Lab Code: 200167-0

# FCC PART 15 SUBPART C
# IC RSS-GEN, ISSUE 3, DEC 2010
# TEST AND MEASUREMENT REPORT

For

## Sensys Networks, Inc

2560 Ninth Street, Suite 219 & 217,

Berkeley, CA 94710, USA

**FCC ID: Y8XVSN240M**
**IC: 9498A-VSN240M**

| **Report Type:** | **Product Type:** |
|---|---|
| Original Report | Zigbee Transmitter Sensor with MicroRadar 6.3 GHz Function |

| | |
|---|---|
| **Test Engineer:** | Lionel Lara |
| **Report Number:** | R1201242-209 |
| **Report Date:** | 2012-03-15 |
| **Reviewed By:** | Victor Zhang<br>RF/EMC Lead |
| **Prepared By: (84)** | Bay Area Compliance Laboratories Corp.<br>1274 Anvilwood Avenue,<br>Sunnyvale, CA 94089, USA<br>Tel: (408) 732-9162<br>Fax: (408) 732 9164 |

# TABLE OF CONTENTS

## DOCUMENT REVISION HISTORY

| Revision Number | Report Number | Description of Revision | Date of Revision |
|---|---|---|---|
| 0 | R1201242-209 | Original Report | 2012-03-15 |

# 1 General Information

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

This test and measurement report was prepared on behalf of *Sensys Networks* and their product, *model: VSN240-M, FCC ID: Y8XVSN240M, IC: 9498A-VSN240M* or the "EUT" as referred to this report. The EUT is a battery powered 2.4 GHz Zigbee transmitter sensor with uRadar 6.3 GHz function for traffic use.

## 1.2 Mechanical Description of EUT

The EUT measures approximately 70 mm **(L)** x 70 mm **(W)** x 60 mm **(H)** and weighs approximately 240 g.

*The data gathered are from a typical production sample provided by the manufacturer with serial number: 18FDD.*

## 1.3 Objective

This report is prepared on behalf of *Sensys Networks* in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commissions rules and IC RSS-Gen Issue 3, Dec 2010.

## 1.4 Related Submittal(s)/Grant(s)

None.

## 1.5 Test Methodology

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

## 1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

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

## 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.: R-3729, C-4176, G-469, and T-1206. 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 a National Institute of Standards and Technology (NIST) accredited laboratory under the National Voluntary Laboratory Accredited Program (Lab Code 200167-0). The current scope of accreditations can be found at http://ts.nist.gov/Standards/scopes/2001670.htm

# 2 System Test Configuration

## 2.1 Justification

The system was configured for testing in accordance with ANSI C63.4-2003.

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

## 2.2 EUT Exercise Software

The EUT exercise program, provided by the client, was used during radiated testing was designed to exercise the system components.

## 2.3 Special Accessories

N/A.

## 2.4 Equipment Modifications

No modifications were made to the EUT.

## 2.5 Local Support Equipment

| Manufacturer | Description | Model No. | Serial No. |
|---|---|---|---|
| Lenovo | Laptop | Thinkpad SL510 | LR-NKDPN |
| Sensys Networks | Access Point | AP240-E | 200852 |

## 2.6 Interface Ports and Cabling

| Cable Description | Length (m) | From | To |
|---|---|---|---|
| RF Cable | < 1 | EUT | Spectrum Analyzer |

## 2.7 Internal Parts List and Details

| Manufacturers | Descriptions | Models | Serial Numbers |
|---|---|---|---|
| Sensys Networks | PCB Board | MicroRadar | FXR45145 Rev. 1.9 |

# 3 Summary of Test Results

| FCC & IC Rules | Description of Test | Result |
|---|---|---|
| FCC §15.203<br>IC RSS-Gen §7.1.2 | Antenna Requirement | Compliant |
| FCC §15.207 (a)<br>IC RSS-Gen §7.2.4 | AC Line Conducted Emissions | N/A[1] |
| FCC §15.209<br>IC RSS-Gen §7.2.5 | Spurious Radiated Emissions | Compliant |
| IC RSS-Gen §4.6.1 | Occupied Bandwidth | Compliant |

Note 1: EUT is battery powered.

