



**FCC CFR47 PART 15 SUBPART C  
INDUSTRY CANADA RSS 210 ISSUE 7  
SUPPLEMENTAL CERTIFICATION TEST REPORT**

**FOR**

**802.11a/b/g/n PCI Module**

**MODEL: AR5BMB82**

**FCC ID: PPD-AR5BMB82**

**IC: 4104A-AR5BMB82**

**REPORT NUMBER: 08U11627-2**

**ISSUE DATE: MARCH 06, 2008**

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**NVLAP LAB CODE 200065-0**

Revision History

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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** ATHEROS COMMUNICATIONS, INC.  
5480 GREAT AMERICA PARKWAY  
SANTA CLARA, CA 95054, U.S.A.

**EUT DESCRIPTION:** 802.11a/b/g/n PCI Module

**MODEL:** AR5BMB82

**SERIAL NUMBER:** MB82-031-S0263

**DATE TESTED:** MARCH 05, 2008

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	No Non-Compliance Noted
INDUSTRY CANADA RSS-210 Issue 7	No Non-Compliance Noted
INDUSTRY CANADA RSS-GEN ISSUE 2	No Non-Compliance Noted

Compliance Certification Services, Inc. tested the above equipment in accordance with the requirements set forth in the above standards. 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 Compliance Certification Services and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Compliance Certification Services 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:

Tested By:



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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 <http://www.ccsemc.com>.

## 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

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

### 4.2. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Radiated Emission, 30 to 200 MHz	+/- 3.3 dB
Radiated Emission, 200 to 1000 MHz	+4.5 / -2.9 dB
Radiated Emission, 1000 to 2000 MHz	+4.5 / -2.9 dB
Power Line Conducted Emission	+/- 2.9 dB

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

## 5. EQUIPMENT UNDER TEST

### 5.1. DESCRIPTION OF EUT

The EUT is a 3x3 802.11a/b/g/n PCI Module.

The radio module is manufactured by ATHEROS COMMUNICATIONS, INC.

### 5.2. DESCRIPTION OF CHANGES

The following changes have been made to the product as originally tested:

A) The Baseband chip AR9160 has been updated from version 1.0 to version 1.1

Changes implemented in the 1.0 version Baseband chip:

- 1) Corrected various digital logic bugs related to IEEE protocol functions
- 2) Corrected digital logic bug that sometimes caused baseband to hang during radar detection

Version 1.1 chip has the same pinout and hardware specifications as originally tested chip (1.0).

The product's capabilities, features, RF modulations and power are unchanged from the originally tested product.

B) The board has undergone minor layout change and some component changes

Changes to board & Schematic:

- 1) Added extra filtering in 5GHz Tx Path to improve EVM
- 2) Added and optimized decoupling caps to improve linearity of transmitter in each chain
- 3) Reduced clock voltage swing
- 4) Minor layout change to accommodate above changes

### 5.3. DESCRIPTION OF SUPPLEMENTAL MEASUREMENTS

The following supplemental measurements were made on the product with the Version 1.1 baseband chip installed: Bandwidth, Power and PPSD tests were performed on the low, middle, and high channels of each 5 GHz band. Conducted and Radiated Spurious tests were performed on the middle channel of each 5 GHz band.

## 5.4. MAXIMUM OUTPUT POWER

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

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5745 - 5825	802.11a	24.94	311.89
5745 - 5825	802.11n HT20	24.90	309.03
5755 - 5795	802.11n HT40	25.00	316.23

## 5.5. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a Dipole Antenna, model: TWF-614C-406, with a maximum gain of 5 dBi in the 5GHz bands.

## 5.6. SOFTWARE AND FIRMWARE

The test utility software used during testing was ART revision 0.5 Build # 20, ART\_11n. For TX-related testing, the program puts the EUT in continuous transmitting mode with a duty cycle of 99%, for RX-related testing, the program puts the EUT in continuous receiving mode.



## 5.7. WORST-CASE CONFIGURATION AND MODE

EUT was tested as an external module inserted to a host Laptop PC.

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

802.11a Mode (20 MHz BW operation): 9Mbps, OFDM, Spatial Stream 1  
802.11n MIMO HT20 Mode: MCS0, 6.5Mbps, OFDM, Spatial Stream 1  
802.11n MIMO HT40 Mode: MCS0, 13.5Mbps, OFDM, Spatial Stream 1

For 6 dB and 99% BW measurement preliminary testing showed that Chain 2 is worst-case chain, so final measurement was performed on chain 2 for all modes and channels.

For conducted and PSD measurements preliminary testing showed that combiner is worst-case compared to individual chains; therefore, final measurement was performed using combiner for each mode.

For conducted and radiated spurious, the test was performed on worst channel for each mode of each frequency band.

For radiated receiver spurious, the test was performed on worst channel for each frequency band.

## 5.8. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop PC	ThinkPad	R50	99-C4812	DOC
AC/DC Adapter	IBM	9P1020	11S92P1020Z1Z	N/A
Cardbus to MINI-PCI	VYTEK	stcbmpi3	244	N/A

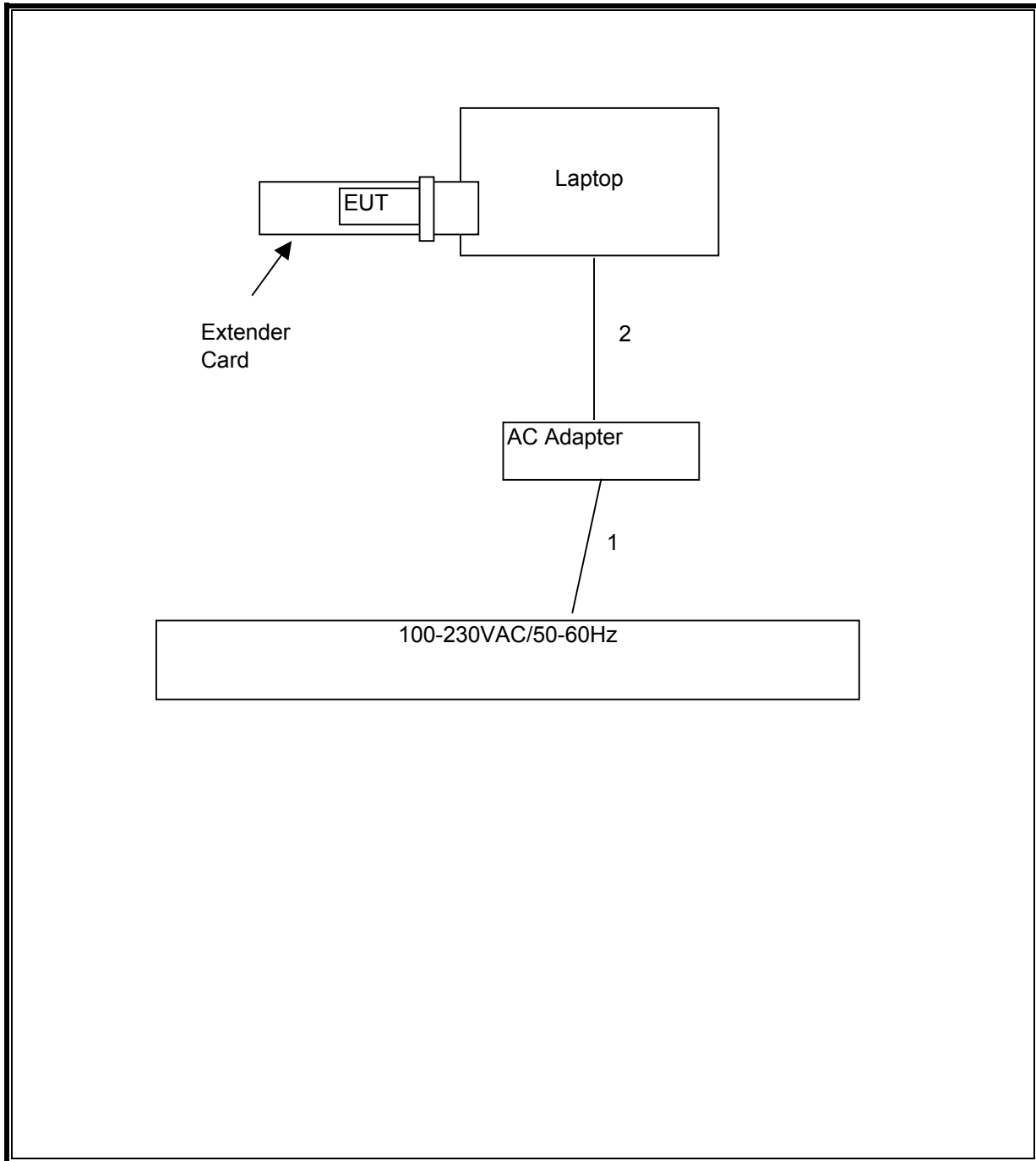
### I/O CABLES

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	US 115V	Un-shielded	0.8m	N/A
2	DC	1	DC	Un-shielded	1.8m	Ferrite at one end

### TEST SETUP

The EUT is connected to a laptop PC via a PCI extension card during the tests. Test software exercised the radio card.

**SETUP DIAGRAM FOR TESTS**



## 6. TEST AND MEASUREMENT EQUIPMENT

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

TEST EQUIPMENT LIST				
Description	Manufacturer	Model	S/N	Cal Due
Power Meter	Agilent / HP	438A	C01068	09/12/08
Power Sensor, 18 GHz	Agilent / HP	8481A	N02782	4/22/08
RF Filter Section	Agilent / HP	85420E	C00958	06/12/08
Harmonic Mixer Cable	Agilent / HP	5061-5458	C00627*	CNR
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01012	08/07/08
Antenna, Horn, 18 GHz	EMCO	3115	C00945	04/15/08
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	08/03/08
EMI Test Receiver, 30 MHz	R & S	ESHS 20	N02396	01/27/08
Reject Filter, 5.725-5.825 GHz	Micro-Tronics	BRC13192	N02677	CNR
Highpass Filter, 7.6 GHz	Micro-Tronics	HPM13195	N02681	CNR
Preamplifier, 40 GHz	Miteq	NSP4000-SP2	C00990	10/11/08
Antenna, Horn, 26.5 GHz	ARA	MMH-1826/B	C00980	09/28/08
Antenna, Horn, 40 GHz	ARA	MMH-2640/B	C00981	04/11/08

## 7. ANTENNA PORT TEST RESULTS

### 7.1. 802.11a THREE CHAINS MODE IN THE 5.8 GHz BAND

#### 7.1.1. 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.

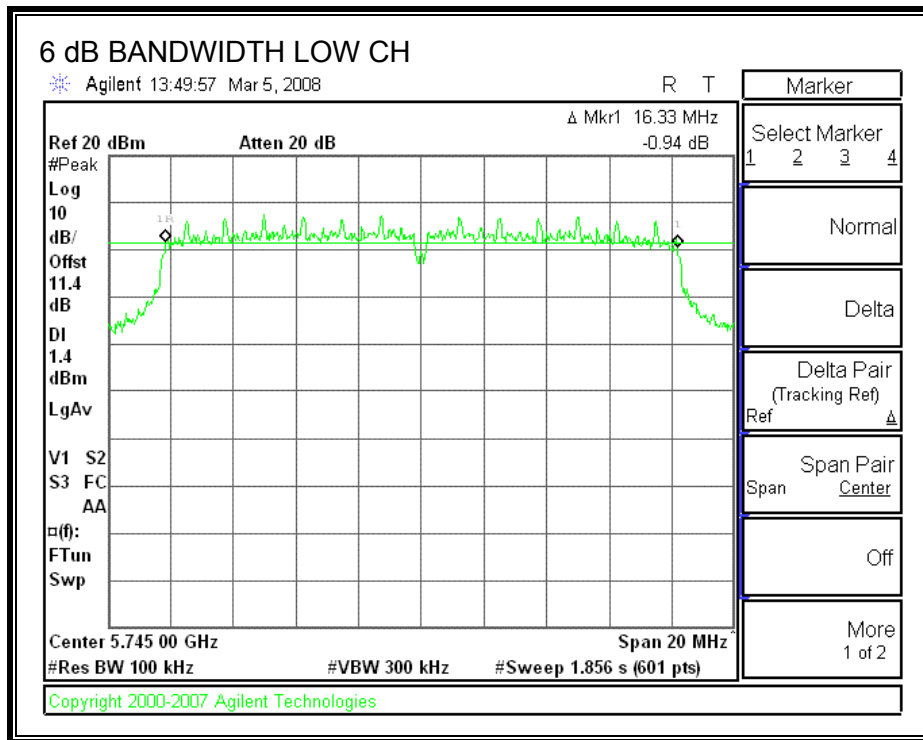
##### TEST PROCEDURE

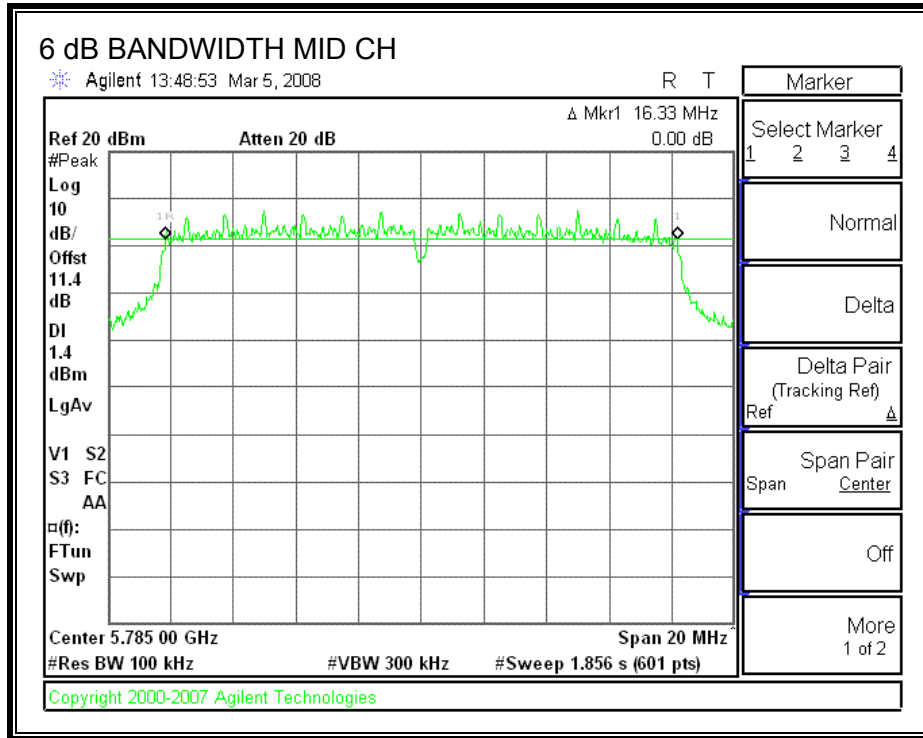
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

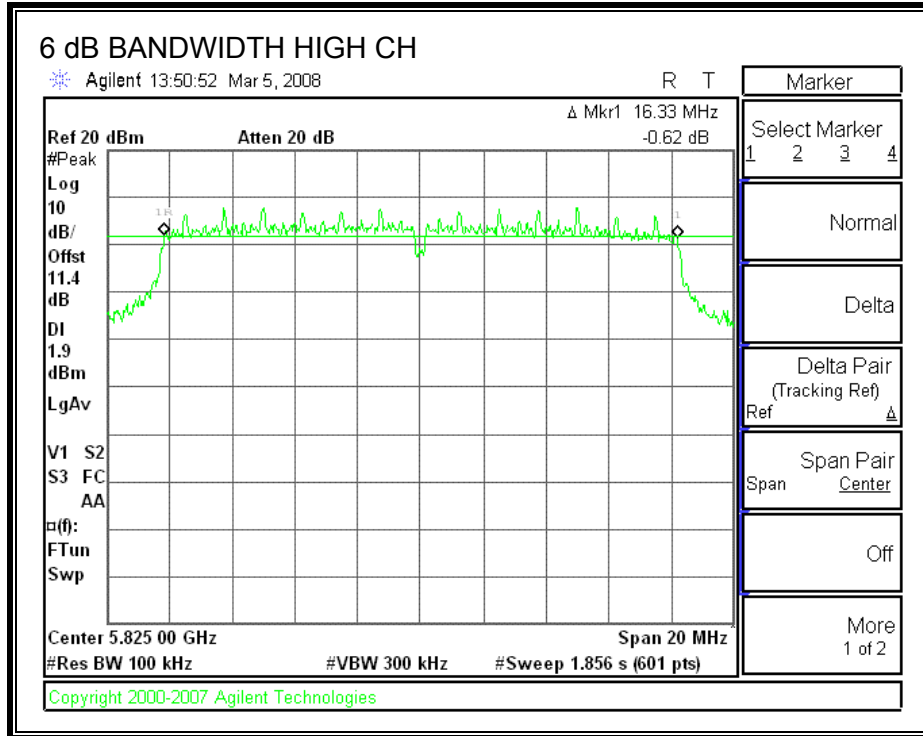
##### RESULTS

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

**6 dB BANDWIDTH**









### 7.1.2. 99% BANDWIDTH

#### LIMITS

None; for reporting purposes only.

