





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

For

**MbientLab Incorporated**

848 Girard Street,  
San Francisco, CA 94134, USA

**FCC ID: 2ACEB-METAR1**  
**IC: 12118A-METAR1**

<b>Report Type:</b> Original Report	<b>Product Type:</b> BTLE Module
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\* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk “\*” (Rev. 2)

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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	R1406124-247	Original Report	2014-07-10

## 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 *MbientLab Incorporated* and their product model: *MetaWear R1, FCC ID: 2ACEB-METAR1, IC: 12118A-METAR1*, which will henceforth be referred to as the EUT (Equipment Under Test). The EUT is a MetaWear compact BTLE module.

### 1.2 Mechanical Description of EUT

The EUT measures approximately 2.6 cm (L) x 1.7 cm (W) x 0.3 cm (H) and weighs 0.002(kg).

*The test data gathered are from typical production sample, serial number: 01.*

### 1.3 Objective

This report is prepared on behalf of *MbientLab Incorporated* in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission's 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, AC Line Conducted Emissions, 6 dB Bandwidth, 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.

### 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 CISPR16-4-2:2011, The Treatment of Uncertainty in EMC Measurements, the values ranging from  $\pm 2.0$  dB for Conducted Emissions tests and  $\pm 4.0$  dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL Corp.

## 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 Luminaires 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.

### 2.2 EUT Exercise Software

The test utility used was MetaWearRadioTest, was provided by MBIENTLAB Inc., and was verified by Cipher Chu 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.

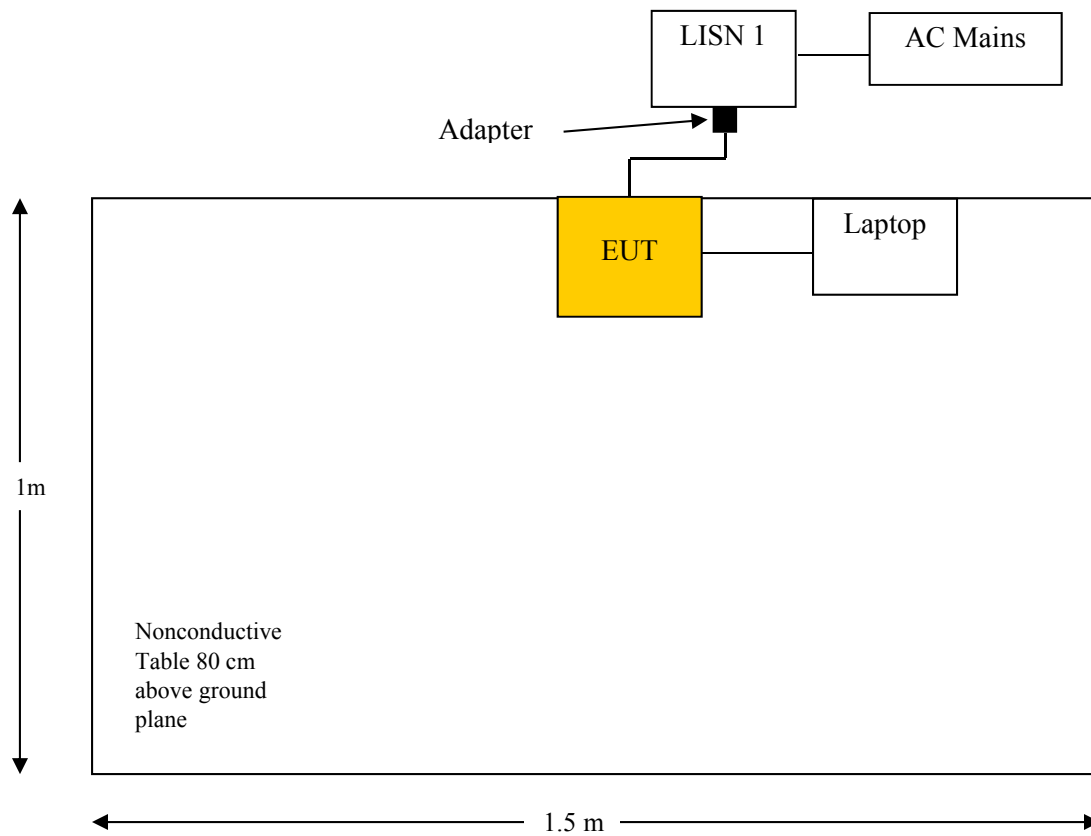
### 2.5 Local Support Equipment

Manufacturer	Description	Model	Serial Number
Apple	Laptop	A1369	C02H3V9KDJWT
FLEXTRONICS	Adapter	A00810-01	09500043-210

### 2.6 Interface Ports and Cables

Cable Description	Length (m)	To	From
USB Cable	<1.0	Laptop	EUT
DC Power Cable	<1.0	EUT	Adapter

## 2.7 Test Setup Block Diagram





### 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	Compliant
FCC §15.205 IC RSS-210 §2.2	Restricted Bands	Compliant
FCC §15.209, §15.247 (d) 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

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

### 4.1 Applicable Standard

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  $\leq 50$  mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where}$$

- $f(\text{GHz})$  is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation<sup>26</sup>
- 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  $\leq 50$  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.

### 4.2 RF Exposure Evaluation Results

For IC, the Maximum output power is  $1.02 \text{ dBm} = 1.26 \text{ mW} < 20 \text{ mW}$

For FCC:

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] = (1.26/5) \cdot \sqrt{2.402} = 0.42 \leq 3.0$$

**Result:** SAR is not required.

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

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### **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.

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.

### **5.2 Antenna Description**

The EUT has a 2 dBi Ceramic Chip antenna, which was permanently attached the PCB; fulfill the requirement of this section. Please refer to the EUT photos.

## 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 <sup>Note</sup>	56 to 46 <sup>Note</sup>
0.5-5	56	46
5-30	60	50

*Note: Decreases with the logarithm of the frequency.*

### 6.2 Test Setup

The measurement was performed at P2450 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-1 and the power cord of the support equipment was connected to 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 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:

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

## 6.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100337	2014-05-28	1 year
Solar Electronics	LISN	9252-50-R-24-N	511205	2014-06-25	1 year
TTE	Filter, High Pass	H962-150k-50-21378	K7133	2014-06-13	1 year

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

## 6.6 Test Environmental Conditions

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	41 %
<b>ATM Pressure:</b>	103.1 kPa

*The testing was performed by CIPHER Chu on 2014-07-01 in 5m chamber3.*

## 6.7 Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC 15C and IC RSS 210 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)
-4.85	0.953889	Neutral	0.15-30



[illegible]

Frequency (MHz)	Corrected Amplitude (dBμV)	Conductor (Line/Neutral)	Limit (dBμV)	Margin (dB)	Detector (QP/Ave.)
0.953889	41.15	Neutral	46	-4.85	Ave.
0.95439	40.98	Neutral	46	-5.02	Ave.
1.267587	39.39	Neutral	46	-6.61	Ave.
0.632118	38.53	Neutral	46	-7.47	Ave.
2.219941	32.07	Neutral	46	-13.93	Ave.
1.579758	29.45	Neutral	46	-16.55	Ave.

