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

CERTIFICATION TEST REPORT

FOR

PLAYBAR

MODEL NUMBER: PLAYBAR

FCC ID: SBVRM006
IC: 5273A-RM006

REPORT NUMBER: 12U14339-2

ISSUE DATE: JULY 03, 2012

Prepared for
Sonos, Inc.
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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
--	07/03/12	Initial Issue	F. Ibrahim

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Sonos, Inc.
223 E. De La Guerra Street
Santa Barbara, CA, 93101, U.S.A.

EUT DESCRIPTION: PLAYBAR

MODEL: PLAYBAR

SERIAL NUMBER: 1205 00-0E-5B-B0-00-16-E (DFS unit 1)
1205 00-0E-5B-B0-00-46-B (DFS unit 2)

DATE TESTED: May 15 – June 21, 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:

DAVID GARCIA
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 C63.10-2003, 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 possesses an 802.11 g/n wireless card. It is a 2.4/5GHz dual band concurrent module based on two Atheros' Osprey chipsets, AR9381 for 2GHz radio and AR9382 for 5GHz radio. The wireless card supports 802.11g,n functionality for 2.4GHz, and 802.11n for 5GHz. The 2.4GHz radio supports (3x3) MIMO, the 5GHz radio support (2x2) MIMO.

The wireless card is manufactured by Alpha Networks, and the model number of this card is WMC-ND06.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5180 - 5240	802.11n HT20	15.063	32.085
5260 - 5320	802.11n HT20	17.383	54.739
5500 - 5700	802.11n HT20	17.771	59.855

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes the following antenna arrangement. The maximum antenna gains as a function of frequency band utilized for FCC Part 15 Subpart E operation are given in the following table.

	Antenna A	Antenna B	Antenna D
5180-5240MHz	4.5dBi	N/A	5.4dBi
5260-5320MHz	4.1dBi	N/A	5.9dBi
5500-5700MHz	4.9dBi	N/A	6.0dBi
Antenna A: Monopole Antenna B: Monopole Antenna D: Dipole			

5.4. SOFTWARE AND FIRMWARE

The software/firmware version is V3.9 Build 20.2-54240.

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emission and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

The fundamental of the EUT was investigated in two orientations that the device can assume: X (oriented to sit on table; Y (oriented to mount on a wall). In both cases the EUT remained in a horizontal orientation. Orienting the EUT such that its longest dimension was aligned vertically caused the unit to shut down. This preliminary investigation resulted in the following worst-case EUT orientation:

X (table-top orientation)

Therefore, all final radiated testing was performed with the EUT as described above for the two frequency bands.

Per the client, only the following data rates are supported by the EUT:

802.11n HT20mode, 5.2, 5.3 and 5.6 GHz Bands: 26 Mbps (QPSK, MCS9)

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop	IBM	X32	2884A2U	DoC
AC Adapter	IBM	02K6810	11S02K6810Z3BJ59G5KY	DoC

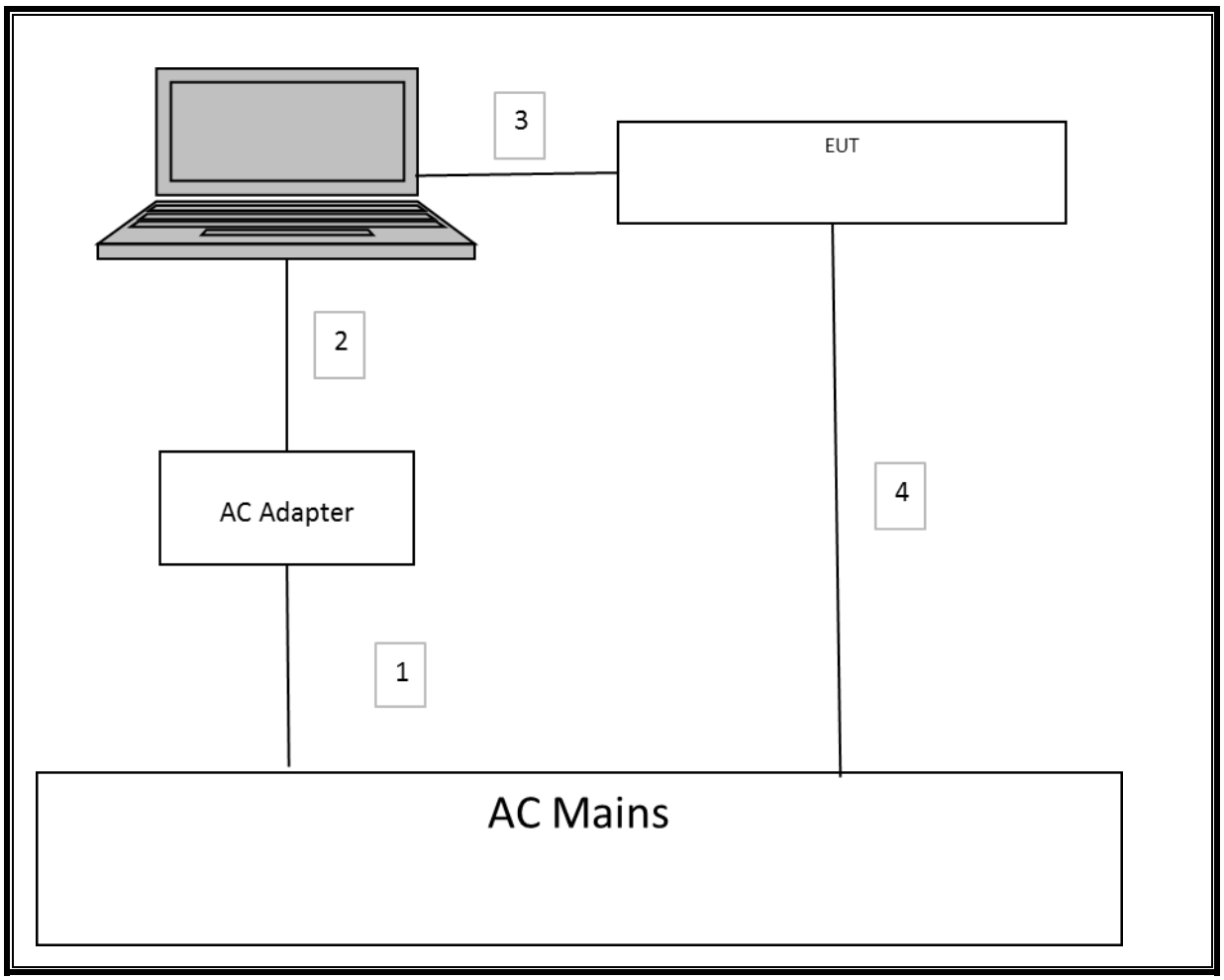
I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Unshielded	1m	
2	DC	1	DC	Unshielded	1.8m	
3	RJ45	2	RJ45	Unshielded	6m	
3	RJ45	2	RJ45	Unshielded	1.8m	
4	AC	1	AC	Unshielded	1.75m	

TEST SETUP

The EUT is a standalone unit with a built in WLAN module. It was connected to a remote laptop PC during tests.

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**
Antenna, Bilog, 30MHz-1 GHz	Sunol Sciences	JB1	C01171	01/26/12	01/26/13
Antenna, Horn, 18 GHz	EMCO	3115	C00872	09/20/11	09/20/12
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00980	07/28/11	07/28/12
Antenna, Horn, 40 GHz	ARA	MWH-2640/B	C00981	06/14/11	06/14/12
EMI Test Receiver, 30 MHz	R & S	ESHS 20	N02396	08/19/11	08/19/13
LISN, 10 kHz ~ 30 MHz	Solar	8012-50-R-24-BNC	N02486	03/07/12	03/07/13
LISN, 30 MHz	FCC	50/250-25-2	C00626	12/13/11	12/13/12
Peak / Average Power Sensor	Agilent / HP	E9323A	s/n US40411681	08/04/11	08/04/12
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00558	11/11/11	11/11/12
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C00749	07/18/11	07/18/12
Preamplifier, 40 GHz	Miteq	NSP4000-SP2	C00990	08/02/11	08/02/12
P-Series single channel Power Meter	Agilent / HP	N1911A	s/n GB45100212	08/04/11	08/04/12
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01012	09/02/11	09/02/12
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01069	12/15/11	12/15/12

7. 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)
802.11n HT20 (5.2GHz band) Note 1	0.707	3.596	0.197	19.661%	7.064	1.414
802.11n HT20 (5.2GHz band) Note 2	1.299	1.443	0.900	90.021%	0.457	0.770
802.11n HT20 (5.3GHz band)	0.700	3.600	0.194	19.444%	7.112	1.429
802.11n HT20 (5.6GHz band)	0.700	3.600	0.194	19.444%	7.112	1.429

Notes:

(1) Duty cycle of 19.661% used for 99% band-width and radiated-emissions testing in 802.11n HT20 5.2GHz band. The minimum VBW associated with this duty-cycle is worst-case compared to that of the 90.021% duty-cycle case.

(2) Duty cycle of 90.021% used for all other testing in 802.11n HT20 5.2GHz band.

7.1.2. MEASUREMENT METHOD FOR POWER AND PPSD

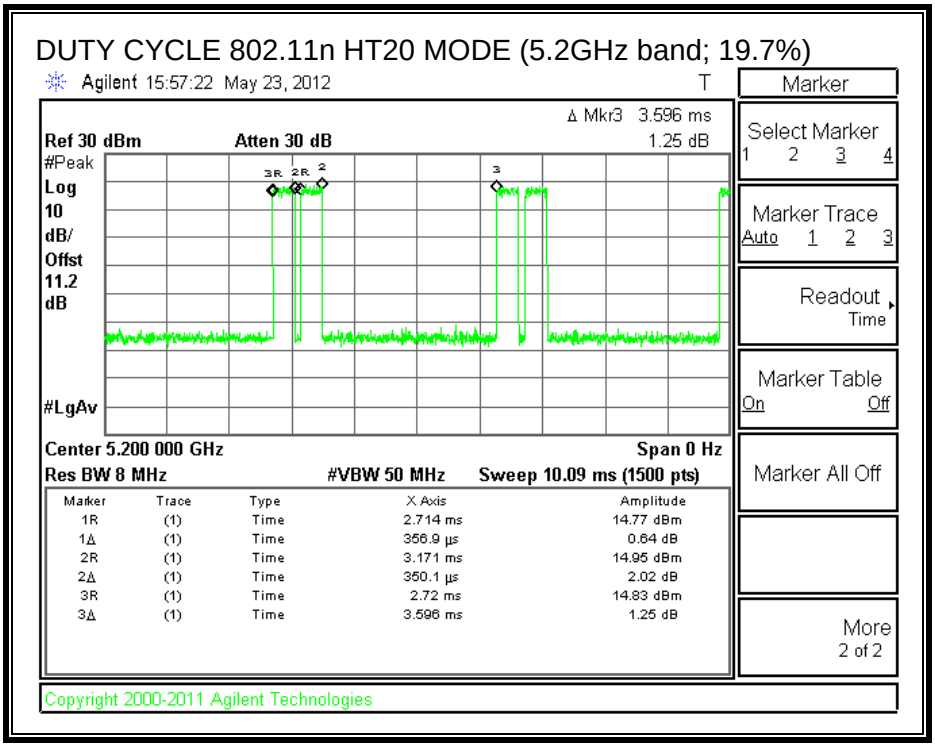
The Duty Cycle is less than 98% and consistent therefore KDB 789033 Method SA-2 is used.

7.1.3. MEASUREMENT METHOD FOR AVG SPURIOUS EMISSIONS ABOVE 1 GHz

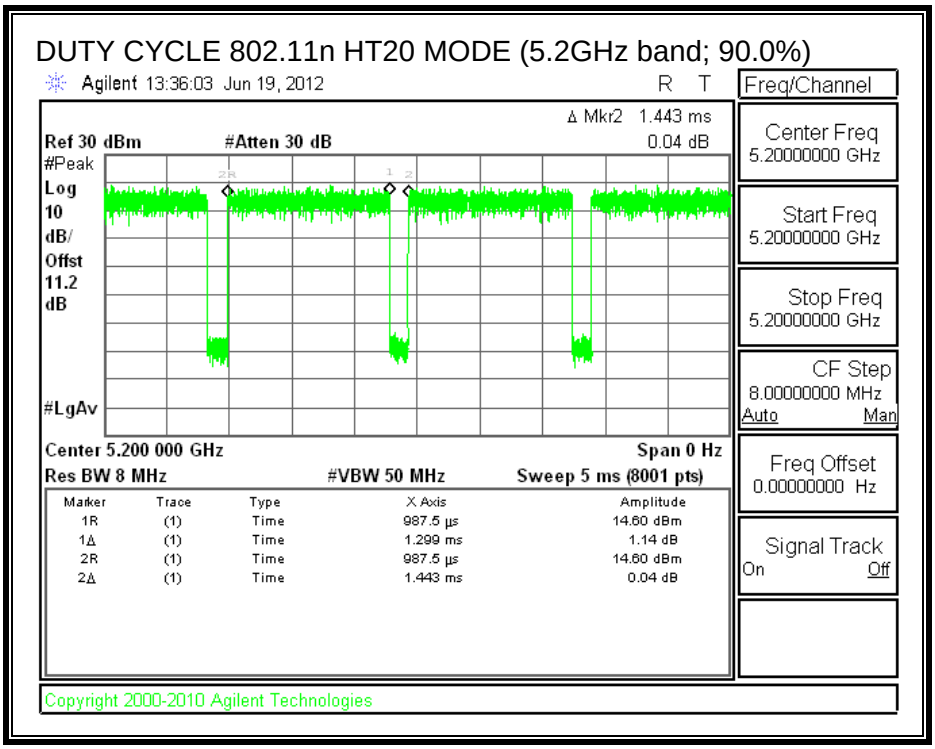
The Duty Cycle is less than 98% and consistent, KDB 789033 Method VB with Power RMS Averaging is used.

7.1.4. DUTY CYCLE PLOTS

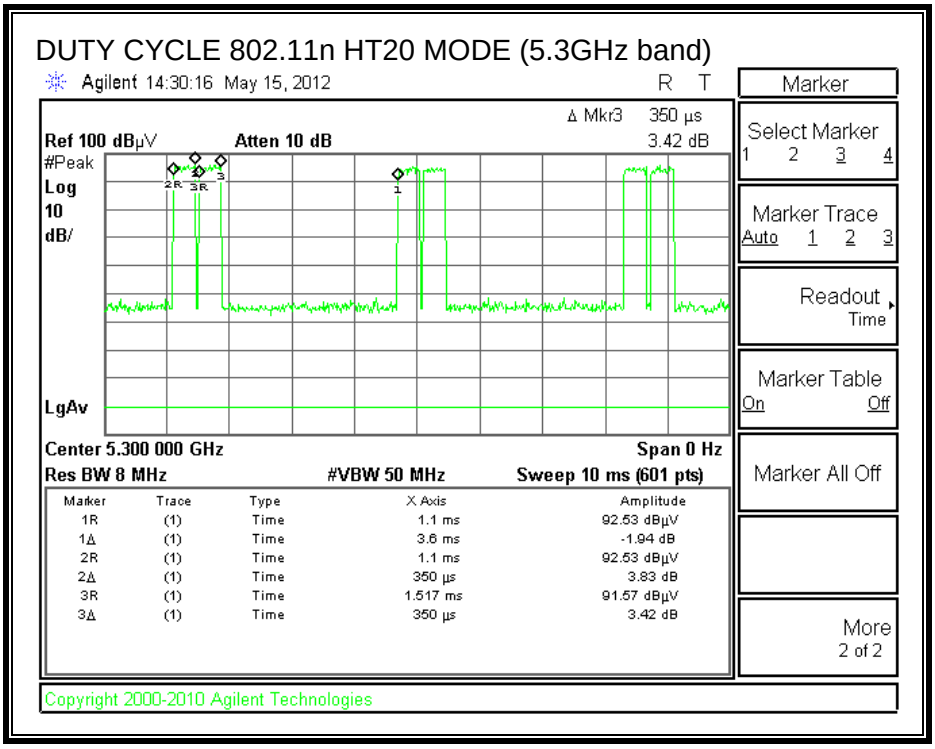
DUTY CYCLE 802.11n HT20 MODE (5.2GHz band; 19.7%)



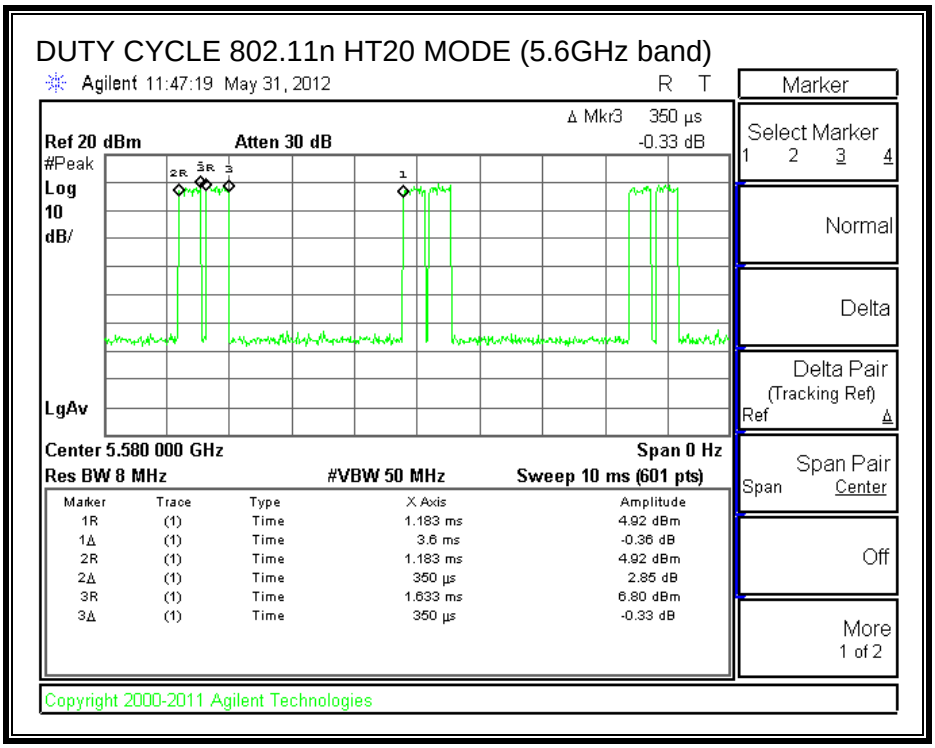
DUTY CYCLE 802.11n HT20 MODE (5.2GHz band; 90.0%)



DUTY CYCLE 802.11n HT20 MODE (5.3GHz band)



DUTY CYCLE 802.11n HT20 MODE (5.6GHz band)



8. ANTENNA PORT TEST RESULTS

8.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND

8.1.1. 26 dB BANDWIDTH

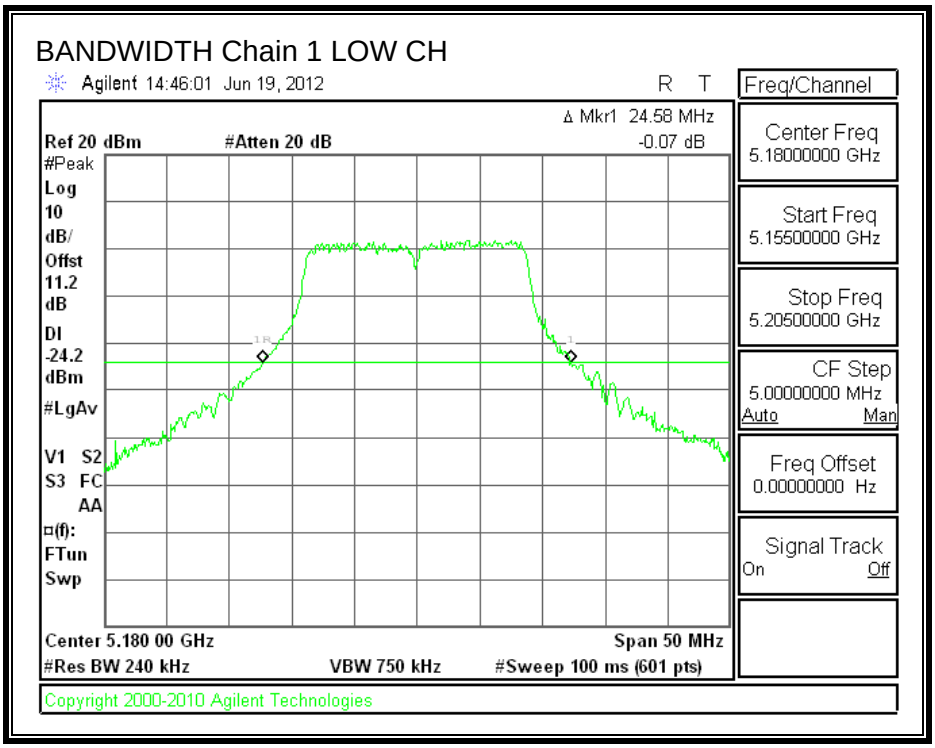
LIMITS

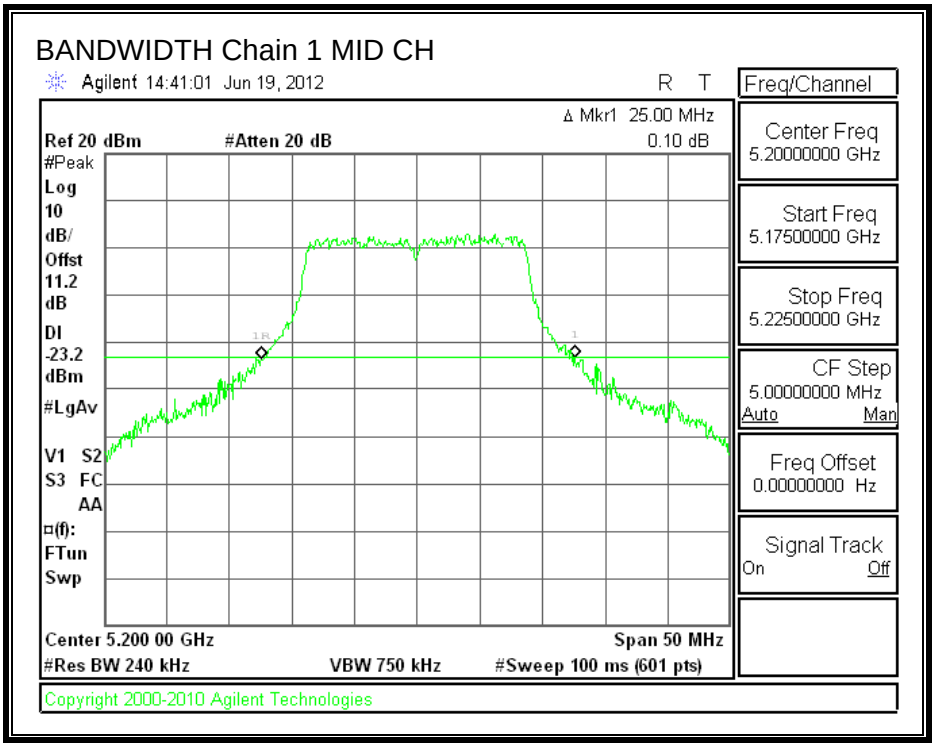
None; for reporting purposes only.

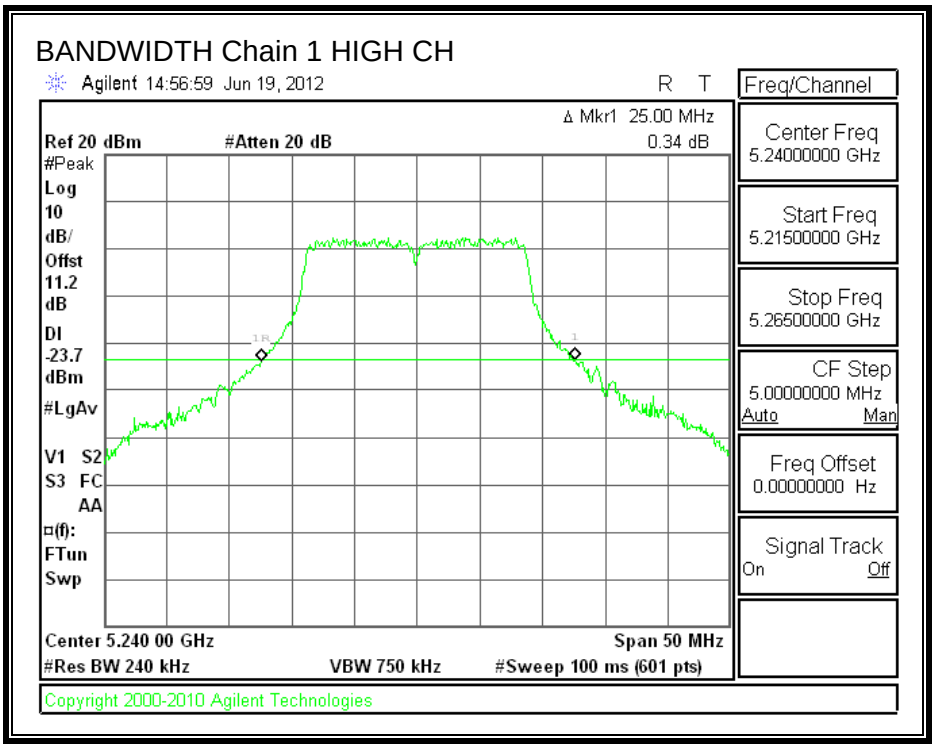
RESULTS

Channel	Frequency (MHz)	26 dB BW Chain 1 (MHz)	26 dB BW Chain 2 (MHz)
Low	5180	24.58	24.50
Mid	5200	25.00	24.75
High	5240	25.00	25.58

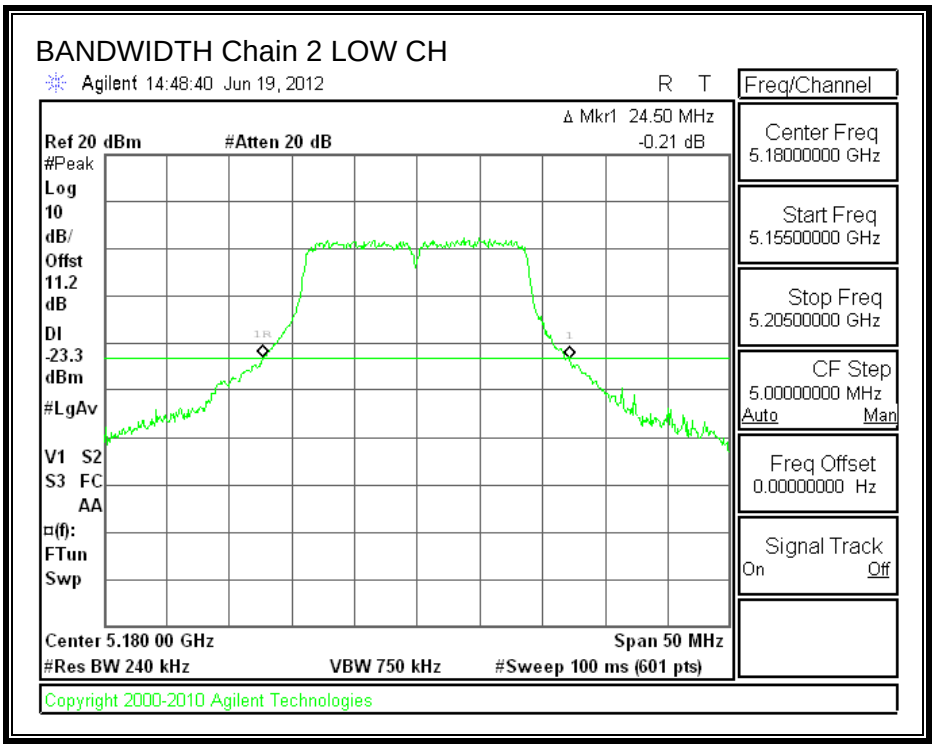
Chain 1

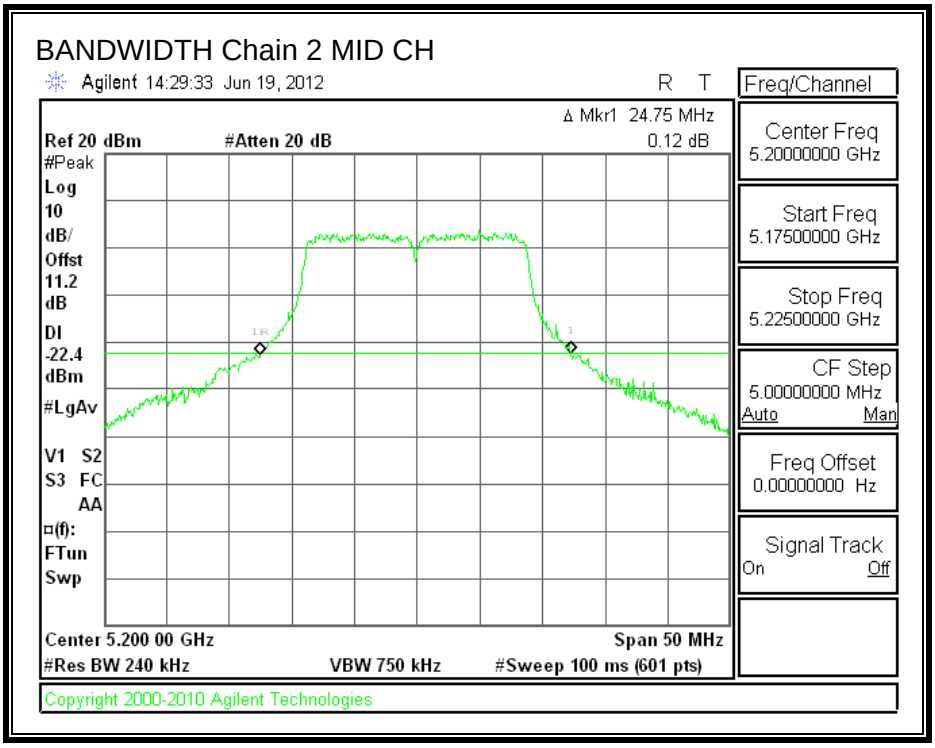




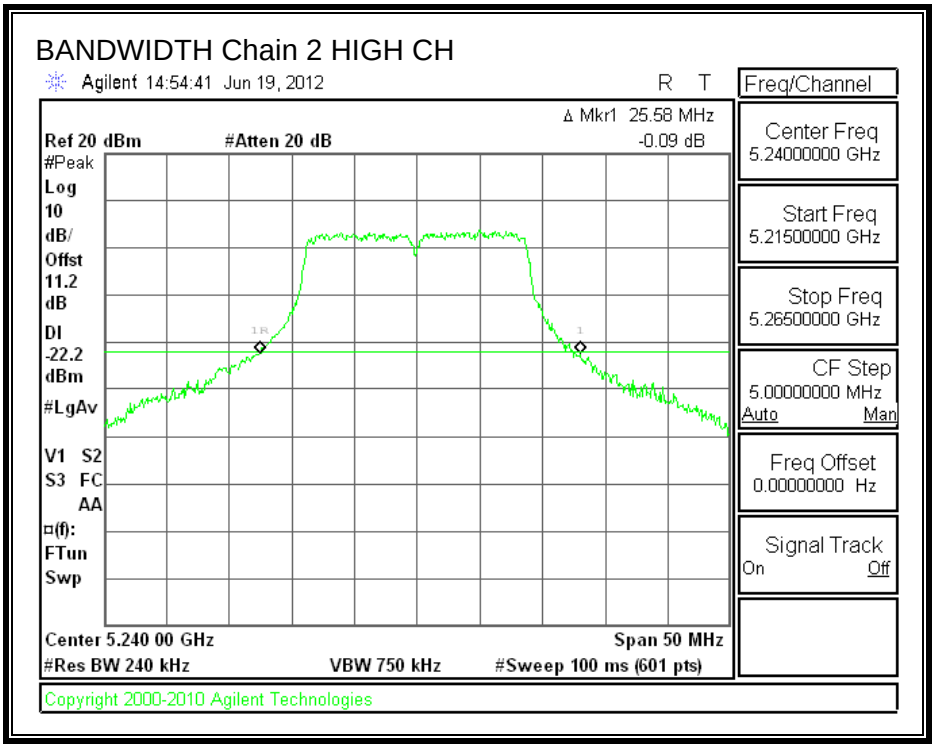


Chain 2





BANDWIDTH Chain 2 HIGH CH



8.1.2. 99% BANDWIDTH

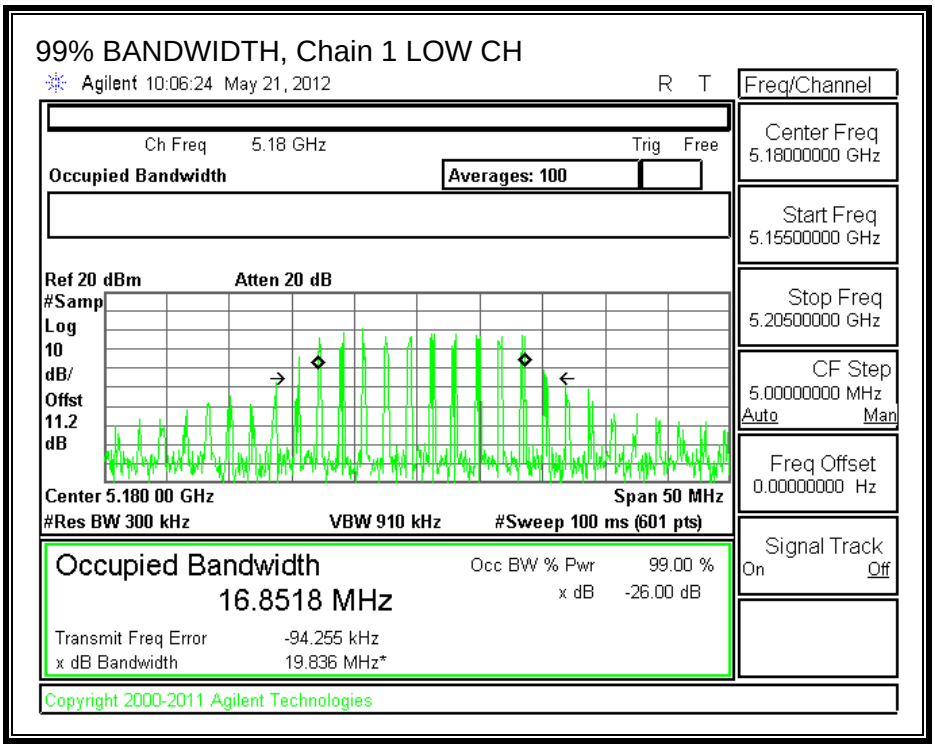
LIMITS

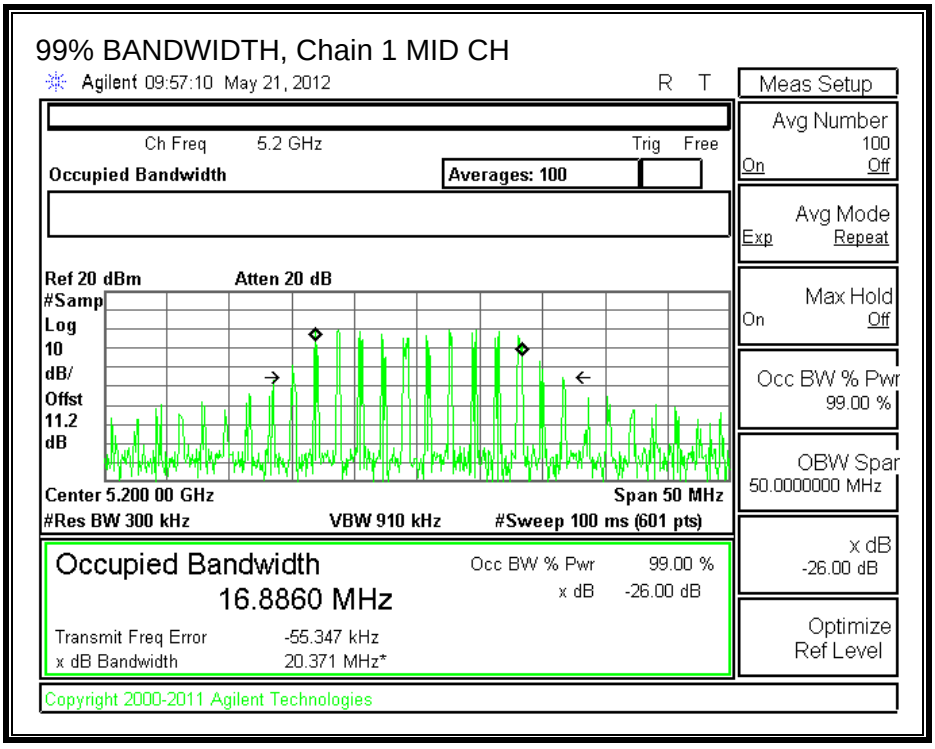
None; for reporting purposes only.

