



**FCC CFR47 PART 15 SUBPART C
CLASS II PERMISSIVE CHANGE**

CERTIFICATION TEST REPORT

FOR

802.11n 2x2 PCIe MINICARD TRANSCEIVER

(Adding a higher antenna gain)

MODEL NUMBER: AR5BXB92

FCC ID: PPD-AR5BXB92

REPORT NUMBER: 11U13650-2, Revision D

ISSUE DATE: JUNE 13, 2011

Prepared for

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1700 TECHNOLOGY DRIVE
SAN JOSE, CA 95110, U.S.A.**

Prepared by

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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
---	04/15/2011	Initial Issue	T. Chan
A	05/09/2011	Addressed TCB Reviewer's Questions	T. Chan
B	05/25/2011	Revised Antenna's Description on Section 5.5 and Updated Setup Photo to Show only PIFA Antenna's Type	T. Chan
C	06/08/2011	Re-measured With WIFI II Logo's Antenna	T. Chan
D	06/13/2011	Corrected Typo Page 72	T. Chan

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: ATHEROS COMMUNICATIONS, INC.
1700 TECHNOLOGY DRIVE
SAN JOSE, CA 95110, U.S.A.

EUT DESCRIPTION: 802.11n 2x2 PCIe MINICARD TRANSCEIVER

MODEL: AR5BXB92P

SERIAL NUMBER: 001F3A6CD9

DATE TESTED: APRIL 06 -MAY 31 & JUNE1-2, 2011

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Pass

Compliance Certification Services (UL CCS) tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL CCS based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL CCS will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For UL CCS By:



THU CHAN
ENGINEERING MANAGER
UL CCS

Tested By:



CHIN PANG
EMC ENGINEER
UL CCS

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2009, FCC CFR 47 Part 2, and FCC CFR 47 Part 15.

3. FACILITIES AND ACCREDITATION

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

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

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

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

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

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

4.3. MEASUREMENT UNCERTAINTY

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

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

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is an 802.11n 2x2 PCIe minicard transceiver, model AR5BXB92.
The radio module is manufactured by Atheros. Communications Inc.

5.2. MAXIMUM OUTPUT POWER

Table shown below is the output power to pass limit due to the higher antenna gain.

Frequency Range (MHz)	Mode	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)	Total Power (mW)
2412 - 2462	802.11b	19.43	19.66	22.56	180.17
2412 - 2462	802.11g	24.09	25.05	27.61	576.34
2412 - 2462	802.11n HT20	24.23	24.75	27.51	563.39
2422 - 2452	802.11n HT40	This mode is not implemented and will be disabled in production devices			
5745 - 5825	802.11a	21.20	22.99	25.20	330.89
5745 - 5825	802.11n HT20	21.15	22.32	24.78	300.92
5755 - 5795	802.11n HT40	21.46	22.28	24.90	309.00

5.3. DESCRIPTION OF CLASS II PERMISSIVE CHANGE

The major change filed under this application is adding higher antenna gains as shown (as showing in the report) in the section below.

5.4. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes same type of PIFA's antennas, with the maximum gain as table below:

Freq [GHz]	WiFi 1	WiFi 2	Combined Log Gain [dBi]
	631-1330(Black) Peak Gain dBi	631-1331(Logo) Peak Gain dBi	
2.4 - 2.484	4.84	2.90	6.99
5.15 - 5.25	5.28	5.97	8.65
5.25 - 5.35	5.21	6.07	8.67
5.47 - 5.725	4.02	4.78	7.43
5.725 - 5.85	3.12	4.73	7.01

5.5. SOFTWARE AND FIRMWARE

The EUT driver software installed during testing was Atheros Radio test Revision 0.6 Build #18 Art_11n.

5.6. WORST-CASE CONFIGURATION AND MODE

The EUT was tested as an external module installed in a test jig board connected to a host Laptop PC.

Worst-Case data rates were utilized from preliminary testing of the Chipset, worst-case data rates used during the testing are as follows:

Thus all emissions tests were made with following data rates:

For 2.4GHz Band:

- 802.11b mode, 1 Mb/s, CCK Modulation,
- 802.11g mode, 6 Mb/s, OFDM Modulation
- 802.11n HT20, mode, MCS0, 6.5Mb/s, OFDM Modulation

For 5GHz Band:

- 802.11a mode, 24 Mb/s, OFDM Modulation
- 802.11n HT20 mode, MCS0, 6.5 Mb/s, OFDM Modulation.
- 802.11n HT40 mode, MCS0, 13.5 Mb/s, OFDM Modulation

Radiated emissions below and above 1 GHz tests were performed for all bands and all modes.

Worst-case mode and channel used for 30-1000 MHz radiated emissions was the mode and channel with the highest output power.

All MIMO modes were measured with the highest combination of gains for each type of antenna.

For MIMO modes measurements were performed using individual chains for all channels and modes.

5.7. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop PC	Lenovo	769	L3-BE291	DoC
AC Adapter	Lenovo	92P1105	11S92P11Z1ZBW9T1J5G1	N/A

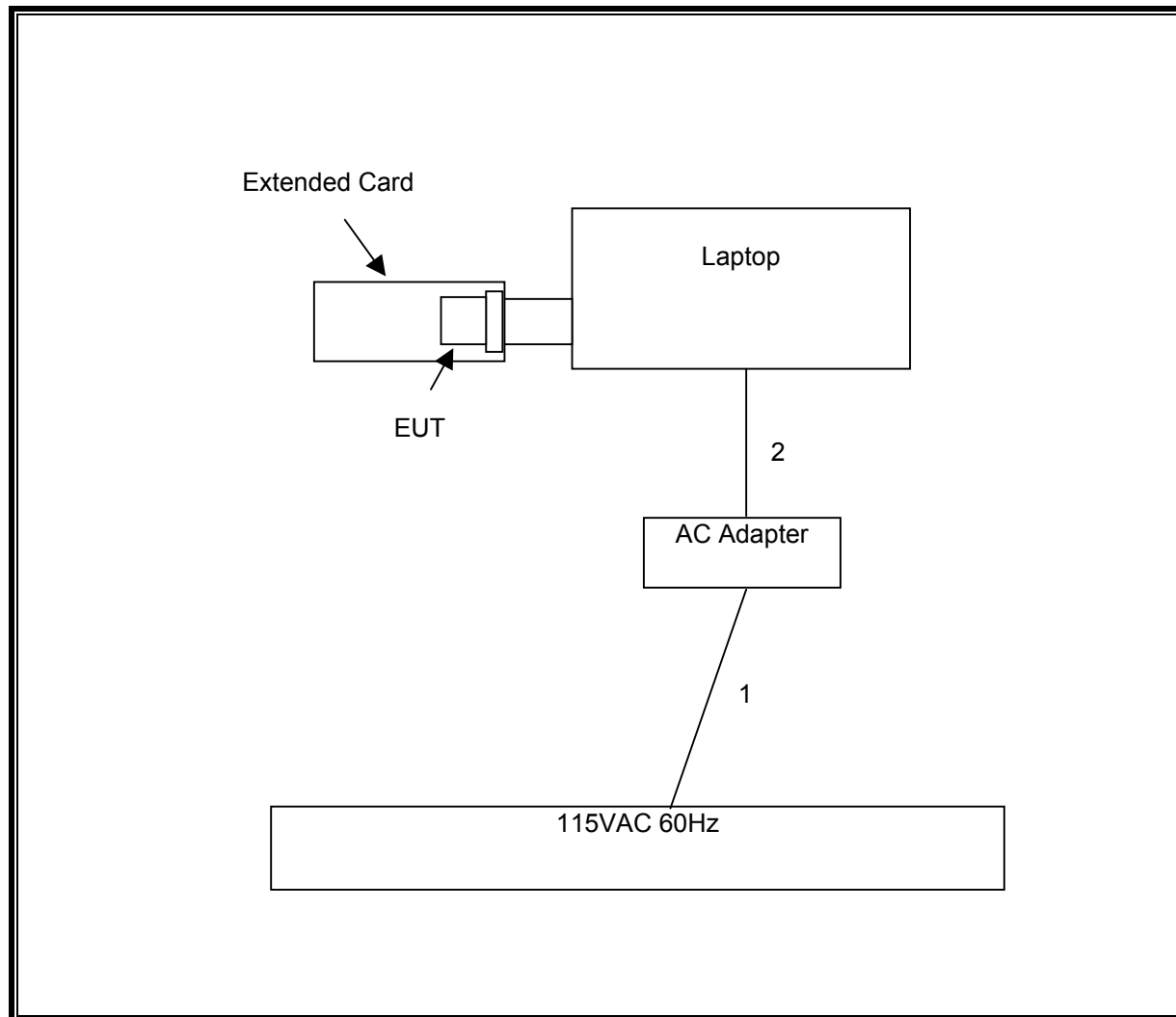
I/O CABLES

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	AC	Unshielded	1.8 m	N/A
2	DC	1	DC	Unshielded	1.8 m	Ferrite on laptop's end

TEST SETUP

The EUT is connected to a host laptop computer via Express card to MiniPCI-E adapter board during the test. Test software exercised the radio card.

SETUP DIAGRAM



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
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01012	06-03-12
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01011	07-14-11
Antenna, Horn, 18 GHz	EMCO	3115	C00945	06-29-11
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00589	11-28-11
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00885	01-27-12
Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRC13192	N02683	CNR
Highpass Filter, 7.6 GHz	Micro-Tronics	HPM13195	N02601	CNR
Preamplifier, 1-26GHz	Agilent / HP	8449B	C01052	07-05-11
Peak Power Meter	Boonton	4541	C01186	03-14-12
Peak Power Sensor	Boonton	4541	C01189	03-15-12

7. ANTENNA PORT TEST RESULTS

7.1. 802.11b DUAL CHAIN LEGACY MODE IN THE 2.4 GHz BAND

7.1.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

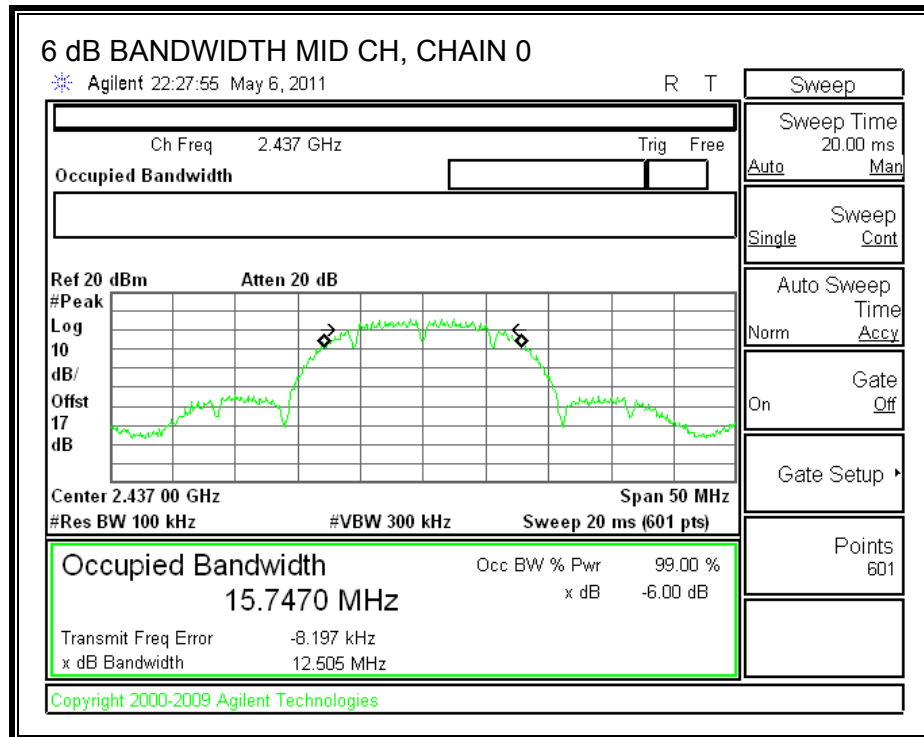
The minimum 6 dB bandwidth shall be at least 500 kHz.

TEST PROCEDURE

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

RESULTS

Channel	Frequency (MHz)	Chain 0 (MHz)	Minimum Limit (MHz)
Middle	2437	12.505	0.5



7.1.2. OUTPUT POWER

LIMITS

FCC §15.247 (b)

The highest combination of antenna gains is equal to 6.99dBi, therefore the limit is 29.01dBm.

TEST PROCEDURE

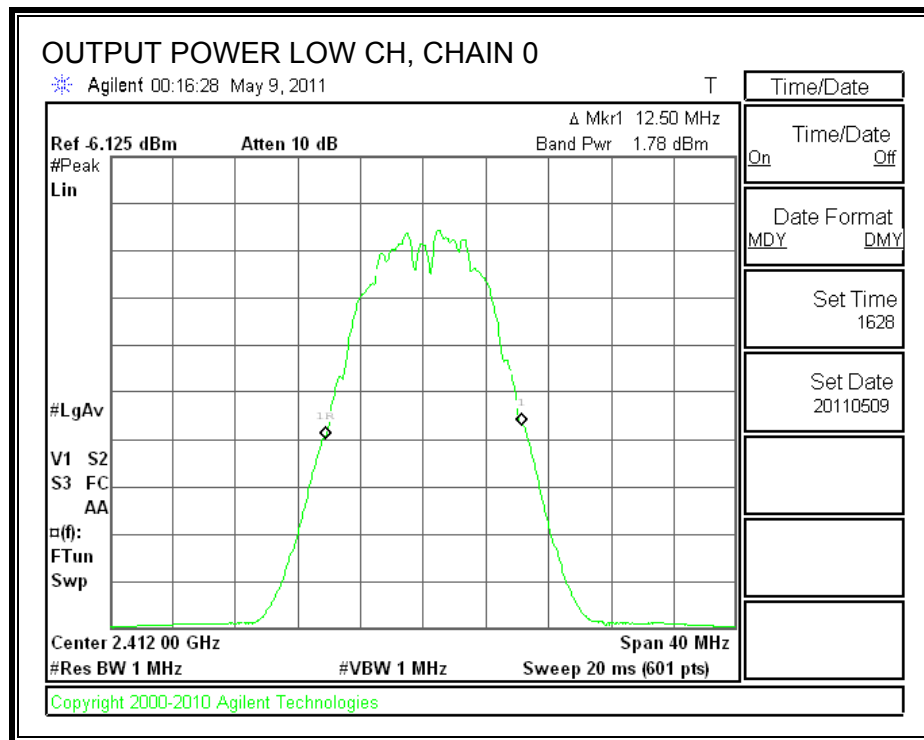
Output power was measured based on the use of RMS averaging over a time interval in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

RESULTS

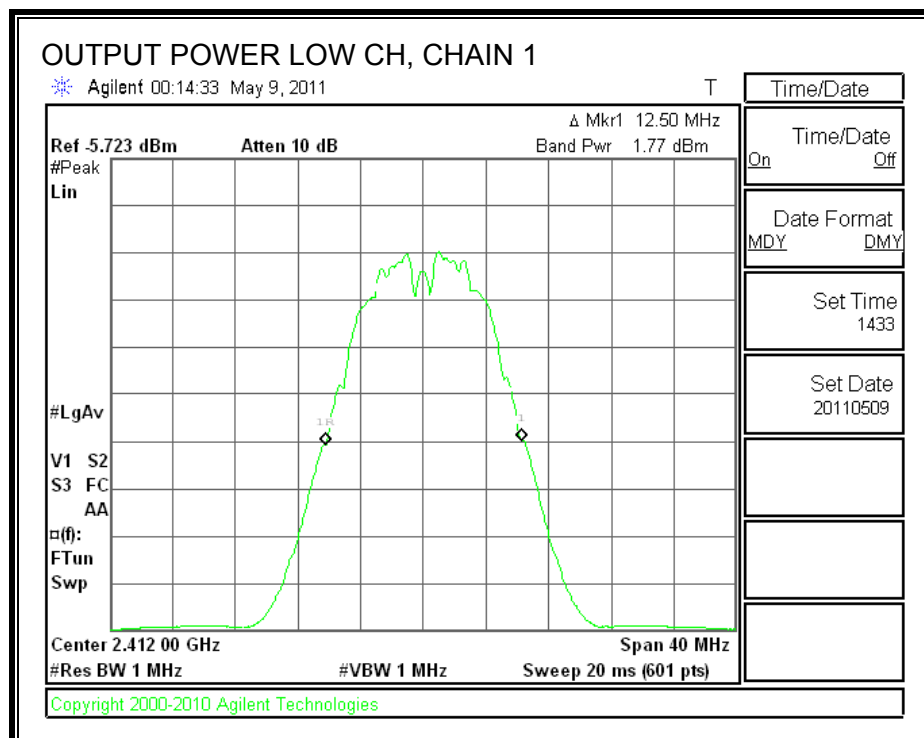
The cable assembly insertion loss of 17.0 dB (including Splitter and cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	Attenuator + Cable Offset (dB)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	1.78	1.77	17.00	21.79	29.01	-7.22
Mid	2437	2.43	2.66	17.00	22.56	29.01	-6.45
High	2462	1.59	1.70	17.00	21.66	29.01	-7.35

