



# L.S. Compliance, Inc.

W66 N220 Commerce Court  
Cedarburg, WI 53012  
262-375-4400 Fax: 262-375-4248

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## COMPLIANCE TESTING OF:

**'ENC-900' 1 Watt Radio Module**

## Prepared For:

**Encom Wireless Data Solutions, Incorporated**

**Attention: Mr. Mike Kwan**

**#7, 640-42 Avenue, NE**

**Calgary, Alberta T2E 7J9**

**Canada**

## Test Report Number:

**304238-TX1000 TCB R2**

## Test Dates:

**August 31<sup>ST</sup> through November 28<sup>TH</sup>, 2004**

*All results of this report relate only to the items that were tested. This report is not to be reproduced, except in full, without written approval of L. S. Compliance, Inc.*

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## **1. L. S. Compliance In Review**

### **L.S. Compliance - Accreditations and Listing's**

**As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:**

#### **A2LA – American Association for Laboratory Accreditation**

Accreditation based on ISO/IEC 17025 : 1999  
with Electrical (EMC) Scope of Accreditation  
A2LA Certificate Number: 1255.01

#### **Federal Communications Commission (FCC) – USA**

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948  
FCC Registration Number: 90756

Listing of 3 and 10 meter OATS based on Title 47CFR – Part 2.948  
FCC Registration Number: 90757

#### **Industry Canada**

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1  
File Number: IC 3088-A

On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1  
File Number: IC 3088

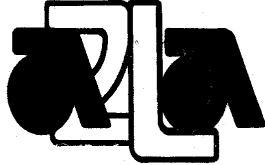
#### **U. S. Conformity Assessment Body (CAB) Validation**

Validated by the European Commission as a U. S. Competent Body operating under the U. S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 89/336/EEC, Article 10.2.  
Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.

Date of Validation: November 20, 2002  
Notified Body Identification Number: 1243

## 2. A2LA Certificate of Accreditation



**THE AMERICAN  
ASSOCIATION  
FOR LABORATORY  
ACCREDITATION**

### **ACCREDITED LABORATORY**

A2LA has accredited

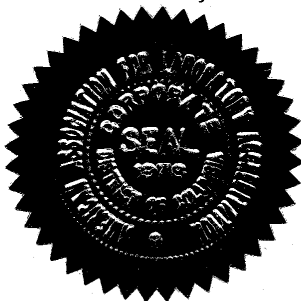
**L.S. COMPLIANCE, INC.**  
**Cedarburg, WI**

for technical competence in the field of

### **Electrical Testing**

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC 17025 - 1999 "General Requirements for the Competence of Testing and Calibration Laboratories" and any additional program requirements in the identified field of testing. Testing and calibration laboratories that comply with this International Standard also operate in accordance with ISO 9001 or ISO 9002 (1994).

Presented this 26<sup>th</sup> day of March 2003.



*Peter Albry*

President  
For the Accreditation Council  
Certificate Number 1255.01  
Valid to January 31, 2005

For tests or types of tests to which this accreditation applies,  
please refer to the laboratory's Electrical Scope of Accreditation.

### 3. A2LA Scope of Accreditation



## American Association for Laboratory Accreditation

### SCOPE OF ACCREDITATION TO ISO/IEC 17025-1999

L.S. COMPLIANCE, INC.  
W66 N220 Commerce Court  
Cedarburg, WI 53012  
James Blaha Phone: 262 375 4400

#### ELECTRICAL (EMC)

Valid to: January 31, 2005

Certificate Number: 1255-01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests:

#### Test

Emissions

#### Test Method(s)

Conducted

Continuous/Discontinuous

Code of Federal Regulations (CFR) 47,  
FCC Method Parts 15, 18 using ANSI C63.4;  
EN: 55011, 55022, 50081-1, 50081-2;  
CISPR: 11, 12, 14-1, 22;  
CNS 13438

Radiated

Code of Federal Regulations (CFR) 47,  
FCC Method Parts 15, 18 using ANSI C63.4;  
EN: 55011, 55022, 50081-1, 50081-2;  
CISPR: 11, 12, 14-1, 22;  
CNS 13438

Current Harmonics

IEC 61000-3-2; EN 61000-3-2

Voltage Fluctuations & Flicker

IEC 61000-3-3; EN 61000-3-3

Immunity

EN: 50082-1, 50082-2  
EN 61000-6-2  
CISPR: 14-2, 24

Conducted Immunity

Fast Transients/Burst

IEC 61000-4-4;  
EN 61000-4-4

Surge

IEC: 61000-4-5; ENV 50142;  
EN 61000-4-5

RF Fields

IEC: 61000-4-6; ENV 50141;  
EN 61000-4-6

Voltage Dips/Interruptions

IEC 61000-4-11;  
EN 61000-4-11




(A2LA Cert. No. 1255-01) 05/13/03

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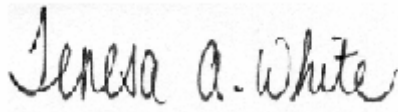
5301 Buckeystown Pike, Suite 350 • Frederick, MD 21704-8373 • Phone: 301-644 3248 • Fax: 301-662 2974



#### 4. Validation Letter – U.S. Competent Body for EMC Directive 89/336/EEC

|  |   |  |
|--|---|--|
| <br>1901-2001<br>NIST CENTENNIAL  | <br>DEPARTMENT OF COMMERCE<br>UNITED STATES OF AMERICA | <b>UNITED STATES DEPARTMENT OF COMMERCE</b><br><b>National Institute of Standards and Technology</b><br>Gaithersburg, Maryland 20899 |
| January 16, 2001   |   |  |
| Mr. James J. Blaha<br>L.S. Compliance Inc.<br>W66 N220 Commerce Court<br>Cedarburg, WI 53012-2636  |   |  |
| Dear Mr. Blaha:  |   |  |
| I am pleased to inform you that the European Commission has validated your organization's nomination as a U.S. Conformity Assessment Body (CAB) for the following checked (✓) sectoral annex(es) of the U.S.-EU Mutual Recognition Agreement (MRA).  |   |  |
| <input checked="" type="checkbox"/> Electromagnetic Compatibility-Council Directive 89/336/EEC, Article 10(2)  |   |  |
| <input type="checkbox"/> Telecommunication Equipment-Council Directive 98/13/EC, Annex III   |   |  |
| <input type="checkbox"/> Telecommunication Equipment-Council Directive 98/13/EC, Annex III and IV  |   |  |
| Identification Number:   |   |  |
| <input type="checkbox"/> Telecommunication Equipment-Council Directive 98/13/EC, Annex V   |   |  |
| Identification Number:   |   |  |
| This validation is only for the location noted in the address block, unless otherwise indicated below.   |   |  |
| <input checked="" type="checkbox"/> Only the facility noted in the address block above has been approved.  |   |  |
| <input type="checkbox"/> Additional EMC facilities:  |   |  |
| <input type="checkbox"/> Additional R&TTE facilities:  |   |  |
| Please note that an organization's validations for various sectors of the MRA are listed on our web site at <a href="http://ts.nist.gov/mra">http://ts.nist.gov/mra</a> . You may now participate in the conformity assessment activities for the operational period of the MRA as described in the relevant sectoral annex or annexes of the U.S.-EU MRA document.  |   |  |
| NIST will continue to work with you throughout the operational period. All CABs validated for the operational phase of the Agreement must sign and return the enclosed CAB declaration form, which states that each CAB is responsible for notifying NIST of any relevant changes such as accreditation status, liability insurance, and key staff involved with projects under the MRA. Please be sure that you fully understand the terms under which you are obligated to operate as a condition of designation as a CAB. As a designating authority, NIST is responsible for monitoring CAB performance to ensure continued competence under the terms of the MRA. |   |  |
|   |   |  |

5. Signature Page



Prepared By:

Teresa A. White, Document Coordinator

February 18, 2005

Date

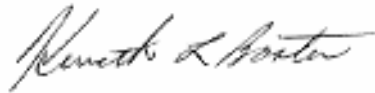


Tested By:

Abtin Spantman, EMC Engineer

February 18, 2005

Date



Approved By:

Kenneth L. Boston, EMC Lab Manager  
PE #31926 Licensed Professional Engineer  
Registered in the State of Wisconsin, United States

February 18, 2005

Date

## 6. Product and General Information

|                   |  |   |                |  |            |
|-------------------|--|---|----------------|--|------------|
| Manufacturer:     | Encom Wireless Data Solutions, Inc.                              |   |                |  |            |
| Date(s) of Test:  | August 31 <sup>ST</sup> through November 28 <sup>TH</sup> , 2004 |   |                |  |            |
| Test Engineer(s): | Tom Smith  | √ | Abtin Spantman |  | Ken Boston |
| Model #:          | 'ENC-900' 1000 mW Radio Module                                   |   |                |  |            |
| Serial #:         | Engineering Unit #43   |   |                |  |            |
| Voltage:          | 3.80 VDC, 1000 mA  |   |                |  |            |
| Operation Mode:   | Normal, continuous transmit, and 'Hopping' mode                  |   |                |  |            |

## 7. Introduction

Between August 31<sup>ST</sup> through November 28<sup>TH</sup>, 2004, a series of Conducted and Radiated RF Emission tests were performed on one sample of the Encom Wireless Data Solutions', Model Number: 'ENC-900 (1000 mW) Radio Module', Serial Number: 'Engineering Unit #43', here forth referred to as the "*Equipment Under Test*" or "*EUT*". These tests were performed using the procedures outlined in ANSI C63.4-2003 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.247 (Industry Canada RSS-210) for a transmitter or intentional radiator. These tests were performed by Abtin Spantman, EMC Engineer at L.S. Compliance, Incorporated.

All Radiated and Conducted Emission tests were performed upon the EUT to measure the emissions in the frequency bands described in Title 47 CFR, FCC Part 15, including 15.35, 15.209, 15.247 and Industry Canada RSS-210 to determine whether these emissions are below the limits expressed within the standards. These tests were performed in accordance with the procedures described in the 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 (ANSI C63.4-2003). Another document used as a reference for the EMI Receiver specification was the Comite International Special Des Perturbations Radioelectriques (CISPR) Number 16-1, 2003.

All tests were performed at L.S. Compliance, Inc., in Cedarburg, Wisconsin, unless otherwise noted.



## **8. Product Description**

The ENCOM 'ENC-900 (1000 mW) Radio Module' is a frequency hopping spread spectrum transceiver operating in the 902 MHz to 928 MHz ISM band. It transmits with a maximum of 1 Watt (+30 dBm) at the antenna port.

The receiver is a direct conversion receiver with no frequency offset for the local oscillator. Individual channel selection occurs within the receiver without the need for external filtering. A band-pass filter restricts the receiver to the stated ISM band.

The module uses an End-Launch MCX Jack on the RF antenna port, and standard 0.1" SIP headers for power, data, and control signal connections.

The users communicate with this module via an asynchronous RS-232 type interface through the SIP headers. The RS-232 interface is used for initial programming of the unit as well as data transfer during normal operation. All data that users send to the module is buffered in banks of SRAM memory, packetized with appropriate header information, and sent over the air at a fixed bit rate. The microcontroller inside the module precisely controls the bit-width, packet size, and hopping algorithm, to ensure that the RF occupied bandwidth and channel dwell-times remain constant.

Users need to provide 3.8 VDC, 1000 mA nominal power to the module. The microcontroller monitors the power supply voltage on a continuous basis. Should the voltage be outside the normal specified operating parameters the unit will refuse to transmit. The ENC-900 hops to a new frequency after a predetermined fixed time interval set by the user, ranging from 8 ms to 120 ms. The ENC-900 hops according to a pseudorandom pattern of 50 channels which are chosen from a pool of 127 available channels. Each radio is programmed with a seed value which determined the table based on a defined pseudorandom generator, and the dwell time is equal among channels.

## 9. Test Requirements

The above mentioned tests were performed in order to determine the compliance of the Encom Wireless Data Solutions', Model Number: 'ENC-900 (1000 mW) Radio Module' with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

|         |         |         |
|---------|---------|---------|
| 15.207  | 15.247b | 15.247g |
| 15.205  | 15.247c | 15.209  |
| 15.247a | 15.247d |         |

## 10. Summary of Test Report

### DECLARATION OF CONFORMITY

The Encom Wireless Data Solutions', Model Number: 'ENC-900 (1000 mW) Radio Module' was found to **MEET** the requirements as described within the specification of Title 47 CFR FCC, Part 15.247, and Industry Canada RSS-210, Section 6.2.2(0) for a Frequency Hopping Spread Spectrum Transmitter.

Some emissions are seen to be within 3 dB of their respective limits. As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

The enclosed test results pertain to the sample(s) of the test item listed, and only for the tests performed on the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein, and could therefore invalidate the findings of this report.

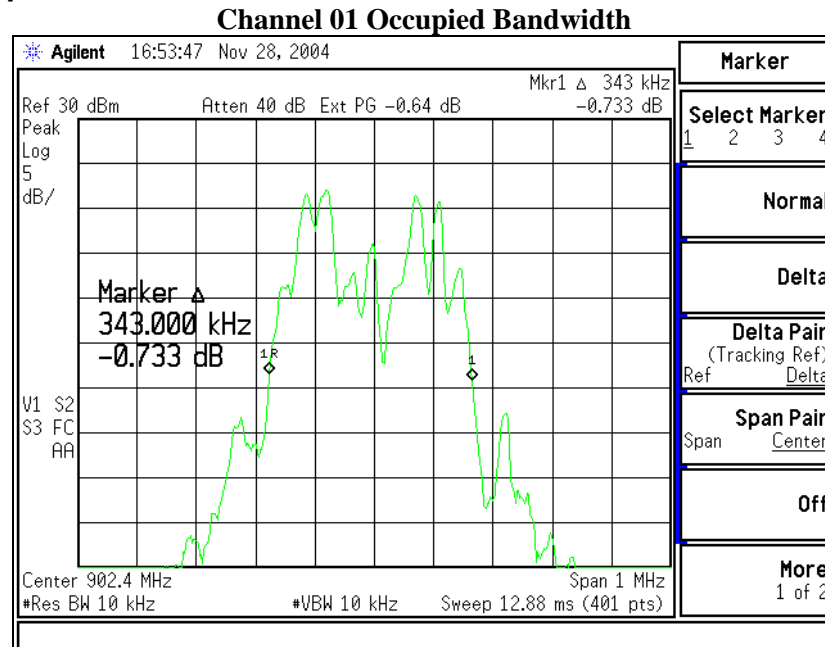
## 11. Conducted Emissions Test, Occupied Bandwidth

The 20 dB bandwidth requirement found in FCC Part 15.247(a)(1)(i) states a maximum allowed occupied bandwidth of 500 kHz. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4407B spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings (-0.64 dB Gain), there by allowing direct readings of the measurements made without the need for any further corrections. A Hewlett Packard model E4407B spectrum analyzer was used with the resolution bandwidth set to 10 kHz for this portion of the tests. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

