FCC CFR47 PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 8

CERTIFICATION TEST REPORT

FOR

2.4 GHZ SHORT RANGE RF MODULE

MODEL NUMBER: 1575

FCC ID: C3K1575
IC: 3048A-1575

REPORT NUMBER: 12U14758-1, Revision C

ISSUE DATE: JUNE 10, 2013

Prepared for
MICROSOFT CORPORATION
ONE MICROSOFT WAY
REDMOND, WA 98052, U.S.A.

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

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	01/29/13	Initial Issue	T.LEE
A	06/05/13	Updated Correction Factors, Average Calculations, Antenna Gain, dwell time, peak power limit, MPE calculation and Photos	T. LEE
B	06/07/13	Corrected Dwell time information. Clarified worst case configuration.	T. LEE
C	06/10/13	Added original MPE in RF Exposure Results	AAumentado

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Microsoft Corporation
One Microsoft Way
Redmond, WA 98052 U.S.A.

EUT DESCRIPTION: 2.4 GHZ SHORT RANGE RF MODULES

MODEL: 1575

SERIAL NUMBER: 3566372810437230 (Conducted) & 3566372810388230 (Radiated)

DATE TESTED: January 15 – January 29, 2013

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

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

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

Approved & Released For UL CCS By:

TIMOTHY K. LEE
WiSE PROGRAM MANAGER
UL CCS

Tested By:

DANNY VU
EMC TECHNICIAN
UL CCS

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2009, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 3, and RSS-210 Issue 8.

3. FACILITIES AND ACCREDITATION

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

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

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

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

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

4.3. MEASUREMENT UNCERTAINTY

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

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

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a 2.4 GHz Short Range RF frequency hopping transceiver Module.

The radio module is manufactured by Microsoft.

5.2. MAXIMUM OUTPUT POWER

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

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2482	FHSS	4.35	2.72

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a Patch antenna, with a maximum gain of 4.8 dBi.

5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was Wireless Device Test Ver. 1.1.2.

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emission and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

The EUT is a desktop device. All radiated tests were conducted based on the normal or natural orientation of the EUT.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop	Toshiba	Tecra 8200	81212625PU	N/A
AC adapter	NEC	ADP57	9701608DE	N/A
Interface Cable and PCB	Boron	MCSO1557	0166-001919	N/A

I/O CABLES

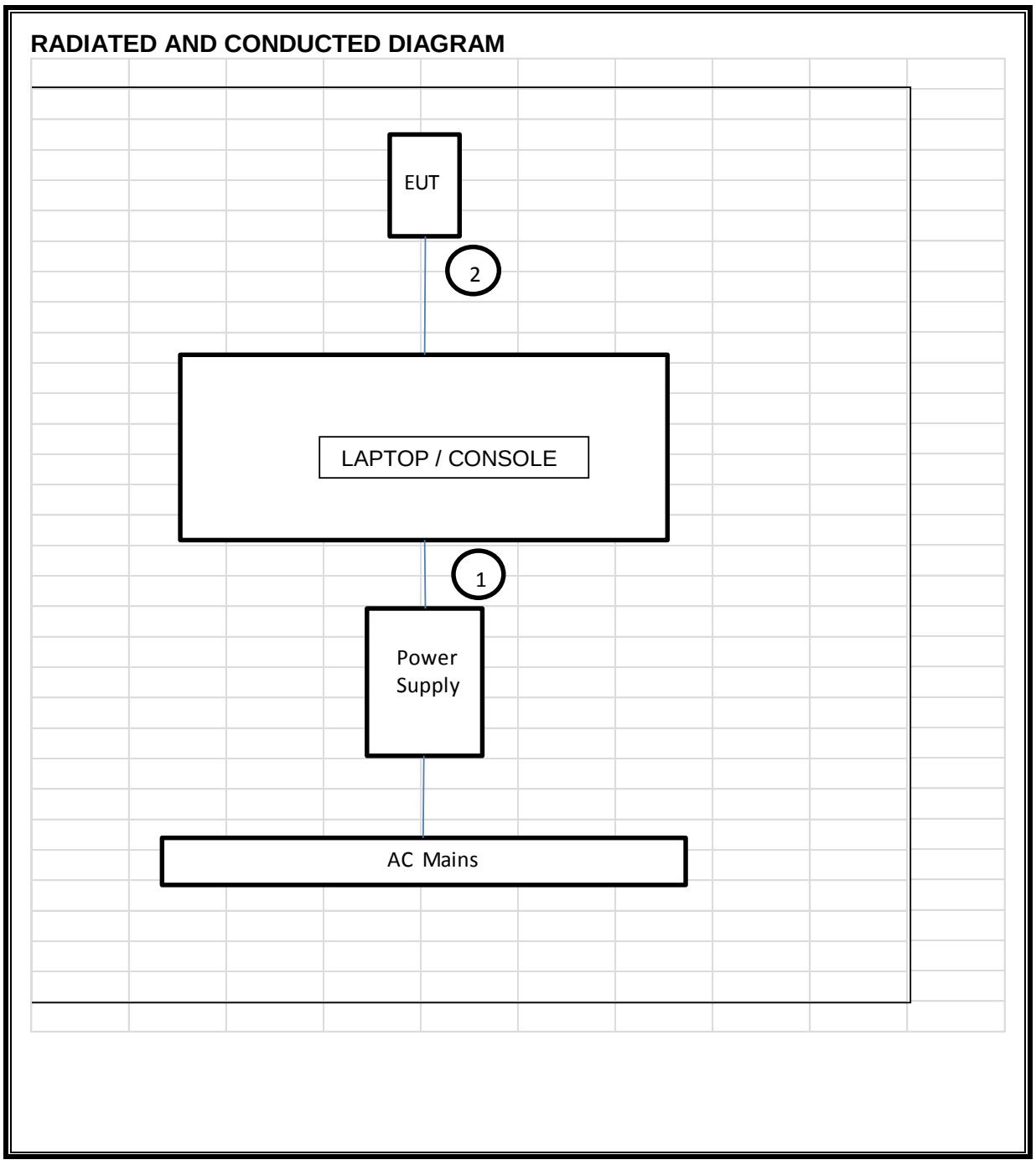
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	US 115V	Un-shielded	0.9 m	none
2	USB	1	USB	Un-shielded	0.9 m	none

Note: Cable # 2 was not used for radiated measurement since EUT was embedded in console.

TEST SETUP

The EUT is connected to a USB interface cable to the laptop computer during the tests. 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**	**Asset**	**Cal Date**	**Cal Due**
Antenna, Horn, 18 GHz	EMCO	3115	C00872	09/20/12	09/20/13
Antenna, Horn, 26.5 GHz	ARA	SWH-28	C01015	04/23/12	04/23/13
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01012	10/21/12	10/21/13
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C00749	10/21/12	10/21/13
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00558	02/21/12	02/21/13
Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRC13192	N02683	CNR	CNR
Bilog 30-2000MHz	Sunol	JB1		02/07/12	02/07/13
Power meter	HP	437B	T226	06/25/12	06/25/13
Power Sensor	HP	8481A	T233	06/26/12	06/26/13
LISN, 30 MHz	FCC	LISN-50/250-25-2	N02625	01/14/13	01/14/14
LISN, 10 kHz ~ 30 MHz	Solar	8012-50-R-24-BNC	N02481	03/07/12	03/07/13

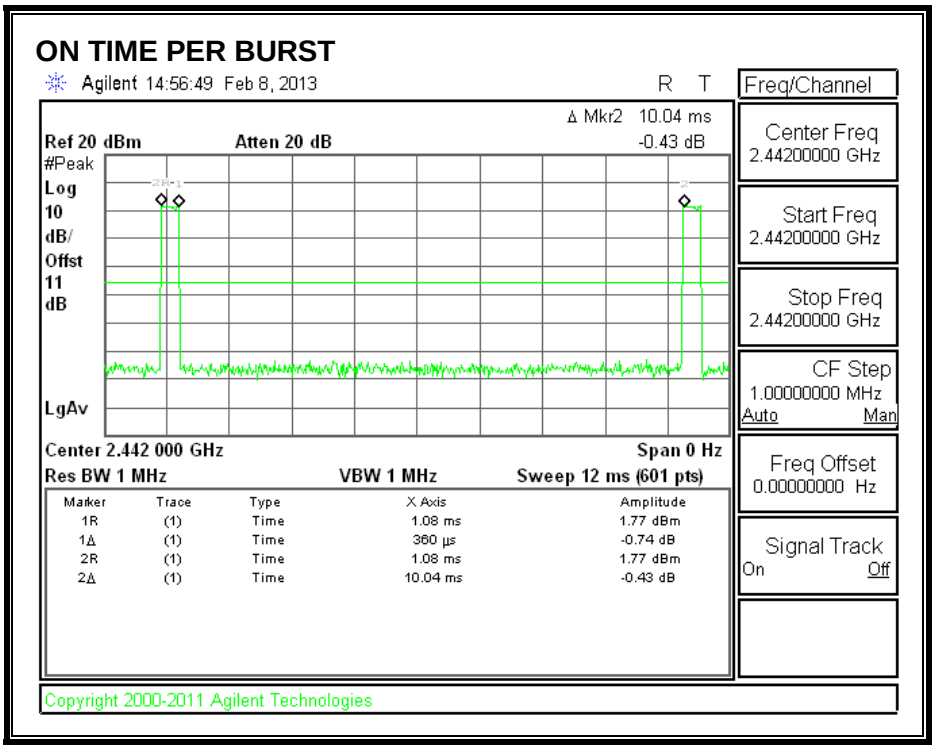
7. DUTY CYCLE CORRECTION FACTOR

LIMITS

None; for reporting purposes only.

RESULTS

Mode	Tx on (msec)	Tx on + Tx off (msec)	Duty Cycle Correction Factor (dB)
FHSS	360	10040	-14.45



8. ANTENNA PORT TEST RESULTS

8.1.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

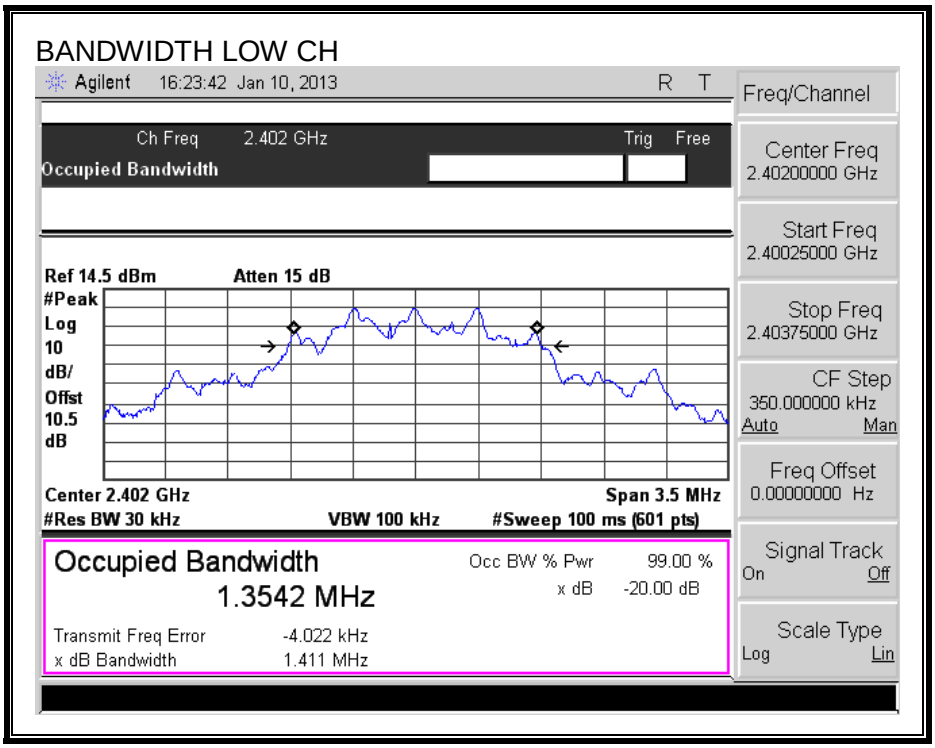
TEST PROCEDURE

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

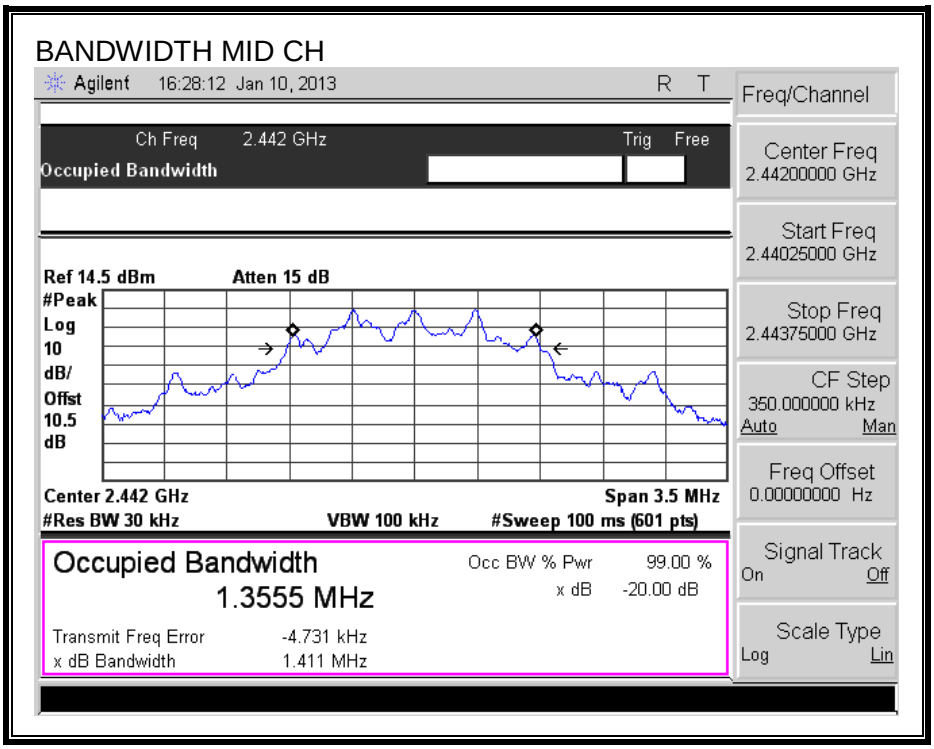
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	1411	1191
Middle	2442	1411	1340
High	2482	1418	1361