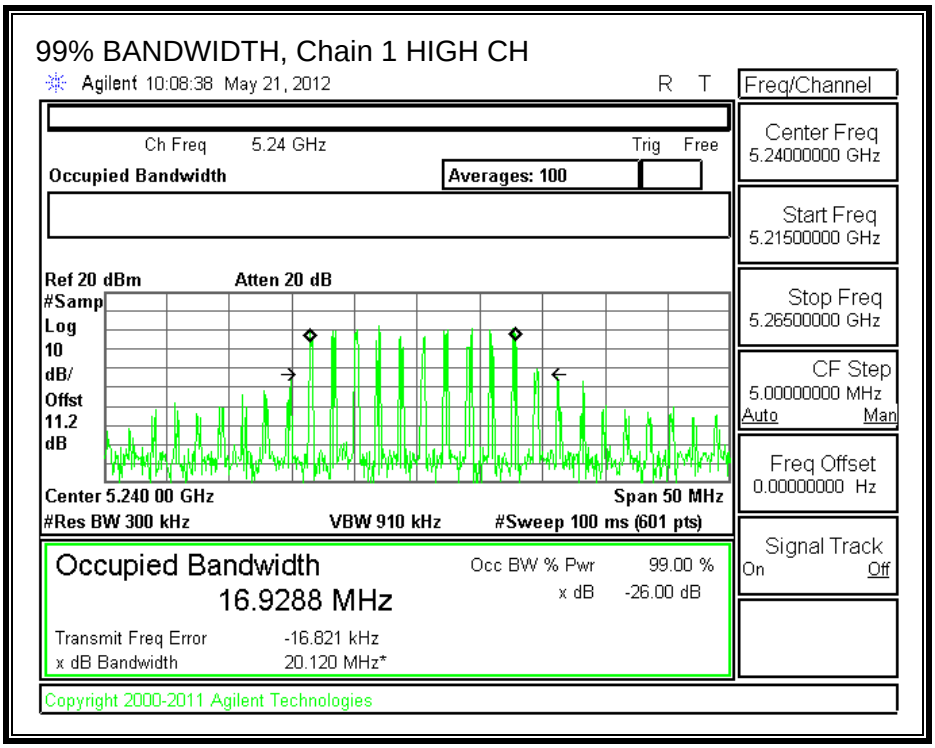
RESULTS

Channel	Frequency (MHz)	99% BW Chain 1 (MHz)	99% BW Chain 2 (MHz)
Low	5180	16.8518	16.9001
Mid	5200	16.8860	16.8391
High	5240	16.9288	16.9025

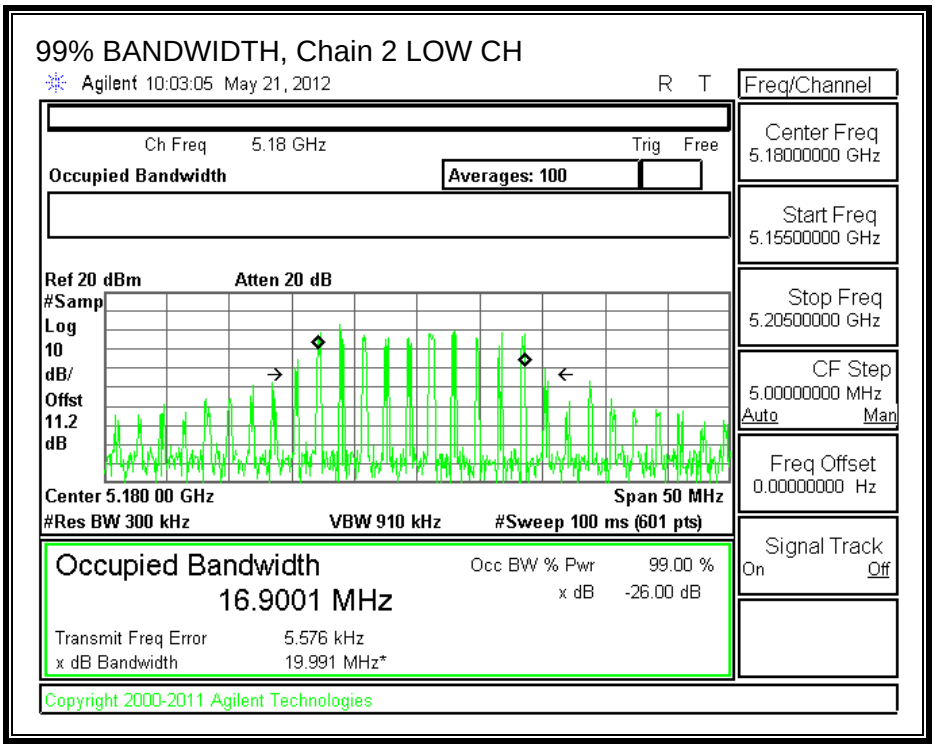
Chain 1

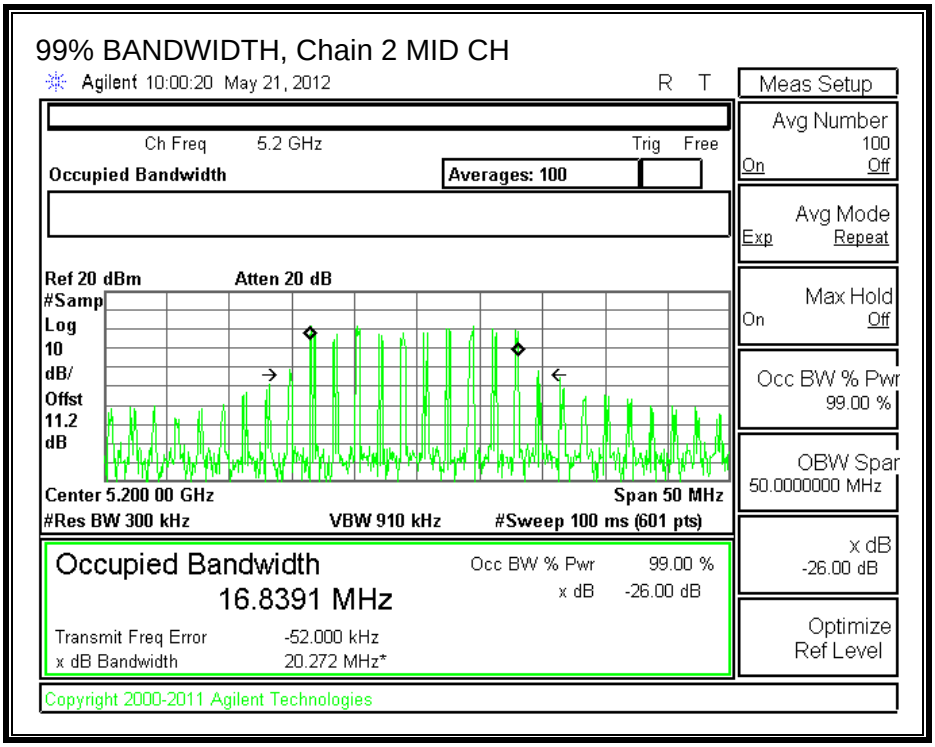


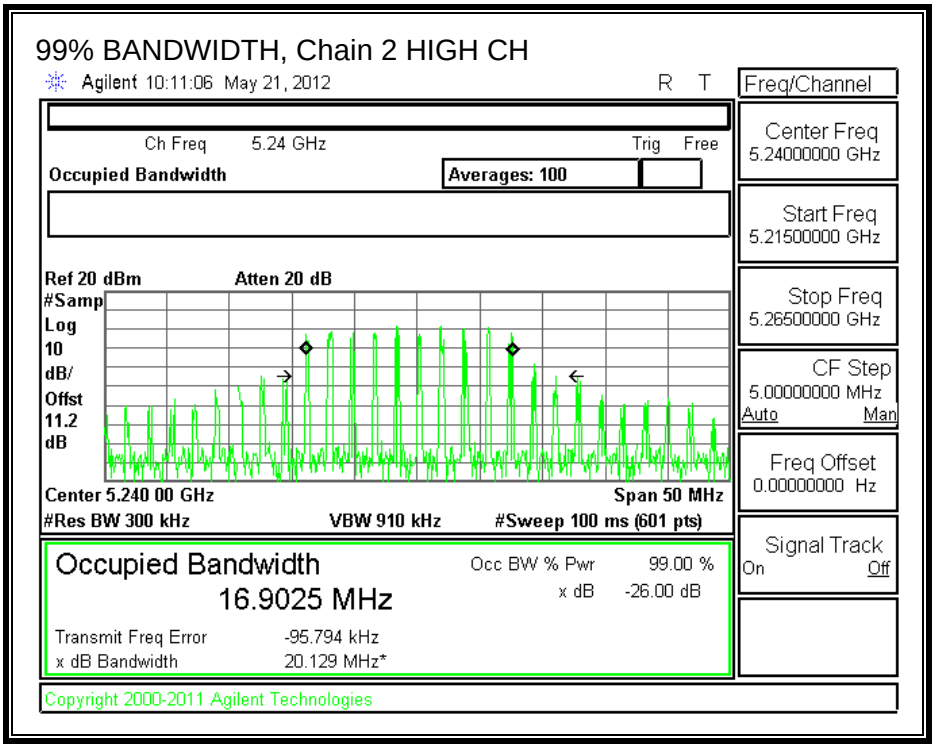




Chain 2







8.1.3. 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 11.2 dB (including 10 dB pad and 1.2 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 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)
Low	5180	11.52	11.89	14.72
Mid	5200	11.02	11.42	14.23
High	5240	10.55	11.71	14.18

8.1.4. 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 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 1 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
5.40	4.50	4.97

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	24.50	17.89	4.97	17.00	4.00
Mid	5200	17	24.75	17.94	4.97	17.00	4.00
High	5240	17	25.00	17.98	4.97	17.00	4.00

Duty Cycle CF (dB)	0.457	Included in Calculations of Corr'd Power & PPSD

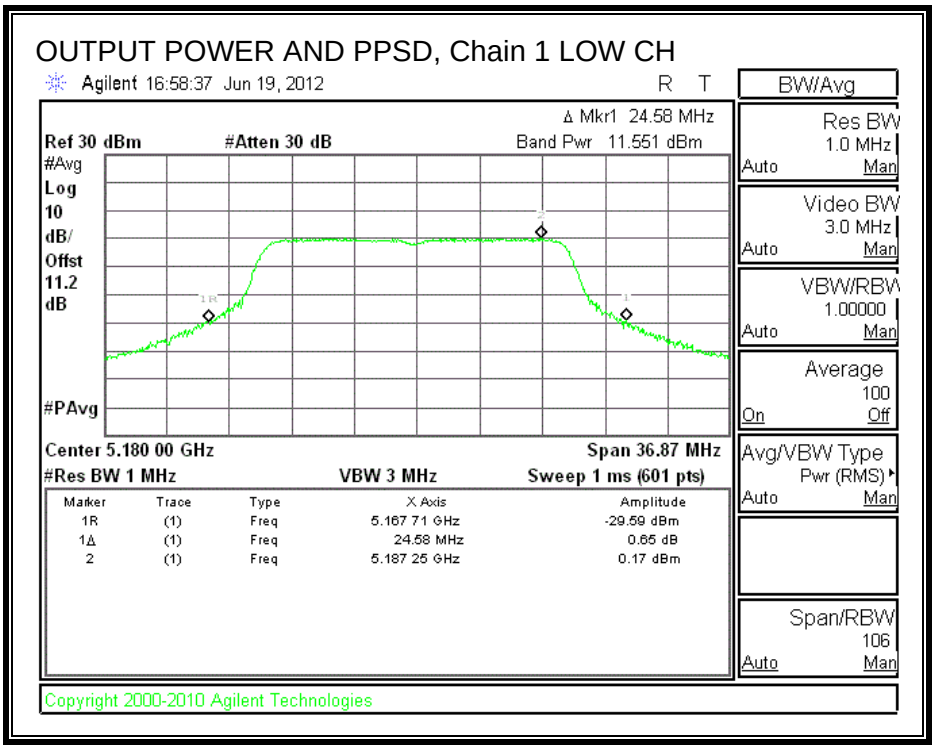
Output Power Results

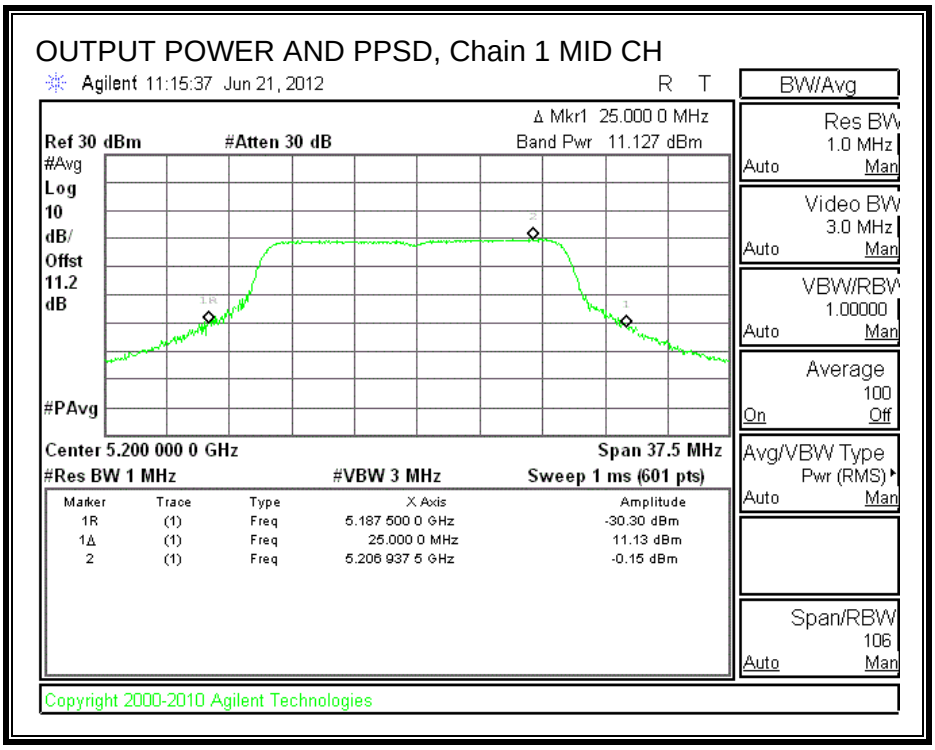
Channel	Frequency (MHz)	Chain 1 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	11.551	11.640	15.063	17.00	-1.937
Mid	5200	11.127	11.790	14.938	17.00	-2.062
High	5240	10.621	11.973	14.816	17.00	-2.184

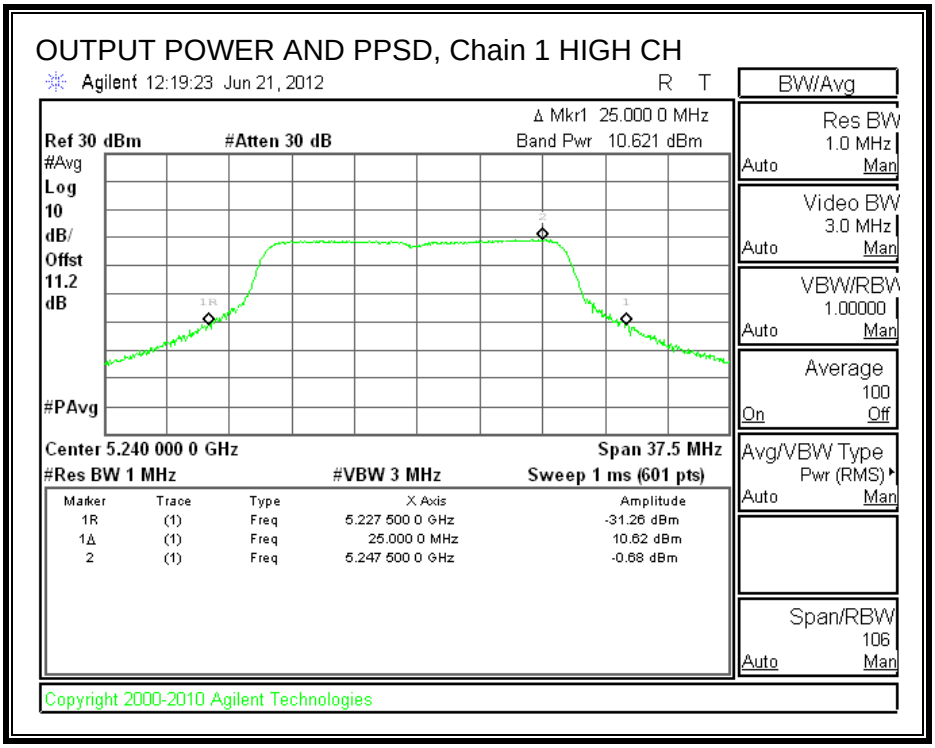
PPSD Results

Channel	Frequency (MHz)	Chain 1 Meas PPSD (dBm)	Chain 2 Meas PPSD (dBm)	Total Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5180	0.17	0.09	3.60	4.00	-0.40
Mid	5200	-0.15	0.30	3.55	4.00	-0.45
High	5240	-0.68	0.54	3.44	4.00	-0.56

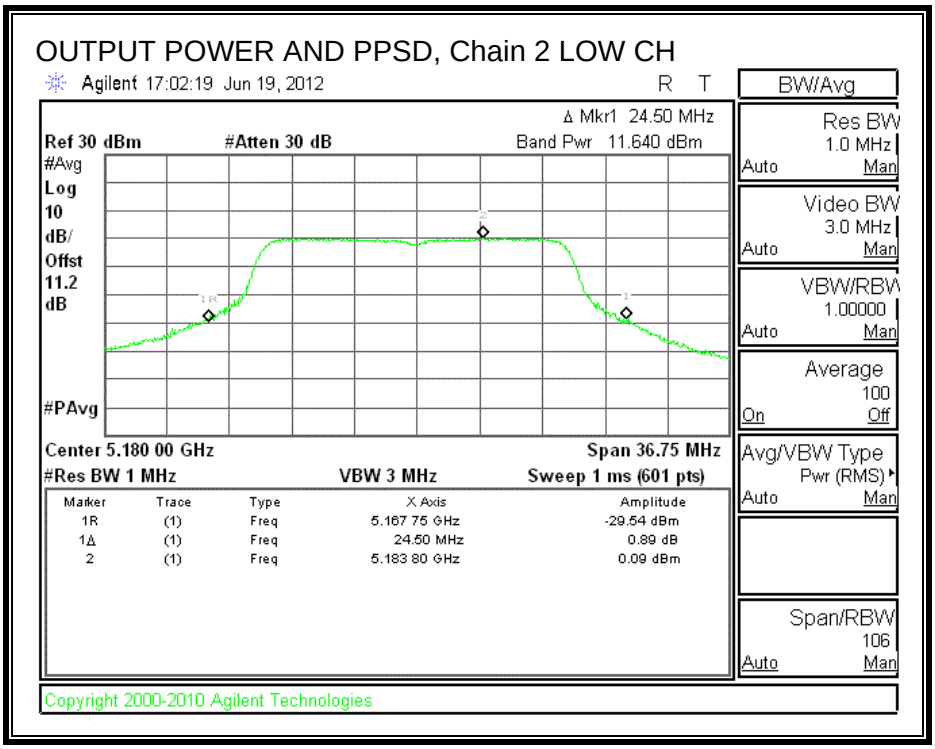
Chain 1

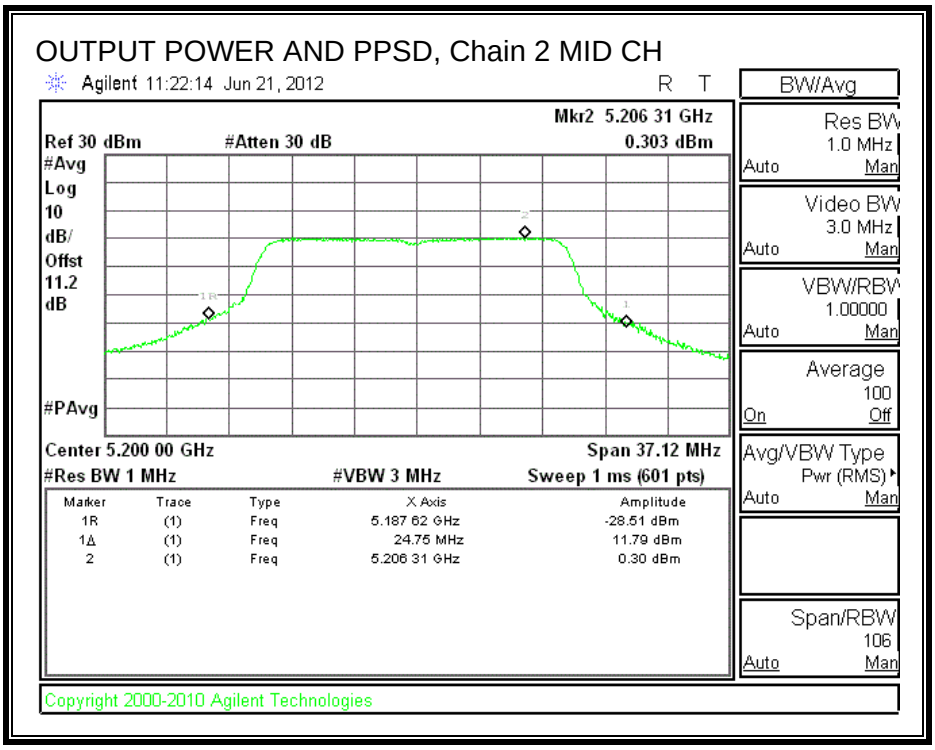


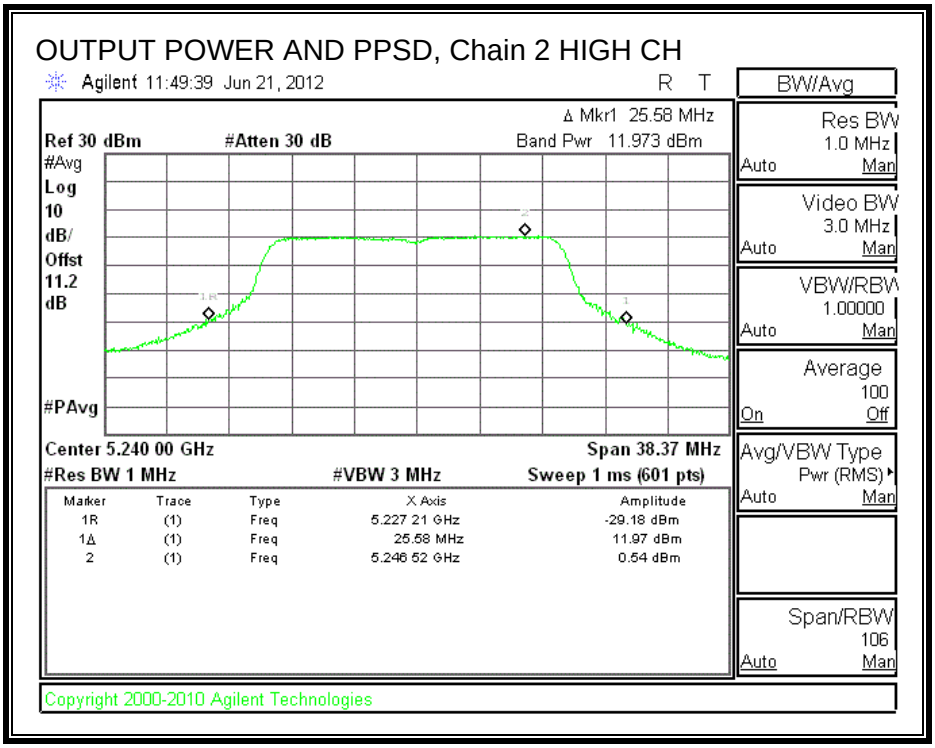




Chain 2







8.1.5. 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.

RESULTS

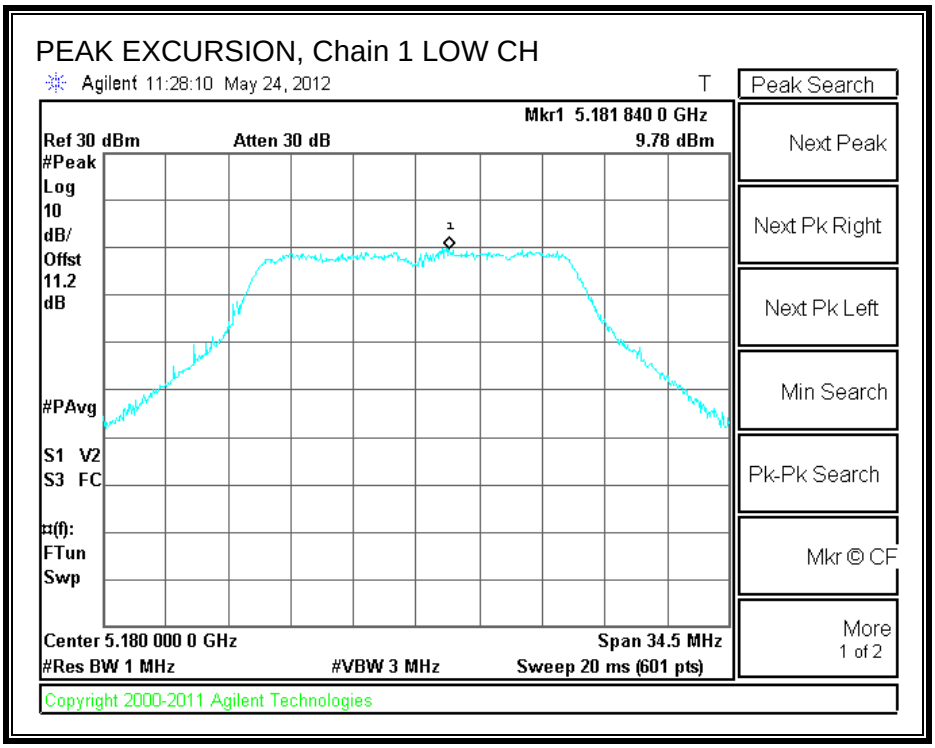
Chain 1

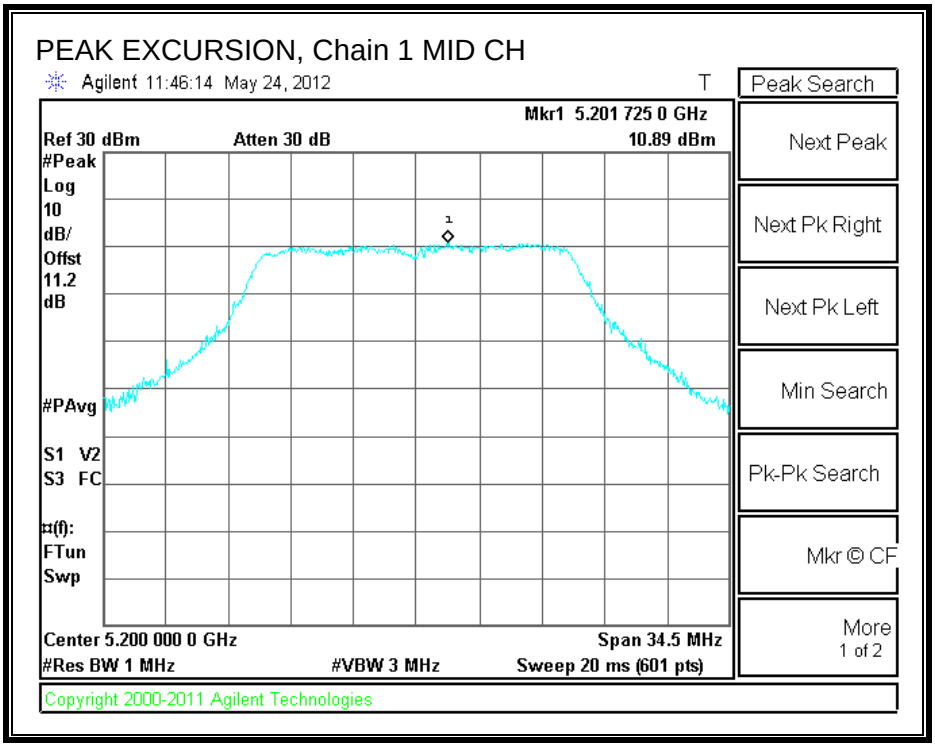
Channel	Frequency (MHz)	PK Level (dBm)	PSD (dBm)	DCCF (dB)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5180	9.78	0.17	0.457	9.153	13	-3.847
Mid	5200	10.89	-0.15	0.457	10.583	13	-2.417
High	5240	10.33	-0.68	0.457	10.553	13	-2.447

Chain 2

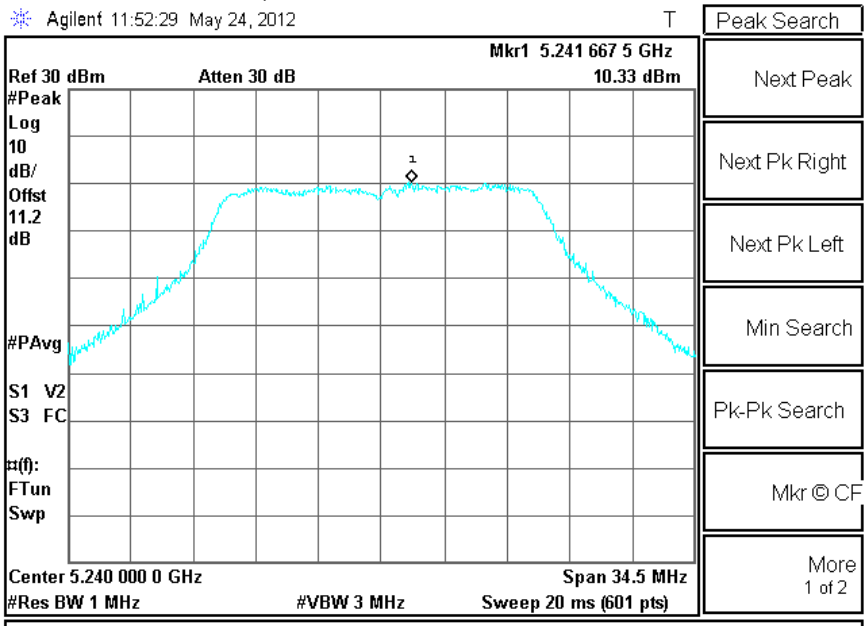
Channel	Frequency (MHz)	PK Level (dBm)	PSD (dBm)	DCCF (dB)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5180	10.86	0.09	0.457	10.313	13	-2.687
Mid	5200	12.18	0.30	0.457	11.423	13	-1.577
High	5240	12.38	0.54	0.457	11.383	13	-1.617

Chain 1

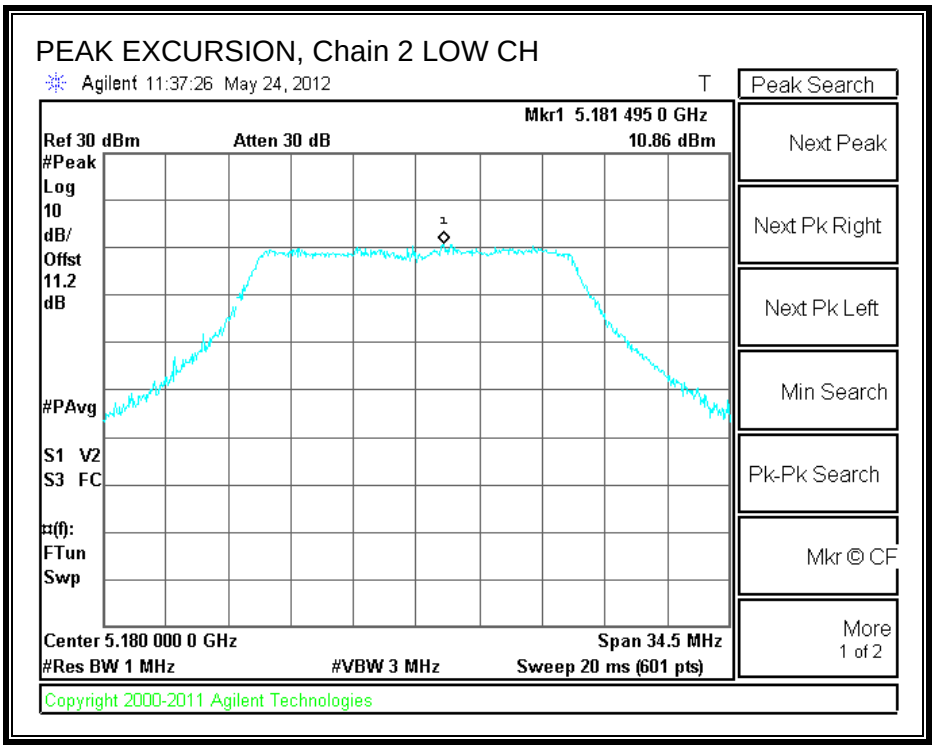


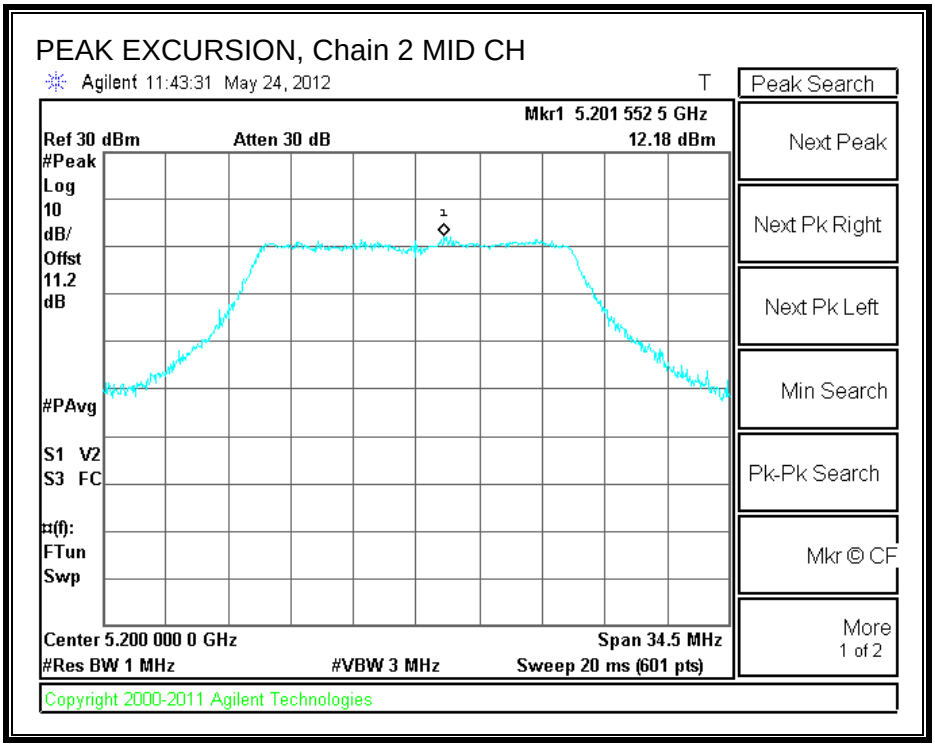


PEAK EXCURSION, Chain 1 HIGH CH

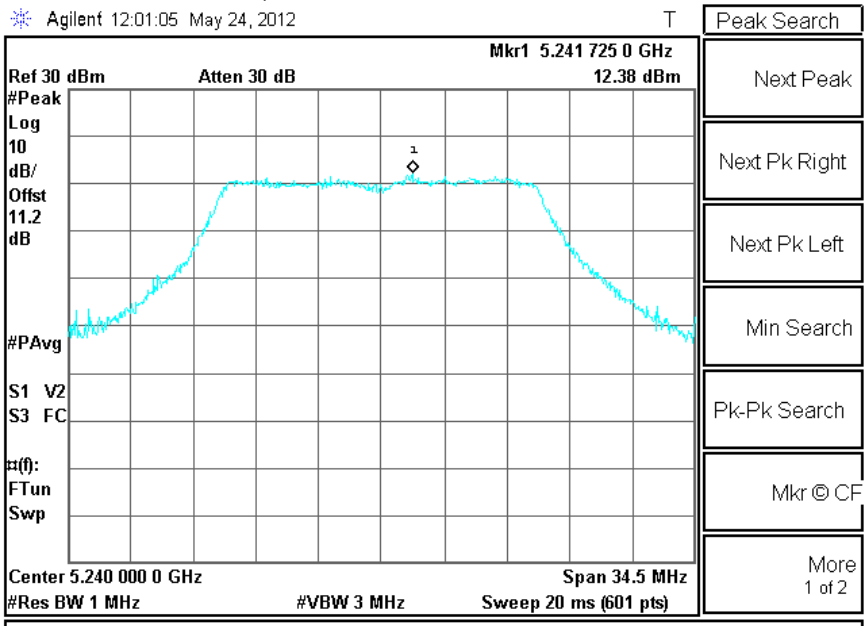


Chain 2





PEAK EXCURSION, Chain 2 HIGH CH



8.2. 802.11n HT20 MODE IN THE 5.3 GHz BAND

8.2.1. 26 dB BANDWIDTH

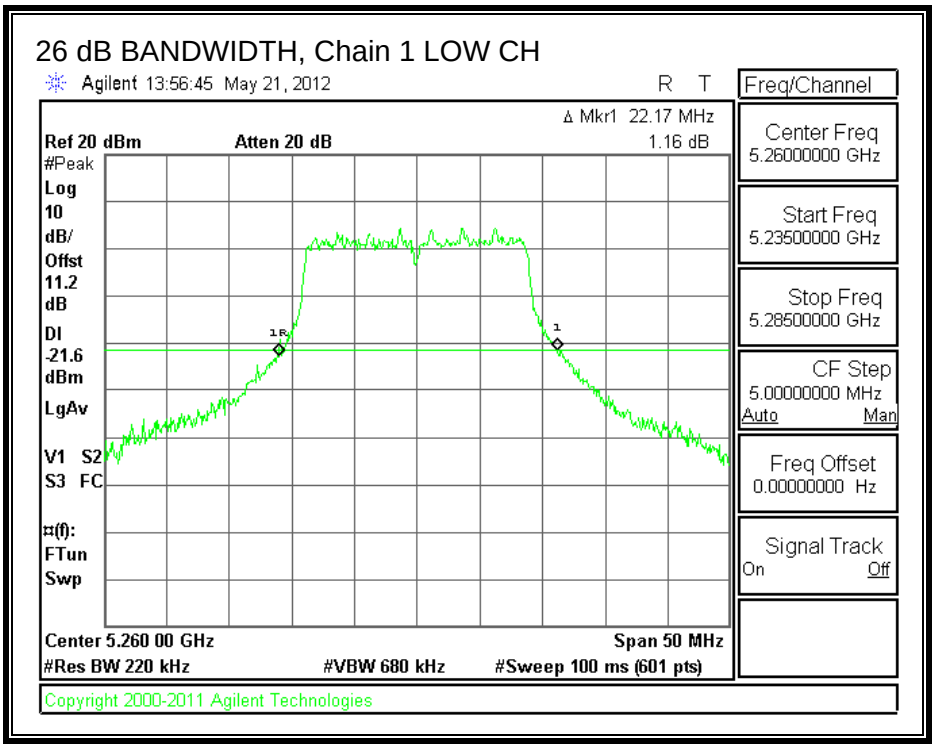
LIMITS

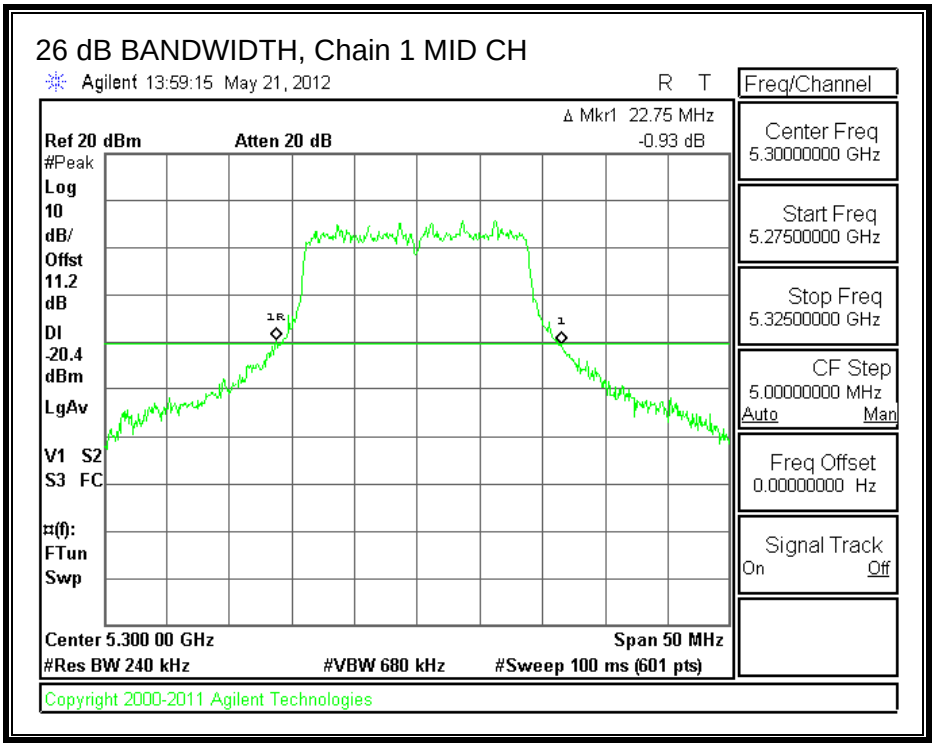
None; for reporting purposes only.

