

FCC PART 15.249
EMI MEASUREMENT AND TEST REPORT

For

Dust Networks, Inc.

2560 Ninth Street, Suite 220
Berkeley, CA 94710

FCC ID: SJC-D1100

This Report Concerns: ☒ Original Report	Equipment Type: Blue Mote
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Report No.: R0409013	
Report Date: 2004-09-30	
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GENERAL INFORMATION

Product Description for Equipment Under Test (EUT)

The *Dust Networks, Inc.* 's product, model no.: *D1100* or the "EUT" as referred to this report is a blue mote which measures approximately 75mmL x 32mmW x 115mmH. The EUT is a DSS device, operating frequency 903.0180 – 926.9796 MHz with maximum output power of 4.33dBm (2.71mW).

** The test data gathered are from typical production sample, serial number: #1, provided by the manufacturer.*

Objective

This document is a test report based on the Electromagnetic Interference (EMI) tests performed on the EUT. The EMI measurements were performed according to the measurement procedure described in ANSI C63.4 - 2001.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.205, 15.207, and 15.249, 15.203, 15.209 rules.

Related Submittal(s)/Grant(s)

No Related Submittals

Test Methodology

All measurements contained in this report were conducted with ANSI C63.4 - 2001, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz. All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Test Facility

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

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

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

Additionally, Bay Area Compliance Laboratory Corporation is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (NVLAP). The scope of the accreditation covers the FCC Method - 47 CFR Part 15 - Digital Devices, CISPR 22:1997 and AS/NZS 3548: Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment test methods under NVLAP Lab Code 200167-0.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The EUT was configured for testing according to ANSI C63.4-2001.

The final qualification test was performed with the EUT operating at normal mode

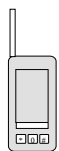
Equipment Modifications

No modifications were made to the EUT.

Power Supply Information

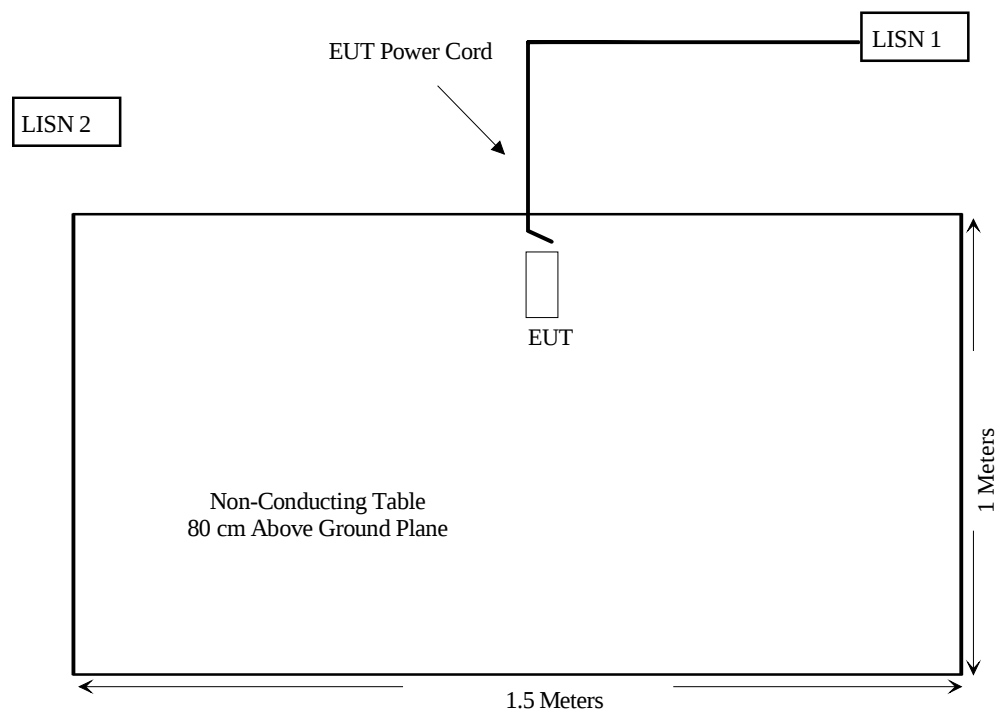
Manufacturer	Description	Model	Serial Number	FCC ID
Arescom	AC/DC adapter	GI12-US0520	None	None