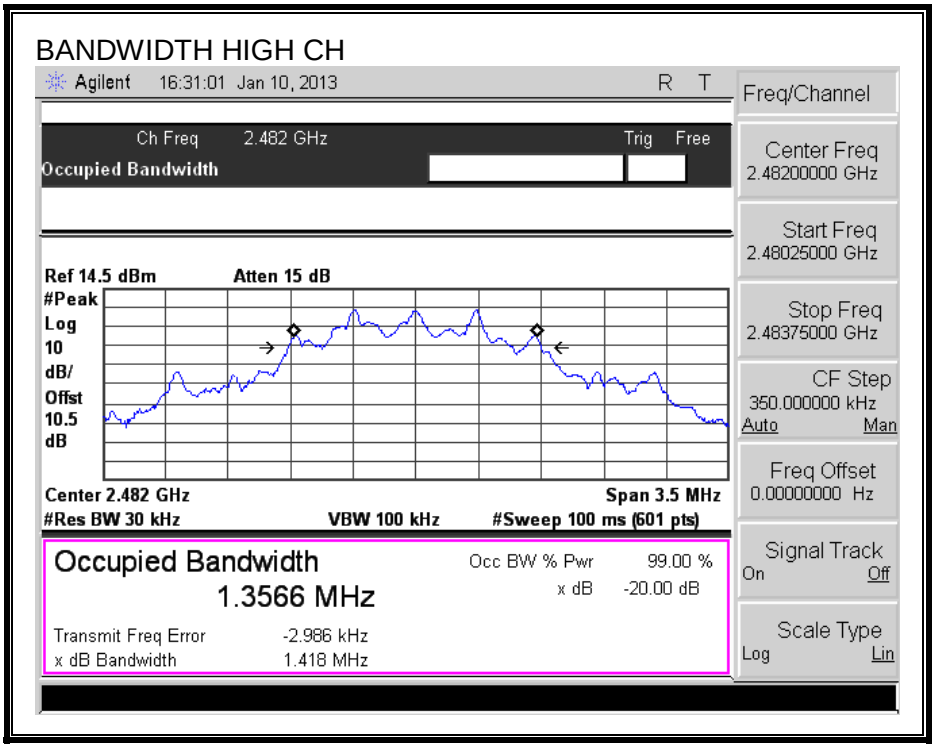
20 dB AND 99% BANDWIDTH



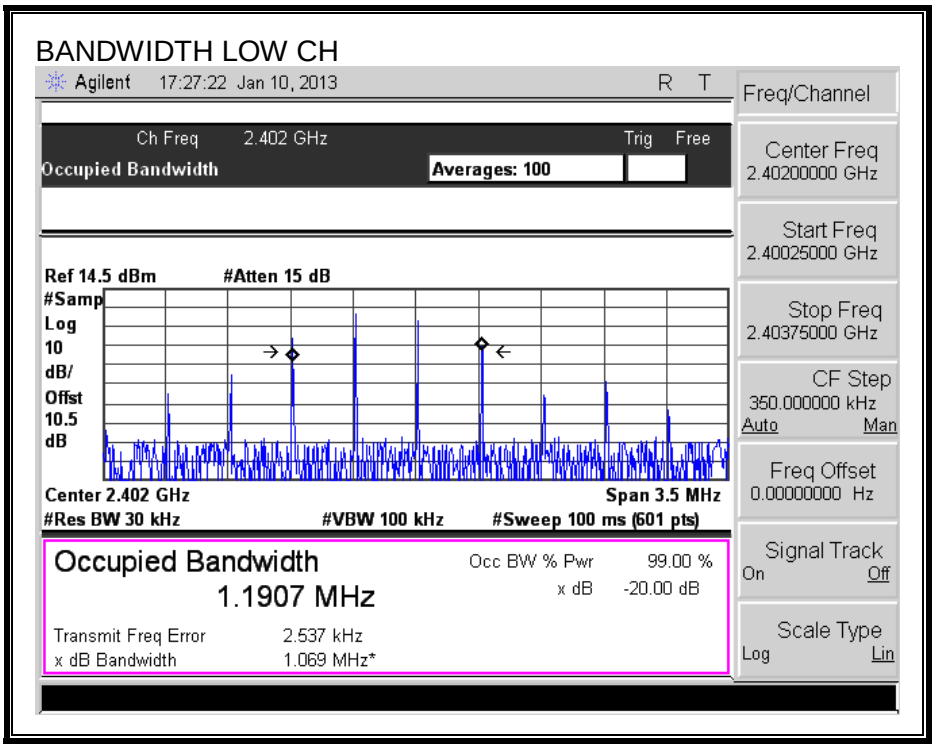
BANDWIDTH MID CH



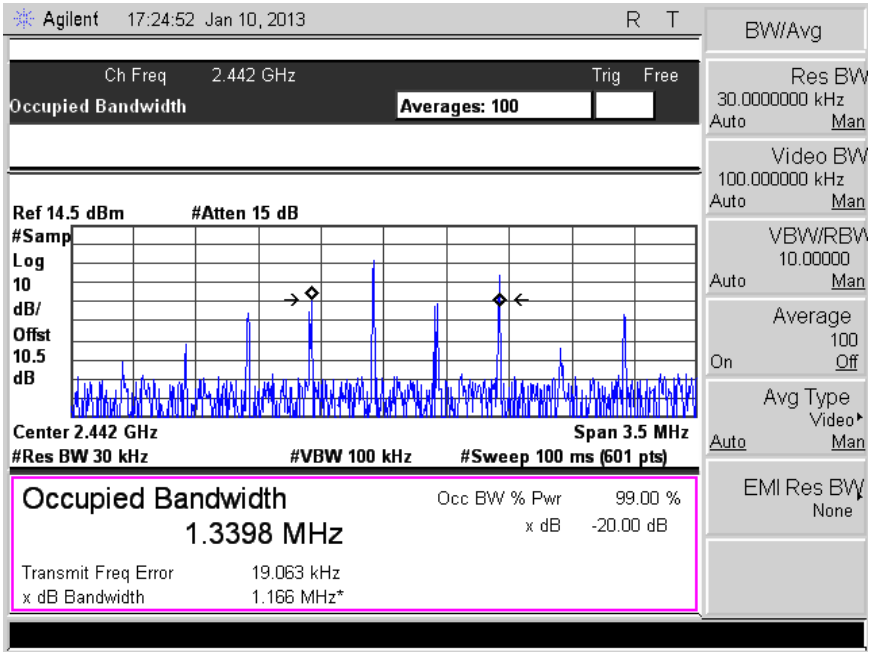
BANDWIDTH HIGH CH



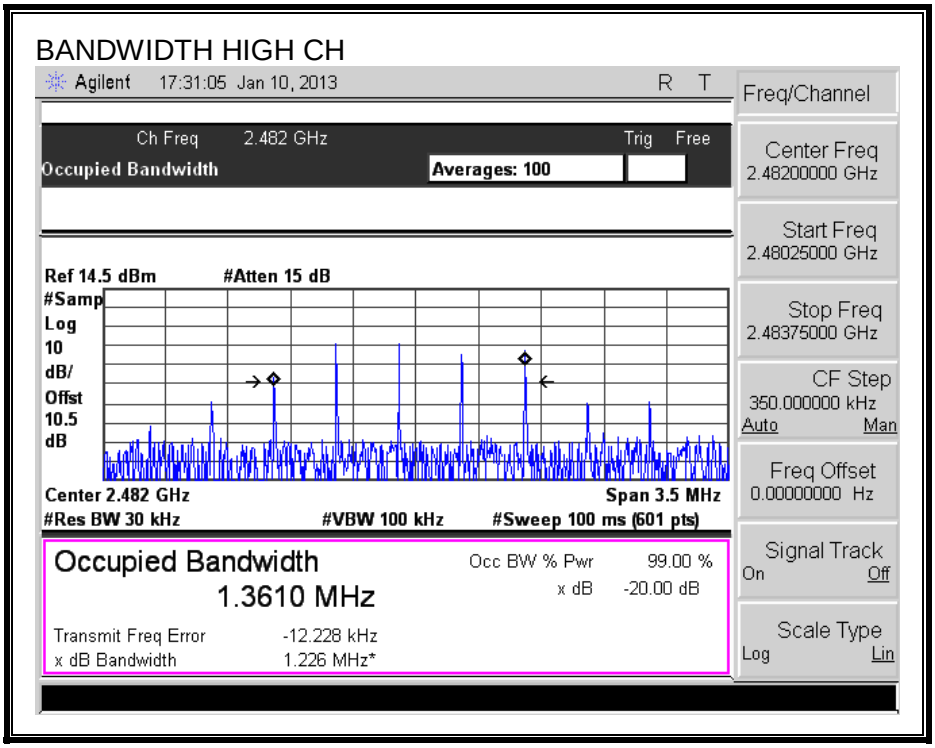
99% BANDWIDTH



BANDWIDTH MID CH



BANDWIDTH HIGH CH



8.1.2. 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.

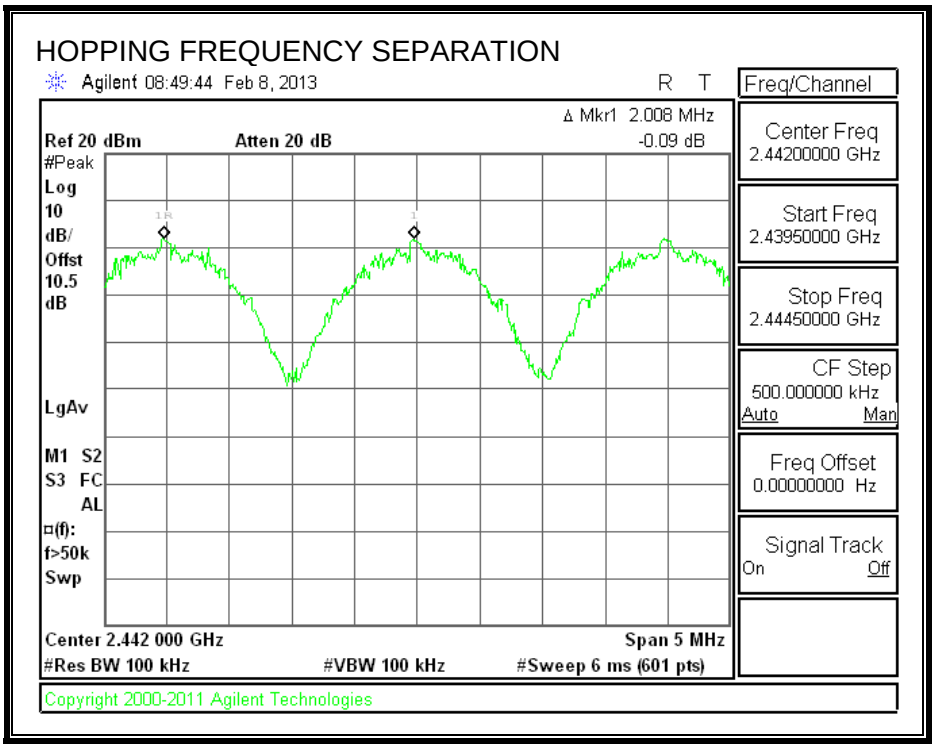
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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



