



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

CERTIFICATION TEST REPORT

FOR

BROADCOM 802.11a/b/g/n WLAN + BLUETOOTH PCI-E MINI CARD

MODEL NUMBER: BCM943228HMB

**FCC ID: QDS-BRCM1058
IC: 4324A-BRCM1058**

REPORT NUMBER: 11U13795-18, Revision A

ISSUE DATE: JUNE 29, 2011

Prepared for

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

Prepared by

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



NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	06/28/11	Initial Issue	T. Chan
A	06/29/11	Removed MPE section	M. Heckrotte

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1. ATTESTATION OF TEST RESULTS

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

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

MODEL: BCM943228HMB

SERIAL NUMBER: 1403512 (P305)

DATE TESTED: JUNE 01 - 23, 2011

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

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

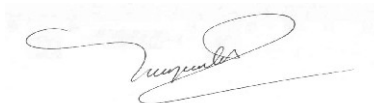
Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL CCS and all revisions are duly noted in the revisions section. Any alteration of this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

Approved & Released For UL CCS By:

Tested By:



MICHAEL HECKROTTE
DIRECTOR OF ENGINEERING
UL CCS



VIEN TRAN
EMC ENGINEER
UL CCS

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with 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:

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

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 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	Low Energy (BLE)	4.51	2.82

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an 802.11bgn WLAN and Bluetooth antenna with a maximum gain of 3.90 dBi.

5.4. SOFTWARE AND FIRMWARE

The EUT driver software installed during testing was Broadcom Bluetooth Version 5.1.0.1400

The test utility software used during testing was Bluetool, ver. 1.4.2.6.

5.5. WORST-CASE CONFIGURATION AND MODE

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

5.6. DESCRIPTION OF TEST SETUP

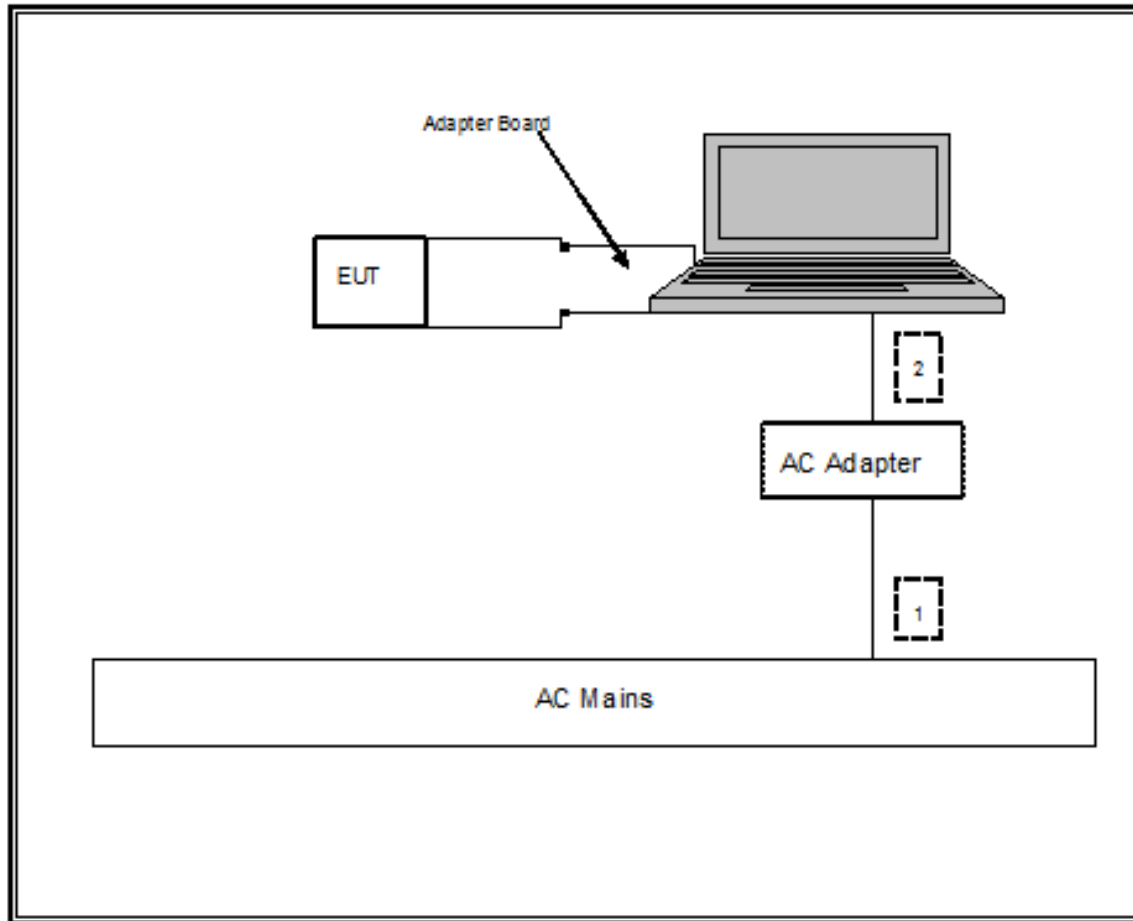
SUPPORT EQUIPMENT

Band	Mode	Separation Distance (m)	Output Power (dBm)	Antenna Gain (dBi)	IC Power Density (W/m ²)	FCC Power Density (mW/cm ²)
2.4 GHz	LE	0.20	4.07	3.90	0.0125	0.0012

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

SETUP DIAGRAM FOR TESTS



TEST SETUP

The EUT was attached to a jig board which was installed in the PCMCIA slot of a host laptop computer during the tests. Test software exercised the radio card.

6. TEST AND MEASUREMENT EQUIPMENT

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

TEST EQUIPMENT LIST				
Description	Manufacturer	Model	Asset	Cal Due
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C00996	10/29/11
Antenna, Bilog, 2 GHz	Sundt Sciences	JB1	C01171	07/14/11
Antenna, Horn, 18 GHz	EMCO	3115	C00872	07/29/11
Antenna, Horn, 26.5 GHz	ARA	MVH-1826/B	C00980	07/29/11
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00778	01/26/12
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C00749	08/04/11
Peak Power Meter	Agilent / HP	E9327A	C00964	03/22/12
Peak Power Sensor	Agilent / HP	E4416A	C00963	01/07/12
Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRM50702	N02685	CNR
LISN, 30 MHz	FCC	LISN-50/250-25-2	N02625	05/06/12
EMI Test Receiver, 30 MHz	R & S	ESHS 20	N02396	05/06/12

7. ANTENNA PORT TEST RESULTS – LE (LOW ENERGY) MODULATION

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.

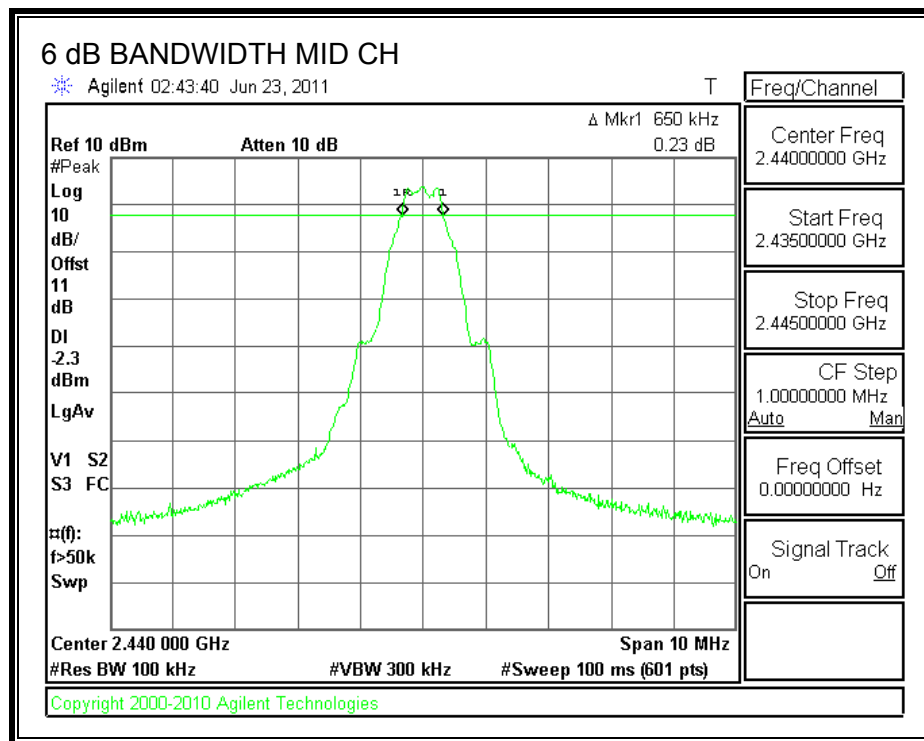
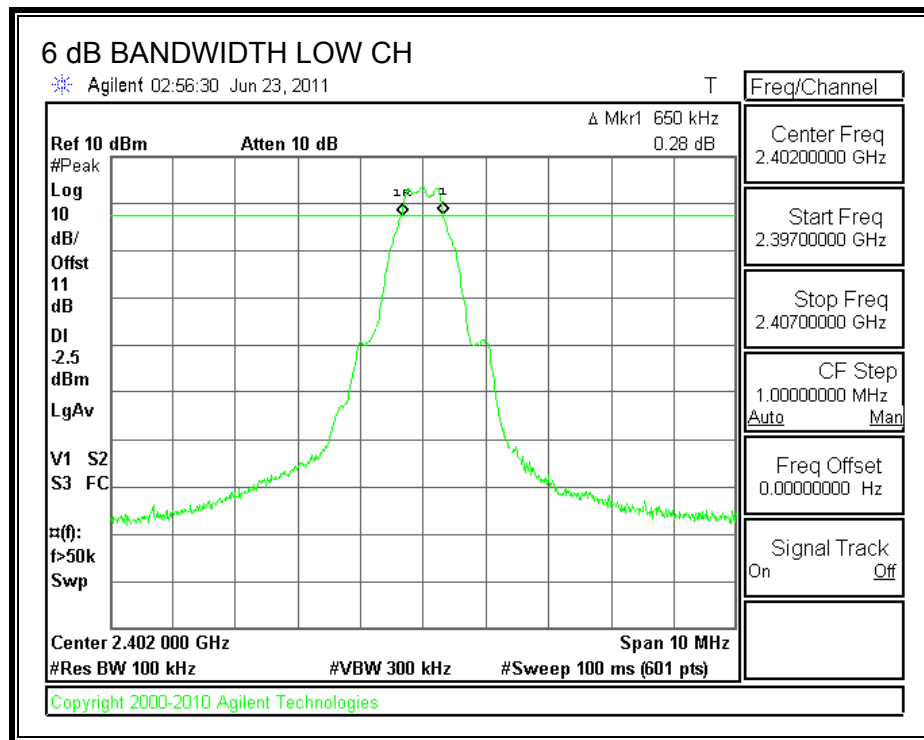
TEST PROCEDURE