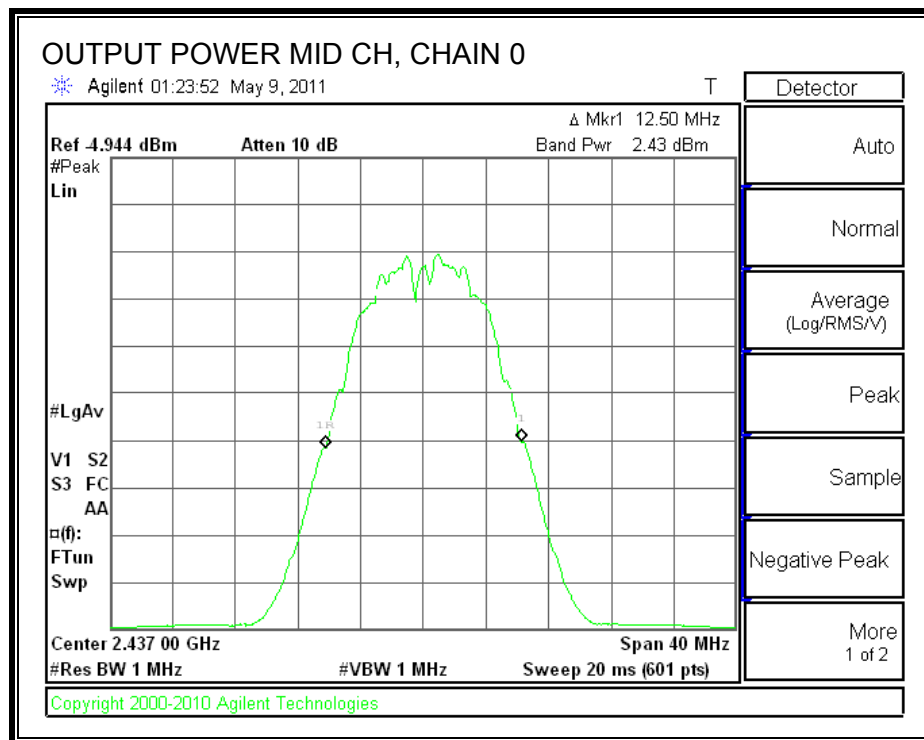
CHAIN 0 OUTPUT POWER



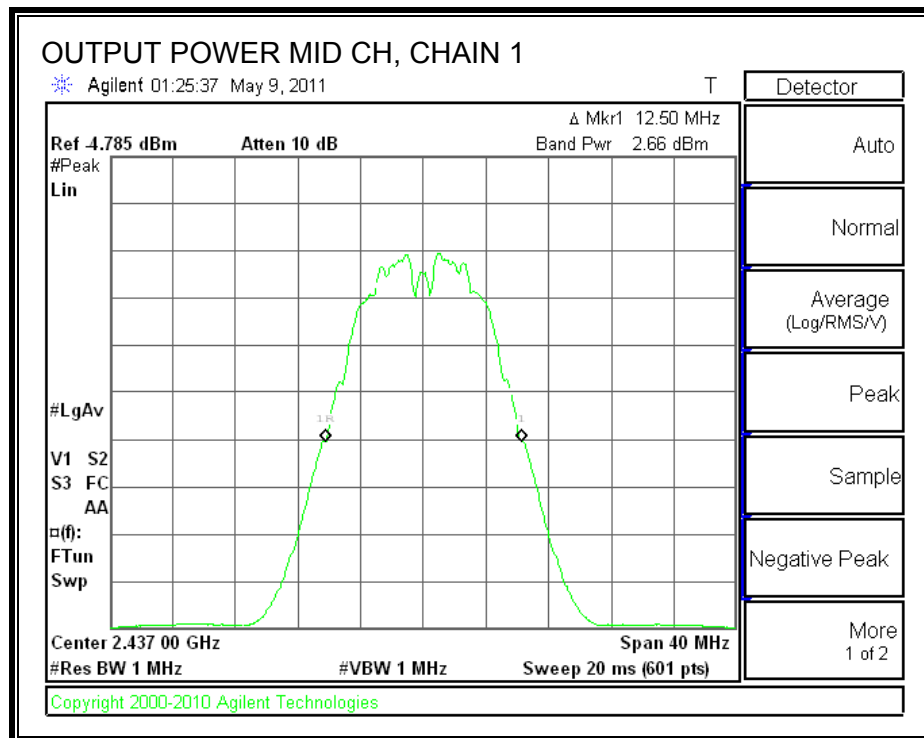
CHAIN 1 OUTPUT POWER



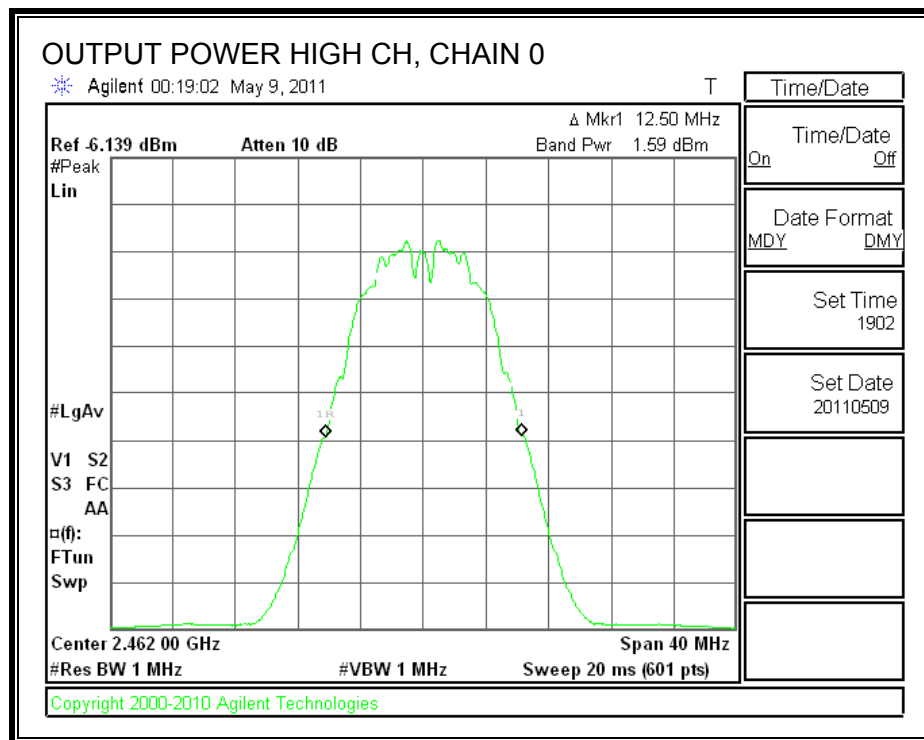
CHAIN 0 OUTPUT POWER



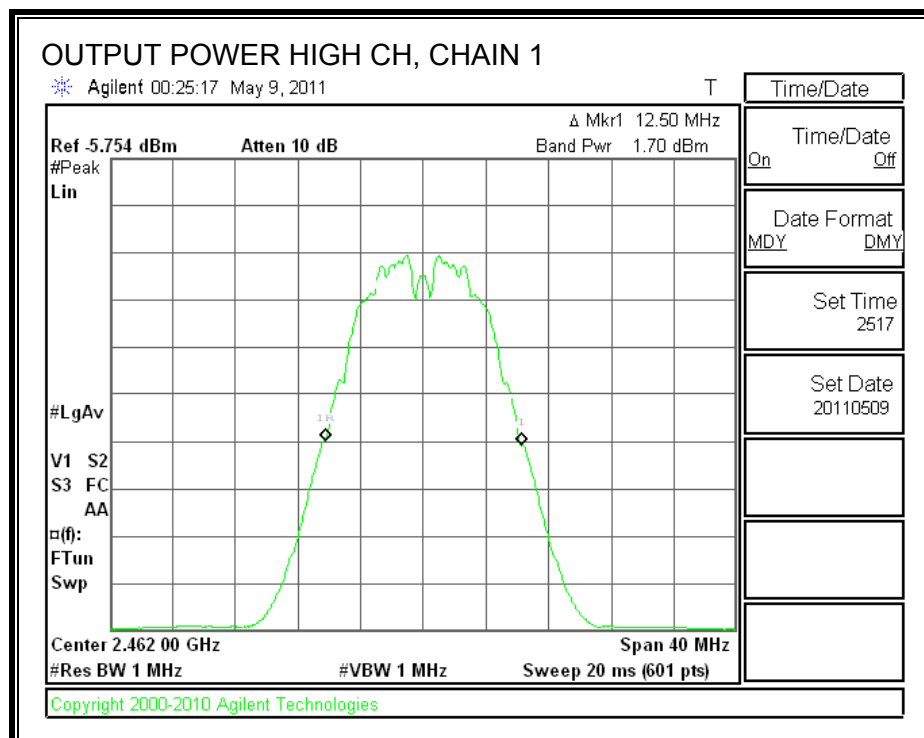
CHAIN 1 OUTPUT POWER



CHAIN 0 OUTPUT POWER



CHAIN 1 OUTPUT POWER



7.1.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

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

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low	2412	16.60	16.61	19.62
Middle	2437	17.24	17.50	20.38
High	2462	16.27	16.44	19.37

7.2. 802.11g DUAL CHAIN LEGACY MODE IN THE 2.4 GHZ BAND

7.2.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

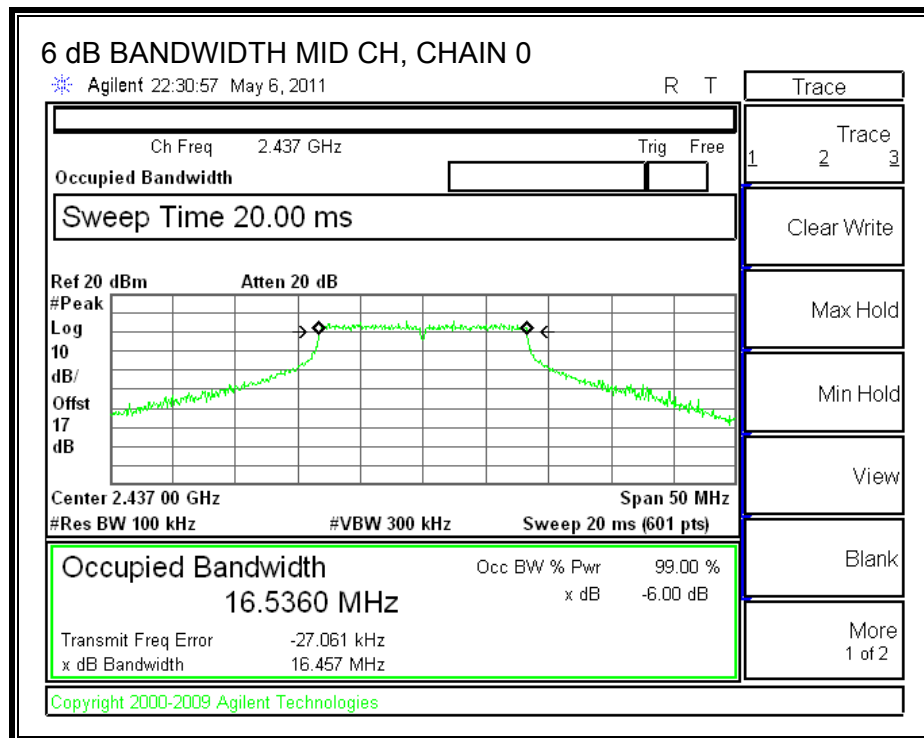
The minimum 6 dB bandwidth shall be at least 500 kHz.

TEST PROCEDURE

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

RESULTS

Channel	Frequency (MHz)	Chain 0 (MHz)	Minimum Limit (MHz)
Middle	2437	16.456	0.5



7.2.2. OUTPUT POWER

LIMITS

FCC §15.247 (b)

The highest combination of antenna gains is equal to 6.99dBi, therefore the limit is 29.01dBm.

TEST PROCEDURE

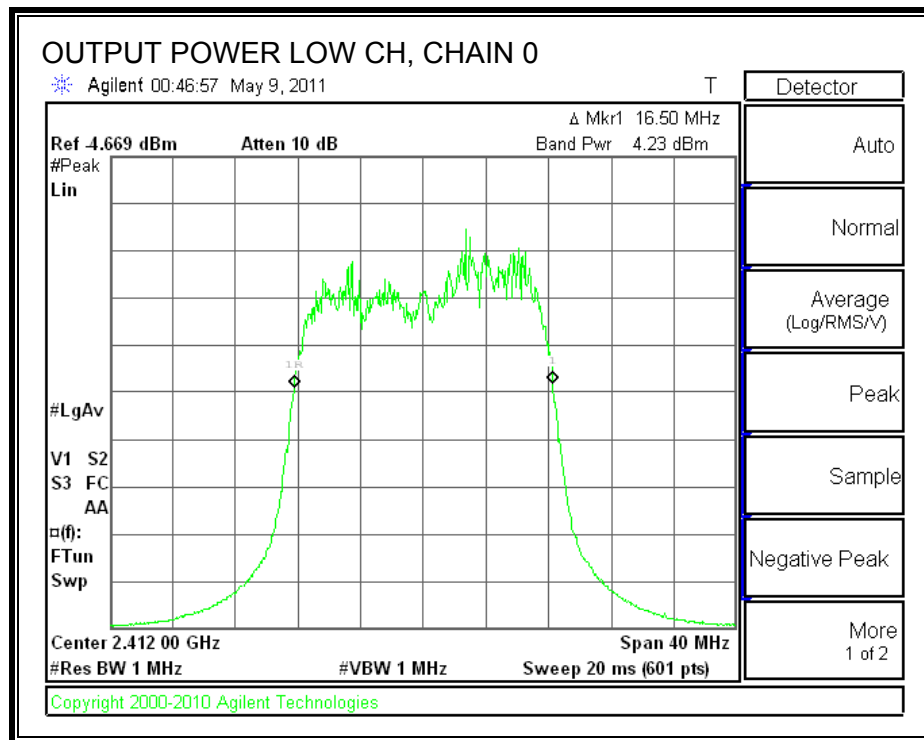
Output power was measured based on the use of RMS averaging over a time interval in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

RESULTS

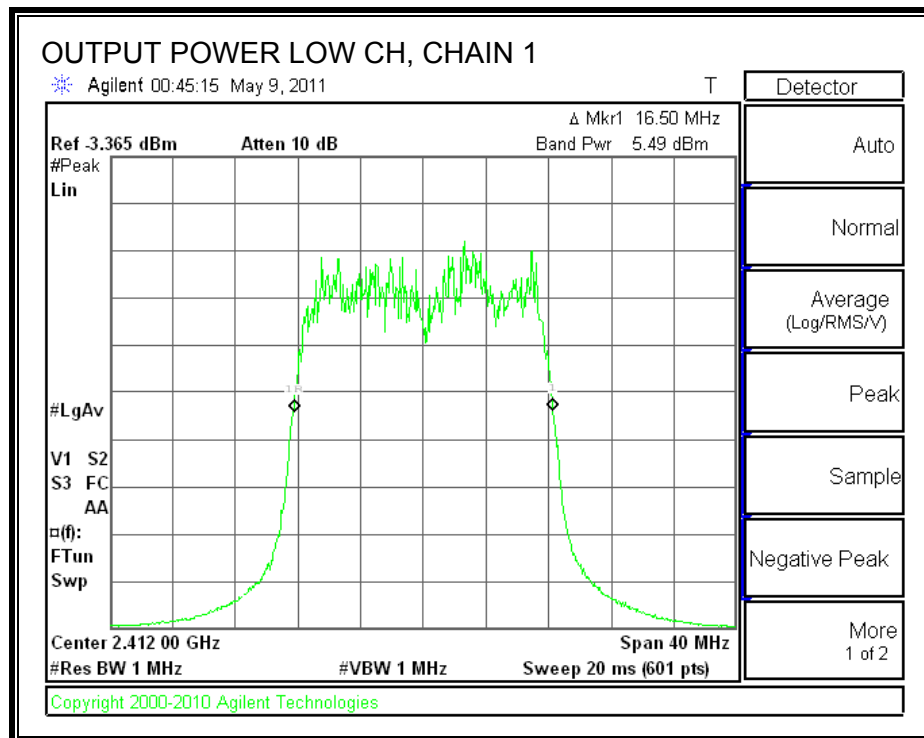
The cable assembly insertion loss of 17.0 dB (Splitter and cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	Attenuator + Cable Offset (dB)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	4.23	5.49	17.00	24.92	29.01	-4.09
Mid	2437	7.09	8.05	17.00	27.61	29.01	-1.40
High	2462	3.99	5.38	17.00	24.75	29.01	-4.26

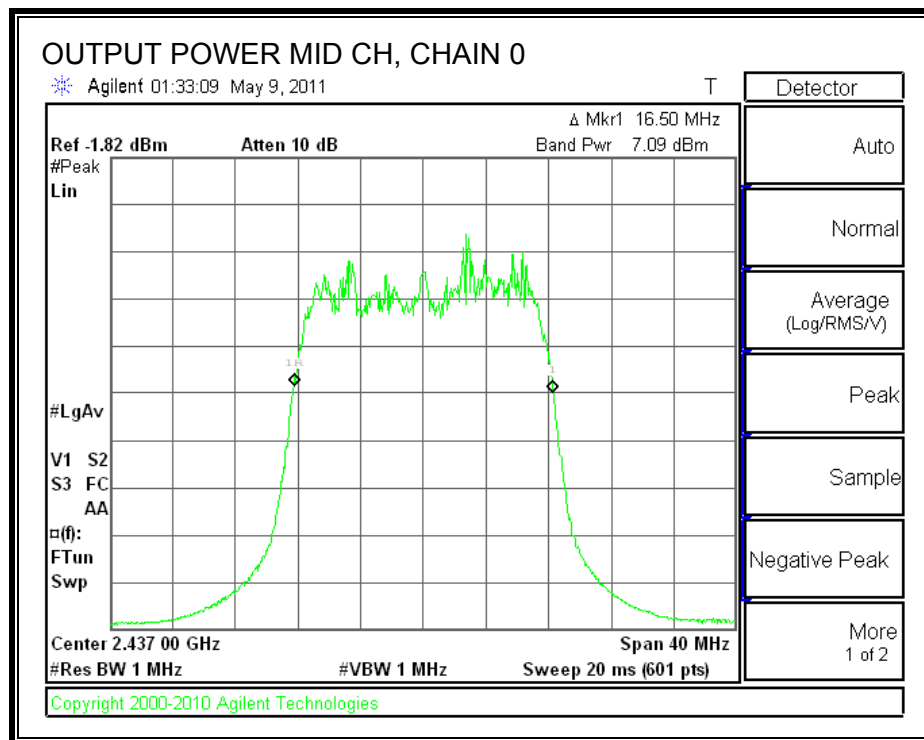
CHAIN 0 OUTPUT POWER



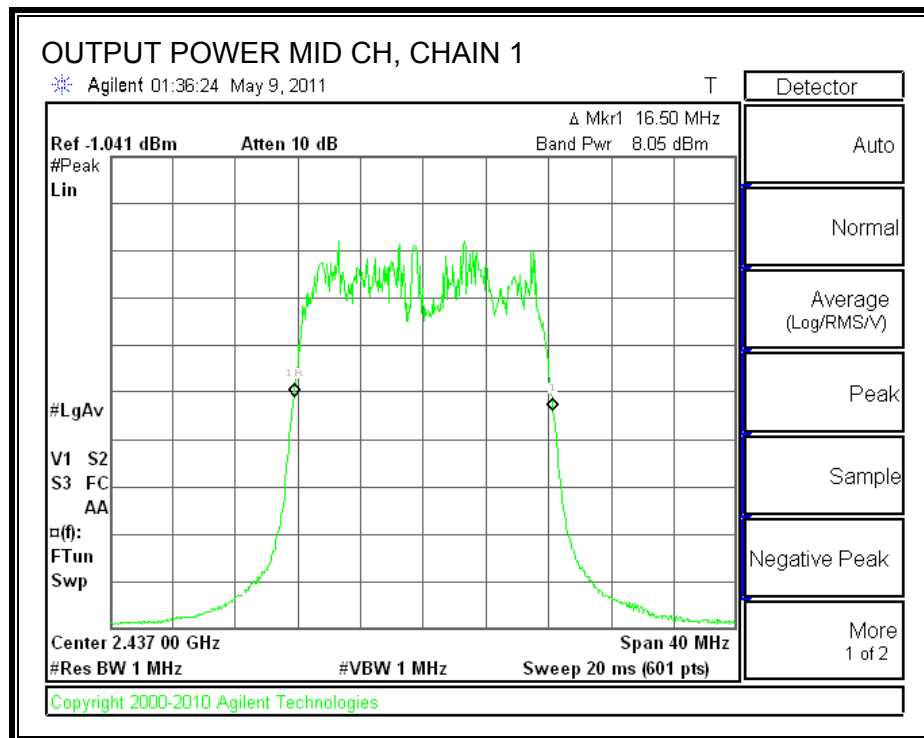
CHAIN 1 OUTPUT POWER



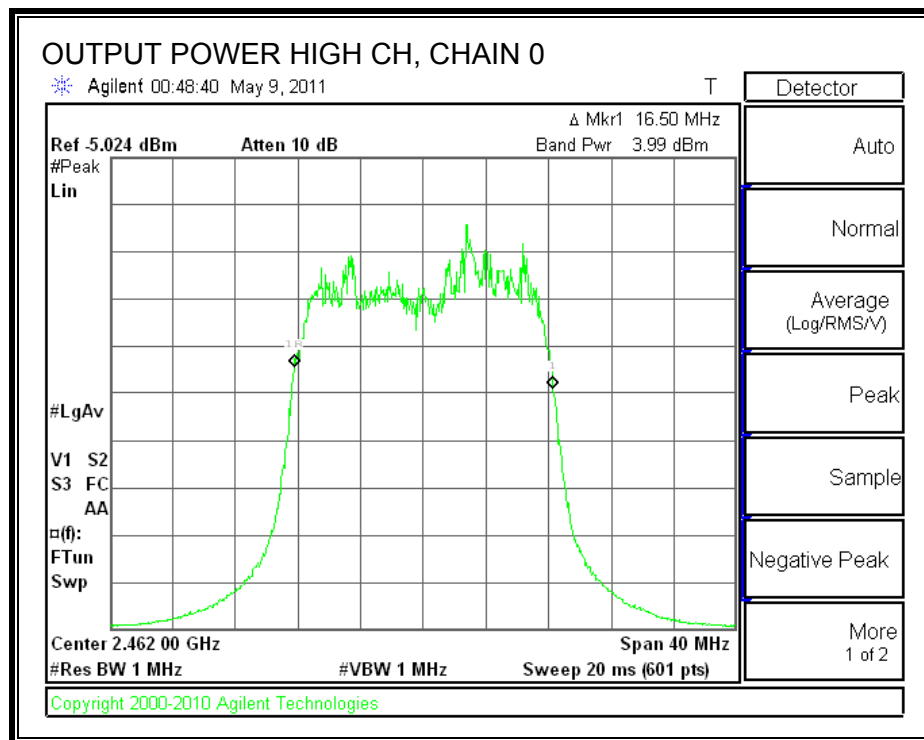
CHAIN 0 OUTPUT POWER



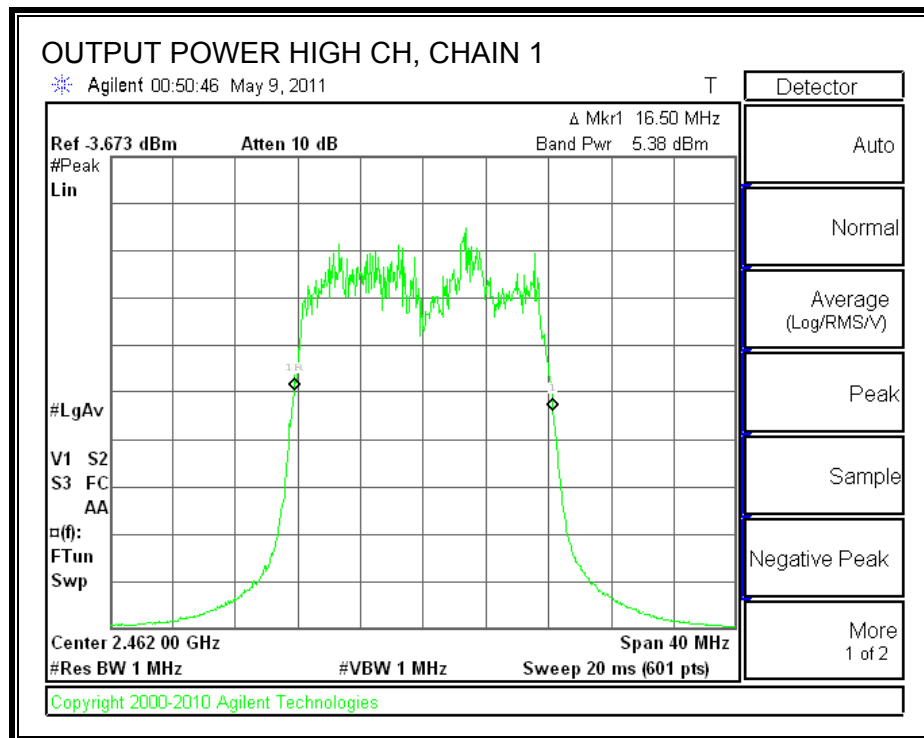
CHAIN 1 OUTPUT POWER



CHAIN 0 OUTPUT POWER



CHAIN 1 OUTPUT POWER



7.2.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

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

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low	2412	13.40	13.60	16.51
Middle	2437	16.25	16.60	19.44
High	2462	13.40	13.47	16.45

7.3. 802.11n HT20 MODE IN THE 2.4 GHz BAND

7.3.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

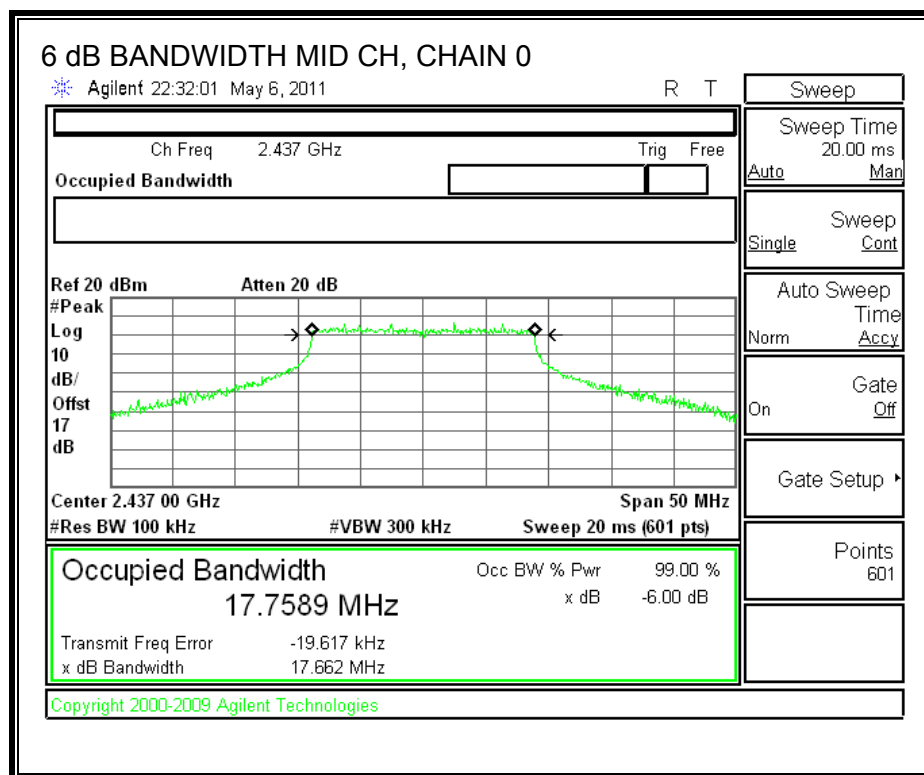
The minimum 6 dB bandwidth shall be at least 500 kHz.

