§15.205 & §15.209 - SPURIOUS RADIATED EMISSION

Measurement Uncertainty

All measurements involve certain levels of uncertainties. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of a radiation emissions measurement at BACL is ±4.0 dB.

According to §15.205, except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
[1]0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2655 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.57725	240 – 285	3345.8 – 3358	36.43 – 36.5
13.36 – 13.41	322 – 335.4	3600 – 4400	([2])

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510MHz
[2] Above 38.6

Except as provided in paragraph (d) and (e), the filed strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

According to §15.209, the device shall meet radiated emission general requirements.

Except for Class A device, the filed strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of Emission (MHz)	Field Strength (Microvolts/meter)	Field Strength (dBμV/meter)
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

EUT Setup

The radiated emission tests were performed in the open area 3-meter test site, using the setup accordance with the ANSI C63.4-2003. The specification used was the FCC 15.209 limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

The EUT was connected to the power adapter which is connected with 120Vac/60Hz power source.

Spectrum Analyzer Setup

According to FCC Rules, 47 CFR, Section 15.33, the frequency was investigated from 30 to 25000 MHz.

During the radiated emission test, the spectrum analyzer was set with the following configurations:

Frequency Range	***RBW***	***Video B/W***
Below 30MHz	10kHz	10kHz
30 – 1000MHz	100kHz	100kHz
Above 1000MHz	1MHz	1MHz

For Average measurement: RBW = 1MHz, VBW = 10Hz (above 1000MHz)

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Cal. Date
HP	Analyzer, Spectrum	8565EC	3946A00131	08/06/2004
ETS	Antenna, Log-Periodic	3148	4-1155	12/14/2004
ETS	Antenna, Biconical	3110B	9603-2315	12/14/2004
HP	Amplifier, Pre	8447D	2944A10198	08/20/2004
HP	Amplifier, Pre, Microwave	8449B	3147A00400	06/14/2004
A. H. Systems	Antenna, Horn, DRG	SAS-200/571	261	04/20/2005
Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100044	09/29/2004
Sunol Sciences	Antenna	JB1	A013105-3	02/11/2005

* **Statement of Traceability:** BACL attests that all calibrations have been performed per the NVLAP requirements, traceable to NIST.

Test Procedure

For the radiated emissions test, the EUT, and all support equipment power cords was connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All data was recorded in the peak detection mode. Quasi-peak readings performed only when an emission was found to be marginal (within -4 dB of specification limits), and are distinguished with a "**Qp**" in the data table.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. - FCC 15.209 Limit

Environmental Conditions

Temperature:	23° C
Relative Humidity:	42%
ATM Pressure:	1018 mbar

The testing was performed by Daniel Deng and Jerry Wang on 2005-07-08.

Summary of Test Results

According to the data hereinafter, the EUT measured -2.6dB within the measurement uncertainty of ±4.0, and had the worst margin of:

802.11b:

-16.3 dB at **7236 MHz** in the **Vertical** polarization, Low Channel

-13.3 dB at **4884 MHz** in the **Horizontal** polarization, Middle Channel

-15.3 dB at **4924** in the **Horizontal** polarization, High Channel

-2.6 dB (QP) at 240 MHz in the **Horizontal** polarization, Unintentional Emission

802.11g:

-16.3 dB at **7236 MHz** in the **Horizontal** polarization, Low Channel

-15.5 dB at **7326 MHz** in the **Horizontal** polarization, Middle Channel

-15.6 dB at **4924 MHz** in the **Vertical** polarization, High Channel

-2.6 dB (QP) at **240 MHz** in the **Horizontal** polarization, Unintentional Emission

Radiated Emission Test Result for 802.11b

Indicated			Table	Antenna		Correction Factor			Corrected Amplitude	FCC 15 Subpart C	
Frequency MHz	Ampl. dBμV/m	Comments	Angle Degree	Height Meter	Polar H/ V	Antenna dB	Cable dB	Amp. dB	Corr. Ampl. dBμV/m	Limit dBμV/m	Margin dB
Low Channel, 1-25GHz											
7236.0000	31.35	Ave	0	1.4	v	36.7	4.3	34.7	37.7	54	-16.3
7236.0000	31.25	Ave	0	1.3	h	36.7	4.3	34.7	37.6	54	-16.4
4824.0000	36.75	Ave	0	1.5	h	32.5	3.1	34.8	37.6	54	-16.5
4824.0000	35.75	Ave	0	1.3	v	32.5	3.1	34.8	36.6	54	-17.5
7236.0000	44.79	Peak	0	1.4	v	36.7	4.3	34.7	51.1	74	-22.9
7236.0000	44.50	Peak	0	1.3	h	36.7	4.3	34.7	50.8	74	-23.2
4824.0000	48.83	Peak	0	1.3	v	32.5	3.1	34.8	49.6	74	-24.4
4824.0000	46.42	Peak	0	1.4	h	32.5	3.1	34.8	47.2	74	-26.8
Middle Channel, 1-25GHz											
4884.0000	39.9	Ave	300	1.5	h	32.5	3.1	34.8	40.7	54	-13.3
7326.0000	31.8	Ave	0	1.3	v	36.7	4.3	34.7	38.2	54	-15.8
7326.0000	31.9	Ave	0	1.6	h	36.7	4.3	34.7	38.2	54	-15.8
4884.0000	35.2	Ave	0	1.1	v	32.5	3.1	34.8	36.0	54	-18.0
7326.0000	45.1	Peak	0	1.6	h	36.7	4.3	34.7	51.4	74	-22.6
7326.0000	44.9	Peak	0	1.3	v	36.7	4.3	34.7	51.3	74	-22.7
4884.0000	48.8	Peak	0	1.1	v	32.5	3.1	34.8	49.6	74	-24.5
4884.0000	47.9	Peak	300	1.5	h	32.5	3.1	34.8	48.7	74	-25.3
High Channel, 1-25GHz											
4924.0000	37.9	Ave	300	1.4	h	32.5	3.1	34.8	38.7	54	-15.3
4924.0000	37.3	Ave	90	1.5	v	32.5	3.1	34.8	38.1	54	-15.9
7386.0000	31.3	Ave	300	1.5	h	36.7	4.3	34.7	37.6	54	-16.4
7386.0000	31.2	Ave	90	1.3	v	36.7	4.3	34.7	37.5	54	-16.5
7386.0000	44.8	Peak	300	1.5	h	36.7	4.3	34.7	51.1	74	-22.9
7386.0000	44.6	Peak	90	1.3	v	36.7	4.3	34.7	50.9	74	-23.1
4924.0000	48.2	Peak	90	1.5	v	32.5	3.1	34.8	49.0	74	-25.0
4924.0000	47.3	Peak	300	1.4	h	32.5	3.1	34.8	48.1	74	-25.9

