



**Test Report: EDCS - 467105**

**For**

**AIR-LAP1510AG-A-K9**

**(United States)**

**and**

**AIR-LAP1510AG-N-K9**

**(Canada, Australia, New Zealand, Mexico, and Taiwan)**

## **Cisco Aironet 1500 Series Outdoor Mesh Access Points**

**Against the following Specifications :**

**CFR47 Parts 15.247, RSS-210, LP0002, AS/NZS 4268:2003**

**Cisco Systems**

EMC Laboratory

170 West Tasman Drive

San Jose, CA 95134



**Certificate Number : 1178-01**

**Author:** James Nicholson

**Approved By:**

**Title:**



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## **Section 1: Overview**

### **Test Summary**

**The samples were assessed against the tests detailed in section 3 under the requirements of the following standards:**

#### **Emissions:**

CFR47 Part 15.247  
RSS-210  
LP0002  
AS/NZS 4268:2003

#### **Notes:**

- 1) Where a specification listed on the front cover of this report has deviations from the basic standards listed above, the additional technical requirements of the specification were also assessed.
- 2) Where appropriate, Cisco may have substituted a later revision of a basic standard to those referenced in the specification on the front sheet of this test report. This decision was based upon improved test methodology and repeatability and/or where the newer revision represented a more stringent test.
- 3) Where relevant, testing has been carried out to the requirements of both EN and IEC Specifications. This was possible because of the similarities of the test methods involved and the Cisco EMC test procedures.
- 4) For Radiated and Conducted emissions results refer to section 2.9 for measurement uncertainty considerations
- 5) Where applicable, details of the precise distance used when performing radiated immunity measurements can be found in Cisco document EDCS-221012.
- 6) Where testing has been performed to EN61000-4-3, additional measurements were conducted to establish the field strength at a 40cm height in both the horizontal and vertical antenna polarities (applies to floor standing EUT's only). This field strength data can be found in Cisco document ENG-72588.



## Section 2: Assessment Information

### 2.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on the samples submitted.

**This report must not be used to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the federal Government.**

**This report may contain data that are not covered by the A2LA accreditation (Certificate number 1178-01). Please refer to Appendix F for further details.**

With regard to this assessment, the following points should be noted:

- a) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.
- b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.
- c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).
- d) All testing was performed under the following environmental conditions:  
Temperature            15°C to 35°C (54°F to 95°F)  
Atmospheric Pressure   860mbar to 1060mbar (25.4" to 31.3")  
Humidity                10% to 75\*%  
  
\*[Where applicable] For ESD testing the humidity limits used were 30% to 60% and for EFT/B tests the humidity limits used were 25% to 75%.
- e) All AC testing was performed at one or more of the following supply voltages:  
110V (+/-10%) 60Hz  
220V (+/-10%) 50 or 60Hz
- f) Cisco Systems Inc., are accredited by the American Association for Laboratory Accreditation (A2LA). For the specific scope of accreditation under certificate number 1178-01.see appendix F for further details.

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## **2.2 Date of start of testing**

10-July-2005

## **2.3 Report Issue Date**

Cisco uses an electronic system to issue, store and control the revision of test reports. This system is called the Engineering Document Control System (EDCS). The actual report issue date is embedded into the original file on EDCS. Any copies of this report, either electronic or paper, that are not on EDCS must be considered uncontrolled

## **2.4 Testing facilities**

This assessment was performed by:

### **Testing Laboratory**

Cisco Systems, Inc.,  
170 West Tasman Drive  
San Jose, CA 95134,  
USA

### **Test Engineers**

James Nicholson

## **2.5 Equipment Assessed (EUT)**

AIR-LAP1510AG-x-K9 Cisco Aironet 1500 Series Outdoor Mesh Access Point

## **2.6 EUT Description**

The AIR-LAP1510AG-x-K9 access point operates simultaneously in both the 2.4 and either 4.9 or 5 GHz spectrum, to provide data rates up to 54 Mbps in each band in accordance with IEEE 802.11a and 802.11g standards, including backwards compatibility to 802.11b. AIR-LAP1510AG-x-K9 supports both inline power and local power. The AIR-LAP1510AG-x-K9 utilized standard "N" type antenna connectors, and requires professional installation.



## 2.7 Scope of Assessment

Tests have been performed in accordance with the relevant Test and Assessment Plan (TAP), a copy of which is contained in Appendix H of this report, and the relevant Cisco EMC compliance test procedures (ENG-23438). This test report may not cover all of the tests highlighted in the test plan.

## 2.8 Units of Measurement

The units of measurements defined in the appendices are reported in specific terms, these are test dependent. Where radiated measurements are concerned these are defined at a particular distance. Basic voltage measurements are defined in dBuV and current in dBuA.

As an example, the basic calculation for all measurements is as follows:

$$\text{Emission level [dBuV]} = \text{Indicated voltage level [dBuV]} + \text{Cable Loss [dB]} + \text{Other correction factors [dB]}$$

The components of factors are dependent upon the exact test configurations [see test equipment lists for further details] and may include:-

Antenna Factors, Pre Amplifier Gain, LISN Loss, Pulse Limiter Loss, Current Probe Factors.

Note: to convert the results from dBuV/m to uV/m use the following formula:-

$$\text{Level in uV/m} = \text{Common Antilogarithm} [(X \text{ dBuV/m})/20] = Y \text{ uV/m}$$

## 2.9 Measurement Uncertainty

Where relevant measurement uncertainty levels have been estimated for tests performed on the apparatus. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Radiated emissions (expanded uncertainty, confidence interval 95%)

10kHz - 30 MHz	+/- 2.8 dB ( E Field)
10kHz - 30 MHz	+/- 2.8 dB ( H Field)
30 MHz - 300 MHz	+/- 3.8 dB
300 MHz - 1000 MHz	+/- 4.3 dB
1 GHz - 10 GHz	+/- 4.0 dB
10 GHz - 18GHz	+/- 8.2 dB
18GHz - 26.5GHz	+/- 4.1 dB
26.5GHz - 40GHz	+/- 3.9 dB

Conducted emissions (expanded uncertainty, confidence interval 95%)

4 kHz - 30 MHz	+/- 2.2 dB (using Current Probe)
9 kHz - 150 kHz	+/- 4.1 dB (using LISN)



10 kHz - 30 MHz	+/- 2.6 dB (using Current Probe)
150 kHz - 30 MHz	+/- 3.7 dB (using LISN)
150 kHz - 30 MHz	+/- 3.1 dB (using CDN)
150 kHz - 30 MHz	Under Consideration (Using CVP-1)

A product is considered to comply with a requirement if the nominal measured value is below the limit line. The product is considered to not be in compliance in case the nominal measured value is above the limit line. For further explanation refer to Cisco Systems Inc Measurement Uncertainty Document: ENG-4001 8



### Section 3: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing. Please also refer to the "Justification for worst Case test Configuration" section of this report for further details on the selection of EUT samples.

#### 3.1 Sample Details

Equipment Details
AIR-LAP1510AG-x-K9
AIR-ANT2455V-N 2.4GHz, 5.5dBi Omni-Directional
Cushcraft S2406BP 2.4GHz, 8dBi Omni-Directional
AIR-ANT5175V-N 5GHz, 7.5dBi Omni-Directional
AIR-ANT58G10SSA-N 5GHz, 9.5dBi Sector
Maxrad MP49020 5GHz, 20dBi Patch

The following antennas are included in this filing:

AIR-ANT2455V-N 2.4GHz, 5.5dBi Omni-Directional  
Cushcraft S2406BP 2.4GHz, 8dBi Omni-Directional  
AIR-ANT5175V-N 5GHz, 7.5dBi Omni-Directional  
AIR-ANT58G10SSA-N 5GHz, 9.5dBi Sector  
Cushcraft S49014WP 5GHz, 14dBi Patch  
Cushcraft S54717P 5GHz, 17dBi Patch  
Maxrad MP49020 5GHz, 20dBi Patch



## Appendix A: Formal Emission Test Results

### Average Output Power

#### 2.4GHz Average Power with 5.5dBi Omni-Directional Antenna

Frequency (MHz)	Data Rate (Mbps)	Target Power (dBm)	Measured Power (dBm)
2412	11	24	24.0
2437	11	24	24.1
2462	11	24	23.9
2412	36	21	20.8
2437	36	24	24.3
2462	36	21	21.1

#### 2.4GHz Average Power with 8dBi Omni-Directional Antenna

Frequency (MHz)	Data Rate (Mbps)	Target Power (dBm)	Measured Power (dBm)
2412	11	22.5	22.5
2437	11	24	24.1
2462	11	24	23.9
2412	36	18.5	18.5
2437	36	24	24.3
2462	36	20	20.5

#### 5GHz Average Power with up to 20dBi Antenna

Frequency (MHz)	Data Rate (Mbps)	Target Power (dBm)	Measured Power (dBm)
5745	36	28	27.9
5785	36	28	28.0
5825	36	28	28.2



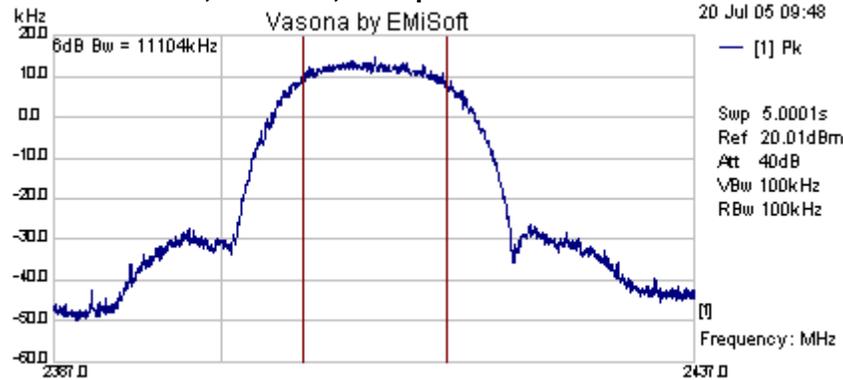
## 6dB Bandwidth

Systems using digital modulation techniques may operate in the 2400-2483.5MHz and 5725-5850MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

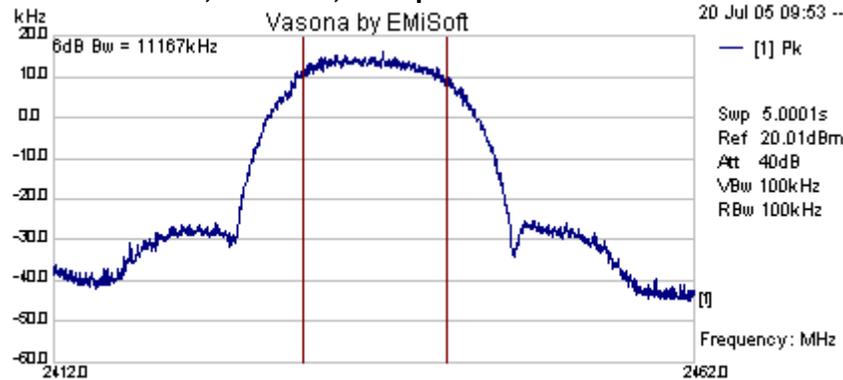
<b>Frequency (MHz)</b>	<b>Data Rate (Mbps)</b>	<b>6dB Bandwidth (kHz)</b>	<b>Limit (kHz)</b>	<b>Margin (kHz)</b>
2412	11	11,104	>500	10,604
2437	11	11,167	>500	10,667
2462	11	11,915	>500	11,415
2412	36	16,500	>500	16,000
2437	36	16,438	>500	15,938
2462	36	16,469	>500	15,969
5745	36	16,532	>500	16,032
5785	36	16,532	>500	16,032
5805	36	16,500	>500	16,000



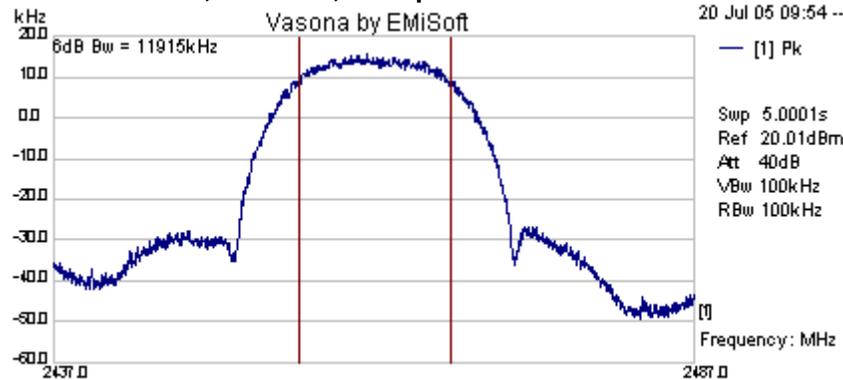
### 6dB Bandwidth, 2412MHz, 11Mbps



### 6dB Bandwidth, 2437MHz, 11Mbps

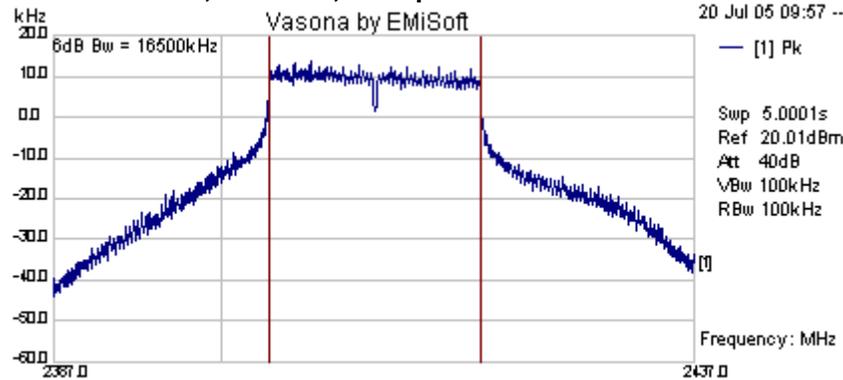


### 6dB Bandwidth, 2462MHz, 11Mbps

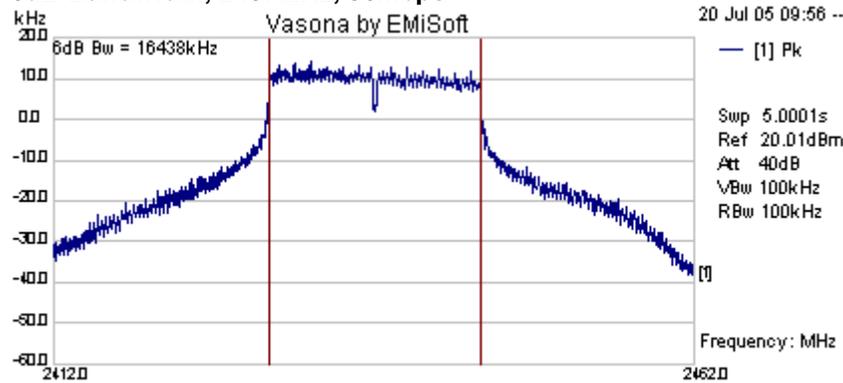




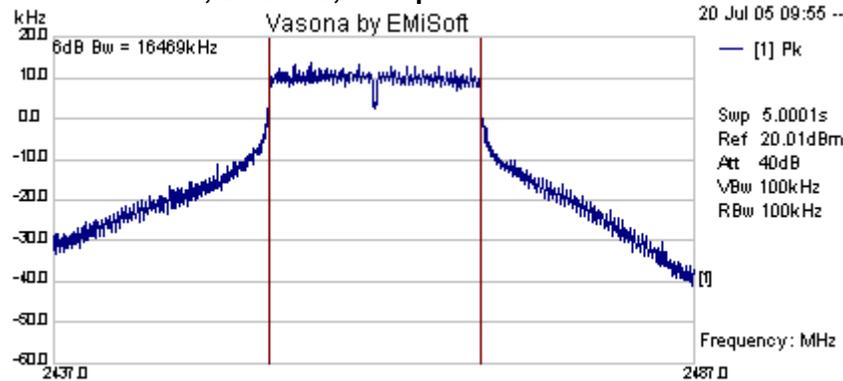
### 6dB Bandwidth, 2412MHz, 36Mbps



### 6dB Bandwidth, 2437MHz, 36Mbps

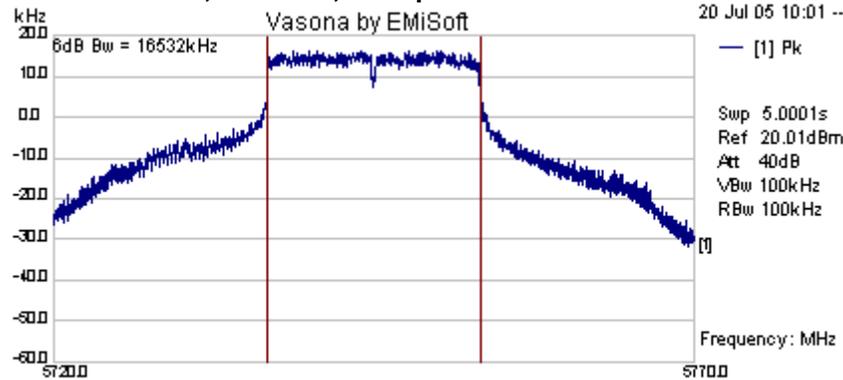


### 6dB Bandwidth, 2462MHz, 36Mbps

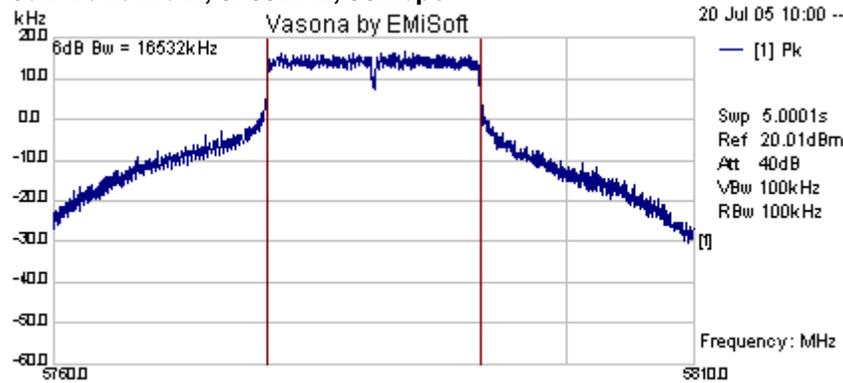




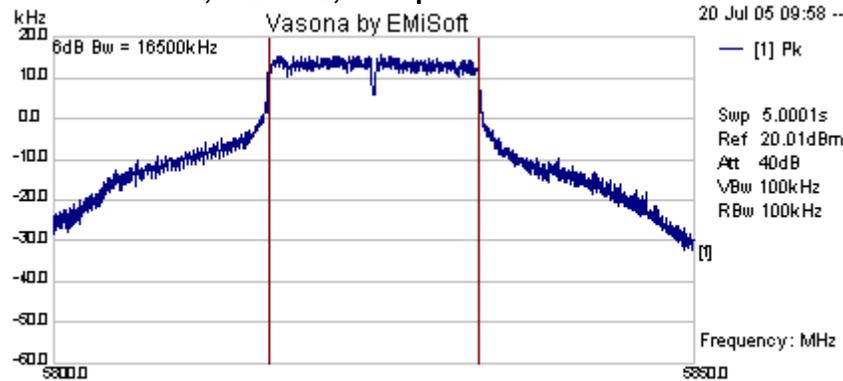
### 6dB Bandwidth, 5745MHz, 36Mbps



### 6dB Bandwidth, 5785MHz, 36Mbps



### 6dB Bandwidth, 5825MHz, 36Mbps



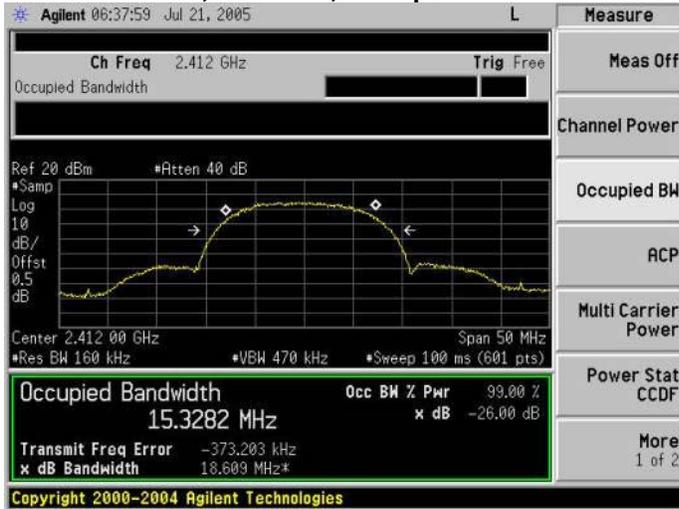


## 99% Bandwidth

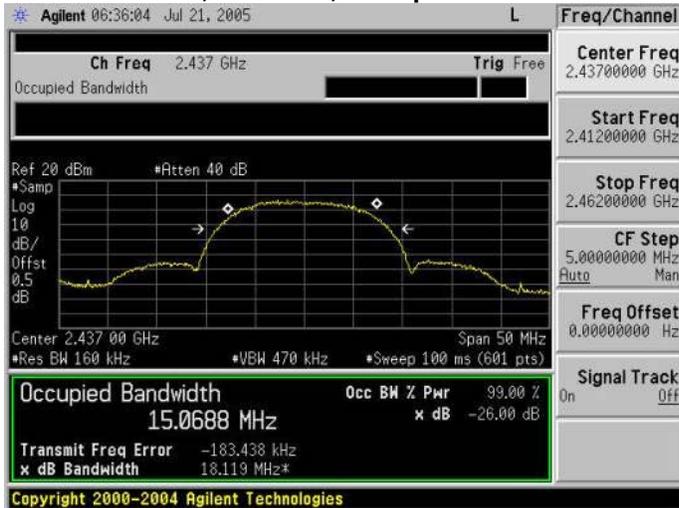
<b>Frequency (MHz)</b>	<b>Data Rate (Mbps)</b>	<b>99% Bandwidth (kHz)</b>
2412	11	15,328
2437	11	15,069
2462	11	15,270
2412	36	16,489
2437	36	16,350
2462	36	16,452
5745	36	16,558
5785	36	16,971
5805	36	16,619