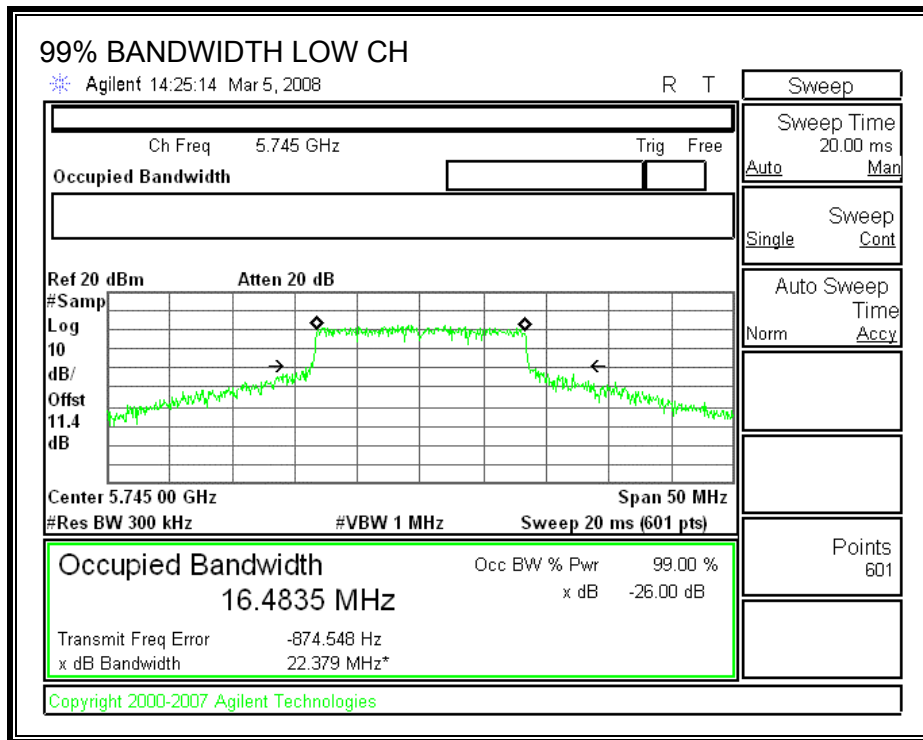
#### TEST PROCEDURE

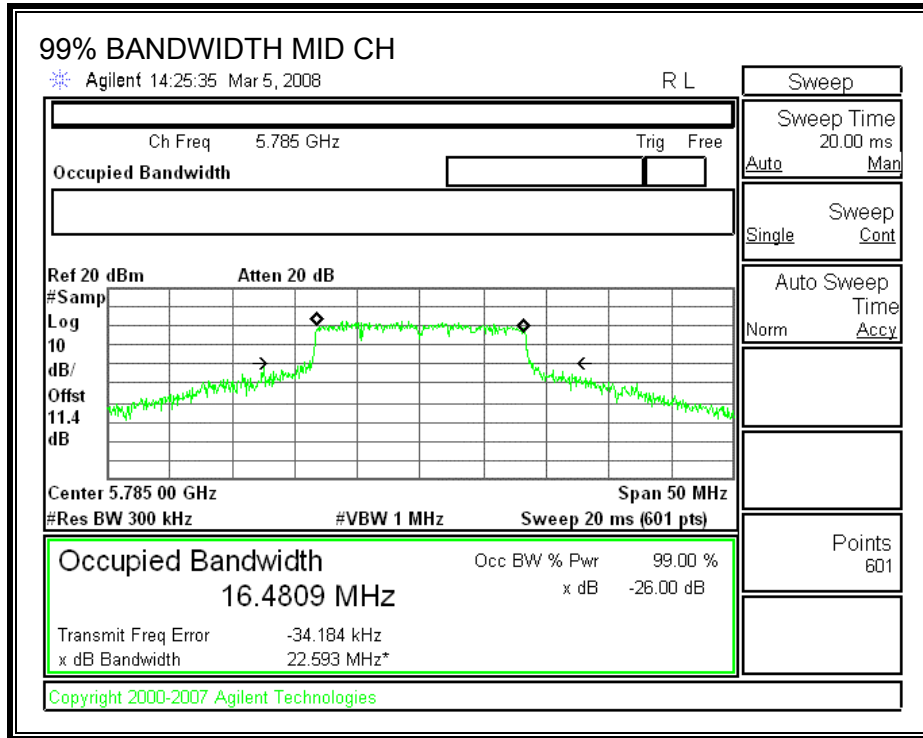
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

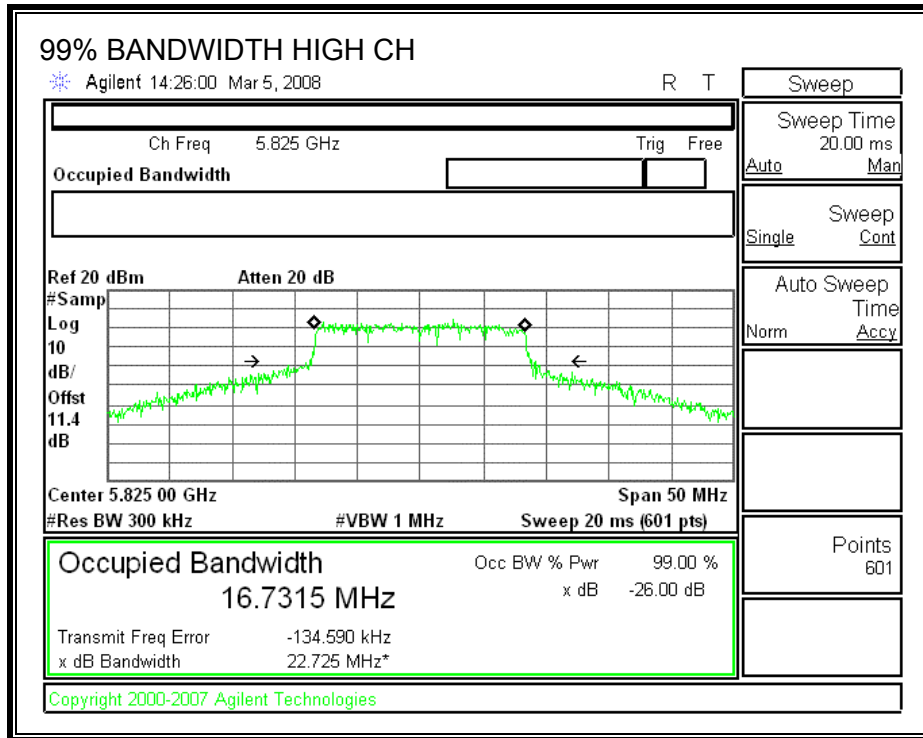
#### RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5745	16.4835
Middle	5785	16.4809
High	5825	16.7315

**99% BANDWIDTH**







### 7.1.3. OUTPUT POWER

#### LIMITS

FCC §15.247 (b)

IC RSS-210 A8.4

Antenna Gain (dBi)	10 Log (# Tx Chains) (dB)	Effective Legacy Gain (dBi)
5	4.77	9.77

The maximum effective antenna gain is 9.77 dBi for other than fixed, point-to-point operations, therefore the limit is 26.23 dBm.

#### TEST PROCEDURE

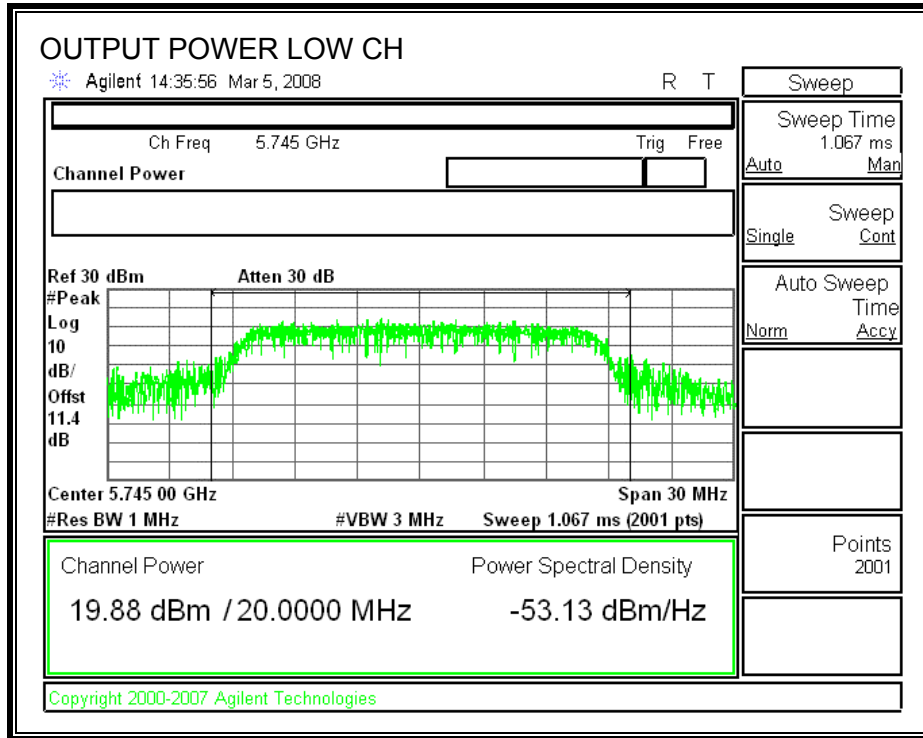
Peak power is measured using the spectrum analyzer's internal channel power integration function. Power is integrated over a bandwidth greater than or equal to the 99% bandwidth.

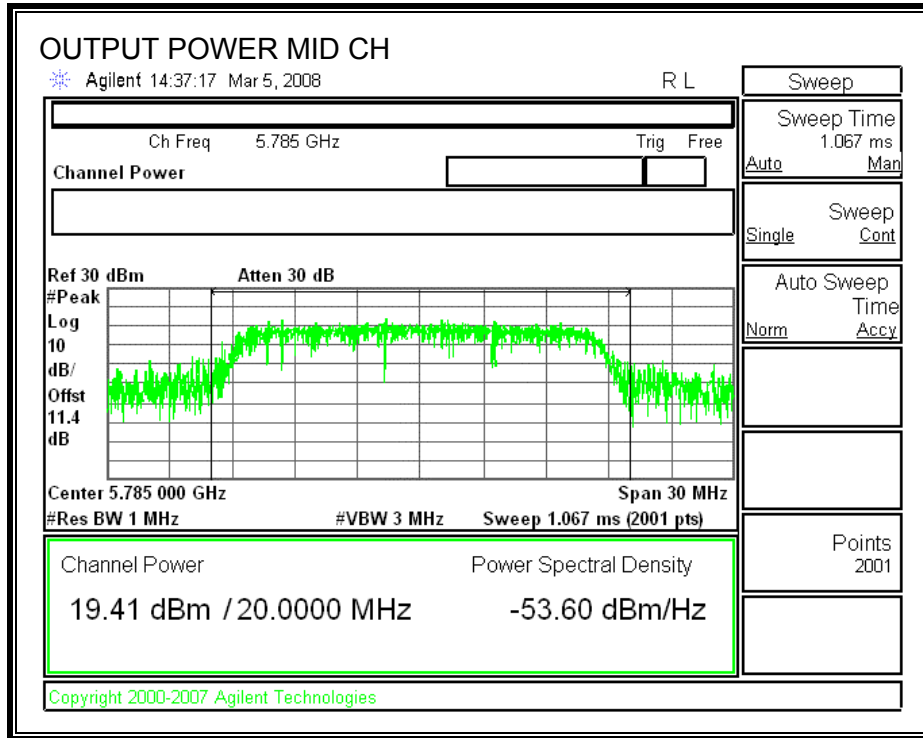
#### RESULTS

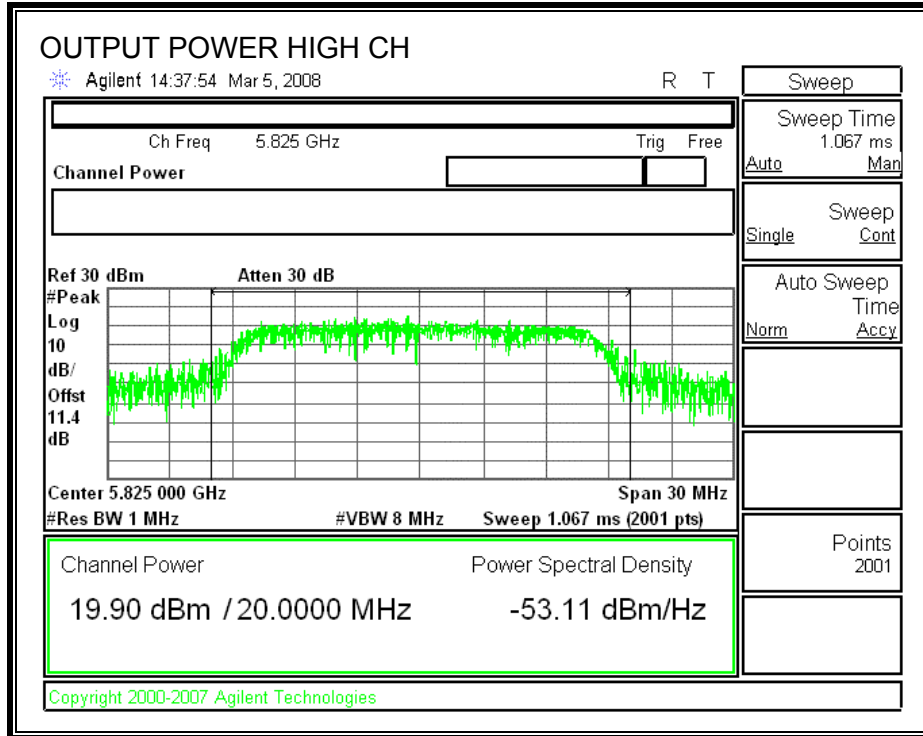
Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5745	19.88	19.80	20.03	24.68	26.23	-1.55
Mid	5785	19.41	20.19	20.00	24.65	26.23	-1.58
High	5825	19.90	20.35	20.24	24.94	26.23	-1.29

