Elliott Laboratories Inc.
www.elliottlabs.com
684 West Maude Avenue
Sunnyvale, CA 94086-3518
408-245-7800 Phone
408-245-3499 Fax

December 16, 2002

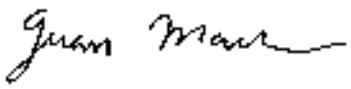
Chief, Equipment Authorization Branch,
Authorization and Evaluation Division,
Office of Engineering and Technology
FEDERAL COMMUNICATIONS COMMISSION
P.O. Box 358315
Pittsburgh, PA 15251-5315

Gentlemen:

The enclosed documents constitute a formal submittal and application for a Grant of Equipment Authorization pursuant to Subpart C of Part 15 of FCC Rules (CFR 47) regarding intentional radiators. Data within this report demonstrates that the equipment tested complies with the FCC limits for intentional radiators.

Elliott Laboratories, as duly authorized agent prepared this submittal. A copy of the letter of our appointment as agent is enclosed.
If there are any questions or if further information is needed, please contact Elliott Laboratories for assistance.

Sincerely,



Juan Martinez
Sr. EMC Engineer

JM/dg
Enclosures:

File: R49679

Elliott Laboratories Inc. 684 West Maude Avenue 408-245-7800 Phone
www.elliottlabs.com Sunnyvale, CA 94086-3518 408-245-3499 Fax

Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator on the Intel Corporation Model: Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)

FCC ID:	ANO20020201CLK
IC:	349E-WM3B2100
MANUFACTURER:	Intel Corporation 2300 Corporate Center Drive Thousand Oaks, CA. 91320
GRANTEE:	International Business Machines Corporation New Orchard Road Armonk, NY 10504
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	December 16, 2002
FINAL TEST DATE:	December 13 & December 14, 2002
AUTHORIZED SIGNATORY:	Juan Martinez Sr. EMC Engineer

ACCREDITED

TABLE OF CONTENTS

DECLARATIONS OF COMPLIANCE

Equipment Name and Model:

Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)

Manufacturer:

Intel Corporation
2300 Corporate Center Drive
Thousand Oaks, CA 91320

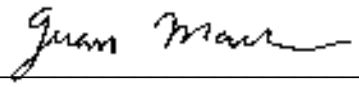
Tested to applicable standards:

RSS-210, Issue 4, December 2000 (Low Power License-Exempt Radiocommunication Devices)
FCC Part 15 Subpart C (DTS)

Measurement Facility Description Filed With Department of Industry:

Departmental Acknowledgement Number: IC2845 **SV2** Dated July 30, 2001
Departmental Acknowledgement Number: IC2845 **SV4** Dated July 19, 2001

I declare that the testing was performed or supervised by me; that the test measurements were made in accordance with the above mentioned departmental standards (through the use of ANSI C63.4 as detailed in section 5.3 of RSS-210, Issue 4); and that the equipment performed in accordance with the data submitted in this report.

Signature	
Name	Juan Martinez
Title	Sr. EMC Engineer
Company	Elliott Laboratories Inc.
Address	684 W. Maude Ave Sunnyvale, CA 94086 USA
Date:	December 16, 2002

Maintenance of compliance with the above standards is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

SCOPE

An electromagnetic emissions test has been performed on the Intel Corporation Model: Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series) pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the Intel Corporation Model: Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series) and therefore apply only to the tested sample. The sample was selected and prepared by Jim Baer of Intel Corporation.

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

STATEMENT OF COMPLIANCE

The tested sample of Model: Intel Corporation Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series) complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators.

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

SUMMARY OF RESULTS

OPERATION IN THE 2400-2483.5MHz BAND

FCC Part 15 Section	RSS 210 Section	Description	Measured Value	Comments	Result
15.247(a)	6.6.2(o)	Digital Modulation	Systems uses Direct Sequence Spread Spectrum techniques	System must utilize a digital transmission technology	Complies
-	6.6.2 (o) (b)	Processing Gain	As per communication from Industry Canada, this requirement has been withdrawn		
15.247 (a) (2)	-	6dB Bandwidth	13.33 MHz	Minimum allowed is 500kHz	Complies
15.247 (b) (3) 15.247 b(4) (i)	-	Output Power	16.9 dBm (0.0489 Watts) EIRP = ??? W	Multi-point applications: Maximum permitted is 1Watt, with EIRP limited to 4 Watts.	Complies
-	6.2.2(o)(b)	Output Power	16.9 dBm (0.0489 Watts) EIRP = ??? W	Maximum permitted is 1Watt. EIRP must not exceed 4 Watts for unlicensed use.	Complies
15.247(d)	6.2.2 (o)(b)	Power Spectral Density	-3.00 dBm / MHz	Maximum permitted is 8dBm/3kHz	Complies
-	6.2.2(o) (d)	Power Spectral Density	3.66mW / MHz	For unlicensed use in the 2400-2450MHz band, use is restarted to indoor use only with spectral density limited to 50mW / MHz (calculated from output power divided by bandwidth)	Complies
15.247(c)	6.2.2(e) (1)	Spurious Emissions – Antenna Conducted 30MHz – 25GHz	All spurious emissions < -20dBc	All spurious emissions < -20dBc. Emissions in restricted bands mu st meet the radiated emissions limits detailed in 15.207	Complies
15.247(c) / 15.209	6.2.2(e) (1)	Radiated Spurious Emissions 30MHz – 25GHz	37.2 dBuV/m @ 4924.0 MHz (-16.8 dB)		Complies
15.207	6.6	AC Conducted Emissions	39.4 dBuV @ .489 MHz (-6.8 dB)	Conducted emissions from the AC power port must meet the limits set forth in RSS210 and 15.207	Complies
15.247 (b) (5)		RF Exposure Requirements			
15.203	6.2.2(o) (e2)	RF Connector	Antenna and connector is integral to the host device	Integral antenna or specialized connector required	Complies

