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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 mar

Juan Martinez Sr. EMC Engineer

JM/dmg Enclosures:

Application Fee FCC Form 159 FCC Form 731 Agent Authorization Letter Emissions Test Report with Exhibits



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### 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 14" 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 Man-

Juan Martinez Sr. EMC Engineer



Elliott Laboratories, Inc. is accredited by the A2LA, certificate number 2016-01, to perform the test(s) listed in this report. This report shall not be reproduced, except in its entirety, without the written approval of Elliott Laboratories, Inc.

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#### **SCOPE**

An electromagnetic emissions test has been performed on the Intel Corporation Model: Intel 802.11B (M/N: WM3B2100) in 14" 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 14" 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 Intel Corporation Model: Intel 802.11B (M/N: WM3B2100) in 14" 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.).

#### OPERATION IN THE 2400-2483.5MHz BAND

		1			
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 communic this requirem	ation from Industry Canada, ent has been withdrawn	
15.247 (a) (2)	-	6dB Bandwidth	13.00 MHz	Minimum allowed is 500kHz	Complies
15.247 (b) (3) 15.247 b(4) (i)	-	Output Power	17.1 dBm (0.0513 Watts) EIRP = ??? W	Multi-point applications: Maximum permitted is 1Watt, with EIRP limited to 4 Watts.	Complies
-	6.2.2(o)(b)	Output Power	17.1 dBm (0.0513 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	-1.17 dBm / MHz	Maximum permitted is 8dBm/3kHz	Complies
-	6.2.2(o) (d)	Power Spectral Density	3.95mW / 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 must meet	Complies
15.247(c) / 15.209	6.2.2(e) (1)	Radiated Spurious Emissions 30MHz – 25GHz	40.9 dBuV/m @ 7232.28 MHz (-13.1dB)	the radiated emissions limits detailed in 15.207	Complies
15.207	6.6	AC Conducted Emissions	28.4 dBuV @ 3.94 MHz (-17.6dB)	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 -.37dBi 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 Model: Intel 802.11B (M/N: WM3B2100) in 14" 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	000423467472
IBM/Thinkpad R40 Series/Laptop	15-00162

#### 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 at the Elliott Laboratories Open Area Test Site #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 nonconductive 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:

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on	Linear decrease on
	logarithmic frequency axis	logarithmic frequency axis
$0.500 \pm 5.000$	between 56.0 and 46.0	between 66.0 and 56.0
5.000 to 30.000	50.0	60.0
RADIATED	EMISSIONS SPECIFICATION LIMITS, S	ECTION 15.209
Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	2400/F <sub>KHz</sub> @ 300m	67.6-20*log <sub>10</sub> (F <sub>KHz</sub> ) @ 300m
0.490-1.705	24000/F <sub>KHz</sub> @ 30m	87.6-20*log <sub>10</sub> (F <sub>KHz</sub> ) @ 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

CONDUCTED EMISSIONS SPECIFICATION LIMITS, SECTION 15.207

#### 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	<b>Description</b>	Model #	Assett #	Cal interval	Last Calibrated	<u>Cal Due</u>
Elliott Laboratories	FCC / CISPR LISN	LISN-3, OATS	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-R-24-BNC	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

T49658 17 Pages

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C		

# EMC Test Data

0			
Client:	IBM	Job Number:	J49651
Model:	Intel 802.11B (M/N: WM3B2100) in 14"	T-Log Number:	T49658
	IBM laptop (ThinkPad R40 Series)	Proj Eng:	Juan Martinez
Contact:	Robert Paxman		
Emissions Spec:	FCC Part 15 B and C, RSS-210	Class:	DSSS
Immunity Spec:	N/A	Environment:	-

# **EMC Test Data**

For The

## IBM

Model

#### Intel 802.11B (M/N: WM3B2100) in 14" IBM laptop (ThinkPad R40 Series)

# Elliott

# EMC Test Data

-			
Client:	IBM	Job Number:	J49651
Model:	Intel 802.11B (M/N: WM3B2100) in 14"	T-Log Number:	T49658
	IBM laptop (ThinkPad R40 Series)	Proj Eng:	Juan Martinez
Contact:	Robert Paxman		
Emissions Spec:	FCC Part 15 B and C, RSS-210	Class:	DSSS
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	15-00162	DoC
IBM	02KE754	Power Supply	11S02K6747z1211H244 9EC	DoC