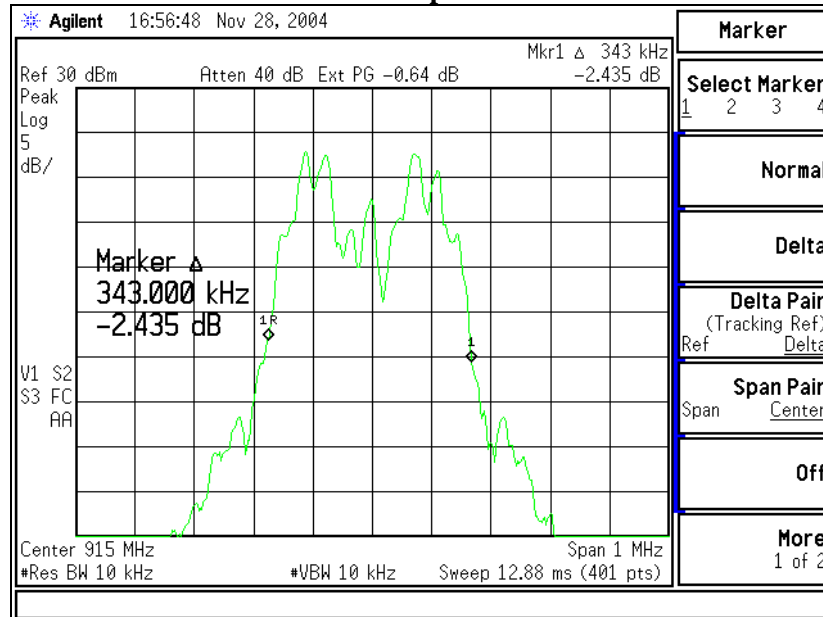
From this data, the bandwidth of Channel 64, which is the closest data to the specification limit, is 343 kHz, which is below the maximum of 500 kHz.

| Channel | Center Frequency (MHz) | Measured 20 dB BW (kHz) | Maximum Limit (kHz) |
|---------|------------------------|-------------------------|---------------------|
| 01      | 903.392                | 343                     | 500                 |
| 64      | 914.996                | 343                     | 500                 |
| 127     | 927.594                | 293                     | 500                 |

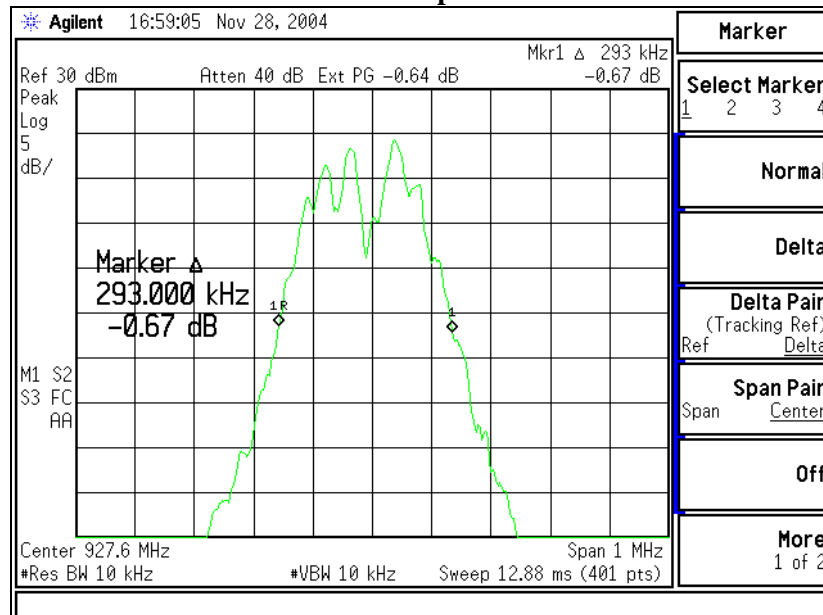
### Plots of Occupied Bandwidth



### Channel 64 Occupied Bandwidth



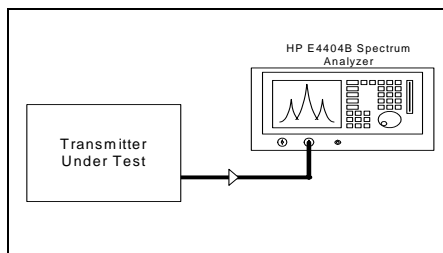
### Channel 127 Occupied Bandwidth



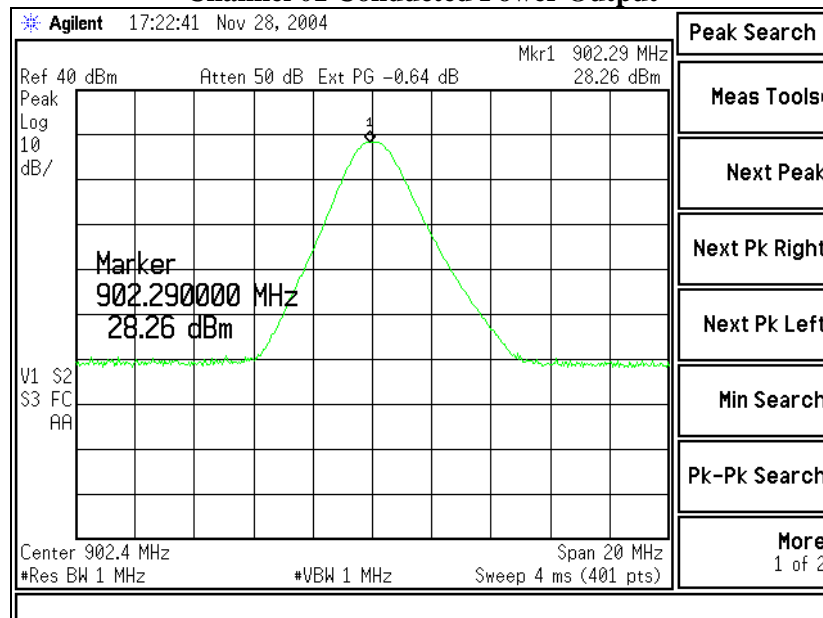
## 12. Conducted Emissions Test, Power Output 15.247(b)

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings (-0.64 dB Gain), thereby allowing direct readings of the measurements made without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data from a large test data file. The spectrum analyzer was used with resolution and video bandwidths set to 1 MHz, and a span of 5 MHz, with measurements from a peak detector presented in the chart below. RF Power Output was also monitored while varying the DC voltage as sourced by a DC bench type power supply. No considerable variation in output power was seen while setting the DC voltage to 3.23 VDC (-15%) or to 4.37 VDC (+15%).

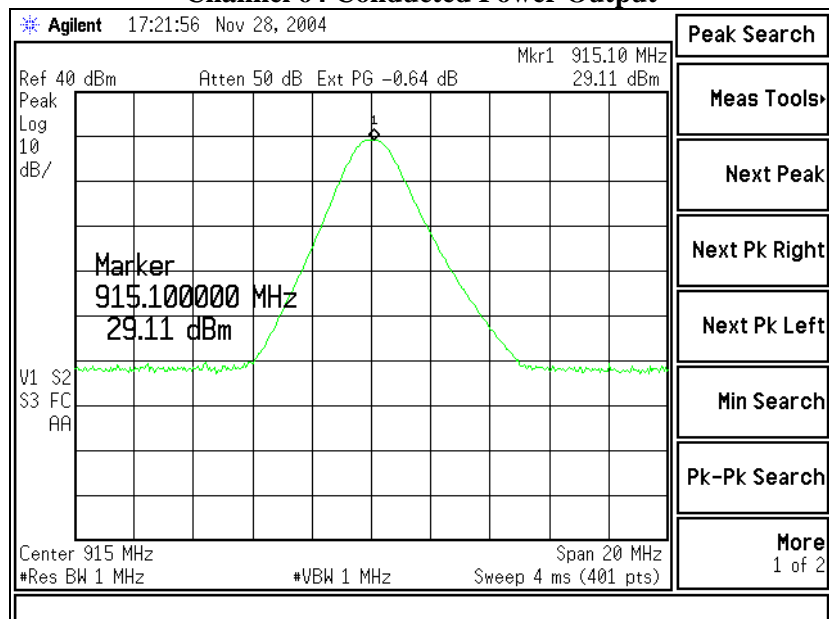
| Channel | Center Frequency (MHz) | Limit (dBm) | Measured Power (dBm) | Margin (dB) |
|---------|------------------------|-------------|----------------------|-------------|
| 01      | 902.3                  | 30 dBm      | 28.26                | 1.74        |
| 64      | 915.1                  | 30 dBm      | 29.11                | 0.89        |
| 127     | 927.5                  | 30 dBm      | 28.96                | 1.04        |



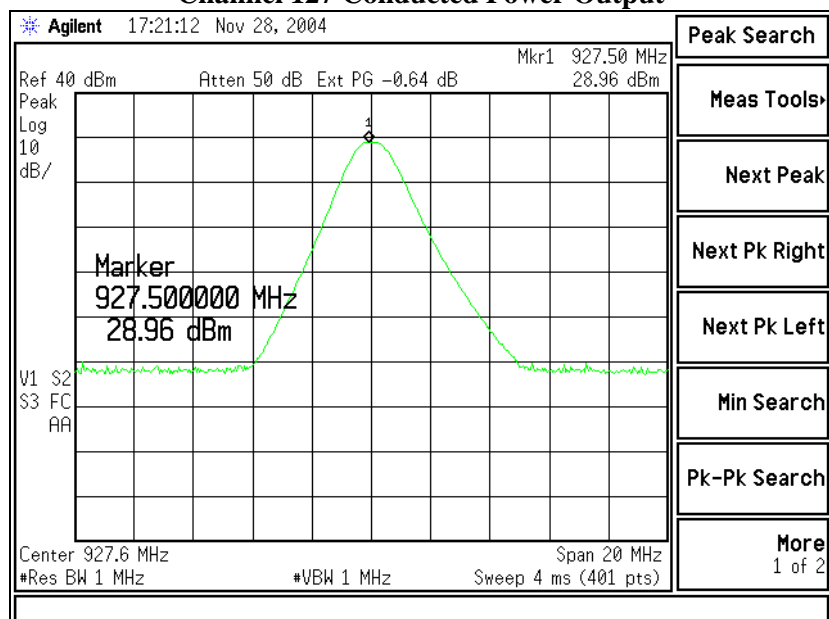
**Channel 01 Conducted Power Output**



### Channel 64 Conducted Power Output



### Channel 127 Conducted Power Output



### 13. Frequency and Power Stability over Voltage Variations

For this test, the EUT was placed in continuous transmit mode. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer. The frequency was measured with a receiver resolution bandwidth of 10 Hz, and video bandwidth of 10 Hz. Channel 127 produced the widest frequency variation during the tests.

|             | DC Voltage Source |            |            |
|-------------|-------------------|------------|------------|
|             | 3.23 V            | 3.80 V     | 4.37 V     |
| Channel 1   | 28.1 (dBm)        | 28.0 (dBm) | 28.0 (dBm) |
| Channel 64  | 28.2 (dBm)        | 28.8 (dBm) | 28.6 (dBm) |
| Channel 127 | 27.9 (dBm)        | 28.6 (dBm) | 28.1 (dBm) |

|             | DC Voltage Source |                 |                 |
|-------------|-------------------|-----------------|-----------------|
|             | 3.23 V            | 3.80 V          | 4.37 V          |
| Channel 1   | 902.40645 (MHz)   | 902.40648 (MHz) | 902.40655 (MHz) |
| Channel 64  | 914.99525 (MHz)   | 914.99525 (MHz) | 914.99560 (MHz) |
| Channel 127 | 927.59065 (MHz)   | 927.59080 (MHz) | 927.59110 (MHz) |

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved during power loss. After power was returned, the system needs to be re-initialized to transmit and the system returned to the same state of operation as before the power cycle. The system did not transmit without re-initialization.

No anomalies were noted, in the measured transmit power, varying less than 1 dB, during the voltage variation tests.

#### 14. Conducted Emissions Test, Spurious Emissions 15.247(d)

FCC Part 15.247(d) requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable. The loss from the cable was added on the analyzer as gain offset settings, thereby allowing direct readings of the measurements made without the need for any further corrections. A Hewlett Packard model E4407B spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

No significant emissions could be noted within -50 dBc of the fundamental level for this product.

|                          | Channel 01   | Channel 64   | Channel 127  |
|--------------------------|--------------|--------------|--------------|
| Fundamental              | + 28.4 (dBm) | + 28.6 (dBm) | + 28.2 (dBm) |
| 2 <sup>nd</sup> Harmonic | - 35.2 (dBm) | - 38.0 (dBm) | - 37.9 (dBm) |
| 3 <sup>rd</sup> Harmonic | Note (1)     | Note (1)     | Note (1)     |
| 4 <sup>th</sup> Harmonic | Note (1)     | Note (1)     | Note (1)     |
| 5 <sup>th</sup> Harmonic | Note (1)     | Note (1)     | Note (1)     |

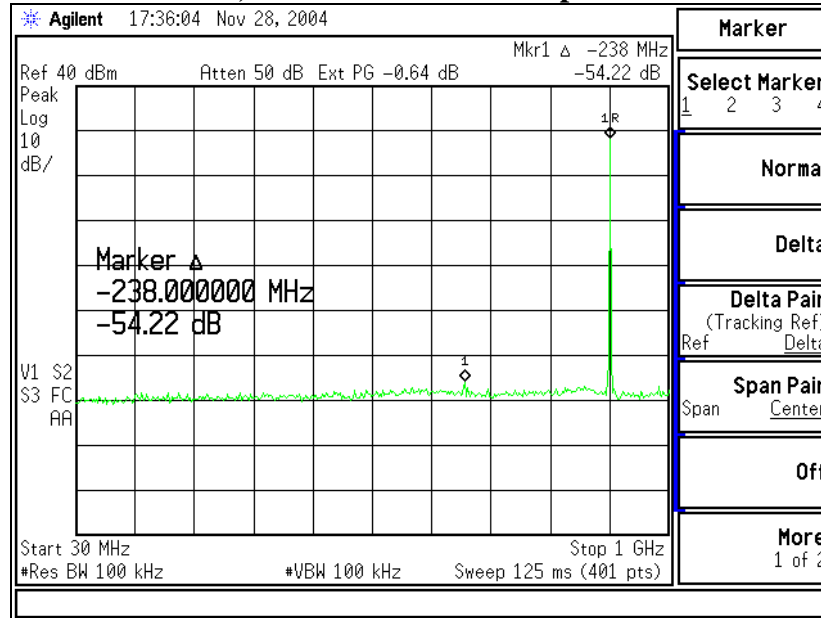
Notes:

(1) Measurement at system noise floor.

