

FCC PART 15.249
MEASUREMENT AND TEST REPORT
For
Electronic Solutions, Inc.

1355 Horizon Ave., Lafayette
CO 80026, USA

FCC ID: P7RFGIMS01
Model: Forest IMS

This Report Concerns: ☒ Original Report	Equipment Type: Wireless Motor Controller
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Report Number:	R0806022-249a
Report Date:	2008-08-05
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* This report may contain data that are not covered by the NVLAP accreditation and are marked with an asterisk "*" (Rev-2)

TABLE OF CONTENTS

1	GENERAL INFORMATION.....	5
1.1	PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT).....	5
1.2	MECHANICAL DESCRIPTION.....	5
1.3	EUT PHOTO.....	5
1.4	OBJECTIVE.....	6
1.5	RELATED SUBMITTAL(S)/GRANT(S).....	6
1.6	TEST METHODOLOGY.....	6
1.7	MEASUREMENT UNCERTAINTY.....	6
1.8	TEST FACILITY.....	6
2	SYSTEM TEST CONFIGURATION.....	8
2.1	JUSTIFICATION.....	8
2.2	EUT EXERCISE SOFTWARE.....	8
2.3	EQUIPMENT MODIFICATIONS.....	8
2.4	SPECIAL ACCESSORIES.....	8
2.5	LOCAL SUPPORT EQUIPMENT.....	8
2.6	REMOTE SUPPORT EQUIPMENT.....	8
2.7	POWER SUPPLY INFORMATION.....	8
2.8	EXTERNAL I/O CABLING LIST AND DETAILS.....	9
2.9	TEST SETUP BLOCK DIAGRAMS.....	9
3	SUMMARY OF TEST RESULTS.....	11
4	§15.203 - ANTENNA REQUIREMENT.....	12
4.1	APPLICABLE STANDARD.....	12
4.2	ANTENNA CONNECTOR CONSTRUCTION.....	12
5	§15.207 - CONDUCTED EMISSIONS.....	13
5.1	SECTION 15.207 CONDUCTED LIMITS:.....	13
5.2	TEST SETUP.....	13
5.3	TEST EQUIPMENT LIST AND DETAILS.....	13
5.4	TEST PROCEDURE.....	13
5.5	ENVIRONMENTAL CONDITIONS.....	14
5.6	SUMMARY OF TEST RESULTS.....	14
6	§15.205, §15.209(A), §15.249(A) AND §15.249 - RADIATED EMISSIONS.....	17
6.1	APPLICABLE STANDARD.....	17
6.2	TEST SETUP.....	18
6.3	EUT SETUP.....	18
6.4	TEST EQUIPMENT LIST AND DETAILS.....	18
6.5	TEST PROCEDURE.....	19
6.6	ENVIRONMENTAL CONDITIONS.....	19
6.7	SUMMARY OF TEST RESULTS.....	20
6.8	RADIATED EMISSIONS DATA:.....	21
7	EXHIBIT A - FCC ID LABEL INFORMATION.....	24
7.1	FCC § 2.925 IDENTIFICATION OF EQUIPMENT.....	24
7.2	FCC ID LABEL REQUIREMENTS AS PER FCC § 15.19.....	24
7.3	FCC ID LABEL.....	24
7.4	PROPOSED LABEL LOCATION ON EUT.....	25
8	EXHIBIT B - TEST SETUP PHOTOGRAPHS.....	26
8.1	CONDUCTED EMISSIONS –FRONT VIEW.....	26

8.2	CONDUCTED EMISSIONS – SIDE VIEW.....	26
8.3	RADIATED EMISSIONS (30-1GHz) – FRONT VIEW	27
8.4	RADIATED EMISSIONS (ABOVE 1GHz) – FRONT VIEW.....	27
	RADIATED	28
8.5	EMISSIONS (30-1GHz) – REAR VIEW.....	28
8.6	RADIATED EMISSIONS (ABOVE 1GHz) – FRONT VIEW.....	28
9	EXHIBIT C - EUT PHOTOGRAPHS.....	29
9.1	EUT FRONT VIEW	29
9.2	EUT TOP VIEW	29
9.3	EUT SIDE VIEW (1)	30
9.4	EUT SIDE VIEW (2).....	30
9.5	EUT – BOARD COMPONENT SIDE VIEW	31
9.6	EUT – BOARD SOLDER SIDE VIEW	31
9.7	RF MODULAR VIEW	33
9.8	ANTENNA VIEW	33

DOCUMENT REVISION HISTORY

Revision #	Report Number	Description of Revision	Date of Revision
0	R0806022-249	Original Report	2008-06-25
1	R0806022-249a	Updated test data and plot in Radiated Emissions Section	2008-08-05

1 GENERAL INFORMATION

1.1 Product Description for Equipment under Test (EUT)

This measurement and test report has been compiled on behalf of the company *Electronic Solutions Inc.* and their product *model: Forest IMS, FCC ID: P7RFGIMS01*, which will be henceforth in this report referred to as the EUT (Equipment under Test).

