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**FCC Part 15, Subpart C,
ISM (15.247)
Class II Permissive Change Application**

**EMI Test Report
and
Technical Documentation
on
Nortel 802.11 Access Point.
Models: 2230 & 2230 INT**

FCC ID: [RVW2230](#)

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General Information

Unit(s) Under Test: Nortel access point
Model: 2230 & 2230 INT
Product Description: IEEE 802.11A / B / G Access point

FCC ID: **RVW2230**

Tested For: Nortel Networks
4655 Great America Parkway
Santa Clara, CA, 95054, USA

Tested At: Elliott Laboratories
684 West Maude Ave
Sunnyvale, CA 94086

Tested By: Juan Martinez, Sr. Test Engineer, Elliott Laboratories
David Waitt, (Independent Consultant)

Test Specifications: FCC CFR 47, Part Subpart C (15.247)

Test Date: September 2004

Requested Certification: Class II Permissive change application

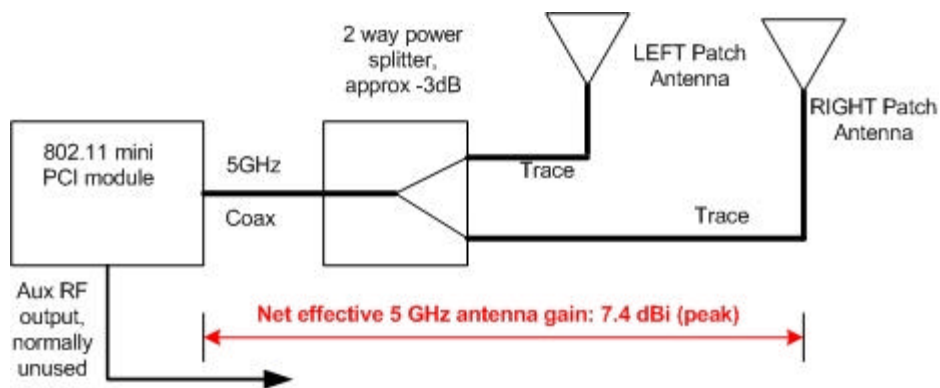
Detailed Product Information / Operational Description

The Nortel radio is an IEEE 802.11 A / B / G Access point is intended to be professionally installed and configured in corporate and industrial environments.

There are two versions of the Nortel Access point

INTERNAL ANTENNA VERSION

The access point utilizes integral antennas on the 802.11 A / B / G bands. The access point includes two integral 5 GHz patch antennas pointing 180° from each other to create a somewhat omni directional 5 GHz pattern. The effective gain of the 5 GHz antenna path (the power divider and the antenna itself) is 7.4dBi. The diagrams below outline the RF path from the output of the mini PCI module within the access point to the integral antennas within the access point

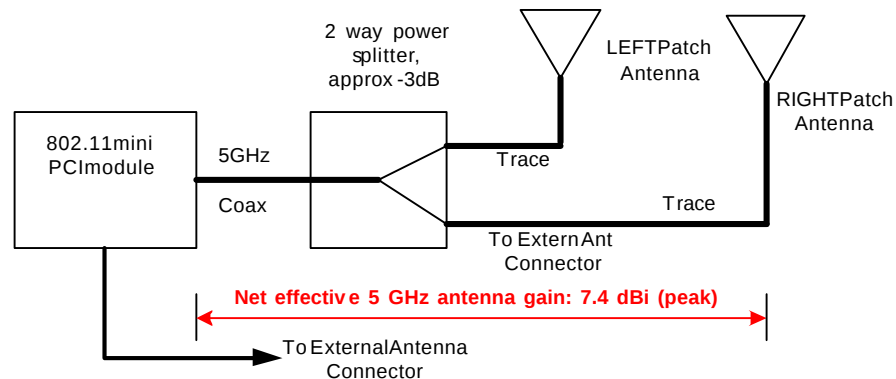


5 GHz RF Path Block Diagram (Internal Antenna Version)

INTERNAL / EXTERNAL ANTENNA VERSION

There is another version of the access point which allows the connection of an external 5 GHz antenna. This option can be selected by the configuration software. If an external 5 GHz antenna is used, it is permanently attached to the access point to meet FCC "Integral" antenna requirements and it is below 7.4 dBi net effective gain (antenna gain - cable loss). Note that in contrast to the internal antennas, only ONE external 5 GHz antenna can be used. The configuration software cannot be configured to rapidly switch between the internal and external antenna.

The only difference between the two versions is the inclusion of a short coax and external connector in the housing.



