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

COMPLIANCE TESTING OF:

Sensicast A2400 Coordinator

Prepared For:
Sensicast Systems Incorporated
Attention: Mr. Jay Werb
220-3 Reservoir Street
Needham, MA 02494

Test Report Number:
304553-Tx-TCB-v1

Test Dates:
February 16TH through August 18TH, 2005

Table of Contents

1. <u>L. S. Compliance In Review</u>

L.S. Compliance - Accreditations and Listing's

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

<u>A2LA – American Association for Laboratory Accreditation</u>

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

<u>Federal Communications Commission (FCC) – USA</u>

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

<u>Industry Canada</u>

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>U. S. Conformity Assessment Body (CAB) Validation</u>

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.

Presented this 29th day of April 2005.

President
For the Accreditation Council
Certificate Number 1255.01
Valid to January 31, 2007

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

3. 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

4. Signature Page

Prepared By: December 28, 2005

Teresa A. White, Document Coordinator Date

Tested By: December 28, 2005

Abtin Spantman, EMC Engineer Date

Approved By: December 28, 2005

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

5. <u>Product and General Information</u>

Manufacturer:	Sensicast Systems Incorporated					
Date(s) of Test:	February 16th through August 18th, 2005					
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	A2400 Coordinator					
Serial #:	Engineering Prototype					
Voltage:	5.0 VDC					
Operation Mode:	Normal operation and continuous modulated transmit					

6. <u>Introduction</u>

Between February 16th and August 18th, 2005, a series of Conducted and Radiated RF Emission tests were performed on one sample of the Sensicast Systems' "A2400 Coordinator", 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 low power transmitter. These tests were performed by Abtin Spantman, EMC Engineer at L.S. Compliance, Incorporated.

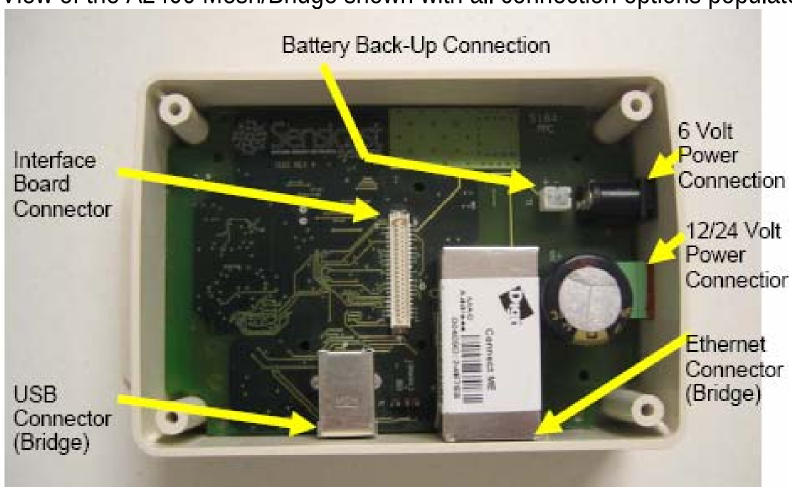
All Radiated and Conducted RF Emission tests were performed upon the EUT to measure the emissions in the frequency bands described in Title 47 CFR, FCC Part 15, including 15.35, 15.205, 15.247 and Industry Canada RSS-210 to determine whether these emissions are below the limits expressed within the standards. 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.

7. Product Description

The Sensicast A2400 Mesh/Bridge Nodes can function either as network coordinators or as sensing/actuating nodes, depending on their configuration. As a coordinator, the Mesh node automatically configures itself into a wireless mesh network with redundant connections to all leaf nodes and routing tables for all mesh nodes within connectivity range. To configure as a sensing/actuating node, the Mesh node must be combined with the appropriate interface card and/or firmware so that it can wirelessly transmit data from third-party sensors and receive control commands for device actuation. The Mesh node supports a completely wireless, self-configuring, self-healing, power managed sensor network. Sensicast Bridge nodes are specialized Mesh nodes that route data between the wireless mesh network and a host computer or LAN via Ethernet or USB connections.
The RF characteristics of the transmitter portion of the transceiver within the A2400 Mesh/Bridge Nodes was tested and covered in this report.

Top View of the A2400 Mesh/Bridge shown with all connection options populated.



Components and Functions
The primary components of a Mesh/Bridge node include the node itself, the battery pack, the power supply, and the interface connection, each of which is described below. The node is comprised of the node circuit board inside a two-piece plastic housing. The Sensicast-supplied 3V battery pack is used as a backup power for the Mesh/Bridge node in case of an external power disruption. The external power supply to the unit is a 120VAC/60Hz input, to 6V DC output adapter, that is used as the primary power source for the Mesh/Bridge node. The A2400, in Bridge configuration, uses a standard RJ-45 jack for Ethernet connection to a network or a Standard USB jack for USB connection to a local PC. Only 1 of these connections can be used at a time.

Mesh nodes. Mesh nodes are specialized nodes that can be used as coordinators to repeat or route the data transmitted between the Star nodes and a host. They transmit messages from Star nodes to other Mesh nodes or to Bridge nodes. They may also be configured to support various sensor connections. Bridge nodes are similar to Mesh nodes, except that, in place of re-transmitting incoming messages (or receiving outgoing messages), they act as a gateway and are typically attached to a wired network of some sort. The default configuration of a Bridge node is for it to communicate via RS232 protocol. Different versions may be configured for such communications methods like Ethernet, LonWorks, or even simply binary switch outputs.
The A2400 was configured as a Bridge Node and tested in all communication and power combination modes.

Modulation
Radio modulation follows the IEEE 802.15.4 standard. As per the standard, channels 11-25 are spaced at 5 Mhz intervals through the 2400 – 2483 Mhz ISM band. While the IEEE standard allows flexibility of channel and timing, the bit rate is fixed and inflexible. The system operates at a chip rate of 2000 kchip/sec, a symbol rate of 62.5 ksymbol/sec, and a bit rate of 250 kbit/sec. O-QPSK modulation is used with 16-ary orthogonal symbols. An IEEE compliant radio transceiver is used, the Chipcon CC2420. This transceiver supplies approximately 0 dBm in its native mode, which is boosted in this module to 15 dBm.

Although considered as a DTS/DSSS type device, the proprietary software that links the Sensicast system does call for frequency scanning techniques, as used for commissioning, associating and linking nodes to parent systems, and as generally used in power saving techniques in such devices. When in frequency scanning or hopping mode, the system changes the operating frequency channels every 300 ms. With 15 channels at 300 milliseconds each, the pattern repeats every 4.5 seconds. The system hops according to a pseudorandom sequence, but may be altered at the discretion of the system installer and administrator.

The system does not change the transmit characteristics of modulation, occupied bandwidth or RF power output during DSSS or FHSS operation. Additional supporting test results on the FHSS modes of operation are provided within this report. The system does in all cases operate at power levels that meet the DTS/DSSS requirements, and in doing so, meets the requirements of a hybrid transmitter as well as a DTS transmitter as supported by this report.

The A2400 was physically tested in the following configurations to investigate worst-case conditions:

- Mesh Mode, 6 volt power connection.
- Mesh Mode 24 volt power connection.
- Bridge Mode, 6 volt power connection, RS-232 uplink.
- Bridge Mode, 24 volt power connection, RS-232 uplink.
- Bridge Mode, 24 volt power connection, USB uplink.
- Bridge Mode, power over USB, USB uplink.
- Bridge Mode, 24 volt power connection, Ethernet uplink.
- Bridge Mode, power over Ethernet, Ethernet uplink.

The worst case results among all modes tested are published in a cumulative fashion and presented in this report.

8. Test Requirements

The above mentioned tests were performed in order to determine the compliance of the Sensicast Systems' "A2400 Coordinator", with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

15.31	15.247a	15.247d
15.205	15.247b	15.247e
15.207	15.247c	

9. Summary of Test Report

DECLARATION OF CONFORMITY

The Sensicast Systems' "A2400 Coordinator", transmitter 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(o) for a Digital Spread Spectrum (DTS) Transmitter.

10. 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 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. Power, data and control signals were provided for the EUT through the appropriate means, during each mode of operation. A Laptop PC was used to program the EUT for the desired test modes and channel selection. The same Laptop PC was also used along with proprietary access and programming software for connections to the EUT for uplinks as necessary. The EUT was placed and operated in continuous transmit modulated mode for this portion of the testing. The unit operates on 15 channels.

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 (Ch 11: 2405 MHz), middle (Ch 18: 2440 MHz) and high (Ch 25: 2475 MHz) to comply with FCC Part 15.35. The channels and operating modes were changed using a lap-top PC with the special test serial link.

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 25000 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. From 18 GHz to 25 GHz, the EUT was measured at a 0.3 meter separation, using a standard gain Horn Antenna and pre-amplifier.

The EUT is typically installed either in a horizontal attitude, on a platform or cross-beam, or in a vertical attitude on a wall or cross-beam. The EUT was rotated along both orthogonal axis (horizontal and vertical attitude for the EUT) 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 18 GHz, an HP E4407B Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the HP E4407B Spectrum Analyzer with a standard gain horn, and preamp were used.

Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for a DTS transmitter [Canada RSS-210, Clause 6.2.2(o)]. 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 2400-2483.5 MHz band, as specified in 47 CFR 15.247 (b)(3), is 1 Watt. 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:
dBμV/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(DTS)
Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	Sensicast Systems Incorporated					
Date(s) of Test:	February 16th through August 18th, 2005					
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	A2400 Coordinator					
Serial #:	Engineering Prototype					
Voltage:	5.0 VDC					
Operation Mode:	Normal operation and continuous modulated transmit					
EUT Power:		Single Phase ___VAC		3 Phase ___VAC		
		Battery:	√	Other: Host PC & 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
Pre-Amp: Advanced Microwave WHA6224
Standard Gain Horn: EMCO 3160-09

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

Frequency (MHz)	Antenna Polarity	Channel /Mode	Height (meters)	Azimuth (0° - 360°)	Measured ERP (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
58.9	V	18/Com	1.10	100	26.2	40.0	13.8
66.3	V	18/Com	1.10	100	23.9	40.0	16.1
162.2	V	18/Com	1.00	295	25.7	43.0	17.3
169.6	V	18/Com	1.00	310	28.9	43.0	14.1
173.3	V	18/Com	1.00	310	28.2	43.0	14.8
177.0	H	18/Com	1.00	0	28.0	43.0	15.0
603.3	V	18/Com	1.00	200	31.0	46.0	15.0
2260	V	11/All	1.00	220	45.9	54.0	8.1
2550	V	11/All	1.10	270	43.8	84.1 (Note 2)	40.3
2490	V	25/All	1.00	0	40.6	54.0	13.4
2627	V	25/All	1.00	310	36.8	83.9 (Note 2)	47.1
39.2	V	All/USB	1.30	215	31.3	40.0	8.7
91.2	V	All/USB	1.30	215	28.4	43.0	14.6
107.3	V	All/USB	1.00	205	25.0	43.0	18.0
379.7	V	All/USB	1.00	0	21.0	46.0	25.0

Notes:
1) *There were no other significant spurious emissions observed to within 20 dB below the limits.*
2) *15.247 Limit, at -20dBc.*

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 11:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured ERP (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
2405	V	1.00	80	104.1 (Note 4)	125.2	21.1
4810	H	1.00	145	41.9	54.0	12.1
7215	H	1.00	125	42.8 (Note 2)	93.6	50.8
9620	H	1.00	225	37.2 (Note 2)	93.6	56.4
12025	H	1.05	25	38.1 (Note 2)	63.5	25.4
14430				(Note 3)	63.5	
16835				(Note 3)	93.6	
19240				(Note 3)	74.0	
21645				(Note 3)	104.1	
24050				(Note 3)	104.1	

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 18:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured ERP (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
2440	V	1.00	115	105.1 (Note 4)	125.2	20.1
4880	V	1.00	115	42.5	54.0	11.5
7320	H	1.00	150	42.9 (Note 2)	63.5	20.6
9760	H	1.00	260	39.9 (Note 2)	94.8	54.9
12200	H	1.00	20	37.9 (Note 2)	63.5	25.6
14640				(Note 3)	94.8	
17080				(Note 3)	94.8	
19520				(Note 3)	74.0	
21960				(Note 3)	105.3	
24400				(Note 3)	105.3	