30MHz – 1GHz

Indicated			Table	Antenna		Correction Factor			FCC 15 Subpart B	
Frequency	Ampl.	Direction	Height	Polar	Antenna	Cable Loss	Amp.	Corr. Ampl.	Limit	Margin
MHz	dBμV/m	Degree	Meter	H/V	dB	dB	dB	dBμV/m	dBμV/m	dB
240	55.3	0	1.0	H3	12.3	3.3	27.5	43.4	46	-2.6QP
480	48.7	120	1.2	H3	18.0	4.8	28.6	42.9	46	-3.1QP
480	48.5	200	1.5	V3	18.0	4.8	28.6	42.7	46	-3.3QP
600	46.3	200	1.2	H3	19.5	5.4	28.6	42.6	46	-3.4QP
159.7	52.3	200	1.5	H3	12.8	2.5	28.0	39.6	43.5	-3.9QP
200	51.6	180	1.5	H3	12.6	3.0	27.7	39.5	43.5	-4.0
200	51.4	200	1.2	V3	12.6	3.0	27.7	39.3	43.5	-4.2
600	45.3	180	1.2	V3	19.5	5.4	28.6	41.6	46	-4.4QP
240	53.4	200	1.2	V3	12.3	3.3	27.5	41.5	46	-4.5QP
720	42.3	180	1.2	H3	20.8	6.0	28.2	40.9	46	-5.1
120	48.9	120	1.2	H3	14.2	2.4	28.2	37.3	43.5	-6.2QP

Radiated Emission Test Result for 802.11g

Indicated			Table	Antenna		Correction Factor			Corrected Amplitude	FCC 15 Subpart C	
Frequency MHz	Ampl. dBμV/m	Comments	Angle Degree	Height Meter	Polar H/V	Antenna dB	Cable dB	Amp. dB	Corr. Ampl. dBμV/m	Limit dBμV/m	Margin dB
Low Channel, 1-25GHz											
7236.0000	31.33	Ave	0	1.2	h	36.7	4.3	34.7	37.7	54	-16.3
7236.0000	30.83	Ave	90	1.3	v	36.7	4.3	34.7	37.2	54	-16.8
4824.0000	34.58	Ave	0	1.3	h	32.5	3.1	34.8	35.4	54	-18.6
4824.0000	34.10	Ave	90	1.5	v	32.5	3.1	34.8	34.9	54	-19.1
7236.0000	44.25	Peak	0	1.2	h	36.7	4.3	34.7	50.6	74	-23.4
7236.0000	44.08	Peak	90	1.3	v	36.7	4.3	34.7	50.4	74	-23.6
4824.0000	47.50	Peak	0	1.3	h	32.5	3.1	34.8	48.3	74	-25.7
4824.0000	45.42	Peak	90	1.5	v	32.5	3.1	34.8	46.2	74	-27.8
Middle Channel, 1-25GHz											
7326.0000	32.2	Ave	0	1.4	h	36.7	4.3	34.7	38.5	54	-15.5
7326.0000	31.7	Ave	150	1.6	v	36.7	4.3	34.7	38.0	54	-16.0
4884.0000	36.9	Ave	300	1.5	h	32.5	3.1	34.8	37.7	54	-16.3
4884.0000	35.8	Ave	90	1.5	v	32.5	3.1	34.8	36.6	54	-17.4
7326.0000	45.1	Peak	0	1.4	h	36.7	4.3	34.7	51.4	74	-22.6
7326.0000	44.3	Peak	150	1.5	v	36.7	4.3	34.7	50.6	74	-23.4
4884.0000	46.8	Peak	300	1.5	h	32.5	3.1	34.8	47.6	74	-26.4
4884.0000	45.9	Peak	0	1.1	v	32.5	3.1	34.8	46.7	74	-27.3
High Channel, 1-25GHz											
4924.0000	37.6	Ave	330	1.4	v	32.5	3.1	34.8	38.4	54	-15.6
7386.0000	31.1	Ave	330	1.4	v	36.7	4.3	34.7	37.4	54	-16.6
7386.0000	31.1	Ave	0	1.5	h	36.7	4.3	34.7	37.4	54	-16.6
4924.0000	34.4	Ave	90	1.4	h	32.5	3.1	34.8	35.2	54	-18.8
7386.0000	44.6	Peak	0	1.5	h	36.7	4.3	34.7	50.9	74	-23.1
7386.0000	44.5	Peak	90	1.3	v	36.7	4.3	34.7	50.8	74	-23.2
4924.0000	47.3	Peak	330	1.4	v	32.5	3.1	34.8	48.1	74	-25.9
4924.0000	45.5	Peak	90	1.4	h	32.5	3.1	34.8	46.3	74	-27.7

30MHz – 1GHz

Indicated			Table	Antenna		Correction Factor			FCC 15 Subpart B	
Frequency	Ampl.	Direction	Height	Polar	Antenna	Cable Loss	Amp.	Corr. Ampl.	Limit	Margin
MHz	dBμV/m	Degree	Meter	H/V	dB	dB	dB	dBμV/m	dBμV/m	dB
240	55.3	0	1.0	H3	12.3	3.3	27.5	43.4	46	-2.6QP
480	48.7	120	1.2	H3	18.0	4.8	28.6	42.9	46	-3.1QP
480	48.5	200	1.5	V3	18.0	4.8	28.6	42.7	46	-3.3QP
600	46.3	200	1.2	H3	19.5	5.4	28.6	42.6	46	-3.4QP
159.7	52.3	200	1.5	H3	12.8	2.5	28.0	39.6	43.5	-3.9QP
200	51.6	180	1.5	H3	12.6	3.0	27.7	39.5	43.5	-4.0
200	51.4	200	1.2	V3	12.6	3.0	27.7	39.3	43.5	-4.2
600	45.3	180	1.2	V3	19.5	5.4	28.6	41.6	46	-4.4QP
240	53.4	200	1.2	V3	12.3	3.3	27.5	41.5	46	-4.5QP
720	42.3	180	1.2	H3	20.8	6.0	28.2	40.9	46	-5.1
120	48.9	120	1.2	H3	14.2	2.4	28.2	37.3	43.5	-6.2QP

§15.247(a)(2) – 6 dB BANDWIDTH

Standard Applicable

According to §15.247(a)(2), for digital modulation techniques, the minimum 6dB bandwidth shall be at least 500 kHz.

