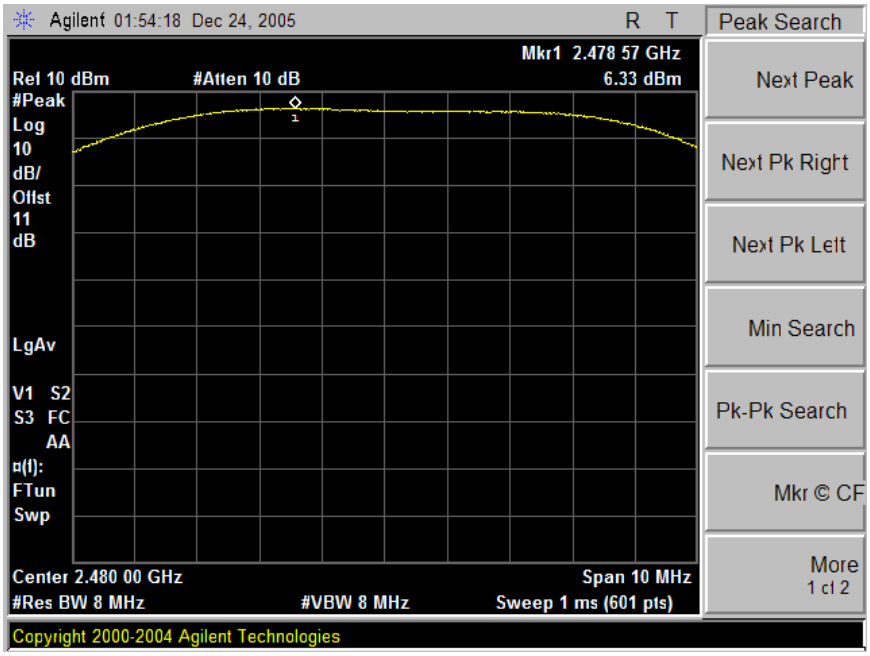
PEAK POWER LOW CH



PEAK POWER MID CH



PEAK POWER HIGH CH



## 7.1.6. AVERAGE POWER

### AVERAGE POWER LIMIT

None; for reporting purposes only.

### TEST PROCEDURE

The transmitter output is connected to a power meter.

### RESULTS

No non-compliance noted:

The cable assembly insertion loss of 11 dB (including 10 dB pad and 1 dB 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 | 3.64 |
| Middle | 2441 | 4.25 |
| High | 2480 | 4.48 |

## 7.1.7. MAXIMUM PERMISSIBLE EXPOSURE

**LIMITS**

§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.

**CALCULATIONS**

Given

$E = \sqrt{(30 * P * G) / d}$

and

$S = E \wedge 2 / 3770$

where

E = Field Strength in Volts/meter
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power Density in milliwatts/square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

$d = \sqrt{((30 * P * G) / (3770 * S))}$

Changing to units of Power to mW and Distance to cm, using:

P (mW) = P (W) / 1000 and
d (cm) =100 * d (m)

yields

$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$
$d = 0.282 * \sqrt{(P * G / S)}$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

P (mW) = 10 ^ (P (dBm) / 10) and
G (numeric) = 10 ^ (G (dBi) / 10)

yields

$d = 0.282 * 10 \wedge ((P + G) / 20) / \sqrt{S}$

where

d = MPE distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW/cm^2

Rearranging terms to calculate the power density at a specific distance yields

$S = 0.0795 * 10 \wedge ((P + G) / 10) / (d\wedge 2)$

**LIMITS**

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

**RESULTS**

No non-compliance noted.

| Mode | MPE Distance (cm) | Output Power (dBm) | Antenna Gain (dBi) | Power Density (mW/cm^2) |
|---|---|---|---|---|
| 8PSK | 20.0 | 6.33 | -1.34 | 0.0006 |

NOTE: For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

## 7.1.8. PEAK POWER SPECTRAL DENSITY

**LIMIT**

§15.247 (d) For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

§15.247 (f) The digital modulation operation of the hybrid system, with the frequency hopping turned off, shall comply with the power density requirements of paragraph (d) of this section.

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer, the maximum level in a 3 kHz bandwidth is measured with the spectrum analyzer using RBW = 3 kHz and VBW > 3 kHz, sweep time = span / 3 kHz, and video averaging is turned off. The PPSD is the highest level found across the emission in any 3 kHz band.

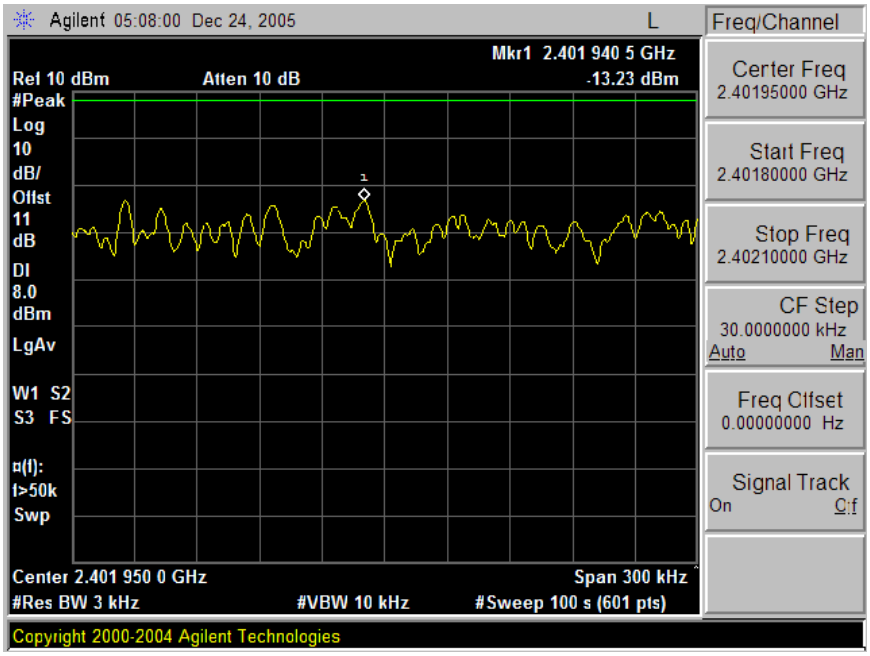
**RESULTS**

No non-compliance noted:

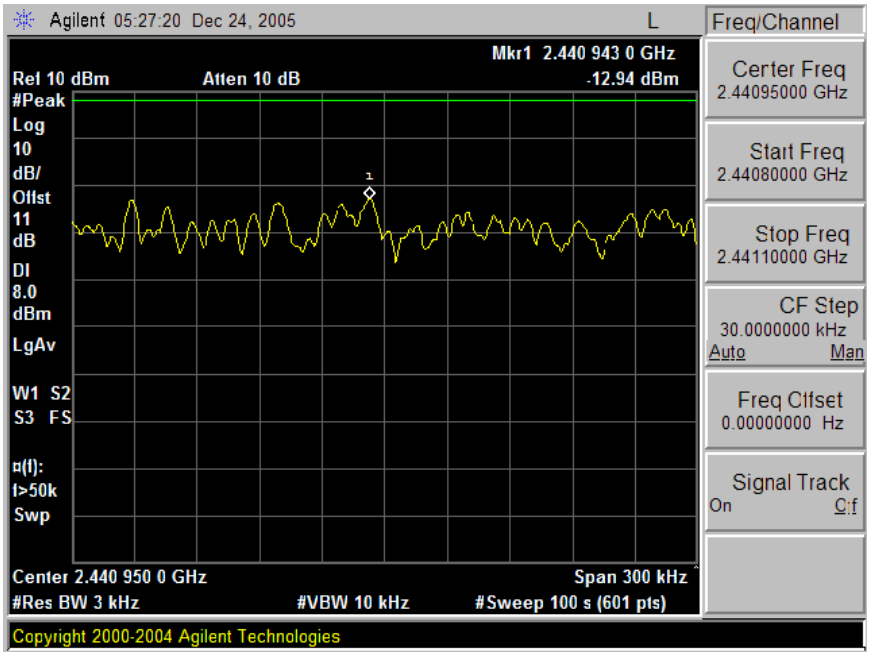
| Channel | Frequency (MHz) | PPSD (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | -13.23 | 8 | -21.23 |
| Middle | 2441 | -12.94 | 8 | -20.94 |
| High | 2480 | -12.49 | 8 | -20.49 |

## PEAK POWER SPECTRAL DENSITY

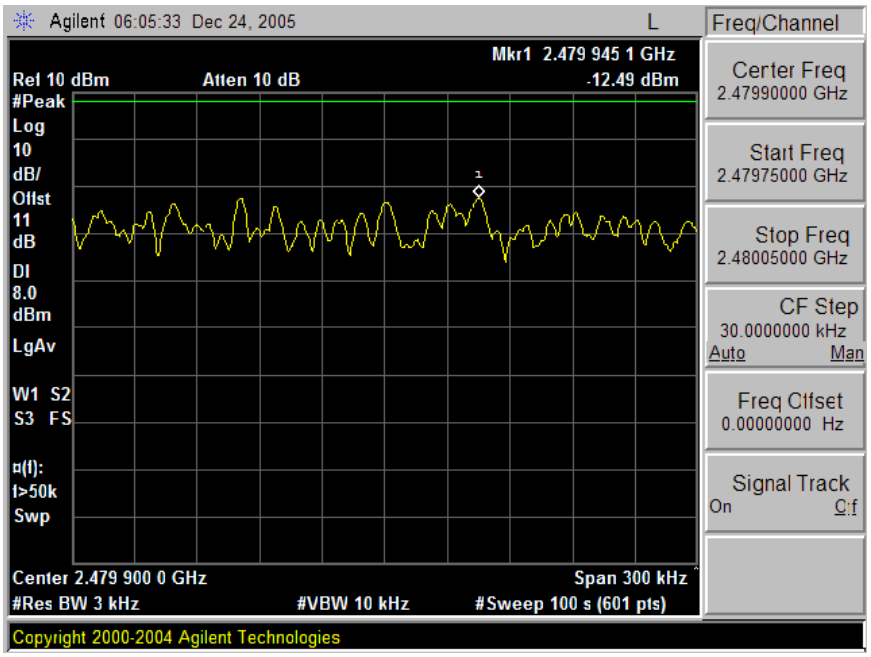
PPSD LOW CH



PPSD MID CH



PPSD HIGH CH



## 7.1.9. CONDUCTED SPURIOUS EMISSIONS

**LIMITS**

§15.247 (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in§15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

**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.

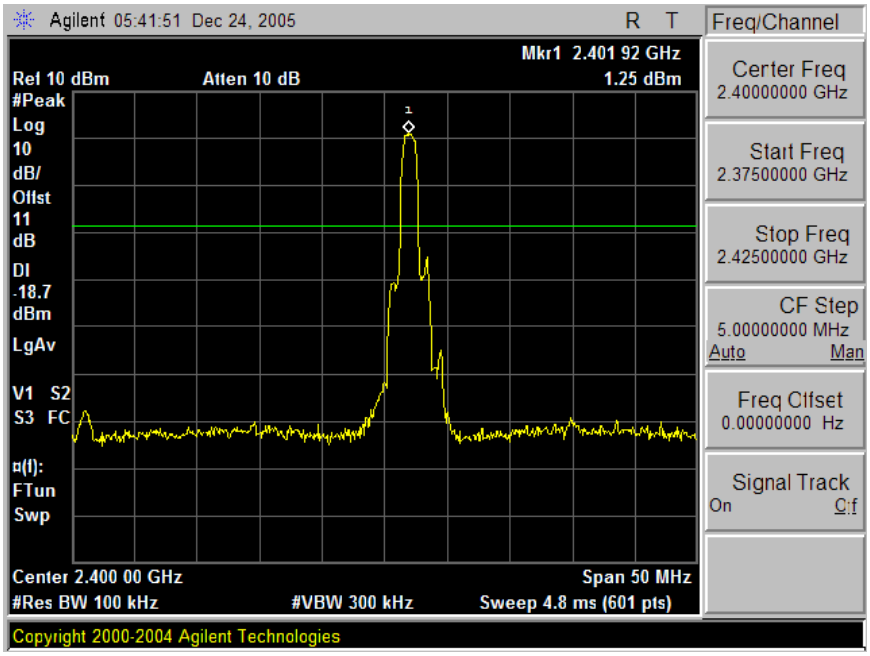
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

**RESULTS**

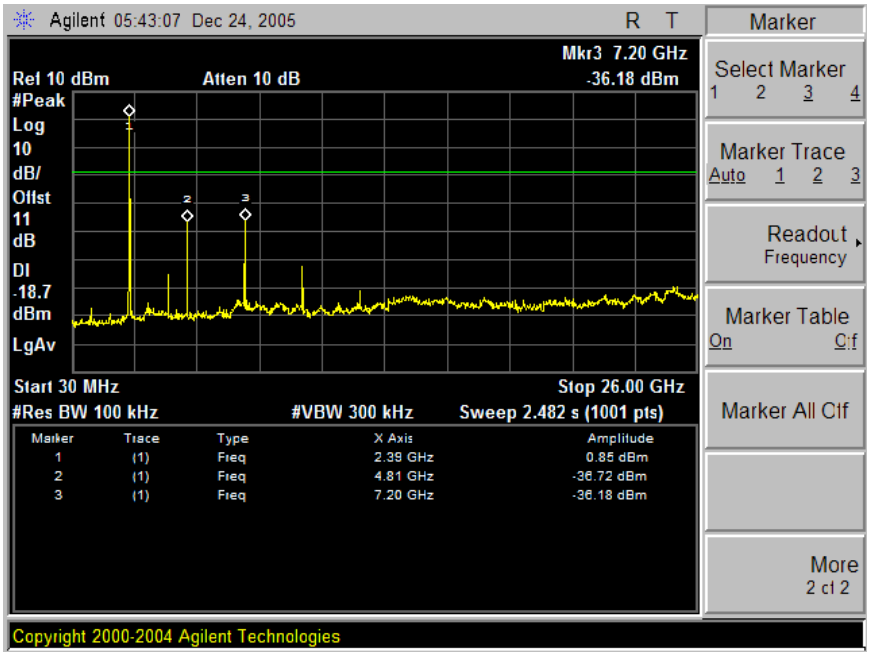
No non-compliance noted:

**SPURIOUS EMISSIONS, LOW CHANNEL**

LOW CHANNEL BANDEDGE

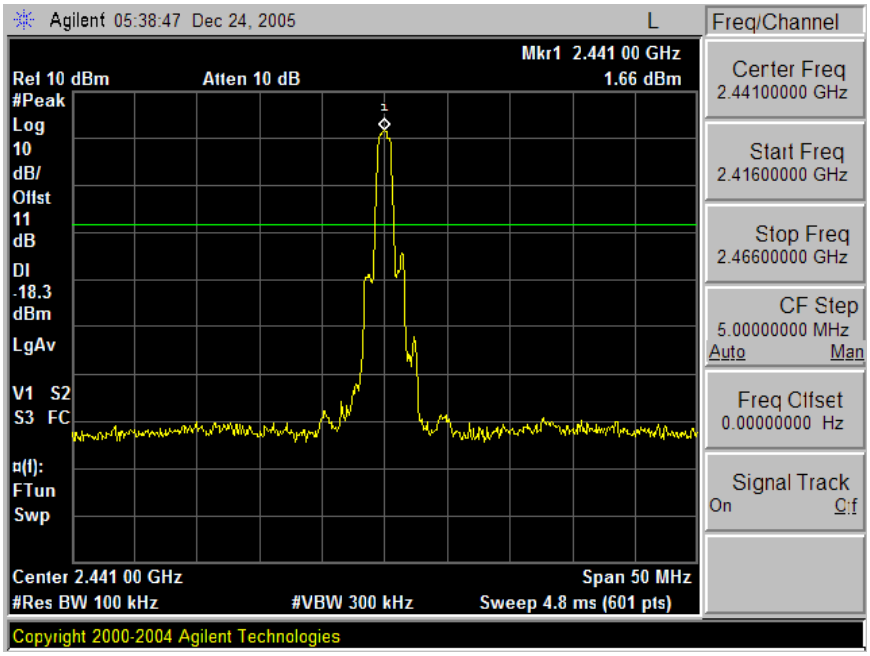


LOW CHANNEL SPURIOUS

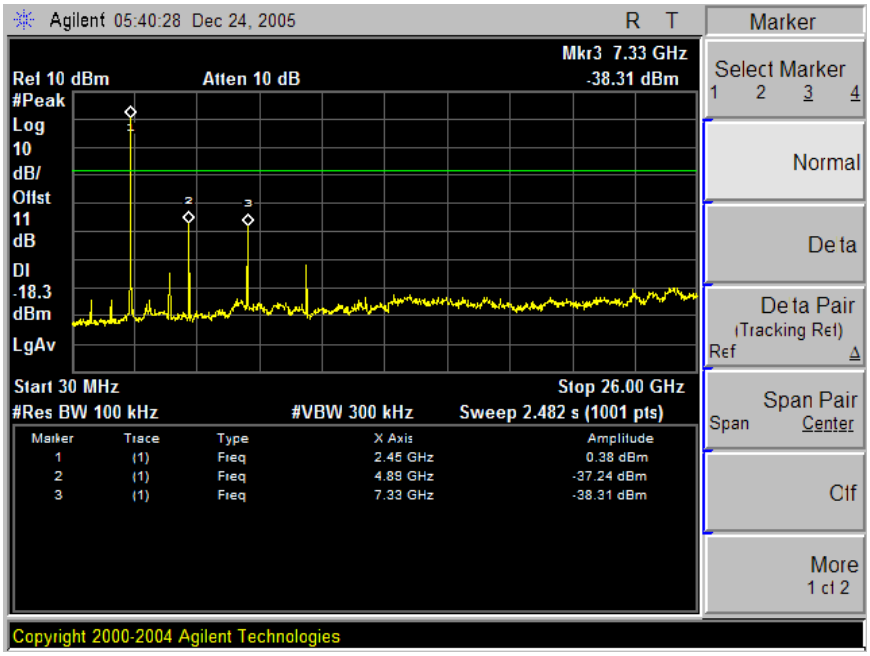


**SPURIOUS EMISSIONS, MID CHANNEL**

MID CHANNEL REFERENCE

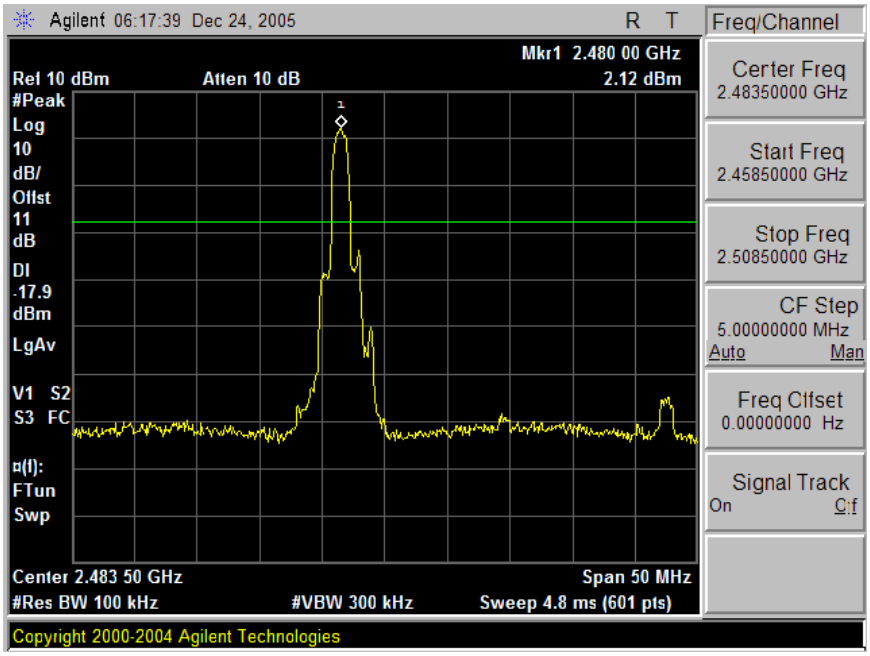


MID CHANNEL SPURIOUS

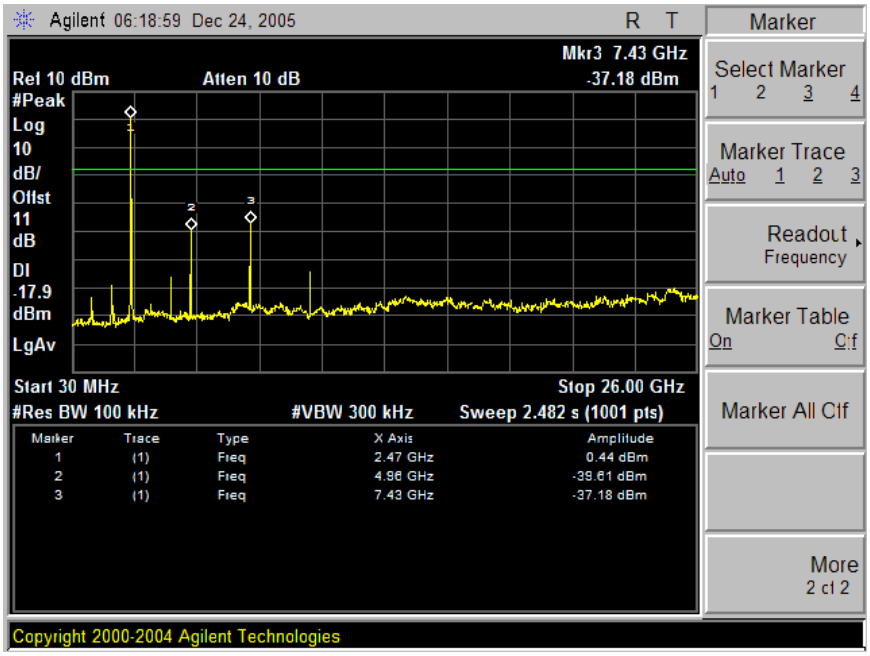


**SPURIOUS EMISSIONS, HIGH CHANNEL**

HIGH CHANNEL BANDEDGE

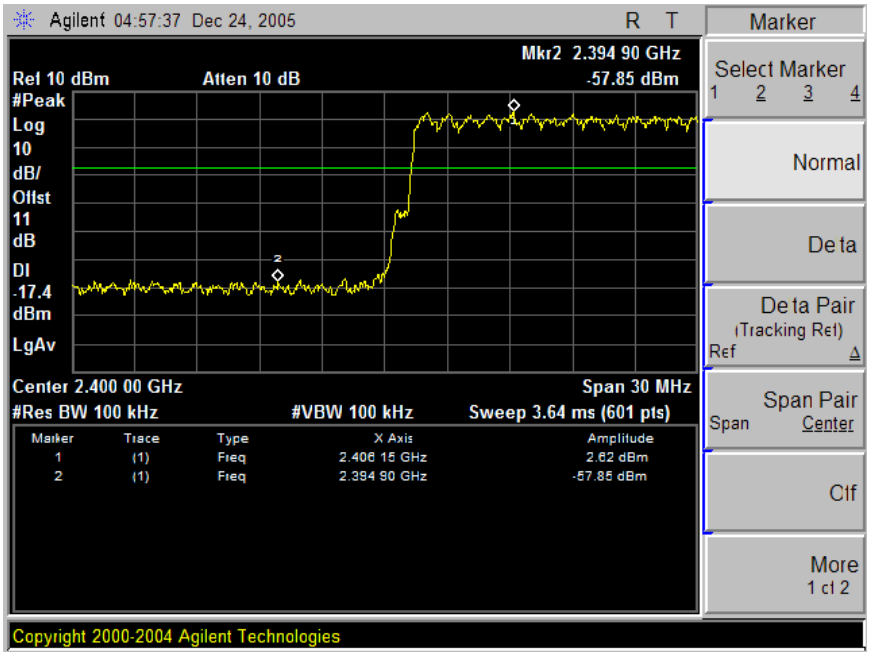


HIGH CHANNEL SPURIOUS

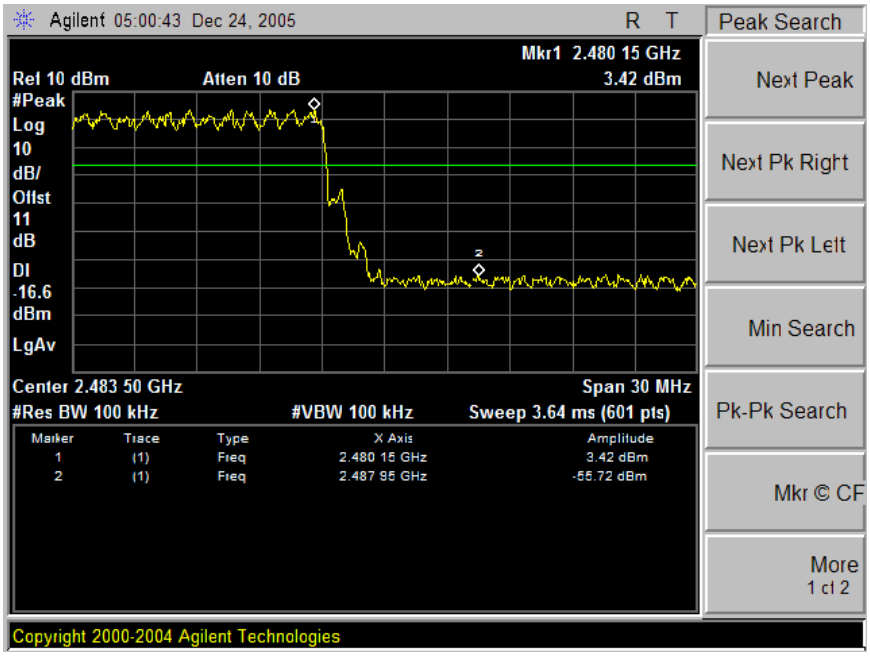


**SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**

LOW BANDEDGE WITH HOPPING ON



HIGH BANDEDGE WITH HOPPING ON



## 7.2. ANTENNA PORT CHANNEL TESTS FOR EUT WITH GFSK MODULATION

### 7.2.1. 20 dB BANDWIDTH

**LIMIT**

None; for reporting purposes only.

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The RBW is set to 1% to 3% of the 20 dB bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled.

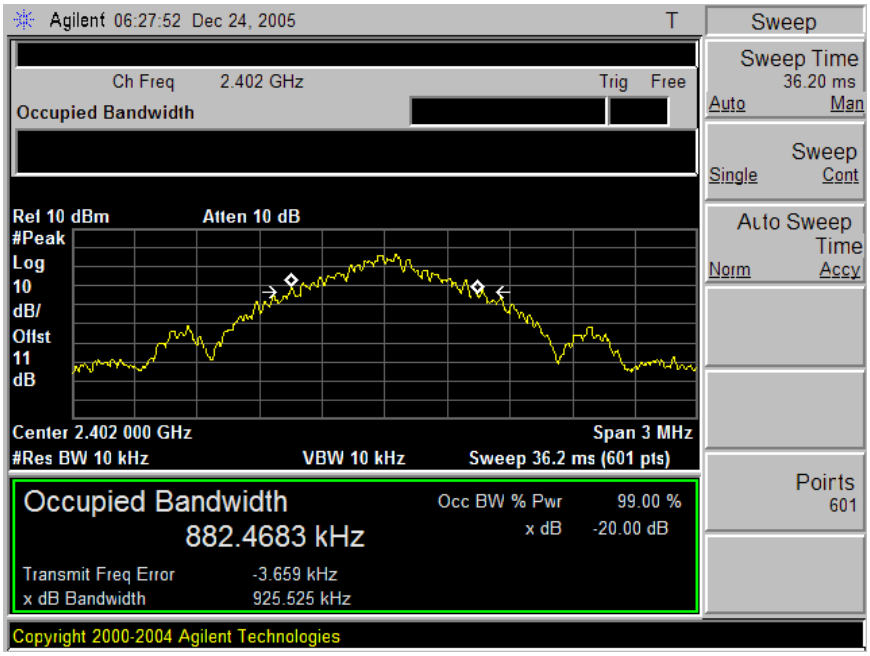
**RESULTS**

No non-compliance noted:

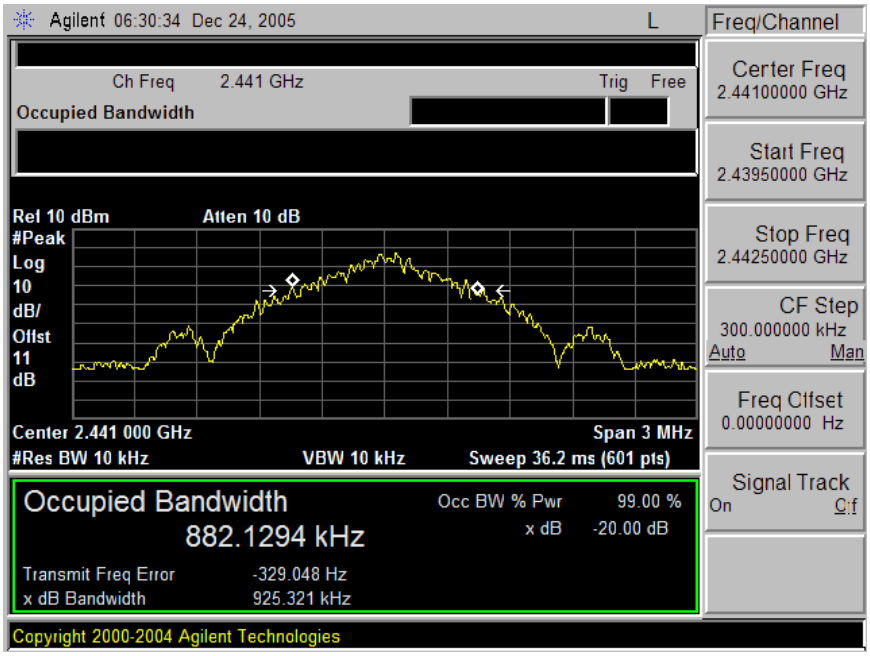
| Channel | Frequency (MHz) | 20 dB Bandwidth (kHz) |
|---|---|---|
| Low | 2402 | 925.525 |
| Middle | 2441 | 925.321 |
| High | 2480 | 925.059 |

**20 dB BANDWIDTH**

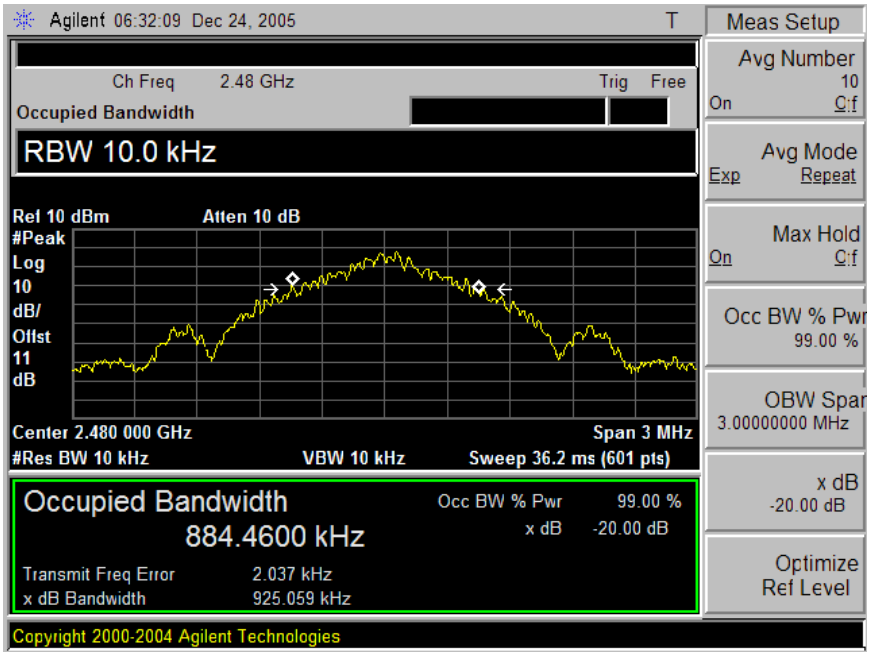
20 dB BANDWIDTH LOW CH



20 dB BANDWIDTH MID CH



20 dB BANDWIDTH HIGH CH



## 7.2.2. HOPPING FREQUENCY SEPARATION

**LIMIT**

§15.247 (a) (1) 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.

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 100 kHz. The sweep time is coupled.

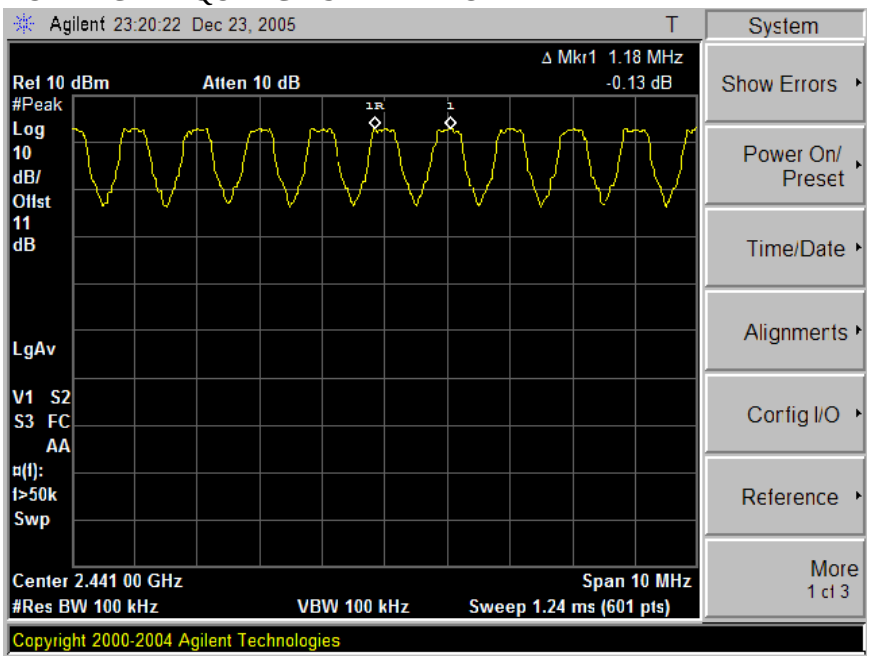
**RESULTS**

No non-compliance noted:

| Modulation | Frequency (MHz) | Hopping Separation (kHz) | 20dB Bandwidth (kHz) | Margin (kHz) |
|---|---|---|---|---|
| GFSK | 2441 | 1180 | 925.53 | 254.48 |

## HOPPING FREQUENCY SEPARATION

HOPPING FREQUENCY SEPARATION



## 7.2.3. NUMBER OF HOPPING CHANNELS

**LIMIT**

§15.247 (a) (1) (iii) 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 1 % of the span. The analyzer is set to Max Hold.

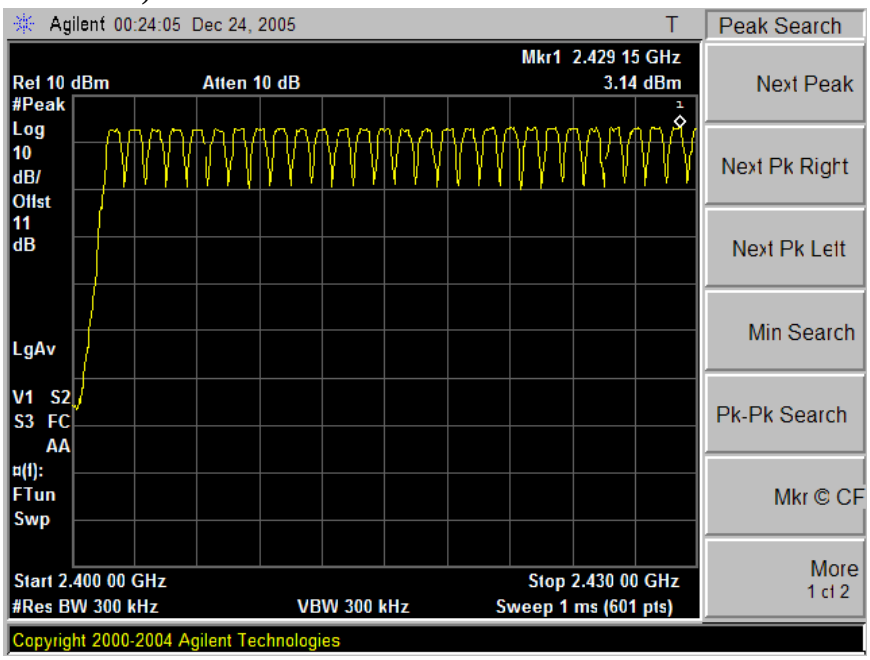
**RESULTS**

No non-compliance noted:

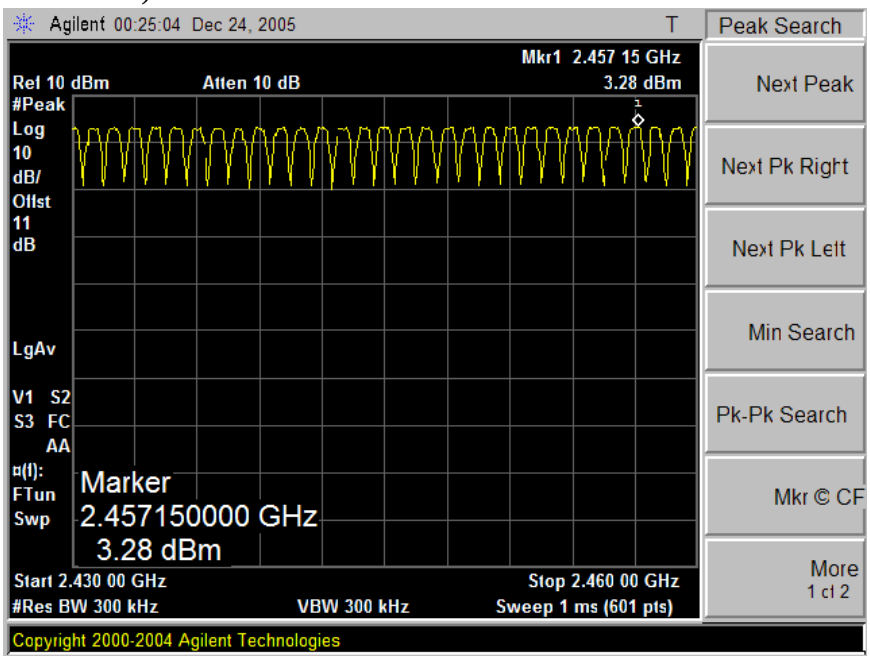
79 Channels observed.

## NUMBER OF HOPPING CHANNELS

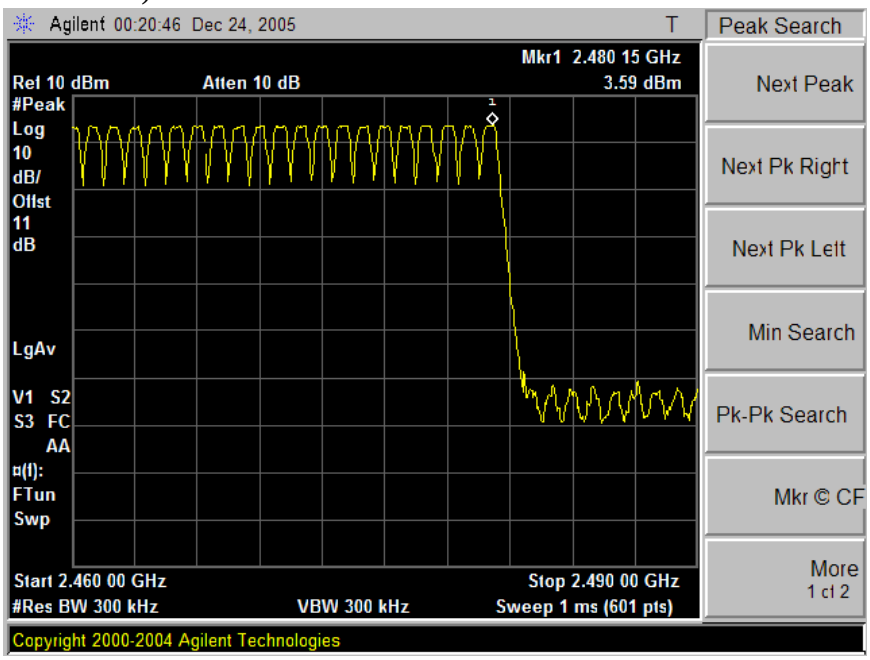
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



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**

§15.247 (a) (1) (iii) Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping 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.

