



**FCC CFR47 PART 15 SUBPART C  
INDUSTRY CANADA RSS-210 ISSUE 8  
CLASS II PERMISSIVE CHANGE  
CERTIFICATION TEST REPORT**

**FOR**

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

**MODEL NUMBER: BCM943228HMB**

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

**REPORT NUMBER: 12U14229-3, Revision A**

**ISSUE DATE: MARCH 27, 2012**

*Prepared for*  
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**NVLAP**<sup>®</sup>

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	03/19/12	Initial Issue	T. Chan
A	03/27/12	Revised Description of Available Antenna section	A. Zaffar

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## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** BROADCOM CORPORATION  
190 MATHILDA PLACE  
SUNNYVALE, CA 94086, UNITED STATES

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

**MODEL:** BCM943228HMB

**SERIAL NUMBER:** 74DE2B3448FE (P305)

**DATE TESTED:** 02/11/2012, 02/13/2012, 02/16-02/17/2012, and 02/20/2012

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

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:



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THU CHAN  
ENGINEERING MANAGER  
UL CCS

Tested By:



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DAVID GARCIA  
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 2, 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 WLAN + Bluetooth PCI-E Mini Card.

The radio module is manufactured by Broadcom.

### 5.2. MAXIMUM OUTPUT POWER

The measured average power values were within  $\pm 0.5$  dB of the original values. Refer to original report number "11U13795-16A FCC IC BLUETOOTH FHSS Report" for exact output power values and for all antenna port results.

### 5.3. DESCRIPTION OF CLASS II PERMISSIVE CHANGE

The change filed under this application is the addition of an alternate monopole antenna.

### 5.4. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes antennas with maximum gains as a function of frequency as given in the following table:

Antenna Type	Peak Gain (dBi)					Comments
	2400-2483.5MHz	5150-5250MHz	5250-5350MHz	5470-5725MHz	5725-5850MHz	
802.11g/g/n WLAN	3.9	5.6	5.6	4.2	4.2	Original authorization
Monopole	1.21	2.15	2.06	1.62	1.36	Class 2 Permissive Change

### 5.5. SOFTWARE AND FIRMWARE

The EUT driver software installed during testing was Broadcom Bluetooth Version 5.5.0.7600

The test utility software used during testing was Bluetool, ver. 1.4.3.

## 5.6. 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 antennas were oriented to provide worst case radiated emissions. X, Y and Z antenna positions were tested to determine worst case emissions. The antennas in the Y position was determined to be the worst case orientation and provided the highest levels of emissions.

## 5.7. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop PC	Lenovo	G560	CBD6427441	DoC
AC Adapter	Lenovo	PA-1650-56LC	11S36001651ZZH0008KCMA	DoC
Mini PC Adapter	Catalyst	MINI2EXP	Suhail 02	N/A

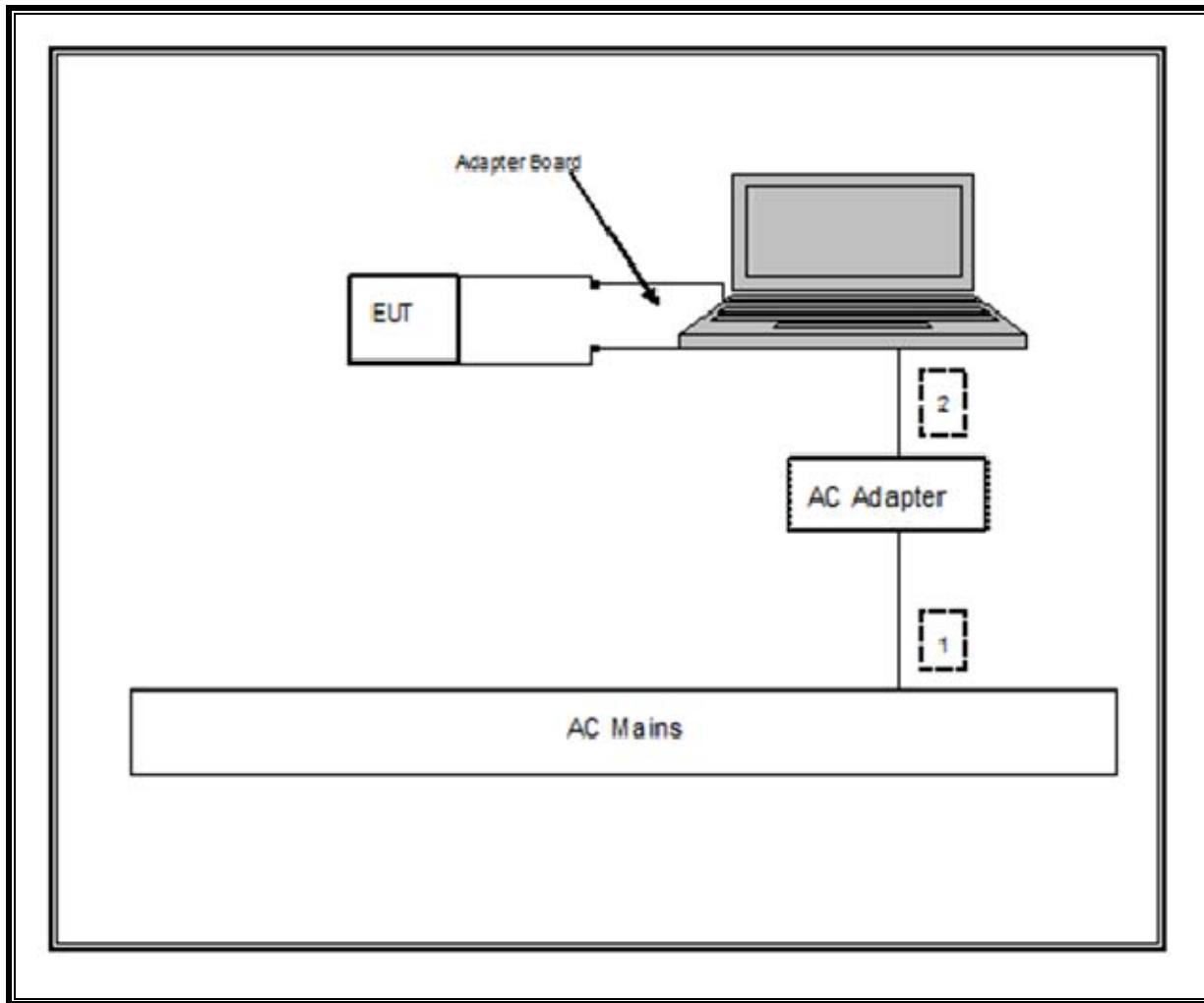
### I/O CABLES

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	AC	Unshielded	1.0m	Detachable. 3C/18AWG.
2	DC	1	DC	Unshielded	1.8m	Non-detachable. Ferrite loaded at laptop end of cable.

### 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 Due
EMI Receiver, 6.5GHz	Agilent / HP	85462A	N/A	02/23/13
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01179	02/16/13
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01011	07/16/12
Antenna, Horn, 18 GHz	EMCO	3115	C00945	10/06/12
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	07/12/12
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00885	11/11/12
Peak / Average Power Sensor	Agilent / HP	E9327A	C00964	12/13/13
Peak Power Meter	Agilent / HP	E4416A	C00963	12/13/13