EIRP calculated using antenna gain of .46dBi in the 2.4 GHz band

MEASUREMENT UNCERTAINTIES

ISO Guide 25 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with NAMAS document NIS 81.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	30 to 1000	± 3.2

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Intel Corporation Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series) is a Mini PCI Card single band (802.11b) transceiver which is designed to be installed into a laptop PC and connect to antennas mounted in the screen of the laptop. The sample was received on and tested on December 13, 2002. The EUT consisted of the following component(s):

The sample was received on December 13, 2002 and tested December 13 & 14, 2002. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
Intel WM3B7100 Dual Band Mini PCI Card	00042346750A
IBM R40Series Laptop	FX-00089

ENCLOSURE

The EUT has no enclosure. It is designed to be installed within the enclosure of a host computer.

MODIFICATIONS

N/A

SUPPORT EQUIPMENT

No support equipment was used during emissions testing.

EXTERNAL I/O CABLING

The I/O cabling configuration during emissions testing was as follows:

Cable Description	Length (m)	From Unit/Port	To Unit/Port
None	-	-	-

TEST SOFTWARE

The radio was transmitting at full power on the specified channels and at a data rate of 1 and 11 Mb/s. The channels were selected since they are at the top, center and bottom of the allocated bands.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on December 13 & December 14, 2002 at the Elliott Laboratories Open Area Test Site #2 & 4 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

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

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

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

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde and Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

POWER METER

A power meter and thermister mount are used for all direct output power measurements from transmitters as they provide a broadband indication of the power output.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

ANSI C63.4 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The FCC requires that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements are performed with the antenna port of the EUT connected to either the peak power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS LIMITS – AC MAINS PORT

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

* Broadband Level - Per ANSI C63.4, 13 dB may be subtracted from the quasi-peak level if it is determined that the emission is broadband in nature. If the signal level in the average mode is six dB or more below the signal level in the peak mode, the emission is classified as broadband.

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

1 Page

Conducted and Radiated Emissions, 14-Dec-02
Engineer: Rafael

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	FCC / CISPR LISN	LISN-3, C	304	12	6/5/2002	6/5/2003
EMCO	Biconical Antenna, 30-300 MHz	3110B	801	12	5/13/2002	5/13/2003
EMCO	Log Periodic Antenna, 0.2-1 GHz	3146	1294	12	4/12/2002	4/12/2003
Rohde& Schwarz	Pulse Limiter	ESH3 Z2	812	12	1/23/2002	1/23/2003
Rohde & Schwarz	Test Receiver, 0.009-2000 MHz	ESN	1332	12	4/16/2002	4/16/2003
Solar Electronics	Support Equipment LISN, 0.150-30.0 MHz	8012-50-F	305	12	8/20/2002	8/20/2003

Radiated Emissions, 1 - 22,000 MHz, 15-Dec-02
Engineer: jmartinez

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	487	12	4/22/2002	4/22/2003
Hewlett Packard	Spectrum Analyzer 9KHz - 26GHz, non programable	8563E	284	12	3/21/2002	3/21/2003
Miteq	Preamplifier, 1-18GHz	AFS44	1346	12	1/7/2002	1/7/2003

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T 49662 17 Pages

Elliott

EMC Test Data

Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15"	T-Log Number:	T49662
	IBM laptop (ThinkPad R40 Series)	Proj Eng:	
Contact:			
Emissions Spec:	FCC Part 15 B and C RSS-210	Class:	
Immunity Spec:	N/A	Environment:	-

EMC Test Data

For The

IBM

Model

Intel 802.11B (M/N: WM3B2100) in 15"
IBM laptop (ThinkPad R40 Series)

Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15"	T-Log Number:	T49662
	IBM laptop (ThinkPad R40 Series)	Proj Eng:	
Contact:	Enter contact name on cover shee		
Emissions Spec:	FCC Part 15 B and C RSS-210	Class:	
Immunity Spec:	N/A	Environment:	-

EUT INFORMATION

General Description

The EUT is a mini PCI Card single band (802.11b) transceiver which is designed to be installed into a laptop PC and connect to antennas mounted in the screen of the laptop. The host laptop was treated as table-top equipment during testing to simulate the end user environment. The electrical rating of the laptop is 120/240 V, 50/60 Hz, 0.5 Amps.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Intel Corporation	WM3B2100	MPCI Card	00042346750A	ANO20020201CLK
IBM	R40 Series	Laptop	FX-00089	DoC
IBM	02KE756	Power Supply	11S02K6749ZJ1MN328 95U5	DoC

Antenna

The EUT uses an integral antenna with a gain of .46 dBi.

