



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

**CERTIFICATION TEST REPORT**

**FOR**

**802.11 a/b/g/n 2X2 ACCESS POINT**

**MODEL NUMBER: A1392**

**FCC ID: BCGA1392  
IC: 579C-A1392**

**REPORT NUMBER: 12U14326-1, Revision B**

**ISSUE DATE: JUNE 06, 2012**

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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	05/21/12	Initial Issue	F. Ibrahim
A	05/25/12	Updated section 5.3, some formatting issues	F. Ibrahim
B	06/06/12	Removed references and data that belong to DFS bands and removed RX data	F. Ibrahim

## TABLE OF CONTENTS

<b>1. ATTESTATION OF TEST RESULTS.....</b>	<b>5</b>
<b>2. TEST METHODOLOGY .....</b>	<b>6</b>
<b>3. FACILITIES AND ACCREDITATION.....</b>	<b>6</b>
<b>4. CALIBRATION AND UNCERTAINTY .....</b>	<b>6</b>
4.1. <i>MEASURING INSTRUMENT CALIBRATION .....</i>	<i>6</i>
4.2. <i>SAMPLE CALCULATION.....</i>	<i>6</i>
4.3. <i>MEASUREMENT UNCERTAINTY .....</i>	<i>6</i>
<b>5. EQUIPMENT UNDER TEST .....</b>	<b>7</b>
5.1. <i>DESCRIPTION OF EUT.....</i>	<i>7</i>
5.2. <i>MAXIMUM OUTPUT POWER.....</i>	<i>7</i>
5.3. <i>DESCRIPTION OF AVAILABLE ANTENNAS .....</i>	<i>7</i>
5.4. <i>SOFTWARE AND FIRMWARE .....</i>	<i>8</i>
5.5. <i>WORST-CASE CONFIGURATION AND MODE.....</i>	<i>8</i>
5.6. <i>DESCRIPTION OF TEST SETUP.....</i>	<i>9</i>
<b>6. TEST AND MEASUREMENT EQUIPMENT .....</b>	<b>11</b>
<b>7. ANTENNA PORT TEST RESULTS .....</b>	<b>12</b>
7.1. <i>ON TIME, DUTY CYCLE AND MEASUREMENT METHODS .....</i>	<i>12</i>
7.1.1. <i>ON TIME AND DUTY CYCLE RESULTS .....</i>	<i>12</i>
7.1.2. <i>MEASUREMENT METHOD FOR POWER AND PPSD .....</i>	<i>12</i>
7.1.3. <i>MEASUREMENT METHOD FOR AVG SPURIOUS EMISSIONS ABOVE 1 GHz</i>	<i>12</i>
7.1.4. <i>DUTY CYCLE PLOTS.....</i>	<i>13</i>
7.2. <i>802.11a MODE IN THE 5.2 GHz BAND.....</i>	<i>15</i>
7.2.1. <i>26 dB BANDWIDTH .....</i>	<i>15</i>
7.2.2. <i>99% BANDWIDTH .....</i>	<i>19</i>
7.2.3. <i>AVERAGE POWER .....</i>	<i>24</i>
7.2.4. <i>OUTPUT POWER AND PPSD.....</i>	<i>25</i>
7.2.5. <i>PEAK EXCURSION .....</i>	<i>31</i>
7.3. <i>802.11n HT20 MODE IN THE 5.2 GHz BAND.....</i>	<i>36</i>
7.3.1. <i>26 dB BANDWIDTH .....</i>	<i>36</i>
7.3.2. <i>99% BANDWIDTH .....</i>	<i>40</i>
7.3.3. <i>AVERAGE POWER .....</i>	<i>45</i>
7.3.4. <i>OUTPUT POWER AND PPSD.....</i>	<i>46</i>
7.3.5. <i>PEAK EXCURSION .....</i>	<i>52</i>
7.4. <i>802.11n HT40 MODE IN THE 5.2 GHz BAND.....</i>	<i>57</i>
7.4.1. <i>26 dB BANDWIDTH .....</i>	<i>57</i>
7.4.2. <i>99% BANDWIDTH .....</i>	<i>60</i>
7.4.3. <i>AVERAGE POWER .....</i>	<i>63</i>
7.4.4. <i>OUTPUT POWER AND PPSD.....</i>	<i>64</i>
7.4.5. <i>PEAK EXCURSION .....</i>	<i>68</i>

<b>8. RADIATED TEST RESULTS .....</b>	<b>71</b>
8.1. <i>LIMITS AND PROCEDURE .....</i>	71
8.2. <i>TRANSMITTER ABOVE 1 GHz .....</i>	72
8.2.1. <i>TX ABOVE 1 GHz 802.11a MODE IN THE 5.2 GHz BAND.....</i>	72
8.2.2. <i>TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.2 GHz BAND.....</i>	76
8.2.3. <i>TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.2 GHz BAND.....</i>	79
8.3. <i>WORST-CASE BELOW 1 GHz .....</i>	82
<b>9. AC POWER LINE CONDUCTED EMISSIONS .....</b>	<b>85</b>
<b>10. MAXIMUM PERMISSIBLE EXPOSURE .....</b>	<b>89</b>
<b>11. SETUP PHOTOS .....</b>	<b>93</b>
11.1. <i>ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP .....</i>	93
11.2. <i>RADIATED RF MEASUREMENT SETUP .....</i>	94
11.3. <i>POWERLINE CONDUCTED EMISSIONS MEASUREMENT SETUP.....</i>	96

## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** APPLE, INC.  
1 INFINITE LOOP  
CUPERTINO, CA 95014, U.S.A.

**EUT DESCRIPTION:** 802.11 a/b/g/n 2X2 ACCESS POINT

**MODEL:** A1392

**SERIAL NUMBER:** C86H809NF2R9 (RADIATED UNIT),  
PT602637 (CONDUCTED UNIT)

**DATE TESTED:** MARCH 12 – MAY 18, 2012

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart E	Pass
INDUSTRY CANADA RSS-210 Issue 8 Annex 9	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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FRANK IBRAHIM  
EMC SUPERVISOR  
UL CCS

Tested By:



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TOM CHEN  
EMC ENGINEER  
UL CCS

## 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 06-96, FCC KDB 789033, ANSI C63.10-2009, RSS-GEN Issue 3, and RSS-210 Issue 8.

## 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

UL CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <http://www.ccsemc.com>.

## 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

### 4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

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

### 4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	3.52 dB
Radiated Disturbance, 30 to 1000 MHz	4.94 dB

Uncertainty figures are valid to a confidence level of 95%.

## 5. EQUIPMENT UNDER TEST

### 5.1. DESCRIPTION OF EUT

The EUT is an 802.11 a/b/g/n transceiver Access Point.

### 5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

Frequency (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5180 - 5240	802.11a	15.03	31.84
5180 - 5240	802.11n HT20	14.55	28.51
5190 - 5230	802.11n HT40	16.52	44.87

### 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes 2 IFA integrated antennas, with the following peak gains in dBi:

Frequency Range (MHz)	Ant0	Ant1
2400-2483.5	1.49	1.82
5150-5250	0.93	1.88
5250-5350	1.54	2.07
5470-5725	3.09	3.28
5745-5850	2.74	3.11

## 5.4. SOFTWARE AND FIRMWARE

The Utility software installed in the EUT during testing was ART v3.3.

The firmware installed in the EUT during testing was v7.6.2.d1auto20120216T6T0030-T0T

## 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.

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

For 11b mode: 1Mbps

For 11g mode: 6Mbps

For 11n HT20 (2.4 GHz band): MCS0

For 11a mode: 6Mbps

For 11n HT20 (5.8 GHz band): MCS0

For 11n HT40 (5.8 GHz band): MCS0

EUT only has one orientation (laid down on the desktop) and it was tested in that orientation.

## 5.6. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST			
Description	Manufacturer	Model	Serial Number
AC Adapter	Apple	A1184	N/A
Laptop PC	Apple	MacBook Pro	AOU269116

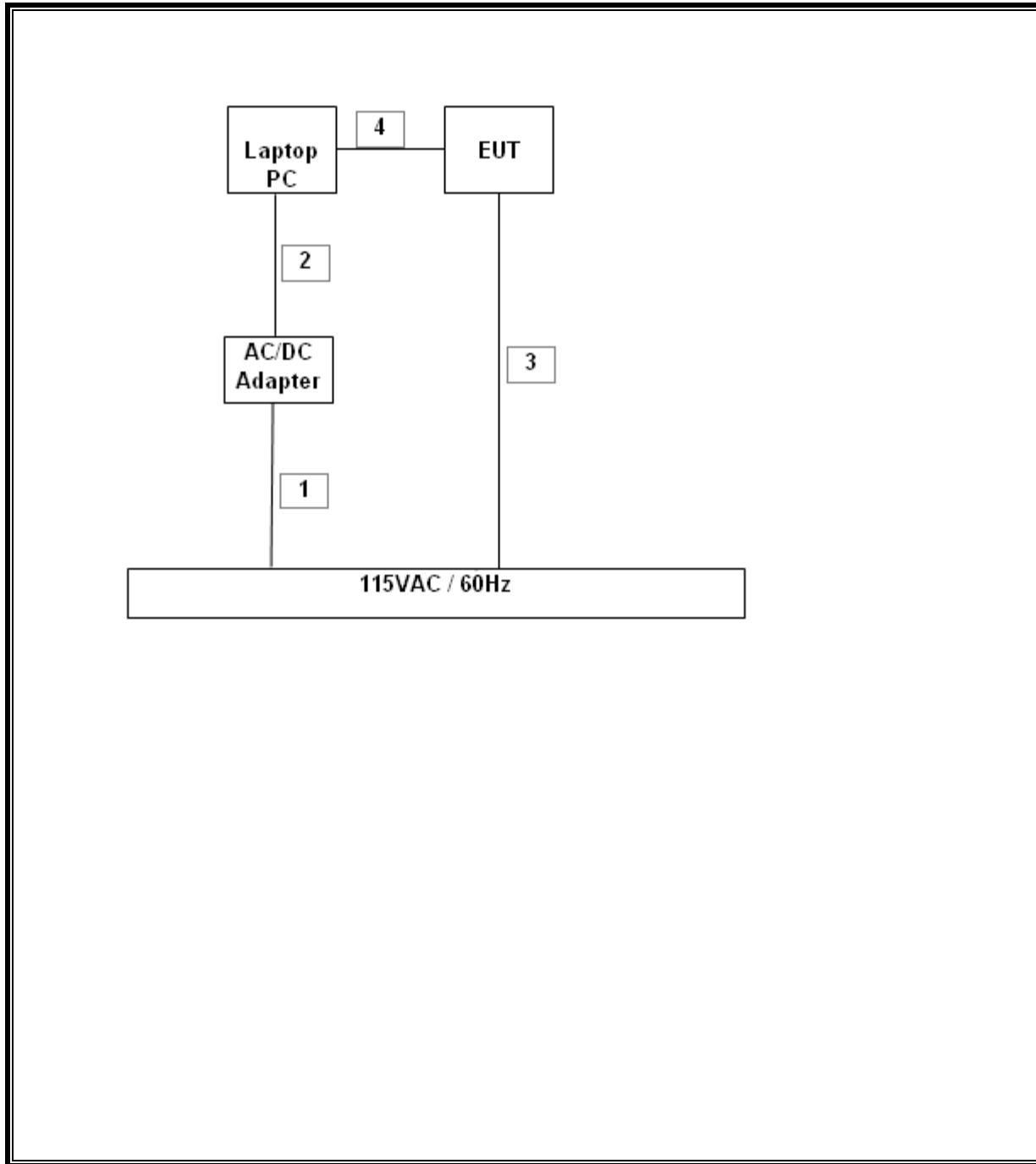
### I/O CABLES

I/O CABLE LIST						
Cable No.	Port	#of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	AC	Unshielded	2m	N/A
2	DC	1	DC	Unshielded	2.5m	N/A
3	AC	1	AC	Unshielded	2m	N/A
4	Ethernet	1	RJ45	Shielded	1.5m	N/A

### TEST SETUP

The Access Point EUT is controlled externally with a laptop, via Ethernet.

**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
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	07/14/12
Antenna, Horn, 18 GHz	EMCO	3115	C00945	06/29/12
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00580	11/11/12
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01016	07/12/12
Horn Antenna, 26.5 GHz	ARA	MWH-1826/B	C00589	07/28/12
Horn Antenna, 40 GHz	ARA	MWH-2640/B	C00981	06/14/12
Preamplifier, 40 GHz	Miteq	NSP4000-SP2	C00990	03/14/13
Reject Filter, 2.0-2.9 GHz	Micro-Tronics	BRM50702	N02684	CNR
High Pass Filter, 7.6 GHz	Micro-Tronics	HPM13195	N02682	CNR
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01159	05/11/12
Peak Power Meter	Agilent	N1911A	1260847C	08/04/12
Peak Power Sensor	Agilent	E9323A	1244073F	08/04/12
Reject Filter, 5.725-5.825 GHz	Micro-Tronics	BRC13192	N02676	CNR
Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRM50702	N02685	CNR
Highpass Filter, 7.6 GHz	Micro-Tronics	HPM13195	N02682	CNR
EMI Test Receiver, 30MHz	R & S	ESHS 20	N02396	08/19/13
LISN, 30 MHz	FCC	LISN-50/250-25-2	N02625	12/13/12

## 7. ANTENNA PORT TEST RESULTS

### 7.1. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS

#### LIMITS

None; for reporting purposes only.

#### PROCEDURE

KDB 789033 Zero-Span Spectrum Analyzer Method.

#### 7.1.1. ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
802.11a 20 MHz	1.353	1.400	0.966	96.6%	0.15	0.739
802.11n HT20	1.263	1.310	0.964	96.4%	0.16	0.792
802.11n HT40	0.6317	0.6533	0.967	96.7%	0.15	1.583

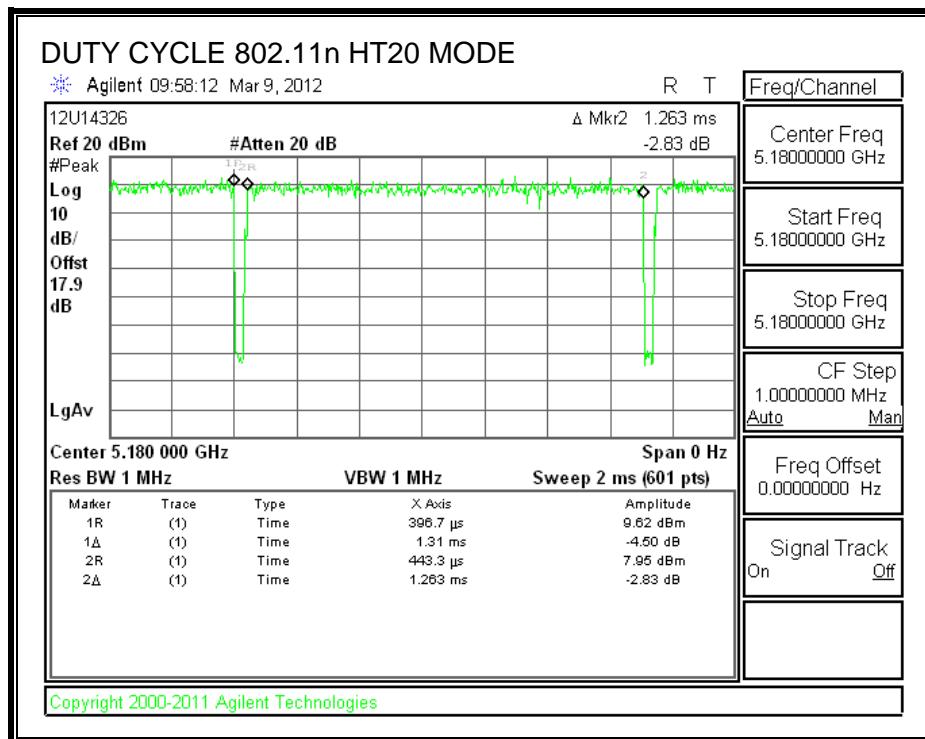
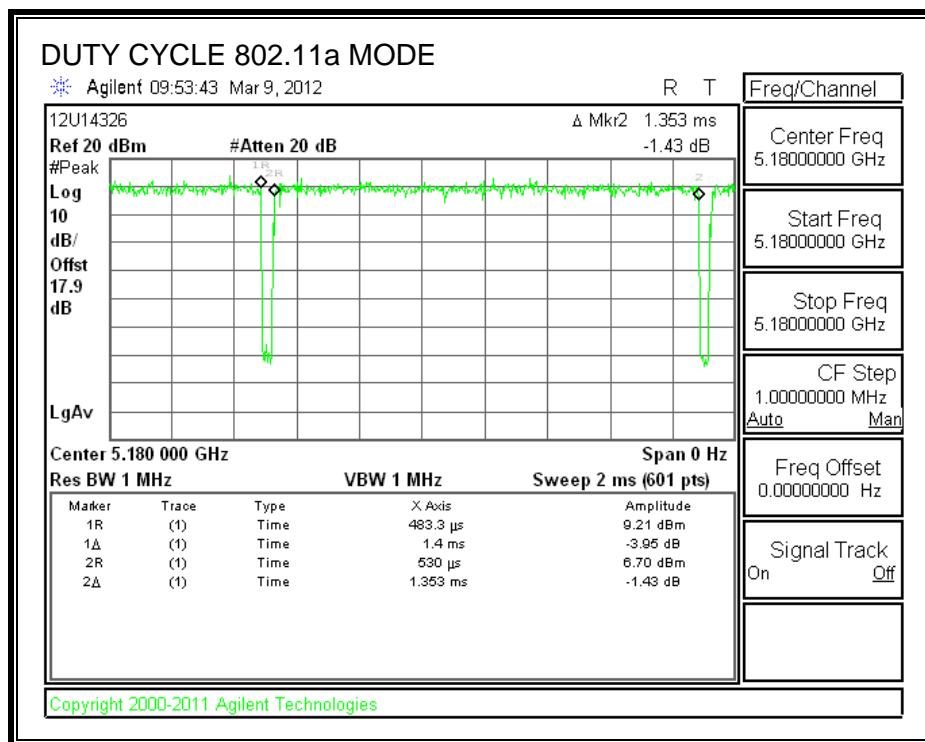
#### 7.1.2. MEASUREMENT METHOD FOR POWER AND PPSD

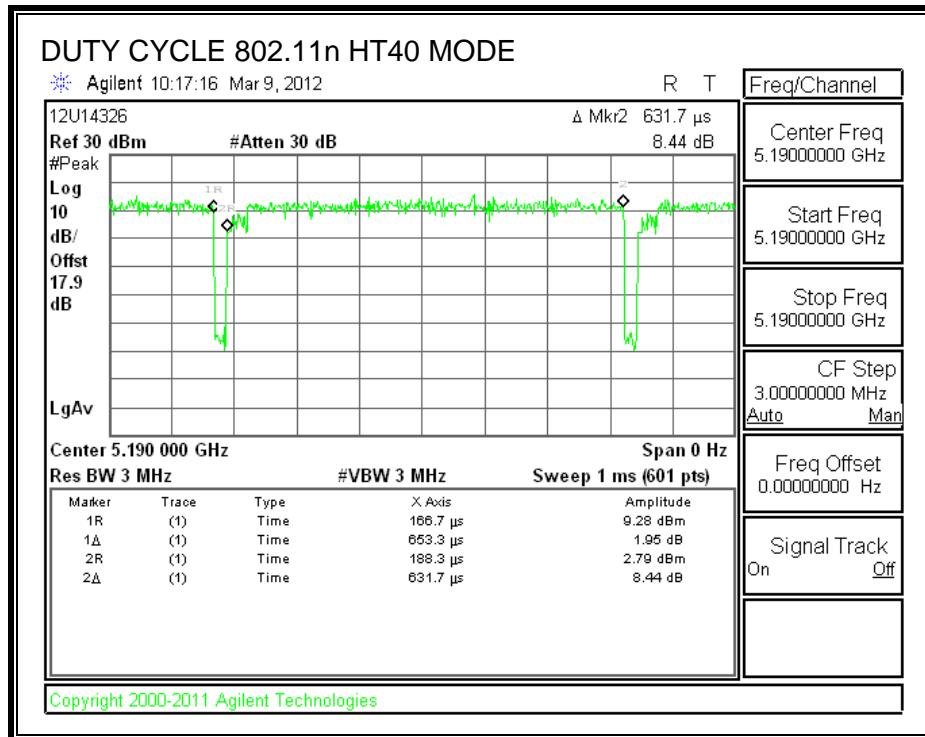
The Duty Cycle is less than 98% and not consistent therefore KDB 789033 Method SA-3 Alternative with Power RMS Averaging is used.

#### 7.1.3. MEASUREMENT METHOD FOR AVG SPURIOUS EMISSIONS ABOVE 1 GHz

The Duty Cycle is less than 98% and consistent, KDB 789033 Method VB with Power RMS Averaging is used.

### 7.1.4. DUTY CYCLE PLOTS





## 7.2. 802.11a MODE IN THE 5.2 GHz BAND

### 7.2.1. 26 dB BANDWIDTH

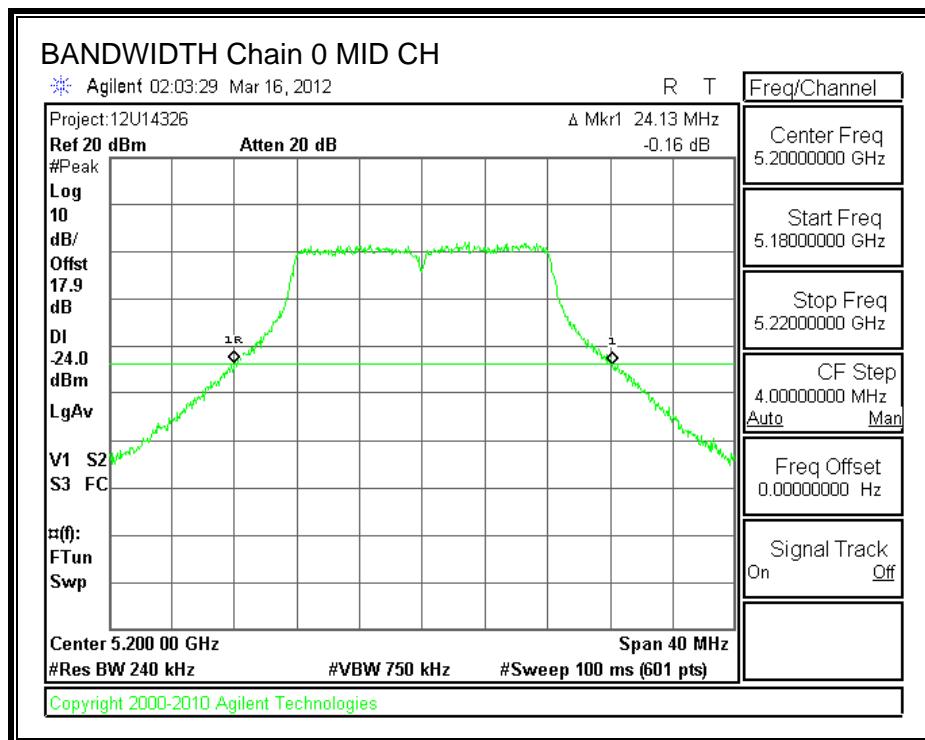
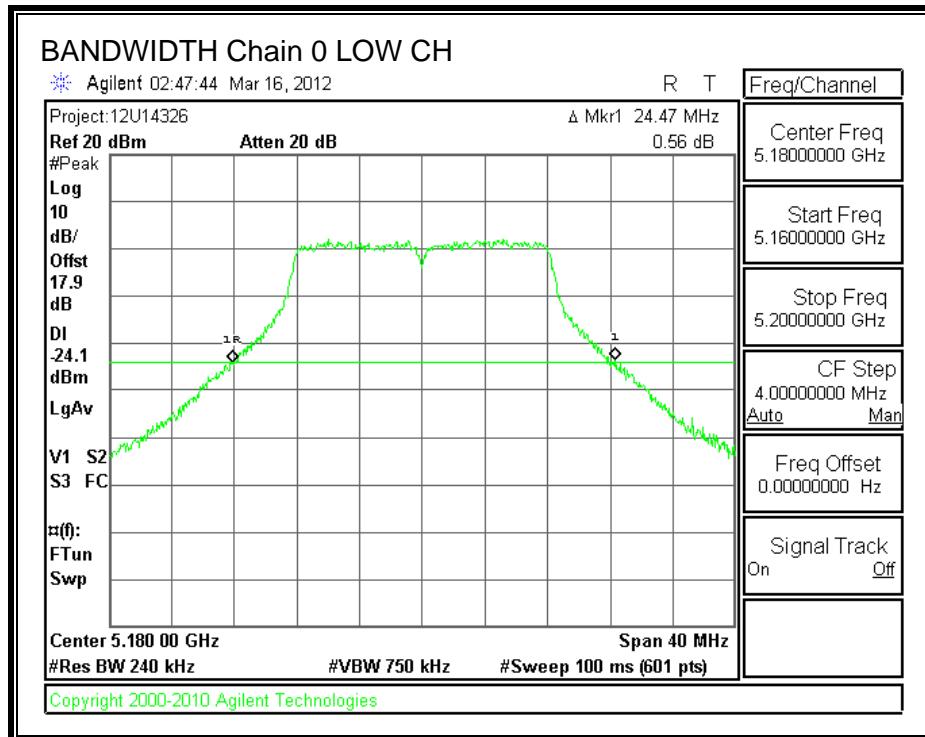
#### LIMITS

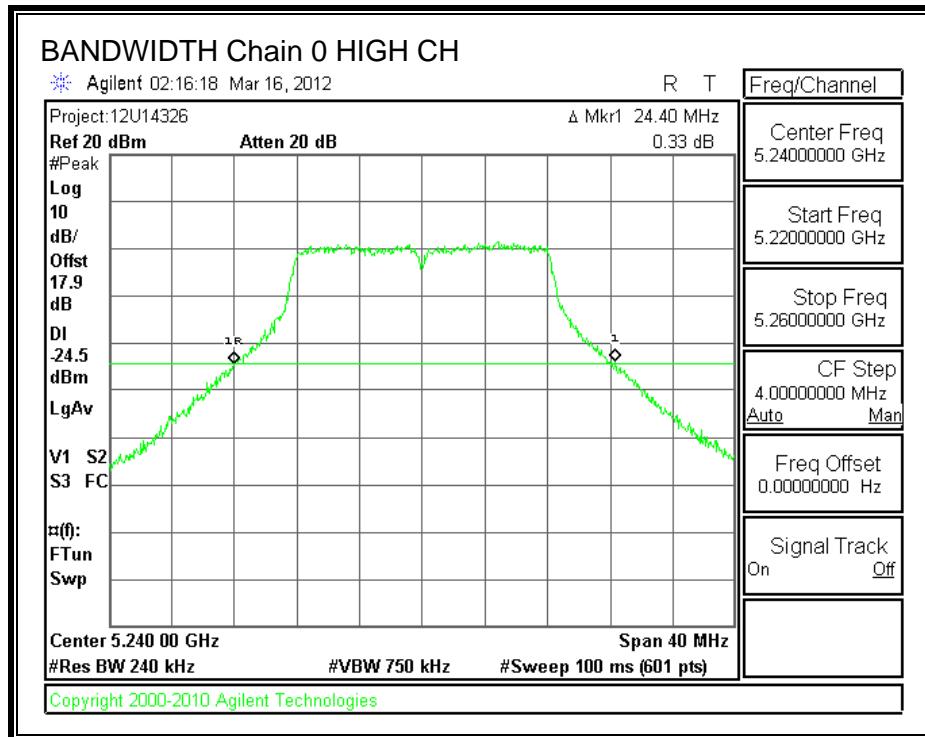
None; for reporting purposes only.