**OUTPUT POWER**

CH 0



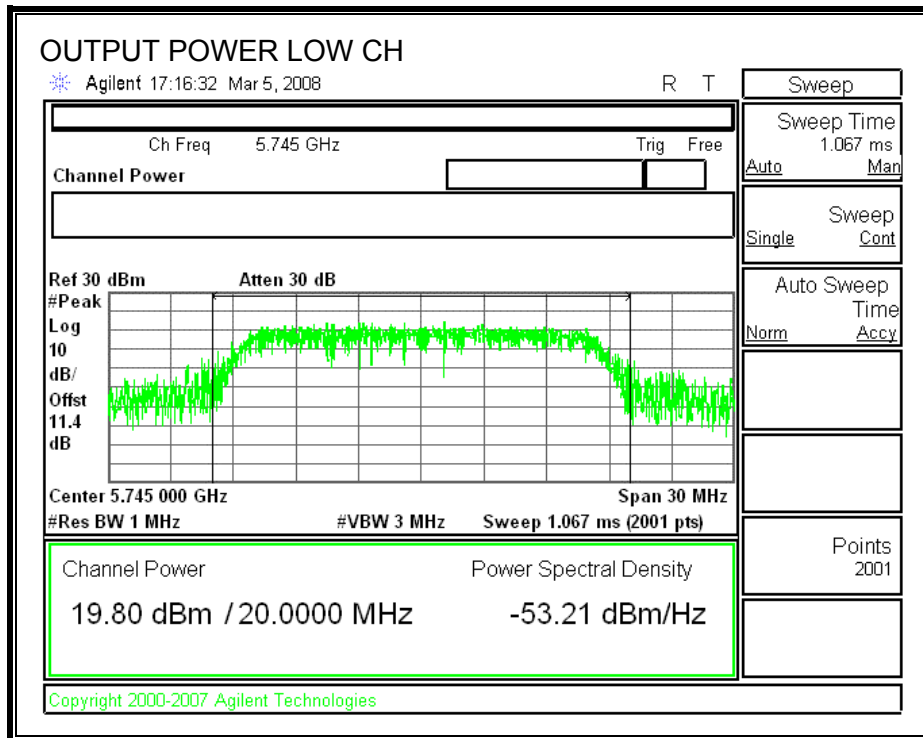


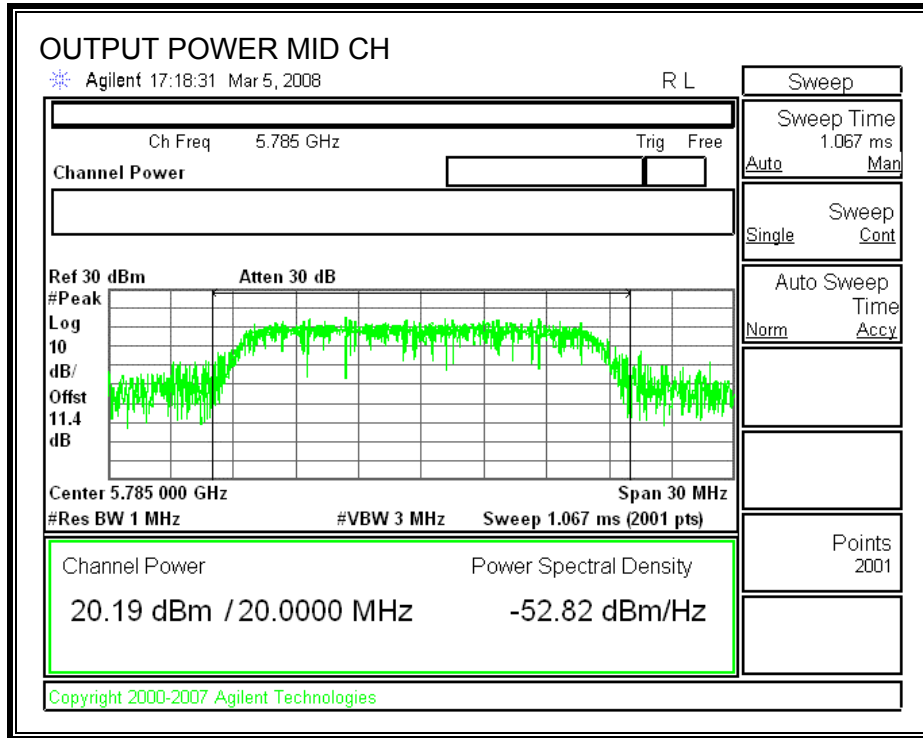


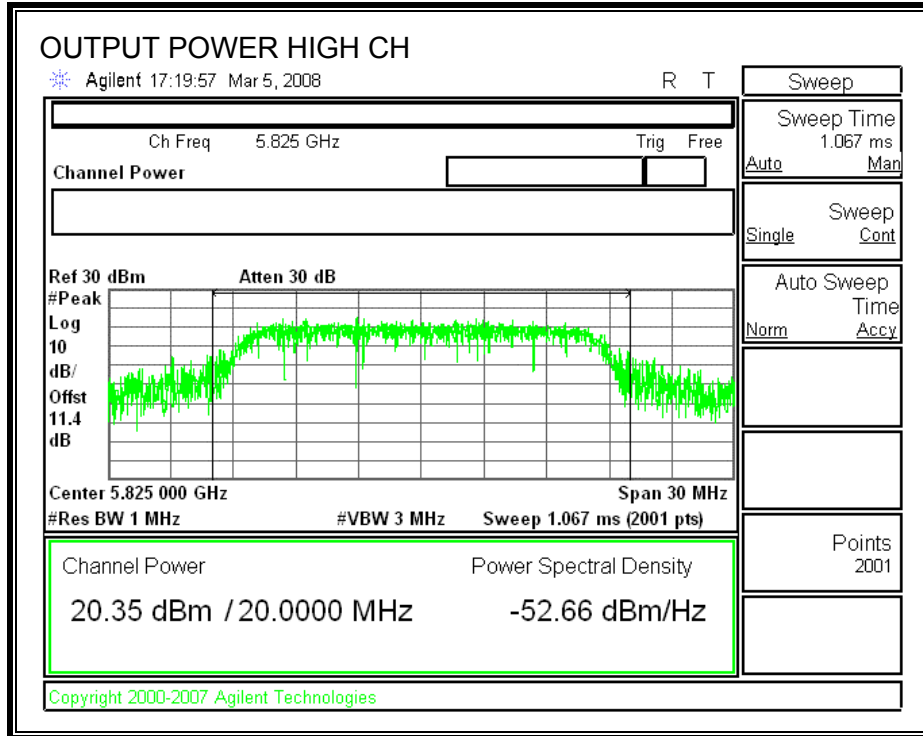


**OUTPUT POWER**

CH 1

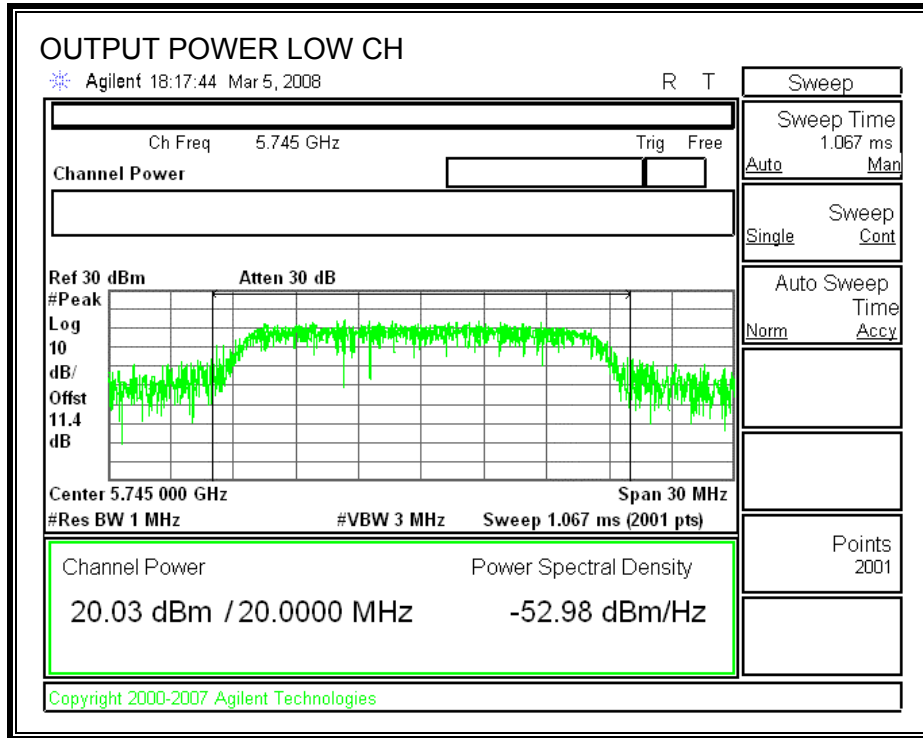


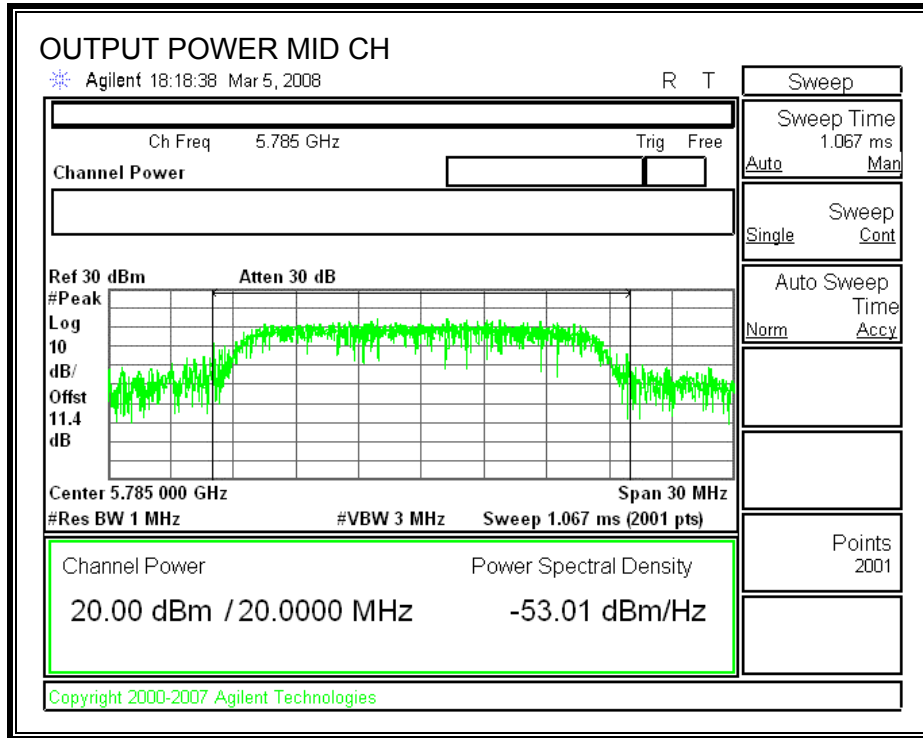


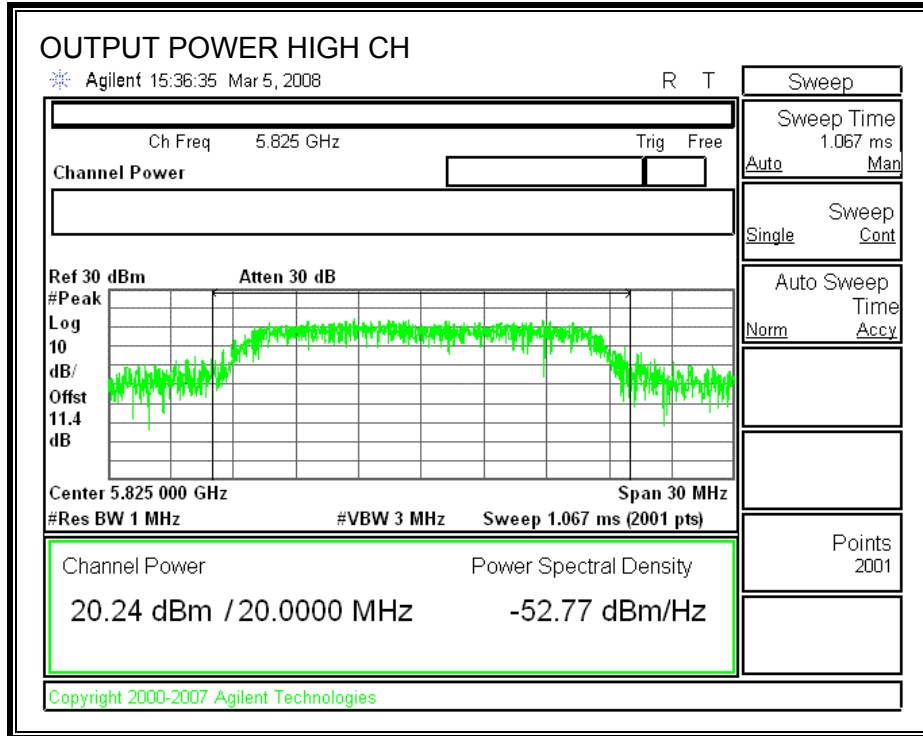


**OUTPUT POWER**

CH 2







### 7.1.4. AVERAGE POWER FOR LEGACY MODES (5.8GHz)

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

#### RESULTS

The cable assembly insertion loss of 11.45 dB (including 10 dB pad and 1.45 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 (dBm)	Chain 1 (dBm)	Chain 2 (dBm)	Total Power (dBm)
Low	5745	17.63	17.58	17.33	22.29
Middle	5785	17.40	17.79	17.54	22.35
High	5825	17.67	18.20	18.10	22.77

### 7.1.5. 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

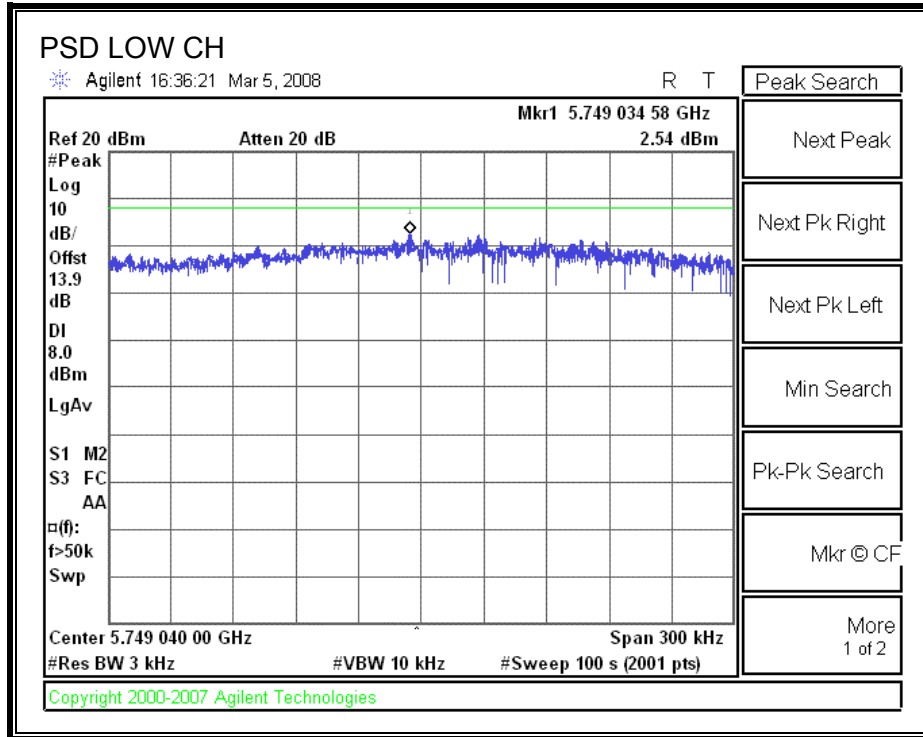
Output power was measured based on the use of a peak measurement, therefore the power spectral density was measured using PSD Option 1 in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

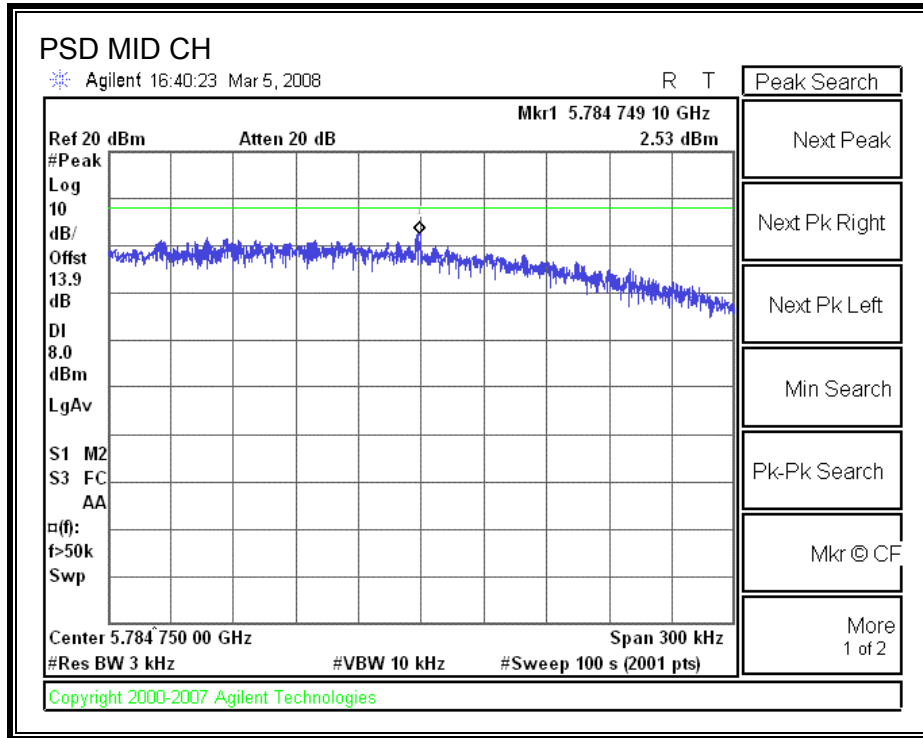
#### RESULTS:

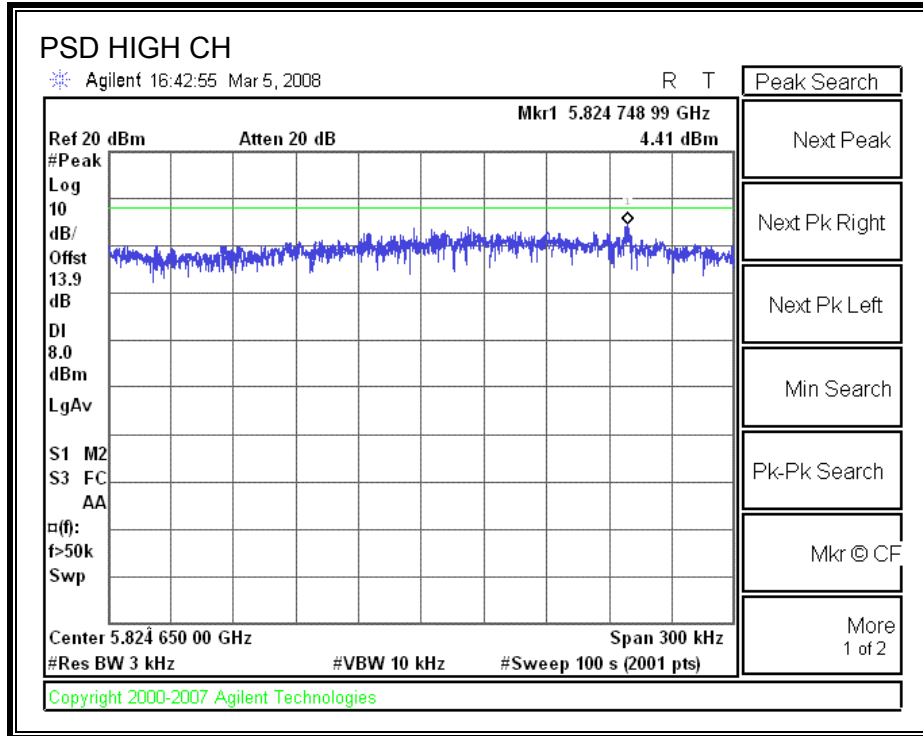
Channel	Frequency (MHz)	PSD with Combiner (dBm)	Limit (dBm)	Margin (dB)
Low	5745	2.54	8	-5.46
Middle	5785	2.53	8	-5.47
High	5825	4.41	8	-3.59