TEST PROCEDURE

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

RESULTS

Channel	Frequency (MHz)	Chain 0 (MHz)	Minimum Limit (MHz)
Middle	2437	17.662	0.5



7.3.2. OUTPUT POWER

LIMITS

FCC §15.247 (b)

The highest combination of antenna gains is equal to 6.99dBi, therefore the limit is 29.01dBm.

TEST PROCEDURE

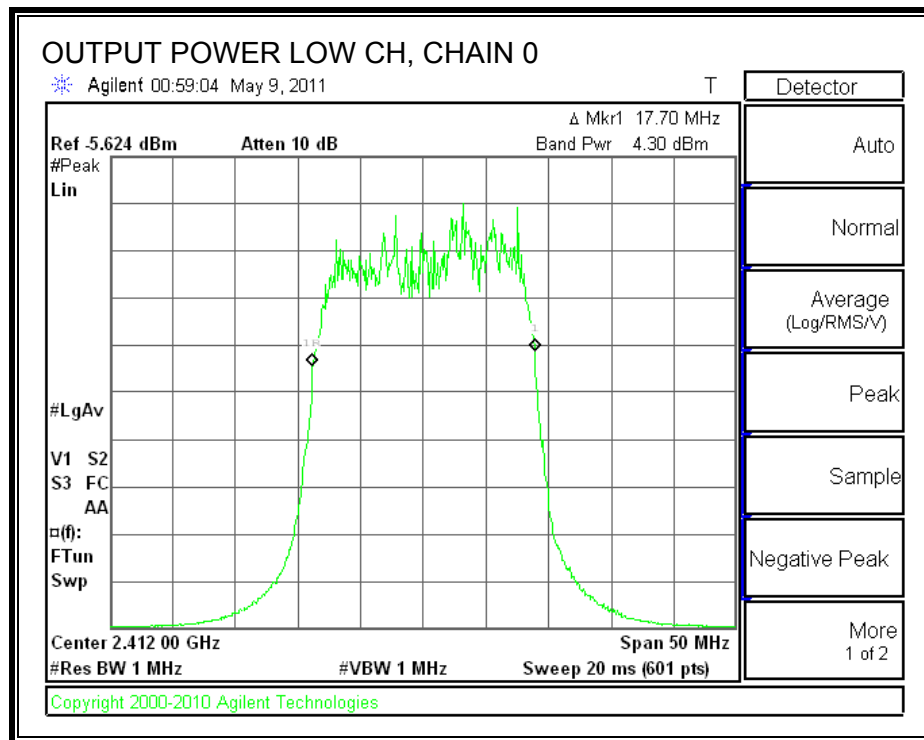
Output power was measured based on the use of RMS averaging over a time interval in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

RESULTS

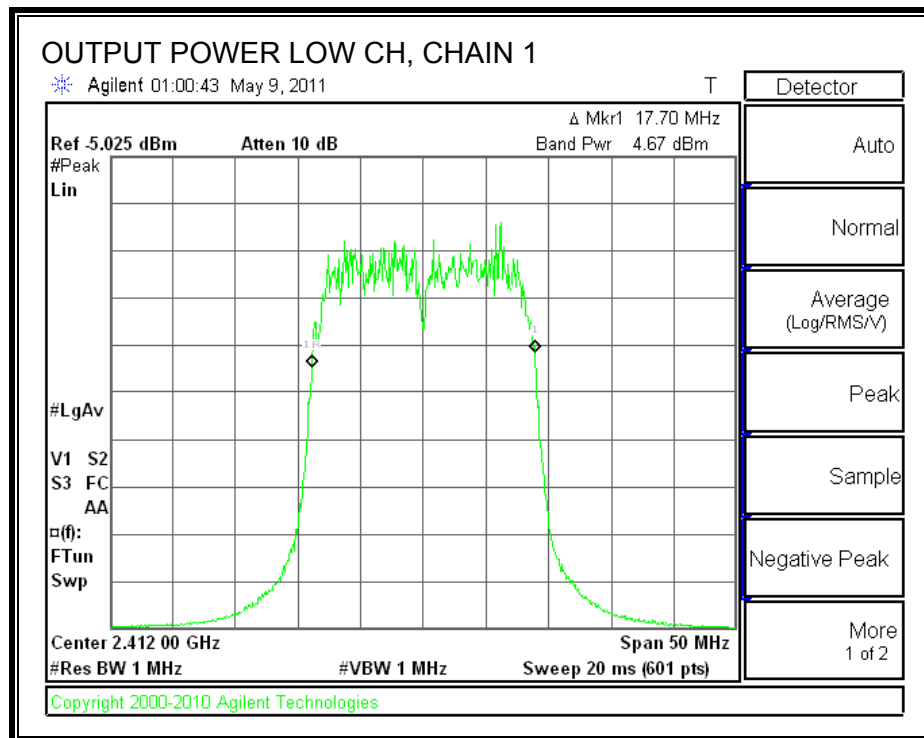
The cable assembly insertion loss of 17.0 dB (including Splitter and cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	Attenuator + Cable Offset (dB)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	4.30	4.67	17.00	24.50	29.01	-4.51
Mid	2437	7.23	7.75	17.00	27.51	29.01	-1.50
High	2462	4.17	4.44	17.00	24.32	29.01	-4.69

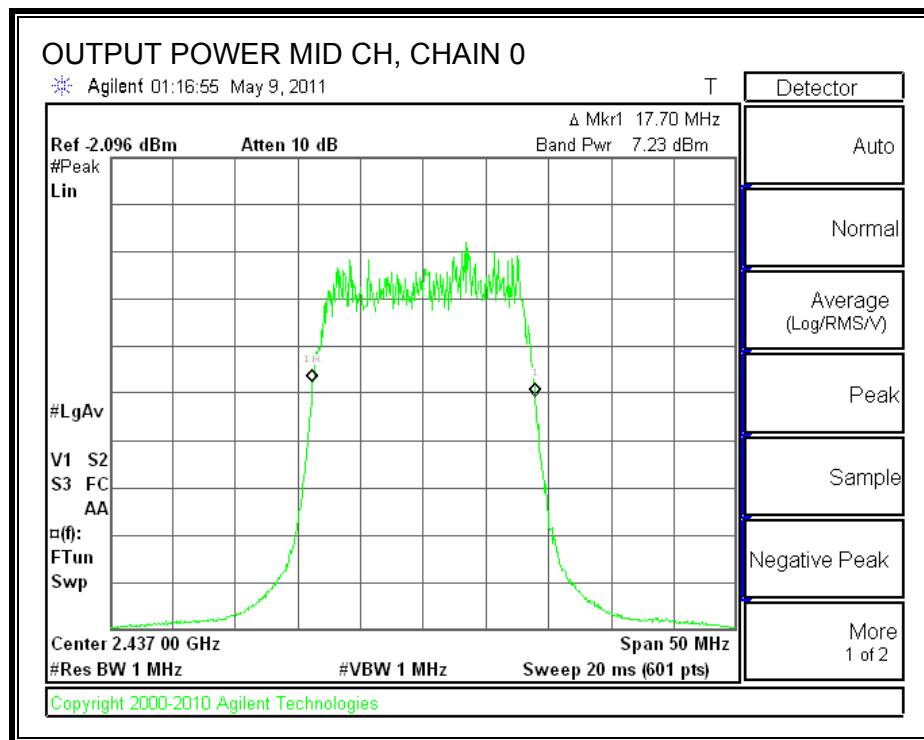
CHAIN 0 OUTPUT POWER



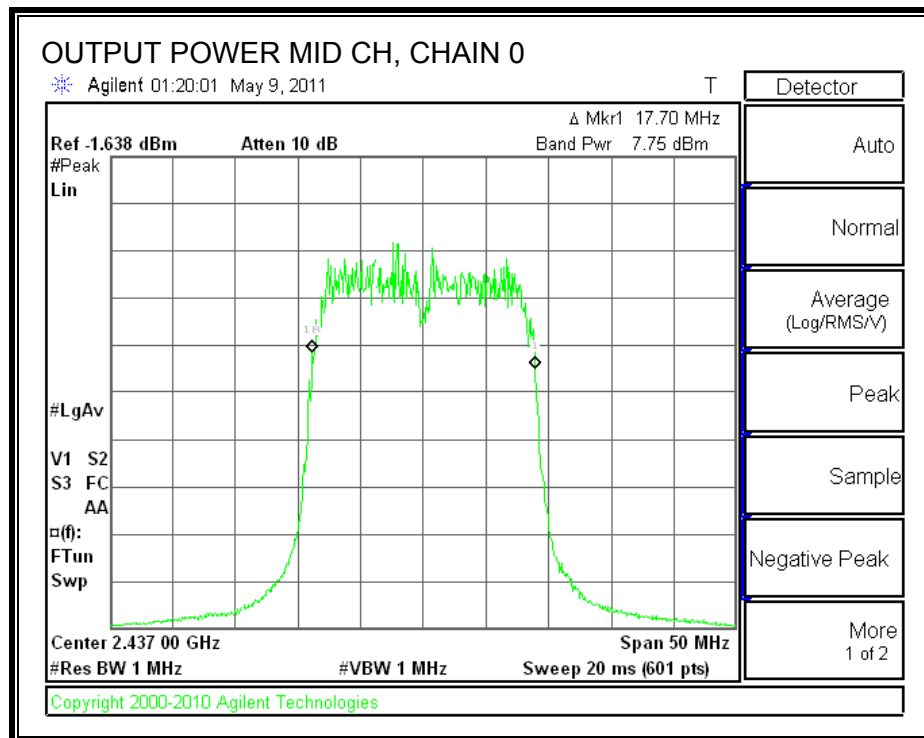
CHAIN 1 OUTPUT POWER



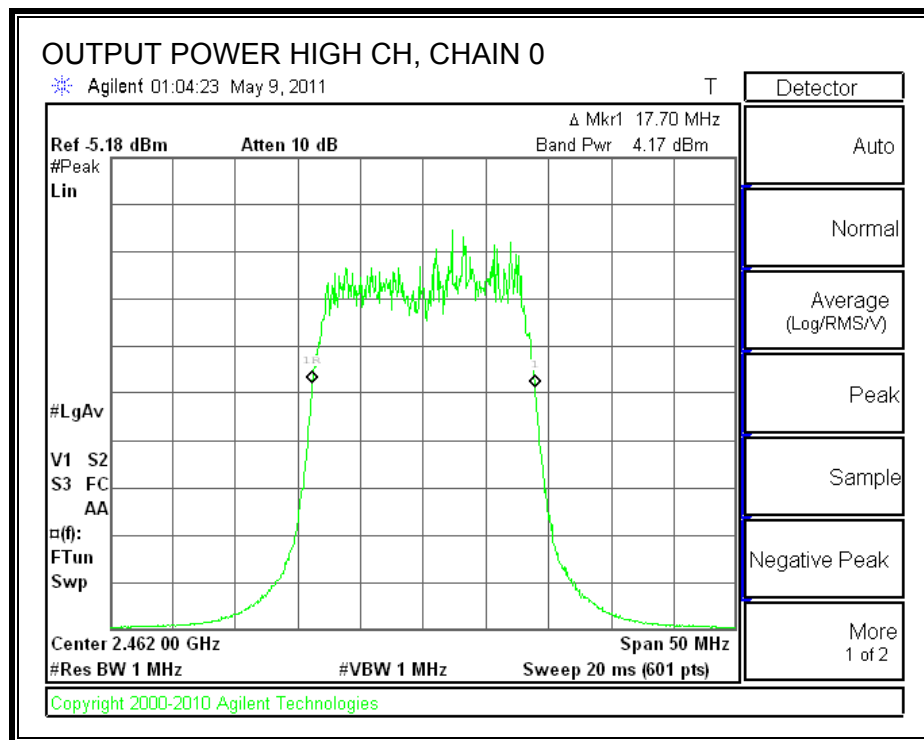
CHAIN 0 OUTPUT POWER



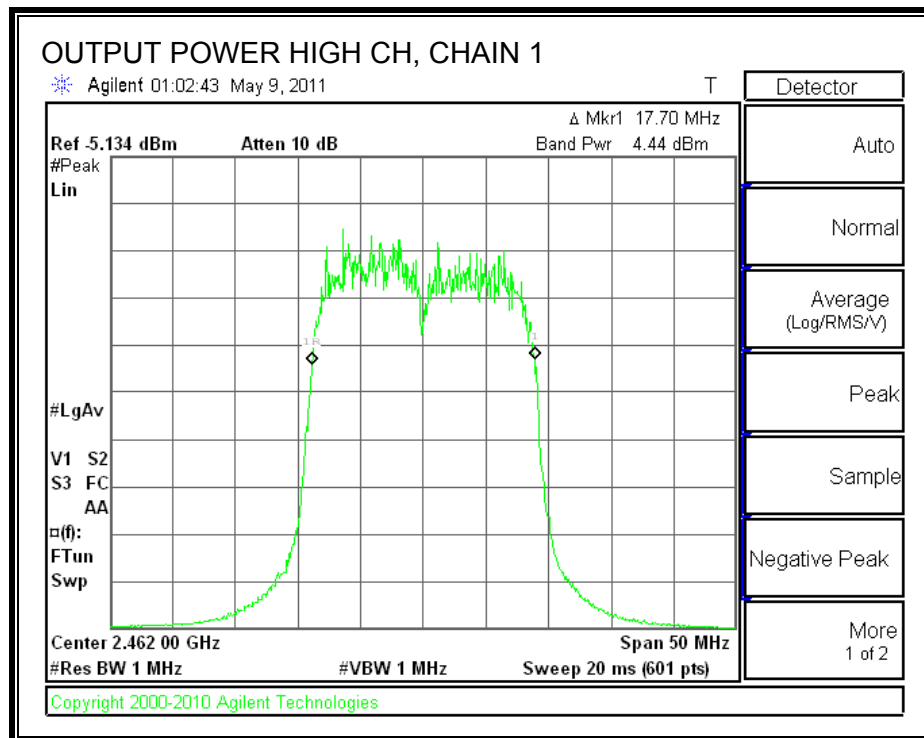
CHAIN 1 OUTPUT POWER



CHAIN 0 OUTPUT POWER



CHAIN 1 OUTPUT POWER



7.3.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

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

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low	2412	13.40	13.50	16.46
Middle	2437	16.40	16.60	19.51
High	2462	13.60	13.90	16.76

7.4. 802.11a MODE IN THE 5.8 GHz BAND

7.4.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

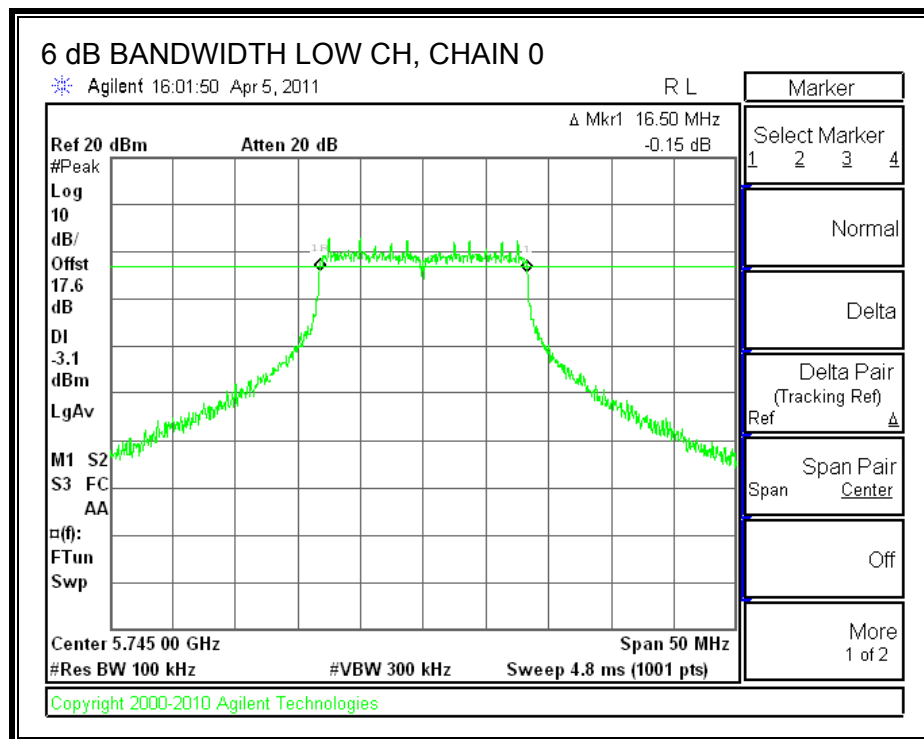
The minimum 6 dB bandwidth shall be at least 500 kHz.

TEST PROCEDURE

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

RESULTS

Channel	Frequency (MHz)	Chain 0 (MHz)	Minimum Limit (MHz)
LOW	5745	16.5	0.5



7.4.2. OUTPUT POWER

LIMITS

FCC §15.247 (b)

The highest combination of antenna gains is equal to 7.01Bi, therefore the limit is 28.99dBm.

TEST PROCEDURE

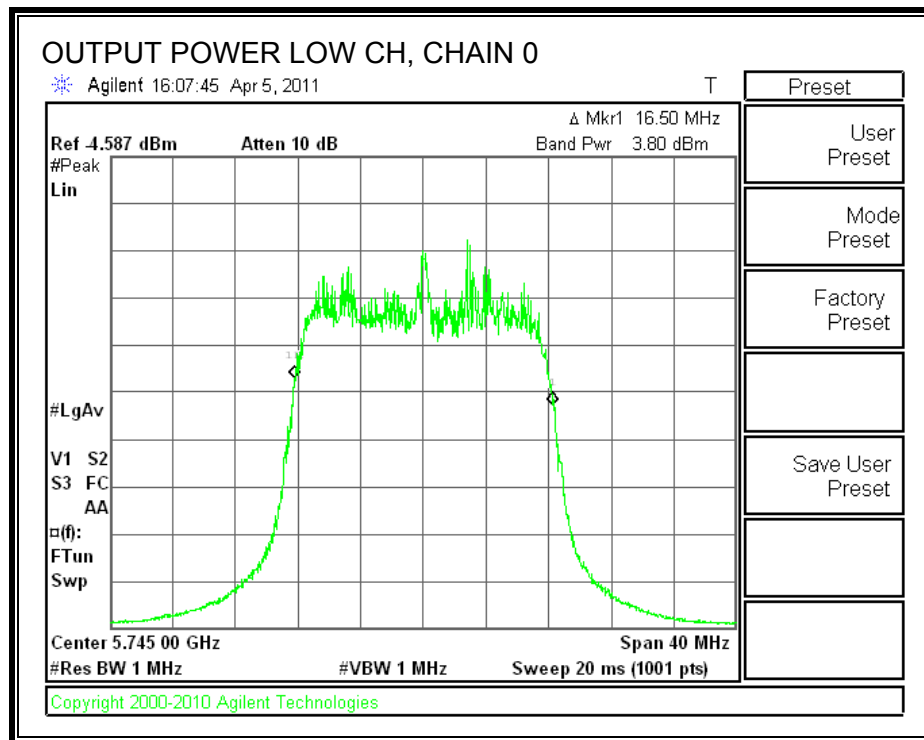
Output power was measured based on the use of RMS averaging over a time interval in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

RESULTS

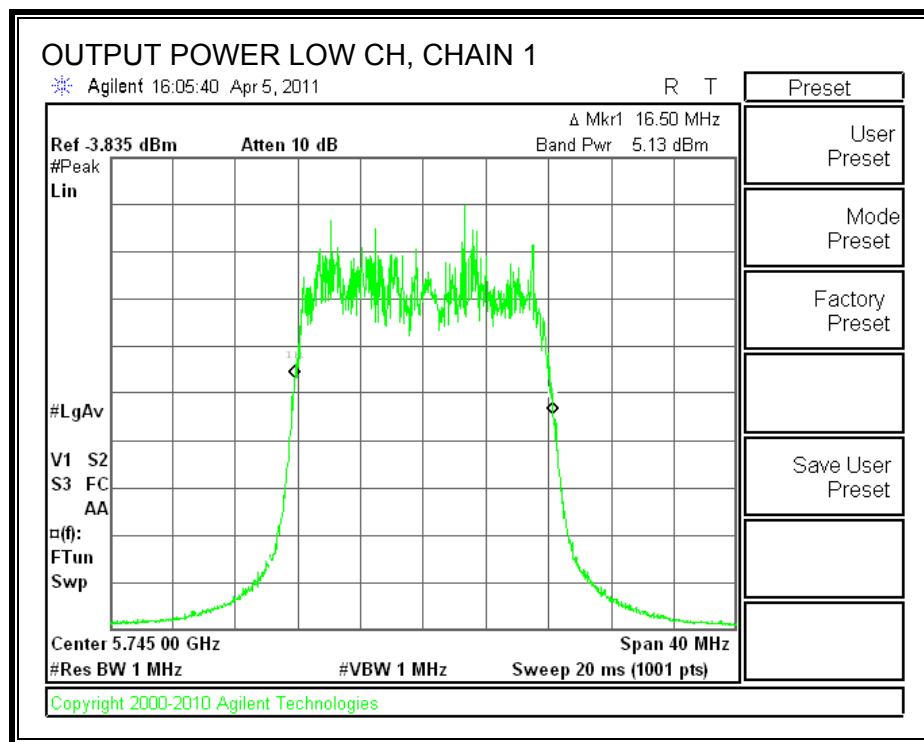
The cable assembly insertion loss of 17.6 dB (including Splitter and cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	Attenuator + Cable Offset (dB)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5745	3.80	5.13	17.60	25.13	28.99	-3.86
Mid	5785	3.60	5.39	17.60	25.20	28.99	-3.79
High	5825	3.54	5.43	17.60	25.20	28.99	-3.79

