



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

TEST AND MEASUREMENT REPORT

For

**Panamax, LLC**

1690 Corporate Circle,  
Petaluma, CA 94954, USA

**FCC ID: LDV-BBZIGBEE**  
**IC: 10379A-BBZIGBEE**

<b>Report Type:</b> Original Report	<b>Product Type:</b> Ethernet Bridge(networking device)
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<b>Report Number</b> <u>R1205101-247</u>	
<b>Report Date</b> <u>2012-07-09</u>	
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\* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "\*" Rev. 01

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**DOCUMENT REVISION HISTORY**

<b>Revision Number</b>	<b>Report Number</b>	<b>Description of Revision</b>	<b>Date of Revision</b>
0	R1205101-247	Original Report	2012-07-09

## 1 General Description

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### 1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Panamax*, and their product FCC ID: LDV-BBZIGBEE, IC: 10379A-BBZIGBEE, model: *BB-Zigbee* or the “EUT” as referred on this report is an Ethernet bridge (networking device). It is housed in a plastic enclosure and is powered by an external class 2 switch mode power supply, EUT work at 2400-2483.5 MHz.

### 1.2 Mechanical Description of EUT

The “EUT” measures approximately 13.3cm (L) x 10cm (W) x 3.1cm (H), and weighs approximately 119.5g.

*The test data gathered are from typical production sample, serial number: R1205101-1 assigned by BAACL.*

### 1.3 Objective

This report is prepared on behalf of *Panamax, LLC* in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commissions rules and IC RSS-210 Issue 8, Dec 2010.

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)

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 BAACL Corp.

## 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 C63.4-2003, 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.

The EUT was tested in a configuration of low channel=2405 MHz, Middle channel=2440 MHz and High channel=2465 MHz.

### 2.2 EUT Exercise Software

The test utility used was EMBER EM250 NODETEST (version 1.0) was provided by Panamax, LLC and was verified Ning Ma 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

The high channel of the EUT was set to be 2465 MHz by the request of clients.

### 2.5 EUT Internal Configuration Details

Manufacturer	Description	Model	Serial Number
Panamax, LLC	Main Board	E225430 KB-04	-

### 2.6 Power Supply List and Details

Manufacturer	Description	Model	Serial Number
AK	Power Supply	AK06G-0500120UW	-

### 3 Summary of Test Results

Results reported relate only to the product tested.

FCC & IC Rules	Description of Test	Results
FCC §15.247(i), §2.1091 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 §15.209 IC RSS-210 §A8.5	Spurious Emissions at Antenna Port	Compliant
FCC §15.205 IC RSS-210 §2.2	Restricted Bands	Compliant
FCC §15.209, §15.247 IC RSS-210 §A8.5	Radiated Spurious Emissions	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
IC RSS-210 §2.3 & RSS-Gen §6.1	Receiver Spurious Emission	Compliant



## 4 FCC §15.247 (i), §2.1091 & IC RSS-102 – RF Exposure

### 4.1 Applicable Standard

According to FCC §15.247(i) §1.1307(b)(1) and §1.1310 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.

#### Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* (100)	30
1.34-30	824/f	2.19/f	* (180/f <sup>2</sup> )	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

\* = Plane-wave equivalent power density

Before equipment certification is granted, the procedure of IC RSS-102 must be followed concerning the exposure of humans to RF fields.

According to IC RSS-102 Issue 2 section 4.1, RF limits used for general public will be applied to the EUT.

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m <sup>2</sup> )	Time Averaging (min)
0.003 - 1	280	2.19	-	6
1 - 10	280 / f	2.19 / f	-	6
10 - 30	28	2.19 / f	-	6
30 – 300	28	0.073	2*	6
300 – 1 500	1.585 f <sup>0.5</sup>	0.0042 f <sup>0.5</sup>	f / 150	6
1 500 – 15 000	61.4	0.163	10	6
15 000 – 150 000	61.4	0.163	10	616000 / f <sup>1.2</sup>
150 000- 300 000	0.158 f <sup>0.5</sup>	4.21 x 10 <sup>-4</sup> f <sup>0.5</sup>	6.67 x 10 <sup>-5</sup> f	616000 / f <sup>1.2</sup>

**Note:** f is frequency in MHz

\* = Power density limit is applicable at frequencies greater than 100 MHz

## 4.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density

P = power input to antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

## 4.3 MPE Results

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>20.25</u>
<u>Maximum peak output power at antenna input terminal (mW):</u>	<u>105.93</u>
<u>Prediction distance (cm):</u>	<u>20</u>
<u>Prediction frequency (MHz):</u>	<u>2440</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>0</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.0</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm<sup>2</sup>):</u>	<u>0.021</u>
<u>Power density of prediction frequency at 20.0 cm (W/m<sup>2</sup>):</u>	<u>0.21</u>
<u>MPE limit for uncontrolled exposure at prediction frequency (mW/cm<sup>2</sup>):</u>	<u>1.0</u>
<u>MPE limit for uncontrolled exposure at prediction frequency (W/m<sup>2</sup>):</u>	<u>10</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.021 mW/cm<sup>2</sup> (0.21 W/m<sup>2</sup>). Limit is 1.0 mW/cm<sup>2</sup> (10 W/m<sup>2</sup>).

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

### 5.1 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.

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

Antenna Model	Antenna Gain (dBi)
Inverted F	0

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

### 6.1 Applicable Standards

As per FCC §15.207 and IC RSS-Gen §7.2.4 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  $\mu$ 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.*

### 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-1 which provided 120 V / 60 Hz AC power.

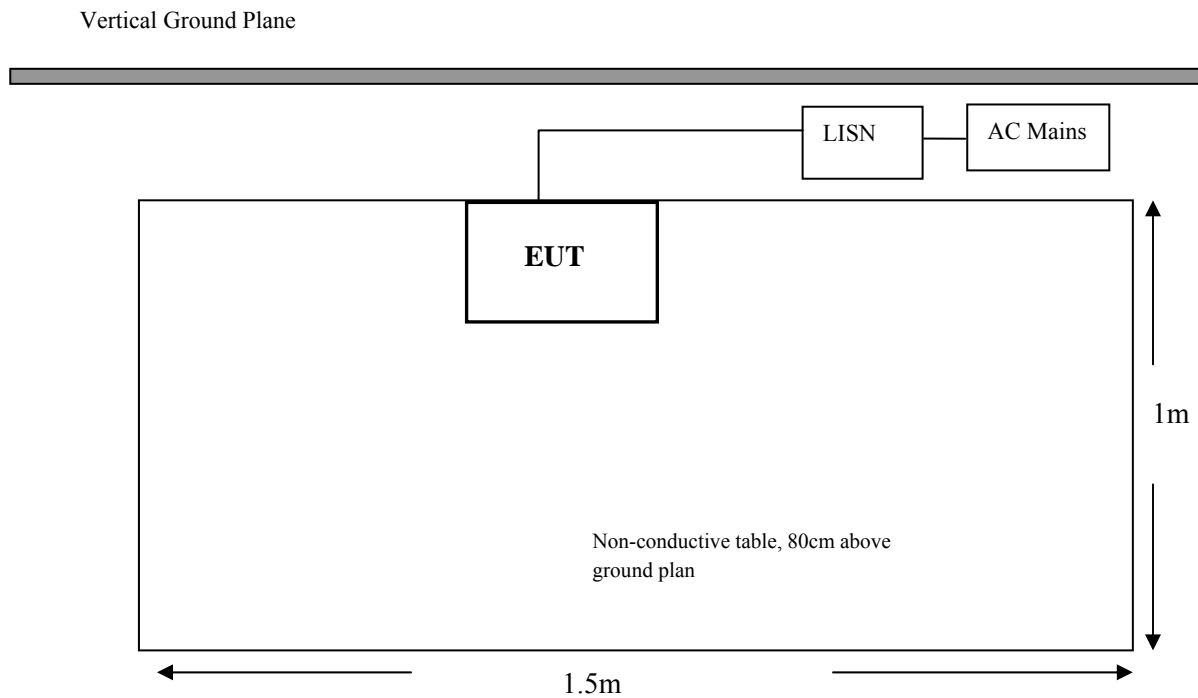
### 6.3 Test Procedure

During the conducted emissions test, the power cord of the EUT host system was connected to the mains outlet of the LISN-2.

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



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

$$CA = A_i + AF + CL + \text{Atten} - G_a$$

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:

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

## 6.6 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates
Solar Electronics	LISN	9252-R-24-BNC	511205	2011-06-25
TTE	Filter, High Pass	H9962-150K-50-21378	K7133	2011-06-10
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100338	2011-09-14

**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

<b>Temperature:</b>	20.57 °C
<b>Relative Humidity:</b>	36.77 %
<b>ATM Pressure:</b>	102.6 kPa

The testing was performed by Ning Ma on 2012-05-05 at Chamber2.

## 6.8 Summary of Test Results

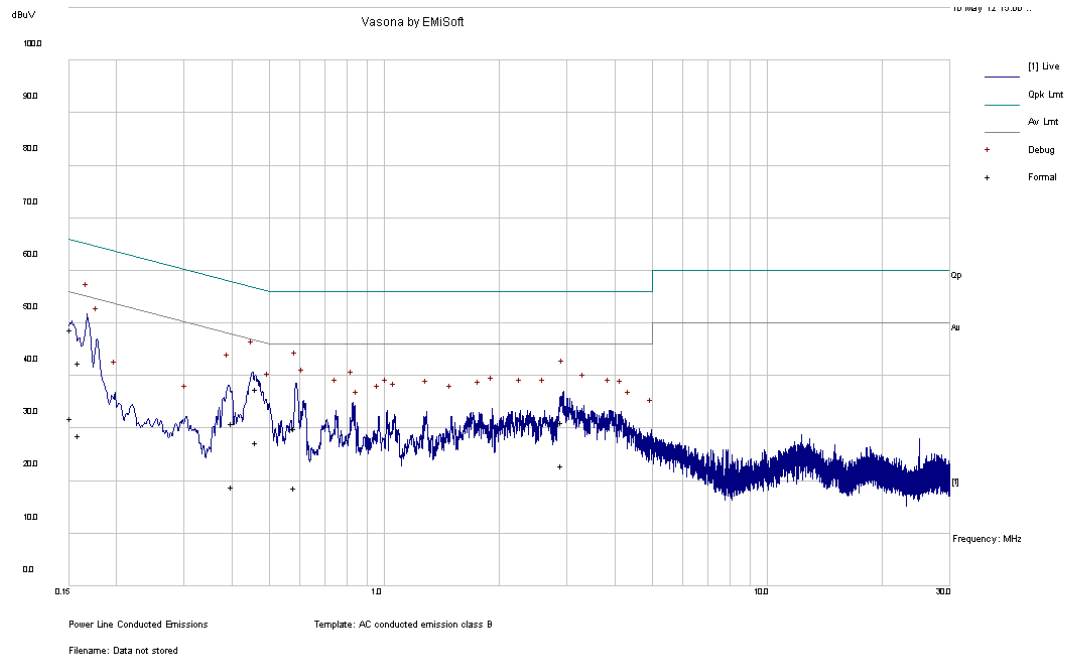
According to the recorded data in following table, the EUT complied with the FCC standard's conducted emissions limits, with the margin reading of:

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	Frequency (MHz)	Conductor Mode (Line/Neutral)	Range (MHz)
-15.28	0.456343	Neutral	0.15 MHz to 30 MHz

## 6.9 Conducted Emissions Test Plots and Data

Transmitting Mode the Worst Case: Middle channel

## 120 V, 60 Hz – Line

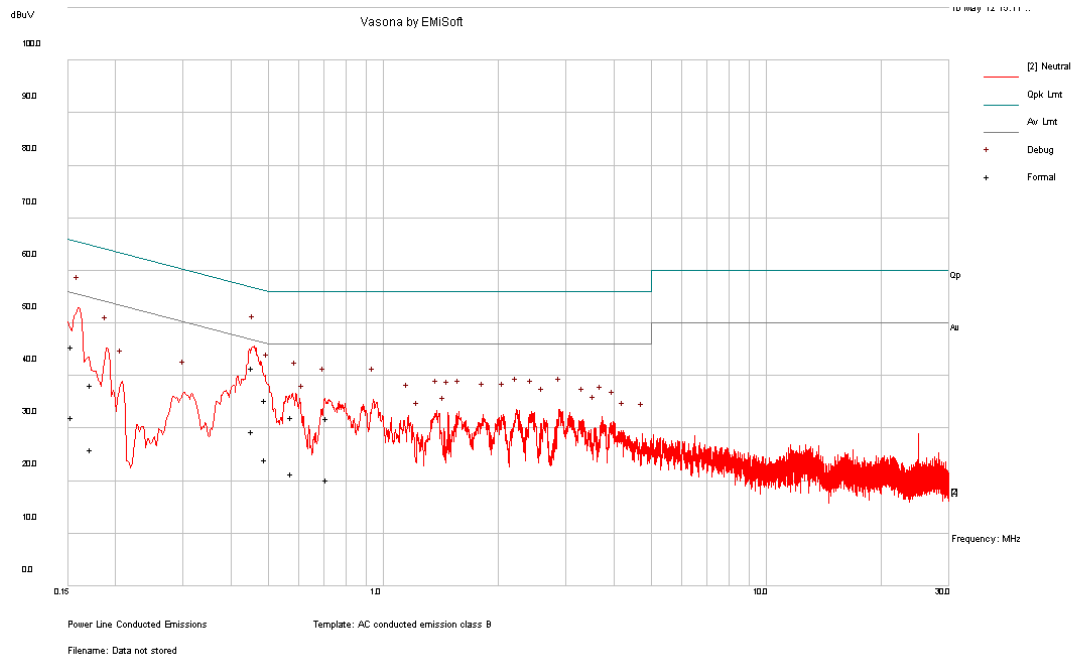


## Quasi-Peak Measurements:

Frequency (MHz)	Corrected Amplitude (dBμV)	Conductor (Line/Neutral)	Limit (dBμV)	Margin (dB)
0.152571	48.69	Line	65.86	-17.17
0.464874	37.55	Line	56.61	-19.06
0.160116	42.44	Line	65.46	-23.02
2.915447	31.05	Line	56	-24.95
0.583344	29.97	Line	56	-26.03
0.402249	30.89	Line	57.81	-26.92

## Average Measurements:

Frequency (MHz)	Corrected Amplitude (dBμV)	Conductor (Line/Neutral)	Limit (dBμV)	Margin (dB)
0.464874	27.33	Line	46.61	-19.28
2.915447	22.81	Line	46	-23.19
0.152571	31.91	Line	55.86	-23.94
0.160116	28.67	Line	55.46	-26.79
0.583344	18.62	Line	46	-27.38
0.402249	18.85	Line	47.81	-28.96

**120 V, 60 Hz – Neutral**

## Quasi-Peak Measurements:

Frequency (MHz)	Corrected Amplitude (dBμV)	Conductor (Line/Neutral)	Limit (dBμV)	Margin (dB)
0.456343	41.48	Neutral	56.76	-15.28
0.154018	45.59	Neutral	65.78	-20.19
0.491739	35.39	Neutral	56.14	-20.75
0.578558	32.11	Neutral	56	-23.89
0.711728	31.84	Neutral	56	-24.16
0.172328	38.15	Neutral	64.85	-26.70

## Average Measurements:

Frequency (MHz)	Corrected Amplitude (dBμV)	Conductor (Line/Neutral)	Limit (dBμV)	Margin (dB)
0.456343	29.43	Neutral	46.76	-17.33
0.491739	24.05	Neutral	46.14	-22.09
0.154018	32.03	Neutral	55.78	-23.75
0.578558	21.37	Neutral	46	-24.63
0.711728	20.13	Neutral	46	-25.87
0.172328	25.89	Neutral	54.85	-28.95



## 7 FCC §2.1051, §15.247(d) & IC RSS-210 §A8.5 – Spurious Emissions at Antenna Terminals

### 7.1 Applicable Standard

For FCC §15.247(d) and IC RSS-210 §A8.5 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.

### 7.2 Measurement Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

### 7.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2012-04-10

**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

<b>Temperature:</b>	23.7 °C
<b>Relative Humidity:</b>	41.2 %
<b>ATM Pressure:</b>	101.7 kPa

*The testing was performed by Ning Ma on 2012-05-02.*

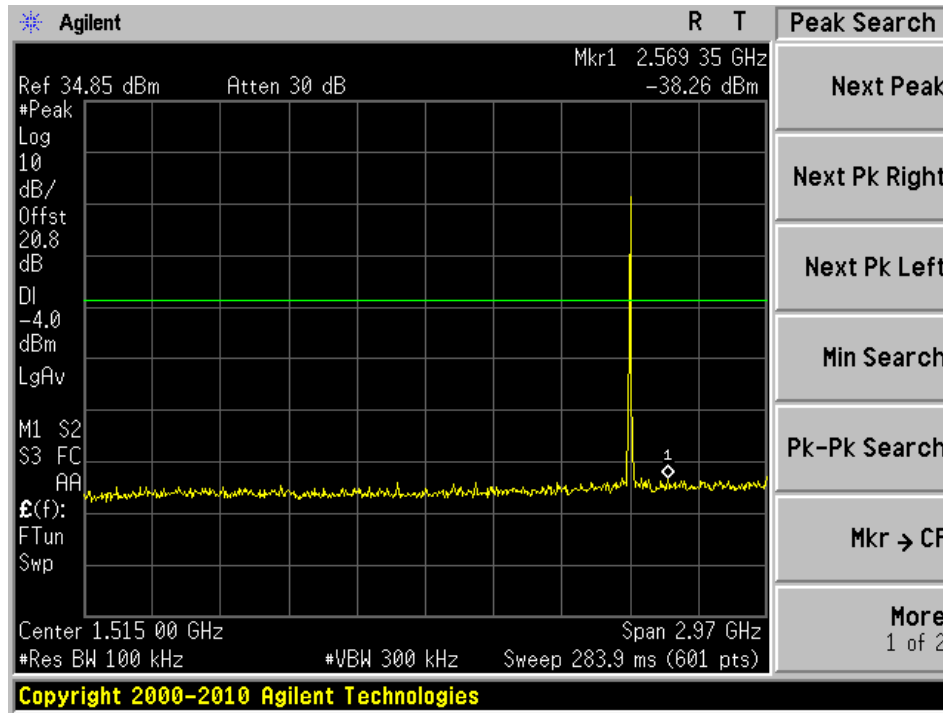
### 7.5 Test Results

Please refer to following plots of spurious emissions.

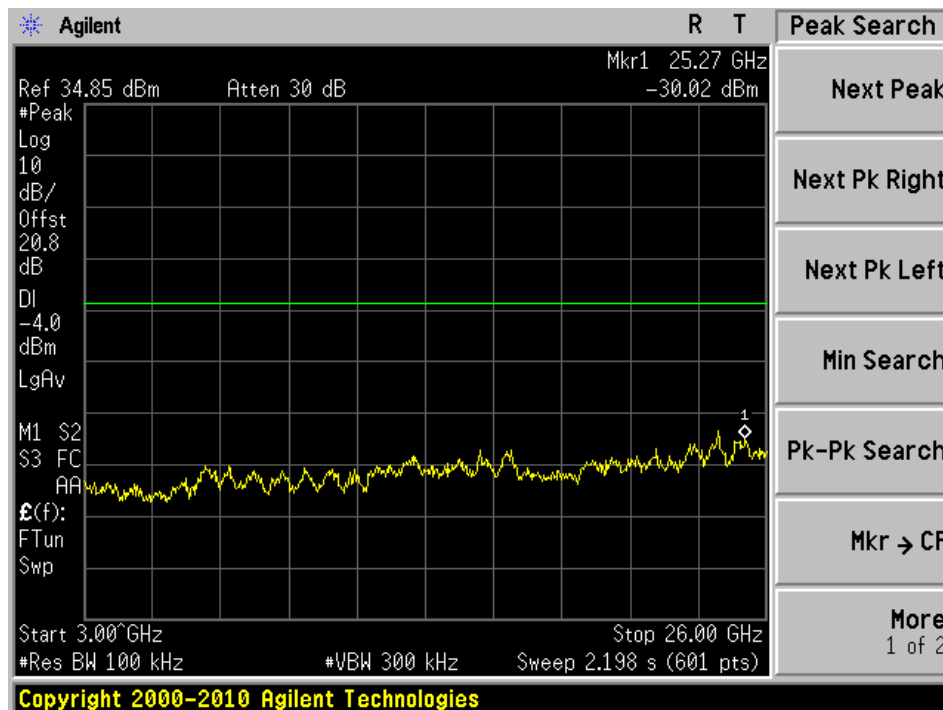
Note: The highest channel of the EUT was set to be 2465 MHz by the request of clients.

