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

BLUETOOTH LOW ENERGY CERTIFICATION TEST REPORT

FOR

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

MODEL NUMBER: BCM94360CS

FCC ID: QDS-BRCM1069
IC: 4324A-BRCM1069

REPORT NUMBER: 12U14668-4

ISSUE DATE: MAY 28, 2013

Prepared for

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

Prepared by

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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	05/28/13	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: Broadcom 802.11a/g/n/ac WLAN + Bluetooth PCI-E Custom Combination Card

MODEL: BCM94360CS

SERIAL NUMBER: C8Y2382001EF563ES

DATE TESTED: DECEMBER 21 - 28, 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 LEAD
UL CCS

Tested By:

STEVE AGUILAR
EMC ENGINEER
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 Broadcom 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)	4.18	2.62

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The following antennas are utilized for this device:

No.	Antenna Manufacturer	Antenna Type	Model	Peak gain @ 2412, 2422, 2432MHz	Peak gain (5150-5250MHz) @5200MHz	Peak gain (5250-5350MHz) @5320MHz	Peak gain (5470-5725MHz) @5500, 5700MHz	Peak gain (5725-5850MHz) @5785, 5805MHz	
1	Amphenol/Molex	802.11abgn WLAN Antenna	613-1143 Wi-Fi1	0.12	7.04	7.09	5.03	2.66	Host2 antenna
1	Amphenol/Molex	802.11abgn WLAN/BT Antenna	613-1143 Wi-Fi2	5.3	6.7	7.06	6.66	5.93	Host2 antenna
1	Amphenol/Molex	802.11abgn WLAN Antenna	613-1143 Wi-Fi3 & Bluetooth	4.69	3.79	3.58	3.94	6.04	Host2 antenna
2	Amphenol/Molex	802.11abgn WLAN Antenna	613-1631 Wi-Fi1	2.47	4.18	3.35	3.32	3.56	Host1 antenna
2	Amphenol/Molex	802.11abgn WLAN Antenna	613-1631 Wi-Fi2	2.64	4.22	3.44	2.41	3.68	Host1 antenna
2	Amphenol/Molex	802.11abgn WLAN Antenna	613-1631 Wi-Fi3 & Bluetooth	4.82	4.63	3.01	4.63	4.31	Host1 antenna

5.4. SOFTWARE AND FIRMWARE

The EUT driver software installed during testing was Broadcom, rev. 6.30.118.23.

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

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	Apple	A1465	2012-2333	DoC
AC Adapter	Liteon Technology	MagSafe2	NSW25804	DoC
Mouse	HP	N8ROU	537749-001	DoC

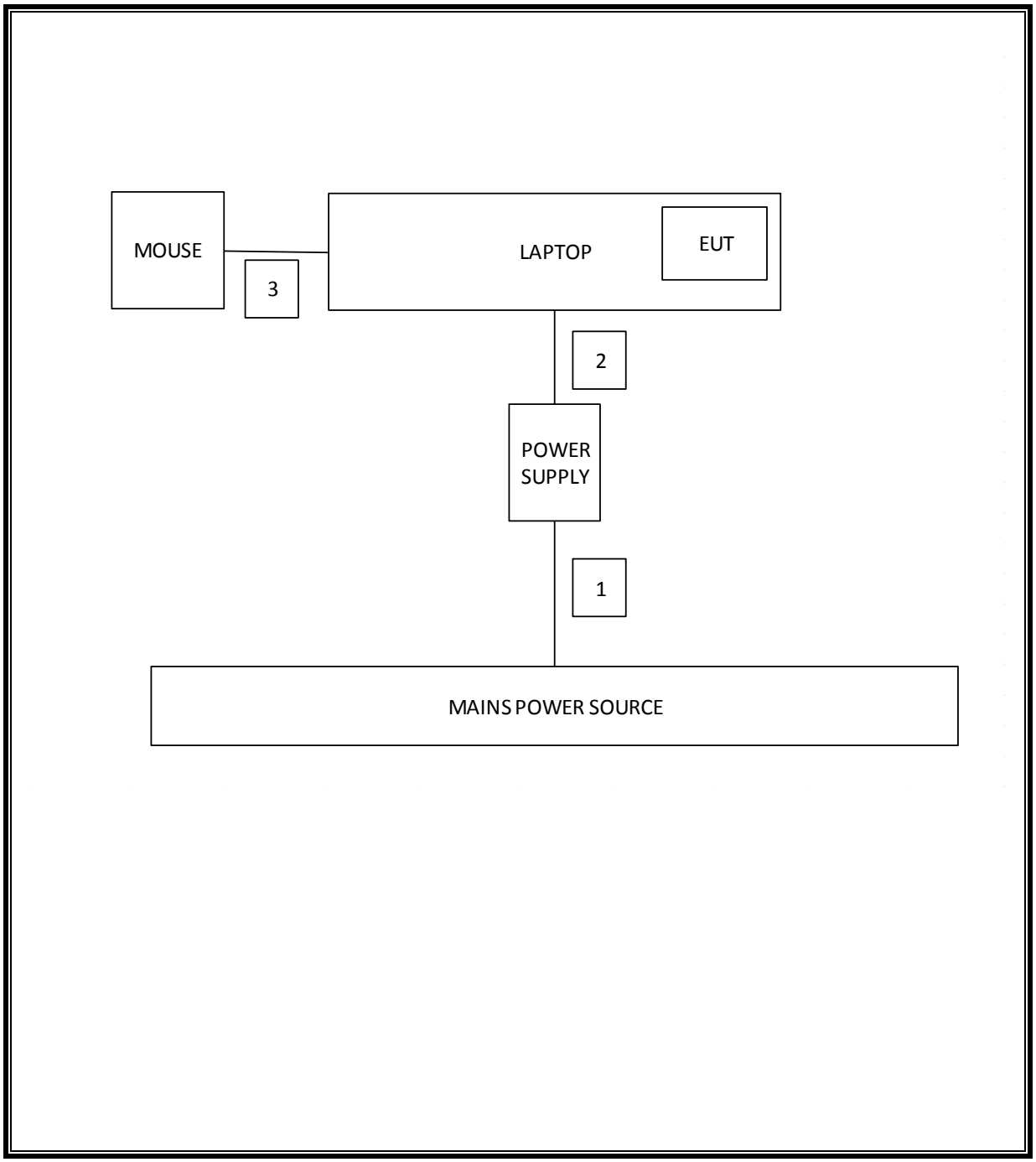
I/O CABLES

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**
Peak Power Meter	Agilent / HP	E4416A	C00963	12/13/11	12/13/12
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01176	12/13/12	12/13/13
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01161	05/02/12	05/02/13
Antenna, Horn, 18 GHz	EMCO	3115	C00945	11/12/12	11/12/13
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	10/22/12	10/22/13
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00885	12/20/11	12/30/13
Antenna, Bilog, 30MHz-1 GHz	Sunol Sciences	JB1	--	02/07/12	02/07/13
Antenna, Horn, 26.5 GHz	ARA	SWH-28	C01015	04/23/12	04/23/13
EMI Test Receiver, 30 MHz	R & S	ESHS 20	N02396	08/08/12	08/08/13
LISN, 30 MHz	FCC	50/250-25-2	C00626	12/13/11	01/13/14

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.

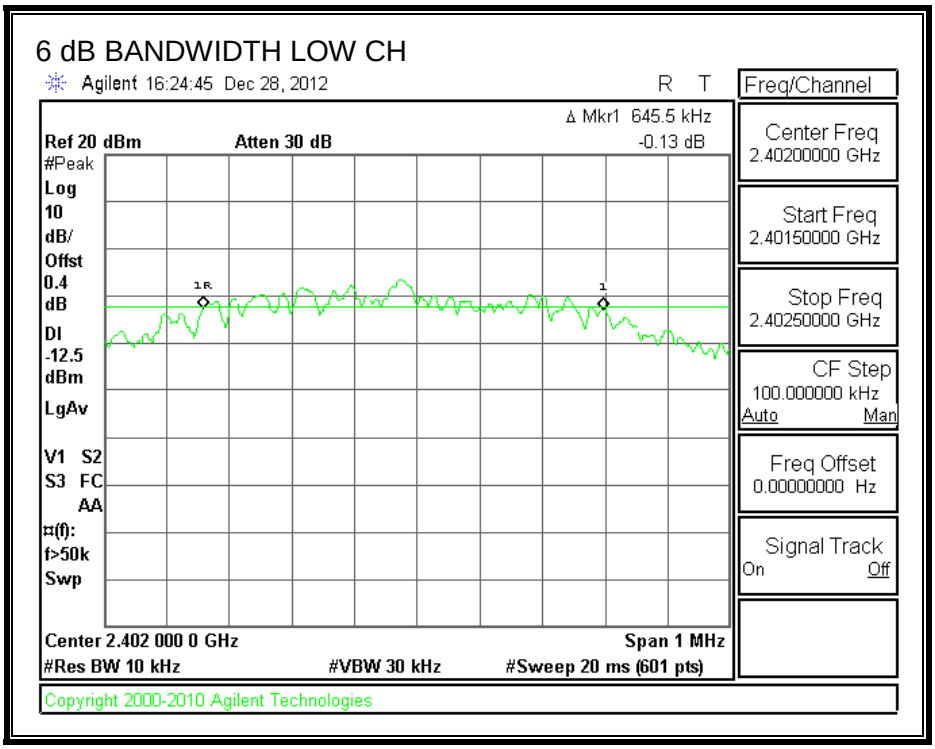
TEST PROCEDURE

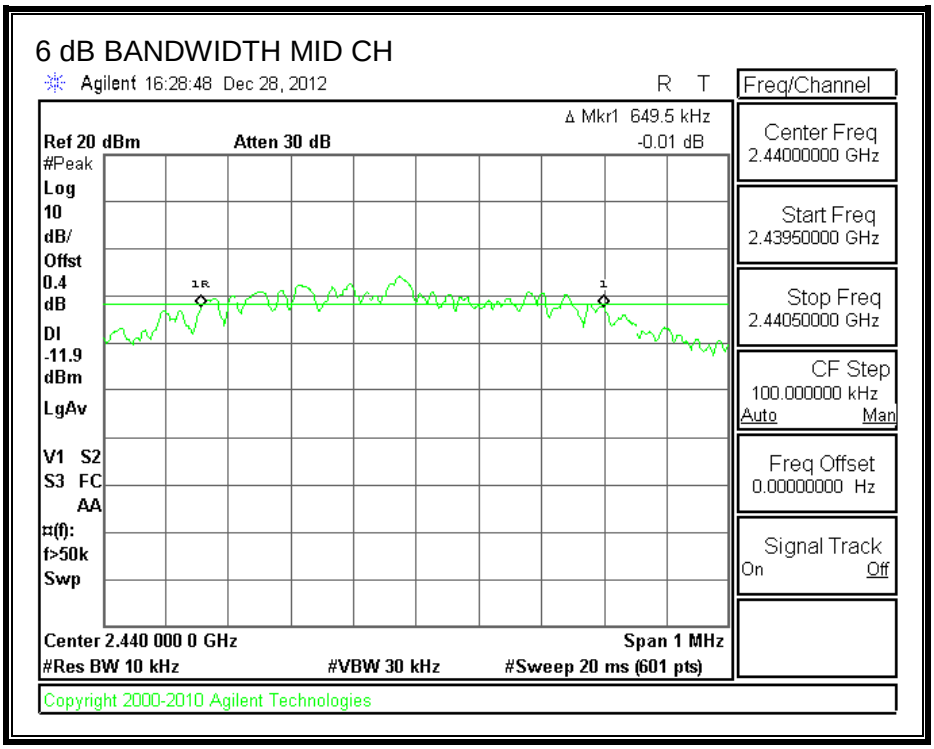
KDB 558074 D01 v02 “Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247”.

