

### FCC CFR47 PART 15 SUBPART C INDUSTRY CANADA RSS-210 ISSUE 7

**CERTIFICATION TEST REPORT** 

FOR

### ACCESS POINT

### MODEL NUMBER: A1302

FCC ID: BCGA1302 IC: 579C-A1302

REPORT NUMBER: 08U12087-1, Revision A

**ISSUE DATE: FEBRUARY 06, 2009** 

Prepared for APPLE INC. 1 INFINITE LOOP CUPERTINO, CALIFORNIA 95014, U.S.A.

Prepared by COMPLIANCE CERTIFICATION SERVICES 47173 BENICIA STREET FREMONT, CA 94538, U.S.A. TEL: (510) 771-1000 FAX: (510) 661-0888

(R)

NVLAP LAB CODE 200065-0

#### **Revision History**

Rev.	lssue Date	Revisions	Revised By
	01/19/09	Initial Issue	F. Ibrahim
A	02/06/09	Revised Maximum Output Power section, revised section 7.5.2 for 99% plots, revised MPE section and antenna gains throughout the report	F. Ibrahim

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## **1. ATTESTATION OF TEST RESULTS**

COMPANY NAME:	APPLE, INC.
	1 INFINITY LOOP
	CUPERTINO, CALIFORNIA 95014, U.S.A.

- EUT DESCRIPTION: ACCESS POINT
- MODEL: A1302
- SERIAL NUMBER: 6F83504X2UJ

**DATE TESTED:** SEPTEMBER 10 – JANUARY 15, 2009

APPLICABLE STANDARDS				
STANDARD	TEST RESULTS			
CFR 47 Part 15 Subpart C	Pass			
INDUSTRY CANADA RSS-210 Issue 7 Annex 8	Pass			
INDUSTRY CANADA RSS-GEN Issue 2	Pass			

Compliance Certification Services, Inc. (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 CCS based on interpretations and/or observations of test results. 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 CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by CCS will constitute fraud and shall nullify the document. No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.

Approved & Released For CCS By:

FRANK IBRAHIM EMC SUPERVISOR COMPLIANCE CERTIFICATION SERVICES

Tested By:

1 Cautron quyin

THANH NGUYEN EMC ENGINEER COMPLIANCE CERTIFICATION SERVICES

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# 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2003, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 2, and RSS-210 Issue 7.

# 3. FACILITIES AND ACCREDITATION

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

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

# 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. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Power Line Conducted Emission	+/- 2.3 dB
Radiated Emission	+/- 3.4 dB

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

# 5. EQUIPMENT UNDER TEST

### 5.1. DESCRIPTION OF EUT

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

The radio module is manufactured by Ambit subsidiary of Foxconn, which is located in Hon Hai.

## 5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Frequency Range	Mode	Output Power	Output Power
(MHz)		(dBm)	(mW)
2412 - 2462	802.11b	21.72	148.59
2412 - 2462	802.11g	22.24	167.49
2412 - 2462	802.11n HT20	22.37	172.58
5745 - 5825	802.11a	28.37	687.07
5745 - 5805	802.11n HT20	28.25	668.34
5755 - 5795	802.11n HT40	28.25	668.34

# 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes the following PIFA antennas:

Model 631-0878 used for AP1, with a maximum gain of 3.49 dBi in the 2.4 GHz band.

Model 631-0860 used for AP3, with a maximum gain of -0.04 dBi in the 2.4 GHz band.

Model 631-0861 used for AP2, with a maximum gain of 3.62 dBi in the 5.2 GHz band, 3.18 dBi in the 5.3 GHz band, 3.66 dBi in the 5.6 GHz band and 3.4 dBi in the 5.8 GHz band.

Model 631-0859 used for AP4, with a maximum gain of 4.21 dBi in the 5.2 GHz band, 3.78 dBi in the 5.3 GHz band, 3.67 dBi in the 5.6 GHz band, and 2.61 dBi in the 5.8 GHz band.

# 5.4. SOFTWARE AND FIRMWARE

Firmware: k10\_7.4d4auto20080826T0200

EUT Driver Software: ARTR07B13

The test utility software used during testing was ART Build #13, rev. 0.79

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## 5.5. WORST-CASE CONFIGURATION AND MODE

For Radiated Emissions and Power line Conducted Emissions, the channel with the highest conducted output power was selected.

Worst-case data rates as provided by the manufacturer are: For 11b mode: 1Mbps For 11g mode: 6Mbps For 11n HT20 (2.4 GHz band): MCS1 For 11a mode: 6Mbps For 11n HT20 (5.8 GHz band): MCS1 For 11n HT40 (5.8 GHz band): MCS0

Peak Power Spectral Density was investigated in the 11b mode at Low Channel, for individual chains versus combiner, and it was determined that combiner is worst-case; therefore, all other measurements of PPSD in other channels and modes were performed using a combiner.

RF Conducted Spurious was investigated in the 11b mode for Low Channel, for individual chains versus combiner, and it was determined that the combiner is worst-case; therefore, all other measurements of RF conducted spurious were performed using a combiner.

RF Conducted Spurious was investigated in the 11a mode for Low Channel, for individual chains versus combiner, and it was determined that combiner is worst-case; therefore, all other measurements of RF conducted spurious were performed with combiner in the 5.8 GHz band.

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## 5.6. DESCRIPTION OF TEST SETUP

#### SUPPORT EQUIPMENT

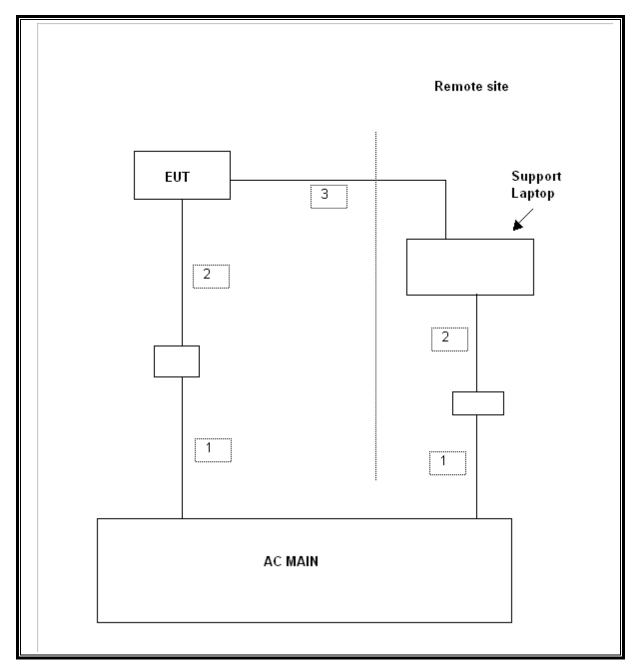
PERIPHERAL SUPPORT EQUIPMENT LIST							
Description Manufacturer Model Serial Number FCC ID							
AC/DC Adapter	Delta Elect., Inc.	611-0265	EH310BRPP5X	N/A			
PowerBook	Apple	MediaMac G4	PT382989	DoC			

#### I/O CABLES

	I/O CABLE LIST							
Cable	Port	# of	Connector	Cable	Cable	Remarks		
No.		Identica Ports	Туре	Туре	Length			
1	AC	2	US 115V	Un-shielded	2m	N/A		
2	DC	2	DC Plug	Un-shielded	2m	N/A		
3	WLAN	1	RJ45	Un-shielded	2m	N/A		

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#### **SETUP DIAGRAM FOR TESTS**



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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		
EMI Test Receiver	Agilent / HP	8542E	C00957	09/12/09		
RF Filter Section	Agilent / HP	85420E	C00958	09/12/09		
Bilog Antenna	Sunol Sciences	JB1	C01011	01/14/10		
Pre-amplifier	Agilent / HP	8447D	C00885	03/31/09		
18 GHz Horn Antenna	ETS	3117	C01006	04/22/09		
26.5 GHz Amplifier	Agilent / HP	8449B	C01063	09/27/09		
4.0 GHz High Pass Filter	Micro-Tronics	HPM13351	N02708	C.N.R.		
2.4-2.5 GHz Regect Filter	Micro-Tronics	BRM50702	N02685	C.N.R.		
5.725-5.825 GHz Reject Filter	Micro-Tronics	BRC13192	N02676	C.N.R.		
Peak Power Meter	Agilent / HP	E4416A	C00963	09/14/09		
10 kHz - 30 MHz LISN	FCC	LISN-50/250-25-2	N02625	10/25/09		
10 kHz - 30 MHz LISN	Solar	8012-50-R-24-BNC	N02481	10/25/09		
EMI Test Receiver	R&S	ESHS 20	N02396	08/06/09		
40 GHz Pre-amplifier	Miteq	NSP4000-SP2	C00990	02/04/10		
26.5 GHz Horn Antenna	ARA	MWH-1826/B	C00589	01/29/10		
40 GHz Horn Antenna	ARA	MWH-2640/B	C00981	04/29/09		

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# 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

### <u>LIMITS</u>

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

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

#### TEST PROCEDURE

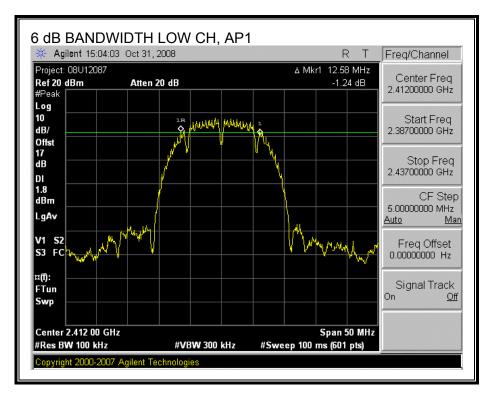
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

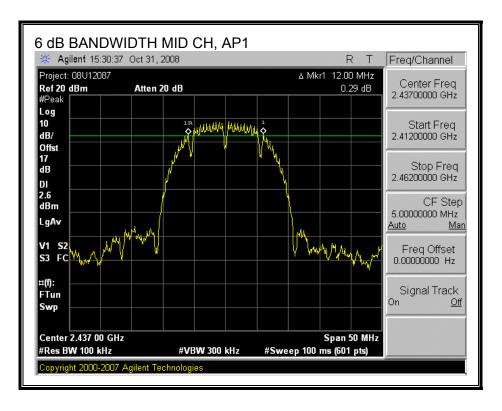
#### **RESULTS**

Channel	Frequency	AP1	AP3	Minimum Limit
		6 dB BW	6 dB BW	
	(MHz)	(MHz)	(MHz)	(MHz)
Low	2412	12.58	12.08	0.5
Middle	2437	12.00	12.17	0.5
High	2462	12.08	12.08	0.5

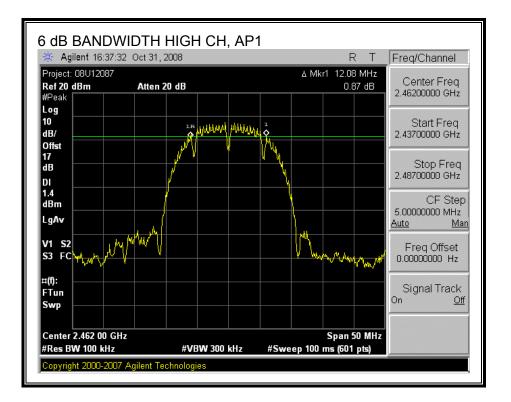
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#### 6 dB BANDWIDTH, AP1

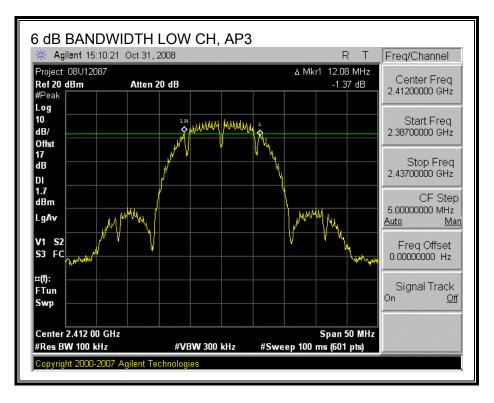




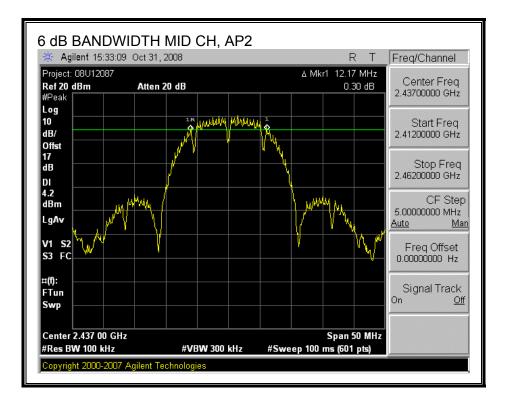
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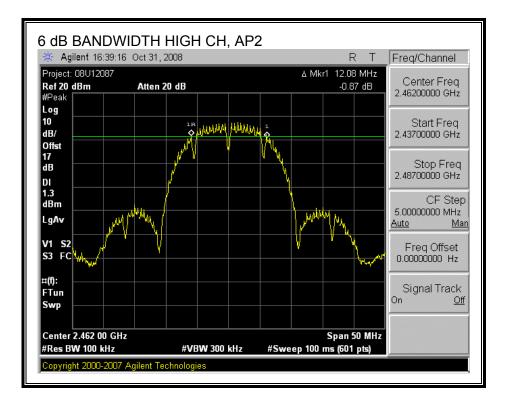


#### 6 dB BANDWIDTH, AP3



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### 7.1.2. 26dB and 99% BANDWIDTH

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 26dB (99%) bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 26dB (99%) bandwidth function is utilized.

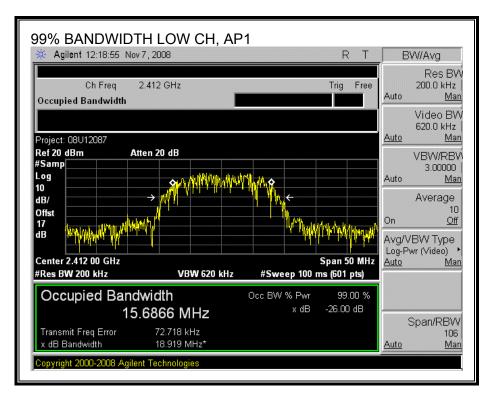
#### **RESULTS**

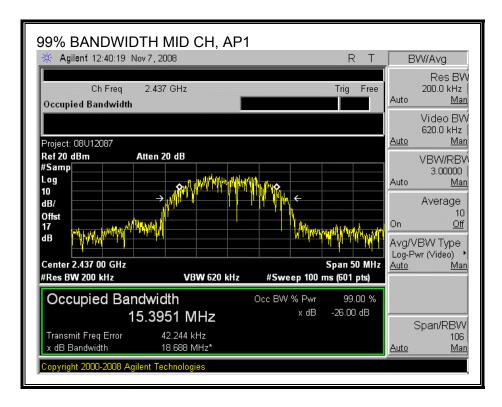
Channel	Frequency	AP1	AP3
		99% Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2412	15.6866	15.5786
Middle	2437	15.3951	15.7698
High	2462	15.4268	15.4815

Channel	Frequency	AP1	AP3
		26dB Bandwidth	26dB Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2412	18.919	18.048
Middle	2437	18.688	18.616
High	2462	18.625	18.403

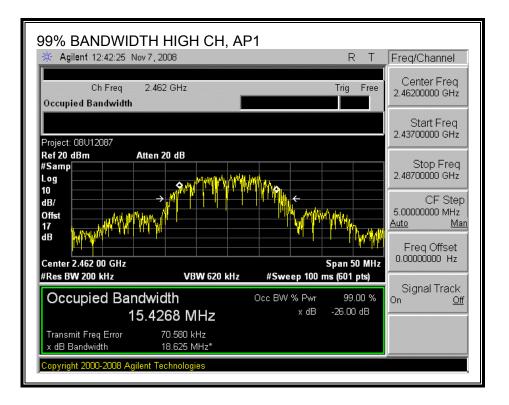
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#### 26dB and 99% BANDWIDTH, AP1

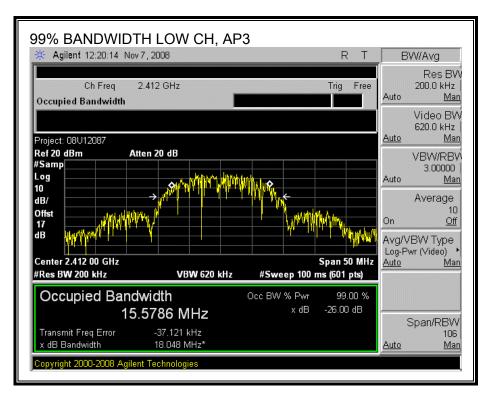




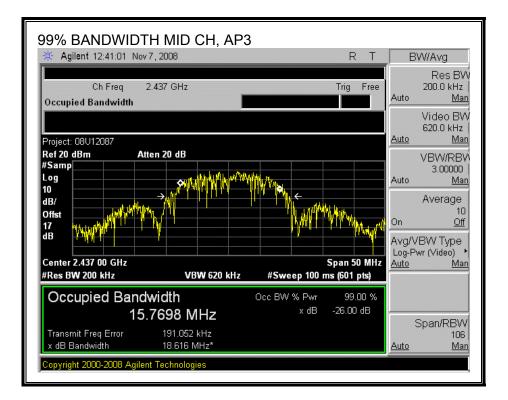
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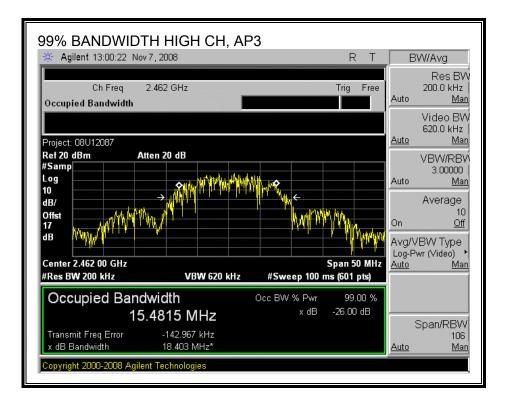


#### 26dB and 99% BANDWIDTH, AP3



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### 7.1.3. OUTPUT POWER

LIMITS

FCC §15.247 (b)

IC RSS-210 A8.4

The combined antenna gain =  $10 \log (10^{AG1/10} + 10^{AG2/10})$ The combined antenna gain = **5.08 dBi** The combined antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

#### TEST PROCEDURE

Peak power is measured using the spectrum analyzer's internal channel power integration function. Power is integrated over a bandwidth greater than or equal to the 26dB bandwidth.

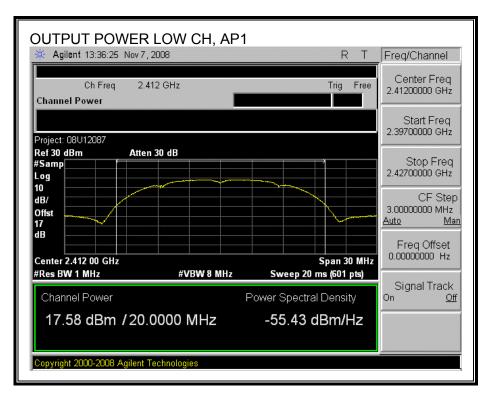
Maximum Conducted Output Power based on RMS averaging over a time interval is measured in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005. The transmitter operates continuously therefore Power Output Option 2, Method # 1 is used.

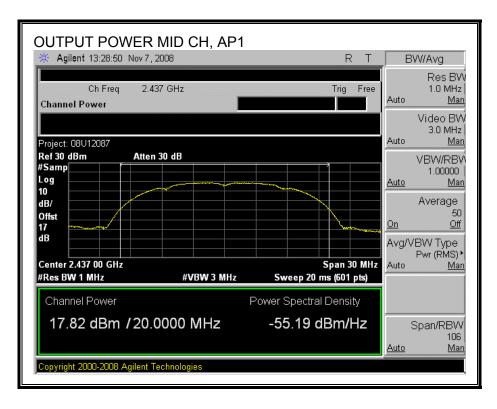
#### **RESULTS**

Channel	Frequency	Limit	AP1	AP3	Total	Margin
			Power	Power	Power	
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	2412	30.00	17.58	17.68	20.64	-9.36
Mid	2437	30.00	17.82	19.45	21.72	-8.28
High	2462	30.00	17.37	17.59	20.49	-9.51

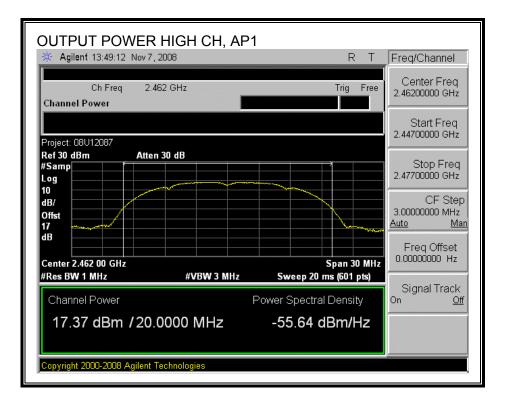
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#### AP1 OUTPUT POWER

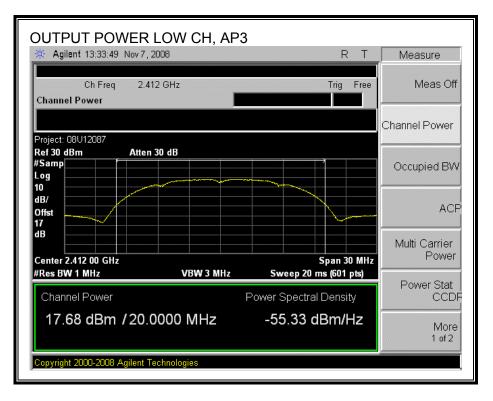




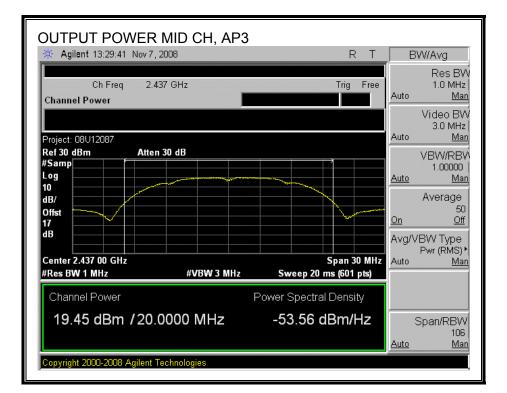
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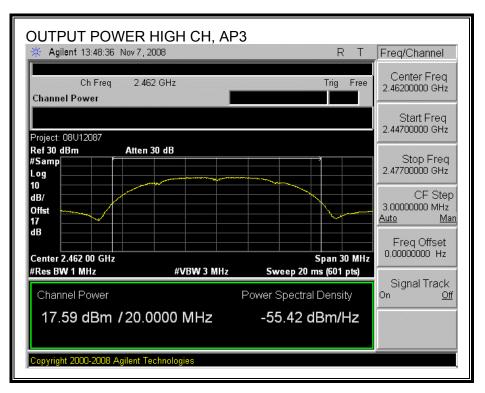


#### **AP3 OUTPUT POWER**



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### 7.1.4. POWER SPECTRAL DENSITY

#### LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

#### TEST PROCEDURE

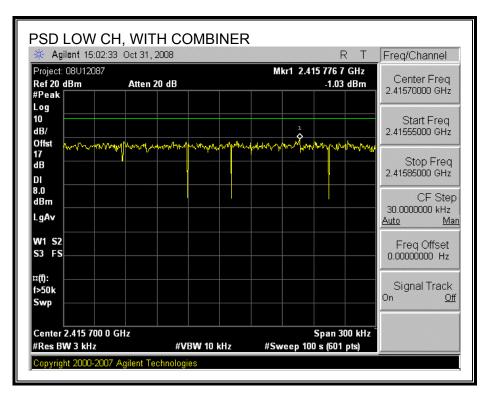
"Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

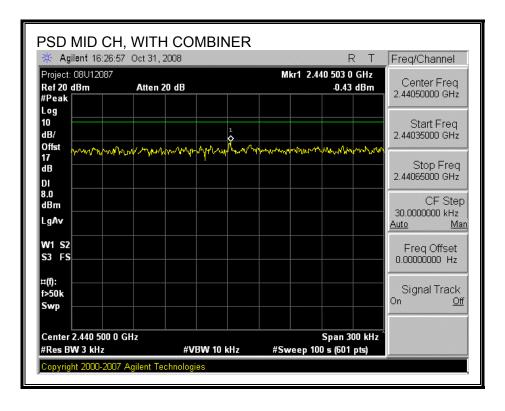
#### **RESULTS**

Channel	Frequency	PSD with Combiner	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
Low	2412	-1.03	8	-9.03
Middle	2437	-0.43	8	-8.43
High	2462	-1.67	8	-9.67

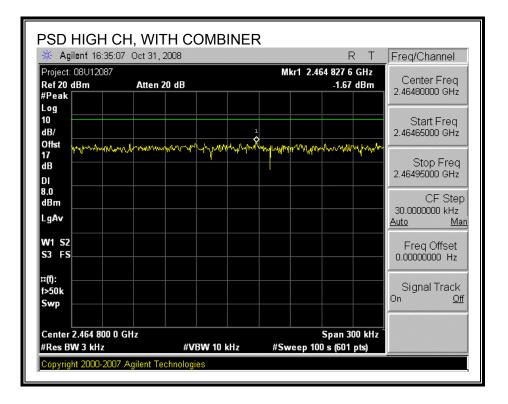
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#### POWER SPECTRAL DENSITY, WITH COMBINER





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### 7.1.5. CONDUCTED SPURIOUS EMISSIONS

#### <u>LIMITS</u>

FCC §15.247 (d)

IC RSS-210 A8.5

Output power was measured based on the use of RMS averaging over a time interval, therefore the required attenuation is 30 dB.

