L.S. Compliance, Inc.
W66 N220 Commerce Court
Cedarburg, WI 53012
262-375-4400 Fax: 262-375-4248

COMPLIANCE TESTING OF:

'ENC-900' 100 Milli-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-TX100-Rev. 2-0

Test Dates:

August 31ST 2004 through February 19TH 2005

Table of Contents

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 26th day of March 2003.

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	Test Method(s)
Emissions	
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

Roxanne M. Robinson

(A2LA Cert. No. 1255-01) 05/13/03 Page 1 of 2

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

NIST CENTENNIAL 1901-2001

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-

January 16, 2001

Mr. James J. Blaha
L.S. Compliance Inc.
W66 N220 Commerce Court
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).

(✓) Electromagnetic Compatibility-Council Directive 89/336/EEC, Article 10(2)
( ) Telecommunication Equipment-Council Directive 98/13/EC, Annex III
( ) Telecommunication Equipment-Council Directive 98/13/EC, Annex III and IV
Identification Number:
( ) 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.

(✓) Only the facility noted in the address block above has been approved.
( ) Additional EMC facilities:
( ) Additional R&TTE facilities:

Please note that an organization's validations for various sectors of the MRA are listed on our web site at http://ts.nist.gov/mra. 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.

NIST

5. Signature Page

Prepared By: February 21, 2005

Teresa A. White, Document Coordinator Date

Tested By: February 21, 2005

Abtin Spantman, EMC Engineer Date

Approved By: February 21, 2005

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

6. Product and General Information

Manufacturer:	Encom Wireless Data Solutions, Inc.
Date(s) of Test:	August 31ST 2004 through February 19TH 2005
Test Engineer(s):	Tom Smith √ Abtin Spantman Ken Boston
Model #:	'ENC-900' 100 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 31ST ,2004, through February 19TH , 2005, a series of Conducted and Radiated RF Emission tests were performed on one sample of the Encom Wireless Data Solutions', Model Number: 'ENC-900 (100 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 Radioelelectriques (CISPR) Number 16-1, 2003.

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

This report qualifies the EUT at 100 mW (+20 dBm) output power, for use with high gain antennas, up to 10 dBd, such as the Yagi antenna and monopole antenna specified by the manufacturer, as covered in this report. The same EUT was tested at 1000 mW (+30 dBm), for use with lower gain antennas.

L.S. Compliance report number 304238-Tx1000 contains the data for the 1000 mW unit, and is published again, in part, in this report, in sections covering channel occupancy, channel separation, and channel dwell.

8. Product Description

The ENCOM ‘ENC-900 (100 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 100 milli-watt (+20 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 (100 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 (100 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

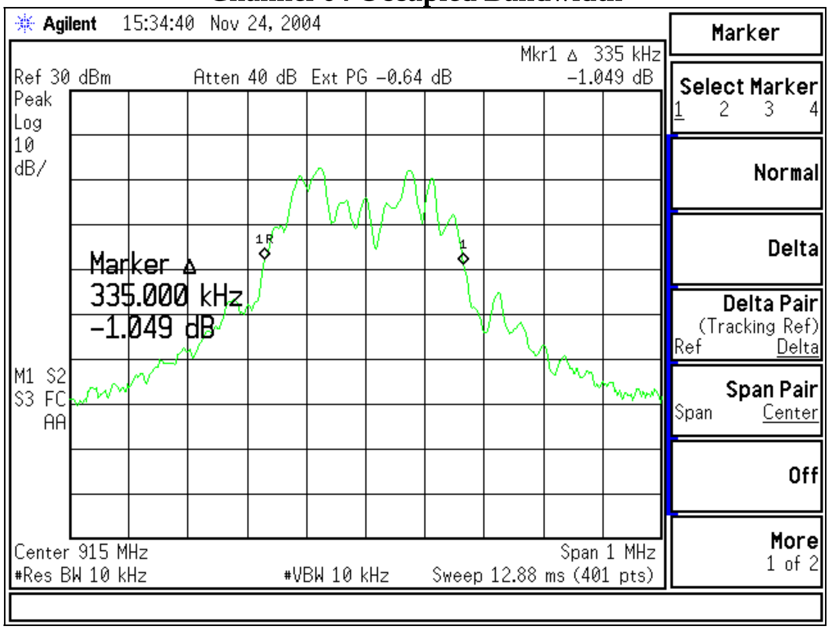
The 20 dB bandwidth requirement found in FCC Part 15.247(a)(1)(i) states a maximum allowed occupied bandwidth of 500 kHz. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4407B spectrum analyzer. 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 335 kHz, which is below the maximum of 500 kHz.

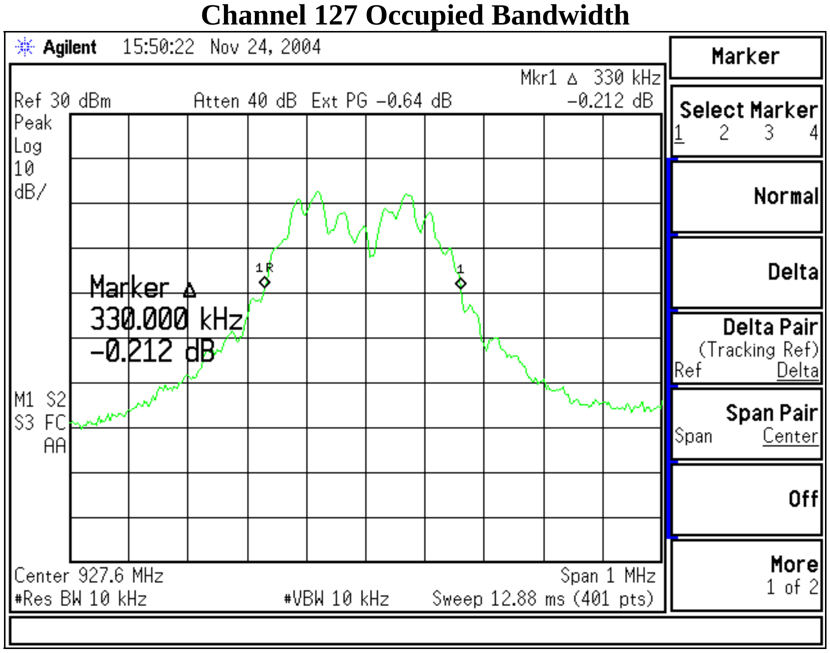
Channel	Center Frequency (MHz)	Measured 20 dB BW (kHz)	Maximum Limit (kHz)
01	903.392	333	500
64	914.996	335	500
127	927.594	330	500

Plots of Occupied Bandwidth

Channel 64 Occupied Bandwidth



Channel 127 Occupied Bandwidth

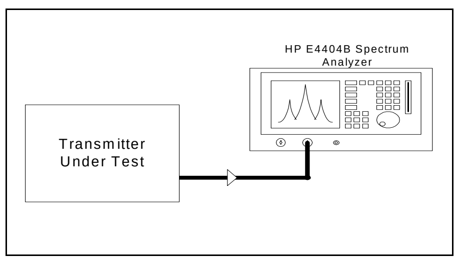


12. Conducted Emissions Test, Power Output 15.247(b)

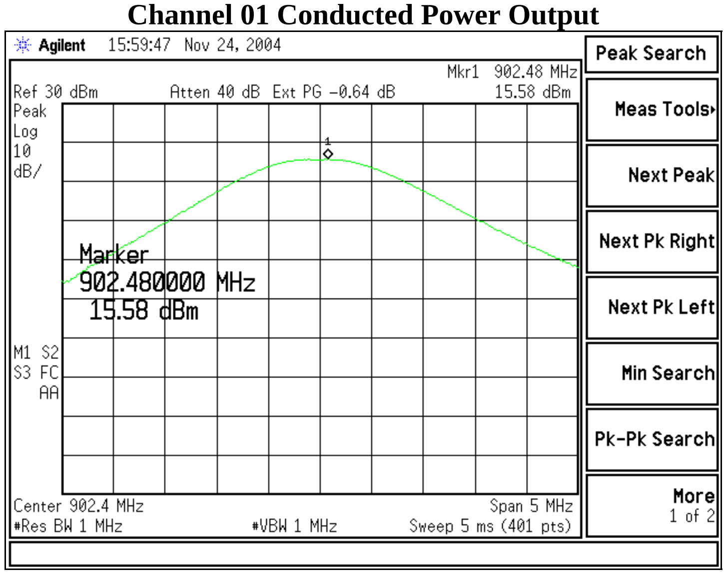
The conducted RF output power of the EUT was measured at the antenna port using a short RF cable for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings (-0.64 dB Gain), there by allowing direct readings of the measurements made without 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%).

The EUT is being qualified using a 10 dBd (~12.1 dBi) high gain antenna. According to 15.247(b)(4), and 15.247(c)(1)(iii) for fixed point-to-point operation, the maximum allowed power output is reduced from +30 dBm, by the amount in dB that the directional gain of the antenna exceeds 6 dBi. New limit is therefore calculated to be: +30 dBm – (12.1 dBi – 6 dB) = + 23.9 dBm

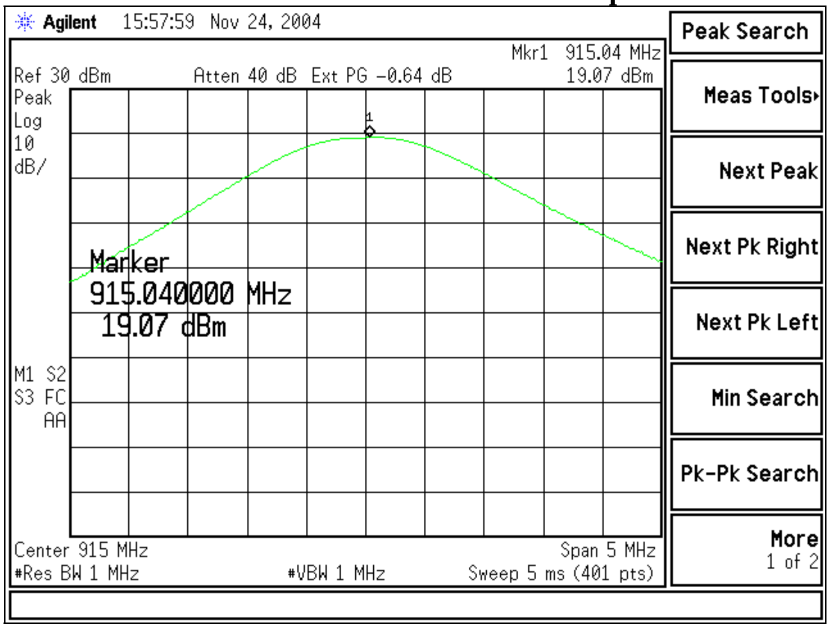
Channel	Center Frequency (MHz)	Limit (dBm)	Measured Power (dBm)	Margin (dB)
01	902.3	+23.9	+15.6	8.3
64	915.1	+23.9	+19.1	4.8
127	927.5	+23.9	+18.8	5.1



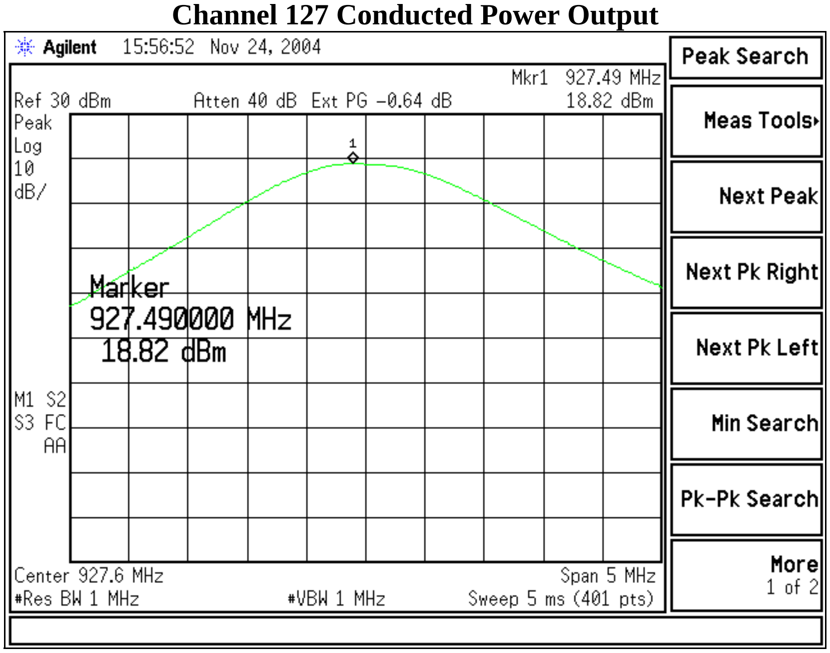
Channel 01 Conducted Power Output



Channel 64 Conducted Power Output



Channel 127 Conducted Power Output



13. Frequency and Power Stability over Voltage Variations

For this test, the EUT was place 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	15.6 (dBm)	15.6 (dBm)	15.5 (dBm)
Channel 64	18.6 (dBm)	19.1 (dBm)	18.6 (dBm)
Channel 127	18.5 (dBm)	18.9 (dBm)	18.2 (dBm)

	DC Voltage Source		
	3.23 V	3.80 V	4.37 V
Channel 1	902.40640 (MHz)	902.40642 (MHz)	902.40650 (MHz)
Channel 64	914.99521 (MHz)	914.99522 (MHz)	914.99554 (MHz)
Channel 127	927.59059 (MHz)	927.59071 (MHz)	927.59102 (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, 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 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.