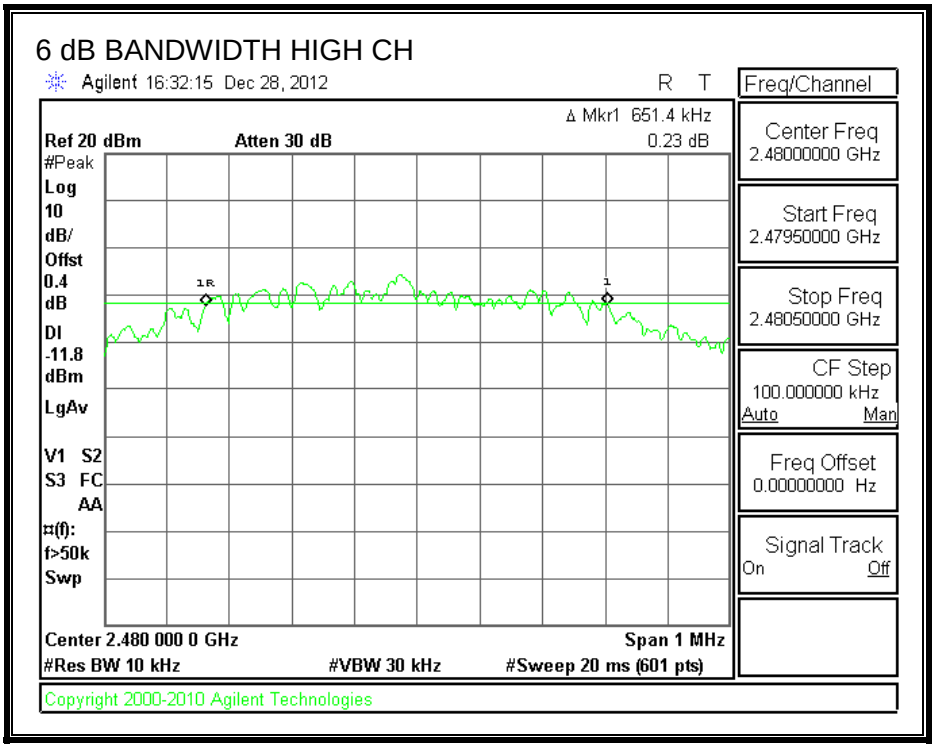
RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6455	0.5
Middle	2440	0.6495	0.5
High	2480	0.6514	0.5

6 dB BANDWIDTH







7.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

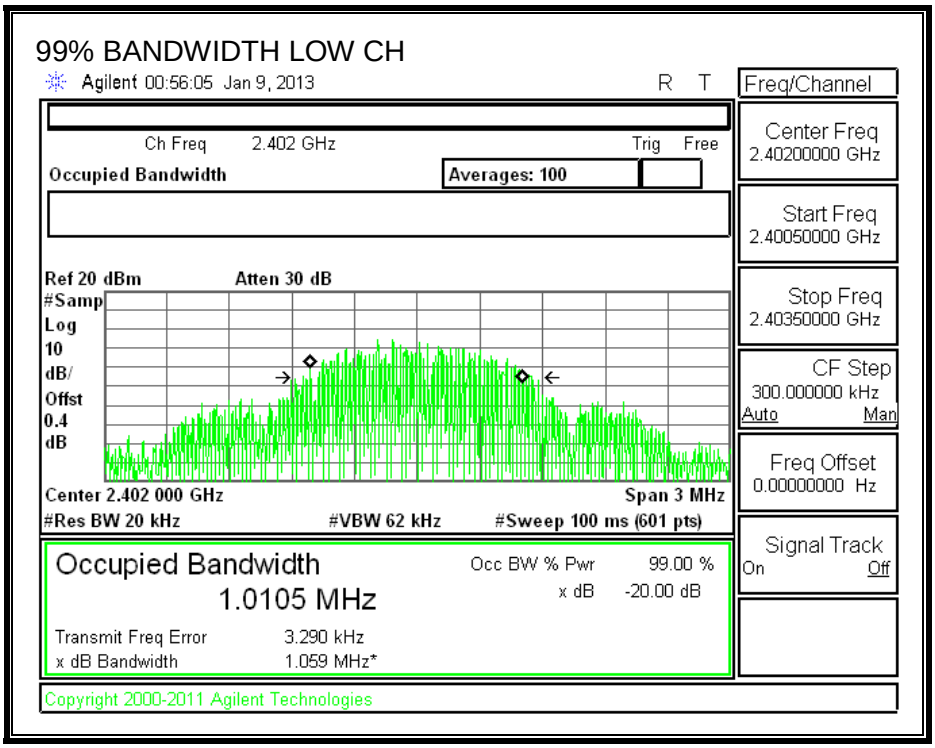
TEST PROCEDURE

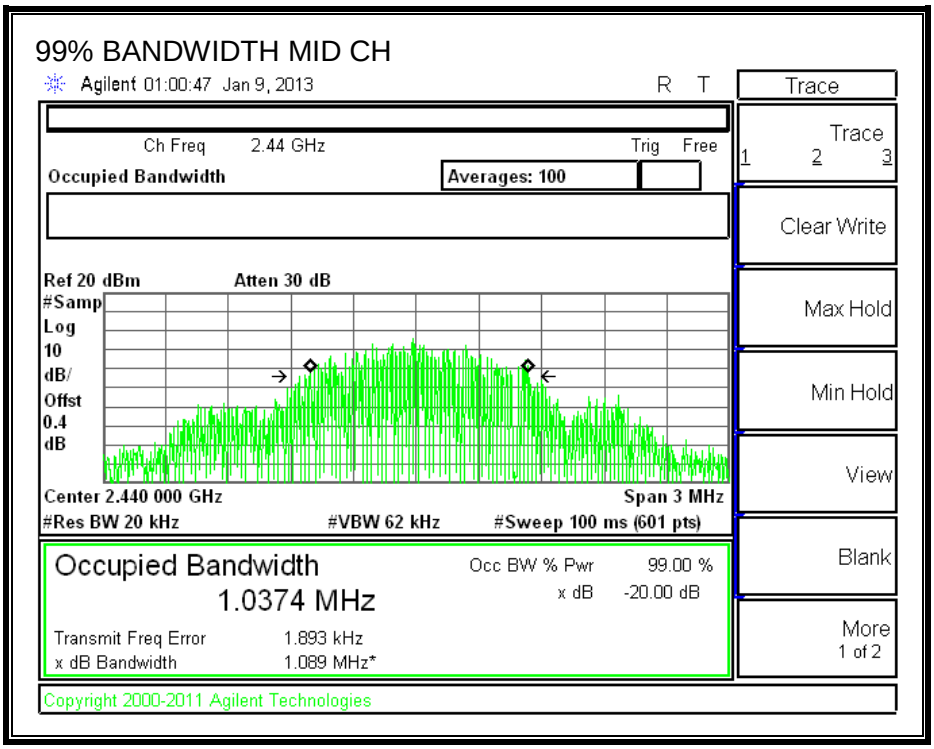
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth and to 1% of the span. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

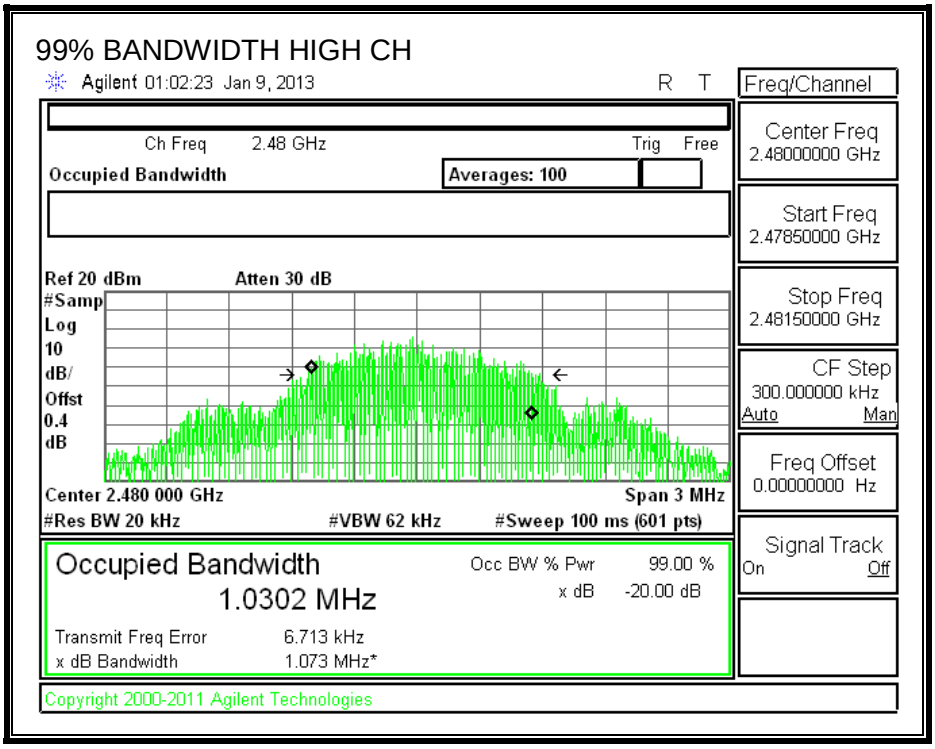
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0105
Middle	2440	1.0374
High	2480	1.0302

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.

