



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

BLUETOOTH LOW ENERGY
CERTIFICATION TEST REPORT

FOR

802.11a/g/n/ac WLAN + Bluetooth PCI-E Custom Combination Card

MODEL NUMBER: BCM94360CS2

FCC ID: QDS-BRCM1072
IC: 4324A-BRCM1072

REPORT NUMBER: 13U14796-3

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Prepared for
BROADCOM CORPORATION
190 MATHILDA PLACE
SUNNYVALE, CA 94086, 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®

NVLAP LAB CODE 200065-0

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Rev.	Issue Date	Revisions	Revised By
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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/g/n/ac WLAN + Bluetooth PCI-E Custom Combination Card

MODEL: BCM94360CS2

SERIAL NUMBER: C8Y2521000MFC31EN

DATE TESTED: FEBRUARY 21 – MARCH 06, 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:



FRANK IBRAHIM
WISE PROJECT LEAD
UL CCS

Tested By:



ROY ZHENG
WISE LAB TECH III
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:

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

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/g/n/ac WLAN + Bluetooth PCI-E Custom Combination 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)	3.30	2.14

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an Amphenol/ Pulse 802.11a/b/g/n WLAN/BT antenna, with a maximum gain of 4.97 dBi for the BT antenna.

5.4. SOFTWARE AND FIRMWARE

The EUT driver software installed during testing was Broadcom, Ver. 5.1.0.1400
The test utility software used during testing was Broadcom BlueTool, Ver 1.7.2

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 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.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Dell	GM3B	1FM3U7U0WI0	DoC
AC Adapter	Dell	LA90PS0	PA-1900-01D3	DoC
Mouse	Microsoft	NA	X817158-005	DoC
Laptop PC	Dell	E6400	BDRBKK1	DoC
AC Adapter	Dell	DA90PE3	WTC0V	DoC
Adapter Board	Broadcom	BCM94331CSAD	1583414	N/A

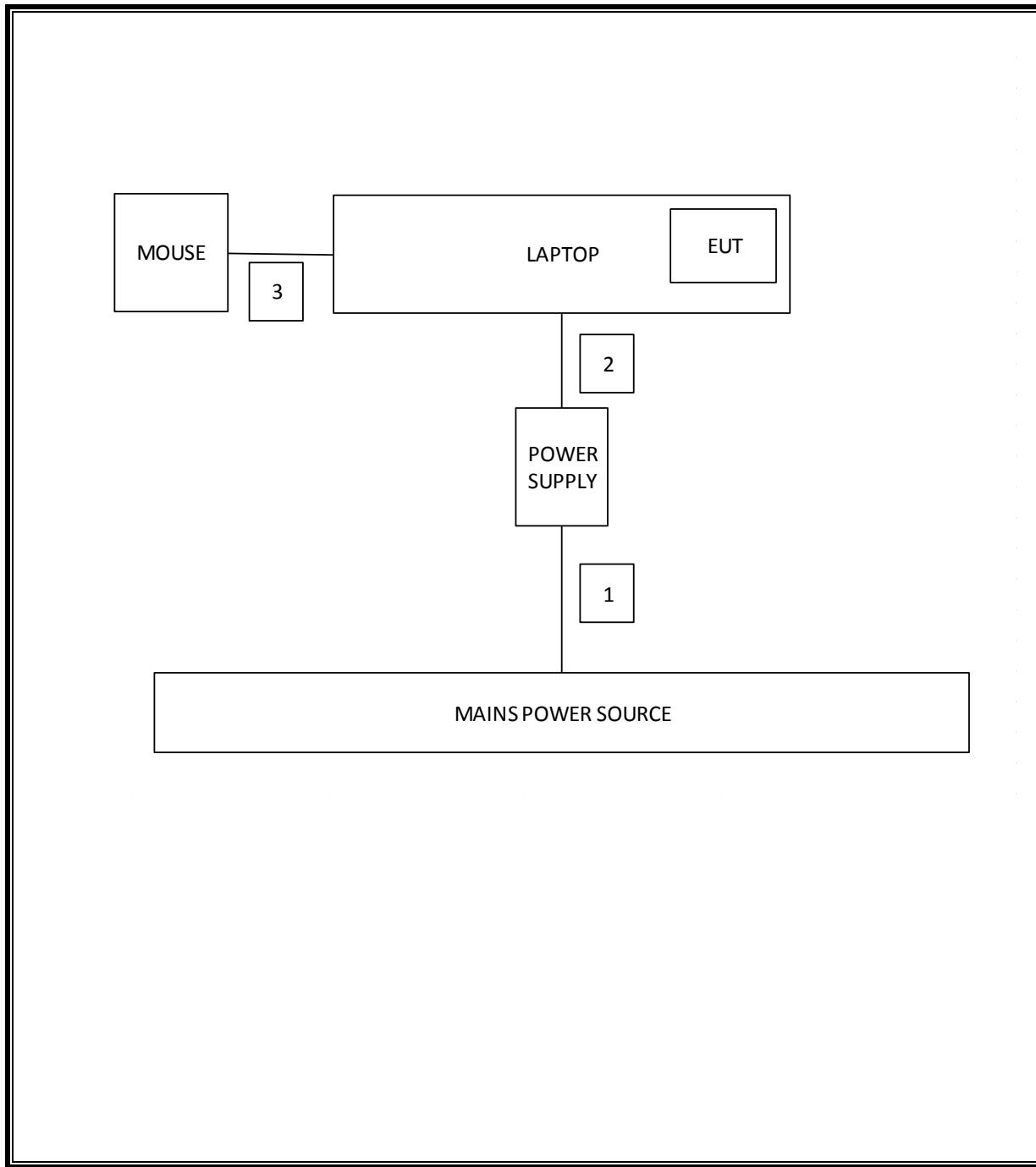
I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	US 115V	Un-Shielded	1.8	N/A
2	DC	1	DC	Shielded	1.8	N/A
3	USB	1	USB	Shielded	1.8	N/A

TEST SETUP

The EUT is installed in 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	12/13/11	12/13/13	
Peak Power Meter	Agilent / HP	E4416A	C00963	12/13/11	12/13/13	
Peak / Average Power Sensor	Agilent / HP	E9327A	C00964	12/13/11	12/13/13	
Antenna, Horn, 18 GHz	EMCO	3115	C00945	11/12/12	11/12/13	
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00946	11/12/12	11/12/13	
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	10/22/12	10/22/13	
LISN, 30 MHz	FCC	50/250-25-2	N02396	08/08/12	08/08/13	
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00558	02/21/12	03/21/13	
Antenna, Bilog, 30MHz-1 GHz	Sunol Sciences	JB1	C01011	03/23/12	03/23/13	
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.

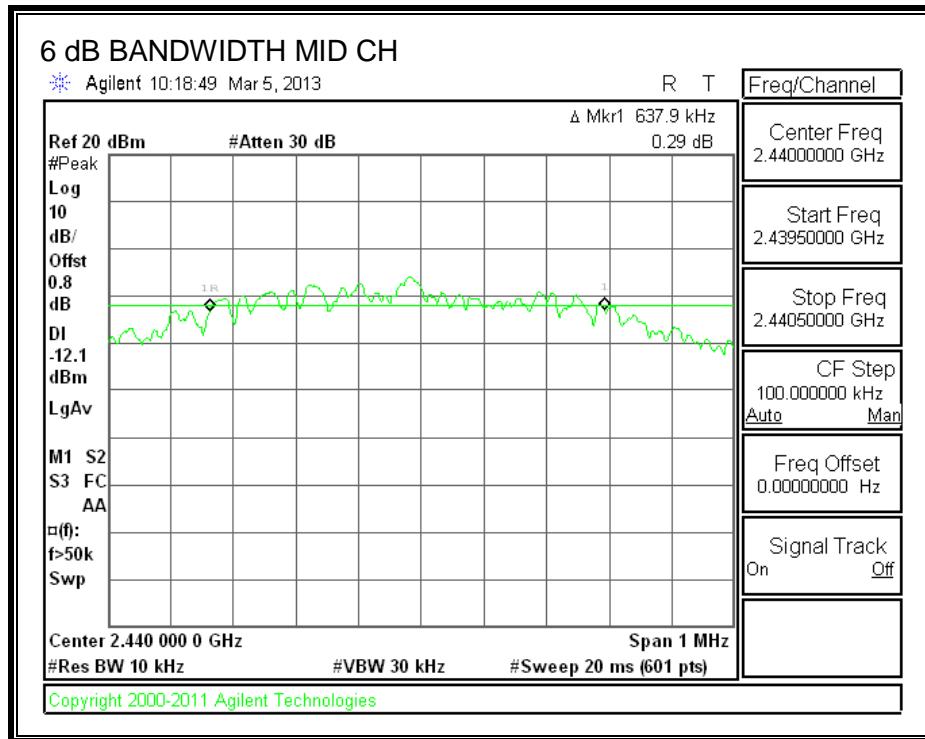
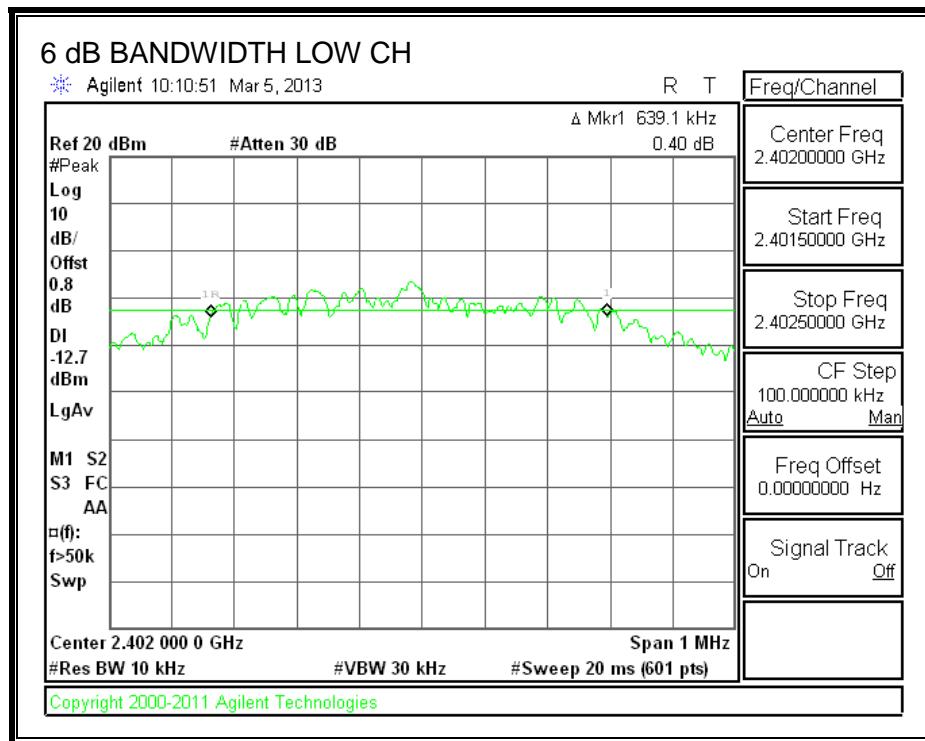
TEST PROCEDURE