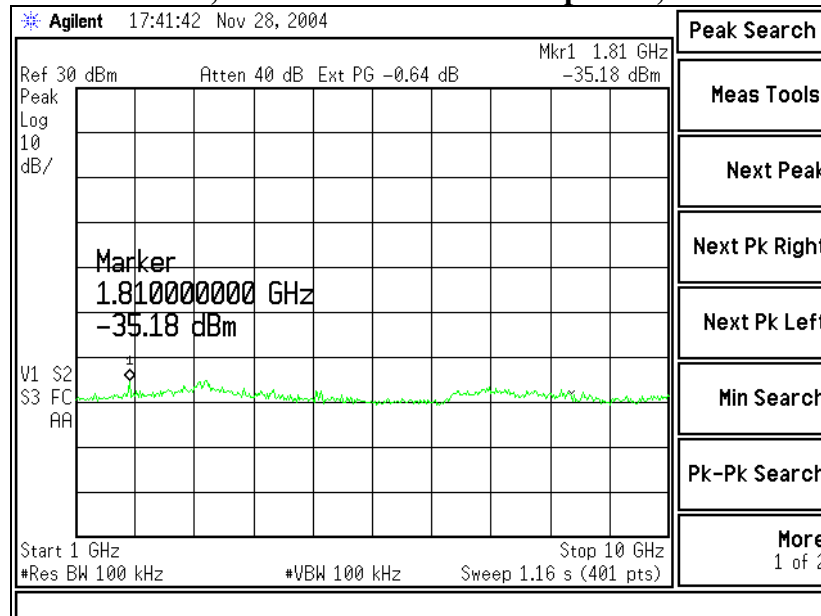


## Plots of Conducted Spurious and Fundamental Levels

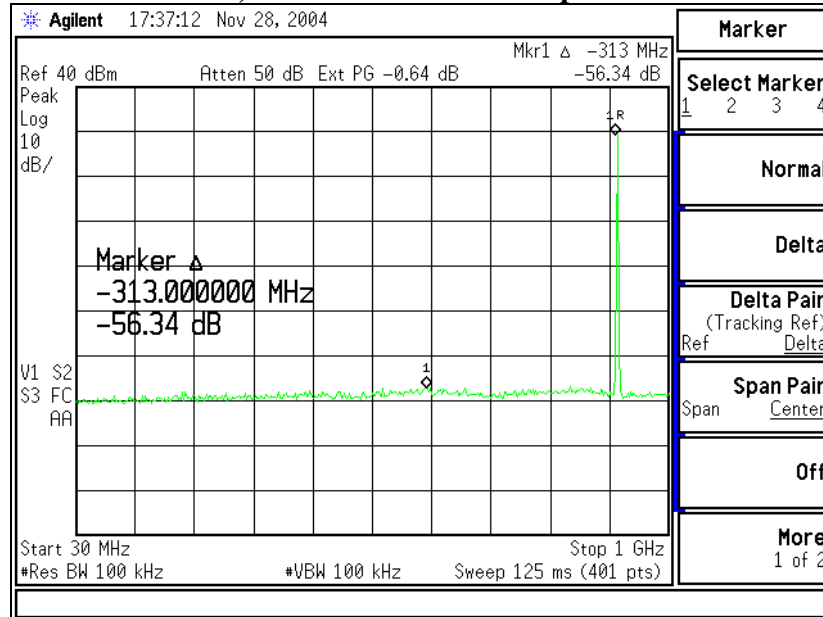
**Channel 01, shown from 30 MHz up to 1000 MHz**



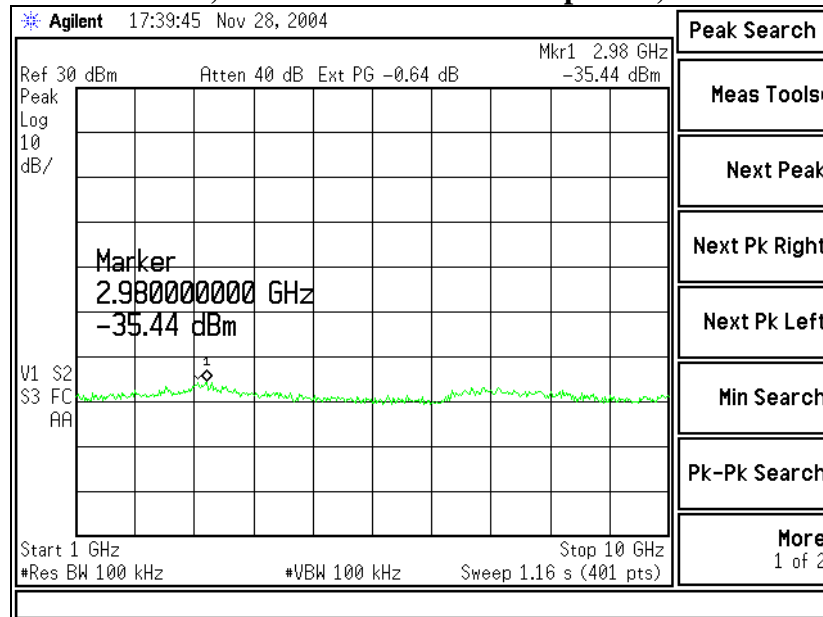
**Channel 01, shown from 1000 MHz up to 10,000 MHz**



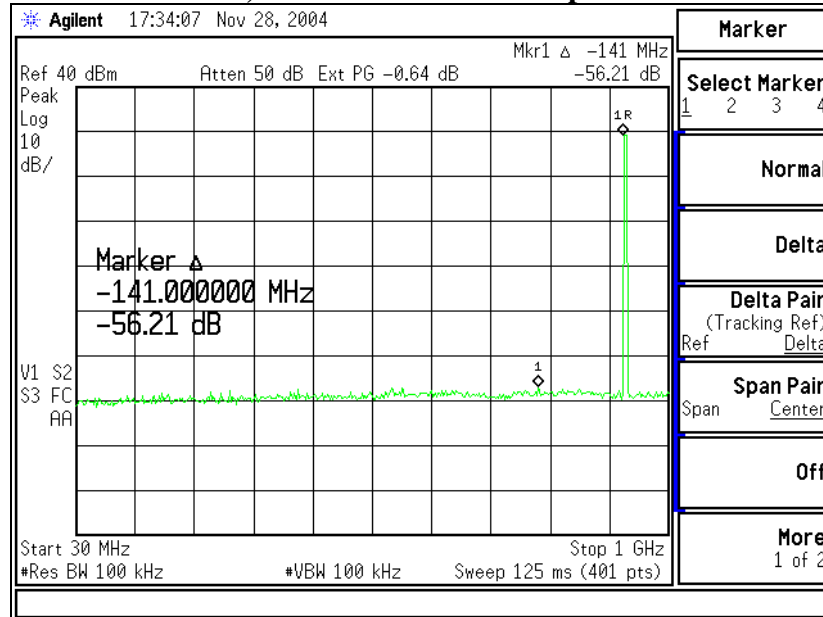
### Channel 64, shown from 30 MHz up to 1000 MHz



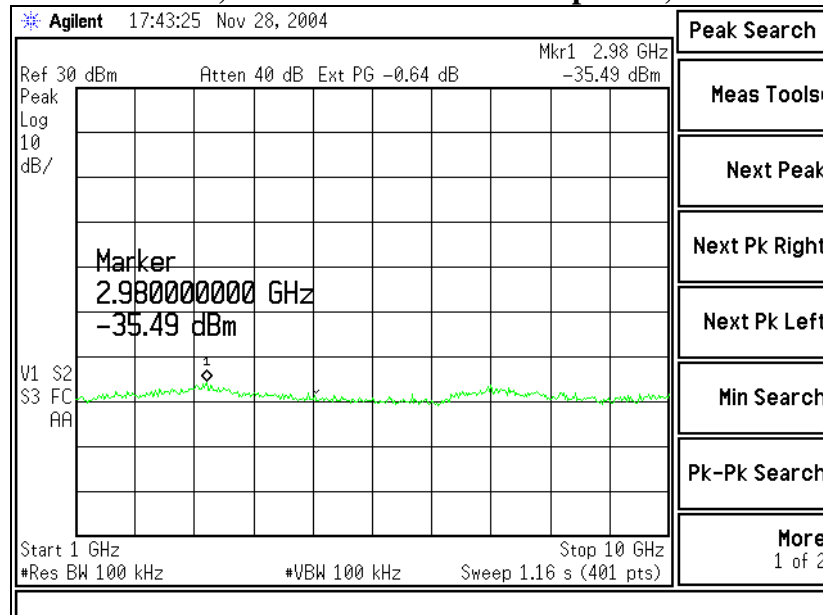
### Channel 64, shown from 1000 MHz up to 10,000 MHz



### Channel 127, shown from 30 MHz up to 1000 MHz



### Channel 127, shown from 1000 MHz up to 10,000 MHz



## 15. Conducted Emissions Test, Minimum Channel Separation

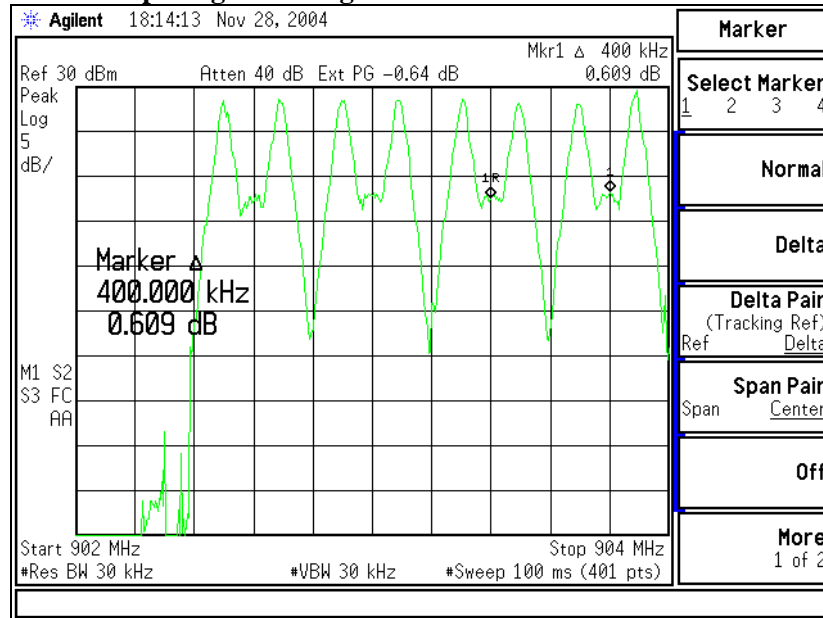
Part 15.247(a)(1) requires a minimum channel separation of 25 kHz or the equivalent of the 20 dB occupied bandwidth of the fundamental transmission, whichever is greater. An HP E4407B spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT.

The minimum channel-separation measured for this device is 400 kHz. The maximum occupied bandwidth of the device, as reported in the previous section is 343 kHz. The minimum channel separation for the EUT exceeds both the 25 kHz criteria and the 20 dB occupied bandwidth criteria, and hence meets the requirements. The following plots describe this spacing, and also establish the number of hop channels, total of 50.

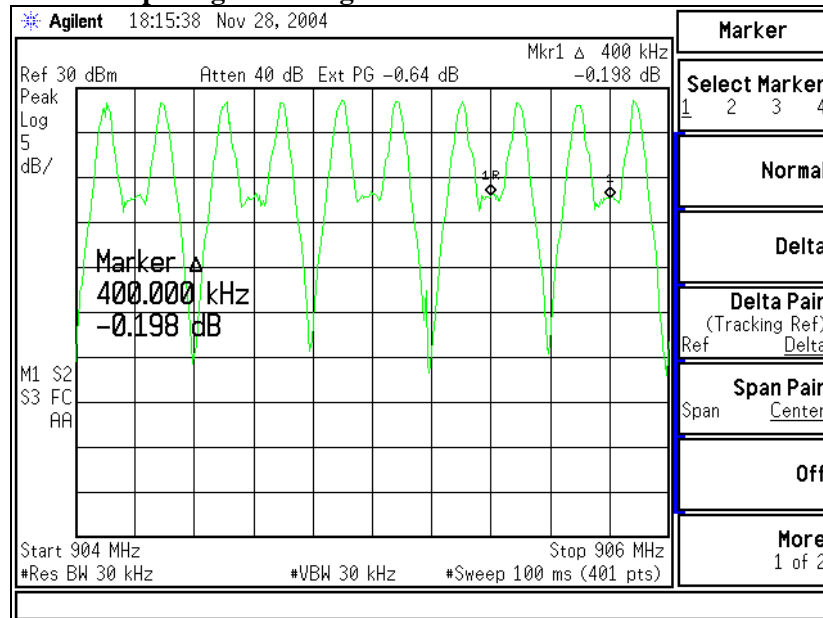
| Frequency Span | Number of Channels | Minimum Separation |
|----------------|--------------------|--------------------|
| 902-904 MHz    | 4                  | 400 kHz            |
| 904-906 MHz    | 5                  | 400 kHz            |
| 906-908 MHz    | 4                  | 400 kHz            |
| 908-910 MHz    | 4                  | 400 kHz            |
| 910-912 MHz    | 4                  | 400 kHz            |
| 912-914 MHz    | 4                  | 400 kHz            |
| 914-916 MHz    | 4                  | 400 kHz            |
| 916-918 MHz    | 4                  | 400 kHz            |
| 918-920 MHz    | 3                  | 400 kHz            |
| 920-922 MHz    | 4                  | 400 kHz            |
| 922-924 MHz    | 4                  | 400 kHz            |
| 924-926 MHz    | 4                  | 400 kHz            |
| 926-928 MHz    | 2                  | 400 kHz            |

## Plots of Channel Separations

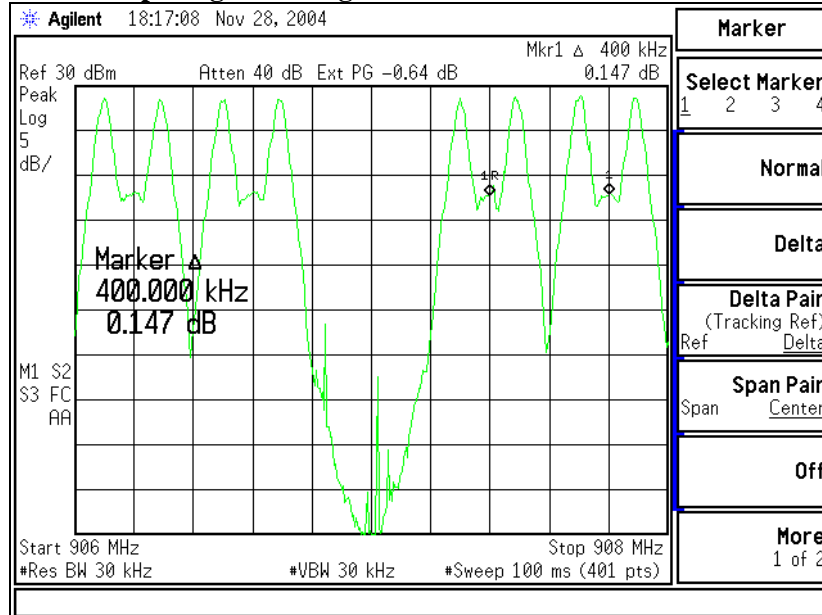
### Channel Spacing and Assignments between 902 MHz to 904 MHz



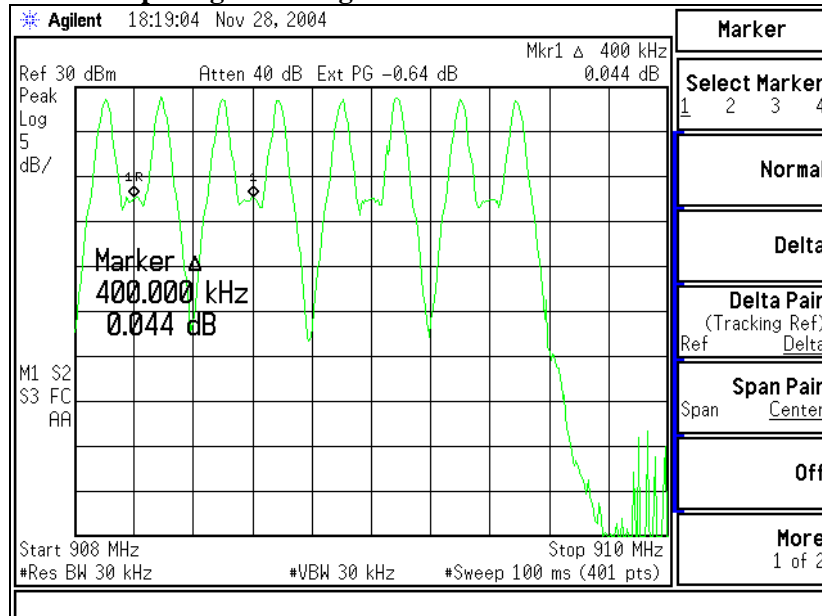
### Channel Spacing and Assignments between 904 MHz to 906 MHz