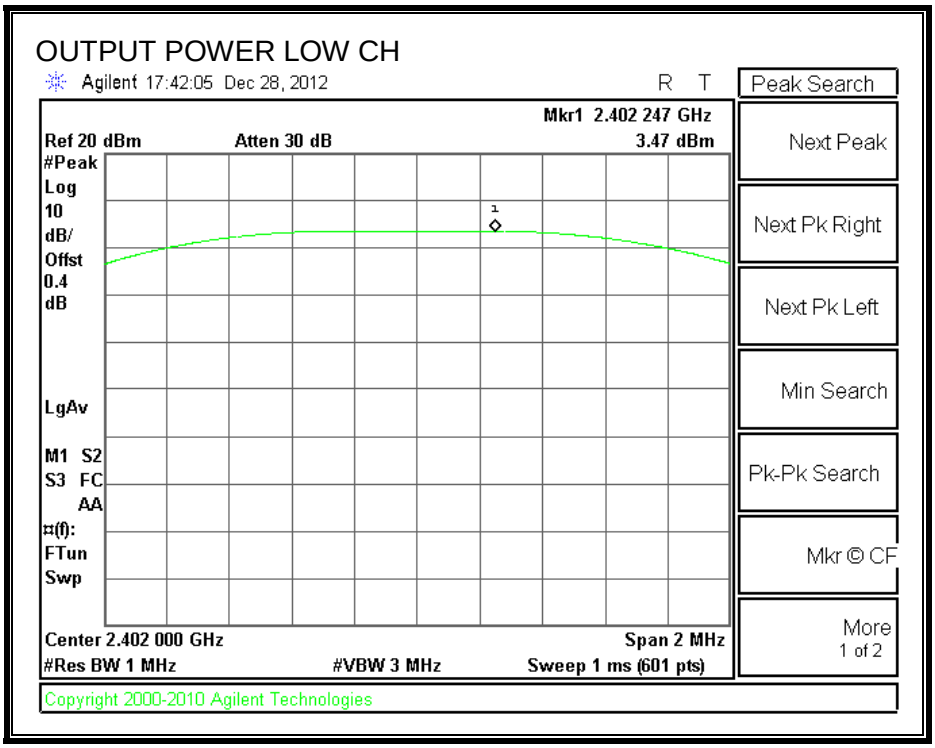
TEST PROCEDURE

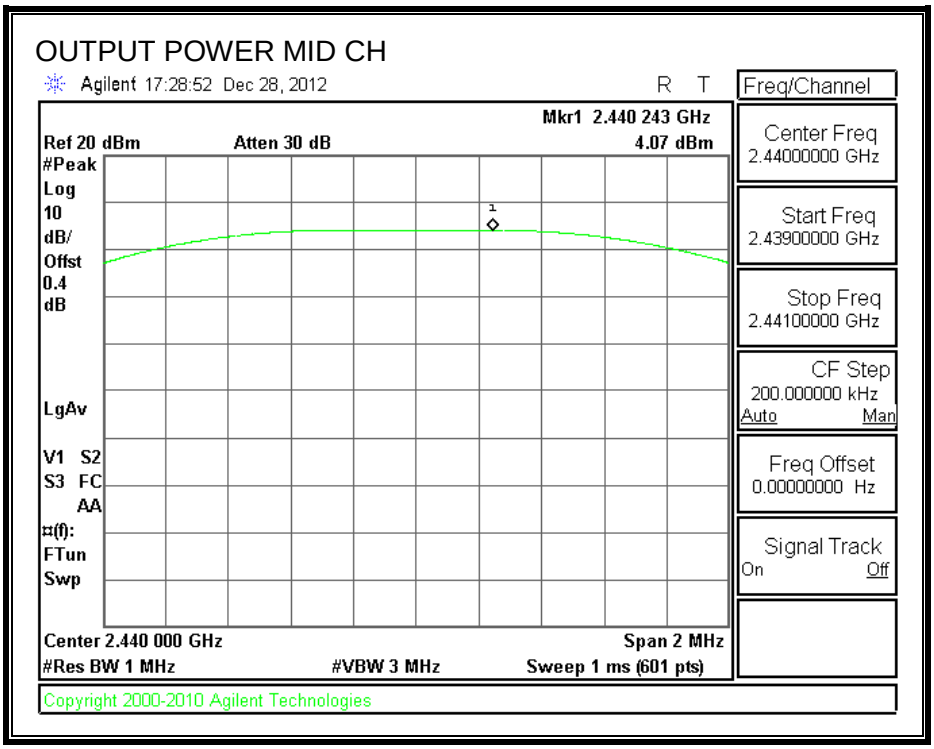
KDB 558074 D01 v02 “Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247”.

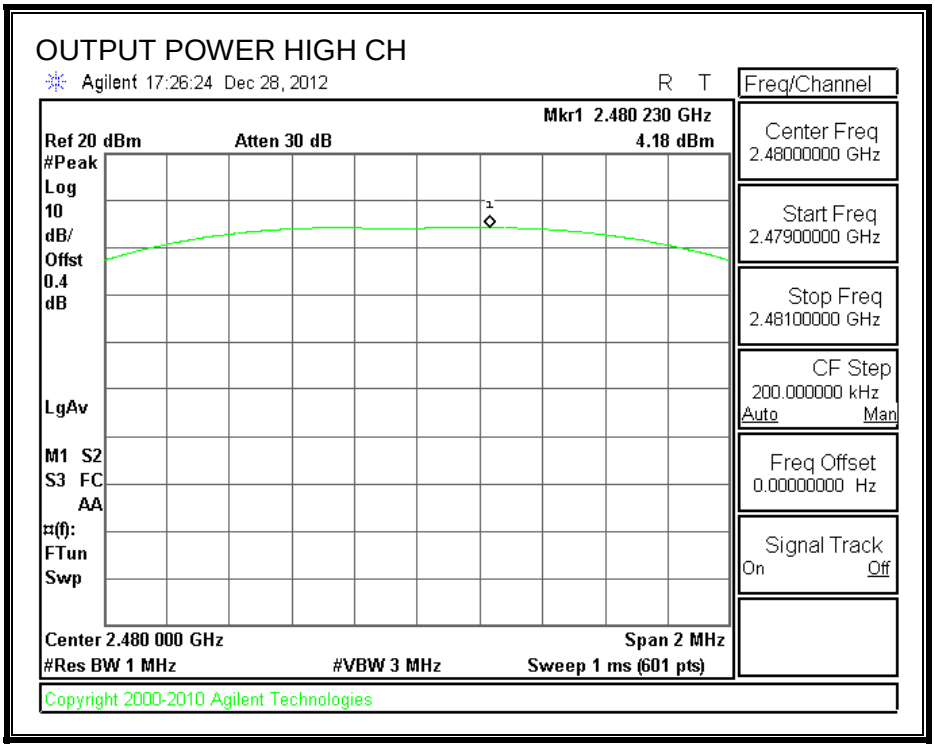
RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	3.47	30	-26.53
Middle	2440	4.07	30	-25.93
High	2480	4.18	30	-25.82

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 0.4dB (including 0 dB pad and 0.4 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	2.34
Middle	2440	3.06
High	2480	3.25

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.

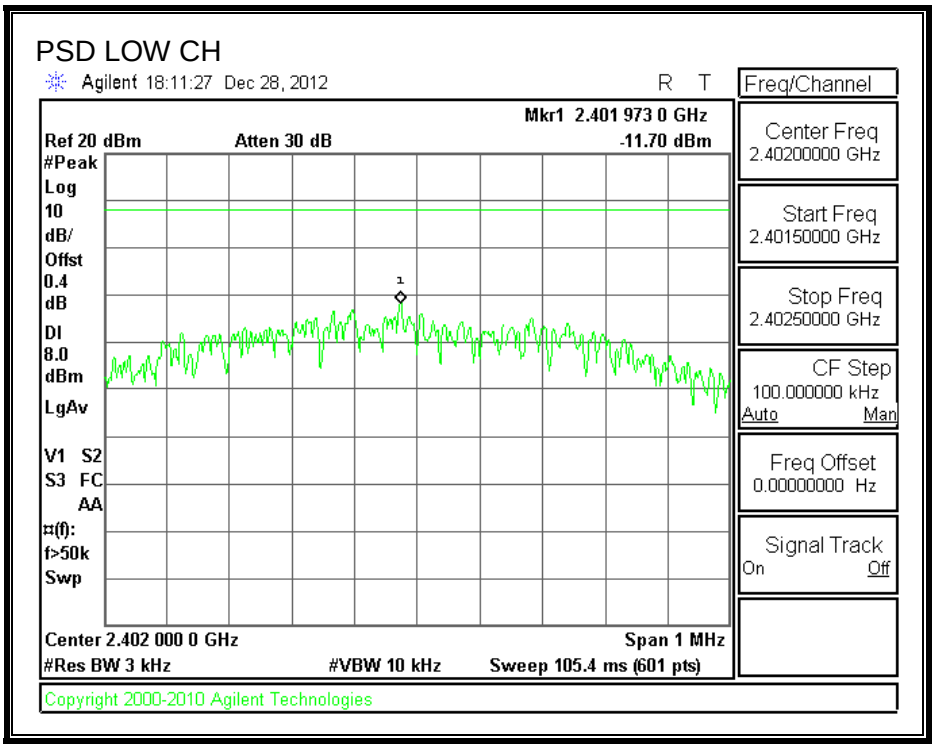
TEST PROCEDURE

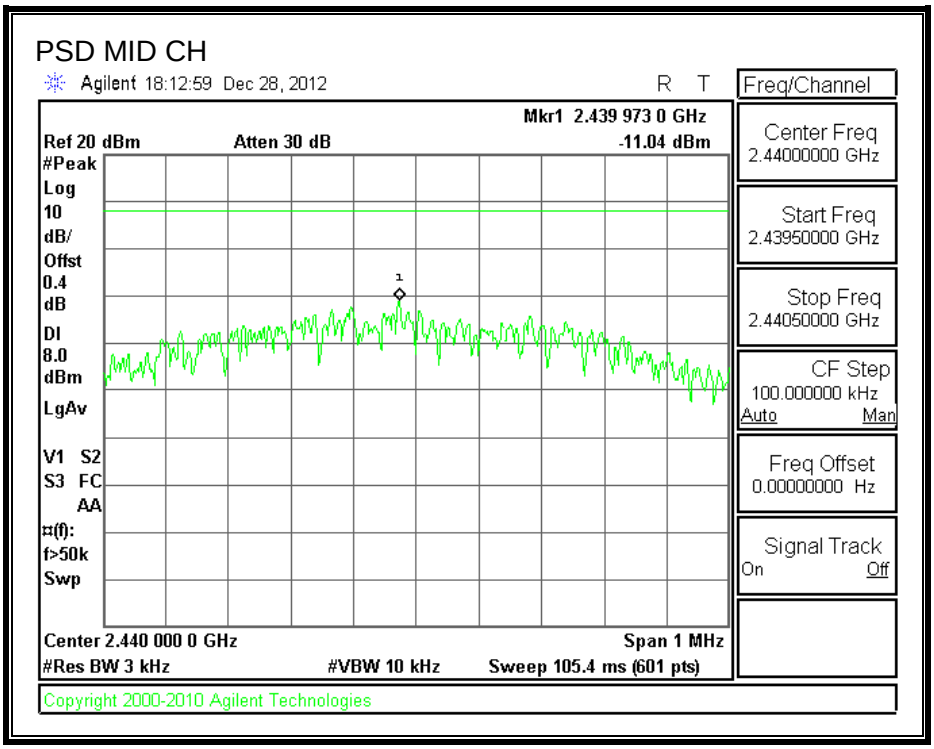
KDB 558074 D01 v02 “Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247”.