The antenna connector used is non-standard antenna (connector description here) to meet the requirements of FCC Part 15.203 and RSS-210. Antennas will be installed inside at the topside of the display screen of the Laptop. The Laptop vendors will professionally install antennas.

EUT Enclosure

The EUT does not have an enclosure as it is designed to be installed within the enclosure of a host computer.

Modification History

Mod. #	Test	Date	Modification
1			

Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15"	T-Log Number:	T49662
	IBM laptop (ThinkPad R40 Series)	Proj Eng:	
Contact:	Enter contact name on cover shee		
Emissions Spec:	FCC Part 15 B and C RSS-210	Class:	DSSS
Immunity Spec:	N/A	Environment:	-

Test Configuration #2

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None	-	-	-	-

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None	-	-	-	-

EUT Operation During Emissions Testing (Radio)

The radio was transmitting at full power on the specified channels and at a data rate of 1and 11 Mb/s. The channels were selected since they are at the top, center and bottom of the allocated bands.

Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 12/13/2002
Test Engineer: jmartinez
Test Location: SVOATS #4

Config. Used: 2
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 10°C
Rel. Humidity: 85%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1a-1c	RE, 30 - 24,000 MHz - Spurious Emissions	FCC Part 15.209 / 15.247(c)	Pass	Refer to individual runs
2a-2c	RE, 30 - 24,000 MHz - Spurious Emissions	FCC Part 15.209 / 15.247(c)	Pass	Refer to individual runs
3a-3b	6dB Bandwidth	15.247(a)	Pass	Refer to individual runs
4	Output Power	15.247(b)	Pass	Refer to individual runs
5a-5b	Power Spectral Density (PSD)	15.247(d)	Pass	Refer to individual runs
6a-6b	Out-of-band emissions	15.247(d)	Pass	Refer to individual runs

Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Modifications Made During Testing:

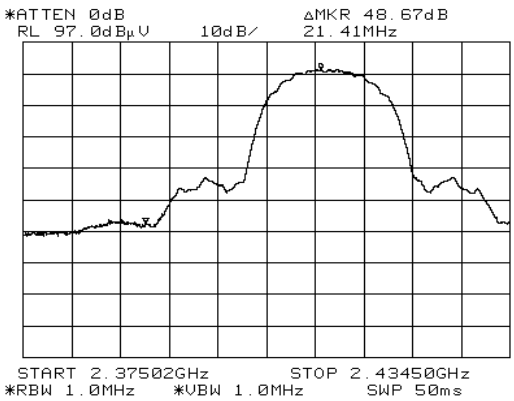
No modifications were made to the EUT during testing

Deviations From The Standard

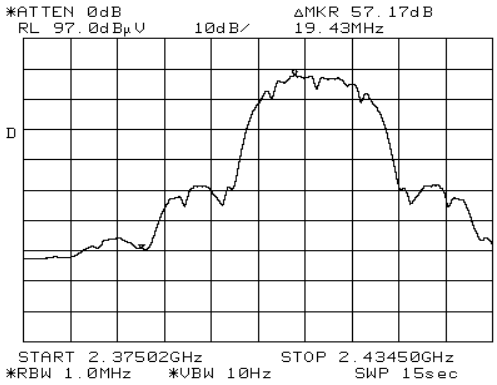
No deviations were made from the requirements of the standard.

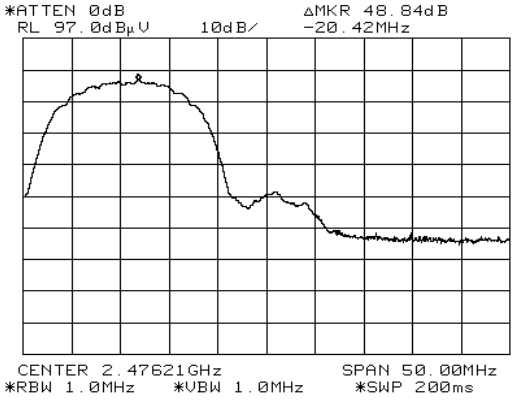
Run #1: Bandedge measurement plots

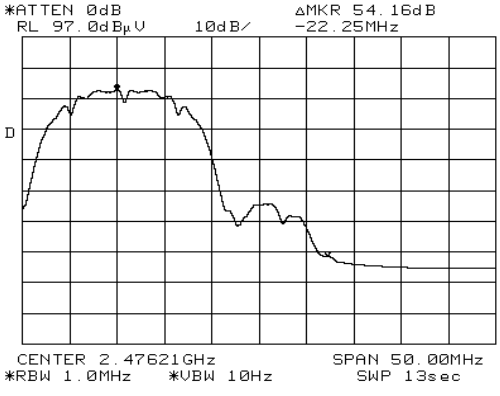
Peak



Average







Elliott

EMC Test Data

Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Run #1a: Radiated Spurious Emissions, 30-24,000 MHz. Low Channel @ 2412 MHz (1 Mbps)