Configuration of Test System



EUT

Test Setup Block Diagram



SUMMARY OF TEST RESULTS

FCC RULES	DESCRIPTION OF TEST	RESULT
§15.203	Antenna Requirement	Compliant
§15.205	Restricted Bands of Operation	Compliant
§15.207 (a)	Conducted Emission	Compliant
§15.209 (a), §15.249 (a)	Radiated Emission	Compliant
§15.249 (c)	Band Edge Testing	Compliant

§15.203 - ANTENNA REQUIREMENT

Standard Applicable

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Connected Construction

The gain of antenna used for transmitting is 2 dBi, and the antenna connector is A male U.FL antenna connector.

§ 15.249 (c) - CONDUCTED EMISSIONS TEST DATA

Measurement Uncertainty

All measurements involve certain levels of uncertainties. These uncertainties are attributed to: Spectrum analyzer, Cable loss, and LISN.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the estimated uncertainty of any conducted emission measurement at BACL is ± 2.4 dB.

EUT Setup

The measurement was performed in the shielded room, using the same setup per ANSI C63.4-2001 measurement procedure. The specification used was FCC 15 Subpart C limits.

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

The EUT was connected with 120Vac/60Hz power source.

Spectrum Analyzer Setup

The spectrum analyzer was set to investigate the spectrum from 150 kHz to 30Mhz.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Cal. Date
Rohde & Schwarz	Artificial LISN	ESH2-Z5	871884/039	2004-03-28
Rohde & Schwarz	EMI Test Receiver	ESCS30	100176	2004-05-06

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

Test Procedure

During the conducted emission test, the power cord of the host system was connected to the auxiliary outlet of the first LISN.

Maximizing procedure were performed on the six (6) highest emissions of the EUT.

All data was recorded in the peak detection mode, quasi-peak and average. Quasi-Peak readings are distinguished with an "QP". Average readings are distinguished with an "Ave".

Environmental Conditions

Temperature:	23° C
Relative Humidity:	42%
ATM Pressure:	1028 mbar

The testing was performed by Ming Jin on 2004-09-04.

Summary of Test Results

According to the recorded data in following table, the EUT complies with the FCC Conducted limit for a Class B device, with the *worst* margin reading of:

-11.8 dB at 0.150 MHz in the Line conductor

Conducted Emissions Test Data

Frequency MHz	LINE CONDUCTED EMISSIONS			FCC 15 SUBPART C	
	Amplitude dBμV	Detector Qp/Ave/Peak	Phase Line/Neutral	Limit dBμV	Margin dB
0.150	44.2	Ave	Line	56	-11.8
0.150	53.6	QP	Line	66	-12.4
0.150	50.1	QP	Neutral	66	-15.9
2.770	39.9	QP	Neutral	56	-16.1
2.770	26.3	Ave	Neutral	46	-19.7
1.770	35.2	QP	Line	56	-20.8
0.150	34.9	Ave	Neutral	56	-22.1
1.770	19.5	Ave	Line	46	-26.5
16.300	22.9	QP	Line	60	-26.5
16.300	14.2	Ave	Line	50	-37.1
16.300	19.8	QP	Neutral	60	-40.2
16.300	8.7	Ave	Neutral	50	-41.3

Plot of Conducted Emissions Test Data

Plot of Conducted Emissions test data was presented hereinafter as reference.