#### Antenna

The EUT uses an integral antenna with a gain of -.37 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	-	-	none

Filiot	t		<b>.</b>	C Toot Data			
	,L		EIVI	C Test Data			
Client:	IBM		Job Number:	J49651			
Model:	Intel 802.11B (M/N: WM3	3B2100) in 14"	T-Log Number:	T49658			
	IBM laptop (ThinkPad R4	40 Series)	Proj Eng:	Juan Martinez			
Contact:	Robert Paxman						
Emissions Spec:	FCC Part 15 B and C, R	SS-210	Class:	DSSS			
Immunity Spec:	N/A		Environment:	-			
	Test Configuration #2 Local Support Equipment						
Manufacturer	Model	Description	Serial Number	FCC ID			
None	-	-	-	-			
None	- IVIODEI	Description	- Serial Number	FCCID -			
The radio was transmitt selected since they are	ing at full power on the s at the top, center and bo	pecified channels and at a attom of the allocated band	data rate of 1 and 11 Mb/s	s. The channels were			

4						1
Client:	IBM				lob Number:	J49651
Model:	Intel 802.	11B (M/N: WM3B2100) in 14" IBI	VI laptop (ThinkPad R40	T-L	og Number:	T49658
	Series)				Proj Eng:	Juan Martine
Contact:	Robert Pa	axman				
Spec:	FCC Part	15 B and C, RSS-210			Class:	N/A
		Radi	ated Emissior	าร		
est Spe	ecifics					
•	Objective:	The objective of this test session specification listed above.	n is to perform final qualif	ication tes	ting of the El	UT with respe
Da	te of Test:	12/13/2002	Config. Used:	2		
Test Engineer: jmartinez/Rafael Config Chang						
Test Location: SVOATS #4 Host Unit Voltage				120V/60H	Z	
General	Test Co	nfiguration				
General The EU For radia When m spectrun measure Ambient	Test Con and all lo ated emissi- easuring the n analyzer ements are condition ry of Res	nfiguration cal support equipment were local ions testing the measurement an ne conducted emissions from the or power meter via a suitable atte corrected to allow for the externation ons: Temperature: Rel. Humidity: S ults	ted on the turntable for ra tenna was located 3 met EUT's antenna port, the enuator to prevent overlo al attenuators used. 10°C 85%	adiated spu ers from th antenna p pading the	urious emissi le EUT. ort of the EU measuremer	ions testing. JT was conne nt system. All
General The EU For radia When m spectrun measure Ambient	Test Con and all lo ated emissi- easuring the n analyzer ements are <b>Conditional</b> <b>Conditional</b> <b>ry of Res</b>	nfiguration cal support equipment were locat ions testing the measurement an ne conducted emissions from the or power meter via a suitable atto corrected to allow for the externat ons: Temperature: Rel. Humidity: a ults	ted on the turntable for rate tenna was located 3 met EUT's antenna port, the enuator to prevent overlo al attenuators used. 10°C 85%	adiated spu ers from th antenna p bading the Result	urious emissi le EUT. lort of the EL measuremer	ions testing. JT was conne nt system. All argin
General The EU For radia When m spectrun measure mbient	Test Con T and all lo ated emissis easuring th n analyzer ements are c Condition ry of Res n # -1c	nfiguration cal support equipment were local ions testing the measurement an ne conducted emissions from the or power meter via a suitable atte corrected to allow for the externation ons: Temperature: Rel. Humidity: a ults Test Performed RE, 30 - 24,000 MHz -	ted on the turntable for ratenna was located 3 met EUT's antenna port, the enuator to prevent overlo al attenuators used. 10°C 85% Limit FCC Part 15.209 /	adiated spu ers from th antenna p bading the Result Pass	urious emissi le EUT. lort of the EL measuremer Ma Refer to in	ions testing. JT was conne nt system. All argin dividual runs
General The EU For radia When m spectrun measure mbient	Test Con and all lo ated emissis easuring th n analyzer ements are c Condition ry of Res n # 1c	nfiguration cal support equipment were local ions testing the measurement an ne conducted emissions from the or power meter via a suitable atte corrected to allow for the externa ons: Temperature: Rel. Humidity: 4 ults <u>Test Performed</u> RE, 30 - 24,000 MHz - Spurious Emissions	eed on the turntable for ra tenna was located 3 met EUT's antenna port, the enuator to prevent overlo al attenuators used. 10°C 85% <u>Limit</u> FCC Part 15.209 / 15.247( c)	adiated spu ers from th antenna p bading the Result Pass	urious emissi le EUT. lort of the EU measuremer Ma Refer to in	ions testing. JT was conne nt system. All argin dividual runs