8.1.3. 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

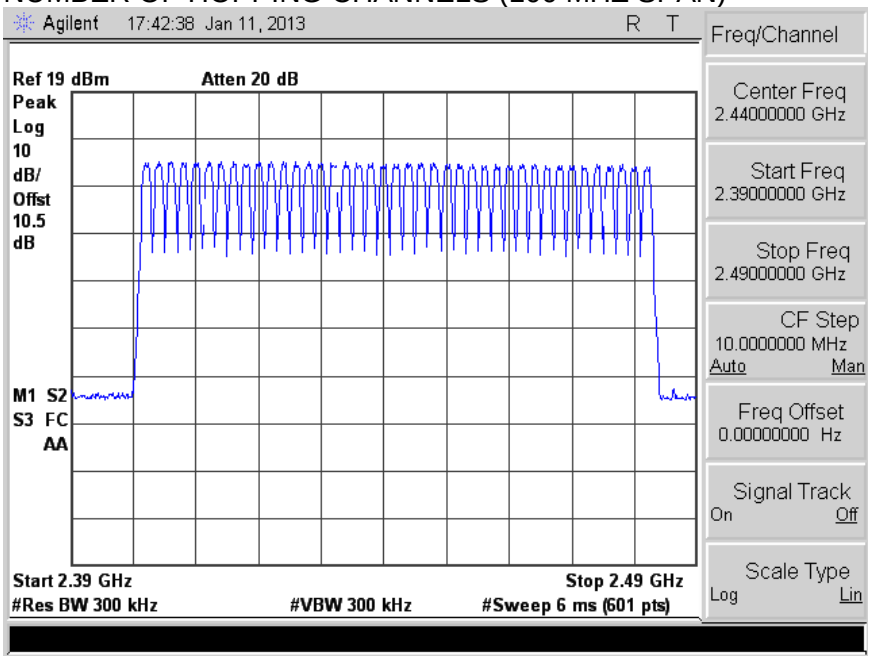
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

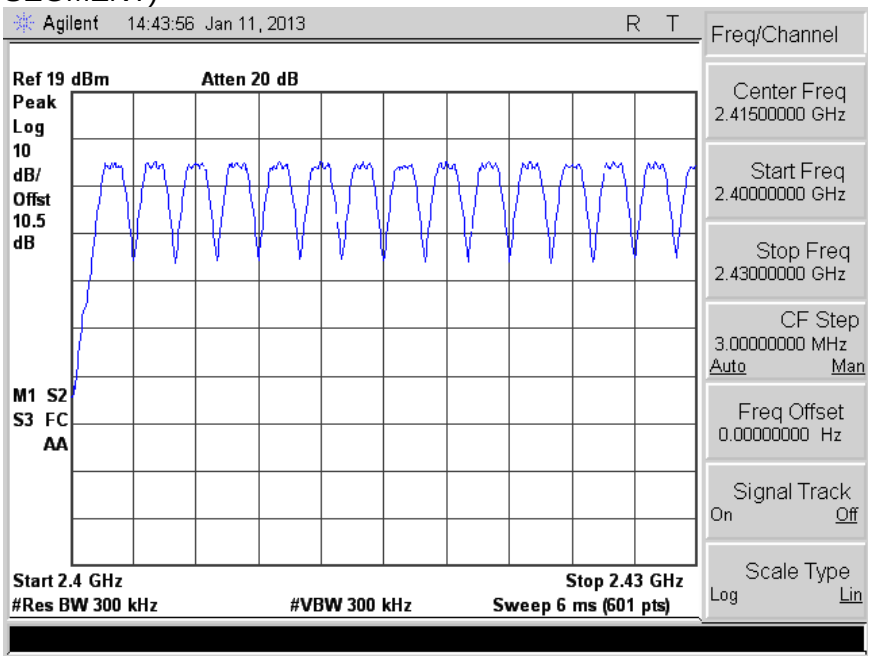
Normal Mode: 41 Channels observed.

NUMBER OF HOPPING CHANNELS

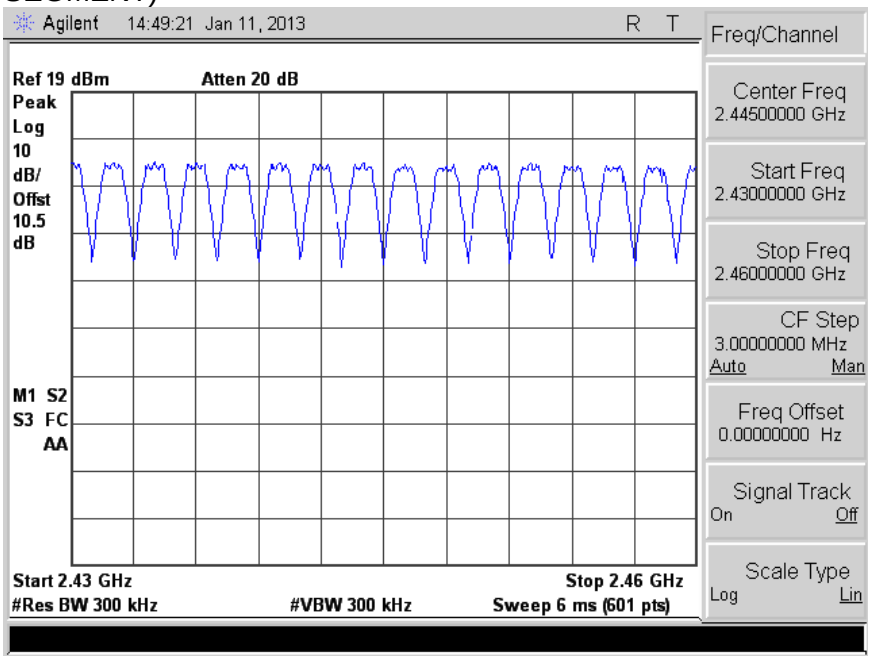
NUMBER OF HOPPING CHANNELS (100 MHZ SPAN)



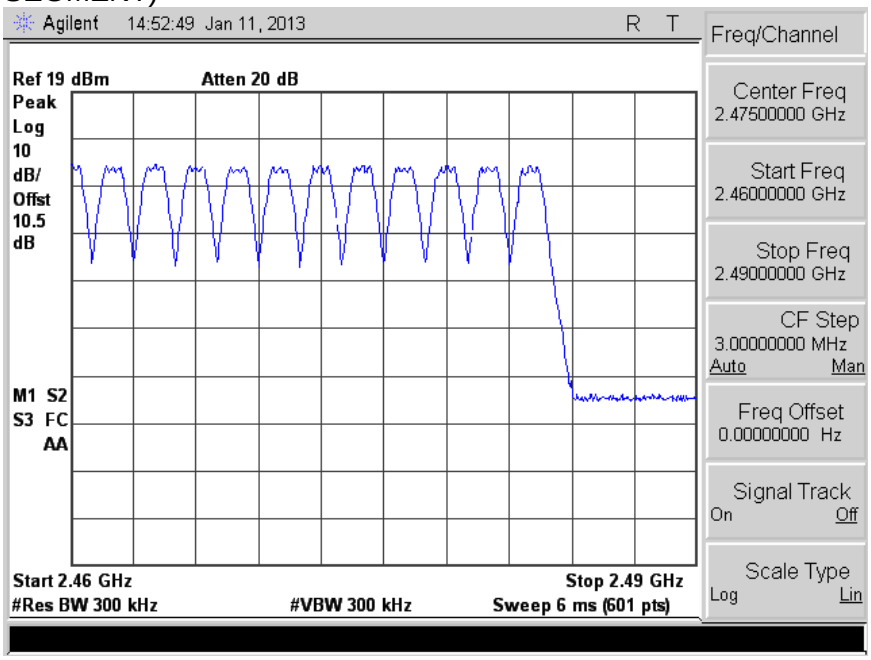
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



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



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



8.1.4. AVERAGE TIME OF OCCUPANCY

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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

TEST PROCEDURE

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

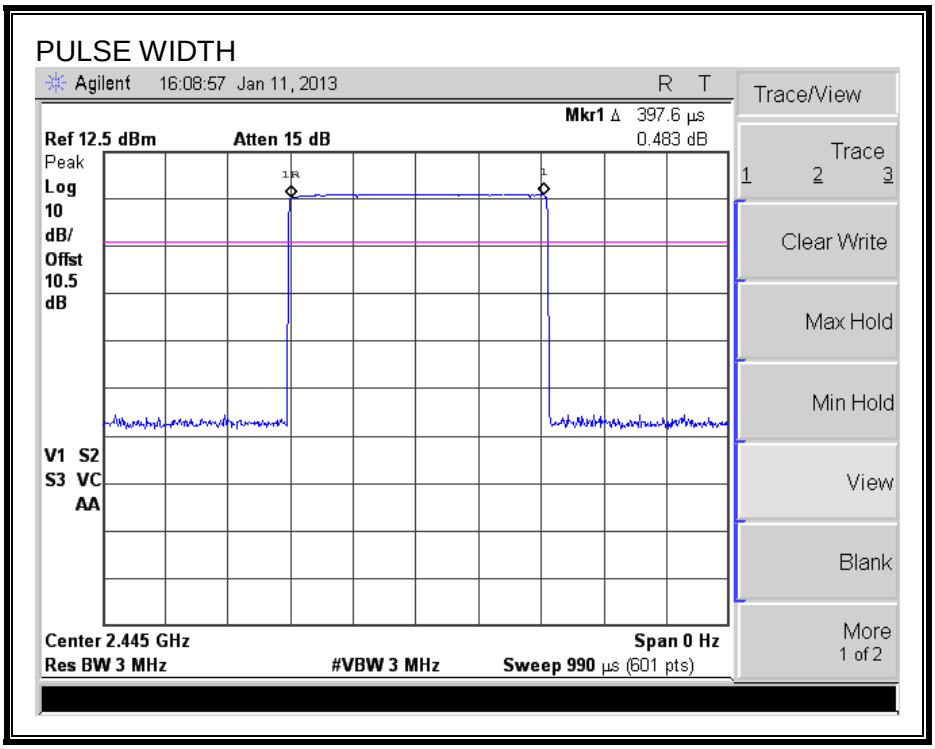
The average time of occupancy in the specified 16.4 second period (41 channels * 0.4 s) is equal to 10 * (# of pulses in 1.64 s) * pulse width.

.

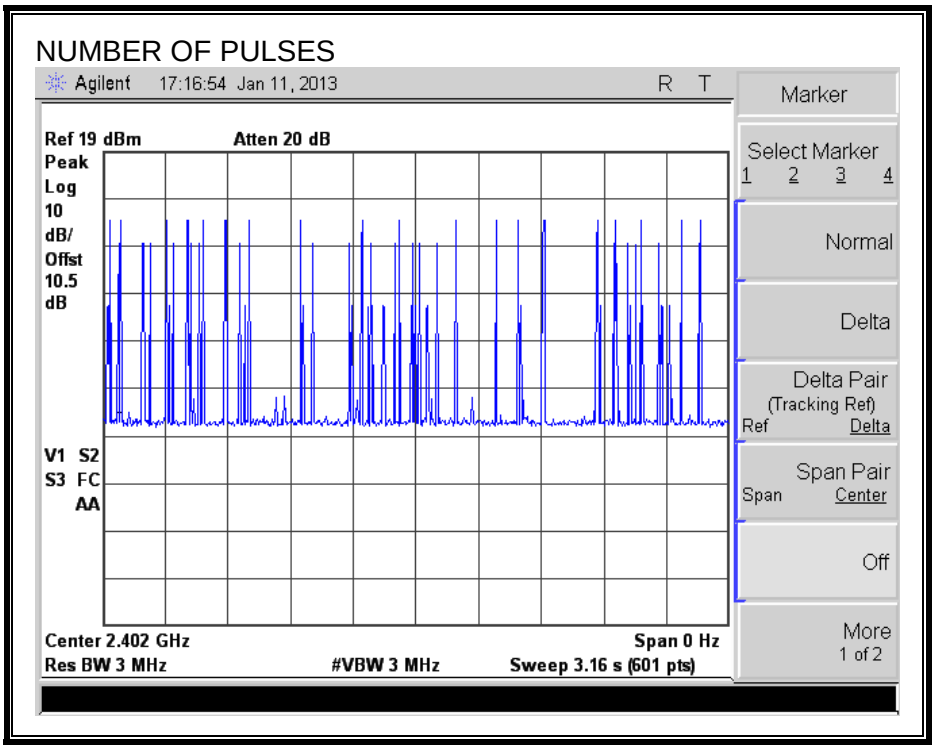
RESULTS

Pulse Width (msec)	Number of Pulses in 1.64 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
0.3976	10	0.040	0.4	-0.360

PULSE WIDTH



NUMBER OF PULSES IN 1.64 SECOND OBSERVATION PERIOD



Time per grid is 0.316s. Therefore, 5.2 grids would represent 1.64 seconds. Only pulses within the 5.2 grids were counted.