#### TEST PROCEDURE

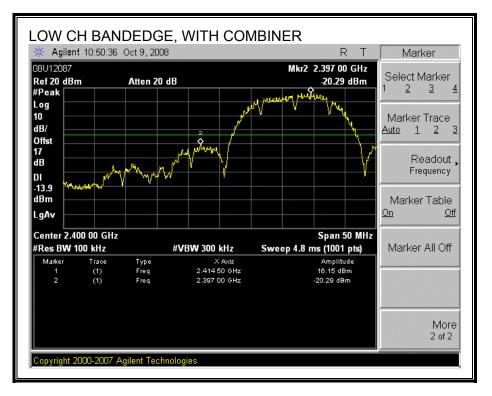
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

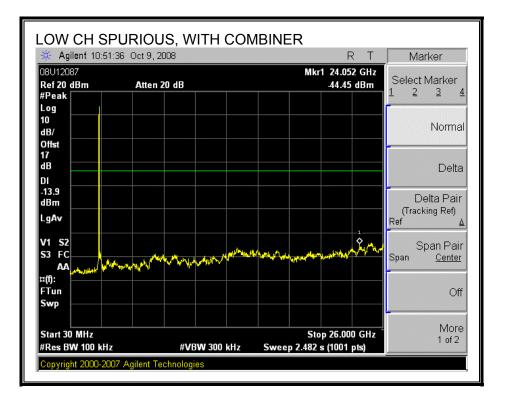
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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#### RESULTS

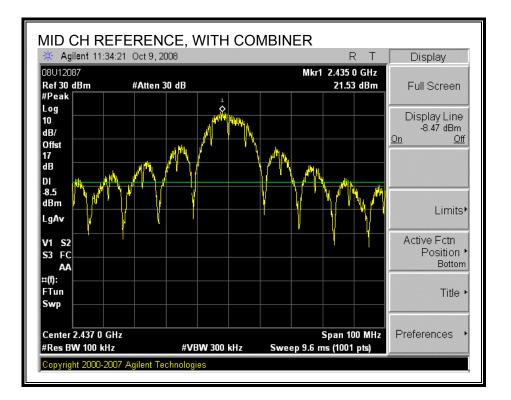
#### SPURIOUS EMISSIONS WITH COMBINER

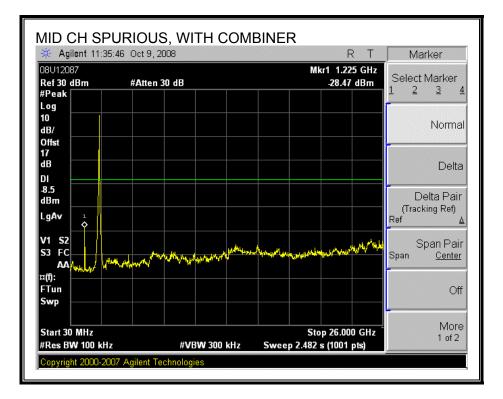




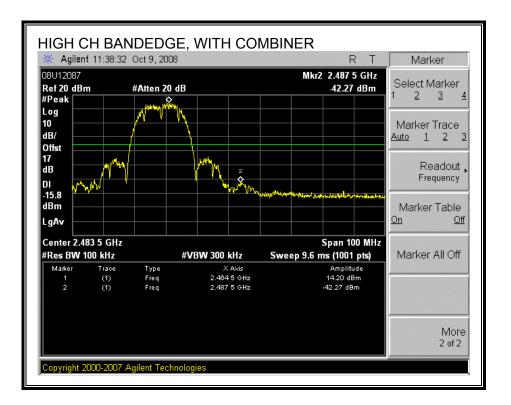
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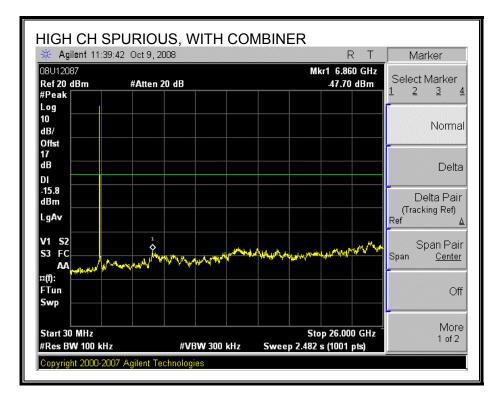
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## 7.2. 802.11g DUAL CHAIN LEGACY MODE IN THE 2.4 GHz BAND

### 7.2.1. 6 dB BANDWIDTH

#### LIMITS

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

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

#### TEST PROCEDURE

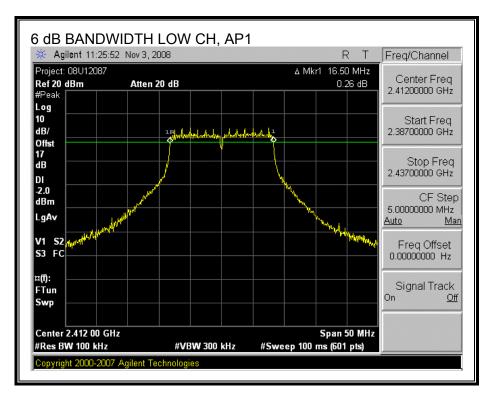
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

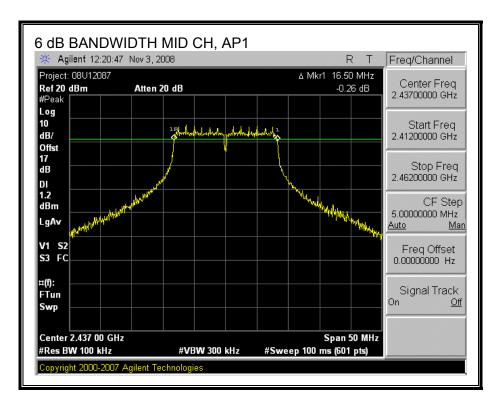
#### RESULTS

Channel	Frequency	AP1	AP3	Minimum Limit
		6 dB BW	6 dB BW	
	(MHz)	(MHz)	(MHz)	(MHz)
Low	2412	16.5	16.5	0.5
Middle	2437	16.5	16.5	0.5
High	2462	16.42	16.42	0.5

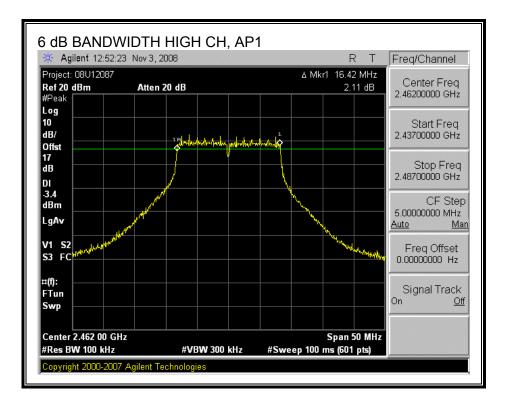
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#### 6 dB BANDWIDTH, AP1

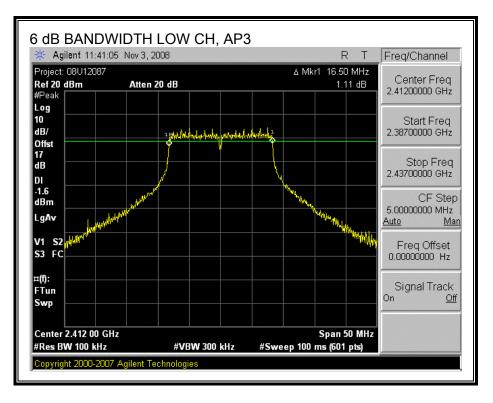




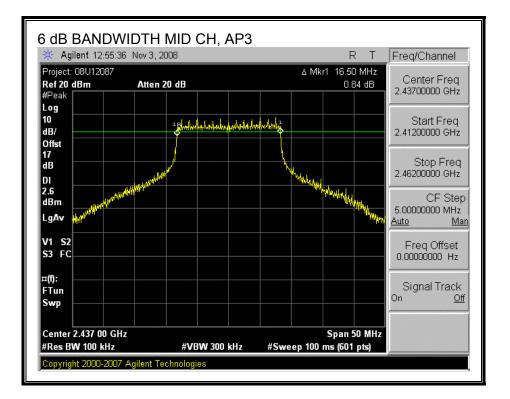
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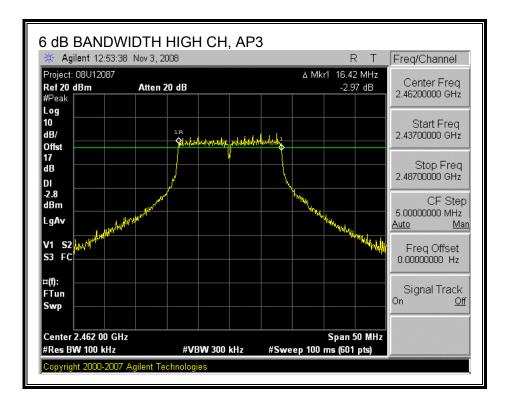


#### 6 dB BANDWIDTH, AP3



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### 7.2.2. 26dB and 99% BANDWIDTH

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 26dB (99 %) bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 26dB (99%) bandwidth function is utilized.

#### **RESULTS**

#### 99% BANDWIDTH

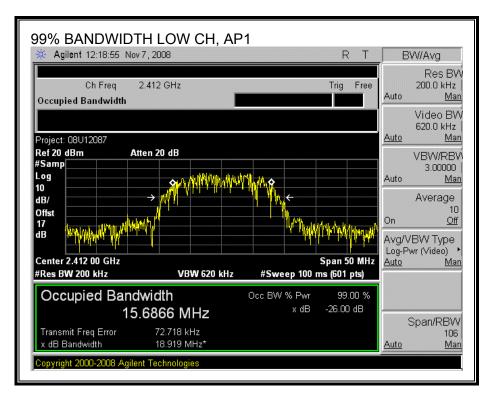
Channel	Frequency	AP1	AP3	
		99% Bandwidth	99% Bandwidth	
	(MHz)	(MHz)	(MHz)	
Low	2412	15.6866	15.5786	
Middle	2437	15.3951	15.7698	
High	2462	15.4268	15.4815	

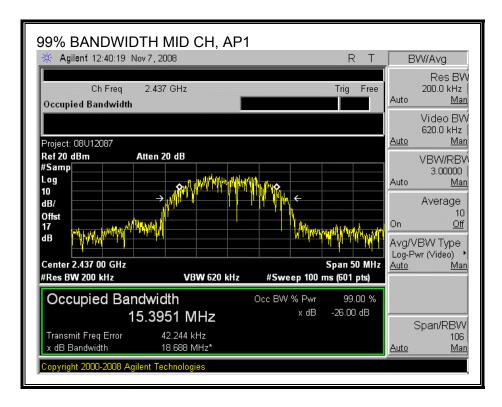
#### 26dB BANDWIDTH

Channel	Frequency	AP1	AP3
		26dB Bandwidth	26dB Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2412	18.919	18.048
Middle	2437	18.688	18.616
High	2462	18.625	18.403

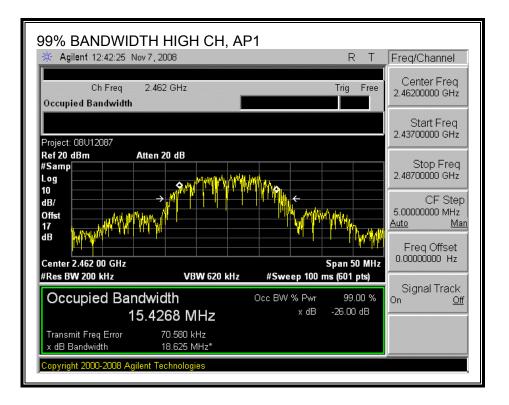
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#### 26dB and 99% BANDWIDTH, AP1

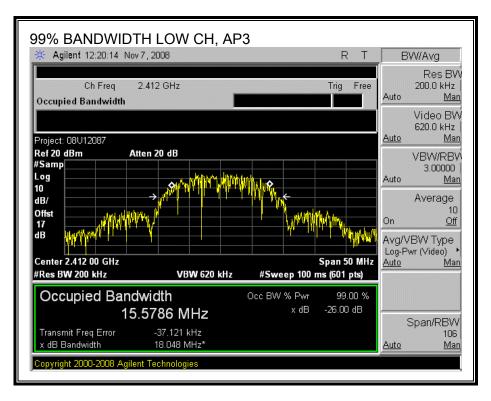




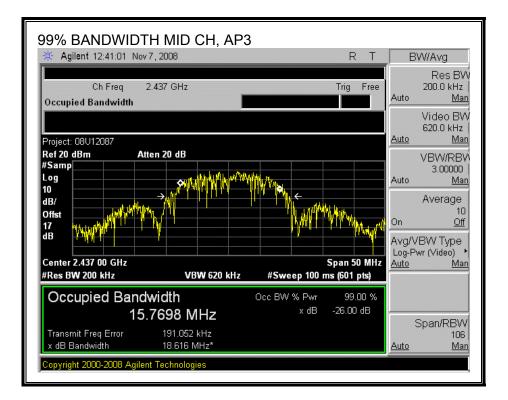
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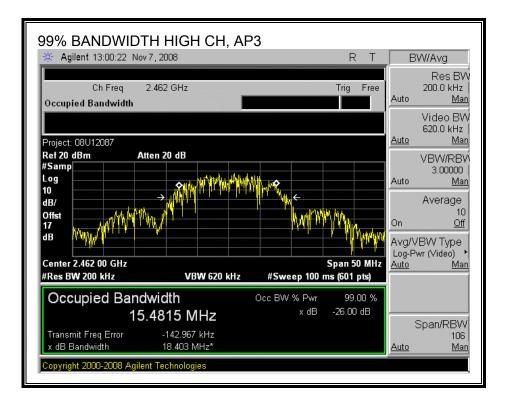


## 26dB and 99% BANDWIDTH, AP3



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# 7.2.3. OUTPUT POWER

<u>LIMITS</u>

FCC §15.247 (b)

IC RSS-210 A8.4

The combined antenna gain =  $10 \log (10^{AG1/10} + 10^{AG2/10})$ The combined antenna gain = **5.08 dBi** The combined antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

## TEST PROCEDURE

Peak power is measured using the spectrum analyzer's internal channel power integration function. Power is integrated over a bandwidth greater than or equal to the 26dB bandwidth.

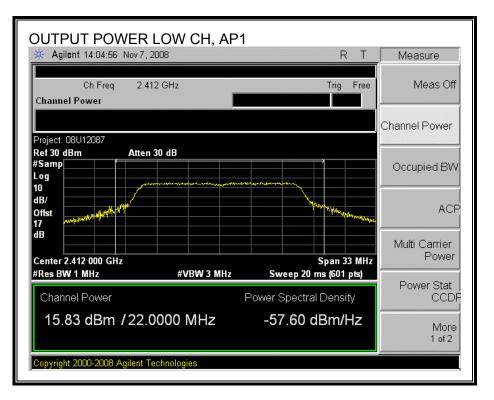
Maximum Conducted Output Power based on RMS averaging over a time interval is measured in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005. The transmitter operates continuously therefore Power Output Option 2, Method # 1 is used.

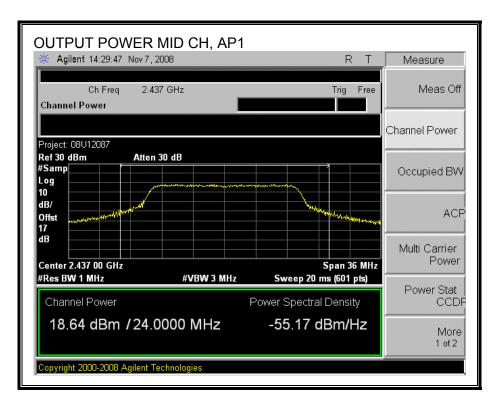
## **RESULTS**

Channel	Frequency	Limit	AP1	AP3	Total	Margin
			Power	Power	Power	
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	2412	30.00	15.83	15.86	18.86	-11.14
Mid	2437	30.00	18.64	19.75	22.24	-7.76
High	2462	30.00	13.76	14.40	17.10	-12.90

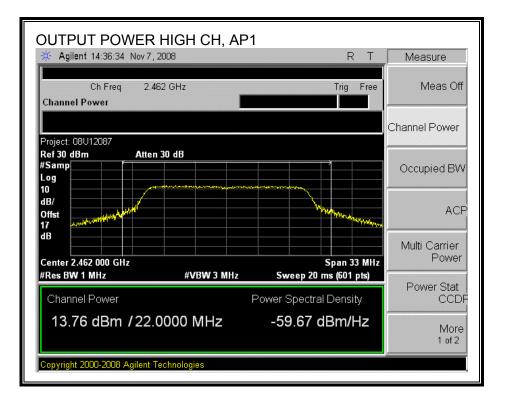
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## AP1 OUTPUT POWER

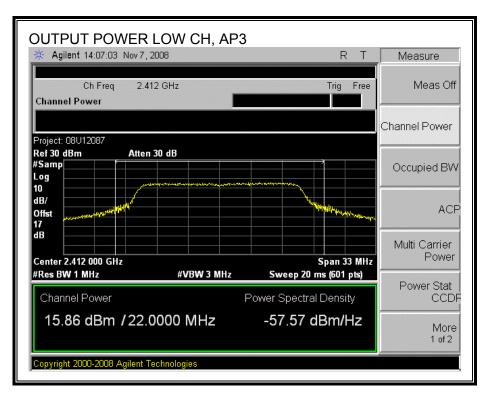




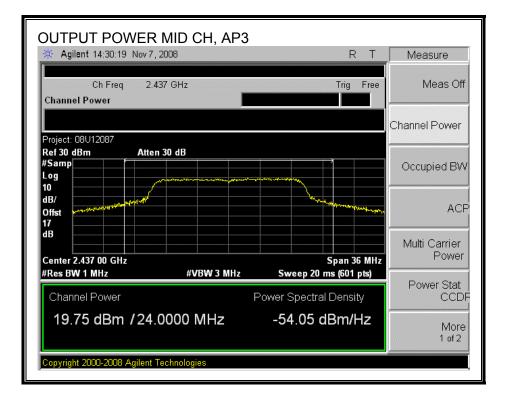
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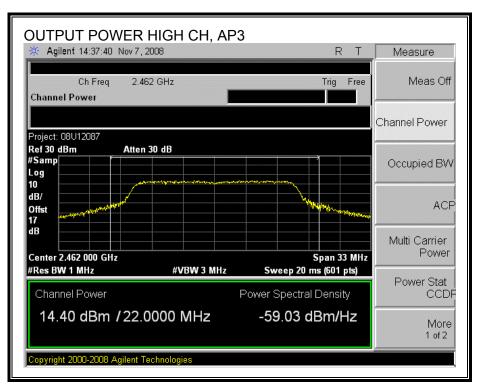


## **AP3 OUTPUT POWER**



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# 7.2.4. POWER SPECTRAL DENSITY

## LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

## TEST PROCEDURE

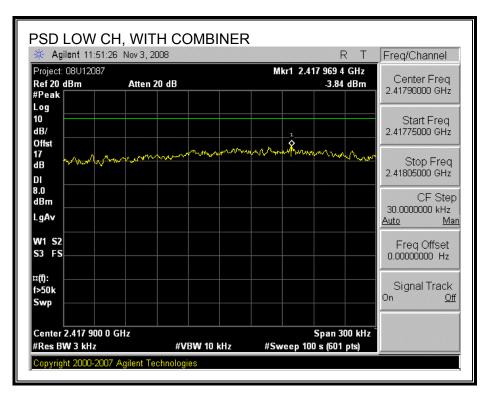
"Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

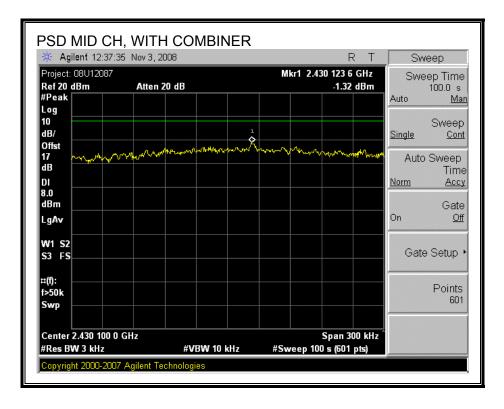
## **RESULTS**

Channel	Frequency	PSD with Combiner	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
Low	2412	-3.84	8	-11.84
Middle	2437	-1.32	8	-9.32
High	2462	-5.50	8	-13.50

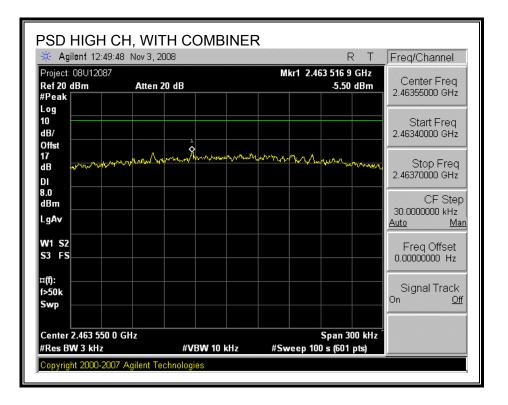
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### POWER SPECTRAL DENSITY, WITH COMBINER





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## 7.2.5. CONDUCTED SPURIOUS EMISSIONS

## <u>LIMITS</u>

FCC §15.247 (d)

IC RSS-210 A8.5

Output power was measured based on the use of RMS averaging over a time interval, therefore the required attenuation is 30 dB.