The EUT is a Wireless Motor Controller for AC limit-switched Home Automation Motors; the ZM3102N connects 120VAC power using 3-pin power connector. The mod jack contains connections to two dry contact manual inputs, and the digital ground of the controller board.

The motor control firmware is configured to run the motor continuously when one of the two buttons closest to the mod jack is pressed. The motor in the device is intended to be run with short duty cycles (less than 1 hour a day) and the motor may get hot and cease to function if run for longer than several minutes. If that happens, allow the motor to cool before operating again.

** All test data gathered is from a production sample.*

1.2 Mechanical Description

The EUT is a Wireless Motor Controller for AC limit-switched Home Automation Motors of plastic construction that measures approximately *306mm (L) x 51 mm (W) x 69 mm (H)* and weighs approximately *1678 g*. It is typically powered by 120VAC/230VAC.

1.3 EUT Photo



Please see additional photos in exhibit C

1.4 Objective

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

The objective is to determine compliance with FCC rules for section 15.203, 15.205, 15.207, 15.209 and 15.249.

1.5 Related Submittal(s)/Grant(s)

No Related Submittals

1.6 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.4-2003, 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.

1.7 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 values range from ± 2.0 for Conducted Emissions tests and ± 4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL.

Detailed instrumentation measurement uncertainties can be found in BACL report QAP-018.

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

1.8 Test Facility

The test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test sites at BACL have 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 C63.4-2003.

The Federal Communications Commission, Industry Canada, and Voluntary Control Council for Interference has the reports on file and is listed under FCC registration number: 90464, IC registration number: 3062A, and VCCI Registration Number: C-2463 and R-2698. The test site has been approved by the FCC, IC, and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (Lab Code 200167-0). The current scope of accreditations can be found at <http://ts.nist.gov/ts/htdocs/210/214/scopes/2001670.htm>



2 SYSTEM TEST CONFIGURATION

2.1 Justification

The EUT was configured for testing according to ANSI C63.4-2003.

The EUT was tested in the testing mode to represent *worst-case* results during the final qualification test.

2.2 EUT Exercise Software

N/A.

2.3 Equipment Modifications

No modifications were made to the EUT.

2.4 Special Accessories

As shown in following test setup block diagram, all interface cables used for compliance testing are unshielded.

2.5 Local Support Equipment

Manufacturer	Description	Model	Serial Number	FCC ID
/	/	/	/	/

2.6 Remote Support Equipment

Manufacturer	Description	Model	Serial Number	FCC ID
/	/	/	/	/

2.7 Power Supply Information

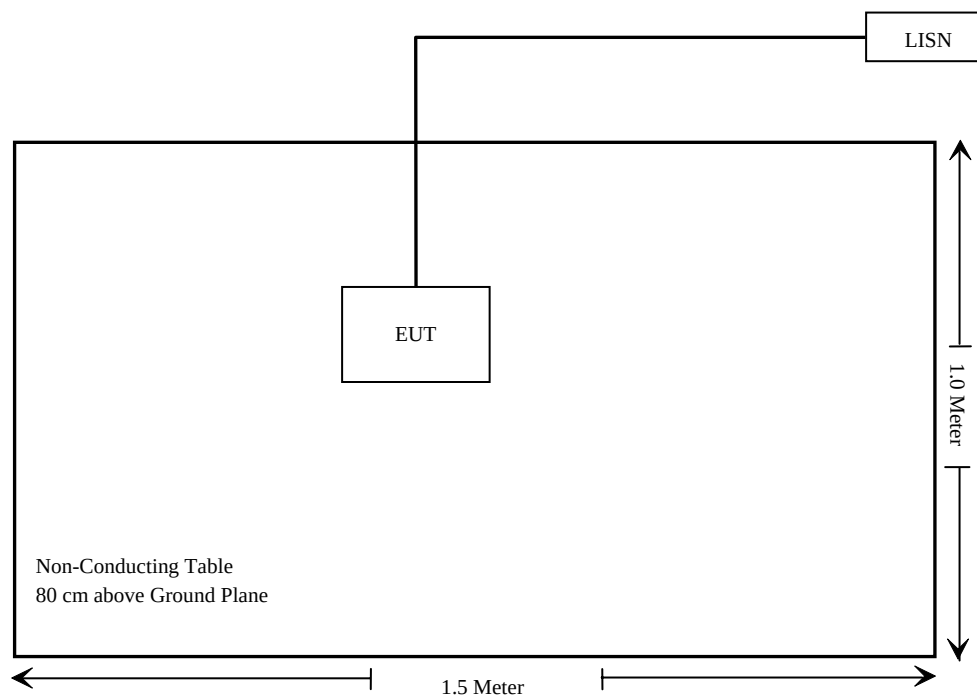
Manufacturer	Description	Model	Serial Number	FCC ID
/	/	/	/	/