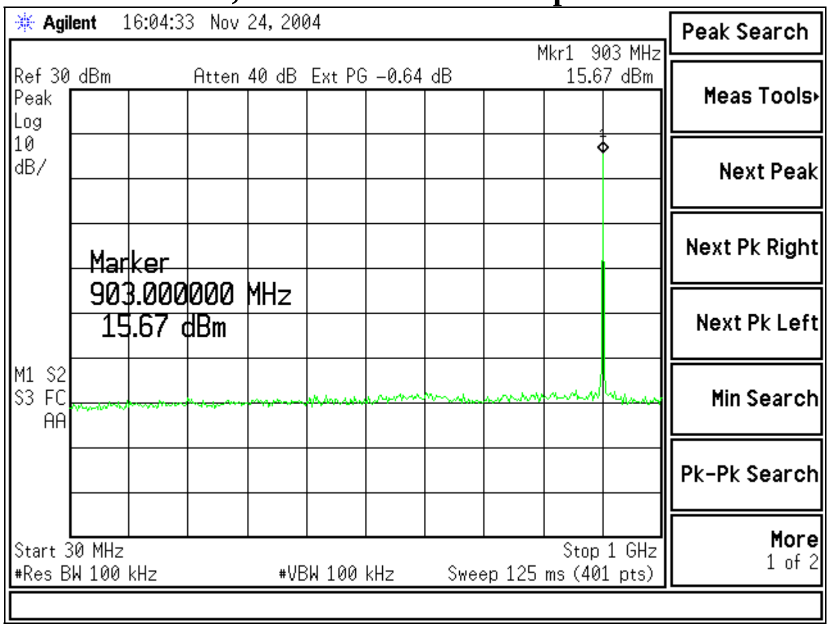
No significant emissions could be noted within -40 dBc of the fundamental level for this product.

	Channel 01	Channel 64	Channel 127
Fundamental	+ 15.6 (dBm)	+ 18.6 (dBm)	+ 17.6 (dBm)
2nd Harmonic	- 27.8 (dBm)	- 33.1 (dBm)	- 34.6 (dBm)
3rd Harmonic	Note (1)	Note (1)	Note (1)
4th Harmonic	Note (1)	Note (1)	Note (1)
5th Harmonic	Note (1)	Note (1)	Note (1)

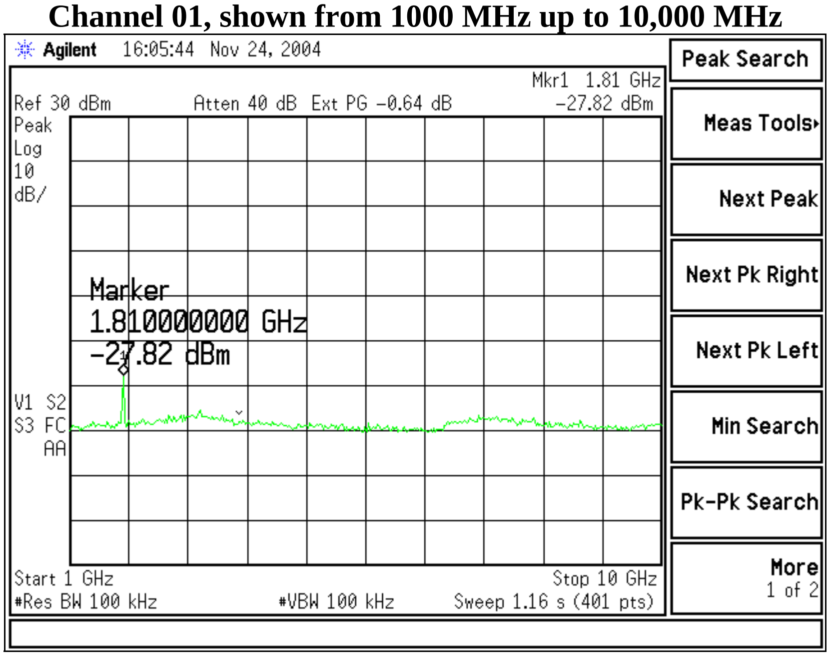
Notes:
(1) Measurement at system noise floor.

Plots of Conducted Spurious and Fundamental Levels

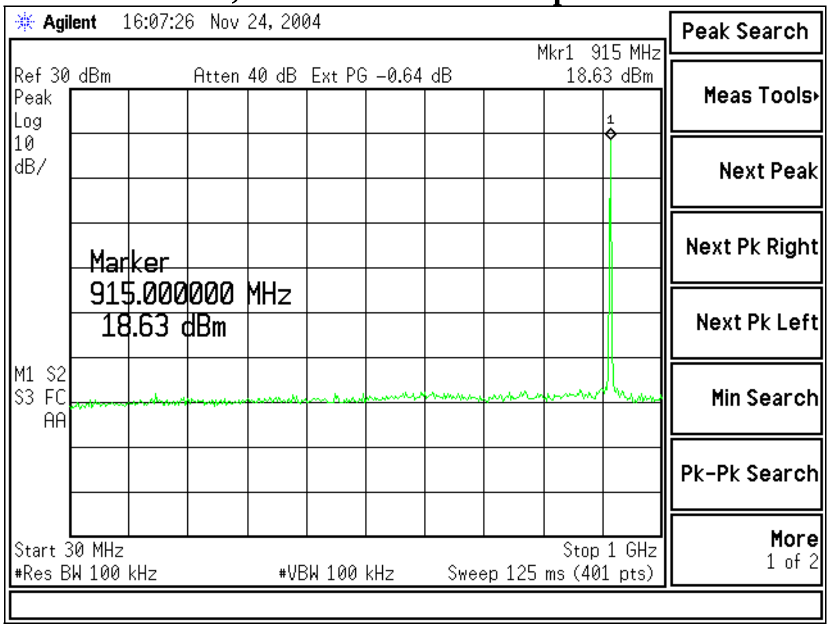
Channel 01, shown from 30 MHz up to 1000 MHz



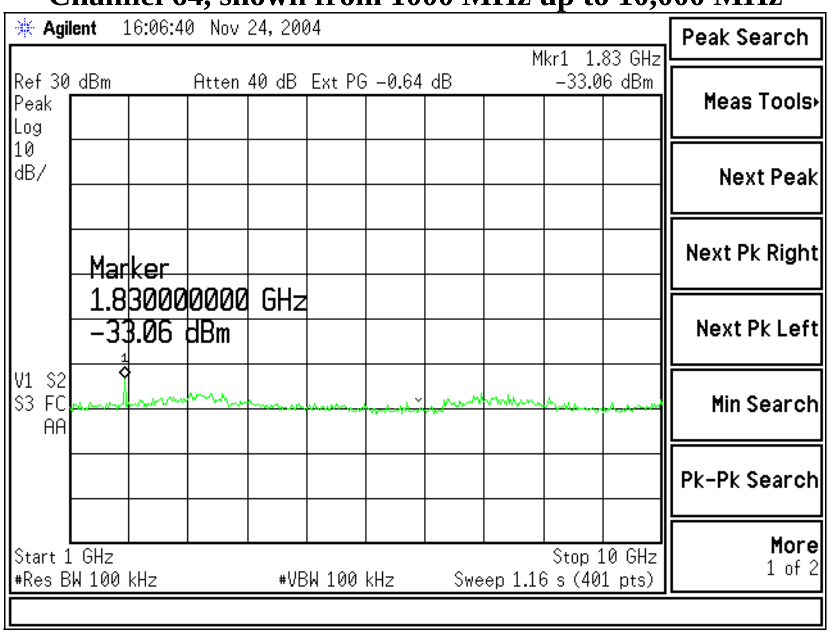
Channel 01, shown from 1000 MHz up to 10,000 MHz



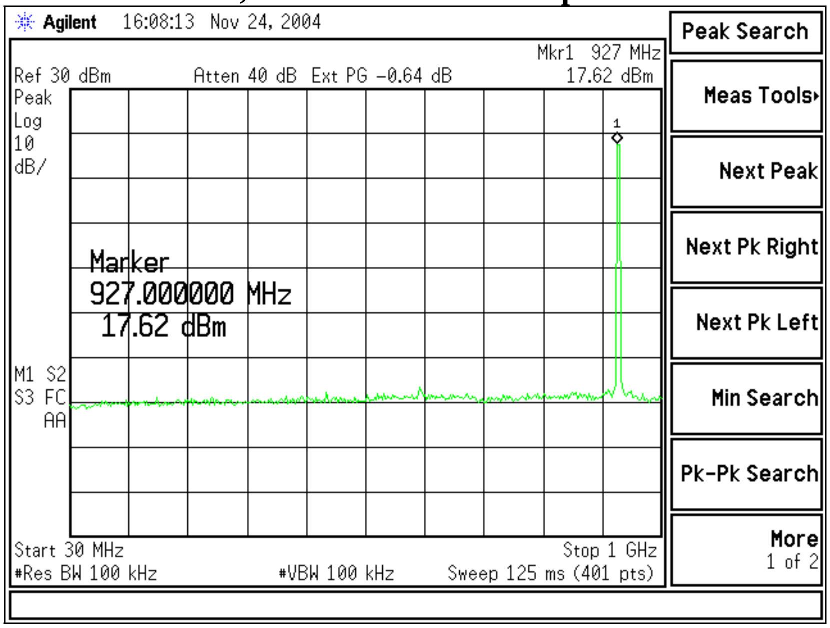
Channel 64, shown from 30 MHz up to 1000 MHz



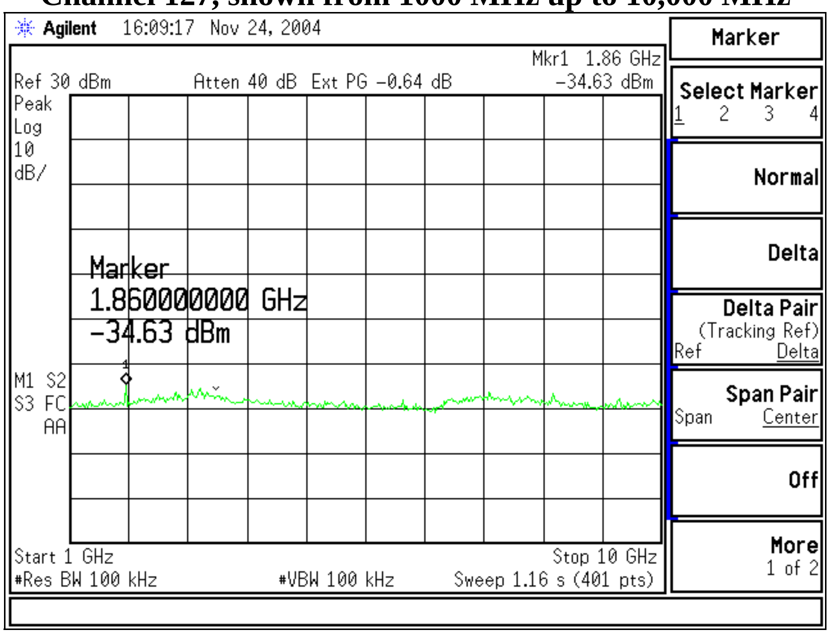
Channel 64, shown from 1000 MHz up to 10,000 MHz



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.

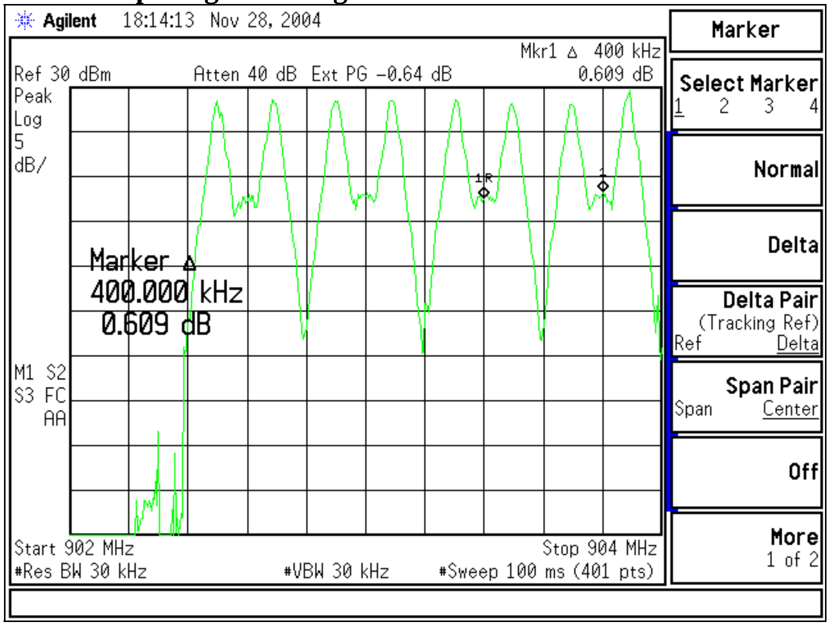
The minimum channel-separation measured for this device is 400 kHz. The maximum occupied bandwidth of the device, as reported in the previous section is 343 kHz. The minimum channel separation for the EUT exceeds both the 25 kHz criteria and the 20 dB occupied bandwidth criteria, and hence meets the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

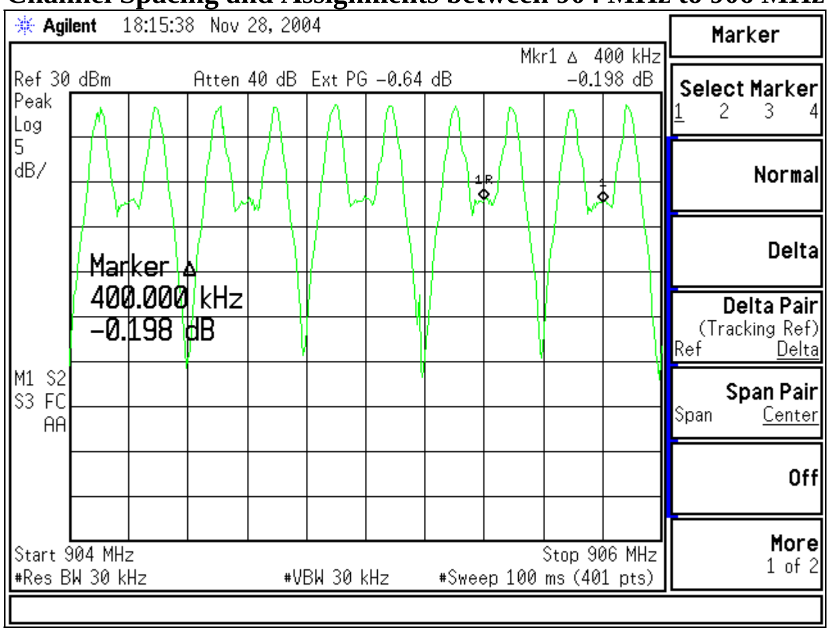
The data contained in this section is reproduced from LS Compliance report number 304238-TX1000.