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. Repeat above procedures until all frequencies measured were complete.

Equipment Lists

Manufacturer	Description	Model	Serial Number	Cal. Date
HP	Analyzer, Spectrum	8565EC	3946A00131	06/08/2004

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Measurement Result

Environmental Conditions

Temperature:	23° C
Relative Humidity:	45%
ATM Pressure:	1015 mbar

The testing was performed by Daniel Deng on 2005-07-07.

Test Result

802.11b

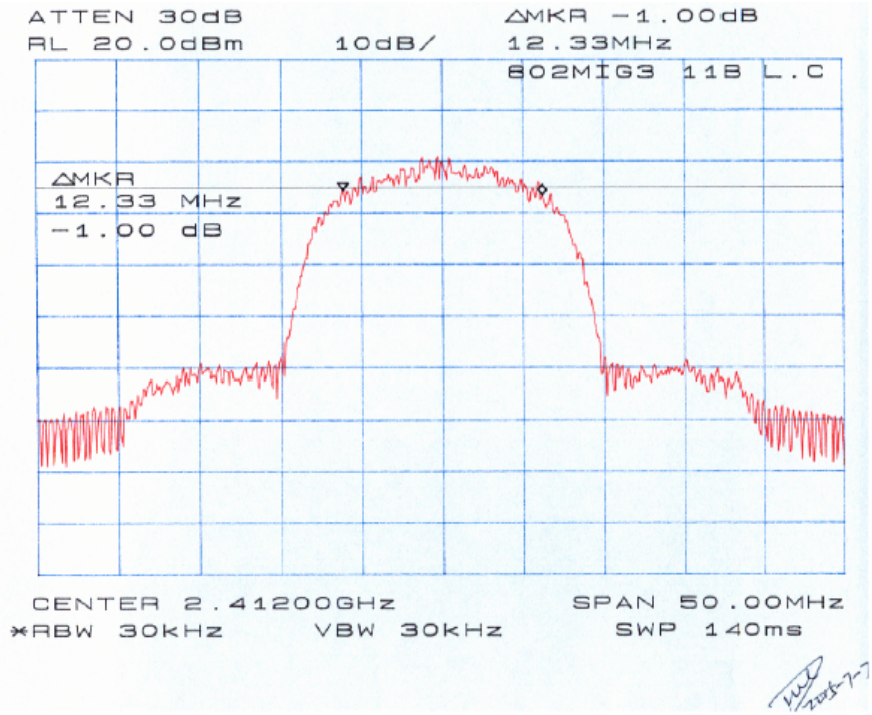
Channel	Frequency (MHz)	Measured (MHz)	Standard (kHz)	Result
Low	2412	12.33	≥ 500	Pass
Mid	2442	12.33	≥ 500	Pass
High	2462	12.33	≥ 500	Pass

802.11g

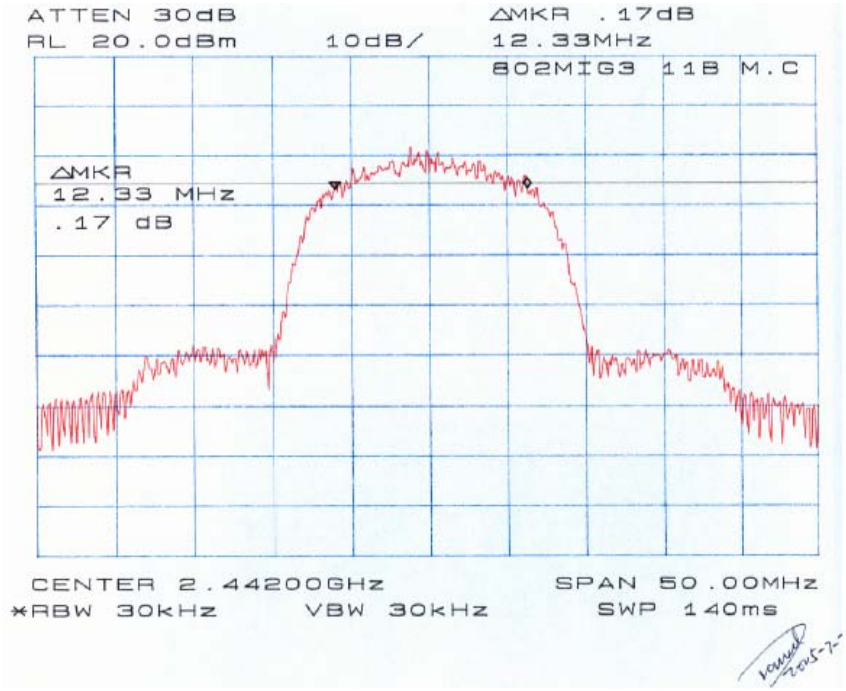
Channel	Frequency (MHz)	Measured (MHz)	Standard (kHz)	Result
Low	2412	16.33	≥ 500	Pass
Mid	2442	16.42	≥ 500	Pass
High	2462	16.42	≥ 500	Pass