eneral The EU For radia When m spectrun measure mbient ummar ummar 1a- 2a-	Test Con T and all lo ated emissi- easuring th n analyzer ements are <b>Conditional</b> <b>Y of Res</b> n # -1c -2c	nfiguration cal support equipment were locat ions testing the measurement an ne conducted emissions from the or power meter via a suitable atto corrected to allow for the externat ons: Temperature: Rel. Humidity: 3 ults Test Performed RE, 30 - 24,000 MHz - Spurious Emissions RE, 30 - 24,000 MHz -	Limit FCC Part 15.209 / FCC Part 15.209 / FCC Part 15.209 /	adiated spu ers from th antenna p bading the Result Pass Pass	urious emissi le EUT. lort of the EU measuremer Refer to in Refer to in	ions testing. JT was conne nt system. All argin dividual runs dividual runs
ieneral The EU For radia When m spectrun measure mbient ummar Run 1a- 2a-	Test Con T and all lo ated emissis easuring th n analyzer ements are <b>Condition</b> <b>t</b> <b>t</b> <b>t</b> <b>t</b> <b>c</b> <b>c</b> <b>c</b> <b>c</b> <b>c</b> <b>c</b> <b>c</b> <b>c</b>	nfiguration cal support equipment were local ions testing the measurement an ne conducted emissions from the or power meter via a suitable atto corrected to allow for the externation ons: Temperature: Rel. Humidity: 3 ults <u>Test Performed</u> RE, 30 - 24,000 MHz - <u>Spurious Emissions</u> RE, 30 - 24,000 MHz - <u>Spurious Emissions</u>	Limit ECC Part 15.209 / 15.247(c)	adiated spu ers from th antenna p bading the Result Pass Pass	urious emissi le EUT. lort of the EL measuremer Refer to in Refer to in	ions testing. JT was conne nt system. All argin dividual runs dividual runs
eneral The EU For radia When m spectrun measure mbient ummar 1a- 2a- 3a-	Test Con and all lo ated emissi- easuring the n analyzer ements are c Condition y of Res n # -1c -2c -3b	nfiguration cal support equipment were local ions testing the measurement an ne conducted emissions from the or power meter via a suitable atte corrected to allow for the externation ons: Temperature: Rel. Humidity: a ults Test Performed RE, 30 - 24,000 MHz - Spurious Emissions RE, 30 - 24,000 MHz - Spurious Emissions	Limit FCC Part 15.209 / 15.247(c) FCC Part 15.209 / 15.247(c) 15.247(c) FCC Part 15.209 / 15.247(c) FCC Part 15.209 / 15.247(c)	Adiated spu ers from the antenna p bading the Result Pass Pass Pass	urious emissi le EUT. lort of the EL measuremer Refer to in Refer to in Refer to in	ions testing. JT was conne nt system. All argin dividual runs dividual runs
For radia For radia When m spectrun measure mbient ummar 1a- 2a- 3a- 4	Test Con and all lo ated emissi- easuring the n analyzer ements are c Condition y of Res n # 1c 2c 3b 4 	nfiguration cal support equipment were local ions testing the measurement an ne conducted emissions from the or power meter via a suitable atte corrected to allow for the externation ons: Temperature: Rel. Humidity: 4 ults Test Performed RE, 30 - 24,000 MHz - Spurious Emissions RE, 30 - 24,000 MHz - Spurious Emissions 6dB Bandwidth Output Power	Limit FCC Part 15.209 / 15.247(c) FCC Part 15.209 / 15.247(c)	Adiated spu ers from the antenna p pading the Result Pass Pass Pass	urious emissi le EUT. ort of the EL measuremer Refer to in Refer to in Refer to in Refer to in	ions testing. JT was conne nt system. All argin dividual runs dividual runs dividual runs
Seneral The EU For radia When m spectrun measure Ambient Summar 1a- 2a- 3a- 4 5a-	Test Con T and all lo ated emissi- easuring the n analyzer ements are c Condition y of Res n # 1c 2c 3b 1 5b	nfiguration cal support equipment were locat ions testing the measurement an ne conducted emissions from the or power meter via a suitable atto corrected to allow for the externat ons: Temperature: Rel. Humidity: 8 ults Test Performed RE, 30 - 24,000 MHz - Spurious Emissions RE, 30 - 24,000 MHz - Spurious Emissions 6dB Bandwidth Output Power Power Spectral Density (PSD)	Limit ECC Part 15.209 / 15.247(c) FCC Part 15.209 / 15.247(c)	Adiated spuers from the antenna poading the antenna poading the antenna poading the Pass Pass Pass Pass Pass Pass Pass Pas	urious emissi le EUT. ort of the EU measuremer Refer to in Refer to in Refer to in Refer to in Refer to in	ions testing. JT was conne nt system. All argin dividual runs dividual runs dividual runs dividual runs dividual runs