5 GHz RF Path Block Diagram (Internal / External Antenna Version)

Report Organization and Results Summary

This report presents the results of the tests that verify compliance with FCC Part 15.247 for the frequency band 5.825 - 5.85GHz.

A brief results summary of all the in this report is below.

Part 15 Paragraph	Test	Results
15.247 (C)	Out of Band Emissions (5.15 - 5.25)	2.2dB Below Limit
15.247 (a)(2)	20dB Bandwidth	16.571 MHz
15.247(b)(1)	Transmit Power (5.275 - 5.825)	17.35 dBm MAX

Test Facilities

All of the certification tests were performed at:

Elliott Labs
684 West Maude Ave
Sunnyvale, CA 94086

General:

Final radiated test measurements were taken in September 2004 at Elliott Laboratories Open Area Semi Anechoic Chamber #5.

The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

OATS:

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated emissions are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 Guidelines.

Antenna, Antenna Mast and Turntable

The Horn antennas that are used to measure radiated emissions above 1000MHz are mounted on a non-conductive antenna mast equipped with a motor drive to vary the antenna height.

ANSI C63.4 specifies that the test height above the ground plane shall be 80cm unless the equipment is intended to be floor mounted. During the radiated emissions tests the equipment is positioned on a motorized turntable in conformance with the ANSI requirement.

Equipment Lists

Instrument Calibration

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles.

The following test equipment was used to perform the testing

Elliott Test Equipment

Radiated Emissions, 1000 - 40,000 MHz, 17-Sep-04

Engineer: Juan Martinez

<u>Manufacturer</u>	<u>Description</u>	<u>Model #</u>	<u>Asset #</u>	<u>Cal Due</u>
EMCO	Horn antenna, D. Ridge 1-18GHz (SA40 system antenna)30Hz sunnyvale	3115	1142	11-Jun-05
Hewlett Packard	EMC Spectrum Analyzer 30Hz - 40 GHz, Sunnyvale	8564E (84125C)	1148	09-Jun-05
EMCO	Horn antenna, 18-26.5 GHz (SA40 30Hz)	3160-09 (84125C)	1150	11-Jun-05
EMCO	Horn antenna, 26.5-40 GHz (SA40 30 Hz)	3160-10 (84125C)	1151	11-Jun-05

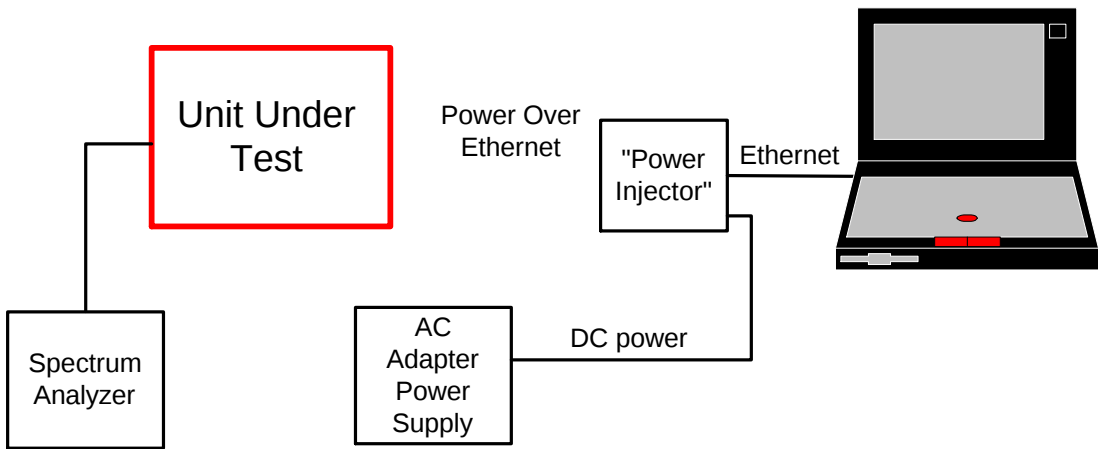
Additional Test Equipment

<u>Item</u>	<u>Desc.</u>	<u>Manufacturer</u>	<u>Model</u>	<u>S/N</u>	<u>Cal due date</u>
Spectrum Analyzer		Agilent	E4404B	US40521093	3 Sep 04

Test Methods

The tests listed below are performed using the basic test setup shown below. In several cases, the EUT was running special diagnostic firmware to allow it to transmit random data on a particular channel indefinitely.

Part 15	Test
15.247(C)	Out of Band Emissions (5.725 - 5.825)
	Restricted Band Emissions
15.247(a)(2)	20dB Bandwidth
15.247(b)(1)	Transmit Power (5.275 - 5.825)



Basic Conducted RF Bench Test Setup

Unless otherwise noted, the support equipment for the bench tests is listed below.