**POWER SPECTRAL DENSITY WITH COMBINER**







## 7.1.6. CONDUCTED SPURIOUS EMISSIONS

### LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

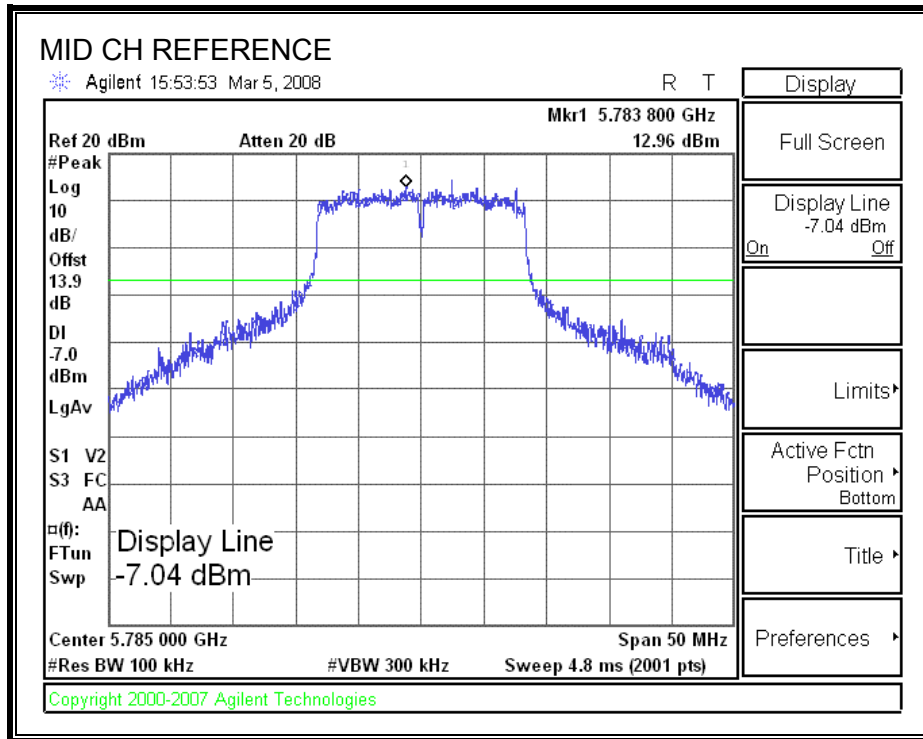
### TEST PROCEDURE

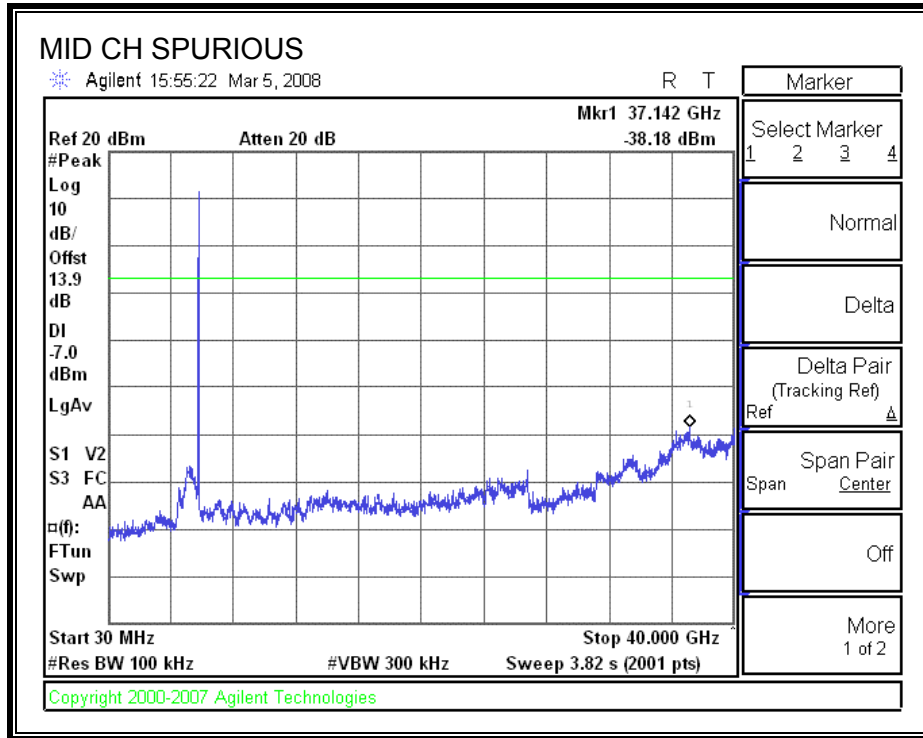
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

### RESULTS

**SPURIOUS EMISSIONS MID CHANNEL WITH COMBINER**





## 7.2. 802.11n THREE CHAINS HT20 MODE IN THE 5.8 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.

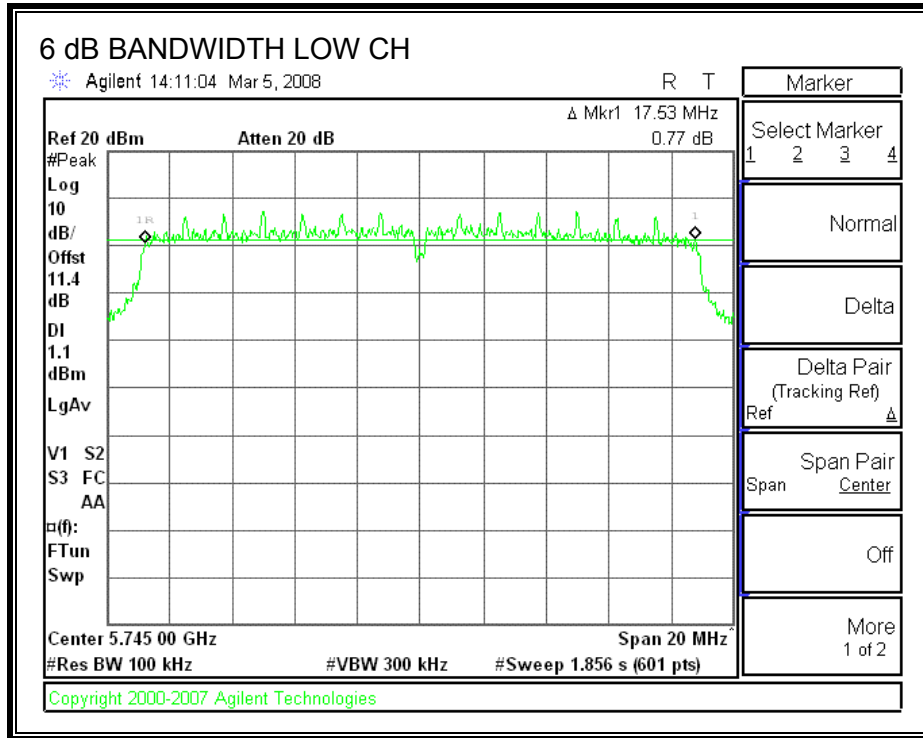
#### TEST PROCEDURE

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.

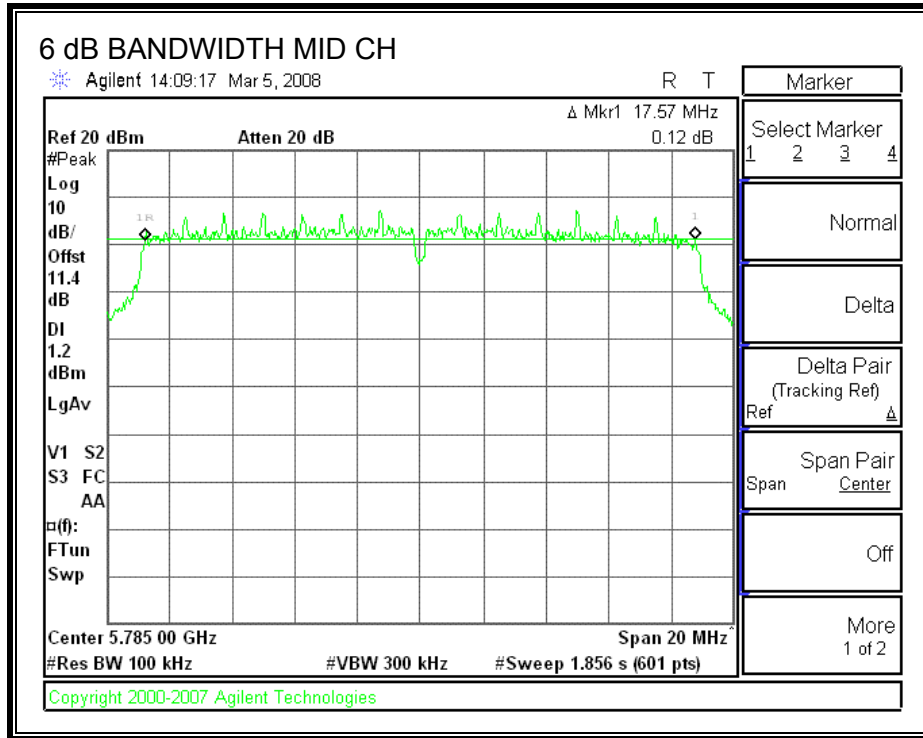
#### RESULTS

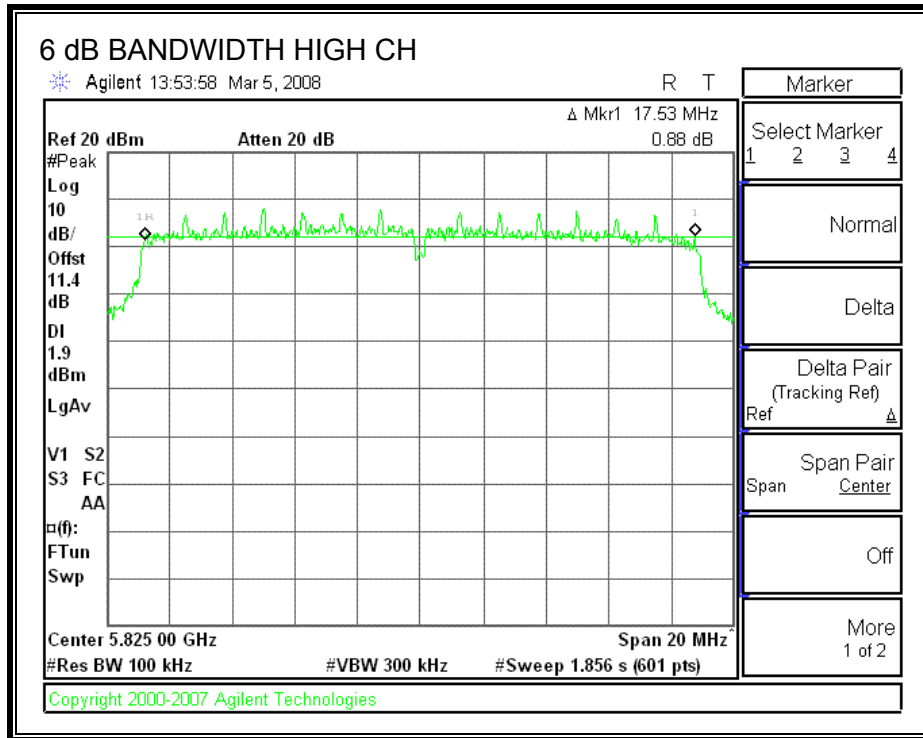
Channel	Frequency (MHz)	6 dB BW (MHz)	Minimum Limit (MHz)
Low	5745	17.53	0.5
Middle	5785	17.57	0.5
High	5825	17.53	0.5

**6 dB BANDWIDTH**









## 7.2.2. 99% BANDWIDTH

### LIMITS

None; for reporting purposes only.

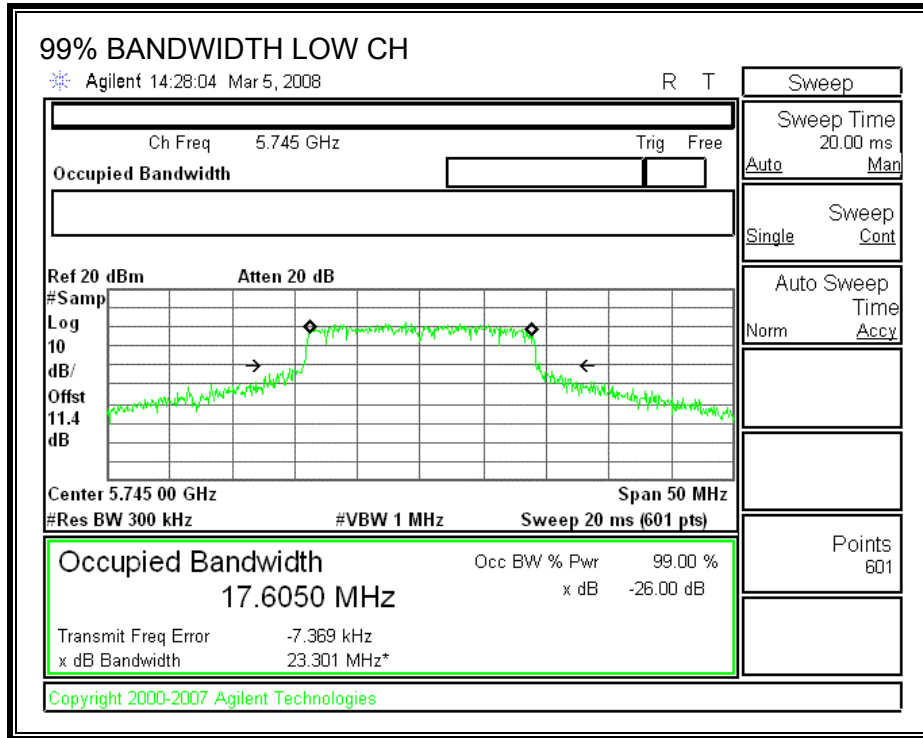
### TEST PROCEDURE

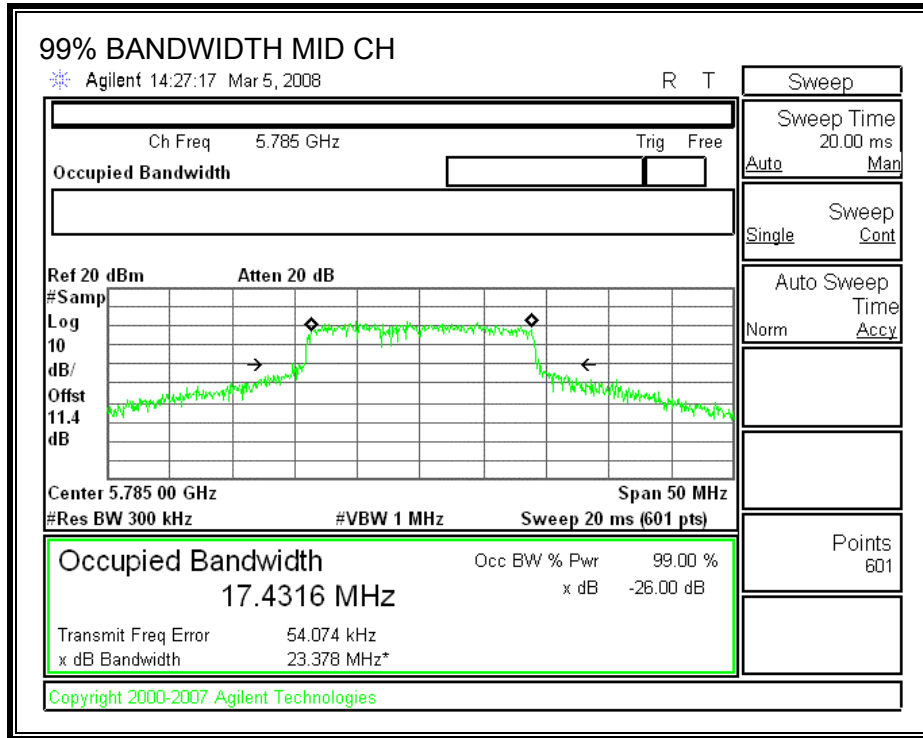
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

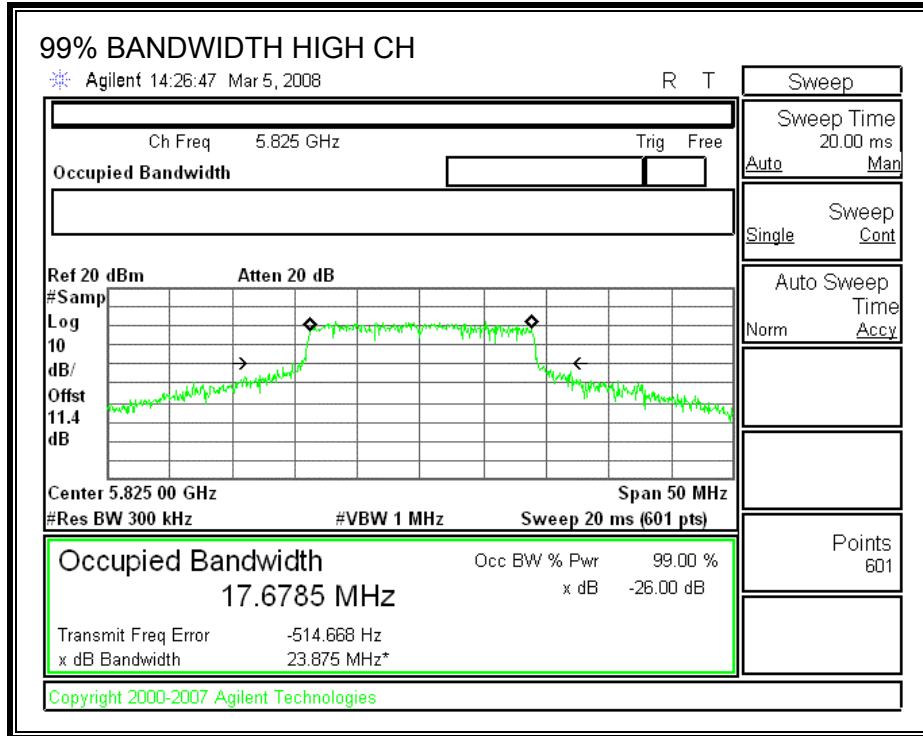
### RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5745	17.6050
Middle	5785	17.4316
High	5825	17.6785

**99% BANDWIDTH,**







### 7.2.3. OUTPUT POWER

#### LIMITS

FCC §15.247 (b)

IC RSS-210 A8.4

The maximum effective antenna gain is 5 dBi for other than fixed, point-to-point operations, therefore the limit is 30 dBm.

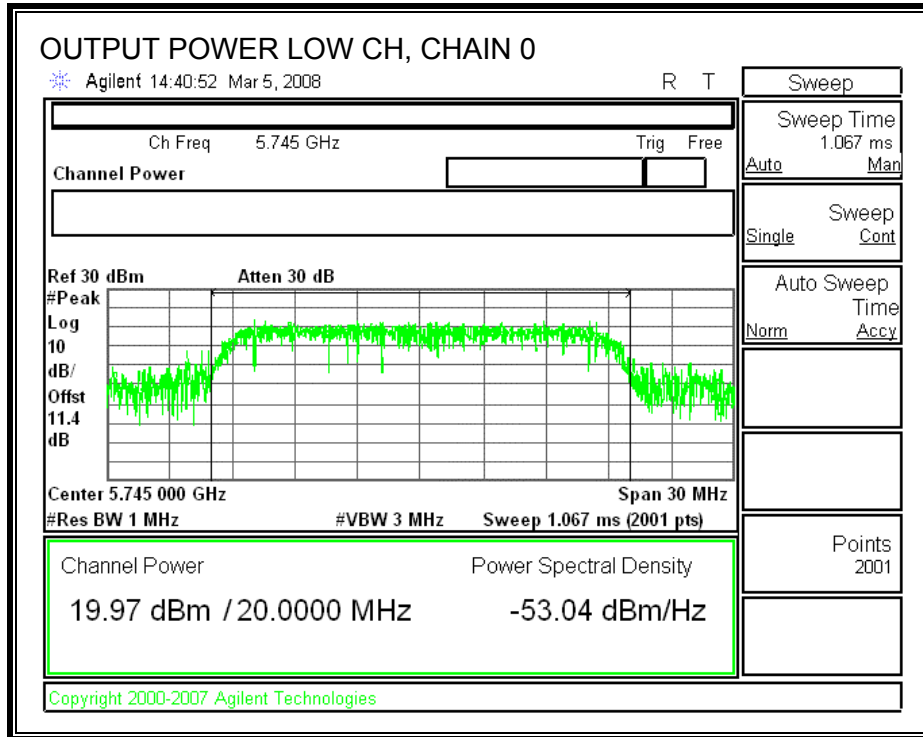
#### TEST PROCEDURE

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 99% bandwidth.