Plots of Channel Separations

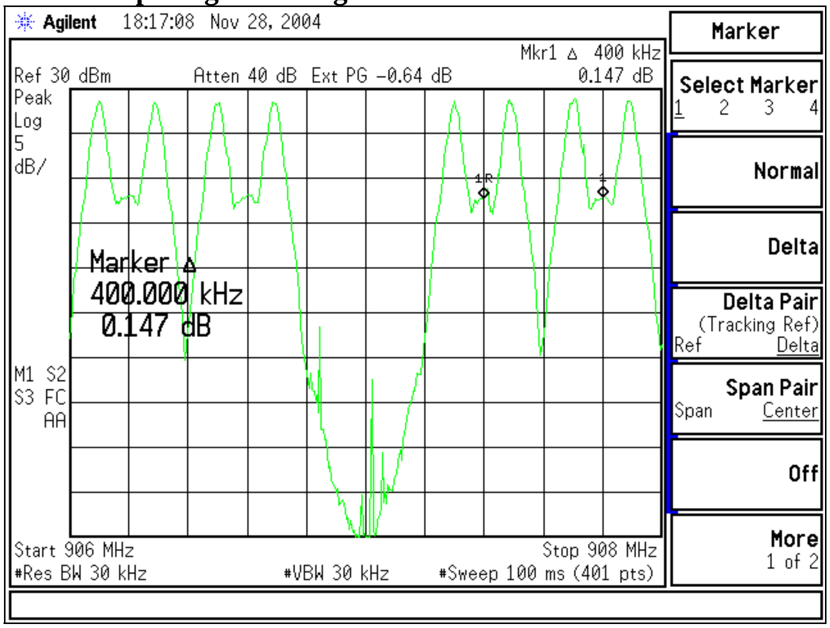
Channel Spacing and Assignments between 902 MHz to 904 MHz



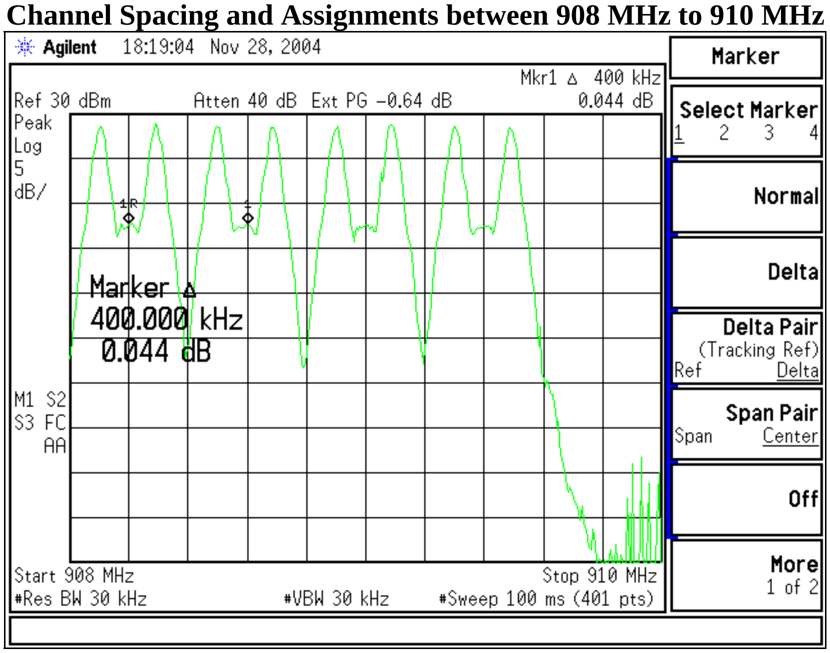
Channel Spacing and Assignments between 904 MHz to 906 MHz



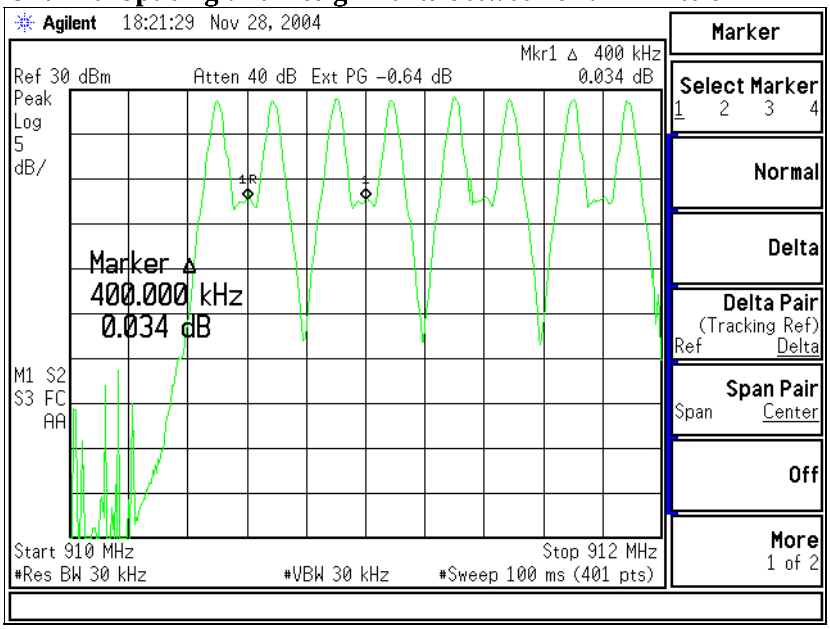
Channel Spacing and Assignments between 906 MHz to 908 MHz



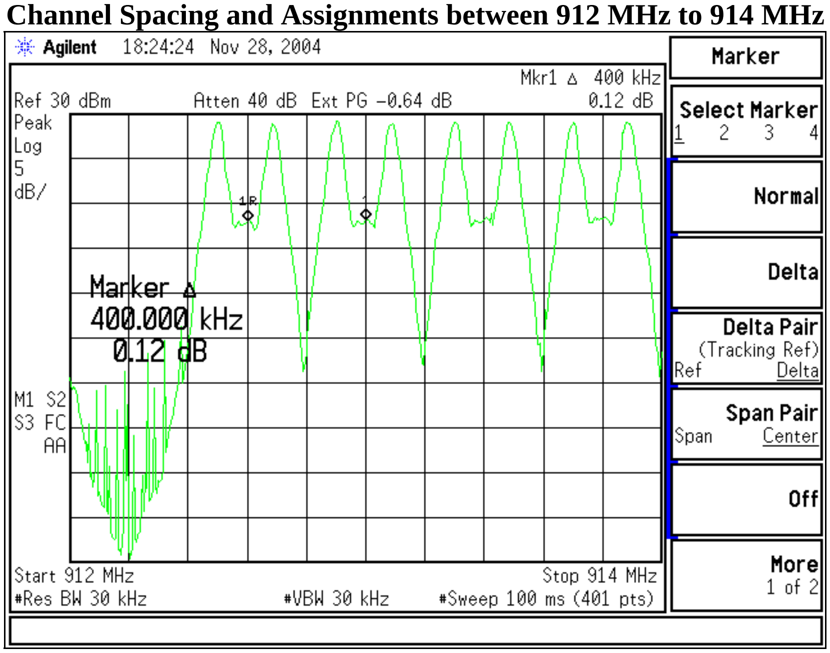
Channel Spacing and Assignments between 908 MHz to 910 MHz



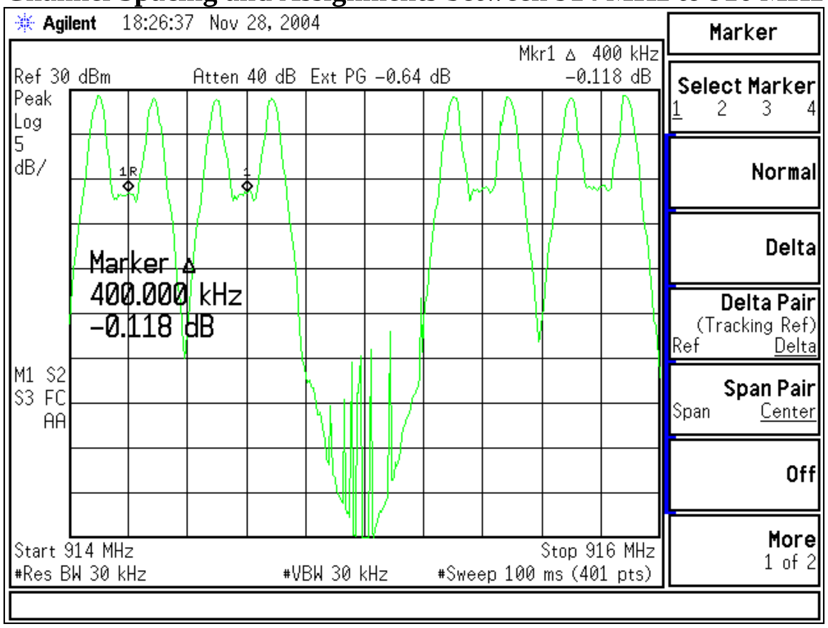
Channel Spacing and Assignments between 910 MHz to 912 MHz



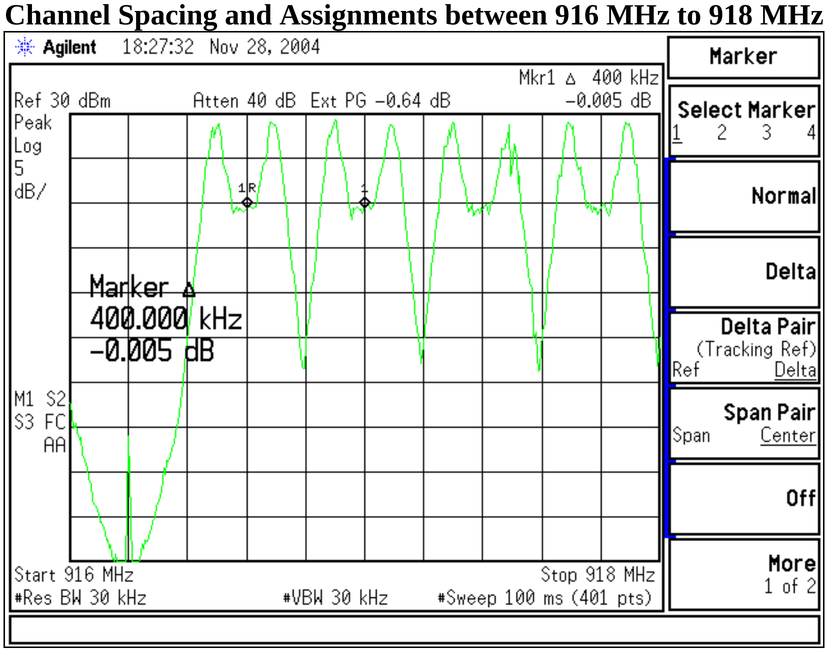
Channel Spacing and Assignments between 912 MHz to 914 MHz



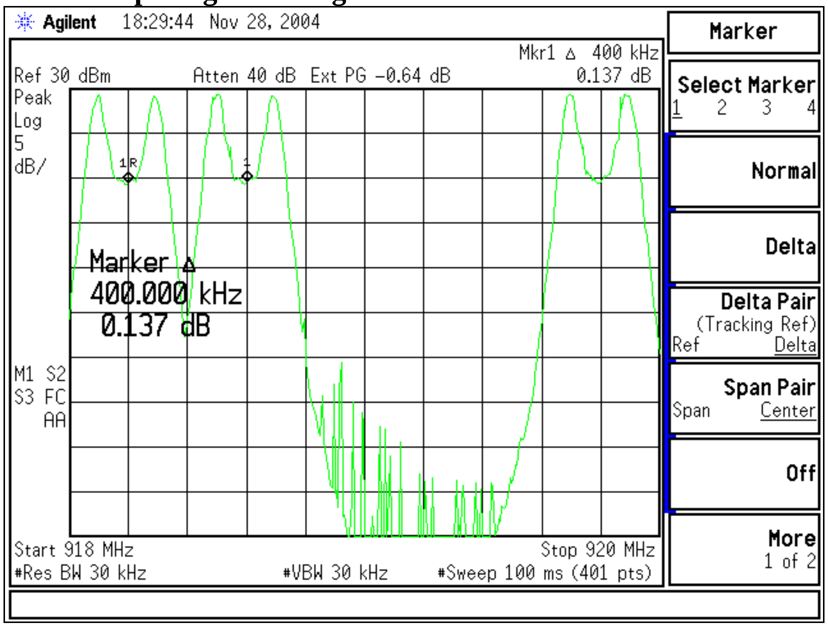
Channel Spacing and Assignments between 914 MHz to 916 MHz