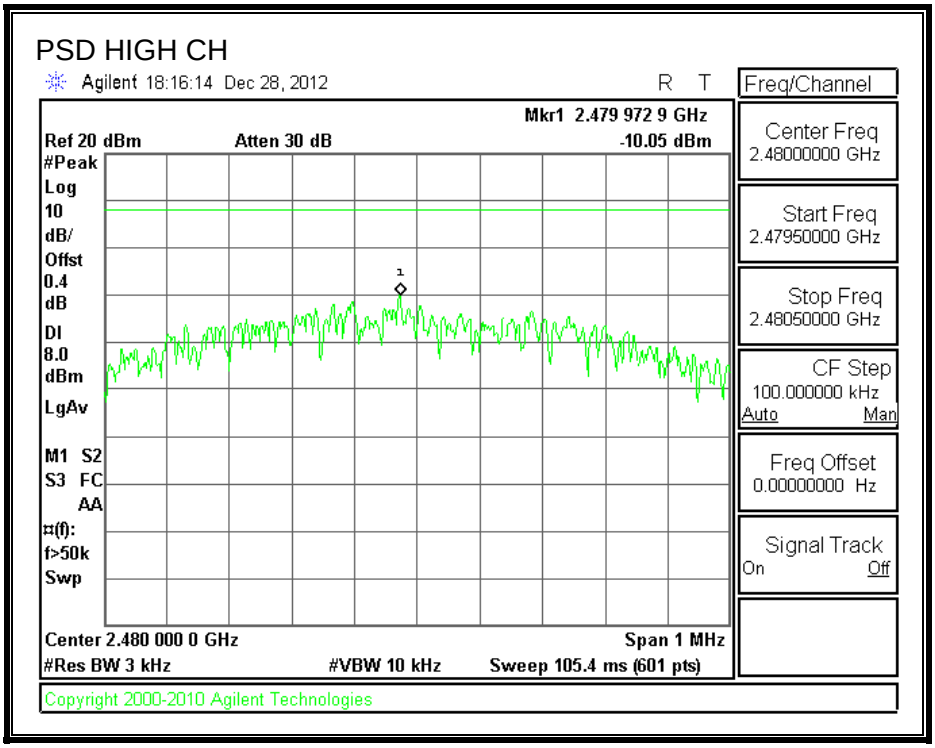
RESULTS

Channel	Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-11.70	8	-19.70
Middle	2440	-11.04	8	-19.04
High	2480	-10.05	8	-18.05

POWER SPECTRAL DENSITY







7.6. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

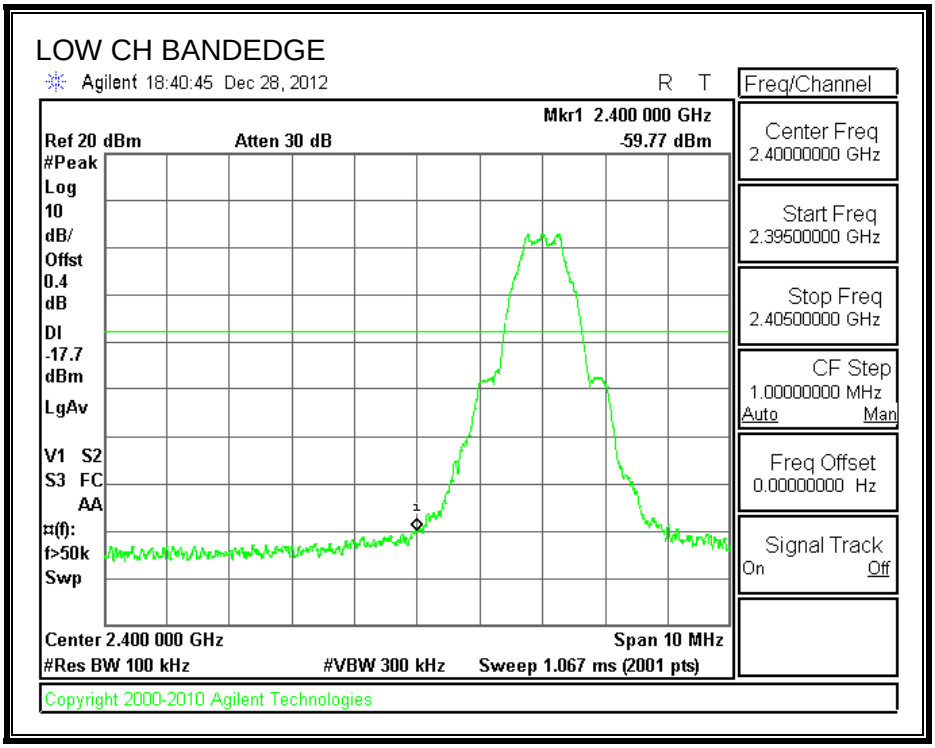
Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

