FCC PART 15.249

TEST AND MEASUREMENT REPORT

For

Actiontec Electronics, Inc.

760 N. Mary Avenue,

Sunnyvale, CA 94085, USA

FCC ID: LNQSG250
Model: SG250

Report Type:	**Product Type:**
Original Report	Wireless Gateway

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1207121-249	Original Report	2012-08-31

1 General Information

1.1 Product Description for Equipment under Test (EUT)

This test and measurement report was prepared on behalf of *Actiontec Electronics, Inc.*, and their product FCC ID: LNQSG250, model: *SG250* or the "EUT" as referred on this report is Wireless Gateway with 908.4 MHz Z-Wave function.

1.2 Mechanical Description of EUT

The "EUT" measures approximately *17cm (L) x 14cm (W) x 3.8cm (H)*, and weighs approximately *300*g.

The test data gathered are from typical production sample, serial number: SC202270000006 provided by the manufacturer.

1.3 Objective

This type approval report is prepared on behalf of *Actiontec Electronics, 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, 15.209 and 15.249.

1.4 Related Submittal(s)/Grant(s)

No Related Submittals

1.5 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.4-2009, 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.

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the 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 CISPR16-4-2:2003, The Treatment of Uncertainty in EMC Measurements, the values ranging from $\pm$2.0 dB for Conducted Emissions tests and $\pm$4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL Corp.

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.

1.7 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 site at BACL Corp. 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 have 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 test site also complies with the test methods and procedures set forth in CISPR 22:2008 §10.4 for measurements below 1 GHz and §10.6 for measurements above 1 GHz as well as ANSI C63.4-2009, ANSI C63.4-2009, TIA/EIA-603 & CISPR 24:2010.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: A-0027. 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, BACL Corp. is an American Association for laboratory Accreditation (A2LA) accredited laboratory (Lab Code 3297-02). The current scope of accreditations can be found at

http://www.a2la.org/scopepdf/3297-02.pdf?CFID=1132286&CFTOKEN=e42a3240dac3f6ba-6DE17DCB-1851-9E57-477422F667031258&jsessionid=8430d44f1f47cf2996124343c704b367816b

2 System Test Configuration

2.1 Justification

The host system was configured for testing according to ANSI C63.4-2009.

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

2.2 EUT Exercise Software

The EUT is in normal operation mode during the testing.

2.3 Equipment Modifications

No modifications were made to the EUT.

2.4 Local Support Equipment

N/A

2.5 EUT Internal Configuration Details

Manufacturer	Description	Model	Serial Number
Actiontec	Gateway	SG250	SC202270000020

2.6 Interface Ports and Cabling

N/A

2.7 External I/O Cabling List and AC Cord

N/A

2.8 Power Supply List and Details

Manufacturer	Description	Model	Serial Number
Actiontec	I.T.E. Power Supply	MT12-Y120100-A1	8PHQUA

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)	AC Line Conduction Emissions	Compliant
§15.205, §15.209, §15.249(a) (d)	Radiated Emissions	Compliant
§15.215	99% Emission Bandwidth	Compliant

4 FCC §15.203 – Antenna Requirement

4.1 Applicable Standard

According to FCC §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.

4.2 Antenna Connector Construction

The EUT antenna is integrated into the PCB construction, which in accordance to FCC §15.203, is considered sufficient to comply with the provisions of this section.

4.3 Antenna List

Antenna Model	Antenna Gain (dBi)
PCB	2.0

The EUT has maximum gain of 2.0 dBi antenna, which in accordance to sections FCC §15.203, is considered sufficient to comply with the provisions of these sections.

5 FCC §15.207 – AC Line Conducted Emissions

5.1 Applicable Standard

As per FCC §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 µH/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 range (MHz)	Limits (dBµV)	
	Quasi-Peak	Average
0.15 to 0.50	66 to 56 [1]	56 to 46 [1]
0.5 to 5	56	46
5 to 30	60	50

Note [1]: Decreases with the logarithm of the frequency.

5.2 EUT Setup

The conducted emissions tests were performed in the 5-meter test chamber, using the setup in accordance with ANSI C63.4-2009 measurement procedures. The specifications used were in accordance with FCC Part 15C limits.