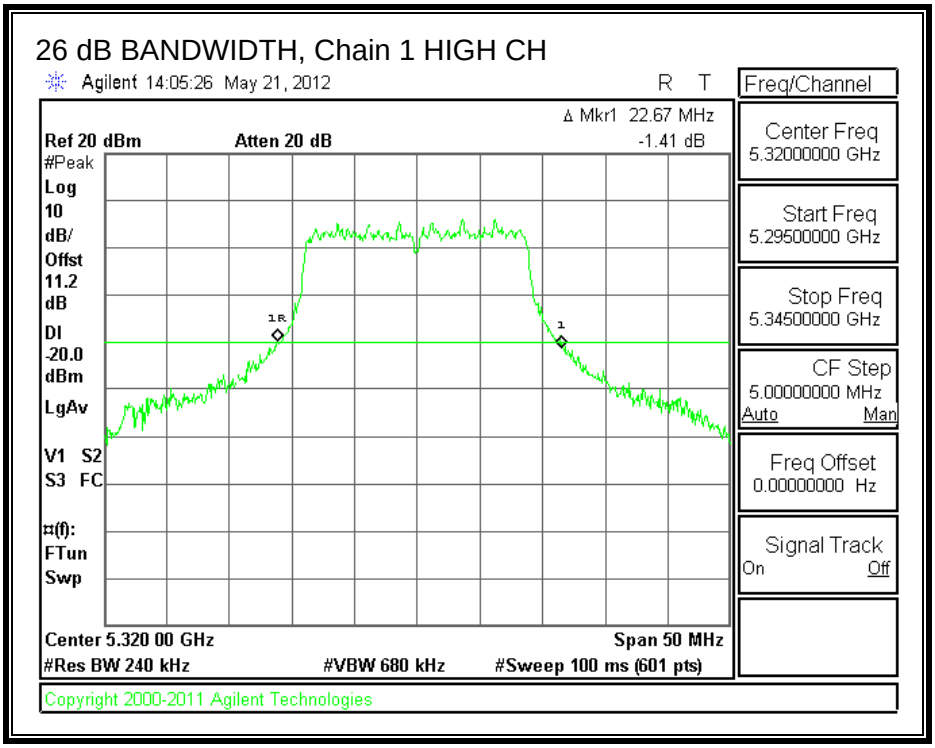
RESULTS

Channel	Frequency (MHz)	26 dB BW Chain 1 (MHz)	26 dB BW Chain 2 (MHz)
Low	5260	22.17	22.50
Mid	5300	22.75	23.08
High	5320	22.67	23.17

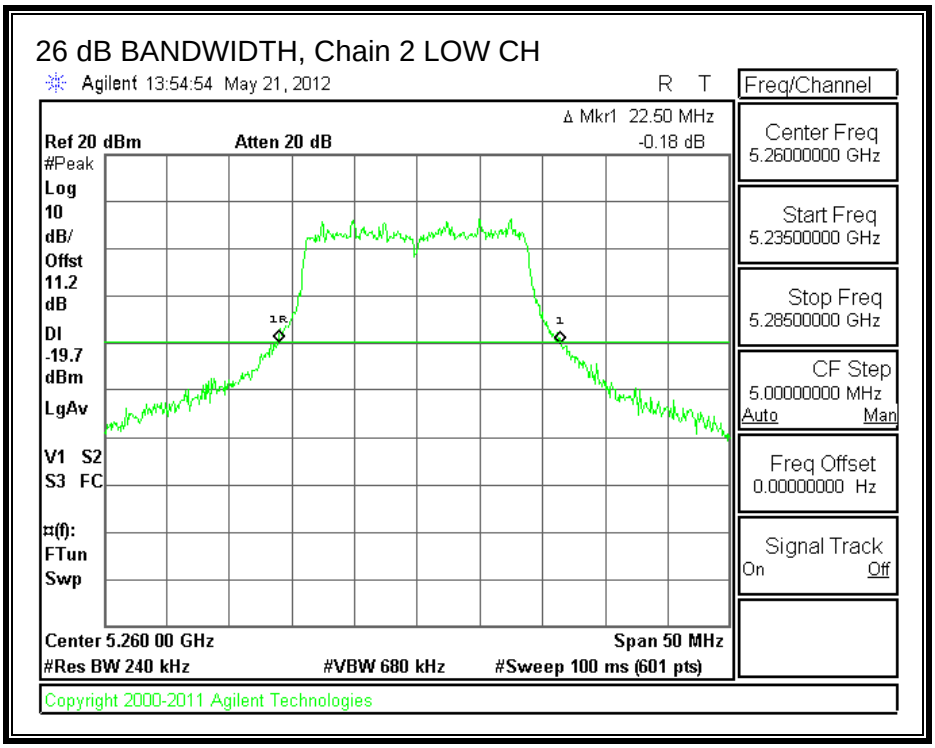
Chain 1

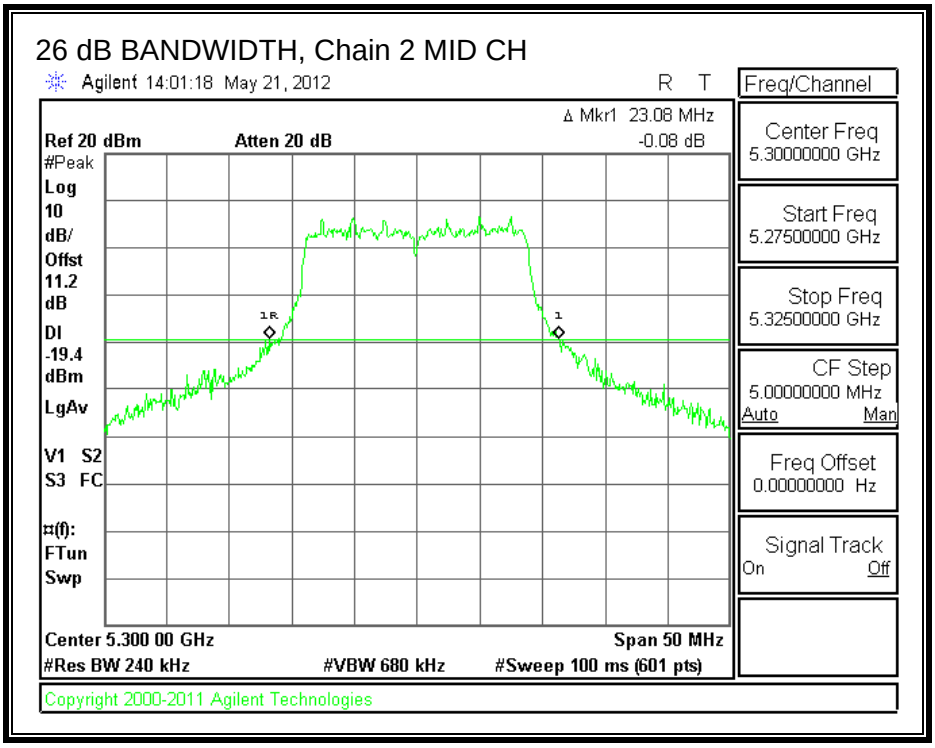


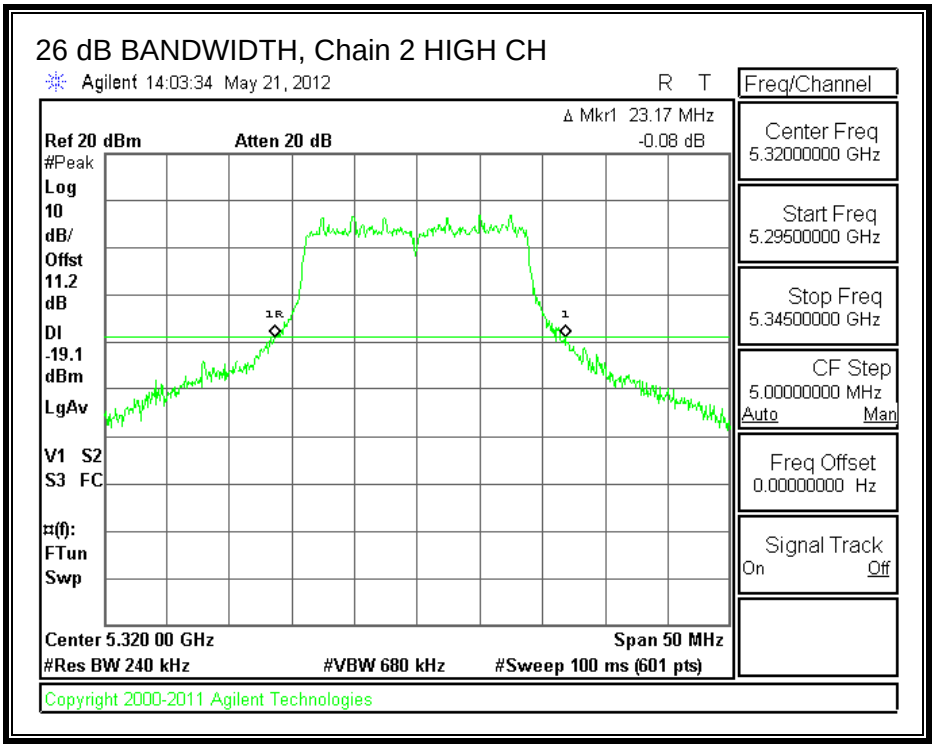




Chain 2







8.2.2. 99% BANDWIDTH

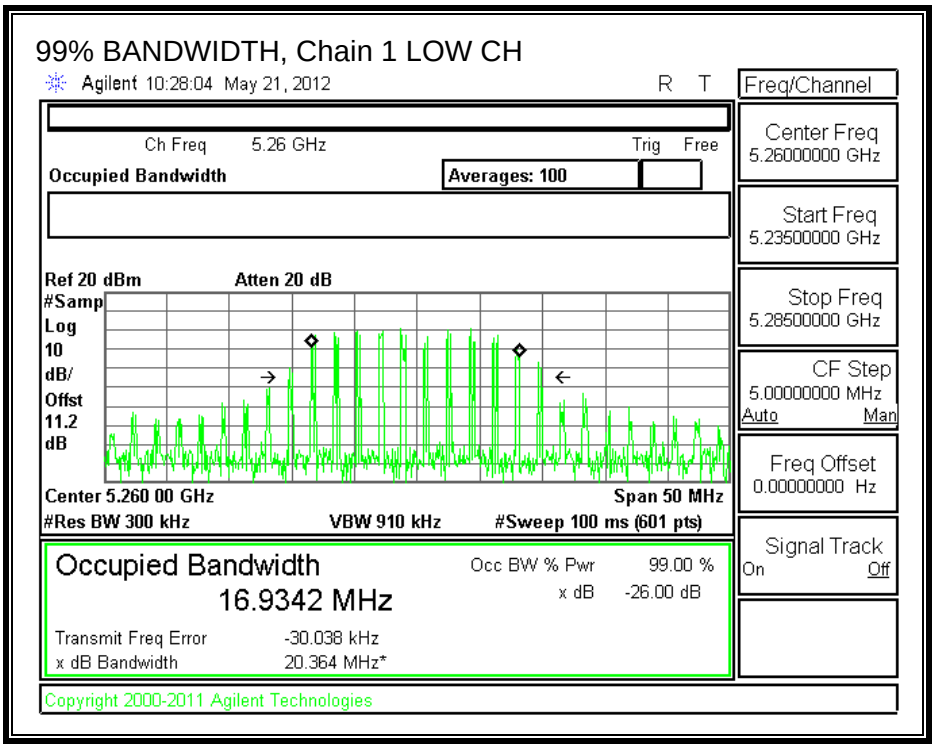
LIMITS

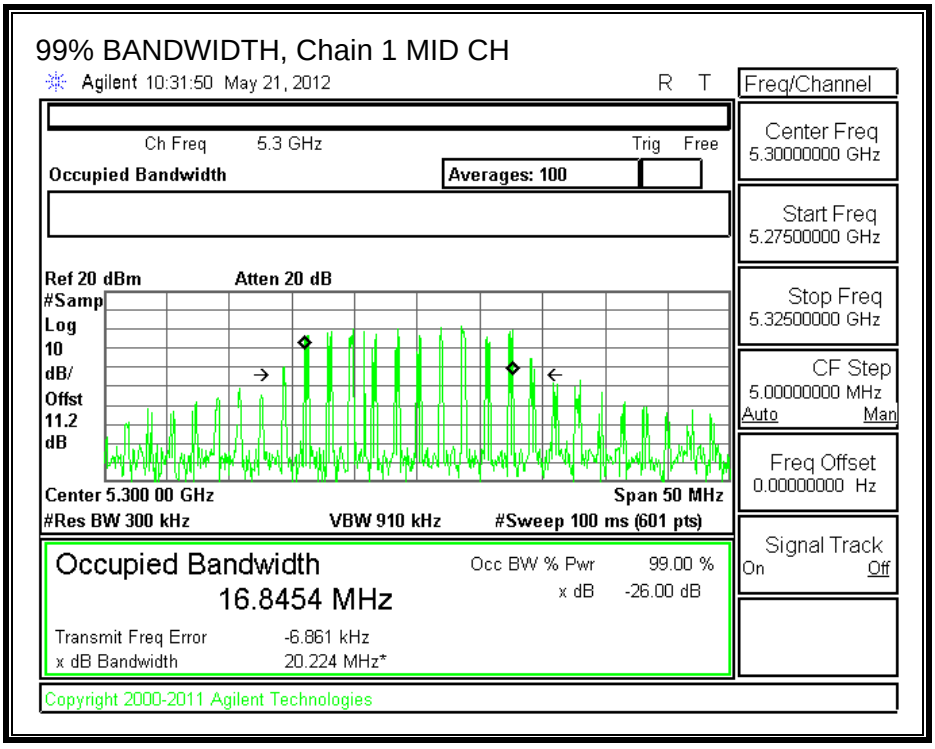
None; for reporting purposes only.

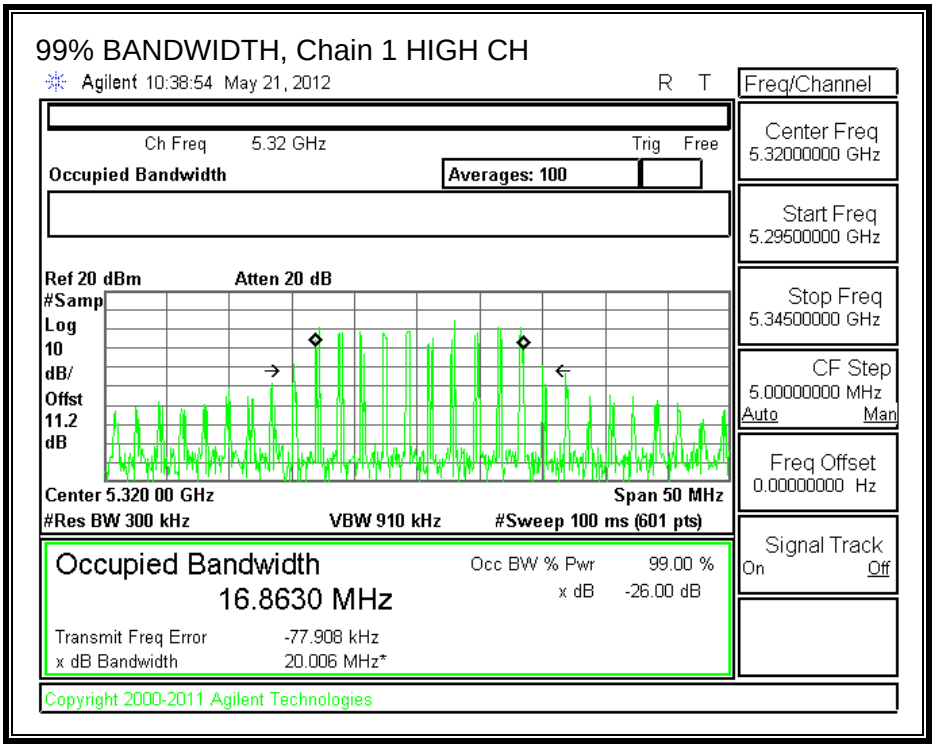
RESULTS

Channel	Frequency (MHz)	99% BW Chain 1 (MHz)	99% BW Chain 2 (MHz)
Low	5260	16.9342	16.8872
Mid	5300	16.8454	16.8715
High	5320	16.8630	16.8967

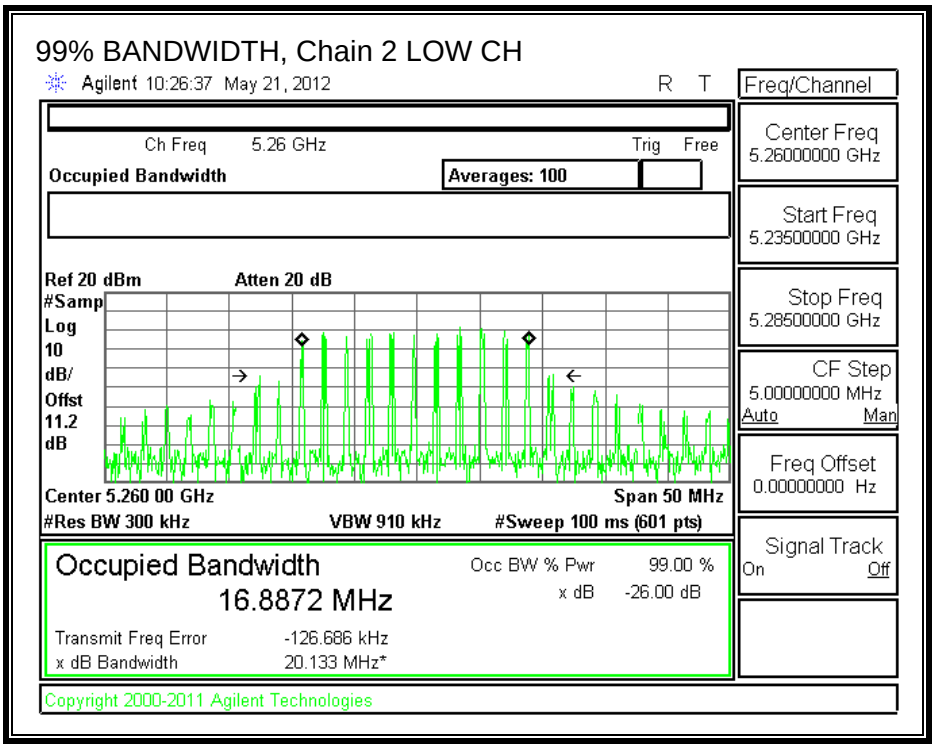
Chain 1

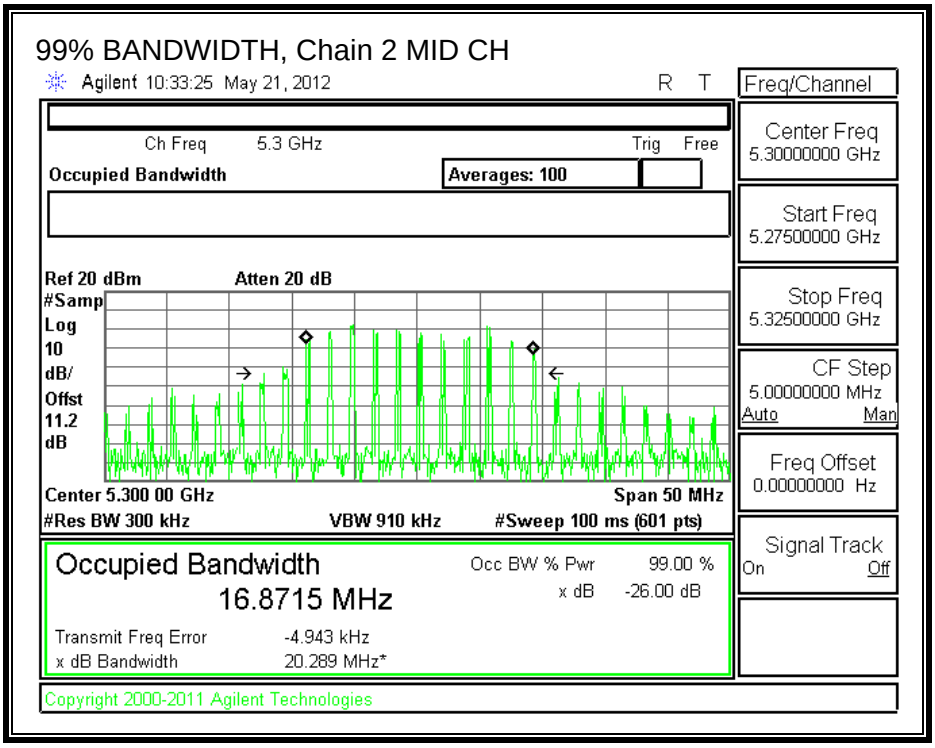


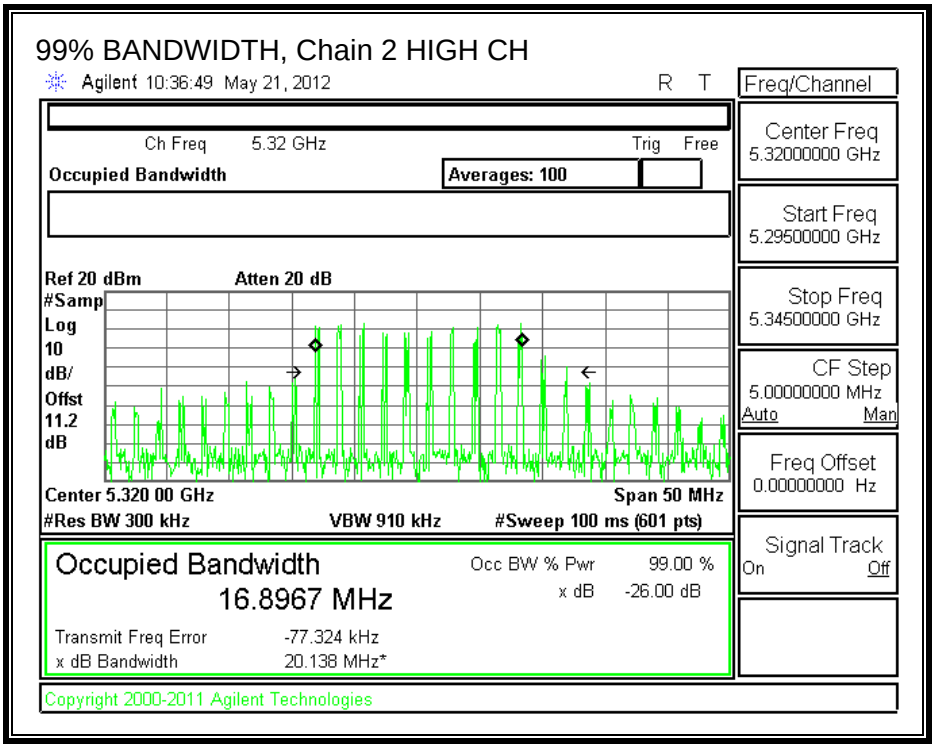




Chain 2







8.2.3. 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 11.2 dB (including 10 dB pad and 1.2 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 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)
Low	5260	11.02	12.09	14.60
Mid	5300	12.55	13.17	15.88
High	5320	12.30	12.71	15.52

8.2.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

IC RSS-210 A9.2 (2)

For the 5.25–5.35 GHz and 5.47–5.725 GHz bands, the maximum conducted output power over the frequency bands 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 megahertz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1 megahertz 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 1 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
5.90	4.10	5.09

RESULTS

Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5260	24	22.17	24.46	5.09	24.00	11.00
Mid	5300	24	22.75	24.57	5.09	24.00	11.00
High	5320	24	22.67	24.55	5.09	24.00	11.00

Duty Cycle CF (dB)	7.112	Included in Calculations of Corr'd Power & PPSD

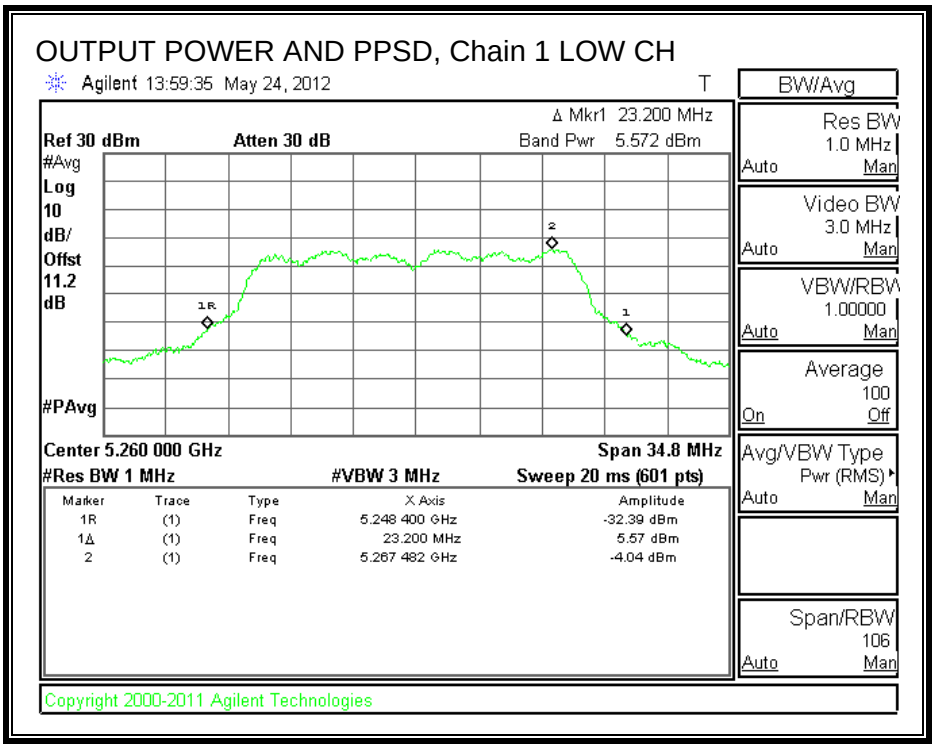
Output Power Results

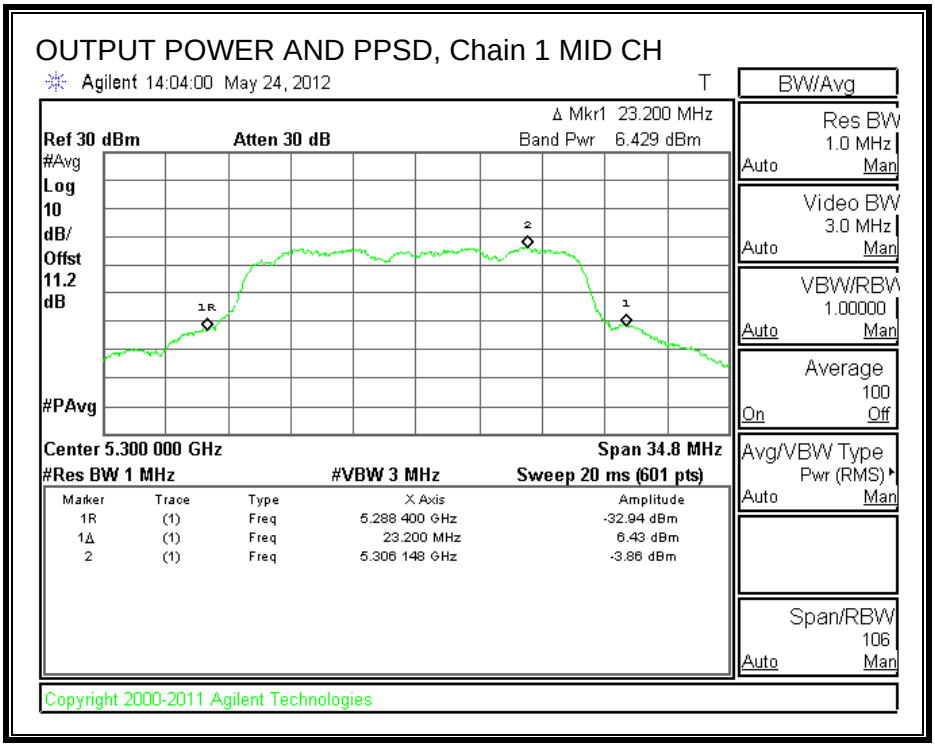
Channel	Frequency (MHz)	Chain 1 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5260	5.572	6.976	16.453	24.00	-7.547
Mid	5300	6.429	7.233	16.972	24.00	-7.028
High	5320	6.800	7.677	17.383	24.00	-6.617

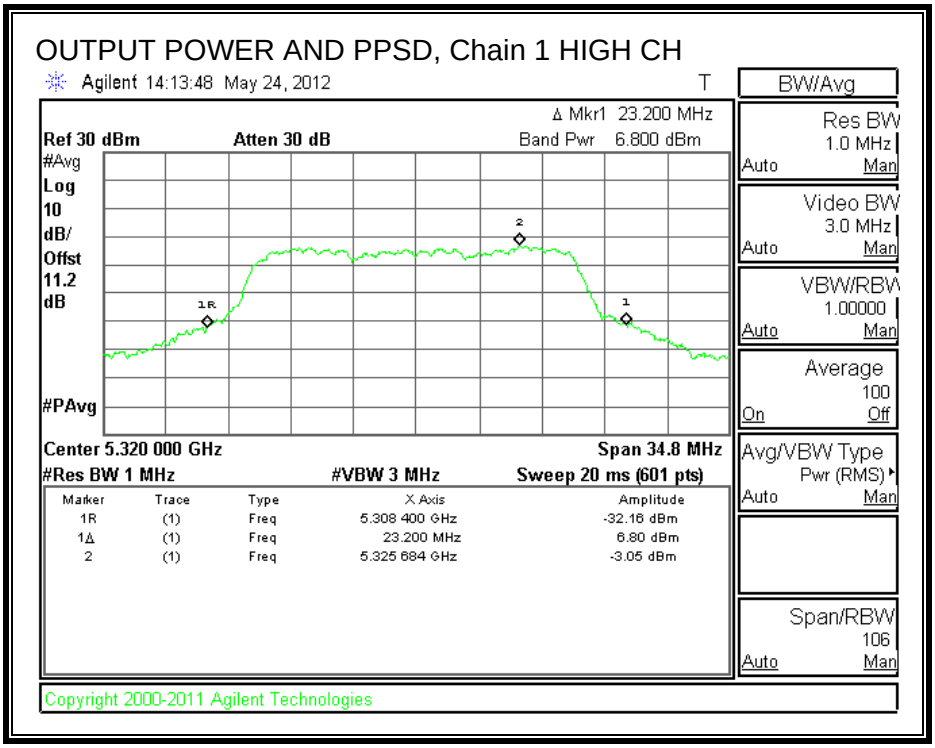
PPSD Results

Channel	Frequency (MHz)	Chain 1 Meas PPSD (dBm)	Chain 2 Meas PPSD (dBm)	Total Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5260	-4.04	-3.20	6.52	11.00	-4.48
Mid	5300	-3.86	-2.75	6.85	11.00	-4.15
High	5320	-3.05	-2.33	7.45	11.00	-3.55