Support Equipment				
Description	Model number	FCC ID or SN	Manufacturer	Power Cable
Laptop	Armada E 500	P31000T4X20DC12N2	Compaq	Laptop PS
Test Software	Atheros Radio Test		Atheros	
48VDC AC adapter	Generic		Generic	Standard Twin lead DC wire

Test Results

Detailed test procedures and test results are contained in the following sections. In cases where the test setup differs from the Conducted RF test setup shown earlier, the test setup is also presented.

Test Conditions			
Temperature	25 C	Humidity:	43%
ATM pressure	1022 mBar	Grounding:	None
Tested By	David Waitt / Juan Martinez	Date of Test:	Sept 2004
Test Reference	Refer to individual test results		
Tested Range	Test Dependent		
Test Voltage	48 VDC to the access point		
Modifications	No modifications were made to the unit during the tests		

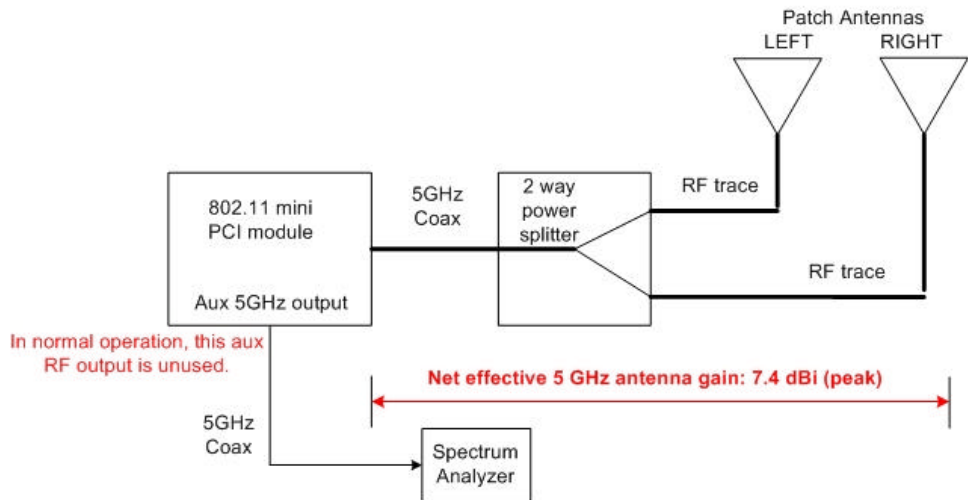
802.11 A Maximum RF Power Output at Antenna Terminals

Specifications:

FCC Specification: Paragraph(s): 15.247 (B)(3)

Procedure:

The test was conducted by connecting the secondary output of the 802.11 module directly to a spectrum analyzer. This measured power is therefore the same level that will be present at the input of the FET antenna switch under normal operation.



The unit was tuned to the test channels and configured to transmit continuous random data packets. The power integration was performed over a 30 MHz BW to be certain to include the entire BW of the channel. The integrated power was read directly off the spectrum analyzer

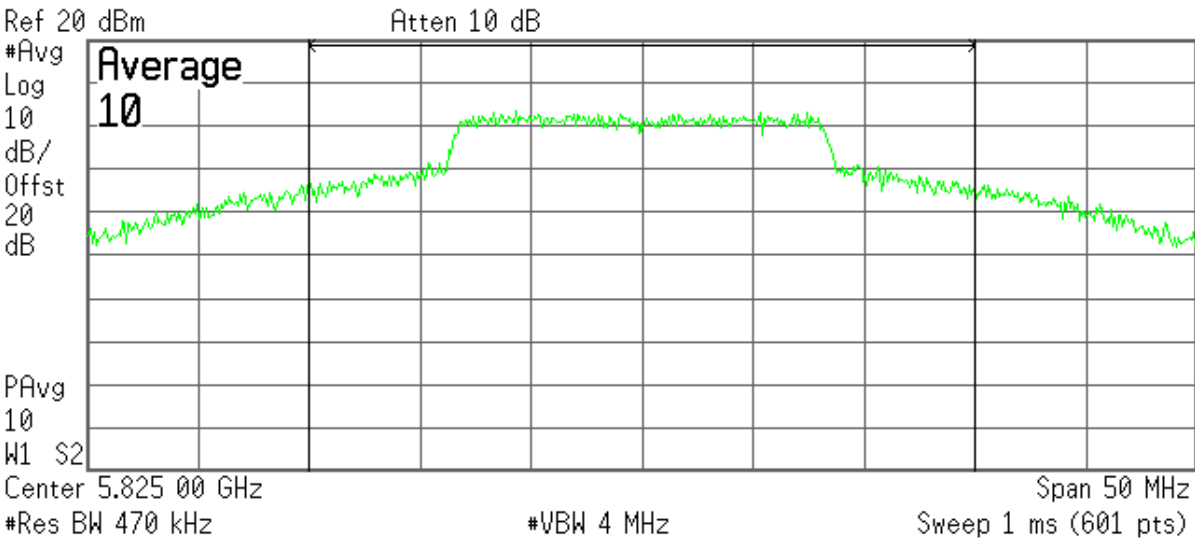
Because the unit will be operated at different power levels depending on the channel / band being used, the RF power out was measured at the appropriate power setting for the test channel. The settings that were used during the test are the settings that will be entered into the firmware of the access point. These firmware configuration limits will ensure that the power levels are not exceeded.