## 7. RADIATED TEST RESULTS

### 7.1. 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.

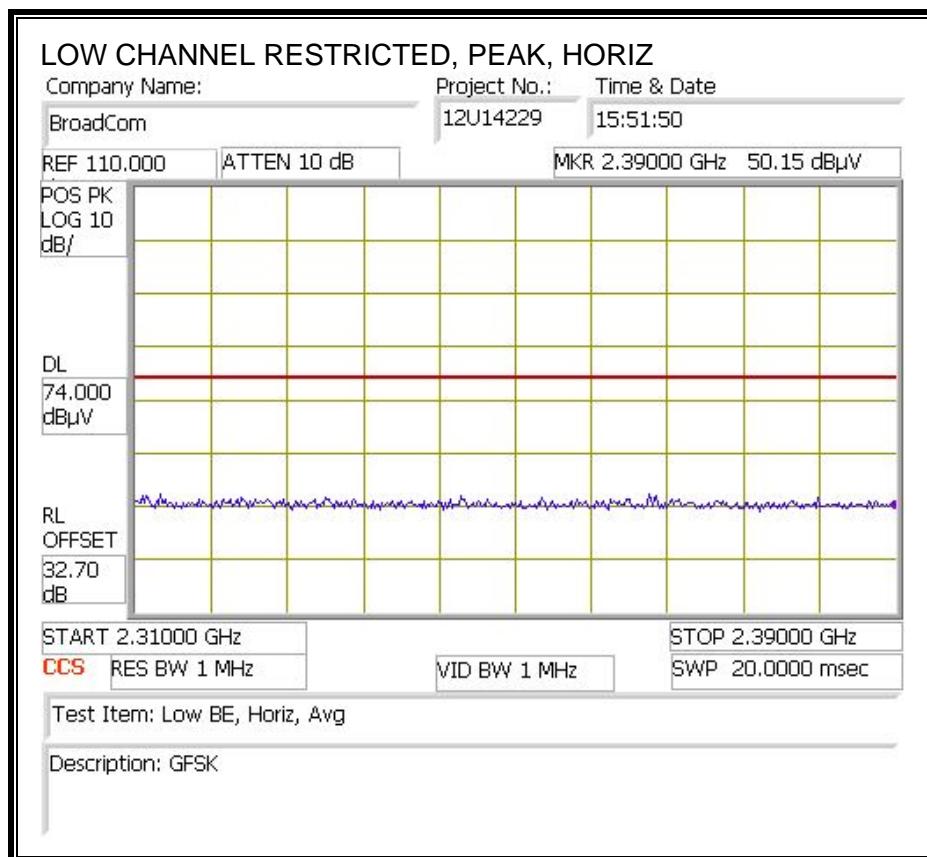
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

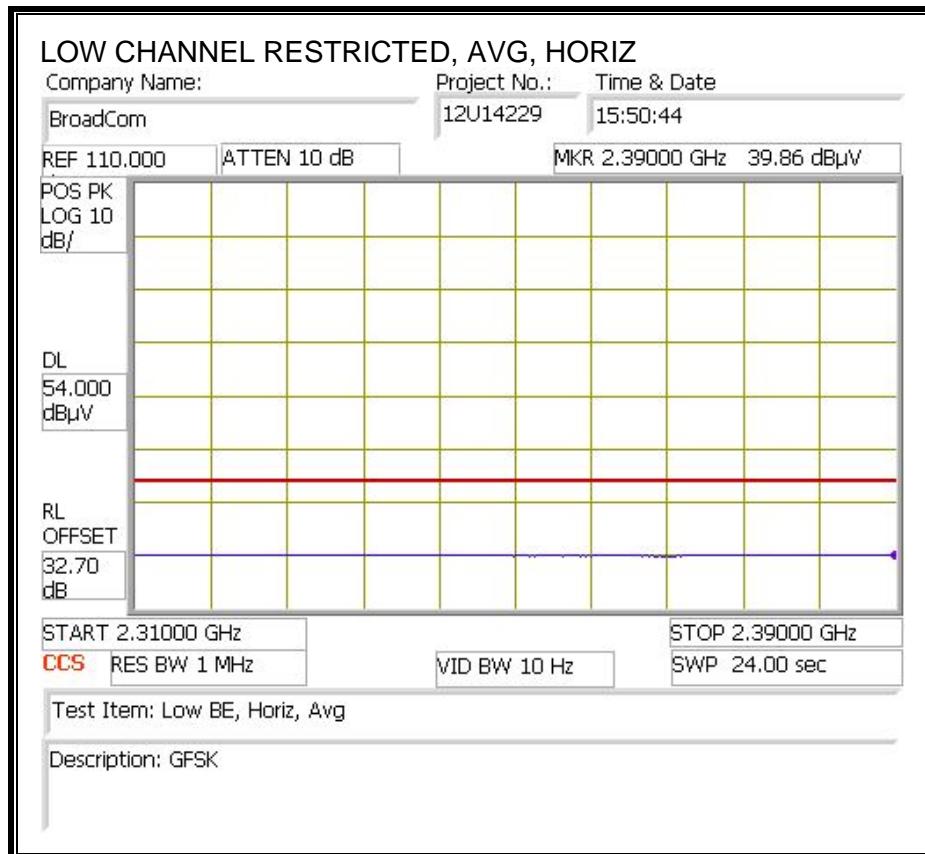
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

## 7.2. TRANSMITTER ABOVE 1 GHz

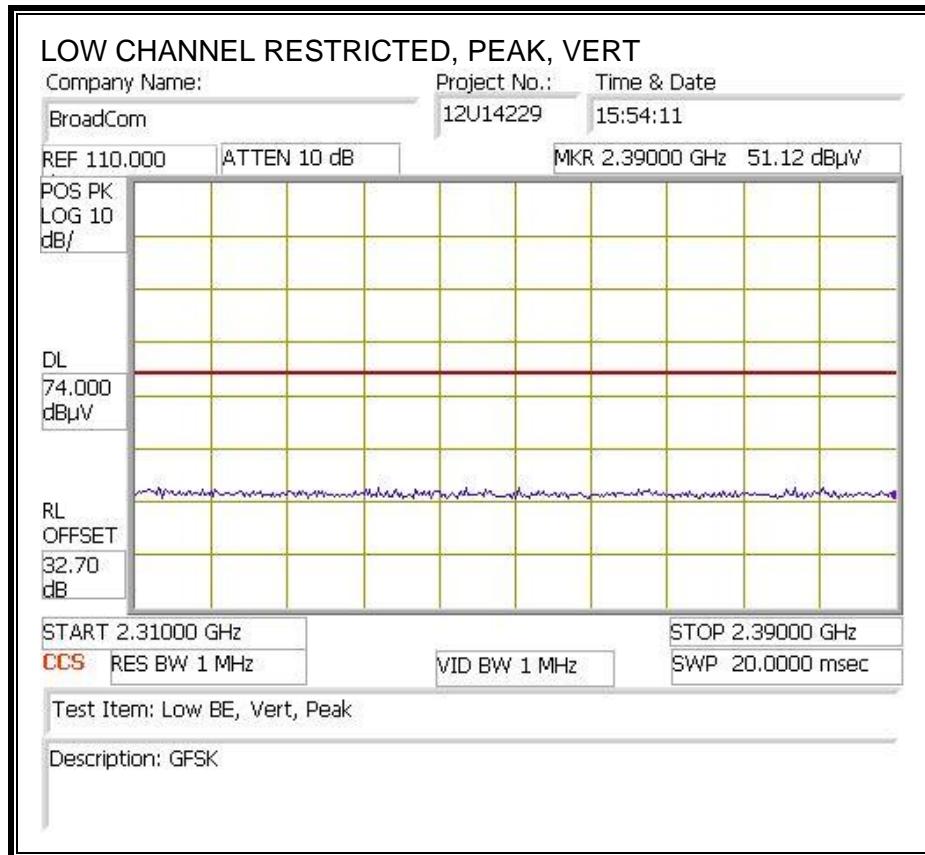
### 7.2.1. BASIC DATA RATE GFSK MODULATION