802.11b

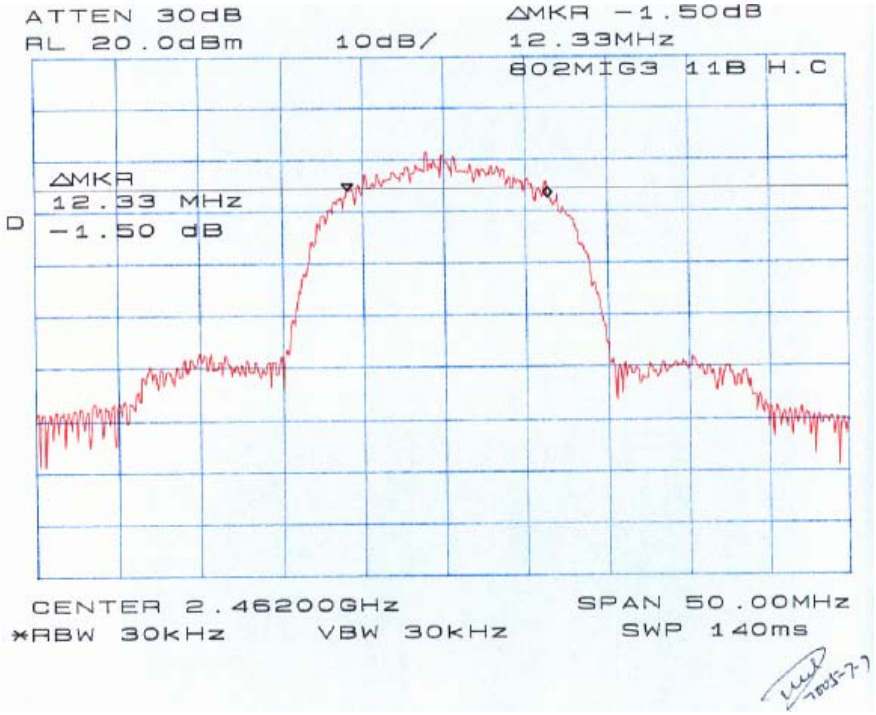
Low Channel



Middle Channel



High Channel



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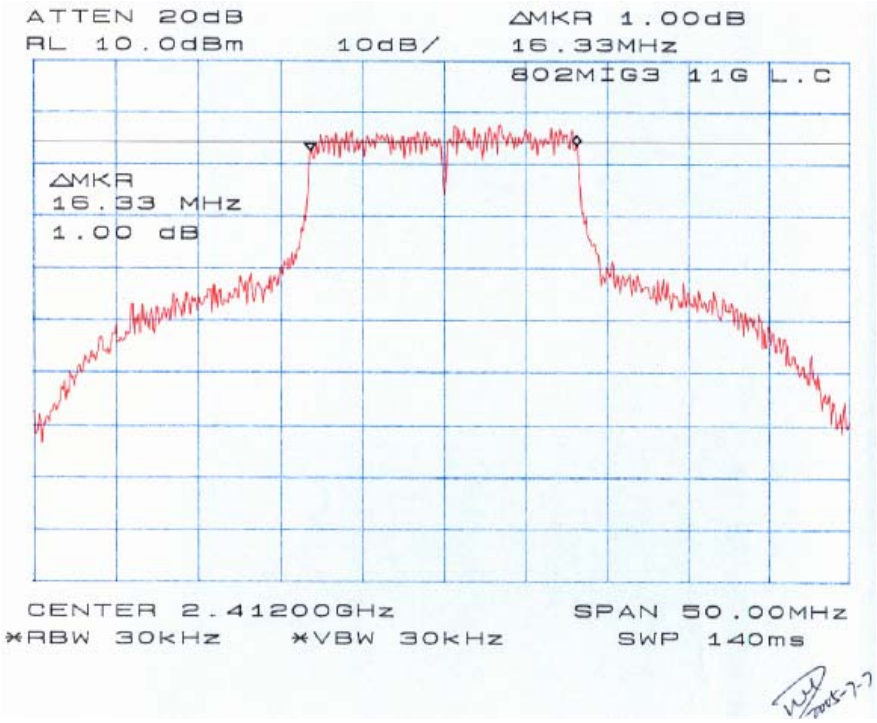
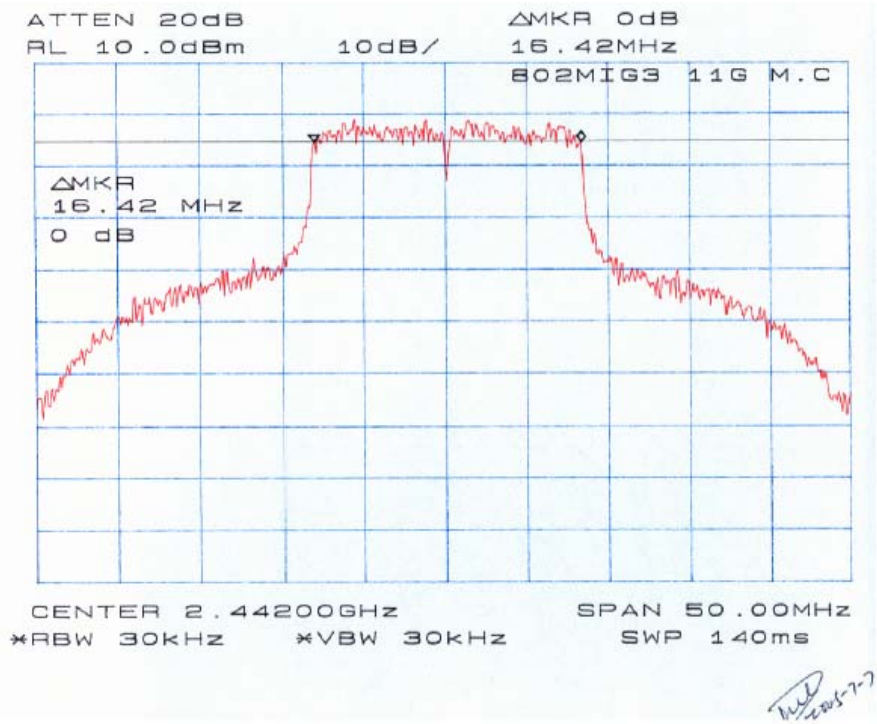
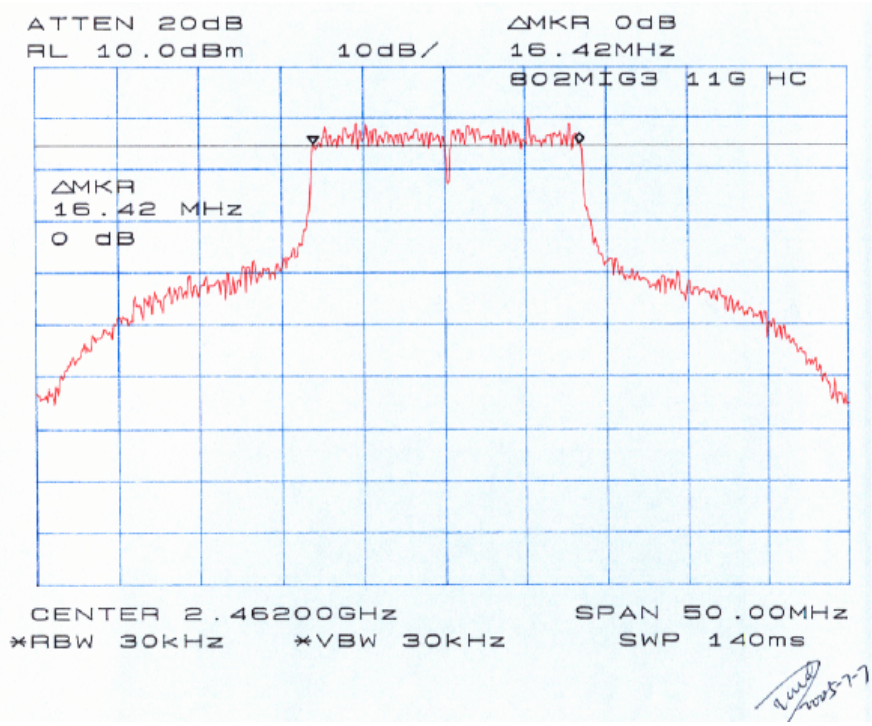
Low Channel