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

## 4.1 Applicable Standard

For intentional device, according to FCC Part §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used.

Per IC RSS-Gen §7.1.2, A transmitter can only be sold or operated with antennas with which it was certified. A transmitter maybe 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 IC RSS-210 or RSS-310 for devices of RF output powers of 10 milliwatts or less. For devices of output powers greater than 10 milliwatts, except devices subject to IC RSS-210 Annex 8 or RSS-210 Annex 9, the total antenna gain shall be added to the measured RF output power before using the specified power limits. For devices subject to IC RSS-210 Annex 8 or Annex 9, the antenna gain shall not be added.

## 4.2 Result

The EUT has maximum gain of 0 dBi antenna, which in accordance to sections FCC Part 15.203 and IC RSS-Gen §7.1.2, is considered sufficient to comply with the provisions of these sections. Please refer to the EUT photos.

# 5 FCC §15.209 & IC RSS-Gen §7.2.5 – Spurious Radiated Emissions

## 5.1 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 Note 1 | 3 |
| 88 - 216 | 150 Note 1 | 3 |
| 216 - 960 | 200 Note 1 | 3 |
| Above 960 | 500 | 3 |

Note 1: 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 | | |

## 5.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.4-2003. The specification used was the FCC 15C and IC RSS-Gen 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.

## 5.3 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

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

CA = Ai + AF + CL + Atten – Ga

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

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

Margin = Corrected Amplitude - Limit

## 5.5 Test Equipment List and Details

| Manufacturer | Description | Model No. | Serial No. | Calibration Date |
|---|---|---|---|---|
| A.H Systems | Antenna, Horn | SAS-200/571 | 261 | 2012-01-18 |
| Hewlett Packard | Pre-amplifier | 8447D | 2944A06639 | 2011-06-09 |
| Sunol Science Corp | Combination Antenna | JB3 | A020106-2 | 2011-08-10 |
| Rohde & Schwarz | EMI Test Receiver | ESCI 1166.5950K03 | 100337 | 2011-03-21 |
| Sunol Science Corp | System Controller | SC99V | 122303-1 | N/R |
| Agilent | PSA Series Spectrum Analyzer | E4446A | US44300386 | 2011-08-11 |
| Mini-Circuits | Pre-amplifier | ZVA-183-S | 667400960 | 2011-05-08 |
| Wisewave | Antenna, Horn | ARH-4223-02 | 10555-01 | 2010-06-14 Note 1 |
| Wisewave | Pre Amplifier | ALN-22093530-01 | 12263-01 | 2011-06-09 |
| Wisewave | Antenna, Horn | ARH-2823-02 | 1055-01 | 2010-06-14 Note 1 |
| Wisewave | Pre-amplifier | ALN-33144030-01 | 11424-01 | 2011-03-30 |

Note 1: Based on a two year calibration cycle.

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

## 5.6 Test Environmental Conditions

| | |
|---|---|
| **Temperature:** | 20-22 °C |
| **Relative Humidity:** | 30-34 % |
| **ATM Pressure:** | 101.5kPa |

