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

CERTIFICATION TEST REPORT

FOR

XBox 360 Wireless Controller

MODEL NUMBER: 1403

FCC ID: C3K1403
IC: 3048A-1403

REPORT NUMBER: 09U12392-1A

ISSUE DATE: MARCH 05, 2009

Prepared for
MICROSOFT CORPORATION
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	02/25/09	Initial Issue	T. Chan
A	03/05/09	Revised EUT description	A. Zaffar

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: MICROSOFT CORPORATION
1065 LA AVENIDA
MOUNTAIN VIEW, CA 94043, U.S.A.

EUT DESCRIPTION: XBox 360 Wireless Controller

MODEL: 1403

SERIAL NUMBER: DV-A-016 and DV-A-043 (Conducted), DV-A-002 (Radiated)

DATE TESTED: FEBRUARY 10 – 20, 2009

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 2	Pass

Compliance Certification Services, Inc. (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 CCS based on interpretations and/or observations of test results. 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 CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by CCS 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:

THU CHAN
EMC MANAGER
COMPLIANCE CERTIFICATION SERVICES

Tested By:

DEVIN CHANG
EMC ENGINEER
COMPLIANCE CERTIFICATION SERVICES

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2003, 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.

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
Power Line Conducted Emission	+/- 2.3 dB
Radiated Emission	+/- 3.4 dB

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a frequency hopping transceiver Xbox 360 Wireless controller. EUT is using the propitiatory communication protocol to interact with Xbox 360 console. Propitiatory communication protocol is detailed in the theory of operation.

5.2. MAXIMUM OUTPUT POWER

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

Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
2402 - 2482	3.60	2.29

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a PCB antenna, with a maximum gain of -0.2 dBi.

5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was RTX RF tool v1.82

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 2482 MHz.

The EUT is a portable device that has two orientations; therefore X and Y orientations have been investigated. The worst case was found to be Y orientation.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
NoteBook	DELL	PP10S	CN-0C8862-48643-57L-1789	DoC
AC Adaptor	DELL	N5825	CN-0N5825-48661-575-A028	DoC
Level Converter	MICROSOFT	Xbox MS	N/A	N/A
USB to RS-232 Converter	KEYSPAN	USA-19113	Z3730374BLF1647	DoC
Xbox360 RF Module RF02	MICROSOFT	Freedom	5.26E+12	DoC

I/O CABLES

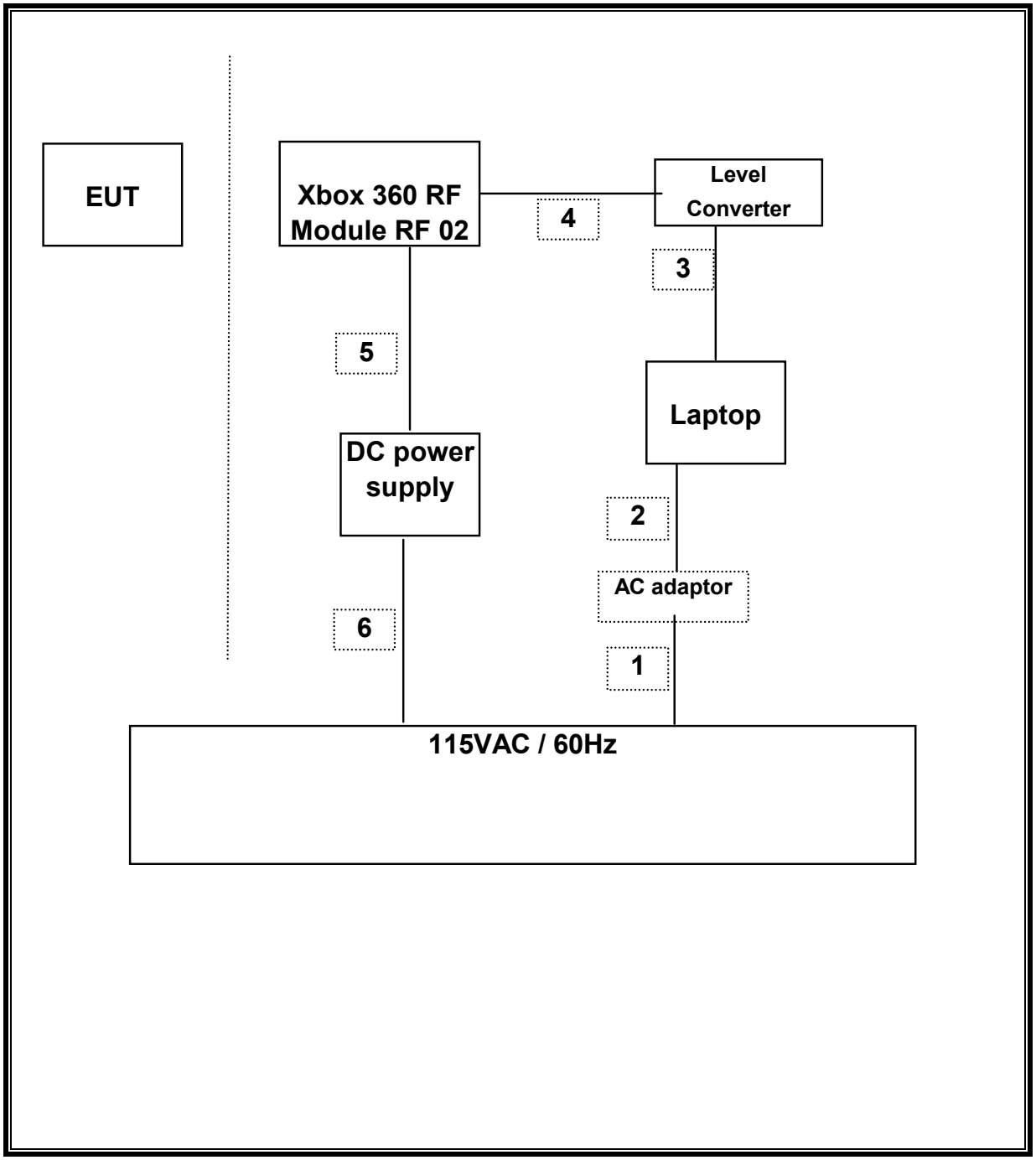
I/O CABLE LIST						
Cable No.	**Port**	**# of Identica Ports**	**Connector Type**	**Cable Type**	**Cable Length**	**Remarks**
1	AC	2	US 115V	Un-shielded	0.9 m	No
2	DC	3	DC	Un-shielded	1.8m	No
3	USB	1	RS-232	Shielded	0.3m	No
4	USB	1	jack	Un-shielded	1m	No
5	USB	1	DC	Un-shielded	1m	No
6	AC	2	US 115V	Un-shielded	1.5 m	No

TEST SETUP

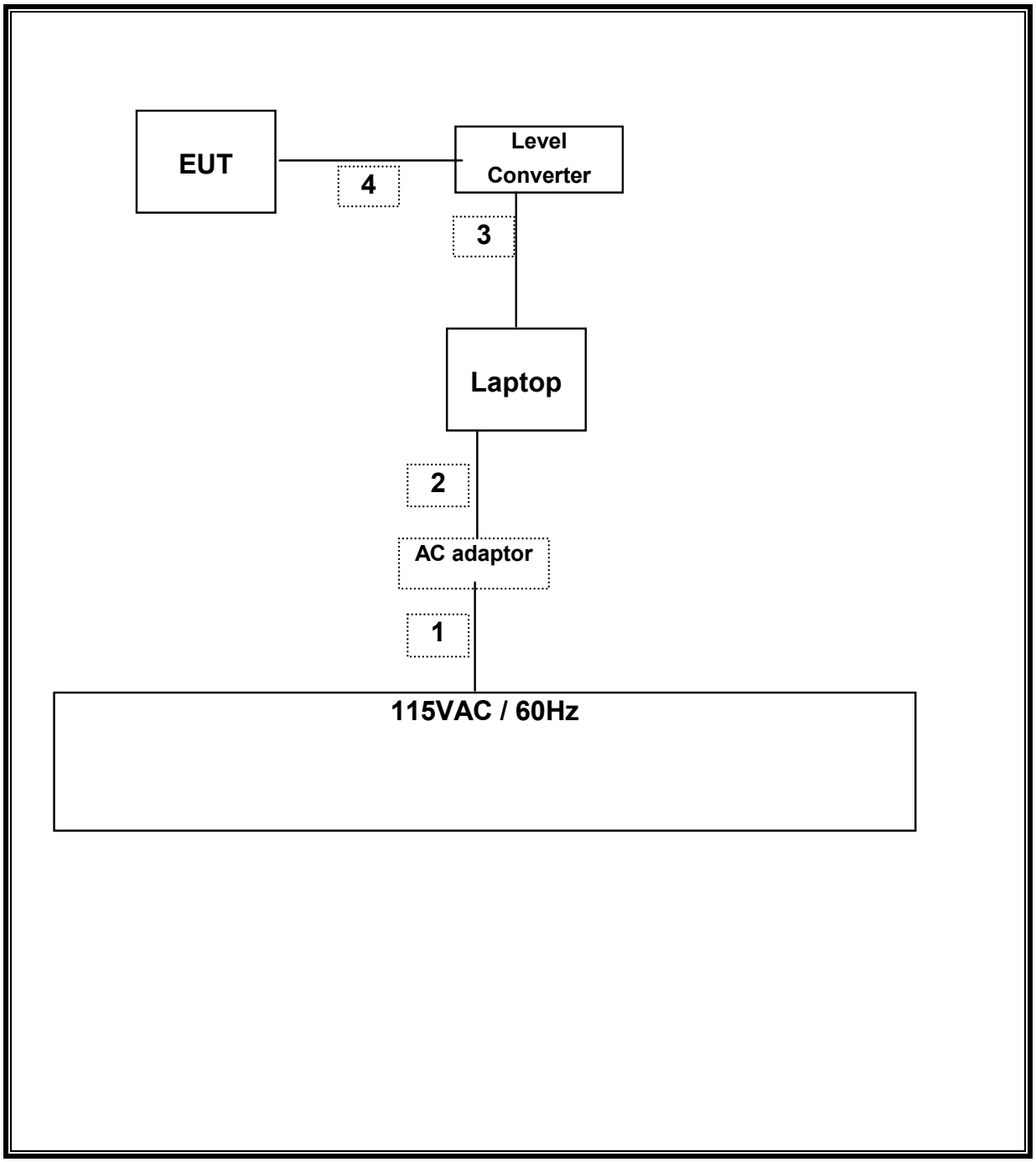
The EUT is test as stand alone unit.