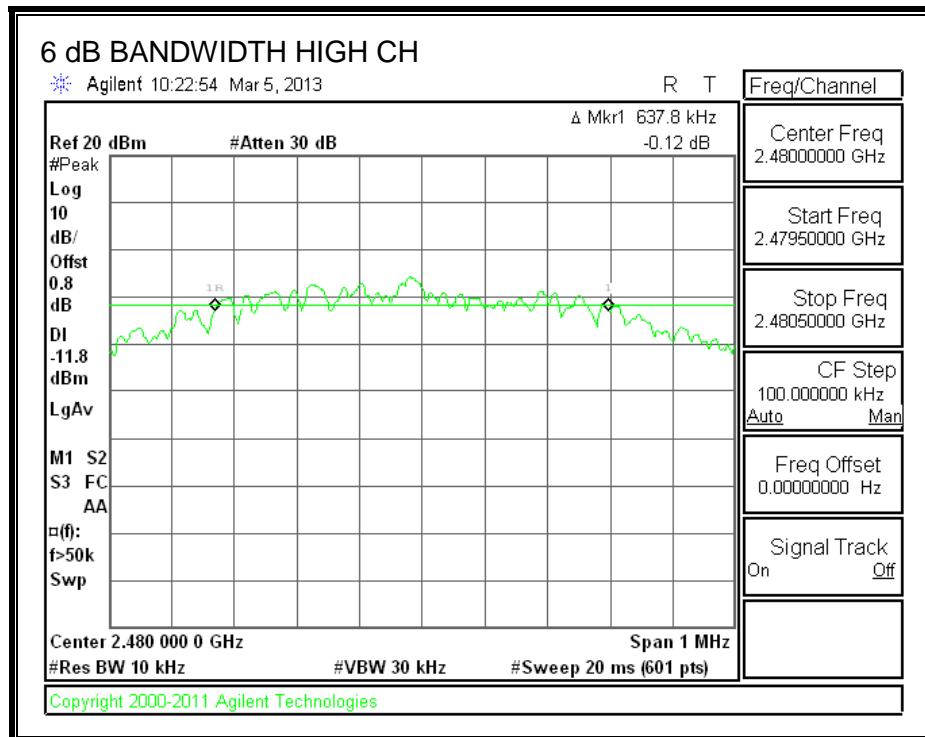
KDB 558074 D01 v02 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247".

RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6391	0.5
Middle	2440	0.6379	0.5
High	2480	0.6378	0.5

6 dB BANDWIDTH





7.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

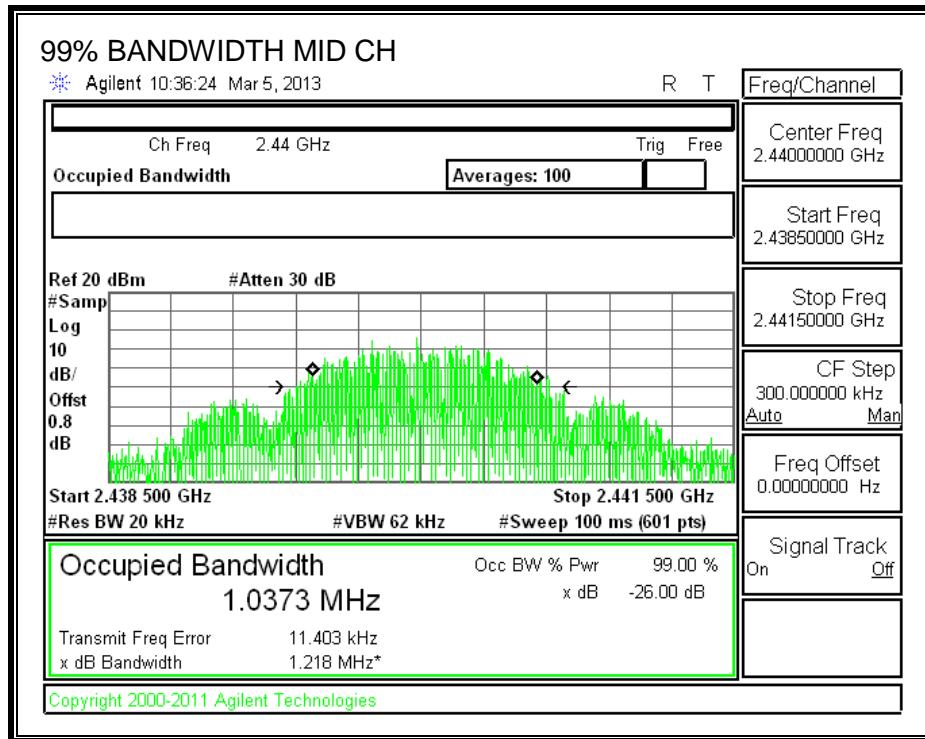
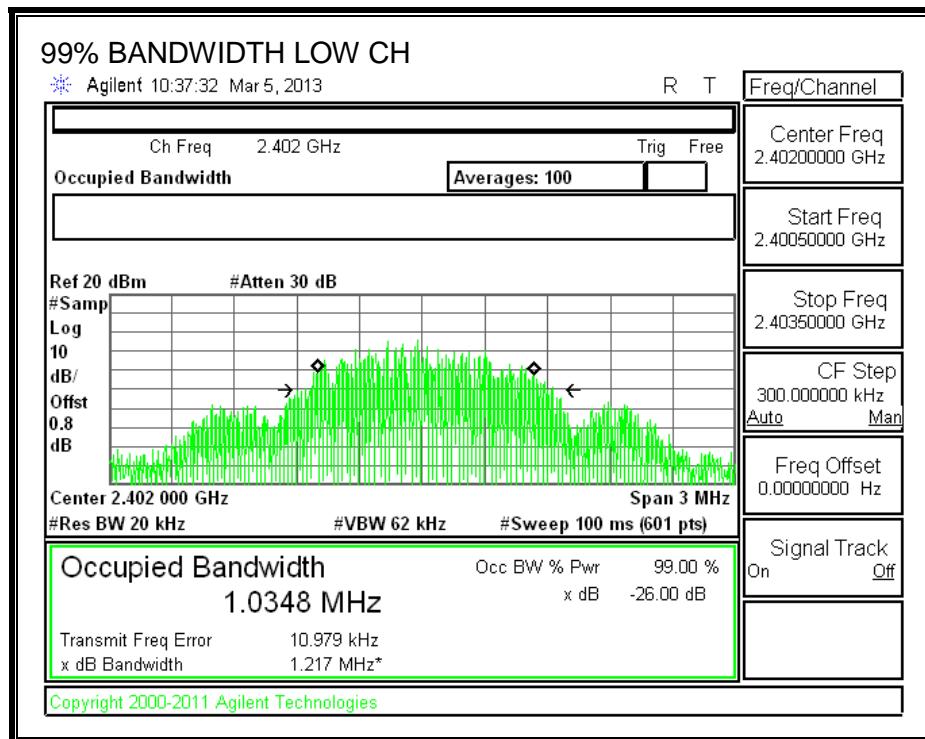
TEST PROCEDURE

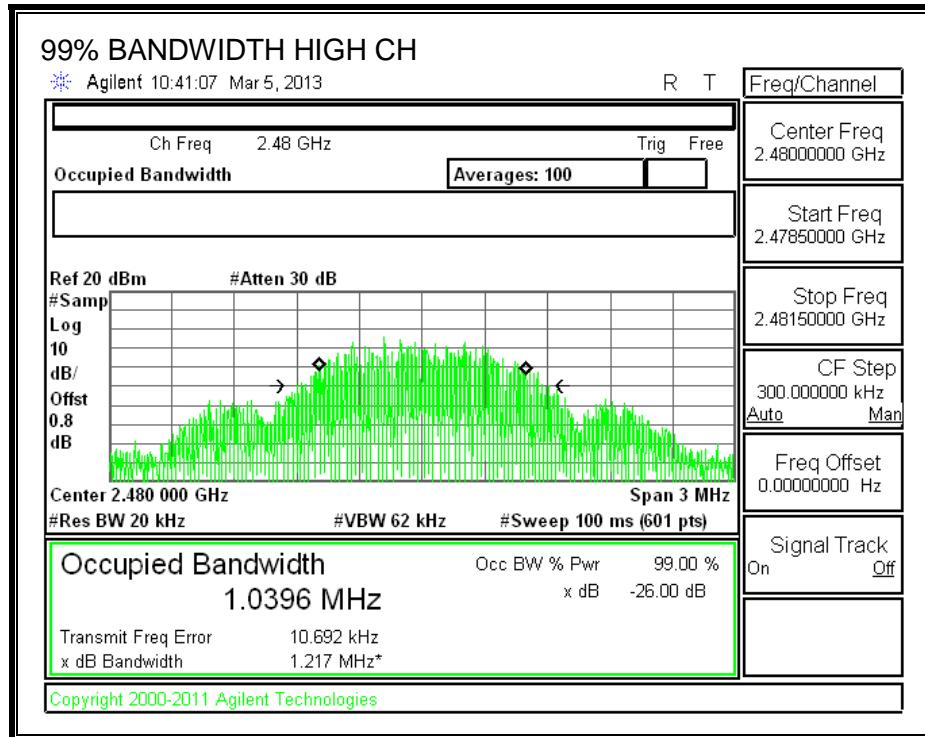
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth and to 1% of the span. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0348
Middle	2440	1.0373
High	2480	1.0396

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.