Result:

Pout settings Vs. Channel	Frequency (MHz)	Spec (dBm) into 6 dBi	Msrd Chan power from module (dBm/ 30 MHzBW)	Pwr into antenna after power divider (- 3dB) (dBm)	Pwr into each antenna (mWatts)
5 GHz ISM	5825	30	17. 35	14.35	27.227

Channel Power @ 5825 MHz

✱ Agilent 16:02:43 Sep 19, 2004



Channel Power

17.35 dBm /30.0000 MHz

Power Spectral Density

-57.42 dBm/Hz

5 GHz 20 dB bandwidth

FCC Specification: Paragraph 15.247(a)(2)

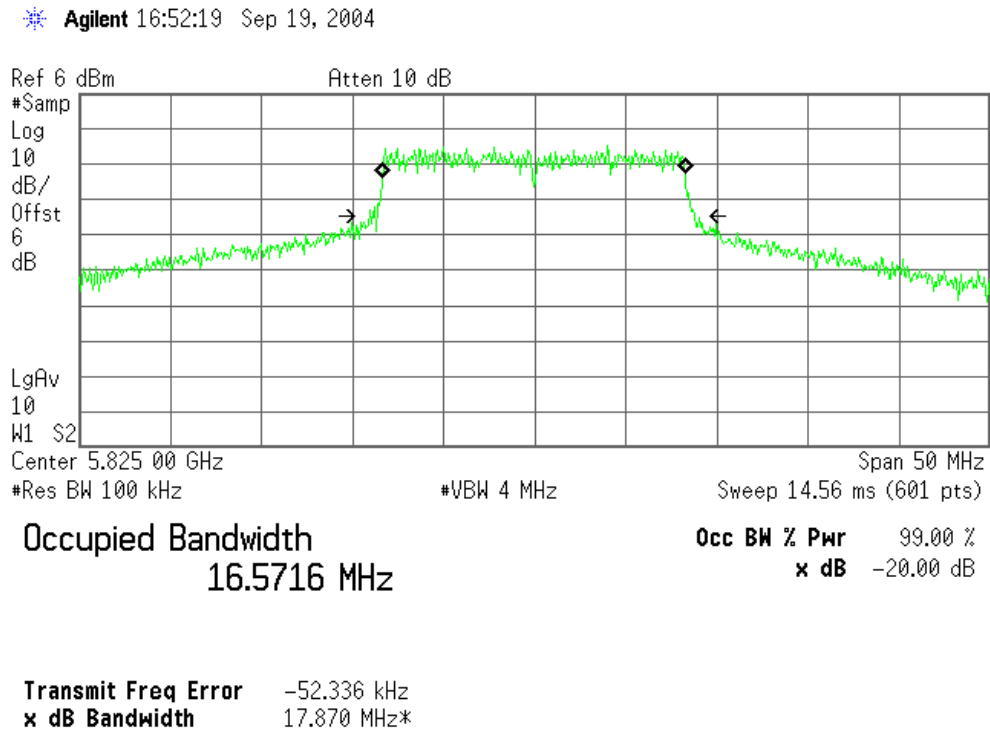
The Nortel access point operates on the standard IEEE 802.11 A channels. The 26dB bandwidth was measured 5825 MHz (Channel 165) using the conducted RF test setup. The spectrum analyzer was configured for MAX HOLD and the trace allowed to stabilize. A peak search was performed and the then Delta-Marker used to locate the point -20 and -26 dB below the peak.

Once this was complete, the point was used as a reference and another delta measurement was performed and an attempt made to make the two markers “level”. The delta frequency between the two markers was measured as the 20 / 26 dB BW of the signal. The bandwidth test was performed at the power settings that will be used in the final system.