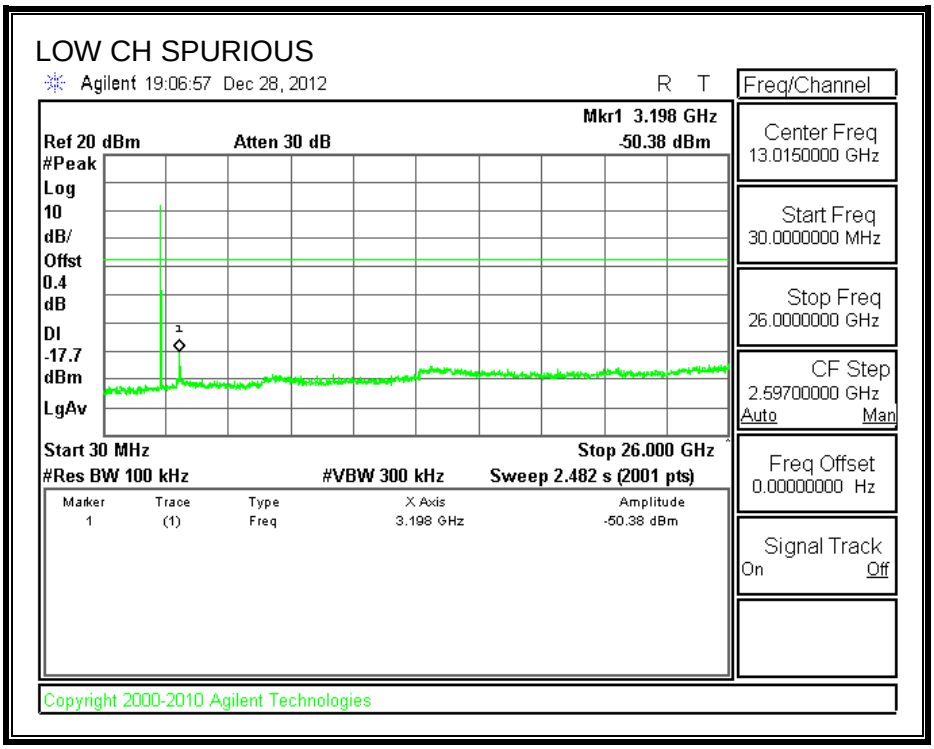
TEST PROCEDURE

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

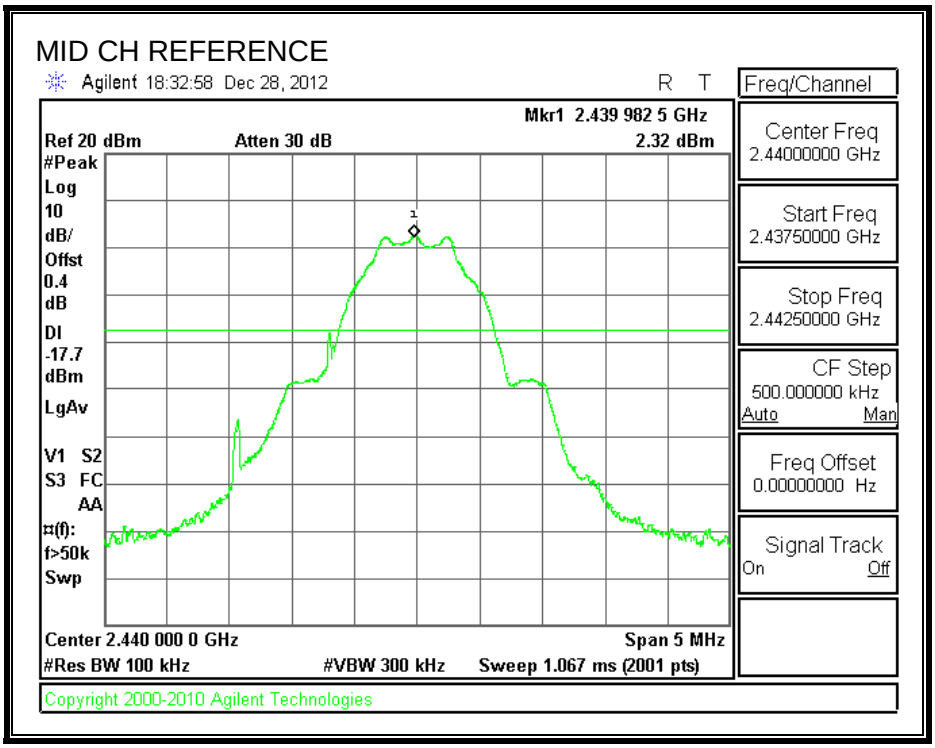
RESULTS

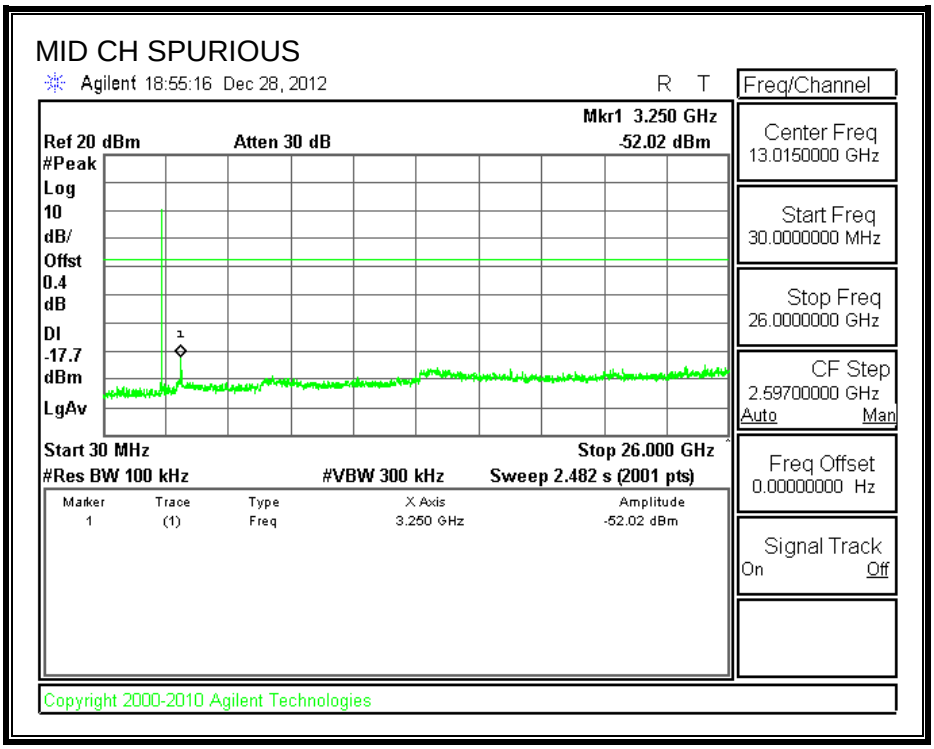
SPURIOUS EMISSIONS, LOW CHANNEL



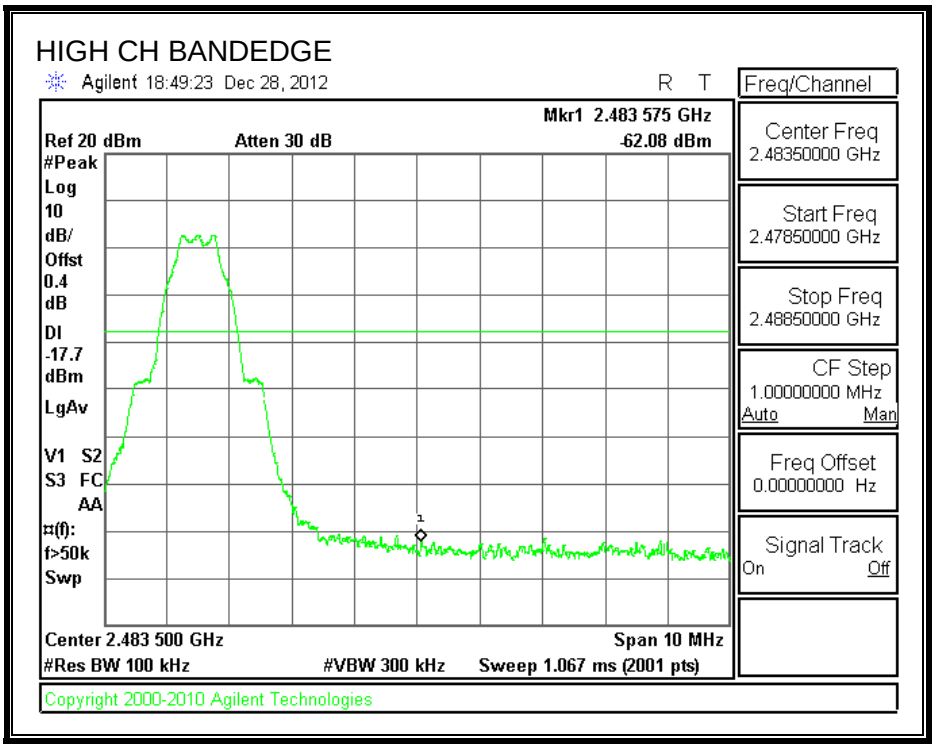


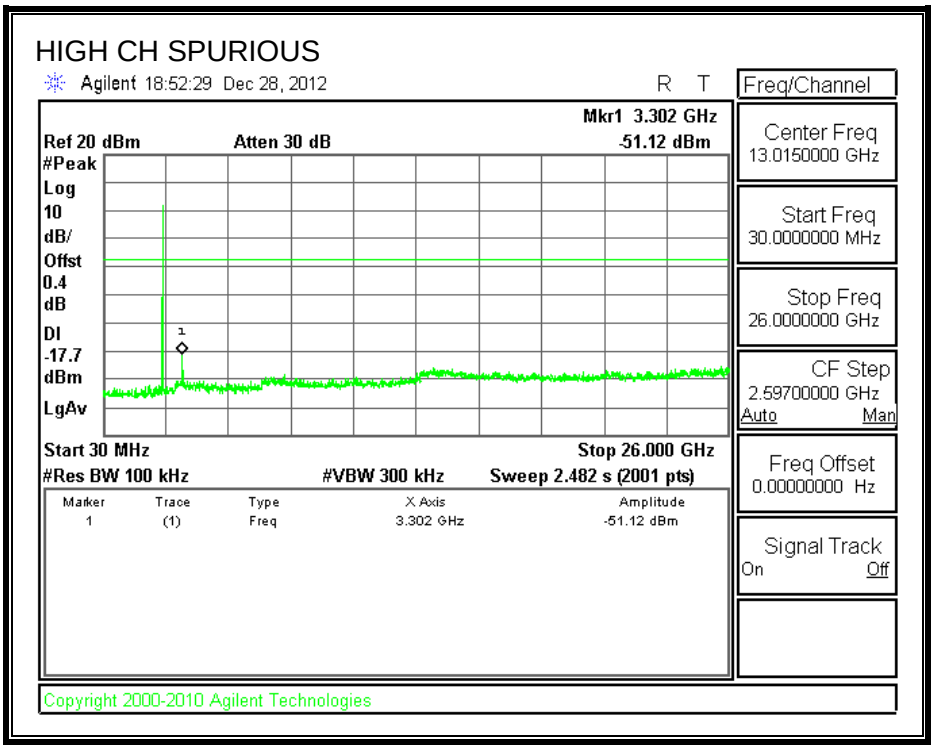
SPURIOUS EMISSIONS, MID CHANNEL





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.

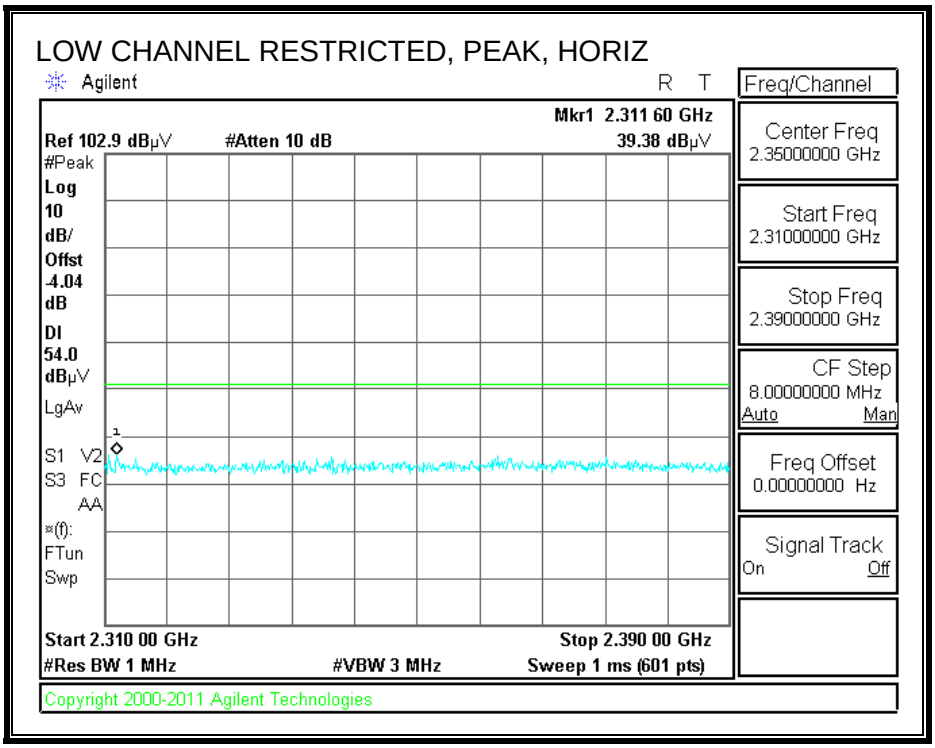
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

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.