The spacing between the peripherals was 10 cm.

The external I/O cables were draped along the test table and bundled as required.

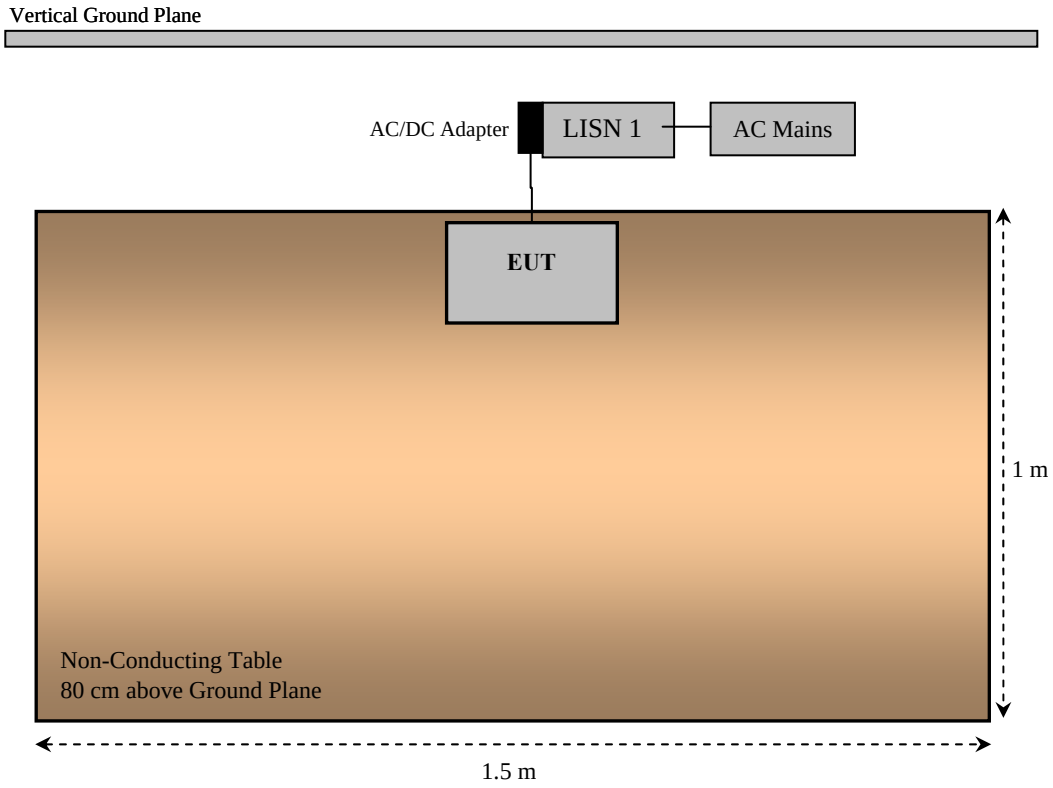
The AC/DC adaptor was connected to a 120 V, 60 Hz AC line power source.

5.3 Test Procedure

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

Maximization procedure was performed on the six (6) highest emission readings from the EUT.

5.4 Test Setup Block Diagram



5.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Cable Loss (CL) plus the High Pass Filter/Attenuator value (HA) and subtracting the Amplifier Gain (Ga) to the indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + CL + HA – Ga

For example, a corrected amplitude (CA) of 36 dBuV = Indicated Amplitude reading (Ai) of 50.0 dBuV + Cable Loss (CL) 1.0 dB + High Pass Filter/Attenuator (IA) 5 dB - Amplifier Gain (Ga) 20 dB

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

Margin (dB) = Corrected Amplitude (dBuV) - Limit (dBuV)

5.6 Test Equipment List and Details

Manufacturers	Descriptions	Model Numbers	Serial Numbers	Calibration Dates
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100337	2012-03-22
Solar Electronics	LISN	9252-R-24-BNC	511205	2012-06-25
TTE	High Pass Filter	H985-150K-50-720N	M1149	2012-05-30

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

5.7 Test Environmental Conditions

Temperature:	26 °C
Relative Humidity:	41 %
ATM Pressure:	101.2 kPa

The testing was performed by Lionel Lara on 2012-08-03 at 5m chamber 3.

