



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

**CERTIFICATION TEST REPORT**

**FOR**

**802.11a/g/n FLOOR STANDING PRODUCT**

**MODEL NUMBER: SUB**

**FCC ID: SBVRM005  
IC: 5373A-RM005**

**REPORT NUMBER: 11U14084-1**

**ISSUE DATE: January 05, 2012**

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**NVLAP LAB CODE 200065-0**

Revision History

Rev.	Issue Date	Revisions	Revised By
--	01/05/12	Initial Issue	F. Ibrahim

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## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** SONOS, INC.  
223 E. De La Guerra ST.  
SANTA BARBARA, CA 93101, U.S.A.

**EUT DESCRIPTION:** 802.11a/g/n FLOOR STANDING PRODUCT

**MODEL:** SUB

**SERIAL NUMBER:** 1111-00-0E-58-94-00-94-A, 00 0E 58 94 00 32 E

**DATE TESTED:** DECEMBER 12-31, 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:



FRANK IBRAHIM  
EMC SUPERVISOR  
UL CCS

Tested By:



TOM CHEN  
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:

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

### 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 a floor standing product with 802.11a/g/n 2x2 MIMO.

The radio module is manufactured by Sonos.

### 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)
2412 - 2462	802.11g	26.69	466.66
2412 - 2462	802.11n HT20	29.29	849.18
5745 - 5825	802.11n HT20	26.66	463.45

### 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes two dipole antennas on PCB, the antennas gains are as follows:

Frequency	Antenna-01(dB)		Antenna-02 (dB)	
	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)
2400MHz	3.86	49.82	2.79	49.82
2450MHz	3.97	48.91	2.71	50.04
2500MHz	3.81	44.56	3.17	47.93
4900MHz	4.27	53.64	3.17	55.06
5150MHz	4.98	56.08	3.00	57.87
5250MHz	4.10	51.39	3.92	59.00
5350MHz	4.03	56.90	3.55	53.41
5725MHz	4.09	50.56	4.27	54.51
5825MHz	3.55	54.82	4.38	59.36
5850MHz	3.42	54.97	4.38	57.25

### 5.4. SOFTWARE AND FIRMWARE

The Sonos software version is V3.6 17.1-48020.

## **5.5. WORST-CASE CONFIGURATION AND MODE**

For Radiated Emissions below 1 GHz and Power line Conducted Emissions, the channel with the highest conducted output power was selected as worst-case scenario.

Worst-case data rates as provided by the manufacturer are:

For 11g mode: 24Mbps

For 11n HT20 (2.4 GHz band): MCS9

For 11n HT20 (5.8 GHz band): MCS9

To determine the worst orientation of the EUT for highest emissions, the EUT's antenna was investigated for X and Y orientations; the worst orientation was Y orientation; therefore, all final radiated emissions were performed with the EUT's antenna laid in the Y orientation.

For 11g mode, the testing was performed on chain 0 as the output power on chain 0 was slightly higher than the output power on chain 1; therefore, chain 0 was selected as worst-case scenario for 11g mode.



## 5.6. DESCRIPTION OF TEST SETUP

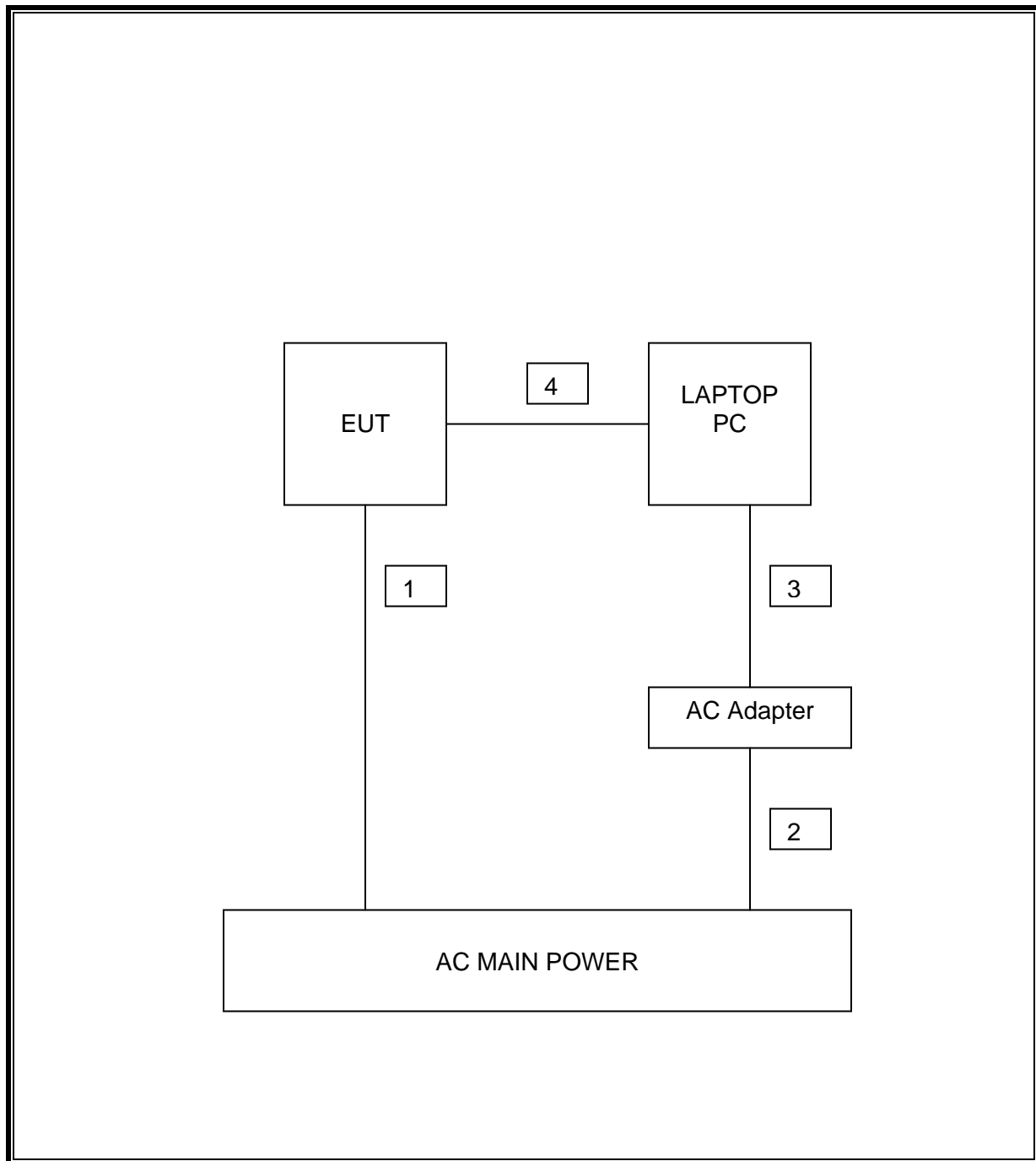
### SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Dell	P05G	3535214077	DoC
Laptop AC Adapter	Dell	LA65NS2-01	72438-084	DoC

### 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	Un-shielded	1.8m	N/A
2	AC	1	US 115V	Un-shielded	1m	N/A
3	DC	1	DC	Un-shielded	1.8m	N/A
4	Ethnet	1	RJ45	Un-shielded	2m	Connect to Laptop

**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, 26.5 GHz	Agilent / HP	E4440A	C01176	08/04/11	08/04/12
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01176	08/04/11	08/04/12
Antenna, Horn, 18 GHz	EMCO	3115	C00872	06/29/11	06/29/12
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C00749	07/18/11	07/18/12
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01171	07/16/11	07/16/12
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00558	01/27/11	01/27/12
Peak Power Meter	Agilent / HP	N1911A	1282124A	08/04/11	08/04/12
Peak and Avg Power Sensor	Agilent / HP	E9323A	1240537J	08/04/11	08/04/12
EMI Test Receiver, 9 kHz-7 GHz	R & S	ESCI 7	1000741	7/6/2011	7/6/2012
LISN, 30 MHz	FCC	LISN-50/250-25-2	N02625	11/10/11	11/10/12
Horn Antenna, 26 GHz	ARA	MWH-1826/B	C00589	07/28/11	07/28/12
Horn Antenna, 40 GHz	ARA	MWH-2640/B	C00981	06/14/11	06/14/12
Preamplifier, 40 GHz	Miteq	NSP4000-SP2	C00990	08/12/11	08/12/12

## 7. ANTENNA PORT TEST RESULTS

### 7.1. 802.11g MODE IN THE 2.4 GHz BAND

#### 7.1.1. 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.

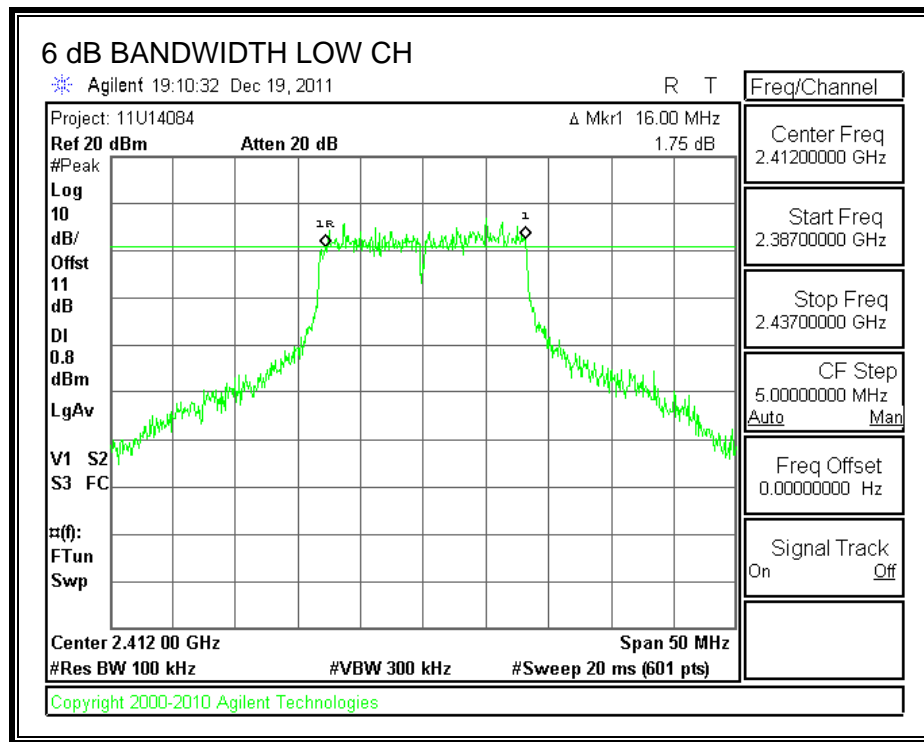
##### TEST PROCEDURE

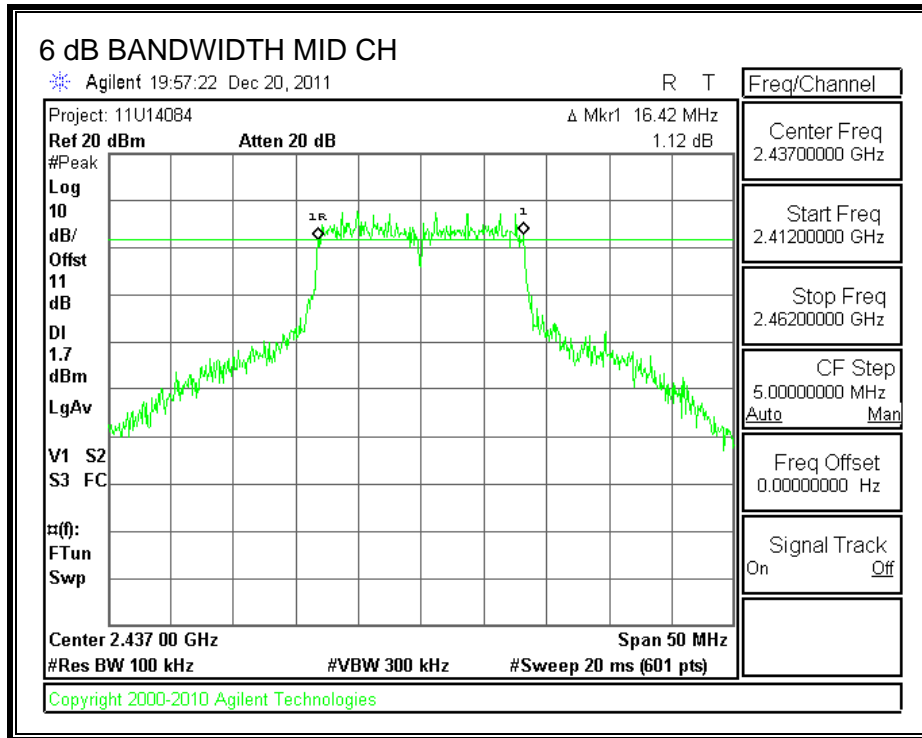
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

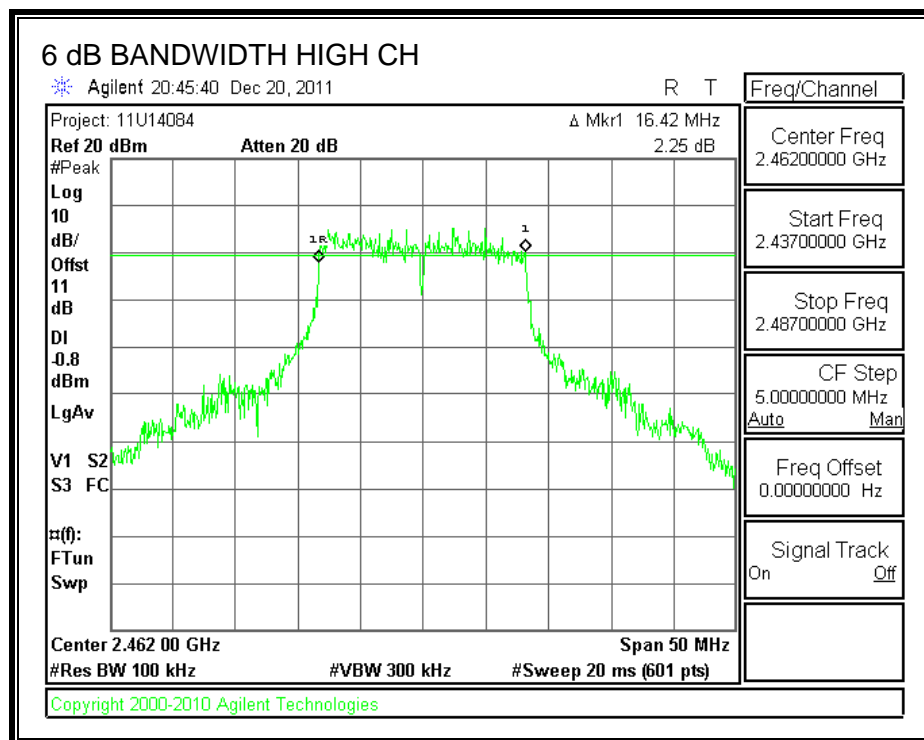
##### RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2412	16.00	0.5
Middle	2437	16.42	0.5
High	2462	16.42	0.5

# **6 dB BANDWIDTH**







### 7.1.2. 99% BANDWIDTH

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

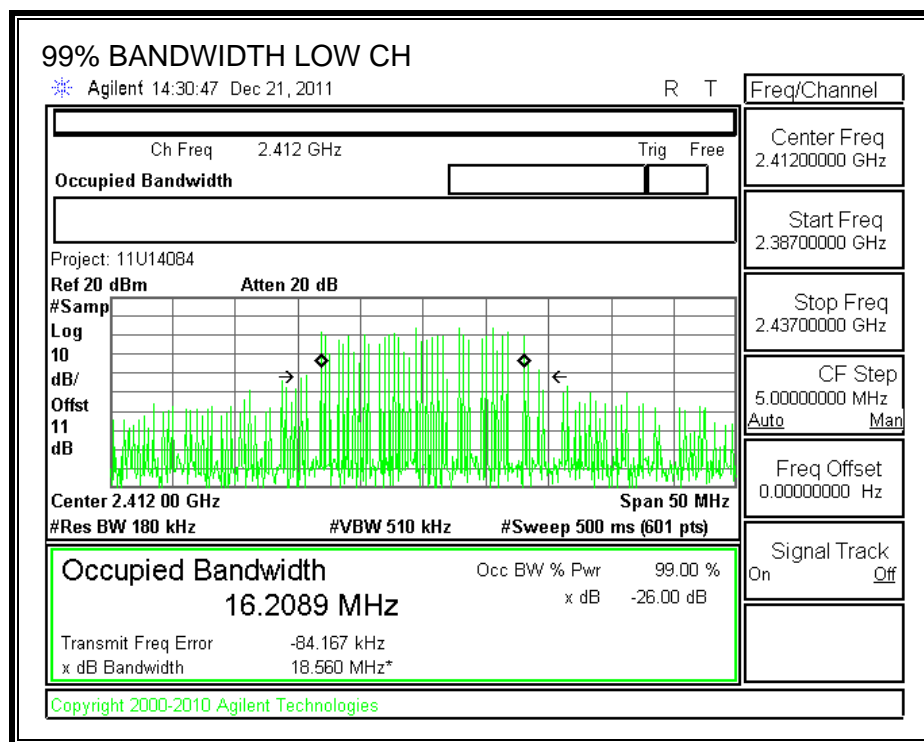
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

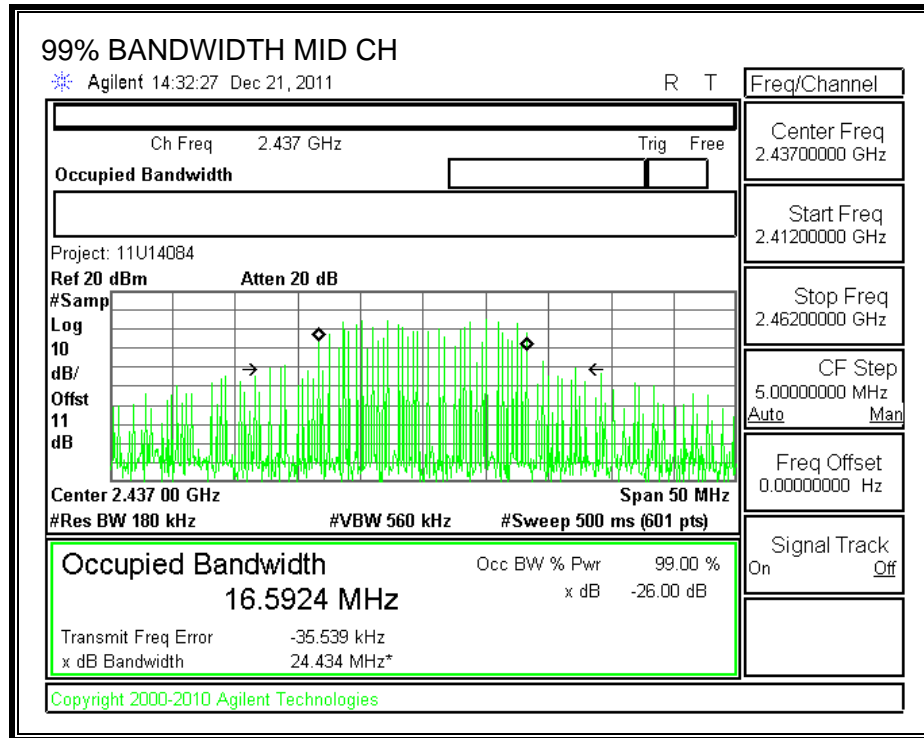
#### RESULTS

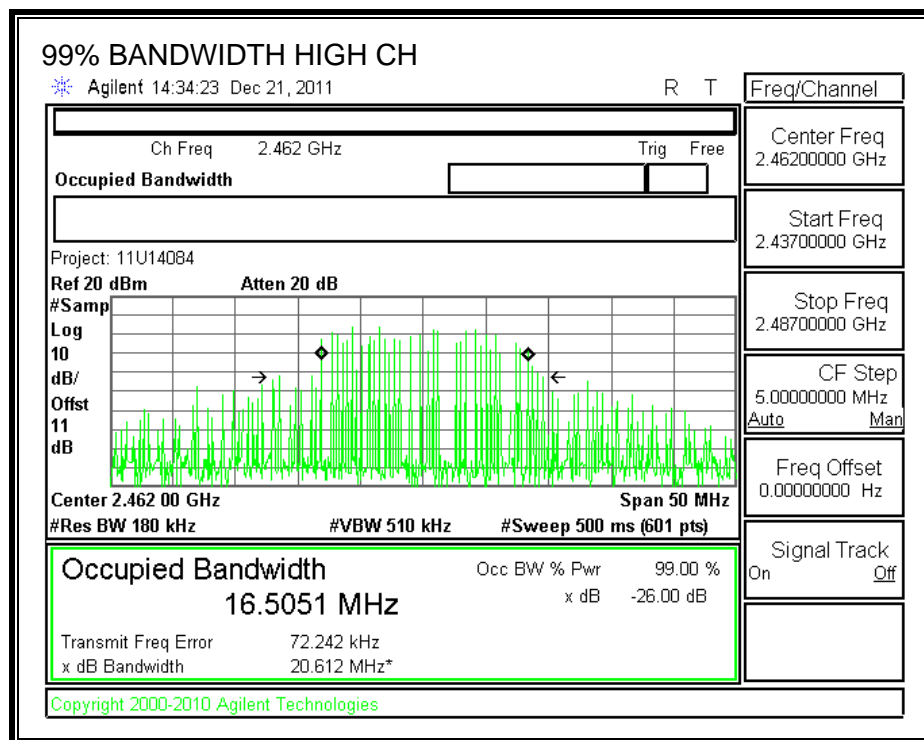
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2412	16.2089
Middle	2437	16.5924
High	2462	16.5051



# **99% BANDWIDTH**







### 7.1.3. 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.

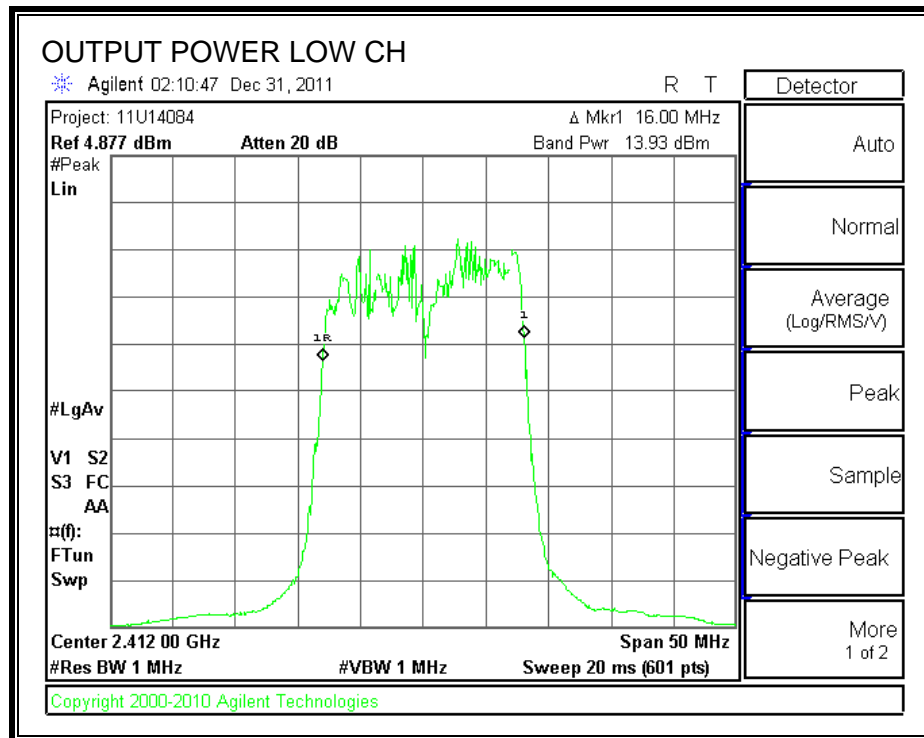
#### TEST PROCEDURE

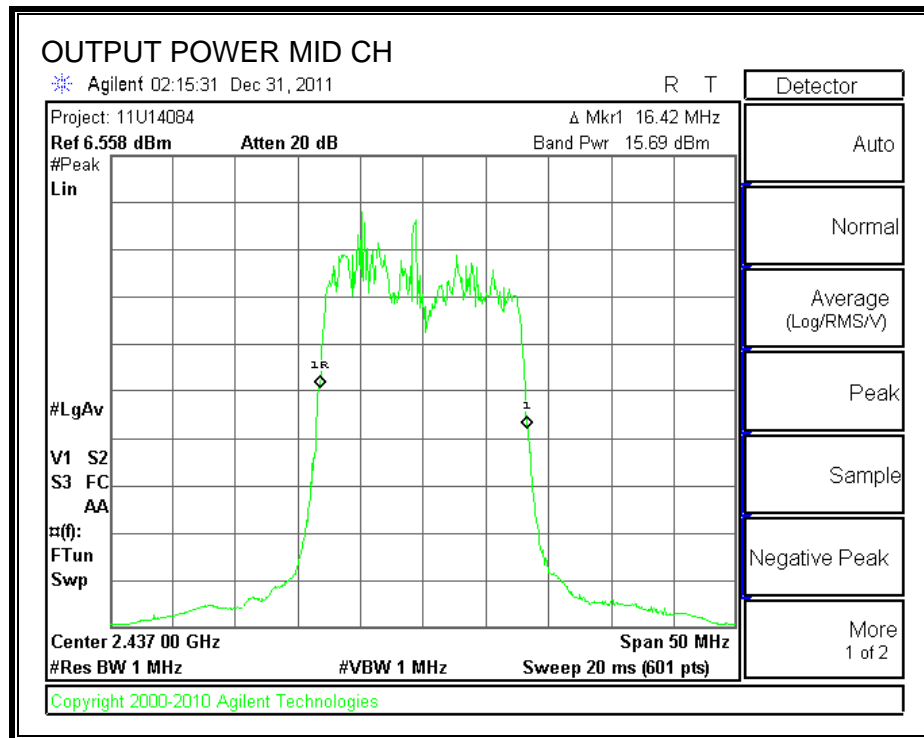
Peak power is measured using the Channel bandwidth Alternative peak output power procedure specified in "TCB Training for Devices covered under Scopes A1 - A4" by Joe Dichoso, May 2003.

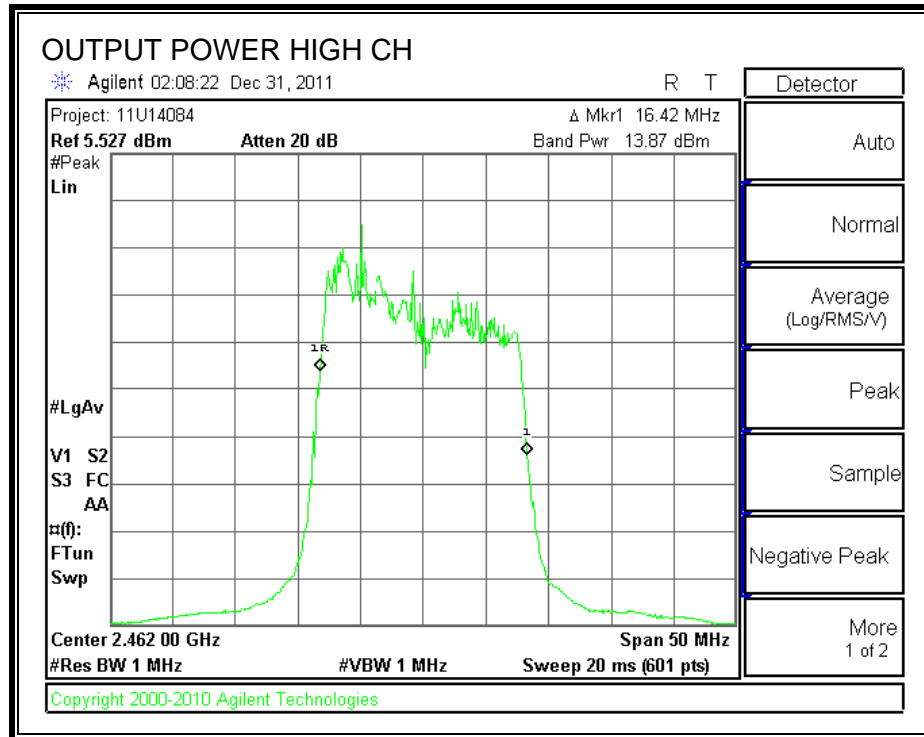
#### RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Attenuator and Cable Offset (dB)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	13.93	11	24.93	30	-5.07
Middle	2437	15.69	11	26.69	30	-3.31
High	2462	13.87	11	24.87	30	-5.13

## OUTPUT POWER







#### 7.1.4. AVERAGE POWER

##### LIMITS

None; for reporting purposes only.

##### TEST PROCEDURE

The transmitter output is connected to a power meter.

##### RESULTS

The cable assembly insertion loss of 11 dB (including 10 dB pad and 1 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Power (dBm)
Low	2412	17.65
Middle	2437	19.52
High	2462	17.72



### 7.1.5. 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.

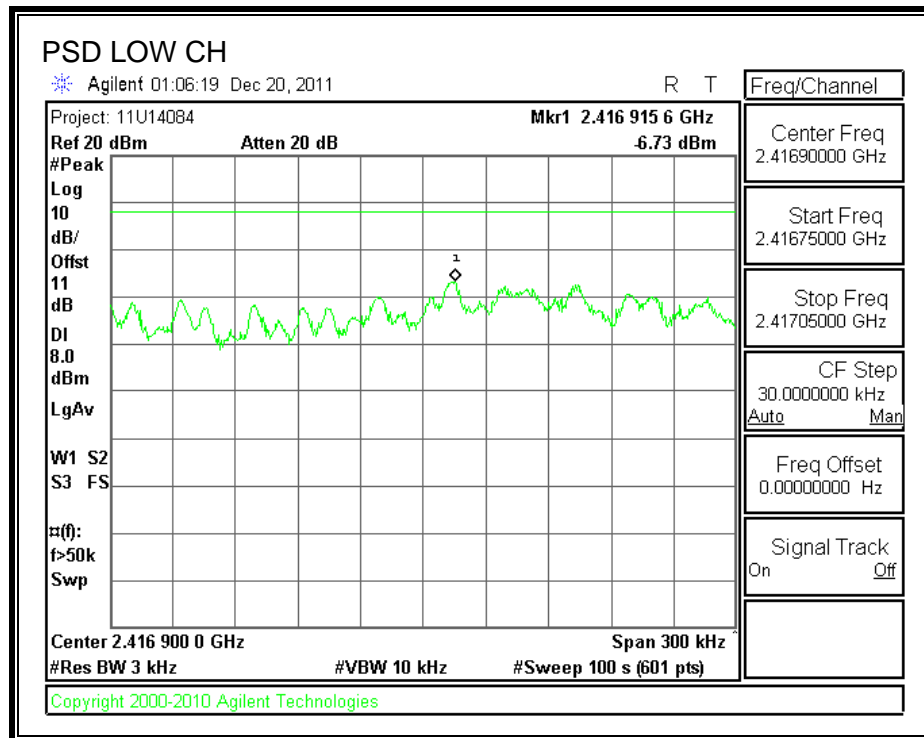
#### TEST PROCEDURE

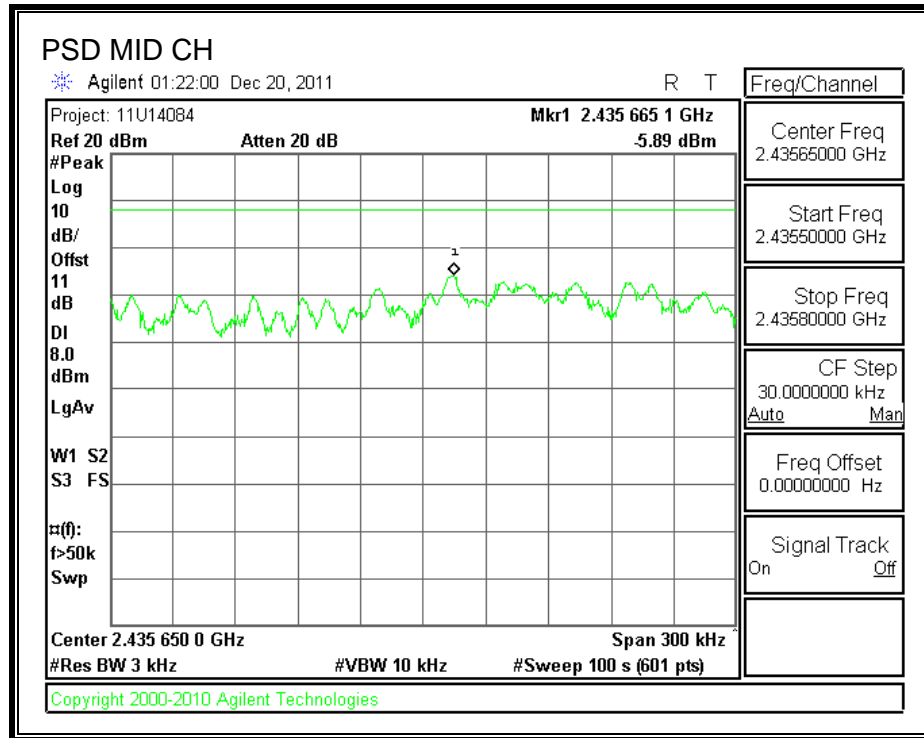
Output power was measured based on the use of a peak measurement, therefore the power spectral density was measured using PSD Option 1 in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

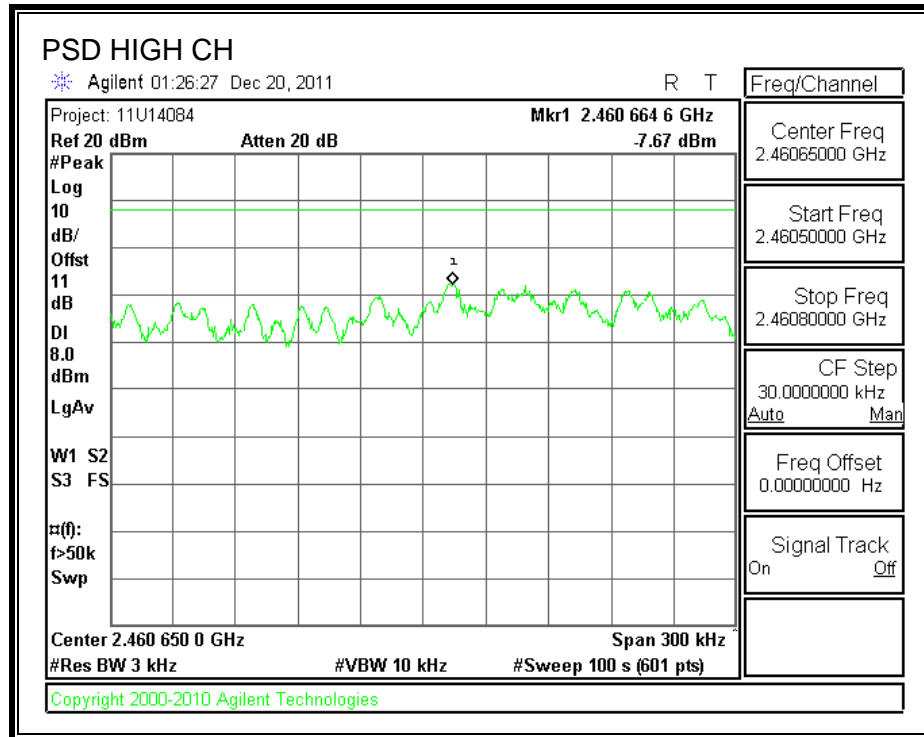
#### RESULTS

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-6.73	8	-14.73
Middle	2437	-5.89	8	-13.89
High	2462	-7.67	8	-15.67