### Low Channel, 2405 MHz

Plot: 30 MHz – 3 GHz

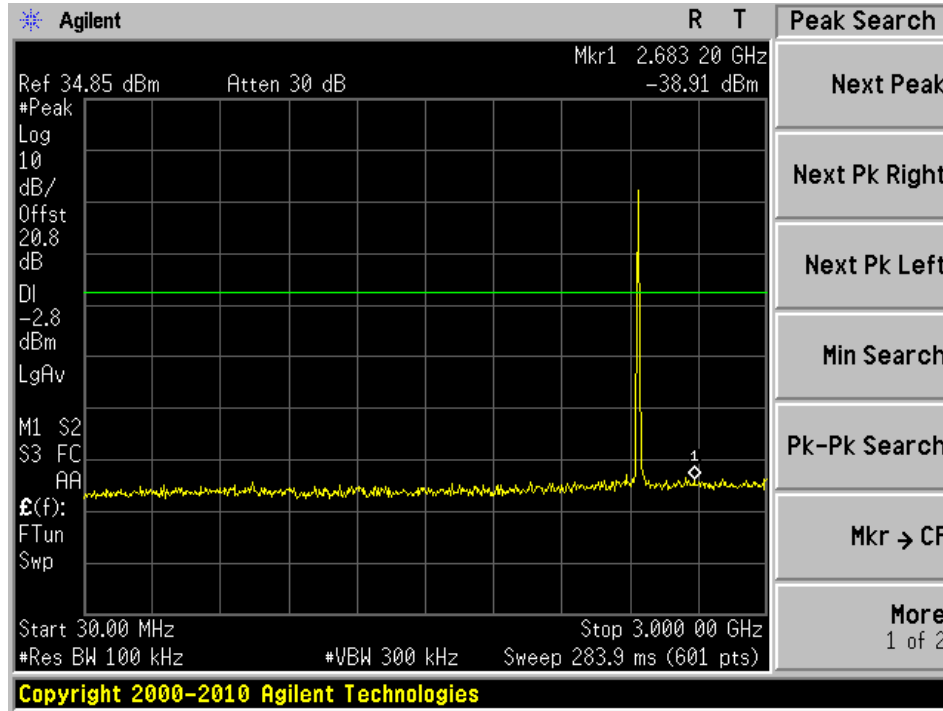


Plot: 3 GHz – 26 GHz

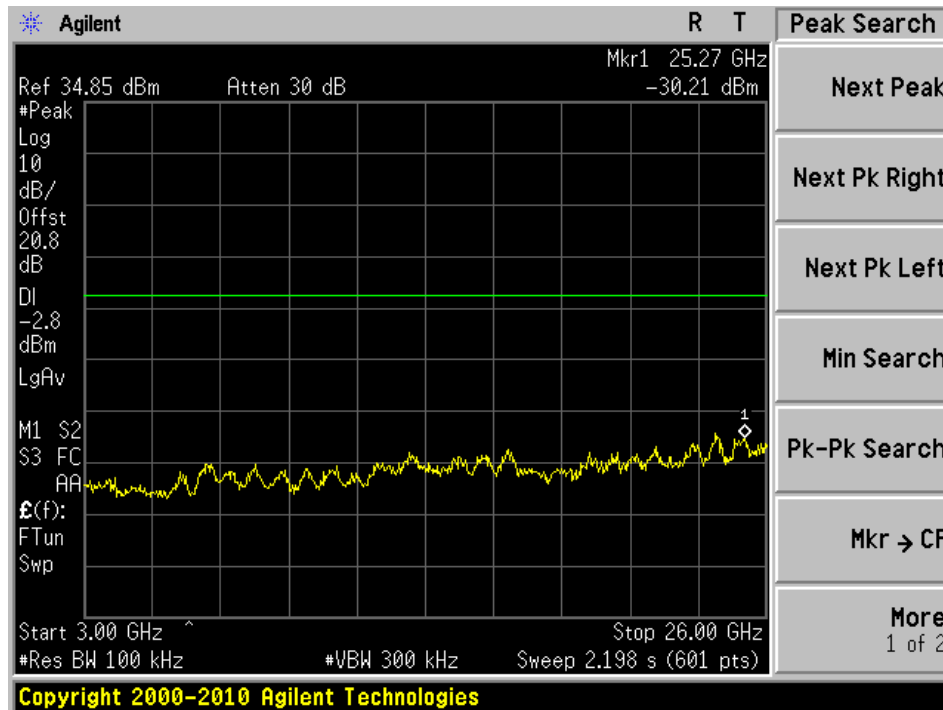


### Middle Channel, 2440 MHz

Plot: 30 MHz – 3 GHz

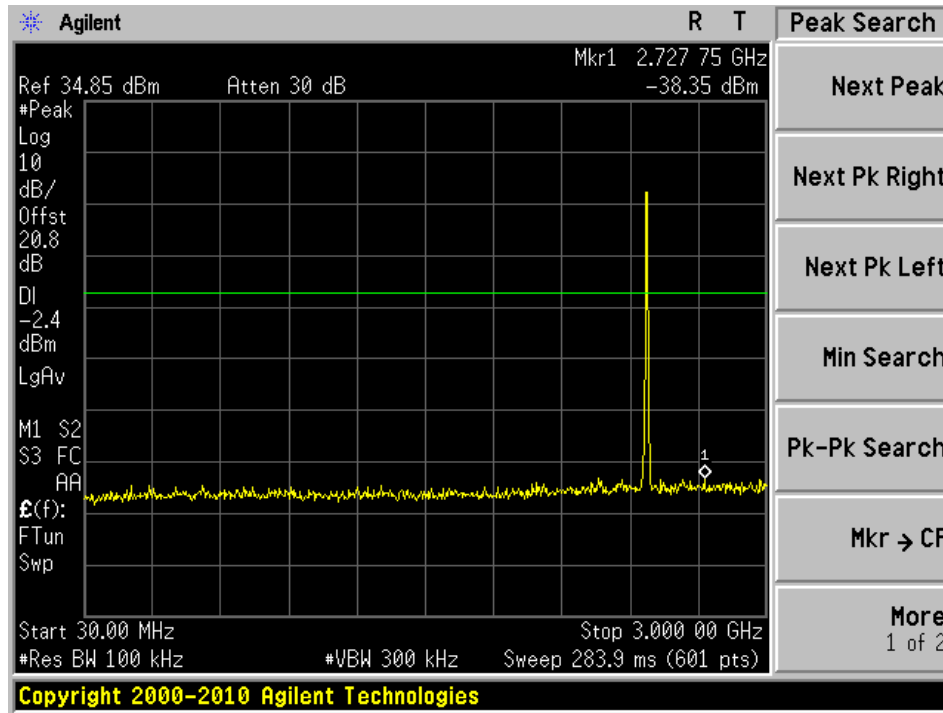


Plot: 3 GHz – 26 GHz

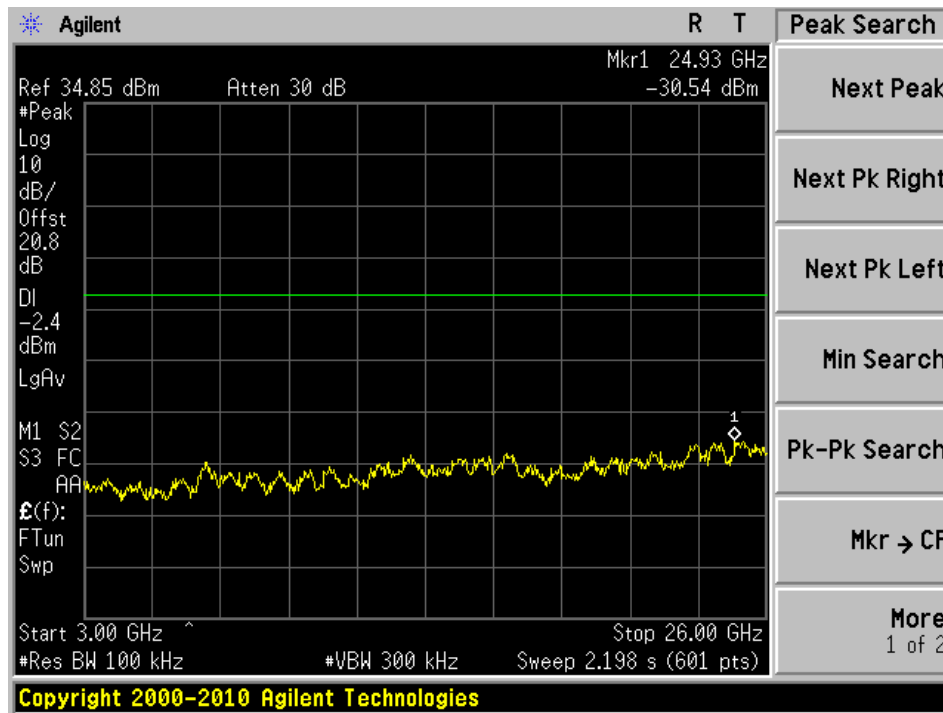


### High Channel, 2465 MHz

Plot: 30 MHz – 3 GHz



Plot: 3 GHz – 26 GHz



## 8 FCC §15.205, §15.209, §15.247(c) & IC RSS-210 §A8.5 – Spurious Radiated Emissions

### 8.1 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) 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

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.

## 8.2 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.

The spacing between the peripherals was 3 centimeters.

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

## 8.3 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

## 8.4 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:

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

## 8.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100338	2011-09-14
Agilent	Spectrum Analyzer	E4440A	MY44303352	2012-04-10
Sunol Science Corp	System Controller	SC99V	122303-1	N/R
Sunol Science Corp	Combination Antenna	JB3	A020106-2	2011-08-10
EMCO	Horn antenna	3115	9511-4627	2011-10-03
Hewlett Packard	Pre amplifier	8447D	2944A06639	2011-06-09
Mini-Circuits	Pre Amplifier	ZVA-183-S	667400960	2011-08-10

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

## 8.6 Test Environmental Conditions

<b>Temperature:</b>	22.7 °C
<b>Relative Humidity:</b>	43.6 %
<b>ATM Pressure:</b>	102.3 kPa

The testing was performed by Ning Ma on 2012-05-16 at 5m Chamber 3.