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2412.981	107.4	V	-	-	Pk	-	-	
2412.787	103.4	V	-	-	Avg	-	-	
2412.931	108.5	H	-	-	Pk	-	-	
2412.739	104.8	H	-	-	Avg	-	-	
7240.973	35.9	H	54.0	-18.1	Avg	1	1.0	Noise Floor Measurement
4824.001	34.3	V	54.0	-19.7	Avg	14	1.0	
7240.973	33.5	V	54.0	-20.5	Avg	1	1.2	Noise Floor Measurement
4828.987	30.8	H	54.0	-23.2	Avg	0	1.0	
7240.994	48.1	H	74.0	-25.9	Pk	1	1.0	Noise Floor Measurement
7240.994	45.6	V	74.0	-28.4	Pk	1	1.2	Noise Floor Measurement
4823.812	44.5	V	74.0	-29.5	Pk	14	1.0	
4829.814	42.6	H	74.0	-31.4	Pk	0	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No other emissions detected above the 3rd harmonic. Readings were all 20-dB below the limit

Run #1b: Radiated Spurious Emissions, 30-24,000 MHz. Center Channel @ 2437 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7311.007	35.0	V	54.0	-19.0	Avg	360	1.0	Noise Floor Measurement
7311.910	34.9	H	54.0	-19.1	Avg	0	1.0	Noise Floor Measurement
4873.735	31.4	V	54.0	-22.6	Avg	242	1.0	
4874.180	30.9	H	54.0	-23.1	Avg	0	1.0	
7311.257	48.2	V	74.0	-25.8	Pk	360	1.0	Noise Floor Measurement
7312.052	47.5	H	74.0	-26.5	Pk	0	1.0	Noise Floor Measurement
4873.999	43.8	V	74.0	-30.2	Pk	242	1.0	
4875.749	42.7	H	74.0	-31.3	Pk	0	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No other emissions detected above the 3rd harmonic. Readings were all 20-dB below the limit

Elliott

EMC Test Data

Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Run #1c: Radiated Spurious Emissions, 30-24,000 MHz. High Channel @ 2462 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2461.956	106.3	V	-	-	Pk	-	-	
2461.189	103.0	V	-	-	Avg	-	-	
2462.066	108.2	H	-	-	Pk	-	-	
2461.014	105.2	H	-	-	Avg	-	-	
4924.003	37.2	V	54.0	-16.8	Avg	1	1.2	
4924.025	36.7	H	54.0	-17.3	Avg	275	1.2	
7385.141	36.2	H	54.0	-17.8	Avg	347	1.2	Noise Floor Measurement
7385.073	34.9	V	54.0	-19.1	Avg	0	1.0	Noise Floor Measurement
7385.383	48.0	H	74.0	-26.0	Pk	347	1.2	Noise Floor Measurement
7385.541	47.0	V	74.0	-27.0	Pk	0	1.0	Noise Floor Measurement
4923.917	45.8	V	74.0	-28.2	Pk	1	1.2	
4924.078	45.6	H	74.0	-28.4	Pk	275	1.2	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No other emissions detected above the 3rd harmonic. Readings were all 20-dB below the limit

Bandedge Measurements

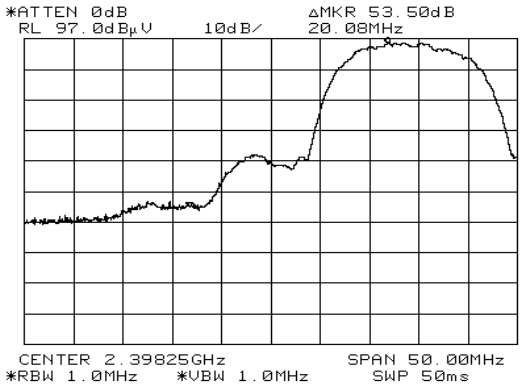
Spurious Signal	Fundamental Level	Detector	Spurious Level		Limit	Margin	Comments
MHz	(dBuV/m @3m)	Pk/Avg	-dBc	dBuV/m	dBuV/m	dB	
2385.98	108.5	Pk	48.7	59.8	74.0	-14.2	
2385.98	104.8	Avg	57.2	47.6	54.0	**-6.4**	
2484.04	108.2	Pk	48.8	59.4	74.0	-14.6	
2484.04	105.2	Avg	54.2	51.0	54.0	**-3.0**	

Note 1:	EUT operating on the lowest channel available in the 2390 - 2412 MHz band. Signal level calculated using the relative measurements in run #1, of CE spreadsheet (48.67 dBc for peak and 57.17 dBc for average) applied to the highest peak and average field strength measurements of the fundamental signal level.
Note 2:	EUT operating on highest channel available in the 2462 - 2483.5 MHz band. Signal level calculated using the relative measurements in run #1, of CE spreadsheet (48.8 dBc for peak and 54.16 dBc for average) applied to the highest peak and average field strength measurements of the fundamental signal level.