**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.

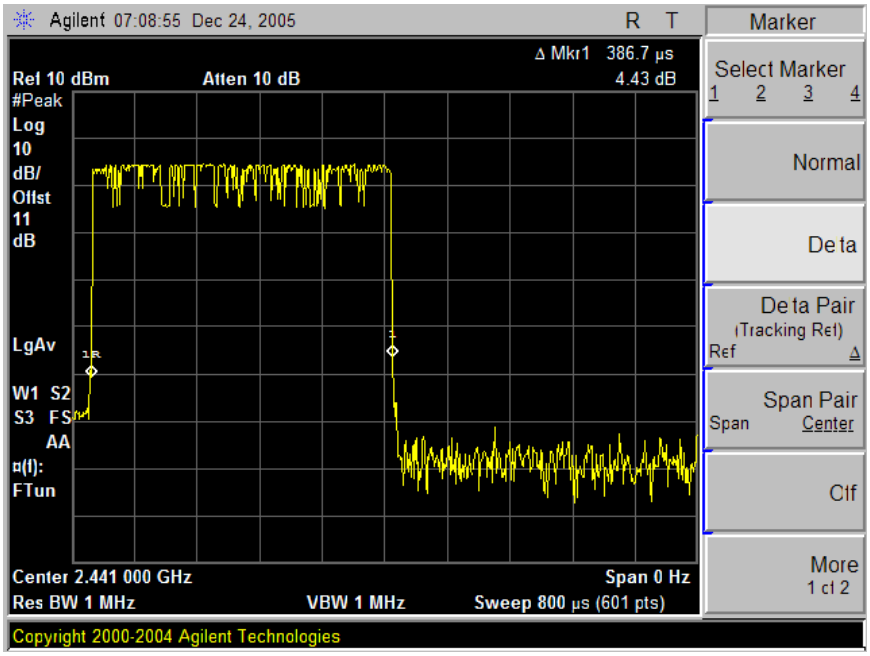
**RESULTS**

No non-compliance noted:

| DH Packet | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
|---|---|---|---|---|---|
| 1 | 0.387 | 31 | 0.120 | 0.4 | 0.280 |
| 3 | 1.645 | 21 | 0.345 | 0.4 | 0.055 |
| 5 | 2.892 | 13 | 0.376 | 0.4 | 0.024 |

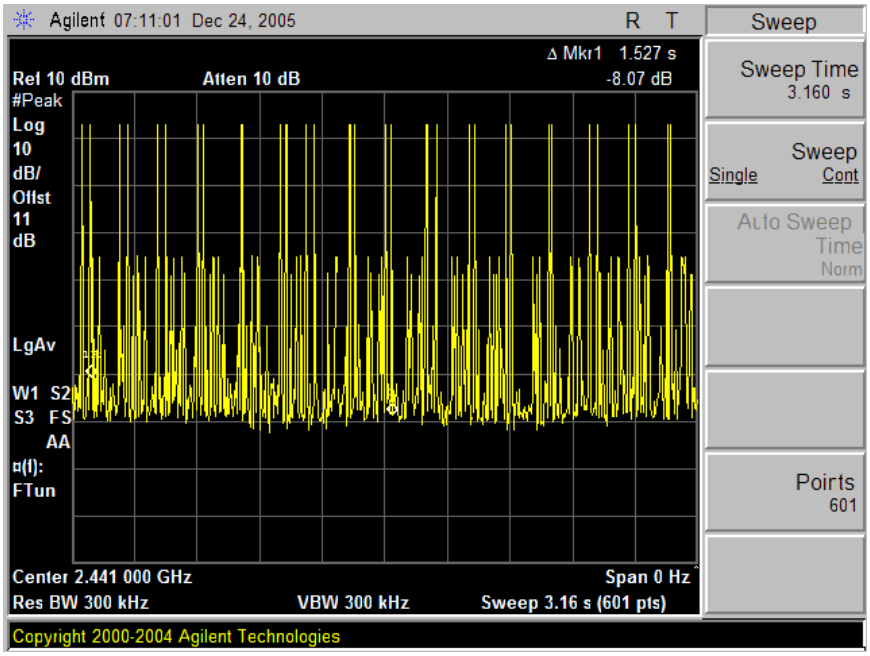
**PULSE WIDTH (DH1 PACKET TYPE)**

PULSE WIDTH



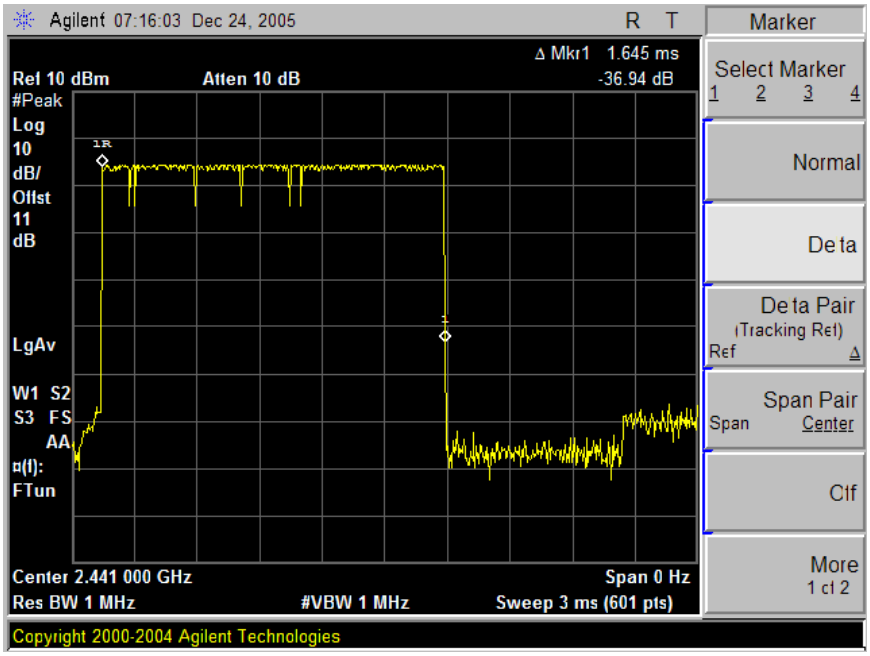
## NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD

NUMBER OF PULSES



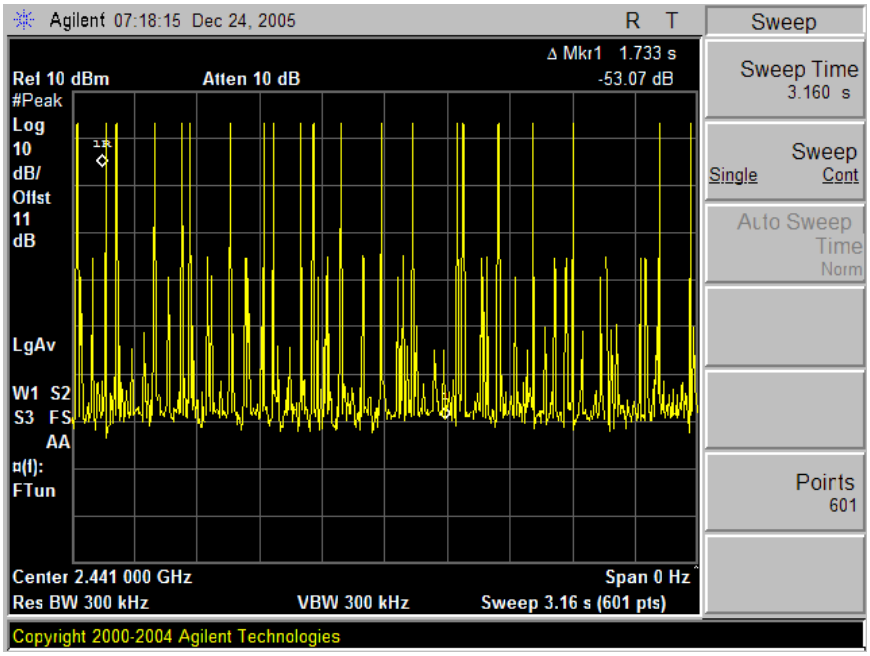
**PULSE WIDTH (DH3 PACKET TYPE)**

PULSE WIDTH



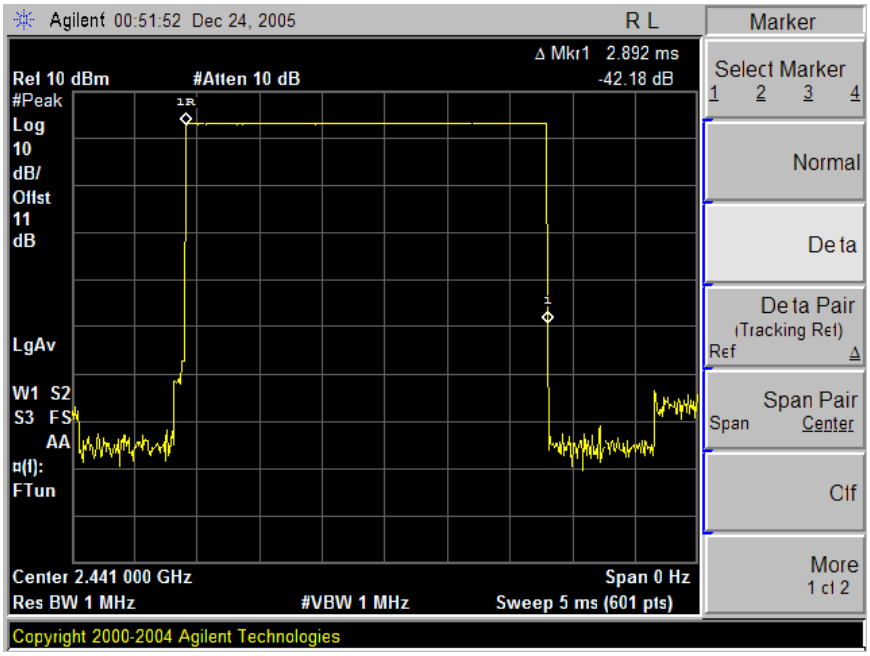
## NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD

NUMBER OF PULSES



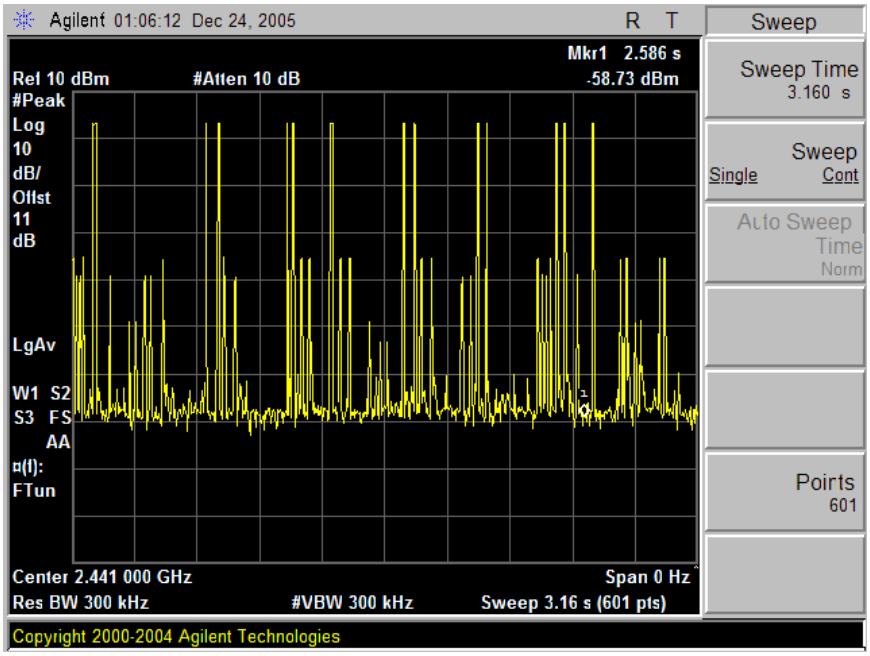
**PULSE WIDTH (DH5 PACKET TYPE)**

PULSE WIDTH



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

NUMBER OF PULSES



## 7.2.5. PEAK OUTPUT POWER

**PEAK POWER LIMIT**

§15.247 (b) The maximum peak output power of the intentional radiator shall not exceed the following:

§15.247 (b) (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt.

§15.247 (b) (4) Except as shown in paragraphs (b)(3) (i), (ii) and (iii) of this section, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1) or (b)(2) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The maximum antenna gain is –1.34 dBi, therefore the limit is 30 dBm.

**TEST PROCEDURE**

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

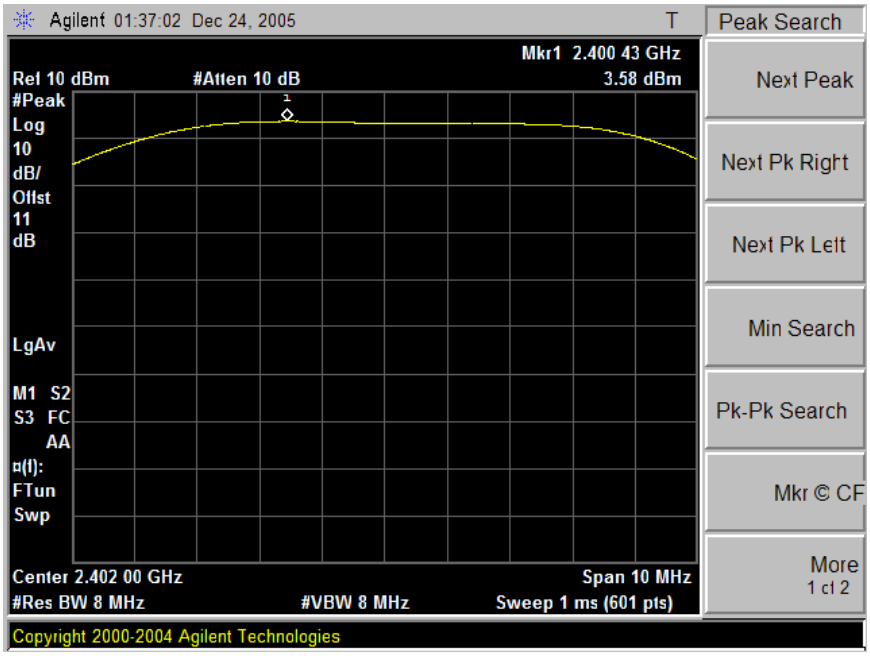
**RESULTS**

No non-compliance noted:

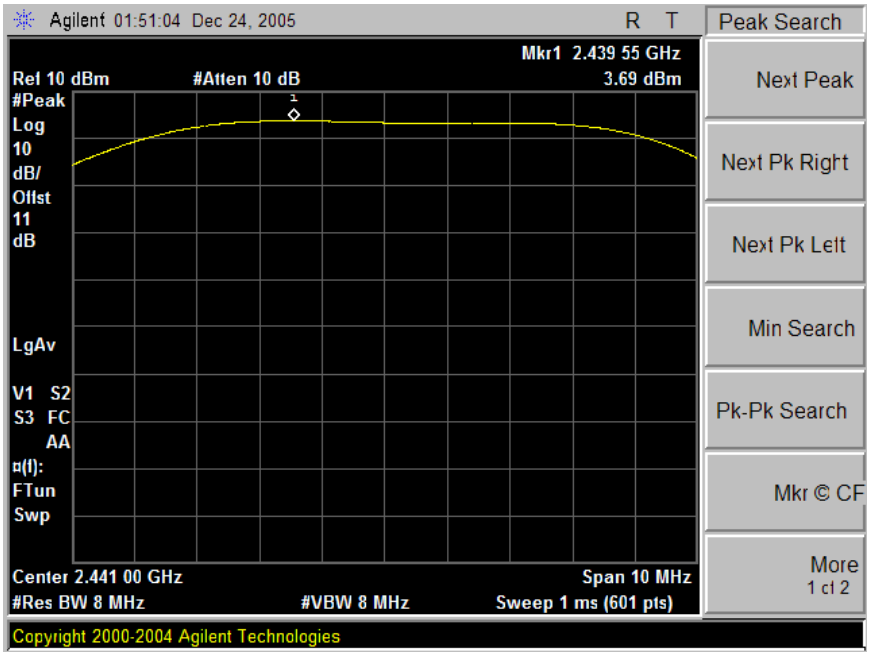
| Channel | Frequency (MHz) | Peak Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 3.58 | 30 | -26.42 |
| Middle | 2441 | 3.69 | 30 | -26.31 |
| High | 2480 | 4.33 | 30 | -25.67 |

**OUTPUT POWER**

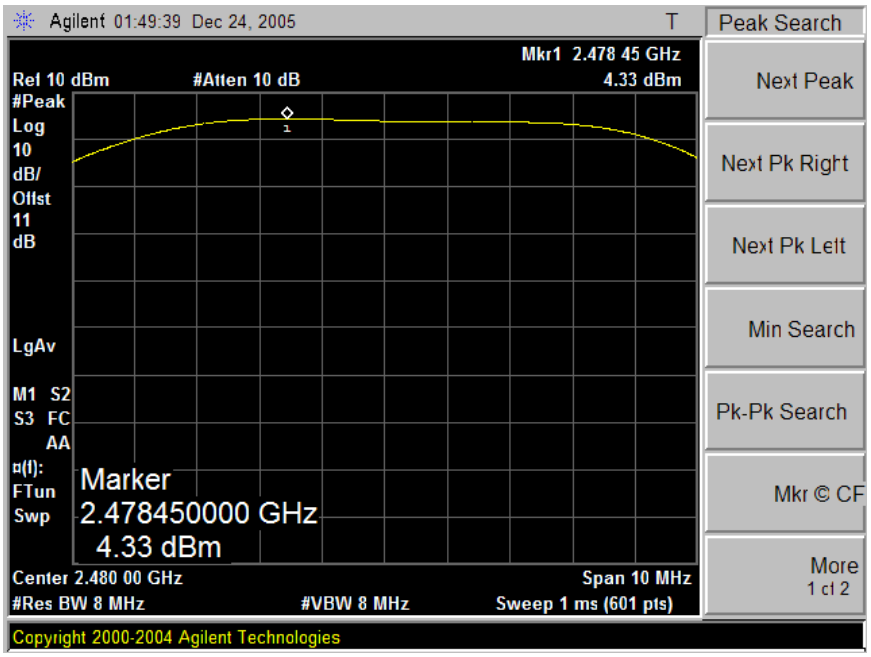
PEAK POWER LOW CH



PEAK POWER MID CH



PEAK POWER HIGH CH



## 7.2.6. AVERAGE POWER

### AVERAGE POWER LIMIT

None; for reporting purposes only.

### TEST PROCEDURE

The transmitter output is connected to a power meter.

### RESULTS

No non-compliance noted:

The cable assembly insertion loss of 11 dB (including 10 dB pad and 1 dB 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 | 3.67 |
| Middle | 2441 | 4.28 |
| High | 2480 | 4.58 |

## 7.2.7. MAXIMUM PERMISSIBLE EXPOSURE

**LIMITS**

§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.

**CALCULATIONS**

Given

$E = \sqrt{(30 * P * G)} / d$

and

$S = E \wedge 2 / 3770$

where

E = Field Strength in Volts/meter
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power Density in milliwatts/square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

$d = \sqrt{((30 * P * G) / (3770 * S))}$

Changing to units of Power to mW and Distance to cm, using:

P (mW) = P (W) / 1000 and
d (cm) =100 * d (m)

yields

$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$
$d = 0.282 * \sqrt{(P * G / S)}$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

P (mW) = 10 ^ (P (dBm) / 10) and
G (numeric) = 10 ^ (G (dBi) / 10)

yields

$d = 0.282 * 10 \wedge ((P + G) / 20) / \sqrt{S}$

where

d = MPE distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW/cm^2

Rearranging terms to calculate the power density at a specific distance yields

$S = 0.0795 * 10 \wedge ((P + G) / 10) / (d\wedge 2)$

**LIMITS**

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

**RESULTS**

No non-compliance noted.

| Mode | MPE Distance (cm) | Output Power (dBm) | Antenna Gain (dBi) | Power Density (mW/cm^2) |
|---|---|---|---|---|
| GFSK | 20.0 | 4.33 | -1.34 | 0.0004 |

NOTE: For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

## 7.2.8. PEAK POWER SPECTRAL DENSITY

**LIMIT**

§15.247 (d) For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

§15.247 (f) The digital modulation operation of the hybrid system, with the frequency hopping turned off, shall comply with the power density requirements of paragraph (d) of this section.

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer, the maximum level in a 3 kHz bandwidth is measured with the spectrum analyzer using RBW = 3 kHz and VBW > 3 kHz, sweep time = span / 3 kHz, and video averaging is turned off. The PPSD is the highest level found across the emission in any 3 kHz band.