## 8.7 Summary of Test Results

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

30-1000 MHz:

<b>Mode: Transmitting</b>			
<b>Margin (dB)</b>	<b>Frequency (MHz)</b>	<b>Polarization (Horizontal/Vertical)</b>	<b>Range (MHz)</b>
-1.39	50.0045	Vertical	30-1000

1 – 25 GHz:

<b>Mode: Transmitting</b>			
<b>Margin (dB)</b>	<b>Frequency (MHz)</b>	<b>Polarization (Horizontal/Vertical)</b>	<b>Range (GHz)</b>
-2.158	4880	Vertical	1-25

Please refer to the following table and plots for specific test result details

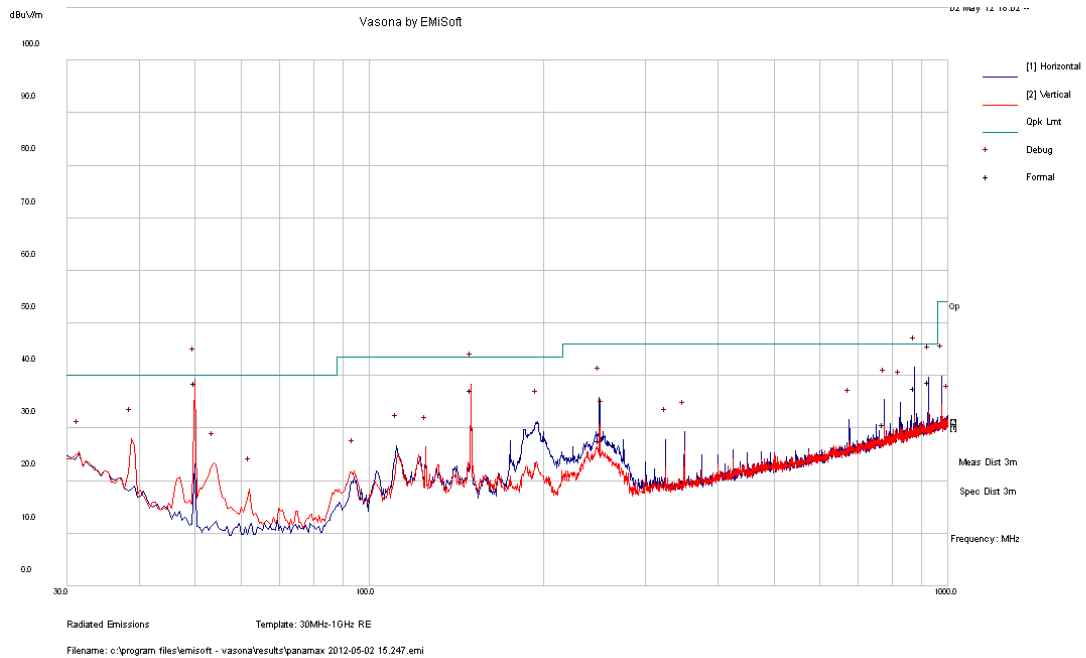
Note: The highest channel of the EUT was set to be 2465 MHz by the request of clients.



## 8.8 Radiated Emissions Test Data and Plots

### 1) 30 MHz – 1 GHz, Measured at 3 meters

Middle channel (2440 MHz)



### Quasi-Peak Measurements

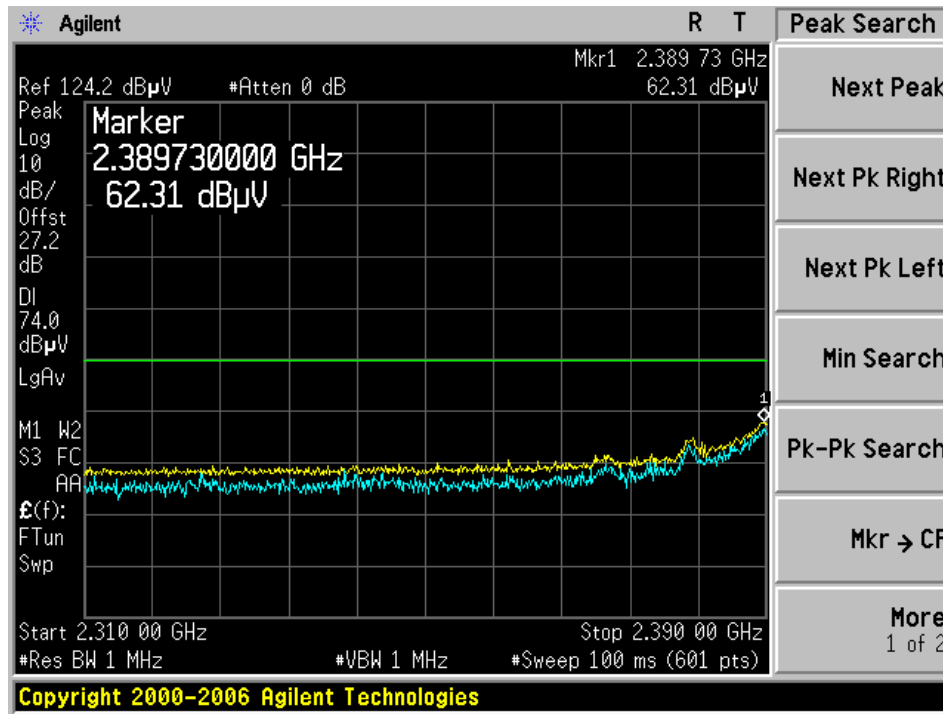
Frequency (MHz)	Corrected Amplitude (dB $\mu$ V/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dB $\mu$ V/m)	Margin (dB)
50.0045	38.61	102	V	33	40	-1.39
150.0073	37.23	99	V	290	43.5	-6.27
925.044	38.88	99	H	308	46	-7.12
875.0348	37.57	101	H	284	46	-8.43
775.0378	30.68	135	V	37	46	-15.32
250.0433	27.6	120	H	272	46	-18.40

## 2) 1–25 GHz, Measured at 3 meters

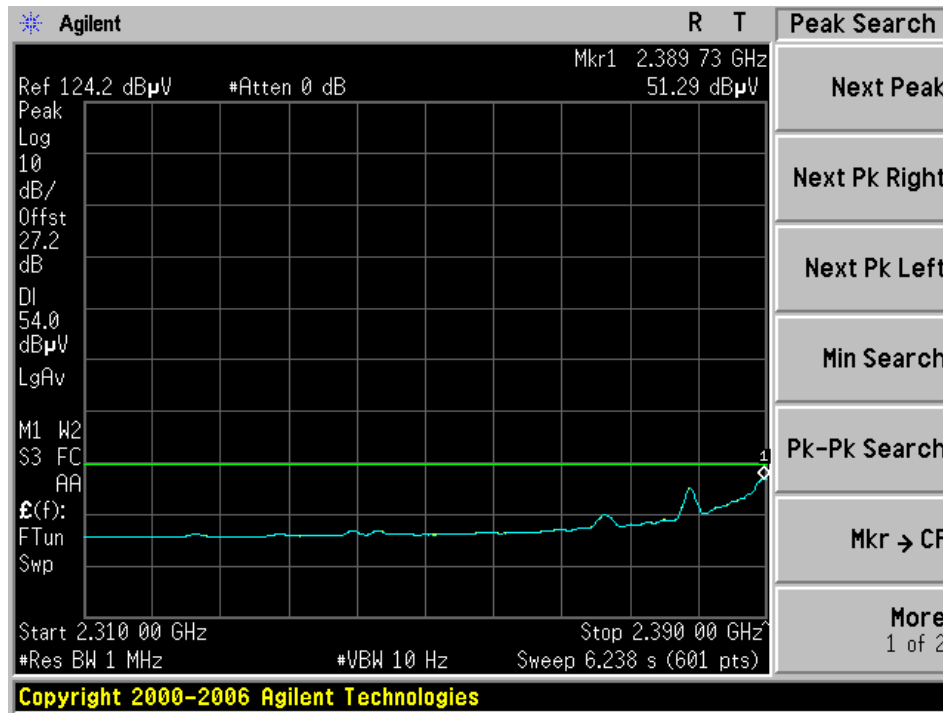
Frequency (MHz)	S.A. Reading (dB $\mu$ V)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dB $\mu$ V/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dB $\mu$ V/m)	Margin (dB)	
Low Channel 2405 MHz, measured at 3 meters											
4810	44.74	221	100	H	32.629	4.56	27.71	54.219	74	-19.781	peak
4810	48.9	285	100	V	32.603	4.56	27.71	58.353	74	-15.647	peak
4810	33.8	221	100	H	32.629	4.56	27.71	43.279	54	-10.721	Ave
4810	38.85	285	100	V	32.603	4.56	27.71	48.303	54	-5.697	Ave
Middle Channel 2440 MHz, measured at 3 meters											
4880	48.58	297	130	H	32.8	4.54	27.71	58.21	74	-15.79	peak
4880	52.09	102	133	V	32.732	4.54	27.71	61.652	74	-12.348	peak
4880	38.53	297	130	H	32.8	4.54	27.71	48.16	54	-5.84	Ave
4880	42.28	102	133	V	32.732	4.54	27.71	51.842	54	-2.158	Ave
High Channel 2465 MHz, measured at 3 meters											
4930	42.76	47	100	H	32.8	4.52	27.71	52.37	74	-21.63	peak
4930	45.29	161	100	V	32.732	4.52	27.71	54.832	74	-19.168	peak
4930	32.05	47	100	H	32.8	4.52	27.71	41.66	54	-12.34	Ave
4930	34.59	161	100	V	32.732	4.52	27.71	44.132	54	-9.868	Ave

