



***Test Report No. 8712318676***

***Applicant: Wavion Ltd.***

***Equipment Under Test:  
2.4 GHz Band Outdoor WiFi  
(802.11b/g) access point***

***Model: WS410AD***

***From The Standards Institution  
Of Israel  
Industry Division  
Electronics & Telematics Laboratory  
EMC Section***



***Certificate No.1487-01***



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Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

FCC ID: UGMWS410AD

<b>Applicant:</b>	Wavion Ltd.
<b>Address:</b>	6 Ha'yetsira Street, Yoqne'am-Illit, 20692, Israel
<b>Sample for test selected by:</b>	The customer
<b>The date of test:</b>	April 2007

#### Description of Equipment

**Under Test (EUT):** 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

**Model:** WS410AD

**Manufactured by:** Wavion Ltd.

#### Reference Documents:

- ❖ **CFR 47 FCC:** Rules and Regulations; Part 15. "Radio frequency devices"; Subpart C: "Intentional radiators" (2006).
- ❖ **Test Results:** The EUT was found meeting with the relevant requirements of CFR 47 FCC Part 15 Sections: 15.205, 15.207, 15.209, 15.247.

This Test Report contains 86 Pages  
and may be used only in full.

This Test Report applies only to the specimen tested and may not  
be applied to other specimens of the same product.

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Model: WS410AD

FCC ID: UGMWS410AD

## 1. Applicant information

Company: Wavion Ltd.  
Address :6 Ha'yetsira Street  
P.O.B.: 580  
City: Yoqneam  
Country : Israel

## 2. Test performance

Location: SII EMC Section  
Wavion Ltd.

Purpose of test: Apparatus compliance verification in according with CFR 47 FCC Requirement

Test specification: CFR 47 FCC Part 15 Sections: 15.205, 15.207, 15.209, 15.247

Test	FCC Part 15	Test result
Radiated emissions in restricted bands	Sec.15.205	Complies
Radiated Emission on Radio Unit: spurious	Sec.15.209	Complies
Conducted emission	Sec.15.207	Complies
Radiated emission – general requirements	Sec.15.209	Complies
Minimum bandwidth	Sec. 15.247 (a) (2)	Complies
Maximum peak output power	Sec.15.247 (b)	Complies
Peak power spectral density	Sec.15.247 (d)	Complies
Conducted spurious emissions	Sec.15.247 (c)	Complies



Approved by: Eng. Yuri Rozenberg  
Position: Head of EMC Branch

Electronics &  
Telematics Laboratory  
14 June 2007



Tested by: Albert Herzenshtein  
Position: Test Engineer

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### 3. Scope

This test report contains results measured on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point (FCC ID: UGMWS410AD) according to the relevant requirements of CFR 47 FCC Part 15 Subpart C.

### 4. EUT (equipment under test) description.

#### 4.1. General Description

The WS410AD is a new category of Wi-Fi Access Point designed from the ground up for metro-Wi-Fi deployments. It is based on six antennas and radios and custom-built ASICs, utilizes Wavion's powerful multi-antenna signal processing technologies, and provides significant performance gains to off-the-shelf 802.11 standards-based Wi-Fi clients. The WS410AD Wi-Fi Access Point uses six omni-directional antennas and beam-forming technology in order to provide significant performance gains to off-the-shelf 802.11 standards-based Wi-Fi clients.

The EUT's block diagram is shown in Figure 1.

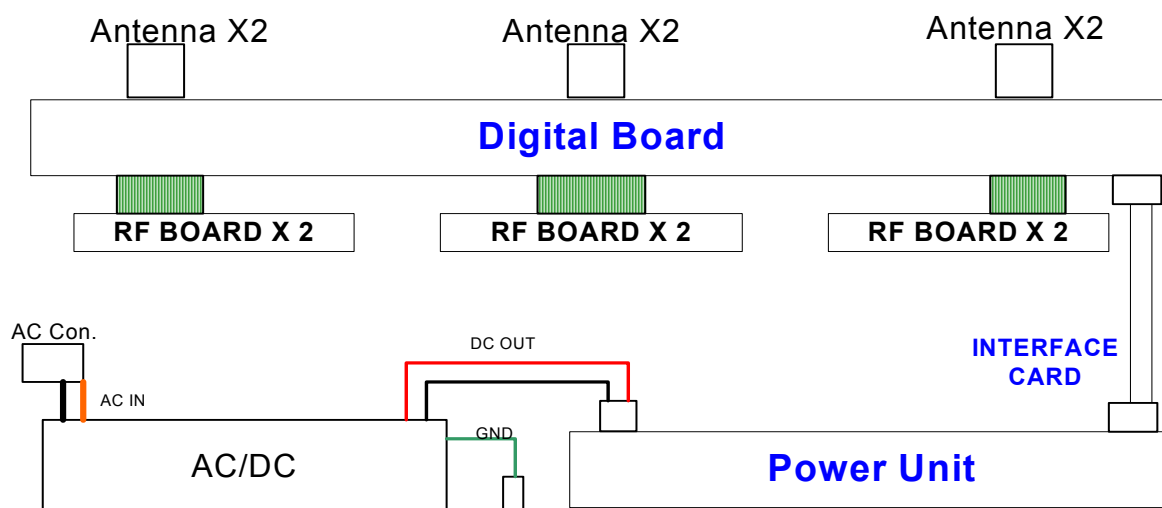


Figure 1. EUT's block diagram

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#### 4.2. EUT's sub-assemblies list.

The EUT ports and lines are detailed in Table 1.

No.	Description	Model	Manufacturer
1	Digital Board	PC00018	Wavion
2	RF Board	Tornado- PC00033	Wavion
3	Interface card	PC00023	Wavion
4	AC/DC	HWS150-48	Nemic Lambda
5	AC Connector	50909	Remke
6	Antenna	SF-245W	Comet
7	Power Unit	PC00019	Wavion

Table 1. Sub-assemblies list

#### 4.3. EUT ports and lines.

The EUT ports and lines are detailed in Table 2.

Port Type	Port Description	Connected from / to	Connector type	Qty.	Cable Type	Cable Length
AC Power	AC inlet	Wall outlet/Power TAP-inlet	Standard	1	Unshielded	20fit
Data	Data/HPoE	HPoE injector	RJ-45 shielded	1	CAT-5e	Up to 100m
Data	Data/PoE	PD-Client	RJ-45 shielded	1	CAT-5e	Up to 100m

Table 2. The EUT ports and lines

#### 4.4. Potential emission source:

The potential emission sources are detailed in Table 3.

Frequency	Location	Remarks
40 MHz	On board	Crystal Oscillator with PLL

Table 3. Potential emission sources

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#### 4.5. EUT technical characteristic

Type of equipment							
Stand-alone (Equipment with or without its own control provisions)							
Intended use			Condition of use				
Fixed			Always at a distance more than 2 m from all people				
Assigned frequency range			2400MHz to 2483.5MHz				
Operating frequency range			2412MHz to 2462MHz (WLAN channels 1 to 11)				
RF channel spacing			5MHz				
Maximum rated output power			At transmitter 50 Ω RF output connector		22dBm@2412MHz		
					22dBm@2437MHz		
					21.5dBm@2462MHz / 6Mbps only		
					22dBm@2462MHz /all rates except 6Mbps		
Is transmitter output power variable?				Yes	minimum RF power		4dBm
					maximum RF power		22dBm
					Antenna connection		
	unique coupling	V (N-Type)	standard connector		integral		with temporary RF connector
						V	without temporary RF connector
External antenna/s technical characteristics							
Type		Manufacturer		Model number		Gain	
Omni-directional		Comet		SF-245W		7.4dBi	
Omni-directional		MTI		MT-342015/NV/A		7.4dBi	
Transmitter 99% power bandwidth				12000kHz to 16000kHz			
Transmitter aggregate data rate/s (min-maximum)				1Mbps to 54Mbps			
Type of modulation				OFDM, DSSS, CCK			
Type of multiplexing				CSMA/CA			
Modulating test signal (baseband)				Random data			
Maximum transmitter duty cycle in normal use			90.0%	Tx ON time	...X....msec	Period	...X....msec
Transmitter duty cycle supplied for test			100%	Tx ON time	...X....msec	Period	...X....msec
Transmitter power source							
V	DC	Nominal rated voltage		HPoE 58VDC			
V	AC mains	Nominal rated voltage		90-240VAC	Frequency: 50/60Hz		
Spread spectrum technique used				Frequency hopping (FHSS)			V
				Digital transmission system (DTS)			
				Hybrid			
Spread spectrum parameters for transmitters tested per FCC 15.247 only							
DSSS	chip sequence length			11bits			
	spectrum width			12MHz			



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## 5. Test configuration:

For Radiated emission measurements per sec. 15.209 requirements the EUT was configured for tests as shown in Figure 2.

For transmitter measurements per sec. 15.247 requirements the EUT was configured for tests as shown in Figure 3.

For Radiated emission measurements per sec. 15.205 requirements the Radio unit was tested with integral antenna, detailed in Table 4.

Mnuf.	Freq. Range GHz	Gain dBi	Model	Type
Comet	2.4-2.4835	7.4	SF-245W	Omni-directional

Table 4. Details of antenna used in WS410AD.

RF output terminated by 50Ω

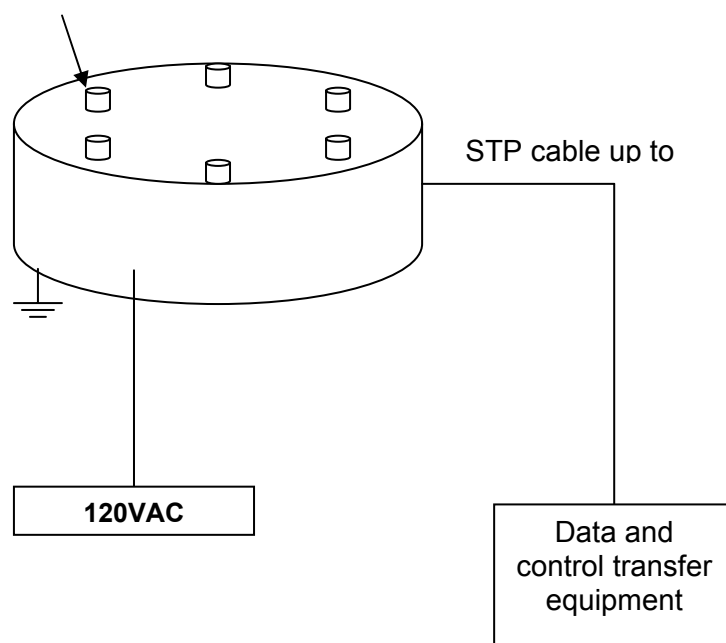


Figure 2. Radiated emission test setup



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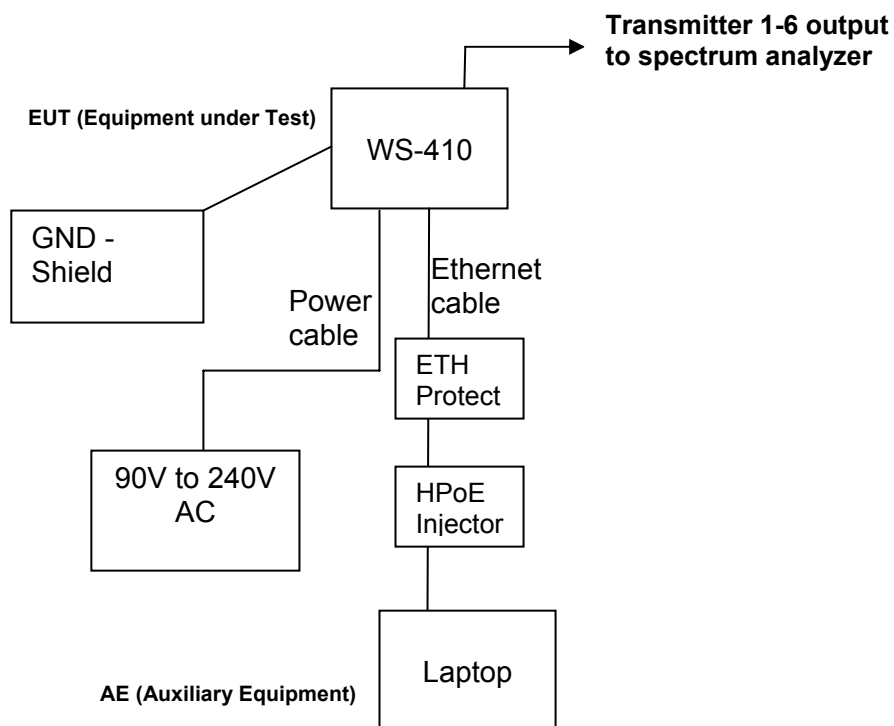


Figure 3. Transmitter measurements test setup

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Limit for power density for general population/uncontrolled exposure is  $1 \text{ mW/cm}^2$ .

