

FCC PART 15

EMI Measurement and TEST REPORT

For

Actiontec Electronics, Inc.

760 North Mary Ave.
Sunnyvale, CA 94086

FCC ID: LNQ802PAG

2003-10-08

This Report Concerns: ☒ Original Report	Equipment Type: 802.11a/g WLAN Dual Band PCI Adapter
Test Engineer: Ling Zhang / 	
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Test Date: 2003-09-05 / 2003-09-08 / 2003-09-09 / 2003-09-16 / 2003-09-17 / 2003-09-18	
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Note: This test report is specially limited to the above client company and product model only. It may not be duplicated without prior written consent of Bay Area Compliance Laboratory Corporation. This report **must not** be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

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1 - GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

The *Actiontec Electronics, Inc.* 's, model: 802PAG, or the "EUT" as referred to in this report is a Wireless LAN 802.11a/g Dual Band PCI Adapter which is measured approximately 4.725"L x 2.52"W x 0.062"H. The design is based on Atheros AR5002X Combo WLAN chip set: AR5112 5/2.4GHz radio and/or AR2112 2.4GHz radio, and AR5212 802.11a/b/g MAC + Baseband.

The EUT has the following features:

- Atheros AR5002X Combo WLAN chip set
- Support IEEE 802.11b/g and/or 802.11a standards
- Full hardware support for Advanced Encryption Standard (AES) security at full line-speed with no performance degradation. Support for Key Integrity Protocol (TKIP) and WEP
- Support Ad hoc, and Infrastructure both network architectures
- Quality of Service support (QoS) for rear time video, audio voice
- Standard rates of 1,2,5.5,11,6,9,12,18,24,48, and 54-Mbps
- Dynamic Frequency Selection (DFS) and Transmit. Power Control (TPC) for international use
- Extended 5.150 to 5.850-GHz and 2.400 to 2.500-GHz tuning ranges
- Enhanced performance, transmission range and reliability
- Onboard diversity antenna
- One or two external antenna

** The test data gathered are from typical production samples provided by the manufacturer.*

1.2 Objective

This type approval report is prepared on behalf of *Actiontec Electronics, Inc.* in accordance with Part 2, Subpart J, Part 15, Subparts A , C, and E of the Federal Communication Commissions rules.

The objective of the manufacturer is to demonstrate compliance with FCC rules for Output Power, Antenna Requirements, 6 dB Bandwidth and 26 dB Bandwidth, power spectral density, 100 kHz Bandwidth of Band Edges Measurement, Out of Band Emission, Spurious Emission, Conducted and Spurious Radiated Emission, Discontinue Transmitting with Absence of Data or Operational Failure, Peak Excursion to Average Ratio and Frequency Stability.

1.3 Related Submittal(s)/Grant(s)

No Related Submittals.

1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.4-2001, 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.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

1.5 Test Facility

The Open Area Test site used by BACL to collect radiated and conducted emission measurement data is located in the back parking lot of the building at 230 Commercial Street, Sunnyvale, California, USA.

Test site at BACL has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2001.

The Federal Communications Commission and Voluntary Control Council for Interference has the reports on file and is listed under FCC file 31040/SIT 1300F2 and VCCI Registration No.: C-1298 and R-1234. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (Lab Code 200167-0). The scope of the accreditation covers the FCC Method – 47 CFR Part – Digital Devices, CISPER 22: 1997: Electromagnetic Interference – Limits and Methods of Measurement of Information Technology Equipment test methods.

1.6 Test Equipment List

Manufacturer	Description	Model	Serial Number	Cal. Due Date
HP	Spectrum Analyzer	8568B	2517A01610	2003-10-30
HP	Amplifier	8447E	2944A07030	2004-06-28
HP	Quasi-Peak Adapter	85650A	2521A00718	2004-03-08
Rohde&Schwarz	EMI Test Receiver	ESC530	C00176	2003-12-03
Com-Power	Log Periodic Antenna	AL-100	16005	2004-08-23
Com-Power	Log Periodic Antenna	AB-900	15049	2004-05-01
Agilent	Spectrum Analyzer (9KHz – 40GHz)	8564E	3943A01781	2004-08-26
Agilent	Spectrum Analyzer (9KHz – 50GHz)	8565EC	3946A00131	2004-05-03
HP	Amplifier (1-26.5GHz)	8449B	3147A00400	2004-03-14
A.H.System	Horn Antenna (700MHz-18GHz)	SAS-200/571	261	2004-05-31

*** Statement of Traceability: Bay Area Compliance Laboratory Corp.** certifies that all calibration has been performed using suitable standards traceable to the NIST.

1.7 Support Equipment List and Details

Manufacturer	Description	Model	Serial Number	FCC ID
HP	Desktop	Pavilion 6830	MX10606093	DOC
Viewsonic	Monitor	Vckts21477-1M	DP0231877	DOC
Gateway	Keyboard	RT3602	82223393	DOC
Microsoft	Mouse	X03-68761	2773493-00000	C3KKMP1
HP	ThinkJet Printer	2225C+	2821S14783	DS16XU2225

1.8 External I/O Cabling List and Details

Cable Description	Length (M)	Port/From	To
Shielded Monitor Cable	1	Desktop / monitor port	Monitor
Shielded Printer Cable	1.5	Printer Port /Host	Printer
Monse cable	1.5	Desktop / mouse port	Mouse
Keyboard Cable	1.5	Desktop / keyboard port	Keyboard

2 - SYSTEM TEST CONFIGURATION

2.1 Justification

The host system was configured for testing in a typical fashion (as normally used by a typical user).

The EUT was tested in the normal (native) operating mode to represent *worst*-case results during the final qualification test.

2.2 EUT Exercise Software

The EUT exercise program used during radiated and conducted testing was designed to exercise the system components in a manner similar to a typical use. The test software, provided by the customer, is started the Windows terminal program under the Windows 98/2000/ME/XP operating system.

Once loaded, set the Tx channel to low, mid and high for testing.

2.3 Special Accessories

As shown in section 2.7, all interface cables used for compliance testing are shielded. The host PC and the peripherals featured shielded metal connectors.

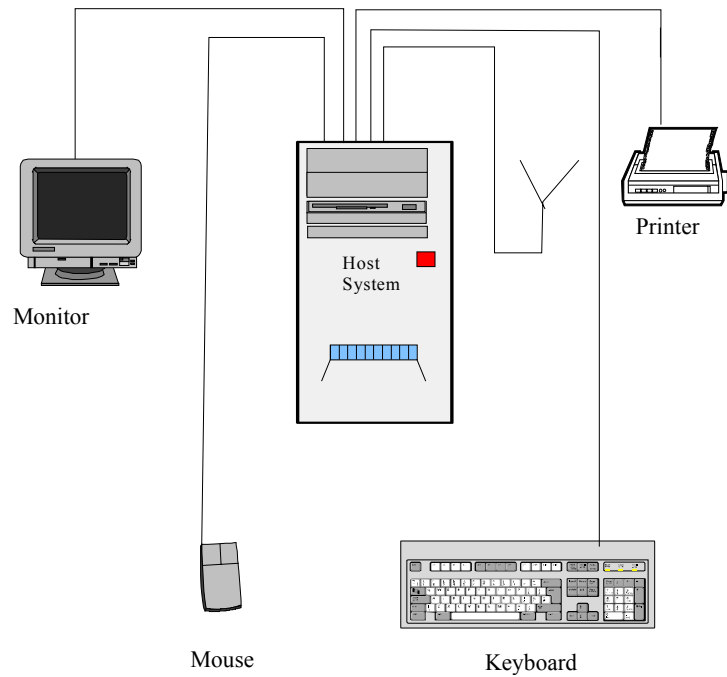
2.4 Schematics / Block Diagram

Please refer to Appendix A.

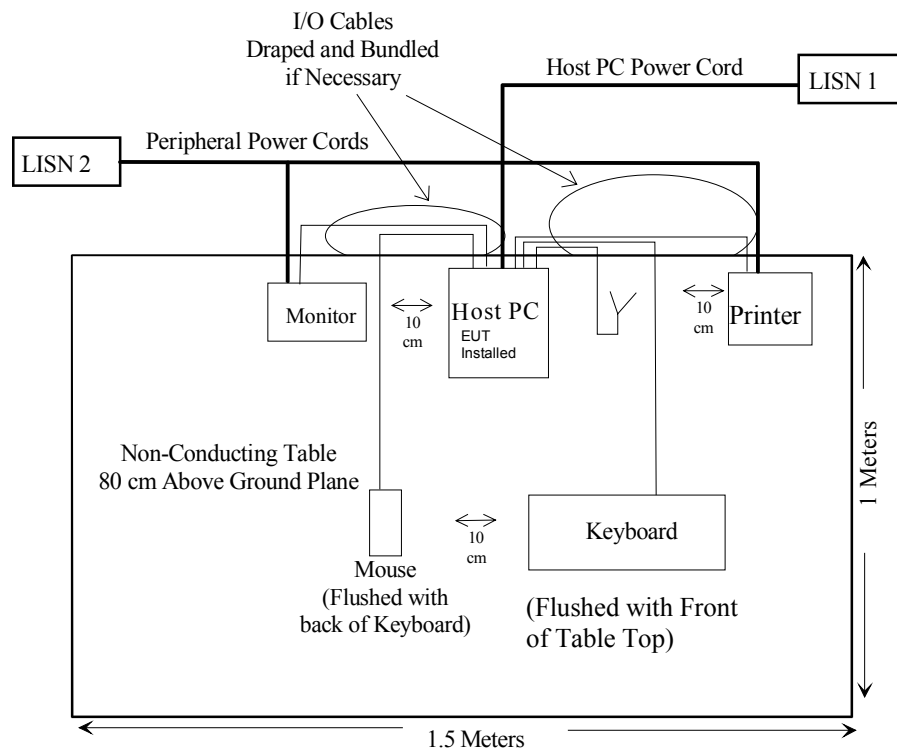
2.5 Equipment Modifications

No modifications were made by BACL to ensure the EUT to comply with the applicable limits and requirements.

2.6 Configuration of Test System



2.7 Test Setup Block Diagram



3 - SUMMARY OF TEST RESULTS

FCC RULES	DESCRIPTION OF TEST	RESULT	REFERENCE
§15.247 (b)(1), §15.407(a)(2)	Maximum Peak Output Power	Compliant	Section 4
§15.247 (a)(2), §15.407(a)(1), §15.407(a)(2), §15.407(a)(3)	6 dB & 26 dB Bandwidth	Compliant	Section 5
§15.247 (d), §15.407 (a)(2)	Peak Power Spectral Density	Compliant	Section 6
§15.247 (c)	100 kHz Bandwidth of Frequency Band Edge	Compliant	Section 7
§15.407 (a)(6)	Peak excursion to Average Ratio	Compliant	Section 8
§15.407 (b)	Out of Band Emissions	Compliant	Section 9
§15.209 (f)	Spurious Emission	Compliant	Section 10
§15.203	Antenna Requirement	Compliant	Section 11
§15.205, §15.407 (b)(6)	Restricted Bands	Compliant	Section 12
§15.209 (a), §15.407 (b)(5)	Radiated Emission	Compliant	Section 12
§15.207 (a)	Conducted Emissions	Compliant	Section 13
§15.247(b)(4), §15.407 (f)	RF Exposure Requirement	Compliant	Section 14
§15.407 (g)	Frequency Stability	Compliant	Section 15
§15.407 (c)	Discontinue Transmitting With Absence Of Data Or Operational Failure	Compliant	See Provided Technical Manual

4 - PEAK OUTPUT POWER MEASUREMENT

4.1 Standard Applicable

According to §15.247(b) (3), for systems using digital modulation in 2400-2483.5 MHz: 1 Watt

According to §15.407(a)(1), for the band 5.15-5.25 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 50 mW or $4 \text{ dBm} + 10\log B$, where B is the 26-dB emission bandwidth in MHz.