Results:

Channel	Frequency (MHz)	Resolution Bandwidth	20 dB Signal Bandwidth (MHz)
165	5825	100kHz	17.87

20 dB BW Plot
Channel 165 20 dB BW (5825)



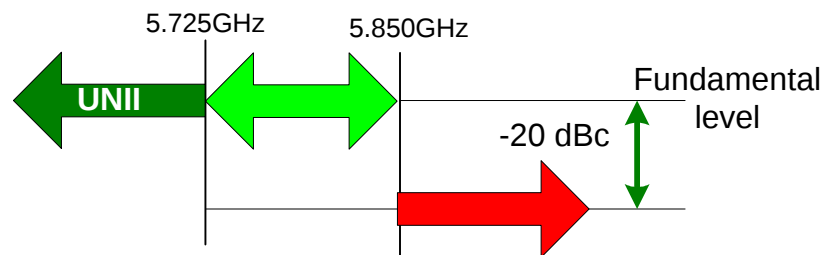
5.825 GHz Bandedge

FCC Specifications: Paragraphs 15.247(C)

Procedure:

The unit was configured to transmit random data packets on 5825 MHz at the correct power level. The maximum level of the fundamental was measured in a 100 kHz RBW using MAX HOLD and PEAK SEARCH. The level of the emissions at 5850 was then measured in a 100kHz BW and verified to be at least 20 dB below the level of the fundamental

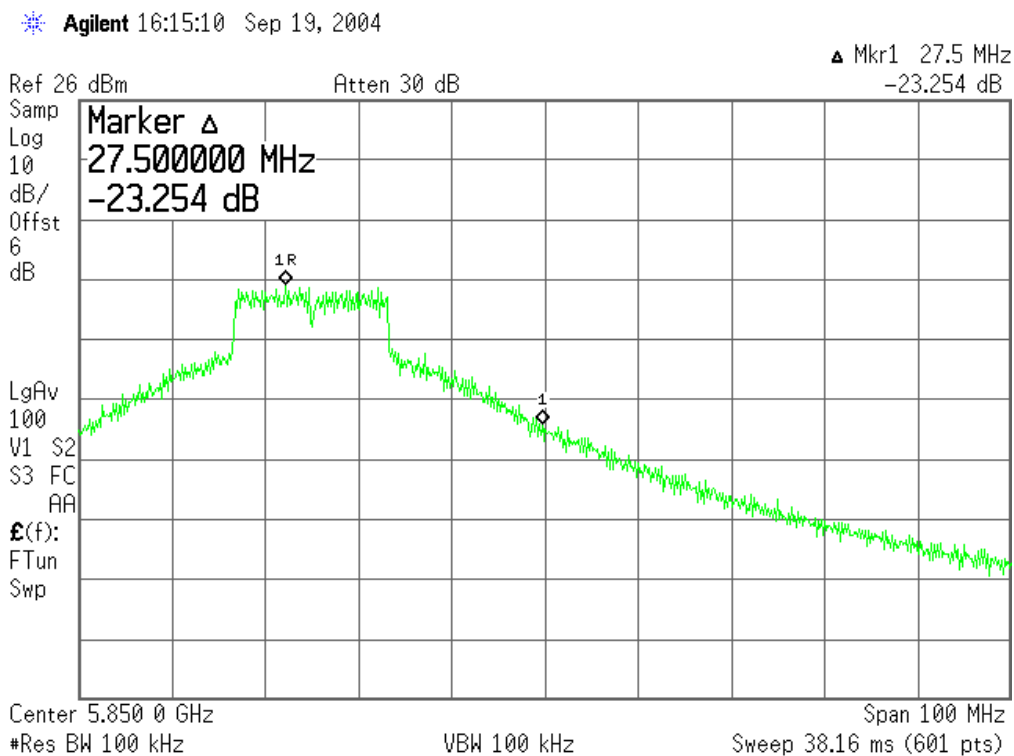
The measurements were made with RBW = 100kHz, VBW = 1MHz, video averaging on. The level of the emissions at the band edge



Out Of Band Spurious Emissions Limits For
Emissions Not Falling In Restricted bands

Results:

The level at the band edge was measured at -23.25 dB below the fundamental power level. This is below the -20 dBc limit.



5 GHz Out of Band Radiated Emissions (Restricted bands)

Specification:

Paragraph 15.247(C)

Procedure:

This test was conducted in a 3-meter semi-anechoic chamber at Elliott Laboratories. The unit was placed on a rotating wooden table 80cm above the ground plane. A Horn antenna(s) were secured to a mast 3 meters away. The unit was tested at each of the Low, Mid and High channels. The UUT was running in the diagnostic mode and set to transmit random data. The transmit power was set to the settings outlined in the power setting table. The test equipment was configured as shown below.

