FCC CFR47 PART 15 SUBPART E

CERTIFICATION TEST REPORT
CLASS II PERMISSIVE CHANGE

FOR

GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/LTE RADIO, IEEE 802.11A/B/G/N AND BLUETOOTH RADIO

MODEL NUMBER: A1428 and A1429

FCC ID: BCG-E2599A

REPORT NUMBER: 15U21850-E26V2

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Prepared for
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Revision History

Rev.	Issue Date	Revisions	Revised By
V1	11/12/15	Initial issue. Upgrade 11U14136-6, Revision A report to 5.2/5.3/5.6GHz band to new rule per KDB 789033 D02 v01.	T. Chu
V2	11/23/15	Revised report to address TCB's questions	T. Chu

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1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: Cellular GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/LTE radio, IEEE 802.11a/b/g/n and Bluetooth radio.

MODEL: A1428 and A1429

SERIAL NUMBER: C39HV0HPF5P5 and C39HW025FPL

DATE TESTED: JULY 10 - AUGUST 06, 2012

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart E	Pass

UL Verification Services Inc. 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 Verification Services Inc. 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 Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. 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.

UL Verification Services Inc. By:

TIM LEE
STAFF ENGINEER
UL Verification Services Inc.

Tested By:

TOM CHEN
EMC ENGINEER
UL Verification Services Inc.

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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 14-30, FCC KDB 662911 D01 v02r01, FCC KDB 905462 D02 v01r02/D03 v01r01/D06 v01, FCC KDB 789033 D02 v01, ANSI C63.10-2009.

3. FACILITIES AND ACCREDITATION

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

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

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%.

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5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

Model A1428, is a mobile phone with multimedia functions (music, application support, and video), cellular GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/CDMA1xRTT/ EV-DO Rev 0, A, B /1xAdvanced/ LTE radio, IEEE 802.11a/b/g/n radio and Bluetooth radio. The rechargeable battery is not user accessible.

5.2. DESCRIPTION OF CLASS II PERMISSIVE CHANGE

Upgrade 5.2/5.3/5.6GHz band to new rule per KDB 789033 D02 v01.

We have reviewed the original test report for UNII-1, UNII-2A and UNII-2C bands and are hereby attesting that all current technical requirements are still met and all applicable test procedures remain the same. Therefore, the original report is still applicable and no additional testing is done.

We updated the following on this report:

- Updated report to latest KDB 789033 D02 v01.
- 5.2G output power table limit/PPSD limit.
- Removed IC related information.
- Removed Peak Excursion.

5.3. 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	802.11a	14.29	26.85
5180 - 5240	802.11n HT20	14.47	27.99
5190 - 5230	802.11n HT40	14.41	27.61
5260 - 5320	802.11a	14.26	26.67
5260 - 5320	802.11n HT20	14.13	25.88
5270 - 5310	802.11n HT40	14.55	28.51
5500 - 5700	802.11a	14.09	25.64
5500 - 5700	802.11n HT20	14.18	26.18
5510 - 5670	802.11n HT40	14.32	27.04

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5.4. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an PIFI antenna.

Frequency (GHz)	Gain (dBi) Type: Pifa
2.400-2.480	-1.4
5.150-5.250	0.14
5.250-5.350	-1.66
5.47-5.725	-0.83
5725-5850	-2.85

5.5. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was WL Tool FW 6.10.56.166.

The firmware installed in the EUT during DFS testing was 10A371.

5.6. MODEL DIFFERNECE

Model A1428 is identical to Model A1429 except in the license bands. Model A1429 encompasses CDMA technology. Testing conducted on Model A1428 is considered representative for Model A1429.

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5.7. WORST-CASE CONFIGURATION AND MODE

The worst-case channel for RF radiated emissions below 1GHz tests is channel with highest RF output power.

Based on the investigation results, the highest peak power and enhanced data rate is the worst-case scenario for all measurements.

For the fundamental investigation, the EUT is investigated for vertical and horizontal antenna orientations and the worst case was determined to be at X-position.

Based on the manufacturer's attestation that the nominal output power is reduced as the data rate increases, the data rates tested represent the highest power and worst-case with respect to EMC performance.

Worst-case data rates were used:

802.11b mode: 1 Mbps
802.11g mode: 6 Mbps
802.11a mode: 6 Mbps
802.11n HT20mode: MCS0
802.11n HT40mode: MCS0

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5.8. DESCRIPTION OF TEST SETUP

RADIATED TESTS SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST			
Description	**Manufacturer**	**Model**	**Serial Number**
AC adapter	Apple	A1344	NA

I/O CABLES

I/O CABLE LIST						
Cable No.	**Port**	**# of Identica Ports**	**Connector Type**	**Cable Type**	**Cable Length**	**Remarks**
2	DC	1	US 115V	Un-shielded	1.5m	NA

TEST SETUP

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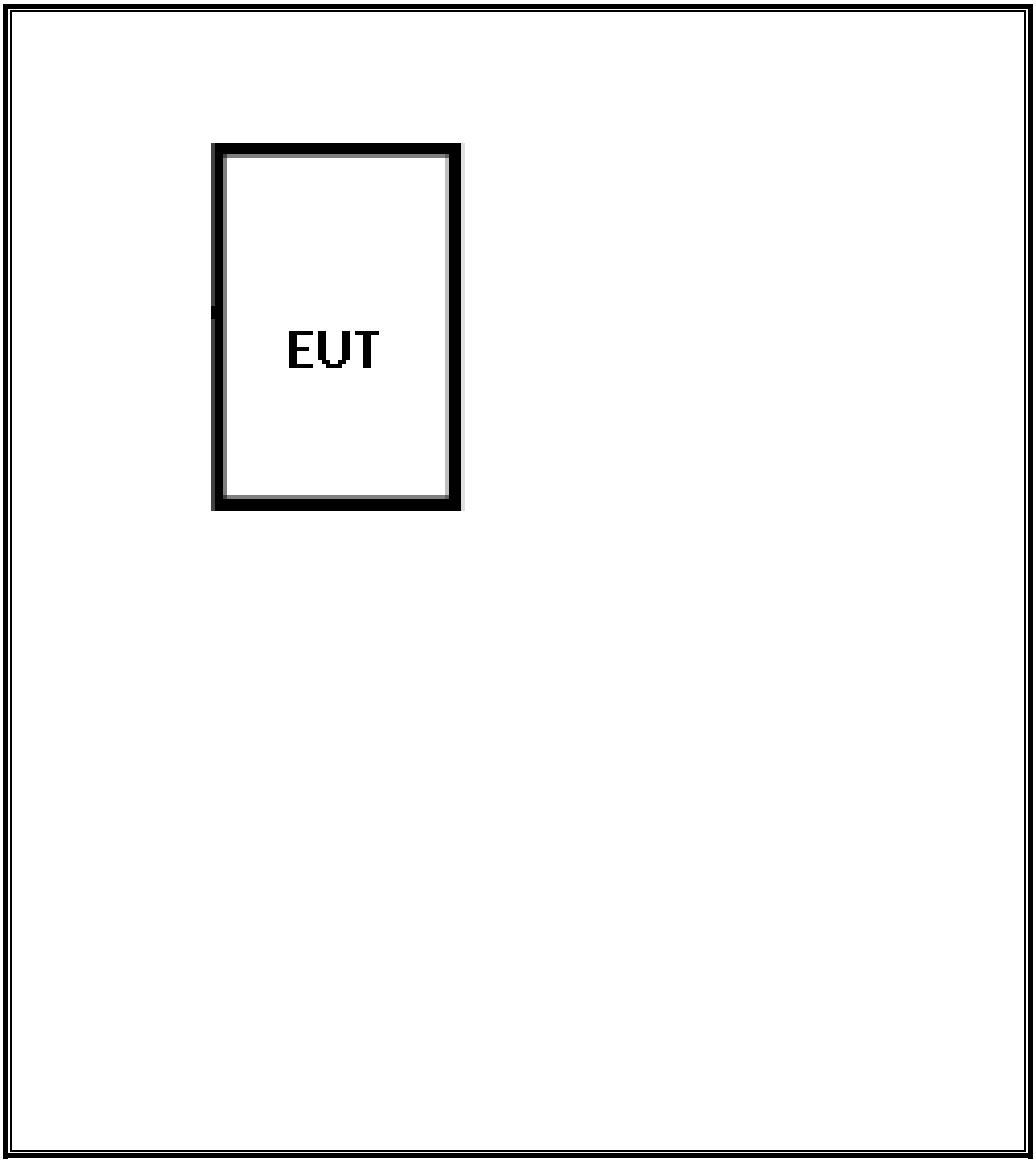
SETUP DIAGRAM FOR TESTS



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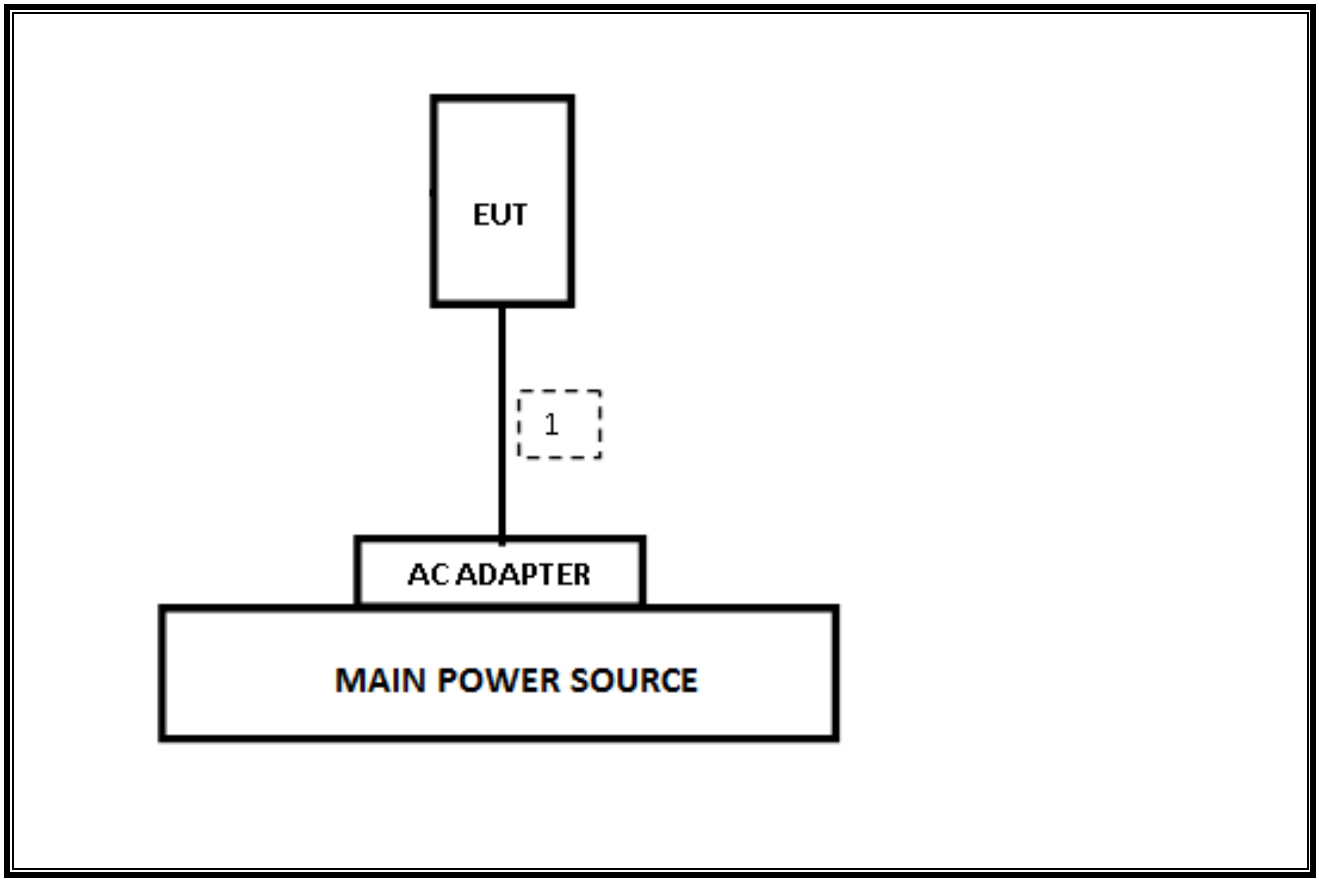

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6. TEST AND MEASUREMENT EQUIPMENT

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

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Asset**	**Cal Due**
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	07/14/13
Antenna, Horn, 18 GHz	EMCO	3115	C00945	06/29/13
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00580	11/11/12
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01016	07/12/13
Horn Antenna, 26.5 GHz	ARA	MWH-1826/B	C00589	07/28/13
Horn Antenna, 40 GHz	ARA	MWH-2640/B	C00981	05/10/13
Preamplifier, 40 GHz	Miteq	NSP4000-SP2	C00990	03/14/13
Reject Filter, 2.0-2.9 GHz	Micro-Tronics	BRM50702	N02684	CNR
High Pass Filter, 7.6 GHz	Micro-Tronics	HPM13195	N02682	CNR
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01159	04/09/13
Peak Power Meter	Agilent	N1911A	1260847C	08/04/12
Peak Power Sensor	Agilent	E9323A	1244073F	08/04/12
Reject Filter, 5.725-5.825 GHz	Micro-Tronics	BRC13192	N02676	CNR
Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRM50702	N02685	CNR
Highpass Filter, 7.6 GHz	Micro-Tronics	HPM13195	N02682	CNR
EMI Test Receiver, 30MHz	R & S	ESHS 20	N02396	08/19/13
LISN, 30 MHz	FCC	LISN-50/250-25-2	N02625	12/13/12

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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)
802.11a 20 MHz	2.04	2.08	0.981	98.1%	0.08	0.490
802.11n HT20	1.91	1.94	0.982	98.2%	0.08	0.525
802.11n HT40	0.94	0.96	0.963	96.3%	0.16	1.059

7.1.2. MEASUREMENT METHOD FOR POWER AND PPSD

The Duty Cycle is greater than or equal to 98% therefore KDB 789033 Method SA-1 is used.

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

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7.1.3. MEASUREMENT METHOD FOR AVERAGE SPURIOUS EMISSIONS ABOVE 1 GHz

The Duty Cycle is greater than or equal to 98%, KDB 789033 Method VB with Power RMS Averaging is used.

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

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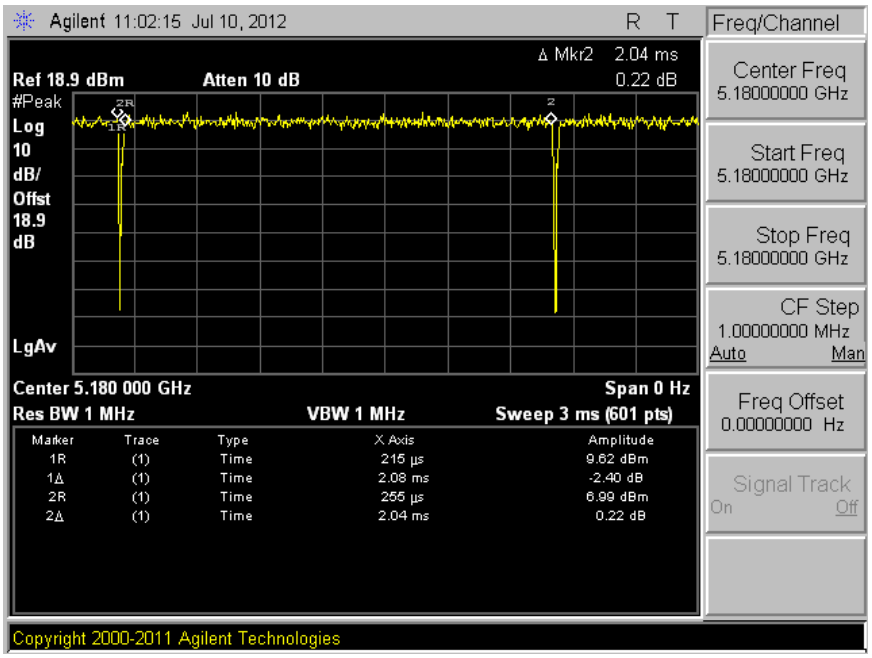
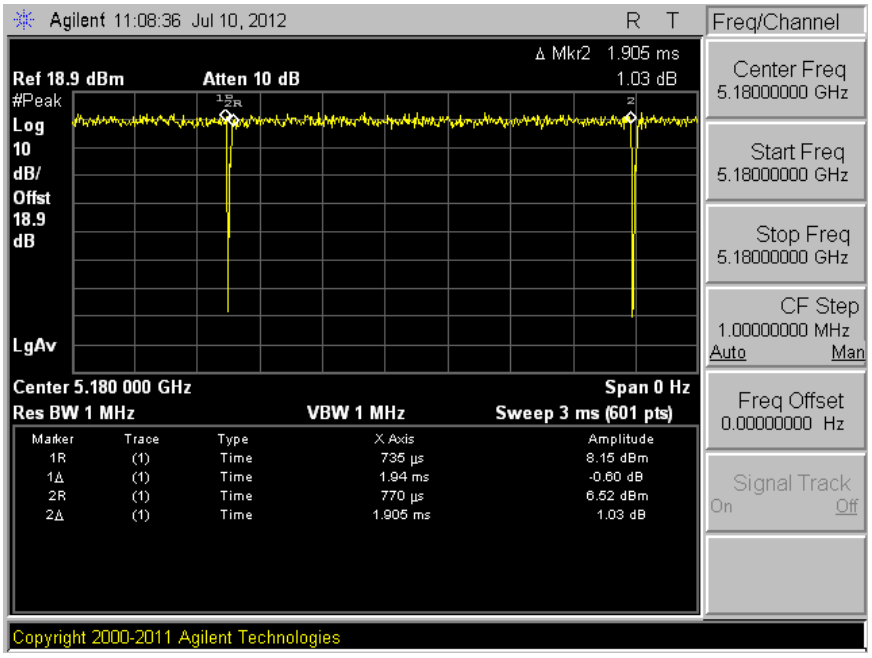
7.1.4. DUTY CYCLE PLOTS

DUTY CYCLE 802.11a MODE



DUTY CYCLE 802.11n HT20 MODE



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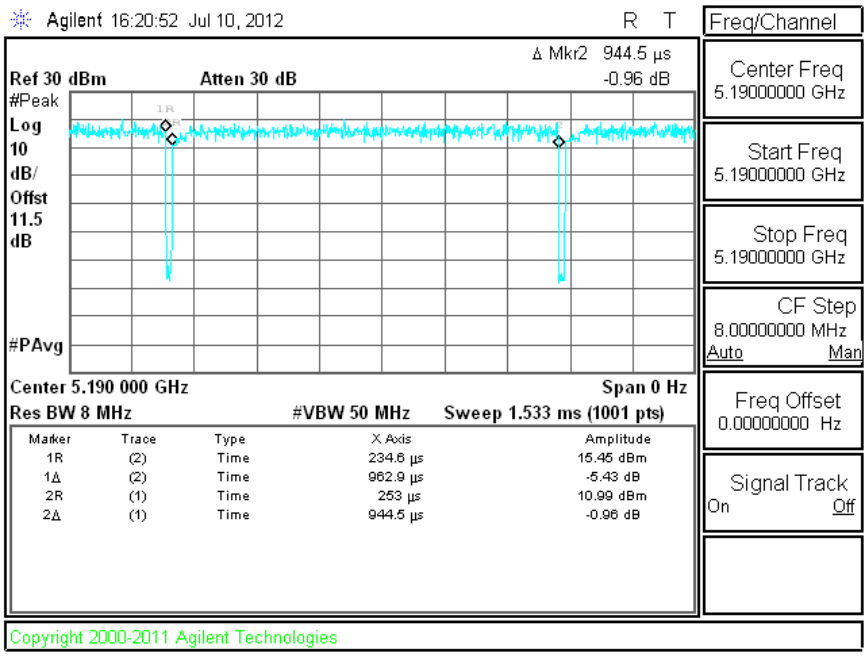
DUTY CYCLE 802.11n HT40 MODE



Marker	Trace	Type	X Axis	Amplitude
1R	(2)	Time	234.6 µs	15.45 dBm
1Δ	(2)	Time	962.9 µs	-5.43 dB
2R	(1)	Time	253 µs	10.99 dBm
2Δ	(1)	Time	944.5 µs	-0.96 dB

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8. ANTENNA PORT TEST RESULTS

8.1. 802.11a 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 Bandwidth (MHz)
Low	5180	19.0
Mid	5200	18.8
High	5240	18.7

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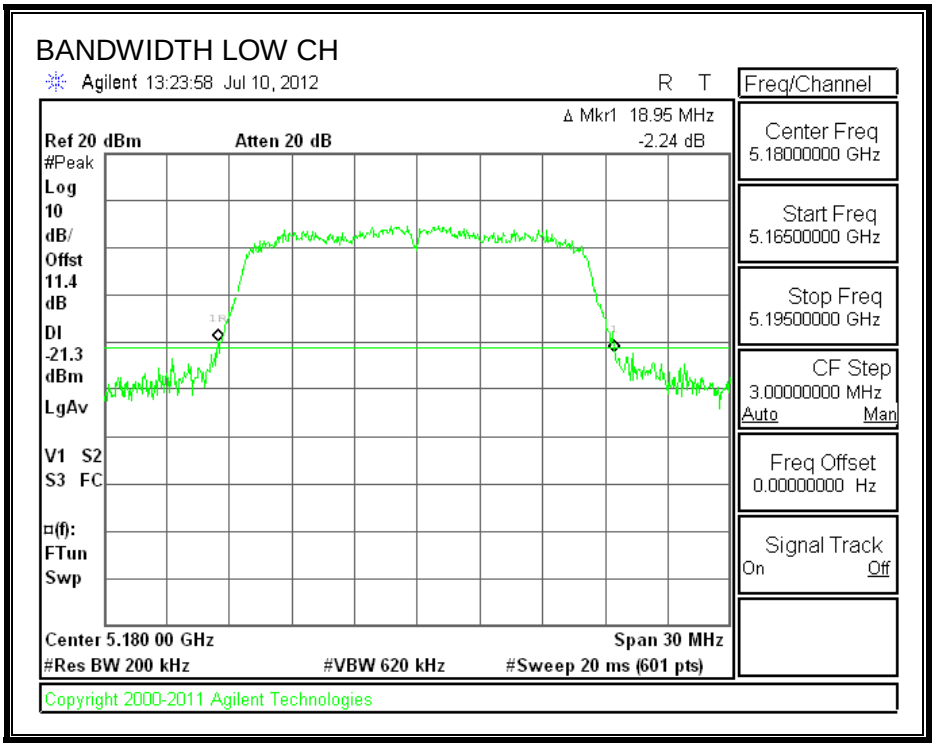
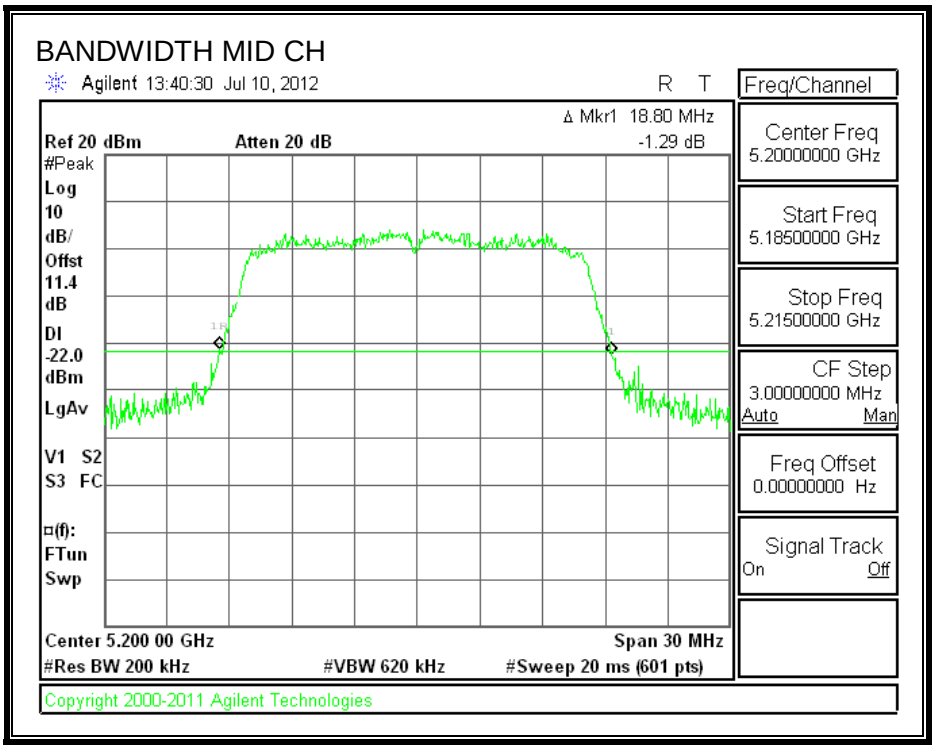
26 dB BANDWIDTH





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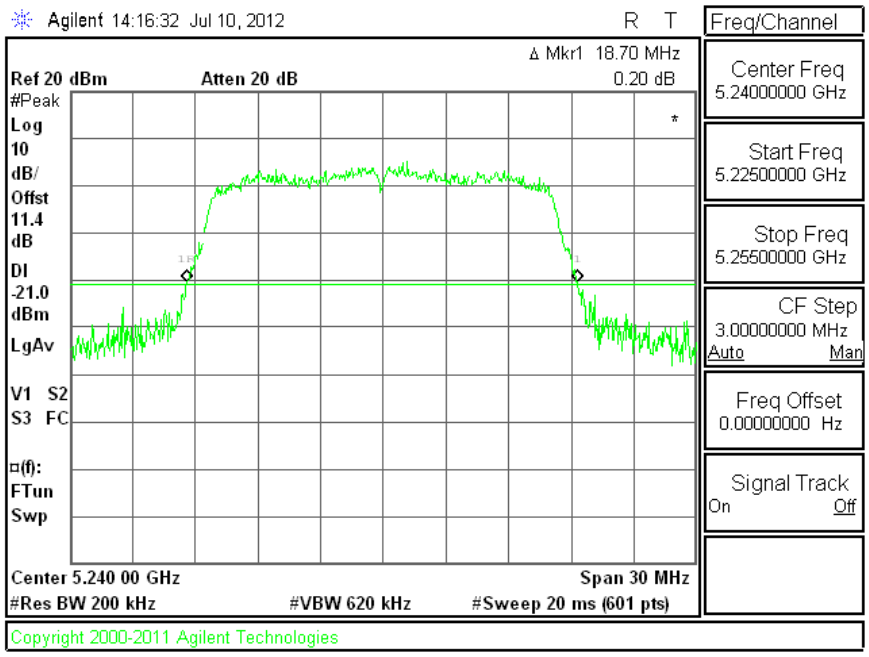
BANDWIDTH HIGH CH



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8.1.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5180	16.387
Mid	5200	16.351
High	5240	16.355

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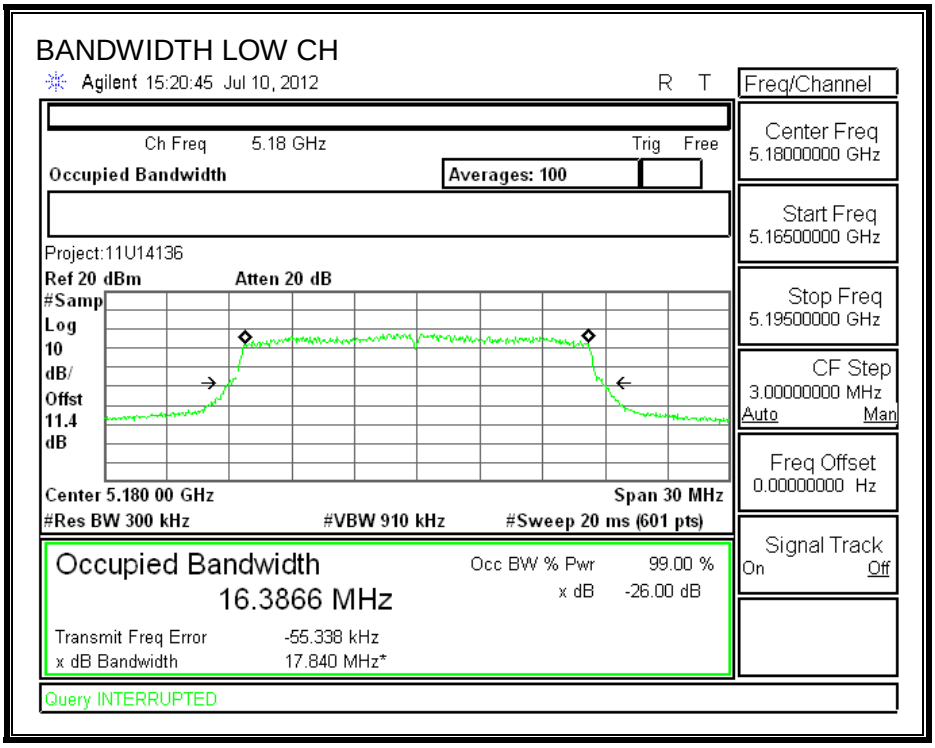
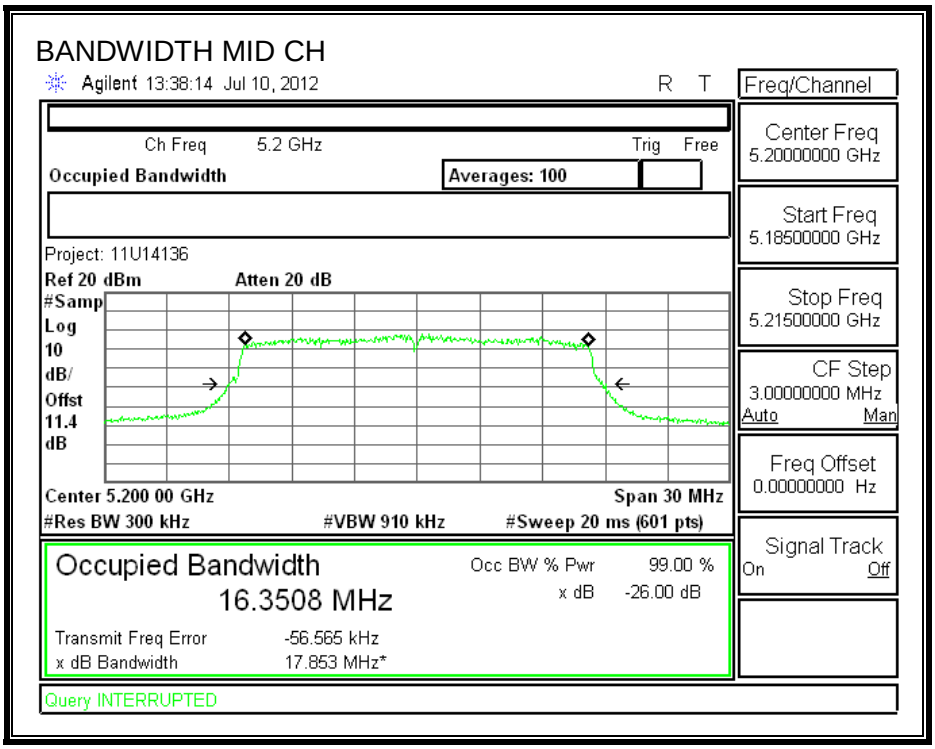
99% BANDWIDTH





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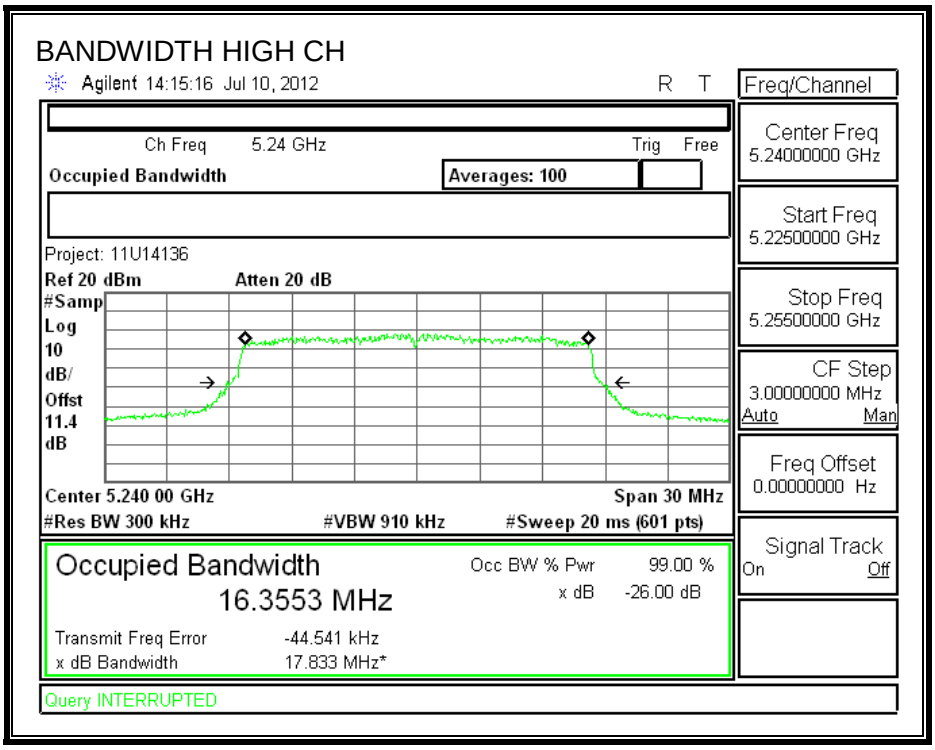

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8.1.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

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

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5180	13.96
Mid	5200	13.94
High	5240	13.98

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8.1.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 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 maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 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 maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum 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 maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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FCC RESULTS

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5180	0.14	24.00	11.00
Mid	5200	0.14	24.00	11.00
High	5240	0.14	24.00	11.00

Duty Cycle CF (dB)	0.08	**Included in Calculations of Corr'd Power & PPSD**

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	14.15	14.23	24.00	-9.77
Mid	5200	14.00	14.08	24.00	-9.92
High	5240	14.21	14.29	24.00	-9.71

PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5180	3.76	3.84	11.00	-7.16
Mid	5200	3.61	3.69	11.00	-7.31
High	5240	3.60	3.68	11.00	-7.32

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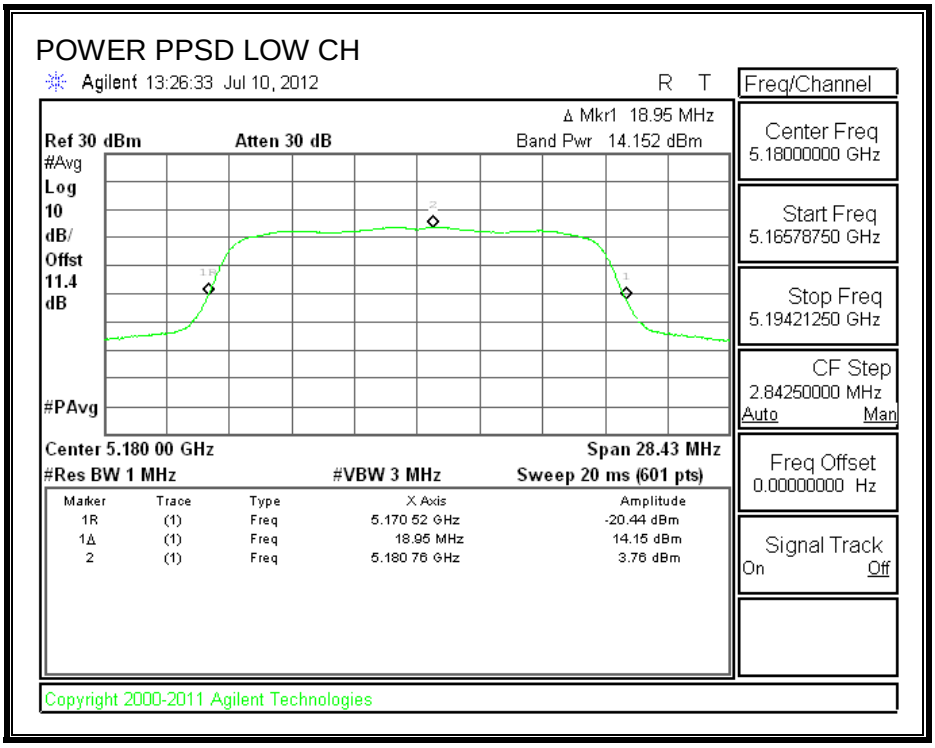
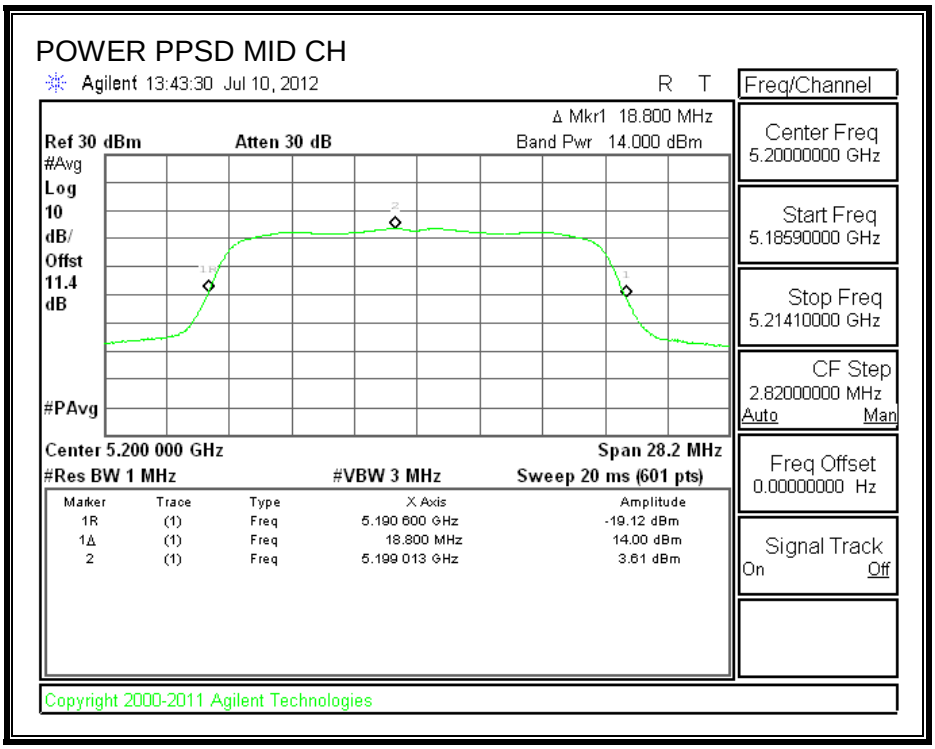
OUTPUT POWER AND PPSD





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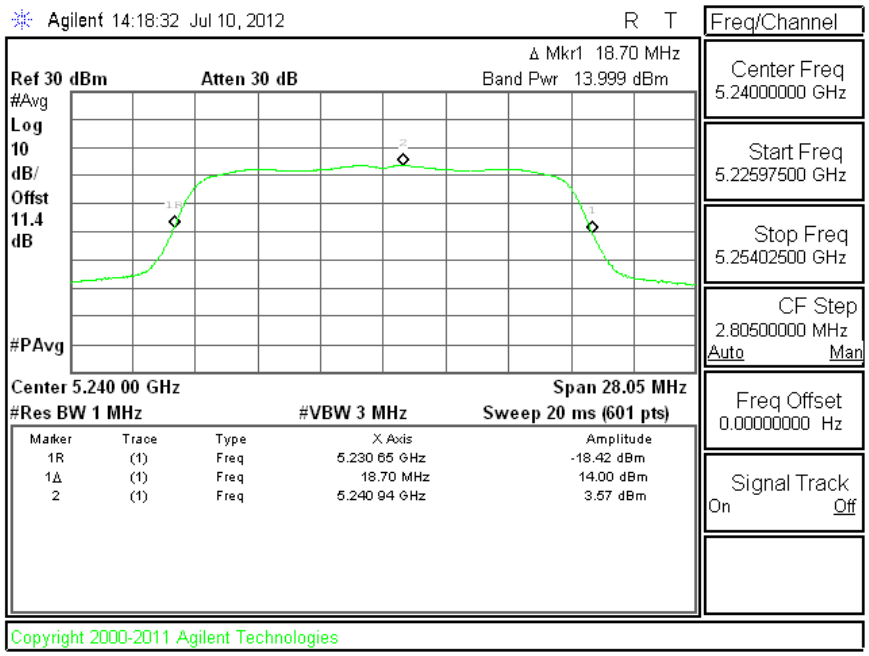
POWER PPSD HIGH CH



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8.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND

8.2.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	19.15
Mid	5200	19.05
High	5240	19.00

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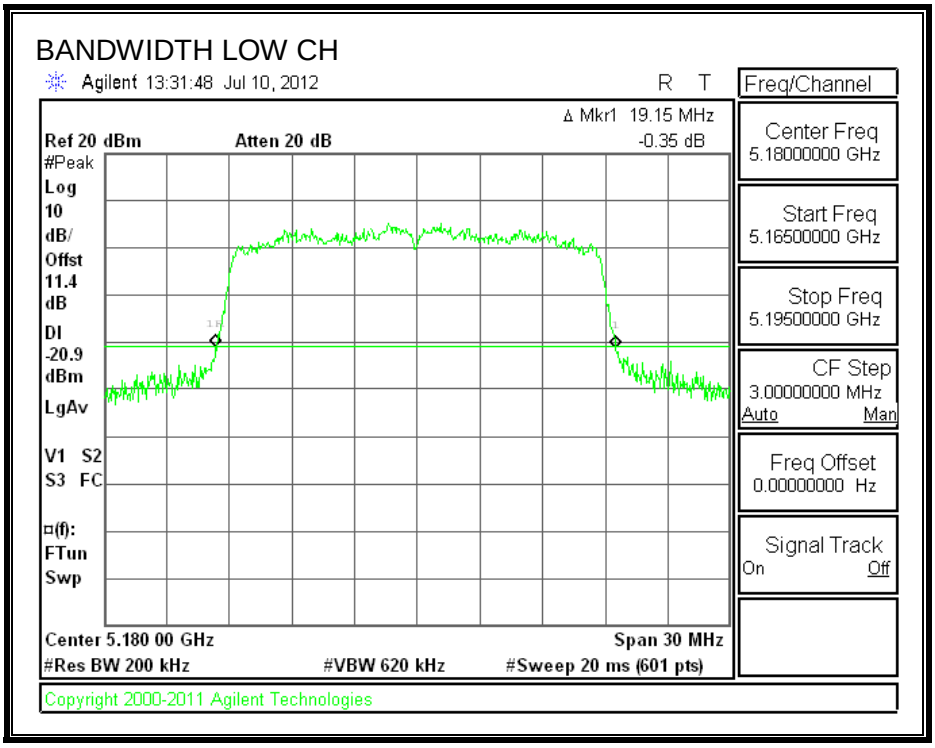
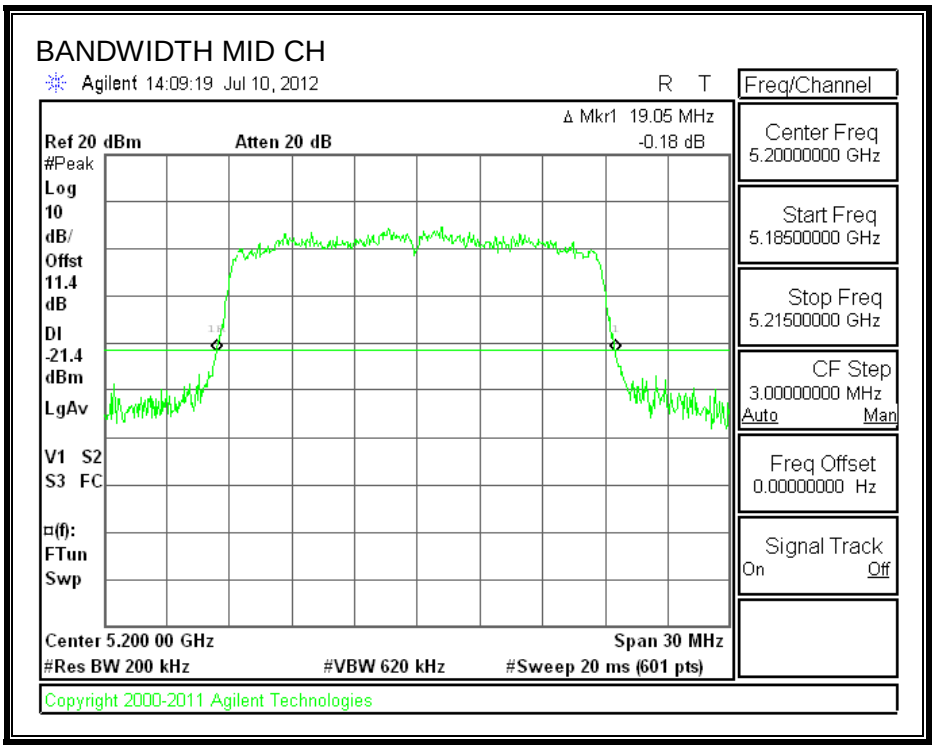
26 dB BANDWIDTH





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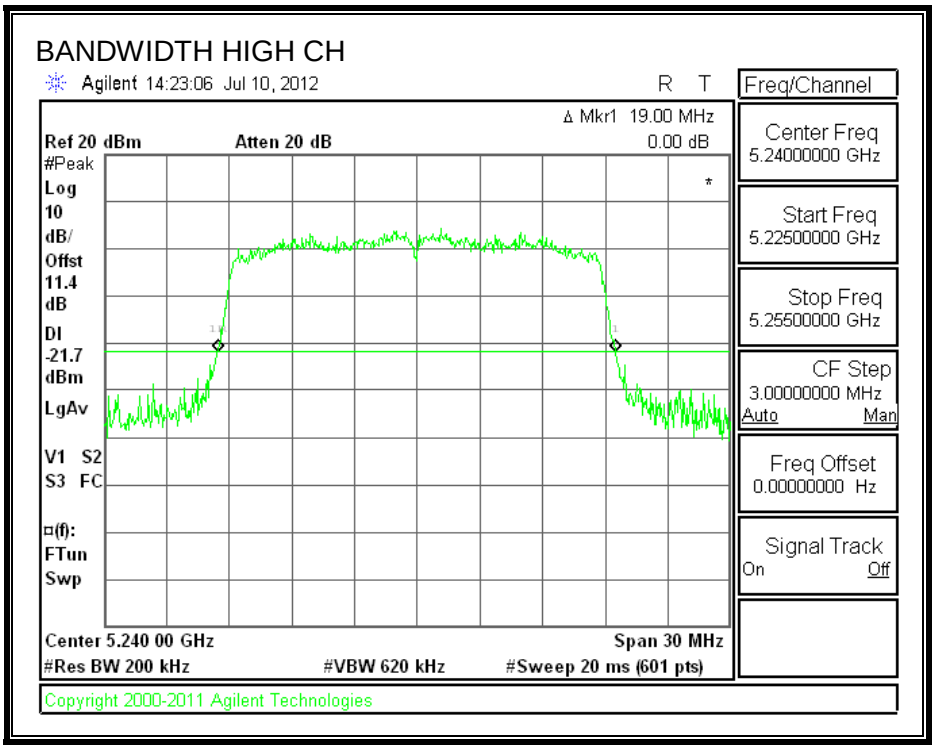
BANDWIDTH HIGH CH