### 3) Restricted Band Edge

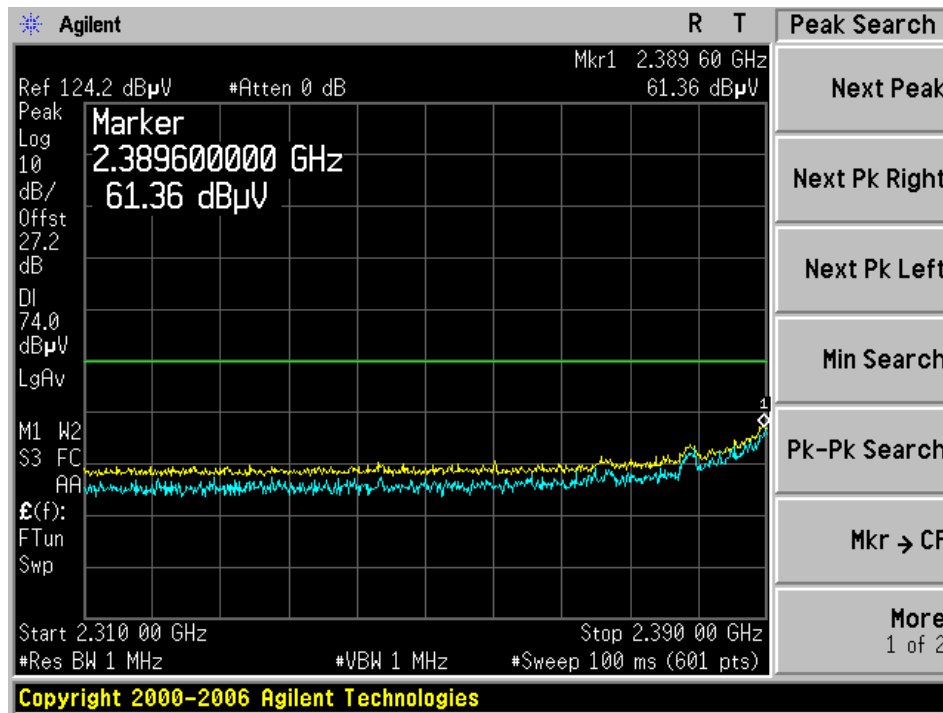
Low channel, Vertical, Peak measurement



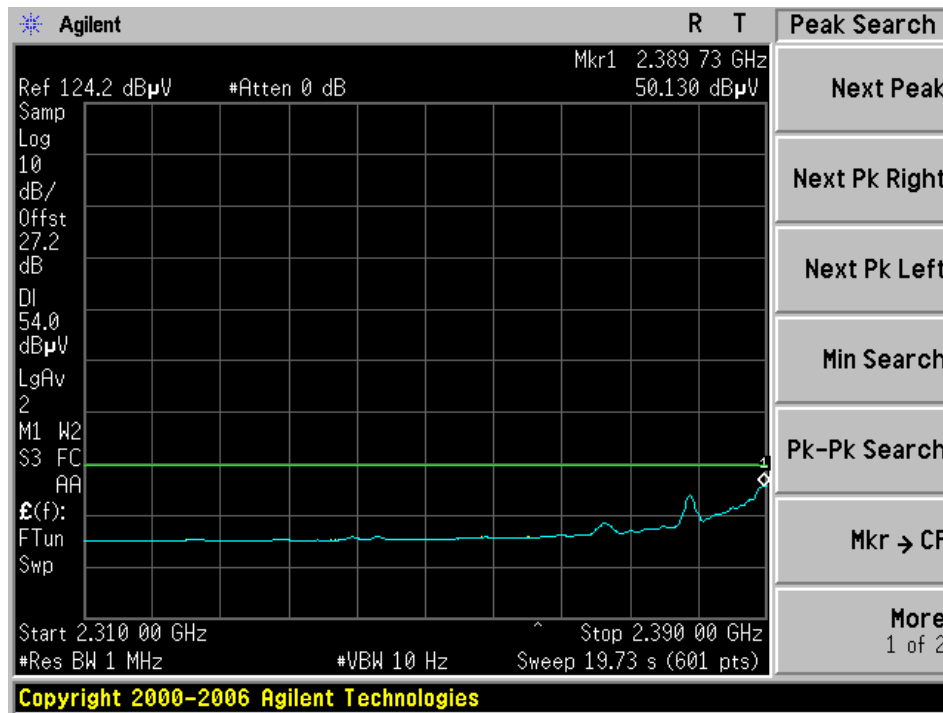
Low channel, Vertical, Average measurement



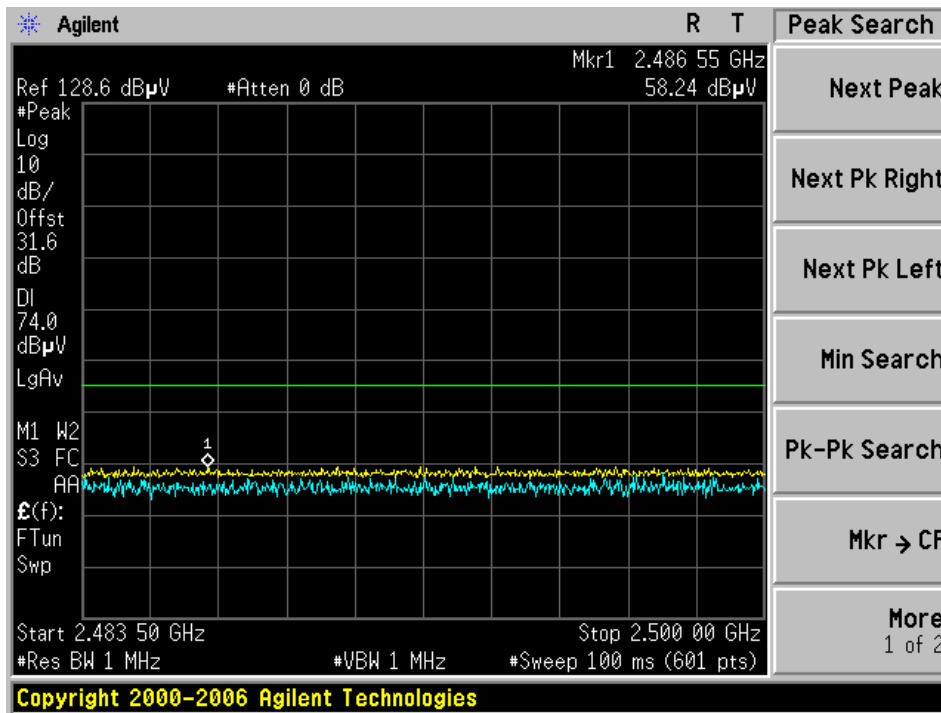
Low channel, Horizontal, Peak measurement



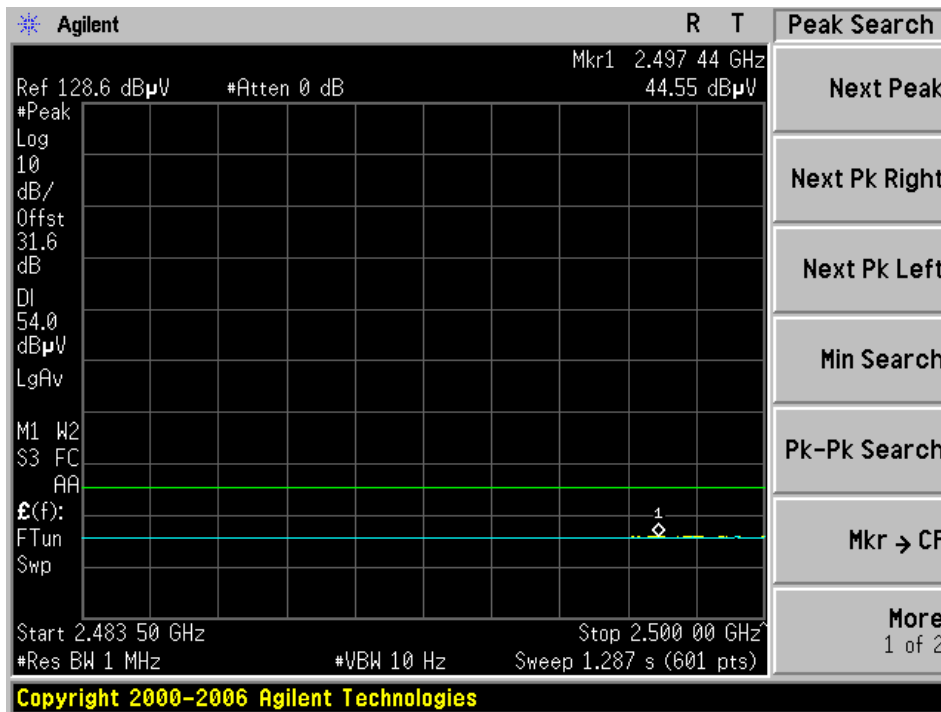
Low channel, Horizontal, Average measurement



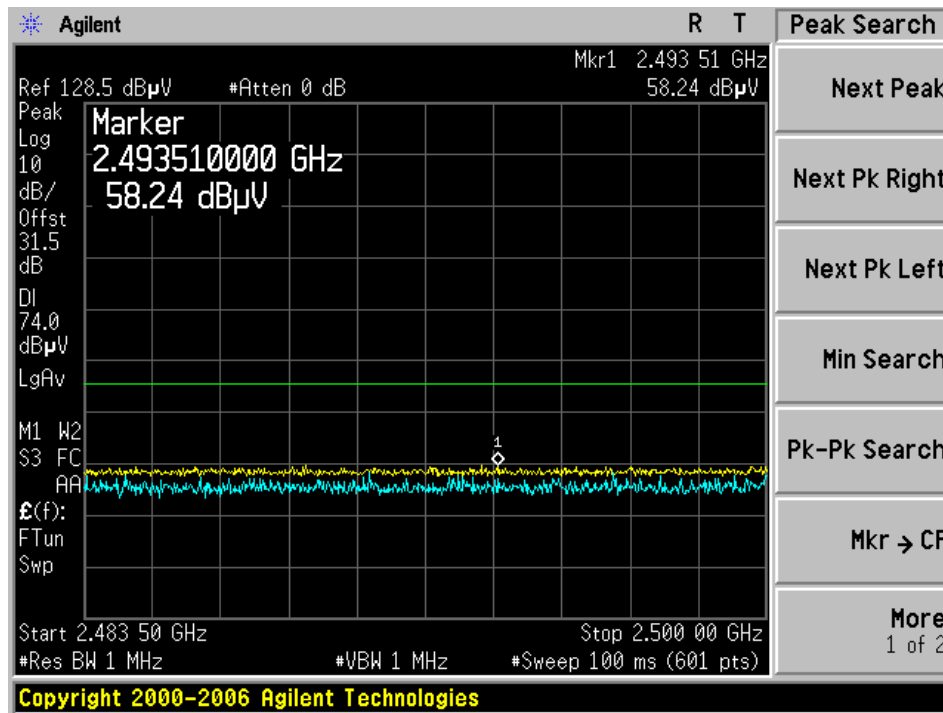
High channel, Vertical, Peak measurement



