



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

**BLUETOOTH LOW ENERGY  
CERTIFICATION TEST REPORT**

**FOR**

**802.11a/b/g/n/ac WLAN + Bluetooth PCI-E Mini Card**

**MODEL NUMBER: BCM94352HMB**

**FCC ID: QDS-BRCM1068  
IC: 4324A-BRCM1068**

**REPORT NUMBER: 12U14473-5**

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**NVLAP LAB CODE 200065-0**

Revision History

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--	09/04/12	Initial Issue	F. Ibrahim

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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** BROADCOM CORPORATION  
190 MATHILDA PLACE  
SUNNYVALE, CA 94086, U.S.A.

**EUT DESCRIPTION:** 802.11a/b/g/n/ac WLAN + Bluetooth PCI-E Mini Card

**MODEL:** BCM94352HMB

**SERIAL NUMBER:** 265 (P238)

**DATE TESTED:** August 23 - 29, 2012

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:



FRANK IBRAHIM  
WiSE PROJECT LEADER  
UL CCS

Tested By:



VIEN TRAN  
WiSE ENGINEER  
UL CCS

## 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2003, 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:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

### 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 an 802.11a/b/g/n/ac WLAN + Bluetooth PCI-E Mini Card.

The radio module is manufactured by Broadcom.

### 5.2. MAXIMUM OUTPUT POWER

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

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	Bluetooth Low Energy (BLE)	0.12	1.03

### 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an 802.11a/g/n WLAN + Bluetooth antenna with a maximum gain of 3.9dBi.

### 5.4. SOFTWARE AND FIRMWARE

The EUT driver software installed during testing was Broadcom Bluetooth 4.0 + HS USB Device, version 5.6.0.3200.

The test utility software used during testing was Blue Tool, ver. 1.6.0.4.

### 5.5. WORST-CASE CONFIGURATION AND MODE

The EUT was tested as an external module installed in a test jig board connected to a host Laptop PC. The EUT was oriented in a flat orientation, similar to the orientation it would have in real installations; see setup photos for details.

Worst-case mode and channel used for 30-1000 MHz radiated and power line conducted emissions was the mode and channel with the highest output power.

## 5.6. DESCRIPTION OF TEST SET

### SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Lenovo	G560	CBU4473193	DoC
AC/DC Adapter	Lenovo	PA-1650-56LC	11S36001646ZZ400008KCM8	DoC
Jig Board	Catalyst	MINI2EXP	BRCM 2011-05	N/A

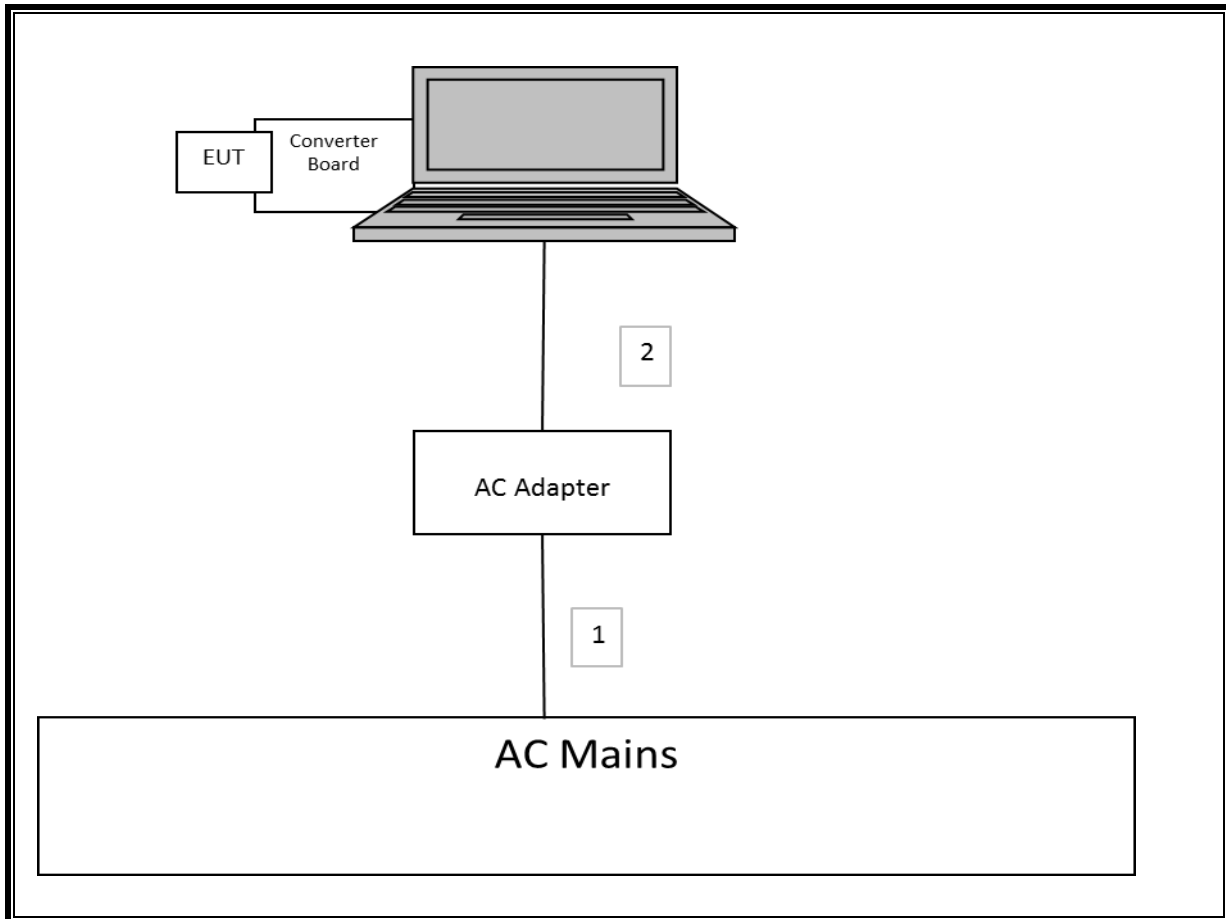
### I/O CABLES

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	US 115V	Shielded	1.5m	NA
2	DC	1	DC	Un-shielded	1.5m	Ferrite at laptop's end

### TEST SETUP

The EUT is attached to a jig board which is installed in the PCMCIA slot of a host 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
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01069	12/15/11	12/15/12
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01012	09/02/11	09/02/12
EMI Test Receiver, 9 kHz-7 GHz	R & S	ESCI 7	1000741	07/13/12	07/06/13
EMI Test Receiver, 30 MHz	R & S	ESHS 20	N02396	08/19/11	08/19/13
Peak Power Meter	Agilent / HP	E4416A	C00963	12/13/11	12/13/12
Peak / Average Power Sensor	Agilent / HP	E9327A	C00964	12/13/11	12/13/12
Antenna, Horn, 18 GHz	EMCO	3115	C00872	09/20/11	09/20/12
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00589	11/01/11	11/01/12
Antenna, Bilog, 30MHz-1 GHz	Sunol Sciences	JB1	C00682	02/07/12	02/07/13
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00885	11/11/11	11/11/12
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01063	07/12/12	07/12/13
LISN, 30 MHz	FCC	50/250-25-2	C00626	12/13/11	12/13/12
Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRC13192	N02683	CNR	CNR

## 7. ANTENNA PORT TEST RESULTS

### 7.1. 6 dB BANDWIDTH

#### LIMITS

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

The minimum 6 dB bandwidth shall be at least 500 kHz.

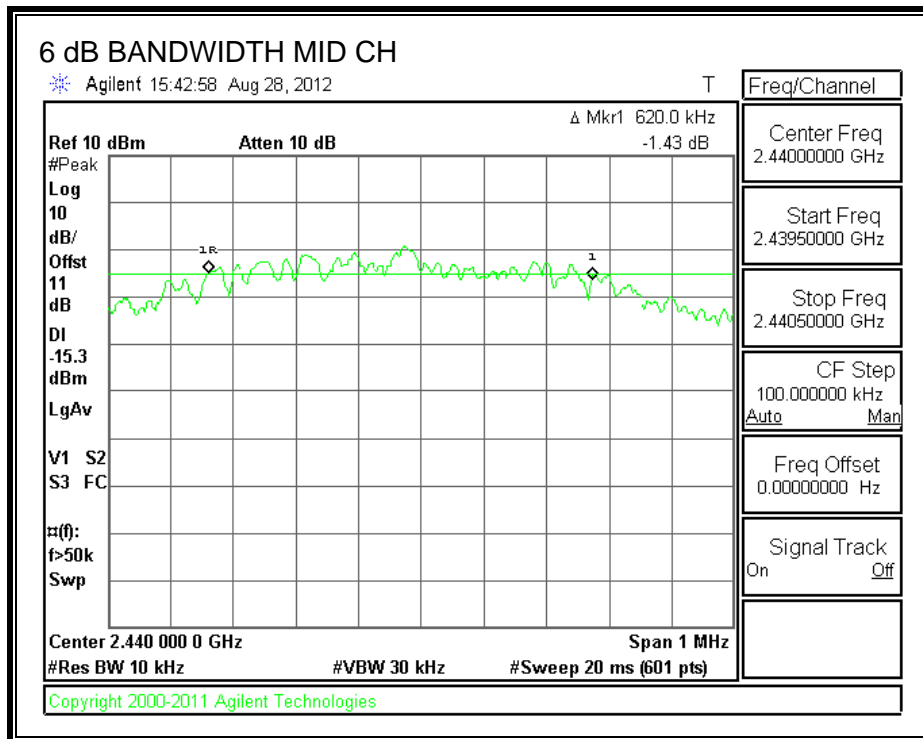
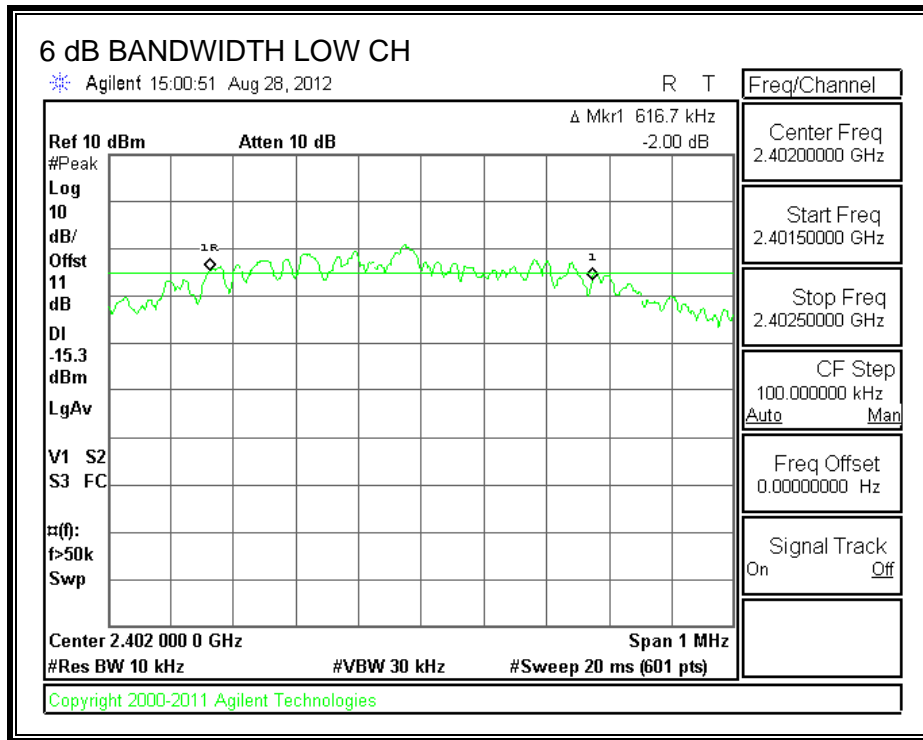
#### TEST PROCEDURE