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8.2.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5180	17.577
Mid	5200	17.587
High	5240	17.565

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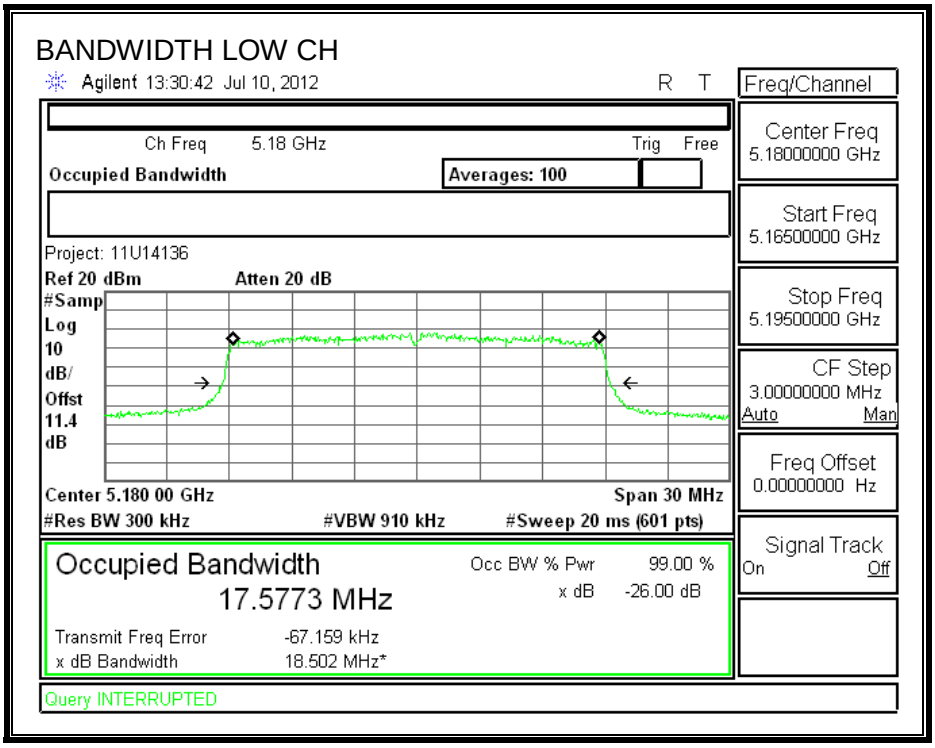
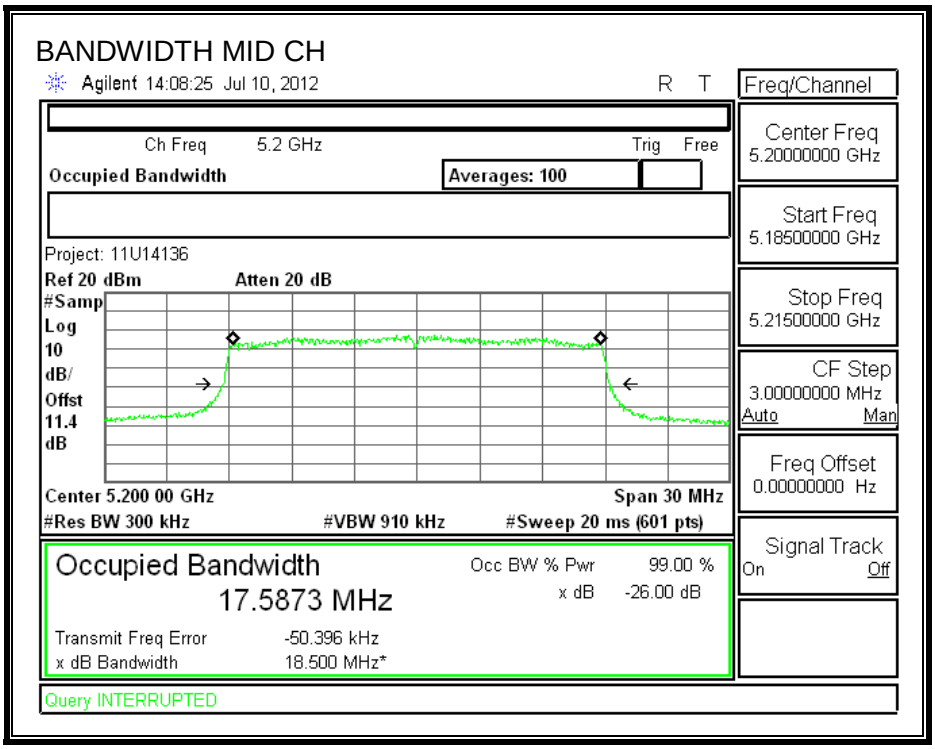
99% BANDWIDTH





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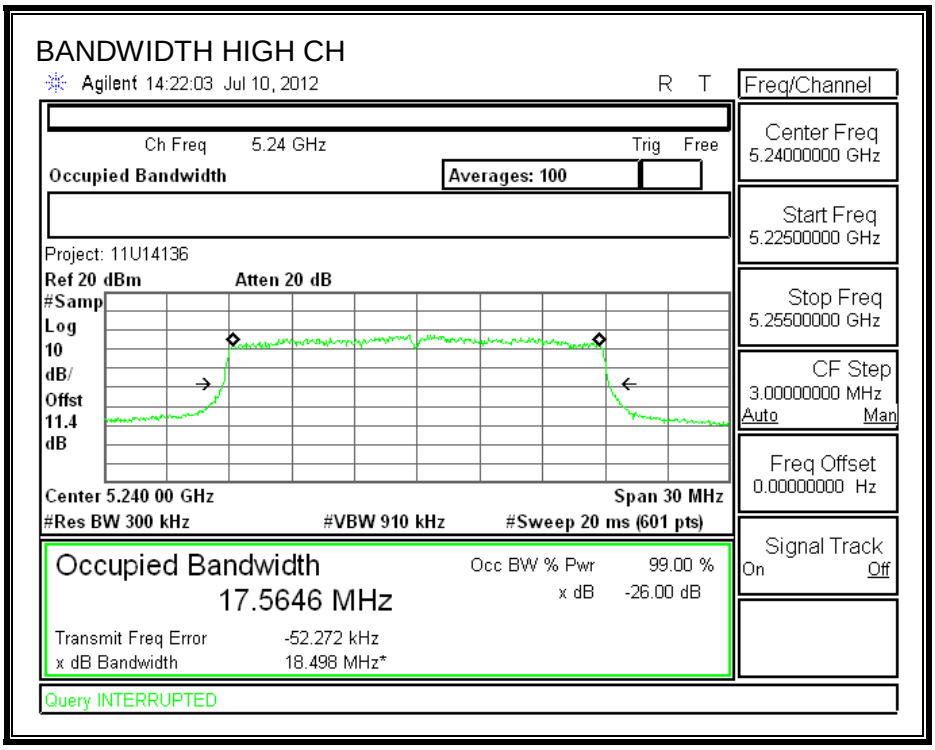

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8.2.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

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

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5180	14.0
Mid	5200	14.0
High	5240	14.0

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8.2.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 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 maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 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 maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum 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 maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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FCC RESULTS

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5180	0.14	24.00	11.00
Mid	5200	0.14	24.00	11.00
High	5240	0.14	24.00	11.00

Duty Cycle CF (dB)	0.08	**Included in Calculations of Corr'd Power & PPSD**

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	14.39	14.47	24.00	-9.54
Mid	5200	14.10	14.18	24.00	-9.82
High	5240	14.21	14.29	24.00	-9.71

PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5180	3.85	3.93	11.00	-7.07
Mid	5200	3.50	3.58	11.00	-7.42
High	5240	3.60	3.68	11.00	-7.32

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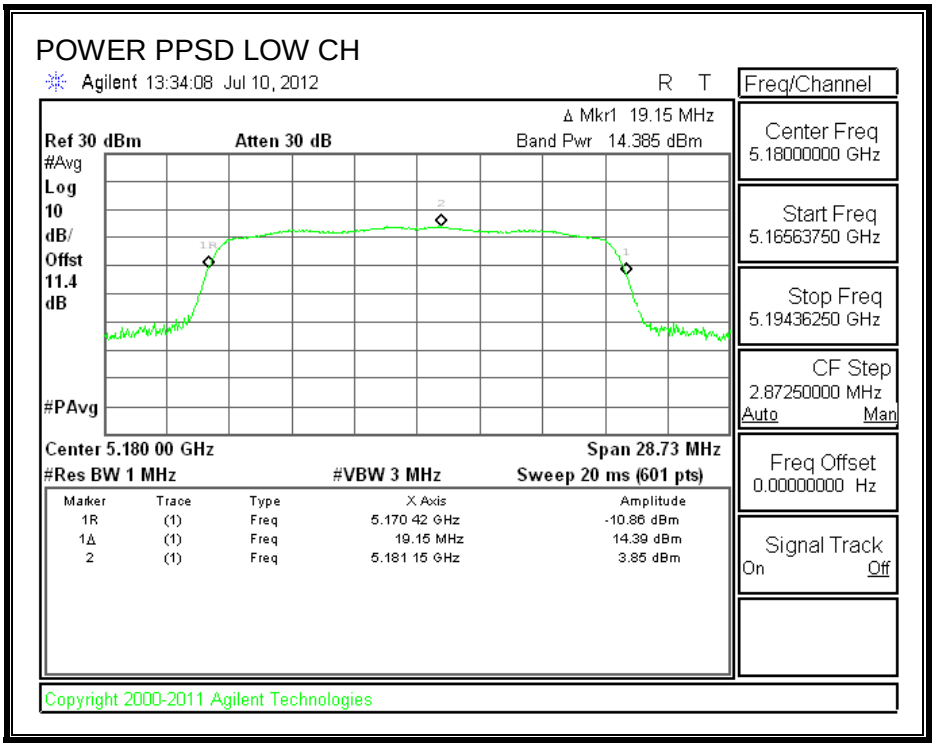
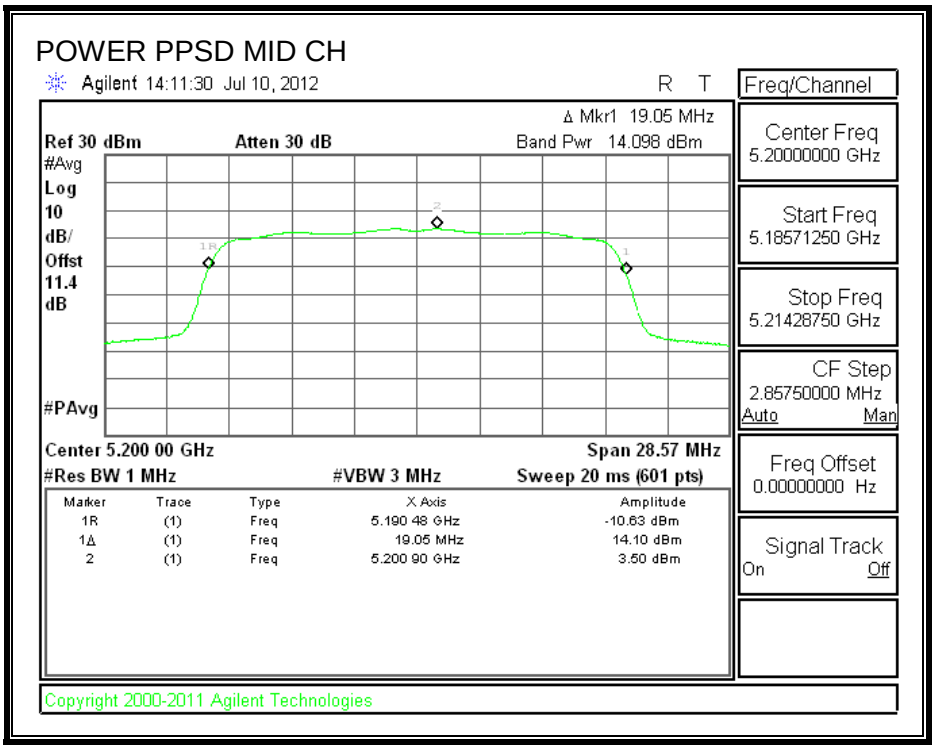
OUTPUT POWER AND PPSD





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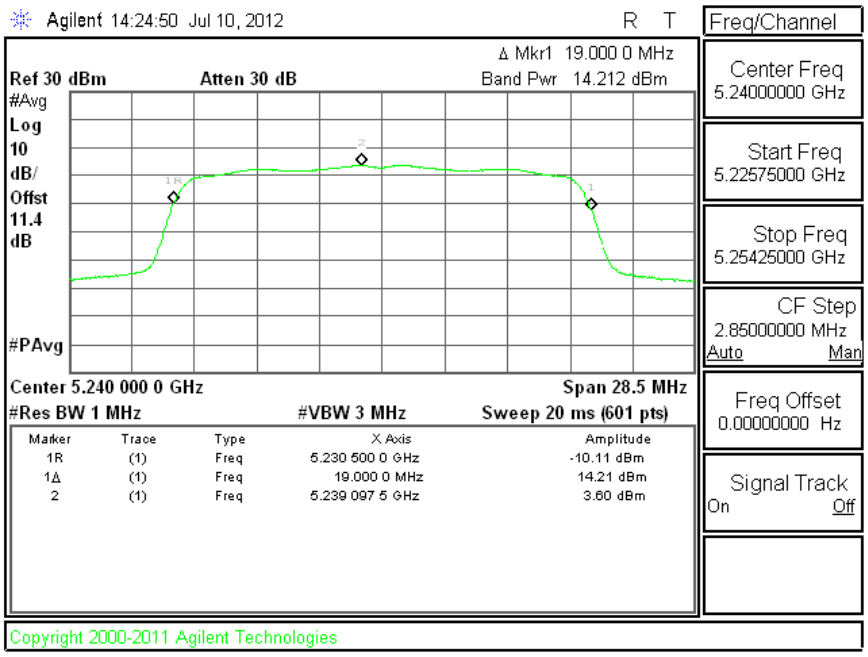
POWER PPSD HIGH CH



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8.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND

8.3.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5190	45.4
High	5230	44.2

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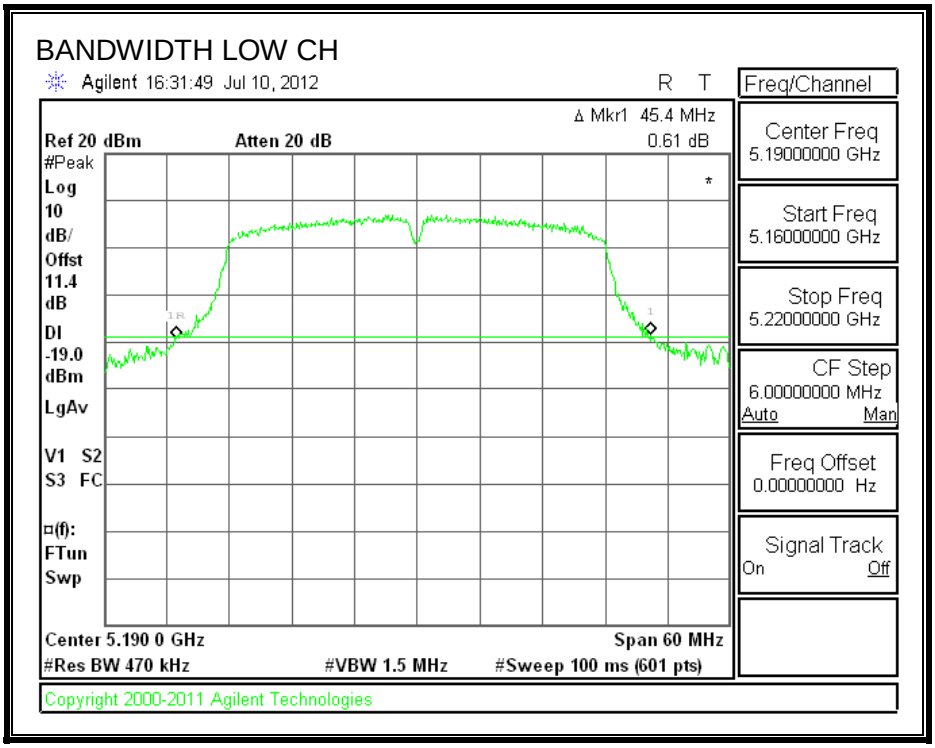
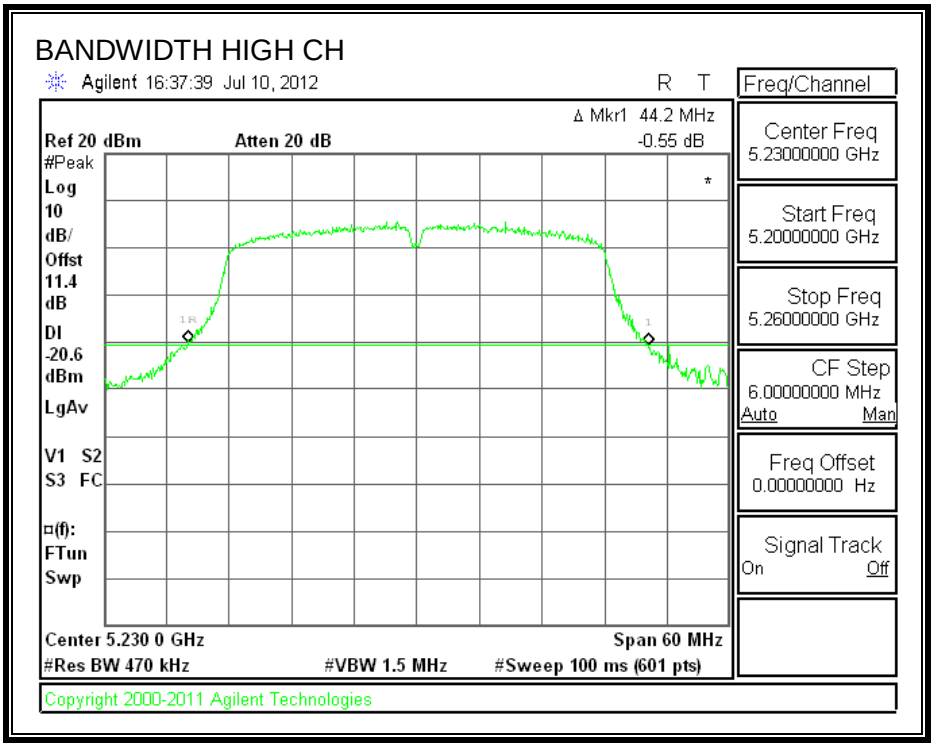
26 dB BANDWIDTH





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8.3.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5190	35.982
High	5230	36.045

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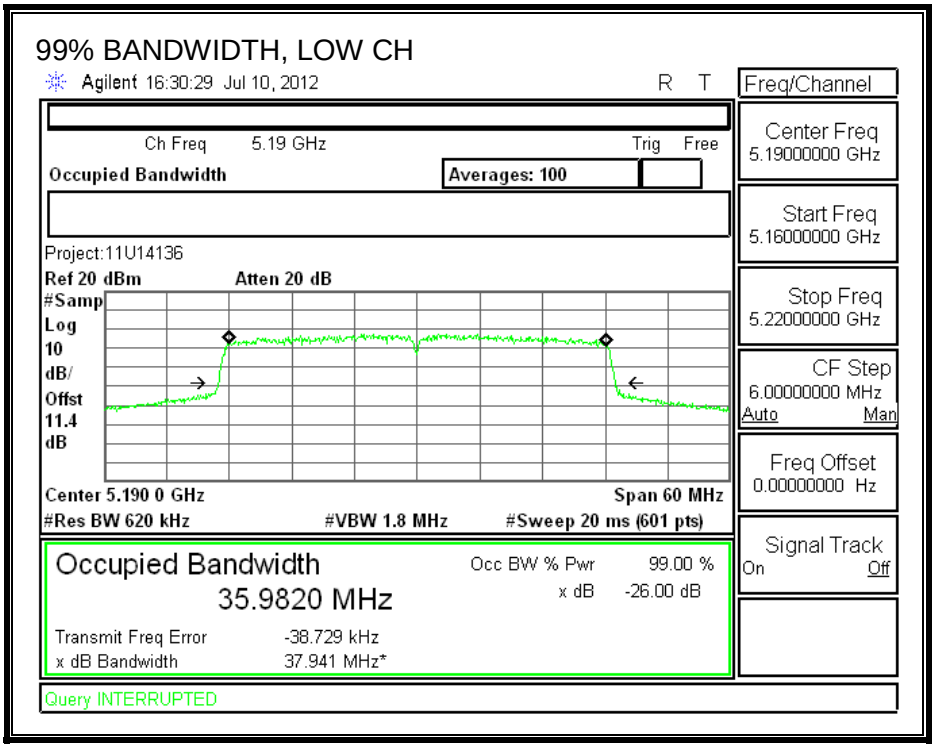
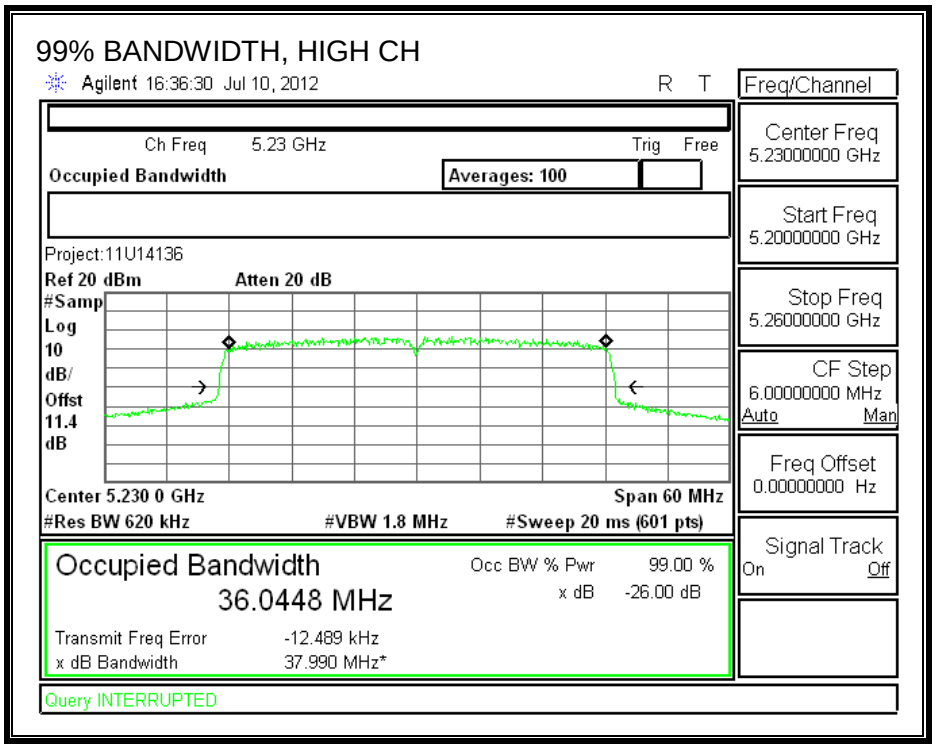
99% BANDWIDTH





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

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5190	14.00
High	5230	13.97

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8.3.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 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 maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 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 maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum 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 maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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FCC RESULTS

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5190	0.14	24.00	11.00
High	5230	0.14	24.00	11.00

Duty Cycle CF (dB)	0.16	**Included in Calculations of Corr'd Power & PPSD**

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5190	14.22	14.38	24.00	-9.62
High	5230	14.25	14.41	24.00	-9.59

PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5190	0.23	0.39	11.00	-10.61
High	5230	0.22	0.38	11.00	-10.62

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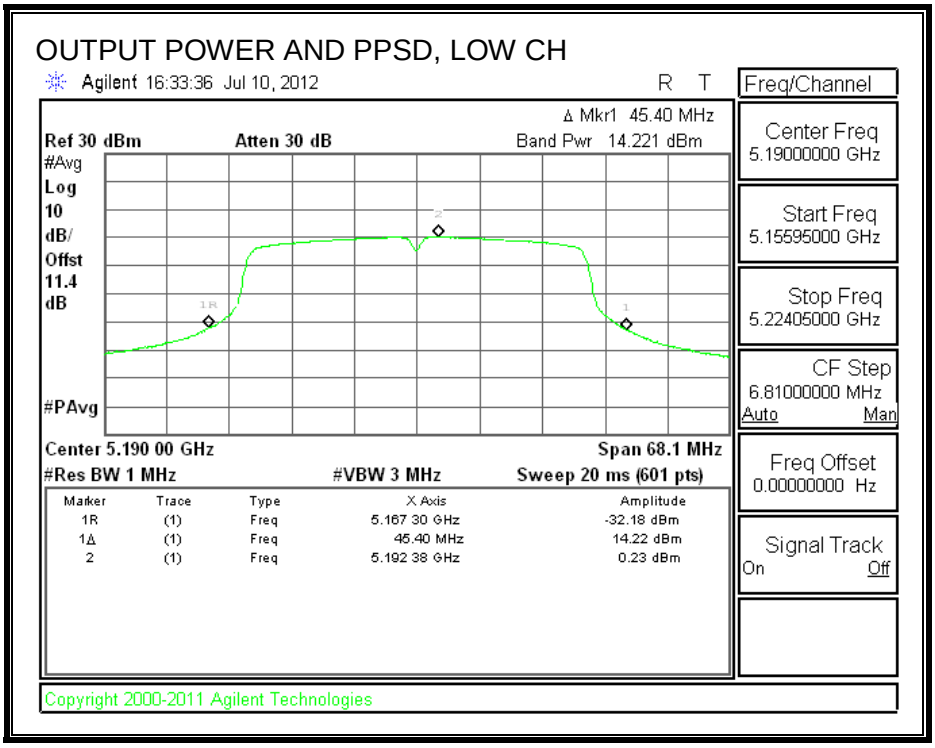
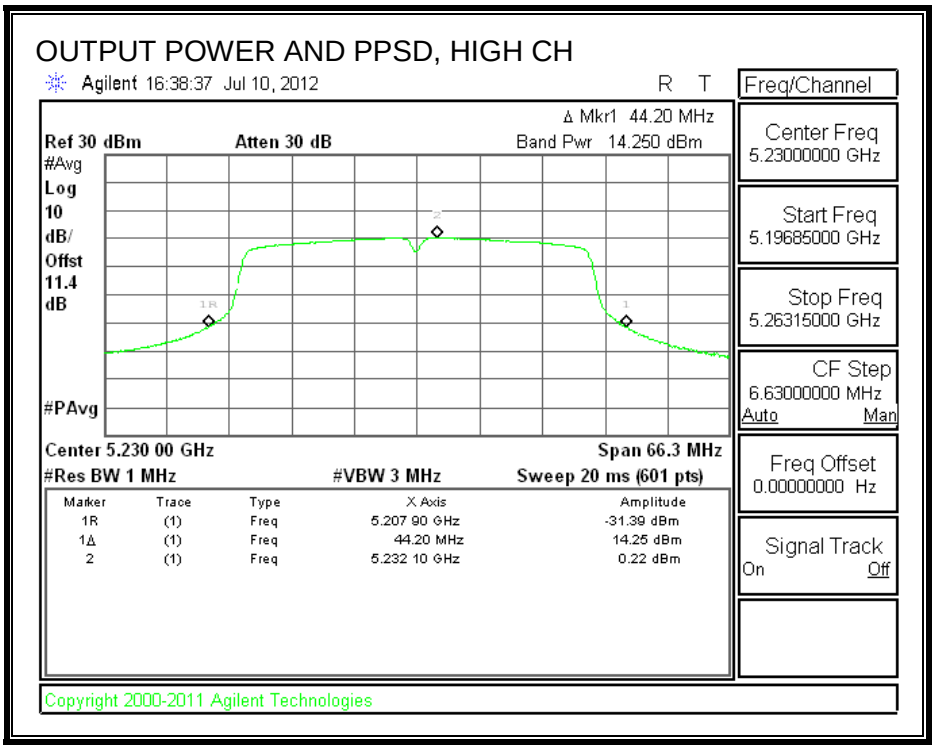
OUTPUT POWER AND PPSD





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8.4. 802.11a MODE IN THE 5.3 GHz BAND

8.4.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5260	19.25
Mid	5300	18.90
High	5320	18.90

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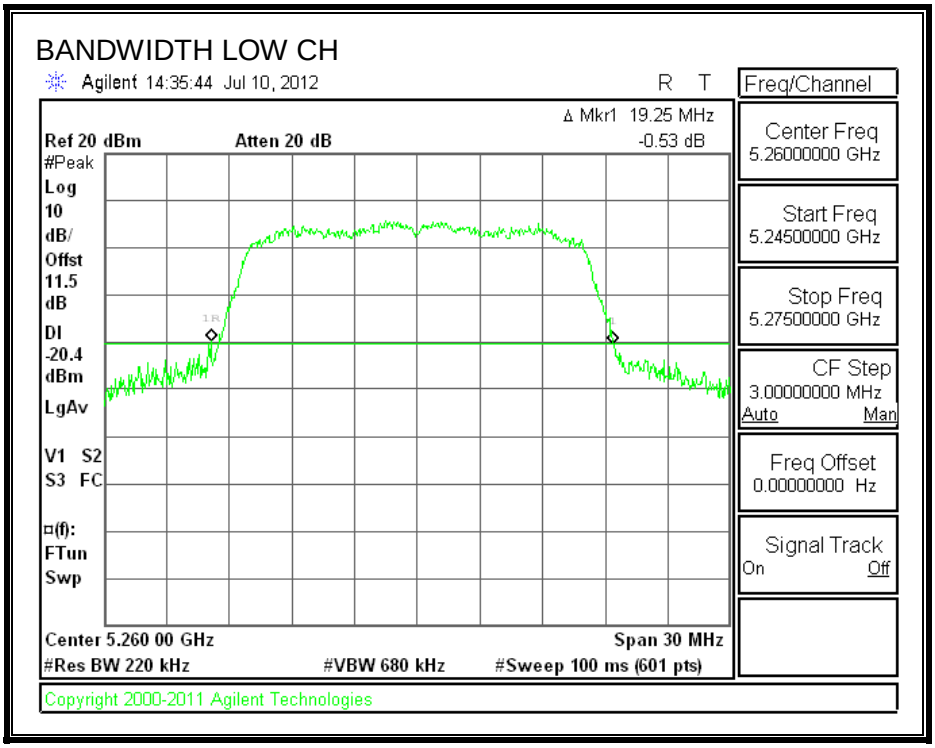
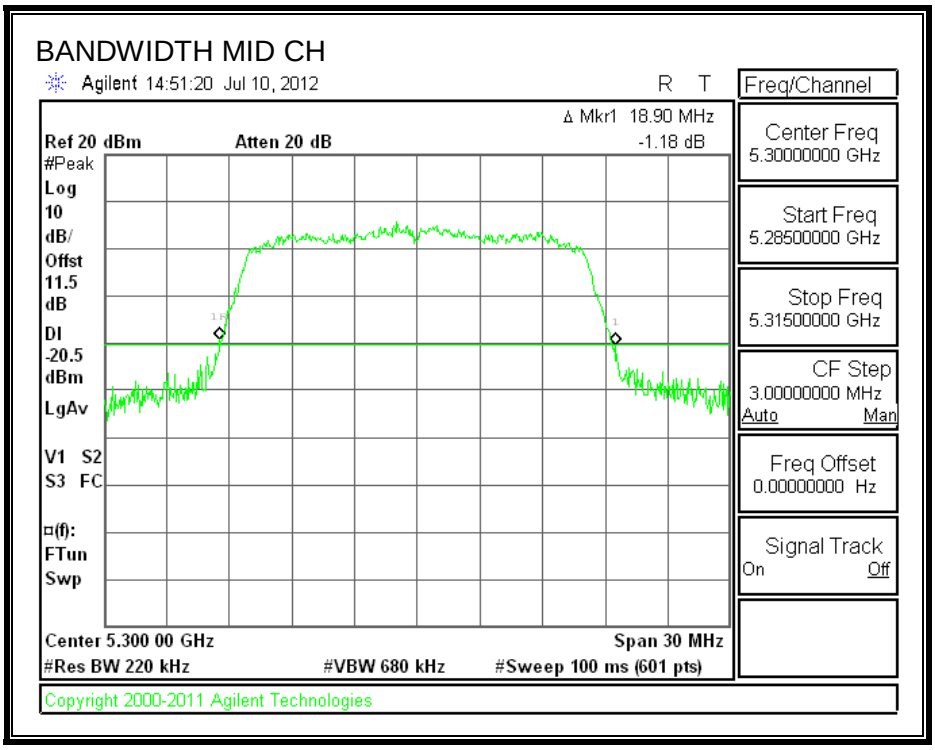
26 dB BANDWIDTH





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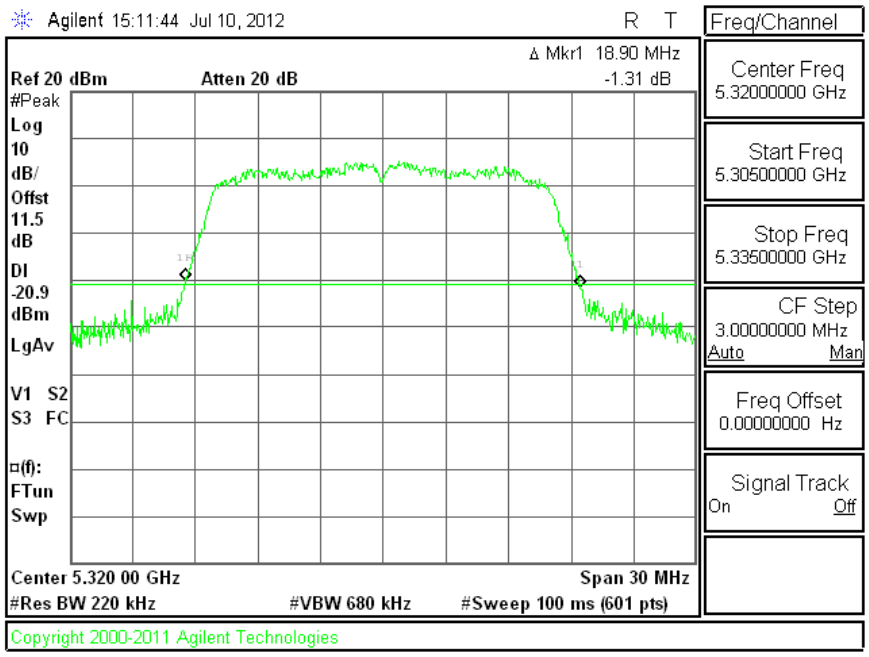
BANDWIDTH HIGH CH



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8.4.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5260	16.355
Mid	5300	16.357
High	5320	16.363

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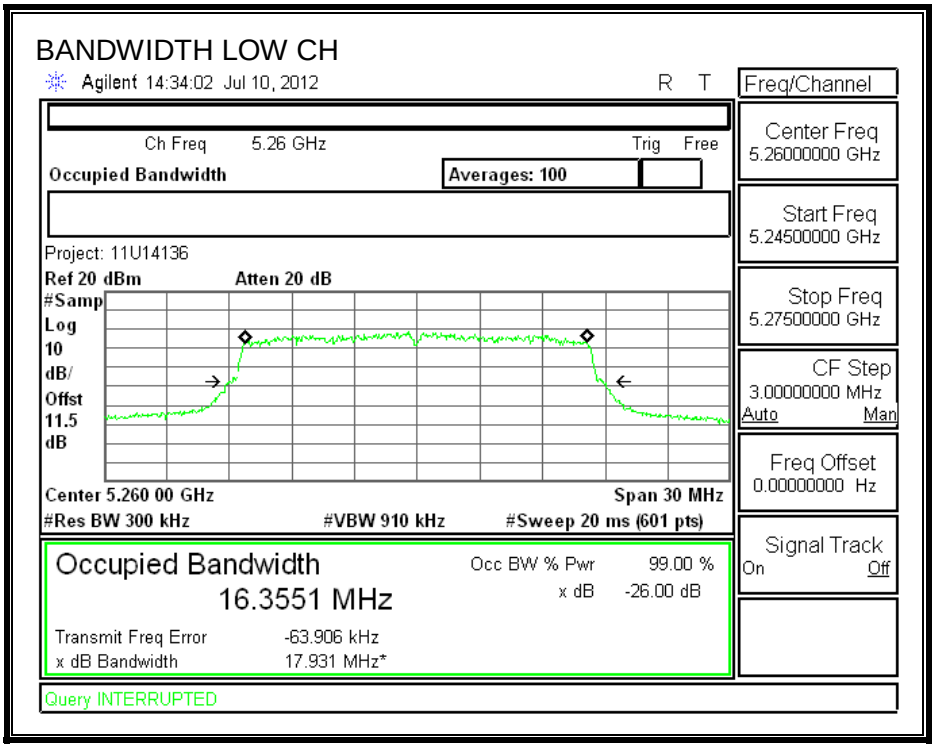
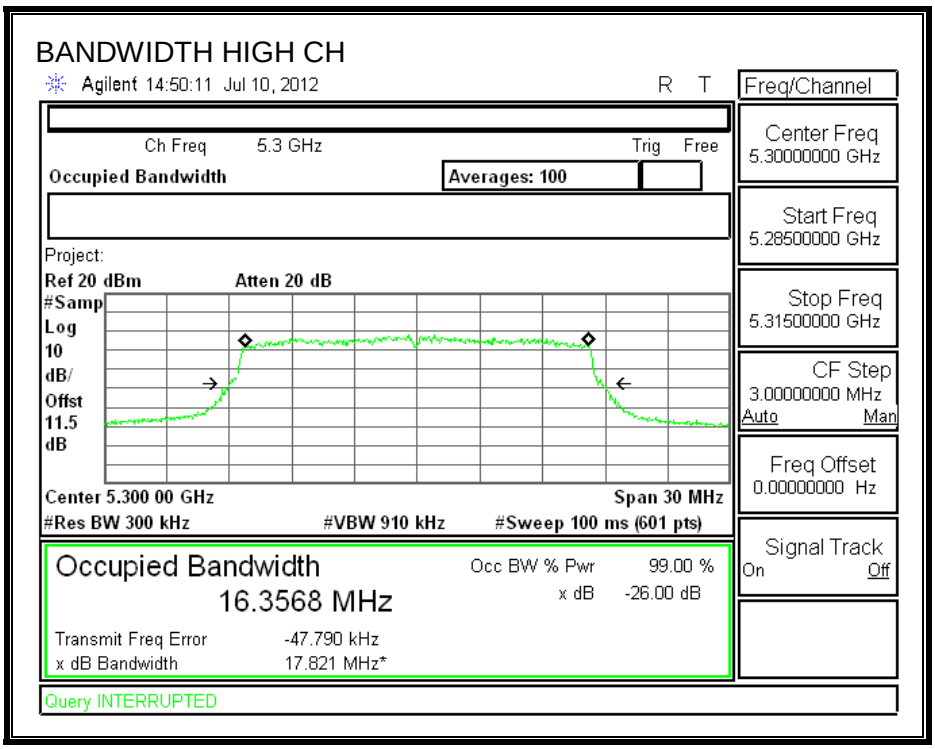
99% BANDWIDTH





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8.4.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

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

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5260	13.50
Mid	5300	13.49
High	5320	13.49

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8.4.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.25–5.35 GHz, 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. In addition, the maximum 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 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

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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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	16.4	23.14	-1.66	23.14	11.00
Mid	5300	24	16.4	23.14	-1.66	23.14	11.00
High	5320	24	16.4	23.14	-1.66	23.14	11.00

Duty Cycle CF (dB)	0.08	**Included in Calculations of Corr'd Power & PPSD**

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5260	14.18	14.26	23.14	-8.88
Mid	5300	14.02	14.10	23.14	-9.04
High	5320	14.10	14.18	23.14	-8.96

PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5260	3.71	3.79	11.00	-7.21
Mid	5300	3.61	3.69	11.00	-7.31
High	5320	3.67	3.75	11.00	-7.25

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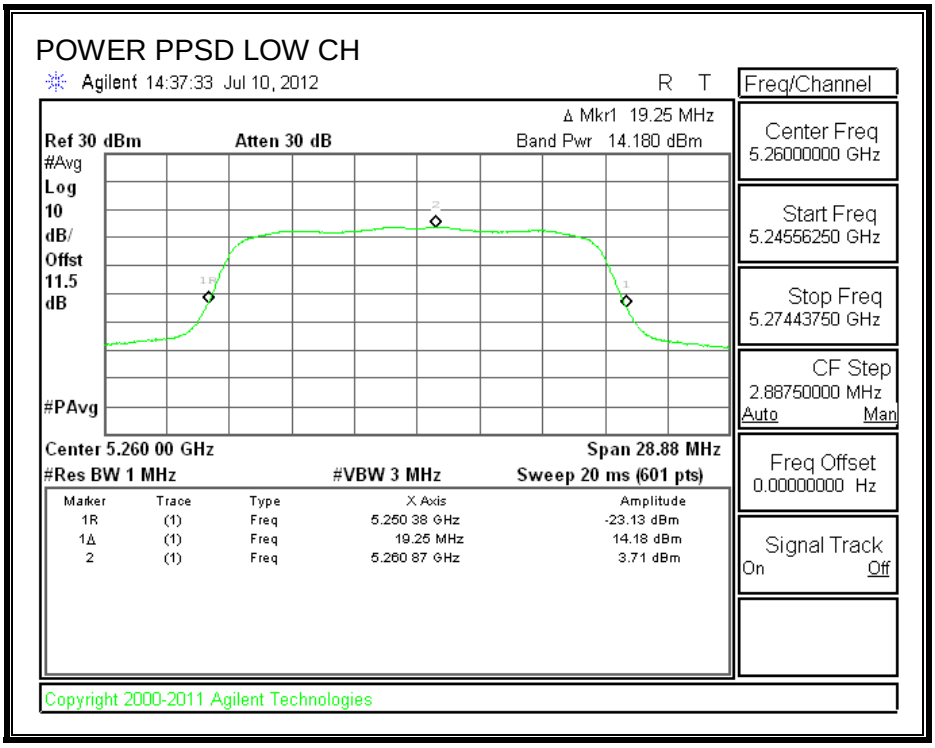
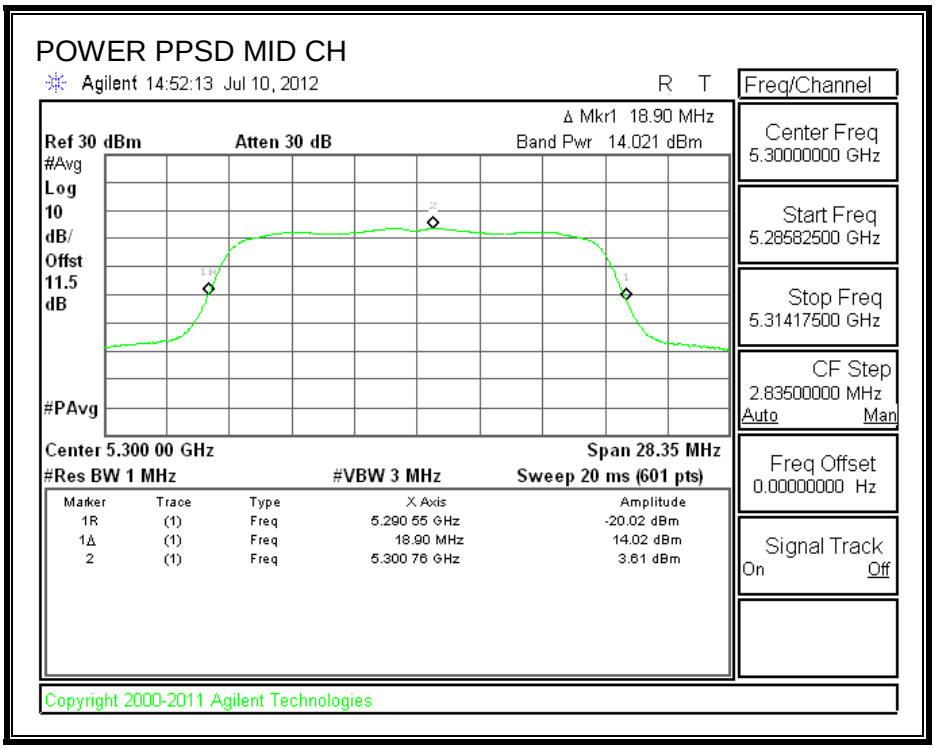
OUTPUT POWER AND PPSD





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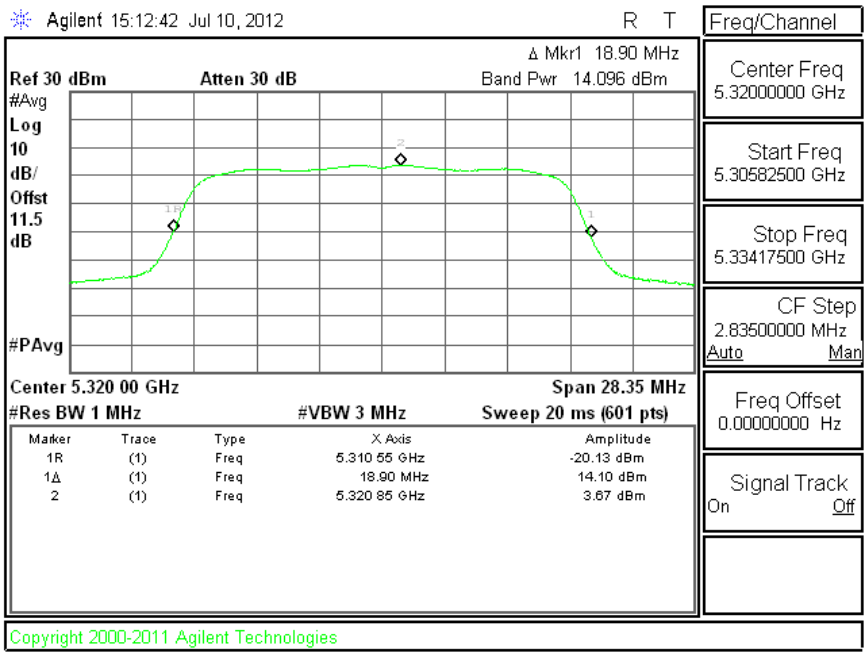
POWER PPSD HIGH CH



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8.5. 802.11n HT20 MODE IN THE 5.3 GHz BAND

8.5.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5260	19.20
Mid	5300	19.15
High	5320	19.35