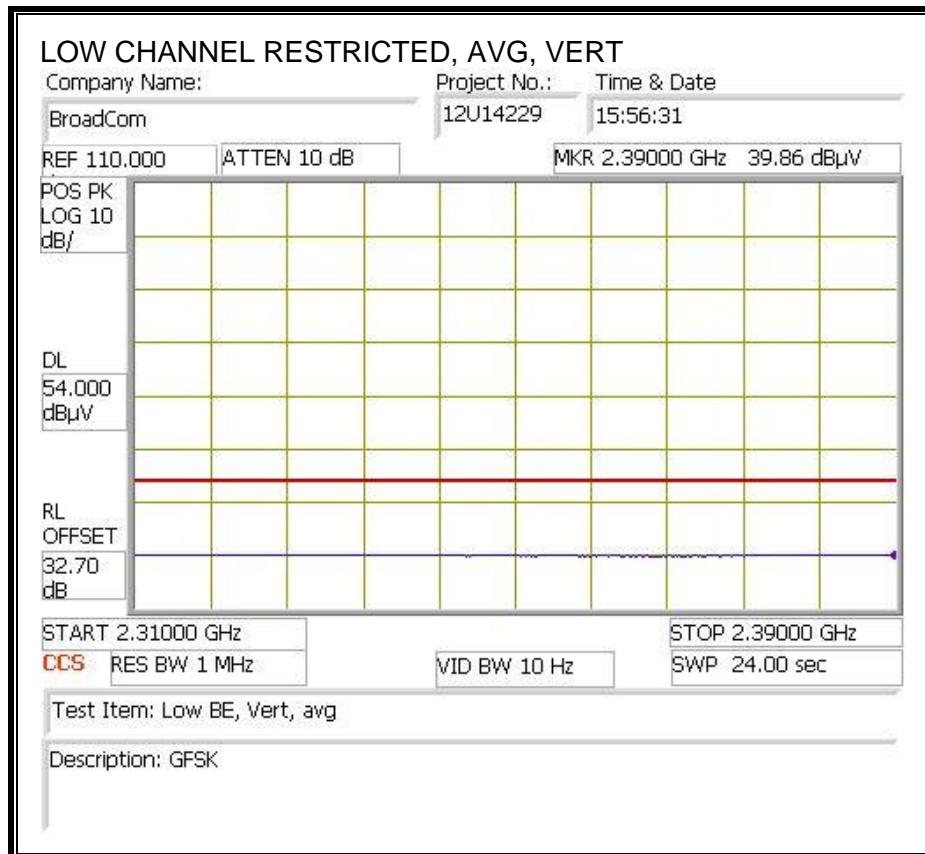
#### RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



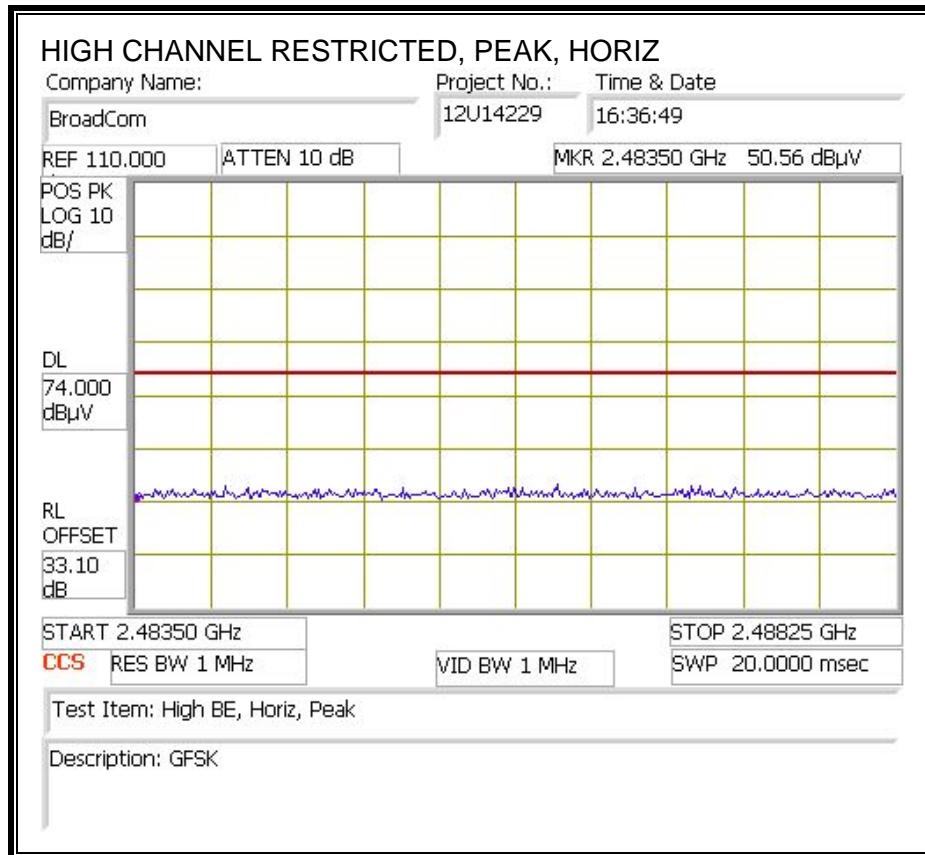


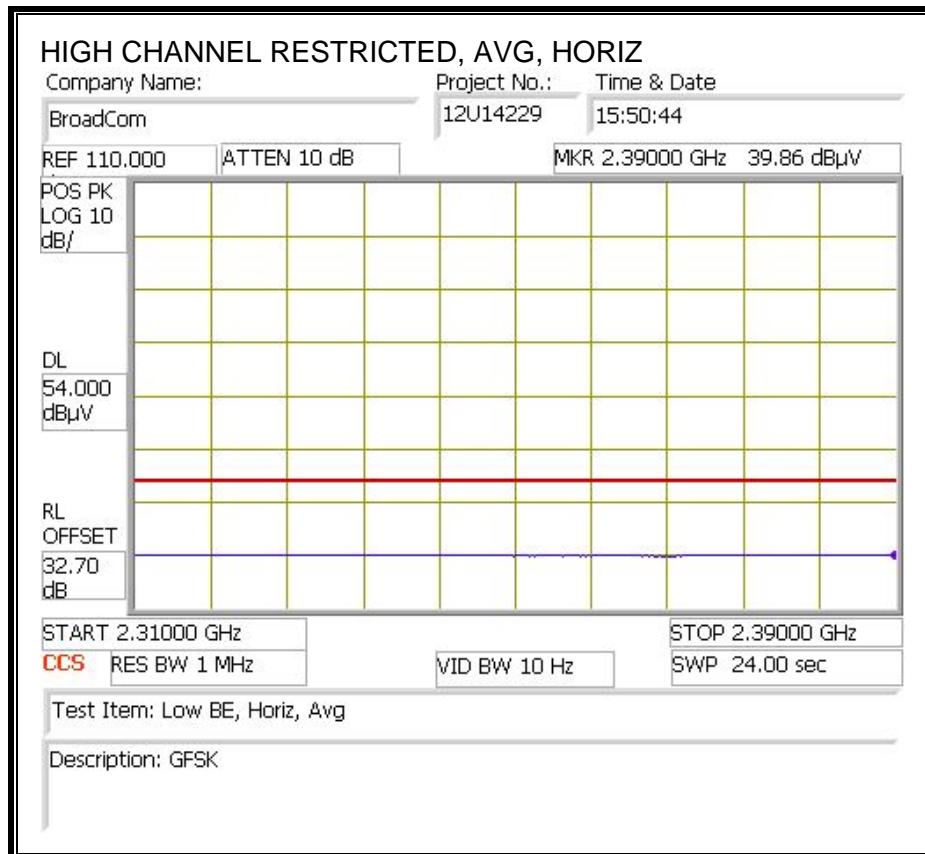
**RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**