#### RESULTS

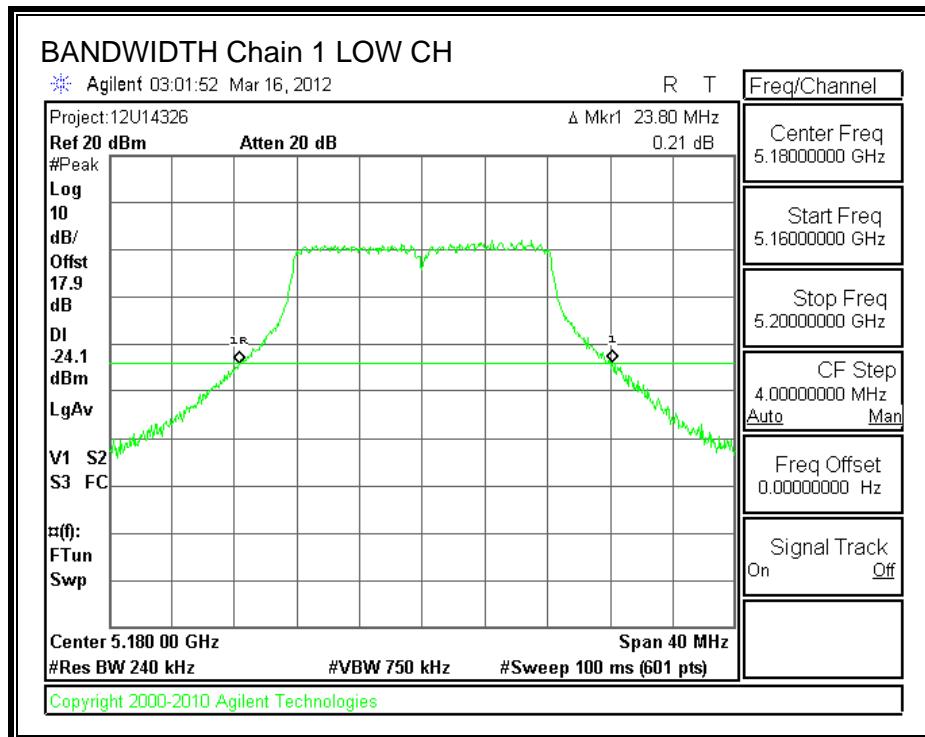
Channel	Frequency (MHz)	26 dB BW Chain 0 (MHz)	26 dB BW Chain 1 (MHz)
Low	5180	24.47	23.80
Mid	5200	24.13	23.80
High	5240	24.40	24.07

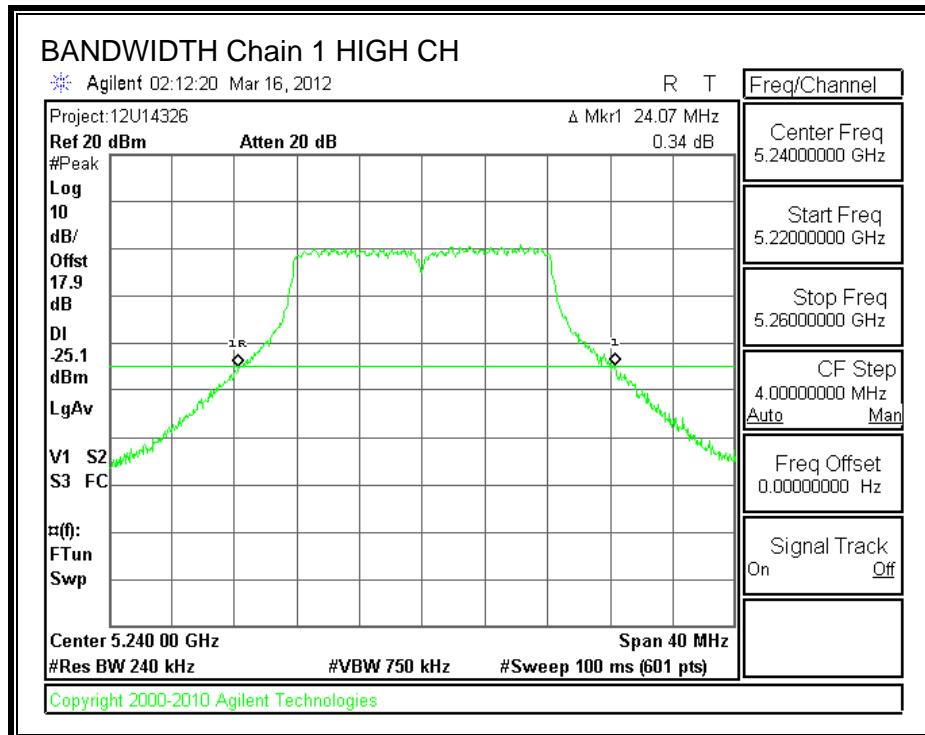
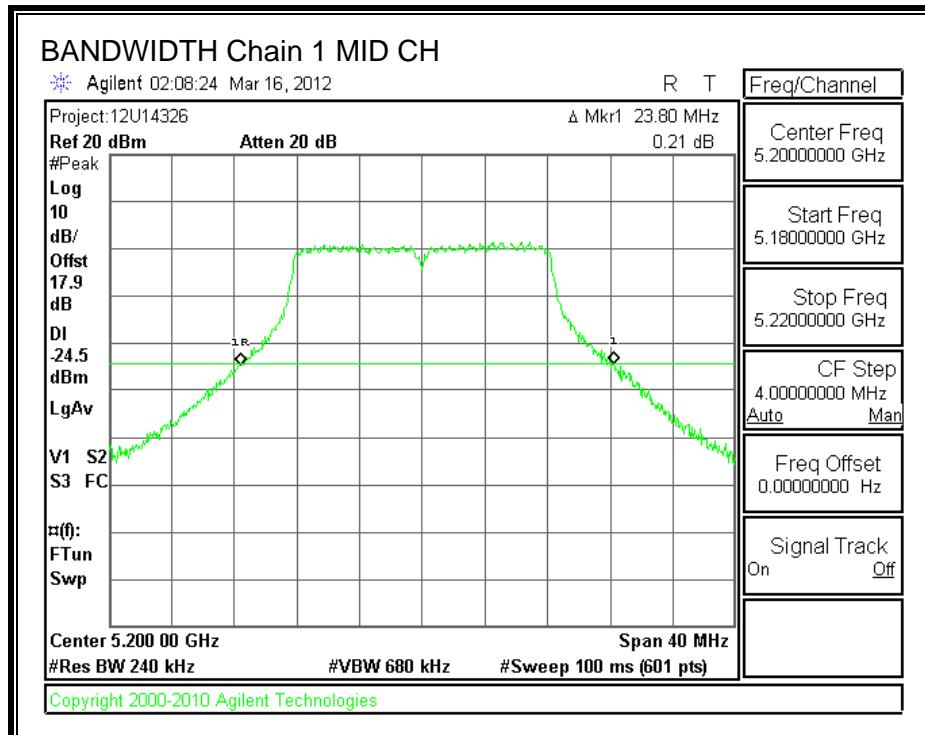
**26 dB BANDWIDTH, Chain 0**





### 26 dB BANDWIDTH, Chain 1





## 7.2.2. 99% BANDWIDTH

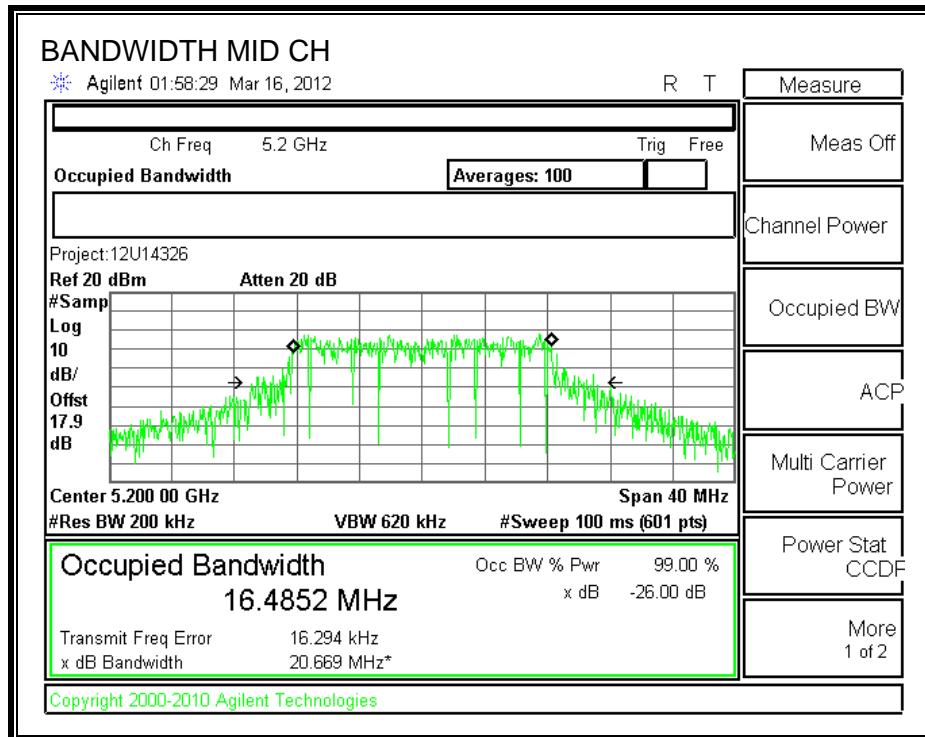
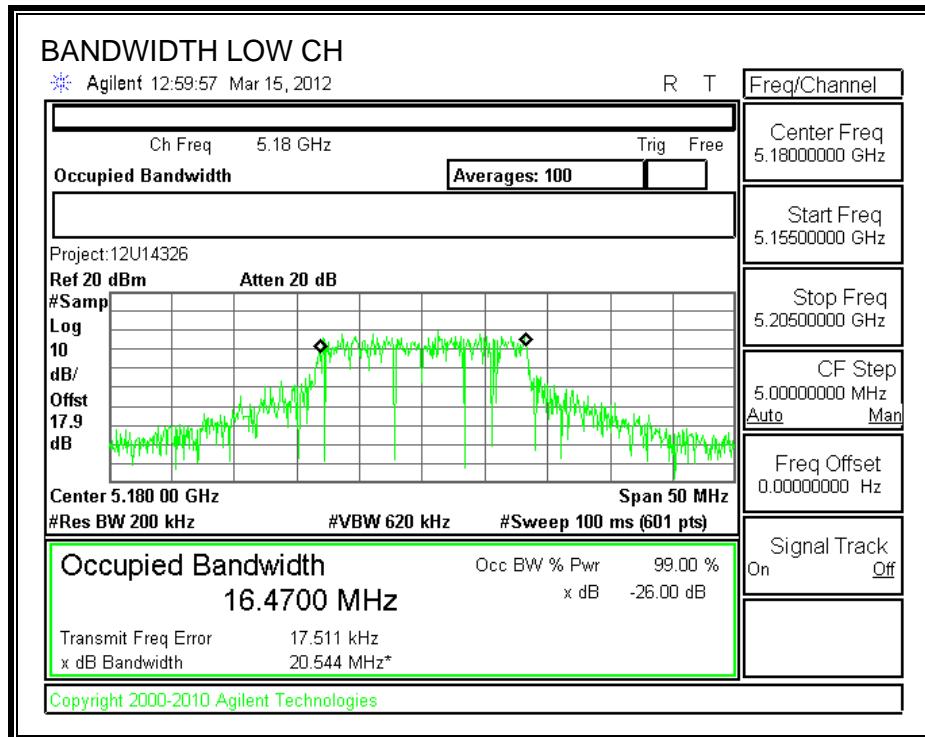
### LIMITS

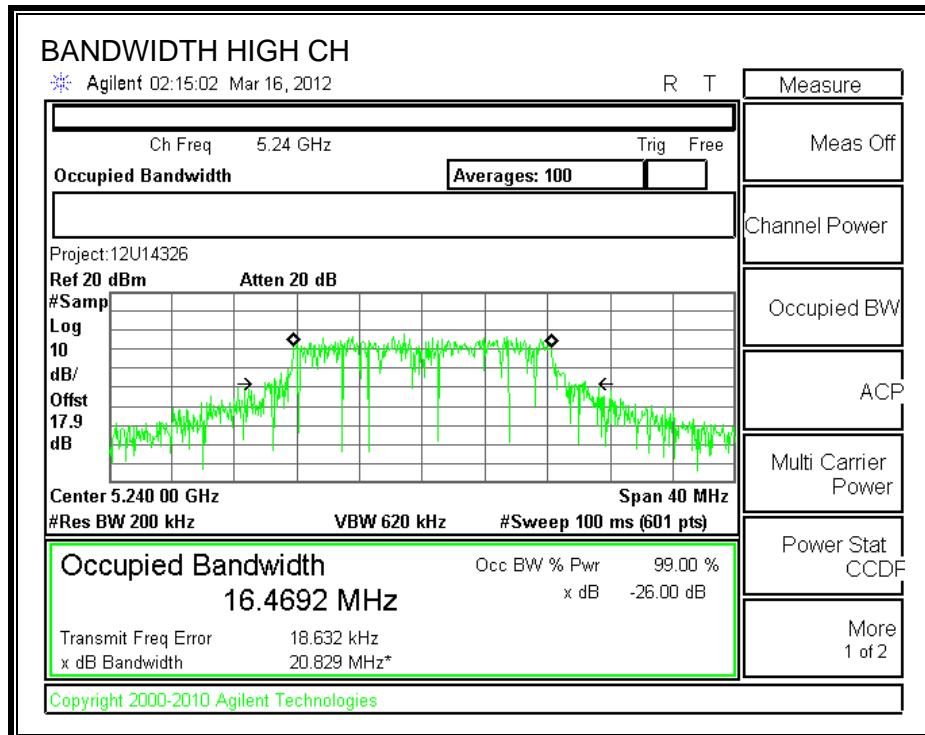
None; for reporting purposes only.

### RESULTS

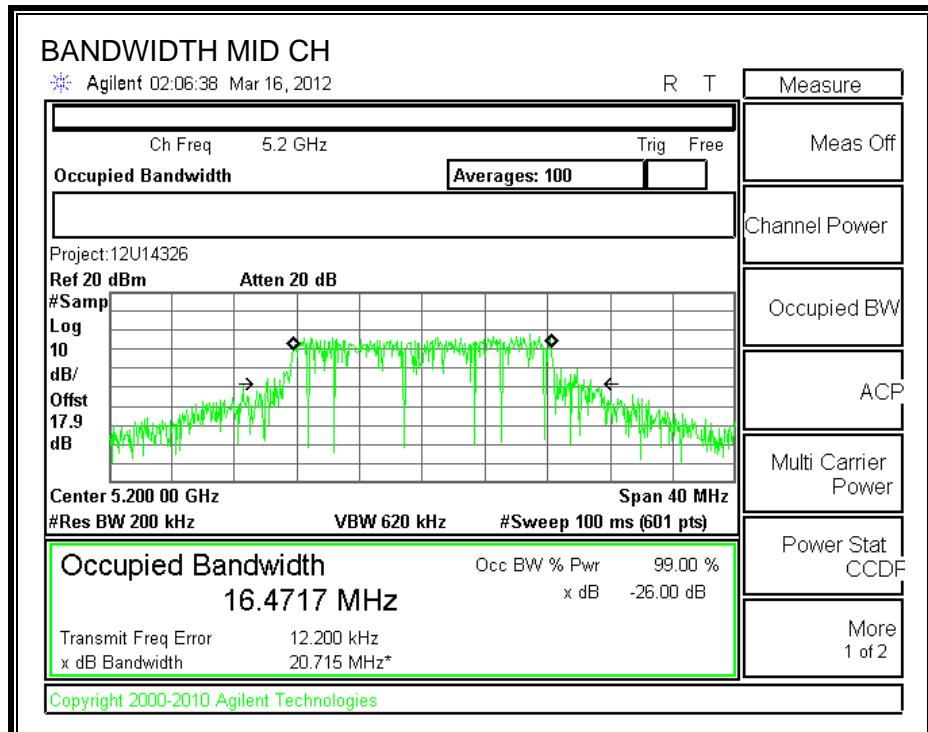
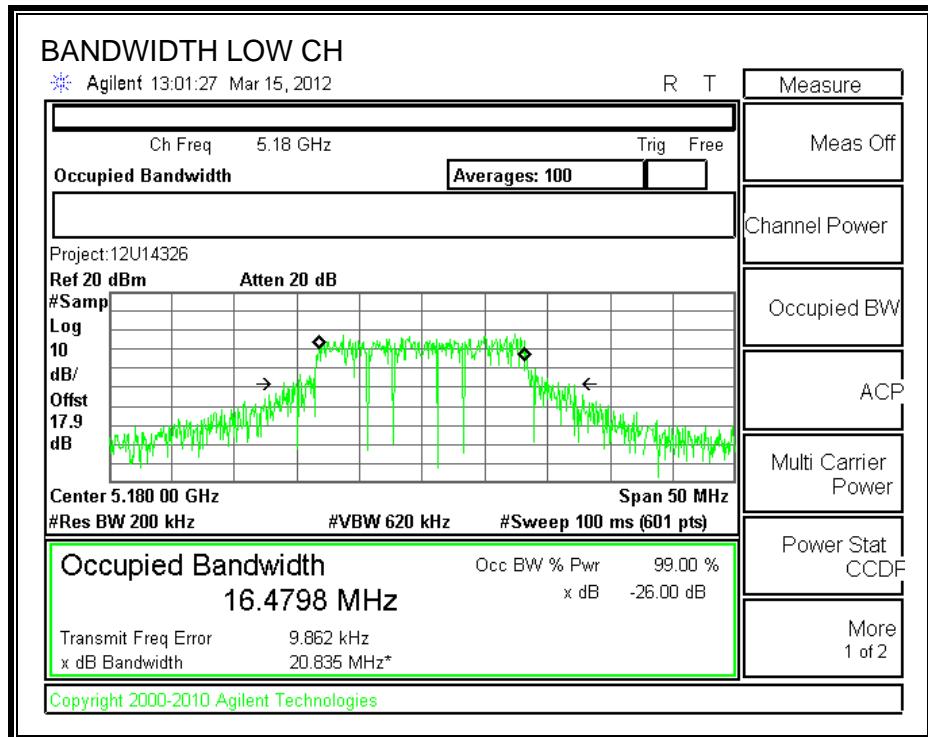
Channel	Frequency (MHz)	99% BW Chain 0 (MHz)	99% BW Chain 1 (MHz)
Low	5180	16.4700	16.4798
Mid	5200	16.4852	16.4717
High	5240	16.4692	16.4800

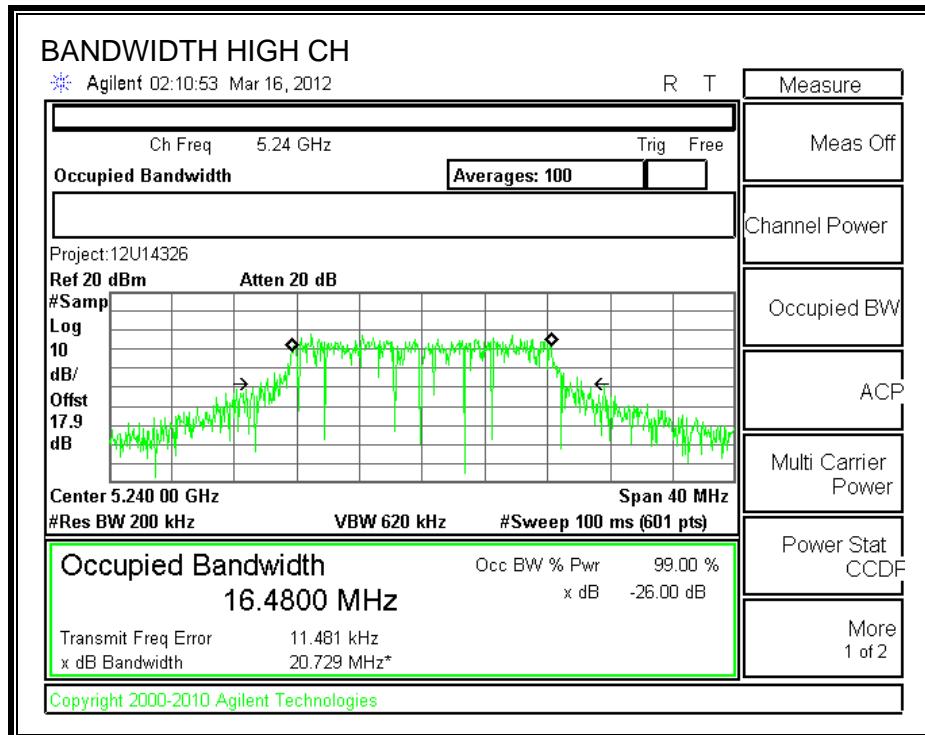
**99% BANDWIDTH CHAIN 0**





**99% BANDWIDTH CHAIN 1**





### 7.2.3. AVERAGE POWER

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.4 dB (including 10 dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

#### RESULTS

##### Average Power Results

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low	5180	11.60	12.10	14.87
Mid	5200	11.90	11.80	14.86
High	5240	11.00	11.30	14.16

## 7.2.4. OUTPUT POWER AND PPSD

### LIMITS

FCC §15.407 (a) (1)

IC RSS-210 A9.2 (1)

For the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or  $4 \text{ dBm} + 10 \log B$ , where B is the 26–dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### DIRECTIONAL ANTENNA GAIN

The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated Chains Directional Gain (dBi)
0.93	1.88	4.43

## RESULTS

### Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	4 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5180	17	23.8	17.77	4.43	17.00	4.00
Mid	5200	17	23.8	17.77	4.43	17.00	4.00
High	5240	17	24.1	17.81	4.43	17.00	4.00

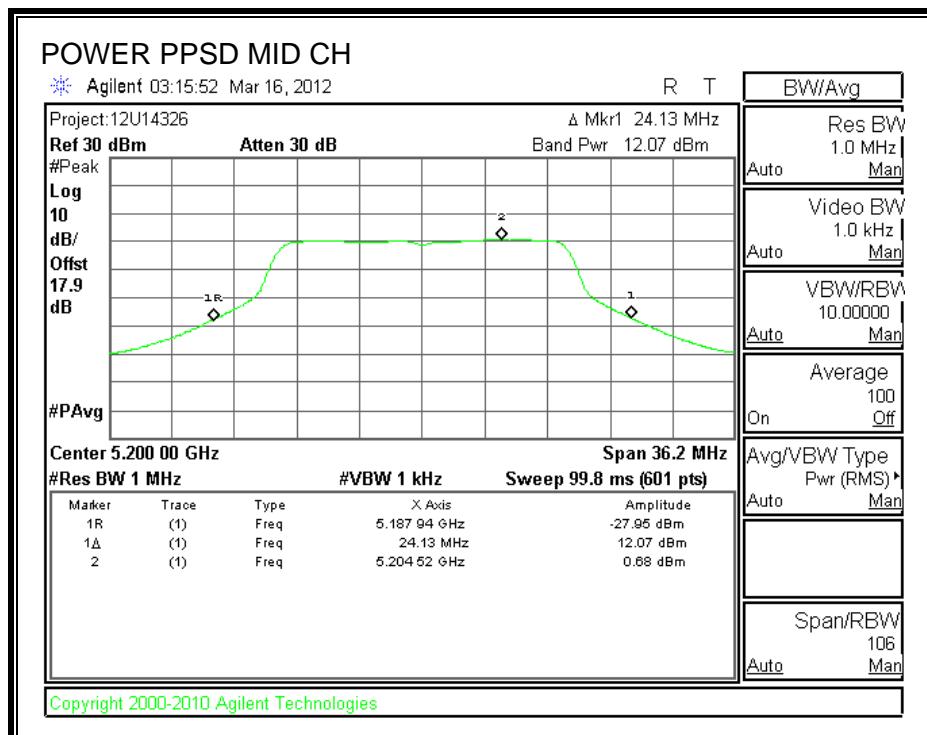
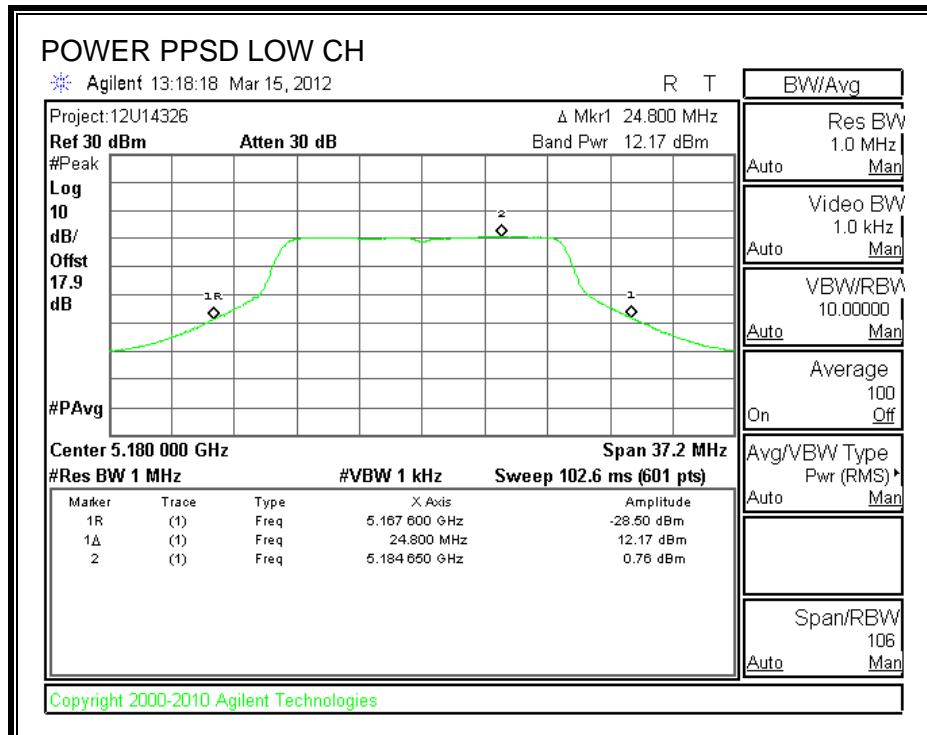
### Output Power Results

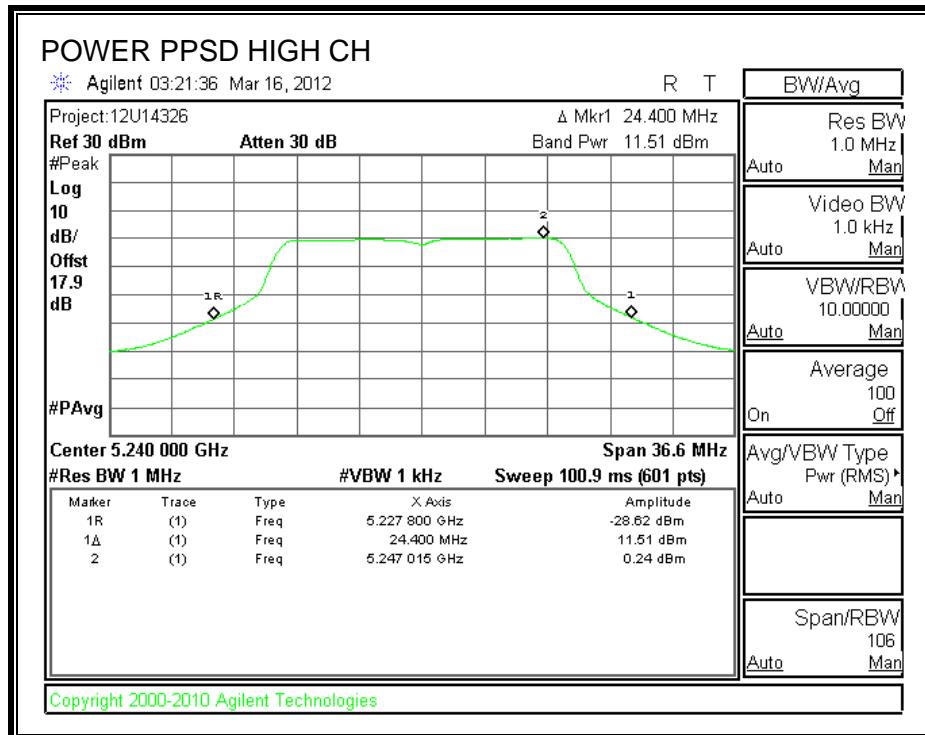
Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	12.17	11.87	15.03	17.00	-1.97
Mid	5200	12.07	11.63	14.87	17.00	-2.13
High	5240	11.51	10.90	14.22	17.00	-2.78