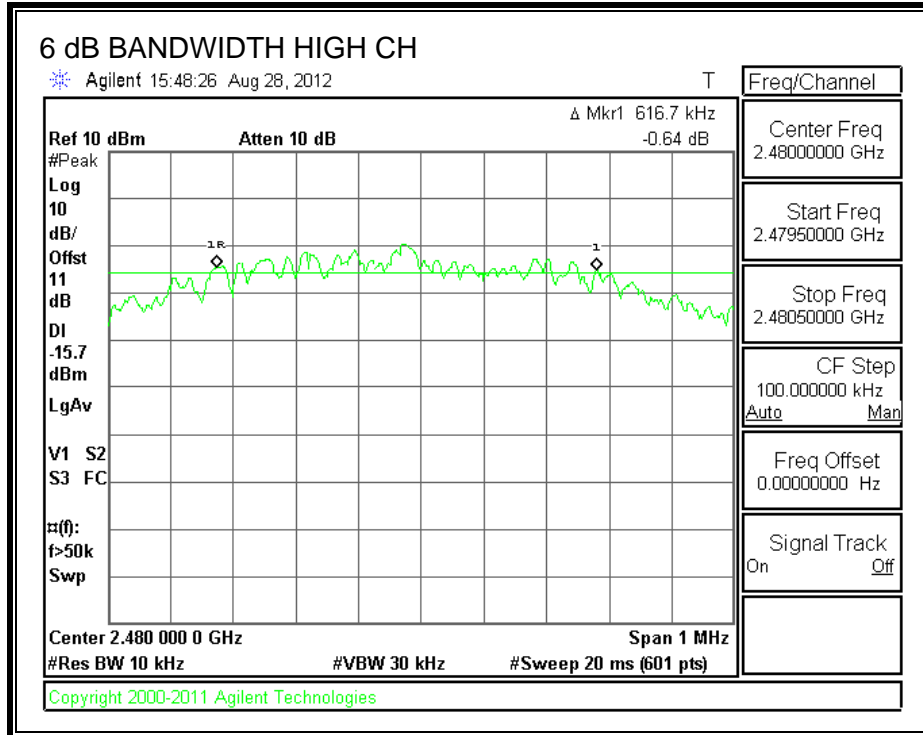
KDB 558074 D01 DTS Measurement Guidance V01 dated 01-18-12.

#### RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6167	0.5
Middle	2440	0.6200	0.5
High	2480	0.6167	0.5

**6 dB BANDWIDTH**





## 7.2. 99% BANDWIDTH

### LIMITS

None; for reporting purposes only.

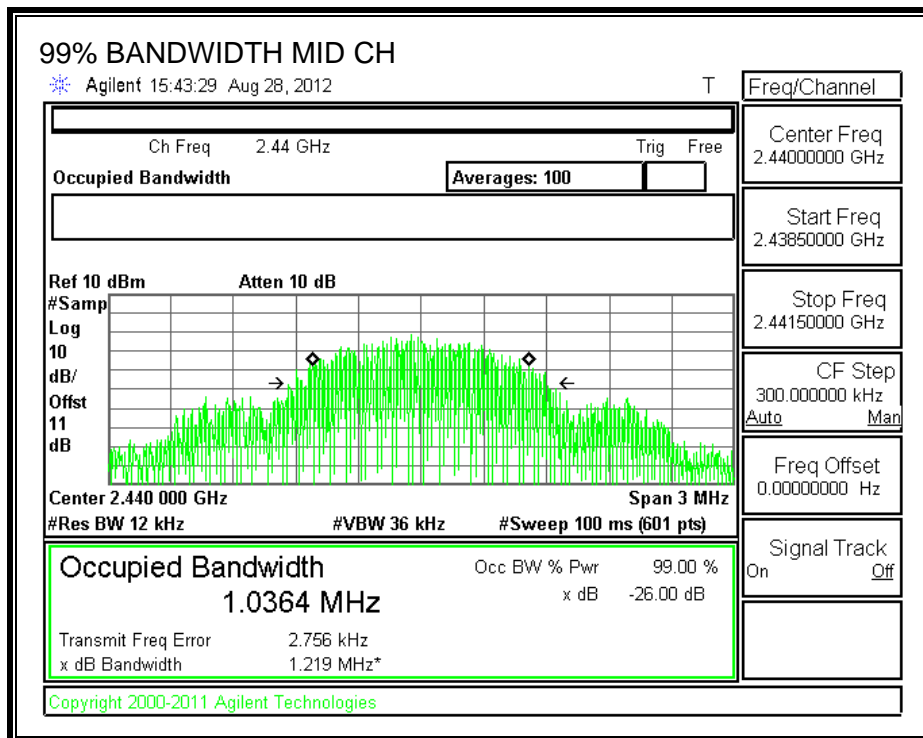
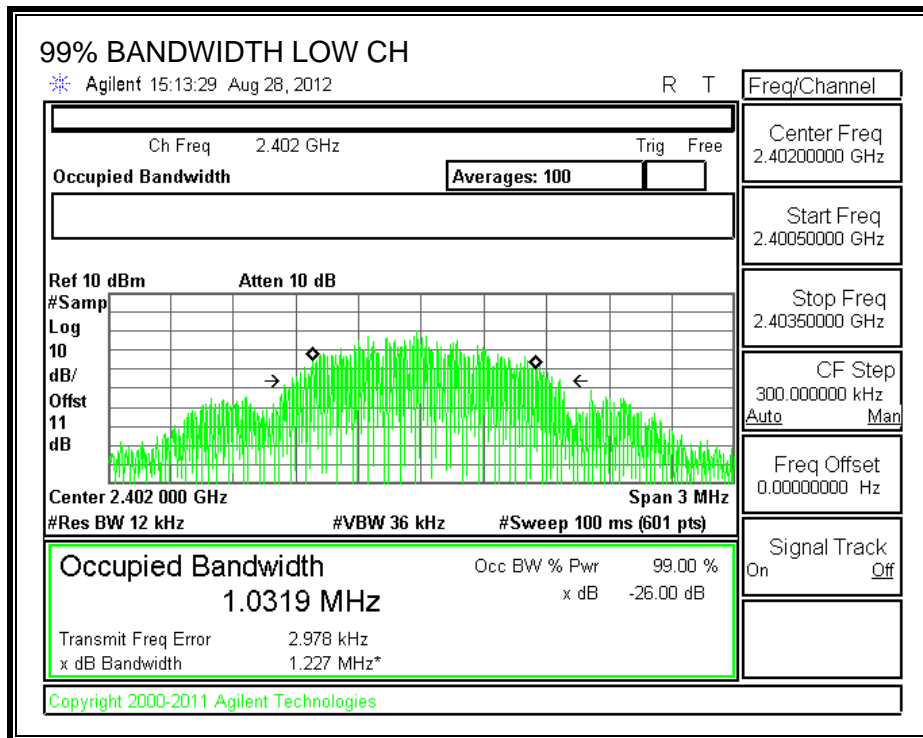
### TEST PROCEDURE

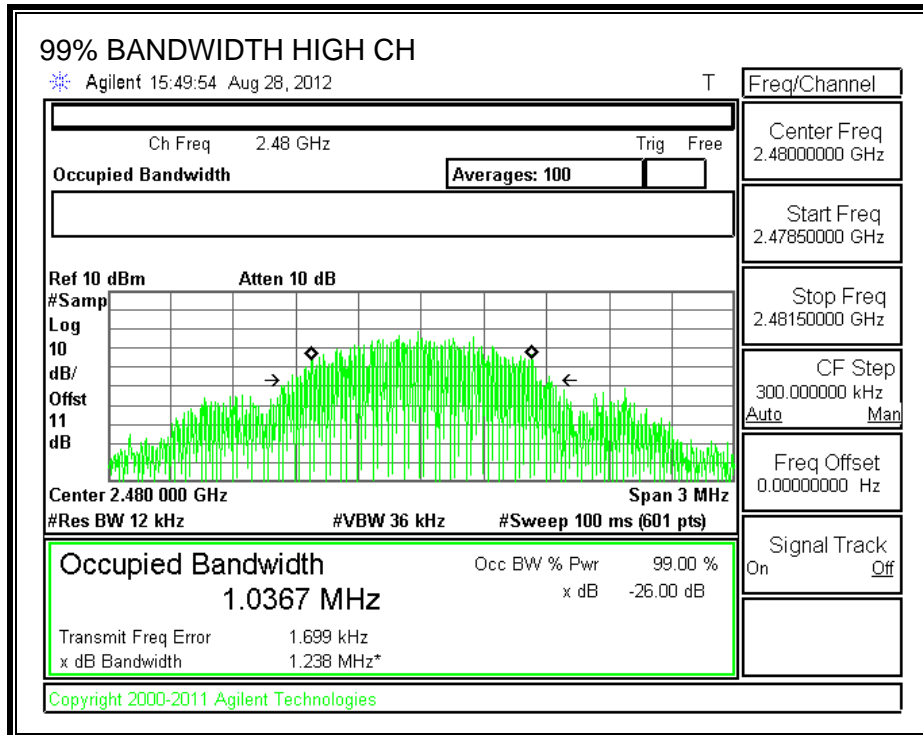
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

### RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.3019
Middle	2440	1.0364
High	2480	1.0367

**99% BANDWIDTH**





### 7.3. OUTPUT POWER

#### LIMITS

FCC §15.247 (b)

IC RSS-210 A8.4

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

#### TEST PROCEDURE

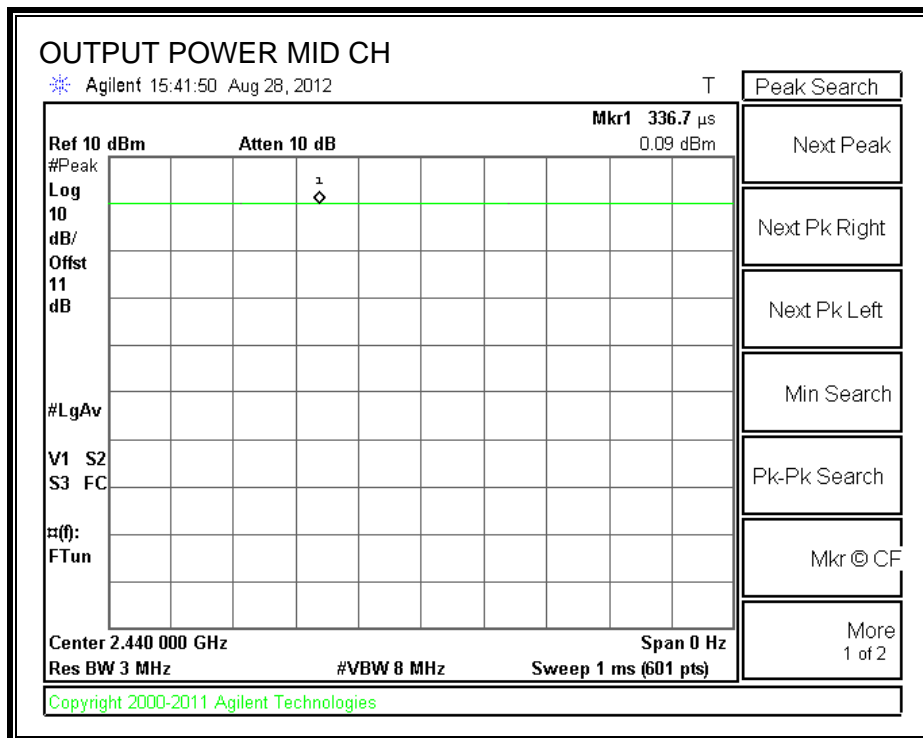
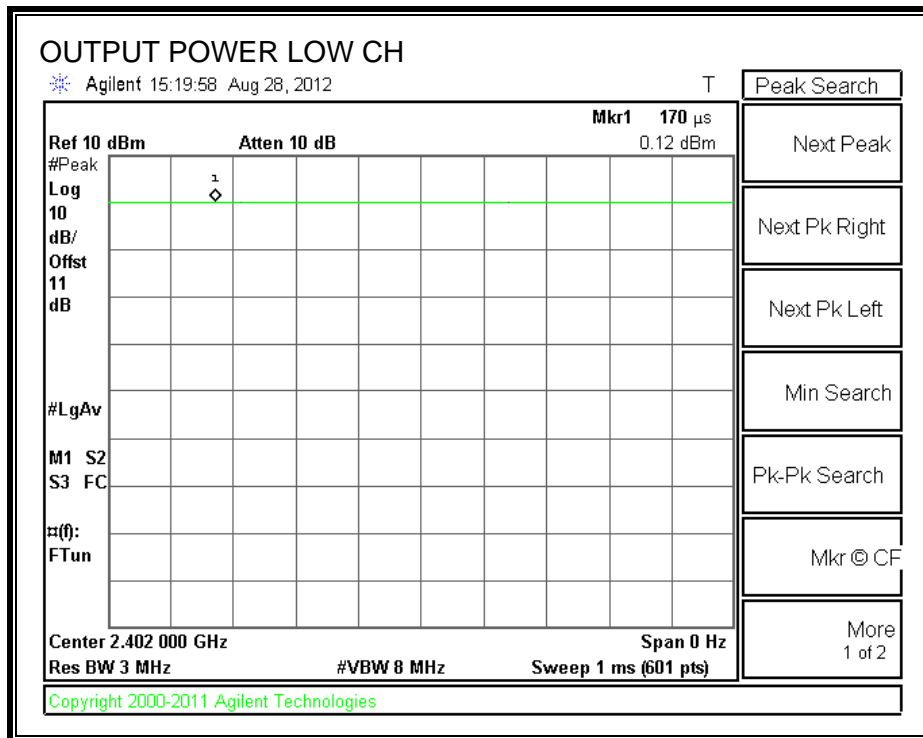
KDB 558074 D01 DTS Measurement Guidance V01 dated 01-18-12.

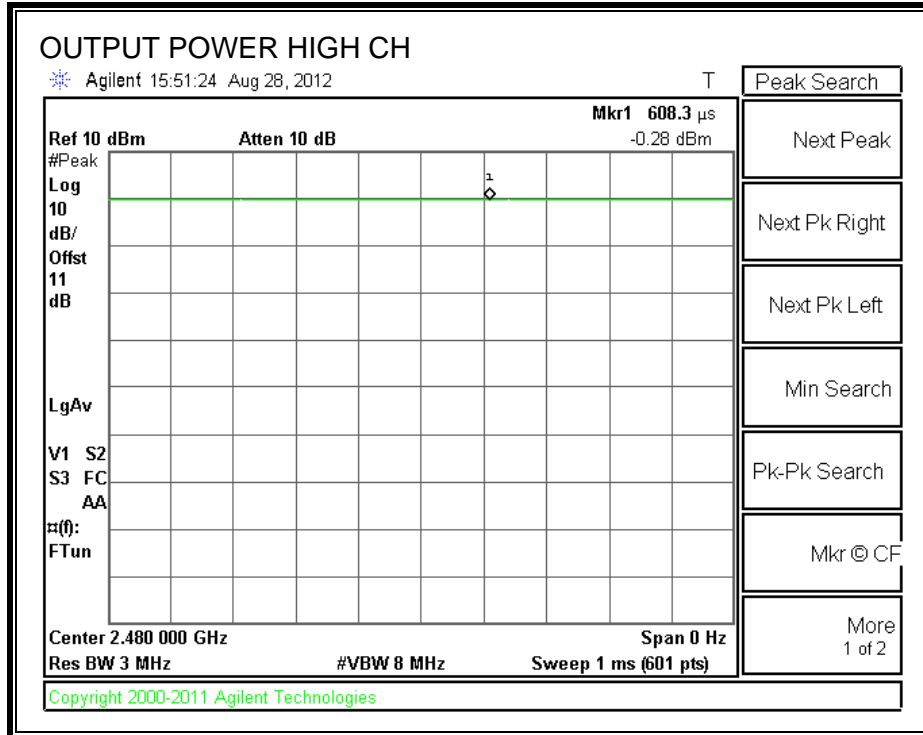
#### RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	0.12	30	-29.88
Middle	2440	0.09	30	-29.91
High	2480	-0.28	30	-30.28



**OUTPUT POWER**





## 7.4. POWER SPECTRAL DENSITY

### LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

### TEST PROCEDURE

KDB 558074 D01 DTS Measurement Guidance V01 dated 01-18-12.

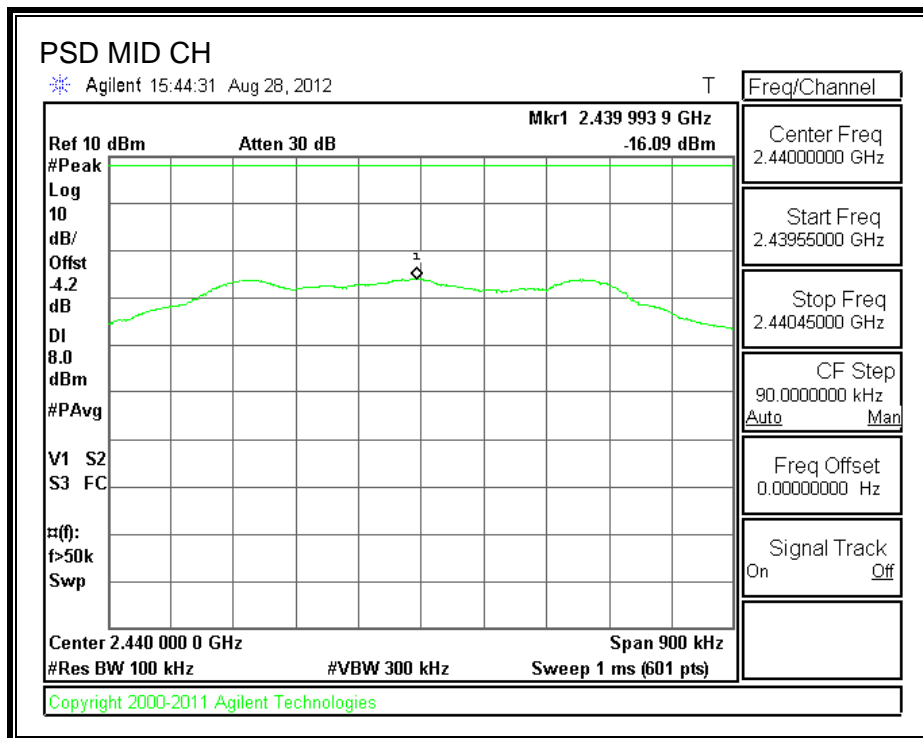
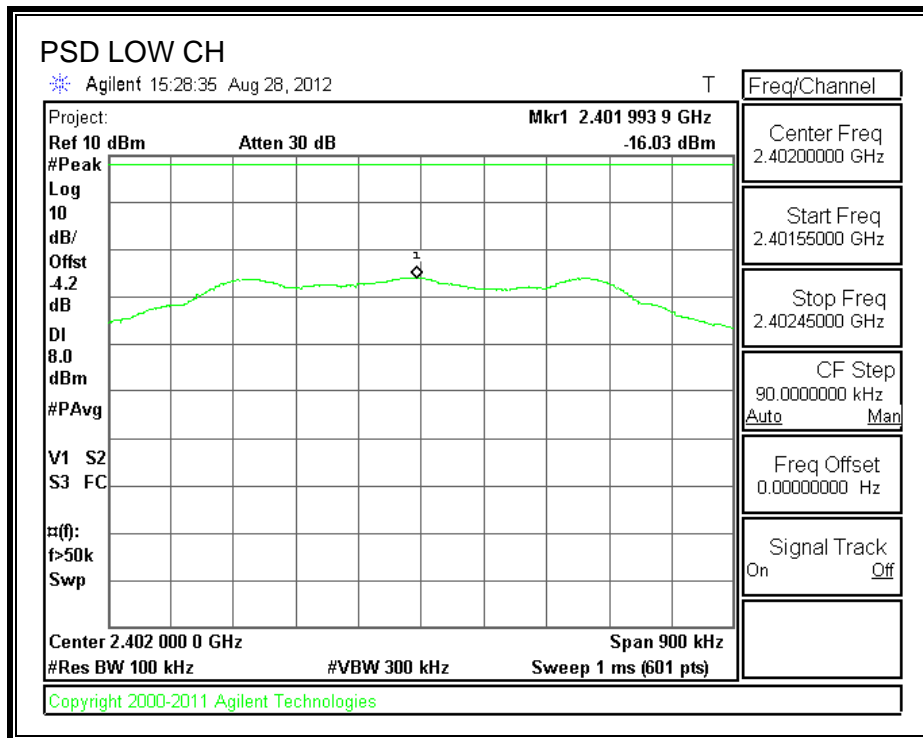
### RESULTS