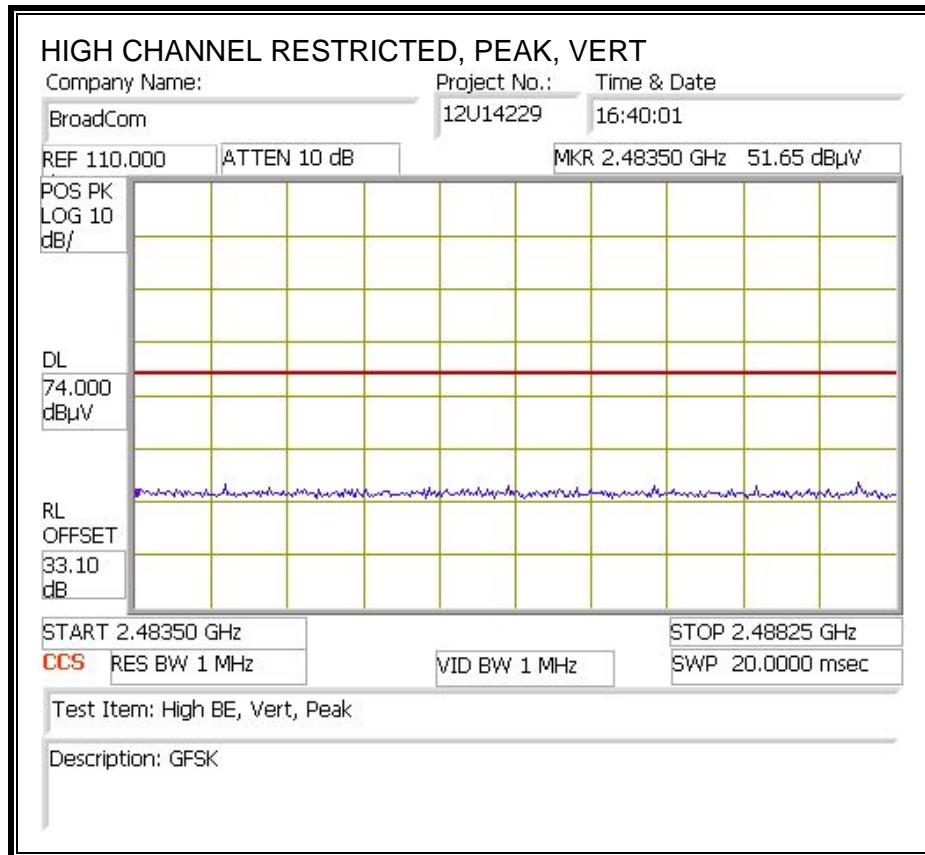


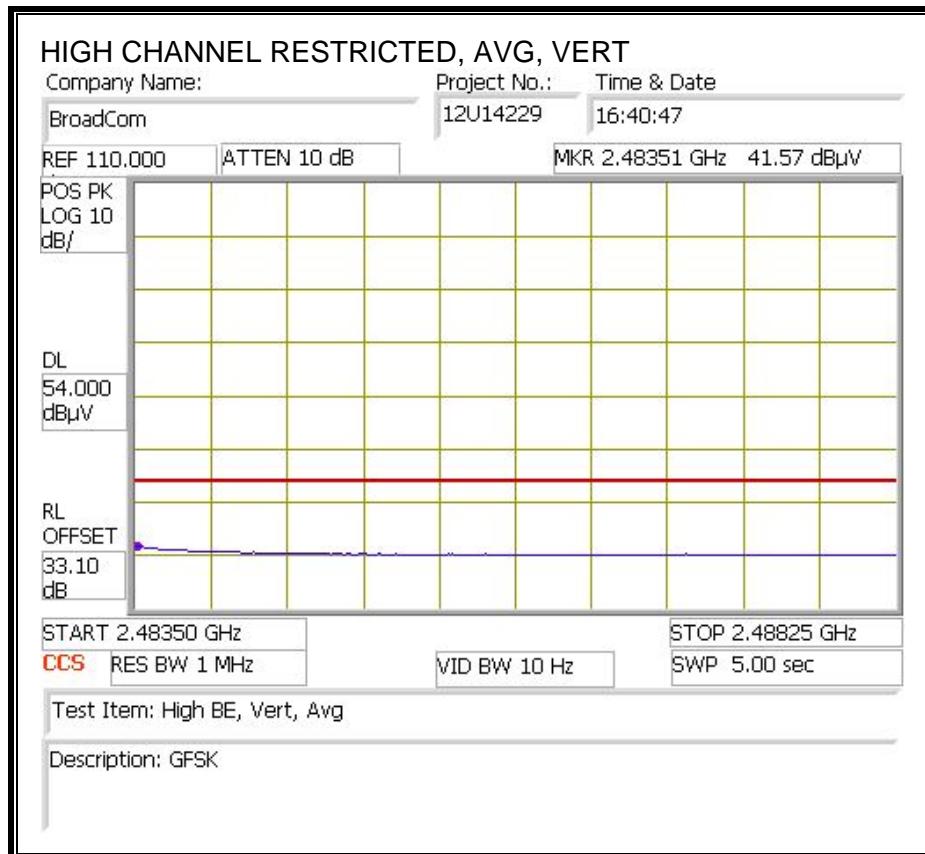
**RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**





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





## HARMONICS AND SPURIOUS EMISSIONS

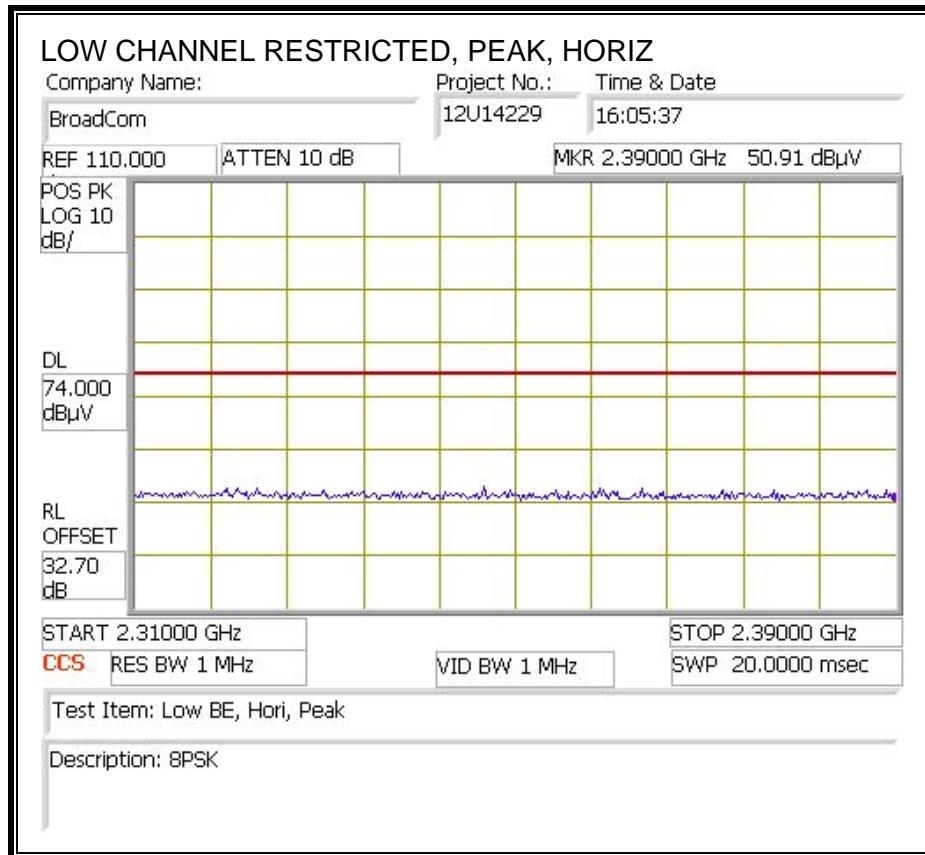
High Frequency Measurement Compliance Certification Services, Fremont 5m Chamber															
Test Engr:	Dennis Huang														
Date:	02/20/12														
Project #:	12U14229														
Company:	Broadcom														
Test Target:	15.205														
Mode Oper:	Bluetooth GFSK														
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 GHz	Dist m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/Q/P	Ant.High cm	Table Angle Degree	Notes
4.804	3.0	44.7	33.1	5.8	-34.8	0.0	0.0	48.7	74.0	-25.3	V	P	100.0	90.4	
4.804	3.0	40.2	33.1	5.8	-34.8	0.0	0.0	44.3	54.0	-9.7	V	A	100.0	90.4	
4.804	3.0	39.3	33.1	5.8	-34.8	0.0	0.0	43.4	74.0	-30.6	H	P	123.5	345.9	
4.804	3.0	28.3	33.1	5.8	-34.8	0.0	0.0	32.3	54.0	-21.7	H	A	123.5	345.9	
4.882	3.0	44.6	33.2	5.8	-34.9	0.0	0.0	48.9	74.0	-25.1	V	P	100.1	90.9	
4.882	3.0	39.9	33.2	5.8	-34.9	0.0	0.0	44.1	54.0	-9.9	V	A	100.1	90.9	
4.882	3.0	39.7	33.2	5.8	-34.9	0.0	0.0	43.9	74.0	-30.1	H	P	102.5	110.9	
4.882	3.0	28.5	33.2	5.8	-34.9	0.0	0.0	32.7	54.0	-21.3	H	A	102.5	110.9	
4.960	3.0	44.3	33.3	5.9	-34.9	0.0	0.0	48.6	74.0	-25.4	V	P	100.0	90.6	
4.960	3.0	39.4	33.3	5.9	-34.9	0.0	0.0	43.8	54.0	-10.2	V	A	100.0	90.6	
4.960	3.0	38.2	33.3	5.9	-34.9	0.0	0.0	42.6	74.0	-31.4	H	P	133.6	113.0	
4.960	3.0	25.6	33.3	5.9	-34.9	0.0	0.0	30.0	54.0	-24.0	H	A	133.6	113.0	