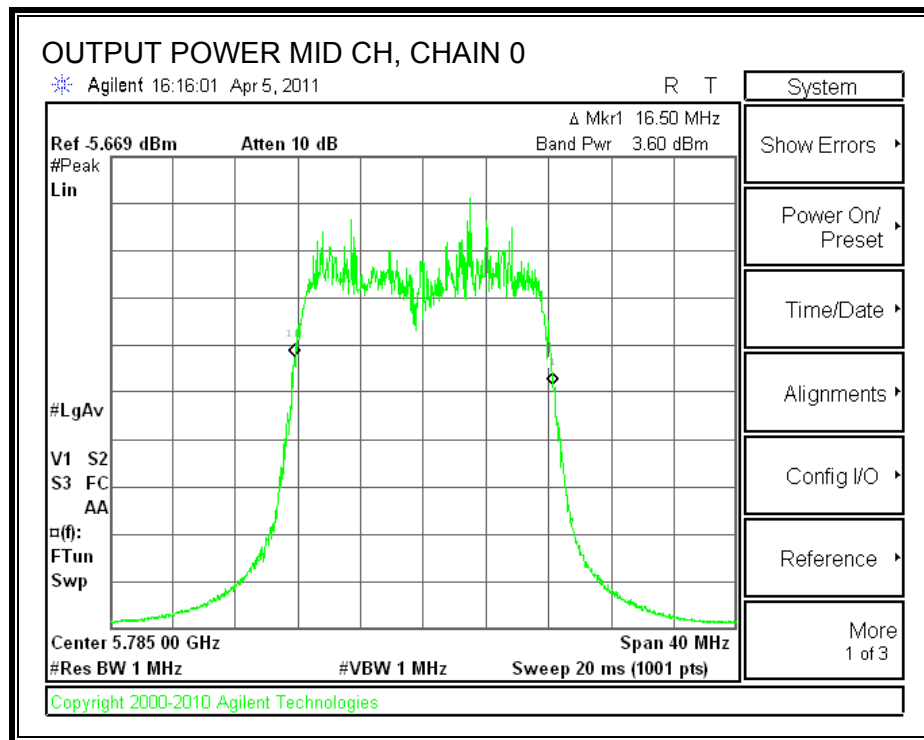
CHAIN 0 OUTPUT POWER



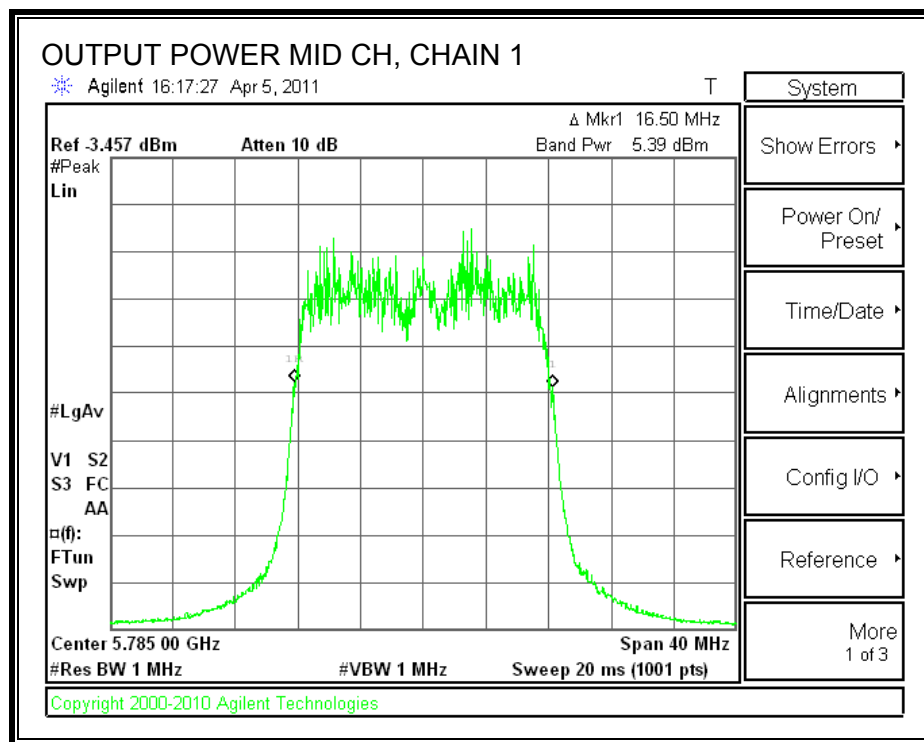
CHAIN 1 OUTPUT POWER



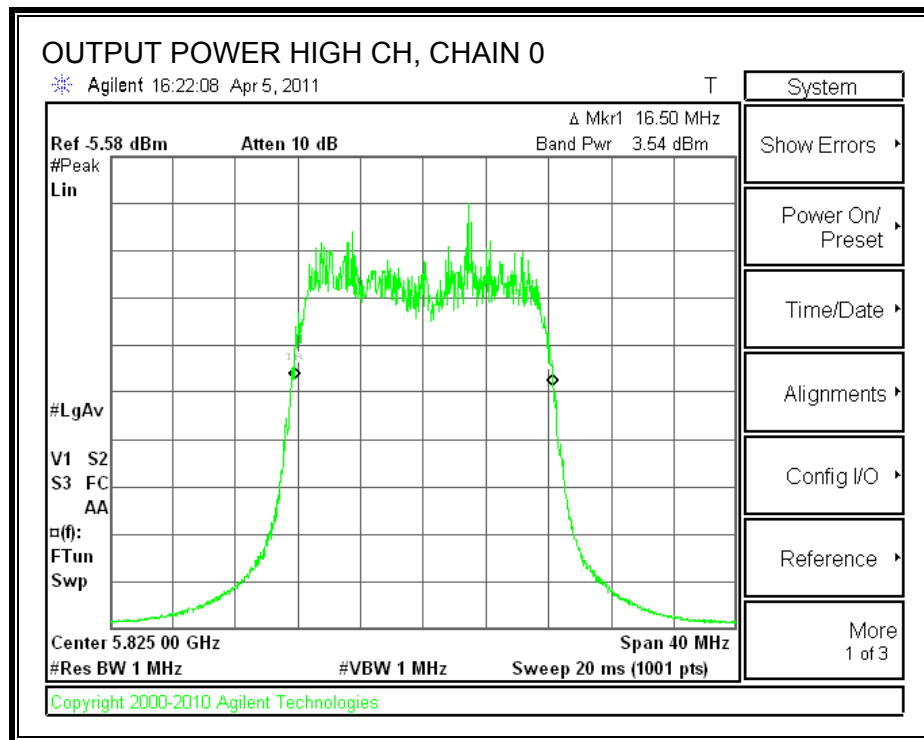
CHAIN 0 OUTPUT POWER



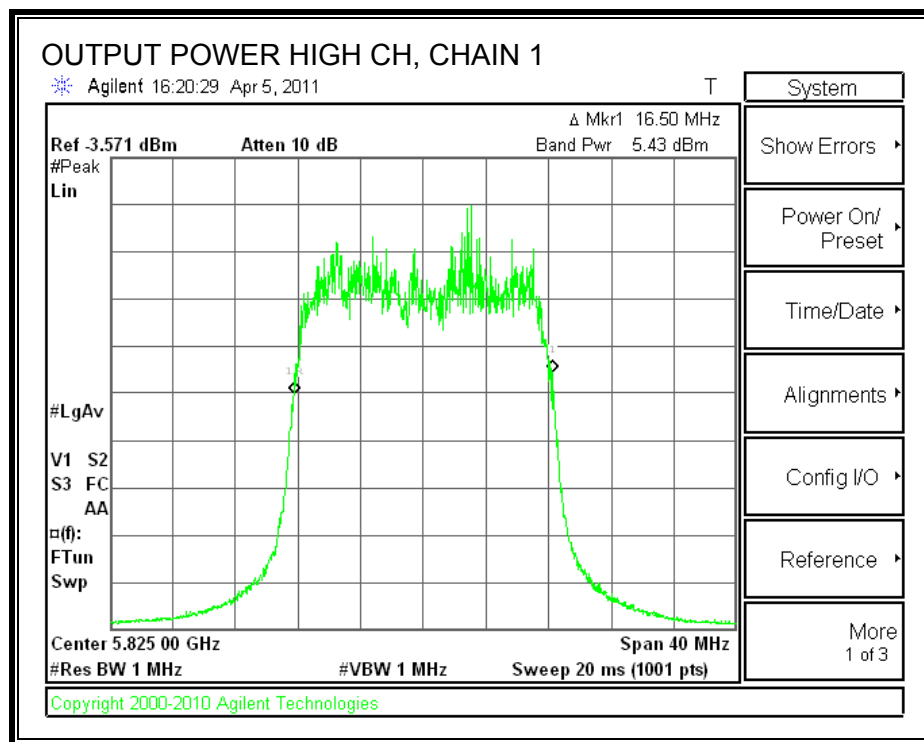
CHAIN 1 OUTPUT POWER



CHAIN 0 OUTPUT POWER



CHAIN 1 OUTPUT POWER



7.4.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 11.4dB (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.

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low	5745	13.80	14.10	16.96
Middle	5785	14.00	14.40	17.21
High	5825	13.70	14.40	17.07

7.5. 802.11n HT20 MODE IN THE 5.8 GHz BAND

7.5.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

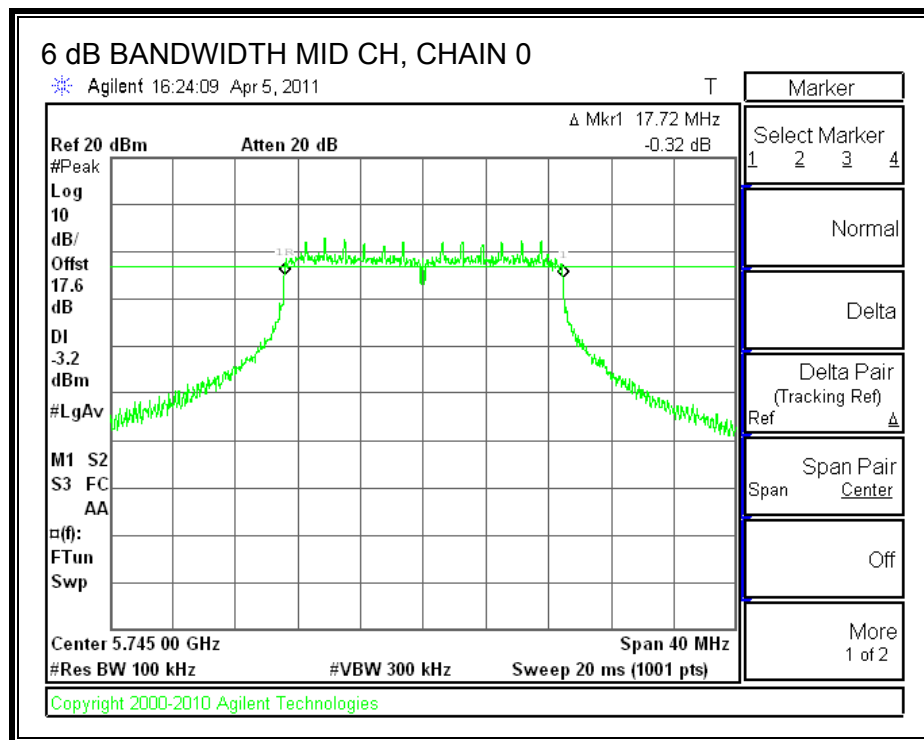
The minimum 6 dB bandwidth shall be at least 500 kHz.

TEST PROCEDURE

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

RESULTS

Channel	Frequency (MHz)	Chain 0 (MHz)	Minimum Limit (MHz)
LOW	5745	17.72	0.5



7.5.2. OUTPUT POWER

LIMITS

FCC §15.247 (b)

The highest combination of antenna gains is equal to 7.01dBi, therefore the limit is 28.99dBm.

TEST PROCEDURE

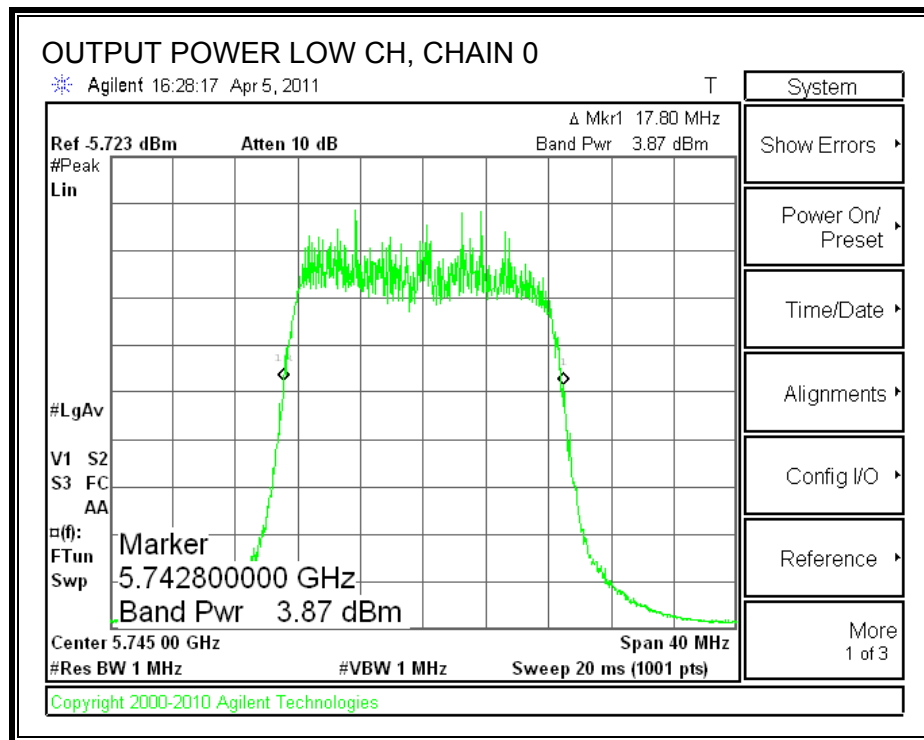
Output power was measured based on the use of RMS averaging over a time interval in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

RESULTS

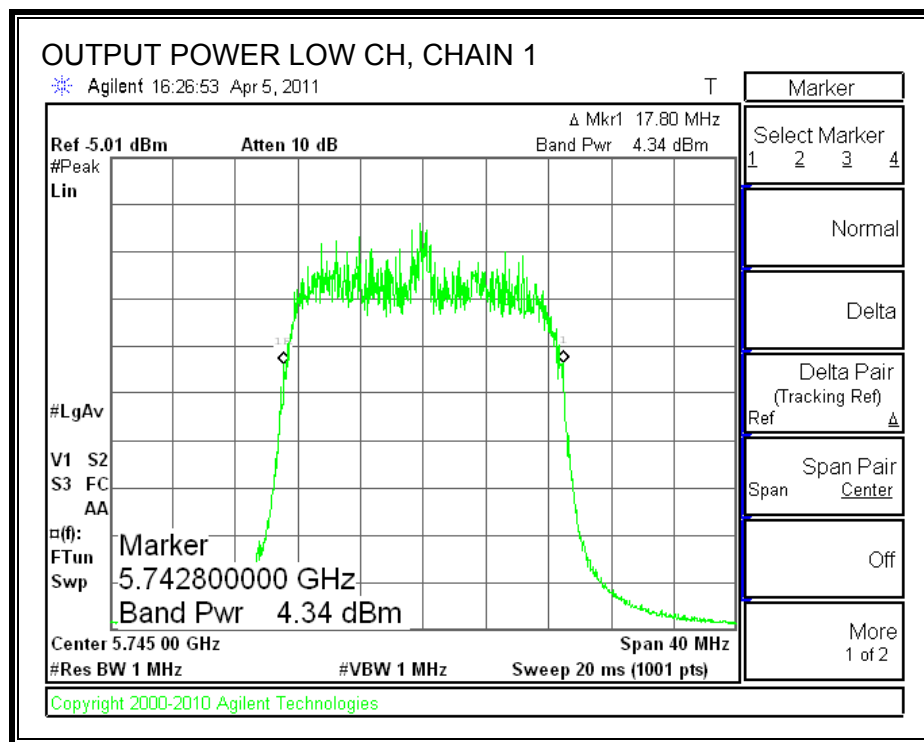
The cable assembly insertion loss of 17.6 dB (including Splitter and cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	Attenuator + Cable Offset (dB)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5745	3.87	4.34	17.60	24.72	28.99	-4.27
Mid	5785	3.68	4.56	17.60	24.75	28.99	-4.24
High	5825	3.55	4.72	17.60	24.78	28.99	-4.21

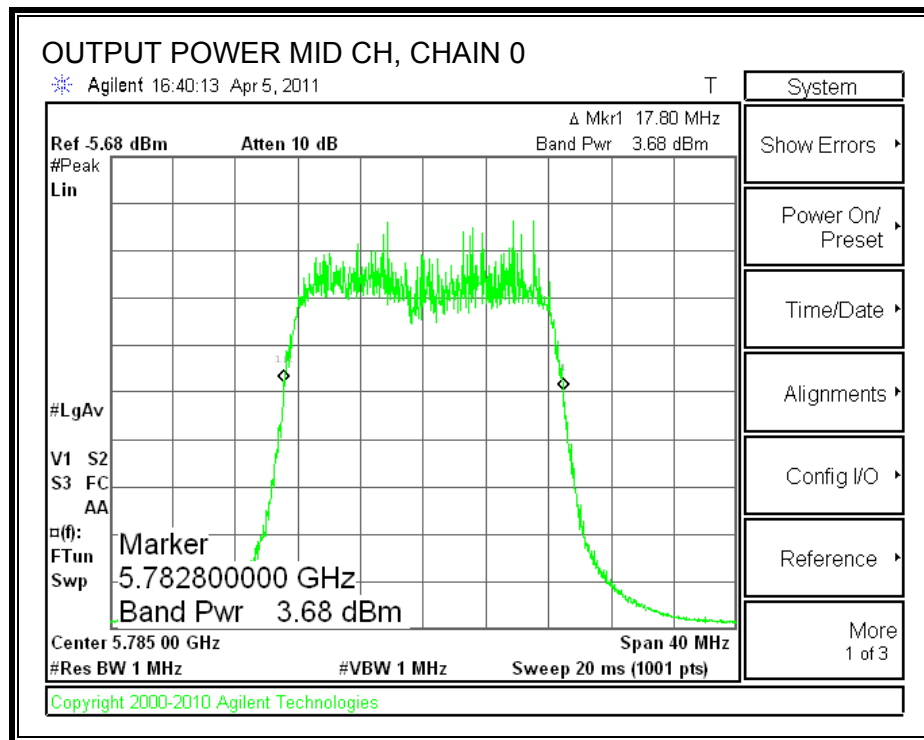
CHAIN 0 OUTPUT POWER



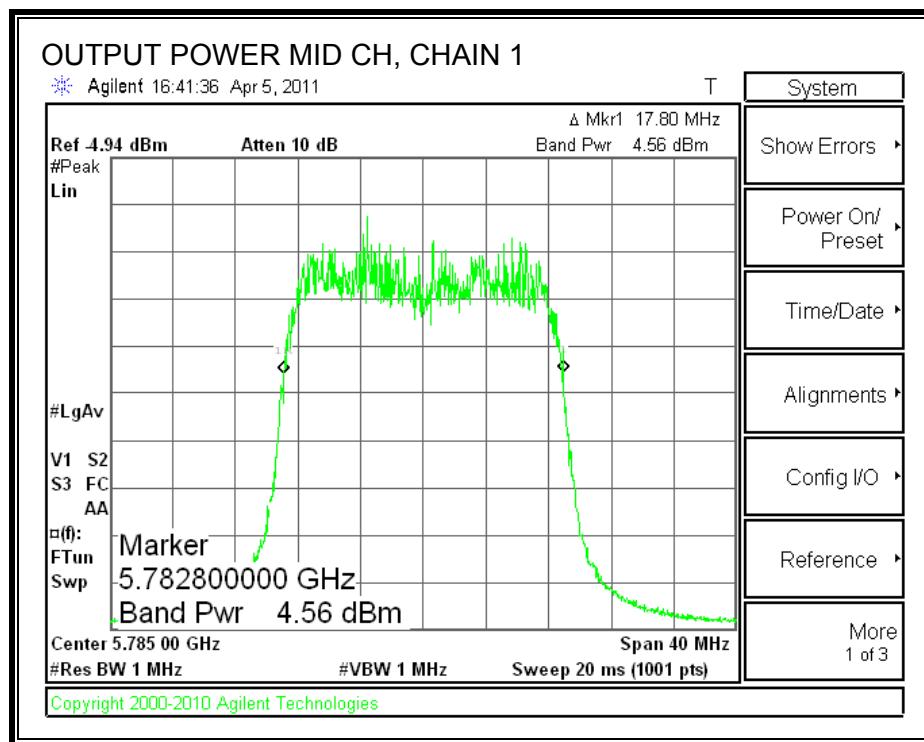
CHAIN 1 OUTPUT POWER



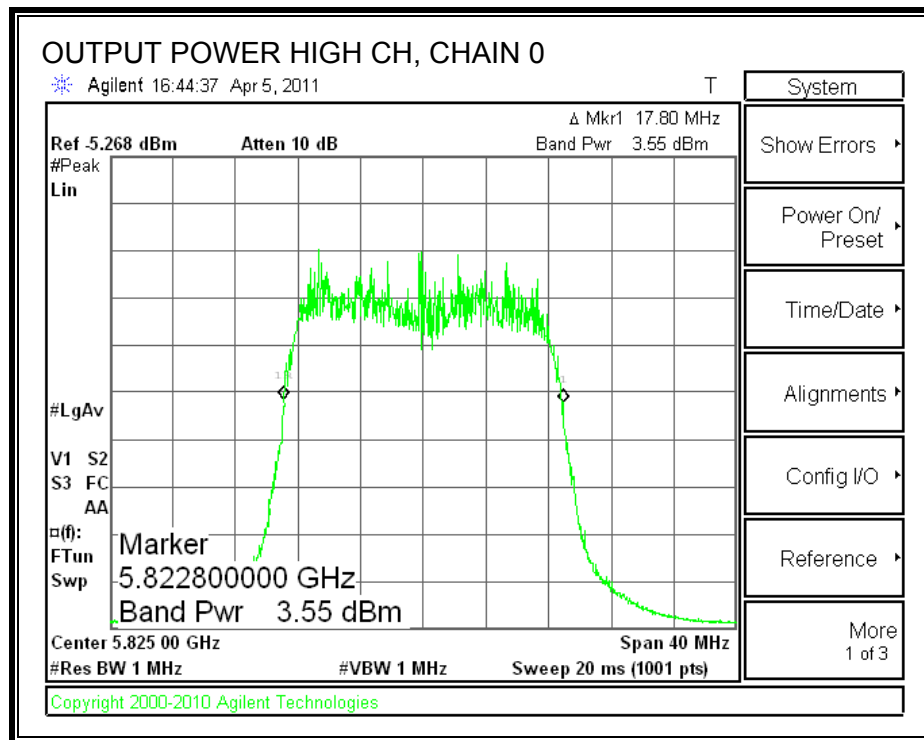
CHAIN 0 OUTPUT POWER



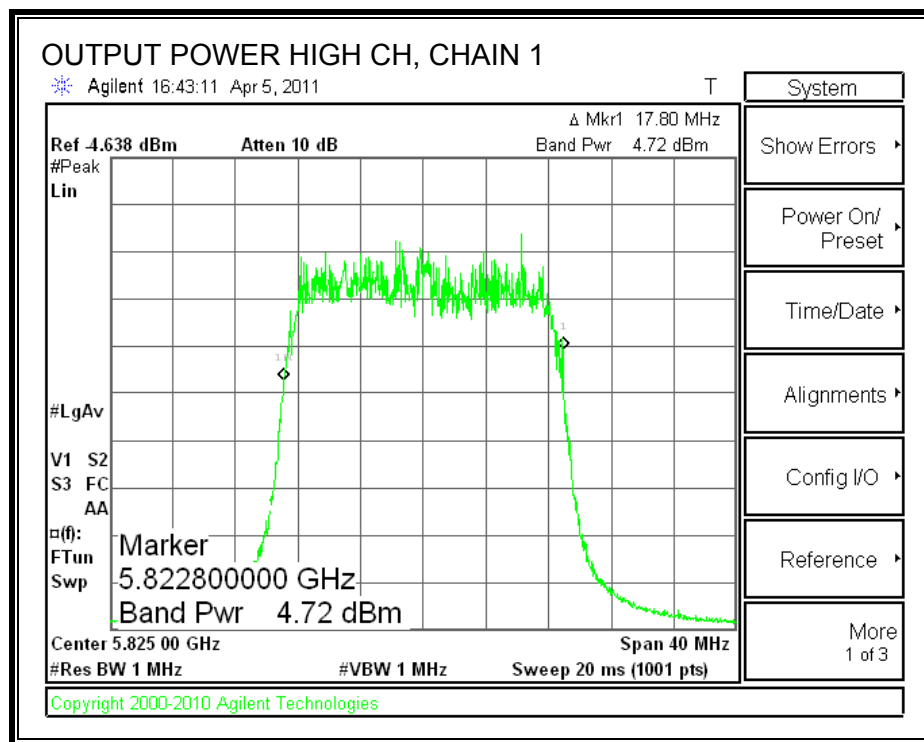
CHAIN 1 OUTPUT POWER



CHAIN 0 OUTPUT POWER



CHAIN 1 OUTPUT POWER



7.5.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 11.4 dB (including 11dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low	5745	13.70	14.20	16.97
Middle	5785	13.60	14.20	16.92
High	5825	13.60	14.30	16.97