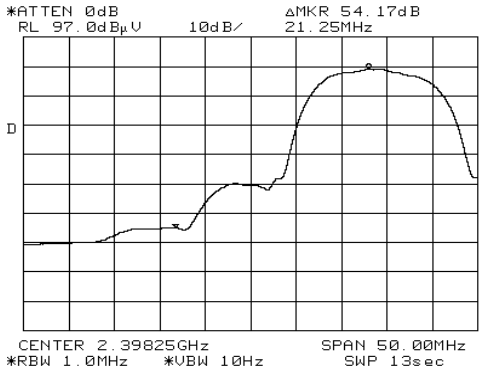
Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

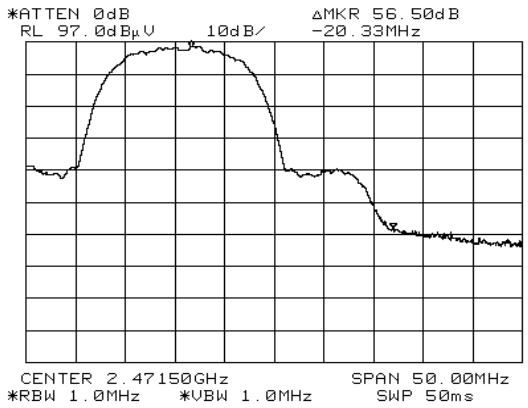
Run #2: Bandedge measurement plots

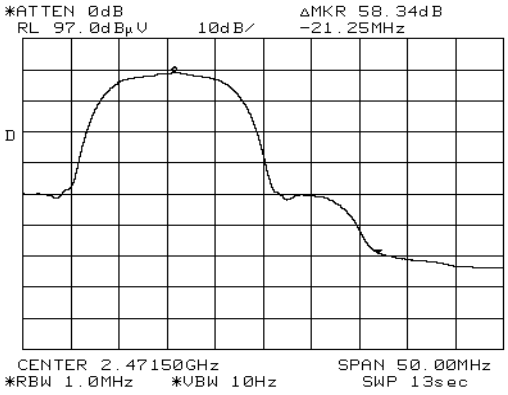
Peak



Average







Elliott

EMC Test Data

Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Run #2a: Radiated Spurious Emissions, 30-24,000 MHz. Low Channel @ 2412 MHz (11 Mbps)

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2411.353	110.1	V	-	-	Pk	-	-	
2412.237	101.9	V	-	-	Avg	-	-	
2410.442	113.7	H	-	-	Pk	-	-	
2411.230	105.9	H	-	-	Avg	-	-	
7233.349	36.5	H	54.0	-17.5	Avg	0	1.1	Noise Floor Measurement
7233.653	36.3	V	54.0	-17.7	Avg	0	1.0	Noise Floor Measurement
4820.983	30.6	V	54.0	-23.4	Avg	0	1.0	
4821.127	30.1	H	54.0	-23.9	Avg	305	1.0	
7233.626	48.9	H	74.0	-25.1	Pk	0	1.1	Noise Floor Measurement
7234.067	48.9	V	74.0	-25.1	Pk	0	1.0	Noise Floor Measurement
4822.314	43.2	H	74.0	-30.8	Pk	305	1.0	
4821.237	42.2	V	74.0	-31.8	Pk	0	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No other emissions detected above the 3rd harmonic. Readings were all 20-dB below the limit

Run #2b: Radiated Spurious Emissions, 30-24,000 MHz. Center Channel @ 2437 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7311.693	34.9	H	54.0	-19.1	Avg	0	1.0	Noise Floor Measurement
7311.552	34.7	V	54.0	-19.3	Avg	360	1.0	Noise Floor Measurement
4874.091	31.3	V	54.0	-22.7	Avg	0	1.0	
4874.328	30.2	H	54.0	-23.8	Avg	360	1.0	
7311.868	47.6	H	74.0	-26.4	Pk	0	1.0	Noise Floor Measurement
7311.789	47.4	V	74.0	-26.6	Pk	360	1.0	Noise Floor Measurement
4874.374	42.9	V	74.0	-31.1	Pk	0	1.0	
4874.783	42.2	H	74.0	-31.8	Pk	360	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No other emissions detected above the 3rd harmonic. Readings were all 20-dB below the limit

Elliott

EMC Test Data

Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Run #2c: Radiated Spurious Emissions, 30-24,000 MHz. High Channel @ 2462 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2463.171	112.6	H	-	-	Pk	-	-	
2462.532	104.5	H	-	-	Avg	-	-	
2463.826	110.1	V	-	-	Pk	-	-	
2462.399	102.7	V	-	-	Avg	-	-	
7387.237	34.6	H	54.0	-19.4	Avg	328	1.0	Noise Floor Measurement
7387.209	34.5	V	54.0	-19.5	Avg	0	1.0	Noise Floor Measurement
4925.346	31.2	H	54.0	-22.8	Avg	0	1.0	
4925.880	31.1	V	54.0	-22.9	Avg	328	1.0	
7387.419	47.0	H	74.0	-27.0	Pk	328	1.0	Noise Floor Measurement
7387.439	46.5	V	74.0	-27.5	Pk	0	1.0	Noise Floor Measurement
4926.367	43.4	H	74.0	-30.6	Pk	0	1.0	
4926.199	43.3	V	74.0	-30.7	Pk	328	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No other emissions detected above the 3rd harmonic. Readings were all 20-dB below the limit