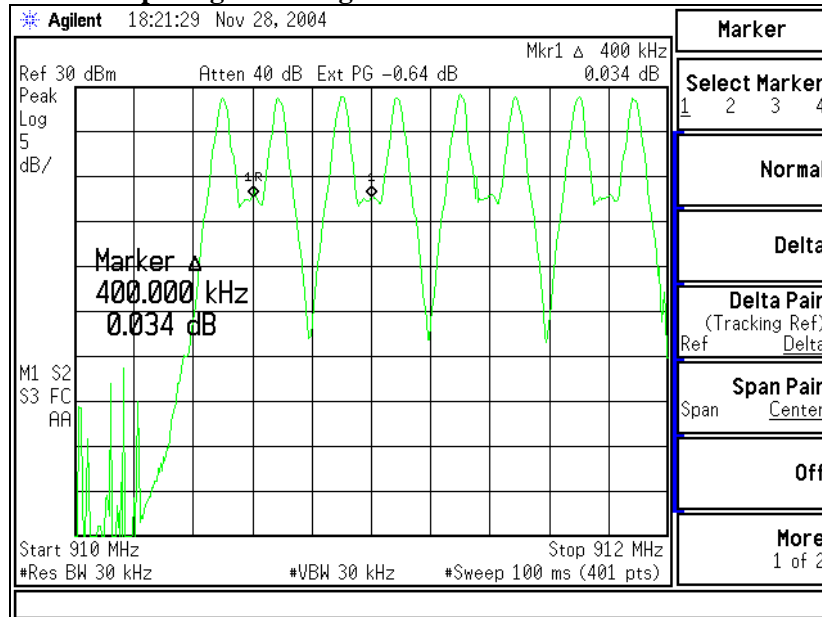
### Channel Spacing and Assignments between 906 MHz to 908 MHz



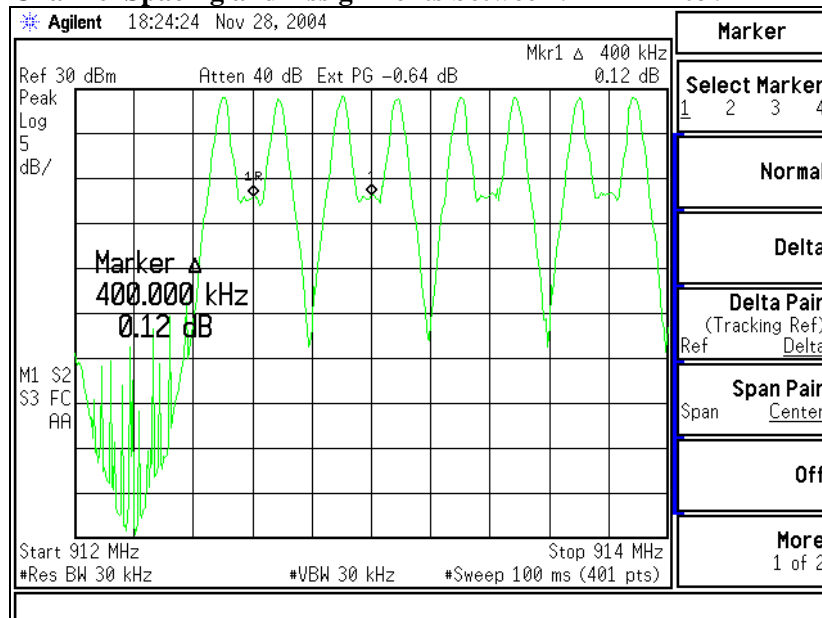
### Channel Spacing and Assignments between 908 MHz to 910 MHz



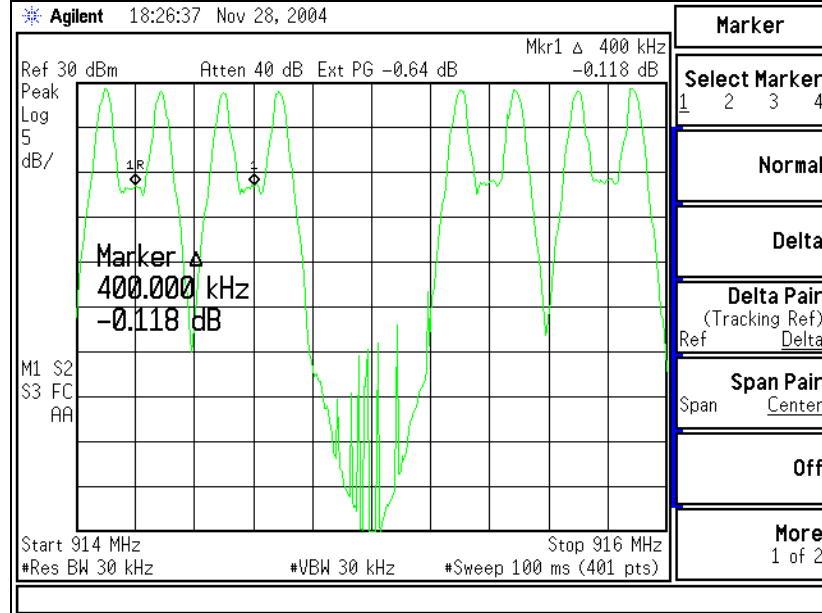
### Channel Spacing and Assignments between 910 MHz to 912 MHz



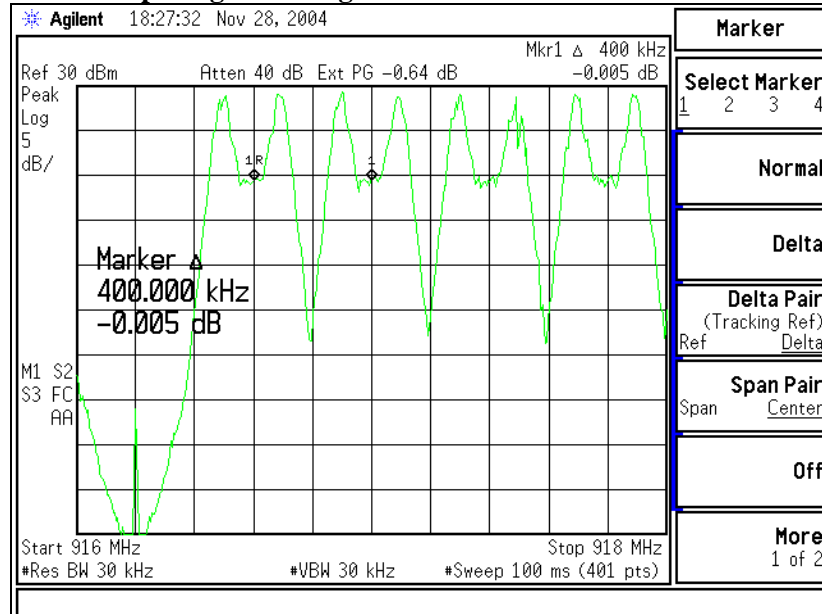
### Channel Spacing and Assignments between 912 MHz to 914 MHz



### Channel Spacing and Assignments between 914 MHz to 916 MHz

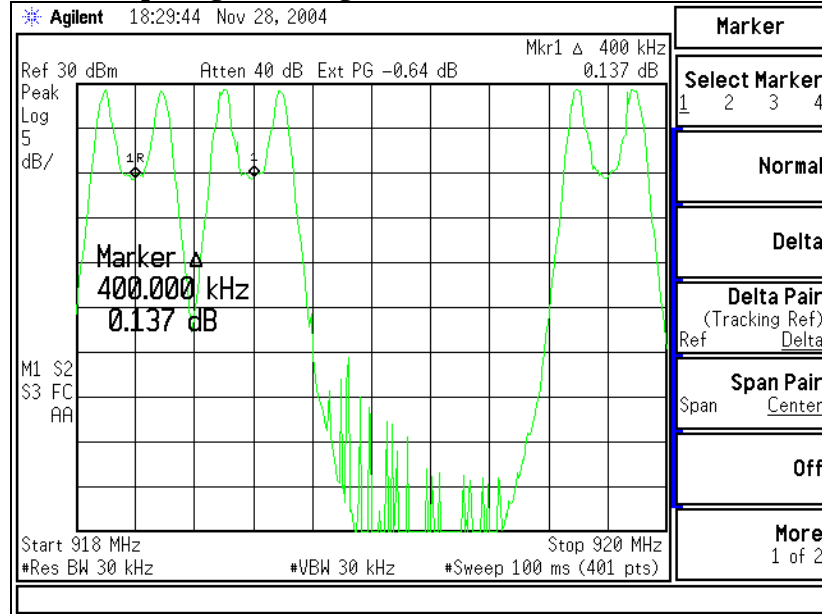


### Channel Spacing and Assignments between 916 MHz to 918 MHz

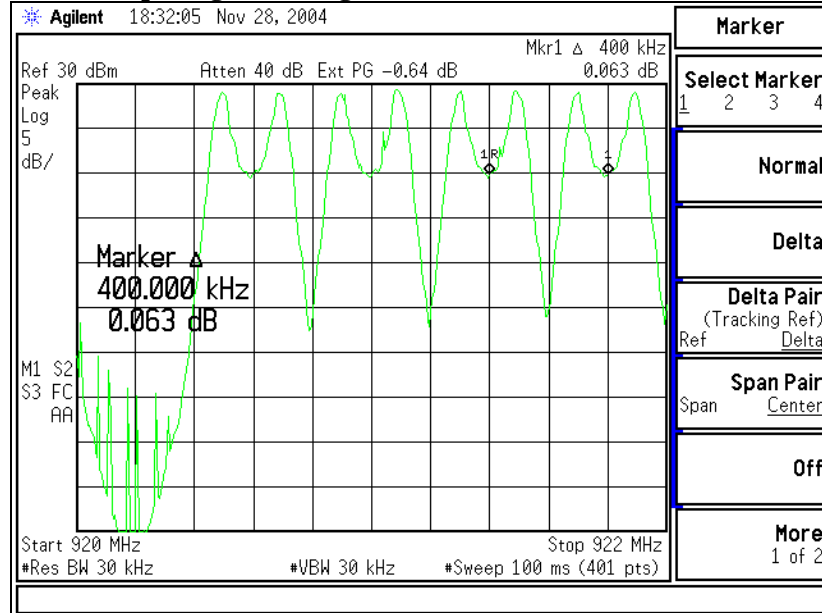




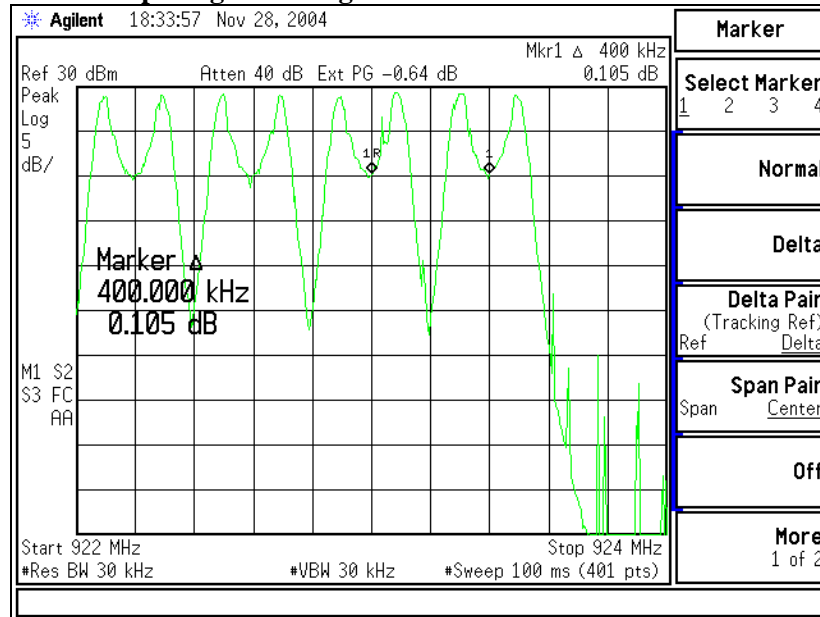
### Channel Spacing and Assignments between 918 MHz to 920 MHz



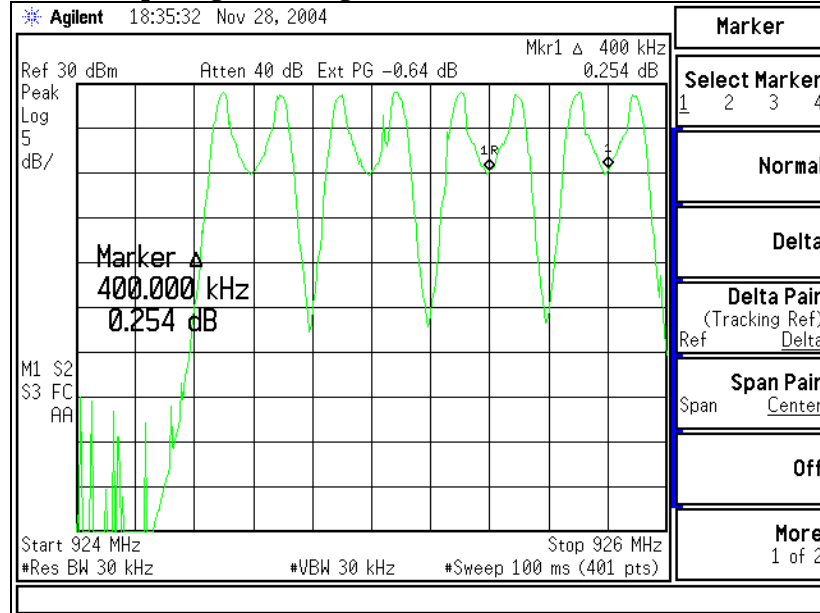
### Channel Spacing and Assignments between 920 MHz to 922 MHz



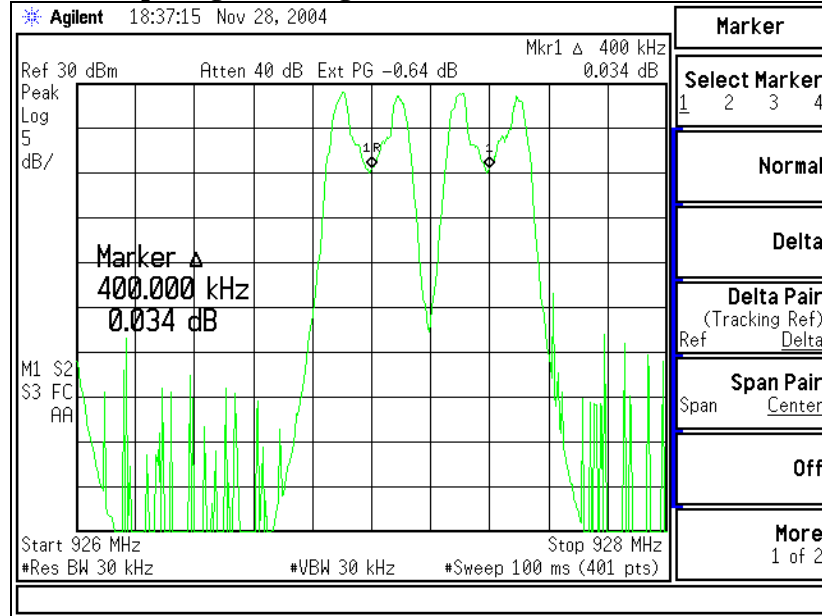
### Channel Spacing and Assignments between 922 MHz to 924 MHz