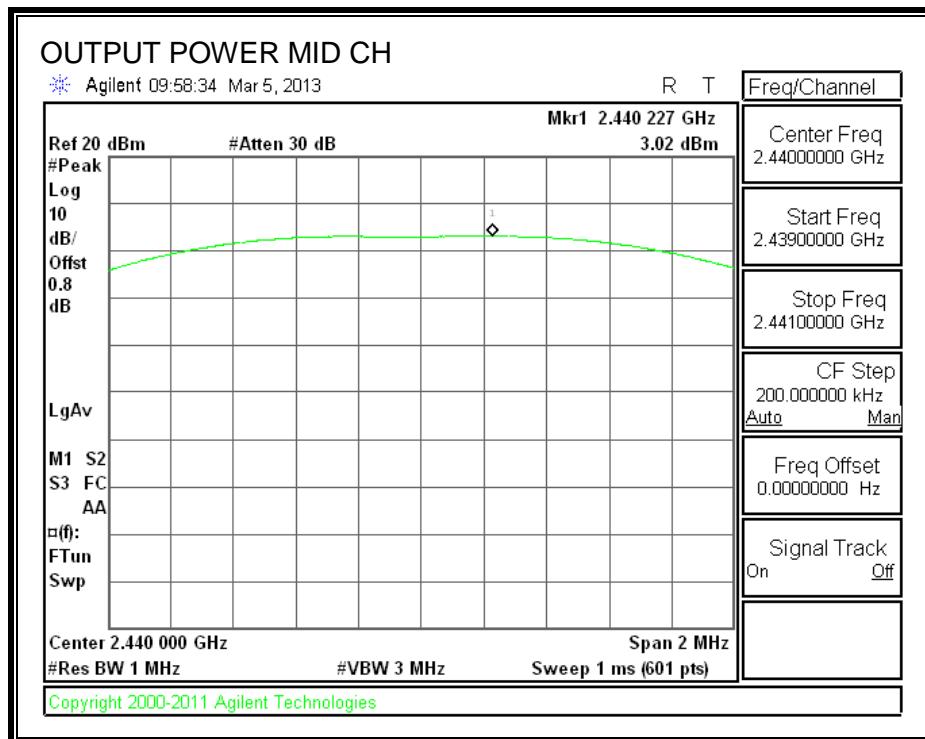
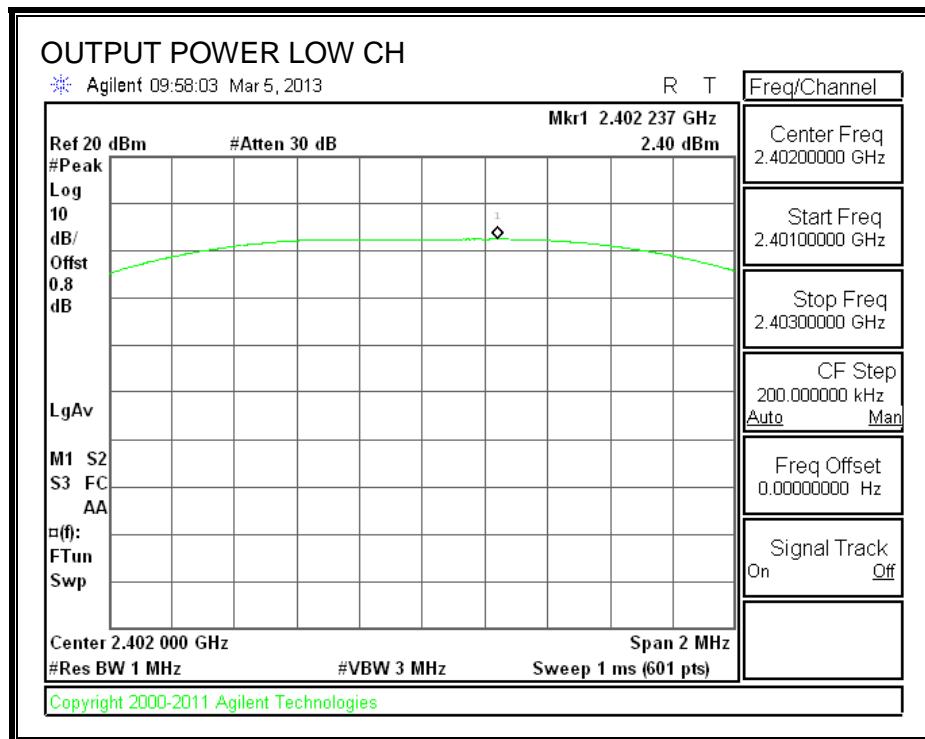
TEST PROCEDURE

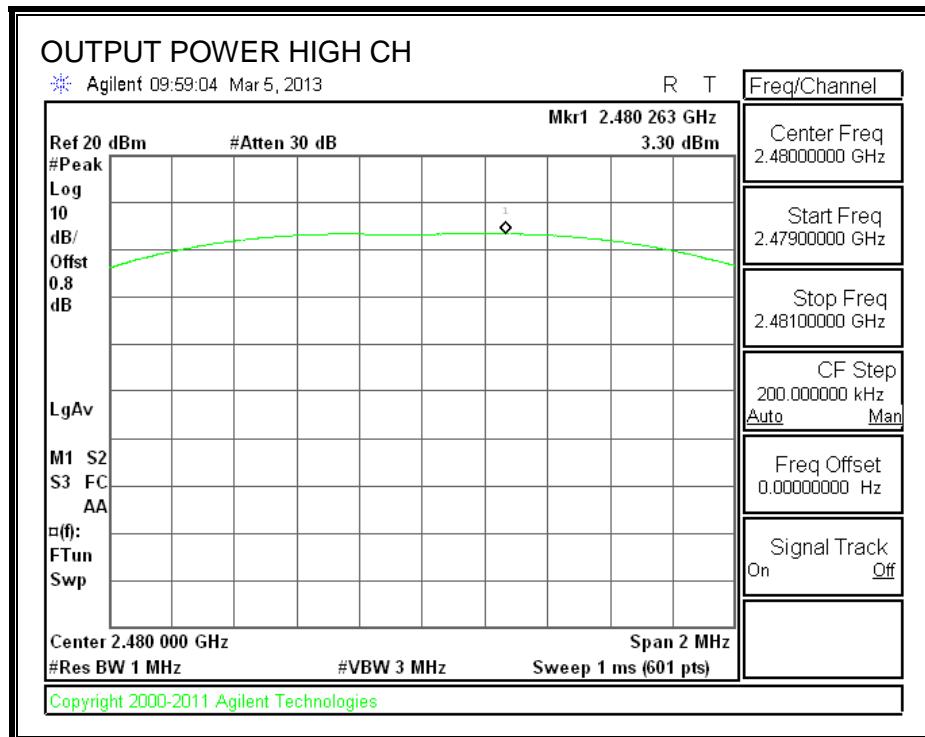
KDB 558074 D01 v02 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247".

RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	2.40	30	-27.60
Middle	2440	3.02	30	-26.98
High	2480	3.30	30	-26.70

OUTPUT POWER





7.4. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

KDB 558074 D01 v02 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247".

RESULTS

The cable assembly insertion loss of 0.8dB (including 0 dB pad and 0.8 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	2.22
Middle	2440	2.88
High	2480	3.18

7.5. 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.

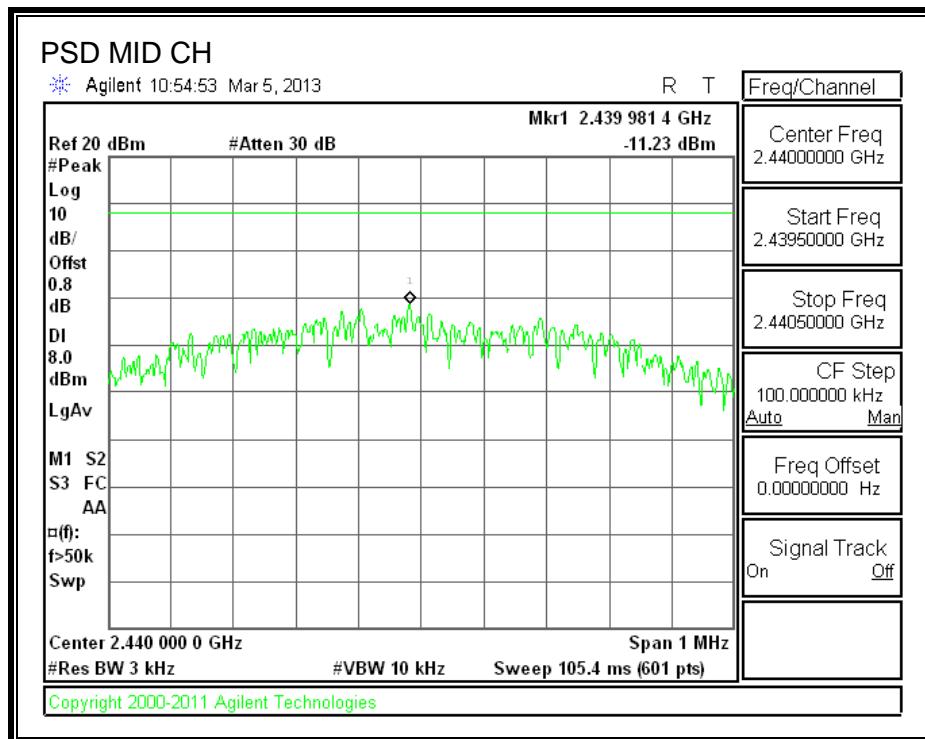
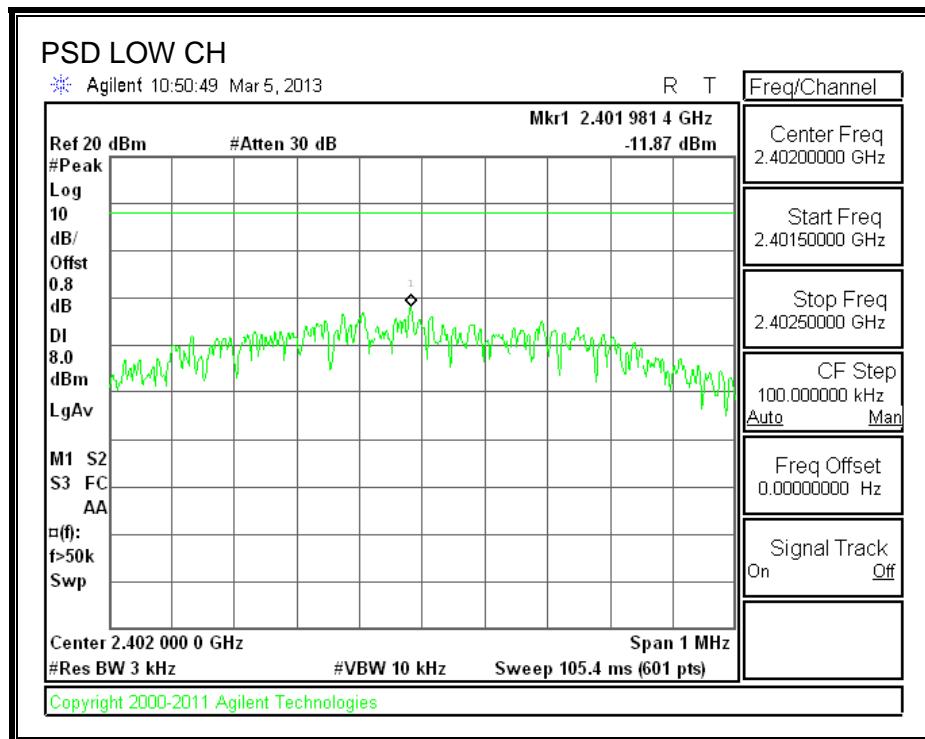
TEST PROCEDURE