#### **Deviations From The Standard**

No deviations were made from the requirements of the standard.



E	Ellio	ott						EM	IC Test Data
Client:	IBM						J	ob Number:	J49651
Model:	Intel 802.	11B (M/N	N: WM3B210	)0) in 14" II	3M laptop (Tł	ninkPad R40	T-L	og Number:	T49658
	Series)	,		,	1 1 1			Proi Ena:	Juan Martinez
Contact:	Robert Pa	ixman							
Snec	FCC Part	15 R an	d C RSS-21	10				Class	N/Δ
Run #1a:	Radiated S	Spuriou	s Emission	s. 30-24.00	0 MHz. Low	Channel @	2412 MHz	(1 Mbps)	14/74
itter i ter i	luulutou	spanoa		5,00 1,00				(1 11000)	
Frequency	Level	Pol	15.209	/ 15.247	Detector	Azimuth	Height	Comments	
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
2414.521	104.7	Н	-	-	Pk	-	-		
2414.762	101.9	Н	-	-	Avg	-	-		
2414.546	106.6	V	-	-	Pk	-	-		
2414.707	103.7	V	-	-	Avg	-	-		
7232.280	40.9	V	54.0	-13.1	Avg	110	1.3	Noise Floo	r Measurement
7231.506	37.5	Н	54.0	-16.5	Avg	120	1.2	Noise Floo	r Measurement
4823.925	35.0	Н	54.0	-19.0	Avg	170	1.4		
4823.960	34.1	V	54.0	-19.9	Avg	260	1.4		
7232.845	52.2	V	74.0	-21.8	Pk	110	1.3	Noise Floo	r Measurement
7231.579	49.1	Н	74.0	-24.9	Pk	120	1.2	Noise Floo	r Measurement
4823.698	44.3	V	74.0	-29.7	Pk	260	1.4		
4824.026	44.2	Н	74.0	-29.8	Pk	170	1.4		
Note 1: Note 2:	For emiss below the No other e	ions in re level of emission	estricted bar the fundame s detected a	nds, the lim ental. above the 3	it of 15.209 v rd harmonic.	vas used. Fo Readings w	or all other o	emissions, th 1B below the	ne limit was set 20dB e limit
Run #1b:	Radiated	Spuriou	s Emission	s, 30-24,00	0 MHz. Cen	ter Channel	@ 2437 M	Hz	
Frequency	Level	Pol	15.209	/ 15.247	Detector	Azimuth	Height	Comments	
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
7307.662	38.5	V	54.0	-15.5	Avg	170	1.3	Noise Floo	r Measurement
7310.424	35.8	Η	54.0	-18.2	Avg	0	1.0	Noise Floo	r Measurement
4873.953	32.9	Η	54.0	-21.1	Avg	210	1.3		
4873.922	32.4	V	54.0	-21.6	Avg	360	1.3		
7307.002	48.9	V	74.0	-25.1	Pk	170	1.3	Noise Floo	r Measurement
7310.350	47.5	Н	74.0	-26.5	Pk	0	1.0	Noise Floo	r Measurement
4874.265	44.0	Н	74.0	-30.0	Pk	210	1.3		
4874.047	43.7	٧	74.0	-30.3	Pk	360	1.3		
Note 1:	For emiss below the	ions in re level of	estricted bar	nds, the lim ental.	it of 15.209 v	vas used. Fo	or all other (	emissions, th	ne limit was set 20dB
Note 2:	No other	emission	s detected a	above the 3	rd harmonic.	Readinas w	ere all 20-0	B below the	e limit
				-		5			