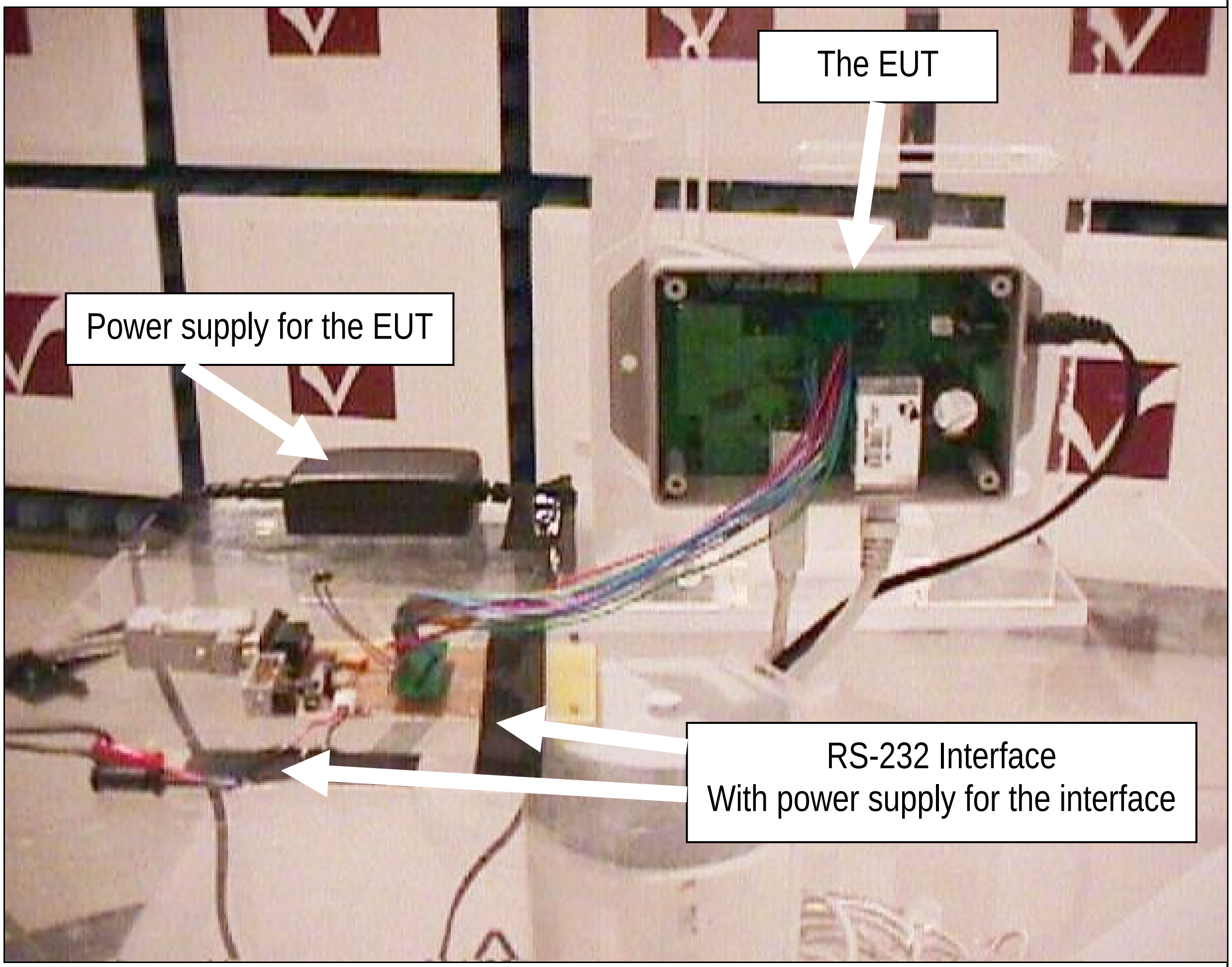
The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 25:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured ERP (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
2475	V	1.00	120	103.9 (Note 4)	125.2	21.3
4950	V	1.00	0	46.5	54.0	7.5
7425	H	1.00	155	42.5 (Note 2)	63.5	21.0
9900	H	1.00	245	32.1 (Note 2)	93.4	61.3
12375	H	1.00	25	37.5 (Note 2)	63.5	26.0
14850				(Note 3)	93.4	
17325				(Note 3)	93.4	
19800				(Note 3)	74.0	
22275				(Note 3)	74.0	
24750				(Note 3)	103.9	

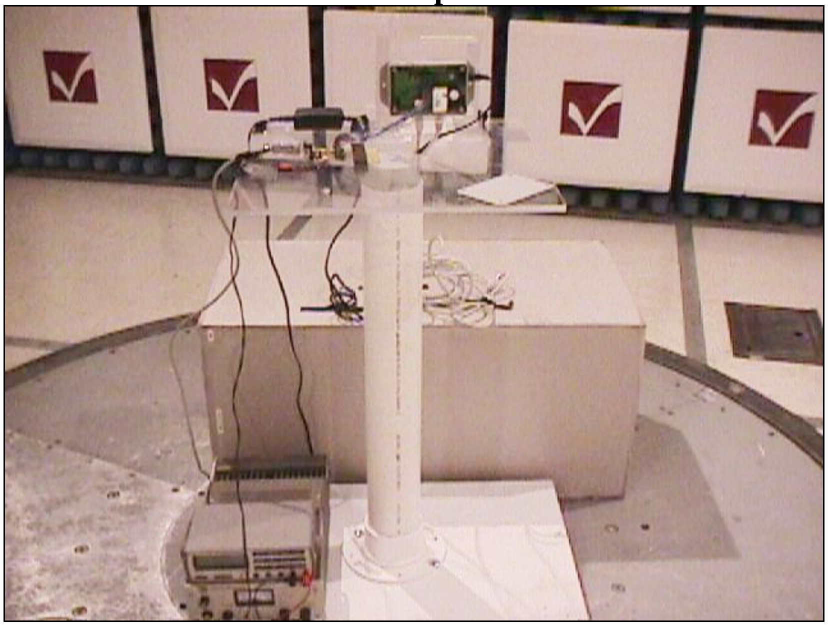
Notes:

1) 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.
2) Measurements above 5 GHz were made at 1 meters of separation from the EUT, and at 0.3 m separation for frequencies between 18 – 25 GHz.
3) Measurement at receiver system noise floor.
4) For measurements of the fundamental power, because of spectral bandwidth, the receiver was set to RBW=VBW=3 MHz.

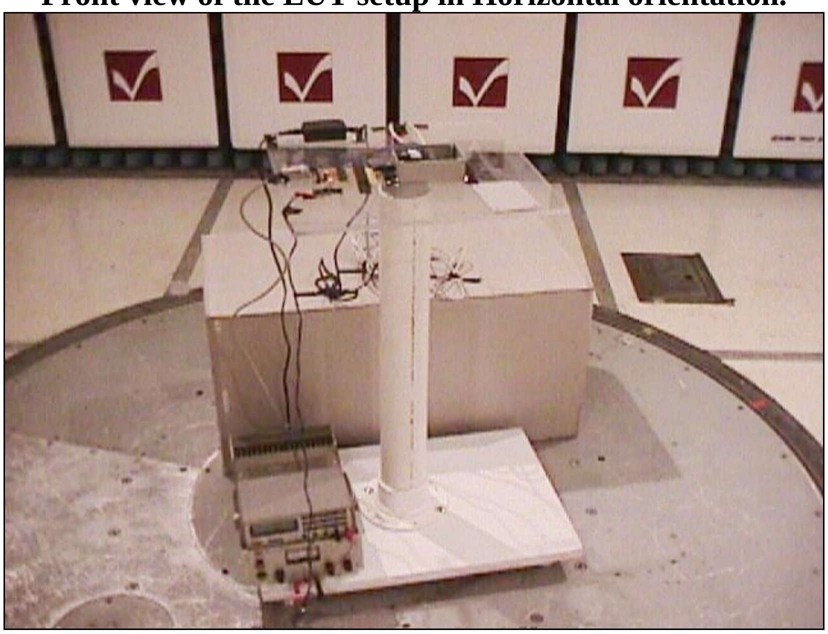
General setup of the EUT on the test stand during radiated emissions tests identifying typical components identified in the setup.



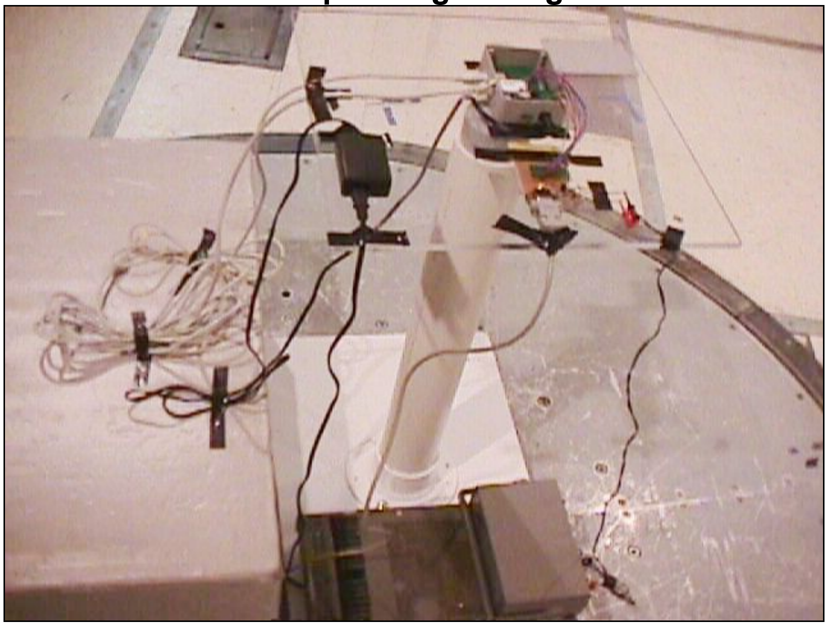
Front view of the EUT setup in vertical orientation.



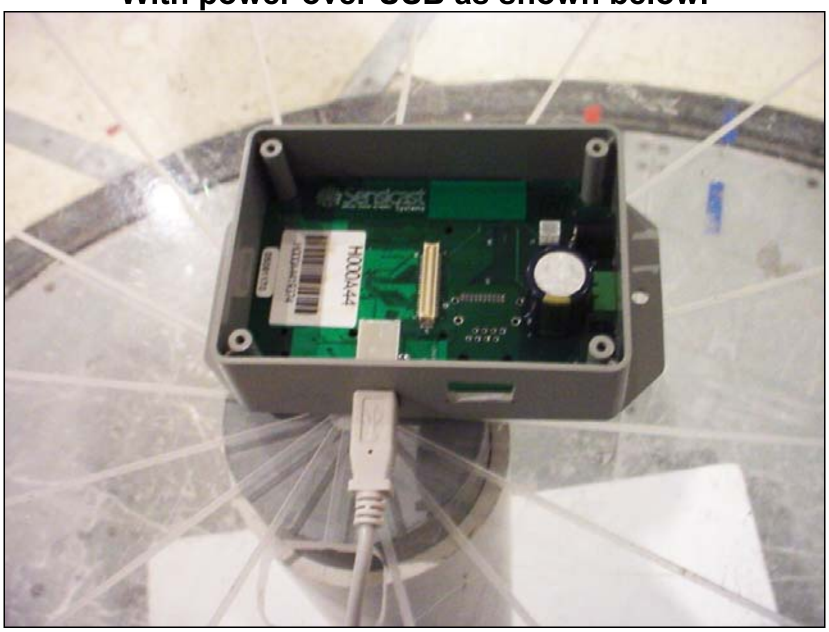
Front view of the EUT setup in Horizontal orientation.