### Channel Spacing and Assignments between 924 MHz to 926 MHz



# Channel Spacing and Assignments between 926 MHz to 928 MHz

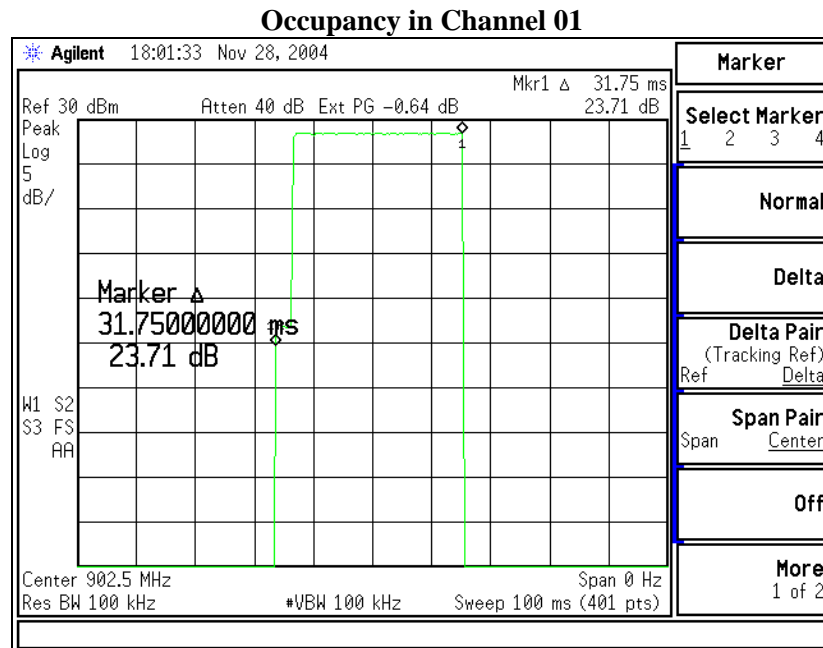


## 16. Conducted Emissions Test, Channel Occupancy

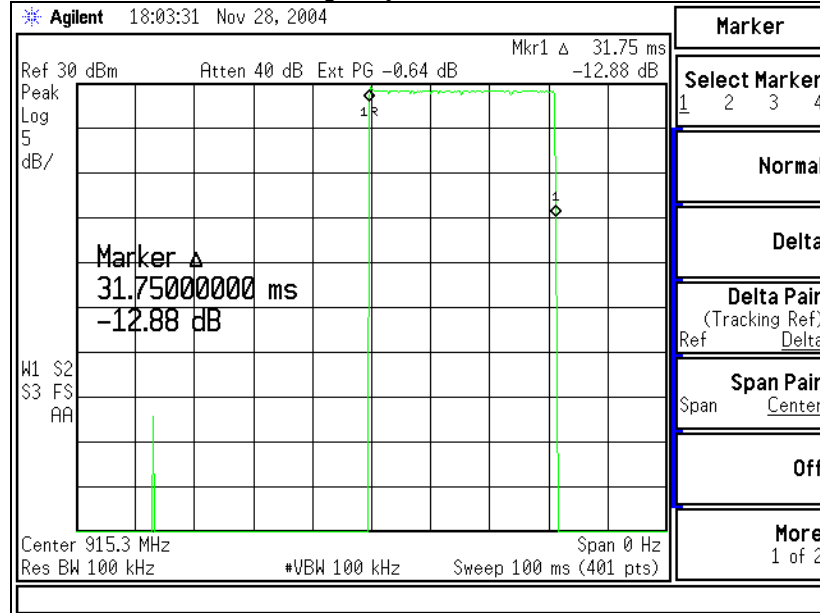
Part 15.247(a)(1) requires a channel occupancy, for this device, of no more than 400 milliseconds in a 10 second window. The channel occupancy for this EUT was measured using an HP E4407B spectrum analyzer, set to zero-span at the frequency of interest. With the analyzer in peak-hold mode, the transmission lengths can be measured by adjusting the sweep rate of the analyzer. A suitable sweep rate was used to measure the channel occupancy at the low, mid and high channels. The longest time any transmission will occur on a single channel is 31.75 ms. With a total of 50 channels used, each occupying a 31.75 ms slot, it will take 1.59 seconds for the sequence to repeat. In a 10 second window, each channel would have 6.29 transmission cycles. The maximum occupancy in a 10 second window is calculated by multiplying the 6.29 transmission cycles by 31.75 ms transmission duration per cycle, to arrive at 199.7 ms total occupancy.

| Channel | Frequency (MHz) | Occupancy Per transmission (ms) | Occupancy in 400 ms window (ms) |
|---------|-----------------|---------------------------------|---------------------------------|
| 01      | 902.5           | 31.75                           | 199.7                           |
| 64      | 915.3           | 31.75                           | 199.7                           |
| 127     | 927.5           | 31.75                           | 199.7                           |

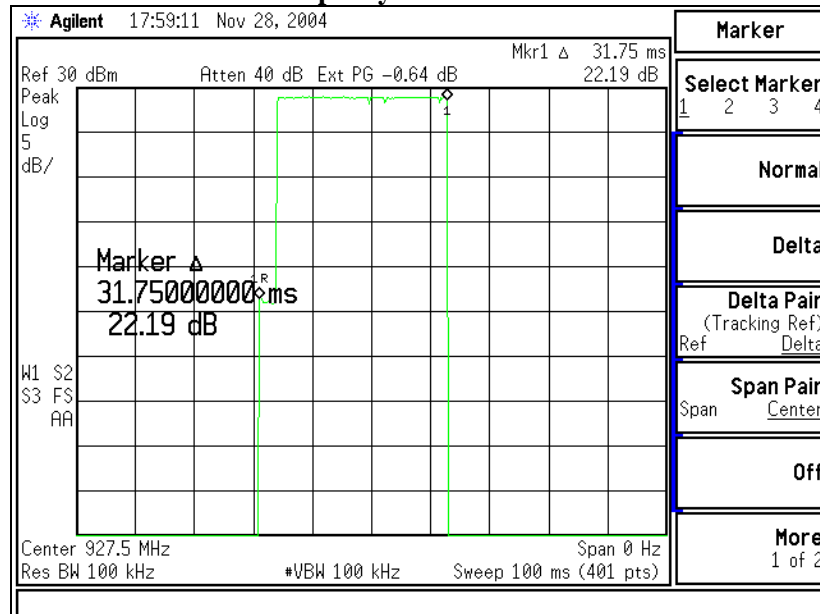
### Plots of Channel Occupancy



### Occupancy in Channel 64



### Occupancy in Channel 127



*The information on this page is provided by the manufacturer.*

#### **17. Equal Channel Usage**

50 channels are chosen from a pool of 127 available frequencies. These channels are arrayed in a table which the system uses to determine the next hopping channel. Each time a transmission is made the system uses the next frequency in the table. The table is started over once the end has been reached. Thus, any given frequency will not be reused until all other frequencies have been accessed. This also addresses part 15.247(g) concerns.

#### **18. Pseudorandom Hopping Pattern**

The hopping table is built using an 8 bit seed into an  $X^{15}+1$  pseudorandom number generator giving the possibility of 64 unique pseudorandom hopping tables. Output from the generator is used to pick frequencies from a pool of 50 available channels. This also addresses part 15.247(h) concerns.

## **19. Radiated Emissions Test**

### **Test Setup**

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.4-2003. The EUT was tested as a module, and was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. A personal computer was used to program the EUT to operate in the desired test modes. An RS-232-to-TTL interface circuit was used in between the personal computer and the EUT. The personal computer was placed outside of the test area, while the interface circuit was placed inside the test area.

The EUT was operated in a continuous transmit mode, using power as provided by a bench type power supply (used on EUT module), as well as a wall type power supply (used on PC interface device). The unit has the capability to operate on 127 channels, controlled via a personal computer during these tests. The personal computer used a simple terminal program to communicate and program the EUT, and a large generic data file was used as source for the modulation of the EUT during these transmitter tests.

The applicable limits apply at a 3 meter distance. Measurements above 5 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (902.392 MHz), middle (914.996 MHz) and high (927.594 MHz) to comply with FCC Part 15.35.

### **Test Procedure**

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 10000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

The EUT was tested and qualified with one type of antennas, as covered in this report. The antenna was an Astron brand, 902-928 MHz Half-Wave Dipole, with a swivel base, and 2 dBi gain. Because the antenna was on a swivel base, and because the EUT and the antenna were connected via a 20 cm coaxial cable, the EUT was rotated along three orthogonal axis, and the EUT antenna was positioned in both Horizontal and Vertical polarizations during the investigations to find the highest emission levels.

### **Test Equipment Utilized**

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at an N.I.S.T. traceable site. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and a HP 8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the HP 8546A EMI Receiver database. As a result, the data taken from the HP 8546A EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The HP 8546A EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz). From 5 GHz to 10 GHz, an HP E4407 Spectrum Analyzer and an EMCO Horn Antenna were used.

### **Test Results**

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for a FHSS transmitter [Canada RSS-210, Clause 6.2.2(0)]. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.



## CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 902-928 MHz band, as specified in 47 CFR 15.247 (b)(2), is 1 Watt for systems employing at least 50 hopping channels. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c).

The following table depicts the Class B limits for an unintentional radiator. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands.

| Frequency<br>(MHz) | 3 m Limit<br>$\mu\text{V/m}$ | 3 m Limit<br>(dB $\mu\text{V/m}$ ) | 1 m Limit<br>(dB $\mu\text{V/m}$ ) |
|--------------------|------------------------------|------------------------------------|------------------------------------|
| 30-88              | 100                          | 40.0                               | -                                  |
| 88-216             | 150                          | 43.5                               | -                                  |
| 216-960            | 200                          | 46.0                               | -                                  |
| 960-24,000         | 500                          | 54.0                               | 63.5                               |

Sample conversion from field strength  $\mu\text{V/m}$  to dB $\mu\text{V/m}$ :

$$\begin{aligned}\text{dB}\mu\text{V/m} &= 20 \log_{10} (100) \\ &= 40 \text{ dB}\mu\text{V/m} \text{ (from 30-88 MHz)}\end{aligned}$$

For measurements made at 1.0 meter, a 9.5 dB correction has been invoked.

$$\begin{aligned}&960 \text{ MHz to } 10,000 \text{ MHz} \\ &500\mu\text{V/m or } 54.0 \text{ dB}\mu\text{V/m at 3 meters} \\ &54.0 + 9.5 = 63.5 \text{ dB}\mu\text{V/m at 1 meter}\end{aligned}$$

For measurements made at 0.3 meter, a 20 dB correction has been invoked.

$$\begin{aligned}&960 \text{ MHz to } 10,000 \text{ MHz} \\ &500\mu\text{V/m or } 54.0 \text{ dB}\mu\text{V/m at 3 meters} \\ &54.0 + 20 = 74 \text{ dB}\mu\text{V/m at 0.3 meters}\end{aligned}$$

**Radiated Emissions Data Chart**  
**3 Meter Measurements of Electromagnetic Radiated Emissions**  
**Test Standard: 47CFR, Part 15.205 and 15.247(FHSS)**  
**Frequency Range Inspected: 30 MHz to 10000 MHz**

|                    |  |   |   |                |                           |                |
|--------------------|--|---|---|----------------|---------------------------|----------------|
| Manufacturer:      | Encom Wireless Data Solutions, Inc.                              |   |   |                |                           |                |
| Date(s) of Test:   | August 31 <sup>ST</sup> through November 28 <sup>TH</sup> , 2004 |   |   |                |                           |                |
| Test Engineer(s):  |  | Tom Smith                                   | √ | Abtin Spantman |                           | Ken Boston     |
| Model #:           | 'ENC-900' 1000 mW Radio Module                                   |   |   |                |                           |                |
| Serial #:          | Engineering Unit #43   |   |   |                |                           |                |
| Voltage:           | 3.80 VDC, 1000 mA  |   |   |                |                           |                |
| Operation Mode:    | Normal, continuous transmit, and 'Hopping' mode                  |   |   |                |                           |                |
| EUT Power:         |  | Single Phase ___VAC                         |   |                | 3 Phase ___VAC            |                |
|                    |  | Battery                                     |   | √              | Other: Bench power supply |                |
| EUT Placement:     |  | 80cm non-conductive table                   |   |                | 10cm Spacers              |                |
| EUT Test Location: | √  | 3 Meter Semi-Anechoic<br>FCC Listed Chamber |   |                | 3/10m OATS                |                |
| Measurements:      |  | Pre-Compliance                              |   |                | Preliminary               | √      Final   |
| Detectors Used:    | √  | Peak  |   | √              | Quasi-Peak                | √      Average |

**Environmental Conditions in the Lab:**

Temperature: 20 – 25°C  
Relative Humidity: 30 – 60 %

**Test Equipment Used:**

EMI Measurement Instrument: HP8546A and Agilent E4407B  
Log Periodic Antenna: EMCO #93146  
Horn Antenna: EMCO #3115  
Biconical Antenna: EMCO 93110

The following table depicts the level of significant spurious radiated RF emissions found:

| Frequency (MHz) | Antenna Polarity | Channel | Height (meters) | Azimuth (0° - 360°) | EMI Meter Reading (dBμV/m) | 15.247 Limit (dBμV/m) | Margin (dB) |
|-----------------|------------------|---------|-----------------|---------------------|----------------------------|-----------------------|-------------|
|                 |                  |         |                 |                     |                            |                       |             |
| <i>Note 2</i>   |                  |         |                 |                     |                            |                       |             |

**Notes:**

- 1) A Quasi-Peak Detector was used in measurements below 1 GHz, and an Average Detector was used in measurements above 1 GHz. The Peak detector was also use to ensure that the emission levels do not exceed 20 dB beyond the Average limits.
- 2) No significant spurious emissions observed. All spurious emissions were better than 20 dB below the limits.

*Antenna 1:*  
*Astron 902-928 MHz Half-Wave Dipole*

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 01:

| Frequency (MHz) | Antenna Polarity | Channel | Height (meters) | Azimuth (0° - 360°) | Measured ERP (dBμV/m) | 15.247 Limit (dBμV/m) | Margin (dB) |
|-----------------|------------------|---------|-----------------|---------------------|-----------------------|-----------------------|-------------|
| 902.3           | V                | 01      | 1.00            | 285                 | 125.3                 | 131.2                 | 5.9         |
| 1805            | H                | 01      | 1.10            | 285                 | 77.0                  | 105.3                 | 28.3        |
| 2707            | H                | 01      | 1.10            | 175                 | 49.7                  | 54.0                  | 4.3         |
| 3610            | H                | 01      | 1.00            | 5                   | 50.7                  | 54.0                  | 3.3         |
| 4512            | V                | 01      | 1.05            | 315                 | 52.1                  | 54.0                  | 1.9         |
| 5414            | V                | 01      | 1.10            | 295                 | 58.7                  | 63.5                  | 4.8         |
| 6317            | H                | 01      | 1.00            | 15                  | 57.2                  | 105.3                 | 48.1        |
| 7219            | H                | 01      | 1.00            | 335                 | 53.7                  | 105.3                 | 51.6        |
| 8122            | H                | 01      | 1.15            | 65                  | 56.4                  | 63.5                  | 7.1         |
| 9024            | V                | 01      | 1.05            | 75                  | 48.2                  | 63.5                  | 15.3        |

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 64:

| Frequency (MHz) | Antenna Polarity | Channel | Height (meters) | Azimuth (0° - 360°) | Measured ERP (dBμV/m) | 15.247 Limit (dBμV/m) | Margin (dB) |
|-----------------|------------------|---------|-----------------|---------------------|-----------------------|-----------------------|-------------|
| 914.9           | V                | 64      | 1.50            | 320                 | 127.1                 | 131.2                 | 4.1         |
| 1830            | V                | 64      | 1.00            | 110                 | 62.8                  | 107.1                 | 44.3        |
| 2745            | V                | 64      | 1.00            | 90                  | 46.9                  | 54.0                  | 7.1         |
| 3659            | H                | 64      | 2.10            | 15                  | 51.5                  | 54.0                  | 2.5         |
| 4574            | H                | 64      | 1.10            | 245                 | 50.5                  | 54.0                  | 3.5         |
| 5490            | V                | 64      | 1.10            | 50                  | 61.3                  | 63.5                  | 2.2         |
| 6405            | H                | 64      | 1.00            | 20                  | 66.2                  | 107.1                 | 40.9        |
| 7320            | H                | 64      | 1.00            | 330                 | 59.2                  | 63.5                  | 4.3         |
| 8235            | V                | 64      | 1.05            | 180                 | 52.8                  | 63.5                  | 10.7        |
| 9150            | V                | 64      | 1.00            | 325                 | 48.0                  | 63.5                  | 15.5        |

