FCC CFR47 PART 15 SUBPART E
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: 11U14084-6, Revision A

ISSUE DATE: APRIL 19, 2012

Prepared for
SONOS, INC.
223 E. DE LA GUERRA
SANTA BARBARA, CA 93101, U.S.A.

Prepared by
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	01/13/12	Initial Issue	F. Ibrahim
A	04/19/12	Added DFS section	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, 2011 - JANUARY 13, 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:

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, FCC 06-96, RSS-GEN Issue 3, and RSS-210 Issue 8.

3. FACILITIES AND ACCREDITATION

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

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

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

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

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

4.3. MEASUREMENT UNCERTAINTY

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

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

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a 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)
5180 - 5240	802.11n HT20	15.92	39.08
5260 - 5320	802.11n HT20	22.40	173.78
5500 - 5700	802.11n HT20	22.76	188.80

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 11n HT20 (5180-5240 GHz band): MCS9
For 11n HT20 (5260-5320 GHz band): MCS9
For 11n HT20 (5500-5700 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.

5.6. DESCRIPTION OF TEST SETUP

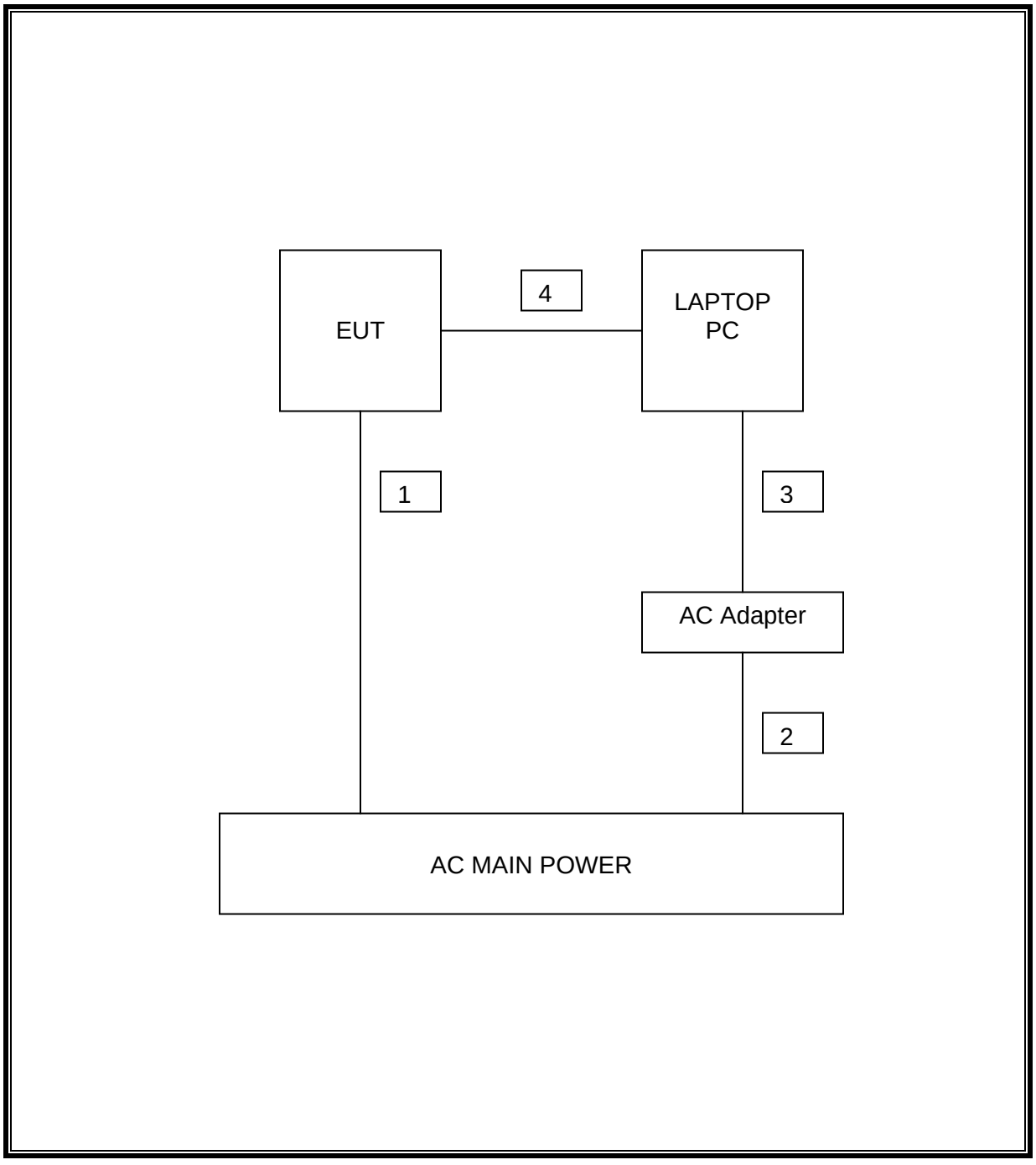
SUPPORT EQUIPMENT

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. 802.11n HT20 MODE IN THE 5.2 GHz BAND

7.1.1. 26 dB and 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

RESULTS

CHAIN 1

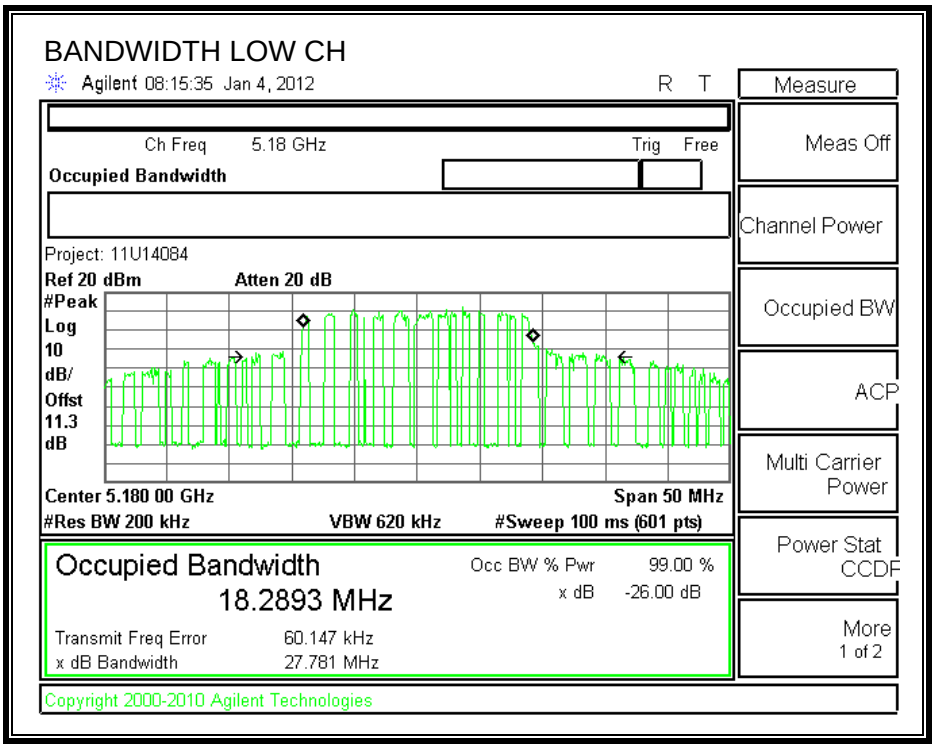
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	5180	27.781	16.7589
Middle	5200	28.221	16.5922
High	5240	28.996	16.5246

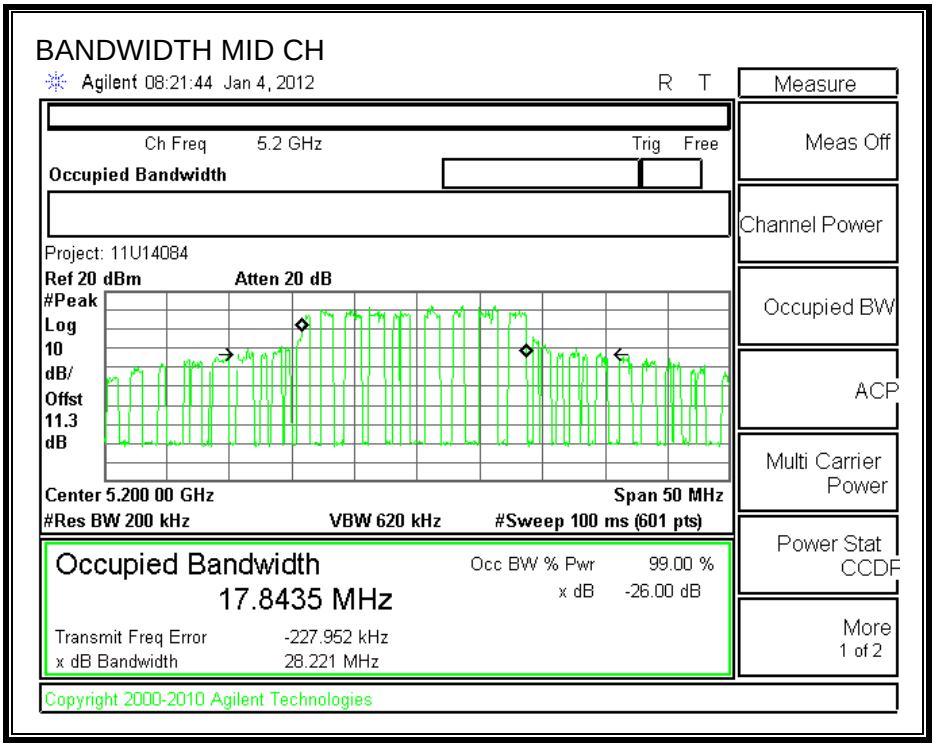
CHAIN 2

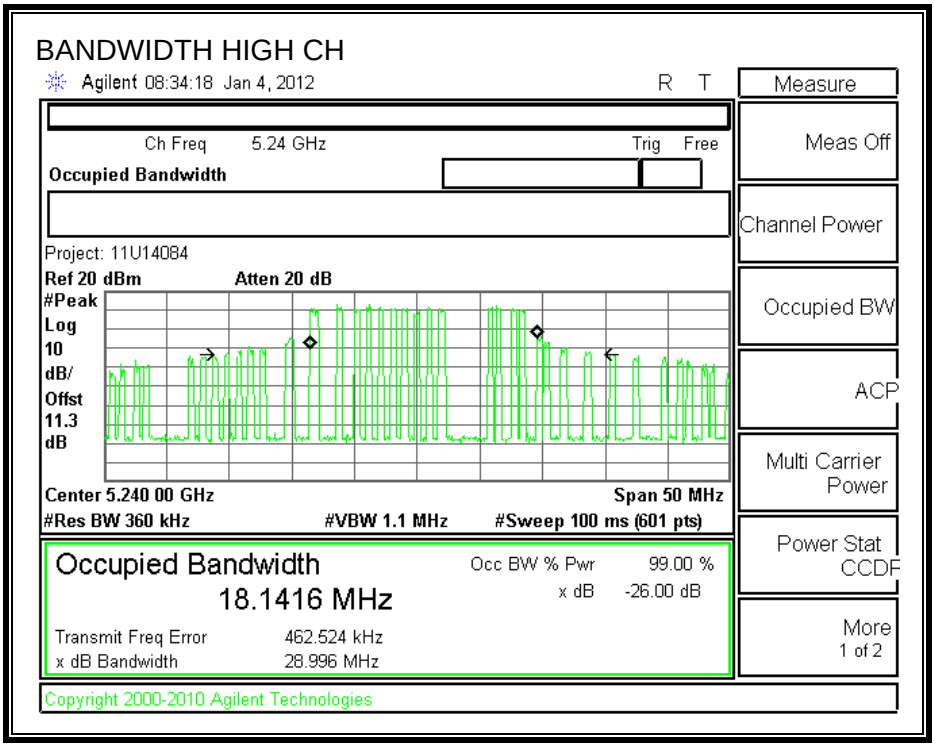
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	5180	27.806	16.7598
Middle	5200	30.942	16.9436
High	5240	33.676	17.1823

CHAIN 1

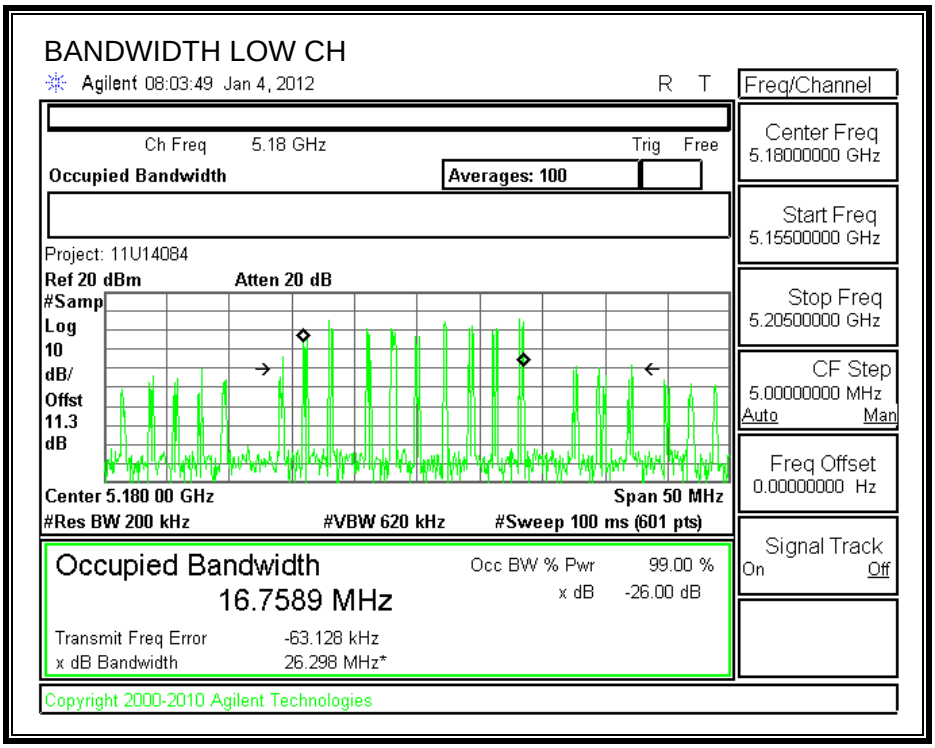
26 dB BANDWIDTH

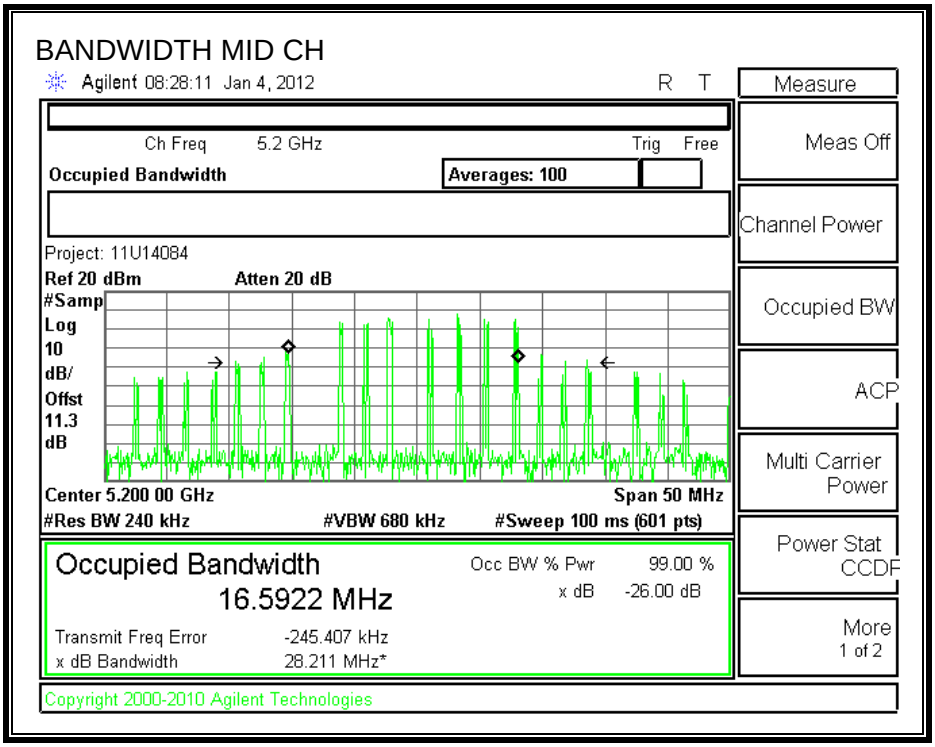


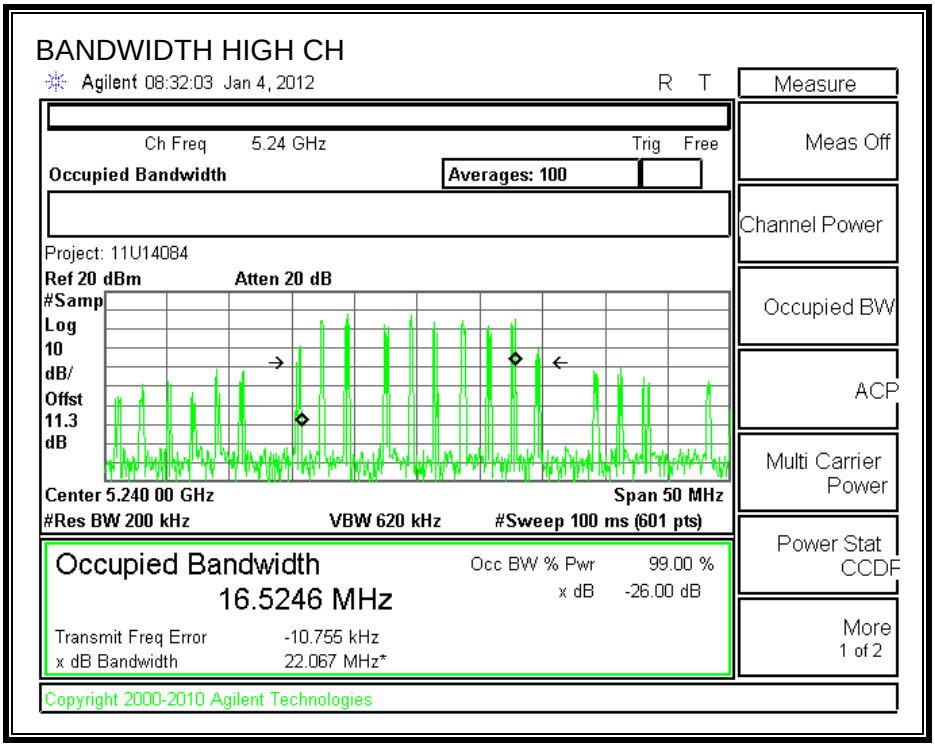




99% BANDWIDTH

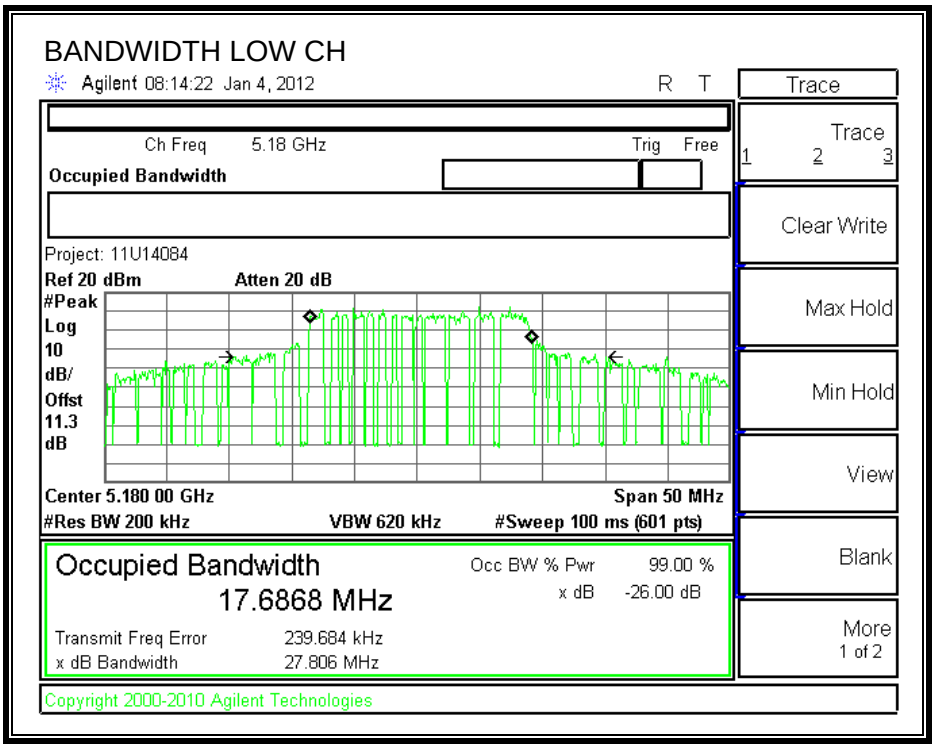


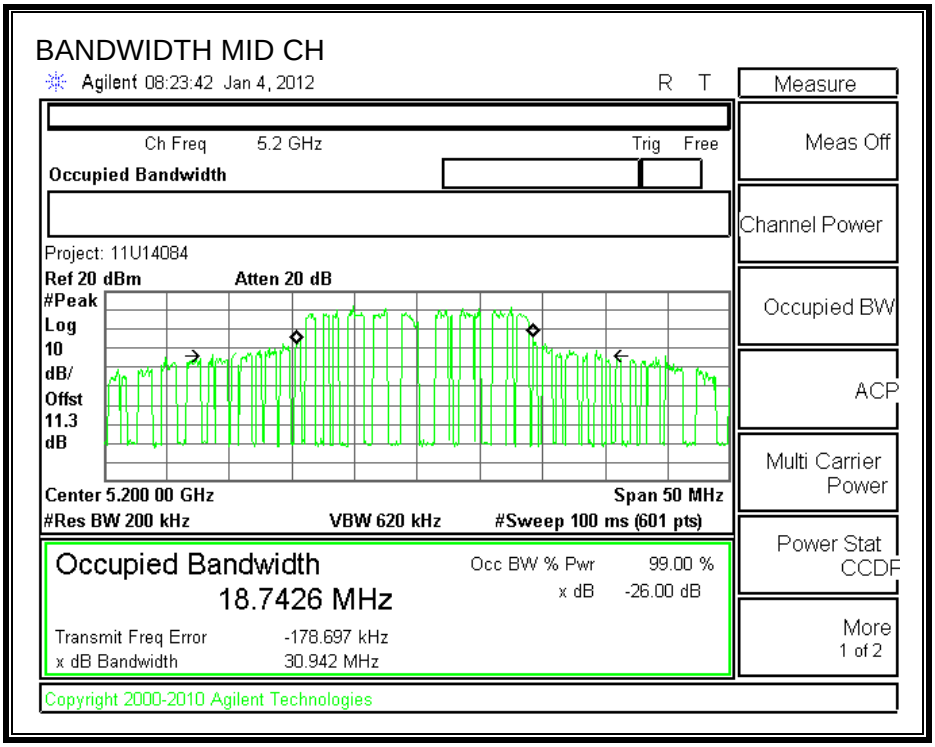


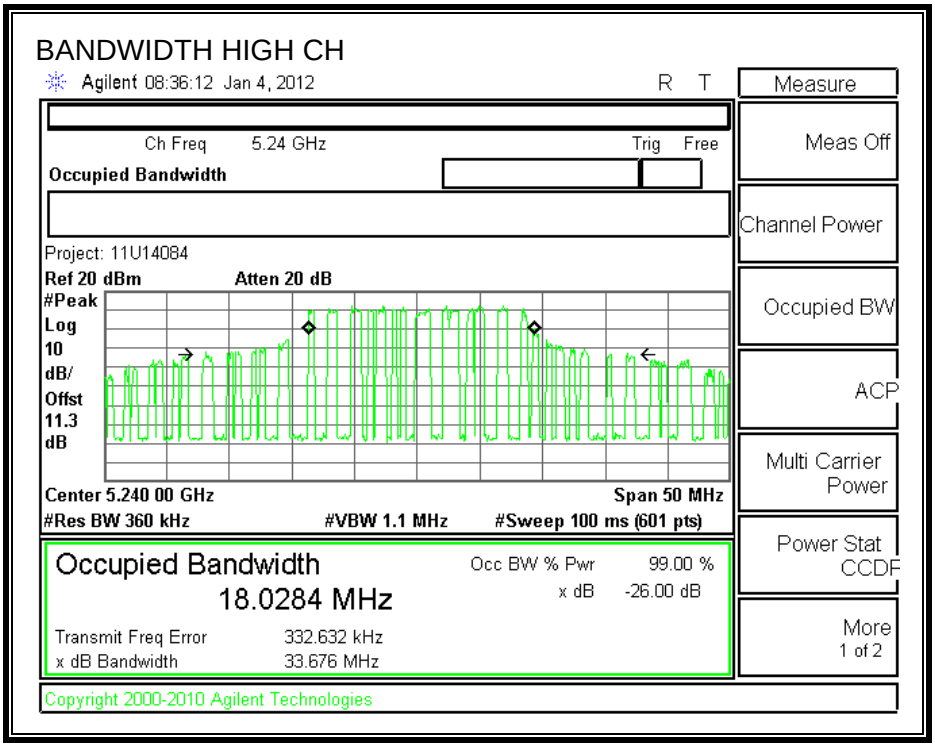


CHAIN 2

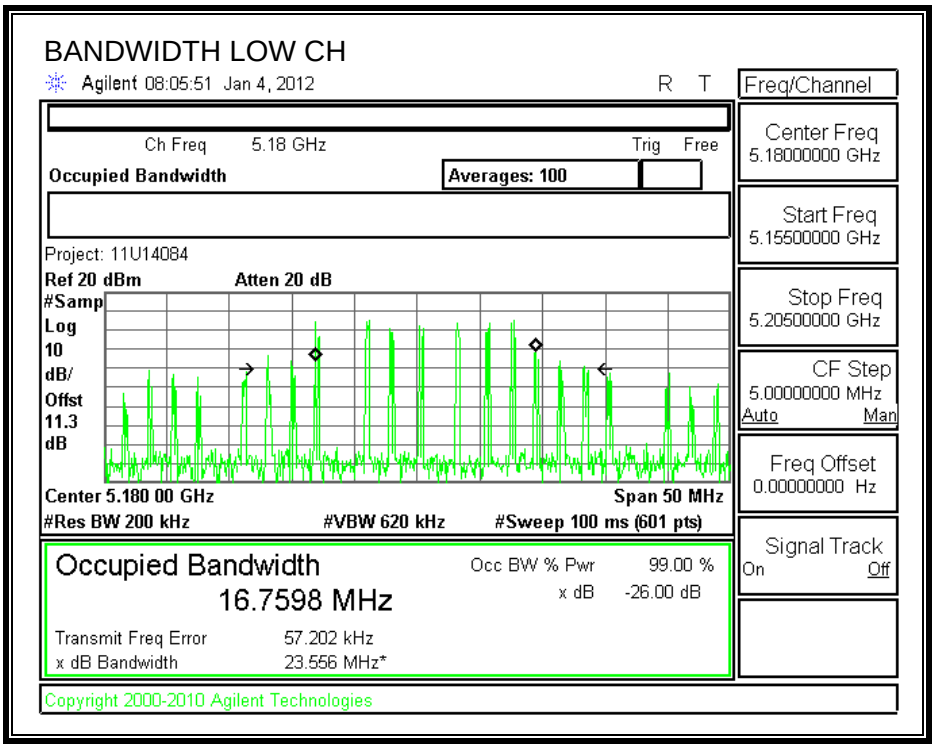
26 dB BANDWIDTH

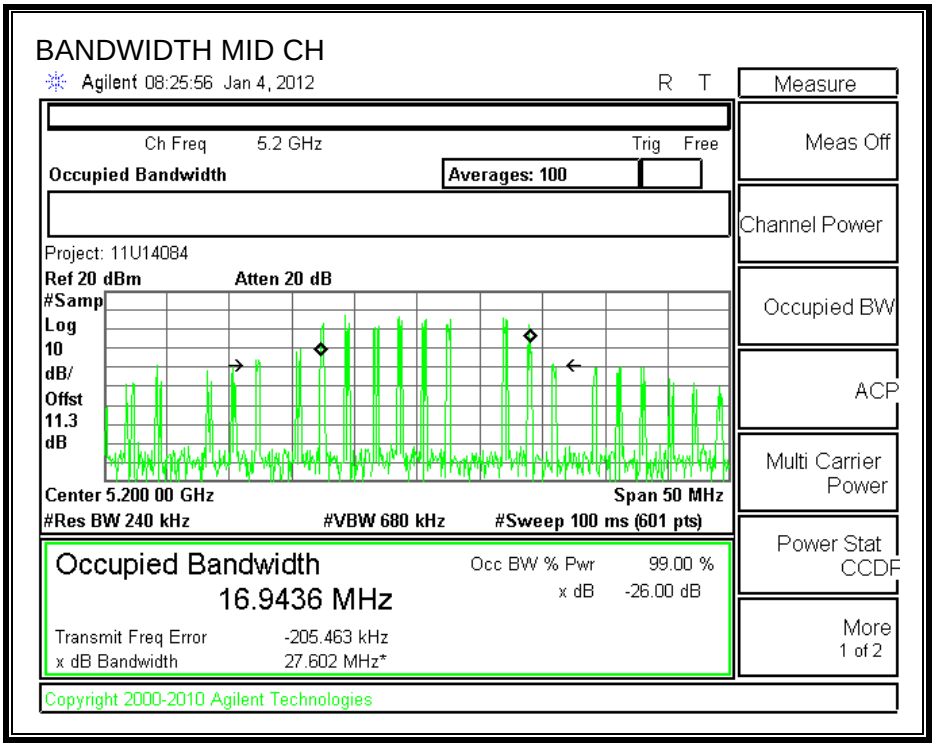


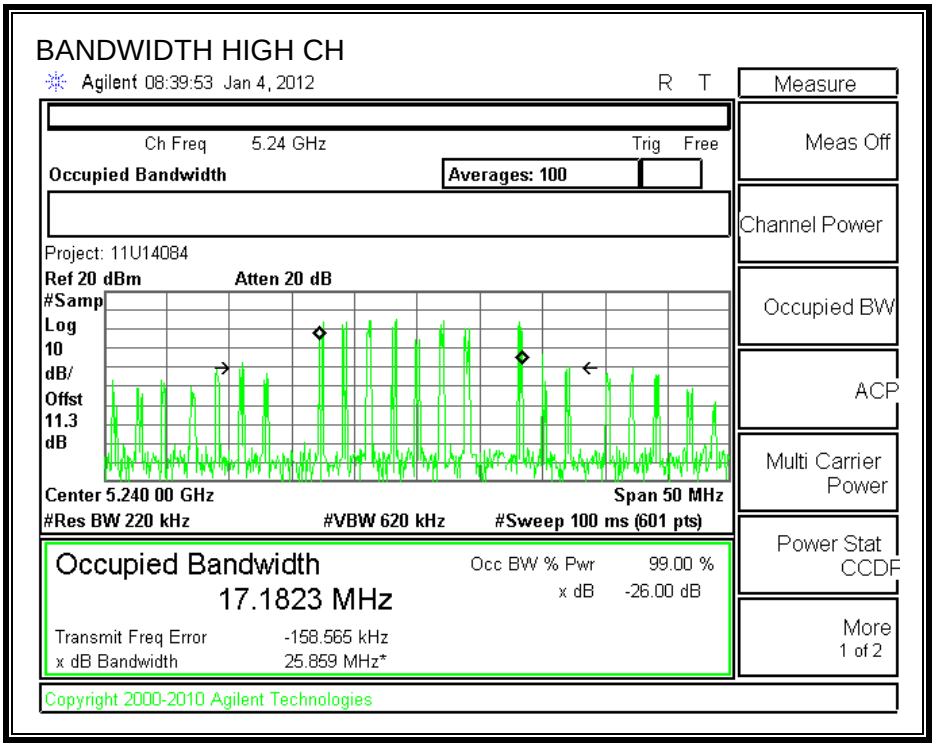




99% BANDWIDTH







7.1.2. OUTPUT POWER

LIMITS

FCC §15.407 (a) (1)

IC RSS-210 A9.2 (1)

For the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10 log B, where B is the 26-dB emission bandwidth in MHz. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit 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.

TEST PROCEDURE

Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

Based on the characteristics of the EUT and various criteria method SA-3 ALT was selected.

RESULTS

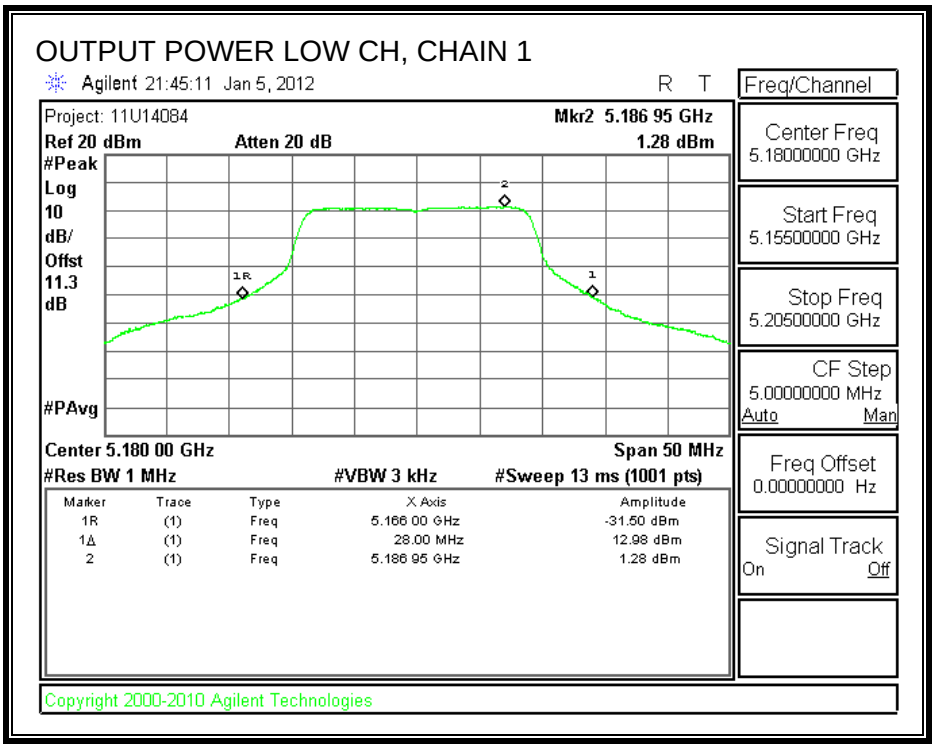
Limit

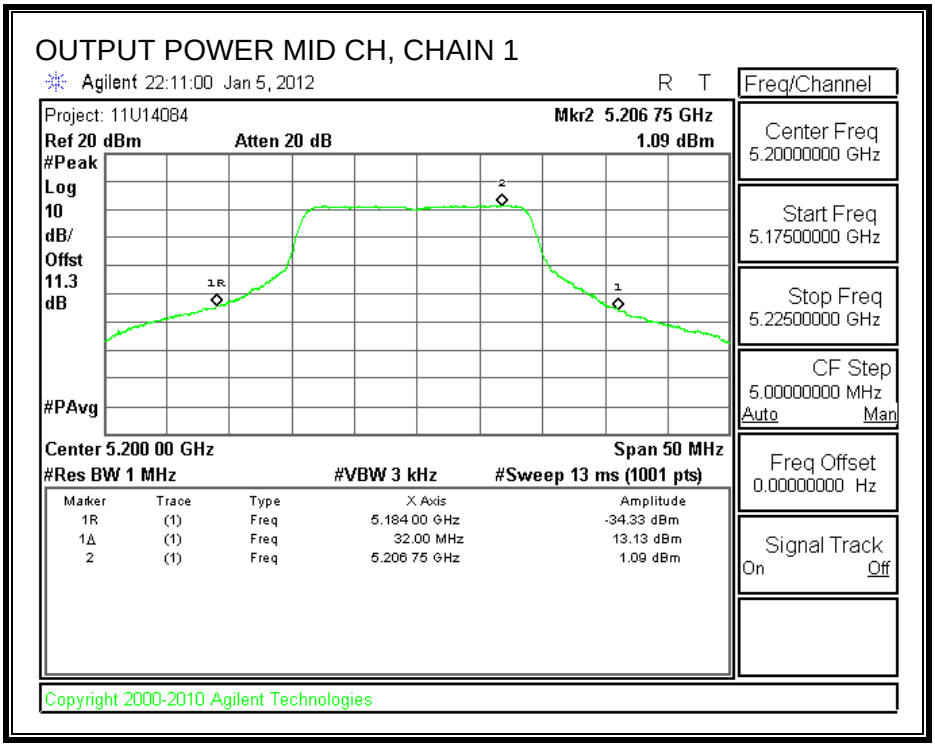
Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	4 + 10 Log B Limit (dBm)	Antenna Gain (dBi)	Limit (dBm)
Low	5180	17	27.781	18.44	4.98	17.00
Mid	5200	17	28.221	18.51	4.98	17.00
High	5240	17	28.996	18.62	4.98	17.00

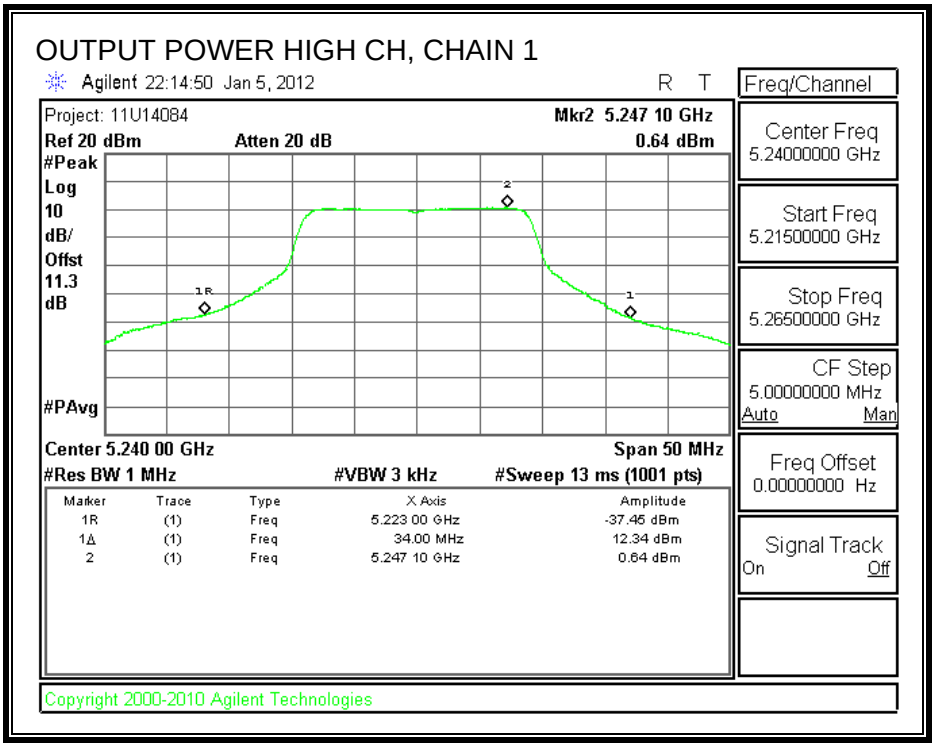
Individual Chain Results

Channel	Frequency (MHz)	Chain 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5180	12.98	12.30	15.66	17.00	-1.34
Mid	5200	13.13	12.68	15.92	17.00	-1.08
High	5240	12.34	12.71	15.54	17.00	-1.46