*The testing was performed by Lionel Lara on 2012-02-24 in 5 meter chamber #3.*

## 5.7 Summary of Test Results

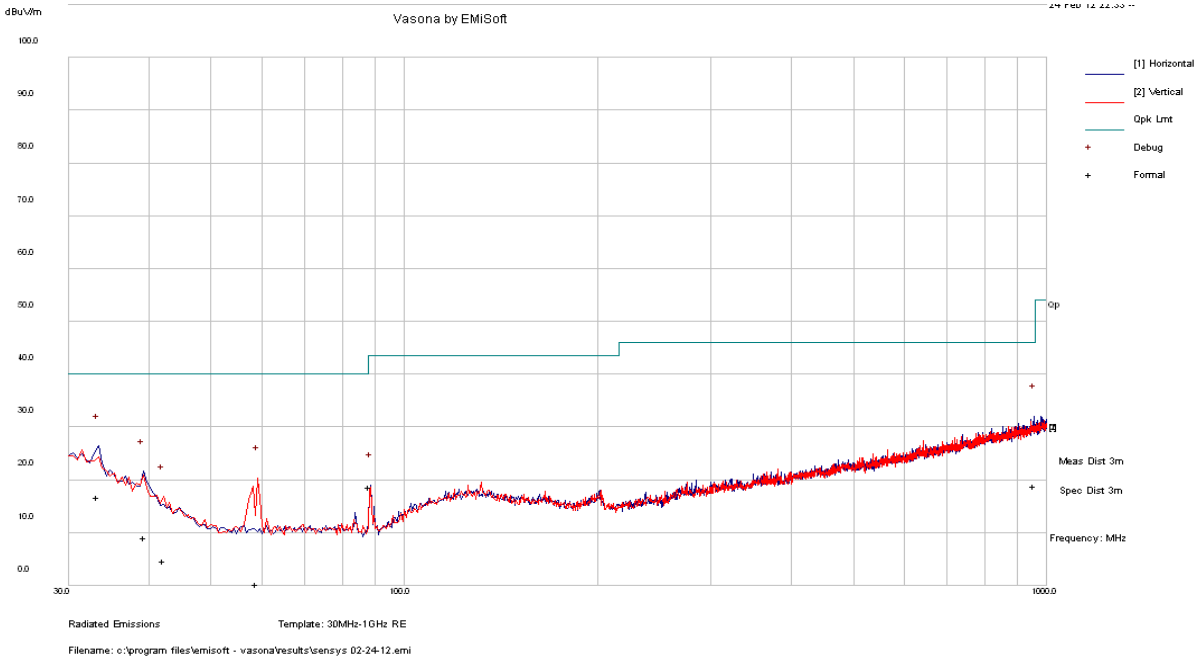
According to the data hereinafter, the EUT complied with the FCC Part 15C and IC RSS-Gen standard's radiated emissions limits, and had the worst case margin reading of:

30-1000 MHz:

| **Mode: Transmitting** | | | |
|---|---|---|---|
| **Margin (dB)** | **Frequency (MHz)** | **Polarization (Horizontal/Vertical)** | **Range** |
| -23.26 | 33.291 | Horizontal | 30 MHz – 1GHz |

## 5.8 Radiated Emissions Test Data & Plots

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




Quasi-Peak Measurement:

| Frequency (MHz) | Corrected Amplitude (dB) | Antenna Height (cm) | Antenna Polarity (H/V) | Turntable Azimuth (degrees) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| 33.291 | 16.74 | 170 | H | 347 | 40.0 | -23.26 |
| 88.504 | 18.69 | 179 | H | 5 | 43.5 | -24.81 |
| 955.431 | 18.81 | 219 | H | 198 | 46.0 | -27.19 |
| 39.429 | 9.12 | 238 | H | 177 | 40.0 | -30.88 |
| 42.254 | 4.62 | 104 | V | 195 | 40.0 | -35.38 |
| 59.017 | 0.27 | 199 | V | 321 | 40.0 | -39.73 |

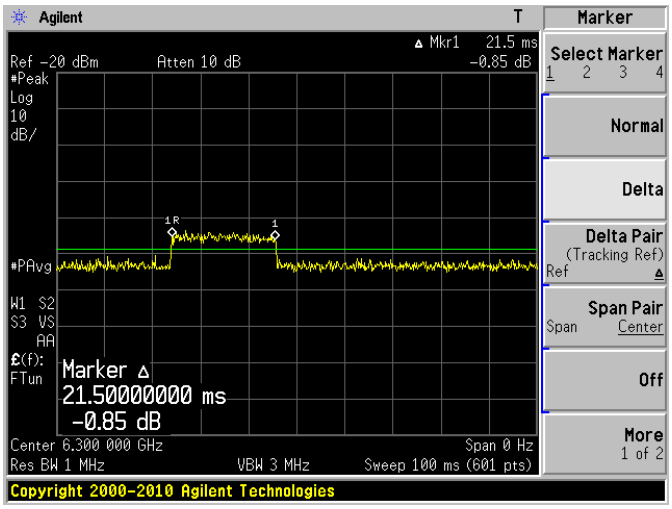
**2) 1 – 18 GHz, Radiated Spurious Emissions Measured at 3 meters**