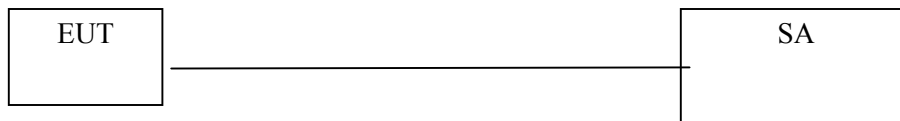
According to §15.407(a)(2), for the band 5.25-5.35 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 250 mW or $11 \text{ dBm} + 10\log B$, where B is the 26-dB emission bandwidth in MHz.

According to §15.407(a)(3), for the band 5.725-5.825 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 1 W or $17 \text{ dBm} + 10\log B$, where B is the 26-dB emission bandwidth in MHz.

4.2 Measurement Procedure

4.2.1 Test Procedure for 802.11b/g

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to a spectrum analyzer.
3. Add a correction factor to the display.



4.2.2 Test Procedure for 802.11a

Sweep time $\leq T$, where T is the transmission pulse duration over which the transmitter is on and transmitting at its maximum power control level, use following steps – spectral trace averaging – and sum the power across the band. Test software control EUT continuously transmit at its maximum power.

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW = 1 MHz.
3. Set VBW ≥ 3 MHz.
4. Use sample detector mod if bin width (i.e., span/number of points in spectrum display) < 0.5 RBW. Otherwise use peak detector mode.
5. Set the trigger to “free run”
6. Trace average 100 traces in power averaging mode
7. Measure power using the spectrum analyzer’s band power measurement function with band limits set equal to the EBW band edges.

4.3 Equipment Lists

Manufacturer	Model No.	Description	Calibration Due Date
Agilent	8564E	Spectrum Analyzer	2004-08-26

4.4 Measurement Result

4.4.1 Output Power (15.247) for 802.11b

Channel	Frequency (MHz)	Output Power (dBm)	Correction Factor (dB)	Corrected Output Power (dBm)	Output Power (W)	Standard (W)	Result
Low	2412	14.00	7.8	21.80	0.151	$\leq 1\text{W}$	Compliant
Mid	2437	14.17	7.8	21.97	0.157	$\leq 1\text{W}$	Compliant
High	2462	13.83	7.8	21.63	0.146	$\leq 1\text{W}$	Compliant

Note: Correction Factor = $10\log(\text{BW6dB}/\text{RBW}) = 10\log(12.17/2) = 7.8\text{ dB}$

4.4.2 Output Power (15.247) for 802.11g

Channel	Frequency (MHz)	Peak Output Power (dBm)	Correction Factor (dBm)	Corrected Factor (dBm)	Output Power (W)	Standard (W)	Result
Low	2142	14.83	9.21	24.04	0.256	$\leq 1\text{ W}$	Compliant
Mid	2437	11.67	12.22	23.89	0.245	$\leq 1\text{ W}$	Compliant
High	2462	14.17	9.21	23.38	0.218	$\leq 1\text{ W}$	Compliant

Note:

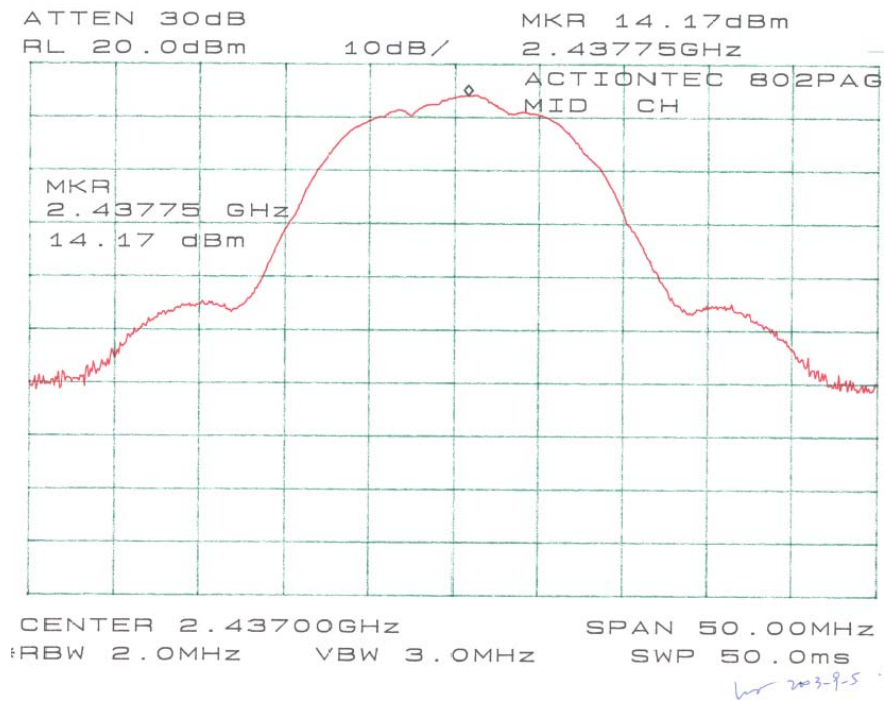
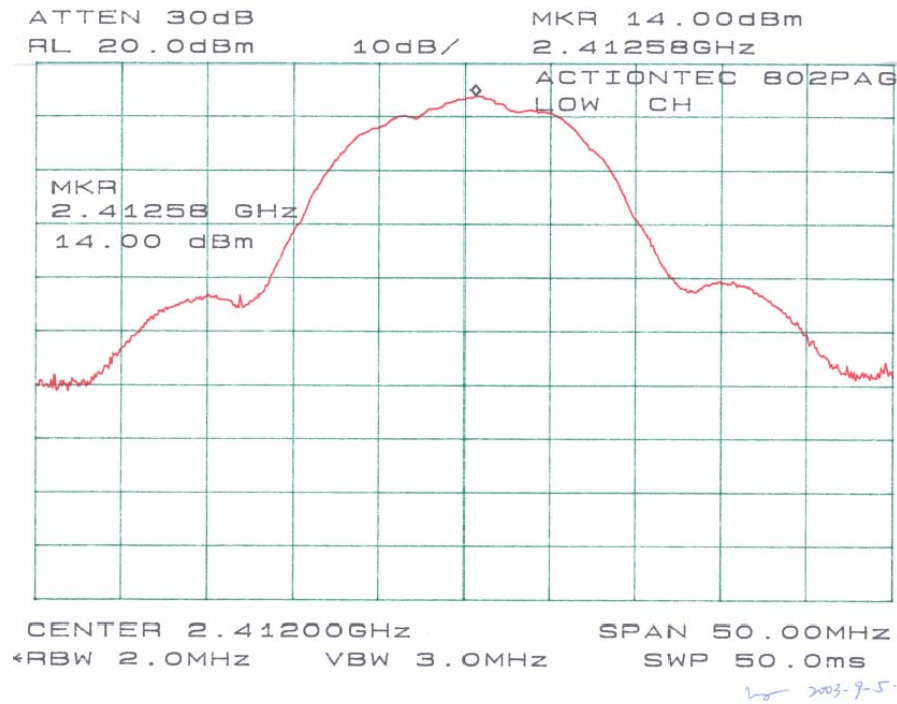
Correction Factor for Turbo Mode = $10\log(\text{BW6dB}/\text{RBW}) = 10\log(33.33/2.0) = 12.22\text{ dBm}$

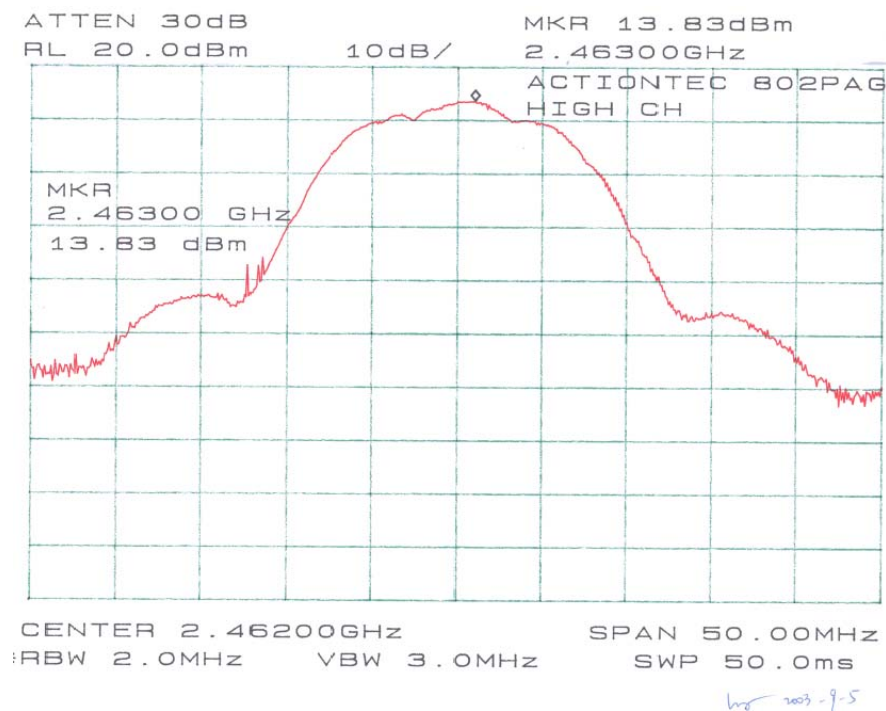
Correction Factor for Turbo Mode = $10\log(\text{BW6dB}/\text{RBW}) = 10\log(16.67/2.0) = 9.21\text{ dBm}$

4.4.3 Output Power (15.407) for 802.11a

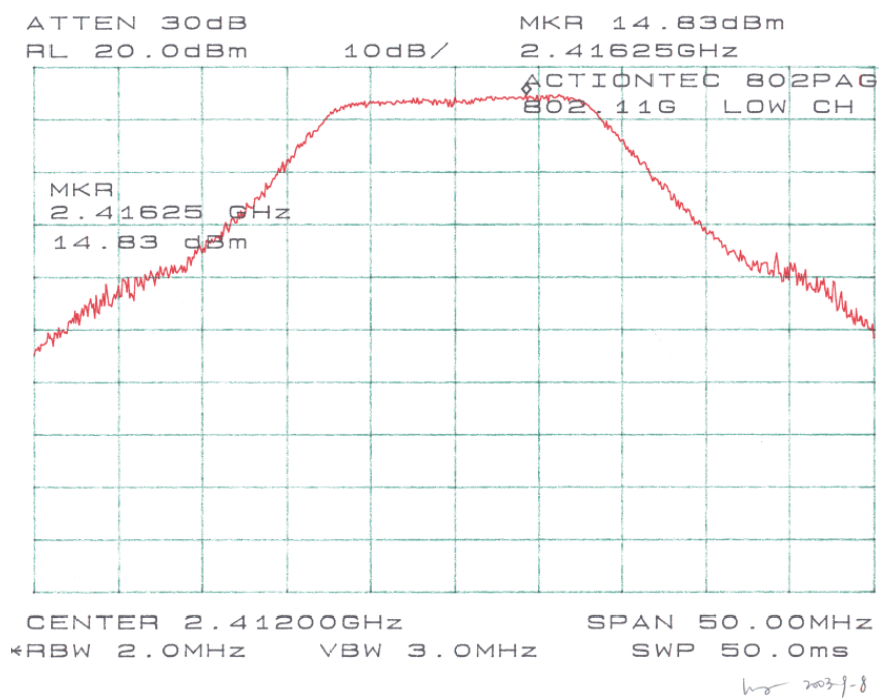
Band	Channel (MHz)	Frequency (MHz)	Output Power (dBm)	Output Power (mW)	Standard (mW)	Result
Low	Low	5165	15.8	38	<50	Compliant
	Mid	5200	15.8	38	<50	Compliant
	High	5250	15.8	38	<50	Compliant
Mid	Low	5265	19.2	83	<250	Compliant
	Mid	5300	18.6	72	<250	Compliant
	High	5330	19.1	81	<250	Compliant
High	Low	5740	18.9	78	<1000	Compliant
	Mid	5770	19.0	79	<1000	Compliant
	High	5810	19.2	83	<1000	Compliant