5.8 Summary of Test Results

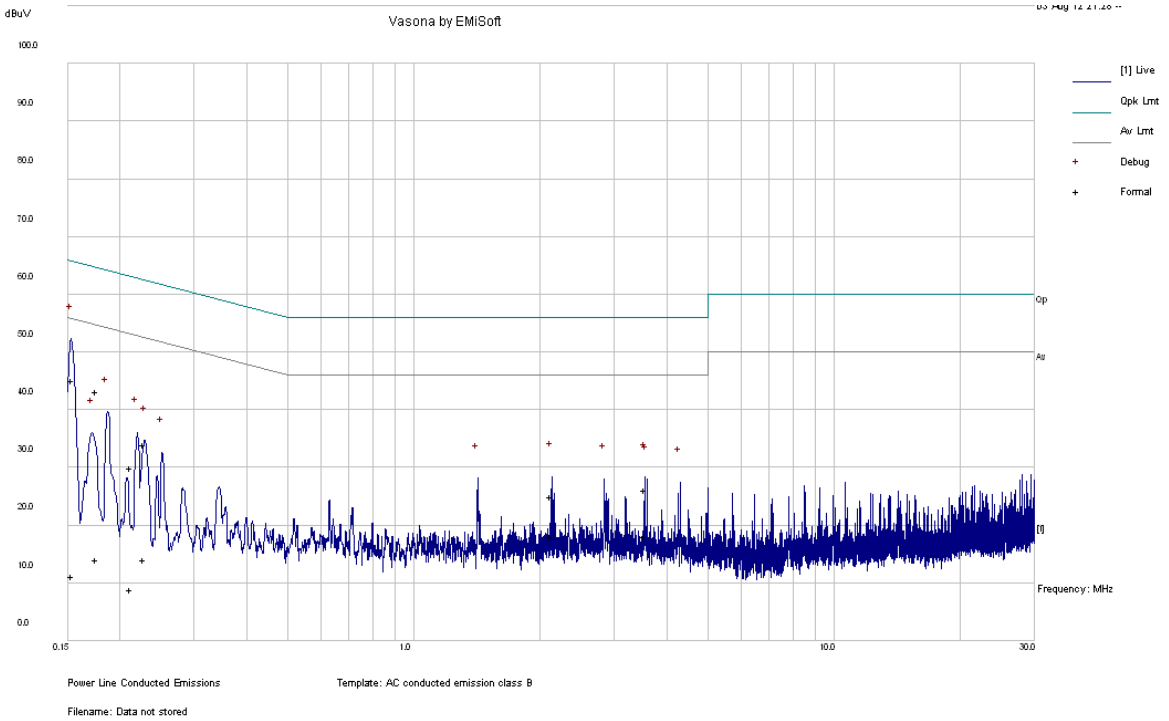
According to the recorded data, the EUT complied with FCC Part 15C limits, and had the worst margin reading of:

Mode: 120 V/ 60 Hz			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Line/Neutral)**	**Range (MHz)**
-20.66	0.154113	Line	0.15 to 30 MHz

Please refer to following plots of emission measurements.