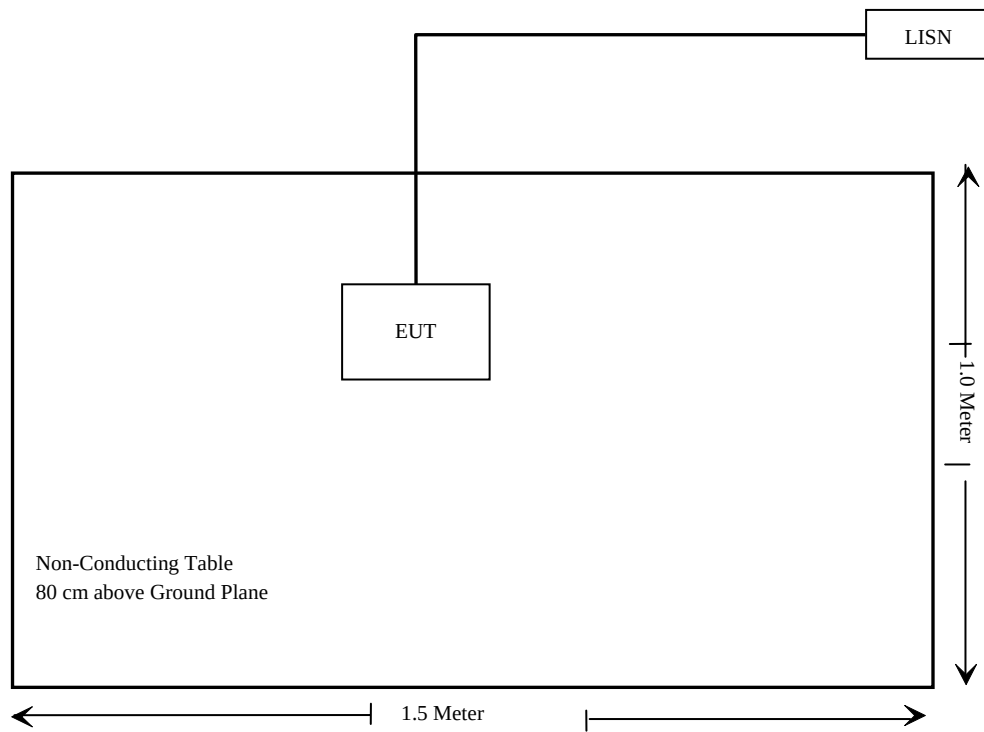
2.8 External I/O Cabling List and Details

Cable Description	Length (m)	Port/From	To
/	/	/	/

2.9 Test Setup Block Diagrams

Conducted Emission



Radiated Emissions

3 SUMMARY OF TEST RESULTS

Results reported relate only to the product tested.

FCC Rules	Description of Test	Result
§15.203	Antenna Requirement	Compliant
§15.207(a)	Conduction Emissions	Compliant
§15.205(a), §15.209(a), §15.249(a), §15.249(d)	Radiated Emissions	Compliant

4 §15.203 - ANTENNA REQUIREMENT

4.1 Applicable Standard

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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

And according to § 15.247 (b) (4), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.2 Antenna Connector Construction

The EUT antenna is a wire soldered onto the PCB, which in accordance to section 15.203, is considered sufficient to comply with the provisions of this section.