**POWER SPECTRAL DENSITY**







## **7.1.6. 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.

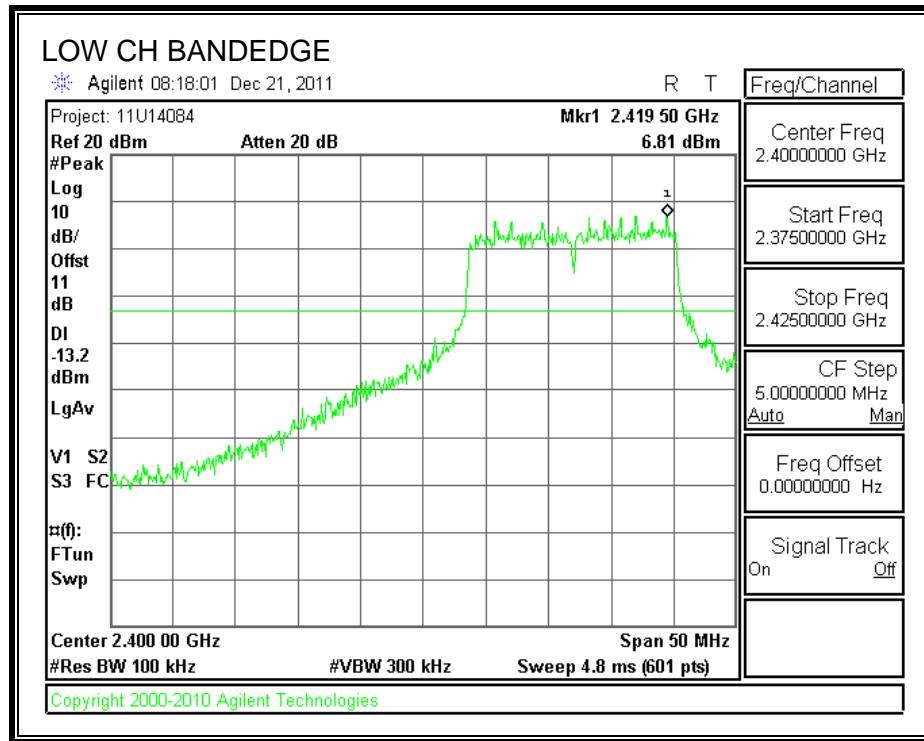
### **TEST PROCEDURE**

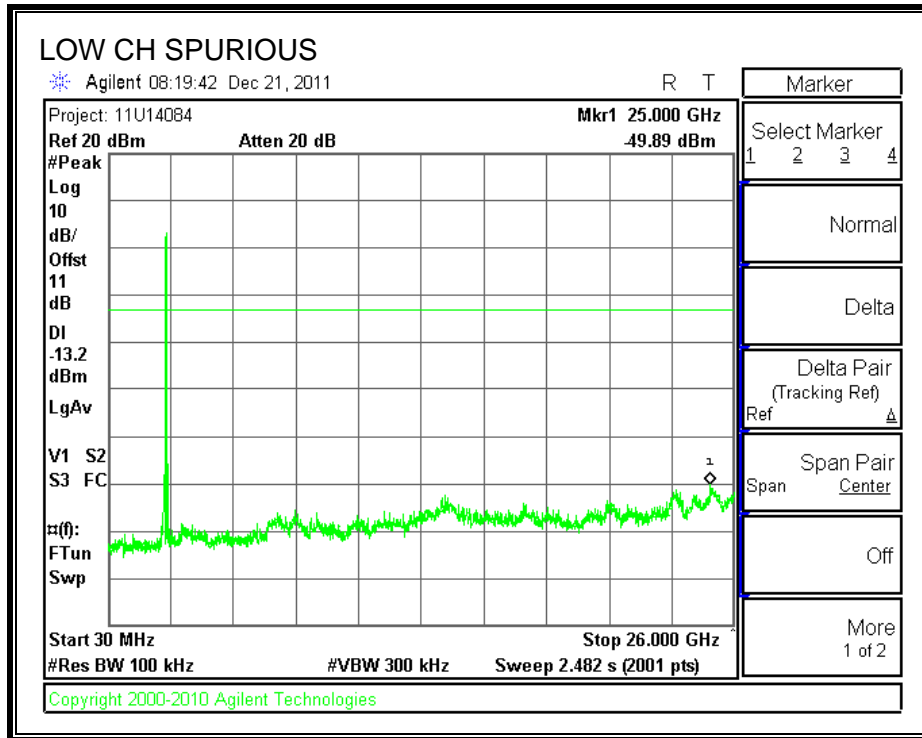
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

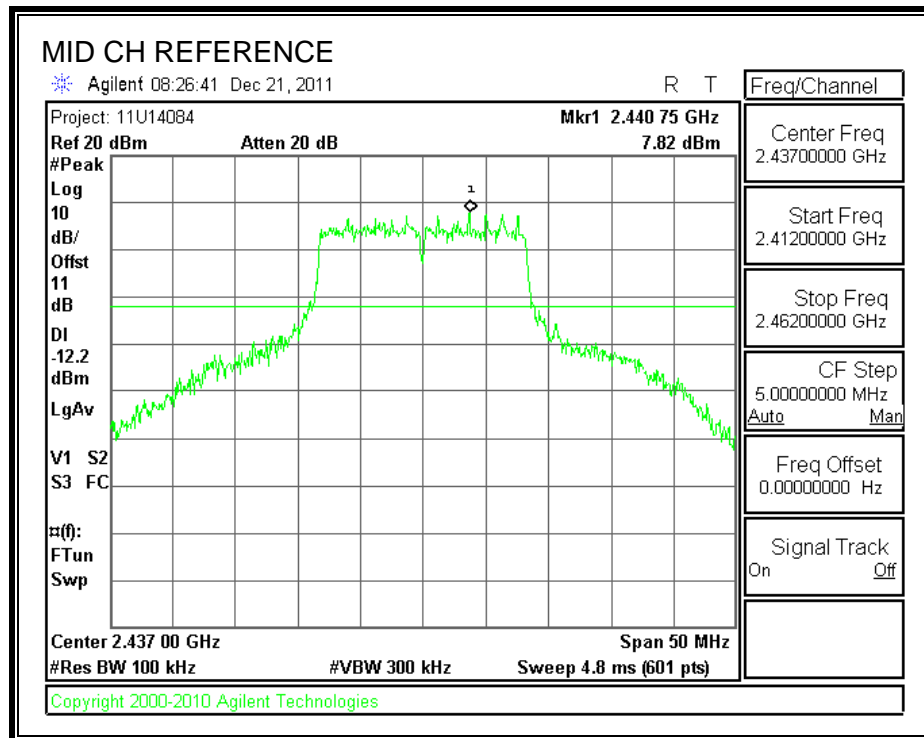
## RESULTS

### SPURIOUS EMISSIONS, LOW CHANNEL

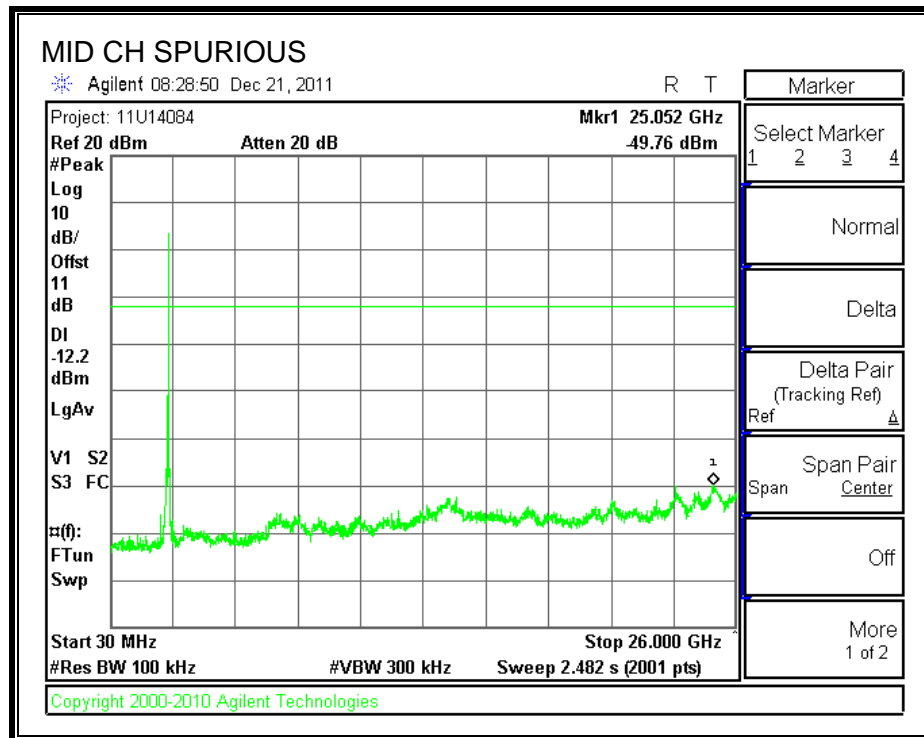




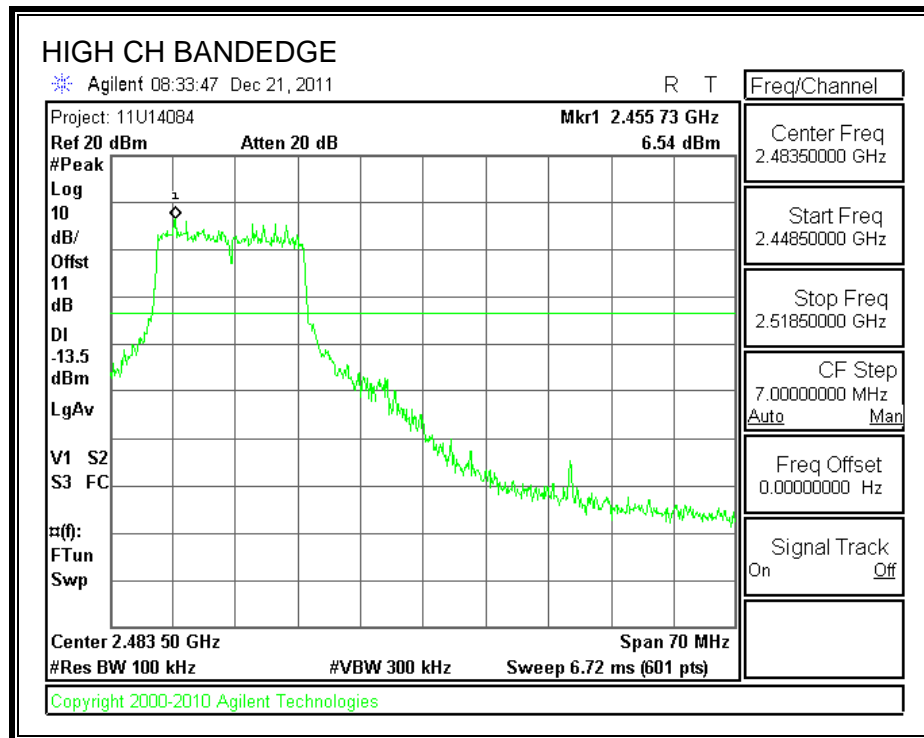
**SPURIOUS EMISSIONS, MID CHANNEL**

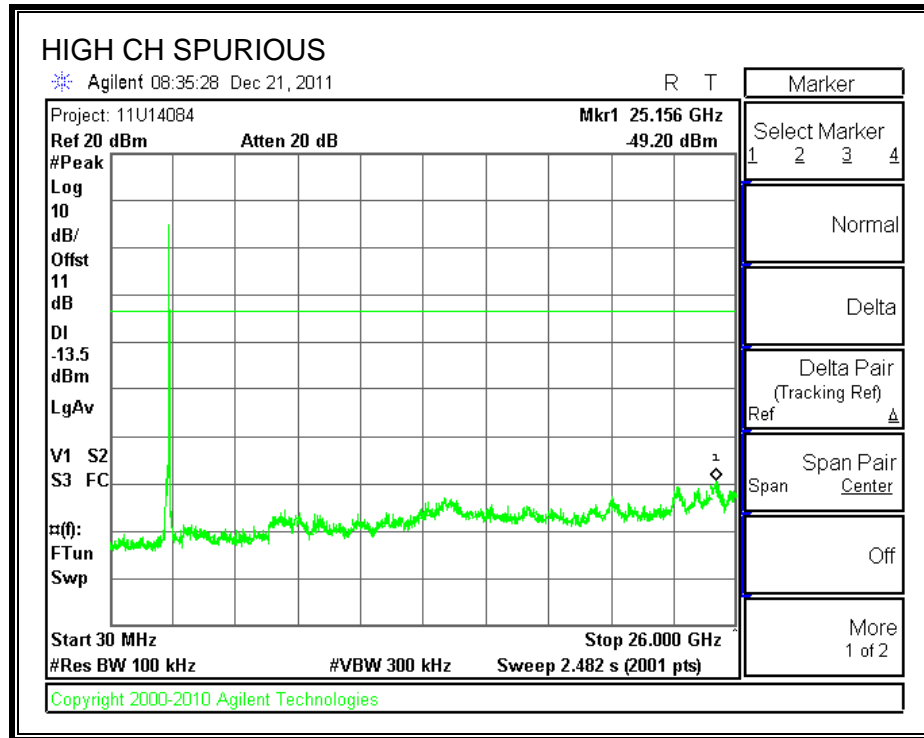






**SPURIOUS EMISSIONS, HIGH CHANNEL**





## **7.2. 802.11n HT20 MODE IN THE 2.4 GHz BAND**

### **7.2.1. 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.

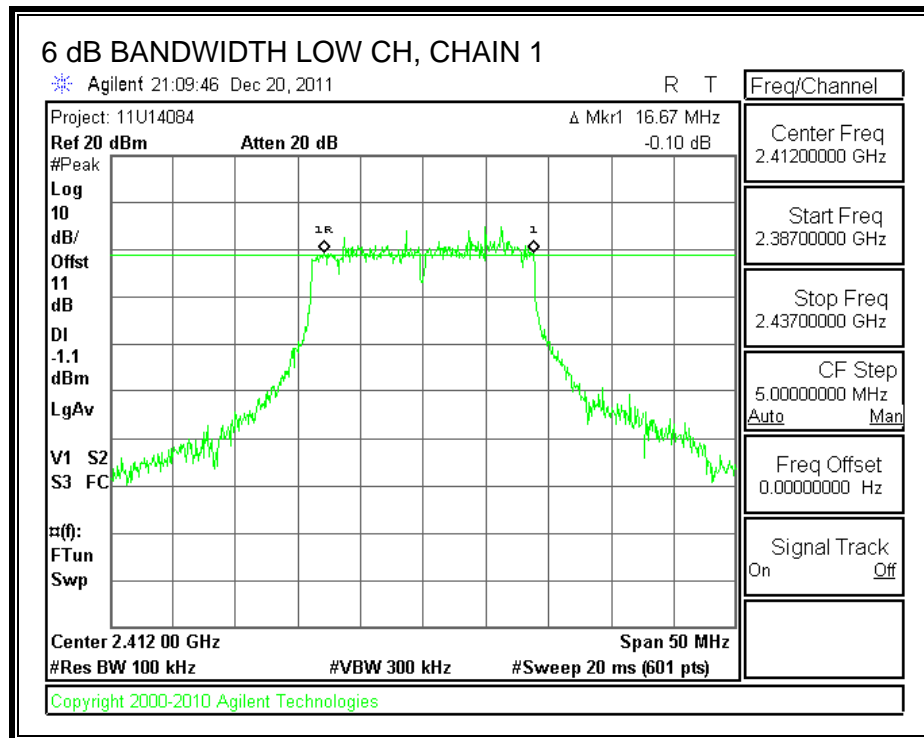
#### **TEST PROCEDURE**

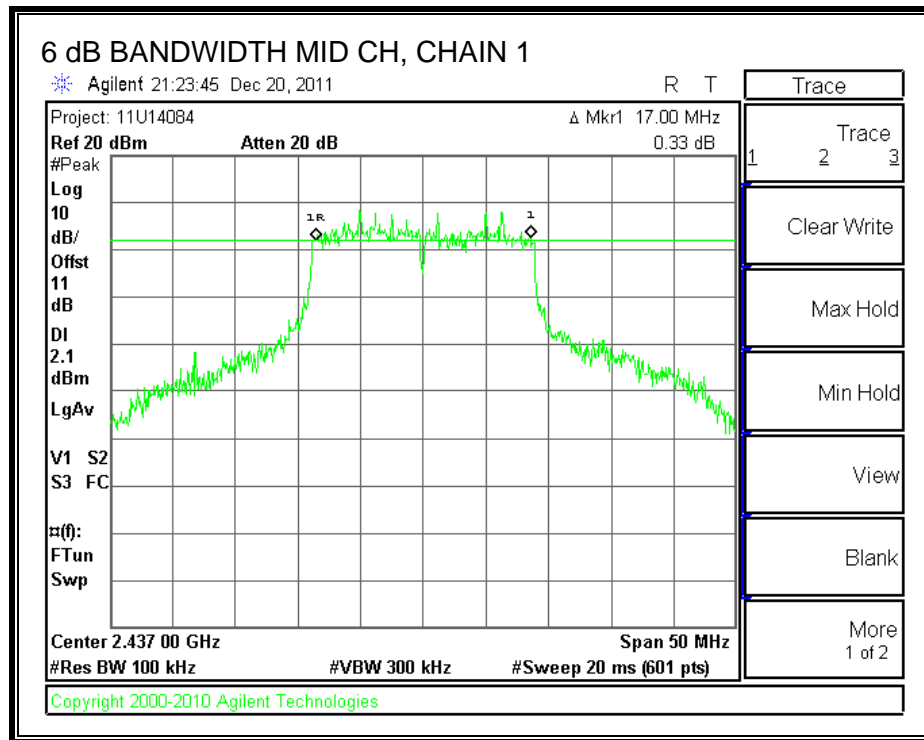
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

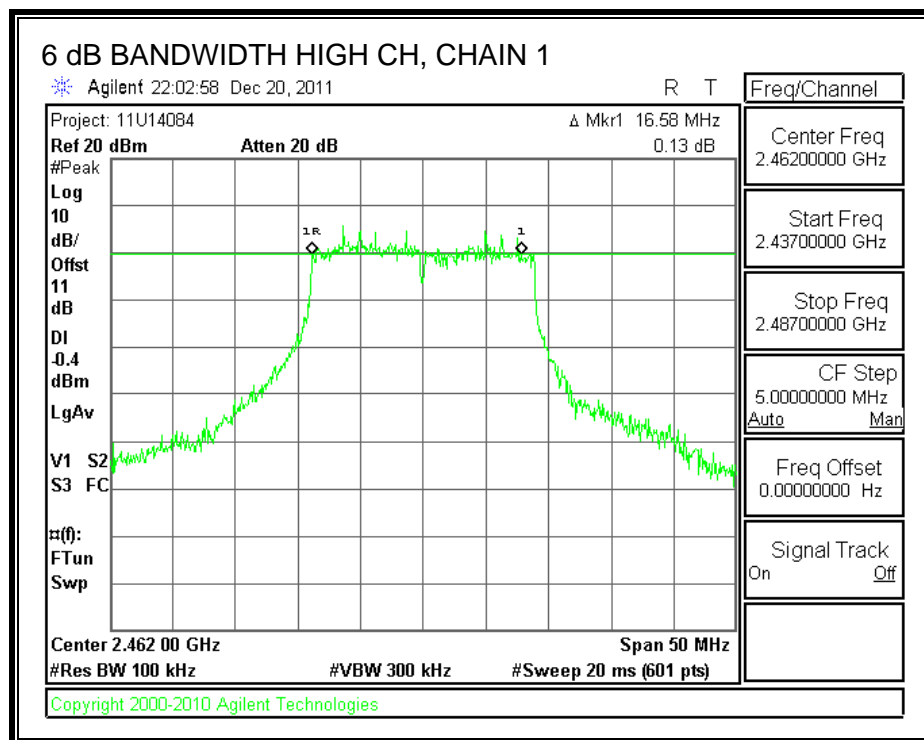
#### **RESULTS**

<b>Channel</b>	<b>Frequency (MHz)</b>	<b>Chain 1 6 dB BW (MHz)</b>	<b>Chain 2 6 dB BW (MHz)</b>	<b>Minimum Limit (MHz)</b>
Low	2412	16.67	17.25	0.5
Middle	2437	17.00	16.92	0.5
High	2462	16.58	16.42	0.5

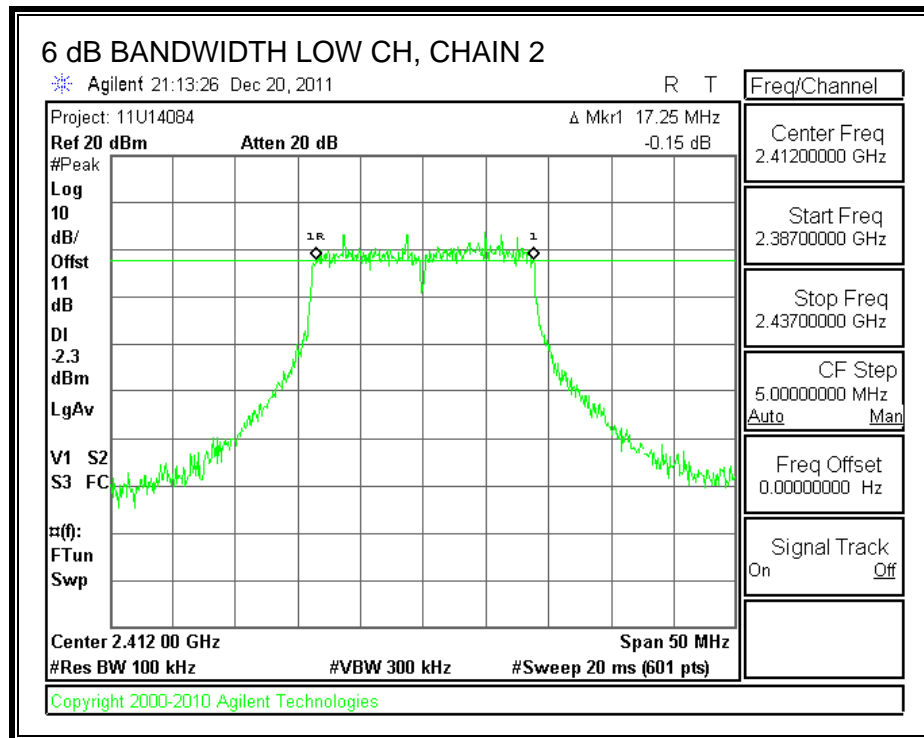
**6 dB BANDWIDTH, CHAIN 1**



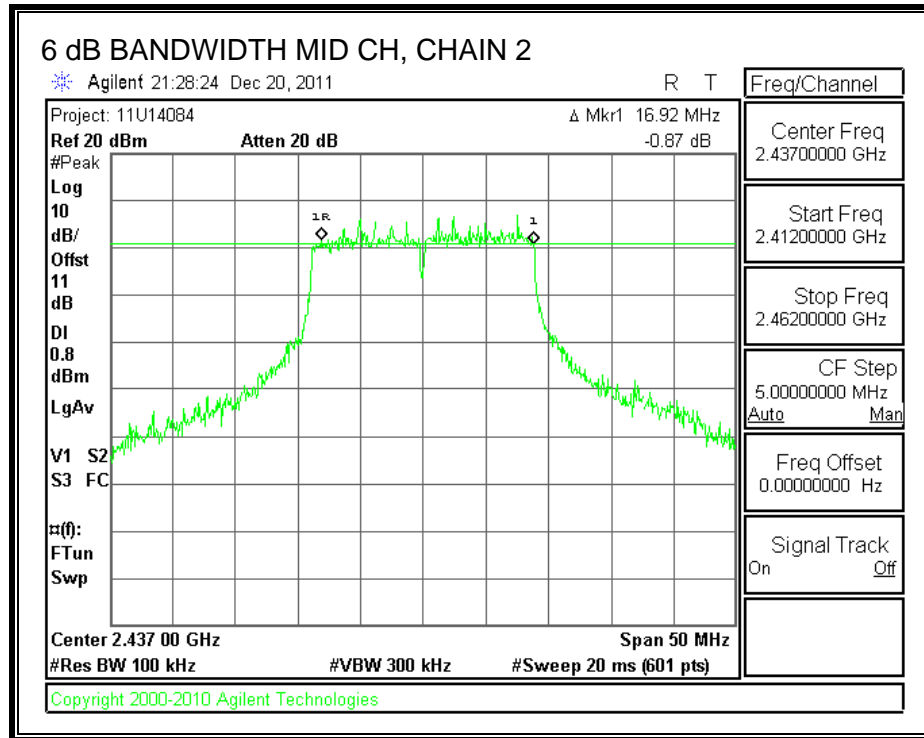


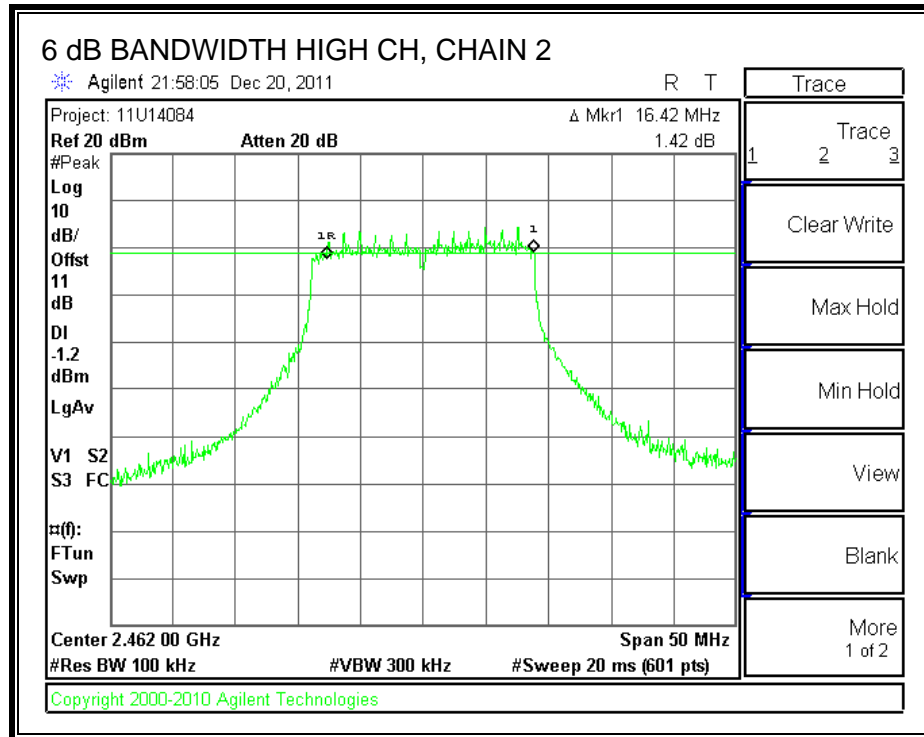


**6 dB BANDWIDTH, CHAIN 2**









## 7.2.2. 99% BANDWIDTH

### LIMITS

None; for reporting purposes only.

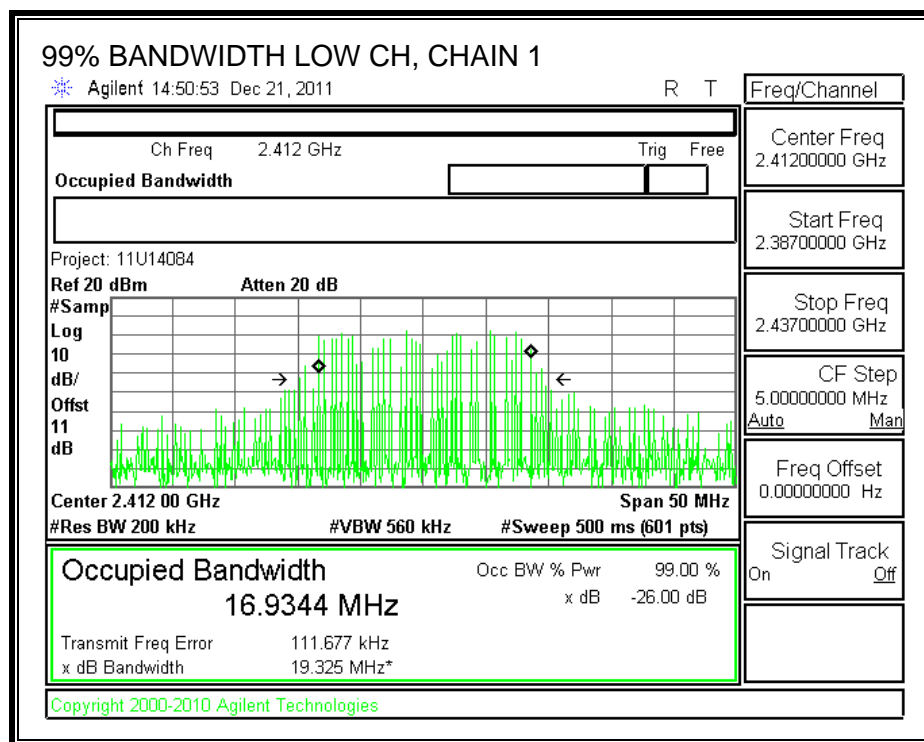
### TEST PROCEDURE

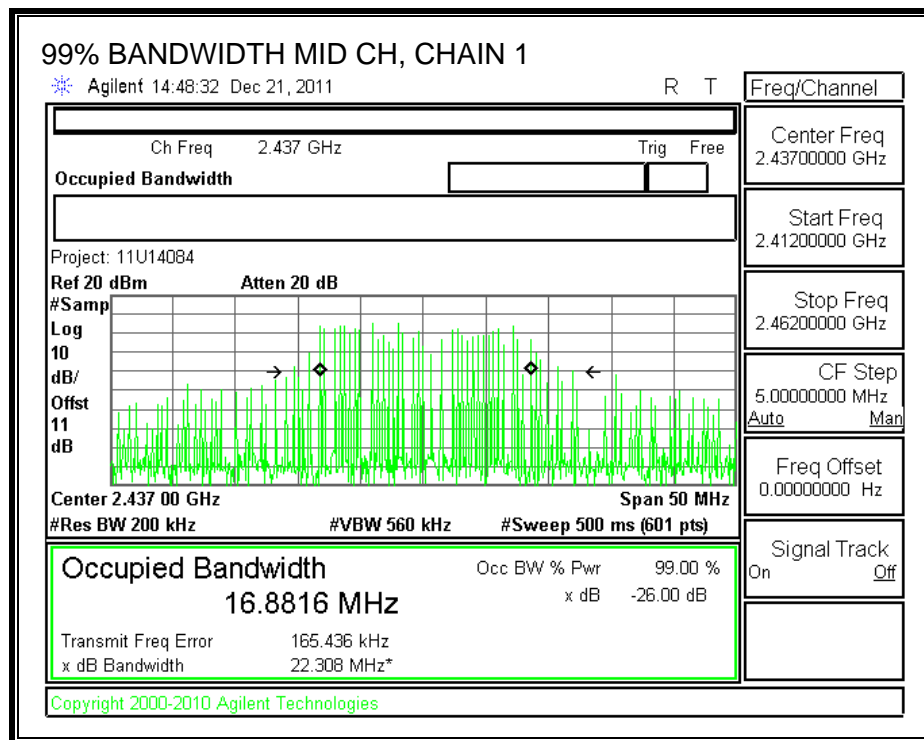
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

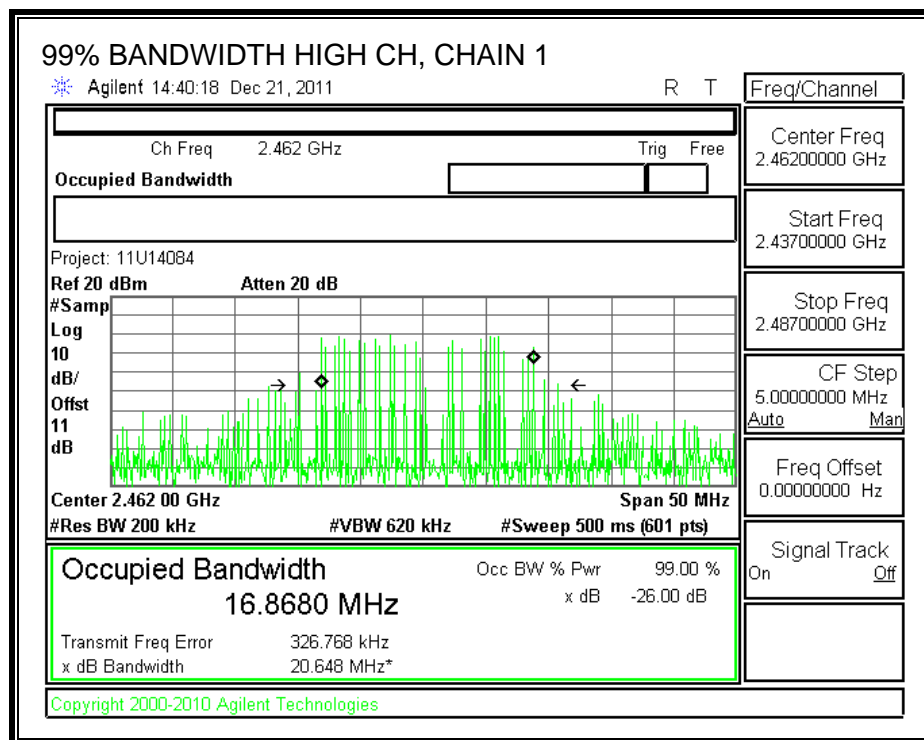
### RESULTS

Channel	Frequency (MHz)	Chain 1 99% Bandwidth (MHz)	Chain 2 99% Bandwidth (MHz)
Low	2412	16.9344	16.8523
Middle	2437	16.8816	16.8539
High	2462	16.8680	16.8725

