FCC PART 15, SUBPART C
IC RSS-210, ISSUE 8, DECEMBER 2010

TEST AND MEASUREMENT REPORT

For

Spire, Inc.

2225 3rd Street, San Francisco, CA 94107, USA

FCC ID: 2ACF5S1
IC: 12129A-S1

Report Type:	**Product Type:**
Original Report	2.4 GHz BLE Activity Tracker

Prepared By:	Chen Ge Test Engineer
Report Number:	R1409046-247 Rev A
Report Date:	2014-09-25
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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1409046-247	Original Report	2014-09-22
1	R1409046-247 Rev A	Revised Report	2014-09-25

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Spire, Inc*. And their product, *FCC ID: 2ACF5S1; IC: 12129A-S1*, model: *S1* or the "EUT" as referred to in this report. The EUT is a 2.4 GHz BLE Activity Tracker.

1.2 Mechanical Description of EUT

The EUT measures approximately 44 mm (L) x 32 mm (W) x 14 mm (H) and weighs 16g.

The test data gathered are from typical production sample, model number: JCT217 provided by customer.

1.3 Objective

This report is prepared on behalf of *Spire, Inc.* in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commissions rules.

The objective is to determine compliance with FCC Part 15.247 and IC RSS-210 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, and power spectral density, 100 kHz Bandwidth of Band Edges Measurement, Spurious Emissions, Conducted and Radiated Spurious Emissions.

1.4 Related Submittal(s)/Grant(s)

N/A

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 and FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

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.

The following calculation follows the procedures as set forth in clause 7.2.3, ETSI TR 100 028-1 V1.4.1 (2001-12), the expression of Uncertainty in Radiated RF Testing is in accordance to ISO/IEC 17025 and TR 100 028-1 V1.4.1 (2001-12).

The expanded Measurement Uncertainty value having a confidence factor of 95%, is within a range of 5.48 dB. This means that the value of conducted RF carrier power test will be within +/- 2.74 dB of the measuring radiated emissions power versus the expected value.
The expected value is defined as the power at the antenna of the Transmitter under Test.

1.7 Test Facility

Bay area compliance Laboratories Corp. (BACL) is:
1- An independent Commercial Test Laboratory accredited to **ISO 17025: 2005** by **A2LA**, in the fields of: Electromagnetic Compatibility & Telecommunications covering Emissions, Immunity, Radio, RF Exposure, Safety and Telecom. This includes NEBS (Network Equipment Building System), Wireless RF, Telecommunications Terminal Equipment (TTE); Network Equipment; Information Technology Equipment (ITE); Medical Electrical Equipment; Industrial, Commercial, and Medical Test Equipment; Professional Audio and Video Equipment; Electronic (Digital) Products; Industrial and Scientific Instruments; Cabled Distribution Systems and Energy Efficiency Lighting.

2- An ENERGY STAR Recognized Laboratory, for the LM80 Testing, a wide variety of Luminares and Computers.

3- A NIST Designated Phase-I and Phase-II CAB including: ACMA (Australian Communication and Media Authority), BSMI (Bureau of Standards, Metrology and Inspection of Taiwan), IDA (Infocomm Development Authority of Singapore), IC(Industry Canada), Korea (Ministry of Communications Radio Research Laboratory), NCC (Formerly DGT; Directorate General of Telecommunication of Chinese Taipei) OFTA (Office of the Telecommunications Authority of Hong Kong), Vietnam, VCCI - Voluntary Control Council for Interference of Japan and a designated EU CAB (Conformity Assessment Body) (Notified Body) for the EMC and R&TTE Directives.

4- A Product Certification Body accredited to **ISO Guide 65: 1996** by **A2LA** to certify:
1- Unlicensed, Licensed radio frequency devices and Telephone Terminal Equipment for the FCC. Scope A1, A2, A3, A4, B1, B2, B3, B4 & C.
2. Radio Standards Specifications (RSS) in the Category I Equipment Standards List and All Broadcasting Technical Standards (BETS) in Category I Equipment Standards List for Industry Canada.
3. Radio Communication Equipment for Singapore.
4. Radio Equipment Specifications, GMDSS Marine Radio Equipment Specifications, and Fixed Network Equipment Specifications for Hong Kong.
5. Japan MIC Telecommunication Business Law (A1, A2) and Radio Law (B1, B2 and B3).
6. Audio/Video, Battery Charging Systems, Computers, Displays, Enterprise Servers, Imaging Equipment, Set-Top Boxes, Telephony, Televisions, Ceiling Fans, CFLs (Including GU24s),Decorative Light Strings, Integral LED Lamps, Luminaires, Residential Ventilating Fans.

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 EUT 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 test utility used was *Nordic Semiconductors nrf51 SDK version 6.1* was provided by Spire Inc., and was verified *Chen Ge* to comply with the standard requirements being tested against.

2.3 Special Equipment

There were no special accessories were required, included, or intended for use with EUT during these tests.

2.4 Equipment Modifications

No modifications were made to the EUT.

2.5 Local Support Equipment

Manufacturer	Description	Model	Serial Number
Apple Inc.	Laptop	MacBook Air	C02L43K1F6T6

2.6 EUT Internal Configuration Details

Manufacturer	Description	Model	Serial Number
Spire Inc.	Main board	V9	-

2.7 AC/DC adapter Details

Manufacturer	Description	Model	Serial Number
Apple Inc.	AC/DC adapter	A1265	1X0453BTZ8QZ

3 Summary of Test Results

Results reported relate only to the product tested.

FCC & IC Rules	Description of Test	Results
FCC §15.247(i), §2.1093 IC RSS-102	RF Exposure	Compliant
FCC §15.203 IC RSS-Gen §7.1.2	Antenna Requirement	Compliant
FCC §15.207(a) IC RSS-Gen §7.2.4	AC Line Conducted Emissions	Compliant
FCC §15.247 (d) IC RSS-210 §A8.5	Spurious Emissions at Antenna Port	N/A
FCC §15.205, §15.209, §15.247 (d) IC RSS-210 §A8.5, RSS-210 §2.2	Radiated Spurious Emissions Including Restricted Bands	Compliant
FCC §15.247(a)(2) IC RSS-210 §A8.2	6 dB Emission Bandwidth	Compliant
FCC §15.247(b)(3) IC RSS-210 §A8.4	Maximum Peak Output Power	Compliant
FCC §15.247(d) IC RSS-210 §A8.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(e) IC RSS-210 §A8.2(b)	Power Spectral Density	Compliant

N/A: The device has no antenna port; all tests are performed by radiated method.

4 FCC §15.247(i), §2.1093 & IC RSS-102 – RF Exposure

4.1 Applicable Standards

According to FCC §15.247(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to KDB 447498 D01 General RF Exposure Guidance v05r02:

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√ f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
• f(GHz) is the RF channel transmit frequency in GHz
• Power and distance are rounded to the nearest mW and mm before calculation26
• The result is rounded to one decimal place for comparison
• 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below
The test exclusions are applicable only when the minimum test separation distance is ⩽ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

According to RSS-102 §2.5.1

SAR evaluation is required if the separation distance between the user and the radiating element of the device is less than or equal to 20 cm, except when the device operates as follows:

from 3 kHz up to 1 GHz inclusively, and with output power (i.e. the higher of the conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 200 mW for general public use and 1000 mW for controlled use;

above 1 GHz and up to 2.2 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 100 mW for general public use and 500 mW for controlled use;

above 2.2 GHz and up to 3 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 20 mW for general public use and 100 mW for controlled use;

above 3 GHz and up to 6 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 10 mW for general public use and 50 mW for controlled use.

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the output power of the device was derived.