The band from 1 to 40 GHz was scanned (40 GHz is the limit of the available test equipment). A high pass filter prior to the pre-amplifier was required to prevent the signal level of the fundamental frequency from overloading the front end of the spectrum analyzer and creating harmonics within the analyzer.

The EUT was rotated 360 degrees and the height of the antenna adjusted from 1 to 4 meters above the ground plane to determine the maximum level of the emission. The level of the harmonic emission was measured in two modes, "Peak" and "Average".

The spectrum analyzer reading was entered into a spreadsheet where correction factors (antenna factor, cable loss, pre-amplifier gain, HPF loss...) were then applied by Elliott Lab's Software to obtain a final corrected measurement.

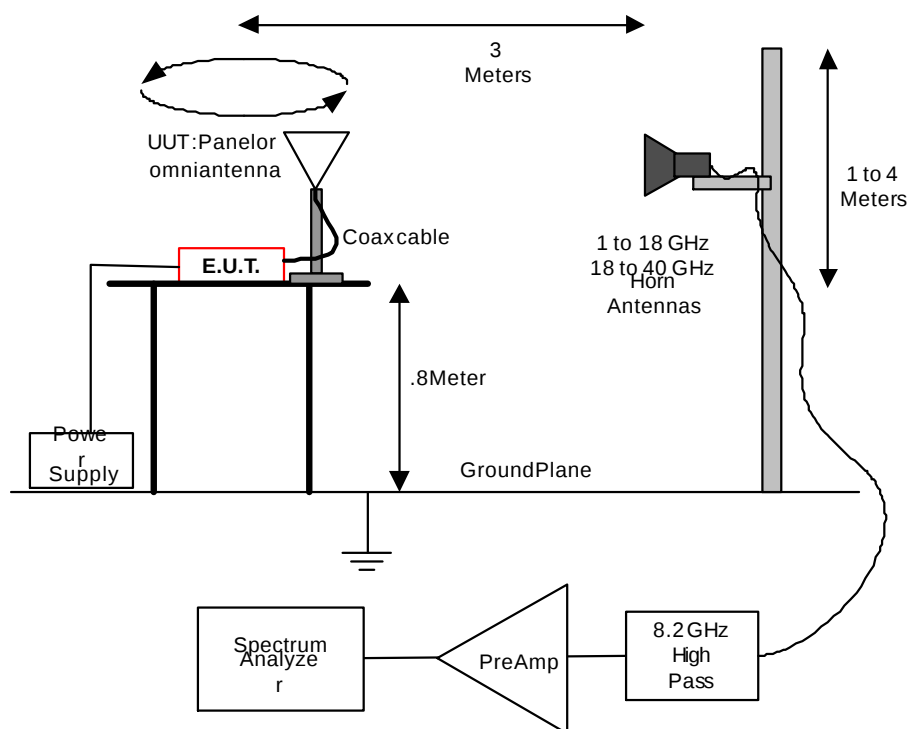
This procedure was repeated for the low mid and high channels across the 5 GHz bands.

Fund	2	3	4	5	6	7	8	9	10
5180	10360	15540	20720	25900	31080	36260	41440	46620	51800
5260	10520	15780	21040	26300	31560	36820	42080	47340	52600
5320	10640	15960	21280	26600	31920	37240	42560	47880	53200
5745	11490	17235	22980	28725	34470	40215	45960	51705	57450
5765	11530	17295	23060	28825	34590	40355	46120	51885	57650
5805	11610	17415	23220	29025	34830	40635	46440	52245	58050

15.247 (C) Harmonic test table

NOTE: **RED** indicates a harmonic that falls within a restricted band, the harmonics in **gray** are NOT in restricted bands.

Test Setup



Radiated Emissions in Restricted Bands Test Setup

Support Equipment				
Description	Model number	FCC ID or SN	Manufacturer	Power Cable
Laptop	Armada E 500	P31000T4X20DC12N2	Compaq	Laptop PS
Test Software	Atheros Radio Test		Atheros	"Zip" cord

Test Conditions			
Temperature	25 C	Humidity:	43%
ATM pressure	1022 mBar	Grounding:	None
Tested By	J Martinez	Date of Test:	Sept 2004
Test Reference	FCC Part 15.205 IC Paragraph RSS210, 6.2.3 (c)		
Setup Method	ANSI C63.4		
Tested Range	1 GHz to 40 GHz		
Test Voltage	120 VAC / 60 Hz		
Modifications	No modifications were made to the unit		

Results: There were some emissions detected during the test. The results are below.
Emissions not in a restricted band are highlighted in yellow.
Emissions in restricted bands are highlighted in orange
The fundamental level is highlighted in green

The fundamental radiated emission level is included in the table below since it serves as a reference for the limit for out of band emissions that do not fall in a restricted band.