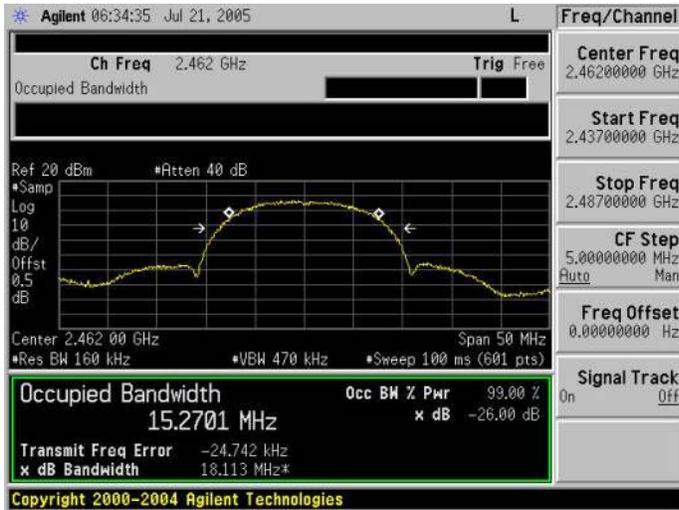
**99% Bandwidth, 2412MHz, 11Mbps**



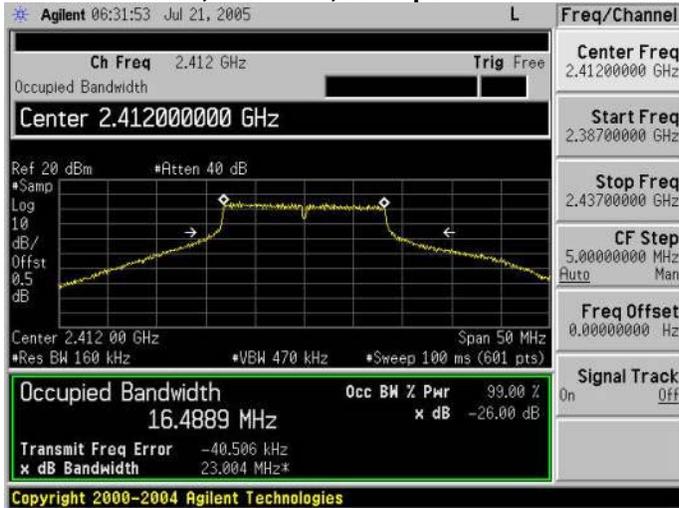
**99% Bandwidth, 2437MHz, 11Mbps**



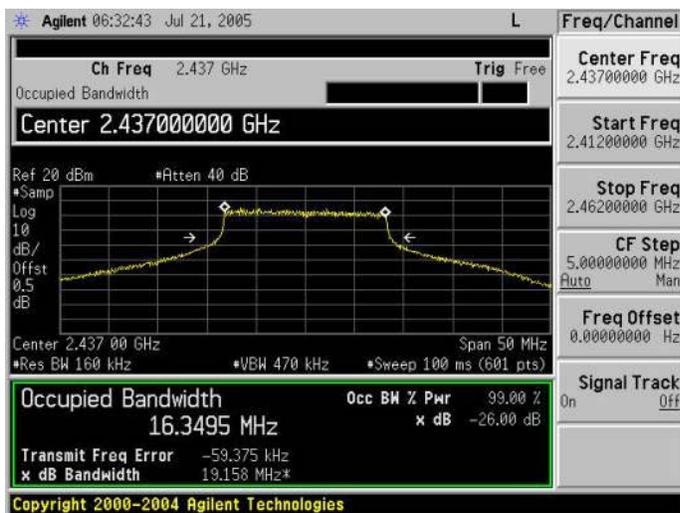
**99% Bandwidth, 2462MHz, 11Mbps**



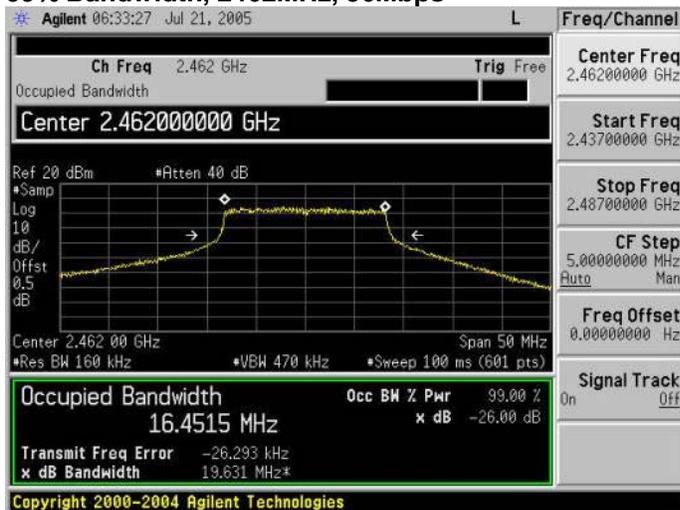
**99% Bandwidth, 2412MHz, 36Mbps**



**99% Bandwidth, 2437MHz, 36Mbps**

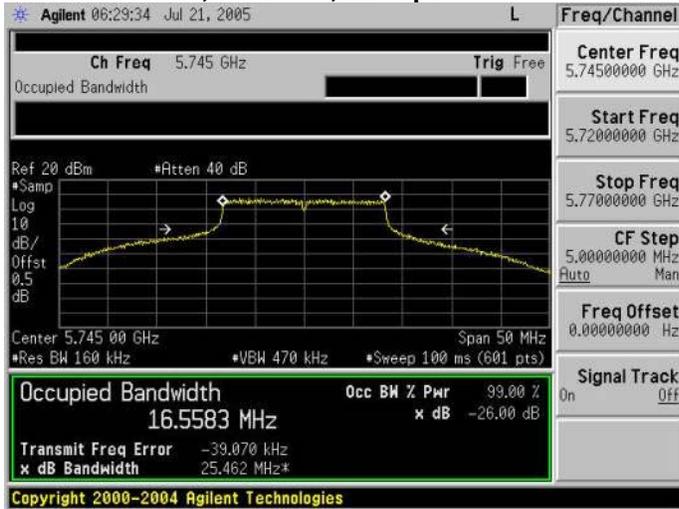


**99% Bandwidth, 2462MHz, 36Mbps**

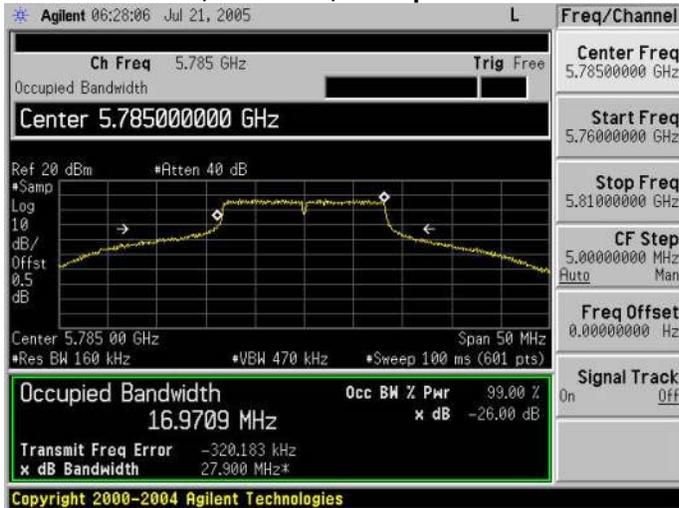




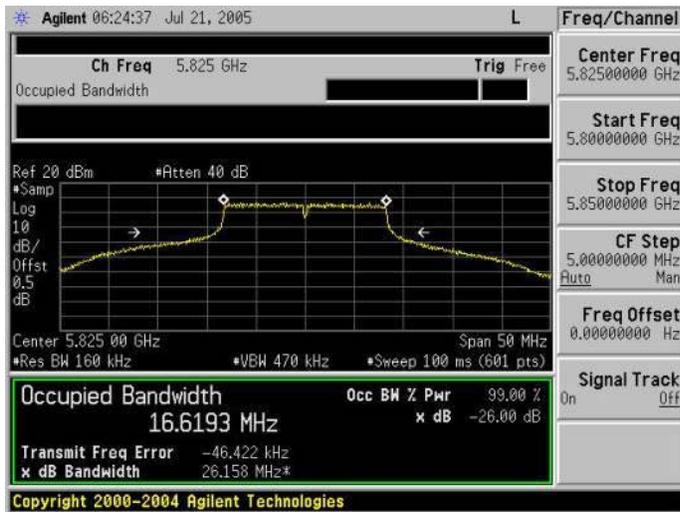
**99% Bandwidth, 5745MHz, 36Mbps**



**99% Bandwidth, 5785MHz, 36Mbps**



**99% Bandwidth, 5825MHz, 36Mbps**



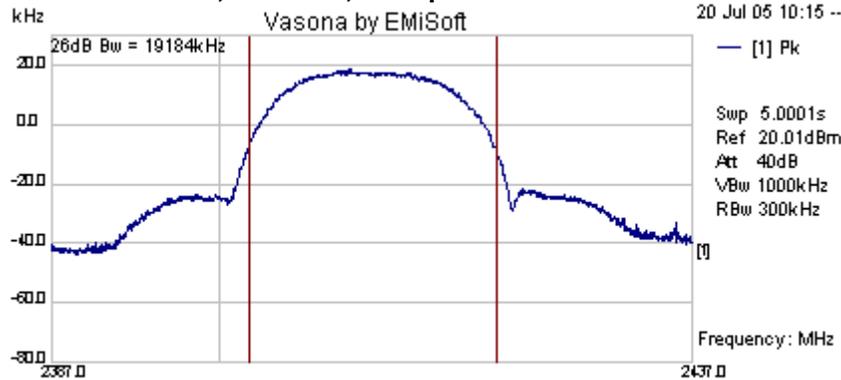


## 26dB Bandwidth

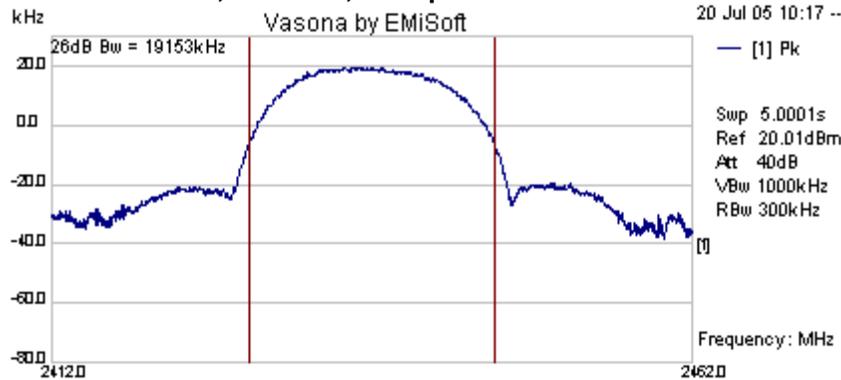
Frequency (MHz)	Data Rate (Mbps)	26dB Bandwidth (kHz)
2412	11	19,184
2437	11	19,153
2462	11	19,121
2412	36	27,917
2437	36	26,108
2462	36	25,204
5745	36	32,284
5785	36	32,627
5805	36	30,132



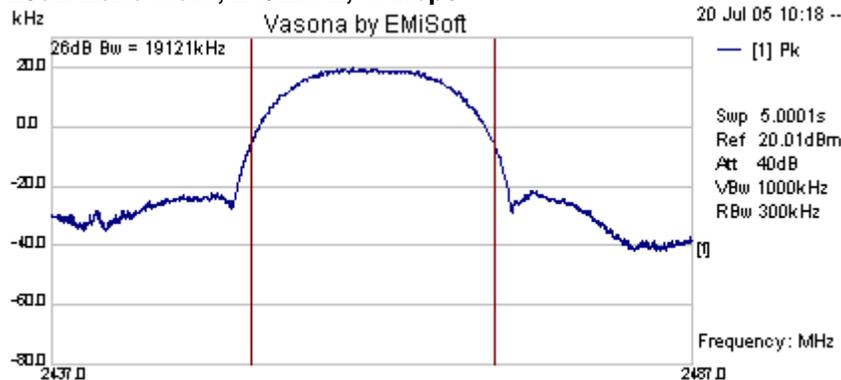
### 26dB Bandwidth, 2412MHz, 11Mbps



### 26dB Bandwidth, 2437MHz, 11Mbps

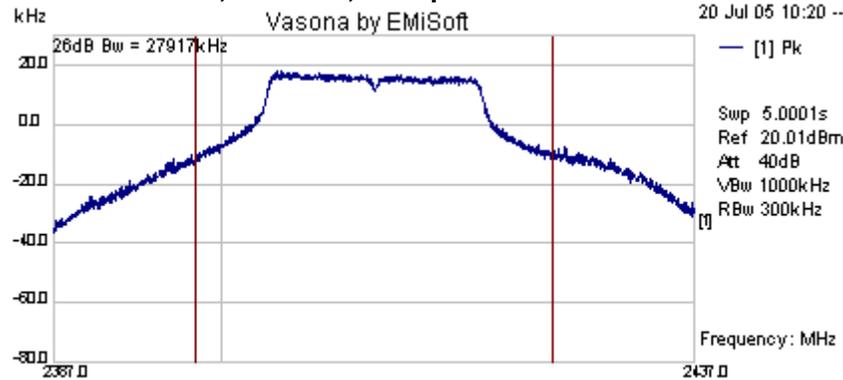


### 26dB Bandwidth, 2462MHz, 11Mbps

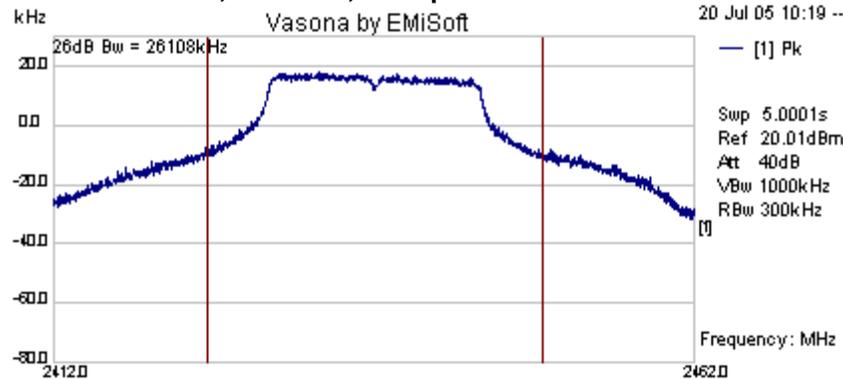




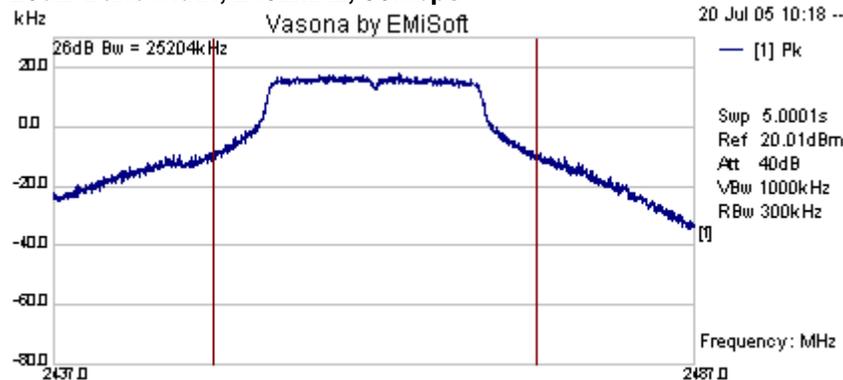
### 26dB Bandwidth, 2412MHz, 36Mbps



### 26dB Bandwidth, 2437MHz, 36Mbps

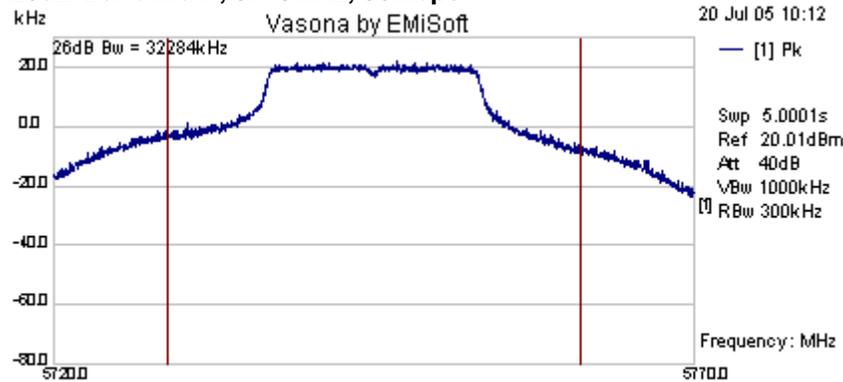


### 26dB Bandwidth, 2462MHz, 36Mbps

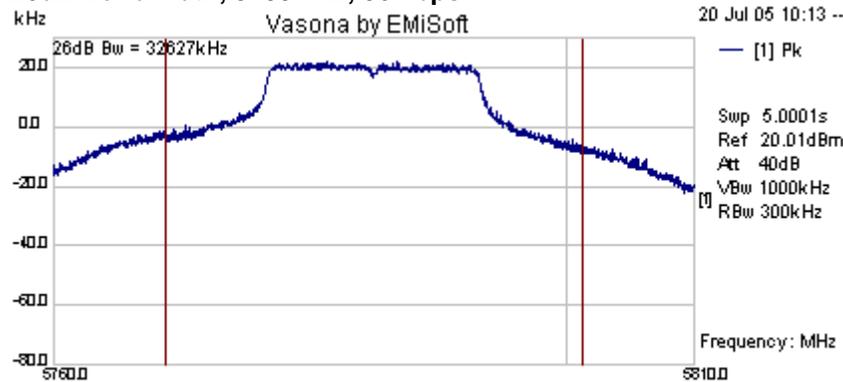




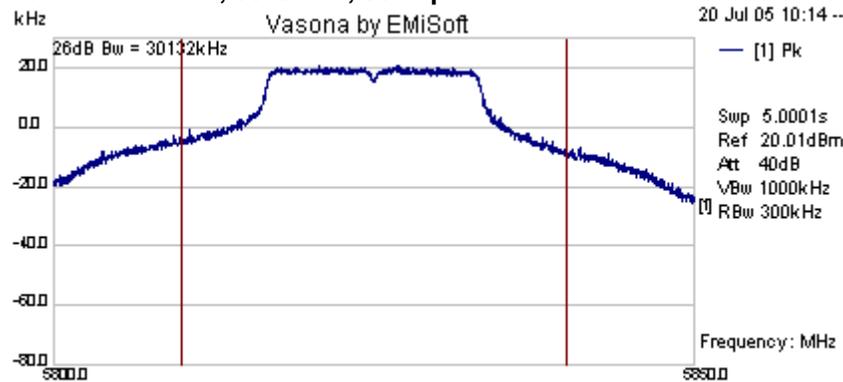
### 26dB Bandwidth, 5745MHz, 36Mbps



### 26dB Bandwidth, 5785MHz, 36Mbps



### 26dB Bandwidth, 5825MHz, 36Mbps





## Peak Output Power

The maximum peak output power of the intentional radiator for systems using digital modulation in the 2400-2483.5 MHz and 5725-5850MHz bands shall not exceed 1 Watt (30dBm).