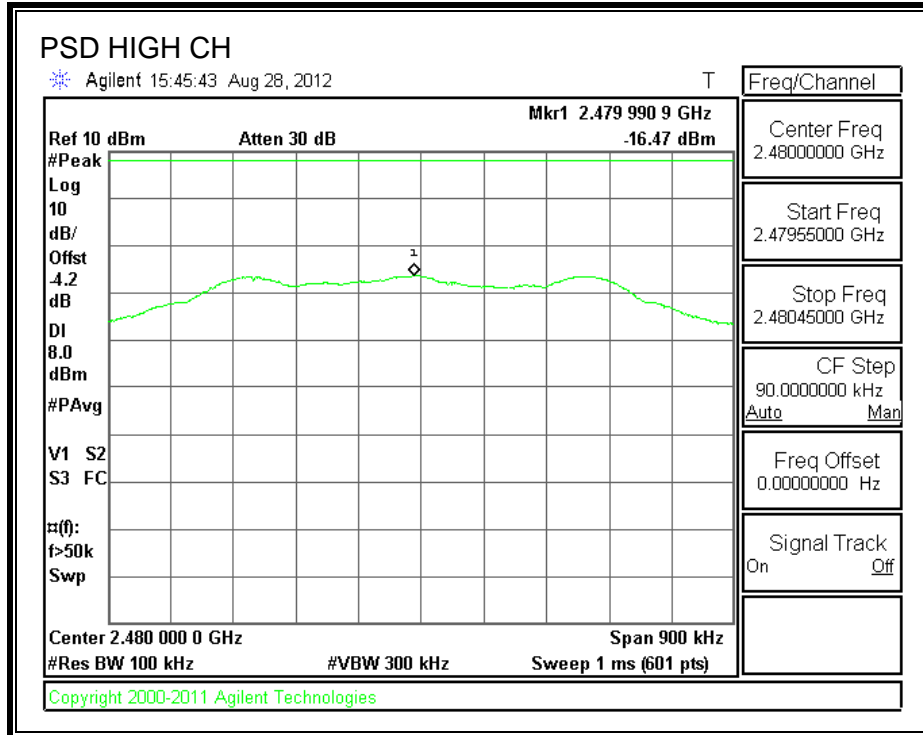
Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-16.03	8	-24.03
Middle	2440	-16.09	8	-24.09
High	2480	-16.47	8	-24.47

### Note:

The spectrum analyzer offset = attenuator loss + cable loss +  $10 \log (3/100 \text{ kHz}) = -4.2\text{dB}$ .

**POWER SPECTRAL DENSITY**





## **7.5. CONDUCTED SPURIOUS EMISSIONS**

### **LIMITS**

FCC §15.247 (d)

IC RSS-210 A8.5

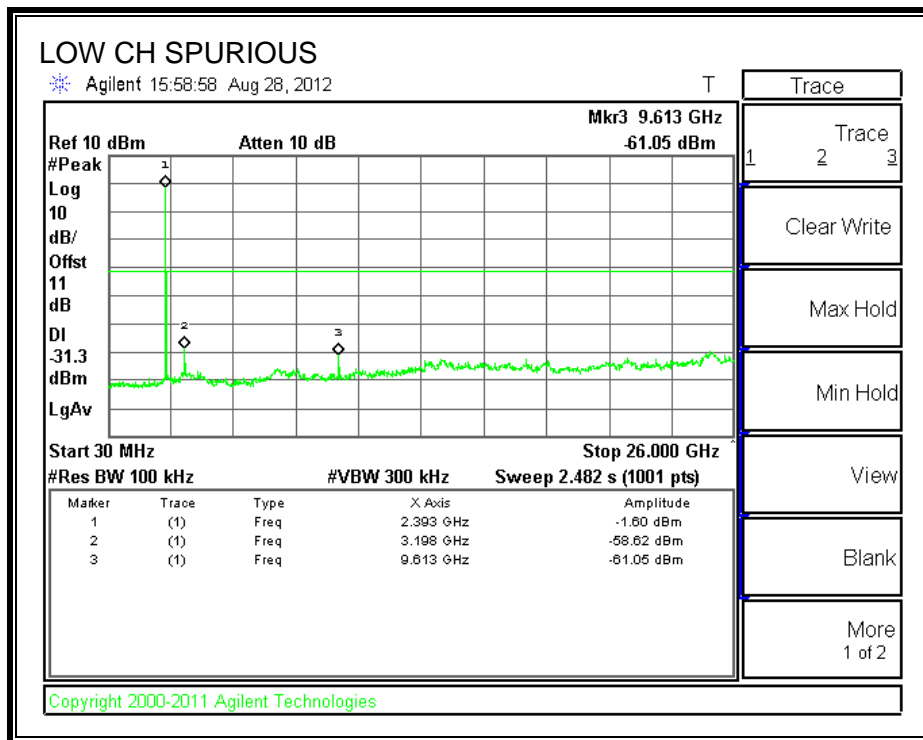
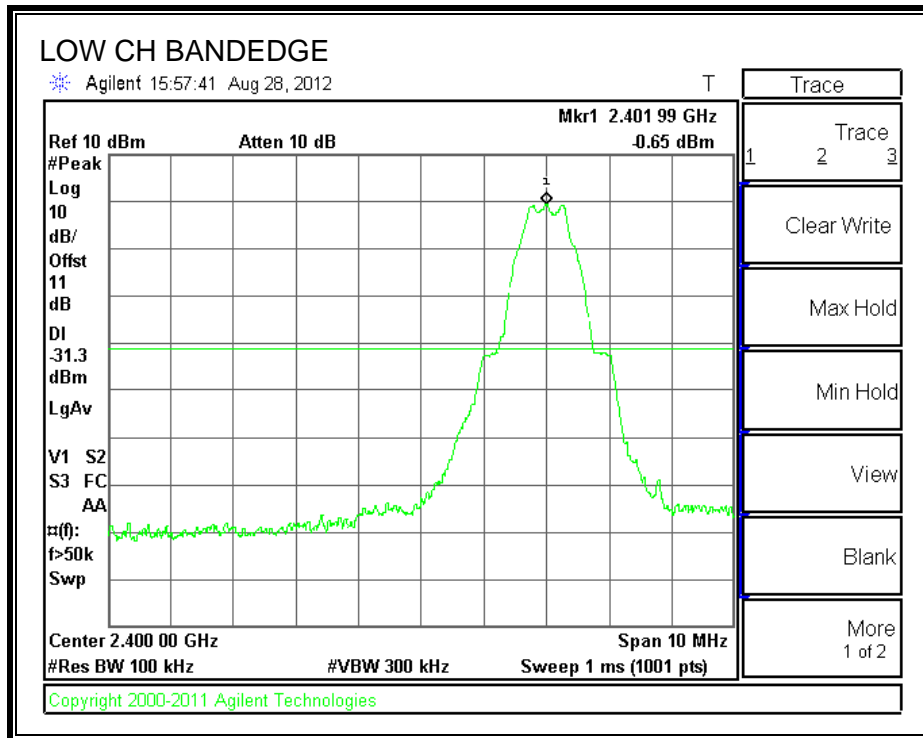
Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