## TEST PROCEDURE

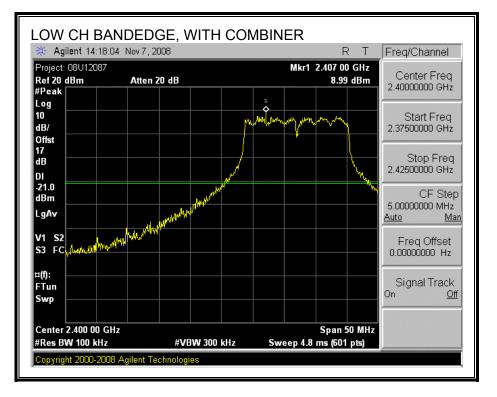
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

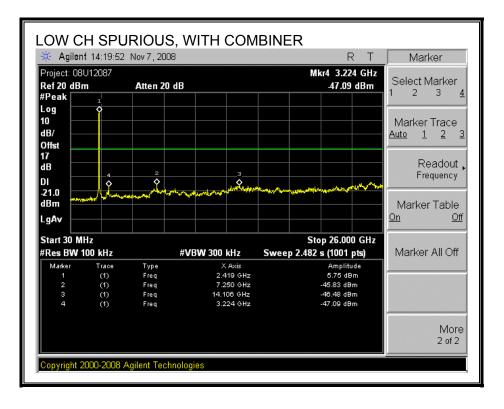
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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### RESULTS

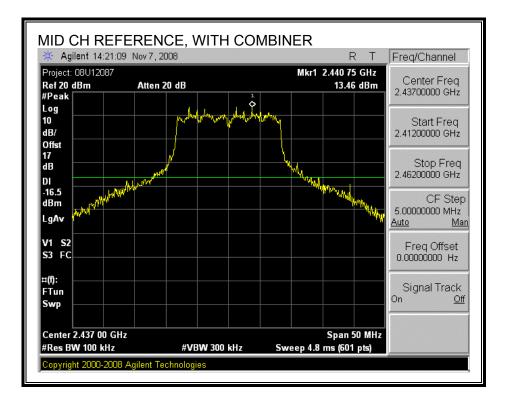
#### SPURIOUS EMISSIONS WITH COMBINER

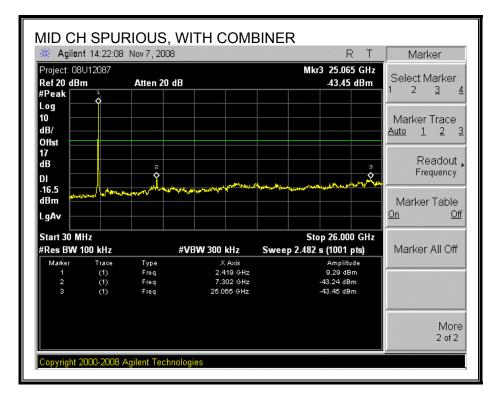




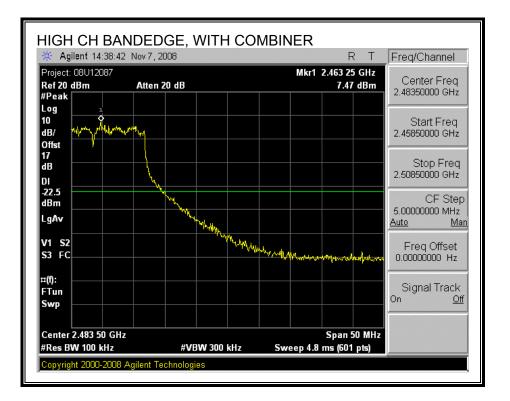
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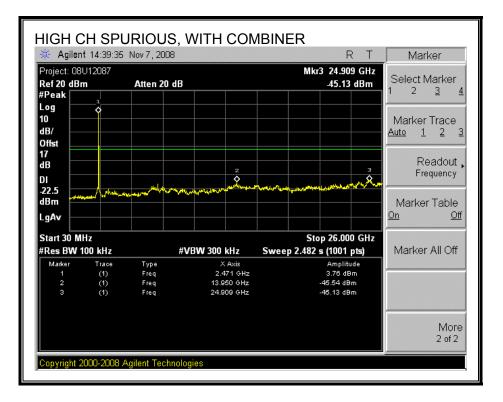
COMPLIANCE CERTIFICATION SERVICESFORM NO: CCSUP4031B47173 BENICIA STREET, FREMONT, CA 94538, USATEL: (510) 771-1000FAX: (510) 661-0888This report shall not be reproduced except in full, without the written approval of CCS.





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# 7.3. 802.11n HT20 MODE IN THE 2.4 GHz BAND

## 7.3.1. 6 dB BANDWIDTH

## LIMITS

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

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

### TEST PROCEDURE

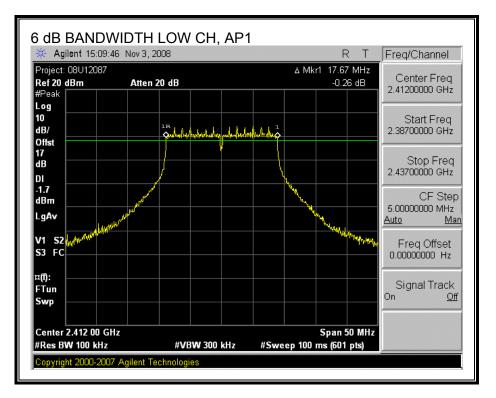
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

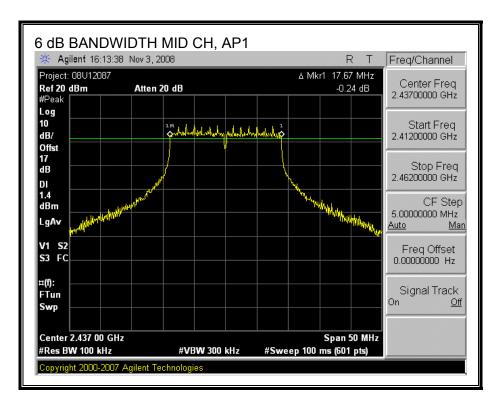
### <u>RESULTS</u>

Channel	Frequency	AP1	AP3	Minimum Limit
		6 dB BW	6 dB BW	
	(MHz)	(MHz)	(MHz)	(MHz)
Low	2412	17.67	17.67	0.5
Middle	2437	17.67	17.67	0.5
High	2462	17.67	17.67	0.5

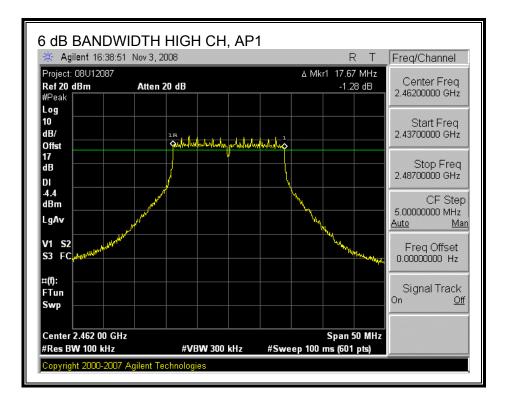
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#### 6 dB BANDWIDTH, AP1

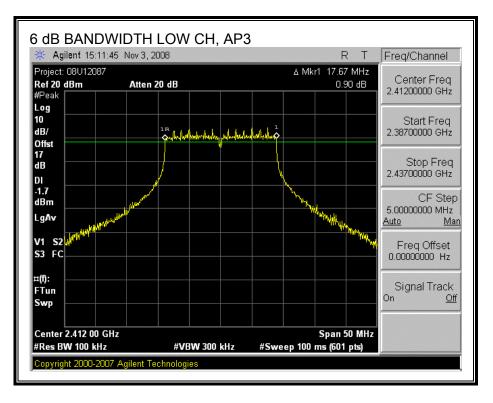




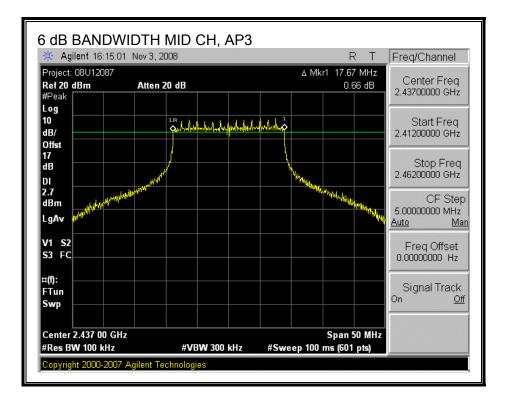
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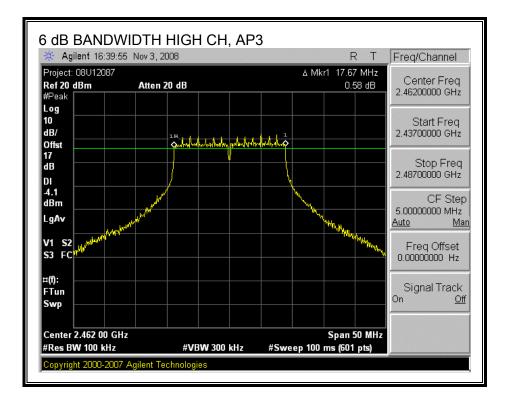


## 6 dB BANDWIDTH, AP3



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## 7.3.2. 26dB and 99% BANDWIDTH

## LIMITS

None; for reporting purposes only.

### TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 26dB (99 %) bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 26dB (99%) bandwidth function is utilized.

#### RESULTS

#### 99% BANDWIDTH

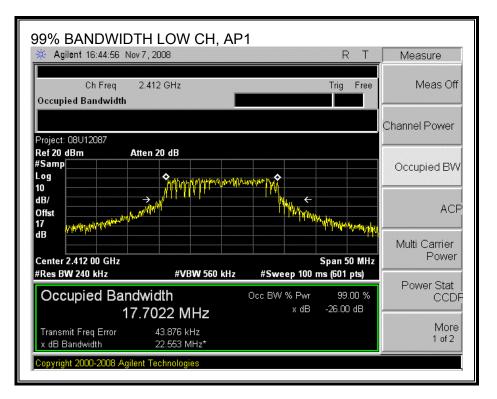
Channel	Frequency	AP1	AP3
		99% Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2412	17.7022	17.6602
Middle	2437	17.7556	17.7974
High	2462	17.5368	17.7462

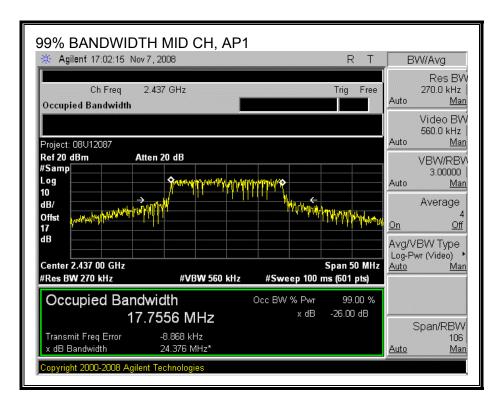
### 26dB BANDWIDTH

Channel	Frequency	AP1	AP3
		26dB Bandwidth	26dB Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2412	22.553	22.450
Middle	2437	24.376	24.413
High	2462	21.202	21.479

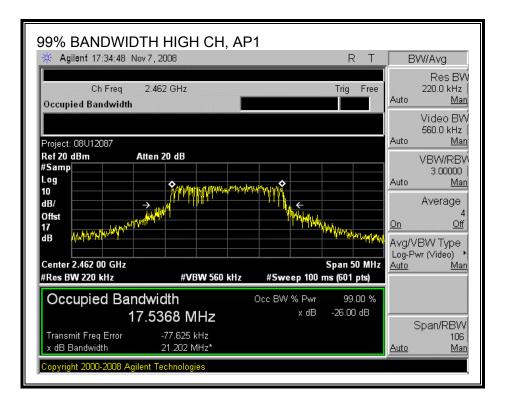
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#### 26dB and 99% BANDWIDTH, AP1

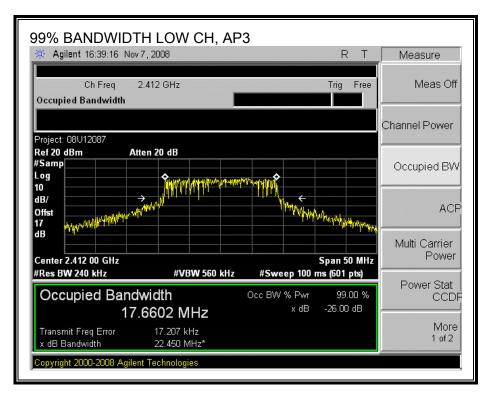




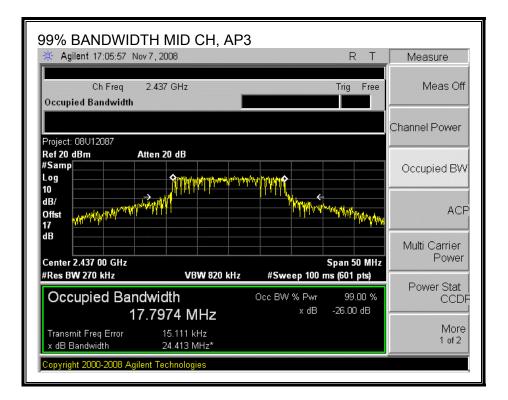
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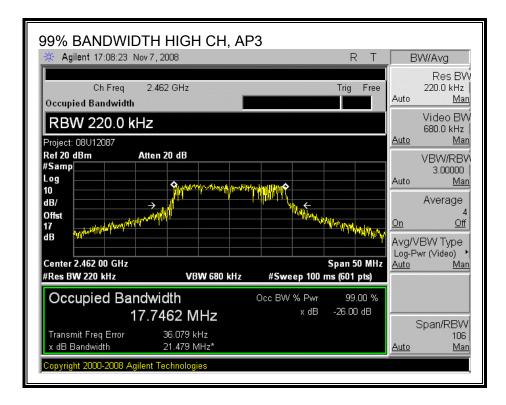


## 26dB and 99% BANDWIDTH, AP3



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# 7.3.3. OUTPUT POWER

## <u>LIMITS</u>

FCC §15.247 (b)

IC RSS-210 A8.4

The maximum antenna gain of **3.49 dBi** is less than or equal to 6 dBi, therefore the limit is 30 dBm.

## TEST PROCEDURE

Peak power is measured using the spectrum analyzer's internal channel power integration function. Power is integrated over a bandwidth greater than or equal to the 26dB bandwidth.

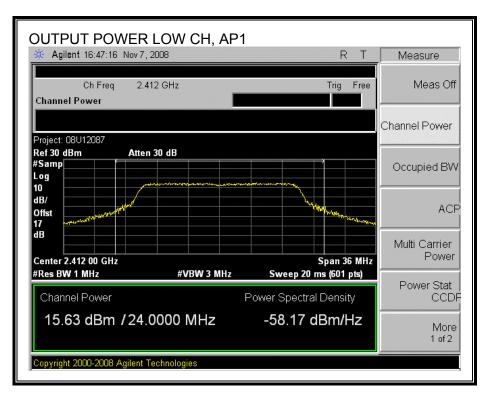
Maximum Conducted Output Power based on RMS averaging over a time interval is measured in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005. The transmitter operates continuously therefore Power Output Option 2, Method # 1 is used.

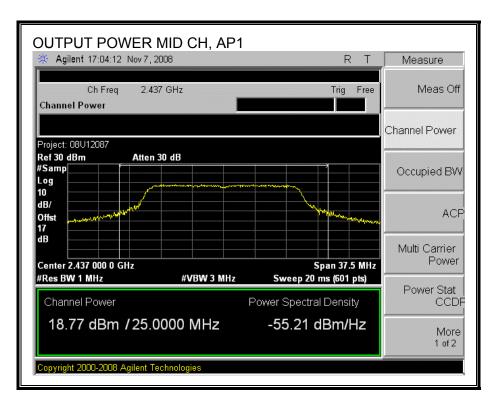
## RESULTS

Channel	Frequency	Limit	AP1	AP3	Total	Margin
			Power	Power	Power	
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	2412	30.00	15.63	15.79	18.72	-11.28
Mid	2437	30.00	18.77	19.88	22.37	-7.63
High	2462	30.00	13.10	12.75	15.94	-14.06

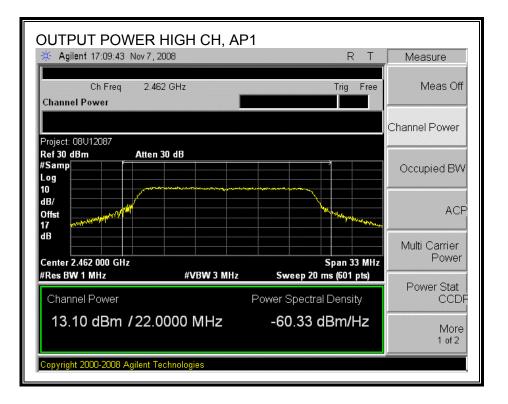
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## AP1 OUTPUT POWER

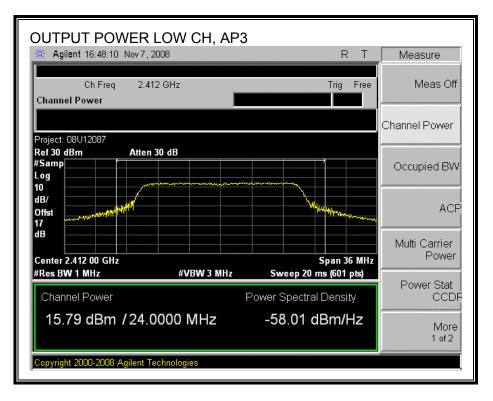




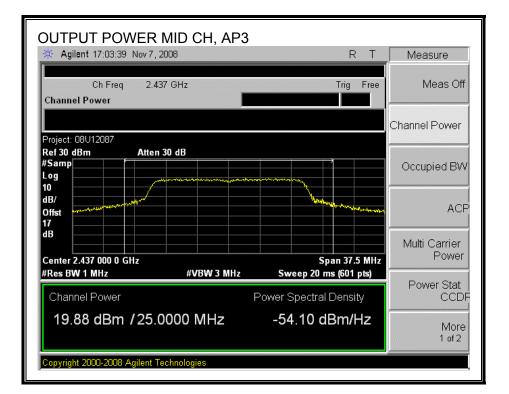
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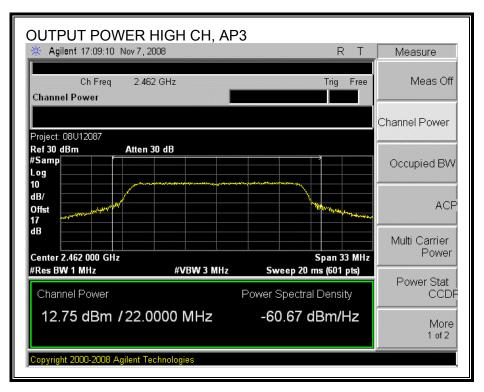


## AP3 OUTPUT POWER



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# 7.3.4. POWER SPECTRAL DENSITY

## LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

## TEST PROCEDURE

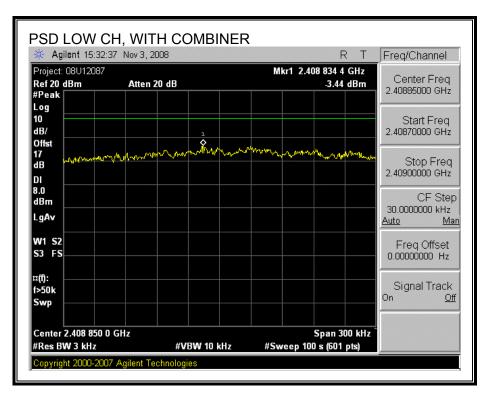
"Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

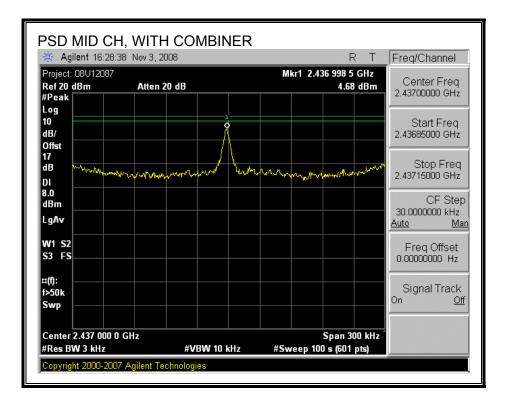
## **RESULTS**

Channel	Frequency	PSD with Combiner	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
Low	2412	-3.44	8	-11.44
Middle	2437	4.68	8	-3.32
High	2462	-6.57	8	-14.57

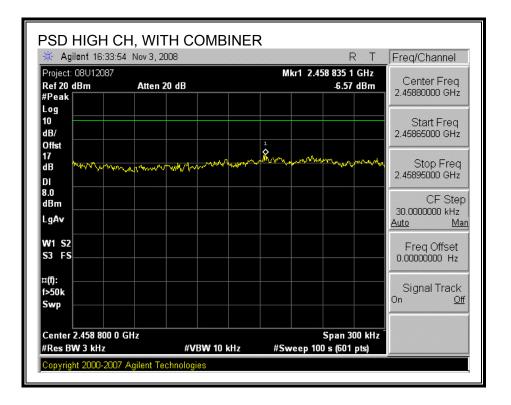
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### POWER SPECTRAL DENSITY, WITH COMBINER





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## 7.3.5. CONDUCTED SPURIOUS EMISSIONS

## <u>LIMITS</u>

FCC §15.247 (d)

IC RSS-210 A8.5

Output power was measured based on the use of RMS averaging over a time interval, therefore the required attenuation is 30 dB.

## TEST PROCEDURE

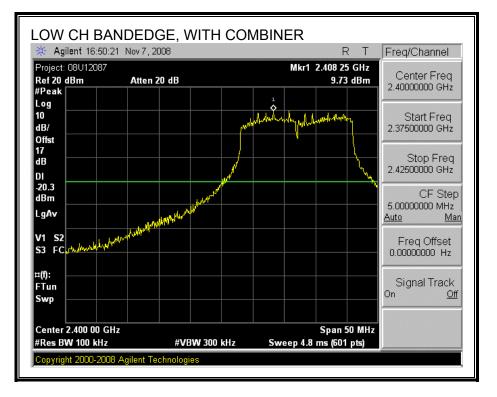
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

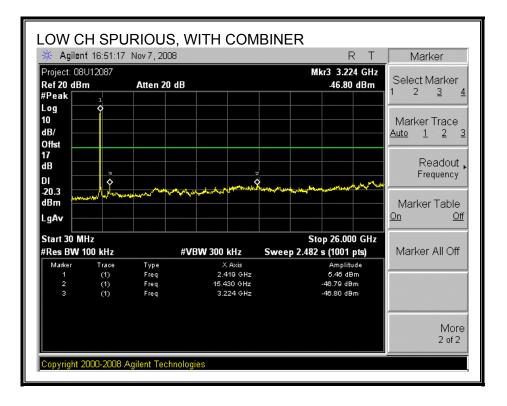
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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### **RESULTS**

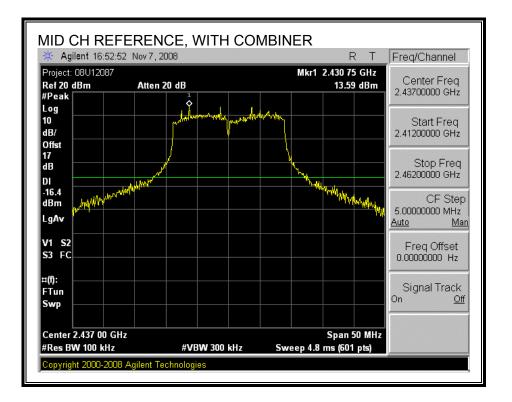
#### SPURIOUS EMISSIONS WITH COMBINER

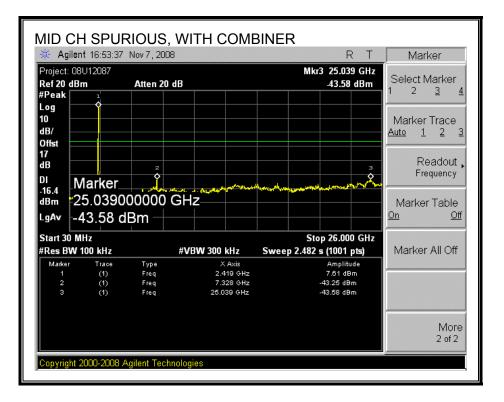




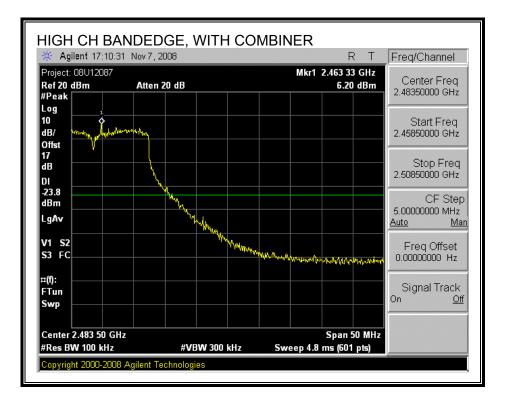
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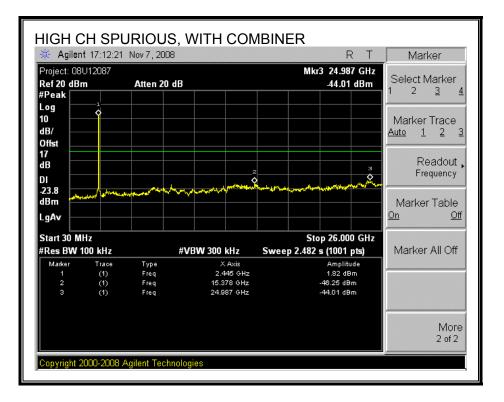
COMPLIANCE CERTIFICATION SERVICESFORM NO: CCSUP4031B47173 BENICIA STREET, FREMONT, CA 94538, USATEL: (510) 771-1000FAX: (510) 661-0888This report shall not be reproduced except in full, without the written approval of CCS.