Middle Channel



High Channel



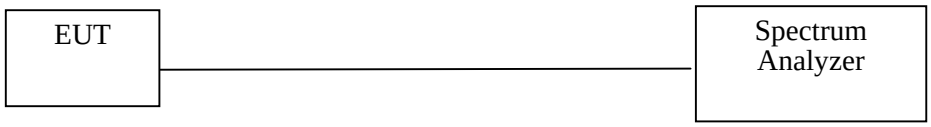
§15.247(b)(3) - PEAK OUTPUT POWER MEASUREMENT

Standard Applicable

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

Measurement Procedure

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.



Equipment Lists

Manufacturer	Description	Model	Serial Number	Cal. Date
HP	Analyzer, Spectrum	8565EC	3946A00131	06/08/2004
Agilent	Sensor, Power	E4412A	US38488542	07/05/2005
Agilent	Meter, Power	E4419B	MY4121511	29/04/2005

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Measurement Result

Environmental Conditions

Temperature:	23° C
Relative Humidity:	45%
ATM Pressure:	1015 mbar

The testing was performed by Daniel Deng on 2005-07-07.

Output Power

802.11b

Channel	Frequency MHz	Max Peak Output Power (dBm)	(mW)	Limit (mW)	Result
Low	2412	16.46	44.26	1000	pass
Mid	2442	16.46	44.26	1000	pass
High	2462	16.56	45.29	1000	pass

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Channel	Frequency MHz	Max Peak Output Power (dBm)	(mW)	Limit (mW)	Result
Low	2412	16.47	44.36	1000	pass
Mid	2442	16.44	44.06	1000	pass
High	2462	16.50	44.67	1000	pass

§15.247(d) - 100 KHZ BANDWIDTH OF BAND EDGES

Standard Applicable

According to §15.247(d), in *any* 100 kHz bandwidth outside the frequency bands in which the spread spectrum 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) see §15.205(c)).

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 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. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Equipment Lists

Manufacturer	Description	Model	Serial Number	Cal. Date
HP	Analyzer, Spectrum	8565EC	3946A00131	06/08/2004

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Measurement Result

Environmental Conditions

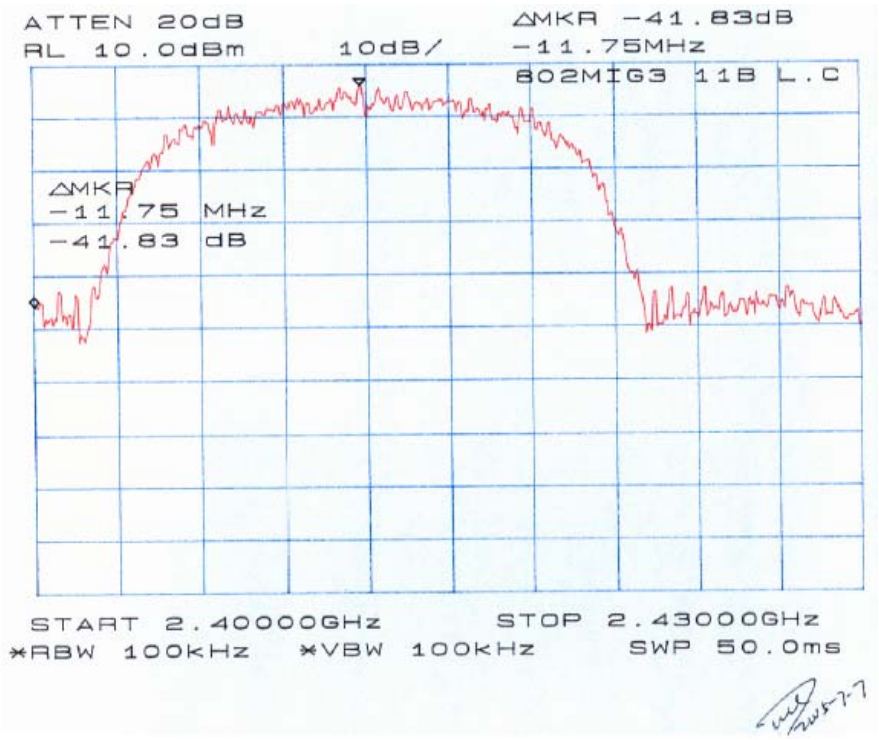
Temperature:	23° C
Relative Humidity:	45%
ATM Pressure:	1015 mbar

The testing was performed by Daniel Deng on 2005-07-07.