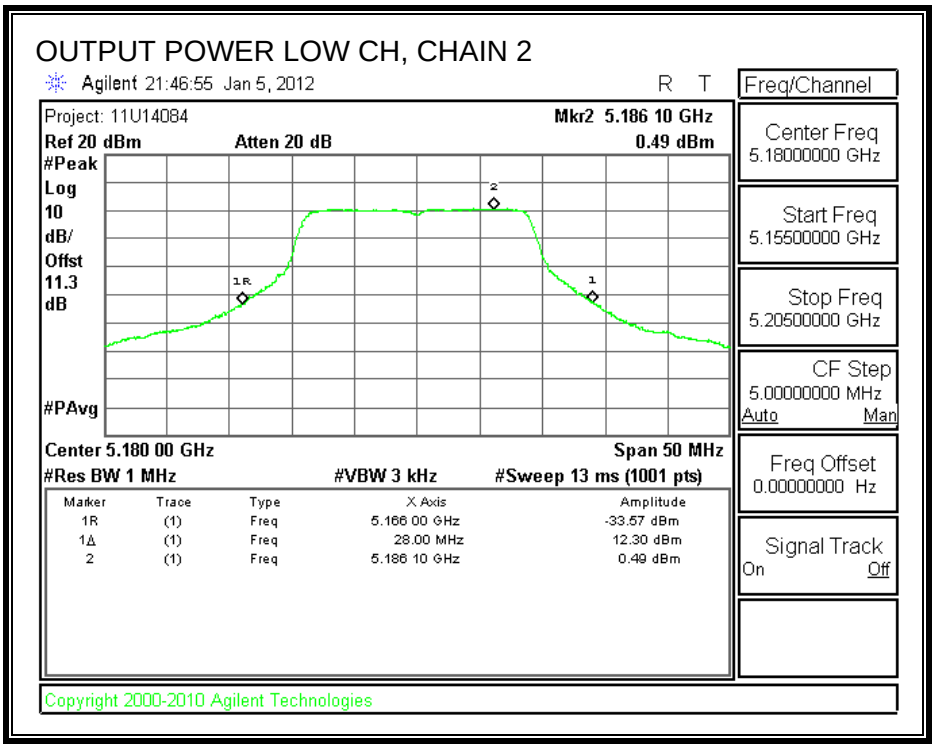
CHAIN 1 OUTPUT POWER

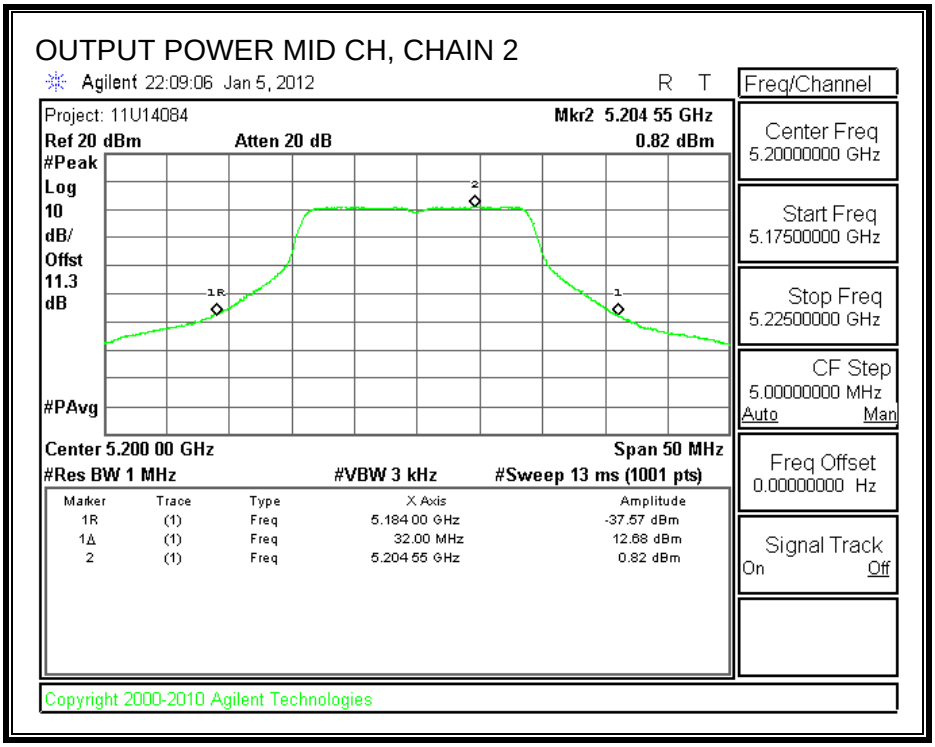


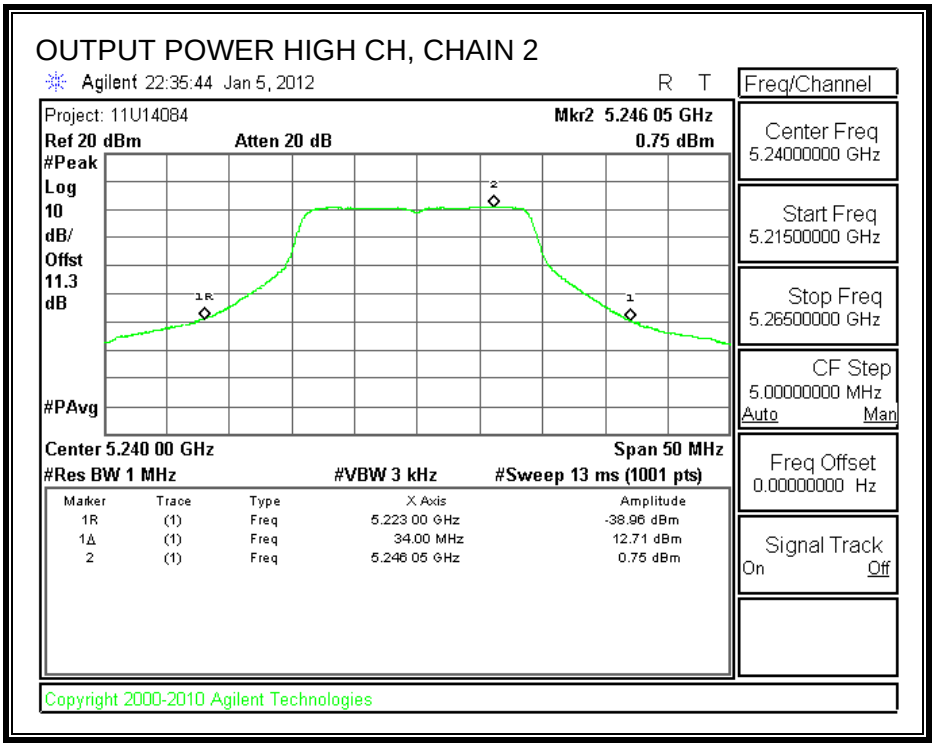




CHAIN 2 OUTPUT POWER







7.1.3. 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	5180	10.50	9.90	13.22
Middle	5200	10.50	10.22	13.37
High	5240	10.30	10.35	13.34

7.1.4. PEAK POWER SPECTRAL DENSITY

LIMITS

FCC §15.407 (a) (1)

IC RSS-210 A9.2 (1)

For the 5.15-5.25 GHz band, 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 peak transmit 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.

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 4 dBm.

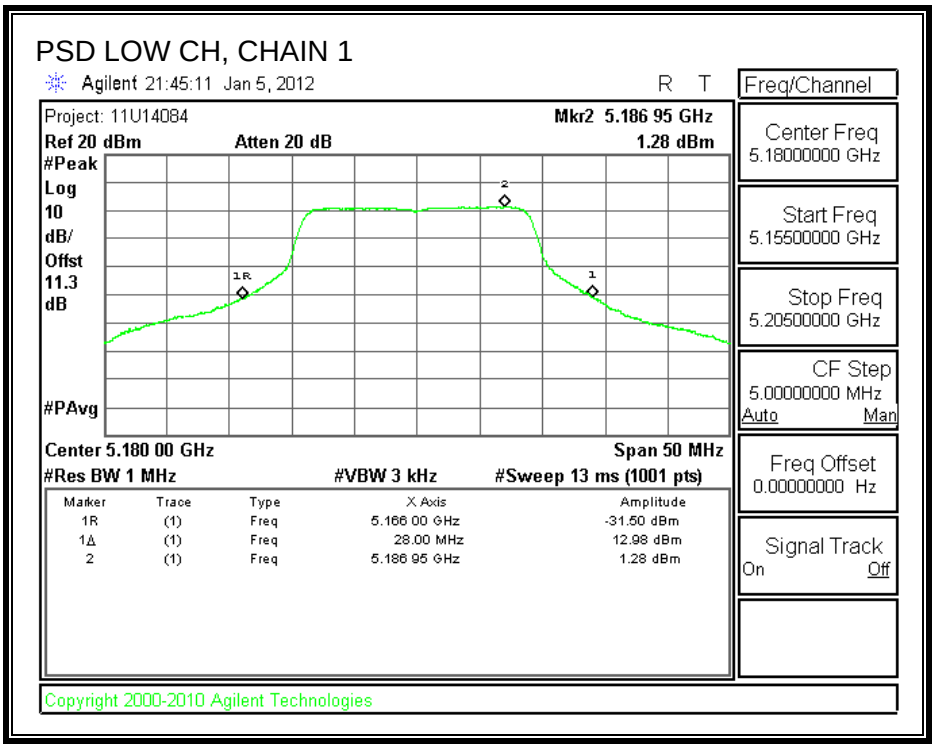
TEST PROCEDURE

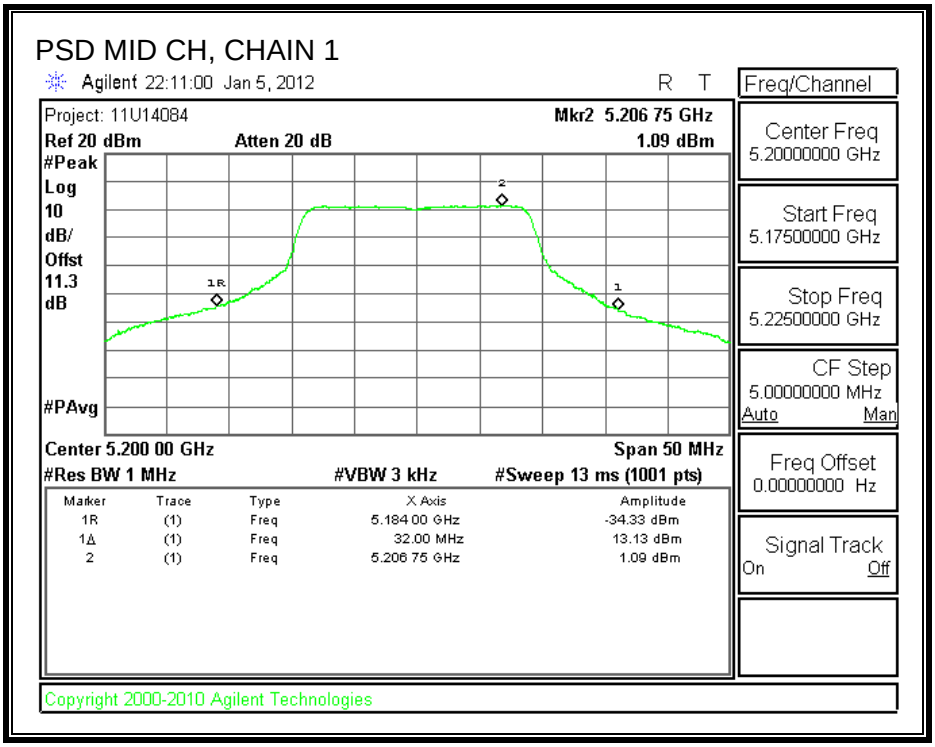
Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

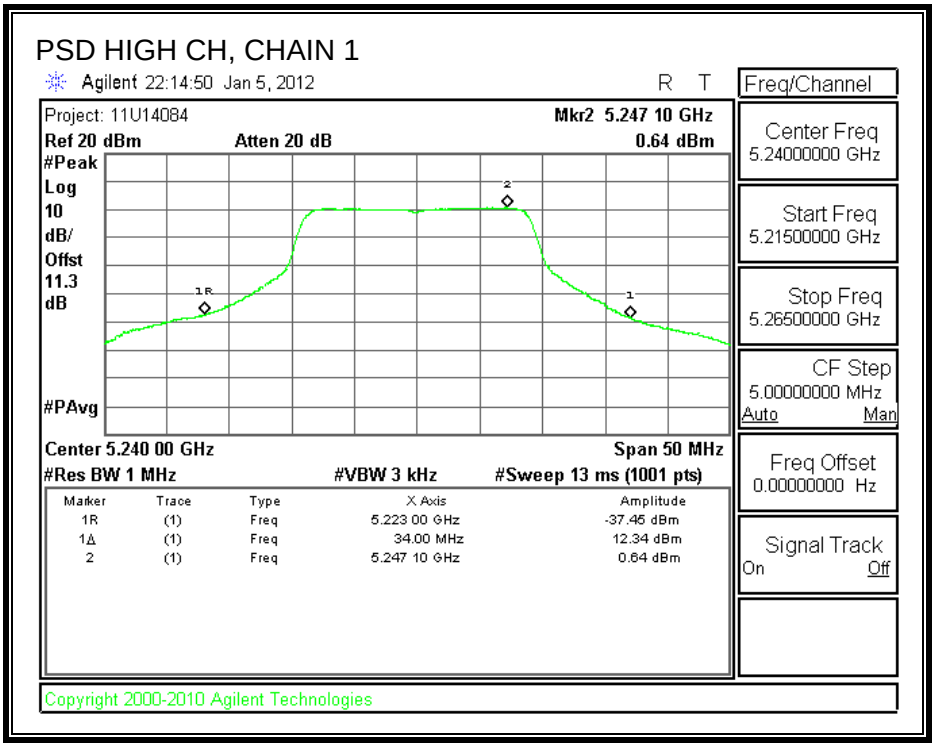
RESULTS

Channel	Frequency (MHz)	Chain 1 PPSD (dBm)	Chain 2 PPSD (dBm)	Total PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	5180	1.28	0.49	3.91	4	-0.09
Middle	5200	1.09	0.82	3.97	4	-0.03
High	5240	0.64	0.75	3.71	4	-0.29

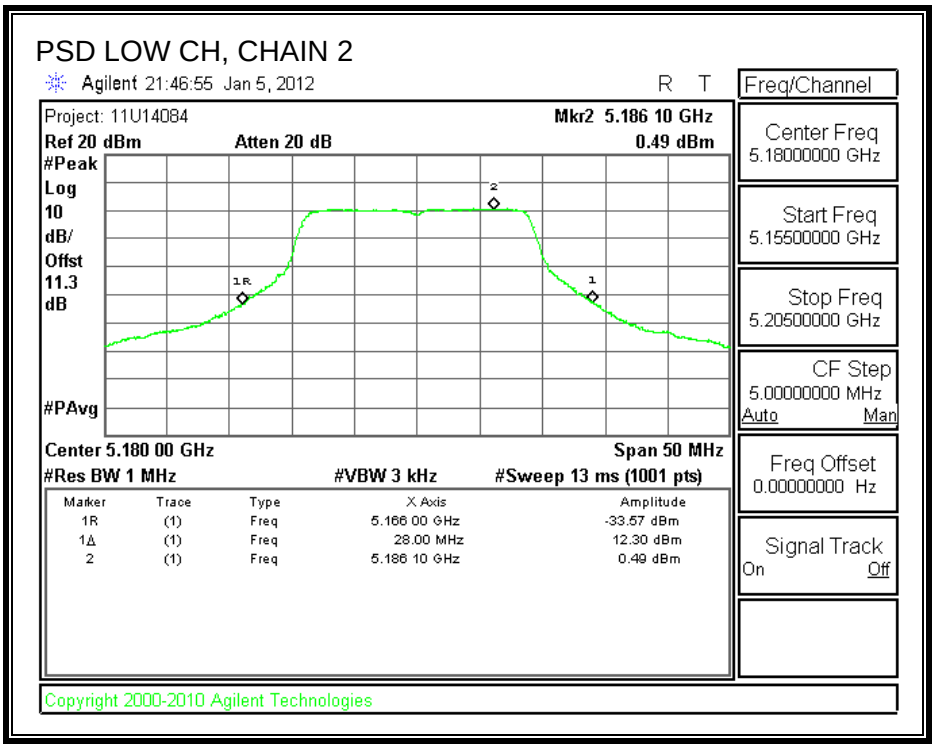
CHAIN 1 POWER SPECTRAL DENSITY

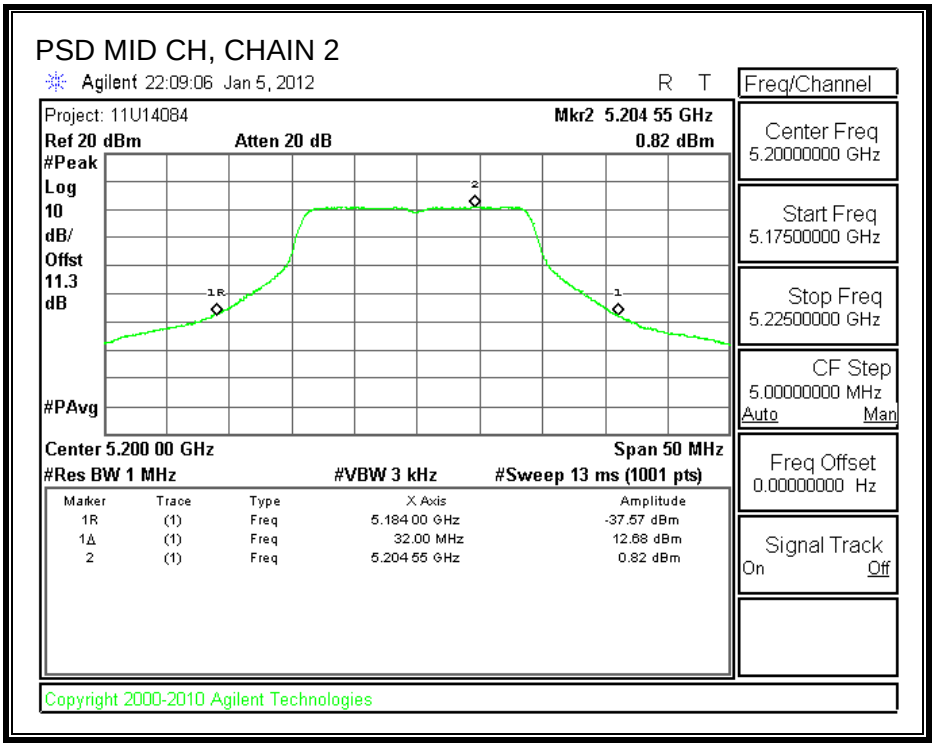


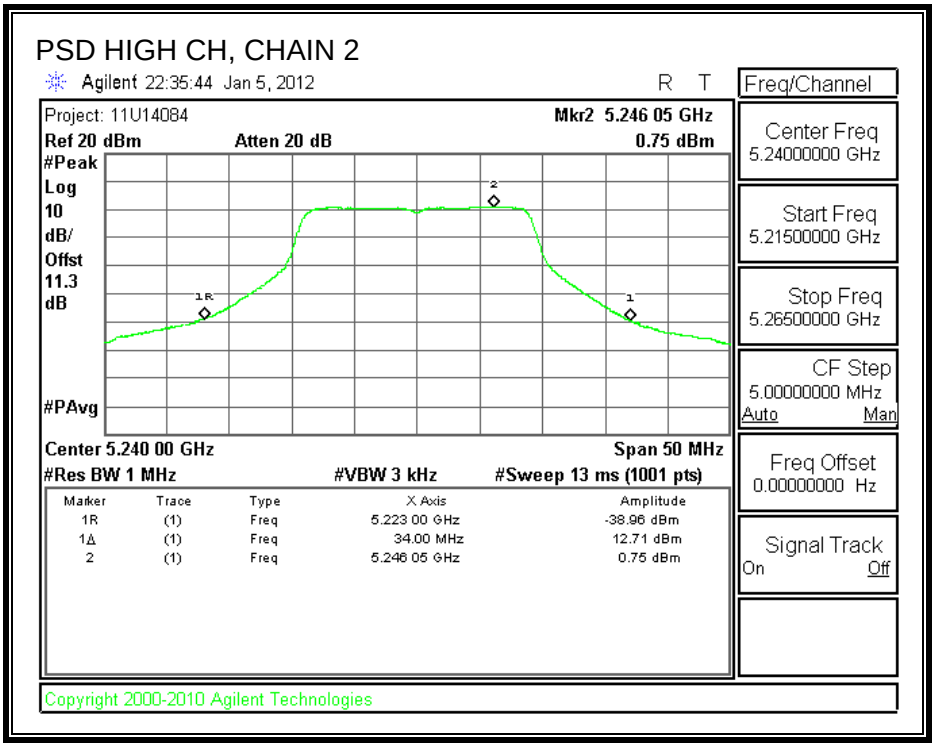




CHAIN 2 POWER SPECTRAL DENSITY







7.1.5. 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.

TEST PROCEDURE

Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

RESULTS

CHAIN 1

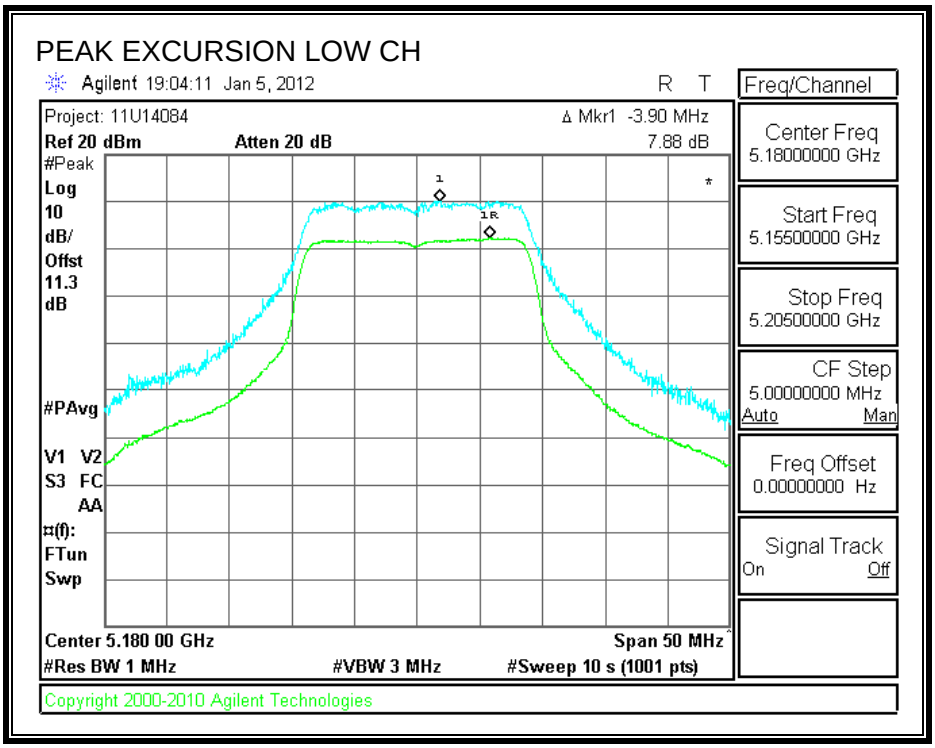
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5180	7.88	13	-5.12
Middle	5200	8.74	13	-4.26
High	5240	8.31	13	-4.69

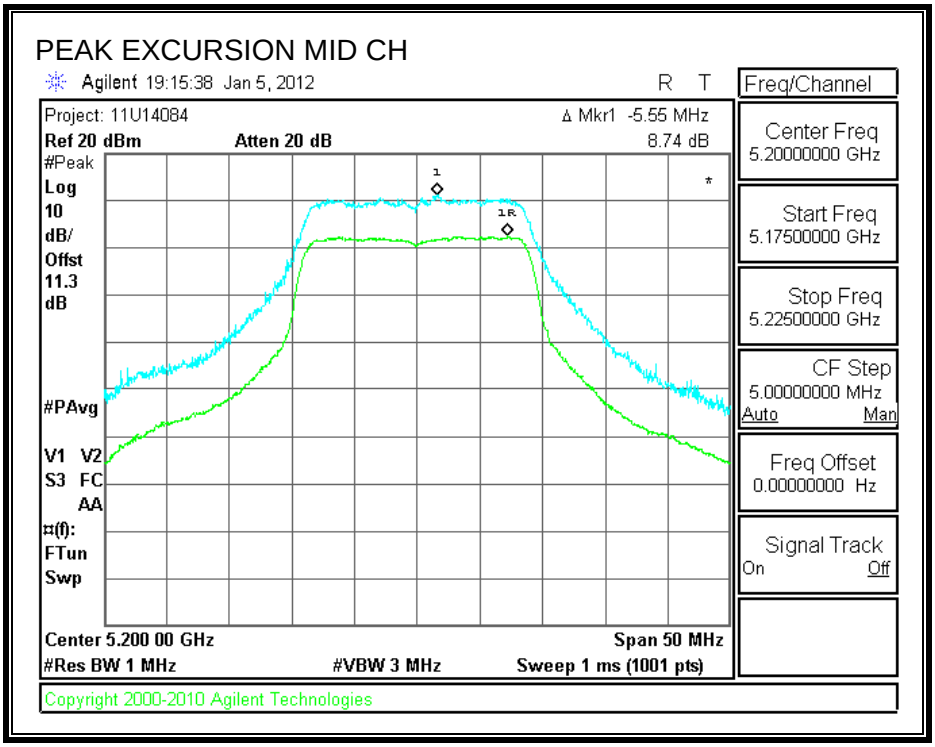
CHAIN 2

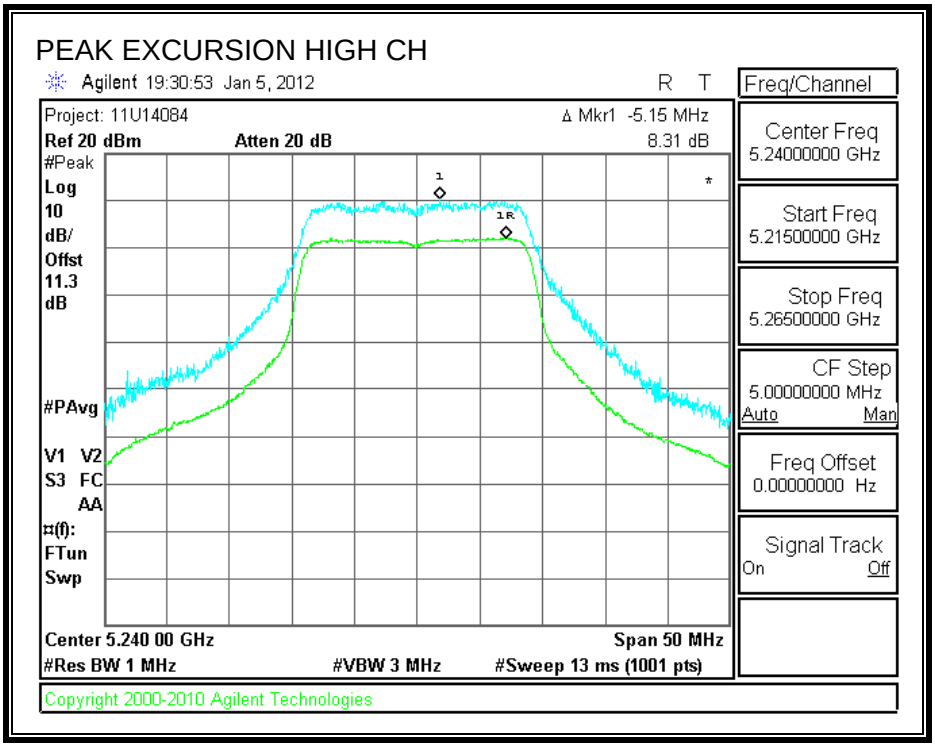
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5180	6.54	13	-6.46
Middle	5200	9.25	13	-3.75
High	5240	9.18	13	-3.82

CHAIN 1

PEAK EXCURSION

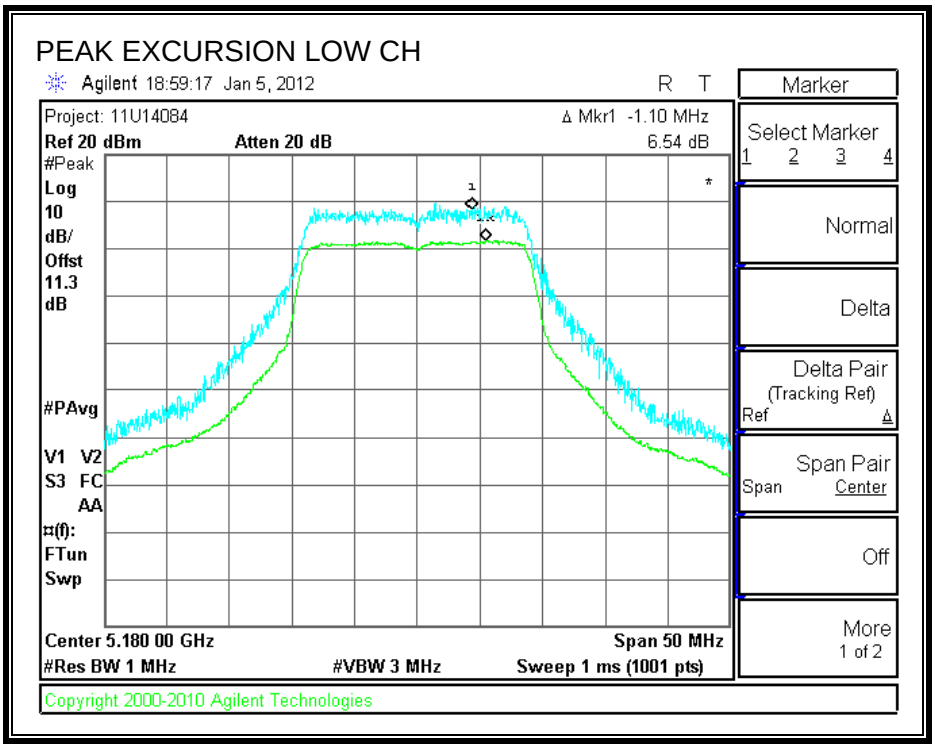


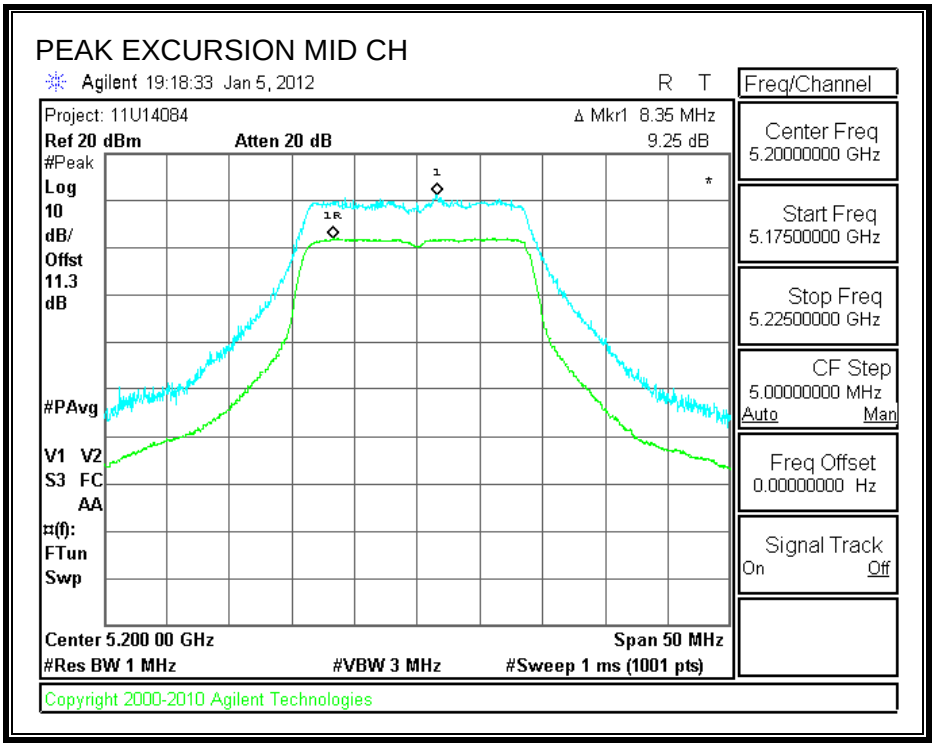




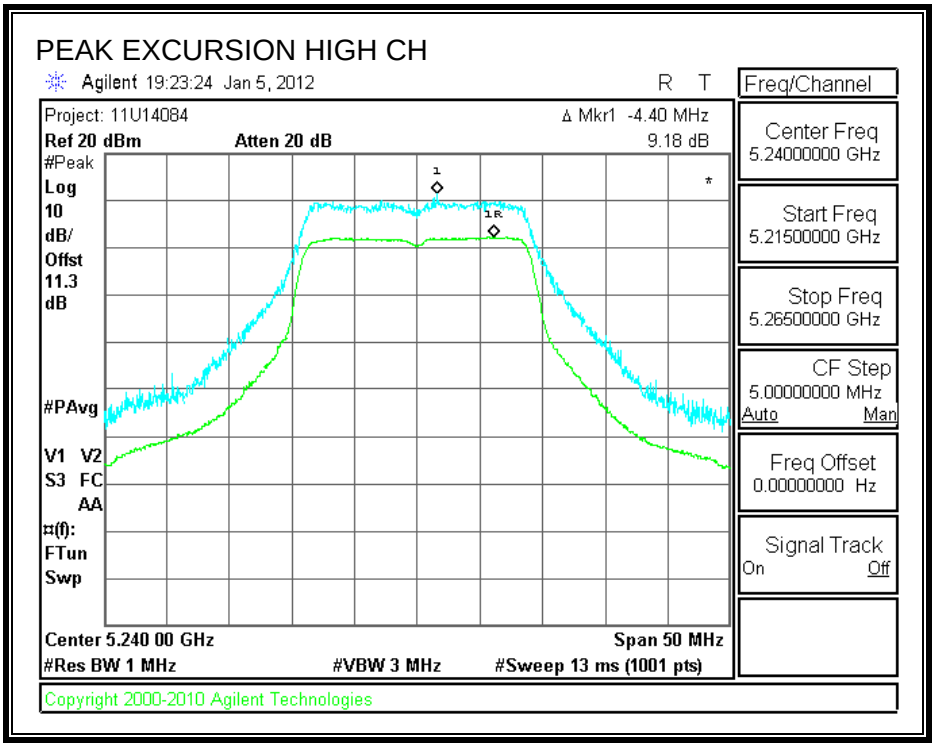
CHAIN 2

PEAK EXCURSION





PEAK EXCURSION HIGH CH



7.2. 802.11n HT20 MODE IN THE 5.3 GHz BAND

7.2.1. 26 dB and 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

RESULTS

CHAIN 1

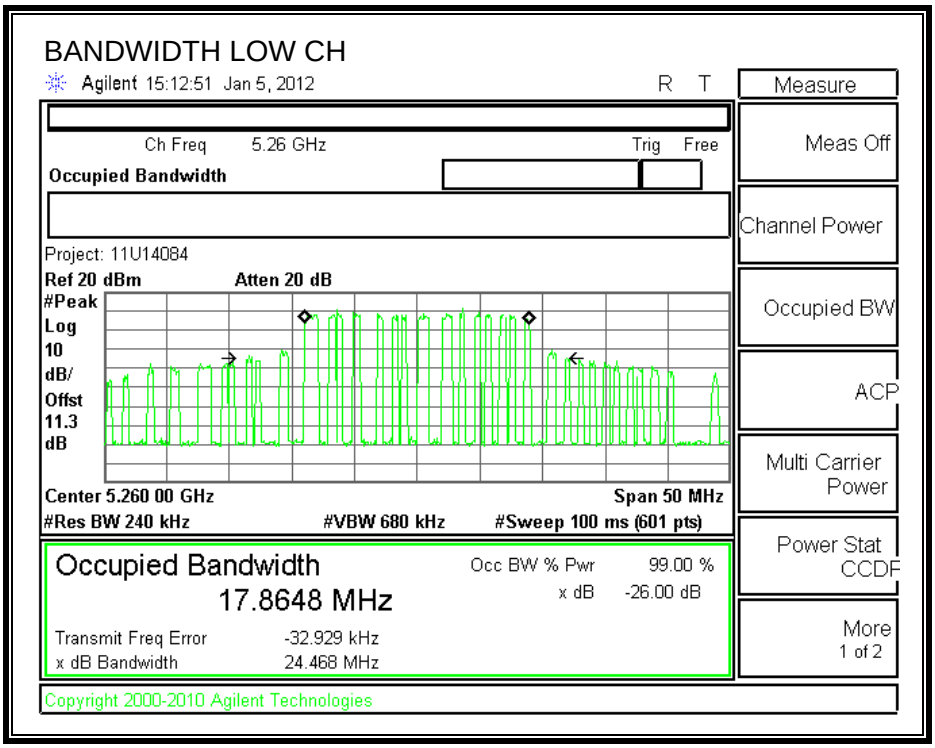
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	5260	24.468	16.1018
Middle	5300	24.778	16.4366
High	5320	27.086	17.0909