## 7 FCC §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	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2013-11-07	1 year

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

### 7.4 Test Environmental Conditions

Temperature:	23 °C
Relative Humidity:	42 %
ATM Pressure:	102 kPa

The testing was performed by Cipher Chu on 2014-06-30 at RF site.

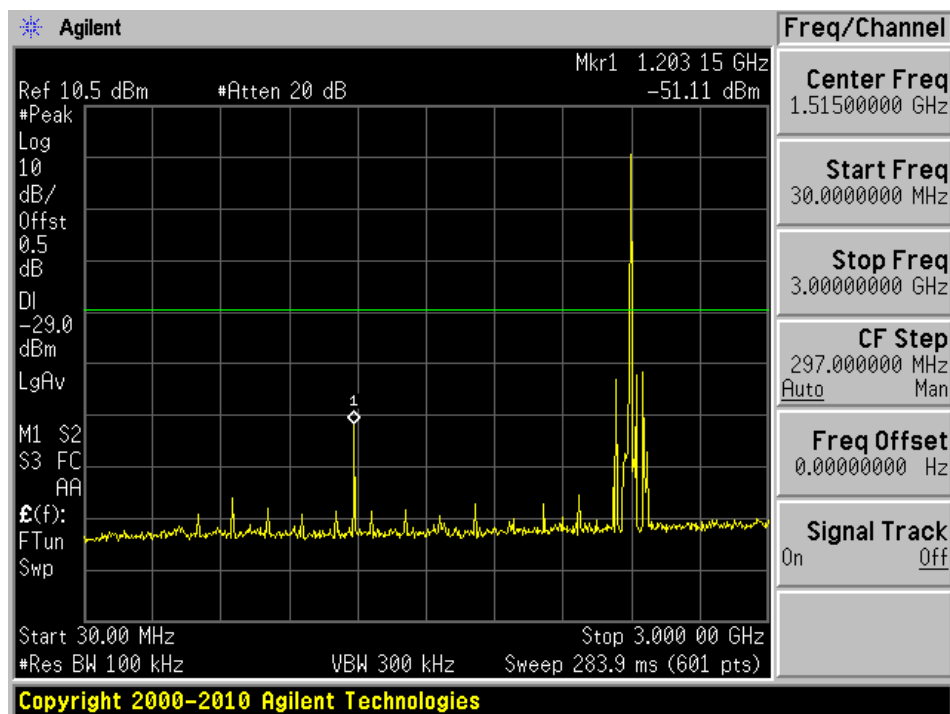
### 7.5 Test Results

Please refer to following plots of spurious emissions.