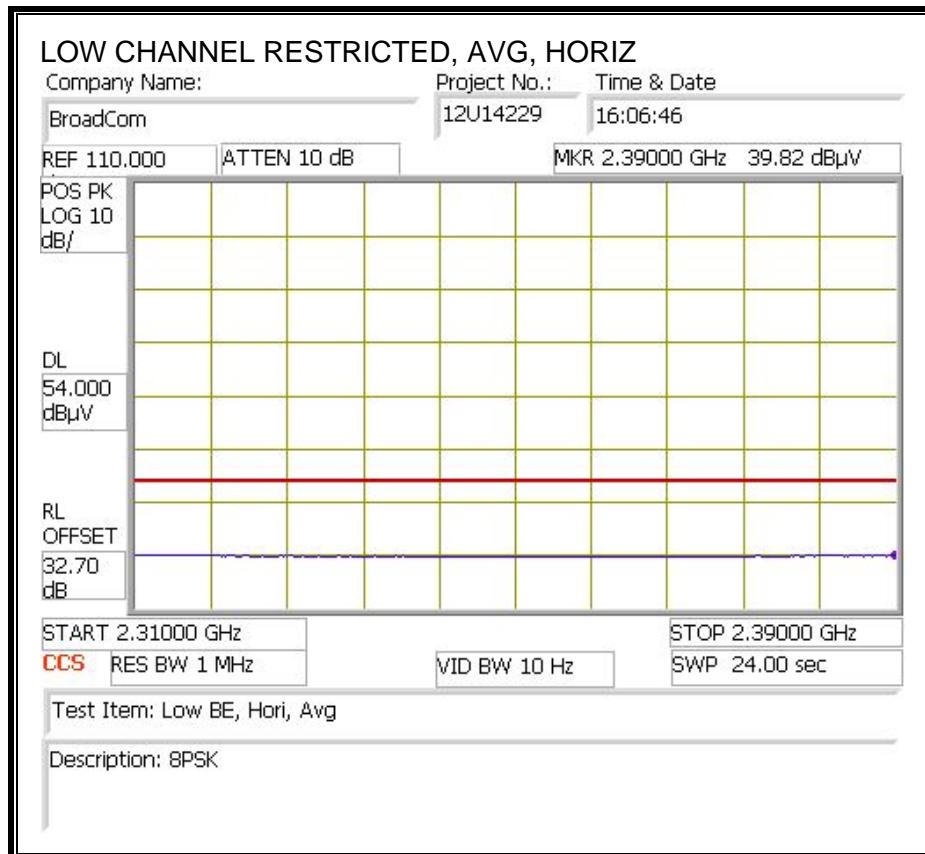
Rev. 4.1.2.7

Note: No other emissions were detected above the system noise floor.

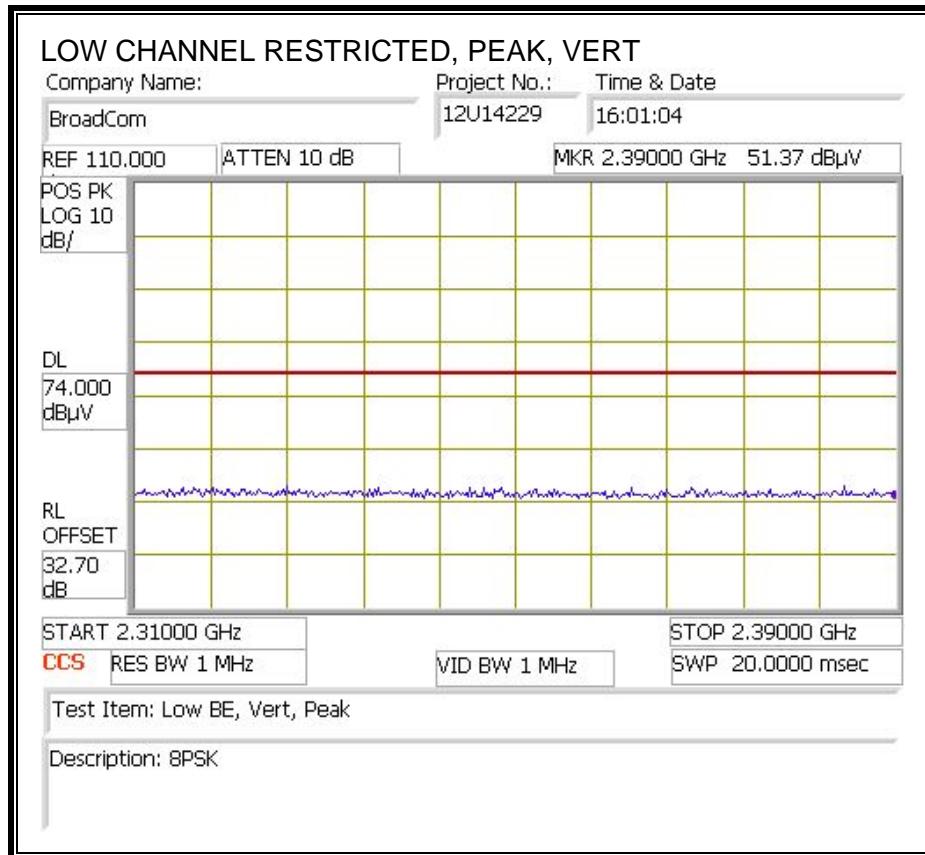
## 7.2.2. ENHANCED DATA RATE 8PSK MODULATION

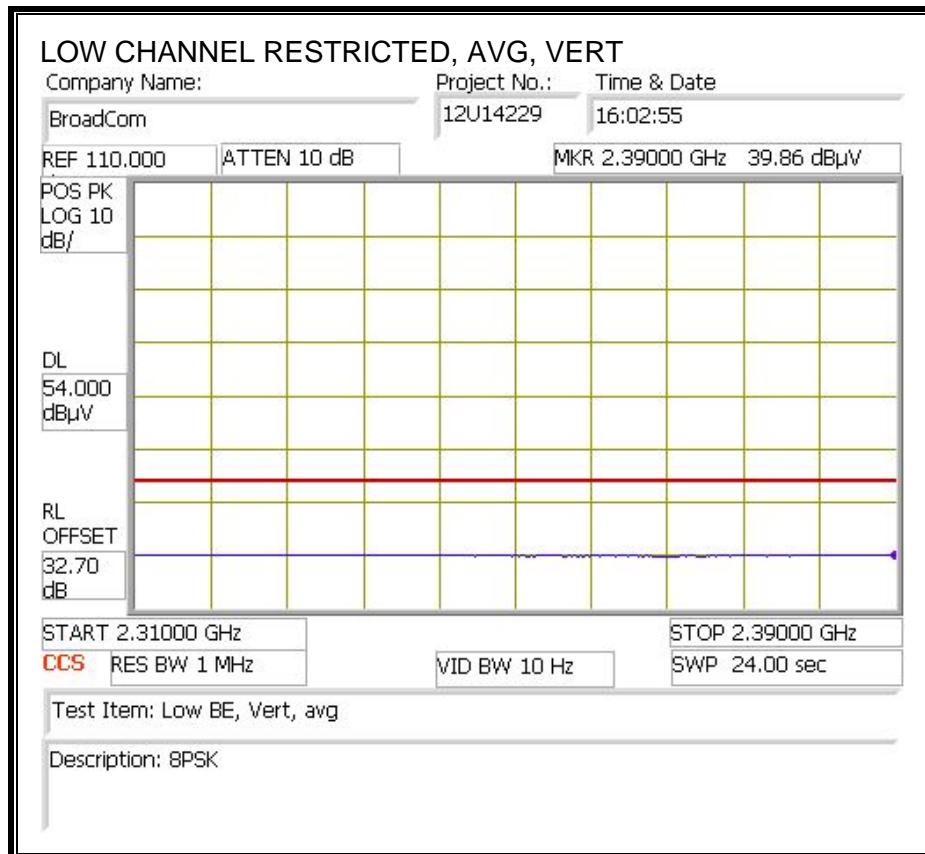
### RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