### **TEST PROCEDURE**

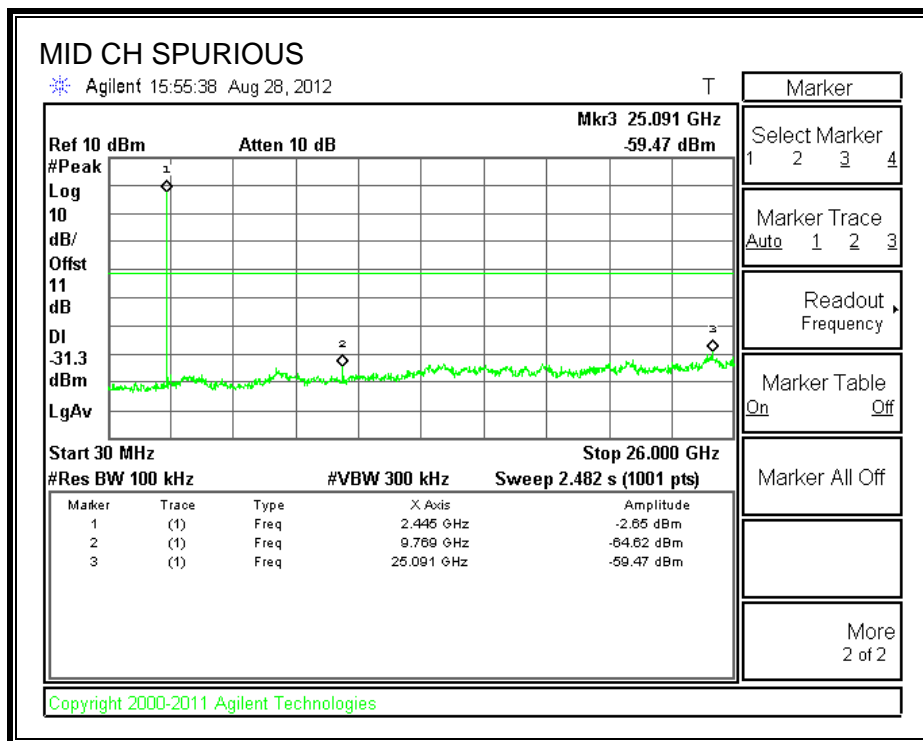
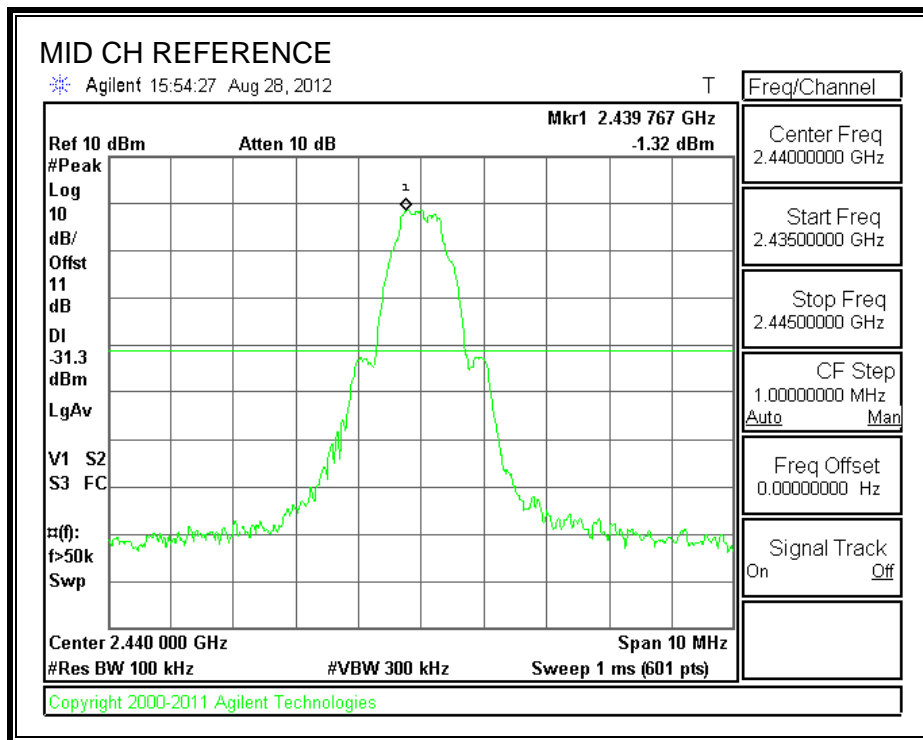
KDB 558074 D01 DTS Measurement Guidance V01 dated 01-18-12.

**RESULTS**

**SPURIOUS EMISSIONS, LOW CHANNEL**

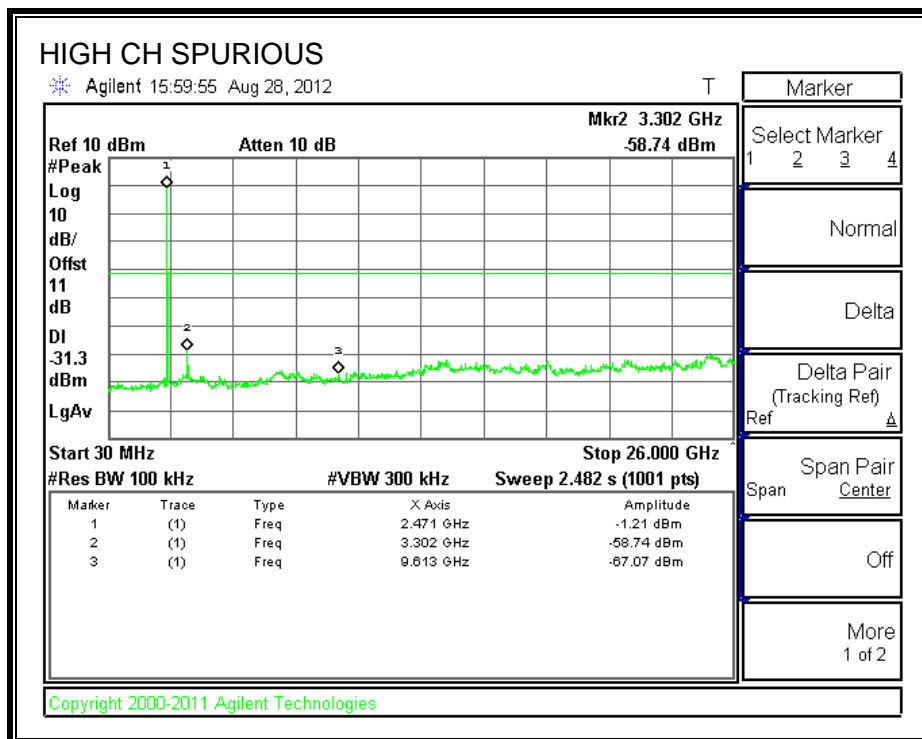
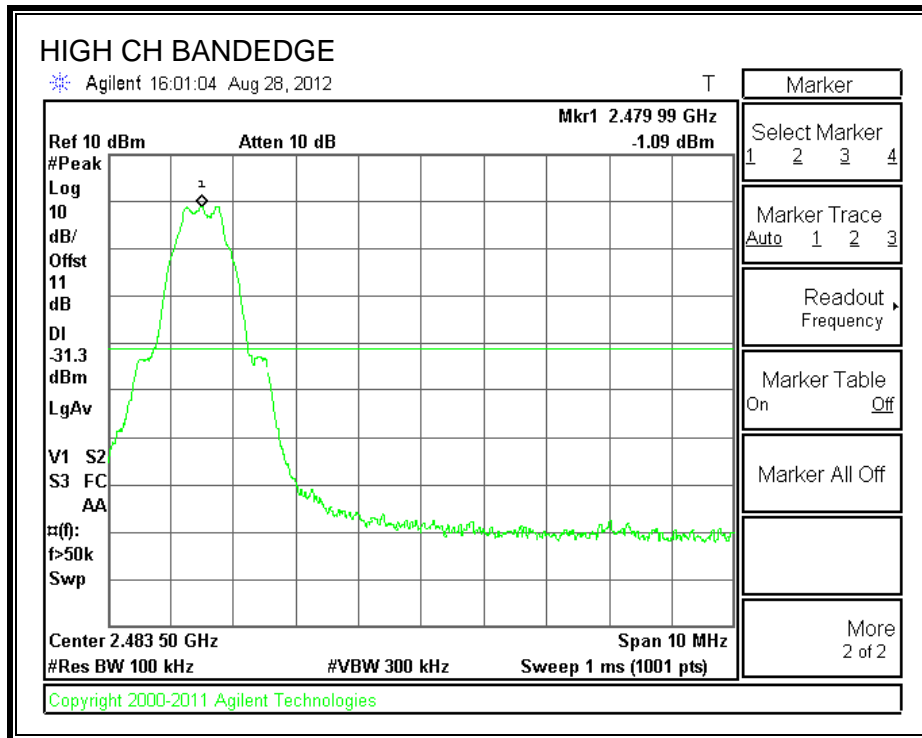


**SPURIOUS EMISSIONS, MID CHANNEL**





**SPURIOUS EMISSIONS, HIGH CHANNEL**



## 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, and then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

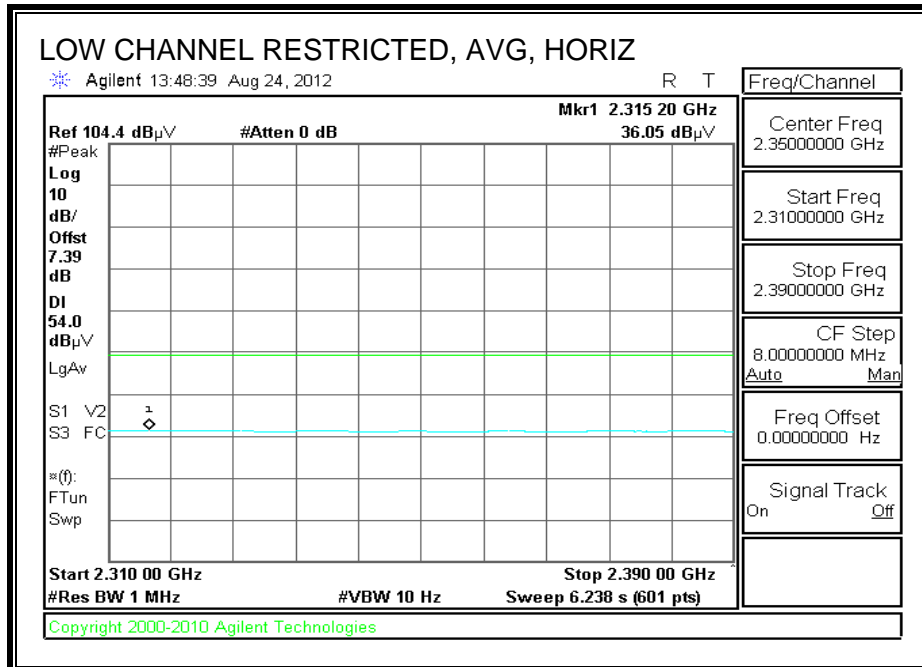
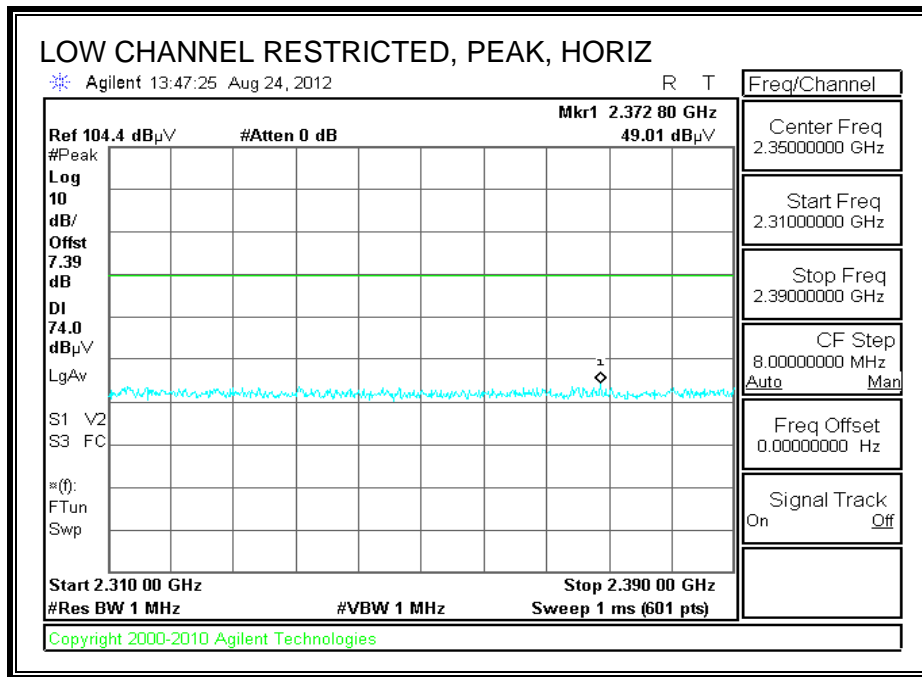
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