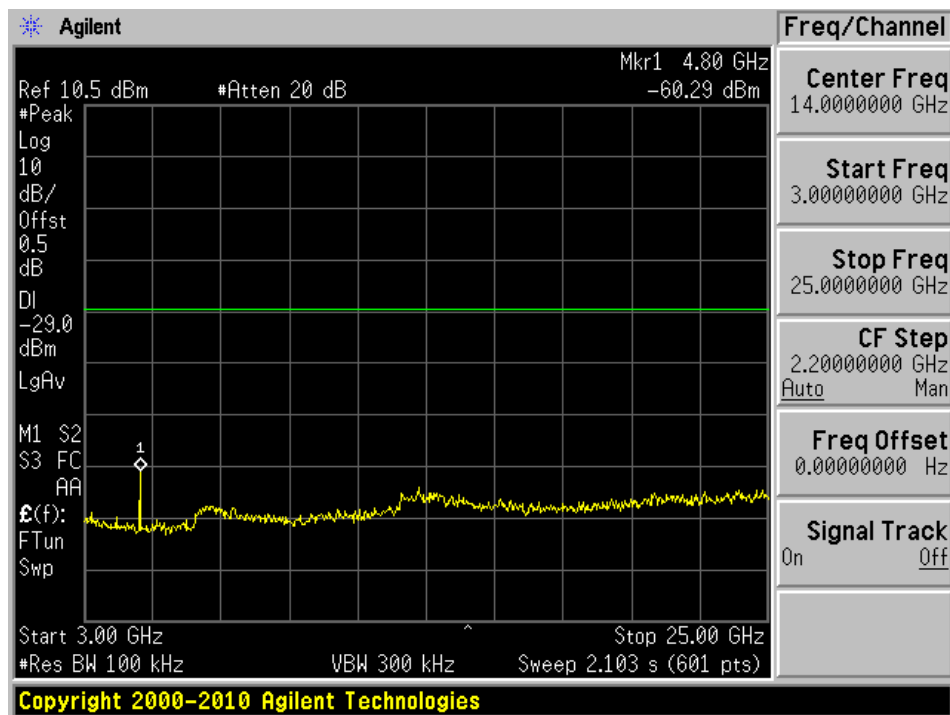


## Low Channel

30 MHz – 3 GHz

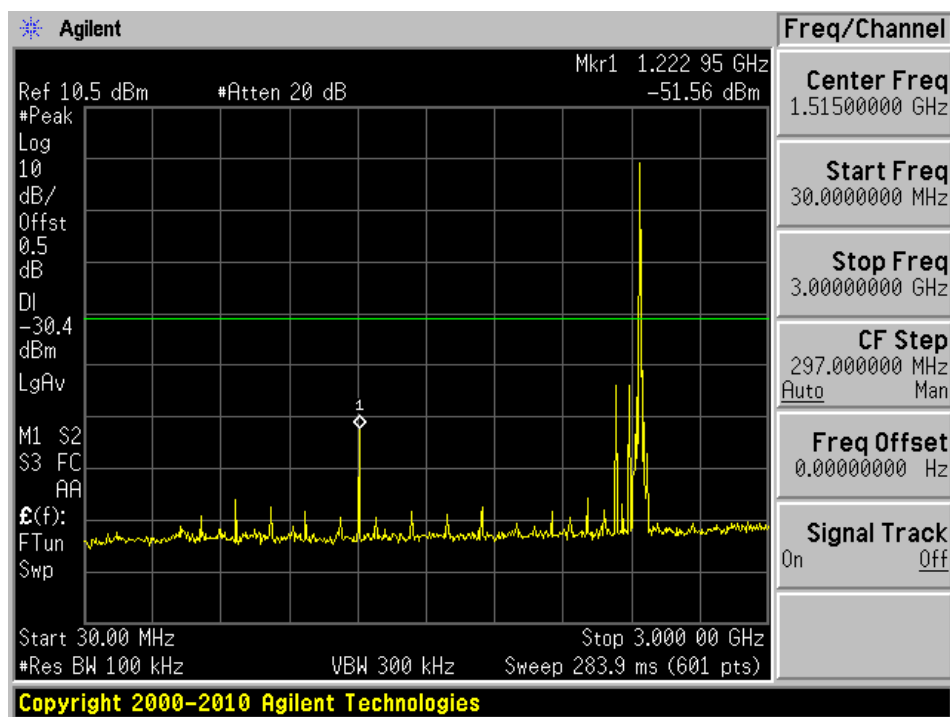


3 GHz – 25 GHz

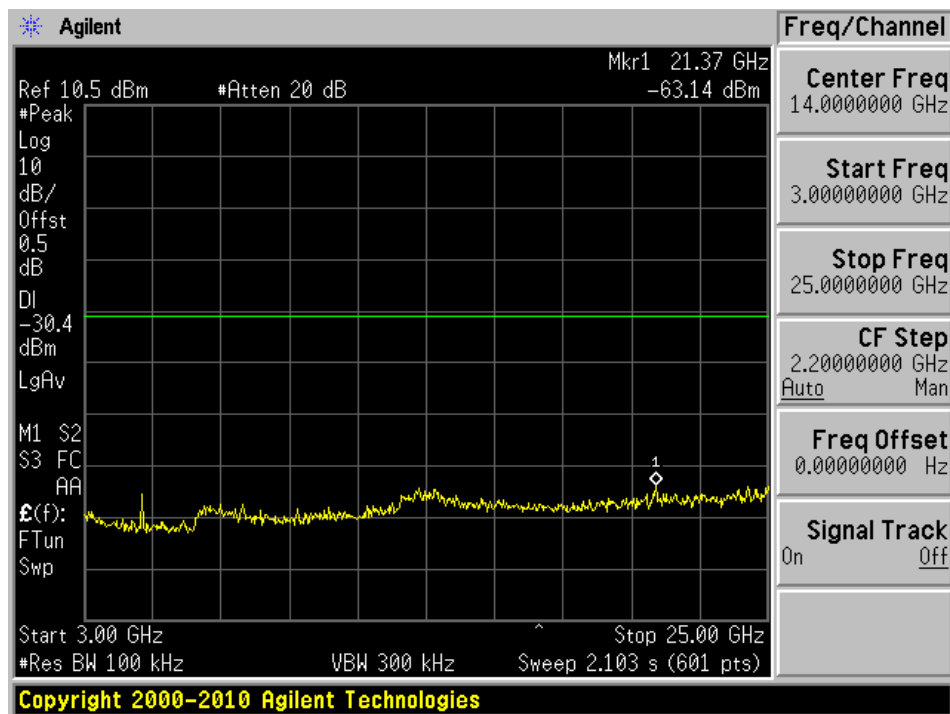


## Middle Channel

30 MHz – 3 GHz

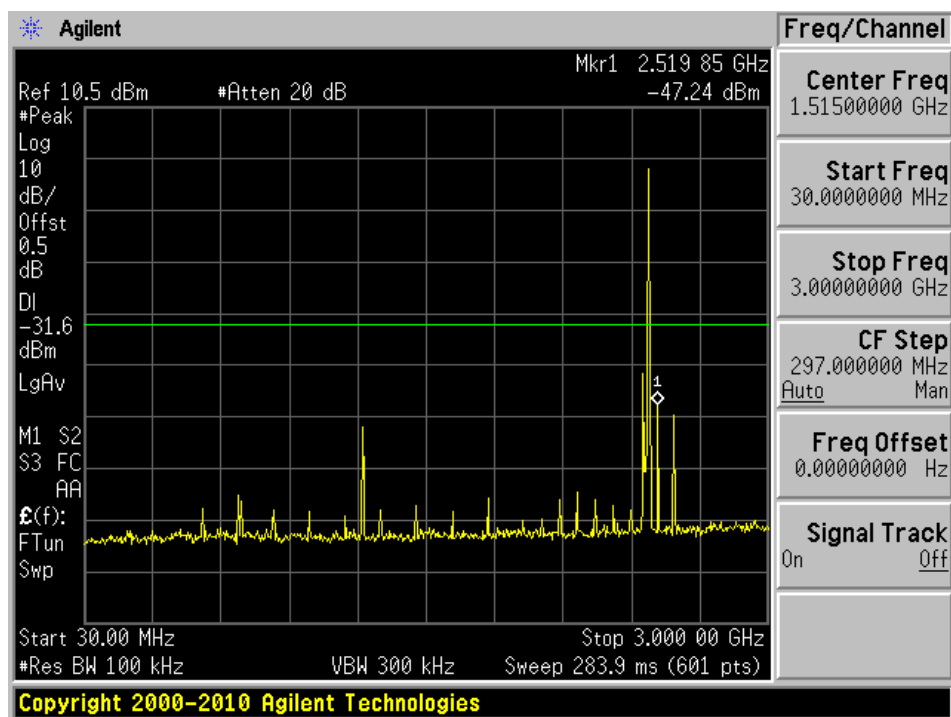


3 GHz – 25 GHz

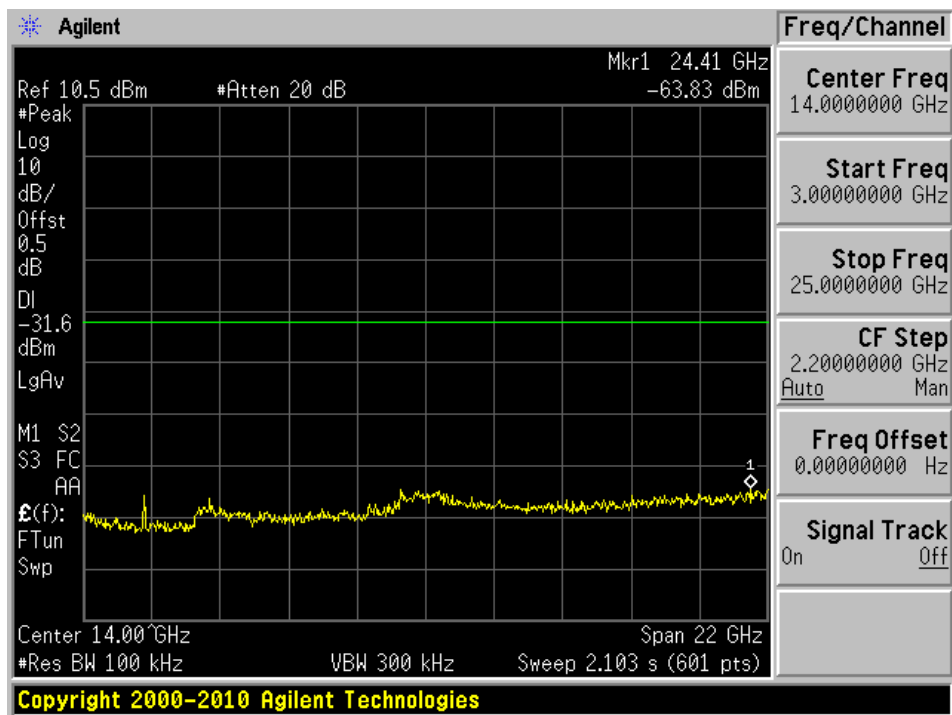


**High Channel**

30 MHz – 3 GHz



3 GHz – 25 GHz



## 8 FCC §15.205, §15.209, §15.247(d) & 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 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.