### PPSD Results

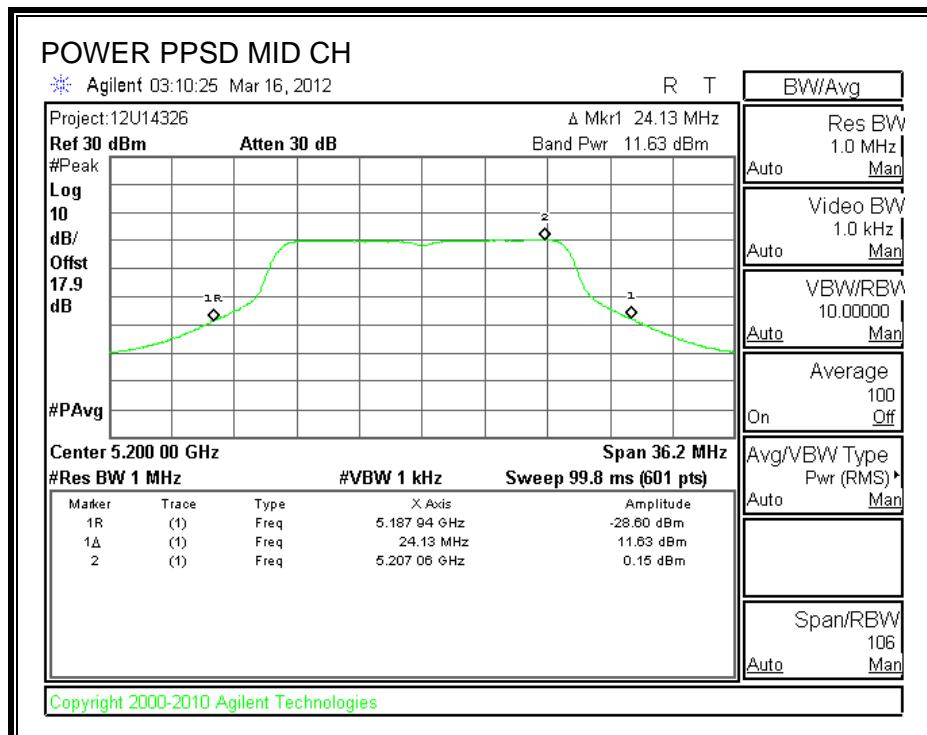
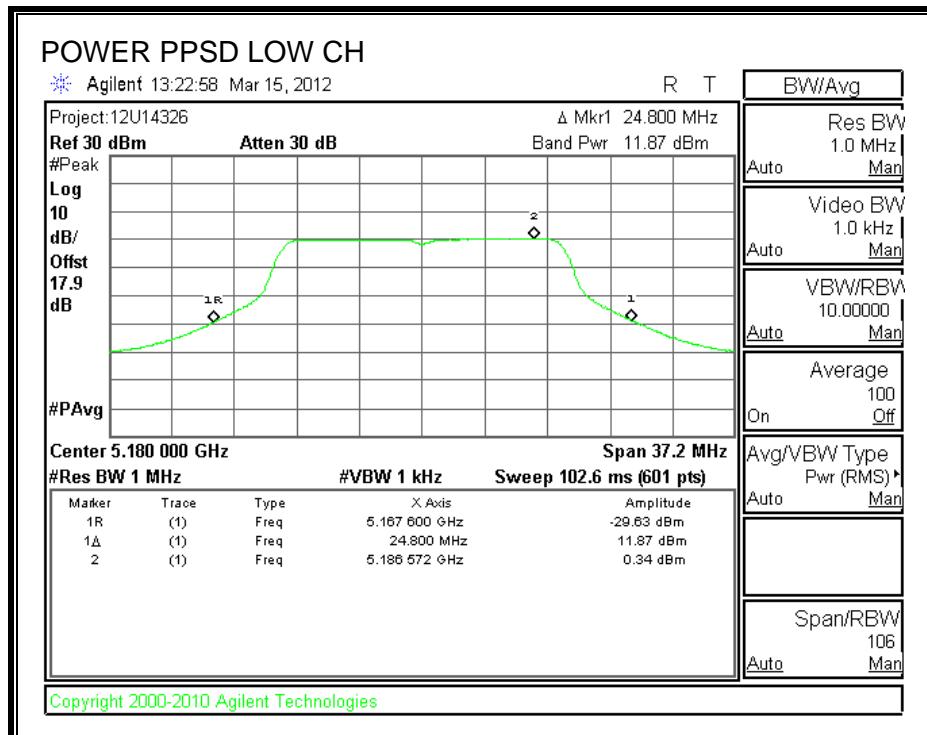
Channel	Frequency (MHz)	Chain 0 Meas PPSD (dBm)	Chain 1 Meas PPSD (dBm)	Total Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5180	0.76	0.34	3.57	4.00	-0.43
Mid	5200	0.68	0.15	3.43	4.00	-0.57
High	5240	0.24	-0.62	2.84	4.00	-1.16

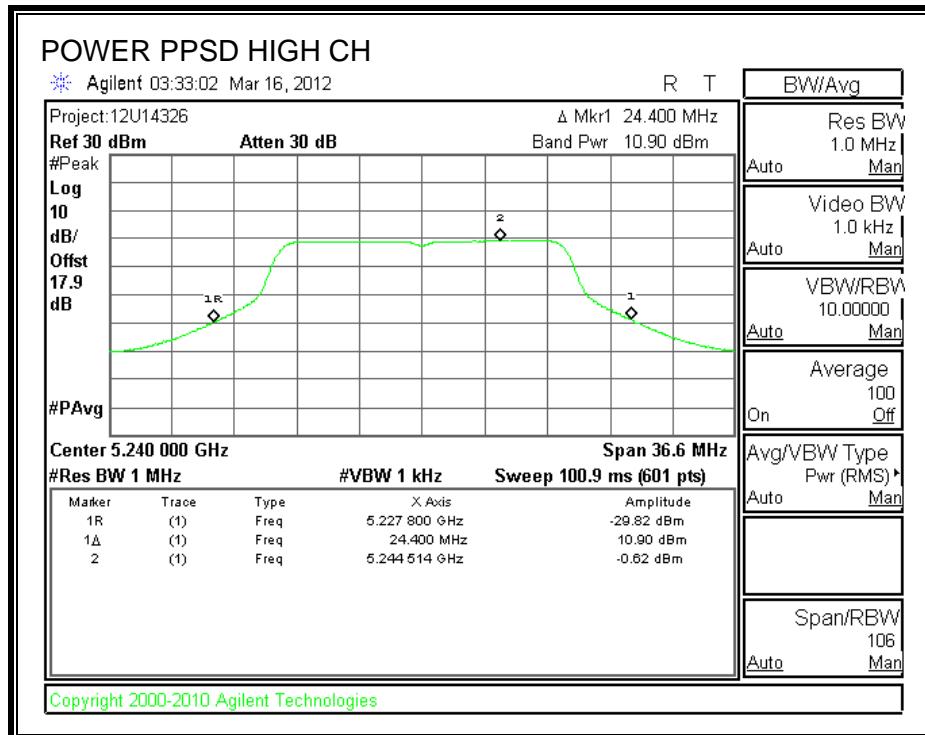
**OUTPUT POWER AND PPSD CHAIN 0**





## OUTPUT POWER AND PPSD CHAIN 1





## 7.2.5. PEAK EXCURSION

### LIMITS

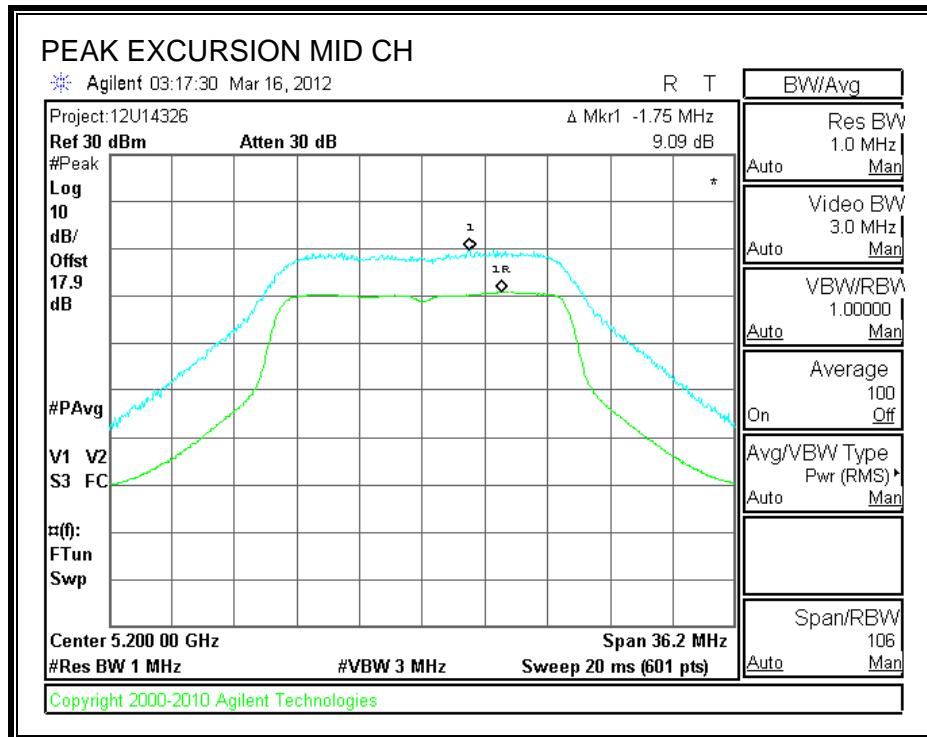
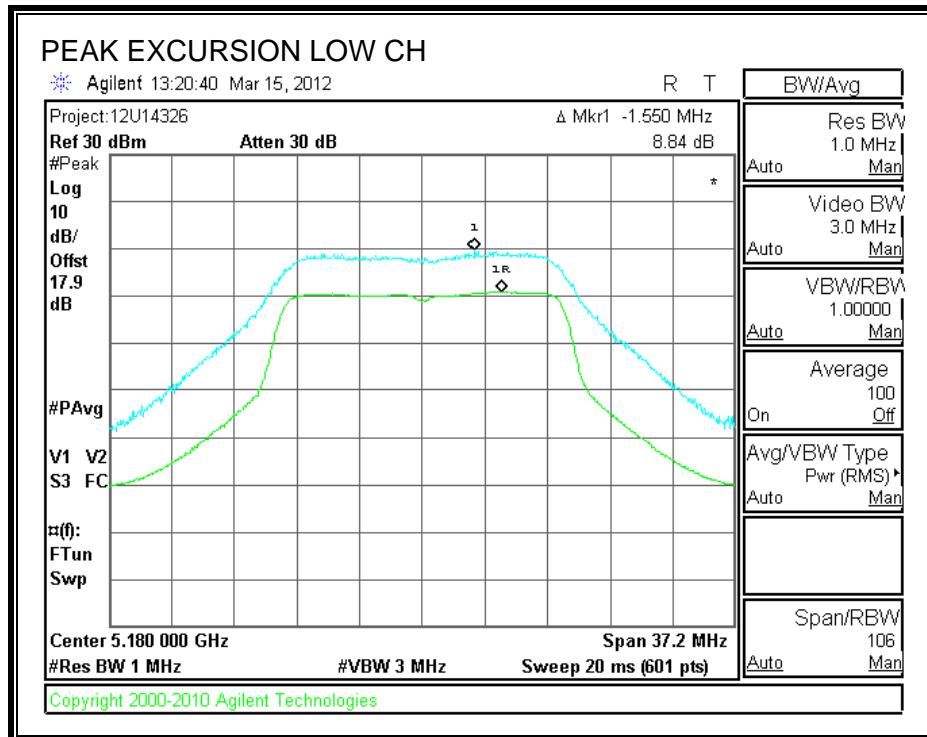
FCC §15.407 (a) (6)

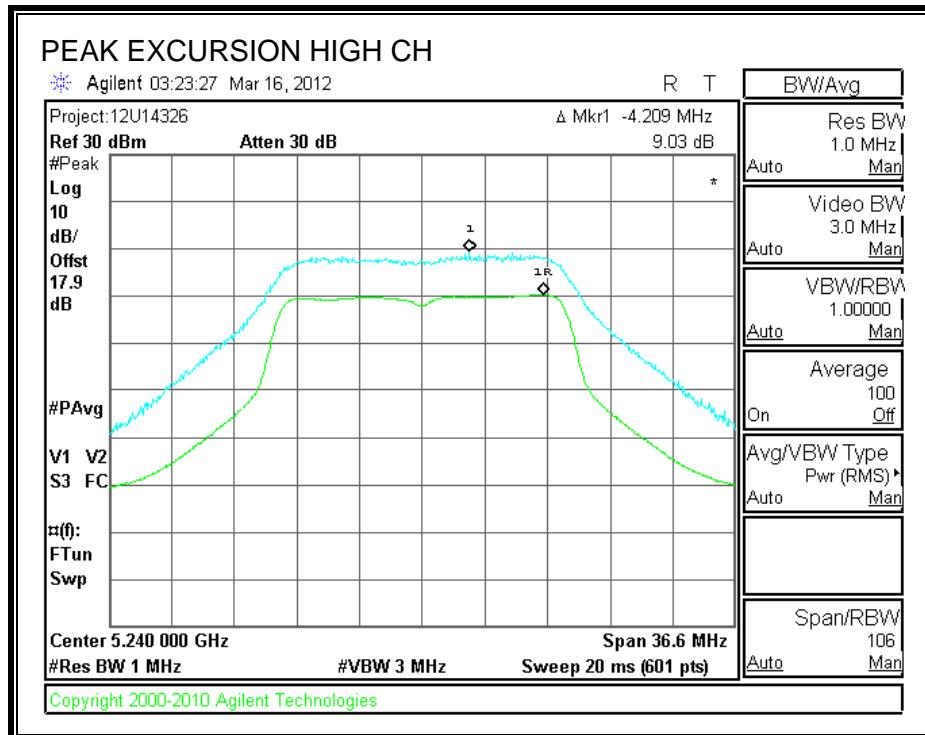
The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

### RESULTS

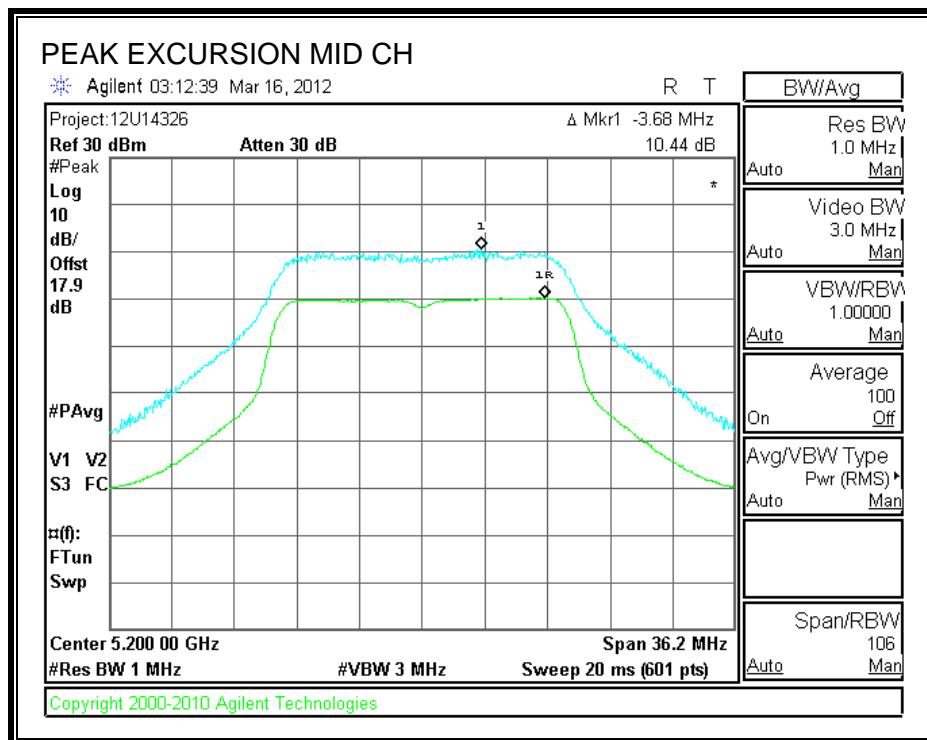
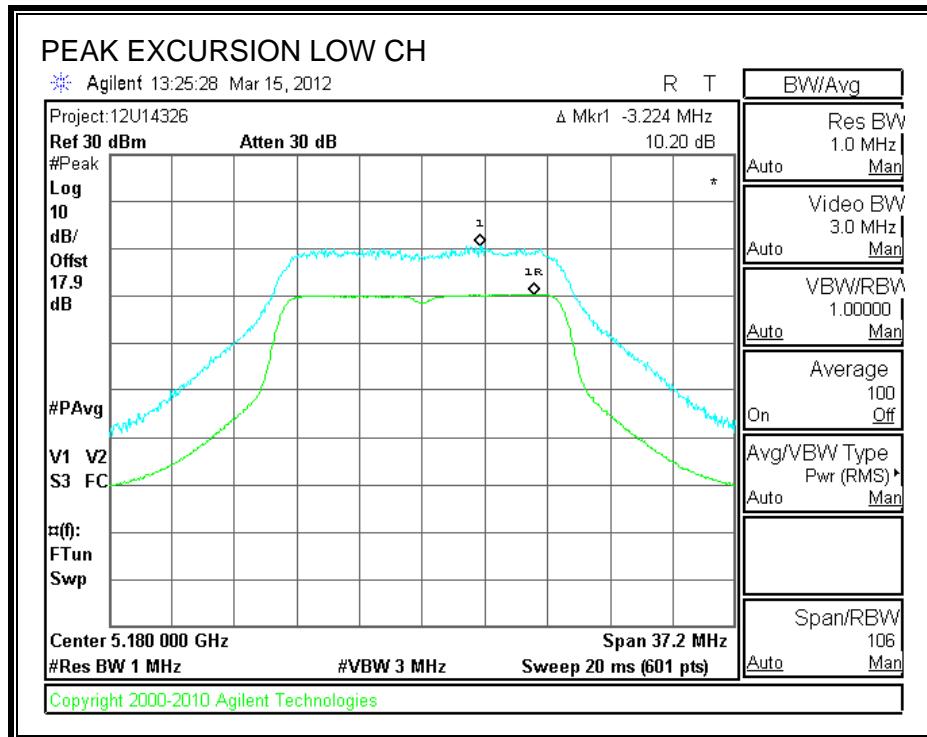
Channel	Frequency (MHz)	Pk Exc Chain 0 (dB)	Pk Exc Chain 1 (dB)	Limit (dB)	Worst-Case Margin (dB)
Low	5180	8.84	10.20	13	-2.8
Mid	5200	9.09	10.44	13	-2.6
High	5240	9.03	10.43	13	-2.6

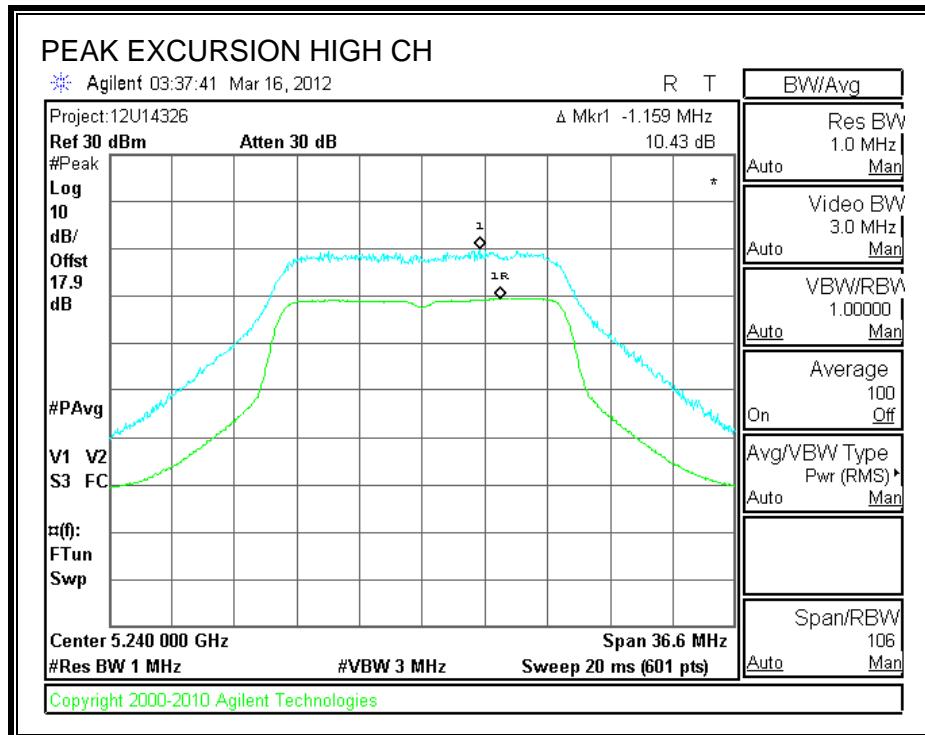
**PEAK EXCURSION CHAIN 0**





**PEAK EXCURSION CHAIN 1**





### 7.3. 802.11n HT20 MODE IN THE 5.2 GHz BAND

#### 7.3.1. 26 dB BANDWIDTH

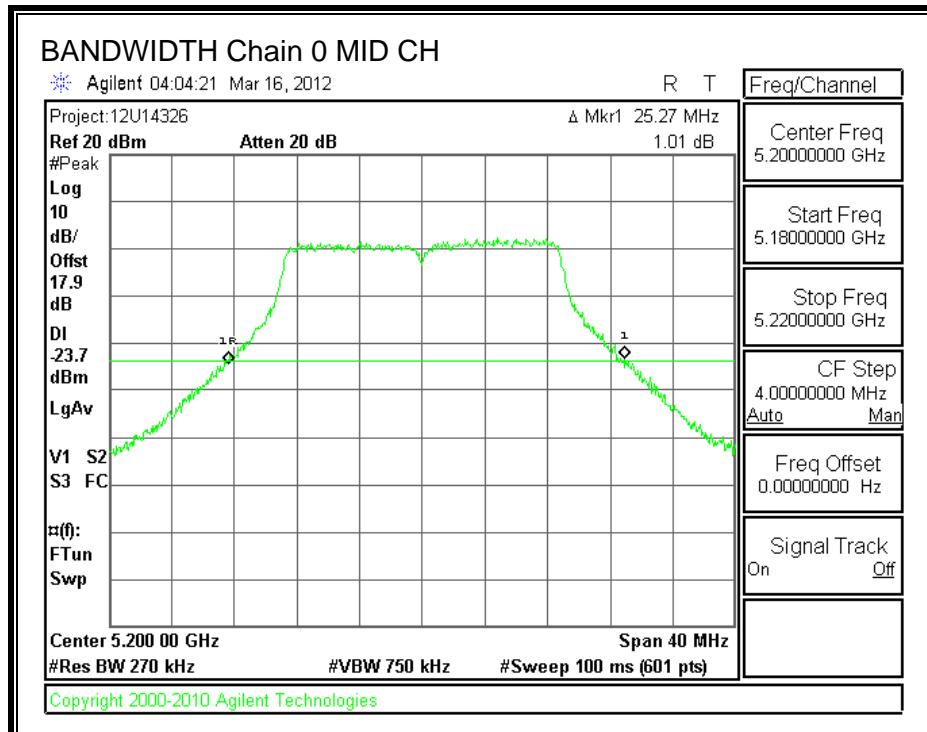
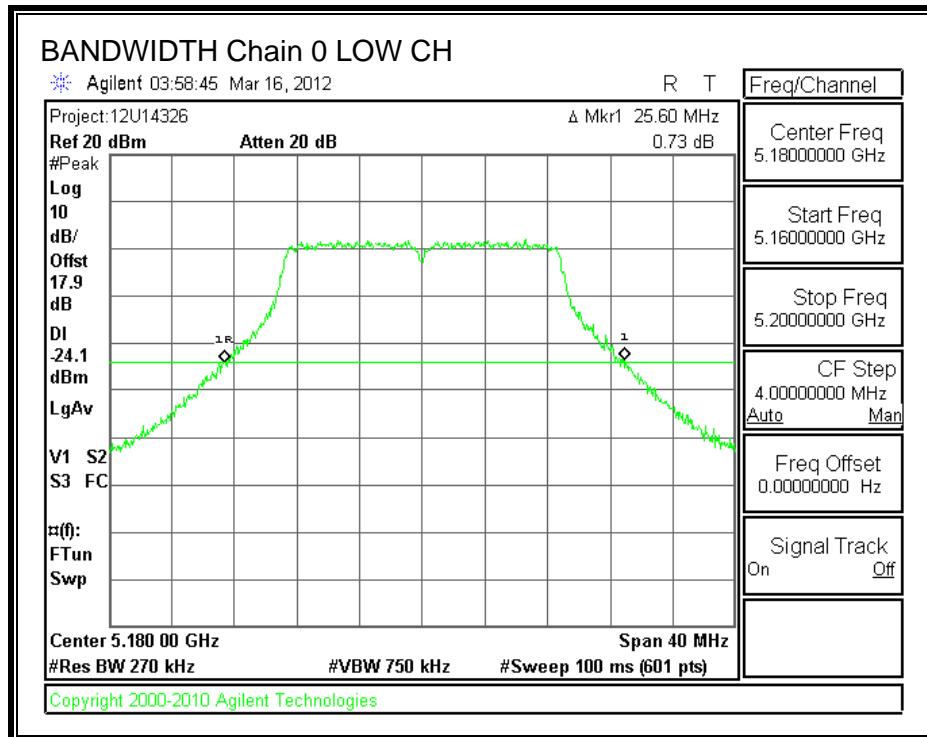
##### LIMITS

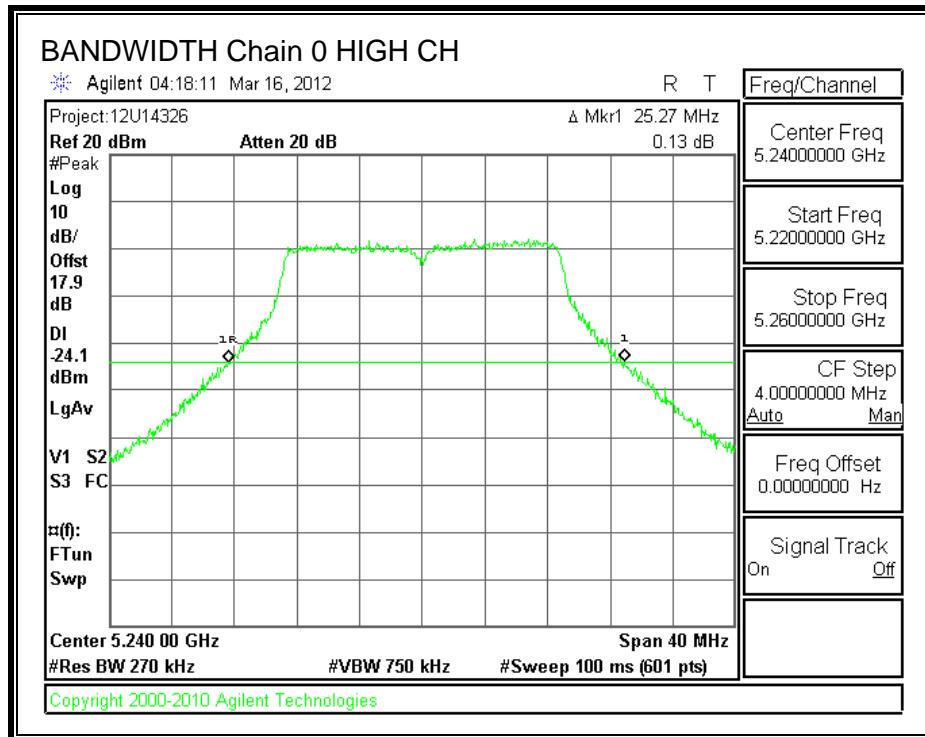
None; for reporting purposes only.