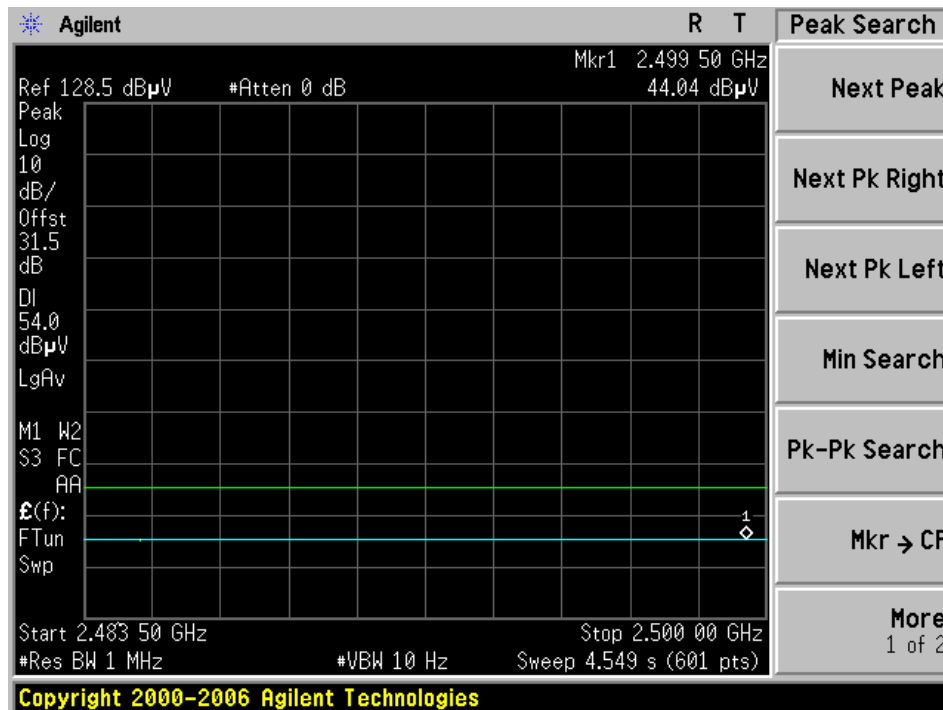
High channel, Vertical, Average measurement



High channel, Horizontal, Peak measurement



High channel, Horizontal, Average measurement



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

### 9.1 Applicable Standard

According to FCC §15.247(a)(2) and IC RSS-210 A8.2 (a), 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

### 9.2 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. 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 6 dB from the reference level.
- 4) Record the frequency difference as the emissions bandwidth.
- 5) Repeat above procedures until all frequencies measured were complete.

### 9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2012-04-10

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

### 9.4 Test Environmental Conditions

<b>Temperature:</b>	24.1 °C
<b>Relative Humidity:</b>	41.5 %
<b>ATM Pressure:</b>	102.3 kPa

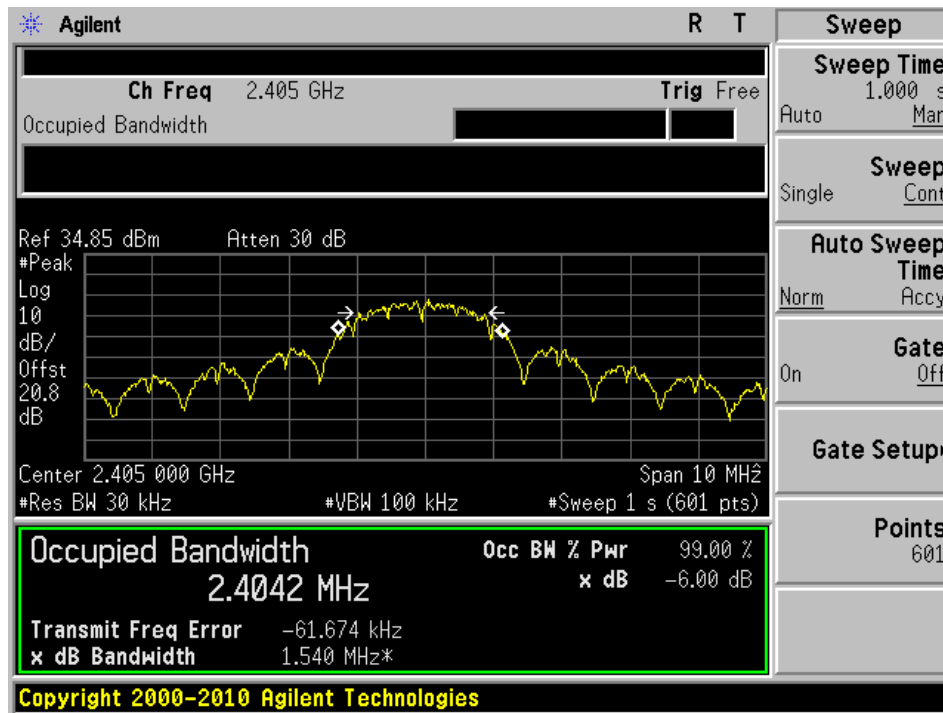
*The testing was performed by Ning Ma on 2012-05-02.*

### 9.5 Test Results

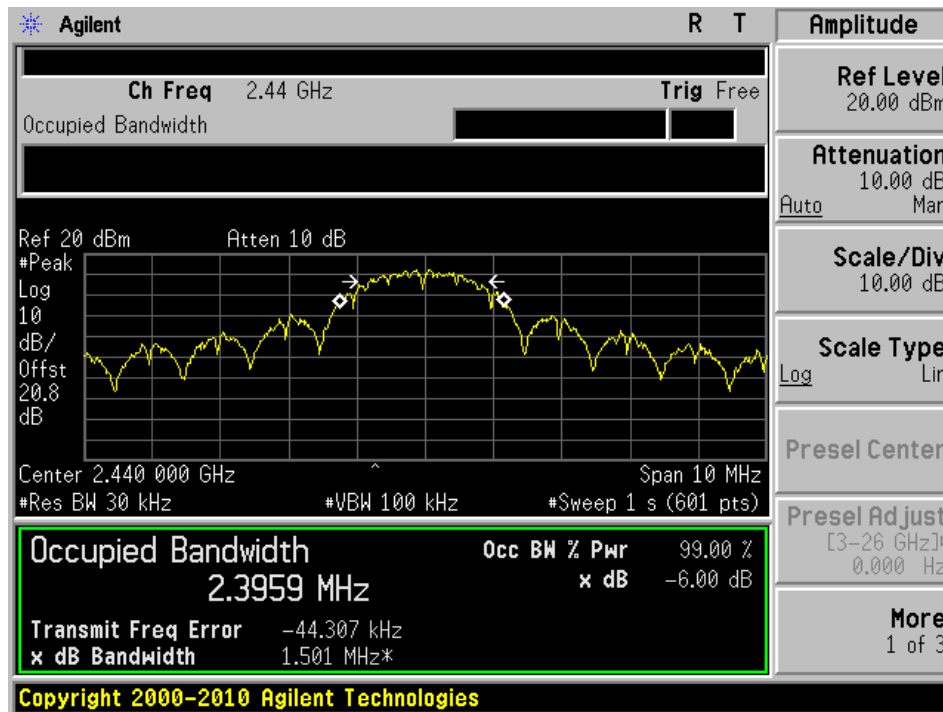
Channel	Frequency (MHz)	99% Emission Bandwidth (MHz)	6 dB Emission Bandwidth (MHz)	Limit (kHz)	Results
Low	2405	2.4042	1.540	> 500	Compliant
Middle	2440	2.3959	1.501	> 500	Compliant
High	2465	2.3850	1.527	> 500	Compliant

Please refer to the following plots for detailed test results

Low Channel 2405 MHz

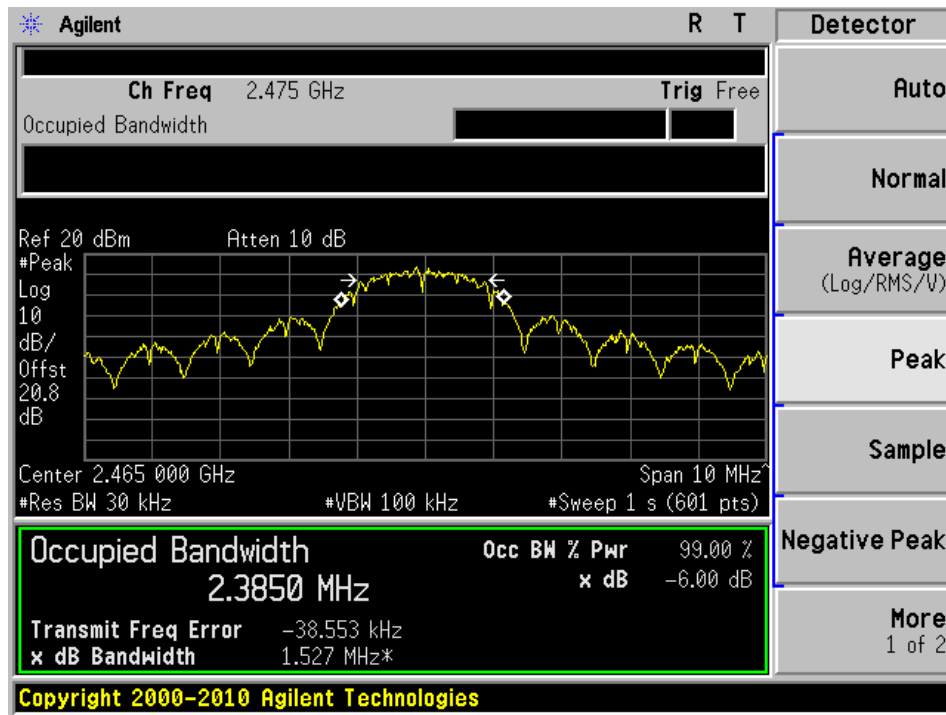


Middle Channel 2440 MHz





High Channel 2465 MHz



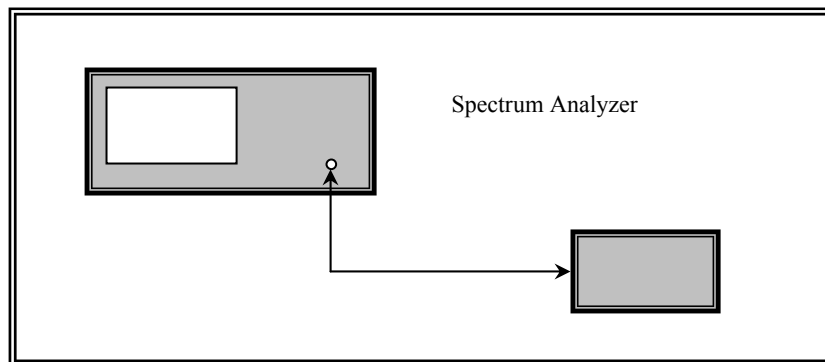
## 10 FCC §15.247(b) & IC RSS-210 §A8.4 – Peak Output Power Measurement

### 10.1 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.

### 10.2 Measurement Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to a spectrum analyzer.
3. Add a correction factor to the display.