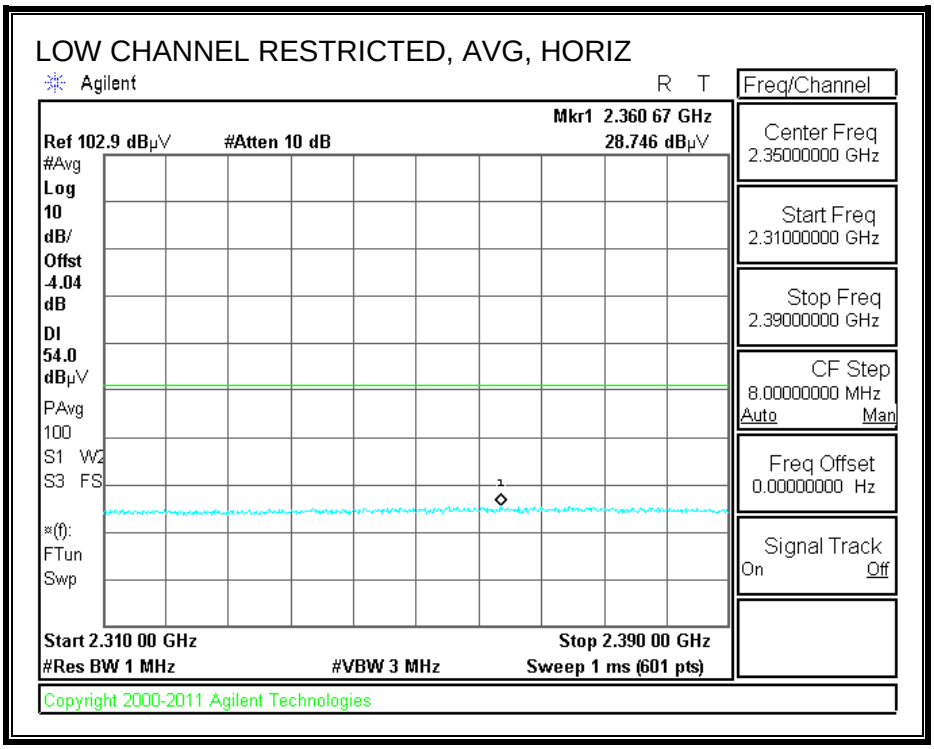
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

8.2. TRANSMITTER ABOVE 1 GHz, BLUETOOTH LOW ENERGY

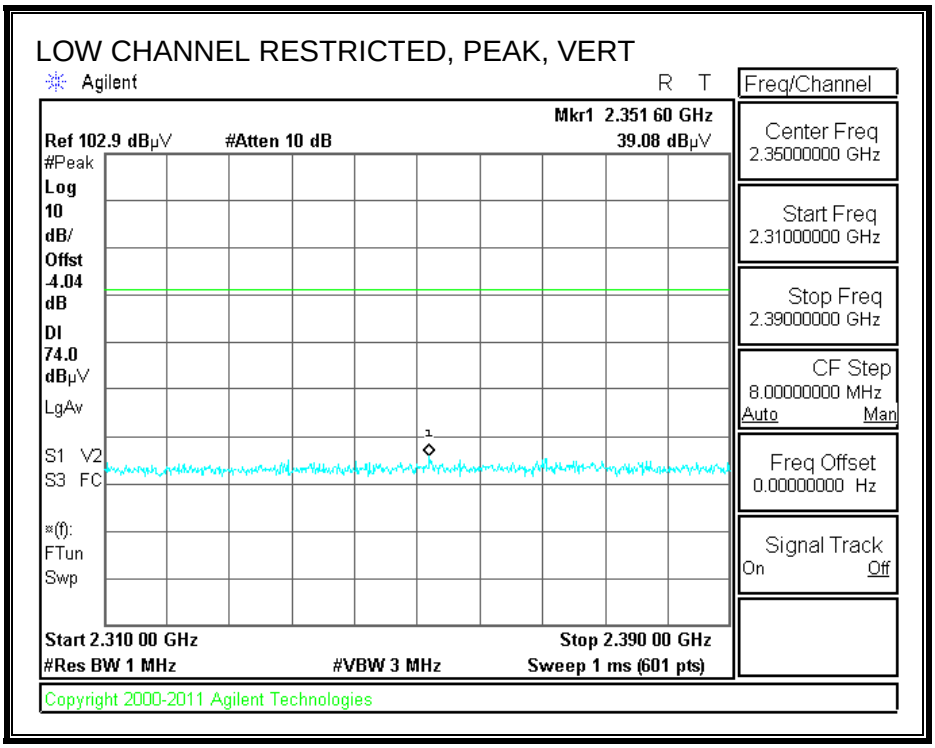
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



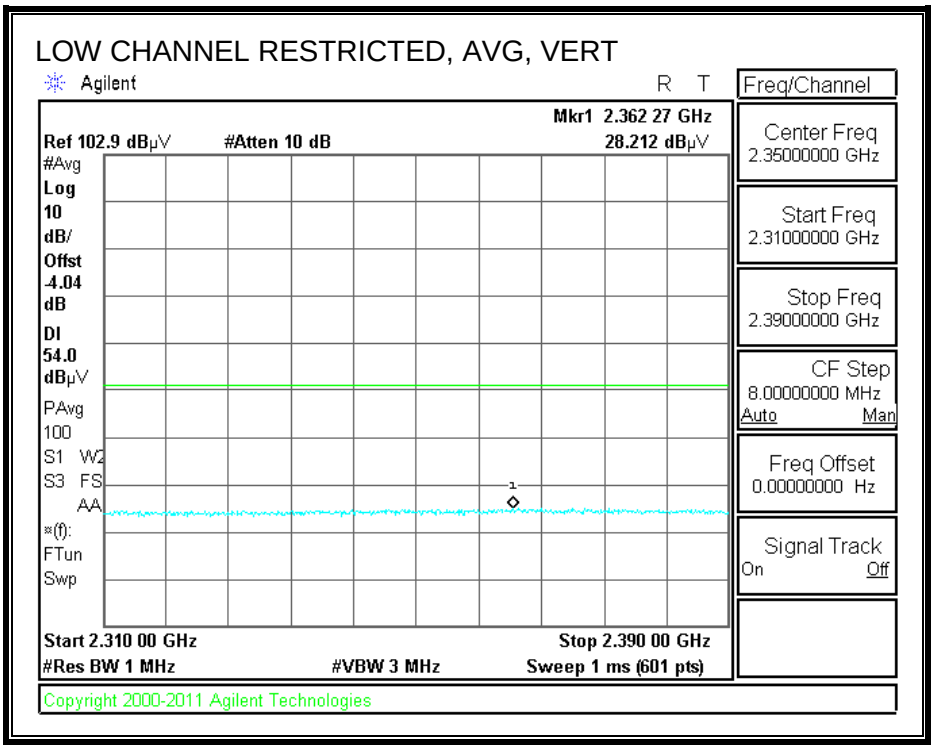
LOW CHANNEL RESTRICTED, AVG, HORIZ



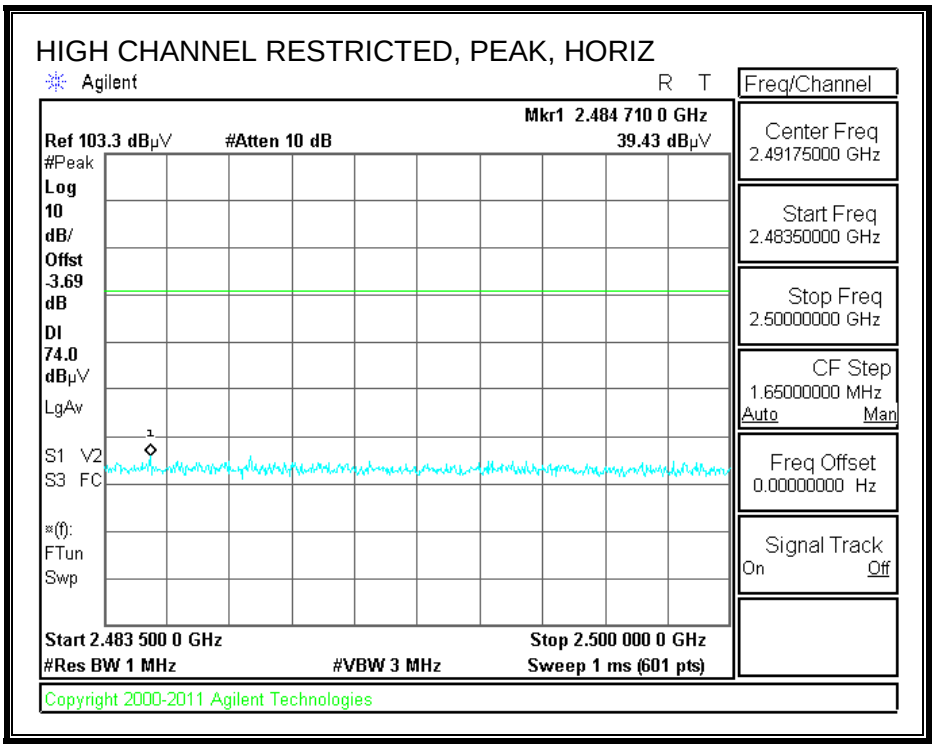
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)