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5825.000	113.0	V	-	-	Pk	-	-	Fundamental
5825.000	98.0	H	-	-	Pk	-	-	Fundamental
17472.35	73.0	H	93.0	-20.0	PK	221	1.0	Non-restricted
11650.55	51.9	H	54.0	-2.2	AVG	213	1.4	Restricted
11650.55	64.8	H	74.0	-9.2	PK	213	1.4	Restricted
23300.80	52.0	V	93.0	-41.0	PK	294	1.2	Non-restricted
39799.89	45.3	V	54.0	-8.7	AVG	193	2.0	Restricted
39799.89	57.1	V	74.0	-16.9	PK	193	2.0	Restricted
5279.74	51.6	V	54.0	-2.5	AVG	84	1.0	Restricted
5279.74	59.7	V	74.0	-14.4	PK	84	1.0	Restricted
5150.85	46.3	V	54.0	-7.7	AVG	84	1.0	Restricted
5150.85	55.7	V	74.0	-18.3	PK	84	1.0	Restricted
5350.04	42.8	V	54.0	-11.2	AVG	84	1.0	Restricted
5350.04	54.4	V	74.0	-19.6	PK	84	1.0	Restricted
1124.89	46.1	V	54.0	-8.0	AVG	106	1.0	Restricted
1124.89	51.1	V	74.0	-22.9	PK	106	1.0	Restricted
4659.79	44.1	V	54.0	-9.9	AVG	266	1.0	Restricted
4659.79	51.7	V	74.0	-22.3	PK	266	1.0	Restricted
2250.02	38.4	V	54.0	-15.6	AVG	298	1.0	Restricted
2250.02	46.4	V	74.0	-27.6	PK	298	1.0	Restricted
999.85	26.2	V	54.0	-27.9	AVG	268	2.0	Restricted
999.85	37.2	V	74.0	-36.8	PK	268	2.0	Restricted

Notes:

#2 Emission is within a restricted band.

Peak measurements: Resolution and Video BW: 1 MHz, 74 dBuV Limit

Average Measurements: Resolution BW: 1MHz and Video BW: 10 Hz, 54 dBuV Limit

Peak measurements: 74 dBuV Limit

Average Measurements: 54 dBuV Limit

#3 Emission is NOT within a restricted band.

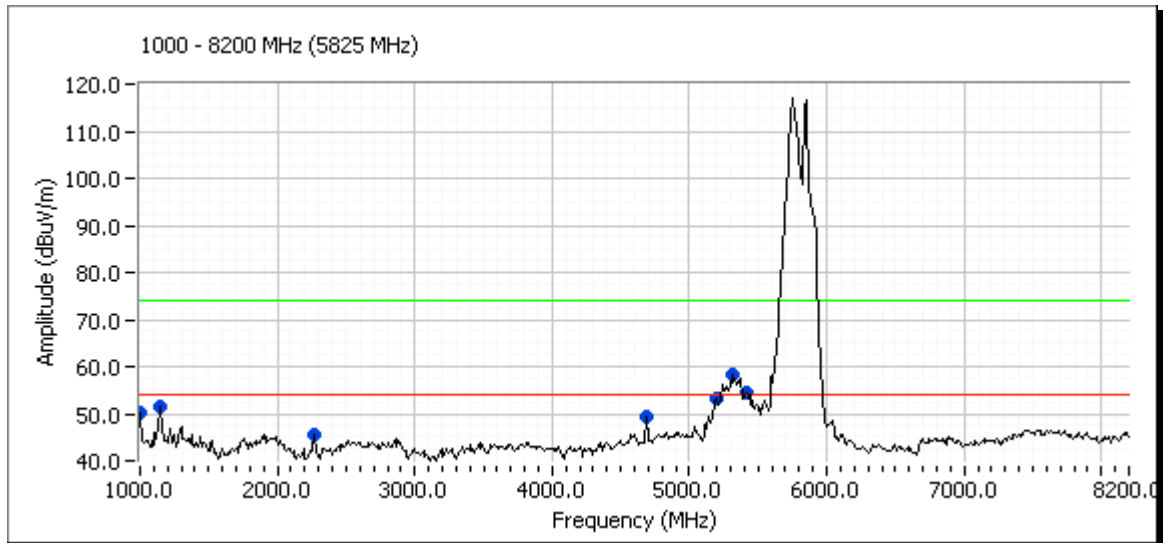
Measurement settings: Resolution BW = 1MHz and VBW = 3MHz.