Result: *Compliant.*

5 §15.207 - CONDUCTED EMISSIONS

5.1 Section 15.207 Conducted limits:

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

5.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.4 – 2003 measurement procedure. The specification used was FCC Class B limits.

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

The EUT was connected with LISN-1 as powered by connection to 120 V/ 60 Hz AC mains

5.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Solar Electronics	LISN	9252-R-24-BNC	511205	2007-07-07
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.595 0K03	100338	2008-05-07

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

5.4 Test Procedure

During the conducted emissions test, the power cord of the EUT was connected to the mains outlet of the LISN-1.

Maximizing procedure was 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 a “QP”. Average readings are distinguished with an “Ave”.

5.5 Environmental Conditions

Temperature:	16 °C
Relative Humidity:	40 %
ATM Pressure:	102.0 kPa

**The testing was performed by Victor Zhang on 2008-06-02*

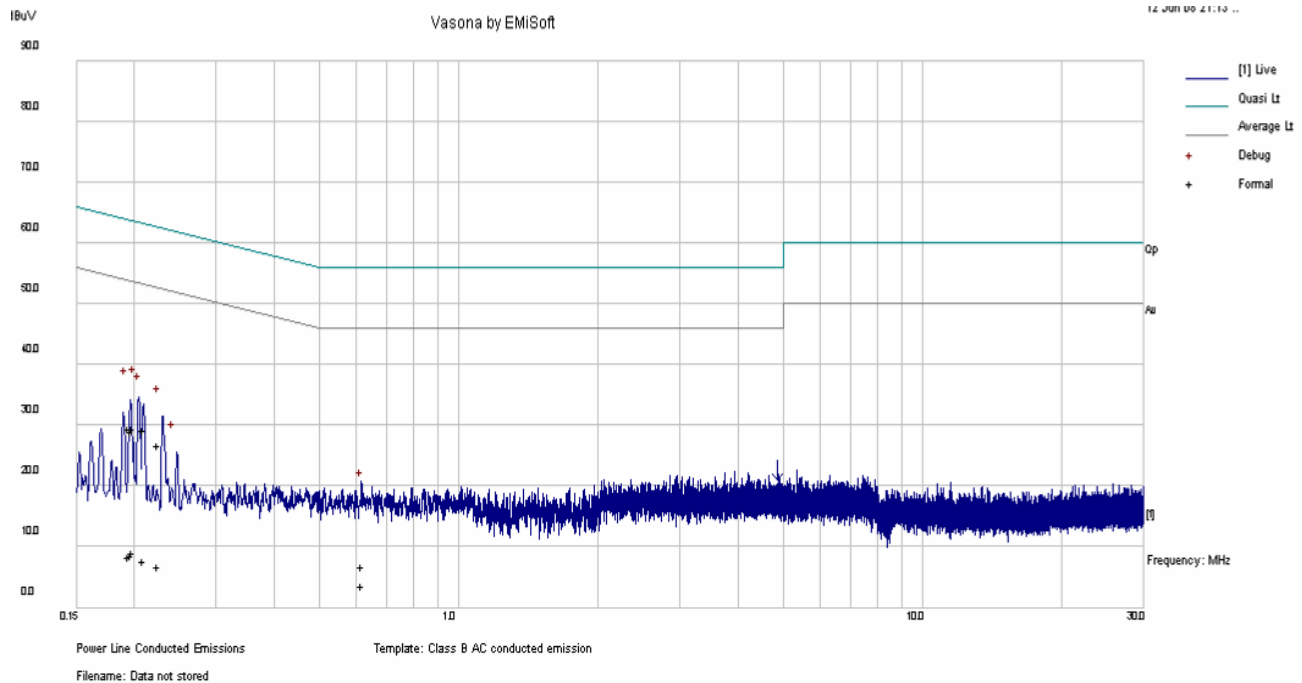
5.6 Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC standard's conducted emissions limits of Part15.207, with the worst margin reading of:

Connection: 120 V/60 Hz AC			
Margin (dB)	Frequency (MHz)	Conductor Mode (Live/Neutral)	Range (MHz)
-38.96	0.213	Live	0.150 MHz to 30 MHz
-38.83	0.214	Neutral	0.150 MHz to 30 MHz