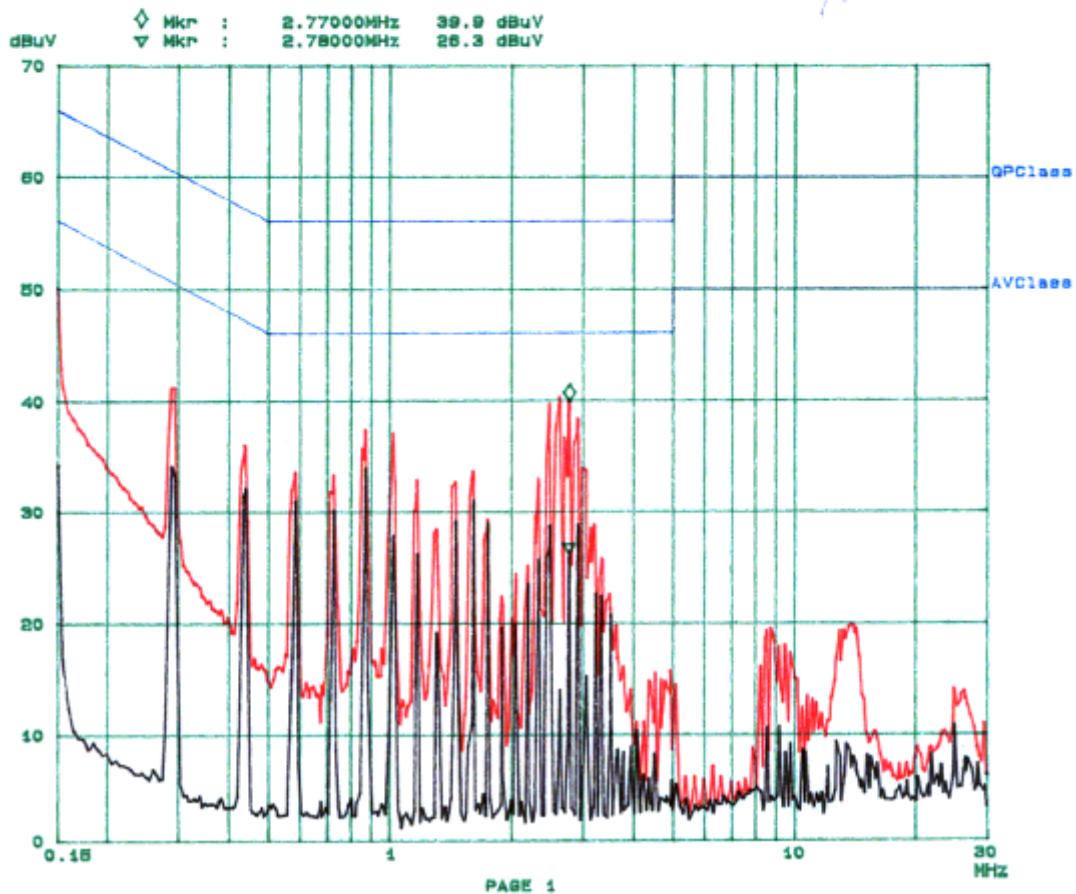
Bay Area Compliance Laboratory Corp
FCC 15

15. Sep 04 14:26

EUT: D1100A
Manuf: Dust Inc.
Op Cond: Normal
Operator: Mng
Comment: N

Scan Settings (3 Ranges)

Frequencies			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp
150k	1M	5k	9k	QP+AV	20ms	15dB LN	OFF
1M	5M	10k	9k	QP+AV	1ms	15dB LN	OFF
5M	30M	100k	9k	QP+AV	1ms	15dB LN	OFF