The power density  $P \text{ (mW/cm}^2\text{)} = P_t / 4\pi r^2$ .

Where:

$P_t$  - The transmitted power (EIRP) (mW)

$P_t$ - the transmitted power which is equal to the output power 22 dBm plus maximum antenna gain – 7.4 dBi

$r$  - The distance from the unit. (cm)

The  $1(\text{mW/cm}^2)$  limit can be calculated from the above based on the following data:

The maximum EIRP for each transmit output = 29.4 dBm = 871 mW

$r = \sqrt{871/4\pi} = 8.3 \text{ cm}$

For aggregate  $P_t$ - the transmitted power which is equal to the output power 26.9 dBm plus maximum directional antenna gain – 15.2 dBi

The maximum aggregate EIRP = 42.1 dBm = 16218 mW:

$r = \sqrt{16218/4\pi} = 35.9 \text{ cm}$

The allowed distance “ $r$ ”, where RF exposure limits may not be exceeded, is 35.9 cm from the unit antenna main lobe.

The EUT with the attached antenna are mounted only outside the building on the high level pole or wall, which are above general public, see the manufacturer instructions for installation provided in attached documentation.

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## 6. Test specification, Methods and Procedures

### Test Specification:

- ❖ CFR 47 FCC: Rules and Regulations; Part 15. "Radio frequency devices";  
Subpart C: "Intentional radiators" (2006).

### Methods and Procedures:

- ❖ ANSI C63/4/2003: "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz".

## 7. Measurements, examinations and derived results

### 7.1. Location of the Test Site:

The tests were conducted in the EMC laboratory of the Standards Institution of Israel in Tel-Aviv, in Wavion's laboratory and at open test site located at Kibbutz Native Halamed Hai in Emek HaEla, Israel.

### 7.2. Normal test condition:

Temperature: 22 °C  
Humidity: 50 %

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### 7.3. Conducted emission test (per Section 15.207):

#### 7.3.1. Requirements:

The EUTs conducted emission within the band 150 kHz to 30 MHz shall not exceed value required in section 15.207 (a).

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

\*Decreases with the logarithm of the frequency.

#### 7.3.2. Test procedure:

Each EUT was placed on a non-metallic table in a shielded chamber at a height of 80 cm from the floor and 40 cm from the nearest wall.

The EUT was operated to transmitting through the customer software.

First, initial scans were performed in normal (transmitting) mode of operation for carrier (channel) frequency at low, middle and the high of the 2.412 - 2.462 GHz frequency range under 4 data transfer bit rates. The worst results from all measurements (2412MHz frequency, 6Mbps bit rate) are presented at the plots 1 and 2.

Test equipment (EMI receiver) setup was as follow:

##### Initial scan:

Detector type	Peak
Mode	Max hold
Bandwidth	9 kHz
Step size	Continuous sweep
Sweep time	>100 msec

##### Measurements

Detector type	Quasi-peak, Avg (CISPR)
Bandwidth	9 kHz
Measurement time	200 seconds/MHz
Observation	>15 seconds

#### 7.3.3. Test results:

The test results were found complies with relevant standard requirements.

Test results are shown in Plots #1, 2.

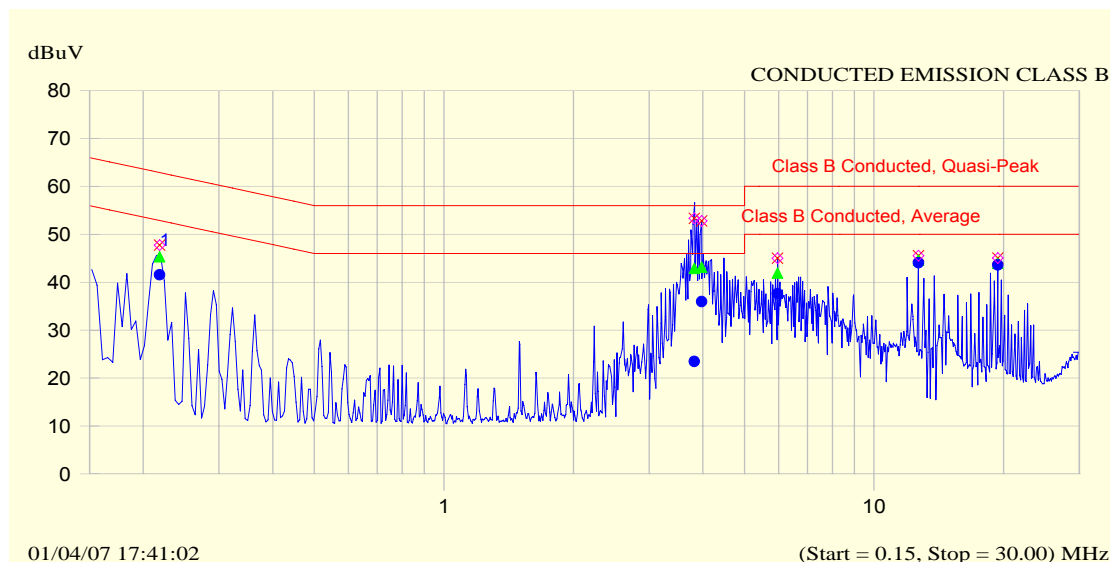
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Frequency	Peak	QP	QP Limit	QP-QP Limit	Avg	AVG-Limit	Avg-Avg Limit
MHz	dBuV	dBuV	dBuV	dB	dBuV	dBuV	dB
0.218	47.7	45.3	62.9	-17.6	41.5	52.9	-11.4
3.823	53.3	42.9	56.0	-13.1	23.5	46.0	-22.5
3.975	52.8	43.2	56.0	-12.8	36.0	46.0	-10.0
5.966	45.0	41.9	60.0	-18.1	37.6	50.0	-12.4
12.679	45.5	44.6	60.0	-15.4	44.1	50.0	-5.9
19.388	45.0	43.9	60.0	-16.1	43.6	50.0	-6.4

**Plot # 1. Conducted emissions measurement result  
on 120 VAC power line: phase**

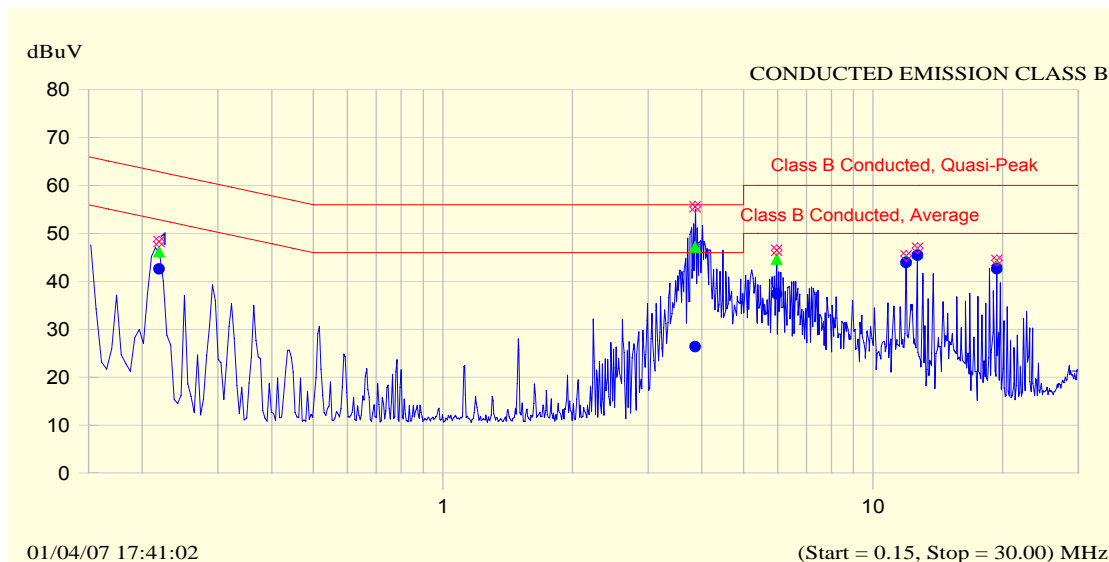
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Frequency	Peak	QP	QP Limit	QP-QP Limit	Avg	AVG-Limit	Avg-Avg Limit
MHz	dBuV	dBuV	dBuV	dB	dBuV	dBuV	dB
0.219	48.3	46.2	62.9	-16.7	42.6	52.9	-10.3
3.860	55.6	47.2	56.0	-8.8	26.4	46.0	-19.6
5.968	46.5	44.7	60.0	-15.3	37.4	50.0	-12.6
11.934	45.3	44.5	60.0	-15.5	43.9	50.0	-6.1
12.678	46.9	45.9	60.0	-14.1	45.4	50.0	-4.6
19.391	44.4	43.2	60.0	-16.8	42.6	50.0	-7.4

**Plot # 2. Conducted emissions measurement result  
on 120 VAC power line: neutral**

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**7.4. Radiated emission test, general requirements (per section 15.209):****7.4.1. Requirements:**

The EUT's radiated emission shall not exceed value required in section 15.209.

**7.4.2. Test description:**

The measurements were performed at the Open Area Test Site.

The test configuration is shown in Fig.2.

The EUT was arranged on a non-metallic table 0.8 m placed on the turn-table.

The measurements were performed at a 10 m measurement distance.

The Biconilog 30 MHz-2 GHz antenna was used.

The frequency range was investigated from 30 MHz to 2 GHz.

The measurements were performed at each frequency at which the signal was 20 dB below the limit or less.

The level were maximized by initially rotating turntable through 360°, varying the antenna height between 1 m and 4 m, rerouting EUT cables and changing antenna polarization from vertical to horizontal. The measuring equipment settings were:

**Initial scan:**

Detector type	Peak
Mode	Max hold
Bandwidth	120 kHz
Step size	Continuous sweep
Sweep time	>1 seconds/MHz

**Measurements:**

Detector type	Quasi-peak (CISPR 16)
Bandwidth	120 kHz
Measurement time	20 seconds/MHz
Observation	>15 seconds

**7.4.3. Radiated emission test results:**

The test results were found complies with relevant standard requirements.

Test results are presented in Table 5.



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**Table 5. Radiated emission test results**  
**FCC Part 15 section 15.209**

Frequency (MHz)	Turn- table Angle (°)	Antenna Polariz.	Antenna Height (m)	Emission Level Note 1 (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin Note 2 (dB)	Results
69.35	251	V	120	25.1	40	14.9	Complies
85.22	101	V	124	29.3	40	10.7	Complies
108.5	235	V	124	31.3	43.5	12.2	Complies
141.1	177	V	120	34.7	43.5	8.8	Complies
160	76	V	122	37.4	43.5	6.1	Complies
213.8	88	V	140	30.1	43.5	13.4	Complies
240	278	V	121	37.5	46	8.5	Complies
273.3	350	V	268	38.1	46	7.9	Complies
399.84	127	H	359	37.8	46	8.2	Complies

Note 1: Emission level = E Reading (dBμV) + Cable loss (dB) + Antenna Factor (dB/m) + 10 dB

Where 10 dB is an extrapolation to 3m distance factor.

For Cable Loss and Antenna Factor refer to Appendix 2.

Note 2: Margin (dB) = Limit (dBμV/m) – Emission level (dBμV/m)

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## 7.5. Radiated emission test on Radio Unit – spurious (per Section 15.209):

### 7.5.1. Requirements:

The levels of any unwanted emission shall not exceed value required in section 15.209.

### 7.5.2. EUT configuration:

The radio unit was tested with Omni-directional antenna model SF-245W.