OUTPUT POWER

LIMIT

§15.247 (b) (2)

RSS-210 Issue 7 Clause A8.4

The maximum antenna gain is less than 6 dBi, therefore the limit is 21 dBm.

TEST PROCEDURE

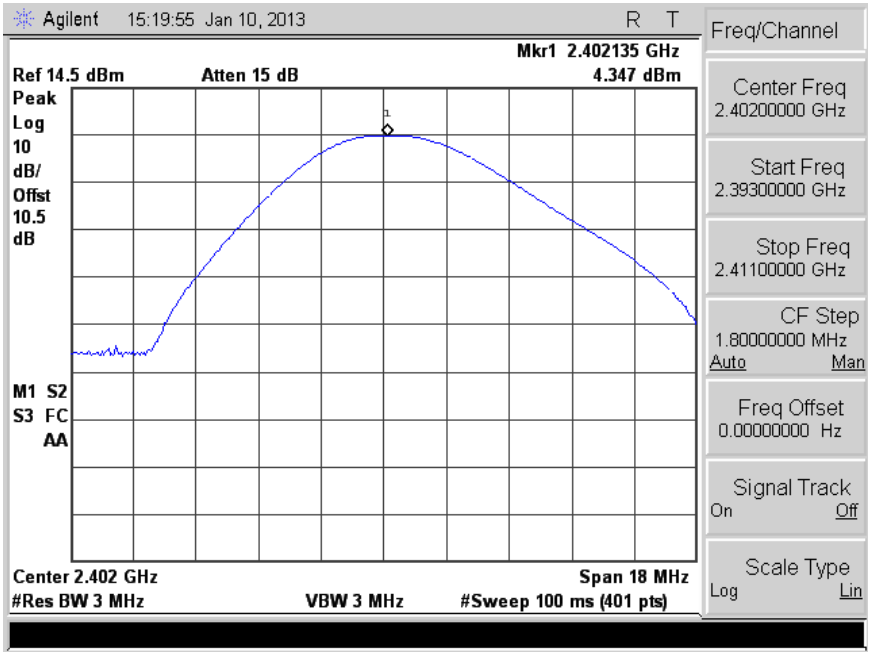
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

RESULTS

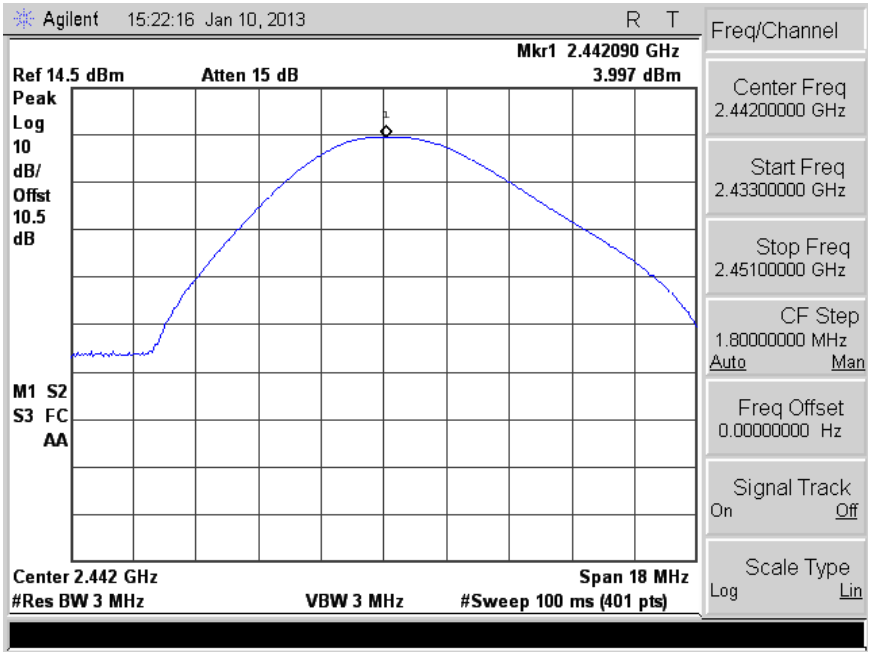
Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	4.35	21	-16.65
Middle	2442	4.00	21	-17.00
High	2482	3.43	21	-17.57

OUTPUT POWER

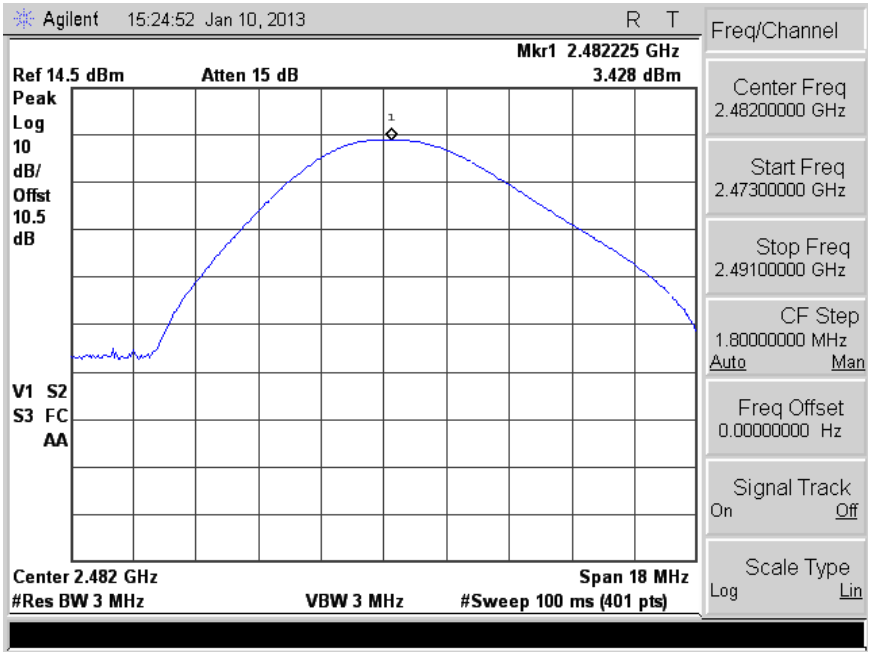
PEAK POWER LOW CH



PEAK POWER MID CH



PEAK POWER HIGH CH



8.1.5. 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 10.5 dB (including 10 dB pad and 0.5 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	4.10
Middle	2442	3.75
High	2482	3.18

8.1.6. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

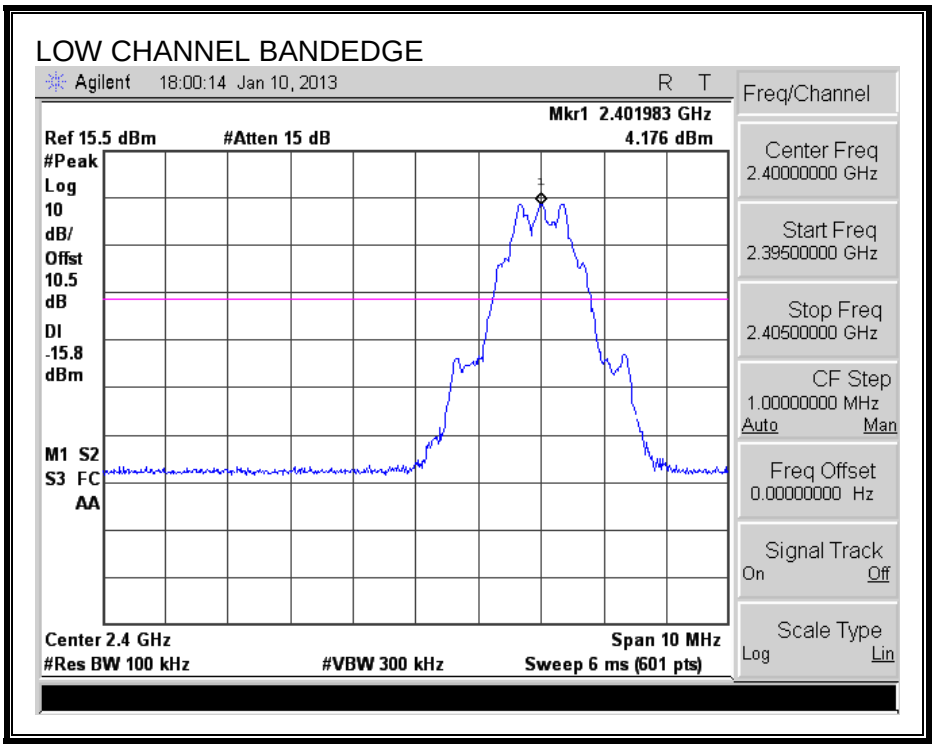
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

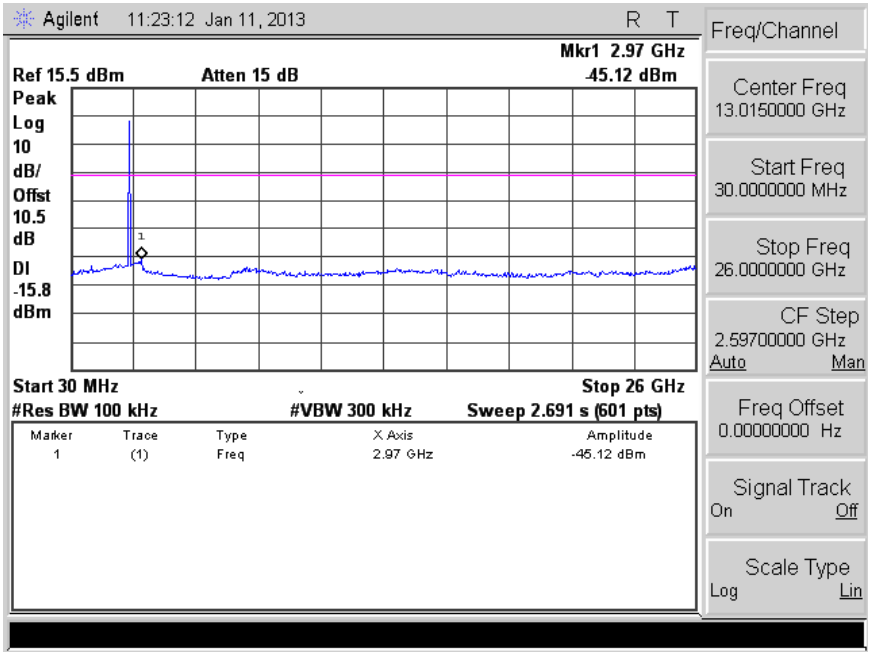
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