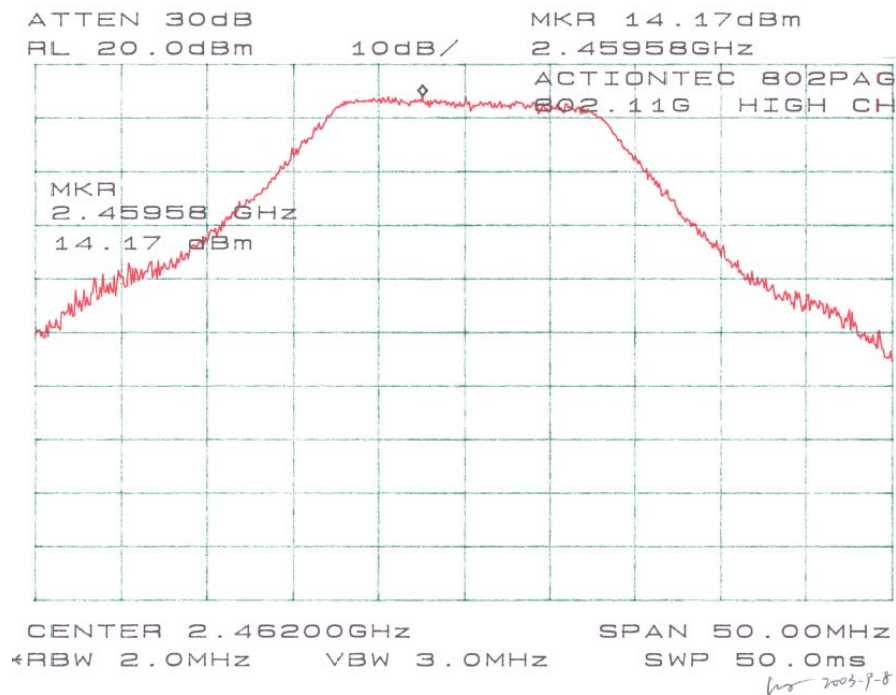
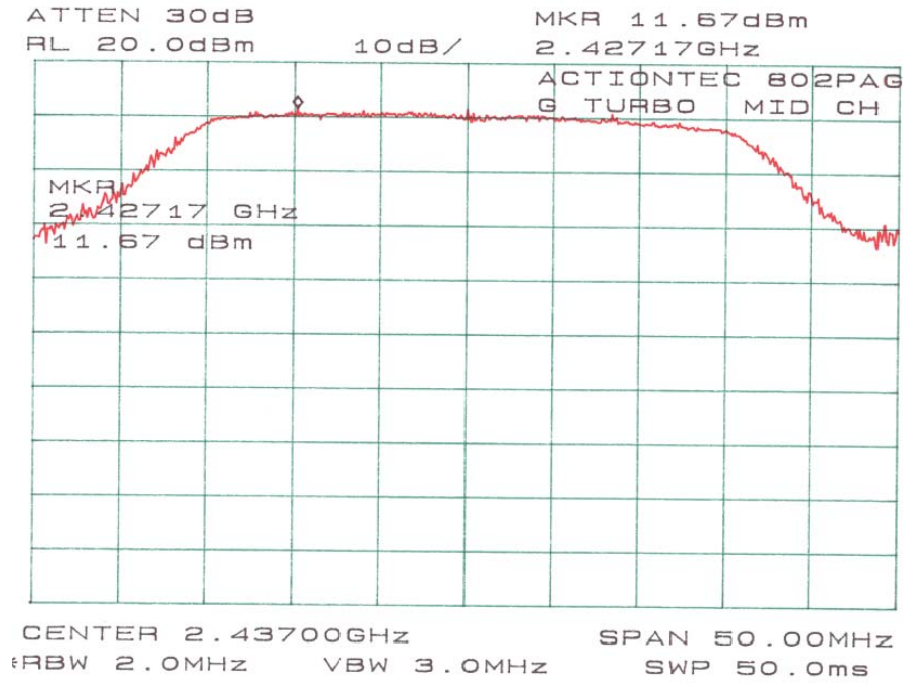
Plots of Peak Output Power for 802.11b (15.247)



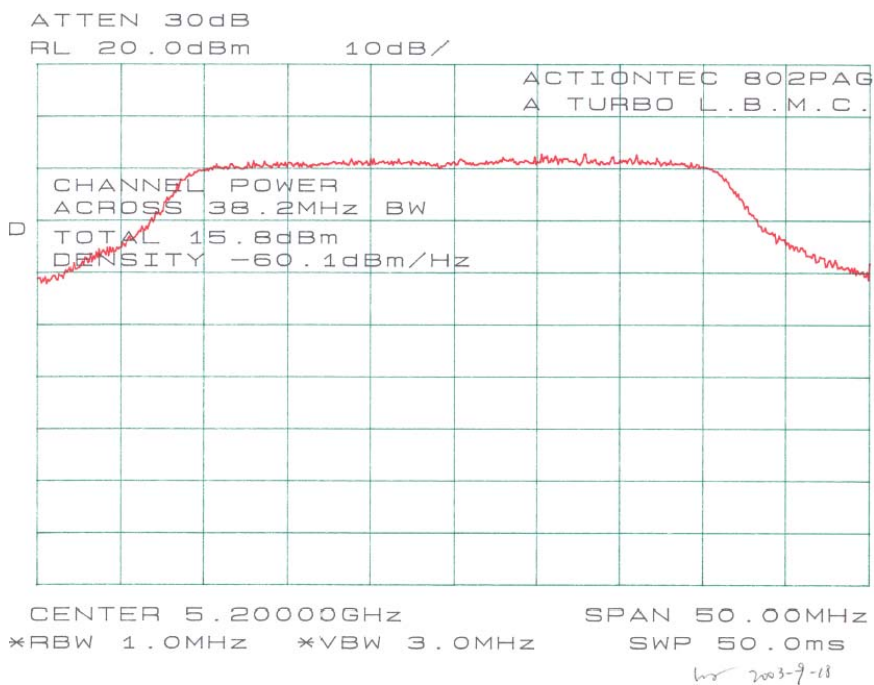
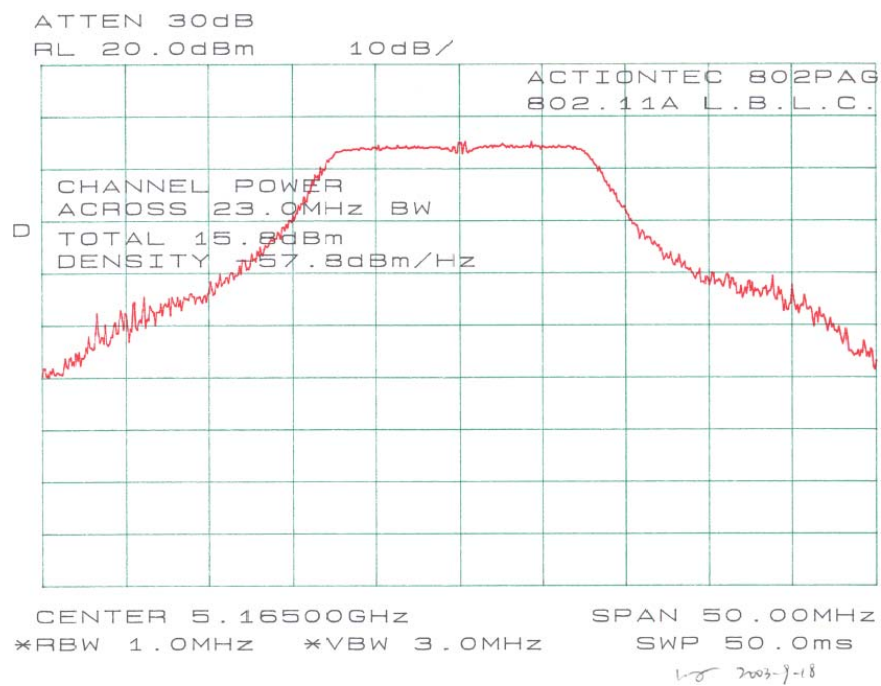


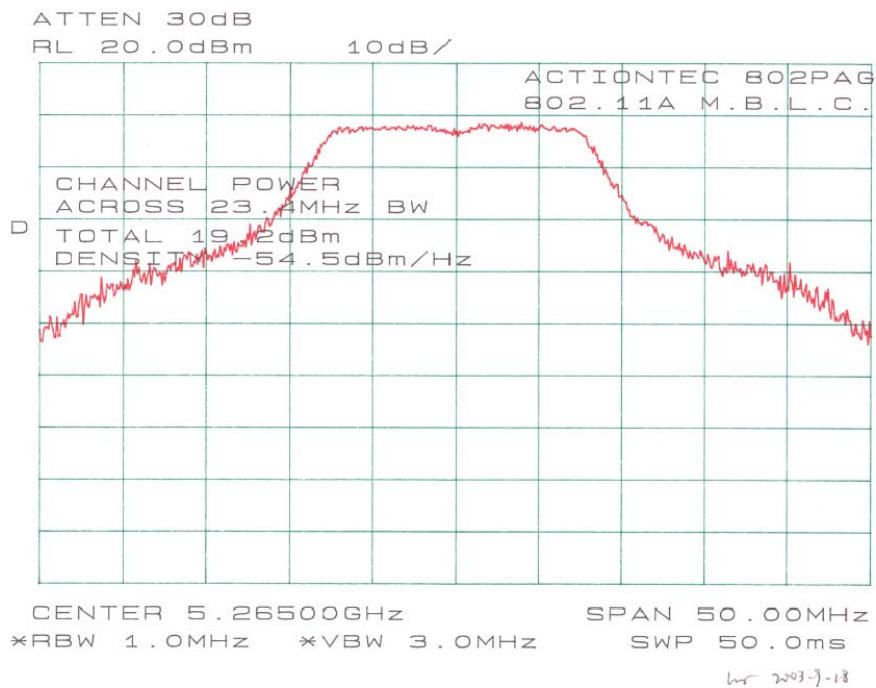
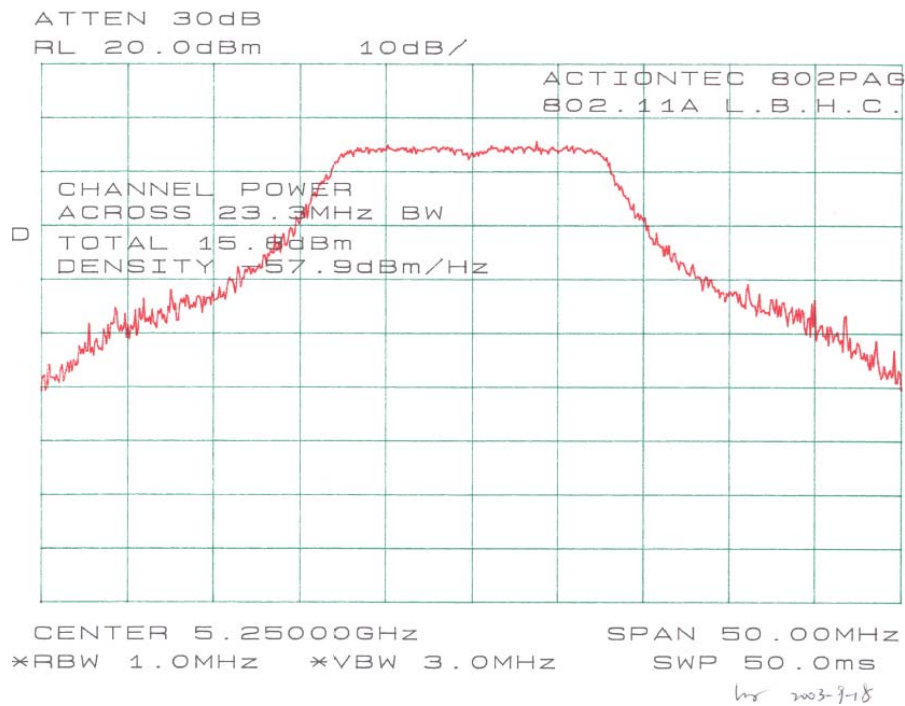
Plots of Peak Output Power for 802.11 g (15.247)