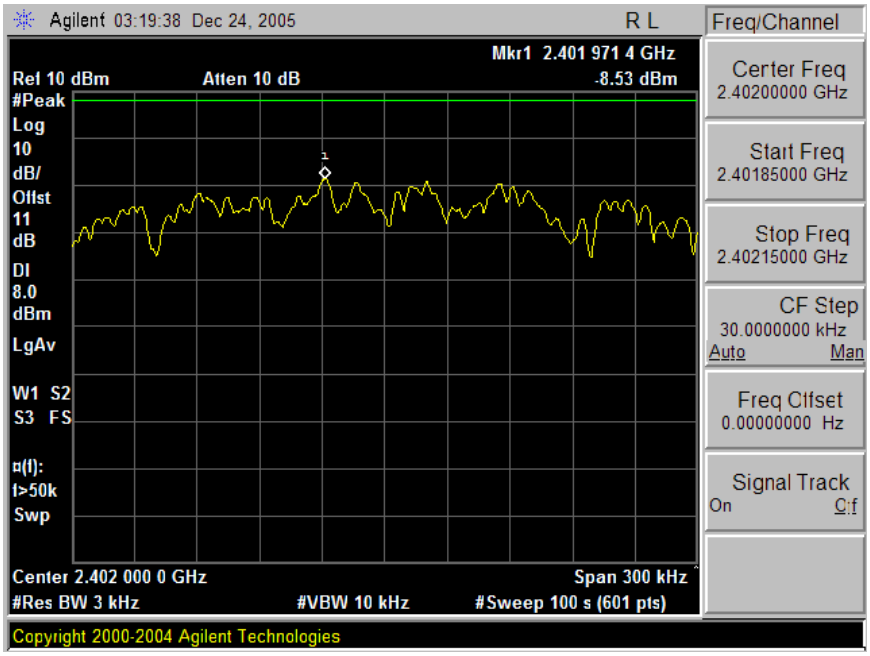
**RESULTS**

No non-compliance noted:

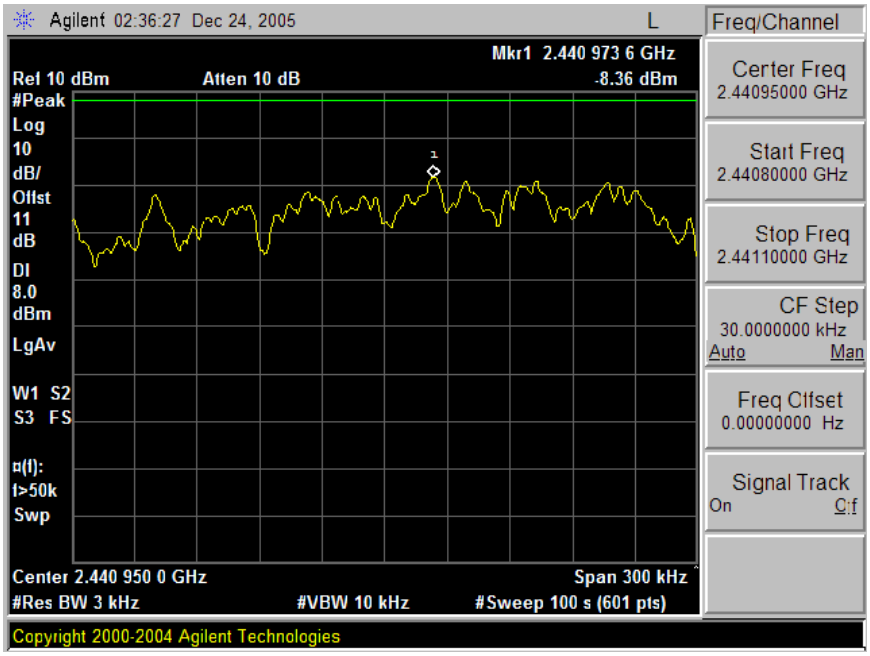
| Channel | Frequency (MHz) | PPSD (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | -8.53 | 8 | -16.53 |
| Middle | 2441 | -8.36 | 8 | -16.36 |
| High | 2480 | -8.01 | 8 | -16.01 |

## PEAK POWER SPECTRAL DENSITY

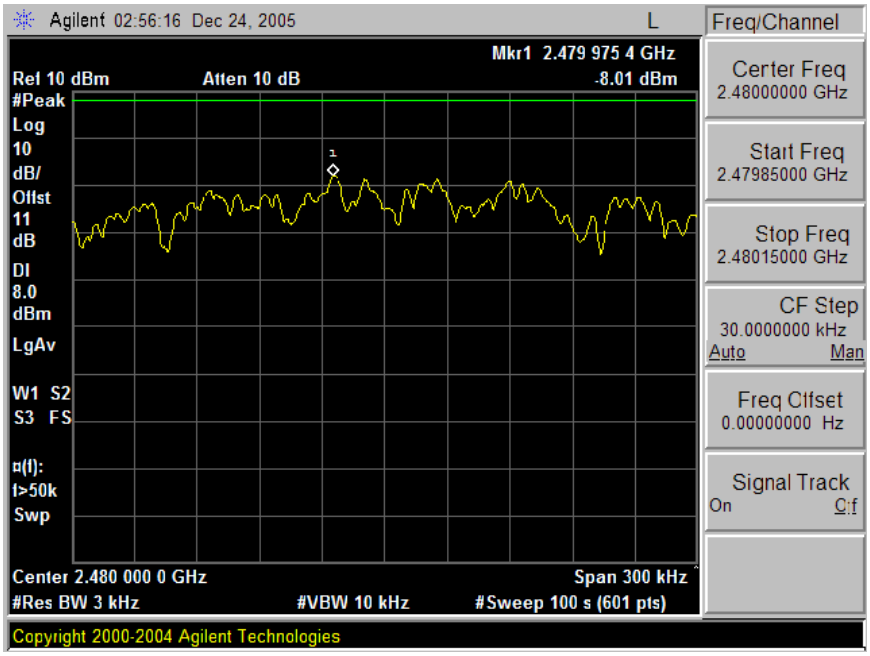
PPSD LOW CH



PPSD MID CH



PPSD HIGH CH



## 7.2.9. CONDUCTED SPURIOUS EMISSIONS

**LIMITS**

§15.247 (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in§15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

**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.

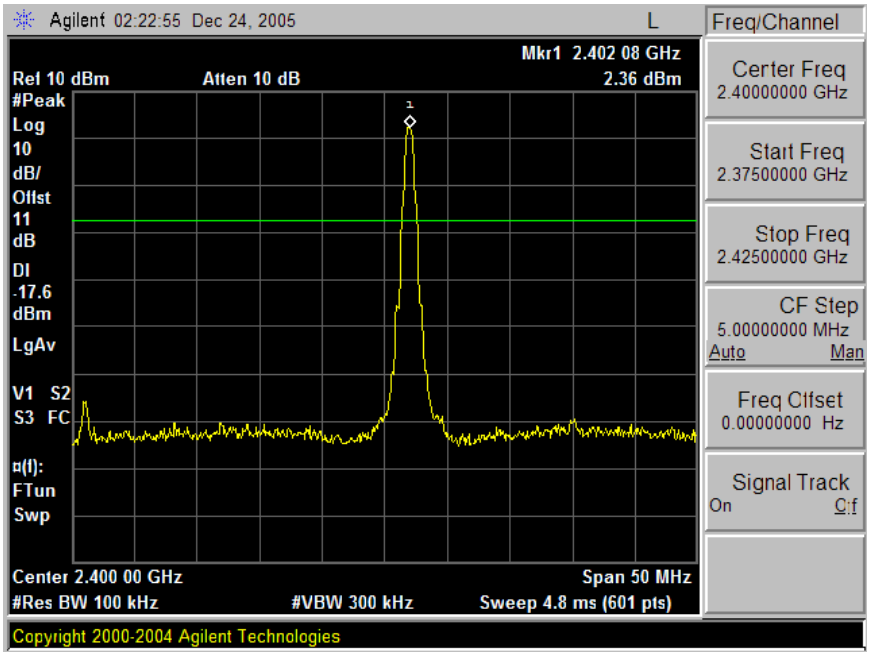
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

**RESULTS**

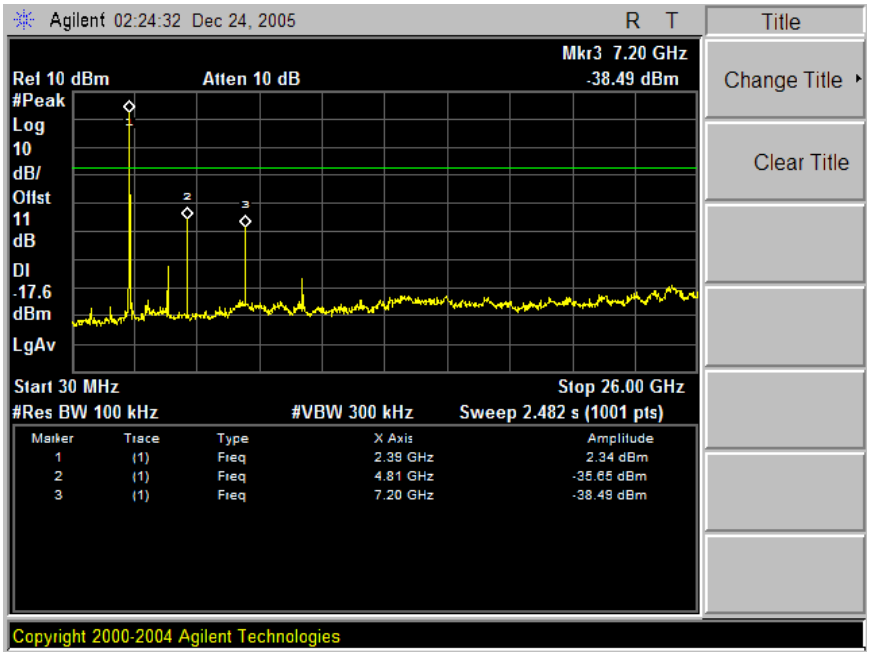
No non-compliance noted:

**SPURIOUS EMISSIONS, LOW CHANNEL**

LOW CHANNEL BANDEDGE

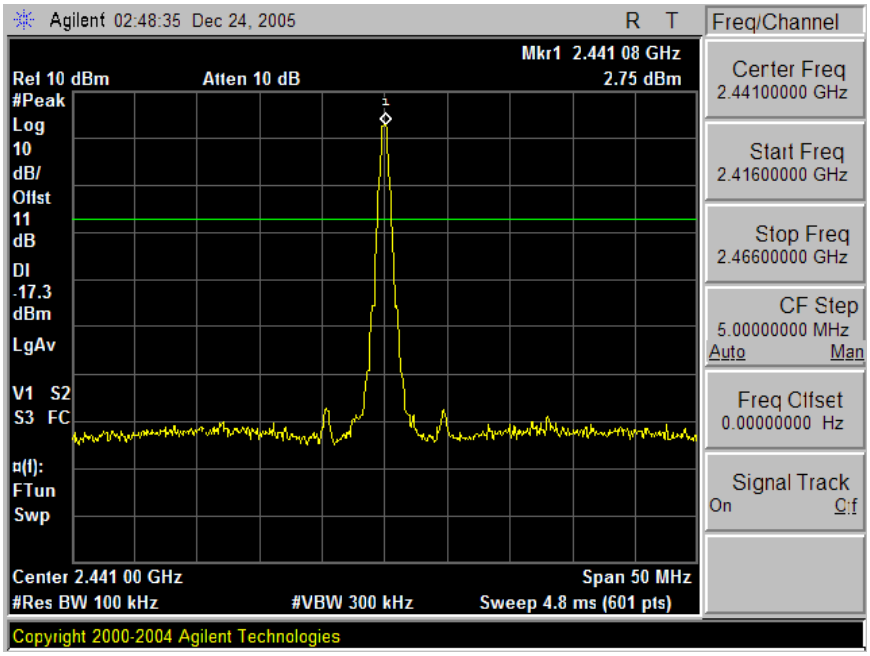


LOW CHANNEL SPURIOUS

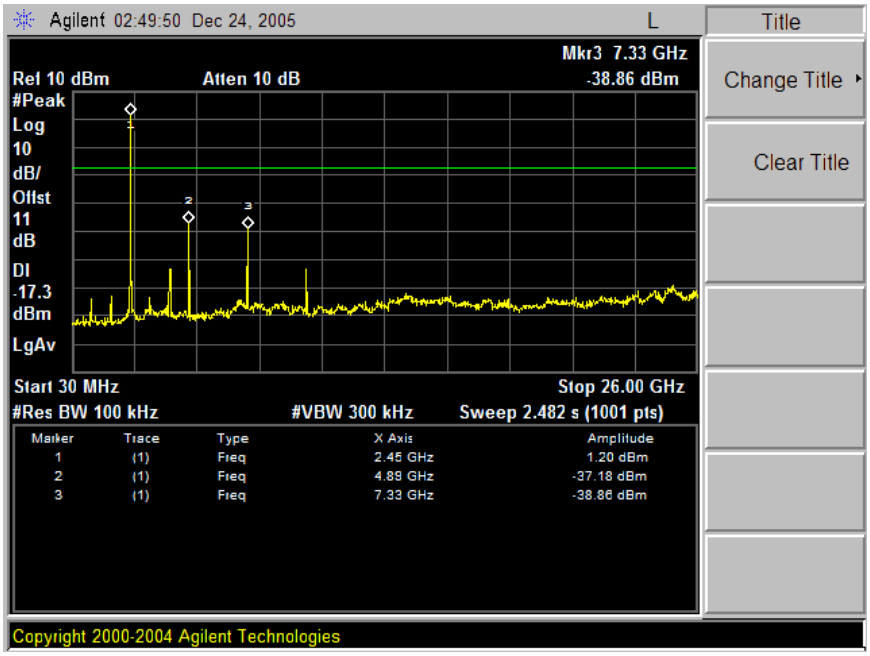


**SPURIOUS EMISSIONS, MID CHANNEL**

MID CHANNEL REFERENCE

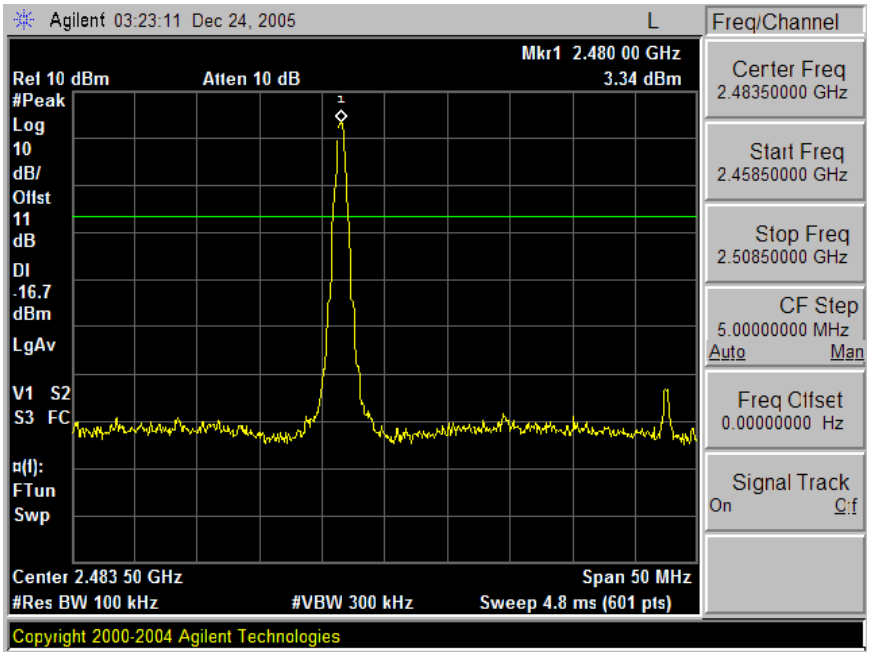


MID CHANNEL SPURIOUS

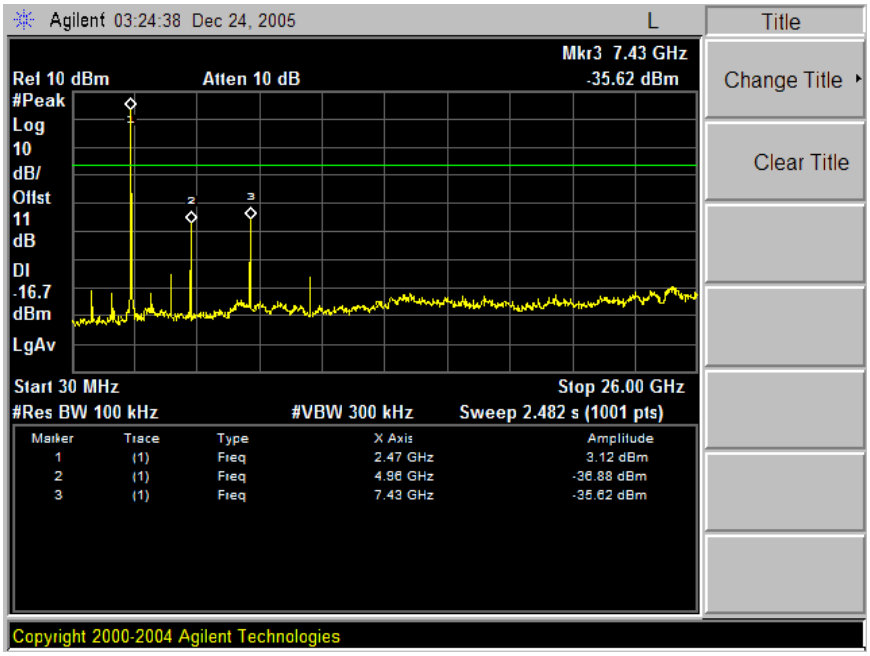


**SPURIOUS EMISSIONS, HIGH CHANNEL**

HIGH CHANNEL BANDEDGE

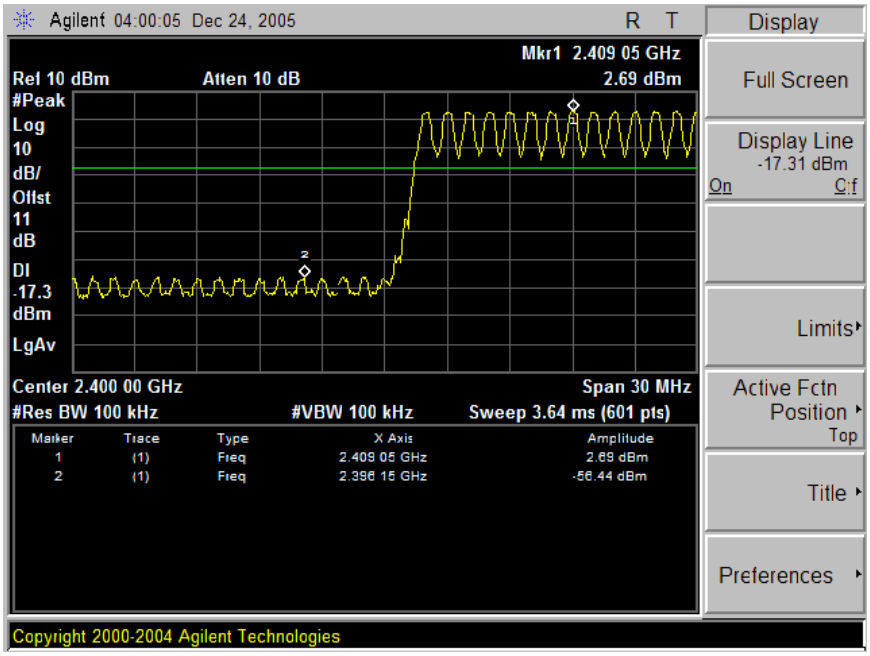


HIGH CHANNEL SPURIOUS

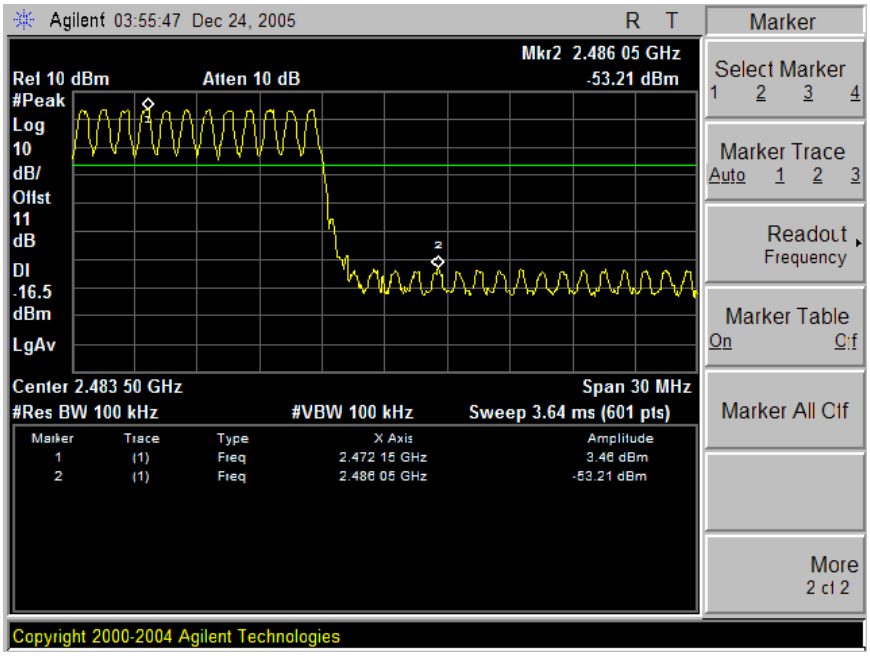


**SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**

LOW BANDEDGE WITH HOPPING ON



HIGH BANDEDGE WITH HOPPING ON



# 7.3. RADIATED EMISSIONS

## 7.3.1. TRANSMITTER RADIATED SPURIOUS EMISSIONS

**LIMITS**

§15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090 - 0.110 | 16.42 - 16.423 | 399.9 - 410 | 4.5 - 5.15* |
| [1]0.495 - 0.505 | 16.69475 - 16.69525 | 608 - 614 | 5.35 - 5.46 |
| 2.1735 - 2.1905 | 16.80425 - 16.80475 | 960 - 1240 | 7.25 - 7.75 |
| 4.125 - 4.128 | 25.5 - 25.67 | 1300 - 1427 | 8.025 - 8.5 |
| 4.17725 - 4.17775 | 37.5 - 38.25 | 1435 - 1626.5 | 9.0 - 9.2 |
| 4.20725 - 4.20775 | 73 - 74.6 | 1645.5 - 1646.5 | 9.3 - 9.5 |
| 6.215 - 6.218 | 74.8 - 75.2 | 1660 - 1710 | 10.6 - 12.7 |
| 6.26775 - 6.26825 | 108 - 121.94 | 1718.8 - 1722.2 | 13.25 - 13.4 |
| 6.31175 - 6.31225 | 123 - 138 | 2200 - 2300 | 14.47 - 14.5 |
| 8.291 - 8.294 | 149.9 - 150.05 | 2310 - 2390 | 15.35 - 16.2 |
| 8.362 - 8.366 | 156.52475 - 156.52525 | 2483.5 - 2500 | 17.7 - 21.4 |
| 8.37625 - 8.38675 | 156.7 - 156.9 | 2655 - 2900 | 22.01 - 23.12 |
| 8.41425 - 8.41475 | 162.0125 - 167.17 | 3260 - 3267 | 23.6 - 24.0 |
| 12.29 - 12.293 | 167.72 - 173.2 | 3332 - 3339 | 31.2 - 31.8 |
| 12.51975 - 12.52025 | 240 - 285 | 3345.8 - 3358 | 36.43 - 36.5 |
| 12.57675 - 12.57725 | 322 - 335.4 | 3600 - 4400 | ([2]) |
| 13.36 - 13.41 | | | |

*: 4.5 – 5.25 per Standard LP0002.