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

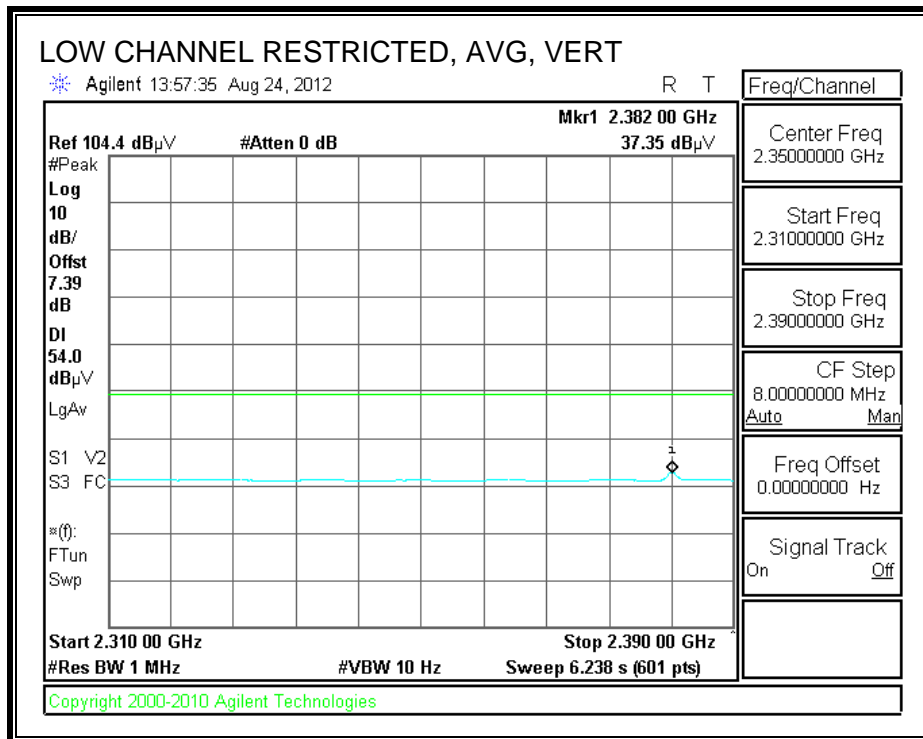
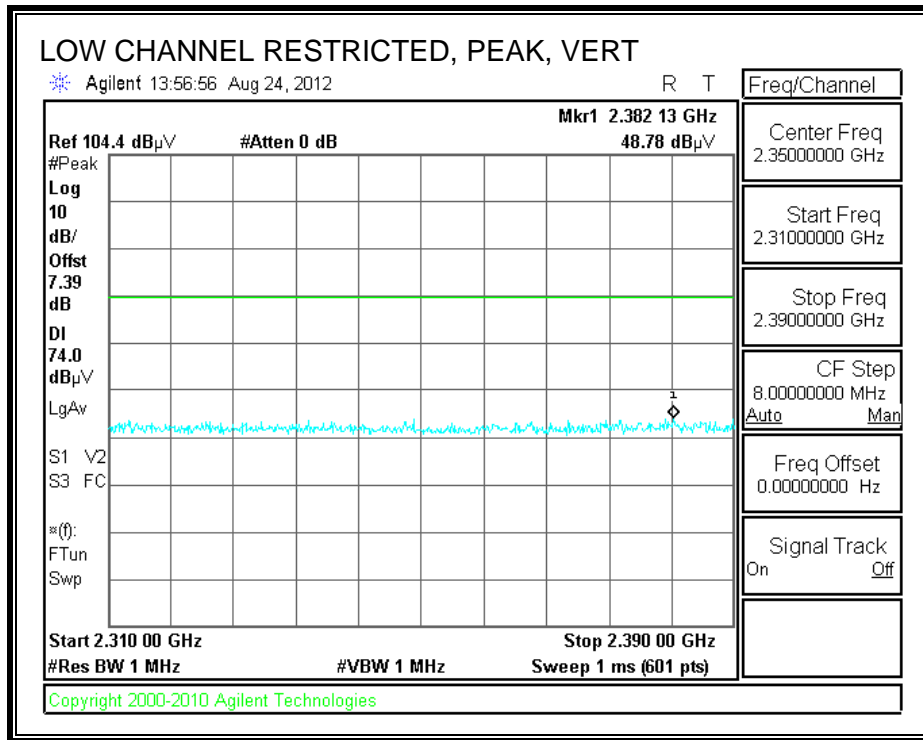
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

## 8.2. TRANSMITTER ABOVE 1 GHz

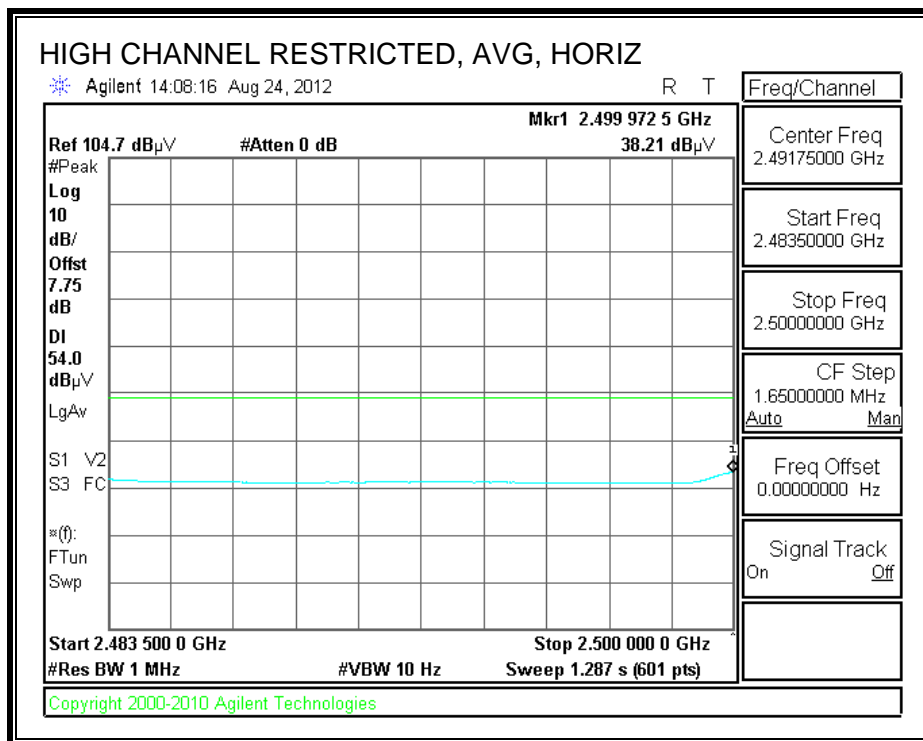
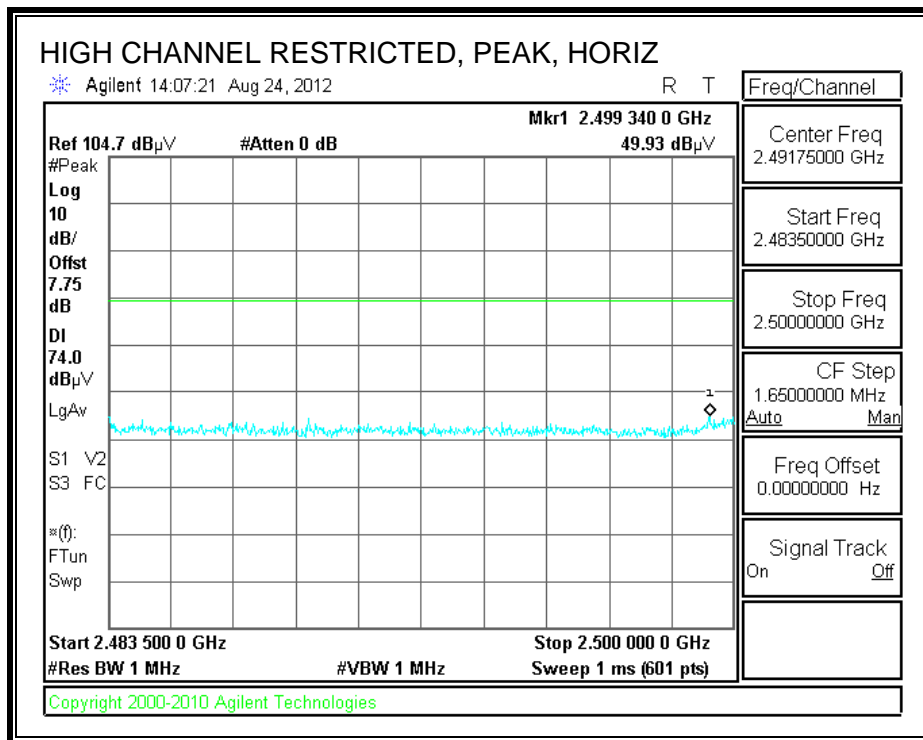
### RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