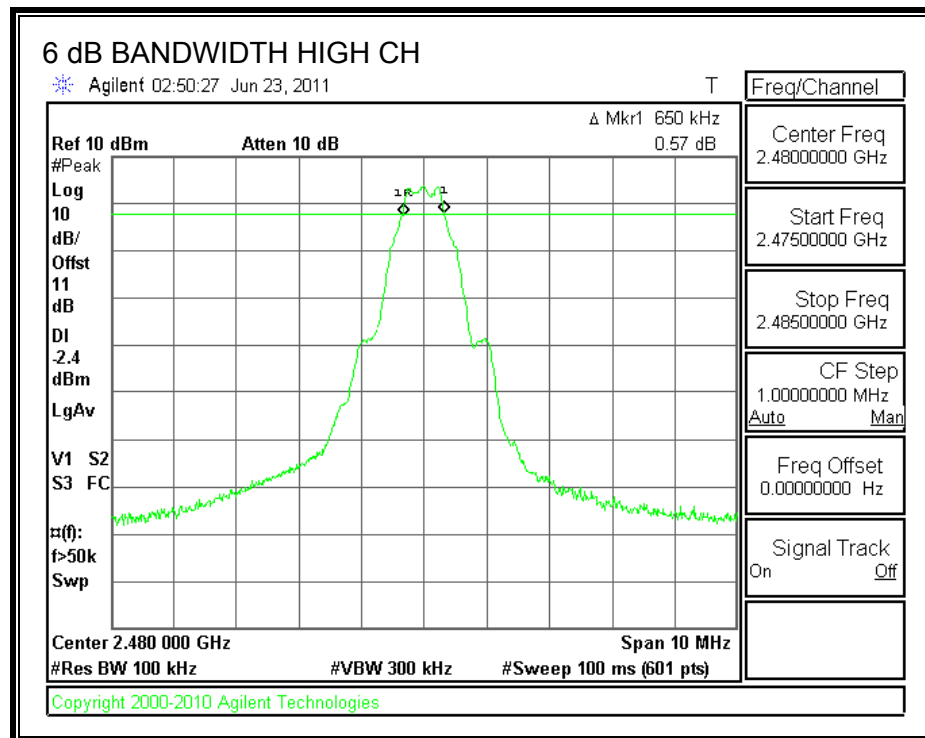
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.650	0.5
Middle	2440	0.650	0.5
High	2480	0.650	0.5

6 dB BANDWIDTH





7.2. 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

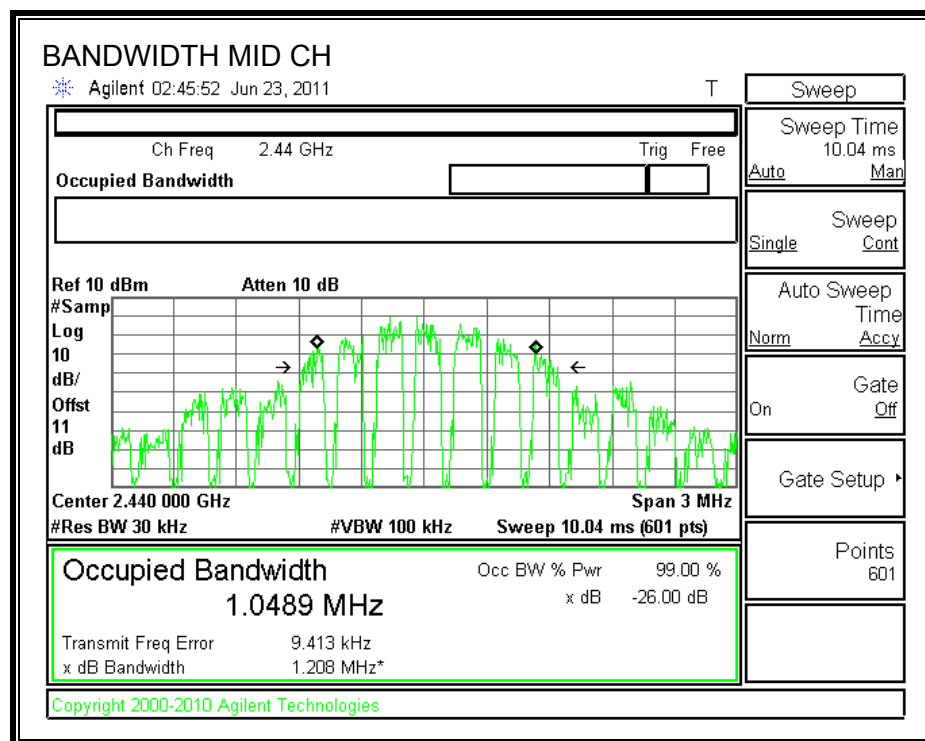
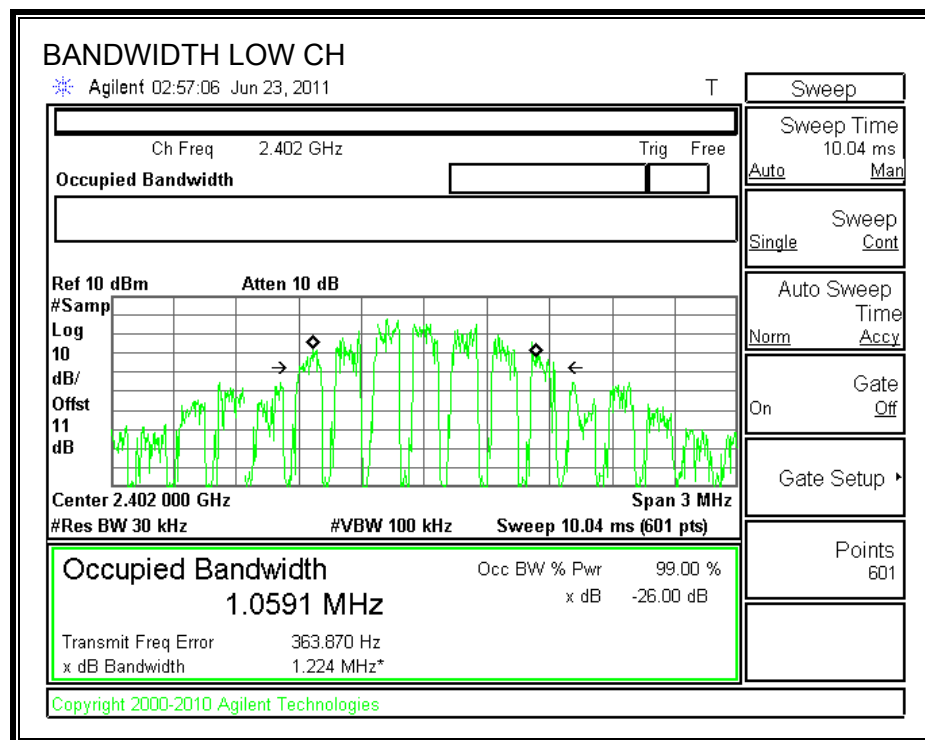
TEST PROCEDURE

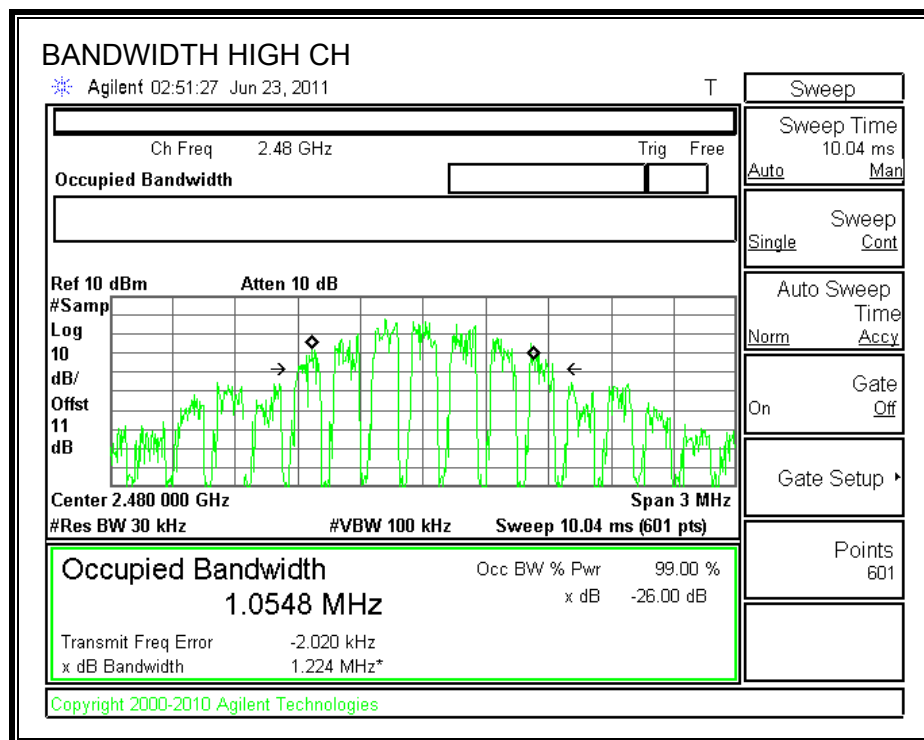
The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1\%$ of the 99% bandwidth. The VBW is set to $\geq$ RBW. The sweep time is coupled.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0591
Middle	2440	1.0489
High	2480	1.0548