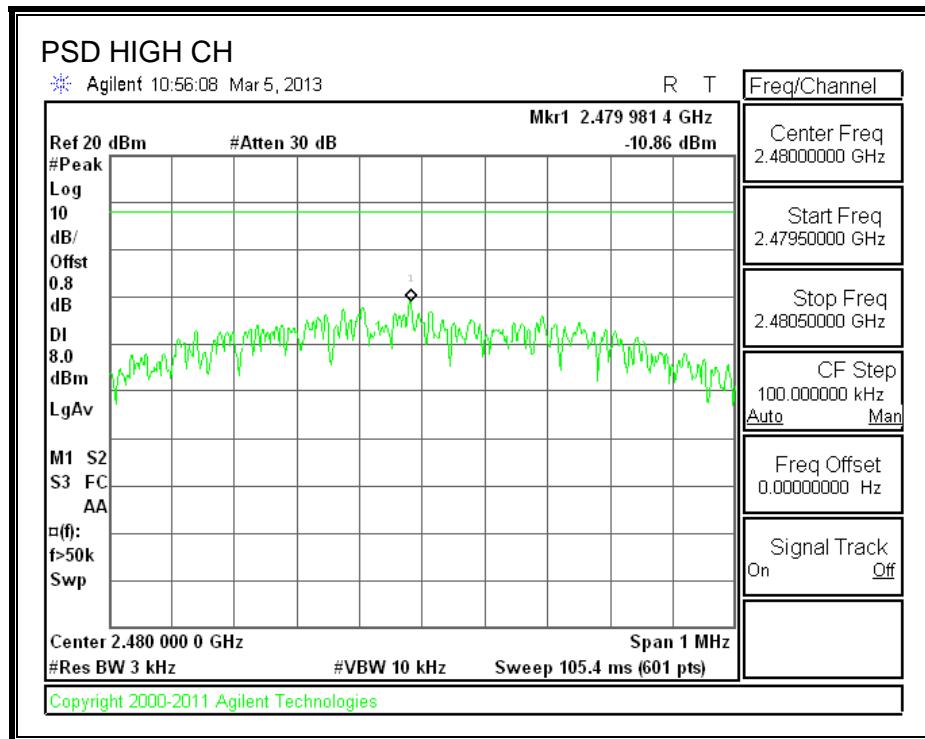
KDB 558074 D01 v02 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247".

RESULTS

Channel	Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-11.87	8	-19.87
Middle	2440	-11.23	8	-19.23
High	2480	-10.86	8	-18.86

POWER SPECTRAL DENSITY





7.6. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

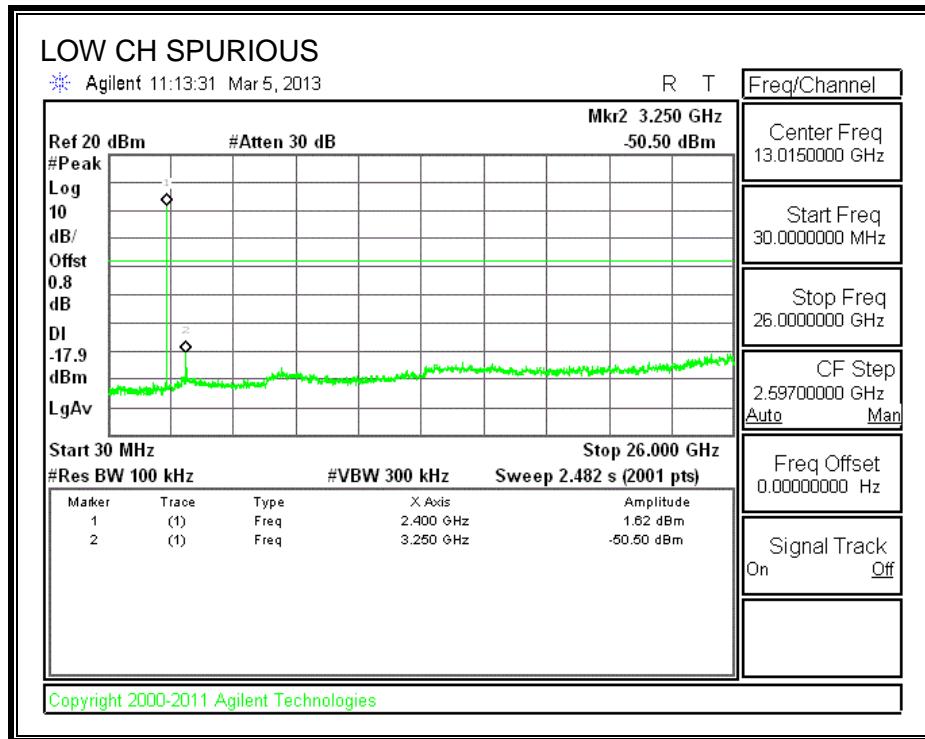
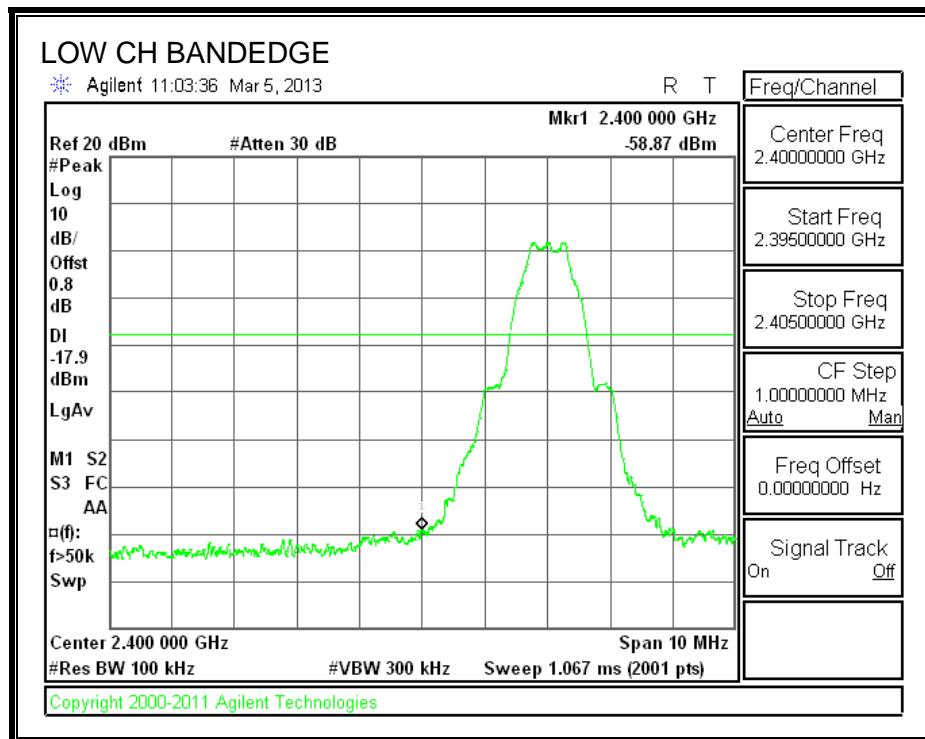
IC RSS-210 A8.5

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

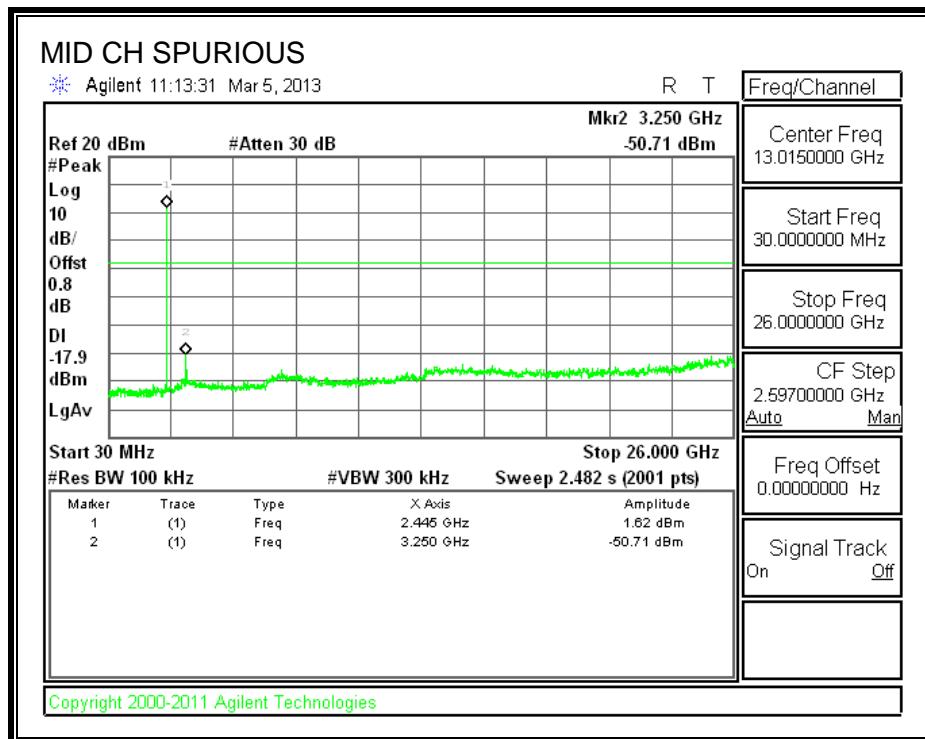
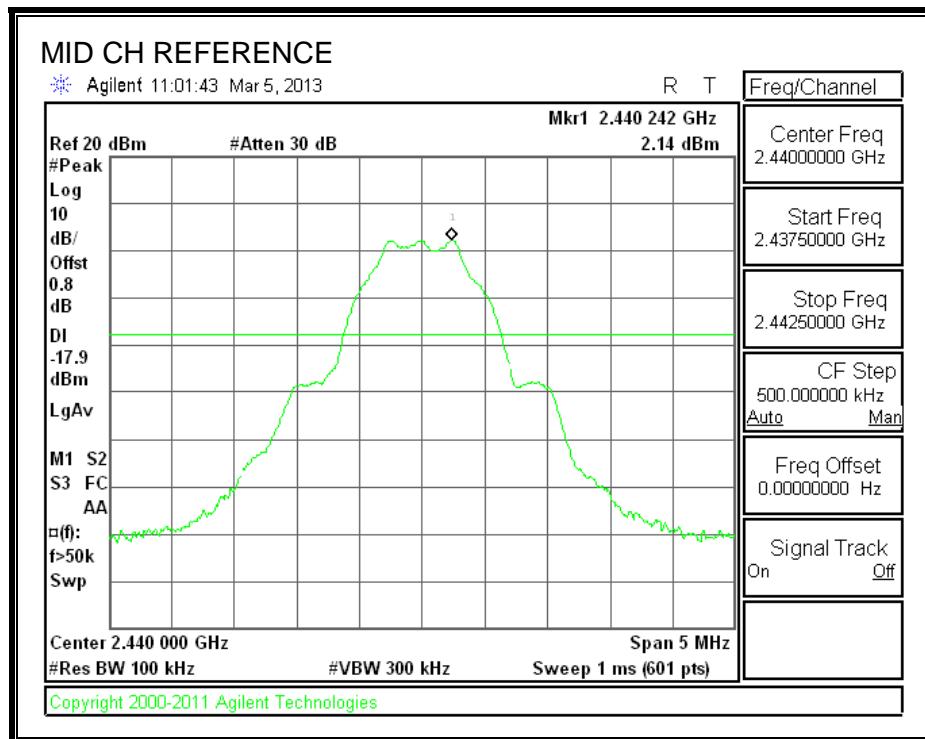
TEST PROCEDURE

KDB 558074 D01 v02 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247".