##### RESULTS

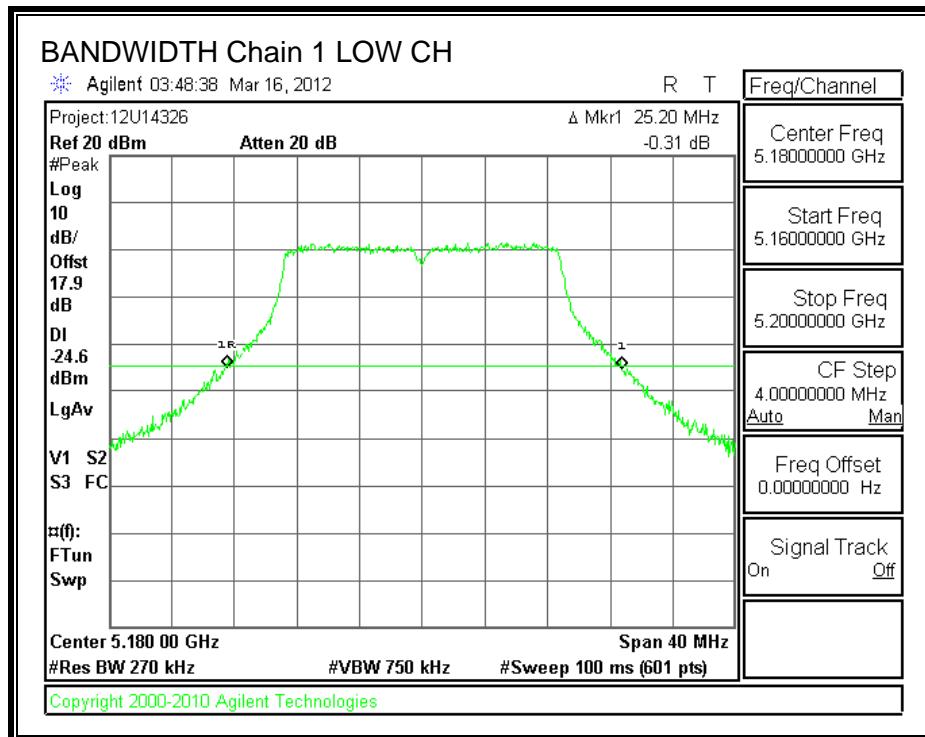
Channel	Frequency (MHz)	26 dB BW Chain 0 (MHz)	26 dB BW Chain 1 (MHz)
Low	5180	25.60	25.20
Mid	5200	25.27	25.13
High	5240	25.27	25.00

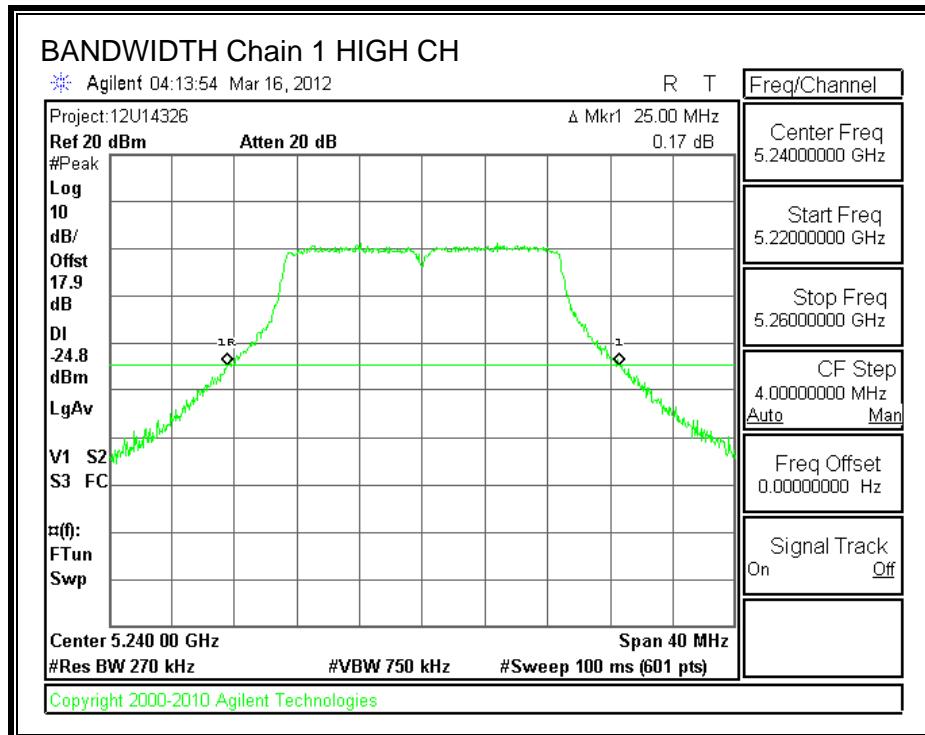
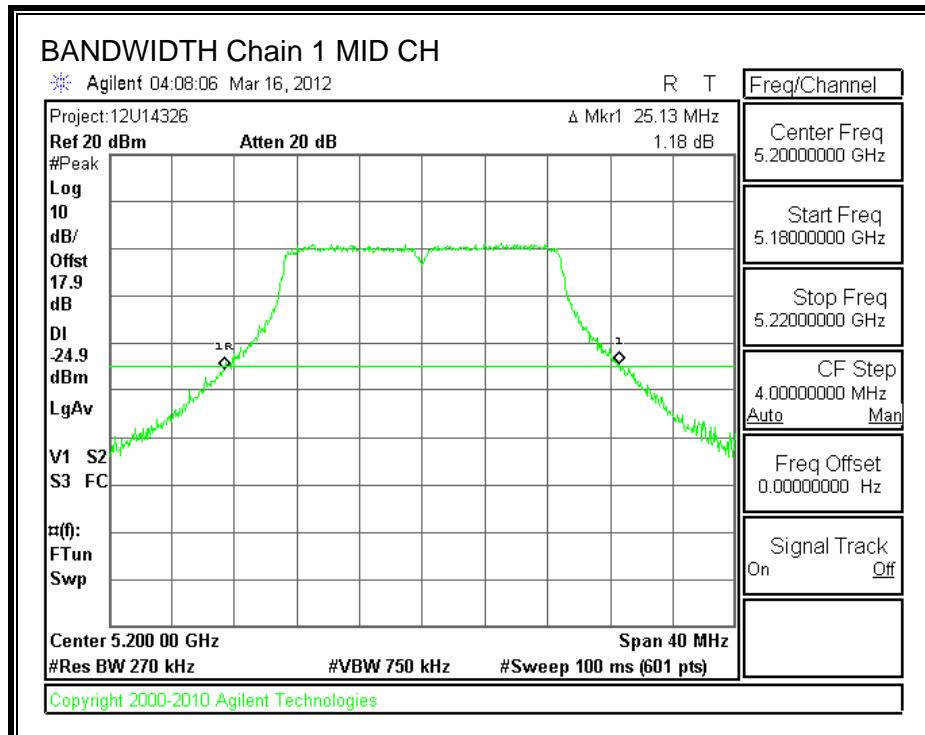
**26 dB BANDWIDTH, Chain 0**





### 26 dB BANDWIDTH, Chain 1





### 7.3.2. 99% BANDWIDTH

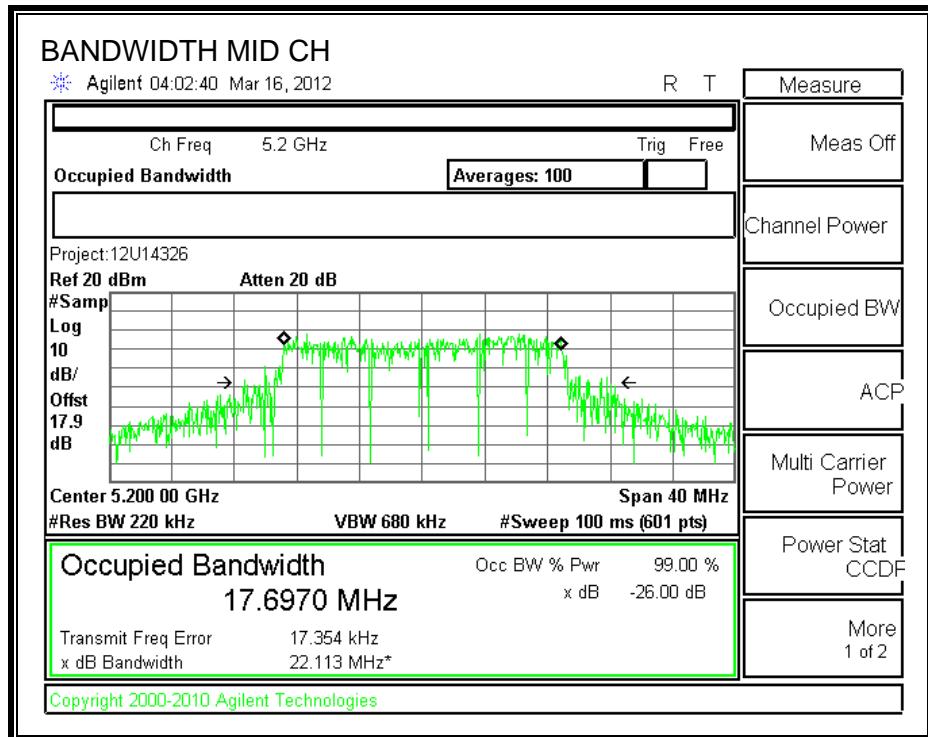
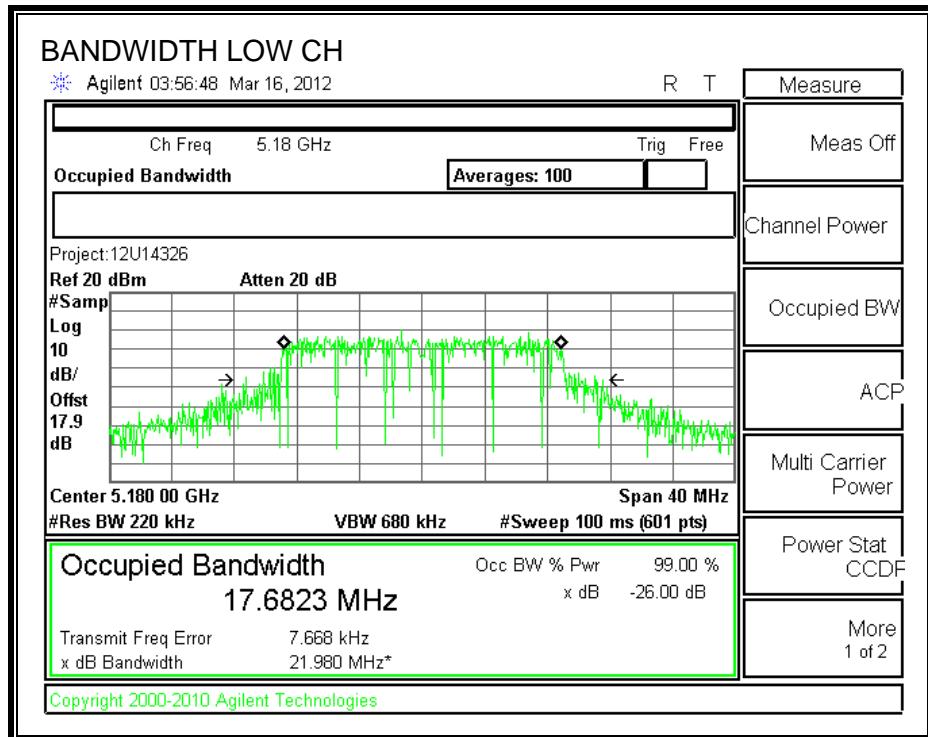
#### LIMITS

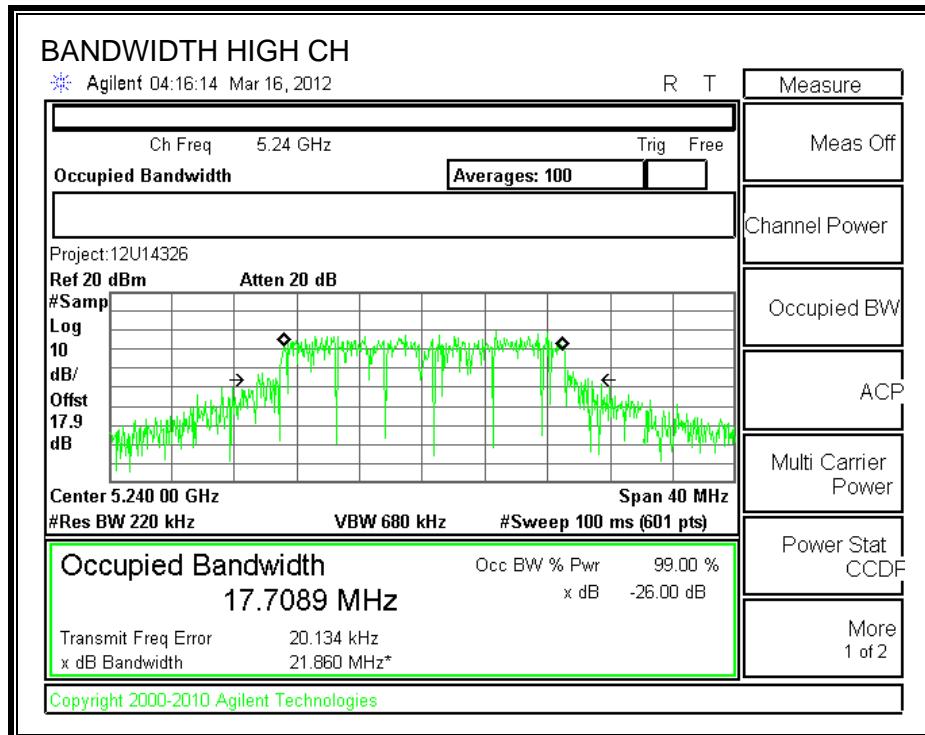
None; for reporting purposes only.

#### RESULTS

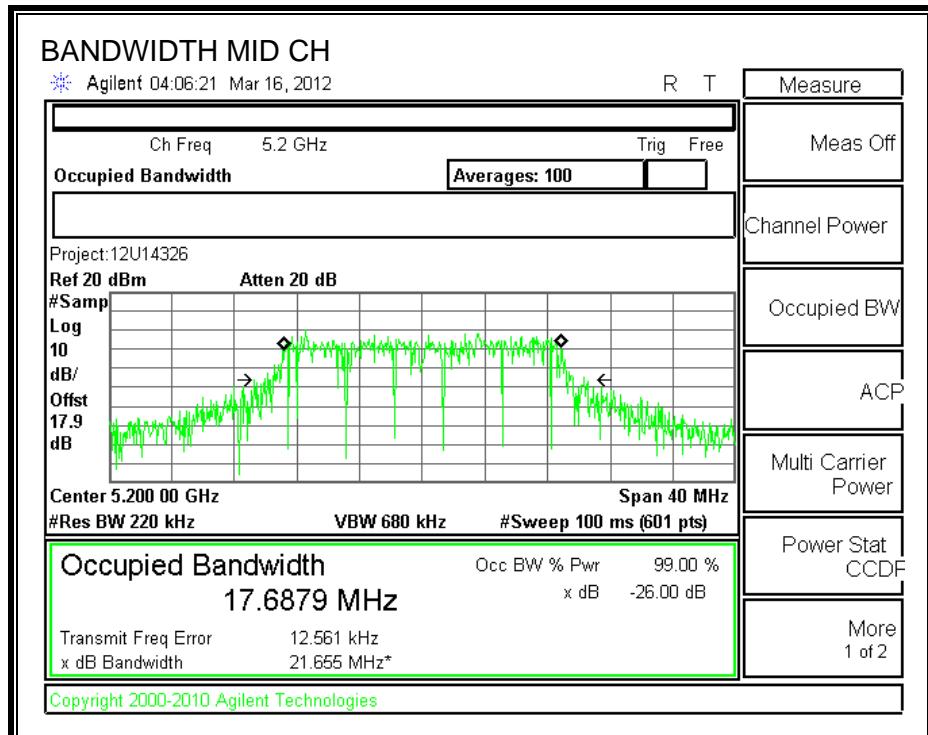
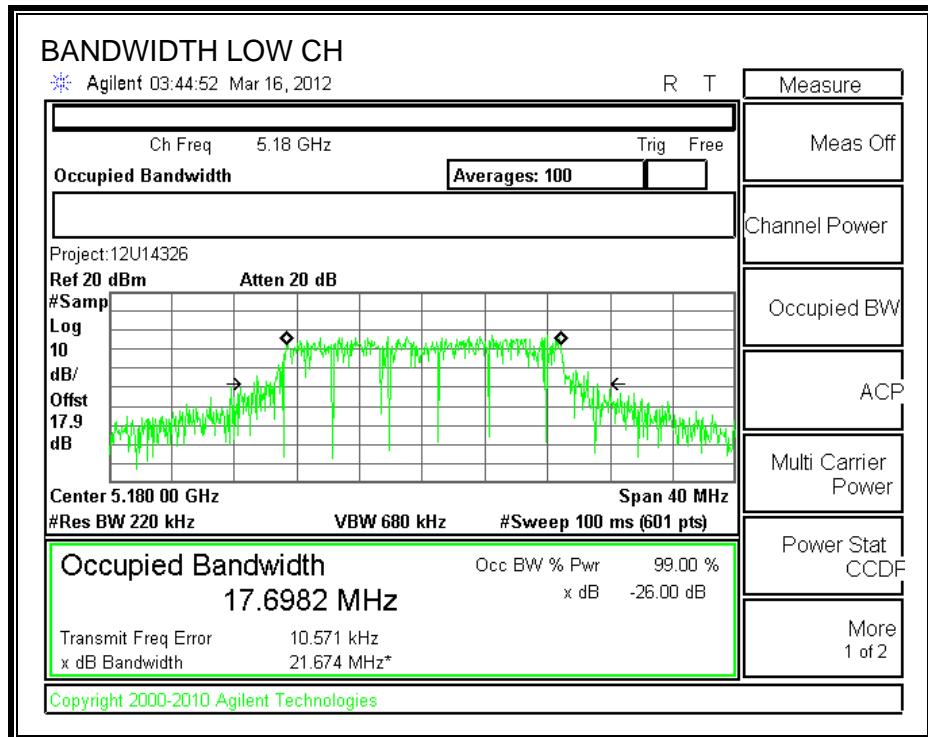
Channel	Frequency (MHz)	99% BW Chain 0 (MHz)	99% BW Chain 1 (MHz)
Low	5180	17.6823	17.6982
Mid	5200	17.6970	17.6879
High	5240	17.7089	17.6777

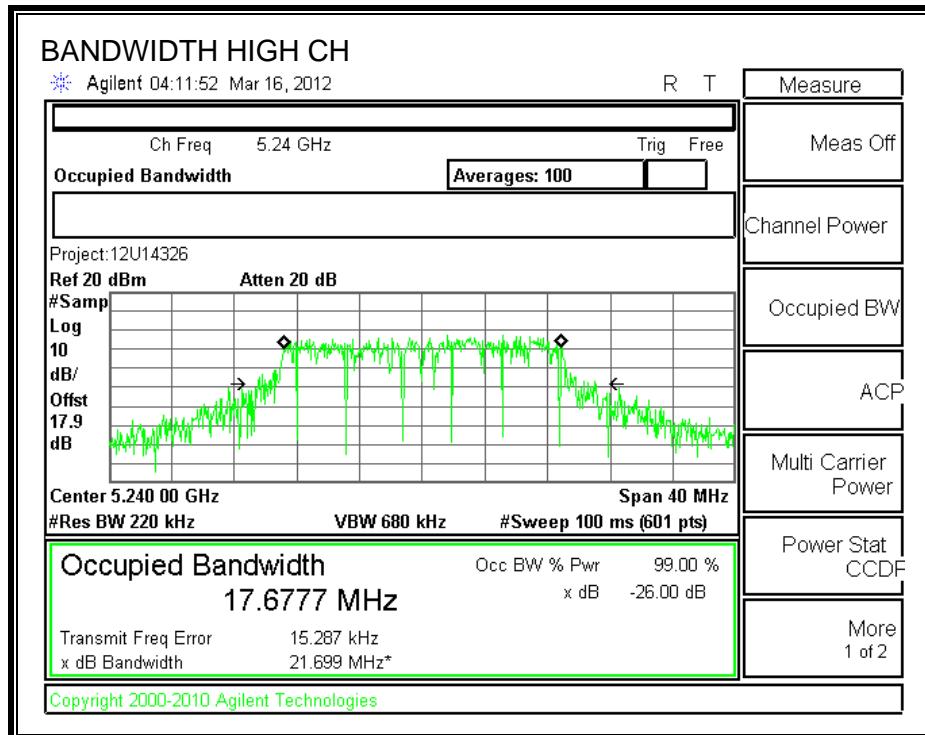
**99% BANDWIDTH CHAIN 0**





**99% BANDWIDTH CHAIN 1**





### 7.3.3. AVERAGE POWER

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.4 dB (including 10 dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

#### RESULTS

##### Average Power Results

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low	5180	11.40	11.50	14.46
Mid	5200	11.40	11.40	14.41
High	5240	11.10	11.50	14.31

### 7.3.4. OUTPUT POWER AND PPSD

#### LIMITS

FCC §15.407 (a) (1)

IC RSS-210 A9.2 (1)

For the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or  $4 \text{ dBm} + 10 \log B$ , where B is the 26–dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### DIRECTIONAL ANTENNA GAIN

The TX chains are uncorrelated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
0.93	1.88	1.43

## RESULTS

### Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	4 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5180	17	25.20	18.01	1.43	17.00	4.00
Mid	5200	17	25.13	18.00	1.43	17.00	4.00
High	5240	17	25.00	17.98	1.43	17.00	4.00

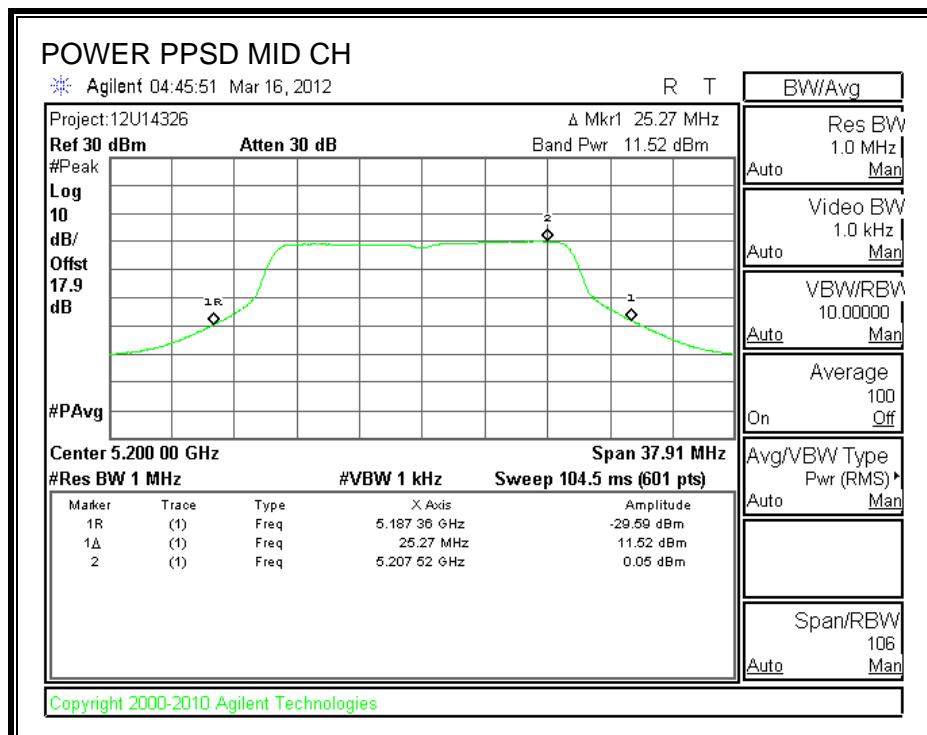
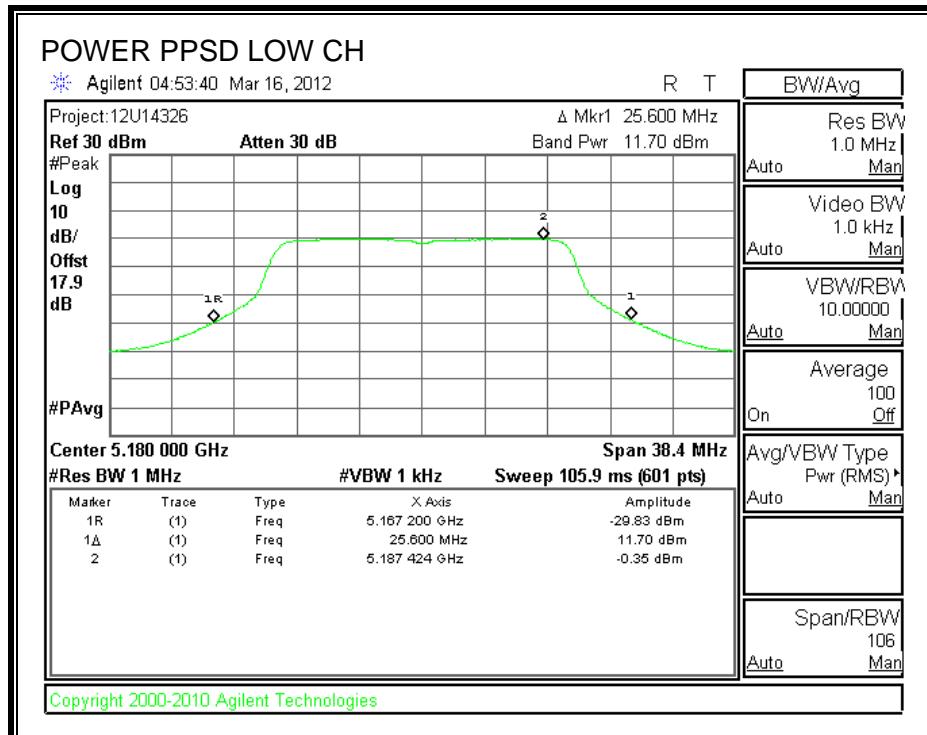
### Output Power Results

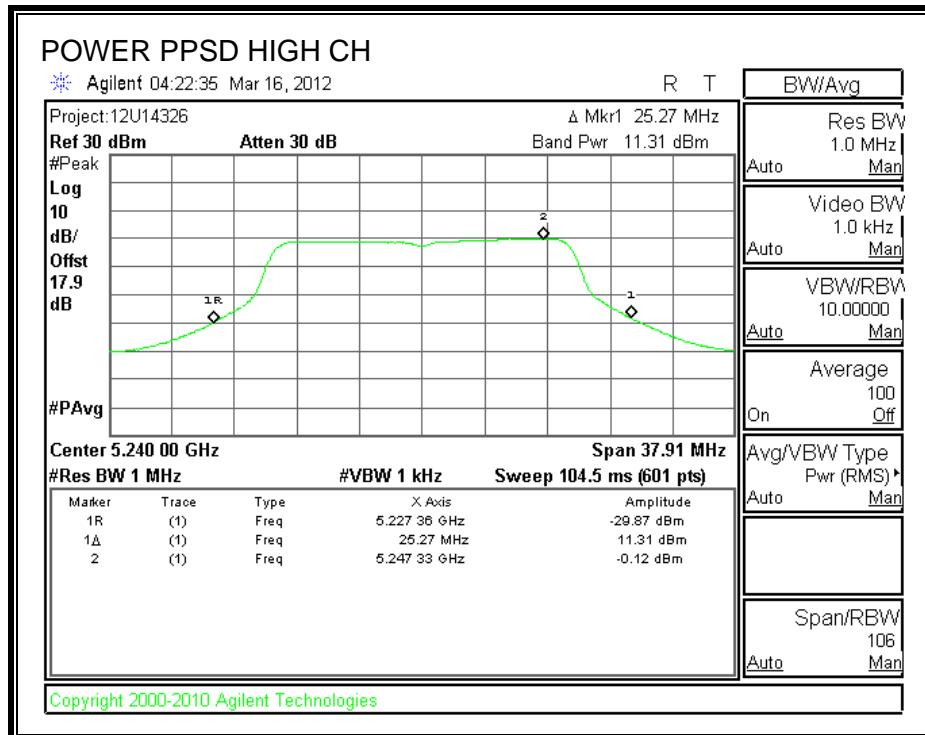
Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	11.70	11.36	14.55	17.00	-2.45
Mid	5200	11.52	11.06	14.31	17.00	-2.69
High	5240	11.31	10.77	14.06	17.00	-2.94