For the 2.4GHz 8dBi Omni-Directional antenna included in this filing, the maximum peak output power shall be reduced by 2dB, for a maximum peak output power of 28dBm.

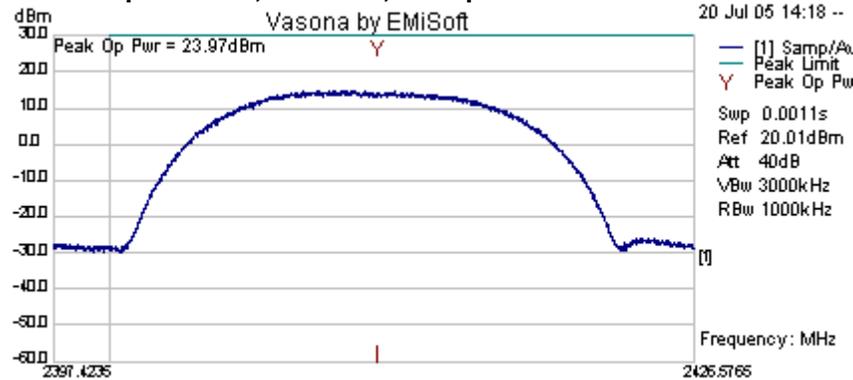
For the 5GHz 7.5 dBi Omni-Directional antenna included in this filing, the maximum peak output power shall be reduced by 1.5dB, for a maximum peak output power of 28.5dBm.

For the 5GHz directional antennas with gain greater than 6dBi, no corresponding reduction in transmitter peak output power is required.

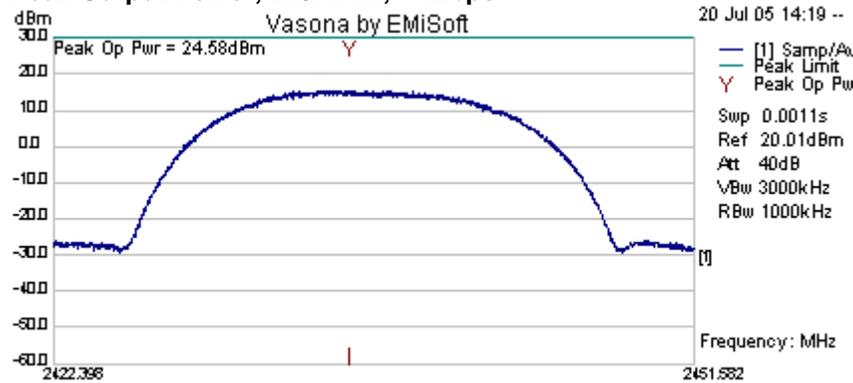
Frequency (MHz)	Data Rate (Mbps)	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
2412	11	23.97	28	4.03
2437	11	24.58	28	3.42
2462	11	23.62	28	4.38
2412	36	20.52	28	7.48
2437	36	23.97	28	4.03
2462	36	20.44	28.5	8.06
5745	36	27.22	28.5	1.28
5785	36	27.36	28.5	1.14
5805	36	26.90	28.5	1.60



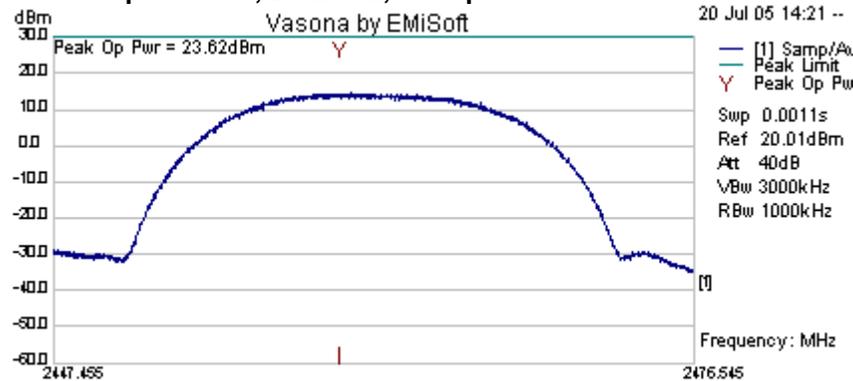
### Peak Output Power, 2412MHz, 11Mbps



### Peak Output Power, 2437MHz, 11Mbps

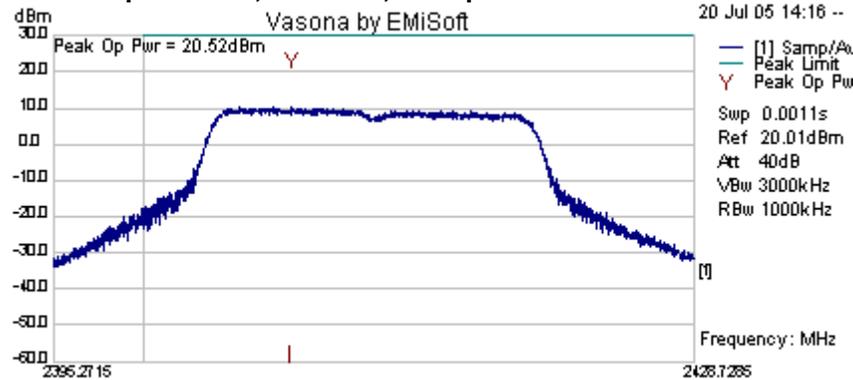


### Peak Output Power, 2462MHz, 11Mbps

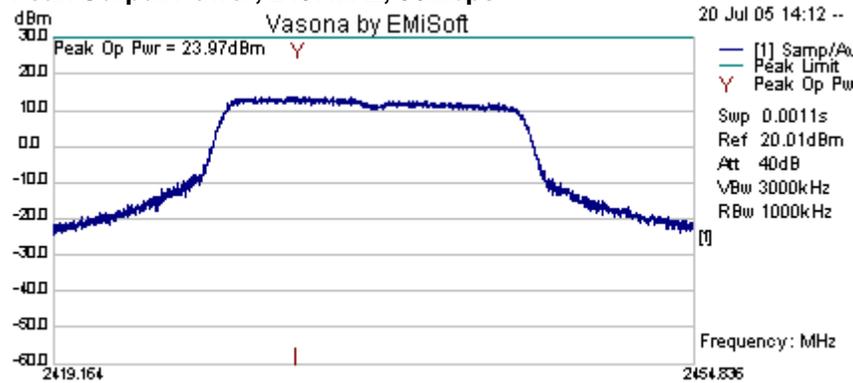




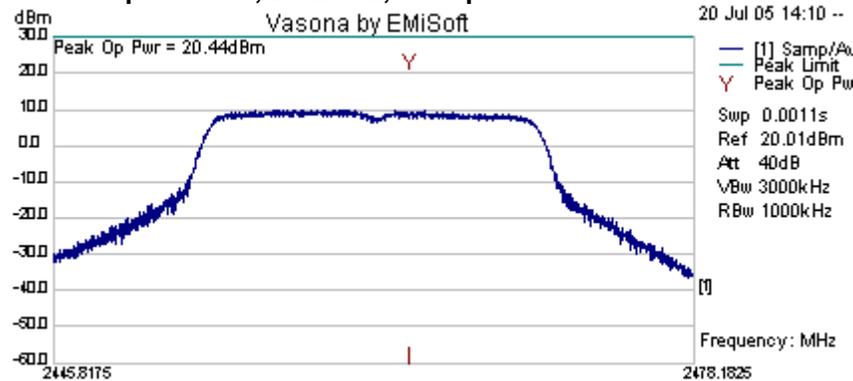
### Peak Output Power, 2412MHz, 36Mbps



### Peak Output Power, 2437MHz, 36Mbps

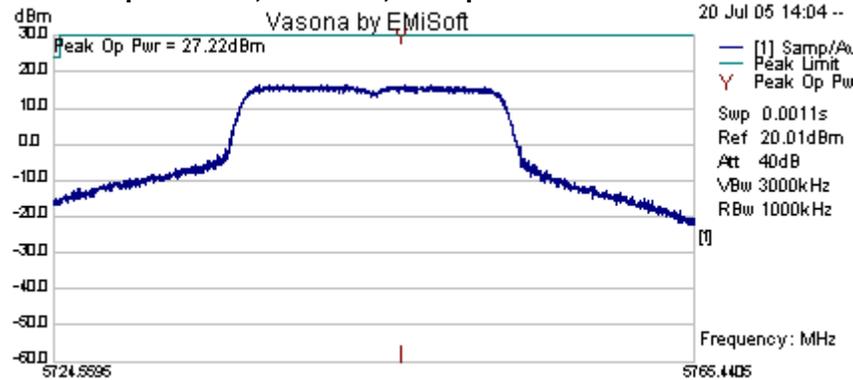


### Peak Output Power, 2462MHz, 36Mbps

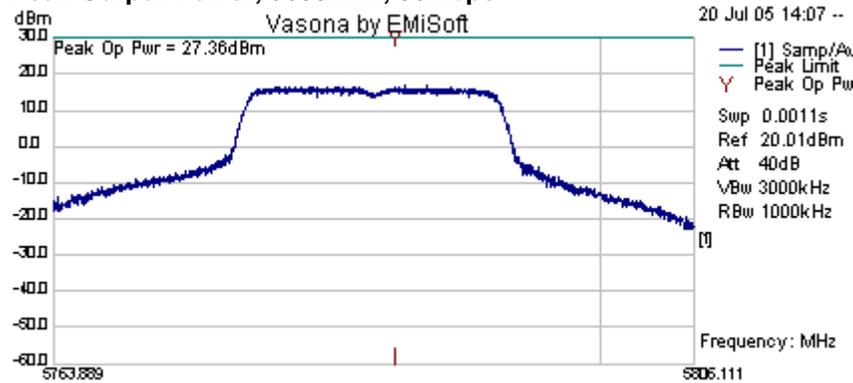




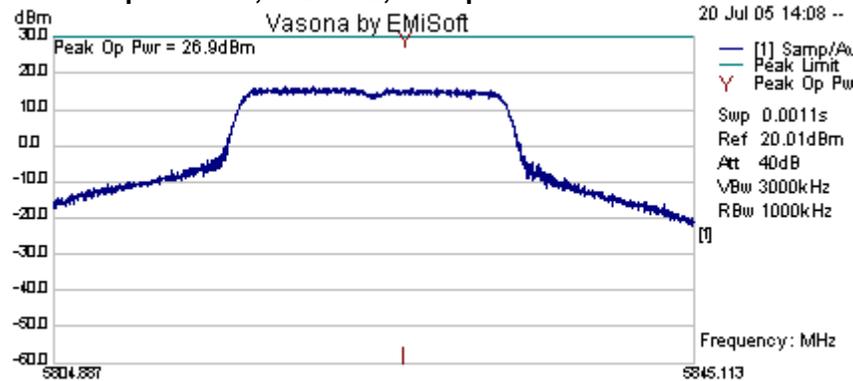
### Peak Output Power, 5745MHz, 36Mbps



### Peak Output Power, 5685MHz, 36Mbps



### Peak Output Power, 5825MHz, 36Mbps





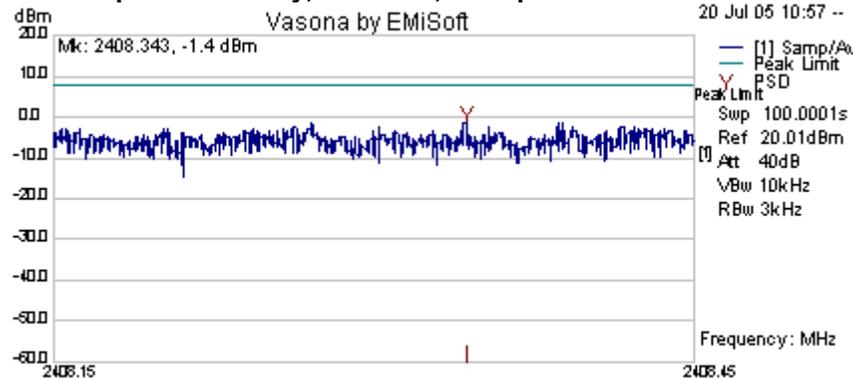
## Power Spectral Density

For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

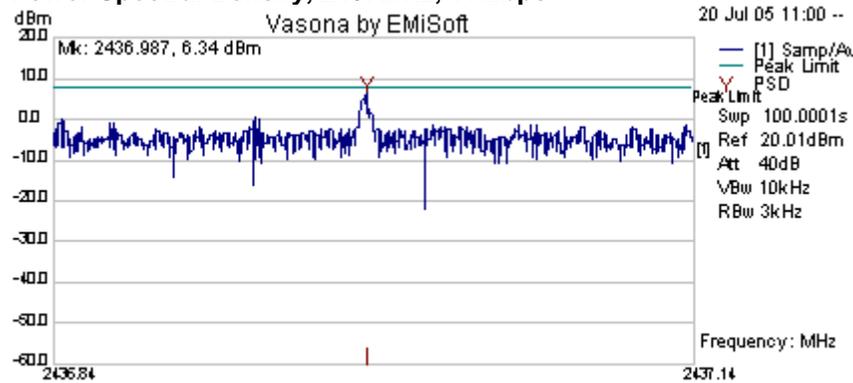
Frequency (MHz)	Data Rate (Mbps)	Power Spectral Density (dBm/3kHz)	Limit (dBm)	Margin (dB)
2412	11	-1.40	8	9.40
2437	11	6.34	8	1.66
2462	11	6.77	8	1.23
2412	36	-1.12	8	9.12
2437	36	-0.09	8	8.09
2462	36	-1.55	8	9.55
5745	36	3.39	8	4.61
5785	36	2.81	8	5.19
5805	36	1.93	8	6.07



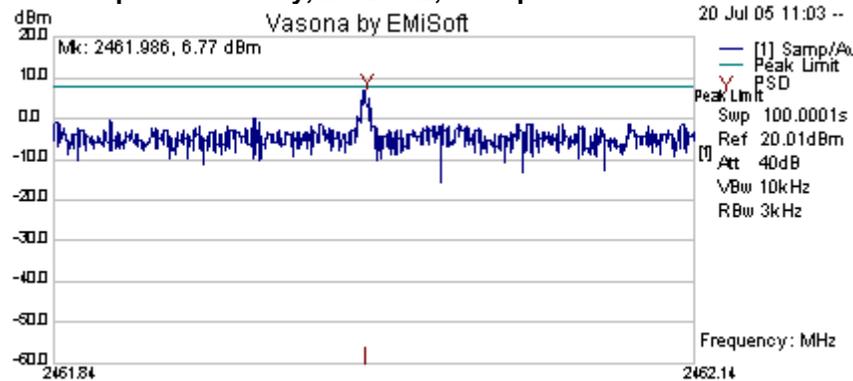
### Power Spectral Density, 2412MHz, 11Mbps



### Power Spectral Density, 2437MHz, 11Mbps

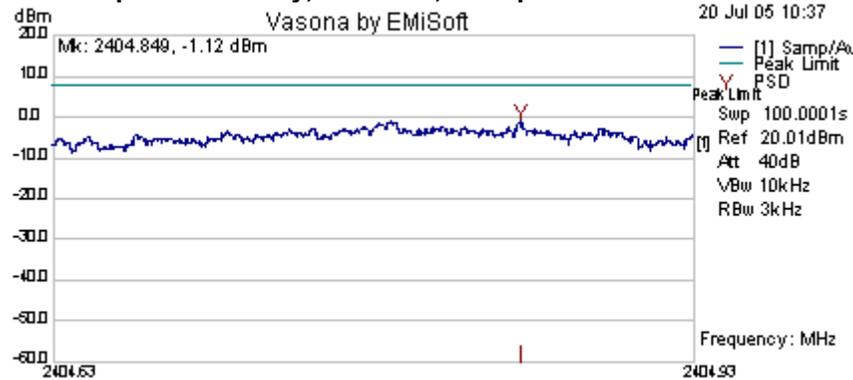


### Power Spectral Density, 2462MHz, 11Mbps

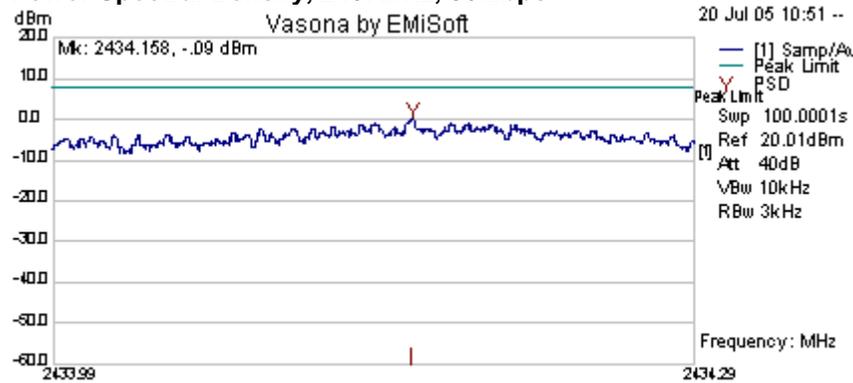




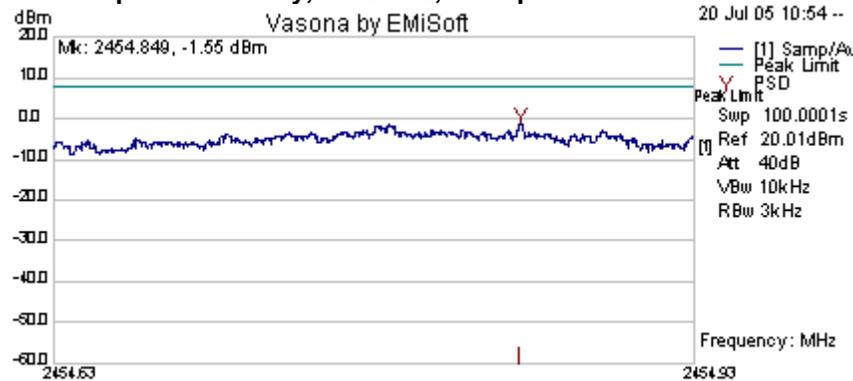
### Power Spectral Density, 2412MHz, 36Mbps