E	Ellic	ott						EM	IC Test Data
Client:	IBM						J	ob Number:	J49651
Model:	Intel 802.2	11B (M/N	I: WM3B210	0) in 14" IE	3M laptop (TI	hinkPad R40	T-L	og Number:	T49658
	Series)							Proj Eng:	Juan Martinez
Contact:	Robert Pa	ixman						, ,	
Spec:	FCC Part	15 B and	d C, RSS-21	0				Class:	N/A
Run #1c:	Radiated S	Spurious	s Emissions	s, 30-24,00	0 MHz. Higi	h Channel @	2462 MHz	<u>.</u>	
Frequency	Level	Pol	15.209 /	15.247	Detector	Azimuth	Height	Comments	
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
2462.887	104.0	V	-	-	Pk	-	-		
2462.708	100.6	V	-	-	Avg	-	-		
2462.917	105.7	Н	-	-	Pk	-	-		
2462.748	102.4	Н	-	-	Avg	-	-		
7382.604	38.3	V	54.0	-15.7	Avg	230	1.4	Noise Floo	r Measurement
7386.704	36.2	Н	54.0	-17.8	Avg	200	1.4	Noise Floo	r Measurement
4923.973	36.1	Н	54.0	-17.9	Avg	230	1.4		
4923.953	35.0	V	54.0	-19.0	Avg	65	1.4		
7382.339	48.4	V	74.0	-25.6	Pk	230	1.4	Noise Floo	r Measurement
7385.805	47.6	Н	74.0	-26.4	Pk	200	1.4	Noise Floo	r Measurement
4924.315	45.4	Н	74.0	-28.6	Pk	230	1.4		
4924.106	45.1	V	74.0	-28.9	Pk	65	1.4		
Note 1:	For emiss below the	ions in re level of	estricted ban	ids, the lim ental.	it of 15.209 v	vas used. Fo	r all other	emissions, th	ne limit was set 20dB
Bandedge	Measurer	nents				Readings w			
Spurious	s Signal	Fundam	iental Level	Detector	Spurio	us Level	Limit	Margin	Comments
MF	IZ	(dBuV	/m @3m)	PK/Avg	-dBc	dBuV/m	dBuV/m	dB	
2385	0.98	1	00.0	PK	52.0	54.6	/4.0	-19.4	
2385	0.98	1	03.7	Avg	58.3	45.4	54.0	-8.6	
2484	.04	1	05.7	Pk	50.2	55.5	/4.0	-18.5	
2484	.04	1	02.4	Avg	53.2	49.2	54.0	-4.8	
Note 1:	EUT oper relative m highest pe	ating on easurem eak and a	the lowest c ents in run # average field	hannel ava #1, of CE s I strength r	ilable in the preadsheet ( neasuremen	2390 - 2412 I (52.00 dBc for ts of the fund	MHz band. r peak and amental sig	Signal leve 68.33 dBc f gnal level.	I calculated using the or average) applied to the
Note 2:	EUT oper- relative m the highes	ating on easurem st peak a	highest chai ients in run # ind average	nnel availa #1, of CE s field strenç	ble in the 24 preadsheet gth measurer	62 - 2483.5 N (50.17 dBc fc nents of the f	1Hz band. or peak and undamenta	Signal level I 53.17 dBc al signal leve	calculated using the for average) applied to II.