SETUP DIAGRAM FOR TESTS

Hopping link mode



Single link mode



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**
Antenna, Horn, 18 GHz	EMCO	3115	C00945	04/22/09
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01063	11/27/09
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01011	02/14/10
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01069	10/08/09
Preamp, 1000MHz	Sonoma	310N	N02891	03/31/09
RF Filter Section, 2.9 GHz	Agilent / HP	85420E	C00958	09/19/09
EMI Receiver, 2.9 GHz	Agilent / HP	8542E	C00957	09/19/09
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00980	09/29/09
Power Meter	Agilent / HP	438A	N02369	04/19/09
Power Sensor, 18 GHz	Agilent / HP	8482A	N02890	12/20/09
2.4 GHz High Pass Filter	Micro Tronics	BRC13192	N02683	CNR
Highpass Filter, 4.0 GHz	Micro-Tronics	HPM13351	N02708	CNR
DC power supply, 60 V @ 18 A	Xantrex	XHR-60-18	C01064	CNR

7. ANTENNA PORT TEST RESULTS

7.1.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

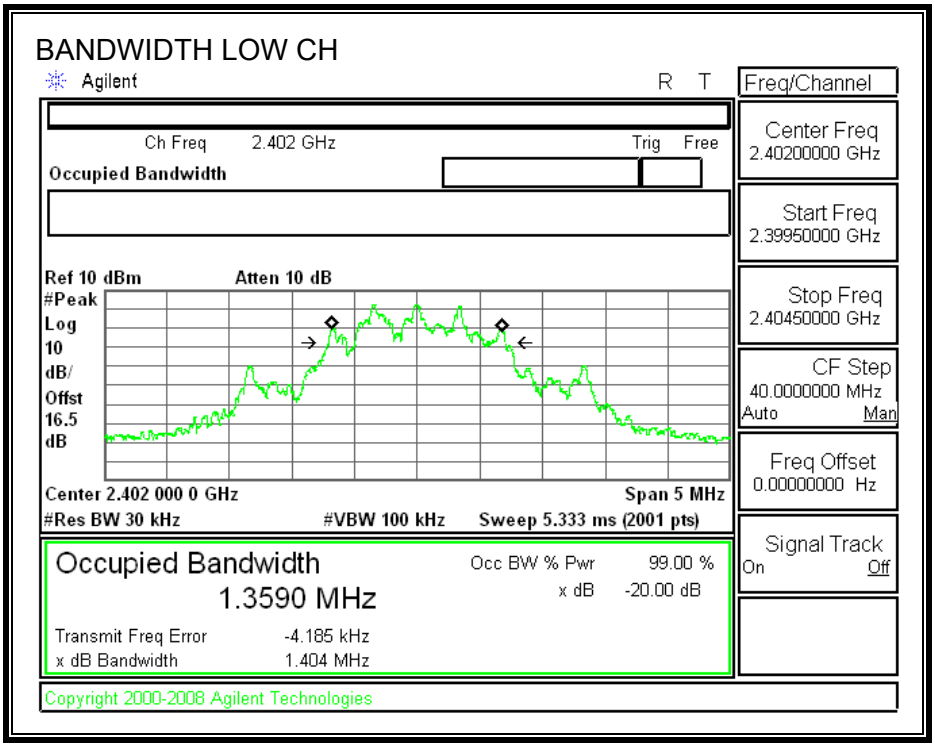
TEST PROCEDURE

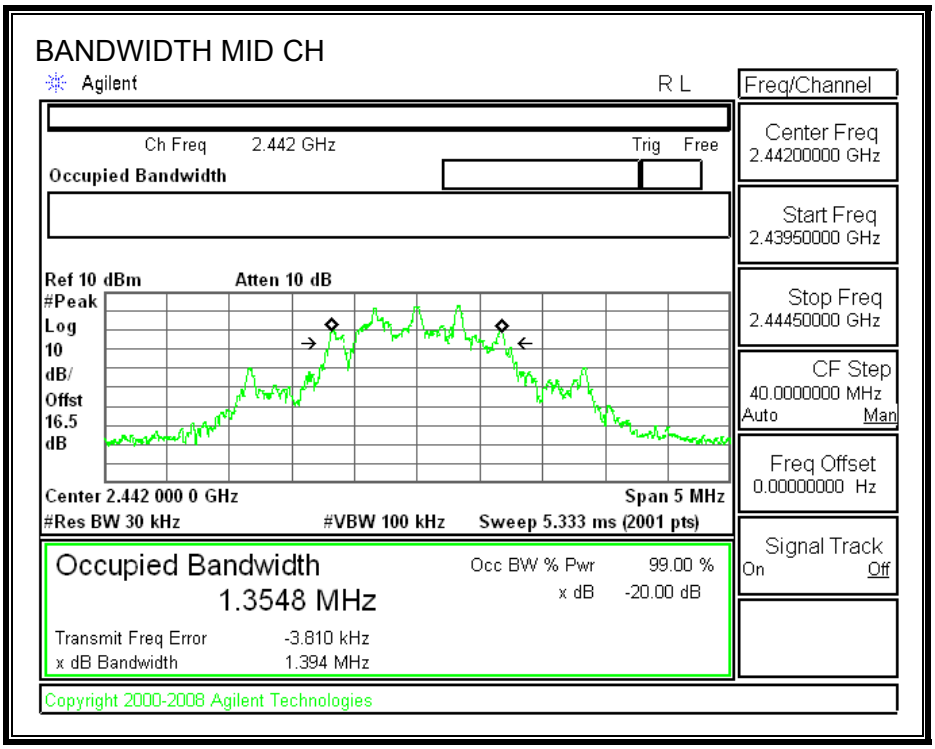
The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

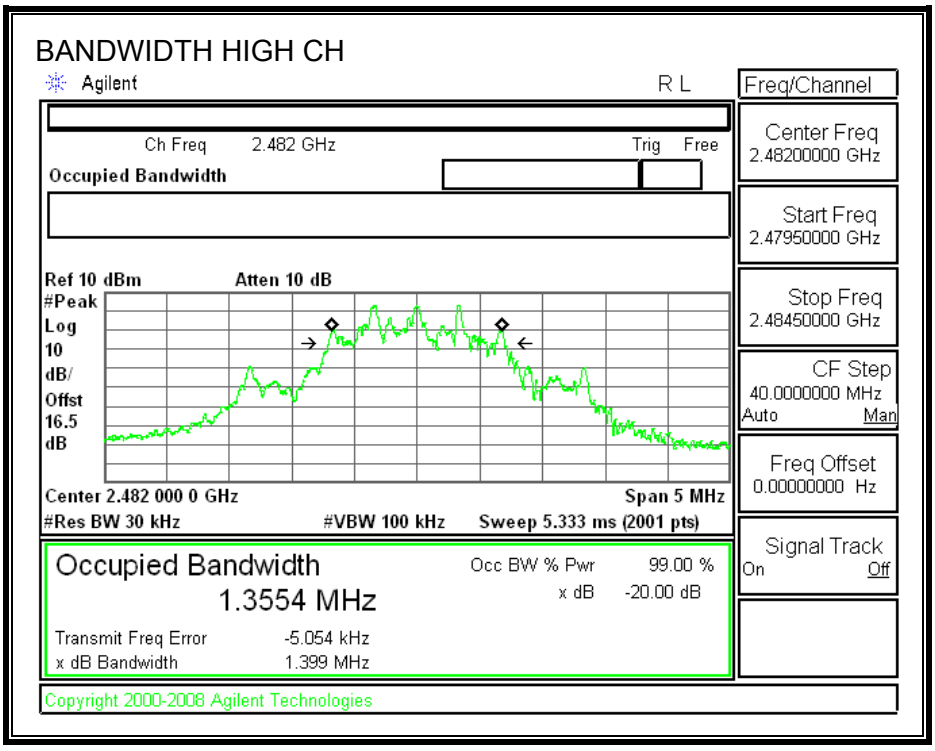
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.404	1.3397
Middle	2442	1.394	1.3621
High	2482	1.399	1.3591