## 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 10 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:

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

Above 1000 MHz:

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

## 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	Calibration Interval
Sunol Science Corp	System Controller	SC99V	122303-1	N/R	N/R
Sunol Science Corp	Combination Antenna	JB3	A020106-2	2013-07-11	1 year
Hewlett Packard	Pre-amplifier	8447D	2944A06639	2014-04-26	1 year
Hewlett Packard	Pre-amplifier	8449B	3147A00400	2014-03-10	1 year
Agilent	Spectrum Analyzer	E4440A	MY44303352	2013-11-07	1 year
EMCO	Horn Antenna	3315	9511-4627	2014-01-06	1 year
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100338	2014-01-20	1 year

**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>	22-23 °C
<b>Relative Humidity:</b>	43 %
<b>ATM Pressure:</b>	102 kPa

The testing was performed by Cipher Chu on 2014-07-01 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/RSS-Gen standard's radiated emissions limits, and had the worst margin of:

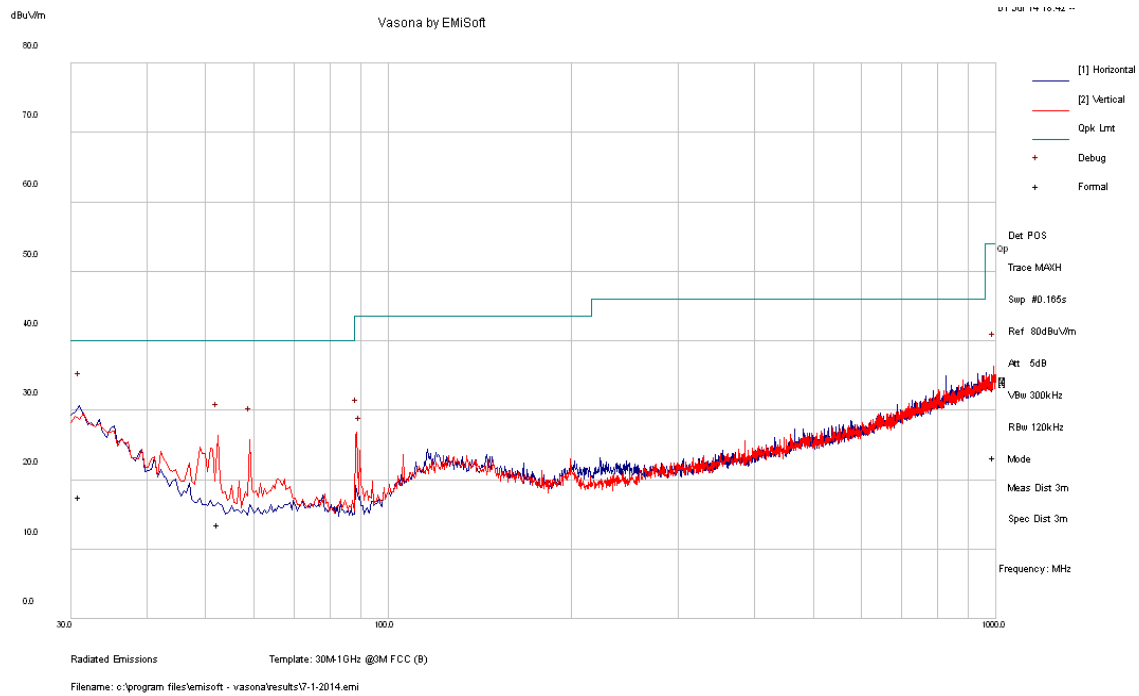
Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Channel
-9.026	2483.5	Horizontal	High Channel

Please refer to the following table for specific test result details

8.8 Radiated Emissions Test Data and Plots

1) Below 1 GHz Test

Low Channel: 2402 MHz



Frequency (MHz)	Corrected Amplitude (dBuV)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
31.013	17.62	276	H	242	40	-22.38	QP
52.38975	13.49	115	V	122	40	-26.51	QP
990.5488	23.18	140	V	90	54	-30.82	QP



## 2) Above 1 GHz Test

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel 2402 MHz											
2402	61.98	80	100	V	28.707	2.94	-	93.627	-	-	Peak
2402	64.47	57	100	H	28.707	2.94	-	96.117	-	-	Peak
2402	46.68	80	100	V	28.707	2.94	-	78.327	-	-	Ave
2402	47.1	57	100	H	28.707	2.94	-	78.747	-	-	Ave
2354	26.6	80	100	V	28.707	2.87	-	58.177	74	-15.823	Peak
2354	28.7	57	100	H	28.707	2.87	-	60.277	74	-13.723	Peak
2354	12.55	80	100	V	28.707	2.87	-	44.127	54	-9.873	Ave
2354	12.59	57	100	H	28.707	2.87	-	44.167	54	-9.833	Ave
4804	45.78	0	100	V	32.752	4.06	36.5	46.092	74	-27.908	Peak
4804	45.1	0	100	H	32.752	4.06	36.5	45.412	74	-28.588	Peak
4804	41.59	0	100	V	32.752	4.06	36.5	41.902	54	-12.098	Ave
4804	40.36	0	100	H	32.752	4.06	36.5	40.672	54	-13.328	Ave
7206	37.56	0	100	V	36.463	4.93	36.7	42.253	73.627	-31.374	Peak
7206	36.06	0	100	H	36.463	4.93	36.7	40.753	76.117	-35.364	Peak
7206	29.48	0	100	V	36.463	4.93	36.7	34.173	58.327	-24.154	Ave
7206	23.97	0	100	H	36.463	4.93	36.7	28.663	58.747	-30.084	Ave
9608	33.44	0	100	V	37.248	5.82	36.9	39.608	73.627	-34.019	Peak
9608	32.75	0	100	H	37.248	5.82	36.9	38.918	76.117	-37.199	Peak
9608	19.24	0	100	V	37.248	5.82	36.9	25.408	58.327	-32.919	Ave
9608	19.26	0	100	H	37.248	5.82	36.9	25.428	58.747	-33.319	Ave
Middle Channel 2442 MHz											
2442	64.04	81	100	V	28.707	2.94	-	95.687	-	-	Peak
2442	65.15	55	100	H	28.707	2.94	-	96.797	-	-	Peak
2442	48.34	81	100	V	28.707	2.94	-	79.987	-	-	Ave
2442	49.28	55	100	H	28.707	2.94	-	80.927	-	-	Ave
4884	43.41	0	100	V	32.752	4.06	36.5	43.722	74	-30.278	Peak
4884	42.5	0	100	H	32.752	4.06	36.5	42.812	74	-31.188	Peak
4884	38.69	0	100	V	32.752	4.06	36.5	39.002	54	-14.998	Ave
4884	36.93	0	100	H	32.752	4.06	36.5	37.242	54	-16.758	Ave
7326	36.24	0	100	V	36.463	4.93	36.7	40.933	74	-33.067	Peak
7326	34.55	0	100	H	36.463	4.93	36.7	39.243	74	-34.757	Peak
7326	29.84	0	100	V	36.463	4.93	36.7	34.533	54	-19.467	Ave
7326	25.57	0	100	H	36.463	4.93	36.7	30.263	54	-23.737	Ave
9768	33.35	0	100	V	37.248	5.82	36.9	39.518	75.687	-36.169	Peak
9768	32.22	0	100	H	37.248	5.82	36.9	38.388	76.797	-38.409	Peak
9768	18.4	0	100	V	37.248	5.82	36.9	24.568	59.987	-35.419	Ave
9768	18.45	0	100	H	37.248	5.82	36.9	24.618	60.927	-36.309	Ave