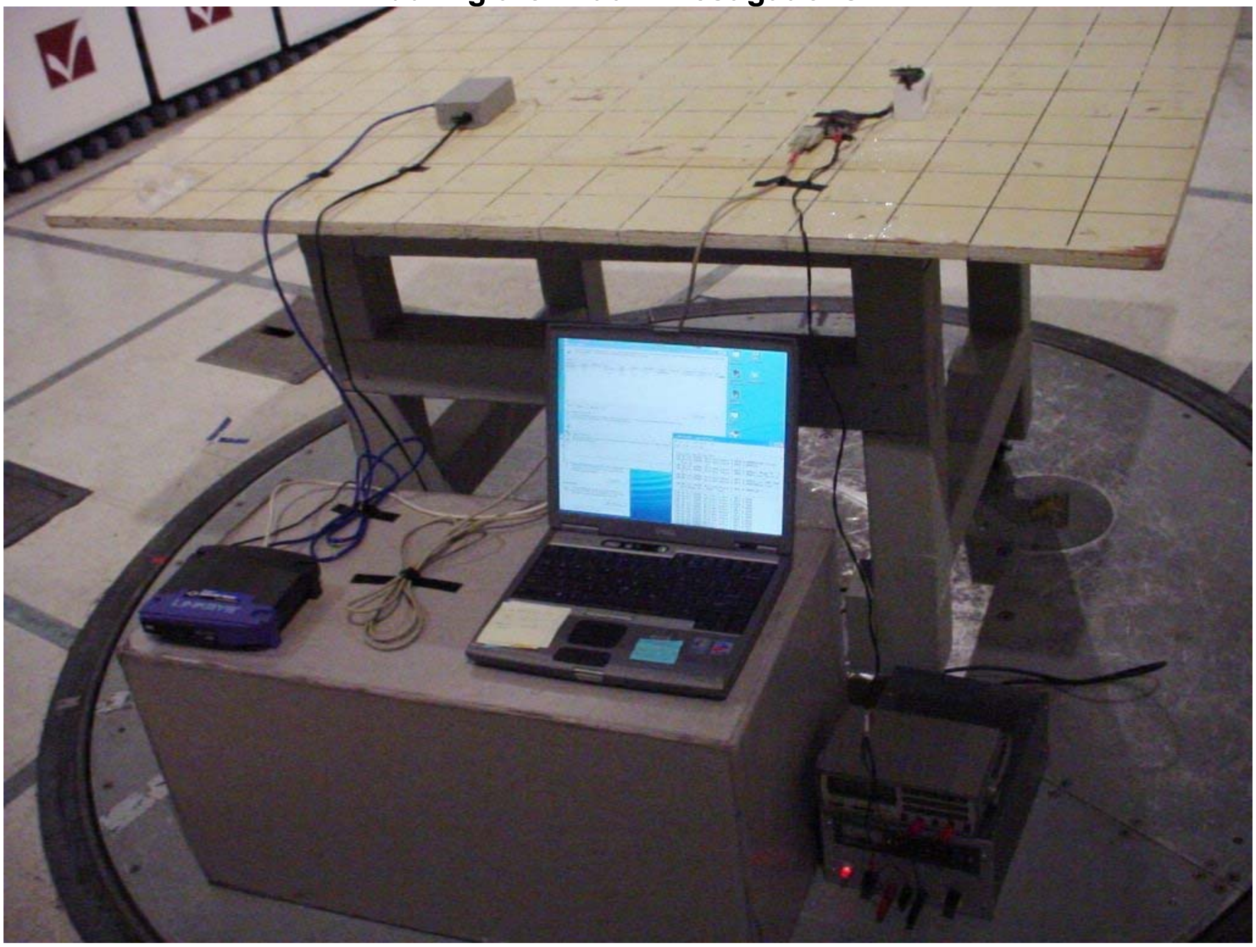
View of the EUT setup during testing in RS-232 mode.



View of the EUT setup during testing in USB and Ethernet mode, With power over USB as shown below.



View of the EUT connections during testing in USB and Ethernet mode, showing laptop connection and Ethernet hub as the case is below, during the initial investigations.



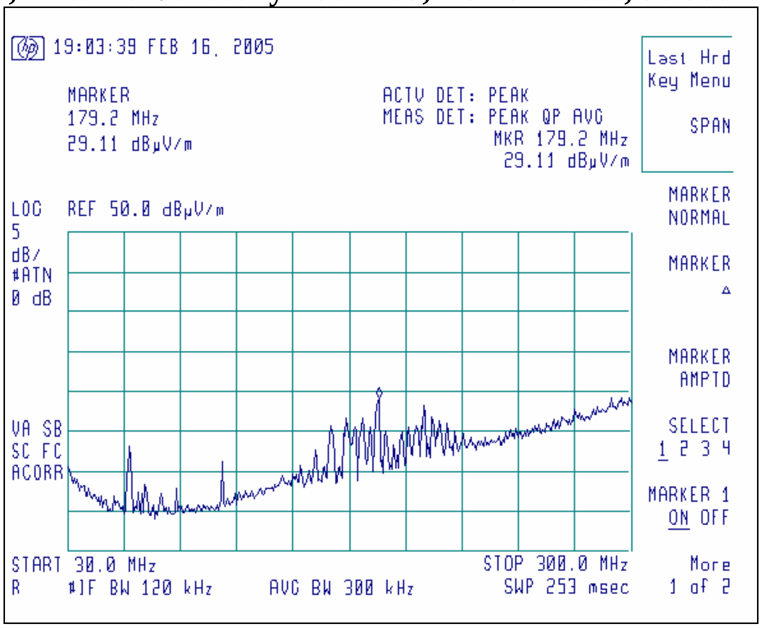
Graphs made during Radiated Emission Testing

Screen Captures of Radiated RF Emissions:

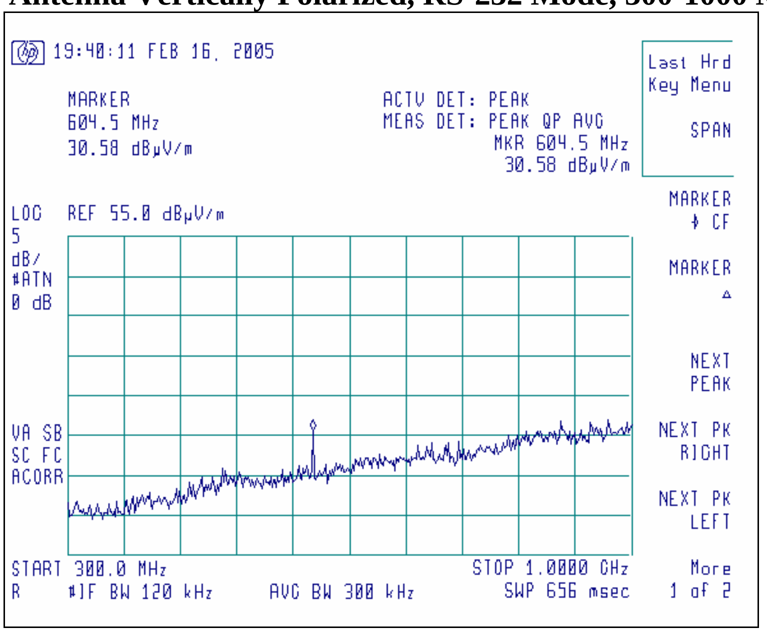
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 11, 18, or 25, with the sense and EUT antennas both in vertical polarity for worst case presentations.

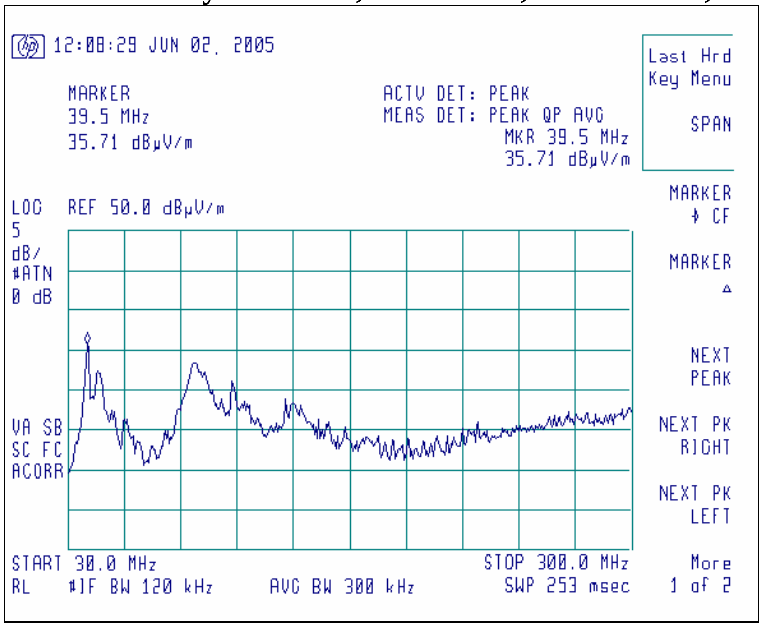
Channel 18, Antenna Vertically Polarized, RS-232 Mode, 30-300 MHz, at 3m.



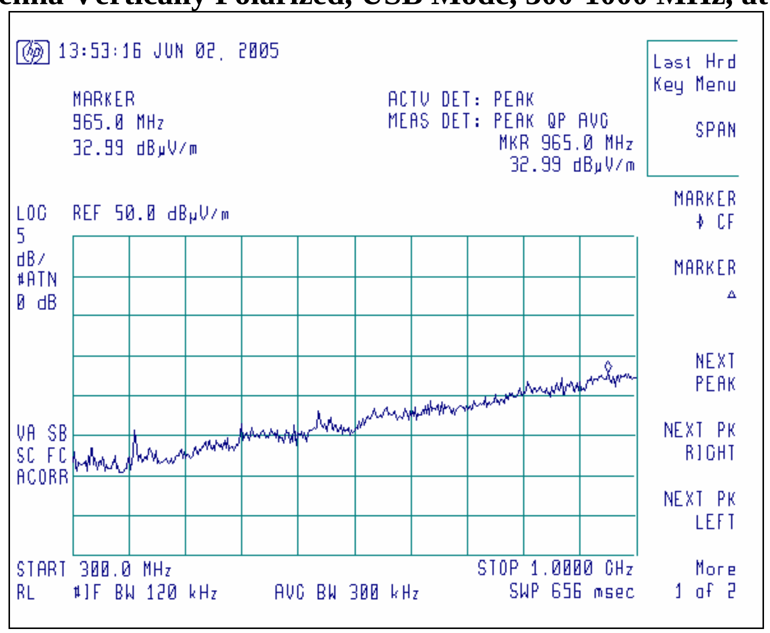
Channel 18, Antenna Vertically Polarized, RS-232 Mode, 300-1000 MHz, at 3m.



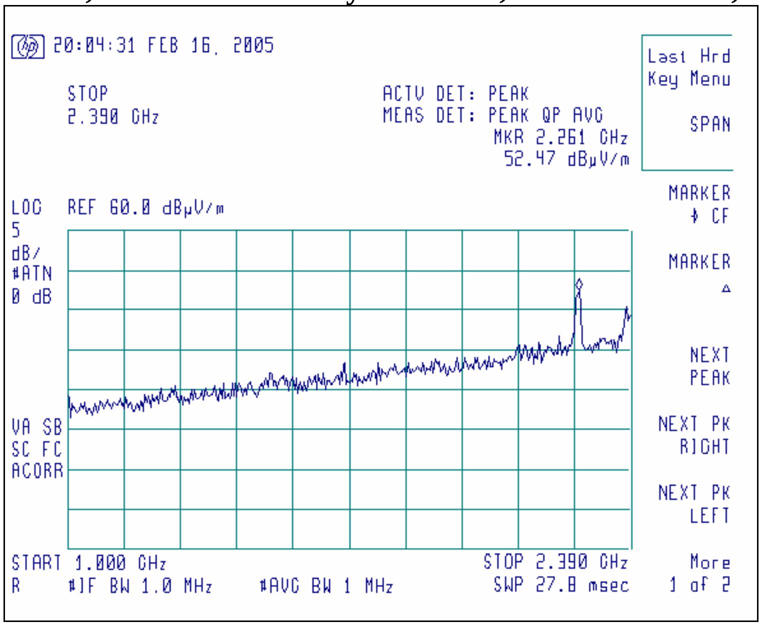
Antenna Vertically Polarized, USB Mode, 30-300 MHz, at 3m.



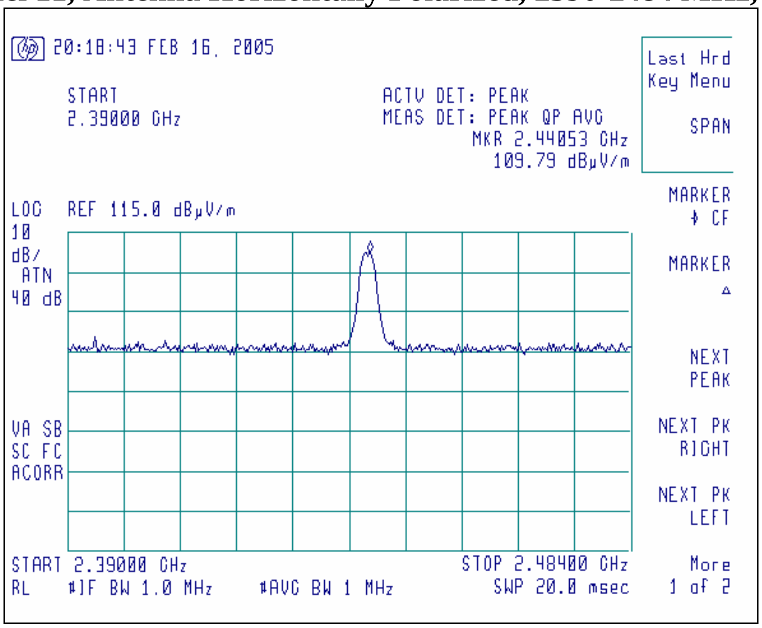
Antenna Vertically Polarized, USB Mode, 300-1000 MHz, at 3m.