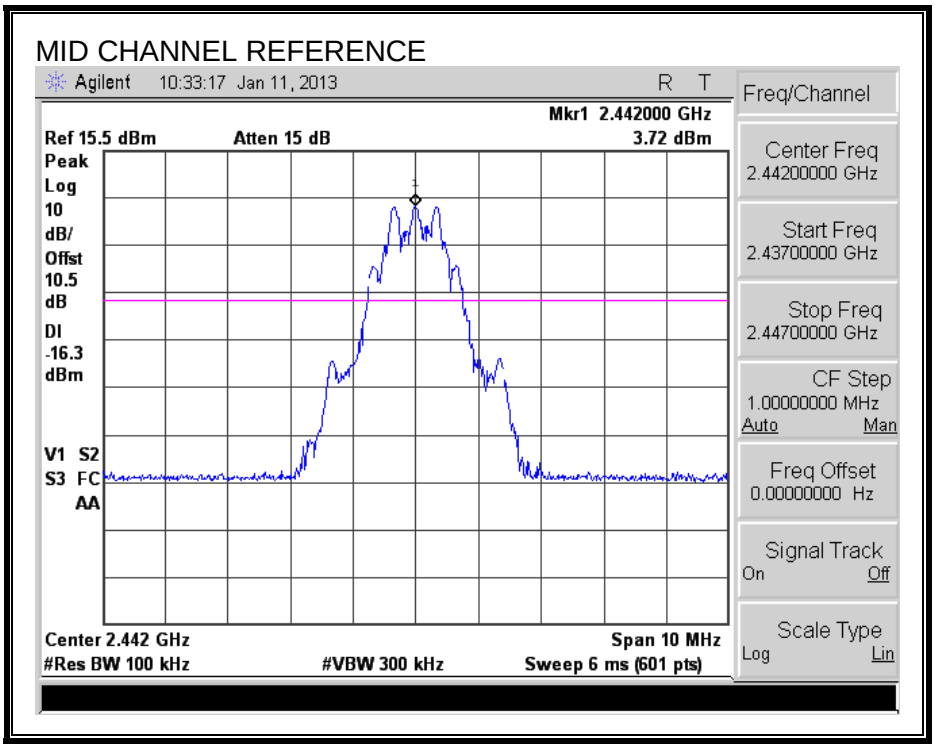
SPURIOUS EMISSIONS, LOW CHANNEL



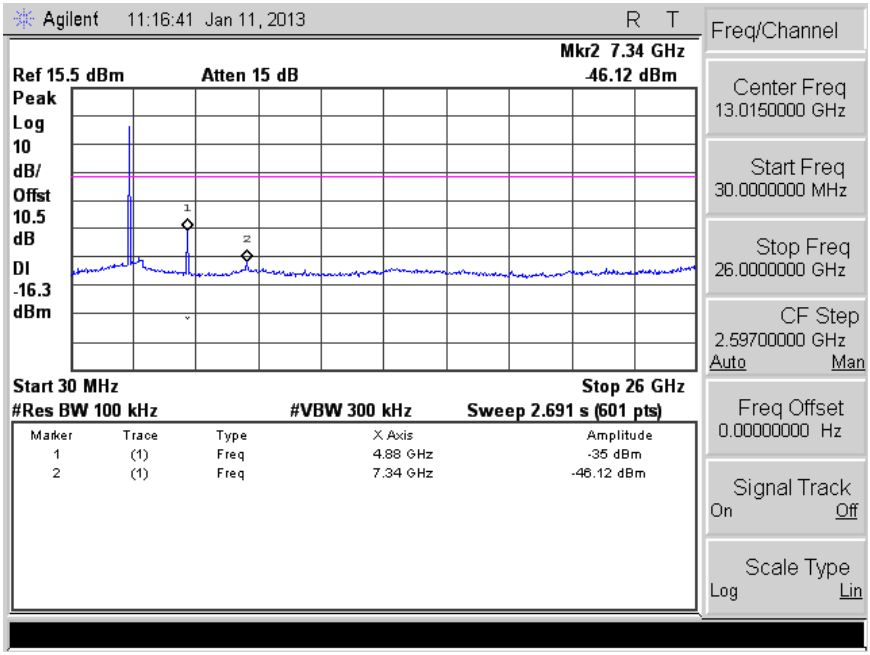
LOW CHANNEL SPURIOUS



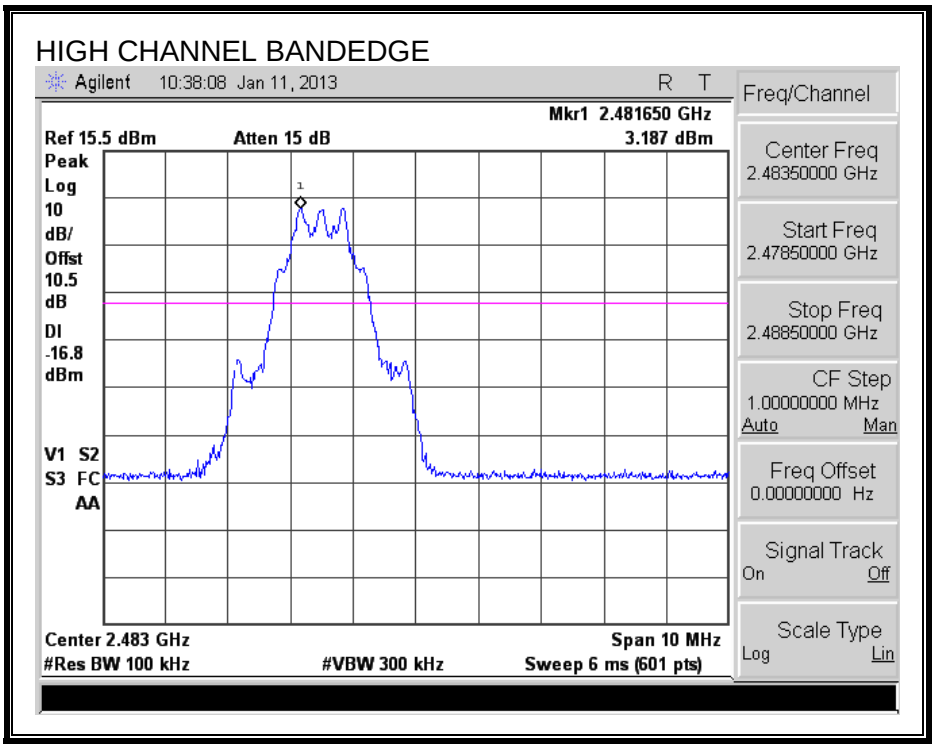
SPURIOUS EMISSIONS, MID CHANNEL



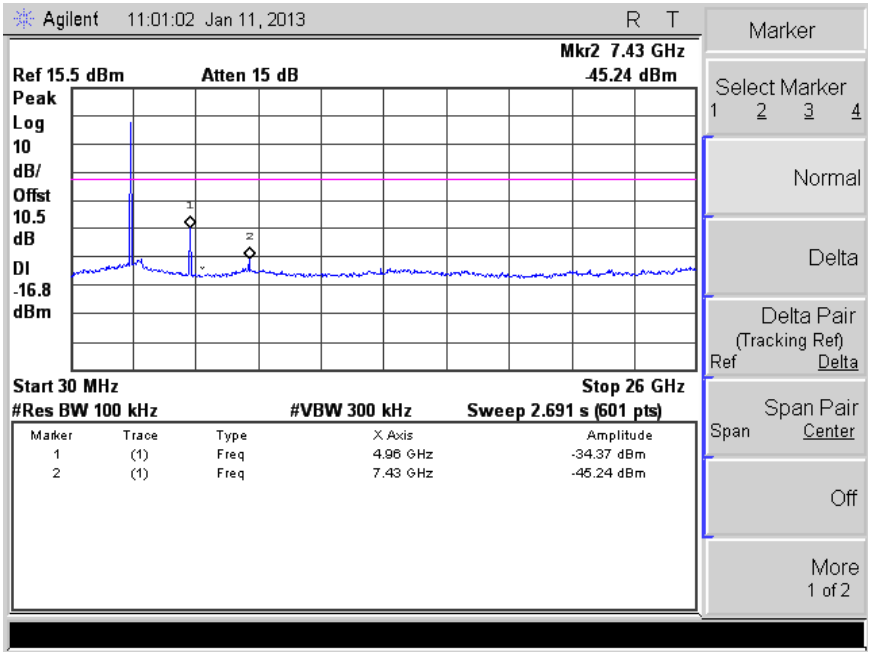
MID CHANNEL SPURIOUS



SPURIOUS EMISSIONS, HIGH CHANNEL

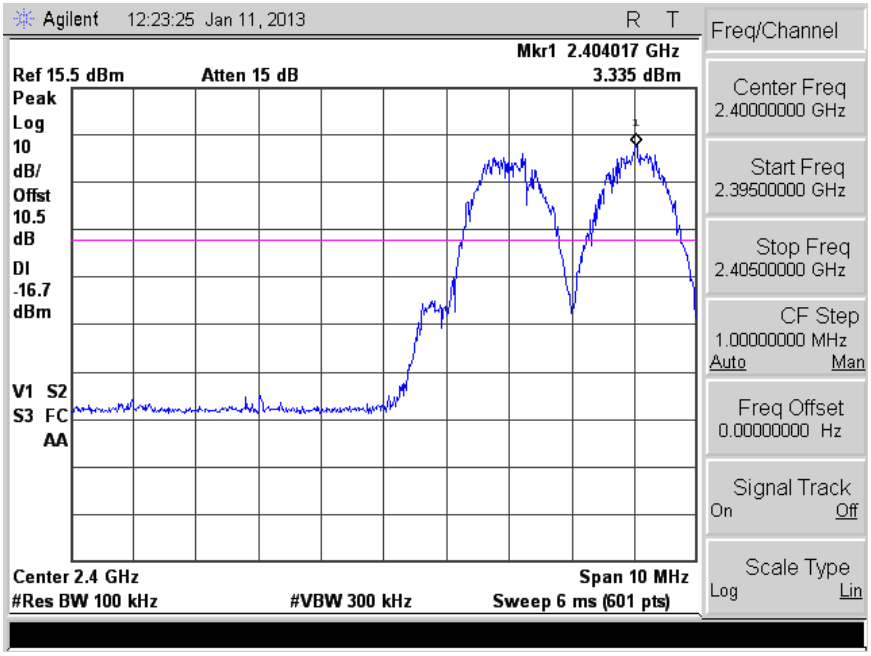


HIGH CHANNEL SPURIOUS

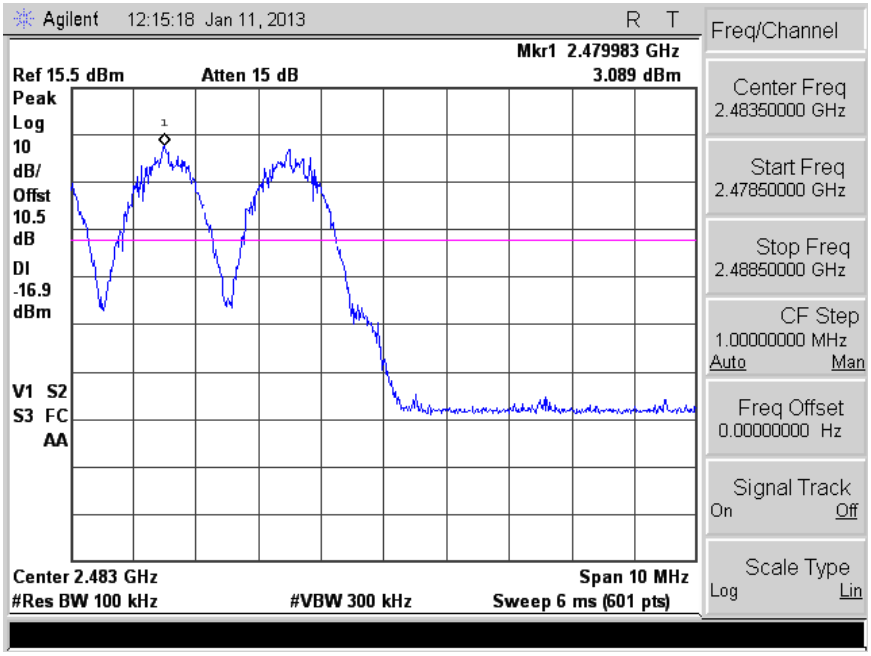


SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE WITH HOPPING ON



HIGH BANDEDGE WITH HOPPING ON



9. RADIATED TEST RESULTS

9.1. 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.

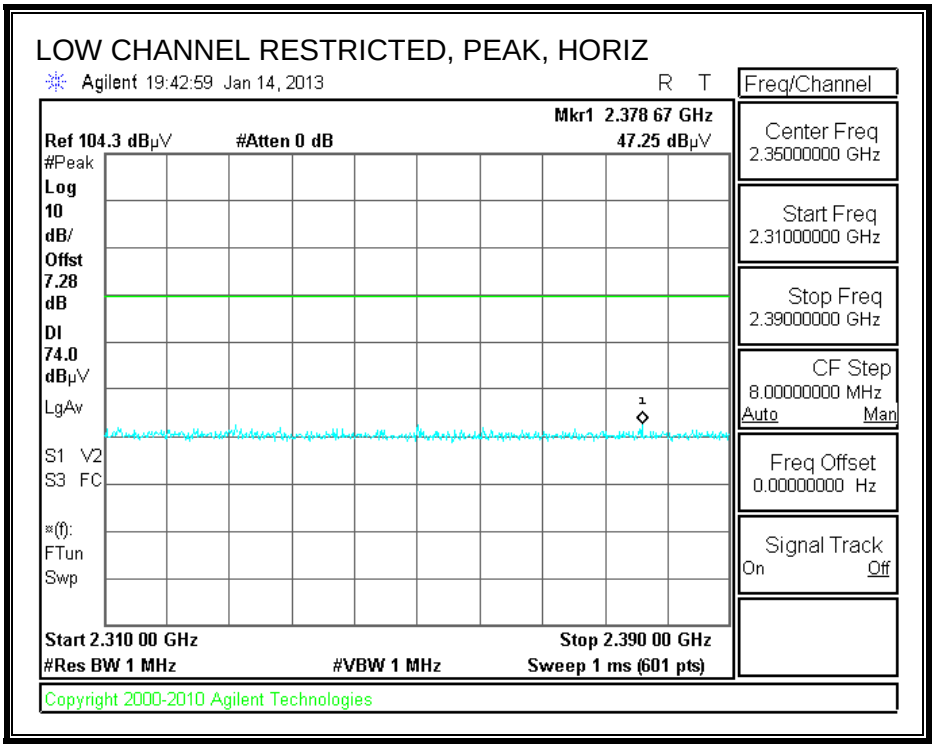
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

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.