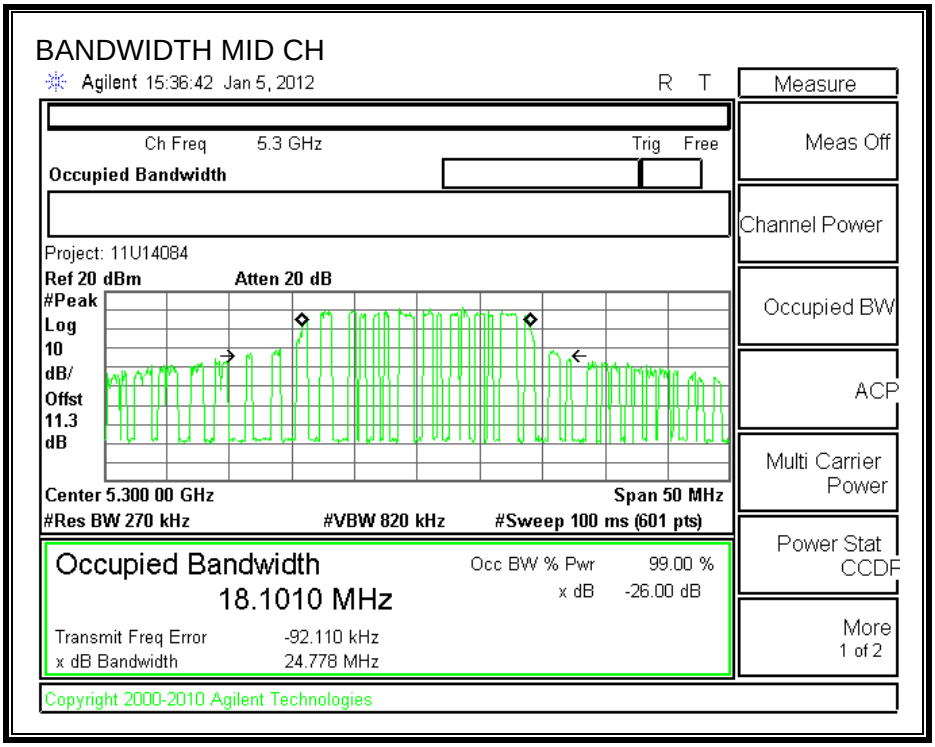
CHAIN 2

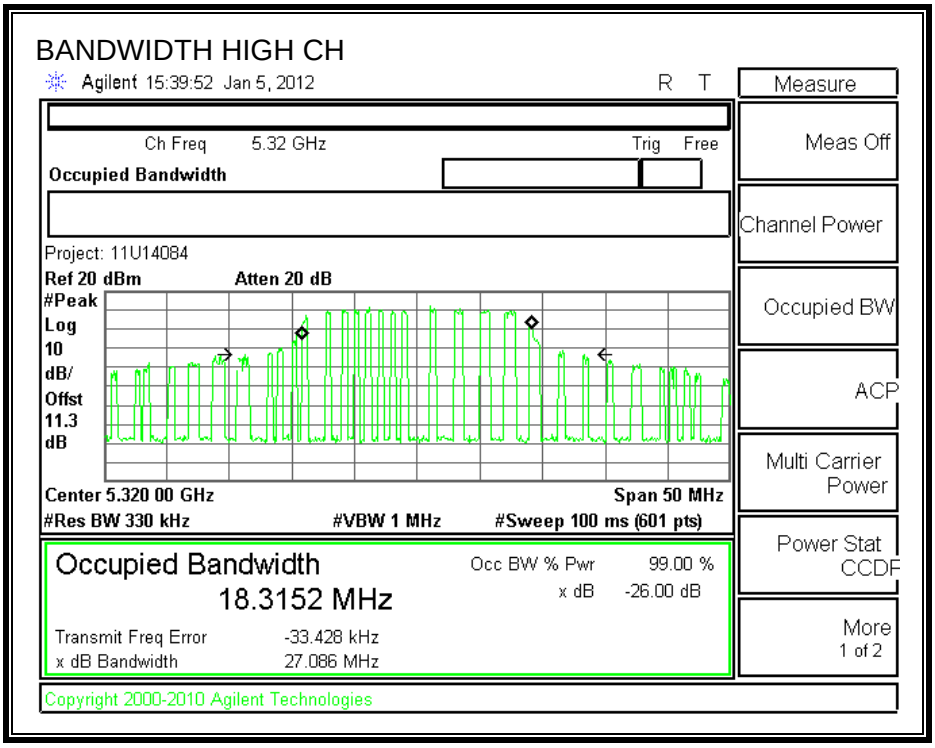
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	5260	33.04	16.1088
Middle	5300	31.297	17.3664
High	5320	31.343	16.3699

CHAIN 1

26 dB BANDWIDTH

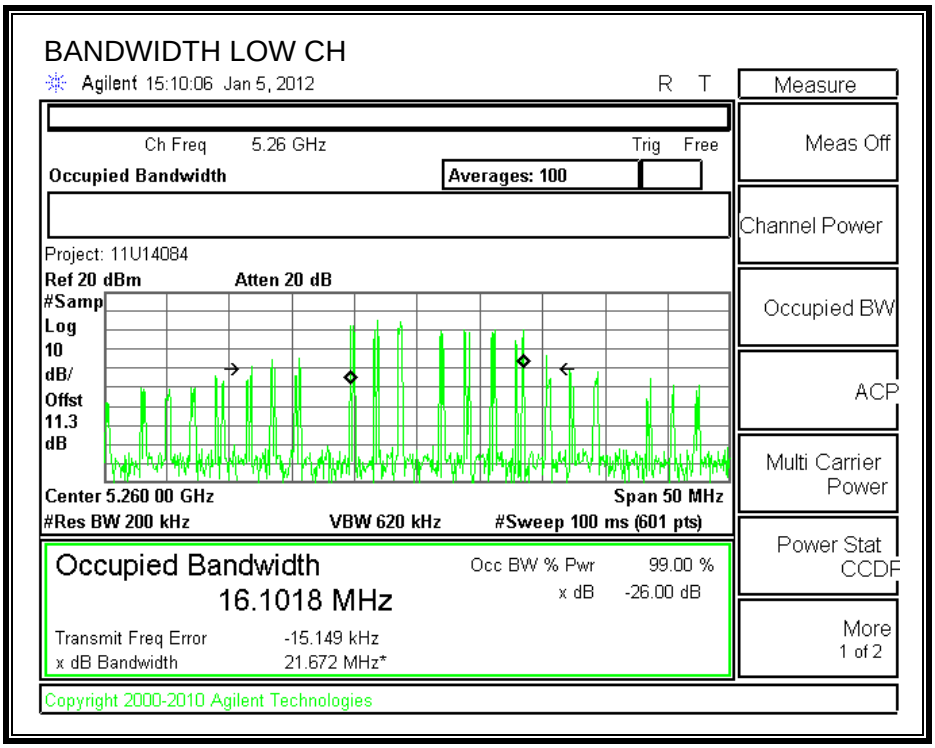


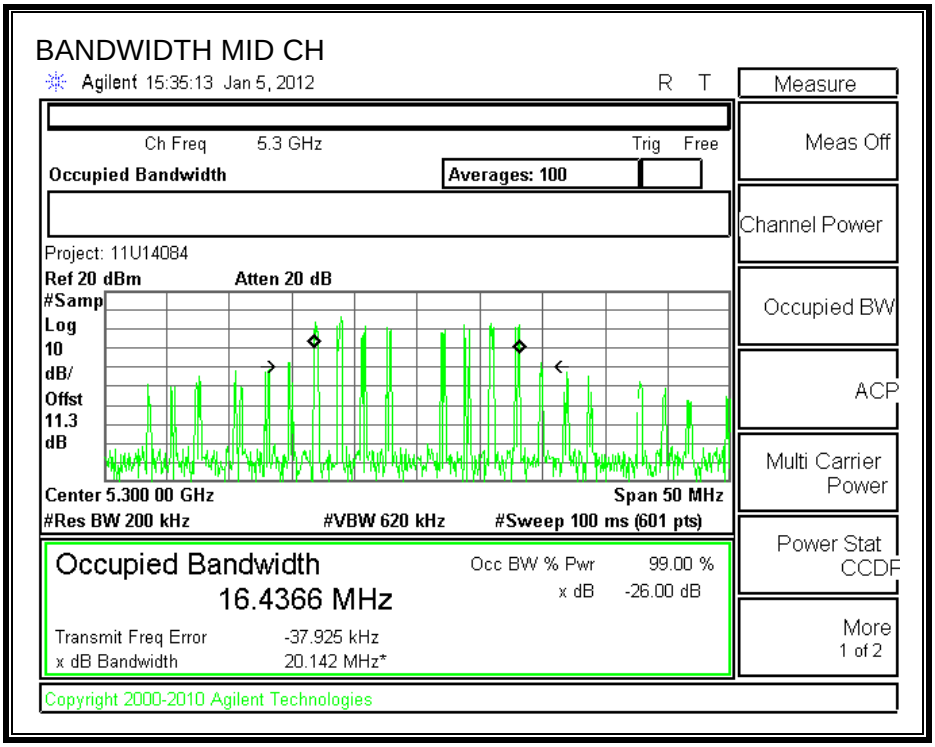


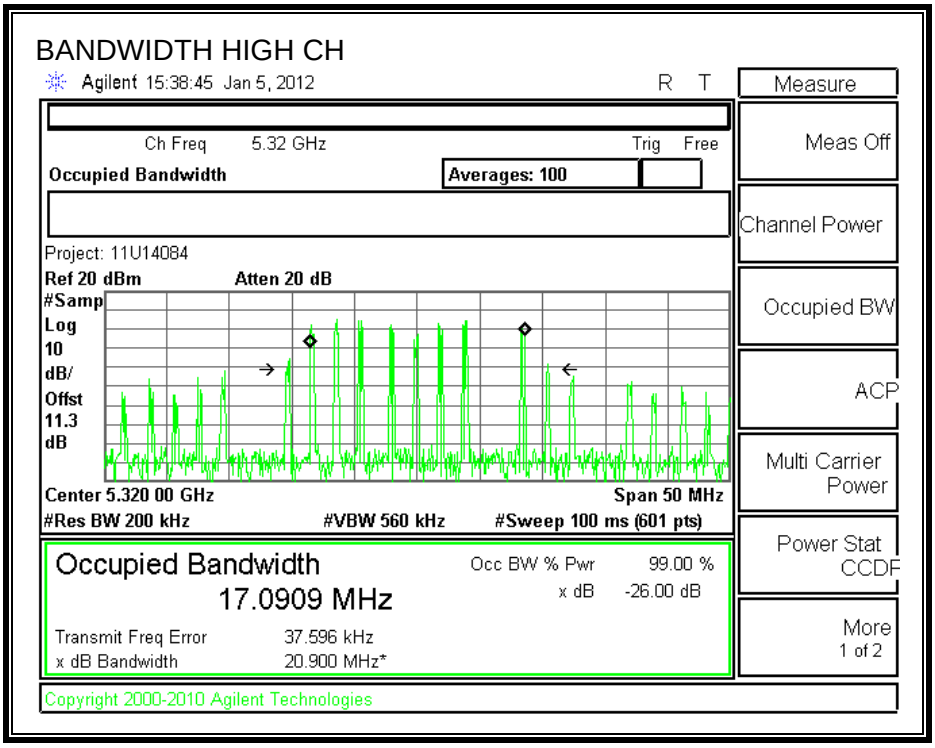


CHAIN 1

99% BANDWIDTH

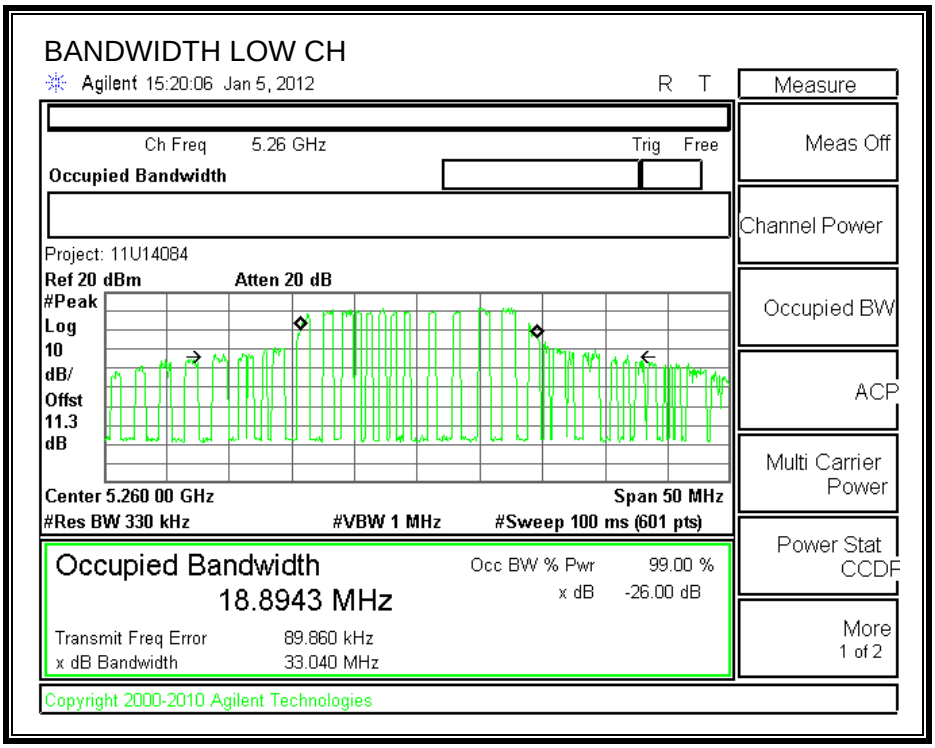


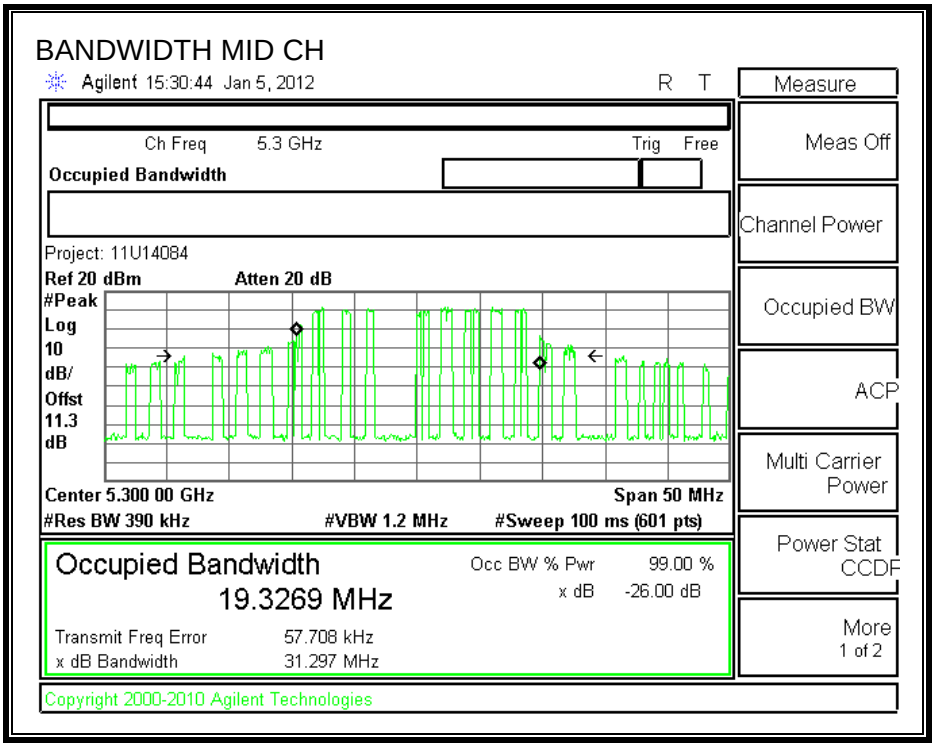


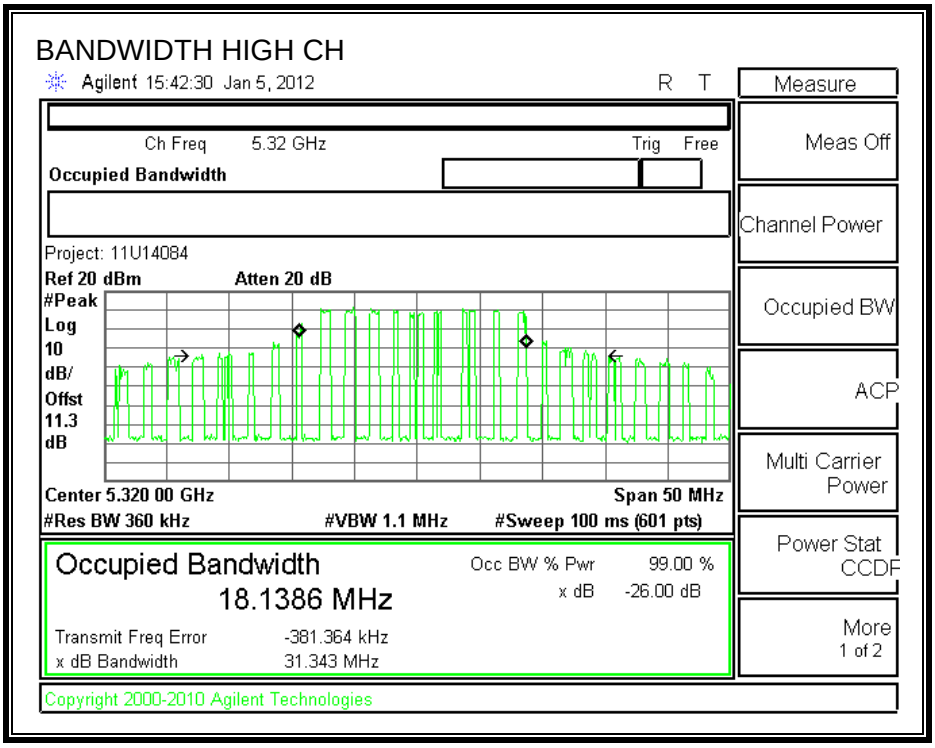


CHAIN 2

26 dB BANDWIDTH

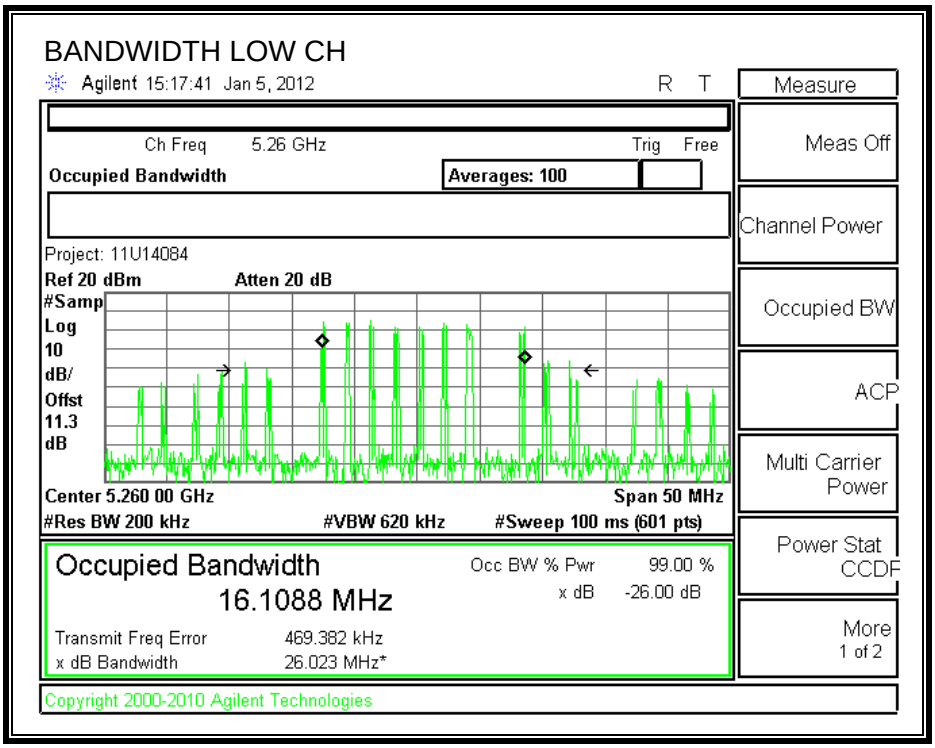


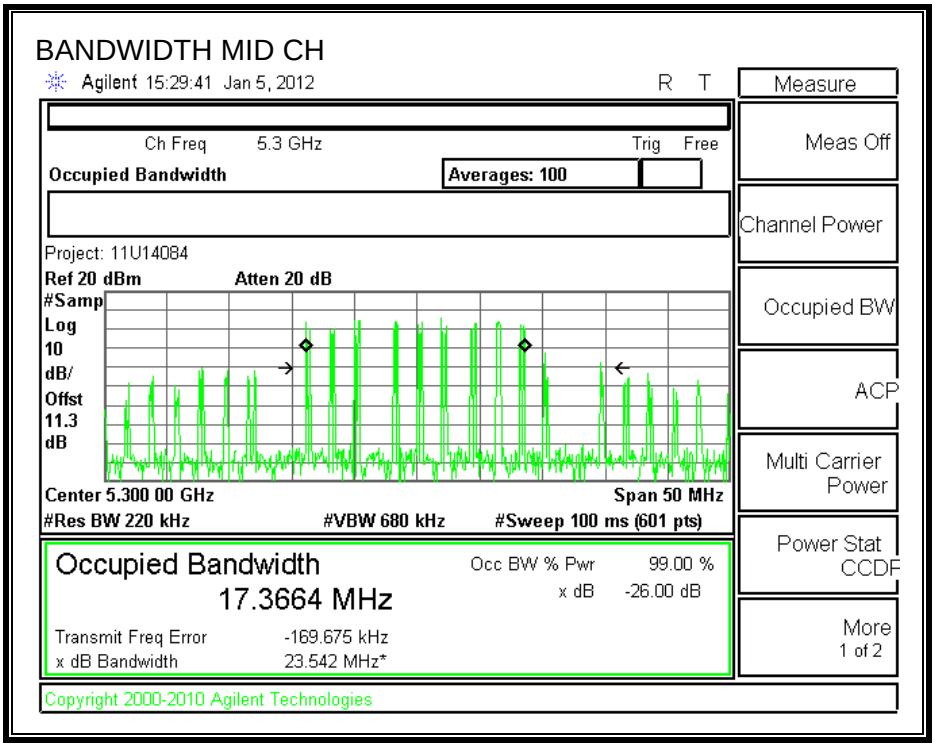


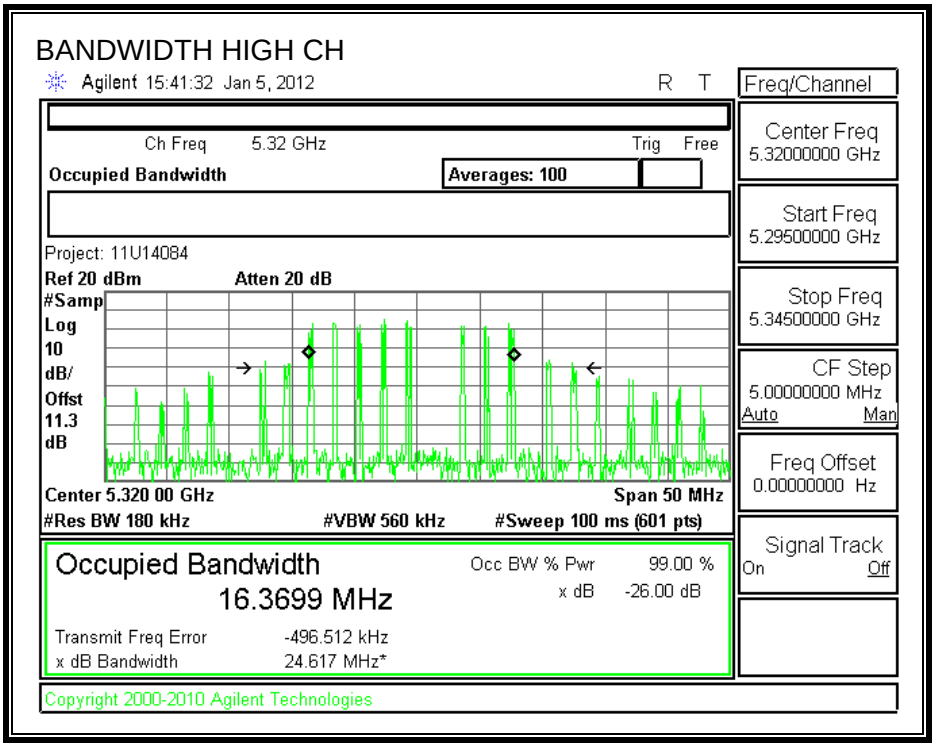


CHAIN 2

99% BANDWIDTH







7.2.2. OUTPUT POWER

LIMITS

FCC §15.407 (a) (2)

IC RSS-210 A9.2 (2)

For the 5.25-5.35 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26-dB emission bandwidth in MHz. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit 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.

TEST PROCEDURE

Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

Based on the characteristics of the EUT and various criteria method SA-3 ALT was selected.

RESULTS

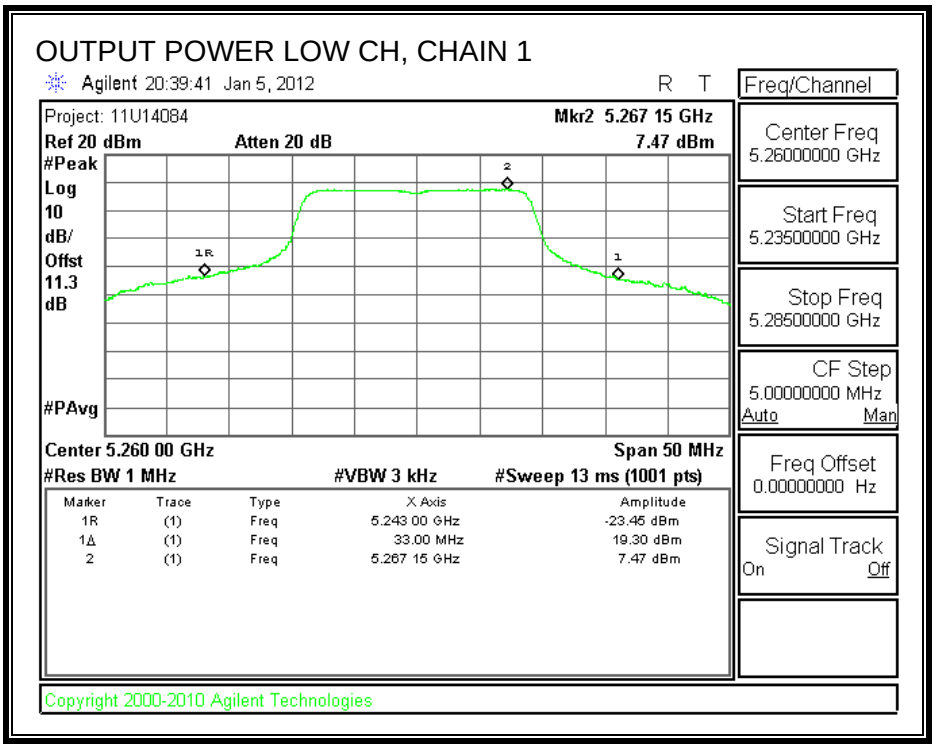
Limit

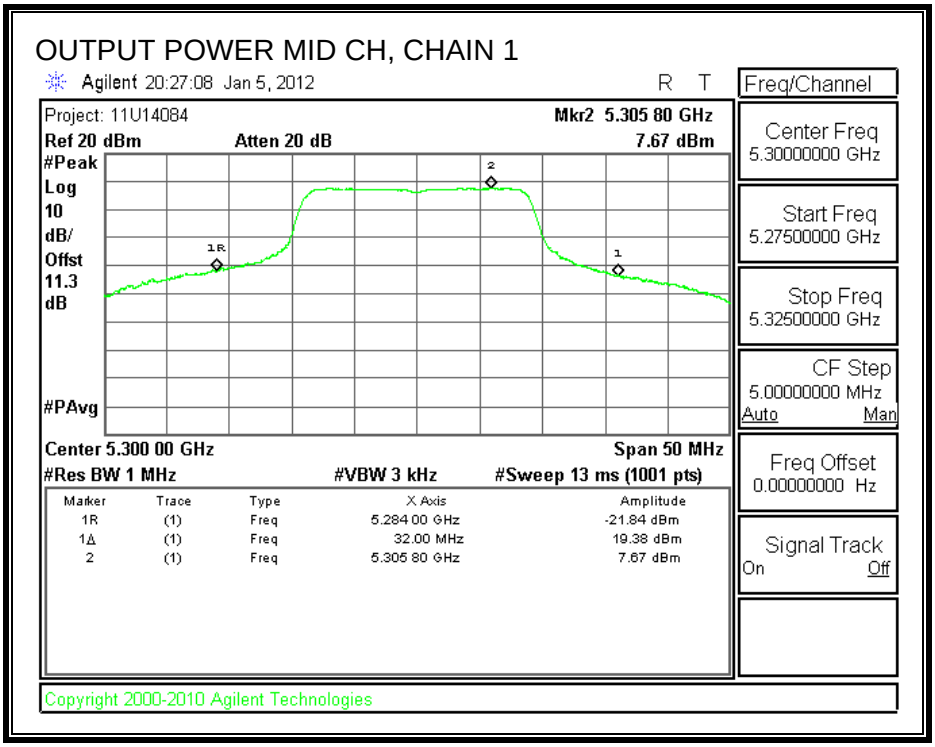
Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Antenna Gain (dBi)	Limit (dBm)
Low	5260	24	24.468	24.89	4.10	24.00
Mid	5300	24	24.778	24.94	4.10	24.00
High	5320	24	27.086	25.33	4.10	24.00

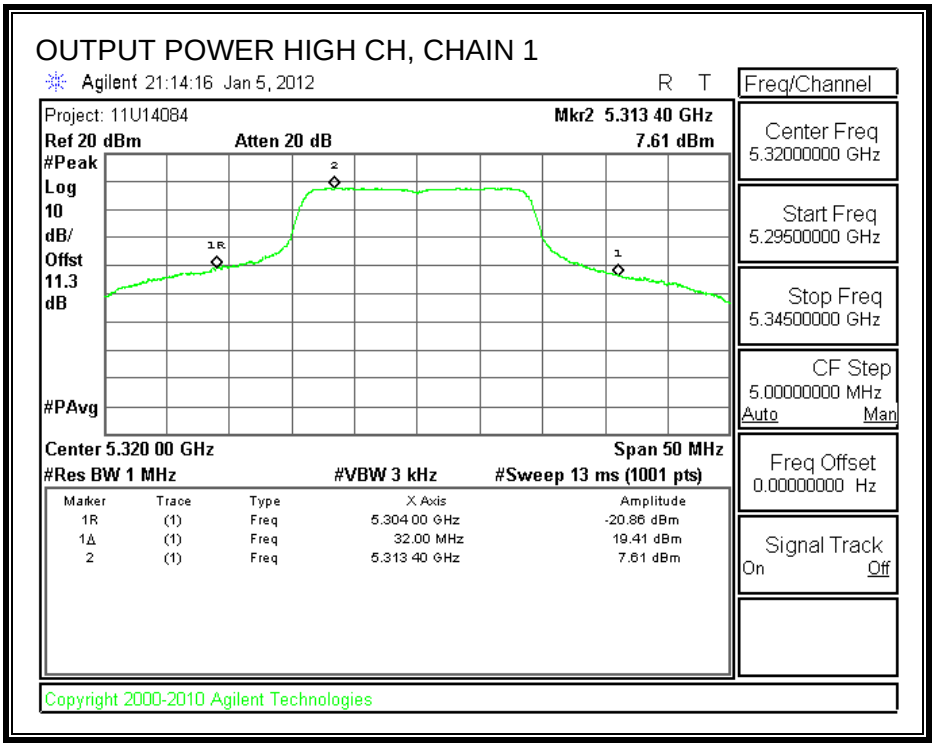
Individual Chain Results

Channel	Frequency (MHz)	Chain 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5260	19.30	19.48	22.40	24.00	-1.60
Mid	5300	19.38	19.39	22.40	24.00	-1.60
High	5320	19.41	19.30	22.37	24.00	-1.63

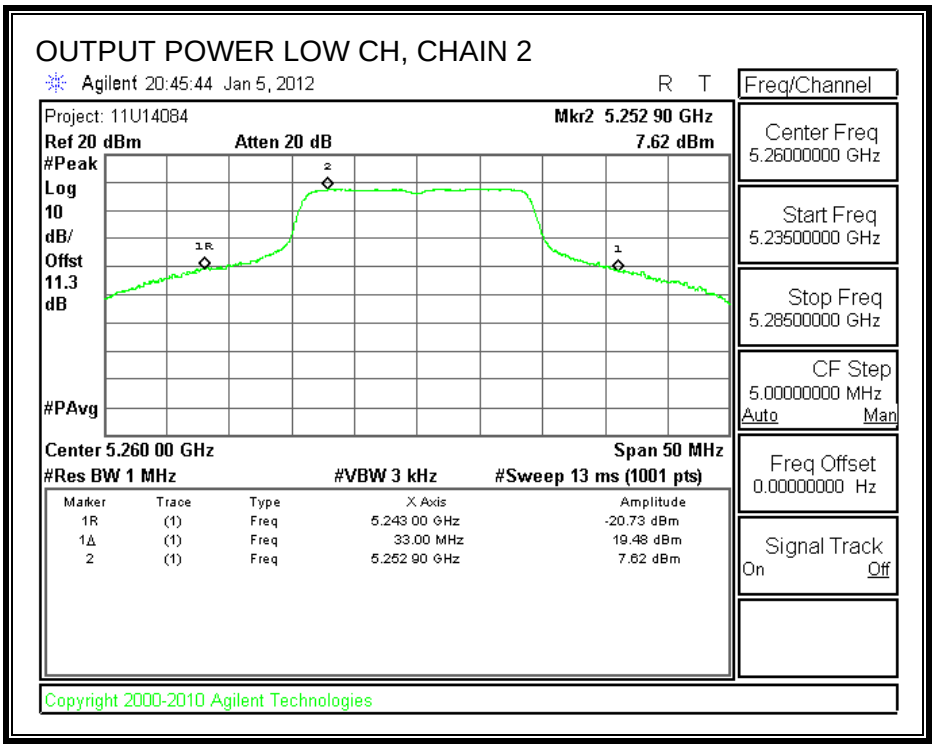
CHAIN 1 OUTPUT POWER

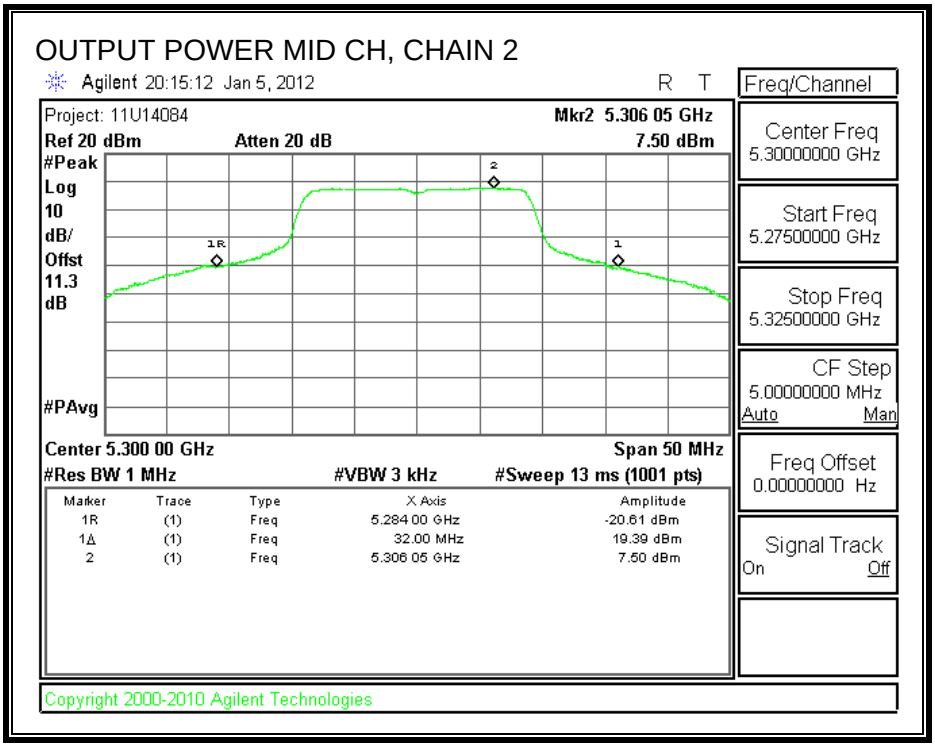


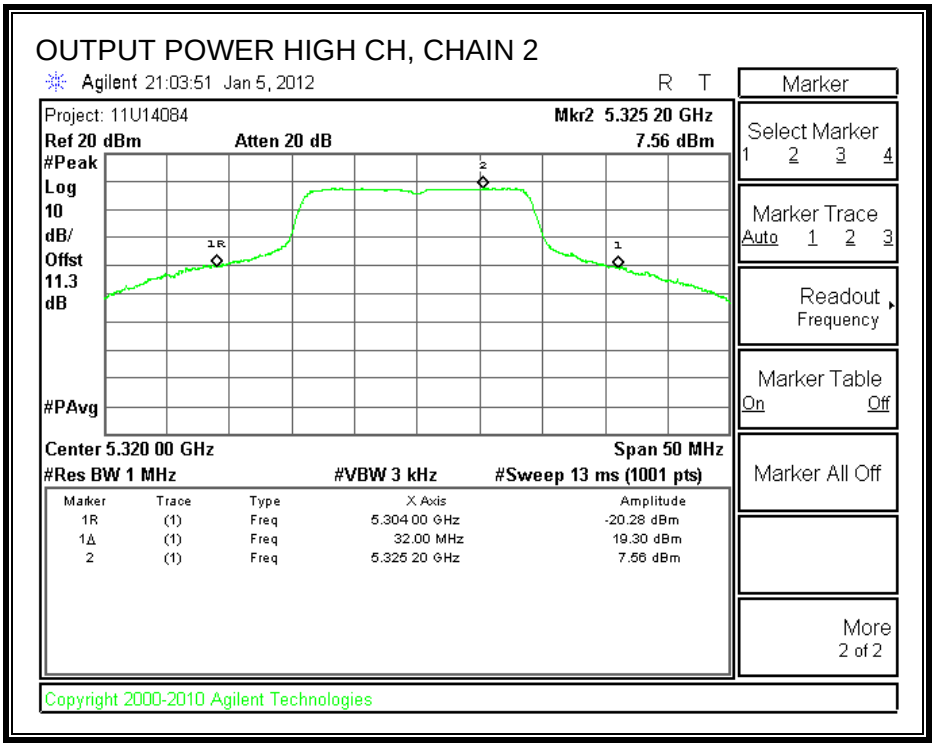




CHAIN 2 OUTPUT POWER







7.2.3. 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	5260	17.30	17.50	20.41
Middle	5300	17.20	17.20	20.21
High	5320	14.90	15.10	18.01

7.2.4. PEAK POWER SPECTRAL DENSITY

LIMITS

FCC §15.407 (a) (2)

IC RSS-210 A9.2 (2)

For the 5.25-5.35 GHz band, the peak power spectral density shall not exceed 11 dBm in any 1 MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit 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.

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 11 dBm.