### 7.5.3. Test procedure:

The measurements were performed in the anechoic chamber.

The EUT was arranged on a non-metallic table 0.8 m placed on the turntable.

Measuring antennas used: Up to 18 GHz - Double Ridge EMCO model 3115. Above 18 GHz - Antenna SHF-EHF Horn 15-40 GHz Schwarzbeck model BBHA 9170.

Cable loss (in dB) is included in SA measurement setup.

The emission levels of the EUT more than 20 dB lower than the specified limit were not recorded in the tables. For the test results refer to relevant Plots.

Test results found in 30 – 2000 MHz are brought in section 7.4 of this test report.

Antenna height = 1 m.

Polarization: Vertical/Horizontal

Measurement distance = 3m.

The frequency range was investigated up to 26 GHz.

The measurements were performed in vertical and horizontal polarization, the maximum reading recorded.

Measuring detector function and bandwidths:

Detector type	Peak
Resolution bandwidth	1MHz
Video bandwidth	1 MHz
Detector type	Average
Resolution bandwidth	1MHz
Video bandwidth	3 kHz

### 7.5.4. Radiated emission test results and calculation ratio:

The test results are shown in Table 6.

The emission level was calculated as:

E Reading (dB $\mu$ V) + measuring cable loss (dB) + measuring antenna factor (dB/m)

For measuring antenna factor refer to Appendix 2.

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**Table 6. Spurious emissions test results**

**Antenna P/N: SF-245W**

Frequency (GHz)	Emission Level (dBμV/m)		Limit @ 3m (dBμV/m)		Margin (dB)		Results
	Average	Peak	Average	Peak	Average	Peak	
LOW 2.412 GHz							
4.824	Noise floor	Noise floor	54	74	10 dB at least	10 dB at least	Complies
12.06	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies
14.47	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies
19.3	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies
MIDDLE 2.437 GHz							
4.874	Noise floor	Noise floor	54	74	10 dB at least	10 dB at least	Complies
7.311	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies
12.19	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies
19.5	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies
HIGH 2.462 GHz							
4.924	Noise floor	Noise floor	54	74	10 dB at least	10 dB at least	Complies
7.386	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies
12.1	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies
19.7	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies
22.16	Noise floor	Noise floor			10 dB at least	10 dB at least	Complies

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**7.6. Radiated emission test on Radio Unit - restricted bands (per Section 15.205):****7.6.1. Requirements:**

Radiated emission in restricted bands should meet the requirements sec. 15.205.

The following frequency bands should be measured:

Operating Frequency Range 2.412 – 2.462 GHz

**7.6.2. EUT configuration:**

The radio unit was tested with all six Omni-directional antennas (model SF-245W) connected to EUT, as it shown on the photos 3-4.

**7.6.3. Test procedure:**

The measurements were performed in the anechoic chamber.

The EUT was arranged on a non-metallic table 0.8 m placed on the turntable.

Measuring antennas used: Double Ridge EMCO model 3115.

Cable loss (in dB) is included in SA measurement calculation.

First, initial scans were performed in normal (transmitting) mode of operation for carrier (channel) frequency at the low and the high of the 2412 - 2462 MHz frequency range under 2 data transfer bit rates. The Output Power (22dBm for the 2412MHz frequency and 22dBm/1Mbps-21.5dBm/6 Mbps for the 2462MHz frequency) was adjusted from the data and control transfer equipment with the system integrator access only (following to Important Safety Instruction of Installation Guide). The worst results from all measurements (Low band edge frequency-2390MHz frequency, and High band edge frequency-2483.5MHz) are presented in summary table of clause 7.6.4 and at the plots 3-18.

Antenna height = 1 m.

Measurement distance = 3m.

Measuring detector function and bandwidths:

Detector type	Peak	Average
RBW	1MHz	1MHz
VBW	1 MHz	30 Hz

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#### 7.6.4. Test results and calculation ratio:

The test results are shown in Plots - as detailed in Table below:

Band edge Freq. MHz	Pol V/H	Rate, Mbps	Read Pk, dBμV	Read Avg, dBμV	AF, dB	Peak, dBμV/m	Avg, dBμV/m	Peak Limit, dB(μV/m)	Avg Limit, dB(μV/m)	Peak Margin dB	Avg Margin dB	Verdict	Plot Number
<b>Transmitting on Low (2.412GHz) frequency.</b>													
2390	V	1	31.98	22.16	30	61.98	52.16	74	54	12.02	1.84	Pass	3,4
2390	H	1	31.68	16.25	30	61.68	46.25	74	54	12.32	7.75	Pass	5,6
2390	V	6	41.26	23.35	30	71.26	53.35	74	54	2.74	0.65	Pass	7,8
2390	H	6	37.17	16.68	30	67.17	46.68	74	54	6.83	7.32	Pass	9,10
<b>Transmitting on High (2.462GHz) frequency.</b>													
2483.5	V	1	30.05	20.59	30	60.05	50.59	74	54	13.95	3.41	Pass	11,12
2483.5	H	1	29.3	20.34	30	59.3	50.34	74	54	14.7	3.66	Pass	13,14
2483.5	V	6	38.81	23.45	30	68.81	53.45	74	54	5.19	0.55	Pass	15,16
2483.5	H	6	31.3	15.07	30	61.3	45.07	74	54	12.7	8.93	Pass	17,18

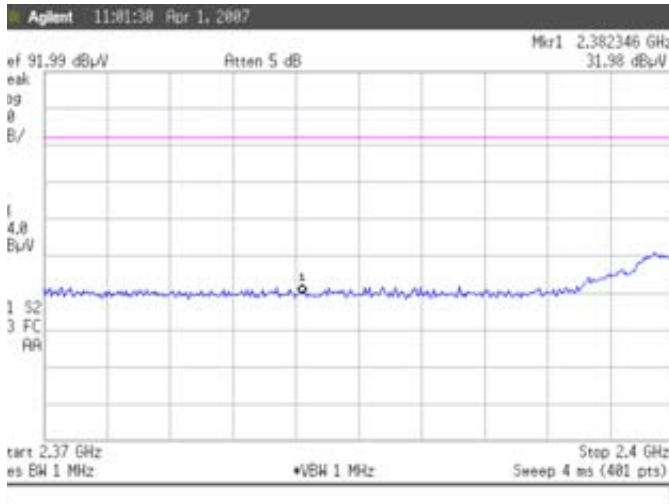
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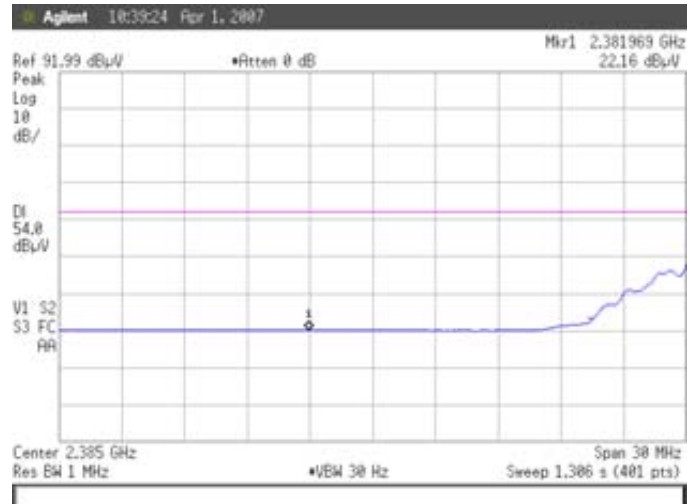
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

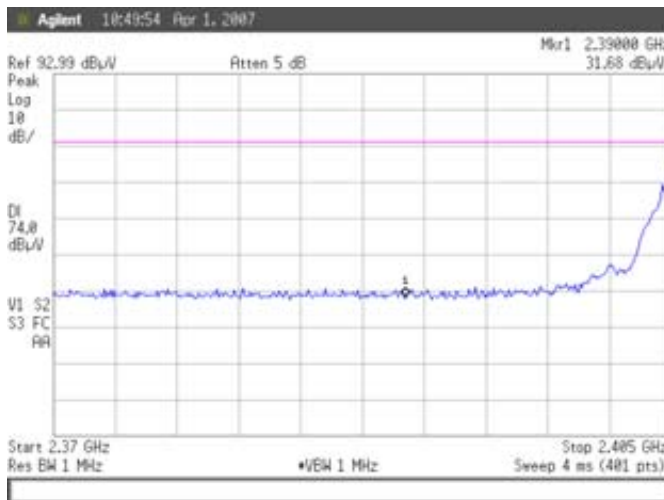
FCC ID: UGMWS410AD



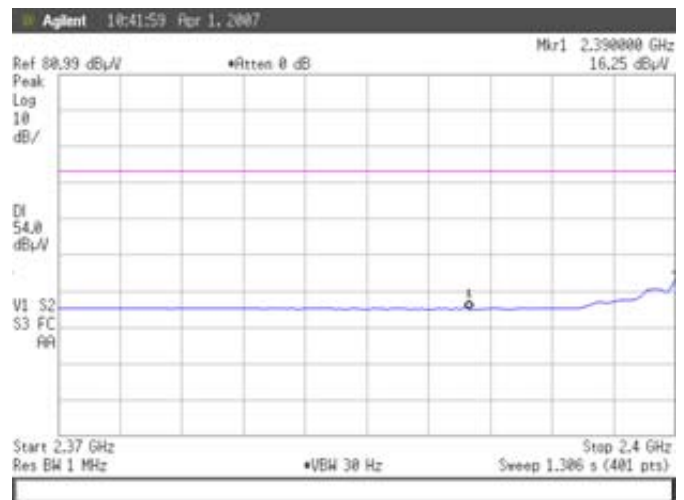
Plot # 3. Low frequency 1Mbps rate.  
802.11b;Peak;Vertical.



Plot # 4. Low frequency 1Mbps rate.  
802.11b;AVG;Vertical.



Plot # 5. Low frequency 1Mbps rate.  
802.11b;Peak; Horizontal.



Plot # 6. Low frequency 1Mbps rate.  
802.11b;AVG; Horizontal.



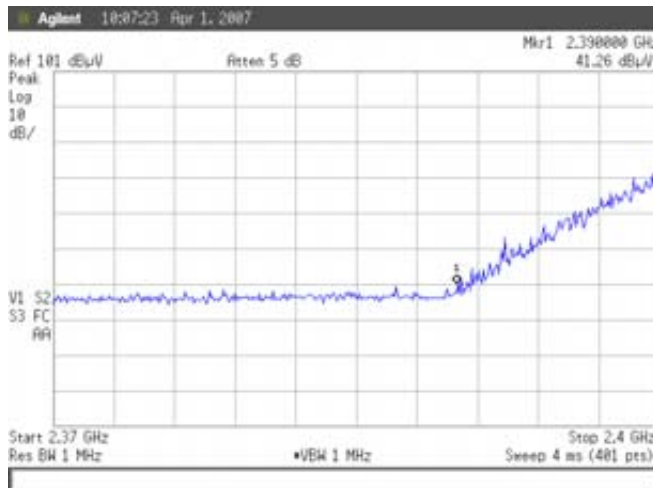
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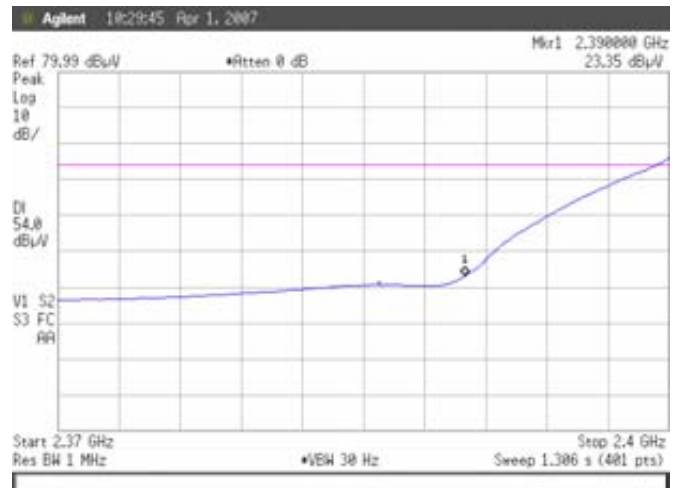
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