99% BANDWIDTH





7.3. OUTPUT POWER

LIMIT

§15.247 (b) (1)

RSS-210 Issue 7 Clause A8.4

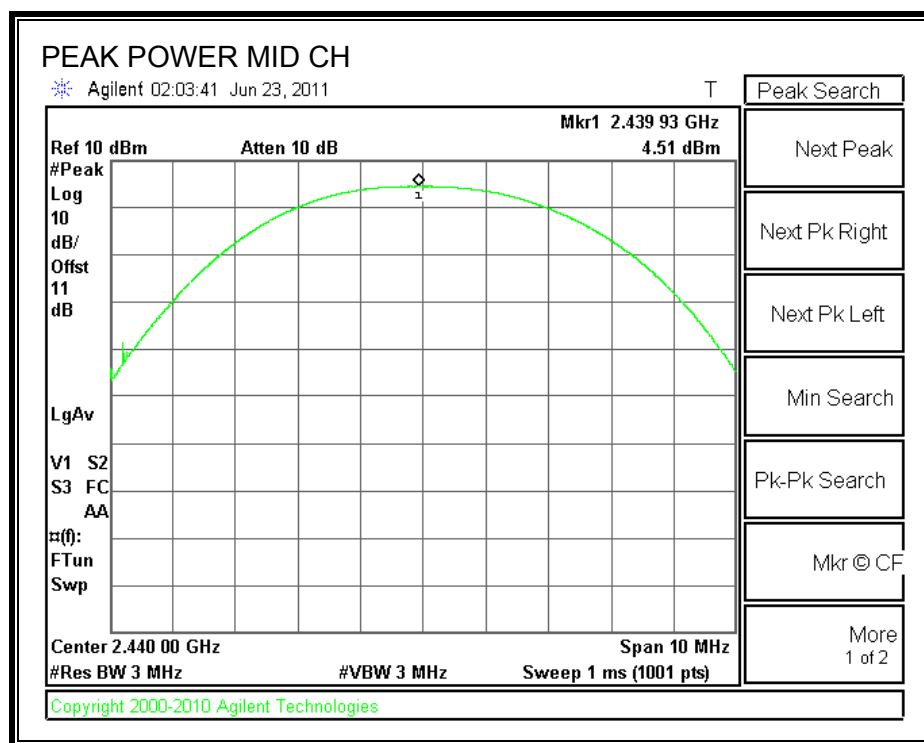
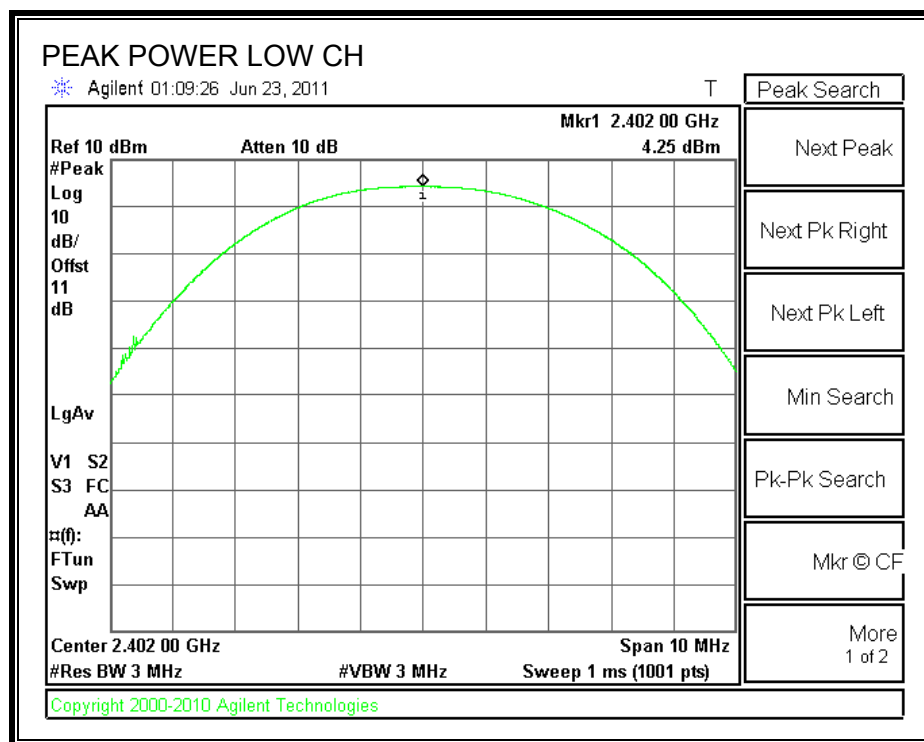
The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm.

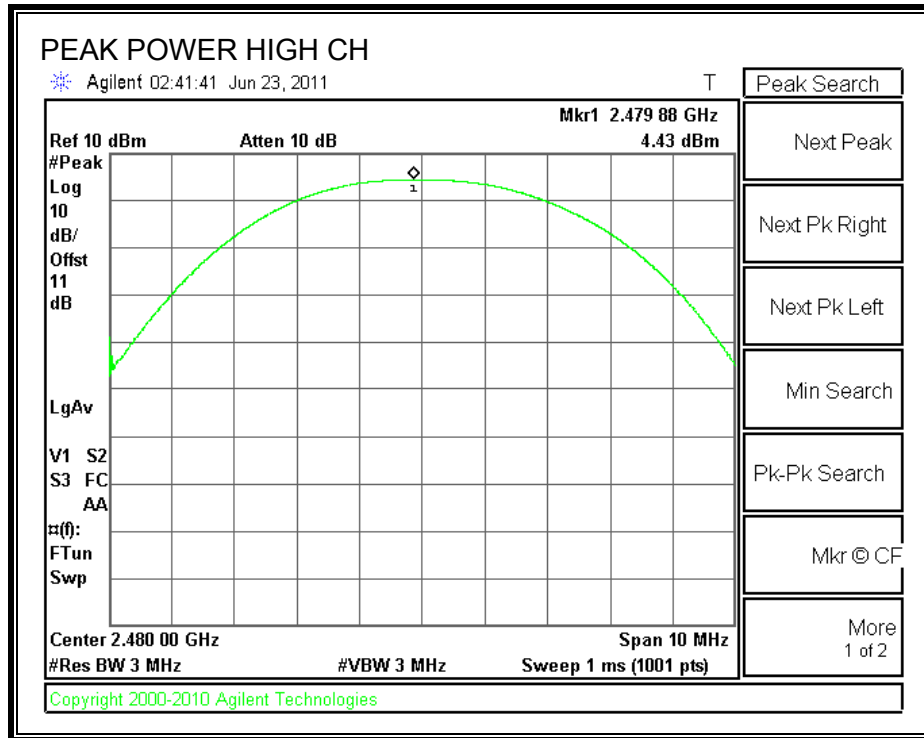
TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer, and 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	4.25	30	-25.75
Middle	2440	4.51	30	-25.49
High	2480	4.43	30	-25.57