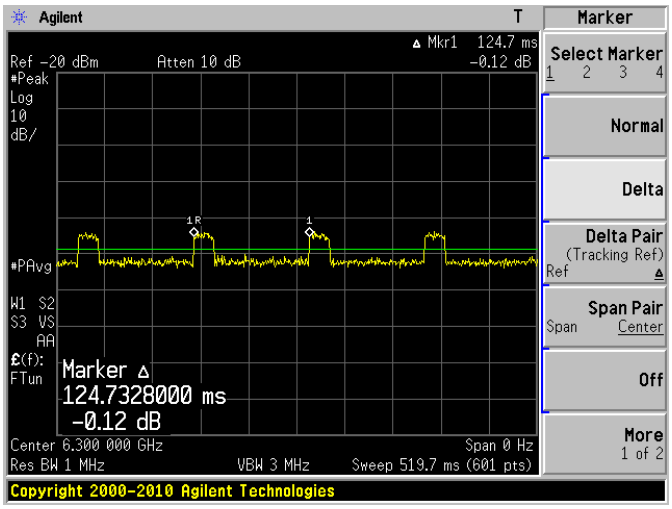
According to FCC 15.35 (c), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

Based on the pulse train of the transmitter (Plots below), it exceed 1ms, therefore C63.10 C.1 need to be used for this case as RBW < PRF. Therefore the Average reading will be 20 Log (τ/T) lower then the peak reading. So the correction factor will be:

20log (21.5/124.7) = -15.3 dB

The Peak reading from the Spectrum Analyzer is 37.94 dBuV/m based on 3 meter distance; therefore the average reading will be 37.94-15.3 = 22.64 dBuV/m.




| Frequency (MHz) | Raw Reading after PDCF Correction (dBµV) | Turntable Azimuth (degrees) | Test Antenna | | | Cable Loss (dB) | Pre-Amp. (dB) | Correction Reading (dBµV/m) | FCC & IC | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Height (cm) | Polarity (H/V) | Factor (dB/m) | | | | Limit (dBµV/m) | Margin (dB) | |
| 6300 | 22.64 | 0 | 131 | V | 35.01 | 5.21 | 27.18 | 35.68 | 54 | -18.32 | Fundamental |
| - Note 1 | - | - | - | - | - | - | - | - | - | - | - |

Note 1: All other spurious emissions were at the noise floor level.

### 3) 18-26 GHz, Radiated Spurious Emissions Measured at 3 meters

| 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) | |
| - Note 1 | - | - | - | - | - | - | - | - | - | - | - |

### 4) 26-40 GHz, Radiated Spurious Emissions Measured at 1 meter

| 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) | |
| - Note 1 | - | - | - | - | - | - | - | - | - | - | - |

Note 1: All spurious emissions were at the noise floor level.

# 6 IC RSS-Gen §4.6.1 - Occupied Bandwidth

## 6.1 Applicable Standard

According to IC RSS-Gen §4.6.1, when an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

## 6.2 Measurement Procedure

The transmitter shall be operated at its maximum carrier power measured under normal test conditions. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.

## 6.3 Test Equipment List and Details

| Manufacturer | Description | Model | Serial Number | Calibration Date |
|---|---|---|---|---|
| Agilent | Spectrum Analyzer | E4446A | US44300386 | 2011-08-11 |

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

## 6.4 Test Environmental Conditions

| | |
|---|---|
| **Temperature:** | 20-22 °C |
| **Relative Humidity:** | 30-34 % |
| **ATM Pressure:** | 101.5kPa |

*The testing was performed by Lionel Lara on 2012-02-24 at 5 meter chamber #3.*

## 6.5 Test Results

Please refer to the following plots.

Occupied Bandwidth