4.1 Result:

For IC, the Maximum output power is 9.676 dBm = 9.28 mW@ 2402 MHz <2 0 mW

For FCC:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√ f(GHz)] =(9.28/5)* √ 2.402=2.877 ≤ 3.0

Result: SAR evaluation is not required.

5 FCC §15.203 & IC RSS-Gen §7.1.2 – Antenna Requirements

5.1 Applicable Standards

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.

And according to FCC §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.

According to IC RSS-Gen §7.1.2: Transmitter Antenna

A transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns. Testing shall be performed using the highest-gain antenna of each combination of transmitter and antenna type for which certification is being sought, with the transmitter output power set at the maximum level. Any antenna of the same type and having equal or lesser gain as an antenna that had been successfully tested for certification with the transmitter, will also be considered certified with the transmitter, and may be used and marketed with the transmitter. The manufacturer shall include with the application for certification a list of acceptable antenna types to be used with the transmitter.

When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on measurement or on data from the antenna manufacturer. Any antenna gain in excess of 6 dBi (6 dB above isotropic gain) shall be added to the measured RF output power before using the power limits specified in RSS-210 or RSS-310 for devices of RF output powers of 10 mW or less. For devices of output powers greater than 10 mW, except devices subject to RSS-210 Annex 8 (Frequency Hopping and Digital Modulation Systems Operating in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz Bands) or RSS-210 Annex 9 (Local Area Network Devices), the total antenna gain shall be added to the measured RF output power before using the specified power limits. For devices subject to RSS-210 Annex 8 or Annex 9, the antenna gain shall not be added.

5.2 Antenna List

Frequency	Antenna Type	Antenna Gain (dBi)
2.4 GHz	Integrated	-5.0

5.3 Result

The antenna is with less 6 dBi gain; therefore, it complies with the antenna requirement.

6 FCC §15.207 & IC RSS-Gen §7.2.4 – AC Line Conducted Emissions

6.1 Applicable Standards

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.

As per IC RSS-Gen §7.2.4 Conducted limits:

Except when the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply, either directly or indirectly (such as with abattery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table below. The more stringent limit applies at the frequency range boundaries. The conducted emissions shall be measured with a 50 ohm/50 microhenry line impedance stabilization network (LISN).

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.*

6.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.4-2009 measurement procedure. The specification used was FCC §15.207 and IC RSS-Gen §7.2.4 limits.

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

The AC/DC power adapter of the EUT was connected with LISN which provided 120 V / 60 Hz AC power.

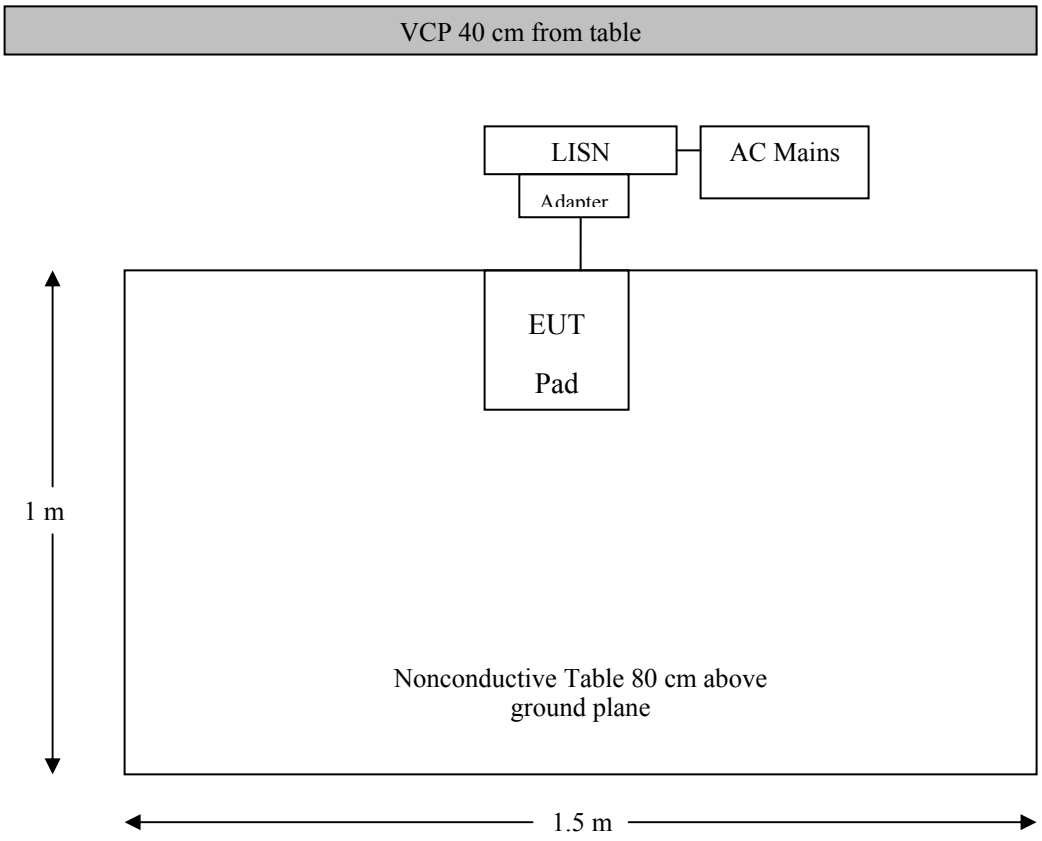
6.3 Test Procedure

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”.

6.4 Test Setup Block Diagram

AC/DC Adapter:



6.5 Corrected Amplitude & Margin Calculation

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

CA = Ai + CL + Atten

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Cable Loss (3.7 dB) + Attenuator (10 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 = Corrected Amplitude - Limit

6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100337	2014-03-28	1 year
Solar Electronics	LISN	9252-50-R-24-N	511205	2014-06-25	1 year
TTE	Filter, High Pass	H9962-150K-50-21378	K7133	2014-05-30	1 year

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:	20-24 °C
Relative Humidity:	41-45 %
ATM Pressure:	101-102 kPa

The testing was performed by Chen Ge on 2014-09-11 to 2014-09-12 at 5m chamber 3.

6.8 Summary of Test Results

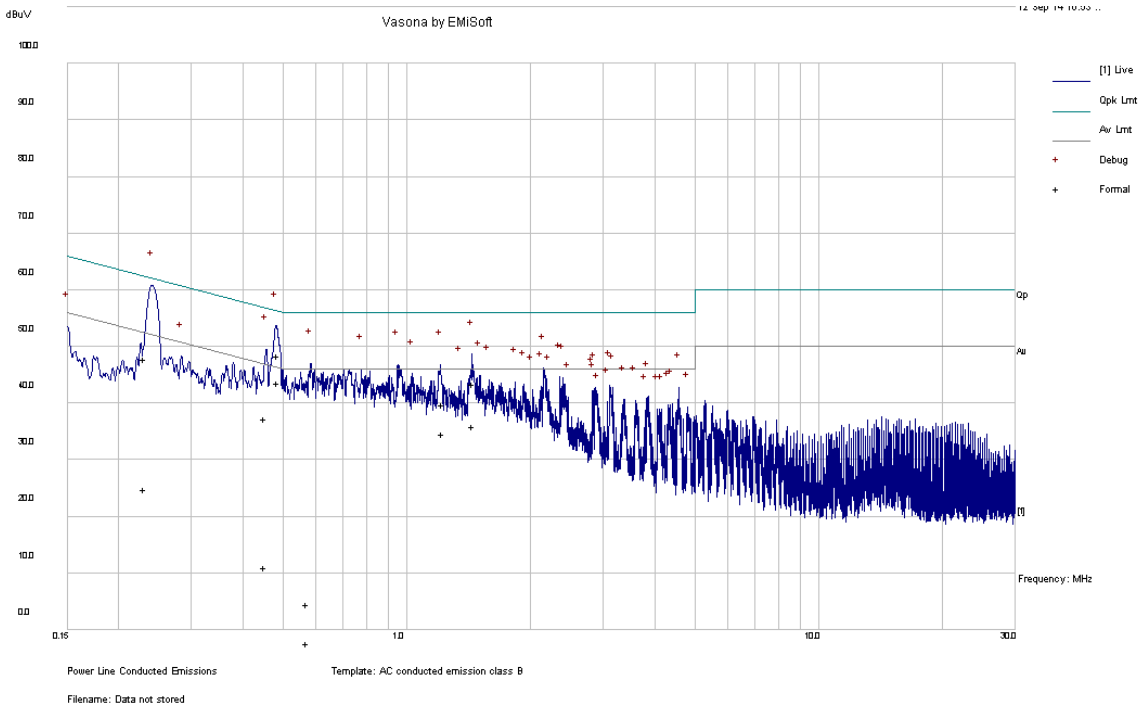
According to the recorded data in following table, the EUT complied with the FCC/IC standard's conducted emissions limits, with the margin reading of:

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Line/Neutral)**	**Range (MHz)**
-2.54	0.486849	Neutral	0.15-30

6.9 Conducted Emissions Test Plots and Data

AC/DC Adapter:

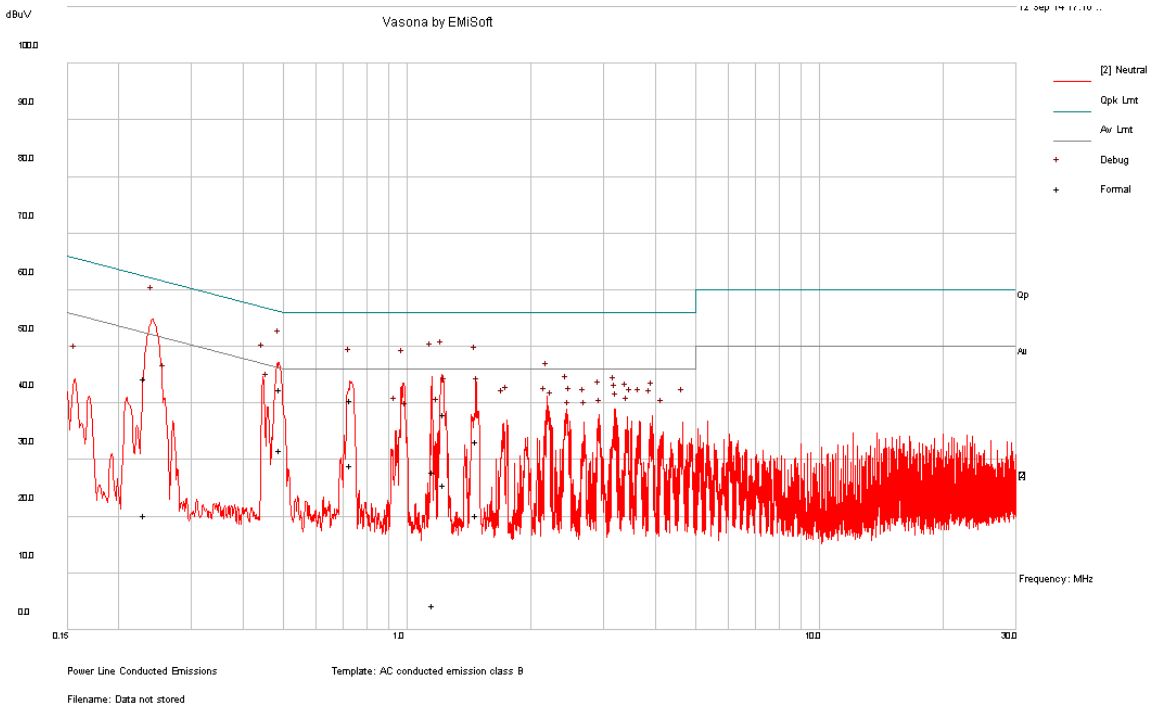
120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.231321	47.89	Line	62.4	-14.51	QP
0.486849	48.47	Line	56.22	-7.75	QP
0.452046	37.2	Line	56.84	-19.64	QP
1.453554	43.45	Line	56	-12.55	QP
0.574359	4.57	Line	56	-51.43	QP
1.222124	39.84	Line	56	-16.16	QP

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.231321	24.82	Line	52.4	-27.58	Ave.
0.486849	43.69	Line	46.22	-2.54	Ave.
0.452046	11	Line	46.84	-35.84	Ave.
1.453554	35.97	Line	46	-10.03	Ave.
0.574359	-2.37	Line	46	-48.37	Ave.
1.222124	34.52	Line	46	-11.48	Ave.

120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.231426	44.28	Neutral	62.4	-18.12	QP
0.492927	42.41	Neutral	56.12	-13.71	QP
1.229277	38.11	Neutral	56	-17.89	QP
1.160283	27.79	Neutral	56	-28.21	QP
1.474956	33.16	Neutral	56	-22.84	QP
0.732822	40.49	Neutral	56	-15.51	QP

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.231426	20.29	Neutral	52.4	-32.11	Ave.
0.492927	31.75	Neutral	46.12	-14.37	Ave.
1.229277	25.57	Neutral	46	-20.43	Ave.
1.160283	4.35	Neutral	46	-41.65	Ave.
1.474956	20.13	Neutral	46	-25.87	Ave.
0.732822	29.12	Neutral	46	-16.88	Ave.

7 FCC §15.209, §15.247(d) & IC RSS-210 §A8.5 – Spurious Radiated Emissions

7.1 Applicable Standards

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) and RSS-210: 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	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 FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

As per IC RSS-210 A8.5 Out-of-band Emissions, In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

7.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.4-2009. The specification used was the FCC 15 Subpart C and IC RSS-210 limits.

7.3 Test Procedure

For the radiated emissions test, the EUT host, 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 meter, 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

7.4 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 indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (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 = Corrected Amplitude - Limit

7.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Sunol Science	System Controller	SC99V	122303-1	N/R	N/R
Sunol Science	Combination Antenna	JB3	A020106-2	2014-08-15	1 year
Hewlett Packard	Pre-amplifier	8447D	2944A06639	2014-06-09	1 year
WiseWave	Horn Antenna	ARH-4223-02	10555-01	2012-08-09	3 Years
Agilent	Pre-amplifier	8449B	3008A01978	2014-02-04	1 year
Agilent	Spectrum Analyzer	E4440A	US42221851	2014-02-28	1 year
EMCO	Horn Antenna	3115	9511-4627	2013-10-17	1 year
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100337	2014-03-22	1 year

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

7.6 Test Environmental Conditions

Temperature:	20-24 °C
Relative Humidity:	41-45 %
ATM Pressure:	101-102 kPa

The testing was performed by Chen Ge on 2014-09-11 to 2014-09-12 at 5m chamber 3.