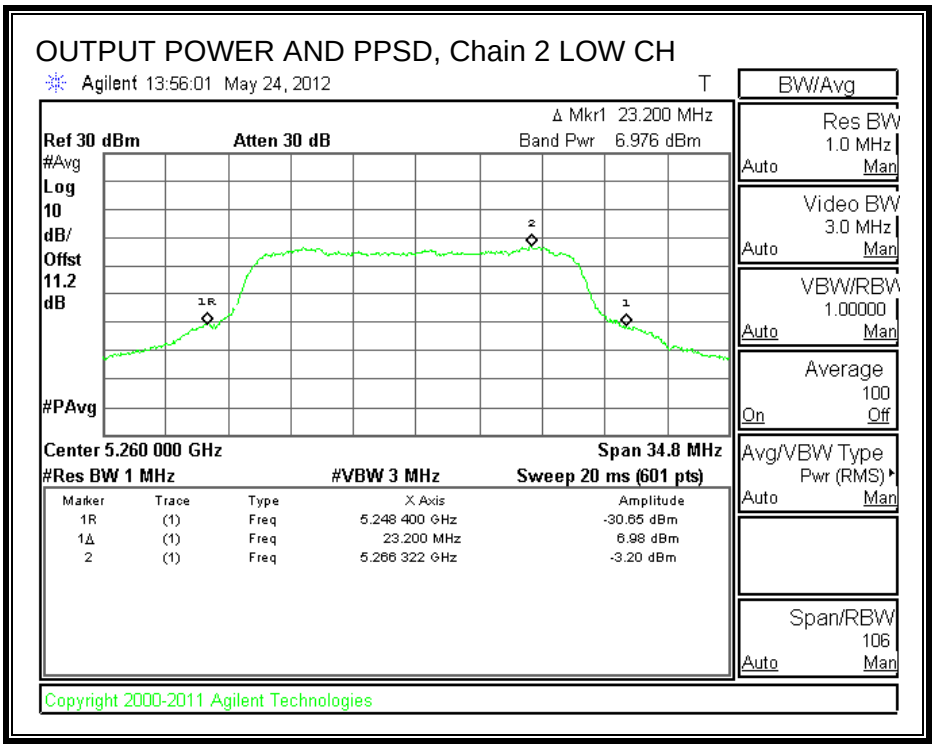
Chain 1

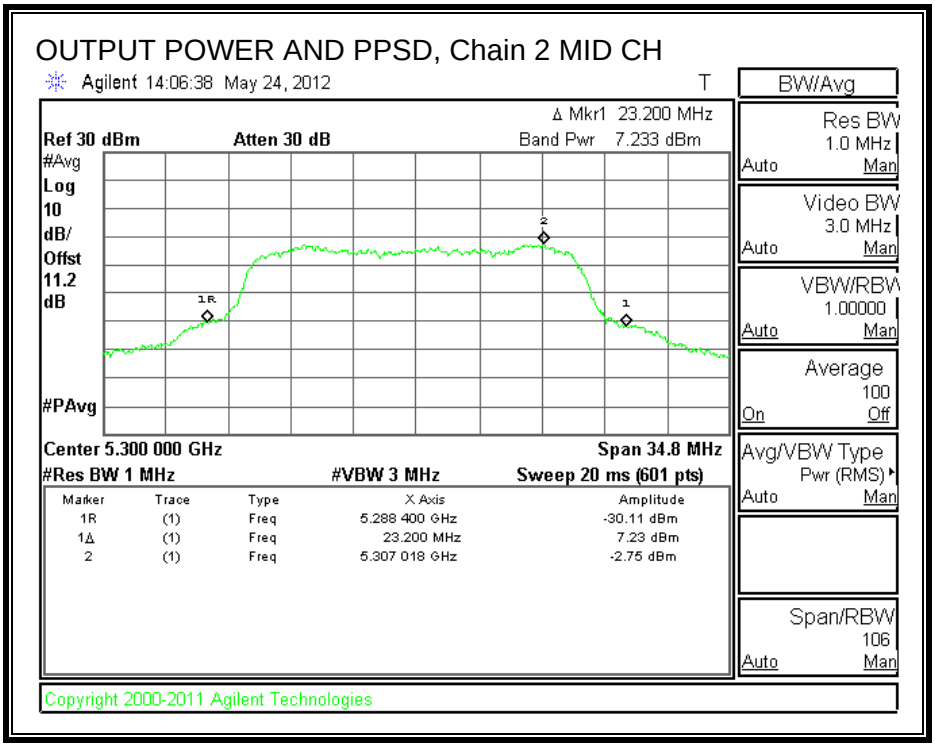


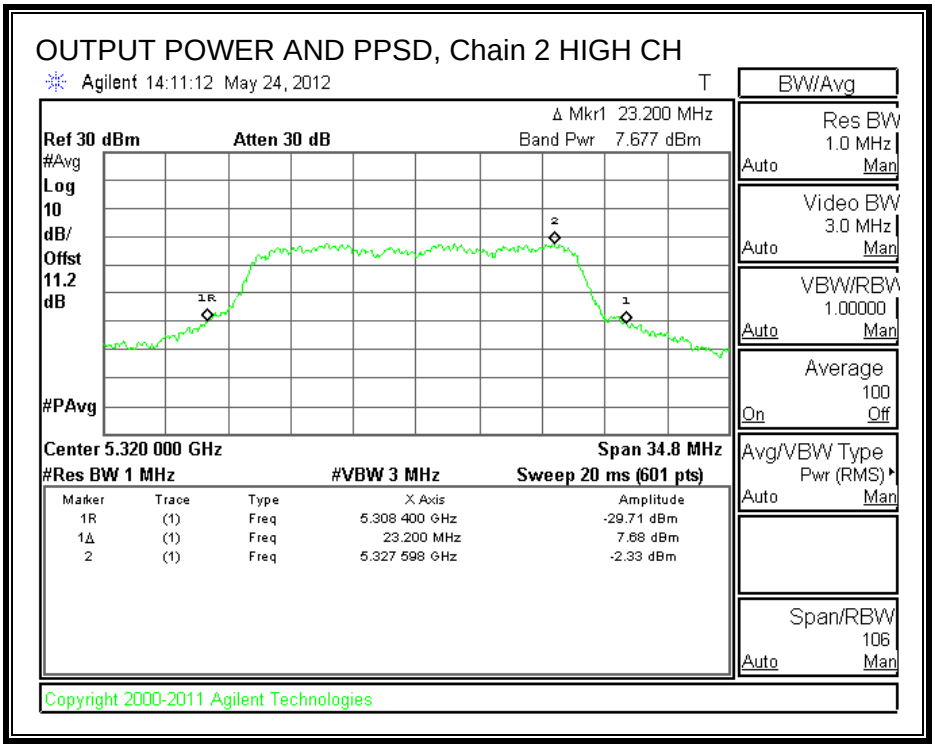




Chain 2







8.2.5. 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

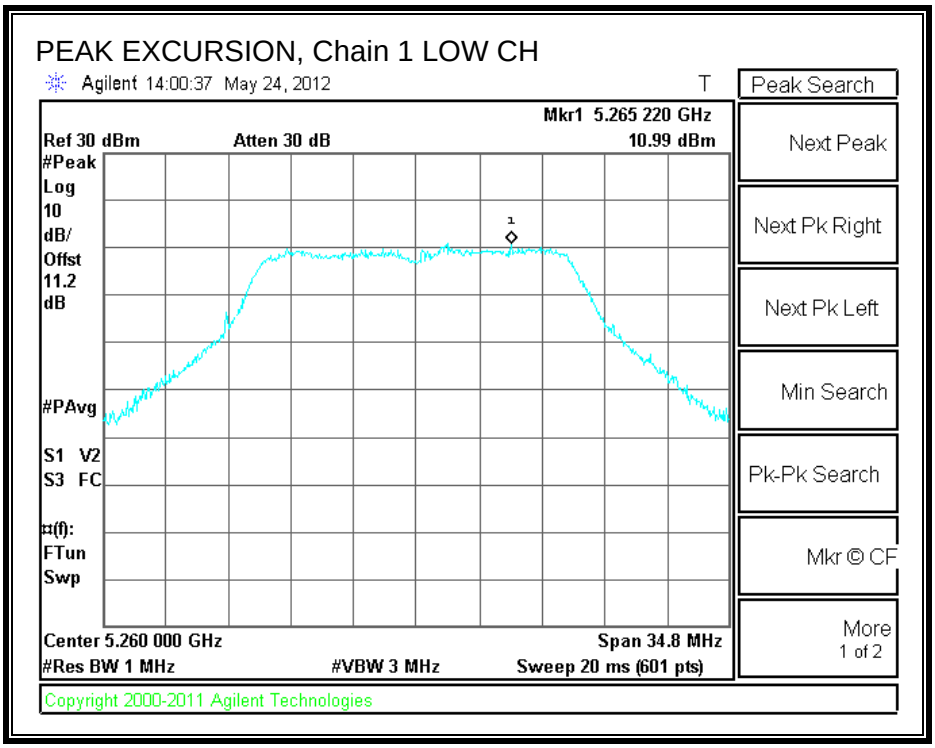
Chain 1

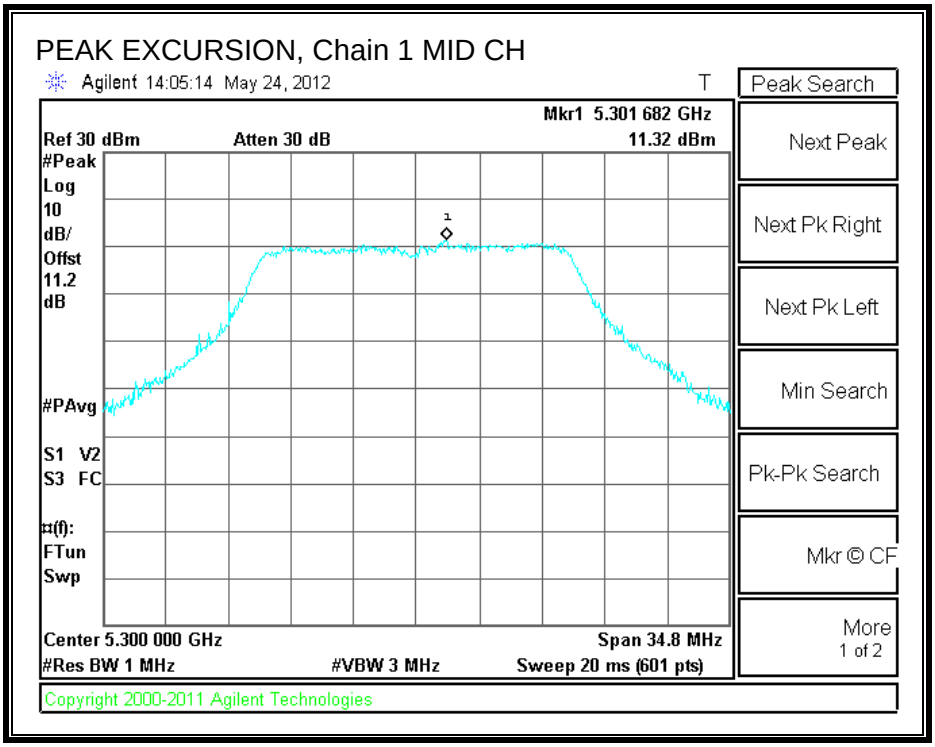
Channel	Frequency (MHz)	PK Level (dBm)	PSD (dBm)	DCCF (dB)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5260	10.99	-4.04	7.112	7.918	13	-5.082
Mid	5300	11.32	-3.86	7.112	8.068	13	-4.932
High	5320	11.59	-3.05	7.112	7.528	13	-5.472

Chain 2

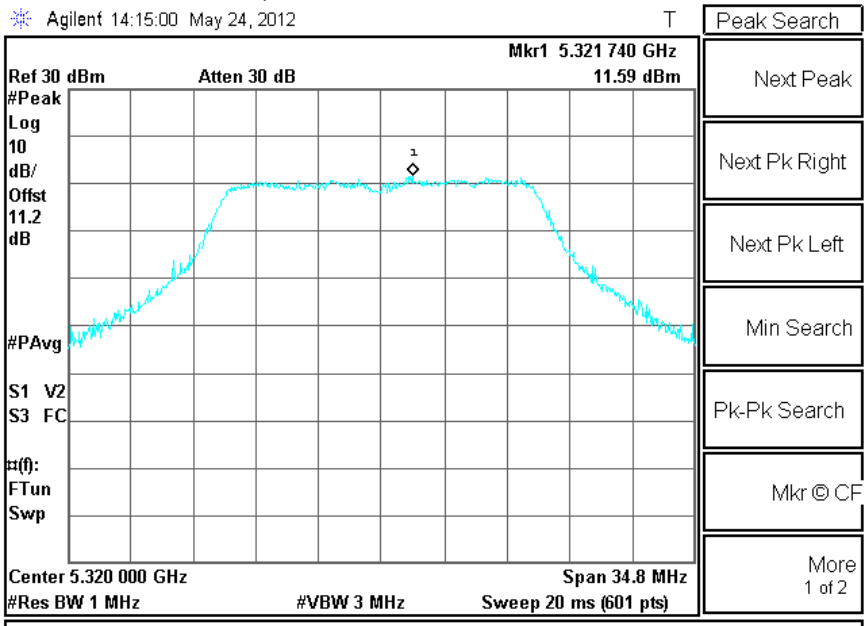
Channel	Frequency (MHz)	PK Level (dBm)	PSD (dBm)	DCCF (dB)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5260	12.13	-3.20	7.112	8.218	13	-4.782
Mid	5300	12.46	-2.75	7.112	8.098	13	-4.902
High	5320	12.81	-2.33	7.112	8.028	13	-4.972

Chain 1

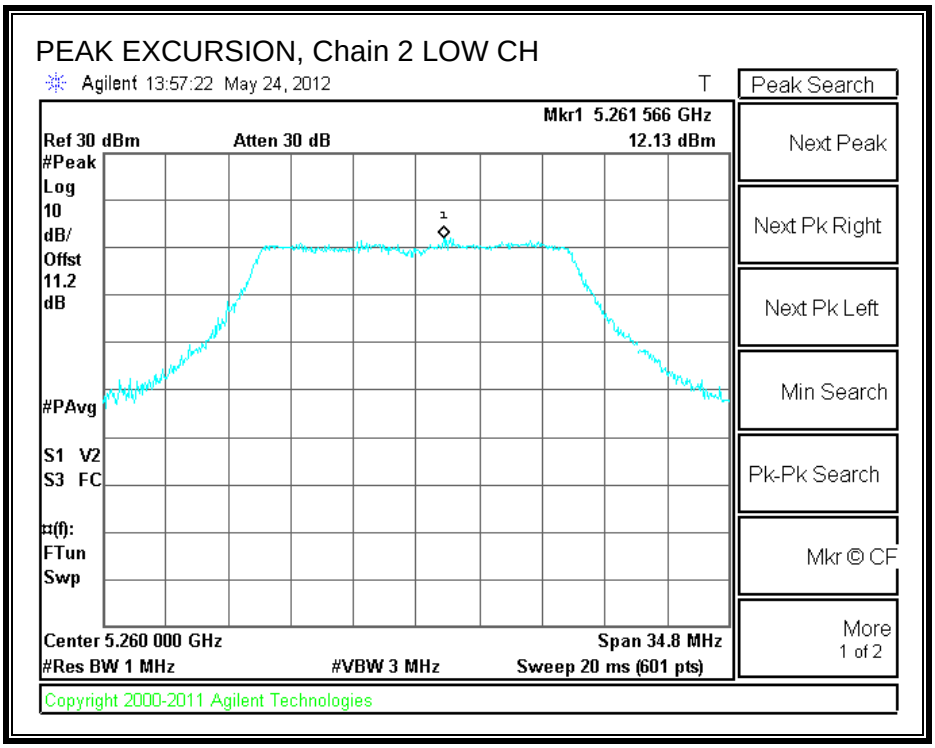


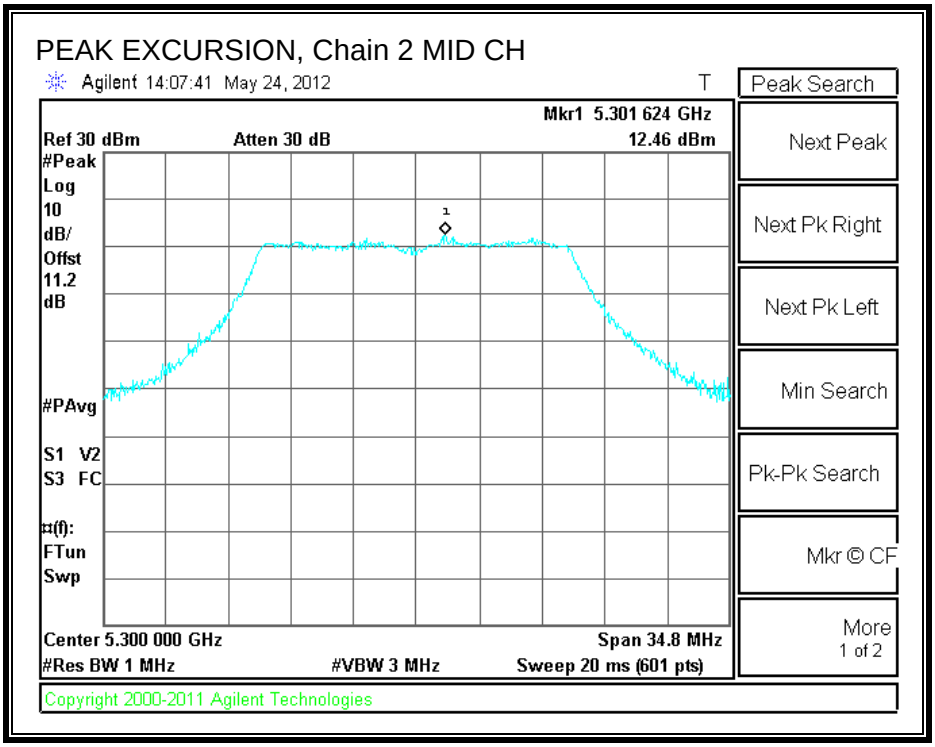


PEAK EXCURSION, Chain 1 HIGH CH

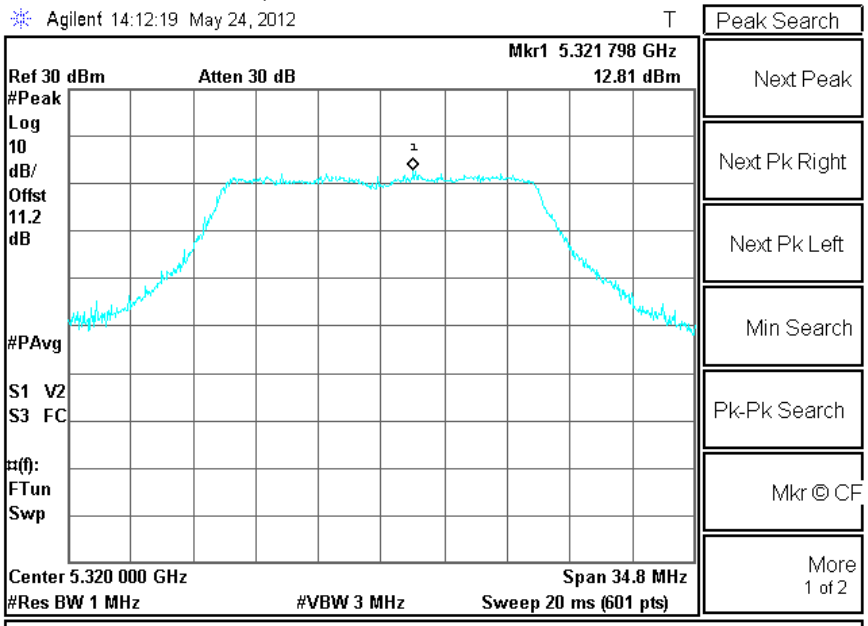


Chain 2





PEAK EXCURSION, Chain 2 HIGH CH



8.3. 802.11n HT20 MODE IN THE 5.6 GHz BAND

8.3.1. 26 dB BANDWIDTH

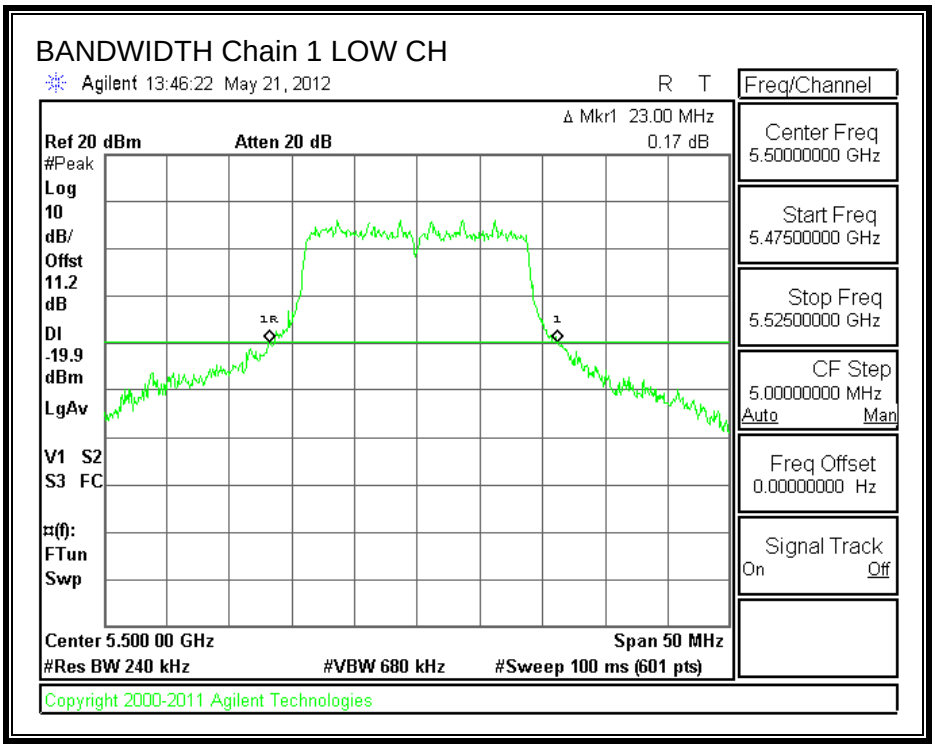
LIMITS

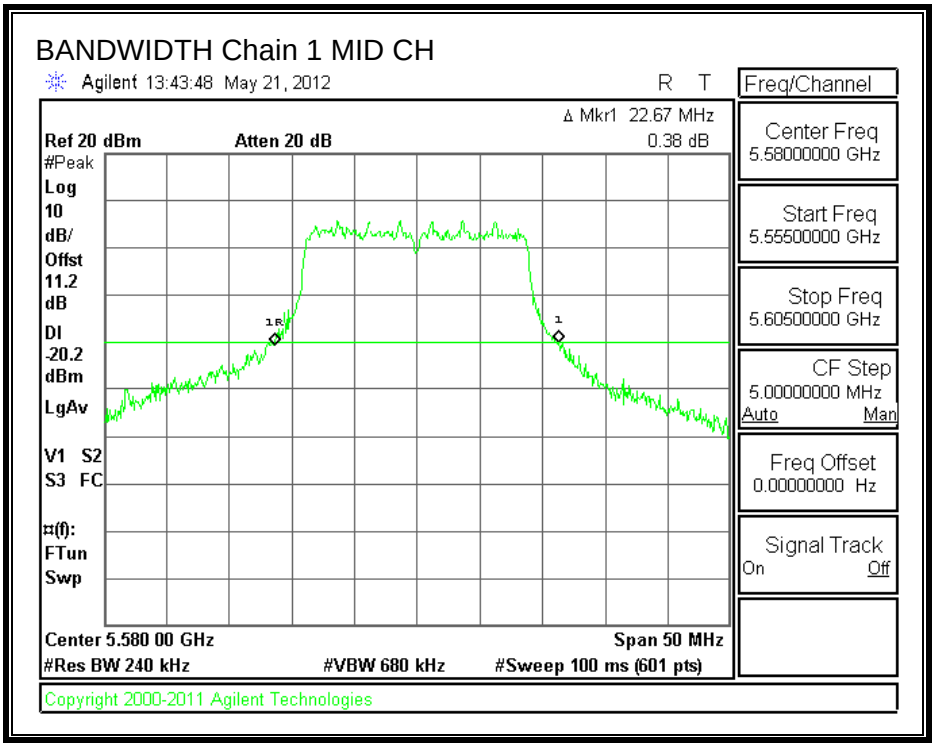
None; for reporting purposes only.

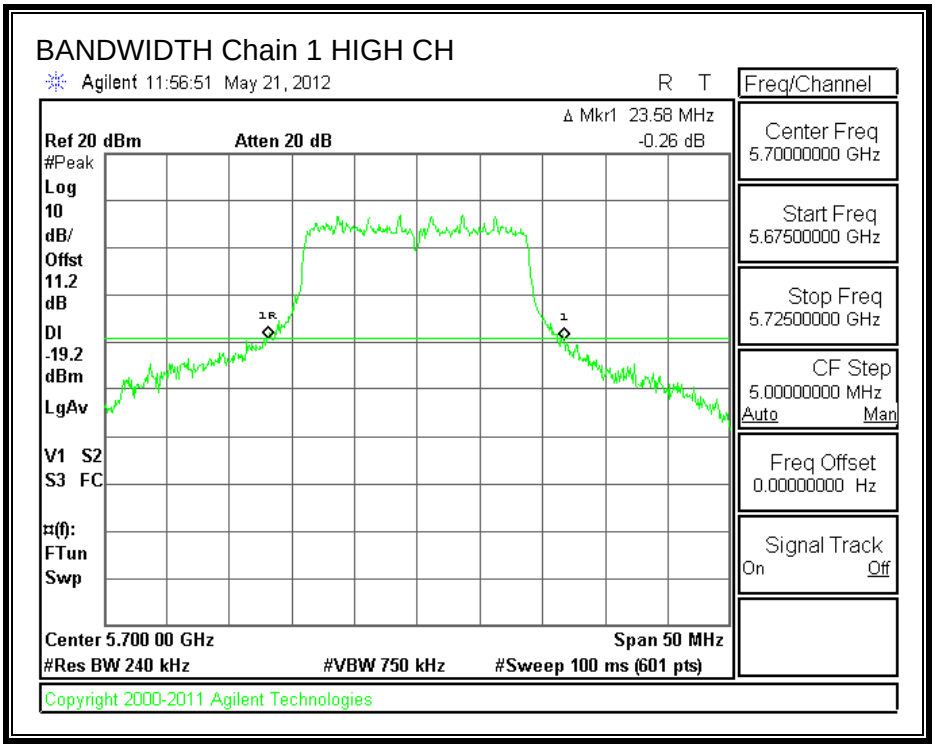
RESULTS

Channel	Frequency (MHz)	26 dB BW Chain 1 (MHz)	26 dB BW Chain 2 (MHz)
Low	5500	23.00	22.75
Mid	5580	22.67	22.50
High	5700	23.58	22.67

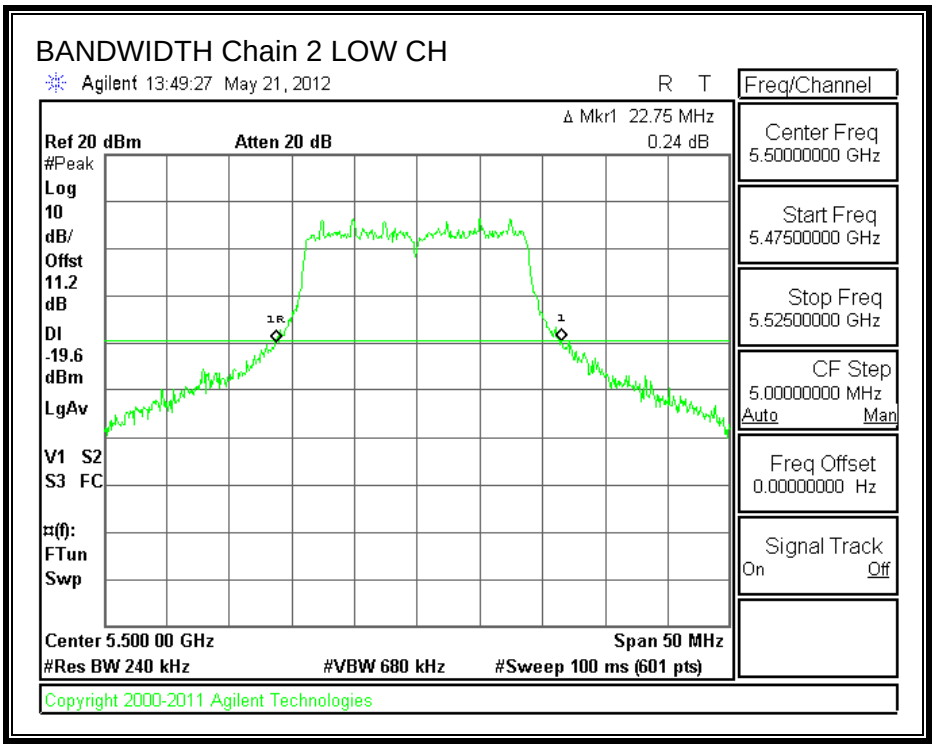
Chain 1

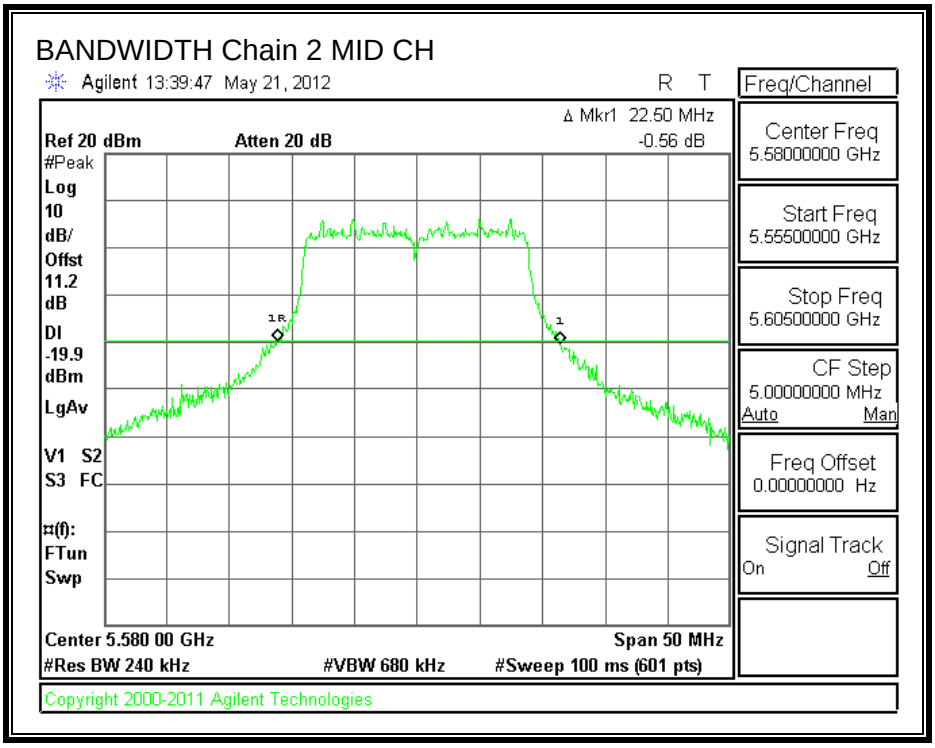


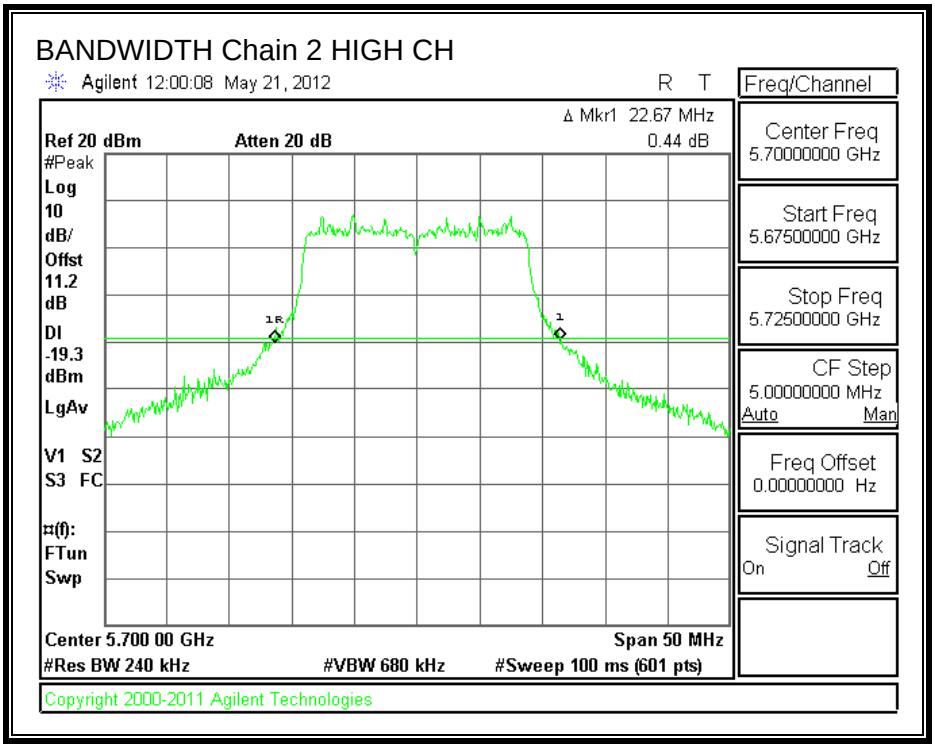




Chain 2







8.3.2. 99% BANDWIDTH

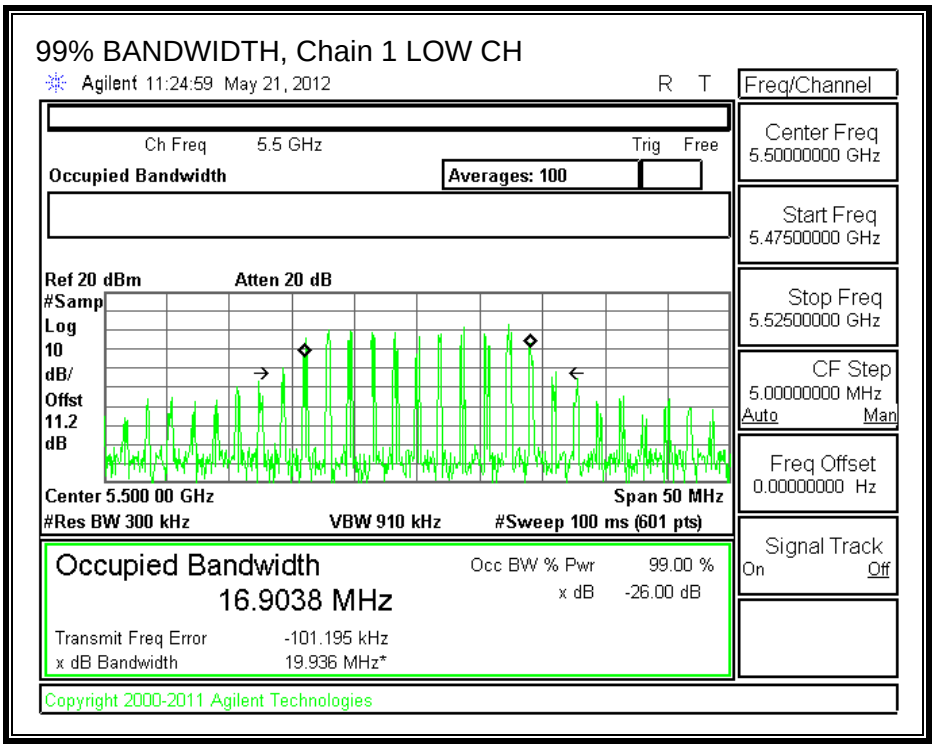
LIMITS

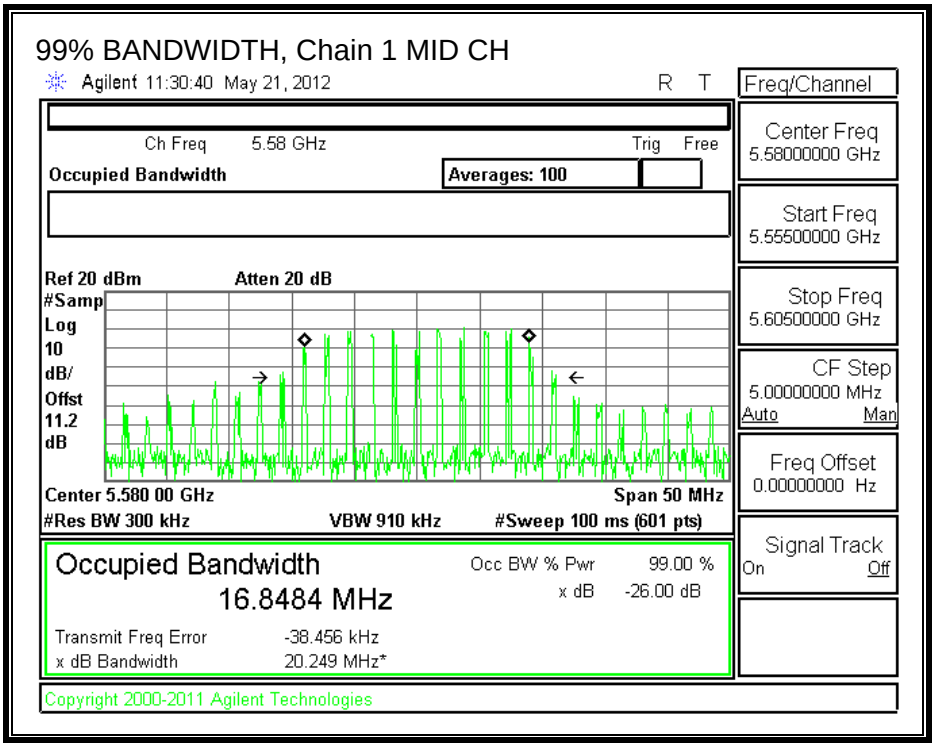
None; for reporting purposes only.

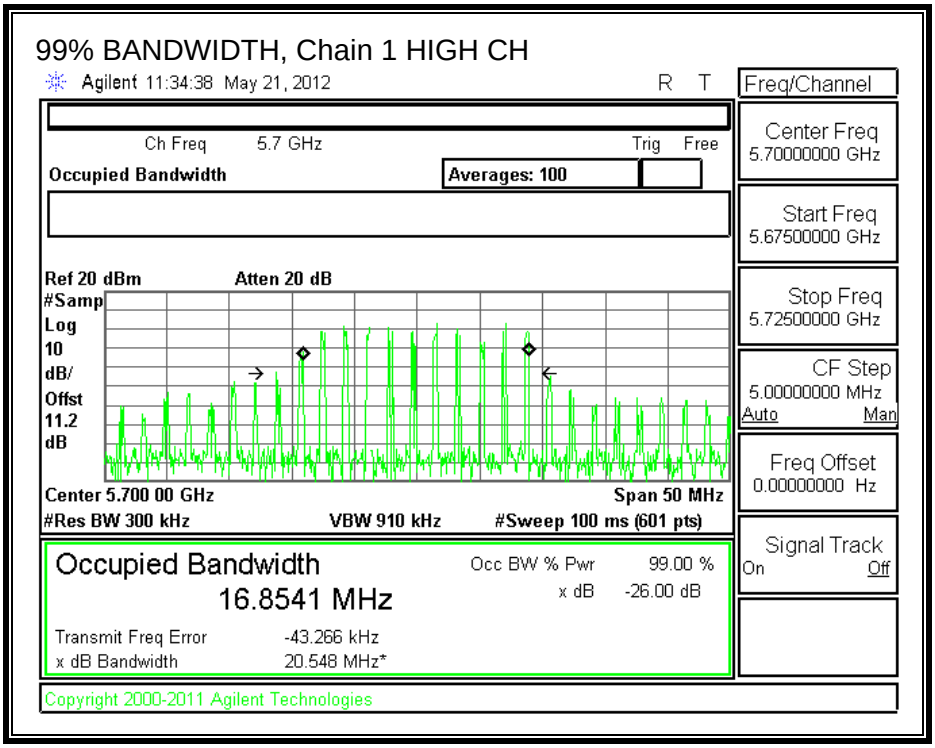
RESULTS

Channel	Frequency (MHz)	99% BW Chain 1 (MHz)	99% BW Chain 2 (MHz)
Low	5500	16.9038	16.8725
Mid	5580	16.8484	16.8678
High	5700	16.8541	16.9225