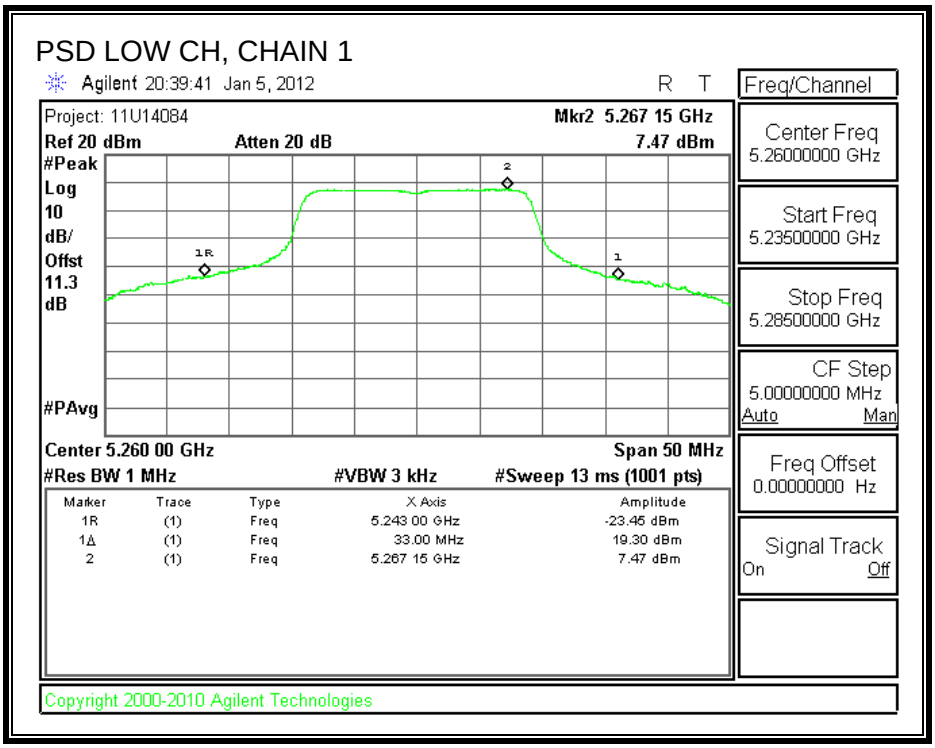
TEST PROCEDURE

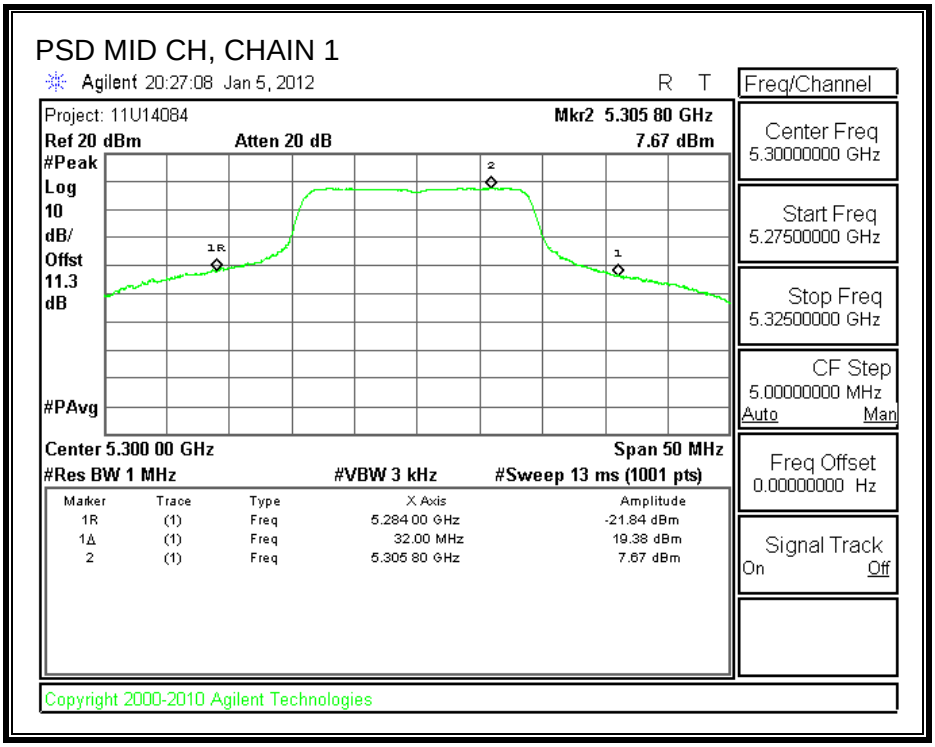
Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

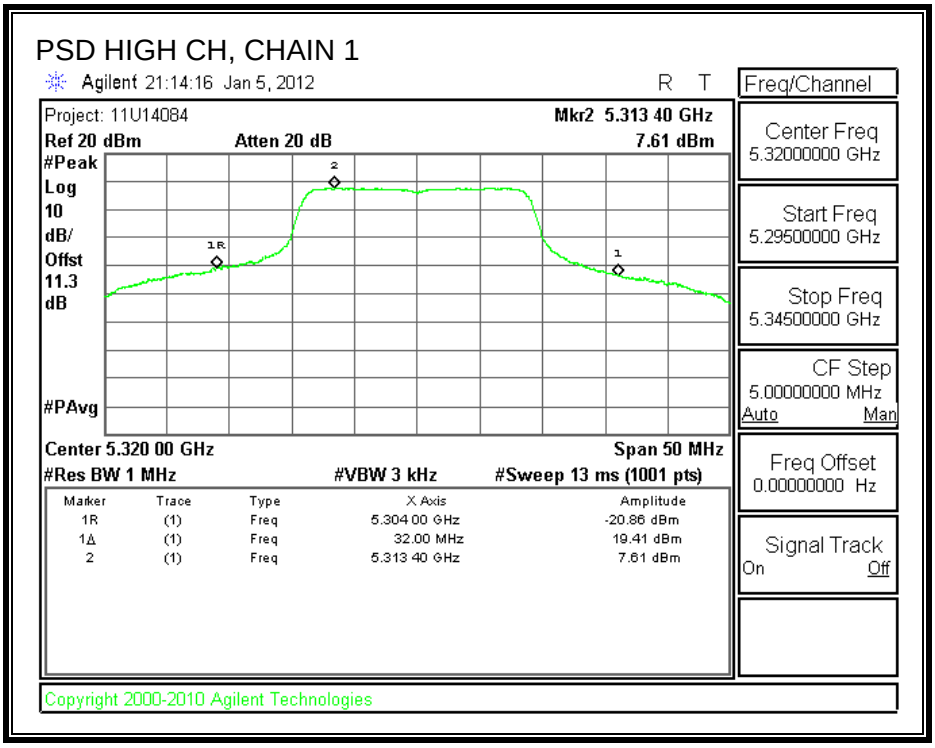
RESULTS

Channel	Frequency (MHz)	Chain 1 PPSD (dBm)	Chain 2 PPSD (dBm)	Total PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	5260	7.47	7.62	10.56	11	-0.44
Middle	5300	7.67	7.5	10.60	11	-0.40
High	5320	7.61	7.56	10.60	11	-0.40

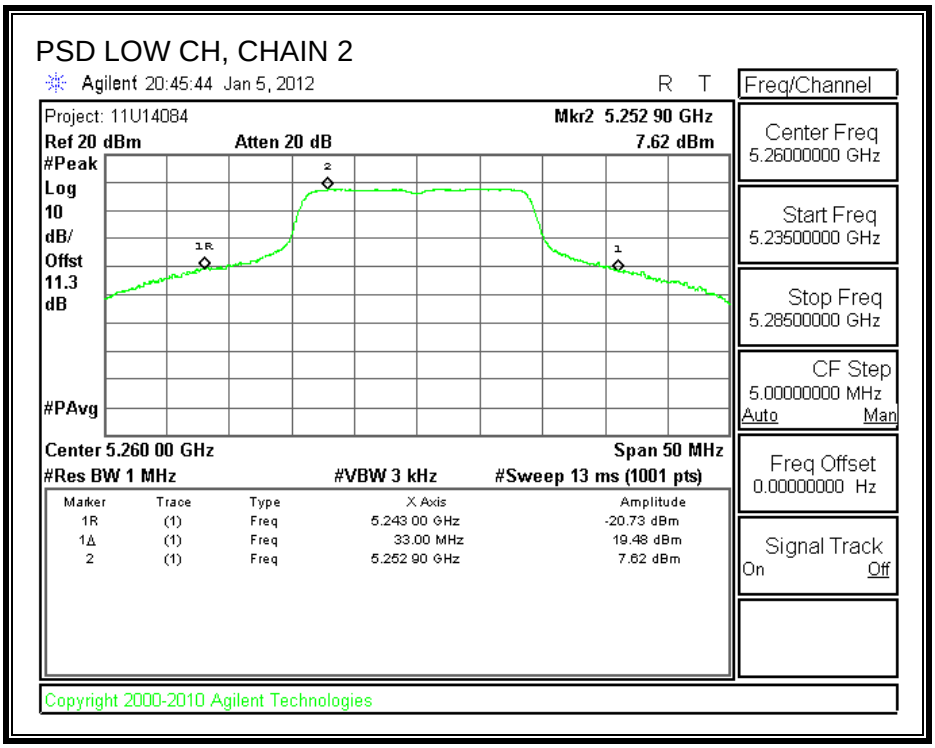
CHAIN 1 POWER SPECTRAL DENSITY

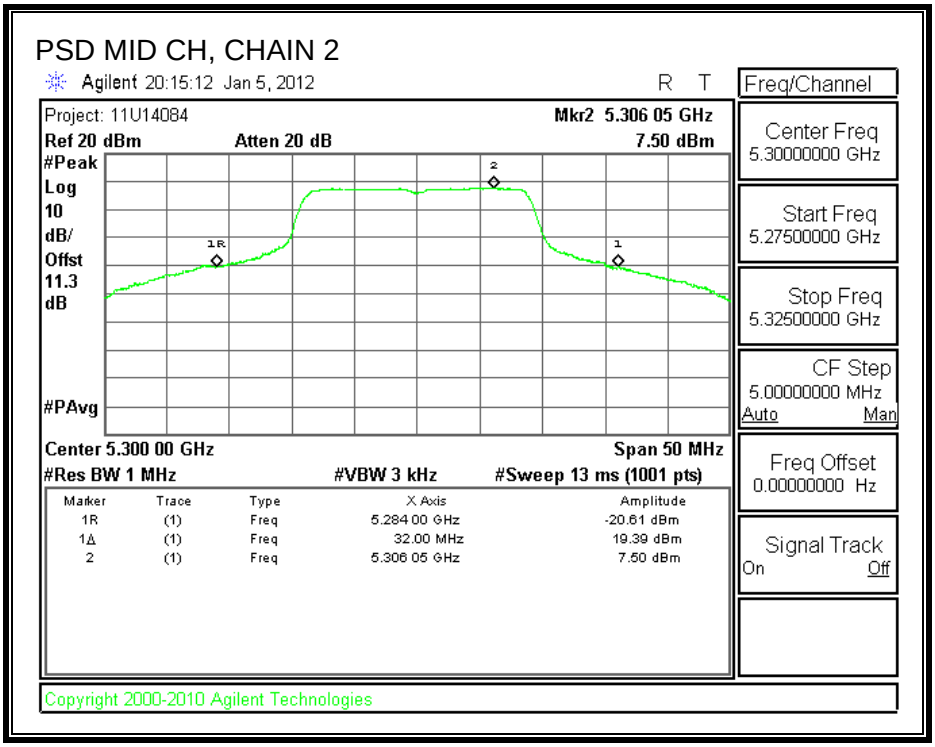


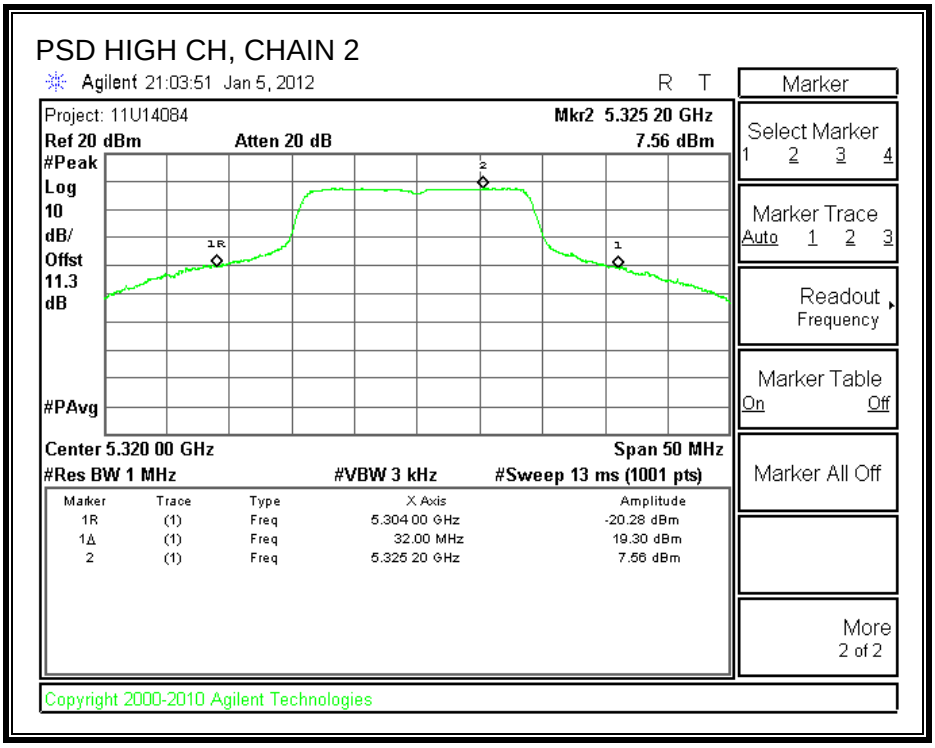




CHAIN 2 POWER SPECTRAL DENSITY







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.

TEST PROCEDURE

Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

RESULTS

CHAIN 1

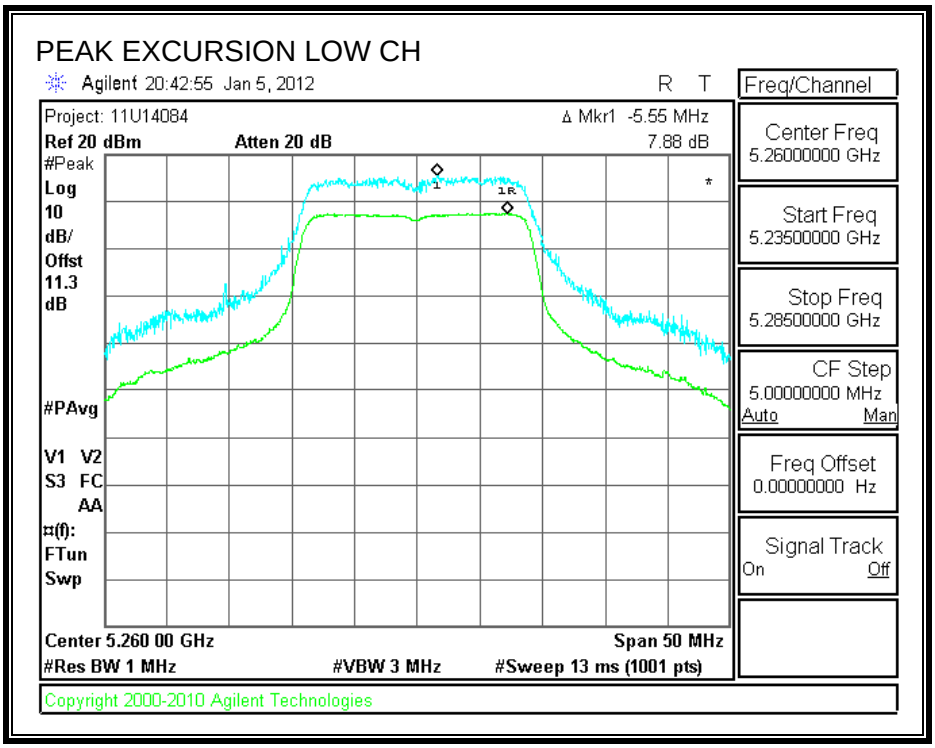
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5260	7.88	13	-5.12
Middle	5300	7.74	13	-5.26
High	5320	7.86	13	-5.14

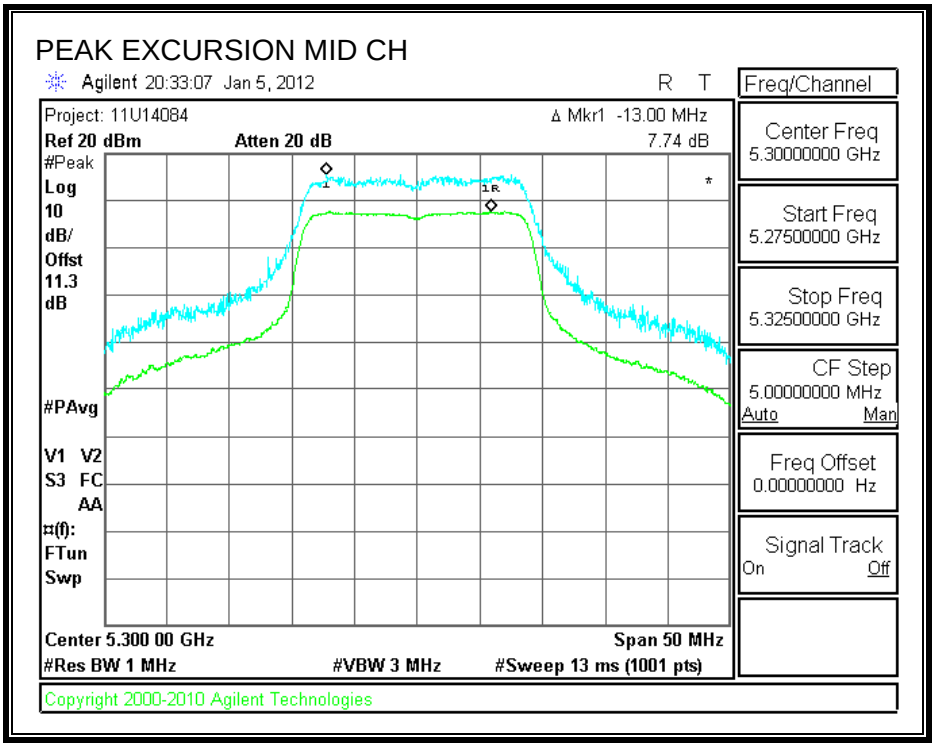
CHAIN 2

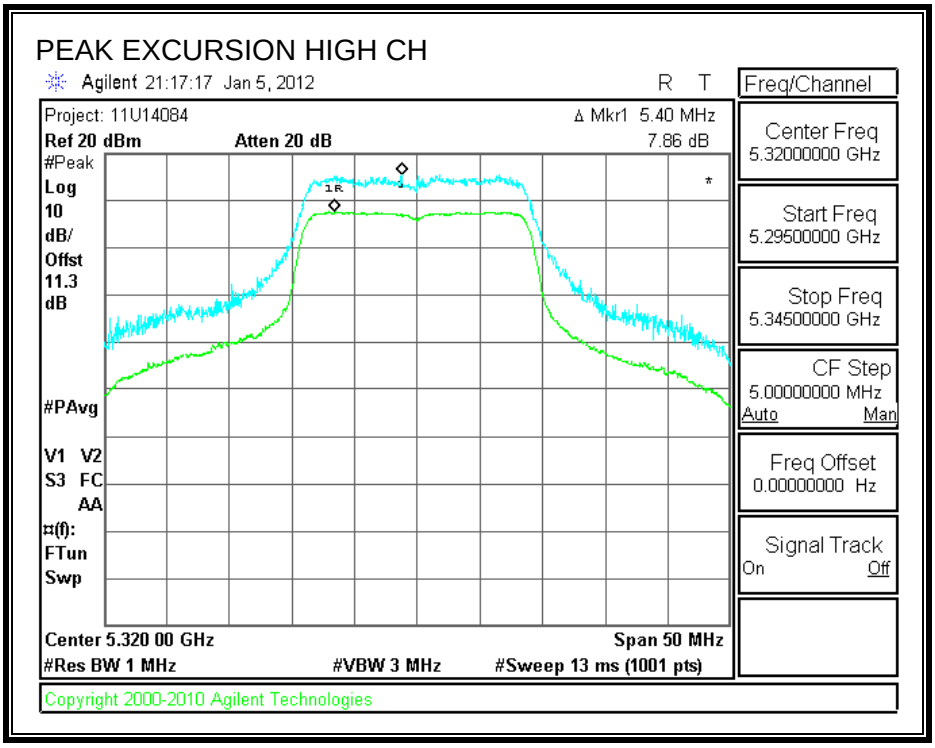
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5260	8.13	13	-4.87
Middle	5300	8.30	13	-4.70
High	5320	8.47	13	-4.53

CHAIN 1

PEAK EXCURSION

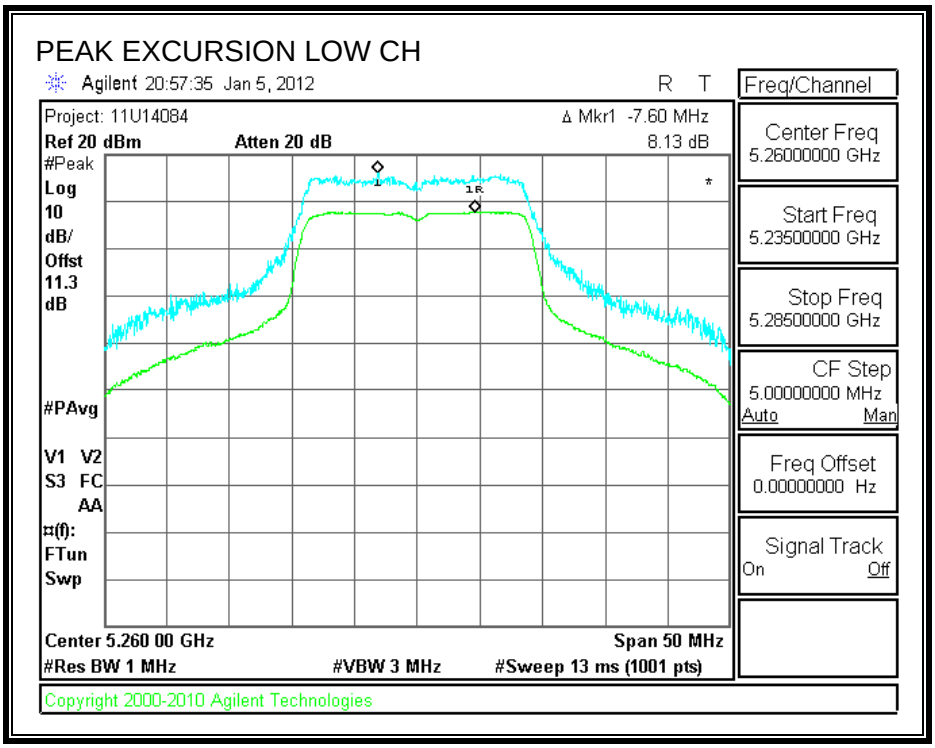


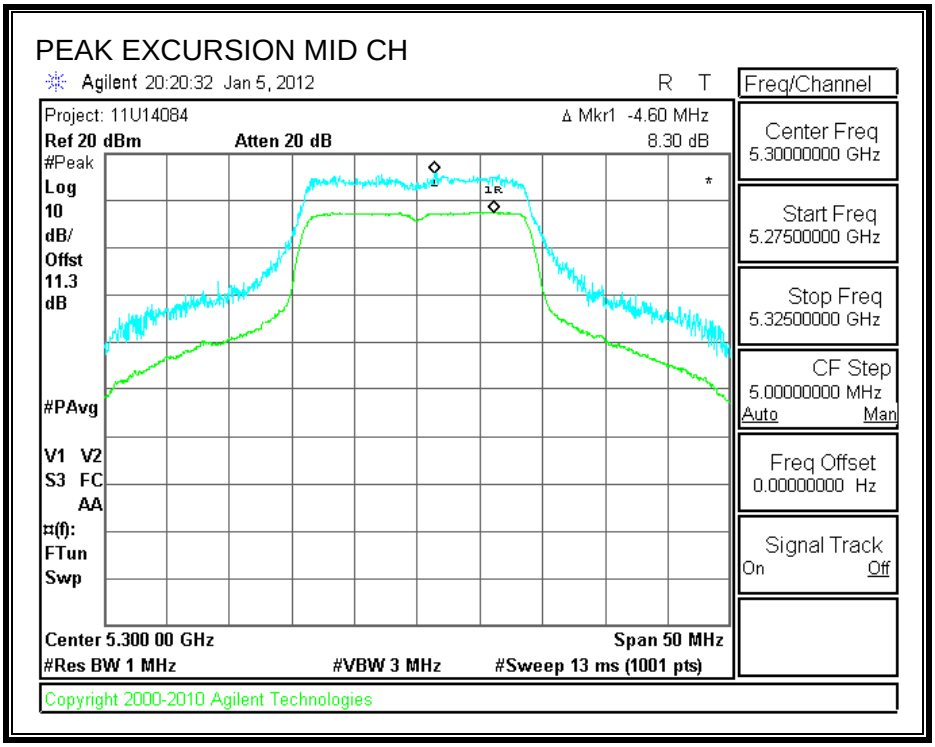


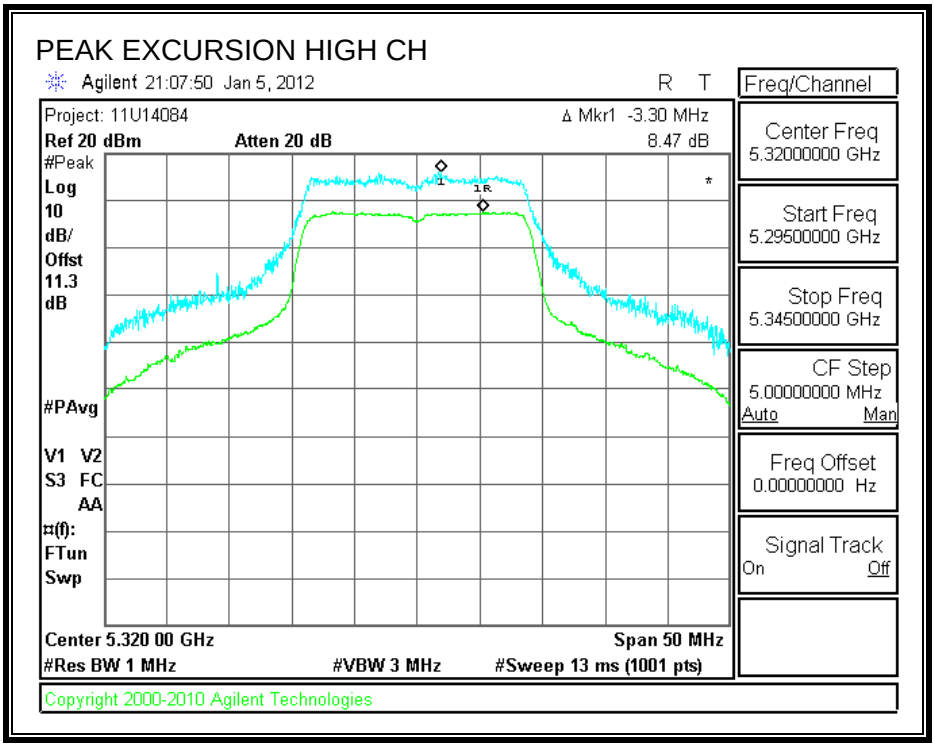


CHAIN 2

PEAK EXCURSION







7.3. 802.11n HT20 MODE IN THE 5.6 GHz BAND

7.3.1. 26 dB and 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

RESULTS

CHAIN 1

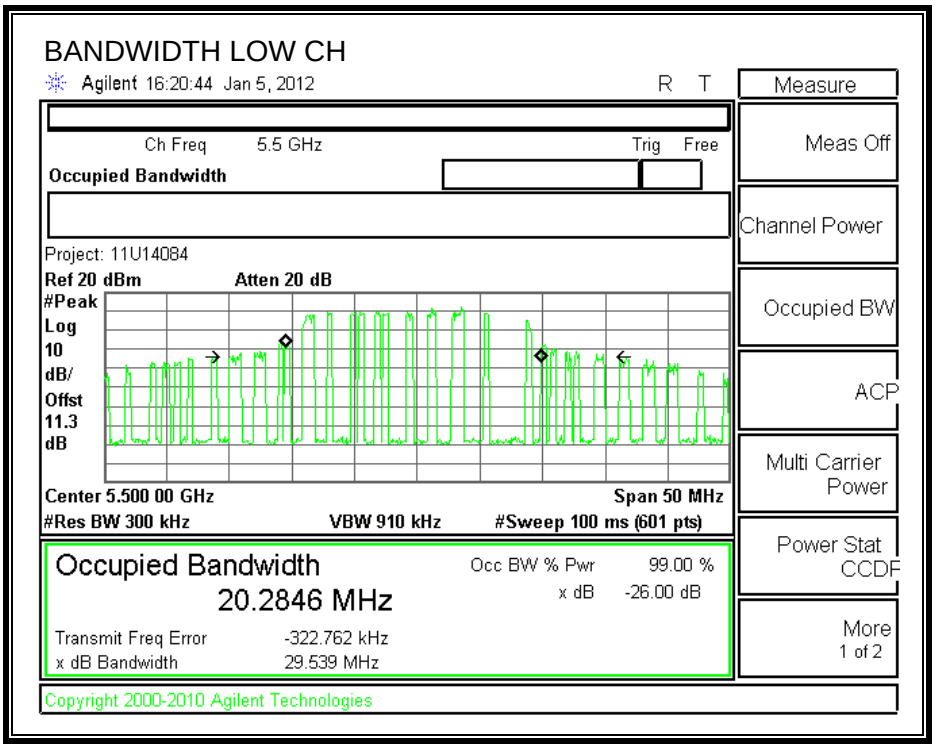
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	5500	29.539	16.9873
Middle	5580	30.923	16.4559
High	5700	29.392	16.692

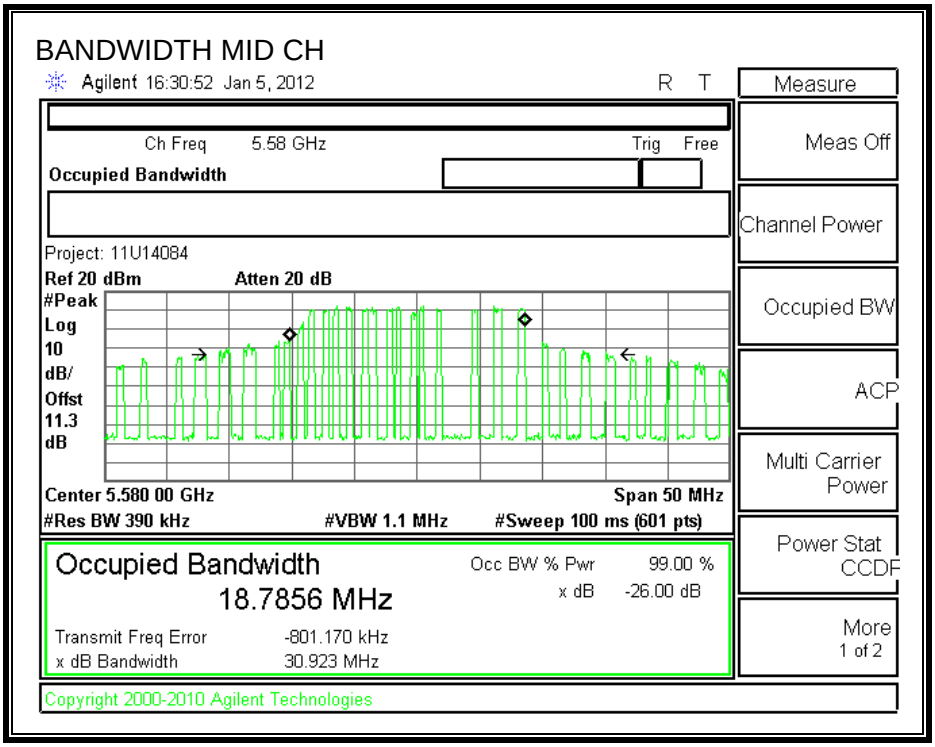
CHAIN 2

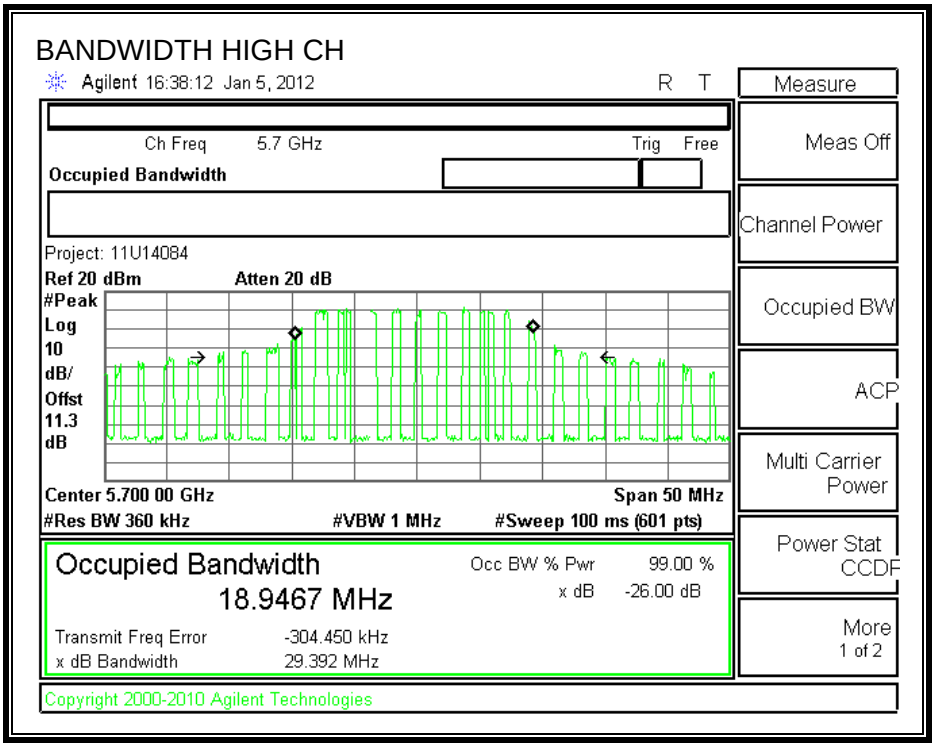
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	5500	28.722	16.1088
Middle	5580	30.685	17.3664
High	5700	29.337	16.3699