7.7 Summary of Test Results

According to the data hereinafter, the EUT complied with the FCC Title 47, Part 15C and IC RSS-210/Gen standard's radiated emissions limits, and had the worst margin of:

30-1000 MHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel**
-24.65	31.18975	Vertical	Low Channel

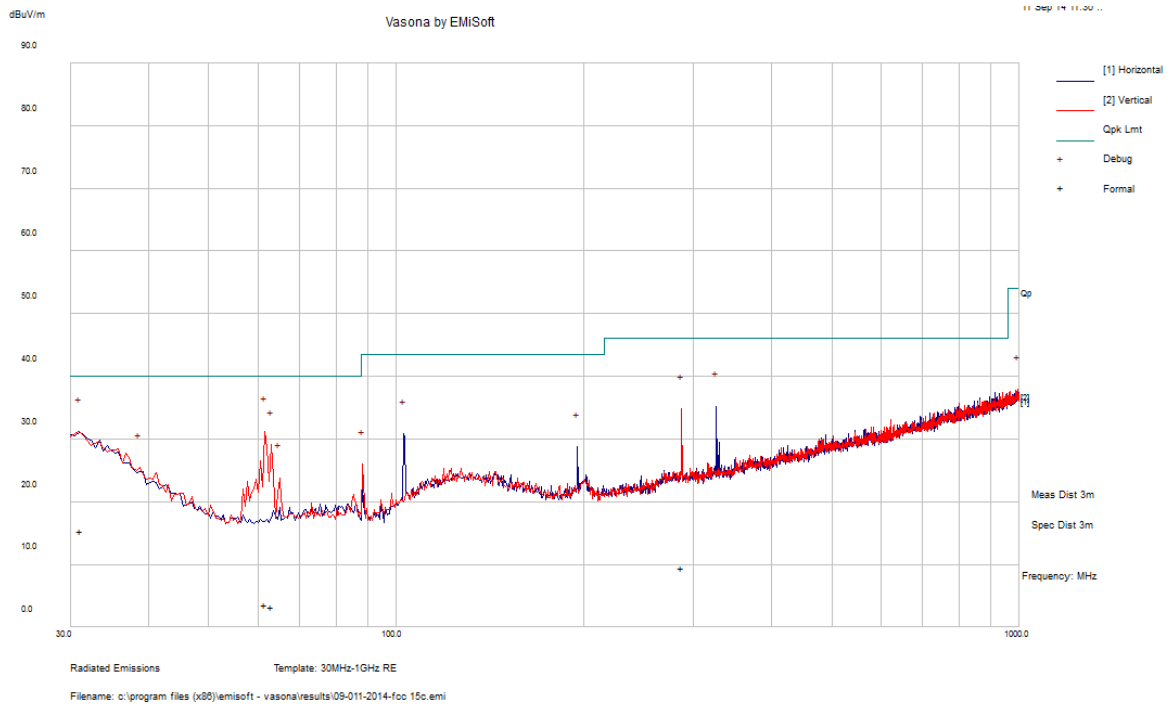
1 – 25 GHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel**
-5.651	7323	Horizontal	Middle Channel

Please refer to the following table for specific test result details

7.8 Radiated Emissions Test Data and Plots

1) 30-1000 MHz, measured at 3m distance Low CH, worst case.



Frequency (MHz)	Corrected Amplitude (dBuV)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave)
61.684	3.51	193	V	308	40	-36.49	QP
31.18975	15.35	267	V	129	40	-24.65	QP
63.10725	3.17	126	V	343	40	-36.83	QP
286.904	9.44	254	V	310	46	-36.56	QP

2) 1 – 25 GHz, measured at 3m distance

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Detector (Peak/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel, 2402 MHz											
2402	62.48	76	114	V	28.956	3.42	0	94.856	-	-	Peak
2402	67.86	49	110	H	28.956	3.42	0	100.236	-	-	Peak
2402	58.55	76	114	V	28.956	3.42	0	90.926	-	-	Ave
2402	63.79	49	110	H	28.956	3.42	0	96.166	-	-	Ave
2390	27.08	0	100	V	28.956	3.42	0	59.456	74	-14.544	Peak
2390	29.9	0	100	H	28.956	3.42	0	62.276	74	-11.724	Peak
2390	11.82	0	100	V	28.956	3.42	0	44.196	54	-9.804	Ave
2390	11.84	0	100	H	28.956	3.42	0	44.216	54	-9.784	Ave
4804	48.01	0	100	V	33.097	5.36	34.29	52.177	74	-21.823	Peak
4804	48.05	0	100	H	33.097	5.36	34.29	52.217	74	-21.783	Peak
4804	33.04	0	100	V	33.097	5.36	34.29	37.207	54	-16.793	Ave
4804	33	0	100	H	33.097	5.36	34.29	37.167	54	-16.833	Ave
7206	47.78	0	100	V	35.928	6.7	34.39	56.018	74.856	-18.838	Peak
7206	49.36	318	100	H	35.928	6.7	34.39	57.598	80.236	-22.638	Peak
7206	32.14	0	100	V	35.928	6.7	34.39	40.378	70.926	-30.548	Ave
7206	35.85	318	100	H	35.928	6.7	34.39	44.088	76.166	-32.078	Ave
9608	46.93	0	100	V	37.954	8.33	34.9	58.314	74.856	-16.542	Peak
9608	46.87	0	100	H	37.954	8.33	34.9	58.254	80.236	-21.982	Peak
9608	32.35	0	100	V	37.954	8.33	34.9	43.734	70.926	-27.192	Ave
9608	32.48	0	100	H	37.954	8.33	34.9	43.864	76.166	-32.302	Ave
Middle Channel, 2440 MHz											
2440	61.71	76	112	V	28.956	3.42	0	94.086	-	-	Peak
2440	66.75	50	110	H	28.956	3.42	0	99.126	-	-	Peak
2440	57.93	76	112	V	28.956	3.42	0	90.306	-	-	Ave
2440	62.73	50	110	H	28.956	3.42	0	95.106	-	-	Ave
4880	47.82	0	100	V	33.327	5.36	34.29	52.217	74	-21.783	Peak
4880	48.36	0	100	H	33.327	5.36	34.29	52.757	74	-21.243	Peak
4880	32.96	0	100	V	33.327	5.36	34.29	37.357	54	-16.643	Ave
4880	32.89	0	100	H	33.327	5.36	34.29	37.287	54	-16.713	Ave
7320	50.76	237	106	V	36.369	6.7	34.39	59.439	74	-14.561	Peak
7320	50.92	58	100	H	36.369	6.7	34.39	59.599	74	-14.401	Peak
7320	37.57	237	106	V	36.369	6.7	34.39	46.249	54	-7.751	Ave
7320	39.67	58	100	H	36.369	6.7	34.39	48.349	54	-5.651	Ave
9760	47.12	0	100	V	38.087	8.33	34.9	58.637	74.086	-15.449	Peak
9760	47.25	0	100	H	38.087	8.33	34.9	58.767	79.126	-20.359	Peak
9760	32.76	0	100	V	38.087	8.33	34.9	44.277	70.306	-26.029	Ave
9760	32.68	0	100	H	38.087	8.33	34.9	44.197	75.106	-30.909	Ave

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Detector (Peak/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
High Channel, 2480 MHz											
2480	58.9	76	108	V	29.155	3.42	0	91.475	-	-	Peak
2480	63.56	50	106	H	29.155	3.42	0	96.135	-	-	Peak
2480	55.17	76	108	V	29.155	3.42	0	87.745	-	-	Ave
2480	59.85	50	106	H	29.155	3.42	0	92.425	-	-	Ave
2483.5	27.46	0	100	V	29.155	3.42	0	60.035	74	-13.965	Peak
2483.5	27.86	0	100	H	29.155	3.42	0	60.435	74	-13.565	Peak
2483.5	12.65	0	100	V	29.155	3.42	0	45.225	54	-8.775	Ave
2483.5	12.77	0	100	H	29.155	3.42	0	45.345	54	-8.655	Ave
4960	49	24	100	V	33.327	5.36	34.29	53.397	74	-20.603	Peak
4960	49.35	79	109	H	33.327	5.36	34.29	53.747	74	-20.253	Peak
4960	34.07	24	100	V	33.327	5.36	34.29	38.467	54	-15.533	Ave
4960	39.34	79	109	H	33.327	5.36	34.29	43.737	54	-10.263	Ave
7440	51.07	69	101	V	36.565	6.7	34.39	59.945	74	-14.055	Peak
7440	49.39	40	100	H	36.565	6.7	34.39	58.265	74	-15.735	Peak
7440	39.44	69	101	V	36.565	6.7	34.39	48.315	54	-5.685	Ave
7440	36.31	40	100	H	36.565	6.7	34.39	45.185	54	-8.815	Ave
9920	47.63	0	100	V	38.287	8.33	34.9	59.347	71.475	-12.128	Peak
9920	47.28	0	100	H	38.287	8.33	34.9	58.997	76.135	-17.138	Peak
9920	32.32	0	100	V	38.287	8.33	34.9	44.037	67.745	-23.708	Ave
9920	32.32	0	100	H	38.287	8.33	34.9	44.037	72.425	-28.388	Ave