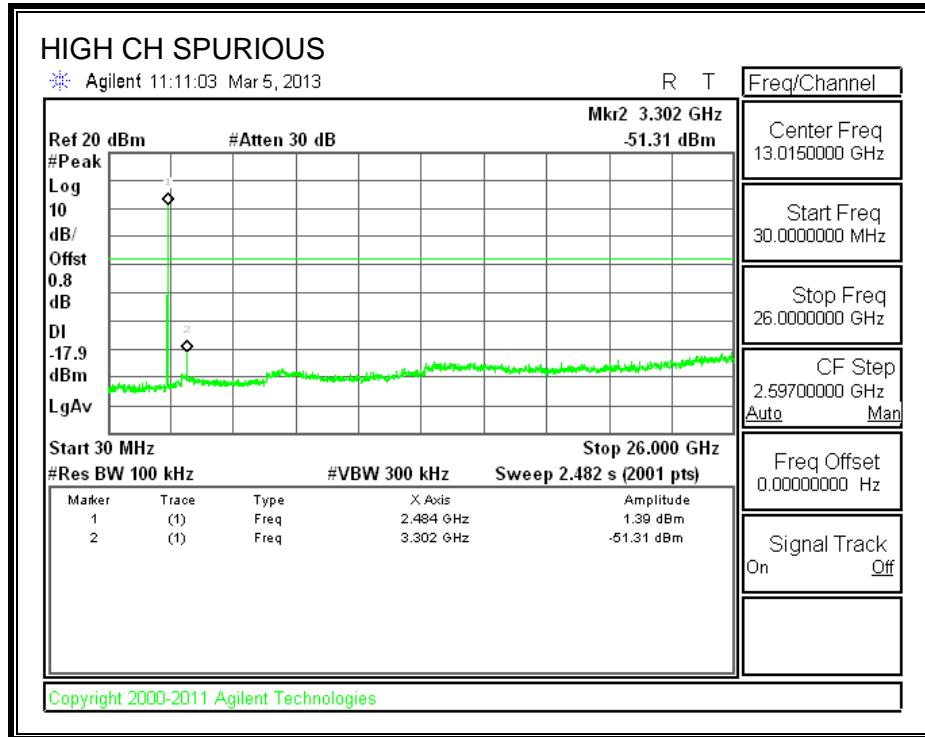
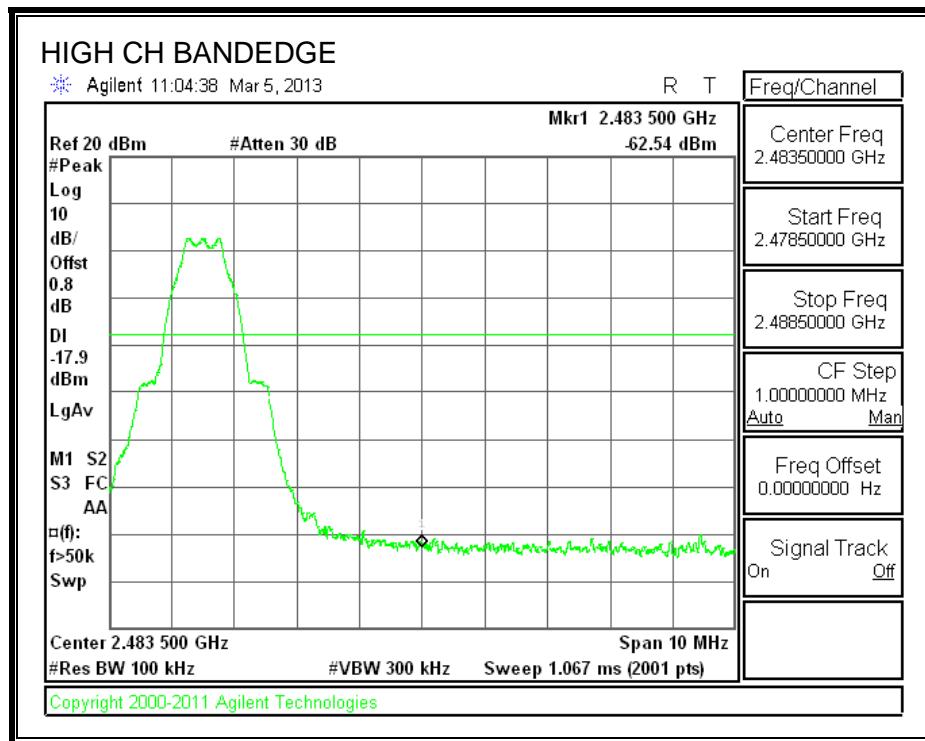
SPURIOUS EMISSIONS, LOW CHANNEL



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.

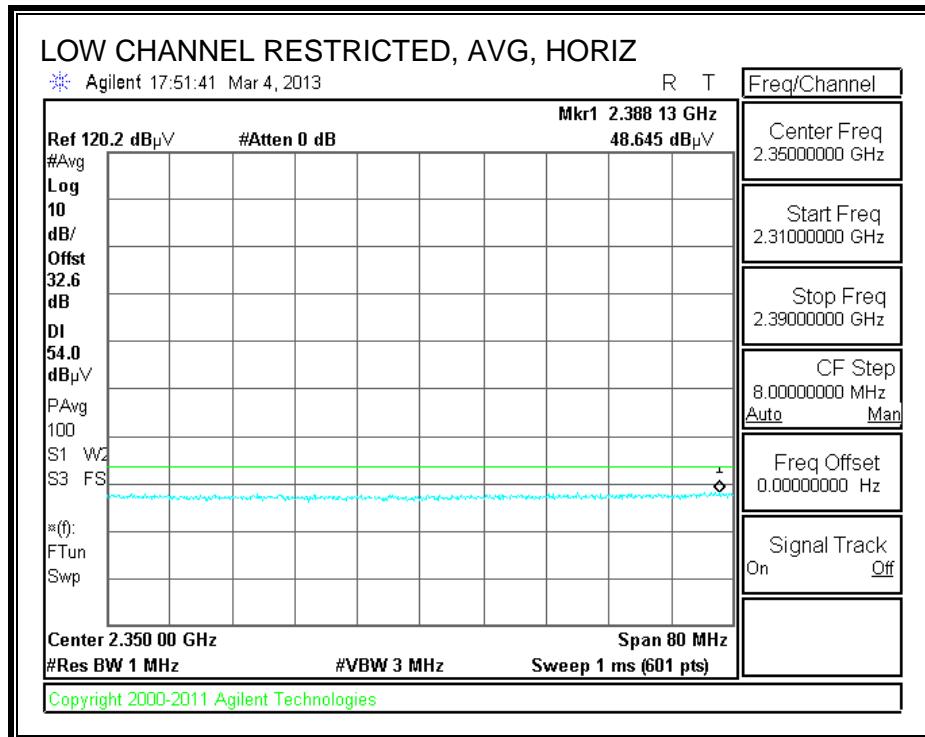
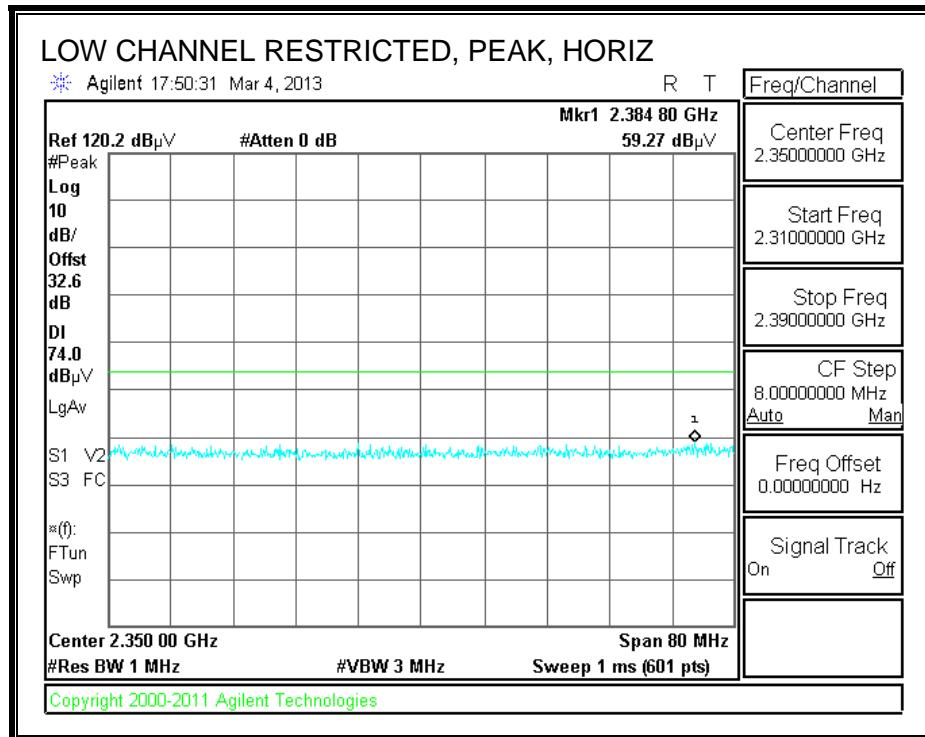
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

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.