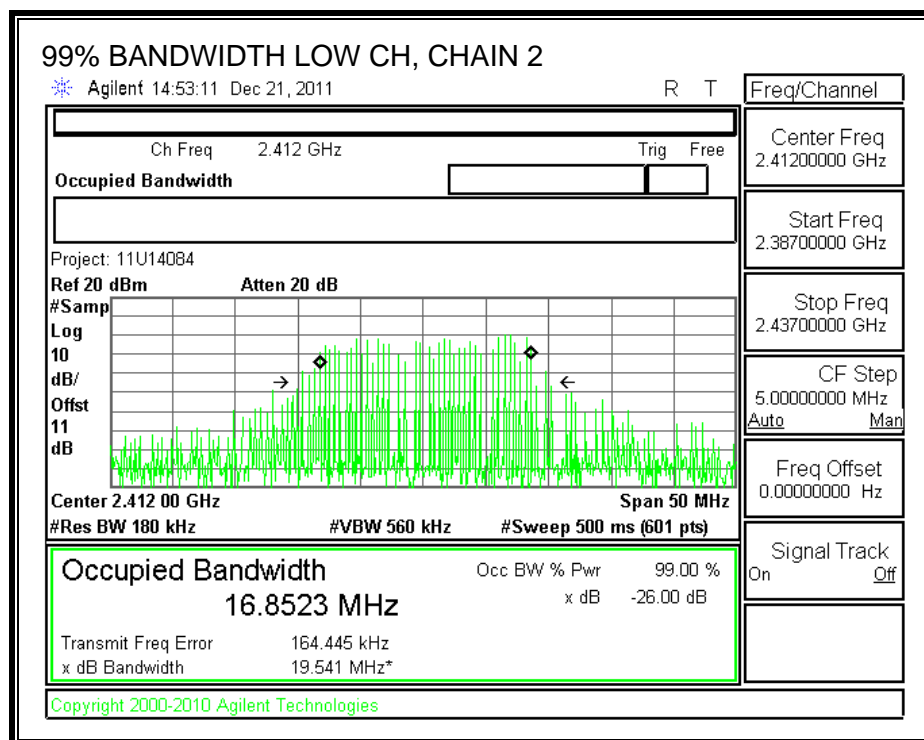
**99% BANDWIDTH, CHAIN 1**

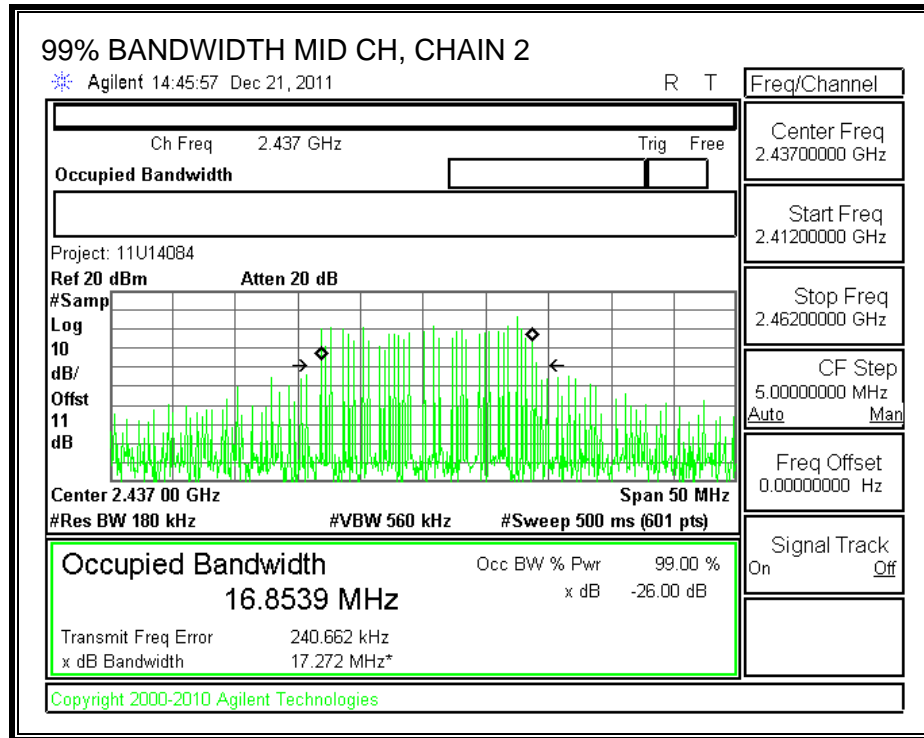




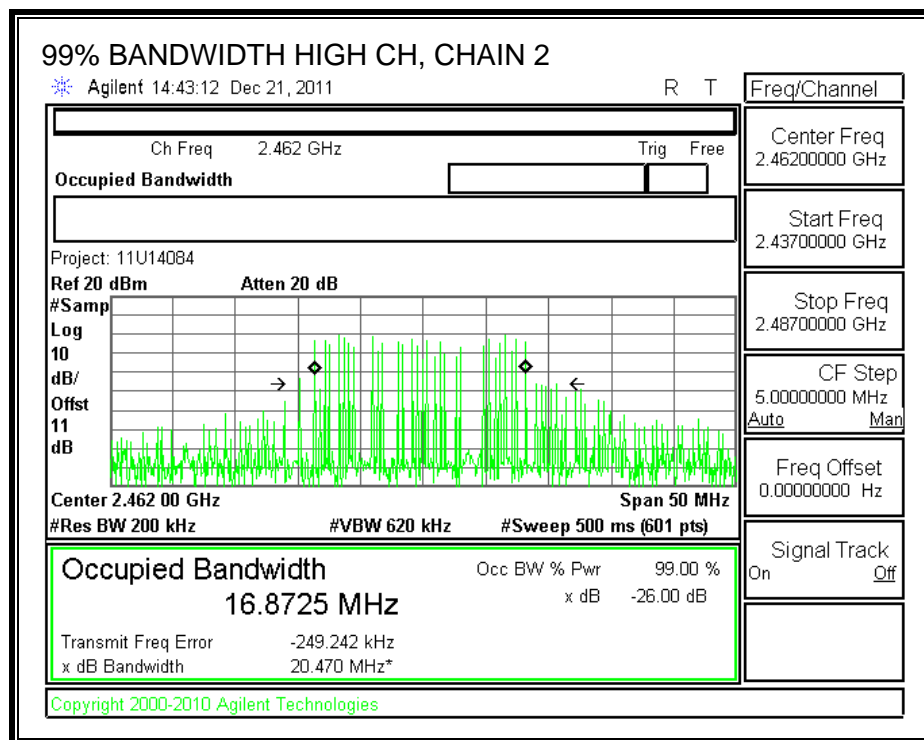


**99% BANDWIDTH, CHAIN 2**









### 7.2.3. 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.

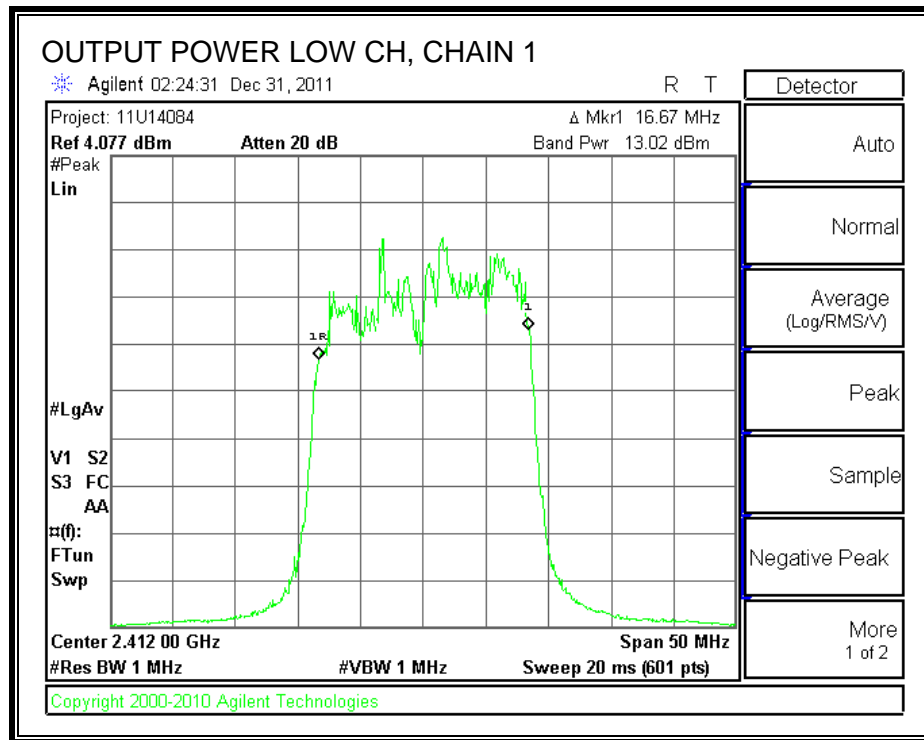
#### TEST PROCEDURE

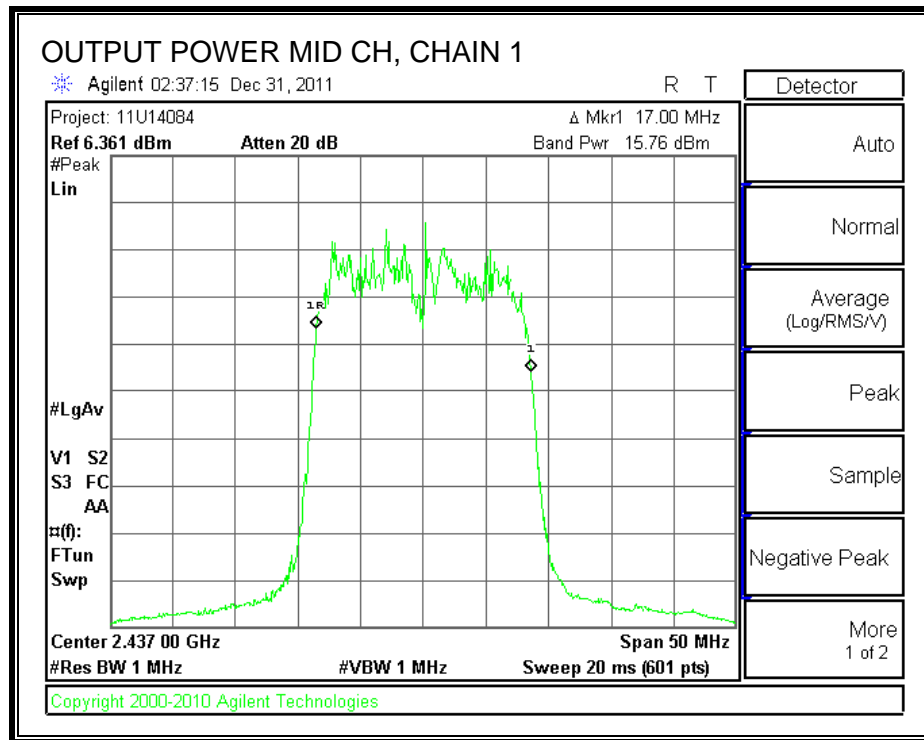
Peak power is measured using the Channel bandwidth Alternative peak output power procedure specified in "TCB Training for Devices covered under Scopes A1 - A4" by Joe Dichoso, May 2003.

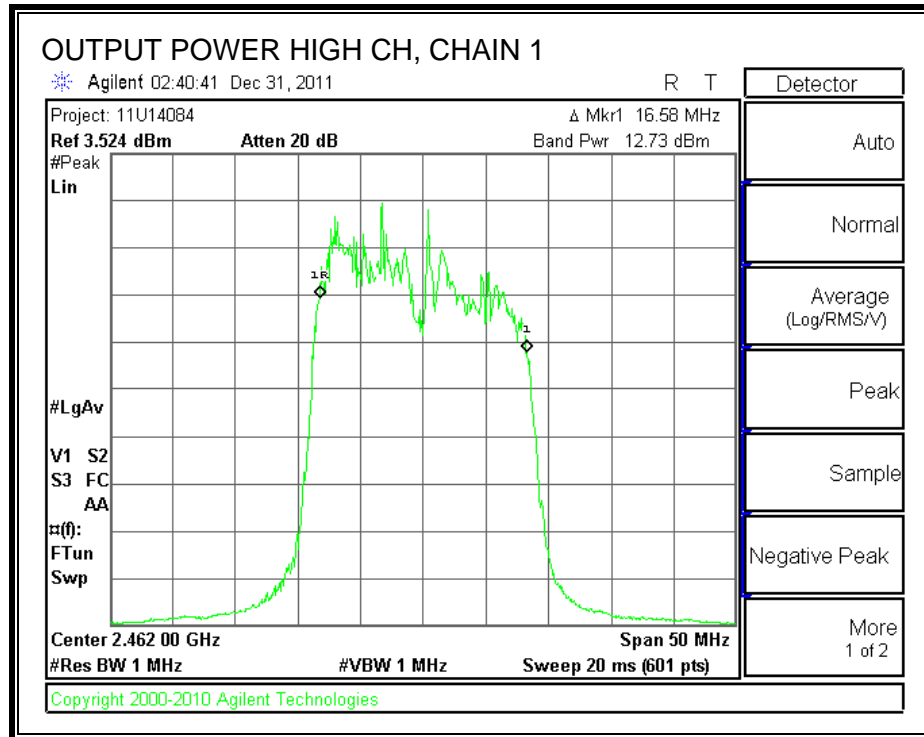
#### RESULTS

Channel	Frequency (MHz)	Chain 1 PK Power (dBm)	Chain 2 PK Power (dBm)	Attenuator + Cable Offset (dB)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	13.02	12.59	11.00	26.82	30.00	-3.18
Mid	2437	15.76	14.73	11.00	29.29	30.00	-0.71
High	2462	12.73	12.04	11.00	26.41	30.00	-3.59

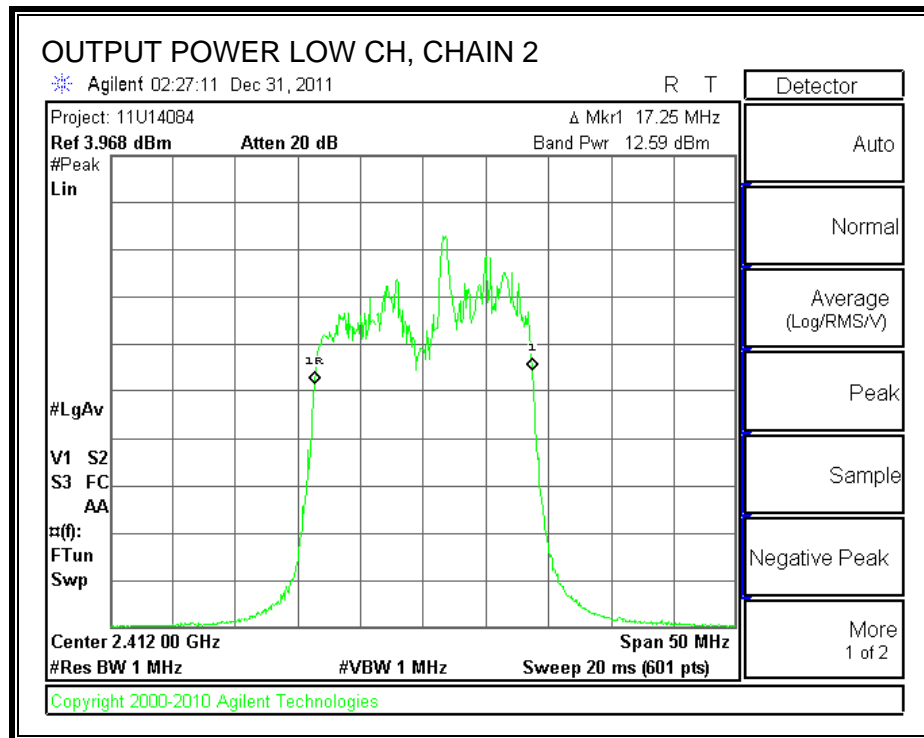
# **CHAIN 1 OUTPUT POWER**

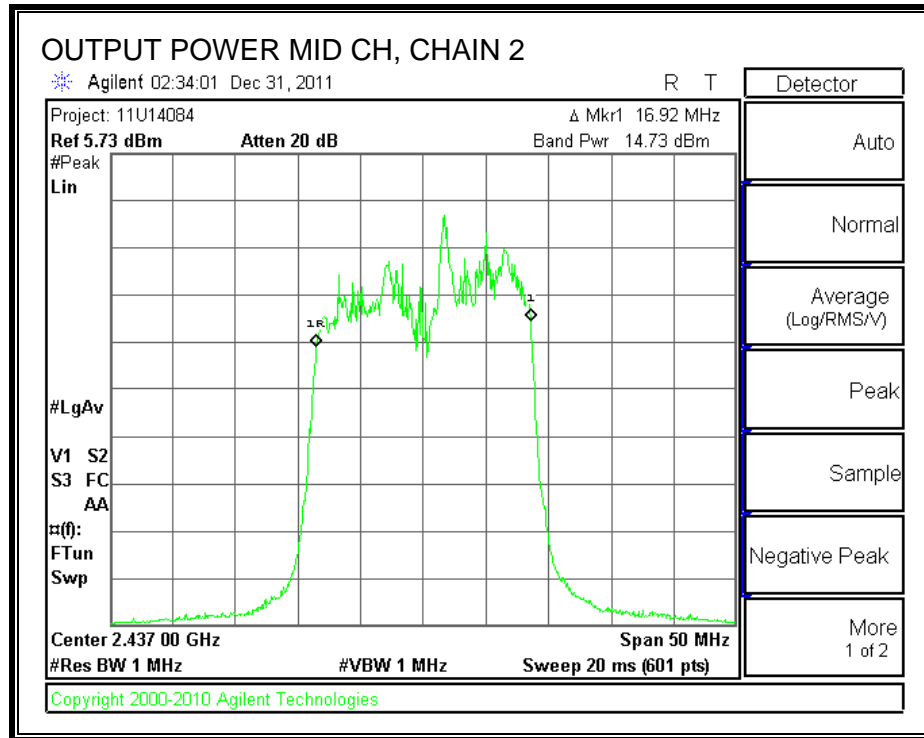


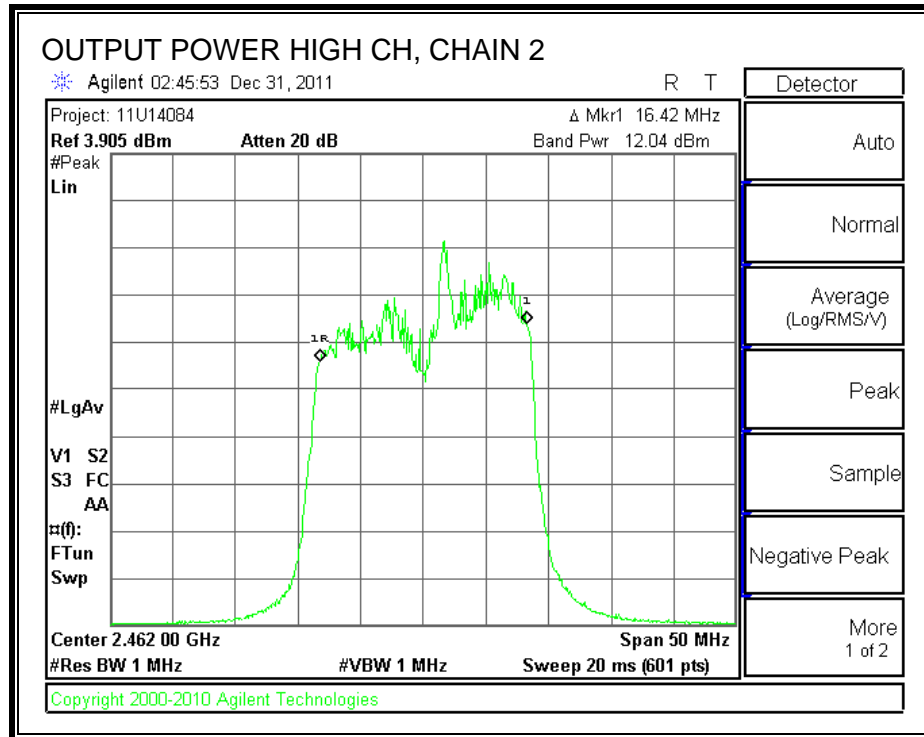




## CHAIN 2 OUTPUT POWER









## 7.2.4. AVERAGE POWER

### LIMITS

None; for reporting purposes only.

### TEST PROCEDURE

The transmitter output is connected to a power meter.

### RESULTS

The cable assembly insertion loss of 11 dB (including 10 dB pad and 1 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)
Low	2412	16.23	15.56	18.92
Middle	2437	19.42	17.73	21.67
High	2462	16.22	15.16	18.73

## 7.2.5. 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.

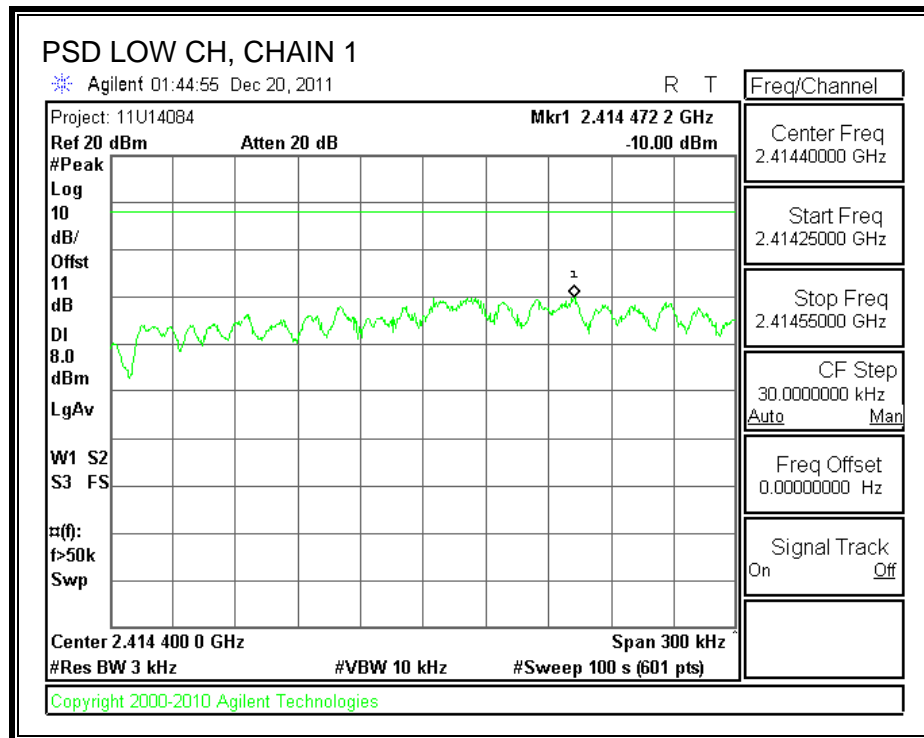
### TEST PROCEDURE

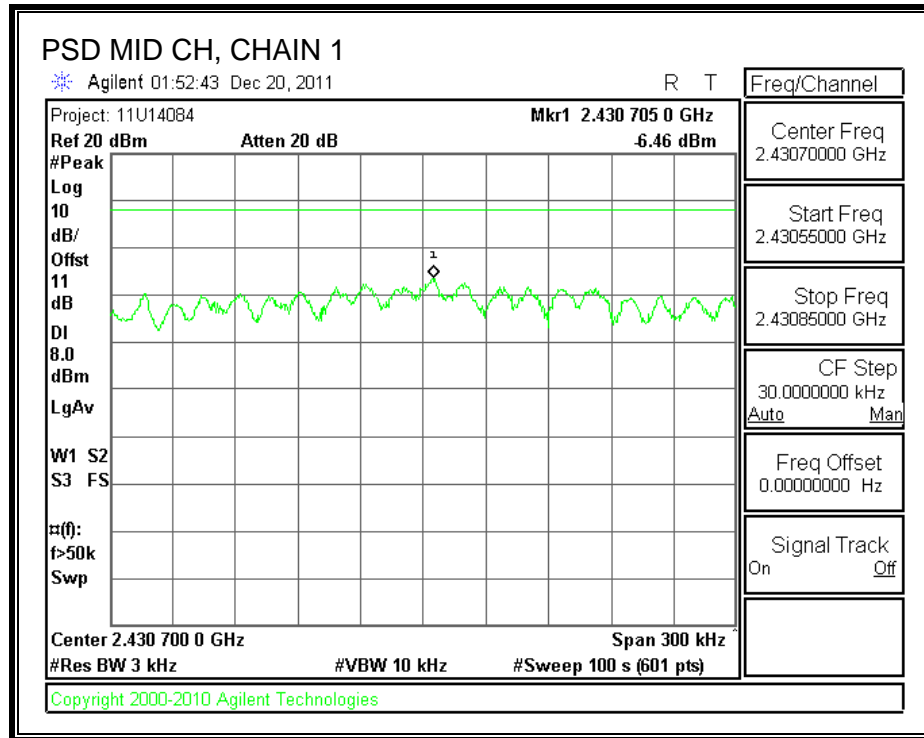
Output power was measured based on the use of a peak measurement, therefore the power spectral density was measured using PSD Option 1 in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

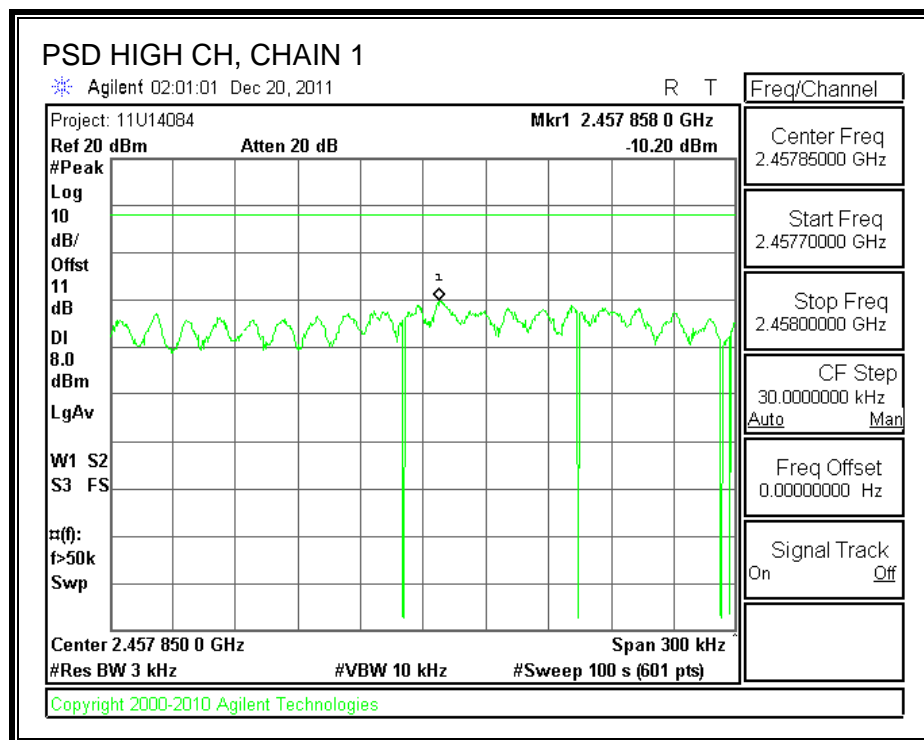
### RESULTS

Channel	Frequency (MHz)	Chain 1 PSD (dBm)	Chain 2 PSD (dBm)	Total PSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-10	-11.74	-7.77	8	-15.77
Middle	2437	-6.46	-8.34	-4.29	8	-12.29
High	2462	-10.2	-10.29	-7.23	8	-15.23

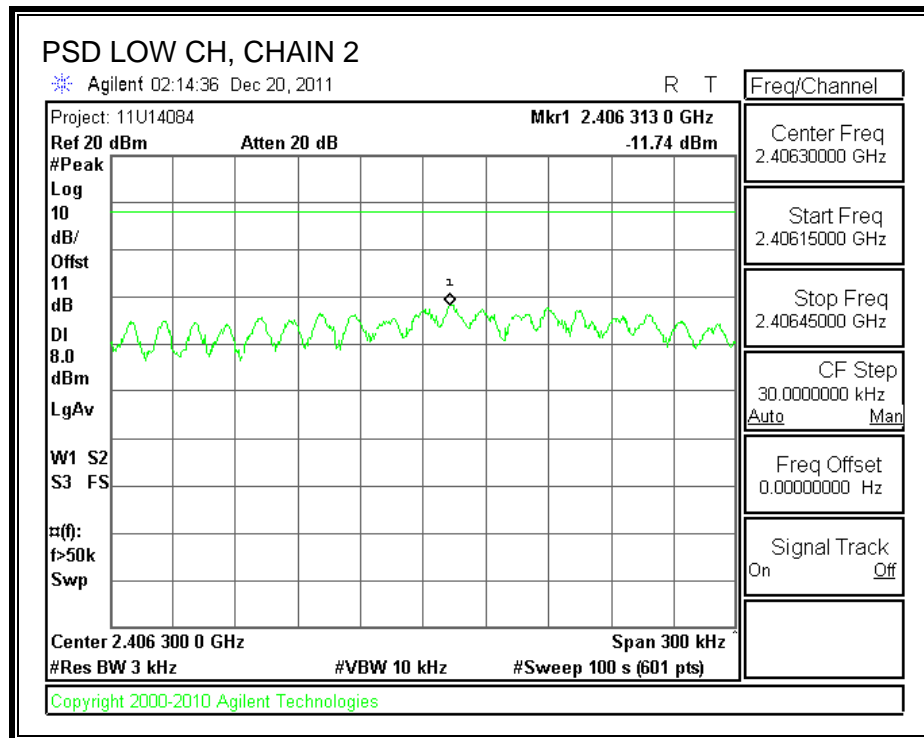
**POWER SPECTRAL DENSITY, CHAIN 1**

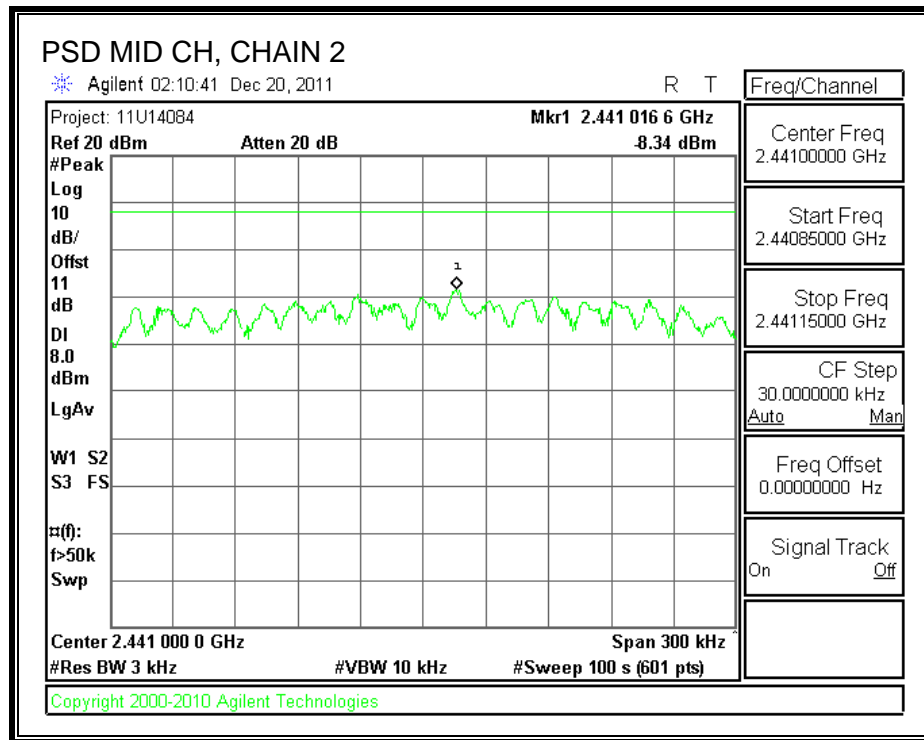


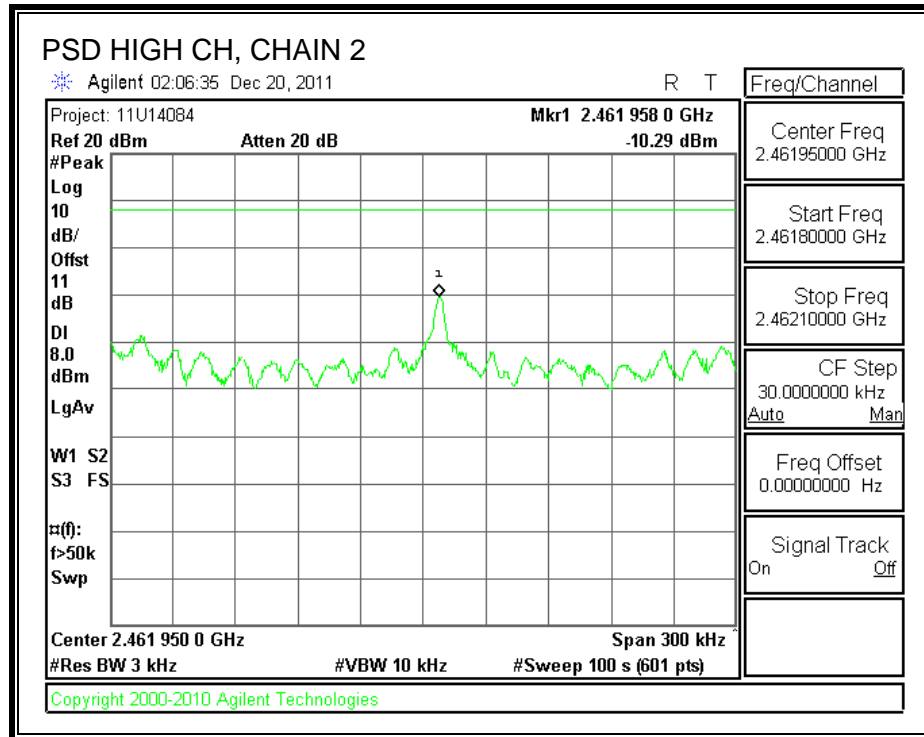




**POWER SPECTRAL DENSITY, CHAIN 2**









## **7.2.6. 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.

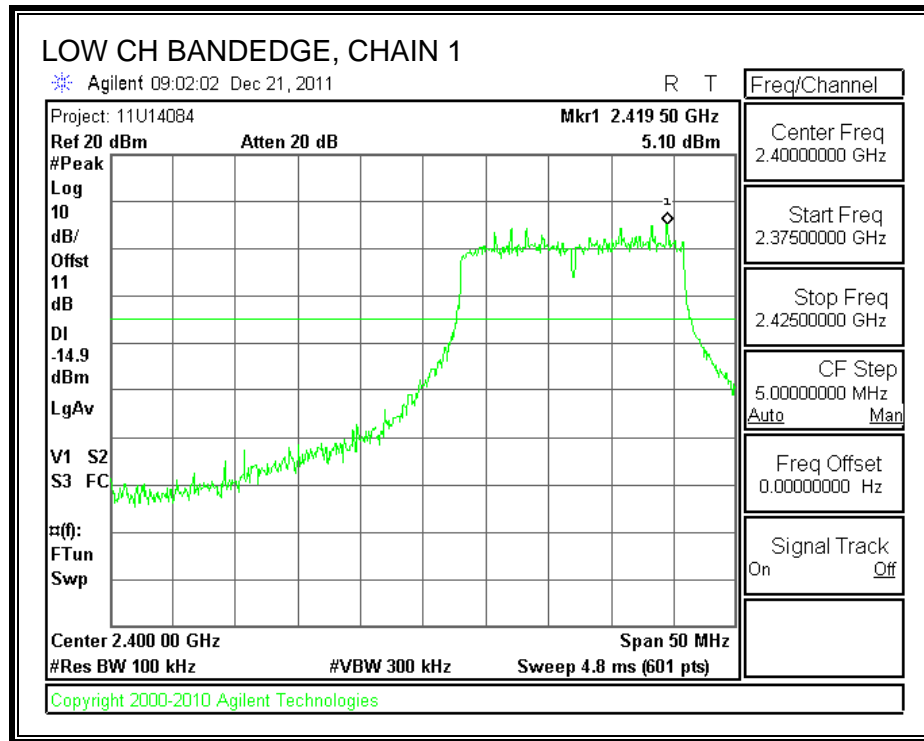
### **TEST PROCEDURE**

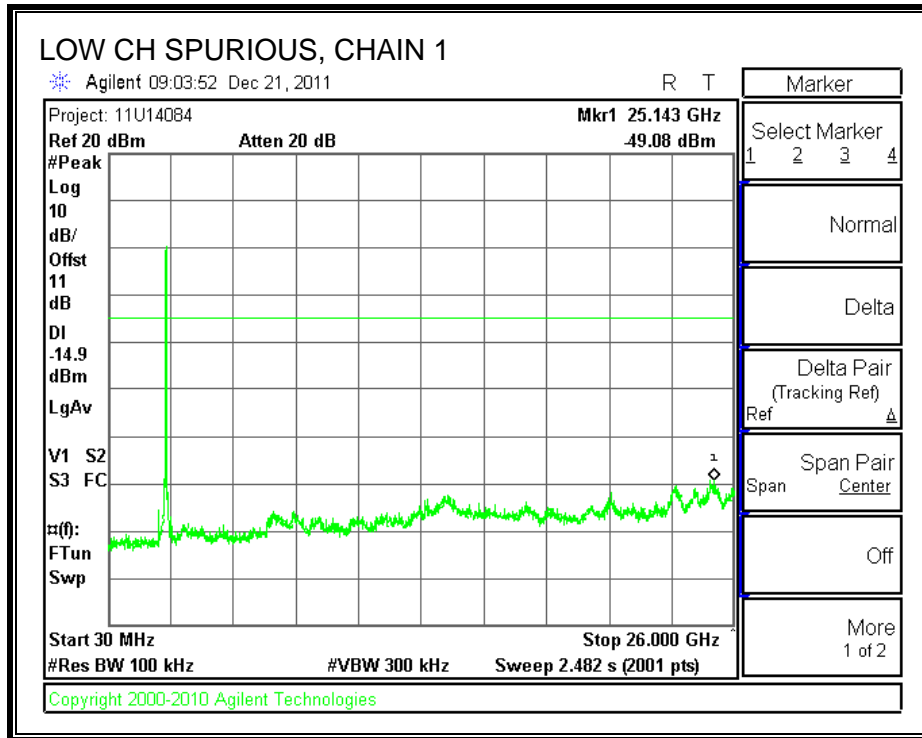
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