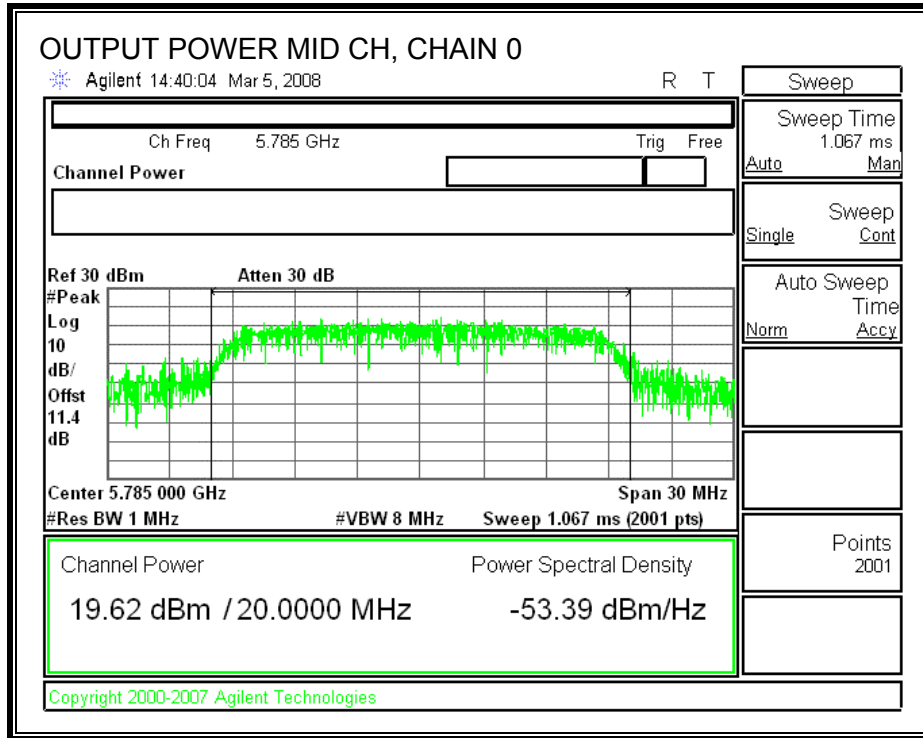
#### RESULTS

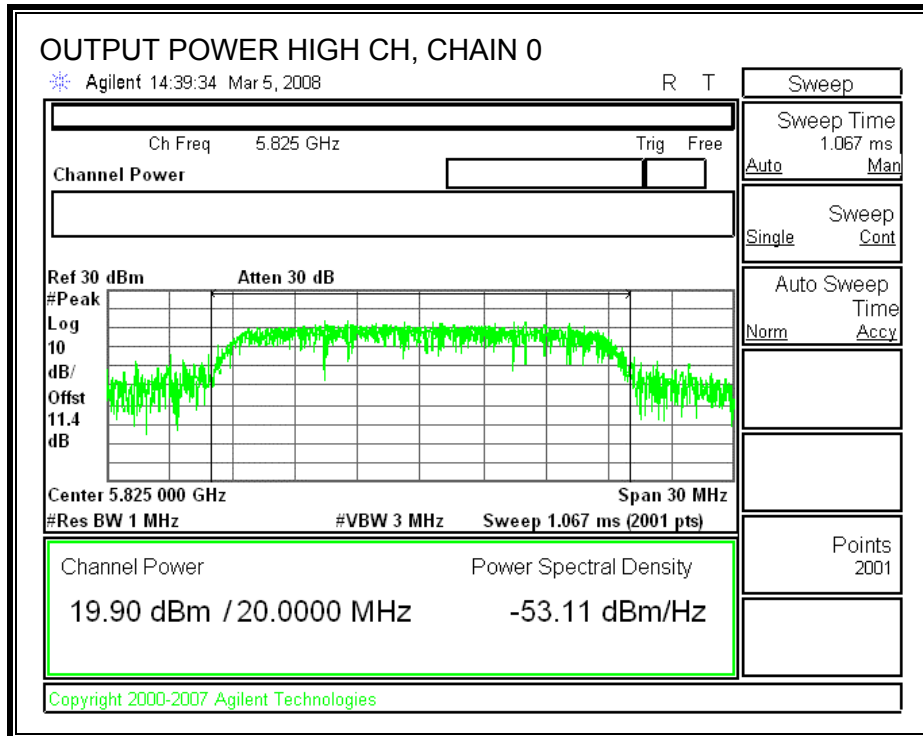
Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5745	19.97	20.47	19.94	24.90	30.00	-5.10
Mid	5785	19.62	19.90	19.82	24.55	30.00	-5.45
High	5825	19.90	19.83	20.27	24.78	30.00	-5.22

**CHAIN 0 OUTPUT POWER**

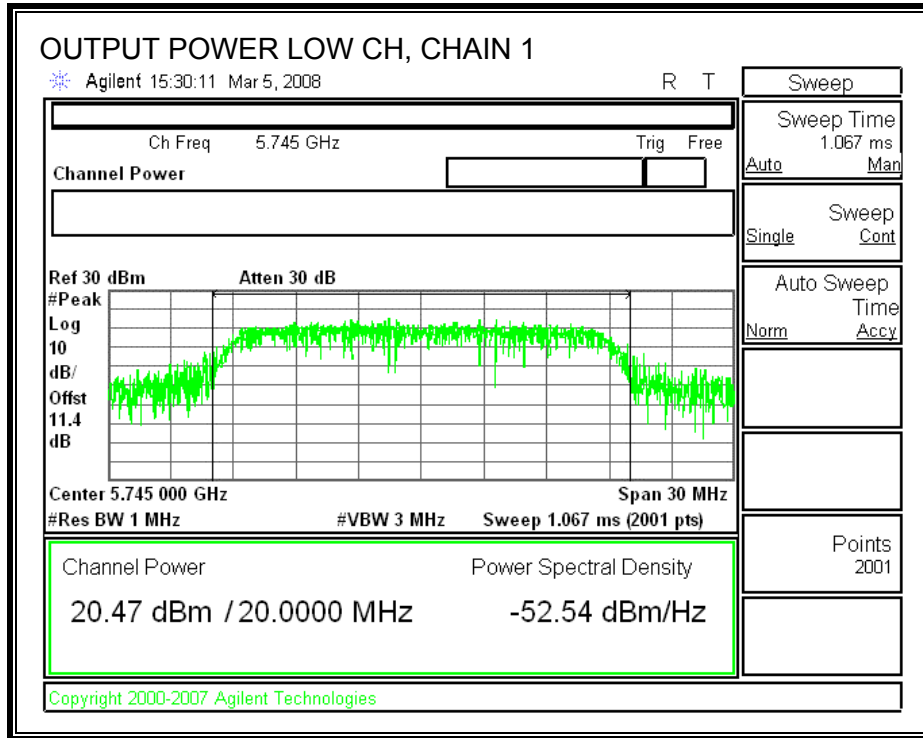


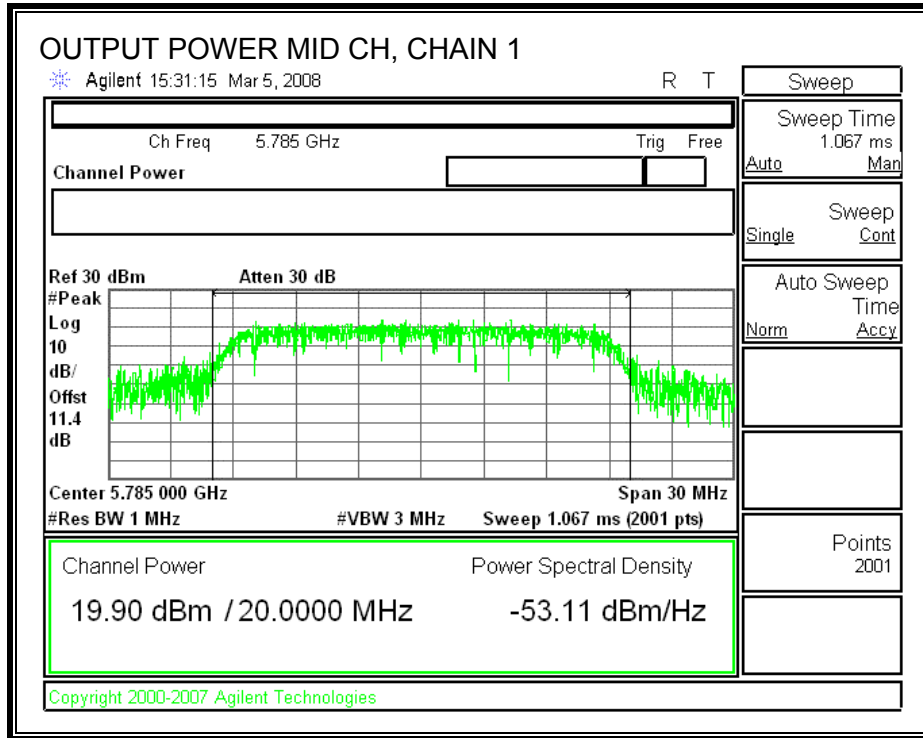


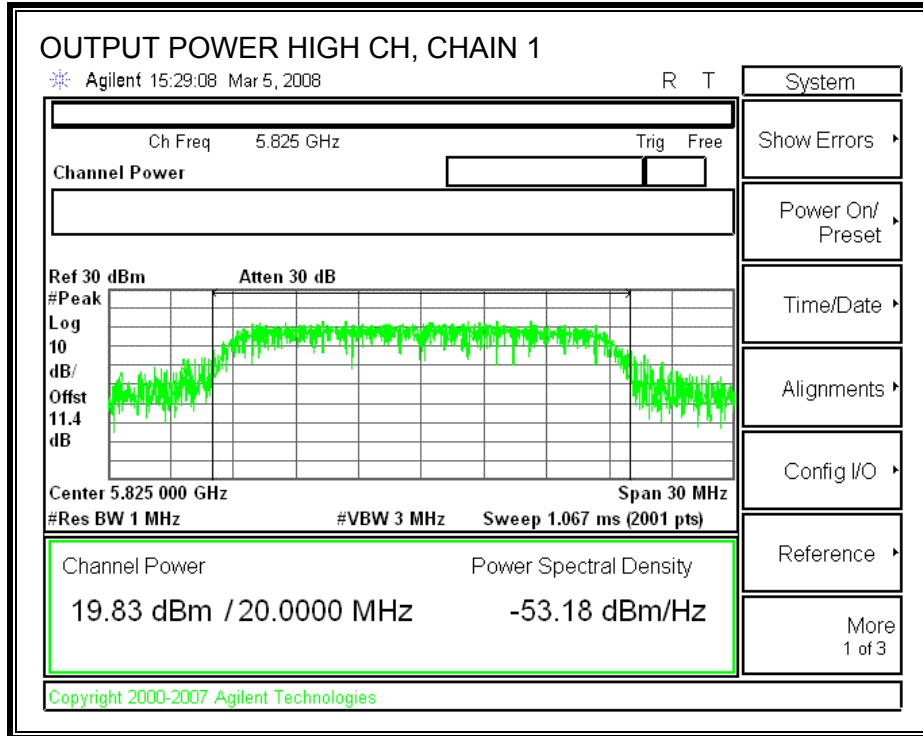




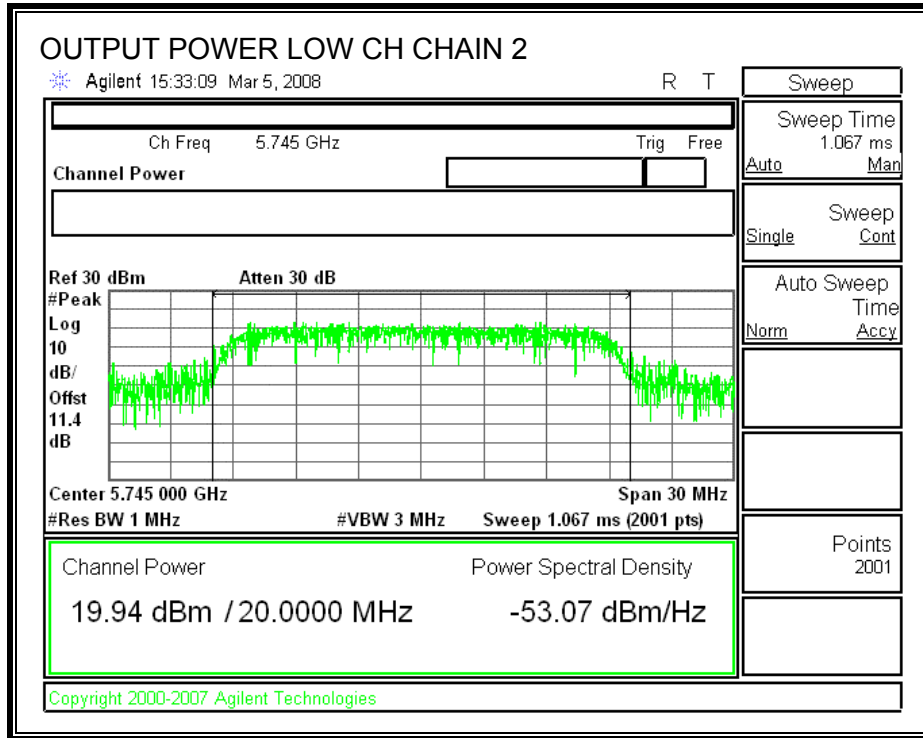
**CHAIN 1 OUTPUT POWER**

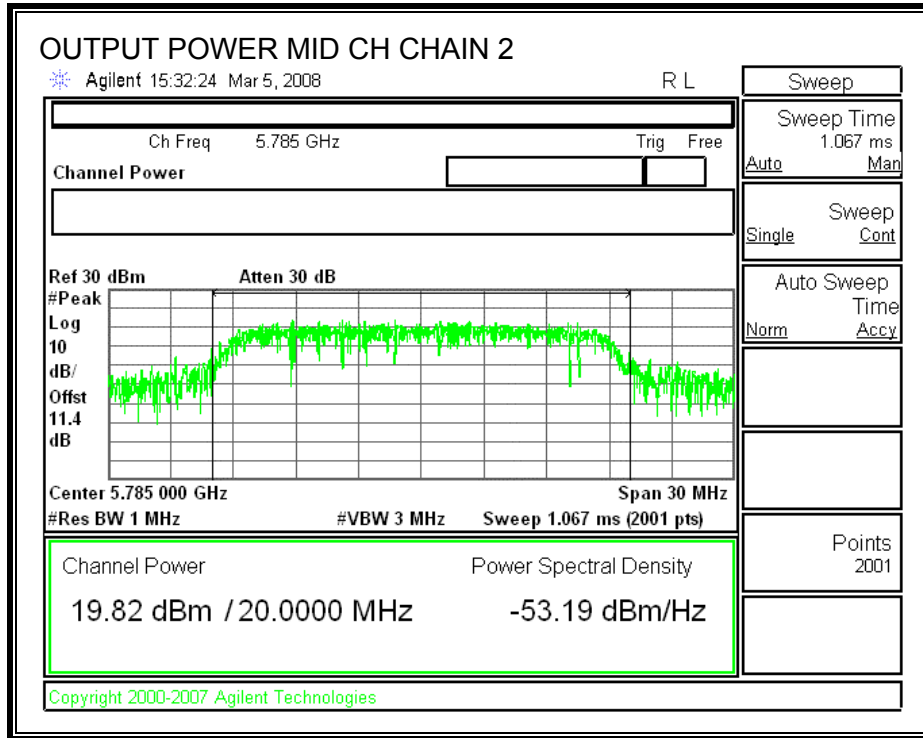


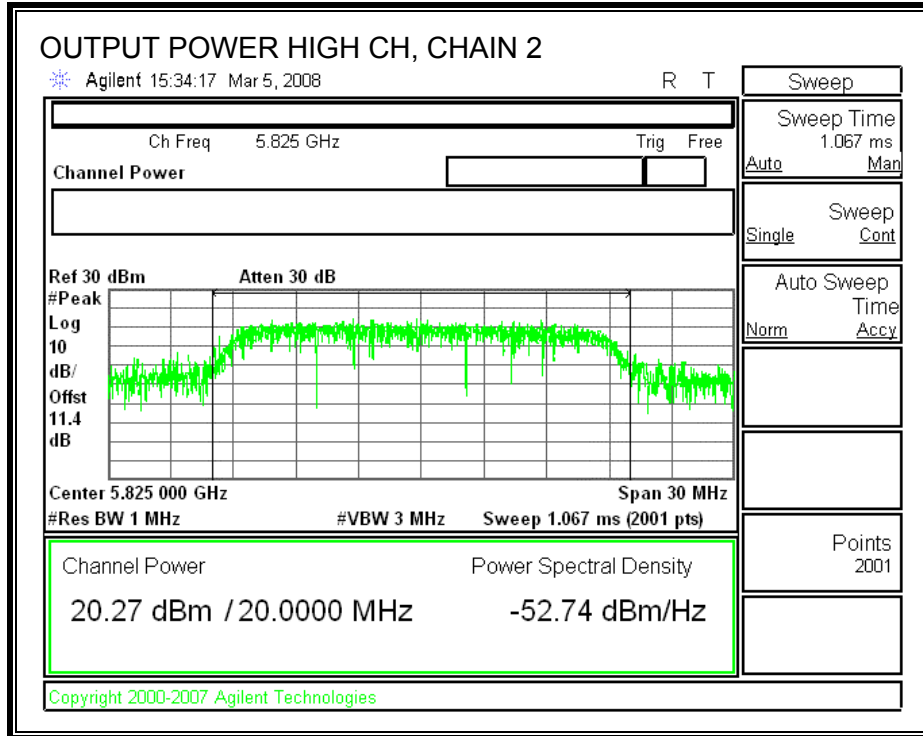




**CHAIN 2 OUTPUT POWER**









### 7.2.4. AVERAGE POWER FOR HT20 MODES (5.8GHz)

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

#### RESULTS

The cable assembly insertion loss of 11.45 dB (including 10 dB pad and 1.45 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 (dBm)	Chain 1 (dBm)	Chain 2 (dBm)	Total Power (dBm)
Low	5745	17.75	17.52	17.75	22.45
Middle	5785	17.35	17.73	17.83	22.41
High	5825	17.80	17.65	18.20	22.66