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# 7.4. 802.11a MODE IN THE 5.8 GHz BAND

# 7.4.1. 6 dB BANDWIDTH

## <u>LIMITS</u>

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

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

## TEST PROCEDURE

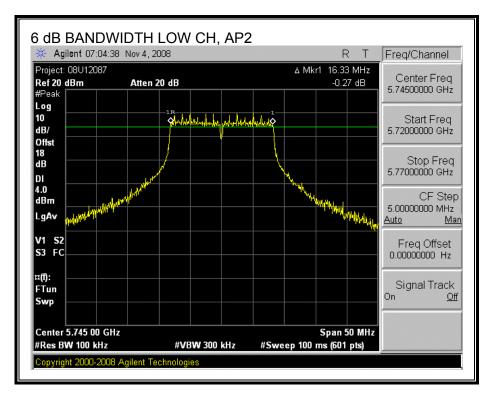
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

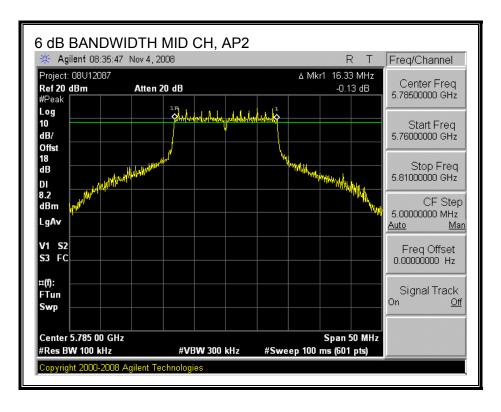
### **RESULTS**

Channel	Frequency	AP2	AP4	Minimum Limit
		6 dB BW	6 dB BW	
	(MHz)	(MHz)	(MHz)	(MHz)
Low	5745	16.33	16.33	0.5
Middle	5785	16.33	16.33	0.5
High	5825	16.33	16.42	0.5

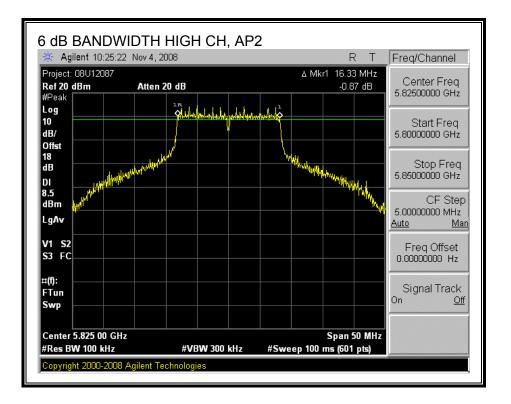
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#### 6 dB BANDWIDTH, AP2

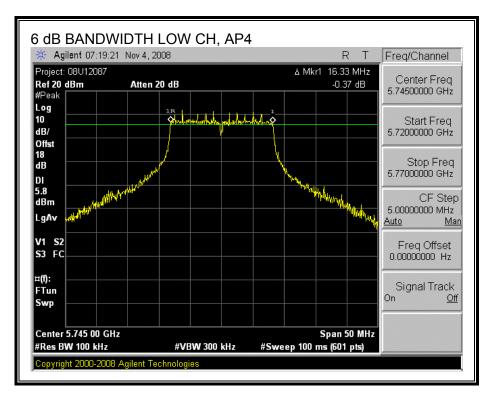




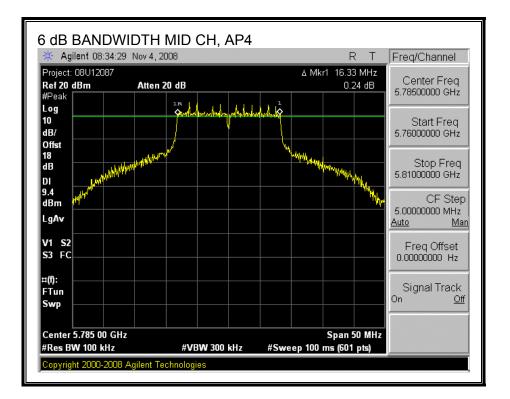
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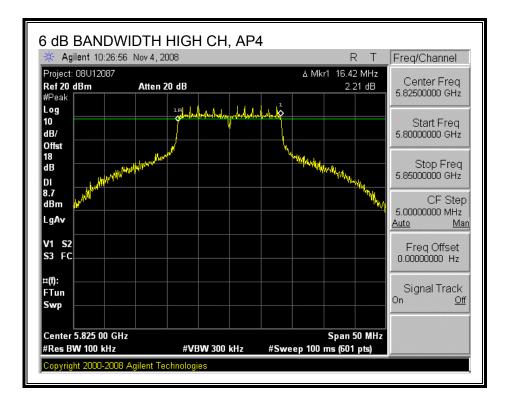


## 6 dB BANDWIDTH, AP4



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## 7.4.2. 26 and 99% BANDWIDTH

## LIMITS

None; for reporting purposes only.

## TEST PROCEDURE

The transmitter outputs are connected to the spectrum analyzer via a combiner. The RBW is set to 1% to 3% of the measured bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal bandwidth function is utilized.

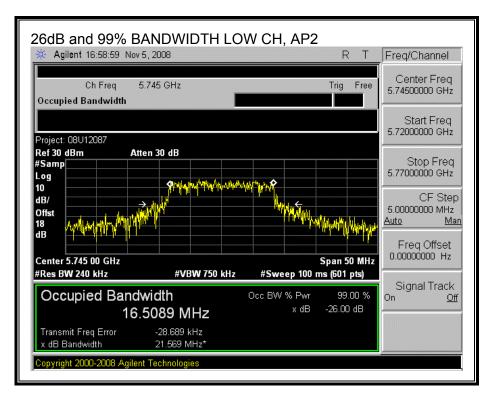
#### **RESULTS**

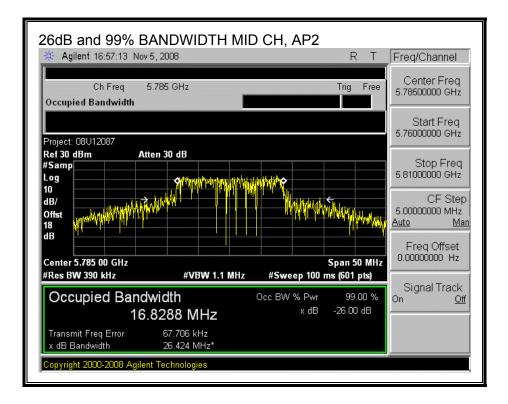
Channel	Frequency	AP2	AP4
		99% Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	5745	16.5089	16.6189
Middle	5785	16.8288	16.8360
High	5825	16.6828	16.9876

Channel	Frequency	AP2	AP 4
		26 dB Bandwidth	26 dB Bandwidth
	(MHz)	(MHz)	(MHz)
Low	5745	21.569	21.619
Middle	5785	26.424	32.635
High	5825	25.756	33.414

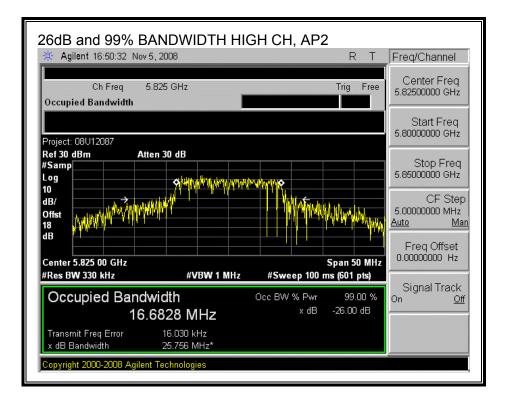
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#### 26 dB and 26dB and 99% BANDWIDTH, AP2

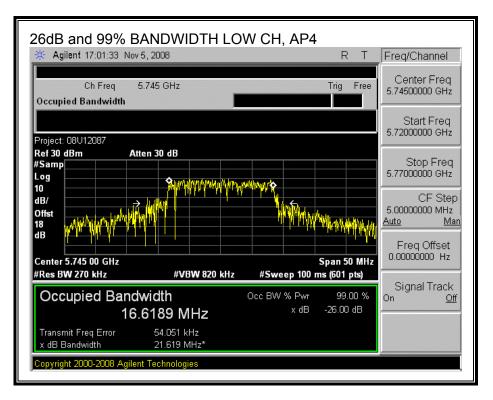




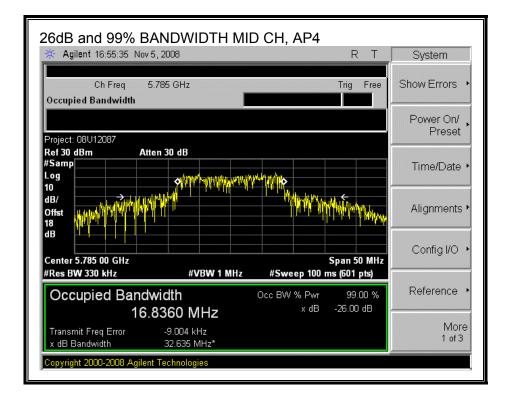
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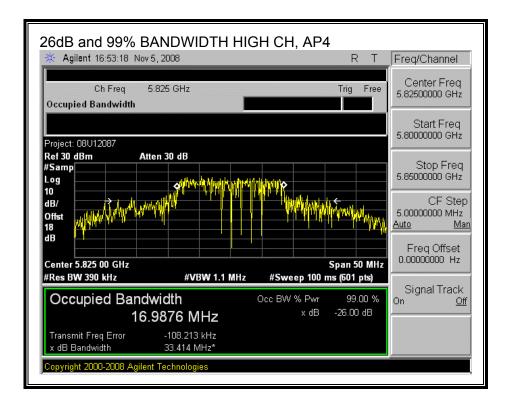


## 26dB and 26dB and 99% BANDWIDTH, AP4



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## 7.4.3. OUTPUT POWER

<u>LIMITS</u>

FCC §15.247 (b)

IC RSS-210 A8.4

The combined antenna gain =  $10 \log (10^{(AG1/10)} + 10^{(AG2/10)})$ The combined antenna gain = **6.03 dBi** The combined antenna gain is greater than 6 dBi by 0.03 dB, therefore the limit is 29.97 dBm.

### TEST PROCEDURE

Peak power is measured using the spectrum analyzer's internal channel power integration function. Power is integrated over a bandwidth greater than or equal to the 26dB bandwidth.

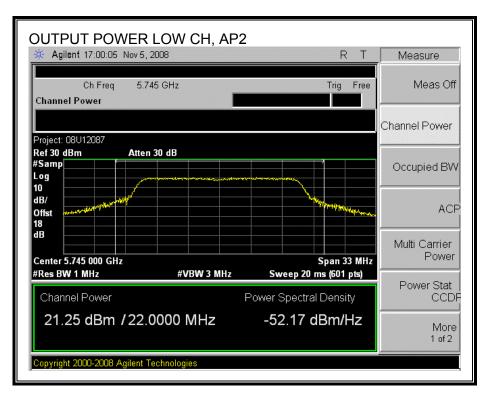
Maximum Conducted Output Power based on RMS averaging over a time interval is measured in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005. The transmitter operates continuously therefore Power Output Option 2, Method # 1 is used.

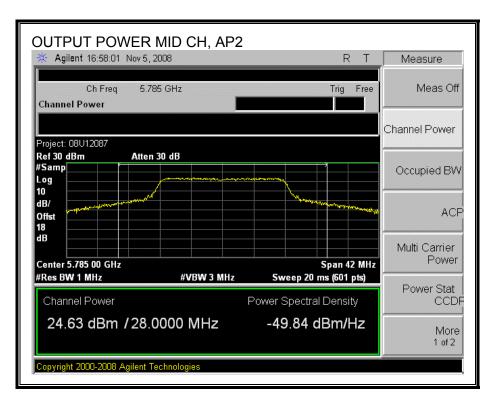
### **RESULTS**

Channel	Frequency	Limit	AP2	AP4	Total	Margin
			Power	Power	Power	
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	5745	29.97	21.25	22.12	24.72	-5.25
Mid	5785	29.97	24.63	25.98	28.37	-1.60
High	5825	29.97	24.48	25.16	27.84	-2.13

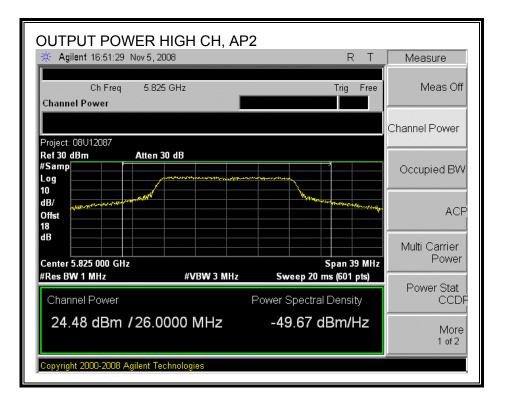
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#### **AP2 OUTPUT POWER**

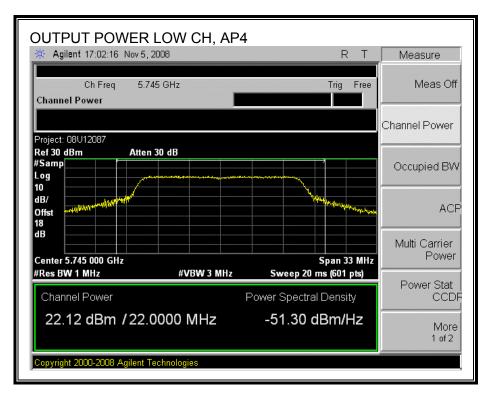




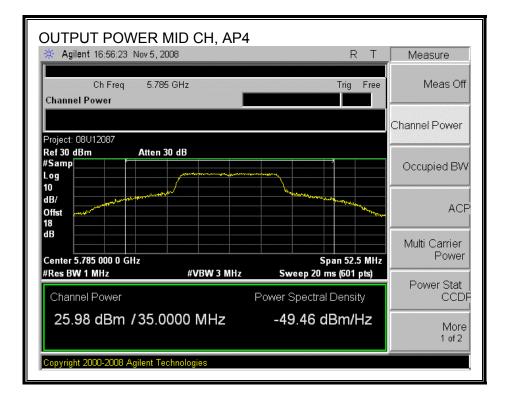
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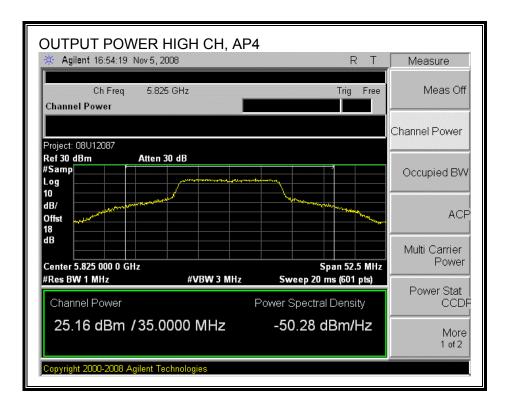


## AP4 OUTPUT POWER



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## 7.4.4. POWER SPECTRAL DENSITY

## LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### TEST PROCEDURE

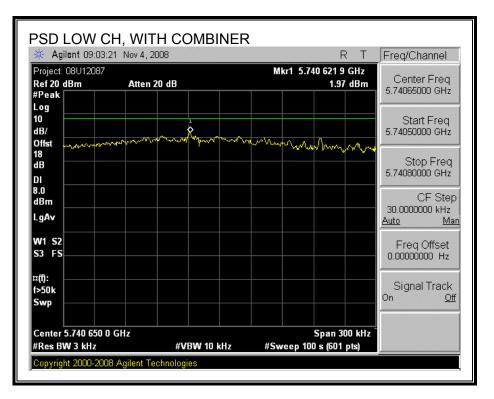
"Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

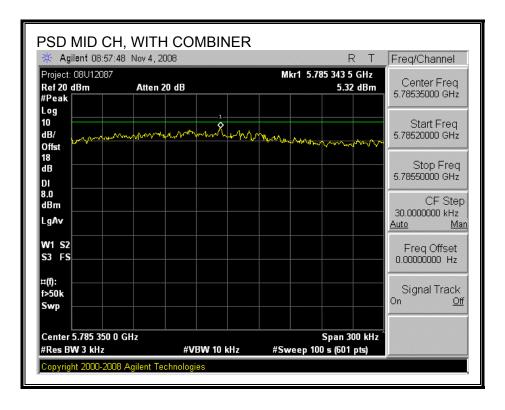
### <u>RESULTS</u>

Channel	Frequency	PSD with Combiner	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
Low	5745	1.97	8	-6.03
Middle	5785	5.32	8	-2.68
High	5825	5.12	8	-2.88

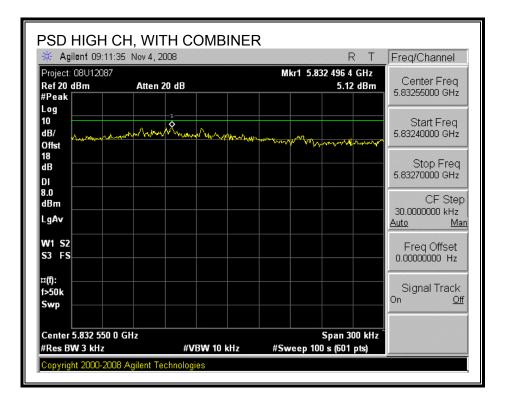
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#### POWER SPECTRAL DENSITY, WITH COMBINER





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## 7.4.5. CONDUCTED SPURIOUS EMISSIONS

## <u>LIMITS</u>

FCC §15.247 (d)

IC RSS-210 A8.5

Output power was measured based on the use of RMS averaging over a time interval, therefore the required attenuation is 30 dB.

### TEST PROCEDURE

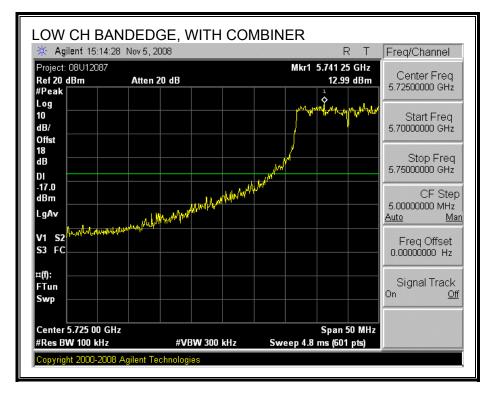
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

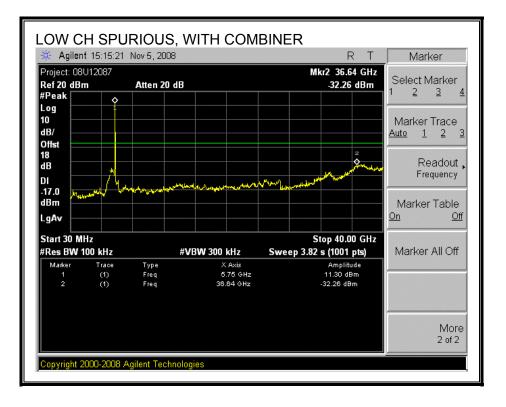
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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#### RESULTS

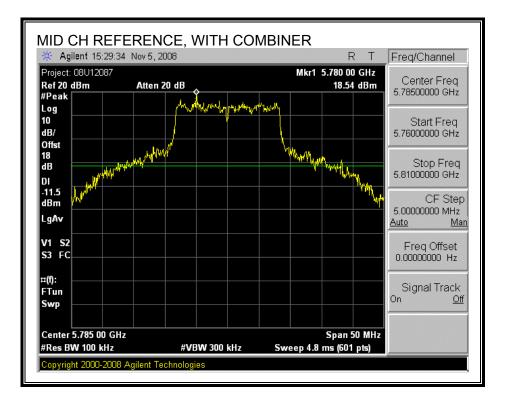
#### SPURIOUS EMISSIONS WITH COMBINER

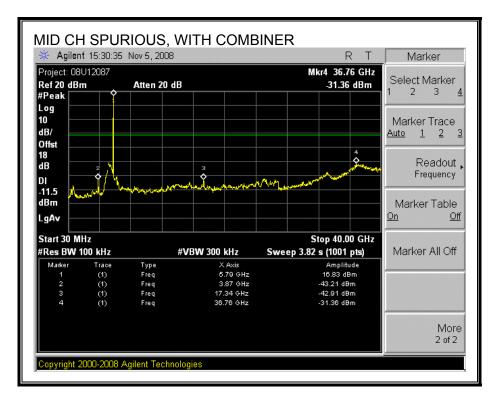




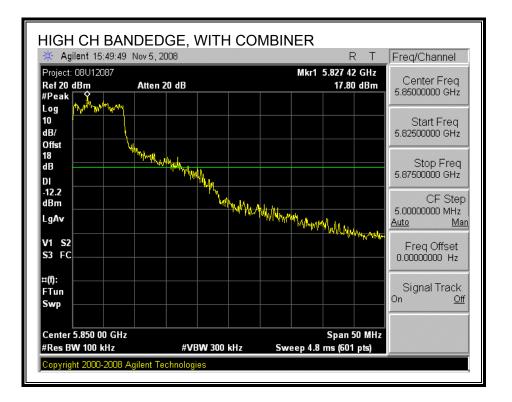
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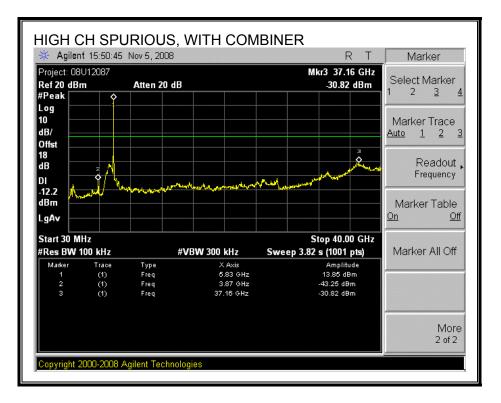
COMPLIANCE CERTIFICATION SERVICESFORM NO: CCSUP4031B47173 BENICIA STREET, FREMONT, CA 94538, USATEL: (510) 771-1000FAX: (510) 661-0888This report shall not be reproduced except in full, without the written approval of CCS.