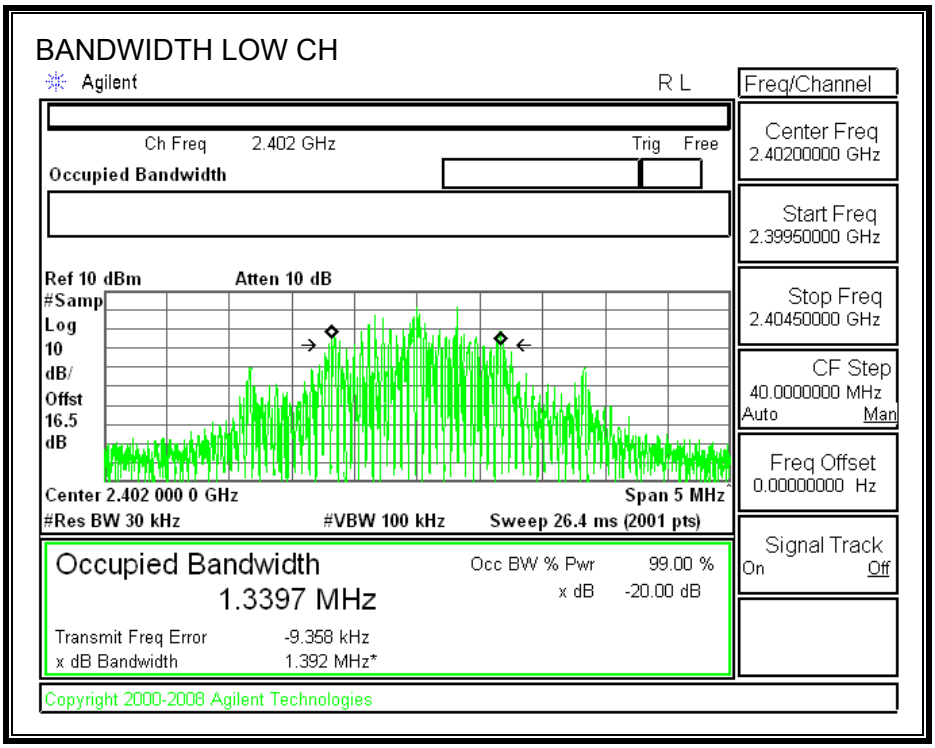
20 dB BANDWIDTH

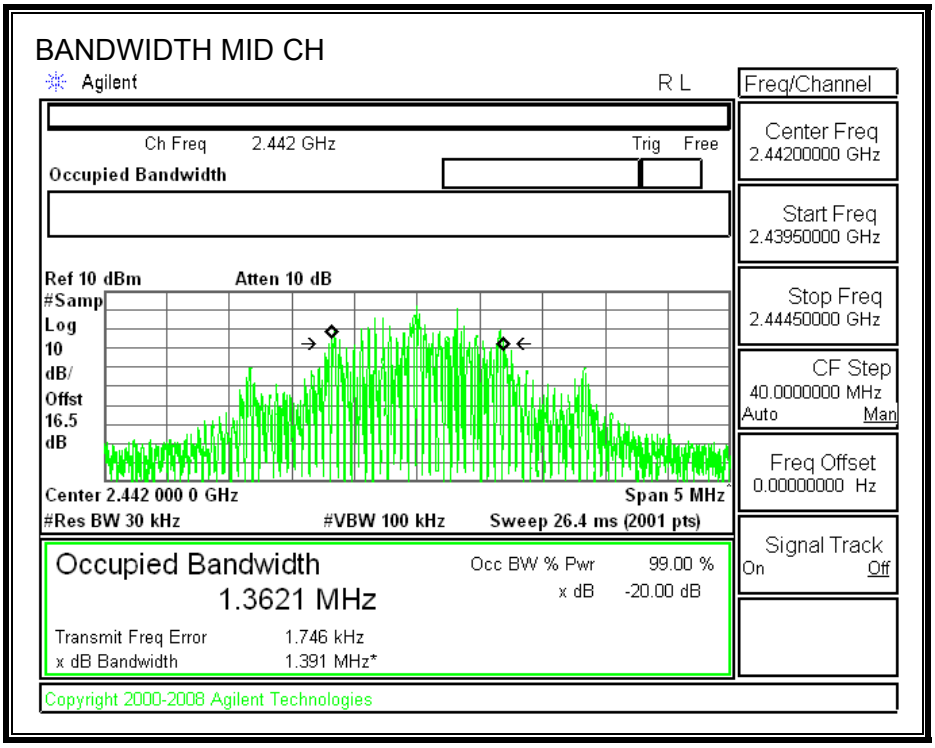


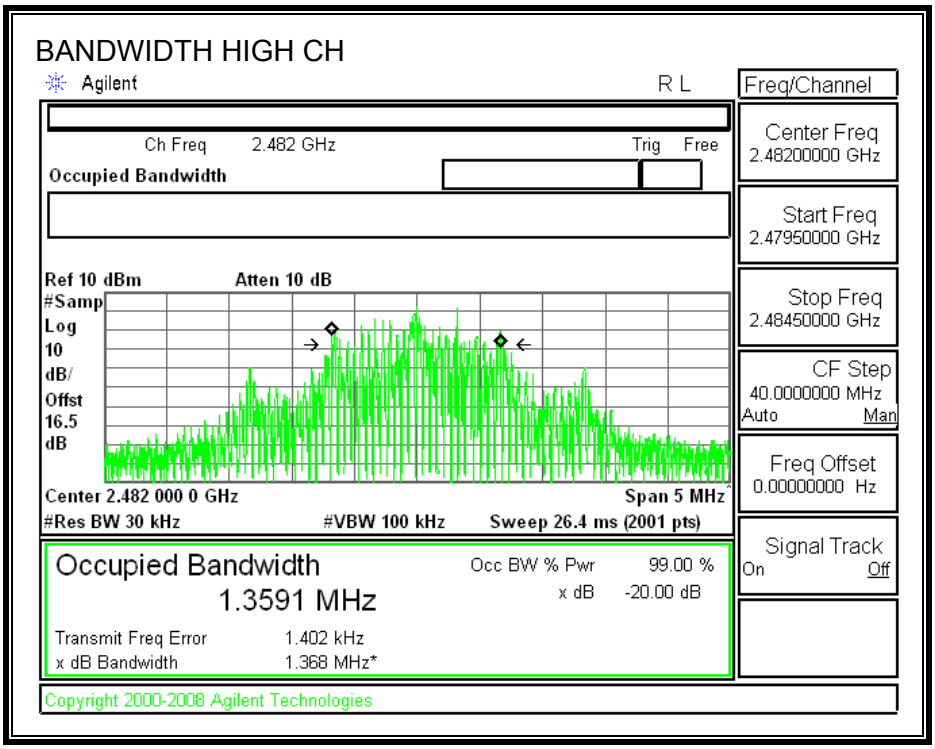




99% BANDWIDTH







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.

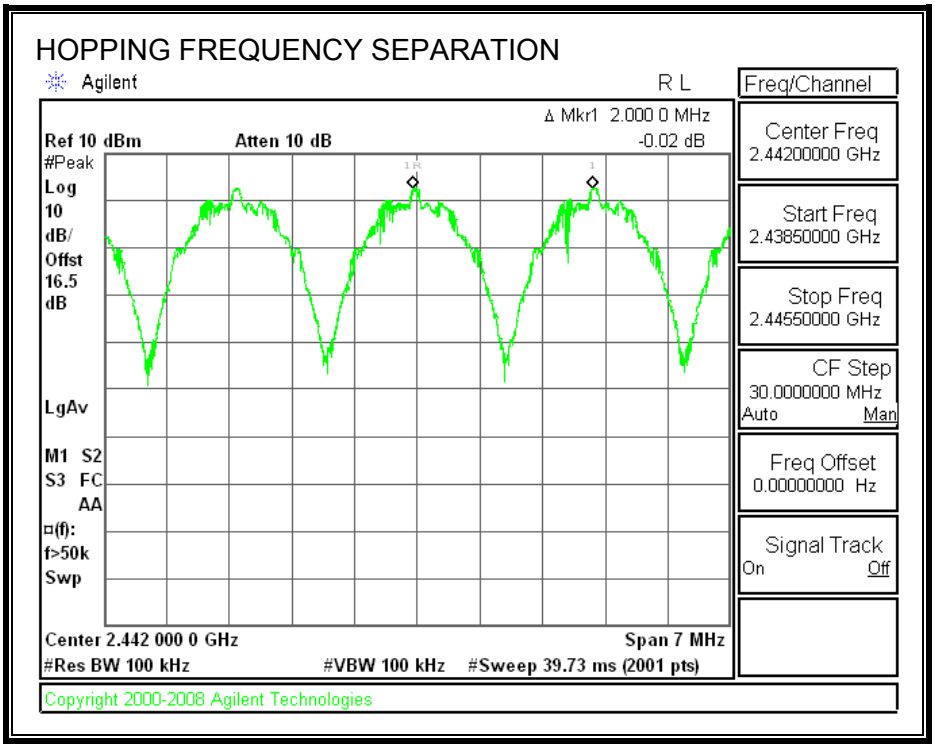
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

TEST PROCEDURE

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

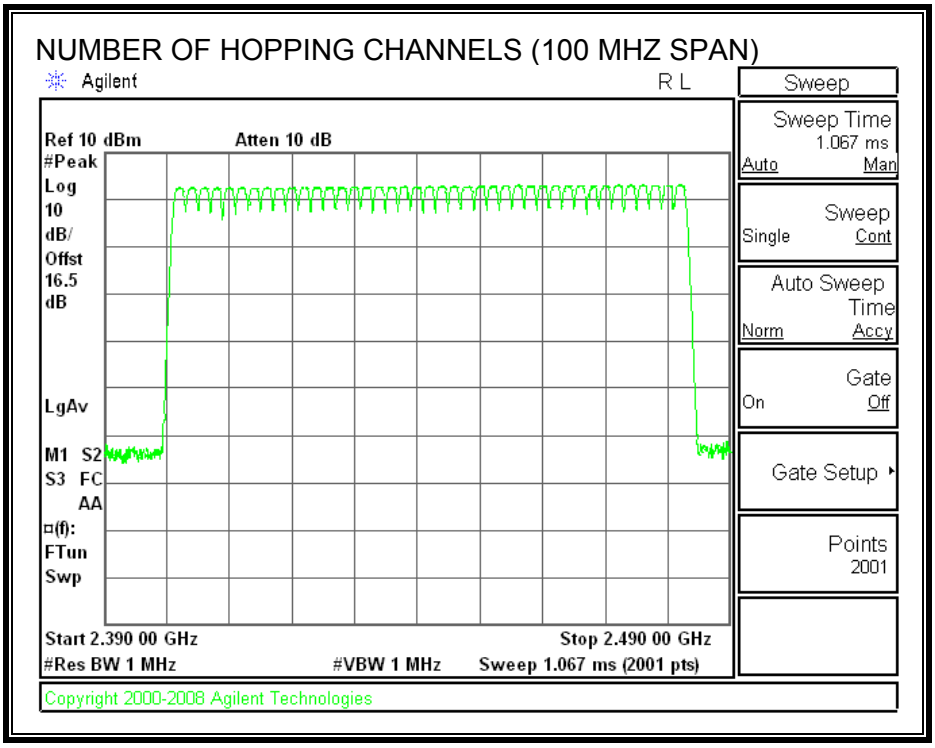
TEST PROCEDURE

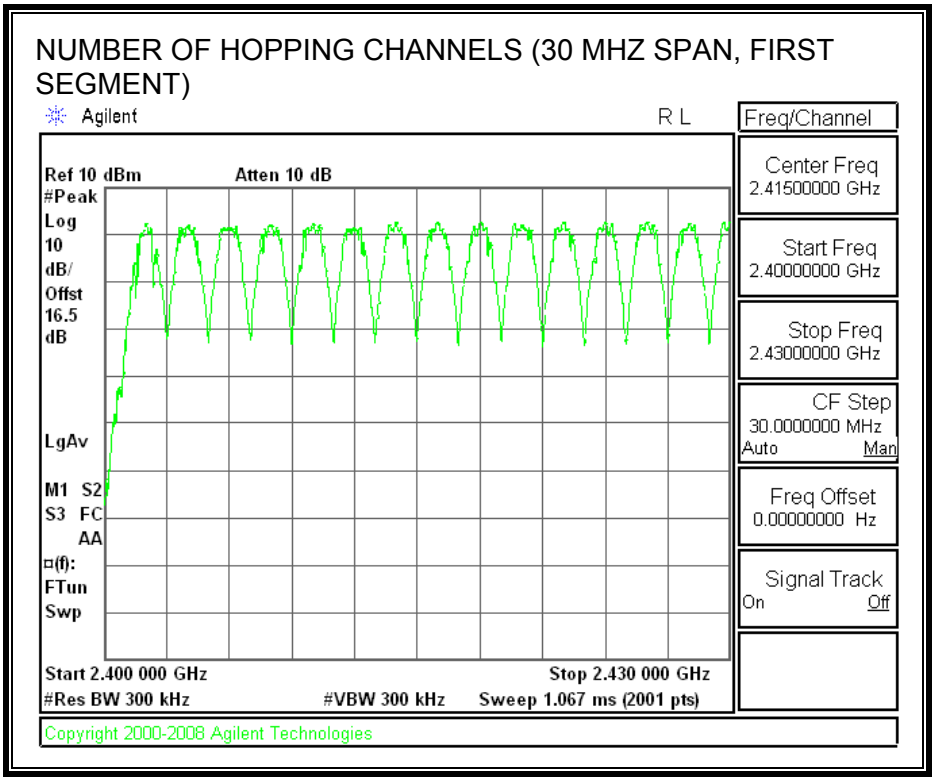
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

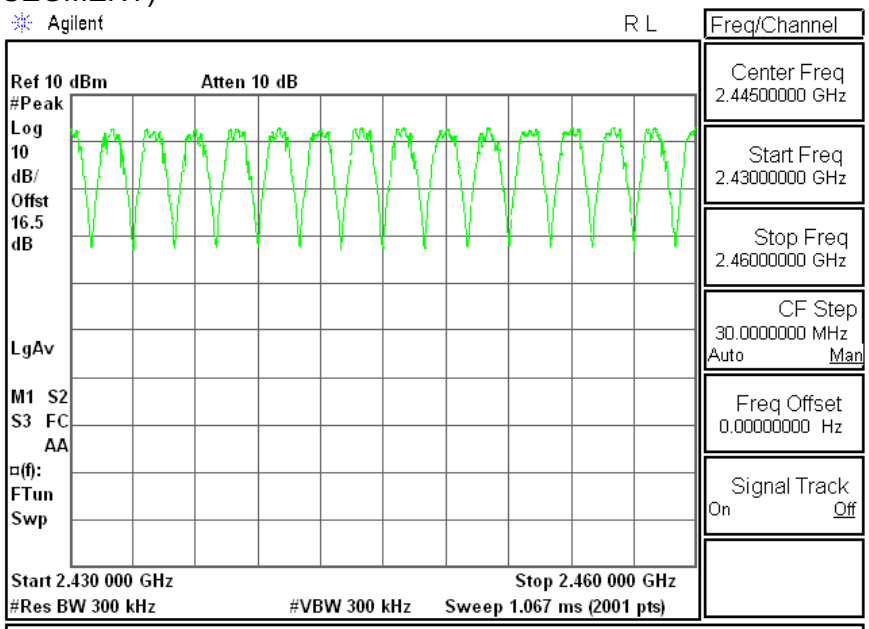
Total of number of hopping channel: 41.