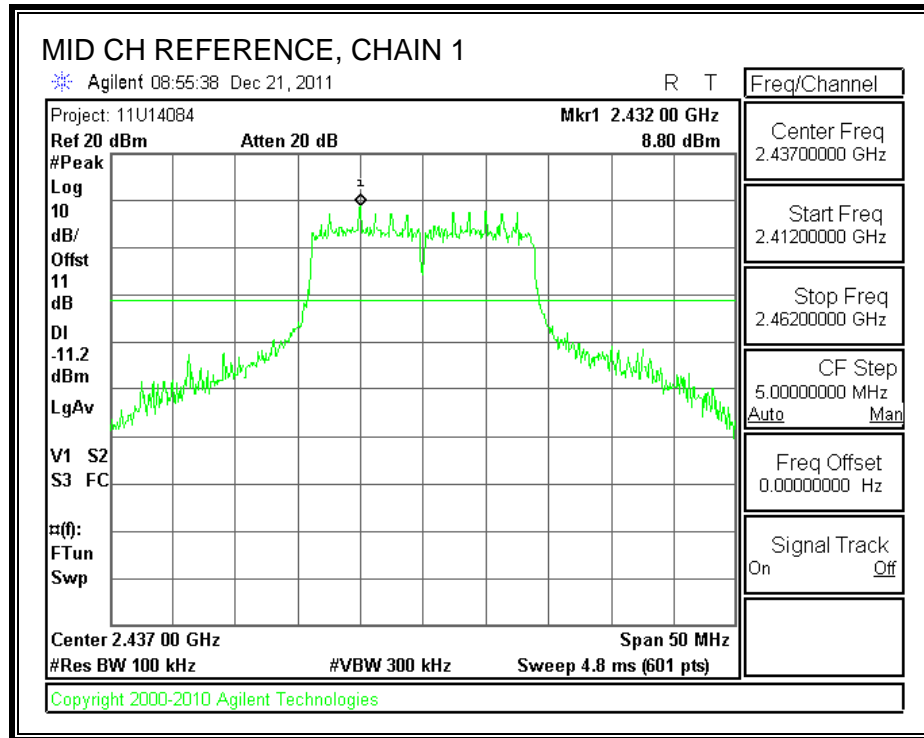
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

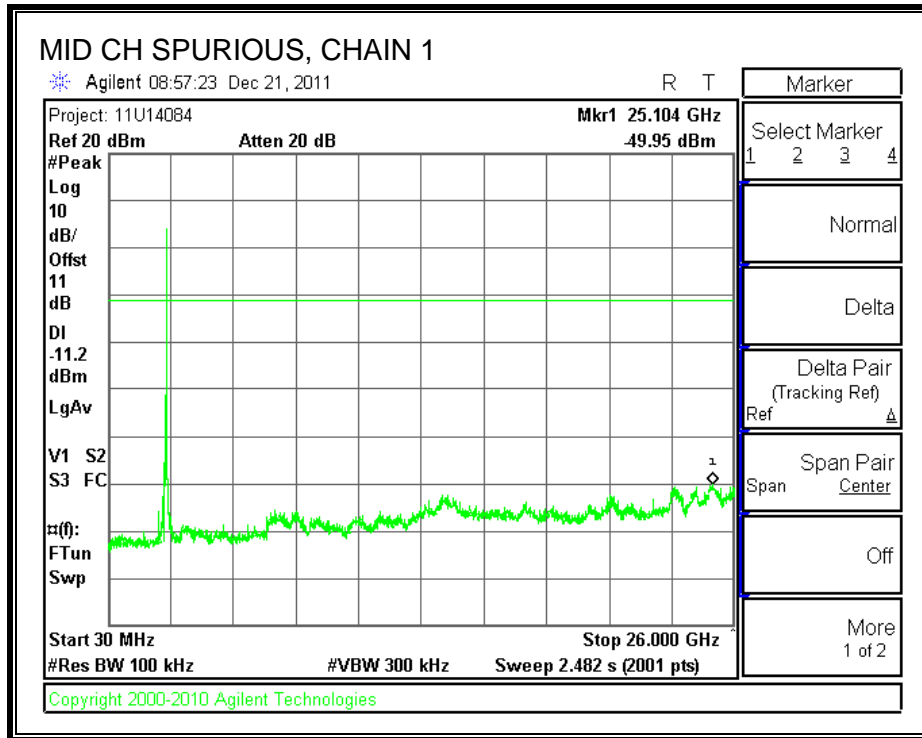
## RESULTS

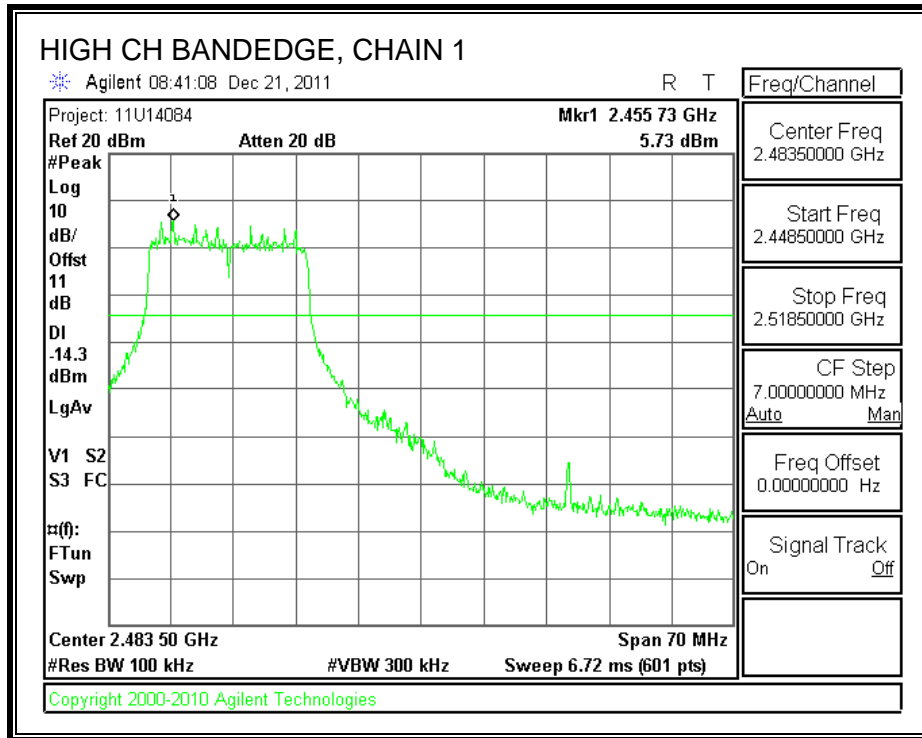
### CHAIN 1 SPURIOUS EMISSIONS

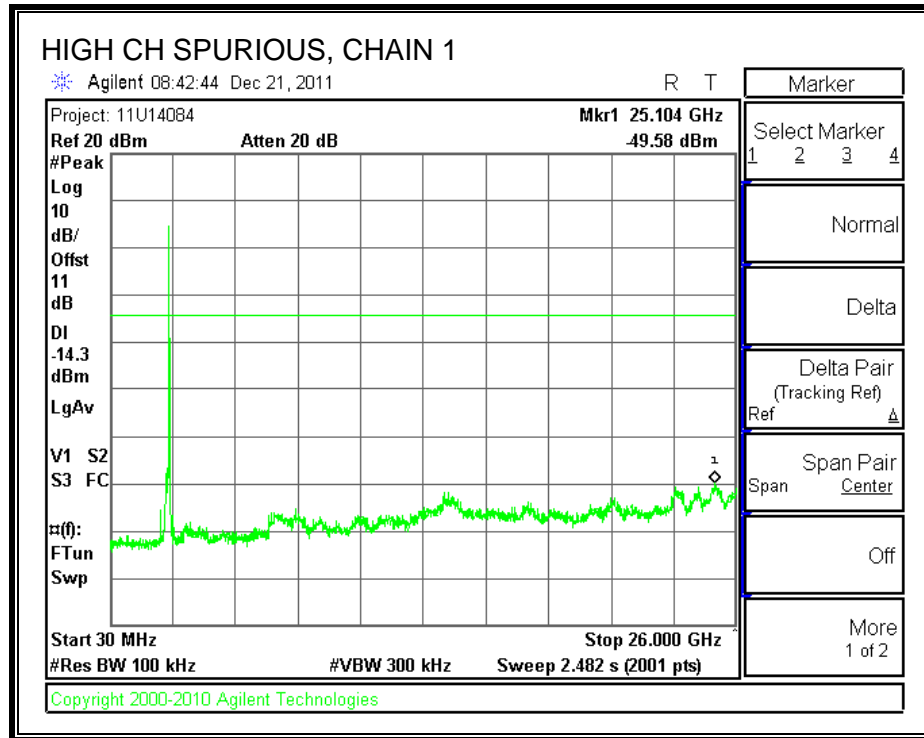




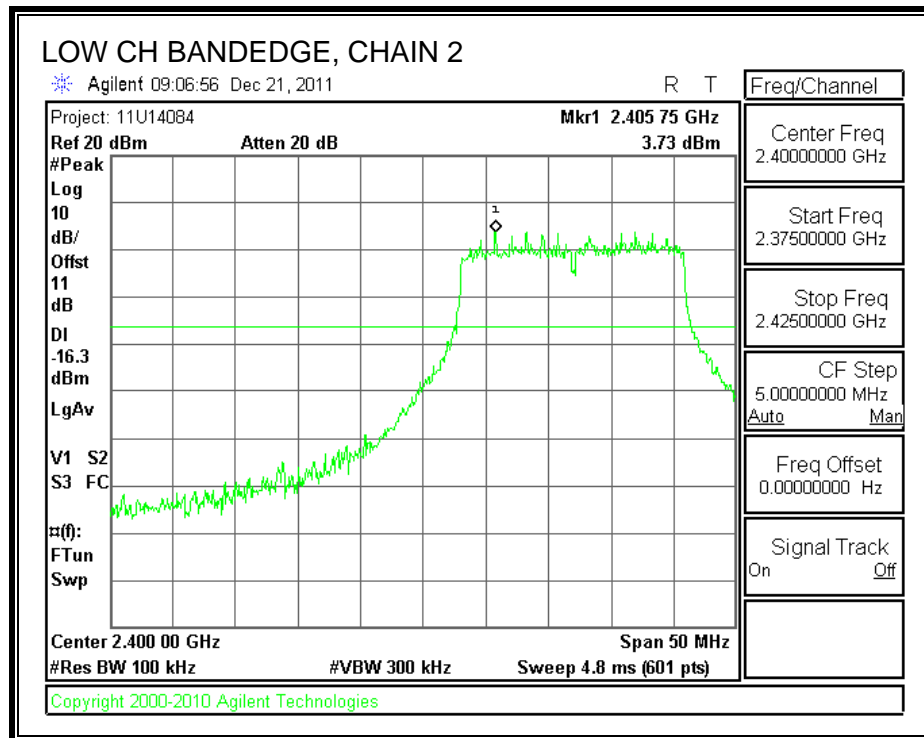




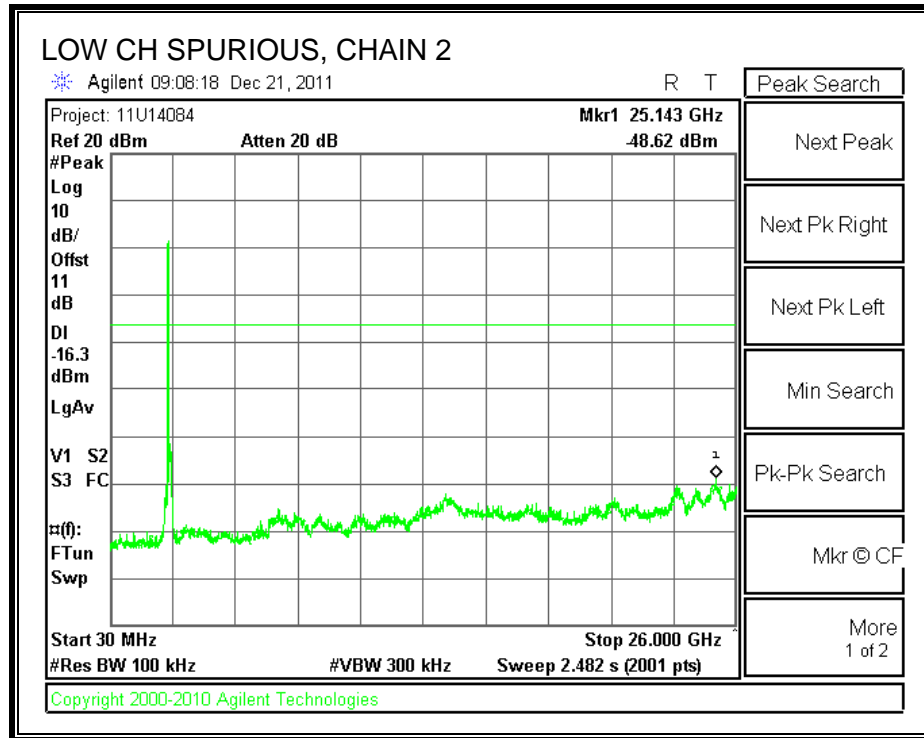


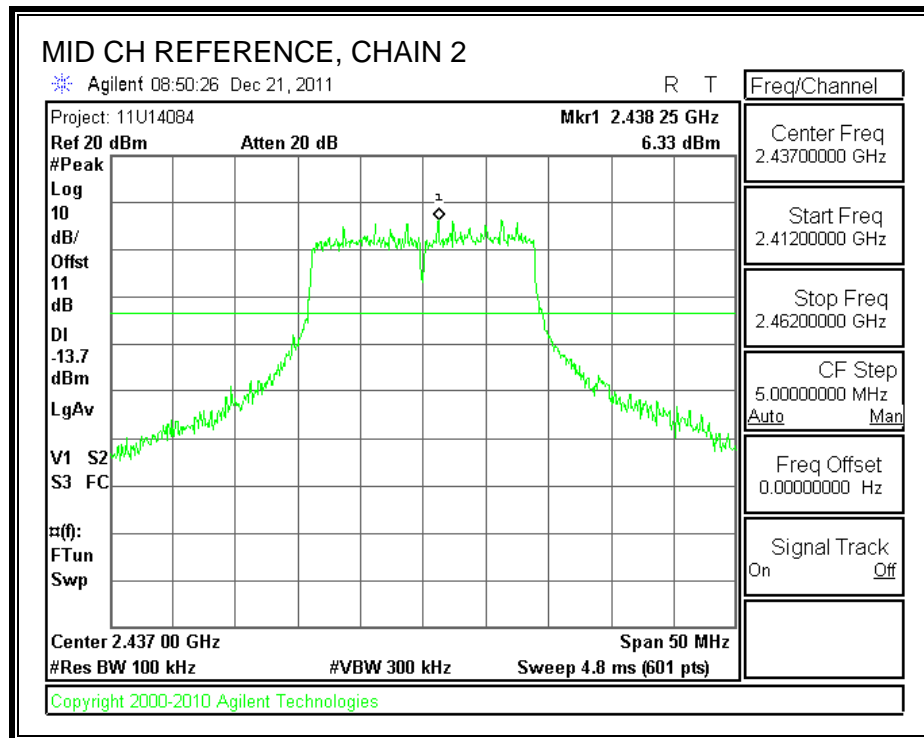


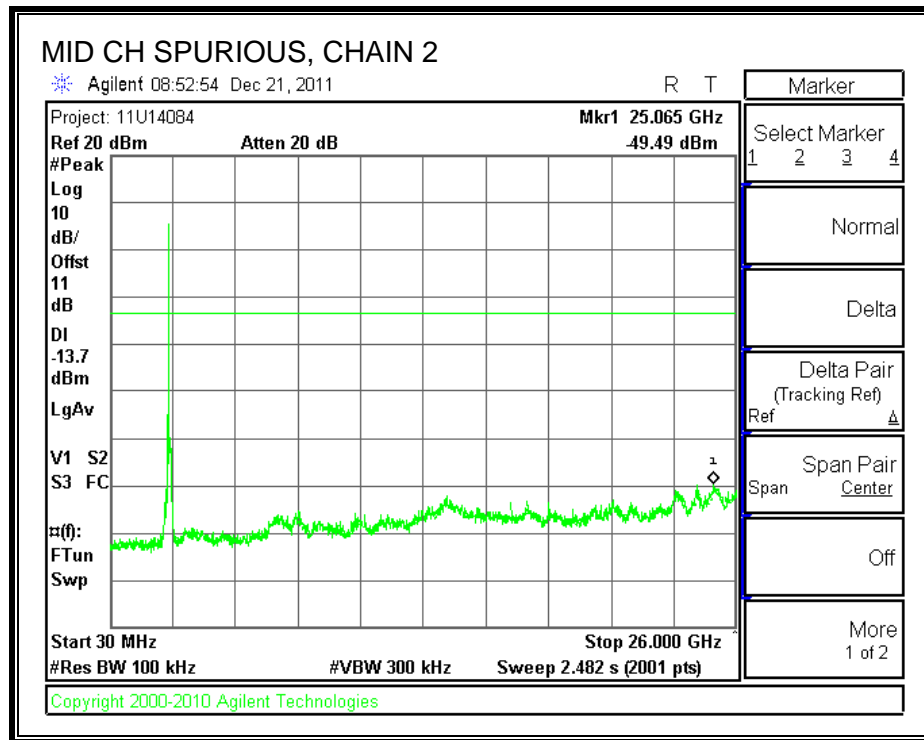
## CHAIN 2 SPURIOUS EMISSIONS

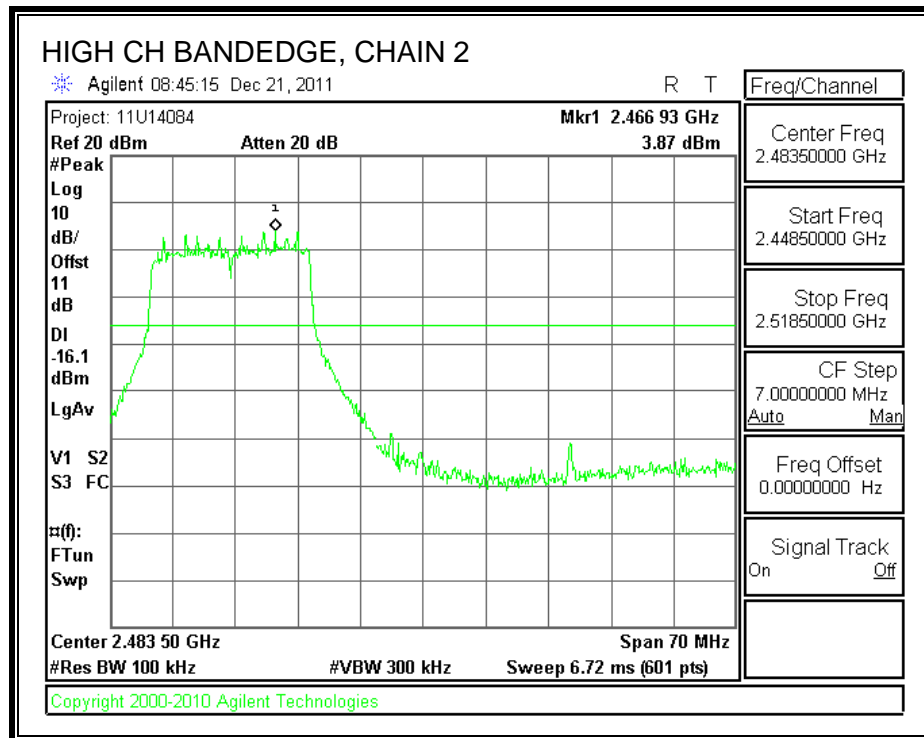


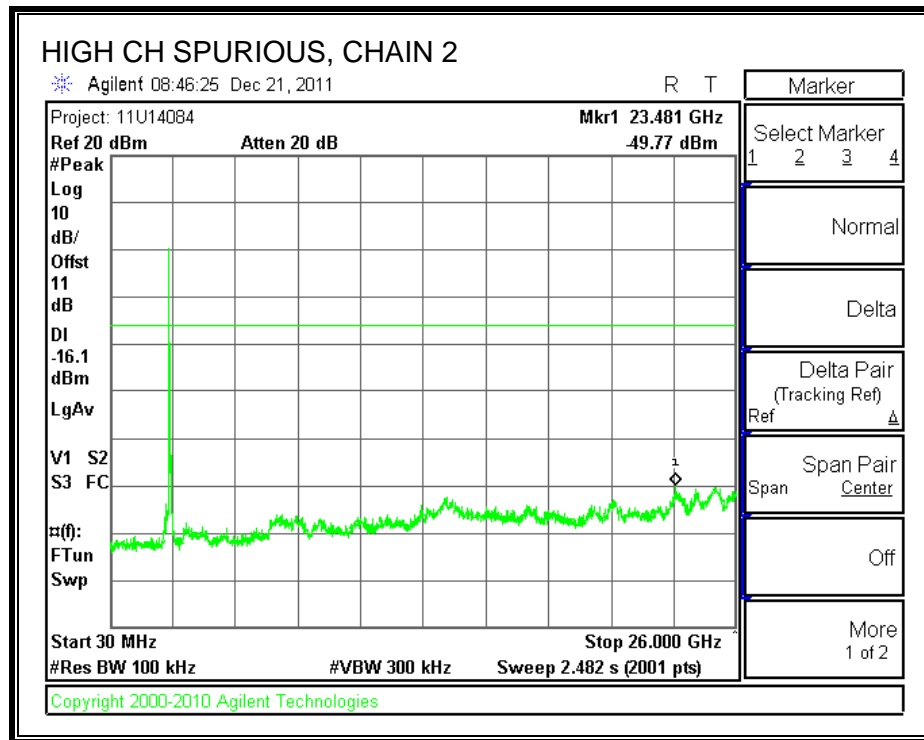












### **7.3. 802.11n HT20 MODE IN THE 5.8 GHz BAND**

#### **7.3.1. 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.

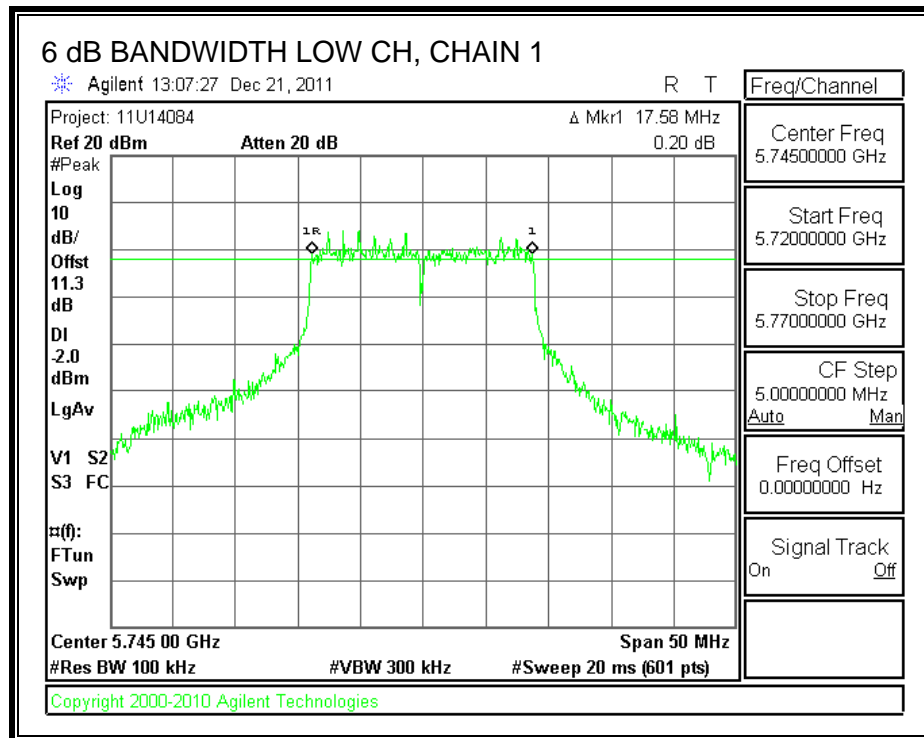
##### **TEST PROCEDURE**

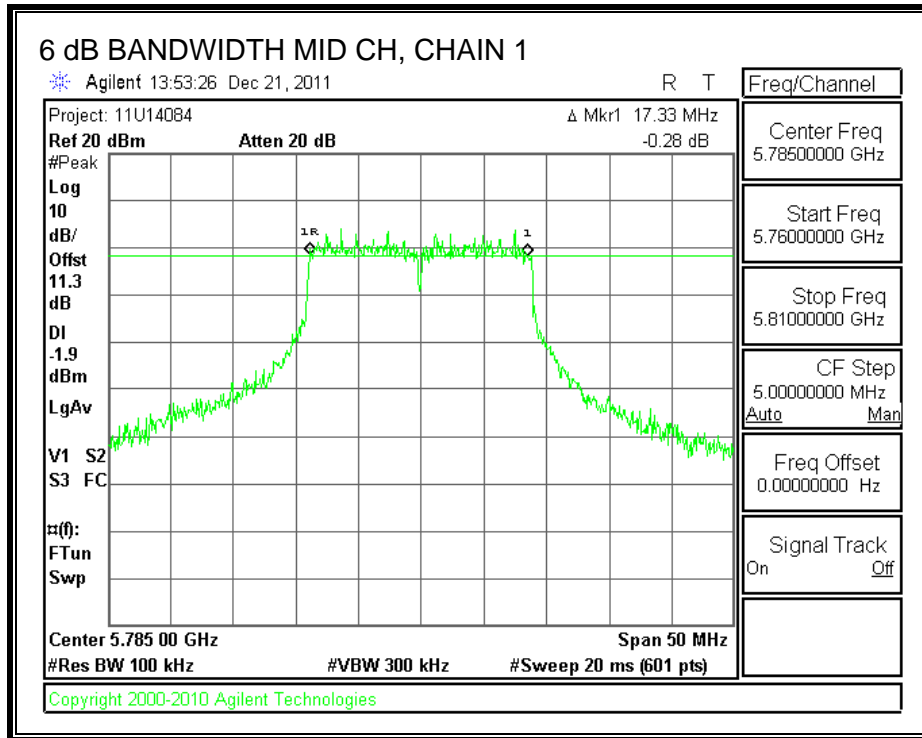
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

##### **RESULTS**

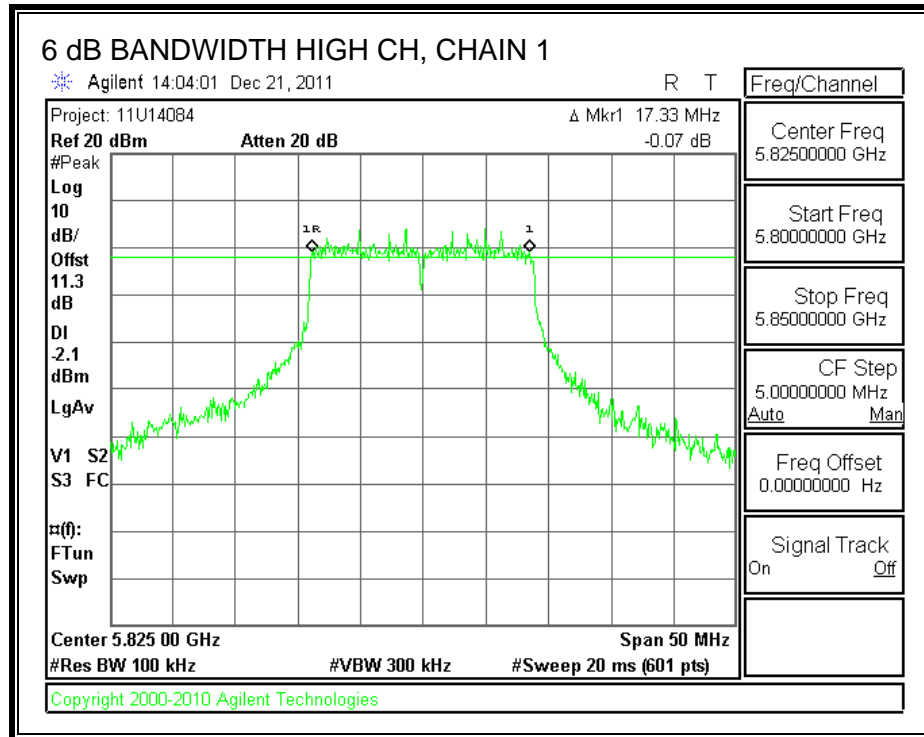
Channel	Frequency (MHz)	Chain 1 6 dB BW (MHz)	Chain 2 6 dB BW (MHz)	Minimum Limit (MHz)
Low	5745	17.58	17.67	0.5
Middle	5785	17.33	17.67	0.5
High	5825	17.33	17.33	0.5

**6 dB BANDWIDTH, CHAIN 1**

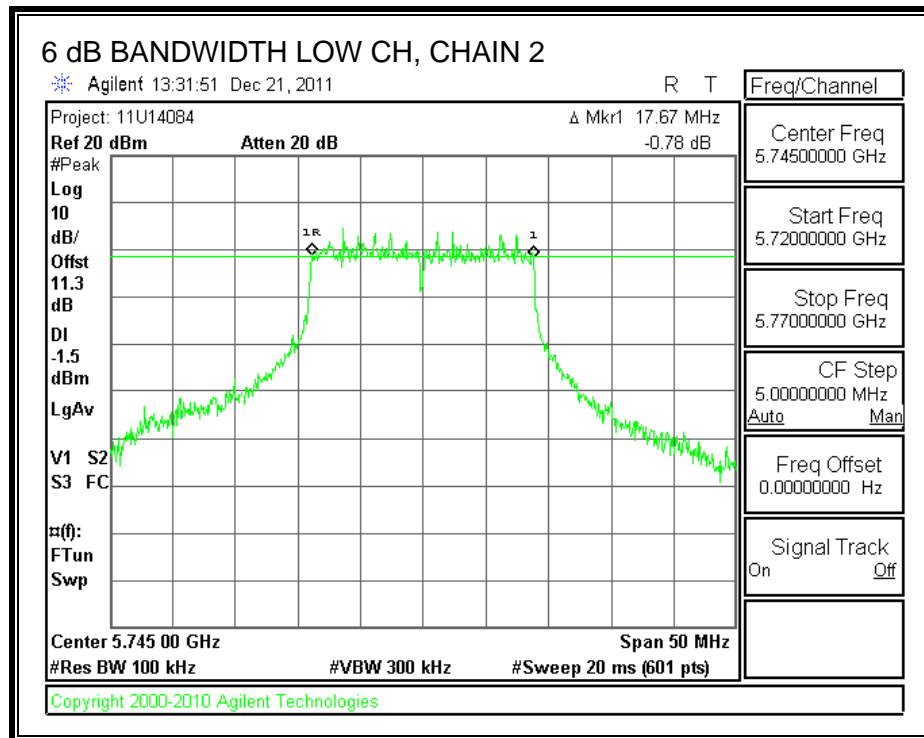


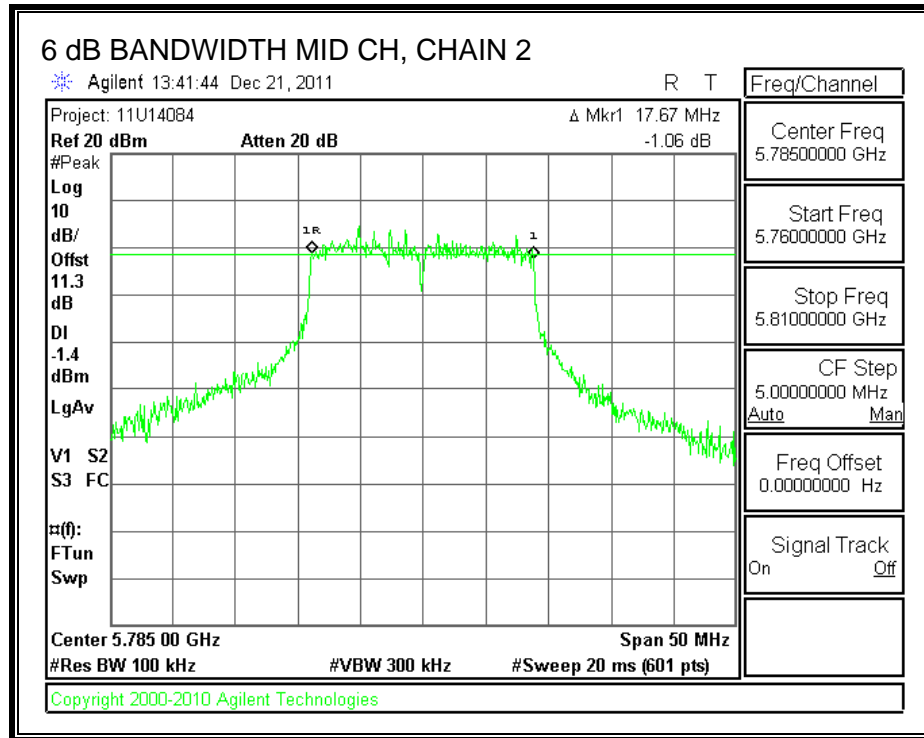


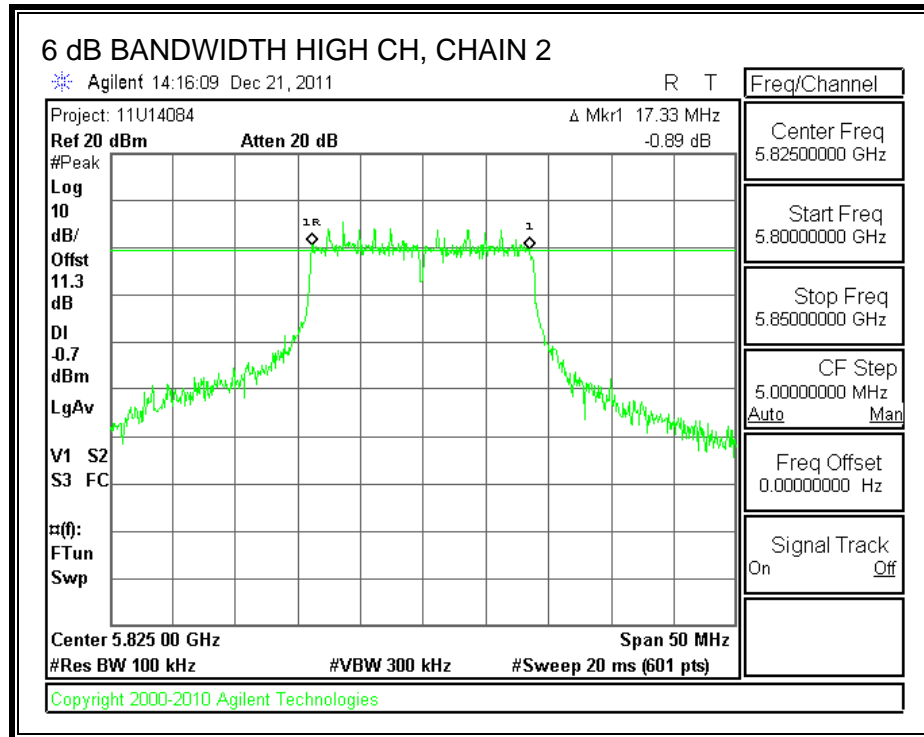




**6 dB BANDWIDTH, CHAIN 2**







### 7.3.2. 99% BANDWIDTH

#### LIMITS

None; for reporting purposes only.