Conducted Emissions Test Plots and Data

120 V, 60 Hz - Live

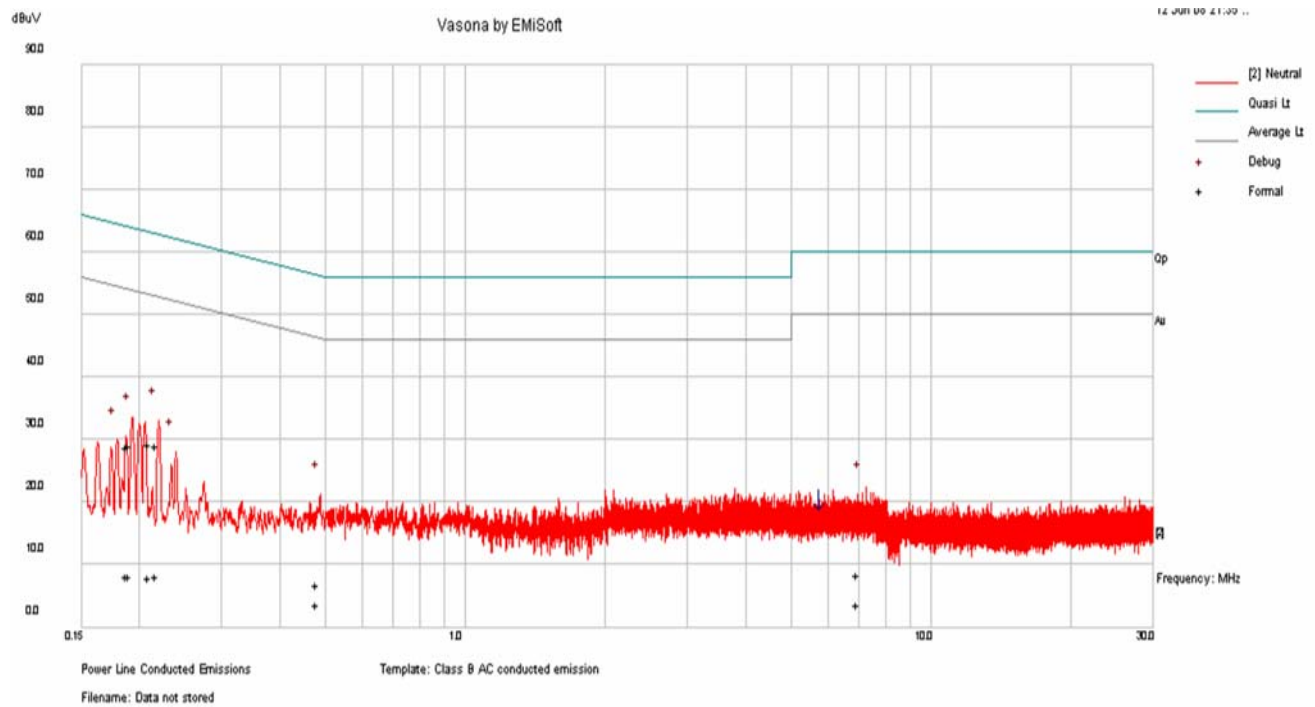


Quasi-Peak Measurements

Frequency (MHz)	Quasi-Peak (dBμV)	Conduction (Live/ Neutral)	Limit (dBμV)	Margin (dB)
0.213	24.12	Live	63.08	-38.96
0.202	24.50	Live	63.53	-39.03
0.198	24.54	Live	63.68	-39.13
0.201	24.10	Live	63.58	-39.49
0.229	21.72	Live	62.48	-40.76
0.632	1.72	Live	56.00	-54.28

Average Measurements

Frequency (MHz)	Average (dBμV)	Conduction (Live/ Neutral)	Limit (dBμV)	Margin (dB)
0.632	1.49	Live	46.00	-44.51
0.202	3.98	Live	53.53	-49.55
0.201	3.64	Live	53.58	-49.94
0.198	3.26	Live	53.68	-50.42
0.213	2.65	Live	53.08	-50.43
0.229	1.78	Live	52.48	-50.70

120 V, 60 Hz – Neutral**Quasi-peak Measurements**

Frequency (MHz)	Quasi-Peak (dBμV)	Conduction (Live/ Neutral)	Limit (dBμV)	Margin (dB)
0.214	24.24	Neutral	63.07	-38.83
0.221	23.93	Neutral	62.77	-38.84
0.194	23.92	Neutral	63.85	-39.93
0.192	23.70	Neutral	63.95	-40.25
0.489	1.74	Neutral	56.18	-54.44
7.106	3.34	Neutral	60.00	-56.66