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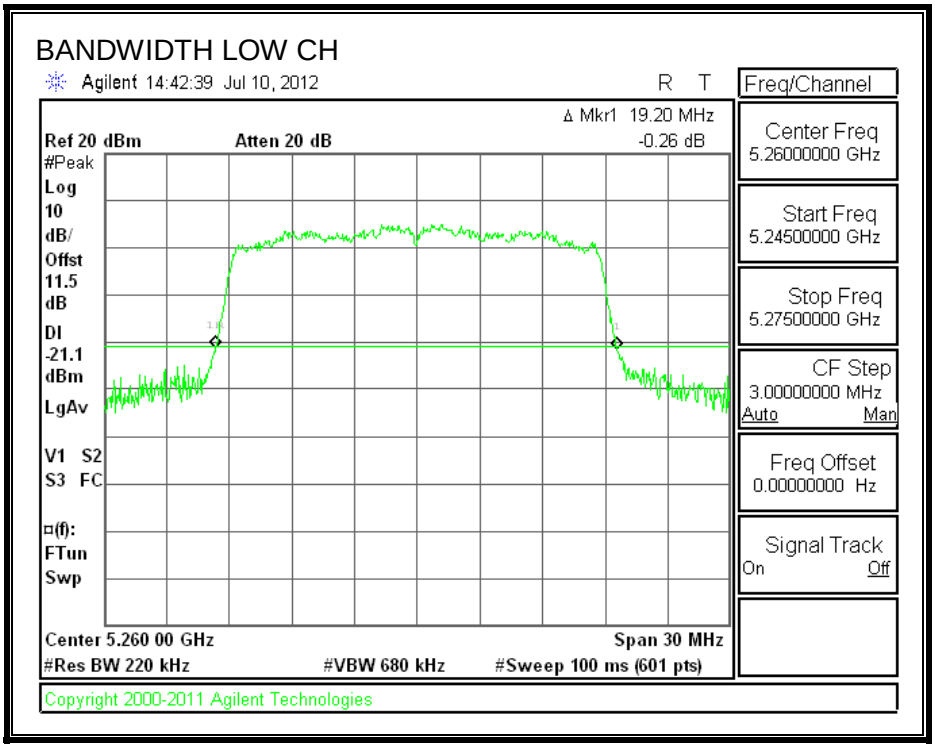
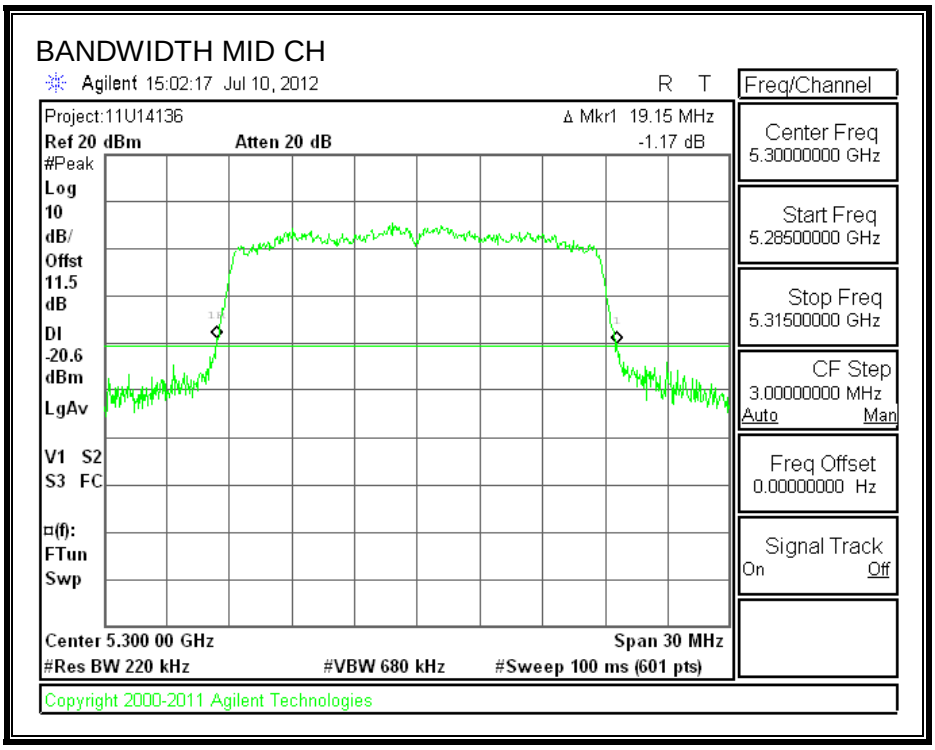
26 dB BANDWIDTH





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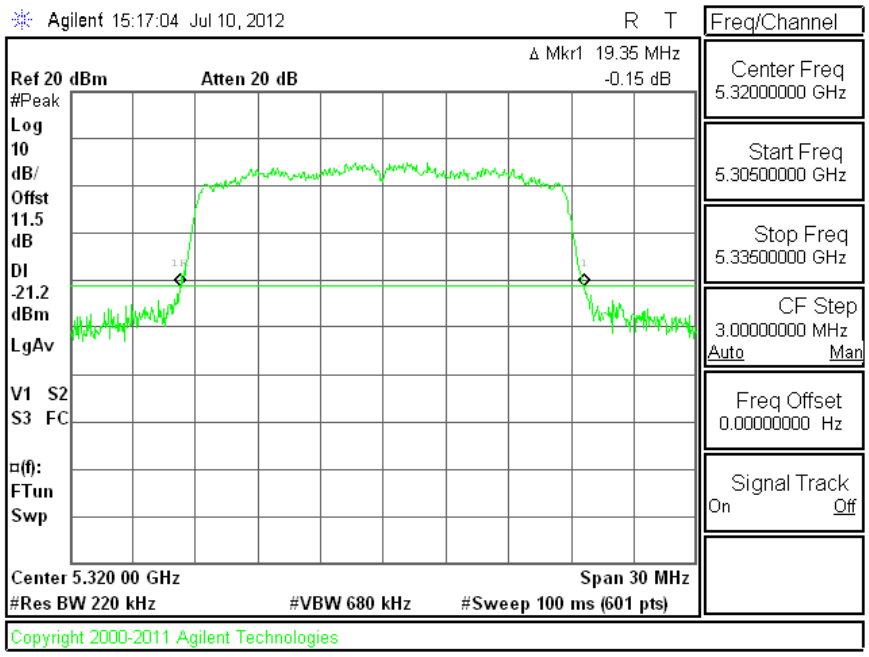
BANDWIDTH HIGH CH



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8.5.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5260	17.568
Mid	5300	17.551
High	5320	17.604

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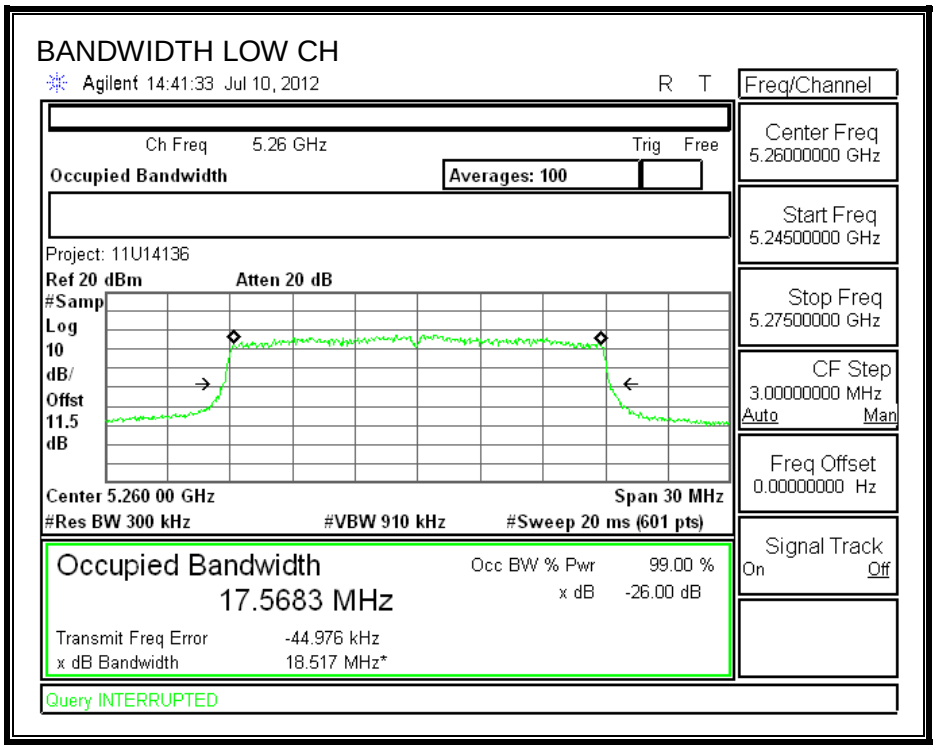
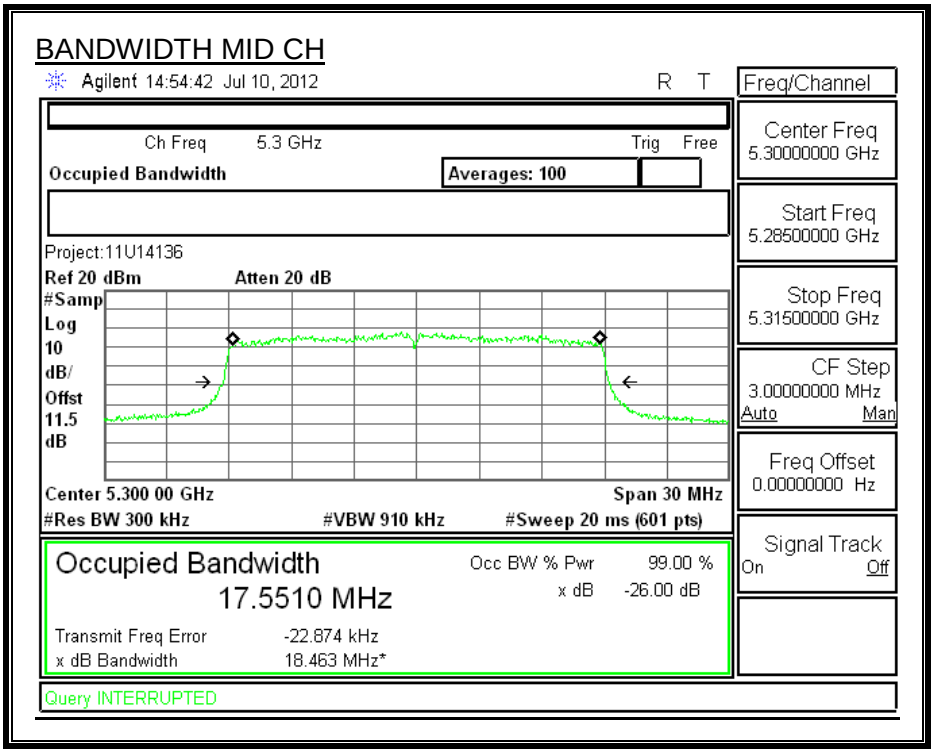
99% BANDWIDTH





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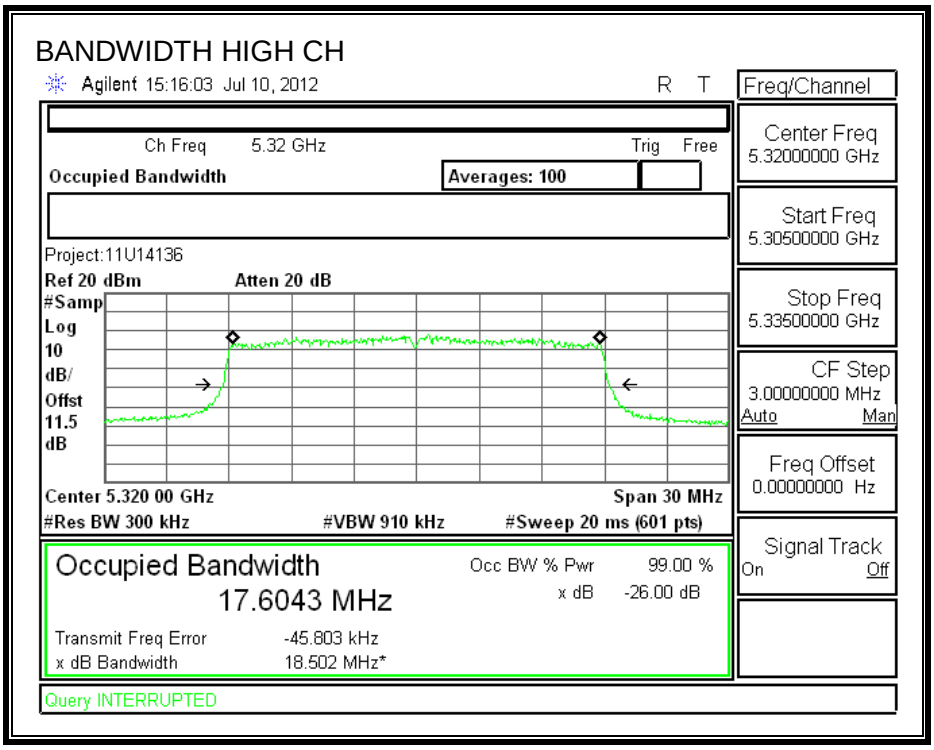

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8.5.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

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

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5260	13.47
Mid	5300	13.50
High	5320	13.45

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8.5.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.25–5.35 GHz, 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. In addition, the maximum 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 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

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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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	17.6	23.45	-1.66	23.45	11.00
Mid	5300	24	17.6	23.44	-1.66	23.44	11.00
High	5320	24	17.6	23.46	-1.66	23.46	11.00

Duty Cycle CF (dB)	0.08	**Included in Calculations of Corr'd Power & PPSD**

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5260	14.00	14.08	23.45	-9.37
Mid	5300	14.05	14.13	23.44	-9.31
High	5320	14.00	14.08	23.46	-9.38

PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5260	3.36	3.44	11.00	-7.56
Mid	5300	3.42	3.50	11.00	-7.50
High	5320	3.37	3.45	11.00	-7.55

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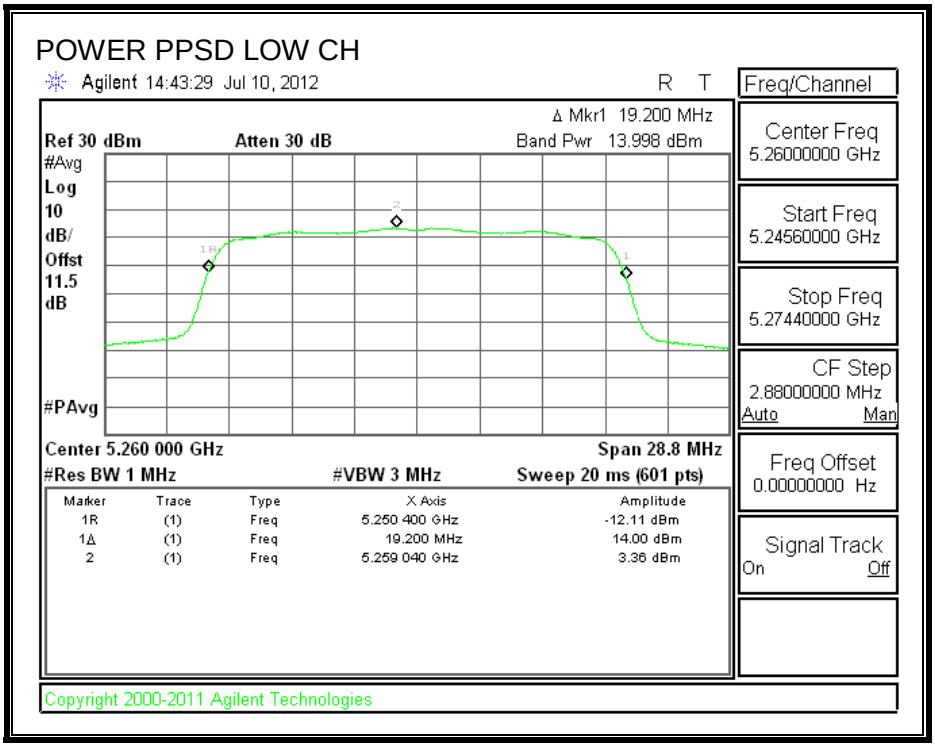
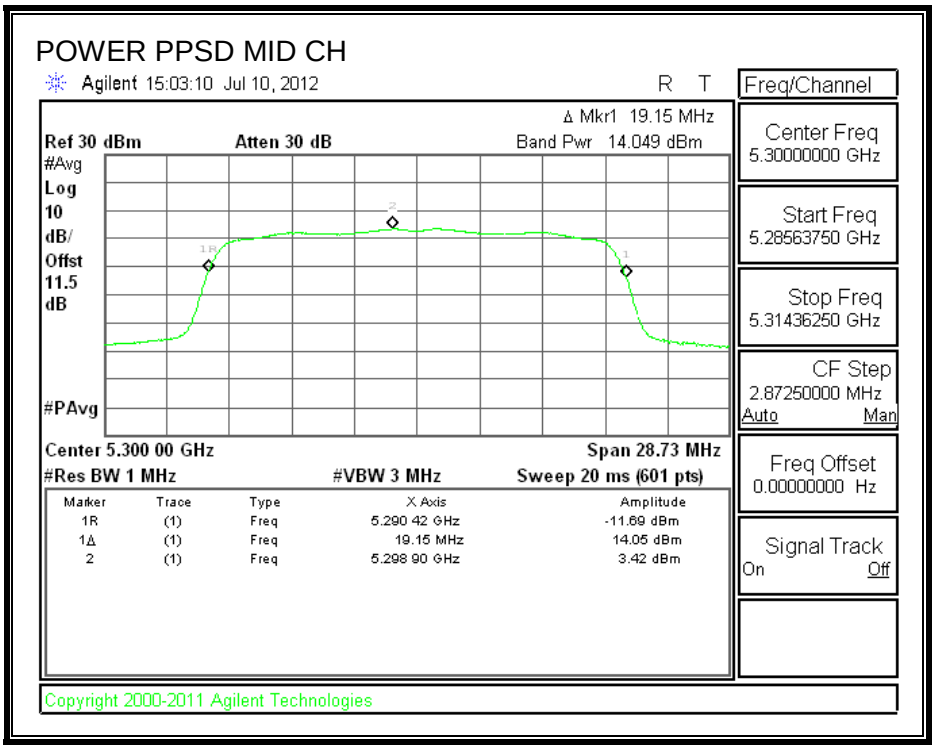
OUTPUT POWER AND PPSD





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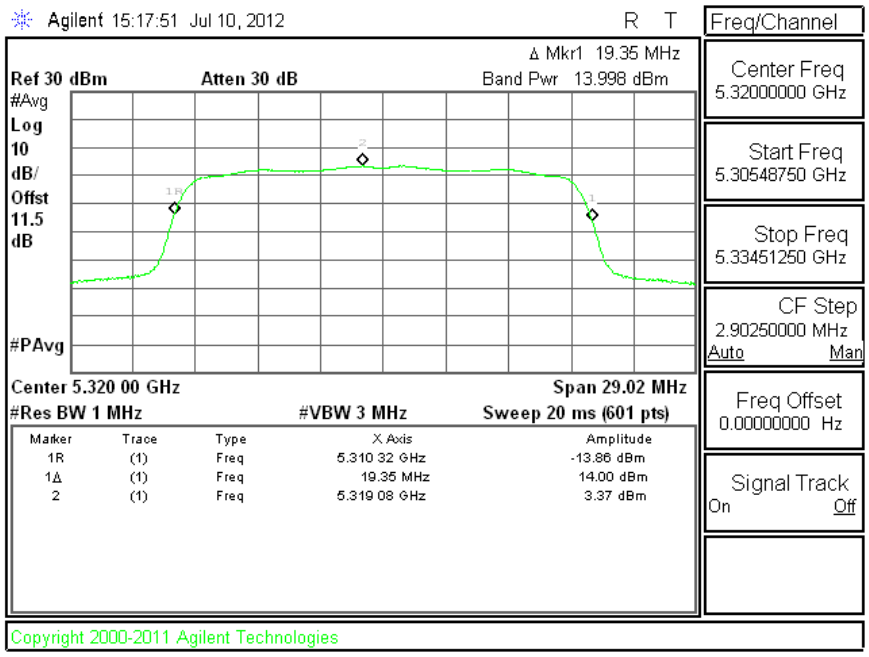
POWER PPSD HIGH CH



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8.6. 802.11n HT40 MODE IN THE 5.3 GHz BAND

8.6.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5270	44.6
High	5310	44.6

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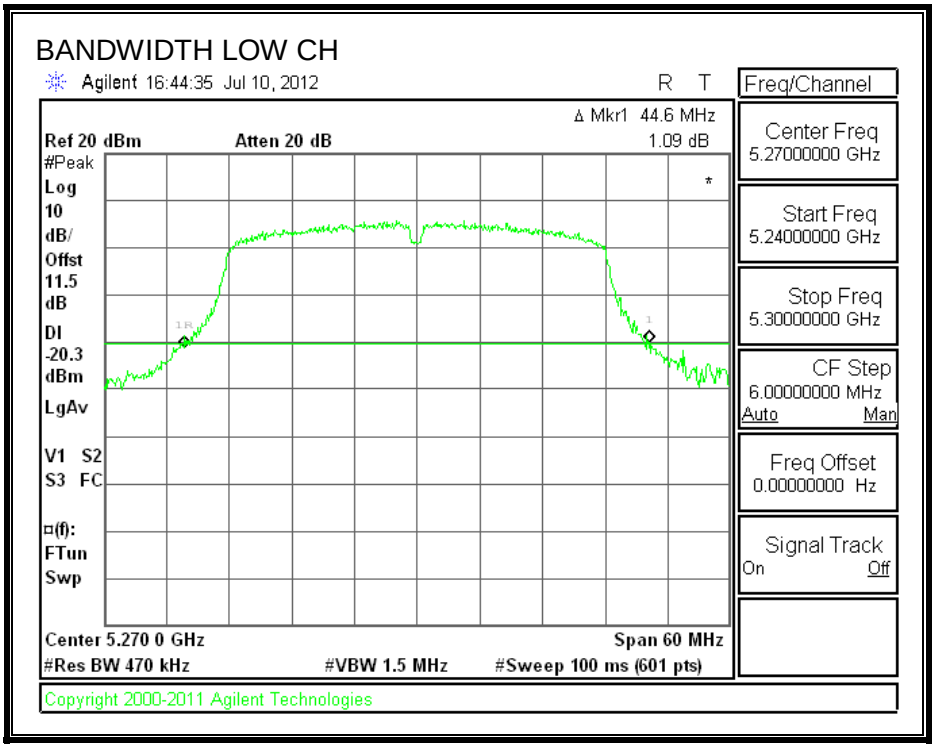
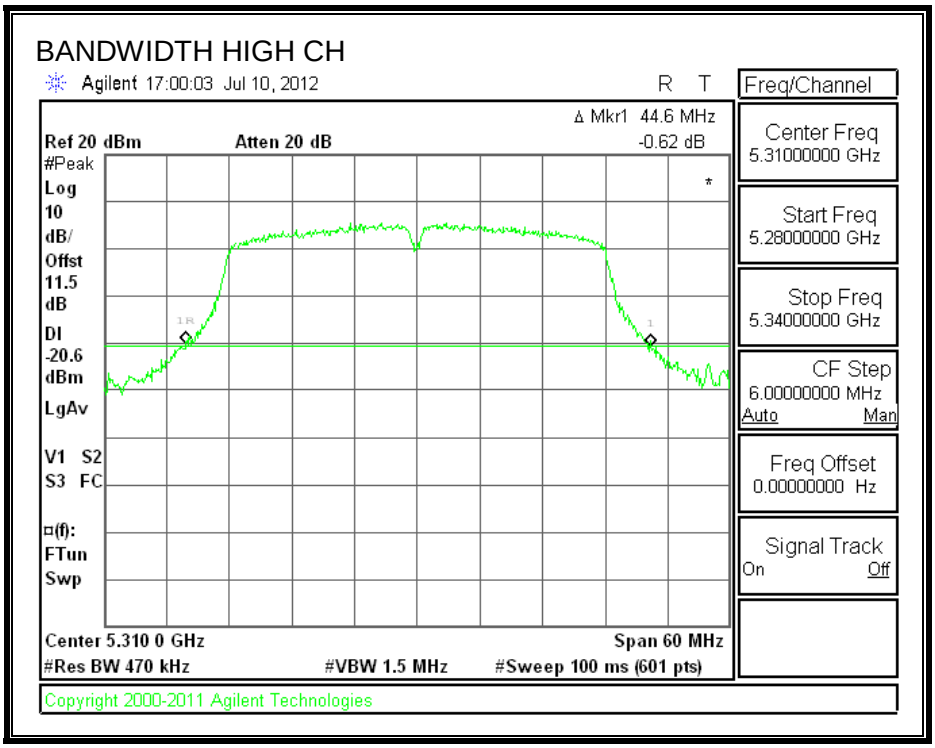
26 dB BANDWIDTH





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8.6.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5270	36.040
High	5310	36.061

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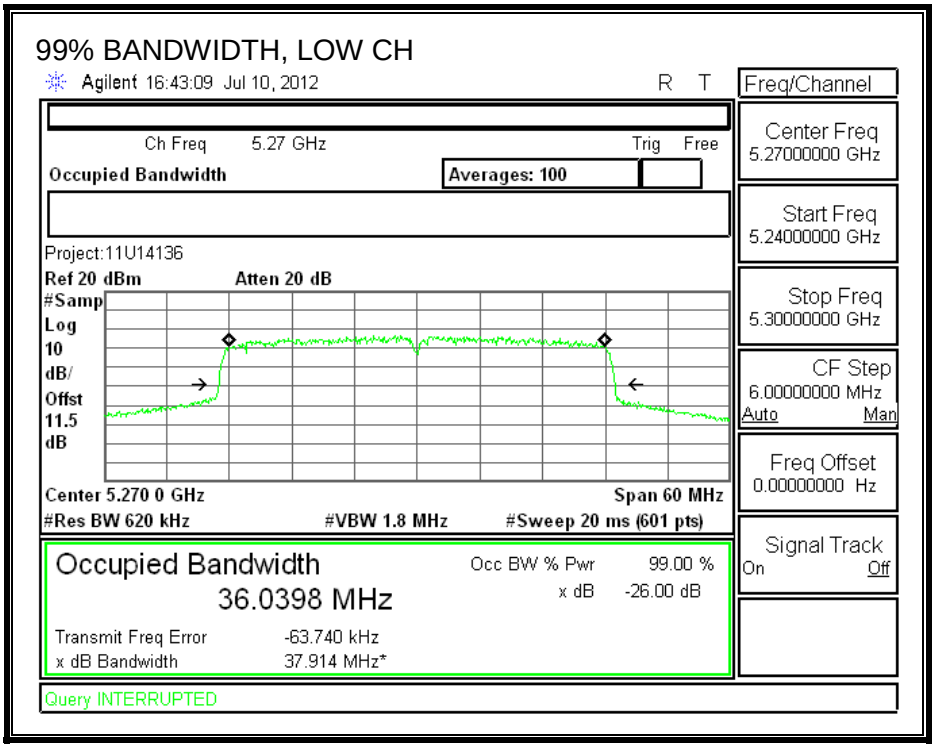
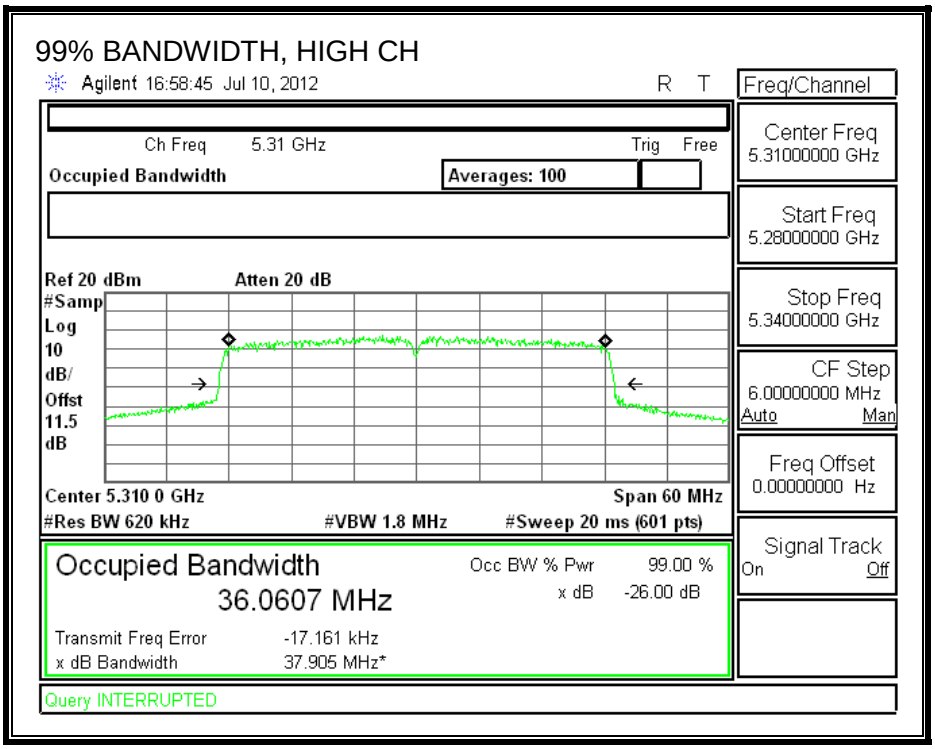
99% BANDWIDTH





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8.6.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

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

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5270	13.45
High	5310	13.49

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8.6.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.25–5.35 GHz, 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. In addition, the maximum 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 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

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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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	5270	24	36.0	26.57	-1.66	24.00	11.00
High	5310	24	36.1	26.57	-1.66	24.00	11.00

Duty Cycle CF (dB)	0.16	**Included in Calculations of Corr'd Power & PPSD**

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5270	14.39	14.55	24.00	-9.45
High	5310	14.38	14.54	24.00	-9.46

PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5270	0.37	0.53	11.00	-10.47
High	5310	0.37	0.53	11.00	-10.47

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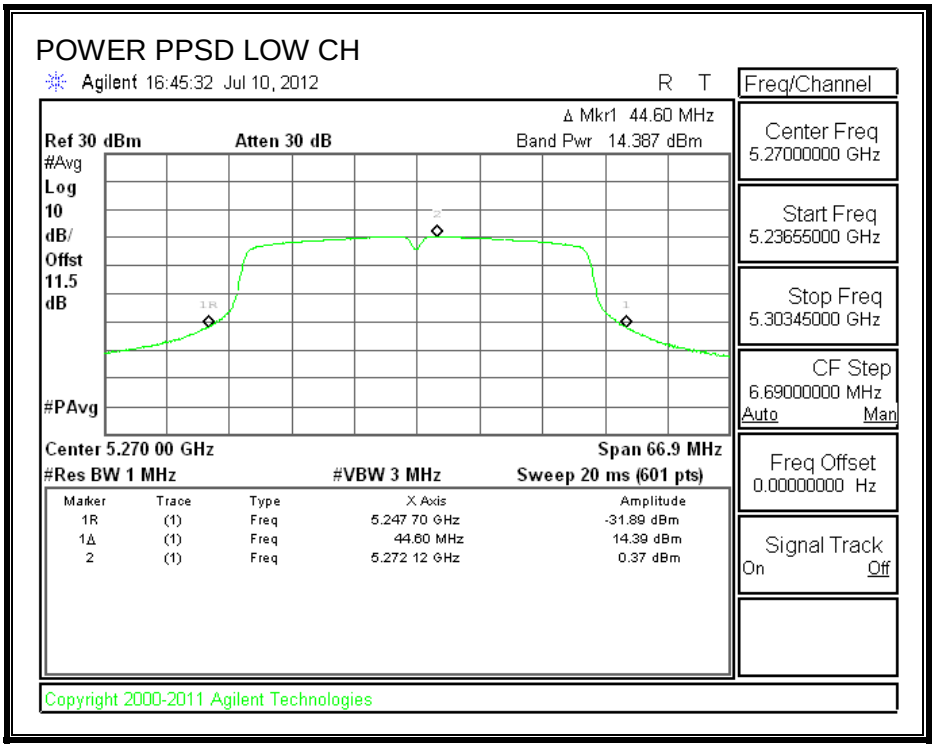
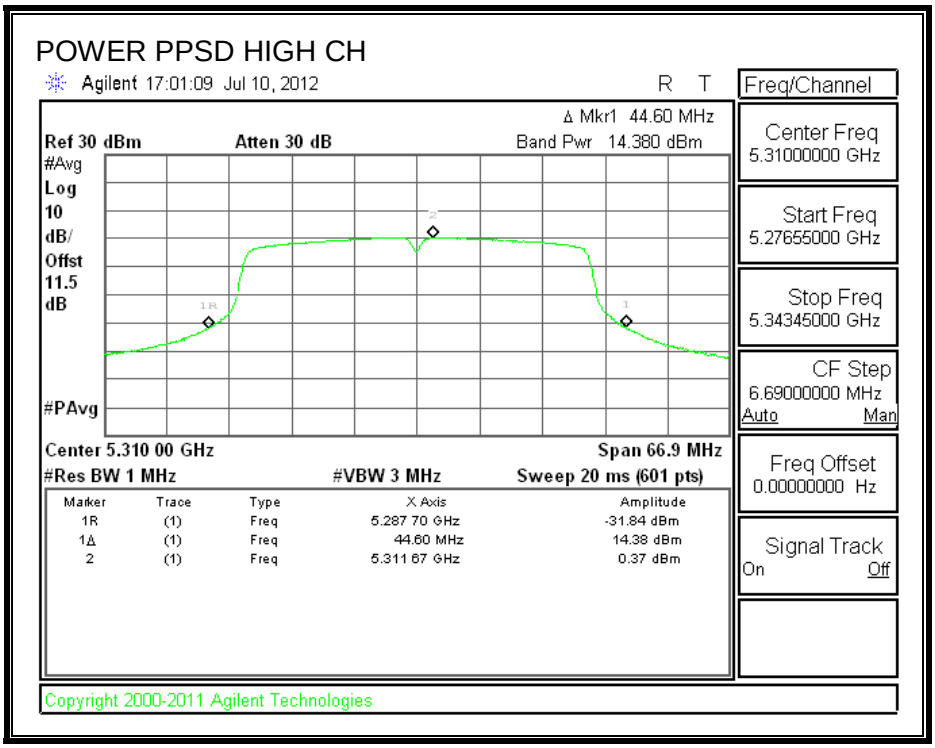
OUTPUT POWER AND PPSD





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8.7. 802.11a MODE IN THE 5.6 GHz BAND

8.7.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5500	18.8
Mid	5580	19.0
High	5700	19.1

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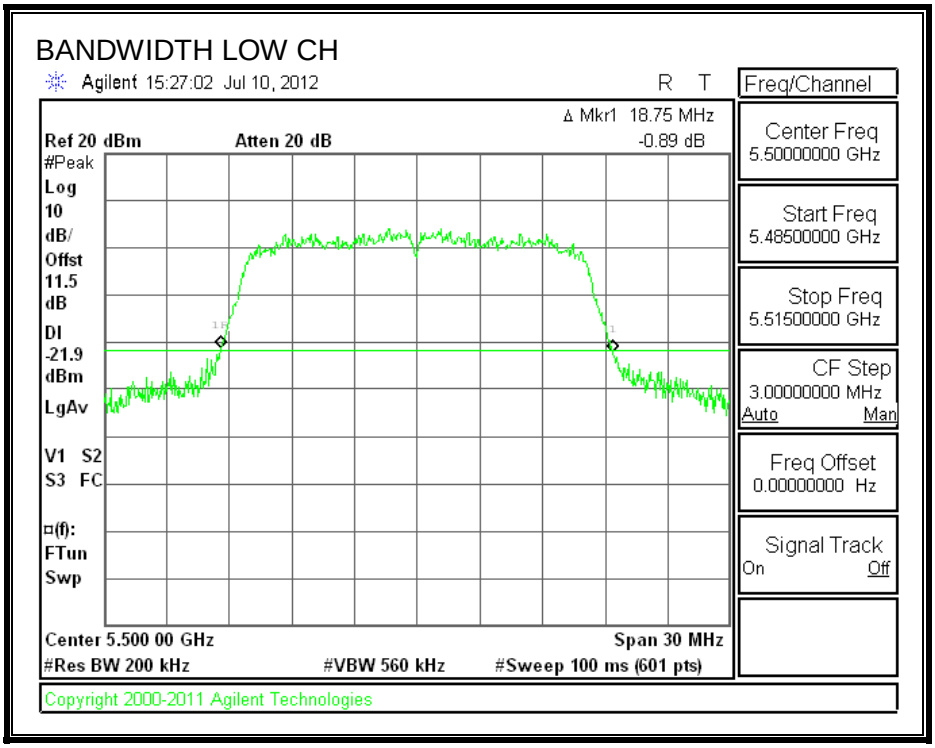
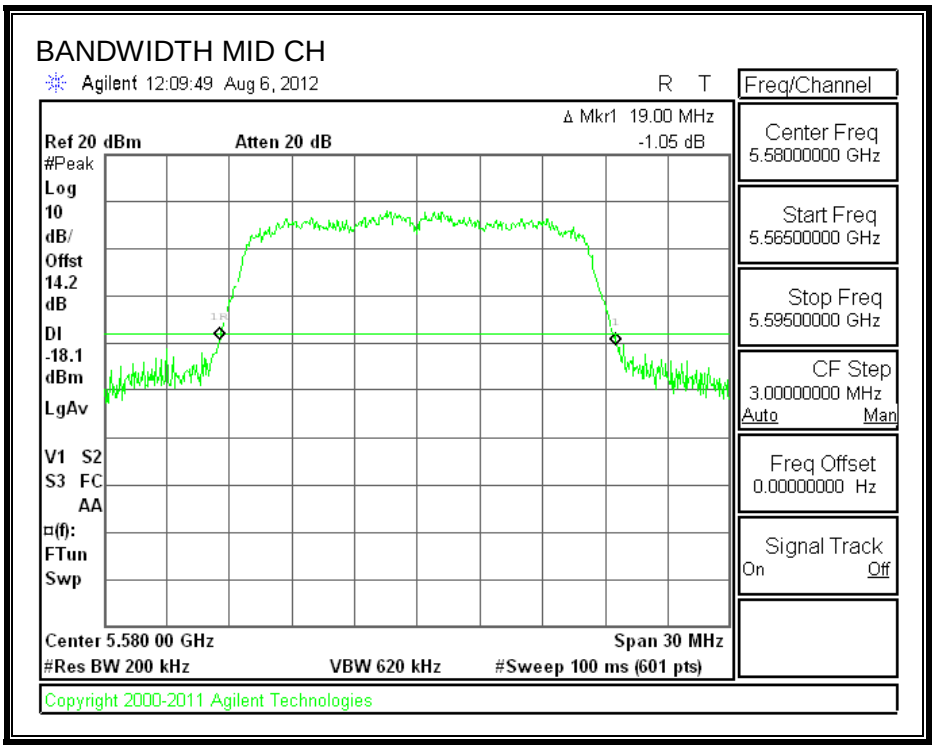
26 dB BANDWIDTH





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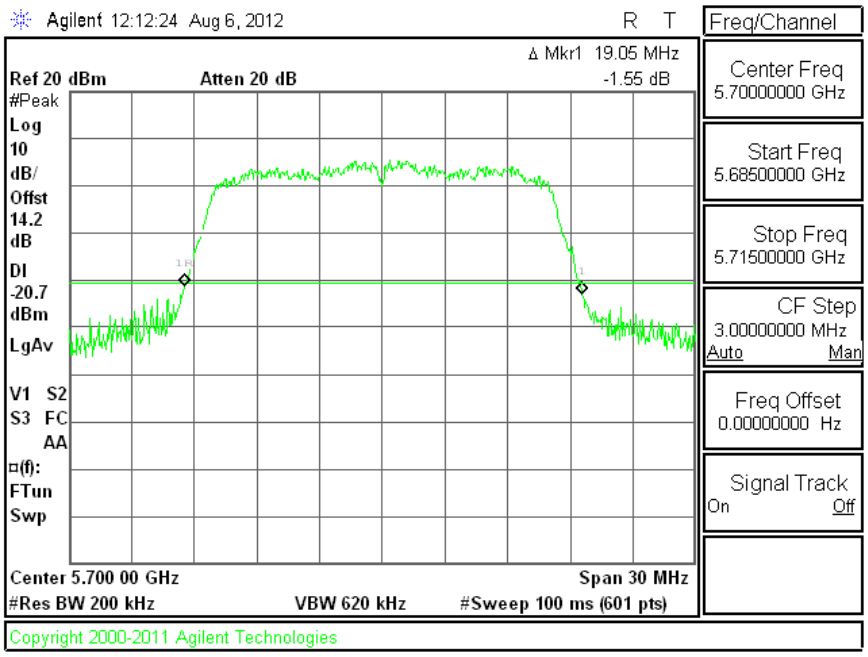
BANDWIDTH HIGH CH



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8.7.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5500	16.352
Mid	5580	16.534
High	5700	16.540

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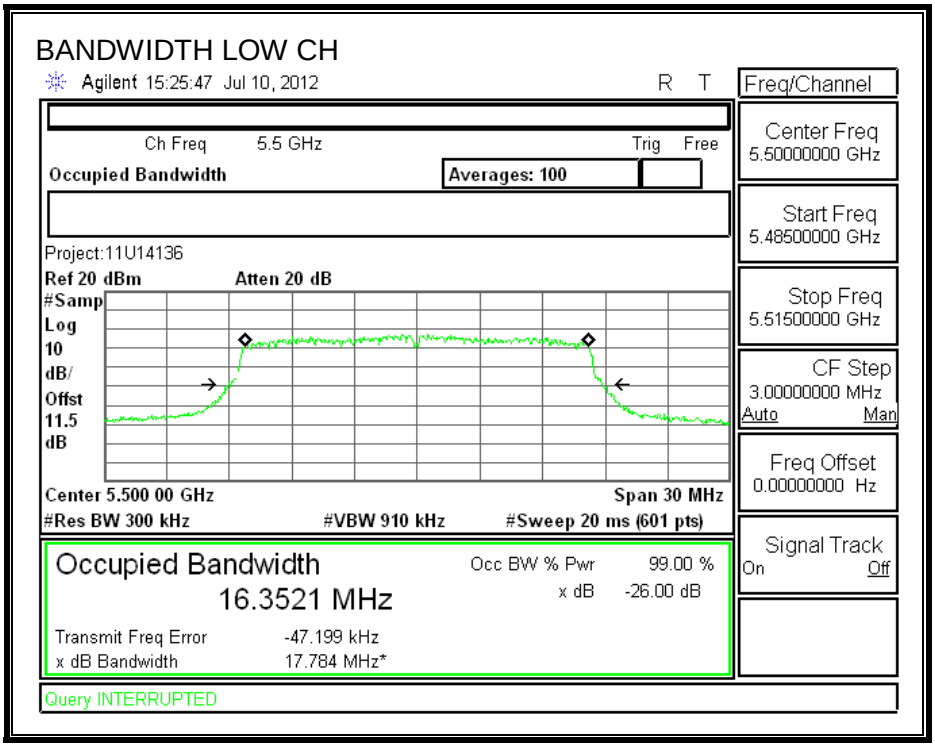
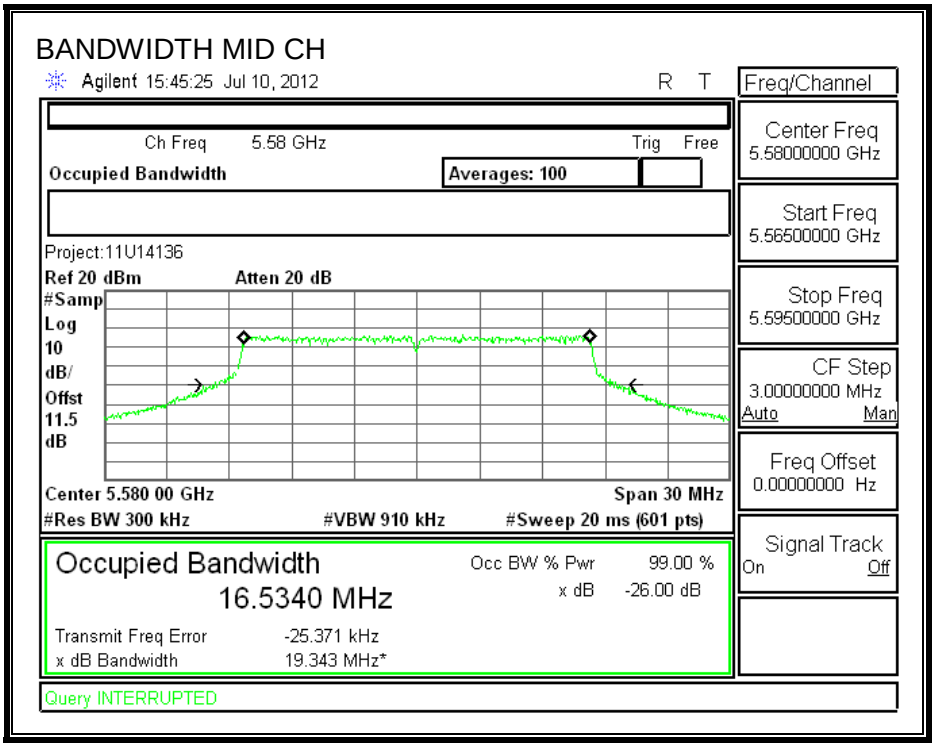
99% BANDWIDTH





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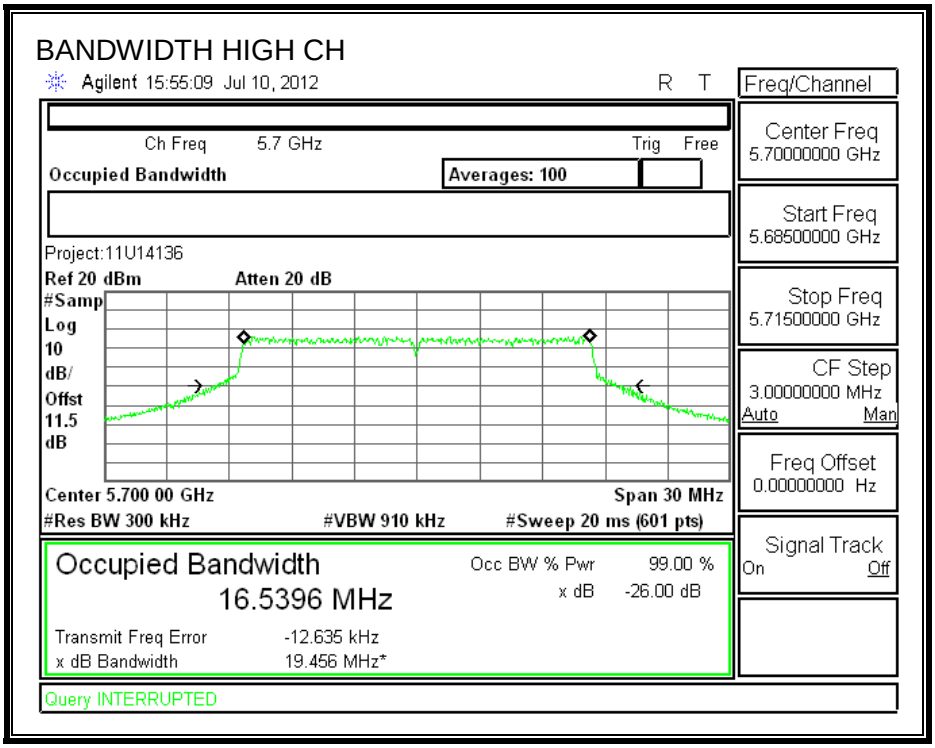

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8.7.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

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

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5500	12.00
Mid	5580	11.98
High	5700	11.96

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8.7.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.47–5.725 GHz, 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. In addition, the maximum 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 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

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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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	16.4	23.14	-0.83	23.14	11.00
Mid	5580	24	16.5	23.18	-0.83	23.18	11.00
High	5700	24	16.5	23.19	-0.83	23.19	11.00

Duty Cycle CF (dB)	0.08	**Included in Calculations of Corr'd Power & PPSD**

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5500	13.92	14.00	23.14	-9.13
Mid	5580	14.01	14.09	23.18	-9.09
High	5700	13.99	14.07	23.19	-9.12

PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5500	3.48	3.56	11.00	-7.44
Mid	5580	2.46	2.54	11.00	-8.46
High	5700	2.43	2.51	11.00	-8.49

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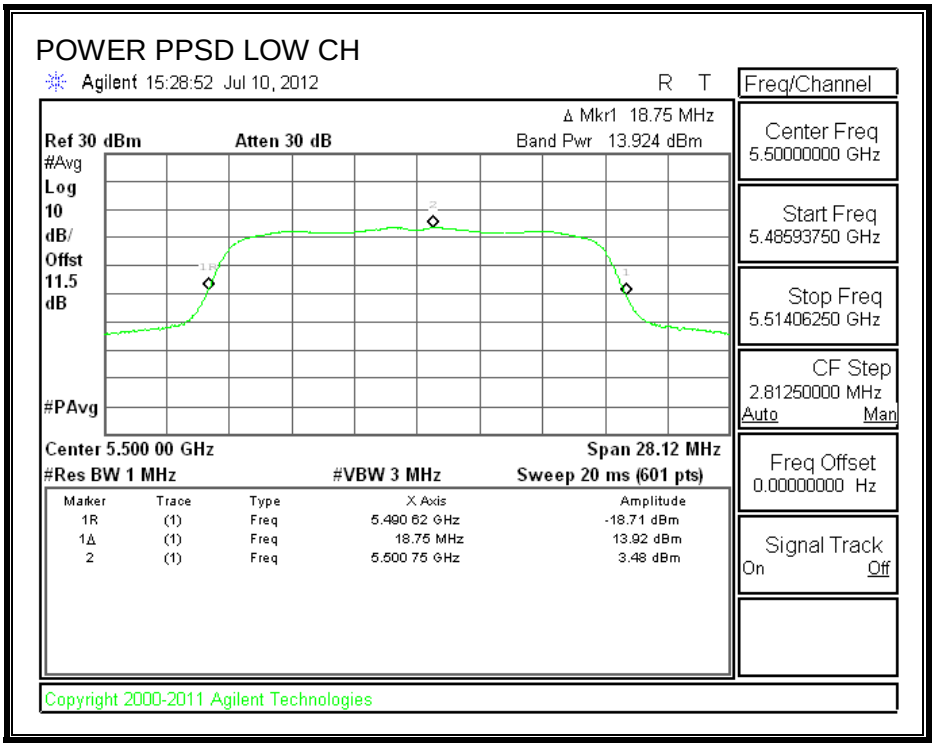
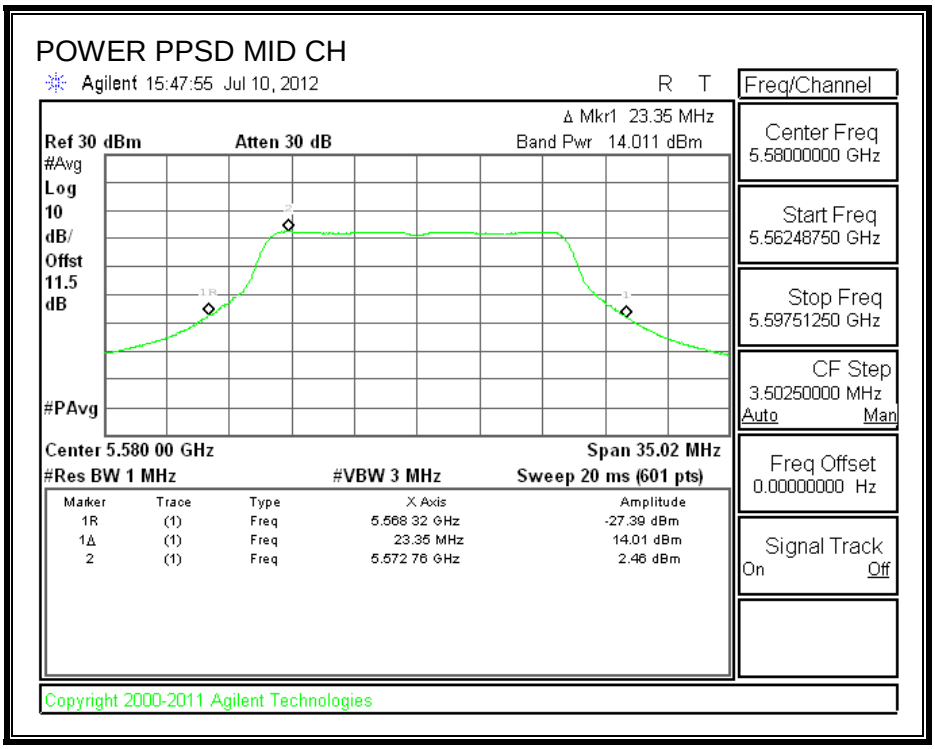
OUTPUT POWER AND PPSD





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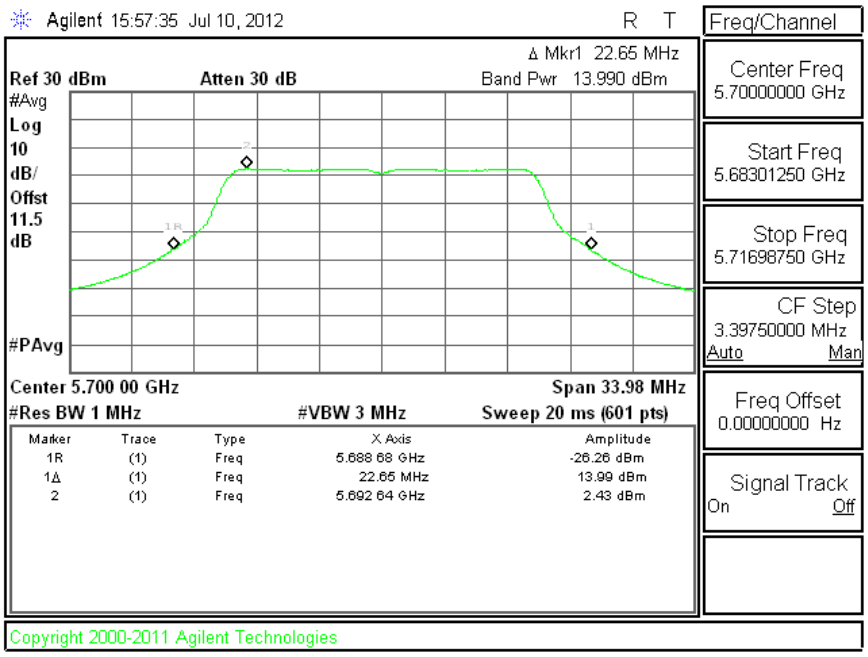
POWER PPSD HIGH CH



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8.8. 802.11n HT20 MODE IN THE 5.6 GHz BAND

8.8.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5500	23.1
Mid	5580	23.0
High	5700	23.1

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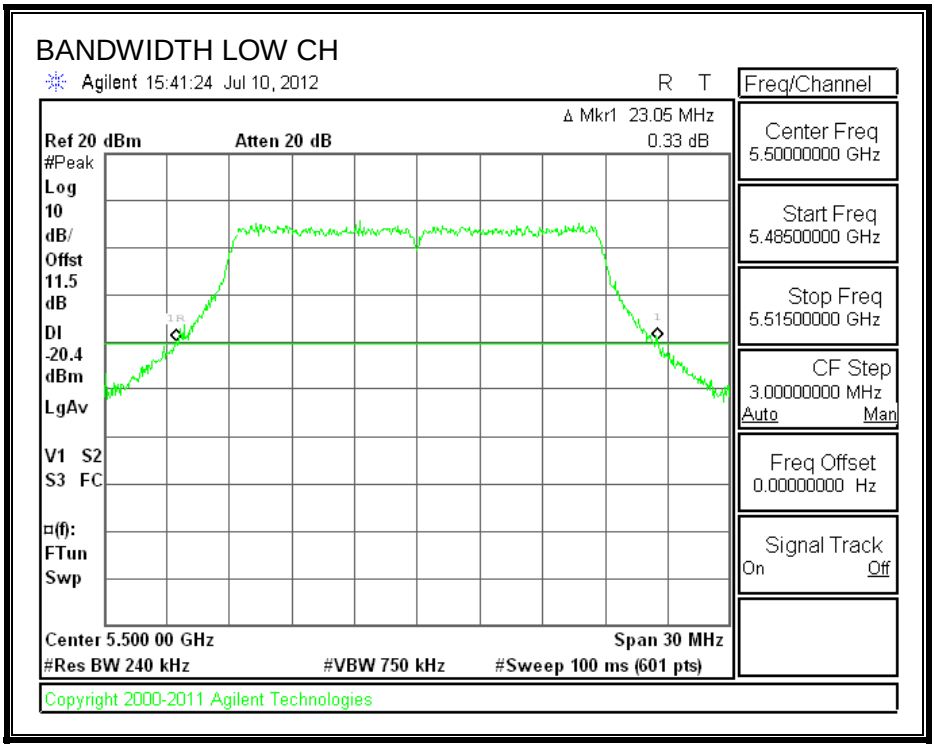
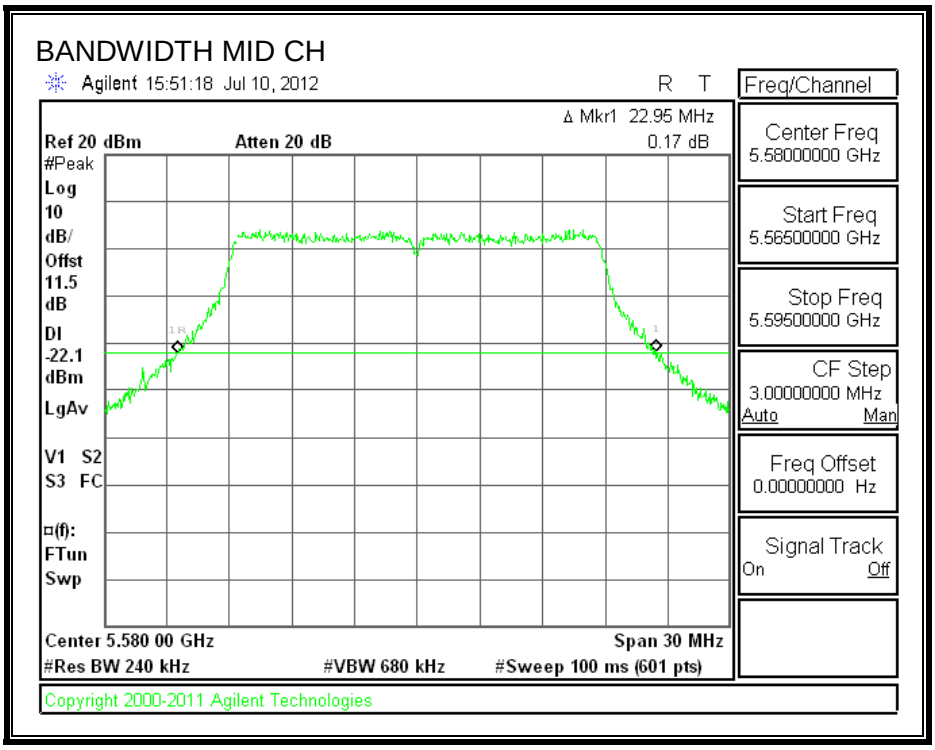
26 dB BANDWIDTH





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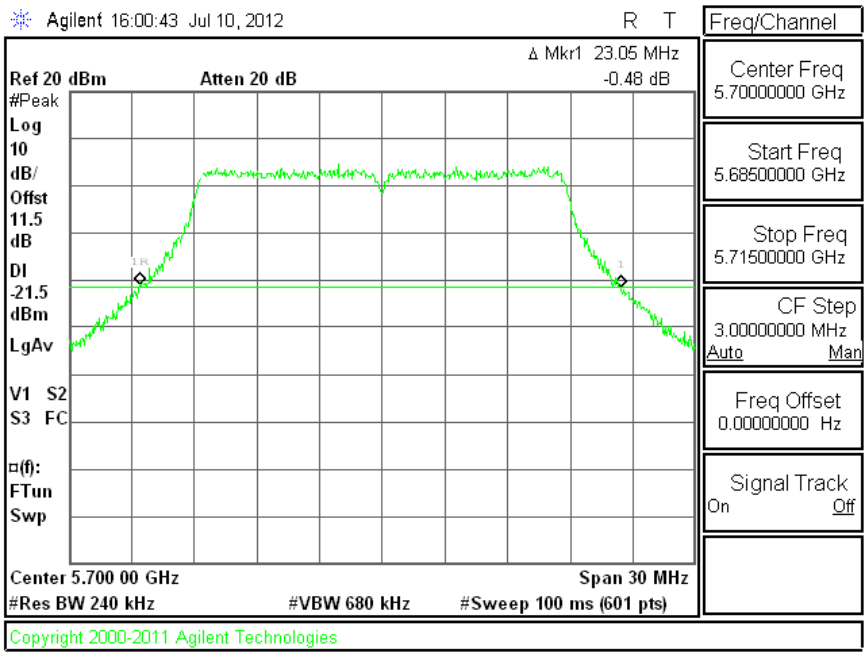
BANDWIDTH HIGH CH



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8.8.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5500	17.740
Mid	5580	17.758
High	5700	17.764

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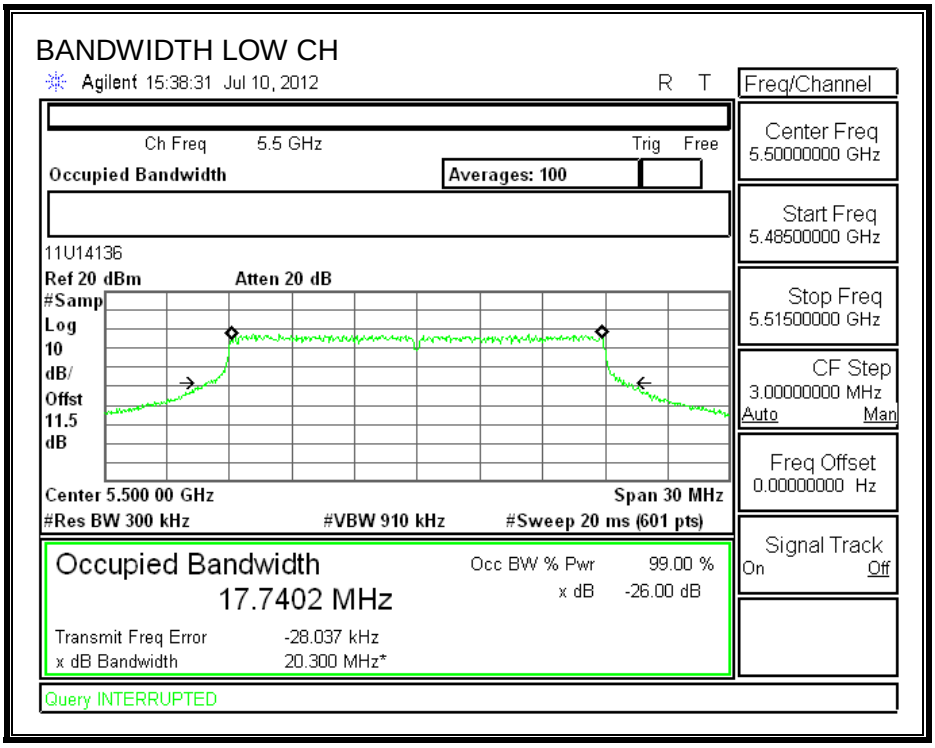
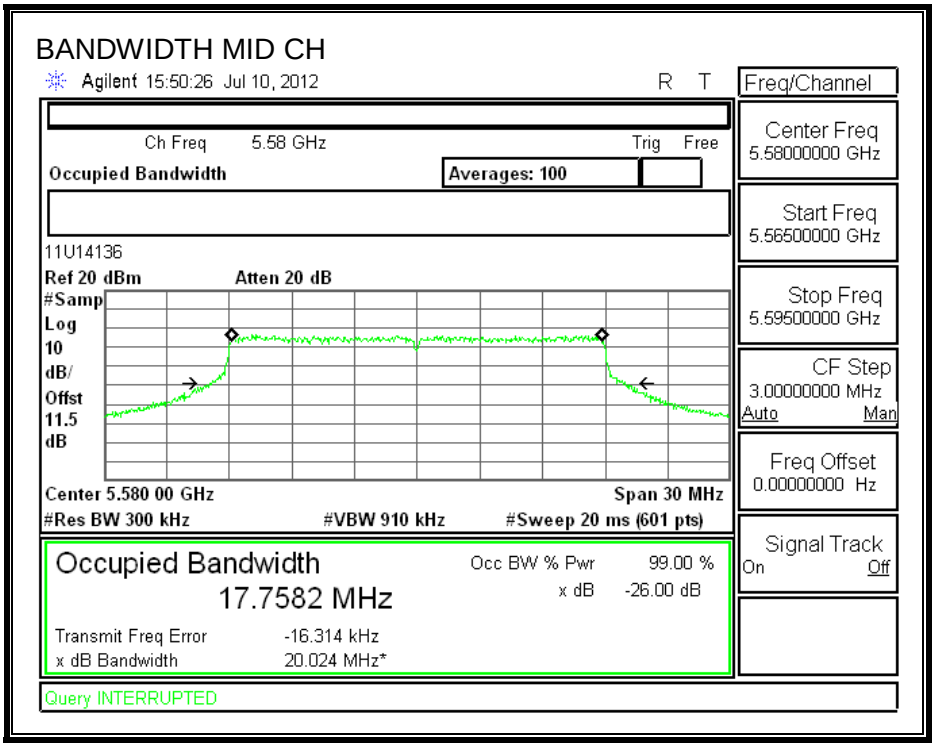
99% BANDWIDTH





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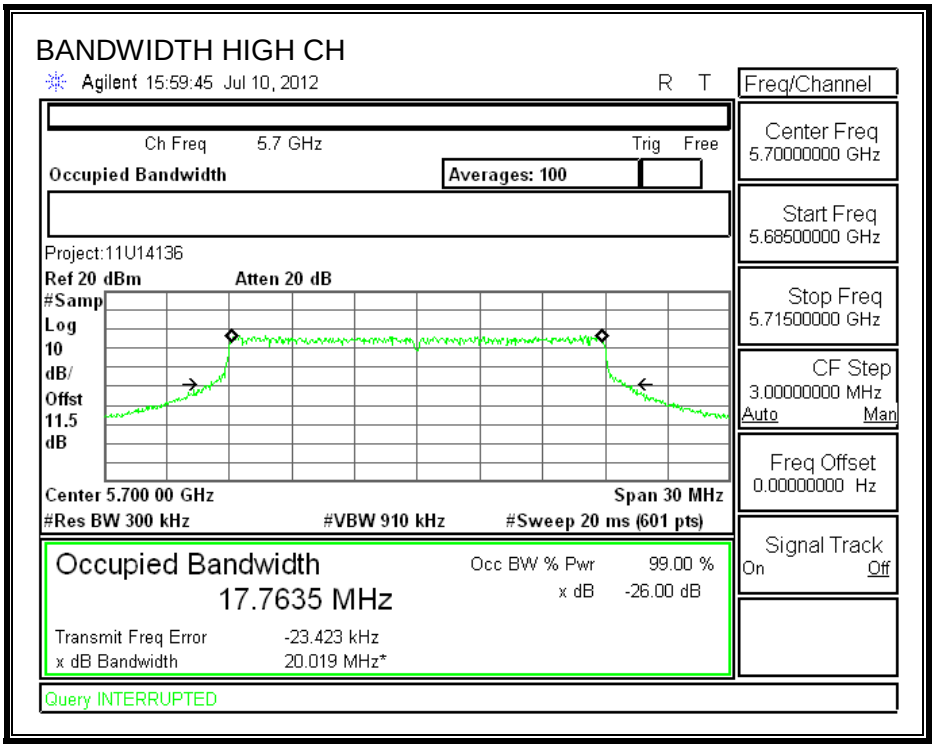

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8.8.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

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

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5500	12.00
Mid	5580	11.94
High	5700	12.00

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8.8.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.47–5.725 GHz, 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. In addition, the maximum 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 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

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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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	17.7	23.49	-0.83	23.49	11.00
Mid	5580	24	17.8	23.49	-0.83	23.49	11.00
High	5700	24	17.8	23.50	-0.83	23.50	11.00

Duty Cycle CF (dB)	0.08	**Included in Calculations of Corr'd Power & PPSD**

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5500	13.93	14.01	23.49	-9.48
Mid	5580	14.01	14.09	23.49	-9.40
High	5700	14.10	14.18	23.50	-9.31

PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5500	2.18	2.26	11.00	-8.74
Mid	5580	2.25	2.33	11.00	-8.67
High	5700	2.36	2.44	11.00	-8.56

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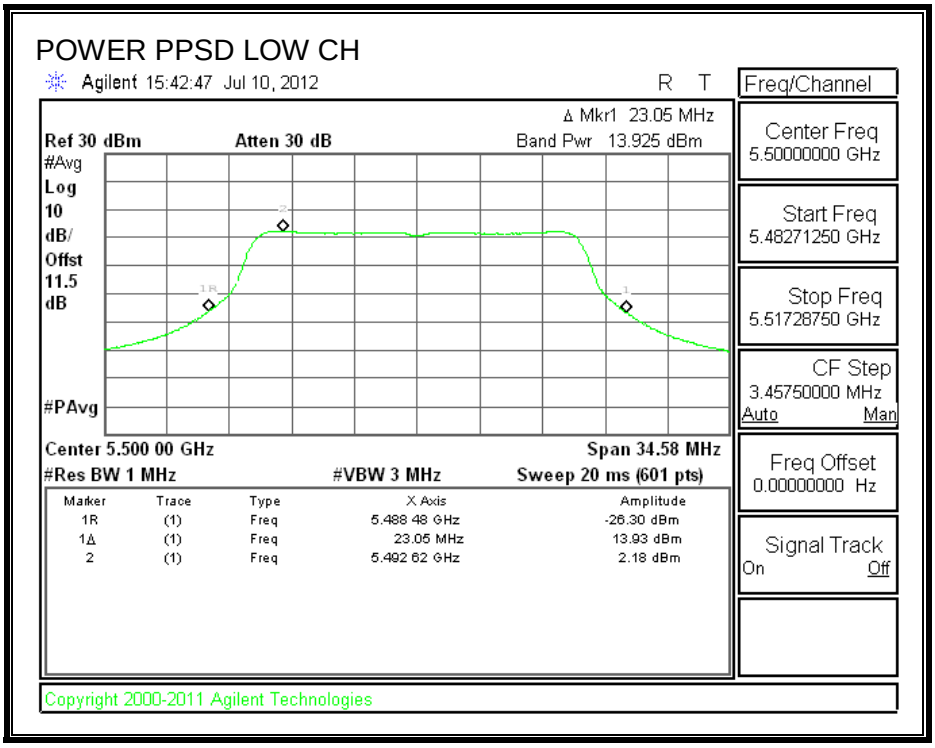
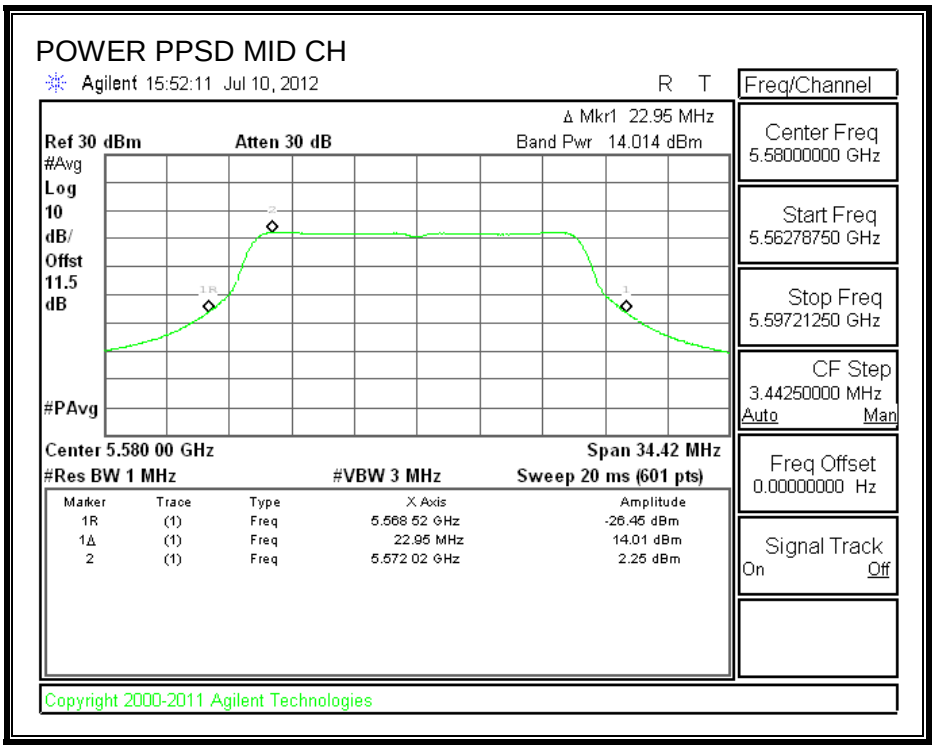
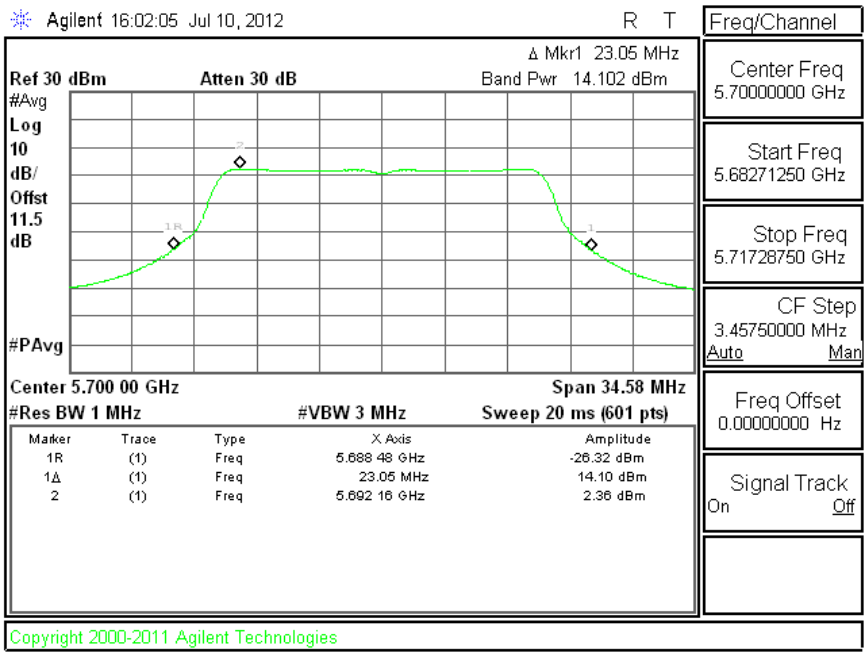
OUTPUT POWER AND PPSD





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

POWER PPSD HIGH CH



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8.9. 802.11n HT40 MODE IN THE 5.6 GHz BAND

8.9.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5510	44.5
Mid	5550	44.7
High	5670	44.5

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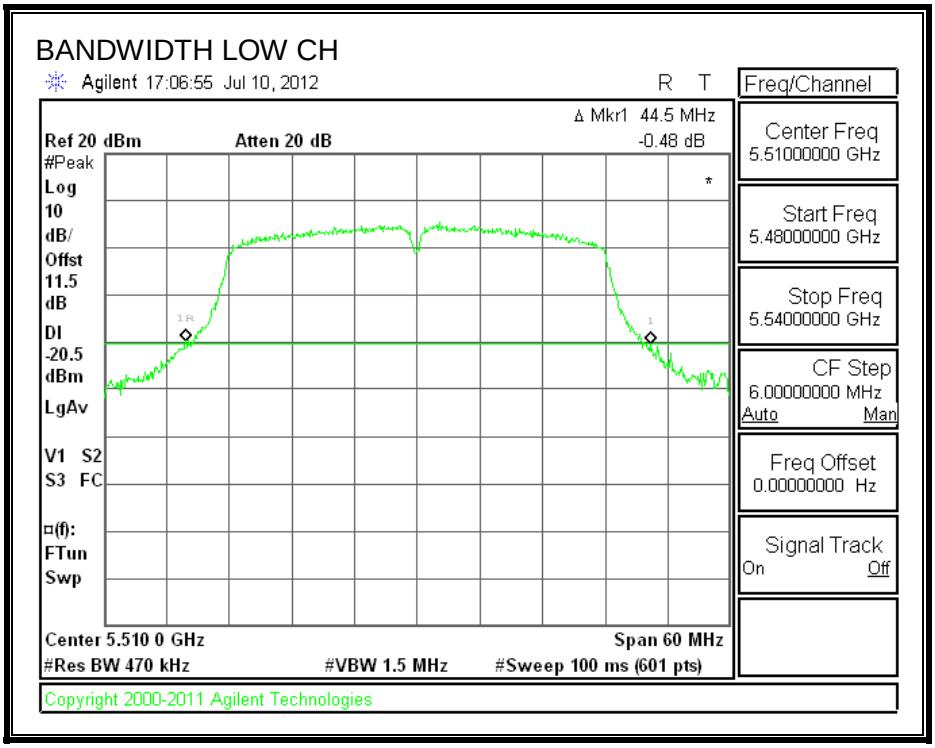
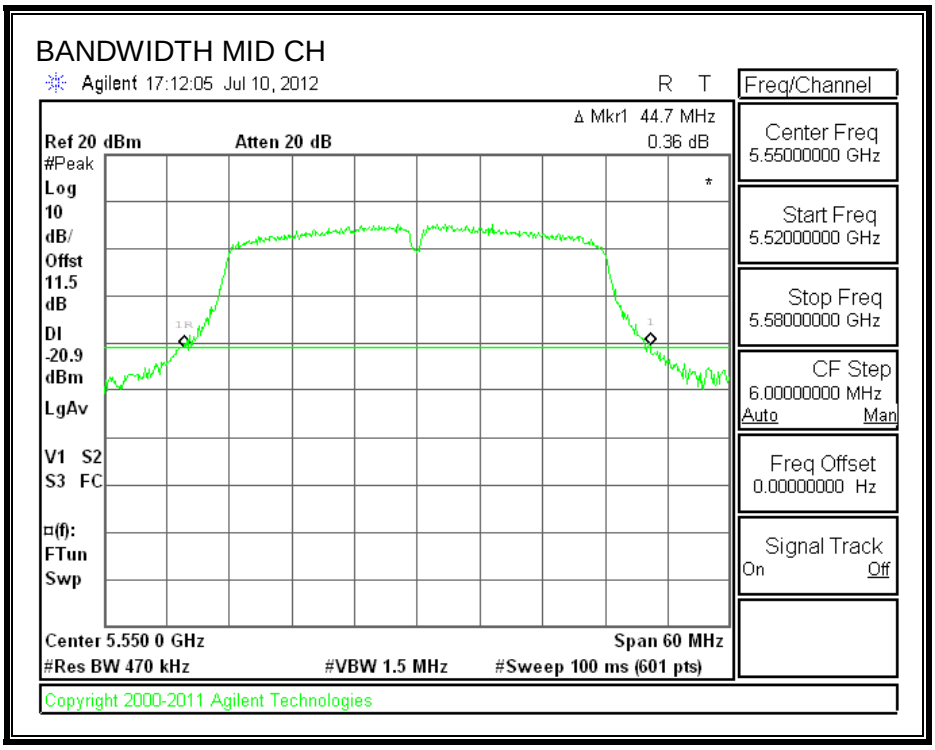
26 dB BANDWIDTH





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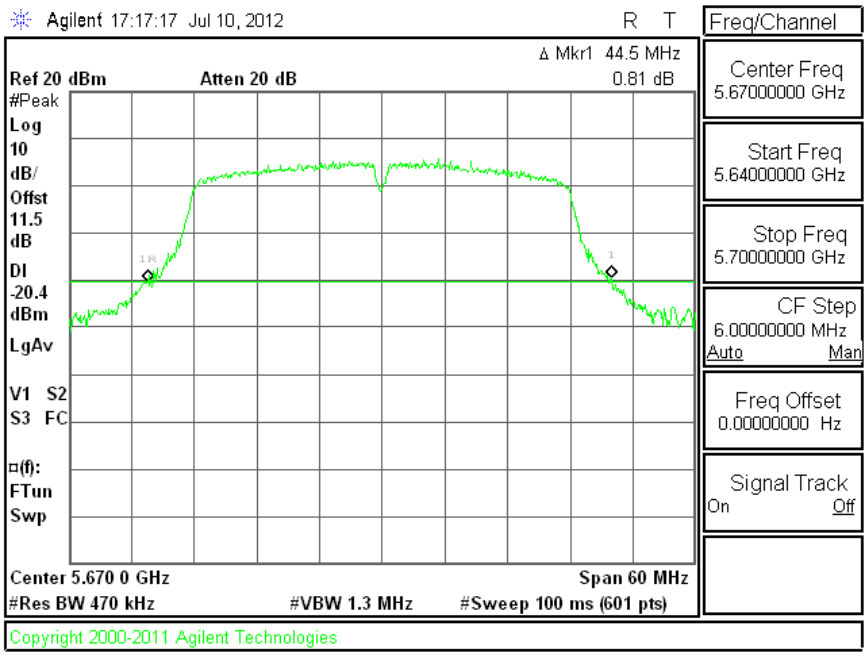
BANDWIDTH HIGH CH



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8.9.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5510	36.1
Mid	5550	36.0
High	5670	36.1

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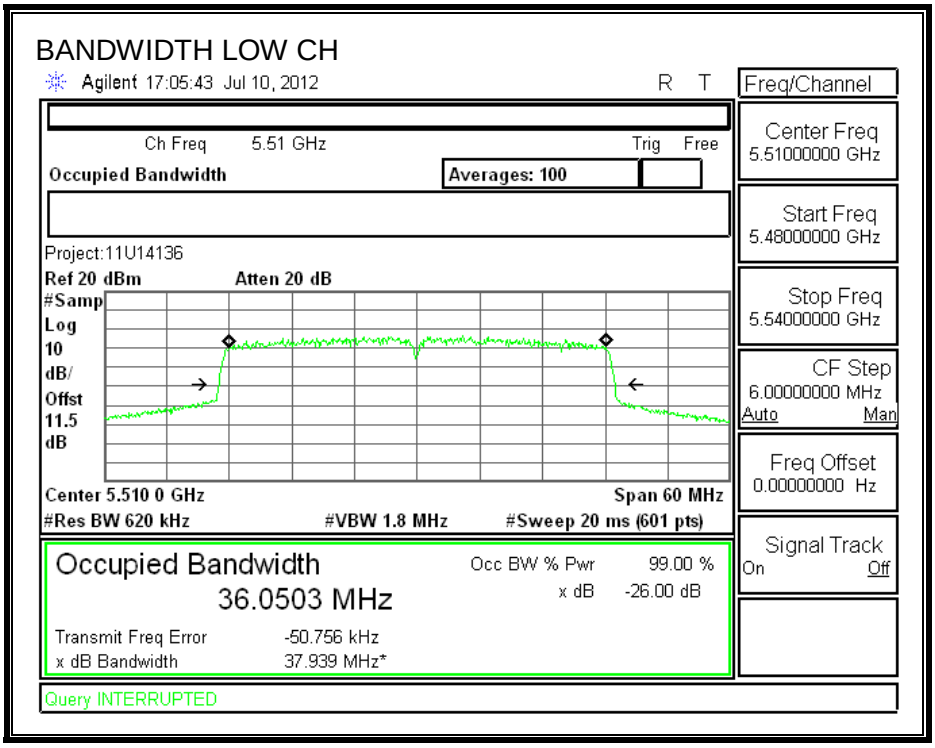
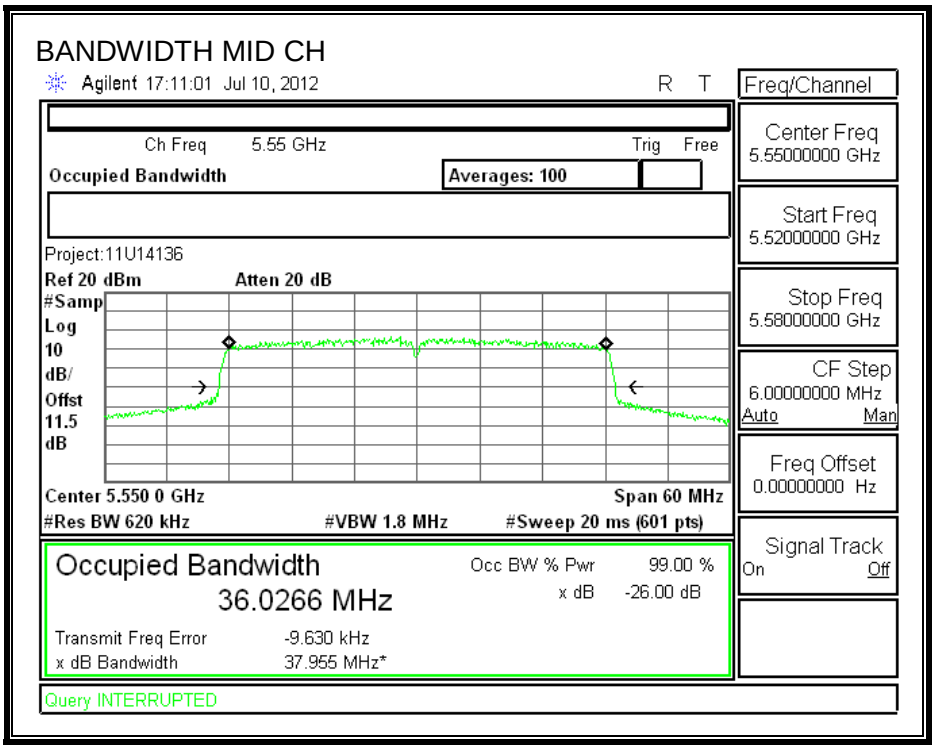
99% BANDWIDTH





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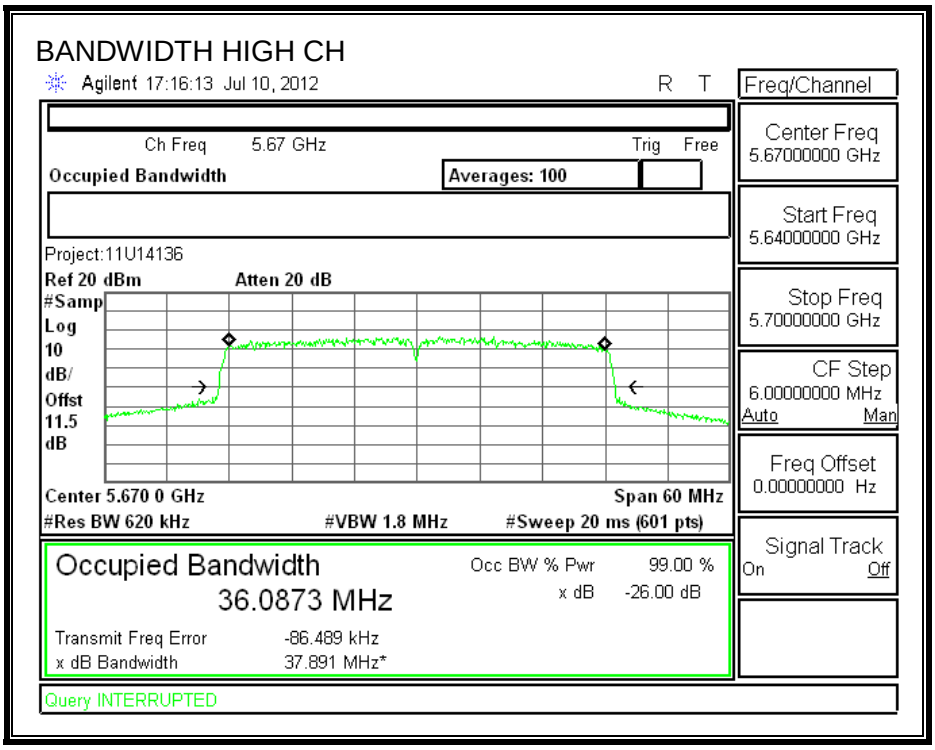

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8.9.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

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

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5510	11.95
Mid	5550	11.97
High	5670	11.95

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8.9.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.47–5.725 GHz, 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. In addition, the maximum 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 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

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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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	5510	24	36.1	26.57	-0.83	24.00	11.00
Mid	5550	24	36.0	26.57	-0.83	24.00	11.00
High	5670	24	36.1	26.57	-0.83	24.00	11.00

Duty Cycle CF (dB)	0.16	**Included in Calculations of Corr'd Power & PPSD**

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5510	14.13	14.29	24.00	-9.71
Mid	5550	14.16	14.32	24.00	-9.68
High	5670	14.00	14.16	24.00	-9.84

PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5510	0.10	0.26	11.00	-10.74
Mid	5550	0.07	0.23	11.00	-10.77
High	5670	0.03	0.19	11.00	-10.81

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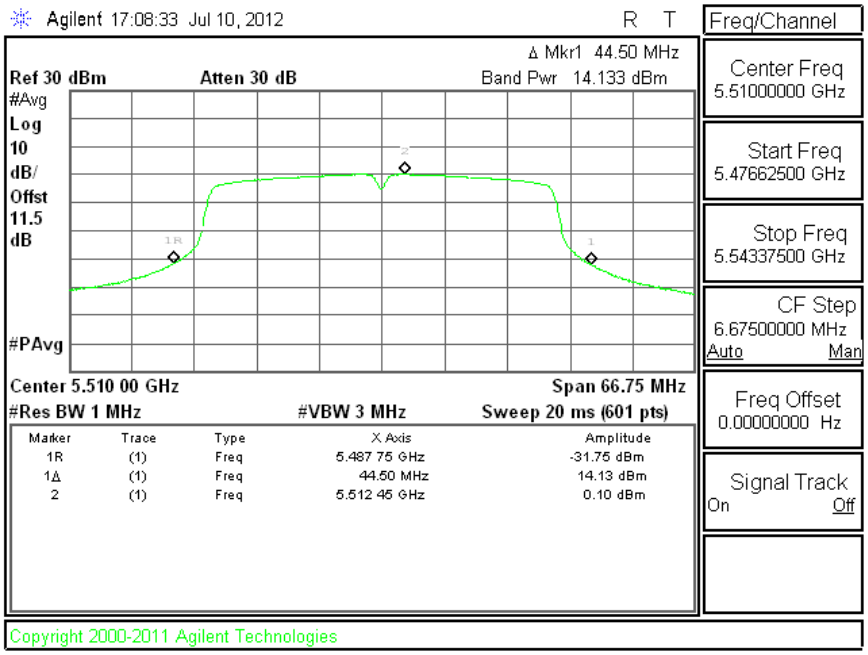
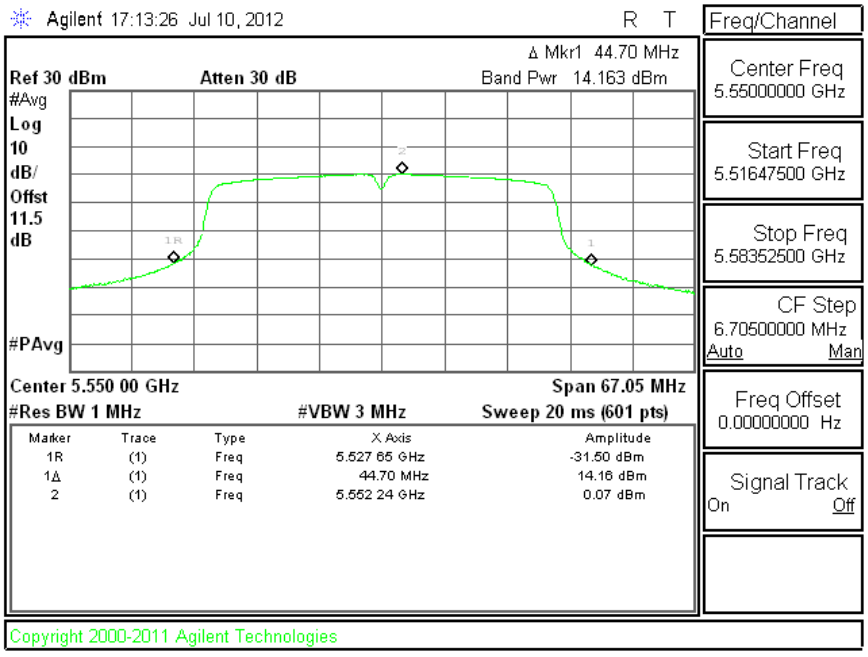
OUTPUT POWER AND PPSD

POWER PPSD LOW CH



POWER PPSD MID CH



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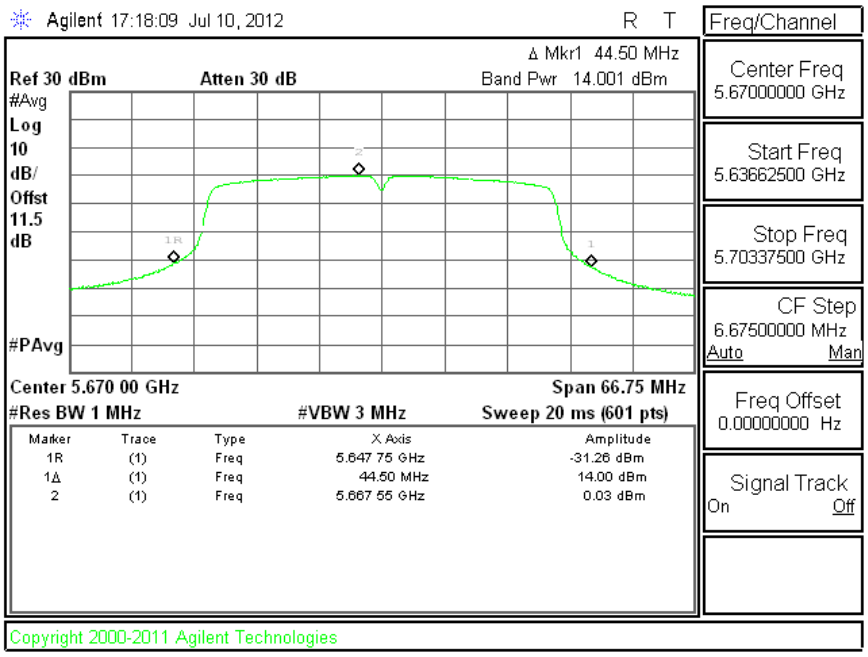
POWER PPSD HIGH CH



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9. RADIATED TEST RESULTS

9.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

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.

TEST RESULT

No other spurious emissions were found above 18G.