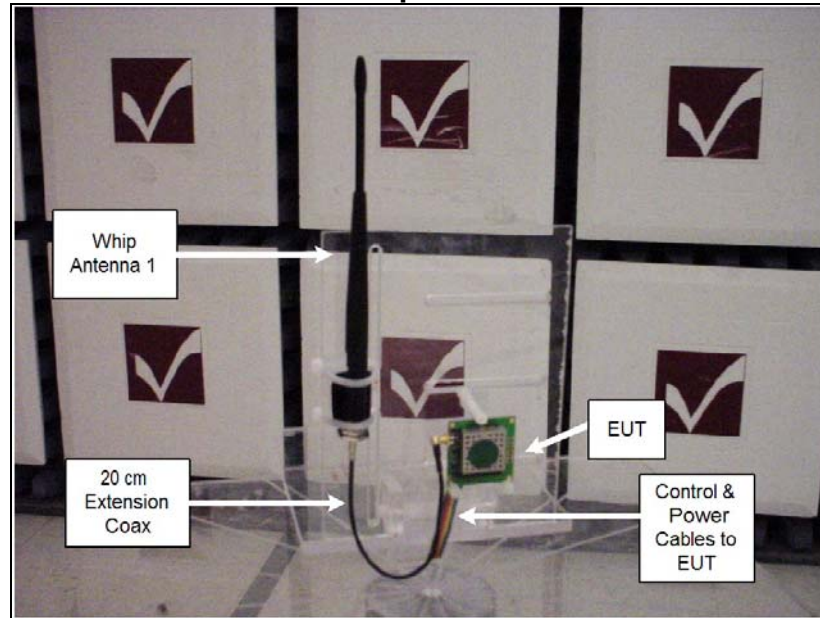
The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 127:

| Frequency (MHz) | Antenna Polarity | Channel | Height (meters) | Azimuth (0° - 360°) | Measured ERP (dBμV/m) | 15.247 Limit (dBμV/m) | Margin (dB) |
|-----------------|------------------|---------|-----------------|---------------------|-----------------------|-----------------------|-------------|
| 927.5           | V                | 127     | 1.00            | 330                 | 127.1                 | 131.2                 | 4.1         |
| 1855            | H                | 127     | 1.00            | 220                 | 56.1                  | 107.1                 | 51.0        |
| 2783            | H                | 127     | 1.10            | 180                 | 49.6                  | 54.0                  | 4.4         |
| 3710            | H                | 127     | 1.50            | 305                 | 53.2                  | 54.0                  | 0.8         |
| 4638            | H                | 127     | 1.25            | 245                 | 52.3                  | 54.0                  | 1.7         |
| 5566            | V                | 127     | 1.15            | 50                  | 60.9                  | 107.1                 | 46.2        |
| 6493            | H                | 127     | 1.00            | 20                  | 58.9                  | 107.1                 | 48.2        |
| 7421            | H                | 127     | 1.00            | 330                 | 52.3                  | 63.5                  | 11.2        |
| 8348            | H                | 127     | 1.00            | 0                   | 50.2                  | 63.5                  | 13.3        |
| 9276            | V                | 127     | 1.15            | 0                   | 44.4                  | 107.1                 | 62.7        |

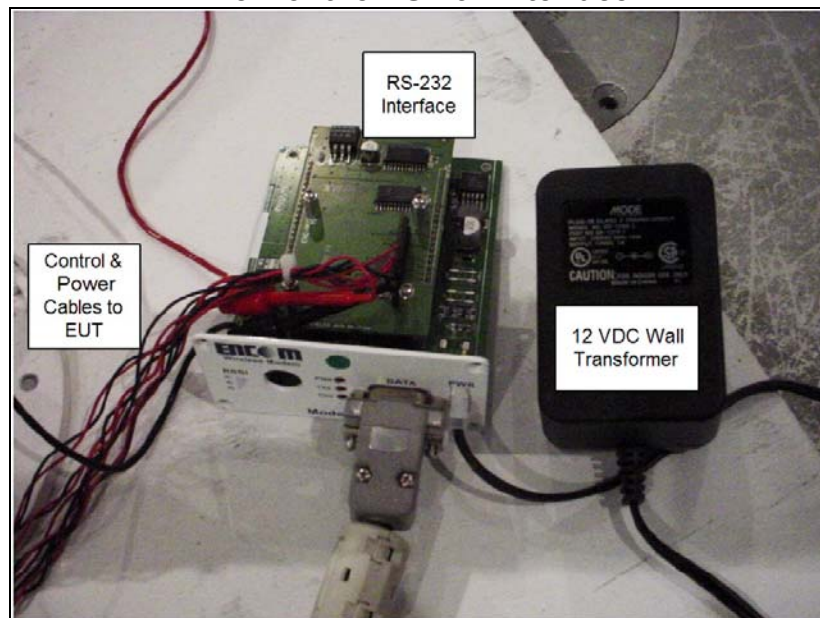
**Notes:** A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. Only the results from the Average detector are published in the table above. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits. Measurements above 5 GHz were made at 1 meters of separation from the EUT, and at 0.3 m separation at 18 – 26 GHz.

## Photos Taken During Radiated Emission Testing

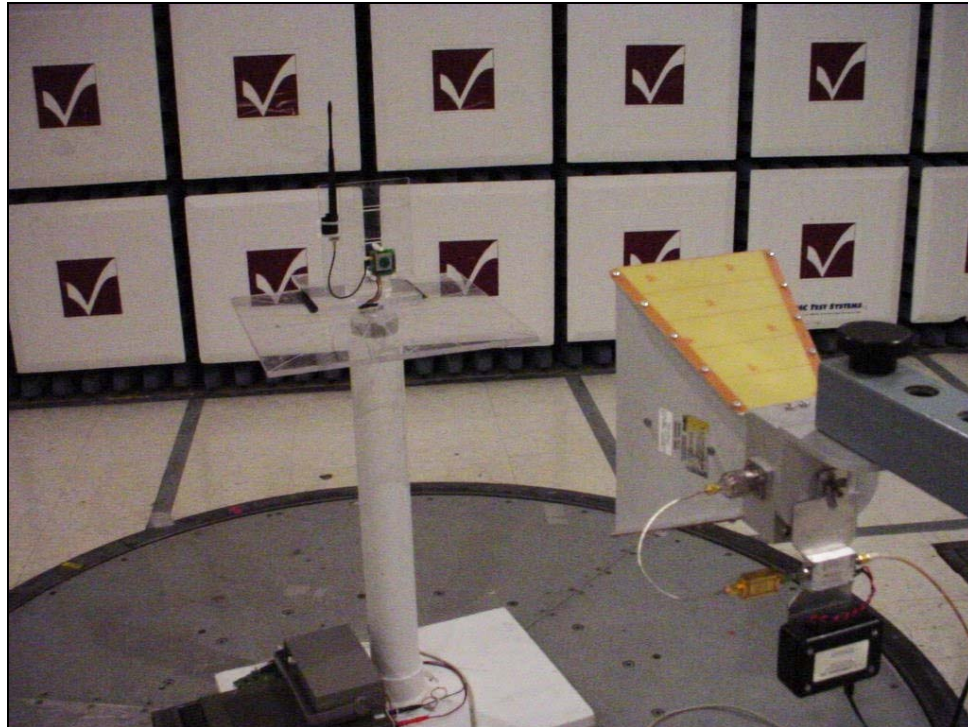
**View of the EUT setup in vertical orientation.**



**View of the RS-232 Interface.**



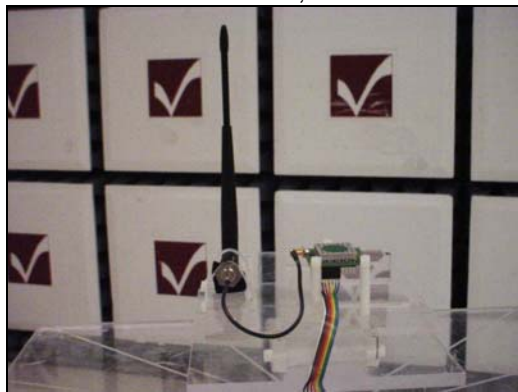
**View of the EUT setup on the test pedestal  
With Antenna 1.**



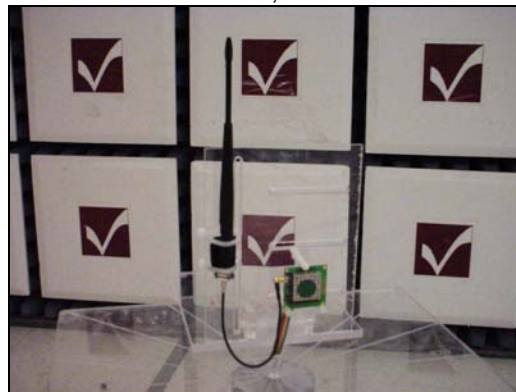
## Setup for testing of Antenna 1

### View of the EUT setup in vertical orientation

Antenna=Vertical ; EUT= Horizontal

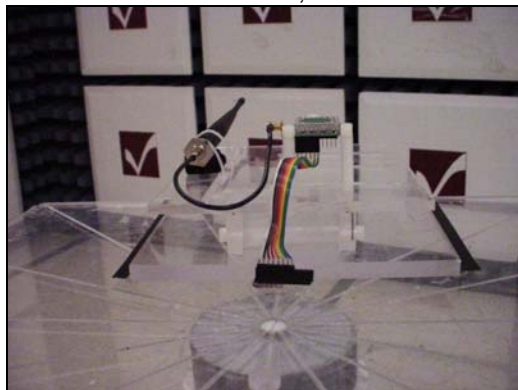


Antenna=Vertical ; EUT= Vertical

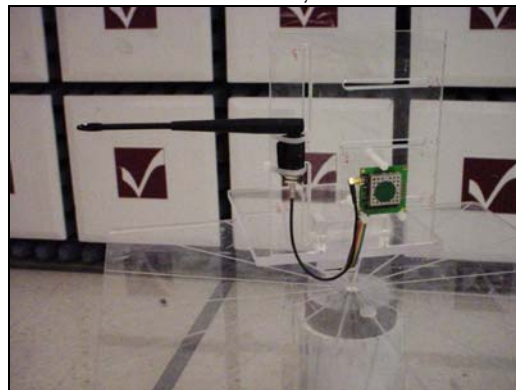


### View of the EUT setup in Horizontal orientation

Antenna=Horizontal ; EUT= Horizontal



Antenna=Horizontal ; EUT= Vertical

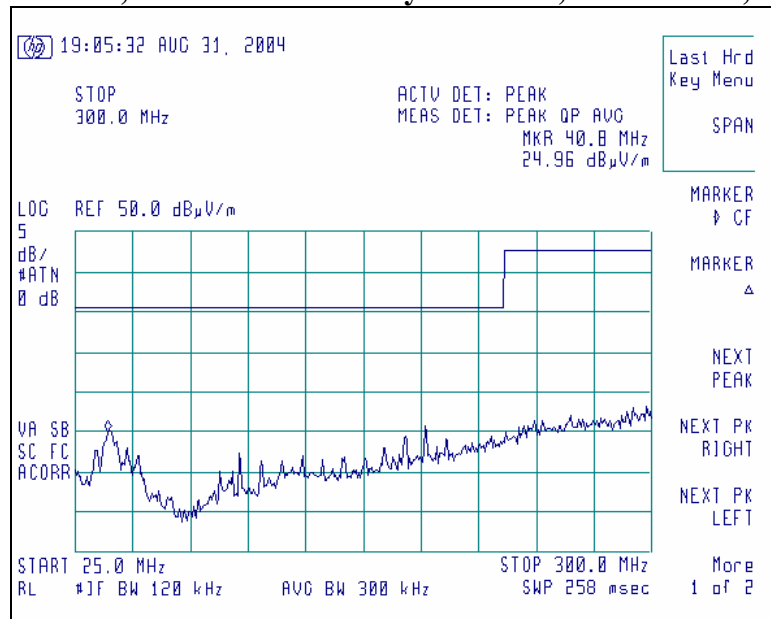


### **Screen Captures of Radiated RF Emissions for Antenna 1:**

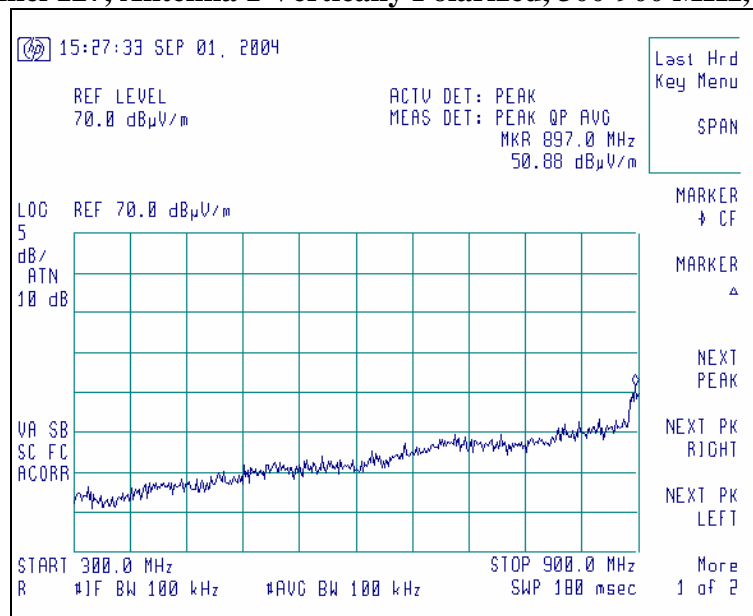
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 01, 64, or 127, with the sense and EUT antennas both in Vertical and Horizontal polarity.