Average Measurements

Frequency (MHz)	Average (dBμV)	Conduction (Live/ Neutral)	Limit (dBμV)	Margin (dB)
0.489	12.31	Neutral	46.18	-47.50
0.221	12.20	Neutral	52.77	-49.58
0.214	12.20	Neutral	53.07	-50.26
0.194	12.09	Neutral	53.85	-50.75
0.192	12.04	Neutral	53.95	-50.87
7.106	12.30	Neutral	50.00	-51.31

6 §15.205, §15.209(a), §15.249(a) and §15.249 - RADIATED EMISSIONS

6.1 Applicable Standard

As per 15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As per 15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As Per 15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	960 – 1240	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5.35 – 5.46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 – 167.17	3.332 – 3.339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3.3458 – 3.358	23.6 – 24.0
12.29 – 12.293	240 – 285	3.600 – 4.400	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4		36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As Per 15.249(a), except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902–928 MHz	50	500
2400–2483.5 MHz	50	500
5725–5875 MHz	50	500
24.0–24.25 GHz	250	2500

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation

6.2 Test Setup

The radiated emissions tests were performed in the 3-meter open area test site, using the setup in accordance with ANSI C63.4-2003. The specification used was the FCC 15 Subpart C limits.

6.3 EUT Setup

The radiated emissions tests were performed using the setup accordance with the ANSI C63.4-2003. The specification used was the FCC 15C limits.

The spacing between the peripherals was 10 centimeters.

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

6.4 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Mini-Circuits	Pre amplifier	ZKL-2	7786100643	2008-01-02
HP	Pre amplifier	8449B	3147A00400	2007-11-02
Sunol Science Corp	Combination Antenna	JB1 Antenna	A103105-3	2008-03-25
A. H. Systems	Antenna, Horn, DRG	SAS-200/571	261	2007-06-07
Agilent	Spectrum Analyzer	E4440A	MY44303352	2008-04-28

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

6.5 Test Procedure

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

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

The EUT is set 3 meter away from the testing antenna, which is varied from 1-4 mete, and the EUT is placed on a turntable, which is 0.8 meter above ground plane, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal and vertical.

The spectrum analyzer or receiver is set as:

Below 1000MHz:

$$\text{RBW} = 100 \text{ kHz} / \text{VBW} = 300 \text{ kHz} / \text{Sweep} = \text{Auto}$$

Above 1000MHz:

- (1) Peak: $\text{RBW} = 1\text{MHz} / \text{VBW} = 1\text{MHz} / \text{Sweep} = \text{Auto}$
- (2) Average: $\text{RBW} = 1\text{MHz} / \text{VBW} = 10\text{Hz} / \text{Sweep} = \text{Auto}$

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:

$$\text{Corrected Amplitude} = \text{Indicated Reading} + \text{Antenna Factor} + \text{Cable Factor} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit.

The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corrected Amplitude} - \text{FCC Limit}$$