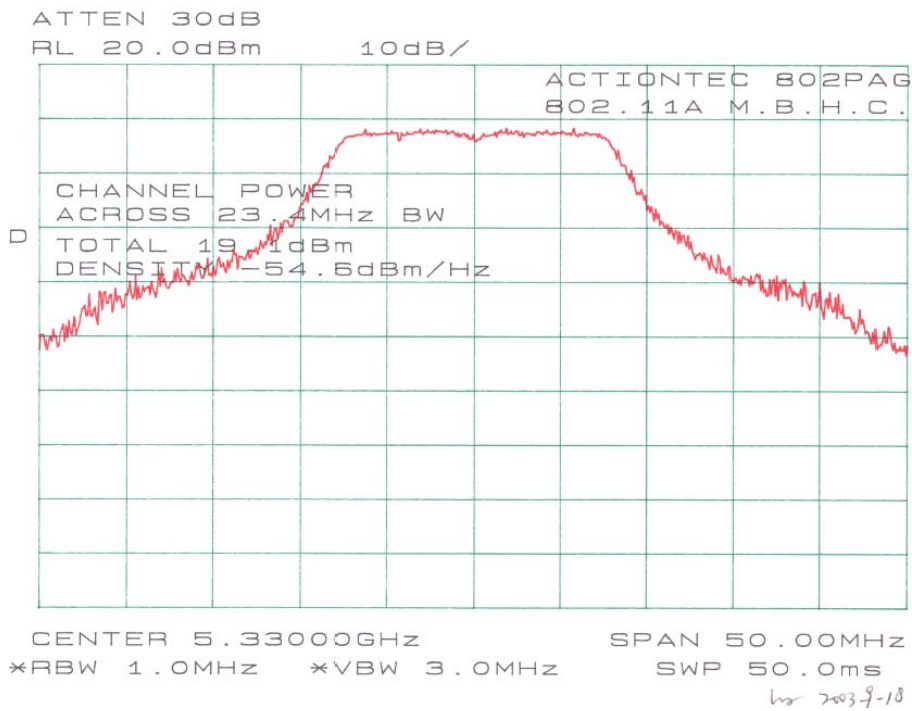
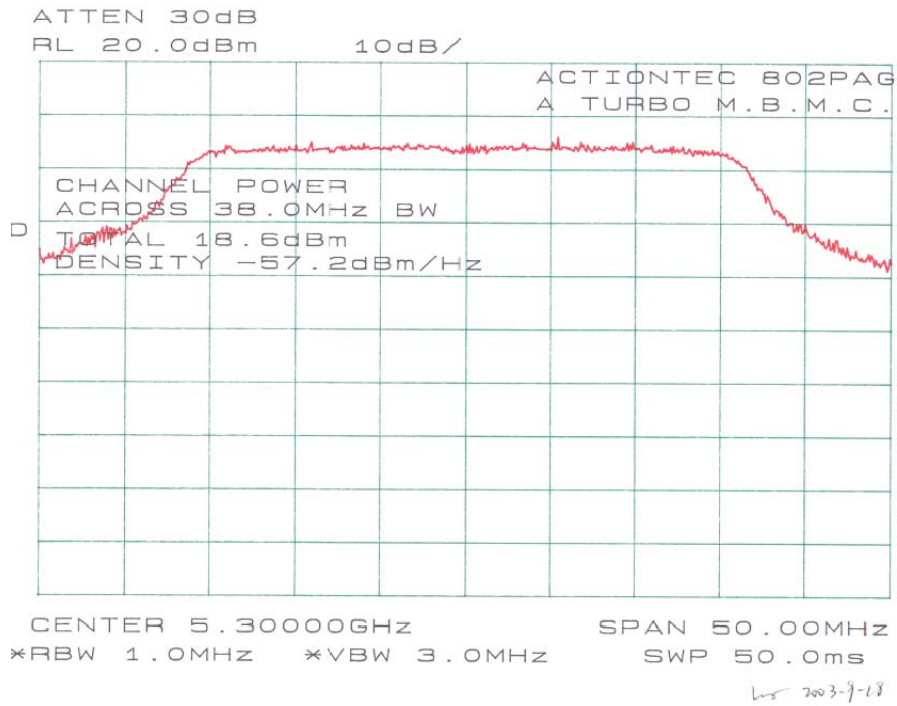


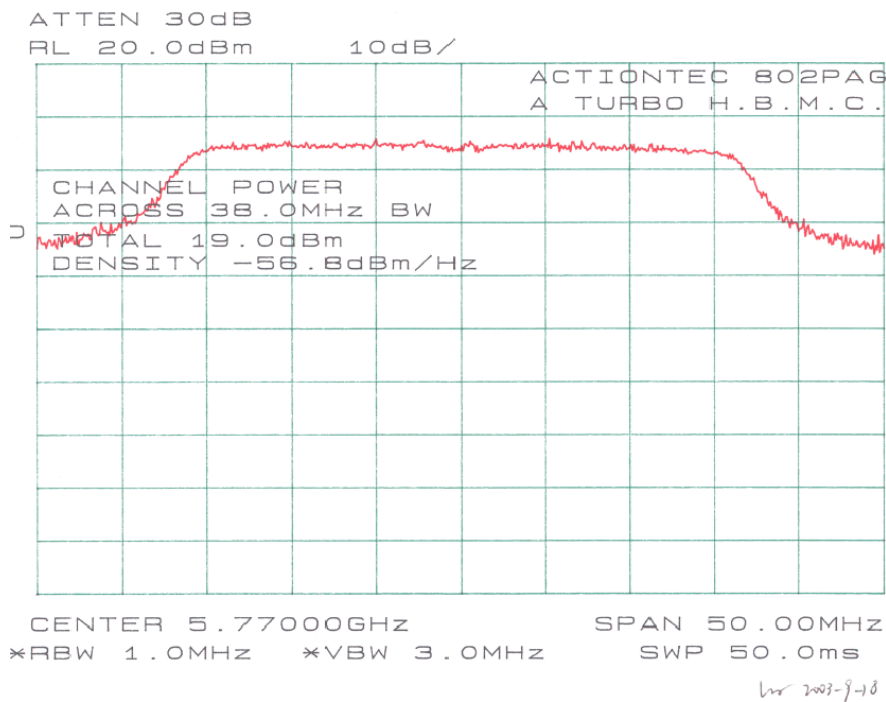
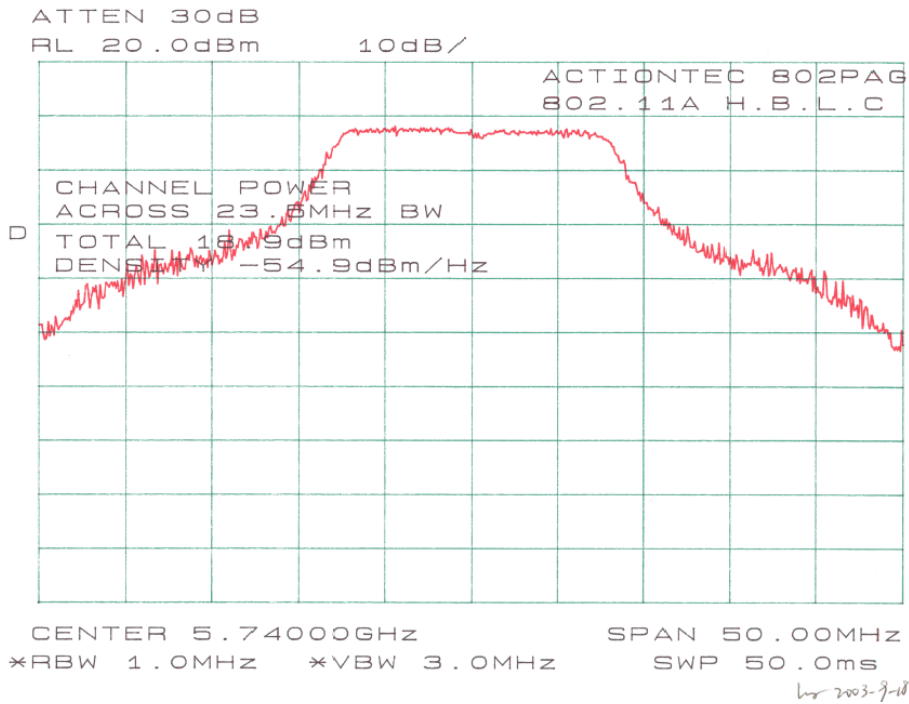


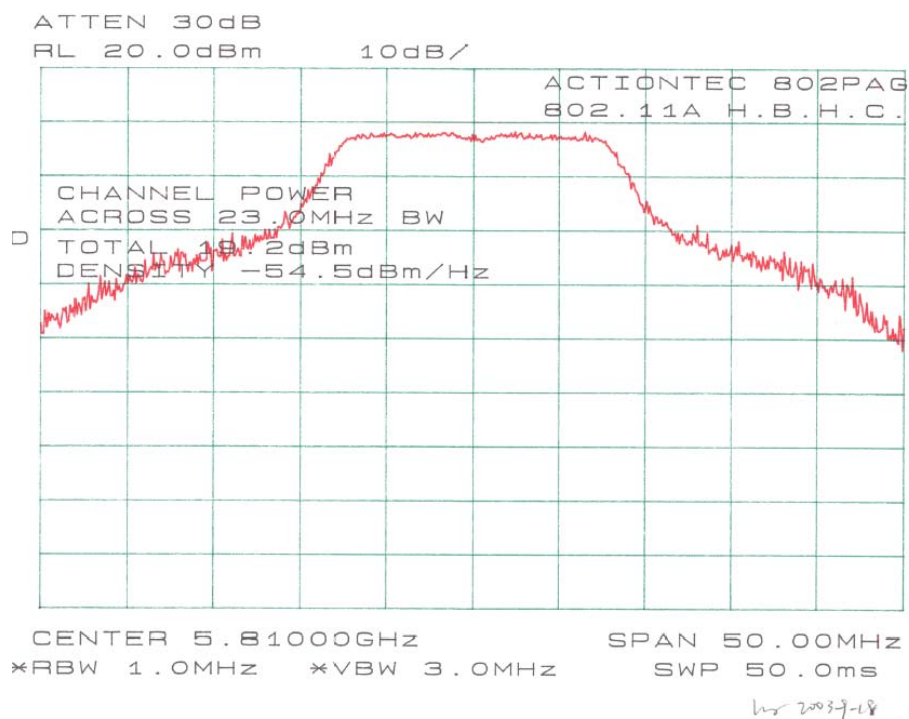
Plots of Peak Output Power for 802.11a (15.407)











5 – 6 DB BANDWIDTH and 26 DB BANDWIDTH

5.1 Standard Applicable

According to §15.247(a)(2), for direct sequence systems, the minimum 6dB bandwidth shall be at least 500 kHz. According to §15.407, 26dB Bandwidth should be shown.