### PPSD Results

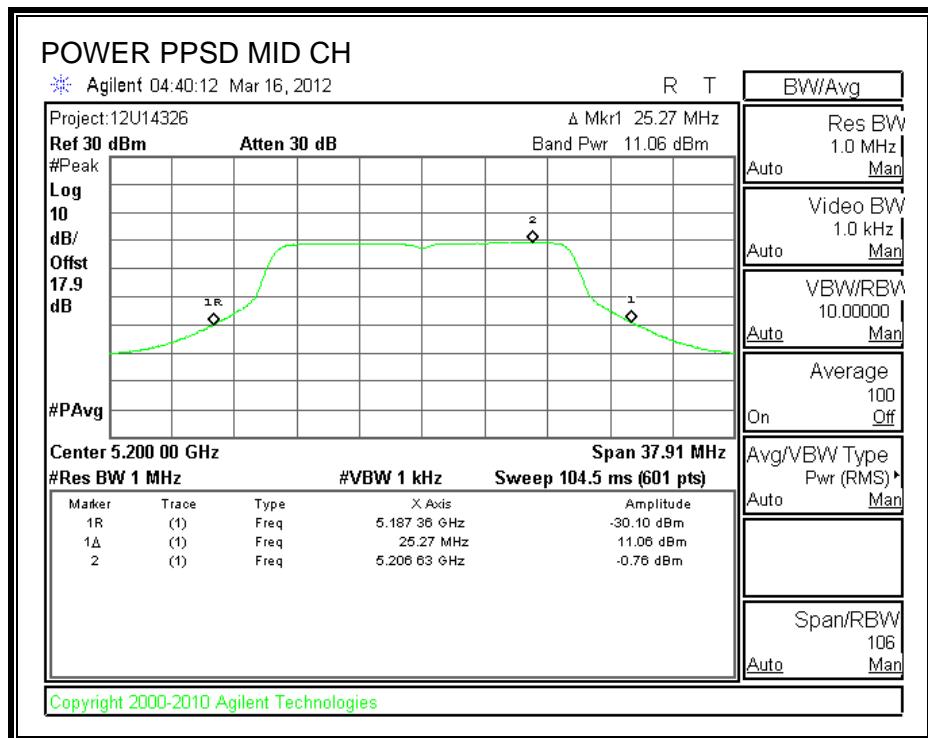
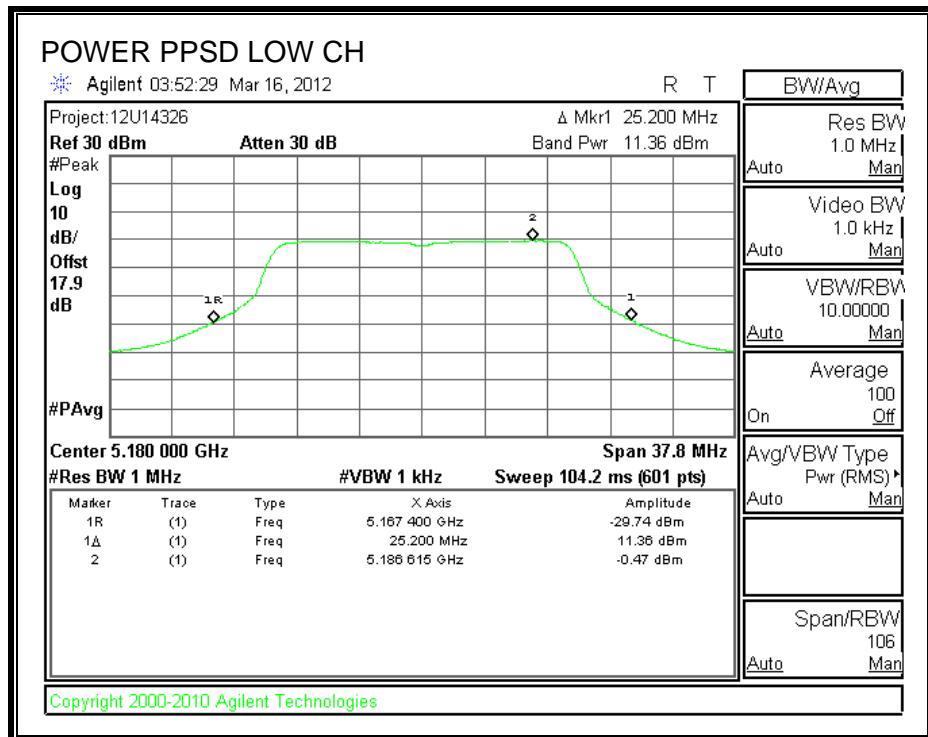
Channel	Frequency (MHz)	Chain 0 Meas PPSD (dBm)	Chain 1 Meas PPSD (dBm)	Total Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5180	-0.35	-0.47	2.60	4.00	-1.40
Mid	5200	0.05	-0.76	2.67	4.00	-1.33
High	5240	-0.12	-1.08	2.44	4.00	-1.56

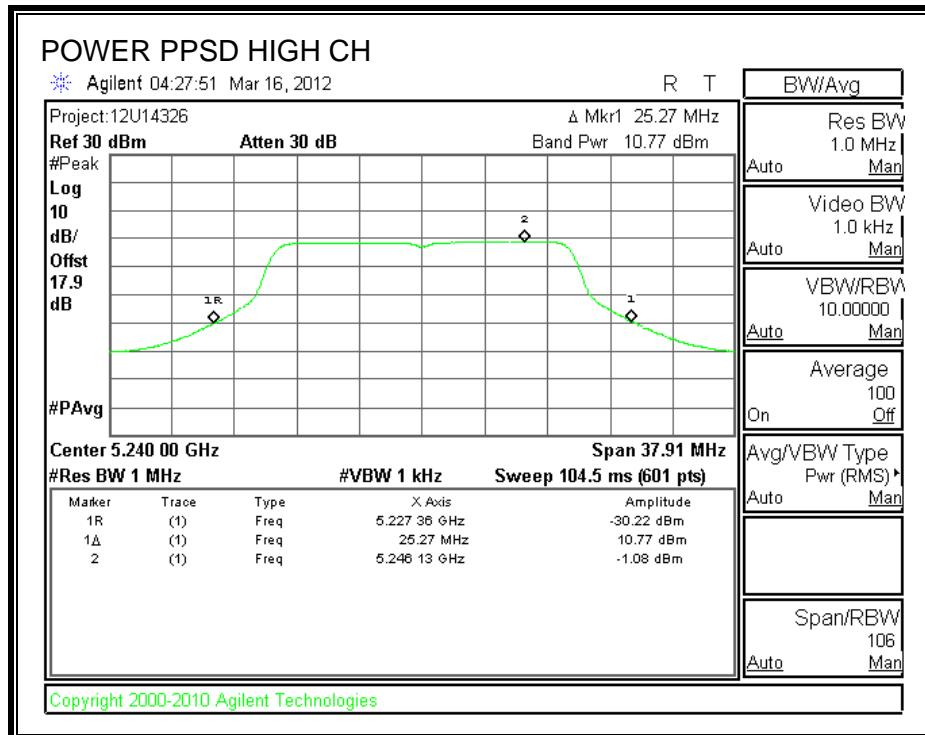
**OUTPUT POWER AND PPSD CHAIN 0**





## OUTPUT POWER AND PPSD CHAIN 1





### 7.3.5. PEAK EXCURSION

#### LIMITS

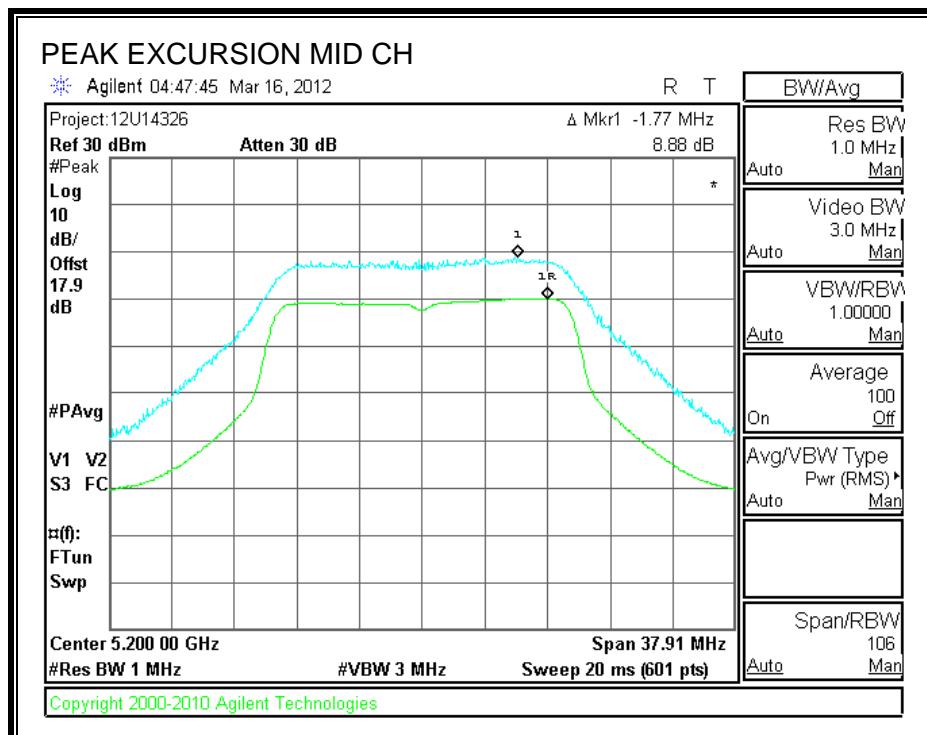
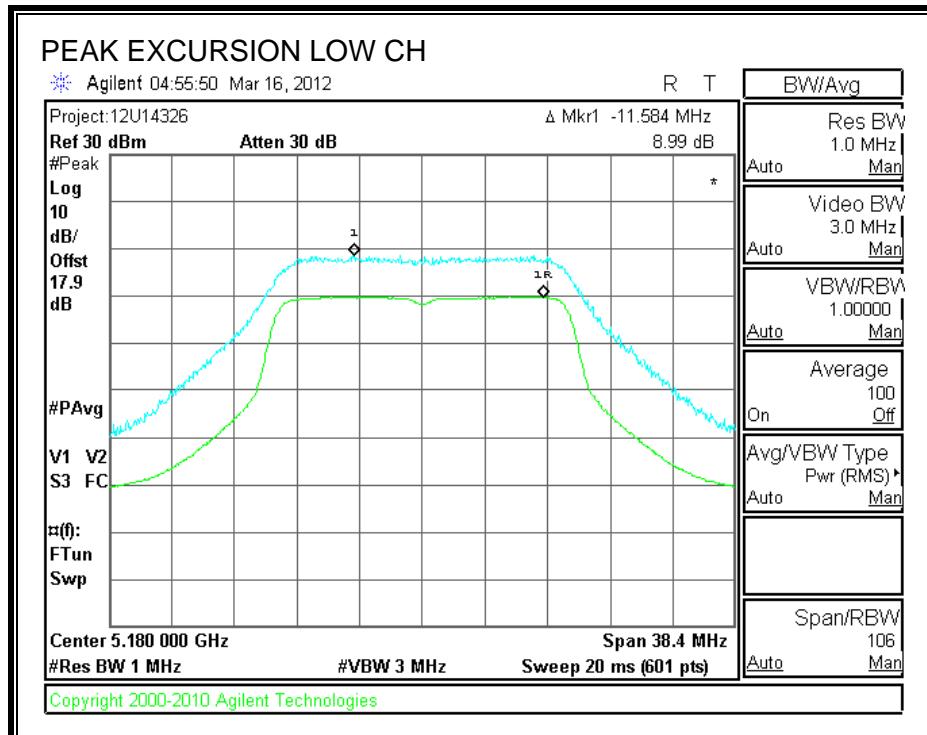
FCC §15.407 (a) (6)

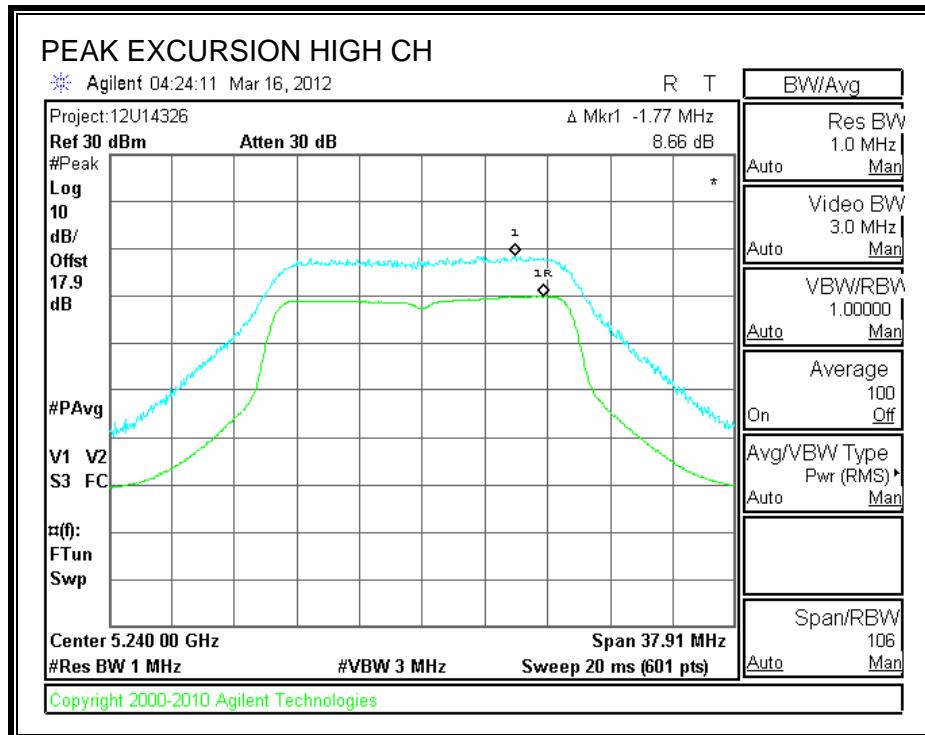
The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

#### RESULTS

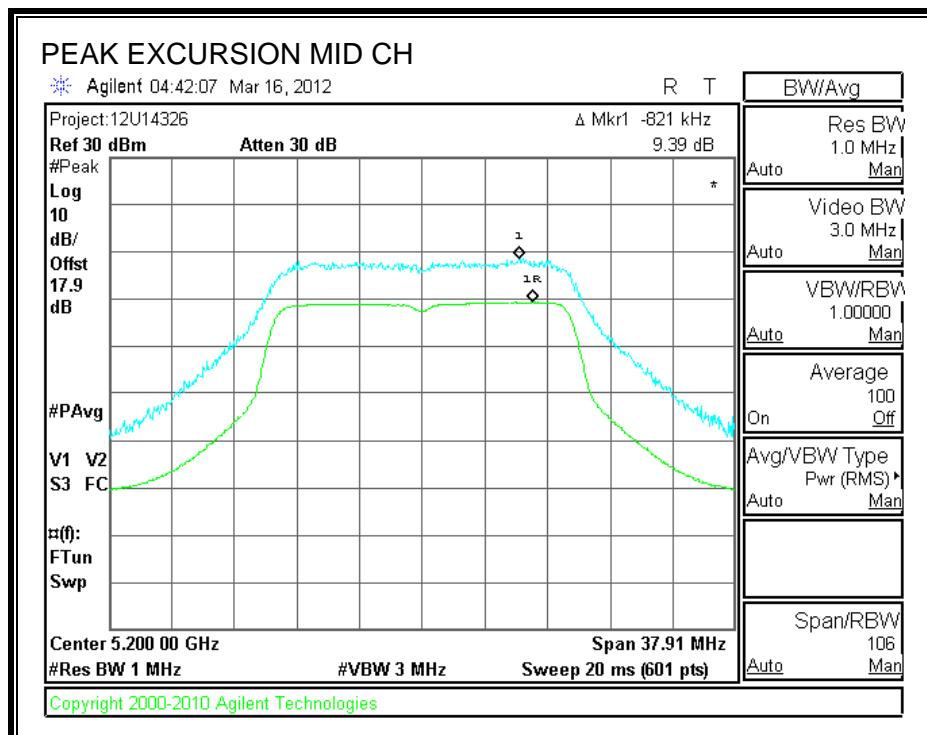
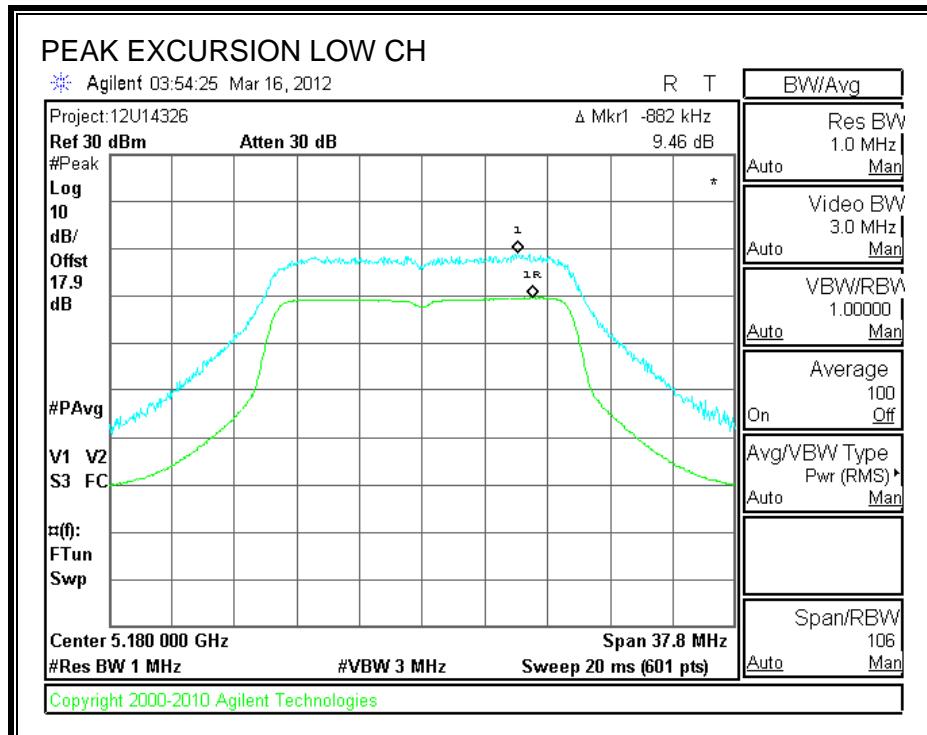
Channel	Frequency (MHz)	Pk Exc Chain 0 (dB)	Pk Exc Chain 1 (dB)	Limit (dB)	Worst-Case Margin (dB)
Low	5180	8.99	9.46	13	-3.5
Mid	5200	8.88	9.39	13	-3.6
High	5240	8.66	9.61	13	-3.4

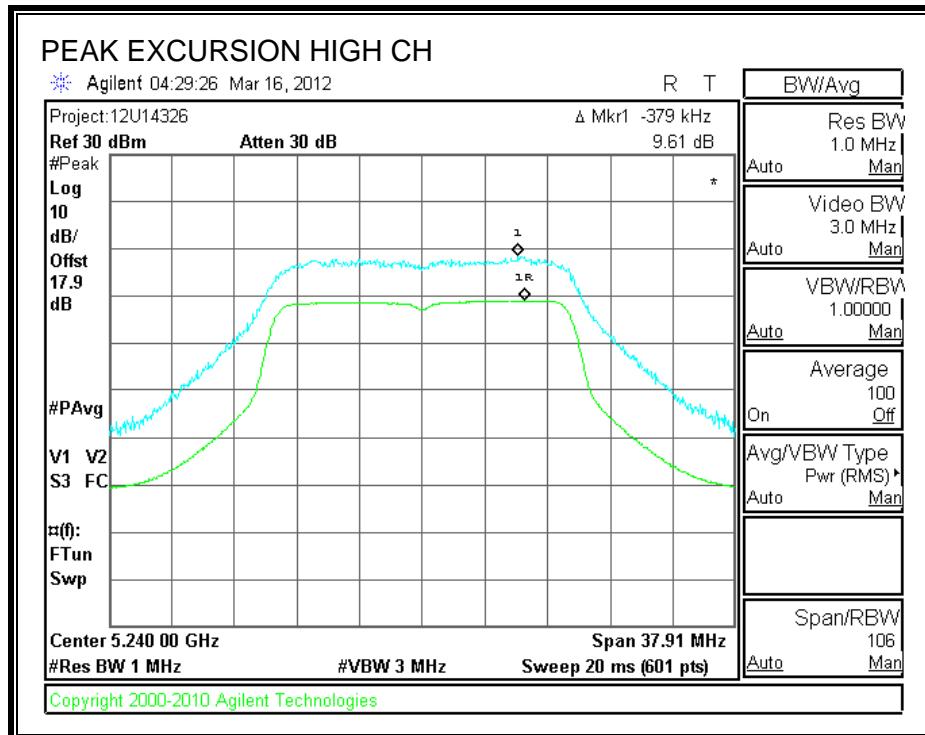
**PEAK EXCURSION CHAIN 0**





**PEAK EXCURSION CHAIN 1**





## 7.4. 802.11n HT40 MODE IN THE 5.2 GHz BAND

### 7.4.1. 26 dB BANDWIDTH

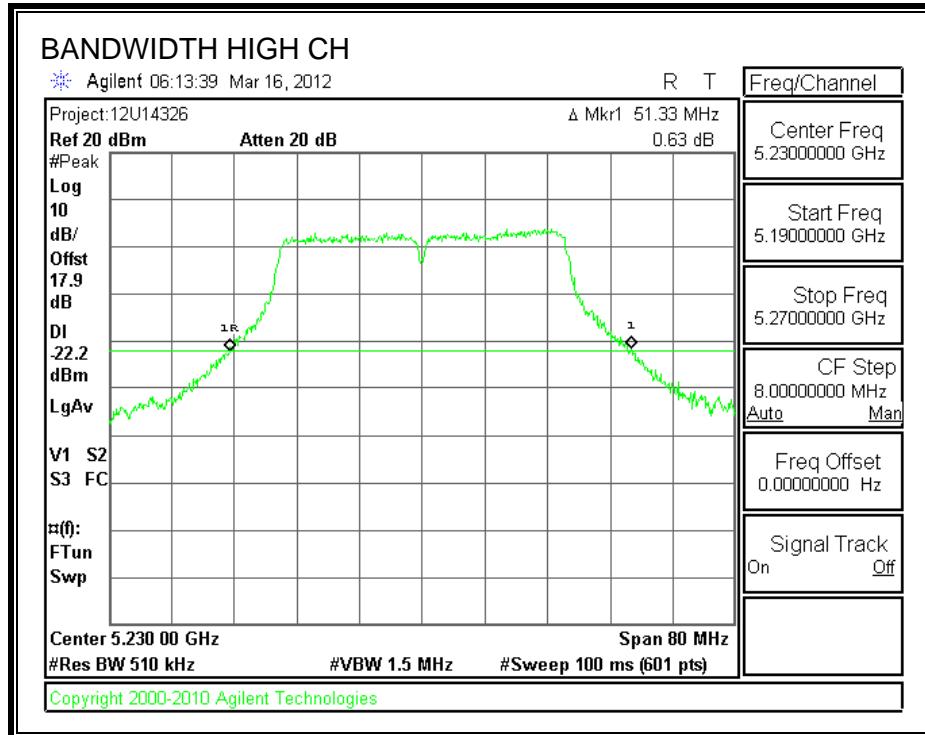
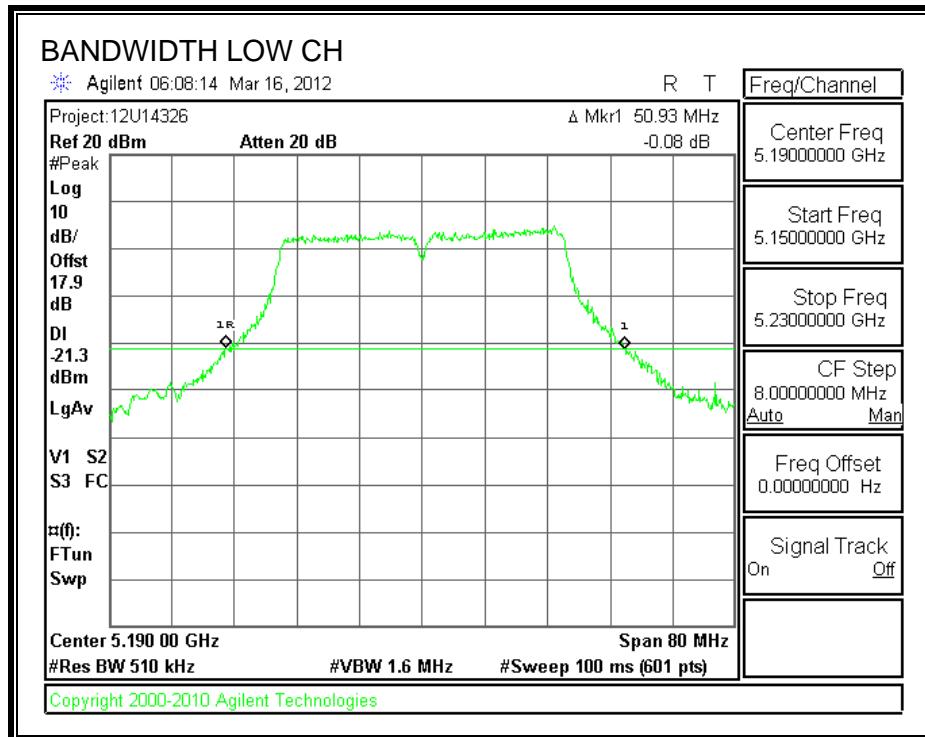
#### LIMITS

None; for reporting purposes only.