7.4. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

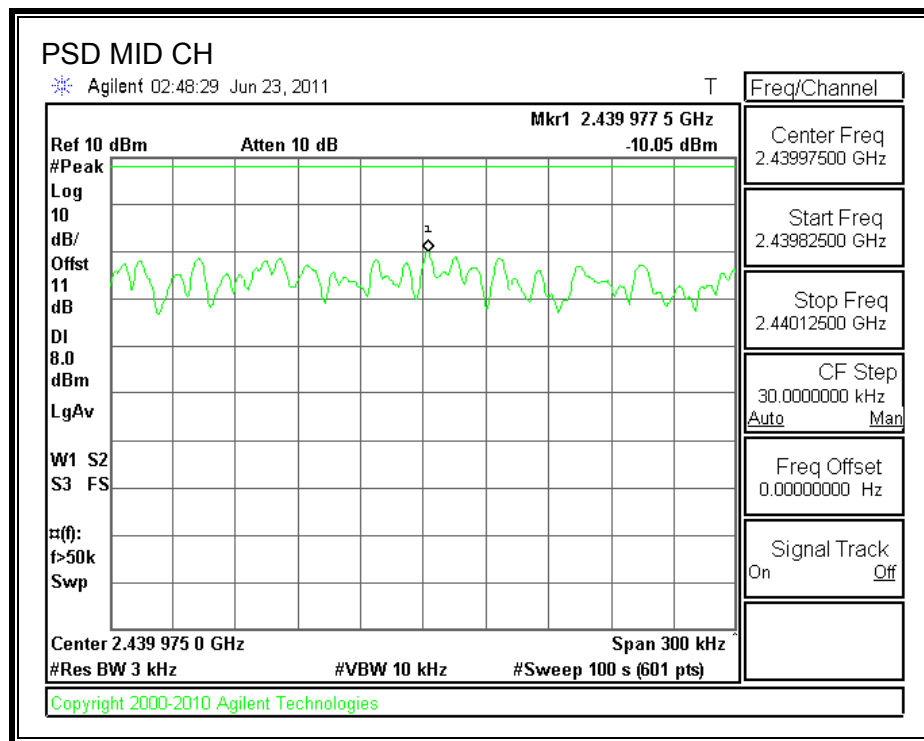
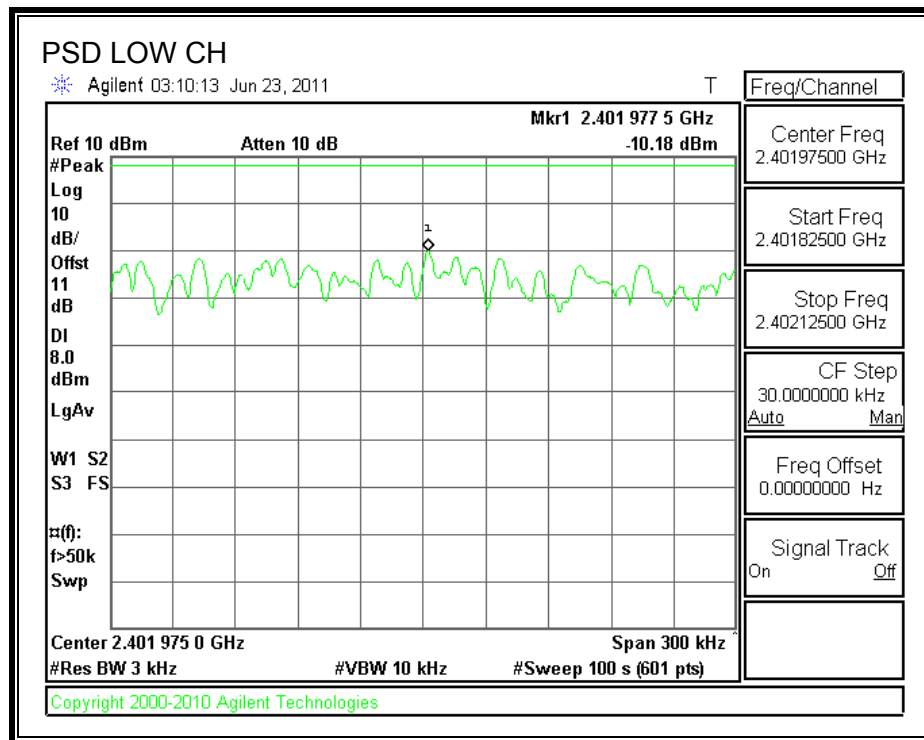
TEST PROCEDURE

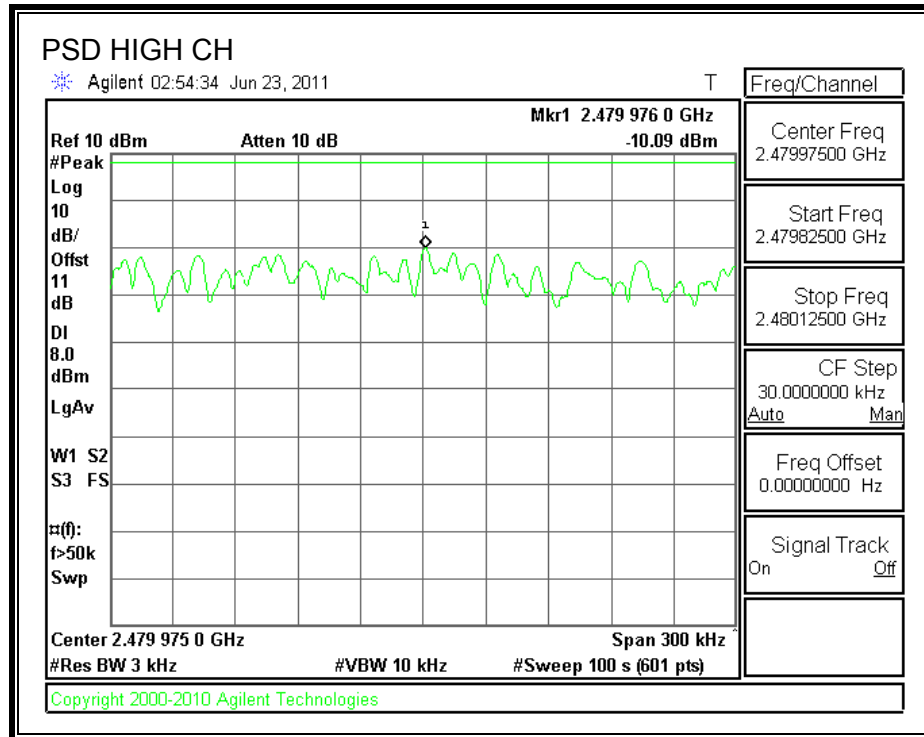
Output power was measured based on the use of a peak measurement, therefore the power spectral density was measured using PSD Option 1 in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

RESULTS

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-10.18	8	-18.18
Middle	2440	-10.05	8	-18.05
High	2480	-10.09	8	-18.09

POWER SPECTRAL DENSITY





7.5. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

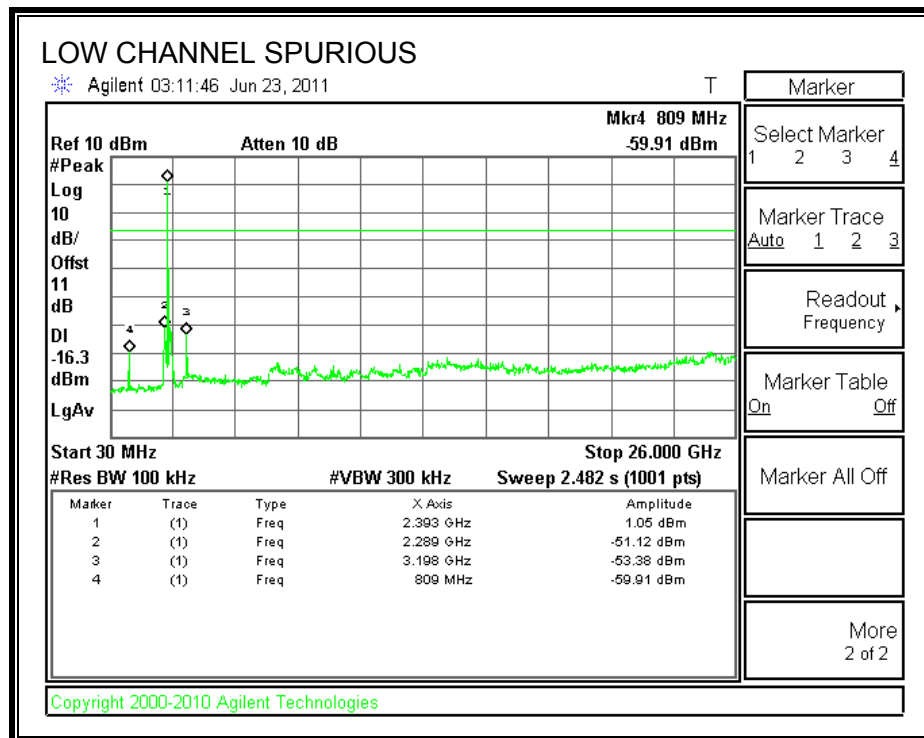
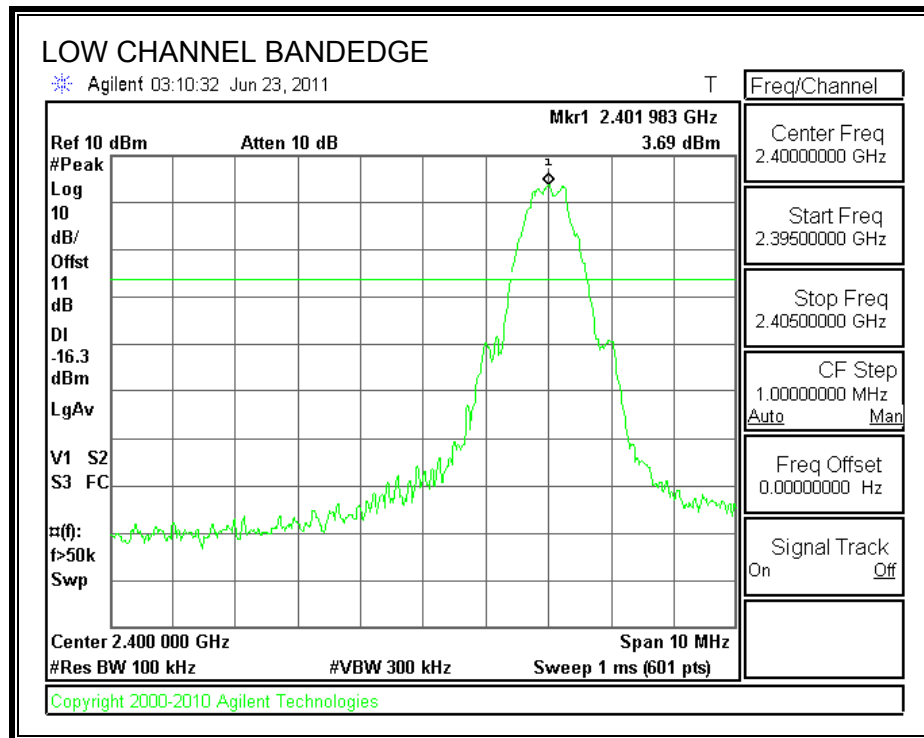
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