8 FCC§15.247(a)(2) & IC RSS-210 §A8.2 – 6 dB & 99% Emission Bandwidth

8.1 Applicable Standards

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz

8.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	US42221851	2014-02-28	1 year
Sunol Science	System Controller	SC99V	122303-1	N/R	N/R
EMCO	Horn Antenna	3115	9511-4627	2013-10-17	1 year

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

8.4 Test Environmental Conditions

Temperature:	20-24 °C
Relative Humidity:	41-45 %
ATM Pressure:	101-102 kPa

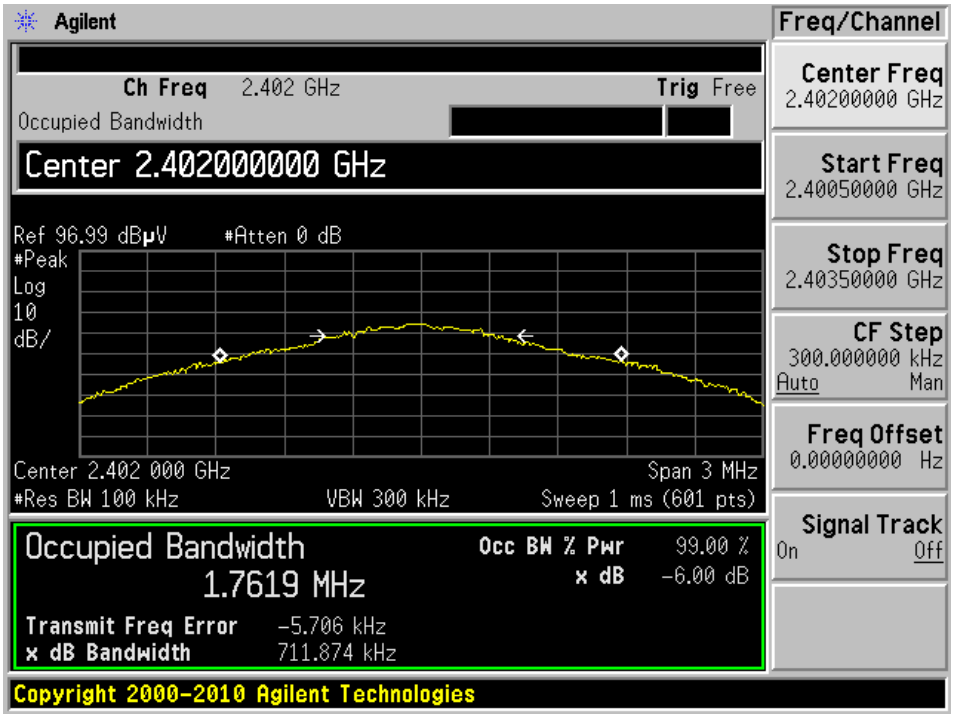
The testing was performed by Chen Ge on 2014-09-11 to 2014-09-12 at 5m chamber 3.

8.5 Test Results

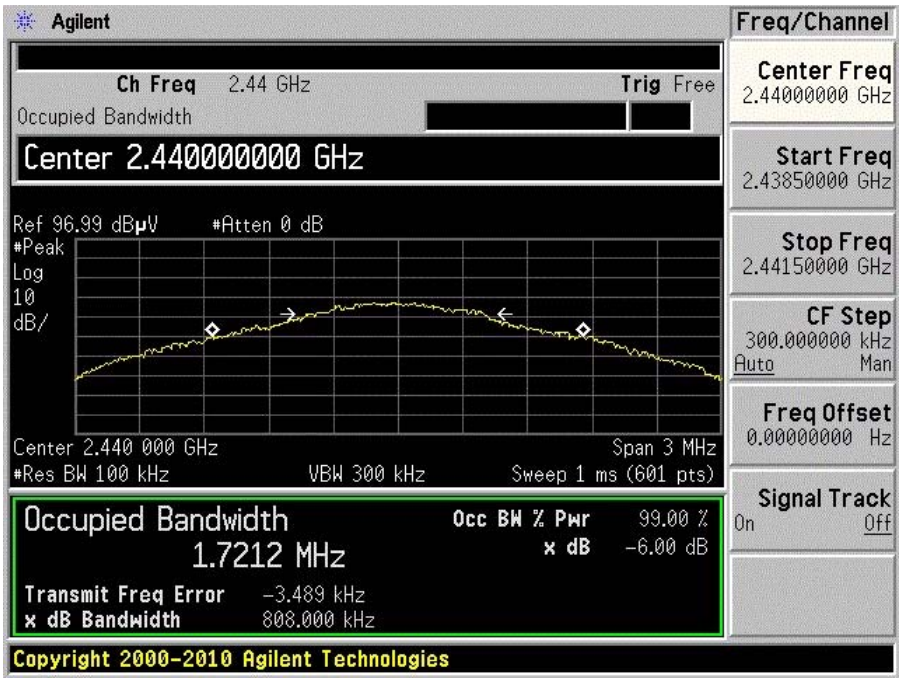
Channel	Frequency (MHz)	6 dB Emission Bandwidth (kHz)	99% Emission Bandwidth (MHz)	6 dB OBW Limit (MHz)	Results
Low	2402	711.874	1.7619	> 0.5	Compliant
Middle	2440	808.000	1.7212	> 0.5	Compliant
High	2480	725.361	1.7123	> 0.5	Compliant

Please refer to the following plots for detailed test results

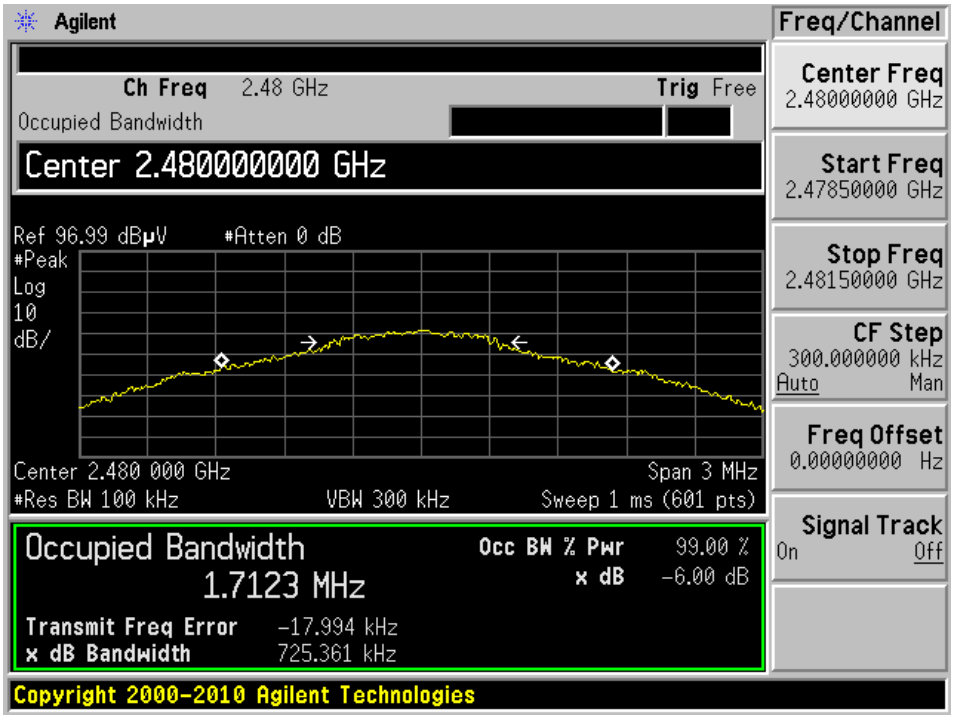
Low channel: 2402 MHz



Middle channel: 2440 MHz



High channel: 2480 MHz



9 FCC §15.247(b) & IC RSS-210 §A8.4 – Peak Output Power Measurement

9.1 Applicable Standard

According to FCC §15.247(b) and IC RSS-210 §A8.4 (4) for systems using digital modulation in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands: 1 Watt.