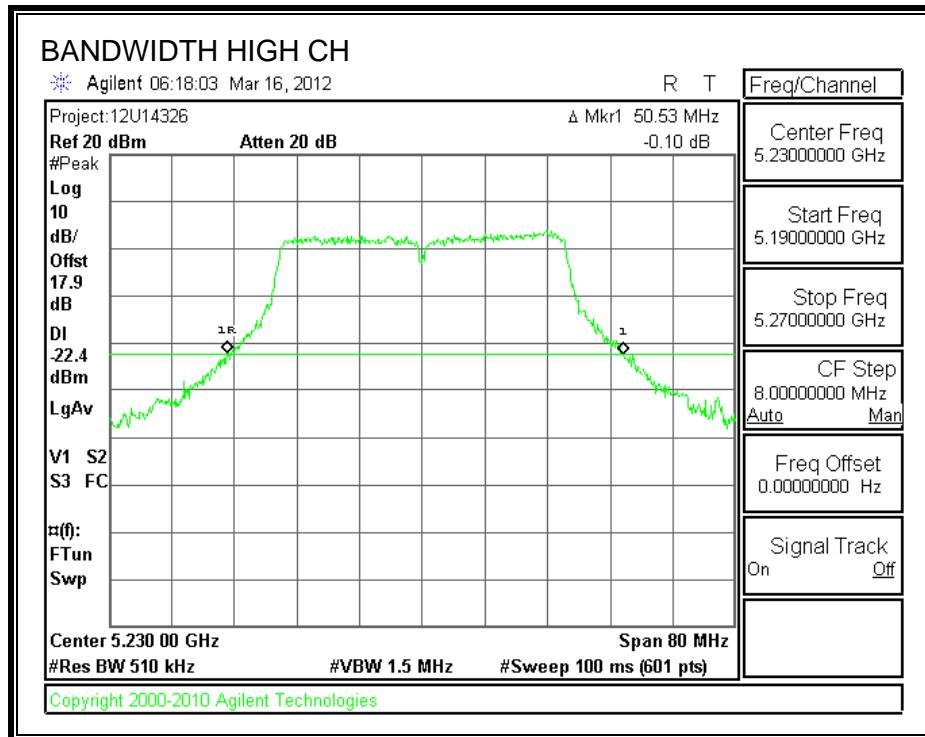
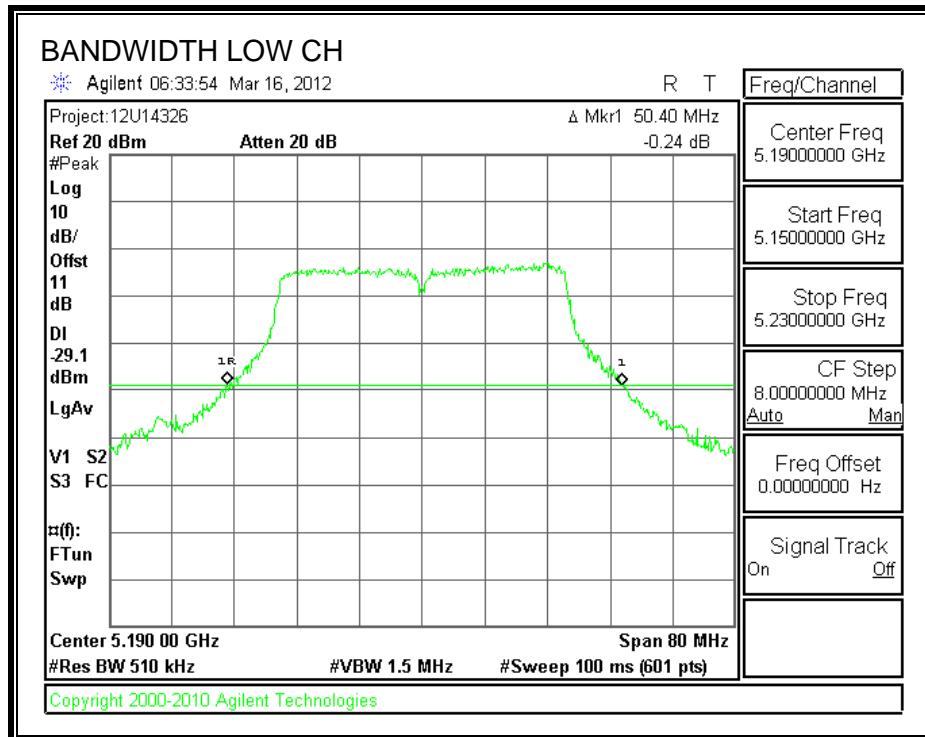
#### RESULTS

Channel	Frequency (MHz)	26 dB BW Chain 0 (MHz)	26 dB BW Chain 1 (MHz)
Low	5190	50.93	50.40
High	5230	51.33	50.53

**26 dB BANDWIDTH CHAIN 0**



**26 dB BANDWIDTH CHAIN 1**



## 7.4.2. 99% BANDWIDTH

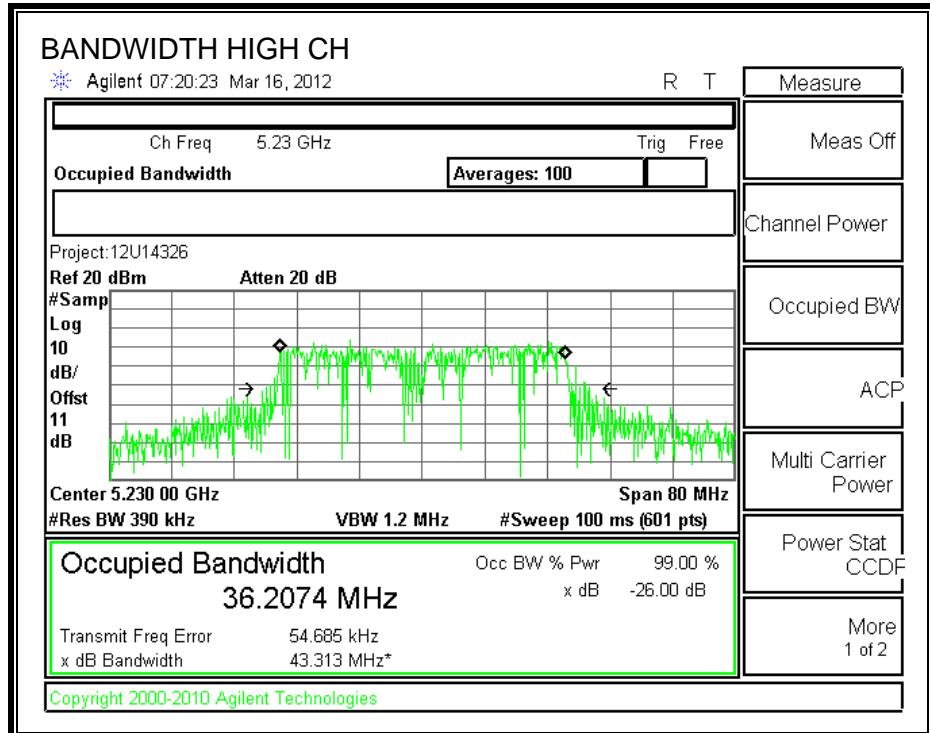
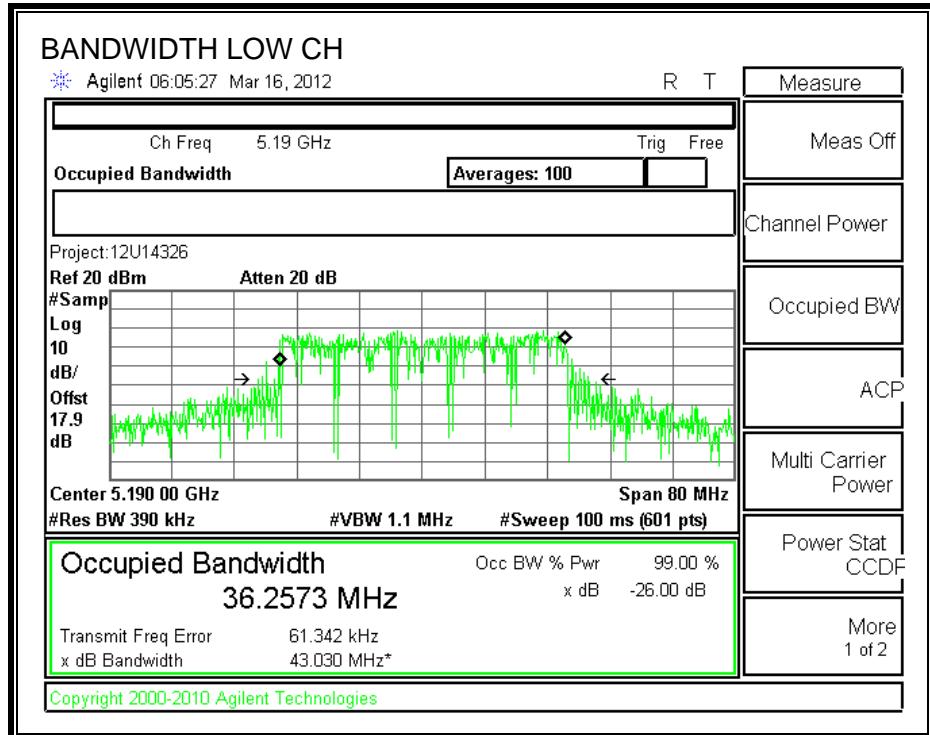
### LIMITS

None; for reporting purposes only.

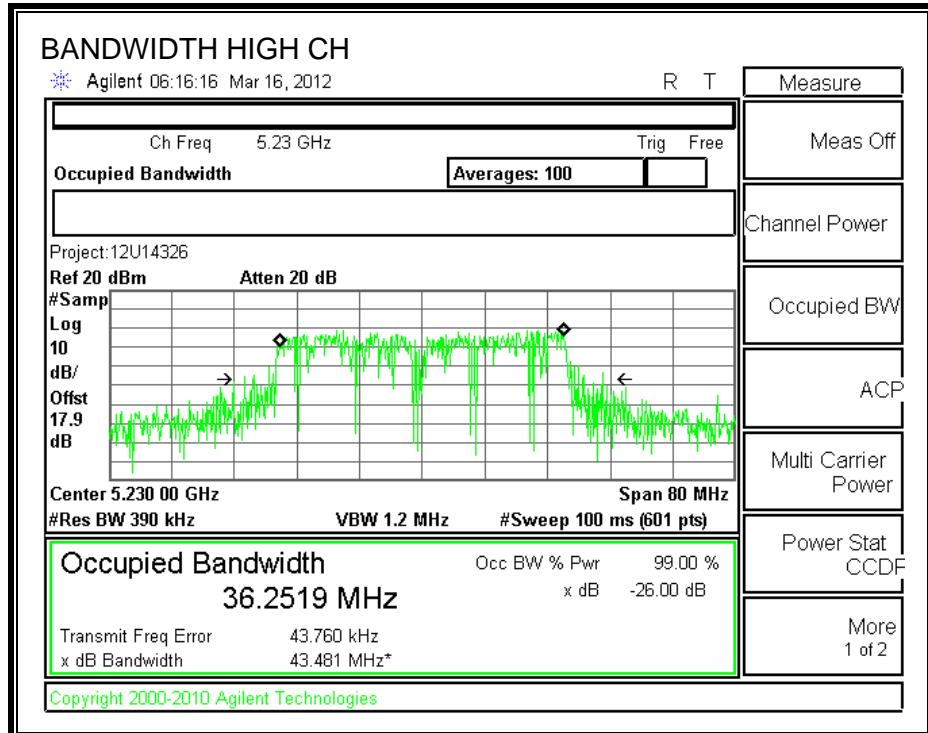
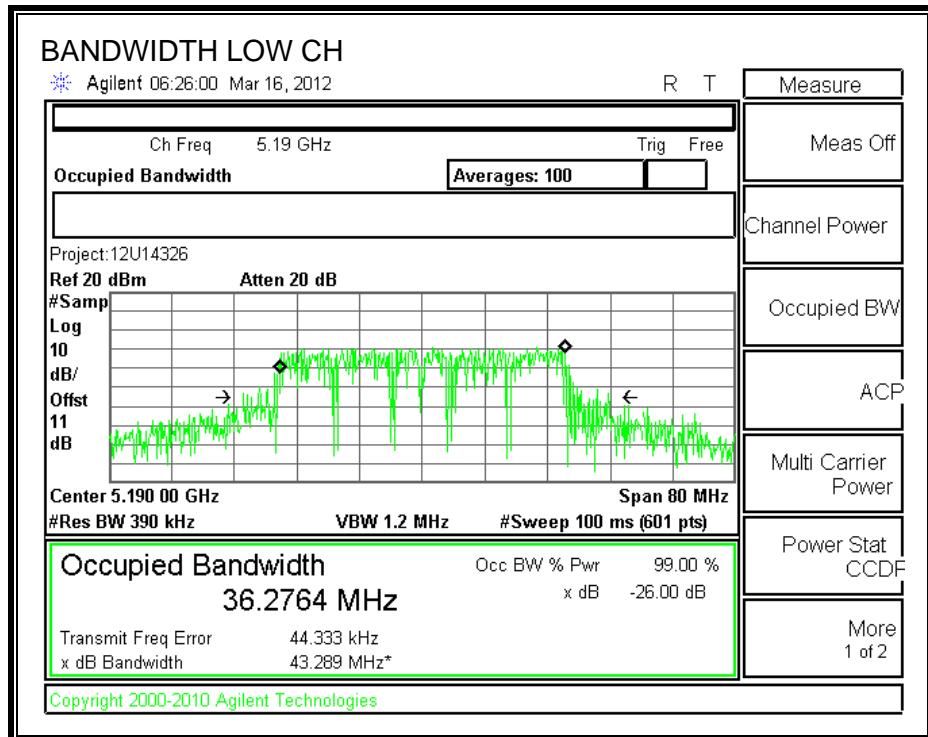
### RESULTS

Channel	Frequency (MHz)	99% BW Chain 0 (MHz)	99% BW Chain 1 (MHz)
Low	5190	36.2573	36.2764
High	5230	36.2074	36.2519

## **99% BANDWIDTH CHAIN 0**



**99% BANDWIDTH CHAIN 1**



### 7.4.3. AVERAGE POWER

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.4 dB (including 10 dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

#### RESULTS

##### Average Power Results

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low	5190	13.60	13.50	16.56
High	5230	13.10	12.90	16.01

#### 7.4.4. OUTPUT POWER AND PPSD

##### LIMITS

FCC §15.407 (a) (1)

IC RSS-210 A9.2 (1)

For the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or  $4 \text{ dBm} + 10 \log B$ , where B is the 26–dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

##### DIRECTIONAL ANTENNA GAIN

The TX chains are uncorrelated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
0.93	1.88	1.43

## RESULTS

### Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	4 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5190	17	50.40	21.02	1.43	17.00	4.00
High	5230	17	50.53	21.04	1.43	17.00	4.00

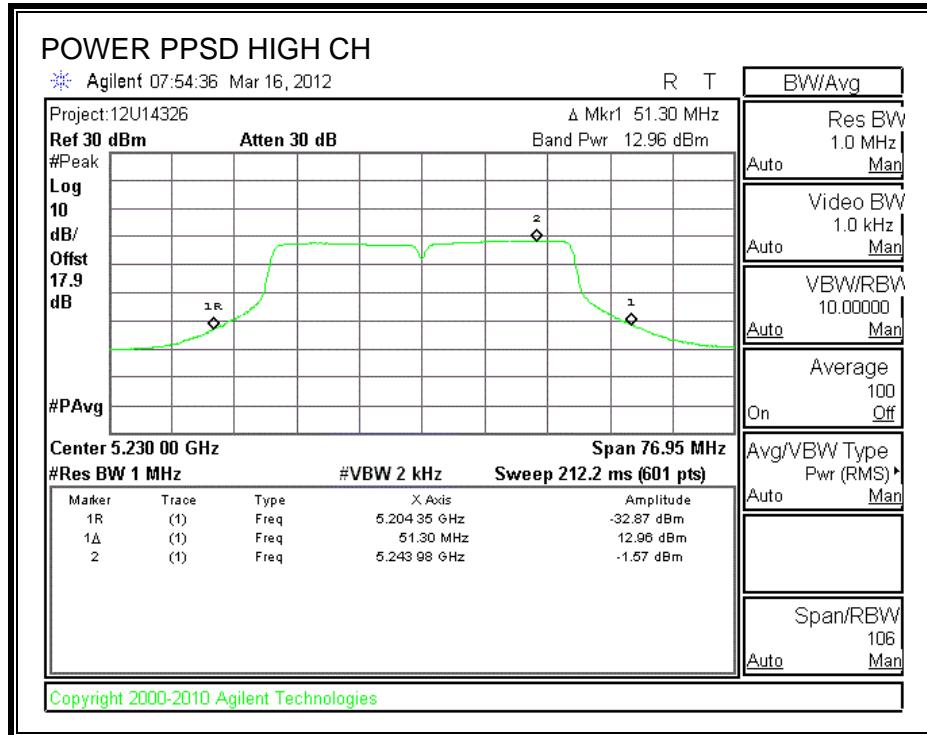
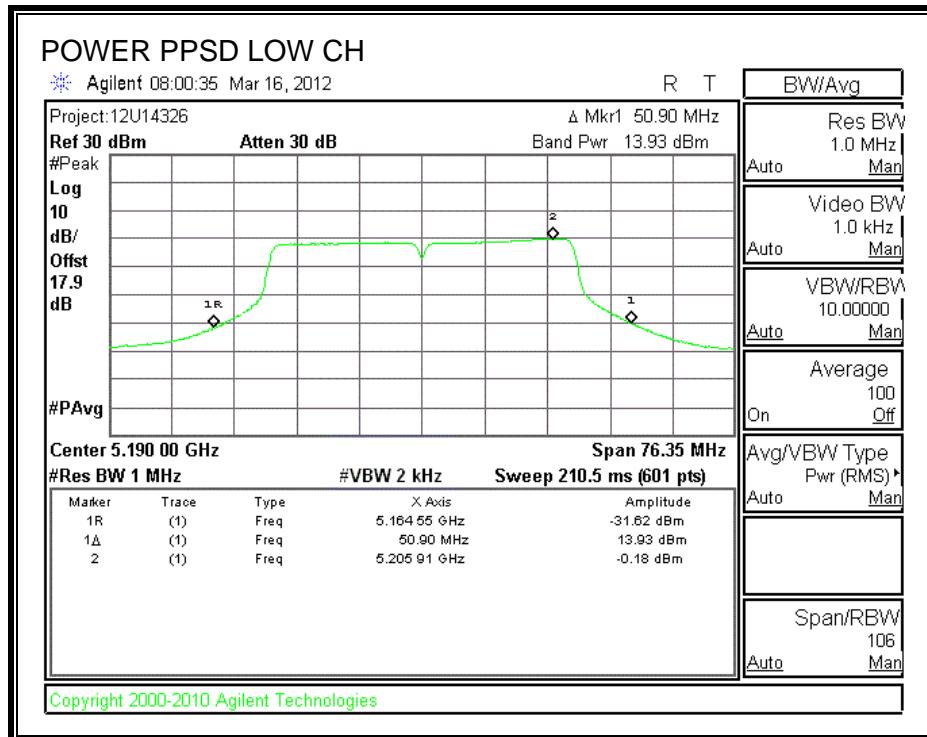
### Output Power Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5190	13.93	13.05	16.52	17.00	-0.48
High	5230	12.96	12.43	15.72	17.00	-1.28

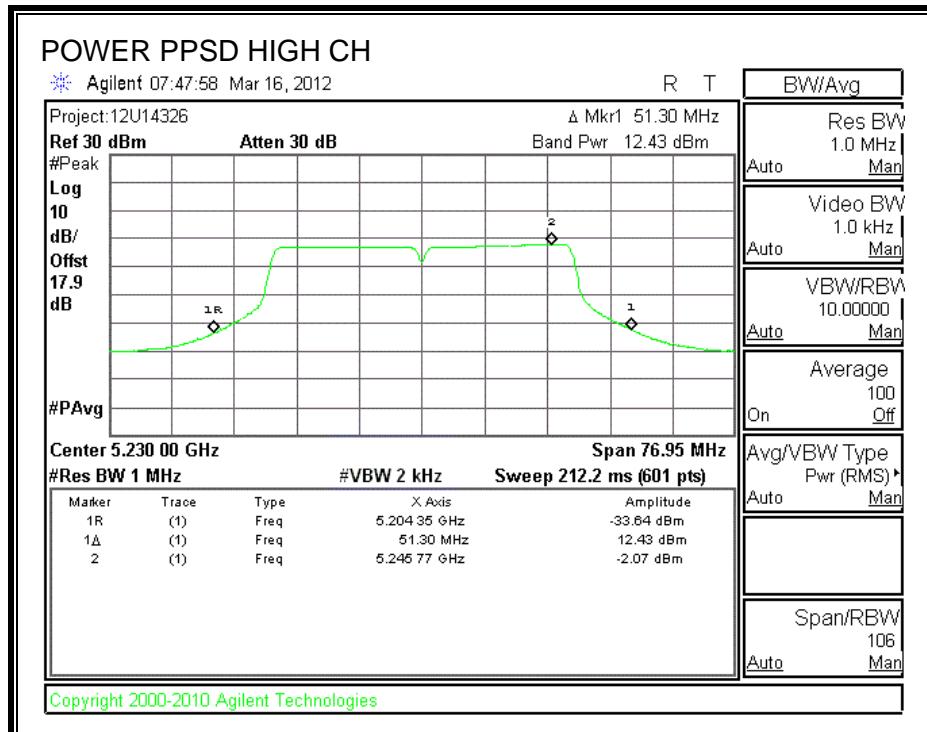
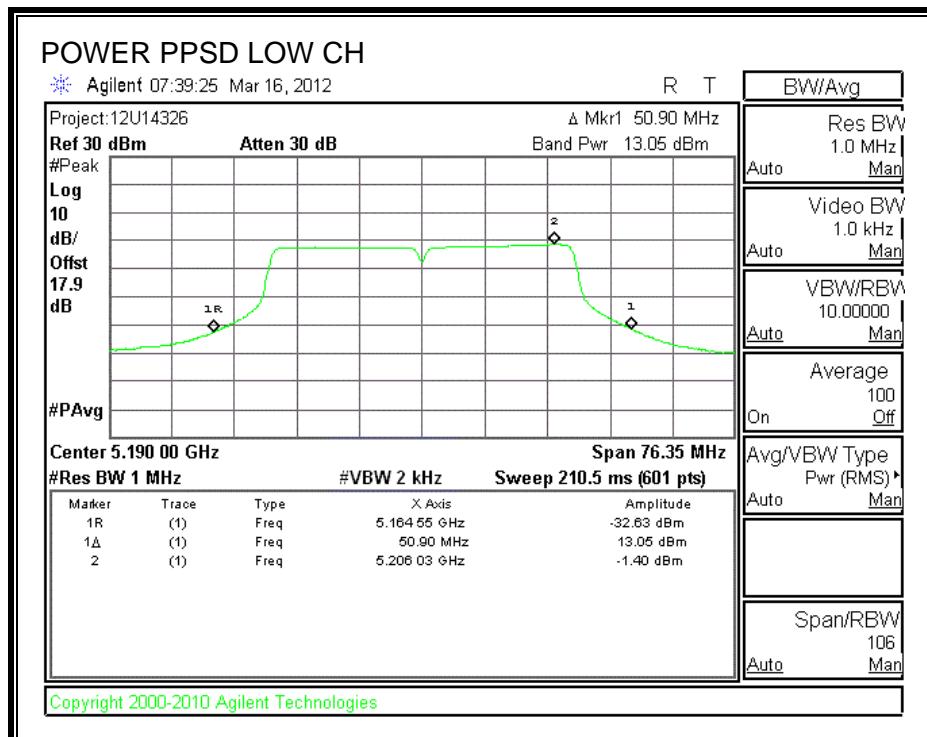
### PPSD Results

Channel	Frequency (MHz)	Chain 0 Meas PPSD (dBm)	Chain 1 Meas PPSD (dBm)	Total Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5190	-0.18	-1.40	2.26	4.00	-1.74
High	5230	-1.57	-2.07	1.20	4.00	-2.80

**OUTPUT POWER AND PPSD CHAIN 0**



**OUTPUT POWER AND PPSD CHAIN 1**



## 7.4.5. PEAK EXCURSION

### LIMITS

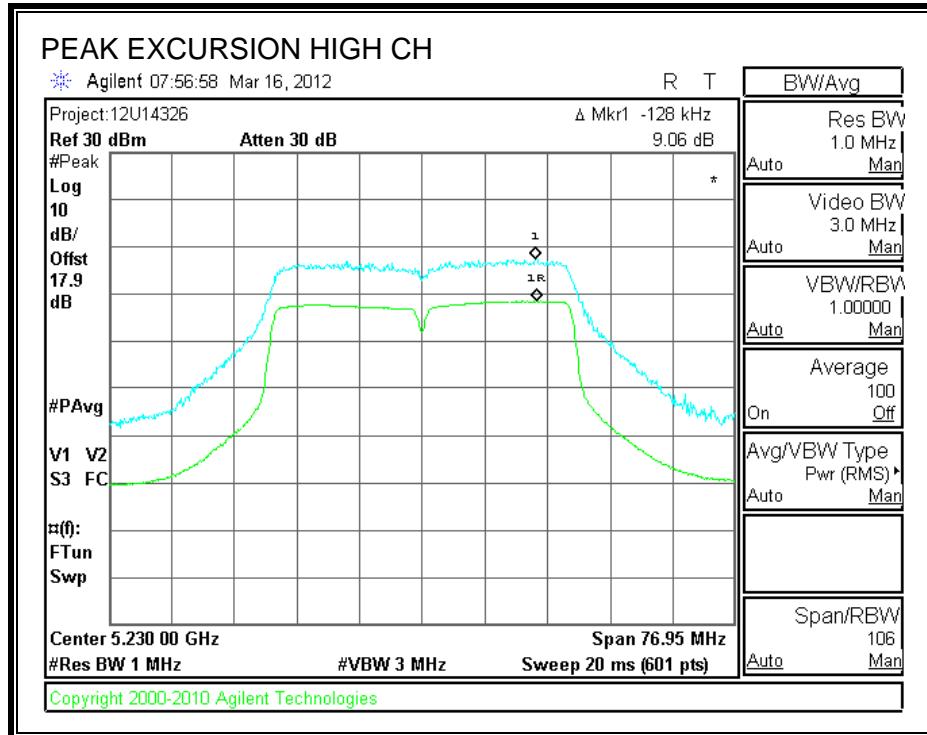
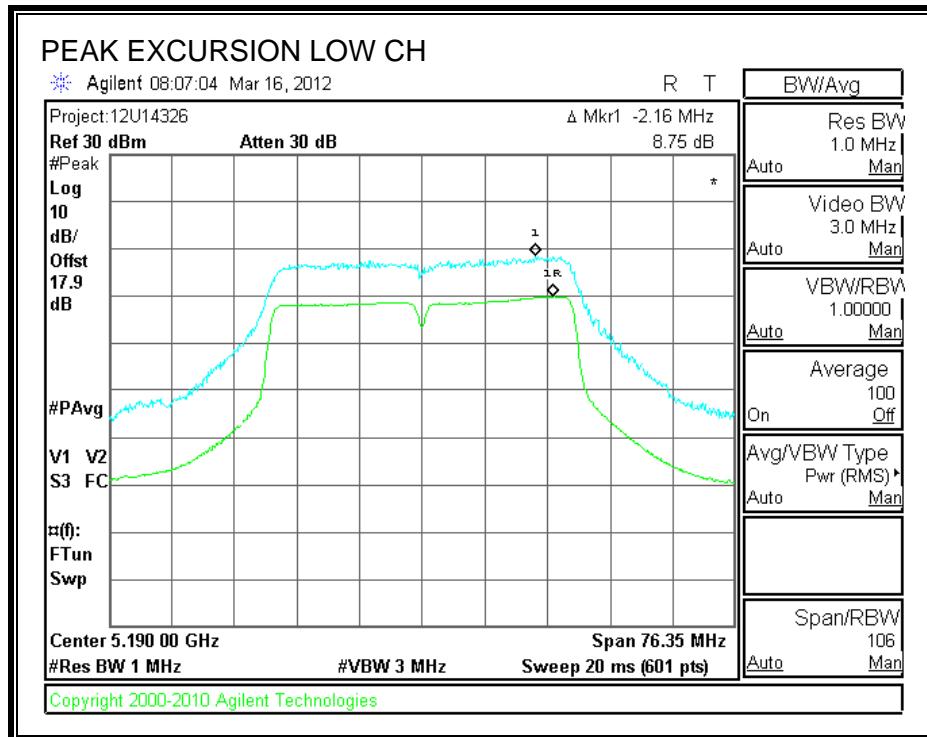
FCC §15.407 (a) (6)