### 10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2012-04-10

**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

<b>Temperature:</b>	24.1 °C
<b>Relative Humidity:</b>	41.5 %
<b>ATM Pressure:</b>	102.3 kPa

*The testing was performed by Ning Ma on 2012-05-02.*

## 10.5 Test Results

Channel	Frequency (MHz)	Conducted Output Power (dBm)	FCC/IC Limit (dBm)	Margin (dB)
Low	2405	19.87	30	10.13
Middle	2440	20.25	30	9.75
High	2465	20.24	30	9.76

Note: The highest channel of the EUT was set to be 2465 MHz by the request of clients.

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

### 11.1 Applicable Standard

According to FCC §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).

According to IC Rss-210 §A8.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency 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 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 section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required.

### 11.2 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 its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

### 11.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2012-04-10

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

### 11.4 Test Environmental Conditions

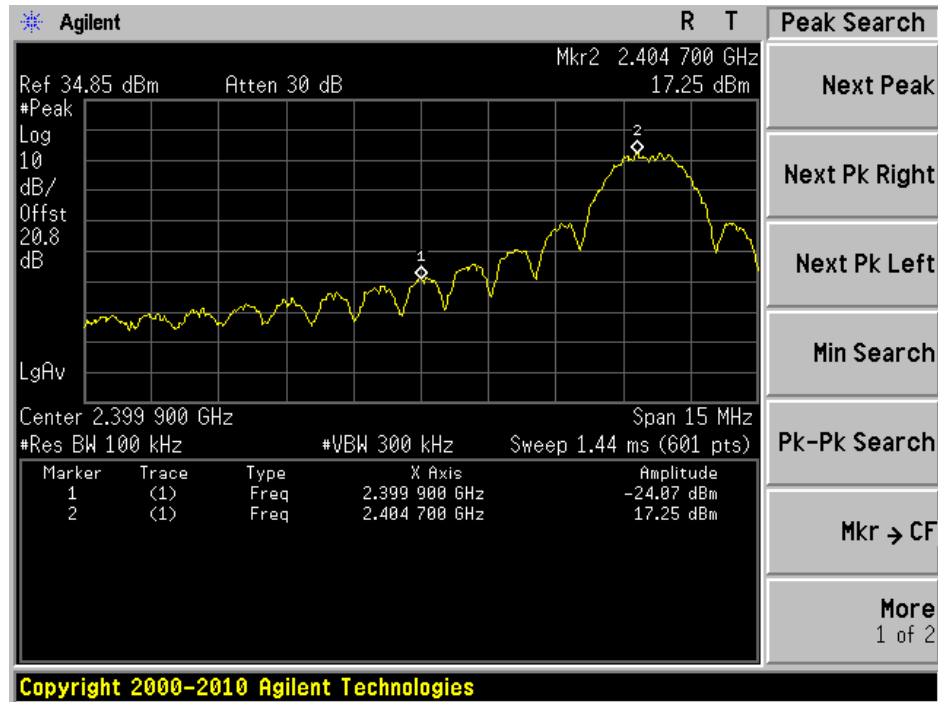
<b>Temperature:</b>	24.1 °C
<b>Relative Humidity:</b>	41.5 %
<b>ATM Pressure:</b>	102.3 kPa

*The testing was performed by Ning Ma on 2012-05-02.*

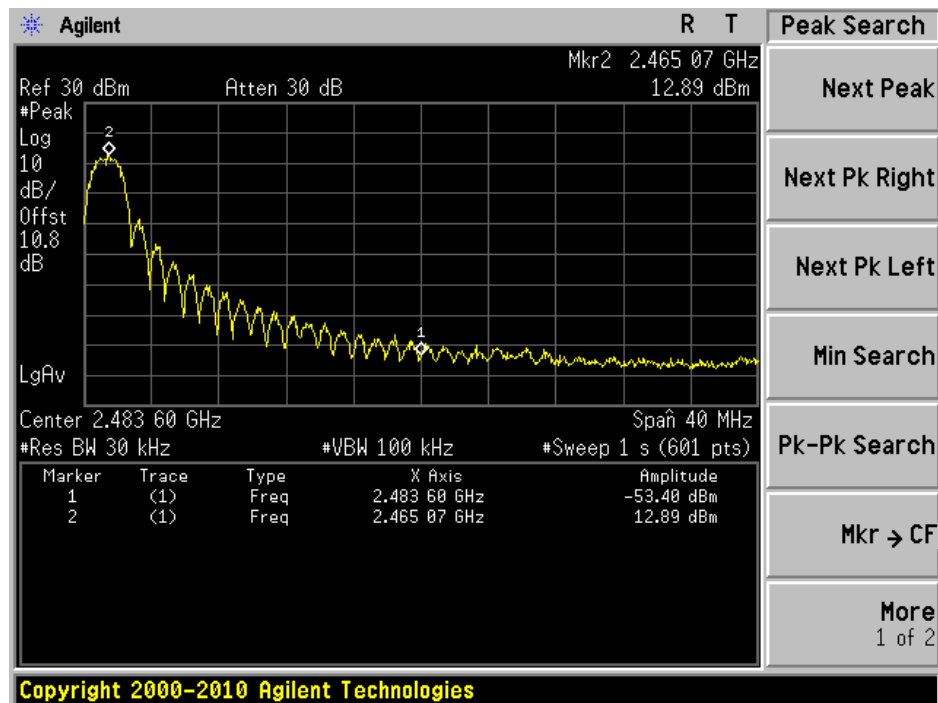
## 11.5 Test Results

Please refer to following pages for plots of band edge.

### Low Channel Band Edge



### High Channel Band Edge



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

### 12.1 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.

### 12.2 Measurement Procedure

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW = 100 kHz.
3. Set the VBW  $\geq$  300 kHz.
4. Set the span to 5-30 % greater than the EBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
10. Scale the observed power level to an equivalent value in 3 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where  $BWCF = 10\log(3\text{ kHz}/100\text{ kHz} = -15.2\text{ dB})$ .
11. The resulting peak PSD level must be  $\leq$  8 dBm.

### 12.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2012-04-10

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

### 12.4 Test Environmental Conditions

<b>Temperature:</b>	24.1 °C
<b>Relative Humidity:</b>	41.5 %
<b>ATM Pressure:</b>	102.3 kPa

*The testing was performed by Ning Ma on 2012-05-02.*

## 12.5 Test Results

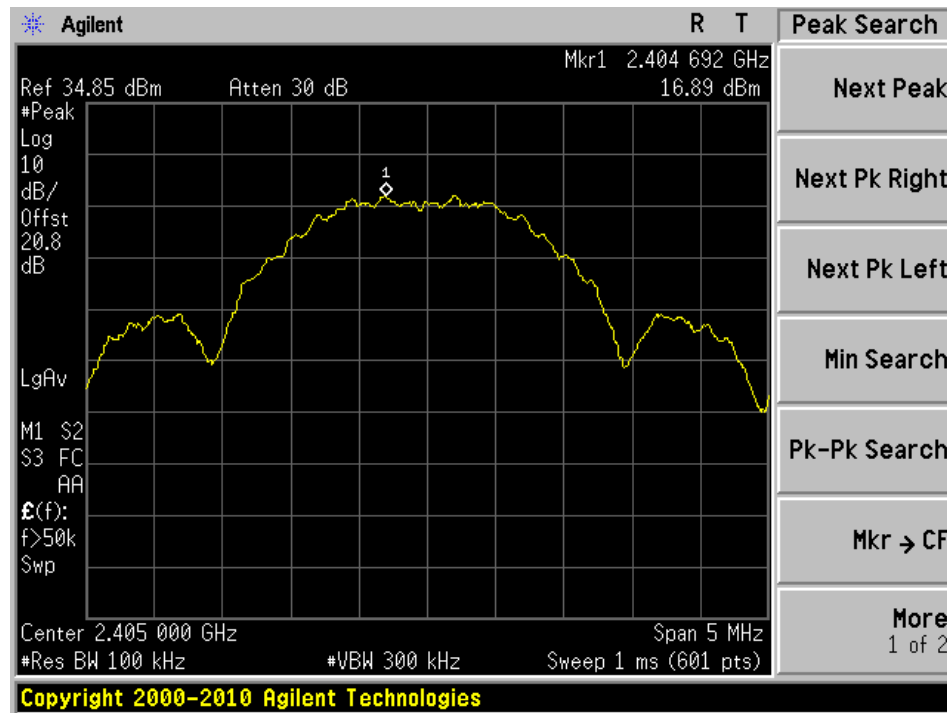
All the data can be scaled to an equivalent value in 3 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where  $BWCF = 10 \log(3 \text{ kHz}/100 \text{ kHz}) = -15.2 \text{ dB}$ .