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# 7.5. 802.11n HT20 MODE IN THE 5.8 GHz BAND

## 7.5.1. 6 dB BANDWIDTH

## LIMITS

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

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

### TEST PROCEDURE

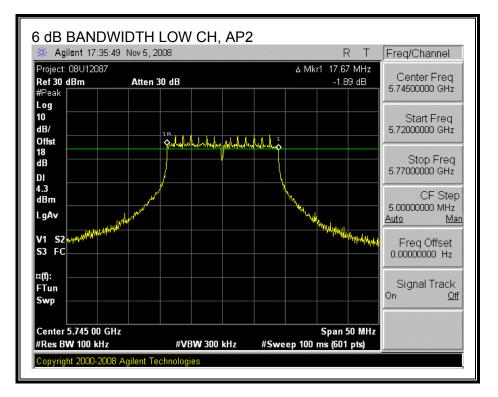
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

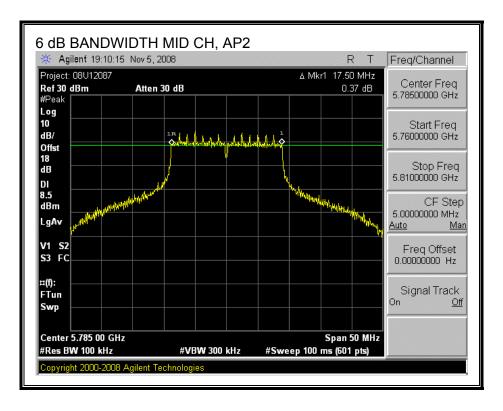
#### RESULTS

Channel	Frequency	AP2	AP4	Minimum Limit
		6 dB BW	6 dB BW	
	(MHz)	(MHz)	(MHz)	(MHz)
Low	5745	17.67	17.33	0.5
Middle	5785	17.50	17.33	0.5
High	5805	17.58	17.58	0.5

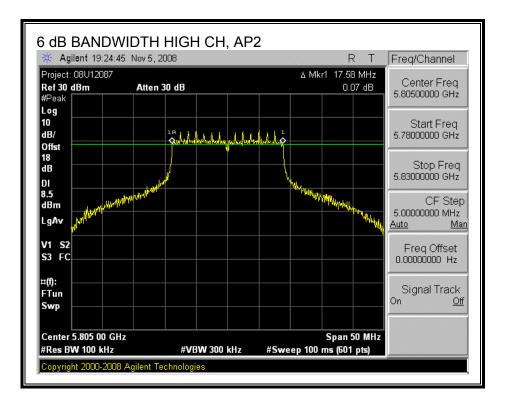
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#### 6 dB BANDWIDTH, AP2

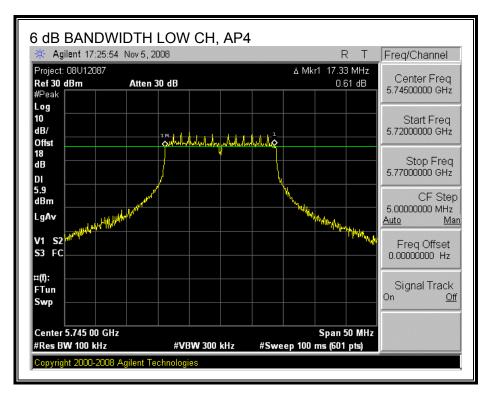




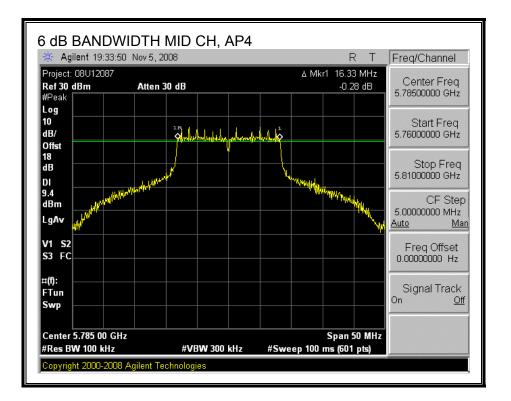
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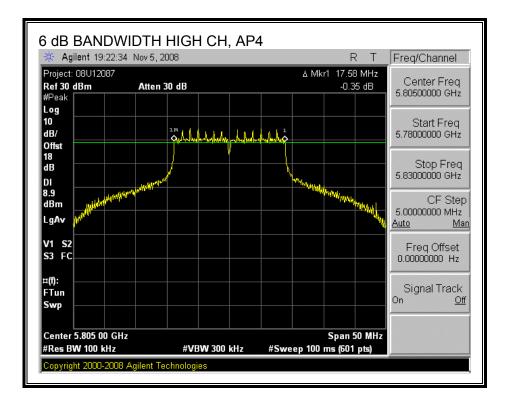


### 6 dB BANDWIDTH, AP4



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## 7.5.2. 26 and 99% BANDWIDTH

## LIMITS

None; for reporting purposes only.

## TEST PROCEDURE

The transmitter outputs are connected to the spectrum analyzer via a combiner. The RBW is set to 1% to 3% of the measured bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal bandwidth function is utilized.

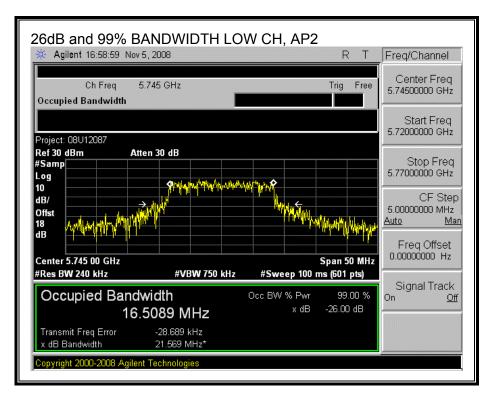
#### **RESULTS**

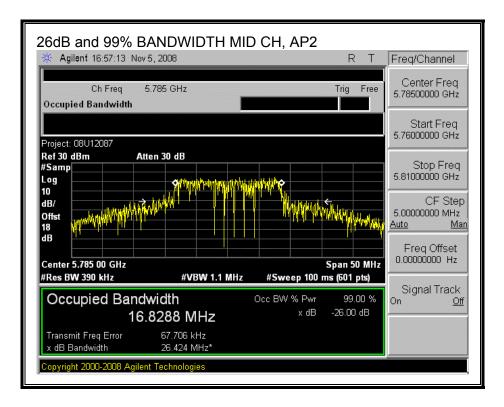
Channel	Frequency	AP2	AP4
		99% Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	5745	16.5089	16.6189
Middle	5785	16.8288	16.8360
High	5805	17.8444	18.2779

Channel	Frequency	AP2	AP 4
		26 dB Bandwidth	26 dB Bandwidth
	(MHz)	(MHz)	(MHz)
Low	5745	21.569	21.619
Middle	5785	26.424	32.635
High	5805	29.38	34.037

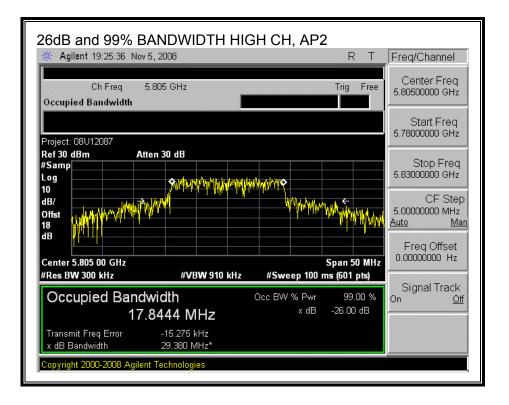
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#### 26 dB and 26dB and 99% BANDWIDTH, AP2

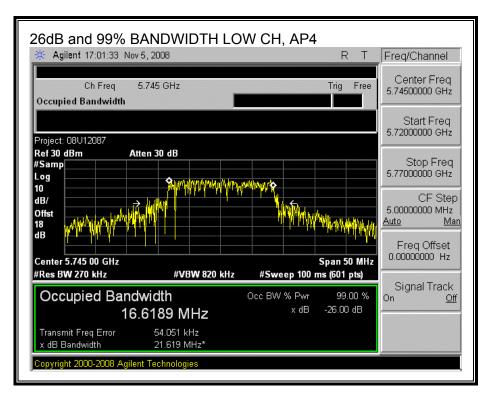




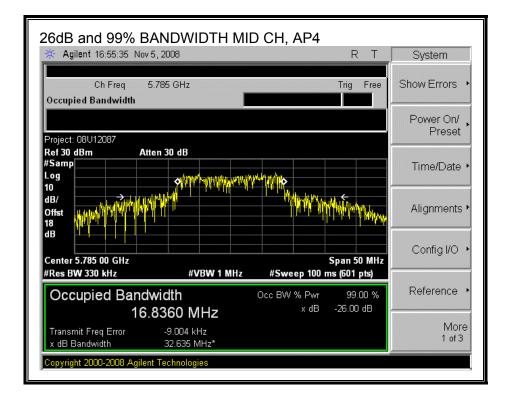
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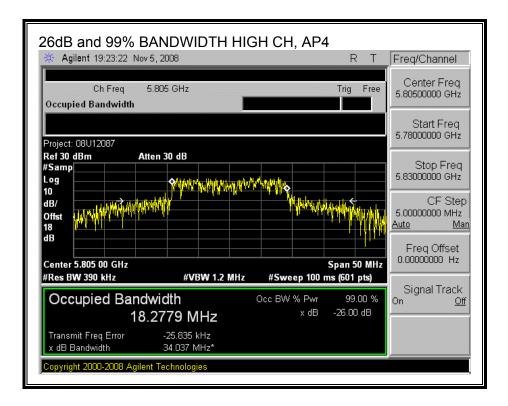


## 26dB and 26dB and 99% BANDWIDTH, AP4



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## 7.5.3. OUTPUT POWER

## <u>LIMITS</u>

FCC §15.247 (b)

IC RSS-210 A8.4

The maximum antenna gain of **3.4 dBi** is less than or equal to 6 dBi, therefore the limit is 30 dBm.

### TEST PROCEDURE

Peak power is measured using the spectrum analyzer's internal channel power integration function. Power is integrated over a bandwidth greater than or equal to the 26dB bandwidth.

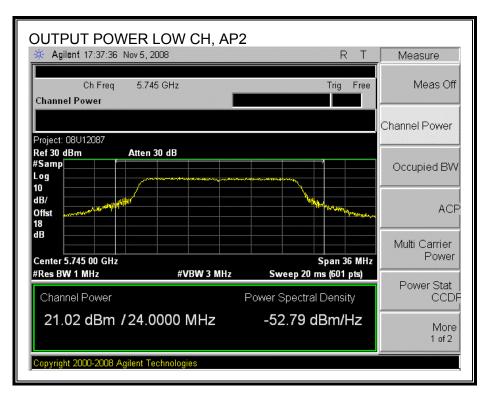
Maximum Conducted Output Power based on RMS averaging over a time interval is measured in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005. The transmitter operates continuously therefore Power Output Option 2, Method # 1 is used.

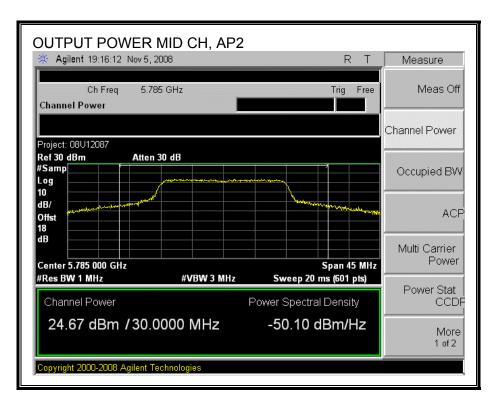
### **RESULTS**

Channel	Frequency	Limit	AP2	AP4	Total	Margin
			Power	Power	Power	
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	5745	30.00	21.02	21.83	24.45	-5.55
Mid	5785	30.00	24.67	25.75	28.25	-1.75
High	5805	30.00	24.57	25.80	28.24	-1.76

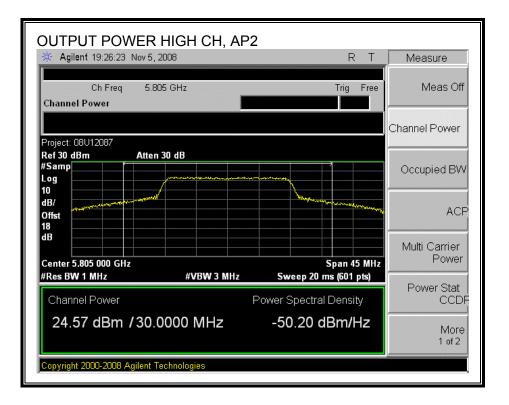
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### **AP2 OUTPUT POWER**

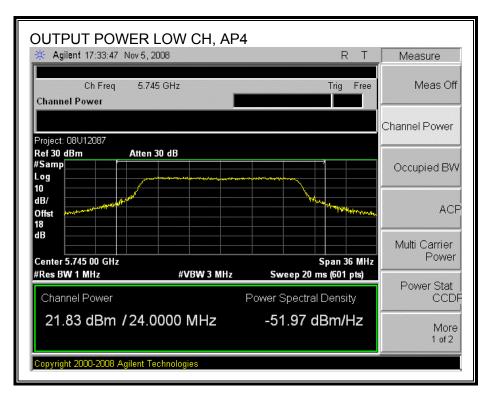




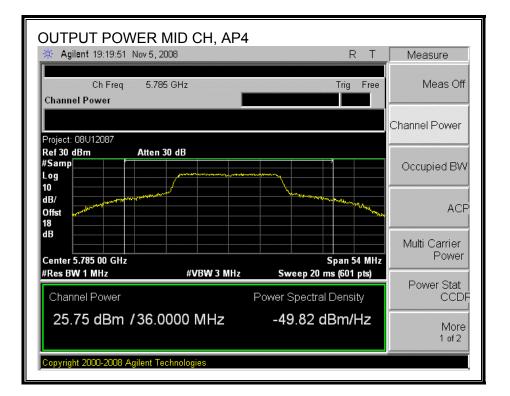
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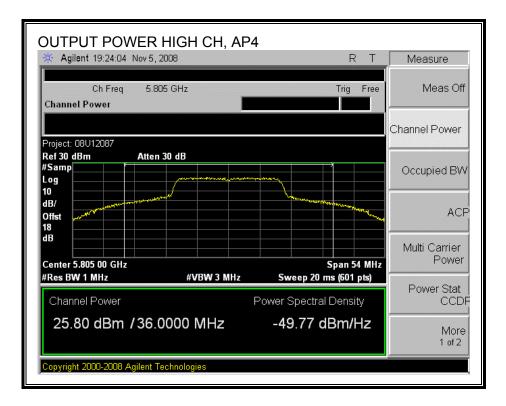


## AP4 OUTPUT POWER



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## 7.5.4. POWER SPECTRAL DENSITY

## LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

#### TEST PROCEDURE

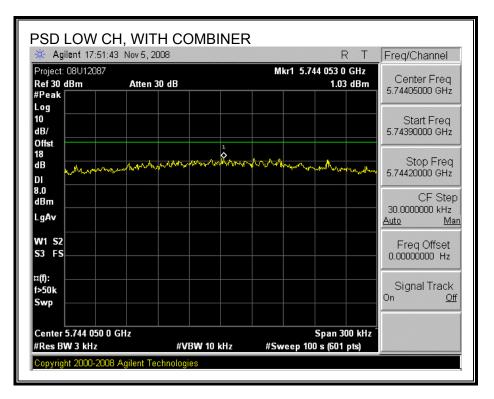
"Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

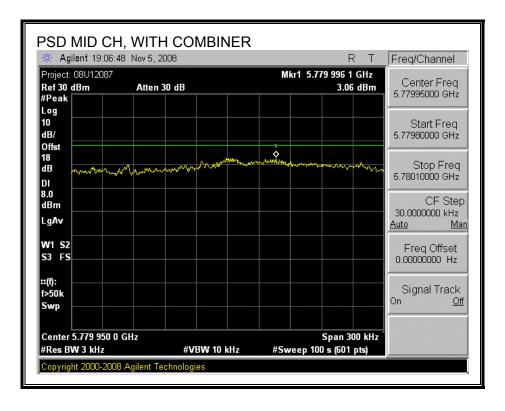
#### RESULTS:

Channel	Frequency	PSD with Combiner	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
Low	5745	1.03	8	-6.97
Middle	5785	3.06	8	-4.94
High	5805	5.34	8	-2.66

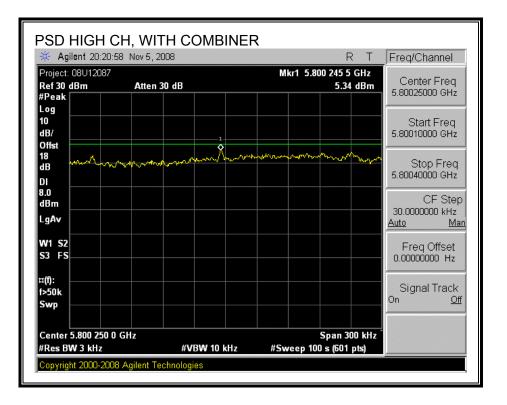
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#### POWER SPECTRAL DENSITY, WITH COMBINER





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## 7.5.5. CONDUCTED SPURIOUS EMISSIONS

## <u>LIMITS</u>

FCC §15.247 (d)

IC RSS-210 A8.5

Output power was measured based on the use of RMS averaging over a time interval, therefore the required attenuation is 30 dB.

### TEST PROCEDURE

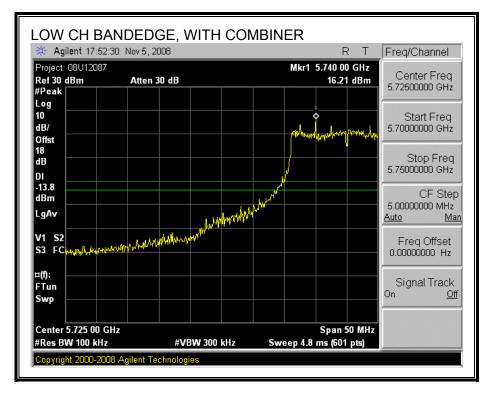
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

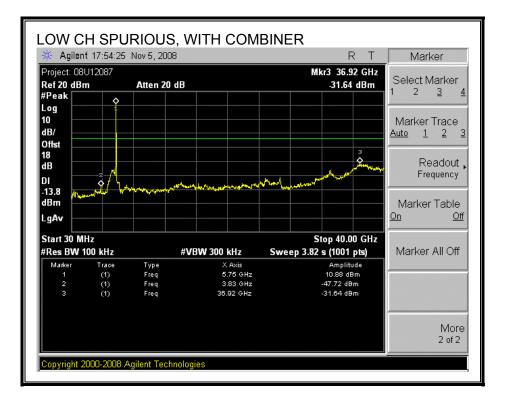
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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#### RESULTS

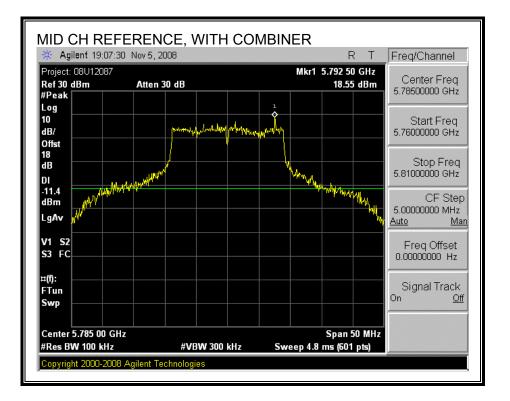
#### SPURIOUS EMISSIONS WITH COMBINER

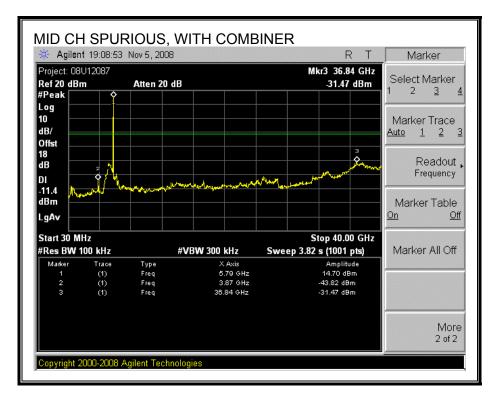




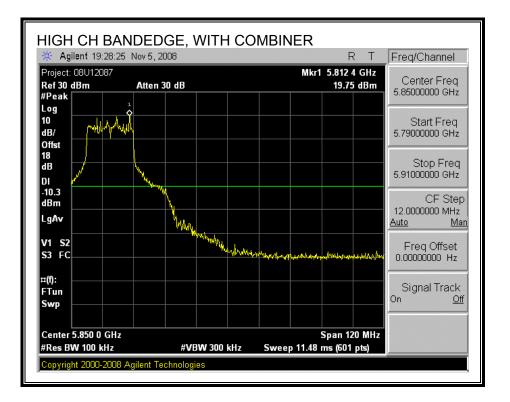
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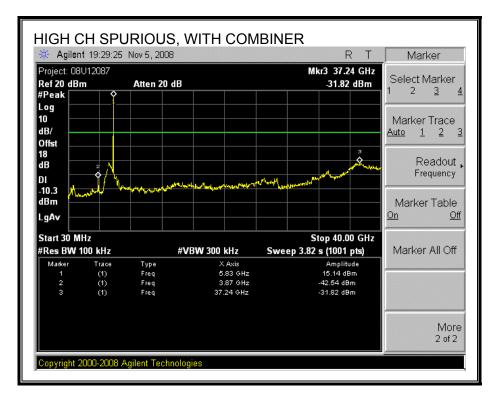
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# 7.6. 802.11n HT40 MODE IN THE 5.8 GHz BAND

## 7.6.1. 6 dB BANDWIDTH

## LIMITS

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

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

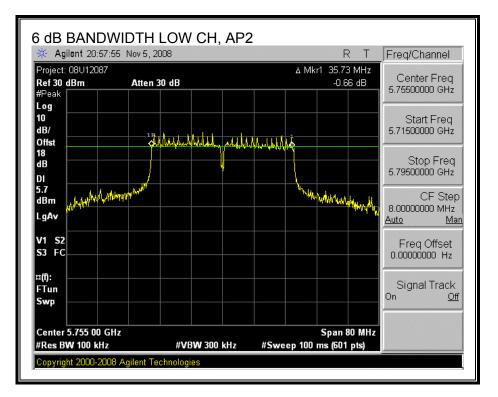
### TEST PROCEDURE

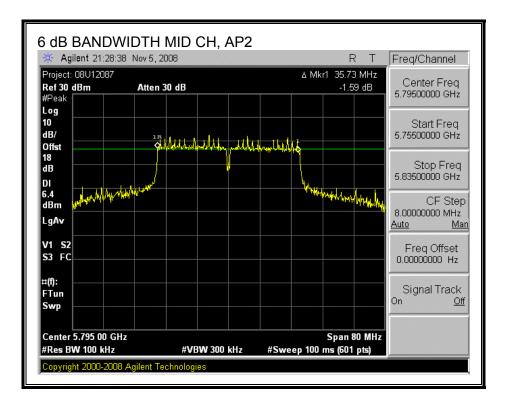
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

#### RESULTS

Channel	Frequency	AP2	AP4	Minimum Limit
		6 dB BW	6 dB BW	
	(MHz)	(MHz)	(MHz)	(MHz)
Low	5755	35.73	35.87	0.5
High	5795	35.73	36.00	0.5

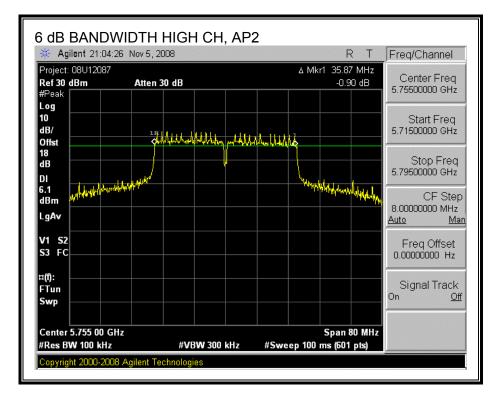
#### 6 dB BANDWIDTH, AP2

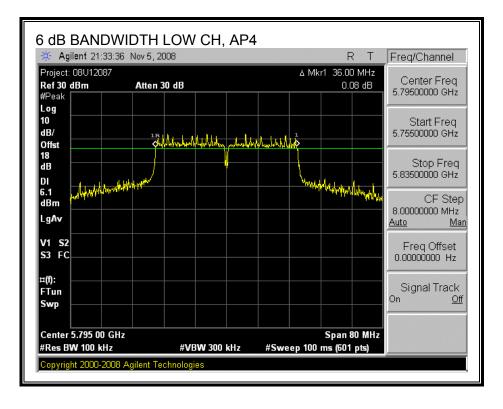




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#### 6 dB BANDWIDTH, AP4





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## 7.6.2. 26 dB and 99% BANDWIDTH

## LIMITS

None; for reporting purposes only.

## TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % and 26dB bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 26% bandwidth function is utilized.

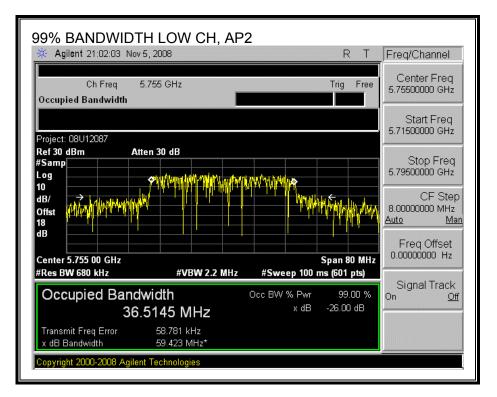
## **RESULTS**

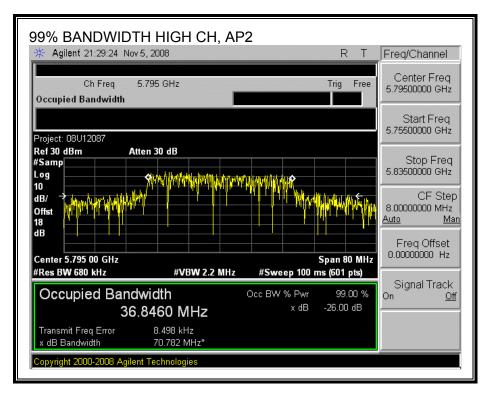
Channel	Frequency	AP2	AP4
		99% Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	5755	36.5145	37.2240
High	5795	36.8460	37.1613

Channel	Frequency	AP2	AP4
		26dB Bandwidth	26dB Bandwidth
	(MHz)	(MHz)	(MHz)
Low	5755	59.423	69.107
High	5795	70.782	71.126

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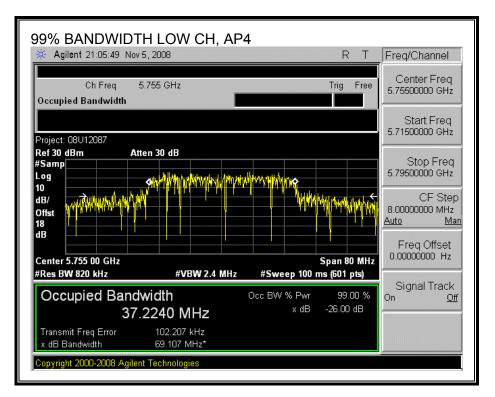
#### 26dB and 99% BANDWIDTH, AP2

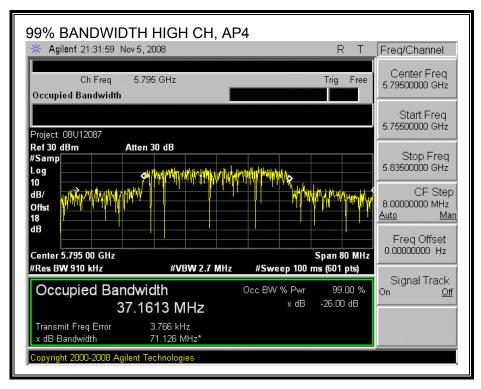




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#### 26dB and 99% BANDWIDTH, AP4





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## 7.6.3. OUTPUT POWER

## <u>LIMITS</u>

FCC §15.247 (b)

IC RSS-210 A8.4

The maximum antenna gain of **3.4 dBi** is less than or equal to 6 dBi, therefore the limit is 30 dBm.

## TEST PROCEDURE

Peak power is measured using the spectrum analyzer's internal channel power integration function. Power is integrated over a bandwidth greater than or equal to the 26dB bandwidth.

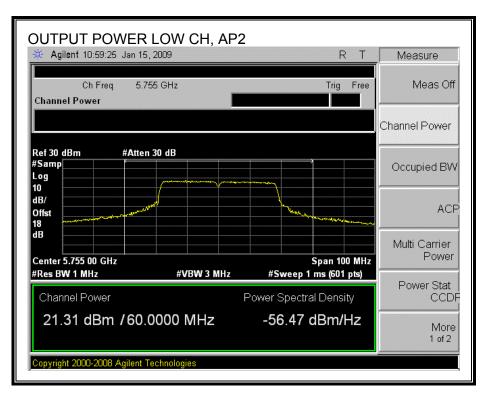
Maximum Conducted Output Power based on RMS averaging over a time interval is measured in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005. The transmitter operates continuously therefore Power Output Option 2, Method # 1 is used.

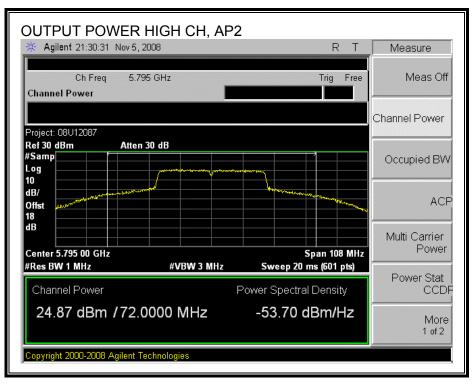
## RESULTS

Channel	Frequency	Limit	AP2	AP4	Total	Margin
			Power	Power	Power	
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	5755	30.00	21.31	22.34	24.87	-5.13
High	5795	30.00	24.87	25.58	28.25	-1.75

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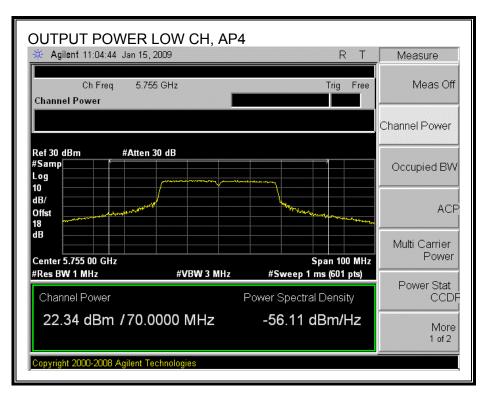
## **AP2 OUTPUT POWER**

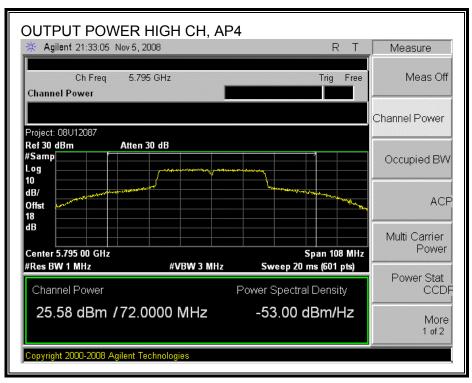




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## **AP4 OUTPUT POWER**





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## 7.6.4. POWER SPECTRAL DENSITY

## LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

## TEST PROCEDURE

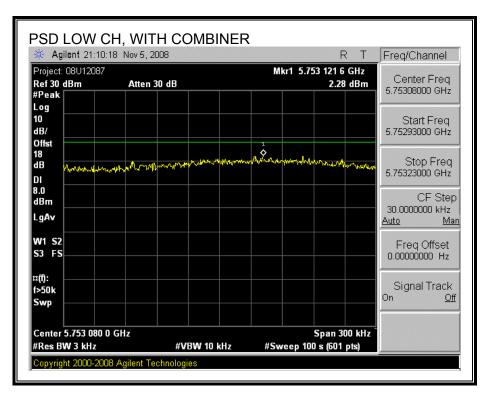
"Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

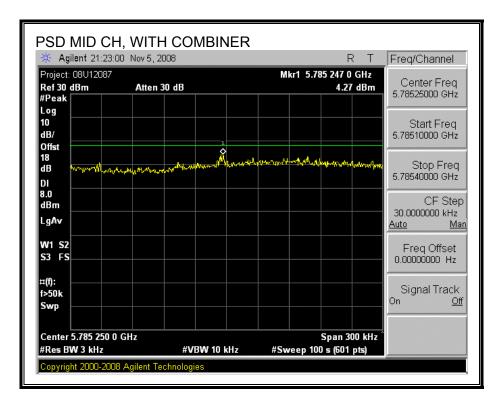
## RESULTS:

Channel	Frequency	PSD with Combiner	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
Low	5755	2.28	8	-5.72
High	5795	4.27	8	-3.73

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## POWER SPECTRAL DENSITY, WITH COMBINER





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## 7.6.5. CONDUCTED SPURIOUS EMISSIONS

## <u>LIMITS</u>

FCC §15.247 (d)

IC RSS-210 A8.5

Output power was measured based on the use of RMS averaging over a time interval, therefore the required attenuation is 30 dB.

## TEST PROCEDURE

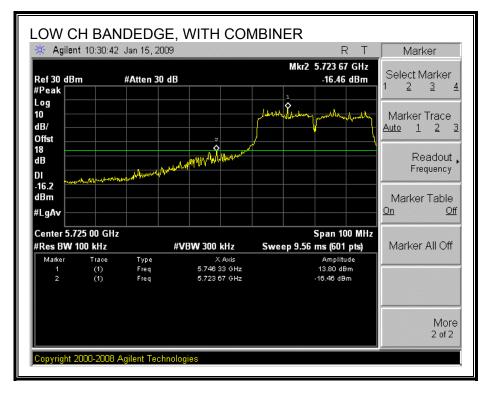
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

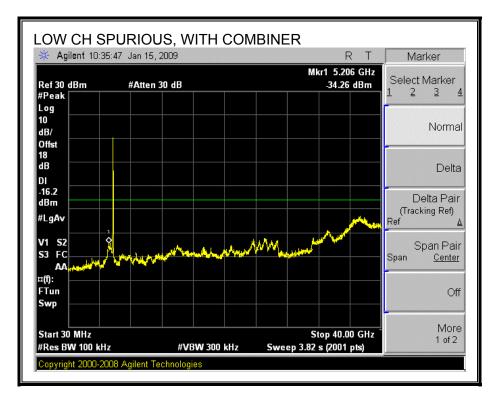
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest and highest channels.

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## RESULTS

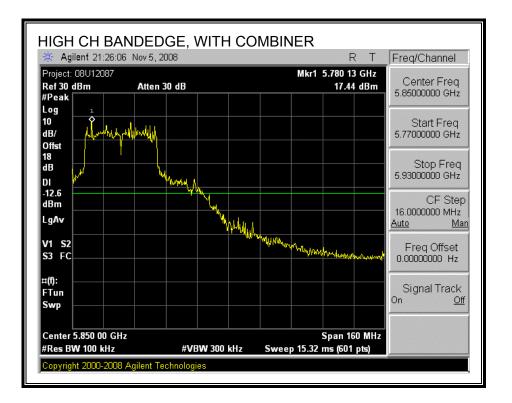
#### SPURIOUS EMISSIONS WITH COMBINER

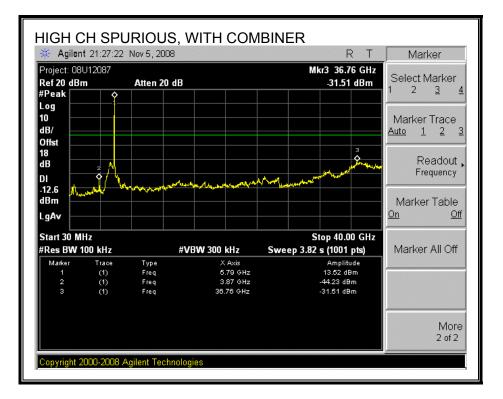




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# 8. RADIATED TEST RESULTS

## 8.1. LIMITS AND PROCEDURE

## <u>LIMITS</u>

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

IC RSS-GEN Clause 6 (Receiver)

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

## TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

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

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, 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 spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band.

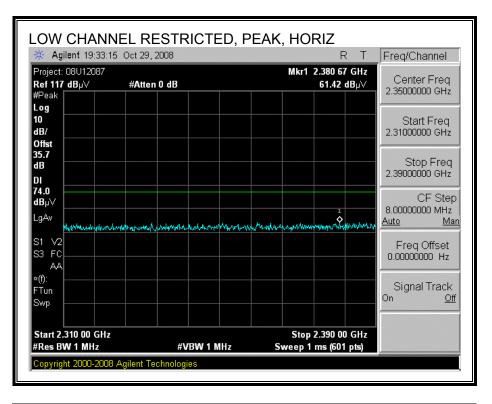
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

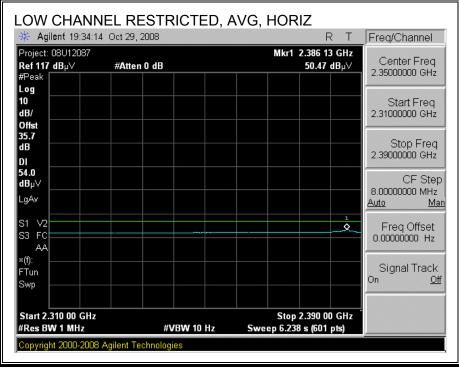
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# 8.2. TRANSMITTER ABOVE 1 GHz

## 8.2.1. TRANSMITTER ABOVE 1 GHz FOR 802.11b MODE

## **RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)**

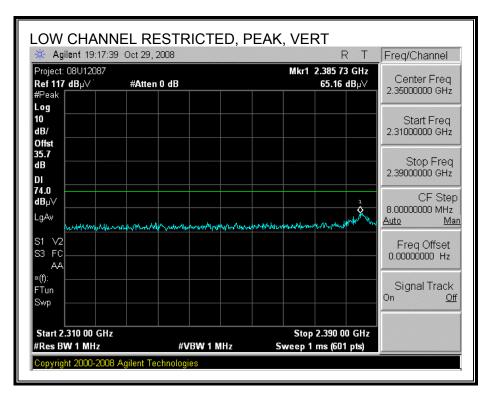


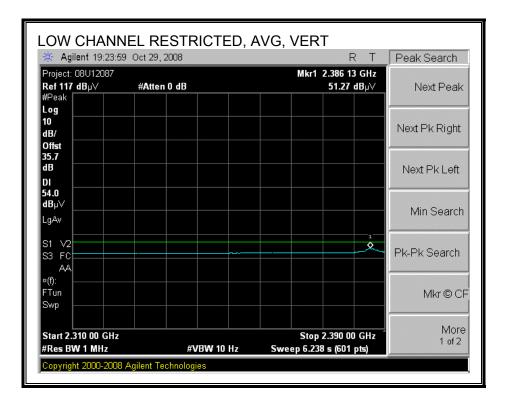


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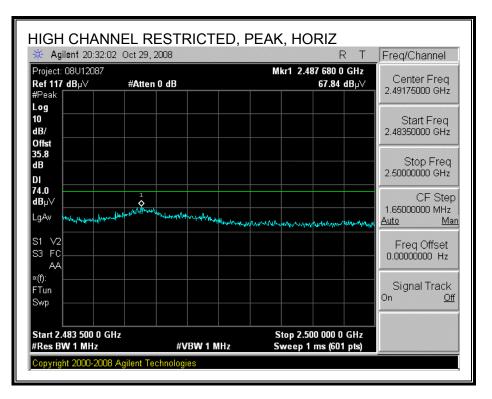
## **RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**

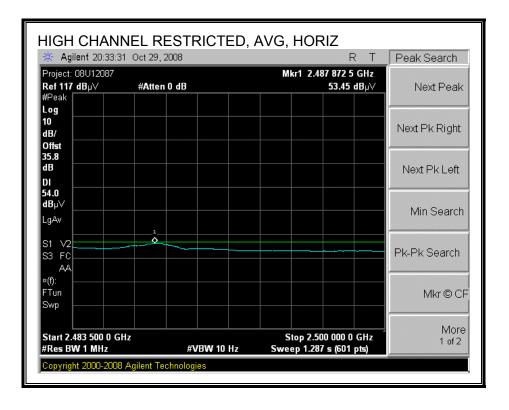




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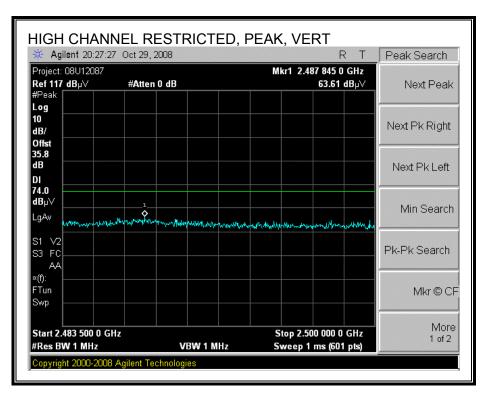
## **RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**

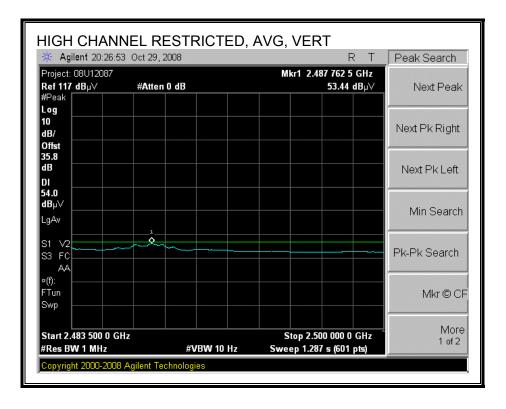




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## **RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)**





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#### HARMONICS AND SPURIOUS EMISSIONS

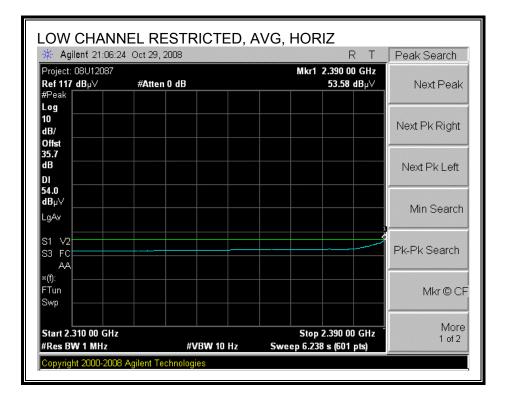
Compli	ance Ce	ertification	Services, Fr	emont :	5m Ch	amber									
Compai			Apple												
Project	#:		08U12087												
Date: Test Er			10/29/08 Vien Tran												
Configu			EUT / Lapt	on											
Mode:			Tx 11b Mo												
Test Eq	upmer	<u>it:</u>												_	
н	orn 1	18GHz	Pre-ar	nplifer	1-260	GHz	Pre-am	plifer	26-40GH	z	н	orn > 18	GHz		Limit
T136;	M/N: 31	17 @3m	▼ T34 HI	P 8449B		•	T88 Mit	eq 26-/	40GHz	T12	5; ARA 18-2	6GHz; S/N	:1007	-	FCC 15.205
[ Hi Free	quency Ca	bles				_									
	2 foot	cable	3	foot c	able		Chan	nber (	Cables		HPF	Re	ject Filte		Measurements
			-				C-5m C	hamt	or i		F_4.0GHz			_	W=VBW=1MHz ge Measurements
			•			•	0.51110	панны	• ·		1_4.00112	•			1MHz; VBW=10Hz
f	Dist	Read Pk	Read Avg.	AF	CL	Amp	D Corr	Fltr	Peak	Avg	Pk Lim	Avg Lim	Pk Mar	Avg Mar	Notes
GHz	(m)	dBuV	dBuV	dB/m	dB	dB	dB	dB		dBuV/m		-	dB	dB	(V/H)
OWCU		2412 MHz													
4.824	3.0	40.9	31.2	32.6	53	-34.8	0.0	0.6	44.6	34.9	74	54	-29.4	-19.1	v
4.824	3.0	39.5	28.2	32.6	53	-34.8	0.0	0.6	43.2	31.9	74	54	-30.8	-22.1	Н
		437 MHz													
4.874	3.0	437 Minz 49.1	44.9	32.6	5.4	-34.8	0.0	0.6	52.9	48.7	74	54	-21.1	-53	v
7.311	3.0	49.6	44.8	34.6	75	-34.1	0.0	0.6	58.2	53.4	74	54	-15.8	<mark>6.0</mark> -	V, Art=18
12.185	3.0	41.0	29.3	36.2	9.0	-32.5	0.0	0.9	54.7	43.0	74	54	-19.3	-11.0	V
4.874 7.311	3.0 3.0	41.2 48.7	32.1 42.8	32.6 34.6	5A 75	-34.8 -34.1	0.0 0.0	0.6 0.6	45.0 57.3	35.9 51.4	74 74	54 54	-29.0 -16.7	-18.1 -2.6	H H
12.185	3.0	46./	42.8	34.0	9.0	-34.1	0.0	0.0	53.8	42.8	74	54 54	-10.7	-2.0	H
HI CHAN															
4.924 7.386	3.0 3.0	40.0 47.1	31.0 40.2	32.6 34.6	5.5 7.6	-34.8 -34.1	0.0 0.0	0.6 0.6	43.9 55.8	34.9 48.9	74 74	54 54	-30.1 -18.2	-19.1 -5.1	v
12.310	3.0	38.4	40.2	34.0	7.0 9.1	-34.1	0.0	0.0	52.2	48.9	74	54 54	-18.2 -21.8	-12.2	v v
1.924	3.0	42.8	35.5	32.6	55	-34.8	0.0	0.6	46.7	39.4	74	54	-27.3	-14.6	Н
7.386	3.0	45.6	39.1	34.6	7.6	-34.1	0.0	0.6	54.3	47.8	74	54	-19.7	-6.2	H
12.310	3.0	39.2	28.3	36.3	9.1	-32.5	0.0	0.9	53.0	42.1	74	54	-21.0	-11.9	H
		1	1	No other	r emissi	ions were	detected ab	ove suy	i rstem noise f	loor	1				
Rev. 10.1:	< no														
Nev. 10.1.	2.06														
			. 7					a .				4 T.			
	f		ent Frequenc	у		Amp	Preamp (					<u> </u>	<u> </u>	ield Strengtl	
	Dist	Distance to							ct to 3 mete					1 Strength Li	
		Analyzer R	<u> </u>			Avg	-		Strength @					Average Li	
	AF	Antenna Fa				Peak IIDE			c Field Stre	ngth		FK Mar	iviargin vs.	Peak Limit	
	CL	Cable Los:	S			HPF	High Pas	s Filter							