9.2. TRANSMITTER ABOVE 1 GHz

RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)

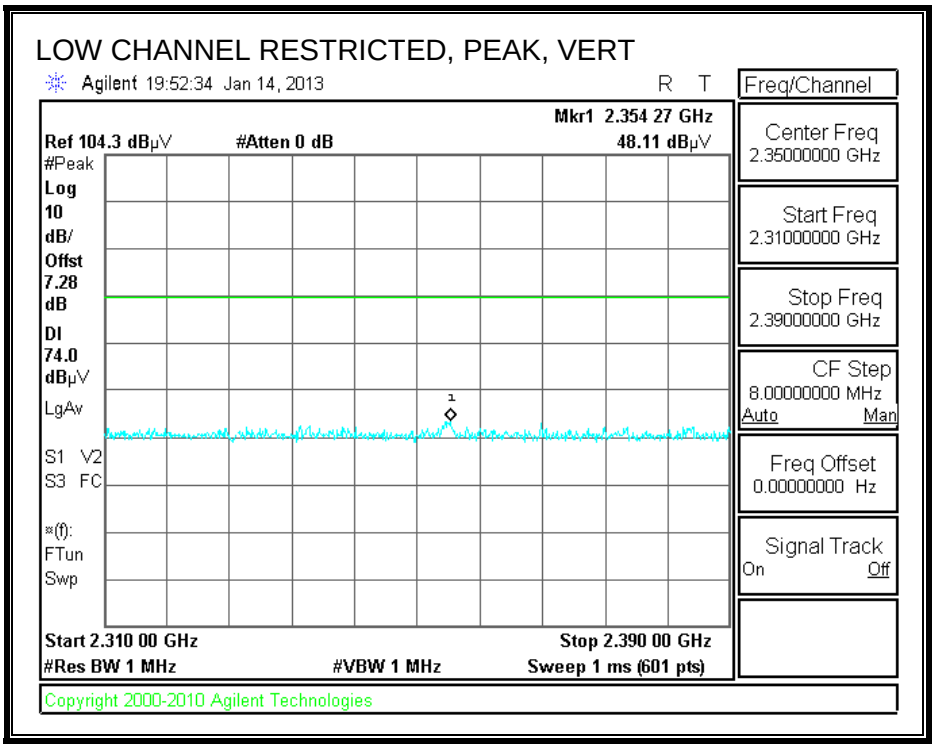


AVERAGE FIELD STRENGTH CALCULATION:

AVG Field Strength = Peak Reading – Duty Cycle Correction Factor
= 47.25 dBuV – 14.45 dBuV
= 32.80dBuV

AVG Margin = AVE Reading – AVE Power Limit
= 32.80 dBuV – 54 dBuV
= -21.20 dBuV

RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



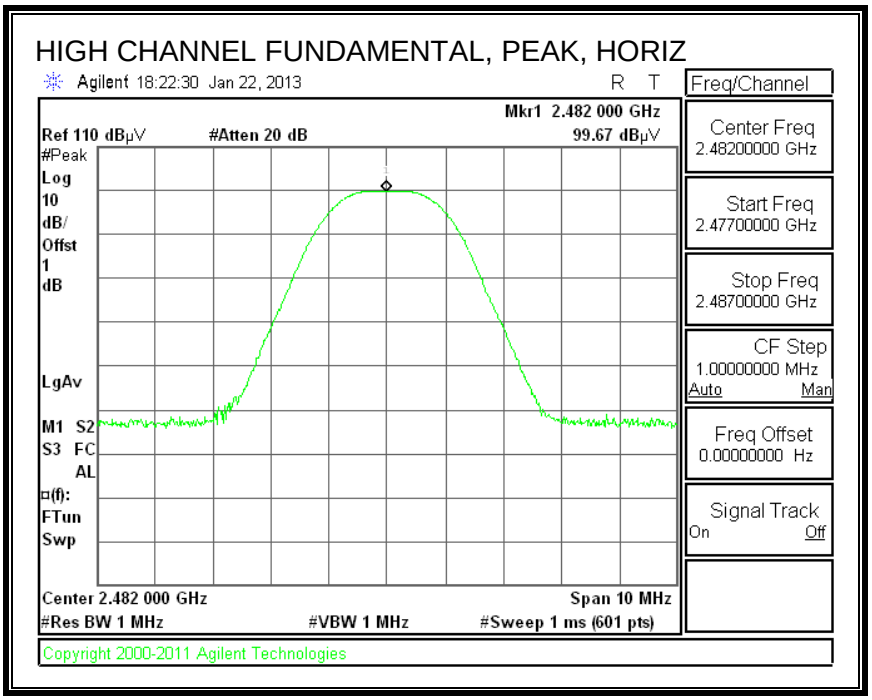
AVERAGE FIELD STRENGTH CALCULATION:

AVG Field Strength = Peak Reading – Duty Cycle Correction Factor
= 48.11 dBuV – 14.45 dBuV
= 33.66dBuV

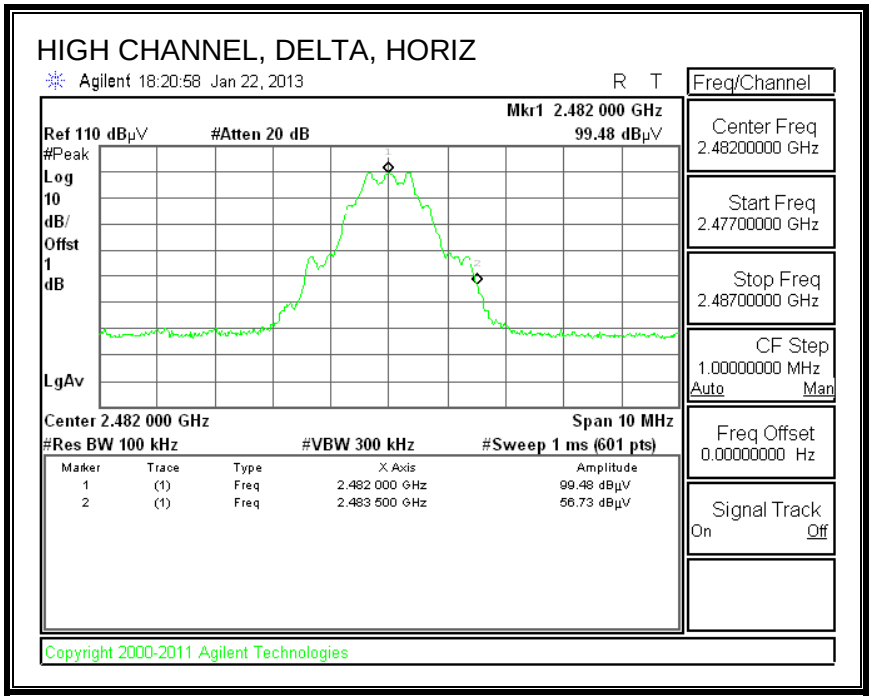
AVG Margin = AVE Reading – AVE Power Limit
= 33.66 dBuV – 54 dBuV
= -20.34 dBuV

RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL) (Marker Delta Method)

Fundamental Peak Power = 99.67dBuV



Delta from Marker Peak to Highest Marker in Restricted Band = 42.75dB



CALCULATION

_ Peak Reading = Fundamental Peak Field Strength - Delta

_Peak Margin = Peak Reading - 74

			Fundamental (dBuV/m)		Reading (dBuV/m)		Limit (dBuV/m)		Margin (dBuV/m)	
	Delta (dB)	Horn Antenna	Peak	AVG	Peak	AVG	Peak	AVG	Peak	AVG
High Ch, 2482MHz	42.75	Horizontal	99.67	N/A	56.92	42.47	74	54	-17.08	-11.53

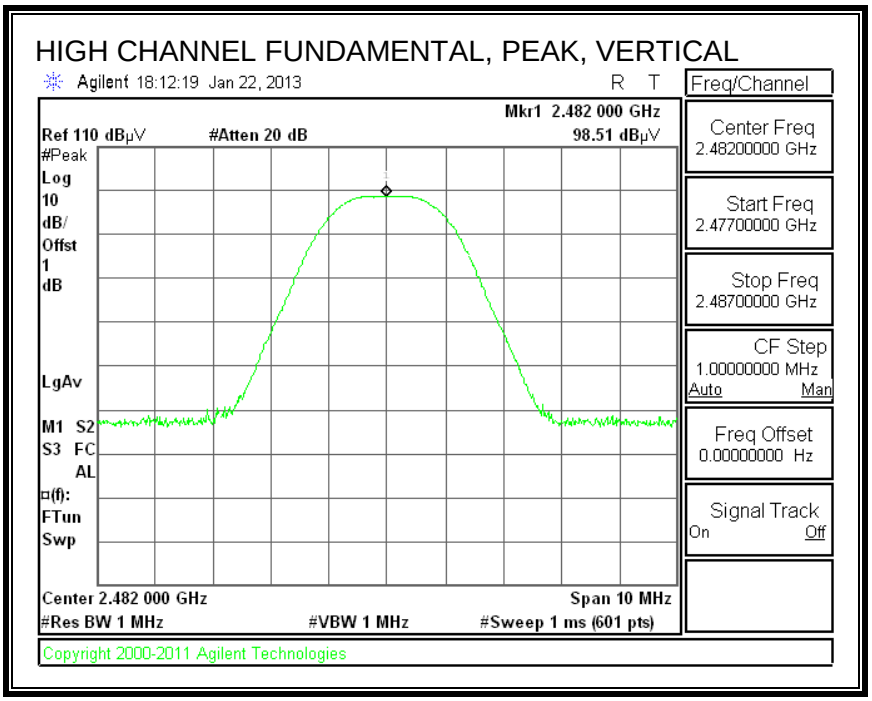
AVERAGE FIELD STRENGTH CALCULATION:

AVG Field Strength = Peak Reading – Duty Cycle Correction Factor
= 56.92 dBuV – 14.45 dBuV
= 42.47 dBuV

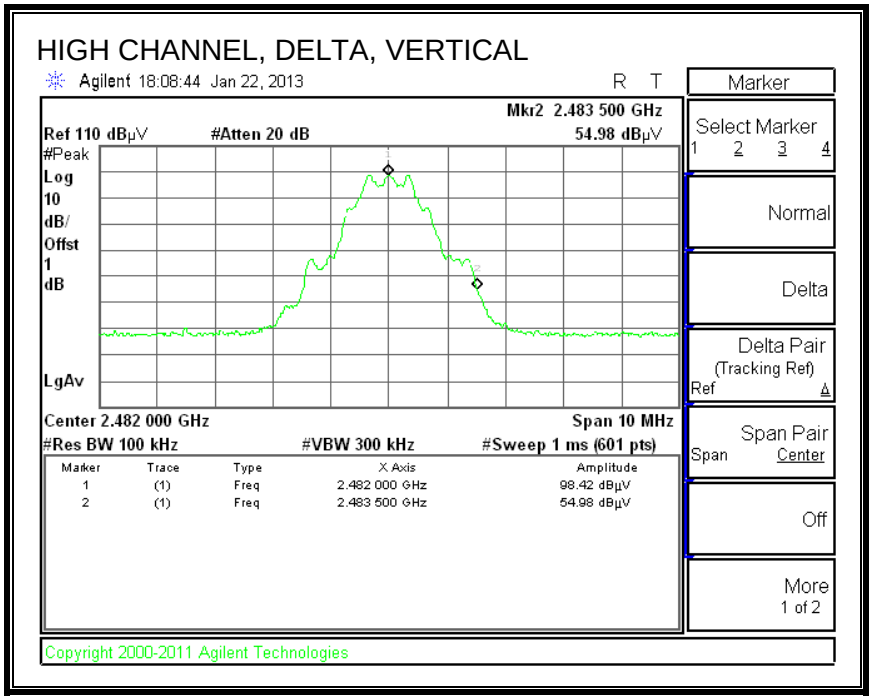
AVG Margin = AVE Reading – AVE Power Limit
= 42.47 dBuV – 54 dBuV
= -11.53 dBuV

RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)

Fundamental Peak Power = 98.51dBuV



Delta from Marker Peak to Highest Marker in Restricted Band = 43.44



CALCULATION

_ Peak Reading = Fundamental Peak Field Strength - Delta

_Peak Margin = Peak Reading - 74

			Fundamental (dBuV/m)		Reading (dBuV/m)		Limit (dBuV/m)		Margin (dBuV/m)	
	Delta (dB)	Horn Antenna	Peak	AVG	Peak	AVG	Peak	AVG	Peak	AVG
High Ch, 2482MHz	43.44	Vertical	98.51	N/A	55.07	41.82	74	54	-18.93	-12.18