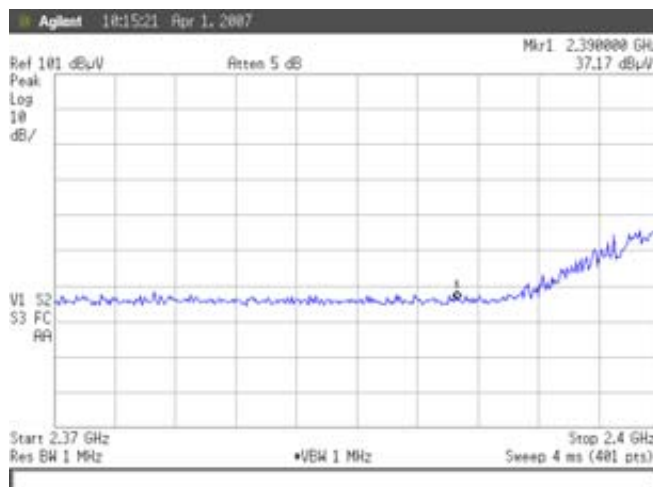
FCC ID: UGMWS410AD



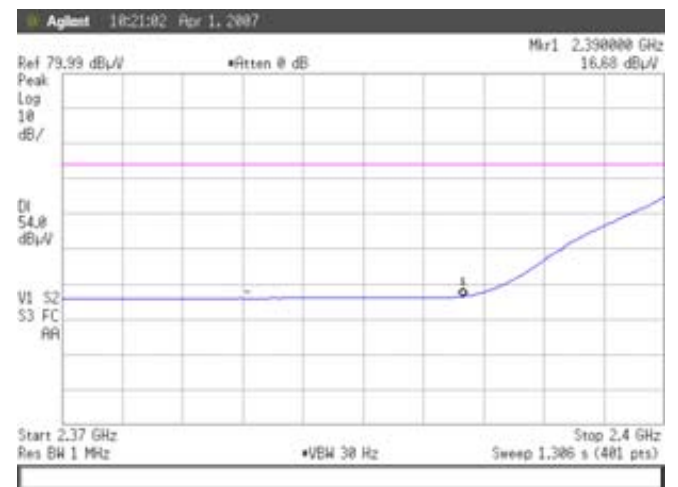
Plot # 7. Low frequency 6Mbps rate.  
802.11g; Peak; Vertical.



Plot # 8. Low frequency 6Mbps rate.  
802.11g; AVG; Vertical.



Plot # 9. Low frequency 6Mbps rate.  
802.11g; Peak; Horizontal.



Plot # 10. Low frequency 6Mbps rate.  
802.11g; AVG; Horizontal.



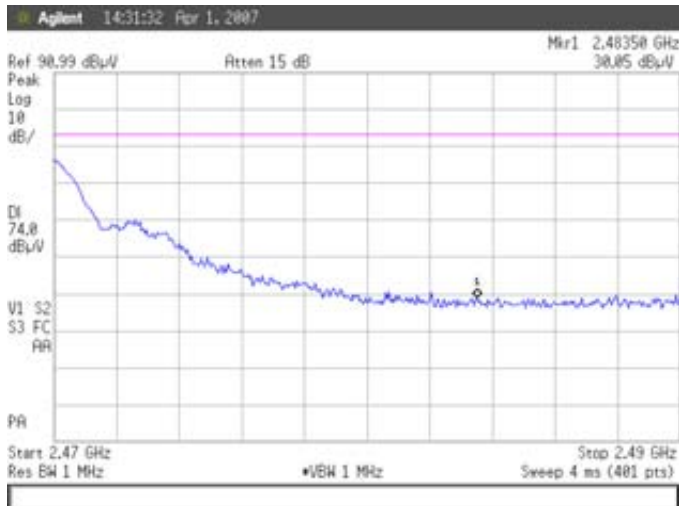
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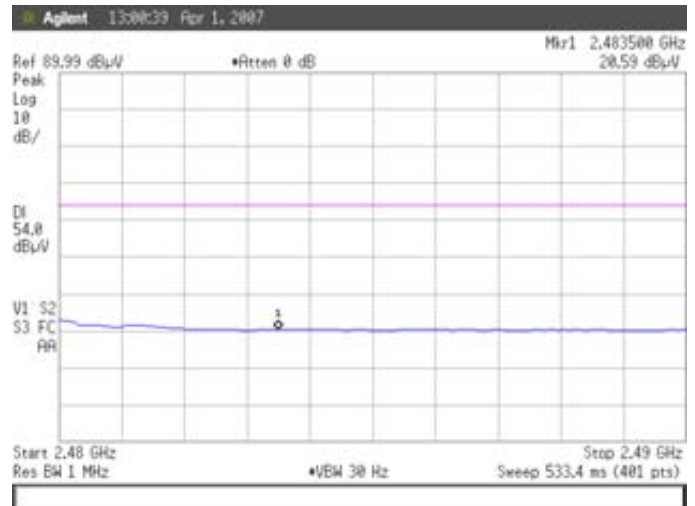
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Model: WS410AD

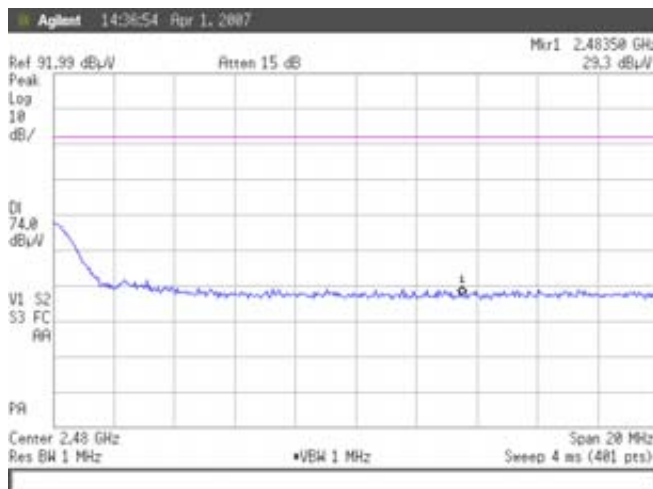
FCC ID: UGMWS410AD



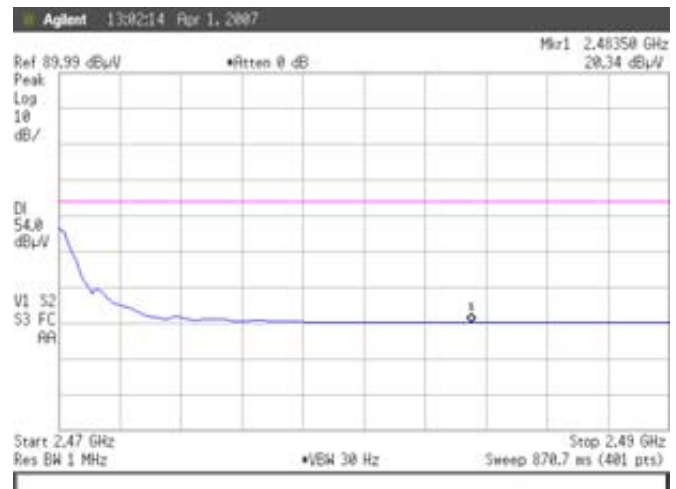
Plot # 11. High frequency 1Mbps rate. 802.11b; Peak; Vertical.



Plot # 12. High frequency 1Mbps rate. 802.11b; AVG; Vertical.



Plot # 13. High frequency 1Mbps rate. 802.11b; Peak; Horizontal.



Plot # 14. High frequency 1Mbps rate. 802.11b; AVG; Horizontal.

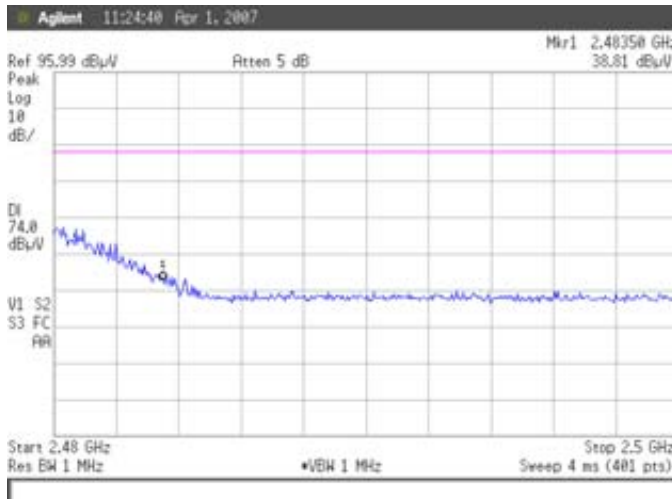
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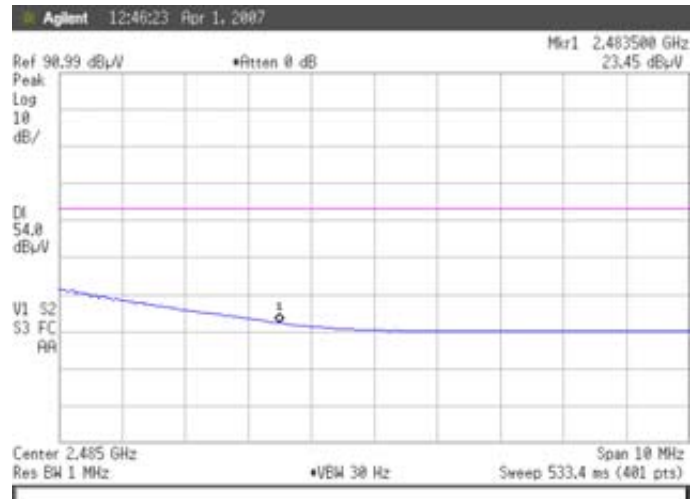
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

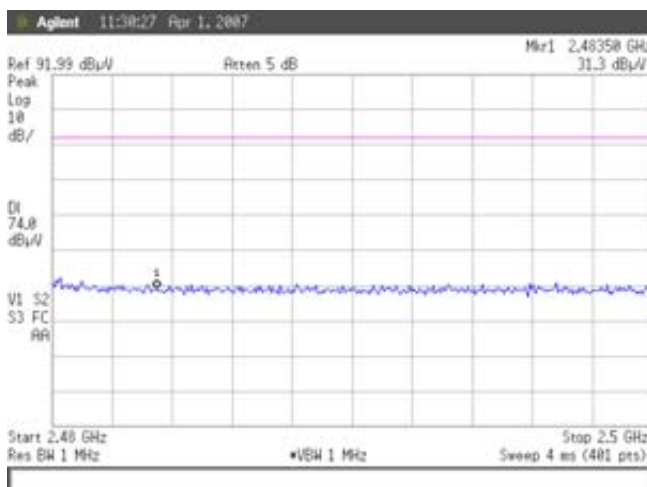
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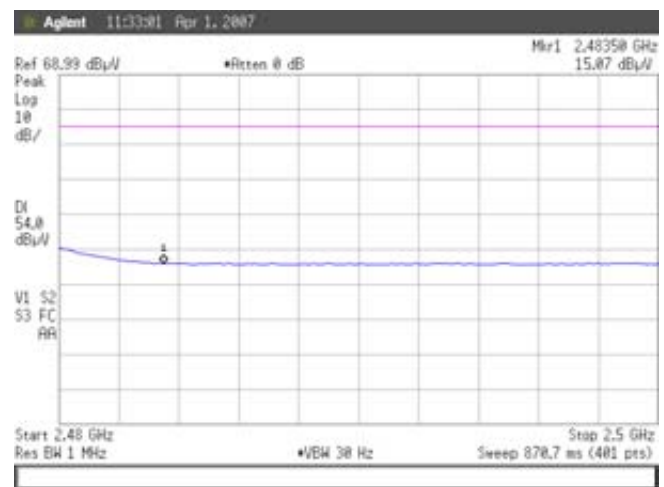
Plot # 15. High frequency 6Mbps rate.  
802.11g; Peak; Vertical.



Plot # 16. High frequency 6Mbps rate.  
802.11g; AVG; Vertical.



Plot # 17. High frequency 6Mbps rate.  
802.11g; Peak; Horizontal.