CHAIN 1

26 dB BANDWIDTH

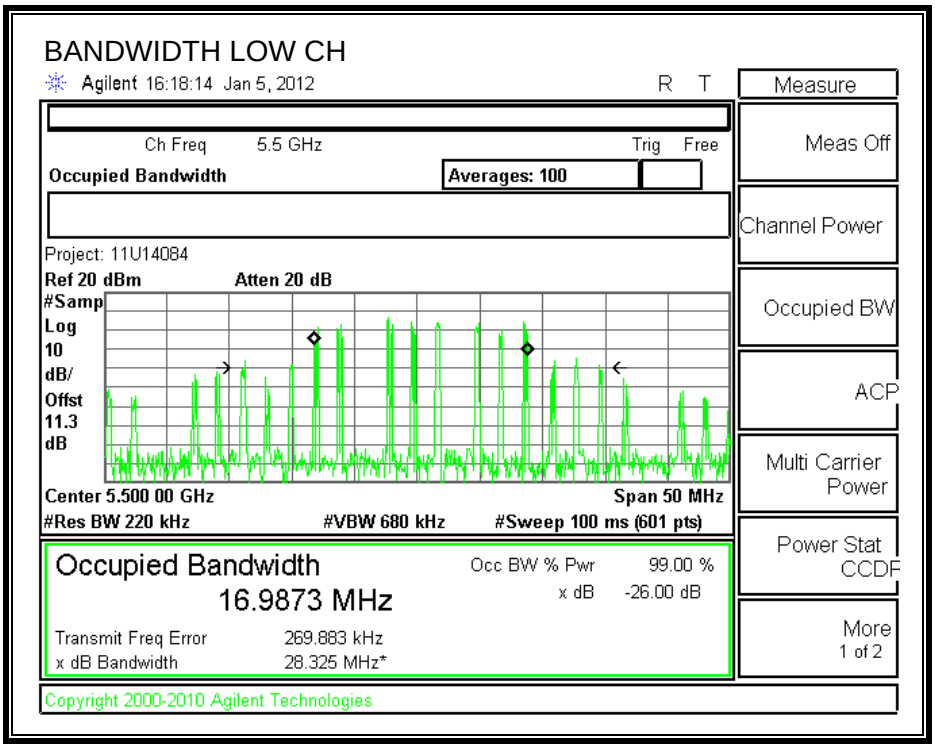


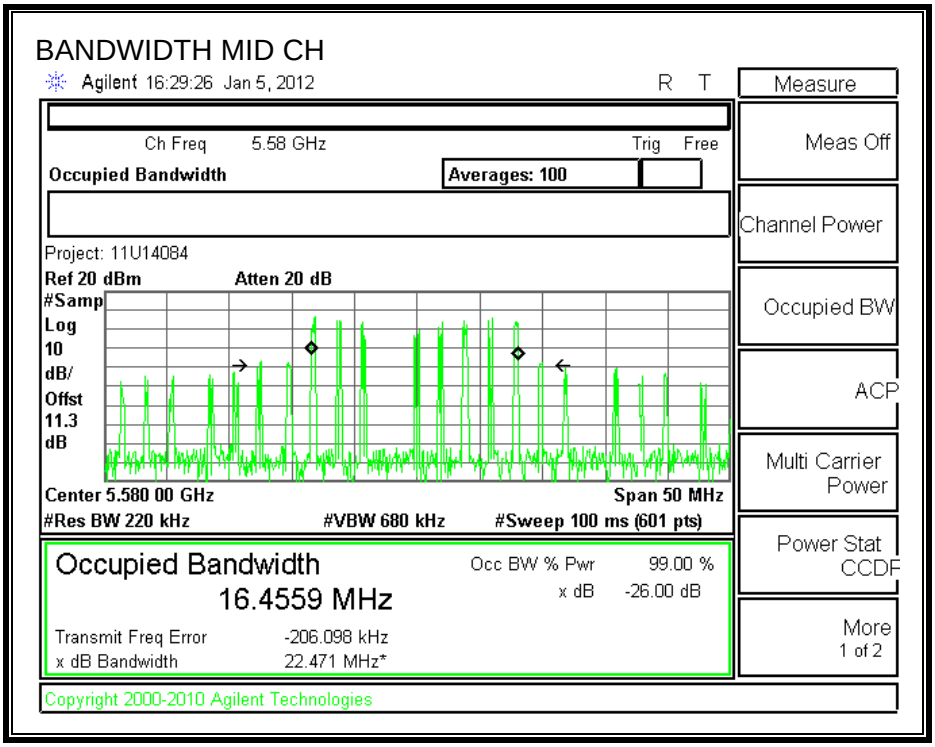


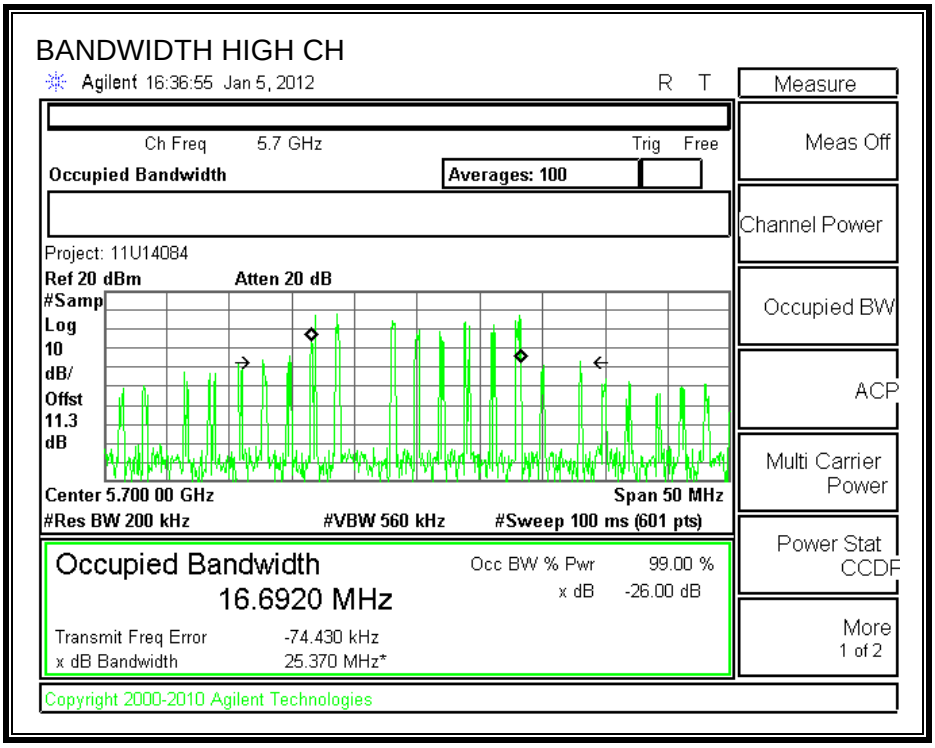


CHAIN 1

99% BANDWIDTH

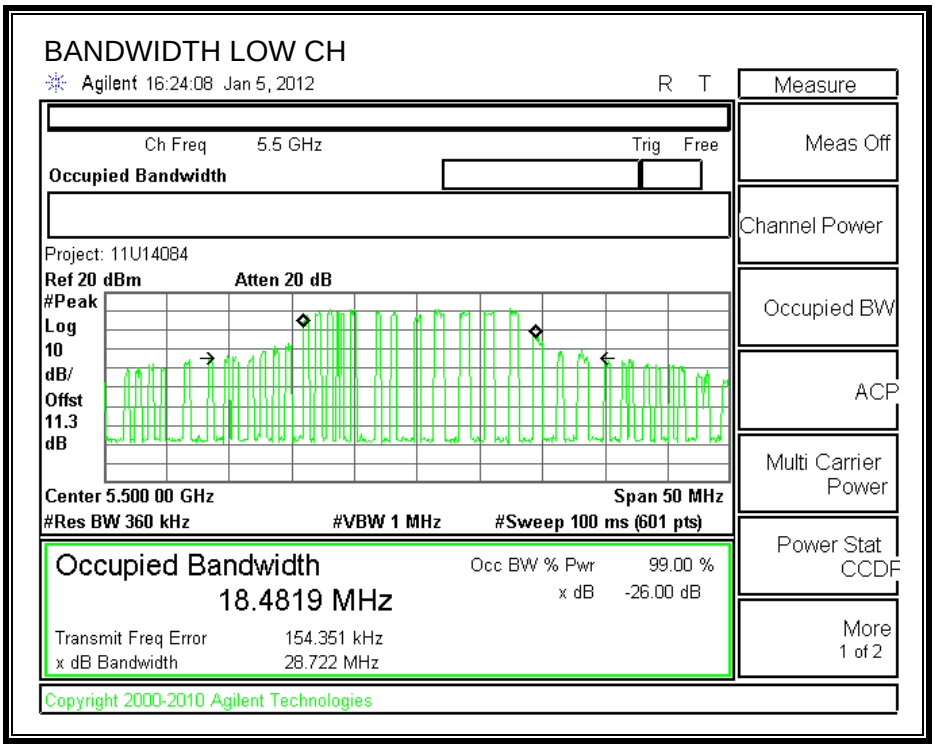


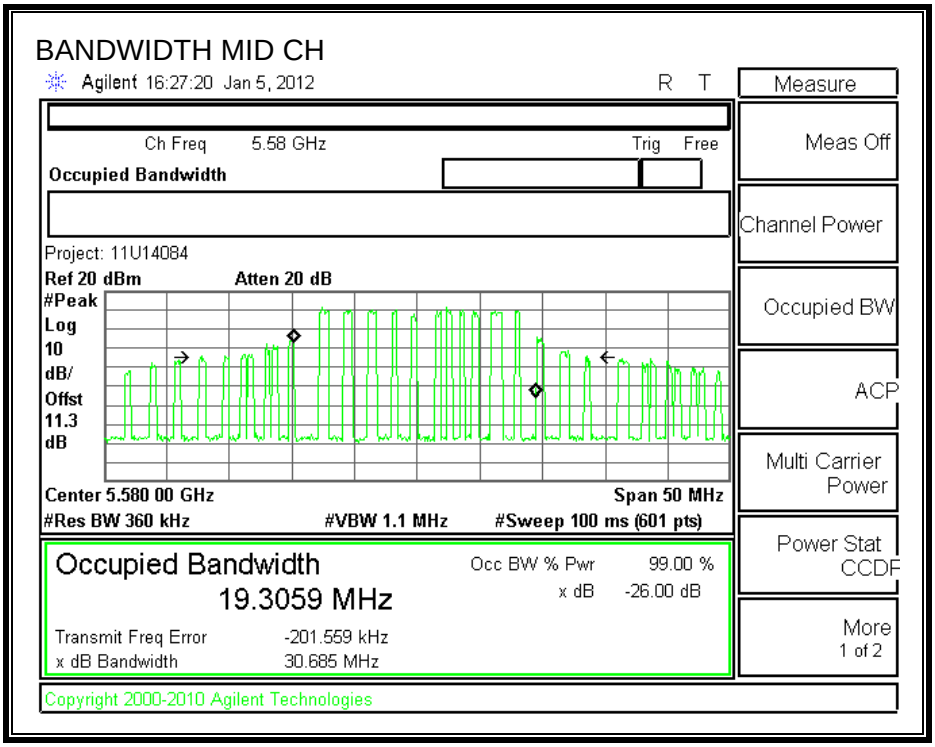


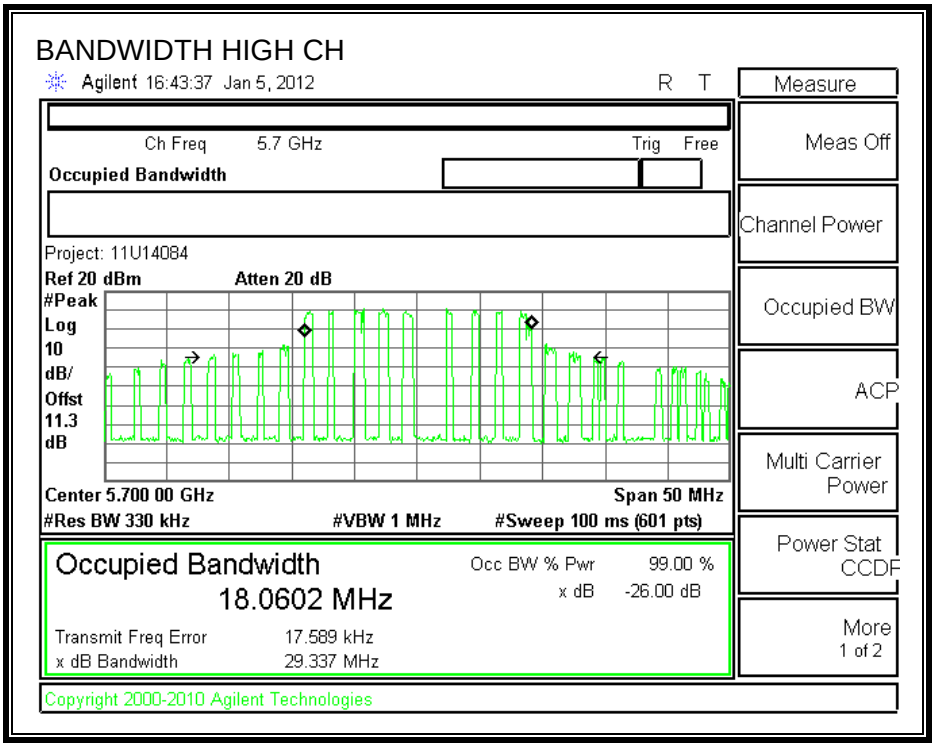


CHAIN 2

26 dB BANDWIDTH

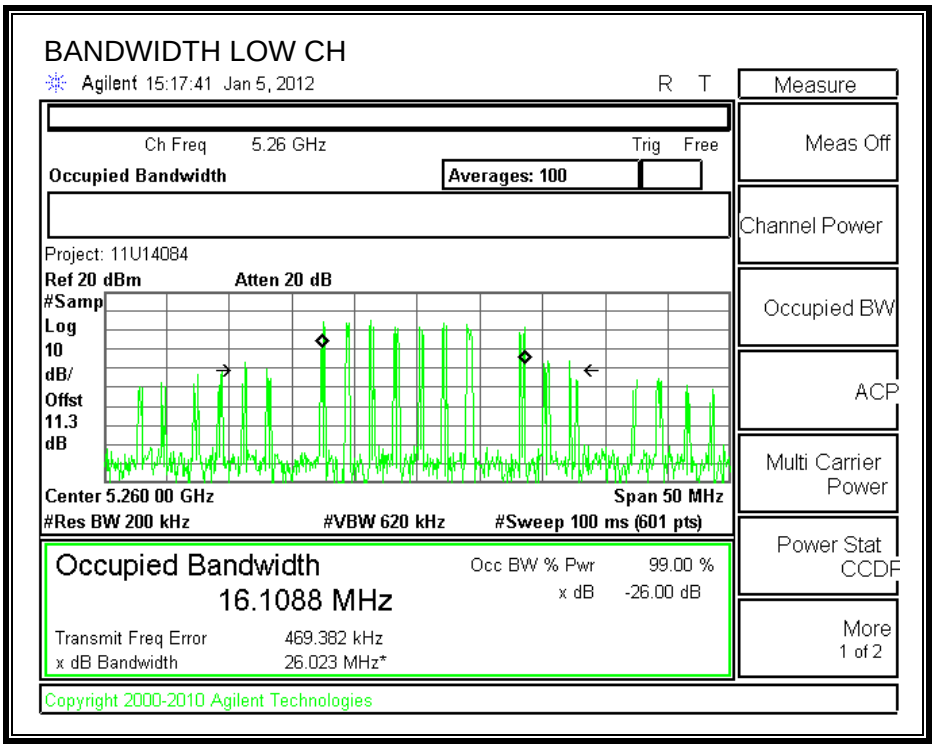


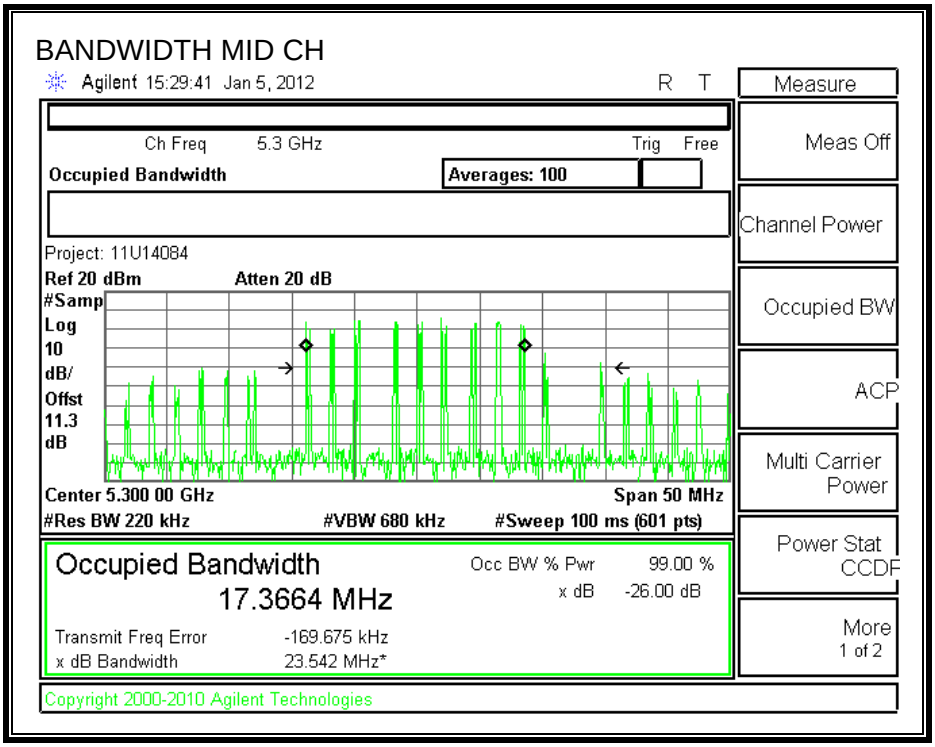


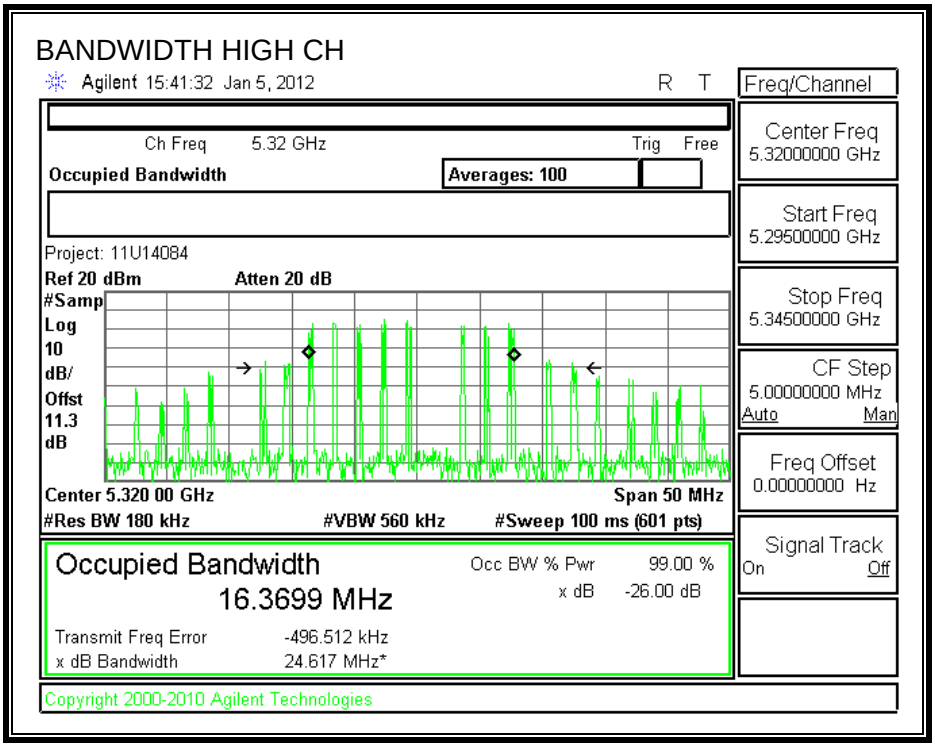


CHAIN 2

99% BANDWIDTH







7.3.2. OUTPUT POWER

LIMITS

FCC §15.407 (a) (2)

IC RSS-210 A9.2 (2)

For the 5.47-5.725 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26-dB emission bandwidth in MHz. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit 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.

TEST PROCEDURE

Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

Based on the characteristics of the EUT and various criteria method SA-3 ALT was selected.

RESULTS

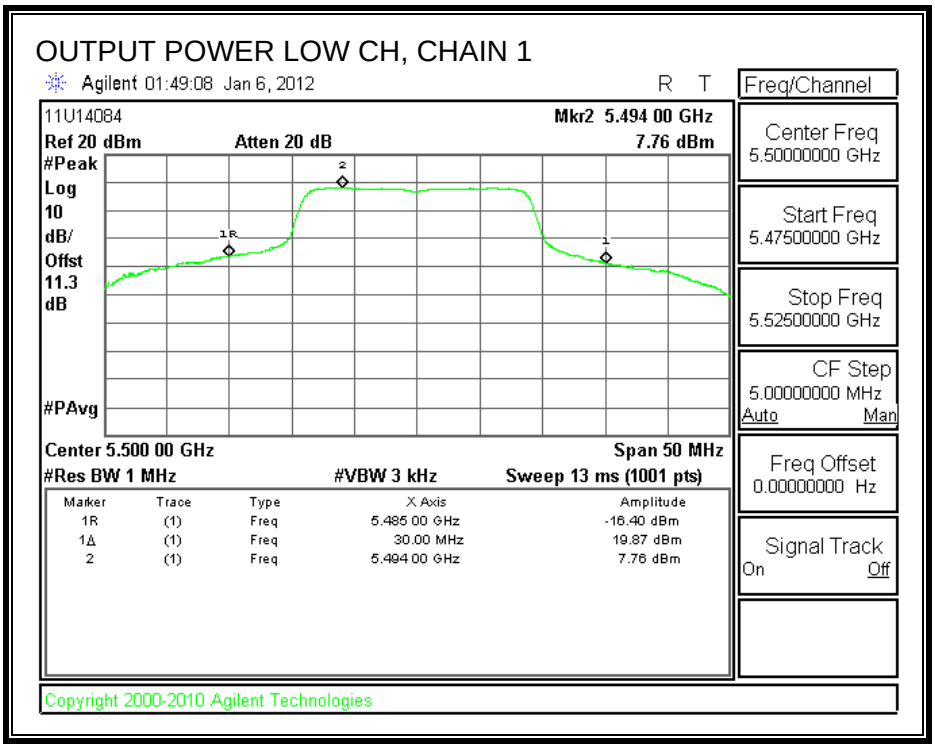
Limit

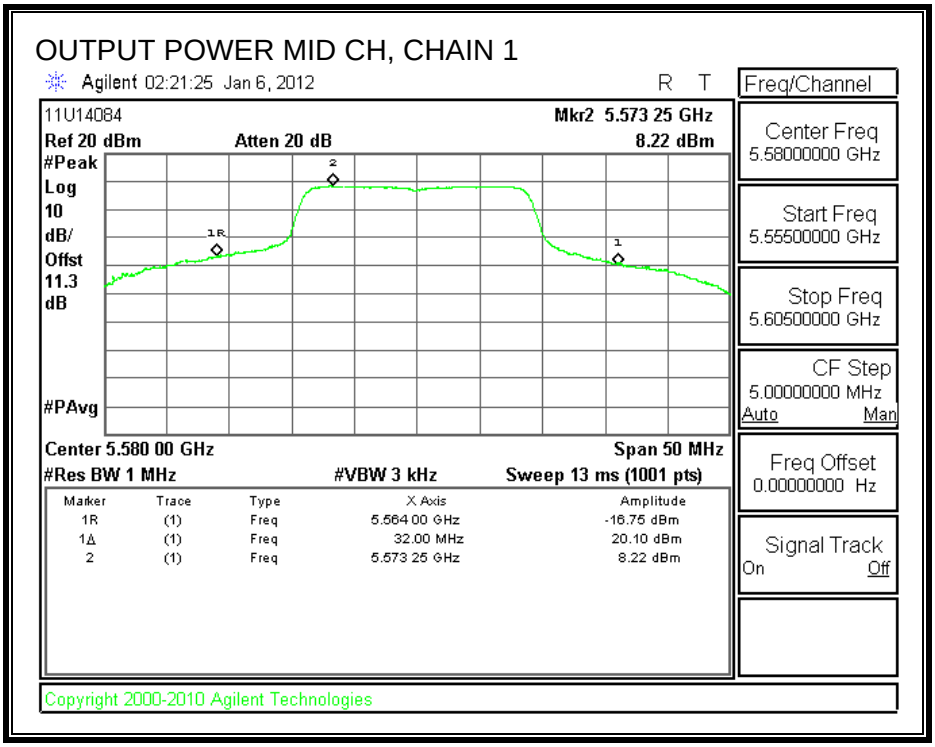
Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Antenna Gain (dBi)	Limit (dBm)
Low	5500	24	28.722	25.58	4.27	24.00
Mid	5800	24	30.685	25.87	4.27	24.00
High	5700	24	29.337	25.67	4.27	24.00

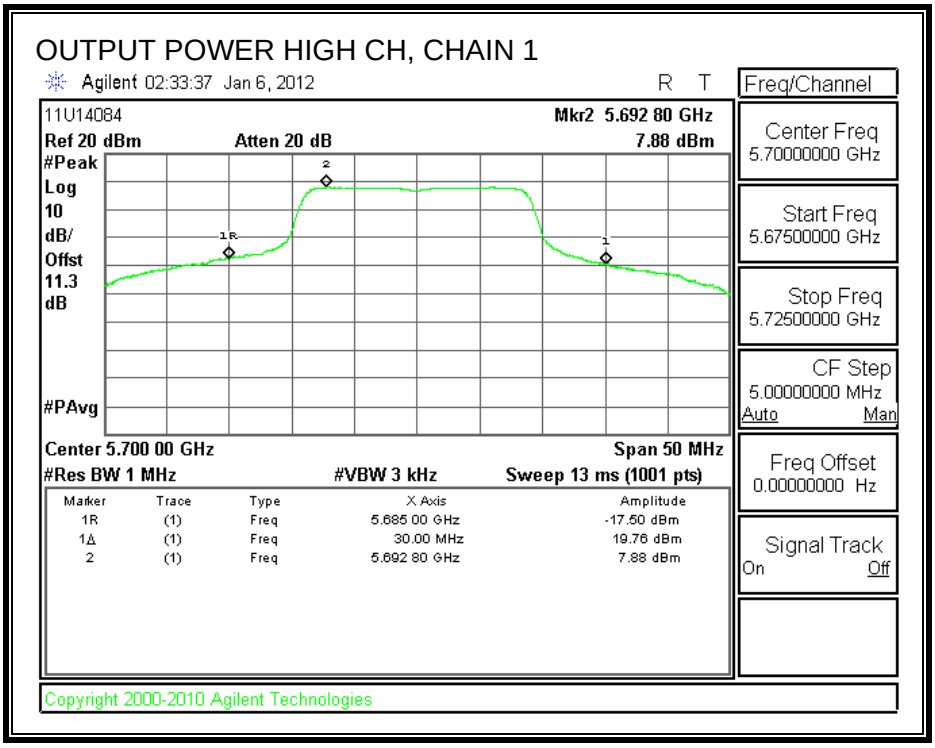
Individual Chain Results

Channel	Frequency (MHz)	Chain 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5500	19.87	19.58	22.74	24.00	-1.26
Mid	5800	20.10	19.37	22.76	24.00	-1.24
High	5700	19.76	19.70	22.74	24.00	-1.26

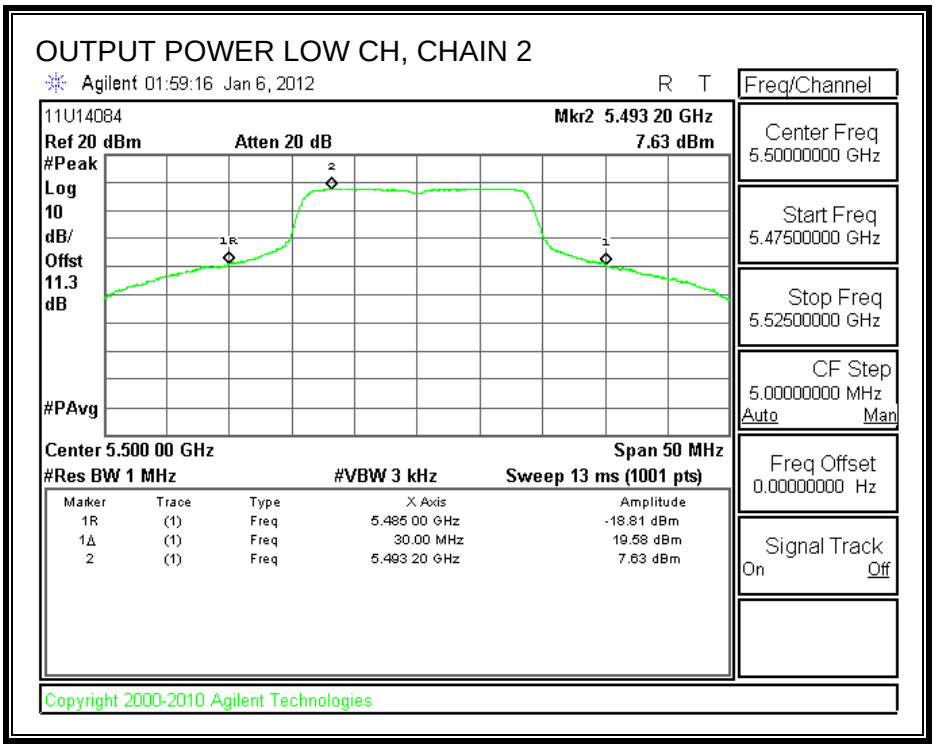
CHAIN 1 OUTPUT POWER

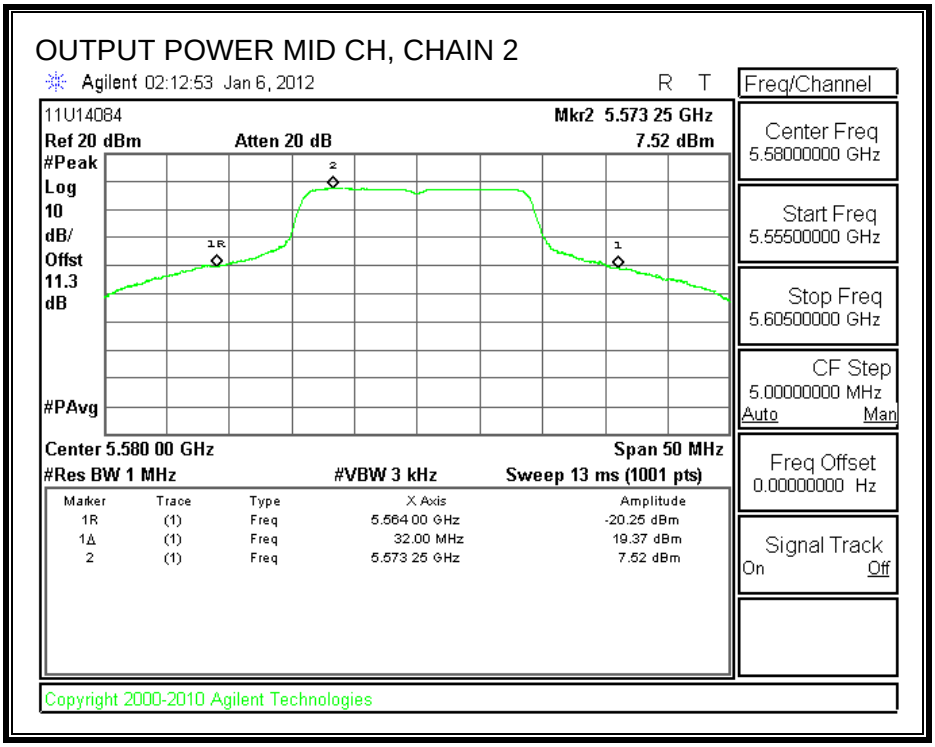


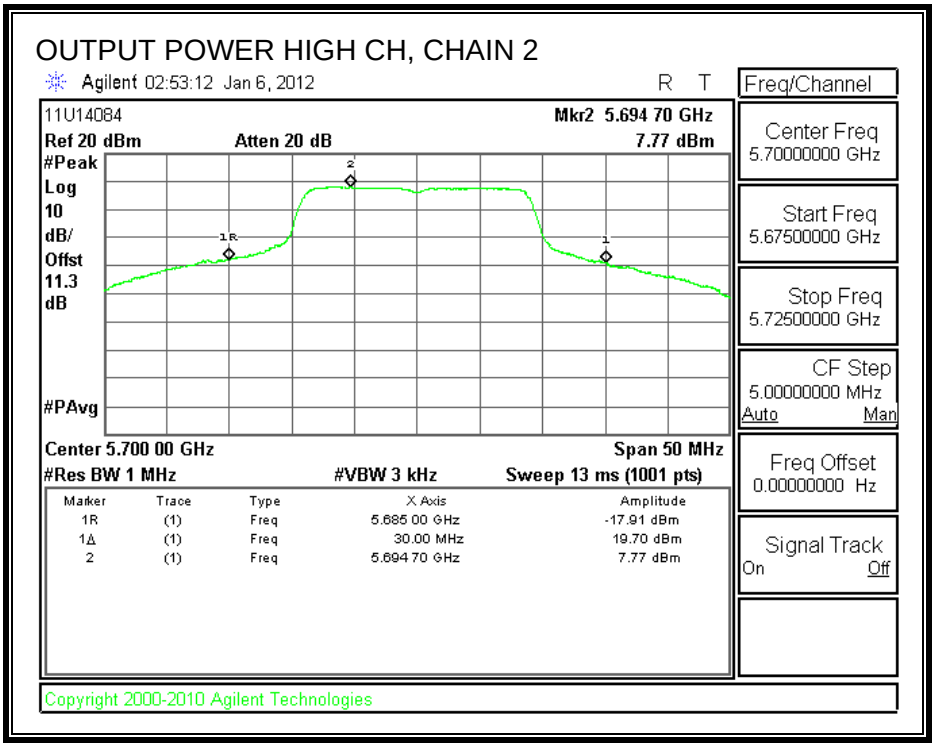




CHAIN 2 OUTPUT POWER







7.3.3. 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	5500	17.60	17.30	20.46
Middle	5580	18.30	17.50	20.93
High	5700	17.90	17.60	20.76

7.3.4. PEAK POWER SPECTRAL DENSITY

LIMITS

FCC §15.407 (a) (2)

IC RSS-210 A9.2 (2)

For the 5.47-5.725 GHz band, the peak power spectral density shall not exceed 11 dBm in any 1 MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit 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.

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 11 dBm.

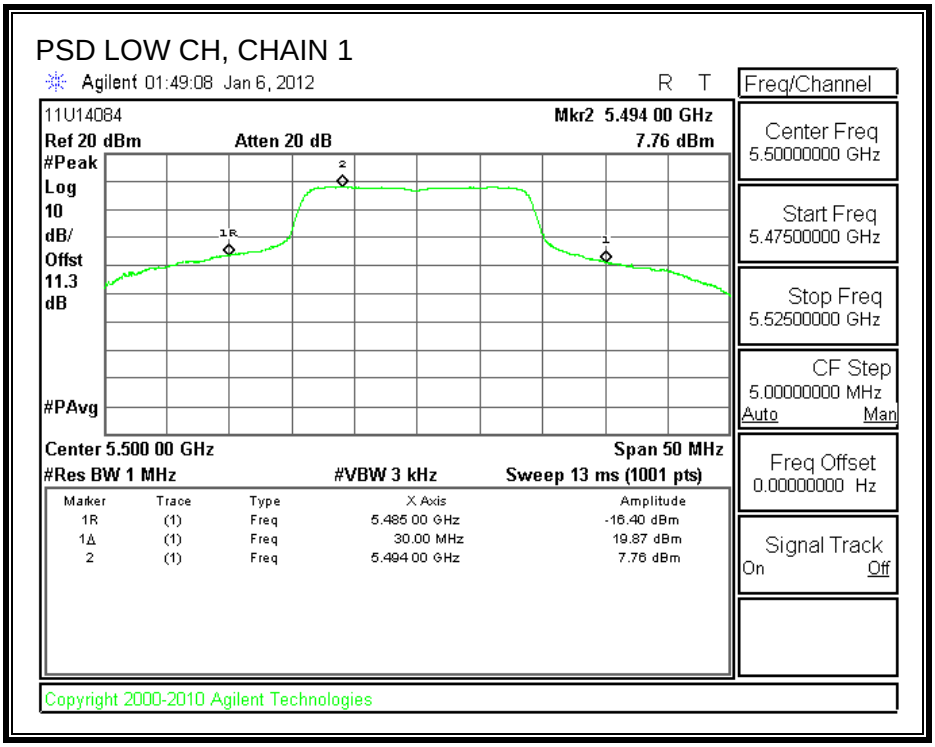
TEST PROCEDURE

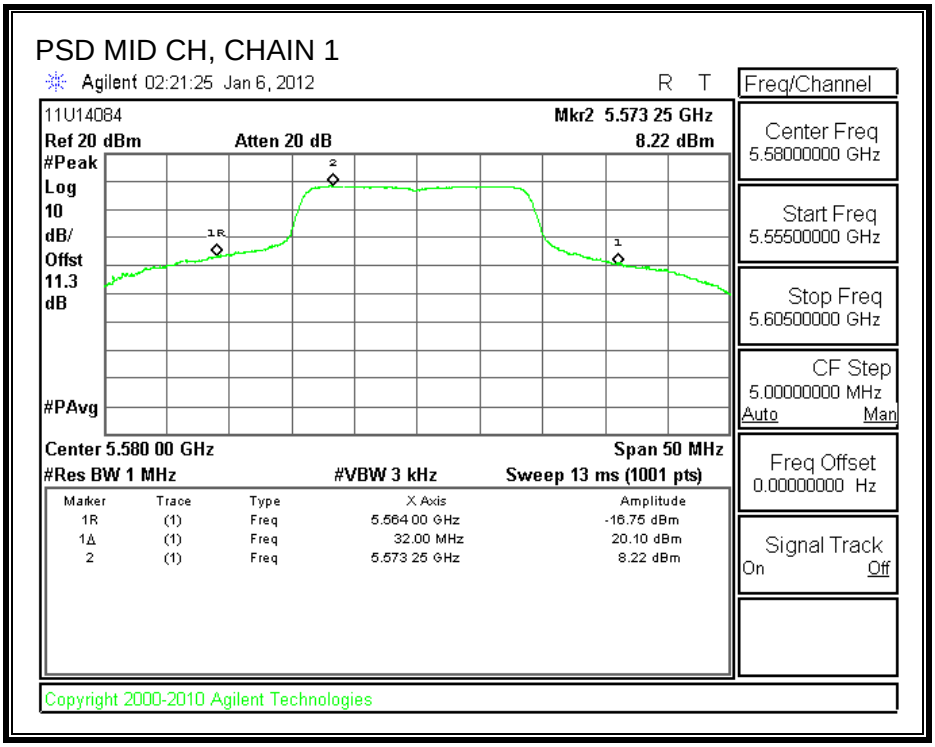
Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

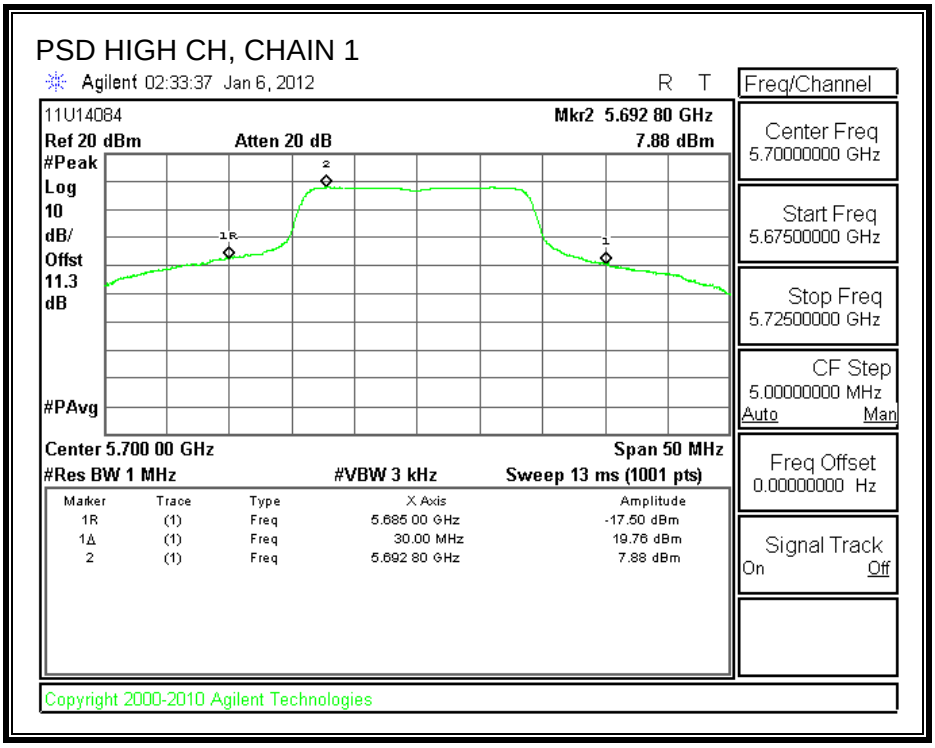
RESULTS

Channel	Frequency (MHz)	Chain 1 PPSD (dBm)	Chain 2 PPSD (dBm)	Total PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	5500	7.76	7.63	10.71	11	-0.29
Middle	5580	8.22	7.52	10.89	11	-0.11
High	5700	7.88	7.77	10.84	11	-0.16

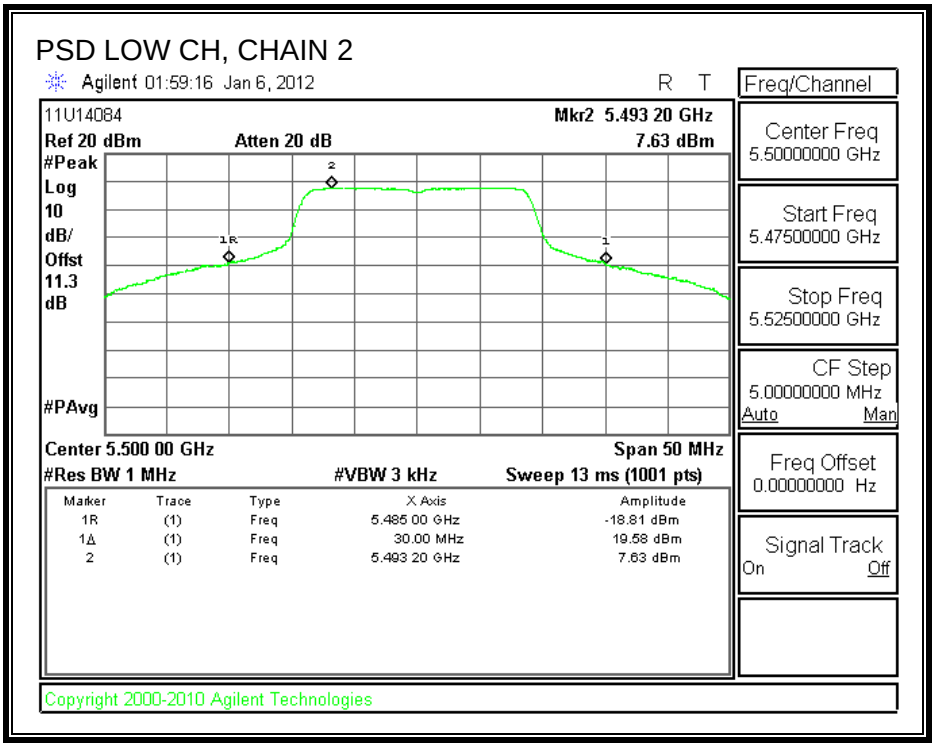
CHAIN 1 POWER SPECTRAL DENSITY

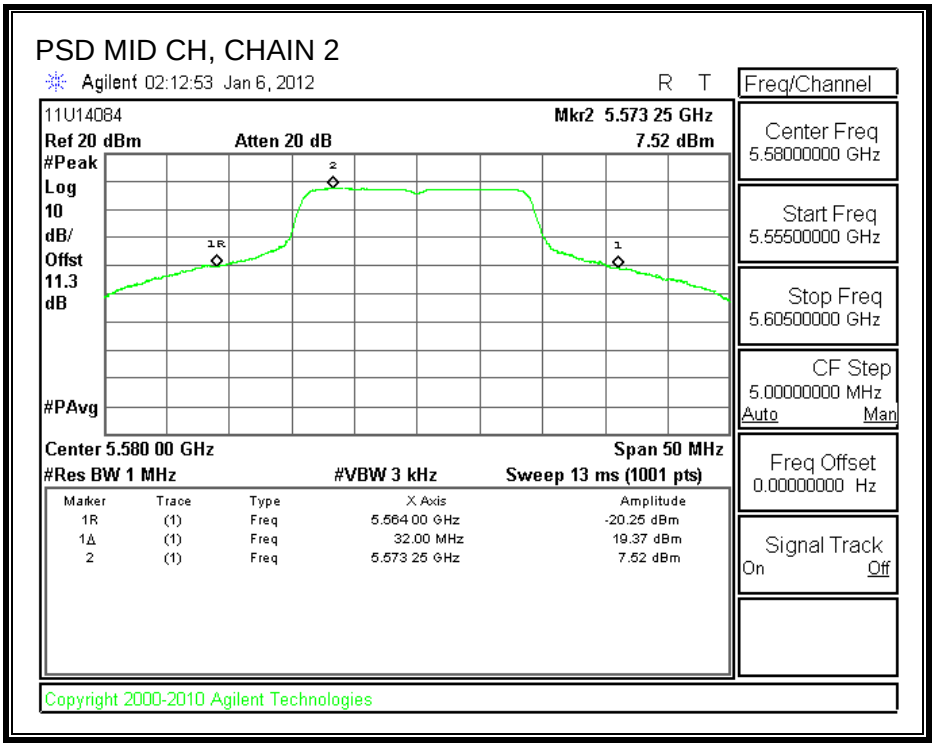


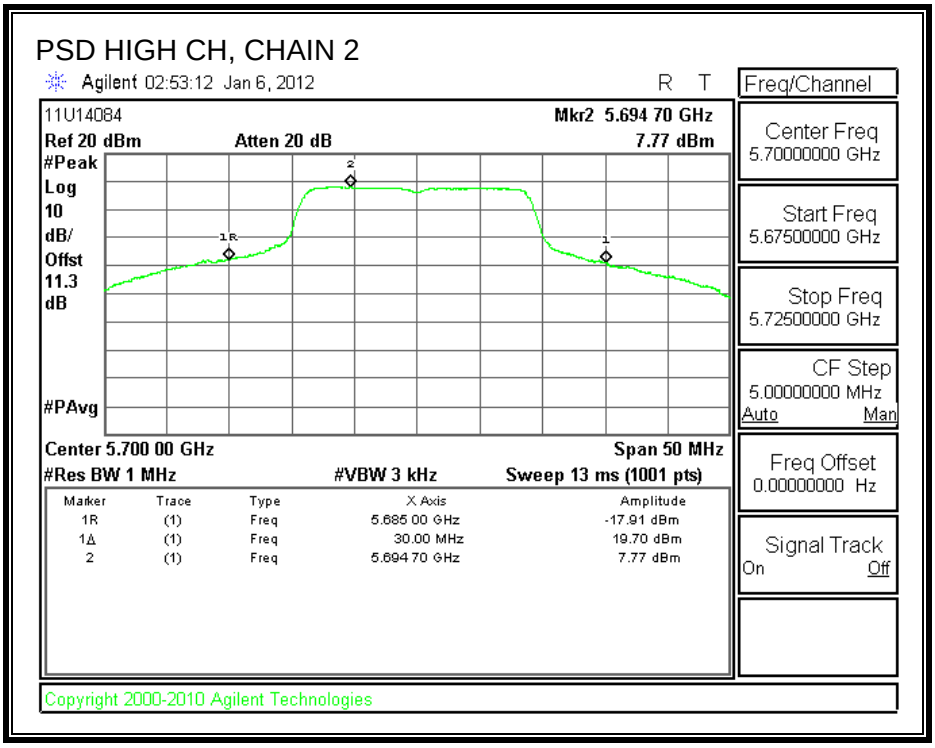




CHAIN 2 POWER SPECTRAL DENSITY







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.