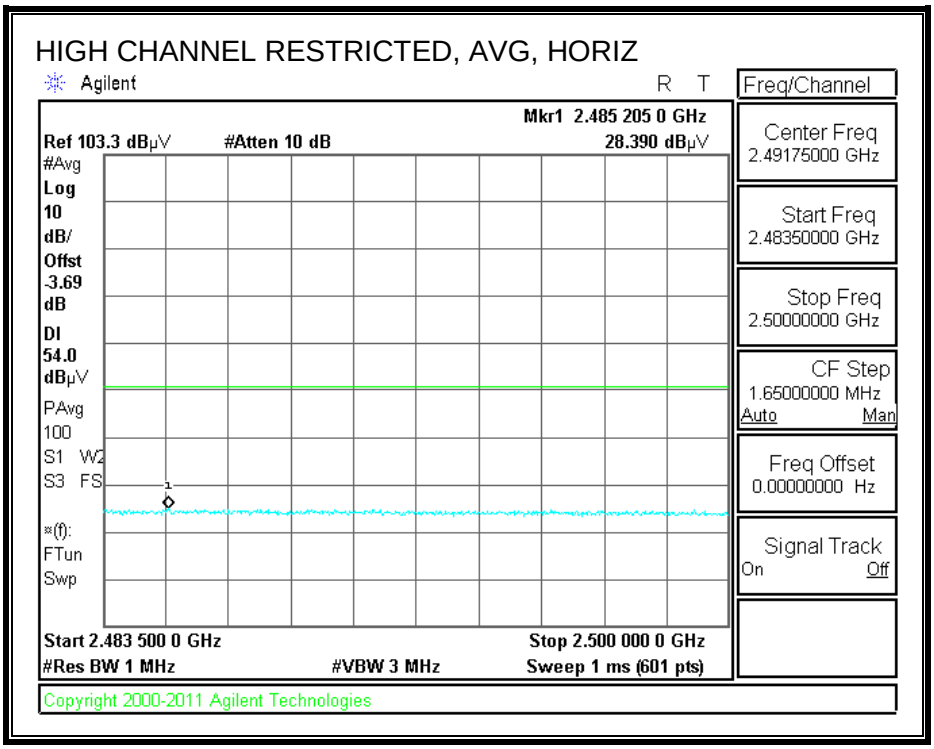


LOW CHANNEL RESTRICTED, AVG, VERT

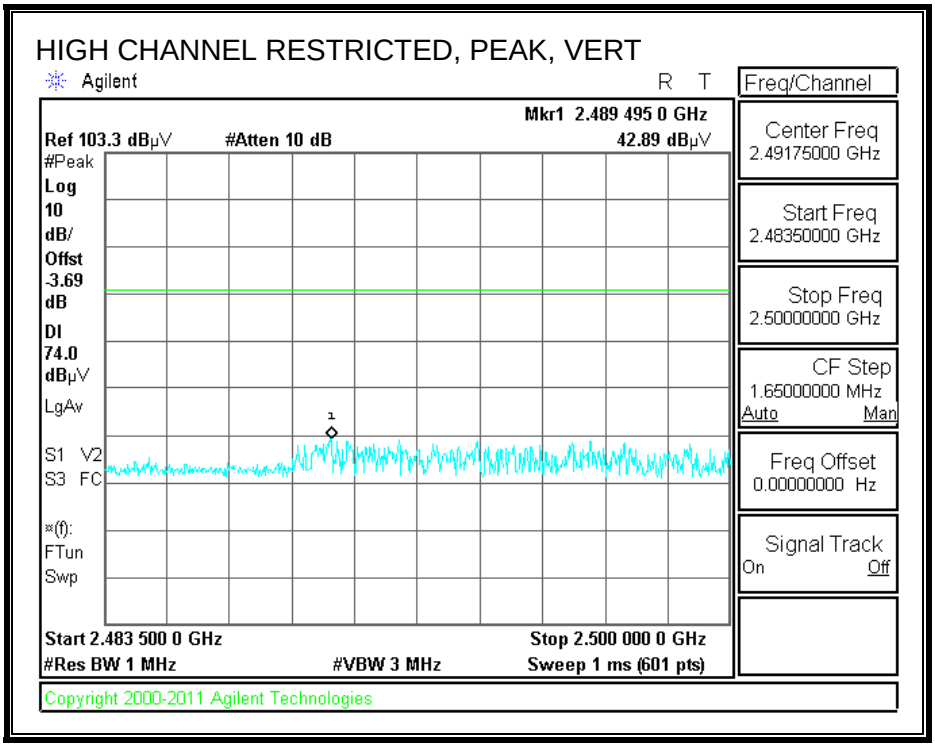


RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)

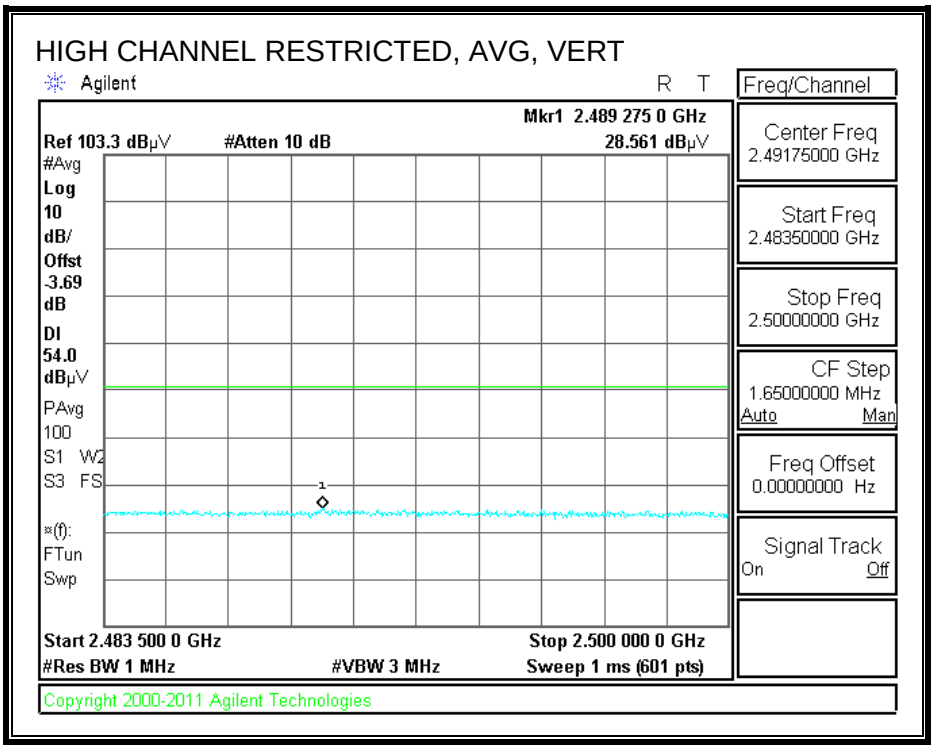




RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HIGH CHANNEL RESTRICTED, AVG, VERT



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber-A

Company: Broadcom
Project #: 12U14668
Date: 12/19/2012
Test Engineer: S. Aguilar
Configuration: EUT Worst case
Mode: TX BT BLE

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T73; S/N: 6717 @3m	T144 Miteq 3008A00931		T125; ARA 18-26GHz; S/N:1007	FCC 15.209

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/3MHz
Average Measurements
RBW=1MHz ; VBW=3 MHz

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	38.53	28.20	33.4	6.2	-35.5	0.0	0.0	42.6	32.3	74	54	-31.4	-21.7	H
4.804	3.0	37.99	27.96	33.4	6.2	-35.5	0.0	0.0	42.1	32.1	74	54	-31.9	-21.9	V
Mid Channel (2441 MHz)															
4.822	3.0	37.62	27.45	33.4	6.2	-35.5	0.0	0.0	41.8	31.6	74	54	-32.2	-22.4	H
4.822	3.0	37.53	27.39	33.4	6.2	-35.5	0.0	0.0	41.7	31.5	74	54	-32.3	-22.5	V
7.323	3.0	37.22	26.86	35.7	8.4	-35.4	0.0	0.0	45.9	35.5	74	54	-28.1	-18.5	H
7.323	3.0	37.10	26.99	35.7	8.4	-35.4	0.0	0.0	45.8	35.7	74	54	-28.2	-18.3	V
High Channel (2480 MHz)															
4.960	3.0	37.74	27.55	33.6	6.3	-35.5	0.0	0.0	42.1	31.9	74	54	-31.9	-22.1	H
4.960	3.0	37.49	27.63	33.6	6.3	-35.5	0.0	0.0	41.9	32.0	74	54	-32.1	-22.0	V
7.440	3.0	36.42	26.36	35.9	8.4	-35.5	0.0	0.0	45.3	35.2	74	54	-28.7	-18.8	H
7.440	3.0	36.51	26.39	35.9	8.4	-35.5	0.0	0.0	45.4	35.3	74	54	-28.6	-18.7	V

Rev. 11.10.11

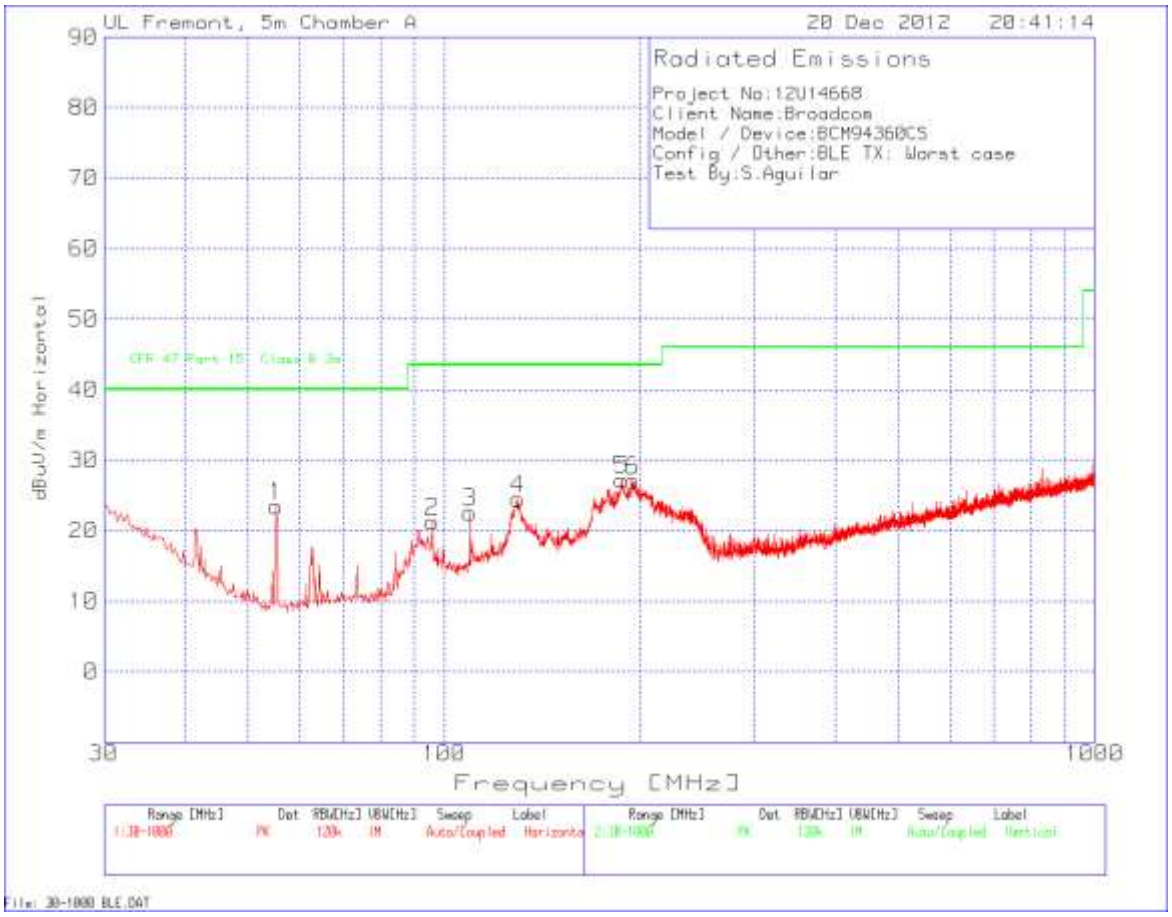
Note: No other emissions up to 26 GHz were detected above the system noise floor.