7.6. 802.11n HT40 MODE IN THE 5.8 GHz BAND

7.6.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

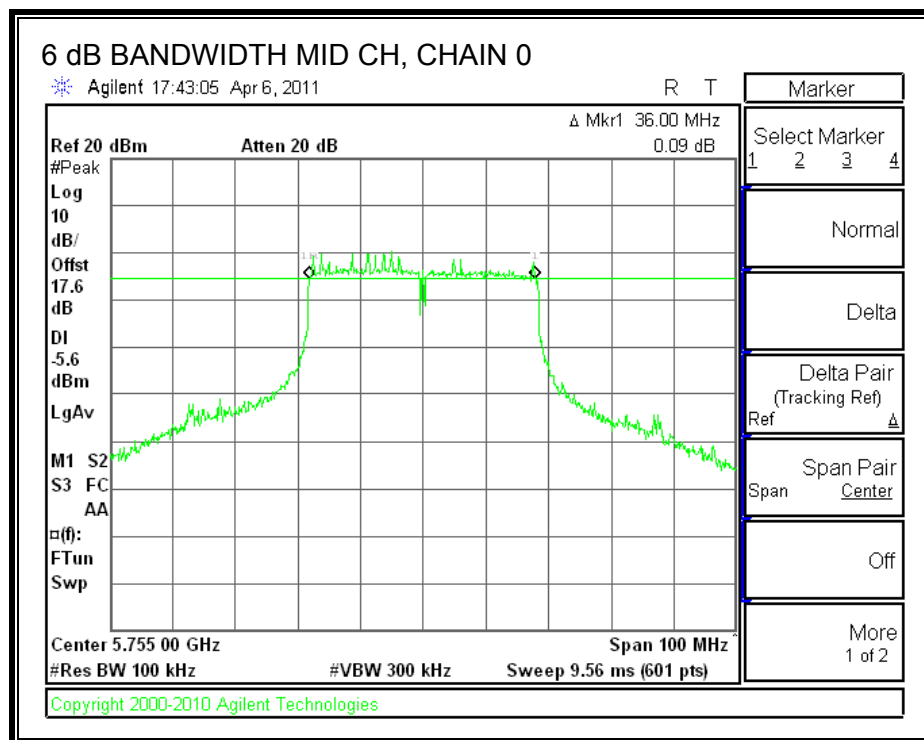
The minimum 6 dB bandwidth shall be at least 500 kHz.

TEST PROCEDURE

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

RESULTS

Channel	Frequency (MHz)	Chain 0 (MHz)	Minimum Limit (MHz)
LOW	5755	36	0.5



7.6.2. OUTPUT POWER

LIMITS

FCC §15.247 (b)

The highest combination of antenna gains is equal to 7.01dBi, therefore the limit is 28.99dBm.

TEST PROCEDURE

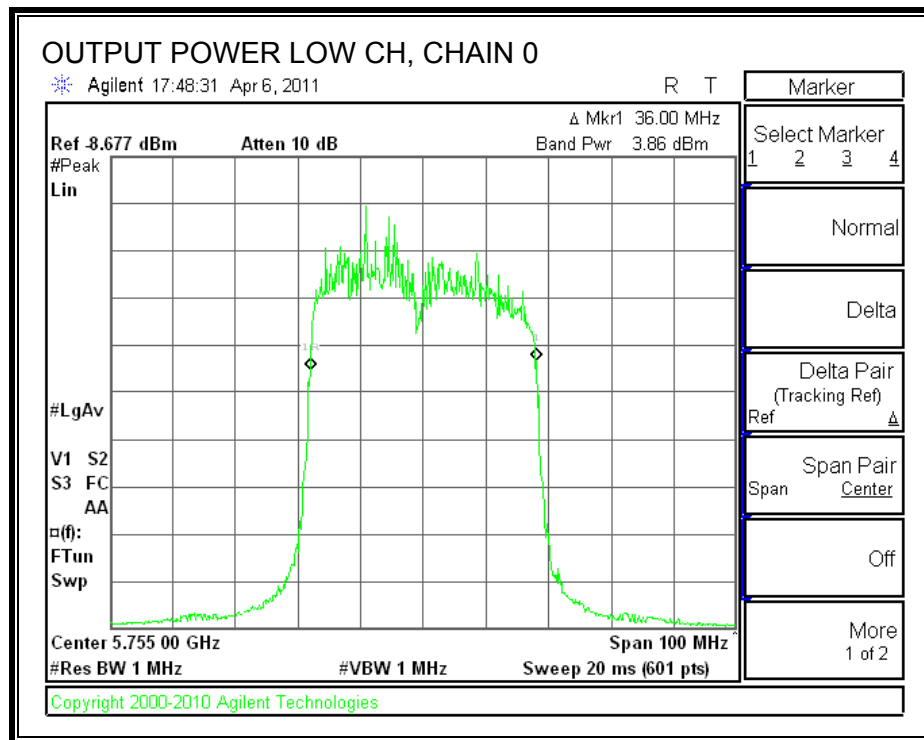
Output power was measured based on the use of RMS averaging over a time interval in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

RESULTS

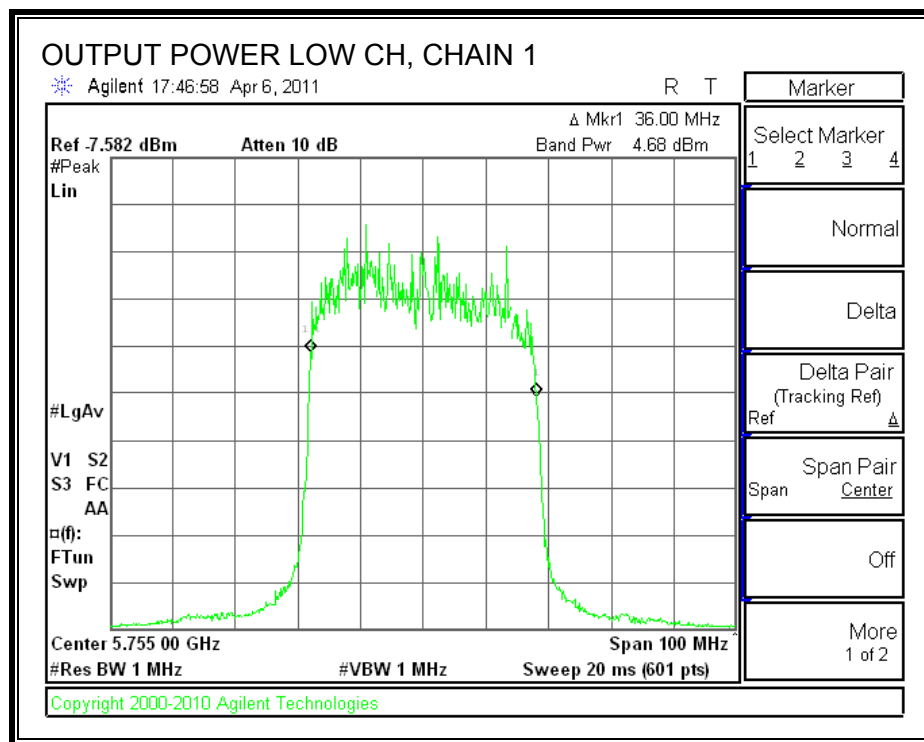
The cable assembly insertion loss of 17.6 dB (including Splitter and cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	Attenuator + Cable Offset (dB)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5755	3.86	4.68	17.60	24.90	28.99	-4.09
High	5795	3.76	4.59	17.60	24.81	28.99	-4.18

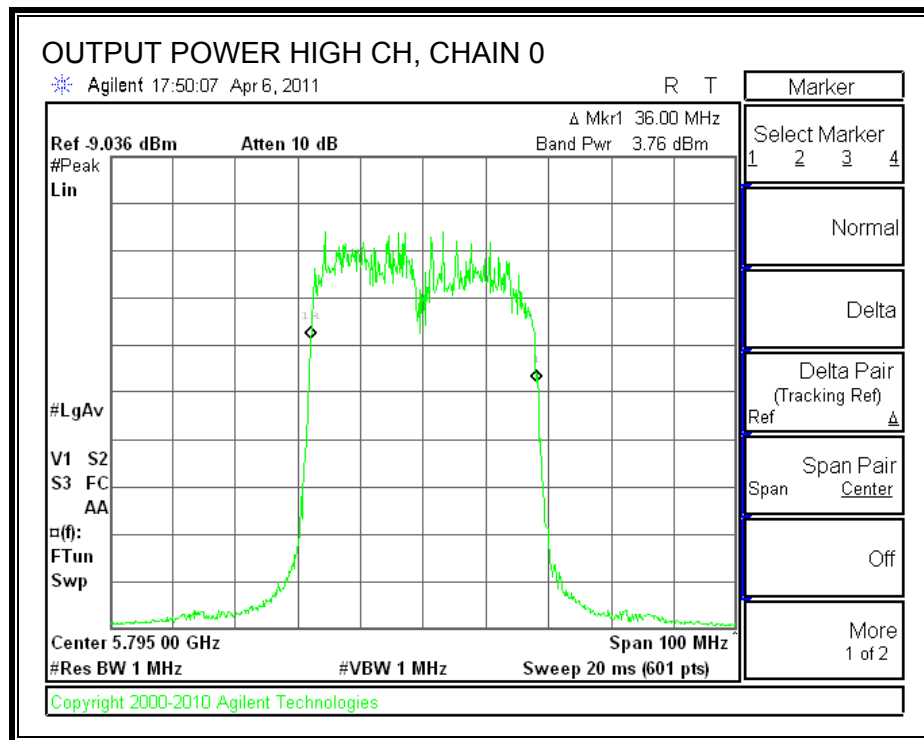
CHAIN 0 OUTPUT POWER



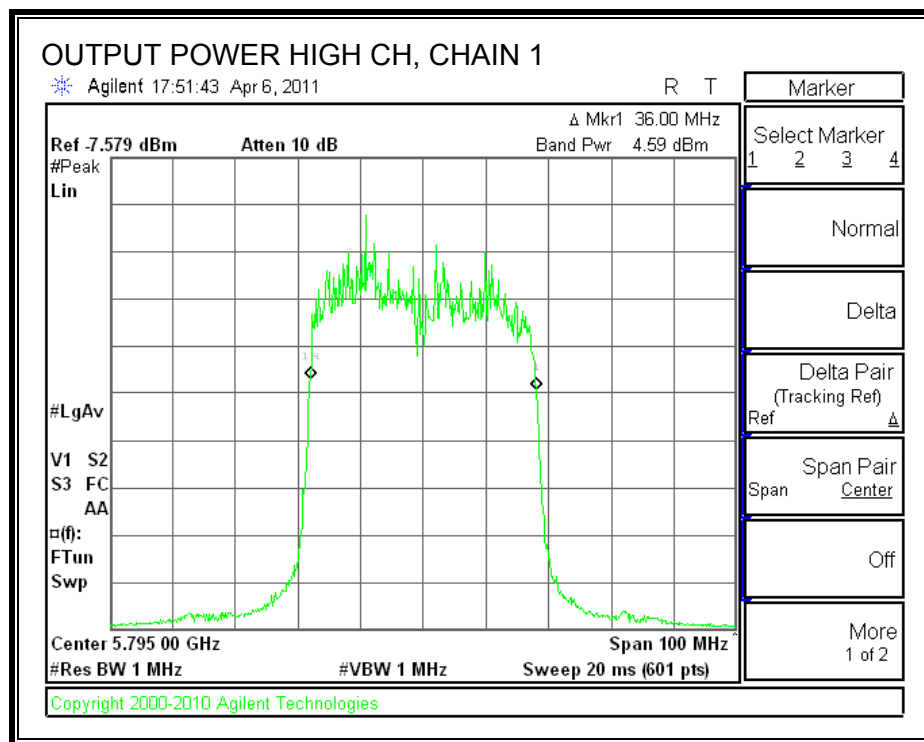
CHAIN 1 OUTPUT POWER



CHAIN 0 OUTPUT POWER



CHAIN 1 OUTPUT POWER



7.6.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 11.4dB (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.

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Total Power (dBm)
Low	5755	13.70	14.30	17.02
High	5795	13.70	14.20	16.97

8. RADIATED TEST RESULTS

8.1. 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. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

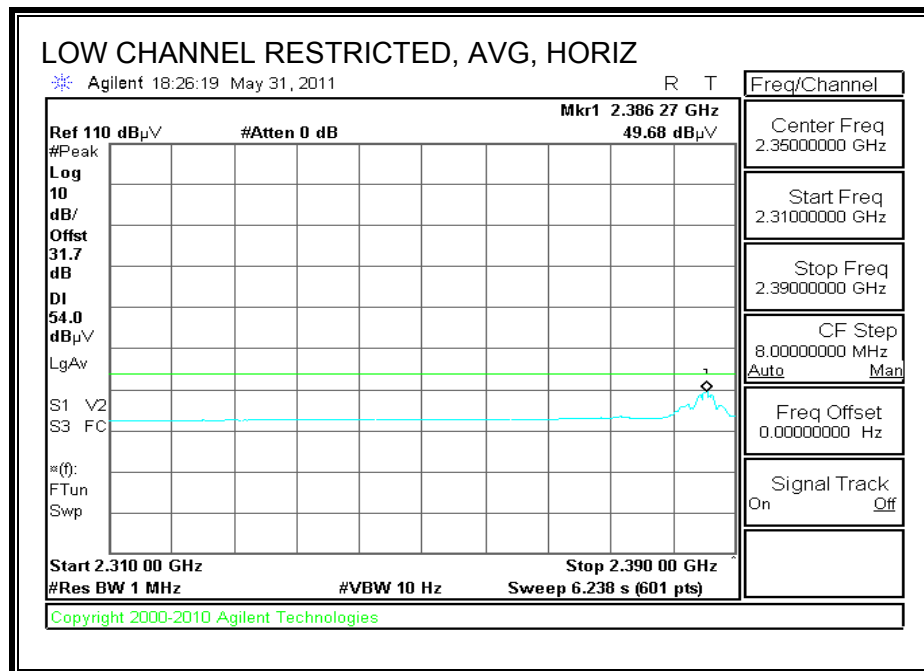
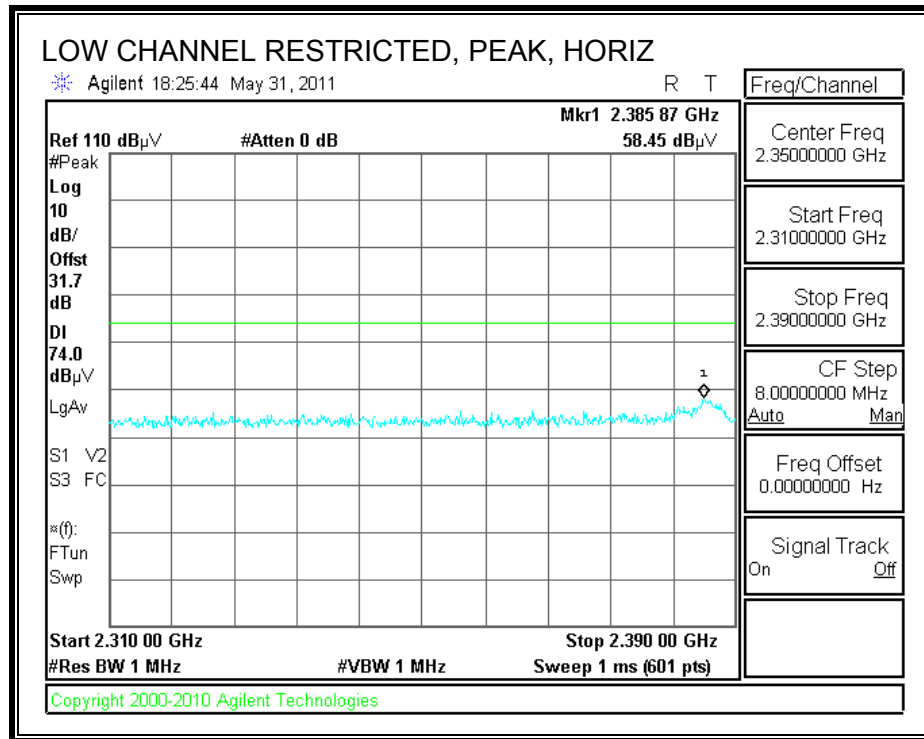
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

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

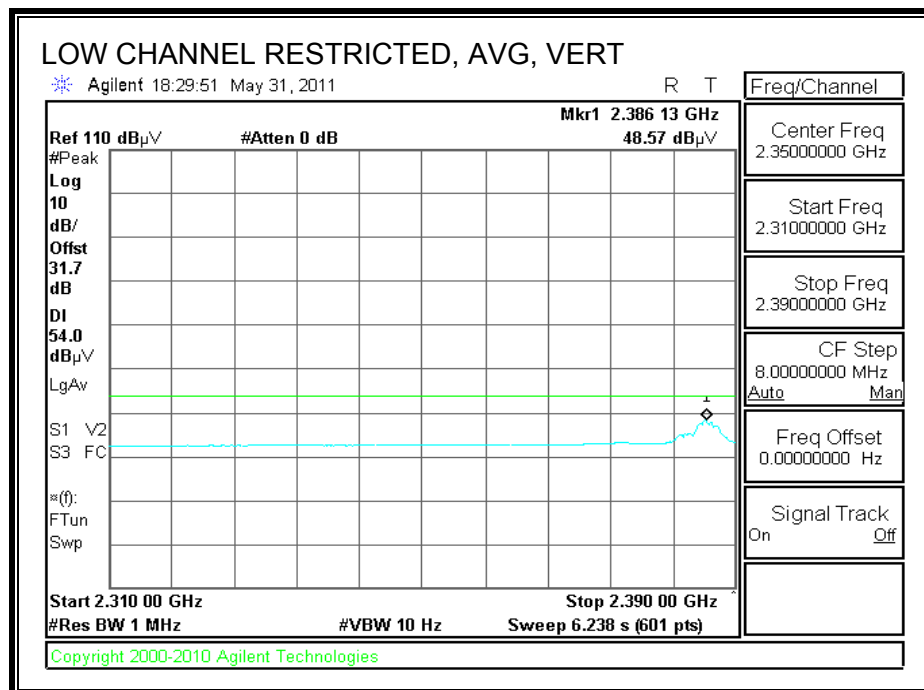
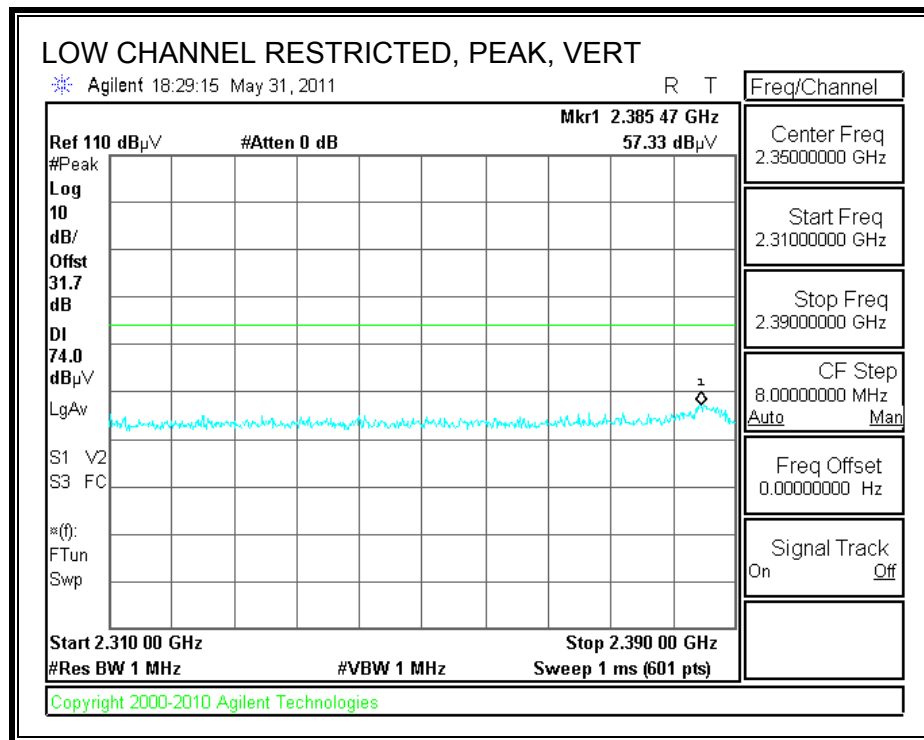
8.2. TRANSMITTER ABOVE 1 GHz