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## 8.2.2. TRANSMITTER ABOVE 1 GHz FOR 802.11g MODE

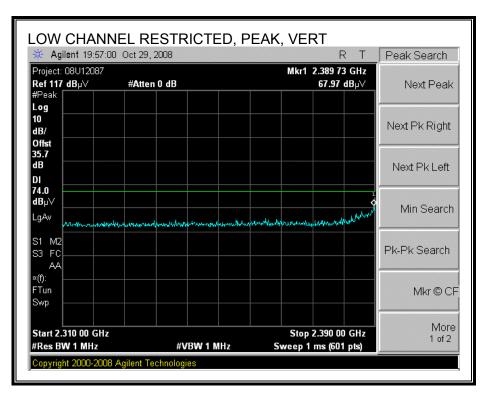
## RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)

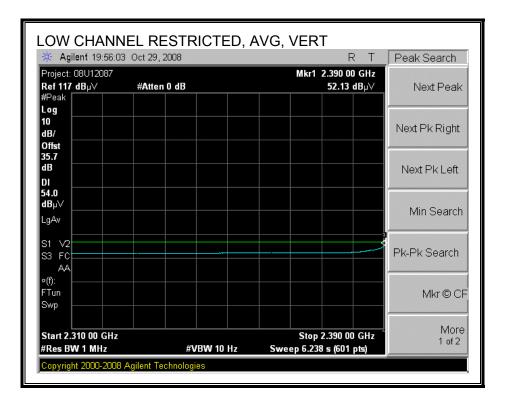
LOW CHANNEL RESTRICTED, PEAK, HORIZ Agilent 21:07:07 Oct 29, 2008 RT Peak Search Project: 08U12087 Mkr1 2.389 73 GHz Ref 117 dBµ∨ #Atten 0 dB 71.30 dB  $\mu \forall$ Next Peak #Peak Log 10 Next Pk Right dB/ Offst 35.7 dB Next Pk Left DI 74.0 dBµ∀ Min Search JAM MALANY LgAv MAN maka MURIN S1 V2 Pk-Pk Search S3 FC AΑ ×(f): FTun Mkr © CF Swp More Start 2.310 00 GHz Stop 2.390 00 GHz 1 of 2 #Res BW 1 MHz #VBW 1 MHz Sweep 1 ms (601 pts) opyright 2000-2008 Agilent Technolog



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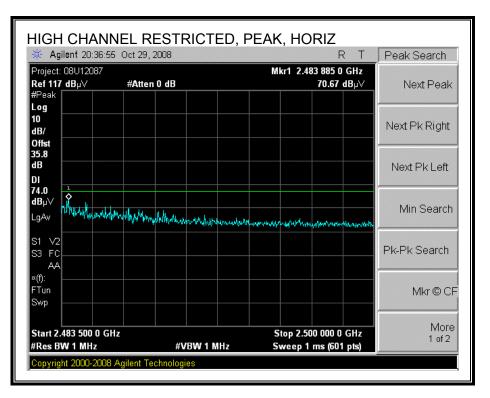
## **RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**

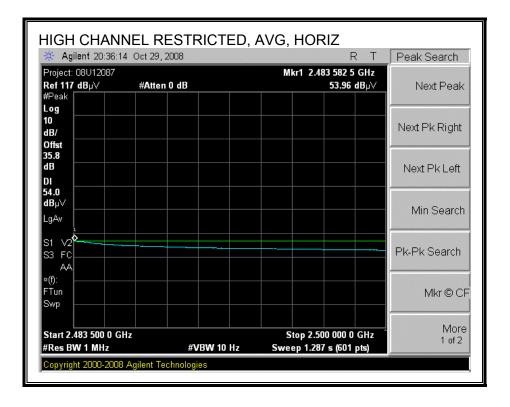




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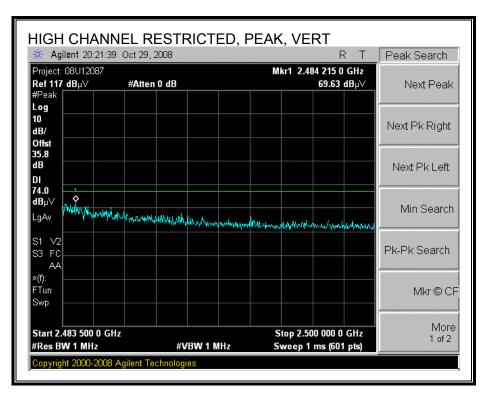
## **RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**

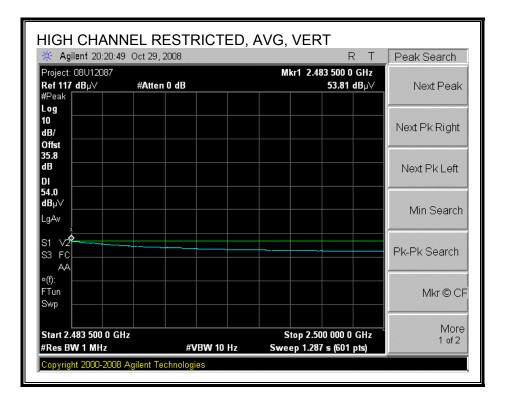




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## **RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)**





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#### HARMONICS AND SPURIOUS EMISSIONS

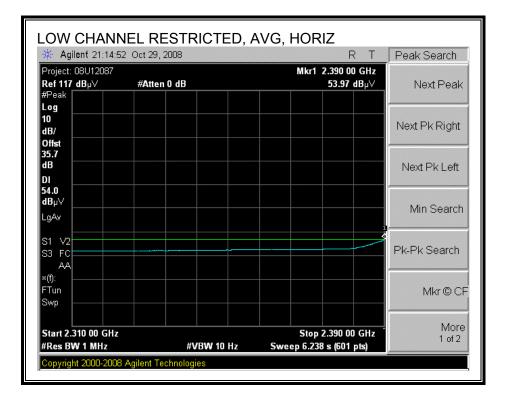
	High	Frequency	/ Measuren	nent											
Complia			Services, Fr		5m Ch	amber									
Compan Project : Date: Test En Configu Mode:	#: gineer:		Apple 08U12087 10/30/08 Vien Tran EUT / Lapt Tx 11g Mo												
<u>Test Eq</u>	uipmen	ıt:													
н	orn 1-	18GHz	Pre-a	mplifer	1-26	GHz	Pre-am	plifer	26-40GH	z	H	orn > 18	GHz		Limit
T136;	M/N: 31	17 @3m	▼ T34 H	P 8449B		•	T88 Mit	eq 26⊿	10GHz	T12	5; ARA 18-2	6GHz; S/N	:1007	•	FCC 15.205
	quency Ca		1						0.11.					Bool	k Measurements
	2 foot	cable		3 foot o	able				Cables		HPF	Re	ject Filte	RB	W=VBW=1MHz
			•			•	C-5m C	hambo	er 💌		F_4.0GHz	-			a <u>ge Measurements</u> =1MHz ; VBW=10Hz
f	Dist		Read Avg.	1	CL	Amp	D Сон		Peak	Avg		Avg Lim		Avg Mar	Notes
GHz	(m)	dBuV	dBuV	dB/m	dB	dB	dB	dB	dBuV/m	dBuV/m	dBuV/m	dBuV/m	dB	dB	(V/H)
		2412 MHz		<b>.</b>					10 -						
4.824 4.824	3.0 3.0	39.5 38.5	28.3 28.4	32.6 32.6	53 53	-34.8 -34.8	0.0 0.0	6.0 6.0	43.2 42.2	32.0 32.1	74 74	54 54	-30.8 -31.8	-22.0 -21.9	V н
												-7			**
		437 MHz			. ·				46.1	<b>A1</b> -					
4.874 7.311	3.0 3.0	39.6 57.4	27.8 45.1	32.6 34.6	5.4 7.5	-34.8 -34.1	0.0 0.0	6.0 6.0	43.4 66.0	31.6 53.7	74 74	54 54	-30.6 -8.0	-22.4 -0.3	V V, Art=18 <i>5</i>
12.185	3.0	57.4 36.0	45.1 28.3	34.0	7.5 9.0	-34.1	0.0 0.0	0.0 9.0	49.7	53.7 42.0	74 74	54 54	-8.0 -24.3	-0.3	V, Art=185 V
4.874	3.0	39.9	28.5	32.6	5.4	-34.8	0.0	<b>6.0</b>	43.7	32.3	74	54	-30.3	-21.7	H
7.311	3.0	54.2	42.1	34.6	75	-34.1	0.0	0.0	62.8	50.7	74	54	-11.2	-3.3	Н
12.185	3.0	39.2	28.7	36.2	9.0	-32.5	0.0	0.9	52.9	42.4	74	54	- <b>21.1</b>	-11.6	Н
HI CHAN	NEL.246	52 MHz		1											
4.924	3.0	40.5	28.3	32.6	5.5	-34.8	0.0	6.0	44.4	32.2	74	54	-29.6	-21.8	v
7.386	3.0	46.8	33.8	34.6	7.6	-34.1	0.0	6.0	55.5	42.5	74	54	-18.5	-11.5	v
12.310	3.0	36.3	28.8	36.3	9.1	-32.5	0.0	0.9	50.1	42.6	74	54	-23.9	-11.4	V
4.924 7.386	3.0 3.0	41.8 44.2	28.8 32.9	32.6 34.6	5.5 7.6	-34.8 -34.1	0.0 0.0	6.0 6.0	45.7 52.9	32.7 41.6	74 74	54 54	-28.3 -21.1	-21.3 -12.4	H H
12.310	3.0	39.7	28.8	36.3	9.1	-32.5	0.0	0.9	53.5	42.6	74	54	-20.5	-11.4	H H
				No. ad											
Rev. 10.15	5.08	I	L	110 Othe	r emiss	INNS WEI'E	uerected at	ove suy	stem noise f	wor					
	f	Measurem	ent Frequenc	у		Amp	Preamp	Gain				Avg Lim	Average F	ield Strengt	h Limit
	Dist	Distance to	Antenna			D Corr	Distance	Corre	ct to 3 mete	ers		Pk Lim	Peak Field	l Strength L	imit
	Read	Analyzer R	eading			Avg	Average	Field S	Strength @	3 m		Avg Mar	Margin vs.	Average L	imit
	4 T	Antenna Fa				Peak								t	
	AF CL	Cable Loss				HPF	High Pas	e Filter							

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## 8.2.3. TRANSMITTER ABOVE 1 GHz FOR 802.11n HT20 MODE

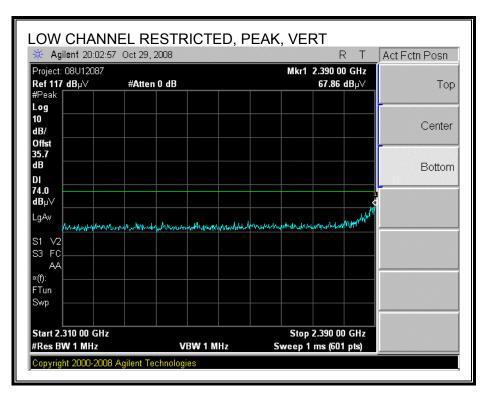
## **RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)**

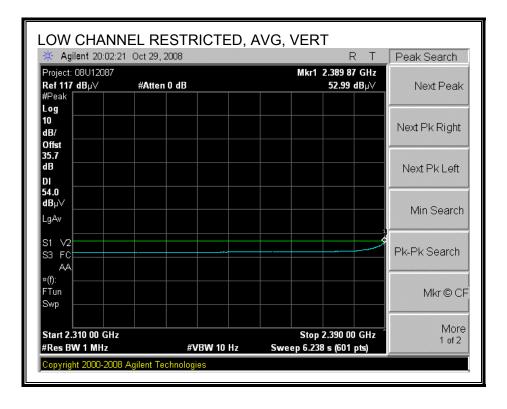
LOW CHANNEL RESTRICTED, PEAK, HORIZ Agilent 21:15:40 Oct 29, 2008 RT Peak Search Project: 08U12087 Mkr1 2.389 47 GHz Ref 117 dBµ∨ #Atten 0 dB 69.78 dBµ∀ Next Peak #Peak Log 10 Next Pk Right dB/ Offst 35.7 dB Next Pk Left DI 74.0 dBµ∀ Min Search MI LgAv downer ALL ALL ALL S1 V2 Pk-Pk Search S3 FC AΑ ×(f): FTun Mkr © CF Swp More Start 2.310 00 GHz Stop 2.390 00 GHz 1 of 2 #Res BW 1 MHz #VBW 1 MHz Sweep 1 ms (601 pts) opyright 2000-2008 Agilent Technolog



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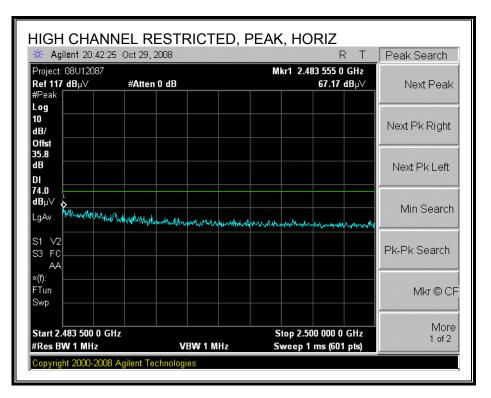
## **RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)**

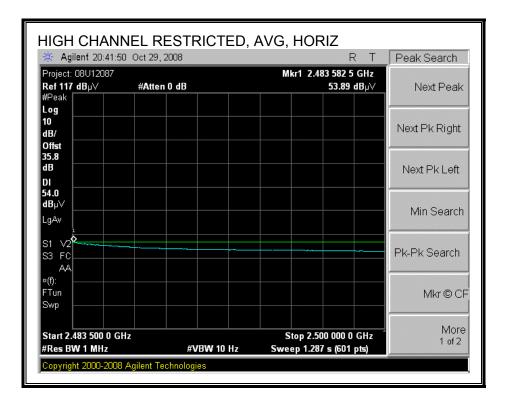




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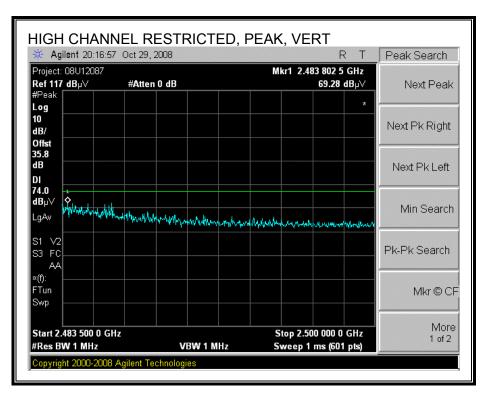
## **RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**

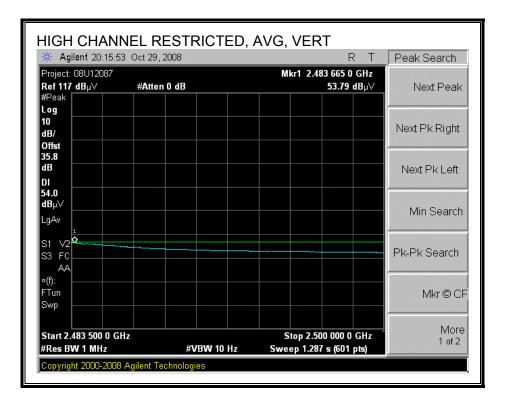




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## **RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)**





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#### HARMONICS AND SPURIOUS EMISSIONS

_	nnce Ce		<sup>7</sup> Measurem Services, Fr		5m Ch	amber									
Compan Project :			Apple 08U12087												
Date:			10/30/08												
'est En Configu	gineer: ration		Vien Tran EUT / Lapt	on											
Node:			Tx 11n HT		le										
fest Eq	uipmen	<u>.t:</u>													
н	orn 1-	18GHz	Pre-ar	nplifer	1-260	GHz	Pre-am	plifer	26-40GH	Iz	н	orn > 18	GHz		Limit
T136;	M/N: 31	17 @3m	T34 HI	P 8449B		-	T88 Mit	eq 26.⊿	40GHz	▼ T12	5; ARA 18-2	26GHz; S/N	:1007	-	FCC 15.205 🗸
Hi Freq	quency Ca	bles				_									
	2 foot	cable	3	foot o	able				Cables		HPF	Re	ject Filte	RB	<u>k Measurements</u> W=VBW=1MHz
			•			•	C-5m C	hamb	er 🗸		F_4.0GHz	•			a <u>ge Measurements</u> =1MHz ; VBW=10Hz
f	Dist		Read Avg.	AF	CL	Amp	D Corr	1	Peak	Avg	Pk Lim	Avg Lim		Avg Mar	Notes
GHz	(m)	dBuV	dBuV	dB/m	dB	dB	dB	dB	dBuV/m	dBuV/m	dBuV/m	dBuV/m	dB	dB	(V/H)
OW CH	ANNEL,	2412 MHz													
.824	3.0	39.9	27.8	32.6	53	-34.8	0.0	0.0	43.6	31.5	74	54	-30,4	-22.5	<u>v</u>
.824	3.0	38.8	27.3	32.6	53	-34.8	0.0	0.0	42.5	31.0	74	54	-31.5	-23,0	H
		437 MHz													
.874 .311	3.0 3.0	40.2 57.3	28.3 45.3	32.6 34.6	5.4 7.5	-34.8 -34.1	0.0 0.0	6.0 6.0	44.0 65.9	32.1 53.9	74 74	54 54	-30.0 -8.1	-21.9 -0.1	V V, Art=18.5
2.185	3.0	40.1	28.6	36.2	9.0	-32.5	0.0	0.9	53.8	42.3	74	54 54	-20.2	-11.7	V, AI-185
.874	3.0	39.1	27.5	32.6	5.4	-34.8	0.0	0.0	42.9	31.3	74	54	-31.1	-22.7	H
.311 2.185	3.0 3.0	54.2 40.7	42.1 28.5	34.6 36.2	7.5 9.0	-34.1 -32.5	0.0 0.0	0.0 Q.0	62.8 54.4	50.7 42.2	74 74	54 54	-11.2 -19.6	-3.3 -11.8	H H
II CHAN 924	NEL, 246 3.0	52 MHz 39.3	28.1	32.6	55	-34.8	0.0	0.0	43.2	32.0	74	54	-30.8	-22.0	v
<b>.38</b> 6	3.0	45.7	32.8	34.6	7.6	-34.1	0.0	0.6	54.4	41.5	74	54	-19.6	-12.5	v
2.310 924	3.0 3.0	39.2 38.6	28.5 27.8	36.3	9.1 5.5	-32.5 -34.8	0.0 0.0	0.9 0.0	53.0 42.5	42.3 31.7	74 74	54 54	-21.0	-11.7	
924 386	3.0	38.0 42.6	31.2	32.6 34.6	55 7.6	-34.8 -34.1	0.0	0.0	42.5 51.3	31./ 39.9	74 74	54 54	-31.5 -22.7	-22.3 -14.1	H
2.310	3.0	38.9	28.0	36 <i>.</i> 3	9.1	-32.5	0.0	0.9	52.7	41.8	74	54	-21.3	-12.2	Н
				No othe	r emiss	ons were	detected al	ove suv	stem noise f	loor					
lev. 10.15	5.08		4										I		
	f		ent Frequenc	у		Amp	Preamp					-	_	ield Strengt	
		Distance to							ct to 3 met					l Strength L	
	Read AF	Analyzer R Antenna Fa	0			Avg Peak	-		Strength @ c Field Stre			-	-	Average L Peak Limit	
	CL	Cable Loss				HPF	High Pas			ngui		FR IVIAI	iviargin vs.	reak Linn	L

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## 8.2.4. TX ABOVE 1 GHz FOR 802.11a LEGACY MODE IN THE 5.8 GHz BAND

## HARMONICS AND SPURIOUS EMISSIONS

Complia	-		' Measurem Services, Fr		5m Ch	amber										
Compan			Apple													
Project≠ Deter	ŧ:		08U12087 10/29/08													
Date: Test Eng	-		Vien Tran													
Configu			EUT / Lapt	on												
Mode:	auon.		Tx 11b Mo													
Test Equ	upmen	t:														
н	orn 1-	18GHz	Pre-ar	nplifer	1-260	GHz	Pre-am	plifer	26-40GH	z		н	orn > 18	GHz		Limit
T136;	M/N: 31	17 @3m	_	P 8449B		-	T88 Mit	·		•	T12	5; ARA 18-2	6GHz; S/N	:1007	-	FCC 15.205 🗸
Hi Frequ	uency Cal	oles —				_				יה						
:	2 foot	cable	3	foot c	able				Cables			HPF	R	eject Filte		<u>k Measurements</u> W=VBW=1MHz
			•			•	C-5m C	hambo	er 🗸		HP	F_4.0GHz	•			n <u>ge Measurements</u> =1MHz ; VBW=10Hz
f	Dist	Read Pk	Read Avg.	AF	CL	Amp	D Corr	Fltr	Peak	A	vg	Pk Lim	Avg Lim	Pk Mar	Avg Mar	Notes
GHz	(m)	dBuV	dBuV	dB/m	dB	dB	dB	dB	dBuV/m		~		dBuV/m	dB	٩B	(V/H)
	()															(
LOW CH																
4.824	3.0	40.9	31.2	32.6	53	-34.8	0.0	6.0	44.6		19	74	54	-29.4	-19.1	<u>v</u>
4.824	3.0	39.5	28.2	32.6	53	-34.8	0.0	0.6	43.2	3	19	74	54	-30.8	-22.1	H
MID CHA	NNEL 2	437 MHz														
4.874	3.0	49.1	44.9	32.6	5.4	-34.8	0.0	0.0	52.9	48	3.7	74	54	-21.1	-53	v
7311	3.0	49.6	44.8	34.6	75	-34.1	0.0	6.0	58.2		3.4	74	54	-15.8	- <mark>0.6</mark>	V, Art=18
12.185	3.0	41.0	29.3	36.2	9.0	-32.5	0.0	0.9	54.7		3.0	74	54	-19.3	-11.0	v
4.874	3.0	41.2	32.1	32.6	5.4	-34.8	0.0	0.0	45.0		5.9	74	54	-29.0	-18.1	H
7.311 12.185	3.0 3.0	48.7 40.1	42.8 29.1	34.6 36.2	7.5 9.0	-34.1 -32.5	0.0 0.0	0.6 0.9	57.3 53.8		l.4 2.8	74 74	54 54	-16.7 -20.2	-2.6 -11.2	H H
12.105	3.0	40.1	27.1	30.2	7.0	-32.5	0.0	0.3	55.6			/4	24	-20.2	-11.2	
HI CHANI	NEL, 246	2 MHz		1					1			•				
4.924	3.0	40.0	31.0	32.6	55	-34.8	0.0	0.0	43.9		19	74	54	- <b>30.1</b>	- <b>19.1</b>	v
7.386	3.0	47.1	40.2	34.6	7.6	-34.1	0.0	0.0	55.8		3.9	74	54	-18.2	-5.1	V
12.310	3.0	38.4	28.0	36.3	9.1	-32.5	0.0	0.9	52.2		1.8	74	54	-21.8	-12.2	V
4.924 7.386	3.0 3.0	42.8 45.6	35.5 39.1	32.6 34.6	5.5 7.6	-34.8 -34.1	0.0 0.0	0.0 0.0	46.7 54.3		9.4 7.8	74 74	54 54	-27.3 -19.7	-14.6 -6.2	<u>н</u> Н
12.310	3.0	45.0 39.2	28.3	36.3	9.1	-34.1	0.0	0.0	53.0		2.1	74	54 54	-19.7	-0.2	Н
		_										-				-
				No other	r emissi	ions were	detected ab	ove suy	stem noise f	loor				ļ		
Rev. 10.15	80.															
	f	Measurem	ent Frequenc			Amp	Preamp (	Fain					Ava Tim	Average T	Field Strengt	h Timit
		Distance to		,		•	-		ct to 3 mete				Pk Lim	-	-	
															d Strength L	
		Analyzer R	-			Avg	-		Strength @				-	-	. Average L	
	AF	Antenna Fa				Peak			c Field Stre	ength			Pk Mar	Margin vs	. Peak Limit	t
	CL	Cable Loss	:			H₽F	High Pas	s Filter								