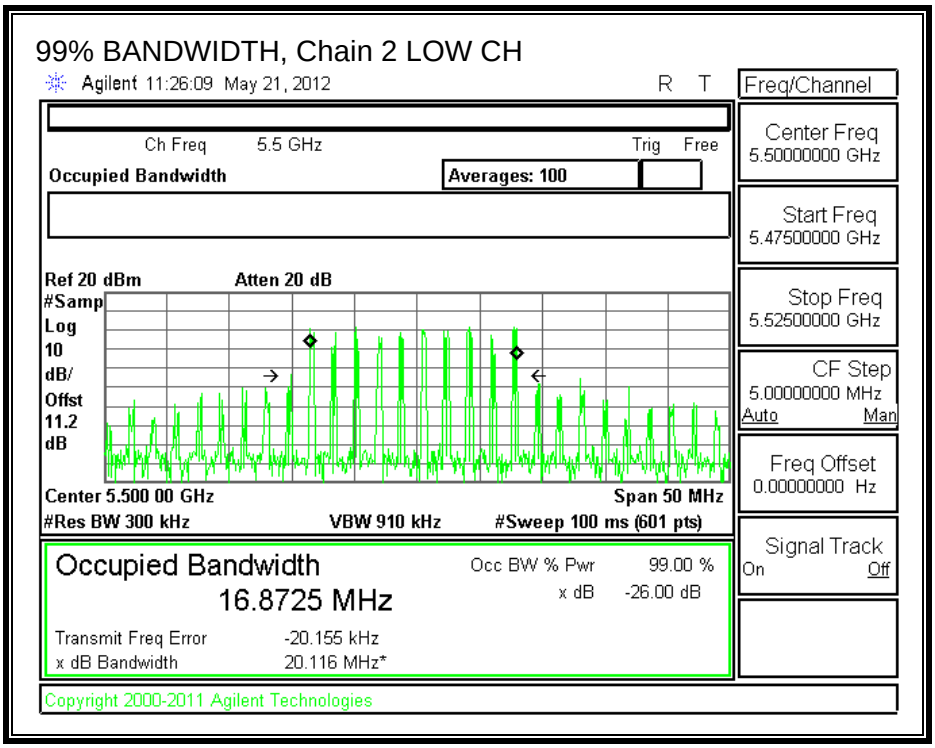
Chain 1

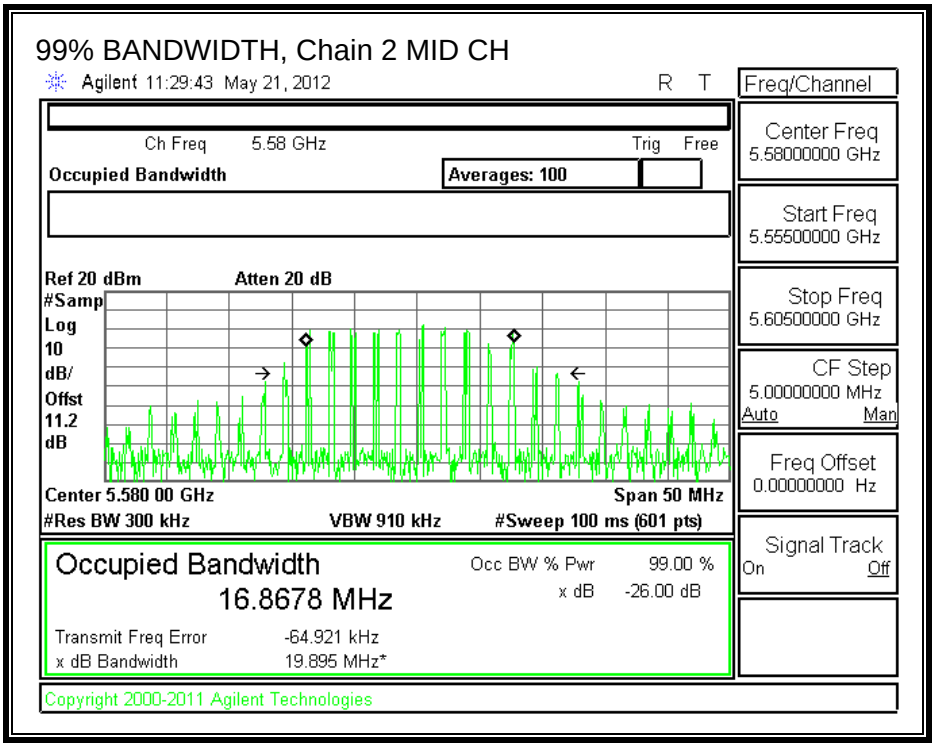


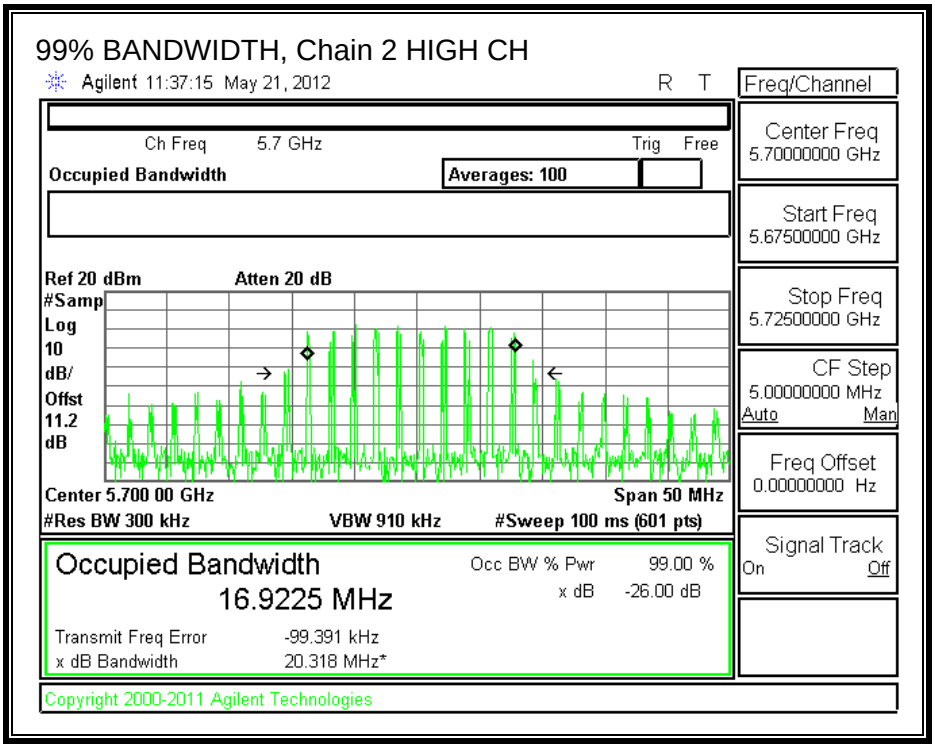




Chain 2







8.3.3. 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 11.2 dB (including 10 dB pad and 1.2 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 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)
Low	5500	13.40	12.91	16.17
Mid	5580	13.06	12.82	15.95
High	5700	13.63	13.91	16.78

8.3.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

IC RSS-210 A9.2 (3)

For the 5.25–5.35 GHz and 5.47–5.725 GHz bands, the maximum conducted output power over the frequency bands 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 megahertz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1 megahertz 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 1 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
6.00	4.90	5.48

RESULTS

Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5500	24	22.75	24.57	5.48	24.00	11.00
Mid	5580	24	22.50	24.52	5.48	24.00	11.00
High	5700	24	22.67	24.55	5.48	24.00	11.00

Duty Cycle CF (dB)	7.112	Included in Calculations of Corr'd Power & PPSD

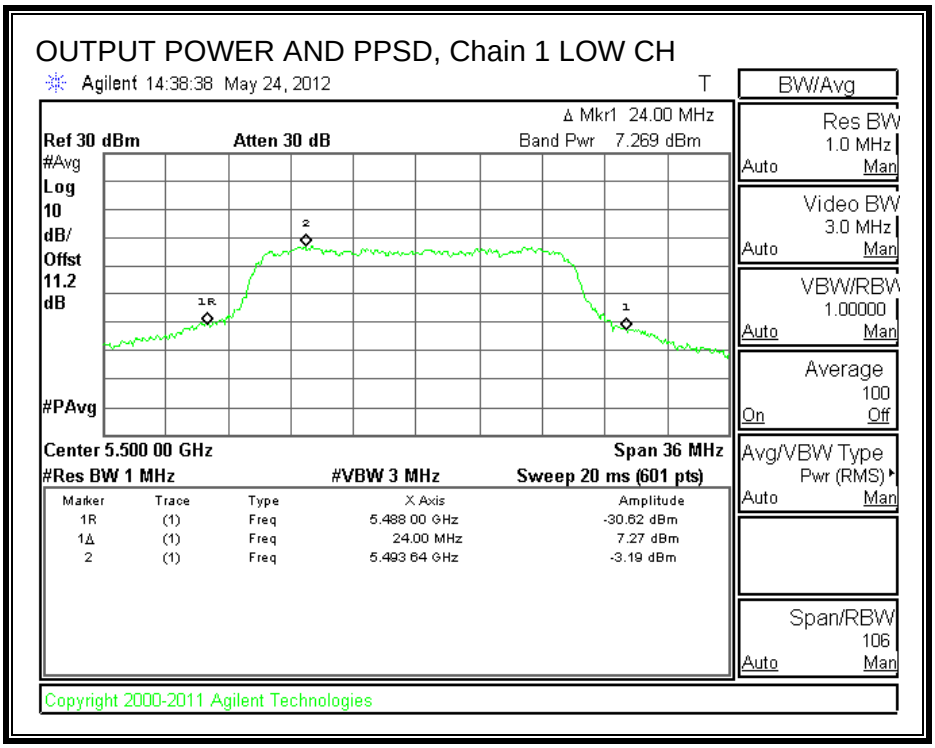
Output Power Results

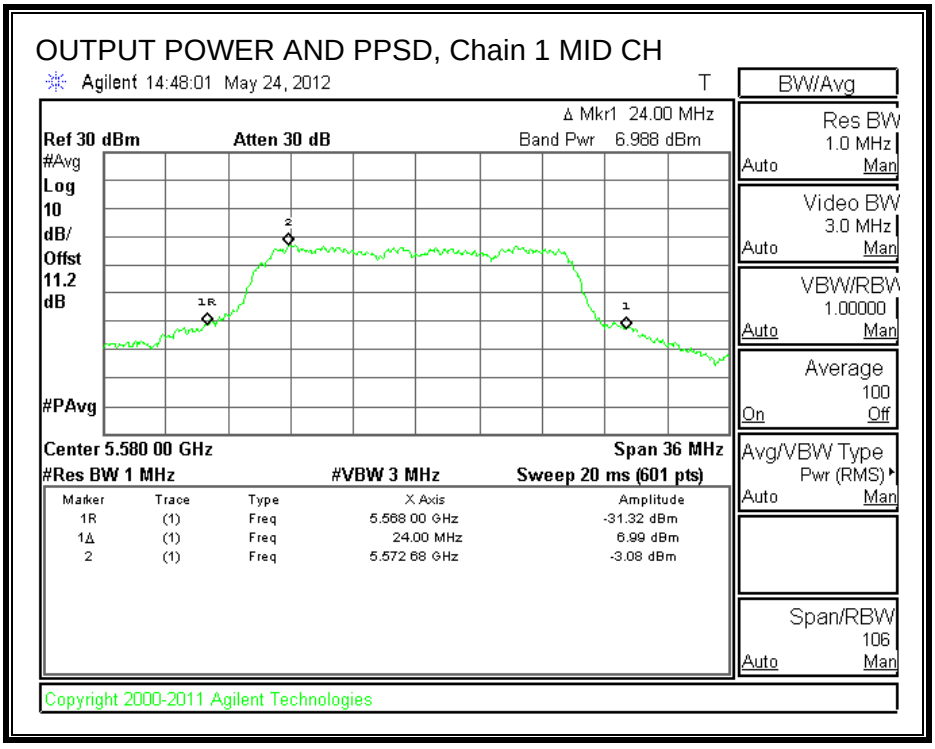
Channel	Frequency (MHz)	Chain 1 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5500	7.269	7.297	17.405	24.00	-6.595
Mid	5580	6.988	6.883	17.058	24.00	-6.942
High	5700	7.779	7.514	17.771	24.00	-6.229

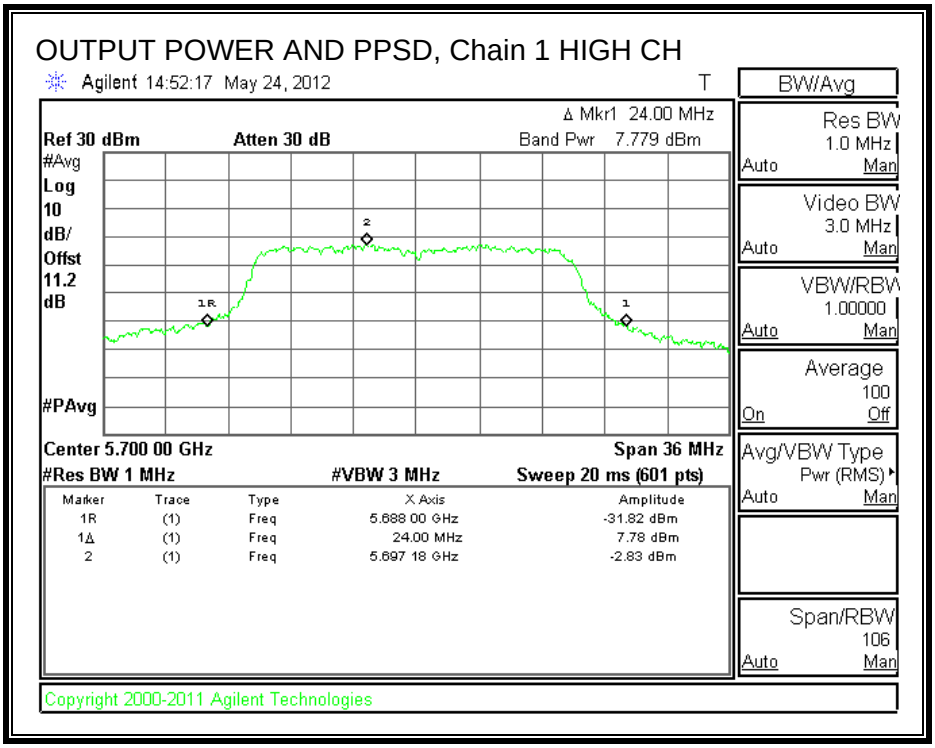
PPSD Results

Channel	Frequency (MHz)	Chain 1 Meas PPSD (dBm)	Chain 2 Meas PPSD (dBm)	Total Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5500	-3.19	-3.06	7.00	11.00	-4.00
Mid	5580	-3.08	-2.94	7.11	11.00	-3.89
High	5700	-2.83	-3.00	7.21	11.00	-3.79

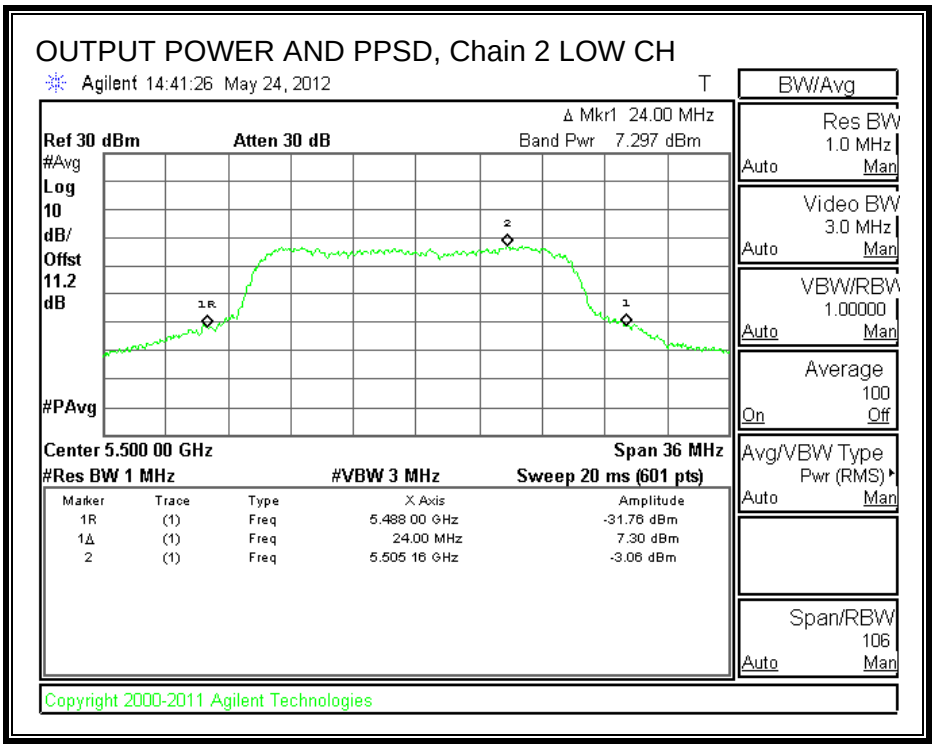
Chain 1

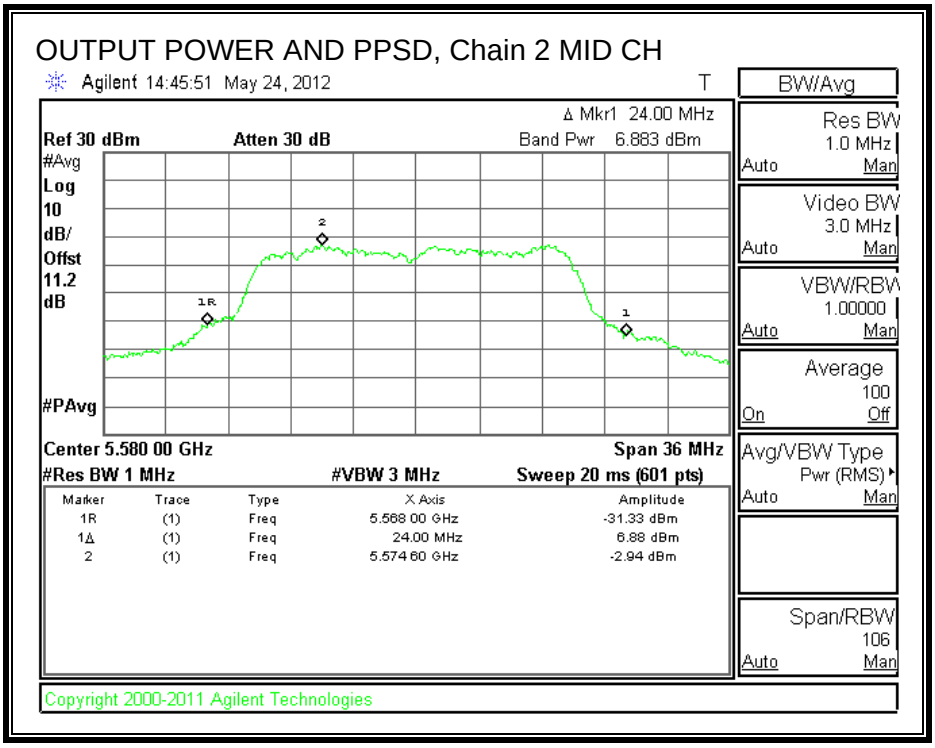


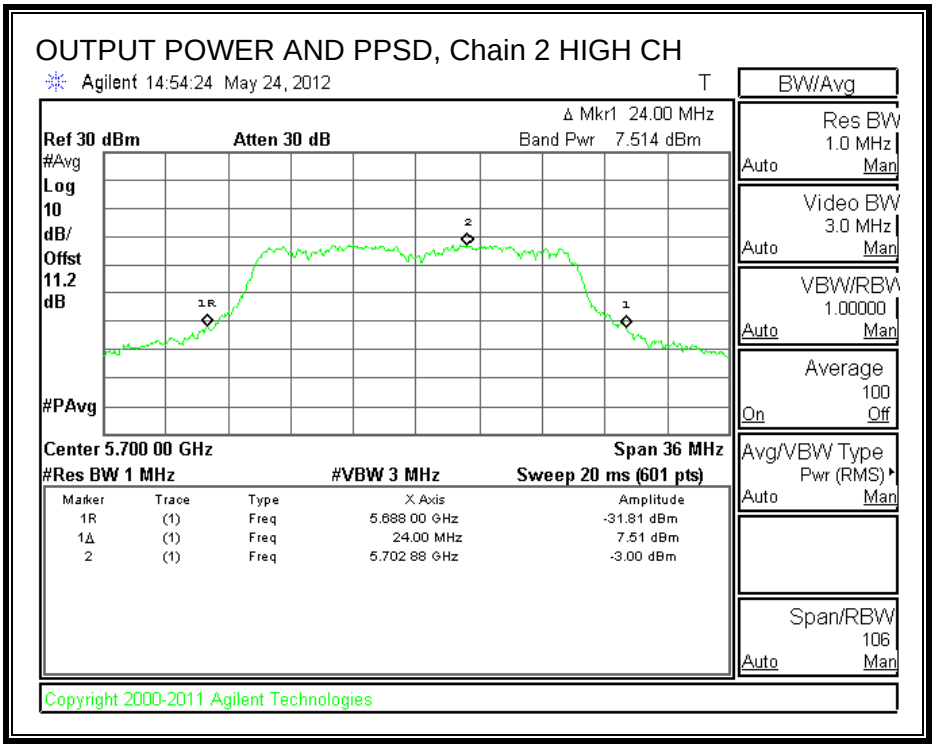




Chain 2







8.3.5. 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

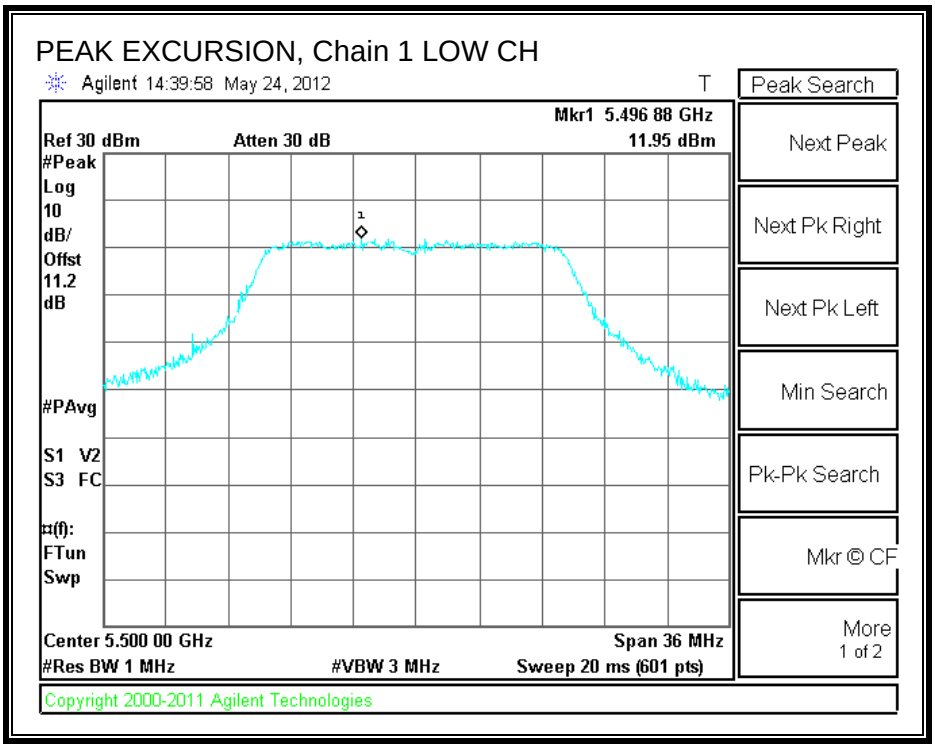
Chain 1

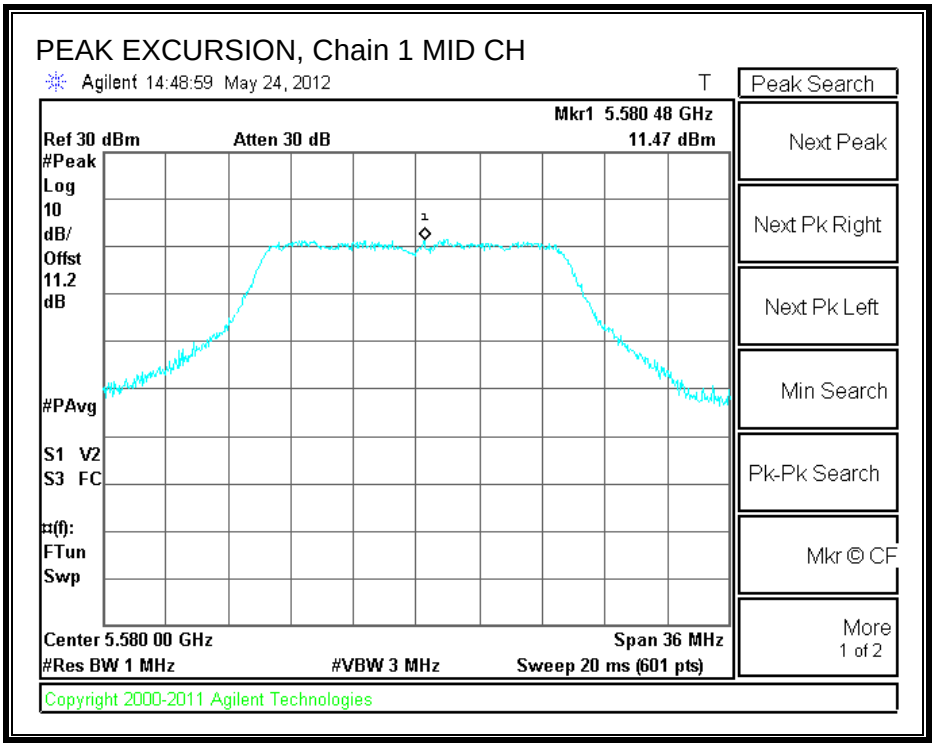
Channel	Frequency (MHz)	PK Level (dBm)	PSD (dBm)	DCCF (dB)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5500	11.95	-3.19	7.112	8.028	13	-4.972
Mid	5580	11.47	-3.08	7.112	7.438	13	-5.562
High	5700	12.17	-2.83	7.112	7.888	13	-5.112

Chain 2

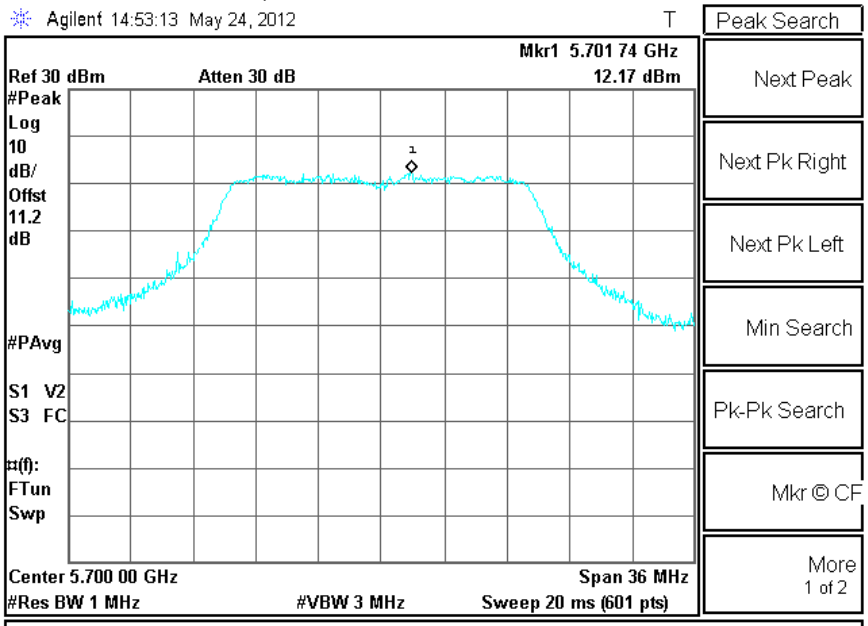
Channel	Frequency (MHz)	PK Level (dBm)	PSD (dBm)	DCCF (dB)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
Low	5500	12.32	-3.06	7.112	8.268	13	-4.732
Mid	5580	12.26	-2.94	7.112	8.088	13	-4.912
High	5700	12.50	-3.00	7.112	8.388	13	-4.612

Chain 1

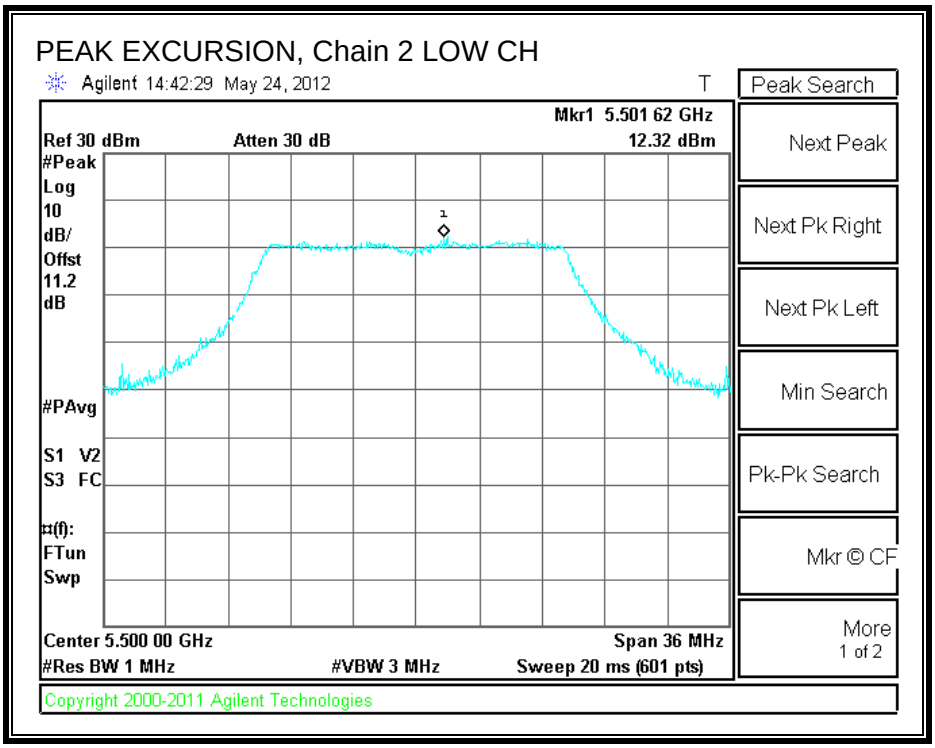


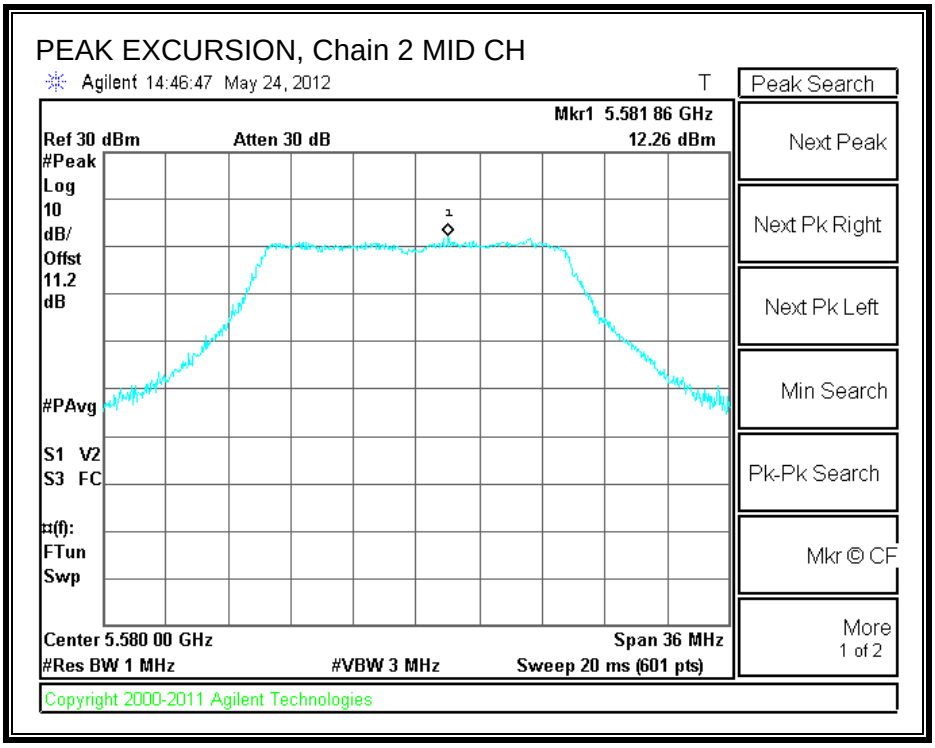


PEAK EXCURSION, Chain 1 HIGH CH

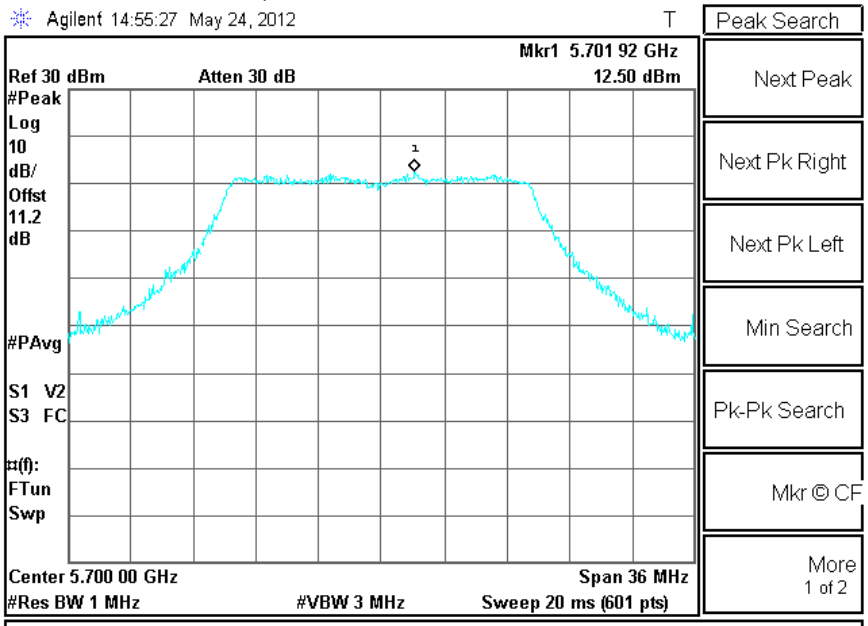


Chain 2





PEAK EXCURSION, Chain 2 HIGH CH



8.3.6. CONDUCTED WEATHER RADAR BAND EMISSIONS

LIMITS

Within 5600 – 5650 MHz band, -20 dBc relative to highest fundamental output power density per 100 kHz.

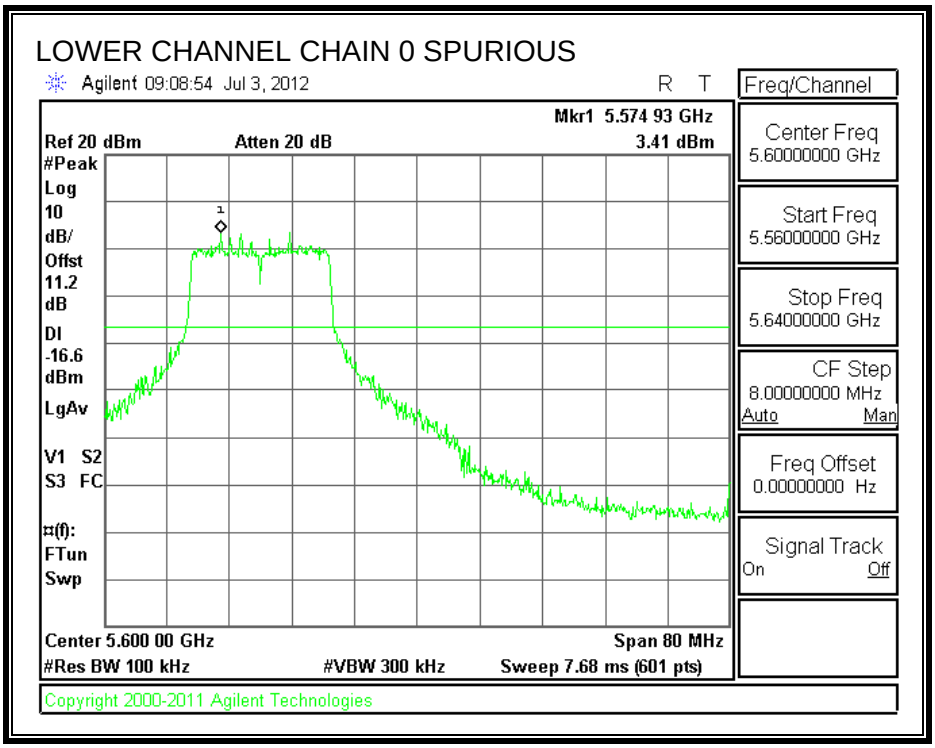
TEST PROCEDURE

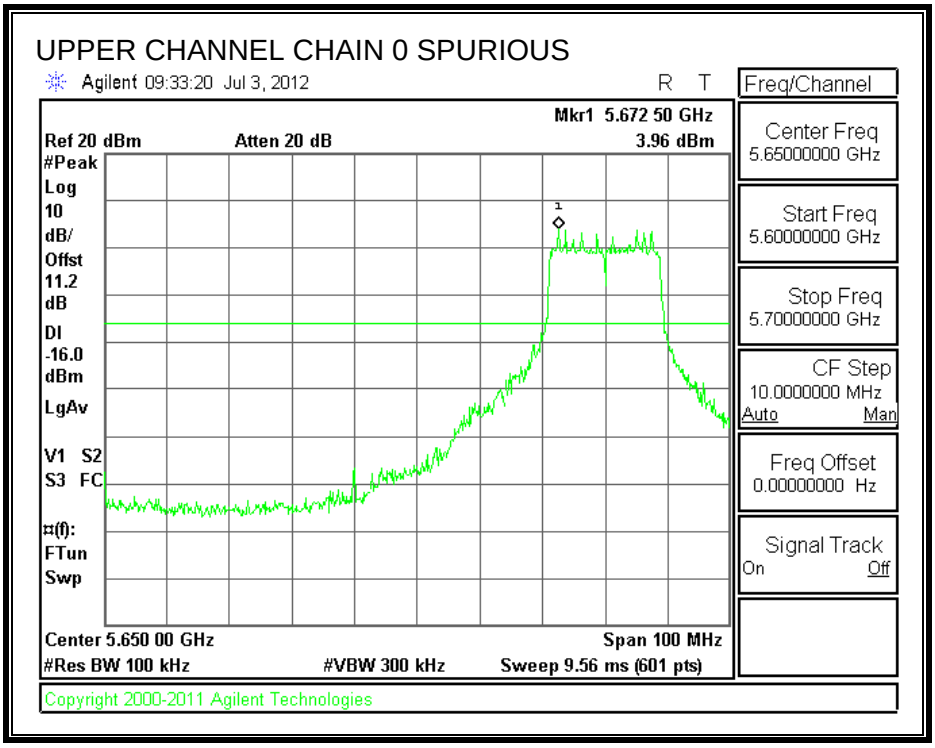
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

The authorized channel nearest to and less than 5600 MHz is measured.

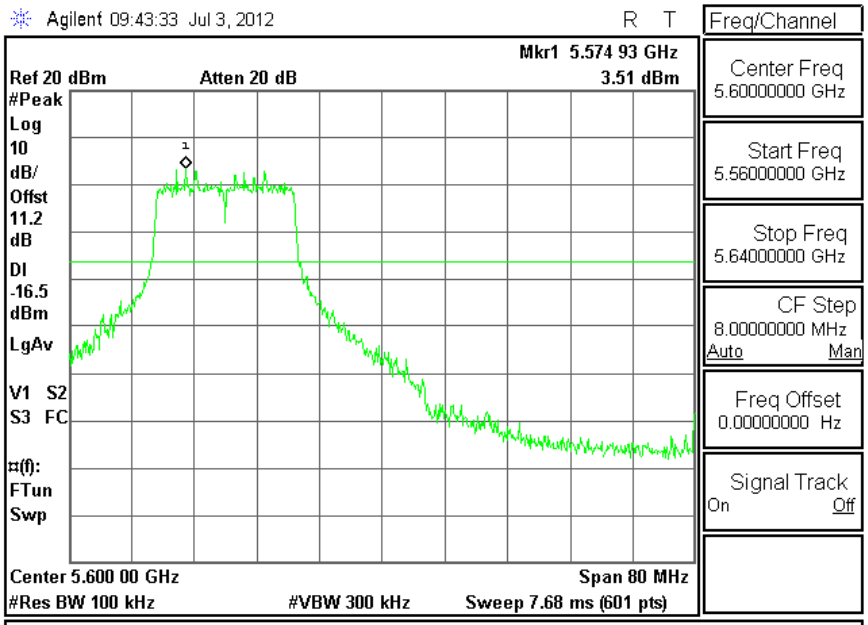
The authorized channel nearest to and greater than 5650 MHz is measured.