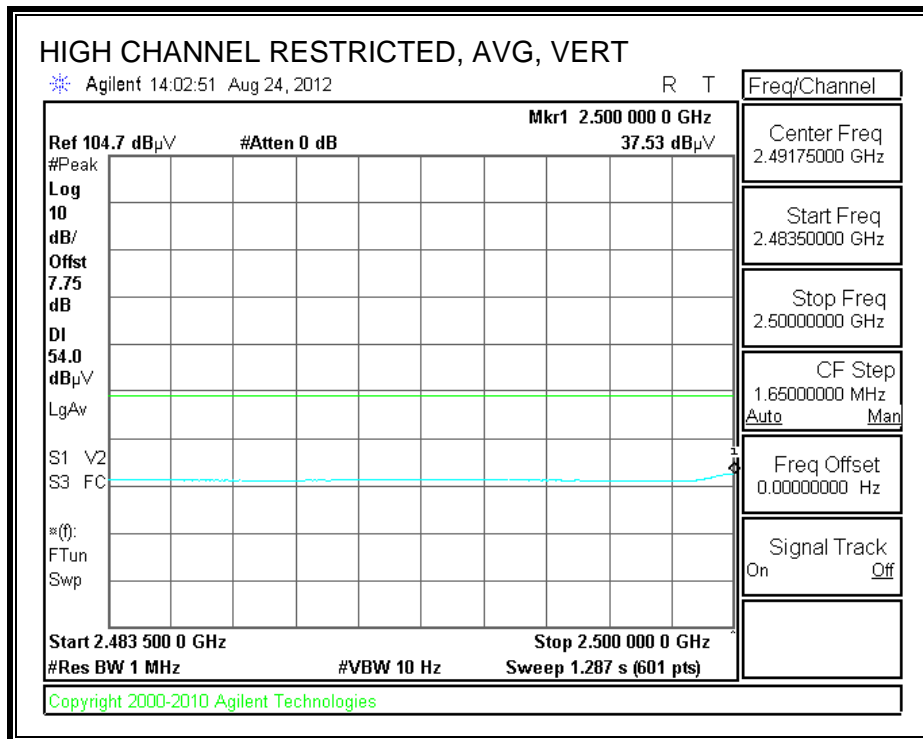
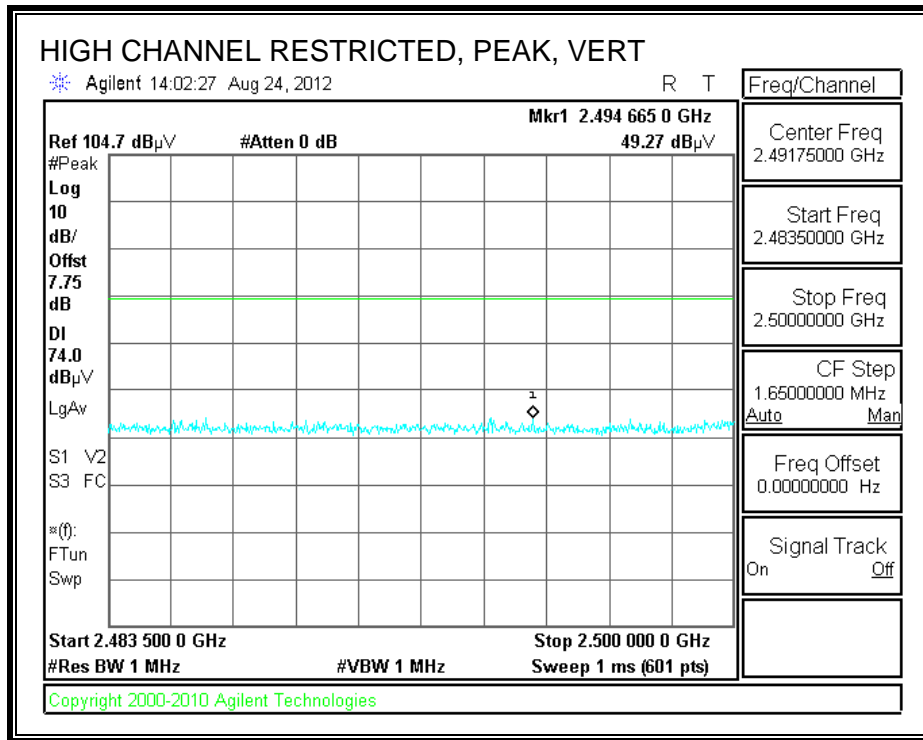
**RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**