8.2.1. 802.11b MODE IN THE 2.4 GHz BAND

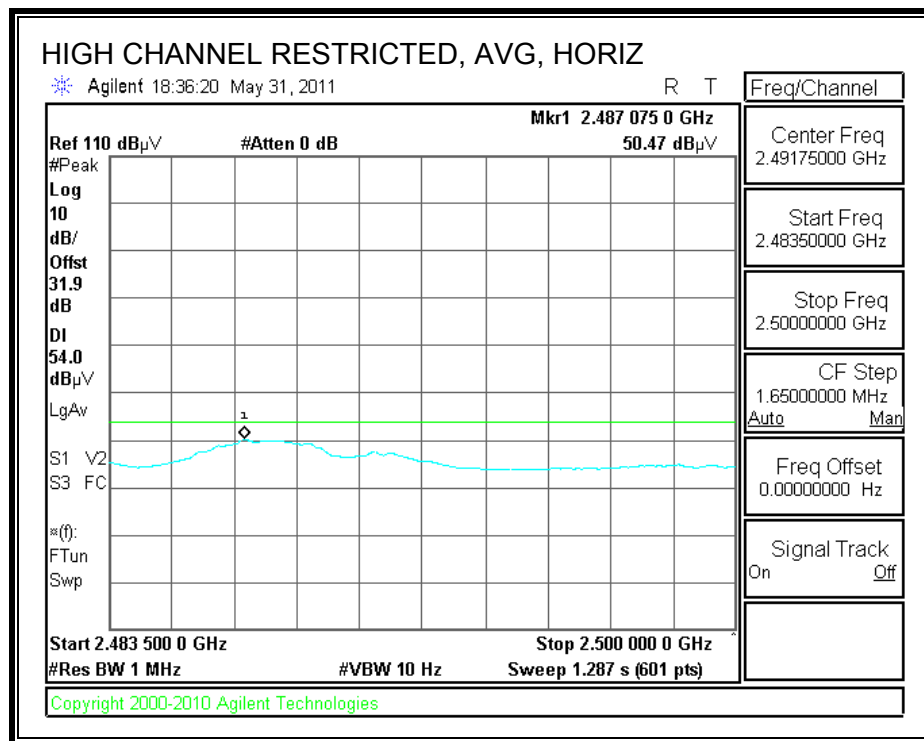
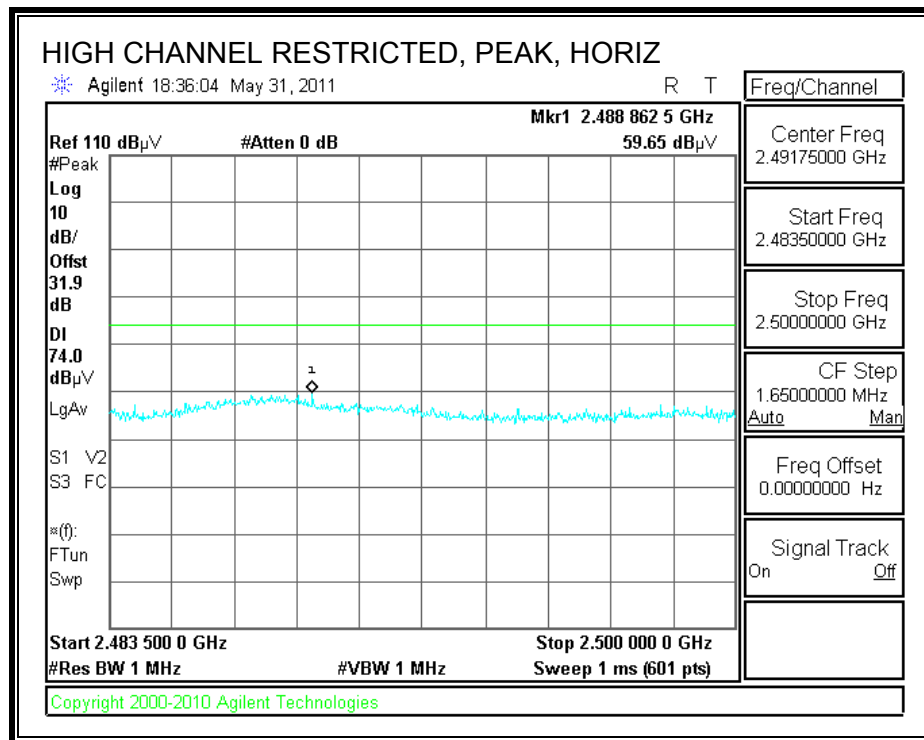
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



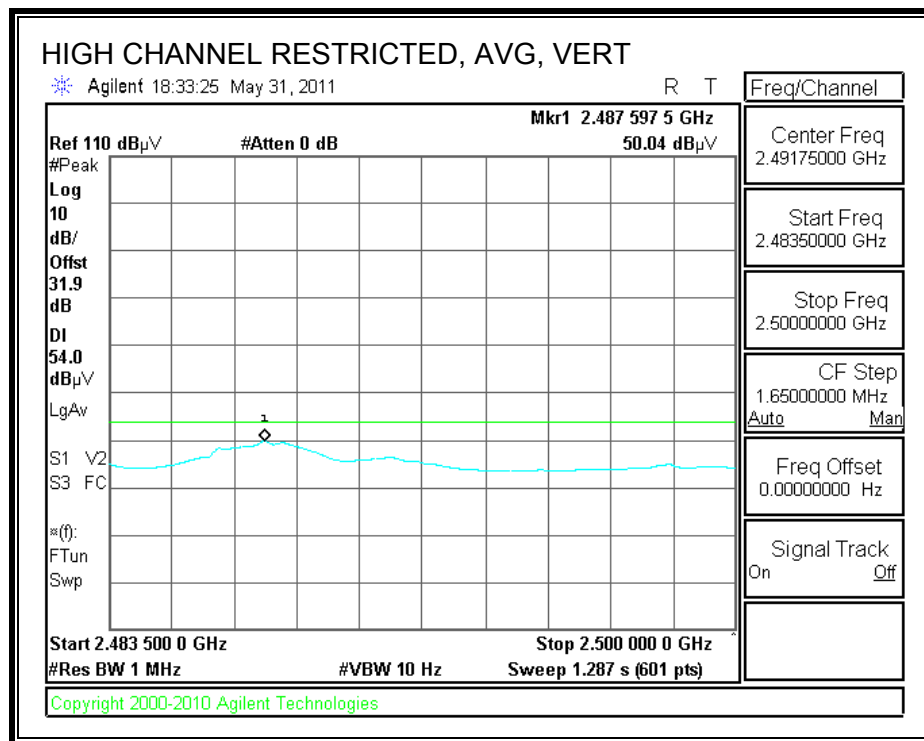
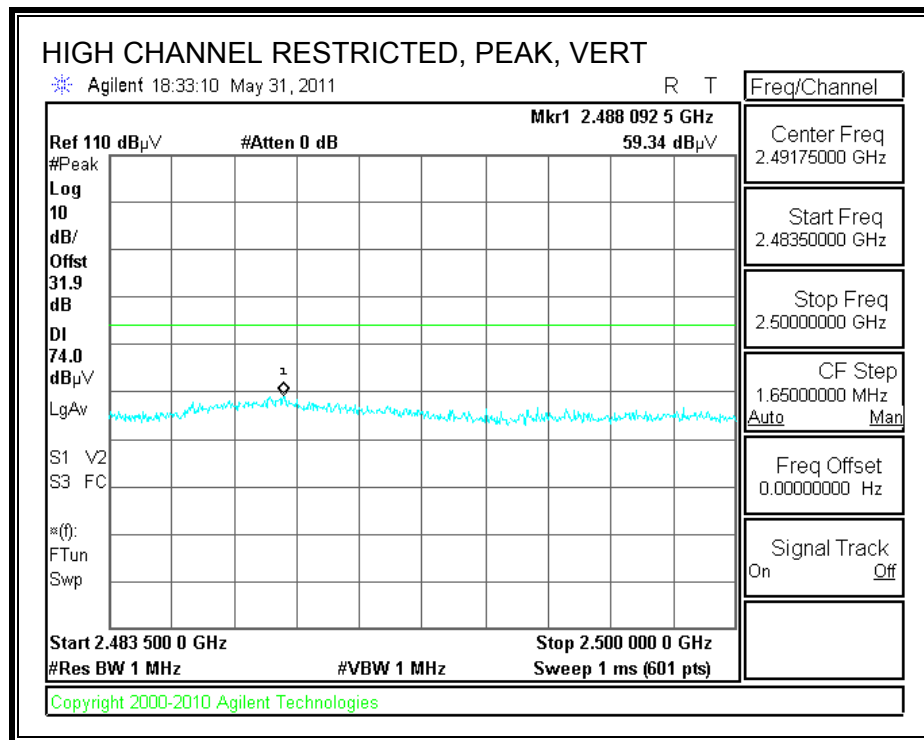
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement

Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 05-31-11
Project #: 11U13650
Company: Apple
Test Target: FCC 15.247
Mode Oper: b mode, TX Harmonic Spurious

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

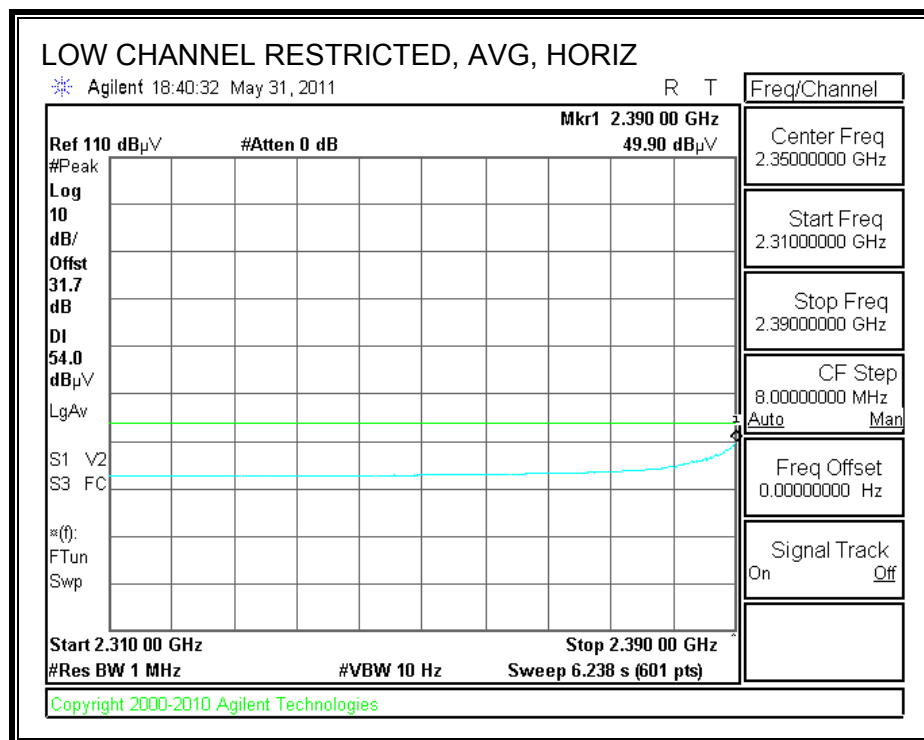
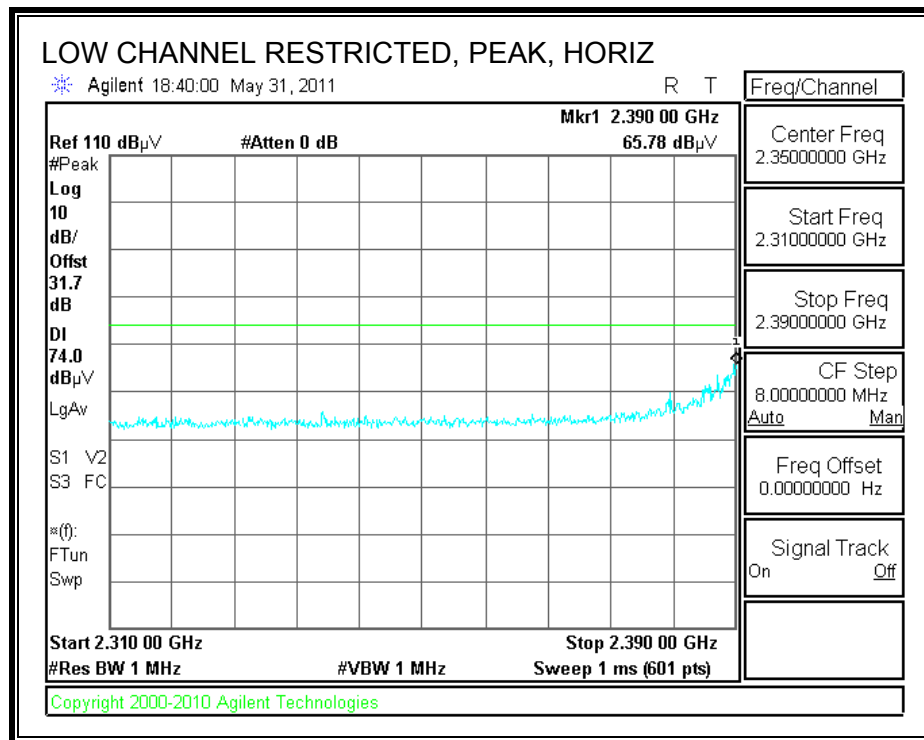
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fitr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol V/H	Det. P/A/QP	Notes
Lowch 2412MHz													
4.824	3.0	49.5	32.8	5.8	-34.8	0.0	0.0	53.2	74.0	-20.8	H	P	
4.824	3.0	47.5	32.8	5.8	-34.8	0.0	0.0	51.2	54.0	-2.8	H	A	
4.824	3.0	48.5	32.8	5.8	-34.8	0.0	0.0	52.3	74.0	-21.7	V	P	
4.824	3.0	46.5	32.8	5.8	-34.8	0.0	0.0	50.2	54.0	-3.8	V	A	
Mid Ch, 2437MHz													
4.874	3.0	46.8	32.8	5.8	-34.9	0.0	0.0	50.6	74.0	-23.4	H	P	
7.311	3.0	45.0	35.2	7.3	-34.7	0.0	0.0	52.8	74.0	-21.2	H	P	
4.874	3.0	44.6	32.8	5.8	-34.9	0.0	0.0	48.3	54.0	-5.7	H	A	
7.311	3.0	39.7	35.2	7.3	-34.7	0.0	0.0	47.5	54.0	-6.5	H	A	
4.874	3.0	47.4	32.8	5.8	-34.9	0.0	0.0	51.2	74.0	-22.8	V	P	
7.311	3.0	41.8	35.2	7.3	-34.7	0.0	0.0	49.6	74.0	-24.4	V	P	
4.874	3.0	45.7	32.8	5.8	-34.9	0.0	0.0	49.4	54.0	-4.6	V	A	
7.311	3.0	34.2	35.2	7.3	-34.7	0.0	0.0	42.0	54.0	-12.0	V	A	
High Ch, 2462MHz													
4.924	3.0	47.1	32.8	5.9	-34.9	0.0	0.0	51.0	74.0	-23.0	H	P	
7.386	3.0	38.9	35.3	7.3	-34.6	0.0	0.0	46.8	74.0	-27.2	H	P	
4.924	3.0	44.3	32.8	5.9	-34.9	0.0	0.0	48.2	54.0	-5.8	H	A	
7.386	3.0	28.8	35.3	7.3	-34.6	0.0	0.0	36.8	54.0	-17.2	H	A	
4.924	3.0	46.9	32.8	5.9	-34.9	0.0	0.0	50.8	74.0	-23.2	V	P	
7.386	3.0	40.5	35.3	7.3	-34.6	0.0	0.0	48.5	74.0	-25.5	V	P	
4.924	3.0	44.6	32.8	5.9	-34.9	0.0	0.0	48.4	54.0	-5.6	V	A	
7.386	3.0	31.0	35.3	7.3	-34.6	0.0	0.0	39.0	54.0	-15.0	V	A	

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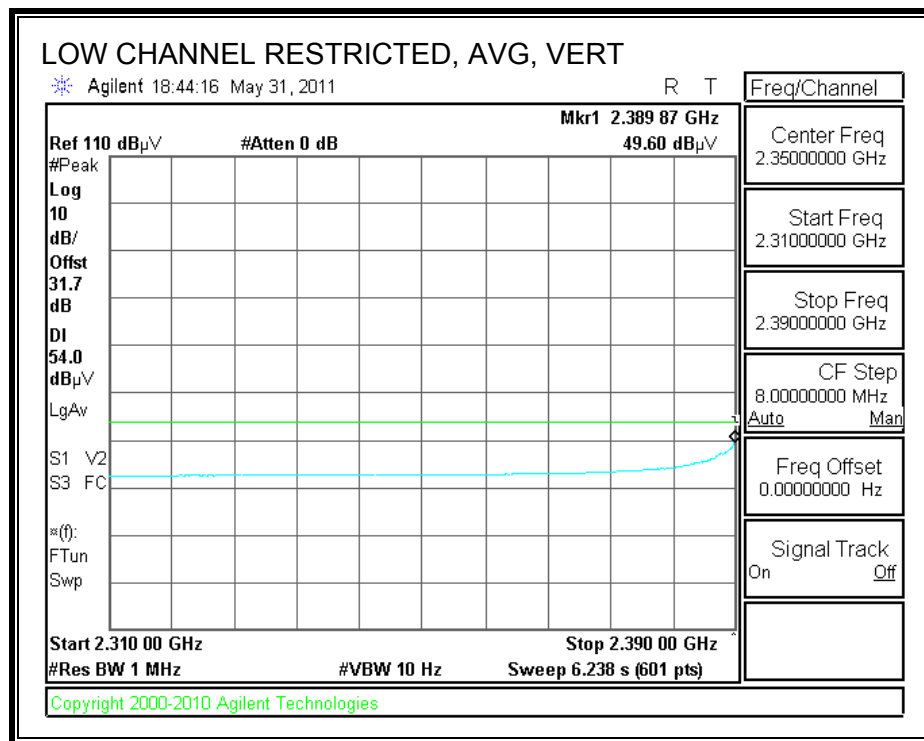
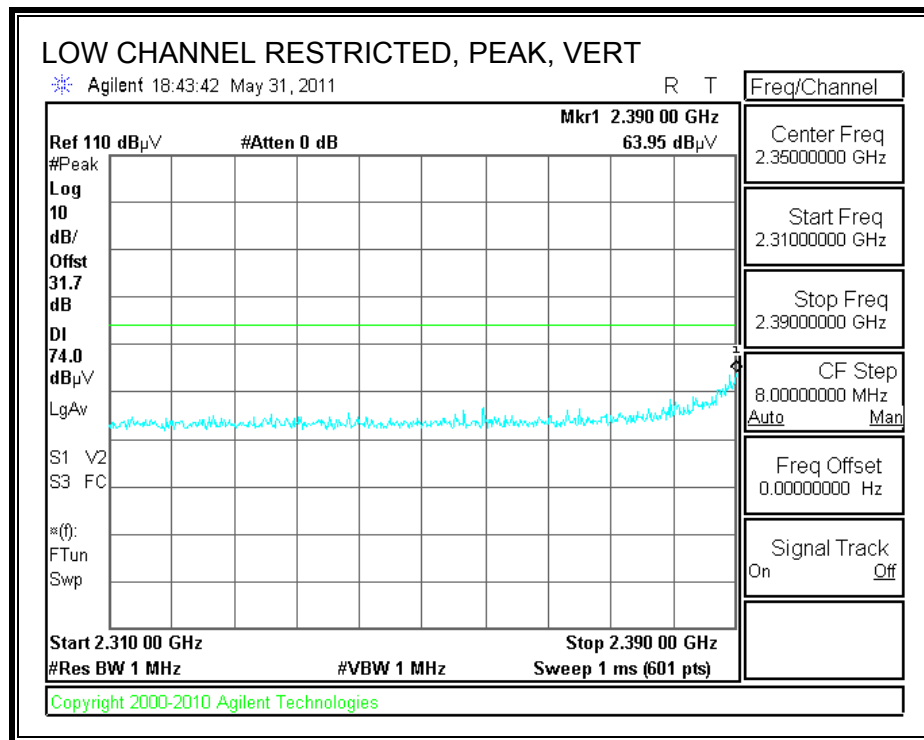
Note: No other emissions were detected above the system noise floor.