Bandedge Measurements

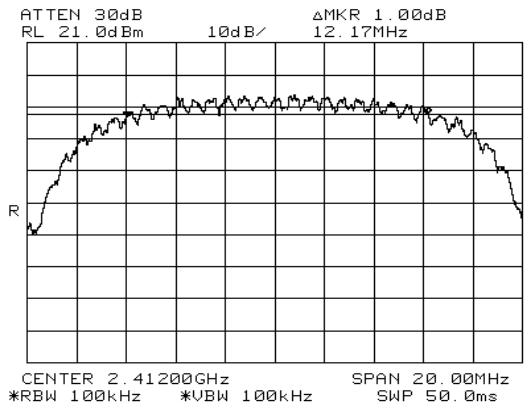
Spurious Signal	Fundamental Level	Detector	Spurious Level		Limit	Margin	Comments
MHz	(dBuV/m @3m)	Pk/Avg	-dBc	dBuV/m	dBuV/m	dB	
2385.98	113.7	Pk	53.4	60.3	74.0	-13.7	
2385.98	105.9	Avg	54.2	51.7	54.0	**-2.3**	
2484.04	112.6	Pk	56.5	56.1	74.0	-17.9	
2484.04	104.5	Avg	58.3	46.2	54.0	**-7.8**	

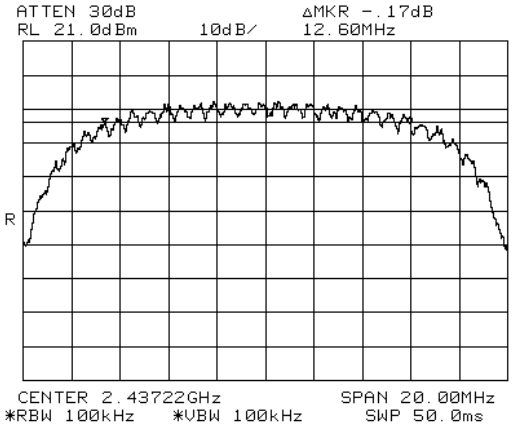
Note 1:	EUT operating on the lowest channel available in the 2390 - 2412 MHz band. Signal level calculated using the relative measurements in run #2, of CE spreadsheet (53.5 dBc for peak and 54.17 dBc for average) applied to the highest peak and average field strength measurements of the fundamental signal level.
Note 2:	EUT operating on highest channel available in the 2462 - 2483.5 MHz band. Signal level calculated using the relative measurements in run #2, of CE spreadsheet (56.5 dBc for peak and 58.34 dBc for average) applied to the highest peak and average field strength measurements of the fundamental signal level.

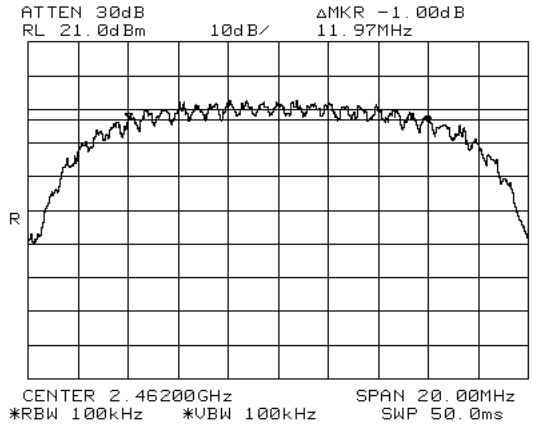
Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Run #3a: Signal Bandwidth
Data Rate=11

Channel	Frequency (MHz)	Resolution Bandwidth	6dB Signal Bandwidth	Graph reference #
Low	2412	100KHz	12.17 MHz	see plot below
Mid	2437	100KHz	12.60 MHz	see plot below
High	2462	100KHz	11.97 MHz	see plot below



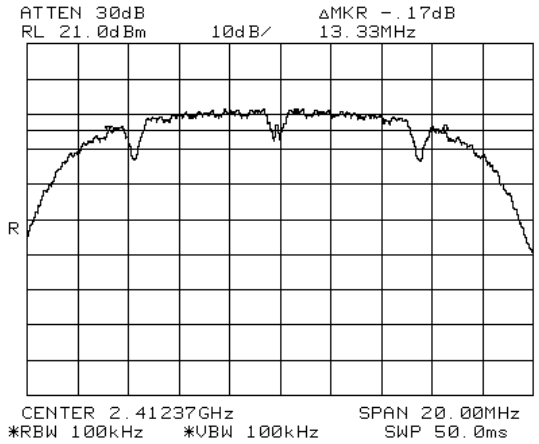


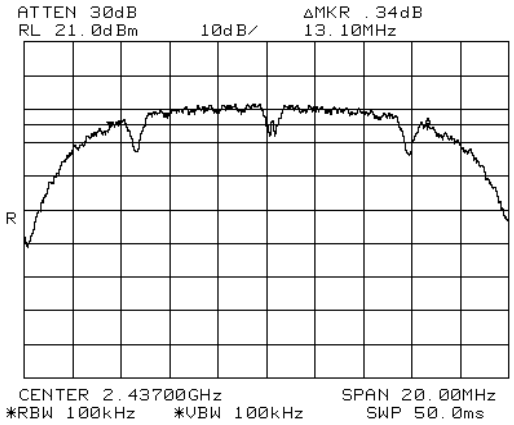


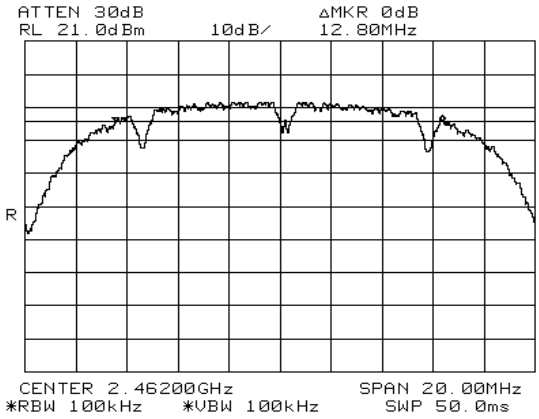
Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Run #3b: Signal Bandwidth
Data Rate=1