The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

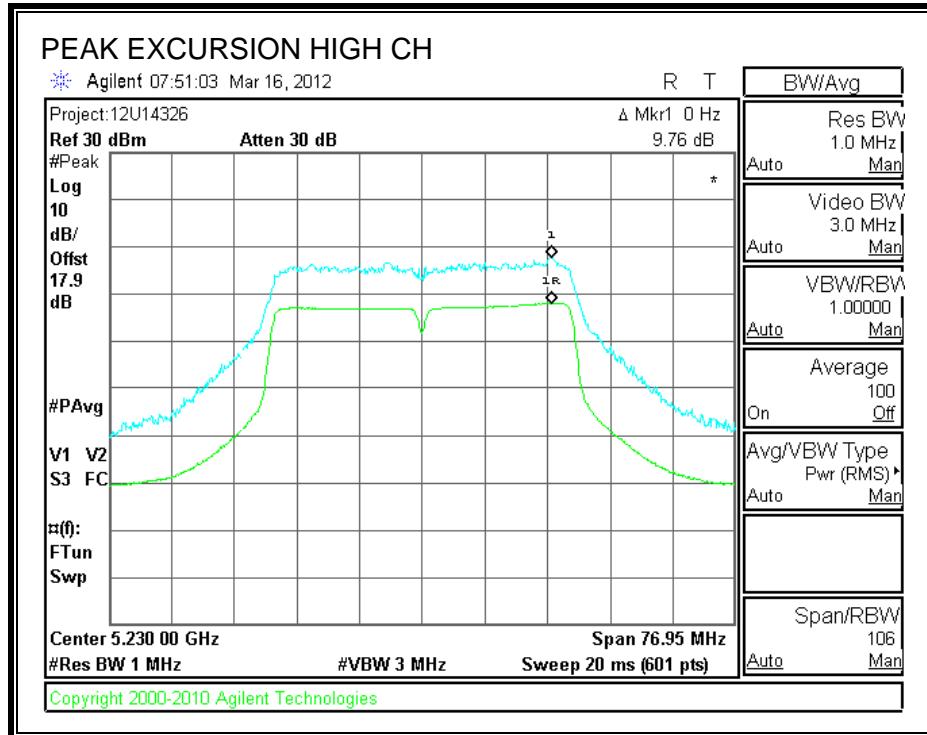
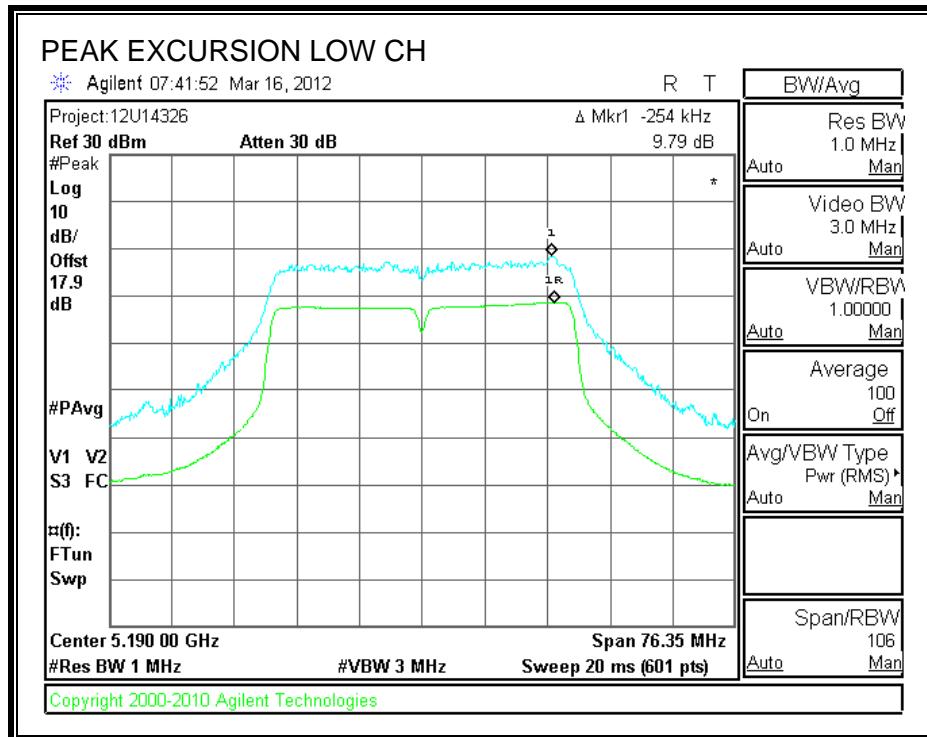
### RESULTS

Channel	Frequency (MHz)	Pk Exc Chain 0 (dB)	Pk Exc Chain 1 (dB)	Limit (dB)	Worst-Case Margin (dB)
Low	5190	8.75	9.79	13	-3.2
High	5230	9.06	9.76	13	-3.2

**PEAK EXCURSION CHAIN 0**



**PEAK EXCURSION CHAIN 1**



## 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.

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; the video bandwidth is set to 1 MHz for peak measurements and as applicable for average measurements.

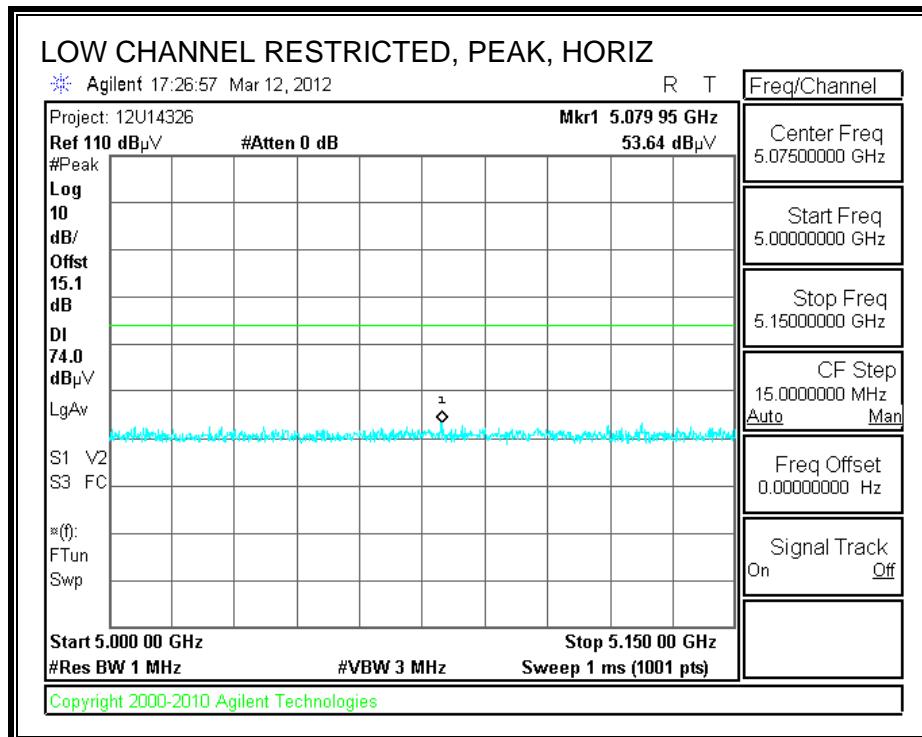
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band.

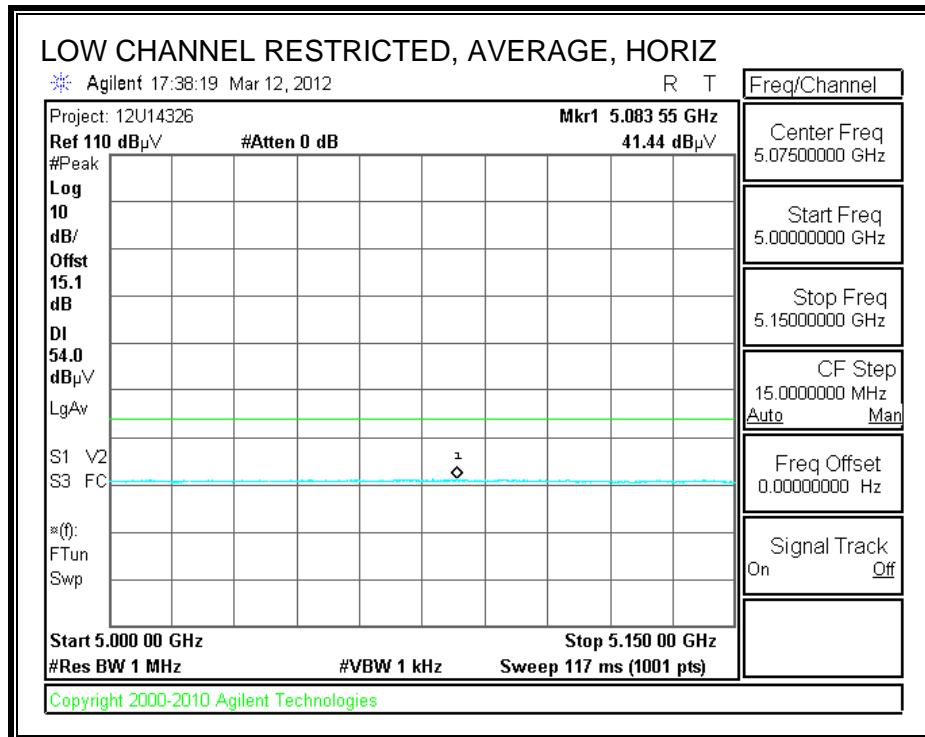
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

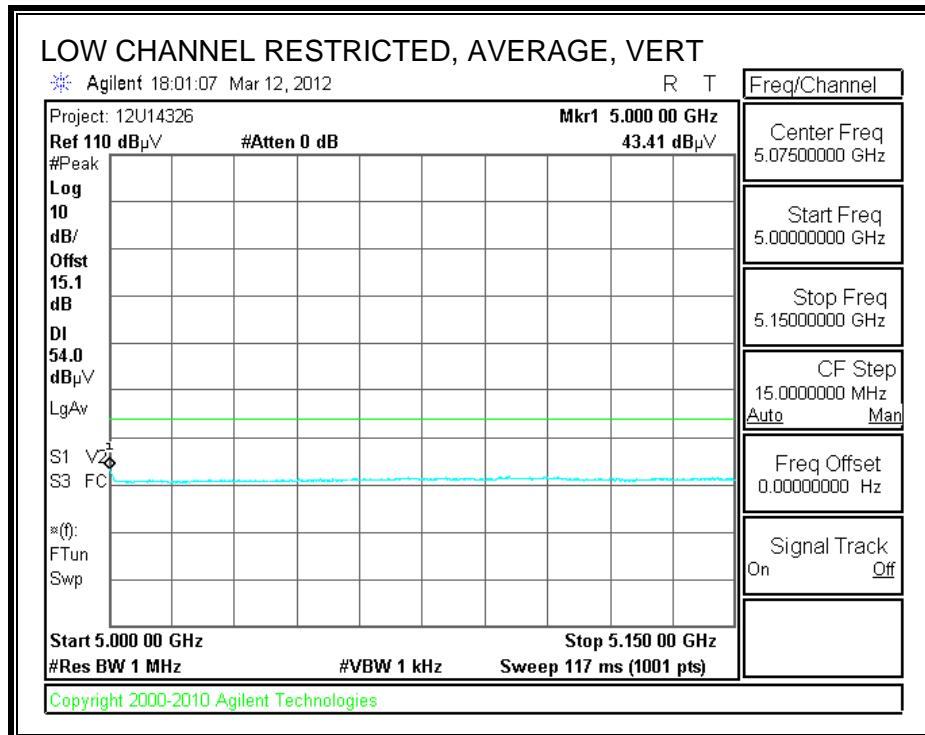
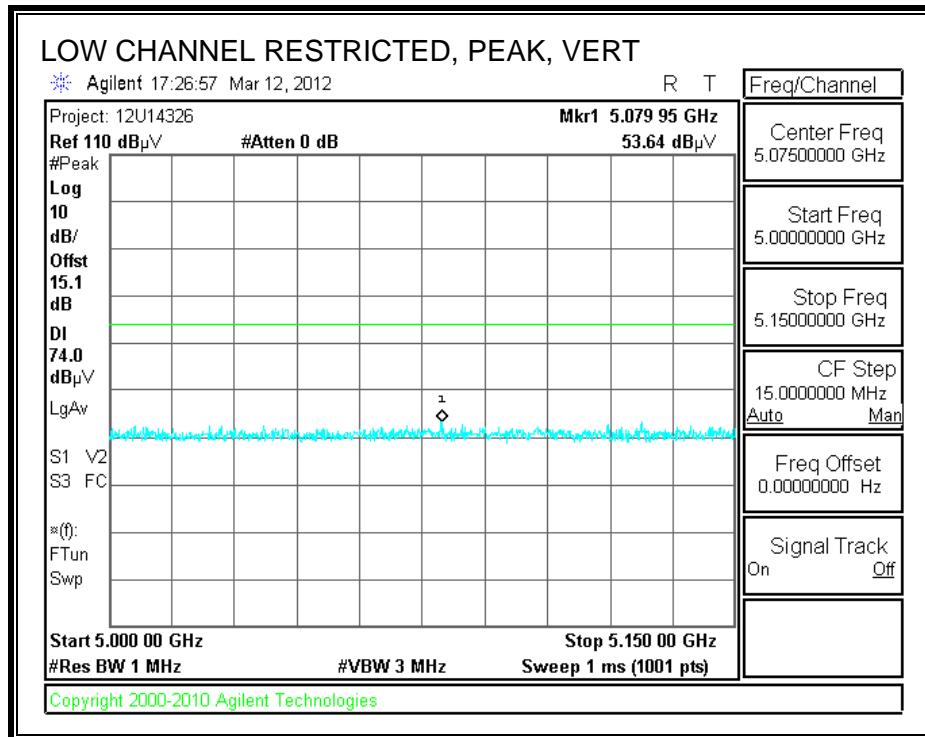
## 8.2. TRANSMITTER ABOVE 1 GHz

### 8.2.1. TX ABOVE 1 GHz 802.11a MODE IN THE 5.2 GHz BAND

#### RESTRICTED BANDEDGE (LOW CHANNEL)







**HARMONICS AND SPURIOUS EMISSIONS**

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

Test Engr: Tom Chen  
Date: 03/22/12  
Project #: 12U14326  
Company: Apple  
Test Target: FCC Class B  
Mode Oper: 802.11a, W52 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	

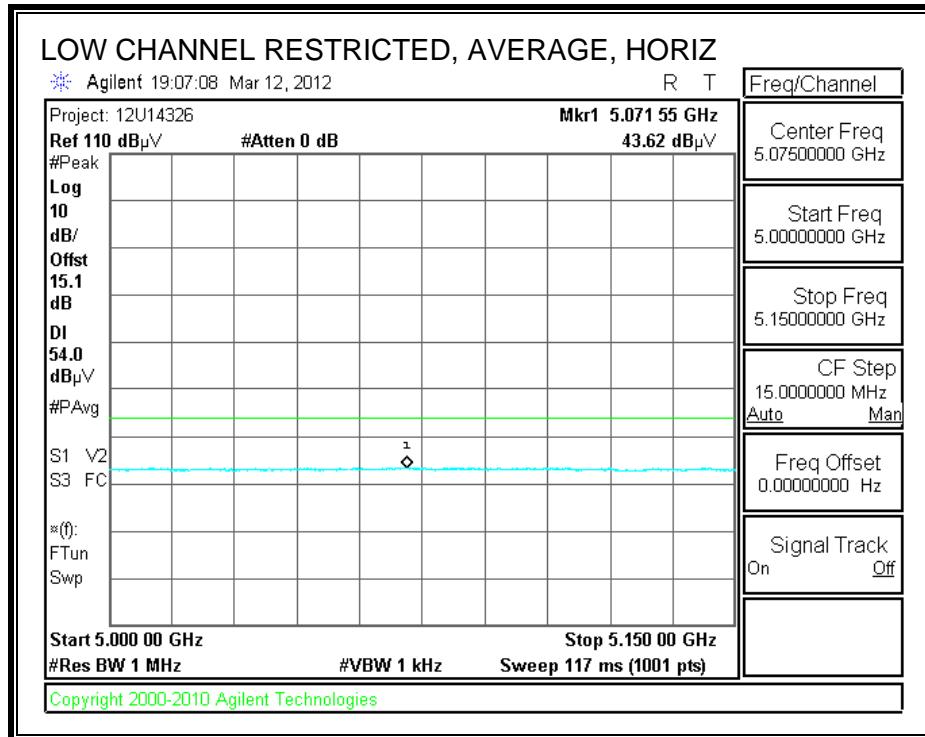
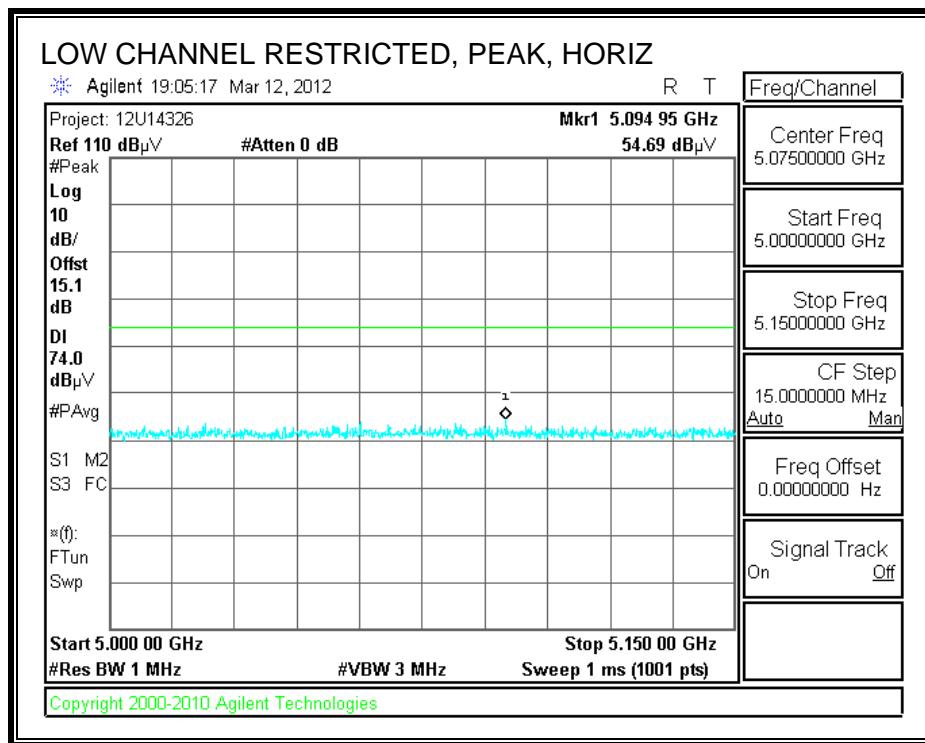
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
<b>5180MHz 11a</b>													
15.540	3.0	35.1	39.1	12.5	-32.3	0.0	0.7	55.1	74.0	-18.9	V	P	
15.540	3.0	22.8	39.1	12.5	-32.3	0.0	0.7	42.8	54.0	-11.2	V	A	
15.540	3.0	35.7	39.1	12.5	-32.3	0.0	0.7	55.7	74.0	-18.3	H	P	
15.540	3.0	22.8	39.1	12.5	-32.3	0.0	0.7	42.8	54.0	-11.2	H	A	
<b>5200MHz 11a</b>													
15.540	3.0	34.9	39.1	12.5	-32.3	0.0	0.7	54.9	74.0	-19.1	H	P	
15.540	3.0	22.8	39.1	12.5	-32.3	0.0	0.7	42.8	54.0	-11.2	H	A	
15.600	3.0	35.3	38.9	12.5	-32.3	0.0	0.7	55.2	74.0	-18.8	V	P	
15.600	3.0	22.9	38.9	12.5	-32.3	0.0	0.7	42.7	54.0	-11.3	V	A	
<b>5240MHz 11a</b>													
15.720	3.0	34.5	38.5	12.6	-32.2	0.0	0.7	54.0	74.0	-20.0	V	P	
15.720	3.0	22.7	38.5	12.6	-32.2	0.0	0.7	42.2	54.0	-11.8	V	A	
15.720	3.0	35.4	38.5	12.6	-32.2	0.0	0.7	54.9	74.0	-19.1	H	P	
15.720	3.0	22.7	38.5	12.6	-32.2	0.0	0.7	42.2	54.0	-11.8	H	A	

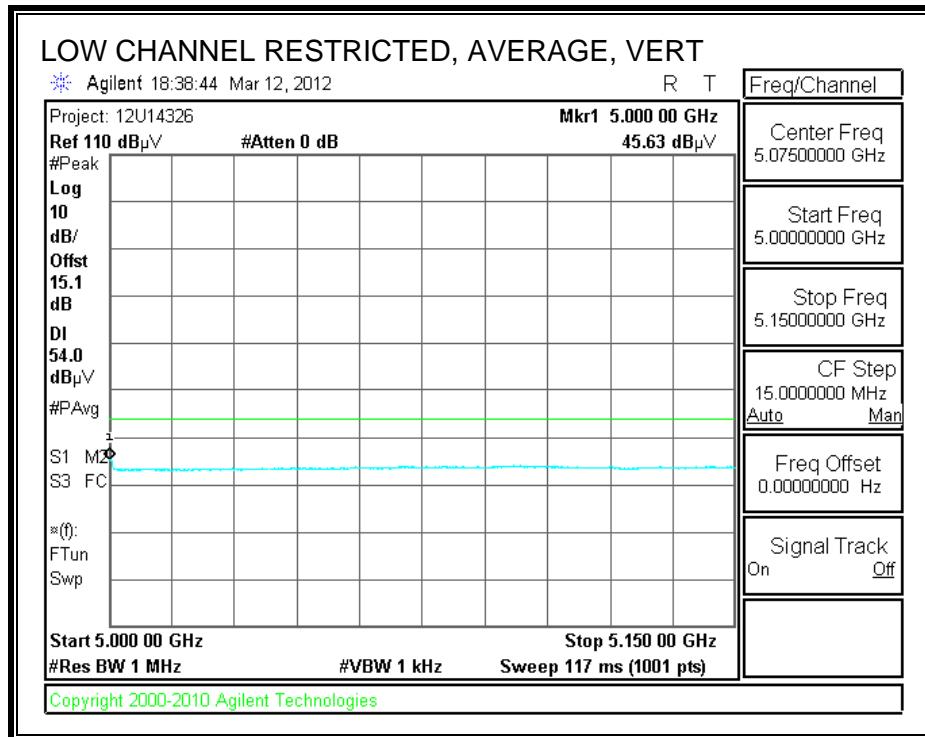
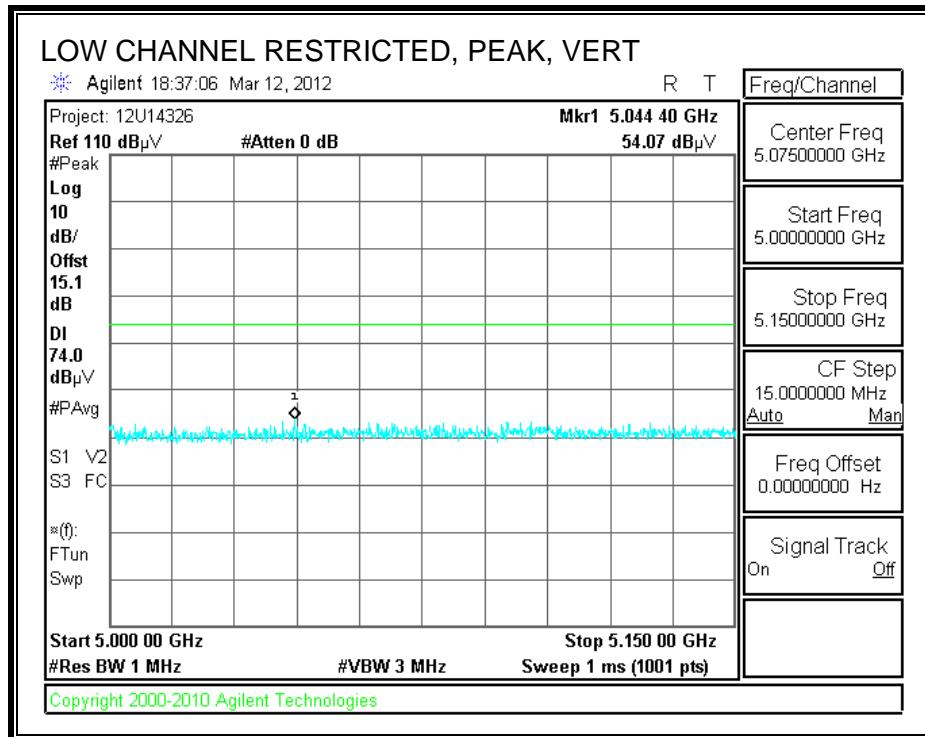
Rev. 4.1.2.7

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

## 8.2.2. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.2 GHz BAND

### RESTRICTED BANDEDGE (LOW CHANNEL)





## HARMONICS AND SPURIOUS EMISSIONS

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

Test Engr: Tom Chen  
Date: 03/22/12  
Project #: 12U14326  
Company: Apple  
Test Target: FCC Class B  
Mode Oper: 802.HT20, W52 TX mode

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

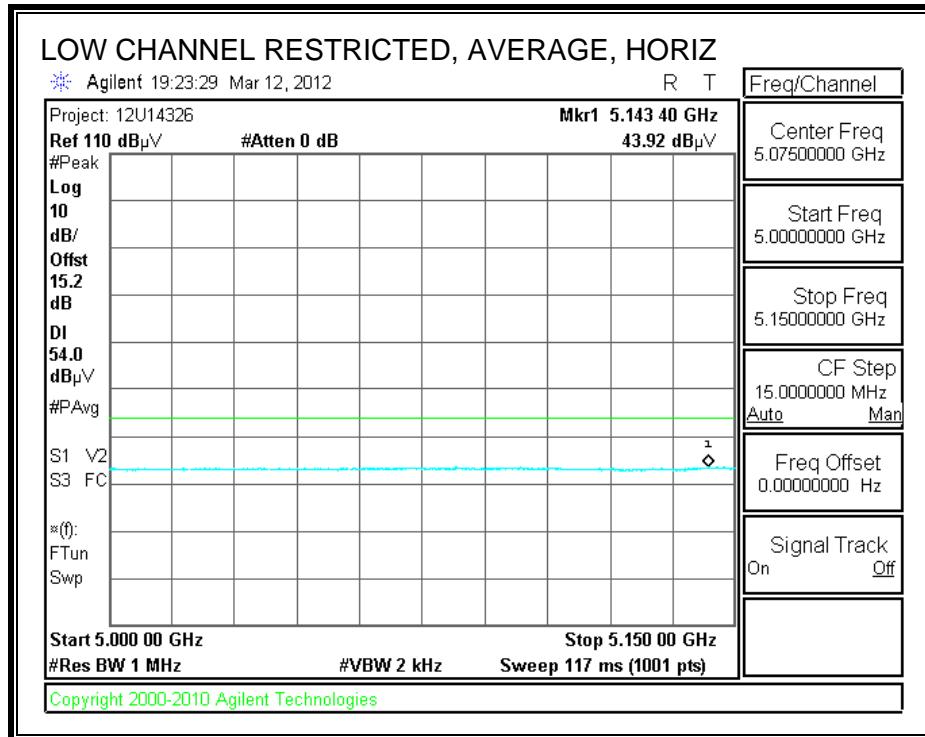
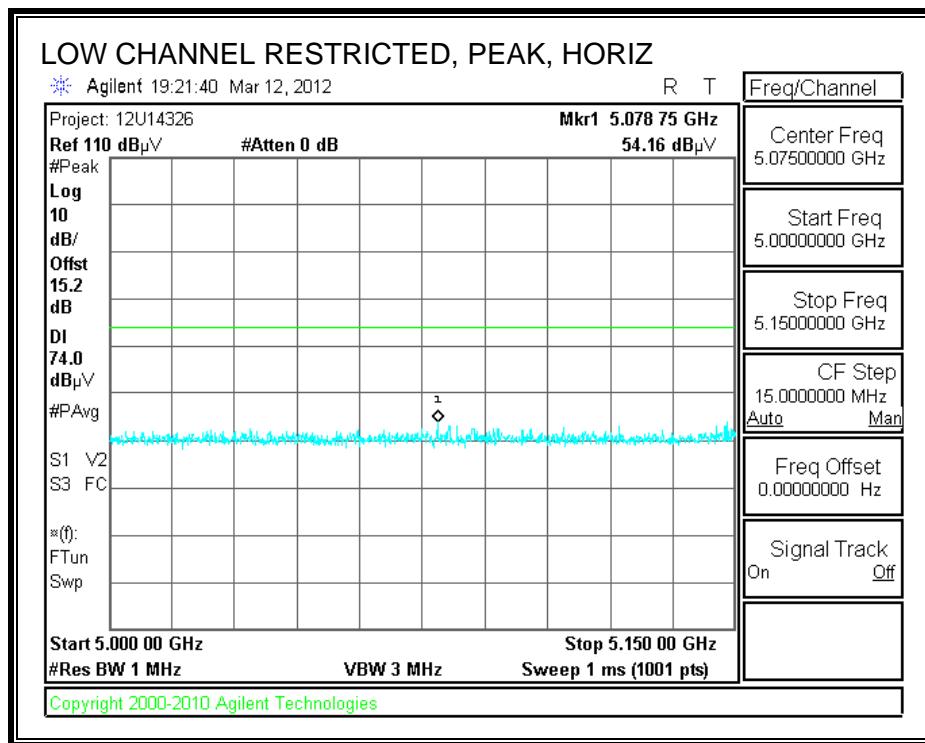
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
<b>5180MHz HT20</b>													
15.540	3.0	35.2	39.1	12.5	-32.3	0.0	0.7	55.2	74.0	-18.8	H	P	
15.540	3.0	22.7	39.1	12.5	-32.3	0.0	0.7	42.8	54.0	-11.2	H	A	
15.540	3.0	35.9	39.1	12.5	-32.3	0.0	0.7	55.9	74.0	-18.1	V	P	
15.540	3.0	22.7	39.1	12.5	-32.3	0.0	0.7	42.7	54.0	-11.3	V	A	
<b>5200MHz HT20</b>													
15.600	3.0	35.6	38.9	12.5	-32.3	0.0	0.7	55.4	74.0	-18.6	V	P	
15.600	3.0	22.9	38.9	12.5	-32.3	0.0	0.7	42.7	54.0	-11.3	V	A	
15.600	3.0	35.1	38.9	12.5	-32.3	0.0	0.7	55.0	74.0	-19.0	H	P	
15.600	3.0	22.9	38.9	12.5	-32.3	0.0	0.7	42.7	54.0	-11.3	H	A	
<b>5240MHz HT20</b>													
15.720	3.0	35.0	38.5	12.6	-32.2	0.0	0.7	54.5	74.0	-19.5	H	P	
15.720	3.0	22.7	38.5	12.6	-32.2	0.0	0.7	42.3	54.0	-11.7	H	A	
15.720	3.0	35.2	38.5	12.6	-32.2	0.0	0.7	54.7	74.0	-19.3	V	P	
15.720	3.0	22.7	38.5	12.6	-32.2	0.0	0.7	42.3	54.0	-11.7	V	A	