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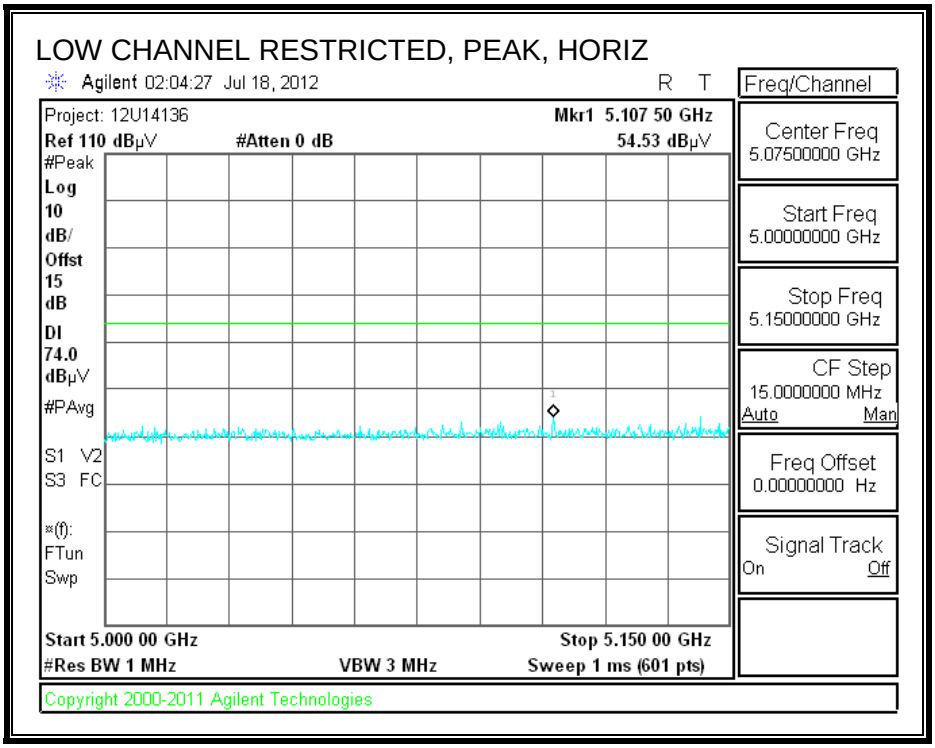
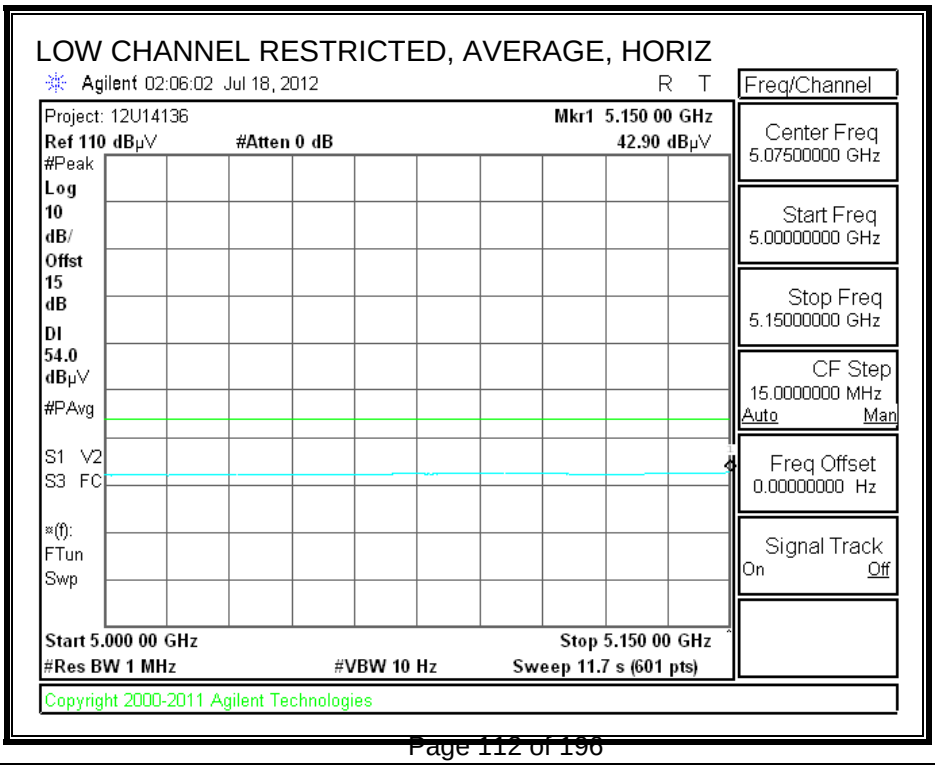
9.2. TRANSMITTER ABOVE 1 GHz

9.2.1. TX ABOVE 1 GHz 802.11a MODE IN THE 5.2 GHz BAND RESTRICTED BANDEDGE (LOW CHANNEL)





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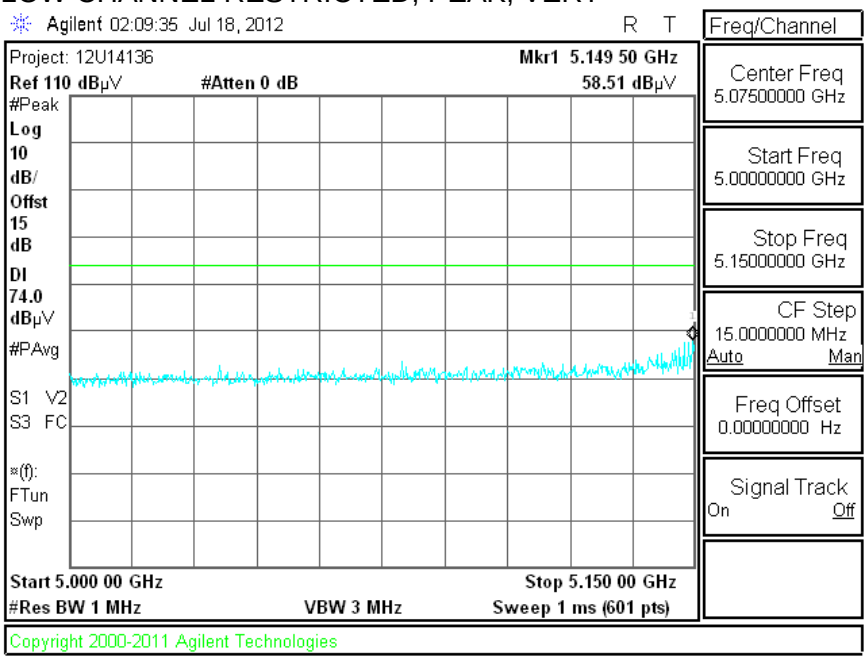
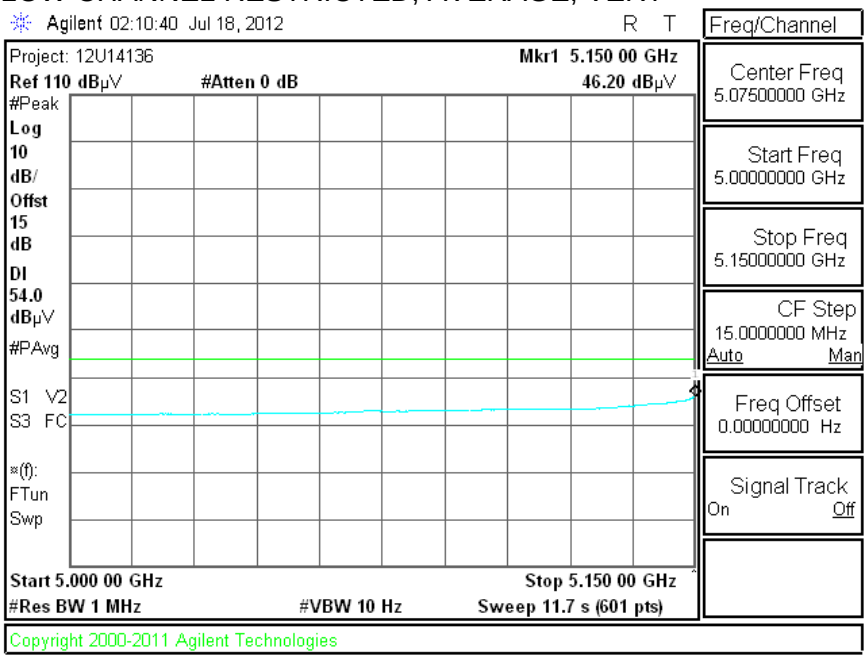
LOW CHANNEL RESTRICTED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



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HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 07/19/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: 802.11a, TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5180MHz 11a													
15.540	3.0	36.7	39.1	12.2	-32.3	0.0	0.7	56.4	74.0	-17.6	V	P	
15.540	3.0	25.7	39.1	12.2	-32.3	0.0	0.7	45.4	54.0	-8.6	V	A	
15.540	3.0	35.5	39.1	12.2	-32.3	0.0	0.7	55.2	74.0	-18.8	H	P	
15.540	3.0	25.7	39.1	12.2	-32.3	0.0	0.7	45.4	54.0	-8.6	H	A	
5200MHz 11a													
15.600	3.0	36.5	38.9	12.2	-32.3	0.0	0.7	56.0	74.0	-18.0	H	P	
15.600	3.0	25.6	38.9	12.2	-32.3	0.0	0.7	45.1	54.0	-8.9	H	A	
15.600	3.0	36.3	38.9	12.2	-32.3	0.0	0.7	55.9	74.0	-18.1	V	P	
15.600	3.0	25.6	38.9	12.2	-32.3	0.0	0.7	45.1	54.0	-8.9	V	A	
5240MHz 11a													
15.720	3.0	36.2	38.5	12.3	-32.2	0.0	0.7	55.5	74.0	-18.5	V	P	
15.720	3.0	25.5	38.5	12.3	-32.2	0.0	0.7	44.8	54.0	-9.2	V	A	
15.720	3.0	35.6	38.5	12.3	-32.2	0.0	0.7	54.9	74.0	-19.1	H	P	
15.720	3.0	25.5	38.5	12.3	-32.2	0.0	0.7	44.7	54.0	-9.3	H	A	

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

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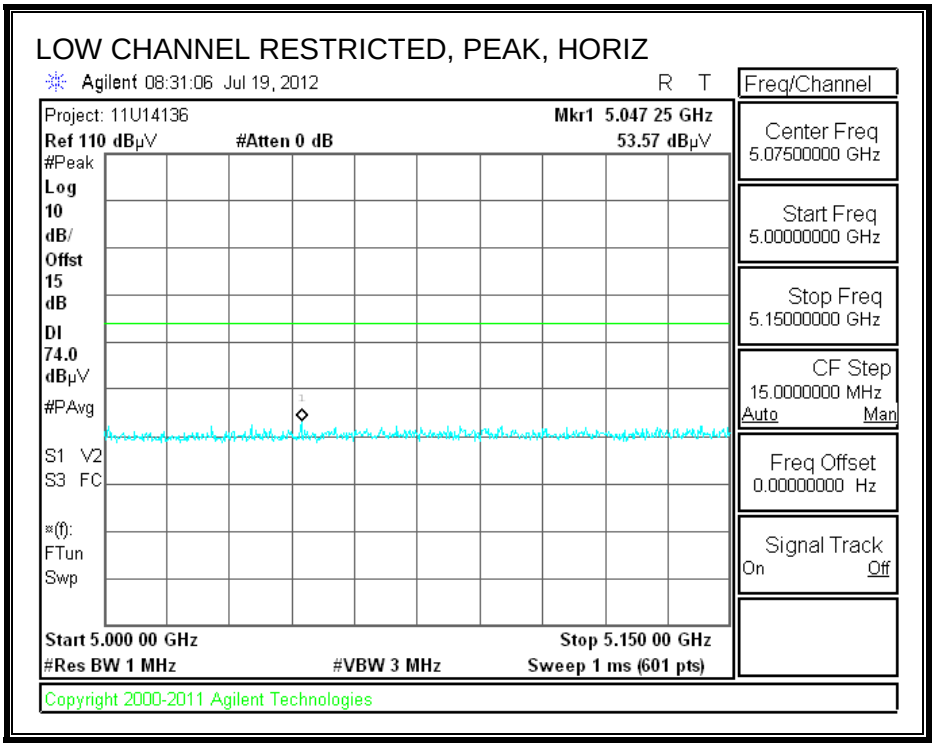
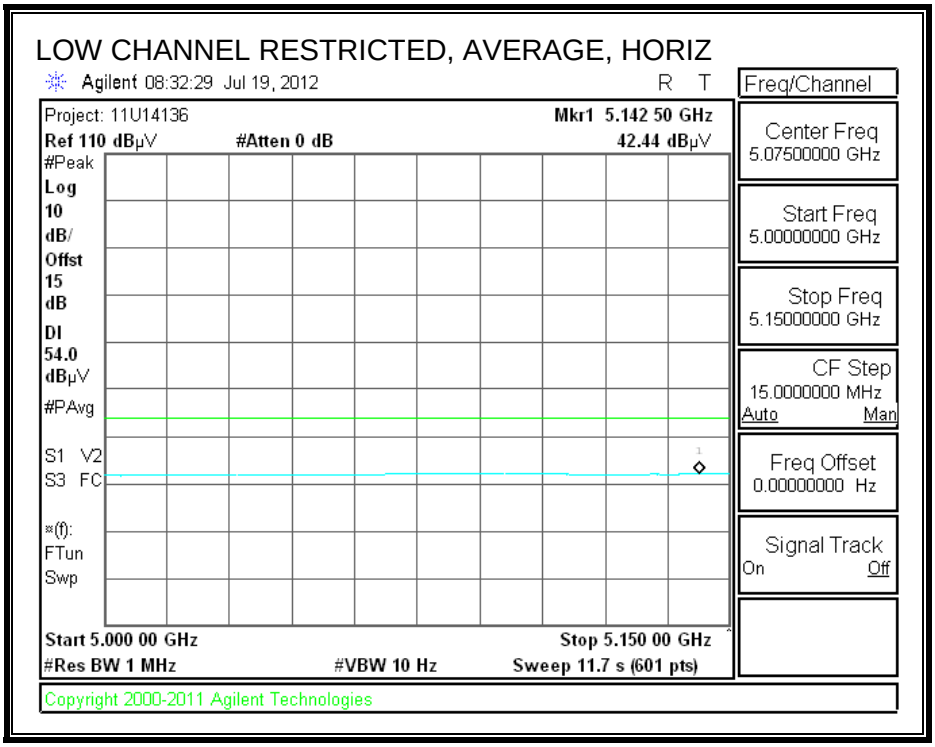
9.2.2. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.2 GHz BAND RESTRICTED BANDEDGE (LOW CHANNEL)





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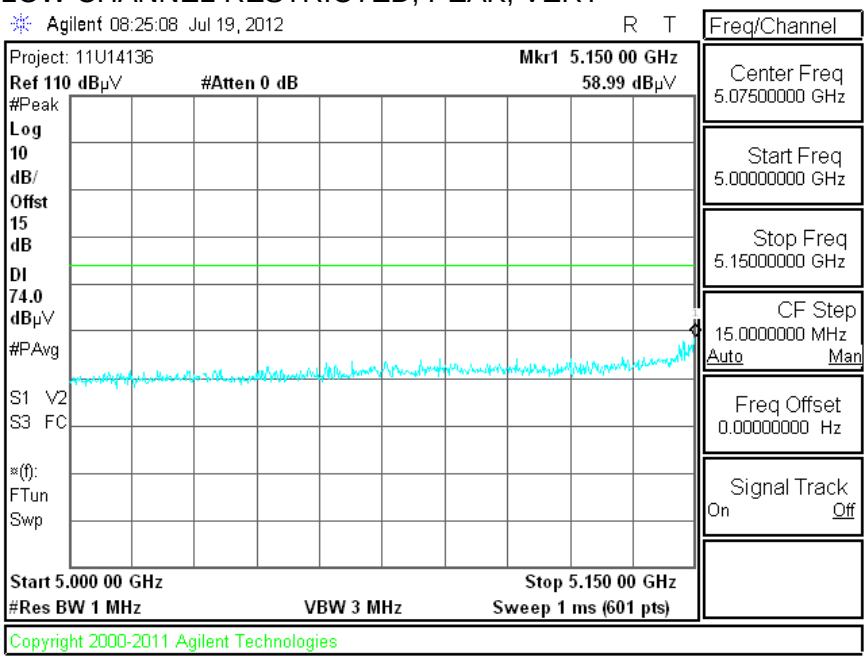
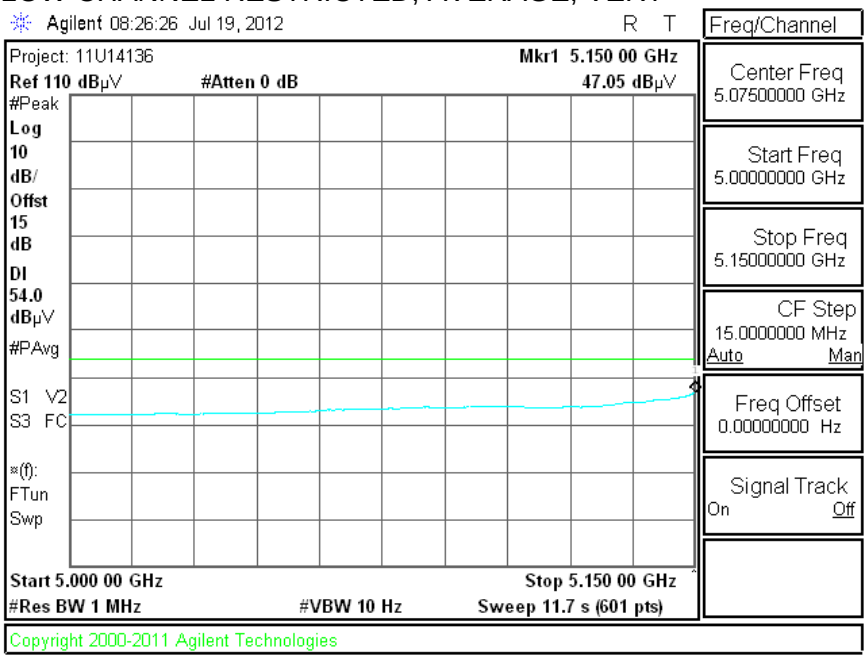
LOW CHANNEL RESTRICTED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



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HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 07/19/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: 802.11n HT20, TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5180MHz HT20													
15.540	3.0	36.1	39.1	12.2	-32.3	0.0	0.7	55.8	74.0	-18.2	H	P	
15.540	3.0	25.6	39.1	12.2	-32.3	0.0	0.7	45.3	54.0	-8.7	H	A	
15.540	3.0	35.7	39.1	12.2	-32.3	0.0	0.7	55.4	74.0	-18.6	V	P	
15.540	3.0	25.6	39.1	12.2	-32.3	0.0	0.7	45.3	54.0	-8.7	V	A	
5200MHz HT20													
15.600	3.0	36.1	38.9	12.2	-32.3	0.0	0.7	55.7	74.0	-18.3	V	P	
15.600	3.0	25.5	38.9	12.2	-32.3	0.0	0.7	45.1	54.0	-8.9	V	A	
15.600	3.0	35.8	38.9	12.2	-32.3	0.0	0.7	55.4	74.0	-18.6	H	P	
15.600	3.0	25.5	38.9	12.2	-32.3	0.0	0.7	45.1	54.0	-8.9	H	A	
5240MHz HT20													
15.720	3.0	36.1	38.5	12.3	-32.2	0.0	0.7	55.4	74.0	-18.6	H	P	
15.720	3.0	25.5	38.5	12.3	-32.2	0.0	0.7	44.7	54.0	-9.3	H	A	
15.720	3.0	35.7	38.5	12.3	-32.2	0.0	0.7	55.0	74.0	-19.0	V	P	
15.720	3.0	25.5	38.5	12.3	-32.2	0.0	0.7	44.8	54.0	-9.2	V	A	

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

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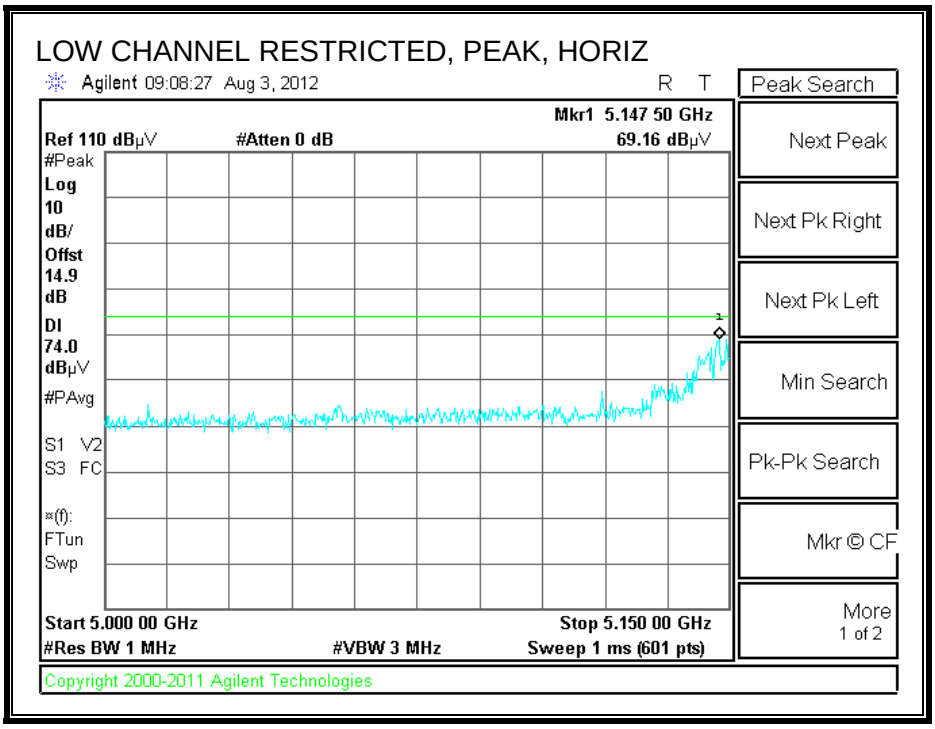
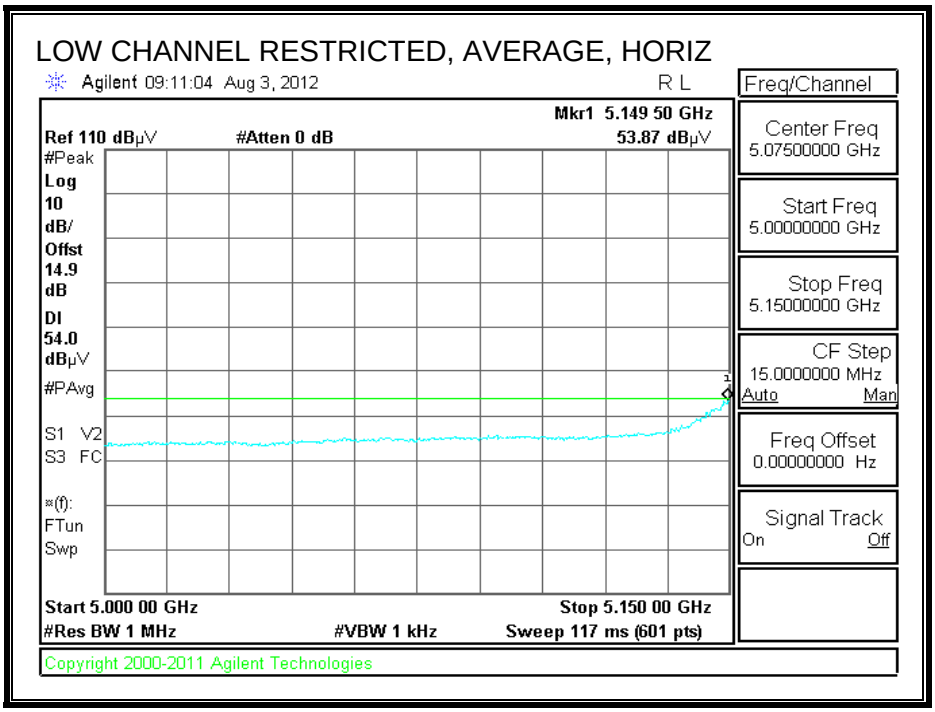
9.2.3. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.2 GHz BAND RESTRICTED BANDEDGE (LOW CHANNEL)





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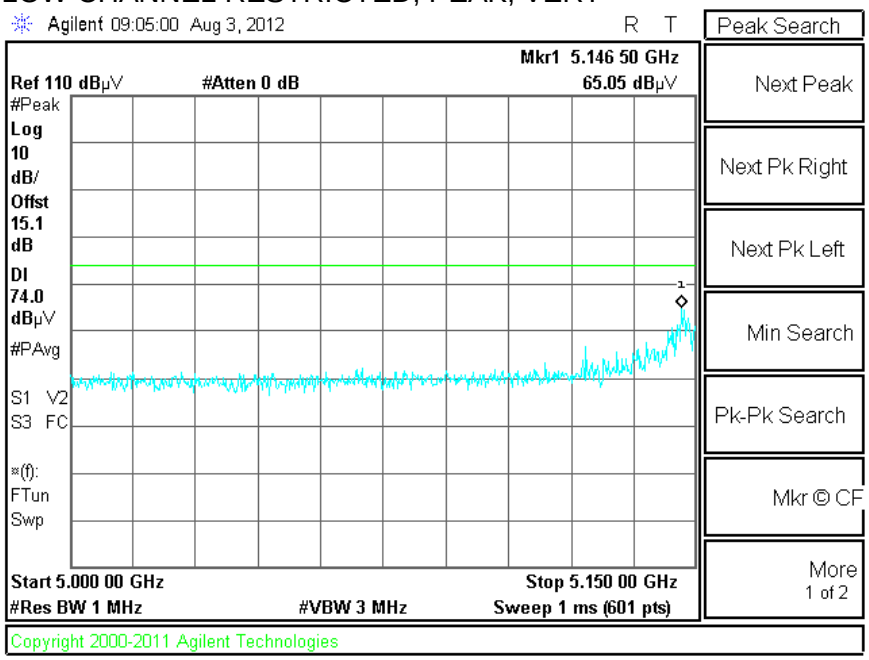
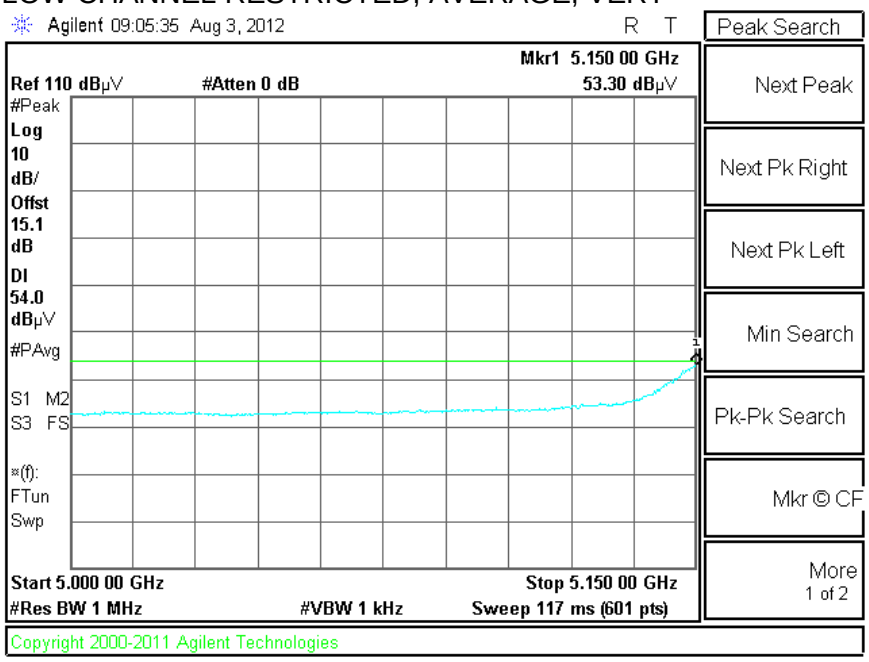
LOW CHANNEL RESTRICTED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



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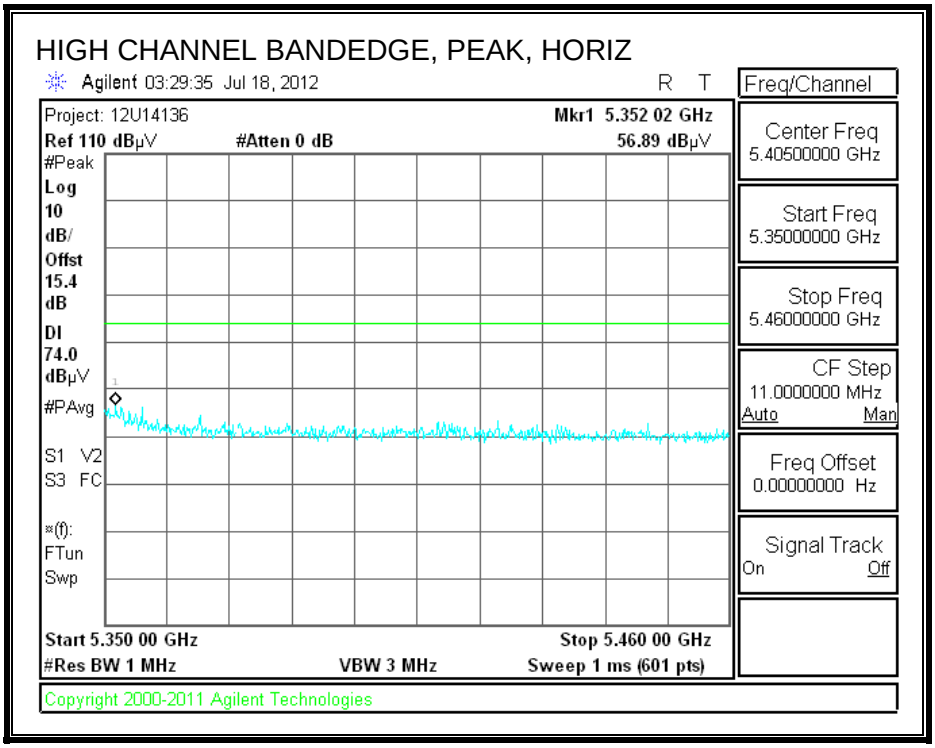
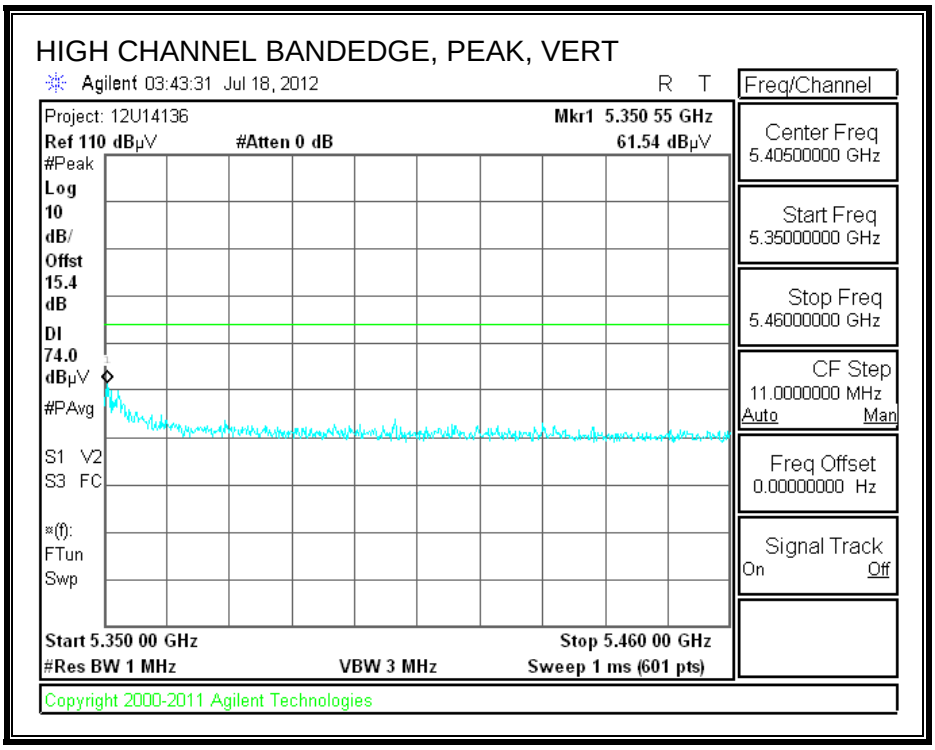
AUTHORIZED BANDEDGE (HIGH CHANNEL)





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HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 07/20/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: 802.11n, HT40, TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5190MHz HT40													
15.570	3.0	36.0	39.0	12.5	-32.3	0.0	0.7	56.0	74.0	-18.0	H	P	
15.570	3.0	25.5	39.0	12.5	-32.3	0.0	0.7	45.4	54.0	-8.6	H	A	
15.570	3.0	35.4	39.0	12.5	-32.3	0.0	0.7	55.4	74.0	-18.6	V	P	
15.570	3.0	25.5	39.0	12.5	-32.3	0.0	0.7	45.4	54.0	-8.6	V	A	
5230MHz HT40													
15.690	3.0	35.7	38.6	12.6	-32.3	0.0	0.7	55.3	74.0	-18.7	V	P	
15.690	3.0	25.4	38.6	12.6	-32.3	0.0	0.7	45.0	54.0	-9.0	V	A	
15.690	3.0	36.0	38.6	12.6	-32.3	0.0	0.7	55.6	74.0	-18.4	H	P	
15.690	3.0	25.3	38.6	12.6	-32.3	0.0	0.7	45.0	54.0	-9.0	H	A	

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

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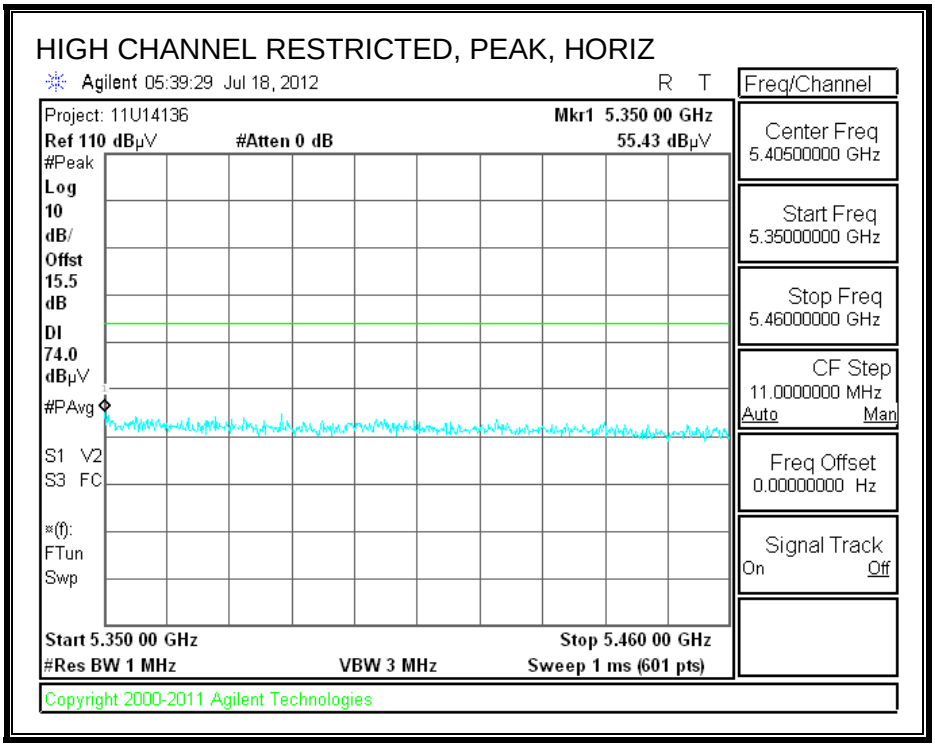
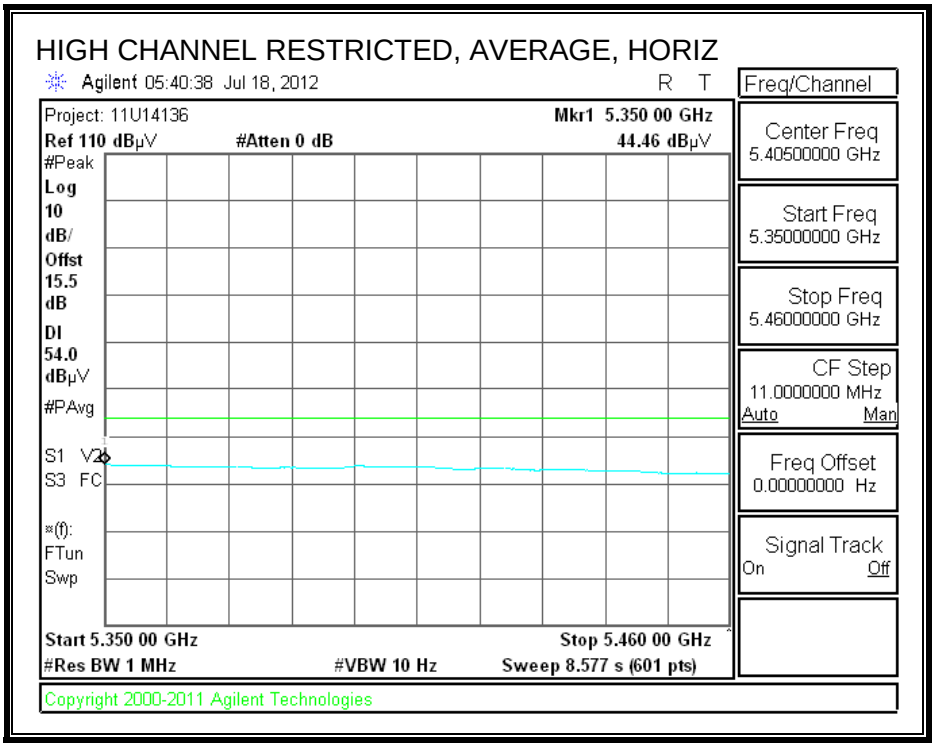
9.2.4. TX ABOVE 1 GHz 802.11a MODE IN THE 5.3 GHz BAND RESTRICTED BANDEDGE (HIGH CHANNEL)





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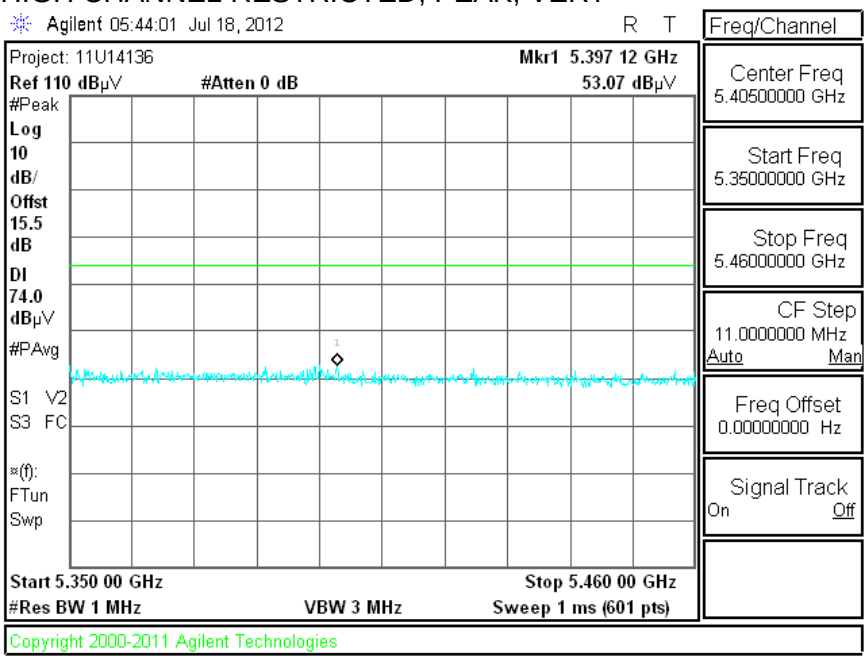
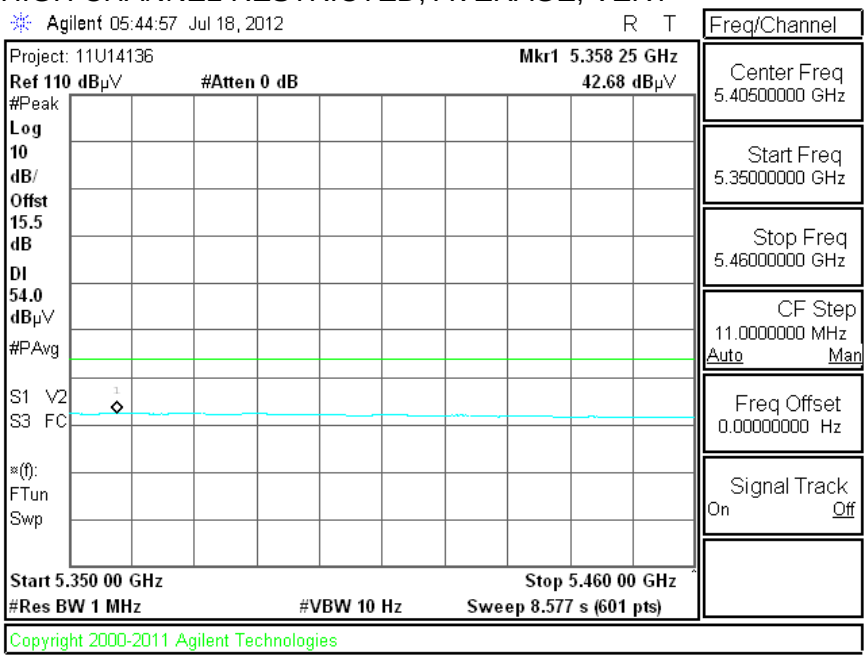
HIGH CHANNEL RESTRICTED, PEAK, VERT



HIGH CHANNEL RESTRICTED, AVERAGE, VERT



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HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 07/19/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: 802.11a, TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5260MHz 11a													
15.780	3.0	35.7	38.3	12.3	-32.2	0.0	0.7	54.8	74.0	-19.2	V	P	
15.780	3.0	25.2	38.3	12.3	-32.2	0.0	0.7	44.3	54.0	-9.7	V	A	
15.780	3.0	35.9	38.3	12.3	-32.2	0.0	0.7	55.0	74.0	-19.0	H	P	
15.780	3.0	25.2	38.3	12.3	-32.2	0.0	0.7	44.3	54.0	-9.7	H	A	
5300MHz 11a													
15.900	3.0	34.6	37.9	12.4	-32.2	0.0	0.7	53.4	74.0	-20.6	V	P	
15.900	3.0	24.5	37.9	12.4	-32.2	0.0	0.7	43.3	54.0	-10.7	V	A	
15.900	3.0	34.6	37.9	12.4	-32.2	0.0	0.7	53.5	74.0	-20.5	H	P	
15.900	3.0	24.5	37.9	12.4	-32.2	0.0	0.7	43.3	54.0	-10.7	H	A	
5320MHz 11a													
15.960	3.0	35.5	37.7	12.4	-32.2	0.0	0.7	54.1	74.0	-19.9	H	P	
15.960	3.0	24.7	37.7	12.4	-32.2	0.0	0.7	43.3	54.0	-10.7	H	A	
15.960	3.0	34.9	37.7	12.4	-32.2	0.0	0.7	53.5	74.0	-20.5	V	P	
15.960	3.0	24.7	37.7	12.4	-32.2	0.0	0.7	43.4	54.0	-10.6	V	A	

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

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47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
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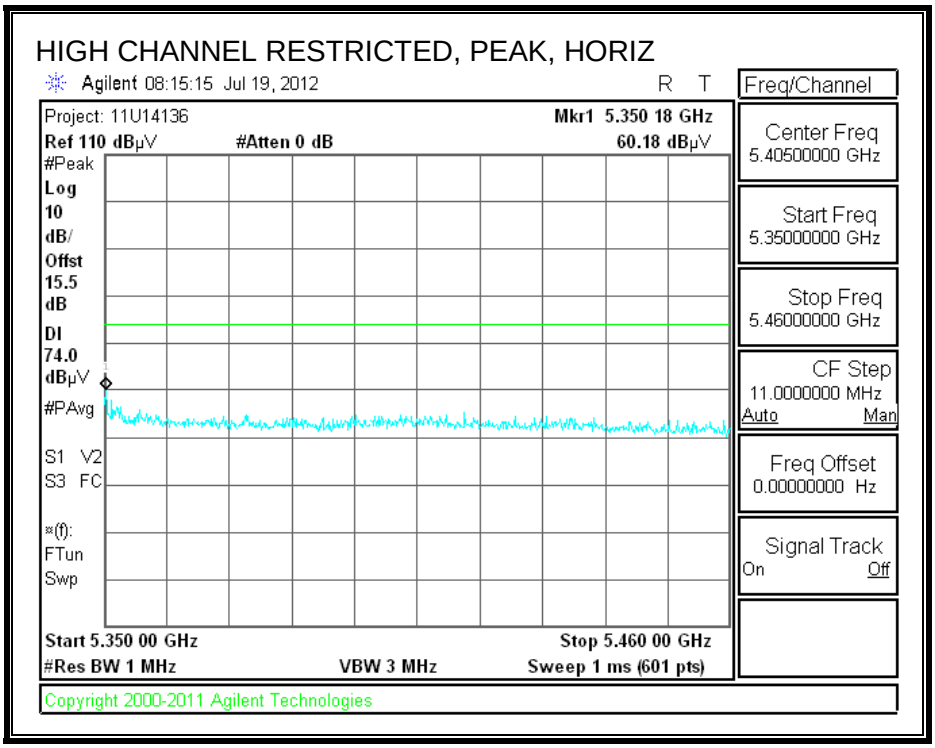
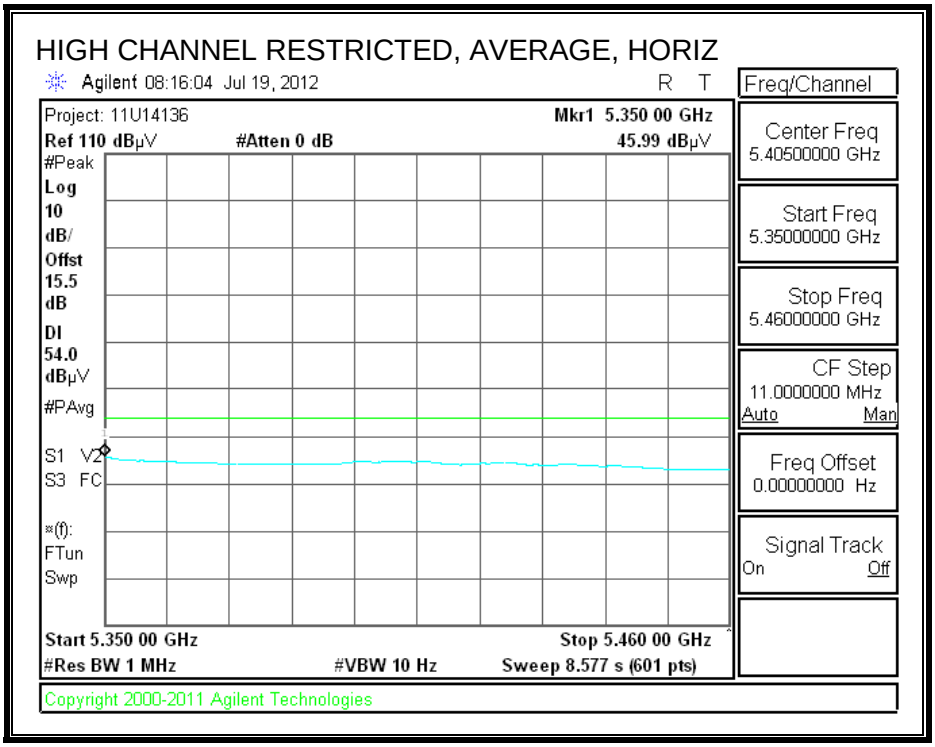
9.2.5. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.3 GHz BAND RESTRICTED BANDEDGE (HIGH CHANNEL)