NUMBER OF HOPPING CHANNELS

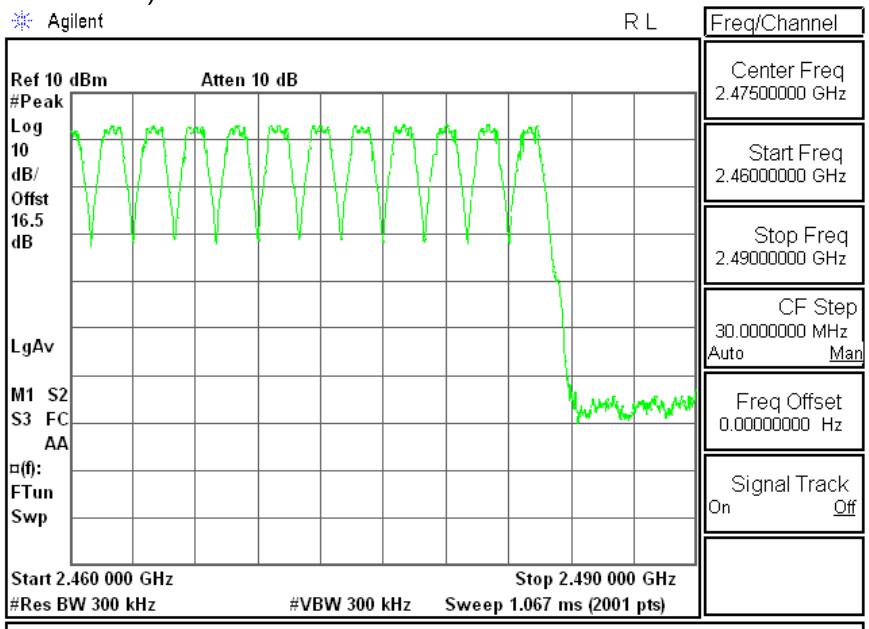




NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, SECOND SEGMENT)



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 1.64 second scan, to enable resolution of each occurrence.

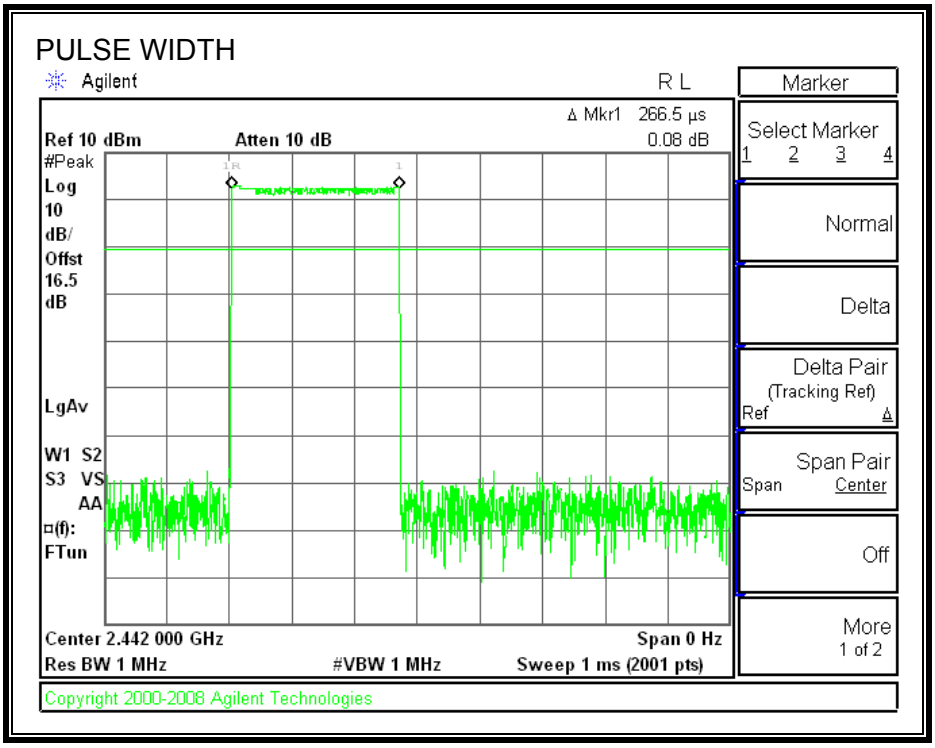
The average time of occupancy in the specified 16.4 second period (41 channels * 0.4 s) is equal to 10 * (# of pulses in 1.64 s) * pulse width.

RESULTS

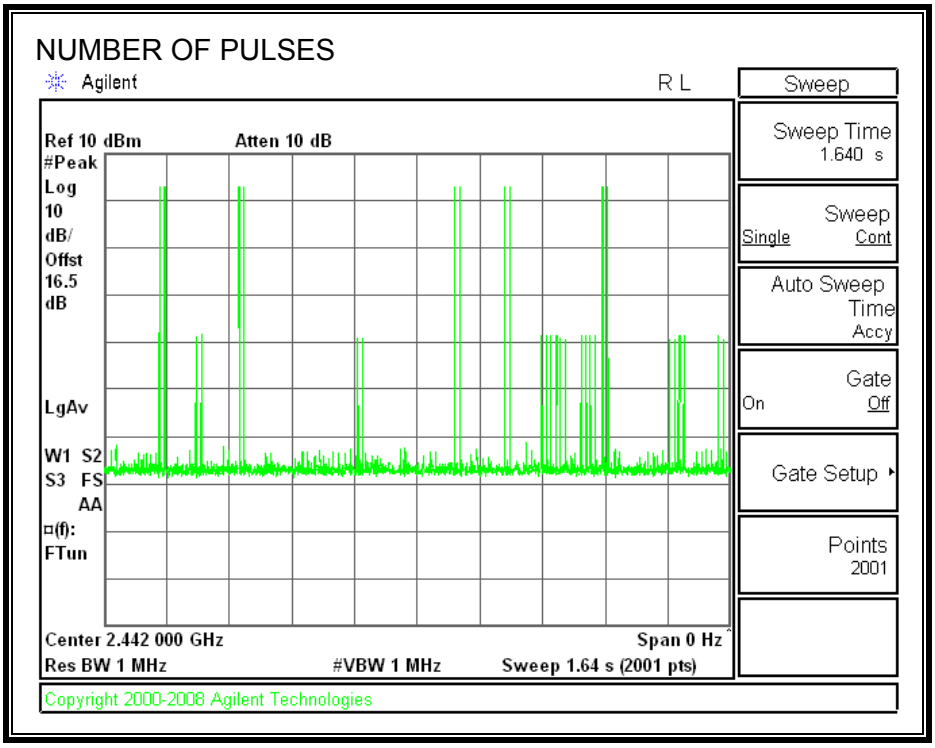
Time Of Occupancy = 10 * 10 pulses * 0.2665 msec = 26.65 msec

Pulse Width (msec)	Number of Pulses in 1.64 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
0.2665	10	0.02665	0.4	0.373

PULSE WIDTH



NUMBER OF PULSES IN 1.64 SECOND OBSERVATION PERIOD



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.

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 peak power meter.

RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	3.08	21	-17.89
Middle	2442	3.41	21	-17.56
High	2482	3.60	21	-17.37

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 16.5 dB (including 10 dB pad and 6.5 dB cable) was entered as an offset in the power meter to allow for direct reading of power.
Duty cycle factor = 14.69dB

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	-11.87
Middle	2442	-11.24
High	2482	-11.06

7.1.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

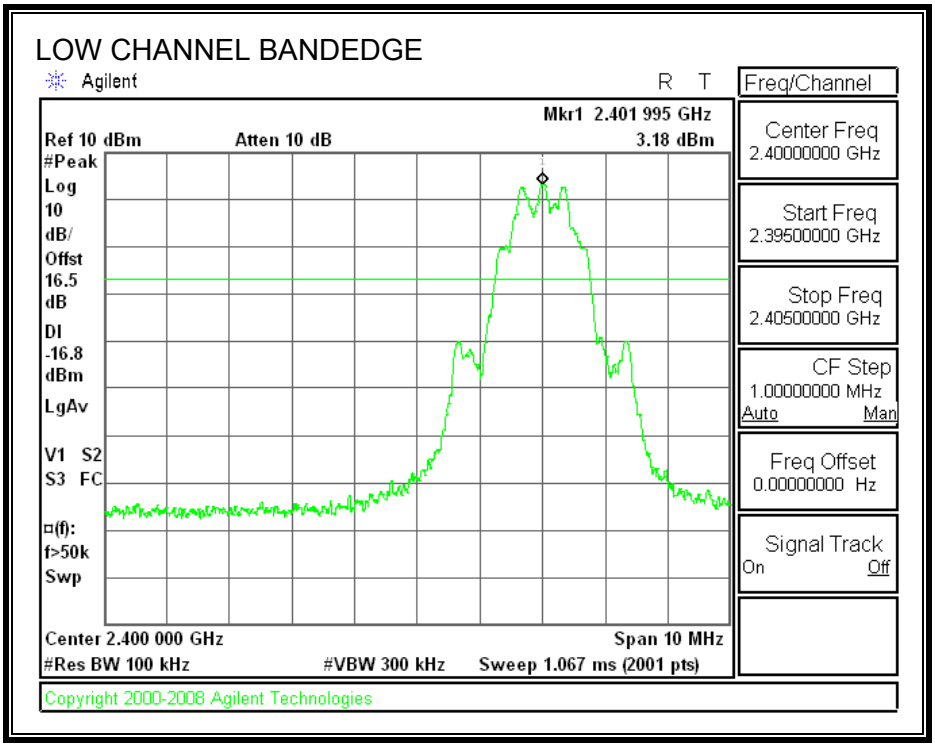
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

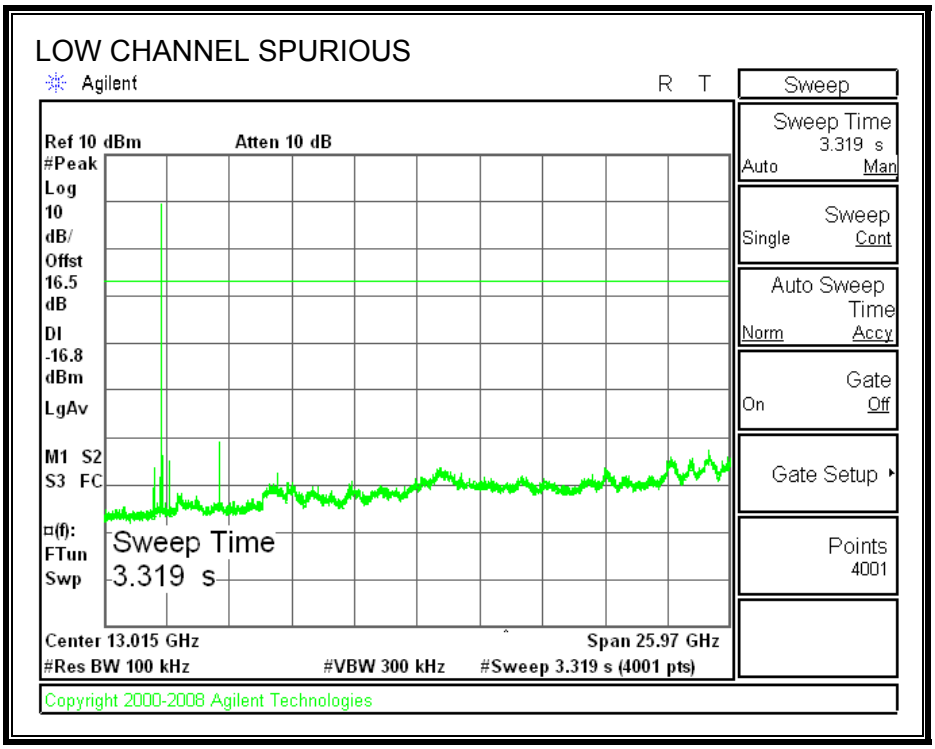
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