Limit -20 dBc

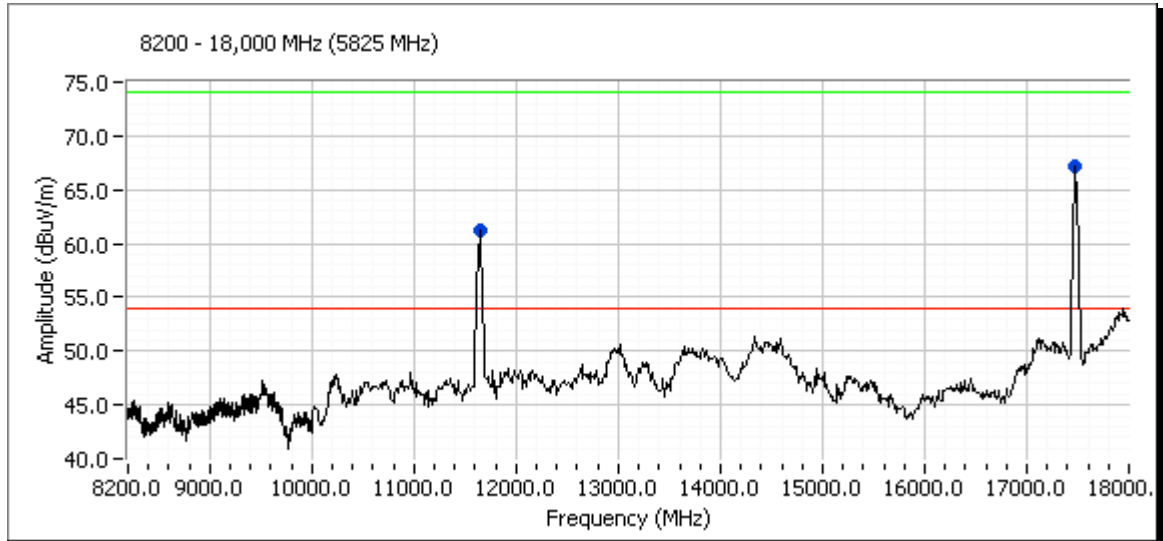
For emissions falling in the restricted bands detailed in 15.205 the general limits of 15.209 apply.

Peak Out of band emissions, Emissions in restricted bands.

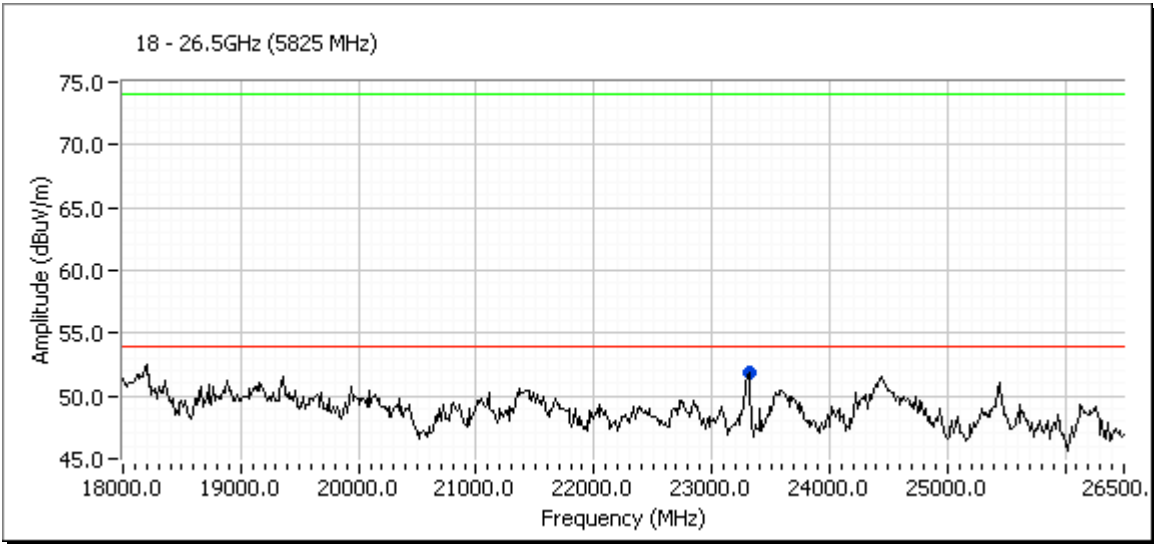
1.0 - 8.2 GHz



10 - 18 GHz



18 - 26.5 GHz



26.5 - 40 GHz