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2] Above 38.6

§15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

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

| Frequency (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|---|---|---|
| 30 - 88 | 100 ** | 3 |
| 88 - 216 | 150 ** | 3 |
| 216 - 960 | 200 ** | 3 |
| Above 960 | 500 | 3 |

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

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

**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.

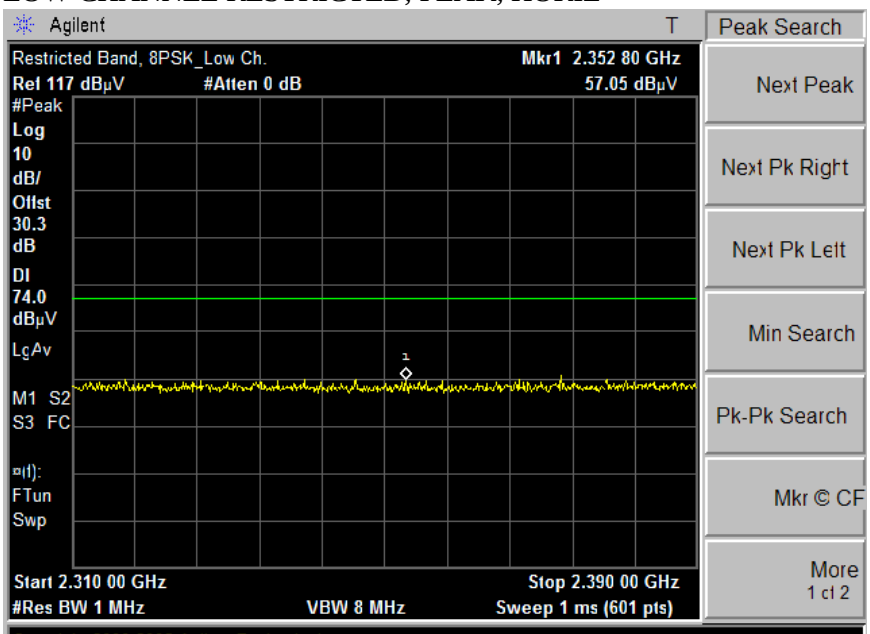
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each 5 GHz band.

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.

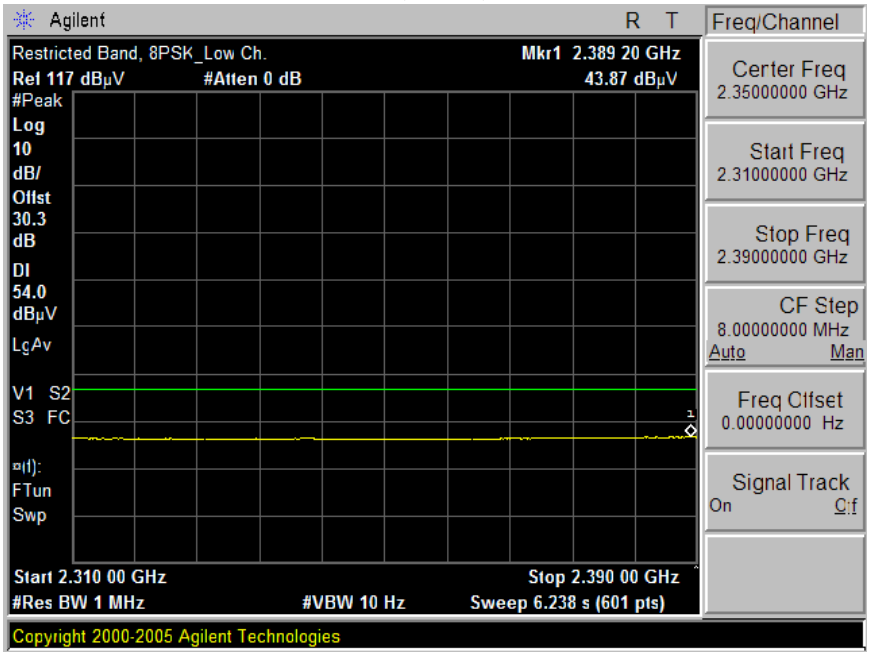
## 7.3.2. TRANSMITTER RADIATED EMISSIONS ABOVE 1 GHZ WITH 8PSK MODULATION

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

LOW CHANNEL RESTRICTED, PEAK, HORIZ

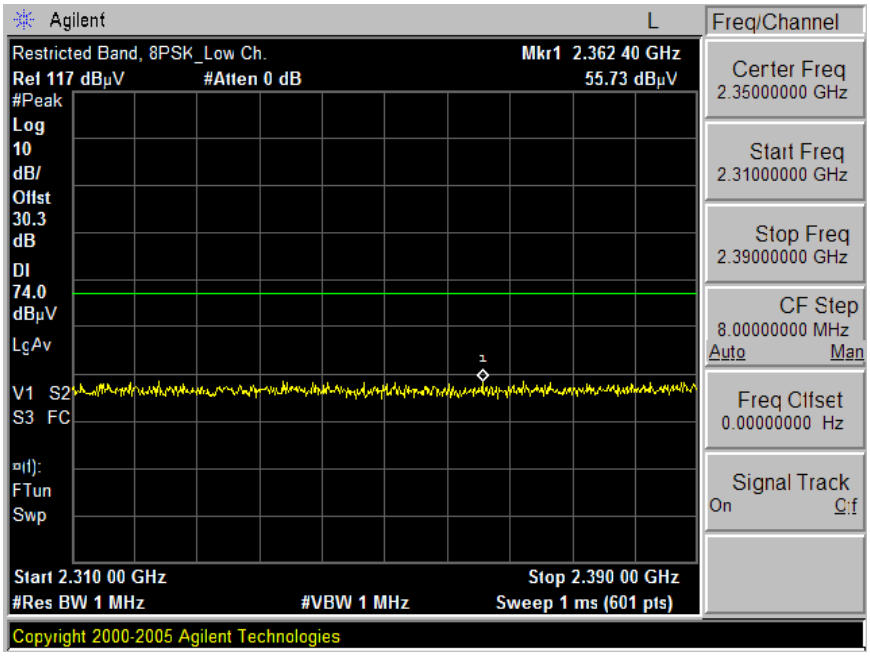


LOW CHANNEL RESTRICTED, AVG, HORIZ

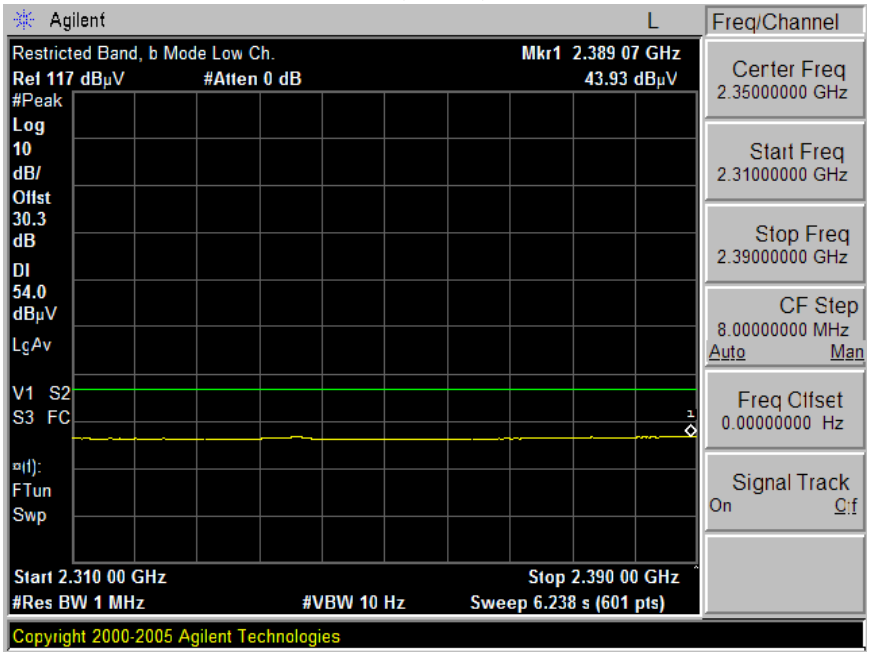


**RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**

LOW CHANNEL RESTRICTED, PEAK, VERT

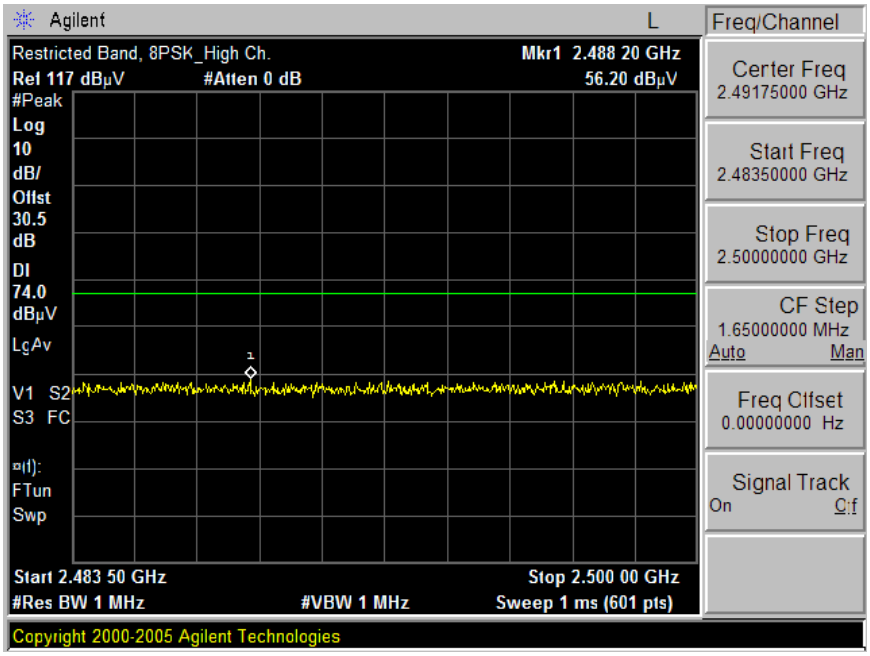


LOW CHANNEL RESTRICTED, AVG, VERT

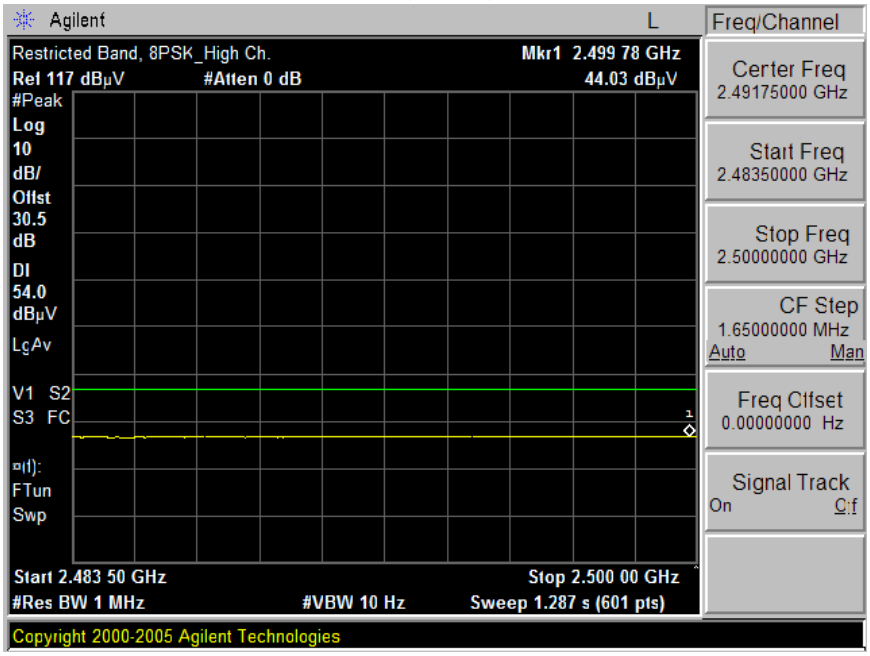


**RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**

HIGH CHANNEL RESTRICTED, PEAK, HORIZ

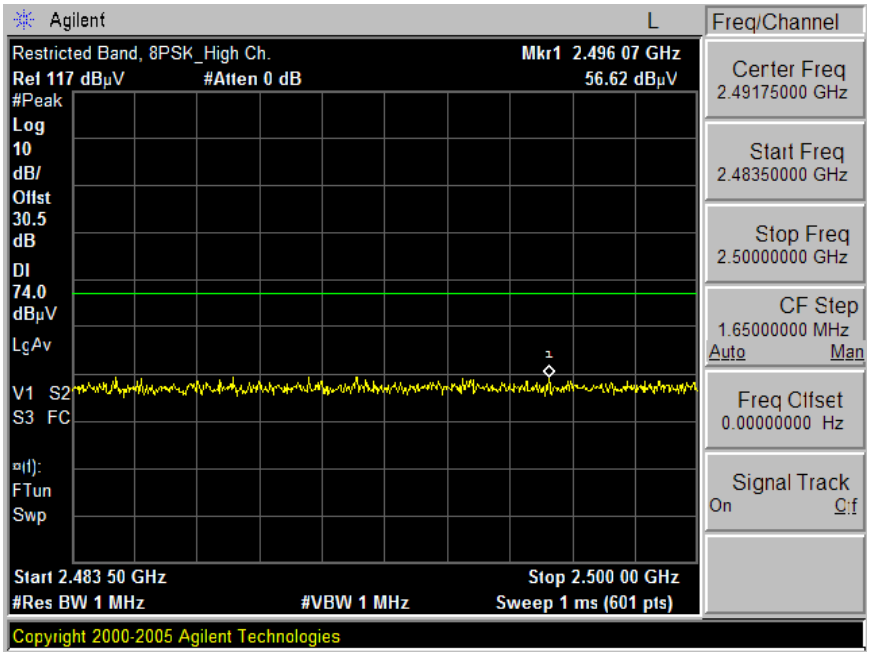


HIGH CHANNEL RESTRICTED, AVG, HORIZ

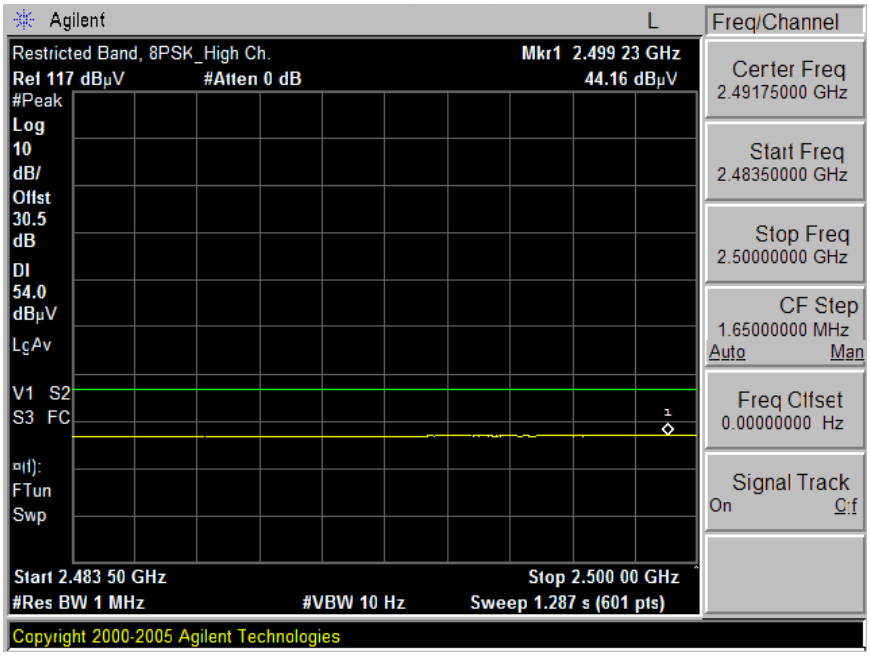


**RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)**

HIGH CHANNEL RESTRICTED, PEAK, VERT



HIGH CHANNEL RESTRICTED, AVG, VERT



## HARMONICS AND SPURIOUS EMISSIONS

01/12/06 **High Frequency Measurement**
**Compliance Certification Services, Morgan Hill Open Field Site**

**Test Engr: Vien Tran**
**Project #:05U3907**
**Company: Broadcom**
**EUT Descrip.: USB Bluetooth EDR Module**
**EUT M/N:BCM92045MD**
**Test Target: DGT**
**Mode Oper:Tx 8PSK**

**Test Equipment:**

| Horn 1-18GHz | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz | Limit |
|---|---|---|---|---|
| T73; S/N: 6717 @3m | T34 HP 8449B | | | FCC 15.209 |

Hi Frequency Cables

| 2 foot cable | 3 foot cable | 12 foot cable | HPF | Reject Filter |
|---|---|---|---|---|
| Vien 177079005 | | Vien 197209005 | HPF_4.0GHz | |

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

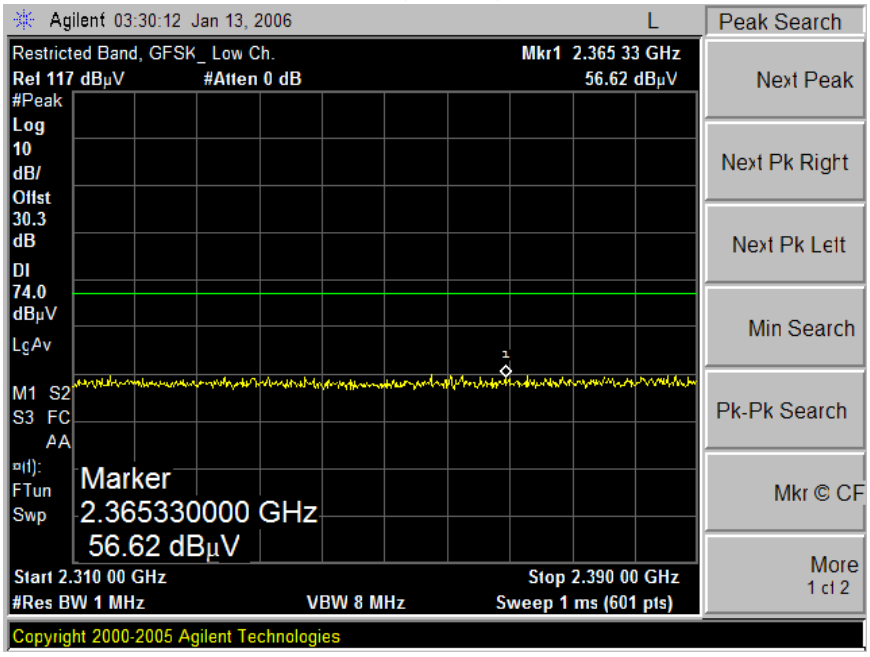
| f GHz | Dist (m) | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | Fltr dB | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes (V/H) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOW CH, 2402 MHz | | | | | | | | | | | | | | | |
| 4.804 | 3.0 | 42.1 | 30.5 | 33.7 | 3.3 | -34.8 | 0.0 | 0.6 | 44.9 | 33.3 | 74 | 54 | -29.1 | -20.7 | V |
| 7.206 | 3.0 | 50.3 | 39.6 | 35.4 | 3.9 | -34.2 | 0.0 | 0.6 | 56.0 | 45.3 | 74 | 54 | -18.0 | -8.7 | V |
| 9.608 | 3.0 | 42.0 | 31.2 | 37.4 | 4.6 | -33.7 | 0.0 | 0.8 | 51.1 | 40.3 | 74 | 54 | -22.9 | -13.7 | V |
| 4.804 | 3.0 | 42.9 | 31.9 | 33.7 | 3.3 | -34.8 | 0.0 | 0.6 | 45.7 | 34.7 | 74 | 54 | -28.3 | -19.3 | H |
| 7.206 | 3.0 | 51.4 | 45.9 | 35.4 | 3.9 | -34.2 | 0.0 | 0.6 | 57.1 | 51.6 | 74 | 54 | -16.9 | -2.4 | H |
| 9.608 | 3.0 | 41.8 | 31.3 | 37.4 | 4.6 | -33.7 | 0.0 | 0.8 | 50.9 | 40.4 | 74 | 54 | -23.1 | -13.6 | H |
| | | | | | | | | | | | | | | | |
| MID CH, 2441 MHz | | | | | | | | | | | | | | | |
| 4.882 | 3.0 | 42.1 | 30.5 | 33.8 | 3.4 | -34.8 | 0.0 | 0.6 | 45.1 | 33.5 | 74 | 54 | -28.9 | -20.5 | V |
| 7.323 | 3.0 | 49.3 | 39.5 | 35.5 | 3.9 | -34.1 | 0.0 | 0.6 | 55.2 | 45.4 | 74 | 54 | -18.8 | -8.6 | V |
| 9.764 | 3.0 | 41.3 | 30.9 | 37.5 | 4.6 | -33.3 | 0.0 | 0.8 | 51.0 | 40.6 | 74 | 54 | -23.0 | -13.4 | V |
| 4.882 | 3.0 | 45.8 | 37.6 | 33.8 | 3.4 | -34.8 | 0.0 | 0.6 | 48.8 | 40.6 | 74 | 54 | -25.2 | -13.4 | H |
| 7.323 | 3.0 | 51.0 | 45.5 | 35.5 | 3.9 | -34.1 | 0.0 | 0.6 | 56.9 | 51.4 | 74 | 54 | -17.1 | -2.6 | H |
| 9.764 | 3.0 | 41.8 | 31.3 | 37.5 | 4.6 | -33.3 | 0.0 | 0.8 | 51.5 | 41.0 | 74 | 54 | -22.5 | -13.0 | H |
| | | | | | | | | | | | | | | | |
| HI CH, 2480 MHz | | | | | | | | | | | | | | | |
| 4.960 | 3.0 | 43.8 | 32.5 | 33.9 | 3.4 | -34.8 | 0.0 | 0.6 | 46.9 | 35.6 | 74 | 54 | -27.1 | -18.4 | V |
| 7.440 | 3.0 | 50.0 | 40.1 | 35.7 | 3.9 | -34.1 | 0.0 | 0.6 | 56.2 | 46.3 | 74 | 54 | -17.8 | -7.7 | V |
| 9.920 | 3.0 | 42.8 | 31.7 | 37.6 | 4.6 | -32.9 | 0.0 | 0.8 | 53.1 | 42.0 | 74 | 54 | -20.9 | -12.0 | V |
| 4.960 | 3.0 | 47.3 | 42.2 | 33.9 | 3.4 | -34.8 | 0.0 | 0.6 | 50.4 | 45.3 | 74 | 54 | -23.6 | -8.7 | H |
| 7.440 | 3.0 | 50.0 | 44.6 | 35.7 | 3.9 | -34.1 | 0.0 | 0.6 | 56.2 | 50.8 | 74 | 54 | -17.8 | -3.2 | H |
| 9.920 | 3.0 | 43.0 | 31.6 | 37.6 | 4.6 | -32.9 | 0.0 | 0.8 | 53.3 | 41.9 | 74 | 54 | -20.7 | -12.1 | H |
| | | | | | | | | | | | | | | | |
| | | | No other emissions were detected above system noise floor | | | | | | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 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 | | |