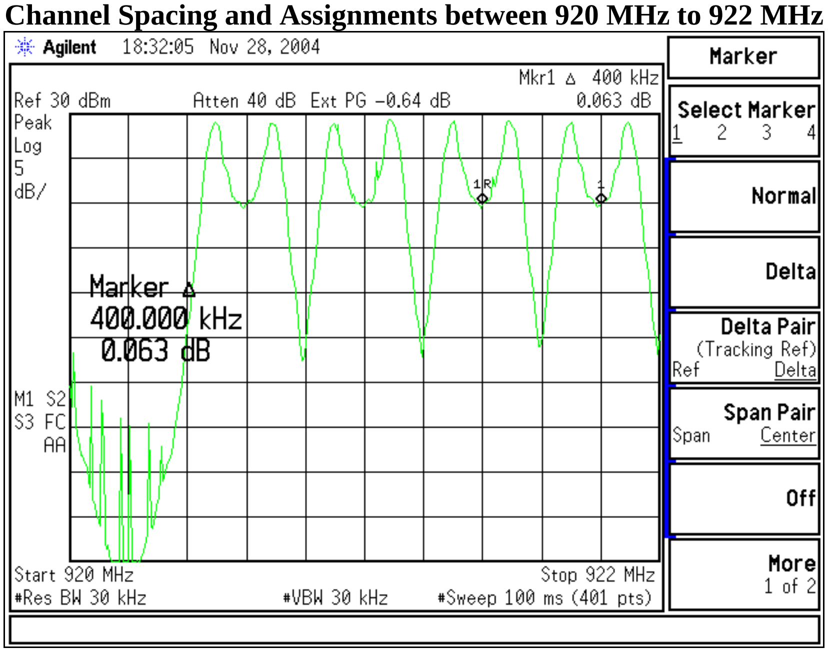
Channel Spacing and Assignments between 916 MHz to 918 MHz



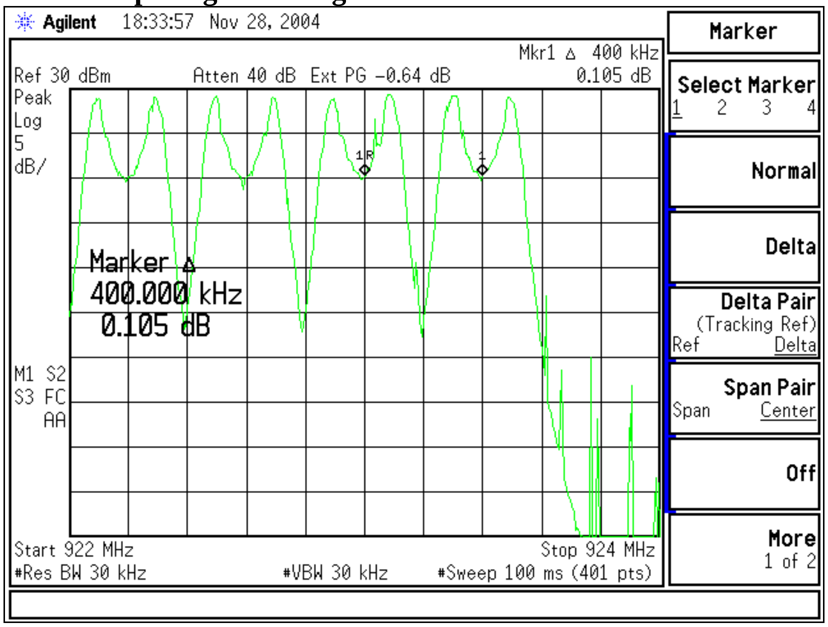
Channel Spacing and Assignments between 918 MHz to 920 MHz



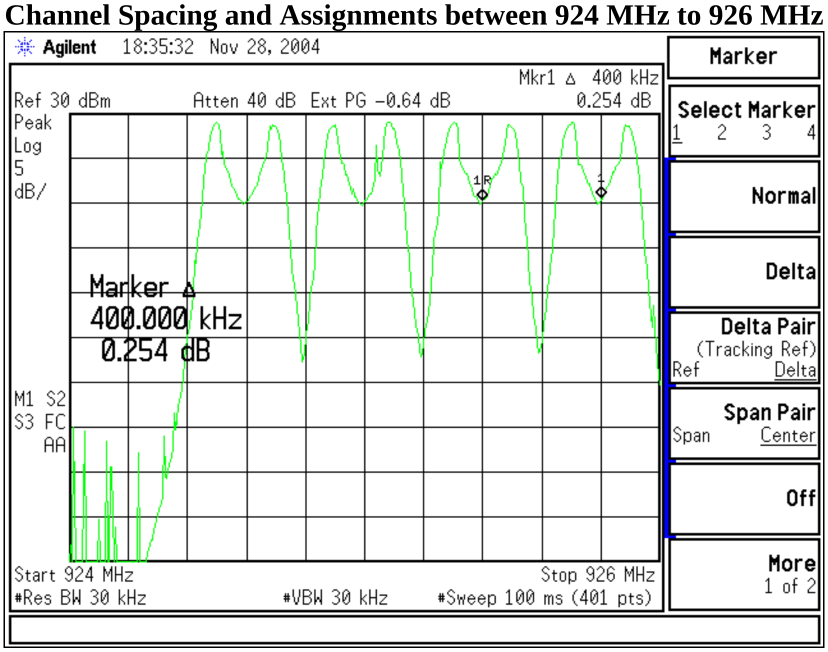
Channel Spacing and Assignments between 920 MHz to 922 MHz



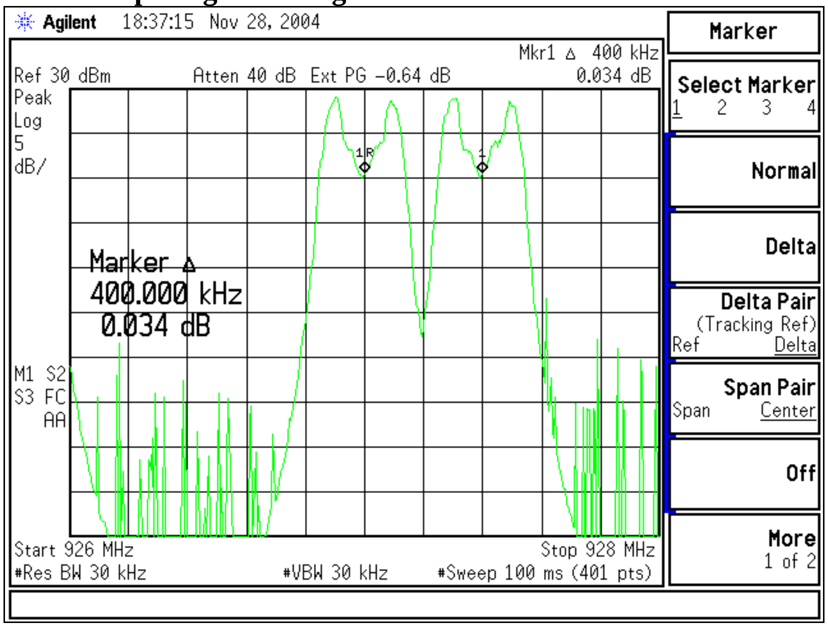
Channel Spacing and Assignments between 922 MHz to 924 MHz



Channel Spacing and Assignments between 924 MHz to 926 MHz



Channel Spacing and Assignments between 926 MHz to 928 MHz



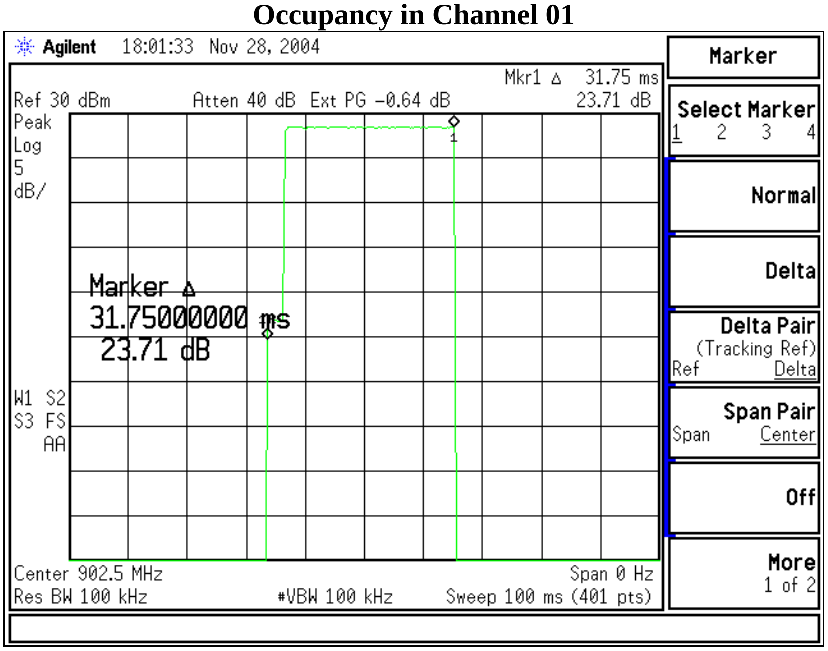
16. Conducted Emissions Test, Channel Occupancy

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

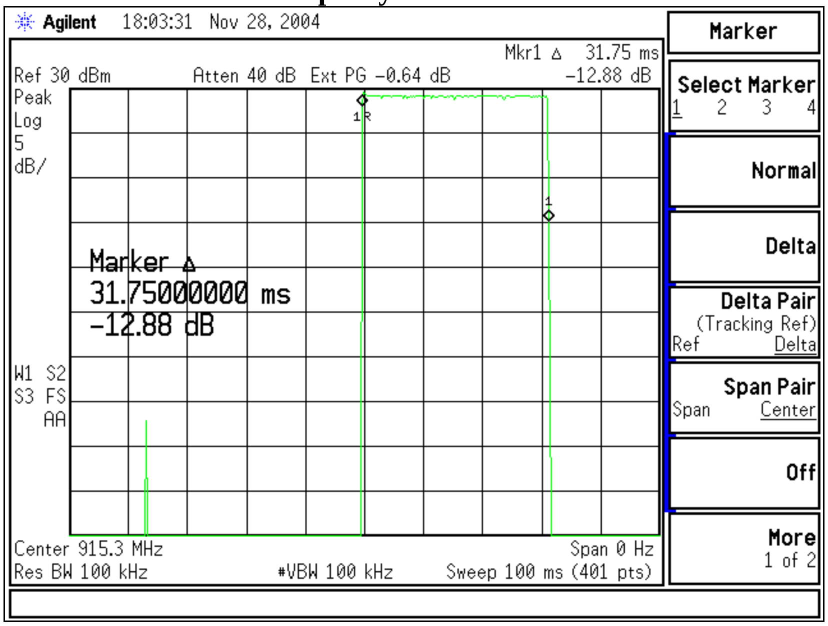
Plots of Channel Occupancy

Occupancy in Channel 01

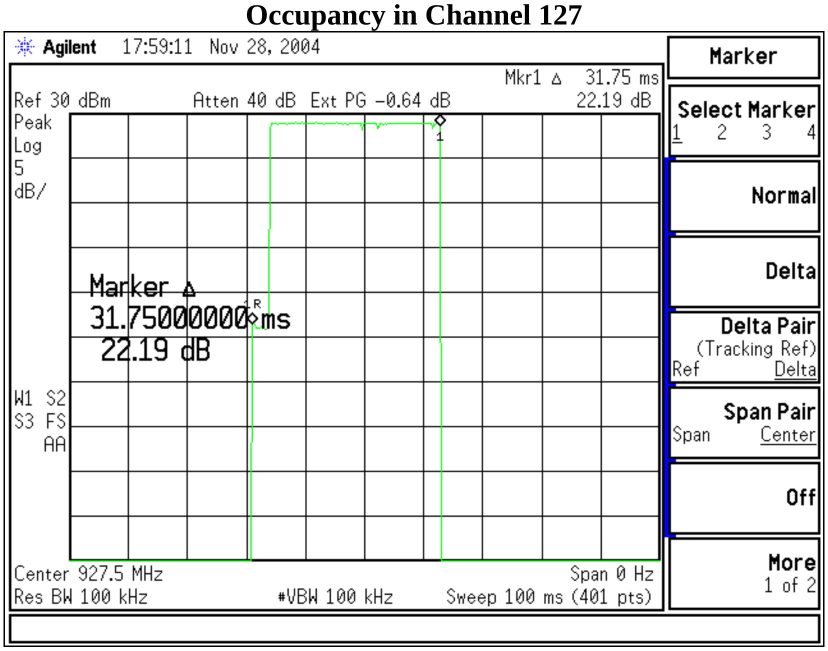


The data contained in this section is reproduced from LS Compliance report number 304238-TX1000.

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 two different types of antennas, as covered in this report. The first antenna was an Bluewave™ brand, 902-928 MHz 10 dBd Yagi. Because the EUT and the antenna were connected via a 20 cm coaxial cable, followed by a 182 cm coaxial extension cable for the Yagi, as provided by the manufacturer, 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.

The second antenna was an Antenex Brand, model FG9026, 6 dBd monopole, installed on a 2 meter high non-conductive stand, only in vertical orientation, with a 20 cm coaxial cable, as well as a 182 cm coaxial extension for the Dipole as provided by the manufacturer. During these tests, only the EUT was investigated in along three orthogonal axis while the EUT antenna was kept in the vertical installation.