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



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



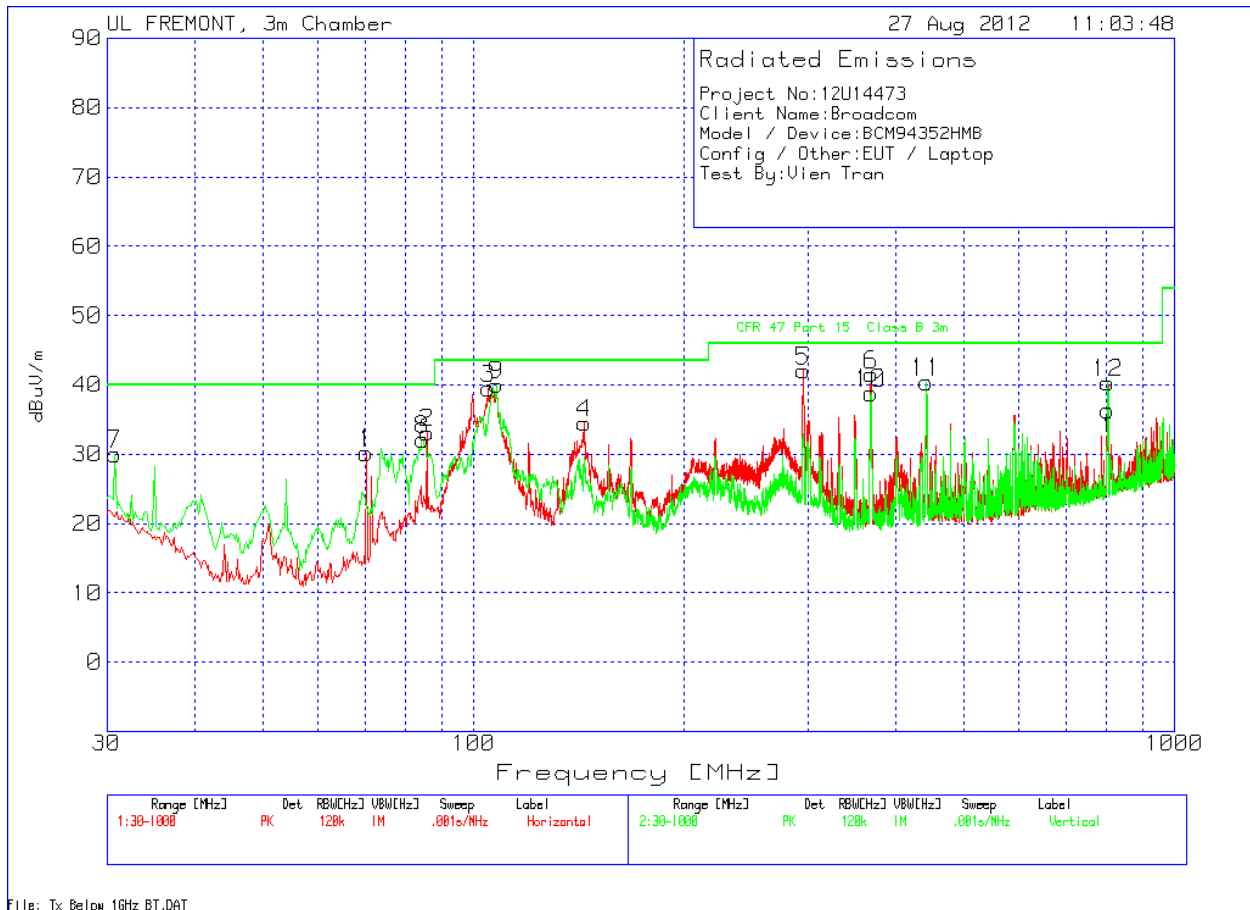
**HARMONICS AND SPURIOUS EMISSIONS**

High Frequency Measurement															
Compliance Certification Services, Fremont 5m Chamber															
Test Engr:		Vien Tran													
Date:		08/27/12													
Project #:		12U14473													
Company:		Broadcom													
Test Target:		FCC 15.247													
Mode Oper:		Tx LE 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	Dist	Read	AF	CL	Amp	D Corr	Fltr	Corr.	Limit	Margin	Ant. Pol.	Det.	Ant.High	Table Angle	Notes
GHz	(m)	dBuV	dB/m	dB	dB	dB	dB	dB	dBuV/m	dBuV/m	dB	V/H	P/A/QP	cm	Degree
<b>LOW CHANNEL (0), 2402MHz</b>															
4.804	3.0	37.9	33.1	6.8	-34.1	0.0	0.0	43.7	74.0	-30.3	V	P	98.0	170.0	
4.804	3.0	27.0	33.1	6.8	-34.1	0.0	0.0	32.9	54.0	-21.1	V	A	98.0	170.0	
4.804	3.0	37.8	33.1	6.8	-34.1	0.0	0.0	43.6	74.0	-30.4	H	P	101.0	321.0	
4.804	3.0	26.3	33.1	6.8	-34.1	0.0	0.0	32.1	54.0	-21.9	H	A	101.0	321.0	
<b>MID CHANNEL (19), 2440MHz</b>															
4.880	3.0	39.4	33.2	6.8	-34.0	0.0	0.0	45.4	74.0	-28.6	V	P	100.0	165.0	
4.880	3.0	27.1	33.2	6.8	-34.0	0.0	0.0	33.1	54.0	-20.9	V	A	100.0	165.0	
7.320	3.0	35.9	36.3	9.1	-33.1	0.0	0.0	48.1	74.0	-25.9	V	P	135.0	221.0	
7.320	3.0	23.4	36.3	9.1	-33.1	0.0	0.0	35.7	54.0	-18.3	V	A	135.0	221.0	
4.880	3.0	37.3	33.2	6.8	-34.0	0.0	0.0	43.2	74.0	-30.8	H	P	98.0	17.0	
4.880	3.0	26.2	33.2	6.8	-34.0	0.0	0.0	32.1	54.0	-21.9	H	A	98.0	17.0	
7.320	3.0	35.4	36.3	9.1	-33.1	0.0	0.0	47.6	74.0	-26.4	H	P	99.0	19.0	
7.320	3.0	23.4	36.3	9.1	-33.1	0.0	0.0	35.7	54.0	-18.3	H	A	99.0	19.0	
<b>HIGH CHANNEL (39), 2480MHz</b>															
4.960	3.0	37.1	33.2	6.9	-34.0	0.0	0.0	43.2	74.0	-30.8	V	P	98.0	174.0	
4.960	3.0	25.5	33.2	6.9	-34.0	0.0	0.0	31.6	54.0	-22.4	V	A	98.0	174.0	
7.440	3.0	36.0	36.5	9.1	-33.0	0.0	0.0	48.6	74.0	-25.4	V	P	99.0	174.0	
7.440	3.0	22.9	36.5	9.1	-33.0	0.0	0.0	35.4	54.0	-18.6	V	A	99.0	174.0	
4.960	3.0	38.6	33.2	6.9	-34.0	0.0	0.0	44.7	74.0	-29.3	H	P	165.0	335.0	
4.960	3.0	26.6	33.2	6.9	-34.0	0.0	0.0	32.7	54.0	-21.3	H	A	165.0	335.0	
7.440	3.0	35.8	36.5	9.1	-33.0	0.0	0.0	48.4	74.0	-25.6	H	P	164.0	332.0	
7.440	3.0	22.8	36.5	9.1	-33.0	0.0	0.0	35.4	54.0	-18.6	H	A	164.0	332.0	

Rev. 4.1.2.7

### 8.3. WORST-CASE BELOW 1 GHz

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



File: Tx Below 10Hz\_BT.DAT

#### Trace Markers



**Horizontal 30 - 1000MHz**

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	25MHz-1GHz Chambr 3m Amplified (dB)	Antenna T185 (dB)	Corrected Reading dBuV/m	CFR 47 Part 15 Class B 3m	Margin to Limit (dB)	Height (cm)	Polarity
1	70.3197	49.11	PK	-27.1	8.2	30.21	40	-9.79	301	Horz
2	85.8273	52.79	PK	-27	7.3	33.09	40	-6.91	400	Horz
3	105.018	55	PK	-26.8	11.3	39.5	43.5	-4	201	Horz
4	143.9808	48.23	PK	-26.4	12.7	34.53	43.5	-8.97	201	Horz
5	295.7614	53.93	PK	-25.2	13.3	42.03	46	-3.97	99	Horz
6	369.0348	52	PK	-25.5	15	41.5	46	-4.5	99	Horz

**Vertical 30 - 1000MHz**

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	25MHz-1GHz Chambr 3m Amplified (dB)	Antenna T185 (dB)	Corrected Reading dBuV/m	CFR 47 Part 15 Class B 3m	Margin to Limit (dB)	Height (cm)	Polarity
7	30.7754	36.8	PK	-27.5	20.7	30	40	-10	100	Vert
8	84.6643	51.74	PK	-27	7.4	32.14	40	-7.86	100	Vert
9	107.9257	54.6	PK	-26.7	12.1	40	43.5	-3.5	100	Vert
10	369.0348	49.32	PK	-25.5	15	38.82	46	-7.18	301	Vert
11	443.0835	49.53	PK	-25.8	16.7	40.43	46	-5.57	100	Vert
12	804.0228	43.59	PK	-24.6	21.3	40.29	46	-5.71	100	Vert

PK - Peak detector

## 9. AC POWER LINE CONDUCTED EMISSIONS

### LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

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

\* Decreases with the logarithm of the frequency.

### TEST PROCEDURE

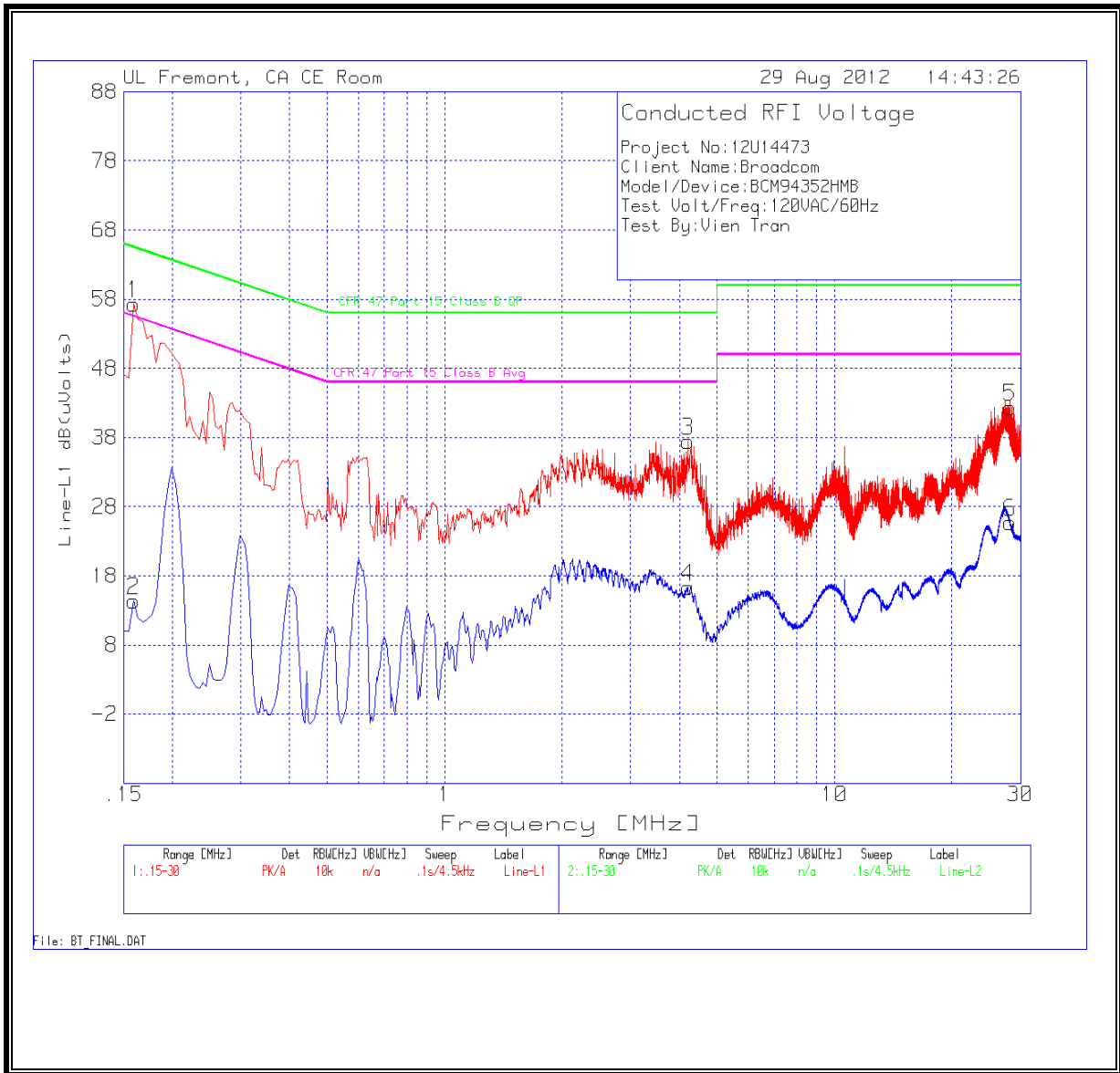
ANSI C63.4

**RESULTS**

**6 WORST EMISSIONS**

Project No:12U14473									
Client Name:Broadcom									
Model/Device:BCM94352HMB									
Test Volt/Freq:120VAC/60Hz									
Test By:Vien Tran									
Frequency MHz	Reading dB(μV)	Detector	T24 LISN dB	Cables dB	Corrected dB(μV)	Class B QP Limit dB(μV)	QP Margin dB	Class B Av Limit dB(μV)	Av Margin dB
<b>Line-L1 .15 - 30MHz</b>									
0.159	57.22	PK	0.1	0	57.32	65.5	-8.18	-	-
0.159	14.27	Av	0.1	0	14.37	-	-	55.5	-41.13
4.2	37.26	PK	0.1	0.1	37.46	56	-18.54	-	-
4.2	16.08	Av	0.1	0.1	16.28	-	-	46	-29.72
28.1715	41.56	PK	0.5	0.3	42.36	60	-17.64	-	-
28.1715	24.89	Av	0.5	0.3	25.69	-	-	50	-24.31
Frequency MHz	Reading dB(μV)	Detector	T24 LISN dB	Cables dB	Corrected dB(μV)	Class B QP Limit dB(μV)	QP Margin dB	Class B Av Limit dB(μV)	Av Margin dB
<b>Line-L2 .15 - 30MHz</b>									
0.168	51.61	PK	0.1	0	51.71	65.1	-13.39	-	-
0.168	16.77	Av	0.1	0	16.87	-	-	55.1	-38.23
3.417	36.62	PK	0.1	0.1	36.82	56	-19.18	-	-
3.417	16.16	Av	0.1	0.1	16.36	-	-	46	-29.64
25.9395	42.72	PK	0.5	0.3	43.52	60	-16.48	-	-
25.9395	21.99	Av	0.5	0.3	22.79	-	-	50	-27.21
PK - Peak detector									
QP - Quasi-Peak detector									
LnAv - Linear Average detector									
LgAv - Log Average detector									
Av - Average detector									
CAV - CISPR Average detector									
RMS - RMS detection									
CRMS - CISPR RMS detection									
Text File: BT_FINAL.TXT									
File: BT_FINAL.DAT									

**LINE 1 RESULTS**



**LINE 2 RESULTS**