5.9 Conducted Emissions Test Plots and Data

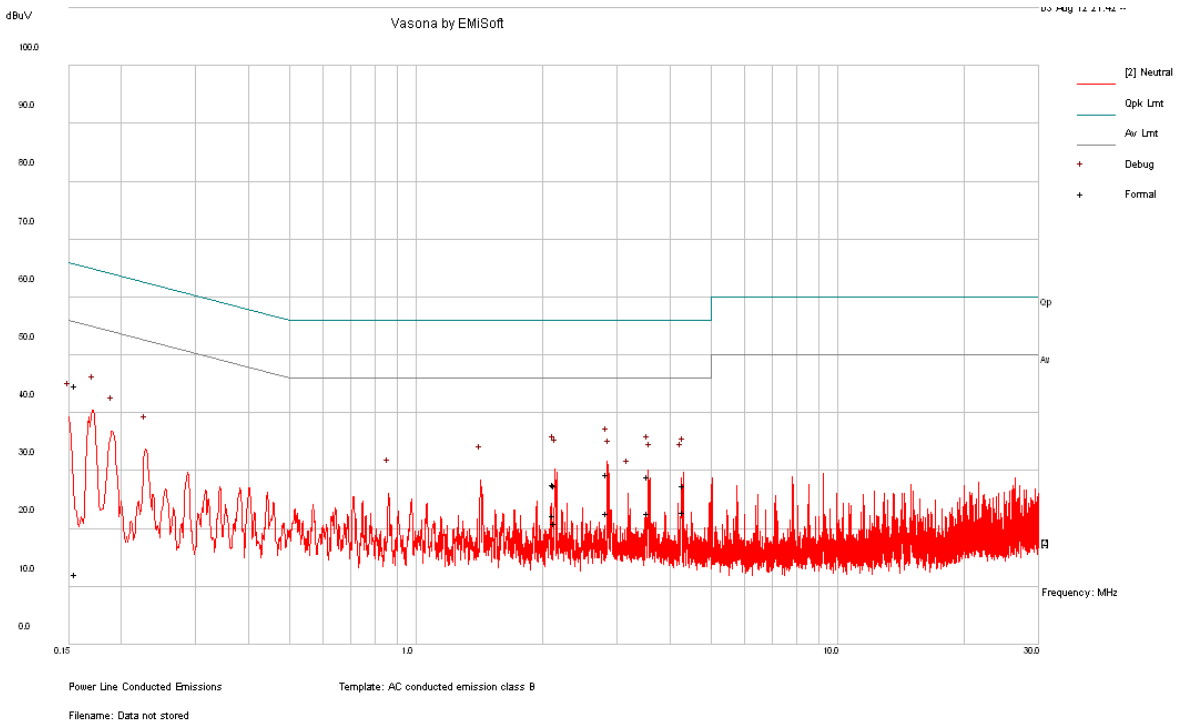
120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector
0.154113	45.12	Line	65.78	-20.66	QP
0.176487	43.25	Line	64.65	-21.40	QP
0.229014	34.07	Line	62.49	-28.41	QP
3.548256	26.07	Line	56	-29.93	QP
2.12718	25.04	Line	56	-30.96	QP
0.211719	30.07	Line	63.14	-33.07	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector
3.548256	18.13	Line	46	-27.87	Ave.
2.12718	18.02	Line	46	-27.98	Ave.
0.229014	14.18	Line	52.49	-38.31	Ave.
0.176487	14.06	Line	54.65	-40.59	Ave.
0.211719	8.92	Line	53.14	-44.21	Ave.
0.154113	11.23	Line	55.78	-44.55	Ave.

120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector
0.155745	44.81	Neutral	65.69	-20.88	QP
2.844233	29.33	Neutral	56	-26.67	QP
3.552703	29.05	Neutral	56	-26.95	QP
2.129621	27.68	Neutral	56	-28.32	QP
4.309304	27.54	Neutral	56	-28.46	QP
2.134415	27.46	Neutral	56	-28.54	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector
4.309304	22.96	Neutral	46	-23.04	Ave.
2.844233	22.64	Neutral	46	-23.36	Ave.
3.552703	22.62	Neutral	46	-23.38	Ave.
2.129621	22.4	Neutral	46	-23.60	Ave.
2.134415	21.07	Neutral	46	-24.93	Ave.
0.155745	12.09	Neutral	55.69	-43.60	Ave.

6 FCC §15.205, §15.209 & §15.249(a), (d) – Radiated Emissions

6.1 Applicable Standard

As per FCC §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 FCC §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 FCC §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	3332 – 3339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3345.8 – 3358	23.6 – 24.0
12.29 – 12.293	240 – 285	3600 – 4400	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 FCC §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 using the setup accordance with the ANSI C63.4-2009. The specification used was the FCC 15C.

The spacing between the peripherals was 10 centimeters.

6.3 Test Procedure

For the radiated emissions test, the EUT was performed using a new battery.