#### **Channel 127, Antenna 1 Vertically Polarized, 30-300 MHz, at 3m.**

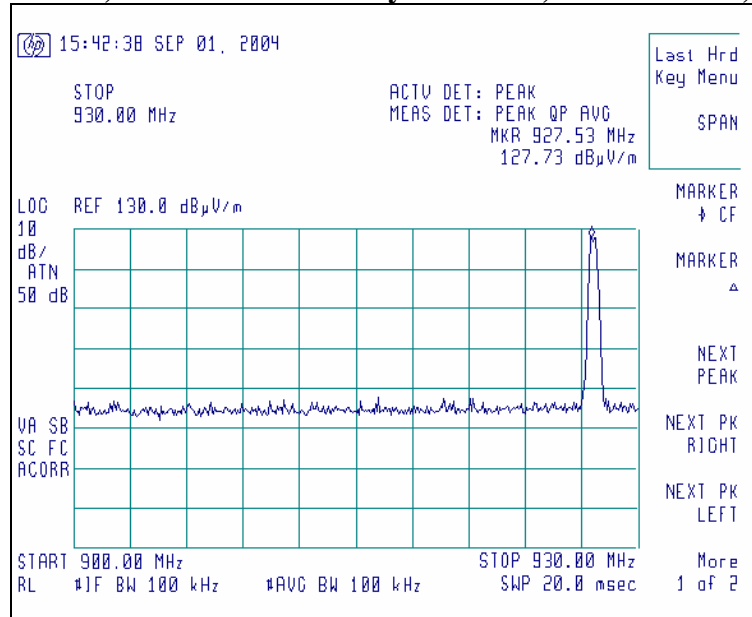


#### **Channel 127, Antenna 1 Vertically Polarized, 300-900 MHz, at 3m.**

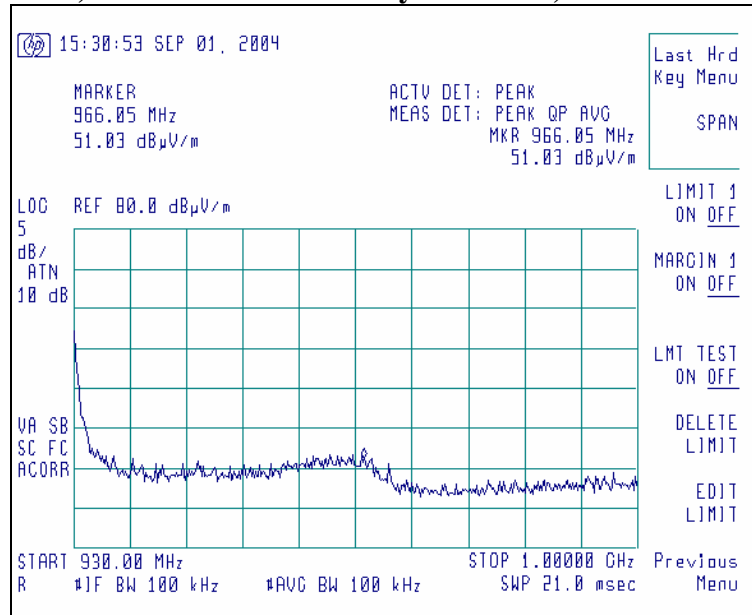




### Channel 127, Antenna 1 Vertically Polarized, 900-930 MHz, at 3m.

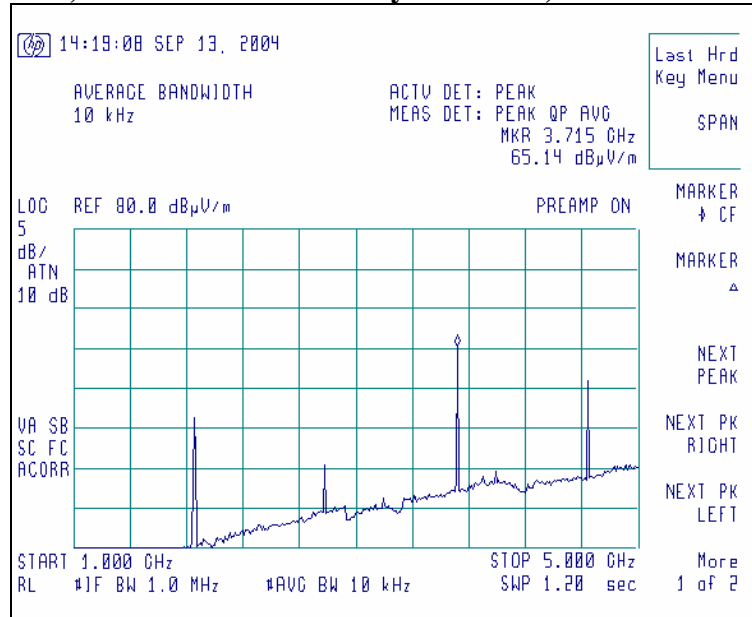


### Channel 127, Antenna 1 Horizontally Polarized, 930-1000 MHz, at 3m.

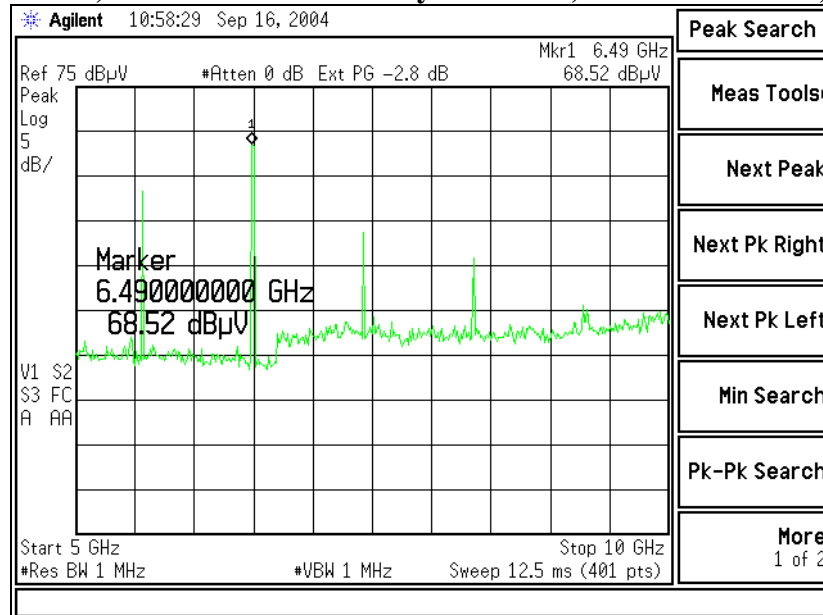




**Channel 127, Antenna 1 Horizontally Polarized, 1000-5000 MHz, at 3m.**



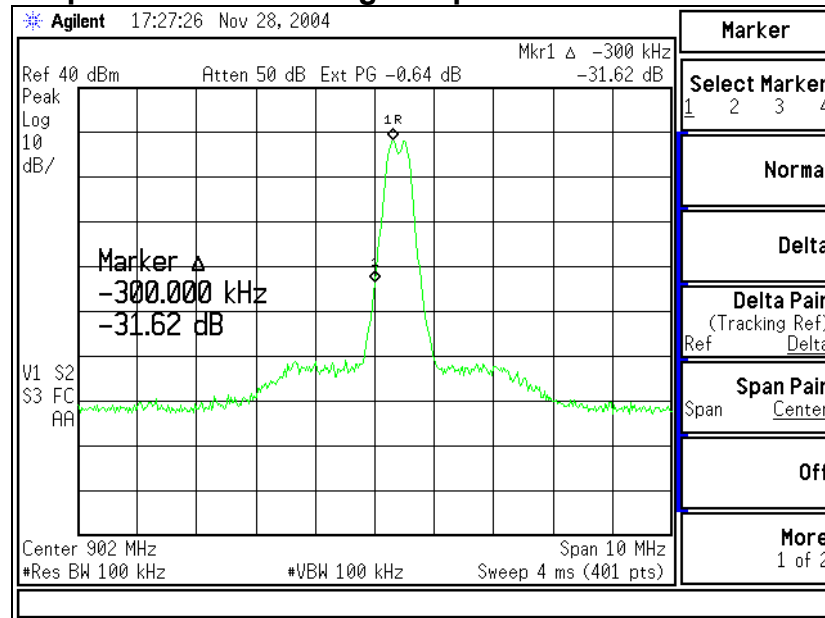
**Channel 127, Antenna 1 Horizontally Polarized, 5000-10000 MHz, at 1m.**



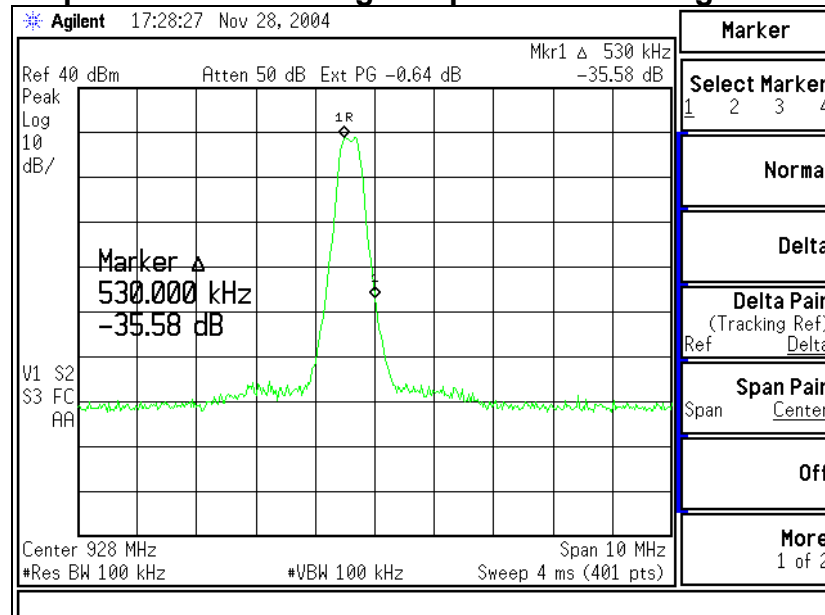
## 20. Band-Edge Measurements

FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the band-edges where the intentional radiator operates. The following screen captures demonstrate compliance of the intentional radiator at the 902.0-928.0 MHz band-edges. The EUT was operated in continuous transmit mode, with modulation provided using a large test file for the data source. The EUT was operated at the lowest channel, for the investigation of the lower band-edge, and at the highest channel for the investigation of the higher band-edge.

**Screen Capture demonstrating compliance at the Lower Band-Edge**



**Screen Capture demonstrating compliance at the Higher Band-Edge**



## **21. Conducted RF Emissions Test, on AC Power Line**

### **Test Setup**

The Conducted Emissions test was performed at L.S. Compliance, Inc. in Cedarburg, Wisconsin. The test area and setup are in accordance with ANSI C63.4-2003 and with Title 47 CFR, FCC Part 15 (Industry Canada RSS-210). The EUT was placed on a test fixture, on top of a non-conductive wooden table, with a height of 80 cm above the reference ground plane. Antenna 1, the Astron 902-928 MHz antenna was used for these tests. The EUT's power source was plugged into a 50 $\Omega$  (ohm), 50/250  $\mu$ H Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided inside the Shielded Test Room via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the HP 8546A EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50 $\Omega$  (ohm) load when switched to either L1 (line) or L2 (neutral).

### **Test Procedure**

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1 (2003), Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30MHz. Final readings were then taken and recorded.

### **Test Equipment Utilized**

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. Calibrations of the LISN and Limiter are traceable to N.I.S.T. All cables are calibrated and checked periodically for conformance. The emissions are measured on the HP 8546A EMI Receiver, which has automatic correction for all factors stored in memory and allows direct readings to be taken.

### **Test Results**

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

### Calculation of Conducted Emissions Limits

The following table describes the Class **B** limits for an unintentional radiator. These limits are obtained from Title 47 CFR, Part 15.107 (a) for Conducted Emissions.

| Frequency (MHz) | Quasi-Peak Limit (dBµV) | Average Limit (dBµV) |
|-----------------|-------------------------|----------------------|
| 0.15 – 0.5      | 66 – 56 *               | 56 - 46              |
| 0.5 – 5.0       | 56                      | 46                   |
| 5.0 – 30.0      | 60                      | 50                   |

\* Decreases with the logarithm of the frequency.

#### Sample calculation for the limits in the 0.15 to 0.5 MHz:

$$\text{Limit} = -19.12 ( \text{Log}_{10} ( F[\text{MHz}] / 0.15 [\text{MHz}] ) ) + 66.0 \text{ dB}\mu\text{V}$$

For a frequency of 200 kHz for example:

$$\text{Quasi-Peak Limit (F = 200kHz)} = -19.12 ( \text{Log}_{10} ( 0.2[\text{MHz}] / 0.15 [\text{MHz}] ) ) + 66.0 \text{ dB}\mu\text{V}$$

$$\text{Quasi-Peak Limit (F = 200kHz)} = 63.6 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F=200kHz)} = -19.12 ( \text{Log}_{10}(0.2[\text{MHz}]/0.15[\text{MHz}]) ) + 56.0 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F = 200 kHz)} = 53.6 \text{ dB}\mu\text{V}$$

## Measurement of Electromagnetic Conducted Emission

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.207 (a)

|                  |  |                                 |                |             |              |
|------------------|--|---------------------------------|----------------|-------------|--------------|
| Manufacturer:    | Encom Wireless Data Solutions, Inc.                              |                                 |                |             |              |
| Date(s) of Test: | August 31 <sup>ST</sup> through November 28 <sup>TH</sup> , 2004 |                                 |                |             |              |
| Test Engineer:   | Tom Smith  | √                               | Abtin Spantman |             | Ken Boston   |
| Model #:         | 'ENC-900' 1000 mW Radio Module                                   |                                 |                |             |              |
| Serial #:        | Engineering Unit #43   |                                 |                |             |              |
| Voltage:         | 3.80 VDC, 1000 mA  |                                 |                |             |              |
| Operation Mode:  | Normal, continuous transmit, and 'Hopping' mode                  |                                 |                |             |              |
| Test Location:   | √  | Shielded Room                   |                |             | Chamber      |
| EUT Placed On:   | √  | 40cm from Vertical Ground Plane |                |             | 10cm Spacers |
|                  | √  | 80cm above Ground Plane         |                |             | Other:       |
| Measurements:    |  | Pre-Compliance                  |                | Preliminary | √ Final      |
| Detectors Used:  |  | Peak                            | √              | Quasi-Peak  | √ Average    |

### Environmental Conditions in the Lab:

Temperature: 20 – 25° C

Atmospheric Pressure: 86 kPa – 106 kPa

Relative Humidity: 30 – 60%

### Test Equipment Utilized:

EMI Receiver: HP 8546A

LISN: EMCO 3816/2NM

Transient Limiter: HP 119474A

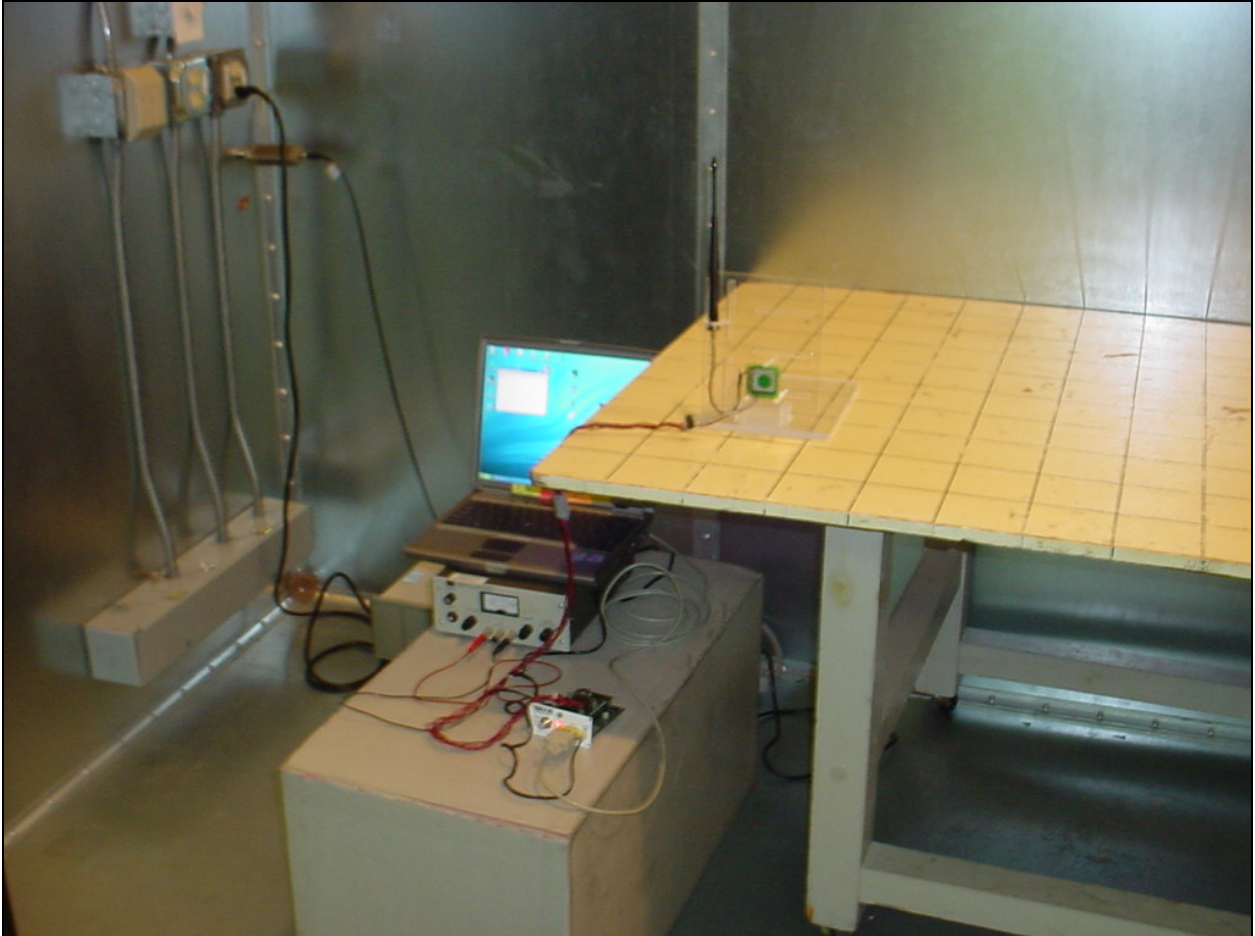
|                 |      | <u>QUASI-PEAK</u>       |                        |                        | <u>AVERAGE</u>           |                         |                     |
|-----------------|------|-------------------------|------------------------|------------------------|--------------------------|-------------------------|---------------------|
| Frequency (MHz) | Line | Q-Peak Reading (dBμV/m) | Q-Peak Limit (dBμ V/m) | Quasi-Peak Margin (dB) | Average Reading (dBμV/m) | Average Limit (dBμ V/m) | Average Margin (dB) |
| 0.16            | L1   | 47.3                    | 65.5                   | 18.2                   | 19.9                     | 55.5                    | 35.6                |
| 0.32            | L1   | 42.6                    | 59.7                   | 17.1                   | 16.5                     | 49.7                    | 33.2                |
| 0.45            | L1   | 39.1                    | 56.9                   | 17.8                   | 13.0                     | 56.9                    | 43.9                |
| 0.49            | L1   | 38.2                    | 56.2                   | 18.0                   | 11.6                     | 46.2                    | 34.6                |
| 0.55            | L1   | 36.7                    | 56.0                   | 19.3                   | 10.0                     | 46.0                    | 36.0                |
|                 |      |                         |                        |                        |                          |                         |                     |
| 0.16            | L2   | 49.2                    | 65.5                   | 16.3                   | 20.0                     | 55.5                    | 35.5                |
| 0.22            | L2   | 45.1                    | 62.8                   | 17.7                   | 15.7                     | 52.8                    | 37.1                |
| 0.25            | L2   | 42.8                    | 61.8                   | 19.0                   | 14.3                     | 51.8                    | 37.5                |
| 0.74            | L2   | 37.8                    | 56.0                   | 18.2                   | 10.3                     | 46.0                    | 35.7                |