RESULTS

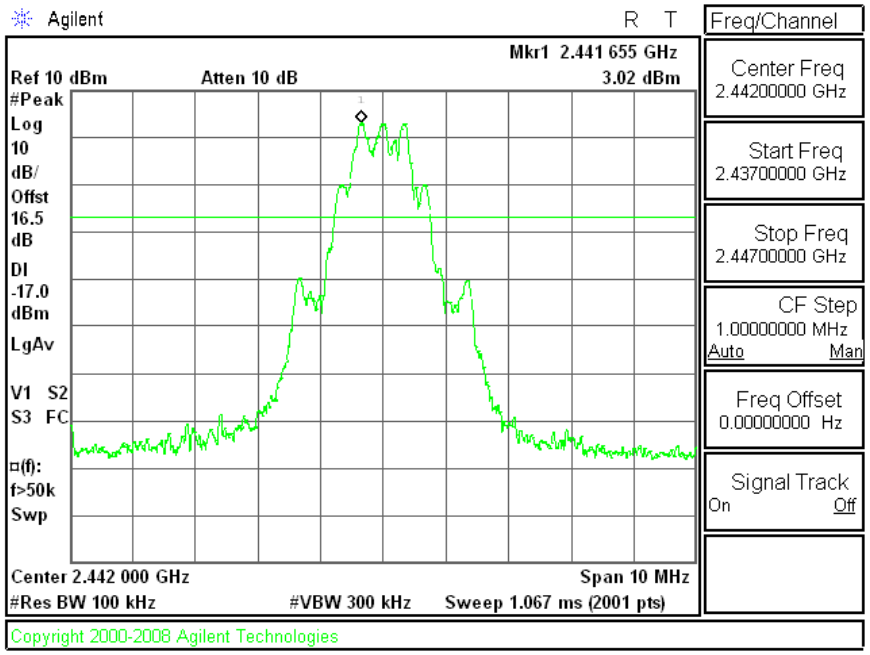
SPURIOUS EMISSIONS, LOW CHANNEL



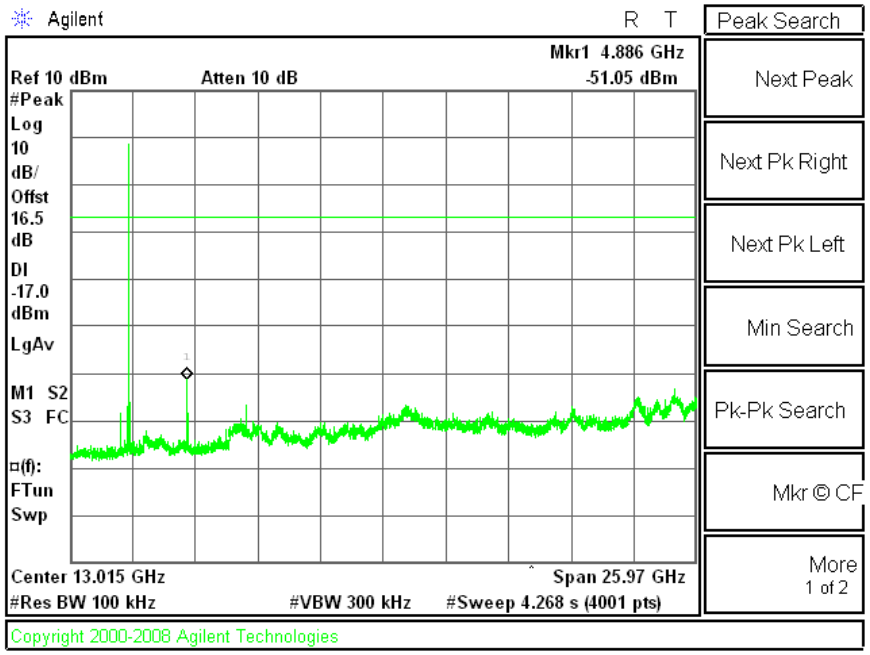


SPURIOUS EMISSIONS, MID CHANNEL

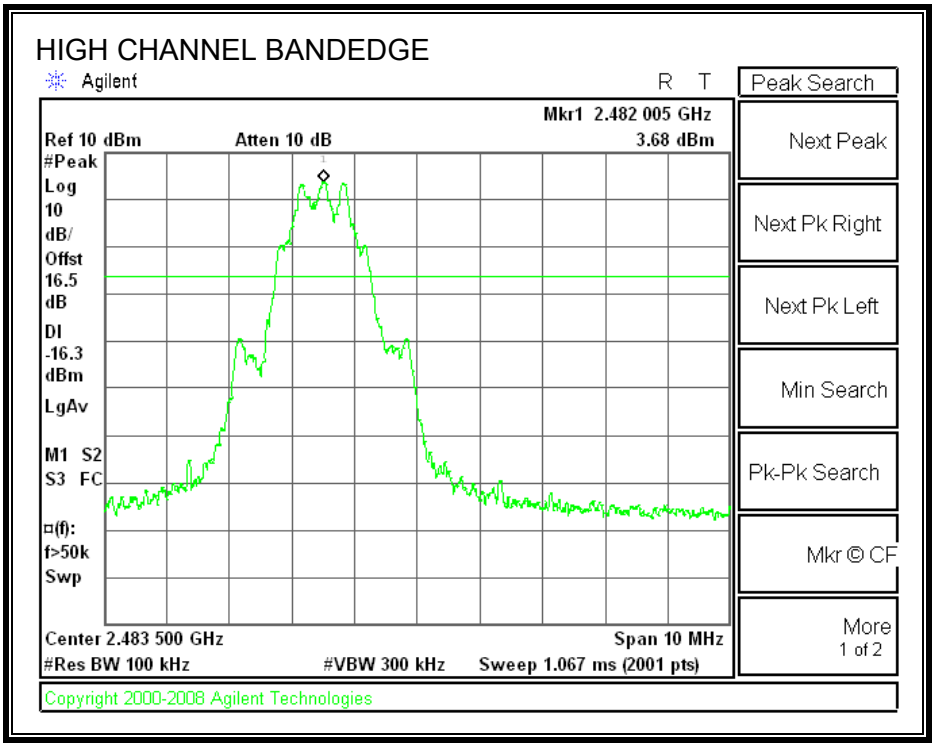
MID CHANNEL REFERENCE

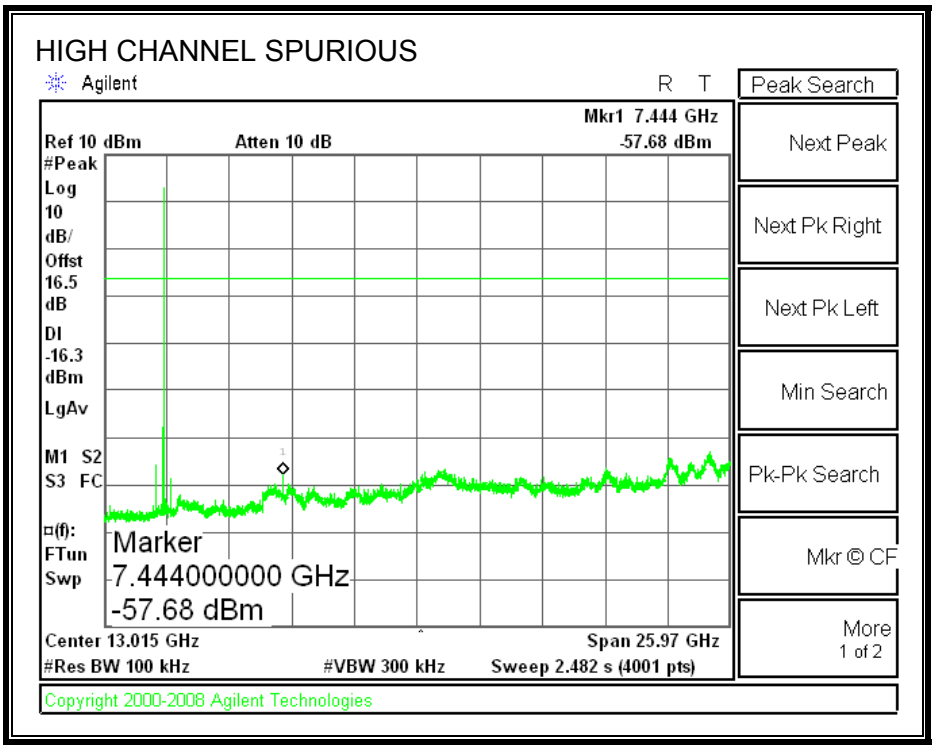


MID CHANNEL SPURIOUS



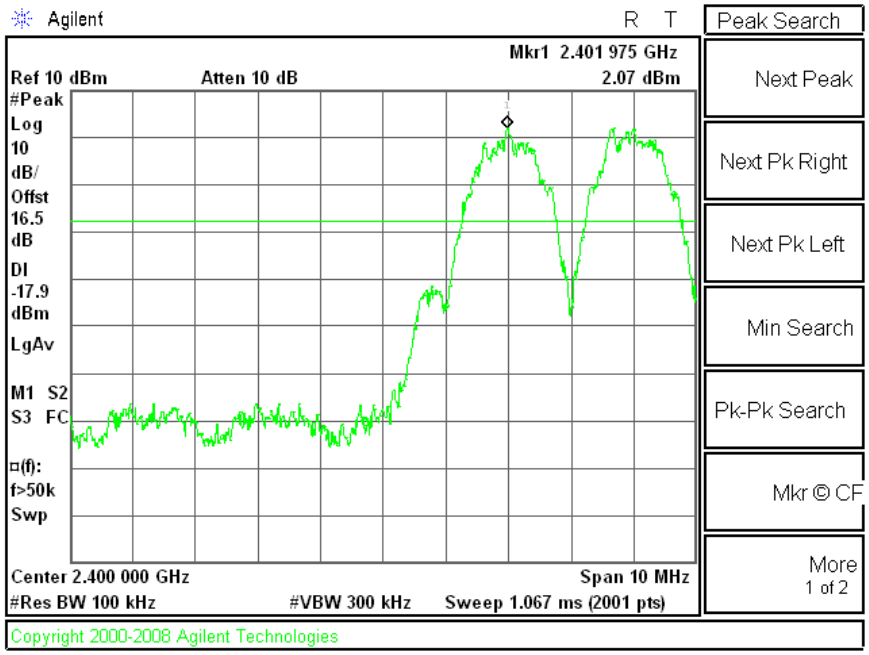
SPURIOUS EMISSIONS, HIGH CHANNEL



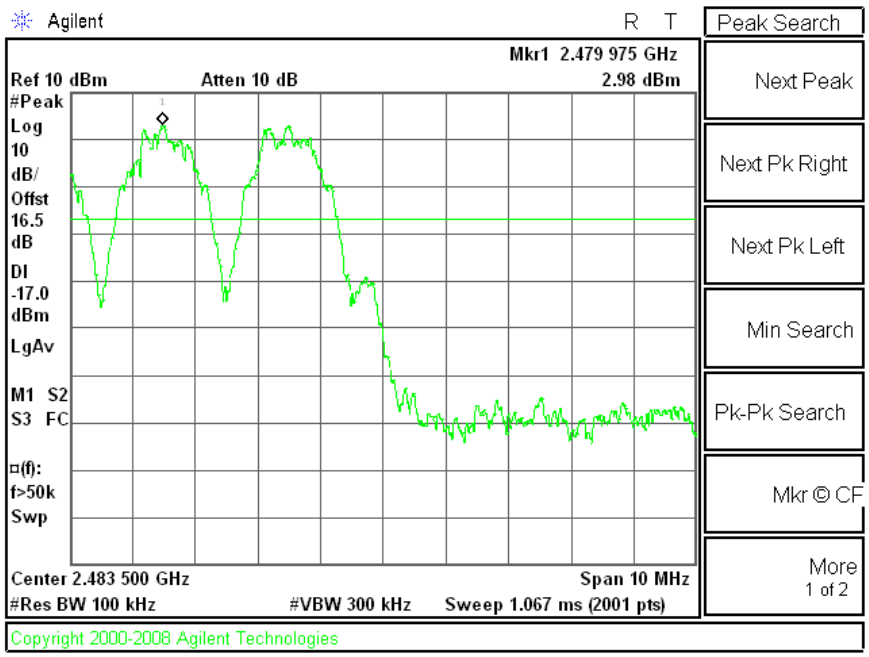


SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE 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.