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

The EUT is set 3 meters away from the testing antenna, which is varied from 1-4 meters, 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:

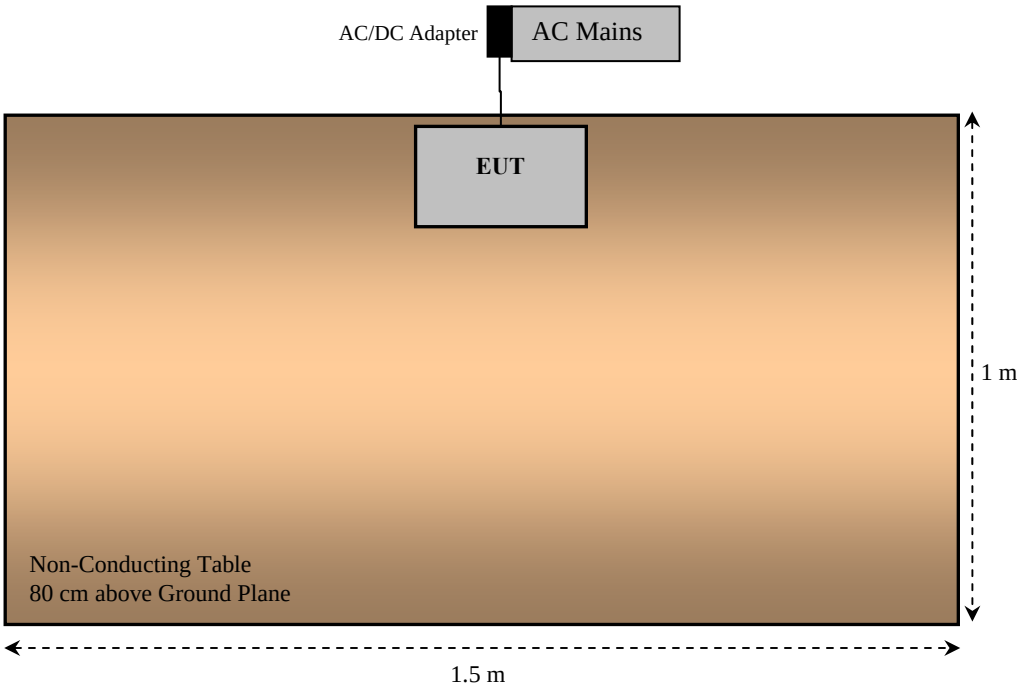
Below 1000 MHz:

RBW = 100 kHz, VBW = 300 kHz, Sweep = Auto

Above 1000 MHz:

(1) Peak: RBW = 1MHz, VBW = 1MHz, Sweep = Auto
(2) Average: RBW = 1MHz, VBW = 10Hz, Sweep = Auto

6.4 Test Setup Block Diagram



6.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to the indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

For example, the Corrected Amplitude (CA) of 40.3 dBuV/m = indicated Amplitude reading (Ai) 32.5 dBuV + Antenna Factor (AF) 23.5dB + Cable Loss (CL) 3.7 dB + Attenuator (Atten) 10 dB - Amplifier Gain (Ga) 29.4 dB

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

Margin (dB) = Corrected Amplitude (dBuV/m) - Limit (dBuV/m)

6.6 Test Equipment List and Details

Manufacturers	Descriptions	Model No.	Serial No.	Calibration Dates
EMCO	Horn Antenna	3115	9511-4627	2011-10-03
Agilent	PSA Spectrum Analyzer	E4440A	US45303156	2010-08-09[Note1]
Mini-Circuits	Pre-amplifier	ZVA-183-S	570400946	2012-05-09
Sunol Sciences	Biconi-Log Antenna	JB3	A020106-3	2012-06-18
HP	Pre-amplifier	8447D	2944A06639	2012-06-09

Note 1: Two year calibration cycle.

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

6.7 Test Environmental Conditions

Temperature:	26 °C
Relative Humidity:	41 %
ATM Pressure:	101.2 kPa

The testing was performed by Lionel Lara on 2012-08-03 at 5m chamber 3.