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 radiated emission limits under 15.247(b)(4) make an allowance for directional gains up to 6 dBi, raising the radiated emission limit from 125.2 dBµV/m at 3 meters, to 131.2 dBµV/m at 3 meters. The harmonic and spurious RF emissions, as measured in any 100kHz 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 (MHz)	3 m Limit µV/m	3 m Limit (dBµV/m)	1 m Limit (dBµV/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 µV/m to dBµV/m:
$dB\mu V/m = 20 \log_{10} (100)$
$= 40$ dBµV/m (from 30-88 MHz)

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

960 MHz to 10,000 MHz
500µV/m or 54.0 dB/µV/m at 3 meters
54.0 + 9.5 = 63.5 dB/µV/m at 1 meter

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

960 MHz to 10,000 MHz
500µV/m or 54.0 dB/µV/m at 3 meters
54.0 + 20 = 74 dB/µV/m at 0.3 meters

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 31st 2004 through February 19th 2005					
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	'ENC-900' 100 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 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)
125.9	V	Hop Mode	1.00	0	31.1	43.0	11.9
966.6	V	127	1.95	0	52.1	54.0	1.9

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) *All other spurious emissions were better than 20 dB below the limits.*

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Antenna 1:

Bluewave Antenna model: BW947Y

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	1.95	0	129.9	131.2	1.3
1805	H	01	1.00	35	60.7	109.9	49.2
2707	V	01	1.00	20	50.8	54.0	3.2
3610	H	01	1.05	0	43.2	54.0	10.8
4512	V	01	1.00	75	49.7	54.0	4.3
5414	H	01	1.00	45	48.6	63.5	14.9
6317	H	01	1.00	120	59.9	109.9	50.0
7219	H	01	1.00	120	38.9	109.9	71.0
8122	H	01	1.00	30	42.6	63.5	20.9
9024	H	01	1.00	120	36.6	63.5	26.9

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	2.05	0	129.6	131.2	1.6
1830	H	64	1.00	25	58.2	109.6	51.4
2745	V	64	1.70	30	49.7	54.0	4.3
3659	H	64	1.00	0	45.2	54.0	8.8
4574	V	64	1.00	65	48.8	54.0	5.2
5490	H	64	1.00	55	49.4	63.5	14.1
6405	H	64	1.10	125	60.7	109.6	48.9
7320	H	64	1.00	125	42.8	63.5	20.7
8235	H	64	1.25	65	46.7	63.5	16.8
9150	H	64	1.00	115	36.8	63.5	26.7

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	1.95	0	129.7	131.2	1.5
1855	H	127	1.00	15	59.5	109.7	50.2
2783	V	127	1.00	15	43.5	54.0	10.5
3710	H	127	1.36	0	44.3	54.0	9.7
4638	V	127	1.15	50	49.2	54.0	4.8
5566	H	127	1.00	55	55.2	109.7	54.5
6493	H	127	1.00	130	59.9	109.7	49.8
7421	H	127	1.00	130	44.4	63.5	19.1
8348	H	127	1.00	35	44.6	63.5	18.9
9276	H	127	1.00	0	35.8	107.1	71.3

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.

Antenna 2:

Antenex Model FG9026 Monopole

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	2.35	90	110.8	131.2	20.4
1805	V	01	1.00	5	57.8	90.8	33.0
2707	H	01	1.00	45	47.2	54.0	6.8
3610	H	01	1.00	90	49.9	54.0	4.1
4512	V	01	1.54	145	49.5	54.0	4.5
5414	V	01	1.10	270	45.7	63.5	17.8
6317	V	01	1.05	95	57.7	90.8	33.2
7219	V	01	1.10	145	48.3	90.8	42.5
8122	V	01	1.00	230	47.2	63.5	16.3
9024	H	01	1.20	50	39.9	63.5	23.7

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	2.20	290	113.6	131.2	17.6
1830	V	64	1.00	0	59.2	93.6	34.4
2745	V	64	1.75	25	49.0	54.0	5.0
3659	H	64	1.15	90	51.8	54.0	2.2
4574	V	64	1.24	115	49.5	54.0	4.5
5490	V	64	1.05	90	45.4	63.5	18.2
6405	V	64	1.10	175	55.9	93.6	37.8
7320	V	64	1.10	150	48.0	63.5	15.5
8235	V	64	1.00	75	47.9	63.5	15.7
9150	V	64	1.05	130	39.8	63.5	23.7

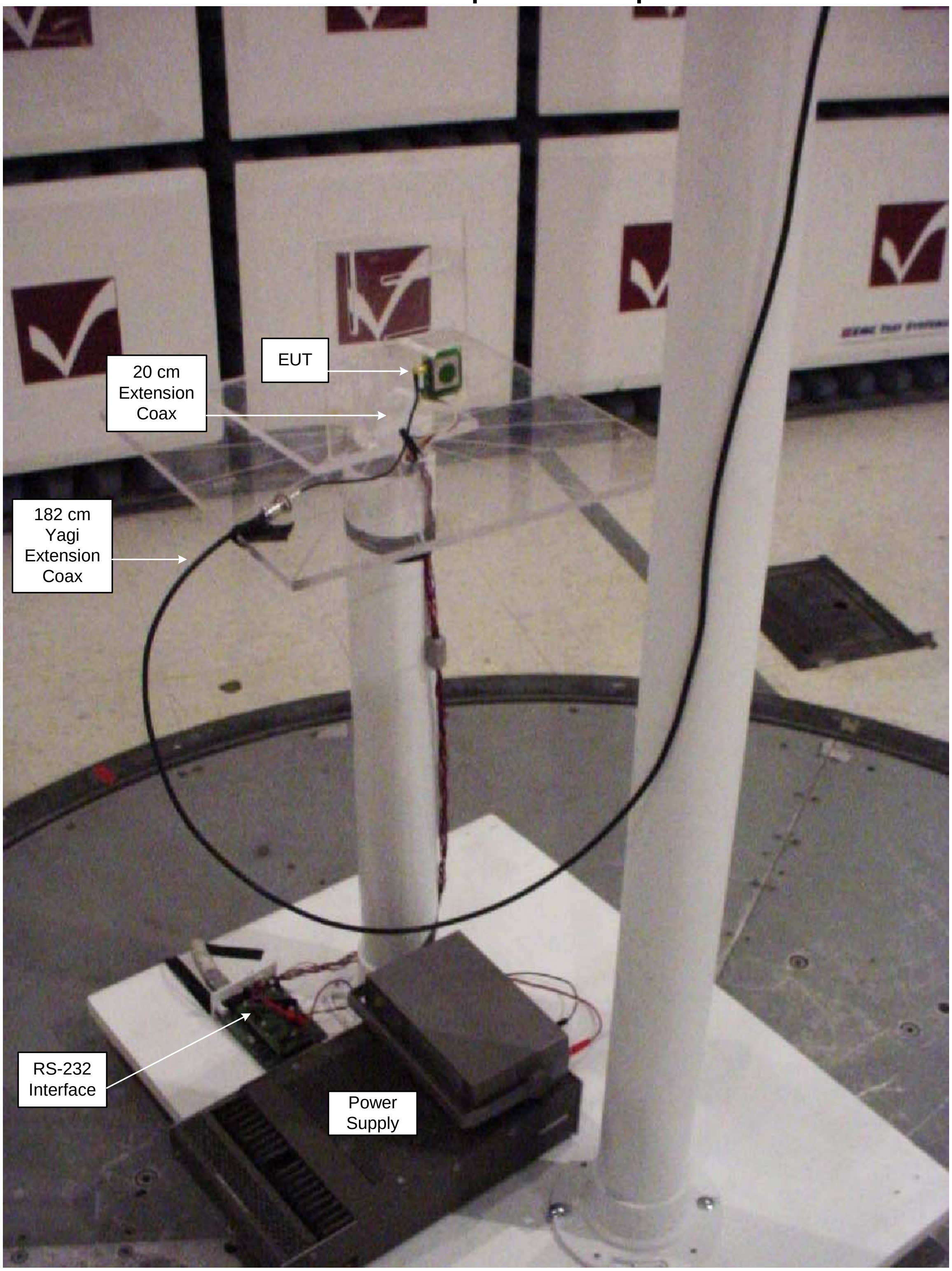
The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 127:

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	2.15	290	114.7	131.2	16.5
1855	H	127	1.38	10	53.7	94.7	41.0
2783	V	127	1.00	25	50.8	54.0	3.2
3710	H	127	1.00	45	52.6	54.0	1.4
4638	V	127	1.60	135	50.3	54.0	3.7
5566	V	127	1.05	100	48.7	94.7	46.1
6493	V	127	1.10	110	58.5	94.7	36.2
7421	V	127	1.05	140	47.2	63.5	16.3
8348	V	127	1.00	55	44.8	63.5	18.8
9276	V	127	1.05	75	37.8	94.7	57.0

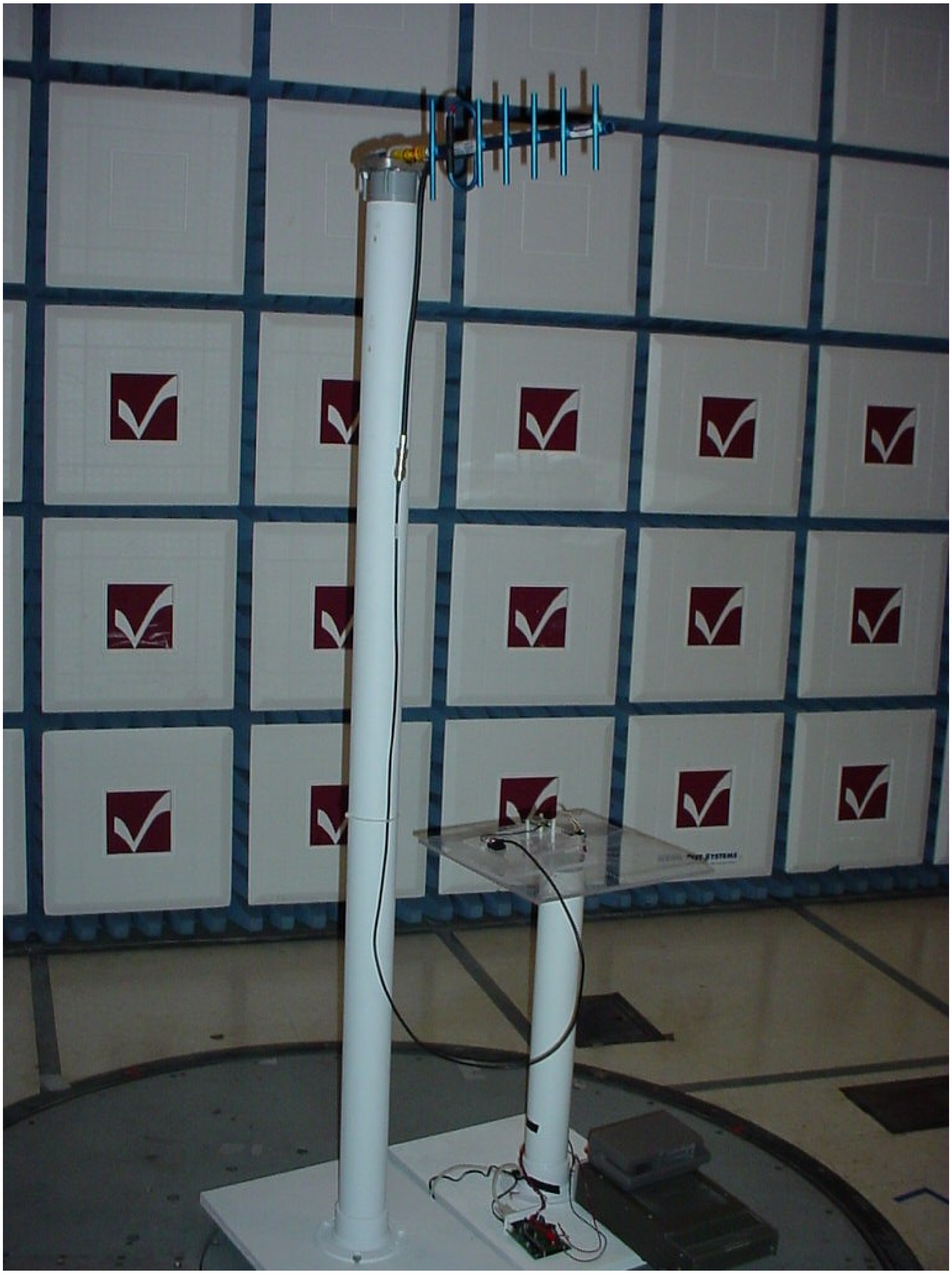
Notes: A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. Only the results from the Average detector are published in the table above. The peak detector was used to ensure the peak emissions did not exceed 20 dB 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

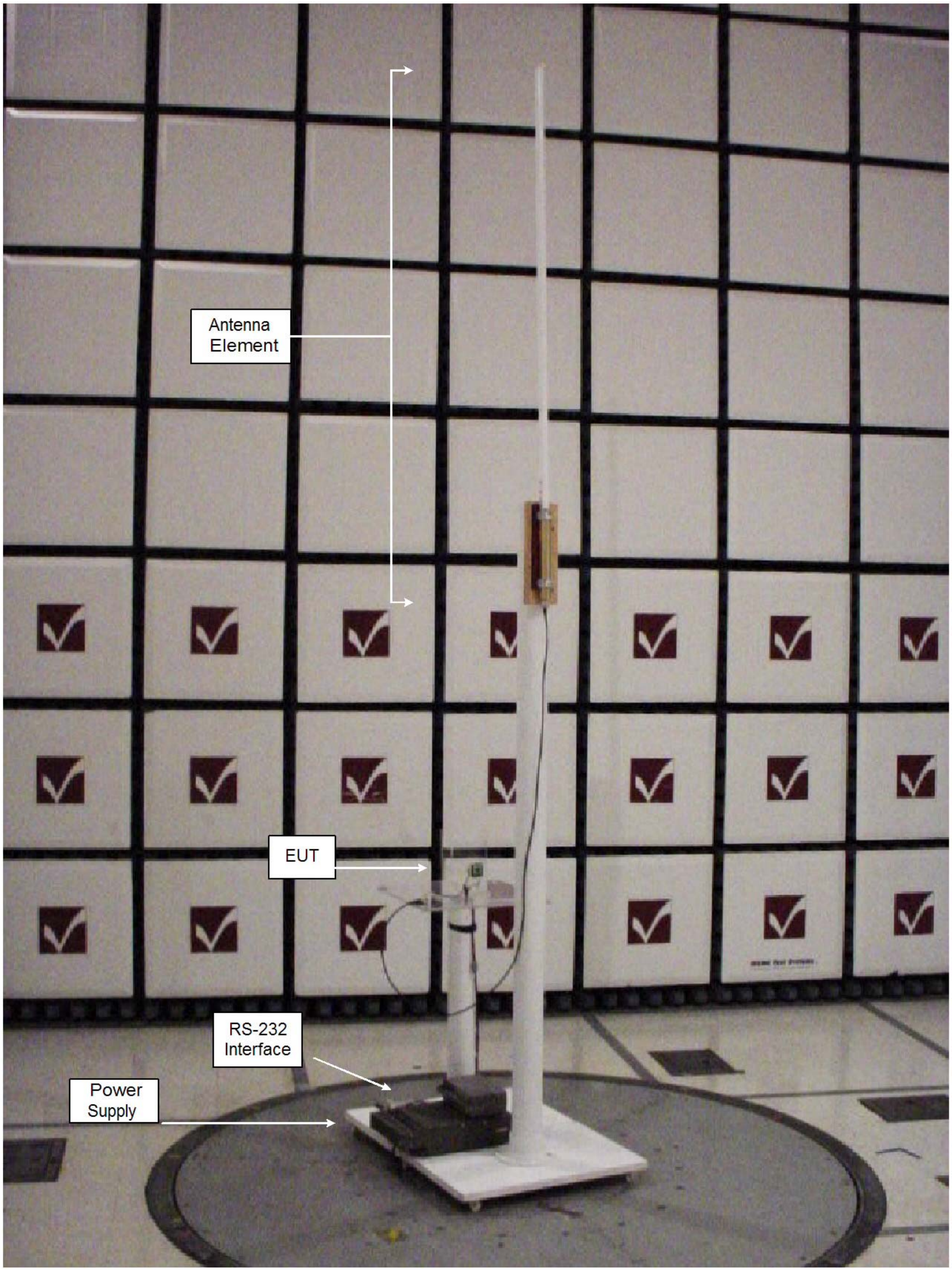
View of the EUT setup on the test pedestal