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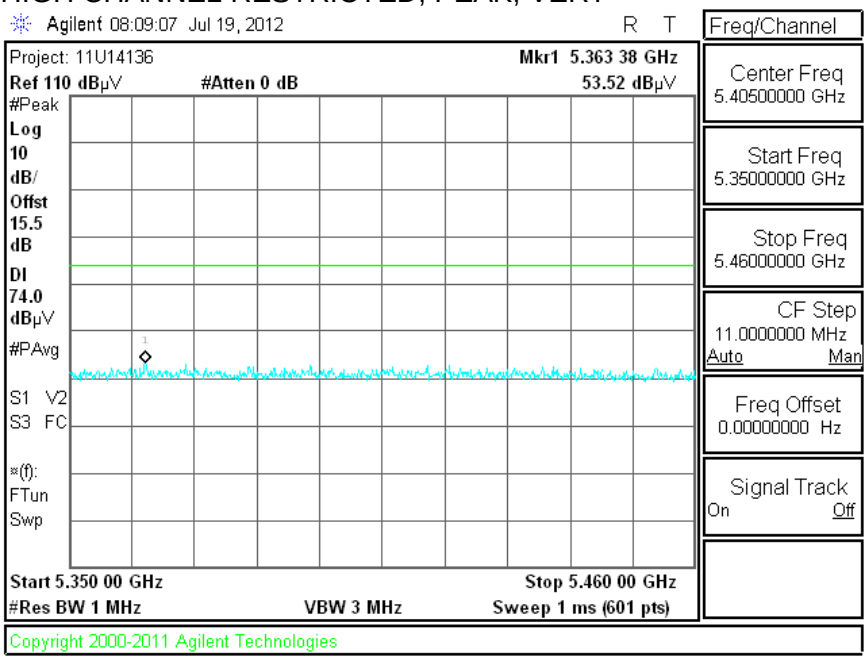
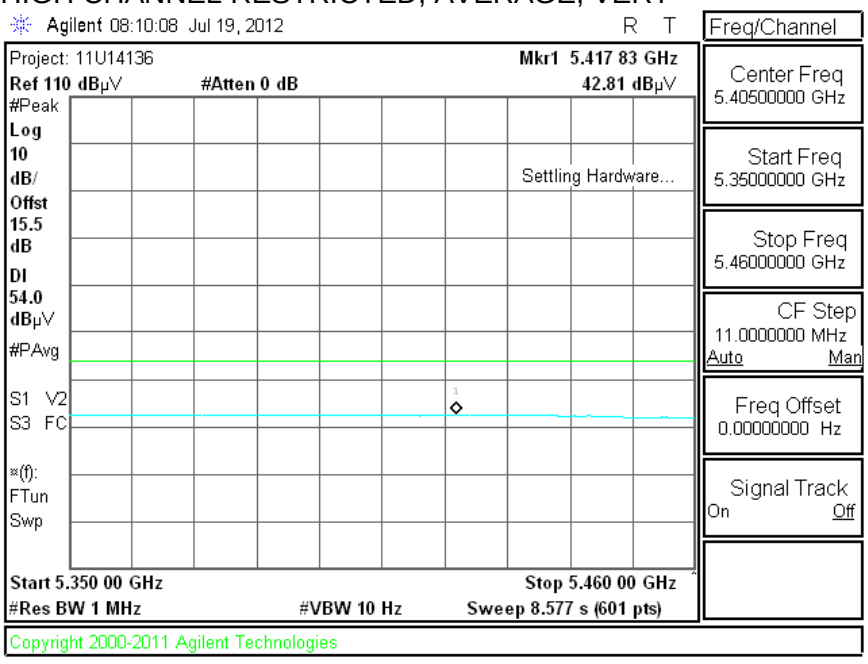
HIGH CHANNEL RESTRICTED, PEAK, VERT



HIGH CHANNEL RESTRICTED, AVERAGE, VERT



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HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 07/19/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: 802.11n HT20, TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5260MHz HT20													
15.780	3.0	35.5	38.3	12.3	-32.2	0.0	0.7	54.6	74.0	-19.4	V	P	
15.780	3.0	25.1	38.3	12.3	-32.2	0.0	0.7	44.2	54.0	-9.8	V	A	
15.780	3.0	36.1	38.3	12.3	-32.2	0.0	0.7	55.2	74.0	-18.8	H	P	
15.780	3.0	25.1	38.3	12.3	-32.2	0.0	0.7	44.2	54.0	-9.8	H	A	
5300MHz HT20													
10.600	3.0	34.3	38.1	9.7	-33.9	0.0	0.8	49.0	74.0	-25.0	H	P	
10.600	3.0	23.7	38.1	9.7	-33.9	0.0	0.8	38.4	54.0	-15.6	H	A	
15.900	3.0	35.1	37.9	12.4	-32.2	0.0	0.7	53.9	74.0	-20.1	H	P	
15.900	3.0	24.4	37.9	12.4	-32.2	0.0	0.7	43.2	54.0	-10.8	H	A	
5300MHz HT20													
10.600	3.0	35.2	38.1	9.7	-33.9	0.0	0.8	49.9	74.0	-24.1	V	P	
10.600	3.0	23.9	38.1	9.7	-33.9	0.0	0.8	38.6	54.0	-15.4	V	A	
15.900	3.0	35.0	37.9	12.4	-32.2	0.0	0.7	53.8	74.0	-20.2	V	P	
15.900	3.0	24.5	37.9	12.4	-32.2	0.0	0.7	43.3	54.0	-10.7	V	A	
5320MHz HT20													
10.640	3.0	34.6	38.2	9.8	-33.9	0.0	0.8	49.4	74.0	-24.6	V	P	
10.640	3.0	24.3	38.2	9.8	-33.9	0.0	0.8	39.1	54.0	-14.9	V	A	
15.960	3.0	34.7	37.7	12.4	-32.2	0.0	0.7	53.3	74.0	-20.7	V	P	
15.960	3.0	24.7	37.7	12.4	-32.2	0.0	0.7	43.3	54.0	-10.7	V	A	
5320MHz HT20													
10.640	3.0	33.7	38.2	9.8	-33.9	0.0	0.8	48.5	74.0	-25.5	H	P	
10.640	3.0	24.4	38.2	9.8	-33.9	0.0	0.8	39.2	54.0	-14.8	H	A	
15.960	3.0	35.0	37.7	12.4	-32.2	0.0	0.7	53.7	74.0	-20.3	H	P	
15.960	3.0	24.7	37.7	12.4	-32.2	0.0	0.7	43.4	54.0	-10.6	H	A	

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

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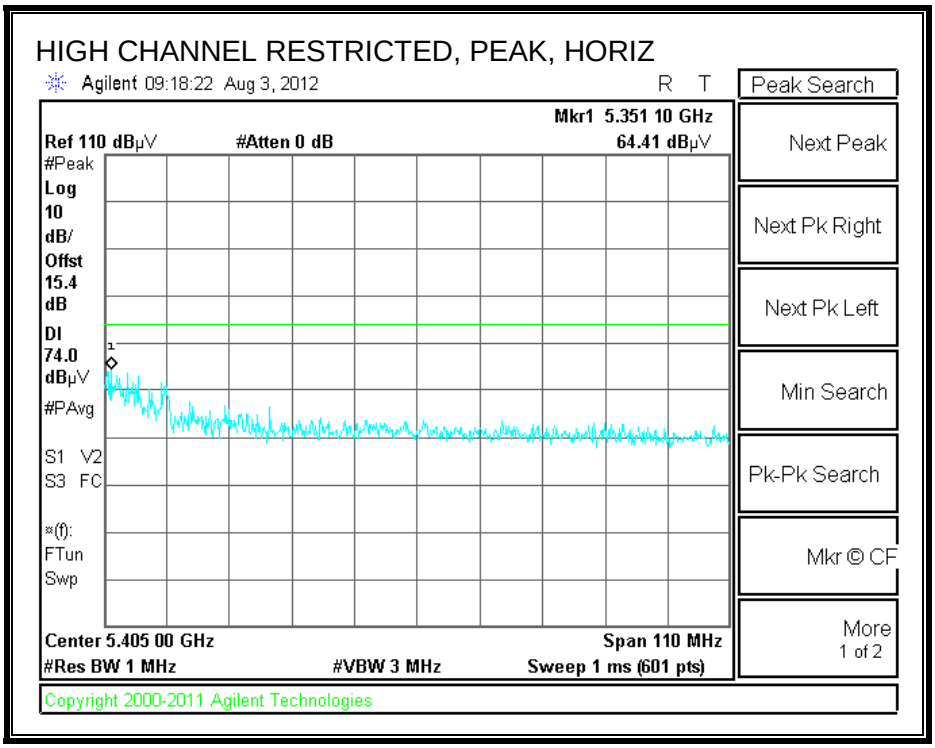
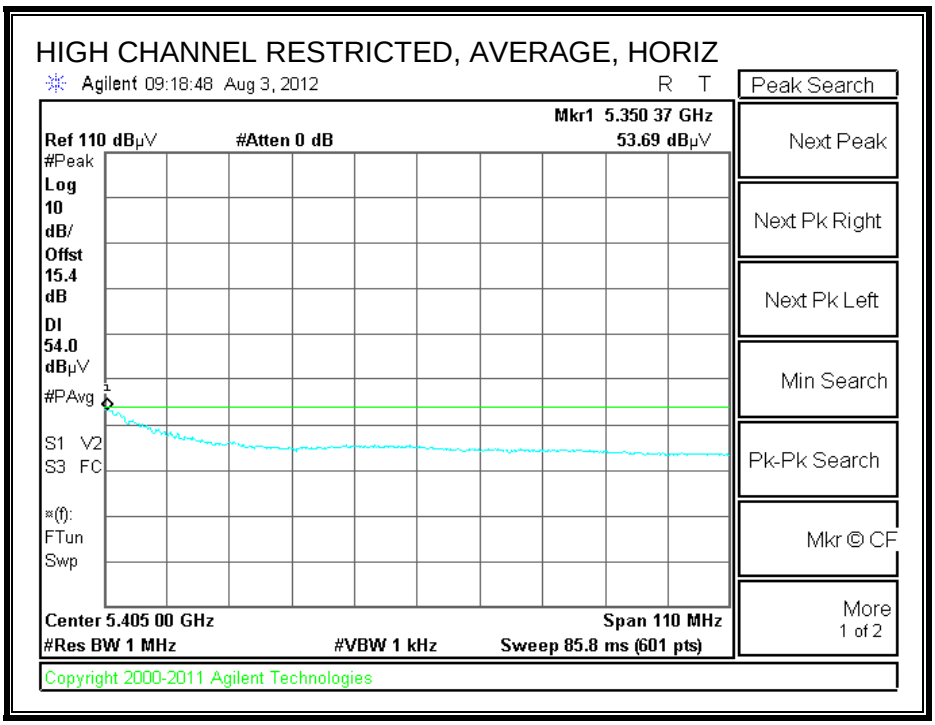
9.2.6. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.3 GHz BAND RESTRICTED BANDEDGE (HIGH CHANNEL)





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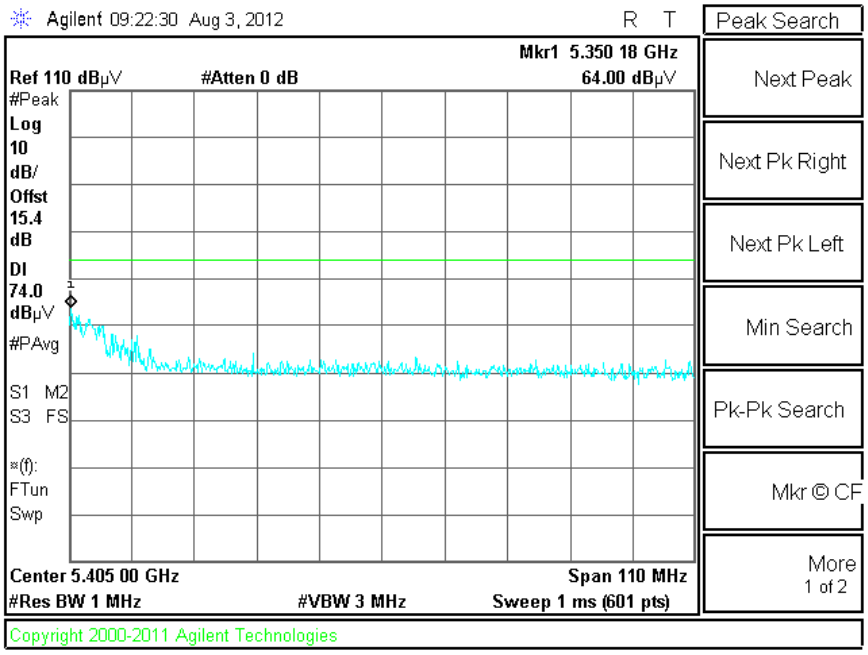
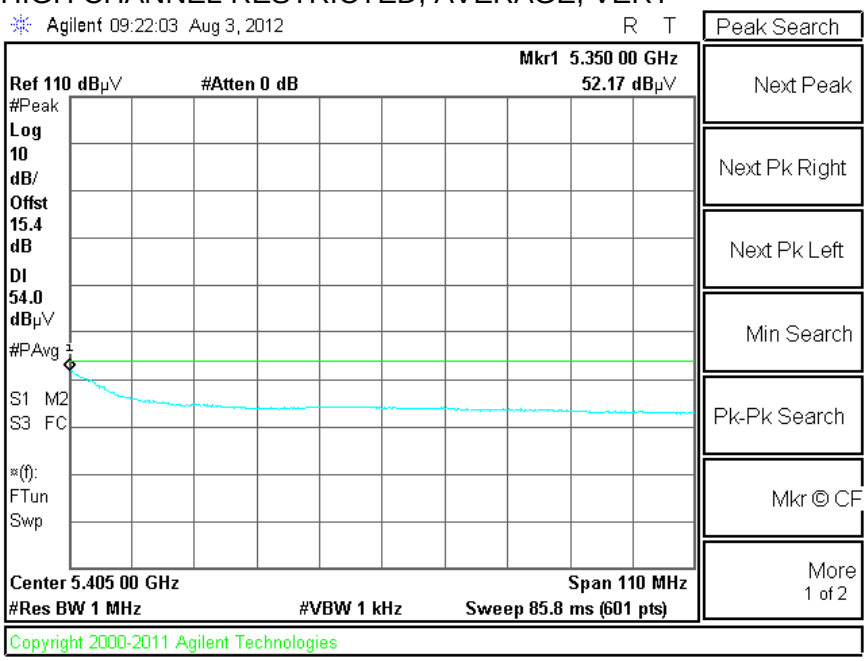
HIGH CHANNEL RESTRICTED, PEAK, VERT



HIGH CHANNEL RESTRICTED, AVERAGE, VERT



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HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 07/20/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: 802.11n, HT40, TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5310MHz HT40													
10.620	3.0	35.2	38.1	9.7	-33.9	0.0	0.8	49.9	74.0	-24.1	H	P	
10.620	3.0	24.2	38.1	9.7	-33.9	0.0	0.8	38.9	54.0	-15.1	H	A	
10.620	3.0	35.5	38.1	9.7	-33.9	0.0	0.8	50.2	74.0	-23.8	V	P	
10.620	3.0	24.2	38.1	9.7	-33.9	0.0	0.8	38.9	54.0	-15.1	V	A	
5270MHz HT40													
15.810	3.0	35.8	38.2	12.6	-32.2	0.0	0.7	55.1	74.0	-18.9	V	P	
15.810	3.0	24.4	38.2	12.6	-32.2	0.0	0.7	43.8	54.0	-10.2	V	A	
15.810	3.0	35.4	38.2	12.6	-32.2	0.0	0.7	54.7	74.0	-19.3	H	P	
15.810	3.0	24.5	38.2	12.6	-32.2	0.0	0.7	43.8	54.0	-10.2	H	A	

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

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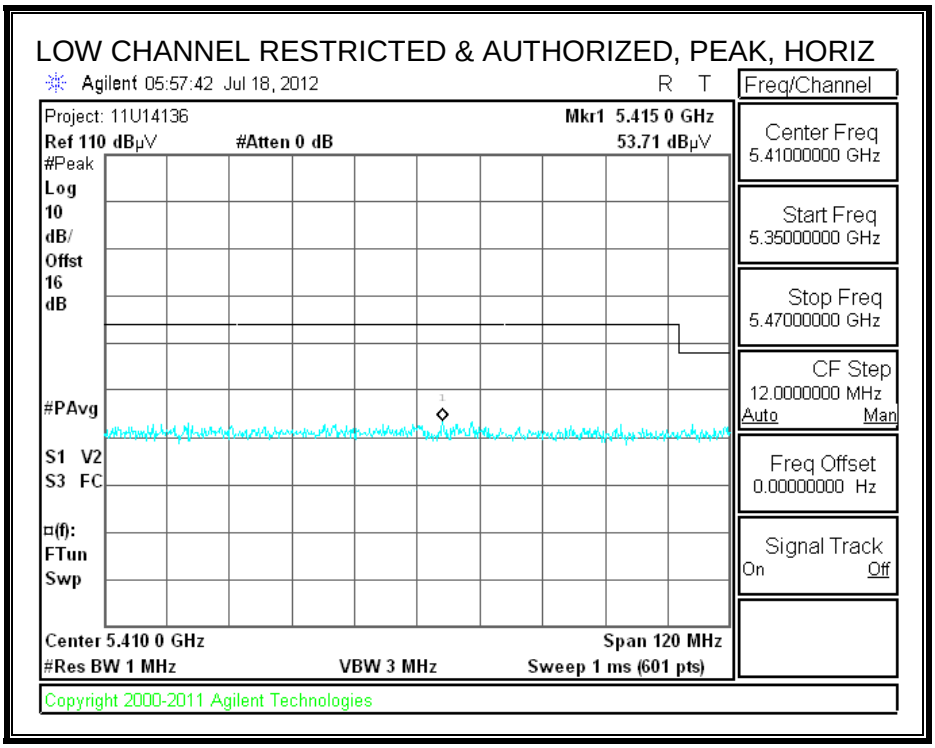
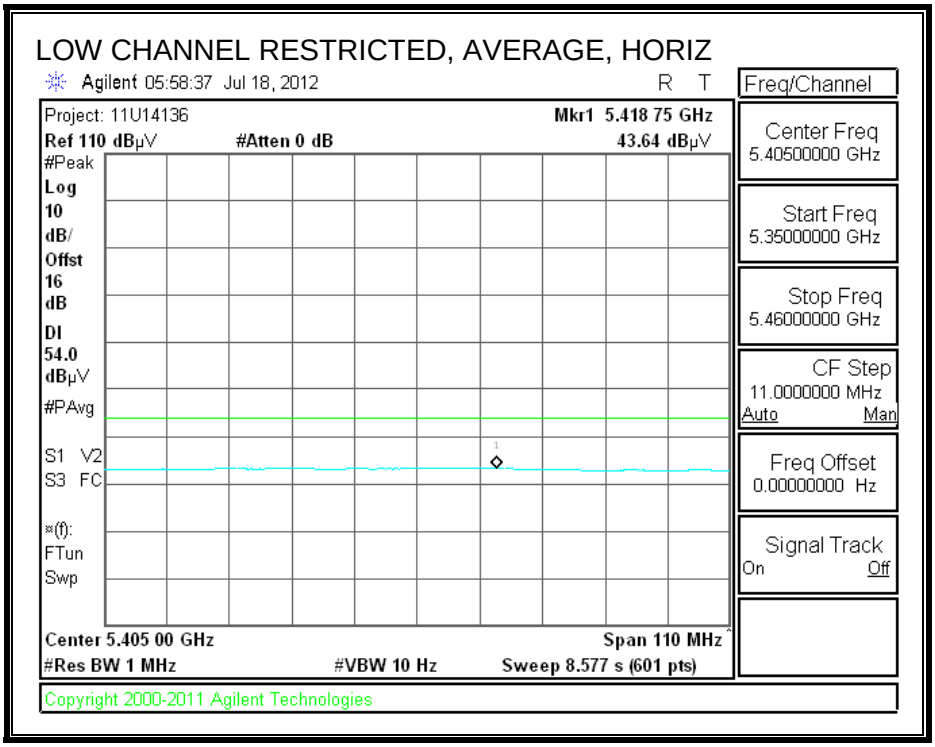
9.2.7. TX ABOVE 1 GHz 802.11a MODE IN THE 5.6 GHz BAND RESTRICTED & AUTHORIZED BANDEDGE (LOW CHANNEL)





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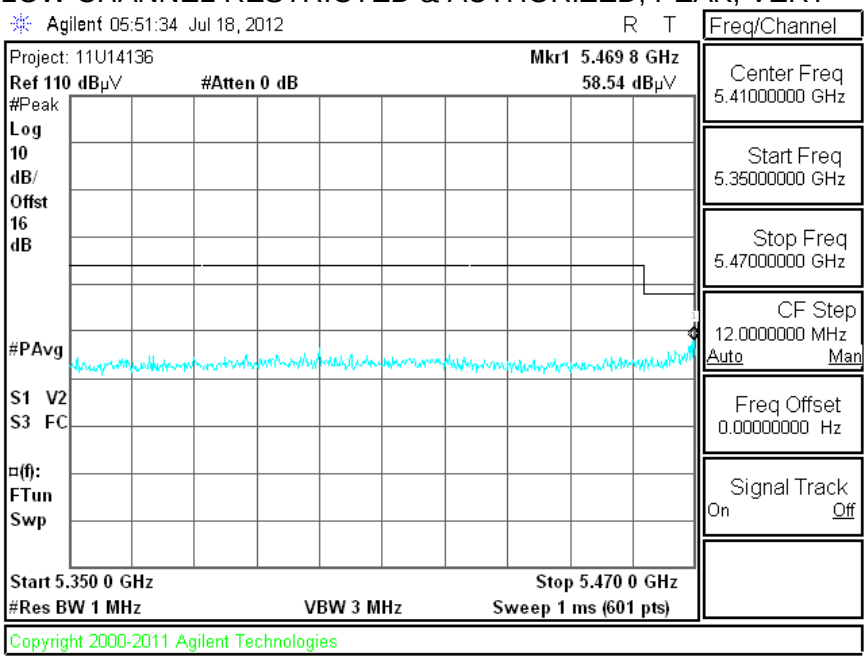
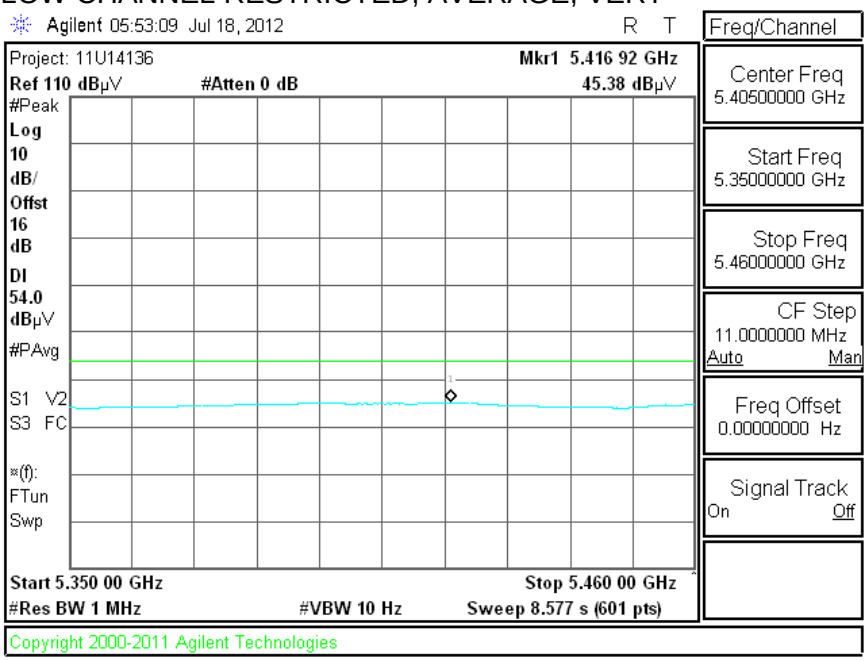
LOW CHANNEL RESTRICTED & AUTHORIZED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



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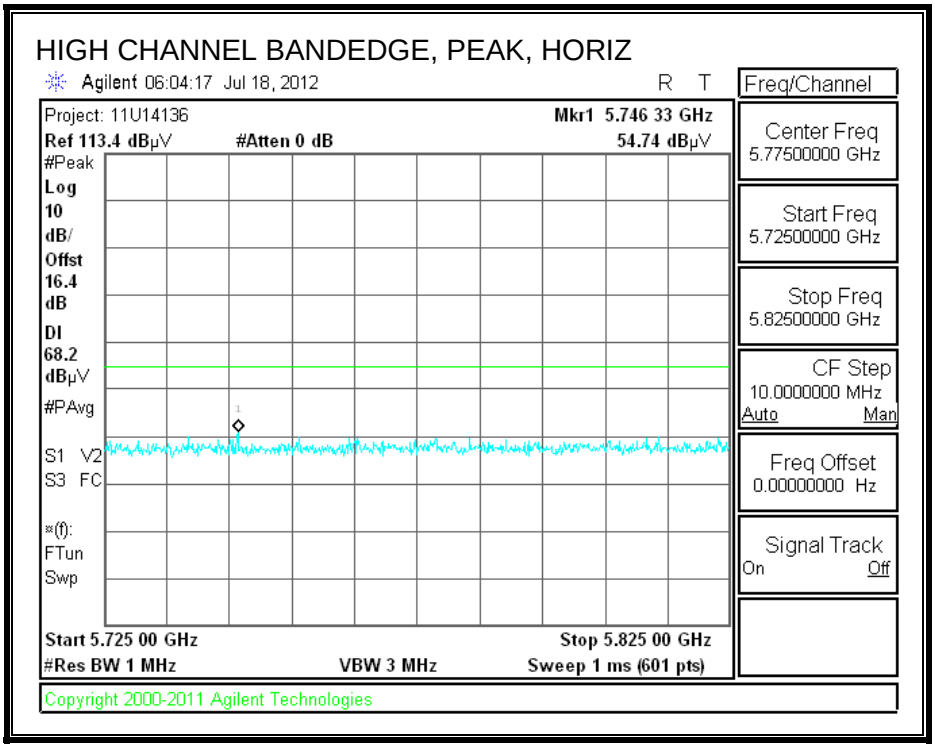
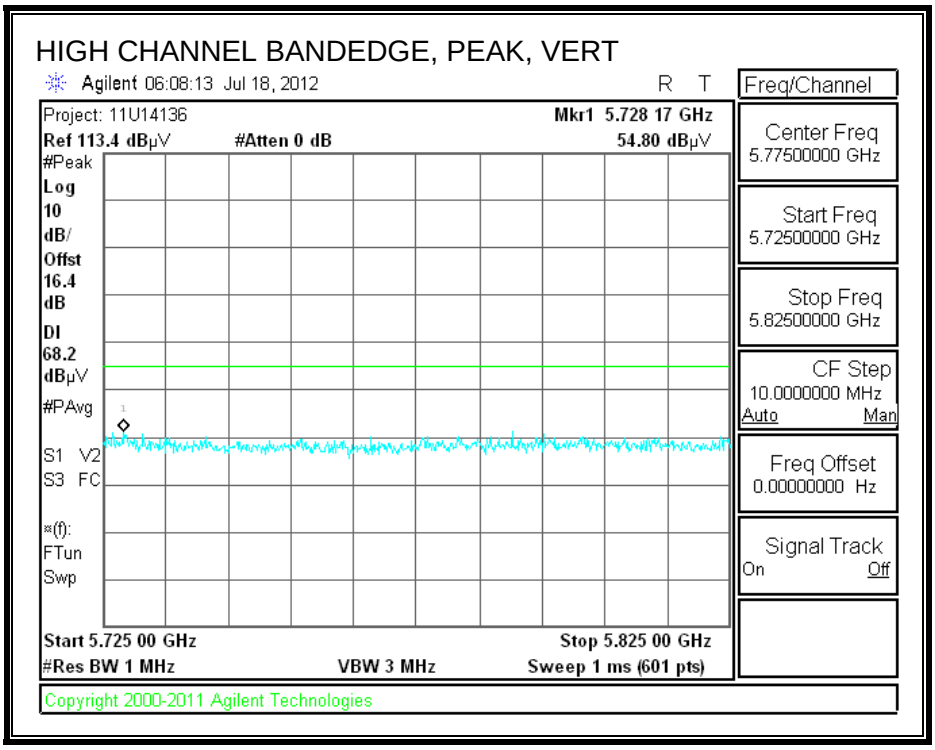
AUTHORIZED BANDEDGE (HIGH CHANNEL)





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HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 07/19/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: 802.11a, TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5500MHz 11a													
11.000	3.0	35.8	38.3	10.2	-33.5	0.0	0.7	51.5	74.0	-22.5	V	P	
11.000	3.0	25.0	38.3	10.2	-33.5	0.0	0.7	40.7	54.0	-13.3	V	A	
11.000	3.0	35.8	38.3	10.2	-33.5	0.0	0.7	51.6	74.0	-22.4	H	P	
11.000	3.0	25.0	38.3	10.2	-33.5	0.0	0.7	40.7	54.0	-13.3	H	A	
5580MHz 11a													
11.160	3.0	35.5	38.5	10.3	-33.3	0.0	0.7	51.8	74.0	-22.2	H	P	
11.160	3.0	24.6	38.5	10.3	-33.3	0.0	0.7	40.9	54.0	-13.1	H	A	
11.160	3.0	34.9	38.5	10.3	-33.3	0.0	0.7	51.2	74.0	-22.8	V	P	
11.160	3.0	24.5	38.5	10.3	-33.3	0.0	0.7	40.8	54.0	-13.2	V	A	
5700MHz 11a													
11.400	3.0	35.0	38.7	10.6	-33.0	0.0	0.7	52.1	74.0	-21.9	V	P	
11.400	3.0	24.6	38.7	10.6	-33.0	0.0	0.7	41.6	54.0	-12.4	V	A	
11.400	3.0	35.3	38.7	10.6	-33.0	0.0	0.7	52.3	74.0	-21.7	H	P	
11.400	3.0	24.5	38.7	10.6	-33.0	0.0	0.7	41.6	54.0	-12.4	H	A	

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

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47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
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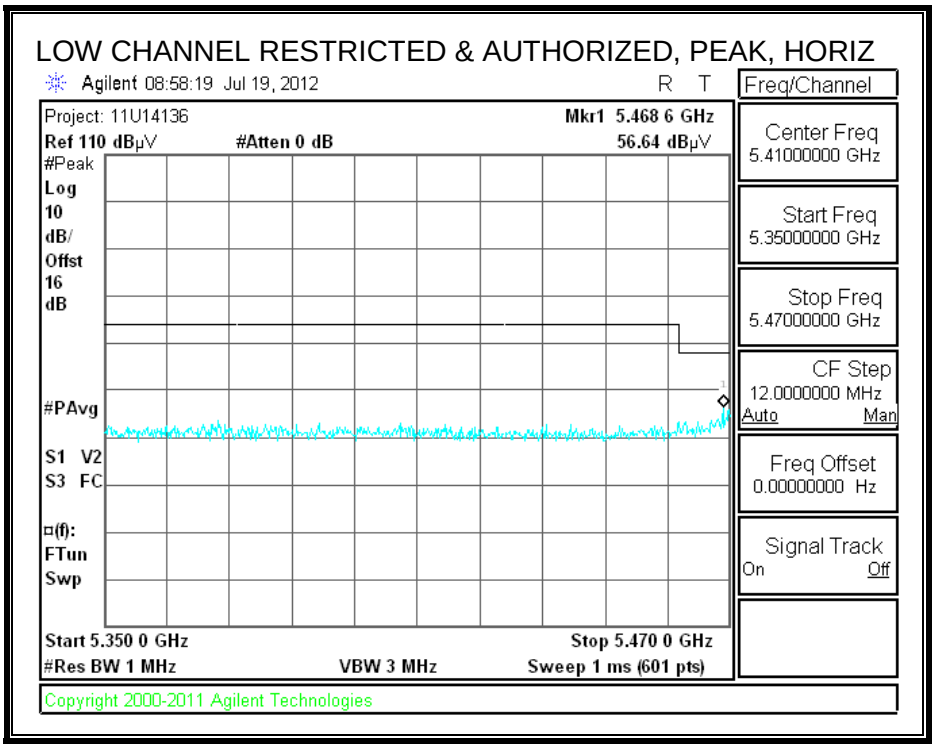
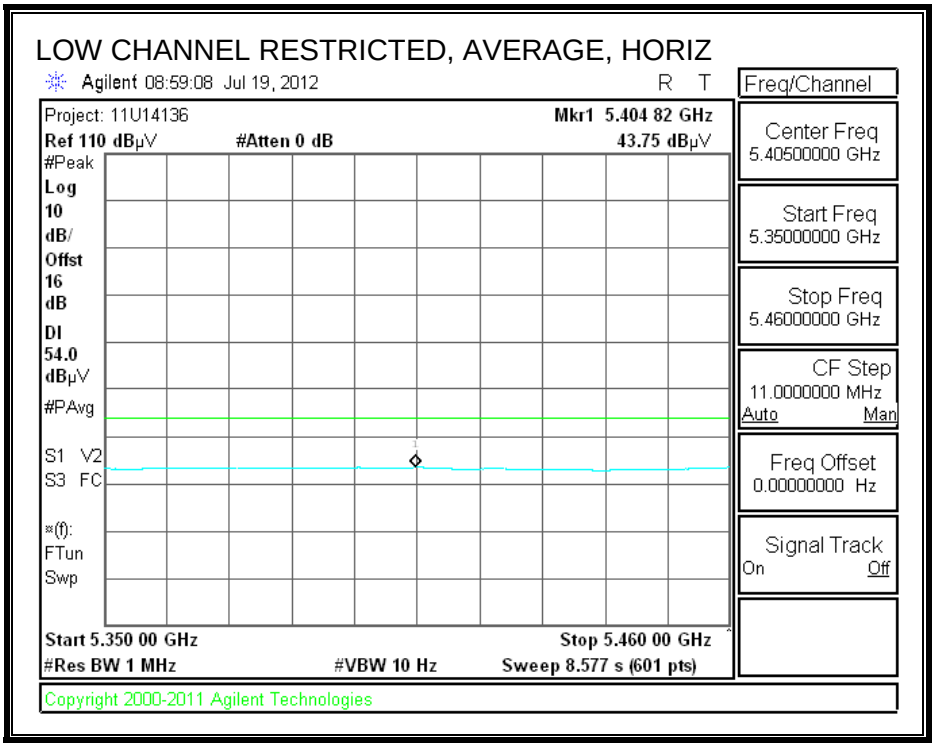
9.2.8. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.6 GHz BAND RESTRICTED & AUTHORIZED BANDEDGE (LOW CHANNEL)





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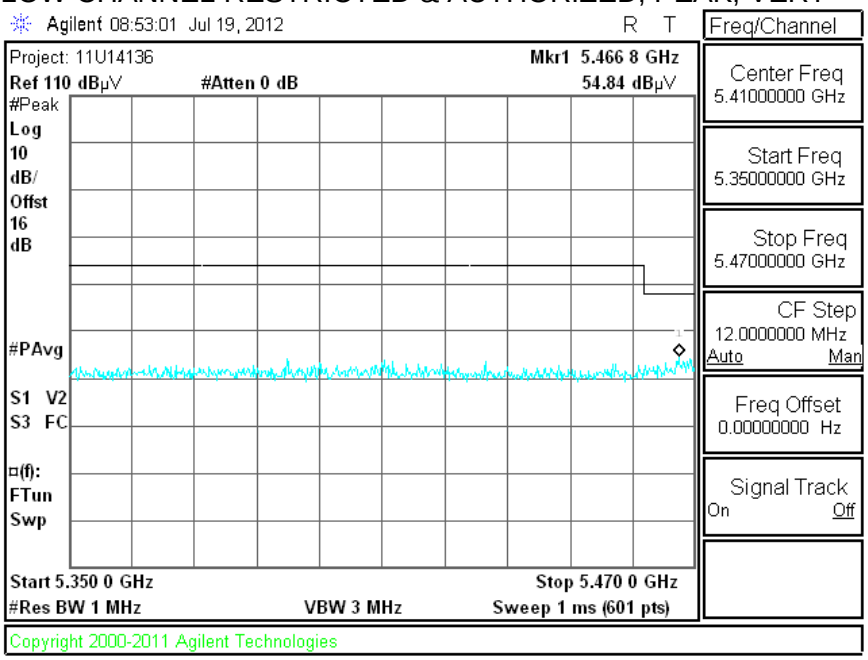
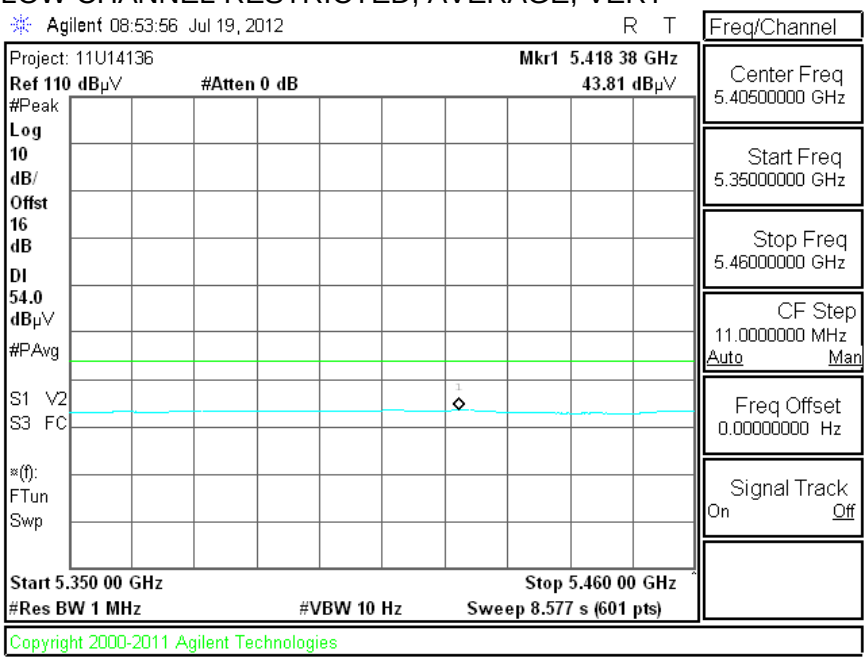
LOW CHANNEL RESTRICTED & AUTHORIZED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



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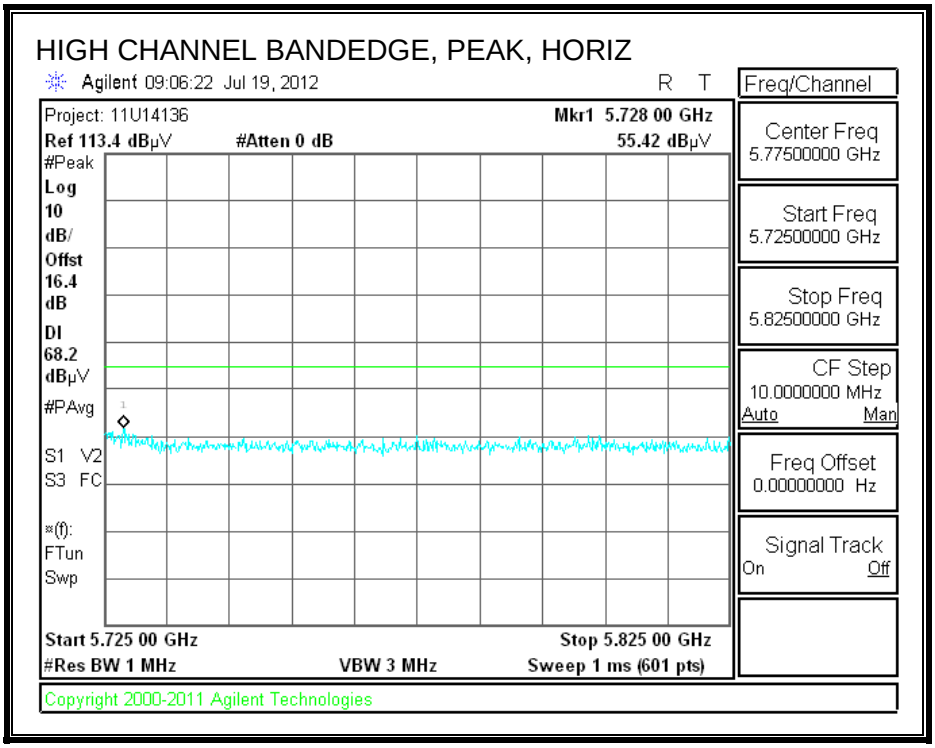
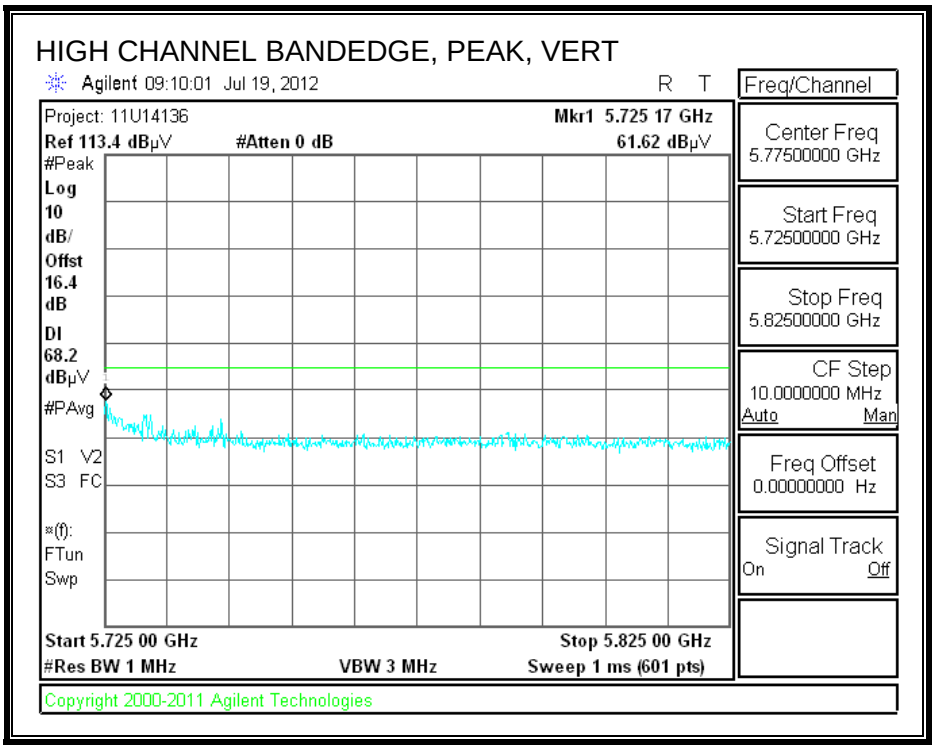
AUTHORIZED BANDEDGE (HIGH CHANNEL)





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HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 07/19/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: 802.11n HT20, TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5500MHz HT20													
11.000	3.0	35.0	38.3	10.2	-33.5	0.0	0.7	50.8	74.0	-23.2	H	P	
11.000	3.0	24.9	38.3	10.2	-33.5	0.0	0.7	40.7	54.0	-13.3	H	A	
11.000	3.0	36.5	38.3	10.2	-33.5	0.0	0.7	52.2	74.0	-21.8	V	P	
11.000	3.0	24.9	38.3	10.2	-33.5	0.0	0.7	40.7	54.0	-13.3	V	A	
5580MHz HT20													
11.160	3.0	35.3	38.5	10.3	-33.3	0.0	0.7	51.5	74.0	-22.5	V	P	
11.160	3.0	24.6	38.5	10.3	-33.3	0.0	0.7	40.9	54.0	-13.1	V	A	
11.160	3.0	34.8	38.5	10.3	-33.3	0.0	0.7	51.1	74.0	-22.9	H	P	
11.160	3.0	24.6	38.5	10.3	-33.3	0.0	0.7	40.9	54.0	-13.1	H	A	
5700MHz HT20													
11.400	3.0	35.4	38.7	10.6	-33.0	0.0	0.7	52.5	74.0	-21.5	V	P	
11.400	3.0	24.5	38.7	10.6	-33.0	0.0	0.7	41.5	54.0	-12.5	V	A	
11.400	3.0	35.1	38.7	10.6	-33.0	0.0	0.7	52.1	74.0	-21.9	H	P	
11.400	3.0	24.4	38.7	10.6	-33.0	0.0	0.7	41.4	54.0	-12.6	H	A	

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

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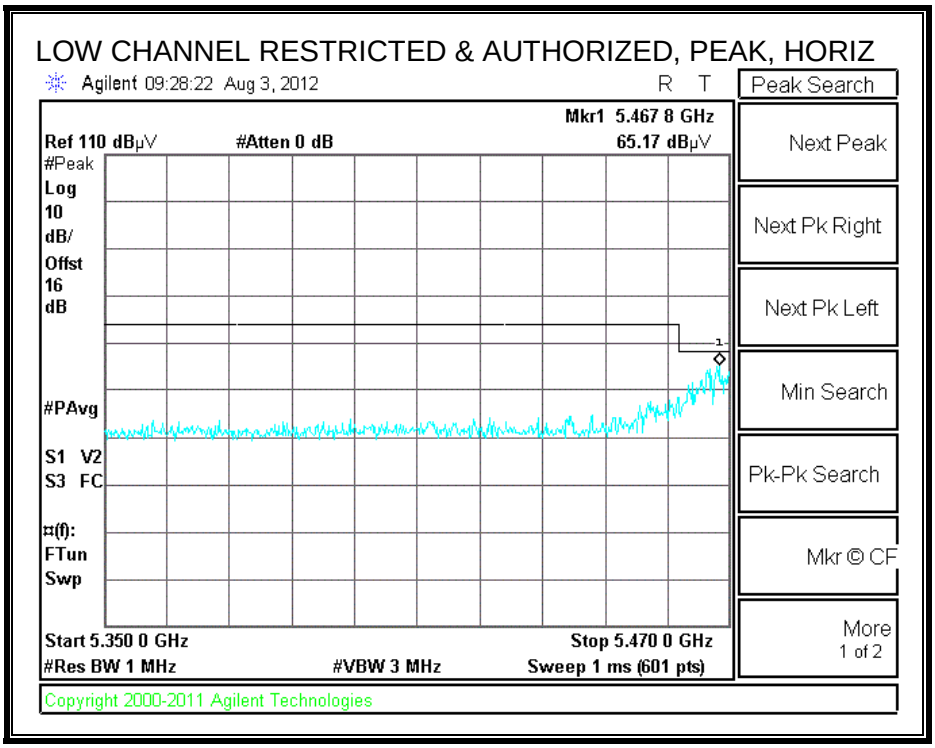
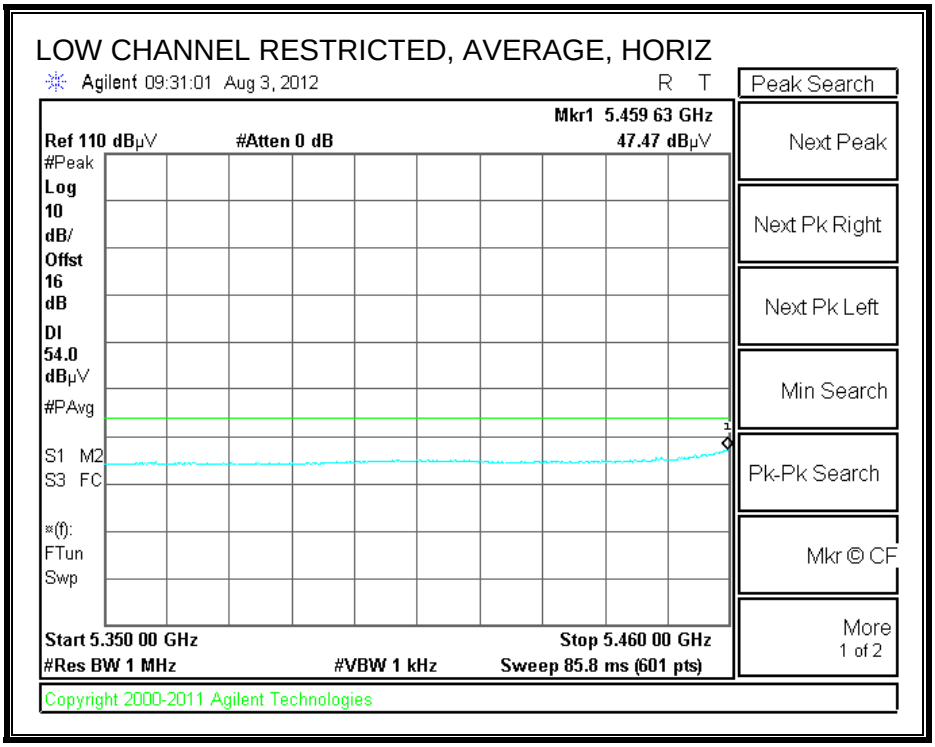
9.2.9. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.6 GHz BAND RESTRICTED & AUTHORIZED BANDEDGE (LOW CHANNEL)