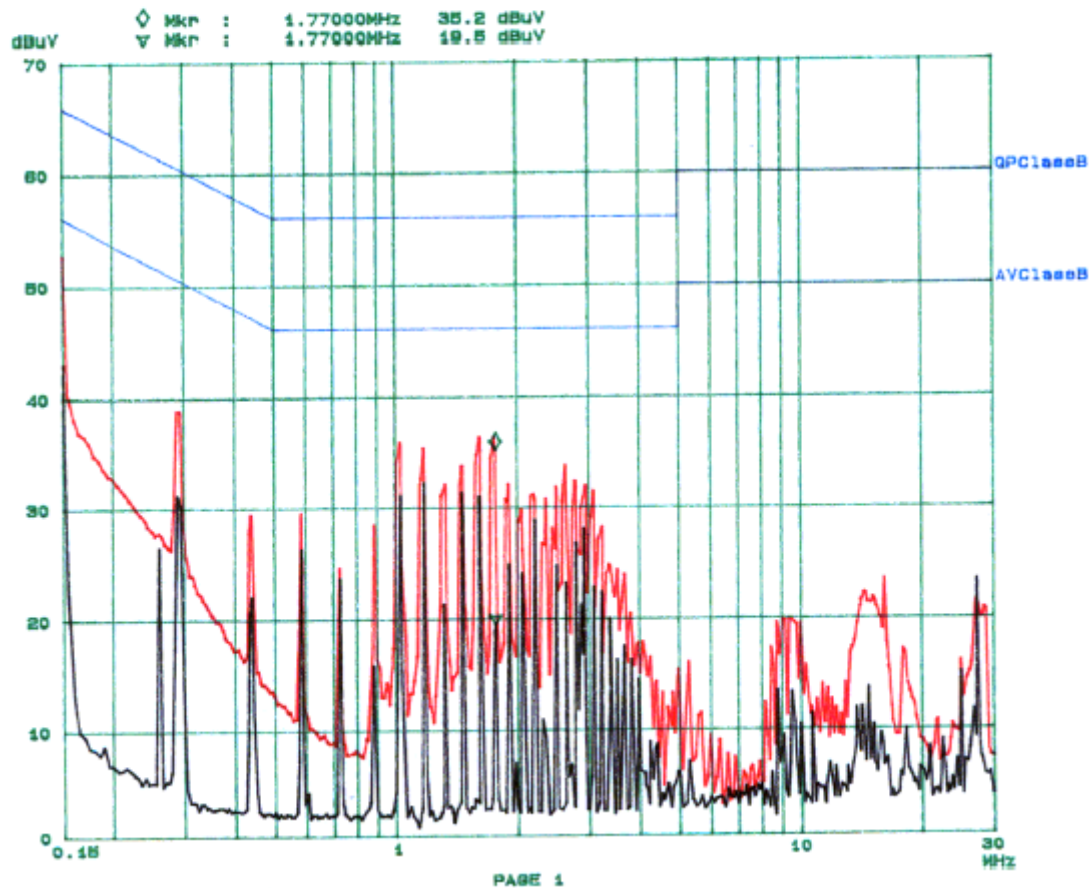


Bay Area Compliance Laboratory Corp
FCC 15

18. Sep 04 14:05

EUT: D1100A
Manuf: Dust Inc.
Op Cond: Normal
Operator: Mng
Comment: L

Scan Settings (3 Ranges)			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp
150k	1M	5k	9k	QP+AV	20ms	15dB LN	OFF
1M	5M	10k	9k	QP+AV	1ms	15dB LN	OFF
5M	30M	100k	9k	QP+AV	1ms	15dB LN	OFF



§15.209(a) - RADIATED EMISSION DATA

Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. 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.

EUT Setup

The radiated emission tests were performed in the open area 3-meter test site, using the setup in accordance with ANSI C63.4-2001. The specification used was the FCC 15 Subpart C limits.

The spacing between the peripherals was 10 centimeters.

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

The EUT was connected with 120Vac/60Hz power source.

Spectrum Analyzer Setup

According to FCC Rules, 47 CFR 15.33 (a) (1), the system was tested to 25GHz.

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

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

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Cal. Date
HP	Spectrum Analyzer	8568B	2601A02165	2004-07-03
HP	Amplifier	8447E	2944A10187	2004-09-23
HP	Quasi-Peak Adapter	85650A	3019A05393	2004-06-13
EMCO	Biconical Antenna	3110B	9309-1165	2003-10-11
EMCO	Log Periodic Antenna	3146	2101	2003-10-11
Agilent	Spectrum Analyzer (9KHz – 50GHz)	8565EC	3946A00131	2004-05-03
HP	Amplifier (1-26.5GHz)	8449B	3147A00400	2004-03-14
A.H.System	Horn Antenna (700MHz-18GHz)	SAS-200/571	261	2004-05-31

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

Environmental Conditions

Temperature:	25° C
Relative Humidity:	39%
ATM Pressure:	1034 mbar

The testing was performed by Ming Jin on 2004-09-01.