6.8 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:

Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Comments
-2.12	908.4	Horizontal	Average Measurement

6.9 Radiated Emissions Test Plot & Data

Freq. (MHz)	S.A. Reading (dBuV)	Turntable Azimuth Degree	Test Antenna			Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord. Amp. (dBµV/m)	FCC Part 15.249/15.209		
			Height (cm)	Polar. (H/V)	Factor (dB/m)				Limit (dBuV/m)	Margin (dB)	Comment
908.4	66.94	80	243	H	22.9	3.46	0	93.3	114	-20.7	Fund/Peak
908.4	66.16	7	100	V	22.9	3.46	0	92.52	114	-21.48	Fund/Peak
908.4	65.52	80	243	H	22.9	3.46	0	91.88	94	-2.12	Fund/Ave
908.4	64.66	7	100	V	22.9	3.46	0	91.02	94	-2.98	Fund/Ave
1816.8	41.37	288	165	H	26.73	2.49	27.67	42.92	74	-31.08	Harm/Peak
1816.8	36.24	124	100	V	26.73	2.49	27.67	37.79	74	-36.21	Harm/Peak
1816.8	29.23	288	165	H	26.73	2.49	27.67	30.78	54	-23.22	Harm/Ave
1816.8	24.27	124	100	V	26.73	2.49	27.67	25.82	54	-28.18	Harm/Ave
2725.2	41.11	72	117	H	28.57	3.14	27.83	44.99	74	-29.01	Harm/Peak
2725.2	41.98	292	100	V	28.57	3.14	27.83	45.86	74	-28.14	Harm/Peak
2725.2	36	72	117	H	28.57	3.14	27.83	39.88	54	-14.12	Harm/Ave
2725.2	37.02	292	100	V	28.57	3.14	27.83	40.9	54	-13.1	Harm/Ave
3633.6	36.06	0	100	H	30.86	3.72	27.95	42.69	74	-31.31	Harm/Peak
3633.6	36.86	69	100	V	30.86	3.72	27.95	43.49	74	-30.51	Harm/Peak
3633.6	21.19	0	100	H	30.86	3.72	27.95	27.82	54	-26.18	Harm/Ave
3633.6	23.92	69	100	V	30.86	3.72	27.95	30.55	54	-23.45	Harm/Ave
609.41	21.93	80	243	H	19.4	10.21	27.72	23.82	46	-22.18	Spur/QP
611.11	21.96	7	100	V	19.4	10.21	27.72	23.85	46	-22.15	Spur/QP
971.2	34.94	80	243	H	23.4	11.07	27.45	41.96	74	-32.04	Spur/Peak
973.1	34.7	7	100	V	23.6	11.07	27.45	41.92	74	-32.08	Spur/Peak
971.2	21.81	80	243	H	23.4	11.07	27.45	28.83	54	-25.17	Spur/Ave
973.1	21.77	7	100	V	23.6	11.07	27.45	28.99	54	-25.01	Spur/Ave

Note: Fundamental-908.4 MHz

7 FCC §15.215 – 20 dB Emission Bandwidth

7.1 Applicable Standard

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §15.217 through §15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

7.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument via radiated horn antenna. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emissions bandwidth. (20 dB bandwidth for DTS)
4. Repeat above procedures until all frequencies measured were complete.

7.3 Test Equipment List and Details

Manufacturers	Description	Model No.	Serial No.	Calibration Dates
Agilent	PSA Spectrum Analyzer	E4440A	US45303156	2010-08-09[Note1]
Sunol Sciences	Biconi-Log Antenna	JB3	A020106-3	2012-06-18

Note 1: Two year calibration cycle.

Statement of Traceability: **BACL Corp.** attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

7.4 Test Environmental Conditions

Temperature:	26 °C
Relative Humidity:	41 %
ATM Pressure:	101.2 kPa

The testing was performed by Lionel Lara on 2012-08-03 at 5m chamber 3.

7.5 Test Results

Frequency (MHz)	20 dB Emission Bandwidth (kHz)	99% Emission Bandwidth (kHz)
908.4	139.761	122.6008

Please refer to the following plots for detailed test results

908.4 MHz