5.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth. (6 dB bandwidth for DTS)
4. Same as (3) except 26 dB. (26dB bandwidth for UNII)
5. Repeat above procedures until all frequencies measured were complete.

5.3 Equipment Lists

Manufacturer	Model No.	Description	Calibration Due Date
Agilent	8564E	Spectrum Analyzer	2004-08-26

5.4 Measurement Result

5.4.1 Test Result for 802.11b (15.247)

Channel	Frequency (MHz)	Measured (MHz)	Measured (kHz)	Standard (kHz)	Result
Low	2412	12.00	1200	≥ 500	Compliant
Mid	2437	12.17	1217	≥ 500	Compliant
High	2462	12.17	1217	≥ 500	Compliant

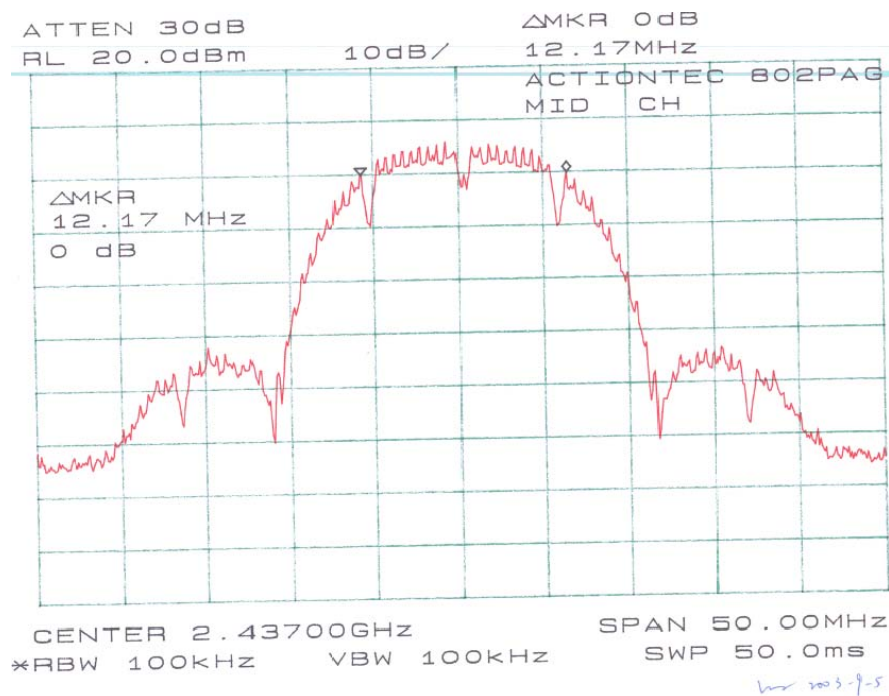
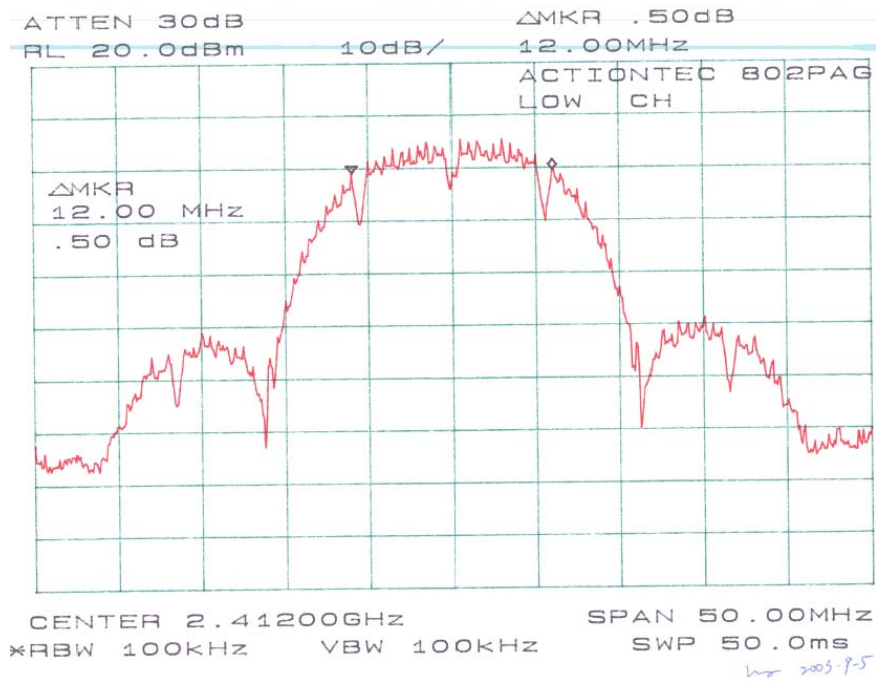
5.4.2 Test Result for 802.11g (15.247)

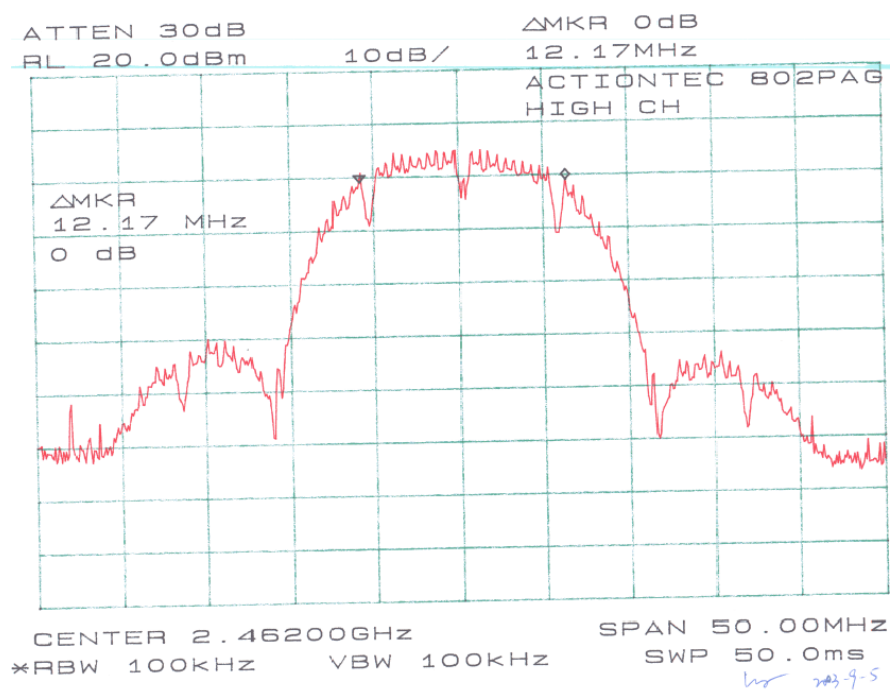
Channel	Frequency (MHz)	Measured (MHz)	Measured (kHz)	Standard (kHz)	Result
Low	2412	16.67	1667	≥ 500	Compliant
Mid	2437	33.33	3333	≥ 500	Compliant
High	2462	16.75	1675	≥ 500	Compliant

5.4.3 Test Result for 802.11a MHz Band (15.407)

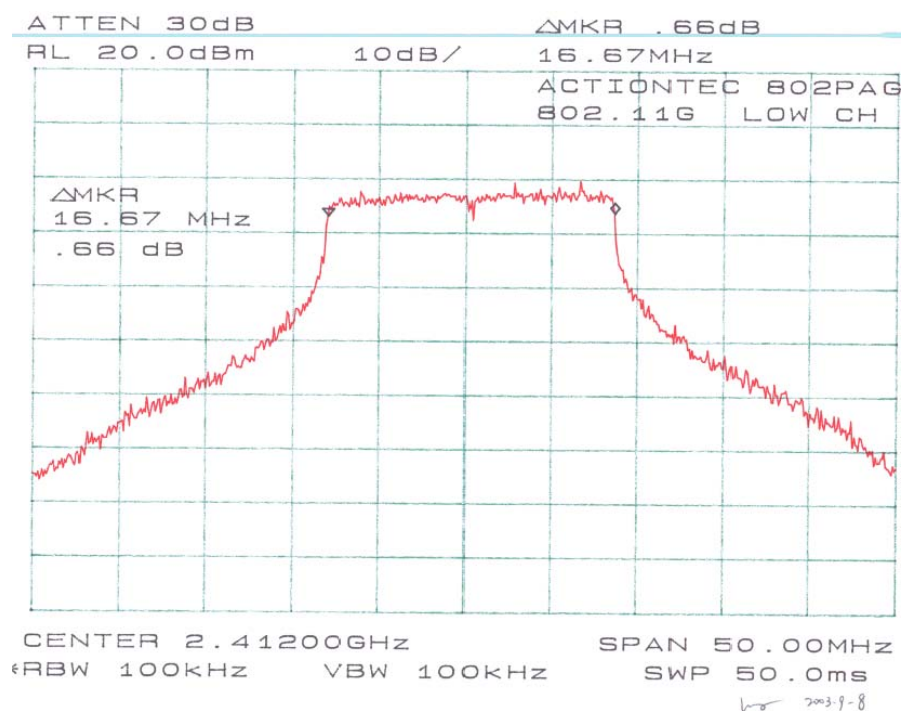
Band	Channel	Frequency (MHz)	Measured (MHz)
Low	Low	5165	23.00
	Mid	5200	38.17
	High	5250	23.33
Mid	Low	5265	23.42
	Mid	5300	38.00
	High	5330	23.40
High	Low	5740	23.50
	Mid	5770	38.00
	High	5810	23.00