Plot # 18. High frequency 6Mbps rate.  
802.11g; AVG; Horizontal.

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## 8. Transmitter characteristics.

### 8.1. Minimum bandwidth

#### 8.1.1. Requirements:

The minimum 6dB bandwidth shall be at least 500 KHz as required in sec. 15.247 (a)(2).

#### 8.1.2. Test procedure:

The measurements were performed in normal (transmitting) mode of operation for carrier (channel) frequency at low, middle and the high of the 2.412 - 2.462 GHz frequency range under 2 data transfer bit rates, that reflect to the worst test results.

The EUT RF output was connected to the Spectrum Analyzer accounted with cable loss in SA settings.

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.

#### 8.1.3. Test results:

The summaries of minimum bandwidth measurements are shown in Table 8.

The minimum measured bandwidth for all configurations is 9038 kHz that is comply with standard required bandwidth.

Frequency MHz	Rate Mbps	Modulation Mode	6dB Bandwidth [kHz]	Minimum Limit [kHz]	Verdict	Plot number
2412	1	802.11b	9503	500	Pass	19
	6	802.11g	15721	500	Pass	20
2437	1	802.11b	9038	500	Pass	21
	6	802.11g	15865	500	Pass	22
2462	1	802.11b	9503	500	Pass	23
	6	802.11g	15625	500	Pass	24

Table 7. 6dB bandwidth results

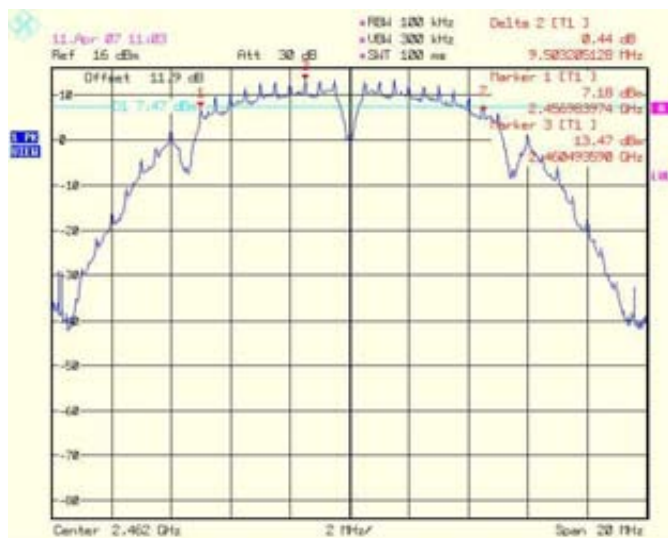
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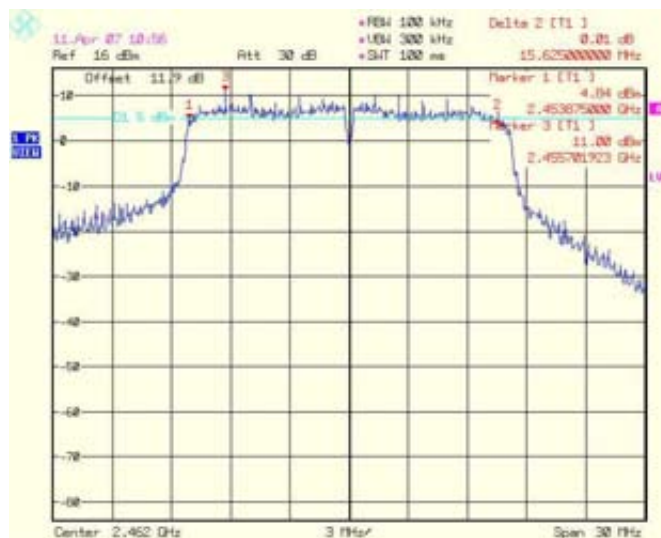
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

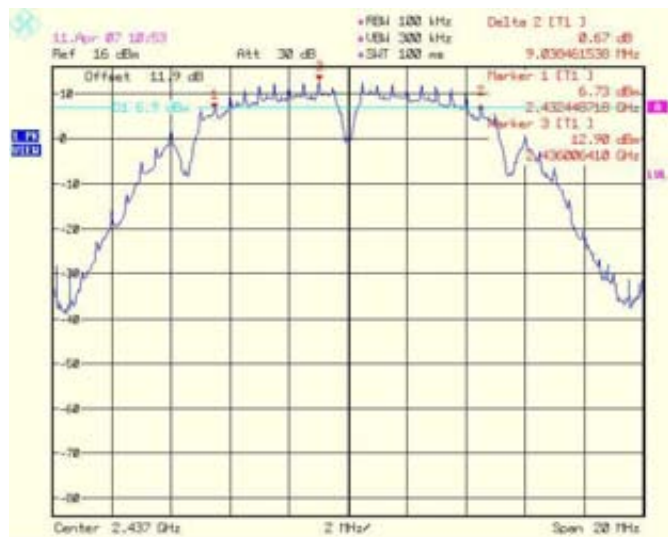
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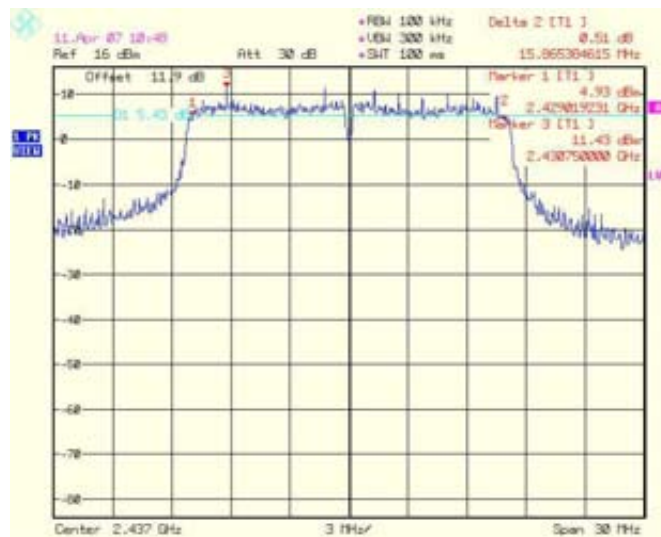
Plot # 19. 6 dB Bandwidth. High frequency.  
1Mbps rate.



Plot # 20. 6 dB Bandwidth. High frequency.  
6Mbps rate.



Plot # 21. 6 dB Bandwidth. Middle frequency.  
1Mbps rate.



Plot # 22. 6 dB Bandwidth. Middle frequency.  
6Mbps rate.



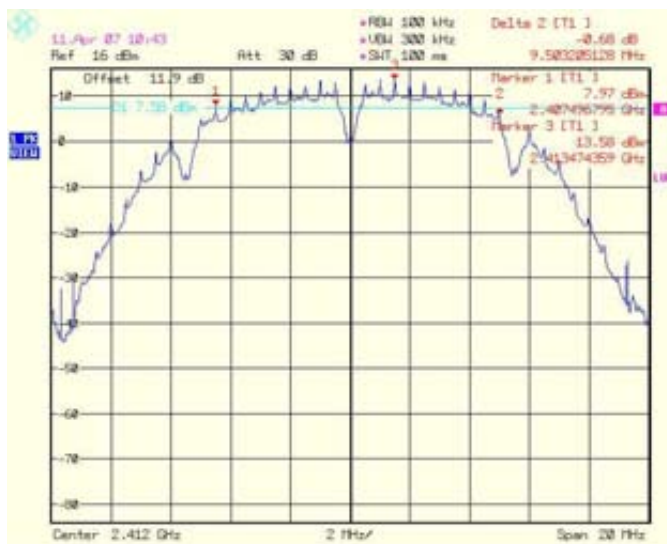
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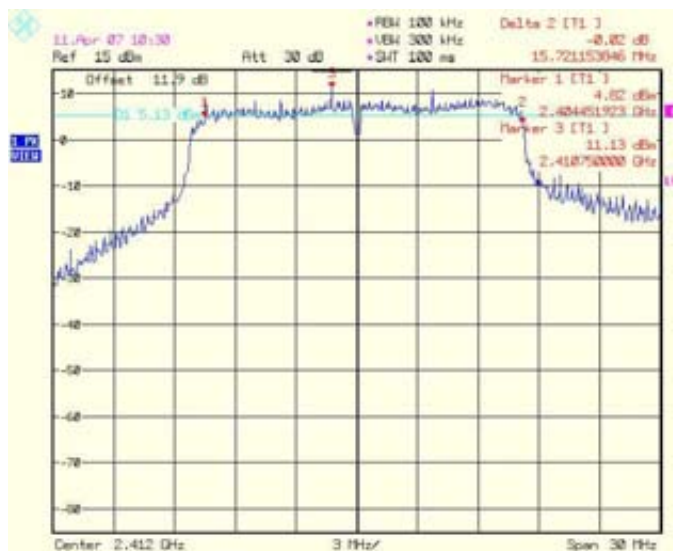
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

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Plot # 23. 6 dB Bandwidth. Low frequency.  
1Mbps rate.



Plot # 24. 6 dB Bandwidth. Low frequency.  
6Mbps rate.

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## 8.2. Maximum peak output power

### 8.2.1. Requirements:

The maximum peak output power shall not exceed 1 Watt as required in sec. 15.247 (b). 15.247 (b) (4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

- The antenna element gain is 7.4 dBi.
- The maximum directional antenna gain is  $7.4 + 10 \cdot \log_{10}(6) = 15.2$  dBi.
- The maximum peak output limit is 30 dBm –  $(15.2 - 6)/3 = 26.9$  dBm.
- The maximum peak output limit for each transmit output for each beam is  $26.9 - 10 \cdot \log_{10}(6) = 19.1$  dBm.
- The maximum peak output limit for each transmit output for 4 beams is  $19.1 + 10 \cdot \log_{10}(4) = 25.1$  dBm.
- The maximum Combined Output Peak Power (for 1 beam mode) limit is 26.9 dBm.
- The maximum Combined Output Peak Power (for 4 beams mode) limit is  $26.9 \text{ dBm} + 8 \text{ dB} = 34.9 \text{ dBm}$ .

### 8.2.2. Test procedure:

The measurements were performed in normal (transmitting) mode of operation for carrier (channel) frequency at low, middle and the high of the 2.412 - 2.462 GHz frequency range at each transmit output under 2 data transfer bit rates that reflect to the worst test results. The tests were performed for 1 beam and for 4 beams in accordance with the limits presented in 8.2.1. Additionally, combined maximum peak output power was calculated and presented in table 10&13.

Detector type	Sample
RBW	1MHz
VBW	3 MHz

### 8.2.3. Test results:

All test results met the requirements.

The maximum measured conducted power at antenna port in 1 beam mode is 19.09 dBm.

The summaries of Peak Power measurements for 1 and 4 beams modes are shown in Tables 8-13 and plots 25-96.

(\*) - Calculated Combined (max) Output, Peak Power [W] is the sum of the measured Power from all Output terminals, where each result (output power from separate output terminal) mathematically converted from Logarithm to linear units. The results were present in Watt. For example, the calculation for 2412 MHz frequency (1 Mbps bit rate, 802.11b modulation) for 4 beams mode is the following:

1.  $22.38 \text{ dBm} = 0.173 \text{ W}$ ;  $22.42 \text{ dBm} = 0.175 \text{ W}$ ;  $22.48 \text{ dBm} = 0.177 \text{ W}$ ;  $22.39 \text{ dBm} = 0.173 \text{ W}$ ;  $22.24 \text{ dBm} = 0.167 \text{ W}$ ;  $22.27 \text{ dBm} = 0.169 \text{ W}$ .
2.  $0.173 + 0.175 + 0.177 + 0.173 + 0.167 + 0.169 = 1.034 \text{ [W]}$

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Frequency MHz	Rate Mbps	Modulation mode	Output 1 Peak Power [dBm]	Output 2 Peak Power [dBm]	Output 3 Peak Power [dBm]	FCC Limit Per 15.247(b) [dBm]	Calculated Limit [dBm]	Margin [dB] Output 1	Plot number	Margin [dB] Output 2	Plot number	Margin [dB] Output 3	Plot number
2412	1	802.11b	18.20	18.32	18.41	30	19.1	0.90	25	0.78	31	0.69	37
	6	802.11g	18.44	18.66	18.65	30	19.1	0.66	26	0.66	32	0.45	38
2437	1	802.11b	18.64	18.70	18.60	30	19.1	0.46	27	0.46	33	0.50	39
	6	802.11g	18.93	19.09	18.98	30	19.1	0.17	28	0.17	34	0.12	40
2462	1	802.11b	18.71	18.72	18.90	30	19.1	0.39	29	0.39	35	0.20	41
	6	802.11g	18.87	18.76	18.86	30	19.1	0.23	30	0.23	36	0.24	42

Table 8.