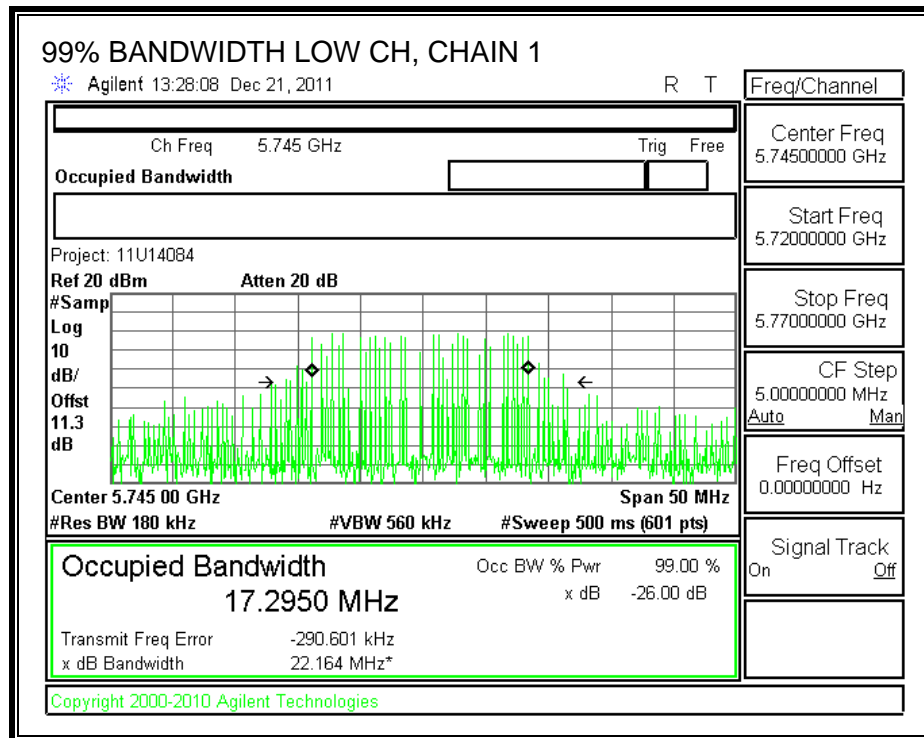
#### TEST PROCEDURE

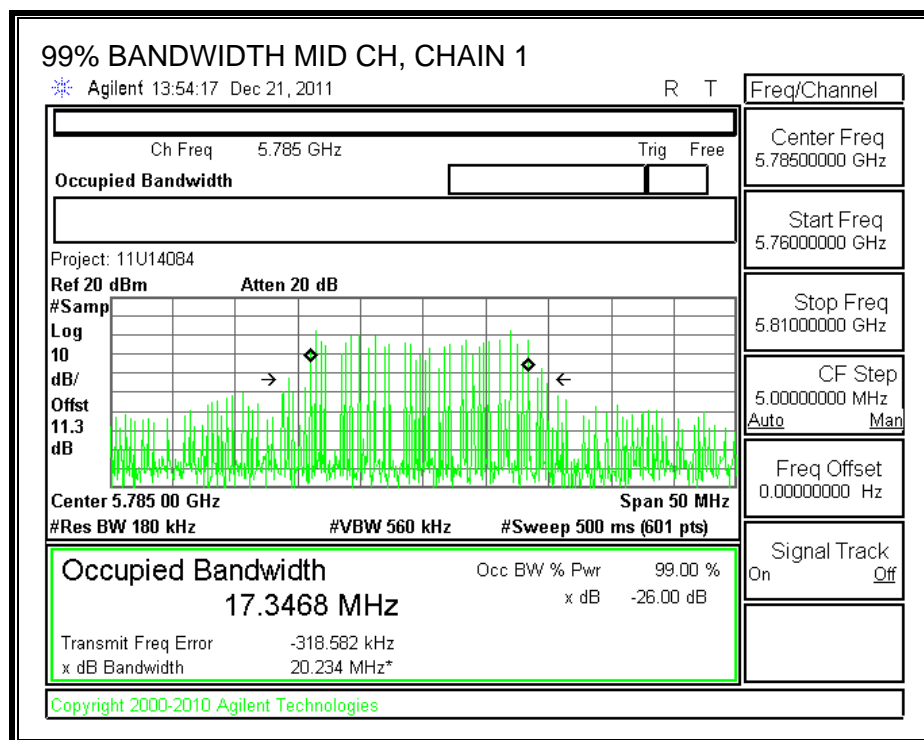
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

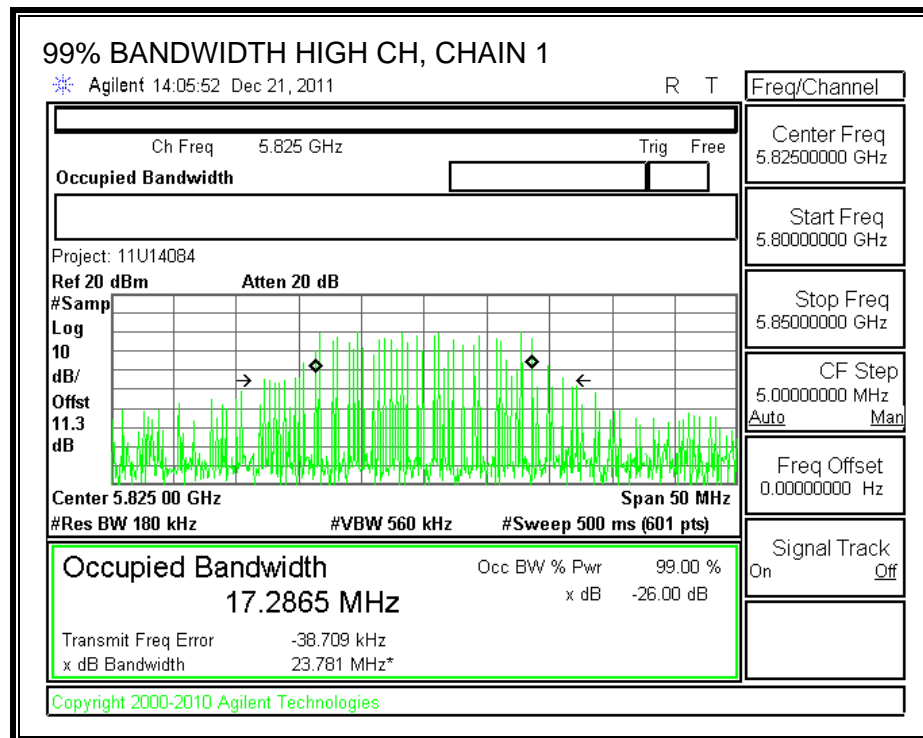
#### RESULTS

Channel	Frequency (MHz)	Chain 1 99% Bandwidth (MHz)	Chain 2 99% Bandwidth (MHz)
Low	5745	17.295	17.3751
Middle	5785	17.3468	17.271
High	5825	17.2865	17.2712

**99% BANDWIDTH, CHAIN 1**

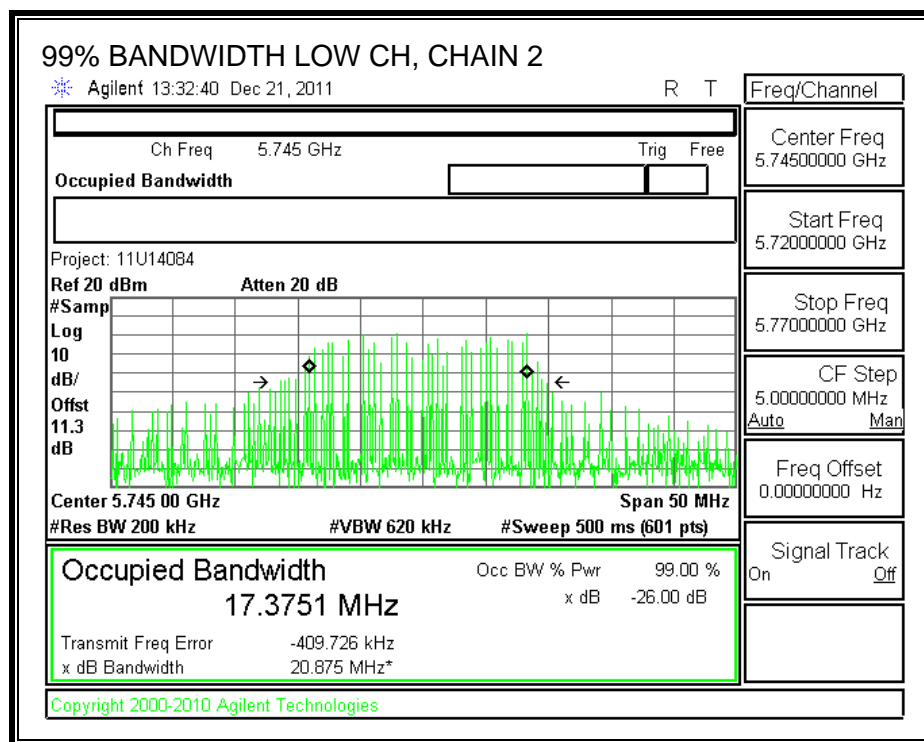


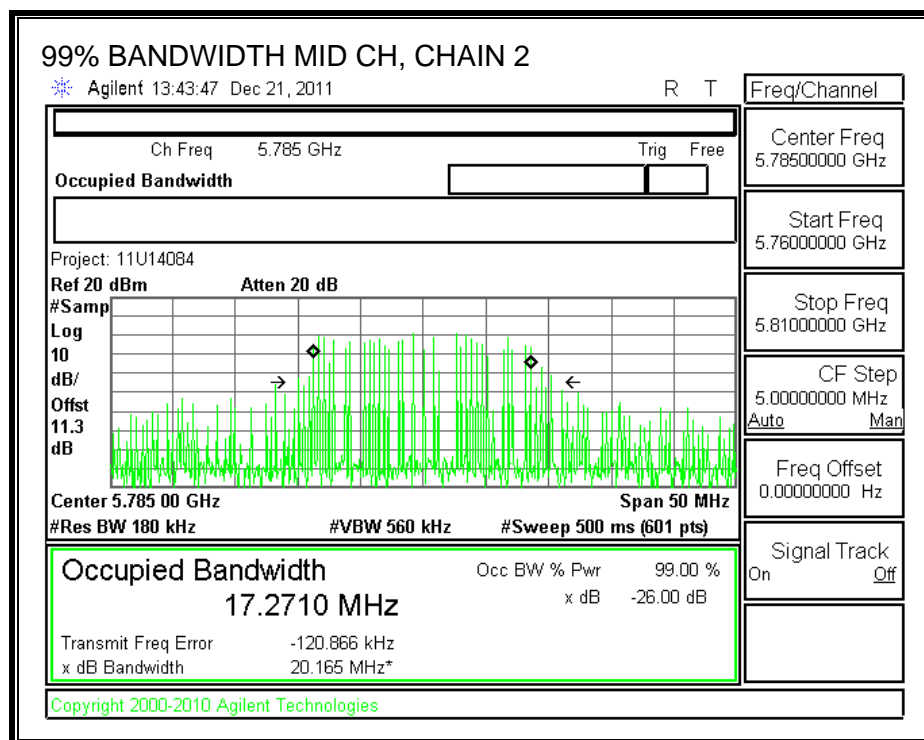


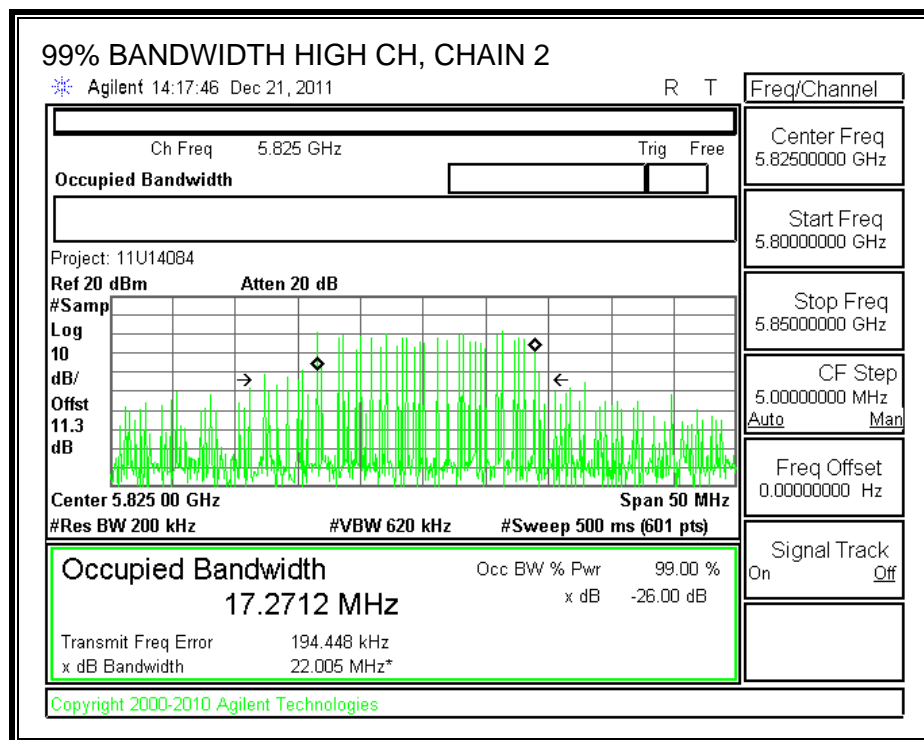




**99% BANDWIDTH, CHAIN 2**







### 7.3.3. 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.

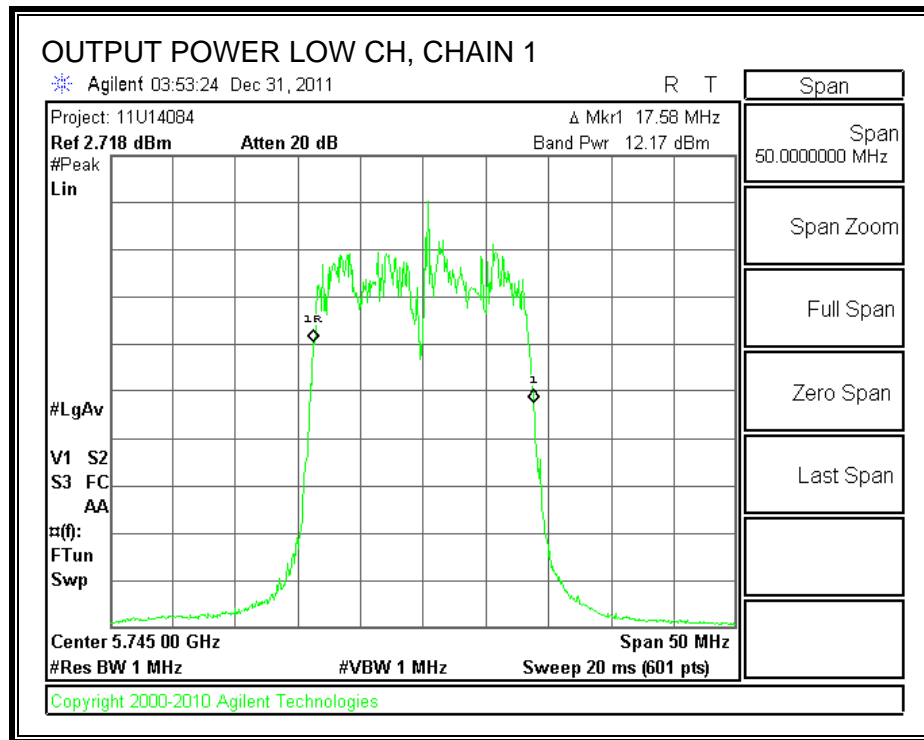
#### TEST PROCEDURE

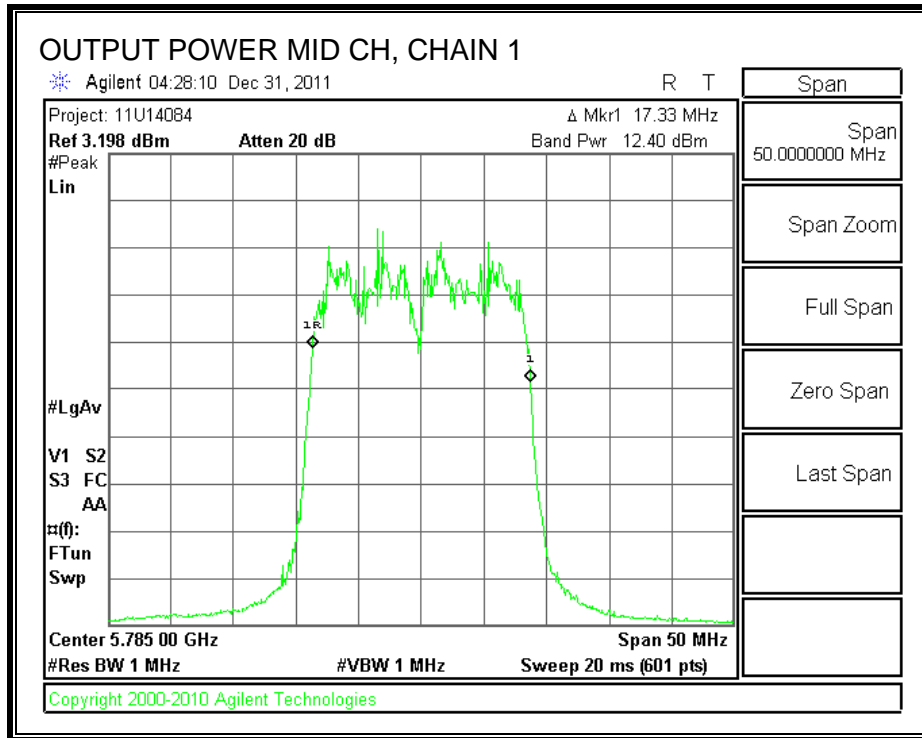
Peak power is measured using the Channel bandwidth Alternative peak output power procedure specified in "TCB Training for Devices covered under Scopes A1 - A4" by Joe Dichoso, May 2003.

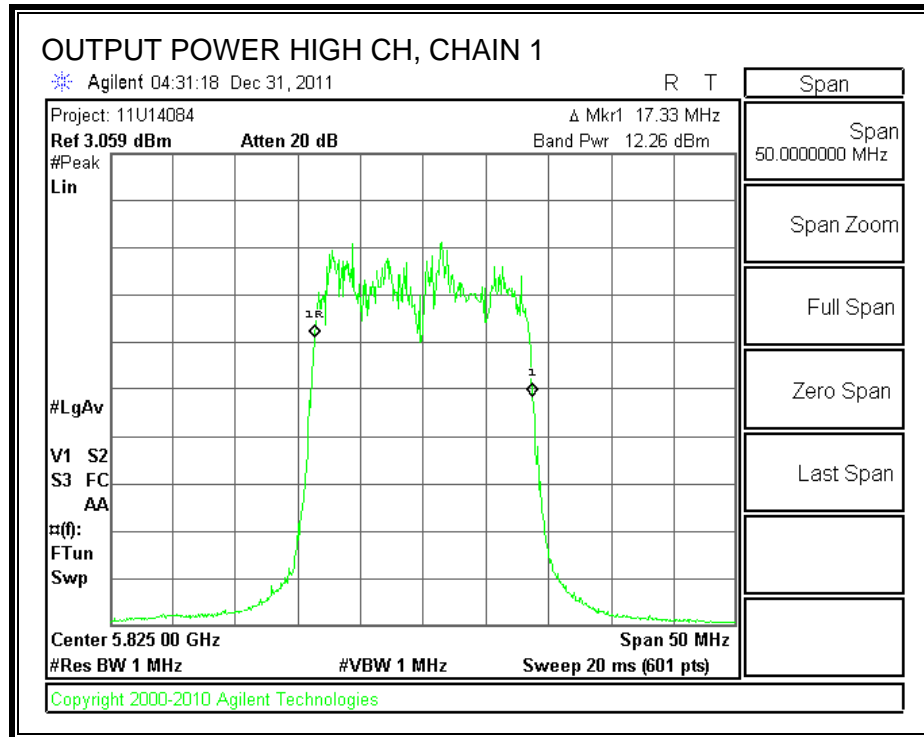
#### RESULTS

Channel	Frequency (MHz)	Chain 1 PK Power (dBm)	Chain 2 PK Power (dBm)	Attenuator + Cable Offset (dB)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5745	12.17	11.60	11.30	26.20	30.00	-3.80
Mid	5785	12.40	12.30	11.30	26.66	30.00	-3.34
High	5825	12.26	12.28	11.30	26.58	30.00	-3.42

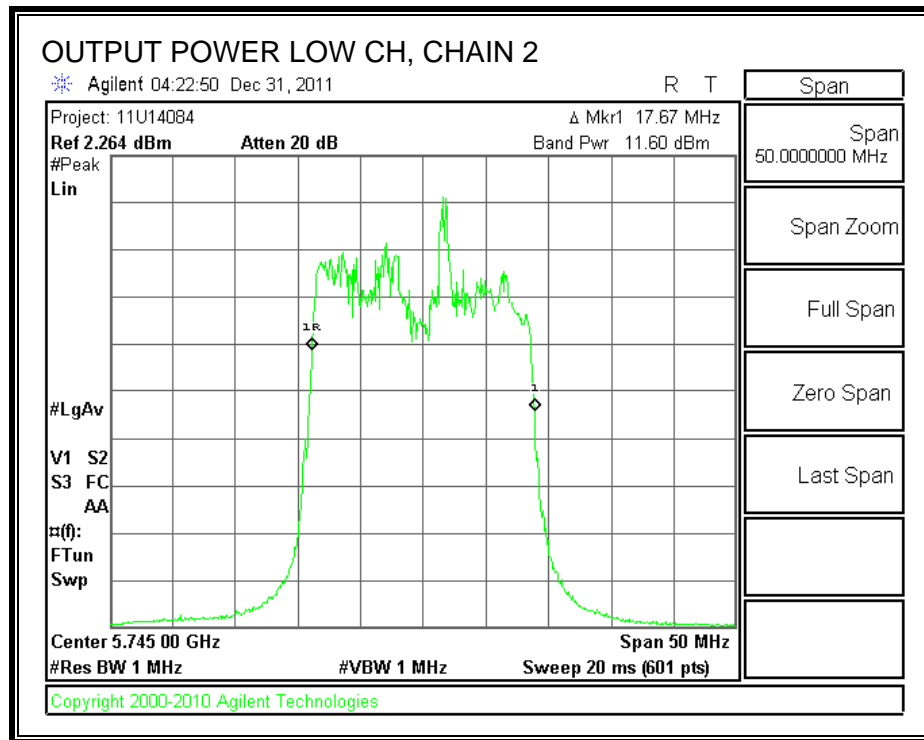
# **CHAIN 1 OUTPUT POWER**



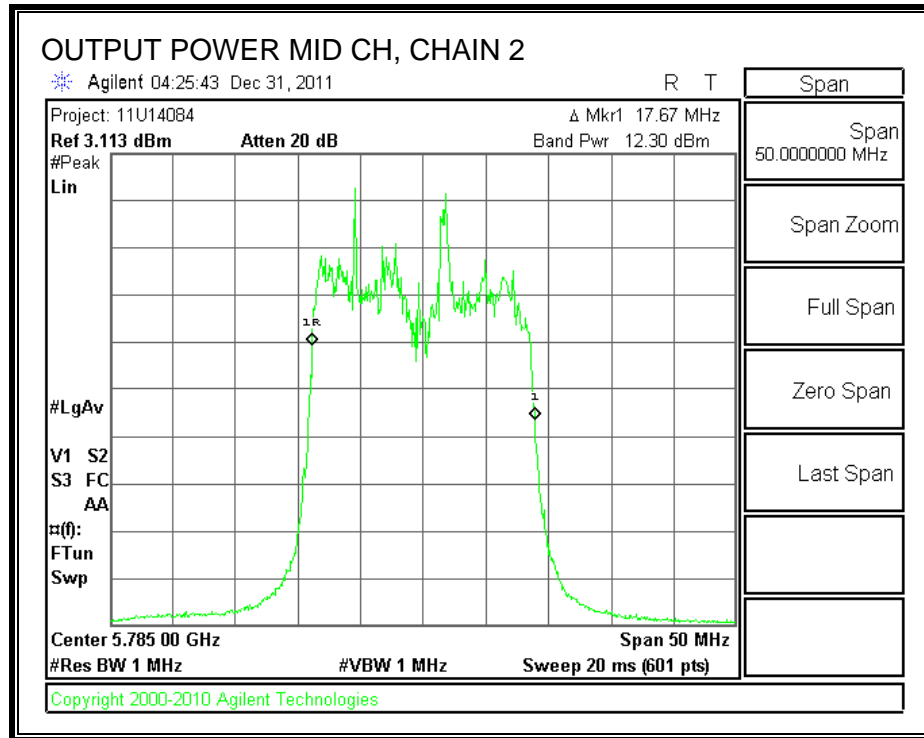


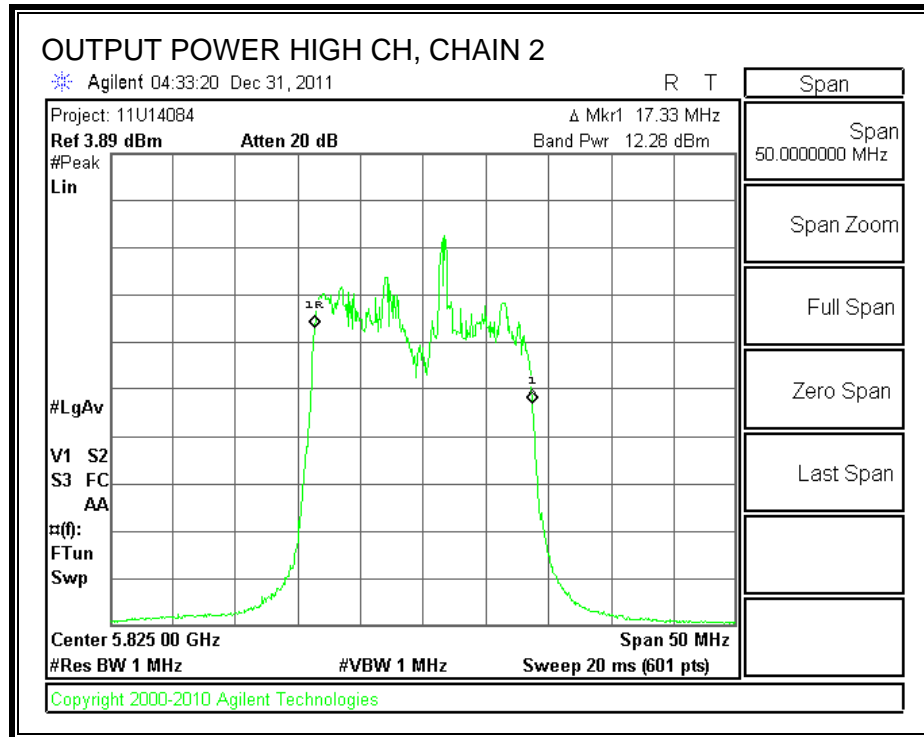


## CHAIN 2 OUTPUT POWER









### 7.3.4. AVERAGE POWER

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

#### RESULTS

The cable assembly insertion loss of 11.3 dB (including 10 dB pad and 1.3 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)
Low	5745	12.81	12.51	15.67
Middle	5785	13.02	12.79	15.92
High	5825	12.90	12.89	15.91

### 7.3.5. 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.

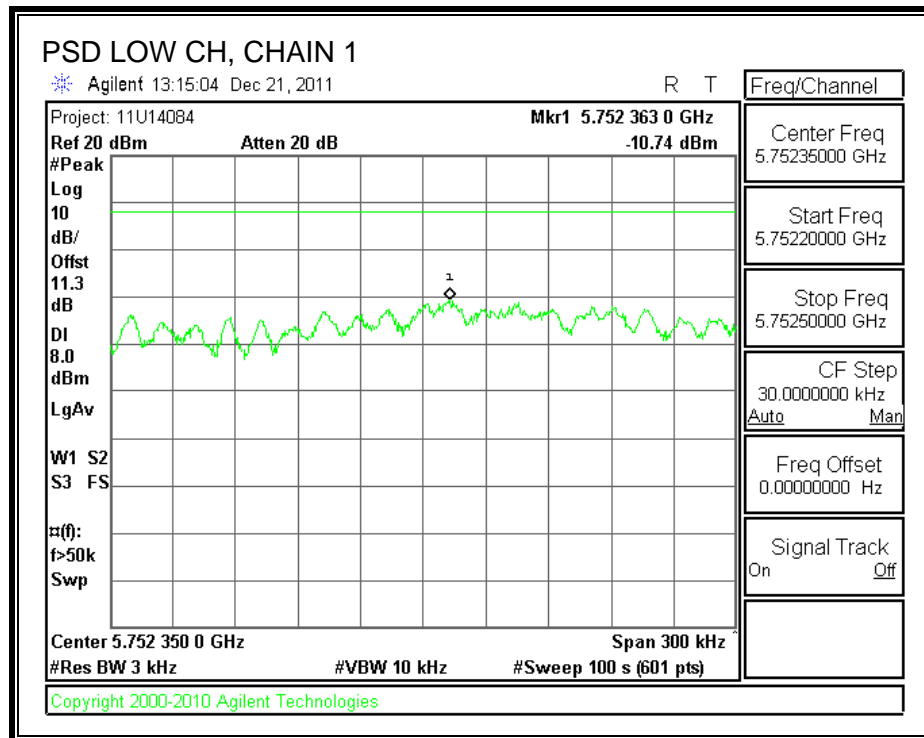
#### TEST PROCEDURE

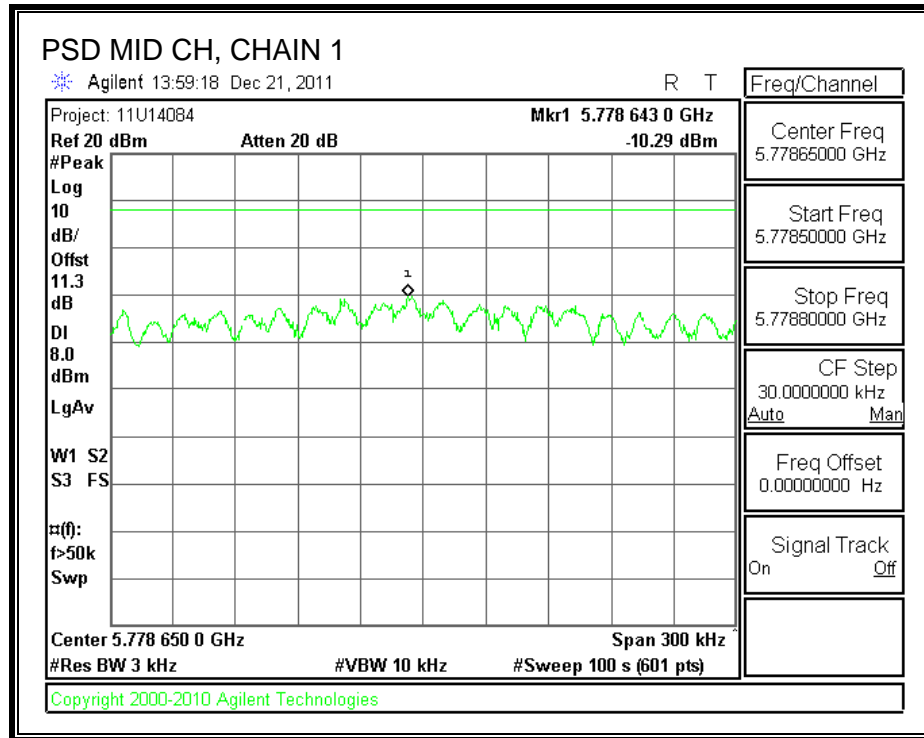
Output power was measured based on the use of a peak measurement, therefore the power spectral density was measured using PSD Option 1 in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