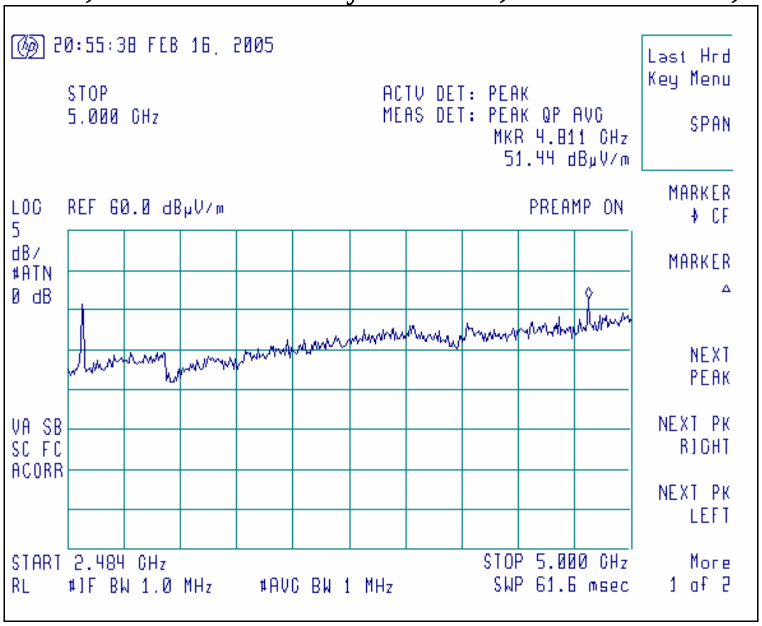
Channel 11, Antenna Vertically Polarized, 1000-2390 MHz, at 3m.



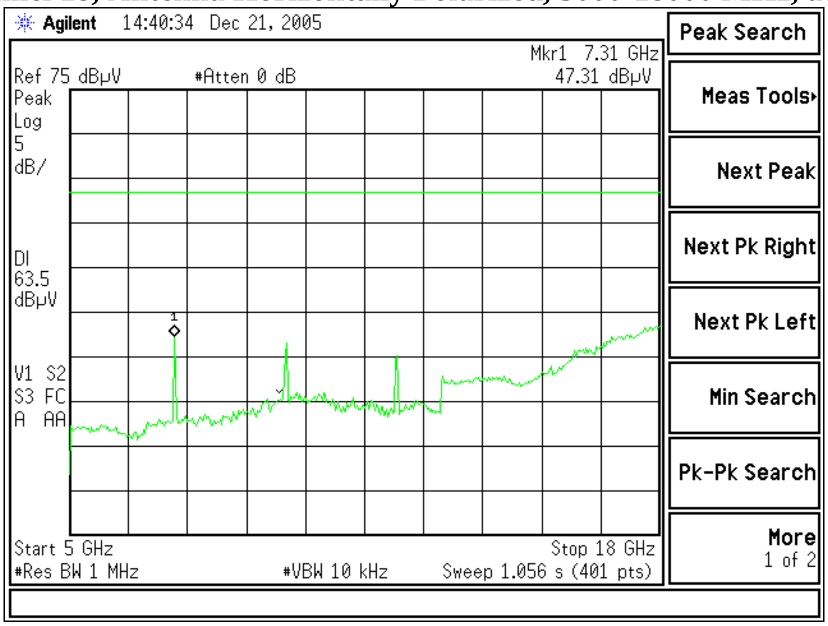
Channel 11, Antenna Horizontally Polarized, 2390-2484 MHz, at 3m.



Channel 18, Antenna Vertically Polarized, 2484-5000 MHz, at 3m.

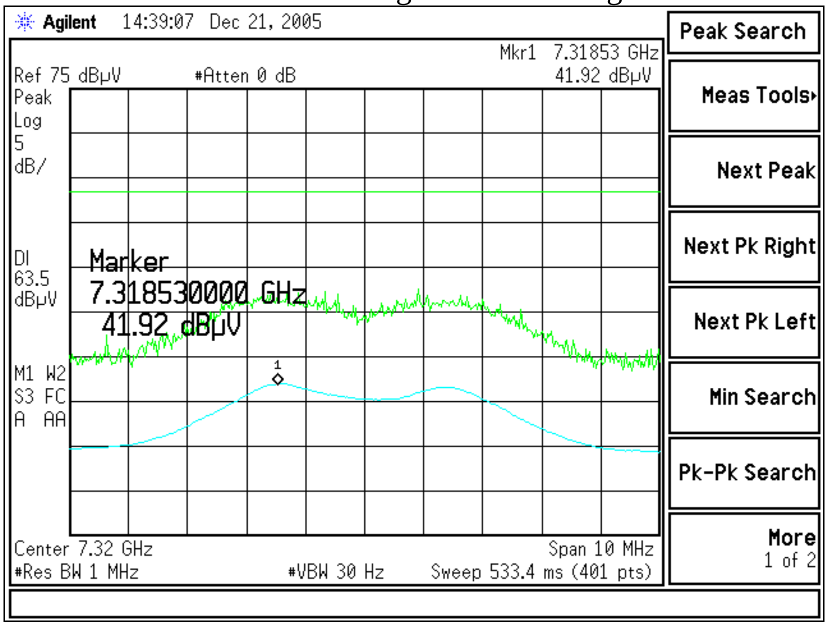


Channel 18, Antenna Horizontally Polarized, 5000-18000 MHz, at 1m.

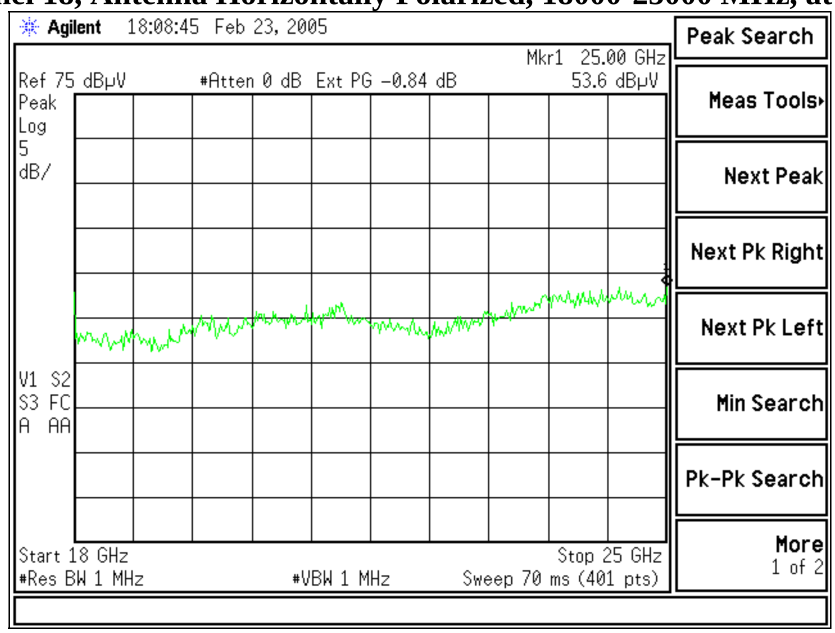


Channel 18, Antenna Horizontally Polarized, 7320 MHz, at 1m.

Detailed view showing Peak-to-Average ratio.



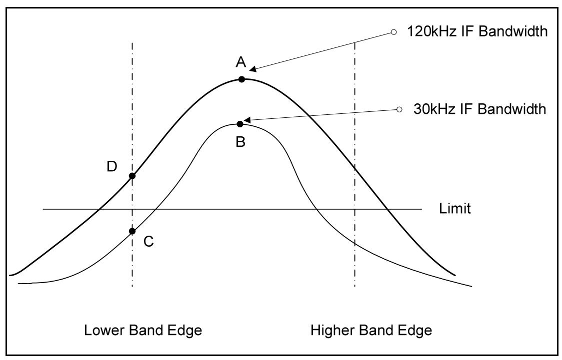
Channel 18, Antenna Horizontally Polarized, 18000-25000 MHz, at 30cm.



11. 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 2400-2483.5 MHz band-edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating 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.

The bandwidth of the modulated signal is measured using a marker delta method, to ensure that the modulated signal does not exceed the emission limits outside of the operational band. The EUT was placed in continuous transmit mode with internal typical data as the source of modulation. The emissions were then measured at the operational band edges to ensure compliance. The following diagram and formula illustrates how the band edge measurements were taken.



Measurement A is taken using a 3 MHz IF Bandwidth at the Center Frequency.
Measurement B is taken using a 30kHz IF Bandwidth at the Center Frequency.
Measurement C is taken using a 30kHz IF Bandwidth at the lower Band Edge Frequency

To Calculate the Value for lower Band Edge Frequency at Point D:

$$A - B = \Delta$$
$$\Delta + C = D$$

The Lower Band-Edge limit, in this case, would be D = -20dBc.
The Upper Band-Edge limit, in this case, would be D = 54 dB.

The measurements and calculations are as follows:

At the Lower Band-edge:

$A - B = \Delta \;;\; 107.2 dB\mu V/m - 98.2\, dB\mu V/m \;=\; 9.0\, dB$

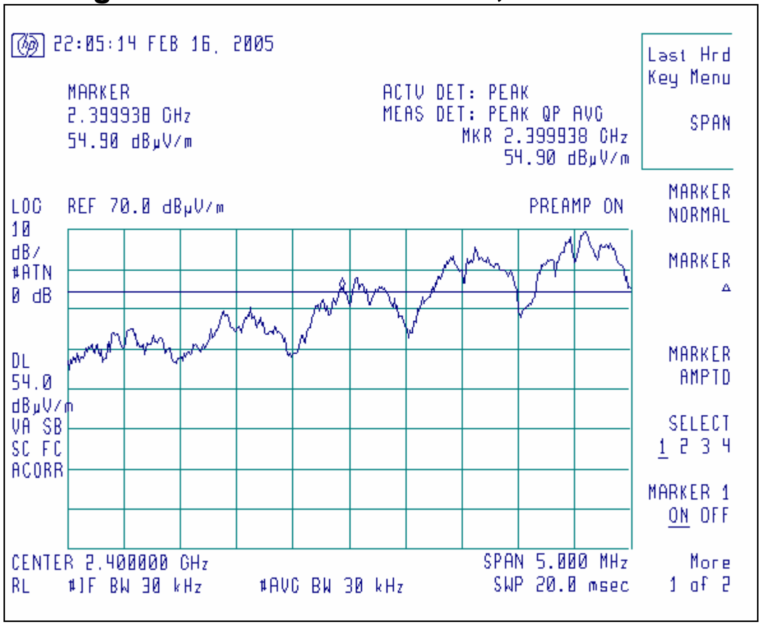
$\Delta + C = D \;;\; 9.0\, dB + 54.9\, dB\mu V/m \;=\; 63.9 dB\mu V/m$ Showing compliance at Lower Band-Edge

At the Upper Band-edge:

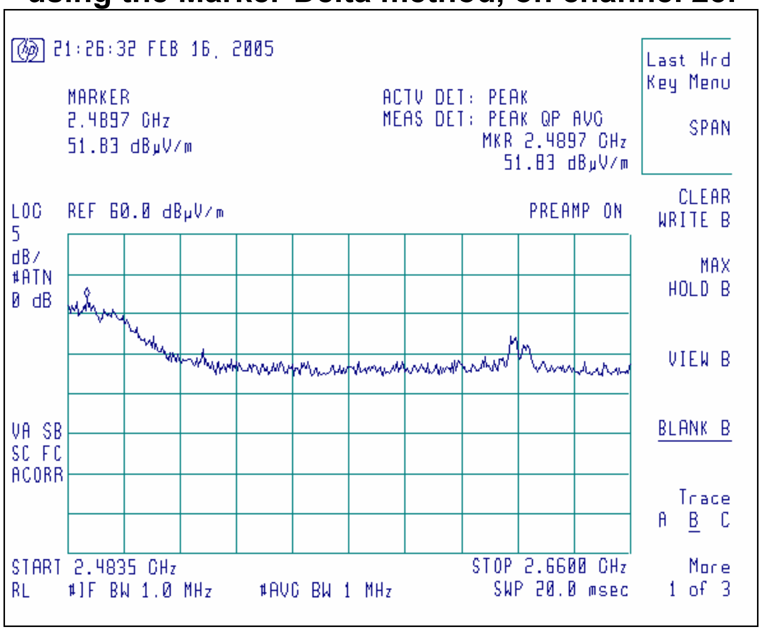
$A - B = \Delta \;;\; 107.0\, dB\mu V/m - 98.4 dB\mu V/m \;=\; 8.6 dB$

$\Delta + C = D \;;\; 8.6\, dB + 36.7\, dB\mu V/m \;=\; 45.3 dB\mu V/m$ Showing compliance at Upper Band-Edge

Screen Capture demonstrating compliance at the Lower Band-Edge, using the Marker-Delta method, on channel 11.



Screen Capture demonstrating compliance at the Higher Band-Edge, using the Marker-Delta method, on channel 25.