SPURIOUS EMISSIONS IN WEATHER RADAR BAND 5600 - 5650 MHz

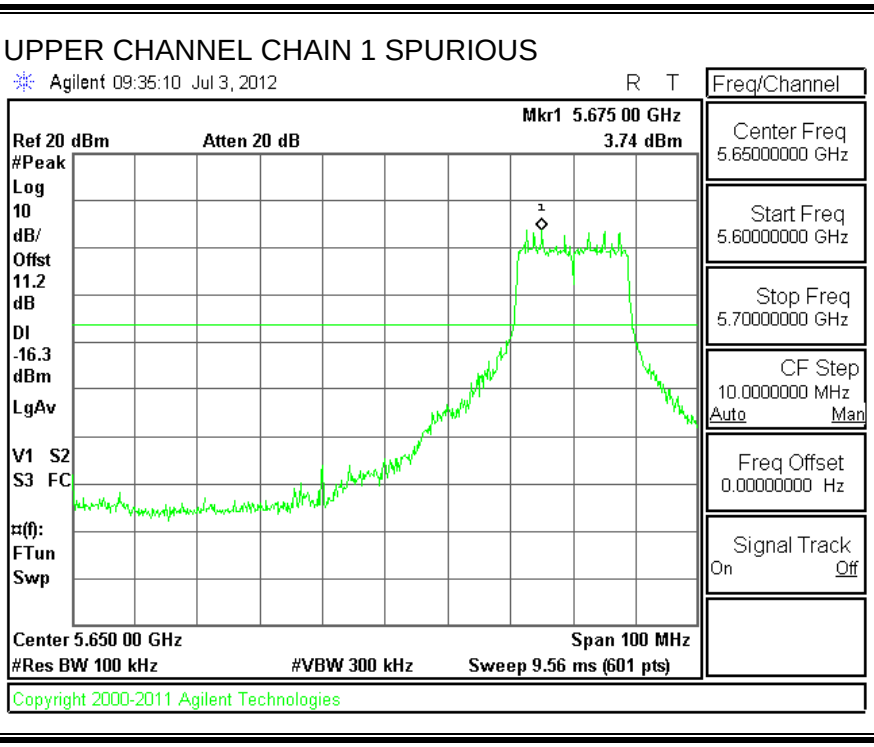




LOWER CHANNEL CHAIN 1 SPURIOUS



UPPER CHANNEL CHAIN 1 SPURIOUS



9. RADIATED TEST RESULTS

9.1. 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.

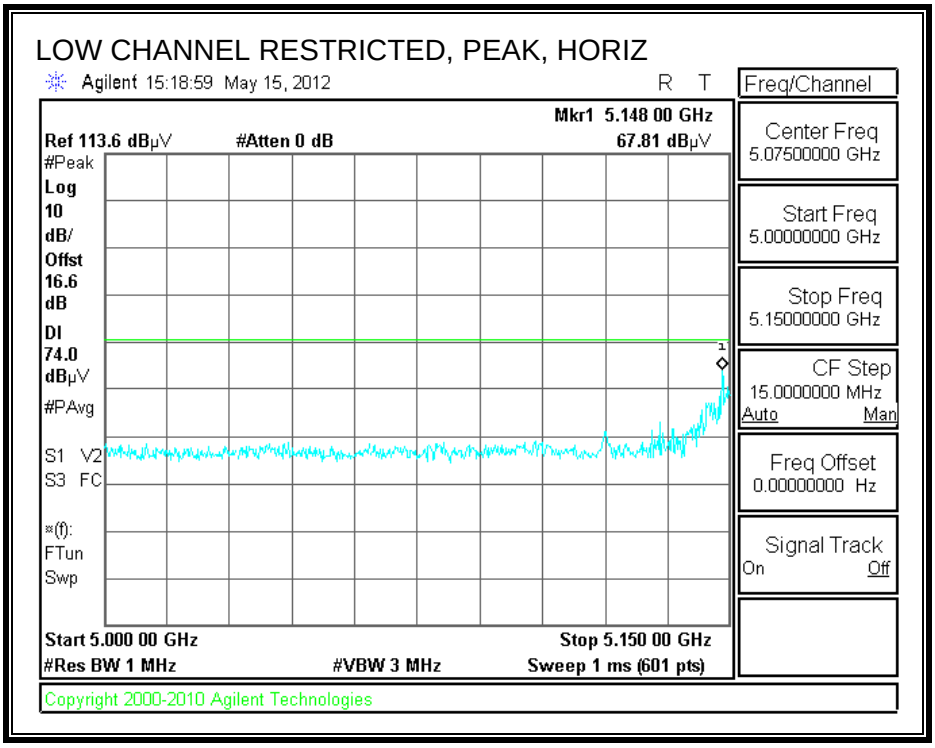
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band.

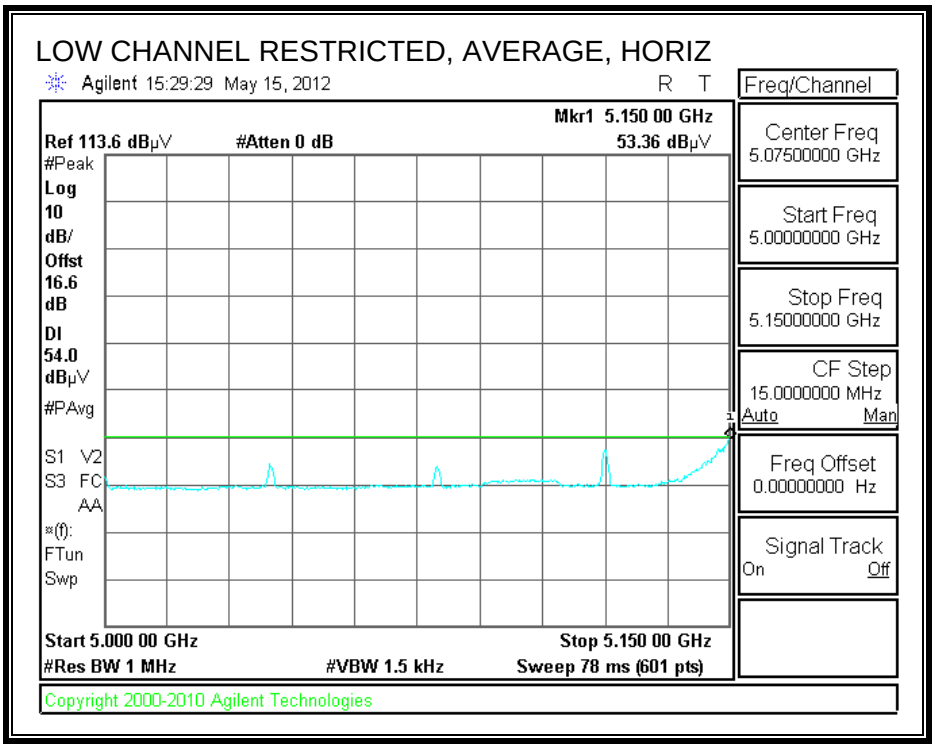
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

9.2. TRANSMITTER ABOVE 1 GHz

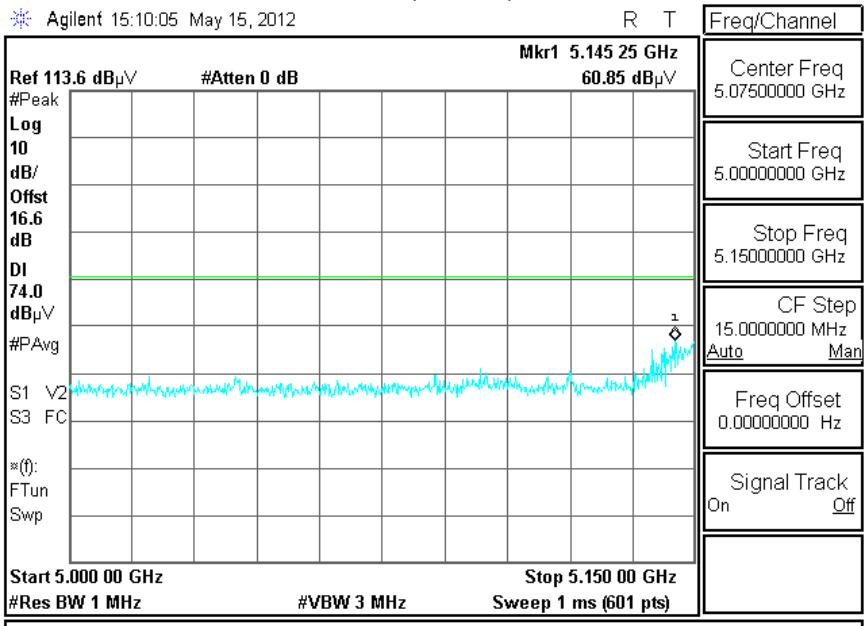
9.2.1. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.2 GHz BAND

RESTRICTED BANDEDGE (LOW CHANNEL)

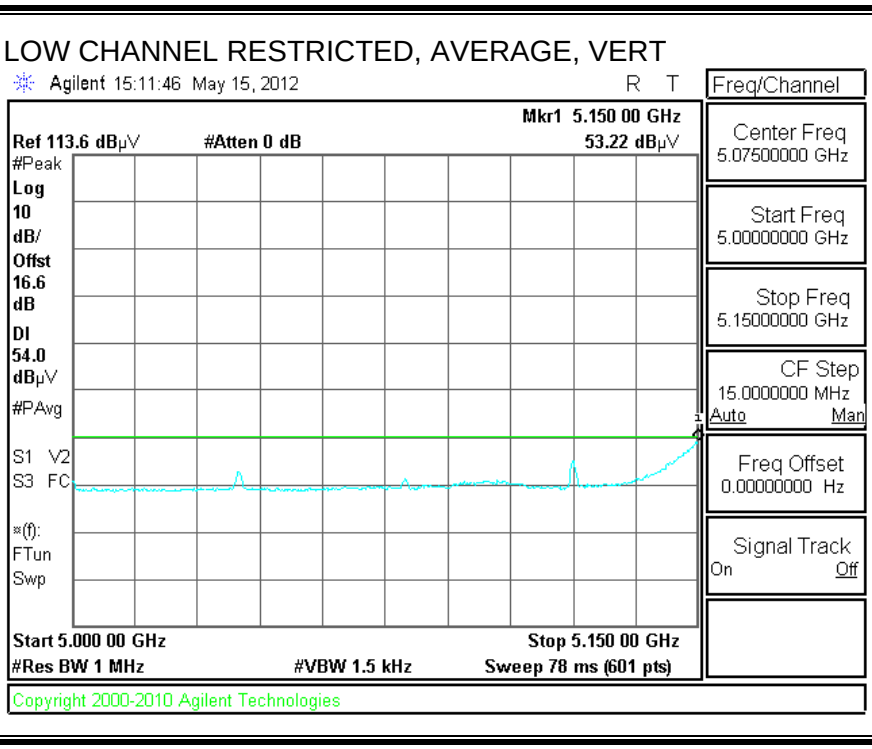




LOW CHANNEL RESTRICTED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 3m Chamber

Company: Sonos, Inc.
Project #: 12U14339
Date: 5/16/2012
Test Engineer: David Garcia
Configuration: EUT standalone, 2 10BT cables connected
Mode: 5.2GHz 11n HT20 MCS9

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T60; S/N: 2238 @3m	T34 HP 8449B	T88 Miteq 26-40GHz	T89; ARA 18-26GHz; S/N:1049	FCC 15.205

Hi Frequency Cables

3' cable 22807700	12' cable 22807600	20' cable 22807500	HPF	Reject Filter
3' cable 22807700	12' cable 22807600	20' cable 22807500		R_001

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

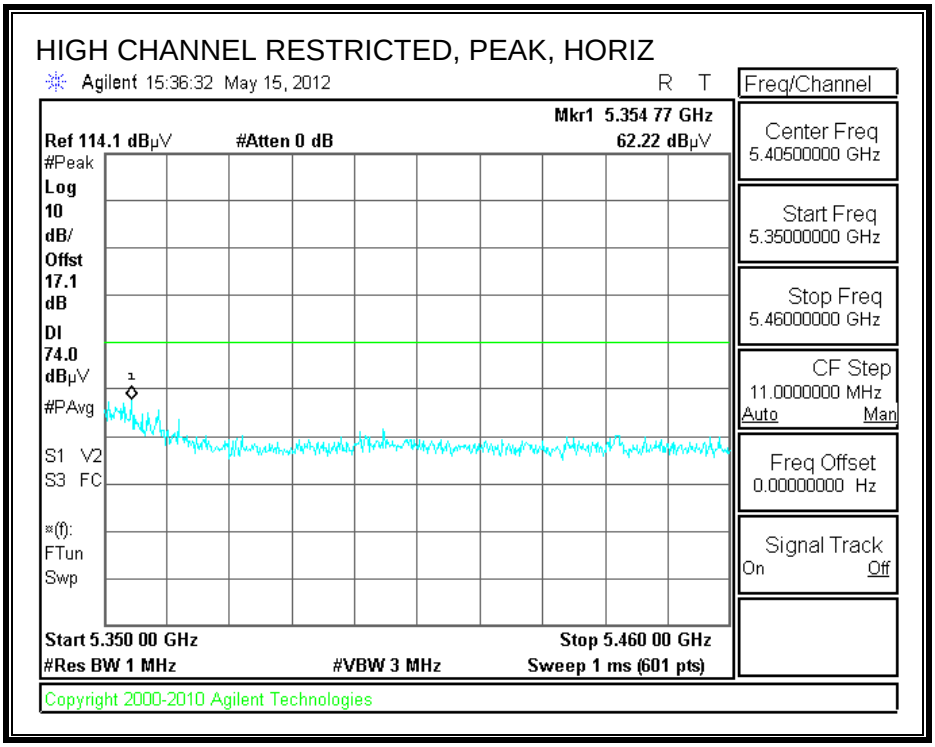
f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
Low Channel: 5180 MHz															
15.540	3.0	34.7	25.8	39.1	13.0	-31.9	0.0	0.0	54.7	45.9	74	54	-19.3	-8.1	H
15.540	3.0	34.4	25.4	39.1	13.0	-31.9	0.0	0.0	54.5	45.5	74	54	-19.5	-8.5	V
Mid Channel: 5200 MHz															
15.600	3.0	34.4	25.5	38.8	13.0	-31.9	0.0	0.0	54.3	45.5	74	54	-19.7	-8.5	H
15.600	3.0	34.7	25.6	38.8	13.0	-31.9	0.0	0.0	54.7	45.6	74	54	-19.3	-8.4	V
High Channel: 5240 MHz															
15.720	3.0	35.3	25.1	38.4	13.1	-31.9	0.0	0.0	54.8	44.7	74	54	-19.2	-9.3	H
15.720	3.0	35.4	25.2	38.4	13.1	-31.9	0.0	0.0	55.0	44.8	74	54	-19.0	-9.2	V

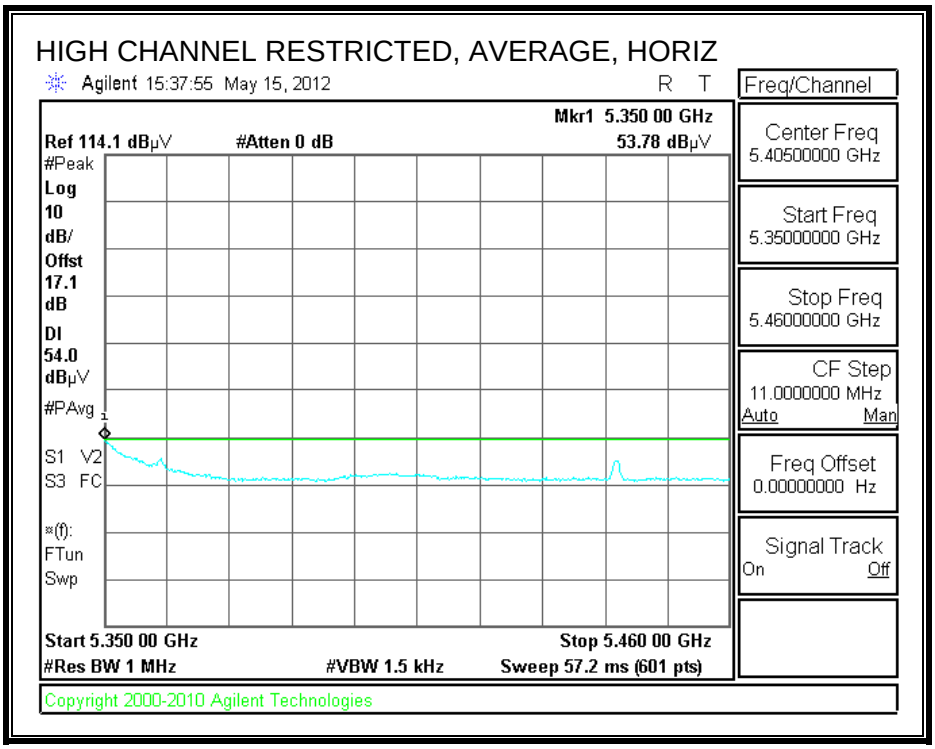
Rev. 11.10.11

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		

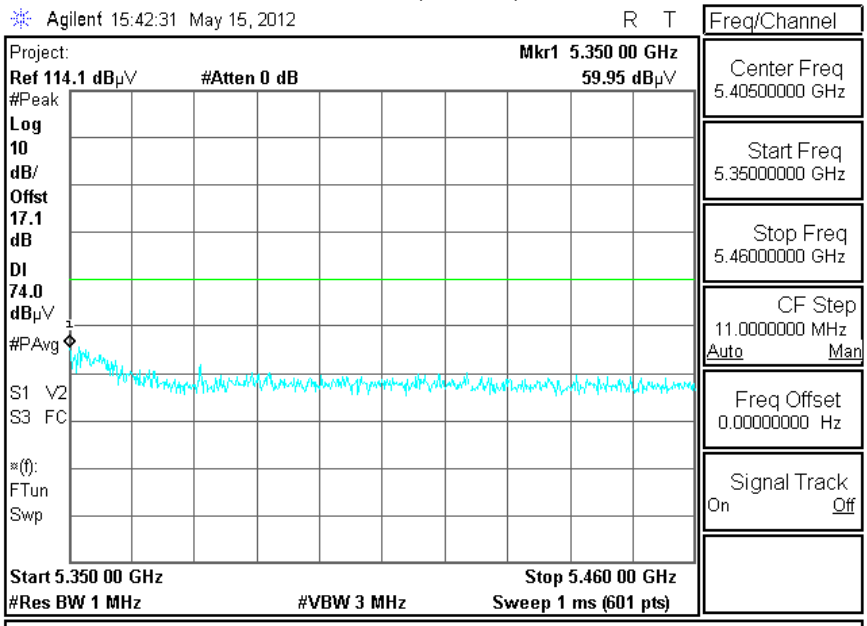
9.2.2. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.3 GHz BAND

RESTRICTED BANDEDGE (HIGH CHANNEL)

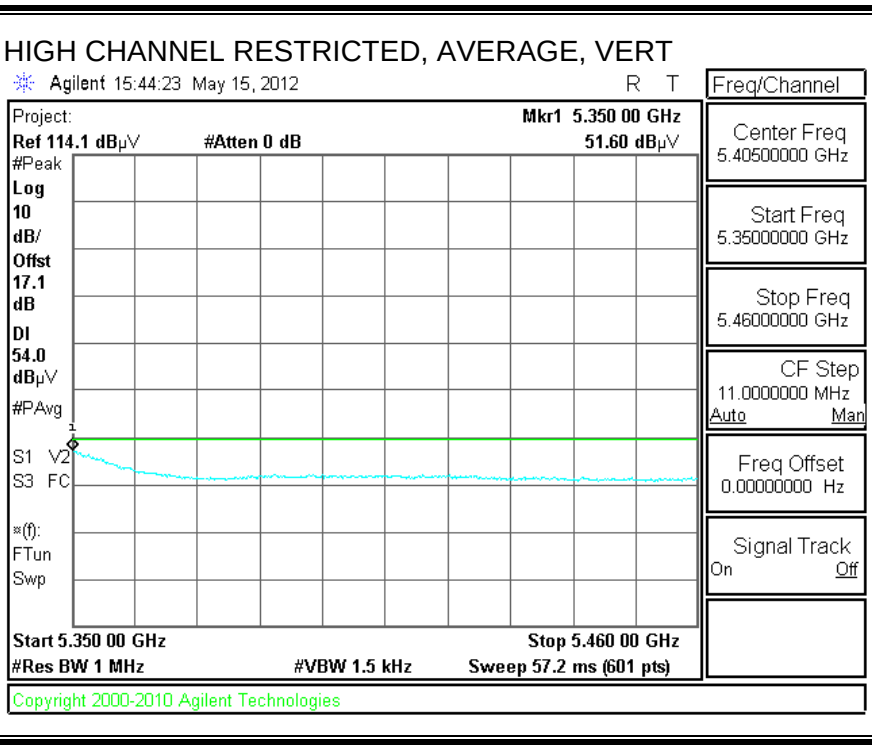




HIGH CHANNEL RESTRICTED, PEAK, VERT



HIGH CHANNEL RESTRICTED, AVERAGE, VERT



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 3m Chamber

Company: Sonos, Inc.
Project #: 12U14339
Date: 5/16/2012
Test Engineer: David Garcia
Configuration: EUT standalone, 2 10BT cables connected
Mode: 5.3GHz 11n HT20 MCS9

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T60; S/N: 2238 @3m	T34 HP 8449B	T88 Miteq 26-40GHz	T89; ARA 18-26GHz; S/N:1049	FCC 15.205

Hi Frequency Cables

3' cable 22807700	12' cable 22807600	20' cable 22807500	HPF	Reject Filter
3' cable 22807700	12' cable 22807600	20' cable 22807500		R_001

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

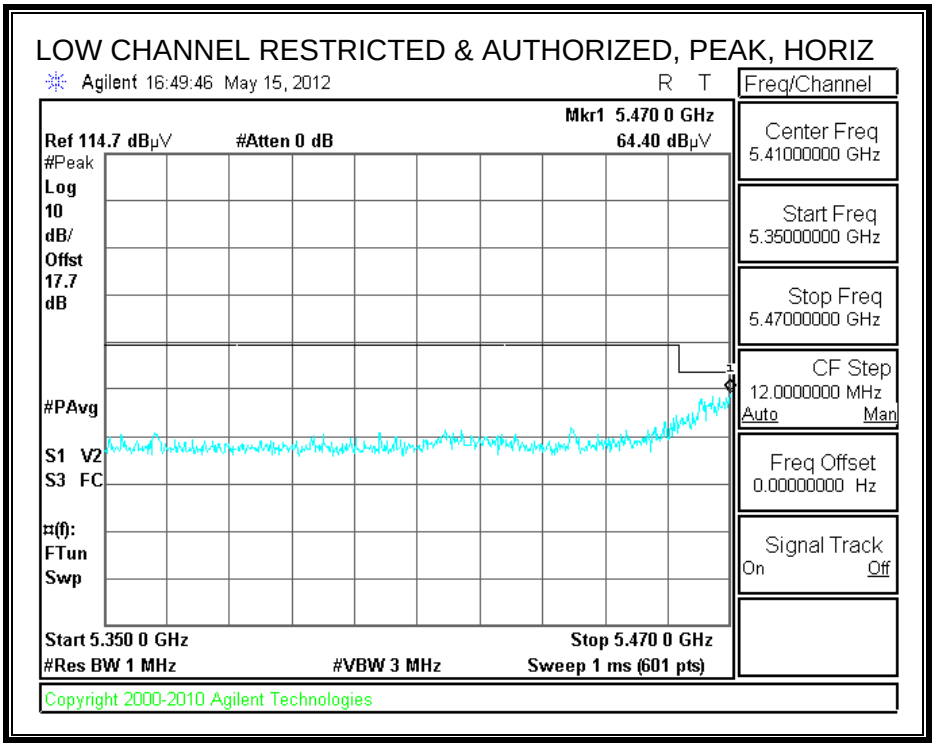
f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
Low Channel: 5260 MHz															
15.780	3.0	34.6	25.1	38.2	13.1	-31.9	0.0	0.0	54.1	44.5	74	54	-19.9	-9.5	H
15.780	3.0	34.8	25.0	38.2	13.1	-31.9	0.0	0.0	54.2	44.4	74	54	-19.8	-9.6	V
Mid Channel: 5300 MHz															
10.600	3.0	35.9	25.4	38.4	9.9	-32.5	0.0	0.0	51.7	41.2	74	54	-22.3	-12.8	H
10.600	3.0	35.5	25.5	38.4	9.9	-32.5	0.0	0.0	51.3	41.3	74	54	-22.7	-12.7	V
15.900	3.0	35.2	25.2	37.8	13.2	-31.8	0.0	0.0	54.3	44.3	74	54	-19.7	-9.7	H
15.900	3.0	34.7	25.3	37.8	13.2	-31.8	0.0	0.0	53.8	44.4	74	54	-20.2	-9.6	V
High Channel: 5320 MHz															
10.640	3.0	34.9	25.4	38.4	10.0	-32.5	0.0	0.0	50.8	41.3	74	54	-23.2	-12.7	H
10.640	3.0	35.2	25.1	38.4	10.0	-32.5	0.0	0.0	51.1	41.0	74	54	-22.9	-13.0	V
15.960	3.0	35.6	25.4	37.6	13.2	-31.8	0.0	0.0	54.5	44.4	74	54	-19.5	-9.6	H
15.960	3.0	35.4	25.3	37.6	13.2	-31.8	0.0	0.0	54.3	44.3	74	54	-19.7	-9.7	V

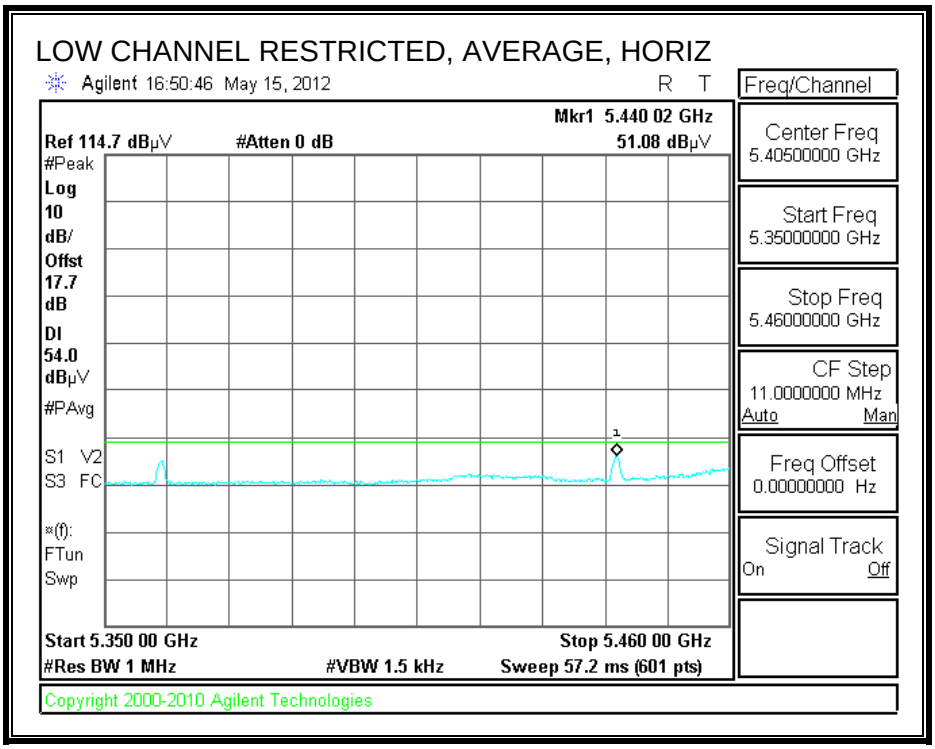
Rev. 11.10.11

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		

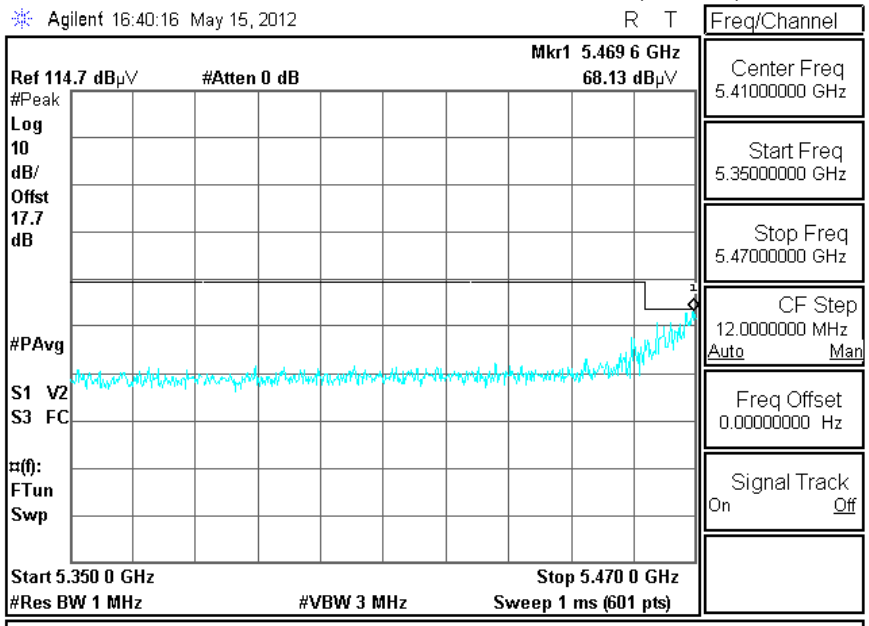
9.2.3. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.6 GHz BAND

RESTRICTED & AUTHORIZED BANDEDGE (LOW CHANNEL)

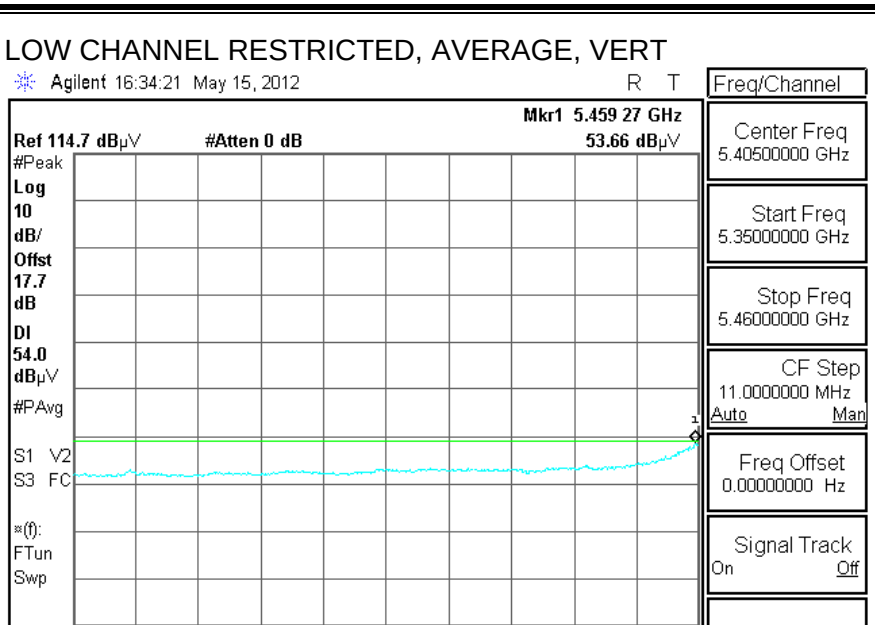




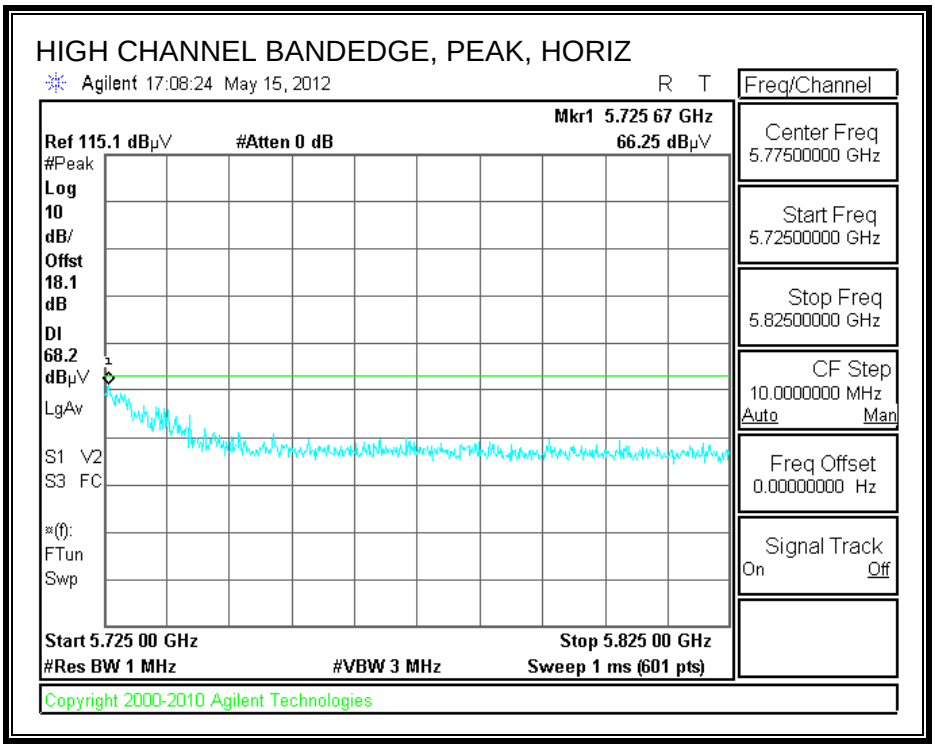
LOW CHANNEL RESTRICTED & AUTHORIZED, PEAK, VERT

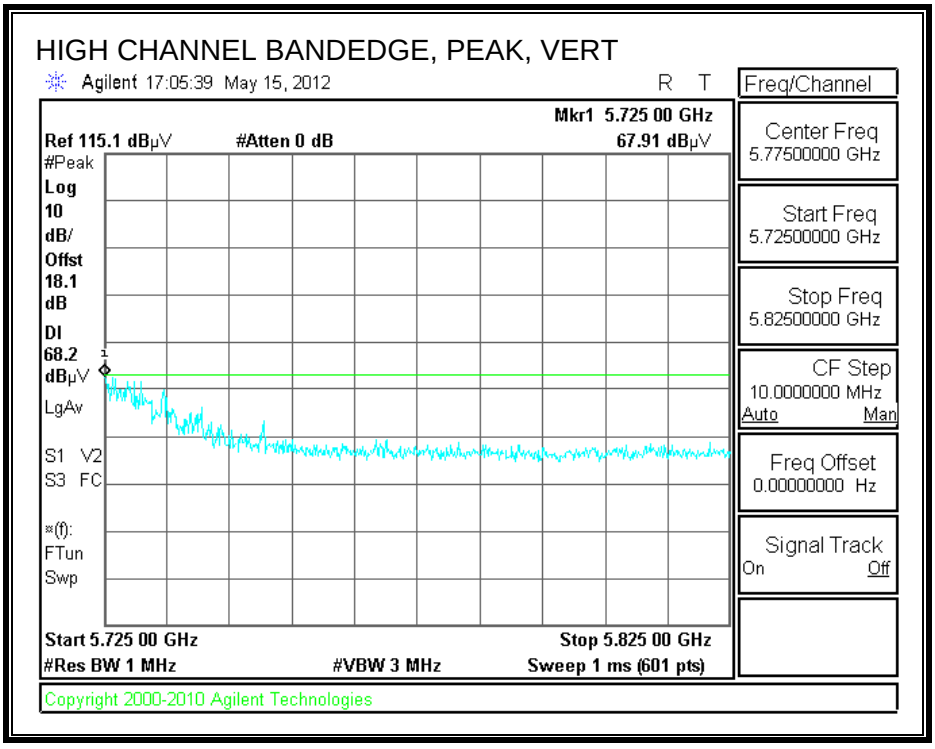


LOW CHANNEL RESTRICTED, AVERAGE, VERT



AUTHORIZED BANDEDGE (HIGH CHANNEL)





HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 3m Chamber

Company: Sonos, Inc.
Project #: 12U14339
Date: 5/16/2012
Test Engineer: David Garcia
Configuration: EUT standalone, 2 10BT cables connected
Mode: 5.5GHz 11n HT20 MCS9

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T60; S/N: 2238 @3m	T34 HP 8449B	T88 Miteq 26-40GHz	T89; ARA 18-26GHz; S/N:1049	FCC 15.205

Hi Frequency Cables

3' cable 22807700	12' cable 22807600	20' cable 22807500	HPF	Reject Filter
3' cable 22807700	12' cable 22807600	20' cable 22807500		R_001

Peak Measurements
RBW=VBW=1MHz
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)
Low Channel: 5500 MHz															
11.000	3.0	37.4	26.6	38.4	10.5	-32.4	0.0	0.0	53.9	43.0	74	54	-20.1	-11.0	H
11.000	3.0	36.2	25.7	38.4	10.5	-32.4	0.0	0.0	52.7	42.1	74	54	-21.3	-11.9	V
Mid Channel: 5580 MHz															
11.160	3.0	34.5	27.0	38.5	10.7	-32.4	0.0	0.0	51.4	43.8	74	54	-22.6	-10.2	H
11.160	3.0	34.5	27.5	38.5	10.7	-32.4	0.0	0.0	51.4	44.3	74	54	-22.6	-9.7	V
High Channel: 5700 MHz															
11.400	3.0	35.9	27.3	38.8	11.1	-32.4	0.0	0.0	53.3	44.8	74	54	-20.7	-9.2	H
11.400	3.0	34.1	25.4	38.8	11.1	-32.4	0.0	0.0	51.6	42.9	74	54	-22.4	-11.1	V