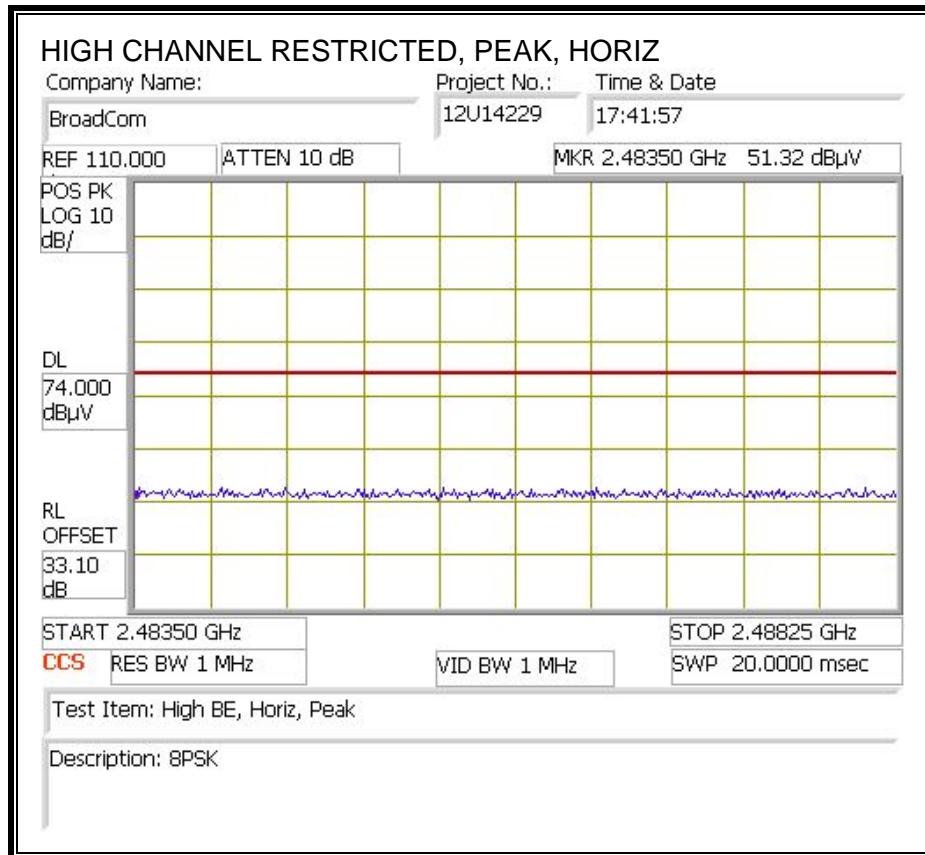


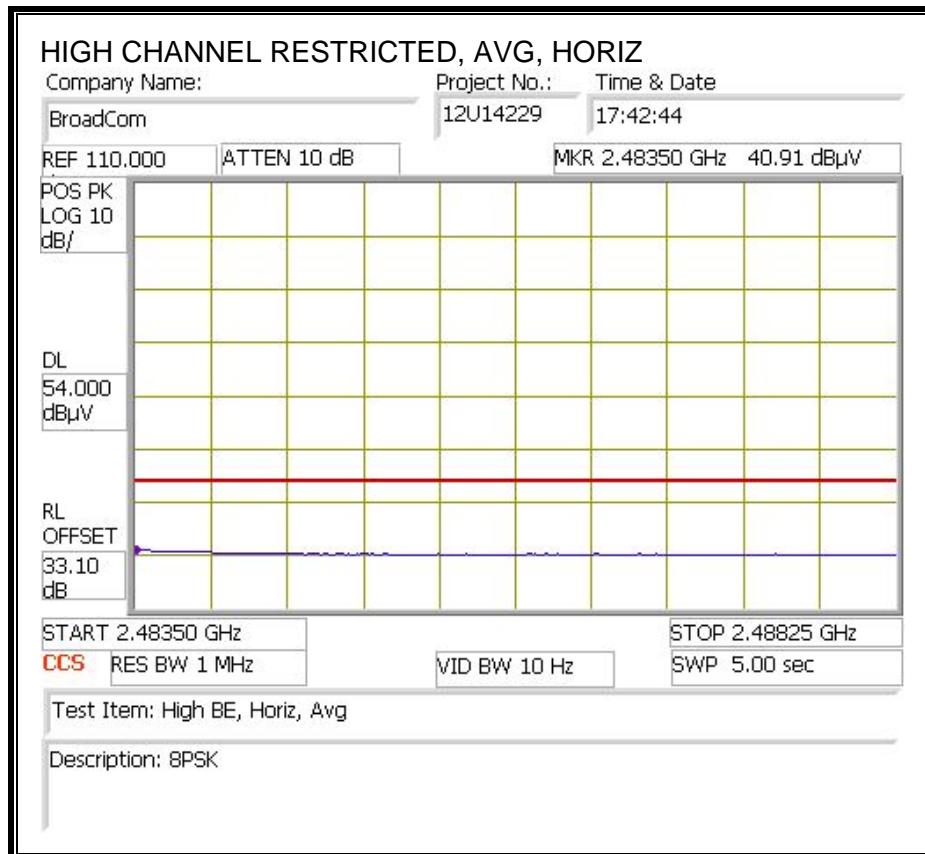
**RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**