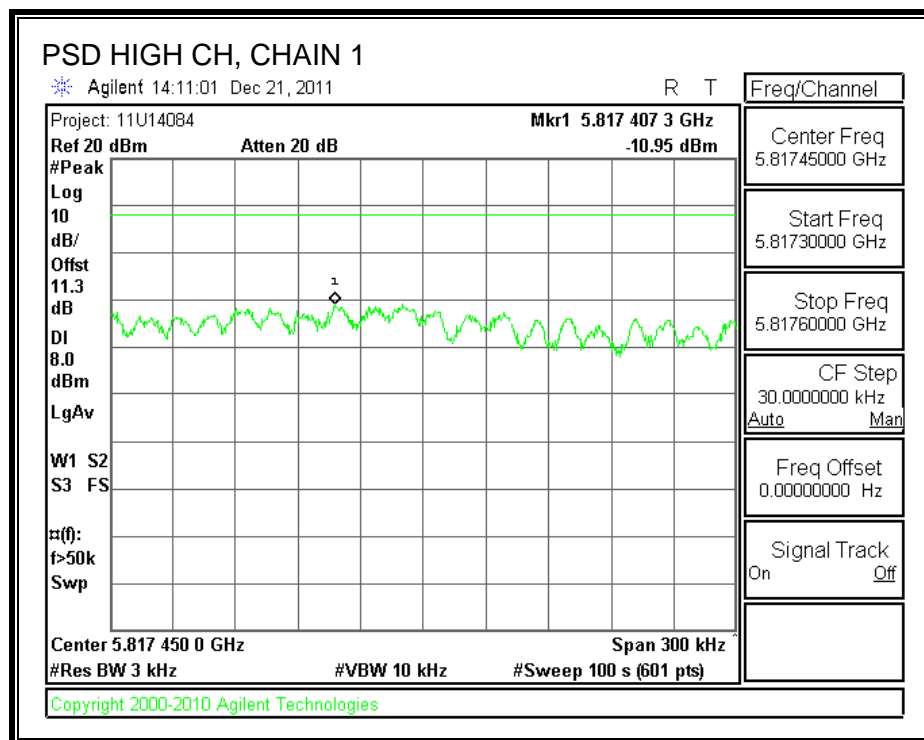
#### RESULTS

Channel	Frequency (MHz)	Chain 1 PSD (dBm)	Chain 2 PSD (dBm)	Total PSD (dBm)	Limit (dBm)	Margin (dB)
Low	5745	-10.74	-10.18	-7.44	8	-15.44
Middle	5785	-10.29	-10.66	-7.46	8	-15.46
High	5825	-10.95	-10.86	-7.89	8	-15.89

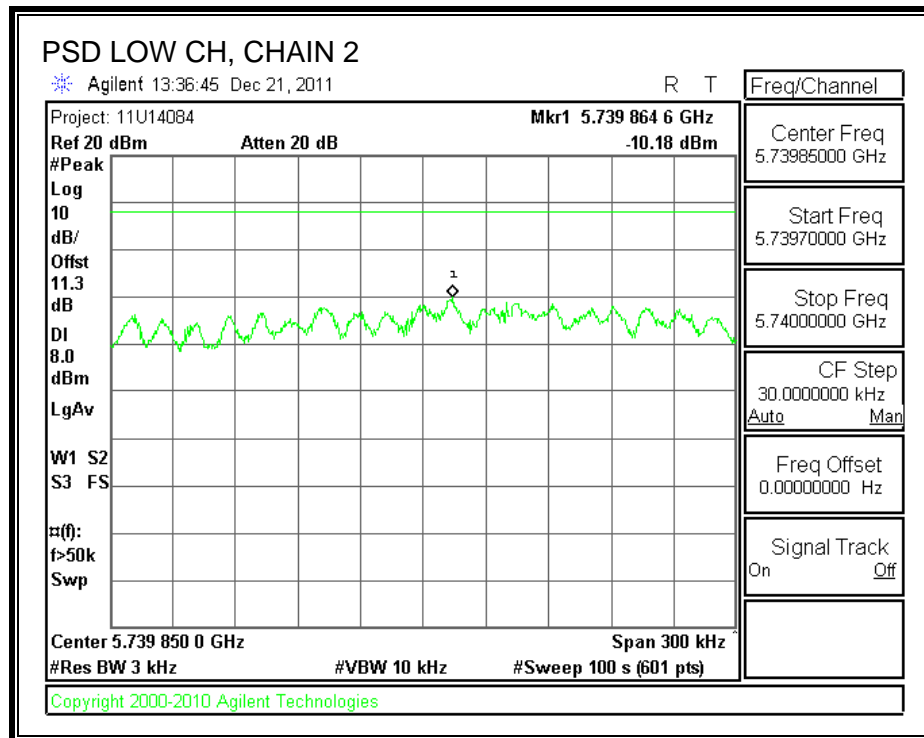
**POWER SPECTRAL DENSITY, CHAIN 1**



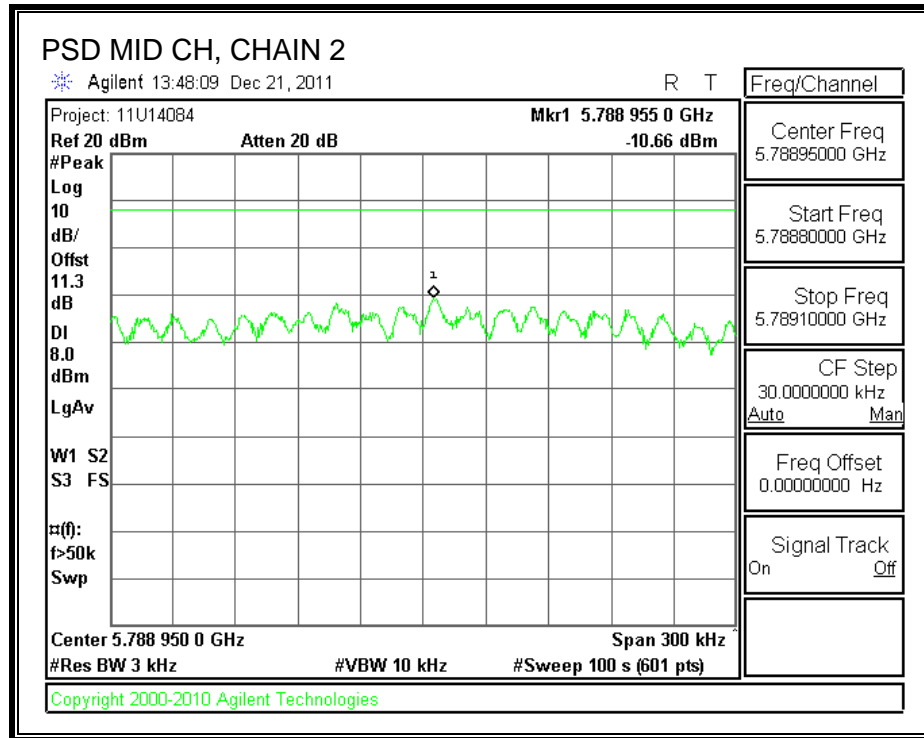


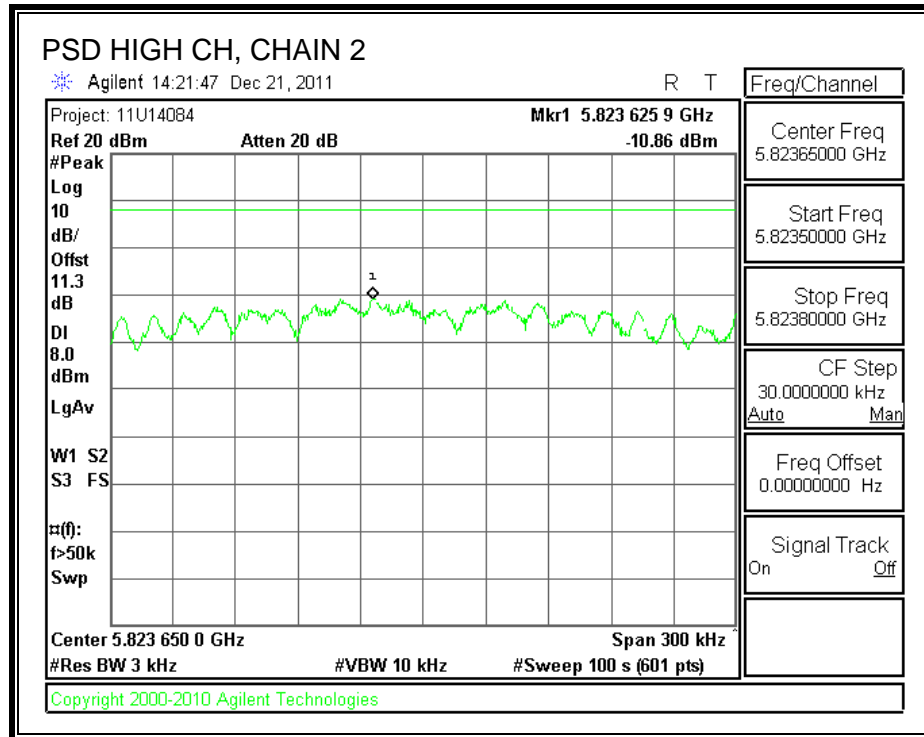


**POWER SPECTRAL DENSITY, CHAIN 2**









### **7.3.6. 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.

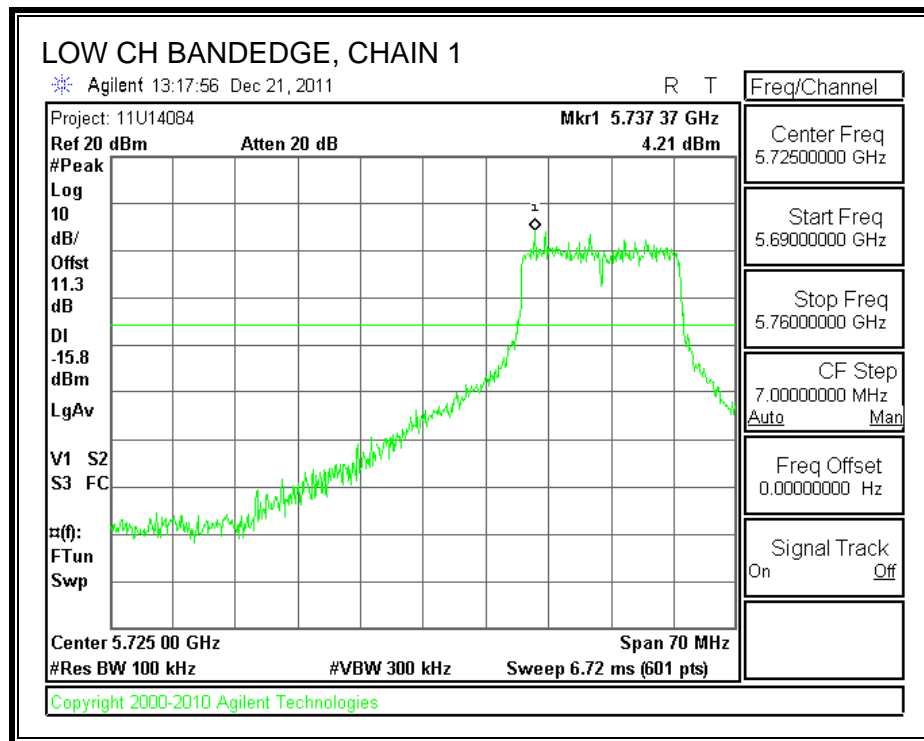
#### **TEST PROCEDURE**

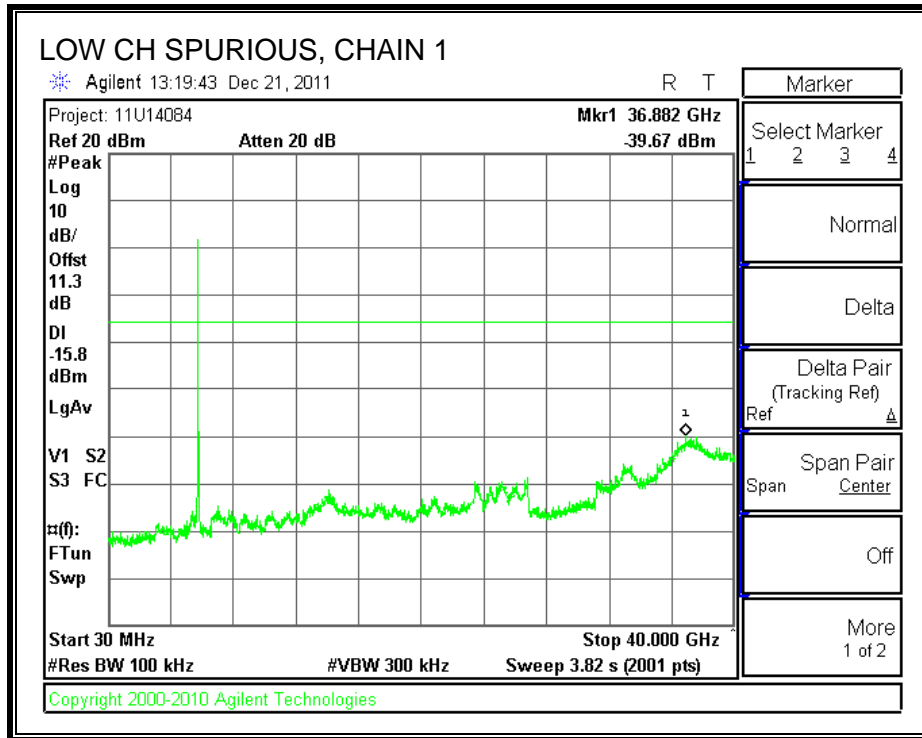
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

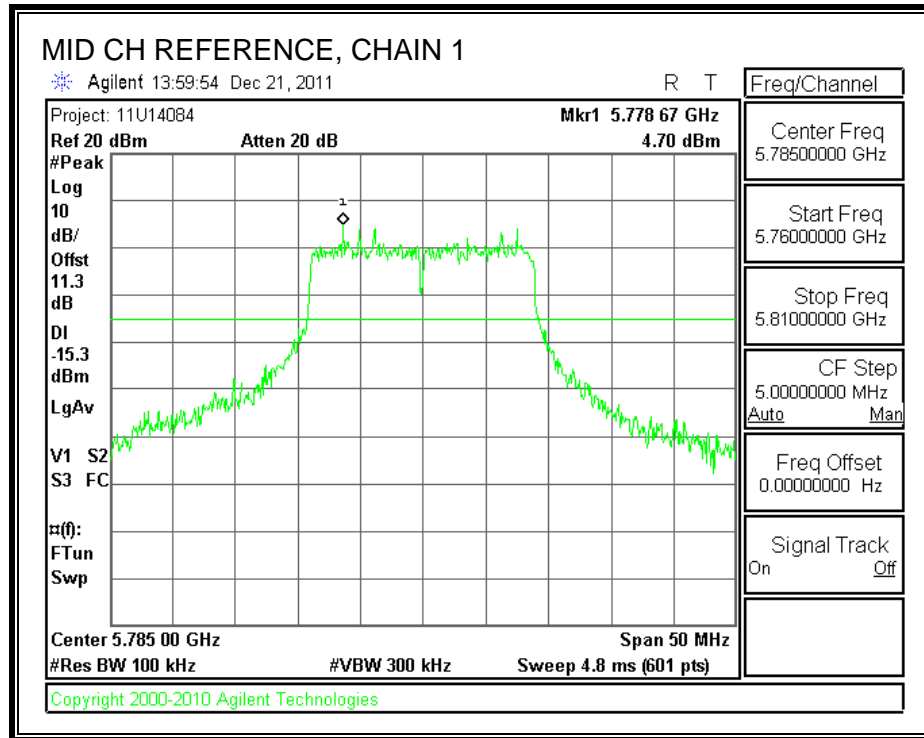
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

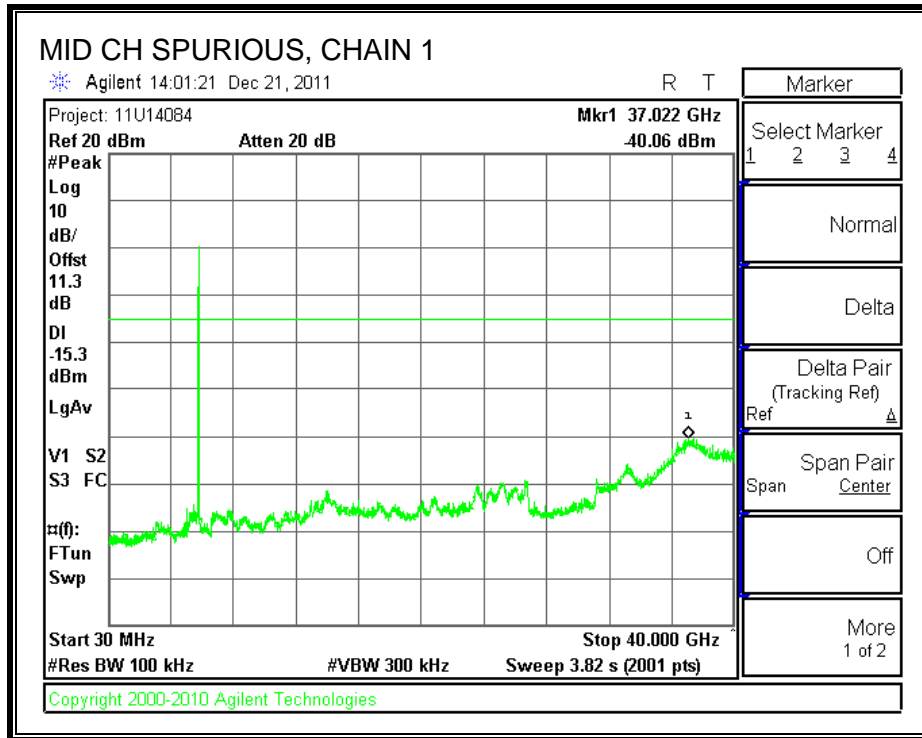
## RESULTS

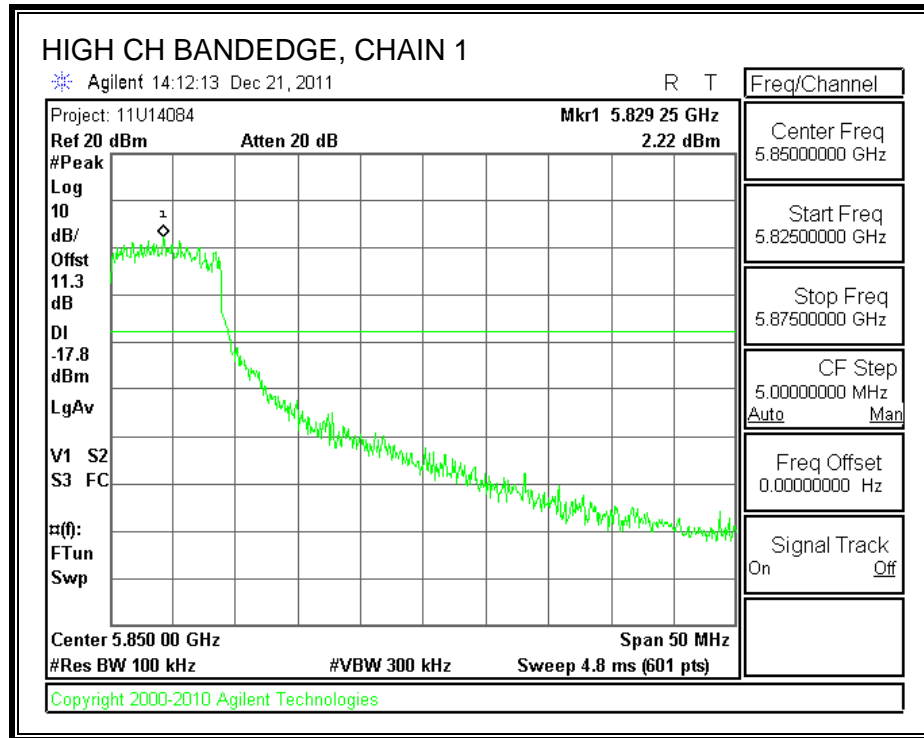
### CHAIN 1 SPURIOUS EMISSIONS



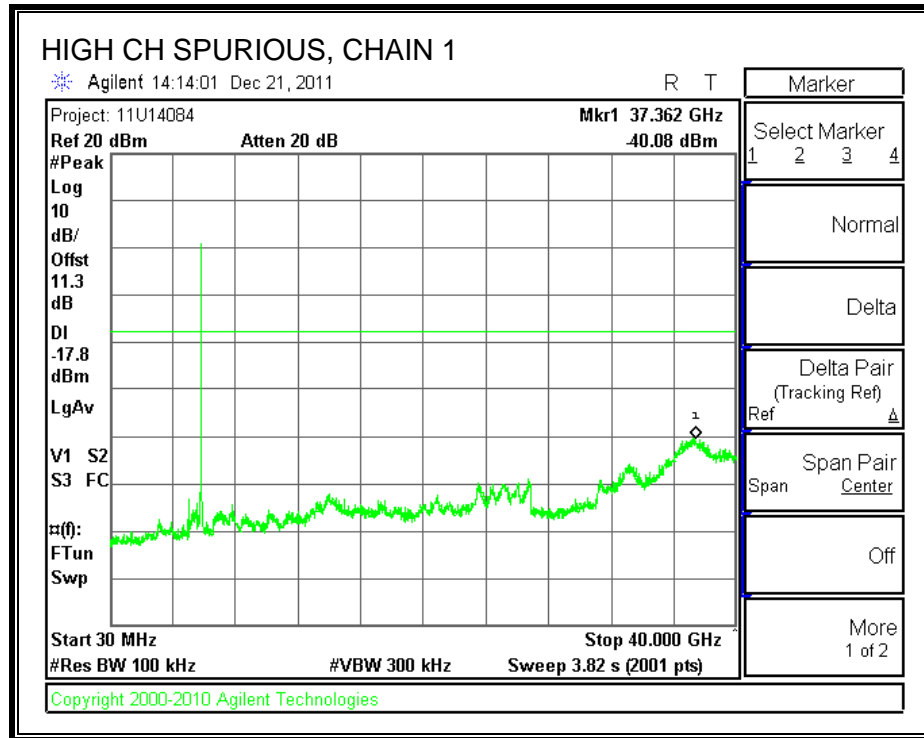




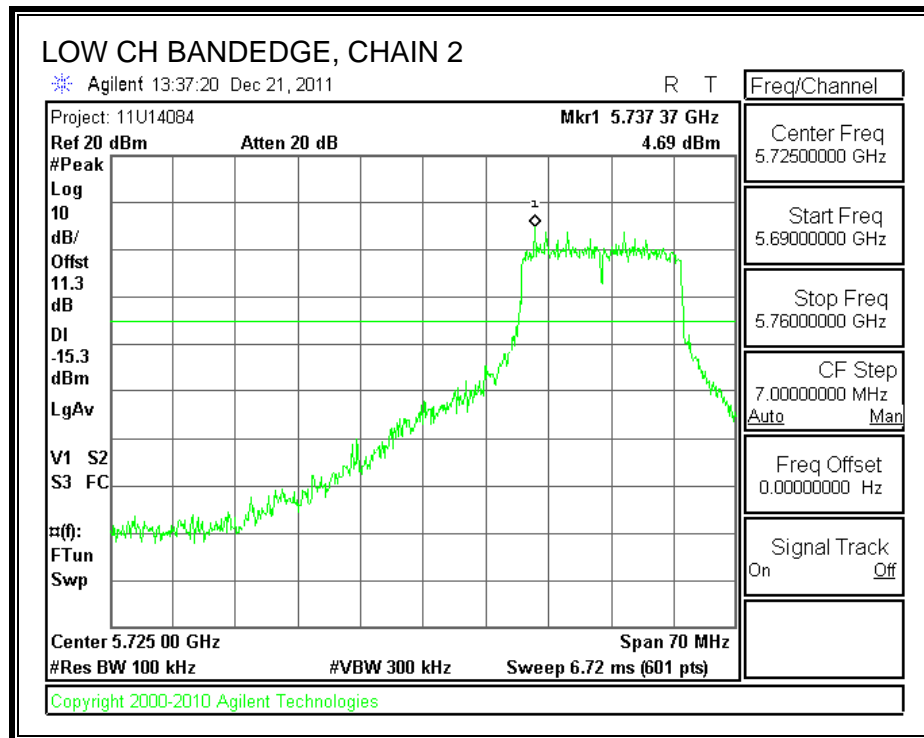


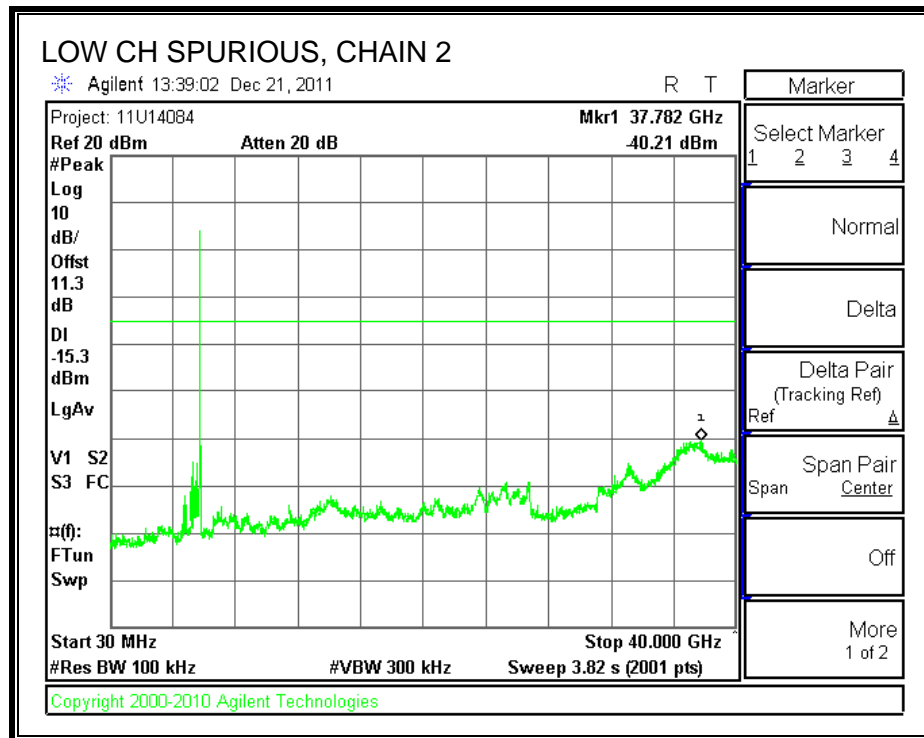


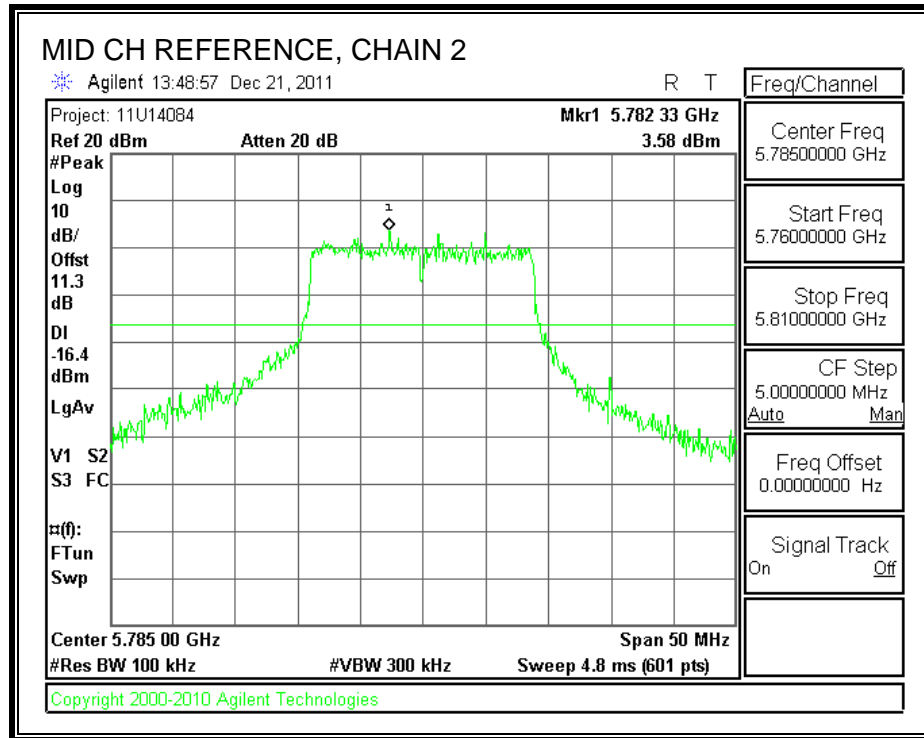


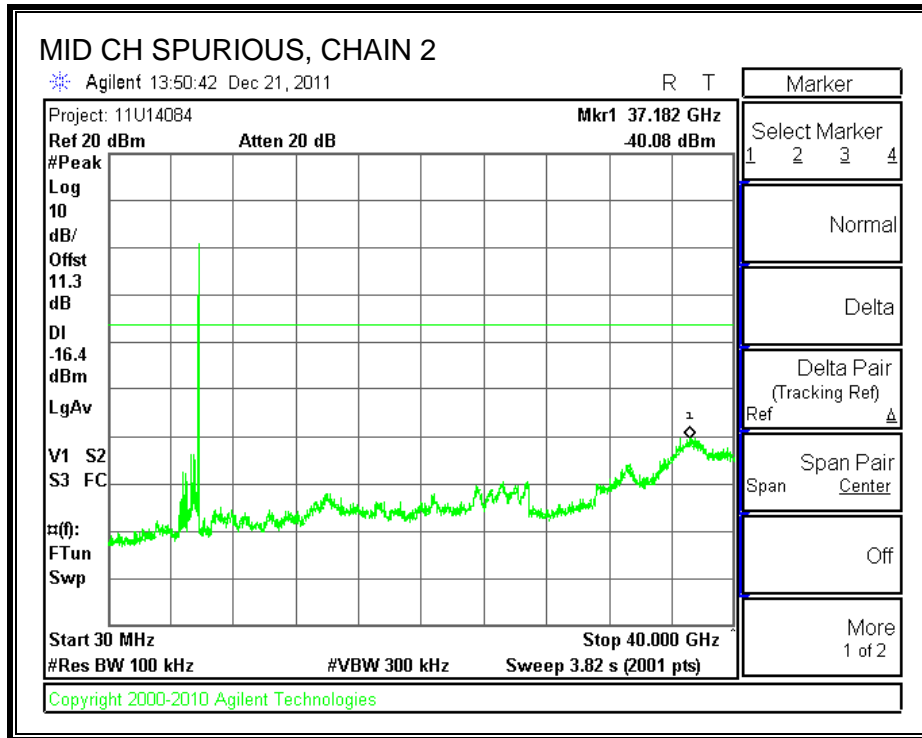


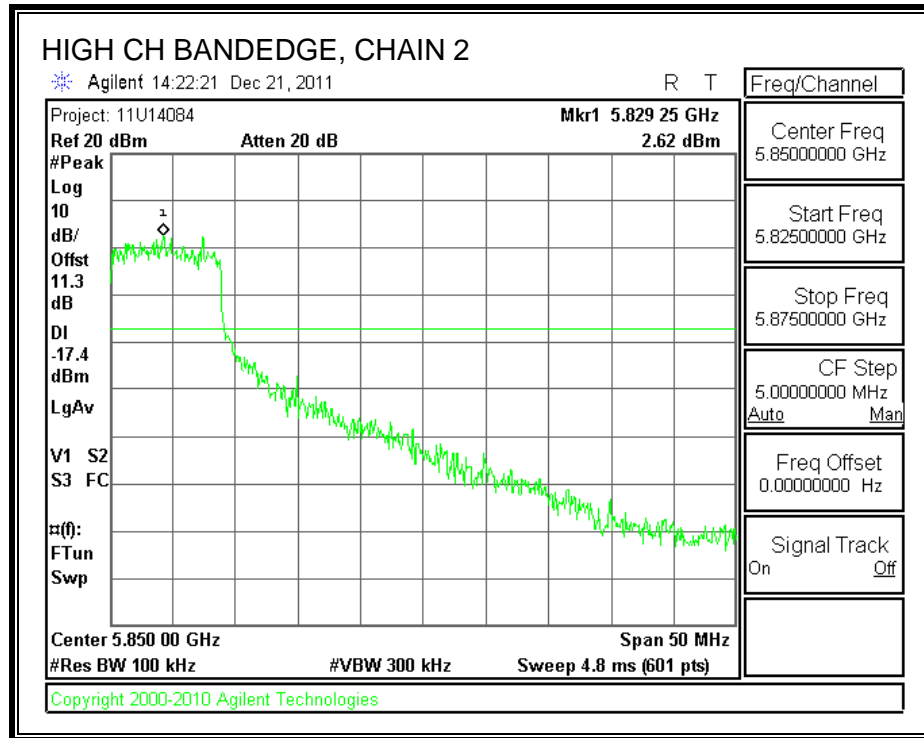
## CHAIN 2 SPURIOUS EMISSIONS

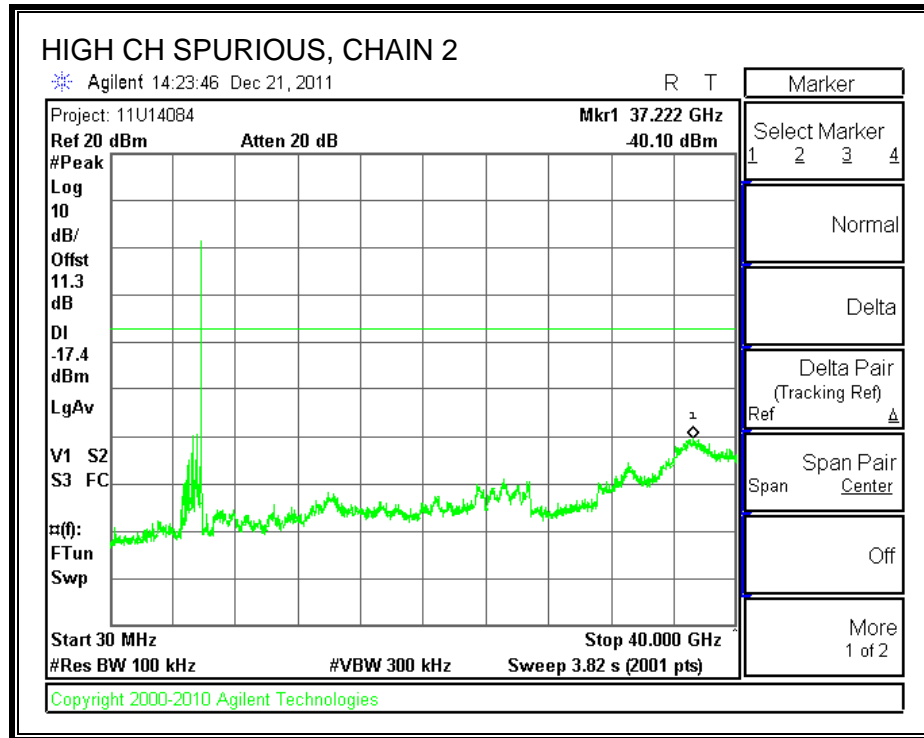












## 8. RADIATED TEST RESULTS

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

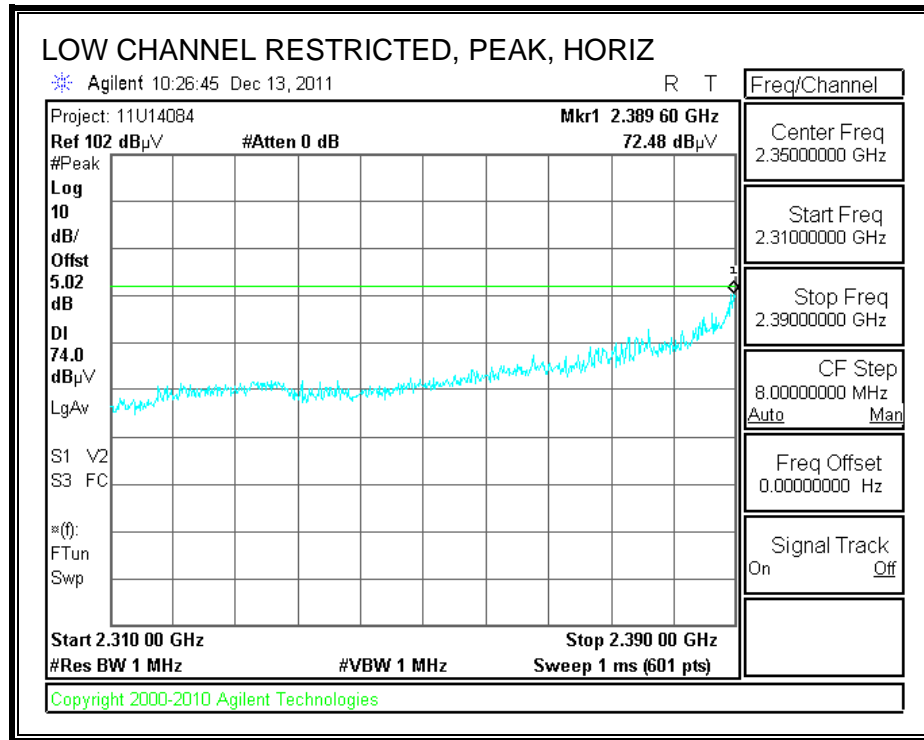
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