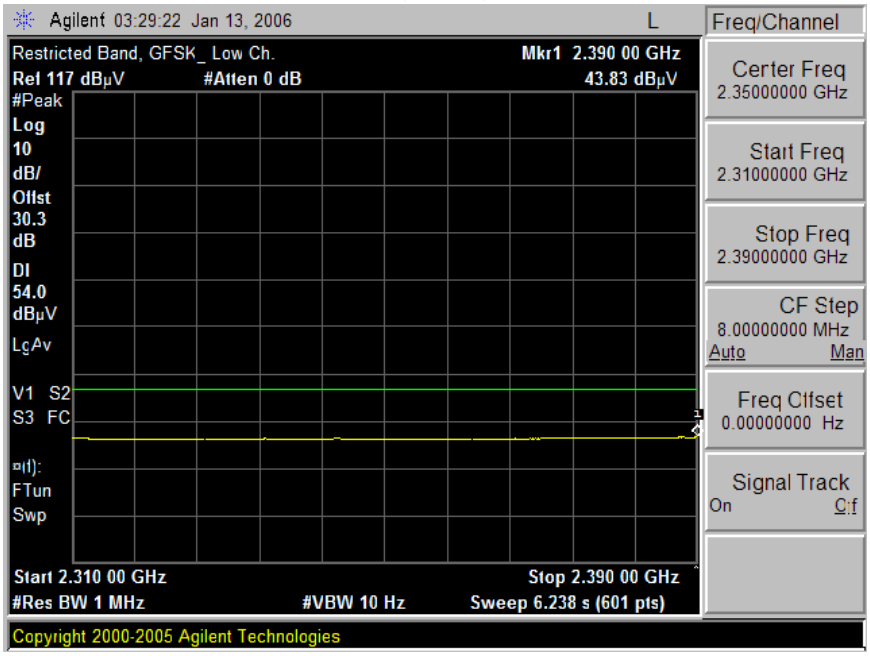
## 7.3.3. TRANSMITTER RADIATED EMISSIONS ABOVE 1 GHZ WITH GFSK MODULATION

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

LOW CHANNEL RESTRICTED, PEAK, HORIZ

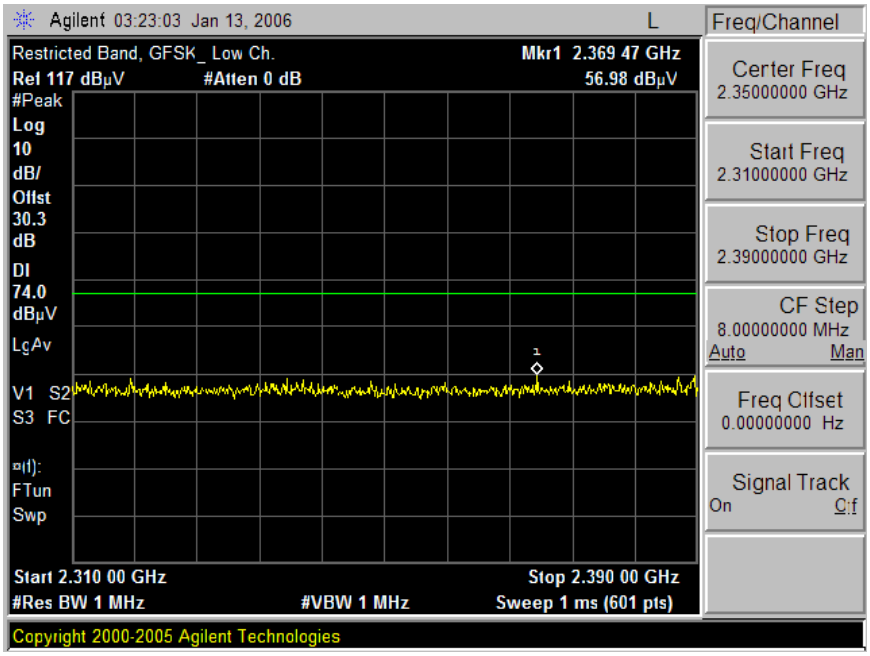


LOW CHANNEL RESTRICTED, AVG, HORIZ

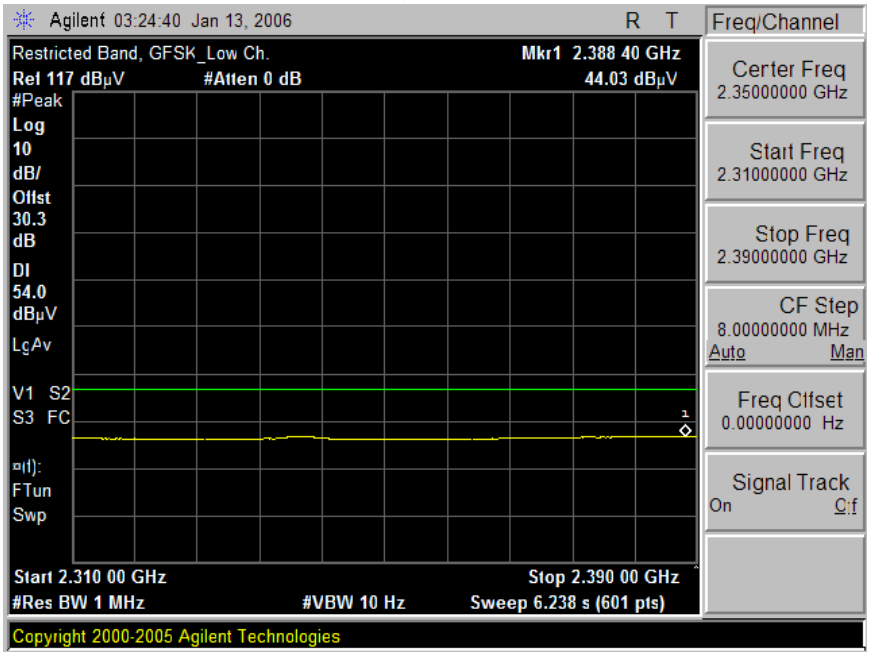


**RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**

LOW CHANNEL RESTRICTED, PEAK, VERT

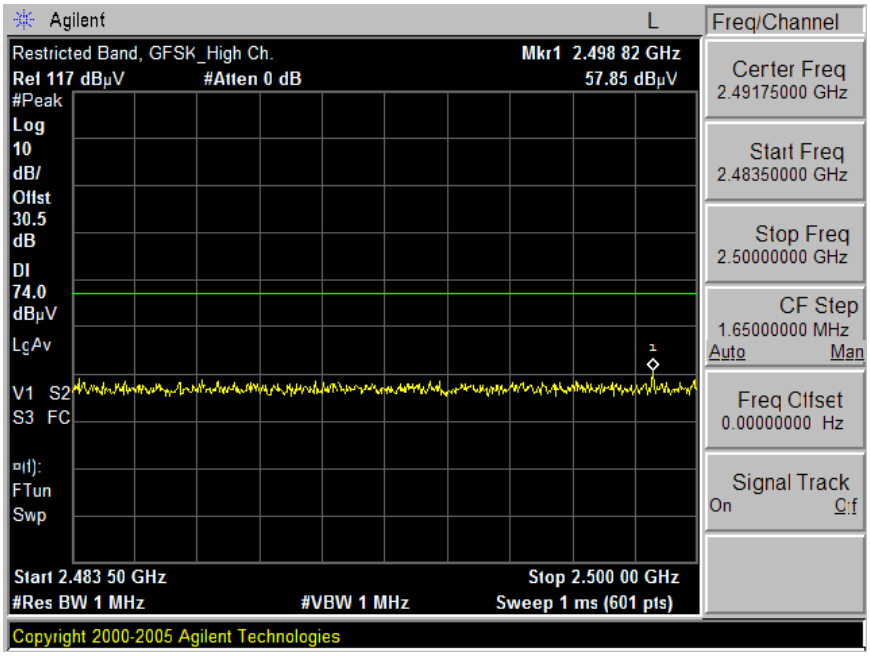


LOW CHANNEL RESTRICTED, AVG, VERT

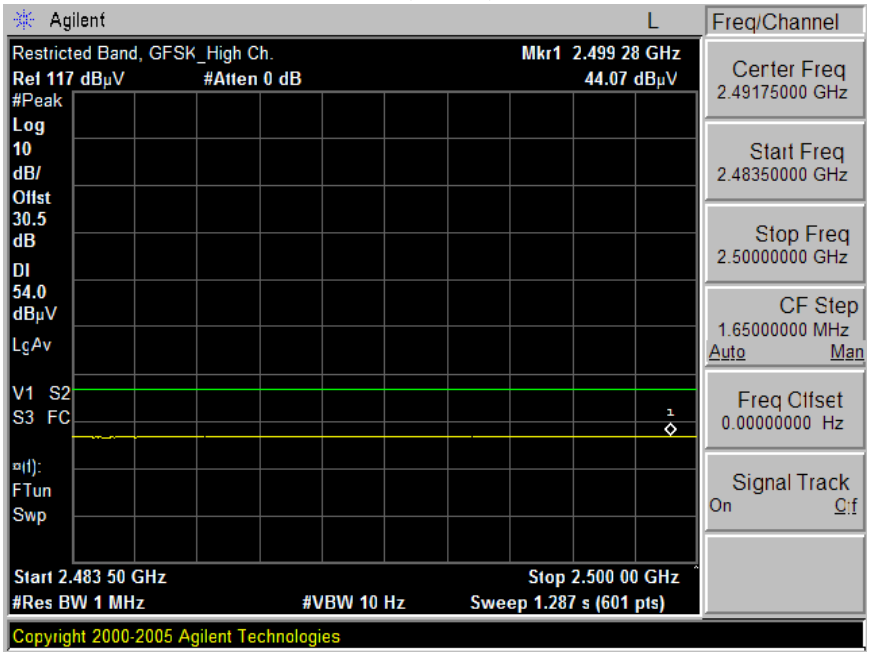


**RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**

HIGH CHANNEL RESTRICTED, PEAK, HORIZ

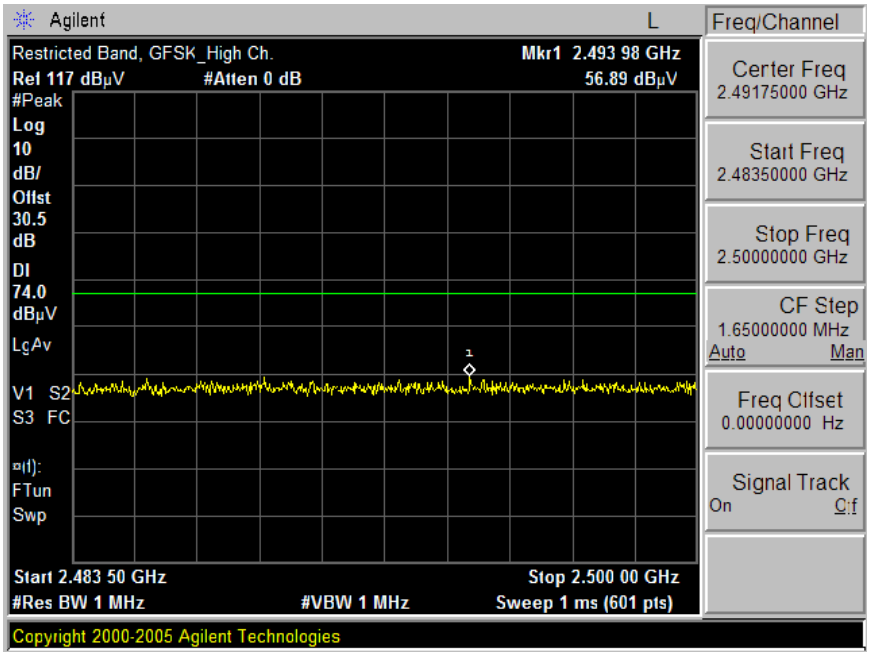


HIGH CHANNEL RESTRICTED, AVG, HORIZ

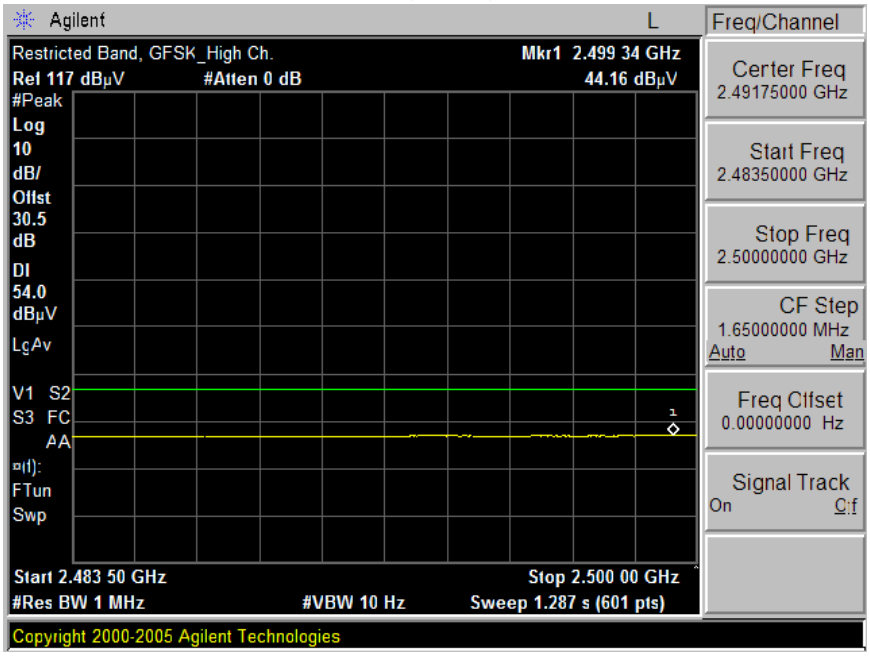


**RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)**

HIGH CHANNEL RESTRICTED, PEAK, VERT



HIGH CHANNEL RESTRICTED, AVG, VERT



## HARMONICS AND SPURIOUS EMISSIONS

01/12/06 **High Frequency Measurement**
**Compliance Certification Services, Morgan Hill Open Field Site**

**Test Engr: Vien Tran**
**Project #:05U3907**
**Company: Broadcom**
**EUT Descrip.: USB Bluetooth EDR Module**
**EUT M/N:BCM92045MD**
**Test Target: DGT**
**Mode Oper:Tx GFSK**

**Test Equipment:**

| Horn 1-18GHz | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz | Limit |
|---|---|---|---|---|
| T73; S/N: 6717 @3m | T34 HP 8449B | | | FCC 15.209 |

Hi Frequency Cables

| 2 foot cable | 3 foot cable | 12 foot cable | HPF | Reject Filter |
|---|---|---|---|---|
| Vien 177079005 | | Vien 197209005 | HPF_4.0GHz | |

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

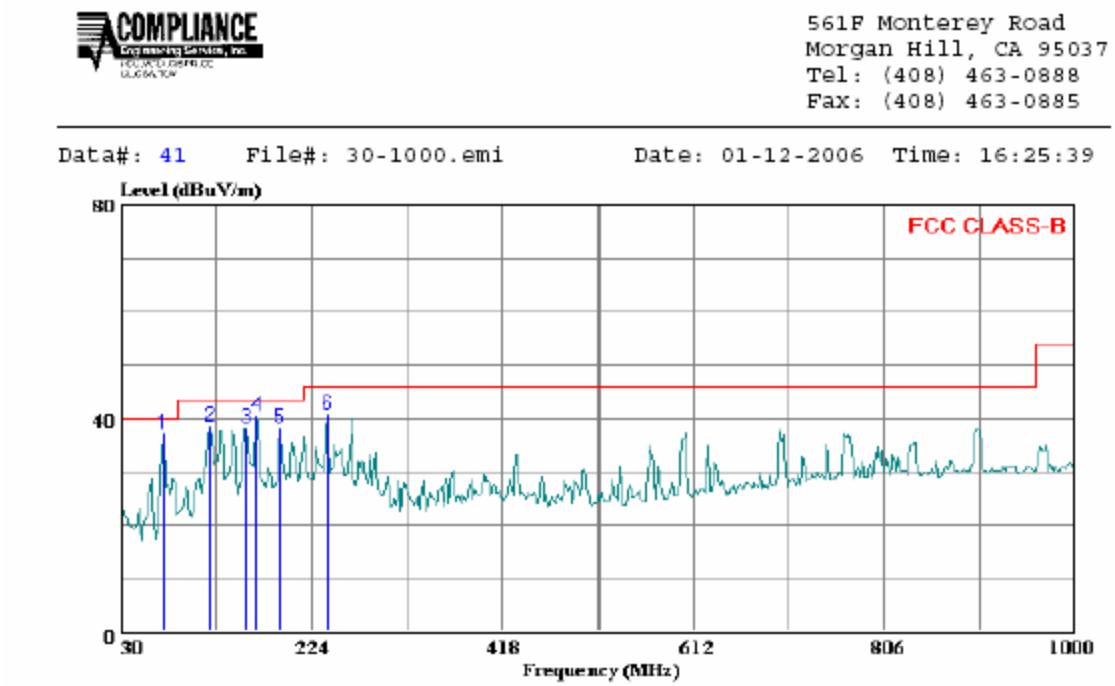
| f GHz | Dist (m) | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | Fltr dB | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes (V/H) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOW CH, 2402 MHz | | | | | | | | | | | | | | | |
| 4.804 | 3.0 | 42.1 | 30.6 | 33.7 | 3.3 | -34.8 | 0.0 | 0.6 | 44.9 | 33.4 | 74 | 54 | -29.1 | -20.6 | V |
| 7.206 | 3.0 | 49.4 | 41.6 | 35.4 | 3.9 | -34.2 | 0.0 | 0.6 | 55.1 | 47.3 | 74 | 54 | -18.9 | -6.7 | V |
| 9.608 | 3.0 | 42.0 | 31.2 | 37.4 | 4.6 | -33.7 | 0.0 | 0.8 | 51.1 | 40.3 | 74 | 54 | -22.9 | -13.7 | V |
| 4.804 | 3.0 | 43.6 | 32.7 | 33.7 | 3.3 | -34.8 | 0.0 | 0.6 | 46.4 | 35.5 | 74 | 54 | -27.6 | -18.5 | H |
| 7.206 | 3.0 | 56.4 | 46.3 | 35.4 | 3.9 | -34.2 | 0.0 | 0.6 | 62.1 | 52.0 | 74 | 54 | -11.9 | -2.0 | H |
| 9.608 | 3.0 | 42.4 | 30.7 | 37.4 | 4.6 | -33.7 | 0.0 | 0.8 | 51.5 | 39.8 | 74 | 54 | -22.5 | -14.2 | H |
| | | | | | | | | | | | | | | | |
| MID CH, 2441 MHz | | | | | | | | | | | | | | | |
| 4.882 | 3.0 | 42.1 | 30.5 | 33.8 | 3.4 | -34.8 | 0.0 | 0.6 | 45.1 | 33.5 | 74 | 54 | -28.9 | -20.5 | V |
| 7.323 | 3.0 | 49.0 | 41.6 | 35.5 | 3.9 | -34.1 | 0.0 | 0.6 | 54.9 | 47.5 | 74 | 54 | -19.1 | -6.5 | V |
| 9.764 | 3.0 | 41.3 | 31.3 | 37.5 | 4.6 | -33.3 | 0.0 | 0.8 | 51.0 | 41.0 | 74 | 54 | -23.0 | -13.0 | V |
| 4.882 | 3.0 | 45.8 | 36.1 | 33.8 | 3.4 | -34.8 | 0.0 | 0.6 | 48.8 | 39.1 | 74 | 54 | -25.2 | -14.9 | H |
| 7.323 | 3.0 | 54.7 | 45.2 | 35.5 | 3.9 | -34.1 | 0.0 | 0.6 | 60.6 | 51.1 | 74 | 54 | -13.4 | -2.9 | H |
| 9.764 | 3.0 | 41.8 | 30.9 | 37.5 | 4.6 | -33.3 | 0.0 | 0.8 | 51.5 | 40.6 | 74 | 54 | -22.5 | -13.4 | H |
| | | | | | | | | | | | | | | | |
| HI CH, 2480 MHz | | | | | | | | | | | | | | | |
| 4.960 | 3.0 | 43.8 | 32.5 | 33.9 | 3.4 | -34.8 | 0.0 | 0.6 | 46.9 | 35.6 | 74 | 54 | -27.1 | -18.4 | V |
| 7.440 | 3.0 | 49.3 | 41.4 | 35.7 | 3.9 | -34.1 | 0.0 | 0.6 | 55.5 | 47.6 | 74 | 54 | -18.5 | -6.4 | V |
| 9.920 | 3.0 | 42.8 | 31.7 | 37.6 | 4.6 | -32.9 | 0.0 | 0.8 | 53.1 | 42.0 | 74 | 54 | -20.9 | -12.0 | V |
| 4.960 | 3.0 | 48.4 | 40.6 | 33.9 | 3.4 | -34.8 | 0.0 | 0.6 | 51.5 | 43.7 | 74 | 54 | -22.5 | -10.3 | H |
| 7.440 | 3.0 | 53.8 | 44.1 | 35.7 | 3.9 | -34.1 | 0.0 | 0.6 | 60.0 | 50.3 | 74 | 54 | -14.0 | -3.7 | H |
| 9.920 | 3.0 | 43.2 | 31.9 | 37.6 | 4.6 | -32.9 | 0.0 | 0.8 | 53.5 | 42.2 | 74 | 54 | -20.5 | -11.8 | H |
| | | | | | | | | | | | | | | | |
| No other emissions were detected above system noise floor | | | | | | | | | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 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 | | |