Test Procedure

For the radiated emissions test, the power cord of the EUT was connected to the AC floor outlet.

Maximizing procedure was performed on the six (6) highest emissions to ensure EUT is compliant with all installation combinations.

All data was recorded in the peak detection mode. Quasi-peak readings was performed only when an emission was found to be marginal (within -4 dBμV 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:

$$\text{Corr. Ampl.} = \text{Indicated Reading} + \text{Antenna Factor} + \text{Cable Factor} - \text{Amplifier Gain}$$

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

$$\text{Margin} = \text{Corr. Ampl.} - \text{Applicable Limit}$$

Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.207, and 15.249 after tested to 10th harmonics as required by FCC and had the worst margin of:

-2.2 dB at 903.0180 MHz in the Vertical polarization, Low Channel.

-2.3 dB at 914.9988 MHz in the Vertical polarization, Middle Channel.

-2.8 dB at 926.9796 MHz in the Vertical polarization, High Channel.

-3.6 dB at 248.84 MHz in the Vertical polarization, Unintentional Emission.

Indicated			Antenna	Antenna		Correction Factor			FCC 15 Subpart C		
Frequency	Ampl.	Direction	Height	Polar	Antenna	Cable Loss	Amp.	Corr. Ampl.	Limit	Margin	Mode
MHz	dBμV/m	Degree	Meter	H/V	dBμV/m	dBμV/m	dB	dBμV/m	dBμV/m	dB	
Low Channel											
903.0180	95.7	180	1.2	v	23.6	0.9	28.4	91.8	94	-2.2	Fund/QP
1806.0360	59.5	210	1.8	v	25.3	1.9	36.3	50.4	54	-3.6	Ave
1806.0360	54.7	0	1.0	h	25.3	1.9	36.3	45.6	54	-8.4	Ave
1806.0360	74.3	210	1.8	v	25.3	1.9	36.3	65.2	74	-8.8	Peak
2709.0540	45.9	30	1.0	v	29.0	2.4	35.5	41.8	54	-12.2	Ave
2709.0540	63.9	30	1.0	v	29.0	2.4	35.5	59.8	74	-14.2	Peak
903.0180	83.0	30	1.1	h	23.6	0.9	28.4	79.1	94	-14.9	Fund/QP
1806.0360	66.1	0	1.0	h	25.3	1.9	36.3	57.0	74	-17.0	Peak
2709.0540	38.6	90	2.0	h	29.0	2.4	35.5	34.5	54	-19.5	Ave
2709.0540	51.4	90	2.0	h	29.0	2.4	35.5	47.3	74	-26.7	Peak
Middle Channel											
914.9988	96.0	90	1.4	v	23.2	0.9	28.4	91.7	94	-2.3	Fund/QP
1829.9976	59.8	310	1.5	v	25.3	1.9	36.3	50.7	54	-3.3	Ave
1829.9976	54.9	270	1.2	h	25.3	1.9	36.3	45.8	54	-8.2	Ave
1829.9976	74.5	310	1.5	v	25.3	1.9	36.3	65.4	74	-8.6	Peak
2744.9964	46.1	0	1.6	v	29.0	2.4	35.5	42.0	54	-12.0	Ave
914.9988	84.5	60	1.0	h	23.2	0.9	28.4	80.2	94	-13.8	Fund/QP
2744.9964	64.1	0	1.6	v	29.0	2.4	35.5	60.0	74	-14.0	Peak
1829.9976	66.2	270	1.2	h	25.3	1.9	36.3	57.1	74	-16.9	Peak
2744.9964	38.8	90	1.5	h	29.0	2.4	35.5	34.7	54	-19.3	Ave
2744.9964	51.7	90	1.5	h	29.0	2.4	35.5	47.6	74	-26.4	Peak
High Channel											
926.9796	95.2	0	1.2	v	23.4	0.9	28.3	91.2	94	-2.8	Fund/QP
1853.9592	59.4	110	1.5	v	25.3	1.9	36.3	50.3	54	-3.7	Ave
1853.9592	54.5	180	1.5	h	25.3	1.9	36.3	45.4	54	-8.6	Ave
1853.9592	74.2	110	1.5	v	25.3	1.9	36.3	65.1	74	-8.9	Peak
2780.9388	45.7	290	1.0	v	29.0	2.4	35.5	41.6	54	-12.4	Ave
926.9796	85.0	60	1.0	h	23.4	0.9	28.3	81.0	94	-13.0	Fund/QP
2780.9388	63.7	290	1.0	v	29.0	2.4	35.5	59.6	74	-14.4	Peak
1853.9592	65.9	180	1.5	h	25.3	1.9	36.3	56.8	74	-17.2	Peak
2780.9388	38.5	30	1.2	h	29.0	2.4	35.5	34.4	54	-19.6	Ave
2780.9388	51.2	30	1.2	h	29.0	2.4	35.5	47.1	74	-26.9	Peak