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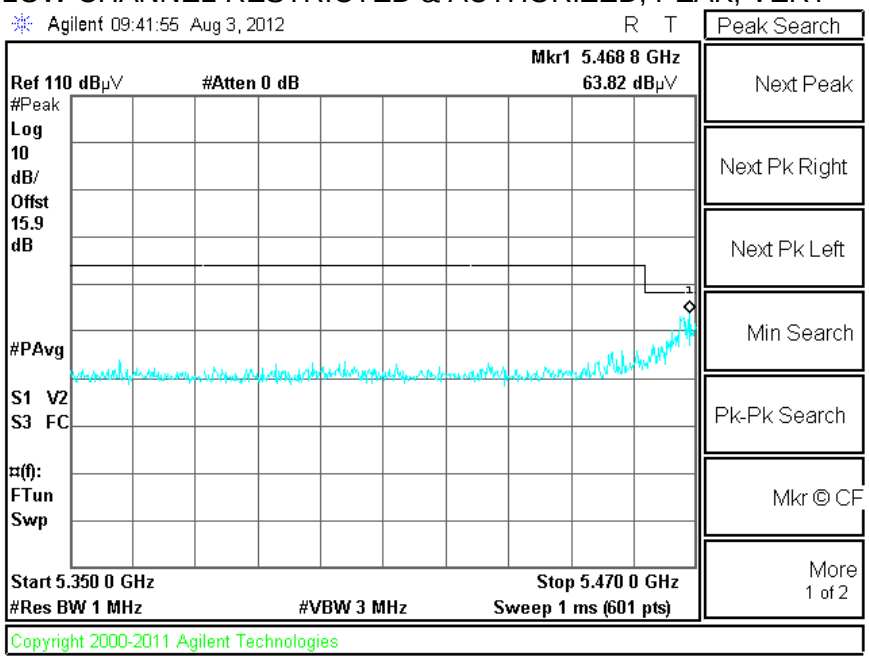
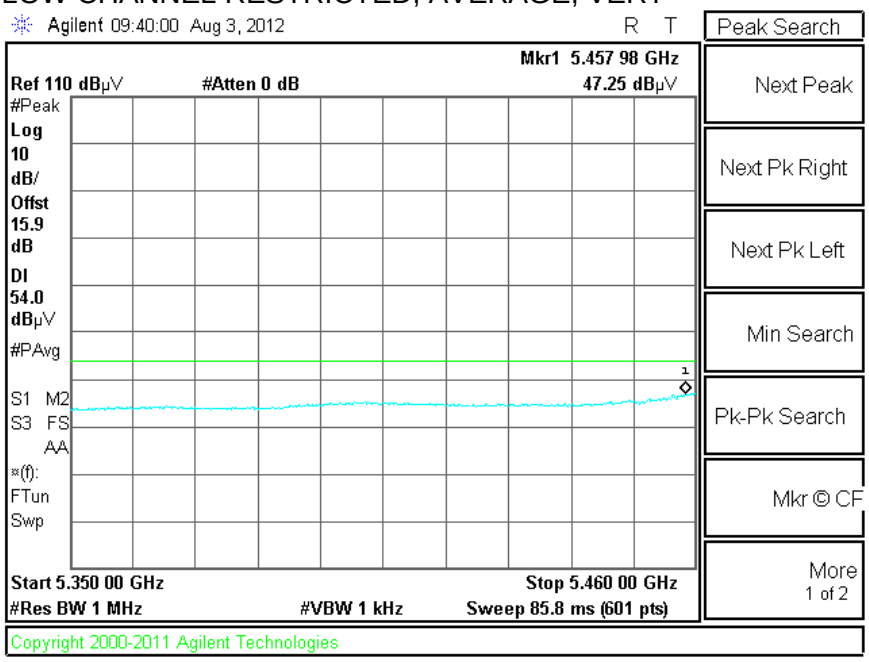
LOW CHANNEL RESTRICTED & AUTHORIZED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



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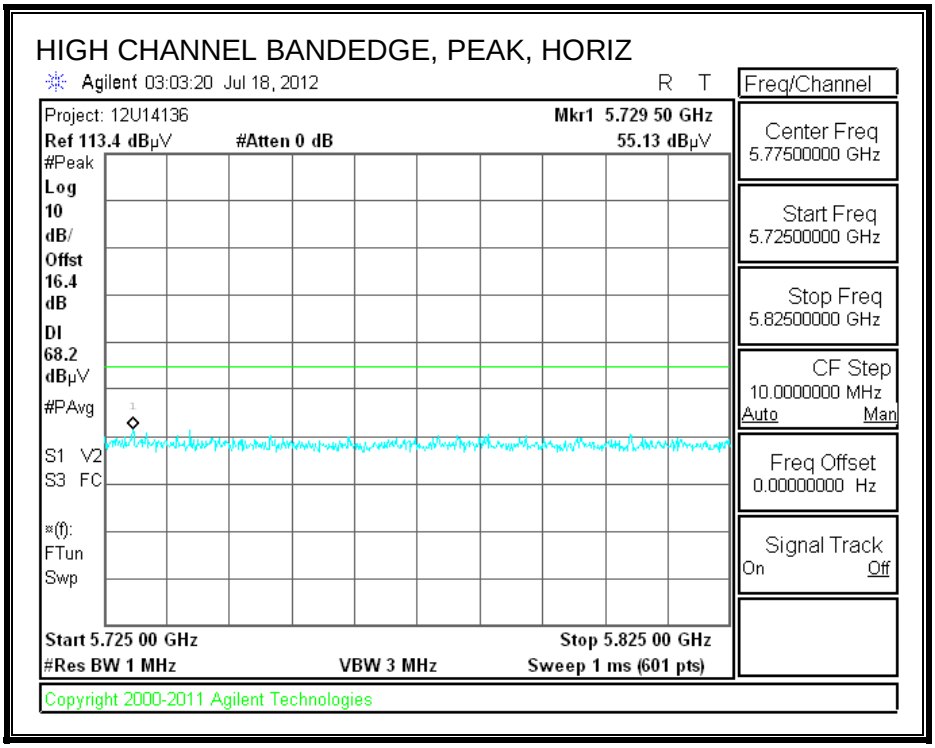
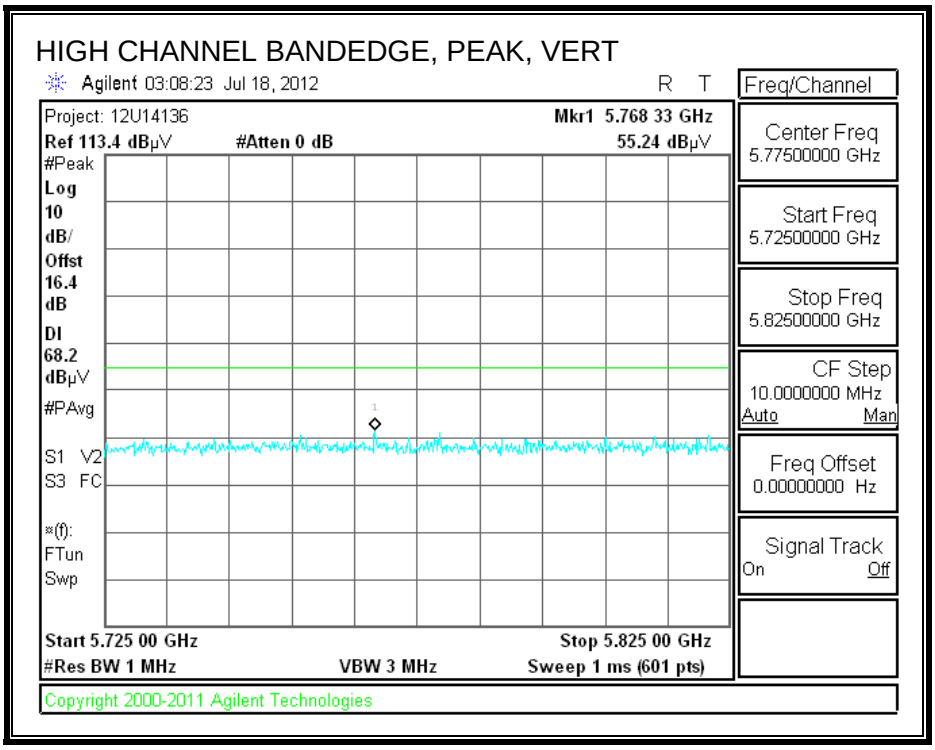
AUTHORIZED BANDEDGE (HIGH CHANNEL)





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HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 07/20/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: 802.11n HT40, TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5510 MHz HT40													
11.020	3.0	34.8	38.3	10.2	-33.4	0.0	0.7	50.7	74.0	-23.3	V	P	
11.020	3.0	24.8	38.3	10.2	-33.4	0.0	0.7	40.7	54.0	-13.3	V	A	
11.020	3.0	35.1	38.3	10.2	-33.4	0.0	0.7	51.0	74.0	-23.0	H	P	
11.020	3.0	24.8	38.3	10.2	-33.4	0.0	0.7	40.6	54.0	-13.4	H	A	
5550MHz HT40													
11.100	3.0	35.3	38.4	10.3	-33.3	0.0	0.7	51.4	74.0	-22.6	H	P	
11.100	3.0	24.7	38.4	10.3	-33.3	0.0	0.7	40.8	54.0	-13.2	H	A	
11.100	3.0	34.8	38.4	10.3	-33.3	0.0	0.7	50.9	74.0	-23.1	V	P	
11.100	3.0	24.7	38.4	10.3	-33.3	0.0	0.7	40.8	54.0	-13.2	V	A	
5670MHz HT40													
11.340	3.0	34.6	38.7	10.6	-33.0	0.0	0.7	51.4	74.0	-22.6	V	P	
11.340	3.0	24.0	38.7	10.6	-33.0	0.0	0.7	40.9	54.0	-13.1	V	A	
11.340	3.0	34.9	38.7	10.6	-33.0	0.0	0.7	51.7	74.0	-22.3	H	P	
11.340	3.0	23.9	38.7	10.6	-33.0	0.0	0.7	40.7	54.0	-13.3	H	A	

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

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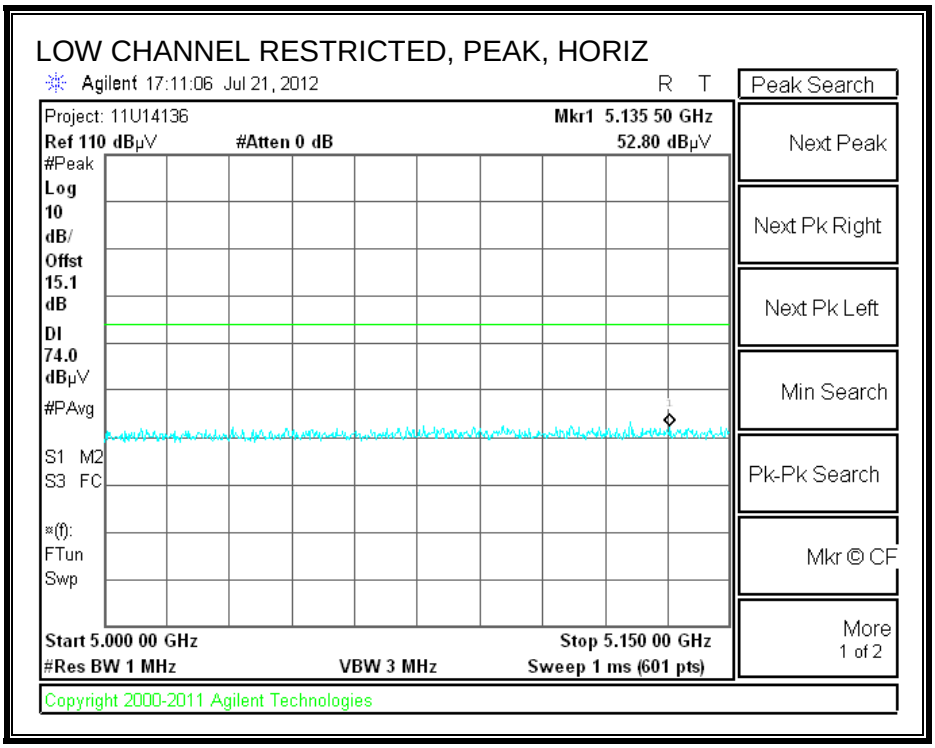
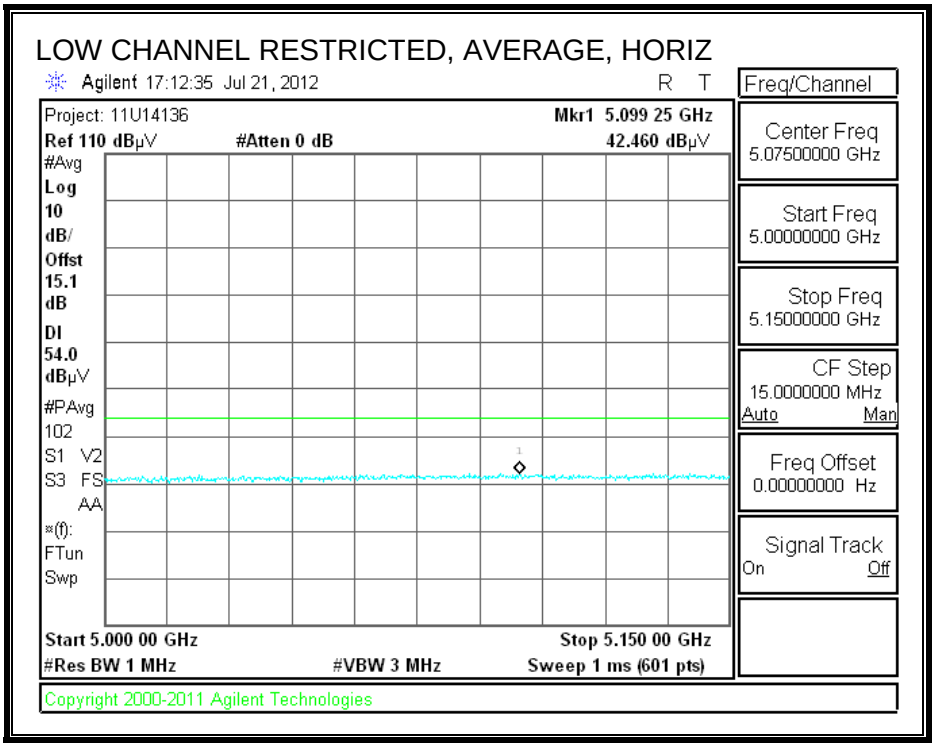
9.2.10. 2.4GHZ AND 5GHZ BAND CO-LOCATION

BANDEDGE (CHANNEL 36 and Bluetooth High CHANNEL)





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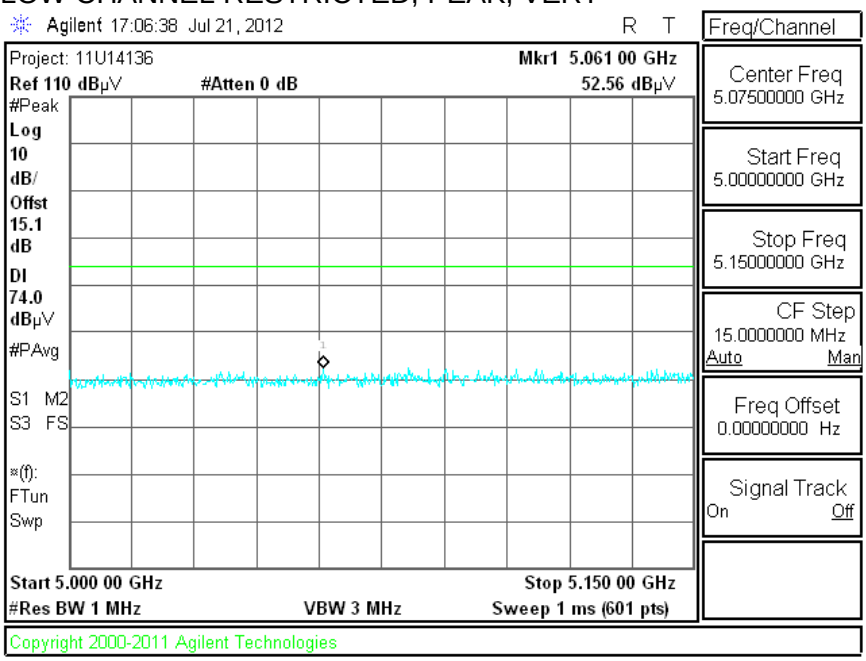
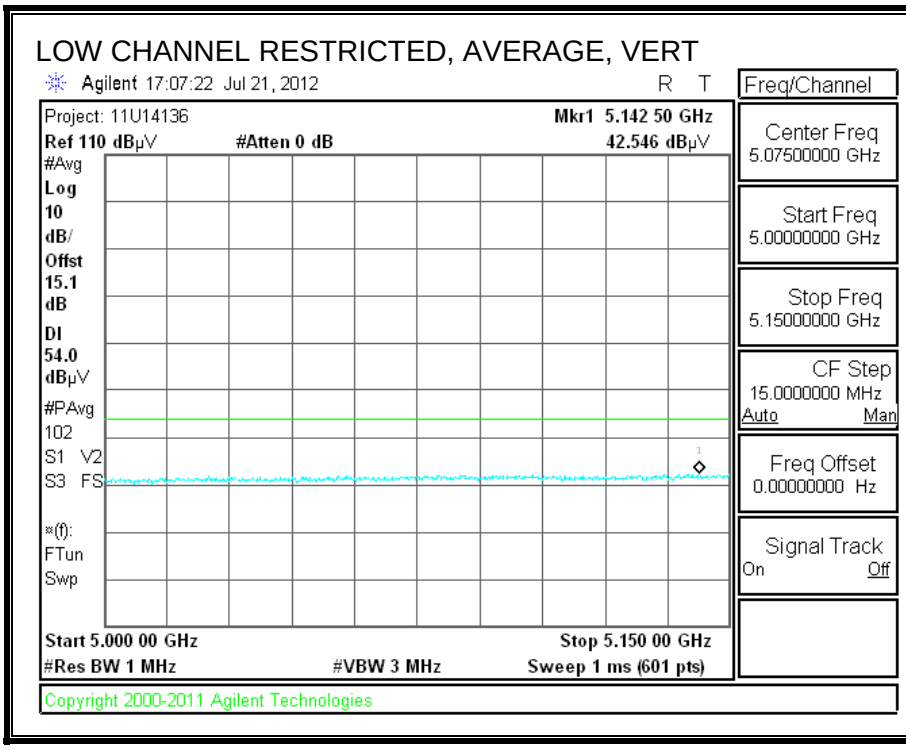
LOW CHANNEL RESTRICTED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



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HARMONICS AND SPURIOUS EMISSIONS

Compliance Certification Services, Fremont 5m Chamber

Test Engr: Tom Chen
Date: 08/06/12
Project #: 11U14136
Company: Apple Inc.
Test Target: FCC Class B
Mode Oper: Bluetooth Hi Channel and UNII Band Channel 36 both on TX mode

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
5180 MHz													
10.360	3.0	38.6	38.0	9.4	-35.8	0.0	0.0	50.3	74.0	-23.7	H	P	
10.360	3.0	25.9	38.0	9.4	-35.8	0.0	0.0	37.5	54.0	-16.5	H	A	
10.360	3.0	41.4	38.0	9.4	-35.8	0.0	0.0	53.1	74.0	-20.9	V	P	
10.360	3.0	26.9	38.0	9.4	-35.8	0.0	0.0	38.6	54.0	-15.4	V	A	
2480 MHz													
4.960	3.0	57.2	33.2	6.4	-35.5	0.0	0.0	61.3	74.0	-12.7	H	P	
4.960	3.0	41.7	33.2	6.4	-35.5	0.0	0.0	45.8	54.0	-8.2	H	A	
4.960	3.0	59.1	33.2	6.4	-35.5	0.0	0.0	63.2	74.0	-10.8	V	P	
4.960	3.0	43.2	33.2	6.4	-35.5	0.0	0.0	47.3	54.0	-6.7	V	A	

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

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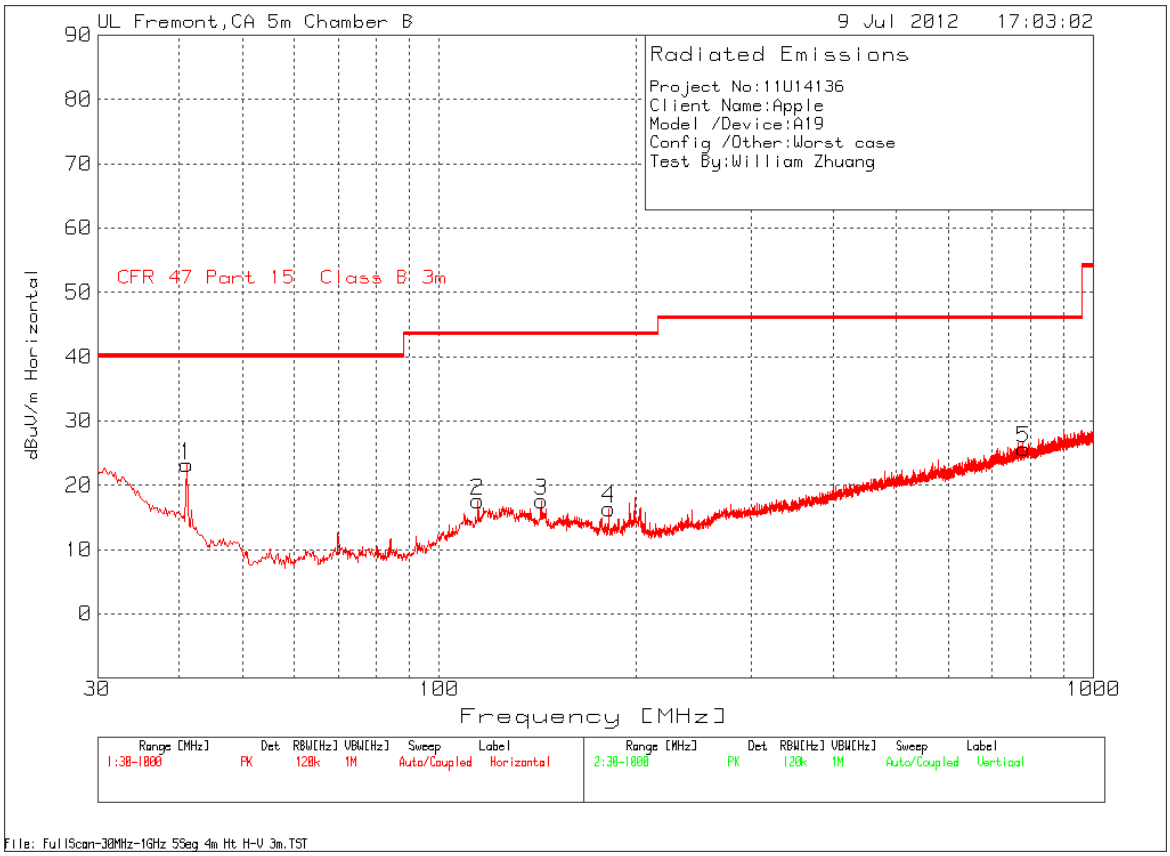
9.3. WORST-CASE BELOW 1 GHz

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

HORIZONTAL PLOT



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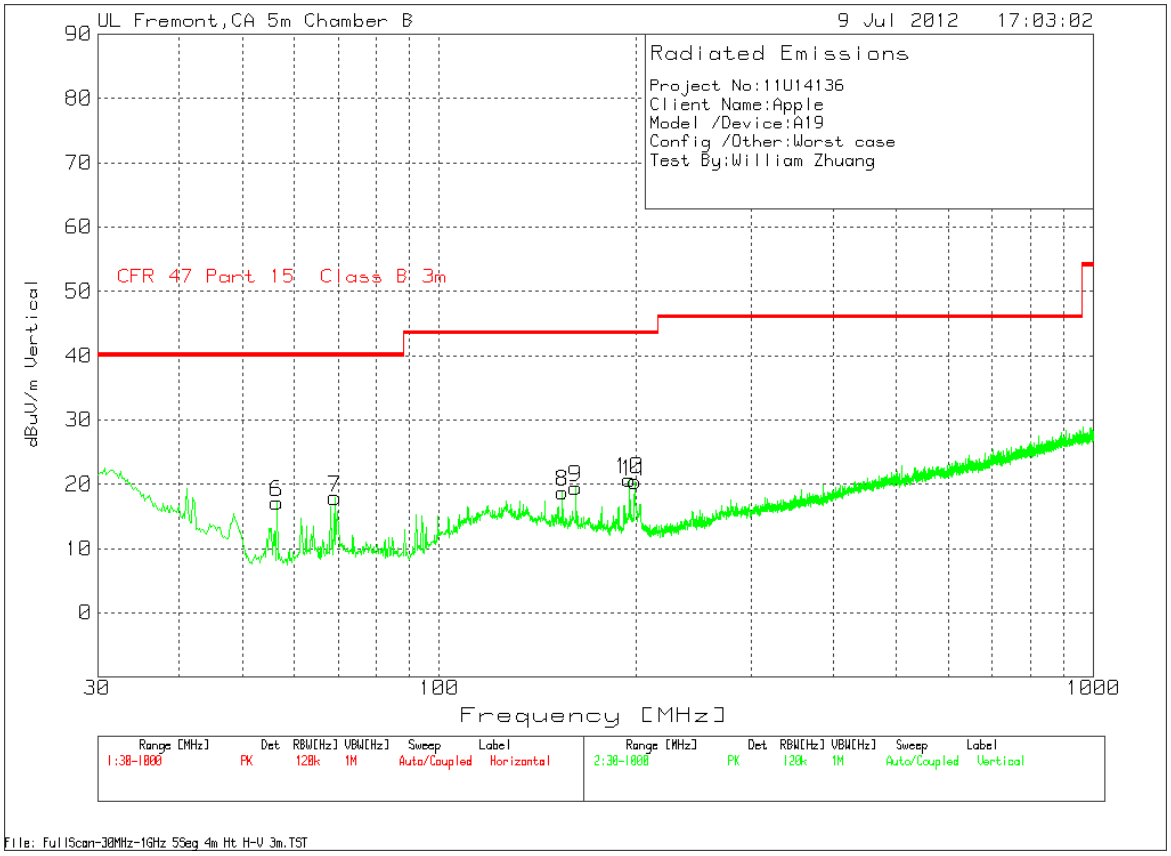
SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, VERTICAL)

VERTICAL PLOT



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HORIZONTAL AND VERTICAL DATA

Project No:11U14136
Client Name:Apple
Model /Device:A1428
Config /Other:Worst case
Test By:William Zhuang

Horizontal 30 - 1000MHz

Test Frequency	Meter Reading	Detector	T122 Sunol Bilog.TXT (dB)	5mB Amp Path 30-1000MHz (dB)	dBuV/m	CFR 47 Part 15 Class B 3m	Margin	Polarity
41.0492	39.36	PK	13	-29.2	23.16	40	-16.84	Horz
114.5164	32.49	PK	13.5	-28.4	17.59	43.5	-25.91	Horz
143.2054	32.78	PK	12.9	-28.1	17.58	43.5	-25.92	Horz
181.5867	32.98	PK	11.1	-27.7	16.38	43.5	-27.12	Horz
783.2814	29.99	PK	21.2	-25.5	25.69	46	-20.31	Horz

Vertical 30 - 1000MHz

Test Frequency	Meter Reading	Detector	T122 Sunol Bilog.TXT (dB)	5mB Amp Path 30-1000MHz (dB)	dBuV/m	CFR 47 Part 15 Class B 3m	Margin	Polarity
56.3629	38.93	PK	7.2	-29	17.13	40	-22.87	Vert
69.1567	38.74	PK	8.1	-28.9	17.94	40	-22.06	Vert
154.2546	34.3	PK	12.5	-28	18.8	43.5	-24.7	Vert
161.4269	35	PK	12.4	-27.9	19.5	43.5	-24	Vert
195.1559	36.44	PK	11.9	-27.6	20.74	43.5	-22.76	Vert
199.0328	35.32	PK	12.7	-27.6	20.42	43.5	-23.08	Vert

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10. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	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

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

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

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

RESULTS

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6 WORST EMISSIONS

Project No:11U14136									
Client Name:Apple									
Model/Device:A1428 and A1429									
Test Volt/Freq:115Vac 60Hz									
Test By:Chin Pang									
Line-L1 .15 - 30MHz									
Test Frequ	Meter Rea	Detector	T24 IL L1.T	LC Cables	dB(uVolts	CISPR 11/2	Margin	CISPR 11/2	Margin
0.168	63.2	PK	0.1	0	63.3	65.1	-1.8	-	-
0.168	45.89	Av	0.1	0	45.99	-	-	55.1	-9.11
0.2445	57.43	PK	0.1	0	57.53	61.9	-4.37	-	-
0.2445	33.52	Av	0.1	0	33.62	-	-	51.9	-18.28
0.3255	54.03	PK	0.1	0	54.13	59.6	-5.47	-	-
0.3255	25.37	Av	0.1	0	25.47	-	-	49.6	-24.13
Line-L2 .15 - 30MHz									
Test Frequ	Meter Rea	Detector	T24 IL L2.T	LC Cables	dB(uVolts	CISPR 11/2	Margin	CISPR 11/2	Margin
0.1635	53.72	PK	0.1	0	53.82	65.3	-11.48	-	-
0.1635	32.37	Av	0.1	0	32.47	-	-	55.3	-22.83
0.2445	50.33	PK	0.1	0	50.43	61.9	-11.47	-	-
0.2445	29.13	Av	0.1	0	29.23	-	-	51.9	-22.67
0.321	46.08	PK	0.1	0	46.18	59.7	-13.52	-	-
0.321	21.42	Av	0.1	0	21.52	-	-	49.7	-28.18

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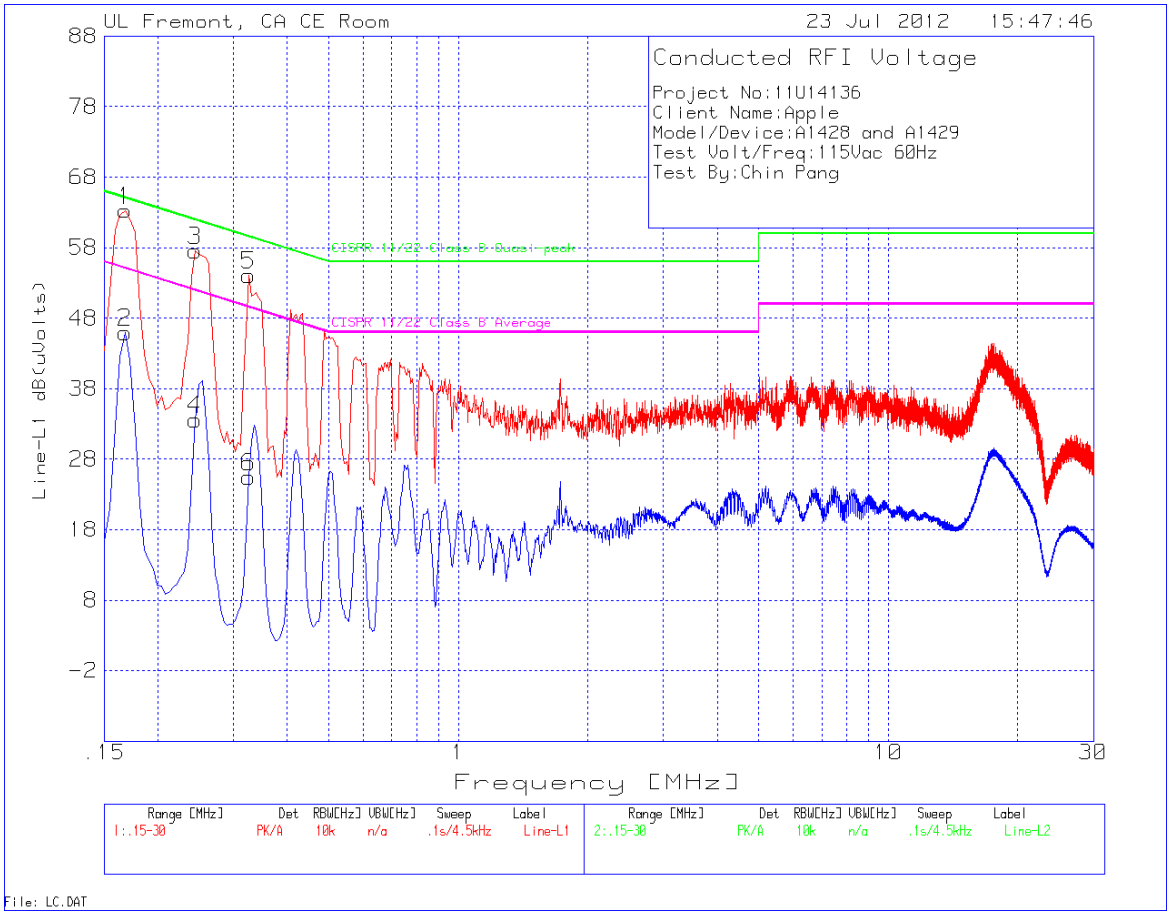
LINE 1 RESULTS



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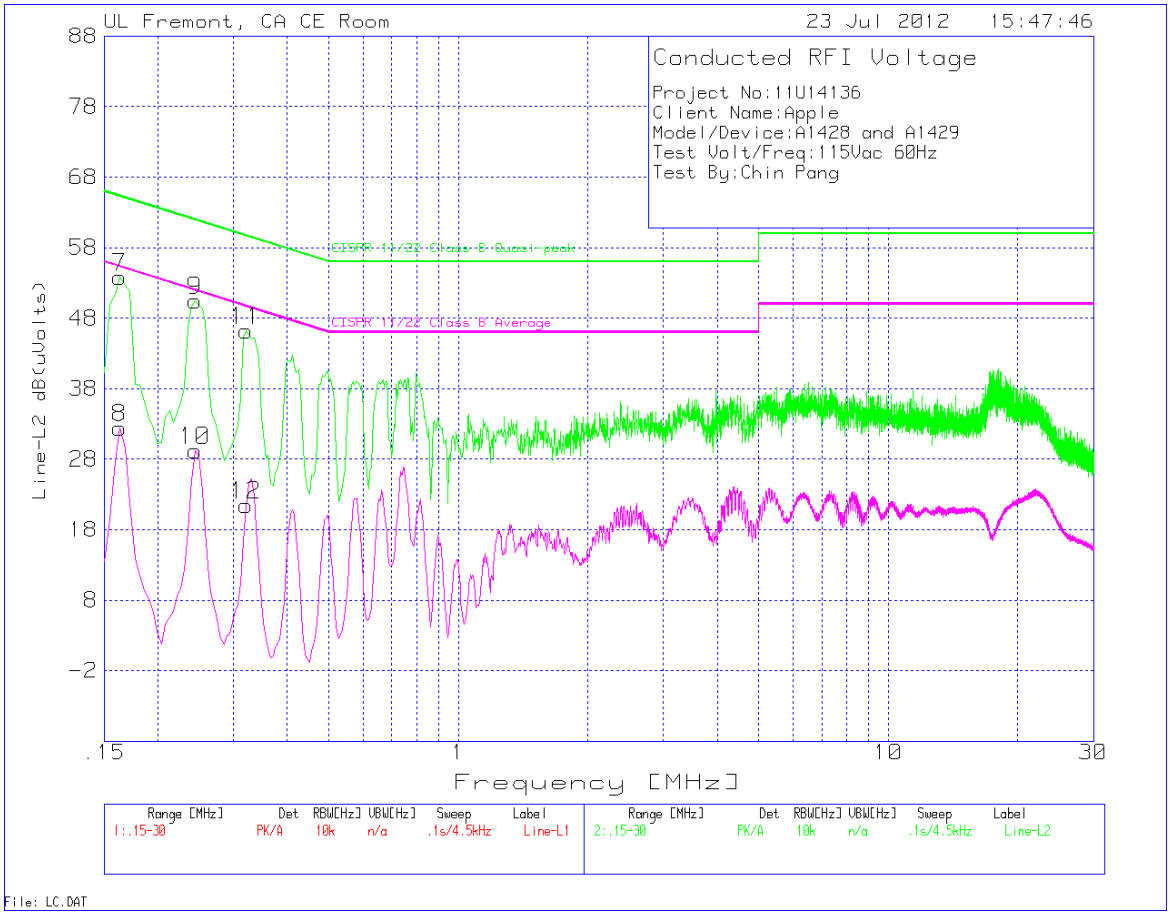
LINE 2 RESULTS



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11. DYNAMIC FREQUENCY SELECTION

11.1. OVERVIEW

11.1.1. LIMITS

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”.

Testing was also conducted per KDB 365942.

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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.	

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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

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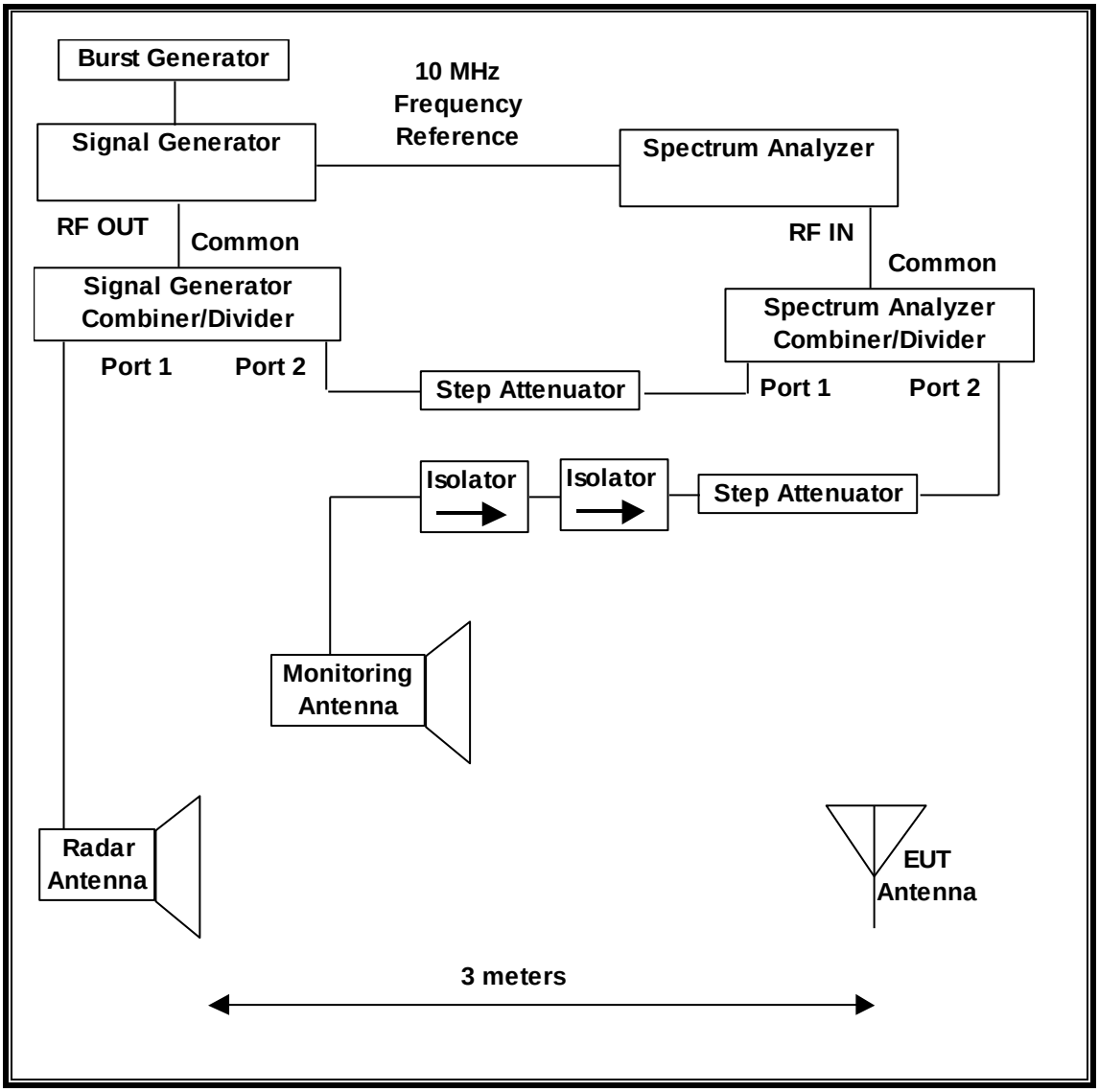
11.1.2. TEST AND MEASUREMENT SYSTEM

RADIATED METHOD SYSTEM BLOCK DIAGRAM



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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.

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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, 26.5 GHz	Agilent / HP	E4440A	C01178	08/15/12
Vector Signal Generator, 20GHz	Agilent / HP	E8267C	C01066	11/17/12

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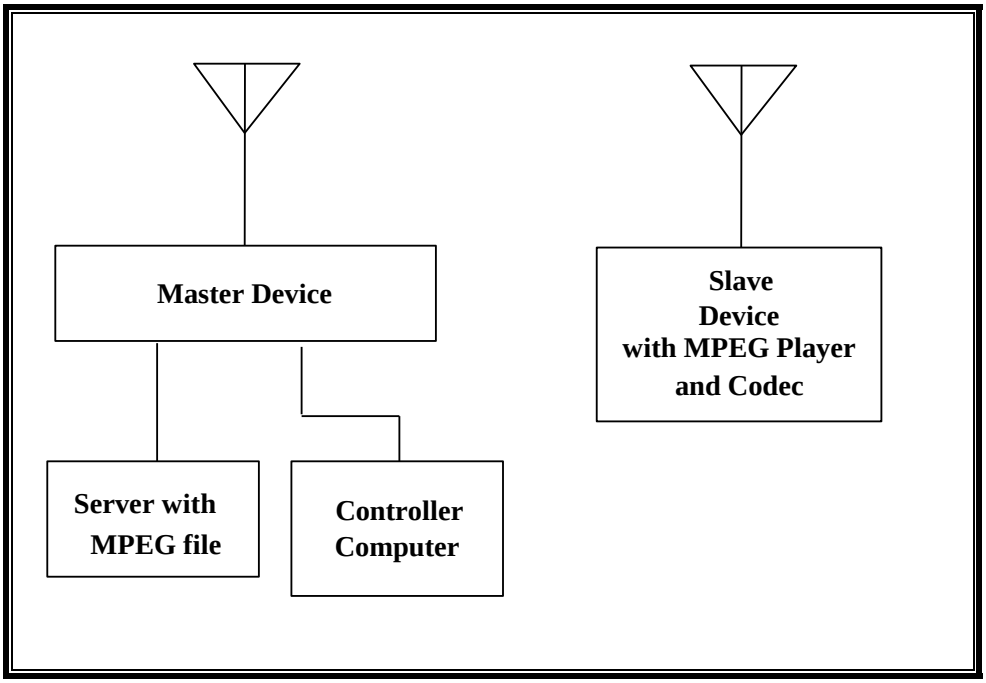
11.1.3. SETUP OF EUT (CLIENT MODE)

RADIATED METHOD 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**
Wireless Access Point (Master Device)	Cisco	AIR-AP1252AG-A-K9	FTX130390D9	LDK102061
AC Adapter (AP)	Delta Electronics	EADP-45BB B	DTH1049902N	DoC
Notebook PC (Server)	Apple	MacBook Pro A1150	AOU257941	DoC
AC Adapter (Server)	Delta Electronics	A1344	MV05104CNAL1A	DoC
Notebook PC (Controller)	Dell	PP18L	10657517725	DoC
AC Adapter (Controller PC)	Dell	LA65SN0-00	CN-ODF263-71615-6AU-1019	DoC

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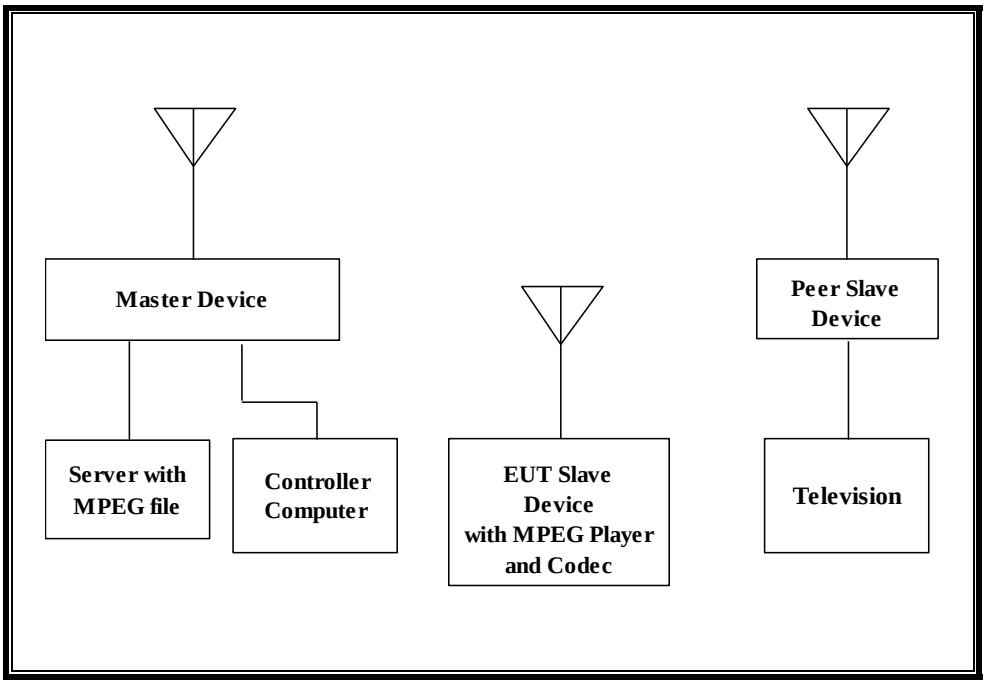
11.1.4. SETUP OF EUT (CLIENT-TO-CLIENT COMMUNICATIONS MODE)

RADIATED METHOD 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**
Wireless Access Point (Master Device)	Cisco	AIR-AP1252AG-A-K9	FTX130390D9	LDK102061
AC Adapter (AP)	Delta Electronics	EADP-45BB B	DTH1049902N	DoC
Notebook PC (Server)	Apple	MacBook Pro A1150	AOU257941	DoC
AC Adapter (Server)	Delta Electronics	A1344	MV05104CNAL1A	DoC
Notebook PC (Controller)	Dell	PP18L	10657517725	DoC
AC Adapter (Controller PC)	Dell	LA65SN0-00	CN-ODF263-71615-6AU-1019	DoC
Apple TV (Peer Slave Device)	Apple	A1427	C07GY040F14P	BCGA1427
LCD Television	Samsung	T23A350	Z3VEHCRC300508H	DoC

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11.1.5. 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 12.89 dBm EIRP in the 5250-5350 MHz band and 13.49 dBm EIRP in the 5470-5725 MHz band.