### Power Spectral Density, 2437MHz, 36Mbps

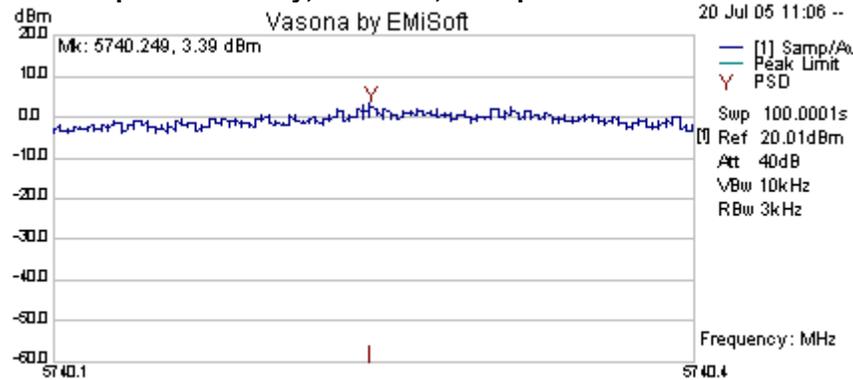


### Power Spectral Density, 2462MHz, 36Mbps

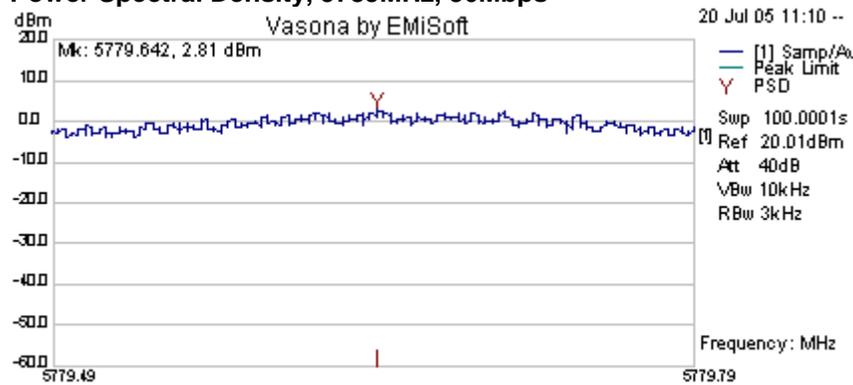




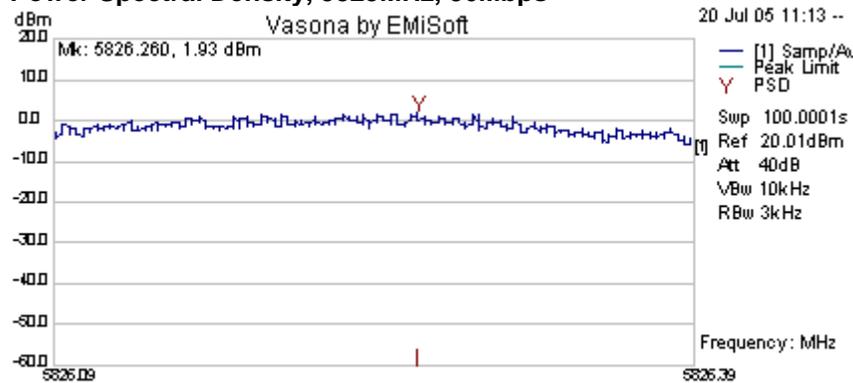
### Power Spectral Density, 5745MHz, 36Mbps



### Power Spectral Density, 5785MHz, 36Mbps



### Power Spectral Density, 5825MHz, 36Mbps



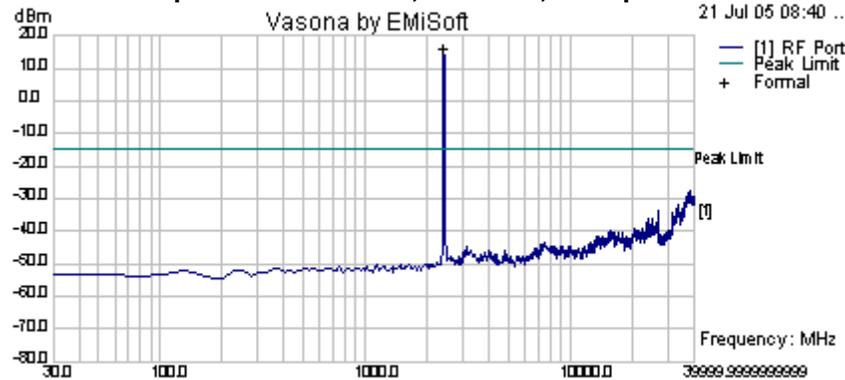


## Conducted Spurious Emissions

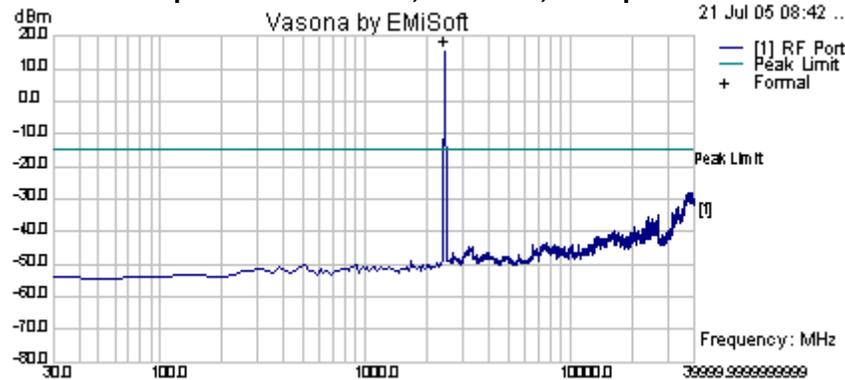
In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.



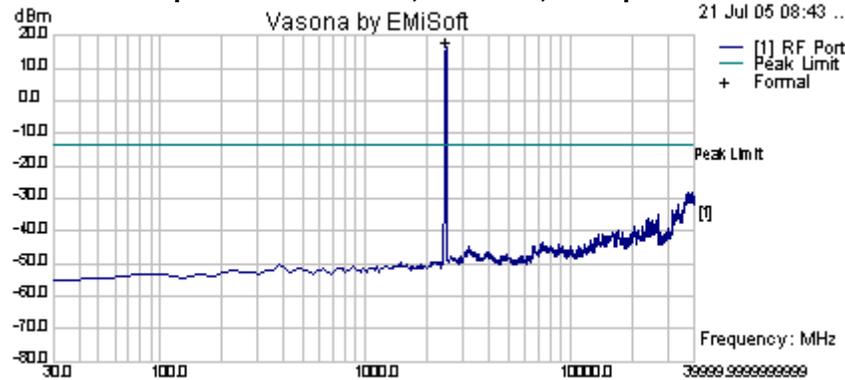
### Conducted Spurious Emissions, 2412MHz, 11Mbps



### Conducted Spurious Emissions, 2437MHz, 11Mbps

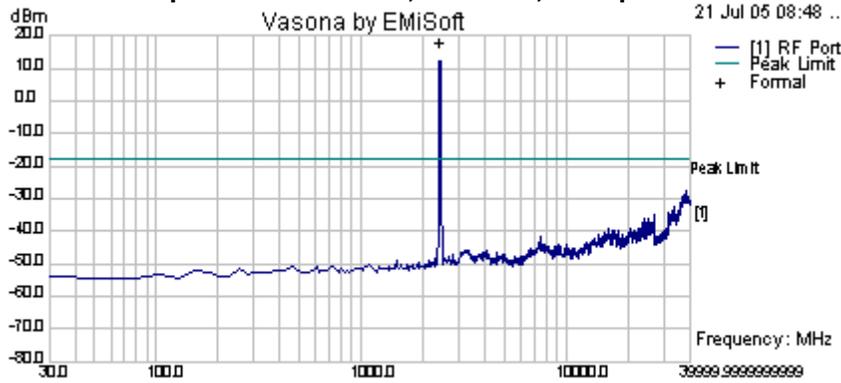


### Conducted Spurious Emissions, 2462MHz, 11Mbps

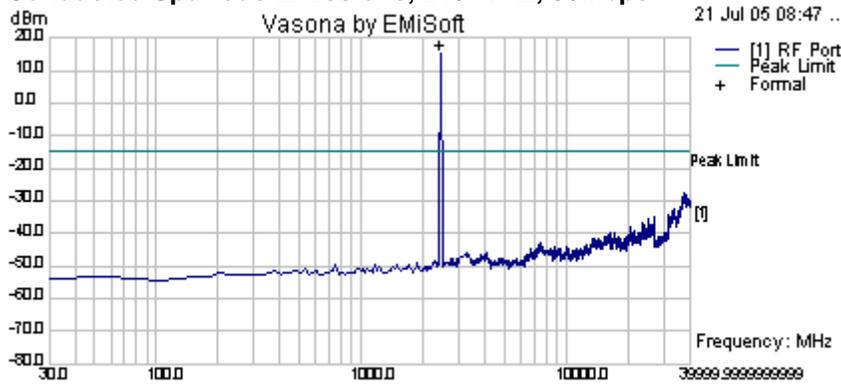




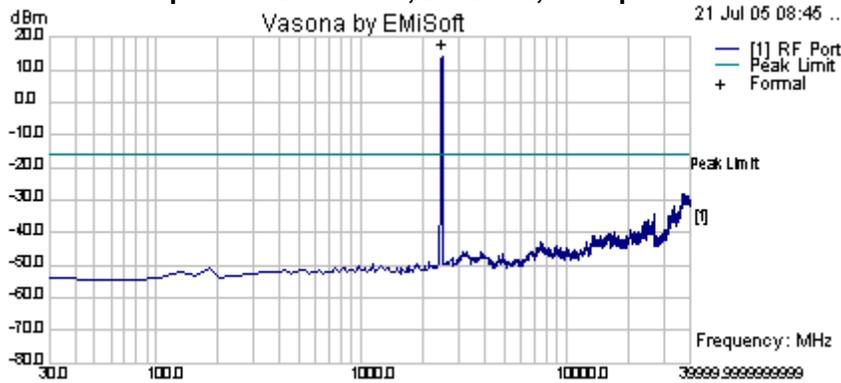
### Conducted Spurious Emissions, 2412MHz, 36Mbps



### Conducted Spurious Emissions, 2437MHz, 36Mbps

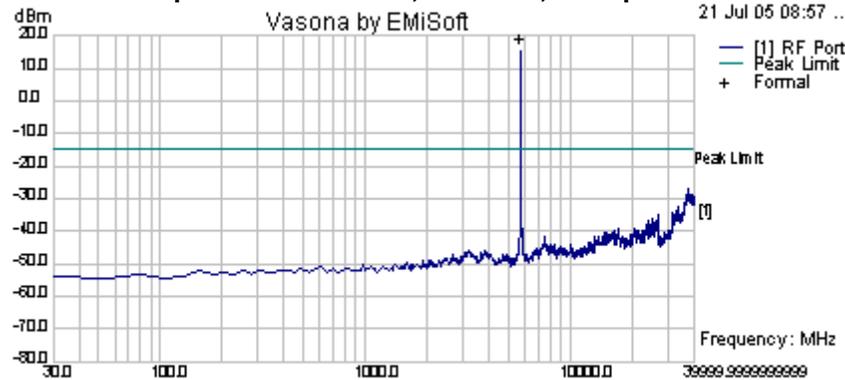


### Conducted Spurious Emissions, 2462MHz, 36Mbps

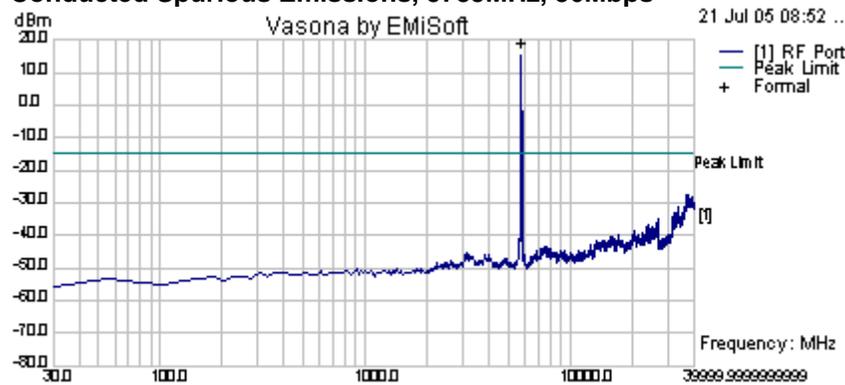




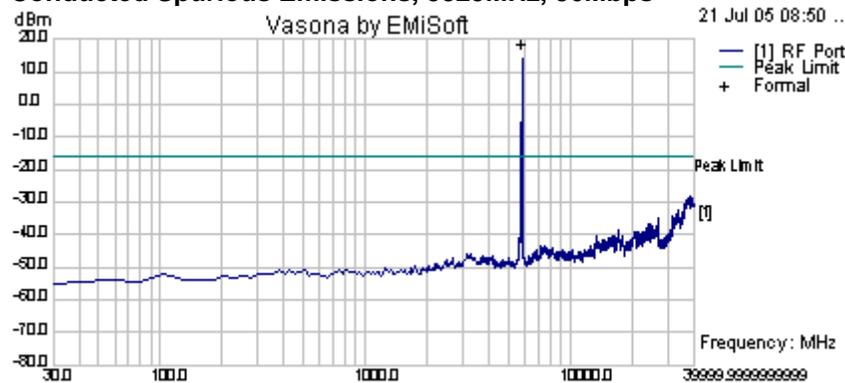
### Conducted Spurious Emissions, 5745MHz, 36Mbps



### Conducted Spurious Emissions, 5785MHz, 36Mbps



### Conducted Spurious Emissions, 5825MHz, 36Mbps





## Radiated Transmitter Spurious Emissions

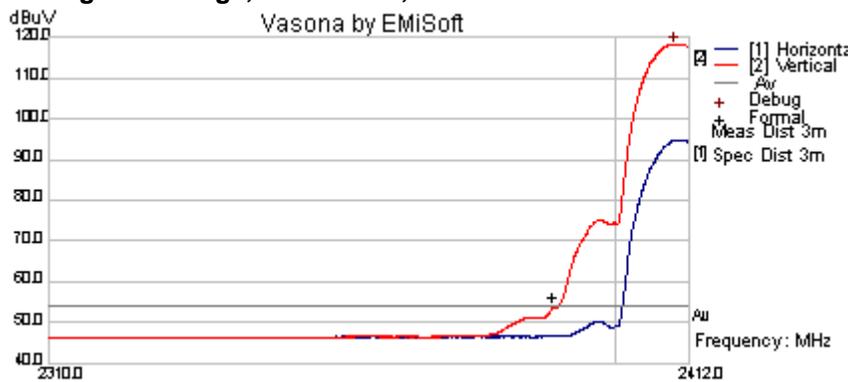
Radiated emissions which fall in the restricted bands, as defined in Sec. 15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a).

Transmit Frequency (MHz)	Data Rate (Mbps)	Antenna Gain (dBi)	Spur Frequency (MHz)	Measurement Type	Spur Level (dBm)	Limit (dBm)	Margin (dB)
2412	11	8	2390	Average	53.65	54	0.35
2412	11	8	2390	Peak	63.69	74	10.30
2462	11	8	2487	Average	50.87	54	3.13
2462	11	8	2483.5	Peak	69.68	74	4.32
2412	36	8	2390	Average	53.65	54	0.35
2412	36	8	2390	Peak	72.78	74	1.22
2462	36	8	2483.5	Average	53.23	54	0.77
2462	36	8	2483.5	Peak	69.22	74	4.78
2412	11	5.5	2385.9	Average	53.35	54	0.65
2412	11	5.5	2385.9	Peak	66.74	74	7.26
2462	11	5.5	2487.2	Average	52.81	54	1.19
2462	11	5.5	2483.5	Peak	70.14	74	3.86
2412	36	5.5	2390	Average	53.89	54	0.11
2412	36	5.5	2390	Peak	70.77	74	3.23
2462	36	5.5	2483.5	Average	53.42	54	0.58
2462	36	5.5	2483.5	Peak	72.28	74	1.72
5745	36	20	5460	Average	53.39	54	0.61
5785	36	20	5460	Average	53.27	54	0.73
5825	36	20	5460	Average	52.63	54	1.37
5745	36	9.5	5460	Average	44.80	54	9.20
5785	36	9.5	5460	Average	44.78	54	9.22
5825	36	9.5	5460	Average	44.62	54	9.38
5745	36	7.5	5460	Average	44.80	54	9.20
5785	36	7.5	5460	Average	44.55	54	9.45
5825	36	7.5	5460	Average	45.03	54	8.97