## 7.2.5. 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.

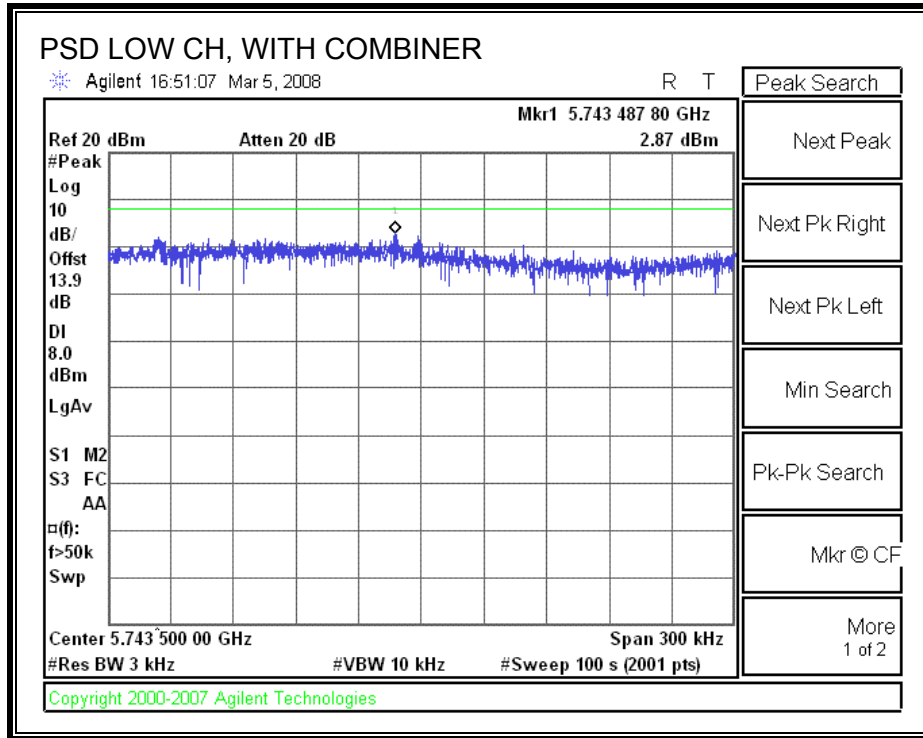
### TEST PROCEDURE

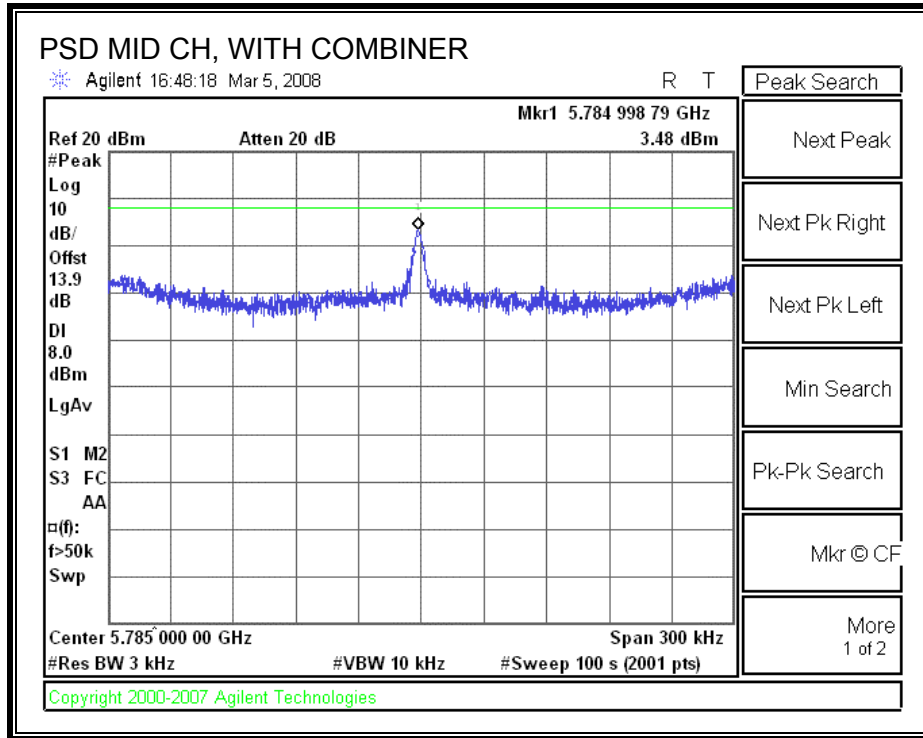
Output power was measured based on the use of a peak measurement, therefore the power spectral density was measured using PSD Option 1 in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

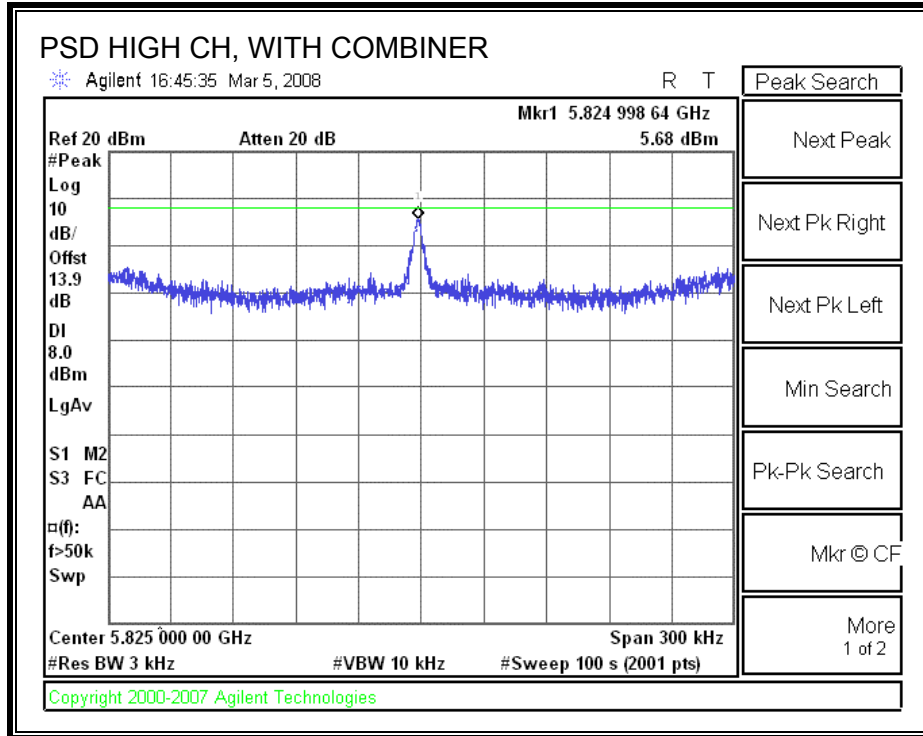
### RESULTS:

Channel	Frequency (MHz)	PSD with Combiner (dBm)	Limit (dBm)	Margin (dB)
Low	5745	2.87	8	-5.13
Middle	5785	3.48	8	-4.52
High	5825	5.68	8	-2.32

**POWER SPECTRAL DENSITY, WITH COMBINER**







## **7.2.6. CONDUCTED SPURIOUS EMISSIONS**

### **LIMITS**

FCC §15.247 (d)

IC RSS-210 A8.5

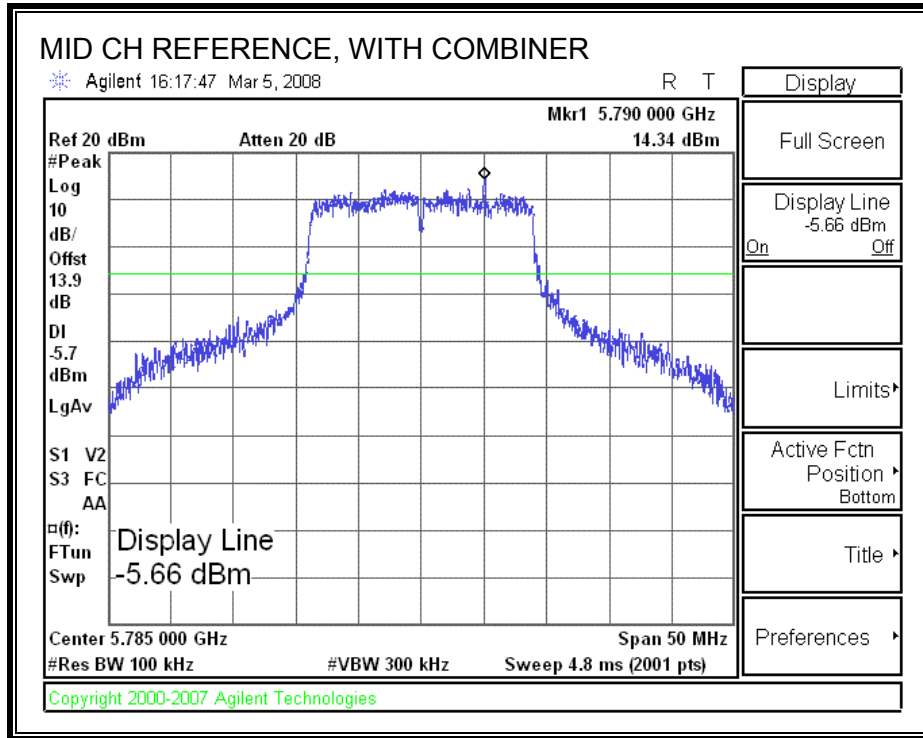
Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

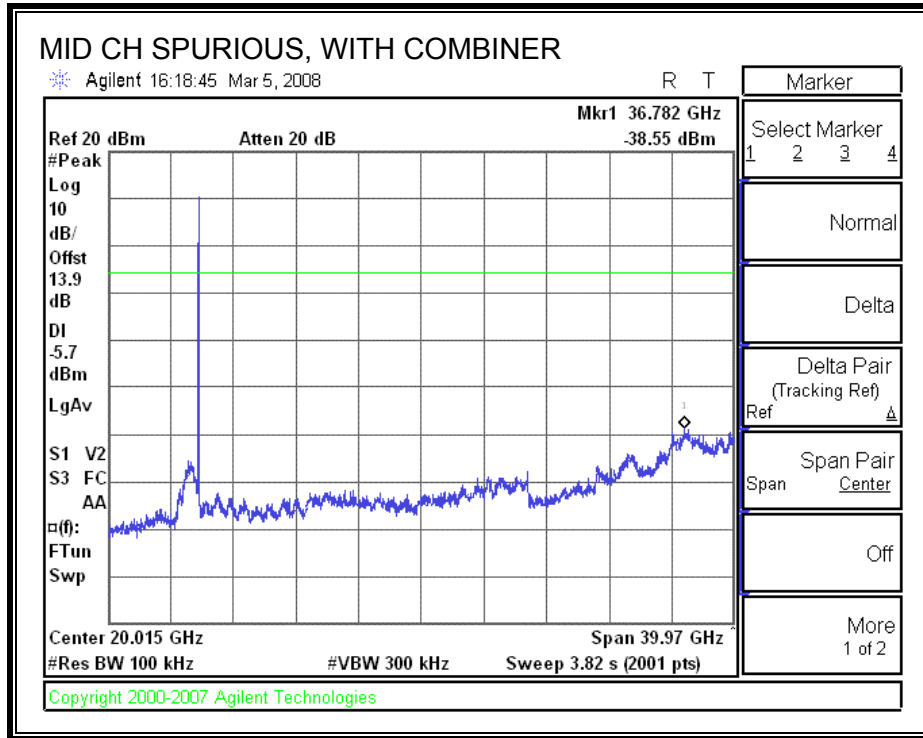
### **TEST PROCEDURE**

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.

### **RESULTS**







### 7.3. 802.11n THREE CHAINS HT40 MODE IN THE 5.8 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.

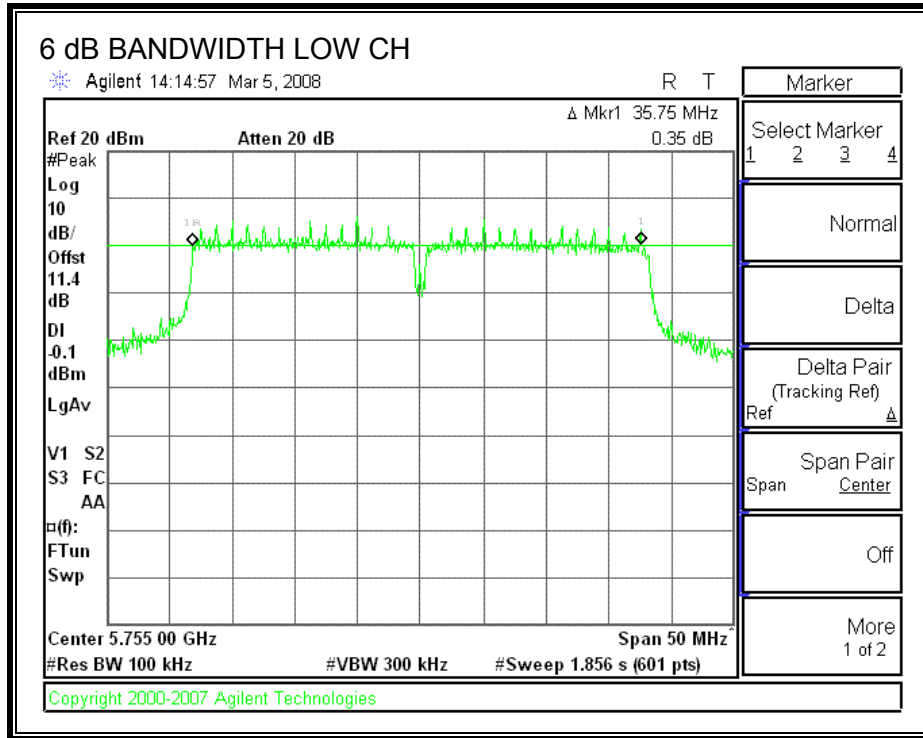
##### TEST PROCEDURE

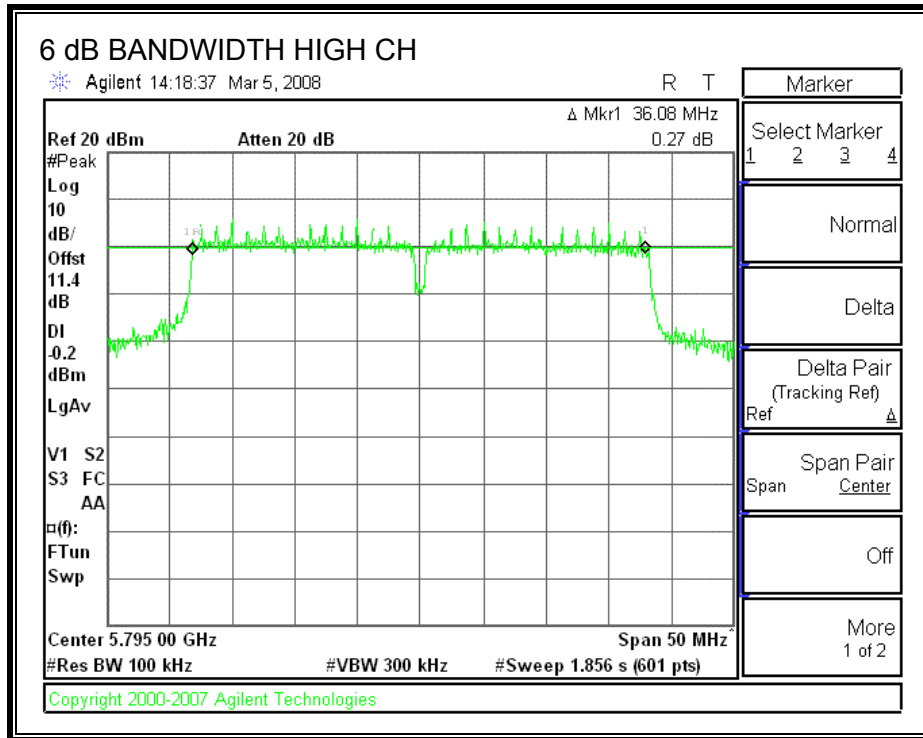
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

##### RESULTS

Channel	Frequency (MHz)	6 dB BW (MHz)	Minimum Limit (MHz)
Low	5755	35.75	0.5
High	5795	36.08	0.5

**6 dB BANDWIDTH,**





### 7.3.2. 99% BANDWIDTH

#### LIMITS

None; for reporting purposes only.