9.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 9: Fundamental emission output power, and ANSI C63.10 -2009.

And base on KDB 412172 D01, 1.3.1. Field Strength Approach (linear terms):
$eirp = pt \times gt = (E \times d)^2/30$
where:
• pt = transmitter output power in watts,
• gt = numeric gain of the transmitting antenna (unitless),
• E = electric field strength in V/m,
• d = measurement distance in meters (m).

9.3 Corrected Amplitude

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 indicated Amplitude (Ai) reading. The basic equation is as follows:

$$CA = Ai + AF + CL + Atten – Ga$$

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

9.4 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	US42221851	2014-02-28	1 year
EMCO	Horn Antenna	3115	9511-4627	2013-10-17	1 Year
Sunol Sciences	System Controller	SC104V	113005-1	N/A	N/A

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

9.5 Test Environmental Conditions

Temperature:	20-24 °C
Relative Humidity:	41-45 %
ATM Pressure:	101-102 kPa

The testing was performed by Chen Ge on 2014-09-11 to 2014-09-12 at 5m chamber 3.

9.6 Test Results

Frequency (MHz)	Radiated Reading (dBµV @ 3m)	Antenna Polarity (H/V)	Antenna Factor (dB/m)	Cable Loss (dB)	Cord. Peak Radiated (dBµV/m @ 3m)	Antenna Gain (dBi)	Cord. Peak Output Power EIRP (dBm)	Conducted Output Power (dBm)	FCC/IC Limit (dBm)	Margin (dB)
2402	61.65	V	28.956	3.42	94.026	-5.0	-1.174	3.826	30	-26.174
2402	67.50	H	28.956	3.42	99.876	-5.0	4.676	9.676	30	-20.324
2440	60.69	V	28.956	3.42	93.066	-5.0	-2.134	2.866	30	-27.134
2440	65.37	H	28.956	3.42	97.746	-5.0	2.546	7.546	30	-22.454
2480	58.97	V	29.155	3.42	91.545	-5.0	-3.655	1.345	30	-28.655
2480	63.58	H	29.155	3.42	96.155	-5.0	0.955	5.955	30	-24.045

$E = EIRP - 20\log D + 104.8$

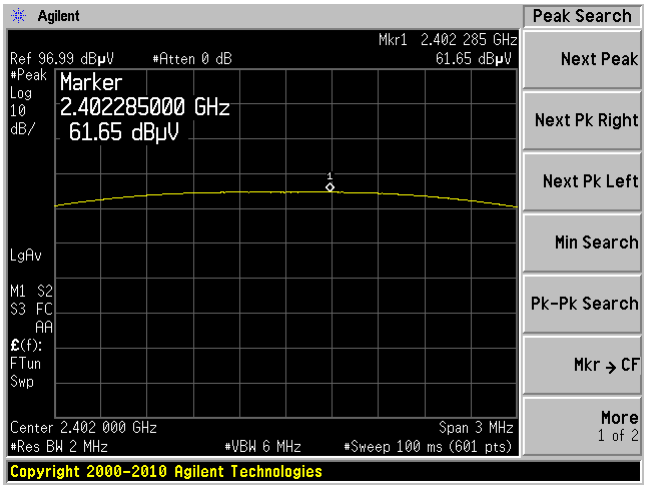
where:

E = electric field strength in dBµV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.

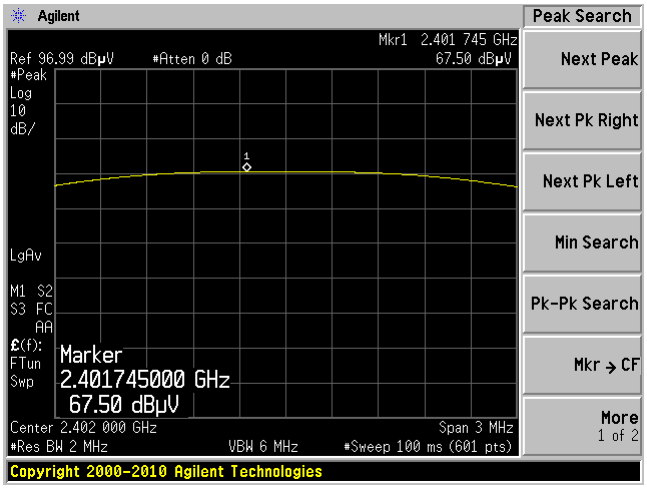
Please refer to the following plots for detailed test results:

Low channel: 2402 MHz

Vertical Polarity

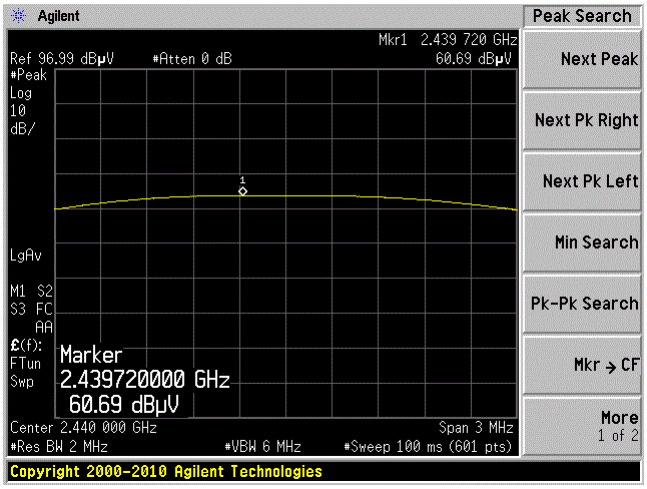


Horizontal Polarity

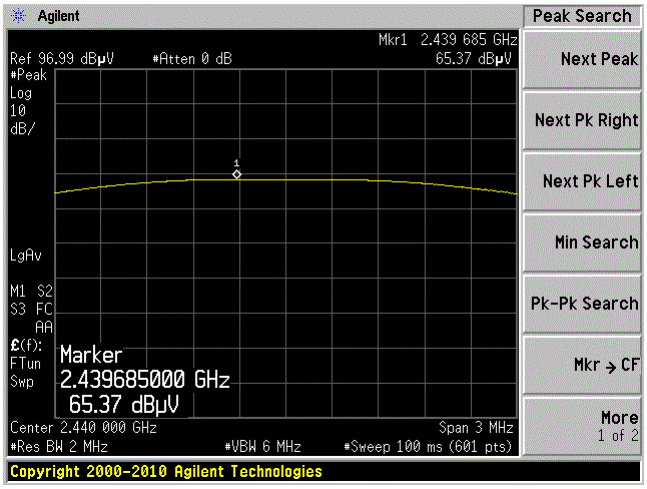


Middle channel: 2440 MHz

Vertical Polarity

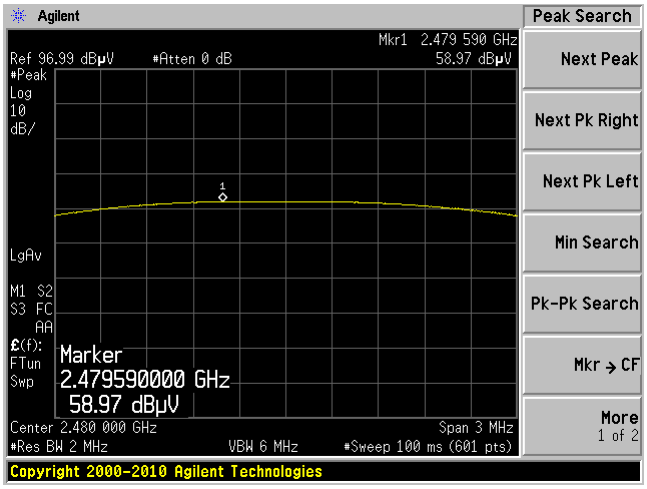


Horizontal Polarity

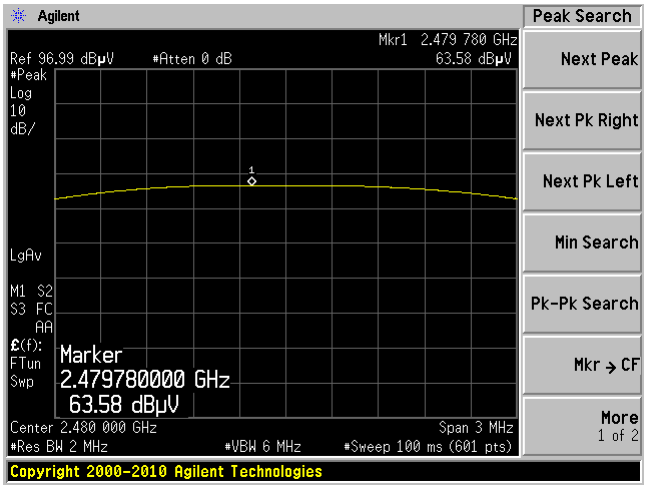


High channel: 2480 MHz

Vertical Polarity



Horizontal Polarity



10 FCC §15.247(d) & IC RSS-210 §A8.5 – 100 kHz Bandwidth of Band Edges

10.1 Applicable Standard

According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) see §15.205(c)).

10.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 13: Band-edge measurements

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	US42221851	2014-02-28	1 year
Sunol Science	System Controller	SC99V	122303-1	N/R	N/R
EMCO	Horn Antenna	3115	9511-4627	2013-10-17	1 year

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

10.4 Test Environmental Conditions

Temperature:	20-24 °C
Relative Humidity:	41-45 %
ATM Pressure:	101-102 kPa

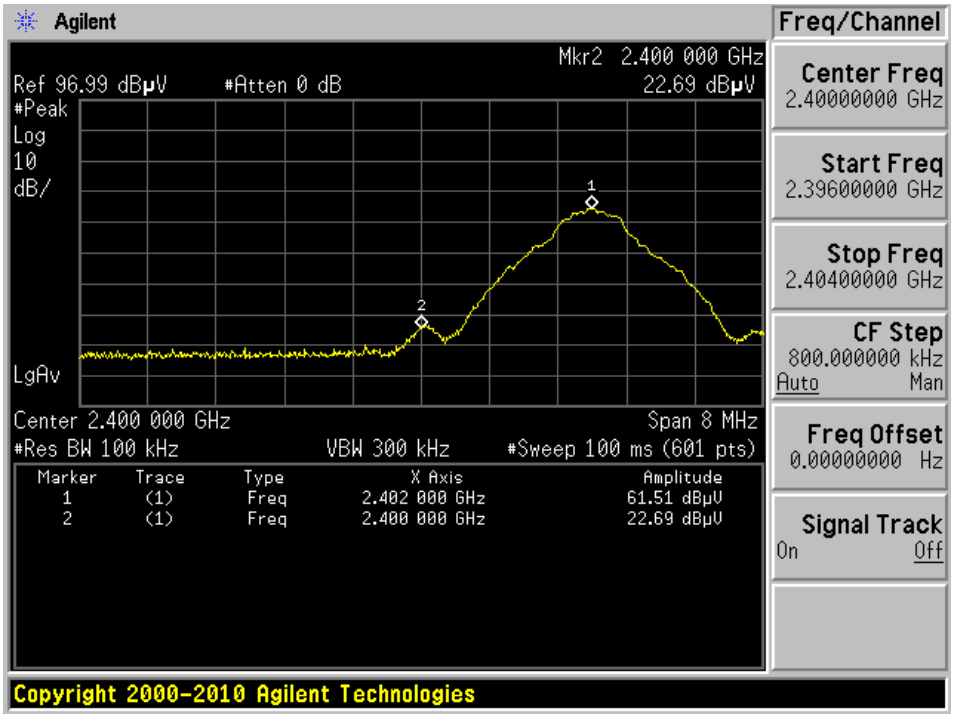
The testing was performed by Chen Ge on 2014-09-11 to 2014-09-12 at 5m chamber 3.

10.5 Test Results

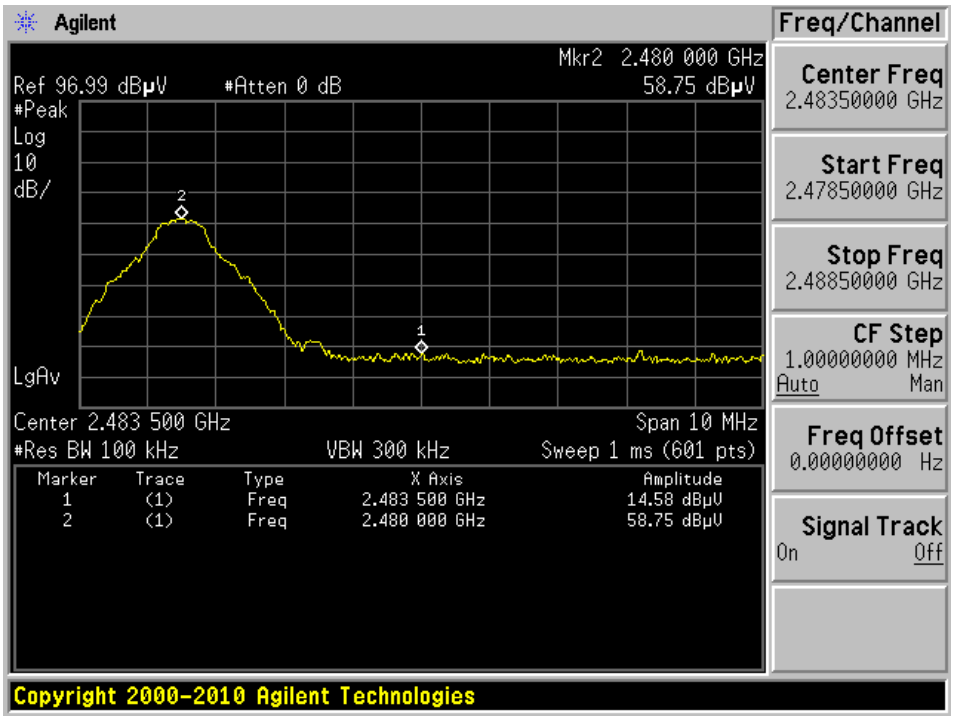
Please refer to following plots of band edge.