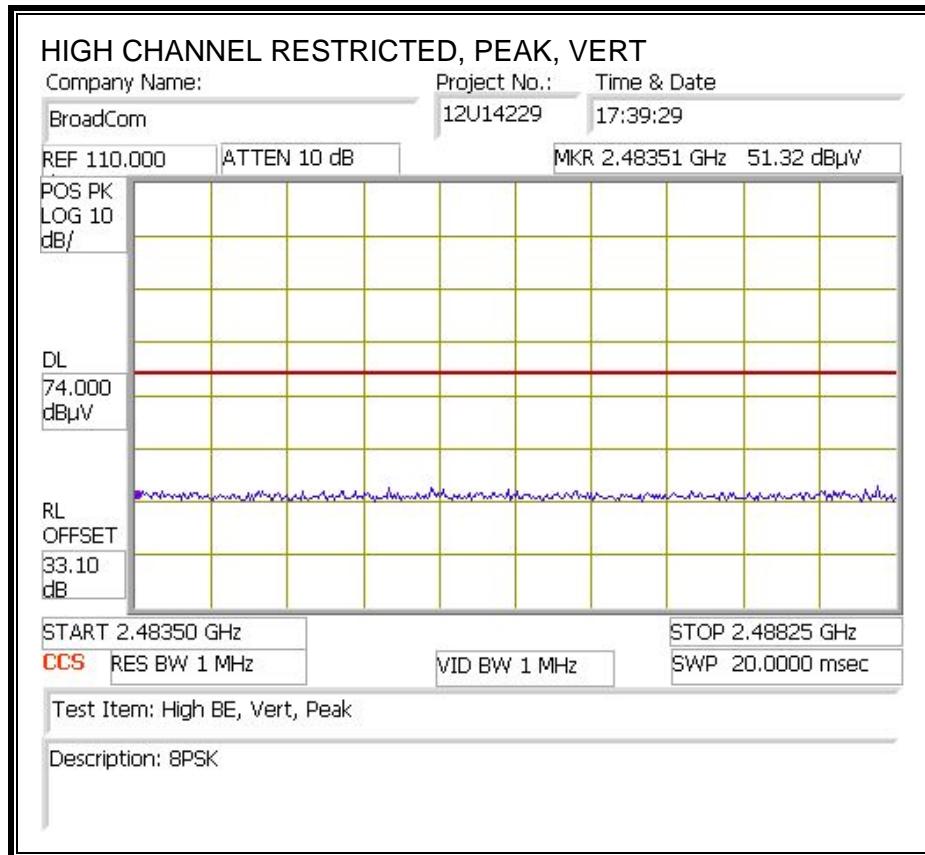


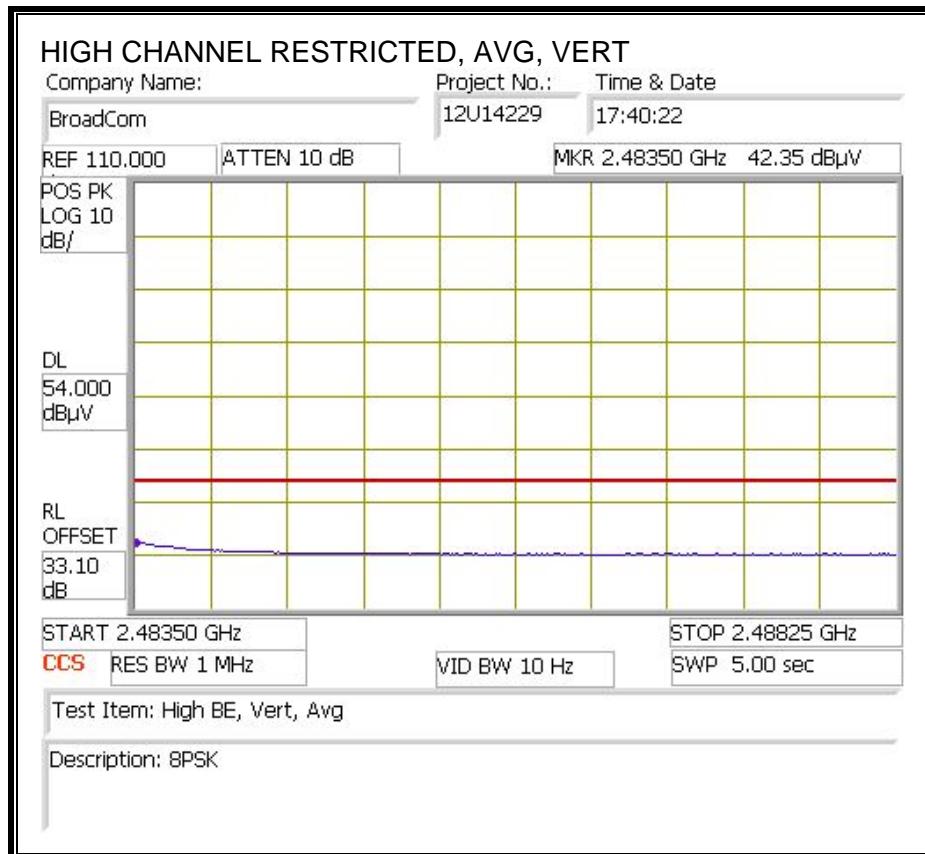
**RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**





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





## HARMONICS AND SPURIOUS EMISSIONS

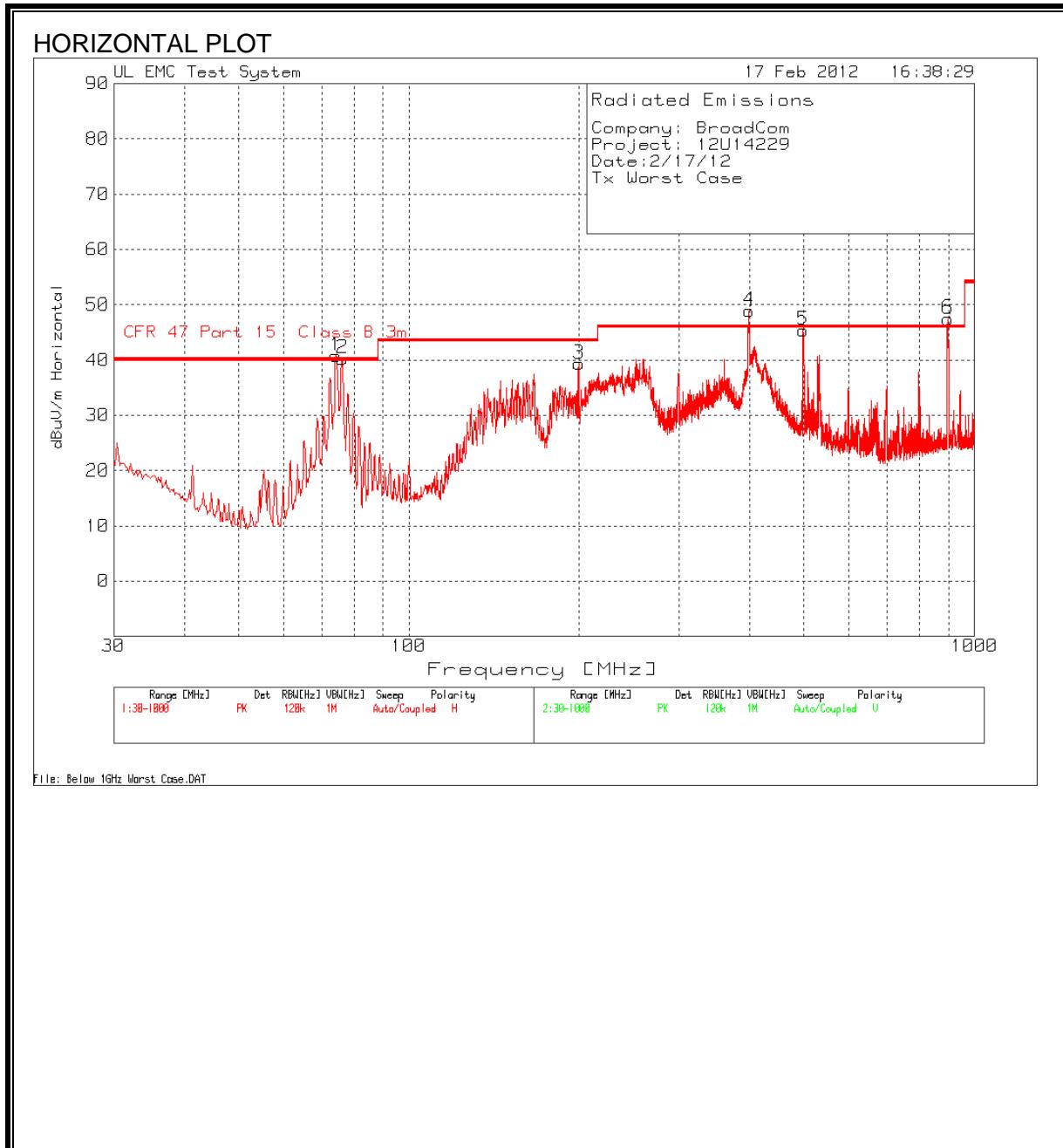
High Frequency Measurement Compliance Certification Services, Fremont 5m Chamber B															
Test Engr:		Dennis Huang													
Date:	02/20/12														
Project #:	12U14229														
Company:	Broadcom														
Test Target:	15.205														
Mode Oper:	Bluetooth 8PSK														
f	Measurement Frequency	Amp	Preamp Gain												Average Field Strength Limit
Dist	Distance to Antenna	D	Corr	Distance	Correct to 3 m										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 GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/Q P	Ant.High cm	Table Angle Degree	Notes
4.804	3.0	48.0	33.1	5.8	-34.8	0.0	0.0	52.1	74.0	-21.9	V	P	100.1	90.5	
4.804	3.0	39.3	33.1	5.8	-34.8	0.0	0.0	43.4	54.0	-10.6	V	A	100.1	90.5	
4.804	3.0	38.9	33.1	5.8	-34.8	0.0	0.0	43.0	74.0	-31.0	H	P	122.1	342.9	
4.804	3.0	27.1	33.1	5.8	-34.8	0.0	0.0	31.2	54.0	-22.8	H	A	122.1	342.9	
4.882	3.0	47.0	33.2	5.8	-34.9	0.0	0.0	51.2	74.0	-22.8	V	P	101.3	89.6	
4.882	3.0	38.3	33.2	5.8	-34.9	0.0	0.0	42.5	54.0	-11.5	V	A	101.3	89.6	
4.882	3.0	39.0	33.2	5.8	-34.9	0.0	0.0	43.2	74.0	-30.8	H	P	100.4	109.4	
4.882	3.0	27.2	33.2	5.8	-34.9	0.0	0.0	31.4	54.0	-22.6	H	A	100.4	109.4	
4.960	3.0	48.0	33.3	5.9	-34.9	0.0	0.0	52.4	74.0	-21.6	V	P	100.0	90.7	
4.960	3.0	38.8	33.3	5.9	-34.9	0.0	0.0	43.2	54.0	-10.8	V	A	100.0	90.7	
4.960	3.0	38.7	33.3	5.9	-34.9	0.0	0.0	43.1	74.0	-30.9	H	P	138.0	328.6	
4.960	3.0	26.0	33.3	5.9	-34.9	0.0	0.0	30.4	54.0	-23.6	H	A	138.0	328.6	
Rev. 4.1.2.7															
Note: No other emissions were detected above the system noise floor.															