Peak Power (Outputs 1-3) test results for 1 beam mode.

Frequency MHz	Rate Mbps	Modulation mode	Output 4 Peak Power [dBm]	Output 5 Peak Power [dBm]	Output 6 Peak Power [dBm]	FCC Limit Per 15.247(b) [dBm]	Calculated Limit [dBm]	Margin [dB] Output 4	Plot number	Margin [dB] Output 5	Plot number	Margin [dB] Output 6	Plot number
2412	1	802.11b	18.35	18.48	18.36	30	19.1	0.75	43	0.62	49	0.74	55
	6	802.11g	18.63	18.61	18.61	30	19.1	0.47	44	0.49	50	0.49	56
2437	1	802.11b	18.69	18.71	18.65	30	19.1	0.41	45	0.39	51	0.45	57
	6	802.11g	19.05	19.08	18.99	30	19.1	0.05	46	0.02	52	0.11	58
2462	1	802.11b	18.56	18.57	18.87	30	19.1	0.54	47	0.53	53	0.23	59
	6	802.11g	18.73	18.78	18.89	30	19.1	0.37	48	0.32	54	0.21	60

Table 9.

Peak Power (Outputs 4-6) test results for 1 beam mode.

Frequency MHz	Rate Mbps	Modulation mode	Calculated Limit [dBm]	FCC Limit Per 15.247(b) [dBm]	FCC Limit Per 15.247(b) [W]	Calculated Limit [W]	Calculated Combined (max) Output *, Peak Power [W]	Margin [W]
2412	1	802.11b	26.9	30	1	0.49	0.41	0.08
	6	802.11g	26.9	30	1	0.49	0.44	0.05
2437	1	802.11b	26.9	30	1	0.49	0.44	0.05
	6	802.11g	26.9	30	1	0.49	0.48	0.01
2462	1	802.11b	26.9	30	1	0.49	0.45	0.04
	6	802.11g	26.9	30	1	0.49	0.46	0.03

Table 10.

Peak Power (combined output) test results for 1 beam mode.



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Frequency MHz	Rate Mbps	Modulation mode	Output 1 Peak Power [dBm]	Output 2 Peak Power [dBm]	Output 3 Peak Power [dBm]	FCC Limit Per 15.247(b) [dBm]	Calculated Limit [dBm]	Margin [dB] Output 1	Plot number	Margin [dB] Output 2	Plot number	Margin [dB] Output 3	Plot number
2412	1	802.11b	22.38	22.42	22.48	30	25.1	2.72	61	2.68	67	2.62	73
	6	802.11g	22.28	22.25	22.19	30	25.1	2.82	62	2.85	68	2.91	74
2437	1	802.11b	21.99	22.02	21.88	30	25.1	3.11	63	3.08	69	3.22	75
	6	802.11g	22.28	22.24	22.06	30	25.1	2.82	64	2.86	70	3.04	76
2462	1	802.11b	22.45	22.33	22.19	30	25.1	2.65	65	2.77	71	2.91	77
	6	802.11g	21.78	21.75	21.79	30	25.1	3.32	66	3.35	72	3.31	78

Table 11

Peak Power (Outputs 1-3) test results for 4 beams mode.

Frequency MHz	Rate Mbps	Modulation mode	Output 4 Peak Power [dBm]	Output 5 Peak Power [dBm]	Output 6 Peak Power [dBm]	FCC Limit Per 15.247(b) [dBm]	Calculated Limit [dBm]	Margin [dB] Output 4	Plot number	Margin [dB] Output 5	Plot number	Margin [dB] Output 6	Plot number
2412	1	802.11b	22.39	22.24	22.27	30	25.1	2.71	79	2.86	85	2.83	91
	6	802.11g	22.13	22.13	22.18	30	25.1	2.97	80	2.97	86	2.92	92
2437	1	802.11b	22.02	21.87	22.19	30	25.1	3.08	81	3.23	87	2.91	93
	6	802.11g	22.21	21.98	22.23	30	25.1	2.89	82	3.12	88	2.87	94
2462	1	802.11b	22.27	22.25	22.27	30	25.1	2.83	83	2.85	89	2.83	95
	6	802.11g	21.66	21.55	21.70	30	25.1	3.44	84	3.55	90	3.4	96

Table 12.

Peak Power (Outputs 4-6) test results for 4 beams mode.

Frequency MHz	Rate Mbps	Modulation mode	Calculated Limit [dBm]	FCC Limit Per 15.247(b) [dBm]	FCC Limit Per 15.247(b) [W]	Calculated Limit [W]	Calculated Combined (max) Output *, Peak Power [W]	Margin [W]
2412	1	802.11b	34.9	30	1	3.09	1.034	2.06
	6	802.11g	34.9	30	1	3.09	0.994	2.10
2437	1	802.11b	34.9	30	1	3.09	0.950	2.14
	6	802.11g	34.9	30	1	3.09	0.988	2.10
2462	1	802.11b	34.9	30	1	3.09	1.018	2.07
	6	802.11g	34.9	30	1	3.09	0.889	2.20

Table 13.

Peak Power (combined output) test results for 4 beams mode.

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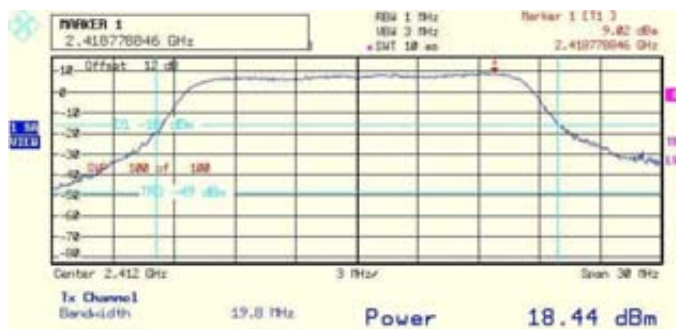
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FCC ID: UGMWS410AD

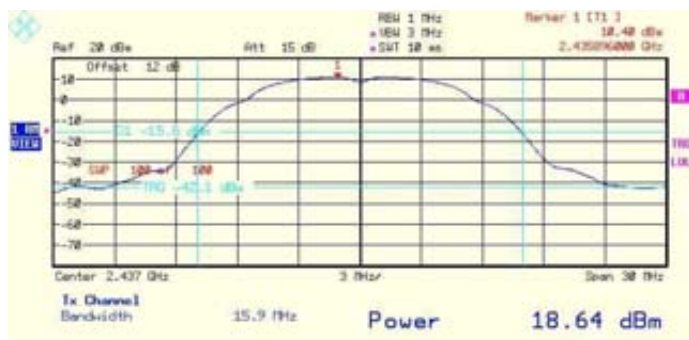
### Measurements results for single beam mode.



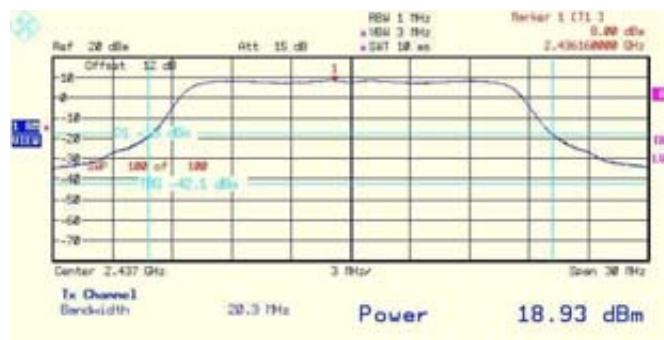
Plot # 25. Output 1 peak power. Lower frequency.  
1Mbps rate.



Plot # 26. Output 1 peak power. Lower frequency.  
6Mbps rate.



Plot # 27. Output 1 peak power. Middle frequency.  
1Mbps rate.



Plot # 28. Output 1 peak power. Middle frequency.  
6Mbps rate.

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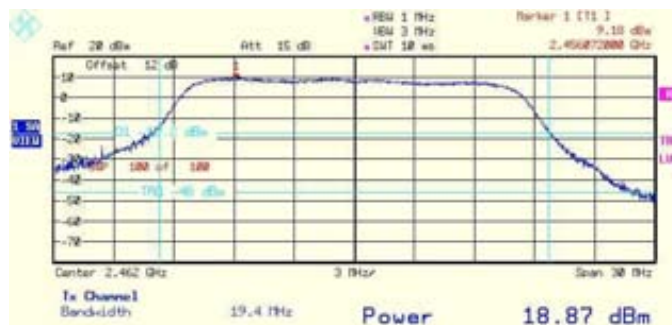
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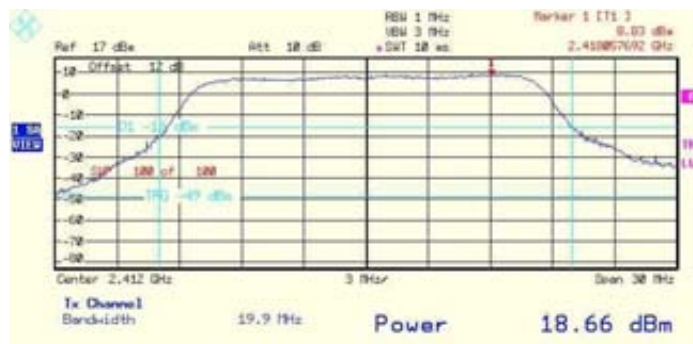
Plot # 29. Output 1 peak power. High frequency. 1Mbps rate.



Plot # 30. Output 1 peak power. High frequency. 6Mbps rate.



Plot # 31. Output 2 peak power. Lower frequency. 1Mbps rate.



Plot # 32. Output 2 peak power. Lower frequency. 6Mbps rate.