AVERAGE FIELD STRENGTH CALCULATION:

AVG Field Strength = Peak Reading – Duty Cycle Correction Factor
= 55.07 dBuV – 14.45 dBuV
= 40.62 dBuV

AVG Margin = AVE Reading – AVE Power Limit
= 40.62 dBuV – 54 dBuV
= -13.38 dBuV

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 3m Chamber

Company: Microsoft
Project #: 12U14758
Date: 1/29/2013
Test Engineer: Danny Vu
Configuration: EUT and Laptop
Mode: Tx

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T60; S/N: 2238 @3m	T34 HP 8449B			FCC 15.205

Hi Frequency Cables

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

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

f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
Low Channel 2402 MHz															
4.804	3.0	39.9	31.9	33.1	6.8	-34.1	0.0	0.0	45.7	37.7	74	54	-28.3	-16.3	H
4.804	3.0	41.1	31.4	33.1	6.8	-34.1	0.0	0.0	46.9	37.2	74	54	-27.1	-16.8	V
Mid Channel 2442 MHz															
4.884	3.0	40.2	32.2	33.2	6.8	-34.0	0.0	0.0	46.1	38.2	74	54	-27.9	-15.8	H
7.326	3.0	42.1	36.8	36.3	9.1	-33.1	0.0	0.0	54.4	49.1	74	54	-19.6	-4.9	H
4.884	3.0	40.8	33.0	33.2	6.8	-34.0	0.0	0.0	46.7	38.9	74	54	-27.3	-15.1	V
7.326	3.0	39.4	32.0	36.3	9.1	-33.1	0.0	0.0	51.7	44.3	74	54	-22.3	-9.7	V
High Channel 2482 MHz															
4.964	3.0	45.8	42.4	33.2	6.9	-34.0	0.0	0.0	51.9	48.5	74	54	-22.1	-5.5	H
7.446	3.0	42.4	36.2	36.5	9.1	-33.0	0.0	0.0	54.9	48.7	74	54	-19.1	-5.3	H
4.964	3.0	43.6	38.9	33.2	6.9	-34.0	0.0	0.0	49.7	44.9	74	54	-24.3	-9.1	V
7.446	3.0	38.2	34.3	36.5	9.1	-33.0	0.0	0.0	50.7	46.8	74	54	-23.3	-7.2	V

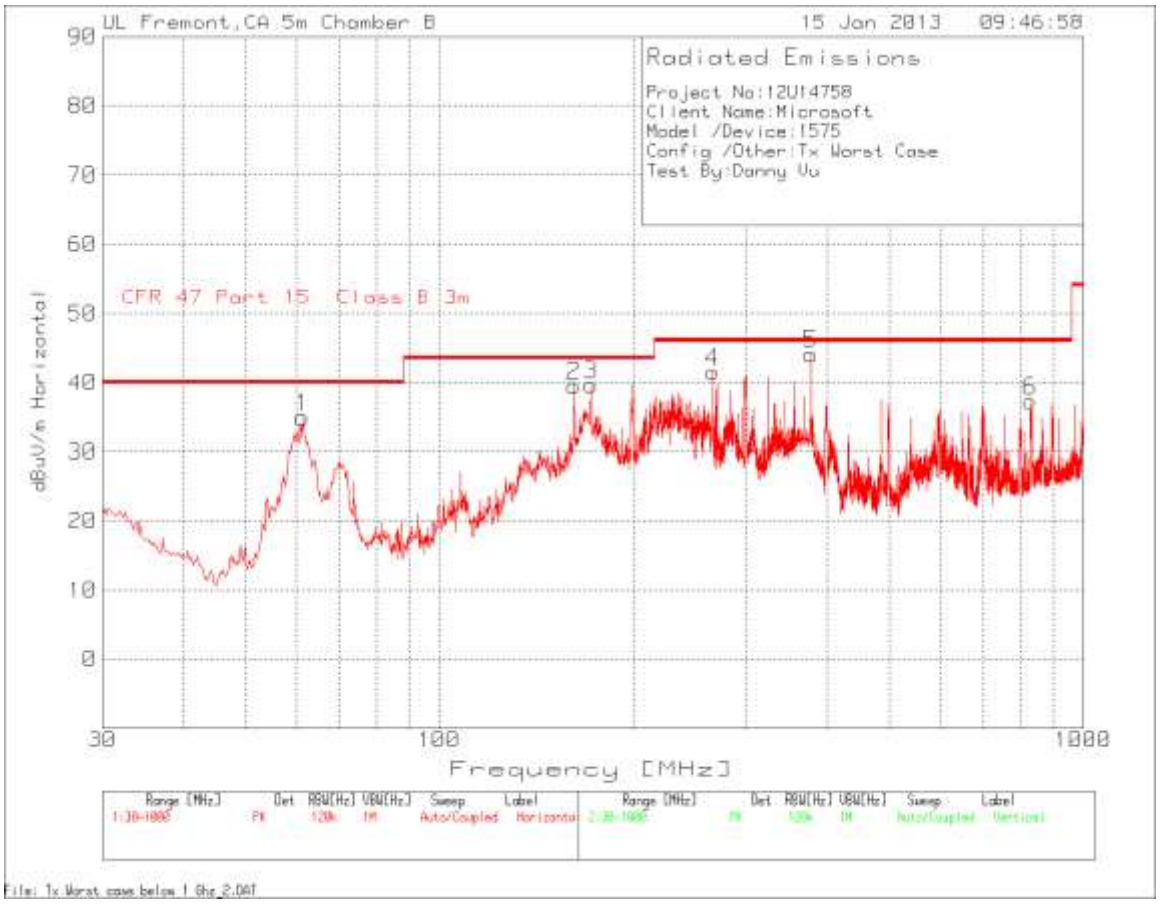
Rev. 11.10.11

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

9.3. WORST-CASE BELOW 1 GHz

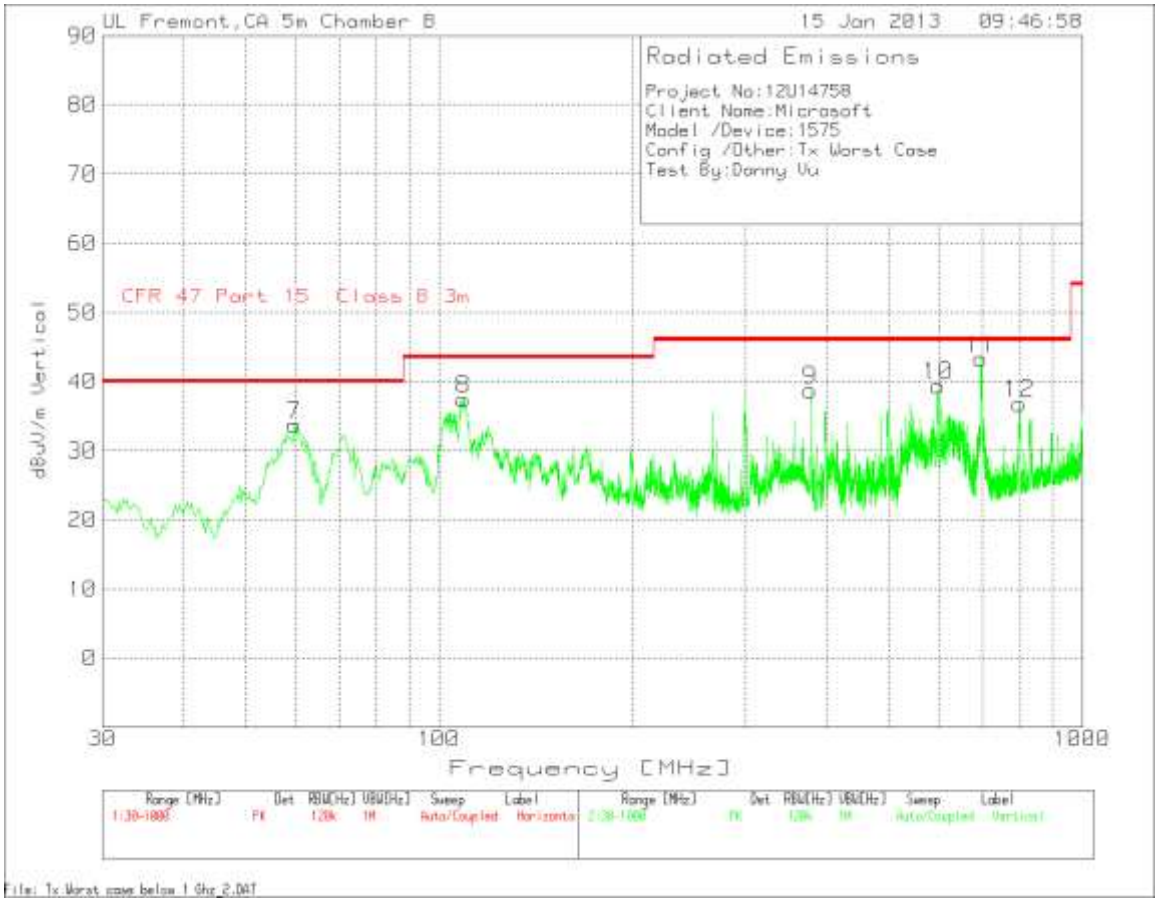
SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)

HORIZONTAL PLOT



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

VERTICAL PLOT



HORIZONTAL AND VERTICAL DATA

Project No:	12U14758
Client Name:	Microsoft
Model /Device:	1575
Config /Other:	Tx Worst Case
Test By:	Danny Vu

Horizontal 30 - 1000MHz

Marker No.	Test Frequency	Meter Reading	Detector	T122 Sunol Bilog.TXT	5mB Amp Path 30-1000MHz	dBuV/m	CFR 47 Part 15 Class B	Margin	Height [cm]	Polarity
1	61.4029	56.4	PK	7.5	-28.9	35	40	-5	300	Horz
2	161.8145	55.1	PK	12.4	-27.9	39.6	43.5	-3.9	200	Horz
3	171.8945	55.78	PK	11.7	-27.8	39.68	43.5	-3.82	200	Horz
4	266.1031	55.67	PK	12.9	-27	41.57	46	-4.43	100	Horz
5	377.9516	55.93	PK	15	-26.8	44.13	46	-1.87	100	Horz
6	828.4472	41.07	PK	21.6	-25.3	37.37	46	-8.63	100	Horz

Vertical 30 - 1000MHz

Marker No.	Test Frequency	Meter Reading	Detector	T122 Sunol Bilog.TXT	5mB Amp Path 30-1000MHz	dBuV/m	CFR 47 Part 15 Class B	Margin	Height [cm]	Polarity
7	59.6583	55.36	PK	7.4	-29	33.76	40	-6.24	100	Vert
8	109.2826	53.35	PK	12.6	-28.5	37.45	43.5	-6.05	100	Vert
9	377.9516	50.6	PK	15	-26.8	38.8	46	-7.2	100	Vert
10	597.9656	47.67	PK	18.4	-26.6	39.47	46	-6.53	100	Vert
11	696.0512	49.39	PK	20.1	-26.2	43.29	46	-2.71	100	Vert
12	798.2074	40.93	PK	21.3	-25.4	36.83	46	-9.17	100	Vert

PK - Peak detector
QP - Quasi-Peak detector
Av - Average detector

10. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

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

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

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

RESULTS

RESULTS

WORST EMISSIONS

Project No:12U14758
Client Name:Microsoft
Model/Device:1575
Test Volt/Freq:120VAC/60 Hz
Test By:Danny Vu