Channel	Frequency (MHz)	PDS (dBm/100 kHz)	Corrected PSD (dBm)	FCC/IC Limit (dBm/3 kHz)	Results
Low	2405	16.89	1.69	8	Compliant
Mid	2440	17.11	1.91	8	Compliant
High	2465	16.06	0.86	8	Compliant

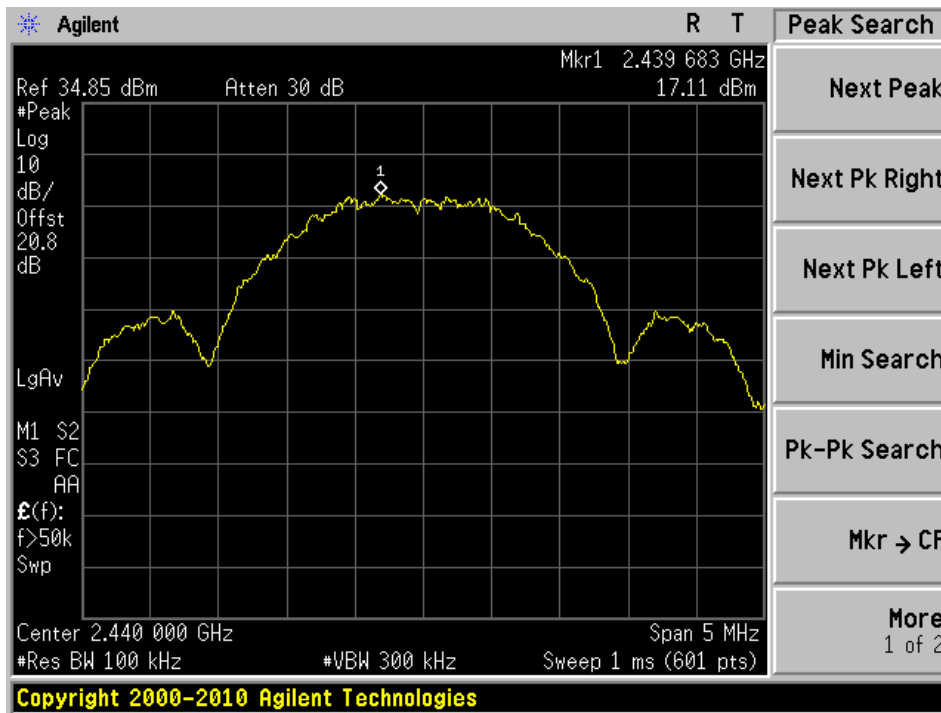
Note: The highest channel of the EUT was set to be 2465 MHz by the request of clients.

Please refer to the following plots for detailed test results:

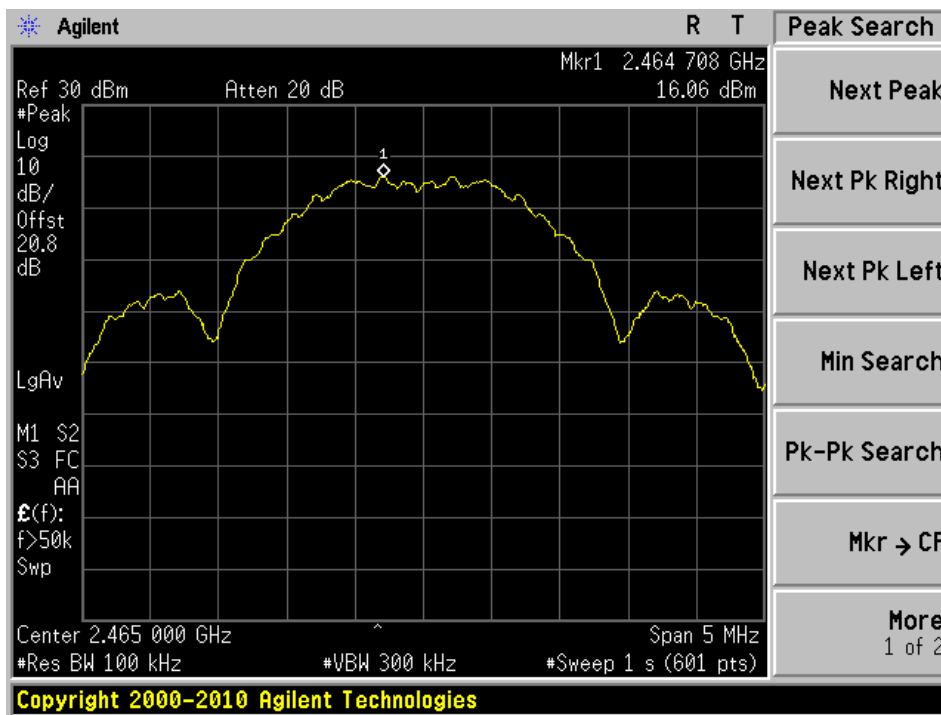
Low Channel 2405 MHz



Middle Channel 2440 MHz



High Channel 2465 MHz





## 13 IC RSS-210 §2.3 & RSS-Gen §6.1 – Receiver Spurious Radiated Emissions

### 13.1 Applicable Standard

According to IC RSS-Gen §4.10, the receiver shall be operated in the normal receive mode near the mid-point of the band over which the receiver is designed to operate.

Unless otherwise specified in the applicable RSS, the radiated emission measurement is the standard measurement method (with the device's antenna in place) to measure receiver spurious emissions.

Radiated emission measurements are to be performed using a calibrated open-area test site.

For either method, the search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tuneable or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

For emissions below 1 GHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. As an alternative to CISPR quasi-peak measurement, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector with the same measurement bandwidth as that for CISPR quasi-peak measurements. Above 1 GHz, measurements shall be performed using an average detector and a resolution bandwidth of 300 kHz to 1 MHz.

According to RSS-Gen §6.1, Table 2, the radiated limit of receiver spurious emissions

Frequency (MHz)	Field Strength (Microvolts/m at 3 meters)
30-88	100
88-216	150
216-960	200
Above 960	500

### 13.2 EUT Setup

The radiated emissions tests were performed in the 3 meter chamber, using the setup in accordance with ANSI C63.4-2009.

### 13.3 Test Procedure

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

All data were recorded in the peak detection mode. Quasi-peak readings was performed only when an emissions was found to be marginal (within -4 dB of specification limits), and are distinguished with a "QP" in the data table.

### 13.4 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:

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

### 13.5 Test Equipment Lists and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100338	2011-09-14
Agilent	Spectrum Analyzer	E4440A	MY44303352	2011-05-10
Sunol Science Corp	System Controller	SC99V	122303-1	N/R
Sunol Science Corp	Combination Antenna	JB3	A020106-2	2011-08-10
EMCO	Horn antenna	3115	9511-4627	2011-10-03
Hewlett Packard	Pre-amplifier	8447D	2944A06639	2011-06-09
Mini-Circuits	Pre-amplifier	ZVA-183-S	667400960	2011-05-08

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

### 13.6 Test Environmental Conditions

<b>Temperature:</b>	22.7 °C
<b>Relative Humidity:</b>	43.6 %
<b>ATM Pressure:</b>	102.3 kPa

*The testing was performed by Ning Ma on 2012-05-03 at 5m Chamber 3.*

### 13.7 Summary of Test Results

According to the test data, the EUT complied with the with the RSS-210, with the closest margins from the limit listed below:

Below 1 GHz:

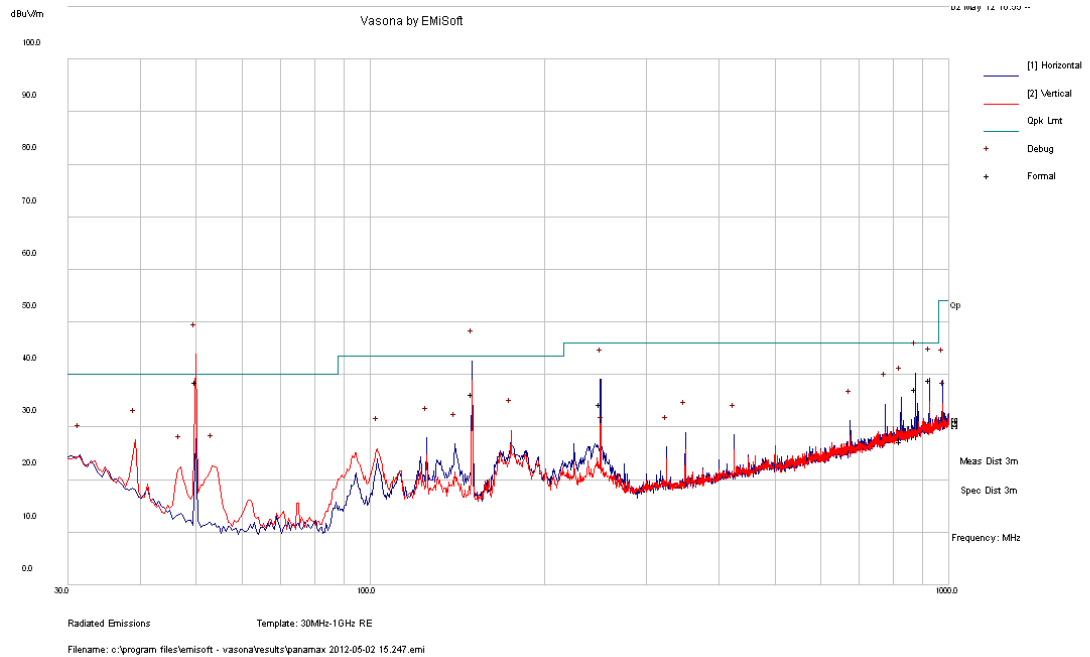
<b>Mode: Receiving</b>			
<b>Margin (dB)</b>	<b>Frequency (MHz)</b>	<b>Polarization (Horizontal/Vertical)</b>	<b>Range (MHz)</b>
-1.37	50.00425	Vertical	30-1000

Above 1 GHz:

<b>Mode: Receiving</b>			
<b>Margin (dB)</b>	<b>Frequency (MHz)</b>	<b>Polarization (Horizontal/Vertical)</b>	<b>Range (MHz)</b>
-22.695	1600	Vertical	Above 1 GHz

## 13.8 Radiated Emissions Test Data and Plots

### 1) 30-1000 MHz, Measured at 3 meters



Frequency (MHz)	Corrected Amplitude (dB $\mu$ V/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dB $\mu$ V/m)	Margin (dB)	Comments
50.00425	38.63	107	V	317	40	-1.37	Quasi-Peak
150.0205	36.38	99	V	299	43.5	-7.12	Quasi-Peak
875.0775	37.26	99	H	317	46	-8.74	Quasi-Peak
925.0635	38.92	100	H	302	46	-7.08	Quasi-Peak
250.0628	34.48	111	H	108	46	-11.52	Quasi-Peak
825.0713	27.29	133	V	85	46	-18.71	Quasi-Peak

### 2) Above 1 GHz Measured at 3 meters

Frequency (MHz)	S.A. Reading (dB $\mu$ V)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dB $\mu$ V/m)	IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dB $\mu$ V/m)	Margin (dB)	
1600	41.76	55	107	H	25.279	2.46	27.71	41.789	74	-32.211	Peak
1600	43.12	145	109	V	25.225	2.46	27.71	34.305	74	-39.695	Peak
1600	39.64	55	107	H	25.225	2.46	27.71	30.825	54	-23.175	Ave
1600	40.12	145	109	V	25.225	2.46	27.71	31.305	54	-22.695	Ave