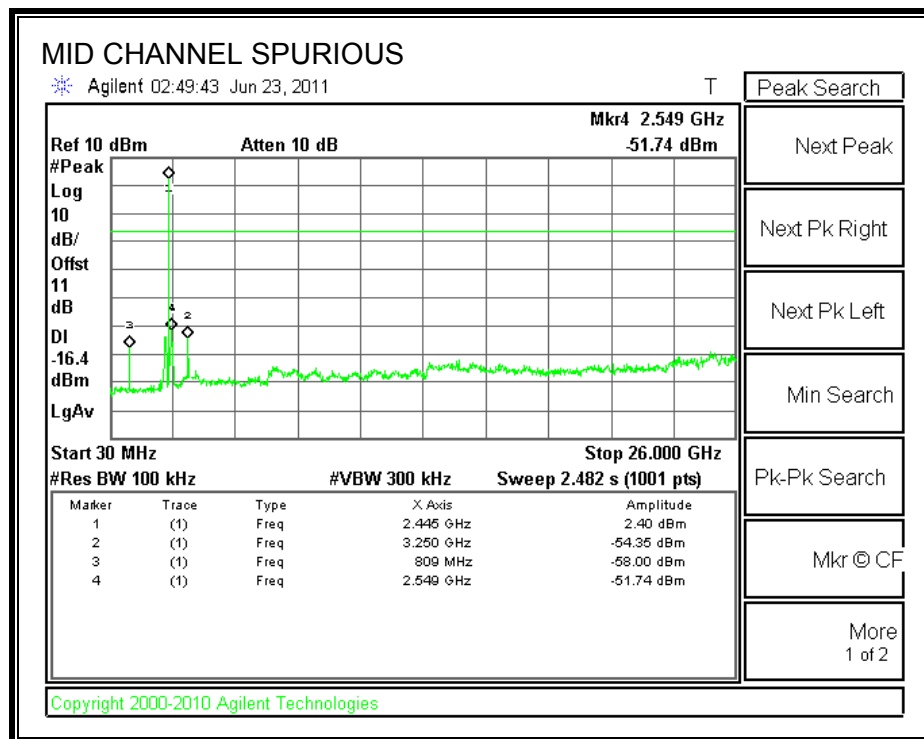
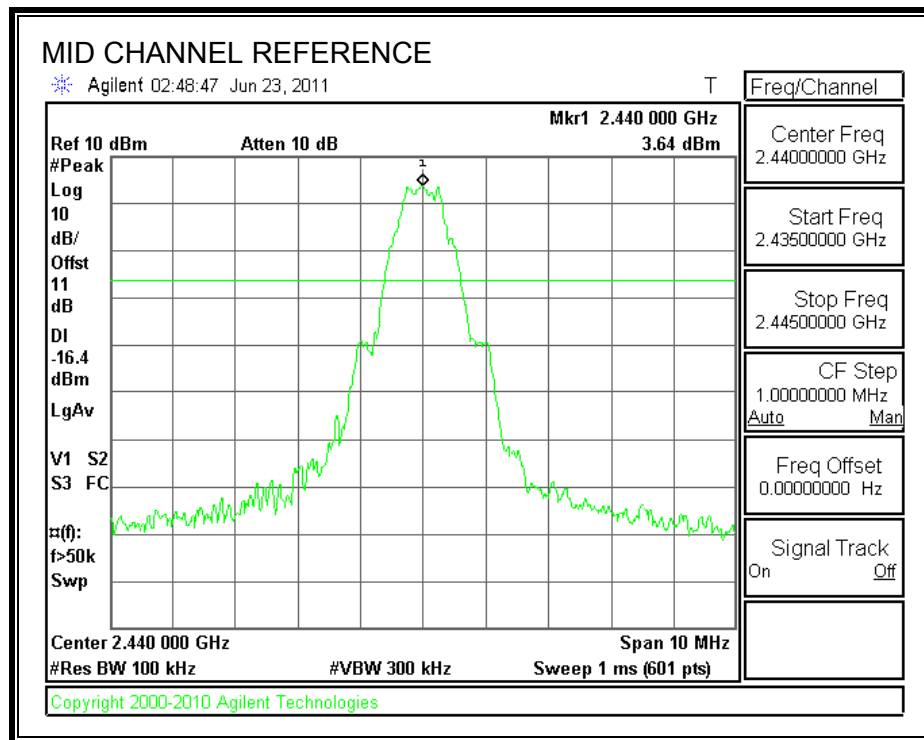
The band edges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

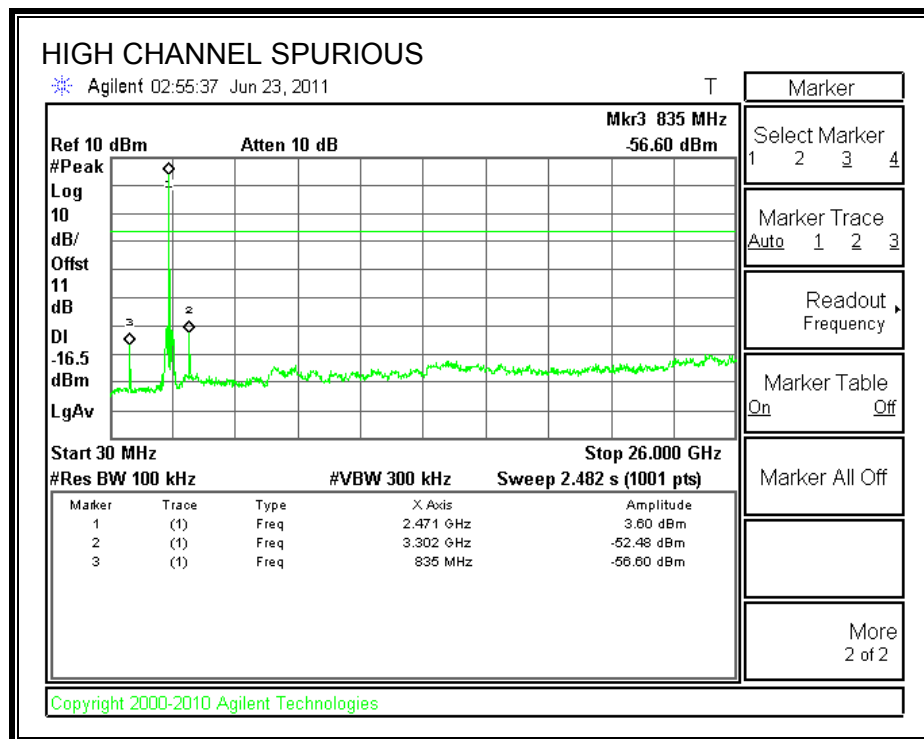
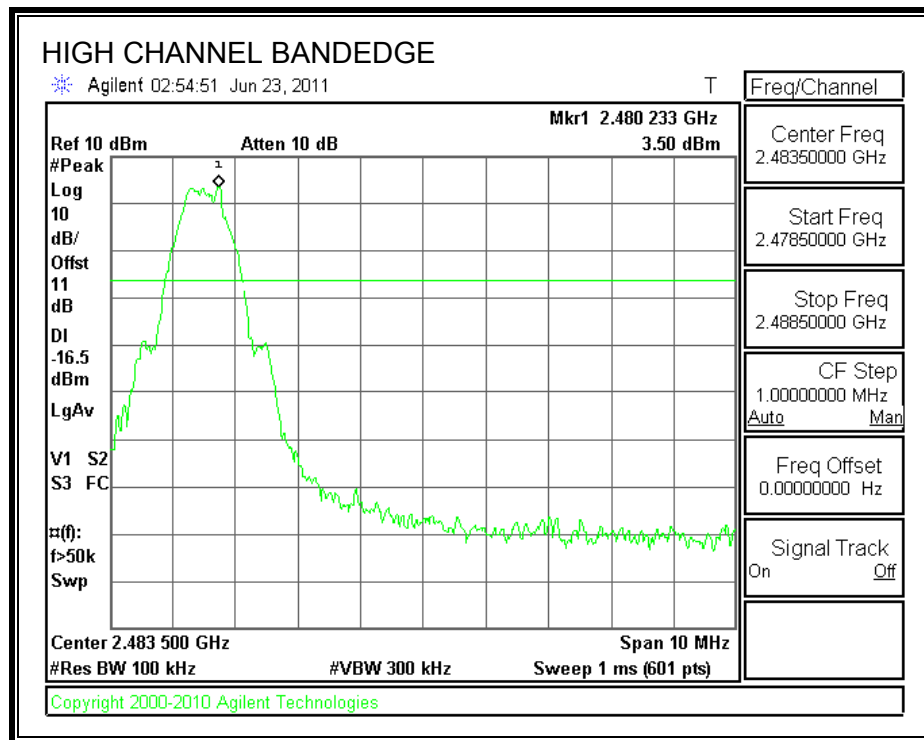
SPURIOUS EMISSIONS, LOW CHANNEL



SPURIOUS EMISSIONS, MID CHANNEL



SPURIOUS EMISSIONS, HIGH CHANNEL



8. RADIATED TEST RESULTS – LE (LOW ENERGY) MODULATION

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.