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

## HARMONICS AND SPURIOUS EMISSIONS

Compli	~		7 Measurem Services, Fr		5m Ch	amher									
Compu	ance ce	a thic actoir	services, ri	emont .	sin en	lamoer									
Compa			Apple												
Project Date:	#:		08U12087 10/29/08												
	ngineer:		Vien Tran												
Configu	0		EUT / Lapt	ор											
Mode:			Tx 11b Mo												
Test Ec	quipmen	<u>t:</u>													
н	lorn 1-	18GHz	Pre-ar	mplifer	1-26	GHz	Pre-am	plifer	26-40GH	z	н	orn > 18	GHz		Limit
T136;	; M/N: 31	17 @3m	▼ T34 HI	P 8449B		•	T88 Mit	eq 26⊿	40GHz	<b>-</b> T1	25; ARA 18-2	26GHz;S/N	:1007	-	FCC 15.205
Hi Fre	quency Ca	bles													
	2 foot	cable	3	3 foot c	able		Chan	nber (	Cables		HPF	Re	eject Filte		<u>k Measurements</u> W=VBW=1MHz
			•			•	C-5m C	hambo	er 🗸		PF_4.0GHz	•			<b>ige Measurements</b> =1MHz ; VBW=10Hz
f	Dist	Read Pk	Read Avg.	AF	CL	Amp	D Corr	Fltr	Peak	Avg	Pk Lim	Avg Lim	Pk Mar	Avg Mar	Notes
GHz	(m)	dBuV	dBuV	dB/m	dB	dB	dB	dB	dBuV/m	dBuV/n	n dBuV/m	dBuV/m	dB	dB	(V/H)
		2412 MHz													
4.824	3.0	40.9	31.2	32.6	53	-34.8	0.0	0.0	44.6	34.9	74	54	-29.4	-19.1	V T
4.824	3.0	39 <i>.</i> 5	28.2	32.6	53	-34.8	0.0	6.0	43.2	31.9	74	54	-30.8	-22.1	H
MID CH/	ANNEL, 2	437 MHz													
4.874	3.0	49.1	44.9	32.6	5.4	-34.8	0.0	6.0	52.9	48.7	74	54	- <b>21.1</b>	-53	V
7.311 12.185	3.0 3.0	49.6 41.0	44.8 29.3	34.6	7.5 9.0	-34.1	0.0 0.0	0.6 0.9	58.2 54.7	53.4 43.0	74 74	54 54	-15.8	-0.6 -11.0	V, Art=18 V
4.874	3.0	41.0	32.1	36.2 32.6	9.0 5.4	-32.5 -34.8	0.0	0.9	54./ 45.0	43.0	74	54 54	-19.3 -29.0	-11.0 -18.1	H
7.311	3.0	48.7	42.8	34.6	75	34.1	0.0	0.0	57.3	51.4	74	54	-16.7	-2.6	H
12.185	3.0	40.1	29.1	36.2	9.0	-32.5	0.0	0.9	53.8	42.8	74	54	-20.2	-11.2	Н
HI CHAN 4.924	NEL, 240 3.0	52 MHz 40.0	31.0	32.6	55	-34.8	0.0	0.6	43.9	34.9	74	54	-30.1	-19.1	v
7.386	3.0	40.0	40.2	34.6	3.5 7.6	-34.0	0.0	0.0 6.0	43.9 55.8	48.9	74	54 54	-30.1	-19.1 -5.1	v
12.310	3.0	38.4	28.0	36.3	9.1	-32.5	0.0	0.9	52.2	41.8	74	54	- <b>21.8</b>	-12.2	V
4.924	3.0	42.8	35.5	32.6	5.5	-34.8	0.0	0.0	46.7	39.4	74	54	-27.3	-14.6	Н
7.386	3.0 3.0	45.6 39.2	39.1 28.3	34.6 36.3	7.6 9.1	-34.1 -32.5	0.0 0.0	0.6 0.9	54.3 53.0	47.8 42.1	74	54 54	-19.7 -21.0	-6.2 -11.9	<u>н</u> н
12.310	3.0	39.2	28-3								/4	24	-21.0	-11.9	n
		ļ	<u> </u>	No other	r emiss	ions were	detected ab	ove suy	stem noise f	loor	<u>    l</u>	l	I		
Rev. 10.1.	5.08														
	f	Maarin	ant East and			A	Description	Tair				A	A	1.1.1 Character	A. T. instit
	t Dist		ent Frequency	У		Amp D.C	Preamp (					-	-	field Strengt	
		Distance to							ct to 3 mete			Pk Lim		i Strength L	
		Analyzer R	0			Avg	-		Strength @			-	-	Average L	
	AF	Antenna Fa				Peak			c Field Stre	ngth		FK Mar	iviargin vs	. Peak Limi	C I
	CL	Cable Los:	3			HPF	High Pas	s Filter							

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

## HARMONICS AND SPURIOUS EMISSIONS

Complia Compan Project : Date: Test En Configu Mode:	unce Ce uy: #: gineer:	Frequency rtification		Fremont 7 guyen ptop		namber										
<u>Test Eq</u>	uipmen	<u>t:</u>														
н	orn 1-	18GHz	Pre	amplife	r 1-26	GHz	Pre-am	plifer	26-40GH	Iz		H	orn > 18	GHz		Limit
T136;	M/N: 31	17 @3m	▼ T34	HP 8449E	;	•	T88 Mit	eq 26-	40GHz	•	T125	i; ARA 18-2	26GHz; S/I	1:1007	-	FCC 15.205
	uency Cal 2 foot			3 foot o	cable		Char C-5m C		Cables		ног	HPF 4.0GHz	R	eject Filte	RB	<u>k Measurements</u> W=VBW=1MHz age Measurements
			•			•	com c	manno	· _			_4.00112	•			=1MHz; VBW=10Hz
f GHz	Dist (m)	Read Pk dBuV	Read Av dBuV	'g. AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Peak dBuV/m		vg V/m	Pk Lim dBuV/m	Avg Lim dBuV/m	1	Avg Mar dB	Notes (V/H)
LOW CH	ANNEL,	5755 MHz														
11 <i>5</i> 10 11 <i>5</i> 10	3.D 3.D	48.3 46.9	37.0 34.3	35.9 35.9	9.0 9.0	-32.5 -32.5	0.0 0.0	0.9 0.9	61 <i>.5</i> 60.1		).2 7.4	74 74	54 54	-12.5 -13.9	-3.8 -6.6	V, Art=19 V, Art=19
HI CHAN	NEL. 579	5 MHz														
11.590	3.0	50.5	39.2	35.9	9.0	-32.5	0.0	0.9	63.8		25	74	54	-10.2	-15	V, Art=23
11.590	3.0	48.8	37.8	35.9	9.0	-32.5	۵0	0.9	62.1	51	.1	74	54	-11.9	-29	H, Art=23
				No othe	r emiss	ions were	detected al	ove suy	stem noise f	loor						
Rev. 10.13	f Dist	Measurem Distance to Analyzer R Antenna F: Cable Los:	Antenna teading actor	ncy		Amp D Corr Avg Peak HPF	Average	Corre Field : d Peal	ct to 3 mete Strength @ k Field Stre	3 m			Pk Lim Avg Mar	Average F Peak Field Margin vs. Margin vs.	l Strength L Average L	imit imit

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# 8.3. RECEIVER ABOVE 1 GHz

## 8.3.1. RX ABOVE 1 GHz FOR 20 MHz BANDWIDTH IN THE 2.4 GHz BAND

)ate: `est Engi 'onfigura 'Iode: `est Equi	tion:	te.	Apple Inc. 08U12087-2 12/01/08 Thanh Nguye EUT and rem Receive mode	ote suppo											
		18GHz	Pre-a	mplifer	1-26	GHz	Pre-am	plifer	26-40GH	z	H	orn > 18	GHz		Limit
T119; S/	/N: 293	601 @3m	▼ T145	Agilent	008A0	05( 🗸	T88 Mit	eq 26-	40GHz	• T12	5; ARA 18-2	26GHz;S/N	:1007	-	RX RSS 210 🗸
- Hi Freque	ency Cab	cable	•	3 foot c	able	•	12 B-5m C	foot c hamb			HPF	Re	eject Filte	RB	k Measurements W=VBW=1MHz age Measurements =1MHz ; VBW=10Hz
f	Dist	Read Pk	Read Avg	AF	CL	Amp	D Corr	Fltr	Peak	Avg	Pk Lim	Avg Lim	Pk Mar	Avg Mar	
GHz	(m)	dBuV	dBuV	dB/m	dB	dB	dB	dB		dBuV/m			1	dB	(V/H)
purious en															
.020 066	3.0	53.2	43.5	28.0	33	-36.1	0.0	0.0	48.4	38.6	74	54 54	-25.6	-15.4	v v
.066 .300	3.0 3.0	51.4 46.5	42.5 42.4	28.2 28.9	3.3 3.6	-36.1 -35.9	0.0 0.0	0.0 0.0	46.8 43.1	37.9 39.0	74 74	54 54	-27.2 -30.9	-16.1 -15.0	v v
385	3.0	40.5	41.2	29.2	3.7	-35.9	0.0	0.0	43.1	39.0	74	54 54	-29.5	-15.0	v
.815	3.0	48.3	41.3	31.8	5.4	-35.2	0.0	0.0	50.4	43.3	74	54	-23.6	- <b>10.7</b>	v
375	3.0	48.2	40.1 ed above syste	29.2	3.7	-35.9	Q.O	0.0	45.3	37.1	74	54	-28.7	-16.9	Н
Rev. 4.12.7			<u></u>		<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u>I</u>	<u></u>	L	<u>.</u>		<u>.</u>	<u> </u>
f			ent Frequenc	у		Amp	Preamp					-	-	Field Strengt	
		Distance to							ct to 3 mete					d Strength L	
		Analyzer R	-			Avg	-		Strength @			-	-	: Average L	
		Antenna Fa				Peak			c Field Stre	ngth		Pk Mar	Margin vs	. Peak Limi	t
0	CL	Cable Los:	5			HPF	High Pas	s Filter	-						

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## 8.3.2. RX ABOVE 1 GHz FOR 20 MHz BANDWIDTH IN THE 5.8 GHz BAND

Compin Compan Project : Date: Test En Configu Mode: Test Eq	ıy: #: gineer: ration:		Services, F1 Apple Inc. 08U12087-2 12/01/08 Thanh Nguye EUT and remo Receive mode	n vite suppor	rt Laptoj	P									
Н		18GHz		mplifer P 8449B		GHz	Pre-am	·	26-40GH		H	orn > 18 26GHz; S/N			Limit RX RSS 210
3' 0	quency Cal cable 2 able 228	2807700		able 2 able 228		000 •	20' cal 20' cab		807500 <sup>7500</sup> •		HPF	<b>R</b> ∉	eject Filte	RB Avera	<u>x Measurements</u> W=VBW=1MHz ge Measurements 11MHz ; VBW=10Hz
f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m		Avg Mar dB	Notes (V/H)
1 027 1 431 2 030 1 432 1 562	3.0 3.0 3.0 3.0 3.0 3.0	53.5 52.3 44.8 54.3 54.2	46.8 30.9 32.1 43.0 22.3	25.8 26.9 28.5 26.9 27.2	2.4 29 3.5 29 3.0	-38.2 -37.7 -36.8 -37.7 -37.5	0.0 0.0 0.0 0.0 0.0	00 00 00 00	43.5 44.3 39.9 46.3 46.9	36.8 23.0 27.3 35.1 15.0	74 74 74 74 74 74	54 54 54 54 54 54	-30.5 -29.7 -34.1 -27.7 -27.1	-17.2 -31.0 -26.7 -18.9 -39.0	H H H V V
2.162	3.0	48.4	28.9 ed above syster	28.8	3.6	-36.6	0.0	0.0	44.1	24.6	74	54	-29.9	-29.4	v
Rev. 10.15	f Dist	Measurem Distance to Analyzer R Antenna F Cable Los	leading actor	y		Amp D Corr Avg Peak HPF	Average	Corre Field S d Peal	ct to 3 mete Strength @ c Field Stre	3 m		Pk Lim Avg Mar	Peak Fiel Margin vs	Field Strengt d Strength L s. Average L s. Peak Limit	imit imit
							11.2.1 1 43								

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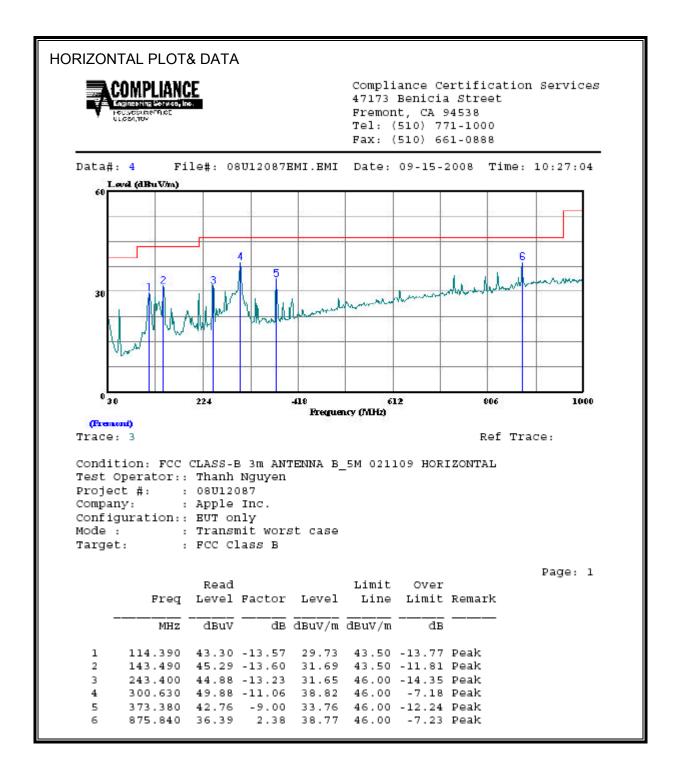
## 8.3.3. RX ABOVE 1 GHz FOR 40 MHz BANDWIDTH IN THE 5.8 GHz BAND

Compar Project : Date: Fest En Configu Mode:	#: gineer: ration:		Apple 08U12079 11/10/2008 Thanh Nguy EUT and re Receive mo	mote s			z band								
	orn 1-	18GHz	Pre-ar				Pre-am	plifer	26-40GH	z	H	orn > 18	GHz		Limit
Hi Fred	S/N: 29 quency Ca 2 foot			lgilent 3		•	12 · B-5m C	foot c hamb			HPF	Re •	eject Filte	RB Avera	RX RSS 210 <u>x Measurements</u> W=VBW=1MHz <u>ge Measurements</u> 1MHz ; VBW=10Hz
f		1	Read Avg.	AF	CL	Amp	D Coit		Peak	Avg	Pk Lim		1	Avg Mar	Notes
GHz	(m) emission	dBuV 1s	dBuV	dB/m	dB	dB	dB	dB	dBuV/m	dBuV/m	dBuV/m	dBuV/m	dB	dB	(V/H)
.110	3.0	51.5	41.5	28.3	3.4	-36.1	0.0	0.0	47.1	37.1 34.9	74	54	-26.9	-16.9	<u>v</u>
.100 .330	3.0 3.0	48.6 48.8	39.4 42.5	28.3 29.0	3.4 3.7	-36.1 -35.9	0.0 0.0	0.0 0.0	44.1 45.6	34.9 39.3	74 74	54 54	-29.9 -28.4	-19.1 -14.7	v
.810	3.0	46.7	38.6	31.8	5.4	-35.2	0.0	0.0	48.7	40.6	74	54	-25.3	-13.4	v
.100 .110	3.0 3.0	49.9 50.2	40.1 39.2	28.3 28.3	3.4 3.4	-36.1 -36.1	0.0 0.0	0.0 0.0	45.4 45.9	35.7 34.9	74 74	54 54	-28.6 -28.1	-18.3 -19.1	 н
375	3.0	48.6	40.3 ed above system	29.2	3.7	-35.9	0.0	0.0	45.6	37.3	74	54	-28.4	- <b>16.7</b>	H
lev. 4.12.							-								
		Distance to Analyzer B	leading	9		Avg	Average	Corre Field S	ct to 3 mete Strength @	3 m		Pk Lim Avg Mar	Peak Fiel Margin vs	Field Strengt d Strength L: . Average L:	imit imit
	AF CL	Antenna F Cable Los				Peak HPF	Calculate High Pas		c Field Stre	ngth		Pk Mar	Margin vs	. Peak Limit	

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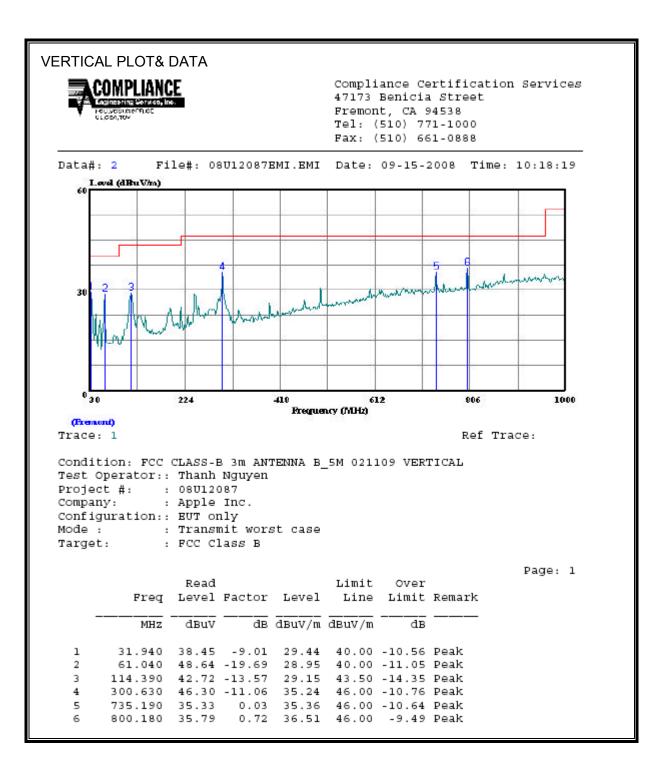
## 8.4. WORST-CASE BELOW 1 GHz

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



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



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# 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.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm²)	Averaging time (minutes)
(A) Lim	its for Occupational	/Controlled Exposu	res	
0.3–3.0 3.0–30	614 1842/f	1.63 4.89/f	*(100) *(900/f²)	6
30–300 300–1500	61.4	0.163	1.0 f/300	6
1500-100,000			5	6
(B) Limits	for General Populati	on/Uncontrolled Ex	posure	
0.3–1.34	614 824/f	1.63 2.19/f	*(100) *(180/f <sup>2</sup> )	30 30

#### TABLE 1-LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

#### 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/cm²)	Averaging time (minutes)
30–300 300–1500 1500–100,000	27.5	0.073	0.2 f/1500 1.0	30 30 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 occu-pational/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 ex-posed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or exponent exercise exercise exposed as a consequence of their employment may not be fully aware of the potential for exposure.

exposure or can not exercise control over their exposure.

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## IC RULES

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

## Table 5

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

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m <sup>2</sup> )	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	280/f	2.19/ <i>f</i>		6
10–30	28	2.19/ <i>f</i>		6
30–300	28	0.073	2*	6
300–1 500	1.585 <i>f</i> <sup>0.5</sup>	0.0042f <sup>0.5</sup>	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 <sup>1.2</sup>
150 000–300 000	0.158 <i>f</i> <sup>0.5</sup>	4.21 x 10 <sup>-4</sup> f <sup>0.5</sup>	6.67 x 10 <sup>-5</sup> ƒ	616 000 /f <sup>1.2</sup>

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

Notes: 1. Frequency, f, is in MHz.

- 2. A power density of 10 W/m<sup>2</sup> is equivalent to 1 mW/cm<sup>2</sup>.
- A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

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## CALCULATIONS

Given

 $E = \sqrt{(30 * P * G)} / d$ 

and

S = E ^ 2 / 3770

where

E = Field Strength in Volts/meter

P = Power in Watts

G = Numeric antenna gain

d = Distance in meters

S = Power Density in milliwatts/square centimeter

Combining equations, rearranging the terms to express the distance as a function of the remaining variables, changing to units of Power to mW and Distance to cm, and substituting the logarithmic form of power and gain yields:

 $d = 0.282 * 10 ^ ((P + G) / 20) / \sqrt{S}$ 

where

d = MPE distance in cm P = Power in dBm G = Antenna Gain in dBi S = Power Density Limit in mW/cm^2

Rearranging terms to calculate the power density at a specific distance yields

S = 0.0795 \* 10 ^ ((P + G) / 10) / (d^2)

The power density in units of mW/cm<sup>2</sup> is converted to units of W/m<sup>2</sup> by multiplying by a factor of 10.

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## LIMITS

From FCC §1.1310 Table 1 (B), the maximum value of S = 1.0 mW/cm<sup>2</sup>

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

## <u>RESULTS</u>

Mode	Band	MPE	Output	Antenna	FCC Power	IC Power
		Distance	Power	Gain	Density	Density
		(cm)	(dBm)	(dBi)	(mW/cm^2)	(W/m^2)
WLAN, 11b	2.4 GHz	20.0	21.72	5.08	0.10	0.95
WLAN, 11g	2.4 GHz	20.0	22.24	5.08	0.11	1.07
WLAN, HT20	2.4 GHz	20.0	22.37	3.49	0.08	0.77
WLAN, 11a	5.8 GHz	20.0	28.37	6.03	0.55	5.47
WLAN, HT20	5.8 GHz	20.0	28.25	3.40	0.29	2.91
WLAN, HT40	5.8 GHz	20.0	28.25	3.40	0.29	2.91
WLAN, 11a	5.2 GHz	20.0	14.12	6.94	0.03	0.25
WLAN, HT20	5.2 GHz	20.0	12.96	4.21	0.01	0.10
WLAN, HT40	5.2 GHz	20.0	16.10	4.21	0.02	0.21

## Notes:

Antenna Gain for 11b, 11g and 11a is the combined antenna gain for both chains. Antenna gain for HT20 and HT40 is the maximum antenna gain of both chains. Output power is the combined output power for both chains.

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## **CO-LOCATED MPE CALCULATIONS**

For multiple colocated transmitters operating simultaneously the total power density can be calculated by summing the Power \* Gain product (in linear units) of each transmitter.

yields

 $d = 0.282 * \sqrt{((P1 * G1) + (P2 * G2) + ... + (Pn * Pn)) / S)}$ where d = distance in cmPx = Power of transmitter x in mWGx = Numeric gain of antenna x $S = Power Density in mW/cm^{2}$ 

In the table below, Power and Gain are entered in units of dBm and dBi respectively, then converted to their linear forms for the purpose of the calculations.

## LIMITS

From FCC §1.1310 Table 1 (B), the maximum value of S = 1.0 mW/cm<sup>2</sup>

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

## **RESULTS**

Mode	Band	Output	Antenna	MPE	FCC Power	IC Power
		Power	Gain	Distance	Density	Density
		(dBm)	(dBi)	(cm)	(mW/cm^2)	(W/m^2)
WLAN, 11g	2.4 GHz	22.24	5.08			
WLAN, 11a	5.8 GHz	28.37	6.03			
Combi	ned			20.0	0.65	6.55

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