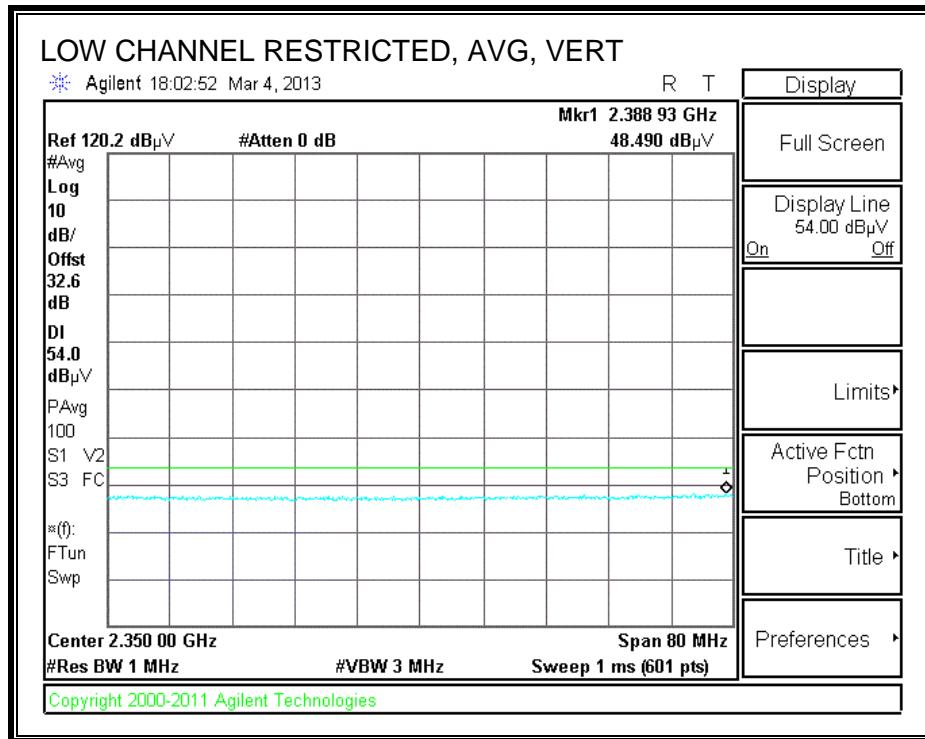
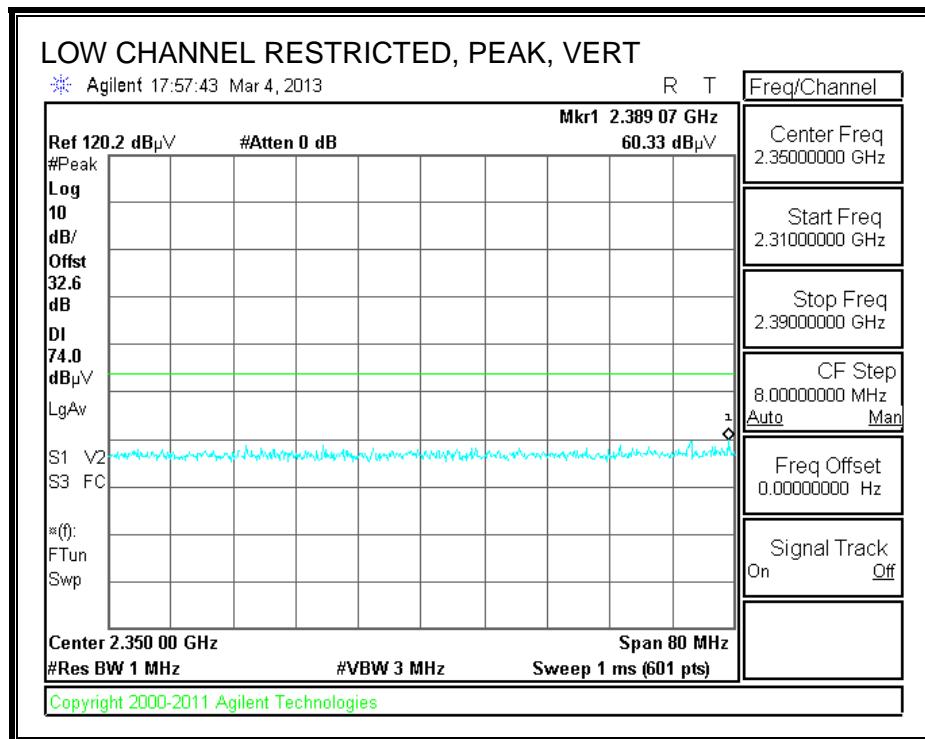
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

8.2. TRANSMITTER ABOVE 1 GHz, BLUETOOTH LOW ENERGY

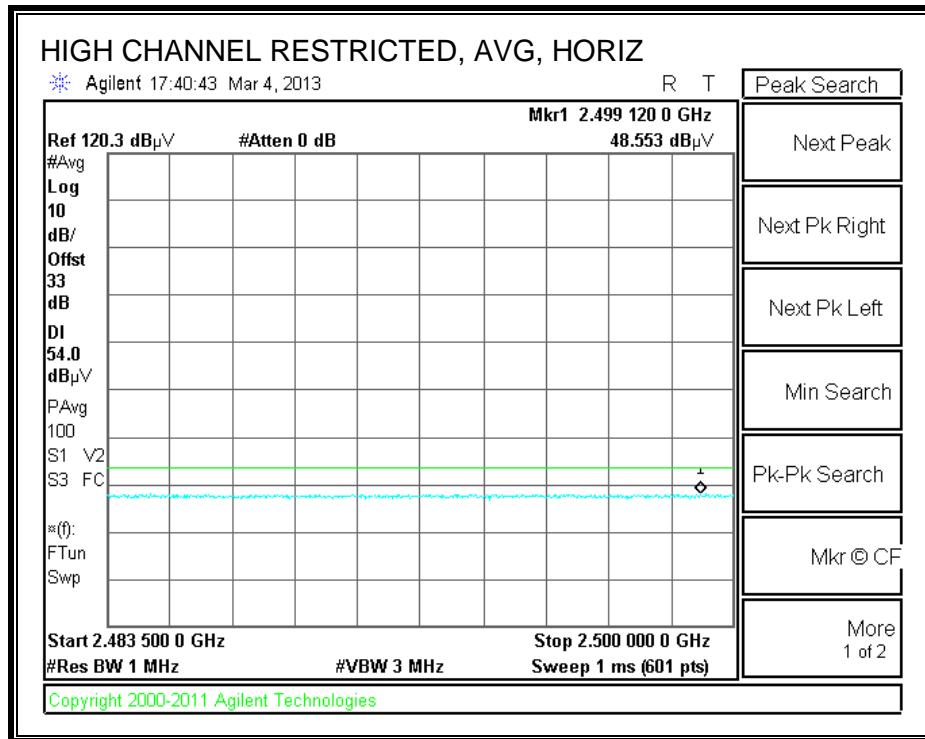
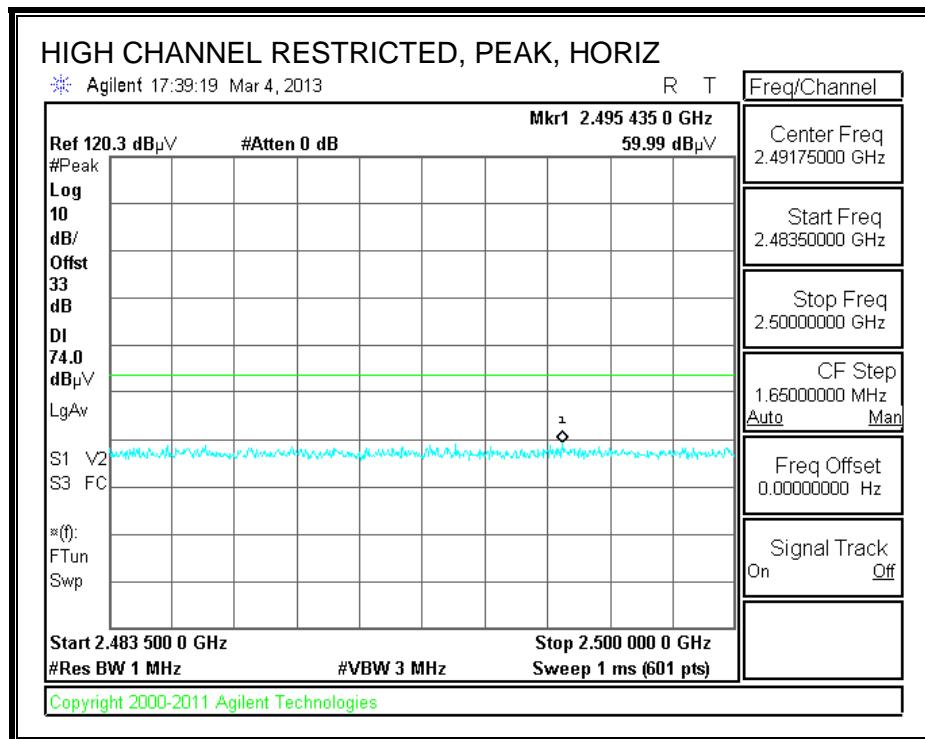
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



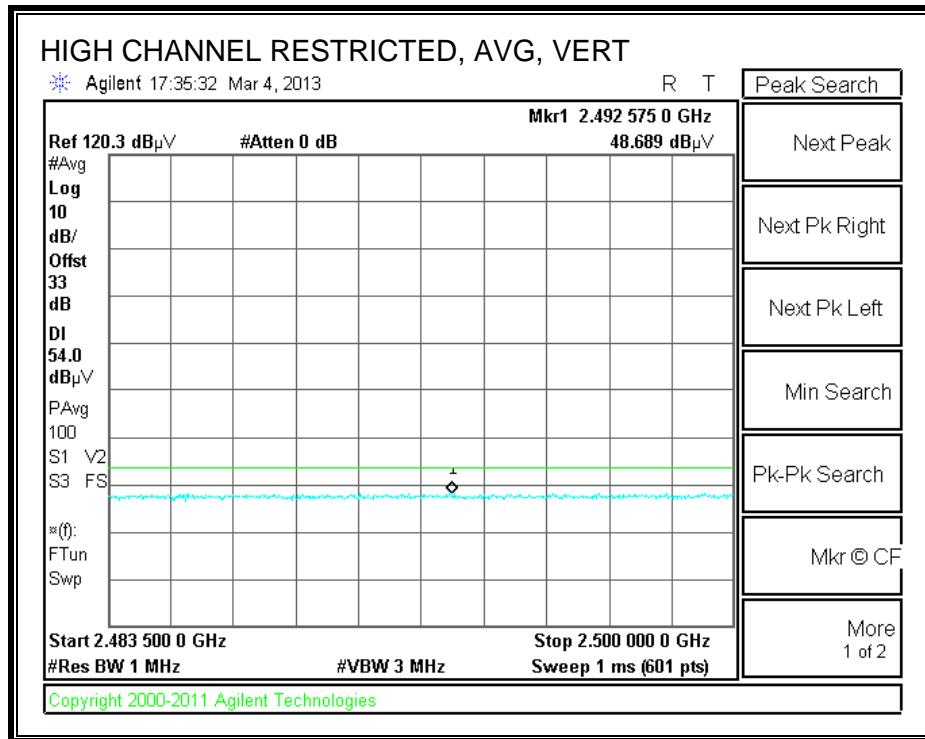
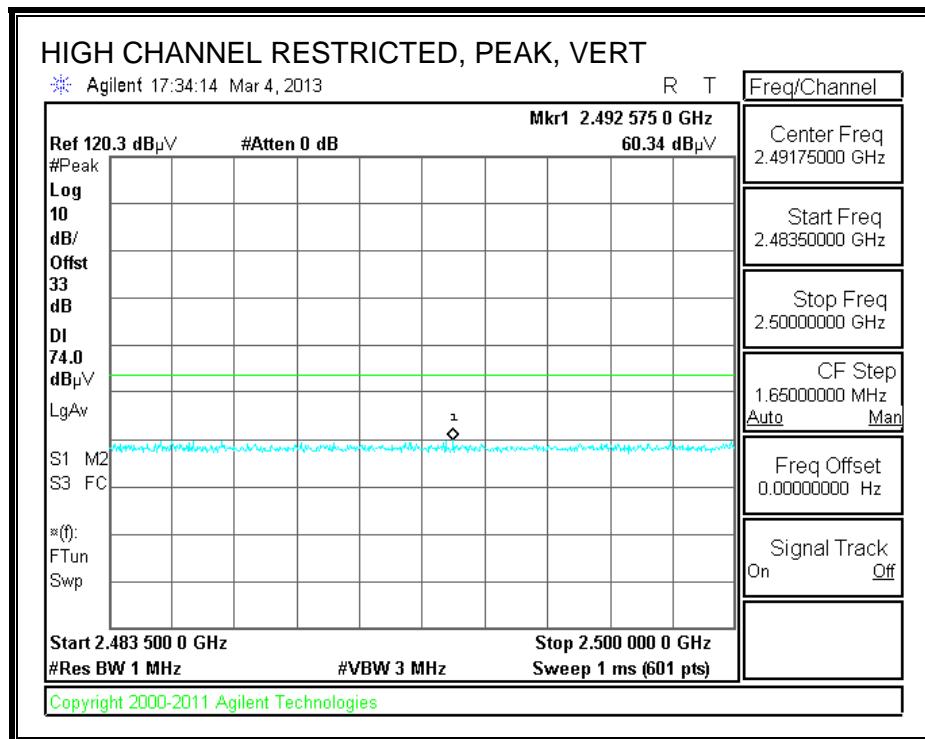
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)