Line 1, 0.15 - 30MHz

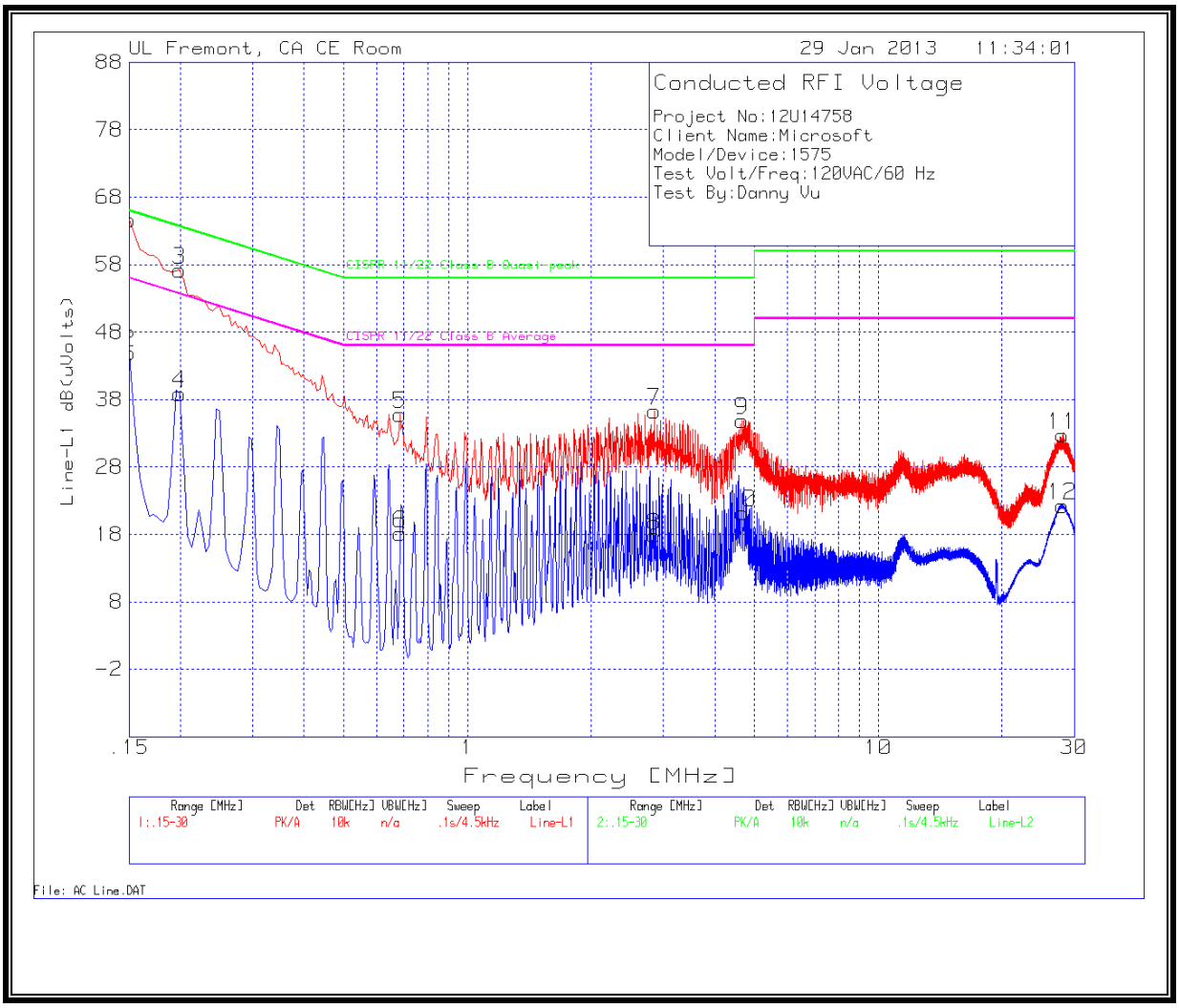
Test Frequency (MHz)	Meter Reading dB(uV)	Detector	LISN Factor (dB)	Cable Loss (dB)	Corrected Reading dB(uV)	Quasi-peak Limit dB(uV)	Margin	Average Limit dB(uV)	Margin (dB)
0.15	64.55	PK	0.1	0	64.65	66	-1.35	-	-
0.15	44.89	Av	0.1	0	44.99	-	-	56	-11.01
0.1995	57.05	PK	0.1	0	57.15	63.6	-6.45	-	-
0.1995	38.72	Av	0.1	0	38.82	-	-	53.6	-14.78
0.6855	35.7	PK	0.1	0	35.8	56	-20.2	-	-
0.6855	18.06	Av	0.1	0	18.16	-	-	46	-27.84
2.85	36.09	PK	0.1	0.1	36.29	56	-19.71	-	-
2.85	17.6	Av	0.1	0.1	17.8	-	-	46	-28.2
4.668	34.65	PK	0.1	0.1	34.85	56	-21.15	-	-
4.668	21.04	Av	0.1	0.1	21.24	-	-	46	-24.76
28.095	31.95	PK	0.5	0.3	32.75	60	-27.25	-	-
28.095	21.4	Av	0.5	0.3	22.2	-	-	50	-27.8

Line 2, 0.15 - 30MHz

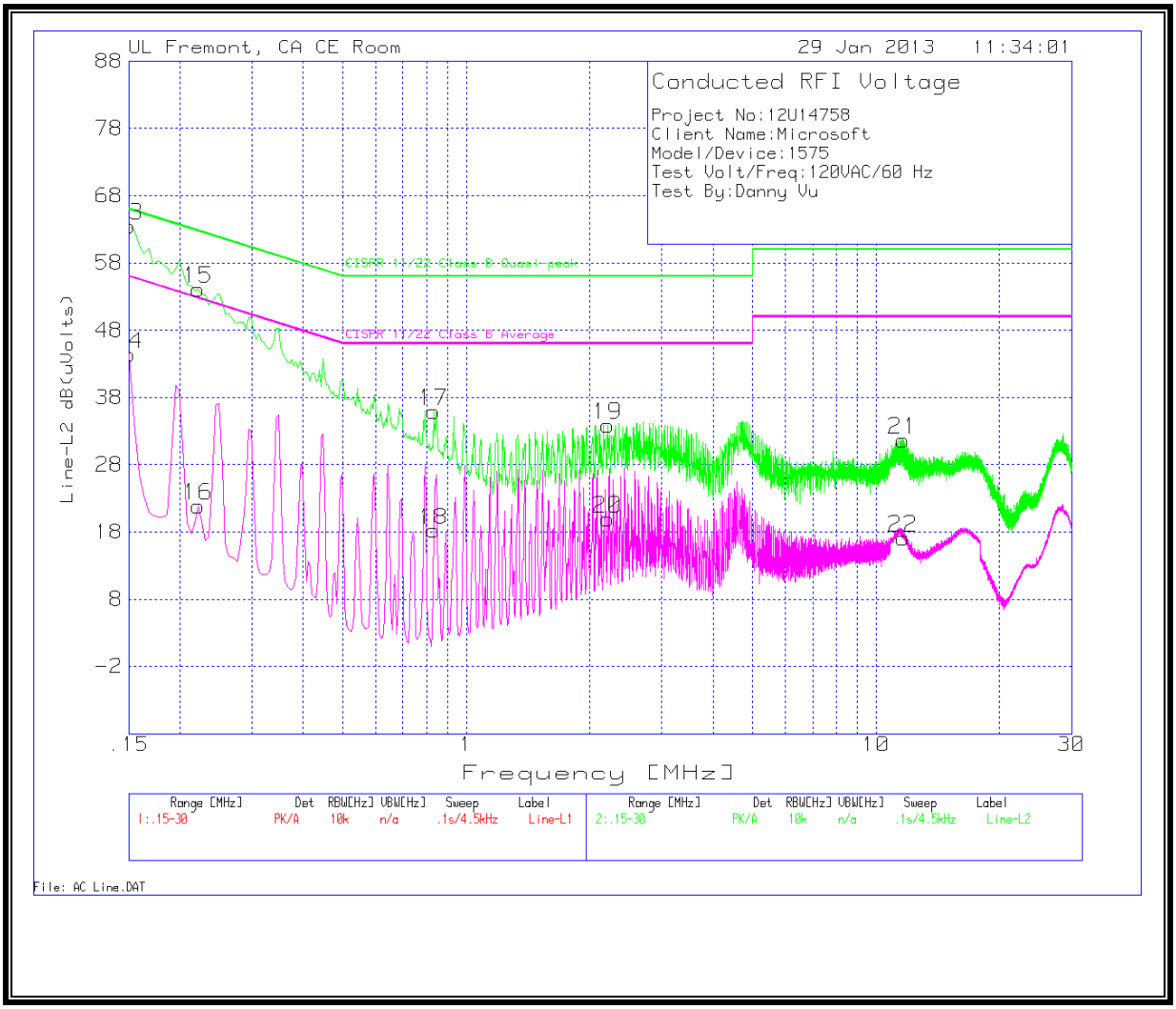
Test Frequency (MHz)	Meter Reading dB(uV)	Detector	LISN Factor (dB)	Cable Loss (dB)	Corrected Reading dB(uV)	Quasi-peak Limit dB(uV)	Margin	Average Limit dB(uV)	Margin (dB)
0.15	63.37	PK	0.1	0	63.47	66	-2.53	-	-
0.15	44.26	Av	0.1	0	44.36	-	-	56	-11.64
0.222	54.01	PK	0.1	0	54.11	62.7	-8.59	-	-
0.222	21.75	Av	0.1	0	21.85	-	-	52.7	-30.85
0.834	35.81	PK	0.1	0	35.91	56	-20.09	-	-
0.834	18.09	Av	0.1	0	18.19	-	-	46	-27.81
2.211	33.68	PK	0.1	0.1	33.88	56	-22.12	-	-
2.211	19.76	Av	0.1	0.1	19.96	-	-	46	-26.04
11.6115	31.27	PK	0.2	0.2	31.67	60	-28.33	-	-
11.6115	16.66	Av	0.2	0.2	17.06	-	-	50	-32.94

PK - Peak detector
QP - Quasi-Peak detector
LnAv - Linear Average detector
LgAv - Log Average detector
Av - Average detector

LINE 1 RESULTS



LINE 2 RESULTS



11. MAXIMUM PERMISSIBLE RF EXPOSURE

11.1. 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.

11.2. 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).

11.3. EQUATIONS

POWER DENSITY

Power density is given by:

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

Where

S = Power density in mW/cm^2
EIRP = Equivalent Isotropic Radiated Power in mW
D = Separation distance in cm

Power density in units of mW/cm^2 is converted to units of W/m^2 by multiplying by 10.

DISTANCE

Distance is given by:

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

Where

D = Separation distance in cm
EIRP = Equivalent Isotropic Radiated Power in mW
S = Power density in mW/cm^2

SOURCE-BASED DUTY CYCLE

Where applicable (for example, multi-slot cell phone applications) a duty cycle factor may be applied.

Source-based time-averaged EIRP = (DC / 100) * EIRP

Where

DC = Duty Cycle in %, as applicable
EIRP = Equivalent Isotropic Radiated Power in W

MIMO AND COLOCATED TRANSMITTERS (IDENTICAL LIMIT FOR ALL TRANSMITTERS)

For multiple chain devices, and colocated transmitters operating simultaneously in frequency bands where the limit is identical, the total power density is calculated using the total EIRP obtained by summing the EIRP (in linear units) of each transmitter.

Total EIRP = (EIRP1) + (EIRP2) + ... + (EIRPn)

where

EIRPx = Source-based time-averaged EIRP of chain x or transmitter x

The total EIRP is then used to calculate the Power Density or the Distance as applicable.

MIMO AND COLOCATED TRANSMITTERS

For multiple colocated transmitters operating simultaneously in frequency bands where different limits apply:

The Power Density at the specified separation distance is calculated for each transmitter chain or transmitter.

The fraction of the exposure limit is calculated for each chain or transmitter as
(Power Density of chain or transmitter) / (Limit applicable to that chain or transmitter).

The fractions are summed.

Compliance is established if the sum of the fractions is less than or equal to one.

11.4. LIMITS AND IC EXEMPTION

VARIABLE LIMITS

For mobile radio equipment operating in the cellular phone band, the lowest power density limit is calculated using the lowest frequency:

824 MHz / 1500 = 0.55 mW/cm^2 (FCC)
824 MHz / 150 = 5.5 W/m^2 (IC).

FIXED LIMITS

For operation in the PCS band, the 2.4 GHz band and the 5 GHz bands:

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

INDUSTRY CANADA EXEMPTION

RSS-102 Clause 2.5.2 RF exposure evaluation is required if the separation distance between the user and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 2.5 W;
- at or above 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 5 W.

RF EXPOSURE RESULTS

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

Single Chain and non-colocated transmitters								
Band	**Mode**	**Separation Distance (cm)**	**Output Power (dBm)**	**Antenna Gain (dBi)**	**Duty Cycle (%)**	**EIRP (mW)**	**FCC Power Density (mW/cm^2)**	**IC Power Density (W/m^2)**
2.4 GHz	FHSS	20	4.10	4.80	100.0	7.8	0.002	0.02

Multiple chain or colocated transmitters									
Band	**Mode**	**Chain for MIMO**	**Separation Distance (cm)**	**Output Power (dBm)**	**Antenna Gain (dBi)**	**Duty Cycle (%)**	**EIRP (mW)**	**FCC Power Density (mW/cm^2)**	**IC Power Density (W/m^2)**
2.4 GHz	FHSS	N/A		4.10	4.80	100.0	7.8		
2.4 GHz	WLAN (C3K1398)	1		24.91	2.00	100.0	490.9		
Combined			20				503.7	0.100	1.00

The device operates above 1.5 GHz with a maximum EIRP less than or equal to 5 Watts as a mobile device with a minimum separation distance of 20 cm, therefore it is exempt from routine RF Exposure Evaluation under RSS-102.