Channel	Delta (dBc)	Limit
Low CH, 2402 MHz	38.82	> 20 dBc
High CH, 2480 MHz	44.17	> 20 dBc

Low Band Edge



High Band Edge



11 FCC §15.247(e) & IC RSS-210 §A8.2 (b) – Power Spectral Density

11.1 Applicable Standard

According to FCC §15.247(e) and RSS-210 §A8.2 (b) , for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

11.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 10: Maximum power spectral density level in the fundamental emission, and ANSI C63.10 -2009.

11.3 Corrected Amplitude

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 indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

11.4 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	US45303156	2013-08-22	2 Years
EMCO	Horn Antenna	3115	9511-4627	2013-10-17	1 Year
Sunol Sciences	System Controller	SC104V	113005-1	N/A	N/A

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

11.5 Test Environmental Conditions

Temperature:	20-24 °C
Relative Humidity:	41-45 %
ATM Pressure:	101-102 kPa

The testing was performed by Chen Ge on 2014-09-11 to 2014-09-12 at 5m chamber 3.

11.6 Test Results

Frequency (MHz)	Radiated Reading (dBµV/m @ 3 Meter)	Antenna Polarity (H/V)	Antenna Factor (dB/m)	Cable Loss (dB)	Cord. Peak Radiated (dBµV/m @ 3 Meter)	Antenna Gain (dBi)	Corrected Peak PSD EIRP (dBm)	Corrected Peak PSD Power (dBm))	FCC/IC Limit (dBm)	Margin (dB)
2402	49.00	V	28.956	5.72	83.676	-5	-11.524	-6.524	8	-14.524
2402	54.68	H	28.956	5.72	89.356	-5	-5.844	-0.844	8	-8.844
2440	47.72	V	28.956	5.72	82.396	-5	-12.804	-7.804	8	-15.804
2440	53.06	H	28.956	5.72	87.736	-5	-7.464	-2.464	8	-10.464
2480	46.04	V	29.155	5.72	80.915	-5	-14.285	-9.285	8	-17.285
2480	50.16	H	29.155	5.72	85.035	-5	-10.165	-5.165	8	-13.165

The corrected Peak PSD was calculated from the formula:

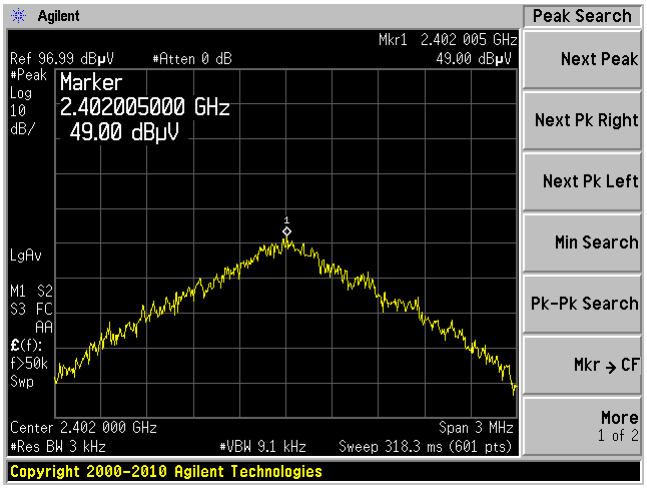
E = EIRP – 20log D + 104.8
where:

E = electric field strength in dBµV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.

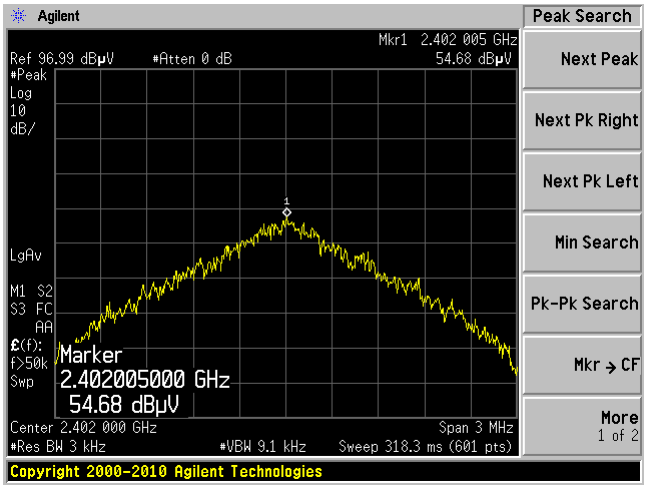
Please refer to the following plots for detailed test results:

Low channel: 2402 MHz

Vertical Polarity

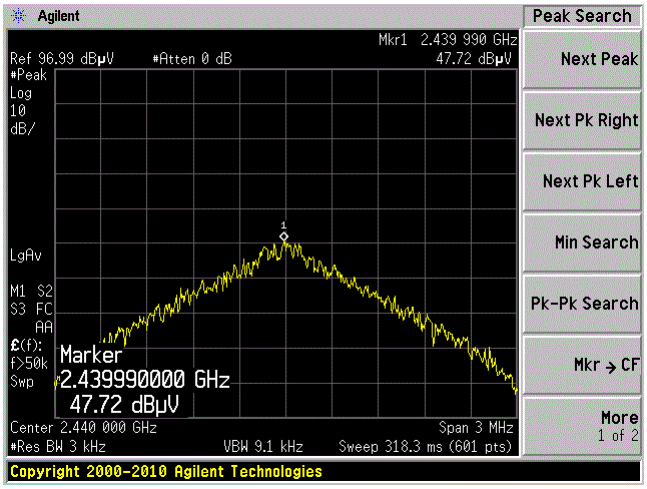


Horizontal Polarity

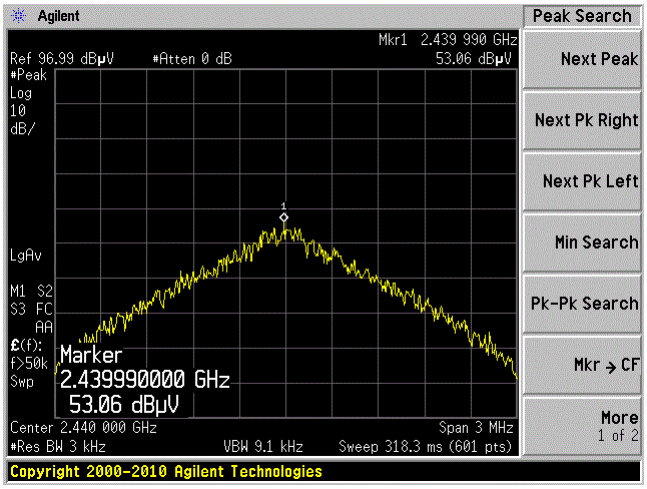


Middle channel: 2440 MHz

Vertical Polarity

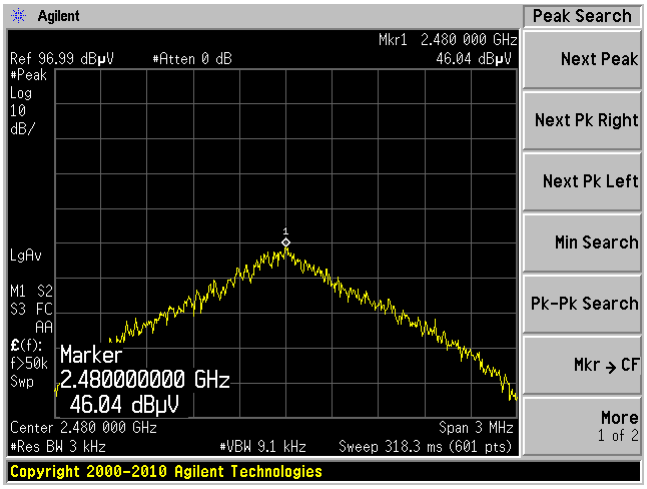


Horizontal Polarity



High channel: 2480 MHz

Vertical Polarity



Horizontal Polarity