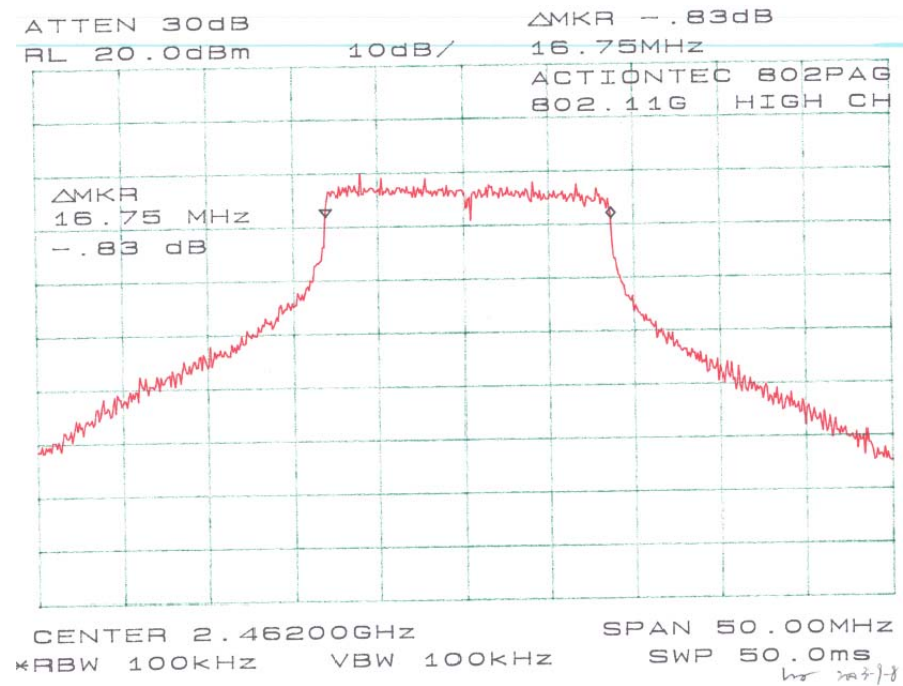
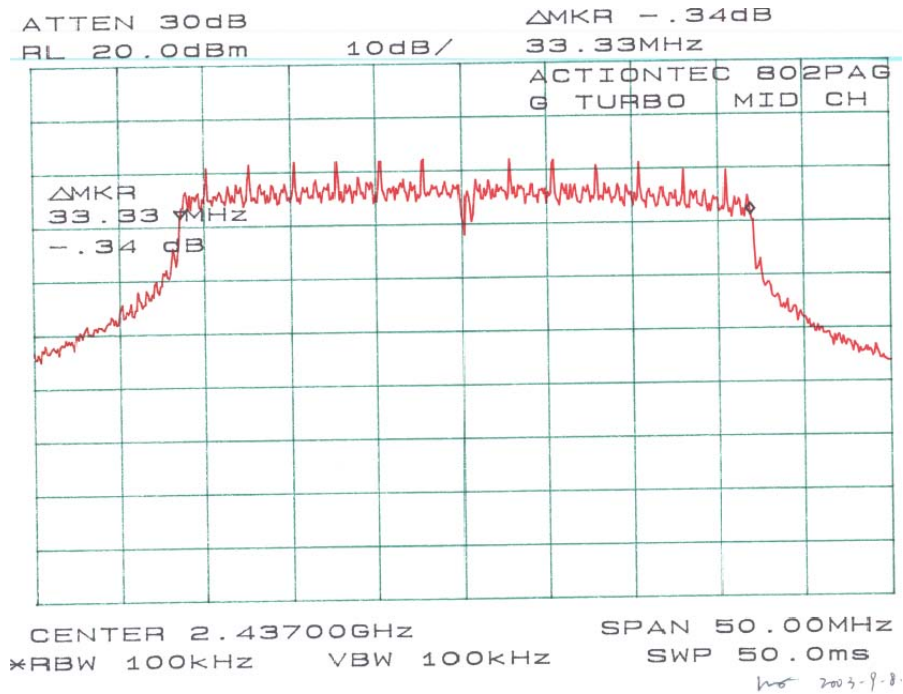
Plots of 6dB Bandwidth for 802.11b (15.247)



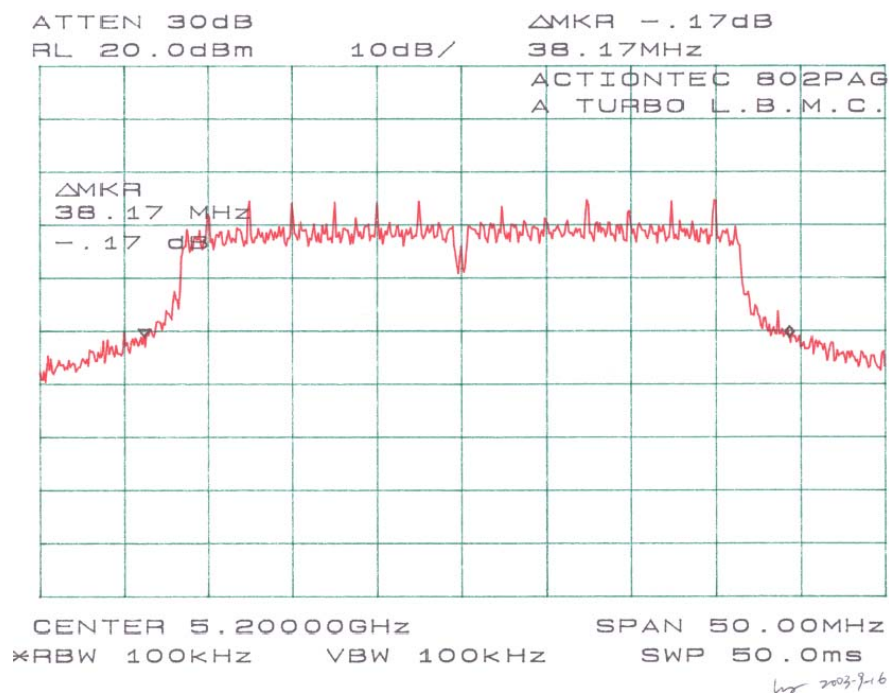
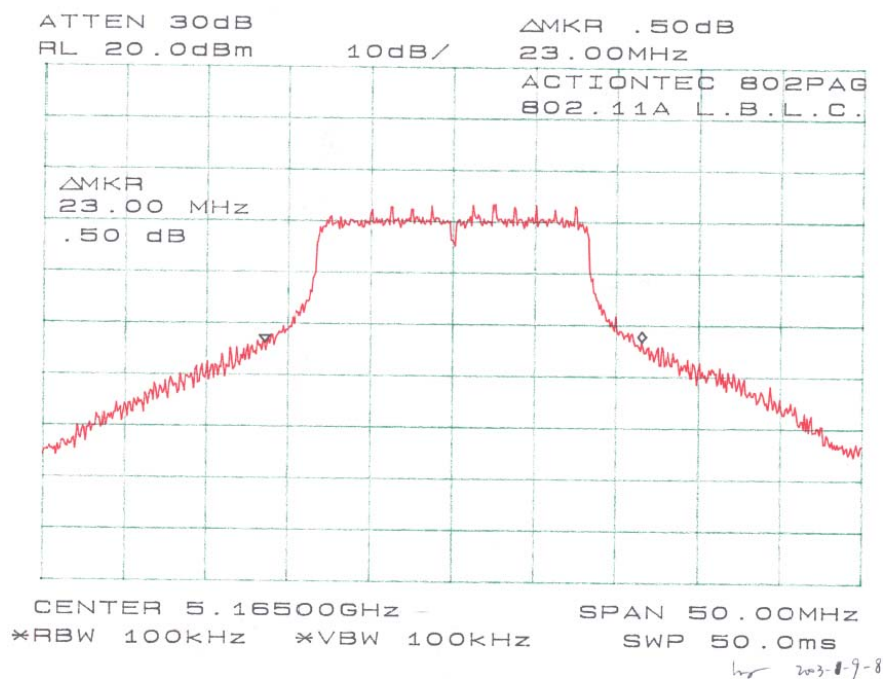


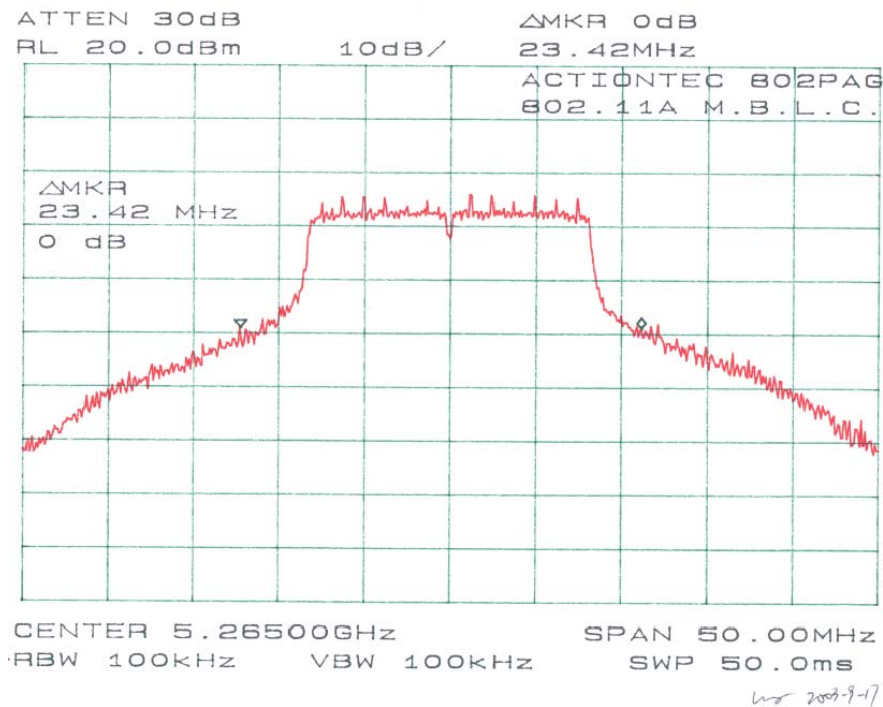
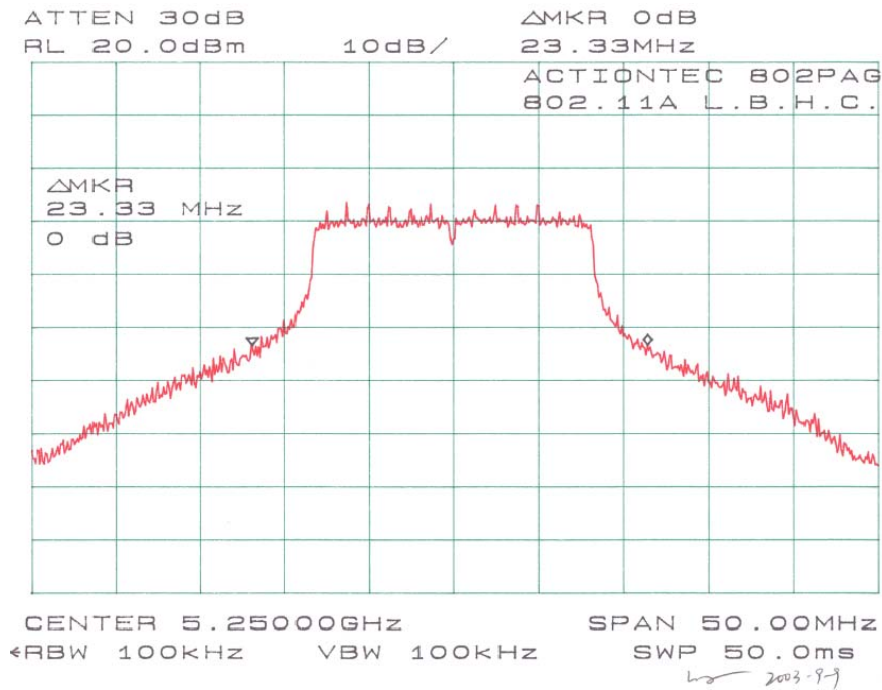
Plots of 6dB Bandwidth for 802.11g (15.247)