Channel	Frequency (MHz)	Resolution Bandwidth	6dB Signal Bandwidth	Graph reference #
Low	2412	100KHz	13.33 MHz	see below
Mid	2437	100KHz	13.10 MHz	see below
High	2462	100KHz	12.80 MHz	see below







Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Run #4: Output Power

Unit S/N #		Freq	Power	Settings				
	Ch.	MHz	dBm	Bias	Data Rate	Scales	Gain	Step
00042346750A	1	2412	16.90	34	1 (1Mb/s)	9	0	0
	6	2437	16.88	32	1 (1Mb/s)	10	0	0
	11	2462	16.64	32	1 (1Mb/s)	12	0	0

Unit S/N #		Freq	Power	Settings				
	Ch.	MHz	dBm	Bias	Data Rate	Scales	Gain	Step
00042346750A	1	2412	16.89	34	5 (5.5Mb/s)	9	0	0
	6	2437	16.87	32	5 (5.5Mb/s)	10	0	0
	11	2462	16.65	32	5 (5.5Mb/s)	12	0	0

Unit S/N #		Freq	Power	Settings				
	Ch.	MHz	dBm	Bias	Data Rate	Scales	Gain	Step
00042346750A	1	2412	16.68	34	11 (11Mb/s)	9	0	0
	6	2437	16.70	32	11 (11Mb/s)	10	0	0
	11	2462	16.60	32	11 (11Mb/s)	12	0	0

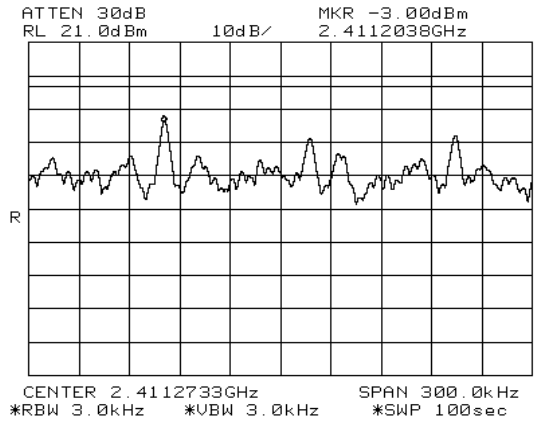
Note 1:	Preliminary power measurements demonstarted that the output power was slightly higher when the unit operated at a data rate of 1Mb/s when compared to the output power at data rates of 11Mb/s.

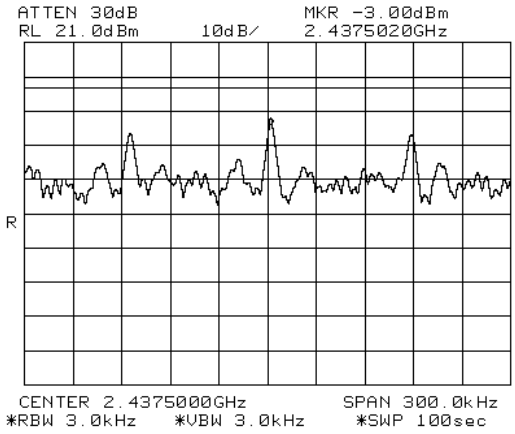
Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

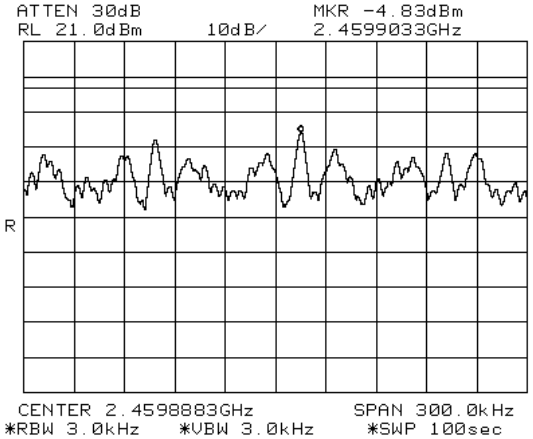
Run #5a: Power Spectral Density

Channel	Frequency (MHz)	Res BW	P.S.D. dBm (averaged over 1 second in a 3kHz bandwidth)	Graph reference #
Low	2412	3 kHz	-3.00 dBm	see below
Mid	2437	3 kHz	-3.00 dBm	see below
High	2462	3 kHz	-4.38 dBm	see below