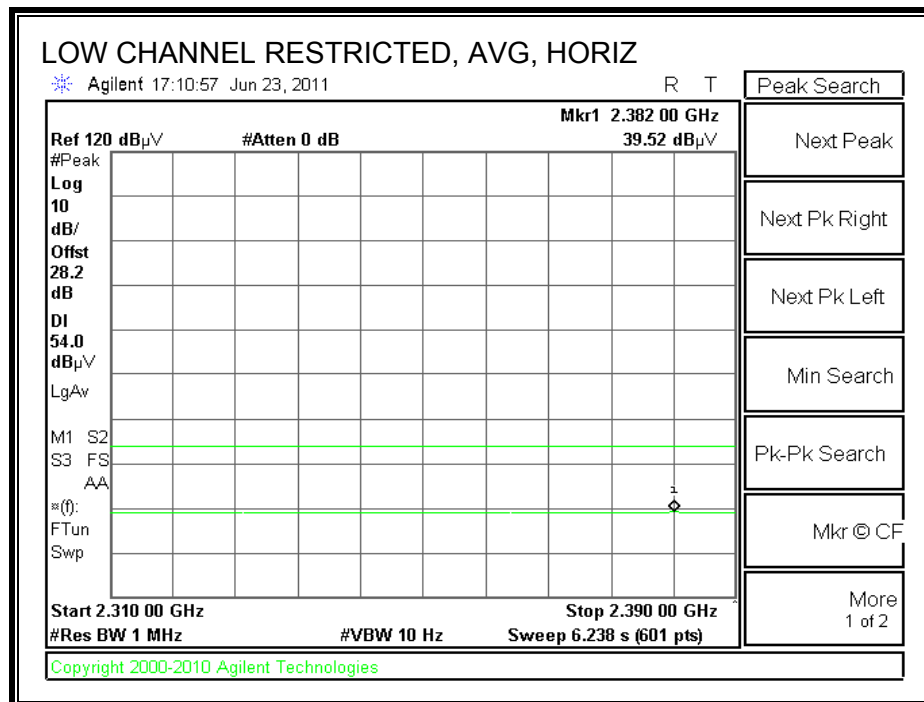
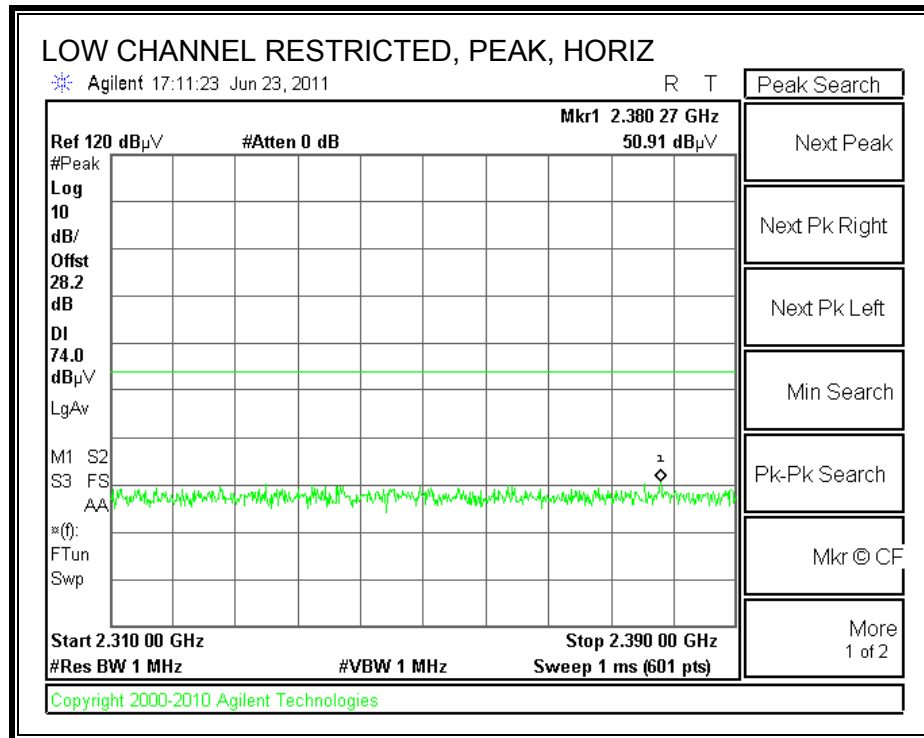
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, and then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

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.

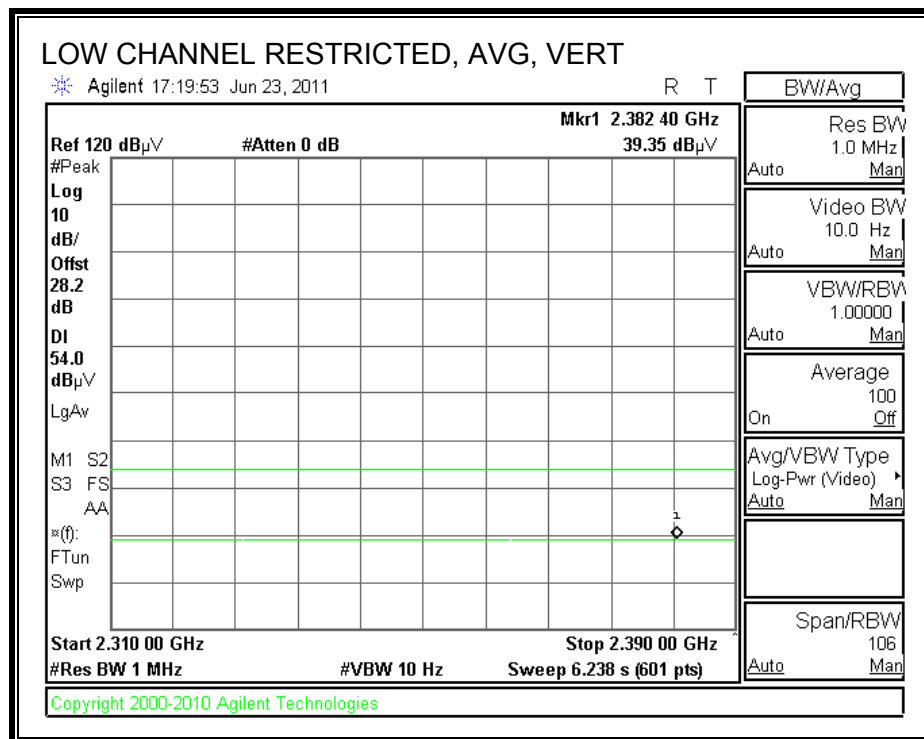
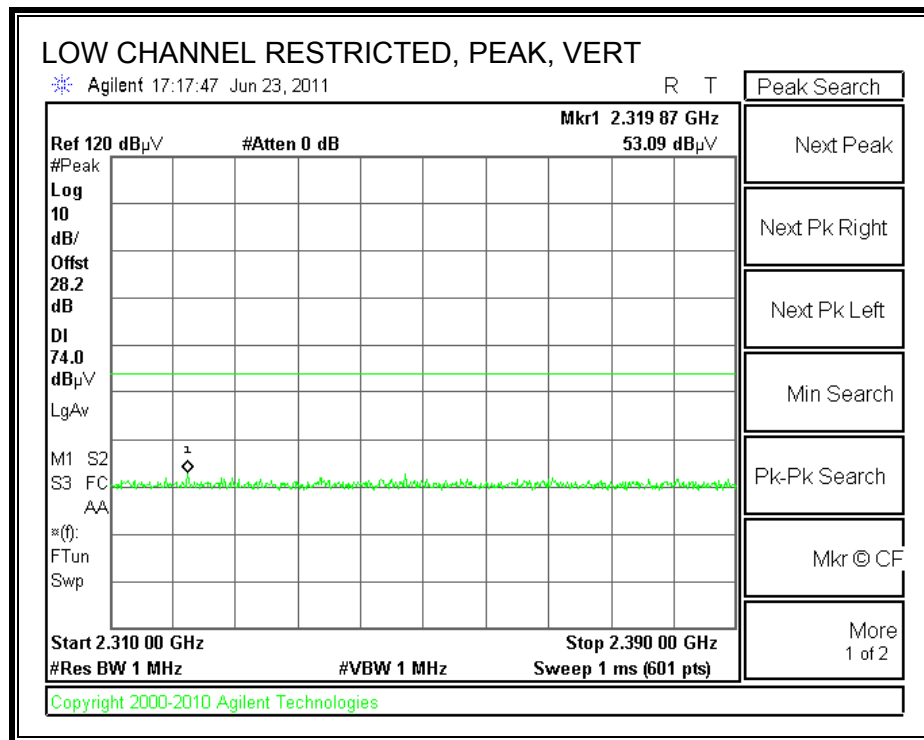
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

8.1. TRANSMITTER ABOVE 1 GHz

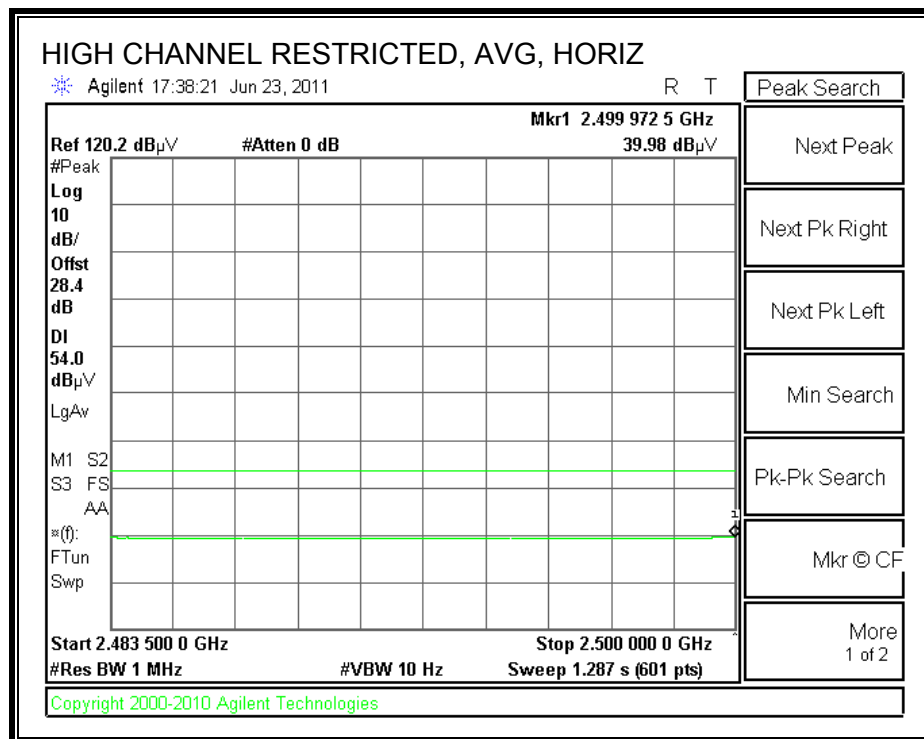
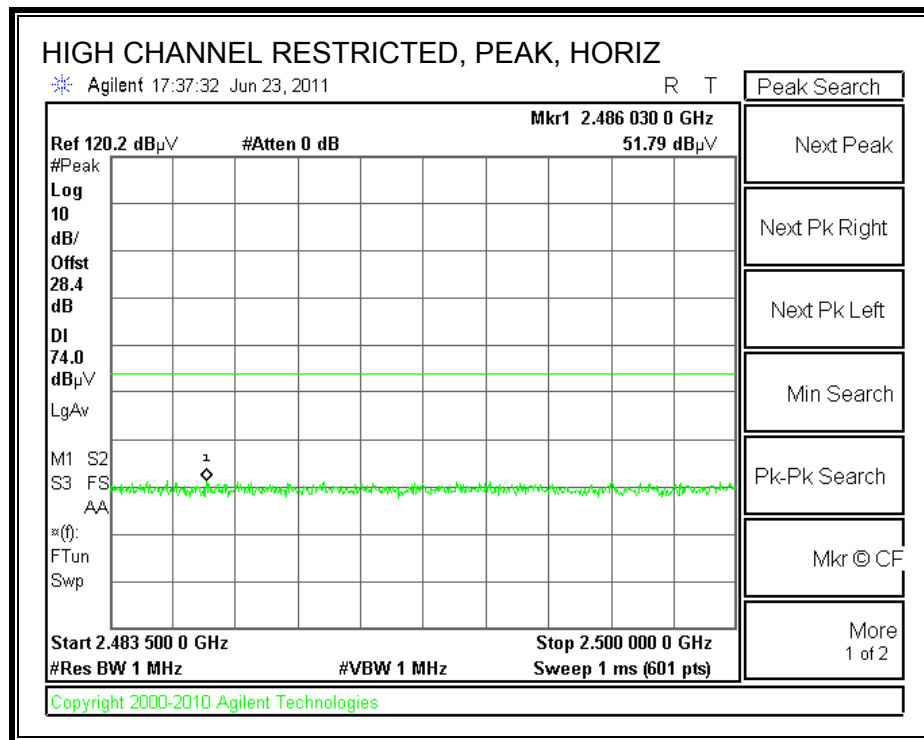
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