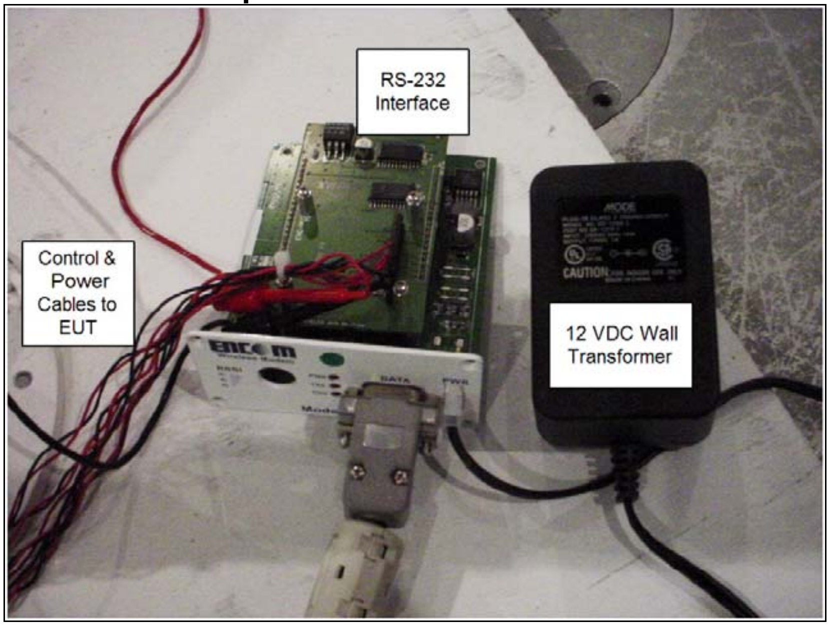
View of the EUT setup showing Yagi (Antenna 1) installation on a 2 meter mast.



View of the EUT setup showing Monopole (Antenna 2) installation on a 2 meter mast.



Close up view of the RS-232 Interface.

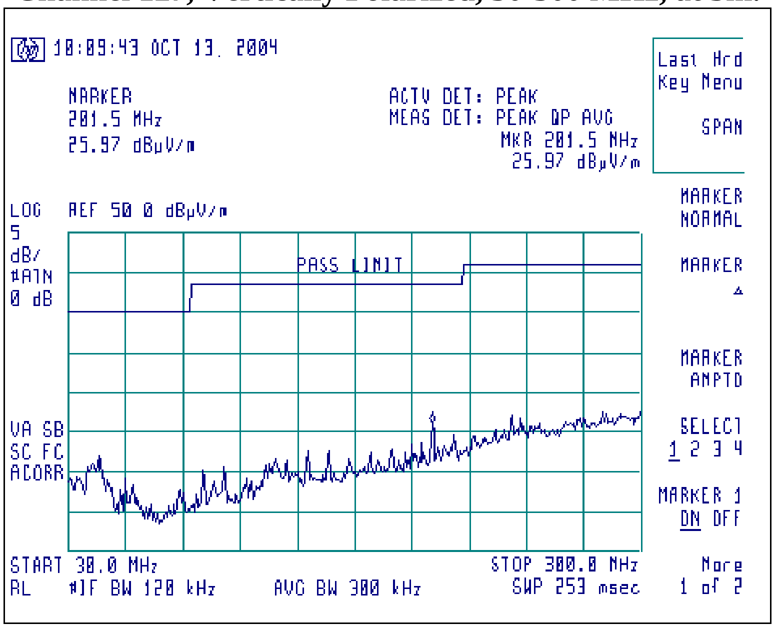


Screen Captures of Radiated RF Emissions for Antenna 1:

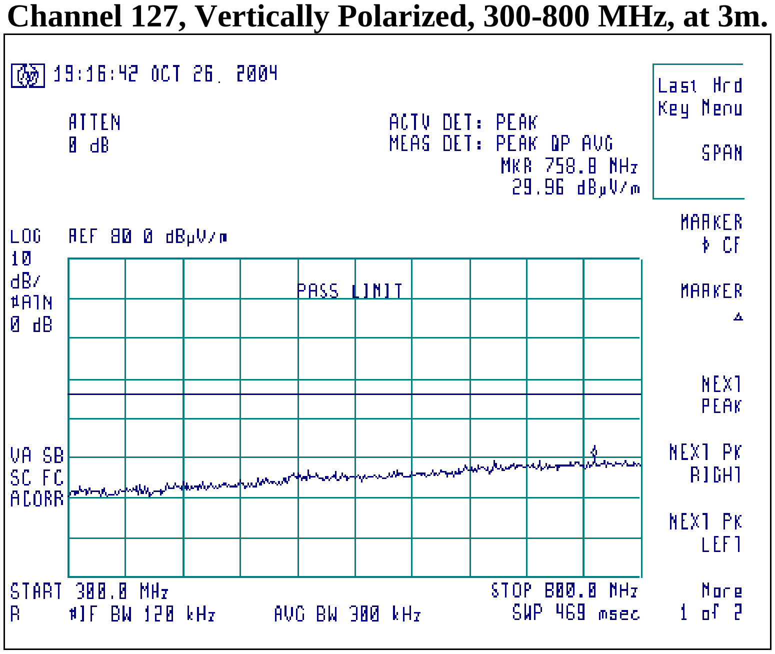
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

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.

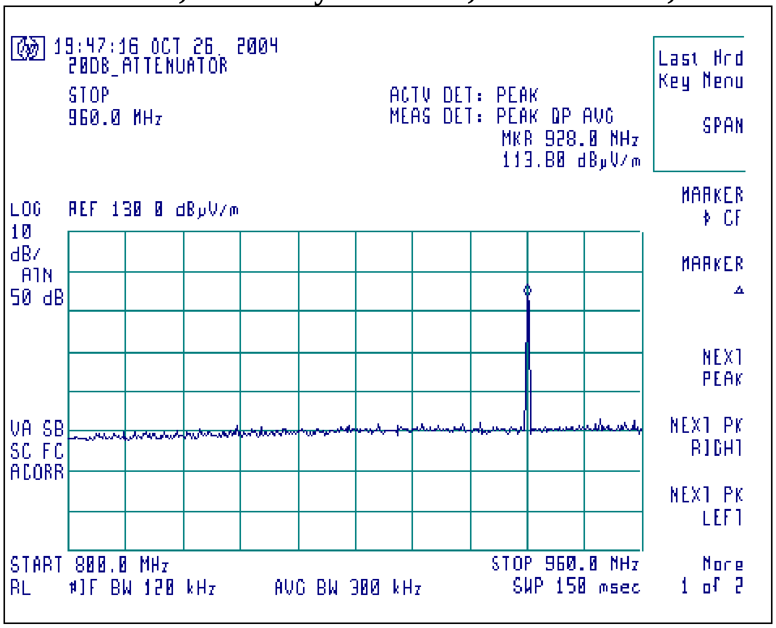
Channel 127, Vertically Polarized, 30-300 MHz, at 3m.



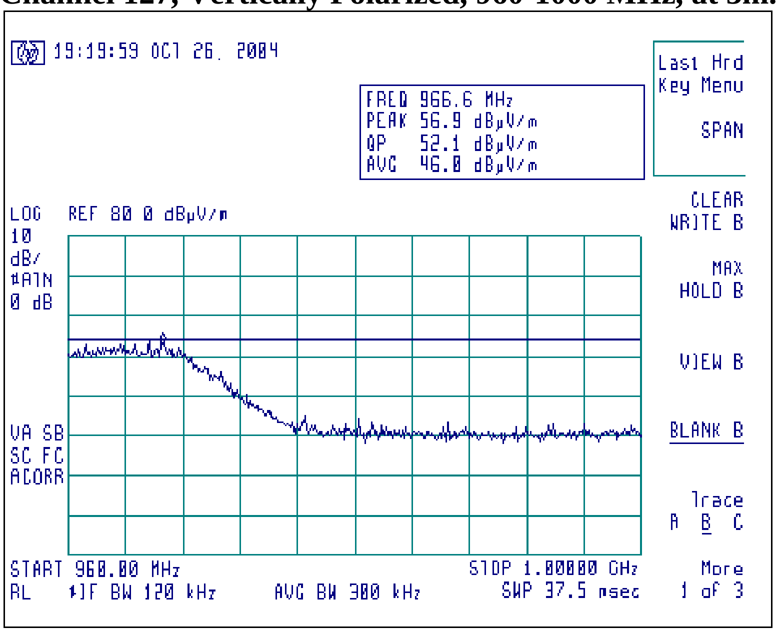
Channel 127, Vertically Polarized, 300-800 MHz, at 3m.



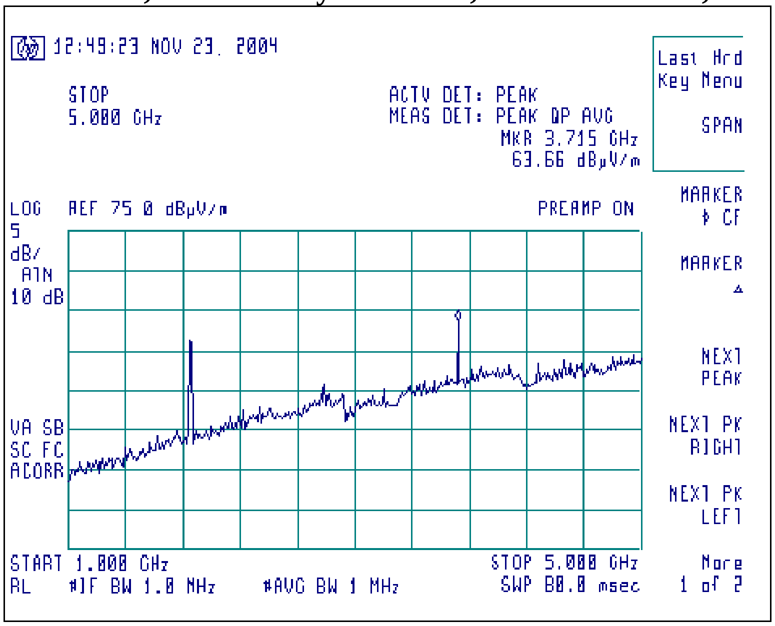
Channel 127, Vertically Polarized, 800-960 MHz, at 3m.



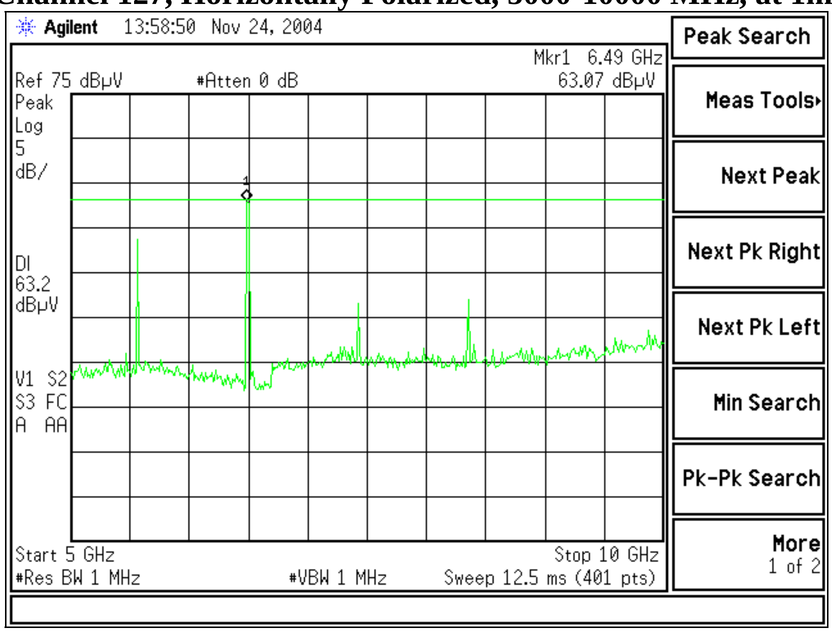
Channel 127, Vertically Polarized, 960-1000 MHz, at 3m.