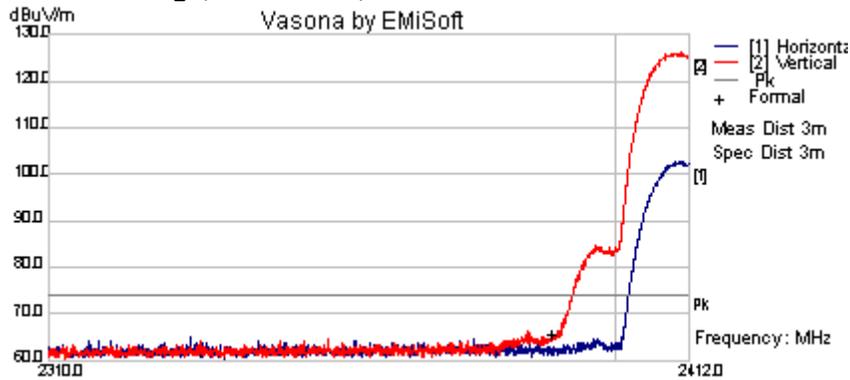


### 2412MHz, 11Mbps, 8dBi Omni-Directional Antenna

#### Average Bandedge, 1MHz RBW, 10Hz VBW



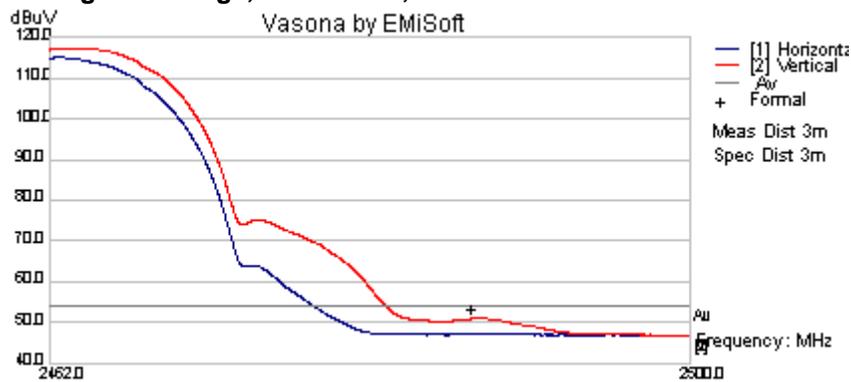
#### Peak Bandedge, 1MHz RBW, 1MHz RBW



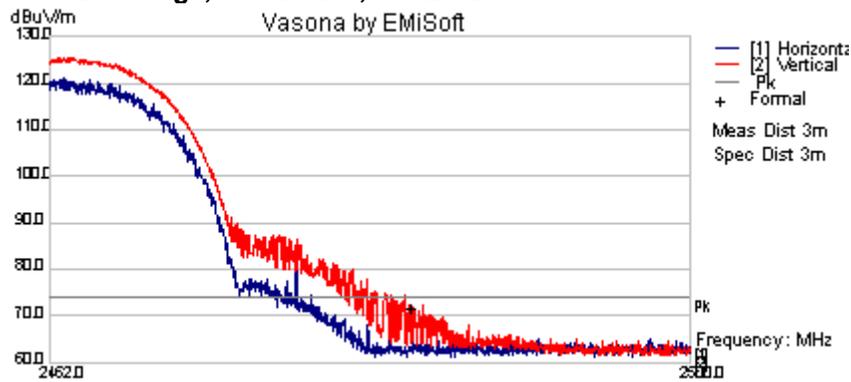


### 2462MHz, 11Mbps, 8dBi Omni-Directional Antenna

#### Average Bandedge, 1MHz RBW, 10Hz VBW



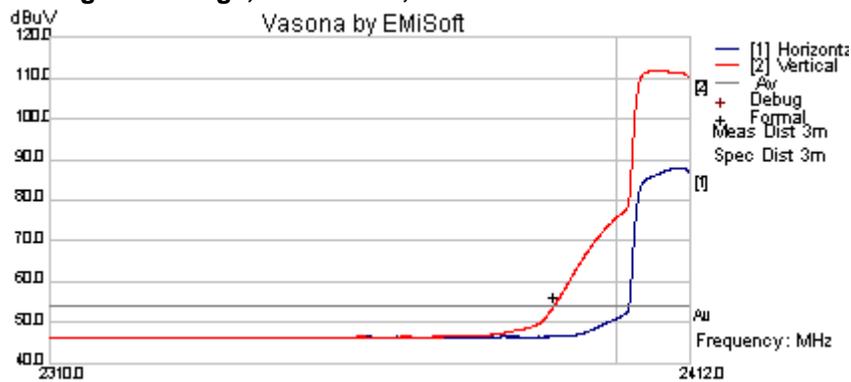
#### Peak Bandedge, 1MHz RBW, 1MHz VBW



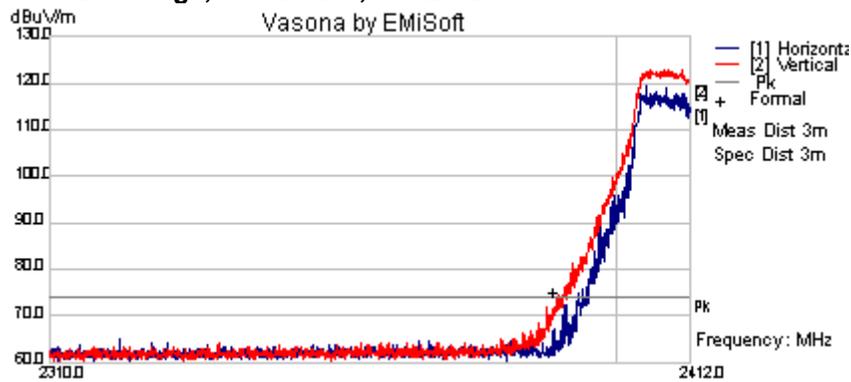


### 2412MHz, 36Mbps, 8dBi Omni-Directional Antenna

#### Average Bandedge, 1MHz RBW, 10Hz VBW



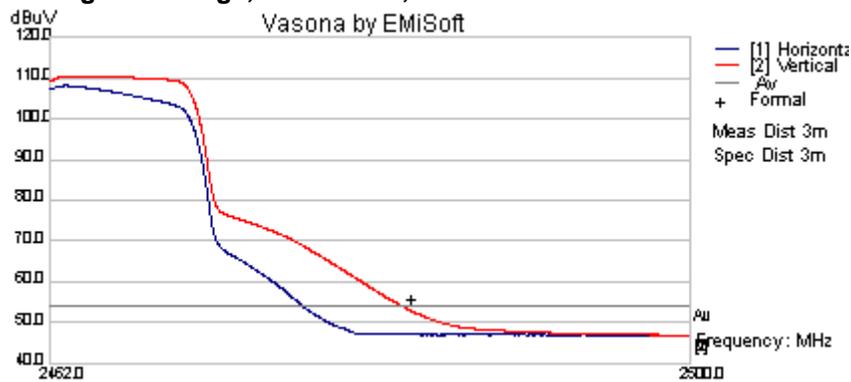
#### Peak Bandedge, 1MHz RBW, 1MHz VBW



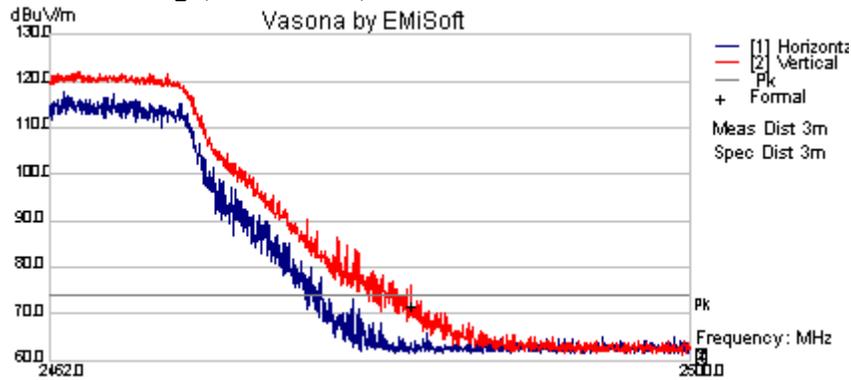


### 2462MHz, 36Mbps, 8dBi Omni-Directional Antenna

#### Average Bandedge, 1MHz RBW, 10Hz VBW



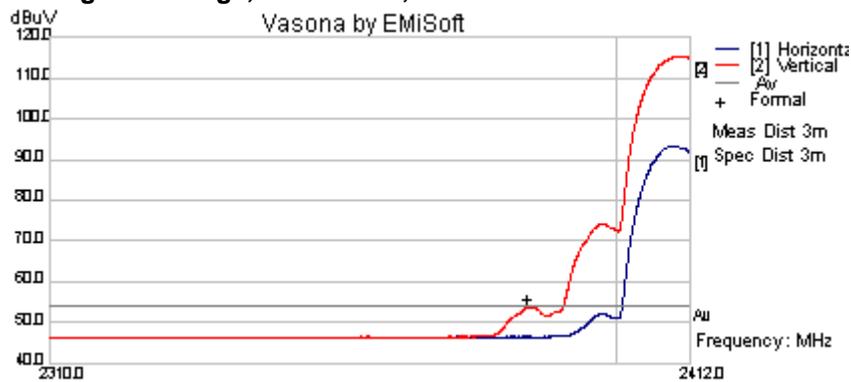
#### Peak Bandedge, 1MHz RBW, 1MHz VBW



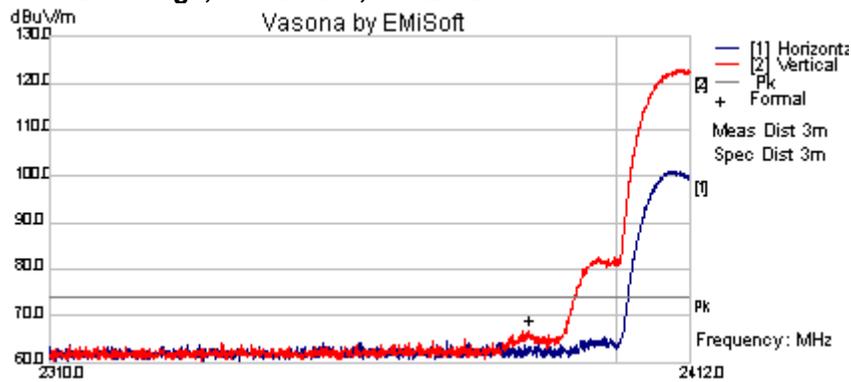


### 2412MHz, 11Mbps, 5.5dBi Omni-Directional Antenna

#### Average Bandedge, 1MHz RBW, 10Hz VBW



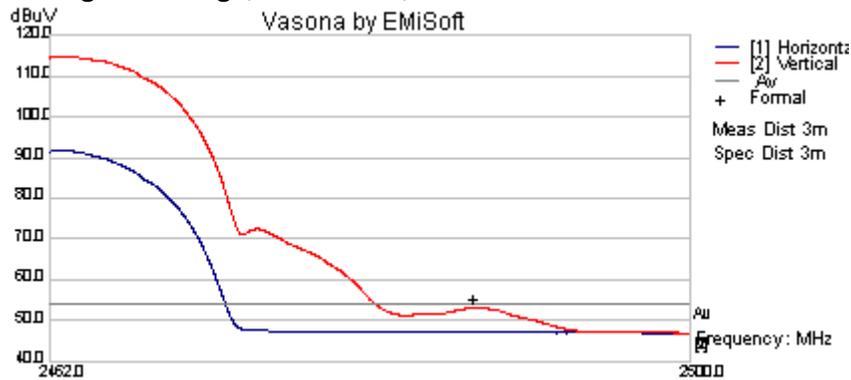
#### Peak Bandedge, 1MHz RBW, 1MHz VBW



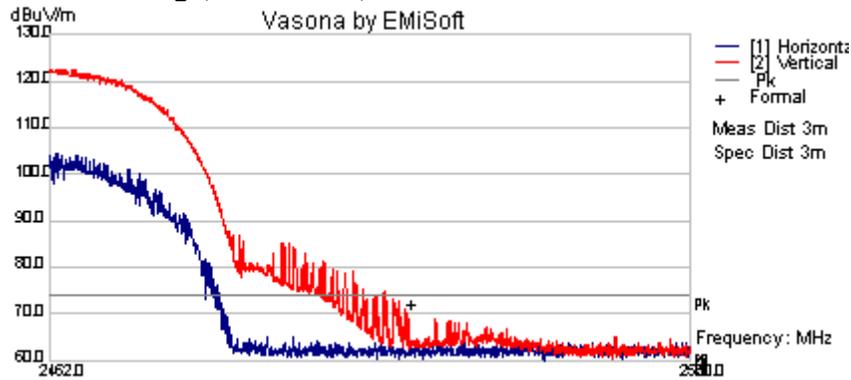


### 2462MHz, 11Mbps, 5.5dBi Omni-Directional Antenna

#### Average Bandedge, 1MHz RBW, 10Hz VBW



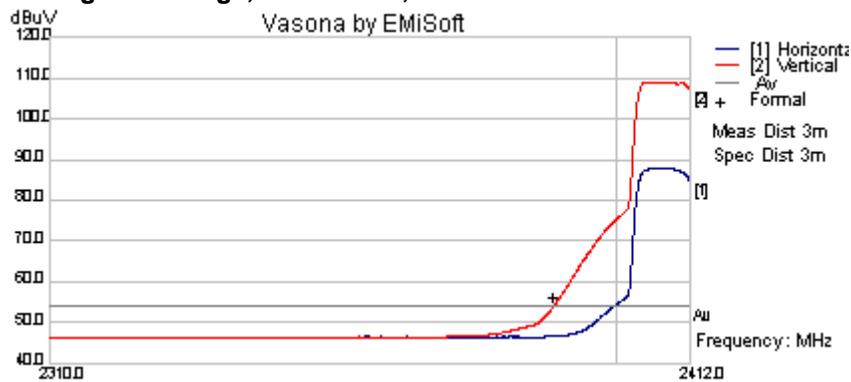
#### Peak Bandedge, 1MHz RBW, 1MHz VBW



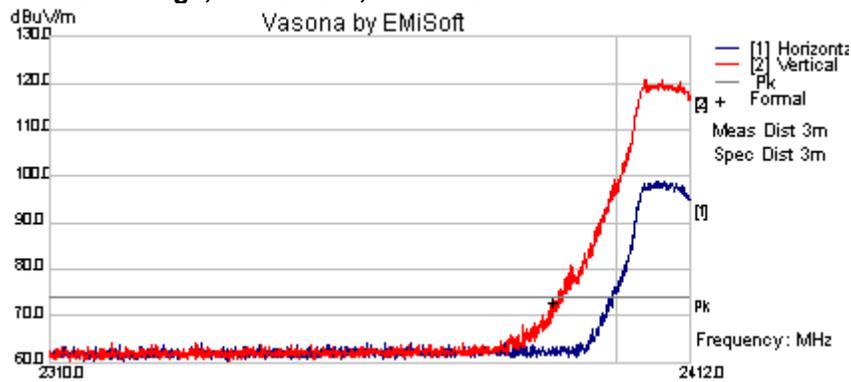


### 2412MHz, 36Mbps, 5.5dBi Omni-Directional Antenna

#### Average Bandedge, 1MHz RBW, 10Hz VBW



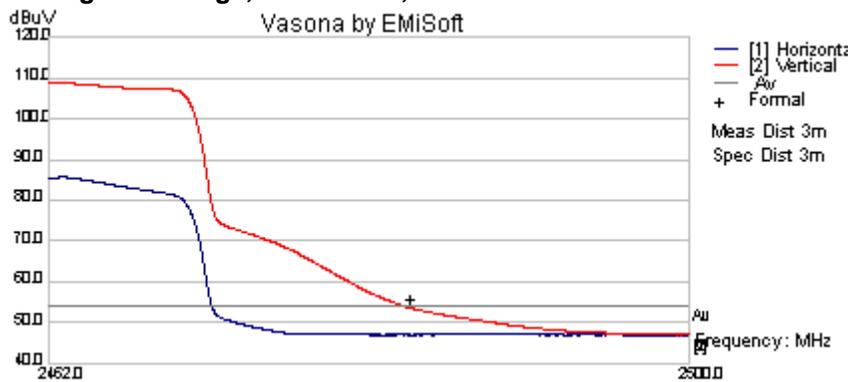
#### Peak Bandedge, 1MHz RBW, 1MHz VBW



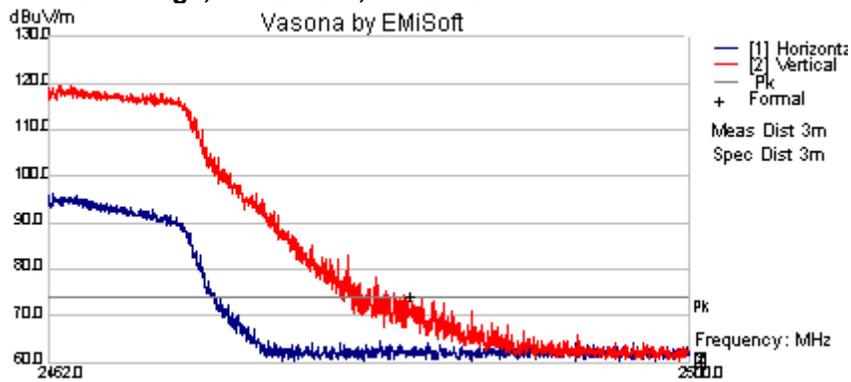


### 2462MHz, 36Mbps, 5.5dBi Omni-Directional Antenna

#### Average Bandedge, 1MHz RBW, 10Hz VBW



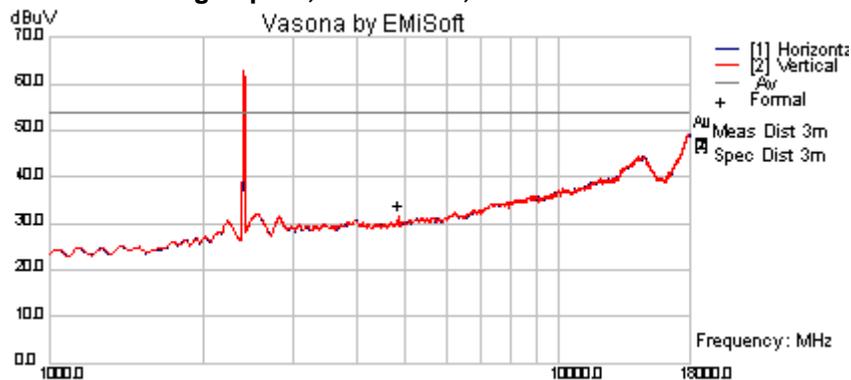
#### Peak Bandedge, 1MHz RBW, 1MHz VBW



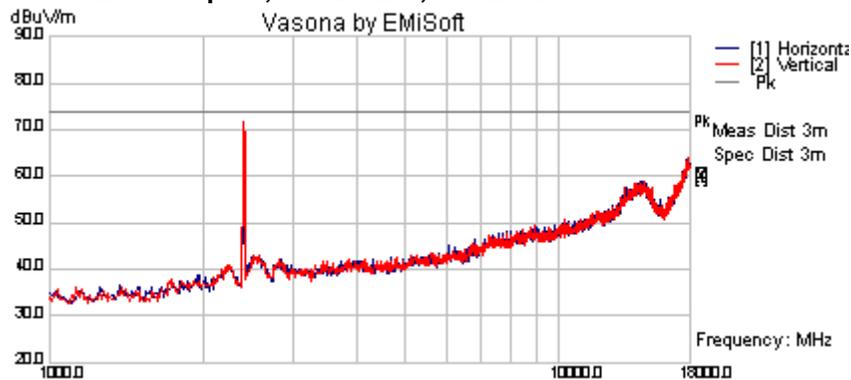


**2412MHz, All Data Rates, All Antennas**

**1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW**



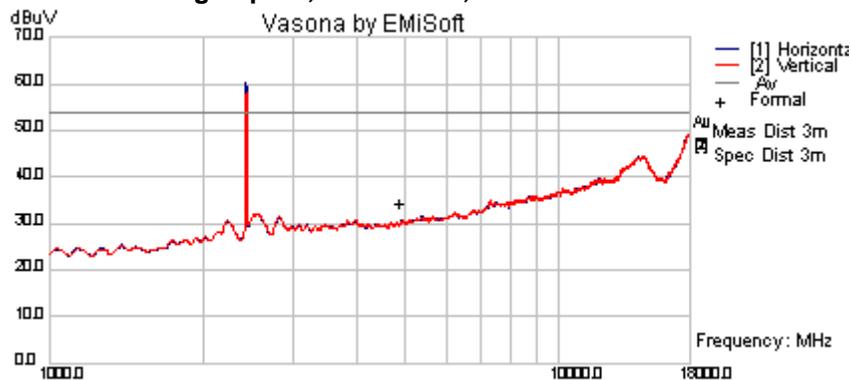
**1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW**



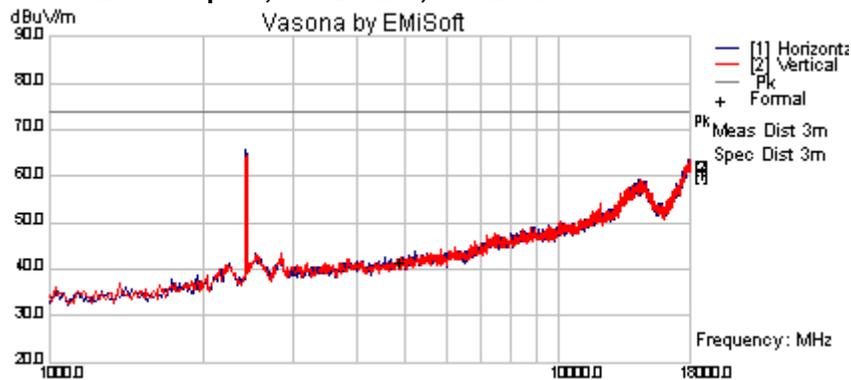


### 2437MHz, All Data Rates, All Antennas

#### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



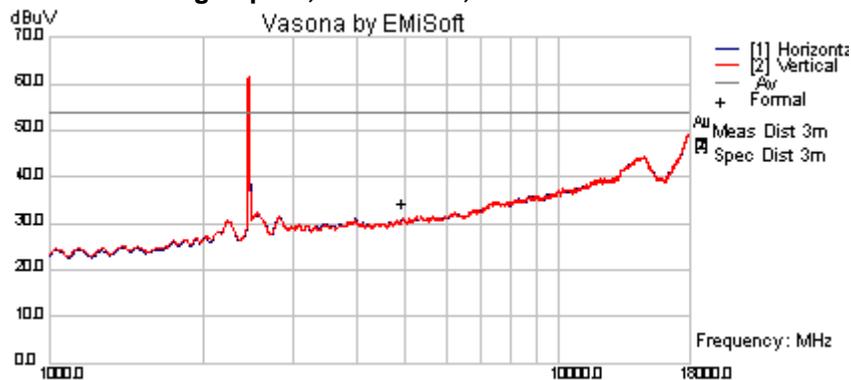
#### 1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW



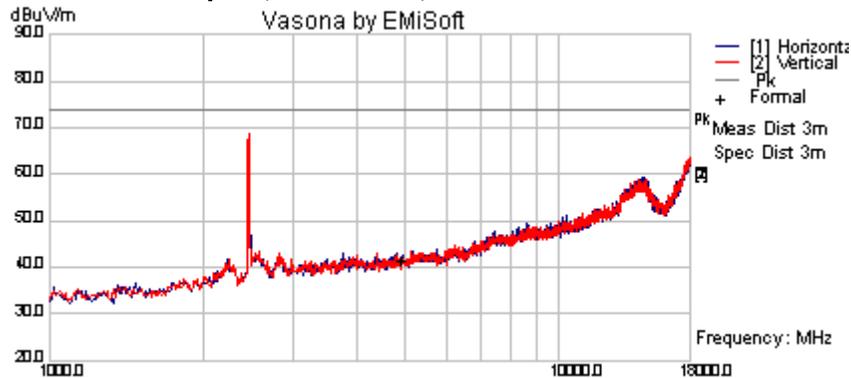


**2462MHz, All Data Rates, All Antennas**

**1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW**



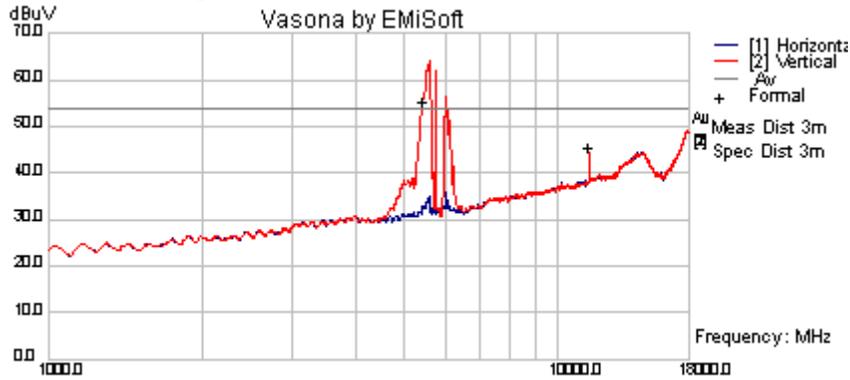
**1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW**