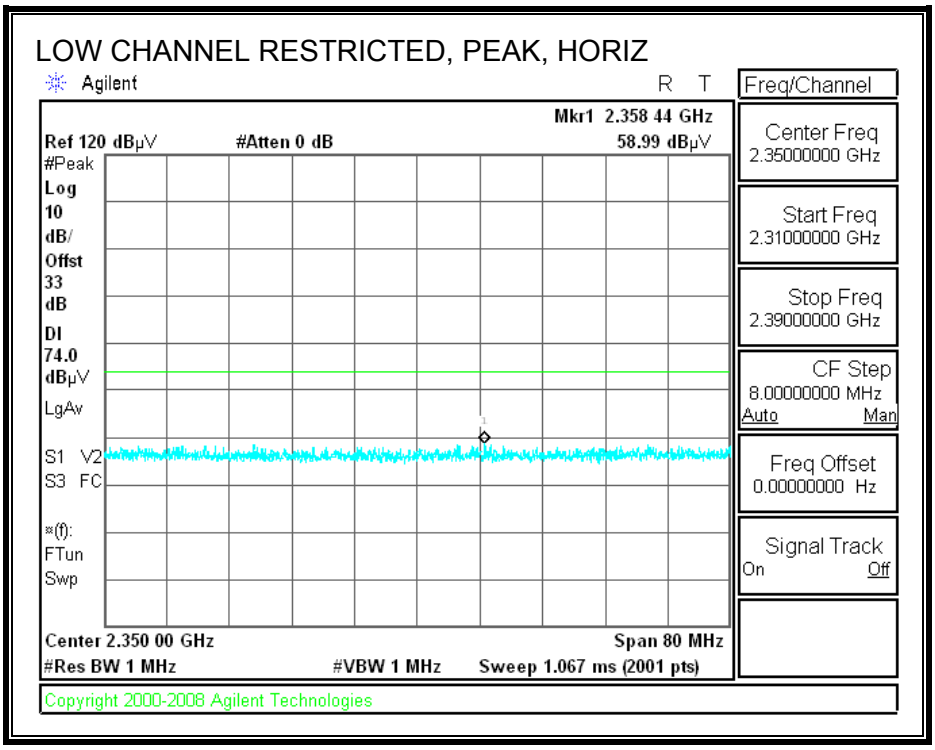
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

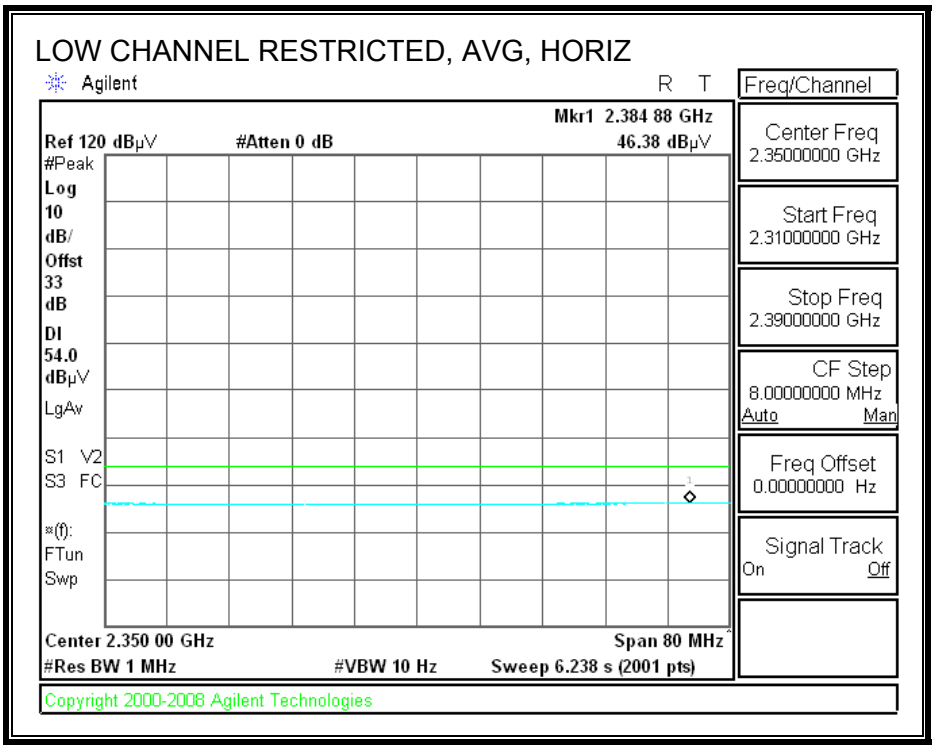
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

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.

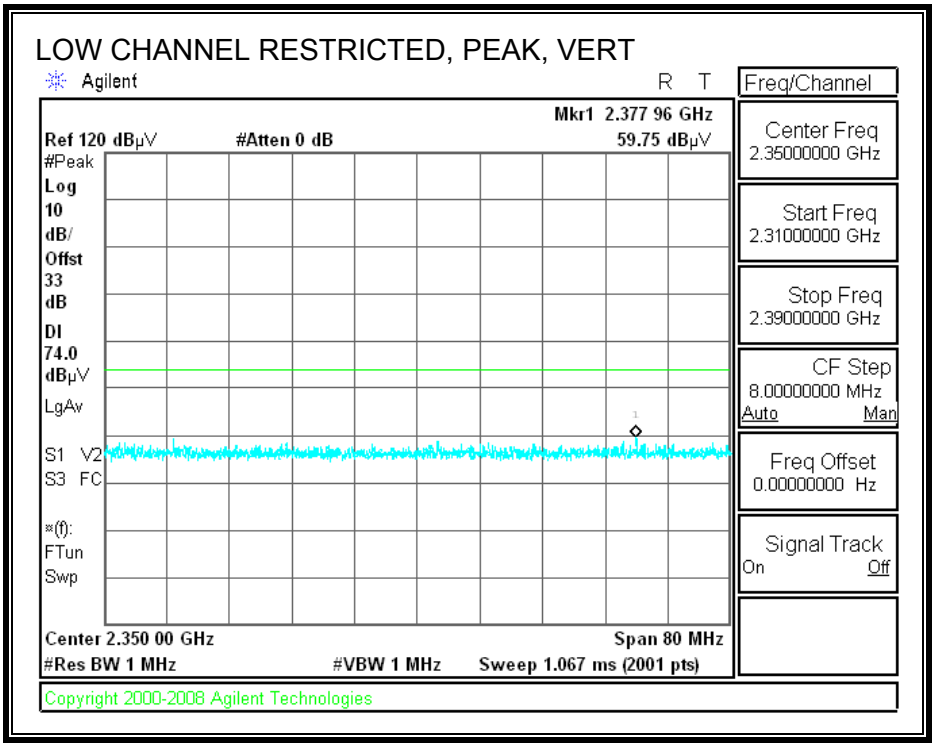
8.2. TRANSMITTER ABOVE 1 GHz

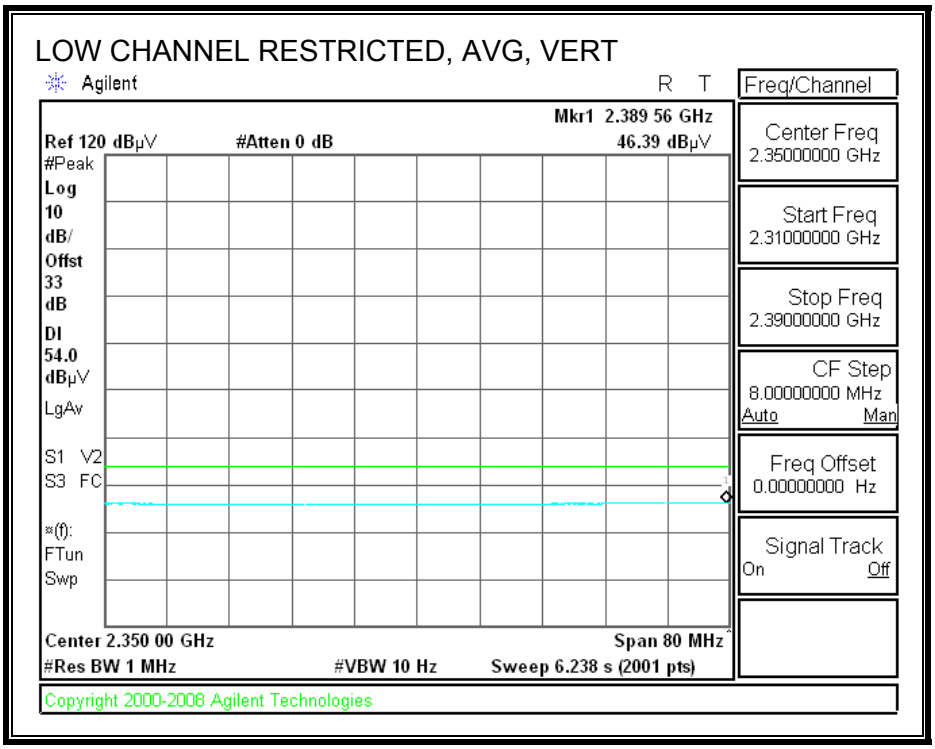
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