E	Ellic	ott						EN	IC Test Data
Client:	IBM						J	ob Number:	J49651
Model:	Intel 802.7	11B (M/N	N: WM3B210	)0) in 14" IE	3M laptop (Th	ninkPad R40	T-L	og Number:	T49658
	Series)			·				Proj Eng:	Juan Martinez
Contact:	Robert Pa	ixman						, ,	
Spec:	FCC Part	15 B an	d C, RSS-21	0				Class:	N/A
Run #2a:	Radiated S	Spuriou	s Emission	s, 30-24,00	0 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		
2413.781	111.8	V	-	-	Pk	-	-		
2413.343	102.7	V	-	-	Avg	-	-		
2413.746	111.2	Н	-	-	Pk	-	-		
2413.433	102.3	Н	-	-	Avg	-	-		
7232.554	39.0	V	54.0	-15.0	Avg	100	1.5	Noise Floo	r Measurement
7235.048	36.6	H	54.0	-17.4	Avg	0	1.0	Noise Floo	r Measurement
4823.912	32.9	H	54.0	-21.1	Avg	200	1.3		
4823.953	31.3	V	54.0	-22.7	AVg	0	1.0	Nieles Eles	
7232.355	50.5	V	74.0	-23.5 25.4	PK	100	1.5	Noise Floo	r Measurement
1233.190	48.0	<u>п</u> ц	74.0	-20.4	PK	200	1.0	INDISE FIDD	I measurement
4023.001	44.0	п V	74.0	-30.0	PK Dk	200	1.3		
Note 1: Note 2: <b>Run #2b:</b>	For emiss below the No other e	ions in re level of emission Spuriou	estricted bar the fundame s detected a s Emission	nds, the lim ental. above the 3 s, 30-24,00	it of 15.209 v Ird harmonic. 10 MHz. Cen	vas used. Fo Readings w ter Channel	or all other o vere all 20-c @ 2437 M	emissions, th dB below the <b>Hz</b>	he limit was set 20dB e limit
Fraguanau	Loval	Del	15 200	15 047	Detector	A zinouth	Lloight	Commonto	
Frequency		P01	15.209 /	15.247 Morgin	Delector	Azimuin	Height	Comments	
IVIFIZ 7207.656	ибµv/III 27 1	V/II V	54.0	16.0	PK/QP/AVg	180	1 2		
7307.030	37.1	V H	54.0	-10.7	Ανα	0	1.5	Noise Floo	r
4873 975	33.4	 Н	54.0	-21.0	Avg	60	1.0	110130 1100	1
4873 949	31.4	V	54.0	-22.6	Ava	0	1.0	Noise Floo	r
7306.982	48.9	v	74.0	-25.1	Pk	180	1.3		1
7310.263	48.0	H	74.0	-26.0	Pk	0	1.0	Noise Floo	r
4874.083	43.9	Н	74.0	-30.1	Pk	60	1.3		
4874.008	43.4	V	74.0	-30.6	Pk	0	1.0	Noise Floo	r
Note 1:	For emiss below the	ions in re level of	estricted bar	nds, the lim ental.	it of 15.209 v	vas used. Fo	or all other o	emissions, th	ne limit was set 20dB
Note 2:	No other e	emission	s detected a	above the 3	rd harmonic.	Readings w	ere all 20-o	B below the	e limit