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



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

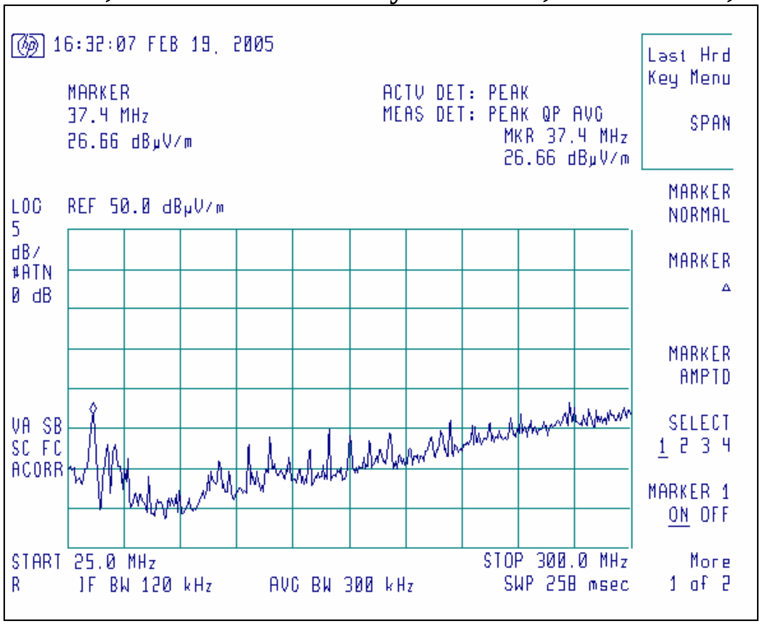


Screen Captures of Radiated RF Emissions for Antenna 2:

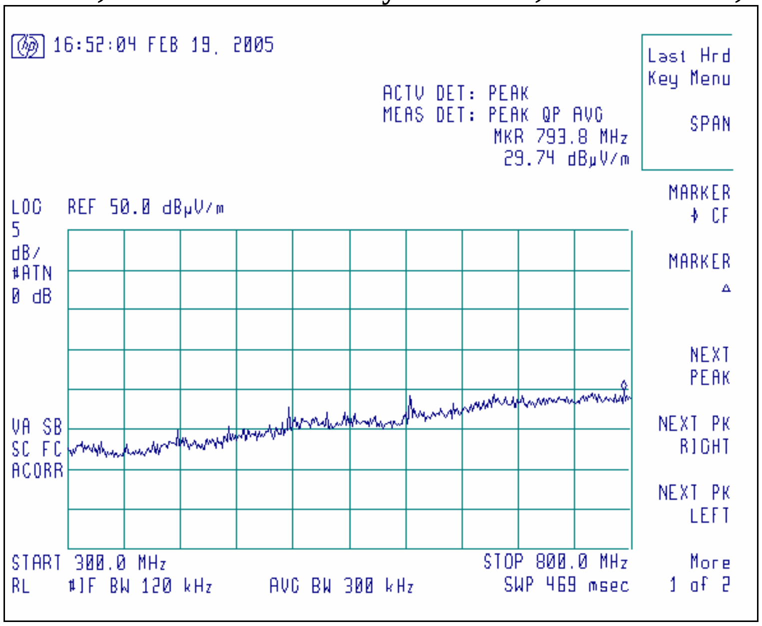
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

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.

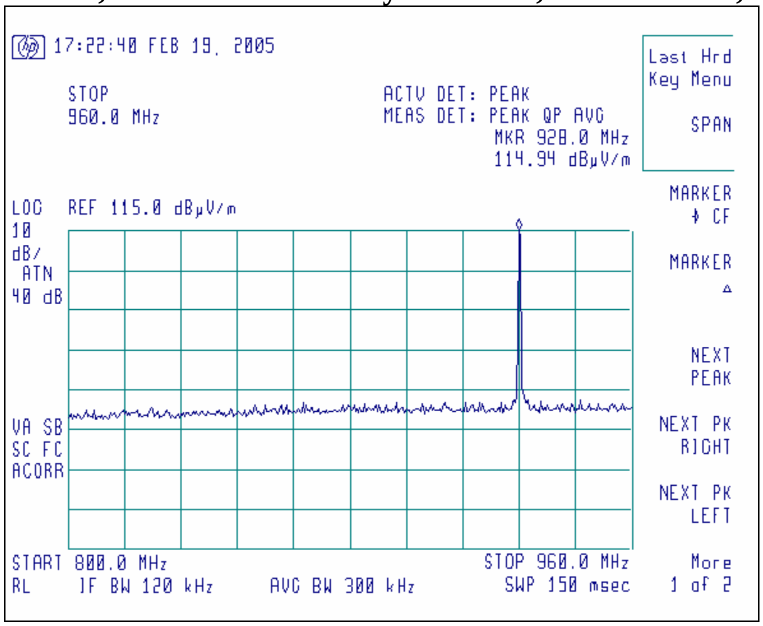
Channel 127, Antenna 2 Vertically Polarized, 25-300 MHz, at 3m.



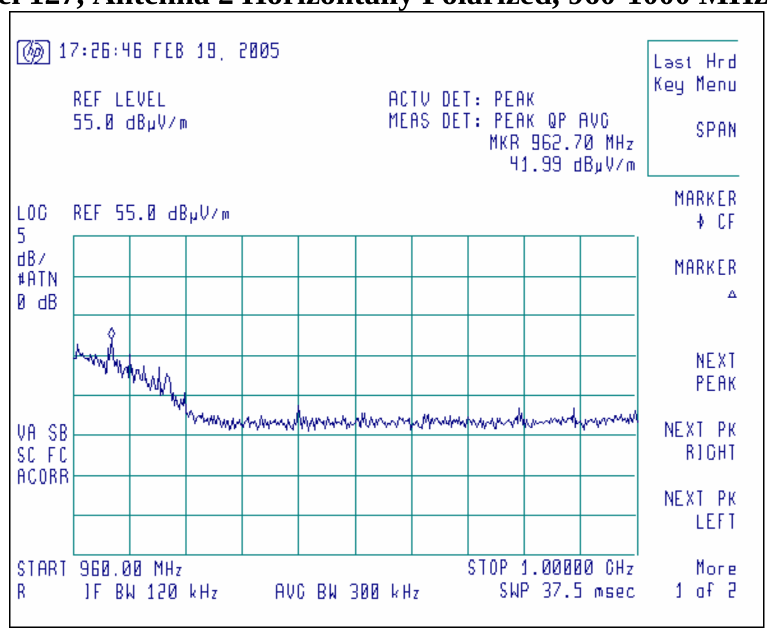
Channel 127, Antenna 2 Vertically Polarized, 300-800 MHz, at 3m.



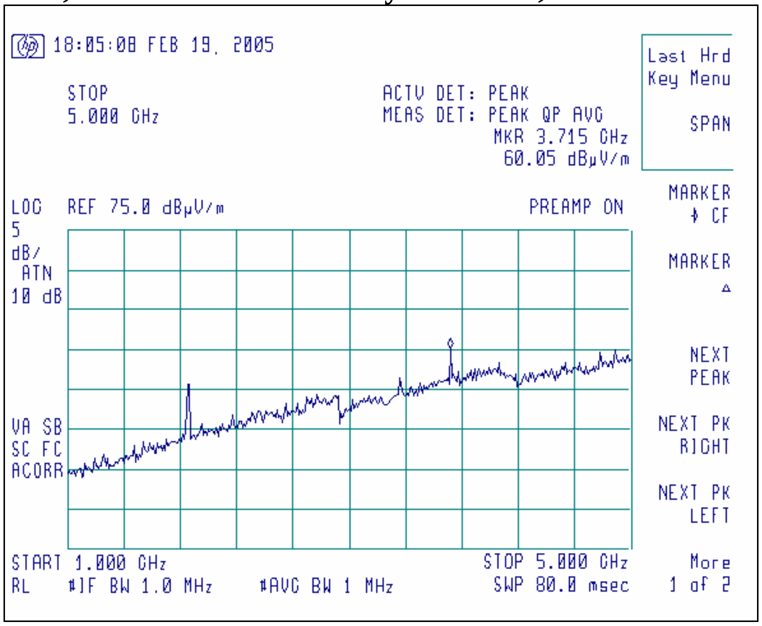
Channel 127, Antenna 2 Vertically Polarized, 800-960 MHz, at 3m.



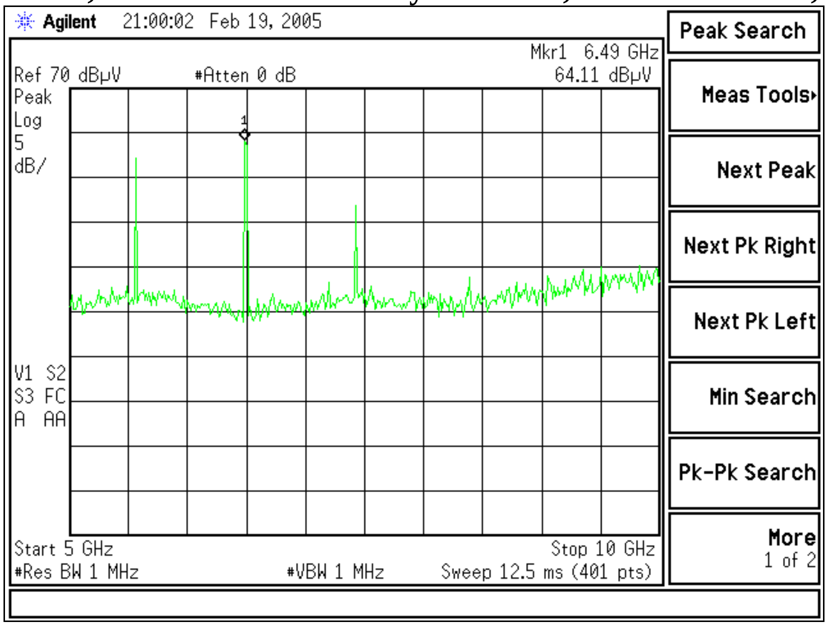
Channel 127, Antenna 2 Horizontally Polarized, 960-1000 MHz, at 3m.



Channel 127, Antenna 2 Horizontally Polarized, 1000-5000 MHz, at 3m.



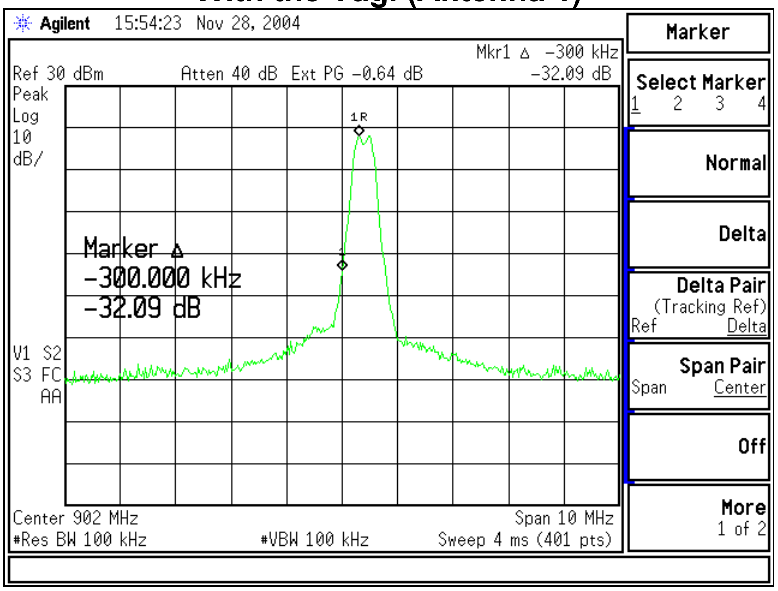
Channel 127, Antenna 2 Horizontally Polarized, 5000-10000 MHz, at 1m.



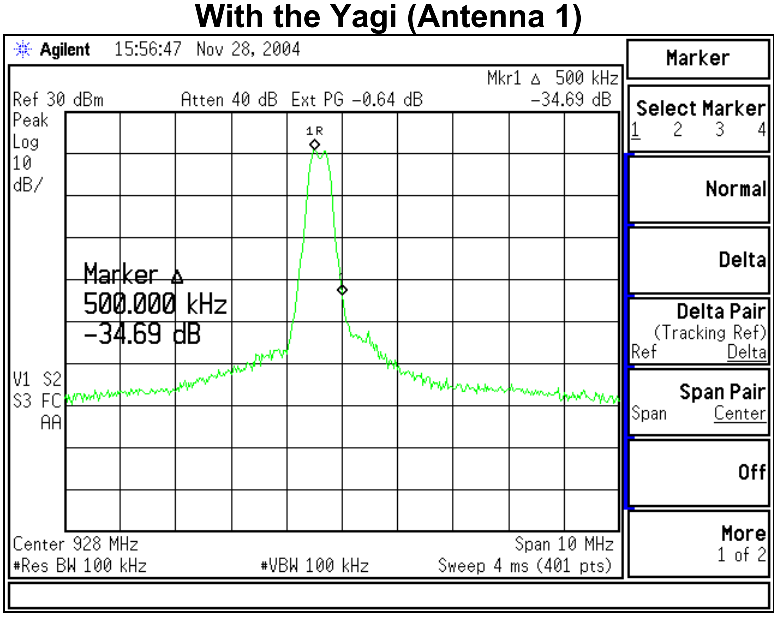
20. Band-Edge Measurements

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 With the Yagi (Antenna 1)



Screen Capture demonstrating compliance at the Higher Band-Edge With the Yagi (Antenna 1)



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. The EUT's power source was plugged into a 50Ω (ohm), 50/250 μH 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 50Ω (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.

The data contained in this section is reproduced from LS Compliance report number 304238-TX1000.

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:

Limit = -19.12 (Log_{10} (F[MHz] / 0.15 [MHz])) + 66.0 dBμV

For a frequency of 200 kHz for example:

Quasi-Peak Limit (F = 200kHz) = -19.12 (Log_{10} (0.2[MHz] / 0.15 [MHz])) + 66.0 dBμV

Quasi-Peak Limit (F = 200kHz) = 63.6 dBμV

Average Limit (F=200kHz) = -19.12 (Log_{10}(0.2[MHz]/0.15[MHz])) + 56.0 dBμV

Average Limit (F = 200 kHz) = 53.6 dBμV

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[ST] 2004 through February 19[TH] 2005					
Test Engineer:		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	'ENC-900' 100 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

		QUASI-PEAK			AVERAGE		
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.