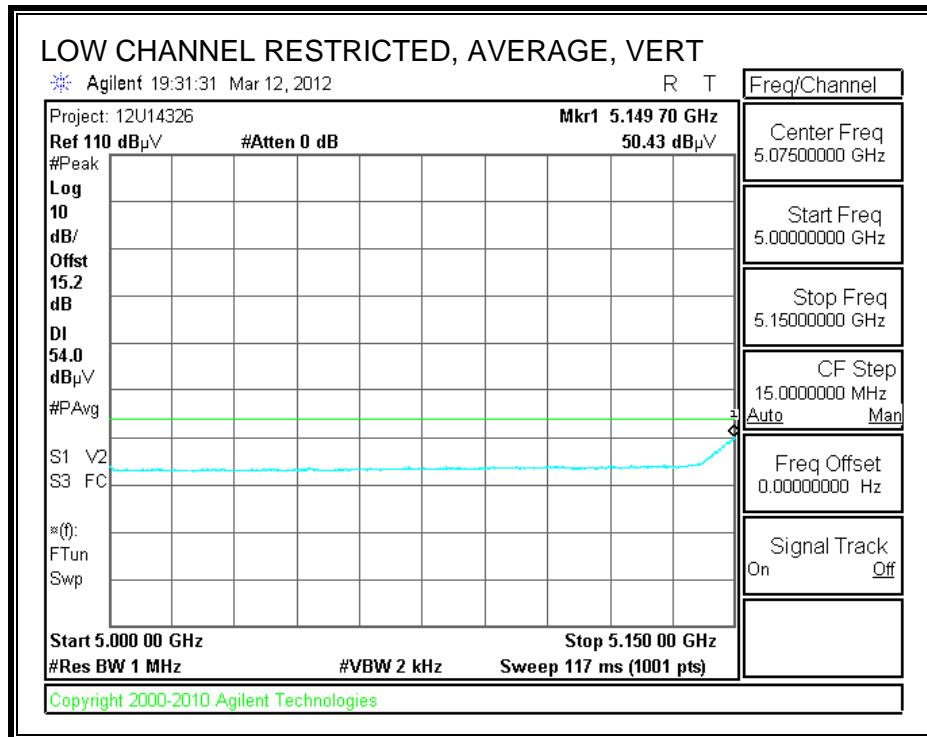
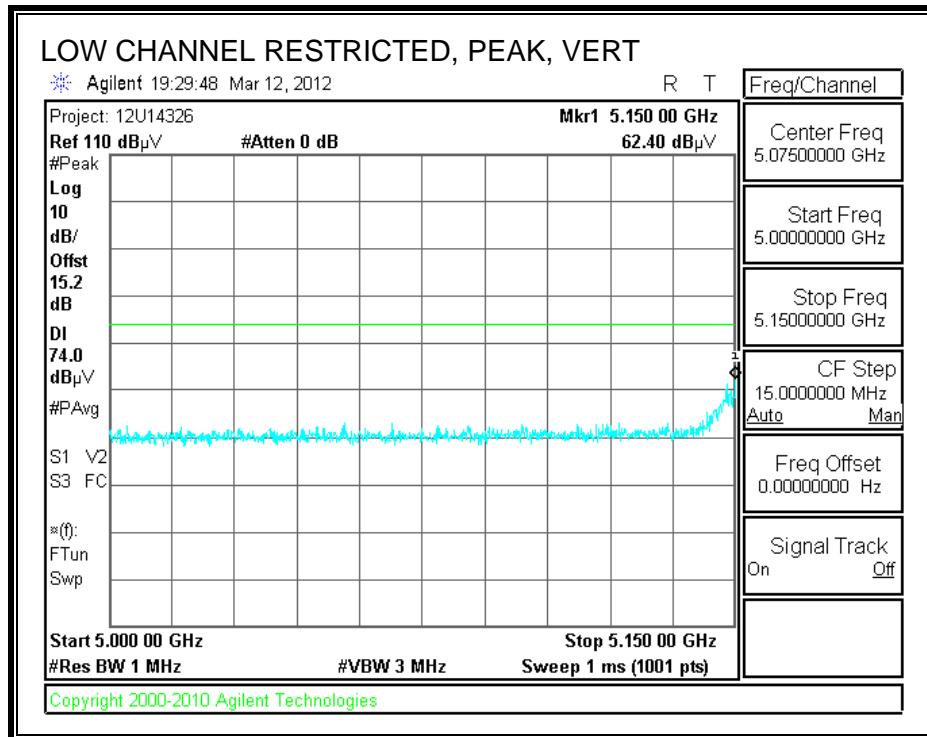
Rev. 4.1.2.7

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

### 8.2.3. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.2 GHz BAND

#### RESTRICTED BANDEDGE (LOW CHANNEL)





**HARMONICS AND SPURIOUS EMISSIONS**

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

Test Engr: Tom Chen  
Date: 03/22/12  
Project #: 12U14326  
Company: Apple  
Test Target: FCC Class B  
Mode Oper: 802.HT40, W52 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	

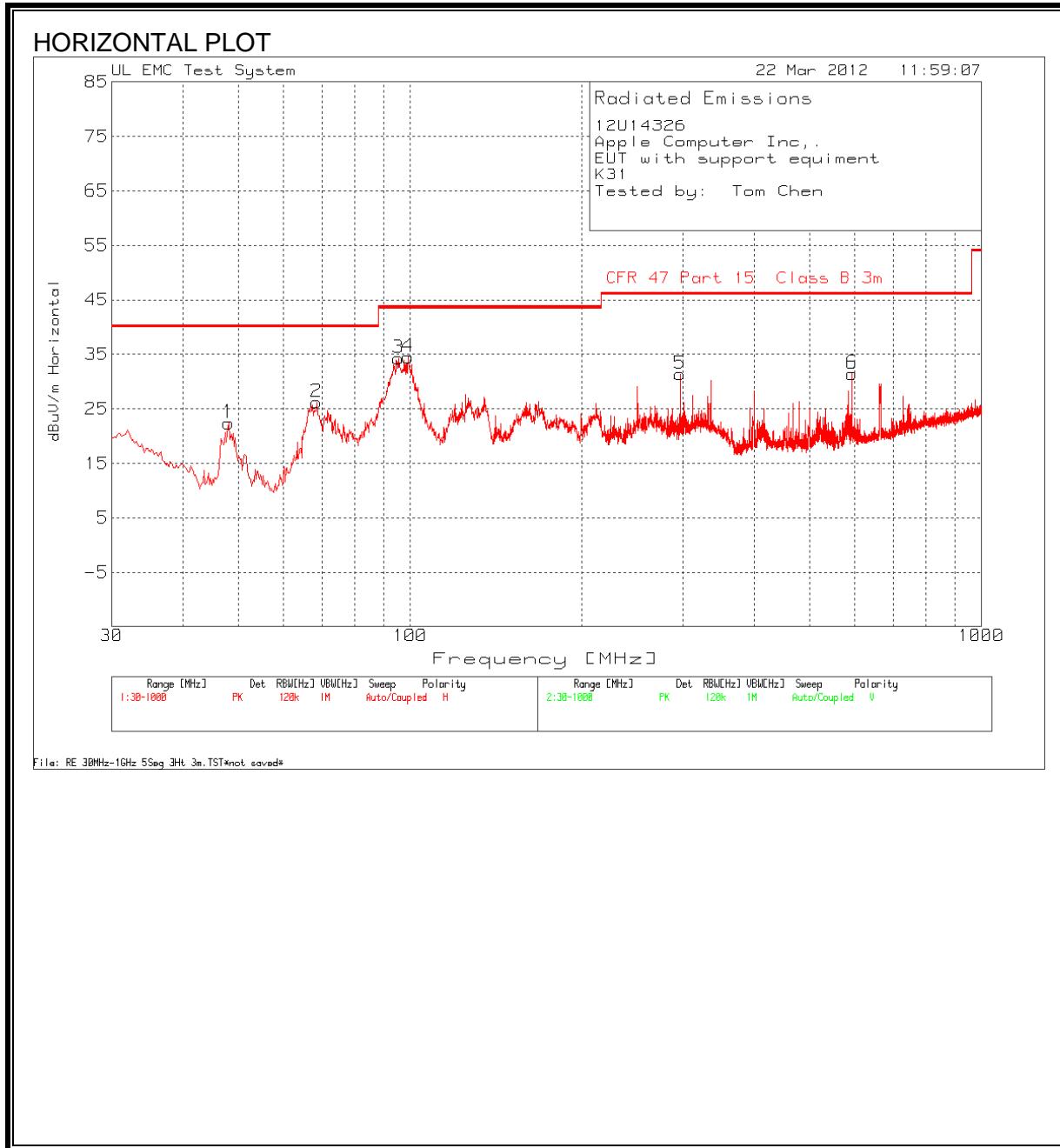
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5190MHz HT40													
15.570	3.0	35.6	39.0	12.5	-32.3	0.0	0.7	55.6	74.0	-18.4	H	P	
15.570	3.0	22.8	39.0	12.5	-32.3	0.0	0.7	42.8	54.0	-11.2	H	A	
5190MHz HT40													
15.570	3.0	34.6	39.0	12.5	-32.3	0.0	0.7	54.5	74.0	-19.5	V	P	
15.570	3.0	22.8	39.0	12.5	-32.3	0.0	0.7	42.8	54.0	-11.2	V	A	
5230MHz HT40													
15.690	3.0	35.8	38.6	12.6	-32.3	0.0	0.7	55.5	74.0	-18.5	V	P	
15.690	3.0	22.7	38.6	12.6	-32.3	0.0	0.7	42.4	54.0	-11.6	V	A	
5230MHz HT40													
15.690	3.0	35.2	38.6	12.6	-32.3	0.0	0.7	54.9	74.0	-19.1	H	P	
15.690	3.0	22.8	38.6	12.6	-32.3	0.0	0.7	42.4	54.0	-11.6	H	A	

Rev. 4.1.2.7

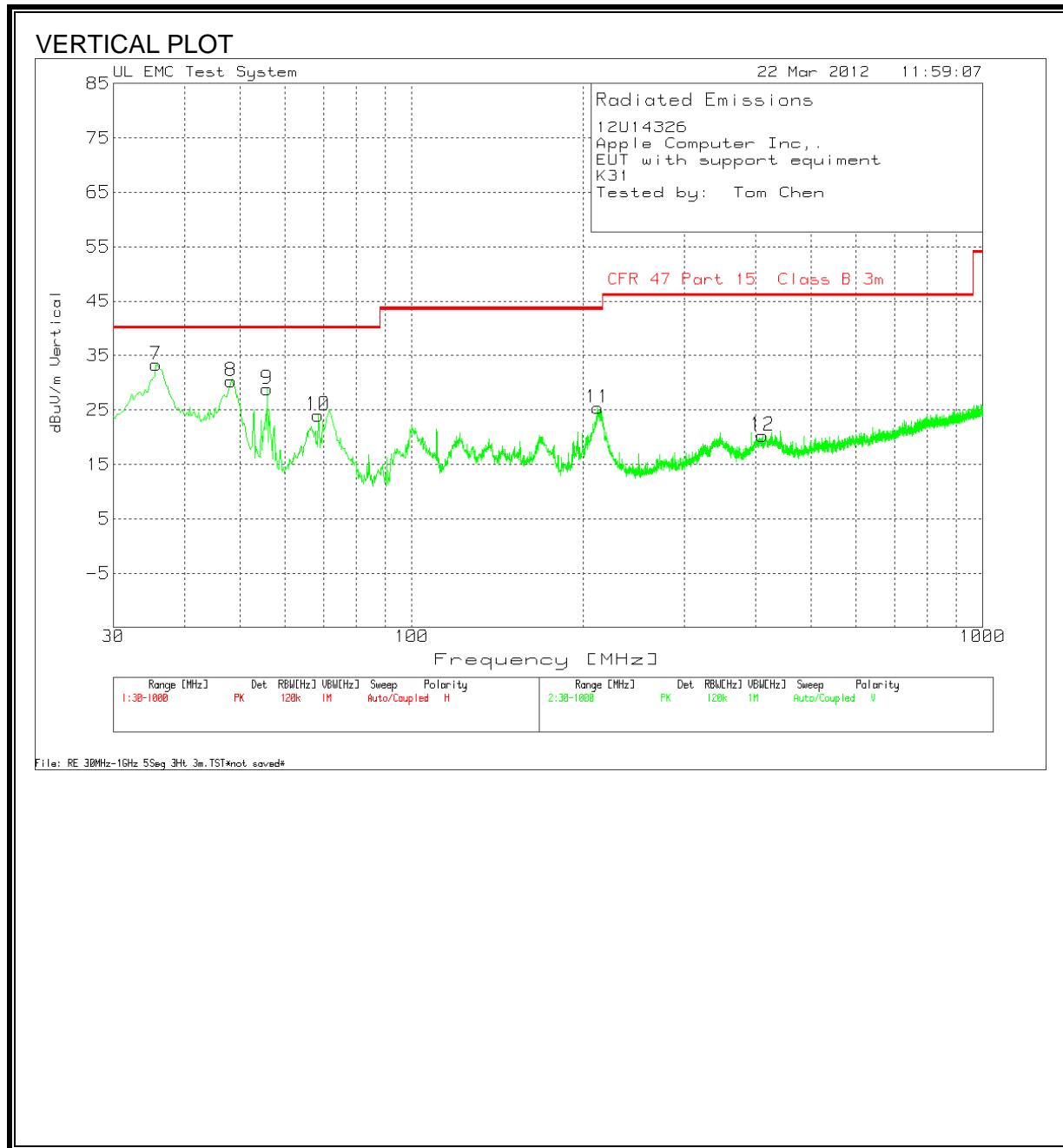
Note: No other emissions were detected above the system noise floor.

### 8.3. WORST-CASE BELOW 1 GHz

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



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



HORIZONTAL AND VERTICAL DATA

12U14326

Apple Computer Inc.,  
EUT with support equipment  
K31  
Tested by: Tom Chen

Range 1 30 - 1000MHz

Test Frequency	Meter Reading	Detector	25MHz-1Ghz ChmbrB Amp [dB]	T130 Bilog Factors.TX T [dB]	dBuV/m	CFR 47 Part 15 Class B 3m	Polarity
48.0276	42.3	PK	-29.1	9.2	22.4	40	Horz
68.5751	46.92	PK	-28.9	8.2	26.22	40	Horz
95.3257	53.96	PK	-28.6	8.9	34.26	43.5	Horz
99.2026	53.23	PK	-28.6	9.9	34.53	43.5	Horz
296.9245	45.05	PK	-26.9	13.2	31.35	46	Horz
593.8949	39.97	PK	-26.7	18.2	31.47	46	Horz

Range 2 30 - 1000MHz

Test Frequency	Meter Reading	Detector	25MHz-1Ghz ChmbrB Amp [dB]	T130 Bilog Factors.TX T [dB]	dBuV/m	CFR 47 Part 15 Class B 3m	Polarity
35.6215	44.95	PK	-29.2	17.6	33.35	40	Vert
48.2214	50.3	PK	-29.1	9.1	30.3	40	Vert
55.7814	49.95	PK	-29	7.9	28.85	40	Vert
68.5751	44.71	PK	-28.9	8.2	24.01	40	Vert
211.6327	40.88	PK	-27.5	12	25.38	43.5	Vert
411.4868	32	PK	-26.9	15.2	20.3	46	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

<sup>\*</sup> Decreases with the logarithm of the frequency.

### TEST PROCEDURE

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

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

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

## RESULTS

### 6 WORST EMISSIONS

Project No:12U14326									
Client Name:Apple computer Inc.,									
Model/Device:K31									
Test Volt/Freq:FCC Class B 120VAC 60 Hz									
Test By:Tom Chen									

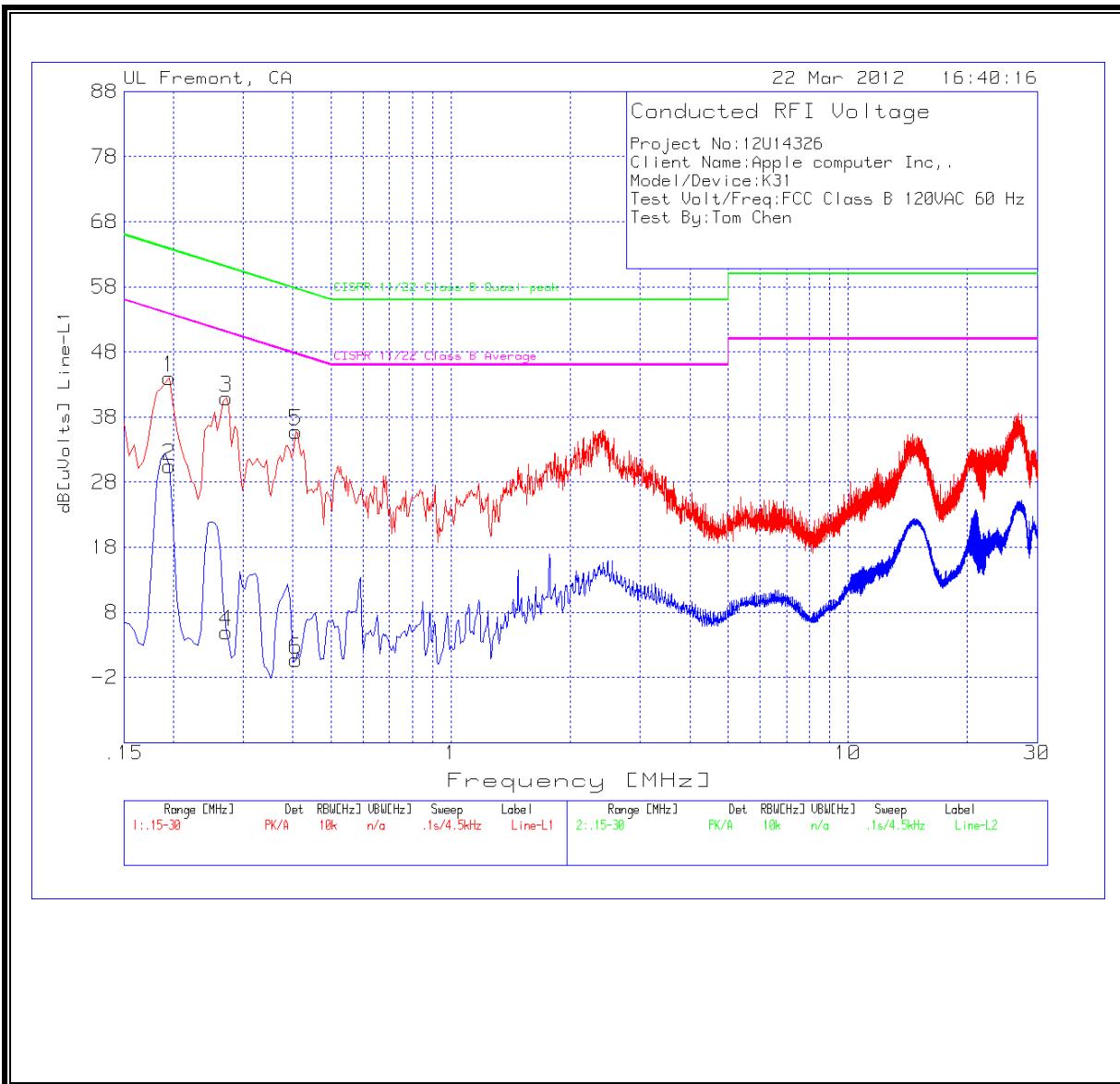
Line-L1 .15 - 30MHz

Test Frequency	Meter Reading	Detector	T24 IL L1.TXT [dB]	LC Cables 1&3.TXT [dB]	dB[uVolts]	CISPR 11/22 Class B Quasi-peak	Margin	CISPR 11/22 Class B Average	Margin
0.195	43.93	PK	0.1	0	44.03	63.8	-19.77	-	-
0.195	30.38	AV	0.1	0	30.48	-	-	53.8	-23.32
0.2715	40.8	PK	0.1	0	40.9	61.1	-20.2	-	-
0.2715	4.93	AV	0.1	0	5.03	-	-	51.1	-46.07
0.4065	35.72	PK	0.1	0	35.82	57.7	-21.88	-	-
0.4065	0.6	AV	0.1	0	0.7	-	-	47.7	-47

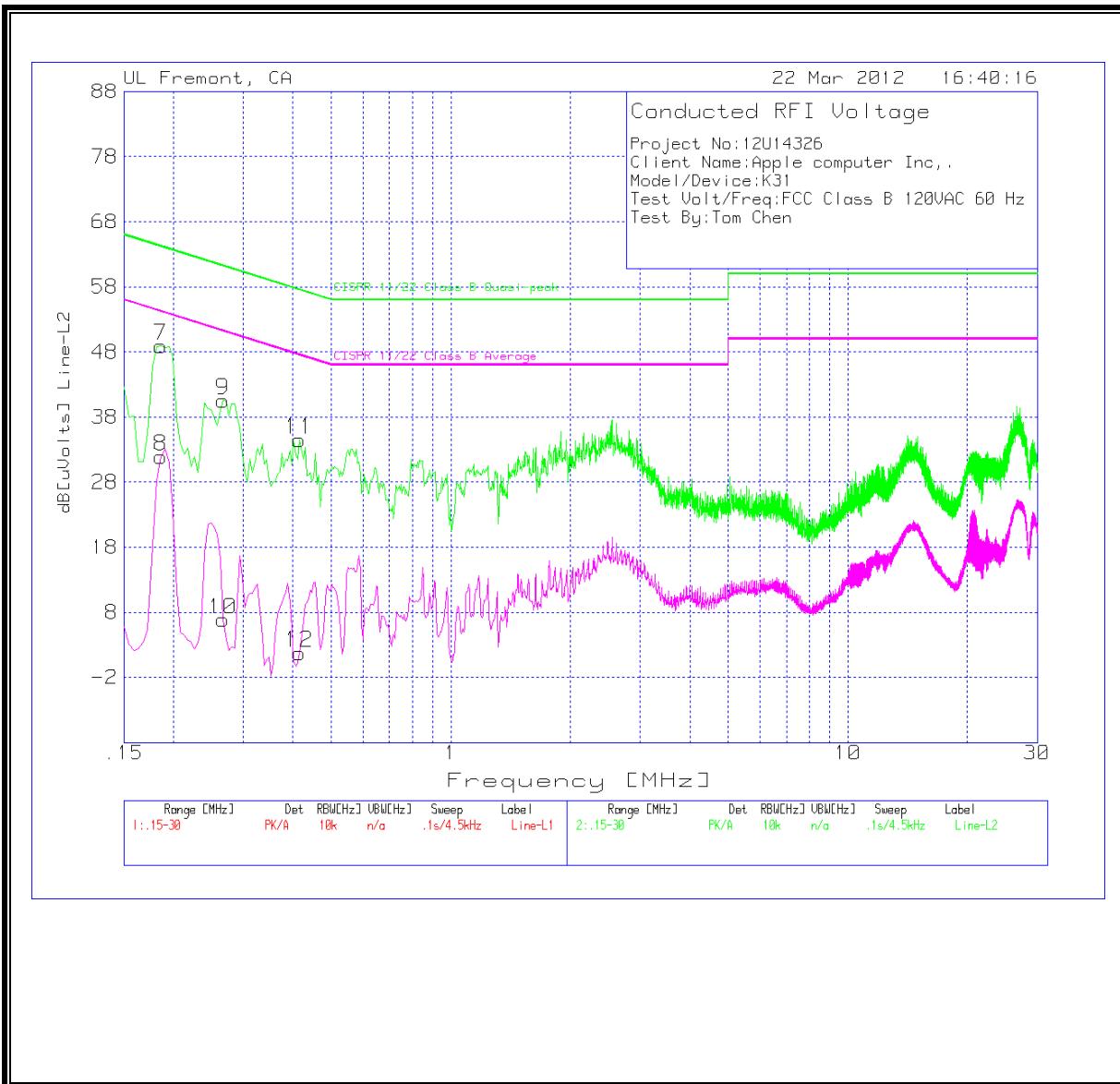
Line-L2 .15 - 30MHz

Test Frequency	Meter Reading	Detector	T24 IL L2.TXT [dB]	LC Cables 2&3.TXT [dB]	dB[uVolts]	CISPR 11/22 Class B Quasi-peak	Margin	CISPR 11/22 Class B Average	Margin
0.186	48.81	PK	0.1	0	48.91	64.2	-15.29	-	-
0.186	31.81	AV	0.1	0	31.91	-	-	54.2	-22.29
0.267	40.45	PK	0.1	0	40.55	61.2	-20.65	-	-
0.267	6.75	AV	0.1	0	6.85	-	-	51.2	-44.35
0.4155	34.38	PK	0.1	0	34.48	57.5	-23.02	-	-
0.4155	1.64	AV	0.1	0	1.74	-	-	47.5	-45.76

**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 ( $\mu$ T) 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 mWc/m<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>

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>

RSS-102 Clause 2.5.2 RF exposure evaluation is required if the separation distance between the user and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 2.5 W;
- at or above 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 5 W.

**RESULTS**

Multiple chain or colocated transmitters								
Band	Mode	Chain for MIMO	Separation Distance (m)	Output AV Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	IC Power Density (W/m^2)	FCC Power Density (mW/cm^2)
5.2 GHz	WLAN	1		13.60	0.93	96.7		
5.2 GHz	WLAN	2		13.50	1.88	96.7		
Combined			0.20				0.12	0.012