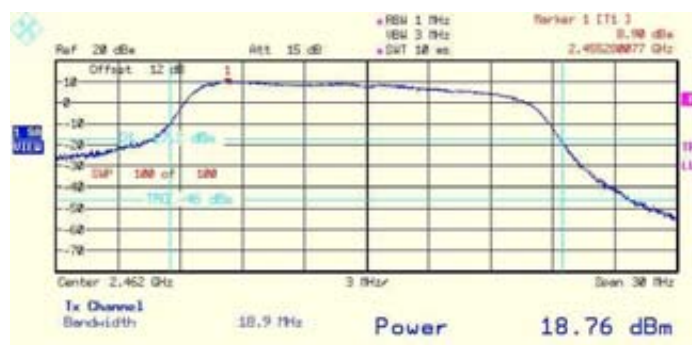
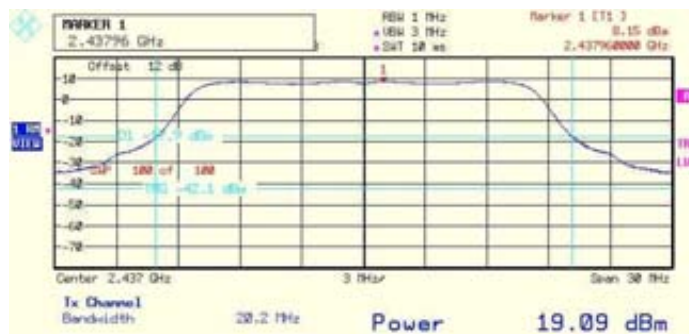
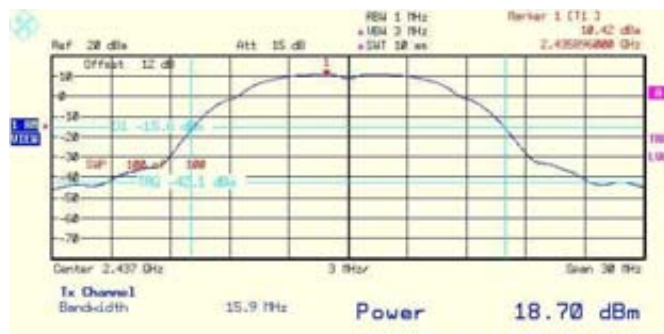
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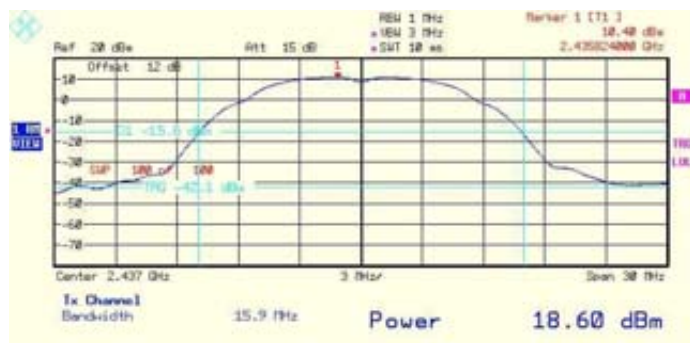
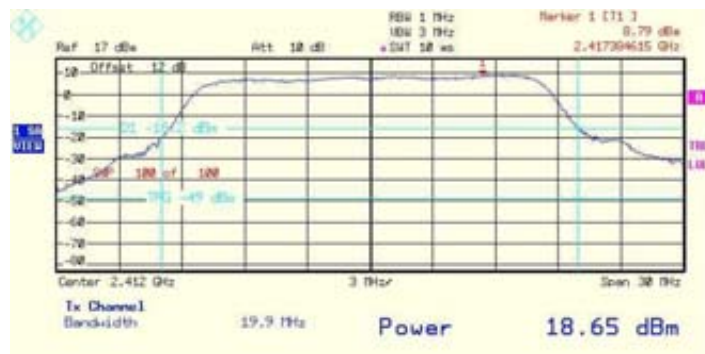
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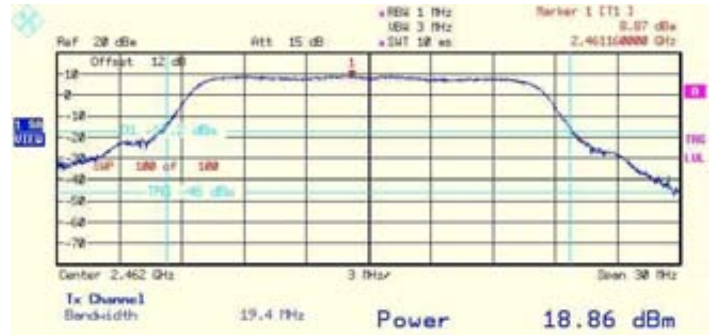
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Model: WS410AD

FCC ID: UGMWS410AD



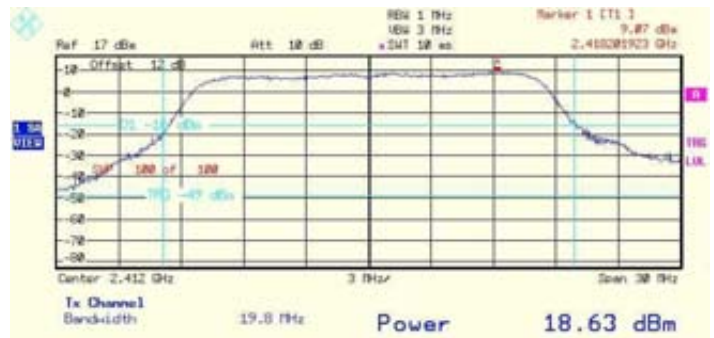
Plot # 41. Output 3 peak power. High frequency. 1Mbps rate.



Plot # 42. Output 3 peak power. High frequency. 6Mbps rate.



Plot # 43. Output 4 peak power. Lower frequency. 1Mbps rate.



Plot # 44. Output 4 peak power. Lower frequency. 6Mbps rate.



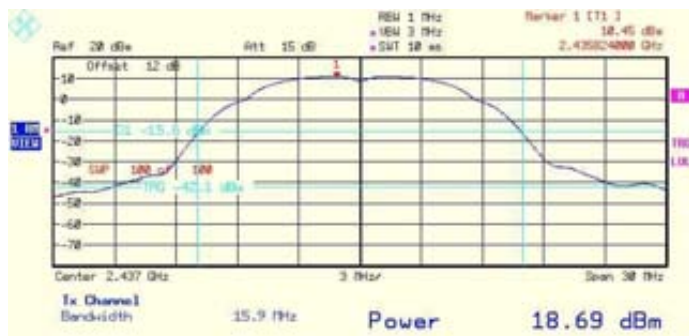
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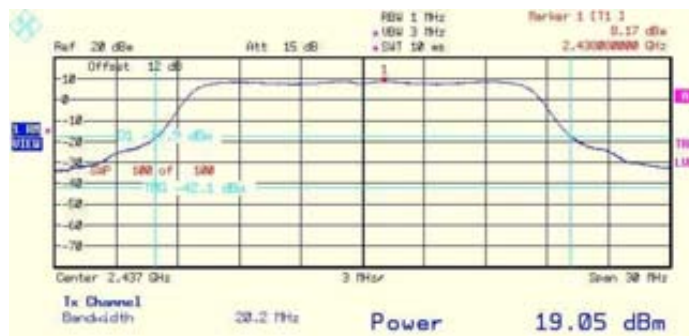
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

FCC ID: UGMWS410AD



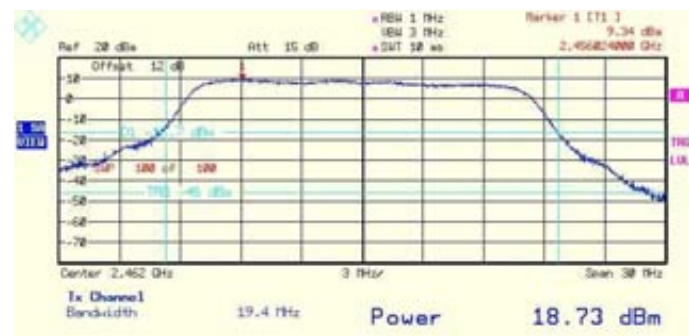
Plot # 45. Output 4 peak power. Middle frequency.  
1Mbps rate.



Plot # 46. Output 4 peak power. Middle frequency.  
6Mbps rate.



Plot # 47. Output 4 peak power. High frequency.  
1Mbps rate.



Plot # 48. Output 4 peak power. High frequency.  
6Mbps rate.



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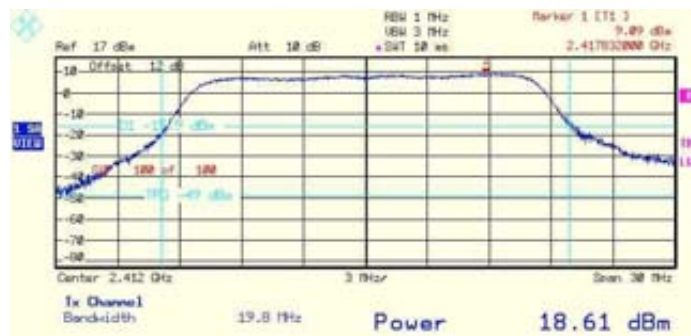
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

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Plot # 49. Output 5 peak power. Lower frequency. 1Mbps rate.



Plot # 50. Output 5 peak power. Lower frequency. 6Mbps rate.



Plot # 51. Output 5 peak power. Middle frequency. 1Mbps rate.



Plot # 52. Output 5 peak power. Middle frequency. 6Mbps rate.

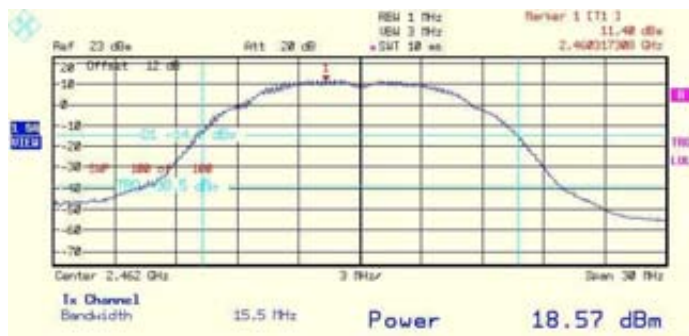
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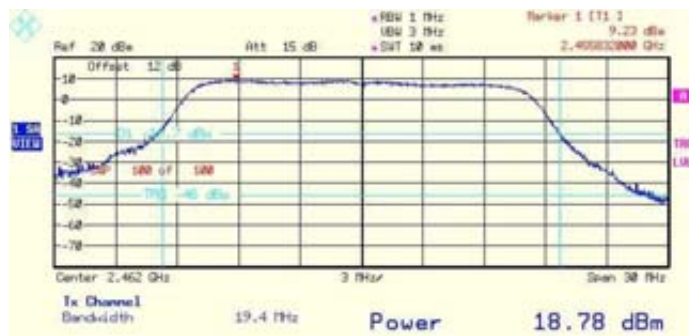
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

FCC ID: UGMWS410AD



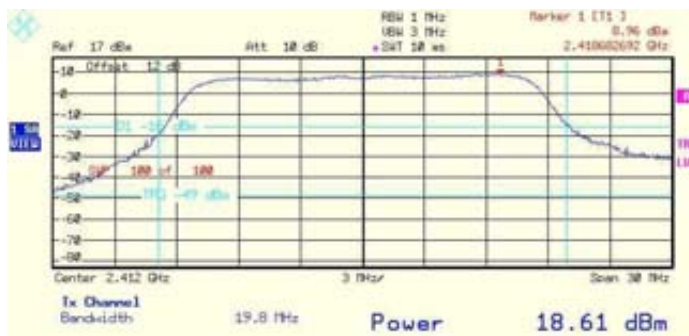
Plot # 53. Output 5 peak power. High frequency.  
1Mbps rate.



Plot # 54. Output 5 peak power. High frequency.  
6Mbps rate.



Plot # 55. Output 6 peak power. Lower frequency.  
1Mbps rate.



Plot # 56. Output 6 peak power. Lower frequency.  
6Mbps rate.

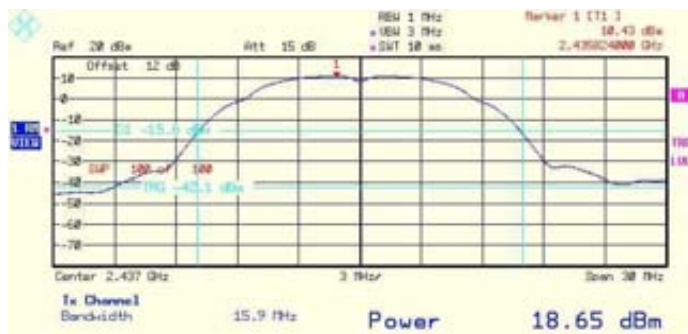
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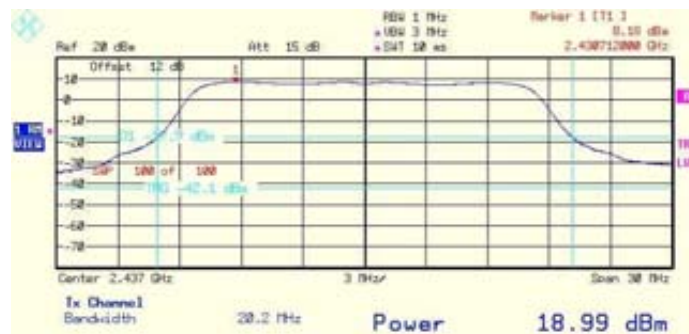
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

FCC ID: UGMWS410AD



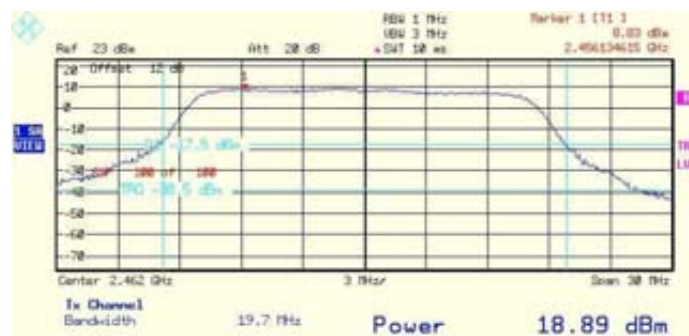
Plot # 57. Output 6 peak power. Middle frequency. 1Mbps rate.