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
High Channel 2480 MHz											
2480	63.82	78	100	V	28.707	2.94	-	95.467	-	-	Peak
2480	66.3	55	100	H	28.707	2.94	-	97.947	-	-	Peak
2480	47.88	78	100	V	28.707	2.94	-	79.527	-	-	Ave
2480	50.32	55	100	H	28.707	2.94	-	81.967	-	-	Ave
2483.5	28.12	78	100	V	28.944	2.94	-	60.004	74	-13.996	Peak
2483.5	30.24	55	100	H	28.944	2.94	-	62.124	74	-11.876	Peak
2483.5	12.94	78	100	V	28.944	2.94	-	44.824	54	-9.176	Ave
2483.5	13.09	55	100	H	28.944	2.94	-	44.974	54	-9.026	Ave
4960	46.52	0	100	V	32.752	4.06	36.5	46.832	74	-27.168	Peak
4960	40.67	0	100	H	32.752	4.06	36.5	40.982	74	-33.018	Peak
4960	42.64	0	100	V	32.752	4.06	36.5	42.952	54	-11.048	Ave
4960	35.2	0	100	H	32.752	4.06	36.5	35.512	54	-18.488	Ave
7440	37.17	0	100	V	36.463	4.93	36.7	41.863	74	-32.137	Peak
7440	35.3	0	100	H	36.463	4.93	36.7	39.993	74	-34.007	Peak
7440	31.67	0	100	V	36.463	4.93	36.7	36.363	54	-17.637	Ave
7440	27.03	0	100	H	36.463	4.93	36.7	31.723	54	-22.277	Ave
9920	31.85	0	100	V	37.248	5.82	36.9	38.018	75.467	-37.449	Peak
9920	30.89	0	100	H	37.248	5.82	36.9	37.058	77.947	-40.889	Peak
9920	17.11	0	100	V	37.248	5.82	36.9	23.278	59.527	-36.249	Ave
9920	17.08	0	100	H	37.248	5.82	36.9	23.248	61.967	-38.719	Ave

## 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. Record the frequency difference as the emissions bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

### 9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2013-11-07	1 year

**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

Temperature:	23 °C
Relative Humidity:	42 %
ATM Pressure:	102 kPa

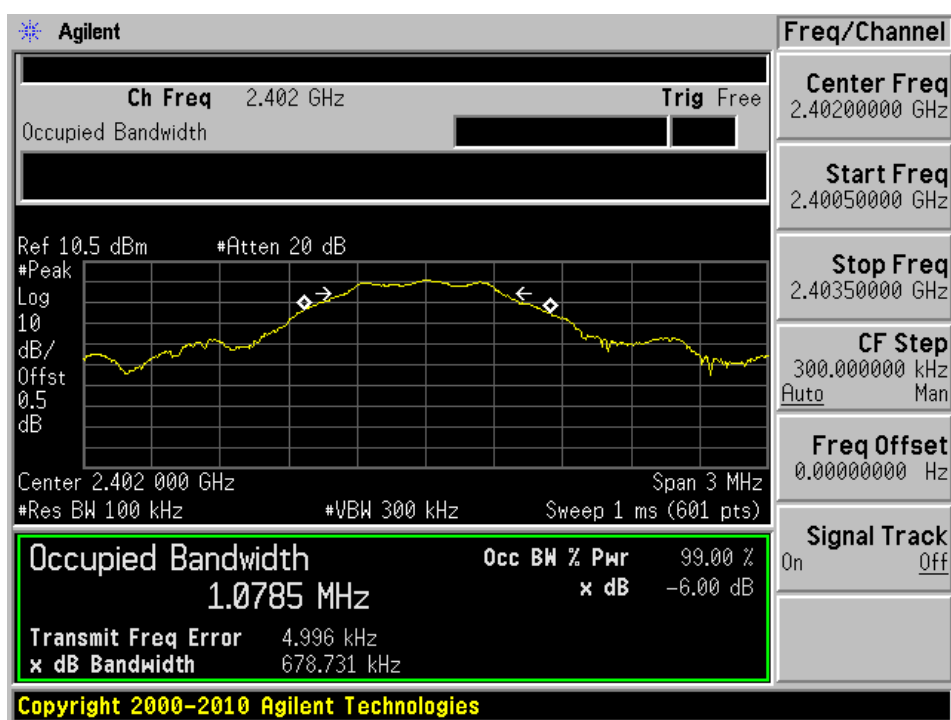
The testing was performed by CIPHER Chu on 2014-06-30 at RF site.

## 9.5 Test Results

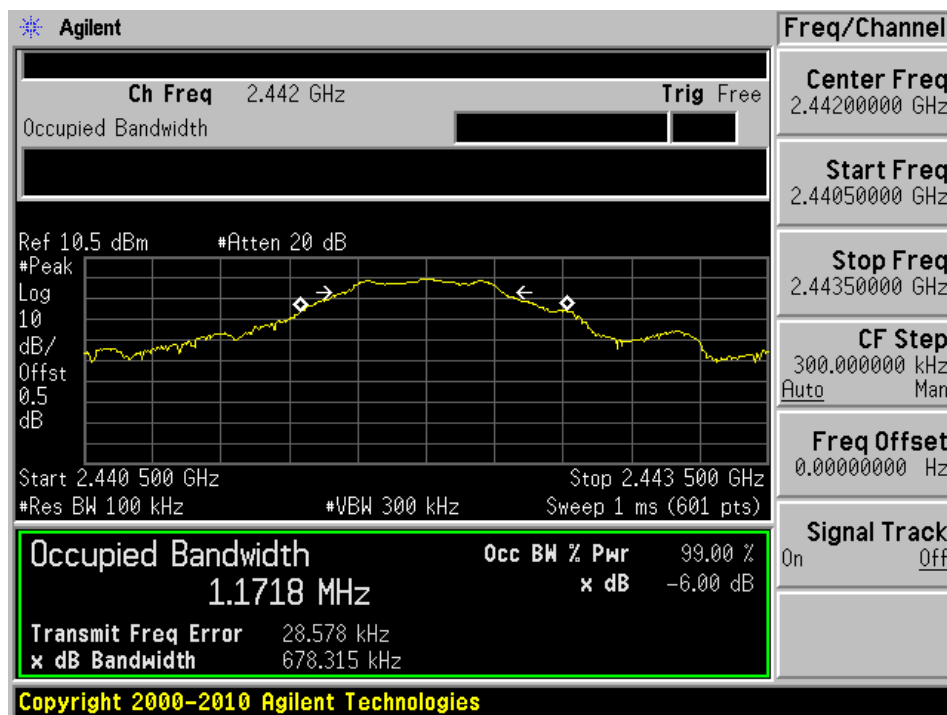
Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	99% Emission Bandwidth (MHz)	Limit (MHz)	Results
Low	2402	0.678	1.0785	> 0.5	Compliant
Middle	2442	0.678	1.1718	> 0.5	Compliant
High	2480	0.672	1.2270	> 0.5	Compliant