TEST PROCEDURE

Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, dated 10/25/2011.

RESULTS

CHAIN 1

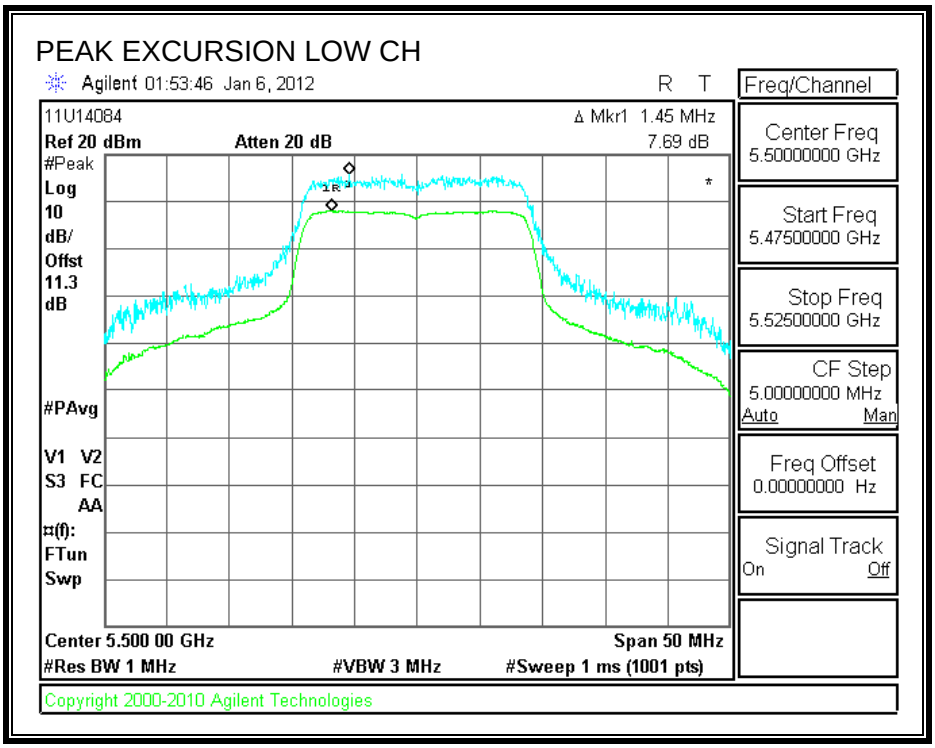
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5500	7.69	13	-5.31
Middle	5580	7.95	13	-5.05
High	5700	8.42	13	-4.58

CHAIN 2

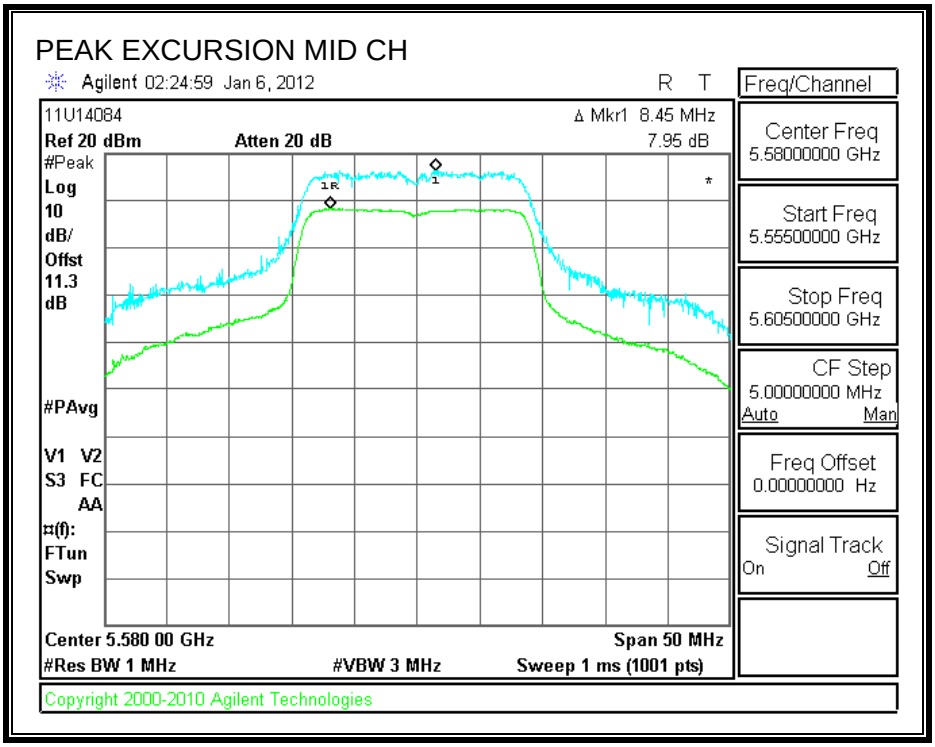
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5500	9.03	13	-3.97
Middle	5580	8.37	13	-4.63
High	5700	8.27	13	-4.73

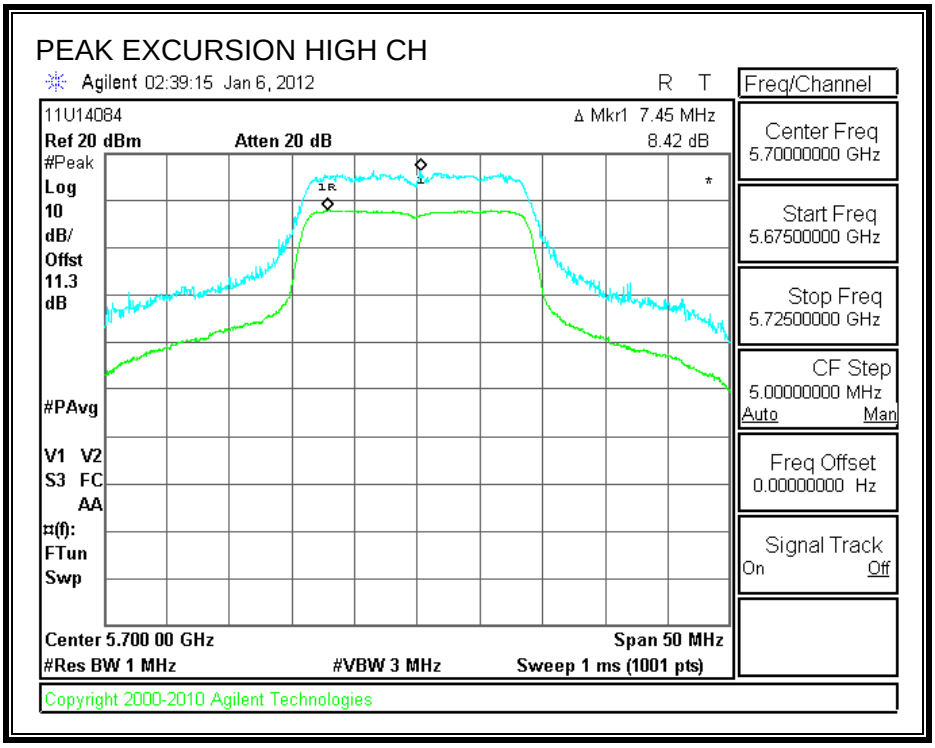
CHAIN 1

PEAK EXCURSION



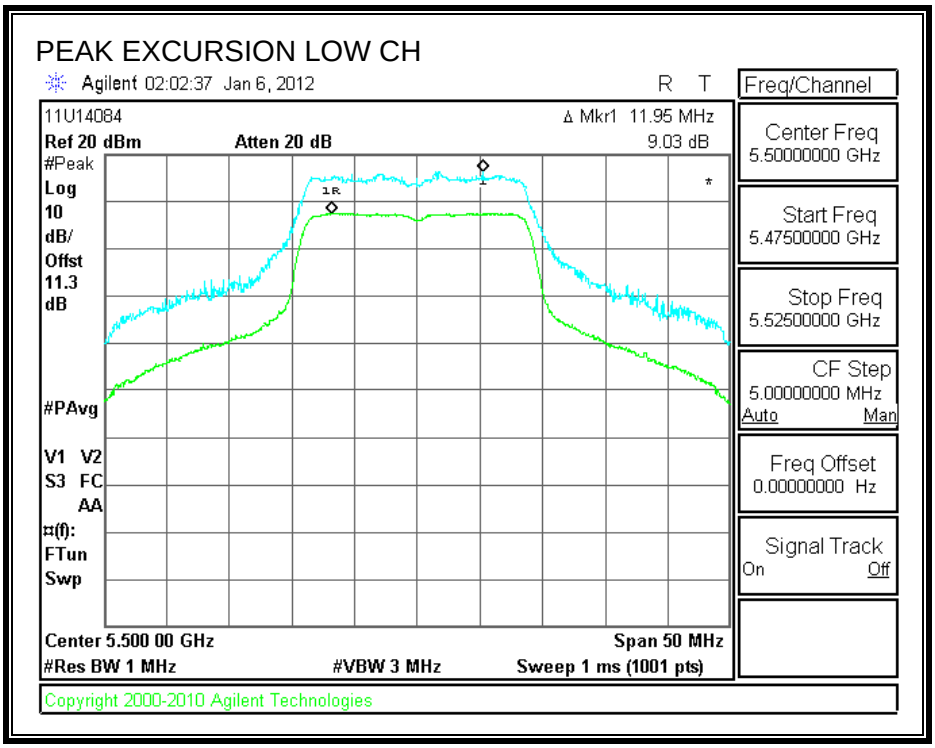
PEAK EXCURSION MID CH

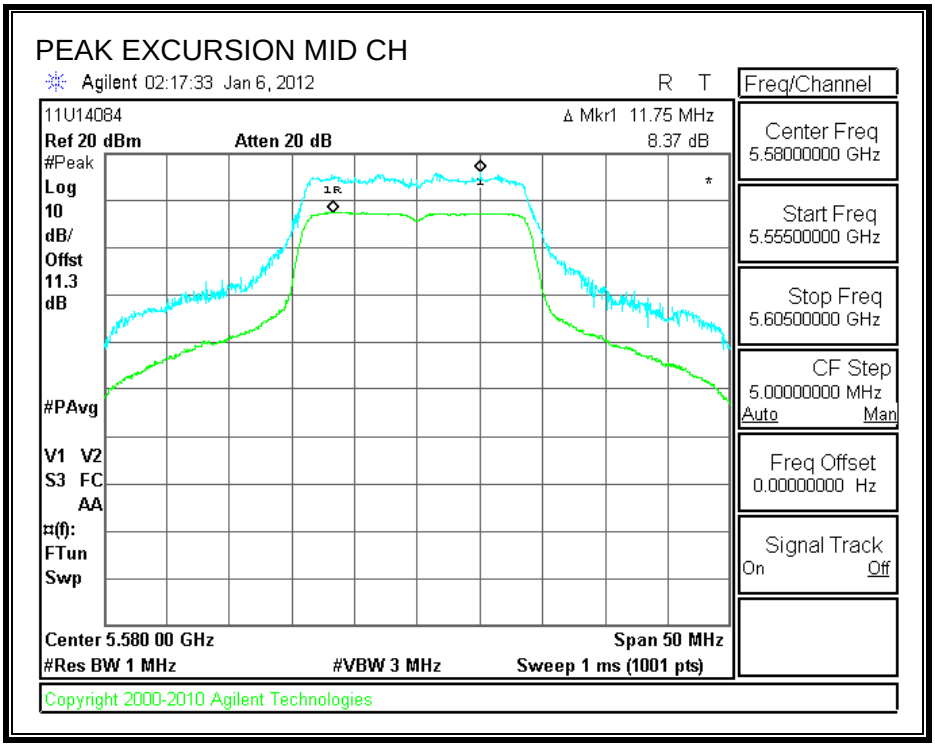




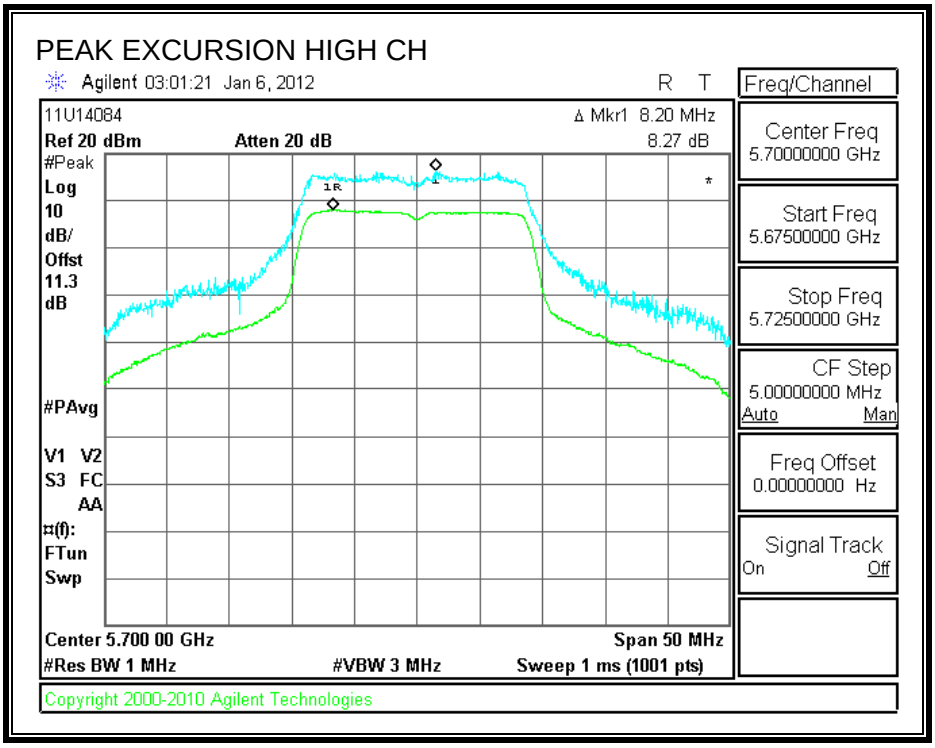
CHAIN 2

PEAK EXCURSION





PEAK EXCURSION HIGH CH



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, and then the video bandwidth is set to 3 MHz for peak measurements and 3 kHz 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.

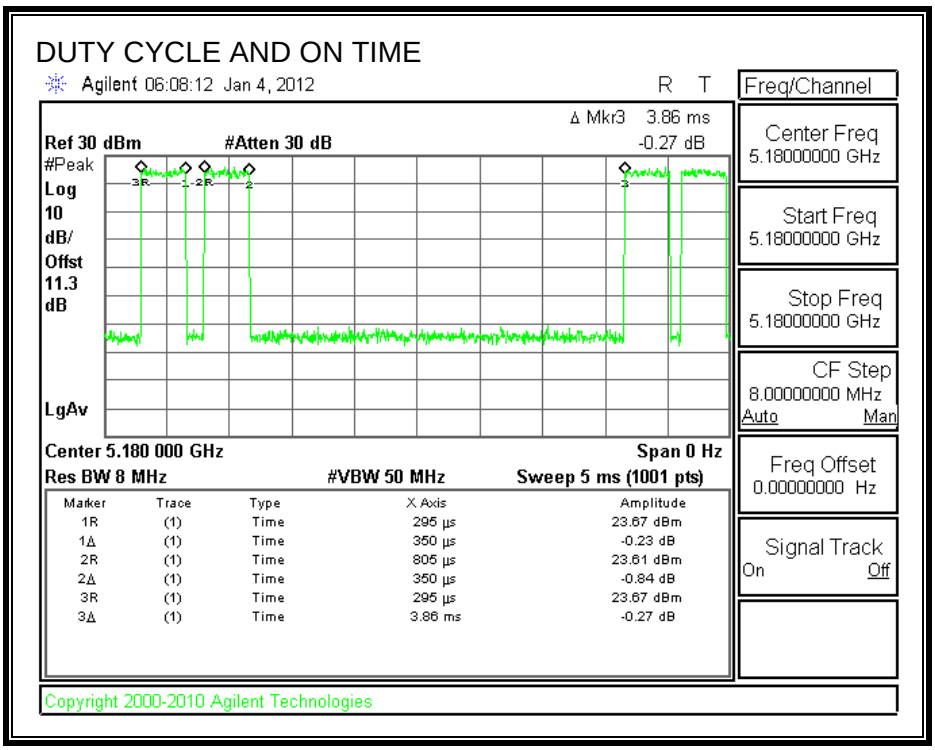
8.2. DUTY CYCLE AND ON TIME

LIMITS

Not Applicable.

TEST PROCEDURE

Using a spectrum analyzer with 0 span, the ON time and the period were captured. Duty cycle is the ON time divided by the period.

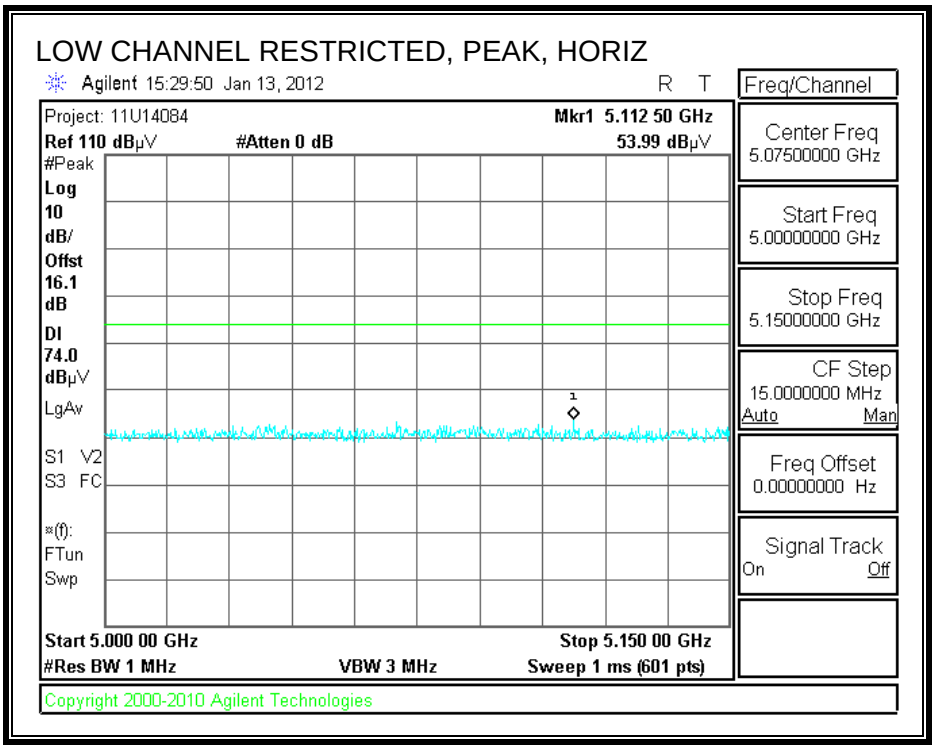


Duty Cycle = (0.35 + 0.35)/3.85 = **18.18%**
ON time used for BE and Spurious = **0.35 mS** as worst case for VBW >= 1/T

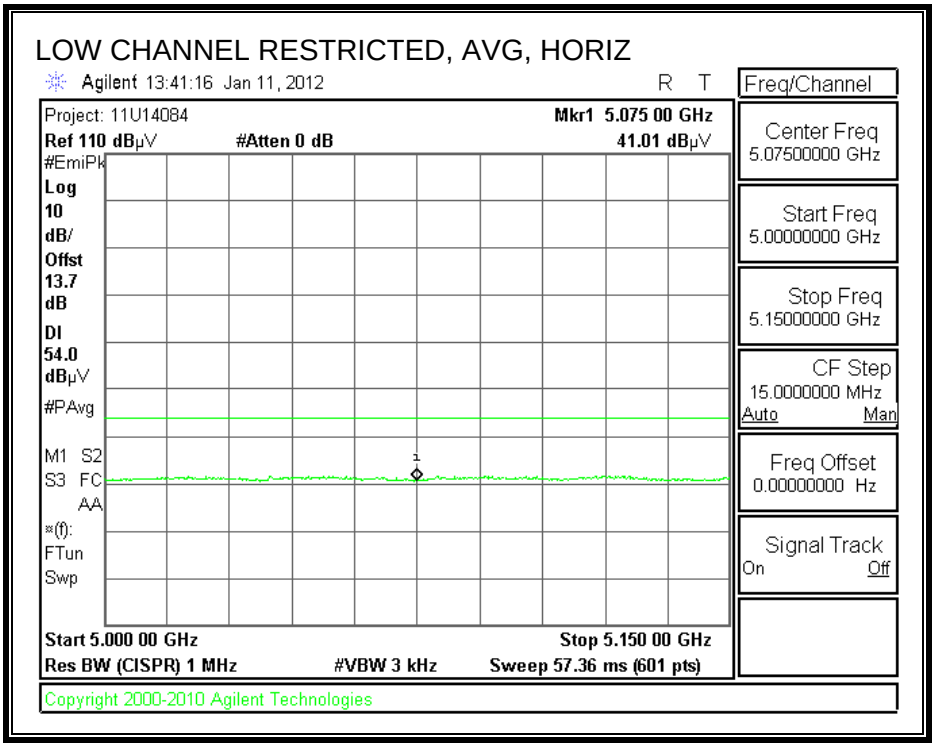
8.3. TRANSMITTER ABOVE 1 GHz

8.3.1. TX ABOVE 1 GHz FOR 802.11n HT20 MODE IN THE LOWER 5.2 GHz BAND

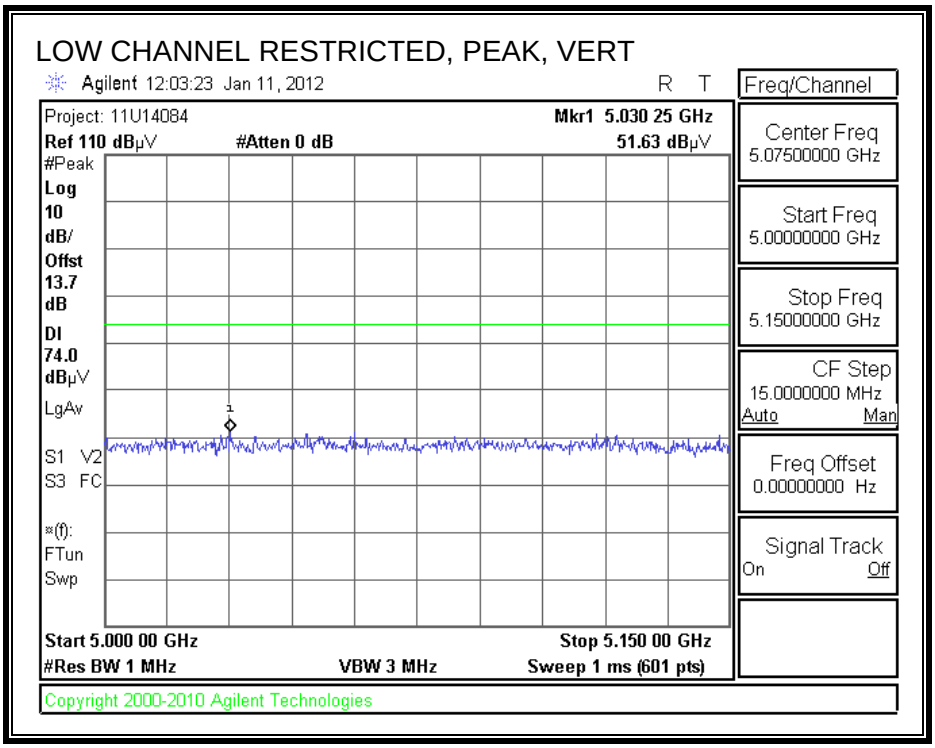
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)

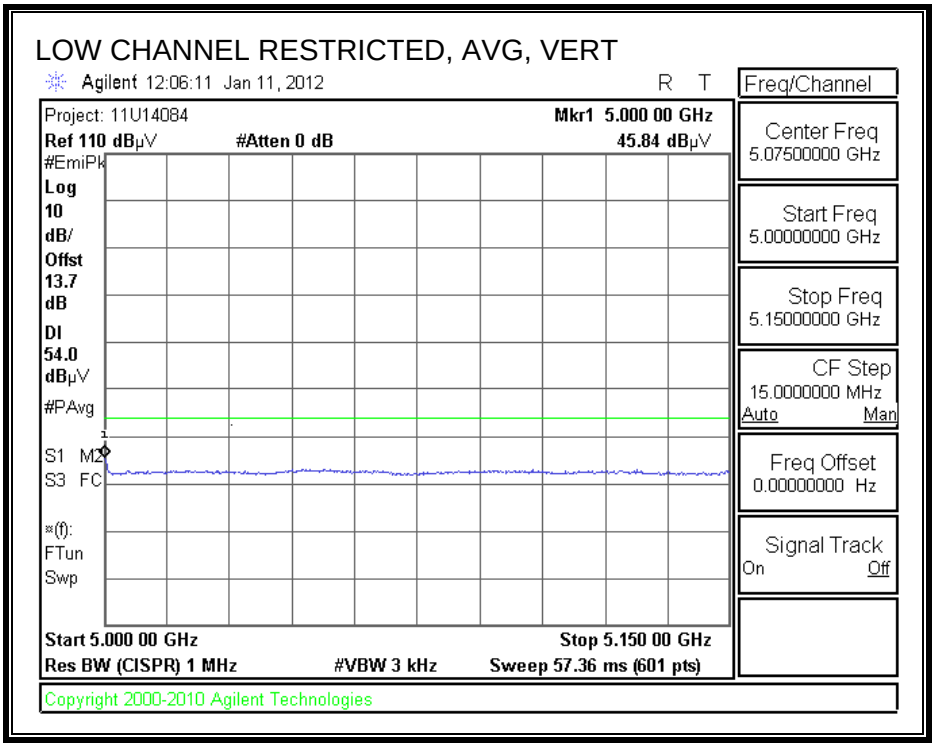


LOW CHANNEL RESTRICTED, AVG, HORIZ



RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)





HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 01/11/12
Project #: 11U14084
Company: Sonos
Test Target: FCC Class B
Mode Oper: W52, 802.11n MCS9

f	Measurement Frequency	Amp	Preamp Gain
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	High Pass Filter

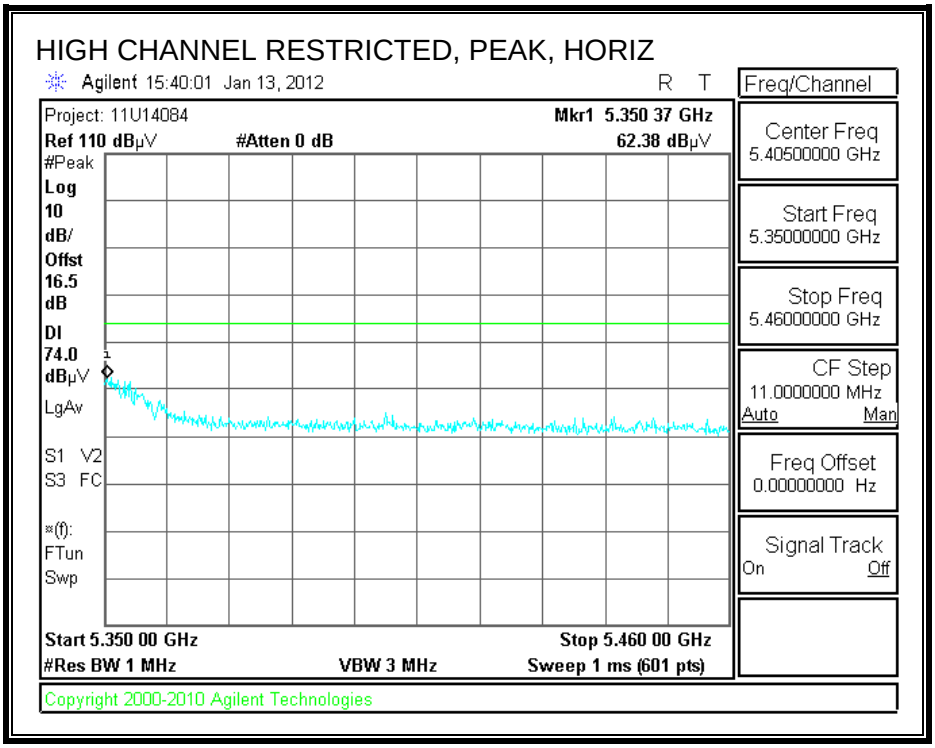
Average Field Strength Limit
Peak Field Strength Limit
Margin vs. Average Limit
Margin vs. Peak Limit

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
5180 MHz, 11n													
15.540	3.0	34.7	39.0	11.3	-34.8	0.0	0.7	51.0	74.0	-23.0	H	P	
15.540	3.0	24.5	39.0	11.3	-34.8	0.0	0.7	40.8	54.0	-13.2	H	A	
15.540	3.0	35.4	39.0	11.3	-34.8	0.0	0.7	51.6	74.0	-22.4	V	P	
15.540	3.0	24.7	39.0	11.3	-34.8	0.0	0.7	40.9	54.0	-13.1	V	A	
5200 MHz, 11n													
15.600	3.0	35.4	38.8	11.4	-34.8	0.0	0.7	51.5	74.0	-22.5	V	P	
15.600	3.0	24.5	38.8	11.4	-34.8	0.0	0.7	40.6	54.0	-13.4	V	A	
15.600	3.0	35.2	38.8	11.4	-34.8	0.0	0.7	51.3	74.0	-22.7	H	P	
15.600	3.0	24.4	38.8	11.4	-34.8	0.0	0.7	40.6	54.0	-13.4	H	A	
5240 MHz, 11n													
15.720	3.0	34.5	38.4	11.4	-34.7	0.0	0.7	50.3	74.0	-23.7	H	P	
15.720	3.0	24.2	38.4	11.4	-34.7	0.0	0.7	40.1	54.0	-13.9	H	A	
15.720	3.0	34.8	38.4	11.4	-34.7	0.0	0.7	50.7	74.0	-23.3	V	P	
15.720	3.0	24.3	38.4	11.4	-34.7	0.0	0.7	40.2	54.0	-13.8	V	A	

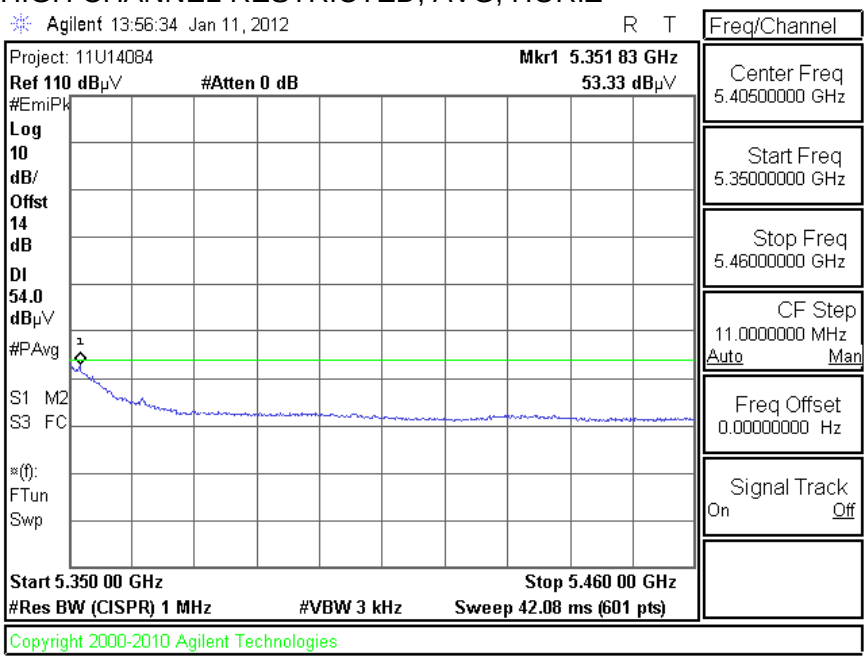
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

8.3.2. TX ABOVE 1 GHz FOR 802.11n HT20 MODE IN THE UPPER 5.2 GHz BAND

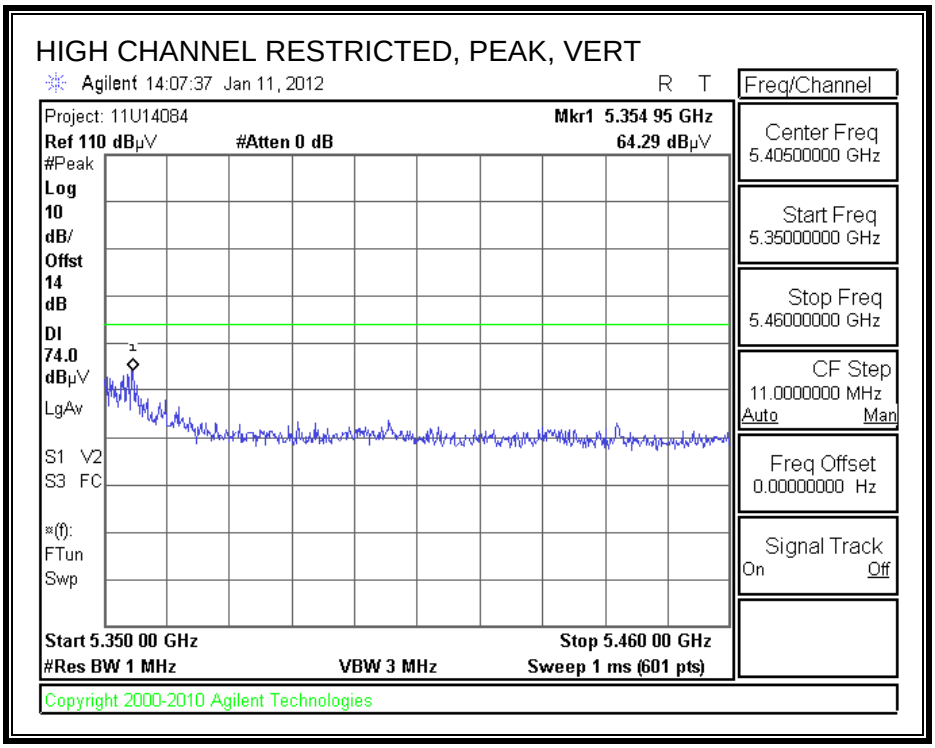
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



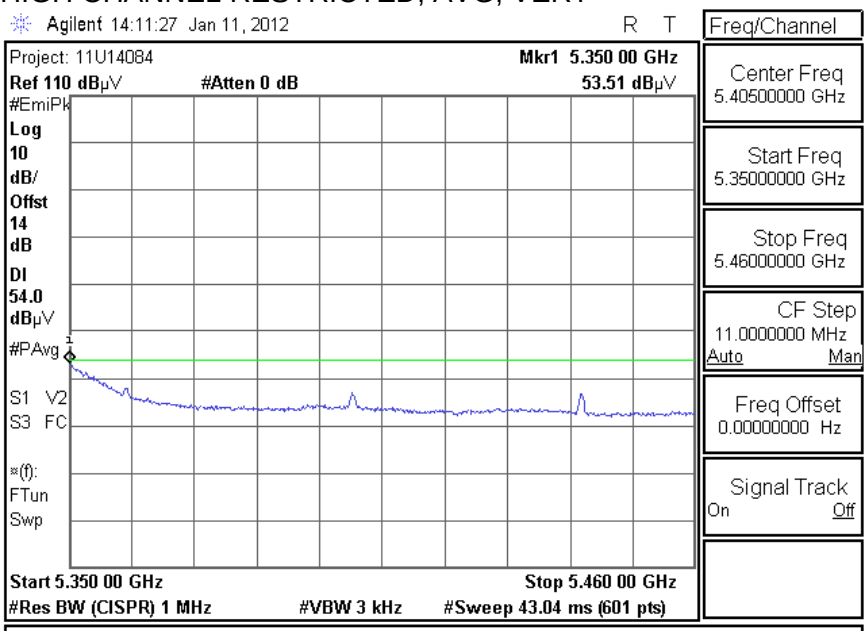
HIGH CHANNEL RESTRICTED, AVG, HORIZ



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HIGH CHANNEL RESTRICTED, AVG, VERT



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 01/11/12
Project #: 11U14084
Company: Sonos
Test Target: FCC Class B
Mode Oper: W53, 802.11n MCS9

f	Measurement Frequency	Amp	Preamp Gain
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	High Pass Filter