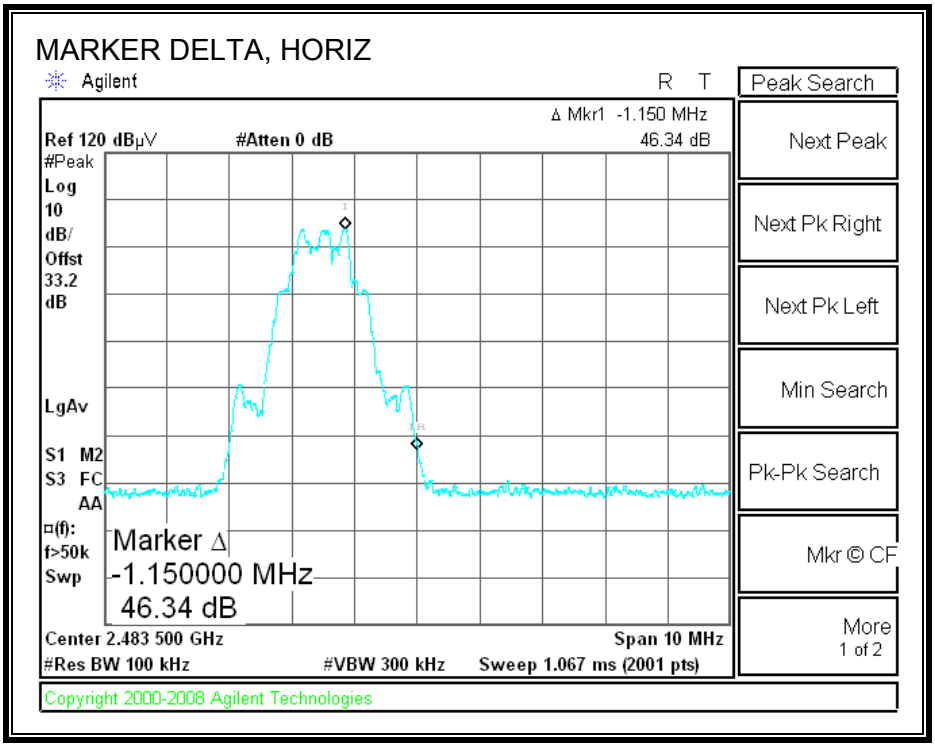


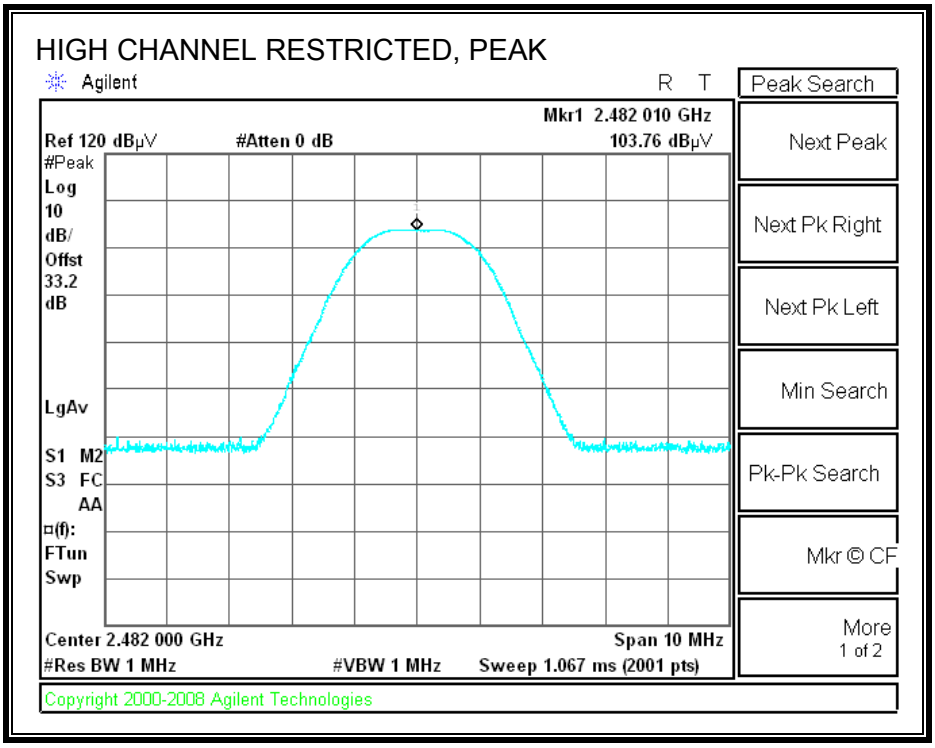
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



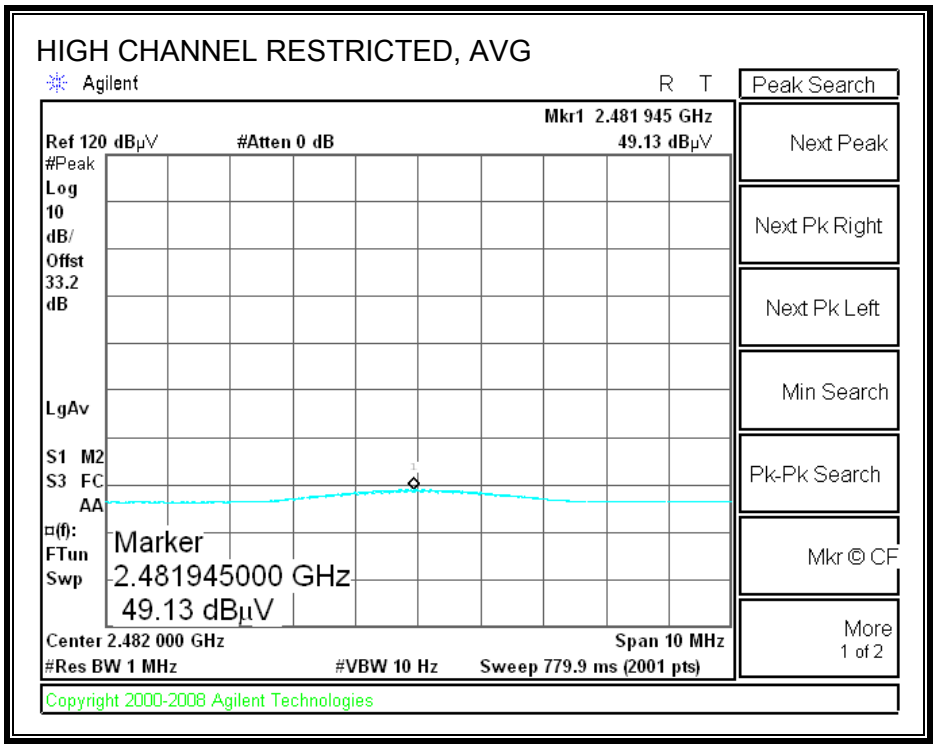


RESTRICTED BANDEDGE (HIGH CHANNEL, MARKER DELTA)