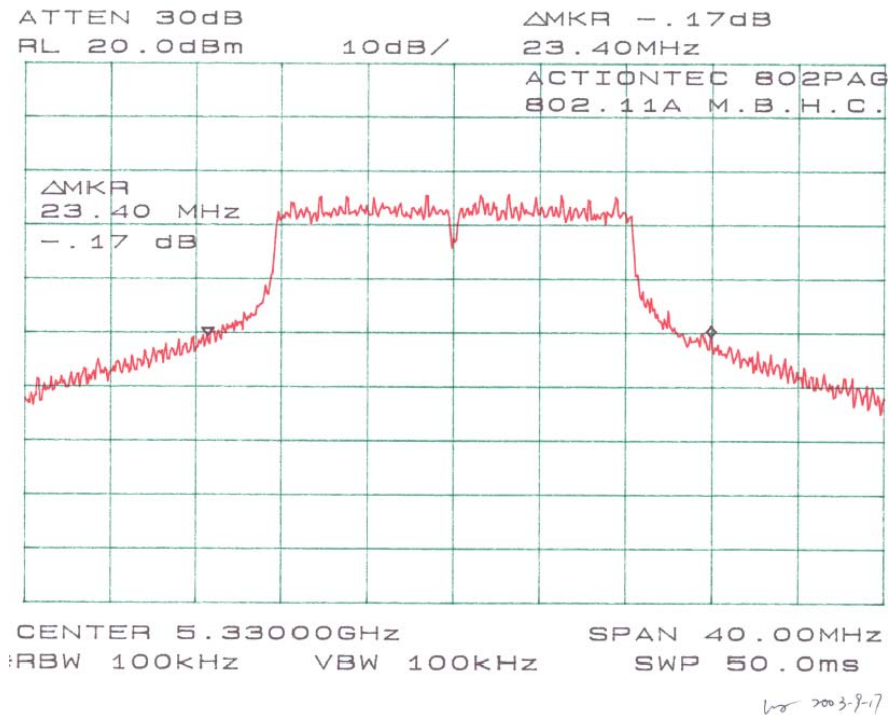
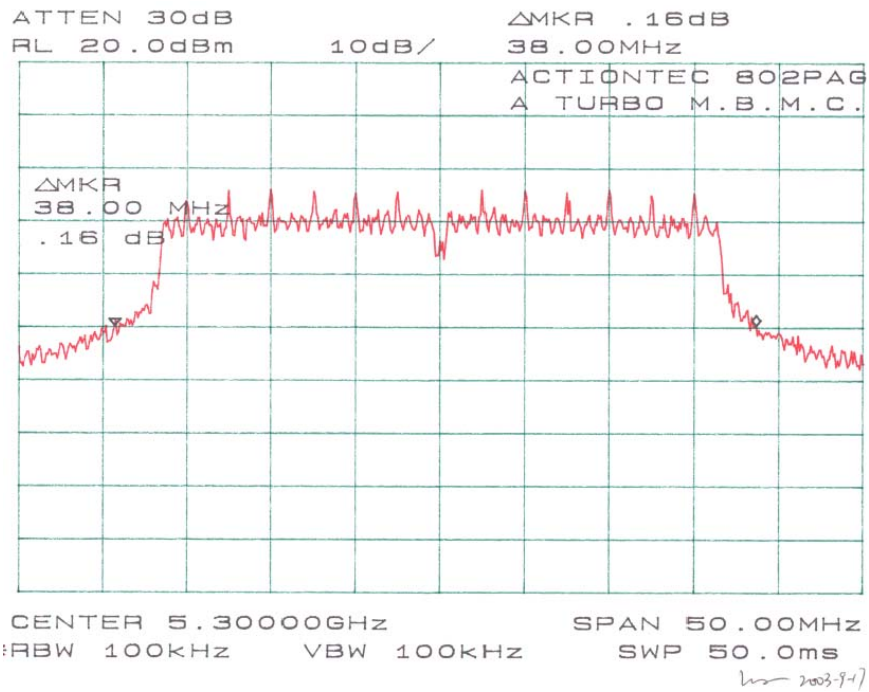


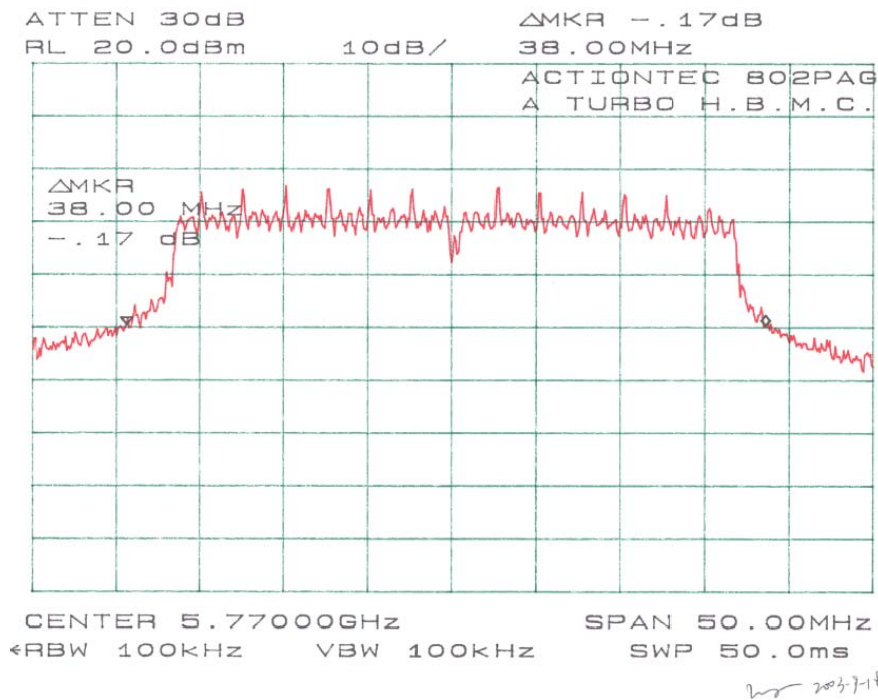
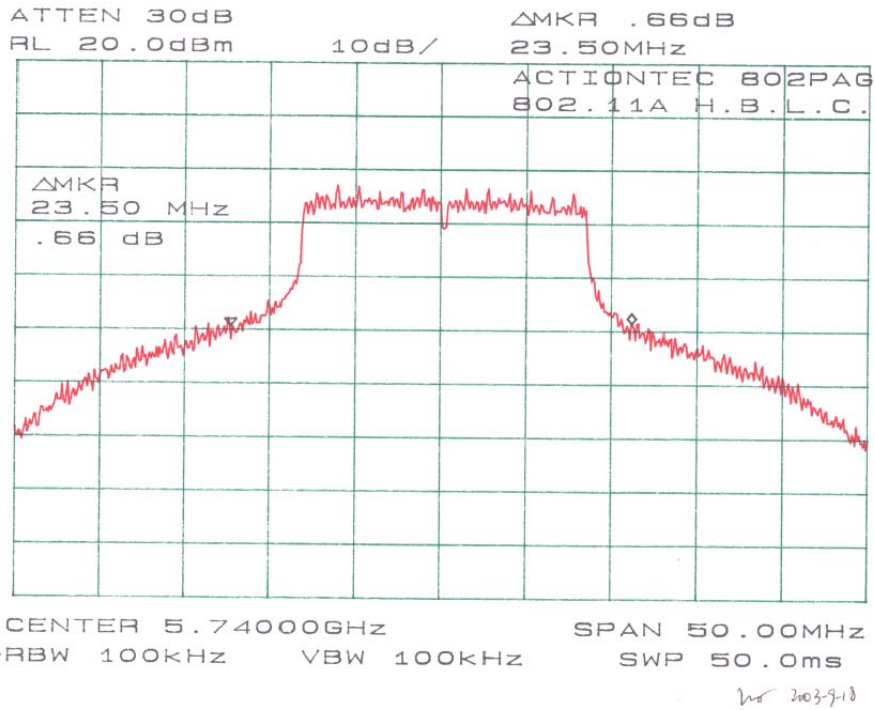


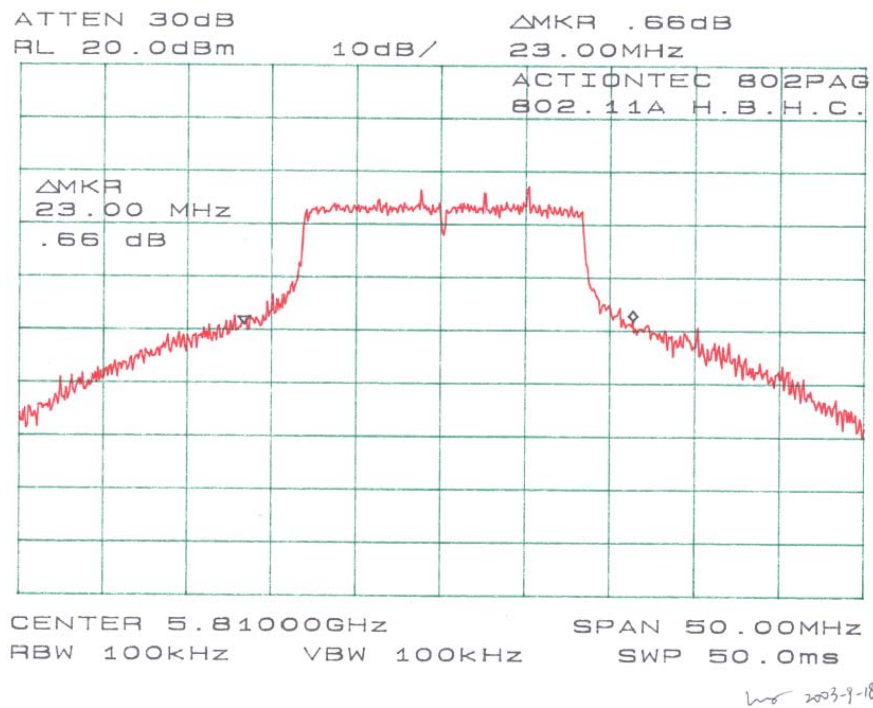
Plots of 26dB Bandwidth for 802.11a (15.407)











6 - POWER SPECTRAL DENSITY

6.1 Standard Applicable

According to §15.247 (d), for direct sequence 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.

According to §15.407(a) (1), for the band 5.15-5.25 GHz, the peak power spectral density shall not exceed 4 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to §15.407(a) (2), for the band 5.25-5.35 GHz, the peak power spectral density shall not exceed 11 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to §15.407(a) (3), for the band 5.725-5.825 GHz, the peak power spectral density shall not exceed 17 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.2 Measurement Procedure

6.2.1 Measurement Procedure for 802.11 b/g (15.247)

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT was set without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Adjust the center frequency of SA on any frequency be measured and set SA to 6MHz span mode. And then, set RBW and VBW of spectrum analyzer to proper value. (DTS)
4. Adjust the center frequency of SA on any frequency be measured and set SA to 50MHz span mode. And then, set RBW and VBW of spectrum analyzer to proper value. (UNII)
5. Repeat above procedures until all frequencies measured were complete.

6.2.2 Measurement Procedure for 802.11a (15.407)

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT was set without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Adjust the center frequency of SA on any frequency be measured and set SA to 6MHz span mode. And then, set RBW and VBW is equal to or larger than RBW.
4. Repeat above procedures until all frequencies measured were complete.

6.3 Equipment Lists

Manufacturer	Model No.	Description	Calibration Due Date
Agilent	8564E	Spectrum Analyzer	2004-08-26