## 7.3.4. WORST-CASE RADIATED EMISSIONS BELOW 1 GHz WITH 8PSK MODULATION

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

HORIZONTAL PLOT

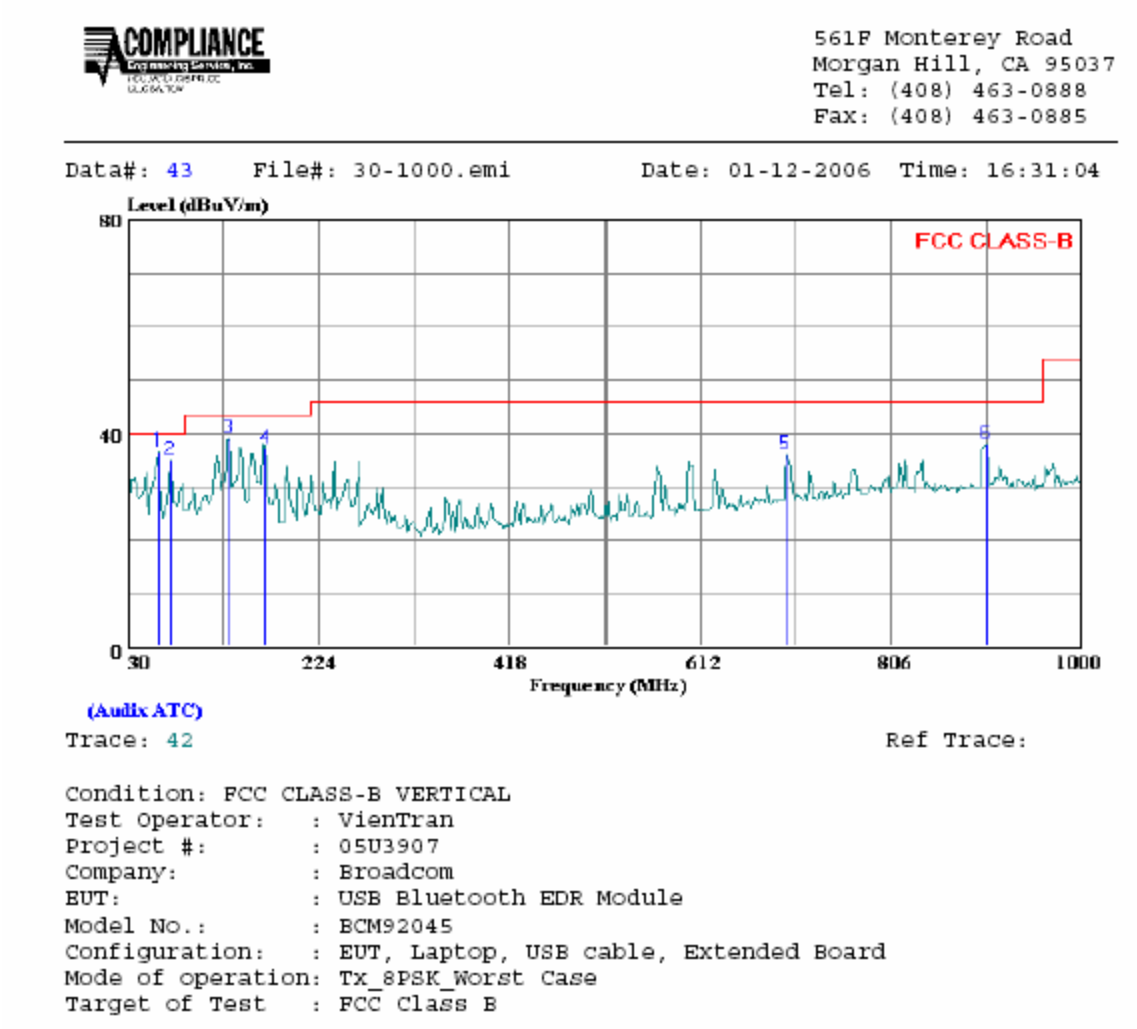


HORIZONTAL DATA

| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV/m | dBuV/m | dB | |
| 1 | 72.680 | 55.76 | -18.61 | 37.15 | 40.00 | -2.85 | Peak |
| 2 | 121.180 | 51.07 | -12.64 | 38.43 | 43.50 | -5.07 | Peak |
| 3 | 158.040 | 52.21 | -13.87 | 38.34 | 43.50 | -5.16 | Peak |
| 4 | 167.740 | 54.52 | -14.20 | 40.32 | 43.50 | -3.18 | Peak |
| 5 | 191.990 | 52.61 | -14.37 | 38.24 | 43.50 | -5.26 | Peak |
| 6 | 240.490 | 54.65 | -14.06 | 40.59 | 46.00 | -5.41 | Peak |

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

VERTICAL PLOT



VERTICAL DATA

| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV/m | dBuV/m | dB | |
| 1 | 61.040 | 55.68 | -19.09 | 36.59 | 40.00 | -3.41 | Peak |
| 2 | 72.680 | 53.47 | -18.61 | 34.86 | 40.00 | -5.14 | Peak |
| 3 | 133.790 | 51.70 | -12.75 | 38.95 | 43.50 | -4.55 | Peak |
| 4 | 169.680 | 51.54 | -14.31 | 37.23 | 43.50 | -6.27 | Peak |
| 5 | 698.330 | 39.17 | -3.25 | 35.92 | 46.00 | -10.08 | Peak |
| 6 | 902.030 | 38.84 | -1.01 | 37.83 | 46.00 | -8.17 | Peak |

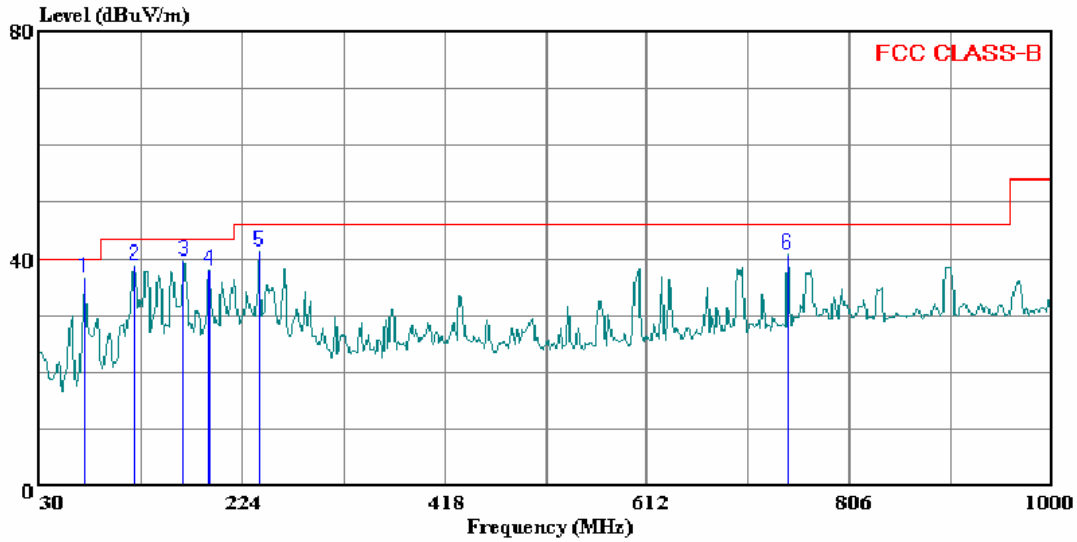
## 7.3.5. WORST-CASE RADIATED EMISSIONS BELOW 1 GHz WITH GFSK MODULATION

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

HORIZONTAL PLOT

COMPLIANCE Engineering Services, Inc.
561F Monterey Road
Morgan Hill, CA 95037
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 37 File#: 30-1000.emi Date: 01-12-2006 Time: 16:07:20




(Audix ATC)

Trace: 36 Ref Trace:

Condition: FCC CLASS-B HORIZONTAL
Test Operator: : VienTran
Project #: : 05U3907
Company: : Broadcom
EUT: : USB Bluetooth EDR Module
Model No.: : BCM92045
Configuration: : EUT, Laptop, USB cable, Extended Board
Mode of operation: Tx_GFSK_Worst Case
Target of Test : FCC Class B

HORIZONTAL DATA

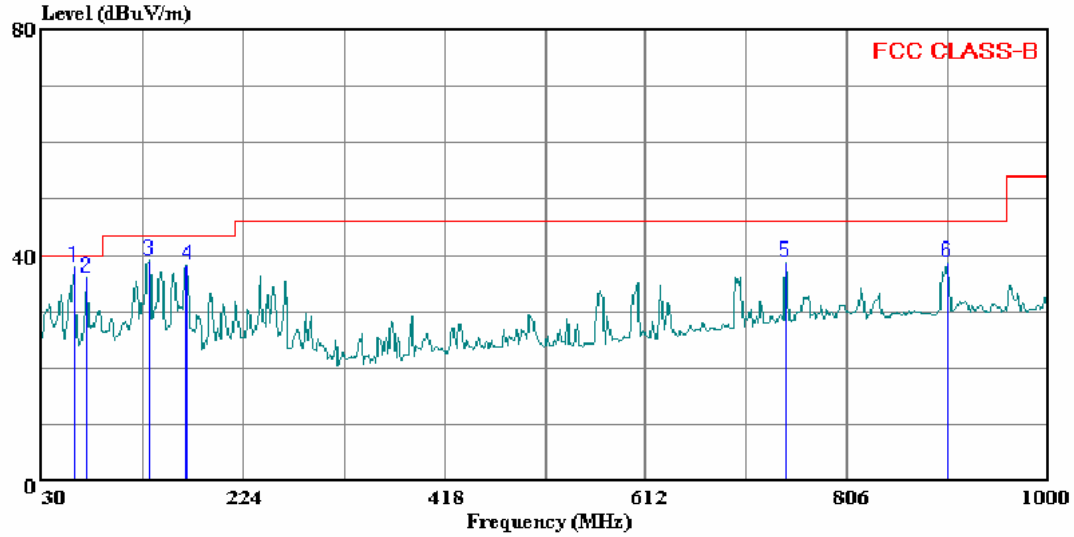
| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV/m | dBuV/m | dB | |
| 1 | 72.680 | 55.27 | -18.61 | 36.66 | 40.00 | -3.34 | Peak |
| 2 | 121.180 | 51.42 | -12.64 | 38.78 | 43.50 | -4.72 | Peak |
| 3 | 167.740 | 53.69 | -14.20 | 39.49 | 43.50 | -4.01 | Peak |
| 4 | 191.990 | 52.26 | -14.37 | 37.89 | 43.50 | -5.61 | Peak |
| 5 | 240.490 | 55.42 | -14.06 | 41.36 | 46.00 | -4.64 | Peak |
| 6 | 746.830 | 43.22 | -2.54 | 40.68 | 46.00 | -5.32 | Peak |

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

VERTICAL PLOT

561F Monterey Road
Morgan Hill, CA 95037
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 39 File#: 30-1000.emi Date: 01-12-2006 Time: 16:17:11




(Audix ATC)

Trace: 38 Ref Trace:

Condition: FCC CLASS-B VERTICAL
Test Operator: : VienTran
Project #: : 05U3907
Company: : Broadcom
EUT: : USB Bluetooth EDR Module
Model No.: : BCM92045
Configuration: : EUT, Laptop, USB cable, Extended Board
Mode of operation: Tx_GFSK_Worst Case
Target of Test : FCC Class B

VERTICAL DATA

| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV/m | dBuV/m | dB | |
| 1 | 61.040 | 56.92 | -19.09 | 37.83 | 40.00 | -2.17 | Peak |
| 2 | 72.680 | 54.65 | -18.61 | 36.04 | 40.00 | -3.96 | Peak |
| 3 | 133.790 | 51.84 | -12.75 | 39.09 | 43.50 | -4.41 | Peak |
| 4 | 169.680 | 52.62 | -14.31 | 38.31 | 43.50 | -5.19 | Peak |
| 5 | 746.830 | 41.43 | -2.54 | 38.89 | 46.00 | -7.11 | Peak |
| 6 | 902.030 | 39.80 | -1.01 | 38.79 | 46.00 | -7.21 | Peak |

## 7.4. POWERLINE CONDUCTED EMISSIONS WITH 8PSK MODULATION

§15.207 (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). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

The lower limit applies at the boundary between the frequency ranges.

| 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 resolution bandwidth is set to 9 kHz for both peak detection and quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

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

**RESULTS**

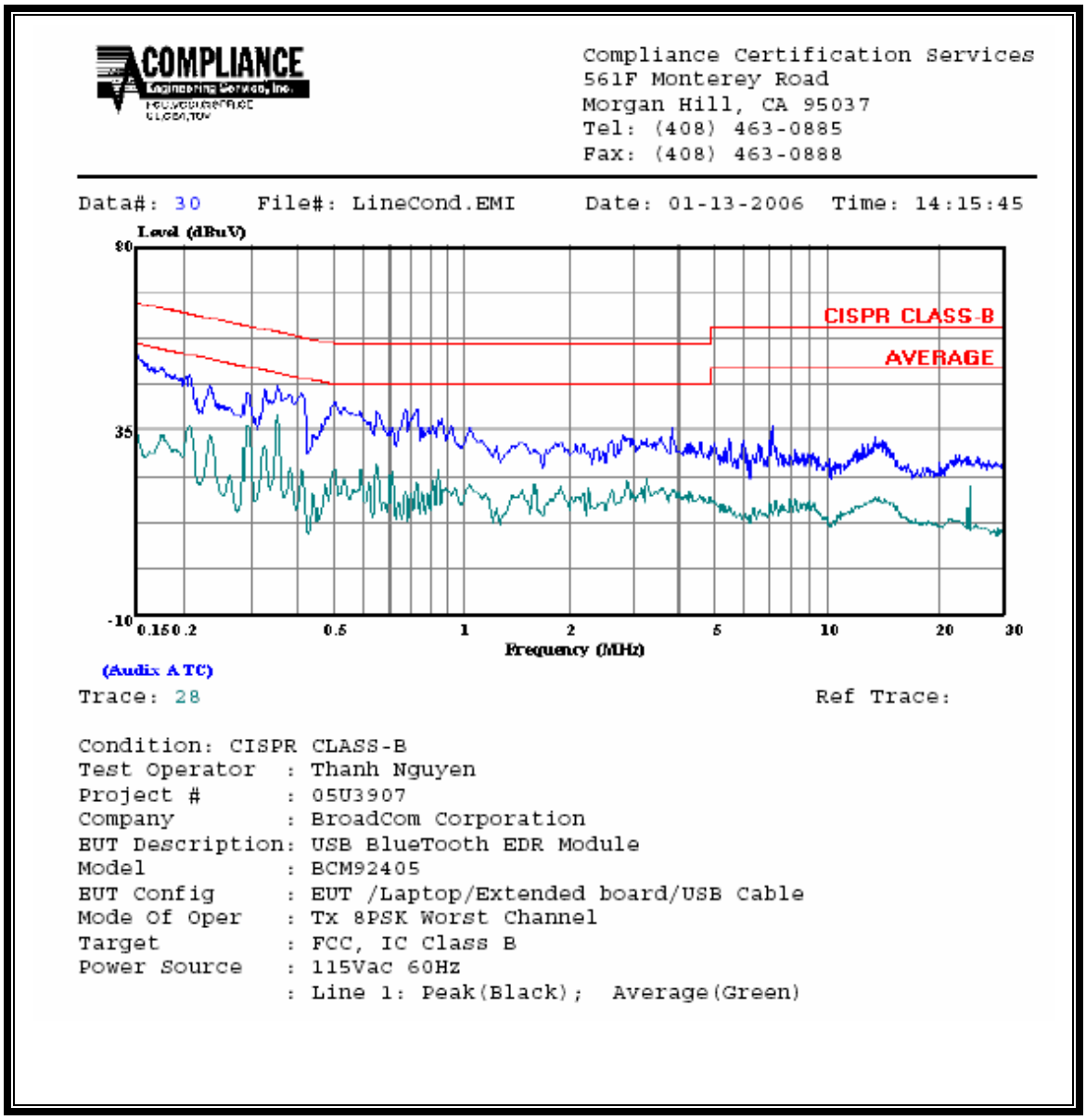
No non-compliance noted:

## 6 WORST EMISSIONS

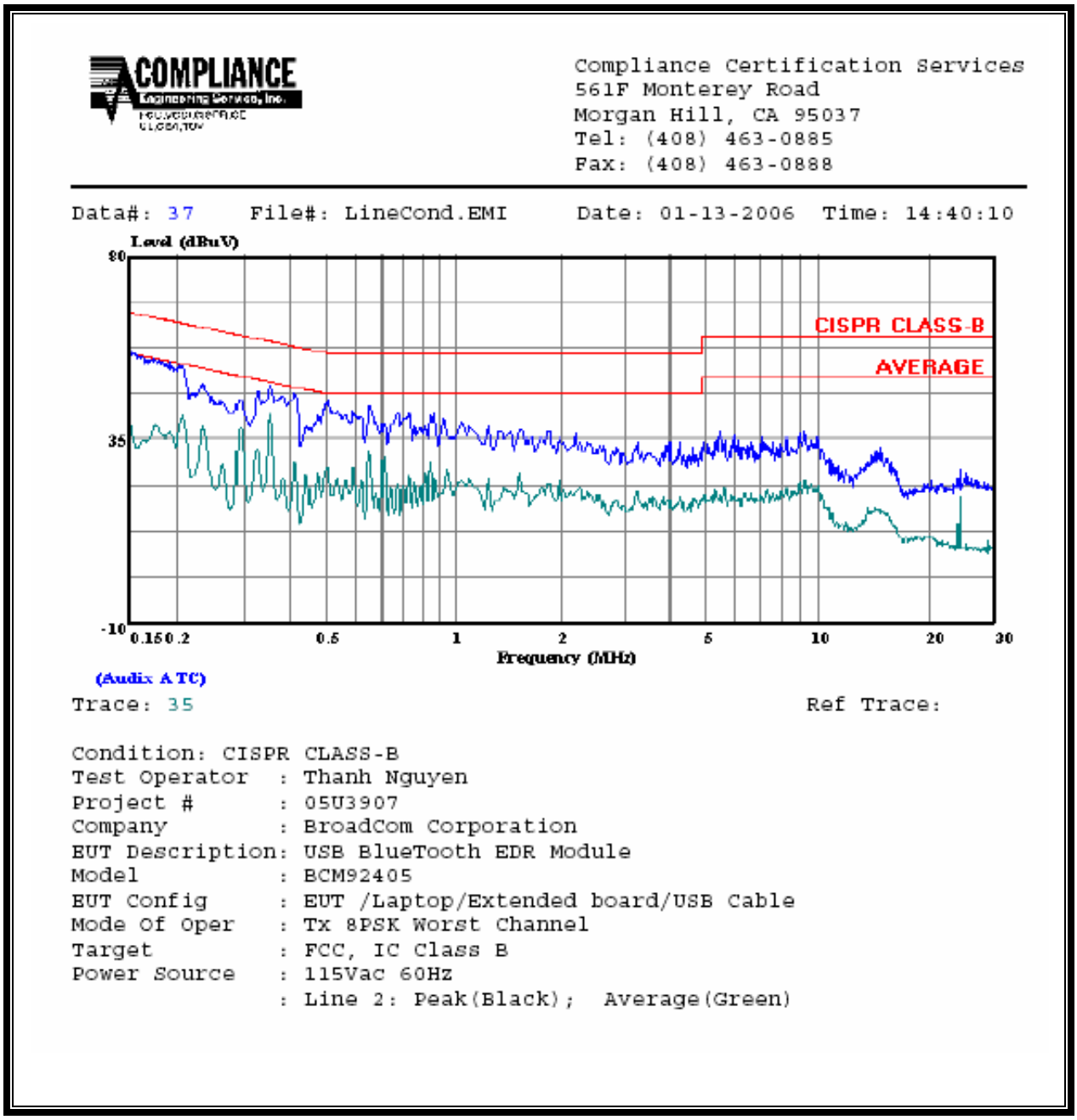
# 8PSK Mode

| CONDUCTED EMISSIONS DATA (115VAC 60Hz) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Freq. | Reading | | | Closs | Limit | EN_B | Margin | | Remark |
| (MHz) | PK (dBuV) | QP (dBuV) | AV (dBuV) | (dB) | QP | AV | QP (dB) | AV (dB) | L1 / L2 |
| 0.15 | 53.84 | -- | 36.51 | 0.00 | 66.00 | 56.00 | -12.16 | -19.49 | L1 |
| 0.35 | 45.70 | -- | 38.84 | 0.00 | 58.87 | 48.87 | -13.17 | -10.03 | L1 |
| 0.84 | 39.86 | -- | 21.52 | 0.00 | 56.00 | 46.00 | -16.14 | -24.48 | L1 |
| 0.15 | 57.02 | -- | 39.39 | 0.00 | 66.00 | 56.00 | -8.98 | -16.61 | L2 |
| 0.35 | 47.96 | -- | 40.91 | 0.00 | 58.87 | 48.87 | -10.91 | -7.96 | L2 |
| 0.65 | 42.96 | -- | 32.06 | 0.00 | 56.00 | 46.00 | -13.04 | -13.94 | L2 |
| 6 Worst Data | | | | | | | | | |