### **Notes:**

- 1) The emissions listed are characteristic of the power supply used, and did not change by the EUT.
- 2) All other emissions were better than 20 dB below the limits.
- 3) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested. Data presented above is from the Middle channel 64.

**Photo(s) Taken During Conducted Emission Testing**

**Setup for the Conducted Emissions Test**

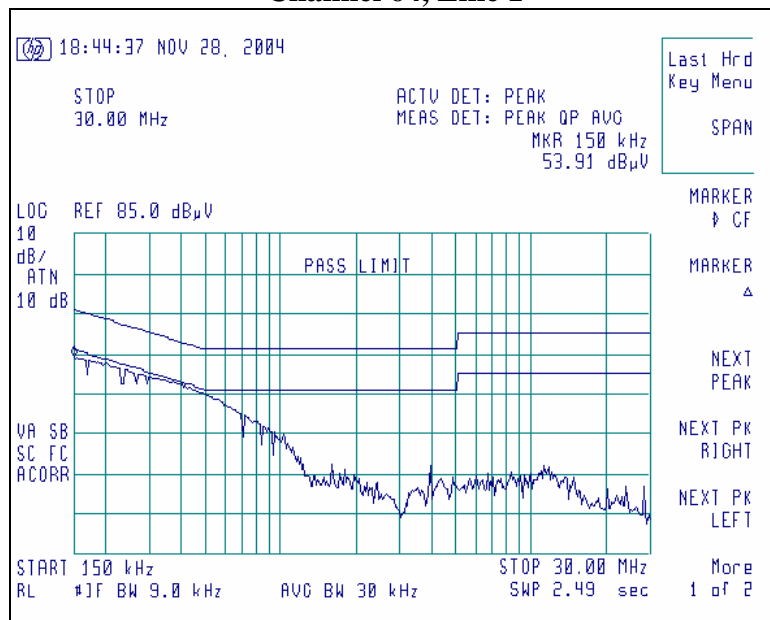


## Screen Captures of Conducted AC Mains Emissions:

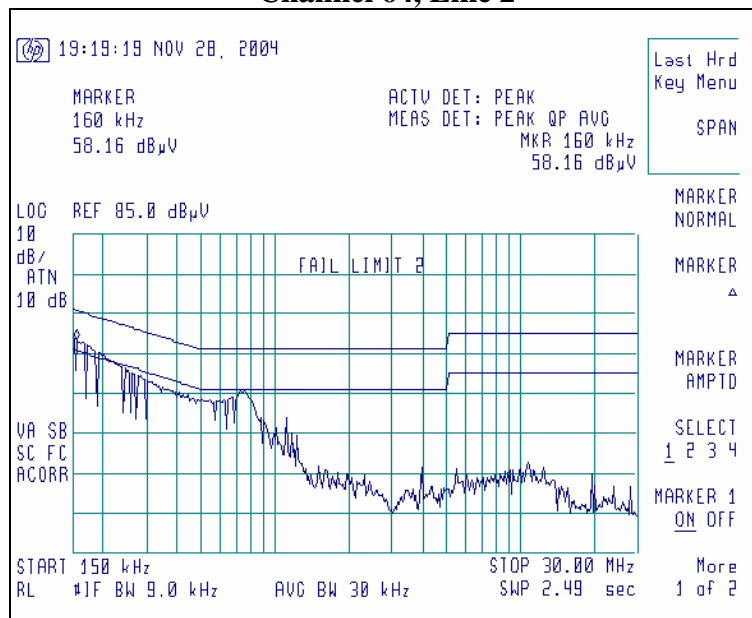
Please note these screen captures represent Peak Emissions. For conducted emission measurements, we utilize both a Quasi-Peak detector function as well as the Average detector function for measurements. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.209.

The signature scans shown here are from channel 64, chosen as being a good representative of channels.

Channel 64, Line 1



Channel 64, Line 2



## **22. Receiver Synchronization**

Each receiver requires the same seed for the pseudorandom sequence generator as the transmitter with which it is operating. The same seed will produce the same hop sequence in each device. Once the receiver scans and finds the transmitter on any given channel it will automatically be synchronized to go to the next correct channel by virtue of using the same hopping table.

## **23. Receiver Input Bandwidth**

The radio receiver is a direct conversion type with a baseband filter whose cutoff frequency is matched to the transmission spectrum. The bandwidth is 600 kHz for use at the 115 kbps rate. Two level frequency shift keying is used for modulation. The simple Carson bandwidth for this type of signal is given as the bit rate plus 2 times the deviation. This system uses 170 kHz deviation for the 115 kbps rate, giving a bandwidth of 340 kHz. The excess filter bandwidth allows for frequency tolerance errors between the transmitter and receiver.



## 24. MPE Calculations

### MPE Calculation

#### Antenna 1

#### Astron 902-928 MHz Half-Wave Dipole

#### Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density

P = power input to the 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

|  |                                |
|--|--------------------------------|
| Maximum peak output power at antenna input terminal:         | 29.11 (dBm)                    |
| Maximum peak output power at antenna input terminal:         | 814.704 (mW)                   |
| Antenna gain(typical):                                       | 2 (dBi)                        |
| Maximum antenna gain:  | 1.585 (numeric)                |
| Prediction distance:   | 20 (cm)                        |
| Prediction frequency:  | 915 (MHz)                      |
| MPE limit for uncontrolled exposure at prediction frequency: | 0.61 (mW/cm <sup>2</sup> )     |
| Power density at prediction frequency:                       | 0.256880 (mW/cm <sup>2</sup> ) |
| Maximum allowable antenna gain:                              | 5.8 (dBi)                      |
| Margin of Compliance at 20 cm =                              | 3.8 dB                         |

## Appendix A

### Test Equipment List

| Asset #  | Manufacturer | Model #    | Serial #   | Description                          | Date     | Due      |
|----------|--------------|------------|------------|--------------------------------------|----------|----------|
| AA960008 | EMCO         | 3816/2NM   | 9701-1057  | Line Impedance Stabilization Network | 9/15/04  | 9/15/05  |
| AA960031 | HP           | 119474A    | 3107A01708 | Transient Limiter                    | Note 1   | Note 1   |
| AA960077 | EMCO         | 93110B     | 9702-2918  | Biconical Antenna                    | 9/16/04  | 9/16/05  |
| AA960078 | EMCO         | 93146      | 9701-4855  | Log-Periodic Antenna                 | 9/16/04  | 9/16/05  |
| AA960081 | EMCO         | 3115       | 6907       | Double Ridge Horn Antenna            | 11-14-03 | 11-14-04 |
| CC00221C | Agilent      | E4407B     | US39160256 | Spectrum Analyzer                    | 11-04-03 | 11-04-04 |
| EE960004 | EMCO         | 2090       | 9607-1164  | Device Controller                    | N/A      | N/A      |
| EE960013 | HP           | 8546A      | 3617A00320 | Receiver RF Section                  | 9/16/04  | 9/16/05  |
| EE960014 | HP           | 85460A     | 3448A00296 | Receiver Pre-Selector                | 9/16/04  | 9/16/05  |
| N/A      | LSC          | Cable      | 0011       | 3 Meter ½" Armored Cable             | Note 1   | Note 1   |
| N/A      | LSC          | Cable      | 0038       | 1 Meter RG 214 Cable                 | Note 1   | Note 1   |
| N/A      | LSC          | Cable      | 0050       | 10 Meter RG 214 Cable                | Note 1   | Note 1   |
| N/A      | Pasternack   | Attenuator | N/A        | 10 dB Attenuator                     | Note 1   | Note 1   |

*Note 1 - Equipment calibrated within a traceable system.*

### Uncertainty Statement

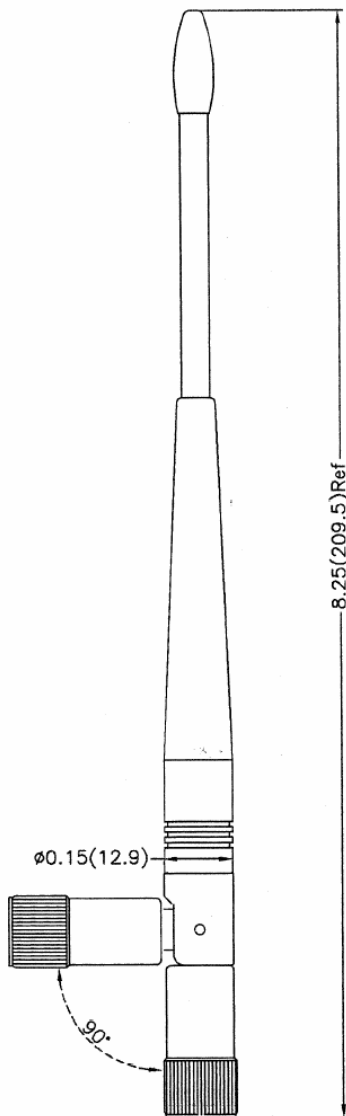
This uncertainty represents an expanded uncertainty  
expressed at approximately the 95% confidence level, using a coverage factor of k=2.

*Table of Expanded Uncertainty Values, (K=2) for Specified Measurements*

| Measurement Type    | Particular Configuration              | Uncertainty Values |
|---------------------|---------------------------------------|--------------------|
| Radiated Emissions  | 3 – Meter chamber, Biconical Antenna  | 4.24 dB            |
| Radiated Emissions  | 3-Meter Chamber, Log Periodic Antenna | 4.8 dB             |
| Radiated Emissions  | 10-Meter OATS, Biconical Antenna      | 4.18 dB            |
| Radiated Emissions  | 10-Meter OATS, Log Periodic Antenna   | 3.92 dB            |
| Conducted Emissions | Shielded Room/EMCO LISN               | 1.60 dB            |
| Radiated Immunity   | 3 Volts/Meter in 3-Meter Chamber      | 1.128 Volts/Meter  |
| Conducted Immunity  | 3 Volts level                         | 1.0 V              |

## Appendix B – Antenna Specification Sheets

### Antenna 1 Specification



#### Electrical Properties:

Frequency Range: 902~928 MHz  
Impedance: 50 $\Omega$  nominal  
VSWR: <2.0:1  
Gain: \*2.0 dBi  
Radiation: Omni  
Polarization: Vertical  
Wave: Half Wave Dipole

#### Mechanical Properties:

Material:  
Whip: Polyurethane(Black)  
Connector: Brass with  
black chrome plating  
Operation Temp.: -20°C to +65°C  
Storage Temp.: -30°C to +75°C

**ASTRON  
PROPRIETARY  
INFORMATION/DATA**

22560 Glenn Drive, Suite 114 • Sterling, Virginia 20164-4440 • 703.450.5517 • Fax: 703.450.9753 • [www.astronwireless.com](http://www.astronwireless.com) • [www.lopro.net](http://www.lopro.net)

## Appendix C

### Firmware and Setup Instructions

#### Procedure for operating Encom Units in ***Continuous mode***

Power up the EUT & connect to PC via RS232

Launch a terminal program on PC such as Teraterm.

If you are using "Hyper Terminal" to send the text file, check the followings:  
"properties – ASCII" setup, line delay and character delay fields should all set to zero.  
Handshaking set to "NONE"

Baud rate = 115200 bps

If you are using "Teraterm" to send the text file, check the followings:

Baud rate = 115200 bps

All other fields should be already set

While in terminal program, type the following (note: it is NOT user friendly):

**Type "AT" [enter] to engage**

**Type "ATMC" [enter] to go into calibration mode**

**Type "ux1" [enter] for channel 1, ux64 for channel 64, or ux127 for channel 127**

**Type "t3" [enter] to set the EUT at full power out**

Note: you will not get any acknowledgement after typing "ux64" [enter], or "t3" [enter].

To change channels, while in terminal program, type "ux1/64/127" depending on channel and "t3". Don't forget the "t3".

## Firmware and Setup Instructions - continued

### Procedure for operating Encom Units in ***HOP mode***

Power up the EUT & connect to PC via RS232

Launch a terminal program on PC such as Teraterm.

If you are using "Hyper Terminal" to send the text file, check the followings:

"properties – ASCII" setup, line delay and character delay fields should all set to zero.

Handshaking set to "NONE"

Baud rate = 115200 bps

If you are using "Teraterm" to send the text file, check the followings:

Baud rate = 115200 bps

All other fields should be already set

While in terminal program, type the following (note: it is NOT user friendly):

Type "AT&V" [enter] to check the current settings

Type "ATS101=1" [enter] to program radio in Master mode

Type "ATS109=5" [enter] to set the maximum dwell time to 30ms

Type "ATS111=100" [enter] 'Minimum packet size = 100 bytes

Type "ATS112=200" [enter] to set the maximum packet size to 200 bytes.

Type "ATS116=10" [enter] 'character timeout = 10ms

Type "ATS117=0" [enter] 'TX buffer ON

Type "ATS120=10" [enter] 'RTS/CTS delay time = 10ms

Type "ATS121=2" [enter] 'RTS/DCD turn off delay time = 2ms

Type "AT&k0" [enter] 'Hardware handshaking OFF

Type "AT&V" [enter] to double check the change you have made,

Type "AT&W" [enter] to save this change to FLASH,

Type "ATA" [enter] to put radio into "DATA MODE"

While still in terminal program, go to the command line:

**File → Send File → C:\Abtins folder\00.WAV [Enter]**

Dumps a very long file (689MB) using "ASCII" protocol, giving you approximately 30 minutes of run time.