Please refer to the following plots for detailed test results

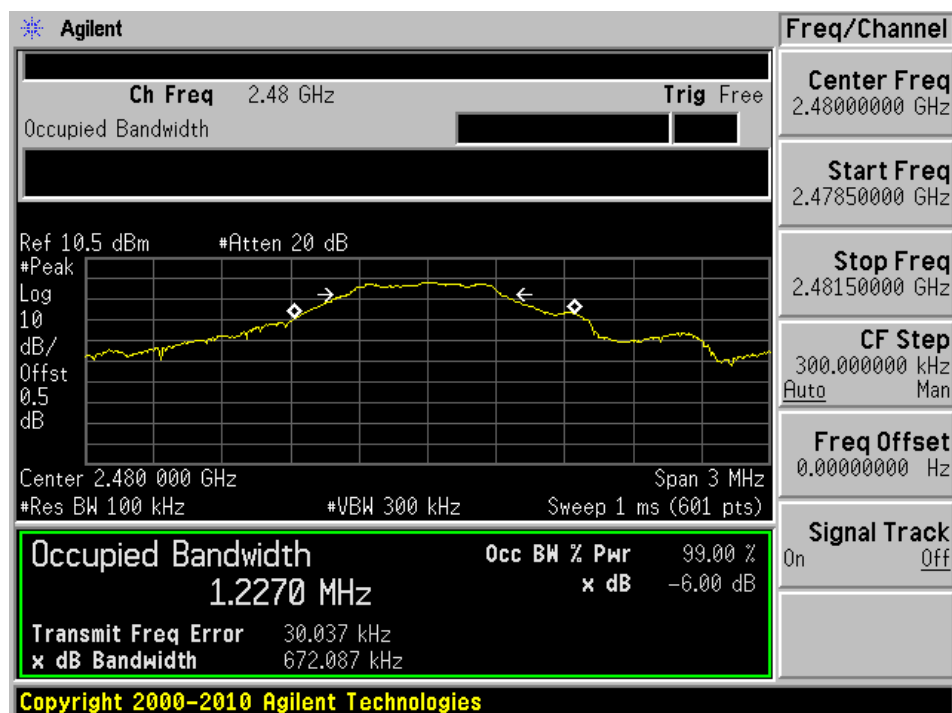
Low channel: 2402 MHz



Middle channel: 2442 MHz



High channel: 2480 MHz



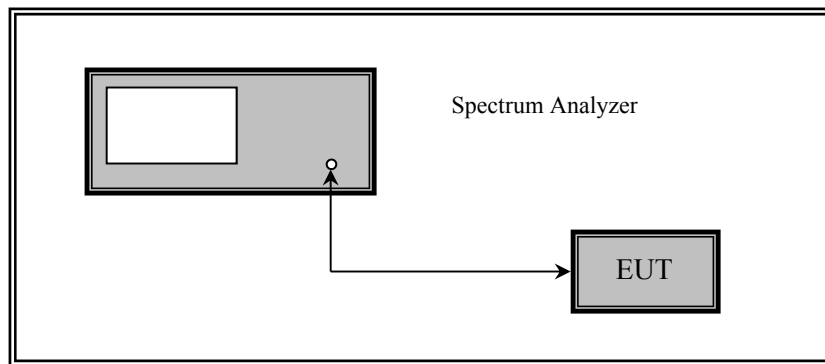
## 10 FCC §15.247(b) & IC RSS-210 §A8.4 – Peak Output Power Measurement

### 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	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2013-11-07	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

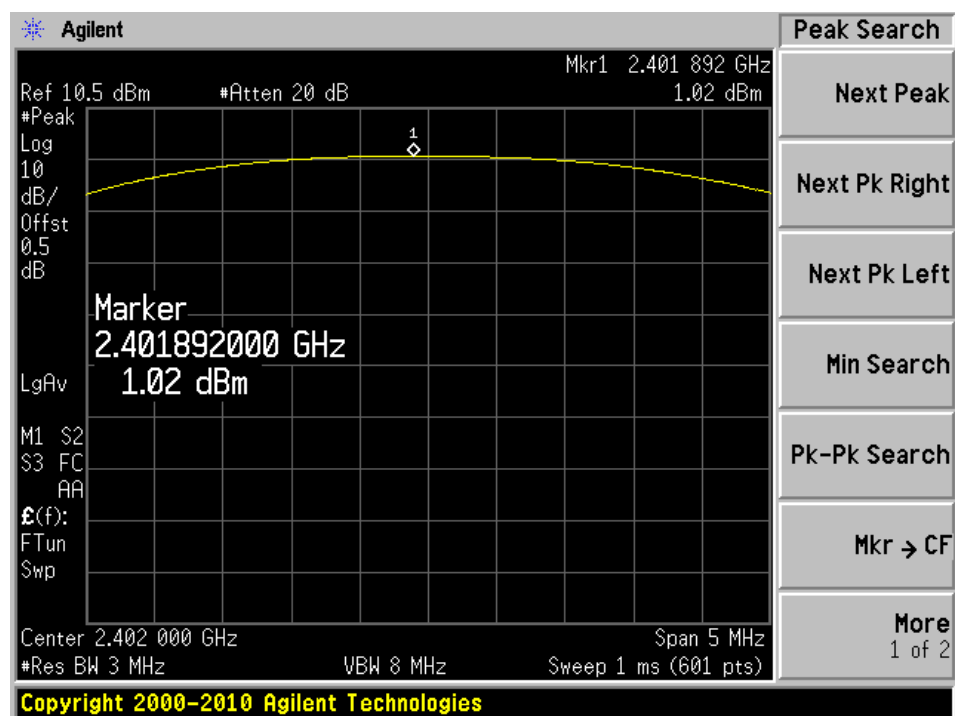
Temperature:	23 °C
Relative Humidity:	42 %
ATM Pressure:	102 kPa

The testing was performed by CIPHER Chu on 2014-06-30 at RF site.