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

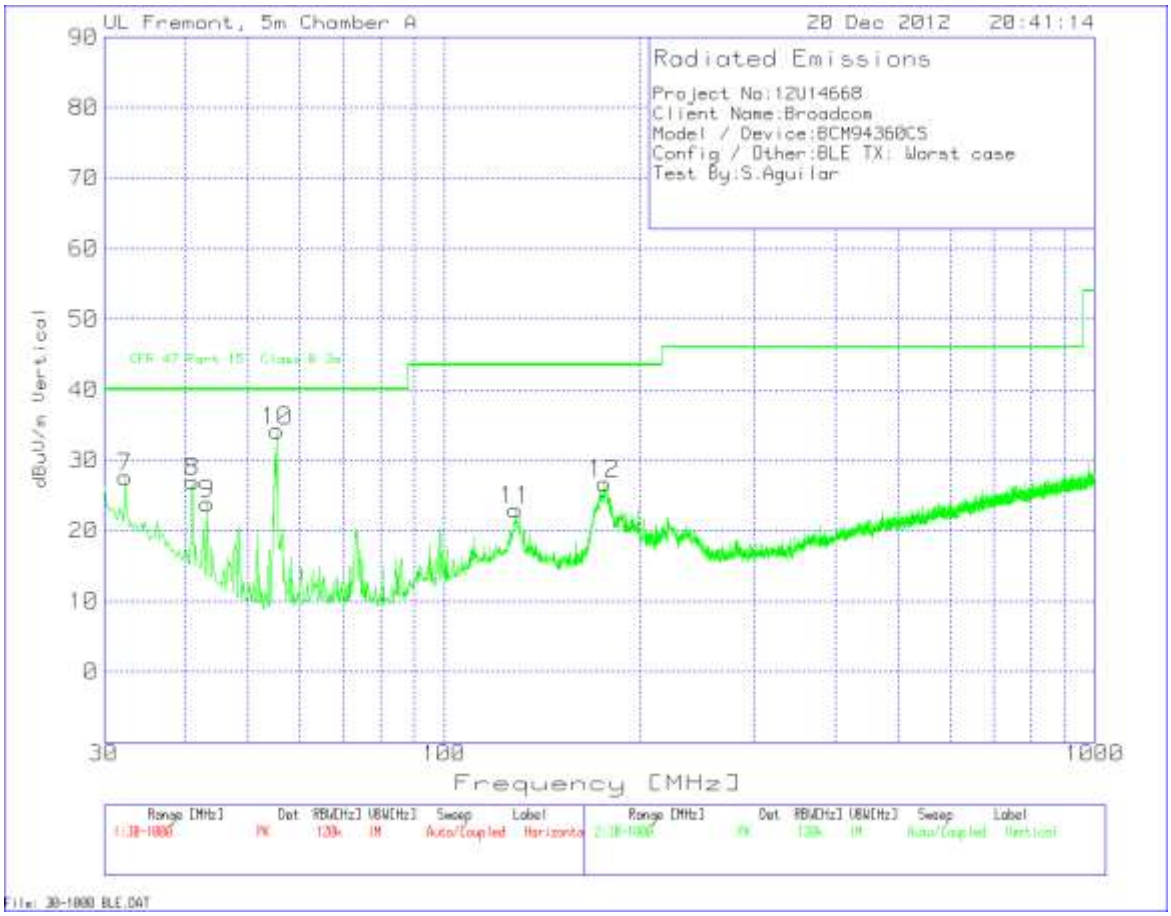
SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)

HORIZONTAL PLOT



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

VERTICAL PLOT



HORIZONTAL AND VERTICAL DATA

Company Name: Broadcom
Project: 12U14668
Model/Device: BCM94360CS
Date: 12/20/2012
Configuraiton: BT BLE TX Worst case
Tested by: Steve Aguilar

Test Frequency [MHz]	Meter Reading [dB(µV)]	Detector	Pre Amp Factor [dB]	Antenna Factor [dB/m]	Corrected [dB(µV/m)]	Class B limit [dB(µV/m)]	Margin [dB]	Height [cm]	Polarity
Range 1 30 - 1000MHz									
55.1998	43.71	PK	-27.3	7.1	23.51	40	-16.49	400	Horz
95.9073	39.12	PK	-26.9	9.1	21.32	43.5	-22.18	300	Horz
109.6703	36.72	PK	-26.7	12.6	22.62	43.5	-20.88	200	Horz
129.8301	37.71	PK	-26.7	13.5	24.51	43.5	-18.99	200	Horz
187.4021	42.21	PK	-26.3	11.3	27.21	43.5	-16.29	100	Horz
194.7682	41.74	PK	-26.4	11.7	27.04	43.5	-16.46	100	Horz
Range 2 30 - 1000MHz									
32.3261	35.66	PK	-27.6	19.5	27.56	40	-12.44	100	Vert
41.0492	41.08	PK	-27.4	13.3	26.98	40	-13.02	100	Vert
43.1815	39.57	PK	-27.4	11.7	23.87	40	-16.13	100	Vert
55.3937	54.35	PK	-27.3	7.1	34.15	40	-5.85	100	Vert
128.8609	36.01	PK	-26.7	13.7	23.01	43.5	-20.49	200	Vert
176.3529	41.82	PK	-26.4	11.3	26.72	43.5	-16.78	100	Vert

PK - Peak detector
QP - Quasi-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 *	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

Company Name:	Broadcom
Project:	12U14668
Model/Device:	BCM94360CS
Date:	12/27/2012
Configuraiton:	TX BLE Worst Case
Test Voltage/Frequency:	120VAC 60Hz
Tested by:	Steve Aguilar

Line-L1 .15 - 30MHz

Test Frequency [MHz]	Meter Reading [dBuV]	Detector Type	LISN [dB]	Cables [dB]	Corrected [dB(uV)]	Class B QP Limit	QP Margin	Class B Av Limit [dB(uV)]	Av Margin [dB]
0.15	40.89	PK	0.1	0	40.99	66	-25.01	-	-
0.15	26.73	Av	0.1	0	26.83	-	-	56	-29.17
0.24	32.33	PK	0.1	0	32.43	62.1	-29.67	-	-
0.24	21.04	Av	0.1	0	21.14	-	-	52.1	-30.96
0.402	41.38	PK	0.1	0	41.48	57.8	-16.32	-	-
0.402	35.83	Av	0.1	0	35.93	-	-	47.8	-11.87

Line-L2 .15 - 30MHz

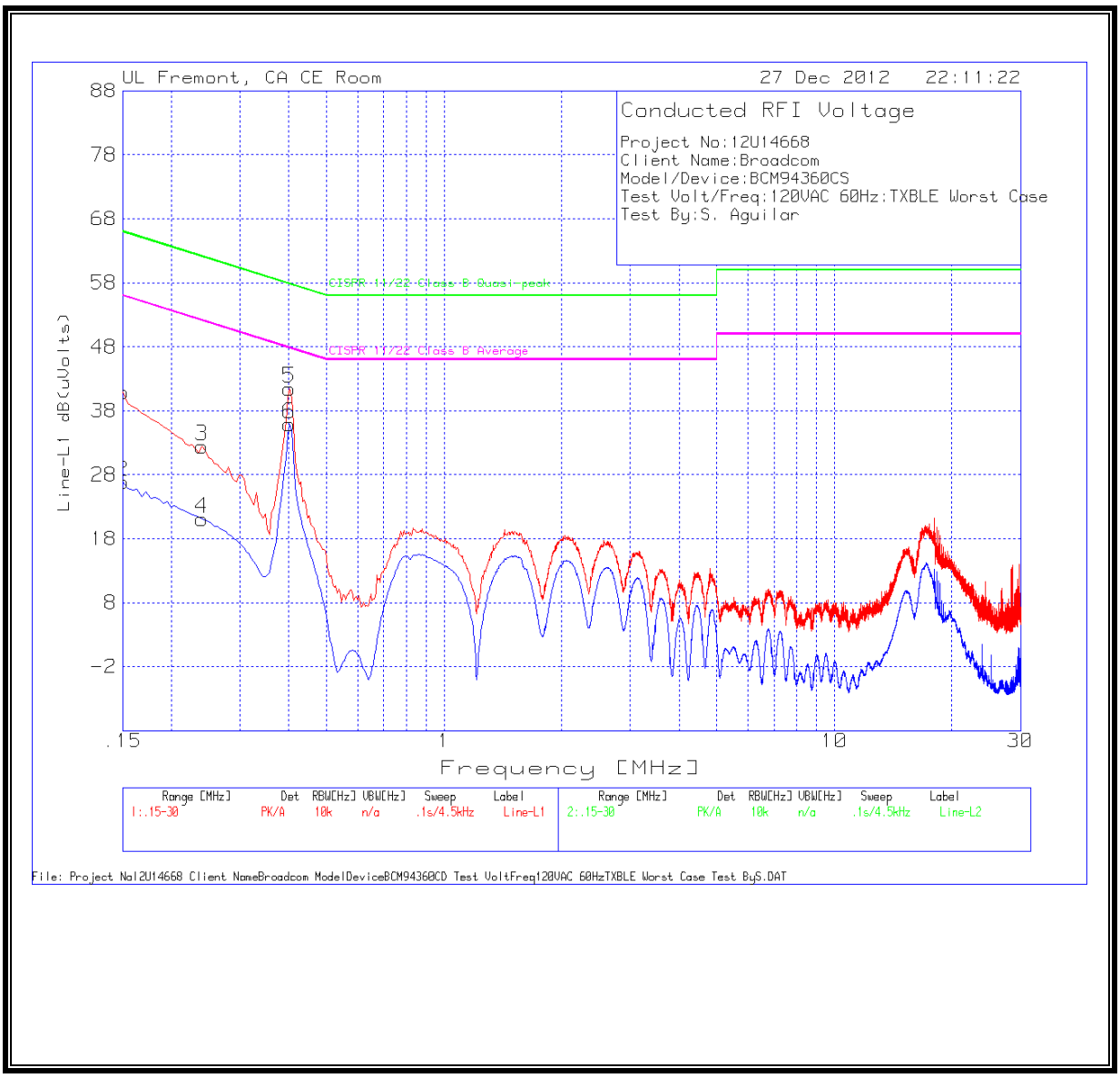
Test Frequency [MHz]	Meter Reading [dBuV]	Detector Type	LISN [dB]	Cables [dB]	Corrected [dB(uV)]	Class B QP Limit	QP Margin	Class B Av Limit [dB(uV)]	Av Margin [dB]
0.1545	42.35	PK	0.1	0	42.45	65.8	-23.35	-	-
0.1545	26.29	Av	0.1	0	26.39	-	-	55.8	-29.41
0.168	41.2	PK	0.1	0	41.3	65.1	-23.8	-	-
0.168	24.93	Av	0.1	0	25.03	-	-	55.1	-30.07
0.402	40.45	PK	0.1	0	40.55	57.8	-17.25	-	-
0.402	34.59	Av	0.1	0	34.69	-	-	47.8	-13.11

PK - Peak detector

QP - Quasi-Peak detector

Av - Average detector

LINE 1 RESULTS



LINE 2 RESULTS