Plot # 58. Output 6 peak power. Middle frequency. 6Mbps rate.



Plot # 59. Output 6 peak power. High frequency. 1Mbps rate.



Plot # 60. Output 6 peak power. High frequency. 6Mbps rate.



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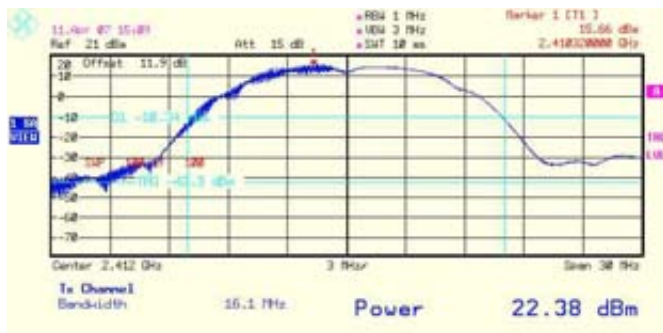
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Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

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### Measurements results for 4 beams mode.



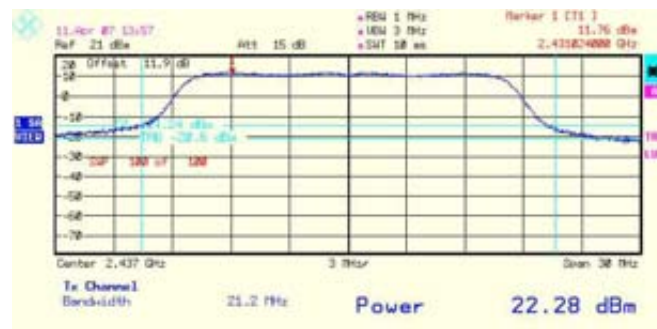
Plot # 61. Output 1 peak power. Lower frequency. 1Mbps rate.



Plot # 62. Output 1 peak power. Lower frequency. 6Mbps rate.



Plot # 63. Output 1 peak power. Middle frequency. 1Mbps rate.



Plot # 64. Output 1 peak power. Middle frequency. 6Mbps rate.

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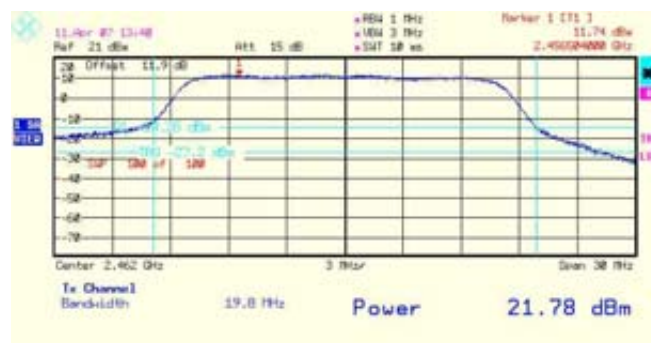
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

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Plot # 65. Output 1 peak power. High frequency. 1Mbps rate.



Plot # 66. Output 1 peak power. High frequency. 6Mbps rate.



Plot # 67. Output 2 peak power. Lower frequency. 1Mbps rate.



Plot # 68. Output 2 peak power. Lower frequency. 6Mbps rate.

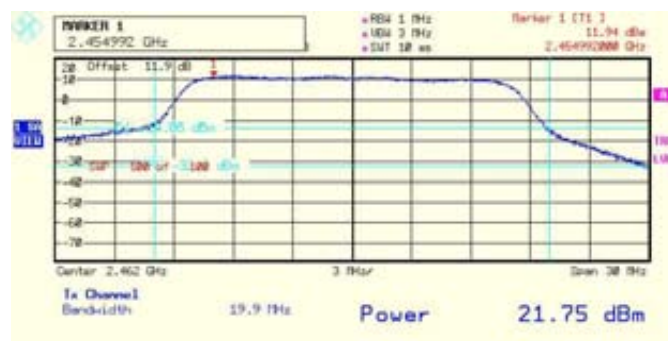
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Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

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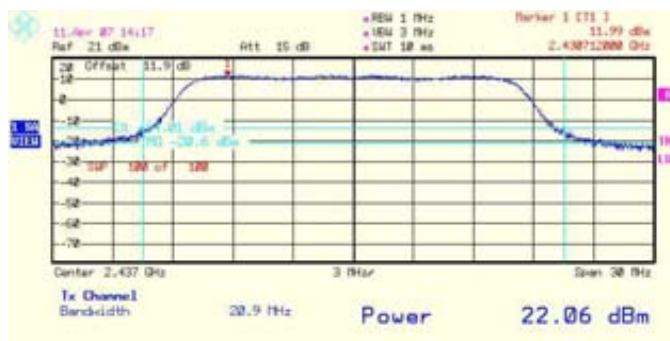
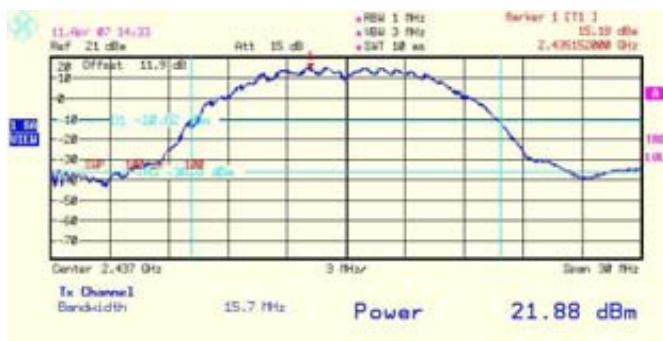
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Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

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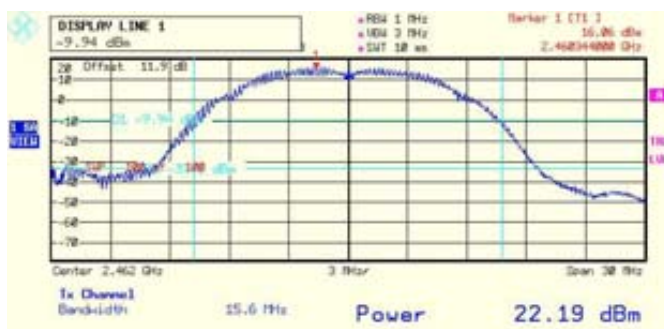
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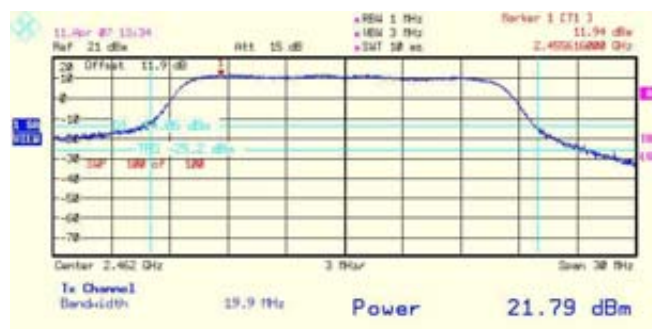
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

FCC ID: UGMWS410AD



Plot # 77. Output 3 peak power. High frequency.  
1Mbps rate.



Plot # 78. Output 3 peak power. High frequency.  
6Mbps rate.



Plot # 79. Output 4 peak power. Lower frequency.  
1Mbps rate.



Plot # 80. Output 4 peak power. Lower frequency.  
6Mbps rate.

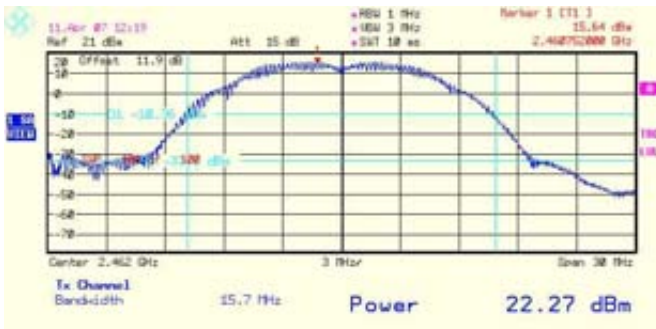
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Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

FCC ID: UGMWS410AD



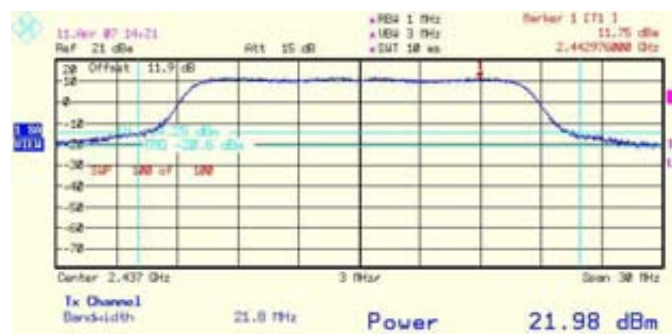
Plot # 85. Output 5 peak power. Lower frequency. 1Mbps rate.



Plot # 86. Output 5 peak power. Lower frequency. 6Mbps rate.



Plot # 87. Output 5 peak power. Middle frequency. 1Mbps rate.



Plot # 88. Output 5 peak power. Middle frequency. 6Mbps rate.

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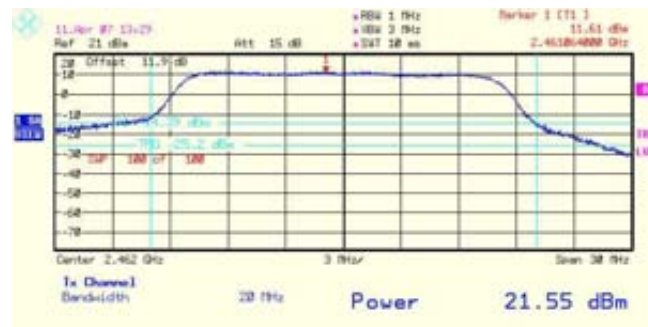
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

FCC ID: UGMWS410AD



Plot # 89. Output 5 peak power. High frequency. 1Mbps rate.



Plot # 90. Output 5 peak power. High frequency. 6Mbps rate.



Plot # 91. Output 6 peak power. Lower frequency. 1Mbps rate.



Plot # 92. Output 6 peak power. Lower frequency. 6Mbps rate.

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Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: WS410AD

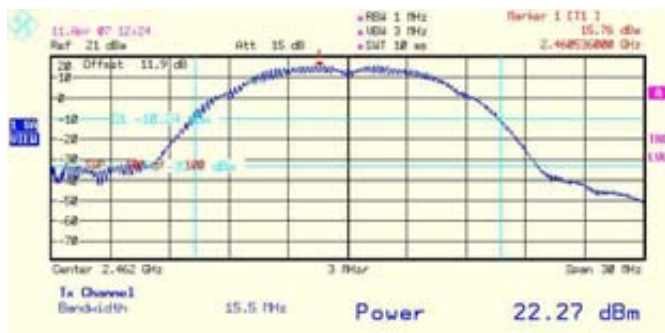
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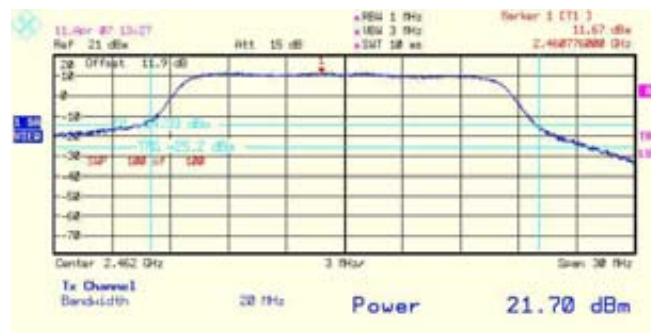
Plot # 93. Output 6 peak power. Middle frequency. 1Mbps rate.



Plot # 94. Output 6 peak power. Middle frequency. 6Mbps rate.



Plot # 95. Output 6 peak power. High frequency. 1Mbps rate.



Plot # 96. Output 6 peak power. High frequency. 6Mbps rate.