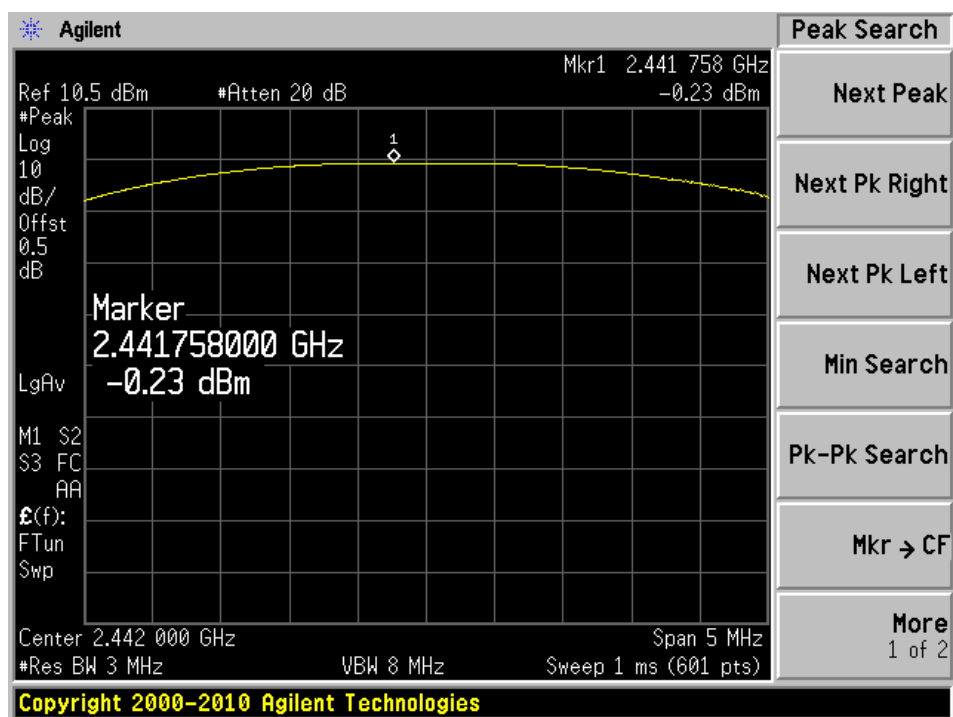
## 10.5 Test Results

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Limit (dBm)
Low	2402	1.02	30
Middle	2442	-0.23	30
High	2480	-1.41	30

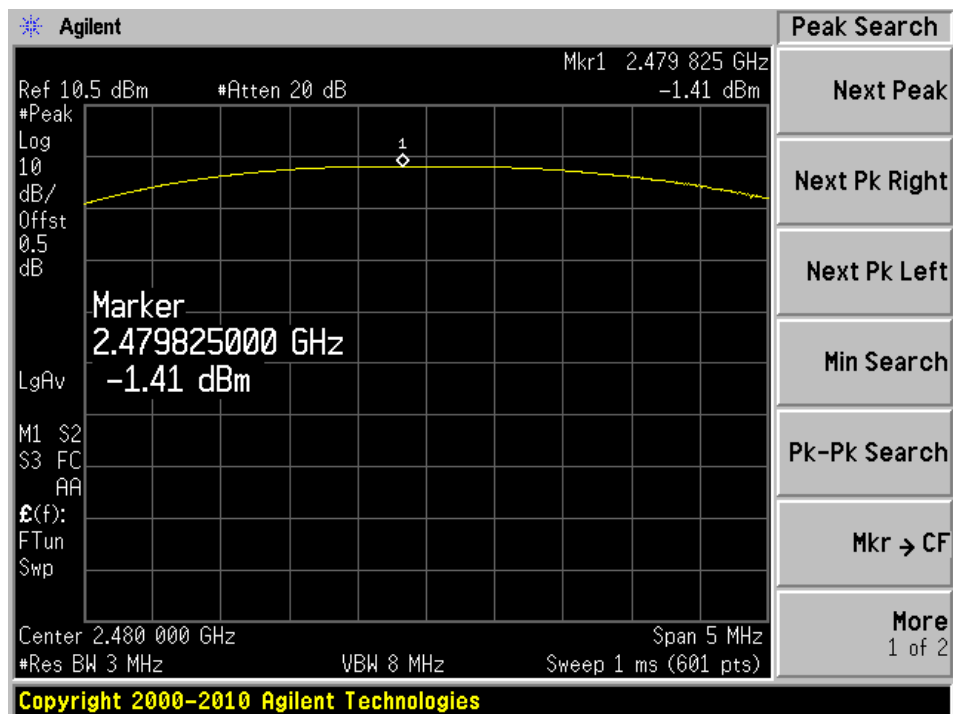
Low channel: 2402 MHz



Middle channel: 2442 MHz



High channel: 2480 MHz





## 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	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2013-11-07	1 year

**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

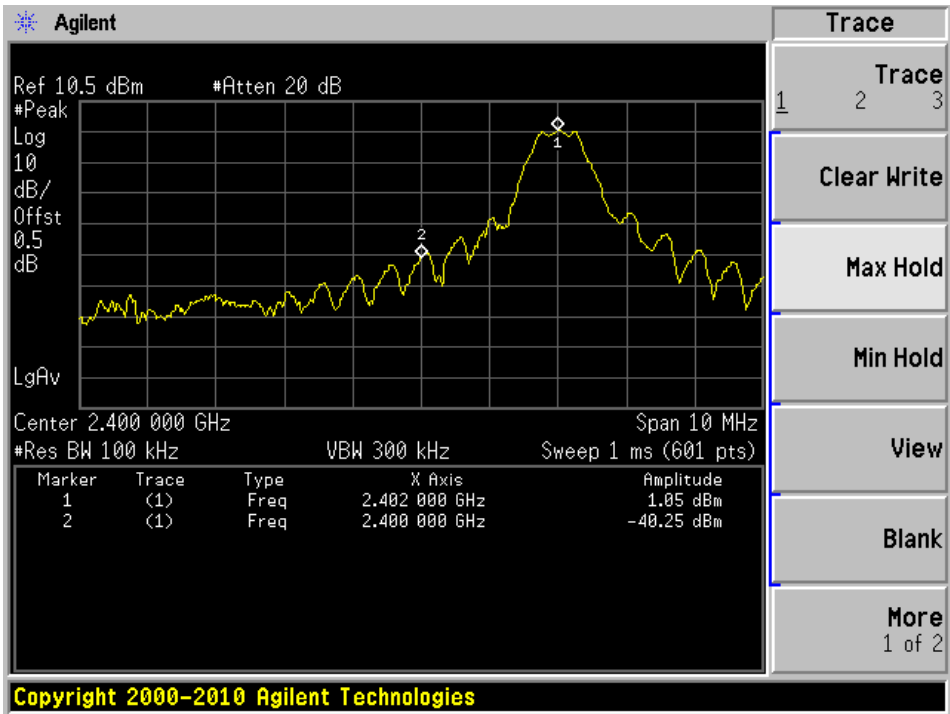
Temperature:	23 °C
Relative Humidity:	42 %
ATM Pressure:	102 kPa

The testing was performed by Cipher Chu on 2014-06-30 at RF site.