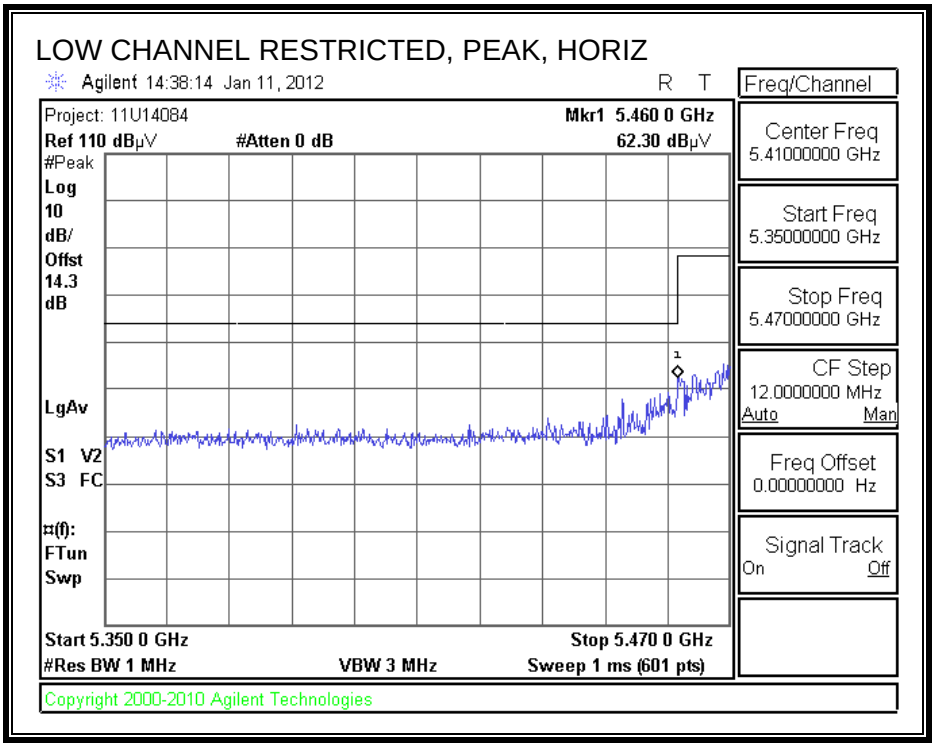
Average Field Strength Limit
Peak Field Strength Limit
Margin vs. Average Limit
Margin vs. Peak Limit

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
5260 MHz, 11n													
15.780	3.0	35.3	38.2	11.5	-34.6	0.0	0.7	51.0	74.0	-23.0	V	P	
15.780	3.0	24.8	38.2	11.5	-34.6	0.0	0.7	40.5	54.0	-13.5	V	A	
15.780	3.0	34.4	38.2	11.5	-34.6	0.0	0.7	50.1	74.0	-23.9	H	P	
15.780	3.0	24.8	38.2	11.5	-34.6	0.0	0.7	40.6	54.0	-13.4	H	A	
5300 MHz, 11n													
10.600	3.0	37.6	38.3	9.0	-36.6	0.0	0.8	49.1	74.0	-24.9	H	P	
10.600	3.0	25.3	38.3	9.0	-36.6	0.0	0.8	36.8	54.0	-17.2	H	A	
15.900	3.0	35.0	37.8	11.5	-34.6	0.0	0.7	50.5	74.0	-23.5	H	P	
15.900	3.0	24.8	37.8	11.5	-34.6	0.0	0.7	40.3	54.0	-13.7	H	A	
5300 MHz, 11n													
10.600	3.0	35.4	38.3	9.0	-36.6	0.0	0.8	46.9	74.0	-27.1	V	P	
10.600	3.0	25.1	38.3	9.0	-36.6	0.0	0.8	36.6	54.0	-17.4	V	A	
15.900	3.0	34.3	37.8	11.5	-34.6	0.0	0.7	49.8	74.0	-24.2	V	P	
15.900	3.0	24.8	37.8	11.5	-34.6	0.0	0.7	40.3	54.0	-13.7	V	A	
5320 MHz, 11n													
10.640	3.0	36.9	38.3	9.1	-36.6	0.0	0.8	48.4	74.0	-25.6	V	P	
10.640	3.0	24.8	38.3	9.1	-36.6	0.0	0.8	36.3	54.0	-17.7	V	A	
15.960	3.0	35.0	37.6	11.5	-34.5	0.0	0.7	50.3	74.0	-23.7	V	P	
15.960	3.0	25.0	37.6	11.5	-34.5	0.0	0.7	40.4	54.0	-13.6	V	A	
5320 MHz, 11n													
10.640	3.0	39.6	38.3	9.1	-36.6	0.0	0.8	51.1	74.0	-22.9	H	P	
10.640	3.0	25.1	38.3	9.1	-36.6	0.0	0.8	36.6	54.0	-17.4	H	A	
15.960	3.0	35.4	37.6	11.5	-34.5	0.0	0.7	50.7	74.0	-23.3	H	P	
15.960	3.0	25.2	37.6	11.5	-34.5	0.0	0.7	40.5	54.0	-13.5	H	A	

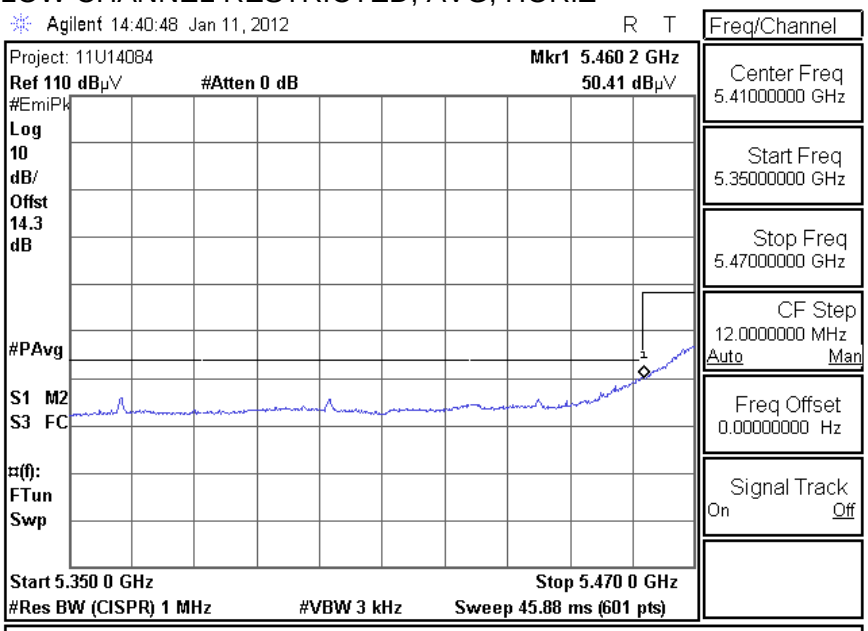
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

8.3.3. TX ABOVE 1 GHz FOR 802.11n HT20 MODE IN THE 5.6 GHz BAND

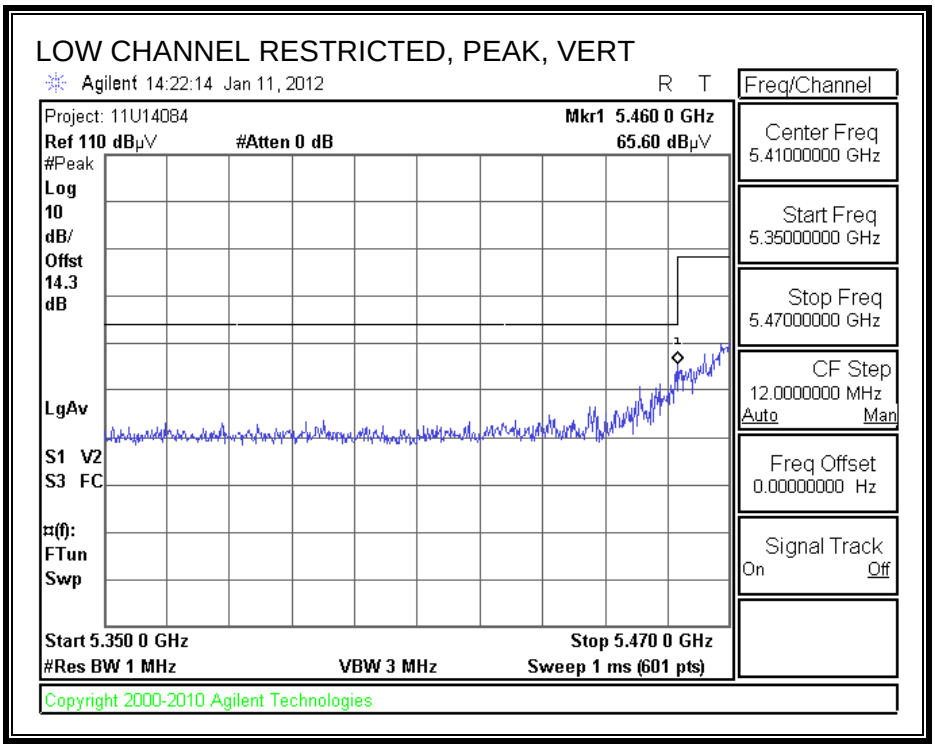
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)

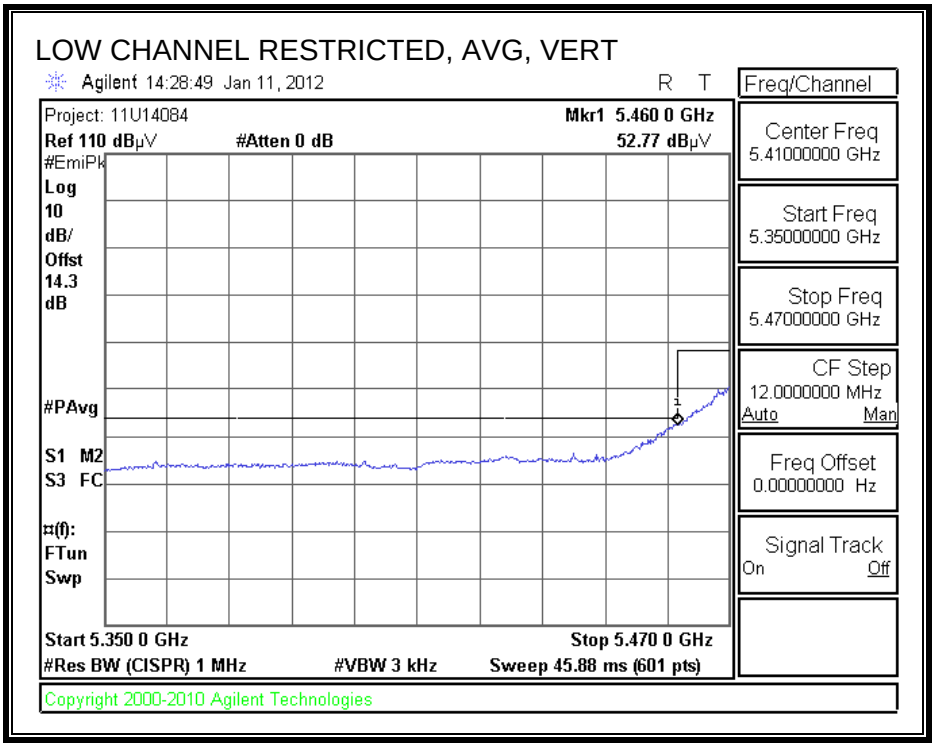


LOW CHANNEL RESTRICTED, AVG, HORIZ

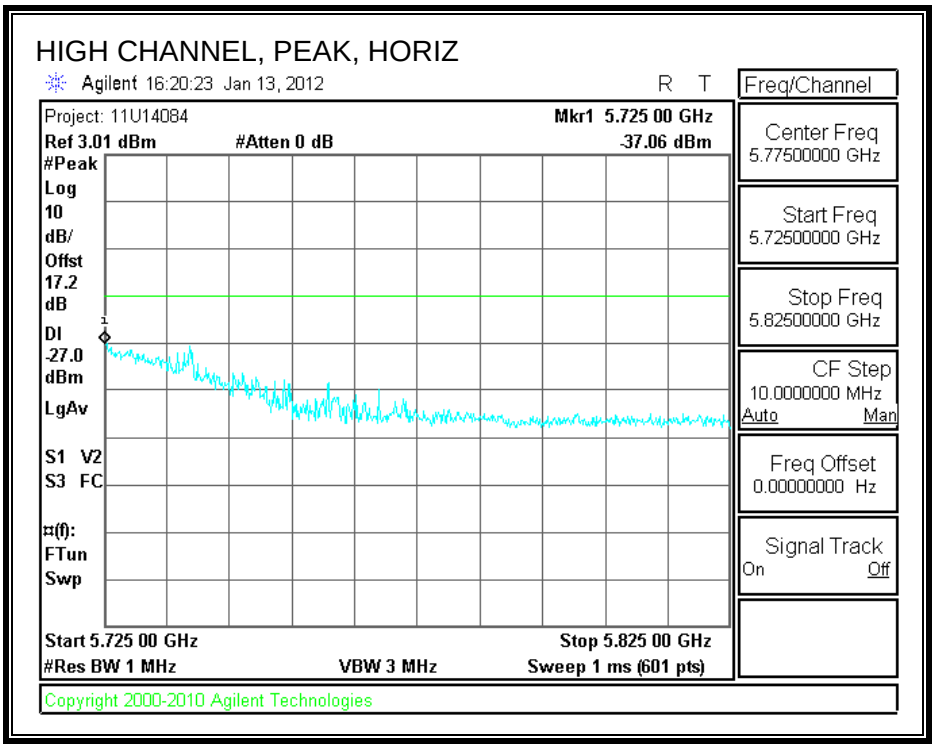


RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)

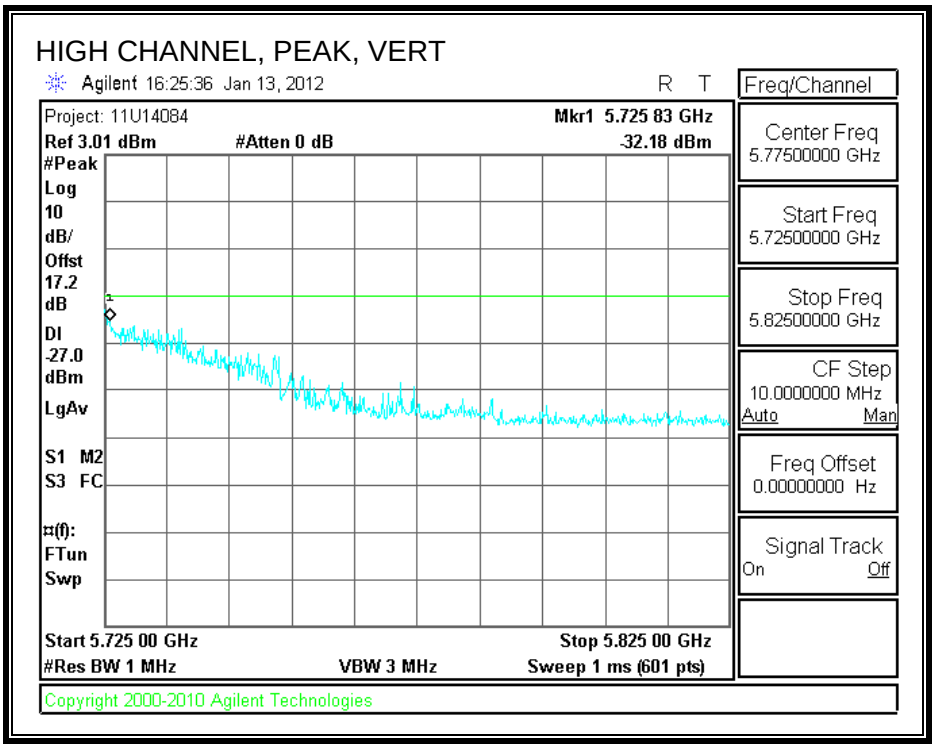




AUTHORIZED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



AUTHORIZED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 01/11/12
Project #: 11U14084
Company: Sonos
Test Target: FCC Class B
Mode Oper: W56, 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	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5500 MHz, 11n													
11.000	3.0	38.3	38.4	9.2	-36.3	0.0	0.7	50.4	74.0	-23.6	H	P	
11.000	3.0	25.2	38.4	9.2	-36.3	0.0	0.7	37.3	54.0	-16.7	H	A	
11.000	3.0	40.7	38.4	9.2	-36.3	0.0	0.7	52.8	74.0	-21.2	V	P	
11.000	3.0	32.6	38.4	9.2	-36.3	0.0	0.7	44.6	54.0	-9.4	V	A	
5580 MHz, 11n													
11.160	3.0	37.6	38.5	9.3	-36.1	0.0	0.7	50.0	74.0	-24.0	V	P	
11.160	3.0	32.6	38.5	9.3	-36.1	0.0	0.7	45.0	54.0	-9.0	V	A	
11.160	3.0	44.0	38.5	9.3	-36.1	0.0	0.7	56.4	74.0	-17.6	H	P	
11.160	3.0	26.6	38.5	9.3	-36.1	0.0	0.7	39.1	54.0	-14.9	H	A	
5700 MHz, 11n													
11.400	3.0	39.8	38.7	9.4	-35.9	0.0	0.7	52.7	74.0	-21.3	H	P	
11.400	3.0	26.3	38.7	9.4	-35.9	0.0	0.7	39.3	54.0	-14.7	H	A	
11.400	3.0	46.5	38.7	9.4	-35.9	0.0	0.7	59.4	74.0	-14.6	V	P	
11.400	3.0	33.9	38.7	9.4	-35.9	0.0	0.7	46.9	54.0	-7.1	V	A	

Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

8.4. RECEIVER ABOVE 1 GHz

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

Company:	**Sonons**
Project #:	**11U14084**
Date:	**12/14/2011**
Test Engineer:	**Tom Chen**
Configuration:	**EUT standalone**
Mode:	**RX mode, W52**

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 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
3' cable 22807700	12' cable 22807600	20' cable 22807500		

Peak Measurements
RBW=VBW=1MHz
Average Measurements
RBW=1MHz ; VBW=10Hz

f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
1.260	3.0	50.0	32.4	24.8	3.0	-38.5	0.0	0.0	39.4	21.8	74	54	-34.6	-32.2	H
1.628	3.0	48.3	30.7	26.1	3.5	-38.0	0.0	0.0	39.9	22.3	74	54	-34.1	-31.7	H
5.593	3.0	39.9	22.3	34.5	6.8	-35.4	0.0	0.0	45.8	28.2	74	54	-28.2	-25.8	H
1.130	3.0	46.4	28.8	24.3	2.9	-38.6	0.0	0.0	35.0	17.4	74	54	-39.0	-36.6	V
1.260	3.0	46.6	29.0	24.8	3.0	-38.5	0.0	0.0	36.0	18.4	74	54	-38.0	-35.6	V
1.390	3.0	47.0	29.4	25.3	3.2	-38.3	0.0	0.0	37.2	19.6	74	54	-36.8	-34.4	V

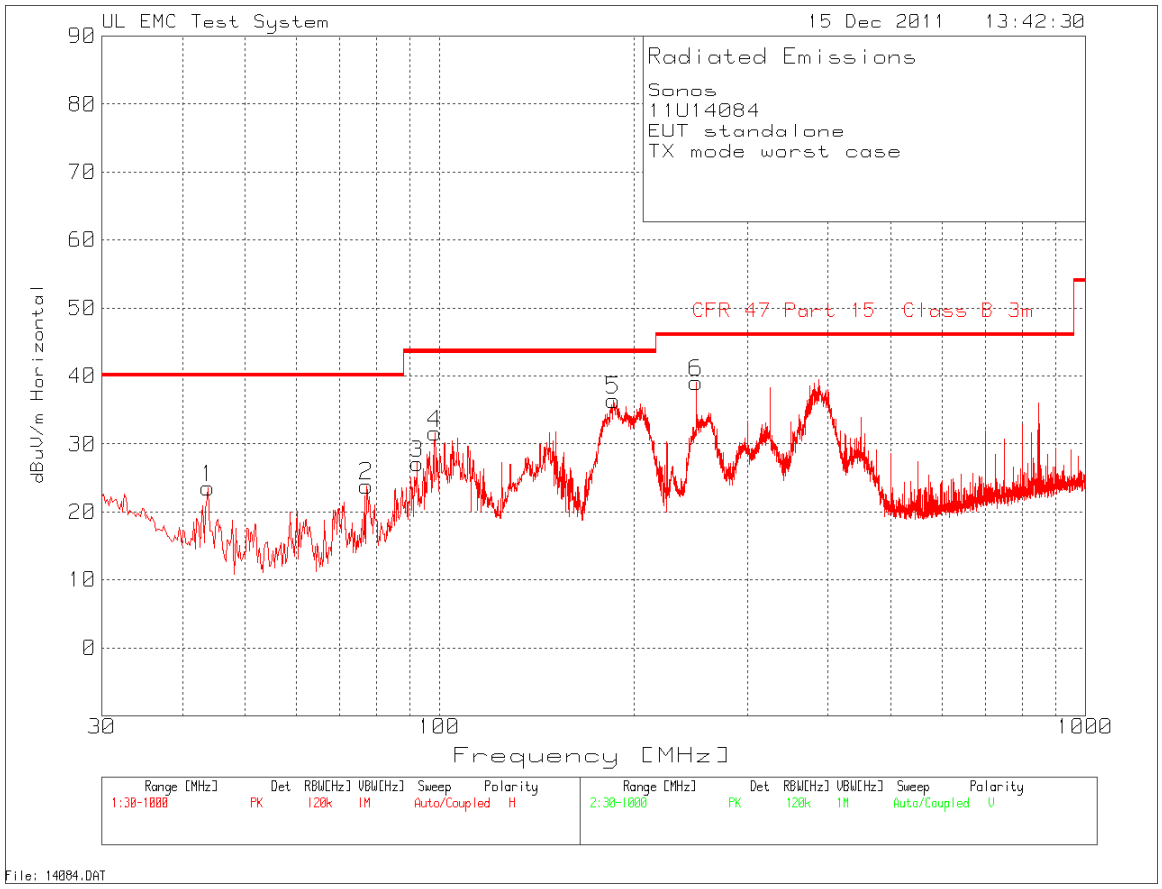
Rev. 07.08.11

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		

8.5. WORST-CASE BELOW 1 GHz

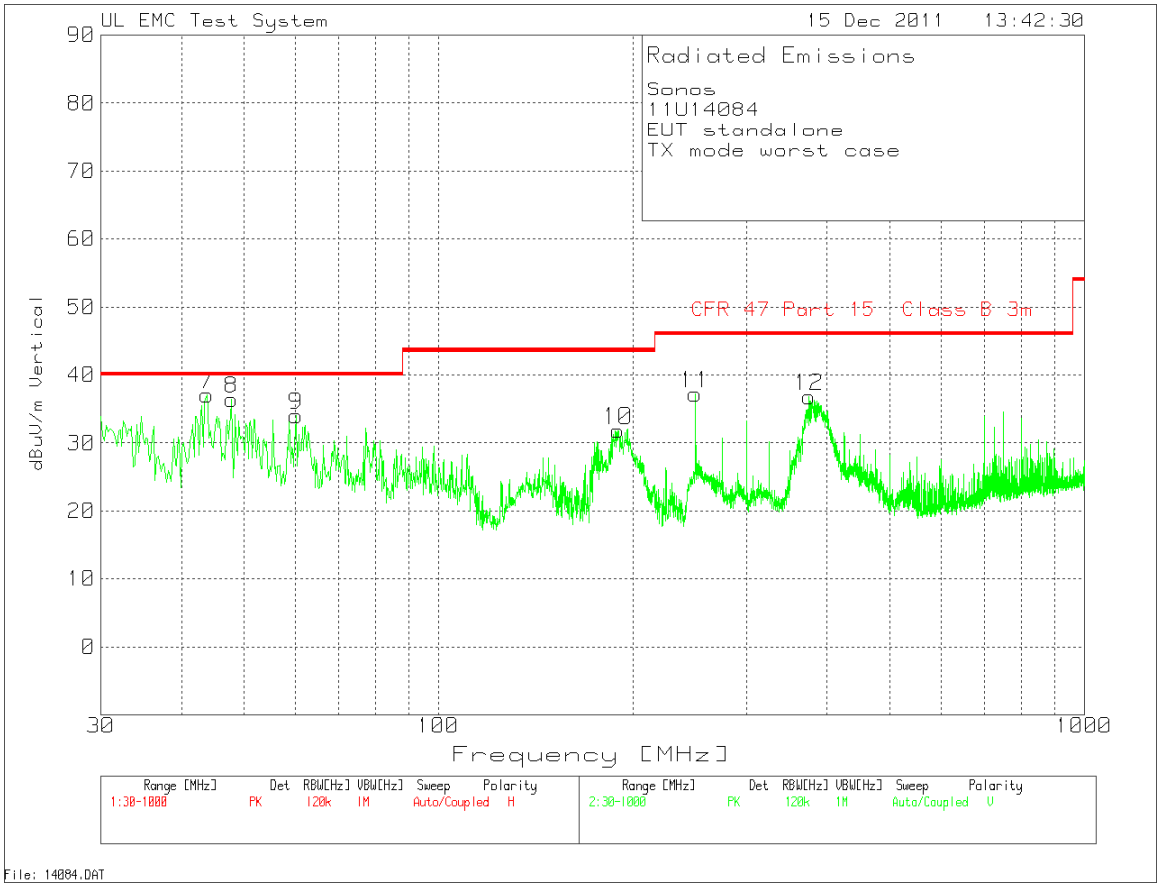
SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)

HORIZONTAL PLOT



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

VERTICAL PLOT



HORIZONTAL AND VERTICAL DATA

Sonos
11U14084
EUT standalone
TX mode worst case

Range 1 30 - 1000MHz

Test Frequency	Meter Reading	Detector	25MHz-1GHz ChmbrA Amplified.TX [dB]	5m A T122 Bilog below 1GHz.TXT [dB]	dBuV/m	CFR 47 Part 15 Class B 3m	Margin	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.TX [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

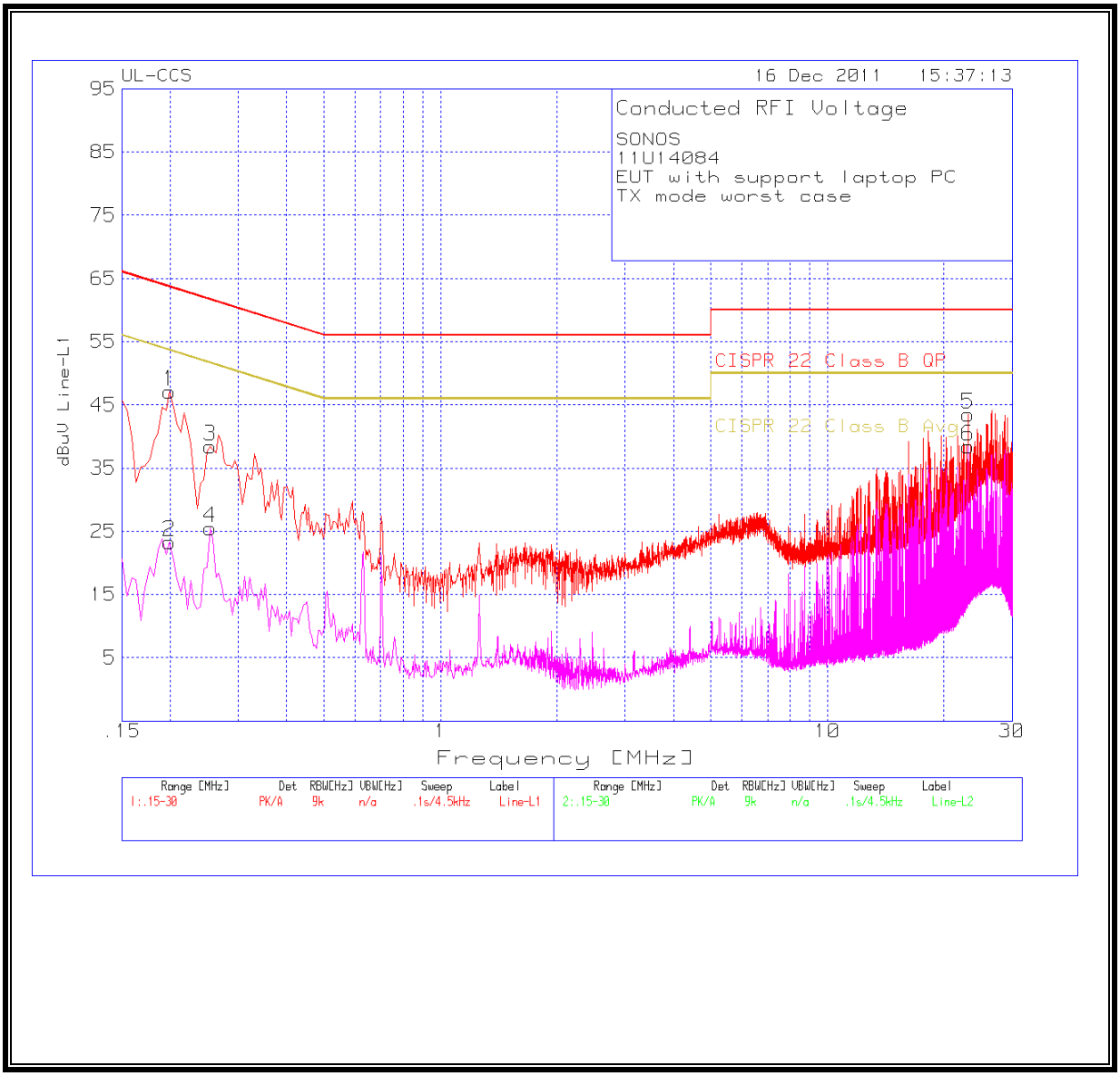
ANSI C63.4

RESULTS

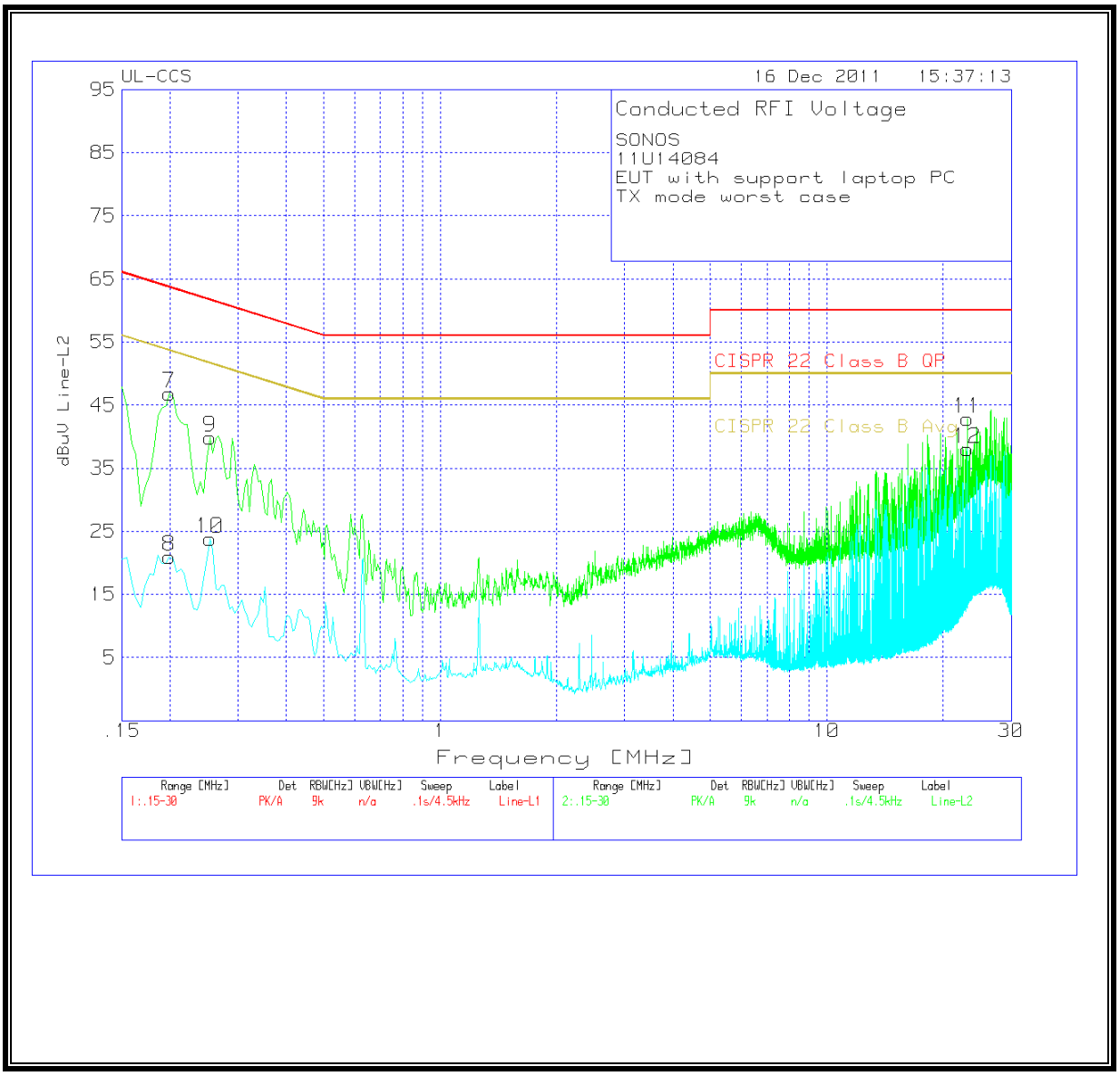
6 WORST EMISSIONS

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^2)	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	*($900/f^2$)	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	*($180/f^2$)	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^2)	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^2)	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^2 is equivalent to 1 mW/cm^2.
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 = EIRP / (4 * Pi * D^2)

where

S = Power density in W/m^2
EIRP = Equivalent Isotropic Radiated Power in W
D = Separation distance in m

Power density in units of W/m^2 is converted to units of mWc/m^2 by dividing by 10.

Distance is given by:

D = SQRT (EIRP / (4 * Pi * S))

where

D = Separation distance in m
EIRP = Equivalent Isotropic Radiated Power in W
S = Power density in W/m^2

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.

Total EIRP = (P1 * G1) + (P2 * G2) + ... + (Pn * Pn)

where

Px = Power of transmitter x
Gx = 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^2

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

RESULTS

Multiple chain or colocated transmitters								
Band	**Mode**	**Chain for MIMO**	**Separation Distance (m)**	**Output Power (dBm)**	**Antenna Gain (dBi)**	**Duty Cycle (%)**	**IC Power Density (W/m^2)**	**FCC Power Density (mW/cm^2)**
5 GHz	WLAN	1		18.30	4.98	18		
5 GHz	WLAN	2		17.60	4.38	18		
Combined			0.20				0.13	0.013

11. DYNAMIC FREQUENCY SELECTION

11.1. OVERVIEW

11.1.1. LIMITS

INDUSTRY CANADA

IC RSS-210 is closely harmonized with FCC Part 15 DFS rules. The deviations are as follows:

RSS-210 Issue 7 A9.4 (b) (ii) **Channel Availability Check Time:** …

Additional requirements for the band 5600-5650 MHz: Until further notice, devices subject to this Section shall not be capable of transmitting in the band 5600-5650 MHz, so that Environment Canada weather radars operating in this band are protected.

RSS-210 Issue 7 A9.4 (b) (iv) **Channel closing time:** the maximum channel closing time is 260 ms.

FCC

§15.407 (h) and FCC 06-96 APPENDIX “COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED-NATIONAL INFORMATION INFRASTRUCTURE DEVCIES OPERATING IN THE 5250-5350 MHz AND 5470-5725 MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION”.

Table 1: Applicability of DFS requirements prior to use of a channel

Requirement	Operational Mode		
	Master	Client (without radar detection)	Client (with radar detection)
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
Uniform Spreading	Yes	Not required	Not required

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode		
	Master	Client **(without DFS)**	Client **(with DFS)**
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	Yes	Yes
Channel Move Time	Yes	Yes	Yes

Table 3: Interference Threshold values, Master or Client incorporating In-Service Monitoring

Maximum Transmit Power	Value (see note)
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.		

Table 4: DFS Response requirement values

Parameter	Value
Non-occupancy period	30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds
Channel Closing Transmission Time	200 milliseconds + approx. 60 milliseconds over remaining 10 second period
The instant that the *Channel Move Time* and the *Channel Closing Transmission Time* begins is as follows: For the Short pulse radar Test Signals this instant is the end of the *Burst*. For the Frequency Hopping radar Test Signal, this instant is the end of the last radar burst generated. For the Long Pulse radar Test Signal this instant is the end of the 12 second period defining the radar transmission. The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate channel changes (an aggregate of approximately 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.	

Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (Microseconds)	PRI (Microseconds)	Pulses	Minimum Percentage of Successful Detection	Minimum Trials
1	1	1428	18	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

Table 6 – Long Pulse Radar Test Signal

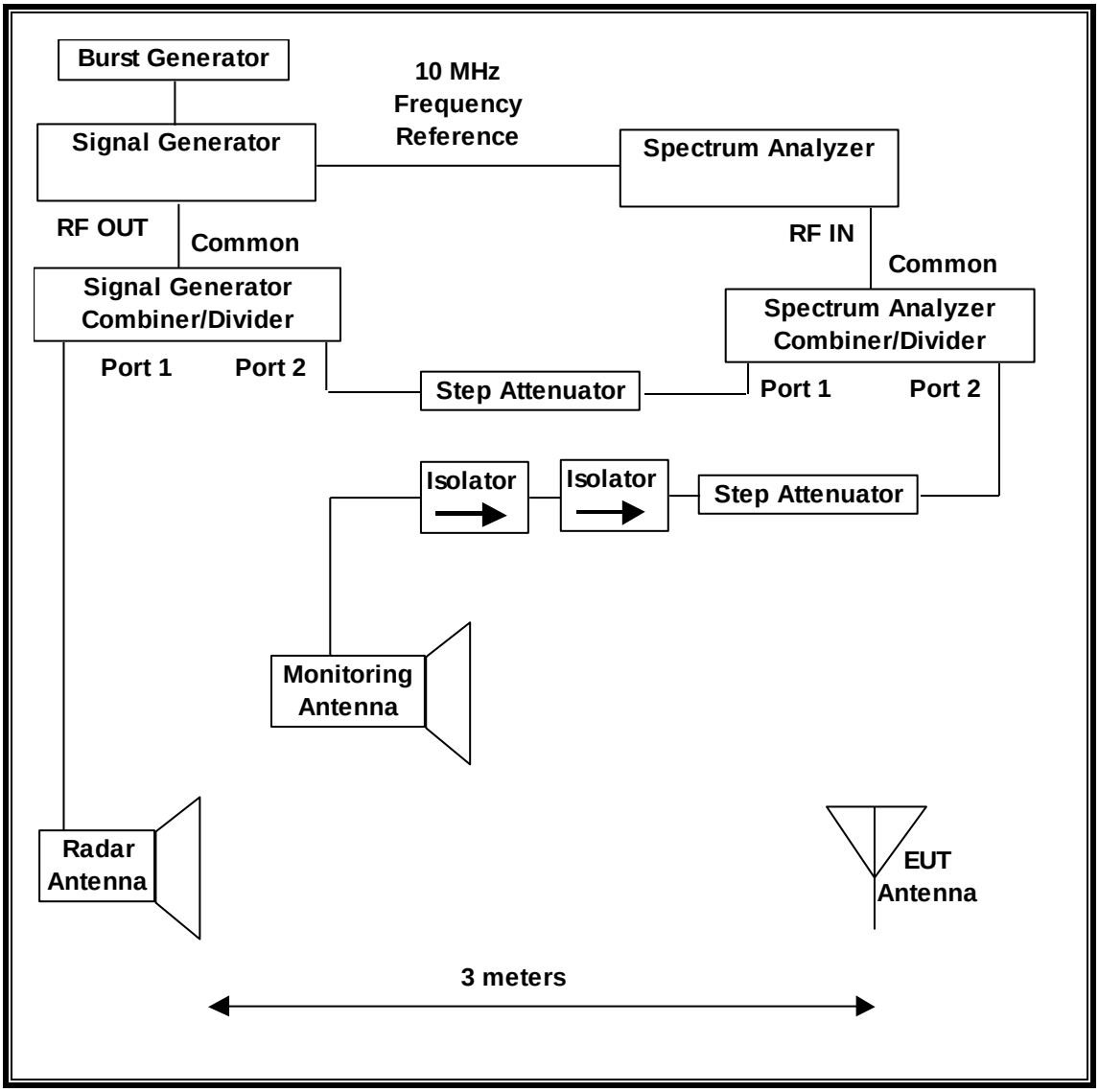
Radar Waveform	Bursts	Pulses per Burst	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Minimum Percentage of Successful Detection	Minimum Trials
5	8-20	1-3	50-100	5-20	1000-2000	80%	30

Table 7 – Frequency Hopping Radar Test Signal

Radar Waveform	Pulse Width (µsec)	PRI (µsec)	Burst Length (ms)	Pulses per Hop	Hopping Rate (kHz)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	300	9	.333	70%	30

11.1.2. TEST AND MEASUREMENT SYSTEM

RADIATED METHOD SYSTEM BLOCK DIAGRAM



SYSTEM OVERVIEW

The short pulse and long pulse signal generating system utilizes the NTIA software. The Vector Signal Generator has been validated by the NTIA. The hopping signal generating system utilizes the CCS simulated hopping method and system, which has been validated by the DoD, FCC and NTIA. The software selects waveform parameters from within the bounds of the signal type on a random basis using uniform distribution.