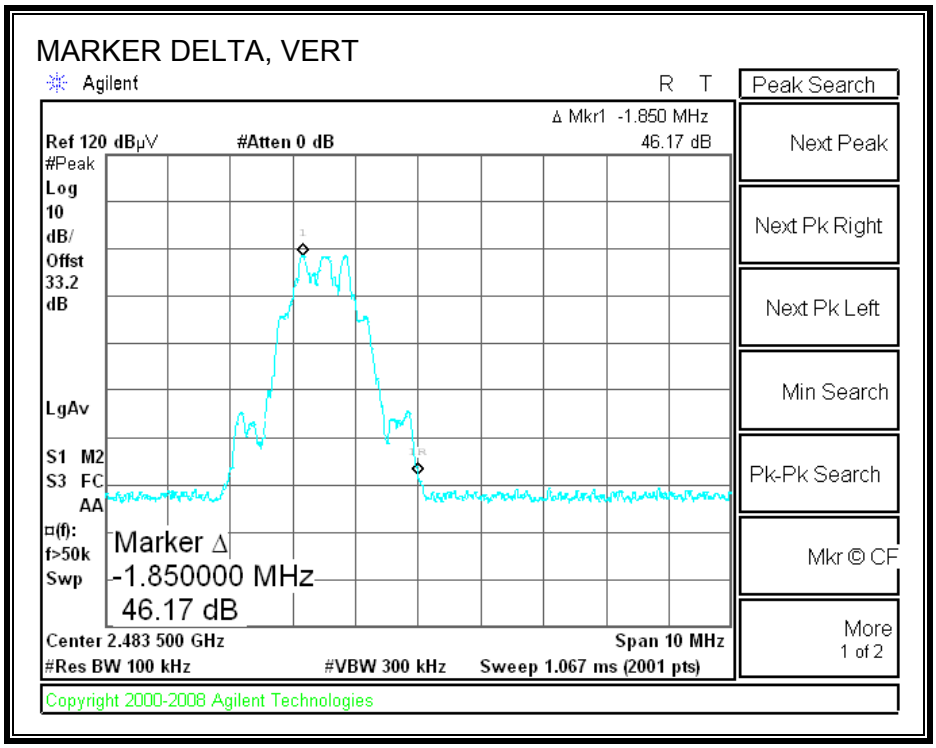


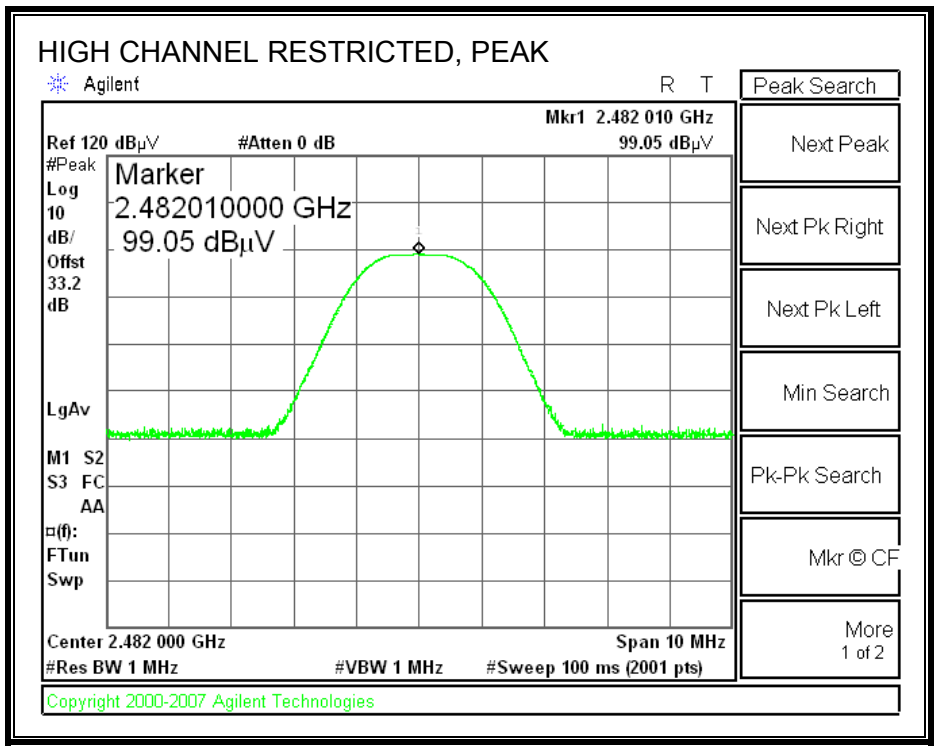


HIGH CHANNEL RESTRICTED, AVG

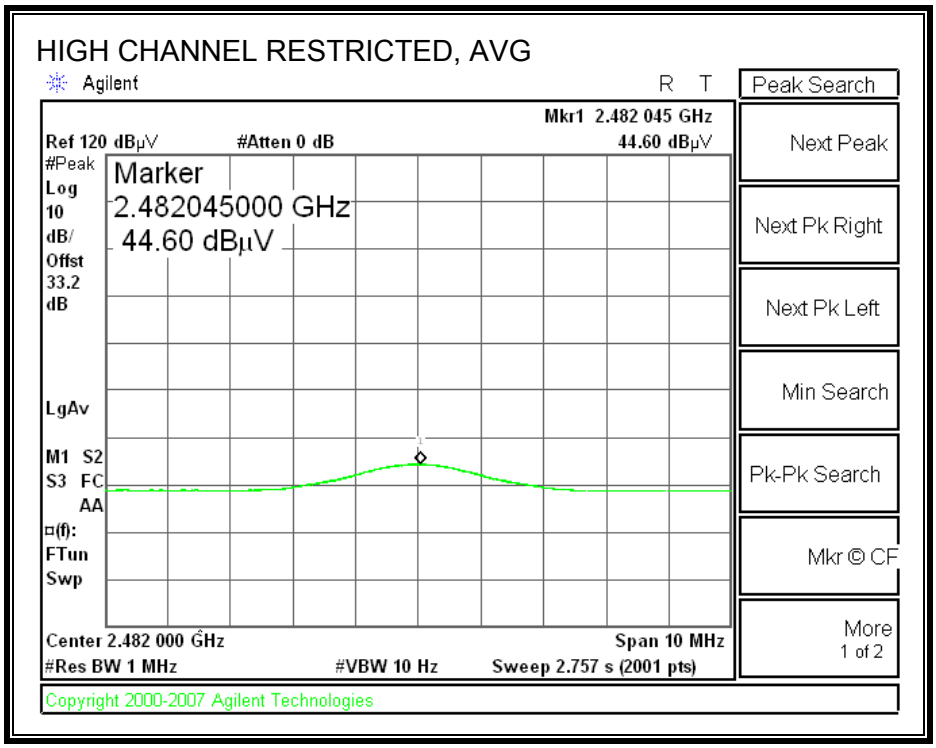


RESTRICTED BANDEDGE (HIGH CHANNEL, MARKER DELTA)





HIGH CHANNEL RESTRICTED, AVG



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Devin Chang
Date: 02/13/09
Project #: 09U12392
Company: Microsoft
EUT Description: XBox 360 Wireless Controller (Radon 4)
EUT M/N: 1403
Test Target: FCC Part 15C
Mode Oper: Tx mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Ant.High cm	Table Angle Degree	Notes
2402MHz															
4.804	3.0	49.8	33.7	5.8	-34.8	0.0	0.0	54.4	74.0	-19.6	H	P	127.3	354.9	
4.804	3.0	27.0	33.7	5.8	-34.8	0.0	0.0	31.7	54.0	-22.3	H	A	127.3	354.9	
4.804	3.0	46.3	33.7	5.8	-34.8	0.0	0.0	50.9	74.0	-23.1	V	P	113.0	340.0	
4.804	3.0	26.8	33.7	5.8	-34.8	0.0	0.0	31.4	54.0	-22.6	V	A	113.0	340.0	
2442MHz															
4.884	3.0	48.3	33.7	5.8	-34.9	0.0	0.0	53.1	74.0	-20.9	H	P	134.7	28.8	
4.884	3.0	26.6	33.7	5.8	-34.9	0.0	0.0	31.3	54.0	-22.7	H	A	134.7	28.8	
7.326	3.0	49.7	36.7	7.3	-34.7	0.0	0.0	59.1	74.0	-14.9	H	P	117.7	69.5	
7.326	3.0	25.2	36.7	7.3	-34.7	0.0	0.0	34.5	54.0	-19.5	H	A	117.7	69.5	
4.884	3.0	50.5	33.7	5.8	-34.9	0.0	0.0	55.3	74.0	-18.7	V	P	102.2	0.1	
4.884	3.0	26.8	33.7	5.8	-34.9	0.0	0.0	31.6	54.0	-22.4	V	A	102.2	0.1	
7.326	3.0	50.0	36.7	7.3	-34.7	0.0	0.0	59.4	74.0	-14.6	V	P	100.0	90.8	
7.326	3.0	25.3	36.7	7.3	-34.7	0.0	0.0	34.7	54.0	-19.3	V	A	100.0	90.8	
2482MHz															
4.964	3.0	52.0	33.8	5.9	-34.9	0.0	0.0	56.9	74.0	-17.1	H	P	146.4	287.0	
4.964	3.0	26.7	33.8	5.9	-34.9	0.0	0.0	31.5	54.0	-22.5	H	A	146.4	287.0	
7.446	3.0	45.8	36.8	7.3	-34.6	0.0	0.0	55.3	74.0	-18.7	H	P	112.2	208.3	
7.446	3.0	26.0	36.8	7.3	-34.6	0.0	0.0	35.5	54.0	-18.5	H	A	112.2	208.3	
4.964	3.0	53.4	33.8	5.9	-34.9	0.0	0.0	58.2	74.0	-15.8	V	P	100.6	357.3	
4.964	3.0	26.6	33.8	5.9	-34.9	0.0	0.0	31.5	54.0	-22.5	V	A	100.6	357.3	
7.446	3.0	46.3	36.8	7.3	-34.6	0.0	0.0	55.8	74.0	-18.2	V	P	110.4	90.6	
7.446	3.0	26.0	36.8	7.3	-34.6	0.0	0.0	35.5	54.0	-18.5	V	A	110.4	90.6	

Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

8.3. RECEIVER ABOVE 1 GHz

Note: No other emissions were detected above the system noise floor.

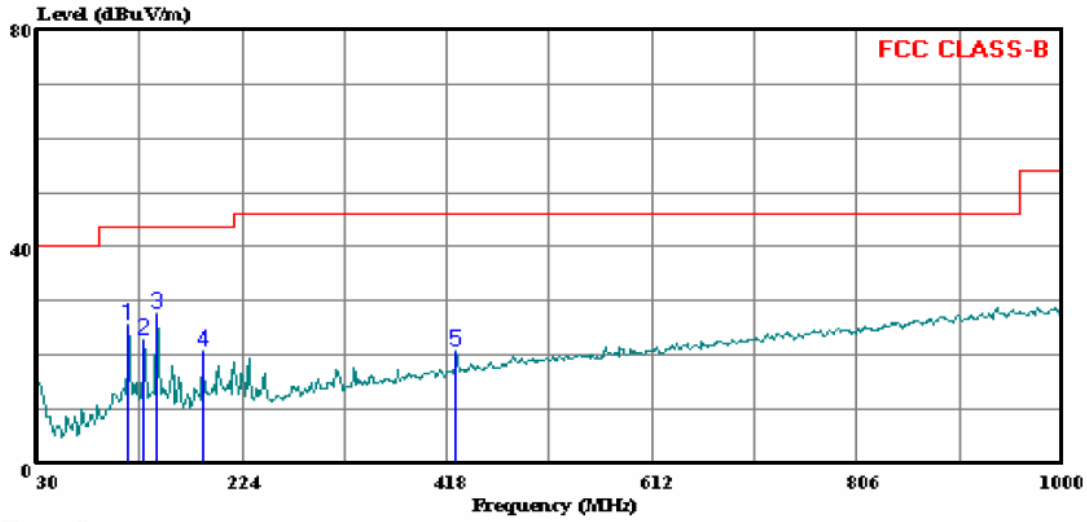
8.4. WORST-CASE BELOW 1 GHz

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

HORIZONTAL PLOT

Compliance Certification Services
47173 Benicia Street
Fremont, CA 94538
Tel: (510) 771-1000
Fax: (510) 661-0888

Data#: 25 File#: 09U12392.EMI Date: 02-13-2009 Time: 13:42:15



Trace: 24 Ref Trace:

Condition: FCC CLASS-B 3m HORIZONTAL
Test Operator:: Devin Chang
Project #: : 09U12392
Company: : Microsoft
Model: :
Configuration:: EUT only
Mode : : Normal
Target: : FCC Class B

Page: 1

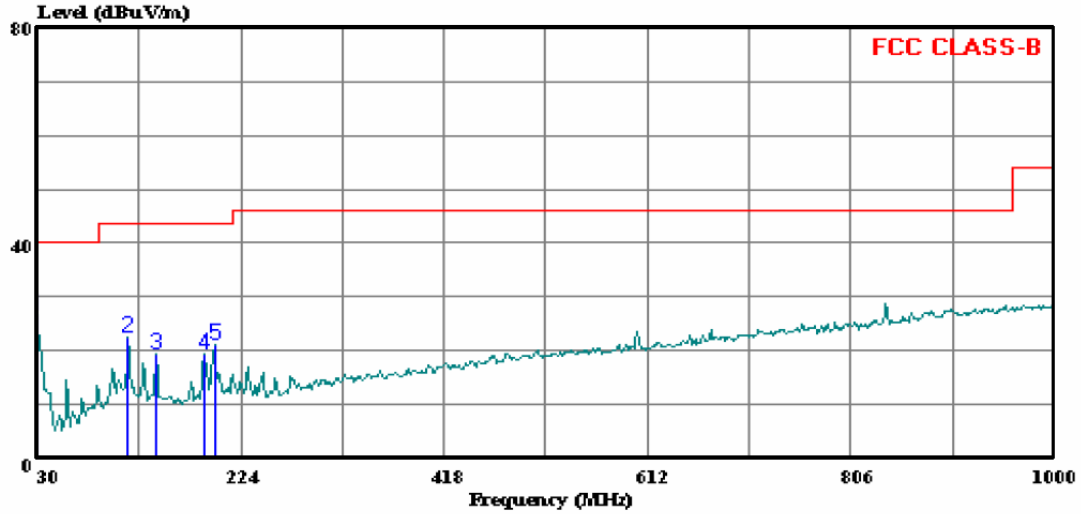
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	116.330	43.46	-17.68	25.78	43.50	-17.72	Peak
2	130.880	40.57	-17.67	22.90	43.50	-20.60	Peak
3	143.490	45.79	-18.04	27.75	43.50	-15.75	Peak
4	187.140	38.28	-17.59	20.69	43.50	-22.81	Peak
5	426.730	32.57	-11.90	20.67	46.00	-25.33	Peak

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

VERTICAL PLOT

Compliance Certification Services
47173 Benicia Street
Fremont, CA 94538
Tel: (510) 771-1000
Fax: (510) 661-0888

Data#: 23 File#: 09U12392.EMI Date: 02-13-2009 Time: 13:32:07



(Fremont)

Trace: 22 Ref Trace:

Condition: FCC CLASS-B 3m VERTICAL
Test Operator:: Devin Chang
Project #: : 09U12392
Company: : Microsoft
Model: :
Configuration:: EUT only
Mode : : Normal
Target: : FCC Class B

Page: 1

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	30.000	38.25	-11.75	26.50	40.00	-13.50	Peak
2	116.330	40.23	-17.68	22.55	43.50	-20.95	Peak
3	143.490	37.52	-18.04	19.48	43.50	-24.02	Peak
4	189.080	36.75	-17.28	19.47	43.50	-24.03	Peak
5	198.780	38.40	-17.29	21.11	43.50	-22.39	Peak

9. 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).

CALCULATIONS

Given

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

and

$S = E ^ 2 / 3770$

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, rearranging the terms to express the distance as a function of the remaining variables, changing to units of Power to mW and Distance to cm, and substituting the logarithmic form of power and gain yields:

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

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

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

The power density in units of mW/cm^2 is converted to units of W/m^2 by multiplying by a factor of 10.

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

Mode	Band	MPE Distance (cm)	Output Power (dBm)	Antenna Gain (dBi)	FCC Power Density (mW/cm^2)	IC Power Density (W/m^2)
FHSS	2.4 GHz	20.0	3.60	-0.20	0.0004	0.0043