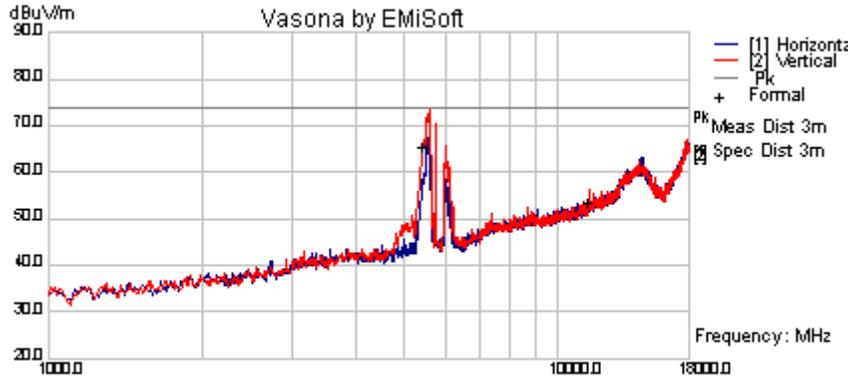


**5745MHz, 36Mbps, 20dBi Patch Antenna**

**1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW**



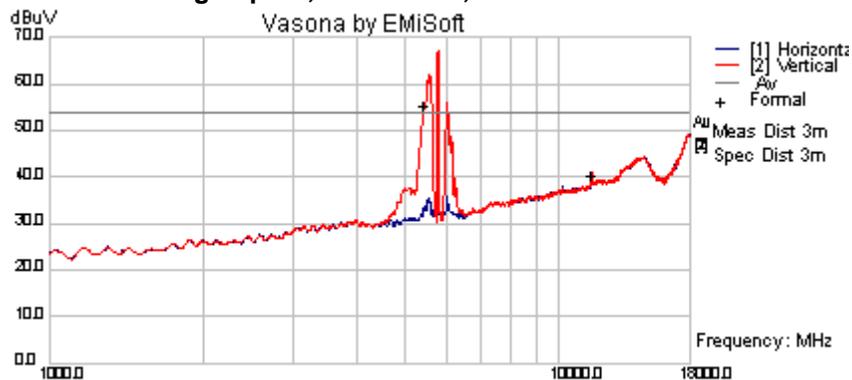
**1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW**



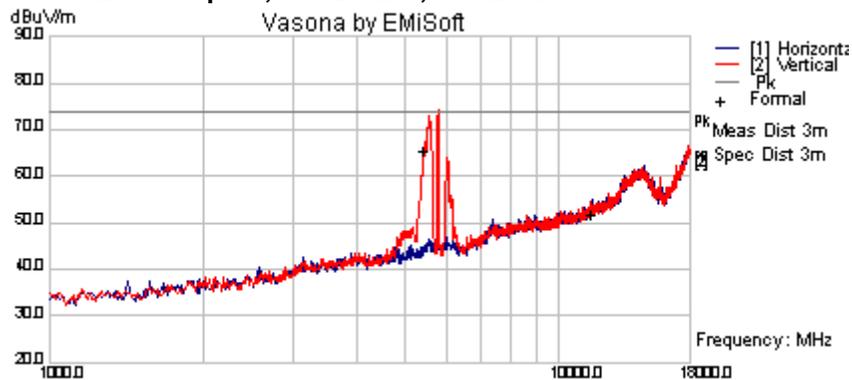


### 5785MHz, 36Mbps, 20dBi Patch Antenna

#### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



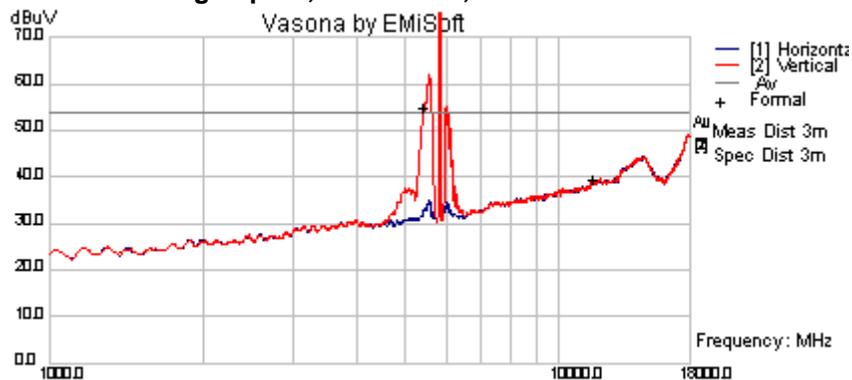
#### 1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW





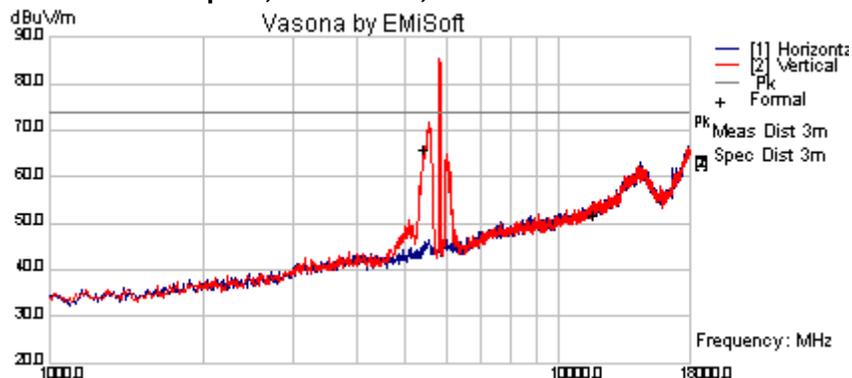
### 5825MHz, 36Mbps, 20dBi Patch Antenna

#### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



### 5825MHz, 36Mbps, 20dBi Patch Antenna

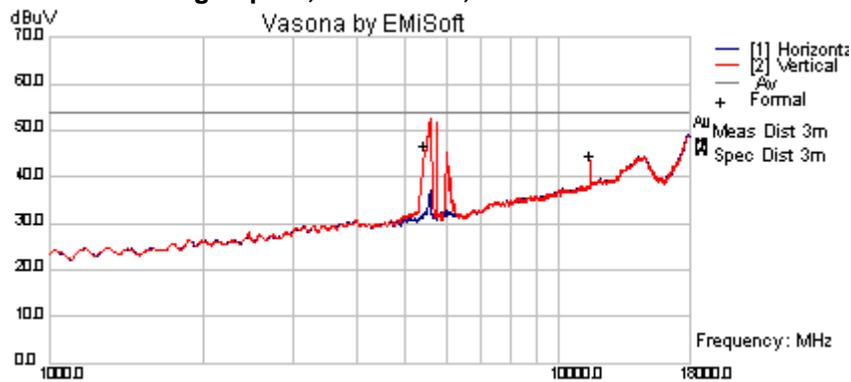
#### 1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW



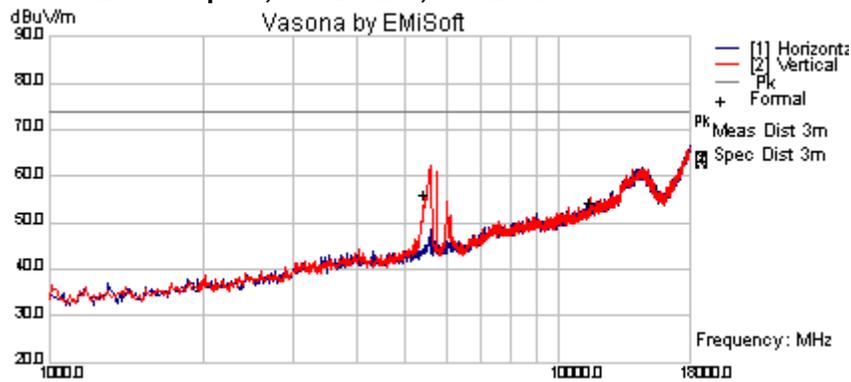


### 5745MHz, 36Mbps, 9.5dBi Sector Antenna

#### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



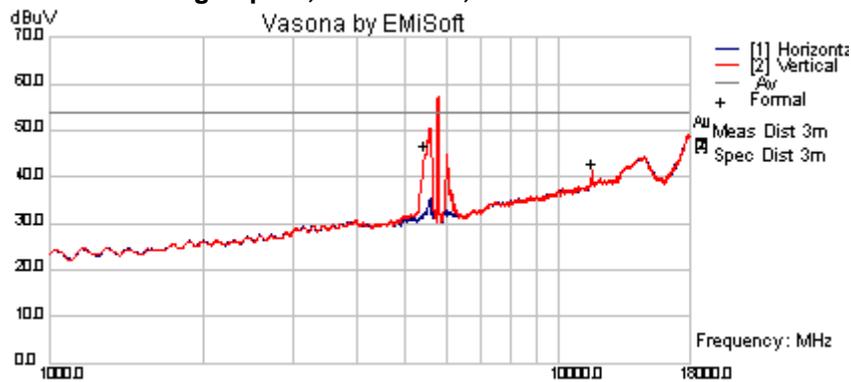
#### 1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW



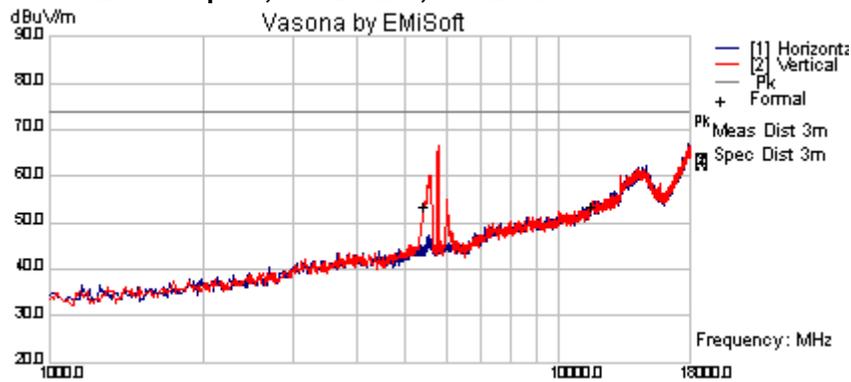


### 5785MHz, 36Mbps, 9.5dBi Sector Antenna

#### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



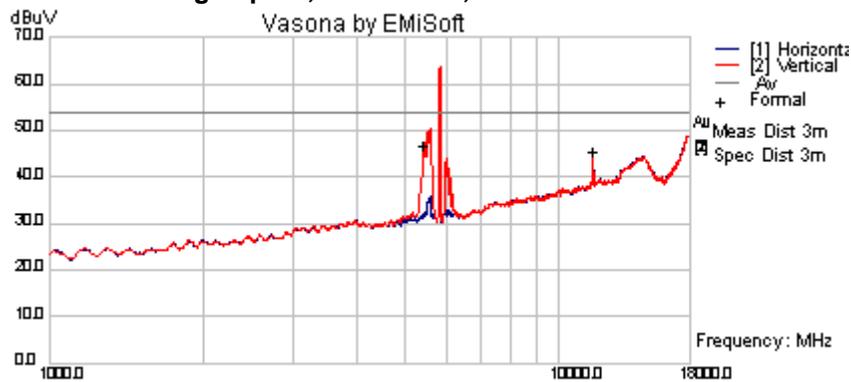
#### 1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW



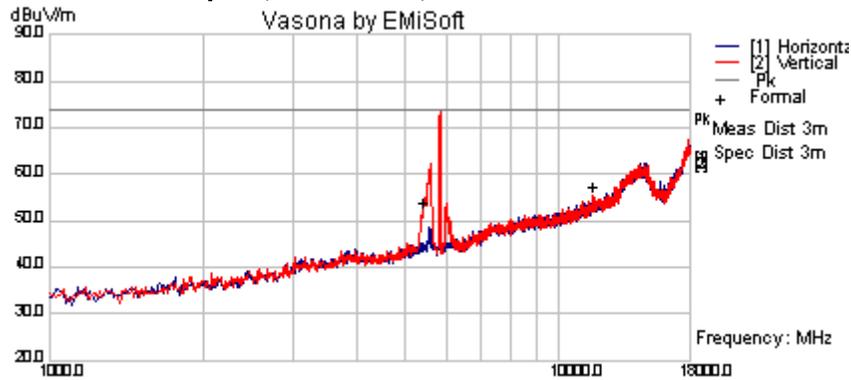


### 5825MHz, 36Mbps, 9.5dBi Sector Antenna

#### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



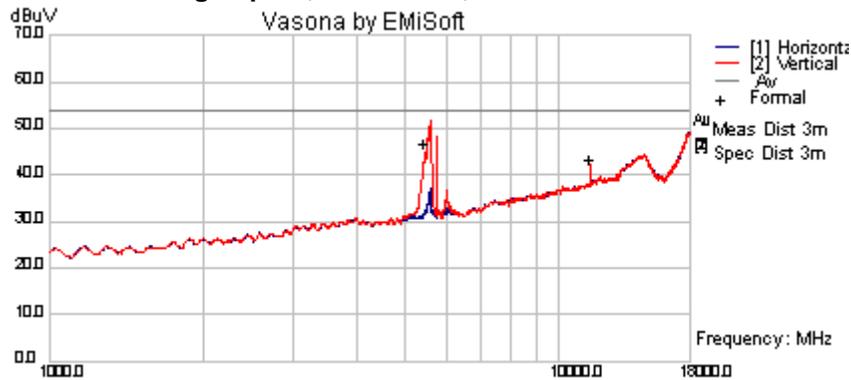
#### 1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW



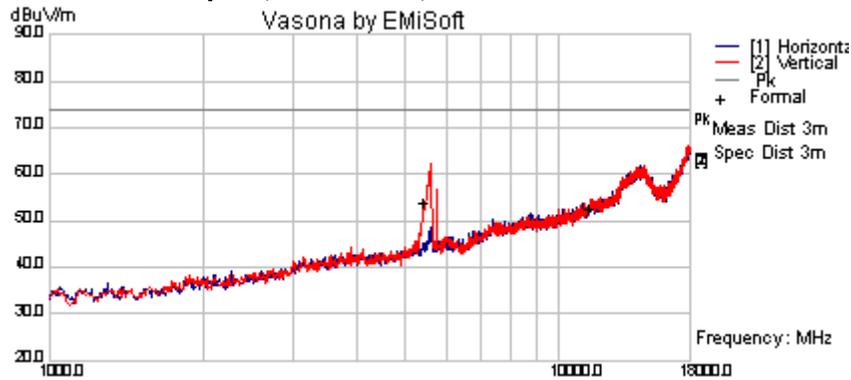


### 5745MHz, 36Mbps, 7.5dBi Omni-Directional Antenna

#### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



#### 1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW



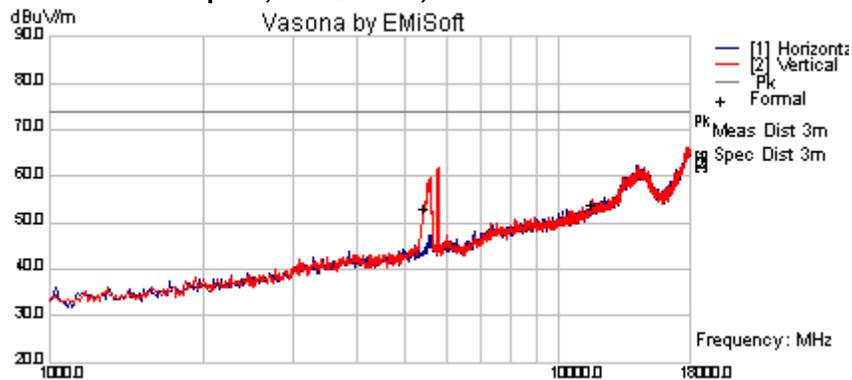


### 5785MHz, 36Mbps, 7.5dBi Omni-Directional Antenna

#### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



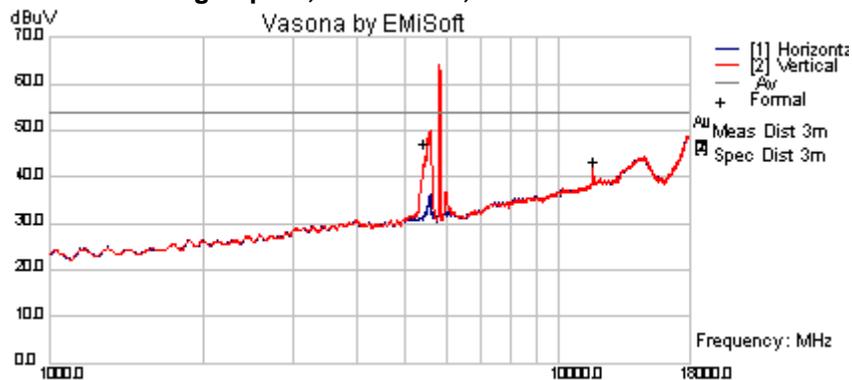
#### 1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW



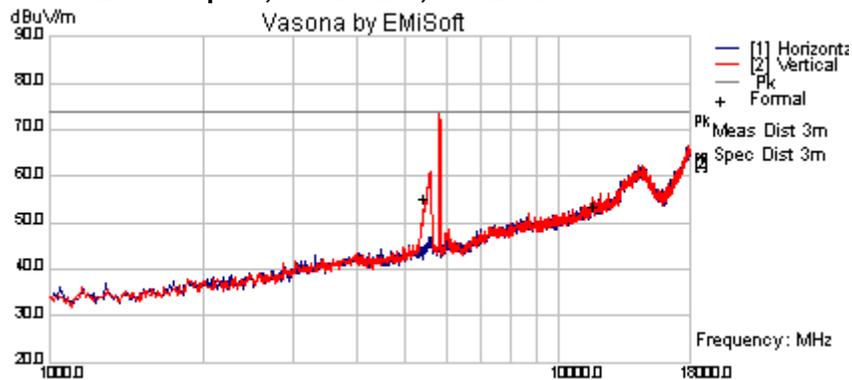


### 5825MHz, 36Mbps, 7.5dBi Omni-Directional Antenna

#### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



#### 1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW



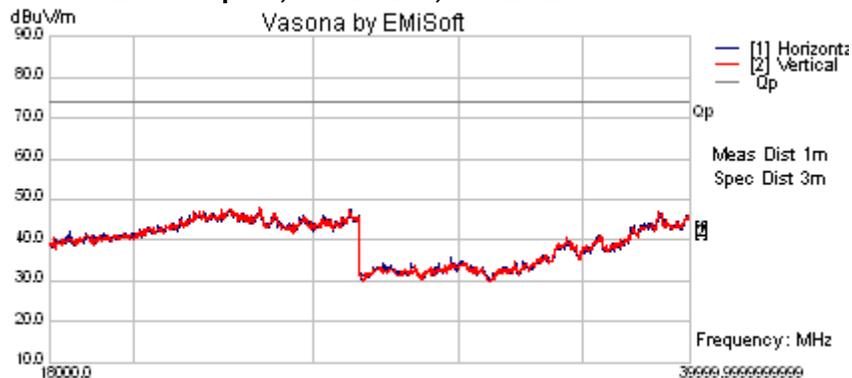


**All Transmit Frequencies, All Data Rates, All Antennas**

**18-40GHz Average Spurs, 1MHz RBW, 10Hz VBW**



**18-40GHz Peak Spurs, 1MHz RBW, 1MHz VBW**





## Radiated Transmitter Co-Located Spurious Emissions

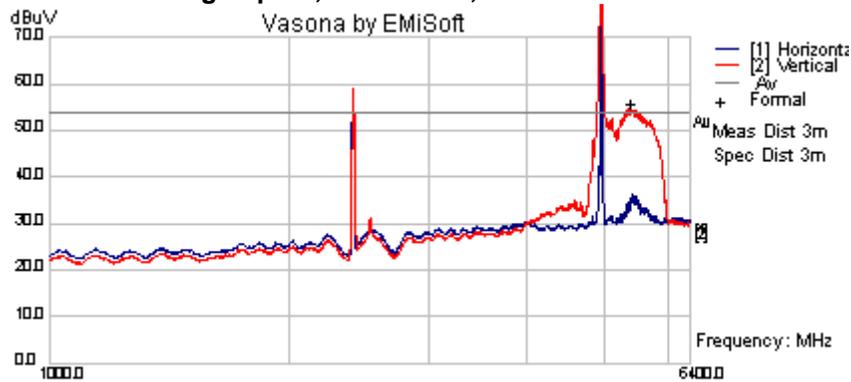
Radiated emissions which fall in the restricted bands, as defined in Sec. 15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a).