The only antenna assembly utilized with the EUT has a gain of –1.66 dBi in the 5250-5350 MHz band and –0.83 dBi in the 5470-5725 MHz band.

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 one transmitter/receiver chain connected to an antenna to perform radiated tests.

In the client mode, WLAN traffic is generated by streaming the video file TestFile.mp2 “6 ½ Magic Hours” from the Master to the Slave in full motion video mode using Safari web browser. In the Client-to-Client Communications mode, WLAN traffic is generated by streaming the video file TestFile.mp2 “6 ½ Magic Hours” from the Master, to the Slave, and mirror to the peer slave device in full motion video mode using Safari web browser.

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

The EUT utilizes the 802.11a/n architecture. Two nominal channel bandwidths of 20 MHz and 40 MHz are implemented in standard client mode.

One nominal channel bandwidth of 20 MHz is implemented in Client-to-Client Communications mode.

The software installed in the EUT is IOS (Build 10A371).

UNIFORM CHANNEL SPREADING

This requirement is not applicable to Slave radio devices.

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

The Master Device is a Cisco Access Point, FCC ID: LDK102061. 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.

The software installed in the access point is 12.4(25d)JA1.

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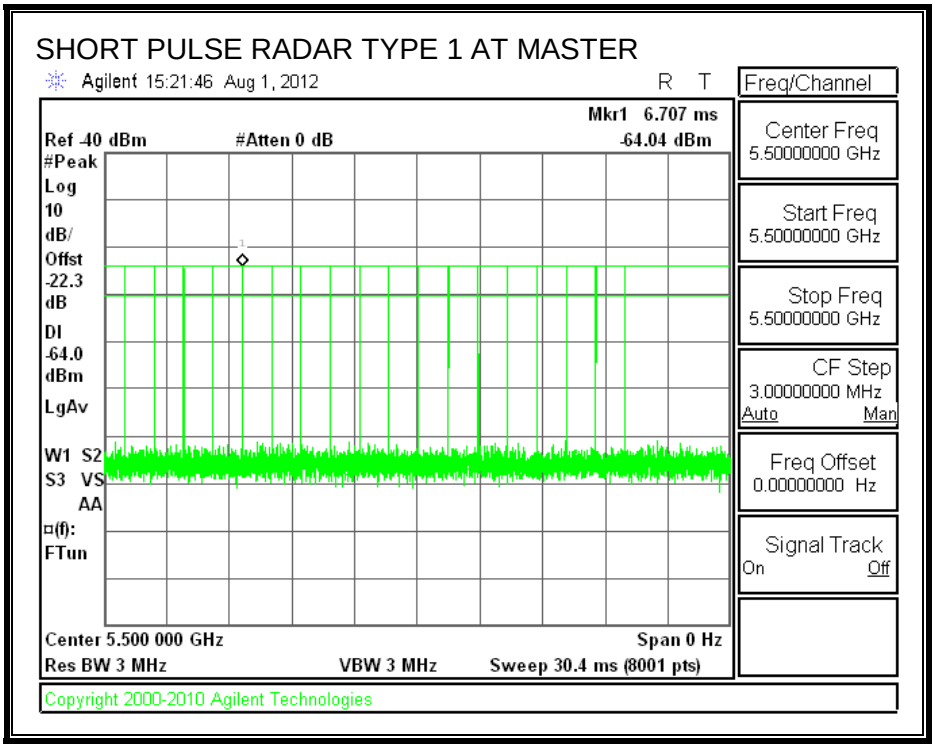
11.2. CLIENT MODE RESULTS FOR 20 MHz BANDWIDTH

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



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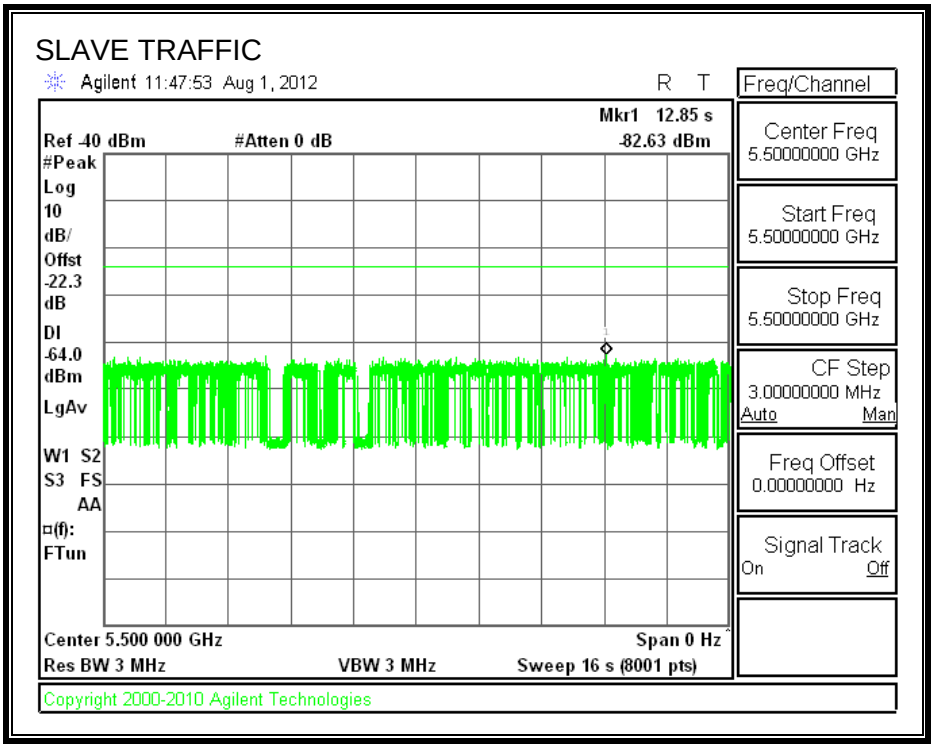
TRAFFIC



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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	0.000	10

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

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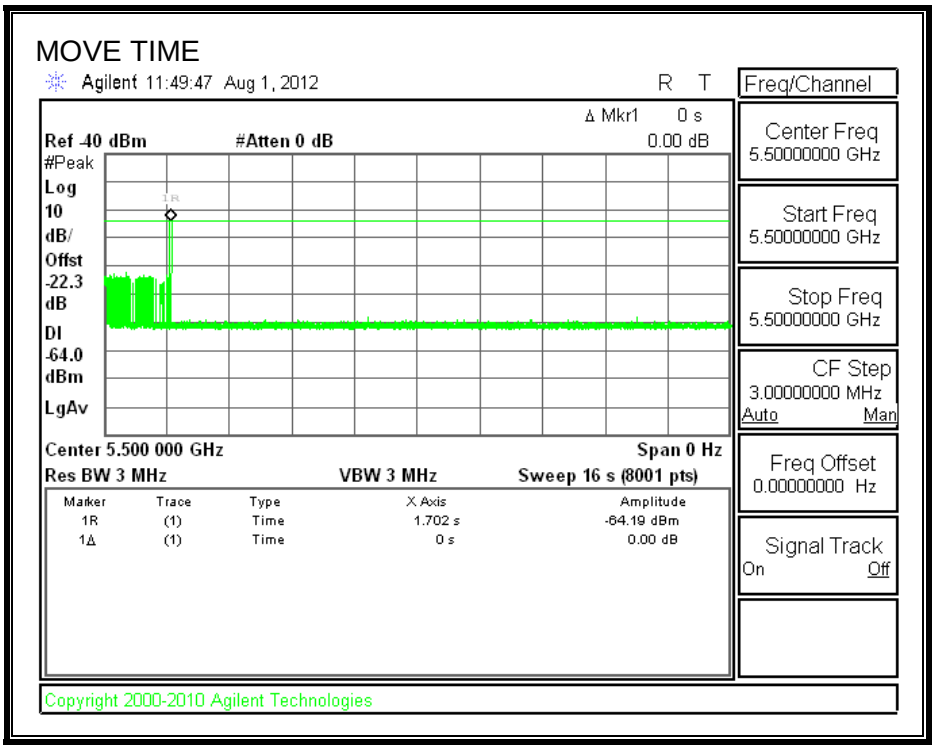
MOVE TIME



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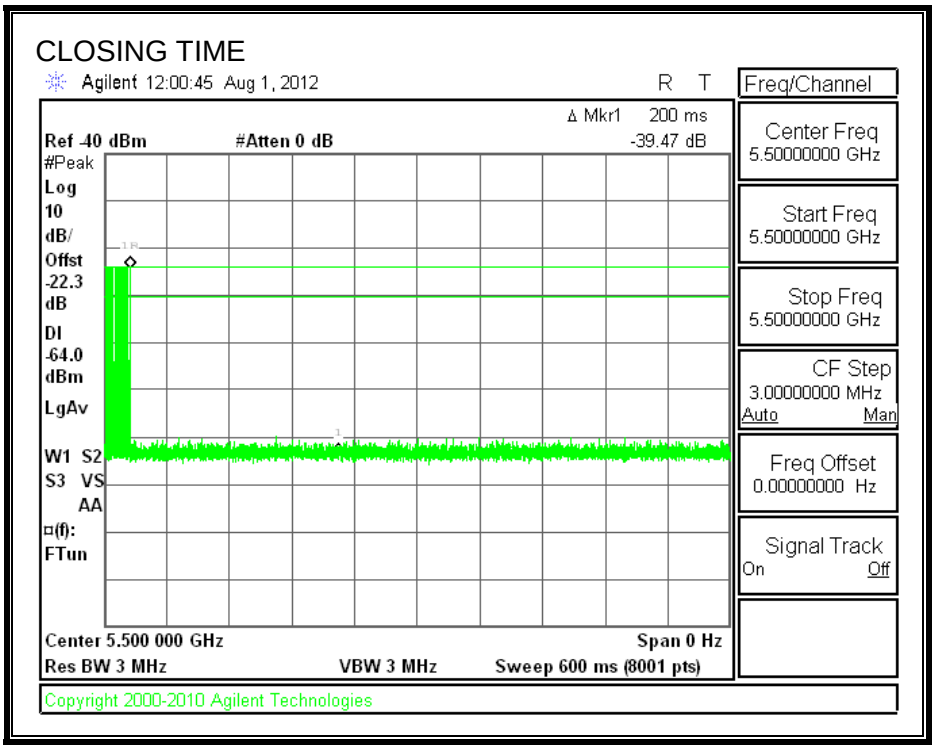
CHANNEL CLOSING TIME



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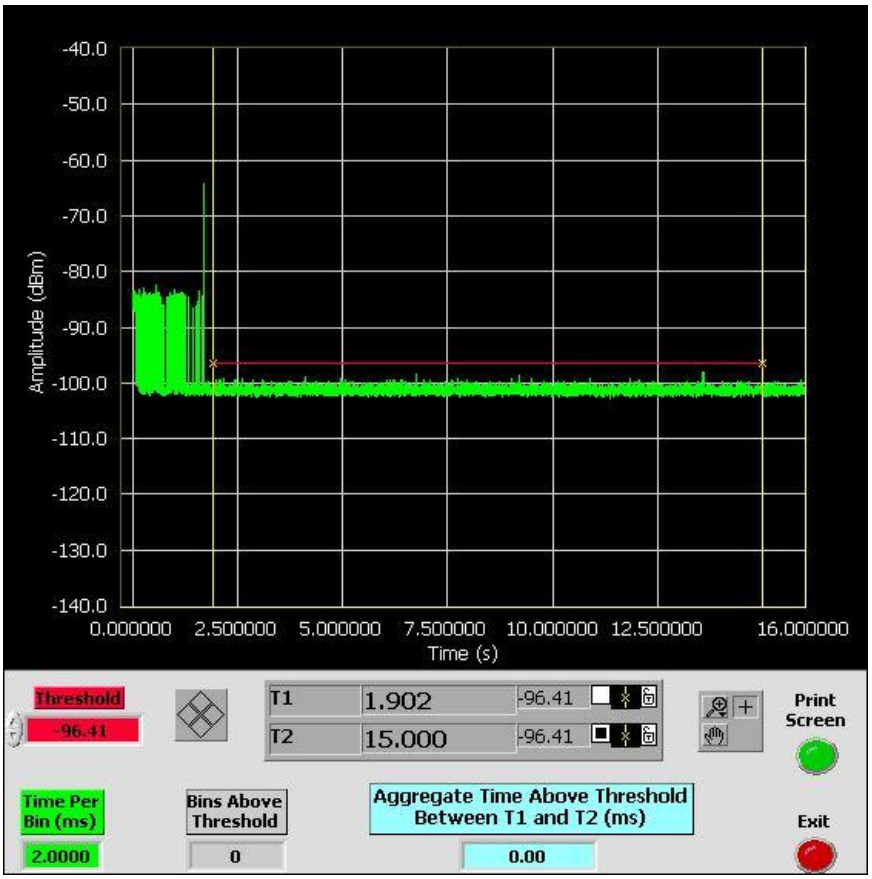
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the FCC aggregate monitoring period.

FCC AGGREGATE CLOSING TIME



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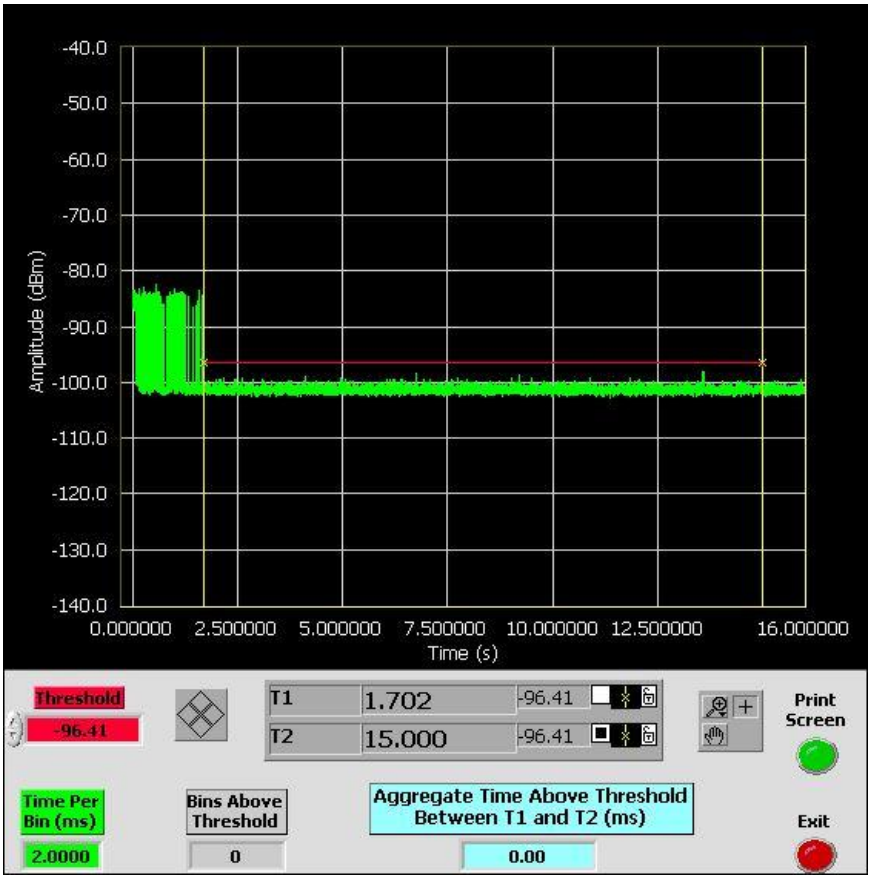
No transmissions are observed during the IC aggregate monitoring period.

IC AGGREGATE CLOSING TIME



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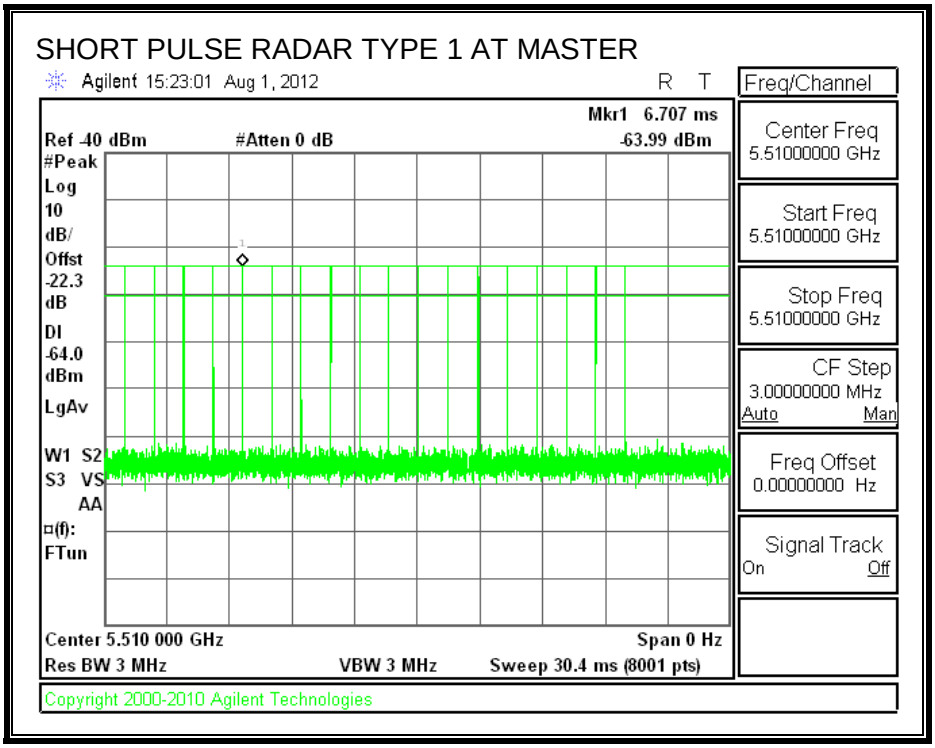
11.3. CLIENT MODE RESULTS FOR 40 MHz BANDWIDTH

11.3.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5510 MHz.

11.3.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM



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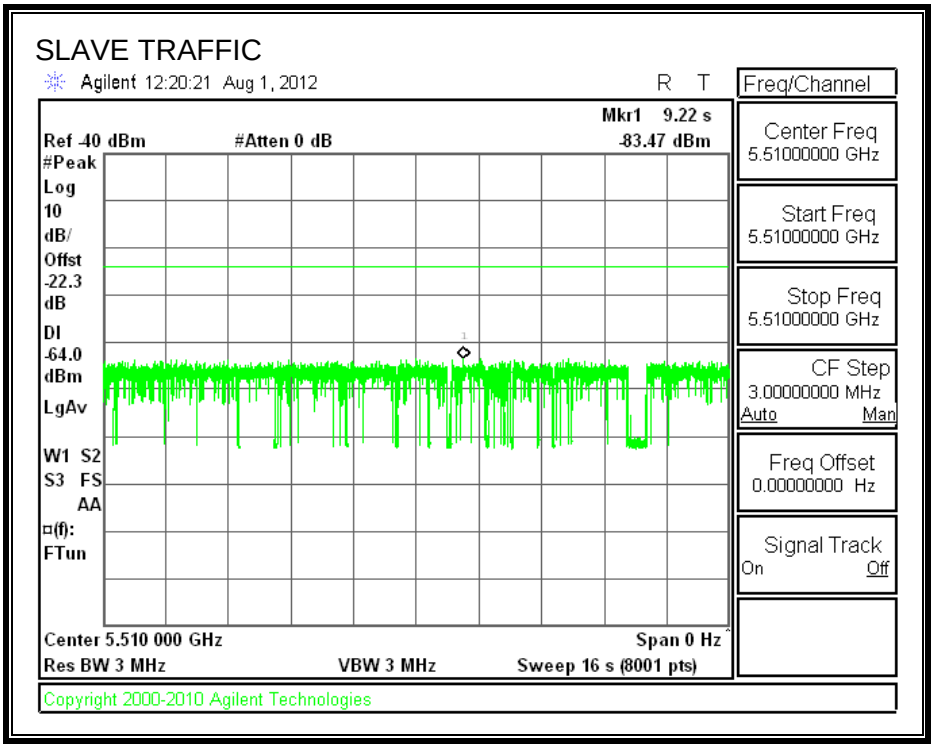
TRAFFIC



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11.3.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.3.4. 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	0.070	10

Agency	Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
FCC	0.0	60
IC	4.0	260

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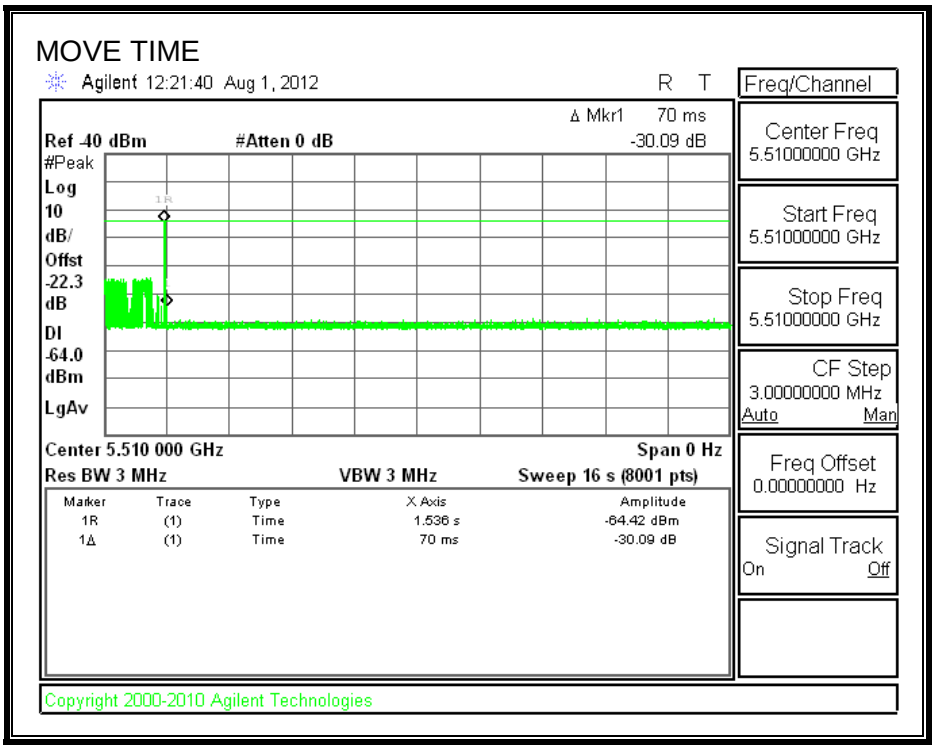
MOVE TIME



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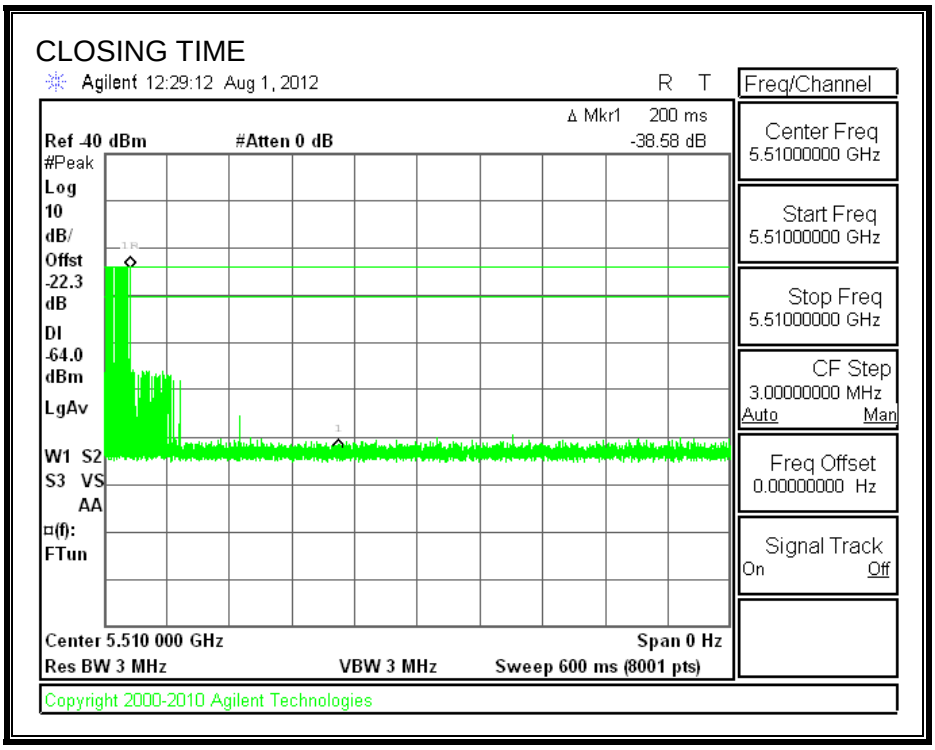
CHANNEL CLOSING TIME



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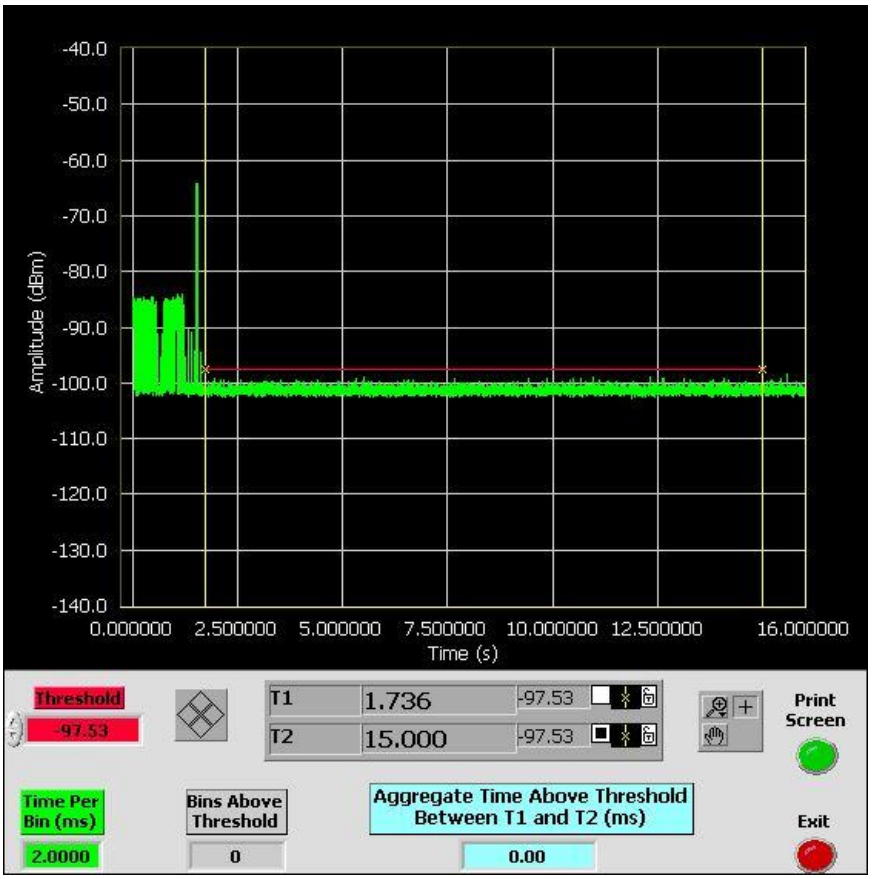
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the FCC aggregate monitoring period.

FCC AGGREGATE CLOSING TIME



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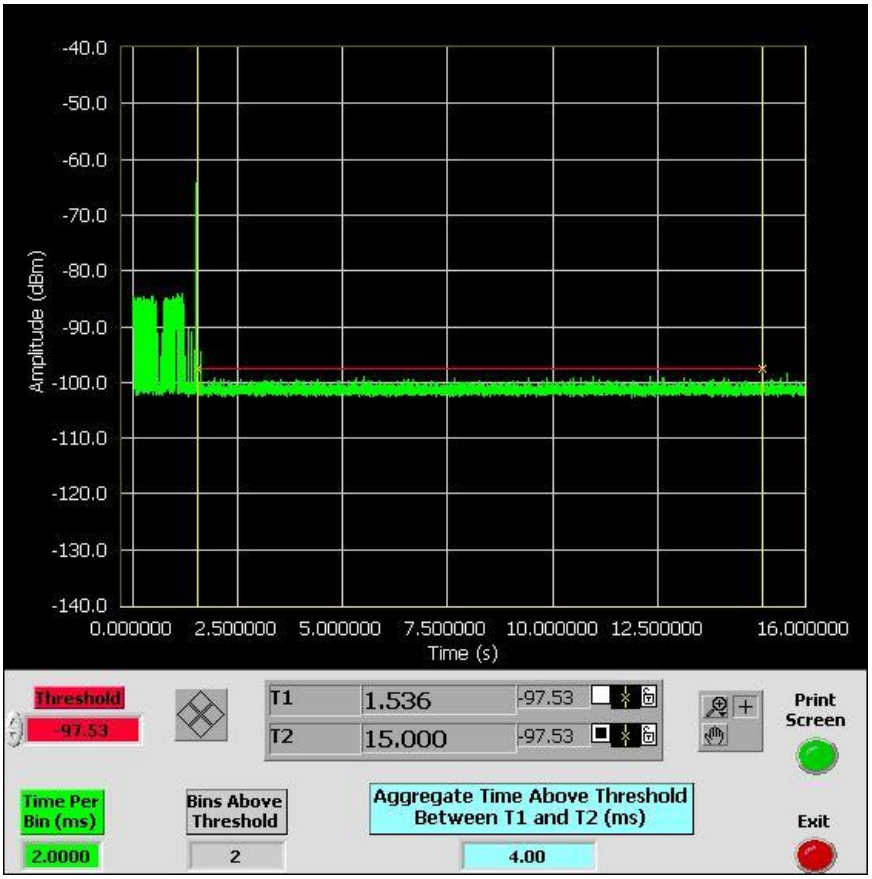
Only intermittent transmissions are observed during the IC aggregate monitoring period.

IC AGGREGATE CLOSING TIME



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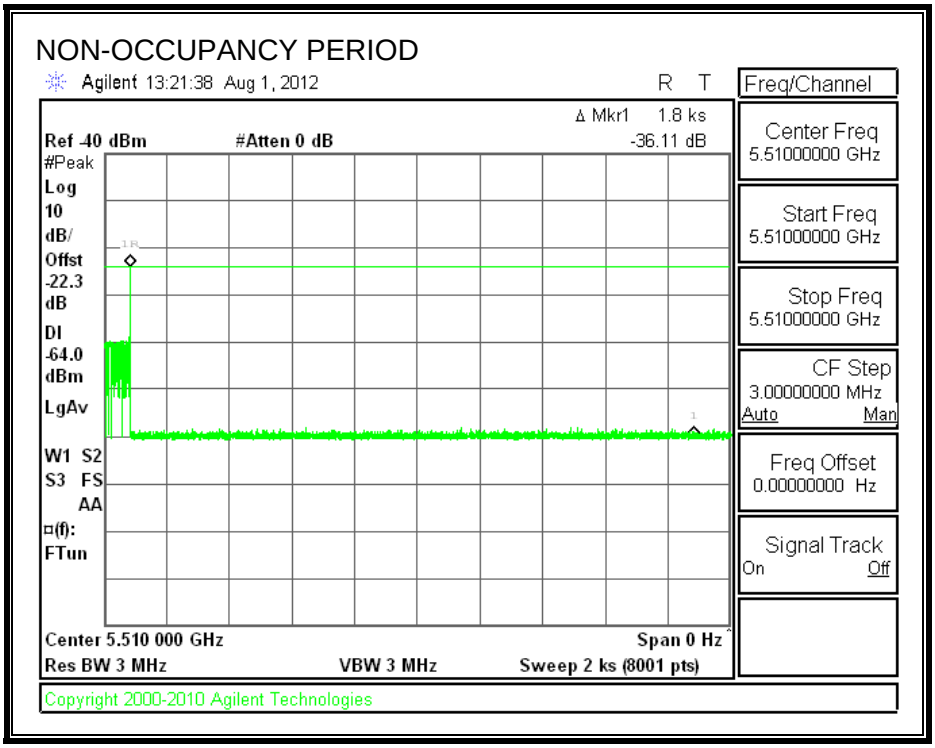
11.3.5. NON-OCCUPANCY PERIOD

RESULTS

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



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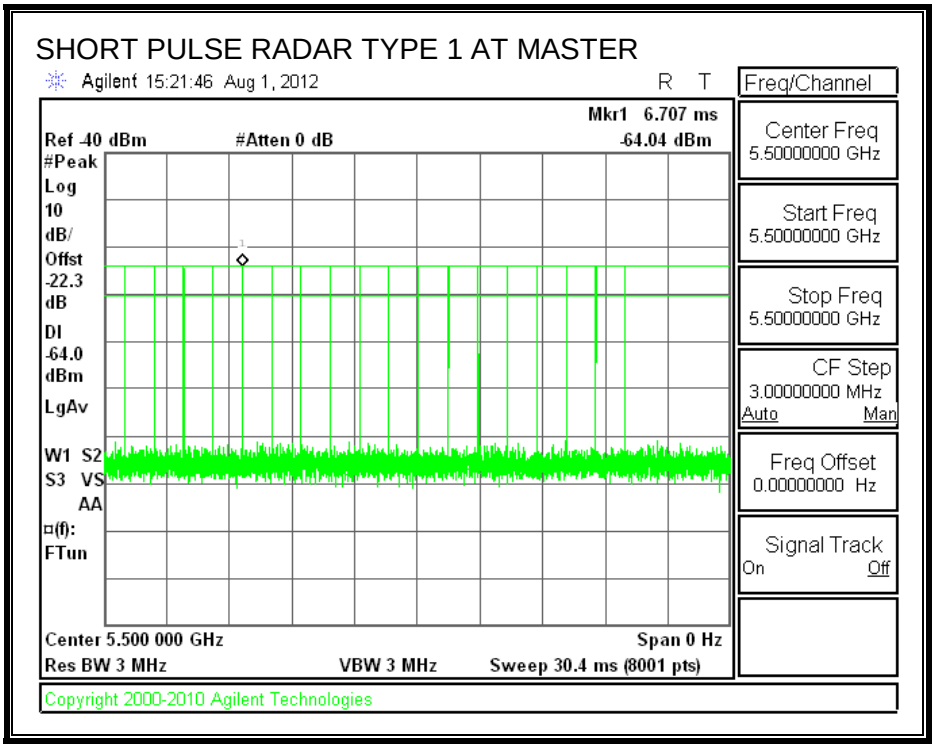
11.4. CLIENT-TO-CLIENT COMMUNICATIONS MODE RESULTS FOR 20 MHz BANDWIDTH

11.4.1. TEST CHANNEL

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

11.4.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM



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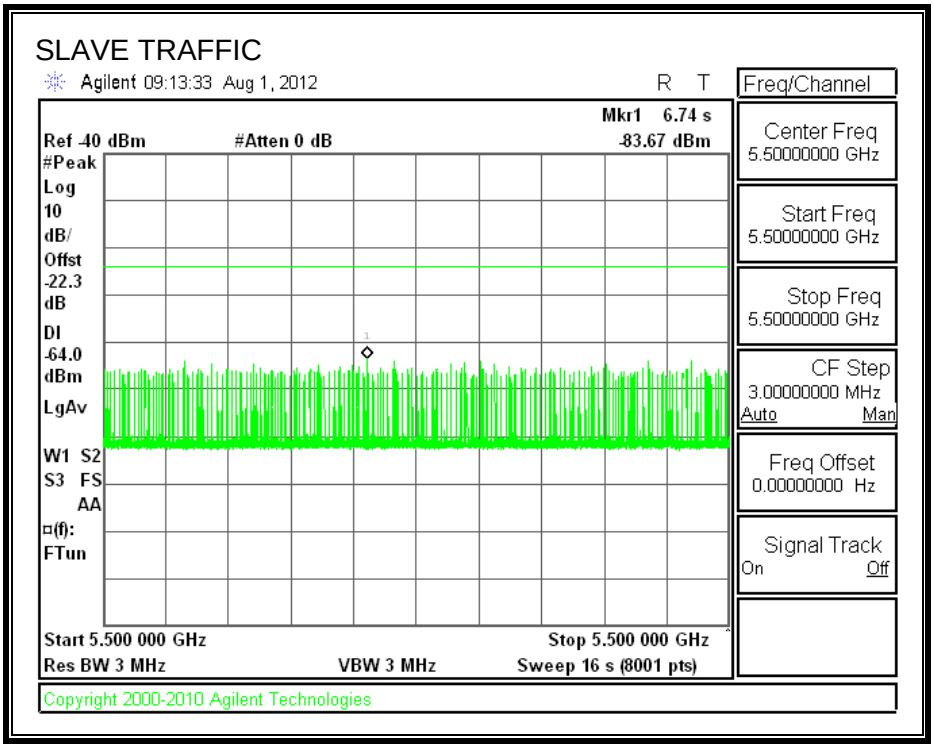
TRAFFIC



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11.4.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.4.4. 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	0.102	10

Agency	Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
FCC	0.0	60
IC	4.0	260

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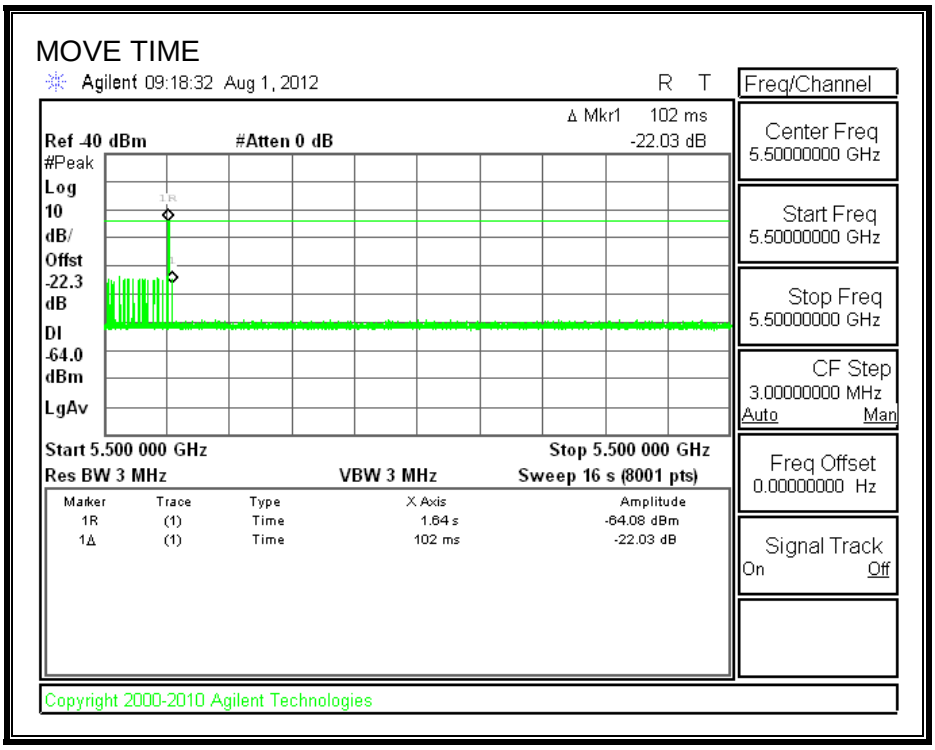
MOVE TIME



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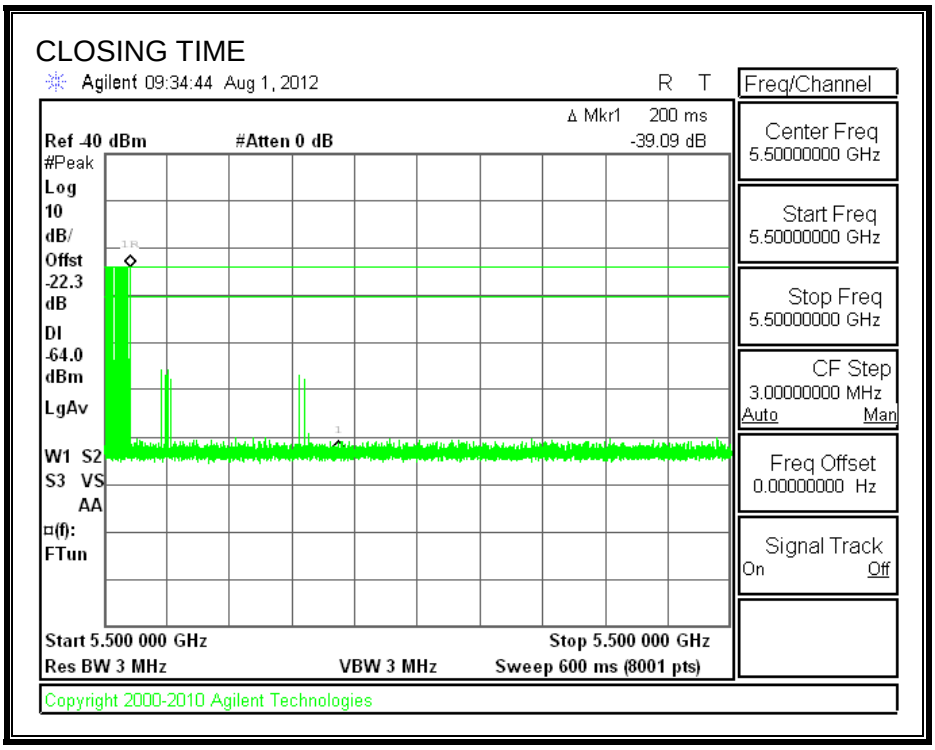
CHANNEL CLOSING TIME



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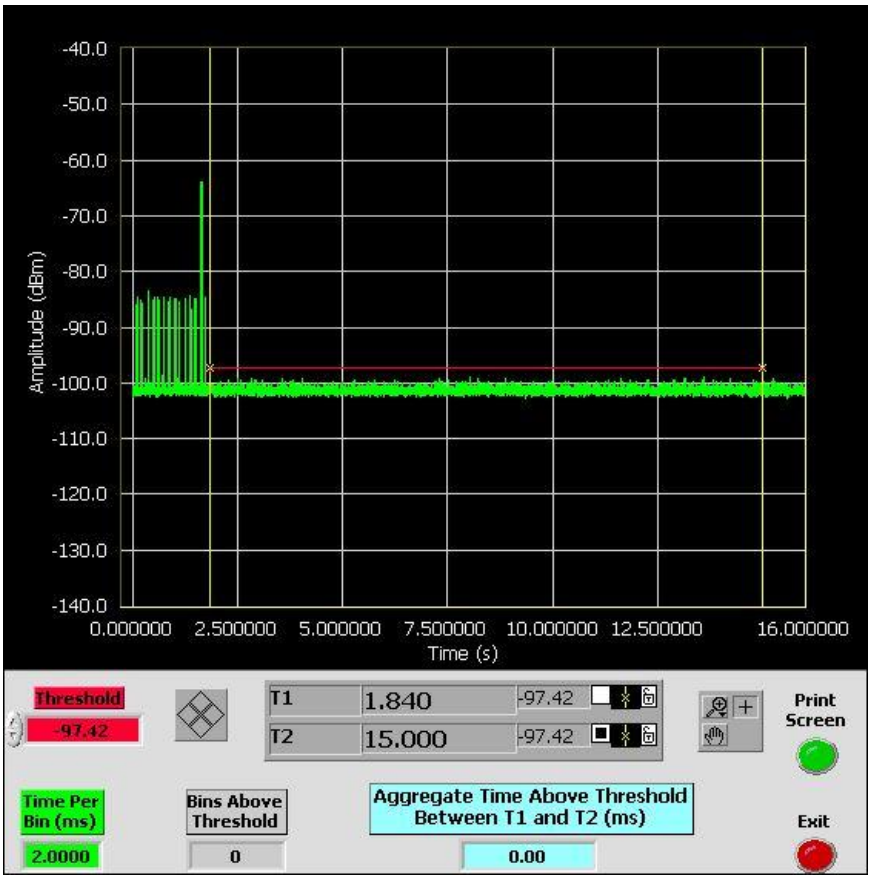
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the FCC aggregate monitoring period.

FCC AGGREGATE CLOSING TIME



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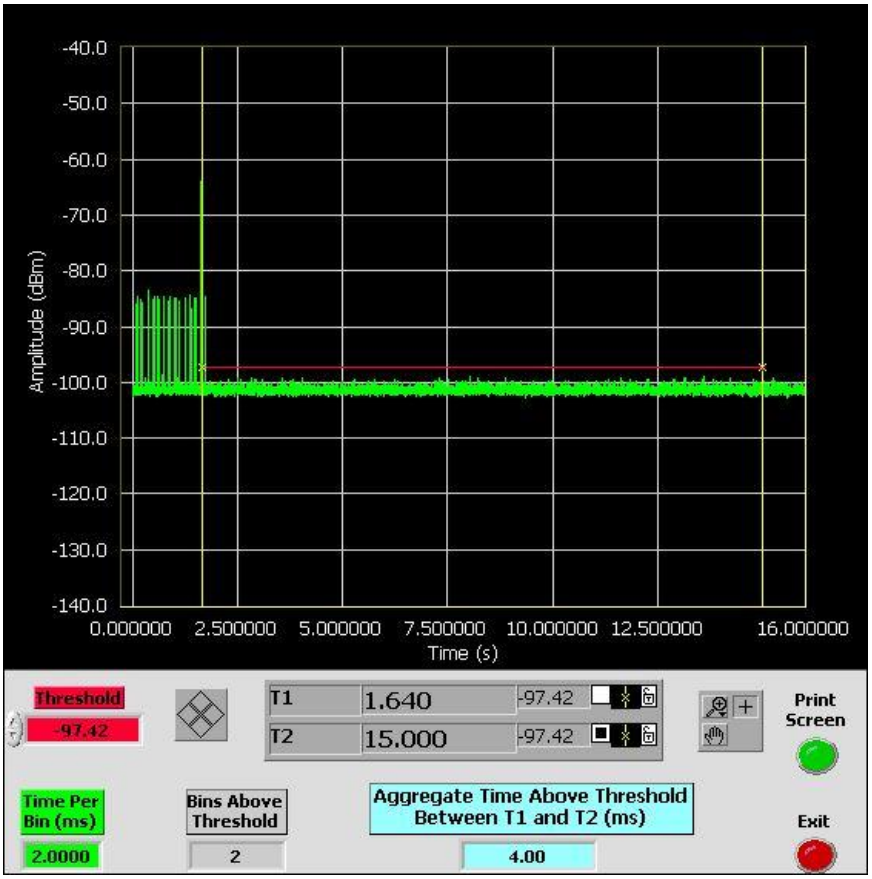
Only intermittent transmissions are observed during the IC aggregate monitoring period.

IC AGGREGATE CLOSING TIME



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