12. Occupied Bandwidth

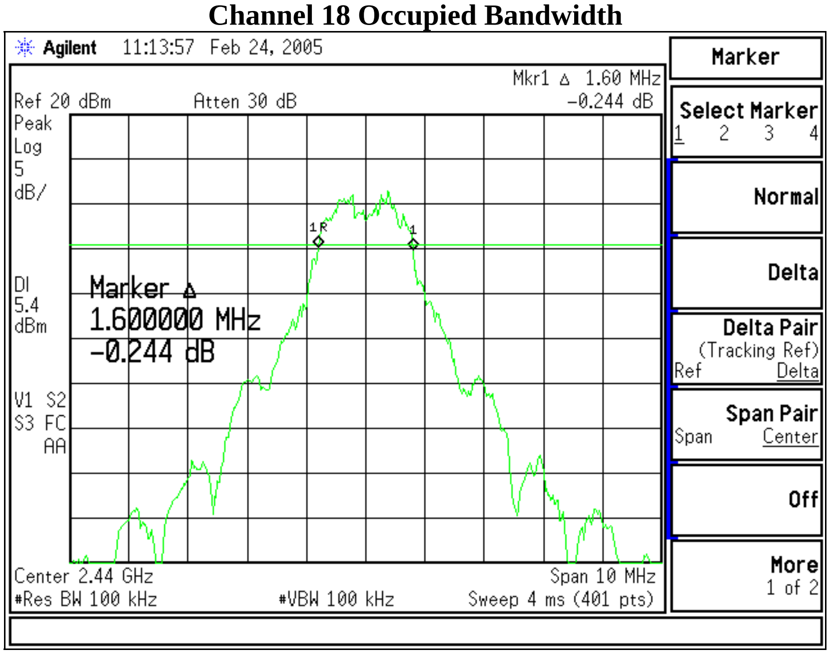
The 20 dB bandwidth requirement found in FCC Part 15.247(a)(2) requires a minimum -6dBc occupied bandwidth of 500 kHz. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4407B spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, 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 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 18, which is the closest data to the specification limit, is 1600 kHz, which is above the minimum of 500 kHz.

Channel	Center Frequency (MHz)	Measured 6 dB BW (kHz)	Minimum Limit (kHz)
11	2405	1630	500
18	2445	1600	500
25	2475	1680	500

Plots of Occupied Bandwidth

Channel 18 Occupied Bandwidth



13. 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 non-conductive pedestal, with a height of 80 cm above the reference ground plane. The EUT was investigated in various modes, drawing power from an external power supply, drawing power from the laptop host through the USB port, and drawing power from the laptop host through the Ethernet port.

The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The power supply of 120VAC, 60 Hz was provided inside the Shielded 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 phase.

Test Procedure

The EUT was investigated in continuous transmit mode, with typical data for modulation during this portion of the testing. A step-down transformer power supply as provided by the manufacturer was used to provide 5 VDC, 200 mA to the EUT, as would typically be the case in a typical installation. The 'Line' side of the step-down transformer (Laptop or EUT transformer) was connected to the sampling port of the LISN. 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 15.207 (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:

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

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), Class B

Manufacturer:	Sensicast Systems Incorporated					
Date(s) of Test:	February 16th through August 18th, 2005					
Test Engineer:		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	A2400 Coordinator					
Serial #:	Engineering Prototype					
Voltage:	5.0 VDC					
Operation Mode:	Normal operation and continuous modulated transmit					
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%

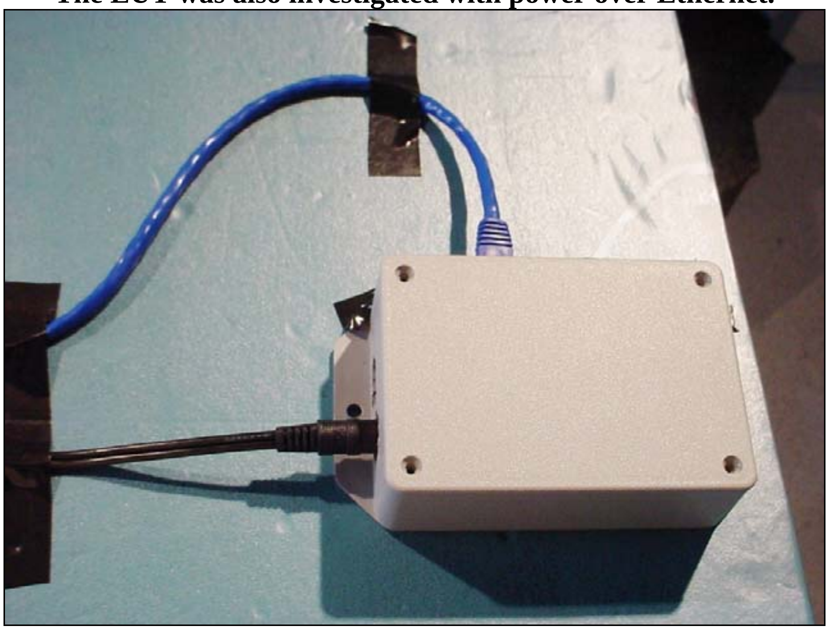
Test Equipment Utilized:
EMI Receiver: HP 8546A
LISN: EMCO 3816/2NM
Transient Limiter: HP 119474A

		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)
0.282	L1	50.2	60.8	60.8	49.4	50.8	1.4
0.566	L1	45.4	56.0	56.0	44.4	46.0	1.6
0.849	L1	42.1	56.0	56.0	41.5	46.0	4.5
1.417	L1	40.1	56.0	56.0	39.4	46.0	6.6
1.699	L1	39.1	56.0	56.0	38.1	46.0	7.9
2.548	L1	38.3	56.0	56.0	35.1	46.0	10.9
5.663	L1	25.2	60.0	60.0	20.6	50.0	29.4
5.945	L1	29.5	60.0	60.0	23.5	50.0	26.5
6.237	L1	23.3	60.0	60.0	16.9	50.0	33.1
0.282	L2	48.5	60.8	60.8	47.6	50.8	3.2
0.566	L2	45.1	56.0	56.0	43.9	46.0	2.1
0.849	L2	41.8	56.0	56.0	41.1	46.0	4.9
1.417	L2	39.6	56.0	56.0	38.8	46.0	7.2
1.699	L2	39.3	56.0	56.0	37.6	46.0	8.4
2.548	L2	38.2	56.0	56.0	35.8	46.0	10.2
5.663	L2	22.7	60.0	60.0	12.1	50.0	37.9
5.945	L2	28.8	60.0	60.0	17.8	50.0	32.2
6.237	L2	21.9	60.0	60.0	13.9	50.0	36.1

Notes:
1) All other emissions were better than 20 dB below the limits.
2) Worst case emissions observed were when power was drawn from the laptop PC host, either through the USB port, or the Ethernet port. The emissions in both cases are from the laptop PC host, and were not affected by the EUT.
3) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested.

General test setup during RF emissions tests onto AC Mains,
Test in RS-232 mode pictured below.

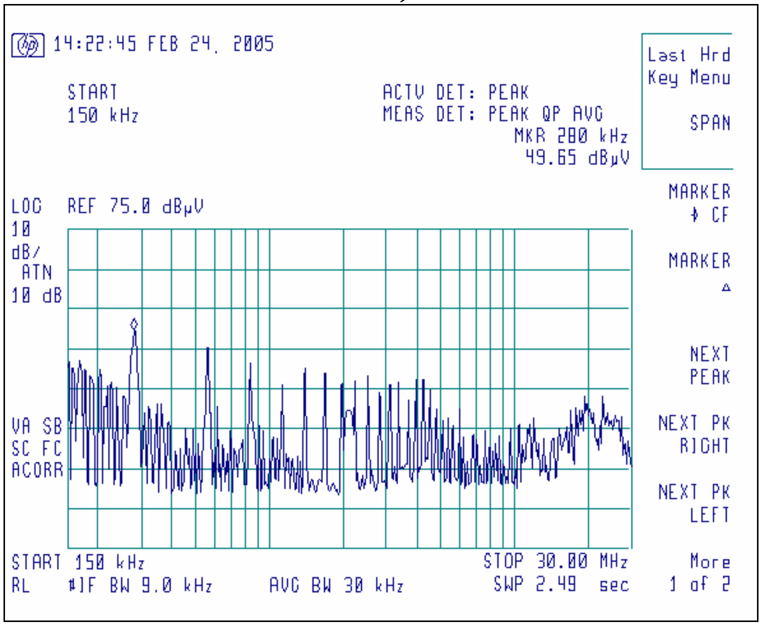
Test in Ethernet mode pictured below, with power from external power source.
The EUT was also investigated with power over Ethernet.



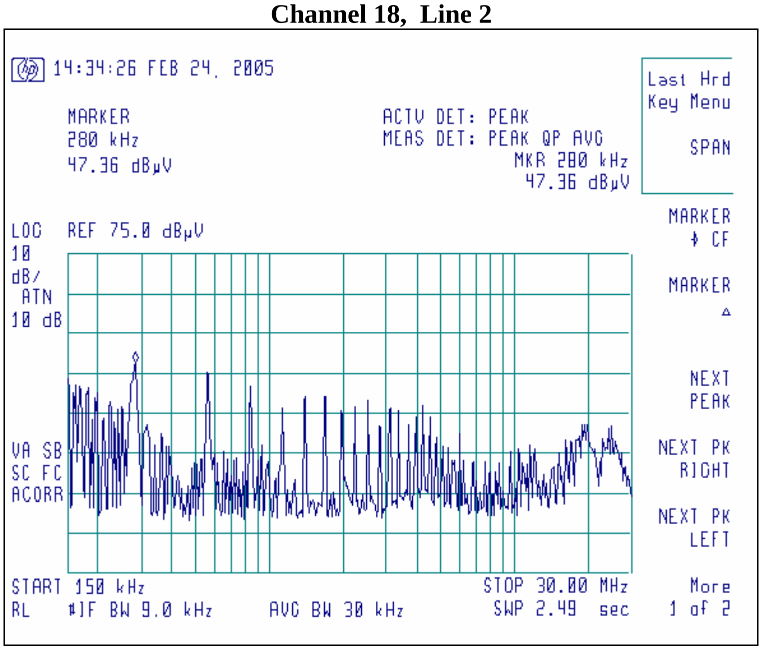
Screen Captures of Conducted AC Mains Emissions:

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 15.207.
The signature scans shown here are from channel 18, chosen as being a good representative of channels.

Channel 18, Line 1



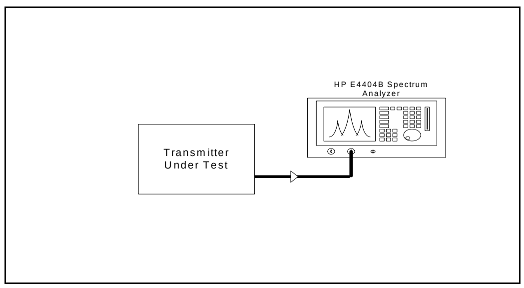
Channel 18, Line 2



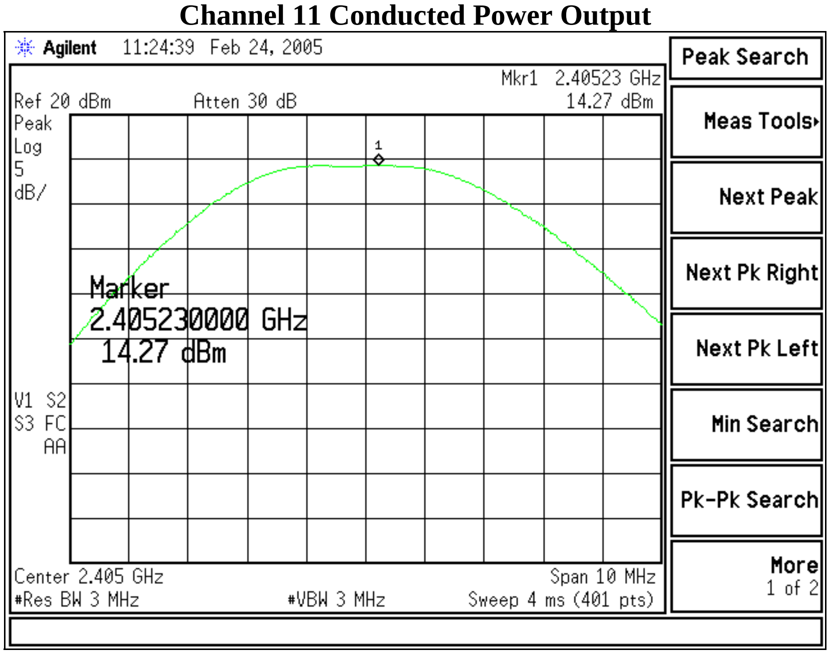
14. Power Output 15.247(b)

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 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. 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 resolution and video bandwidths set to 3 MHz, and a span of 20 MHz, with measurements from a peak detector presented in the chart below. RF Power Output was also monitored while varying the AC Mains voltage as sourced by a variable power supply as described in a later section.