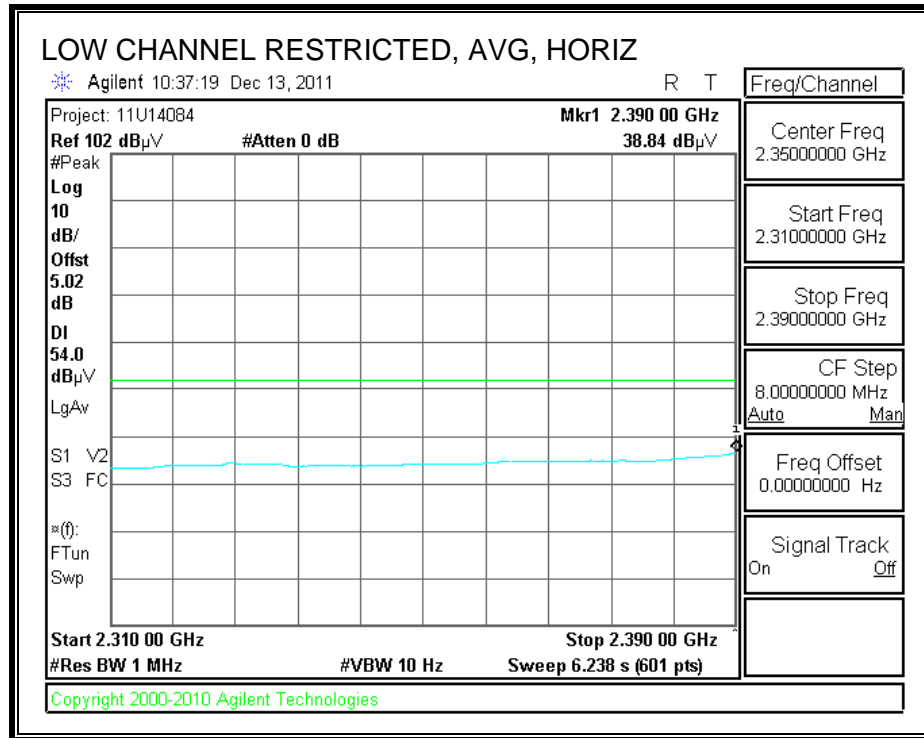


## 8.2. TRANSMITTER ABOVE 1 GHz

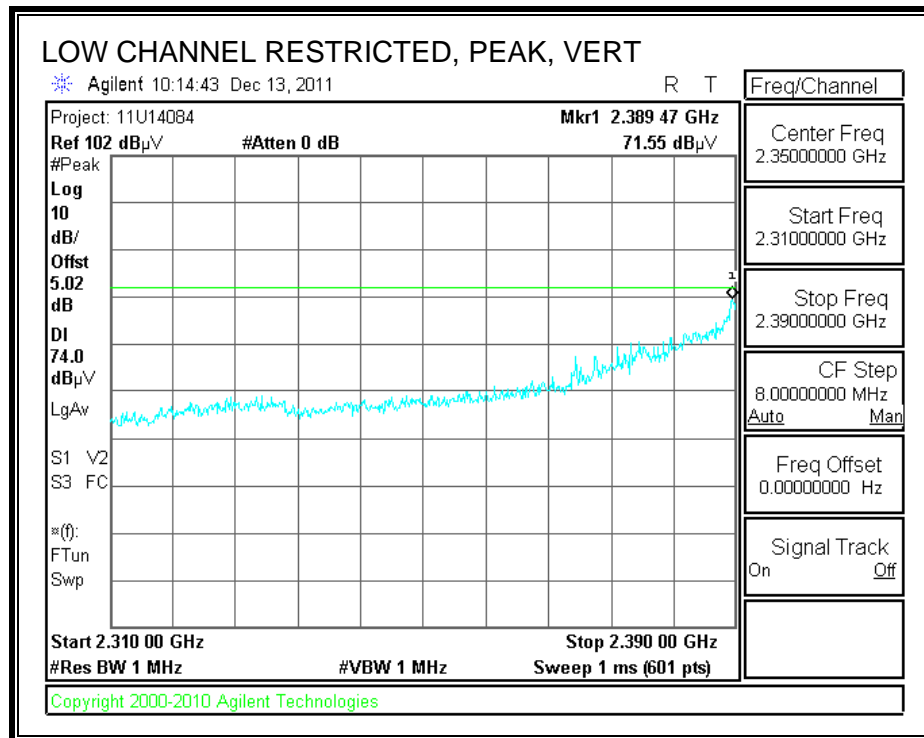
### 8.2.1. TX ABOVE 1 GHz FOR 802.11g 1TX MODE IN THE 2.4 GHz BAND

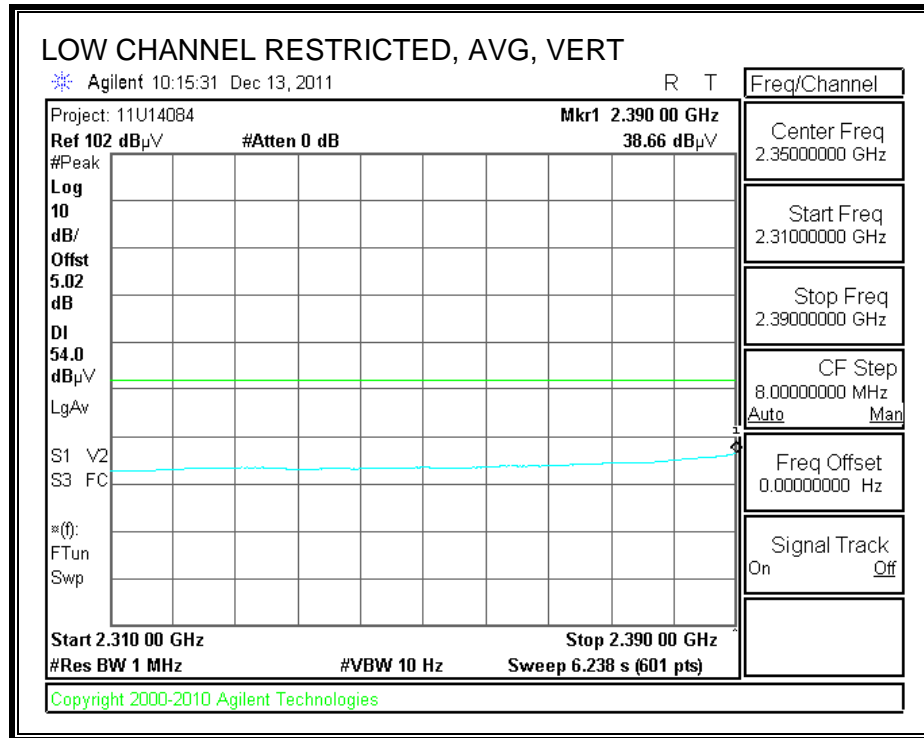
#### RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



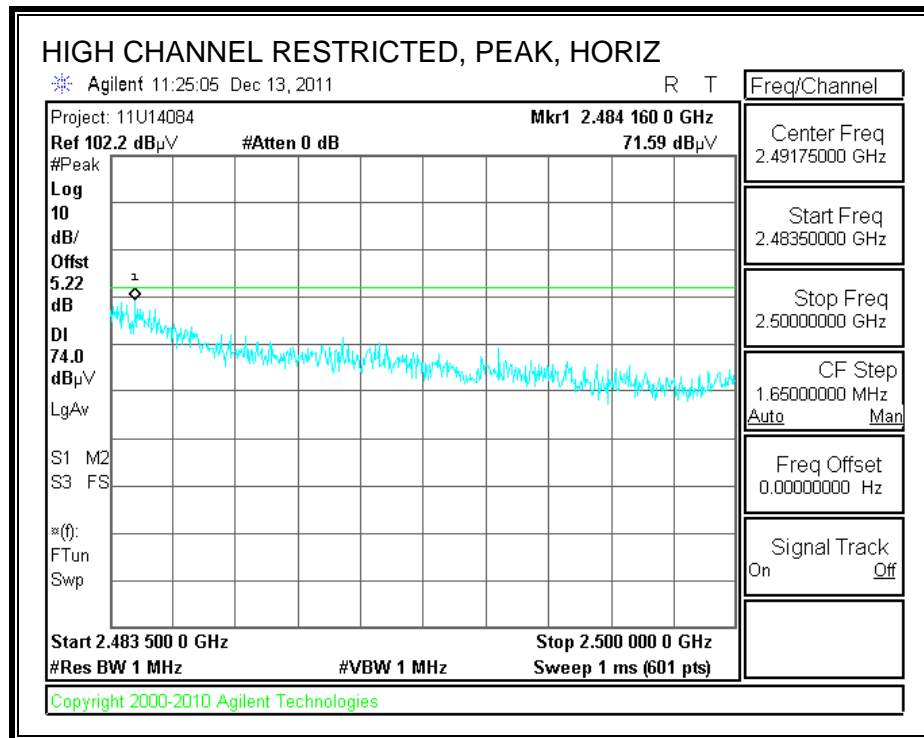


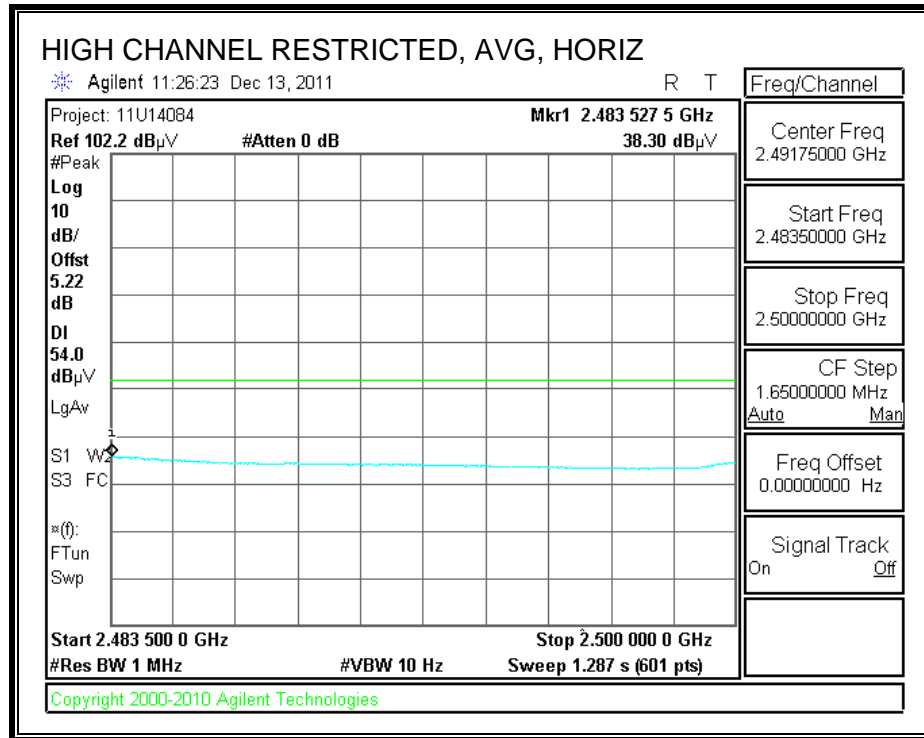
**RESTRICTED BANEDGE (LOW CHANNEL, VERTICAL)**



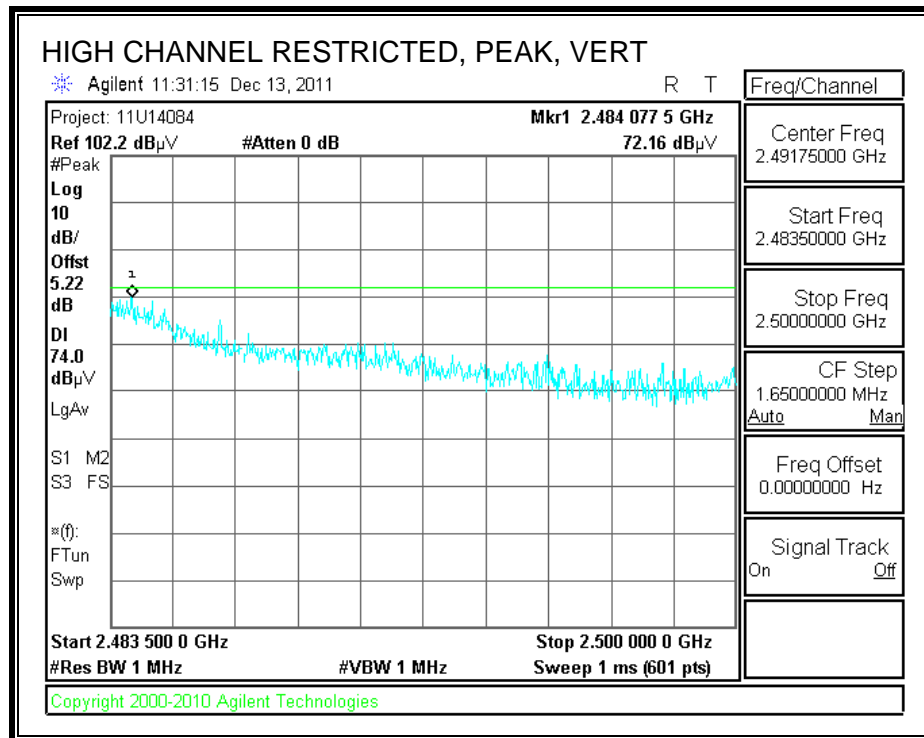


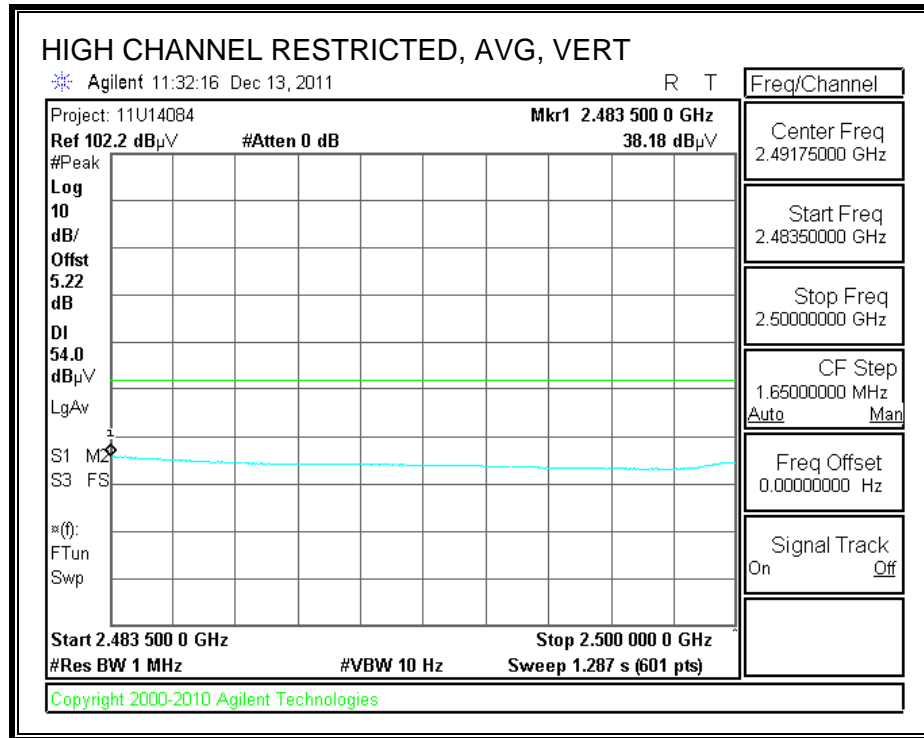
**RESTRICTED BANEDGE (HIGH CHANNEL, HORIZONTAL)**





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







## HARMONICS AND SPURIOUS EMISSIONS

### High Frequency Measurement

Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen  
Date: 12/14/11  
Project #: 11U14084  
Company: Sonos  
Test Target: FCC Class B  
Mode Oper: 802.11g, 24Mbps TX mode

f Measurement Frequency Amp Preamp Gain Average Field Strength Limit  
Dist Distance to Antenna D Corr Distance Correct to 3 meters Peak Field Strength Limit  
Read Analyzer Reading Avg Average Field Strength @ 3 m Margin vs. Average Limit  
AF Antenna Factor Peak Calculated Peak Field Strength Margin vs. Peak Limit  
CL Cable Loss HPF High Pass Filter

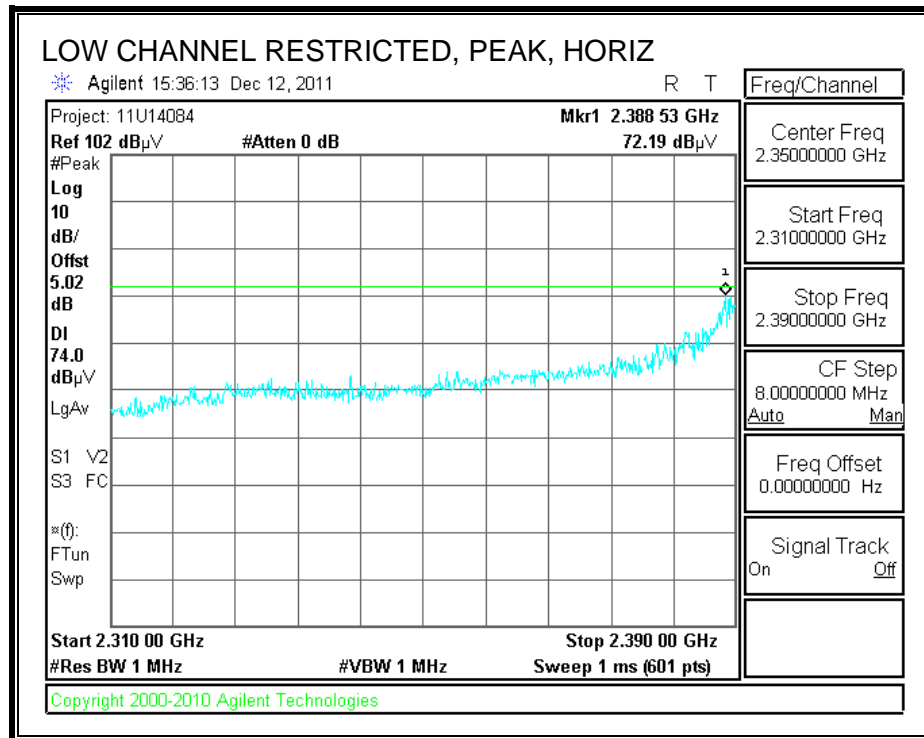
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fitr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
<b>2412MHz 11g</b>													
4.824	3.0	41.8	33.4	5.8	-36.5	0.0	0.0	44.6	74.0	-29.4	V	P	
4.824	3.0	26.6	33.4	5.8	-36.5	0.0	0.0	29.3	54.0	-24.7	V	A	
4.824	3.0	41.2	33.4	5.8	-36.5	0.0	0.0	44.0	74.0	-30.0	H	P	
4.824	3.0	26.3	33.4	5.8	-36.5	0.0	0.0	29.0	54.0	-25.0	H	A	
<b>2437MHz 11g</b>													
4.874	3.0	42.5	33.5	5.8	-36.5	0.0	0.0	45.4	74.0	-28.6	H	P	
4.874	3.0	26.2	33.5	5.8	-36.5	0.0	0.0	29.0	54.0	-25.0	H	A	
7.311	3.0	37.3	35.7	7.3	-36.2	0.0	0.0	44.0	74.0	-30.0	H	P	
7.311	3.0	25.2	35.7	7.3	-36.2	0.0	0.0	31.9	54.0	-22.1	H	A	
<b>2437MHz 11g</b>													
4.874	3.0	44.8	33.5	5.8	-36.5	0.0	0.0	47.7	74.0	-26.3	V	P	
4.874	3.0	26.5	33.5	5.8	-36.5	0.0	0.0	29.4	54.0	-24.6	V	A	
7.311	3.0	37.6	35.7	7.3	-36.2	0.0	0.0	44.4	74.0	-29.6	V	P	
7.311	3.0	25.2	35.7	7.3	-36.2	0.0	0.0	31.9	54.0	-22.1	V	A	
<b>2462MHz 11g</b>													
4.924	3.0	38.3	33.5	5.9	-36.5	0.0	0.0	41.3	74.0	-32.7	H	P	
4.924	3.0	25.9	33.5	5.9	-36.5	0.0	0.0	28.9	54.0	-25.1	H	A	
4.924	3.0	37.8	33.5	5.9	-36.5	0.0	0.0	40.8	74.0	-33.2	V	P	
4.924	3.0	25.9	33.5	5.9	-36.5	0.0	0.0	28.8	54.0	-25.2	V	A	

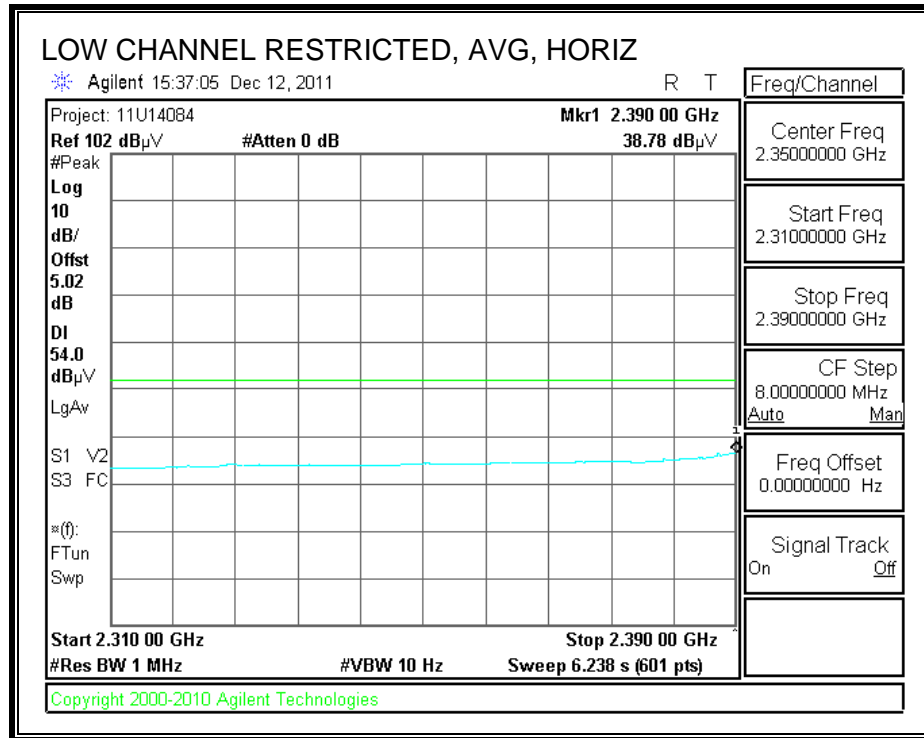
Rev. 4.1.2.7

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

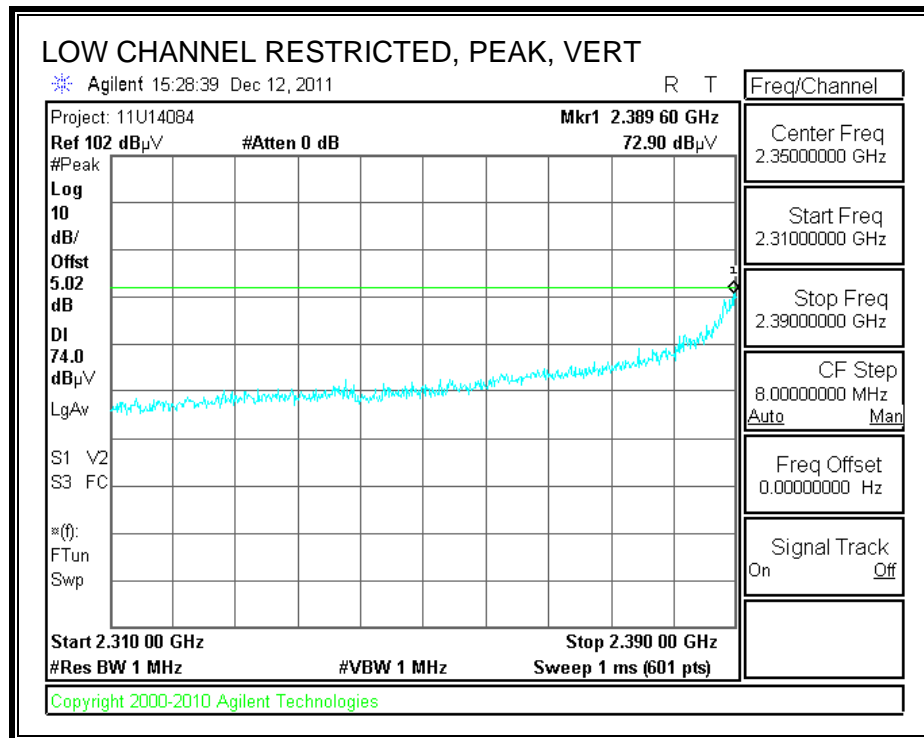
## 8.2.2. TX ABOVE 1 GHz FOR 802.11n HT20 2TX MODE IN THE 2.4 GHz BAND

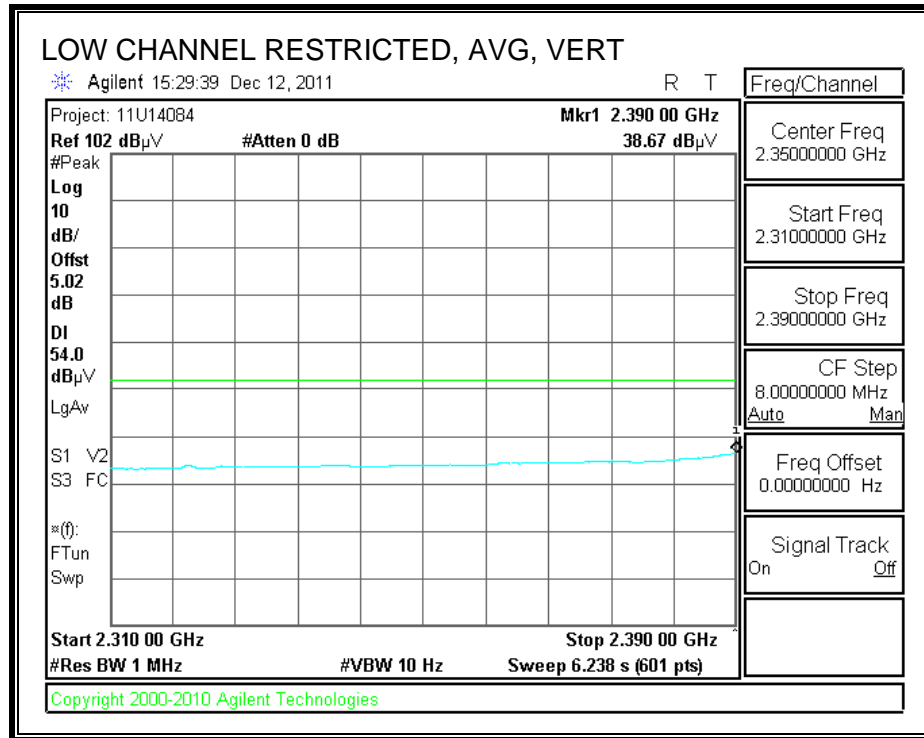
### RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



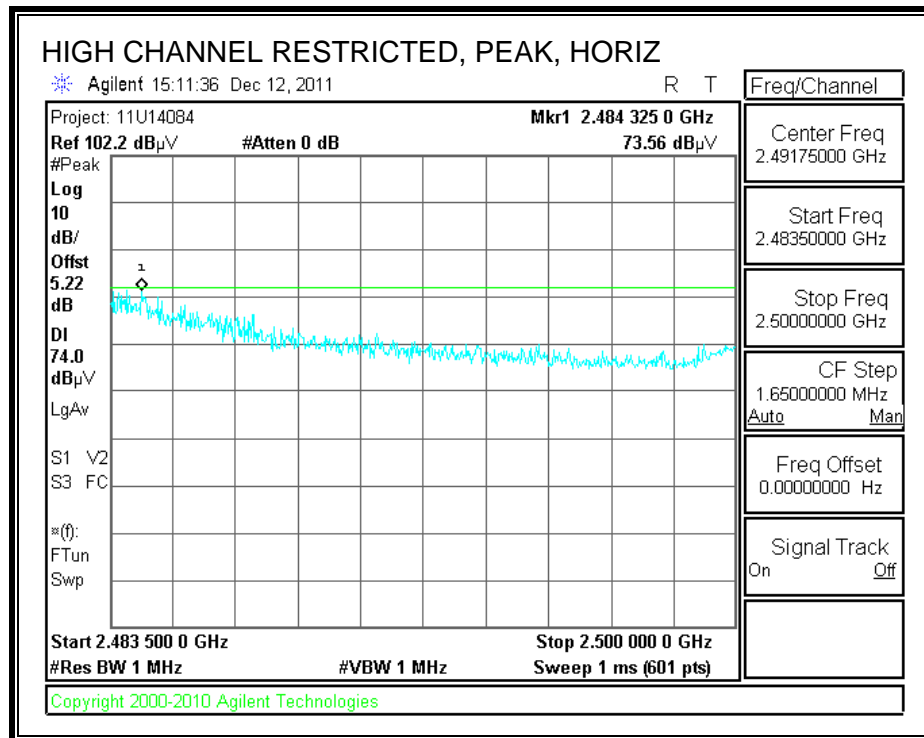


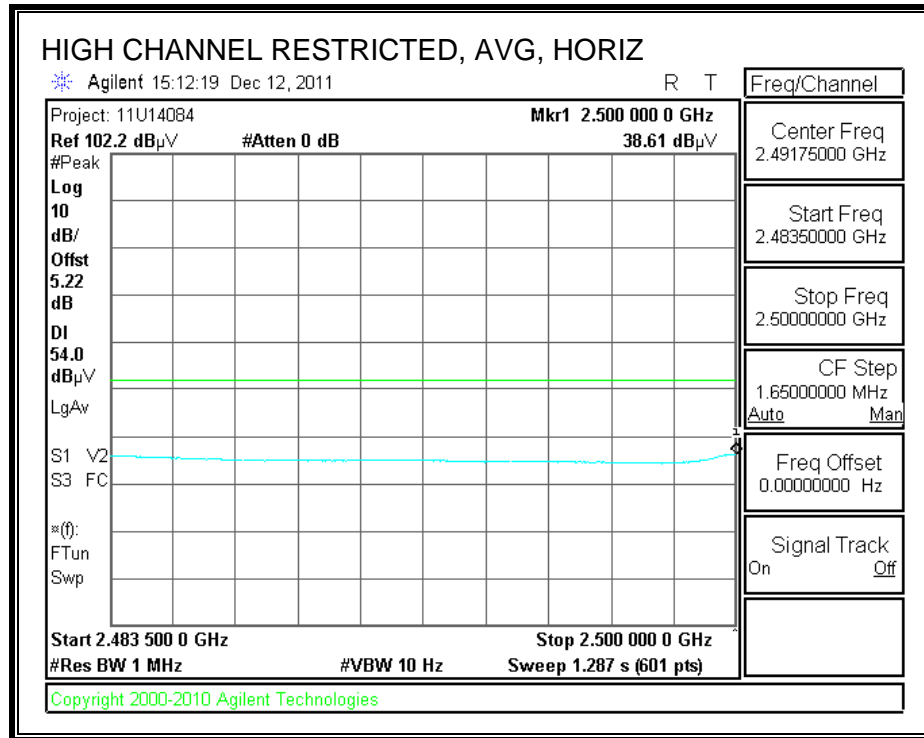
**RESTRICTED BANEDGE (LOW CHANNEL, VERTICAL)**