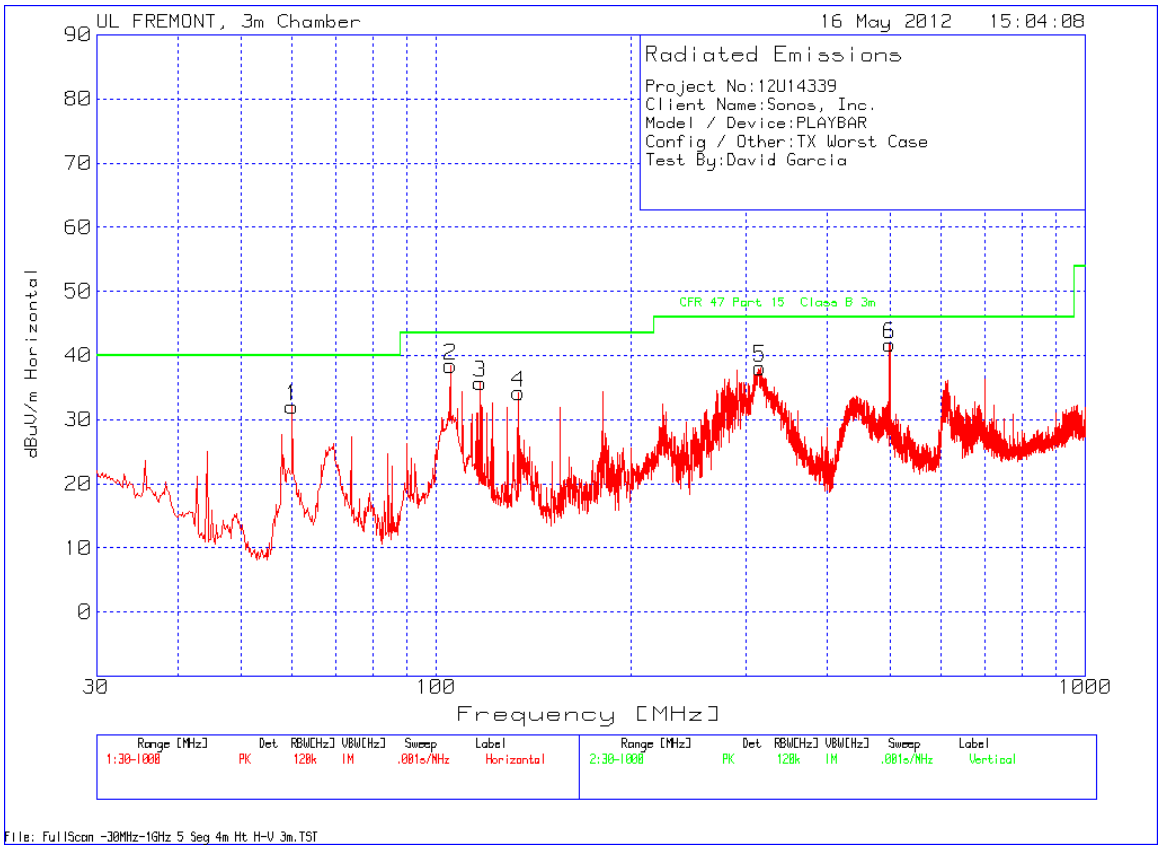
Rev. 11.10.11

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		

9.3. WORST-CASE BELOW 1 GHz

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

HORIZONTAL PLOT



HORIZONTAL DATA

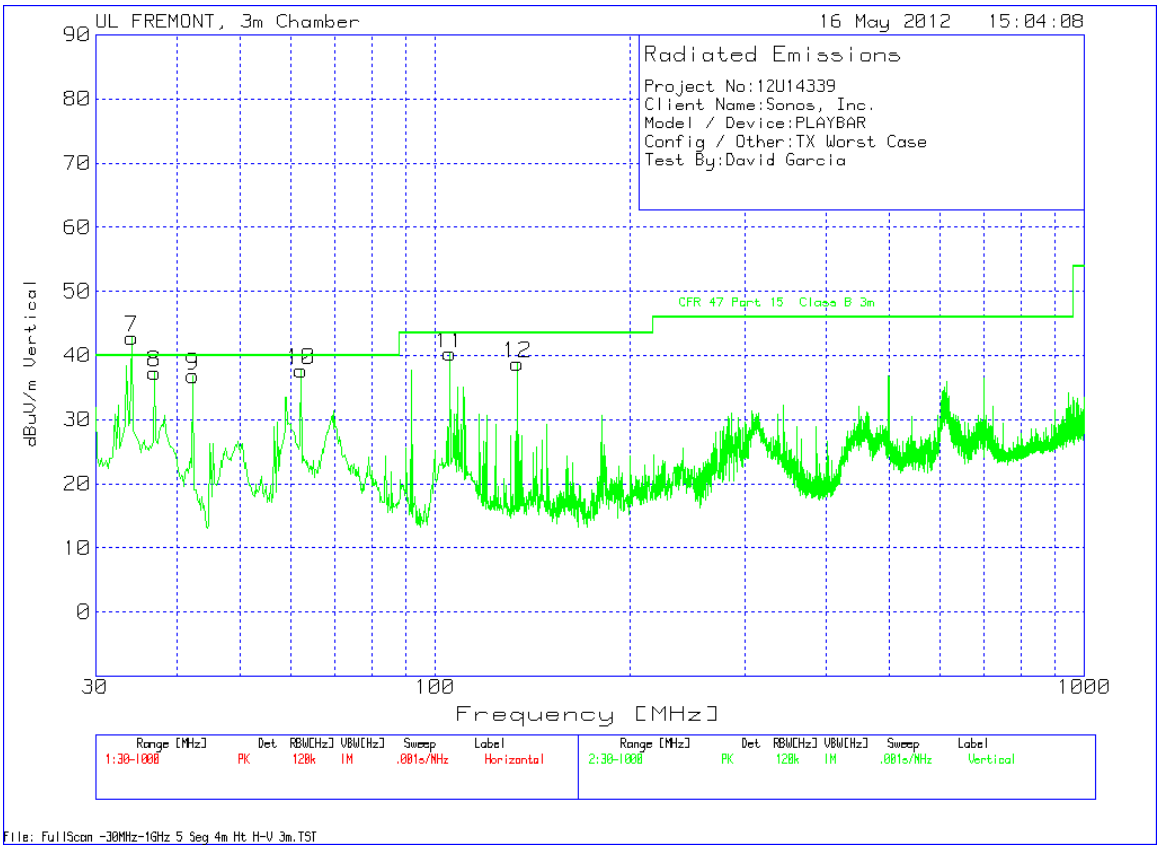
Project No: 12U14339
Client Name: Sonos, Inc.
Model / Device: PLAYBAR
Config / Other: TX Worst Case
Test By: David Garcia

Test Frequency	Meter Reading	Detector	3m-Chamber Amp [dB]	T185 Bilog [dB/m]	Corrected dBuV/m	FCC ClassB 3m Limit	Margin	Height [cm]	Polarity
60.046	52.0	PK	-27.2	7.2	32.0	40.0	-8.0	301	Horz
105.212	53.8	PK	-26.8	11.4	38.4	43.5	-5.1	400	Horz
117.036	48.8	PK	-26.6	13.5	35.7	43.5	-7.8	201	Horz
134.095	47.3	PK	-26.5	13.4	34.2	43.5	-9.3	201	Horz
315.727	49.6	PK	-25.2	13.7	38.1	46.0	-7.9	100	Horz
499.880	50.0	PK	-25.9	17.7	41.8	46.0	-4.2	201	Horz

PK - Peak detector
QP - Quasi-Peak detector

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

VERTICAL PLOT



VERTICAL DATA

Project No: 12U14339
Client Name: Sonos, Inc.
Model / Device: PLAYBAR
Config / Other: TX Worst Case
Test By: David Garcia

Test Frequency	Meter Reading	Detector	3m-Chamber Amp [dB]	T185 Bilog [dB/m]	Corrected dBuV/m	FCC ClassB 3m Limit	Margin	Height [cm]	Polarity
34.071	32.1	QP	-27.5	18.2	22.8	40.0	-17.2	110	Vert
36.978	48.7	PK	-27.4	16.0	37.3	40.0	-2.7	301	Vert
42.406	52.3	PK	-27.4	12.0	36.9	40.0	-3.1	201	Vert
62.178	57.4	PK	-27.2	7.5	37.7	40.0	-2.3	201	Vert
105.406	55.6	PK	-26.8	11.5	40.3	43.5	-3.2	100	Vert
133.901	51.9	PK	-26.5	13.4	38.8	43.5	-4.8	100	Vert

PK - Peak detector
QP - Quasi-Peak detector

10. 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

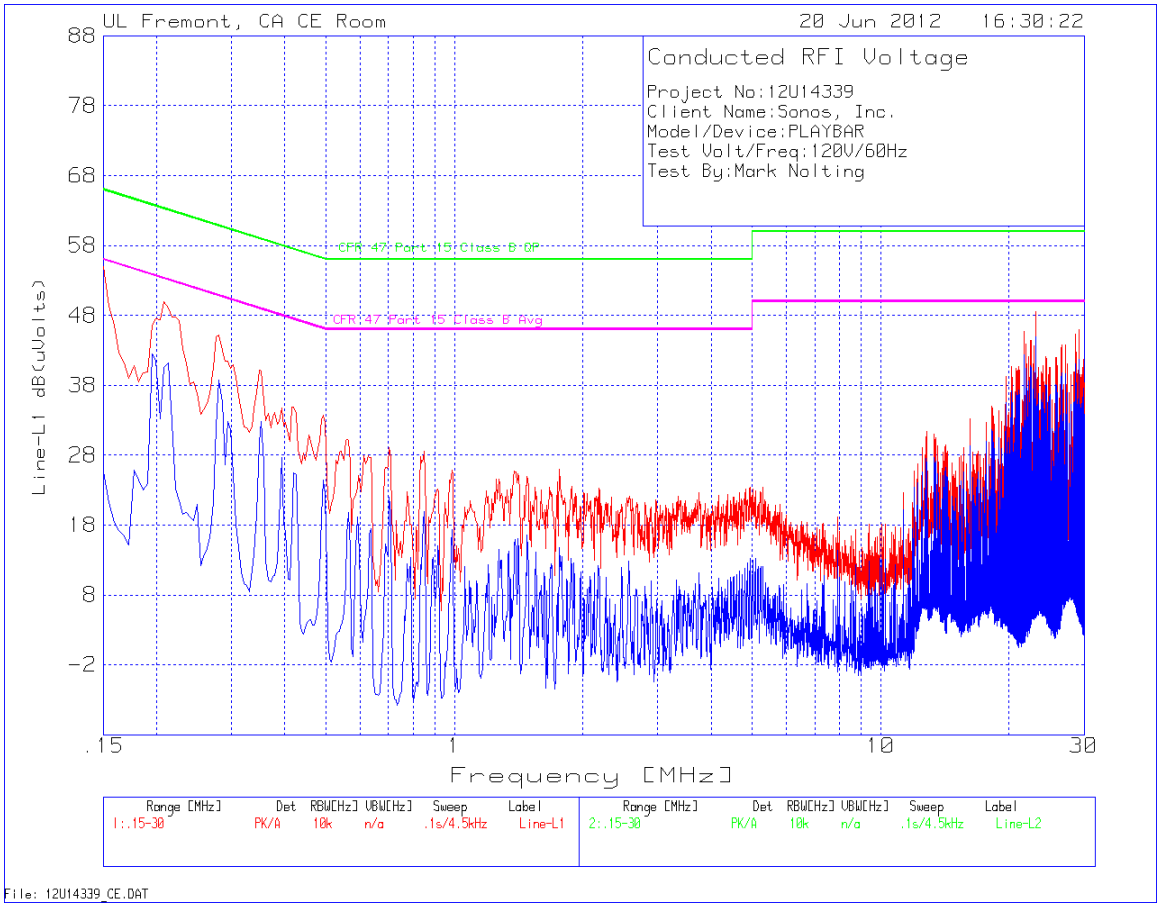
* Decreases with the logarithm of the frequency.

TEST PROCEDURE

ANSI C63.4

RESULTS

LINE 1 PLOT



WORST EMISSIONS

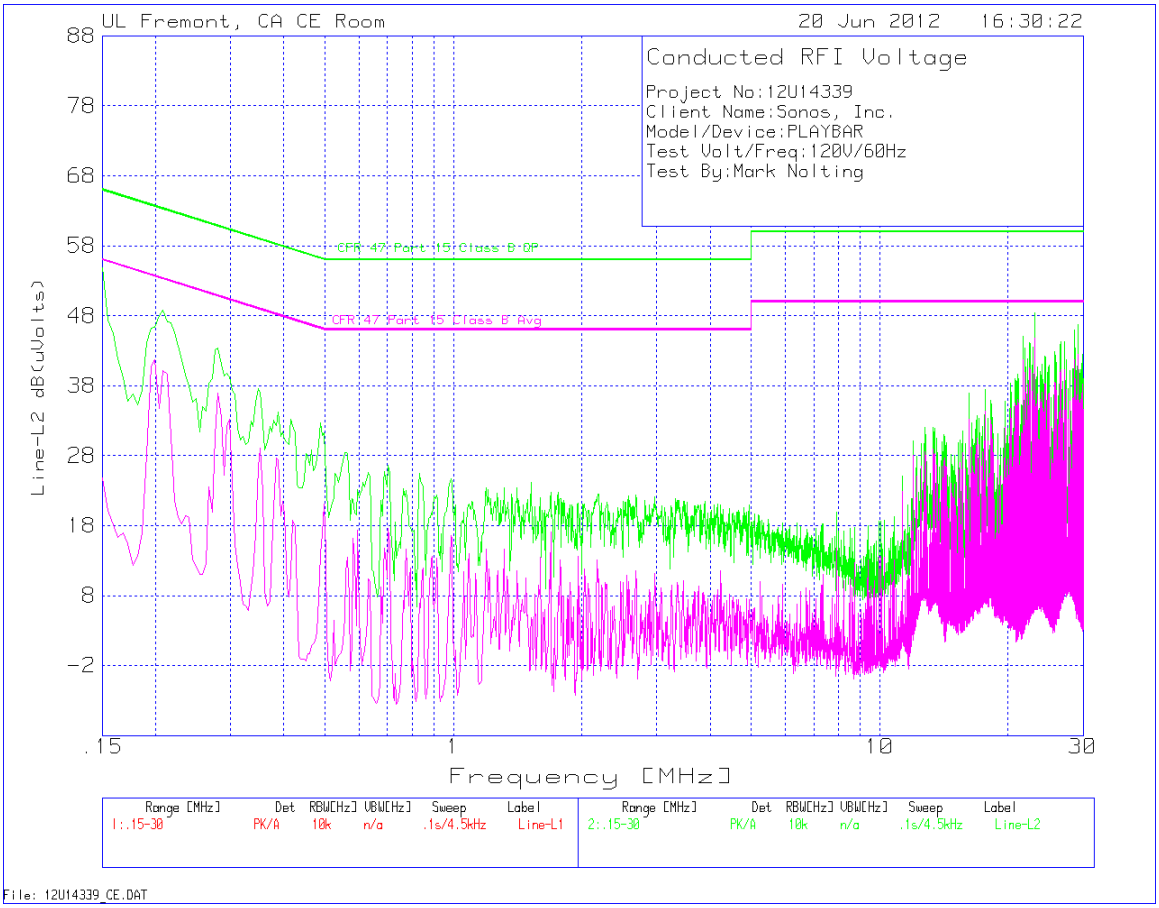
LINE 1 DATA

Project No: 12U14339
Client Name: Sonos, Inc.
Model/Device: PLAYBAR
Test Volt/Freq: 120V/60Hz
Tested By: Mark Nolting

Frequency [MHz]	Meter Reading [dBuV]	Detector	T24 AMN Factor [dB]	Cable Loss [dB]	Corrected Reading [dBuV]	FCC Class-B QP Limit [dBuV]	Margin [dB]	FCC Class-B Av Limit [dBuV]	Margin [dB]
0.1500	54.9	PK	0.1	0.0	55.0	66.0	-11.0	-	-
0.2085	49.9	PK	0.1	0.0	50.0	63.3	-13.4	-	-
0.2805	45.0	PK	0.1	0.0	45.1	60.8	-15.7	-	-
21.6600	45.2	PK	0.3	0.2	45.7	60.0	-14.3	-	-
23.1270	47.9	PK	0.4	0.2	48.5	60.0	-11.5	-	-
29.2335	45.2	PK	0.5	0.3	46.0	60.0	-14.0	-	-
0.1500	25.5	Av	0.1	0.0	25.6	-	-	56.0	-30.4
0.2085	40.5	Av	0.1	0.0	40.6	-	-	53.3	-12.8
0.2805	38.6	Av	0.1	0.0	38.7	-	-	50.8	-12.1
21.6600	41.9	Av	0.3	0.2	42.4	-	-	50.0	-7.6
23.1270	44.3	Av	0.4	0.2	44.9	-	-	50.0	-5.1
29.2335	41.0	Av	0.5	0.3	41.8	-	-	50.0	-8.3

PK - Peak detector
QP - Quasi-Peak detector
Av - Average detector

LINE 2 PLOT



WORST EMISSIONS

LINE 2 DATA

Project No: 12U14339
Client Name: Sonos, Inc.
Model/Device: PLAYBAR
Test Volt/Freq: 120V/60Hz
Tested By: Mark Nolting

Frequency [MHz]	Meter Reading [dBuV]	Detector	T24 AMN Factor [dB]	Cable Loss [dB]	Corrected Reading [dBuV]	FCC Class-B QP Limit [dBuV]	Margin [dB]	FCC Class-B Av Limit [dBuV]	Margin [dB]
0.1500	54.8	PK	0.1	0.0	54.9	66.0	-11.2	-	-
0.2085	48.7	PK	0.1	0.0	48.8	63.3	-14.5	-	-
0.2805	43.3	PK	0.1	0.0	43.4	60.8	-17.4	-	-
21.6600	44.6	PK	0.3	0.2	45.1	60.0	-14.9	-	-
23.1270	47.9	PK	0.4	0.2	48.5	60.0	-11.5	-	-
29.2335	45.9	PK	0.5	0.3	46.7	60.0	-13.3	-	-
0.1500	24.8	Av	0.1	0.0	24.9	-	-	56.0	-31.1
0.2085	40.1	Av	0.1	0.0	40.2	-	-	53.3	-13.1
0.2805	36.8	Av	0.1	0.0	36.9	-	-	50.8	-13.9
21.6600	41.2	Av	0.3	0.2	41.7	-	-	50.0	-8.3
23.1270	44.2	Av	0.4	0.2	44.8	-	-	50.0	-5.2
29.2335	41.7	Av	0.5	0.3	42.5	-	-	50.0	-7.6

PK - Peak detector
QP - Quasi-Peak detector
Av - Average detector

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

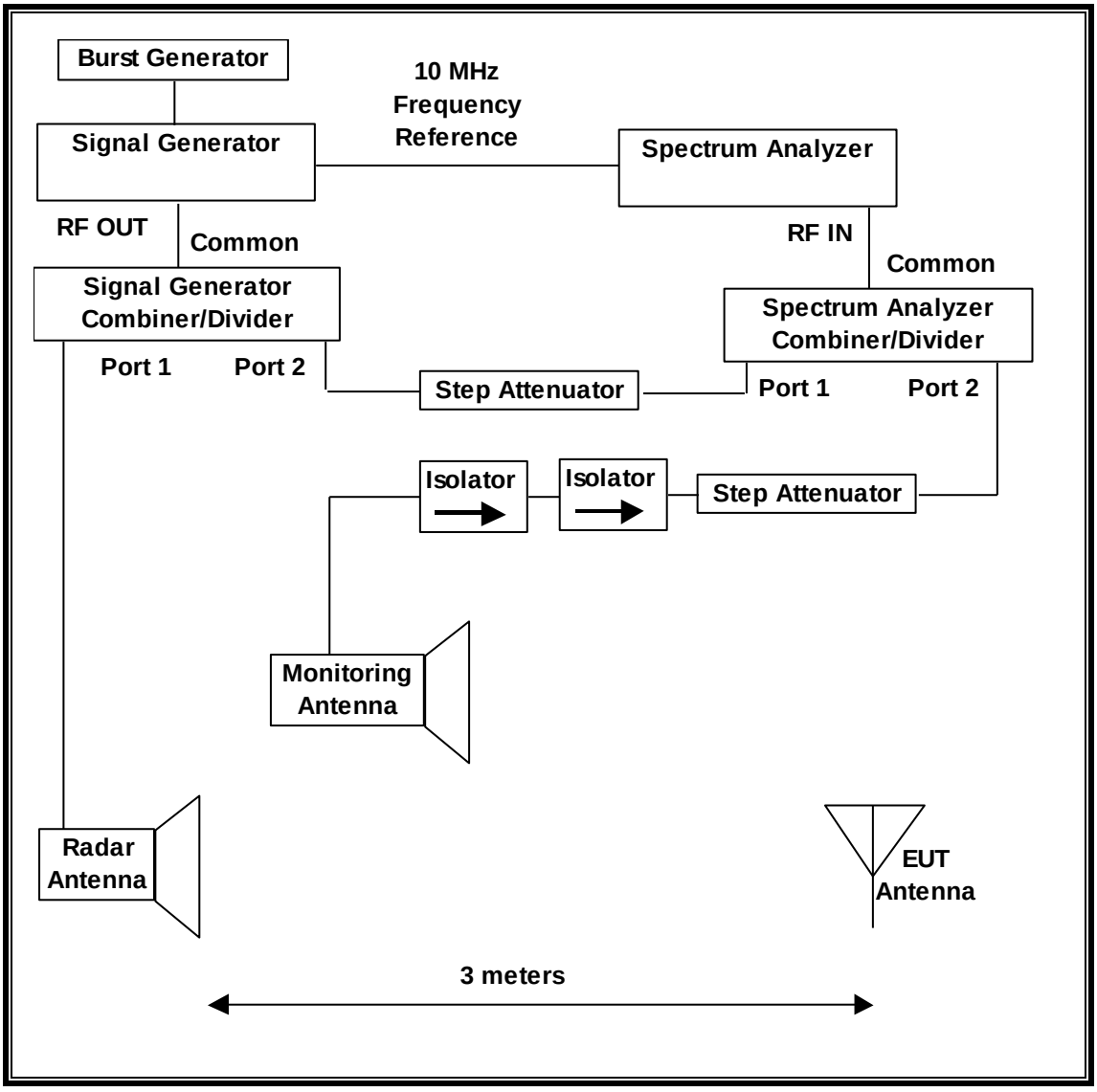
Radar Waveform	Bursts	Pulses per Burst	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Minimum Percentage of Successful Detection	Minimum Trials
5	8-20	1-3	50-100	5-20	1000-2000	80%	30

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.

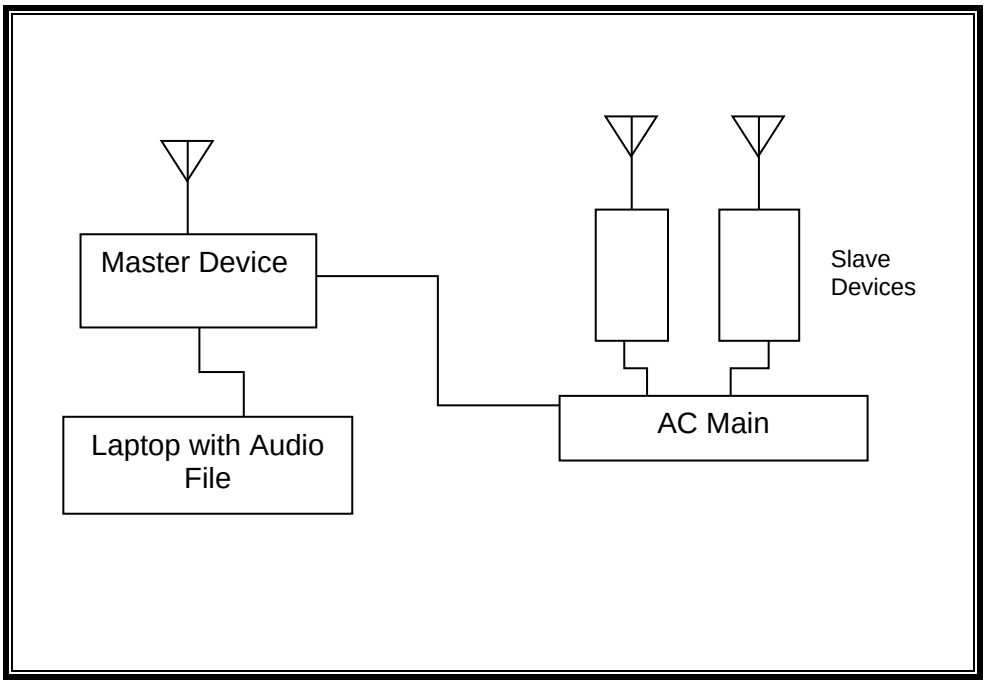
TEST AND MEASUREMENT EQUIPMENT

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

Test Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**Cal Date**
Spectrum Analyzer, 44 GHz	Agilent/HP	E4446A	C01069	12/15/12
Vector signal generator, 20 GHz	Agilent/HP	E8267C	C01066	08/15/12
Arbitrary Waveform Generator	Agilent/HP	33220A	C01146	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**
AC Adapter	**Lenovo**	**92P1156**	**11S92P1156Z1ZDXN09W40R**	**Doc**
Laptop	**Lenovo**	**X200**	**R9-20V1F10/03**	**Doc**
Slave HiFi System 1	**Sunos**	**Play:3**	**1106-00-0E-58-78-09-98-C**	**N/A**
Slave HiFi System 2	**Sunos**	**Play:3**	**1105-00-0OE-58-78-05-5E-1**	**N/A**

11.1.4. DESCRIPTION OF EUT

The EUT operates over the 5250-5350 MHz and 5470-5725 MHz ranges, excluding channels which would overlap the 5600-5650 MHz band.

The EUT is a Master Device.

The highest power level within these bands is 22.78 dBm EIRP in the 5250-5350 MHz band and 23.77 dBm EIRP in the 5470-5725 MHz band.

The highest gain antenna assembly utilized with the EUT has a gain of 5.9 dBi in the 5250-5350 MHz band and 6 dBi in the 5470-5725 MHz band. The lowest gain antenna assembly utilized with the EUT has a gain of 4 dBi in the 5250-5350 MHz band and 4.2 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 margin to the limit.

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

The Slave device associated with the EUT during these tests does not have radar detection capability.

WLAN traffic was generated by streaming the NTIA audio test file from the Master to the Slave using the media player using the media player with the V2.61 Codec package.

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

The EUT utilizes the 802.11n architecture. One nominal channel bandwidth, 20 MHz, is implemented.

The software installed in the Master Device is revision 20.2 with DFS Module revision 1

UNIFORM CHANNEL SPREADING

See Manufacturer's Attestation.

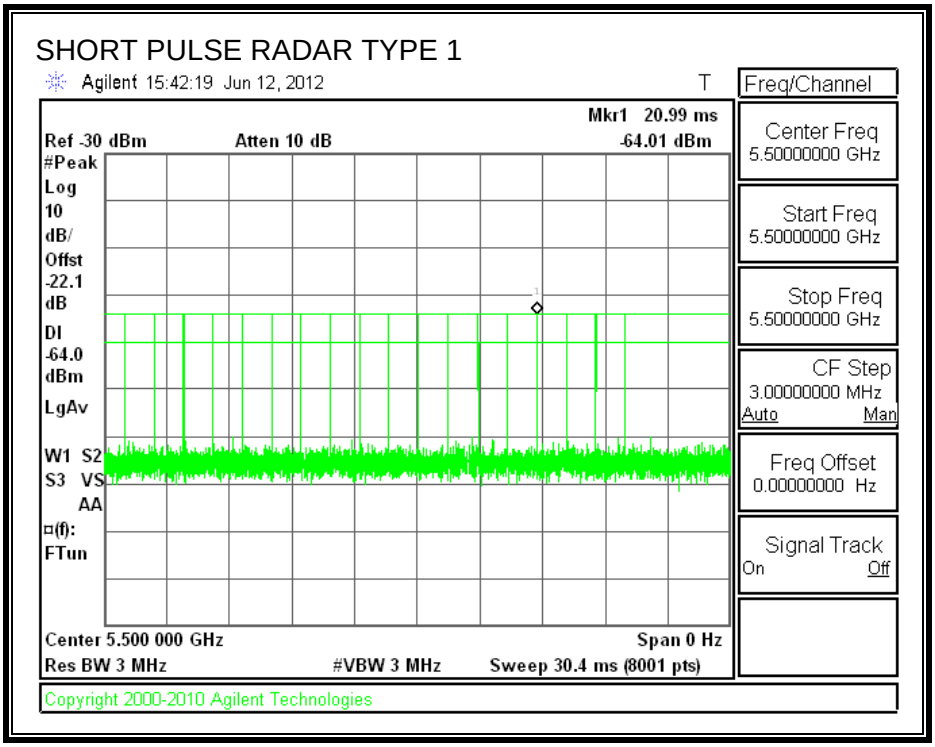
11.2. RESULTS FOR 20 MHz BANDWIDTH

11.2.1. TEST CHANNEL

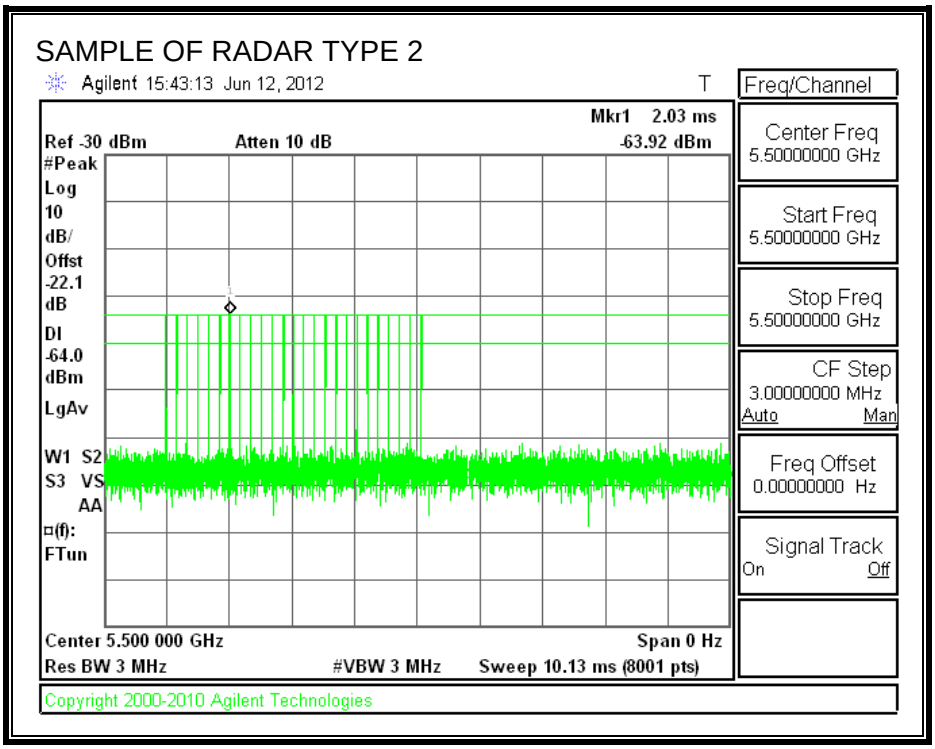
All tests were performed at a channel center frequency of 5500 MHz.

11.2.2. RADAR WAVEFORMS AND TRAFFIC

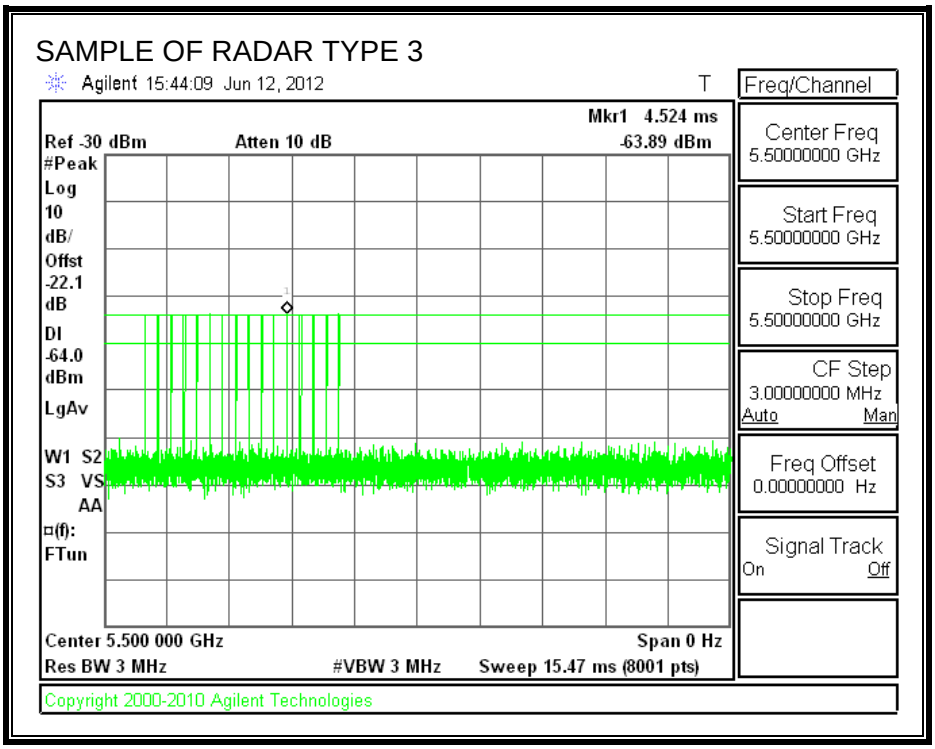
RADAR WAVEFORMS



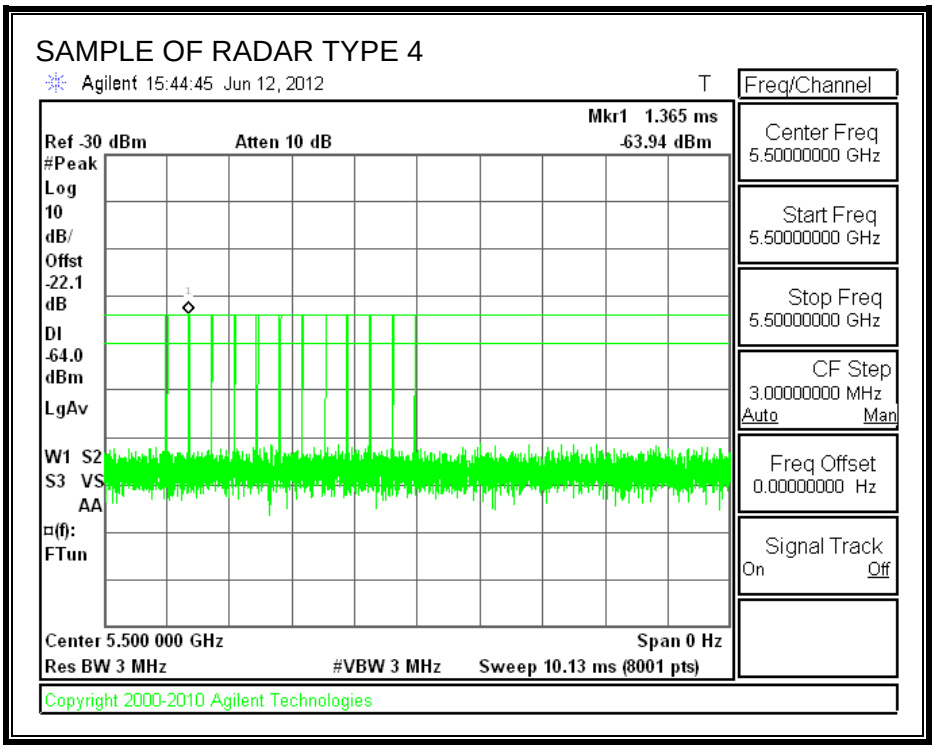
SAMPLE OF RADAR TYPE 2



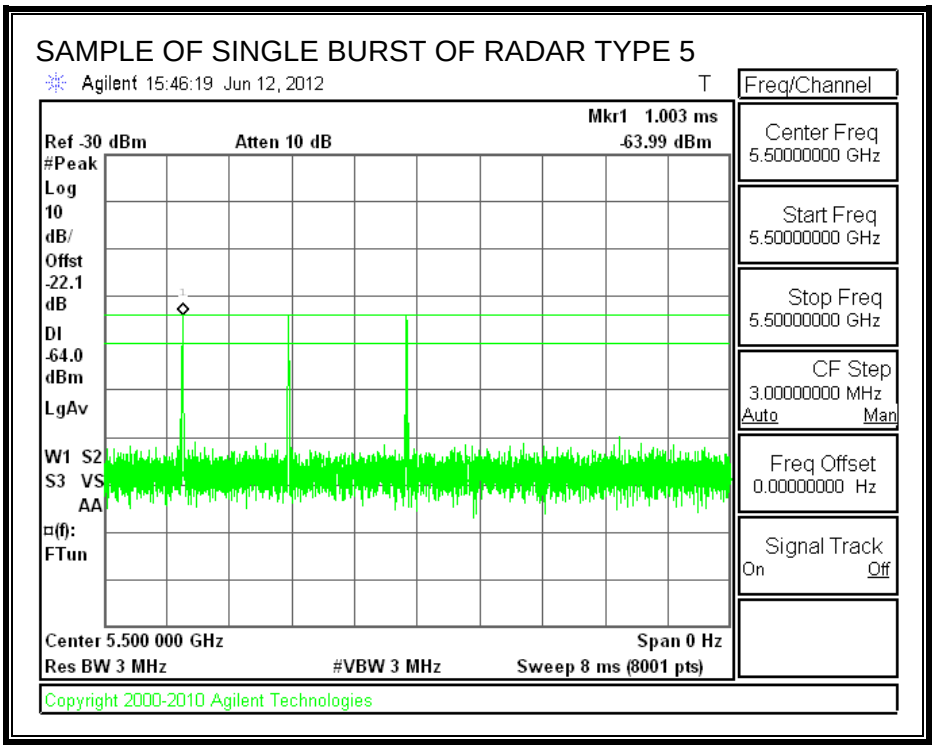
SAMPLE OF RADAR TYPE 3

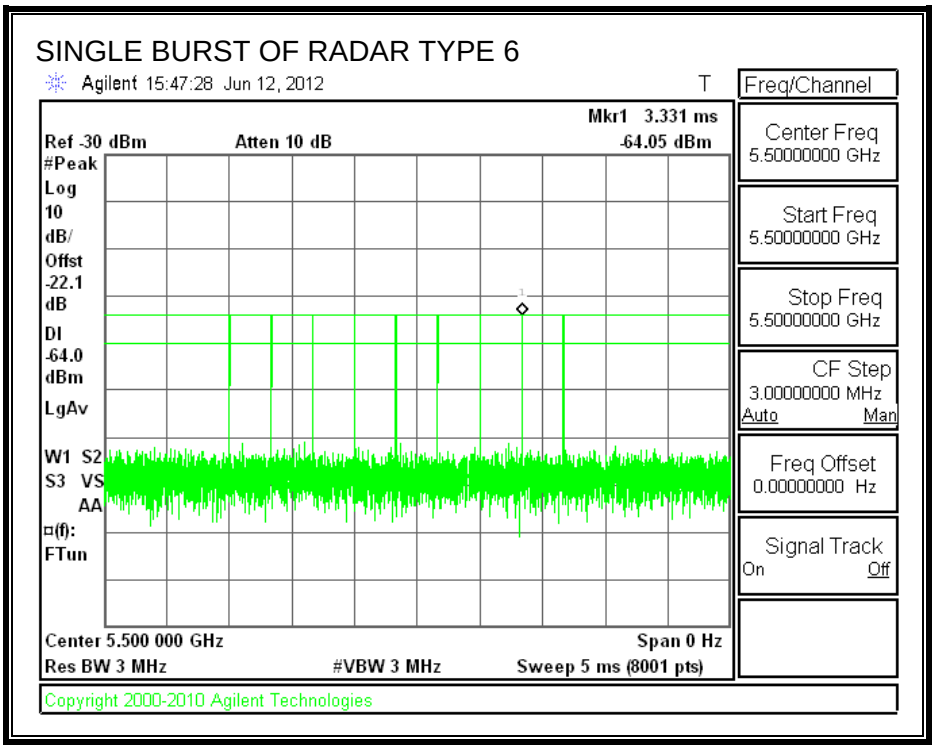


SAMPLE OF RADAR TYPE 4

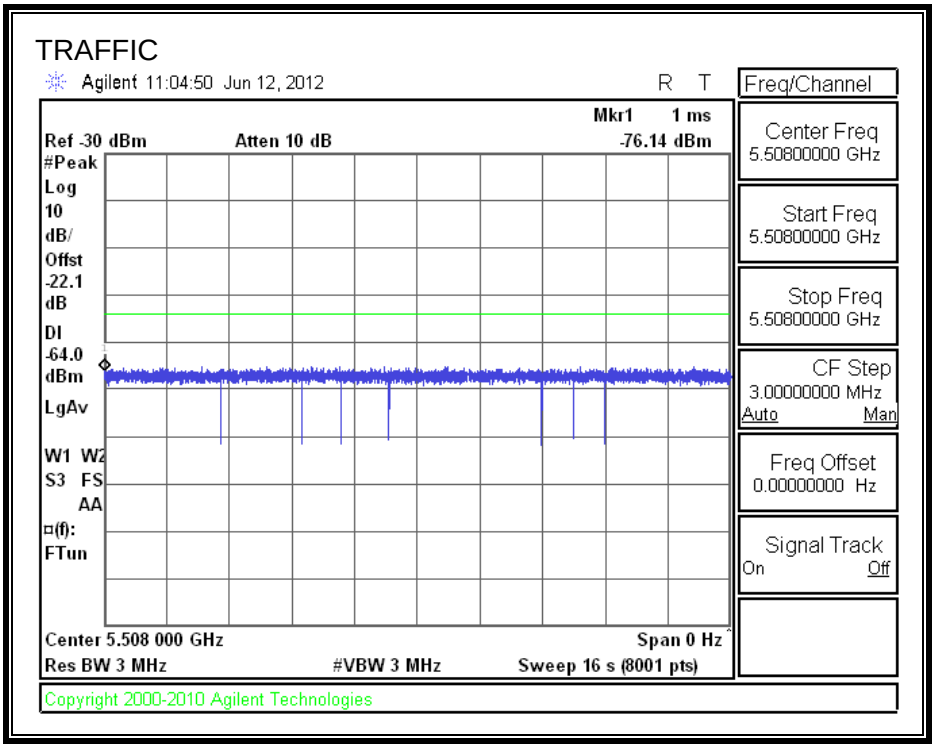


SAMPLE OF SINGLE BURST OF RADAR TYPE 5





TRAFFIC



11.2.3. CHANNEL AVAILABILITY CHECK TIME

PROCEDURE TO DETERMINE INITIAL POWER-UP CYCLE TIME

A link was established on channel then the EUT was rebooted. The time from the cessation of traffic to the re-initialization of traffic was measured as the time required for the EUT to complete the total power-up cycle. The time to complete the initial power-up period is 60 seconds less than this total power-up time.