E	Ellic	ott						EM	IC Test Data
Client:	IBM						J	ob Number:	J49651
Model:	Intel 802.	11B (M/N	I: WM3B210	0) in 14" II	3M laptop (Th	ninkPad R40	T-L	og Number:	T49658
	Series)							Proj Eng:	Juan Martinez
Contact:	Robert Pa	axman							
Spec:	FCC Part	15 B and	d C, RSS-21	0				Class:	N/A
Run #2c:	Radiated S	Spurious	s Emissions	s, 30-24,00	0 MHz. High	n Channel @	2462 MHz	z (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		
2463.713	110.3	Н	-	-	Pk	-	-		
2463.336	101.4	Н	-	-	Avg	-	-		
2463.751	111.4	V	-	-	Pk	-	-		
2463.417	102.5	V	-	-	Avg	-	-		
7385.233	37.2	V	54.0	-16.8	Avg	80	1.2		
7385.511	35.0	Н	54.0	-19.0	Avg	140	1.3		
4923.139	33.0	V	54.0	-21.0	Avg	320	1.1	Noise Floor	r
4923.656	30.9	Н	54.0	-23.1	Avg	0	1.0	Noise Floor	r
7386.263	48.6	V	74.0	-25.4	Pk	80	1.2		
7385.453	47.0	Н	74.0	-27.0	Pk	140	1.3		
4924.303	45.6	V	74.0	-28.4	Pk	320	1.1	Noise Floor	r
4923.440	43.2	Н	74.0	-30.8	Pk	0	1.0	Noise Floor	r
Note 1:	For emiss below the	ions in re level of	estricted ban the fundame	ids, the lim ental.	it of 15.209 w	vas used. Fo	or all other o	emissions, th	ne limit was set 20dB
Note 2:	No other e	emission	s detected a	bove the 3	rd harmonic.	Readings w	ere all 20-o	B below the	e limit
Bandedge	Measurer	nents						1	
Spurious	s Signal	Fundam	iental Level	Detector	Spuriou	IS Level		Margin	Comments
IVIF 2205	12	(aran	/m @3M) 11.0	PK/AVg	-aRC	aBuV/M	aBUV/M	0B	
2385	0.98	1	11.8	PK	50.5	61.3	74.0	-12./	
2385	0.98	1	UZ./	AVg	52.3	50.4	54.0	-3.0	
2484	.04	1	11.4 02.5	PK	53.0	58.4	74.0	-15.0	
2484	.04	I	02.5	Avg	52.8	49.7	54.0	-4.3	
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 (50.5 dBc for peak and 52.33 dBc for average) applied to the highest peak and average field strength measurements of the fundamental signal level.								
Note 2:	EUT oper relative m the highes	ating on easurem st peak a	highest chai ients in run # ind average	nnel availa #2, of CE s field streng	ble in the 246 preadsheet ( gth measuren	52 - 2483.5 N (53.00 dBc fo nents of the f	1Hz band. or peak and fundamenta	Signal level I 52.84 dBc i al signal leve	calculated using the for average) applied to I.





Model: Intel 802.11B (M/ Series) Contact: Robert Paxman Spec: FCC Part 15 B ar	N: WM3B21				Jo	b Number:	J49651
Series) Contact: Robert Paxman Spec: FCC Part 15 B ar 1 #4: Output Power		00) in 14" IB	M laptop (	ThinkPad R40	T-Lo	g Number:	T49658
Contact: Robert Paxman Spec: FCC Part 15 B ar 1 #4: Output Power						Proj Eng:	Juan Martine
Spec: FCC Part 15 B ar 1#4: Output Power							
1 #4: Output Power	d C, RSS-2	10				Class:	N/A
LInit S/N #	Freq	Power			Settings		
Ch.	MHz	dBm	Bias	Data Rate	Scales	Gain	Step
	2412	16.9	34	1 (1Mb/s)	10	1	0
JU423467472 6	2437	1/.0	35	1 (1Mb/s)	12	1	0
	2462	10.5	35	i (iivid/s)	13	2	U
	Fren	Power			Settings		
Unit S/N #	MHz	dBm	Bias	Data Rate	Scales	Gain	Step
1	2412	16.8	34	5 (5.5Mb/s)	10	1	0
00423467472 6	2437	17.1	35	5 (5.5Mb/s)	12	1	0
11	2462	17.0	35	5 (5.5Mb/s)	13	2	0
	-						
Unit S/N #	Freq	Power		1 1	Settings		
Ch.	MHz	dBm	Bias	Data Rate	Scales	Gain	Step
1	2412	16.8	34	11 (11Mb/s)	10	1	0
)042346/4/2 6	2437	17.0	35	11 (11Mb/s)	12	1	0
	2462	16.8	35	TT (TTIVID/S)	13	2	U
e 1: Preliminary power a data rate of 1M	r measureme b/s when col	ents demons mpared to th	started that the output p	t the output pov ower at data ra	ver was slig ites of 11Mb	htly higher /s.	when the unit

# **Elliott**

# EMC Test Data

Client:	IBM	Job Number:	J49651
Model:	Intel 802.11B (M/N: WM3B2100) in 14" IBM laptop (ThinkPad R40	T-Log Number:	T49658
	Series)	Proj Eng:	Juan Martinez
Contact:	Robert Paxman		
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	-1.17	see plots below
Mid	2437	3 kHz	-4.33	see plots below
High	2462	3 kHz	-3.50	see plots below

#### Data Rate=11