The short pulse types 2, 3 and 4, and the long pulse type 5 parameters are randomized at run-time.

The hopping type 6 pulse parameters are fixed while the hopping sequence is based on the August 2005 NTIA Hopping Frequency List. The initial starting point randomized at run-time and each subsequent starting point is incremented by 475. Each frequency in the 100-length segment is compared to the boundaries of the EUT Detection Bandwidth and the software creates a hopping burst pattern in accordance with Section 7.4.1.3 Method #2 Simulated Freqeuncy Hopping Radar Waveform Generating Subsystem of FCC 06-96 APPENDIX. The frequency of the signal generator is incremented in 1 MHz steps from F_L to F_H for each successive trial. This incremental sequence is repeated as required to generate a minimum of 30 total trials and to maintain a uniform frequency distribution over the entire Detection Bandwidth.

The signal monitoring equipment consists of a spectrum analyzer. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold.

SYSTEM CALIBRATION

A 50-ohm load is connected in place of the spectrum analyzer, and the spectrum analyzer is connected to a horn antenna via a coaxial cable, with the reference level offset set to (horn antenna gain – coaxial cable loss). The signal generator is set to CW mode. The amplitude of the signal generator is adjusted to yield a level of –64 dBm as measured on the spectrum analyzer.

Without changing any of the instrument settings, the spectrum analyzer is reconnected to the Common port of the Spectrum Analyzer Combiner/Divider. The Reference Level Offset of the spectrum analyzer is adjusted so that the displayed amplitude of the signal is –64 dBm.

The spectrum analyzer displays the level of the signal generator as received at the antenna ports of the Master Device. The interference detection threshold may be varied from the calibrated value of –64 dBm and the spectrum analyzer will still indicate the level as received by the Master Device.

ADJUSTMENT OF DISPLAYED TRAFFIC LEVEL

A link is established between the Master and Slave and the distance between the units is adjusted as needed to provide a suitable received level at the Master and Slave devices. The video test file is streamed to generate WLAN traffic. The monitoring antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

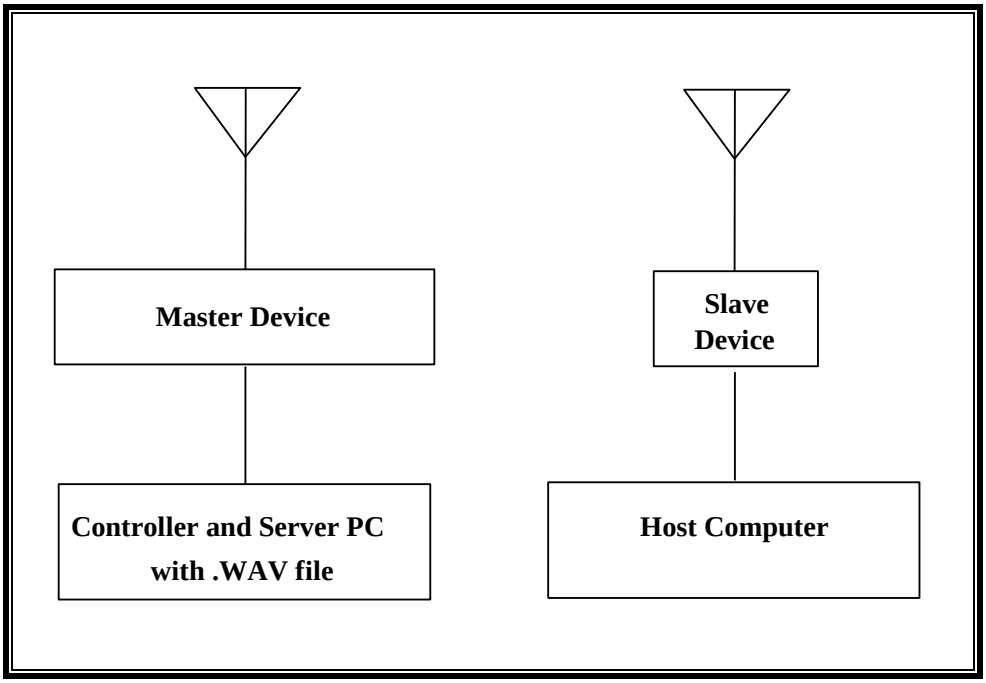
TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the DFS tests documented in this report:

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Asset Number**	**Cal Due**
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C00996	11/04/12
Vector Signal Generator, 20GHz	Agilent / HP	E8267C	C01066	11/17/12

11.1.3. SETUP OF EUT

RADIATED METHOD EUT TEST SETUP



SUPPORT EQUIPMENT

The following support equipment was utilized for the DFS tests documented in this report:

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Notebook PC (Server/Controller)	Dell	P05G001	29717068285	DoC
AC Adapter (Server PC)	Lite On Technologies	LA65NS2-01	CN-0928G4-72438-07F-16ED-A00	DoC
8-Port Gigabit Switch	Netgear	GS108	1DR1823R0685A	DoC
AC Adapter (Gigabit Switch)	Netgear	DSA-12R-12 AUS 120120	01035	DoC
4-Port Serial to USB Converter	N/A	N/A	01037	DoC
Notebook PC (Server/Controller)	Dell	P05G001	3535214077	DoC
AC Adapter (Server PC)	Lite On Technologies	LA65NS2-01	CN-0928G4-72438-084-C430-A00	DoC
Wireless Access Point	Cisco	AIR-AP1242AG-A-K9	FTX1446BOUY	LDK102056
AC Adapter (AP)	Delta Electronics	EADP-18MB B	DAB1433MEWJ	DoC
Cable/DSL Router with 8-	Linksys	BEFSR81	C2220E202196	DoC
AC Adapter (Cable/DSL	Linksys	AM-1201000D41	12247	DoC

11.1.4. DESCRIPTION OF EUT

The EUT operates over the 5250-5350 MHz and 5470-5725 MHz ranges.

The EUT is a Slave Device without Radar Detection.

The highest power level within these bands is 26.5 dBm EIRP in the 5250-5350 MHz band and 26.98 dBm EIRP in the 5470-5725 MHz band.

The only antenna assembly utilized with the EUT has a peak gain of 4.1 dBi in the 5250-5350 MHz band and 4.27 dBi in the 5470-5725 MHz band.

Two identical antennas are utilized to meet the diversity and MIMO operational requirements.

The rated output power of the Master unit is > 23dBm (EIRP). Therefore the required interference threshold level is –64 dBm. After correction for procedural adjustments, the required radiated threshold at the antenna port is –64 + 1 = -63 dBm.

The calibrated radiated DFS Detection Threshold level is set to –64 dBm. The tested level is lower than the required level hence it provides a margin to the limit.

The EUT uses two transmitter/receiver chains, each connected to an antenna to perform radiated tests.

WLAN traffic was generated by streaming the NTIA audio test file from the Master to the Slave using the media player embedded in the Sonos version 3.6 (build 16546280) software resident in the Slave Device.

TPC is not required since the maximum EIRP is less than 500 mW (27 dBm).

The software installed in the access point is release C1240-K9W7-M version 12.4 (21a) JA1.

UNIFORM CHANNEL SPREADING

This does not apply to slave radio devices

OVERVIEW OF MASTER DEVICE WITH RESPECT TO §15.407 (h) REQUIREMENTS

The Master Device is a Cisco Access Point, FCC ID: LDK102056. The minimum antenna gain for the Master Device is 3.5 dBi.

The rated output power of the Master unit is > 23dBm (EIRP). Therefore the required interference threshold level is –64 dBm. After correction for procedural adjustments, the required radiated threshold at the antenna port is –64 + 1 = -63 dBm.

The calibrated radiated DFS Detection Threshold level is set to –64 dBm. The tested level is lower than the required level hence it provides margin to the limit.

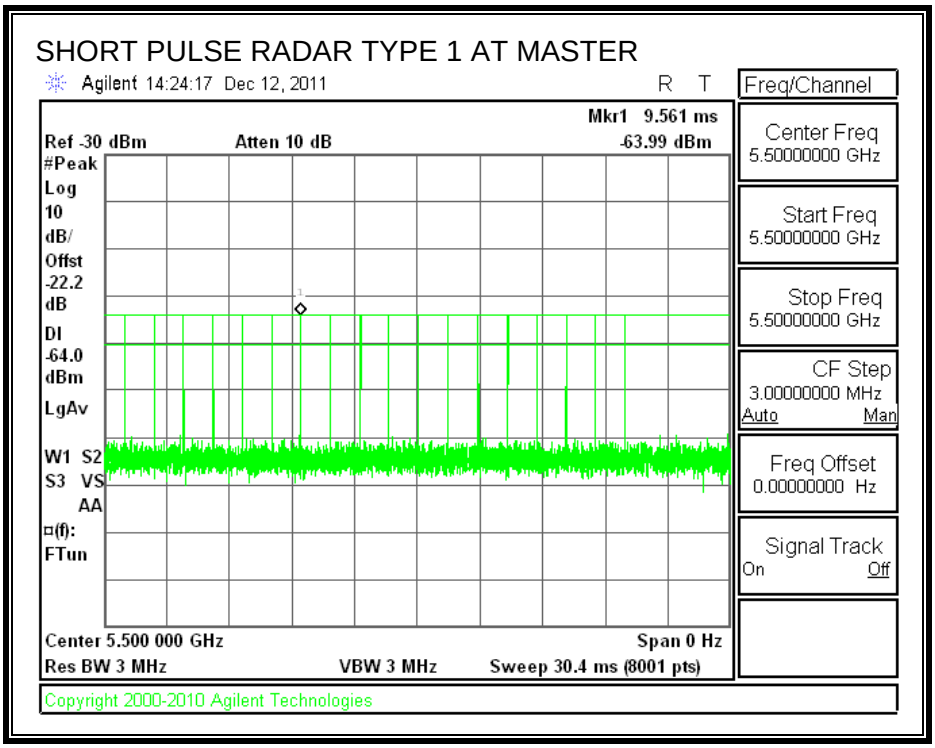
11.2. RESULTS FOR 20 MHz BANDWIDTH

11.2.1. TEST CHANNEL

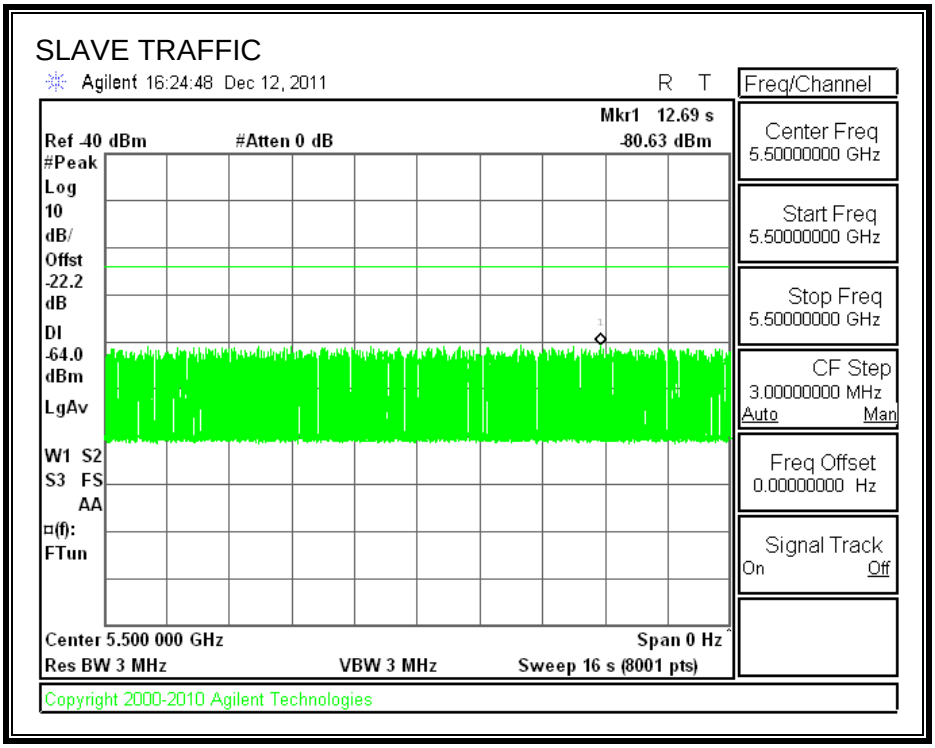
All tests were performed at a channel center frequency of 5500 MHz.

11.2.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM



TRAFFIC



11.2.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.2.4. MOVE AND CLOSING TIME

REPORTING NOTES

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time =
(Number of analyzer bins showing transmission) * (dwell time per bin)

The observation period over which the FCC aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

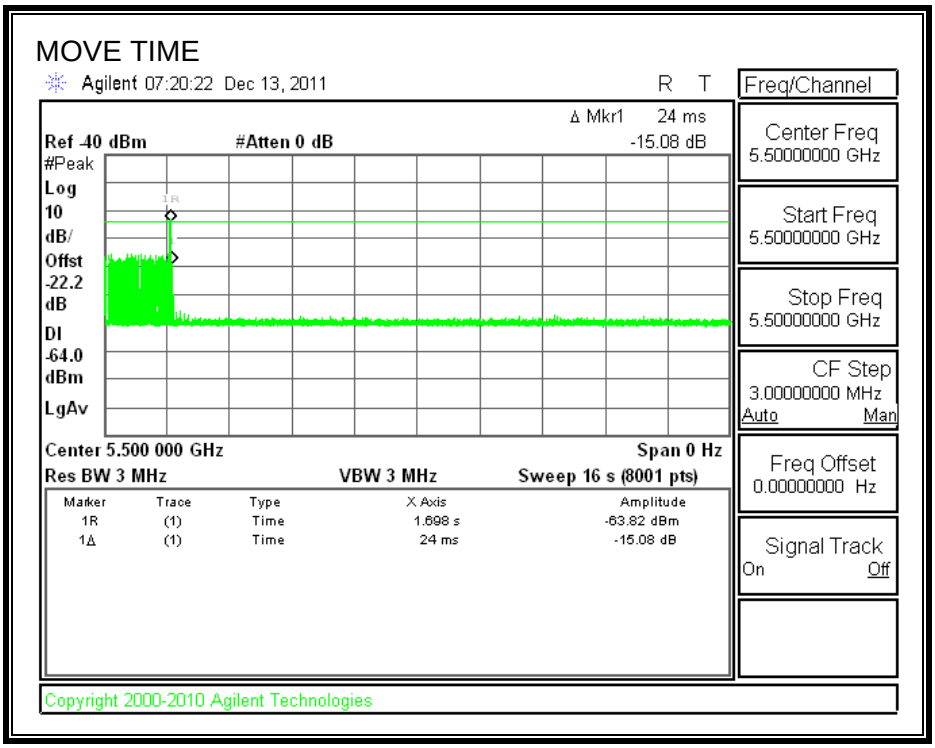
The observation period over which the IC aggregate time is calculated begins at (Reference Marker) and ends no earlier than (Reference Marker + 10 sec).

RESULTS

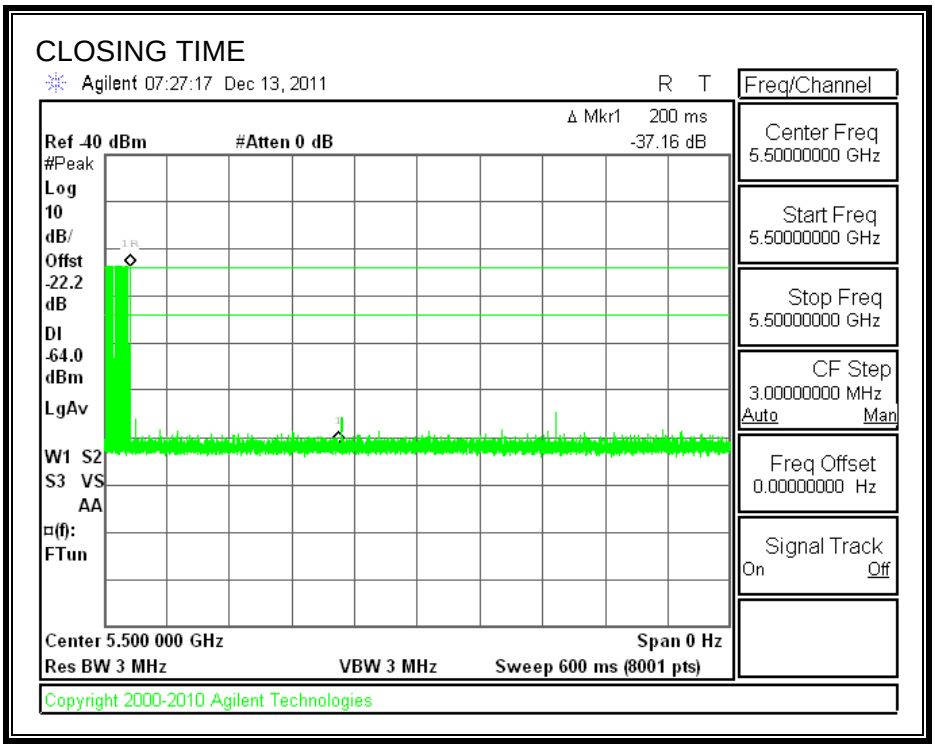
Agency	Channel Move Time (sec)	Limit (sec)
FCC / IC	0.024	10

Agency	Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
FCC	4.0	60
IC	10.0	260

MOVE TIME

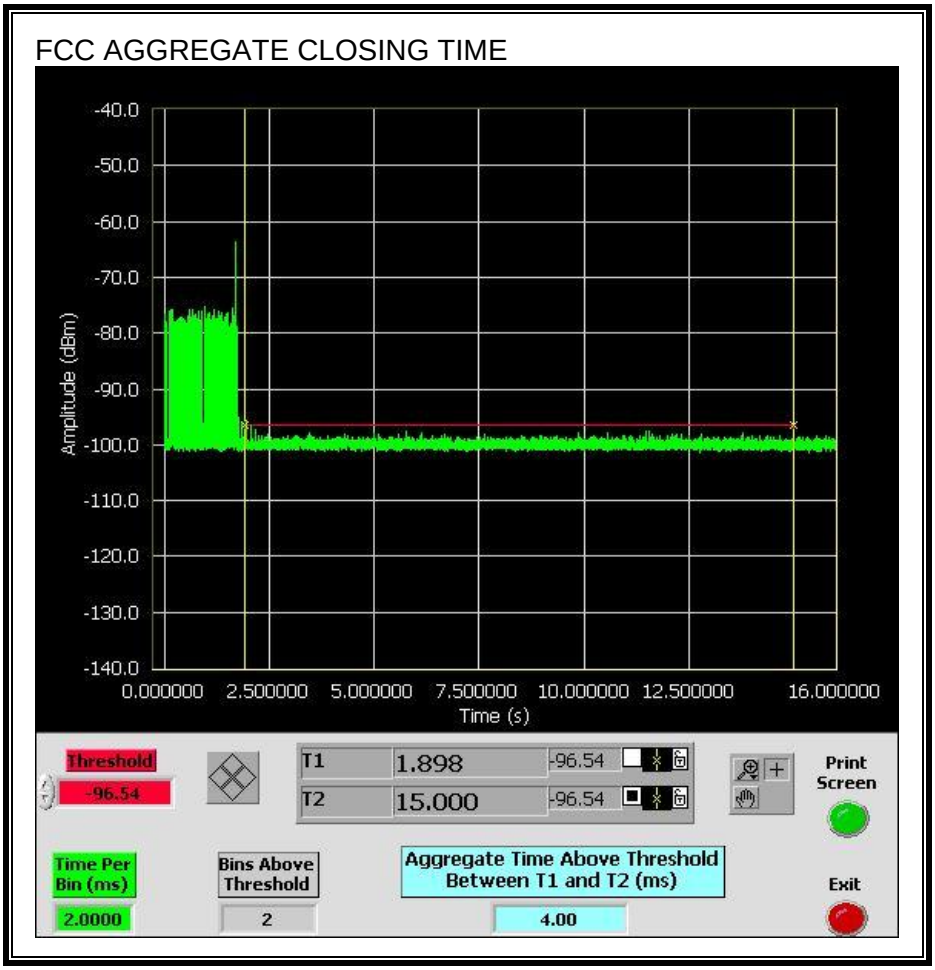


CHANNEL CLOSING TIME

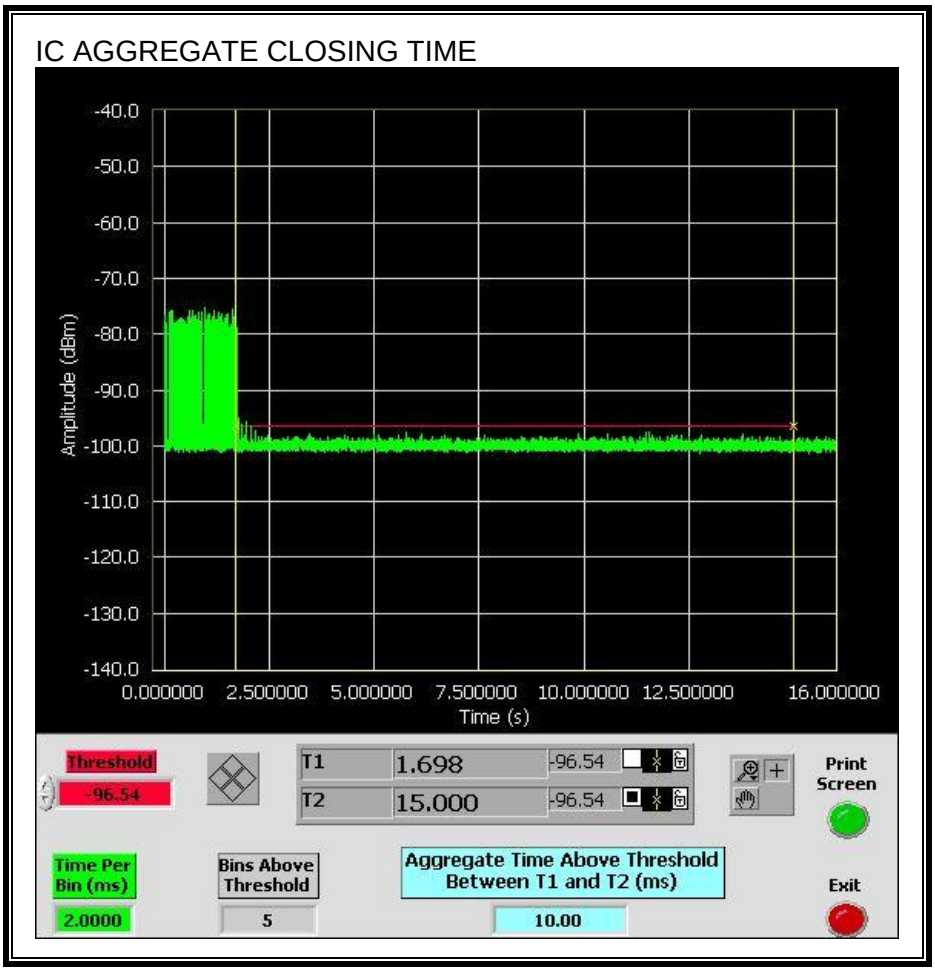


AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

Only intermittent transmissions are observed during the IC aggregate monitoring period.



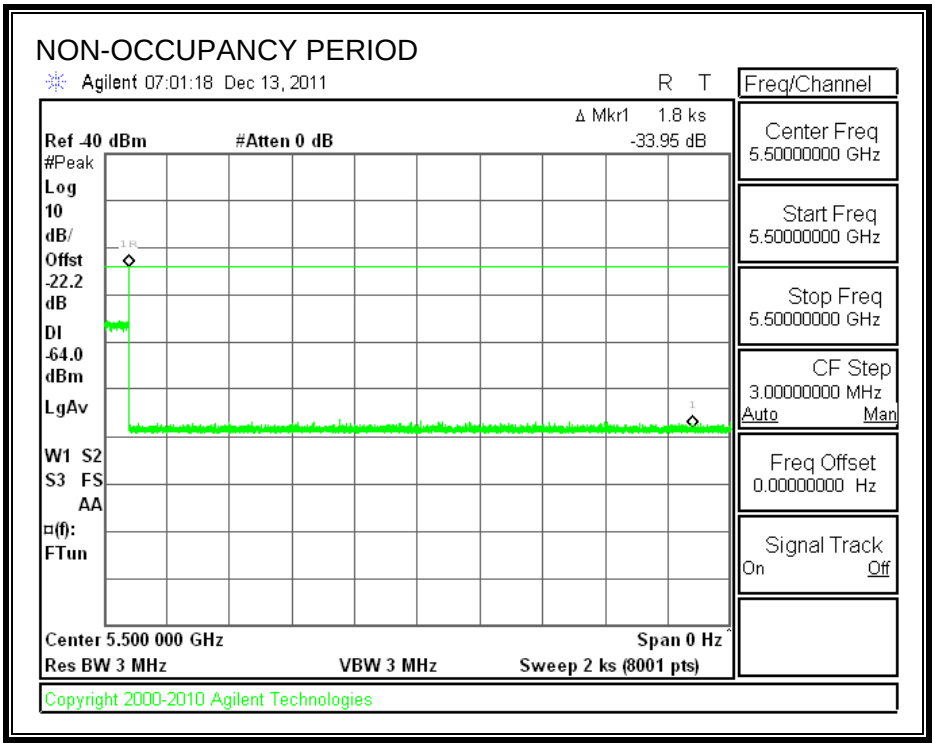
Only intermittent transmissions are observed during the IC aggregate monitoring period.



11.2.5. NON-OCCUPANCY PERIOD

RESULTS

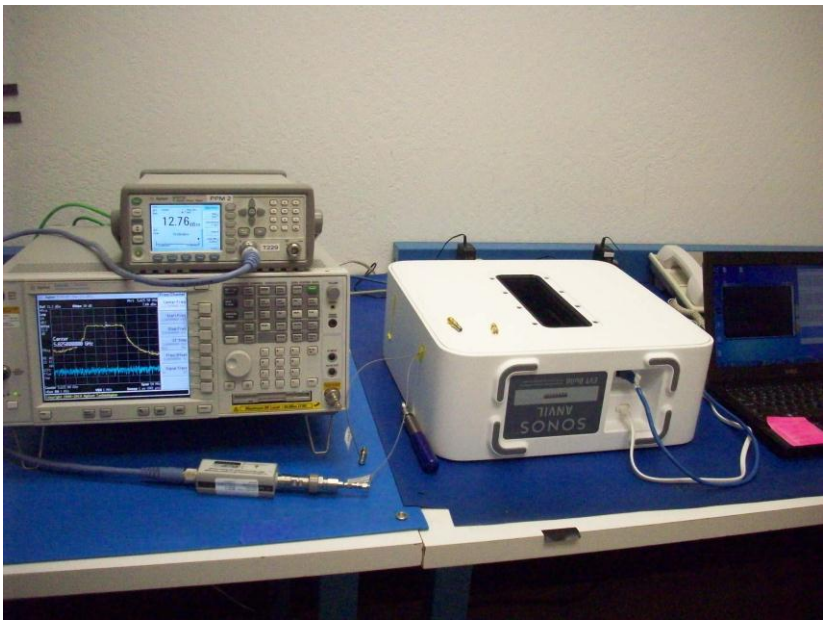
No EUT transmissions were observed on the test channel during the 30-minute observation time.



12. SETUP PHOTOS

ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP

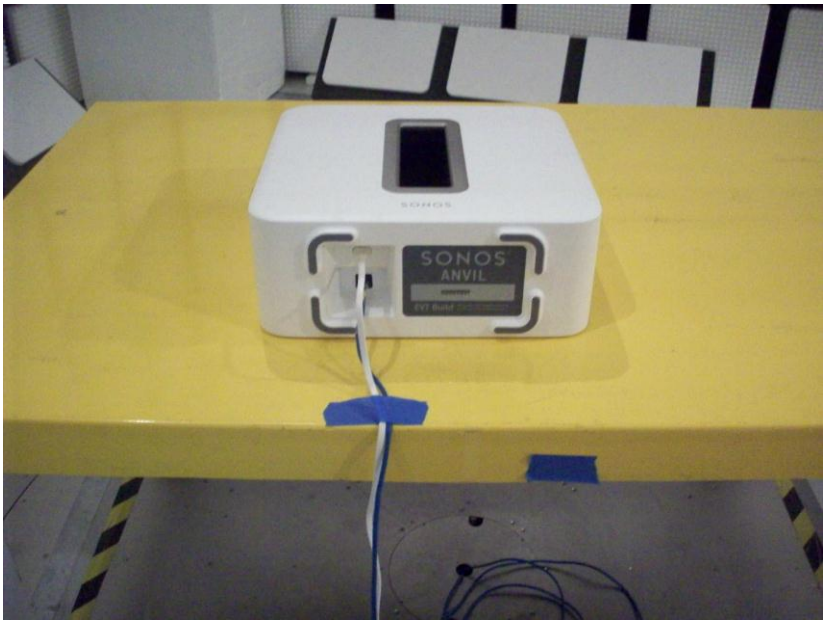
ANTENNA PORT CONDUCTED PHOTO



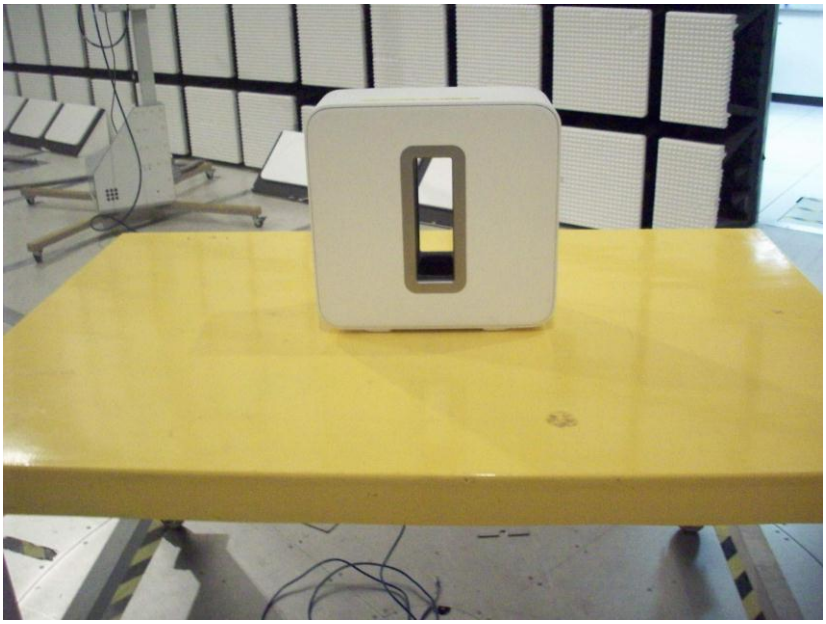
RADIATED RF MEASUREMENT SETUP FOR PORTABLE CONFIGURATION

X-AXIS FRONT PHOTO

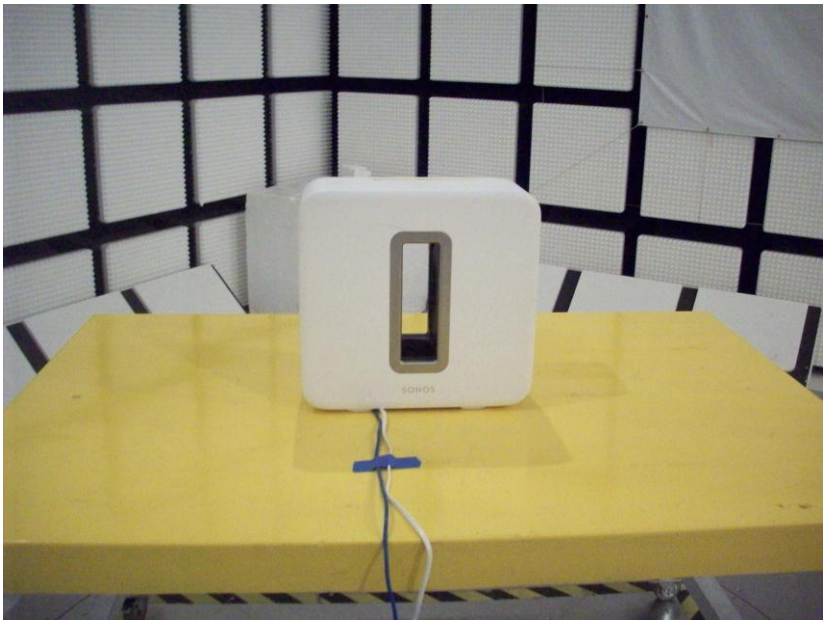
X-AXIS BACK PHOTO



Y-AXIS FRONT PHOTO



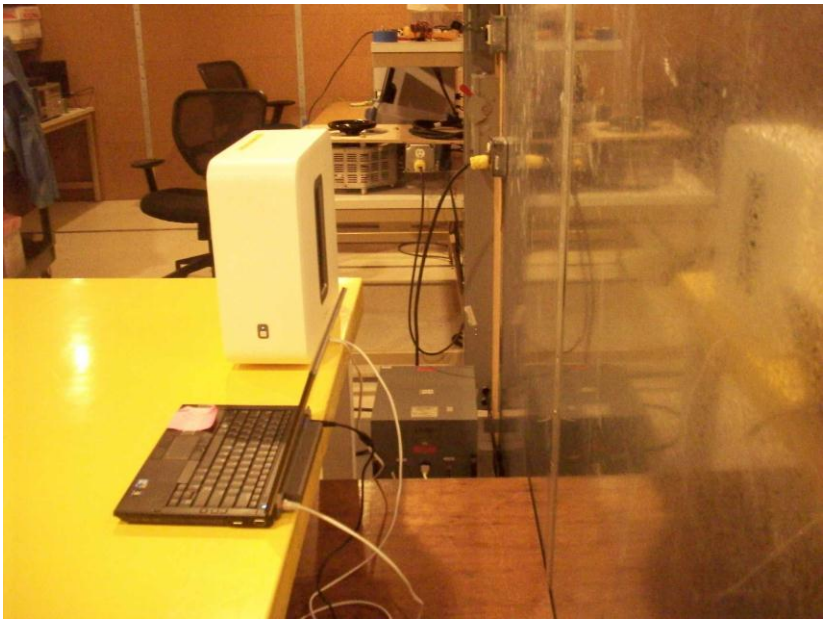
Y-AXIS BACK PHOTO



POWERLINE CONDUCTED EMISSIONS MEASUREMENT SETUP

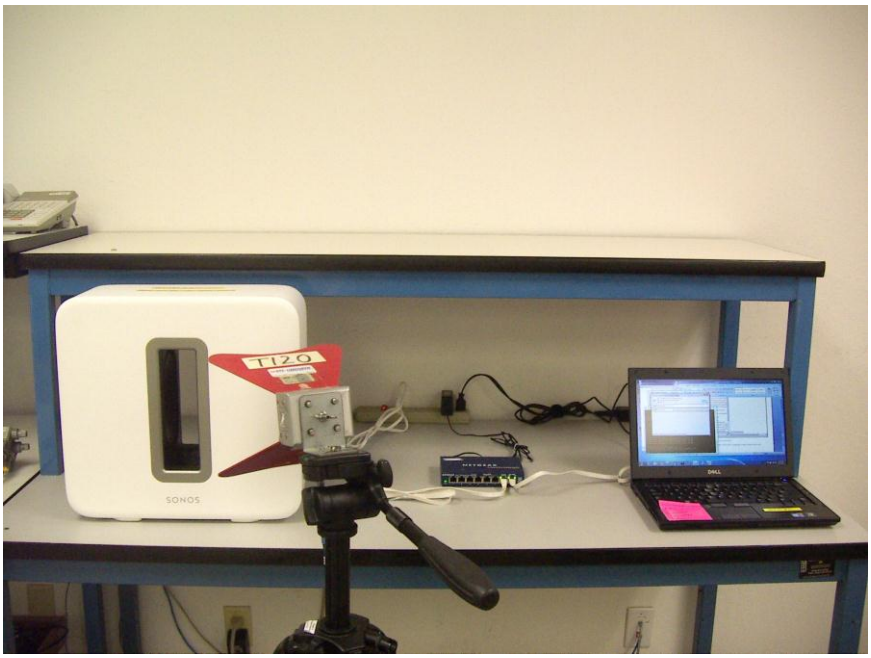
LINE CONDUCTED FRONT PHOTO

LINE CONDUCTED BACK PHOTO

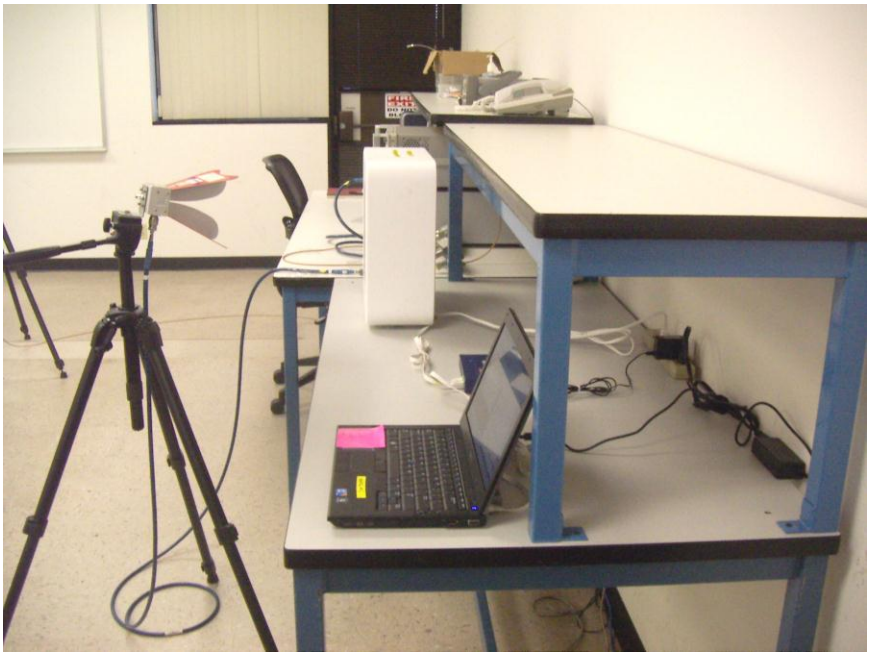


DYNAMIC FREQUENCY SELECTION MEASUREMENT SETUP

DFS FRONT PHOTO



DFS BACK PHOTO



END OF REPORT