6.4 Measurement Results

6.4.1 Test Result for 802.11b (15.247)

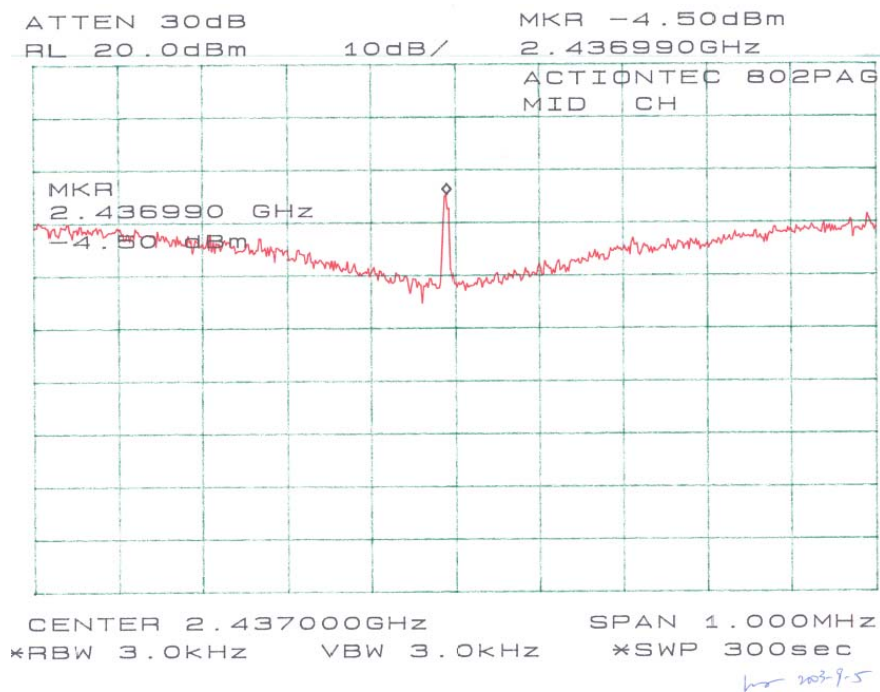
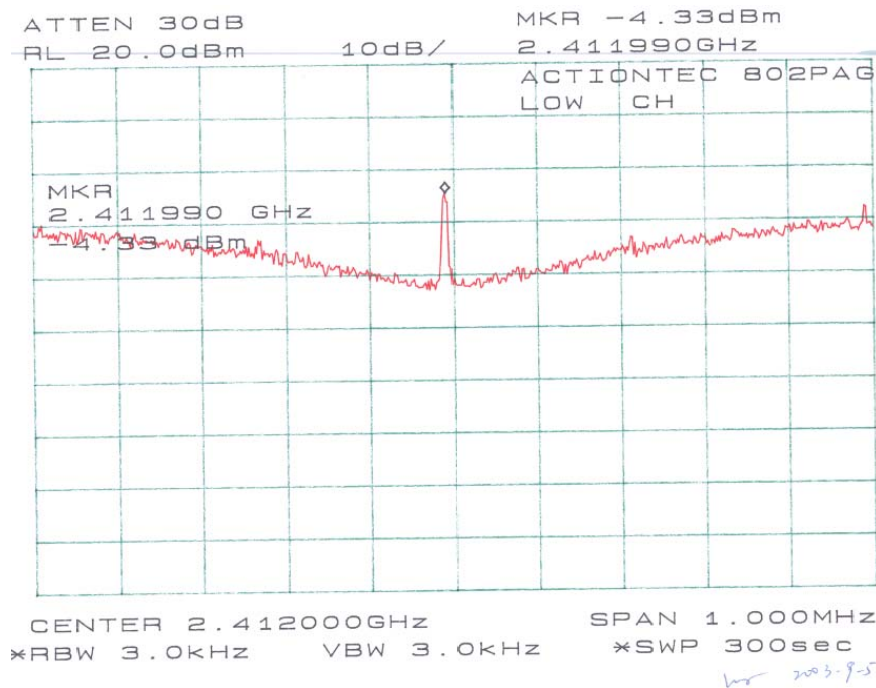
Channel	Frequency (MHz)	Peak Power Spectral Density (dBm)	Standard (dBm)	Result
Low	2412	-4.33	≤ 8	Compliant
Mid	2437	-4.50	≤ 8	Compliant
High	2462	-4.50	≤ 8	Compliant

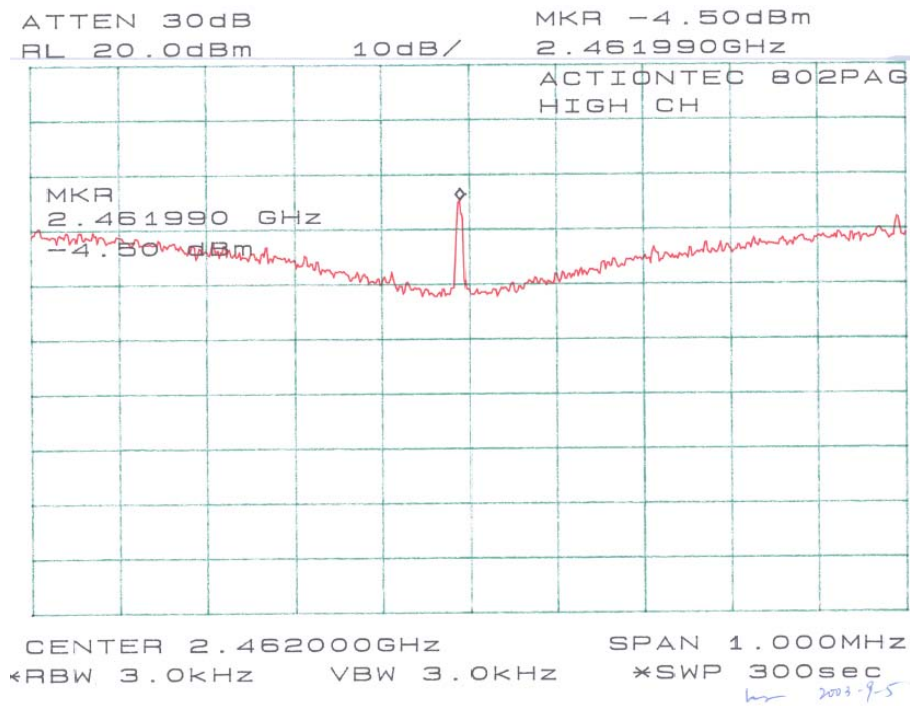
6.4.2 Test Result for 802.11g (15.247)

Channel	Frequency (MHz)	Peak Power Spectral Density (dBm)	Standard (dBm)	Result
Low	2412	-7.83	≤ 8	Compliant
Mid	2437	-5.33	≤ 8	Compliant
High	2462	-7.17	≤ 8	Compliant

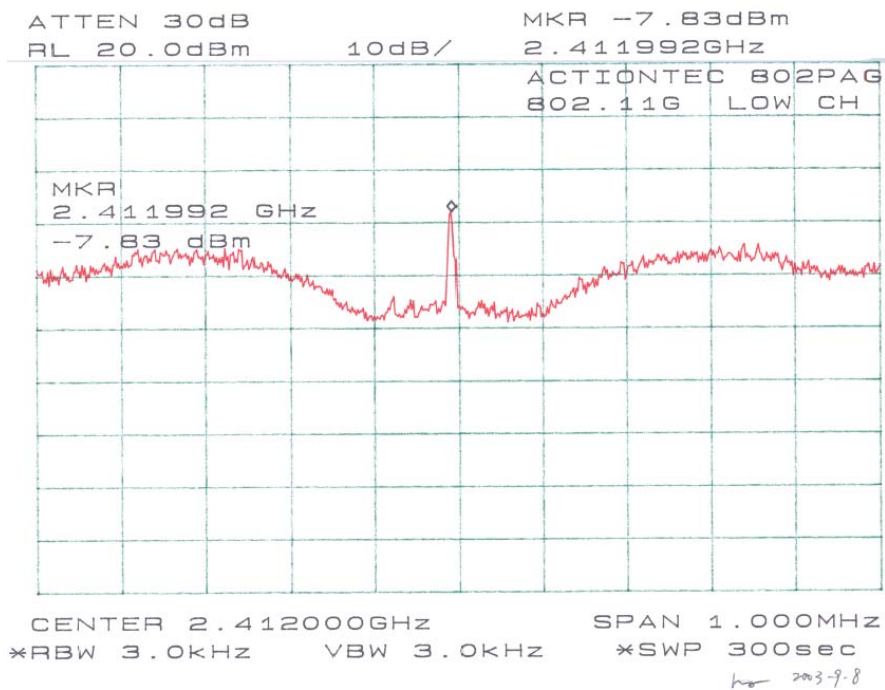
6.4.3 Test Result for 802.11a (15.407)

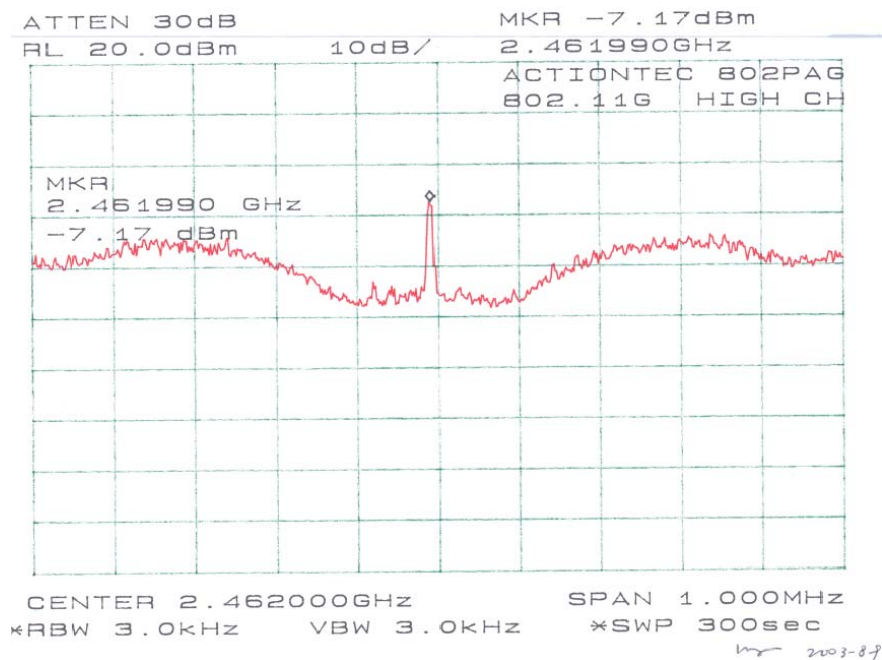
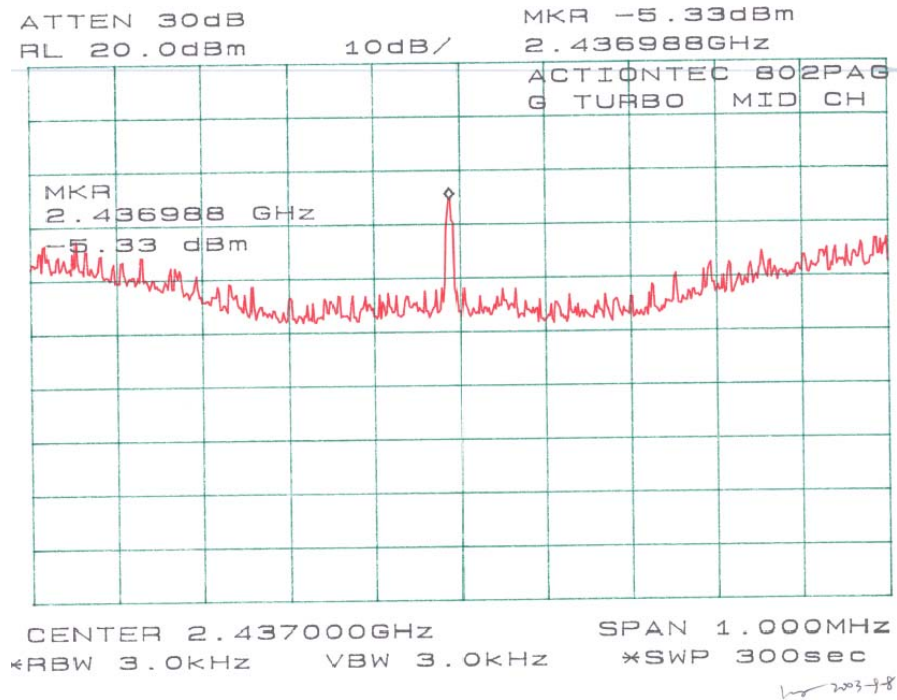
Band	Channel	Frequency (MHz)	Peak Power Spectral Density (dBm)	Standard (dBm)	Result
Low	Low	5165	2.50	≤ 4	Compliant
	Mid	5200	-0.17	≤ 4	Compliant
	High	5250	3.00	≤ 4	Compliant
Mid	Low	5265	4.33	≤ 11	Compliant
	Mid	5300	7.33	≤ 11	Compliant
	High	5330	7.83	≤ 11	Compliant
High	Low	5740	7.67	≤ 17	Compliant
	Mid	5770	4.17	≤ 17	Compliant
	High	5810	6.00	≤ 17	Compliant

Plots of Power Spectral Density for 802.11b (15.247)



Plots of Power Spectral Density for 802.11g (15.247)





Plots of Spectral Density for 802.11a (15.407)