8.2.2. 802.11g MODE IN THE 2.4 GHz BAND

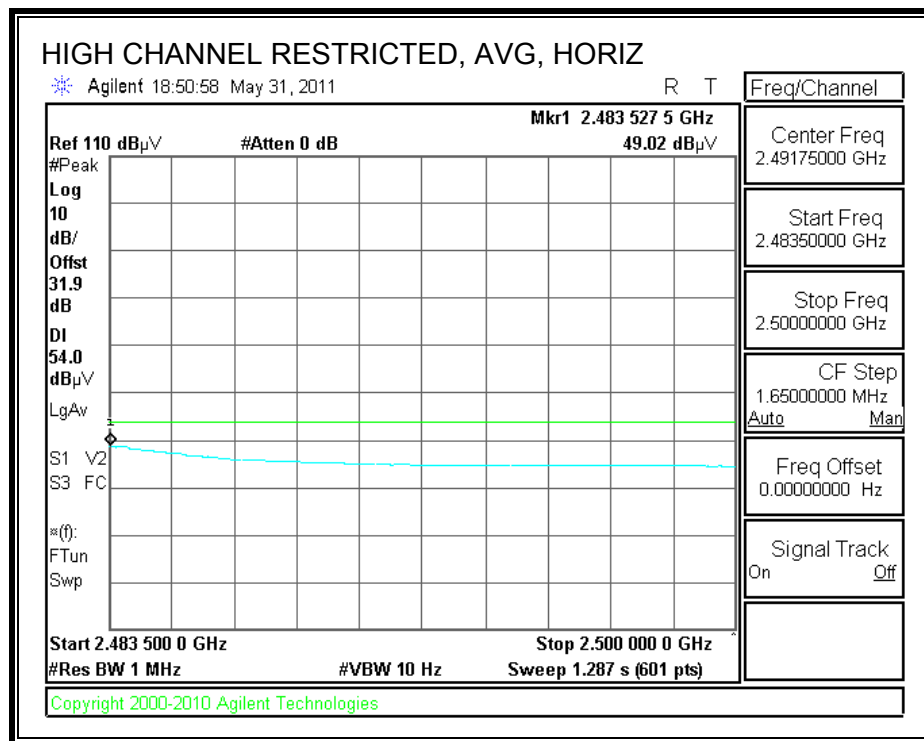
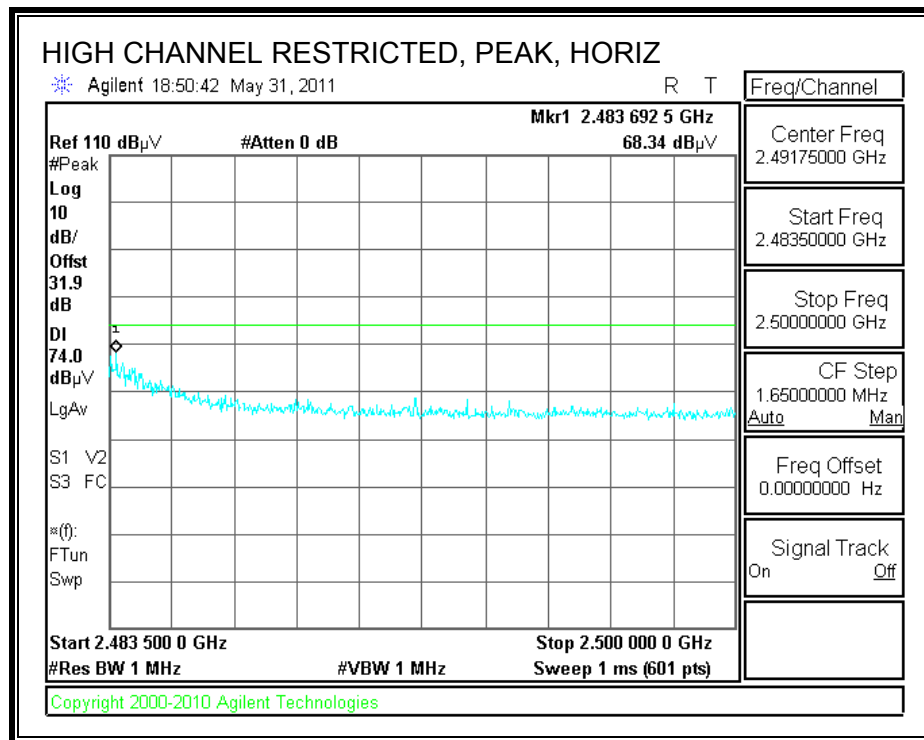
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



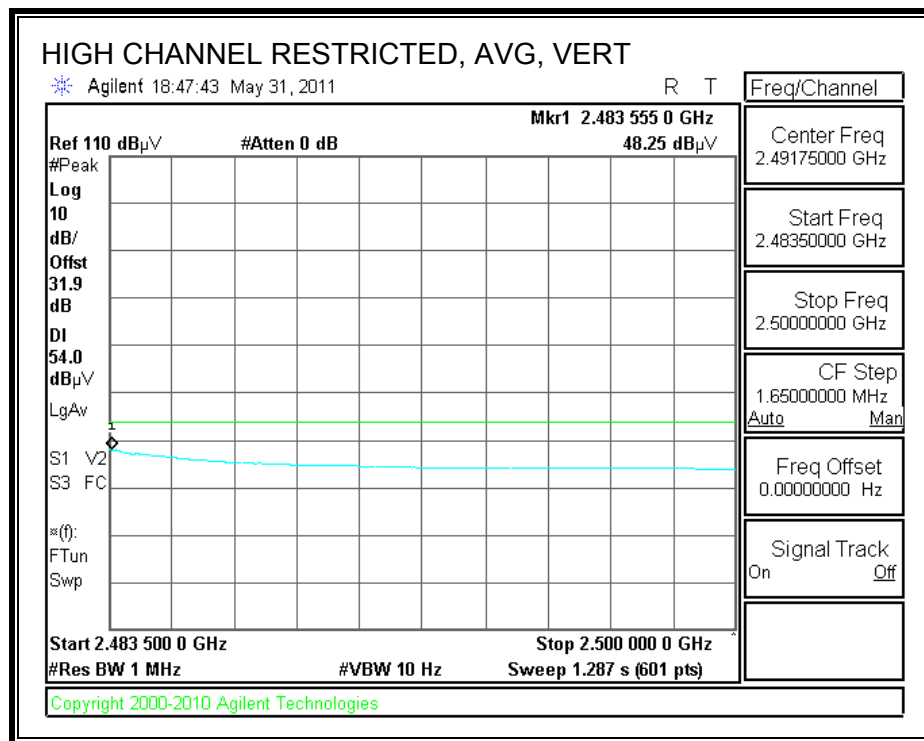
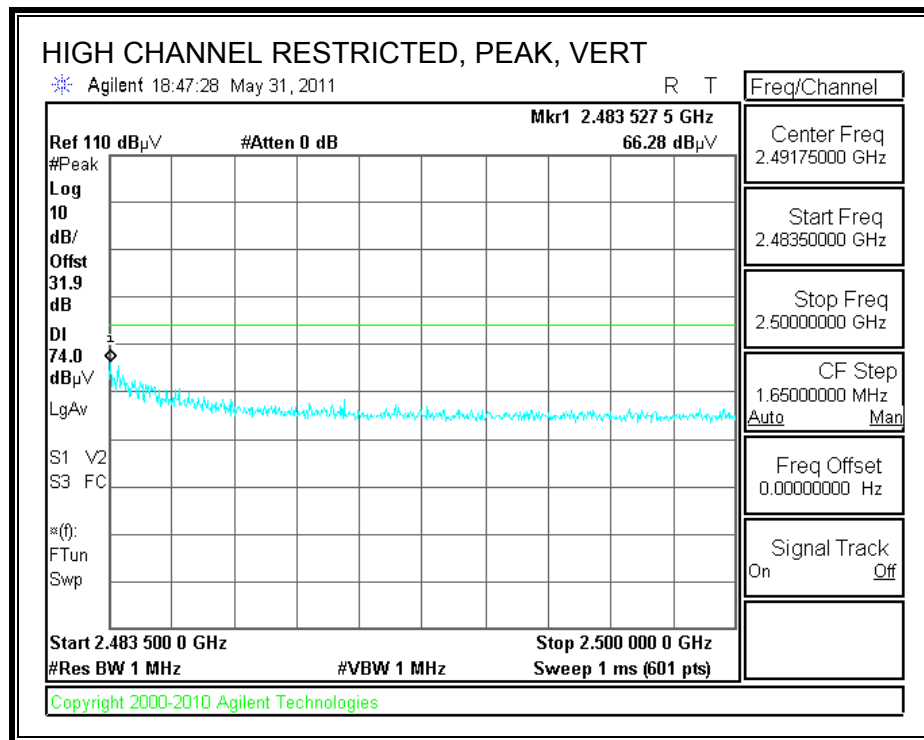
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement

Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 06-01-11
Project #: 11U13650
Company: Apple
Test Target: FCC 15.247
Mode Oper: g, TX

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

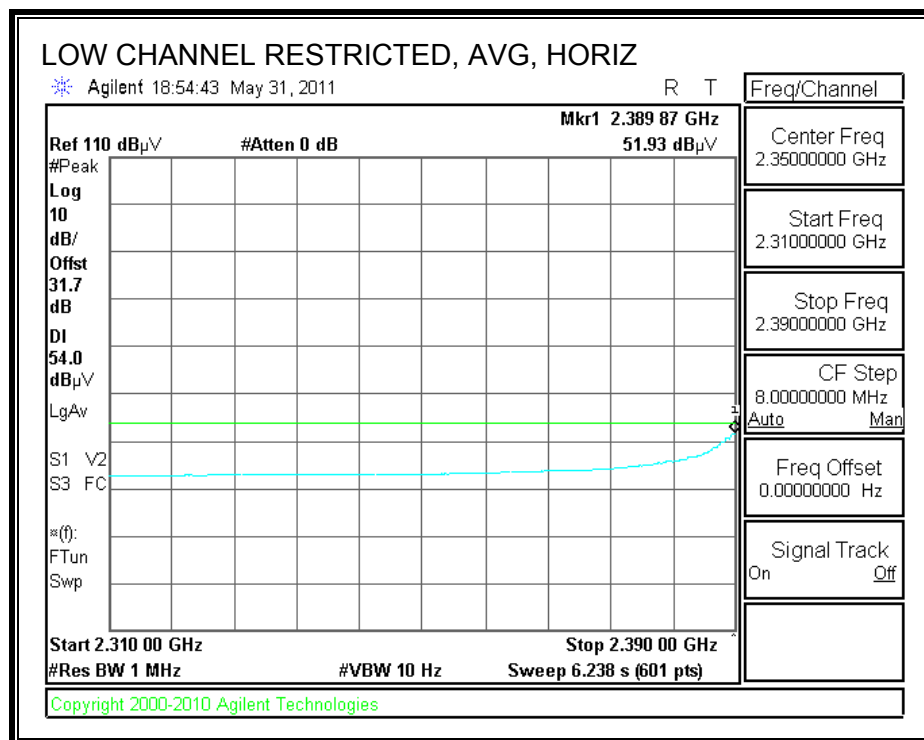
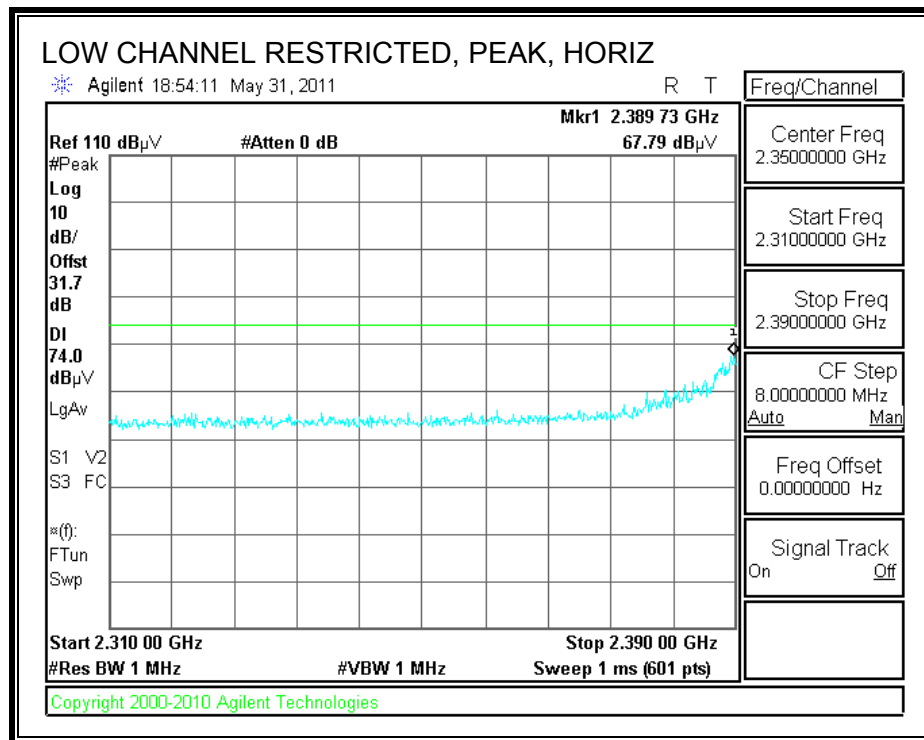
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filt dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol V/H	Det. P/A/QP	Notes
Low Ch, 2412MHz													
4.824	3.0	44.4	32.8	5.8	-34.8	0.0	0.0	48.1	74.0	-25.9	H	P	
4.824	3.0	31.4	32.8	5.8	-34.8	0.0	0.0	35.2	54.0	-18.8	H	A	
4.824	3.0	43.8	32.8	5.8	-34.8	0.0	0.0	47.5	74.0	-26.5	V	P	
4.824	3.0	30.9	32.8	5.8	-34.8	0.0	0.0	34.6	54.0	-19.4	V	A	
Mid Ch, 2437MHz													
4.874	3.0	47.3	32.8	5.8	-34.9	0.0	0.0	51.0	74.0	-23.0	H	P	
4.874	3.0	33.5	32.8	5.8	-34.9	0.0	0.0	37.3	54.0	-16.7	H	A	
7.311	3.0	50.9	35.2	7.3	-34.7	0.0	0.0	58.7	74.0	-15.3	H	P	
7.311	3.0	37.2	35.2	7.3	-34.7	0.0	0.0	45.0	54.0	-9.0	H	A	
4.874	3.0	45.0	32.8	5.8	-34.9	0.0	0.0	48.8	74.0	-25.2	V	P	
4.874	3.0	31.9	32.8	5.8	-34.9	0.0	0.0	35.7	54.0	-18.3	V	A	
7.311	3.0	50.3	35.2	7.3	-34.7	0.0	0.0	58.1	74.0	-15.9	V	P	
7.311	3.0	34.9	35.2	7.3	-34.7	0.0	0.0	42.7	54.0	-11.3	V	A	
High Ch, 2462MHz													
4.924	3.0	44.9	32.8	5.9	-34.9	0.0	0.0	48.8	74.0	-25.2	H	P	
4.924	3.0	32.7	32.8	5.9	-34.9	0.0	0.0	36.6	54.0	-17.4	H	A	
7.386	3.0	43.5	35.3	7.3	-34.6	0.0	0.0	51.4	74.0	-22.6	H	P	
7.386	3.0	29.5	35.3	7.3	-34.6	0.0	0.0	37.5	54.0	-16.5	H	A	
4.924	3.0	45.9	32.8	5.9	-34.9	0.0	0.0	49.8	74.0	-24.2	V	P	
4.924	3.0	32.1	32.8	5.9	-34.9	0.0	0.0	36.0	54.0	-18.0	V	A	
7.386	3.0	42.0	35.3	7.3	-34.6	0.0	0.0	49.9	74.0	-24.1	V	P	
7.386	3.0	28.6	35.3	7.3	-34.6	0.0	0.0	36.6	54.0	-17.4	V	A	

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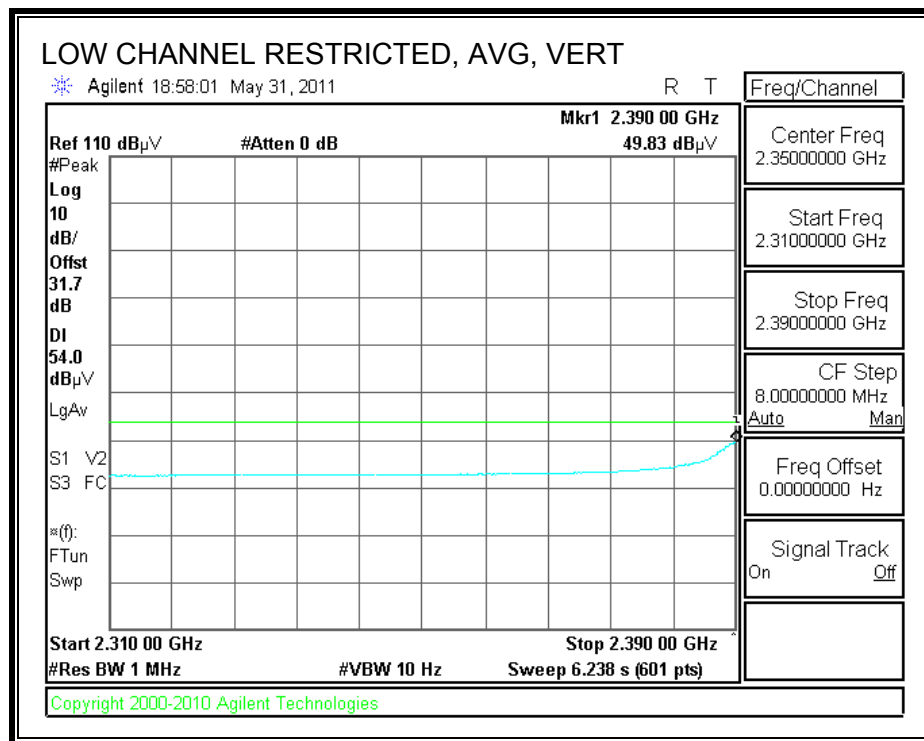
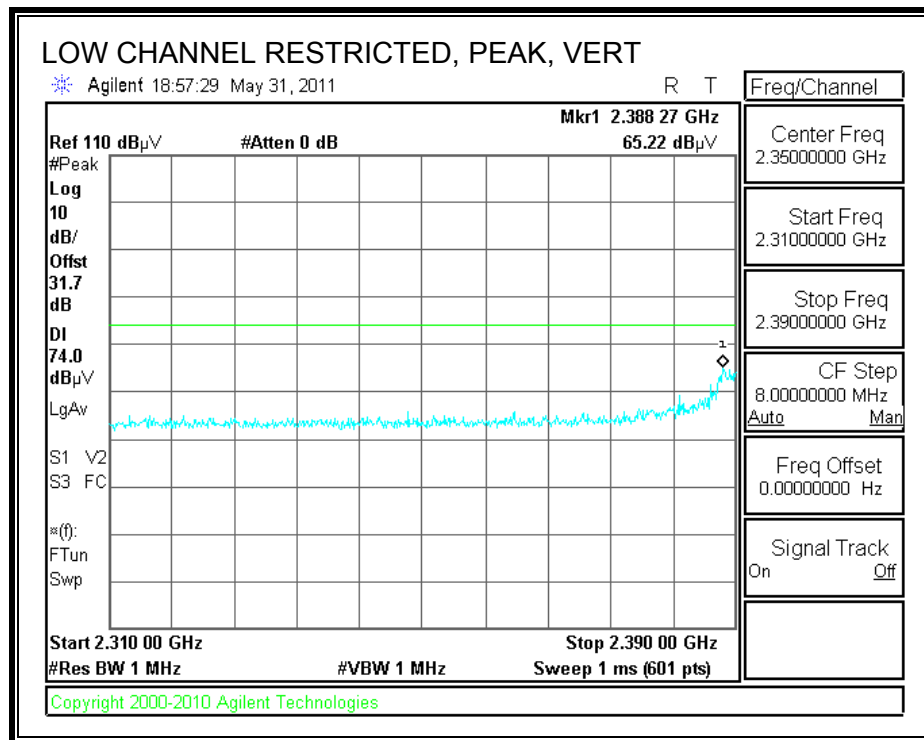
Note: No other emissions were detected above the system noise floor.

8.2.3. 802.11n HT20 MODE MCS0 IN THE 2.4 GHz BAND

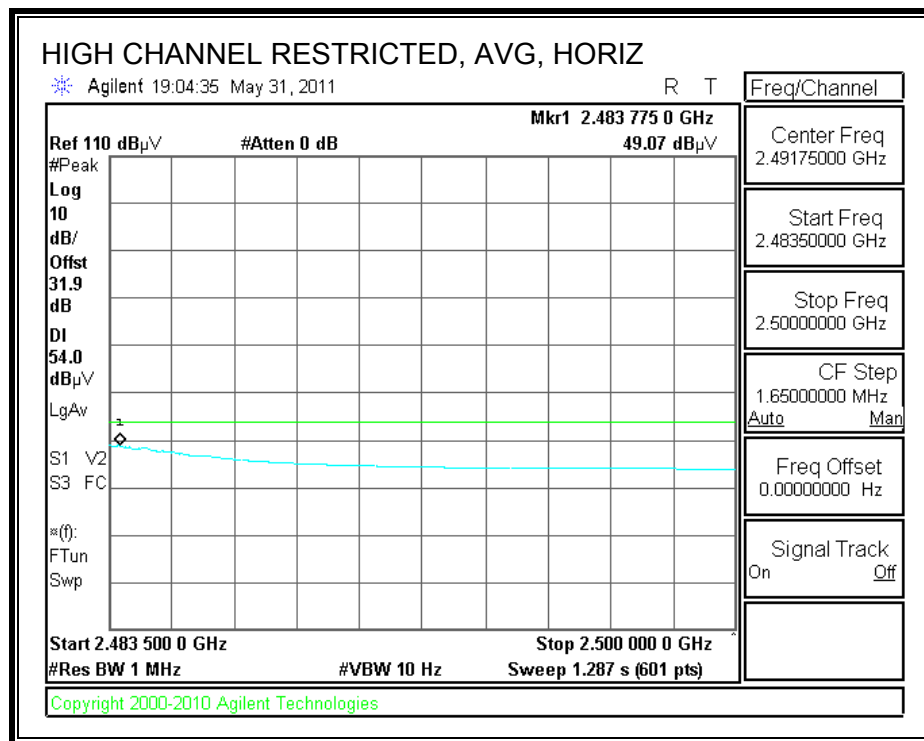
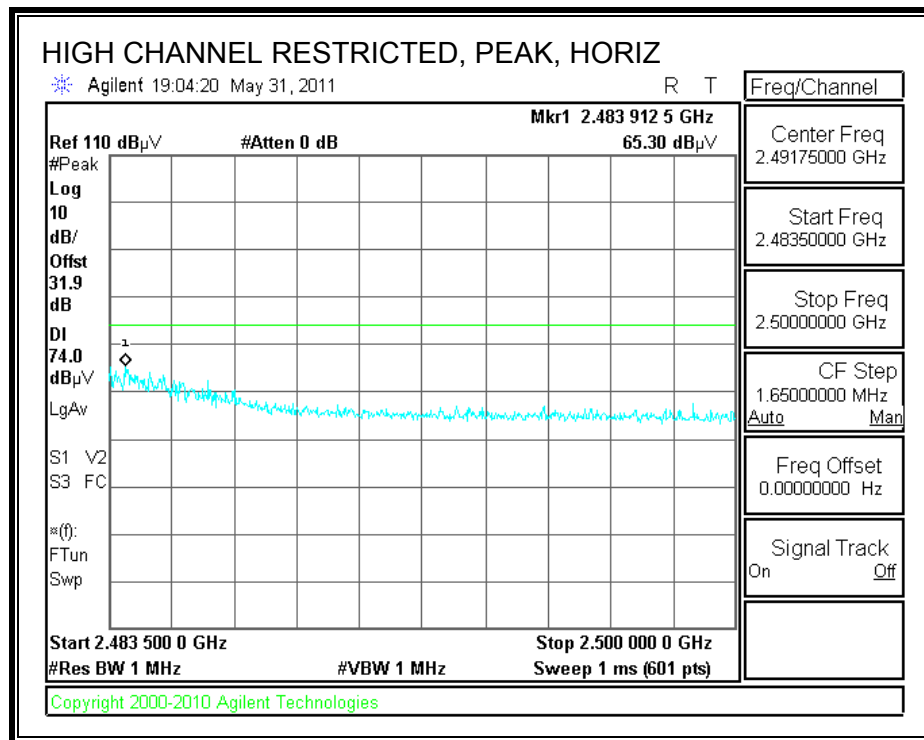
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