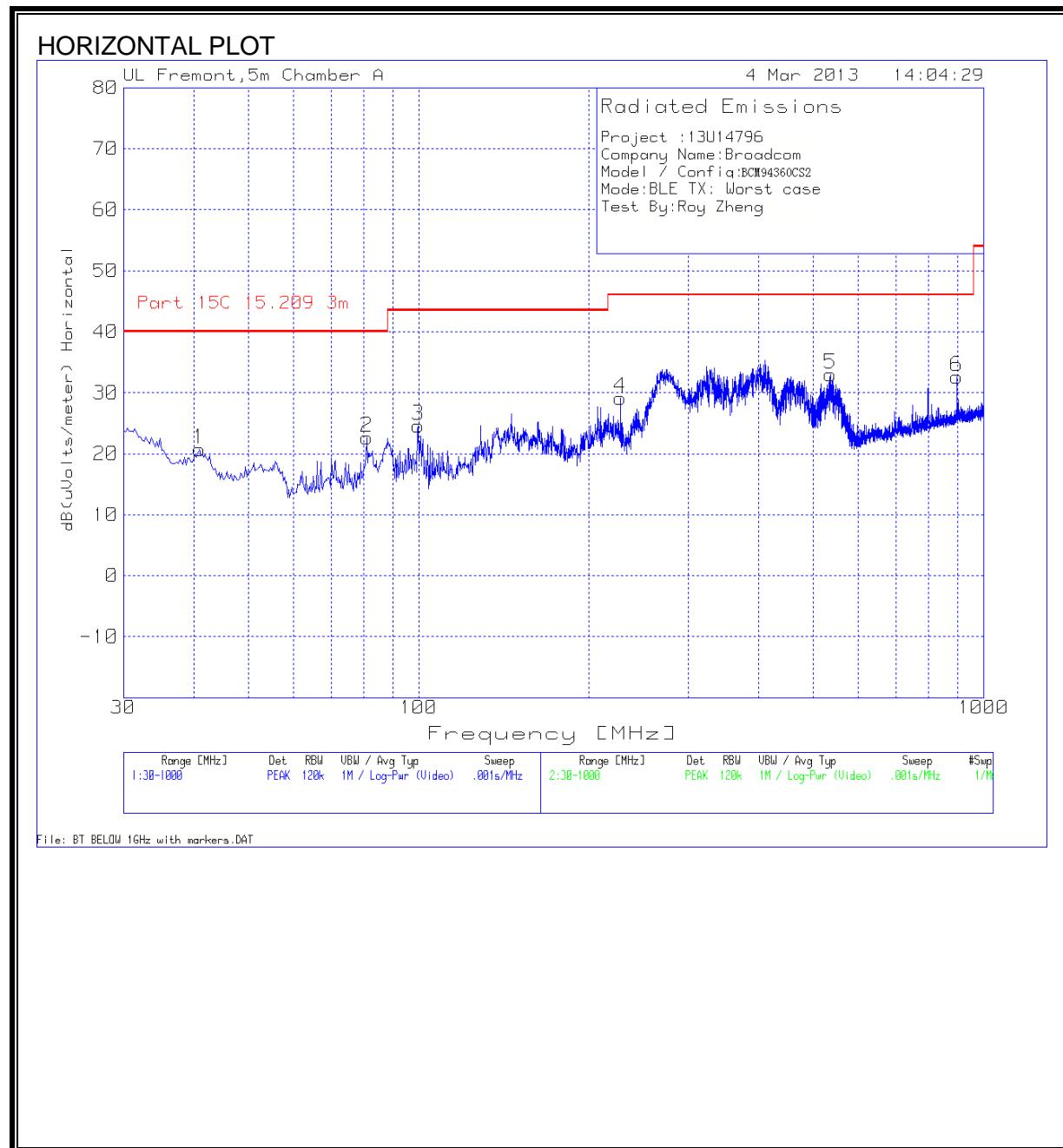


HARMONICS AND SPURIOUS EMISSIONS

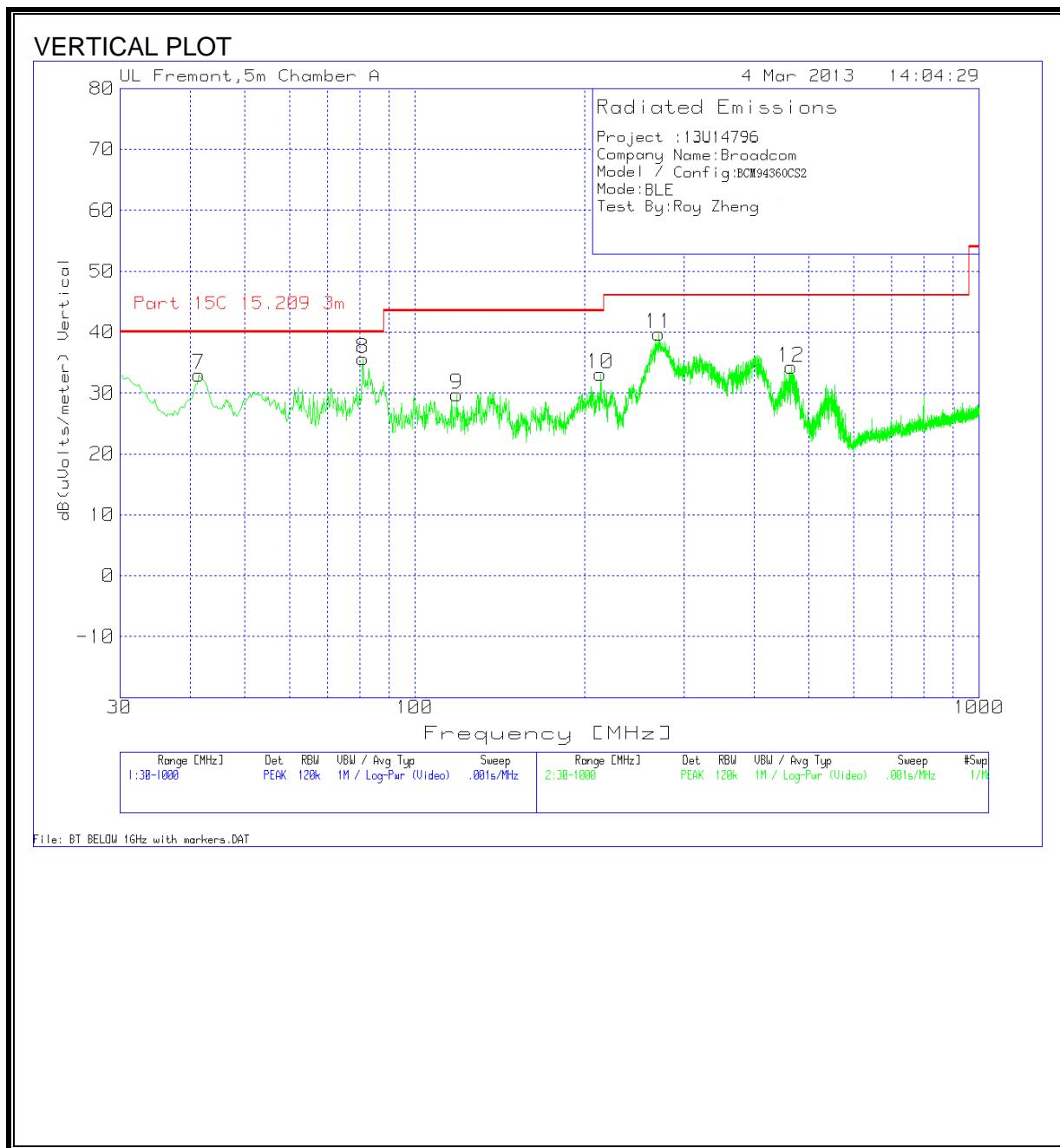
High Frequency Measurement Compliance Certification Services, Fremont 5m Chamber-A																																																	
<p>Company: Broadcom Project #: 13U14796 Date: 3/3/2013 Test Engineer: Danny Vu Configuration: EUT / Laptop Mode: Tx BLE Mode</p> <p><u>Test Equipment:</u></p> <table border="1"> <tr> <td>Horn 1-18GHz</td> <td>Pre-amplifier 1-26GHz</td> <td>Pre-amplifier 26-40GHz</td> <td colspan="3">Horn > 18GHz</td> <td>Limit</td> </tr> <tr> <td>T73; S/N: 6717 @3m</td> <td>T144 Miteq 3008A00931</td> <td></td> <td colspan="3">T89; ARA 18-26GHz; S/N:1049</td> <td>FCC 15.205</td> </tr> <tr> <td colspan="6">Hi Frequency Cables</td> <td></td> </tr> <tr> <td>3' cable 22807700</td> <td>12' cable 22807600</td> <td>20' cable 22807500</td> <td>HPF</td> <td>Reject Filter</td> <td colspan="2">Peak Measurement RBW=VBW=3MHz</td> </tr> <tr> <td>3' cable 22807700</td> <td>12' cable 22807600</td> <td>20' cable 22807500</td> <td></td> <td>R_001</td> <td colspan="2">Average Measurements RBW=VBW=3MHz</td> </tr> </table>															Horn 1-18GHz	Pre-amplifier 1-26GHz	Pre-amplifier 26-40GHz	Horn > 18GHz			Limit	T73; S/N: 6717 @3m	T144 Miteq 3008A00931		T89; ARA 18-26GHz; S/N:1049			FCC 15.205	Hi Frequency Cables							3' cable 22807700	12' cable 22807600	20' cable 22807500	HPF	Reject Filter	Peak Measurement RBW=VBW=3MHz		3' cable 22807700	12' cable 22807600	20' cable 22807500		R_001	Average Measurements RBW=VBW=3MHz	
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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																																																	
4.804	3.0	33.8	21.0	33.4	6.7	-35.7	0.0	0.0	38.3	25.5	74	54	-35.7	-28.5	H																																		
4.804	3.0	33.2	24.3	33.4	6.7	-35.7	0.0	0.0	37.7	28.8	74	54	-36.3	-25.2	V																																		
Mid Channel 2441																																																	
4.880	3.0	32.9	20.7	33.5	6.8	-35.7	0.0	0.0	37.5	25.4	74	54	-36.5	-28.6	H																																		
7.320	3.0	39.5	27.3	36.0	8.7	-35.8	0.0	0.0	48.4	36.2	74	54	-25.6	-17.8	H																																		
4.880	3.0	33.9	28.5	33.5	6.8	-35.7	0.0	0.0	38.6	33.1	74	54	-35.4	-20.9	V																																		
7.320	3.0	39.6	25.3	36.0	8.7	-35.8	0.0	0.0	48.4	34.2	74	54	-25.6	-19.8	V																																		
High Channel 2480																																																	
4.960	3.0	33.3	20.7	33.6	6.9	-35.6	0.0	0.0	38.1	25.5	74	54	-35.9	-28.5	H																																		
7.440	3.0	39.3	27.4	36.1	8.8	-35.8	0.0	0.0	48.4	36.4	74	54	-25.6	-17.6	H																																		
4.960	3.0	33.4	21.2	33.6	6.9	-35.6	0.0	0.0	38.2	26.0	74	54	-35.8	-28.0	V																																		
7.440	3.0	39.5	27.4	36.1	8.8	-35.8	0.0	0.0	48.6	36.4	74	54	-25.4	-17.6	V																																		
Rev. 01.30.13																																																	
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)