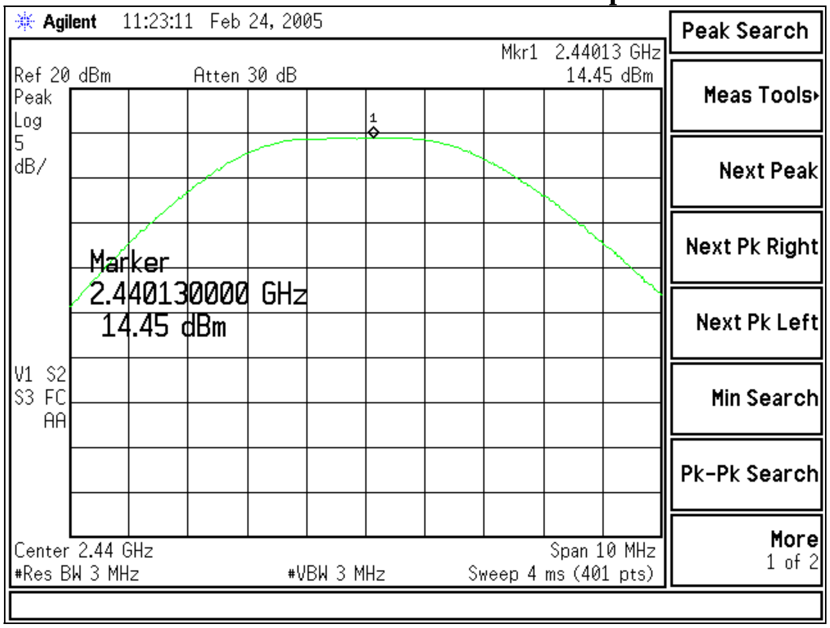
CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
11	2405	+ 30.0	+ 14.3	15.7
18	2440	+ 30.0	+ 14.5	15.5
25	2475	+ 30.0	+ 14.6	15.4



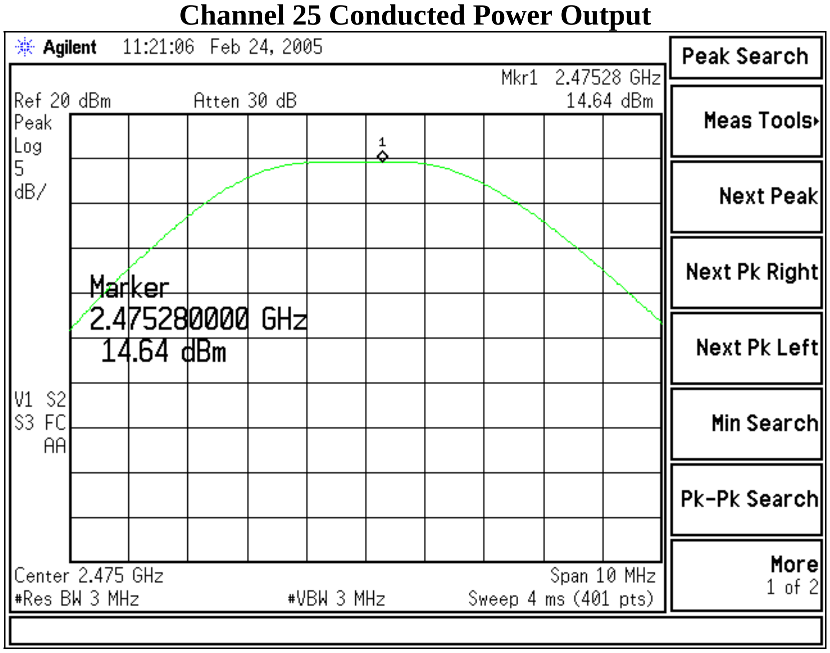
Channel 11 Conducted Power Output



Channel 18 Conducted Power Output



Channel 25 Conducted Power Output



15. 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.

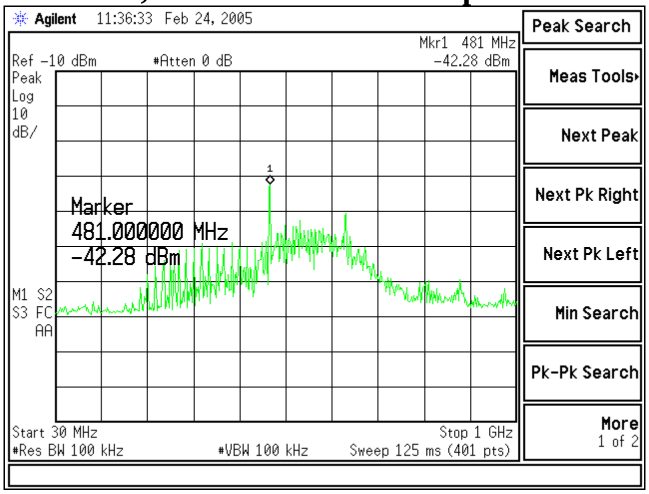
No significant emissions could be noted within -50 dBc of the fundamental level for this product.

	Channel 11	Channel 18	Channel 25
481-585 MHz	- 47.9 (dBm)	-42.3 (dBm)	- 48.7 (dBm)
Fundamental	+ 9.1 (dBm)	+ 9.3 (dBm)	+ 10.9 (dBm)
2nd Harmonic	- 44.9 (dBm)	- 43.4 (dBm)	- 40.0 (dBm)
3rd Harmonic	- 48.1 (dBm)	- 48.4 (dBm)	- 48.7 (dBm)
4th Harmonic	Note (1)	Note (1)	Note (1)
5th Harmonic	Note (1)	Note (1)	Note (1)
6th Harmonic	Note (1)	Note (1)	Note (1)
7th Harmonic	Note (1)	Note (1)	Note (1)
8th Harmonic	Note (1)	Note (1)	Note (1)
9th Harmonic	Note (1)	Note (1)	Note (1)
10th Harmonic	Note (1)	Note (1)	Note (1)

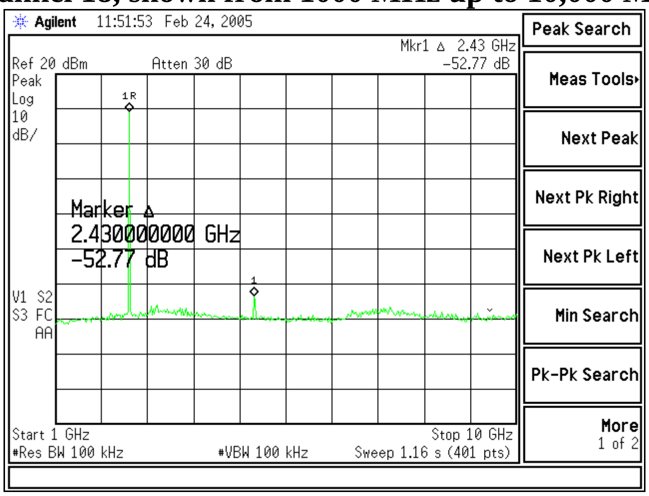
Notes:
(1) Measurement at system noise floor.

Representative plots for the middle channel are presented here, for the conducted RF spurious measurements.

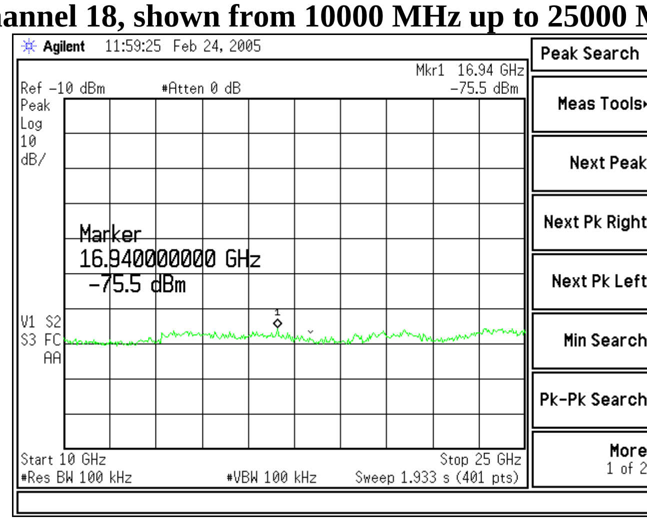
Channel 18, shown from 30 MHz up to 1000 MHz



Channel 18, shown from 1000 MHz up to 10,000 MHz



Channel 18, shown from 10000 MHz up to 25000 MHz

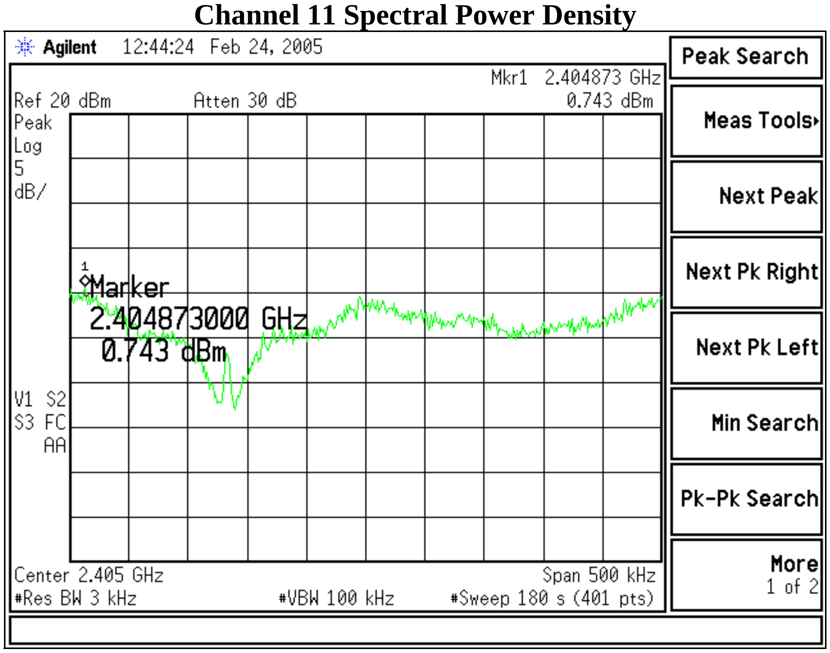


16. Spectral Density

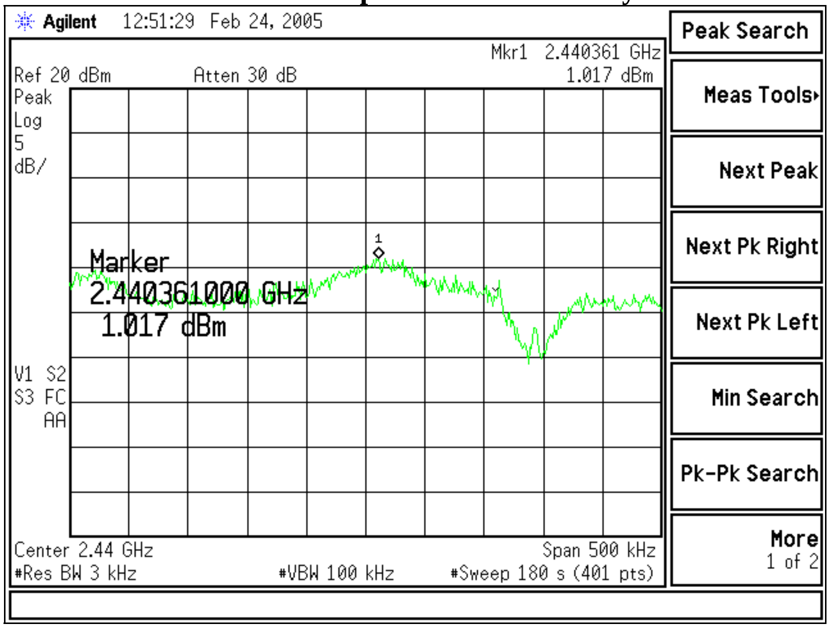
In accordance with FCC Part 15.247(e), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed. The highest density was found to be no greater than +1.0 dBm, which is under the allowable limit by 7 dB.