6.6 Environmental Conditions

Temperature:	18 °C
Relative Humidity:	45 %
ATM Pressure:	101.7 kPa

**The testing was performed by Victor Zhang on 2008-08-01.*

6.7 Summary of Test Results

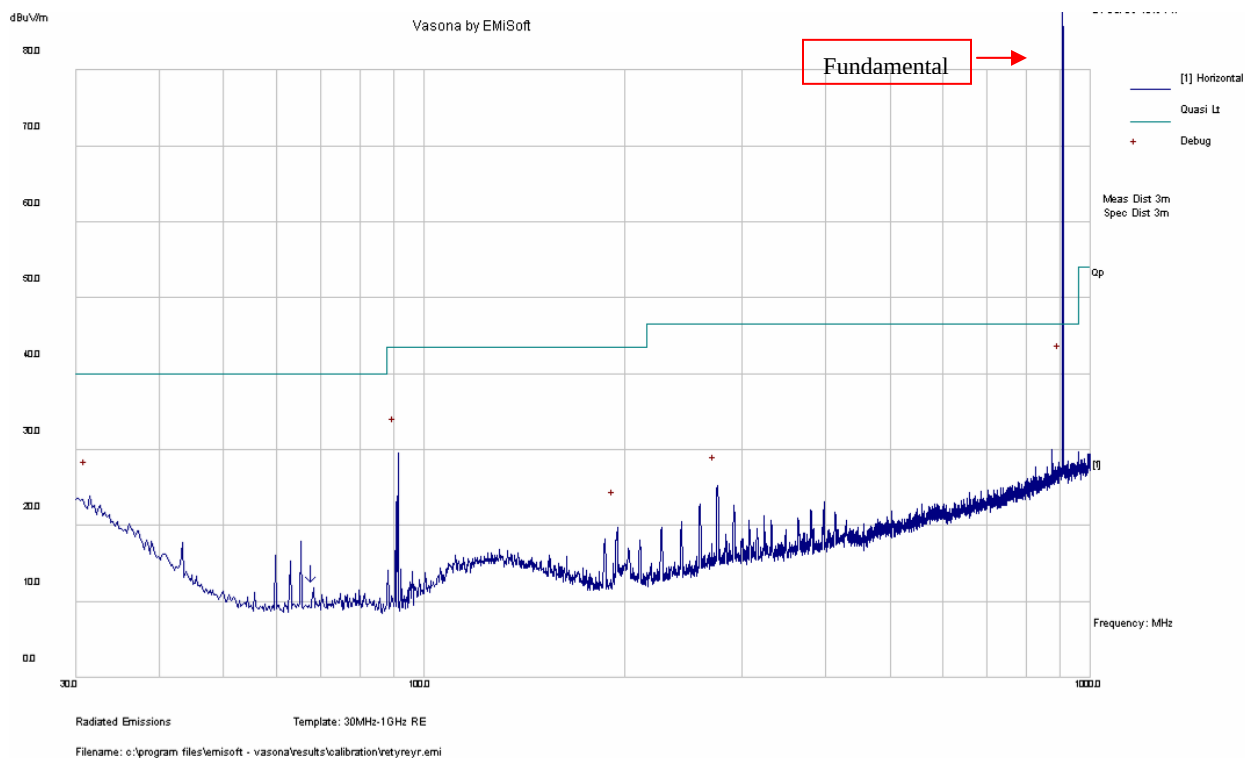
According to the data hereinafter, the EUT complied with the limits presented in FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.249, and had the worst margin of:

Measure at 3 Meters (30 MHz – 1 GHz)

Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Test Range
-9.13	909.187	Horizontal	30 MHz-1 GHz
-16.59	909.195	Vertical	30 MHz-1 GHz

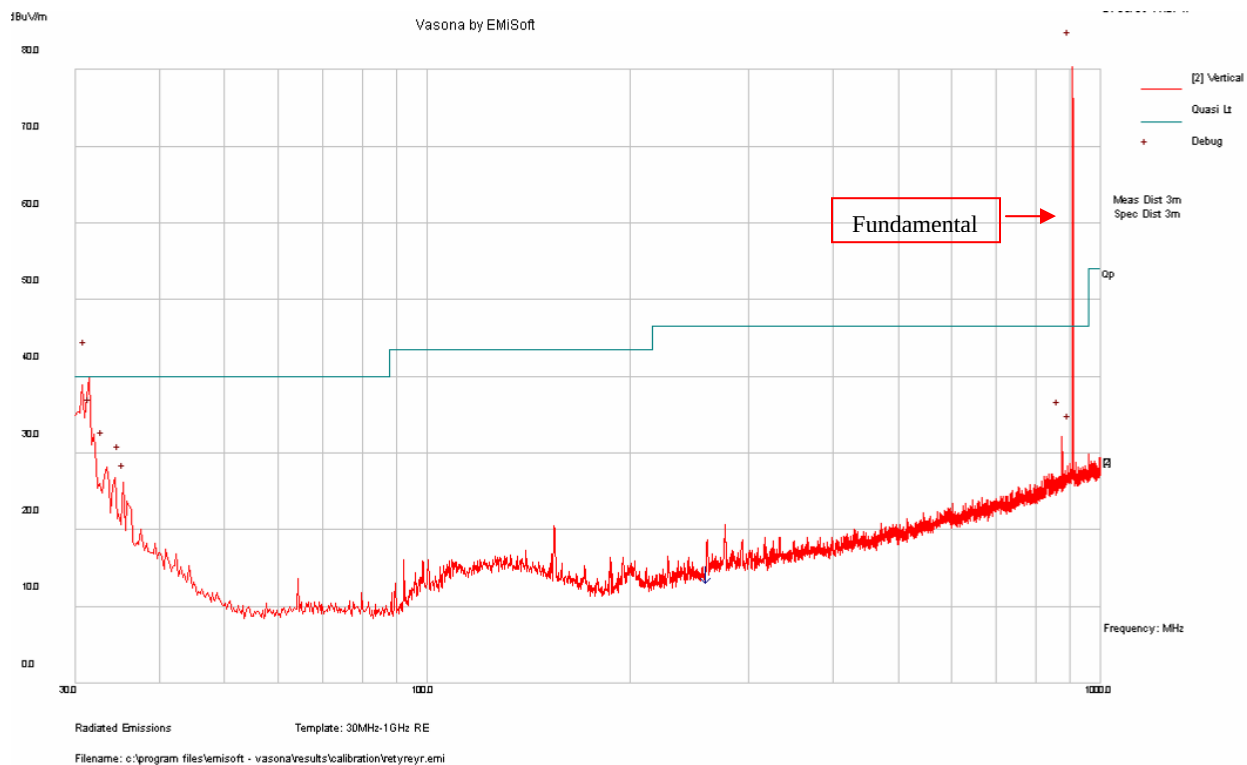
Measure at 3 Meters (30 MHz – 1 GHz)

Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Test Range
-21.51	1816	Horizontal	1 GHz – 10 GHz
-18.57	1816	Vertical	1 GHz – 10 GHz

6.8 Radiated Emissions data:**Measured at 3 meters (30 MHz – 1 GHz)****Horizontal**

Frequency (MHz)	Quasi-Peak (dBμV/m)	Antenna Height (cm)	Correction Factor (dB)	Ant. Polarity (H/V)	Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comment
909.187	37.37	100	5.75	H	333	46.5	-9.13	Spurious
31.595	17.03	152	1.27	H	95	40	-22.97	Spurious
275.884	19.58	107	-4.43	H	240	46.5	-26.92	Spurious
194.739	12.84	187	-6.37	H	293	43.5	-30.66	Spurious
91.418	4.44	1008	-11.02	H	272	43.5	-39.06	Spurious

Vertical



Frequency (MHz)	Quasi-Peak (dBμV/m)	Antenna Height (cm)	Correction Factor (dB)	Ant. Polarity (H/V)	Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comment
909.195	29.91	176	5.75	V	50	46.5	-16.59	Spurious
875.018	29.8	100	4.99	V	170	46.5	-16.7	Spurious
31.592	17.01	110	1.28	V	99	40	-22.99	Spurious
33.563	15.44	167	-0.24	V	229	40	-24.56	Spurious
154.246	16.87	107	-6.27	V	141	43.5	-26.63	Spurious

Fundamental measured at 3 meters:

Frequency (MHz)	Receiver Reading (dBuV)	Detector (PK/AV)	Azimuth (Degree)	Ant. Height (m)	Ant. Polar. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord. Amp. (dBμV/m)	FCC Part 15.249/15.209	
										Limit (dBuV/m)	Margin (dB)
908.4	83.58	QP	5	1	H	23	12.13	29.59	89.12	94	-4.88
908.4	74.84	QP	109	1.1	V	23	12.13	29.59	80.38	94	-13.62

Spurious Emissions measured at 3 meters (Above 1 GHz)

Frequency (MHz)	Receiver Reading (dBuV)	Detector (PK/AV)	Azimuth (Degree)	Ant. Height (m)	Ant. Polar. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord. Amp. (dBμV/m)	FCC Part 15.249/15.209	
										Limit (dBuV/m)	Margin (dB)
1816	42.20	Ave	220	1.77	V	26.2	2.93	35.9	35.43	54	-18.57
1816	39.26	Ave	35	1.00	H	26.2	2.93	35.9	32.49	54	-21.51
1816	47.97	Peak	220	1.77	V	26.2	2.93	35.9	41.20	74	-32.80
1816	45.86	Peak	35	1.00	H	26.2	2.93	35.9	39.09	74	-34.91

Band Edge

Frequency (MHz)	Receiver Reading (dBuV)	Detector (QP/AV)	Azimuth (Degree)	Ant. Height (m)	Ant. Polar. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord. Amp. (dBμV/m)	FCC Part 15.249/15.209	
										Limit (dBuV/m)	Margin (dB)
928	39.70	QP	215	1.2	V	23	1.9	29.59	41.20	46	-4.80
928	26.98	QP	115	1.7	H	23	1.9	29.59	39.09	46	-6.91
902	40.36	QP	200	1.2	V	23	1.9	29.59	35.67	46	-10.33
902	27.12	QP	120	1.7	H	23	1.9	29.59	22.43	46	-23.57