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



HORIZONTAL AND VERTICAL DATA

Project :	13U14796
Company Name:	Broadcom
Model / Config:	BCM94360CS2
Mode:	BLE
Test By:	Roy Zheng

Marker No.	Test Frequency	Meter Reading	Detector	T185 Antenna Factor (dB)	T64 preamp/ cable loss loop (dB)	dB(uVolts/meter)	FCC Part 15B Class B 3m	Margin	Height [cm]	Polarity
Horizontal 30 - 1000MHz										
1	40.9043	35.37	PK	12.9	-27.5	20.77	40	-19.23	300	Horz
2	80.8868	42.12	PK	7.6	-27.1	22.62	40	-17.38	400	Horz
3	99.7877	41.62	PK	10	-27	24.62	43.5	-18.88	300	Horz
4	227.4894	44.18	PK	11	-26.1	29.08	46	-16.92	100	Horz
5	535.9605	39.17	PK	18.1	-24.2	33.07	46	-12.93	100	Horz
6	896.0455	33.25	PK	22	-22.6	32.65	46	-13.35	100	Horz
Vertical 30 - 1000MHz										
7	41.389	48.03	PK	12.5	-27.5	33.03	40	-6.97	100	Vert
8	80.8868	55.16	PK	7.6	-27.1	35.66	40	-4.34	100	Vert
9	118.9308	42.73	PK	13.9	-26.9	29.73	43.5	-13.77	100	Vert
10	213.1926	48.9	PK	10.4	-26.2	33.1	43.5	-10.4	100	Vert
11	270.8644	52.53	PK	13.2	-26	39.73	46	-6.27	100	Vert
12	465.4459	41.94	PK	17.2	-24.9	34.24	46	-11.76	100	Vert

PK - Peak detector

QP - Quasi-Peak detector

Av - Average 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 [*]	56 to 46 [*]
0.5-5	56	46
5-30	60	50

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

TEST PROCEDURE

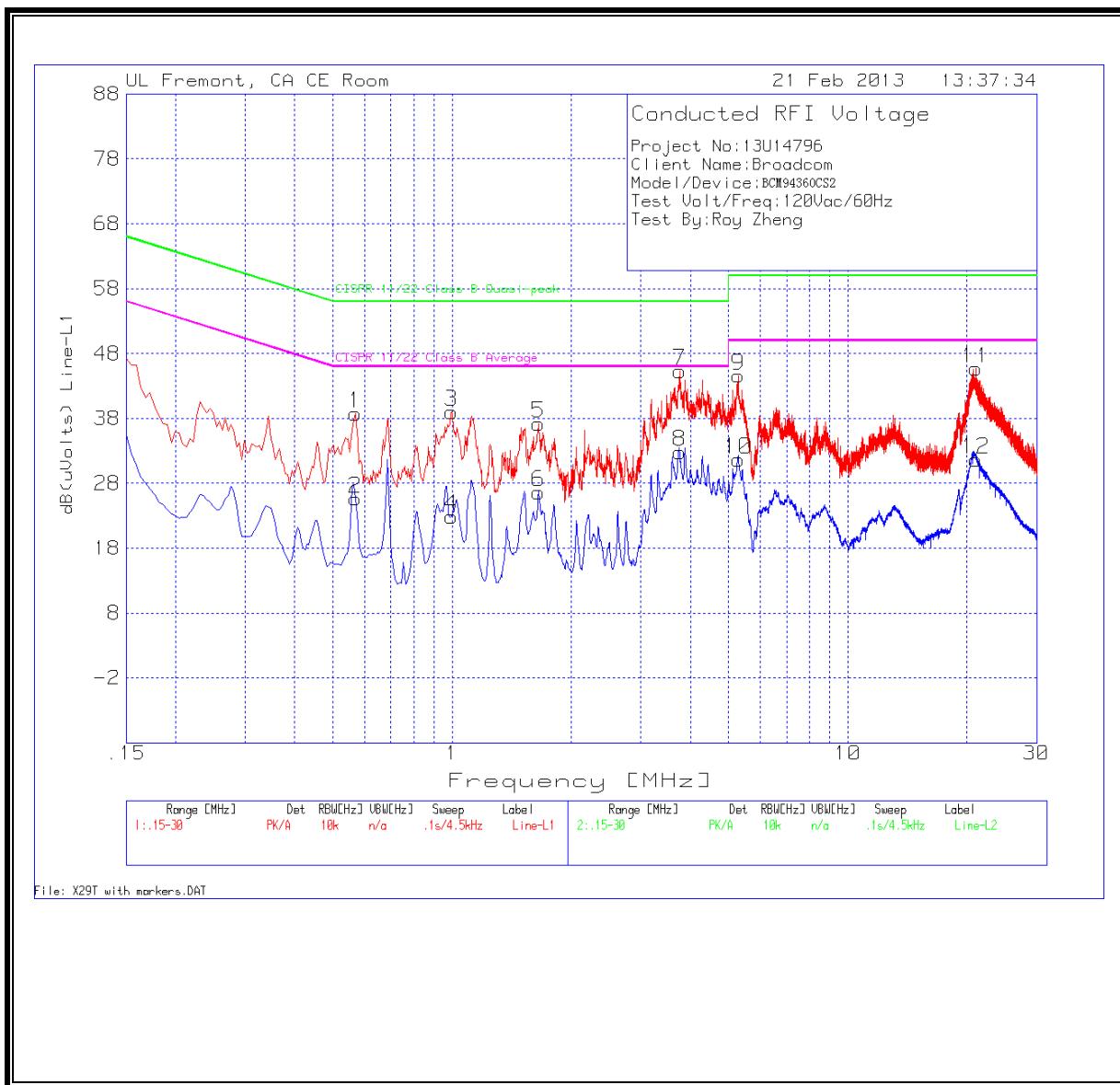
ANSI C63.4

RESULTS

6 WORST EMISSIONS

Project No:	13U14796								
Client Name:	Broadcom								
Model/Device:	BCM94360CS2								
Test Volt/Freq:	120Vac/60Hz								
Test By:	Roy Zheng								
Test Frequency	Meter Reading	Detector	T24 IL L1.TXT (dB)	LC Cables 1&3.TXT (dB)	dB(uVolts)	CISPR 11/22 Class B Quasi-peak	Margin	CISPR 11/22 Class B Average	Margin
Line-L1 .15 - 30MHz									
0.5685	38.63	PK	0.1	0	38.73	56	-17.27	-	-
0.5685	25.56	Av	0.1	0	25.66	-	-	46	-20.34
0.996	38.93	PK	0.1	0	39.03	56	-16.97	-	-
0.996	22.83	Av	0.1	0	22.93	-	-	46	-23.07
1.65525	37.04	PK	0.1	0.1	37.24	56	-18.76	-	-
1.65525	26.48	Av	0.1	0.1	26.68	-	-	46	-19.32
3.7545	45.13	PK	0.1	0.1	45.33	56	-10.67	-	-
3.7545	32.58	Av	0.1	0.1	32.78	-	-	46	-13.22
5.298	44.41	PK	0.1	0.1	44.61	60	-15.39	-	-
5.298	31.5	Av	0.1	0.1	31.7	-	-	50	-18.3
21.0615	45.15	PK	0.3	0.2	45.65	60	-14.35	-	-
21.0615	31.2	Av	0.3	0.2	31.7	-	-	50	-18.3
Line-L2 .15 - 30MHz									
0.402	42.88	PK	0.1	0	42.98	57.8	-14.82	-	-
0.402	27.73	Av	0.1	0	27.83	-	-	47.8	-19.97
0.636	40.36	PK	0.1	0	40.46	56	-15.54	-	-
0.636	29.43	Av	0.1	0	29.53	-	-	46	-16.47
1.2165	40.42	PK	0.1	0.1	40.62	56	-15.38	-	-
1.2165	24.39	Av	0.1	0.1	24.59	-	-	46	-21.41
3.255	41.96	PK	0.1	0.1	42.16	56	-13.84	-	-
3.255	24.18	Av	0.1	0.1	24.38	-	-	46	-21.62
13.0065	39.14	PK	0.2	0.2	39.54	60	-20.46	-	-
13.0065	25.72	Av	0.2	0.2	26.12	-	-	50	-23.88
20.9445	43.22	PK	0.3	0.2	43.72	60	-16.28	-	-
20.9445	31.12	Av	0.3	0.2	31.62	-	-	50	-18.38
PK - Peak detector									
QP - Quasi-Peak detector									
Av - Average detector									

LINE 1 RESULTS



LINE 2 RESULTS