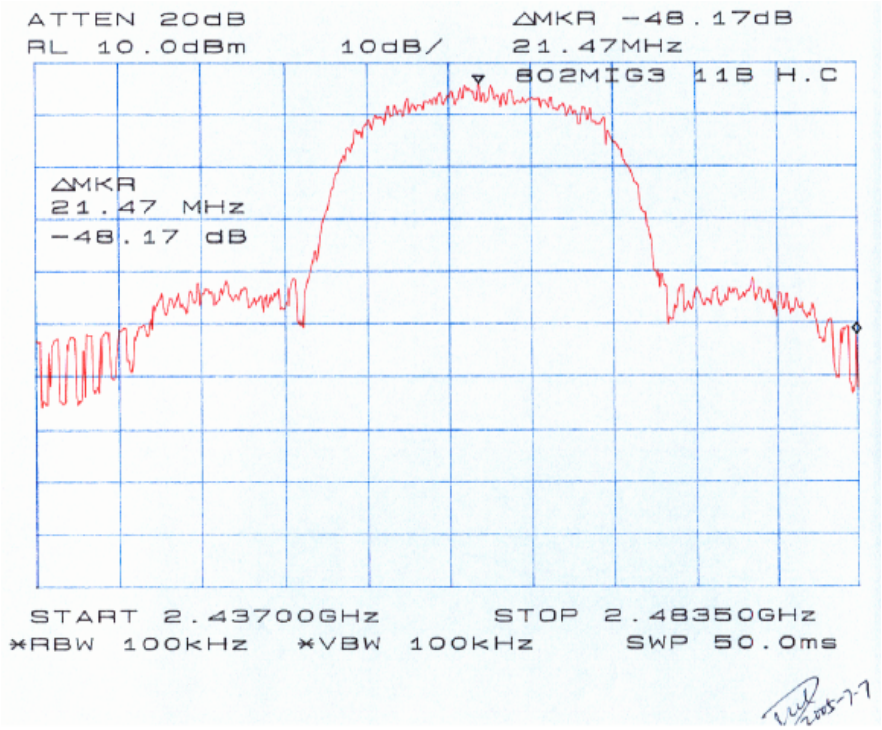
Please refer to following pages for plots of band edge.

802.11b

Low Channel

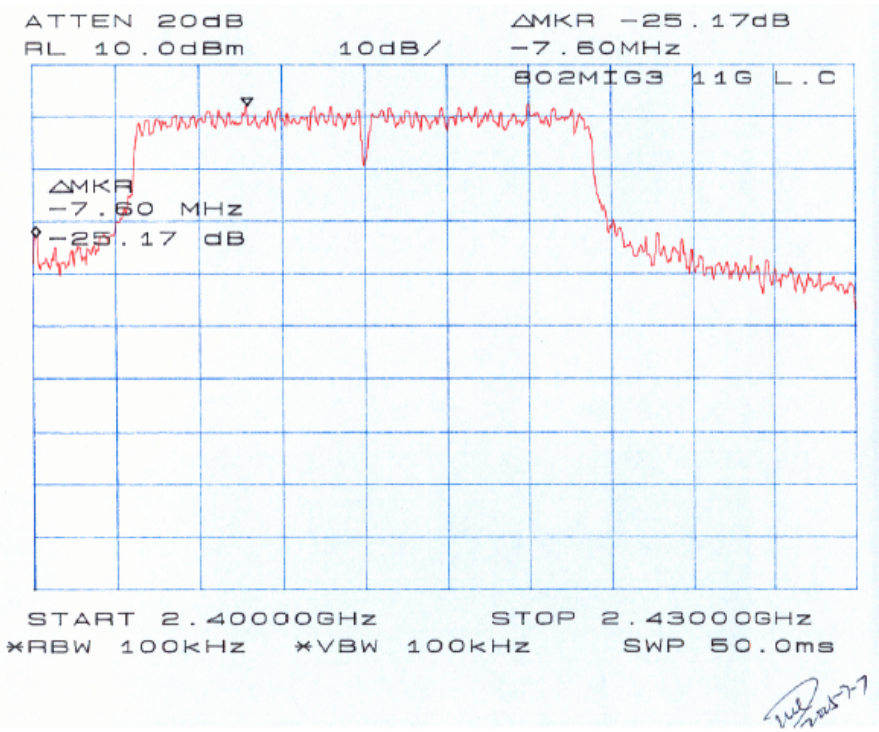


High Channel

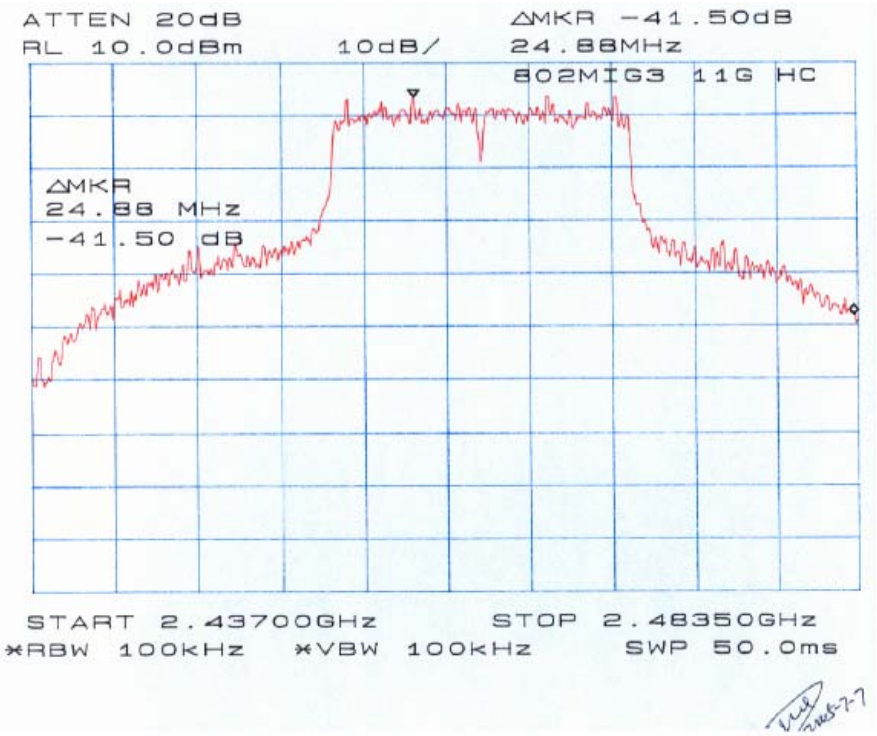


802.11g

Low Channel



High Channel



§15.247(e) - POWER SPECTRAL DENSITY

Standard Applicable

According to §15.247 (e), 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.