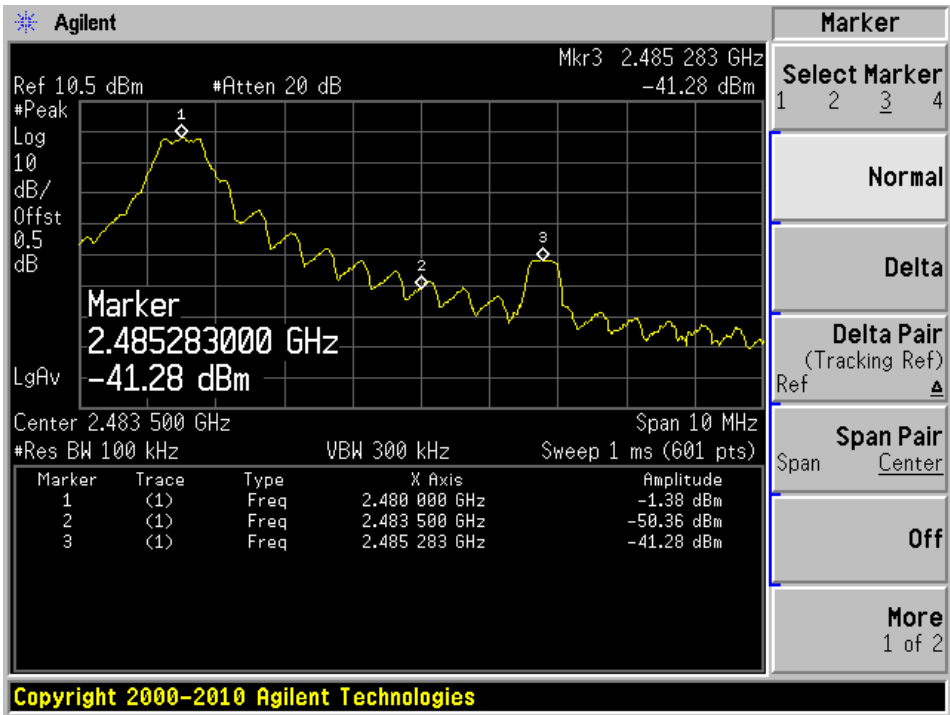
11.5 Test Results

Please refer to following pages for plots of band edge.

Low Band Edge



High 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. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW  $\geq 3$  kHz.
4. Set the VBW  $\geq 3 \times$  RBW.
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 amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 12.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2013-11-07	1 year

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

### 12.4 Test Environmental Conditions

Temperature:	23 °C
Relative Humidity:	42 %
ATM Pressure:	102 kPa

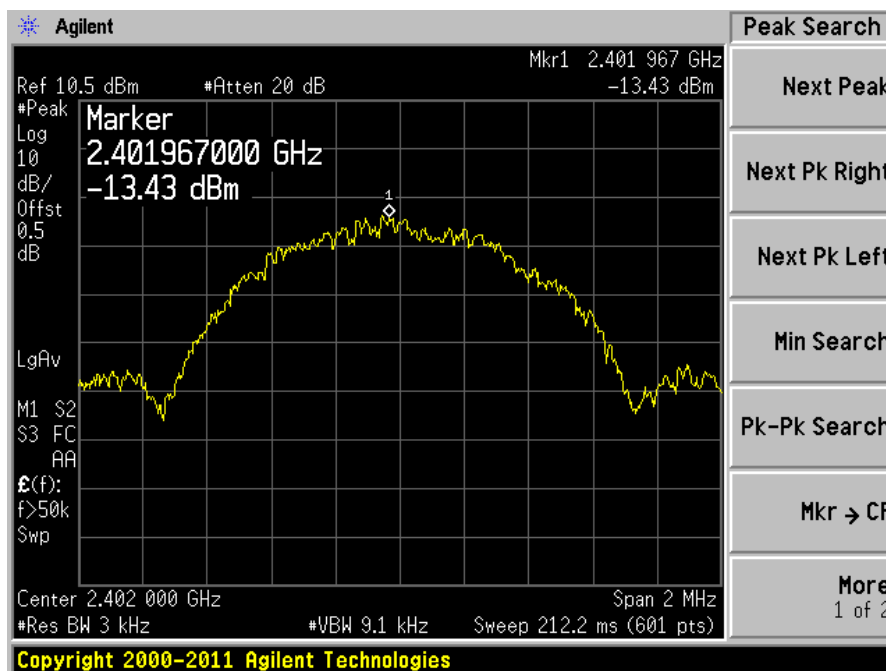
*The testing was performed by Cipher Chu on 2014-06-30 at RF site.*

## 12.5 Test Results

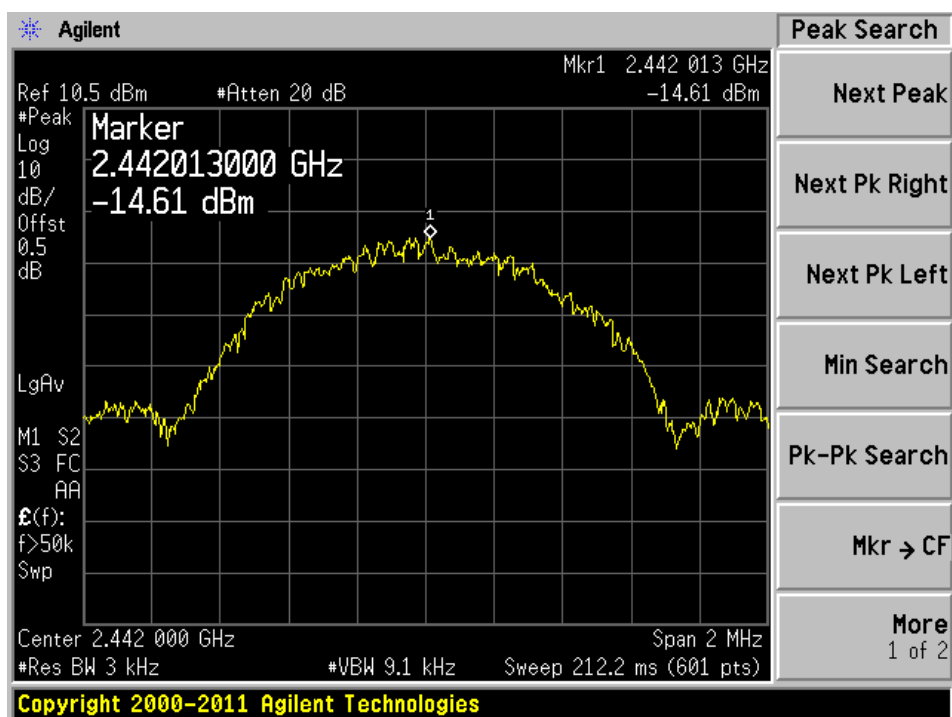
Channel	Frequency (MHz)	Power Spectrum Density (dBm)	Limit (dBm)
Low	2402	-13.43	8
Middle	2442	-14.61	8
High	2480	-14.91	8

Please refer to the following plots for detailed test results:

Low channel: 2402 MHz



Middle channel: 2442 MHz



High channel: 2480 MHz