Channel	Center Frequency (MHz)	Measured Power (dBm)	Limit (dBm)	Margin (dB)
11	2405	+ 0.7	+8 dBm	7.3
18	2440	+ 1.0	+8 dBm	7.0
25	2475	+ 1.0	+8 dBm	7.0

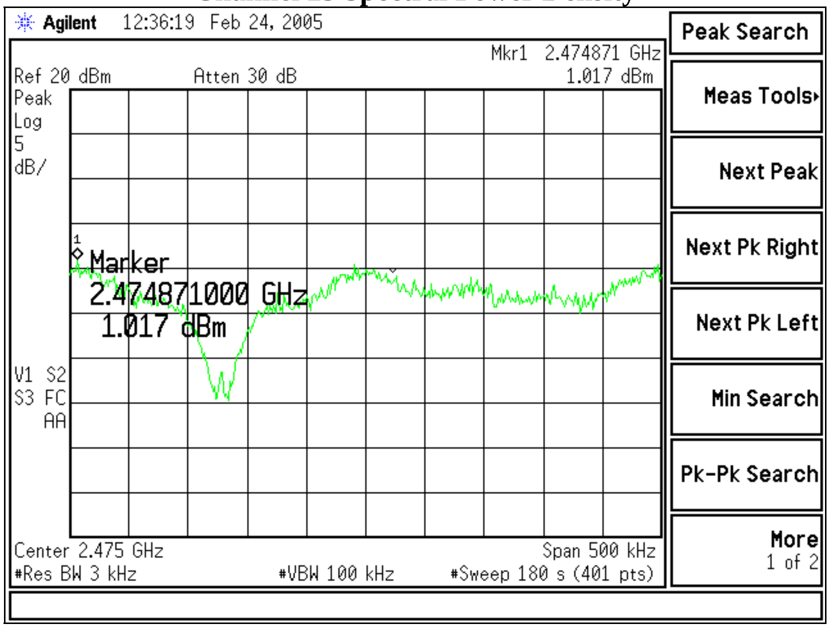
Channel 11 Spectral Power Density



Channel 18 Spectral Power Density



Channel 25 Spectral Power Density



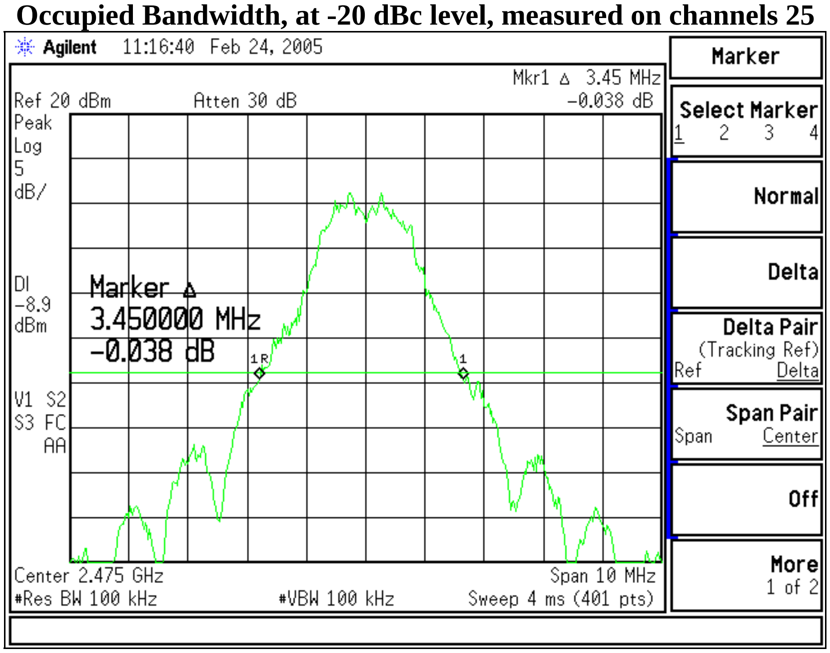
17. Minimum Channel Separation

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 100 kHz to measure the channel separation of the EUT.

The minimum and maximum channel-separations measured for this device are 4.95 MHz and 5.00 MHz respectively. The maximum -20 dBc occupied bandwidth of the device, as measured is 3.45 MHz. 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 15.

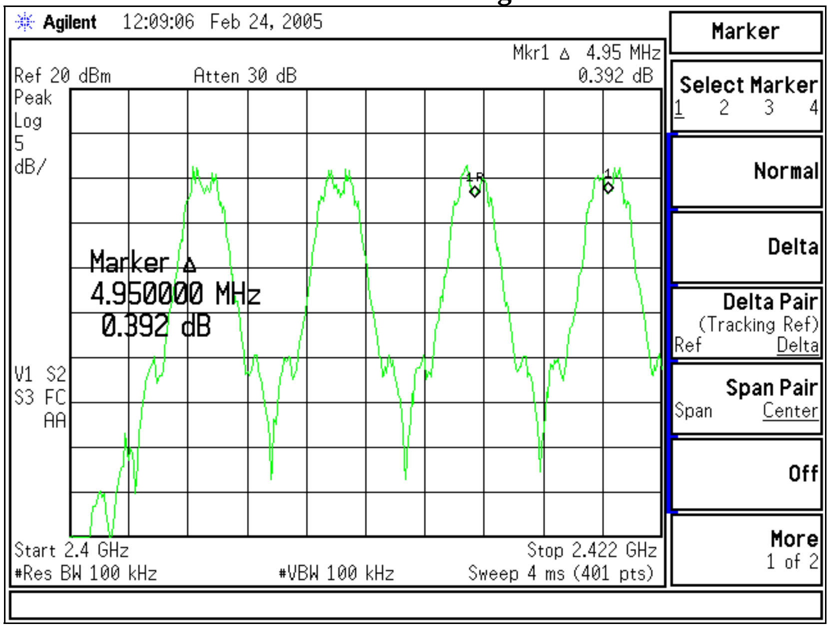
Frequency Span	Number of Channels	Minimum Separation (kHz)
2400-2422 MHz	4	4.95 MHz
2422-2442 MHz	4	5.00 MHz
2442-2462 MHz	4	5.00 MHz
2462-2484 MHz	3	5.00 MHz

Occupied Bandwidth, at -20 dBc level, measured on channels 25

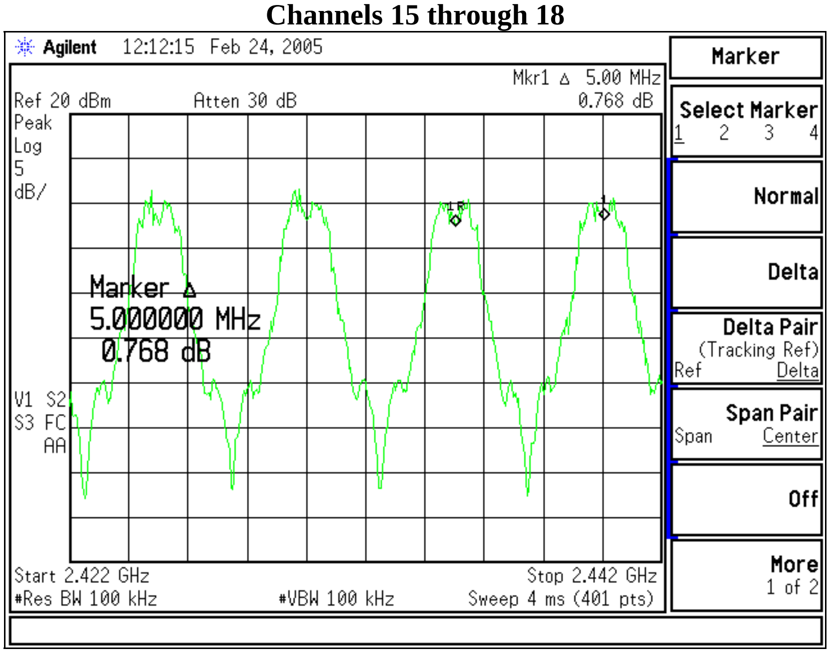


Plots of Channel Separations

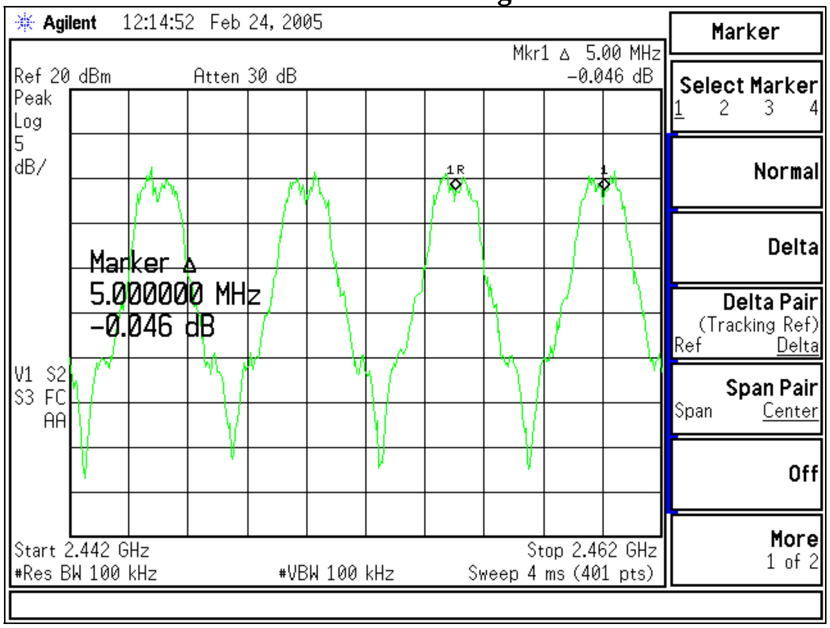
Channels 11 through 14



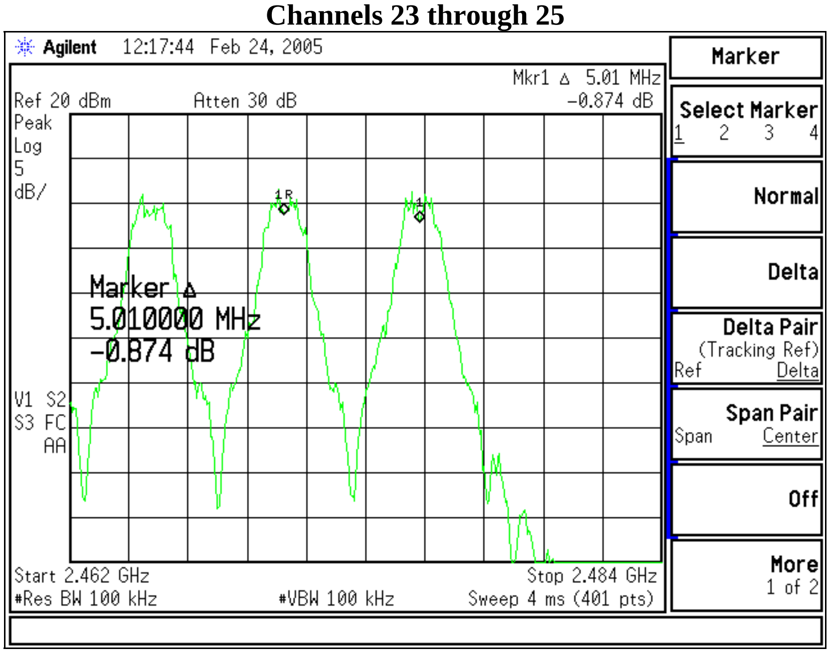
Channels 15 through 18



Channels 19 through 22



Channels 23 through 25



18. Channel Occupancy

Part 15.247(a)(1)(iii) requires a channel occupancy, for this device, of no more than 400 milliseconds in a time span of (400ms times the number of hop channels utilized). For this device, the window of assessment would be: 400 ms x 15 channels = 6.00 seconds.
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.

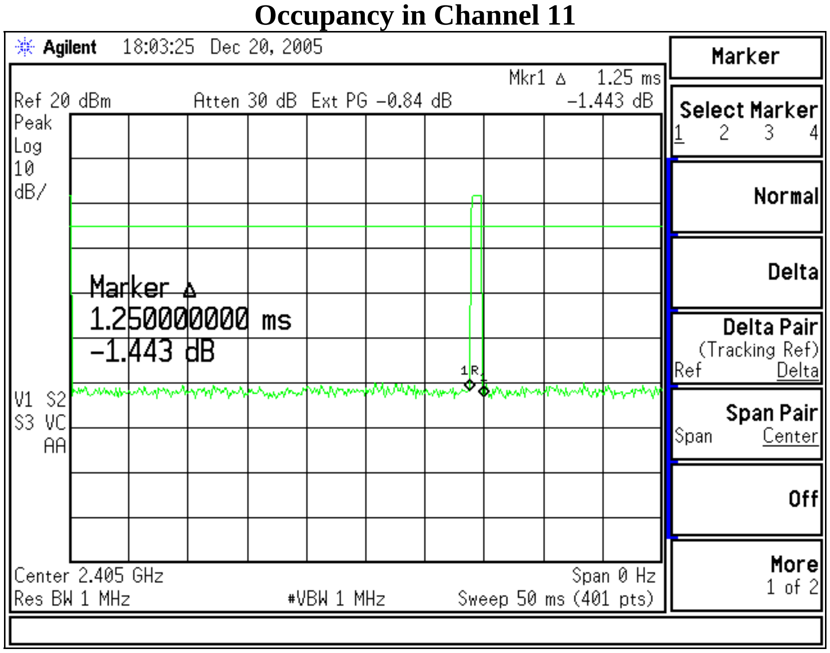
> *The following information is provided by the manufacturer:*
> *"On the OEM200 and A2400, the packet lengths are fixed in the software to 64 bytes. This corresponds to a 3.5ms dwell time per transmission. The system will operate on a single frequency for 300msec during which a maximum of 12 transmissions of length 3.5msec will occur. This gives a total transmission time of 42msec on a channel. The system will then hop to the next frequency and repeat."*

Given that the longest time any transmission will occur on a single channel is 3.5ms, and a maximum of 12 transmissions per 300 ms may occur. With a total of 15 channels used, each channel occupying a 300 ms slot, it will take 4.5 seconds for the sequence to repeat. In a 6 second window, each channel would have 1.33 transmission cycle occurrences. The maximum occupancy in a 6 second window is calculated by multiplying the 1.33 transmission cycles by 42.0 ms (3.5msx12) transmission duration per cycle, to arrive at 55.9 ms total occupancy per channel in any 6 second window.