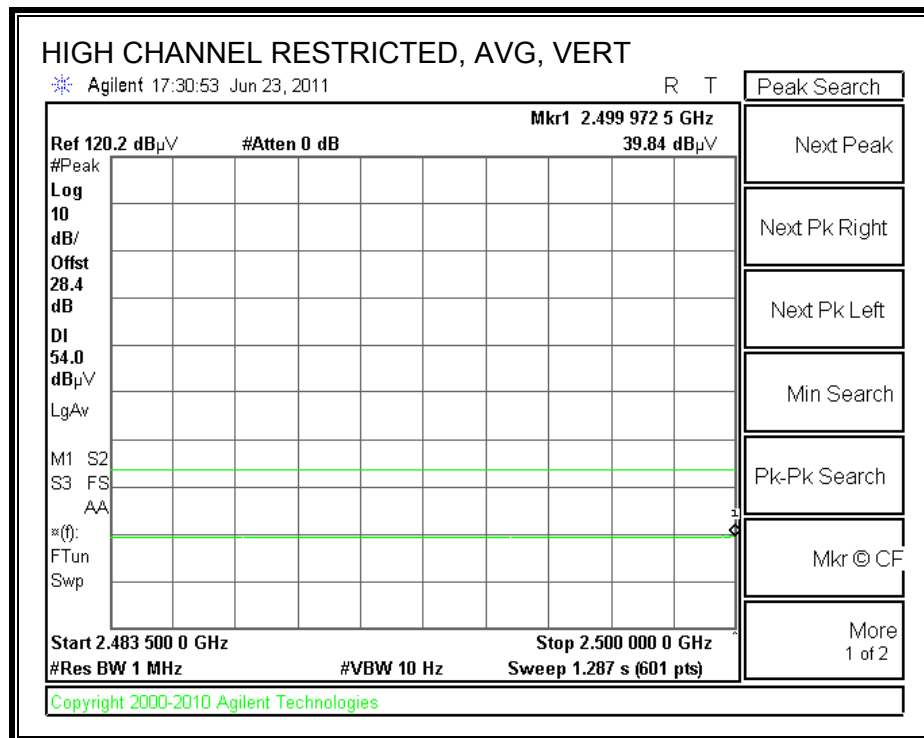
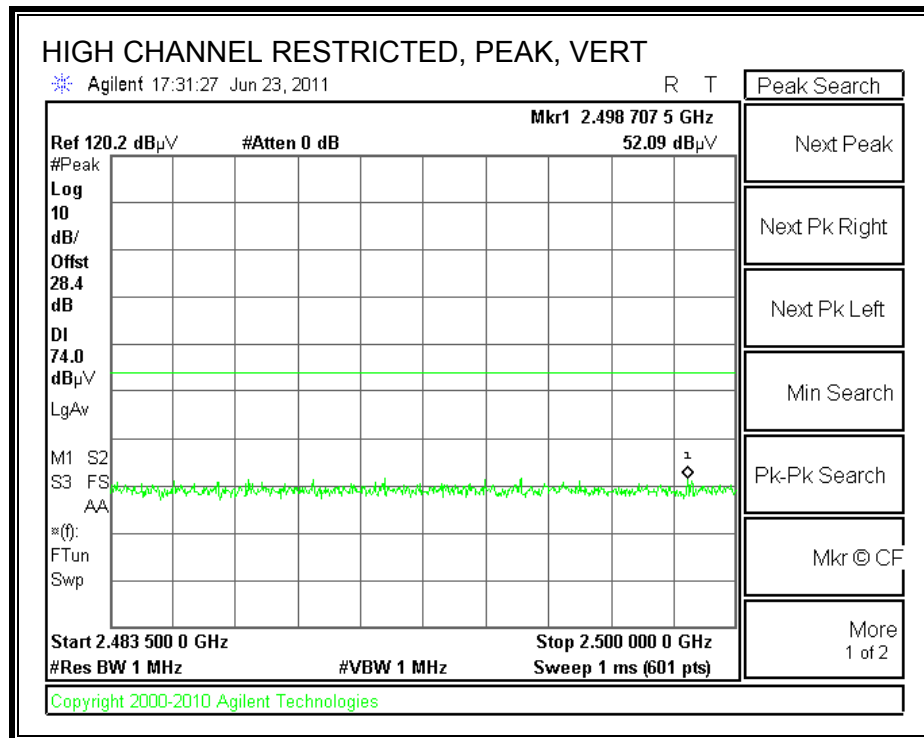
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement																
Compliance Certification Services, Fremont 5m Chamber																
Company:		BroadCom Corporation														
Project #:		11U13795														
Date:		6/23/2011														
Test Engineer:		David Garcia														
Configuration:		EUT, Antenna, support Laptop														
Mode:		Tx, LE Mode														
Test Equipment:																
Horn 1-18GHz			Pre-amplifier 1-26GHz			Pre-amplifier 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			Peak Measurements RBW=VBW=1MHz	
3' cable 22807700			12' cable 22807600			20' cable 22807500						R_001			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	38.9	27.8	32.7	5.8	-34.8	0.0	0.0	42.5	31.4	74	54	-31.5	-22.6	H	
4.804	3.0	41.0	30.7	32.7	5.8	-34.8	0.0	0.0	44.6	34.3	74	54	-29.4	-19.7	V	
Mid Ch 2440 MHz																
4.880	3.0	36.9	27.1	32.7	5.8	-34.8	0.0	0.0	40.6	30.8	74	54	-33.4	-23.2	H	
7.320	3.0	35.8	25.5	35.5	7.3	-34.1	0.0	0.0	44.5	34.2	74	54	-29.5	-19.8	H	
4.880	3.0	38.9	27.8	32.7	5.8	-34.8	0.0	0.0	42.6	31.5	74	54	-31.4	-22.5	V	
7.320	3.0	37.9	27.6	35.5	7.3	-34.1	0.0	0.0	46.6	36.2	74	54	-27.4	-17.8	V	
High Ch 2480 MHz																
4.960	3.0	39.9	28.8	32.8	5.9	-34.8	0.0	0.0	43.8	32.7	74	54	-30.2	-21.3	H	
7.440	3.0	37.5	26.2	35.6	7.3	-34.1	0.0	0.0	46.4	35.1	74	54	-27.6	-18.9	H	
4.960	3.0	40.8	30.7	32.8	5.9	-34.8	0.0	0.0	44.7	34.6	74	54	-29.3	-19.4	V	
7.440	3.0	37.8	27.1	35.6	7.3	-34.1	0.0	0.0	46.7	36.0	74	54	-27.3	-18.0	V	
Rev. 07.22.09																
f	Measurement Frequency					Amp	Preamp Gain					Avg Lim	Average Field Strength Limit			
Dist	Distance to Antenna					D Corr	Distance Correct to 3 meters					Pk Lim	Peak Field Strength Limit			
Read	Analyzer Reading					Avg	Average Field Strength @ 3 m					Avg Mar	Margin vs. Average Limit			
AF	Antenna Factor					Peak	Calculated Peak Field Strength					Pk Mar	Margin vs. Peak Limit			
CL	Cable Loss					HPF	High Pass Filter									