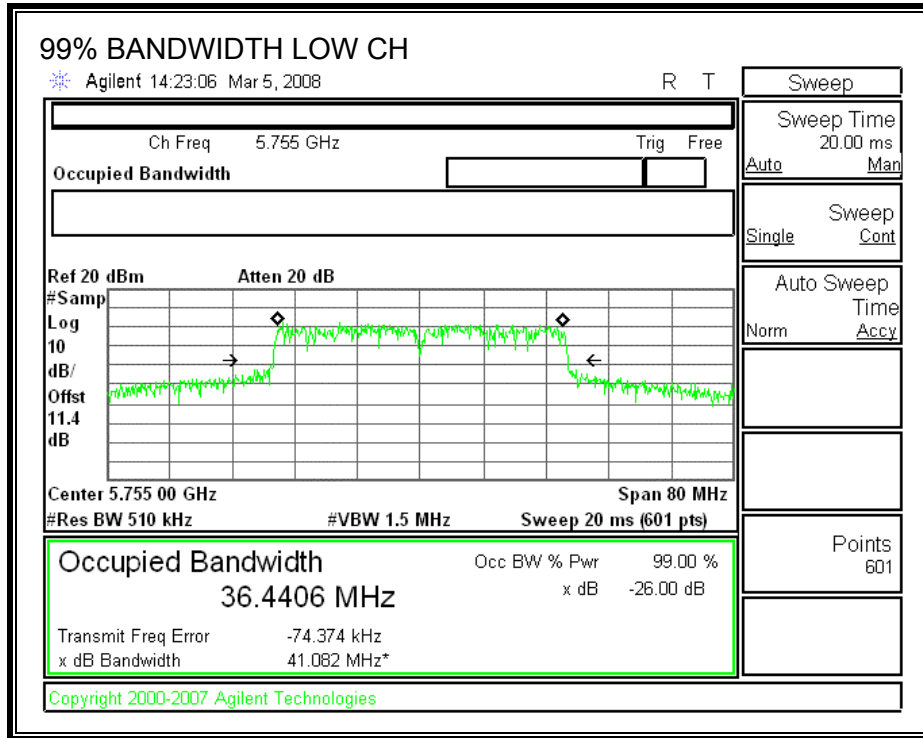
#### TEST PROCEDURE

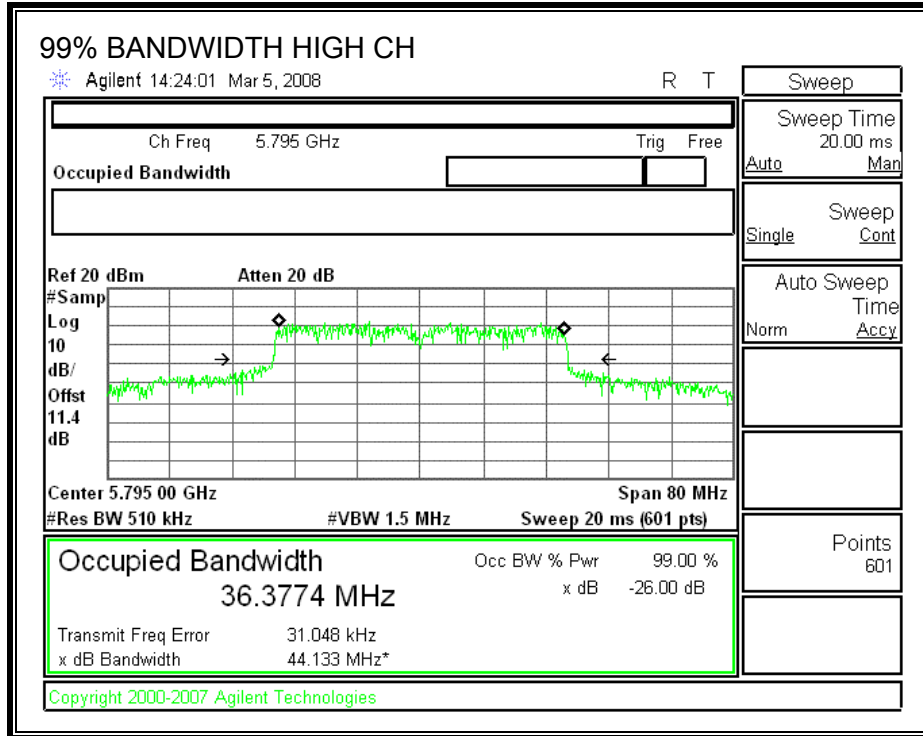
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

#### RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5755	36.4406
High	5795	36.3774

**99% BANDWIDTH,**





### 7.3.3. OUTPUT POWER

#### LIMITS

FCC §15.247 (b)

IC RSS-210 A8.4

The maximum antenna gain is 5 dBi for other than fixed, point-to-point operations, therefore the limit is 30 dBm.

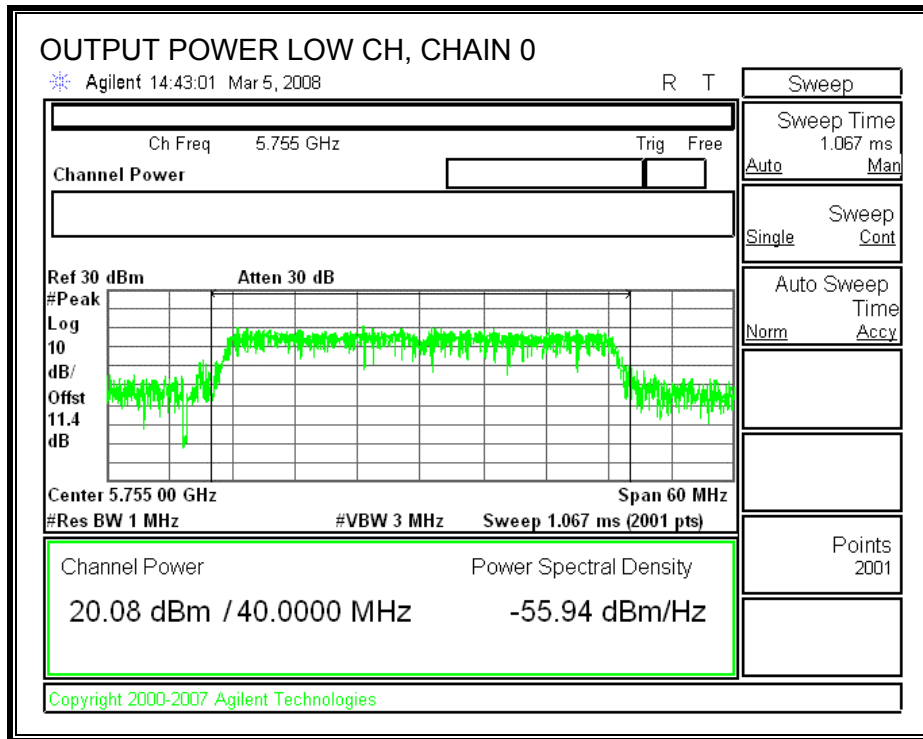
#### TEST PROCEDURE

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 99% bandwidth.

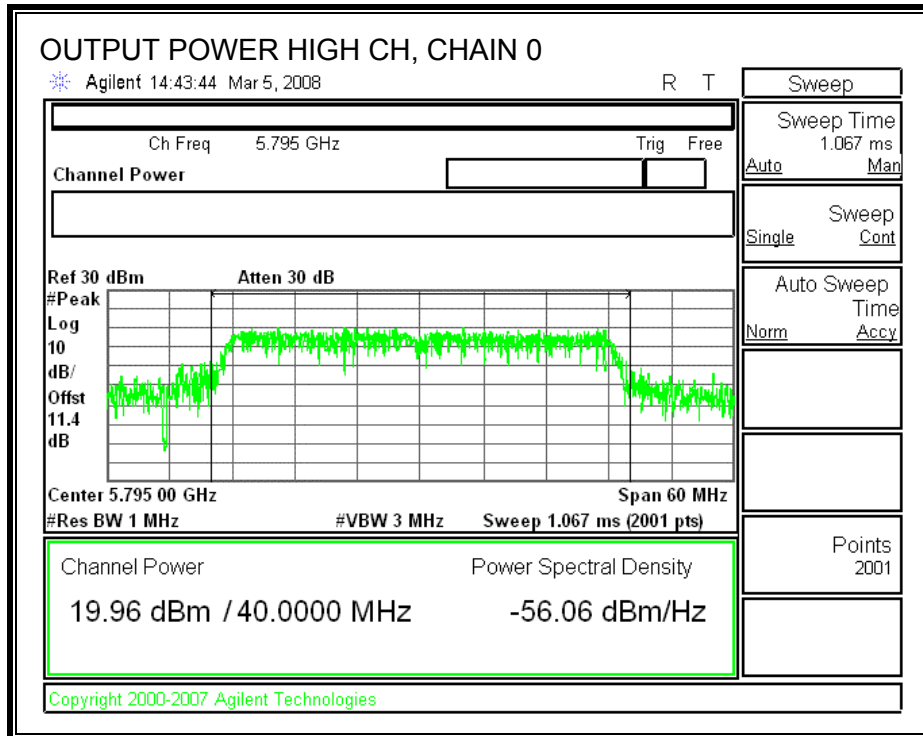
#### RESULTS

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	5755	20.08	20.12	20.37	24.96	30.00	-5.04
High	5795	19.96	20.57	20.12	25.00	30.00	-5.00

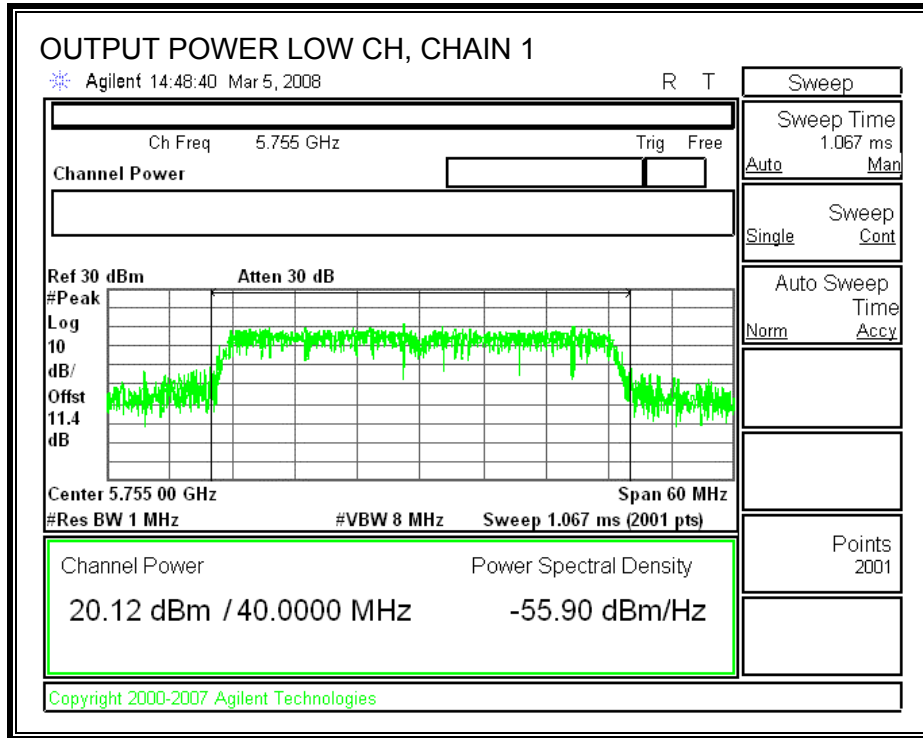
**CHAIN 0 OUTPUT POWER**

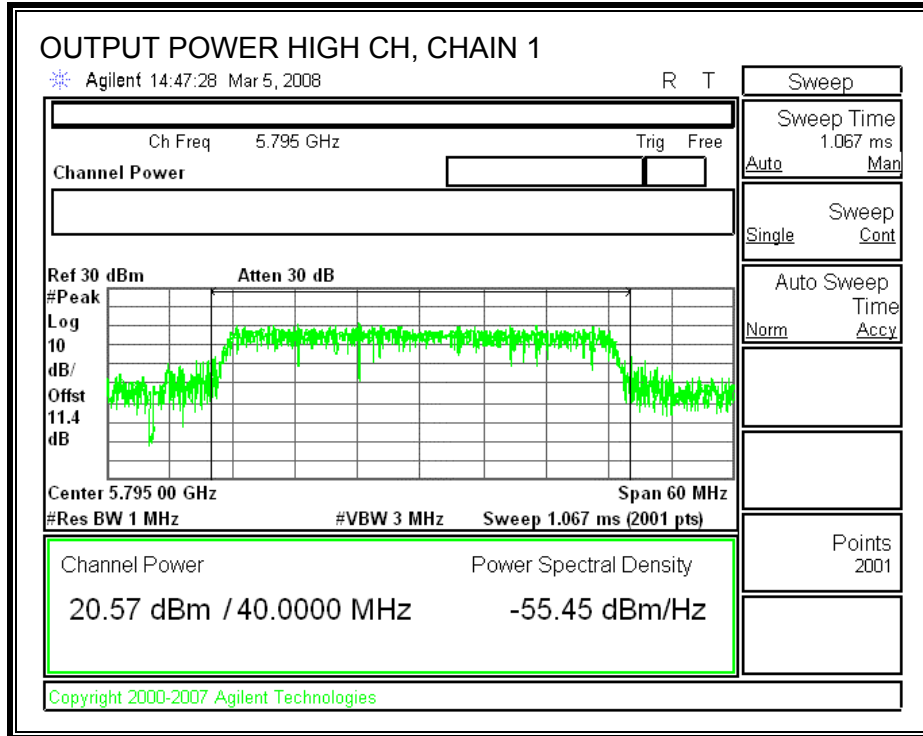




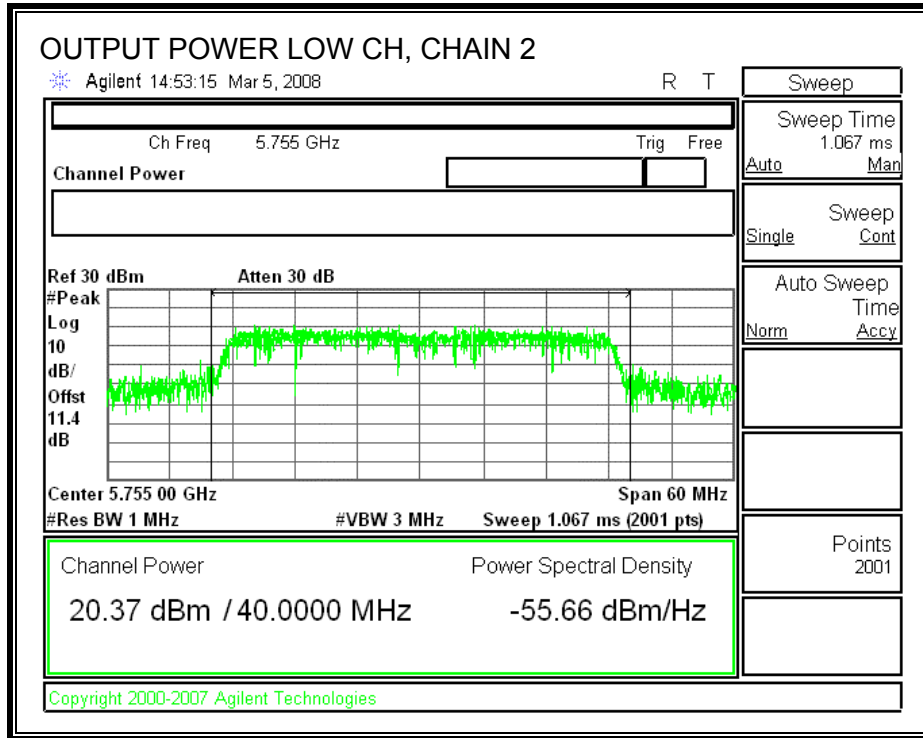


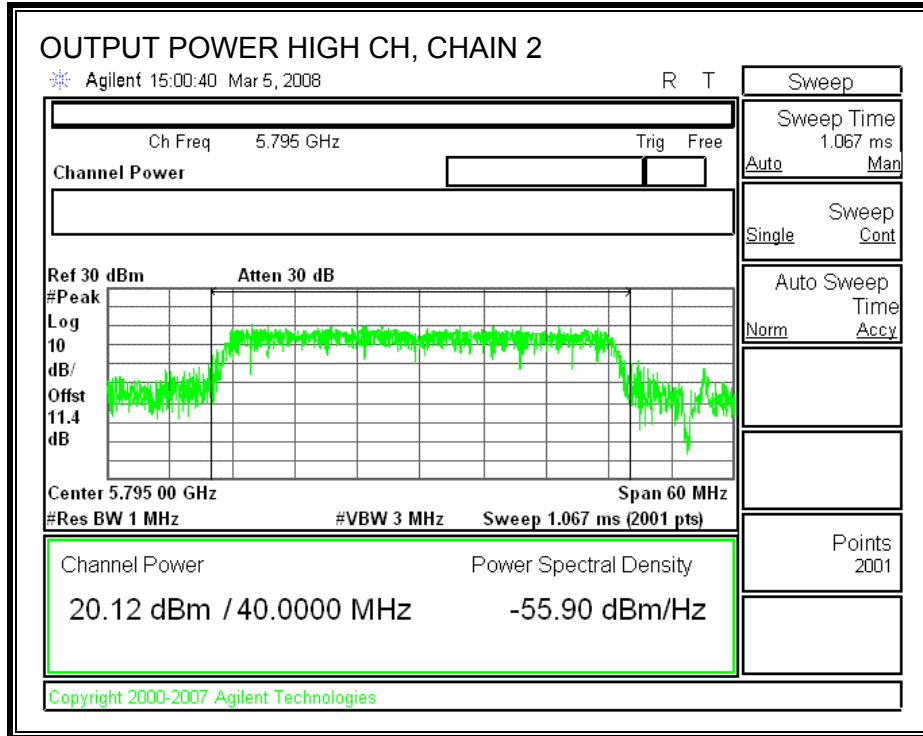
**CHAIN 1 OUTPUT POWER**





**CHAIN 2 OUTPUT POWER**





### 7.3.4. AVERAGE POWER FOR HT40 MODES (5.8GHz)

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

#### RESULTS

The cable assembly insertion loss of 11.45 dB (including 10 dB pad and 1.45 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Chain 0 (dBm)	Chain 1 (dBm)	Chain 2 (dBm)	Total Power (dBm)
Low	5755	17.52	17.63	17.67	22.38
High	5795	17.64	18.01	17.97	22.65