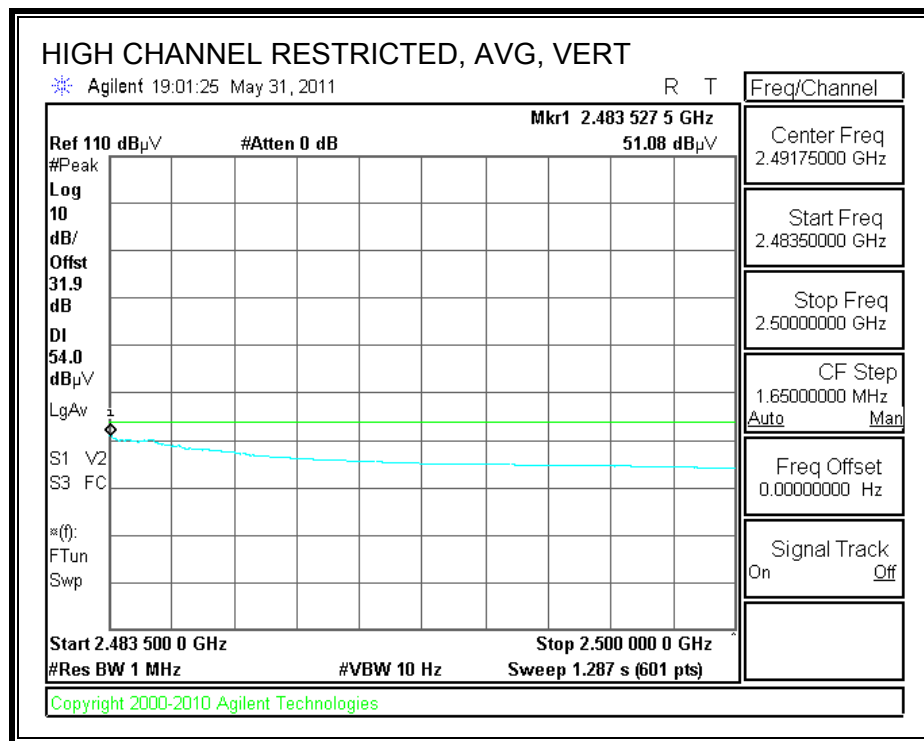
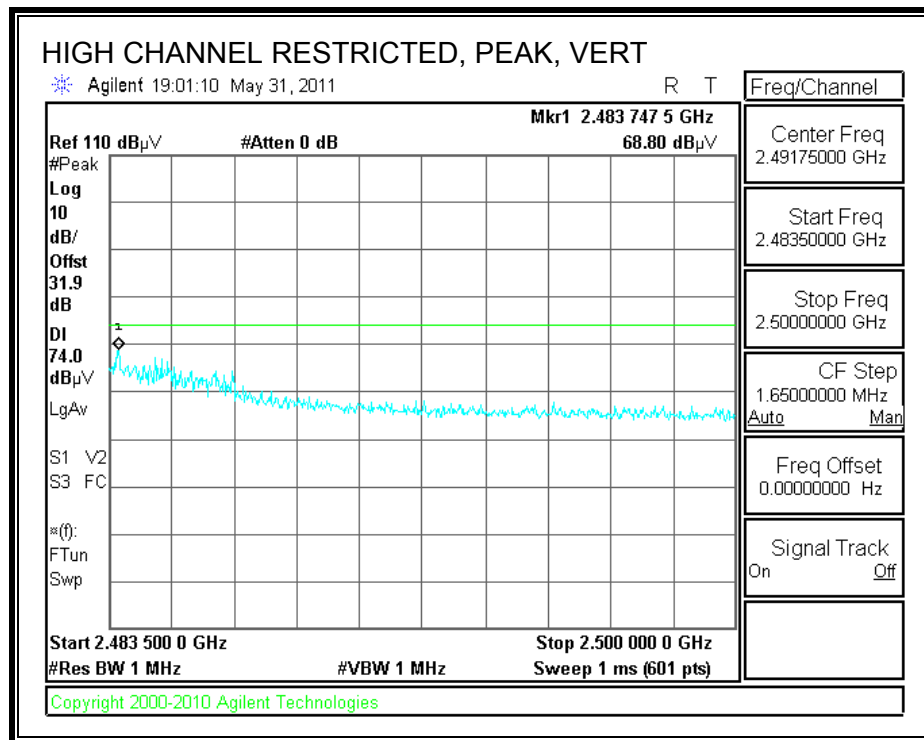
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement

Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 06-01-11
Project #: 11U13650
Company: Apple
Test Target: FCC 15.247
Mode Oper: HT20 mode, TX

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

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filt dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 2412MHz													
4.824	3.0	45.0	32.8	5.8	-34.8	0.0	0.0	48.7	74.0	-25.3	V	P	
4.824	3.0	30.8	32.8	5.8	-34.8	0.0	0.0	34.5	54.0	-19.5	V	A	
4.824	3.0	45.6	32.8	5.8	-34.8	0.0	0.0	49.4	74.0	-24.6	H	P	
4.824	3.0	33.0	32.8	5.8	-34.8	0.0	0.0	36.8	54.0	-17.2	H	A	
Mid Ch, 2437MHz													
4.874	3.0	44.9	32.8	5.8	-34.9	0.0	0.0	48.7	74.0	-25.3	V	P	
4.874	3.0	29.7	32.8	5.8	-34.9	0.0	0.0	33.5	54.0	-20.5	V	A	
7.311	3.0	50.0	35.2	7.3	-34.7	0.0	0.0	57.8	74.0	-16.2	V	P	
7.311	3.0	35.2	35.2	7.3	-34.7	0.0	0.0	43.0	54.0	-11.0	V	A	
4.874	3.0	46.3	32.8	5.8	-34.9	0.0	0.0	50.1	74.0	-24.0	H	P	
4.874	3.0	32.6	32.8	5.8	-34.9	0.0	0.0	36.4	54.0	-17.6	H	A	
7.311	3.0	50.8	35.2	7.3	-34.7	0.0	0.0	58.6	74.0	-15.4	H	P	
7.311	3.0	36.7	35.2	7.3	-34.7	0.0	0.0	44.5	54.0	-9.5	H	A	
High Ch, 2462MHz													
4.924	3.0	45.4	32.8	5.9	-34.9	0.0	0.0	49.3	74.0	-24.7	V	P	
4.924	3.0	31.1	32.8	5.9	-34.9	0.0	0.0	35.0	54.0	-19.0	V	A	
7.386	3.0	40.6	35.3	7.3	-34.6	0.0	0.0	48.6	74.0	-25.4	V	P	
7.386	3.0	27.4	35.3	7.3	-34.6	0.0	0.0	35.4	54.0	-18.6	V	A	
4.924	3.0	46.3	32.8	5.9	-34.9	0.0	0.0	50.2	74.0	-23.8	H	P	
4.924	3.0	31.6	32.8	5.9	-34.9	0.0	0.0	35.4	54.0	-18.6	H	A	
7.386	3.0	41.6	35.3	7.3	-34.6	0.0	0.0	49.5	74.0	-24.5	H	P	
7.386	3.0	27.7	35.3	7.3	-34.6	0.0	0.0	35.6	54.0	-18.4	H	A	

Rev. 4.1.2.7

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

8.2.4. TRANSMITTER ABOVE 1 GHz FOR 802.11a MODE IN THE 5.8 GHz BAND

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement Compliance Certification Services, Fremont 5m Chamber													
Test Engr:		Chin Pang											
Date:		06-01-11											
Project #:		11U13650											
Company:		Apple											
Test Target:		FCC 15.247											
Mode Oper:		Legacy, TX, 5.8GHz Band											
f	Measurement Frequency		Amp	Preamp Gain		Average Field Strength Limit							
Dist	Distance to Antenna		D Corr	Distance Correct to 3 meters		Peak Field Strength Limit							
Read	Analyzer Reading		Avg	Average Field Strength @ 3 m		Margin vs. Average Limit							
AF	Antenna Factor		Peak	Calculated Peak Field Strength		Margin vs. Peak Limit							
CL	Cable Loss		HPF	High Pass Filter									
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fitr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5745MHz													
11.490	3.0	49.8	38.1	9.5	-33.1	0.0	0.7	64.9	74.0	-9.1	V	P	
11.490	3.0	31.2	38.1	9.5	-33.1	0.0	0.7	46.4	54.0	-7.6	V	A	
11.490	3.0	52.6	38.1	9.5	-33.1	0.0	0.7	67.7	74.0	-6.3	H	P	
11.490	3.0	32.1	38.1	9.5	-33.1	0.0	0.7	47.2	54.0	-6.8	H	A	
Mid Ch, 5785MHz													
11.570	3.0	49.4	38.1	9.5	-33.0	0.0	0.7	64.8	74.0	-9.2	V	P	
11.570	3.0	29.2	38.1	9.5	-33.0	0.0	0.7	44.6	54.0	-9.4	V	A	
11.570	3.0	48.0	38.1	9.5	-33.0	0.0	0.7	63.3	74.0	-10.7	H	P	
11.570	3.0	27.3	38.1	9.5	-33.0	0.0	0.7	42.7	54.0	-11.3	H	A	
High Ch, 5825MHz													
11.650	3.0	47.2	38.2	9.6	-32.9	0.0	0.7	62.8	74.0	-11.2	V	P	
11.650	3.0	28.3	38.2	9.6	-32.9	0.0	0.7	43.9	54.0	-10.1	V	A	
11.650	3.0	48.8	38.2	9.6	-32.9	0.0	0.7	64.4	74.0	-9.6	H	P	
11.650	3.0	27.7	38.2	9.6	-32.9	0.0	0.7	43.2	54.0	-10.8	H	A	
Rev. 4.1.2.7													
Note: No other emissions were detected above the system noise floor.													

8.2.5. TRANSMITTER ABOVE 1 GHz FOR 802.11n HT20 MODE IN THE 5.8 GHz BAND

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement													
Compliance Certification Services, Fremont 5m Chamber													
Test Engr:		Chin Pang											
Date:		06-01-11											
Project #:		11U13650											
Company:		Apple											
Test Target:		FCC 15.247											
Mode Oper:		HT20, TX, 5.8GHz Band											
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	Fldr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol V/H	Det. P/A/QP	Notes
Low Ch, 5745MHz													
11.490	3.0	46.3	38.1	9.5	-33.1	0.0	0.7	61.5	74.0	-12.5	H	P	
11.490	3.0	26.5	38.1	9.5	-33.1	0.0	0.7	41.6	54.0	-12.4	H	A	
11.490	3.0	49.1	38.1	9.5	-33.1	0.0	0.7	64.2	74.0	-9.8	V	P	
11.490	3.0	29.4	38.1	9.5	-33.1	0.0	0.7	44.6	54.0	-9.4	V	A	
Mid Ch, 5785MHz													
11.570	3.0	53.0	38.1	9.5	-33.0	0.0	0.7	68.3	74.0	-5.7	H	P	
11.570	3.0	30.5	38.1	9.5	-33.0	0.0	0.7	45.9	54.0	-8.1	H	A	
11.570	3.0	50.3	38.1	9.5	-33.0	0.0	0.7	65.6	74.0	-8.4	V	P	
11.570	3.0	30.4	38.1	9.5	-33.0	0.0	0.7	45.7	54.0	-8.3	V	A	
High Ch, 5825MHz													
11.650	3.0	50.4	38.2	9.6	-32.9	0.0	0.7	66.0	74.0	-8.0	H	P	
11.650	3.0	26.4	38.2	9.6	-32.9	0.0	0.7	42.0	54.0	-12.0	H	A	
11.650	3.0	52.7	38.2	9.6	-32.9	0.0	0.7	68.3	74.0	-5.7	V	P	
11.650	3.0	29.5	38.2	9.6	-32.9	0.0	0.7	45.1	54.0	-8.9	V	A	

Rev. 4.1.2.7

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

8.2.6. TRANSMITTER ABOVE 1 GHz FOR 802.11n HT40 MODE IN THE 5.8 GHz BAND

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement													
Compliance Certification Services, Fremont 5m Chamber													
Test Engr:		Chin Pang											
Date:		06-01-11											
Project #:		11U13650											
Company:		Apple											
Test Target:		FCC 15.247											
Mode Oper:		HT40, TX, 5.8GHz Band											
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
Low Ch, 5755MHz													
11.510	3.0	42.2	38.1	9.5	-33.1	0.0	0.7	57.4	74.0	-16.6	H	P	
11.510	3.0	23.9	38.1	9.5	-33.1	0.0	0.7	39.1	54.0	-14.9	H	A	
11.510	3.0	38.9	38.1	9.5	-33.1	0.0	0.7	54.1	74.0	-19.9	V	P	
11.510	3.0	24.1	38.1	9.5	-33.1	0.0	0.7	39.3	54.0	-14.7	V	A	
High Ch, 5795MHz													
11.590	3.0	41.3	38.2	9.5	-33.0	0.0	0.7	56.7	74.0	-17.3	H	P	
11.590	3.0	25.6	38.2	9.5	-33.0	0.0	0.7	41.0	54.0	-13.0	H	A	
11.590	3.0	41.4	38.2	9.5	-33.0	0.0	0.7	56.8	74.0	-17.2	V	P	
11.590	3.0	26.3	38.2	9.5	-33.0	0.0	0.7	41.7	54.0	-12.3	V	A	

Rev. 4.1.2.7

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

8.3. RECEIVER ABOVE 1 GHz

8.3.1. 20MHZ BANDWIDTH

High Frequency Measurement																
Compliance Certification Services, Fremont 5m Chamber																
Company:		Apple														
Project #:		11U13650														
Date:		2011-3-31														
Test Engineer:		Tom Chen														
Configuration:		EUT with support Laptop PC														
Mode:		RX mode, HT20														
Test Equipment:																
Horn 1-18GHz			Pre-amplifier 1-26GHz			Pre-amplifier 26-40GHz			Horn > 18GHz			Limit				
T73; S/N: 6717 @3m			T144 Miteq 3008A00931									RX RSS 210				
Hi Frequency Cables																
3' cable 22807700			12' cable 22807600			20' cable 22807500			HPF			Reject Filter			Peak Measurements RBW=VBW=1MHz Average Measurements RBW=1MHz; VBW=10Hz	
3' cable 22807700			12' cable 22807600			20' cable 22807500										
f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filt dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)	
1.293	3.0	44.5	29.2	24.8	2.7	-39.1	0.0	0.0	33.0	17.7	74	54	-41.0	-36.3	H	
1.587	3.0	40.8	25.5	25.8	3.0	-38.7	0.0	0.0	31.0	15.7	74	54	-43.0	-38.3	H	
2.493	3.0	41.5	26.2	28.5	3.9	-37.5	0.0	0.0	36.4	21.1	74	54	-37.6	-32.9	H	
5.000	3.0	41.3	26.0	33.2	5.9	-36.5	0.0	0.0	44.0	28.7	74	54	-30.0	-25.3	H	
1.293	3.0	47.2	31.9	24.8	2.7	-39.1	0.0	0.0	35.6	20.3	74	54	-38.4	-33.7	V	
2.493	3.0	44.7	29.4	28.5	3.9	-37.5	0.0	0.0	39.6	24.3	74	54	-34.4	-29.7	V	
5.000	3.0	42.5	27.2	33.2	5.9	-36.5	0.0	0.0	45.2	29.9	74	54	-28.8	-24.1	V	
Rev. 07.22.09																
f	Measurement Frequency			Amp	Preamp Gain			Avg Lim	Average Field Strength Limit							
Dist	Distance to Antenna			D Corr	Distance Correct to 3 meters			Pk Lim	Peak Field Strength Limit							
Read	Analyzer Reading			Avg	Average Field Strength @ 3 m			Avg Mar	Margin vs. Average Limit							
AF	Antenna Factor			Peak	Calculated Peak Field Strength			Pk Mar	Margin vs. Peak Limit							
CL	Cable Loss			HPF	High Pass Filter											

8.3.2. 40MHZ BANDWIDTH

High Frequency Measurement																
Compliance Certification Services, Fremont 5m Chamber																
Company:		Apple														
Project #:		11U13650														
Date:		2011-5-31														
Test Engineer:		Chin Pang														
Configuration:		EUT with support Laptop PC														
Mode:		RX mode, HT40														
Test Equipment:																
Horn 1-18GHz			Pre-amplifier 1-26GHz			Pre-amplifier 26-40GHz			Horn > 18GHz			Limit				
T73; S/N: 6717 @3m			T144 Miteq 3008A00931									RX RSS 210				
Hi Frequency Cables																
3' cable 22807700			12' cable 22807600			20' cable 22807500			HPF			Reject Filter			Peak Measurements RBW=VBW=1MHz Average Measurements RBW=1MHz, VBW=10Hz	
3' cable 22807700			12' cable 22807600			20' cable 22807500										
f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filt dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)	
1.293	3.0	51.5	34.5	24.8	2.7	-39.1	0.0	0.0	40.0	23.0	74	54	-34.0	-31.0	H	
2.493	3.0	52.3	33.0	28.5	3.9	-37.5	0.0	0.0	47.2	27.9	74	54	-26.8	-26.1	H	
5.000	3.0	50.0	29.2	33.2	5.9	-36.5	0.0	0.0	52.7	31.9	74	54	-21.3	-22.1	H	
1.293	3.0	53.1	35.5	24.8	2.7	-39.1	0.0	0.0	41.6	24.0	74	54	-32.4	-30.0	V	
2.493	3.0	52.5	33.2	28.5	3.9	-37.5	0.0	0.0	47.4	28.1	74	54	-26.6	-25.9	V	
5.000	3.0	51.0	30.0	33.2	5.9	-36.5	0.0	0.0	53.7	32.7	74	54	-20.3	-21.3	V	
Rev. 07.22.09																
f	Measurement Frequency		Amp	Preamp Gain		Avg Lim	Average Field Strength Limit									
Dist	Distance to Antenna		D Corr	Distance Correct to 3 meters		Pk Lim	Peak Field Strength Limit									
Read	Analyzer Reading		Avg	Average Field Strength @ 3 m		Avg Mar	Margin vs. Average Limit									
AF	Antenna Factor		Peak	Calculated Peak Field Strength		Pk Mar	Margin vs. Peak Limit									
CL	Cable Loss		HPF	High Pass Filter												

8.4. WORST-CASE BELOW 1 GHz

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

30-1000MHz Frequency Measurement													
Compliance Certification Services, Fremont 5m Chamber													
Test Engr:		Tom Chen											
Date:		03-31-11											
Project #:		11U13650											
Company:		Apple											
Test Target:		FCC Class B											
Mode Oper:		TX mode Worst Case											
f	Measurement Frequency	Amp	Preamp Gain	Margin	Margin vs. Limit								
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters										
Read	Analyzer Reading	Filter	Filter Insert Loss										
AF	Antenna Factor	Corr.	Calculated Field Strength										
CL	Cable Loss	Limit	Field Strength Limit										
f MHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Pad dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
148.565	3.0	45.8	12.7	1.1	29.3	0.0	0.0	30.3	43.5	-13.2	H	P	
166.566	3.0	52.9	10.4	1.2	29.3	0.0	0.0	35.2	43.5	-8.3	H	P	
384.015	3.0	44.8	14.8	1.9	29.2	0.0	0.0	32.2	46.0	-13.8	H	P	
443.897	3.0	45.0	15.8	2.0	29.5	0.0	0.0	33.3	46.0	-12.7	H	P	
517.7	3.0	46.6	17.1	2.2	29.7	0.0	0.0	36.1	46.0	-9.9	H	P	
796.592	3.0	42.3	21.0	2.8	29.2	0.0	0.0	36.9	46.0	-9.1	H	P	
39.36	3.0	48.7	14.6	0.5	29.6	0.0	0.0	34.2	40.0	-5.8	V	P	
99.723	3.0	46.4	10.0	0.9	29.5	0.0	0.0	27.8	43.5	-15.7	V	P	
384.015	3.0	44.4	14.8	1.9	29.2	0.0	0.0	31.8	46.0	-14.2	V	P	
398.295	3.0	49.1	15.0	1.9	29.3	0.0	0.0	36.7	46.0	-9.3	V	P	
585.983	3.0	41.5	18.0	2.4	29.6	0.0	0.0	32.3	46.0	-13.7	V	P	
779.551	3.0	33.0	20.6	2.8	29.2	0.0	0.0	27.2	46.0	-18.8	V	P	
Rev. 1.27.09													
Note: No other emissions were detected above the system noise floor.													

9. MAXIMUM PERMISSIBLE EXPOSURE

FCC RULES

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

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

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

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

f = frequency in MHz

* = Plane-wave equivalent power density

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

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

IC RULES

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

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

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

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

- Notes:**
1. Frequency, f , is in MHz.
 2. A power density of 10 W/m² is equivalent to 1 mW/cm².
 3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

EQUATIONS

Power density is given by:

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

where

S = Power density in W/m²

EIRP = Equivalent Isotropic Radiated Power in W

D = Separation distance in m

Power density in units of W/m² is converted to units of mWc/m² by dividing by 10.

Distance is given by:

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

where

D = Separation distance in m

EIRP = Equivalent Isotropic Radiated Power in W

S = Power density in W/m²

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

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

where

P_x = Power of transmitter x

G_x = Numeric gain of antenna x

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

LIMITS

From FCC §1.1310 Table 1 (B), the maximum value of $S = 1.0 \text{ mW/cm}^2$

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

RESULTS

Band (MHz)	Mode	Separation Distance (m)	Output Power (dBm)	Antenna Gain (dBi)	IC Power Density (W/m ²)	FCC Power Density (mW/cm ²)
2412 - 2462	b-mode Legacy	0.20	22.56	6.99	1.79	0.179
2412 - 2462	g-mode Legacy	0.20	27.61	6.99	5.74	0.574
2412 - 2462	HT20	0.20	27.51	6.99	5.61	0.561
5745 - 5825	a-mode Legacy	0.20	25.20	7.01	3.31	0.331
5745 - 5825	HT20	0.20	24.78	7.01	3.01	0.301
5755 - 5795	HT40	0.20	24.90	7.01	3.09	0.309