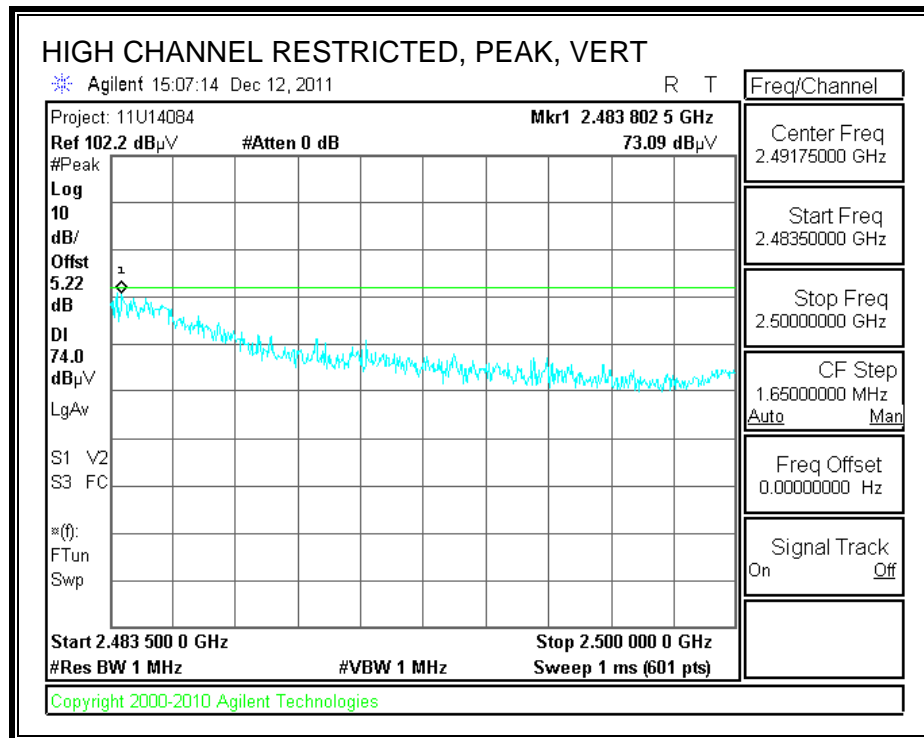


**RESTRICTED BANEDGE (HIGH CHANNEL, HORIZONTAL)**

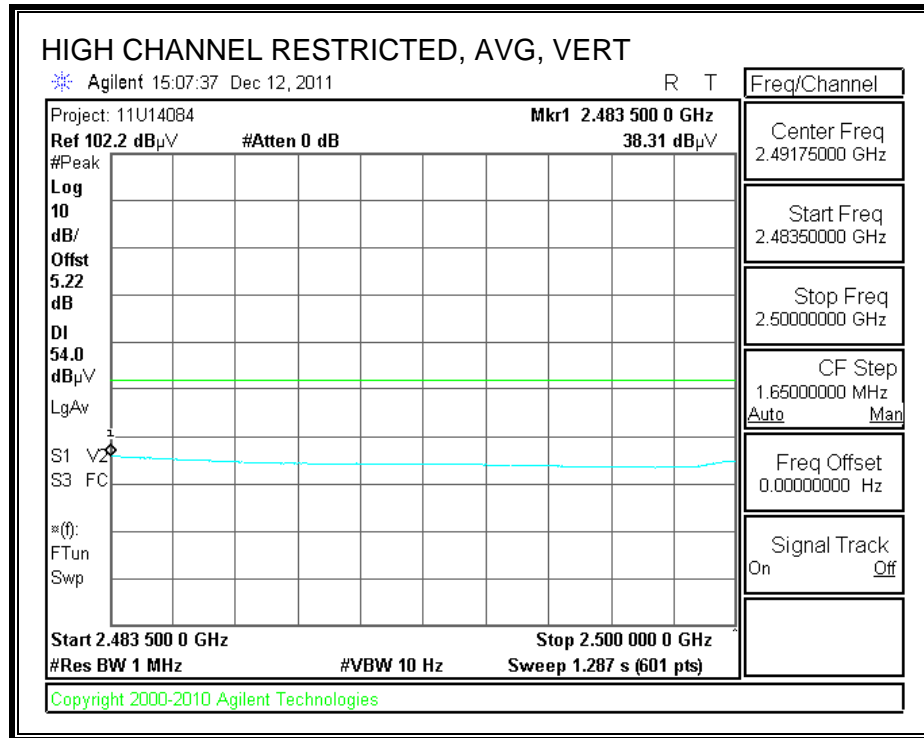




**RESTRICTED BANEDGE (HIGH CHANNEL, VERTICAL)**







# HARMONICS AND SPURIOUS EMISSIONS

## High Frequency Measurement

Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen  
Date: 12/14/11  
Project #: 11U14084  
Company: Sonos  
Test Target: FCC Class B  
Mode Oper: 802.11n MCS9

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	Filt dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol V/H	Det. P/A/QP	Notes
<b>2412MHz 11n</b>													
4.824	3.0	40.3	33.4	5.8	-36.5	0.0	0.0	43.1	74.0	-30.9	V	P	
4.824	3.0	26.5	33.4	5.8	-36.5	0.0	0.0	29.3	54.0	-24.7	V	A	
4.824	3.0	42.0	33.4	5.8	-36.5	0.0	0.0	44.8	74.0	-29.2	H	P	
4.824	3.0	26.7	33.4	5.8	-36.5	0.0	0.0	29.5	54.0	-24.5	H	A	
<b>2437 MHz, 11n</b>													
4.874	3.0	43.1	33.5	5.8	-36.5	0.0	0.0	46.0	74.0	-28.0	V	P	
4.874	3.0	26.4	33.5	5.8	-36.5	0.0	0.0	29.3	54.0	-24.7	V	A	
4.874	3.0	42.7	33.5	5.8	-36.5	0.0	0.0	45.6	74.0	-28.4	H	P	
4.874	3.0	26.4	33.5	5.8	-36.5	0.0	0.0	29.2	54.0	-24.8	H	A	
<b>2462 MHz, 11n</b>													
4.924	3.0	38.1	33.5	5.9	-36.5	0.0	0.0	41.0	74.0	-33.0	H	P	
4.924	3.0	26.0	33.5	5.9	-36.5	0.0	0.0	28.9	54.0	-25.1	H	A	
4.924	3.0	38.1	33.5	5.9	-36.5	0.0	0.0	41.1	74.0	-32.9	V	P	
4.924	3.0	26.0	33.5	5.9	-36.5	0.0	0.0	28.9	54.0	-25.1	V	A	

Rev. 4.1.2.7

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

### 8.2.3. TX ABOVE 1 GHz FOR 802.11n HT20 2TX MODE IN THE 5.8 GHz BAND

#### HARMONICS AND SPURIOUS EMISSIONS

##### High Frequency Measurement Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen  
Date: 12/14/11  
Project #: 11U14084  
Company: Sonos  
Test Target: FCC Class B  
Mode Oper: W58, 802.11n MCS9

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	Fitr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol V/H	Det. P/A/QP	Notes
<b>5745 MHz, 11n</b>													
11.490	3.0	43.6	38.8	9.5	-35.9	0.0	0.7	56.7	74.0	-17.3	V	P	
11.490	3.0	23.9	38.8	9.5	-35.9	0.0	0.7	37.1	54.0	-16.9	V	A	
11.490	3.0	42.0	38.8	9.5	-35.9	0.0	0.7	55.2	74.0	-18.8	H	P	
11.490	3.0	23.6	38.8	9.5	-35.9	0.0	0.7	36.8	54.0	-17.2	H	A	
<b>5785 MHz, 11n</b>													
11.570	3.0	40.3	38.9	9.5	-35.8	0.0	0.7	53.6	74.0	-20.4	H	P	
11.570	3.0	23.2	38.9	9.5	-35.8	0.0	0.7	36.5	54.0	-17.5	H	A	
11.570	3.0	43.1	38.9	9.5	-35.8	0.0	0.7	56.4	74.0	-17.6	V	P	
11.570	3.0	23.2	38.9	9.5	-35.8	0.0	0.7	36.5	54.0	-17.5	V	A	
<b>5825 MHz, 11n</b>													
11.650	3.0	37.1	39.0	9.6	-35.7	0.0	0.7	50.6	74.0	-23.4	V	P	
11.650	3.0	23.5	39.0	9.6	-35.7	0.0	0.7	37.1	54.0	-16.9	V	A	
11.650	3.0	39.7	39.0	9.6	-35.7	0.0	0.7	53.2	74.0	-20.8	H	P	
11.650	3.0	23.6	39.0	9.6	-35.7	0.0	0.7	37.2	54.0	-16.8	H	A	

Rev. 4.1.2.7

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

### 8.3. RECEIVER ABOVE 1 GHz

#### 8.3.1. RX ABOVE 1 GHz FOR 20 MHz BANDWIDTH IN THE 2.4 GHz BAND

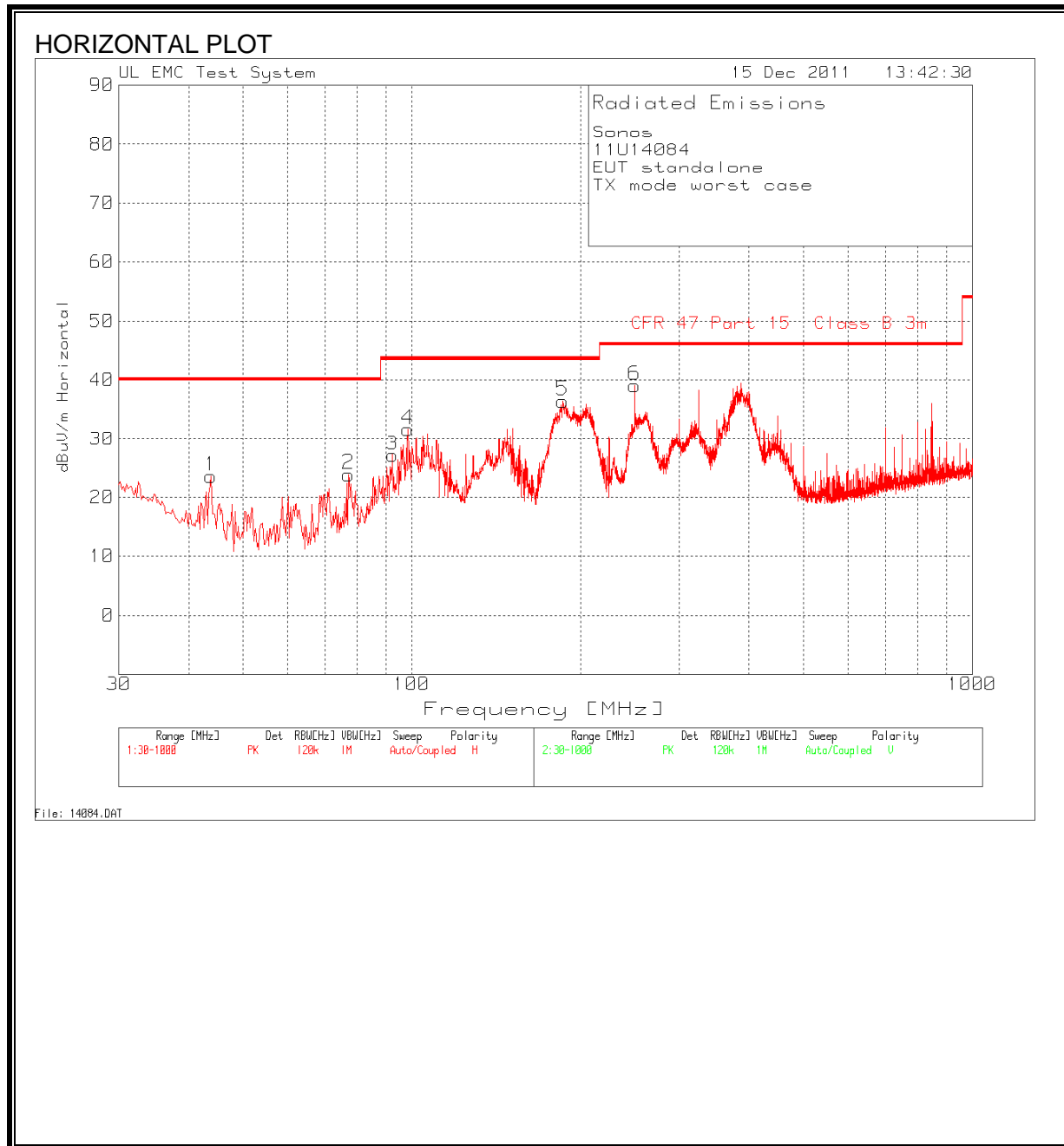
High Frequency Measurement																
Compliance Certification Services, Fremont 5m Chamber-A																
Company:		Sonos														
Project #:		11U14084														
Date:		12/15/2011														
Test Engineer:		Tom Chen														
Configuration:		EUT standalone														
Mode:		RX mode, 2.4GHz														
Test Equipment:																
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 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	Filtr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)	
1.260	3.0	50.5	35.2	24.8	3.0	-38.5	0.0	0.0	39.9	24.5	74	54	-34.1	-29.5	H	
1.672	3.0	48.3	32.9	26.2	3.5	-37.9	0.0	0.0	40.1	24.7	74	54	-33.9	-29.3	H	
7.977	3.0	41.1	25.7	36.8	8.5	-35.5	0.0	0.0	51.0	35.6	74	54	-23.0	-18.4	H	
1.043	3.0	50.8	35.4	24.0	2.8	-38.8	0.0	0.0	38.8	23.4	74	54	-35.2	-30.6	V	
1.888	3.0	52.3	37.0	27.0	3.7	-37.6	0.0	0.0	45.4	30.1	74	54	-28.6	-23.9	V	
6.763	3.0	41.4	26.0	35.0	8.1	-35.4	0.0	0.0	49.1	33.7	74	54	-24.9	-20.3	V	
Rev. 07.08.11																
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									

### 8.3.2. RX ABOVE 1 GHz FOR 20 MHz BANDWIDTH IN THE 5.8 GHz BAND

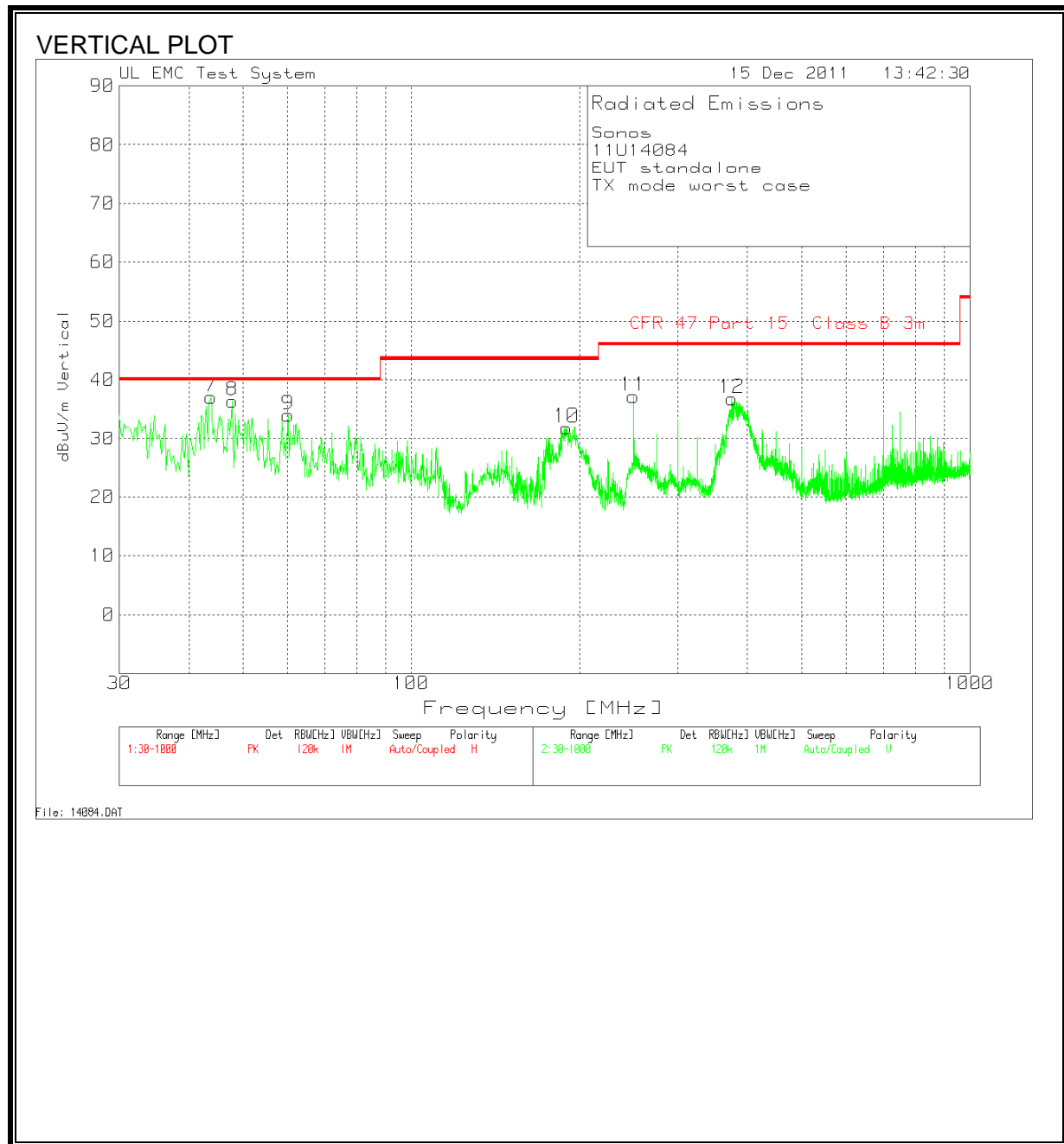
High Frequency Measurement															
Compliance Certification Services, Fremont 5m Chamber-A															
Company:		Sonos													
Project #:		11U14084													
Date:		12/14/2011													
Test Engineer:		Tom Chen													
Configuration:		EUT standalone													
Mode:		RX mode, W58													
<b>Test Equipment:</b>															
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 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	Filtr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
1.260	3.0	51.3	33.7	24.8	3.0	-38.5	0.0	0.0	40.7	23.1	74	54	-33.3	-30.9	H
1.628	3.0	49.6	32.0	26.1	3.5	-38.0	0.0	0.0	41.2	23.6	74	54	-32.8	-30.4	H
5.593	3.0	41.2	23.6	34.5	6.8	-35.4	0.0	0.0	47.1	29.5	74	54	-26.9	-24.5	H
1.130	3.0	47.7	30.1	24.3	2.9	-38.6	0.0	0.0	36.3	18.7	74	54	-37.7	-35.3	V
1.260	3.0	47.9	30.3	24.8	3.0	-38.5	0.0	0.0	37.3	19.7	74	54	-36.7	-34.3	V
1.390	3.0	48.3	30.7	25.3	3.2	-38.3	0.0	0.0	38.5	20.9	74	54	-35.5	-33.1	V
Rev. 07.08.11															
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										

## 8.4. 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

<b>Sonos</b>								
<b>11U14084</b>								
<b>EUT standalone</b>								
<b>TX mode worst case</b>								
Range 1 30 - 1000MHz								
Test Frequency	Meter Reading	Detector	25MHz-1GHz ChmbrA Amplified.T X [dB]	5m A T122 Bilog below 1GHz.TXT [dB]	dBuV/m	CFR 47 Part 15 Class B 3m	Margin	Polarity
43.763	39.37	PK	-27.4	11.6	23.57	40	-16.43	Horz
77.1043	43.45	PK	-27.1	7.5	23.85	40	-16.15	Horz
92.4181	46.03	PK	-27	8.1	27.13	43.5	-16.37	Horz
98.4273	48.89	PK	-26.9	9.6	31.59	43.5	-11.91	Horz
185.8513	51.65	PK	-26.4	11.2	36.45	43.5	-7.05	Horz
250.014	53.2	PK	-25.9	11.8	39.1	46	-6.9	Horz
Range 2 30 - 1000MHz								
Test Frequency	Meter Reading	Detector	25MHz-1GHz ChmbrA Amplified.T X [dB]	5m A T122 Bilog below 1GHz.TXT [dB]	dBuV/m	CFR 47 Part 15 Class B 3m	Margin	Polarity
43.763	52.88	PK	-27.4	11.6	37.08	40	-2.92	Vert
47.8337	54.32	PK	-27.3	9.4	36.42	40	-3.58	Vert
60.2398	53.34	PK	-27.2	7.9	34.04	40	-5.96	Vert
189.7282	46.83	PK	-26.3	11.3	31.83	43.5	-11.67	Vert
250.014	51.29	PK	-25.9	11.8	37.19	46	-8.81	Vert
375.044	47.73	PK	-25.4	14.5	36.83	46	-9.17	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

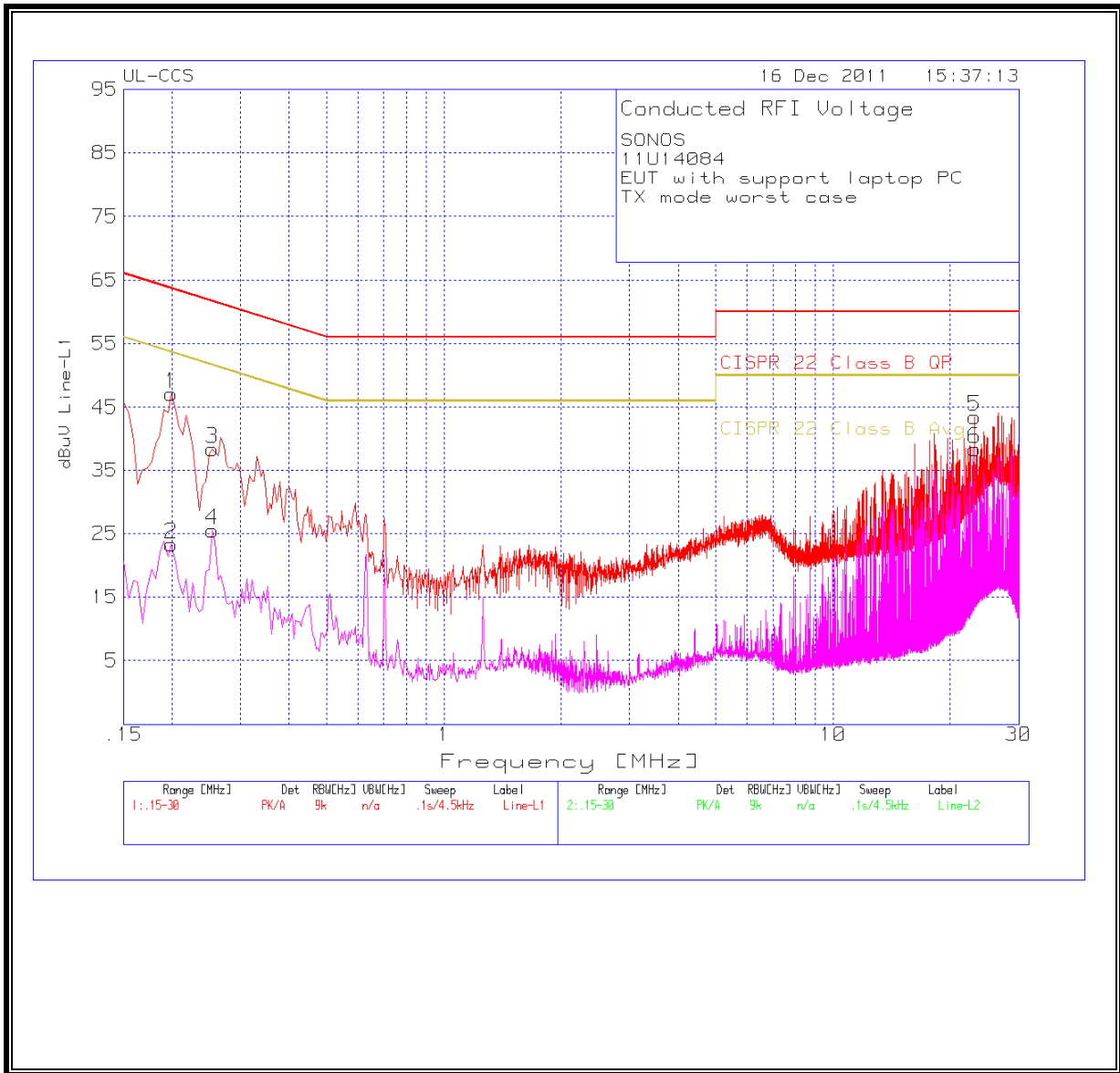
ANSI C63.4

## RESULTS

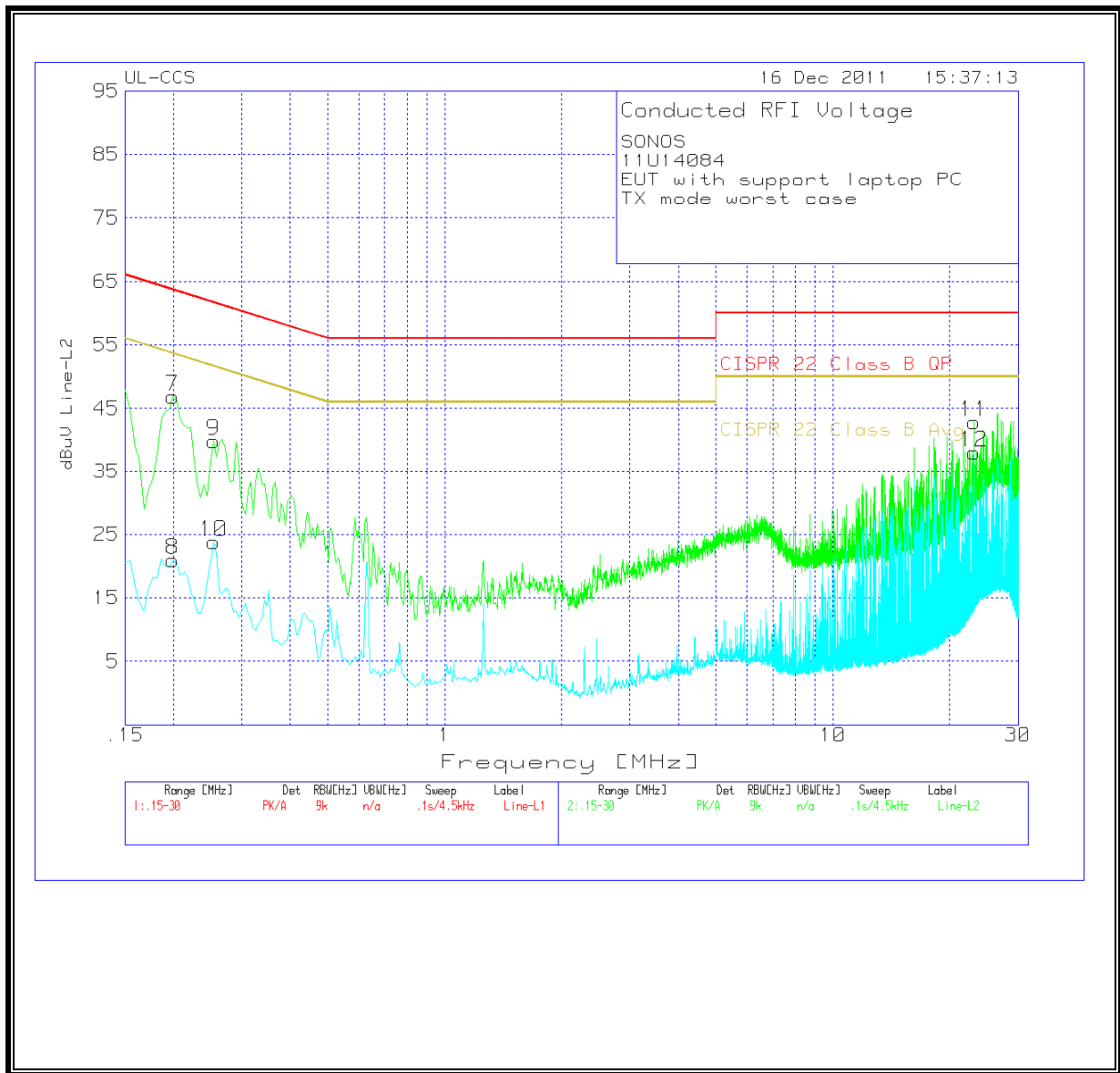
### 6 WORST EMISSIONS

SONOS									
11U14084									
EUT with support laptop PC									
TX mode worst case									
Line-L1 .15 - 30MHz									
Test Frequency	Meter Reading	Detector	T24 IL L1.TXT [dB]	LC Cables 1&3.TXT [dB]	dBuV	CISPR 22 Class B QP	Margin	CISPR 22 Class B Avg	Margin
0.1995	46.97	PK	0.1	0	47.07	63.6	-16.53	-	-
0.1995	23.16	Av	0.1	0	23.26	-	-	53.6	-30.34
0.2535	38.34	PK	0.1	0	38.44	61.6	-23.16	-	-
0.2535	25.41	Av	0.1	0	25.51	-	-	51.6	-26.09
23.1315	42.9	PK	0.4	0.2	43.5	60	-16.5	-	-
23.1315	37.8	Av	0.4	0.2	38.4	-	-	50	-11.6
Line-L2 .15 - 30MHz									
Test Frequency	Meter Reading	Detector	T24 IL L2.TXT [dB]	LC Cables 2&3.TXT [dB]	dBuV	CISPR 22 Class B QP	Margin	CISPR 22 Class B Avg	Margin
0.1995	46.78	PK	0.1	0	46.88	63.6	-16.72	-	-
0.1995	20.82	Av	0.1	0	20.92	-	-	53.6	-32.68
0.2535	39.74	PK	0.1	0	39.84	61.6	-21.76	-	-
0.2535	23.72	Av	0.1	0	23.82	-	-	51.6	-27.78
23.1315	42.28	PK	0.4	0.2	42.88	60	-17.12	-	-
23.1315	37.47	Av	0.4	0.2	38.07	-	-	50	-11.93

**LINE 1 RESULTS**



**LINE 2 RESULTS**



## 10. MAXIMUM PERMISSIBLE EXPOSURE

### FCC RULES

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0 .....	614	1.63	*(100)	6
3.0–30 .....	1842/f	4.89/f	*(900/f <sup>2</sup> )	6
30–300 .....	61.4	0.163	1.0	6
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34 .....	614	1.63	*(100)	30
1.34–30 .....	824/f	2.19/f	*(180/f <sup>2</sup> )	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
30–300 .....	27.5	0.073	0.2	30
300–1500 .....	.....	.....	f/1500	30
1500–100,000 .....	.....	.....	1.0	30

f = frequency in MHz

\* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

## IC RULES

IC Safety Code 6, Section 2.2.1 (a) A person other than an RF and microwave exposed worker shall not be exposed to electromagnetic radiation in a frequency band listed in Column 1 of Table 5, if the field strength exceeds the value given in Column 2 or 3 of Table 5, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of Table 5, when averaged spatially and over time.

**Table 5**  
**Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)**

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m <sup>2</sup> )	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	$280/f$	$2.19/f$		6
10–30	28	$2.19/f$		6
30–300	28	0.073	2*	6
300–1 500	$1.585f^{0.5}$	$0.0042f^{0.5}$	$f/150$	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	$616\,000/f^{1.2}$
150 000–300 000	$0.158f^{0.5}$	$4.21 \times 10^{-4}f^{0.5}$	$6.67 \times 10^{-5}f$	$616\,000/f^{1.2}$

\* Power density limit is applicable at frequencies greater than 100 MHz.

**Notes:** 1. Frequency,  $f$ , is in MHz.  
2. A power density of 10 W/m<sup>2</sup> is equivalent to 1 mW/cm<sup>2</sup>.  
3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

## **EQUATIONS**

Power density is given by:

$$S = \text{EIRP} / (4 * \pi * D^2)$$

where

S = Power density in W/m<sup>2</sup>

EIRP = Equivalent Isotropic Radiated Power in W

D = Separation distance in m

Power density in units of W/m<sup>2</sup> is converted to units of mW/cm<sup>2</sup> by dividing by 10.

Distance is given by:

$$D = \text{SQRT} (\text{EIRP} / (4 * \pi * S))$$

where

D = Separation distance in m

EIRP = Equivalent Isotropic Radiated Power in W

S = Power density in W/m<sup>2</sup>

For multiple colocated transmitters operating simultaneously in frequency bands where the limit is identical, the total power density is calculated using the total EIRP obtained by summing the Power \* Gain product (in linear units) of each transmitter.

$$\text{Total EIRP} = (P_1 * G_1) + (P_2 * G_2) + \dots + (P_n * G_n)$$

where

P<sub>x</sub> = Power of transmitter x

G<sub>x</sub> = Numeric gain of antenna x

In the table(s) below, Power and Gain are entered in units of dBm and dBi respectively and conversions to linear forms are used for the calculations.

## **LIMITS**

From FCC §1.1310 Table 1 (B), the maximum value of S = 1.0 mW/cm<sup>2</sup>

From IC Safety Code 6, Section 2.2 Table 5 Column 4, S = 10 W/m<sup>2</sup>

## RESULTS

Band	Mode	Separation Distance (m)	Output AV Power (dBm)	Antenna Gain (dBi)	IC Power Density (W/m <sup>2</sup> )	FCC Power Density (mW/cm <sup>2</sup> )
2.4 GHz	11g	0.20	19.52	3.97	0.44	0.044

Multiple chain or colocated transmitters									
Band	Mode	Chain for MIMO	Separation Distance (m)	Output AV Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (W)	IC Power Density (W/m <sup>2</sup> )	FCC Power Density (mW/cm <sup>2</sup> )
2.4 GHz	11n HT20	1		19.42	3.97	23.39	0.22		
2.4 GHz	11n HT20	2		17.73	3.97	21.70	0.15		
5 GHz	11n HT20	1		13.02	4.38	17.40	0.05		
5 GHz	11n HT20	2		12.89	4.38	17.27	0.05		
Combined			0.20				0.47	0.94	0.094