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 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 1.5MHz span mode. And then, set RBW and VBW of spectrum analyzer to proper value. (DTS)
4. Repeat above procedures until all frequencies measured were complete.

Equipment Lists

Manufacturer	Description	Model	Serial Number	Cal. Date
HP	Analyzer, Spectrum	8565EC	3946A00131	06/08/2004

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Measurement Result

Environmental Conditions

Temperature:	23° C
Relative Humidity:	45%
ATM Pressure:	1015 mbar

The testing was performed by Daniel Deng on 2005-07-07.

Test Result

802.11b

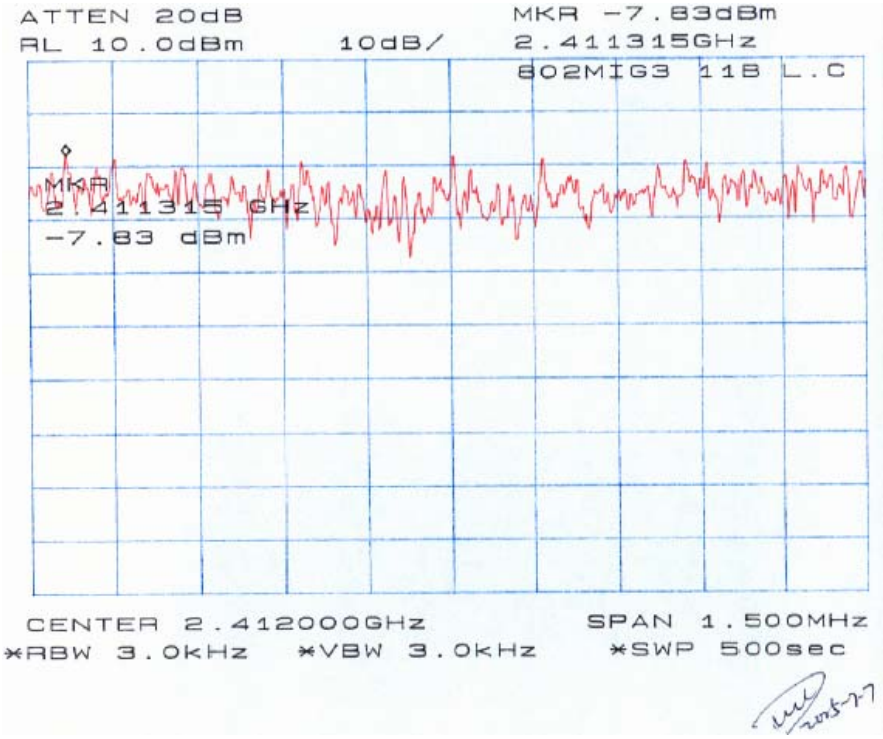
Channel	Frequency (MHz)	Peak Power Spectral Density (dBm)	Standard (dBm)	Result
Low	2412	-7.83	≤ 8	Pass
Mid	2442	-7.50	≤ 8	Pass
High	2462	-7.67	≤ 8	Pass

802.11g

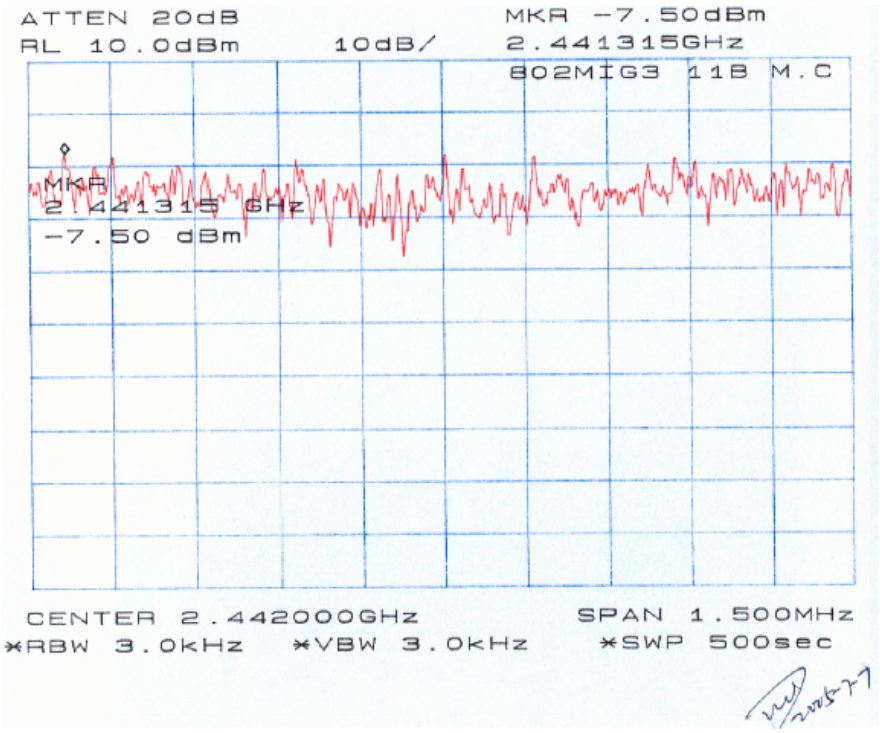
Channel	Frequency (MHz)	Peak Power Spectral Density (dBm)	Standard (dBm)	Result
Low	2412	-11.50	≤ 8	Pass
Mid	2442	-11.33	≤ 8	Pass
High	2462	-11.50	≤ 8	Pass