### 7.3.5. 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.

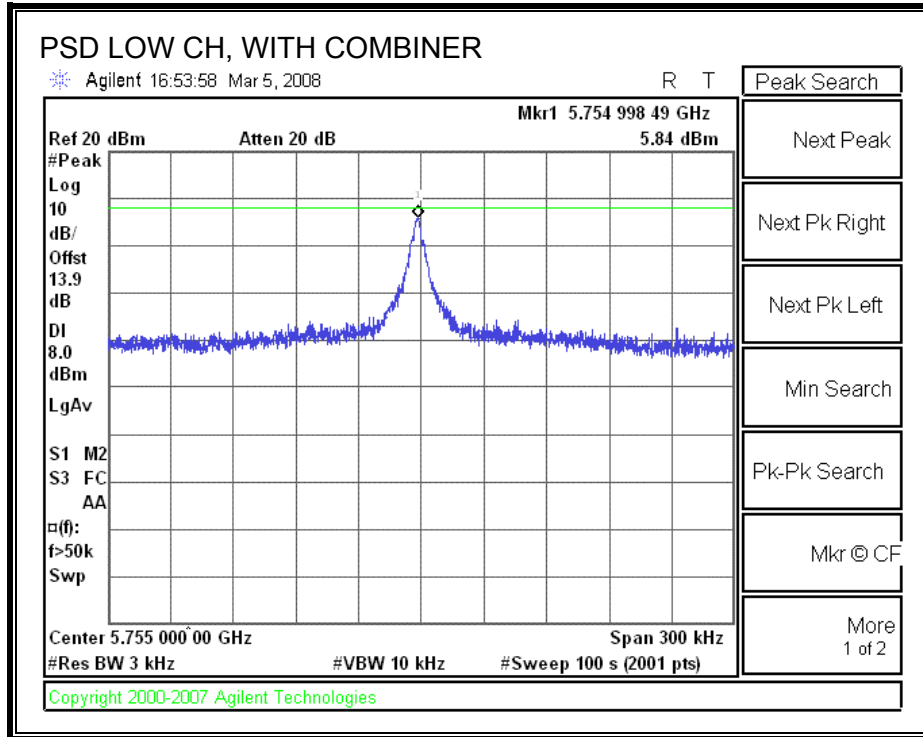
#### TEST PROCEDURE

Output power was measured based on the use of a peak measurement, therefore the power spectral density was measured using PSD Option 1 in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

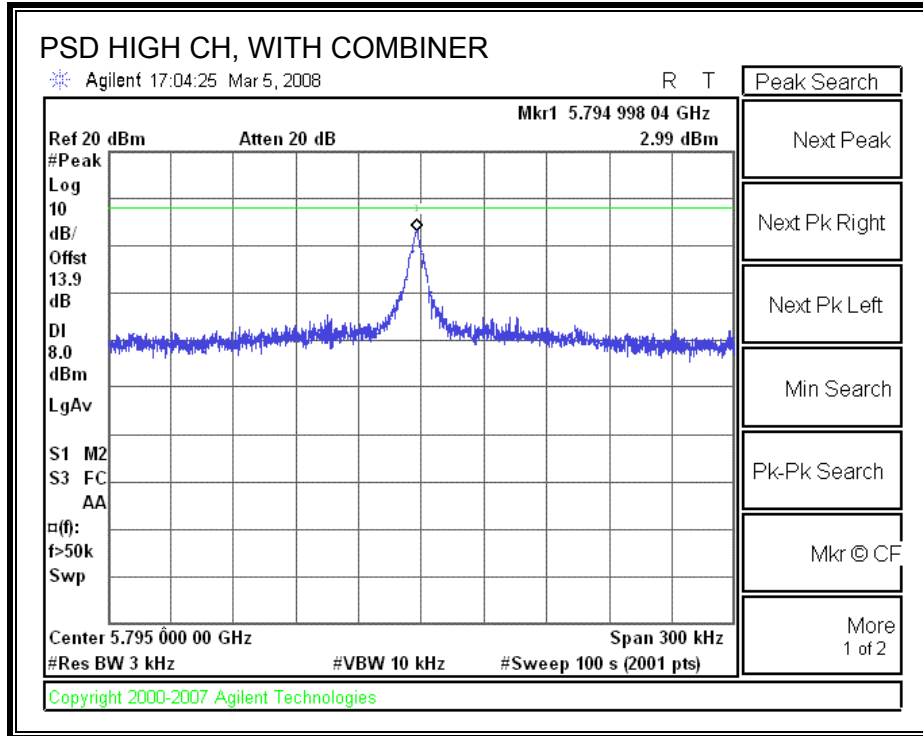
#### RESULTS:

Channel	Frequency (MHz)	PSD with Combiner (dBm)	Limit (dBm)	Margin (dB)
Low	5755	5.84	8	-2.16
High	5795	2.99	8	-5.01

**POWER SPECTRAL DENSITY, WITH COMBINER**







### **7.3.6. CONDUCTED SPURIOUS EMISSIONS**

#### **LIMITS**

FCC §15.247 (d)

IC RSS-210 A8.5

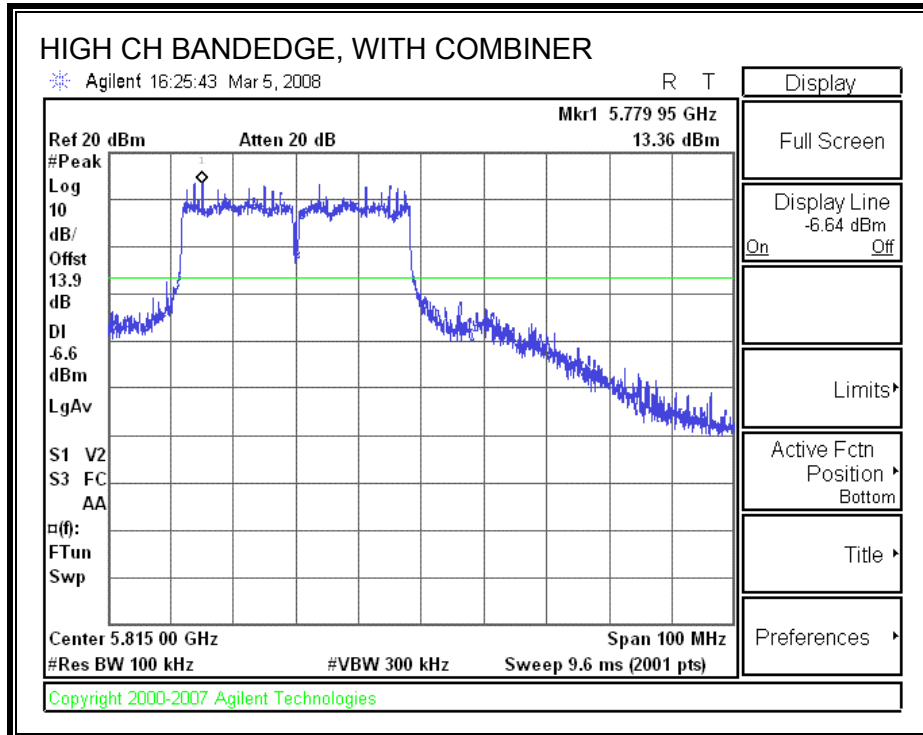
Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

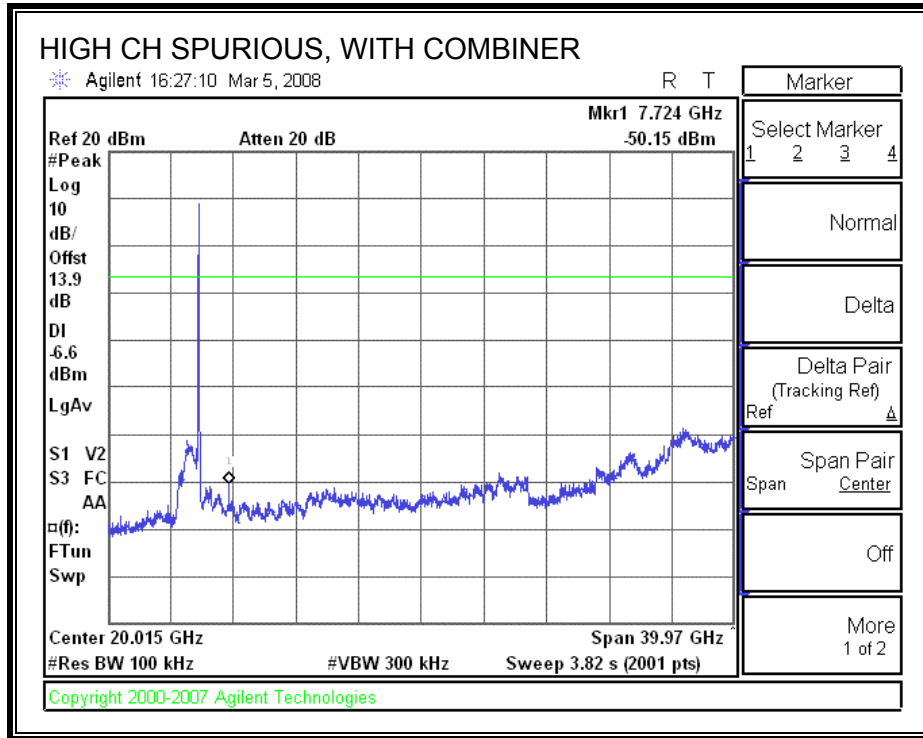
#### **TEST PROCEDURE**

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.

#### **RESULTS**





## 8. RADIATED TEST RESULTS

### 8.1. LIMITS AND PROCEDURE

#### LIMITS

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

IC RSS-GEN Clause 6 (Receiver)

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

#### TEST PROCEDURE

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

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

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

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

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

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

### HARMONICS AND SPURIOUS EMISSIONS

**High Frequency Measurement**  
 Compliance Certification Services, Fremont 5m Chamber

Company: Atheros Communications  
 Project #: 08U11627  
 Date: 3/4/2008  
 Test Engineer: Chin Pang  
 Configuration: EUT/3 Antennas/Laptop  
 Mode: TX, 5.8GHz Band, Legacy

**Test Equipment:**

Horn 1-18GHz	Pre-amplifier 1-26GHz	Pre-amplifier 26-40GHz	Horn > 18GHz	Limit
T120; S/N: 29310 @3m	T145 Agilent 3008A005	T88 Miteq 26-40GHz	T89; ARA 18-26GHz; S/N:1049	FCC 15.205

Hi Frequency Cables

2 foot cable	3 foot cable	12 foot cable	HPF	Reject Filter	Peak Measurements RBW=VBW=1MHz
Chin 177079003		C-5m Chamber	HPF_7.6GHz		Average Measurements RBW=1MHz ; VBW=10Hz

f GHz	Dist (m)	Read Pk dBuV	Read Avg dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filtr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
<b>Mid Ch 5785MHz</b>															
11.570	3.0	43.0	32.0	36.4	4.6	-33.0	0.0	0.7	51.7	40.7	74	54	-22.3	-13.3	V
11.570	3.0	40.6	30.0	36.4	4.6	-33.0	0.0	0.7	49.3	38.7	74	54	-24.7	-15.3	H

Rev. 4.12.7  
**Note: No other emissions were detected above the system noise floor.**

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

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

### HARMONICS AND SPURIOUS EMISSIONS

**High Frequency Measurement**  
 Compliance Certification Services, Fremont 5m Chamber

Company: Atheros Communications  
 Project #: 08U11627  
 Date: 3/4/2008  
 Test Engineer: Chin Pang  
 Configuration: EUT/3 Antennas/Laptop  
 Mode: TX, 5.8GHz Band, HT20

**Test Equipment:**

Horn 1-18GHz	Pre-amplifier 1-26GHz	Pre-amplifier 26-40GHz	Horn > 18GHz	Limit
T120; S/N: 29310 @3m	T145 Agilent 3008A005	T88 Miteq 26-40GHz	T89; ARA 18-26GHz; S/N:1049	FCC 15.205

Hi Frequency Cables

2 foot cable	3 foot cable	12 foot cable	HPF	Reject Filter	Peak Measurements RBW=VBW=1MHz Average Measurements RBW=1MHz ; VBW=10Hz
Chin 177079003		C-5m Chamber	HPF_7.6GHz		

f GHz	Dist (m)	Read Pk dBuV	Read Avg dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filtr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
<b>Mid Ch 5785MHz</b>															
11.570	3.0	45.0	32.0	36.4	4.6	-33.0	0.0	0.7	53.7	40.7	74	54	-20.3	-13.3	V
11.570	3.0	43.5	31.0	36.4	4.6	-33.0	0.0	0.7	52.2	39.7	74	54	-21.8	-14.3	H

Rev. 4.12.7  
**Note: No other emissions were detected above the system noise floor.**

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

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

### HARMONICS AND SPURIOUS EMISSIONS

**High Frequency Measurement**  
 Compliance Certification Services, Fremont 5m Chamber

Company: Atheros Communications  
 Project #: 08U11627  
 Date: 3/4/2008  
 Test Engineer: Chin Pang  
 Configuration: EUT/3 Antennas/Laptop  
 Mode: TX, 5.8GHz Band, HT40

**Test Equipment:**

<b>Horn 1-18GHz</b>	<b>Pre-amplifier 1-26GHz</b>	<b>Pre-amplifier 26-40GHz</b>	<b>Horn &gt; 18GHz</b>	<b>Limit</b>
T120; S/N: 29310 @3m	T145 Agilent 3008A005t	T88 Miteq 26-40GHz	T89; ARA 18-26GHz; S/N:1049	FCC 15.205

Hi Frequency Cables

<b>2 foot cable</b>	<b>3 foot cable</b>	<b>12 foot cable</b>	<b>HPF</b>	<b>Reject Filter</b>	<b>Peak Measurements</b> RBW=VBW=1MHz
Chin 177079003		C-5m Chamber	HPF_7.6GHz		<b>Average Measurements</b> RBW=1MHz, VBW=10Hz

f GHz	Dist (m)	Read Pk dBuV	Read Avg dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fldr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
<b>High Ch 5795MHz</b>															
11.590	3.0	43.6	31.5	36.4	4.6	-33.0	0.0	0.7	52.3	40.2	74	54	-21.7	-13.8	V
11.590	3.0	42.3	30.6	36.4	4.6	-33.0	0.0	0.7	51.0	39.3	74	54	-23.0	-14.7	H

Rev. 4.12.7  
**Note: No other emissions were detected above the system noise floor.**

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



### 8.3. RECEIVER ABOVE 1 GHz

#### 8.3.1. RX ABOVE 1 GHz 40 MHz BANDWIDTH, 5.8 GHz

**High Frequency Measurement**  
 Compliance Certification Services, Fremont 5m Chamber

Company: Atheros Communications  
 Project #: 08U11627  
 Date: 3/5/2008  
 Test Engineer: Chin Pang  
 Configuration: EUT/3 Antennas/Laptop  
 Mode: 5.8GHz RX, HT40 (High Ch)

**Test Equipment:**

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T119; S/N: 29301 @3m	T145 Agilent 3008A005			FCC 15.209

Hi Frequency Cables

2 foot cable	3 foot cable	12 foot cable	HPF	Reject Filter	<u>Peak Measurements</u> RBW=VBW=1MHz <u>Average Measurements</u> RBW=1MHz ; VBW=10Hz
Chin 177079003		C-5m Chamber			

f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filtr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
<b>High Ch, 5795MHz</b>															
1.093	3.0	55.6	34.0	28.3	1.7	-36.1	0.0	0.0	49.5	27.9	74	54	-24.5	-26.1	V
1.458	3.0	52.7	32.8	29.5	1.9	-35.8	0.0	0.0	48.3	28.4	74	54	-25.7	-25.6	V
1.093	3.0	54.6	33.2	28.3	1.7	-36.1	0.0	0.0	48.5	27.1	74	54	-25.5	-26.9	H
1.458	3.0	50.5	30.8	29.5	1.9	-35.8	0.0	0.0	46.1	26.4	74	54	-27.9	-27.6	H

Rev. 4127  
**Note: No other emissions were detected above the system noise floor.**

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

## 9. MAXIMUM PERMISSIBLE EXPOSURE

### FCC RULES

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

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

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

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

f = frequency in MHz

\* = Plane-wave equivalent power density

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

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

**IC RULES**

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

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

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m <sup>2</sup> )	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	280/ <i>f</i>	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>	0.0042 <i>f</i> <sup>0.5</sup>	<i>f</i> /150	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	616 000 / <i>f</i> <sup>1.2</sup>
150 000–300 000	0.158 <i>f</i> <sup>0.5</sup>	4.21 x 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup>	6.67 x 10 <sup>-5</sup> <i>f</i>	616 000 / <i>f</i> <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>.
  3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

## 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<sup>2</sup>

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.

**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**

(MPE distance equals 20 cm)

Mode	Band	MPE Distance (cm)	Output Power (dBm)	Antenna Gain (dBi)	FCC Power Density (mW/cm <sup>2</sup> )	IC Power Density (W/m <sup>2</sup> )
802.11a	5.8 GHz	20.0	24.94	9.77	0.59	5.88
802.11n H20	5.8 GHz	20.0	24.90	5.00	0.19	1.94
802.11n H40	5.8 GHz	20.0	25.00	5.00	0.20	1.99

The power level used for MPE calculations is the sum of the power of all transmitter chains. Since the antennas are identical for each transmitter this is equivalent to summing the power density of all transmitters. All three antennas are assumed to be at the same location to give a worst-case estimate of the total power density at a distance of 20 cm from this point. For 802.11abg transmissions the effective legacy mode antenna gain is used (this effective gain assumes that the legacy signals are coherent thus add in voltage). For 802.11n transmissions the signals are not coherent therefore they add in power and the normal antenna gain is applicable.