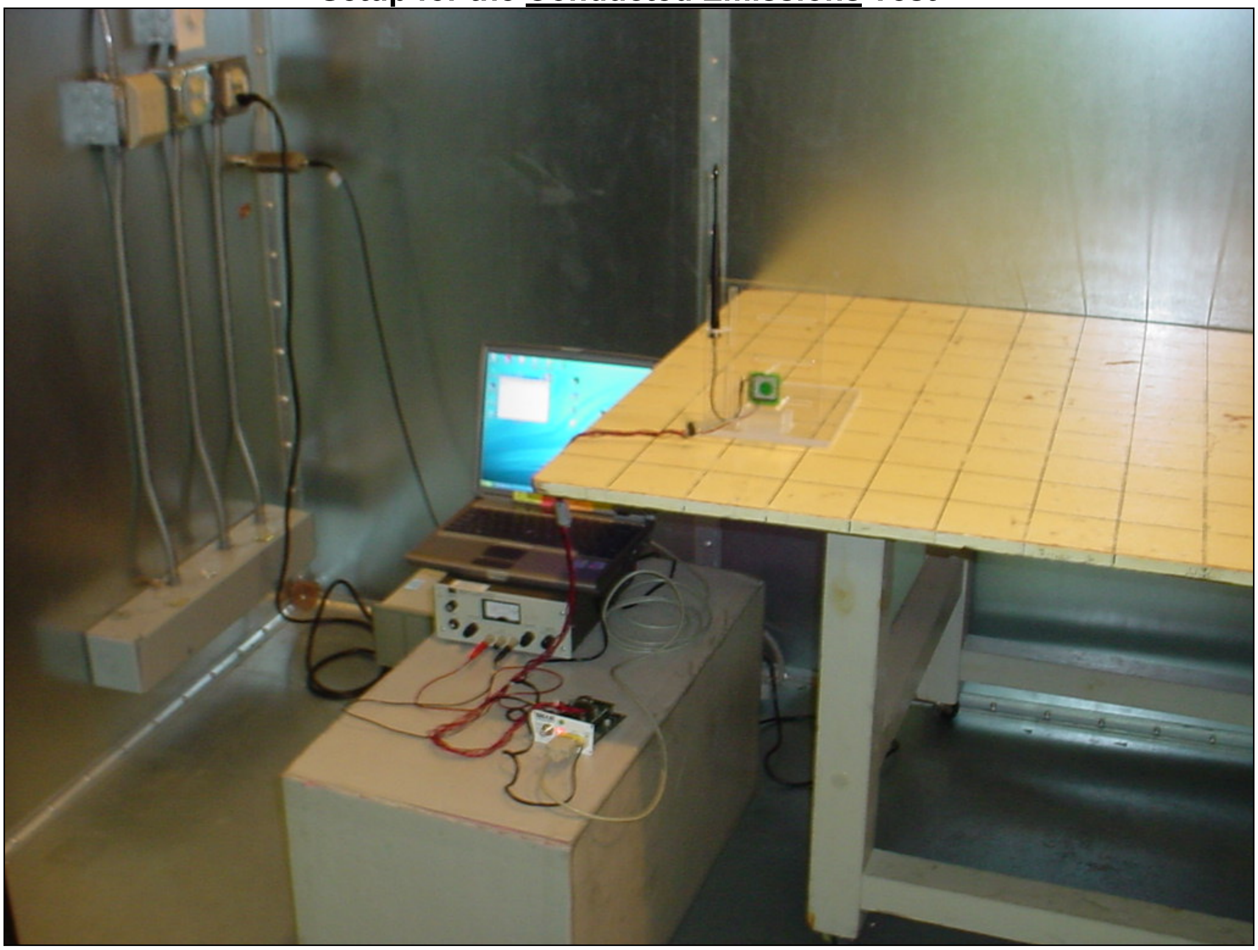
2) All other emissions were better than 20 dB below the limits.

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.

The data contained in this section is reproduced from LS Compliance report number 304238-TX1000.

Photo(s) Taken During Conducted Emission Testing

Setup for the Conducted Emissions Test



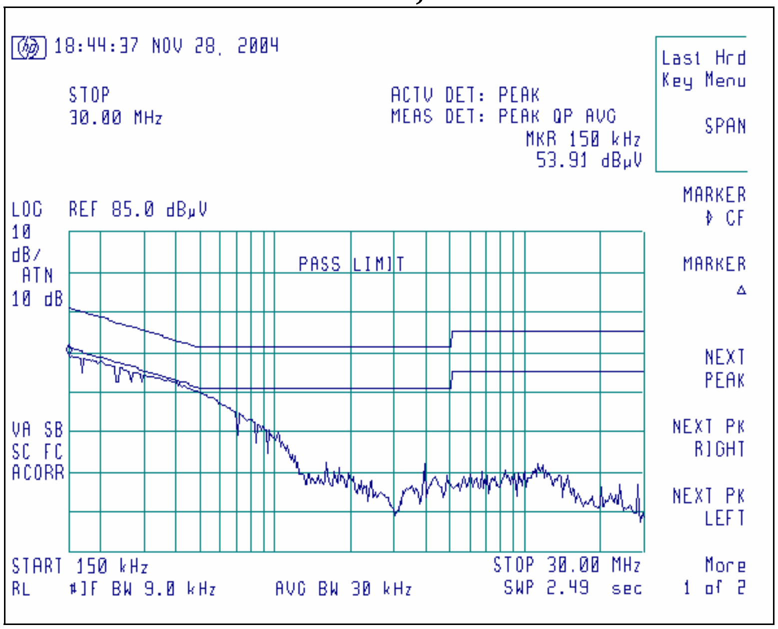
The data contained in this section is reproduced from LS Compliance report number 304238-TX1000.

Screen Captures of Conducted AC Mains Emissions:

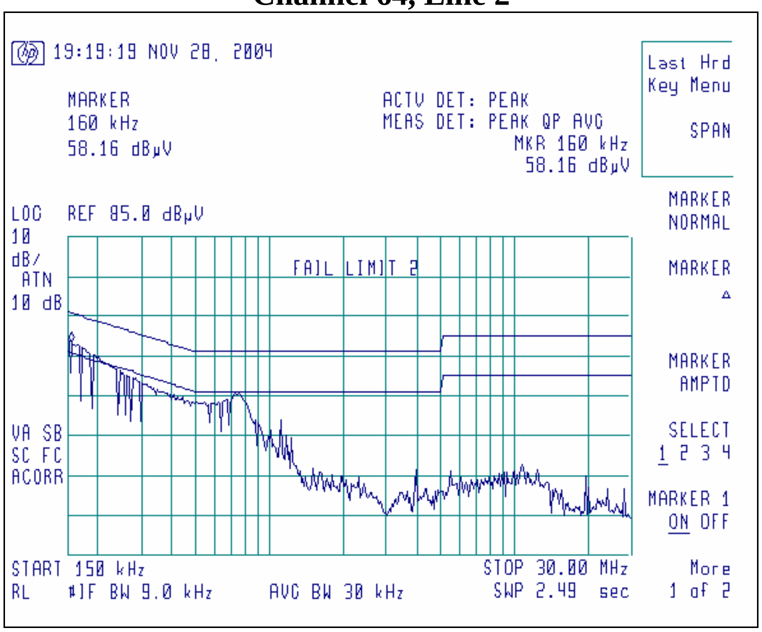
Please note these screen captures represent Peak Emissions. For conducted emission measurements, we utilize both a Quasi-Peak detector function as well as the Average detector function for measurements. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.209.

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 Calcluation

Antenna 1

Bluewave Antenna Model: BW947Y

This antenna is installed on poles or other raised platforms,
Antenna gain is specified at 10 dBd, or 12.1 dBi.

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:	19.10	(dBm)
Maximum peak output power at antenna input terminal:	81.283	(mW)
Antenna gain(typical):	12.1	(dBi)
Maximum antenna gain:	16.218	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	915	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.61	(mW/cm^2)
Power density at prediction frequency:	0.262259	(mW/cm^2)
Maximum allowable antenna gain:	15.8	(dBi)
Margin of Compliance at 20 cm =	3.7	dB

MPE Calcluation

Antenna 2
Antenex FG9026

This antenna is installed on poles or other raised platforms,
Antenna gain is specified at 6 dBd, or 8.1 dBi.

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:	19.10	(dBm)
Maximum peak output power at antenna input terminal:	81.283	(mW)
Antenna gain(typical):	8.1	(dBi)
Maximum antenna gain:	6.457	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	915	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.61	(mW/cm^2)
Power density at prediction frequency:	0.104407	(mW/cm^2)
Maximum allowable antenna gain:	15.8	(dBi)
Margin of Compliance at 20 cm =	7.7	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	12/07/04	12/07/05
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	12/06/04	12/06/05
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

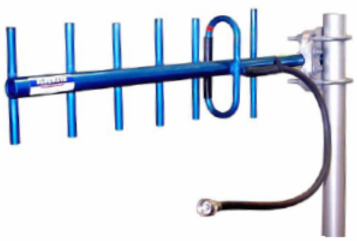
BLUEWAVE™ THE NEW STANDARD

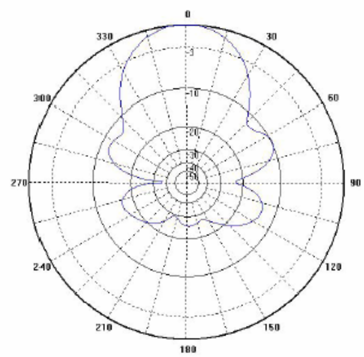
BW947Y

806-985 MHz

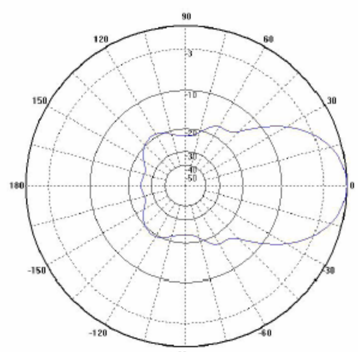
ORDERING INFORMATION

PART#	FREQUENCY
BW947Y-1	806-896 MHz
BW947Y-2	890-960 MHz
BW947Y-3	945-985 MHz





HORIZONTAL PATTERN FOR VERTICAL POLARIZATION



HORIZONTAL PATTERN FOR HORIZONTAL POLARIZATION

ELECTRICAL SPECIFICATIONS

FREQUENCY RANGE	806-985 MHz
NOMINAL GAIN (typical)	10 dBd
BANDWIDTH VSWR 1.5	70-90 MHz
FRONT TO BACK RATIO	20 dB
HORIZONTAL BEAMWIDTH (at half power points) for vertical polarization	50 °
VERTICAL BEAMWIDTH (at half power points) for vertical polarization	45 °
POWER RATING	200 W
LIGHTNING PROTECTION	DC ground
TERMINATION	N-Male

MECHANICAL SPECIFICATIONS

LENGTH	24" (610 mm)
WIDTH @ 806 MHz	6.8" (173 mm)
WEIGHT	1.5 lbs. (.7kg.)
RATED WIND VELOCITY	125 mph (201 kph)
RATED WIND VELOCITY	(with .5 inch radial ice) 120mph (193 kph)
LATERAL THRUST @ 100 mph WIND VELOCITY	6 lbs. (2.7 kg)
PROJECTED AREA (flat plane equivalent)	.24 ftsq (.022 msq)

MOUNTING INFORMATION
C1001 mounting bracket complete with hardware is supplied to mount BW947Y on a 1.50-2.38" Dia. mast. Allows horizontal or vertical polarization.

The BW947Y has been engineered to meet the requirements of a high gain, broadband, premium quality antenna. This antenna provides 10 dBd gain and operates in the 806-985 MHz range. The BW947Y is manufactured using high strength 6061-T6 aluminum to withstand heavy ice, high wind and other extreme conditions. Our patented dipole design has an integral feed line and is welded to the boom for extra strength. This also eliminates misalignment or fastener problems. The entire antenna is anodized for appearance and corrosion resistence. A heavy duty clamp is supplied which easily permits horizontal or vertical polarization. The BW947Y is available with custom feed-line lengths up to 50 ft on special order.

7935 - 8 Street N.E. CALGARY, AB CANADA T2E 8A2 PHONE: 403.291.4422 FAX: 403.219.3644
EMAIL: sales@bluewaveantenna.com WEBSITE: www.bluewaveantenna.com TOLL FREE: 1.888.334.9244

Appendix B – Antenna Specification Sheets (continued)

Antenna 2 Specification

ANTENEX SIGNAL PROPAGATION INC. SYSTEMS

2000 - 205 Bloomingdale Road • Glendale Hts., Illinois 60139 U.S.A.

ANTENNA SPECIFICATIONS
MODEL FG9026

ELECTRICAL SPECIFCATIONS

Frequency Range:	902-928 MHz
Gain:	6 dBd gain, requires no ground plane
VSWR:	1.5:1
Input Impedance:	50 ohms, DC grounded
Maximum Power input:	200 Watts
Lightning Protection:	DC grounded

MECHANICAL SPECIFICATIONS

Construction:	No site assembly required. All copper radiating structure enclosed in a weather-sealed, UV suppressed fiberglass tube. Gold anodized mounting sleeve and end cap.
Mounting Sleeve:	Heavy wall epoxy coated aluminum
Overall Length:	65 inches
Weight:	6 lbs.
Termination Type:	Type N female
Rated Wind Velocity:	125 mph
Shipping:	UPS shippable

Page 1 of 2 Loc: P:\Radio Project\FCC Testing\FCC Documents\Antenex Omni FG9026 spec.doc Orig: Created on 1998/10/22 PM 12:00:00 Rev: 1998/10/22 PM 12:00:00
Confidential Information

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”.

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.