Data Rate=11





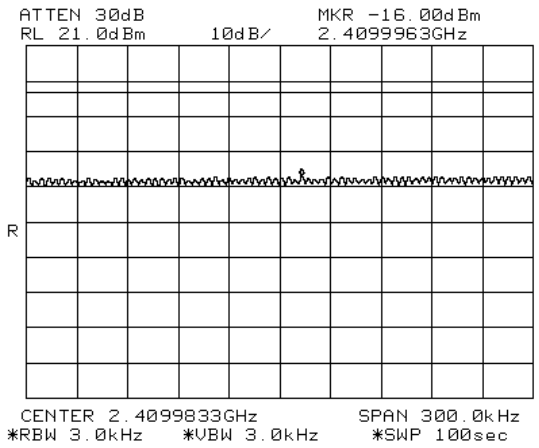


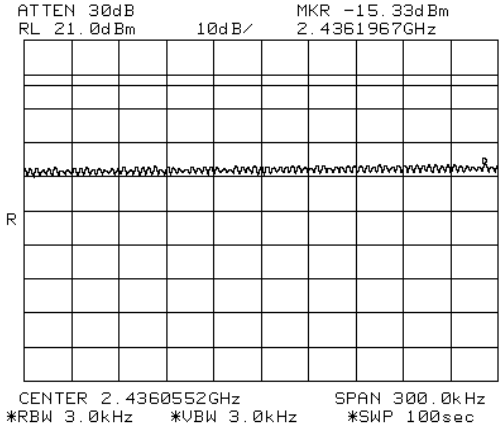
Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

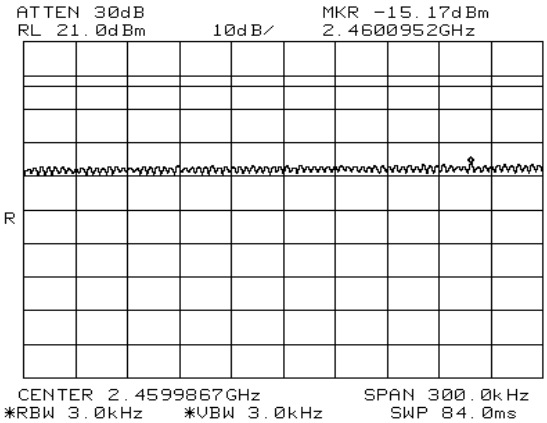
Run #5b: Power Spectral Density

Channel	Frequency (MHz)	Res BW	P.S.D. dBm (averaged over 1 second in a 3kHz bandwidth)	Graph reference #
Low	2412	3 kHz	-16.00 dBm	see below
Mid	2437	3 kHz	-15.33 dBm	see below
High	2462	3 kHz	-15.17 dBm	see below

Data Rate=1

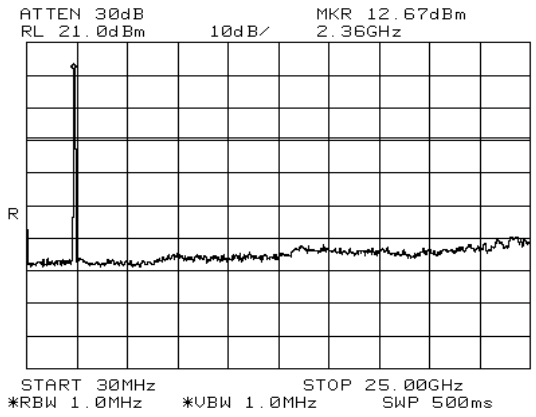


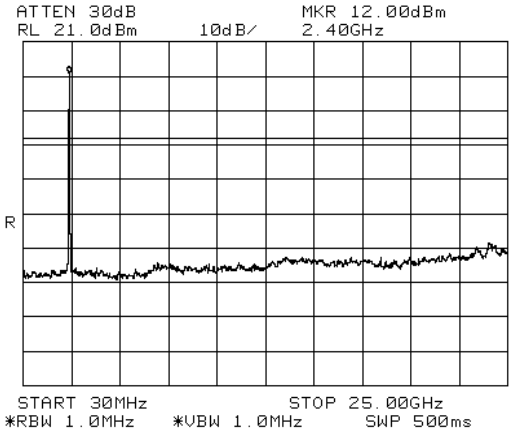


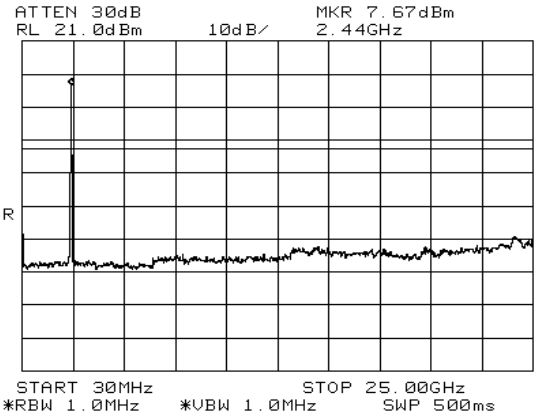


Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Run #6a: Out-of-band emissions
Data Rate=11







Client:	IBM	Job Number:	J49650
Model:	Intel 802.11B (M/N: WM3B2100) in 15" IBM laptop (ThinkPad R40 Series)	T-Log Number:	T49662
		Proj Eng:	Enter on cover sheet
Contact:	Enter client contact on cover sheet		
Spec:	FCC Part 15 B and C RSS-210	Class:	N/A

Run #6b: Out-of-band emissions
Data Rate=1