PROCEDURE FOR TIMING OF RADAR BURST

With a link established on channel, the EUT was rebooted. A radar signal was triggered within 0 to 6 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.

The Non-Occupancy list was cleared. With a link established on channel, the EUT was rebooted. A radar signal was triggered within 54 to 60 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.

QUANTITATIVE RESULTS

No Radar Triggered

Start of CAC (sec)	Timing of Start of Traffic (sec)	Total Time of CAC (sec)
21	81.4	60.4

Radar Near Beginning of CAC

Start of CAC (sec)	Timing of Radar Burst (sec)	Radar Relative to CAC (sec)
20	21.5	1.5

Radar Near End of CAC

Start of CAC (sec)	Timing of Radar Burst (sec)	Radar Relative to CAC (sec)
20	78.9	58.9

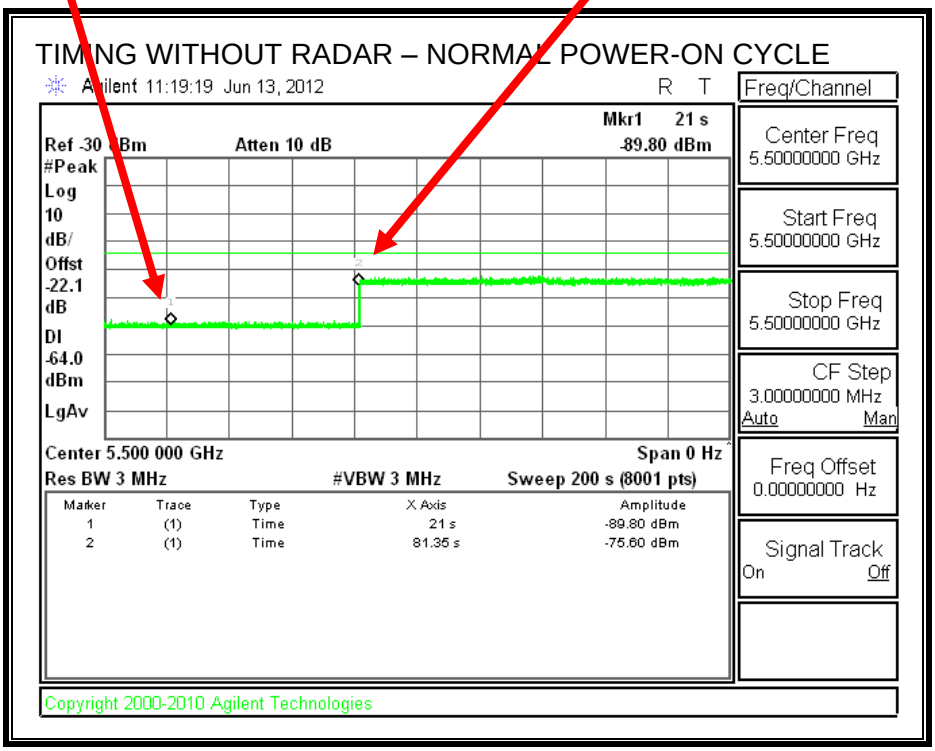
QUALITATIVE RESULTS

Timing of Radar Burst	Display on Control Computer	Spectrum Analyzer Display
No Radar Triggered	EUT marks Channel as active	Transmissions begin on channel after completion of the initial power-up cycle and the CAC
Within 0 to 6 second window	EUT indicates radar detected	No transmissions on channel
Within 54 to 60 second window	EUT indicates radar detected	No transmissions on channel

TIMING WITHOUT RADAR DURING CAC

Start of CAC

End of CAC
Traffic is Initiated

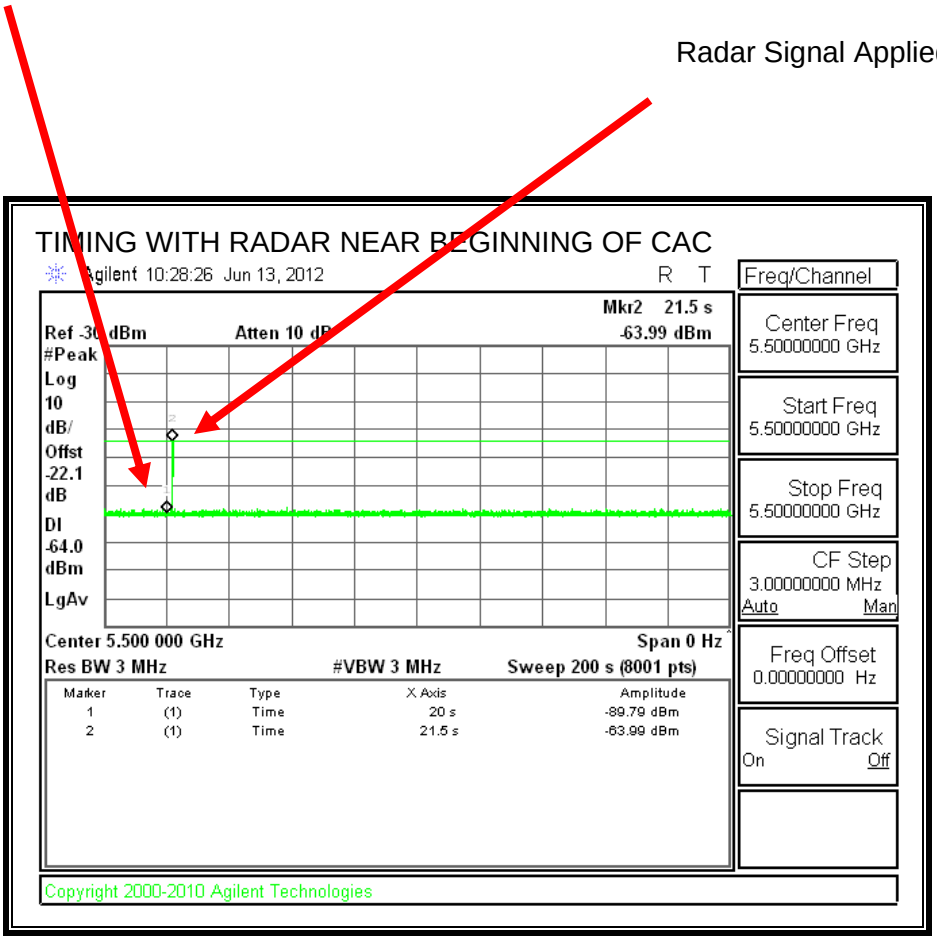


Transmissions begin on channel after completion of the initial power-up cycle and the CAC.

TIMING WITH RADAR NEAR BEGINNING OF CAC

Start of CAC

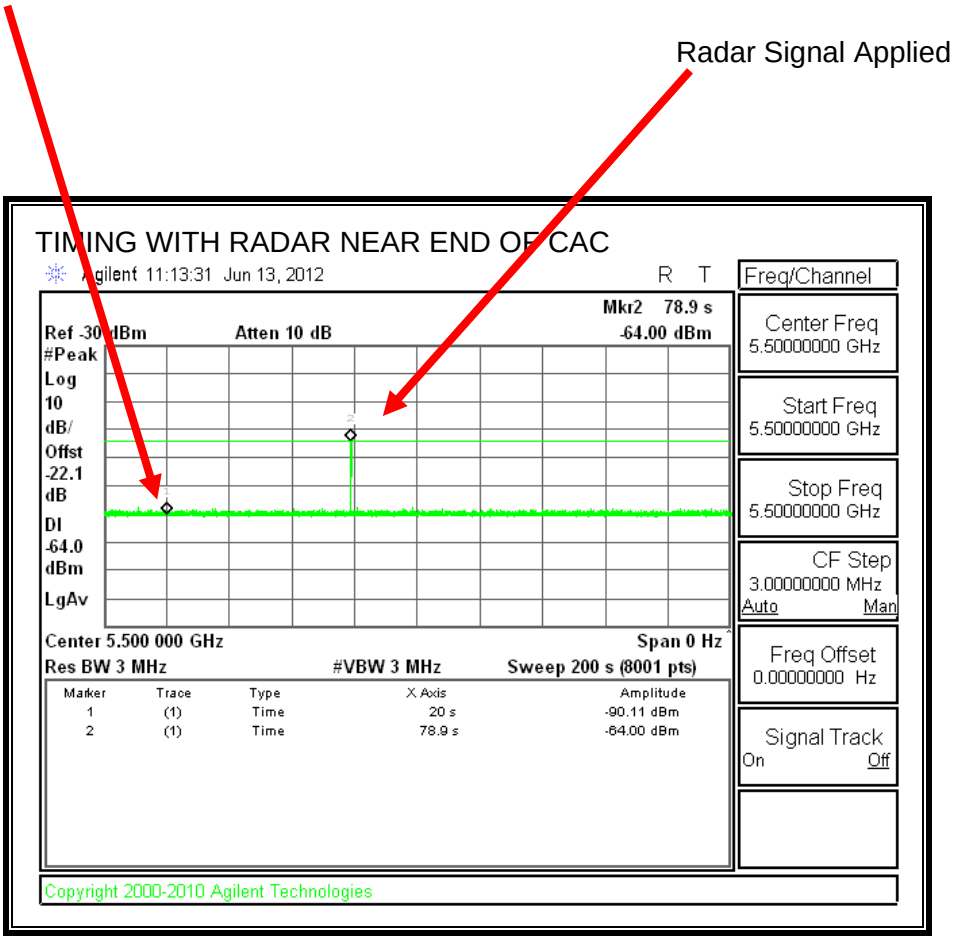
Radar Signal Applied



No EUT transmissions were observed after the radar signal.

TIMING WITH RADAR NEAR END OF CAC

Start of CAC



No EUT transmissions were observed after the radar signal.

11.2.4. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.2.5. 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).

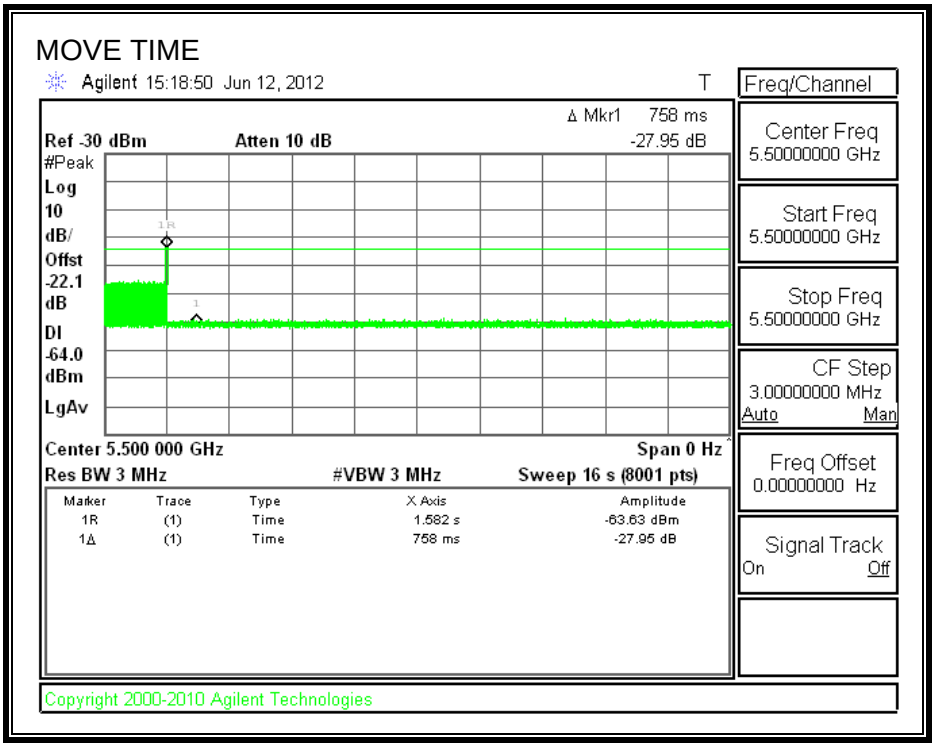
The observation period over which the IC aggregate time is calculated begins at (Reference Marker) and ends no earlier than (Reference Marker + 10 sec).

RESULTS

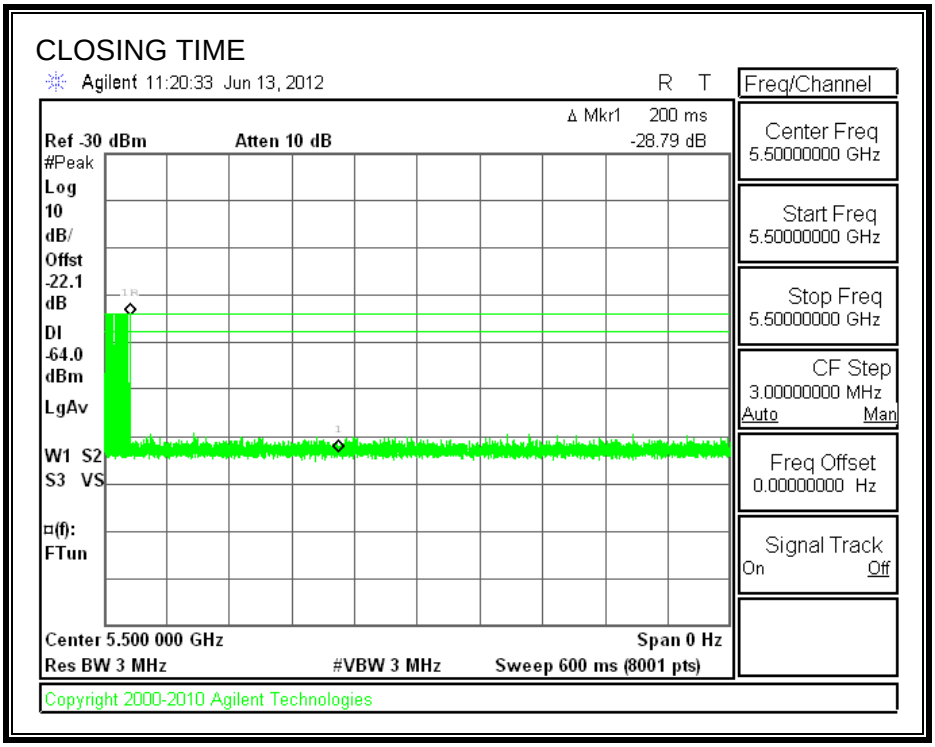
Agency	Channel Move Time (sec)	Limit (sec)
FCC / IC	0.000	10

Agency	Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
FCC	0.0	60
IC	0.0	260

MOVE TIME

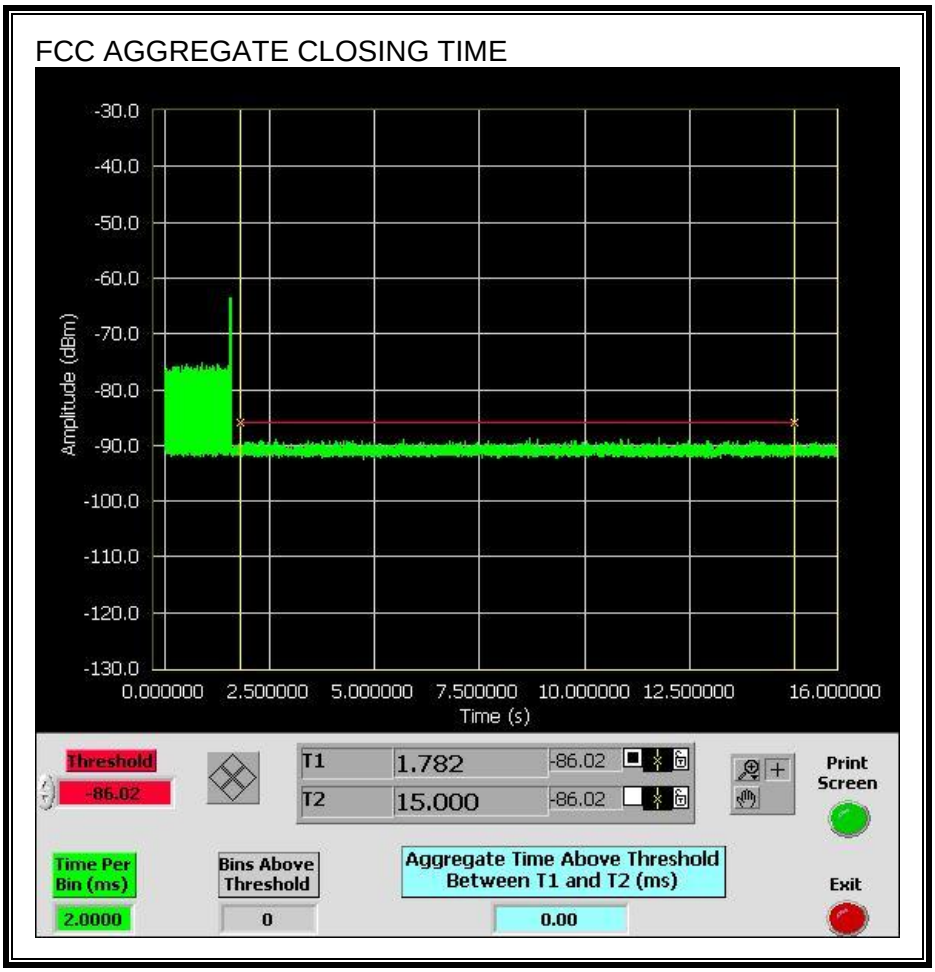


CHANNEL CLOSING TIME



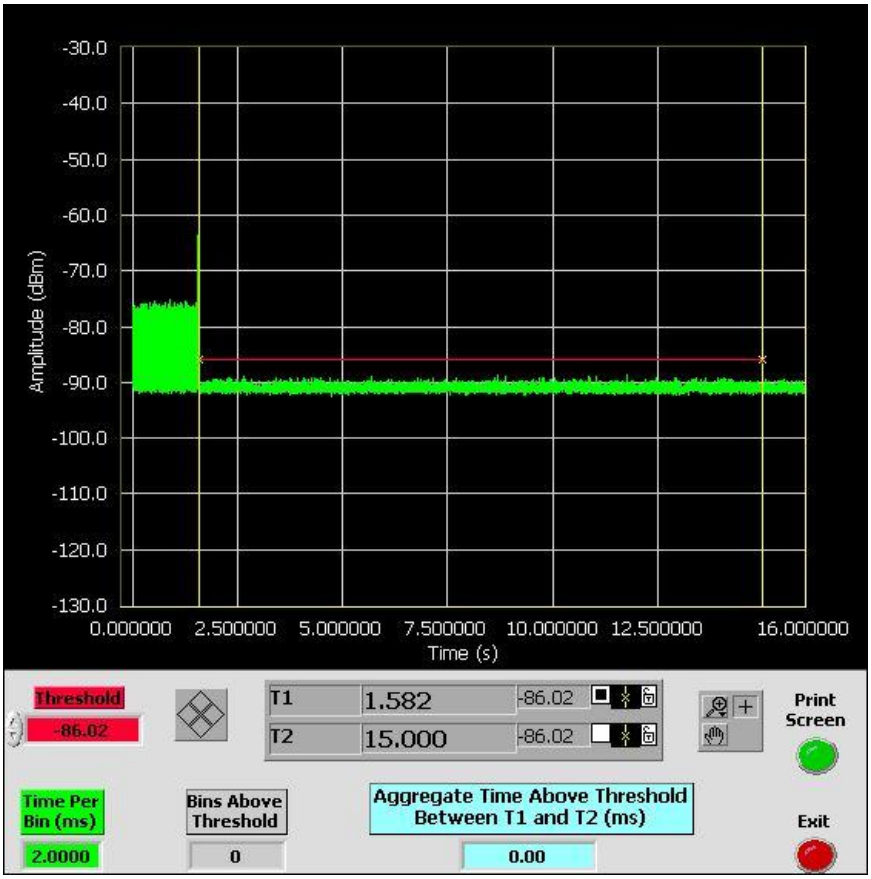
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No intermittent transmissions are observed during the FCC aggregate monitoring period.



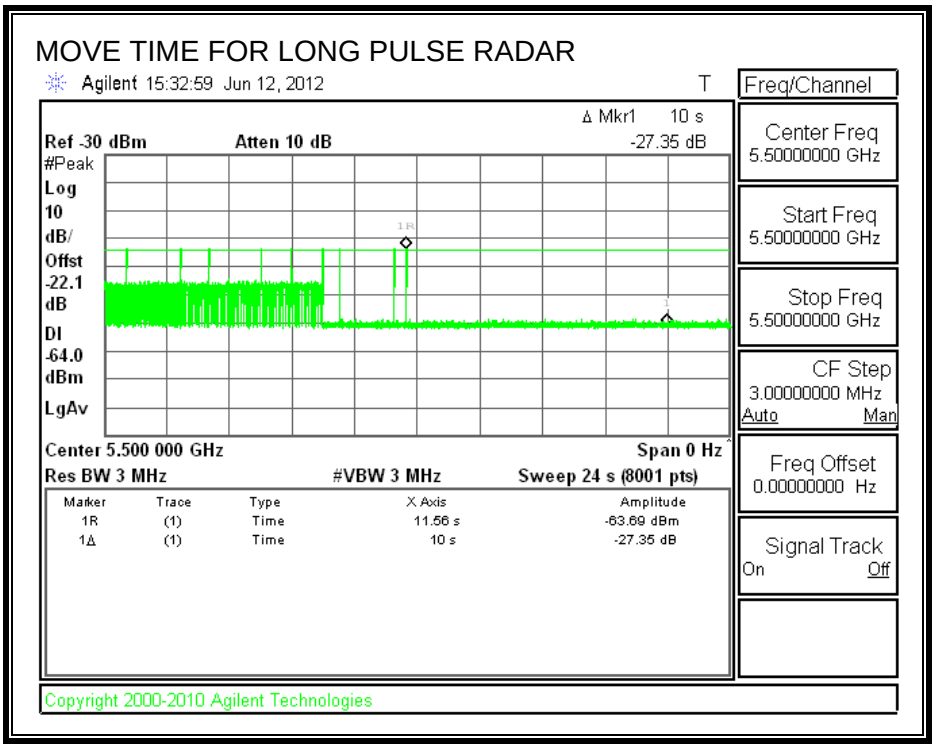
No intermittent transmissions are observed during the IC aggregate monitoring period.

IC AGGREGATE CLOSING TIME



LONG PULSE CHANNEL MOVE TIME

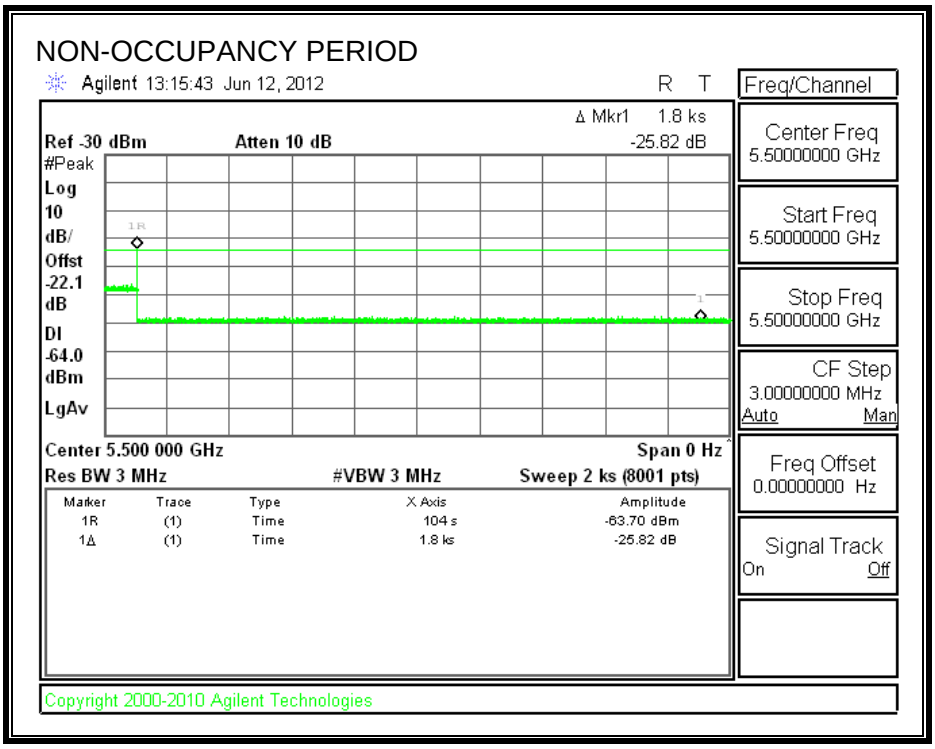
The traffic ceases prior to 10 seconds after the end of the radar waveform.



11.2.6. NON-OCCUPANCY PERIOD

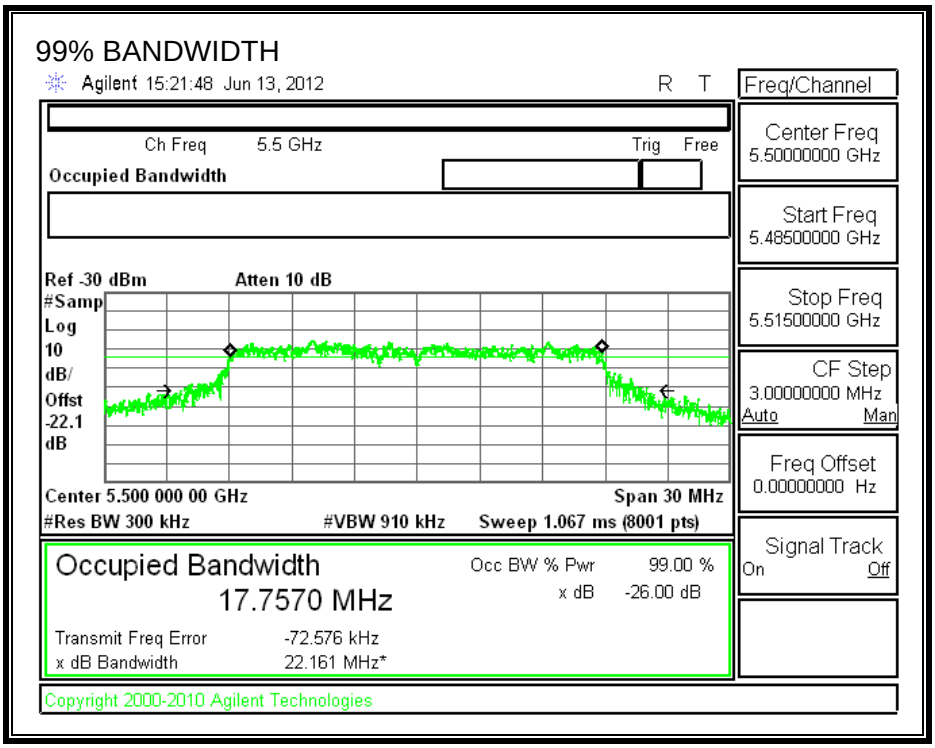
RESULTS

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



11.2.7. DETECTION BANDWIDTH

REFERENCE PLOT OF 99% POWER BANDWIDTH



RESULTS

FL (MHz)	FH (MHz)	Detection Bandwidth (MHz)	99% Power Bandwidth (MHz)	Ratio of Detection BW to 99% Power BW (%)	Minimum Limit (%)
5491	5509	18	17.757	101.4	80

DETECTION BANDWIDTH PROBABILITY

DETECTION BANDWIDTH PROBABILITY RESULTS

Detection Bandwidth Test Results				
FCC Type 1 Waveform: 1 us Pulse Width, 1428 us PRI, 18 Pulses per Burst				
Frequency (MHz)	Number of Trials	Number Detected	Detection (%)	Mark
5491	10	10	100	FL
5492	10	10	100	
5493	10	10	100	
5494	10	10	100	
5495	10	10	100	
5496	10	10	100	
5497	10	10	100	
5498	10	10	100	
5499	10	10	100	
5500	10	10	100	
5501	10	10	100	
5502	10	10	100	
5503	10	10	100	
5504	10	10	100	
5505	10	10	100	
5506	10	10	100	
5507	10	10	100	
5508	10	10	100	
5509	10	10	100	FH

11.2.8. IN-SERVICE MONITORING

RESULTS

FCC Radar Test Summary				
Signal Type	Number of Trials	Detection (%)	Limit (%)	Pass/Fail
FCC Short Pulse Type 1	30	100.00	60	Pass
FCC Short Pulse Type 2	30	80.00	60	Pass
FCC Short Pulse Type 3	30	83.33	60	Pass
FCC Short Pulse Type 4	30	73.33	60	Pass
Aggregate		84.17	80	Pass
FCC Long Pulse Type 5	30	90.00	80	Pass
FCC Hopping Type 6	34	91.18	70	Pass

TYPE 1 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 1	
1 us Pulse Width, 1428 us PRI, 18 Pulses per Burst	
Trial	Successful Detection (Yes/No)
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes
9	Yes
10	Yes
11	Yes
12	Yes
13	Yes
14	Yes
15	Yes
16	Yes
17	Yes
18	Yes
19	Yes
20	Yes
21	Yes
22	Yes
23	Yes
24	Yes
25	Yes
26	Yes
27	Yes
28	Yes
29	Yes
30	Yes

TYPE 2 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 2				
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Successful Detection (Yes/No)
2001	1	172.00	25	No
2002	2.1	209.00	28	Yes
2003	1.2	226.00	27	Yes
2004	4.3	178.00	29	Yes
2005	4.9	197.00	26	Yes
2006	2.2	205.00	25	Yes
2007	4.2	203.00	23	Yes
2008	2.9	229.00	23	Yes
2009	4.1	164.00	24	Yes
2010	2	168.00	27	Yes
2011	2.6	154.00	26	Yes
2012	1.6	156.00	26	No
2013	5	229.00	27	Yes
2014	3.7	210.00	25	Yes
2015	4.7	194.00	26	Yes
2016	3.8	177.00	26	Yes
2017	2.9	208.00	26	No
2018	1.3	221.00	25	No
2019	4.2	177.00	29	Yes
2020	2.7	176.00	23	No
2021	1.8	193.00	24	Yes
2022	2.4	220.00	27	Yes
2023	4.3	218.00	25	Yes
2024	2.2	213.00	24	No
2025	3.5	196.00	29	Yes
2026	5	216.00	26	Yes
2027	3.2	159.00	27	Yes
2028	4.7	180.00	25	Yes
2029	2.4	185.00	28	Yes
2030	4	195.00	24	Yes

TYPE 3 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 3				
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Successful Detection (Yes/No)
3001	7	320.00	16	No
3002	9	489.00	16	Yes
3003	5.3	341.00	18	Yes
3004	5.2	319.00	17	Yes
3005	6.9	482.00	18	Yes
3006	6.2	375.00	16	Yes
3007	6.3	257.00	17	Yes
3008	8.5	268.00	16	No
3009	9.3	478.00	18	Yes
3010	9.9	332.00	17	Yes
3011	7.1	287.00	16	No
3012	9	499.00	18	Yes
3013	7.8	329.00	17	Yes
3014	7.1	401.00	18	Yes
3015	7.4	333.00	17	Yes
3016	6.6	466.00	17	Yes
3017	9.8	343.00	16	Yes
3018	8.6	378.00	16	Yes
3019	6.4	254.00	17	Yes
3020	9.5	351.00	16	Yes
3021	6.3	387.00	17	No
3022	6.1	363.00	18	Yes
3023	8.7	321.00	17	Yes
3024	7.9	276.00	17	Yes
3025	5.5	298.00	18	No
3026	6.2	377.00	17	Yes
3027	5.8	431.00	18	Yes
3028	6.1	263.00	17	Yes
3029	5.6	480	18	Yes
3030	10	331	18	Yes

TYPE 4 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 4				
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Successful Detection (Yes/No)
4001	10	367.00	12	No
4002	12.4	459.00	16	No
4003	17.1	457.00	12	Yes
4004	17.3	312.00	15	Yes
4005	17.7	373.00	15	Yes
4006	10	447.00	12	No
4007	12.9	477.00	16	No
4008	16	358.00	12	No
4009	15.6	268.00	15	Yes
4010	18.7	488.00	12	Yes
4011	12.3	450.00	15	Yes
4012	17.5	483.00	12	Yes
4013	10.1	404.00	15	Yes
4014	12	355.00	13	Yes
4015	12.4	497.00	15	Yes
4016	19.9	294.00	14	Yes
4017	13.8	481.00	14	No
4018	14.4	369.00	15	Yes
4019	13	320.00	14	Yes
4020	13.3	326.00	16	Yes
4021	12.9	429.00	16	Yes
4022	13.7	368.00	12	Yes
4023	10.1	429.00	16	Yes
4024	11	345.00	12	No
4025	15.8	345.00	13	No
4026	16.5	471.00	13	Yes
4027	15.5	486.00	12	Yes
4028	16.4	251.00	16	Yes
4029	18	295.00	13	Yes
4030	15.7	280.00	14	Yes

TYPE 5 DETECTION PROBABILITY

Data Sheet for FCC Long Pulse Radar Type 5	
Trial	Successful Detection (Yes/No)
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	No
9	Yes
10	Yes
11	Yes
12	Yes
13	Yes
14	Yes
15	No
16	Yes
17	Yes
18	Yes
19	Yes
20	No
21	Yes
22	Yes
23	Yes
24	Yes
25	Yes
26	Yes
27	Yes
28	Yes
29	Yes
30	Yes

Note: The Type 5 randomized parameters are shown in a separate document.

TYPE 6 DETECTION PROBABILITY

Data Sheet for FCC Hopping Radar Type 6				
1 us Pulse Width, 333 us PRI, 9 Pulses per Burst, 1 Burst per Hop				
NTIA August 2005 Hopping Sequence				
Trial	Starting Index Within Sequence	Signal Generator Frequency (MHz)	Hops within Detection BW	Successful Detection (Yes/No)
1	199	5492	5	Yes
2	674	5493	5	Yes
3	1149	5494	1	Yes
4	1624	5495	1	No
5	2099	5496	1	No
6	2574	5497	4	Yes
7	3049	5498	3	Yes
8	3524	5499	2	Yes
9	3999	5500	4	Yes
10	4474	5501	4	Yes
11	4949	5502	4	Yes
12	5424	5503	4	Yes
13	5899	5504	4	Yes
14	6374	5505	3	Yes
15	6849	5506	2	Yes
16	7324	5507	4	Yes
17	7799	5508	5	Yes
18	8274	5492	4	Yes
19	8749	5493	3	Yes
20	9224	5494	4	Yes
21	9699	5495	2	Yes
22	10174	5496	2	Yes
23	10649	5497	4	Yes
24	11124	5498	3	Yes
25	11599	5499	5	Yes
26	12074	5500	1	Yes
27	12549	5501	5	Yes
28	13024	5502	2	Yes
29	13499	5503	3	Yes
30	13974	5504	5	Yes
31	14449	5505	1	Yes
32	14924	5506	3	Yes
33	15399	5507	4	Yes
34	15874	5508	4	No