8.2. WORST-CASE RECEIVER ABOVE 1 GHz

High Frequency Measurement															
Compliance Certification Services, Fremont 5m Chamber															
Company:		BroadCom Corporation													
Project #:		11U13795													
Date:		6/22/2011													
Test Engineer:		David Garcia													
Configuration:		EUT, Antenna, support Laptop													
Mode:		Rx Mode_Worst-Case													
Test Equipment:															
Horn 1-18GHz		Pre-amplifier 1-26GHz		Pre-amplifier 26-40GHz		Horn > 18GHz		Limit							
T60; S/N: 2238 @3m		T34 HP 8449B						RX RSS 210							
Hi Frequency Cables															
3' cable 22807700		12' cable 22807600		20' cable 22807500		HPF		Reject Filter		Peak Measurements RBW=VBW=1MHz Average Measurements RBW=1MHz ; VBW=10Hz					
3' cable 22807700		12' cable 22807600		20' cable 22807500											
f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fldr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
1.227	3.0	45.5	31.2	25.2	2.6	-37.9	0.0	0.0	35.4	21.1	74	54	-38.6	-32.9	H
2.127	3.0	47.4	30.0	27.9	3.6	-36.7	0.0	0.0	42.1	24.8	74	54	-31.9	-29.2	H
2.687	3.0	42.1	29.0	28.8	4.1	-36.1	0.0	0.0	38.9	25.8	74	54	-35.1	-28.2	H
1.273	3.0	51.4	35.2	25.4	2.7	-37.9	0.0	0.0	41.6	25.4	74	54	-32.4	-28.6	V
1.593	3.0	47.7	32.4	26.4	3.0	-37.4	0.0	0.0	39.7	24.4	74	54	-34.3	-29.6	V
2.133	3.0	48.3	31.8	27.9	3.6	-36.7	0.0	0.0	43.1	26.6	74	54	-30.9	-27.4	V
Rev. 07.22.09															
f	Measurement Frequency			Amp	Preamp Gain			Avg Lim	Average Field Strength Limit						
Dist	Distance to Antenna			D Corr	Distance Correct to 3 meters			Pk Lim	Peak Field Strength Limit						
Read	Analyzer Reading			Avg	Average Field Strength @ 3 m			Avg Mar	Margin vs. Average Limit						
AF	Antenna Factor			Peak	Calculated Peak Field Strength			Pk Mar	Margin vs. Peak Limit						
CL	Cable Loss			HPF	High Pass Filter										

8.3. WORST-CASE BELOW 1 GHz

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

HORIZONTAL AND VERTICAL DATA

30-1000 MHz HORIZONTAL

Test Frequency	Meter Reading	Detector	Cable [dB]	T15 PreAmp [dB]	Bilog T185 [dB]	dB[uVolt s/meter]	CFR 47 Part 15 Class B 3m	Margin	Height [cm]	Polarity
64.9317	52.94	QP	0.9	-28.2	8.1	33.74	40	-6.26	138	Horz
98.1283	52.19	QP	1	-28.1	9	34.09	43.5	-9.41	168	Horz
143.1853	42.2	QP	1.2	-27.9	13	28.5	43.5	-15	201	Horz
182.5837	48.76	PK	1.3	-27.5	11	33.56	43.5	-9.94	99	Horz
240.2398	53.66	PK	1.5	-28.1	11.9	38.96	46	-7.04	99	Horz
299.6669	52.54	PK	1.8	-28.5	13.6	39.44	46	-6.56	99	Horz
499.8001	50.1	PK	2.2	-27.3	16.8	41.8	46	-4.2	151	Horz
597.6016	47.35	PK	2.5	-28.2	18.4	40.05	46	-5.95	99	Horz
699.4004	46.93	PK	2.7	-28.3	18.9	40.23	46	-5.77	99	Horz

30-1000 MHz VERTICAL

Test Frequency	Meter Reading	Detector	Cable [dB]	T15 PreAmp [dB]	Bilog T185 [dB]	dB[uVolt s/meter]	CFR 47 Part 15 Class B 3m	Margin	Height [cm]	Polarity
35.6922	45.37	PK	0.7	-28.2	17	34.87	40	-5.13	100	Vert
57.6962	53.89	PK	0.8	-28.1	7.9	34.49	40	-5.51	100	Vert
99.8351	53.74	PK	1	-28.1	9.3	35.94	43.5	-7.56	100	Vert
144.013	46.48	PK	1.2	-27.7	13	32.98	43.5	-10.52	100	Vert
230.3797	50.74	PK	1.5	-27.9	11.9	36.24	46	-9.76	251	Vert
498.7342	49.46	PK	2.2	-28.1	15	38.56	46	-7.44	151	Vert
597.6016	47.13	PK	2.5	-27.7	18.4	40.33	46	-5.67	101	Vert
697.002	45.18	PK	2.7	-27.3	18.9	39.48	46	-6.52	101	Vert
899.0007	43.24	PK	3.2	-27.7	22.1	40.84	46	-5.16	101	Vert

9. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

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

^{*} Decreases with the logarithm of the frequency.

TEST PROCEDURE

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

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

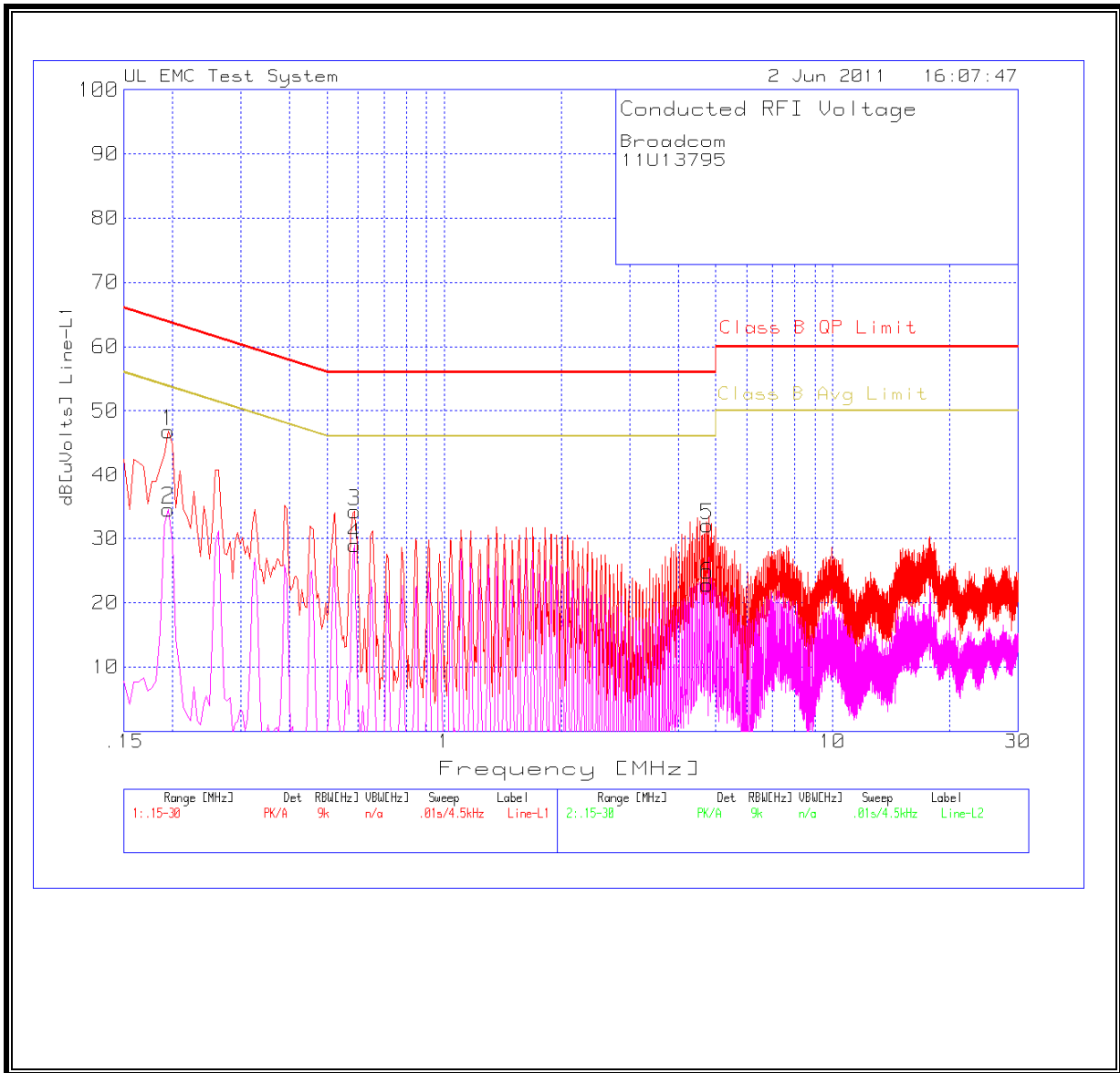
Line conducted data is recorded for both NEUTRAL and HOT lines.

RESULTS

6 WORST EMISSIONS

Line-L1 .15 - 30MHz									
Test Frequency	Meter Reading	Detector	LISN [dB]	Conducted Emission Cable [dB]	dB[uVolts]	Class B QP Limit	Margin	Class B Avg Limit	Margin
0.195	46.84	PK	0	0	46.84	63.8	-16.96	53.8	-6.96
0.195	34.56	Av	0	0	34.56	63.8	-29.24	53.8	-19.24
0.5865	34.25	PK	0	0	34.25	56	-21.75	46	-11.75
0.5865	29.01	Av	0	0	29.01	56	-26.99	46	-16.99
4.749	32.05	PK	0	0	32.05	56	-23.95	46	-13.95
4.749	22.87	Av	0	0	22.87	56	-33.13	46	-23.13
Line-L2 .15 - 30MHz									
Test Frequency	Meter Reading	Detector	LISN [dB]	Conducted Emission Cable [dB]	dB[uVolts]	Class B QP Limit	Margin	Class B Avg Limit	Margin
0.195	48.51	PK	0	0	48.51	63.8	-15.29	53.8	-5.29
0.195	35.39	Av	0	0	35.39	63.8	-28.41	53.8	-18.41
0.5235	35.05	PK	0	0	35.05	56	-20.95	46	-10.95
0.5235	24.28	Av	0	0	24.28	56	-31.72	46	-21.72
4.749	35.15	PK	0	0	35.15	56	-20.85	46	-10.85
4.749	19.59	Av	0	0	19.59	56	-36.41	46	-26.41

LINE 1 RESULTS



LINE 2 RESULTS