**LINE 1 RESULTS**



**LINE 2 RESULTS**



## 7.5. POWERLINE CONDUCTED EMISSIONS WITH GFSK MODULATION

### LIMIT

§15.207 (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). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

The lower limit applies at the boundary between the frequency ranges.

| 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 resolution bandwidth is set to 9 kHz for both peak detection and quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

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

### RESULTS

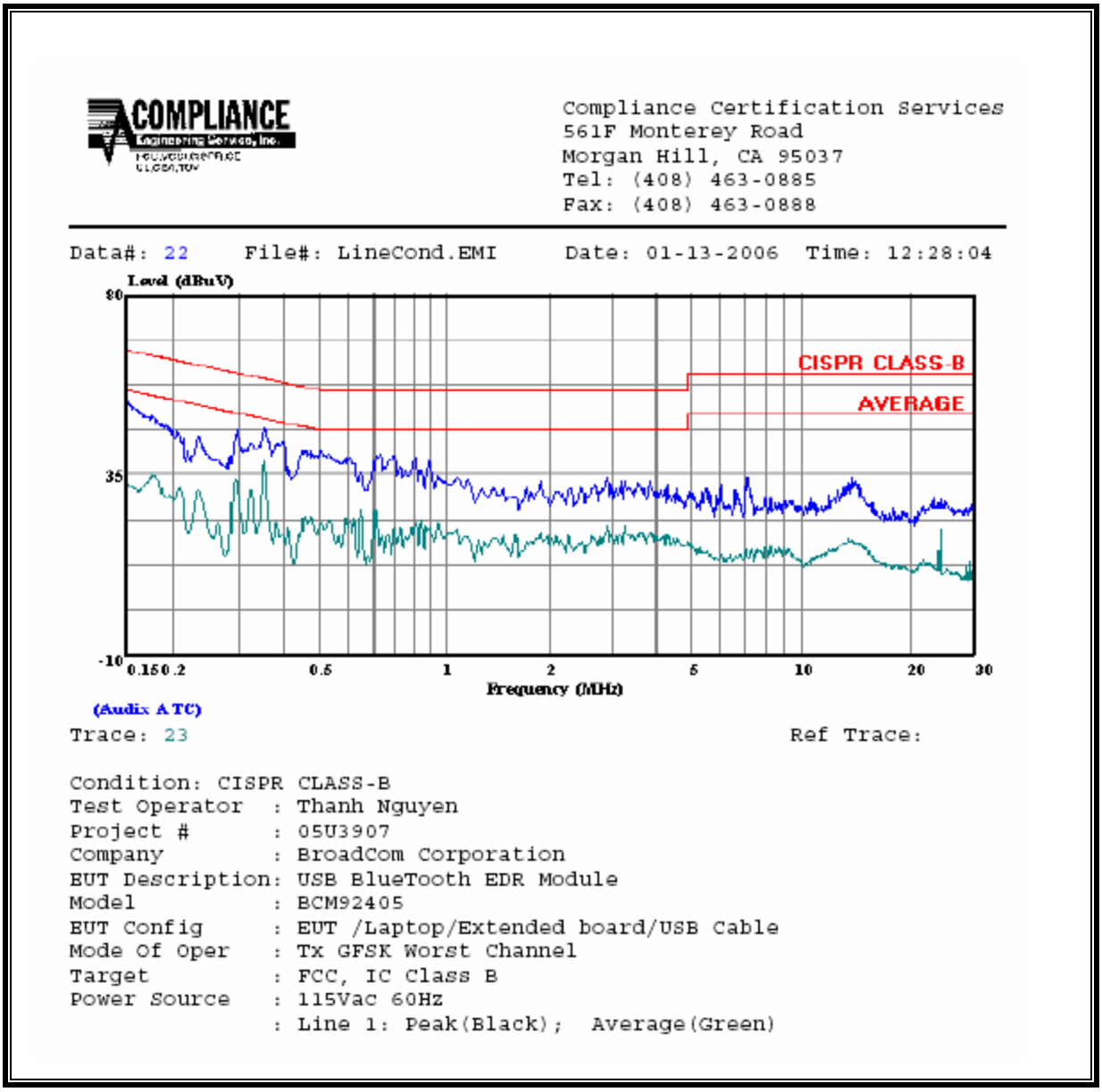
No non-compliance noted:

## 6 WORST EMISSIONS

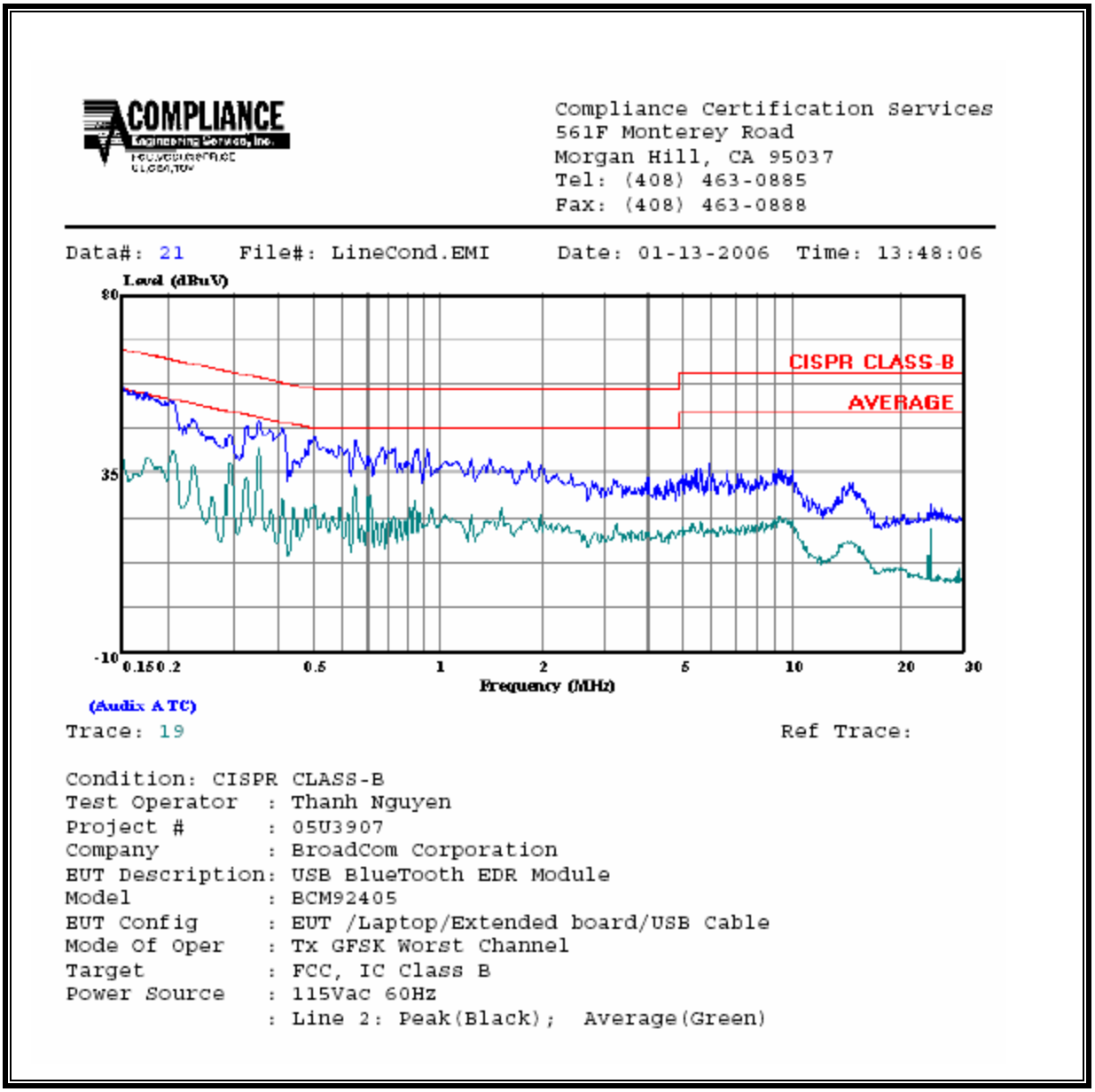
# GFSK Mode

| CONDUCTED EMISSIONS DATA (115VAC 60Hz) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Freq. | Reading | | | Closs | Limit | EN_B | Margin | | Remark |
| (MHz) | PK (dBuV) | QP (dBuV) | AV (dBuV) | (dB) | QP | AV | QP (dB) | AV (dB) | L1 / L2 |
| 0.15 | 52.78 | -- | 32.51 | 0.00 | 65.89 | 55.89 | -13.11 | -23.38 | L1 |
| 0.35 | 46.44 | -- | 38.33 | 0.00 | 58.87 | 48.87 | -12.43 | -10.54 | L1 |
| 0.73 | 39.70 | -- | 26.21 | 0.00 | 56.00 | 46.00 | -16.30 | -19.79 | L1 |
| 0.15 | 57.08 | -- | 39.75 | 0.00 | 66.00 | 56.00 | -8.92 | -16.25 | L2 |
| 0.36 | 47.56 | -- | 40.18 | 0.00 | 58.77 | 48.77 | -11.21 | -8.59 | L2 |
| 0.66 | 42.22 | -- | 31.92 | 0.00 | 56.00 | 46.00 | -13.78 | -14.08 | L2 |
| 6 Worst Data | | | | | | | | | |

**LINE 1 RESULTS**



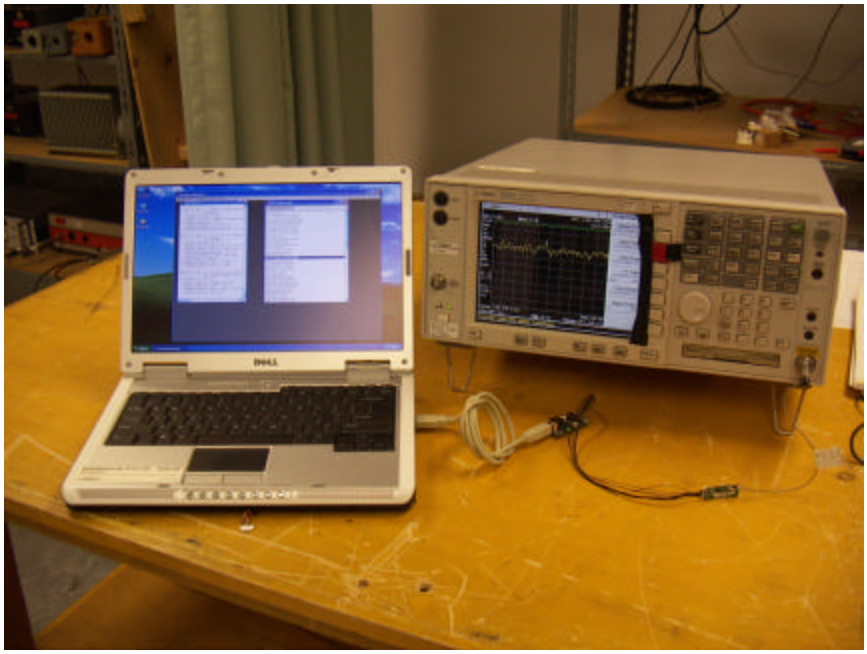
**LINE 2 RESULTS**



# 8. SETUP PHOTOS

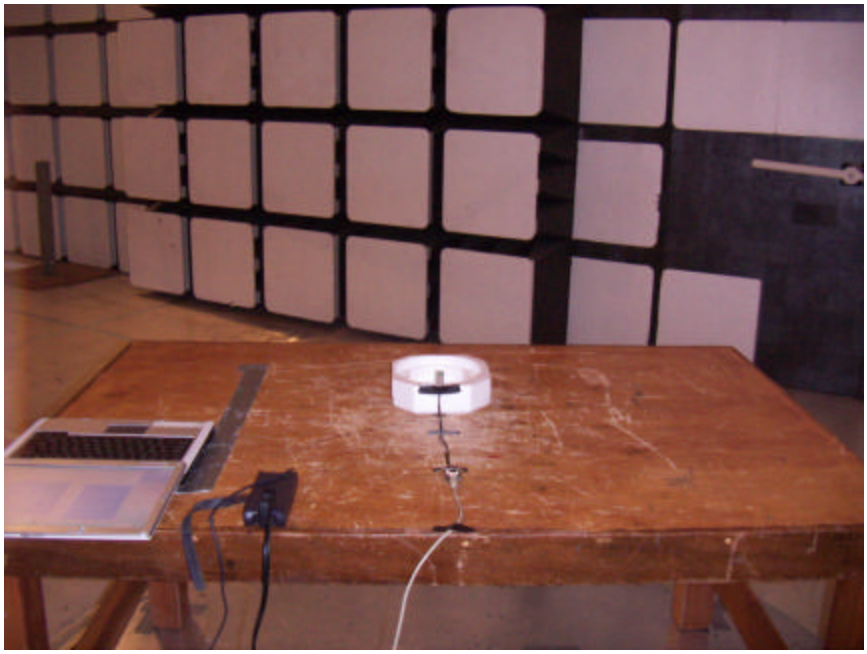
**ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP**

ANTENNA PORT CONDUCTED PHOTO

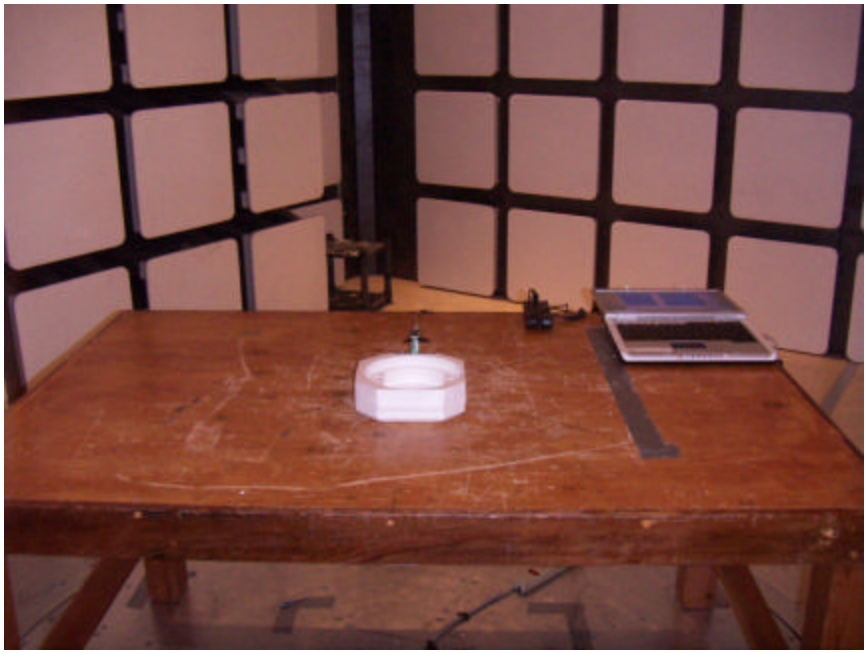


## RADIATED RF MEASUREMENT SETUP

RADIATED FRONT PHOTO

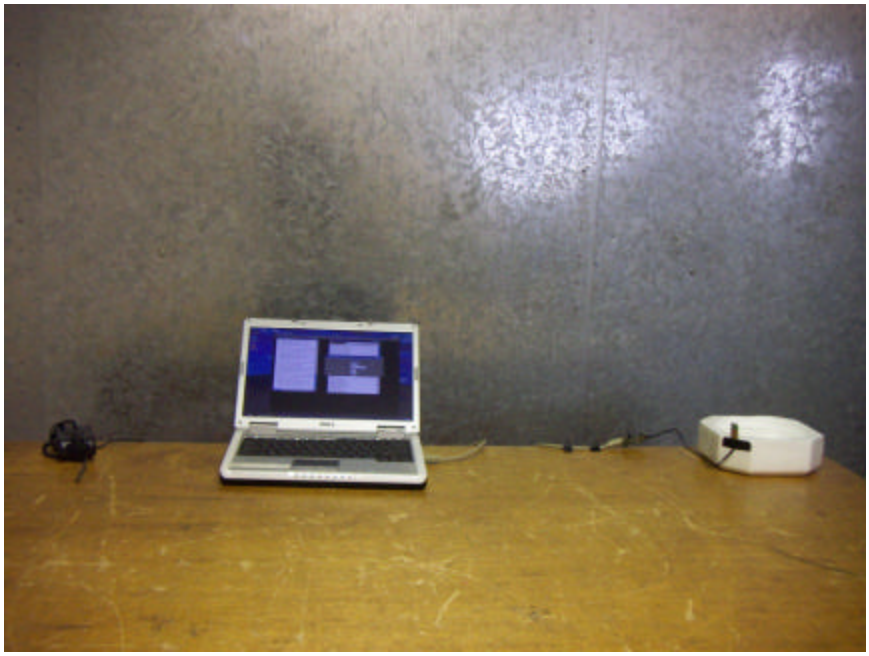


RADIATED BACK PHOTO

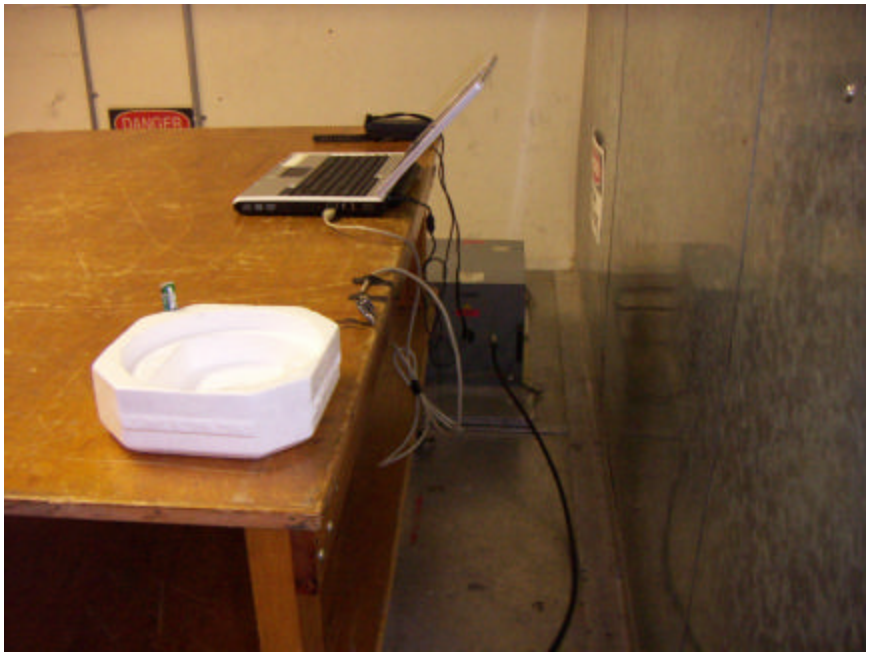


## POWERLINE CONDUCTED EMISSIONS MEASUREMENT SETUP

LINE CONDUCTED FRONT PHOTO



LINE CONDUCTED BACK PHOTO




# END OF REPORT