Transmit Frequency (MHz)	Data Rate (Mbps)	Antenna Gain (dBi)	Spur Frequency (MHz)	Measurement Type	Spur Level (dBm)	Limit (dBm)	Margin (dB)
2412	All	All	5400	Average	53.63	54	0.37
2412	All	All	5440	Peak	66.71	74	7.29
2437	All	All	5360	Average	53.48	54	0.52
2437	All	All	5416	Peak	66.01	74	7.99
2462	All	All	5480	Average	53.51	54	0.49
2462	All	All	5400	Peak	64.58	74	9.42
5745	All	All	5581	Average	53.74	54	0.26
5745	All	All	11489	Average	49.43	54	4.57
5745	All	All	5580	Peak	65.69	74	8.31
5745	All	All	11492	Peak	61.75	74	12.25
5785	All	All	5581	Average	51.66	54	2.34
5785	All	All	11571	Average	52.43	54	1.57
5785	All	All	5578	Peak	61.63	74	12.37
5785	All	All	11568	Peak	63.35	74	10.65
5825	All	All	5581	Average	51.96	54	2.04
5825	All	All	11650	Average	47.51	54	6.49
5825	All	All	5588	Peak	61.86	74	12.14
5825	All	All	11649	Peak	58.58	74	15.42

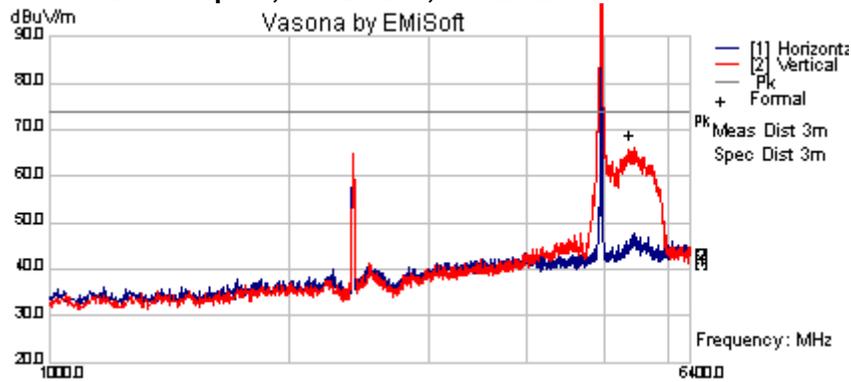


**2412MHz, All Data Rates, All Antennas Co-located with 4950MHz, 36Mbps, 6.5dBi Omni Antenna**

**1-6.4GHz Average Spurs, 1MHz RBW, 10Hz VBW**



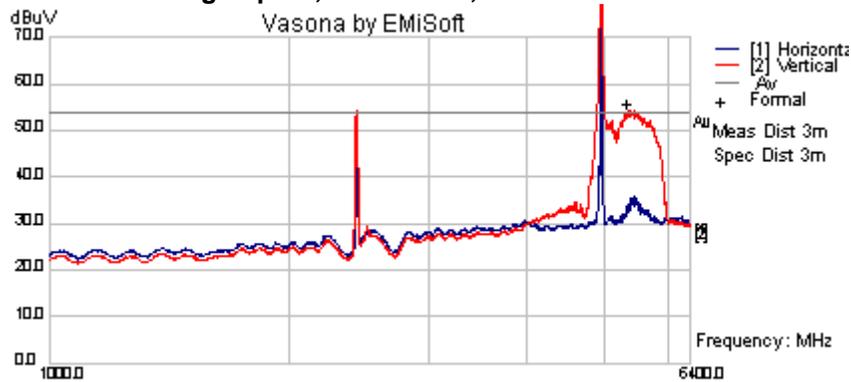
**1-6.4GHz Peak Spurs, 1MHz RBW, 1MHz VBW**



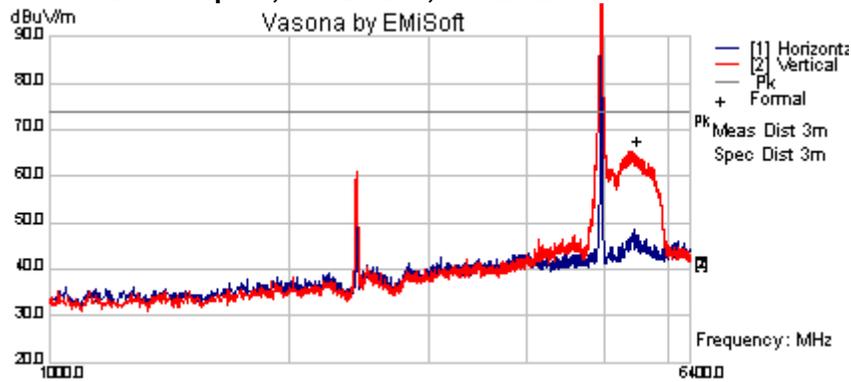


**2437MHz, All Data Rates, All Antennas Co-located with 4950MHz, 36Mbps, 6.5dBi Omni Antenna**

**1-6.4GHz Average Spurs, 1MHz RBW, 10Hz VBW**



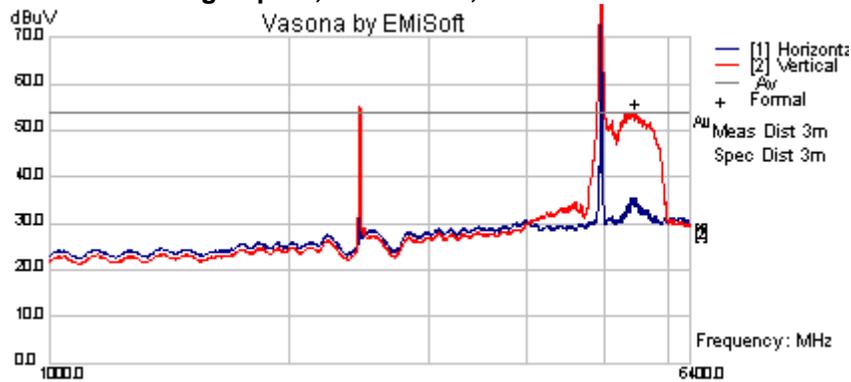
**1-6.4GHz Peak Spurs, 1MHz RBW, 1MHz VBW**



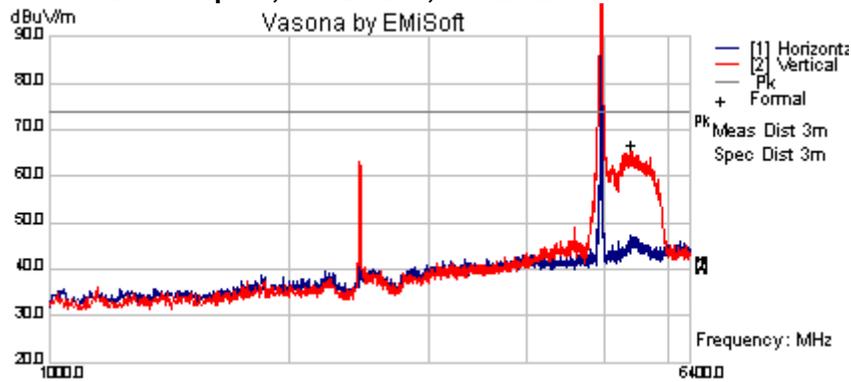


**2462MHz, All Data Rates, All Antennas Co-located with 4950MHz, 36Mbps, 6.5dBi Omni Antenna**

**1-6.4GHz Average Spurs, 1MHz RBW, 10Hz VBW**



**1-6.4GHz Peak Spurs, 1MHz RBW, 1MHz VBW**



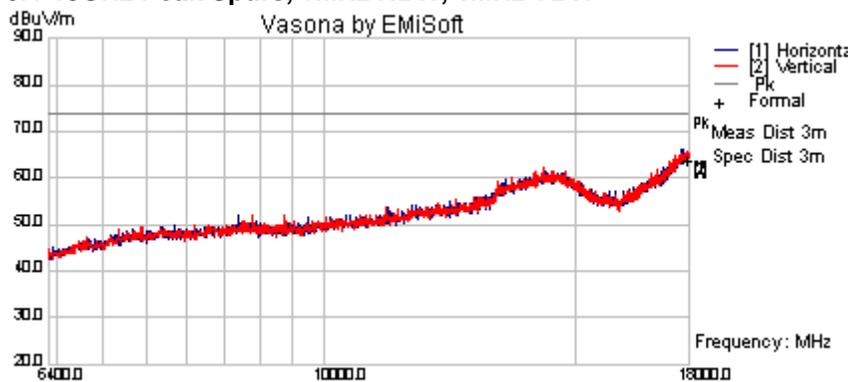


**All 2.4GHz Transmit Frequencies, All Data Rates, All Antennas Co-located with 4950MHz, 36Mbps, 6.5dBi Omni Antenna**

**6.4-18GHz Average Spurs, 1MHz RBW, 10Hz VBW**



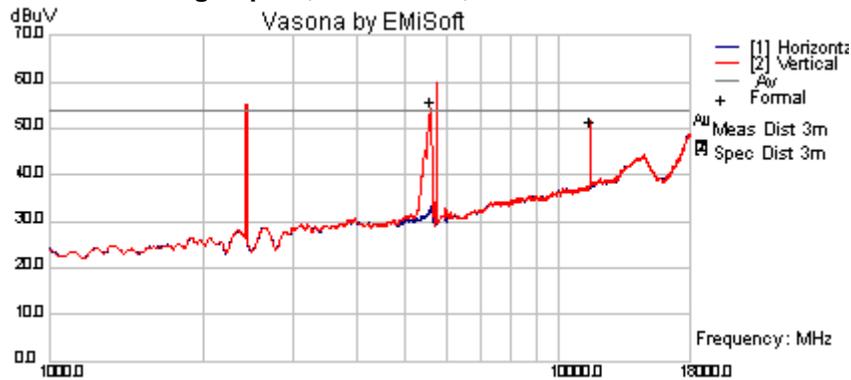
**6.4-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW**



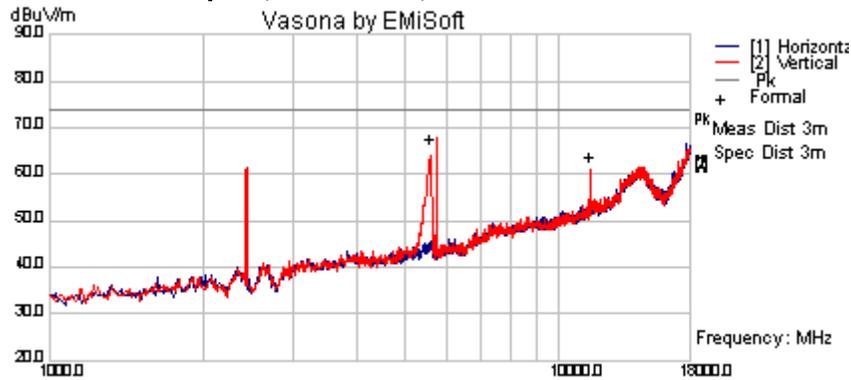


**5745MHz, All Data Rates, All Antennas Co-located with 2437MHz, All Data Rates, All Antennas**

**1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW**



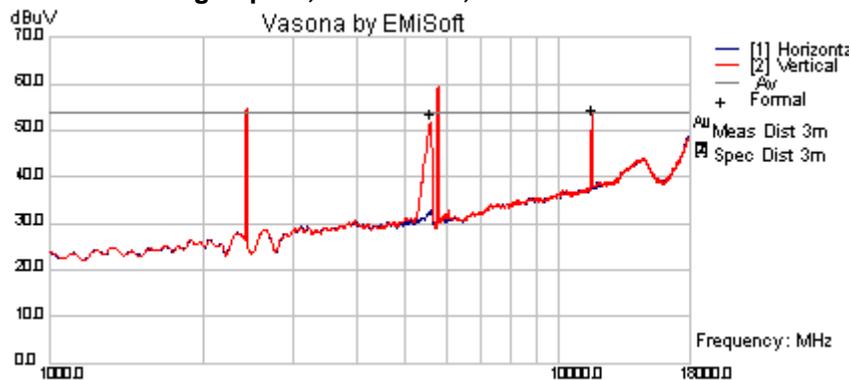
**1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW**



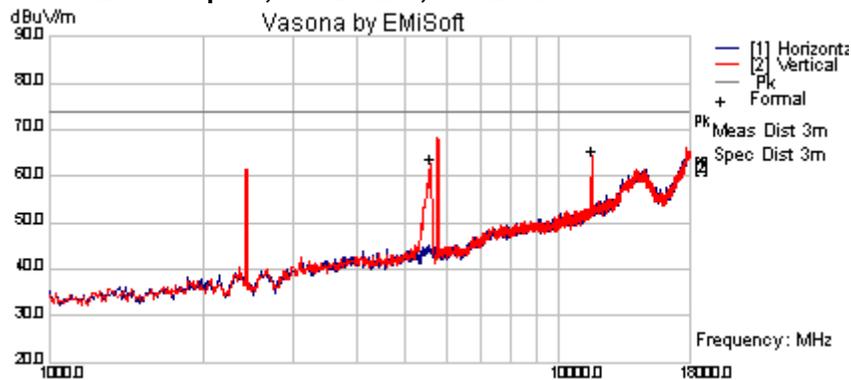


**5785MHz, All Data Rates, All Antennas Co-located with 2437MHz, All Data Rates, All Antennas**

**1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW**



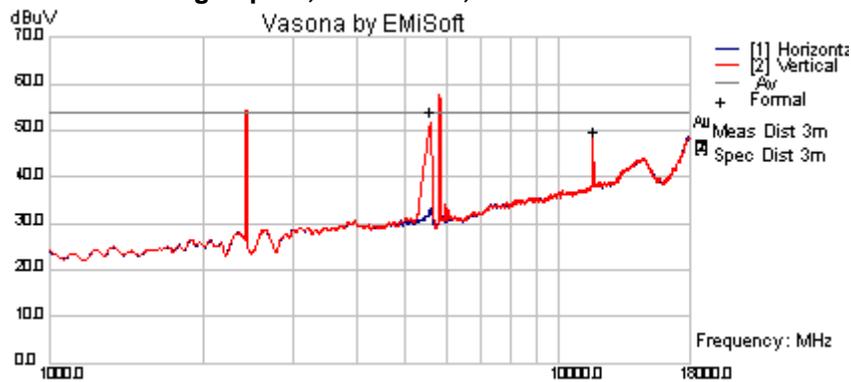
**1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW**



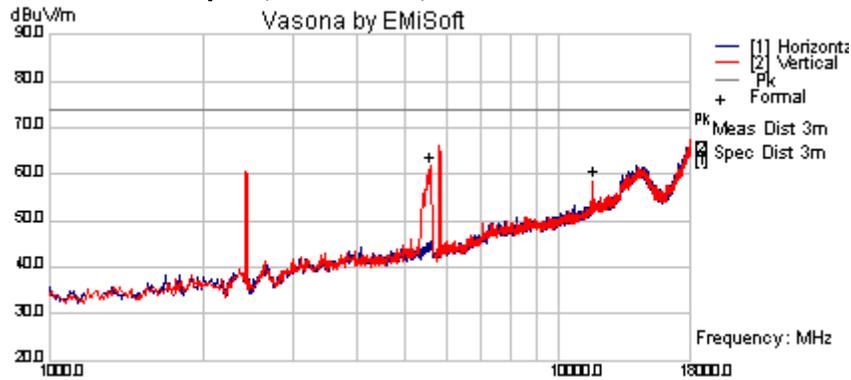


**5825MHz, All Data Rates, All Antennas Co-located with 2437MHz, All Data Rates, All Antennas**

**1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW**



**1-18GHz Peak Spurs, 1MHz RBW, 1MHz VBW**

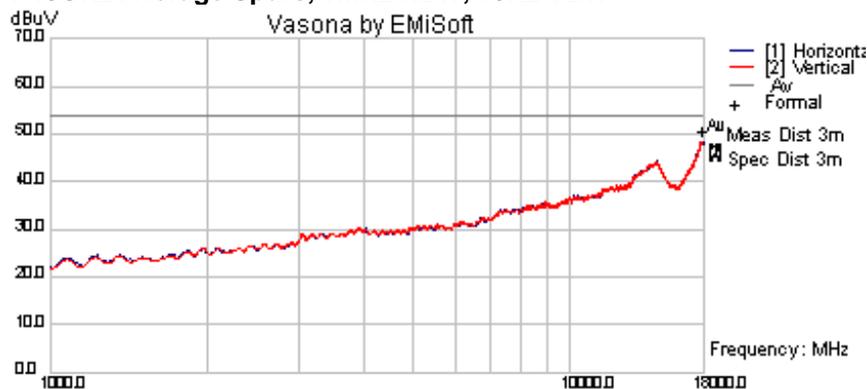




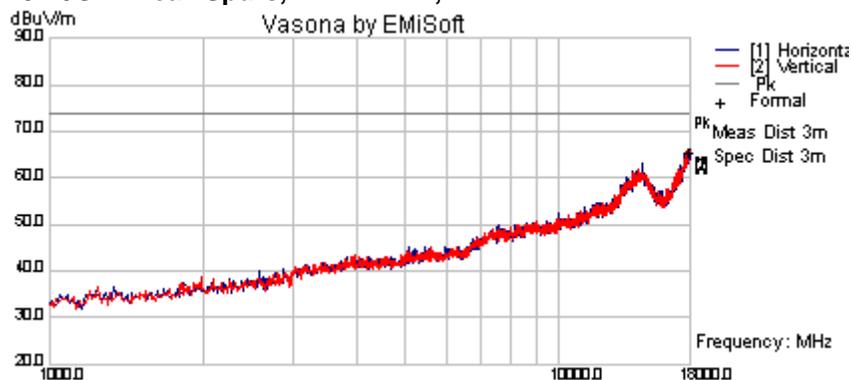
## Radiated Receiver Spurious Emissions

All Transmit Frequencies, All Data Rates, All Antennas

### 1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



### 18-40GHz Peak Spurs, 1MHz RBW, 1MHz VBW





### Maximum Permissible Exposure (MPE) Calculations

Given

$$E = \sqrt{(30 * P * G) / d} \quad \text{and} \quad S = E^2 / 3770$$

where

E=Field Strength in Volts/meter

P=Power in Watts

G=Numeric Antenna Gain

d=Distance in meters

S=Power Density in mW/cm<sup>2</sup>

Combine equations and rearrange the terms to express the distance as a function of the remaining variables:

$$d = \sqrt{((30 * P * G) / (3770 * S))}$$

Changing to units of power in mW and distance in cm, using:

$$P(\text{mW}) = P(\text{W}) / 1000 \quad d(\text{cm}) = 100 * d(\text{m})$$

yields

$$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$$

$$d = 0.282 * \sqrt{(P * G / S)}$$

where

d=Distance in cm

P=Power in mW

G=Numeric Antenna Gain

S=Power Density in mW/cm<sup>2</sup>

Substituting the logarithmic form of power and gain using:

$$P(\text{mW}) = 10^{(P(\text{dBm}) / 10)} \quad G(\text{numeric}) = 10^{(G(\text{dBi}) / 10)}$$

yields

$$d = 0.282 * 10^{((P + G) / 20)} / \sqrt{S} \quad \text{Equation (1)}$$

and

$$s = ((0.282 * 10^{((P + G) / 20)}) / d)^2 \quad \text{Equation (2)}$$

where

d=MPE distance in cm

P=Power in dBm

G=Antenna Gain in dBi

S=Power Density in mW/cm<sup>2</sup>

Equation (1) and the measured peak power is used to calculate the MPE distance. Note that for mobile or fixed location transmitters such as an access point, the minimum separation distance is 20 cm even if the calculations indicate that the MPE distance may be less.