Note:

FUND: Fundamental

AVG: Average

Unintentional Emission, transmitter

Indicated			Antenna	Antenna		Correction Factor			FCC 15 Subpart C	
Frequency	Ampl.	Direction	Height	Polar	Antenna	Cable Loss	Amp.	Corr. Ampl.	Limit	Margin
MHz	dBμV/m	Degree	Meter	H/V	dBμV/m	dBμV/m	dB	dBμV/m	dBμV/m	dB
248.84	56.4	30	1.5	v	13.8	0.2	28.0	42.4	46	-3.6
348.36	53.9	270	1.5	v	15.4	0.8	28.0	42.1	46	-3.9
646.92	50.26	30	2.0	v	20.3	0.3	28.9	42.0	46	-4.0
298.61	55.8	110	1.5	h	13.7	0.2	27.8	41.9	46	-4.1
398.14	52.1	250	1.3	h	16.4	0.8	28.3	41.1	46	-5.0
447.88	47.93	90	1.5	v	16.9	0.5	28.5	36.8	46	-9.2
796.24	40.77	90	1.5	h	22.6	0.3	28.7	35.0	46	-11.1

§15.249(c) – BAND-EDGE TESTING

Standard Applicable

Requirements: FCC 15.249 (c), the emission power at the START and STOP frequencies shall be at least 50 dB below the level of the fundamental or to the general radiated emission limits in FCC 15.209, whichever is the lesser attenuation.

Test Procedure

With the EUT's antenna attached, the EUT's radiated emission power was received by the test antenna which was connected to the spectrum analyzer with the START and STOP frequencies set to the EUT's operation band.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Cal. Due Date
HP	Spectrum Analyzer	8565EC	3946A00131	2004-05-03

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

Environmental Conditions

Temperature:	28° C
Relative Humidity:	37%
ATM Pressure:	1032 mbar

The testing was performed by Ling Zhang on 2004-07-21.

Test Results

Frequency	Reading	Direction	Height	Polar	Antenna Loss	Cable loss	Amplifier	Correction Factor	FCC	FCC	Comments
MHz	dBuV	Degree	Meter	H / V	dBuV	dBuV	dBuV	dBuV	Limit	Margin	
902.0000	47.5	180	1.0	v	23.6	0.9	28.4	43.6	46	-2.4	QP
902.0000	45.2	0	1.2	h	23.6	0.9	28.4	41.3	46	-4.7	QP
928.0000	46.8	180	1.2	v	23.4	0.9	28.3	42.8	46	-3.2	QP
928.0000	45.5	30	1.0	h	23.4	0.9	28.3	41.5	46	-4.5	QP