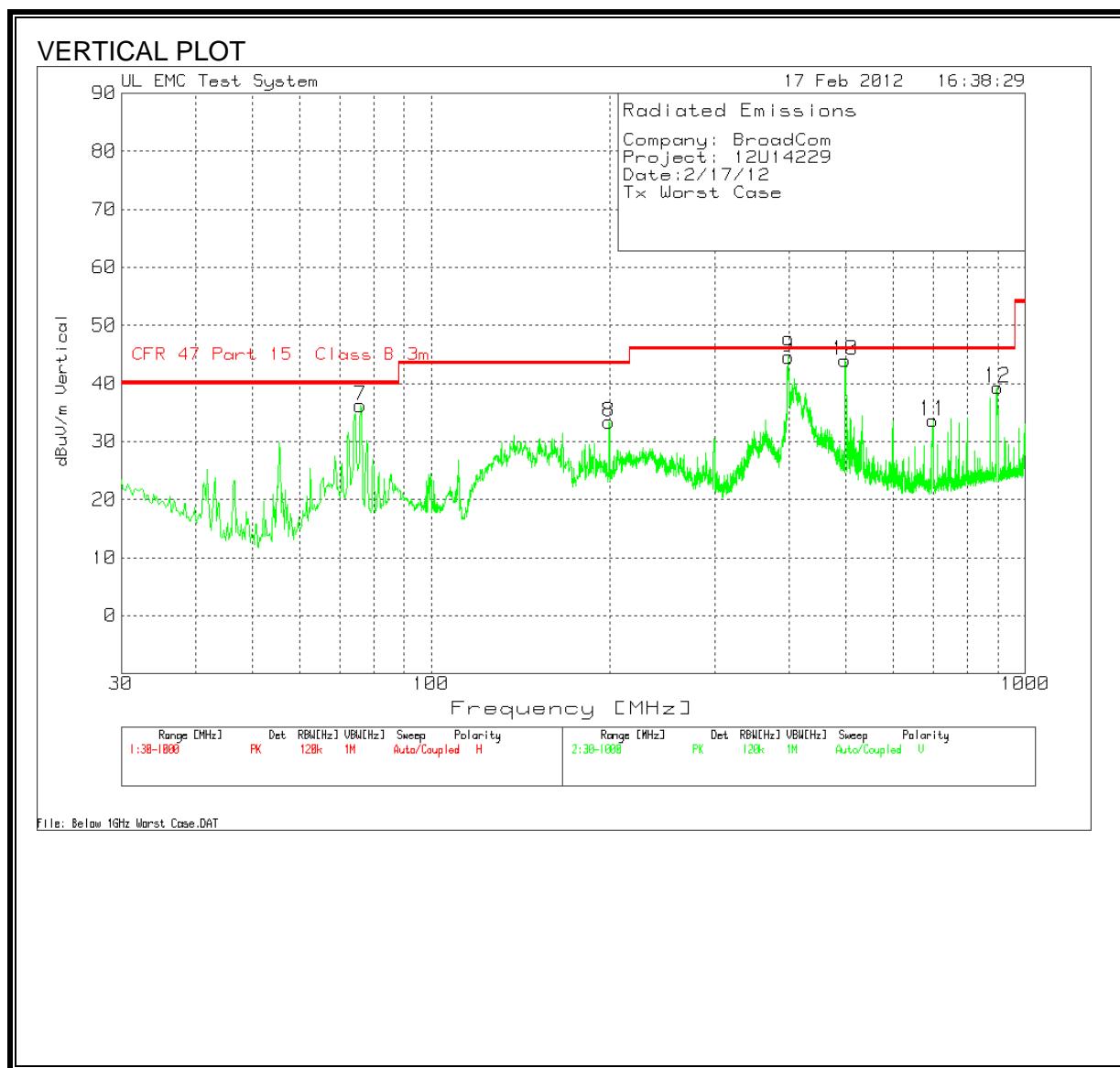
### 7.3. RECEIVER ABOVE 1 GHz

High Frequency Measurement Compliance Certification Services, Fremont 5m Chamber-A																																																																																														
<p>Company: BroadCom Project #: 12U14229 Date: 2/17/2012 Test Engineer: Dennis Huang Configuration: EUT with Support Laptop PC Mode: Rx HT20</p>																																																																																														
<p><b>Test Equipment:</b></p> <table border="1"><tr><td>Horn 1-18GHz</td><td>Pre-amplifier 1-26GHz</td><td>Pre-amplifier 26-40GHz</td><td colspan="4">Horn &gt; 18GHz</td><td>Limit</td></tr><tr><td>T73; S/N: 6717 @3m</td><td>T144 Miteq 3008A00931</td><td></td><td></td><td></td><td></td><td></td><td>RX RSS 210</td></tr><tr><td colspan="8">Hi Frequency Cables</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="4">Peak Measurements RBW=VBW=1MHz</td></tr><tr><td>3' cable 22807700</td><td>12' cable 22807600</td><td>20' cable 22807500</td><td></td><td></td><td colspan="4">Average Measurements RBW=1MHz ; VBW=10Hz</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						RX RSS 210	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			Average Measurements RBW=1MHz ; VBW=10Hz																																									
Horn 1-18GHz	Pre-amplifier 1-26GHz	Pre-amplifier 26-40GHz	Horn > 18GHz				Limit																																																																																							
T73; S/N: 6717 @3m	T144 Miteq 3008A00931						RX RSS 210																																																																																							
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## 7.4. WORST-CASE BELOW 1 GHz

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





**DATA**

**HORIZONTAL & VERTICAL DATA**

Company:		Broadcom							
Project:		12U14229							
Date:		2/17/2012							
Mode		Tx Worst Case							
Test Engineer:		Dennis Huang							
Range 1 30 - 1000MHz									
Test Frequency	Meter Reading	Detector	25MHz-1GHz ChmbrA Amplified.TX [dB]	5m A T122 Bilog below 1GHz.TXT [dB]	dBuV/m	CFR 47 Part 15 Class B 3m	Margin	Height [cm]	Polarity
74.1966	60.21	PK	-27.1	7.7	40.81	40	0.81	200	Horz
74.095	59.3	QP	-27.1	7.7	39.9	40	-0.1	201	Horz
76.1351	59.75	PK	-27.1	7.6	40.25	40	0.25	200	Horz
75.992	59.4	QP	-27.1	7.6	39.9	40	-0.1	201	Horz
199.8082	53.51	PK	-26.2	12	39.31	43.5	-4.19	100	Horz
399.6623	59.29	PK	-25.3	14.9	48.89	46	2.89	100	Horz
399.725	55.36	QP	-25.3	14.9	44.96	46	-1.04	101	Horz
497.9416	53.61	PK	-24.9	16.7	45.41	46	-0.59	200	Horz
899.3945	48.94	PK	-23.4	21.9	47.44	46	1.44	100	Horz
899.394	46.11	QP	-23.4	21.9	44.61	46	-1.39	101	Horz
75.9412	55.74	PK	-27.1	7.6	36.24	40	-3.76	400	Vert
199.0328	47.68	PK	-26.2	11.9	33.38	43.5	-10.12	200	Vert
399.6623	55.01	PK	-25.3	14.9	44.61	46	-1.39	100	Vert
497.7478	52.21	PK	-24.9	16.7	44.01	46	-1.99	100	Vert
699.5404	37.32	PK	-23.3	19.6	33.62	46	-12.38	200	Vert
899.5883	40.8	PK	-23.4	21.9	39.3	46	-6.7	100	Vert