S=1mW/cm<sup>2</sup> maximum. The highest 2.4GHz antenna gain supported is 8 dBi, the highest 4.9GHz antenna gain supported is 6 dBi, and the highest 5 GHz antenna gain is 20 dBi. Using the peak power levels recorded in the test report along with Equation 1 above, the MPE distances are calculated as follows.



Frequency (MHz)	Bit Rate (Mbps)	Power Density (mW/cm <sup>2</sup> )	Peak Transmit Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)	Limit (cm)	Margin (cm)
5745	36	1	28	20	70.84	20	-50.84
5785	36	1	28	20	70.84	20	-50.84
5825	36	1	27	20	63.13	20	-43.13

**MPE Calculations**

To maintain compliance, installations will assure a separation distance of at least 2 meters.

Using Equation 2, the MPE levels (s) at 20 cm are calculated as follows:

Frequency (MHz)	Bit Rate (Mbps)	MPE Distance (cm)	Peak Transmit Power (dBm)	Antenna Gain (dBi)	Power Density (mW/cm <sup>2</sup> )	Limit (mW/cm <sup>2</sup> )	Margin (mW/cm <sup>2</sup> )
2412	11	20	24	8	0.32	1	0.68
2437	11	20	25	8	0.40	1	0.60
2462	11	20	24	8	0.32	1	0.68
2412	36	20	21	8	0.16	1	0.84
2437	36	20	24	8	0.32	1	0.68
2462	36	20	21	8	0.16	1	0.84
4950	36	20	20	6.5	0.09	1	0.91
4980	36	20	20	6.5	0.09	1	0.91
5745	36	20	28	20	12.54	1	-11.54
5785	36	20	28	20	12.54	1	-11.54
5825	36	20	27	20	9.96	1	-8.96

When operating as a dual-band co-located 2.4/5GHz system, the worst case MPE occurs at 2437MHz, 11Mbps, 25dBm power, 8dBi antenna and 5785MHz, 36Mbps, 28dBm power, 20dBi antenna. The MPE in this scenario is  $0.4\text{mW/cm}^2 + 12.54\text{mW/cm}^2 = 12.94\text{mW/cm}^2$ .

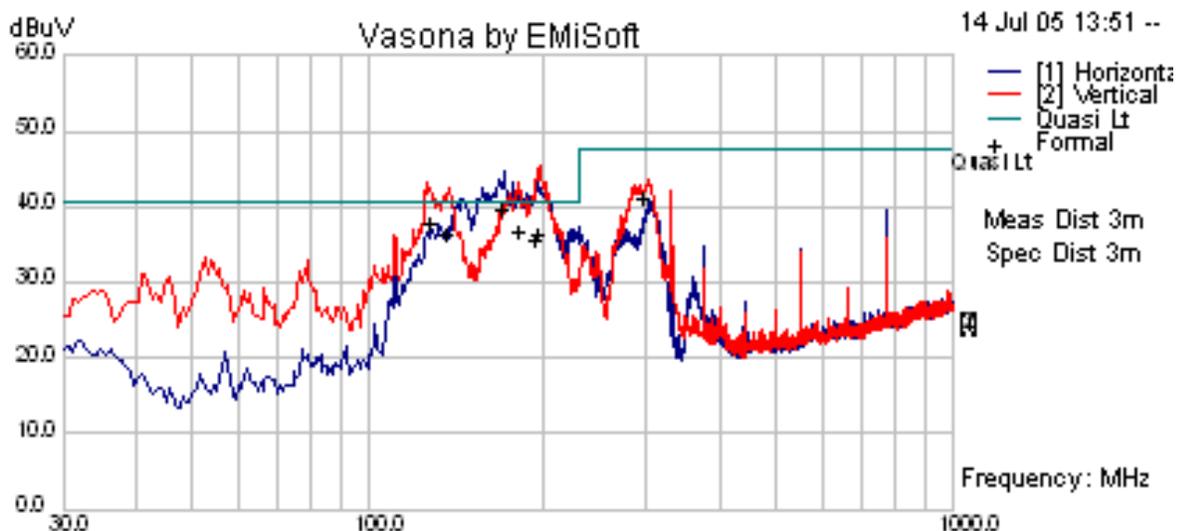
When operating as a dual-band co-located 2.4/4.9GHz system, the worst case MPE occurs at 2437MHz, 11Mbps, 25dBm power, 8dBi antenna and 4950MHz, 36Mbps, 20dBm power, 6.5dBi antenna. The MPE in this scenario is  $0.4\text{mW/cm}^2 + 0.91\text{mW/cm}^2 = 1.31\text{mW/cm}^2$ .



## 30MHz-1GHz Radiated Spurious Emissions

Radiated emissions which fall in the restricted bands, as defined in Sec. 15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a).

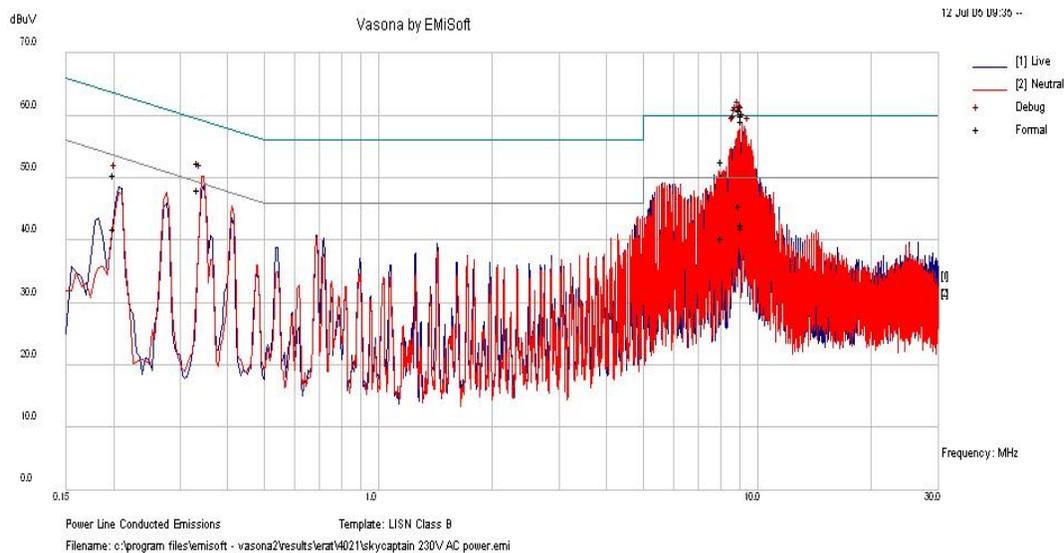
Spur Frequency (MHz)	Spur Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
128.52	36.20	40.5	4.30
136.66	34.75	40.5	5.75
170.71	38.07	40.5	2.43
182.95	35.08	40.5	5.42
194.83	33.93	40.5	6.57
196.18	34.70	40.5	5.80
296.86	39.29	47.5	8.21





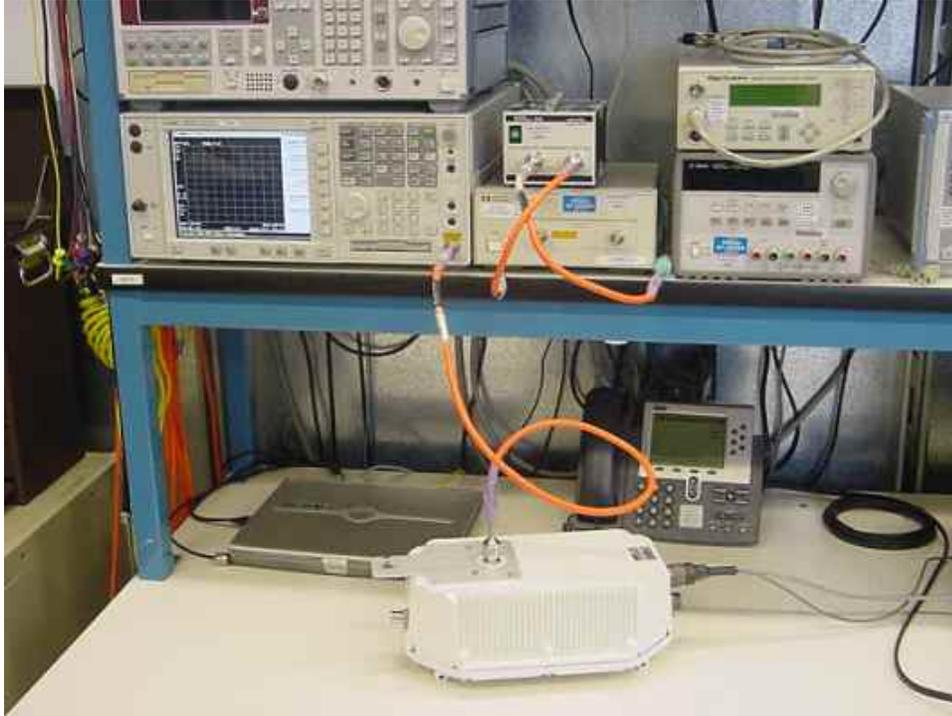
## AC Mains .150-30MHz Conducted Emissions

Frequency (MHz)	Level (dBuV)	Type	Line	Limit dBuV	Margin dB
9.168	57.2	Qp	N	60	2.8
9.302	56.4	Qp	N	60	3.6
9.305	55.6	Qp	L	60	4.4
0.341	44.6	Av	N	49.2	4.6
9.168	41.8	Av	N	50	8.2
0.341	48.8	Qp	N	59.2	10.4
8.217	49	Qp	N	60	11
9.302	38.8	Av	N	50	11.2
9.305	38.4	Av	L	50	11.6
8.217	36.6	Av	N	50	13.4
0.204	38.2	Av	L	53.4	15.2
0.204	46.8	Qp	L	63.4	16.6



## Appendix B: Test Setup Photos

### Conducted Test Configuration



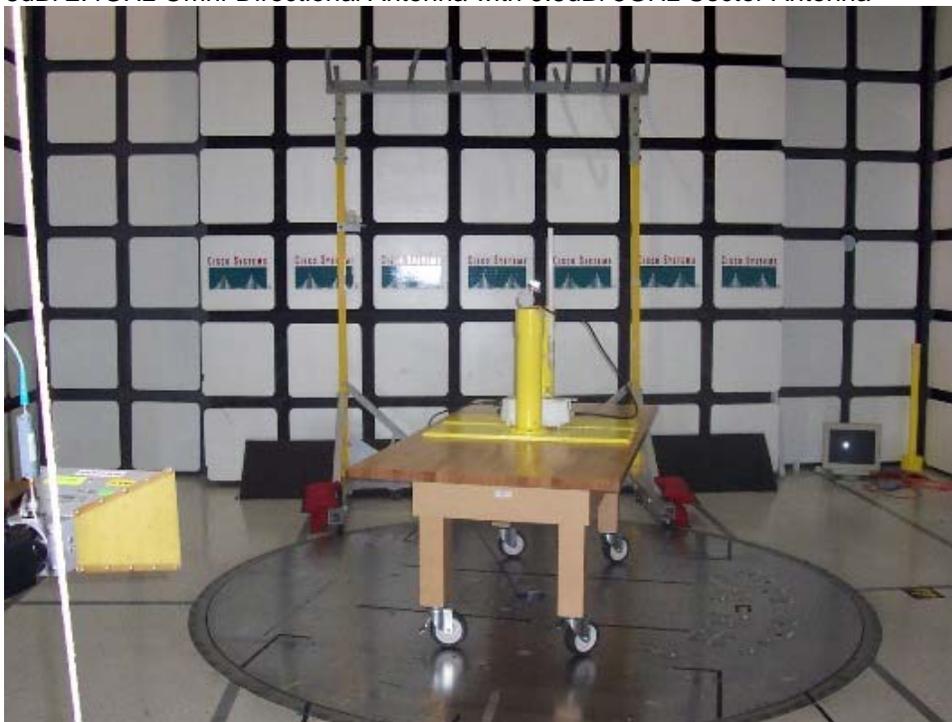
### 5.5dBi 2.4GHz Omni-Directional Antenna with 7.5dBi 5GHz/6dBi 4.9GHz Omni-Directional Antenna



8dBi 2.4GHz Omni-Directional Antenna with 7.5dBi 5GHz/6dBi 4.9GHz Omni-Directional Antenna



8dBi 2.4GHz Omni-Directional Antenna with 9.5dBi 5GHz Sector Antenna



8dBi 2.4GHz Omni-Directional Antenna with 20dBi 5GHz Patch Antenna





## Appendix C: Test Procedures

Test procedures are summarized below

6dB Bandwidth	EDCS # - 422115
26dB Bandwidth	EDCS # - 422115
Average Output Power	EDCS # - 422117
Co-Located Transmitter	EDCS # - 422118
Conducted Spurious Test	EDCS # - 422119
Peak Transmit Power Measurement	EDCS # - 422123
Power Spectral Density	EDCS # - 422113
Peak Excursion Test	EDCS # - 422121
Radiated Band Edge	EDCS # - 422124
Radiated Spurious Test	EDCS # - 422125
Extreme Test Condition	EDCS # - 450056
Equivalent Isotropic Radiated Power	EDCS # - 450047
Frequency Tolerance	EDCS # - 462996
Power per MHz	EDCS # - 463000



**Appendix D: Scope of Accreditation: A2LA certificate number 1178-01**

The scope of accreditation of Cisco Systems, Inc. can be found on the A2LA web page at:

<http://www.a2la2.net/scopepdf/1178-01.pdf>

**Summary of accredited radio testing capabilities:**

San Jose, CA, Building P:	LP0002: 2004 RRL no.2005-25
San Jose, CA, Building N:	LP0002: 2004 RRL no.2005-25
San Jose, CA, Building I:	LP0002: 2004 RRL no. 2005-25
San Jose, CA, Building B:	LP0002: 2004 (conducted measurements only) RRL no.2005-25 (conducted measurement only)



**Appendix E: Test Equipment Used to perform the test**

Equip#	Manufacturer/ Model	Description	Last Cal	Next Due
000513	Gigatronics/ 8542C	Universal Power Meter	21-JAN-2005	21-JAN-2006
000514	Gigatronics/ 80420A	Power Sensor, 0.01-18GHz	11-JAN-2005	11-JAN-2006
000579	Megaphase/ SF26 S1S1 36	RF Coaxial Cable, to 26GHz, 36in	15-FEB-2005	15-FEB-2006
000590	Agilent/ E4448A	Spectrum Analyzer	02-FEB-2005	02-FEB-2006
000599	Weinschel Corp./ 69-20-12	20dB Attenuator	20-DEC-2004	20-DEC-2005
001229	HP/ 85460A	RF Filter Section	06-DEC-2004	06-DEC-2005
001230	HP/ 85462A	EMI Receiver RF Section	06-DEC-2004	06-DEC-2005
003003	HP/ 83731B	Synthesized Signal Generator	21-JAN-2005	21-JAN-2006
004882	EMC Test Systems/ 3115	Double Ridged Guide Horn Antenna	29-APR-2005	29-APR-2006
005691	Miteq/ NSP1800-25-S1	Broadband Preamplifier (1- 18GHz)	07-OCT-2004	07-OCT-2005
007036	HP/ E7401A	Spectrum Analyzer	23-JUL-2004	23-JUL-2005
007221	EMC Test Systems/ 3115	Double Ridged Guide Horn Antenna	Cal Not Required	N/A
008097	Huber + Suhner/ RG-223	RG-233 Cable 9m	29-JUL-2004	29-JUL-2005
008123	Huber + Suhner/ SF106A	1m Sucoflex Cable	03-SEP-2004	03-SEP-2005
008166	HP/ 8491B Opt 010	10dB Attenuator	19-JAN-2005	19-JAN-2006
008002	Fischer Custom Communications/ FCC-450B-2.4-N	Instrumentation Limiter	21-JAN-2005	21-JAN-2006
008197	TTE/ H613-150K-50-21378	Hi Pass Filter - 150KHz cutoff	29-MAR- 2005	29-MAR- 2006
008448	Cisco/ NSA 5m Chamber	NSA 5m Chamber	03-JAN-2005	03-JAN-2006
018719	Rohde & Schwarz/ ESCS 30	EMI Test Receiver, 9kHz- 2.75GHz	13-SEP-2004	13-SEP-2005
019630	Rohde & Schwarz/ ESI 40	EMI Test Receiver, 20Hz - 40GHz	21-OCT-2004	21-OCT- 2005
020666	EMC Test Systems/ 3160-10	Standard Gain Horn Antenna, 26.5-40GHz	Cal Not Required	N/A
020821	Micro-Coax/ UFB142A-1-1572- 200200	RF Coaxial Cable, to 40GHz, 157.2 in	23-SEP-2004	23-SEP-2005
020975	Micro-Coax/ UFB311A-0-1344- 520520	RF Coaxial Cable, to 18GHz, 134.4 in	28-MAR- 2005	28-MAR- 2006
021117	Micro-Coax/ UFB311A-0-2484- 520520	RF Coaxial Cable, to 18GHz, 248.4 in	19-AUG- 2004	19-AUG- 2005



021382	Solar Electronics Company/ 9252-50-24-BNC	LISN	26-APR-2005	26-APR-2006
025654	Micro-Coax/ UFB311A-1-0840-504504	RF Coaxial Cable, to 18GHz, 84 in	28-MAR-2005	28-MAR-2006
025657	Micro-Coax/ UFB311A-1-0840-504504	RF Coaxial Cable, to 18GHz, 84 in	19-AUG-2004	19-AUG-2005
025666	Micro-Coax/ UFB142A-1-0720-200504	RF Coaxial Cable, to 40GHz, 72 in	23-SEP-2004	23-SEP-2005
026860	Cisco/ 1840	18-40GHz EMI Test Head/Verification Fixture	23-SEP-2004	23-SEP-2005
030265	Agilent/ 11713A	Attenuator/Switch Driver	Cal Not Required	N/A
030495	Agilent/ 8761B	SPDT RF Switch, to 18GHz	28-MAR-2005	28-MAR-2006
030560	Micro-Coax/ UFB311A-1-0950-504504	RF Coaxial Cable, to 18GHz	28-MAR-2005	28-MAR-2006
030562	Micro-Coax/ UFB311A-1-0950-504504	RF Coaxial Cable, to 18GHz	19-AUG-2004	19-AUG-2005
030563	Micro-Coax/ UFB311A-1-0950-504504	RF Coaxial Cable, to 18GHz	28-MAR-2005	28-MAR-2006
030569	Micro-Coax/ UFB311A-1-3510-504504	RF Coaxial Cable, to 18GHz	28-MAR-2005	28-MAR-2006
031700	Micro-Tronics/ BRC50705	Notch Filter, SB:5.725-5.875GHz, to 12 GHz	06-OCT-2004	06-OCT-2005
033599	Midwest Microwave/ CSY-NMNM-80-273001	RF Coaxial Cable, 27ft. to 18GHz	09-MAY-2005	09-AUG-2005
033599	Midwest Microwave/ CSY-NMNM-80-273001	RF Coaxial Cable, 27ft. to 18GHz	10-FEB-2005	09-AUG-2005
034064	Micro-Coax/ UFB293C-2-0840-300504	RF Coaxial Cable, 7ft to 18GHz	28-OCT-2004	28-OCT-2005
034075	Schaffner/ RSG 2000	Reference Spectrum Generator, 1-18GHz	12-AUG-2004	12-AUG-2005
034188	Micro-Tronics/ BRC50703-02	Notch Filter, SB:5.150-5.350GHz, to 11GHz	26-APR-2005	26-APR-2006
034189	Micro-Tronics/ BRC50704-02	Notch Filter, SB:5.470-5.725GHz, to 12GHz	26-APR-2005	26-APR-2006
034304	Micro-Tronics/ BRM50702-02	Band Reject Filter	26-APR-2005	26-APR-2006
035040	Micro-Tronics/ HPM50112-02	Hi Pass Filter	26-APR-2005	26-APR-2006
035268	Agilent/ E4440A	Precision Spectrum Analyzer	12-APR-2005	12-APR-2006