802.11b

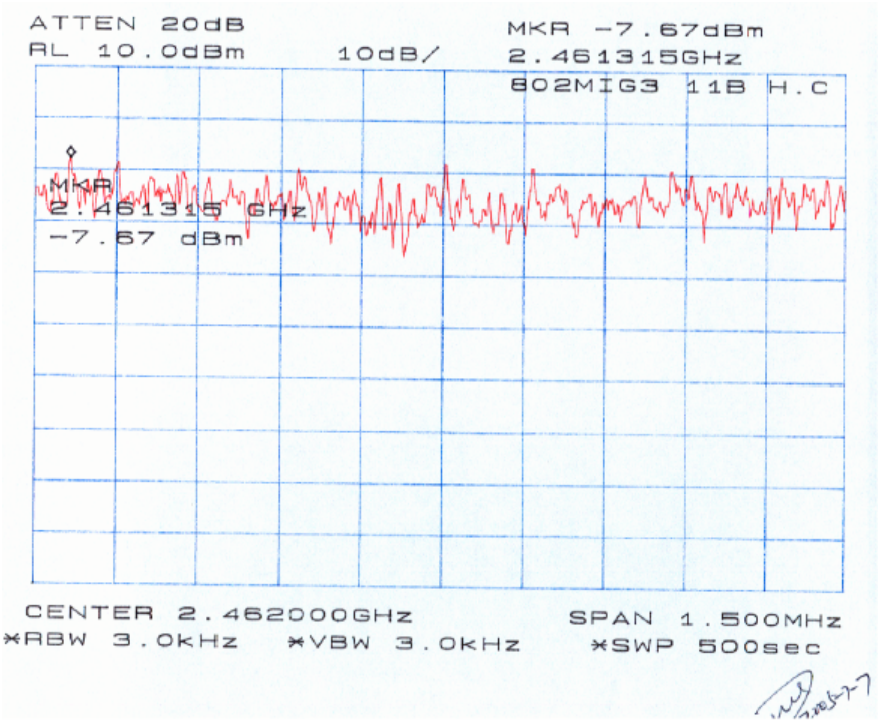
Low Channel



Middle Channel

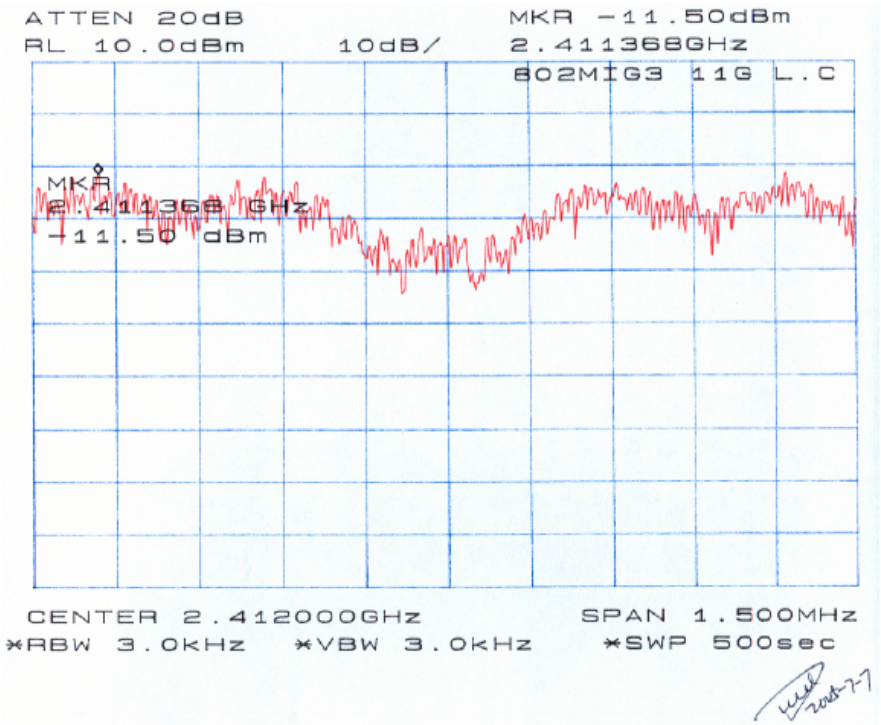


High Channel

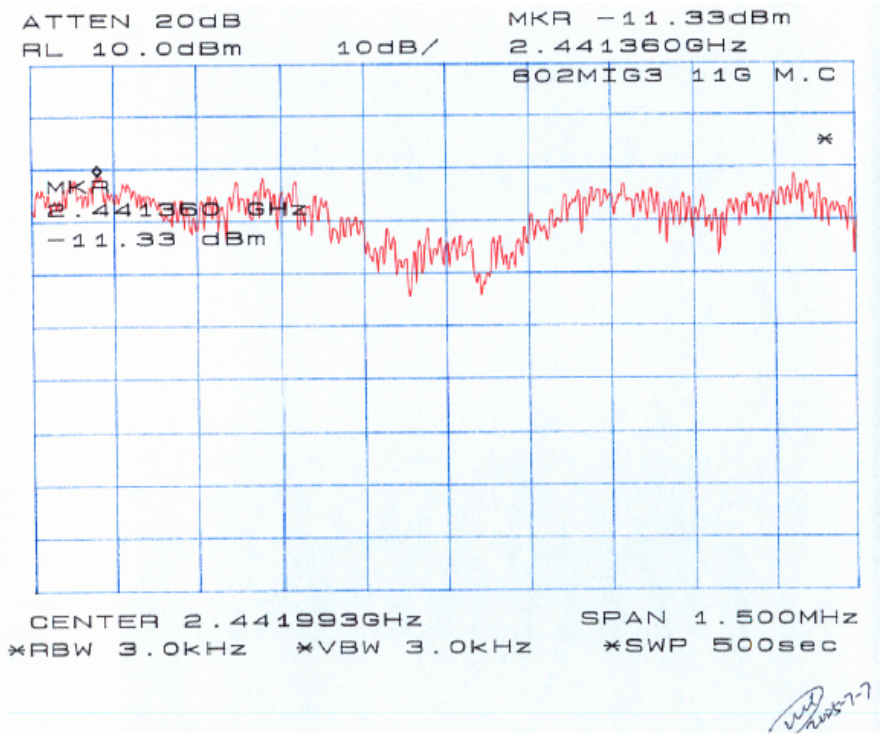


802.11g

Low Channel



Middle Channel



High Channel