Channel	Frequency (MHz)	Occupancy Per transmission (ms)	Occupancy in 6 second window (ms)
11	2405	1.25	2.50 Note (1)
18	2440	1.12	2.25 Note (1)
25	2475	1.12	2.25 Note (1)

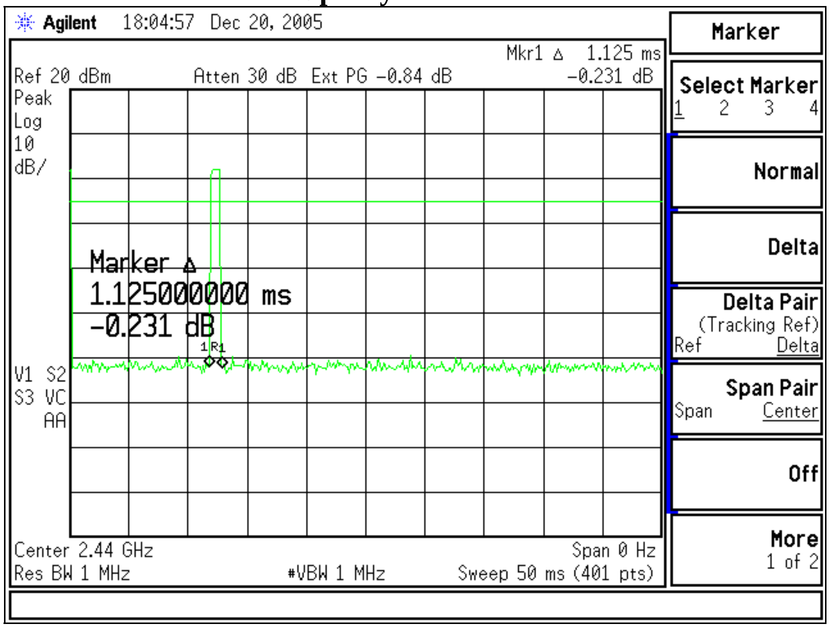
Plots of Channel Occupancy

Occupancy in Channel 11

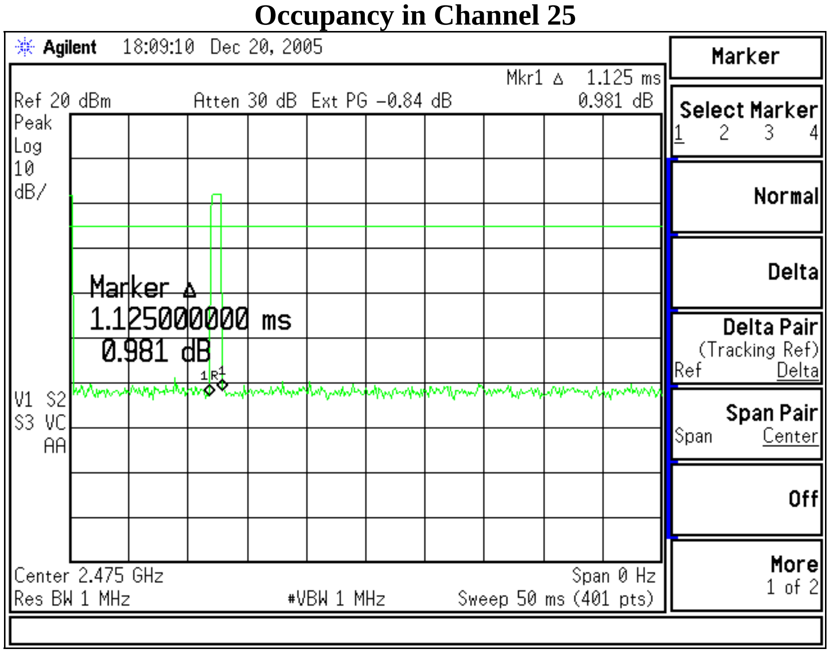


Note 1: The measurements reflect what was seen in actual operation, given a fully functional unit, in the setup that was provided. In no instance did more than two transmissions occur, during the testing, but the declarations indicate the possibility of a maximum of 12 transmissions that should be used for worst case calculations.

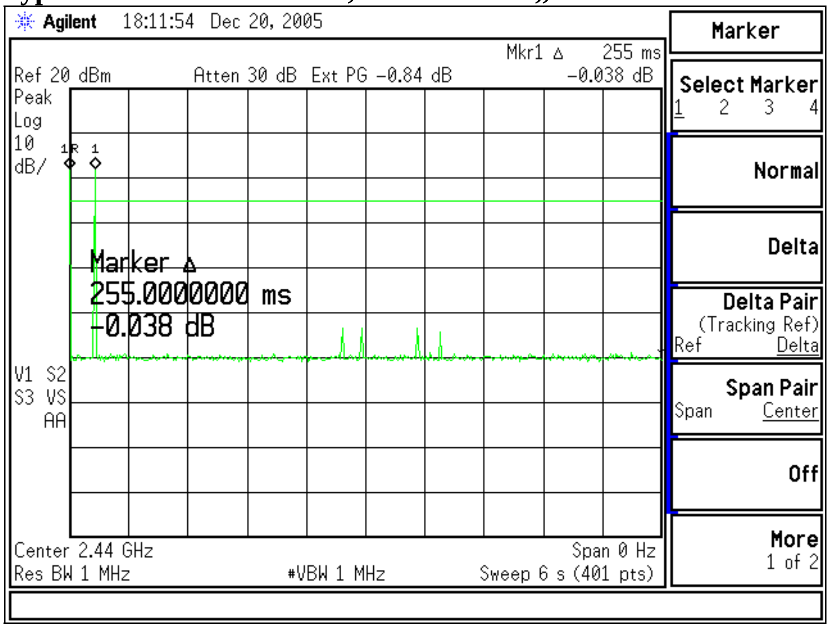
Occupancy in Channel 18



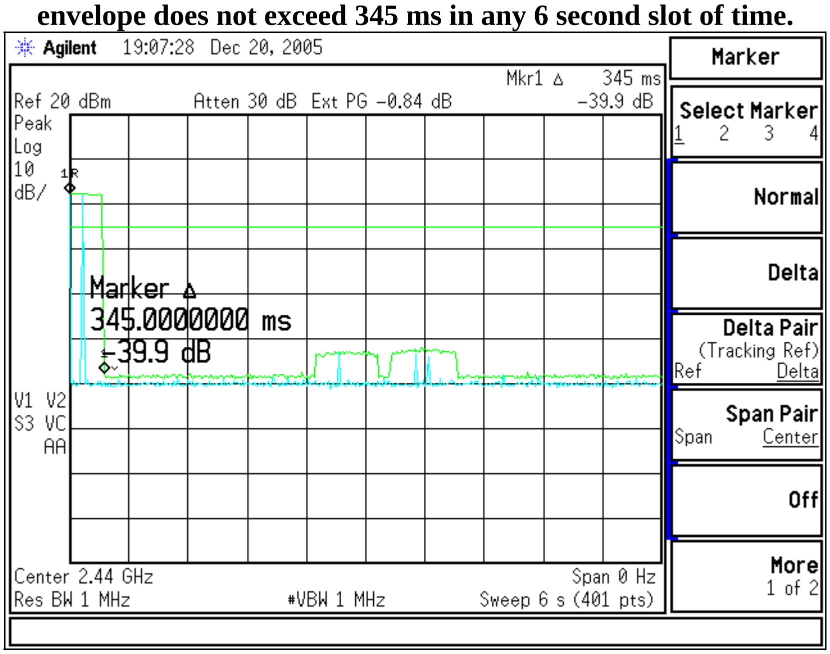
Occupancy in Channel 25



Typical transmission bursts, on channel 18,, in a 6 second window.



Extended view (very long duration) of the 6 second window, demonstrating that the transmission envelope does not exceed 345 ms in any 6 second slot of time.



The information on this page is provided by the manufacturer.

19. Equal Channel Usage

Frequency hopping is handled in OSI level 2. When the network or application needs to send a packet, it initiates the request without regard to the position in the hop pattern, thus resulting in a system that does not favor one frequency over another over time. The one exception to this is that layers above OSI level 2 may wait for the next hop during the back-off-and-retry procedure. If a message is sent by the system to a node but no acknowledgment is received, the system waits for the next hop and resends the message. (Because the system simply waits for the next hop, whatever it happens to be, this procedure does not bias the system toward the use of a particular channel.)

20. Pseudorandom Hopping Pattern

An IEEE compliant radio transceiver is used, the Chipcon CC2420.
Through the host software, the user can select which pseudorandom sequence is used.
The system hops according to a pseudorandom sequence. Supported hop patterns are as follows.
Sequence C: 4, 11, 2, 9, 0, 7, 14, 5, 12, 3, 10, 1, 8, 15, 6, 13
Currently, the entire network utilizes the same hop schedule. If multiple separate networks are used within the system, each network may use a different hop schedule. In the future, the system may allow the user to place different Mesh nodes on different hop schedules by selecting one of the available hop patterns for each Mesh node. Future versions may also randomize the timing of the hop patterns, with each mesh node hopping on its own schedule, in a pseudorandom manner that can be tracked by neighboring nodes that have locked onto the mesh node's pseudorandom schedule.

21. Receiver Synchronization and Input Bandwidth

When a node first awakens, it needs to acquire the time base of the system. To enable this, Mesh nodes transmit beacons. Mesh nodes select a random time during each hop to transmit a beacon. A node that wishes to join the network can listen to a random channel of the 15 available channels. Eventually (within 4.5 seconds), a beacon will be transmitted on that channel; this will allow the node to acquire the time base of the system. If no beacon is detected within 4.5 seconds, the node may be in a null. To attempt again to acquire the system's time base, the node can select a different channel and listen again.

22. Frequency and Power Stability over Voltage Variations

For measurements of the frequency and voltage stability, the EUT was placed in continuous transmit mode, at specific channels. Because of the particular test mode that was programmed on the EUT, operating with modulation, a suitable local maxima point was chosen on the spectral plot as the reference point for frequency and power variation tests. A Spectrum Analyzer was used to measure the frequency and the conducted RF power level. Power to the EUT was supplied by an external AC variable power supply. The frequency and relative power output were measured with a receiver resolution bandwidth of 100 Hz, and video bandwidth of 100 Hz. The test was repeated twice, the first with the EUT external power supply being varied, and the second with the power supply to the laptop host being varied to check for power-over-Ethernet and power-over-USB. In both cases, the mains voltage would be the source of power variation. The 120 VAC source was therefore chosen as the voltage to be tested at ±15%. The data from the external EUT power supply is presented below as a good representative sample.

	RF Power Output as a function of AC Voltage Source		
	102 VAC	120 VAC	138 VAC
Channel 11	+ 8.3 (dBm)	+ 8.4 (dBm)	+ 8.2 (dBm)
Channel 18	+ 8.5 (dBm)	+ 8.5 (dBm)	+ 8.5 (dBm)
Channel 25	+ 9.1 (dBm)	+ 9.1 (dBm)	+ 9.2 (dBm)

	Center Frequency as a function of AC Voltage Source		
	102 VAC	120 VAC	138 VAC
Channel 11	2405.393955 (MHz)	2405.393705 (MHz)	2405.393500 (MHz)
Channel 18	2441.393010 (MHz)	2441.392955 (MHz)	2441.392720 (MHz)
Channel 25	2475.393480 (MHz)	2475.393200 (MHz)	2475.393250 (MHz)

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the proper power-up state (no transmissions). At the extreme temperature settings, a wide frequency sweep was also investigated, with minimum and maximum input voltages, to ensure that no unexpected anomalies have occurred. No anomalies were noted, in the measured transmit power during the voltage variation tests.

23. MPE Calculations

The MPE calculations are based on 0 dBi declared antenna gain.

Note: Empirically determined gain for the PCB trace antenna used in this product is approximately – 5.5 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:	14.60	(dBm)
Maximum peak output power at antenna input terminal:	28.840	(mW)
Antenna gain(typical):	0	(dBi)
Maximum antenna gain:	1.000	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2400	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)
Power density at prediction frequency:	0.005738	(mW/cm^2)
Maximum allowable antenna gain:	22.4	(dBi)
Margin of Compliance at 20 cm =	22.4	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	12/06/04	12/06/05
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	12/07/04	12/07/05
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.

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

The antenna used in this product is a printed circuit board trace, ‘inverted F’ antenna, approximately 2.5 cm in length. The conservative estimated and declared gain by the manufacturer is 0 dBi. Empirical testing results showed a gain of approximately -5dBi. The PC-board trace antenna is the only antenna defined for this product.

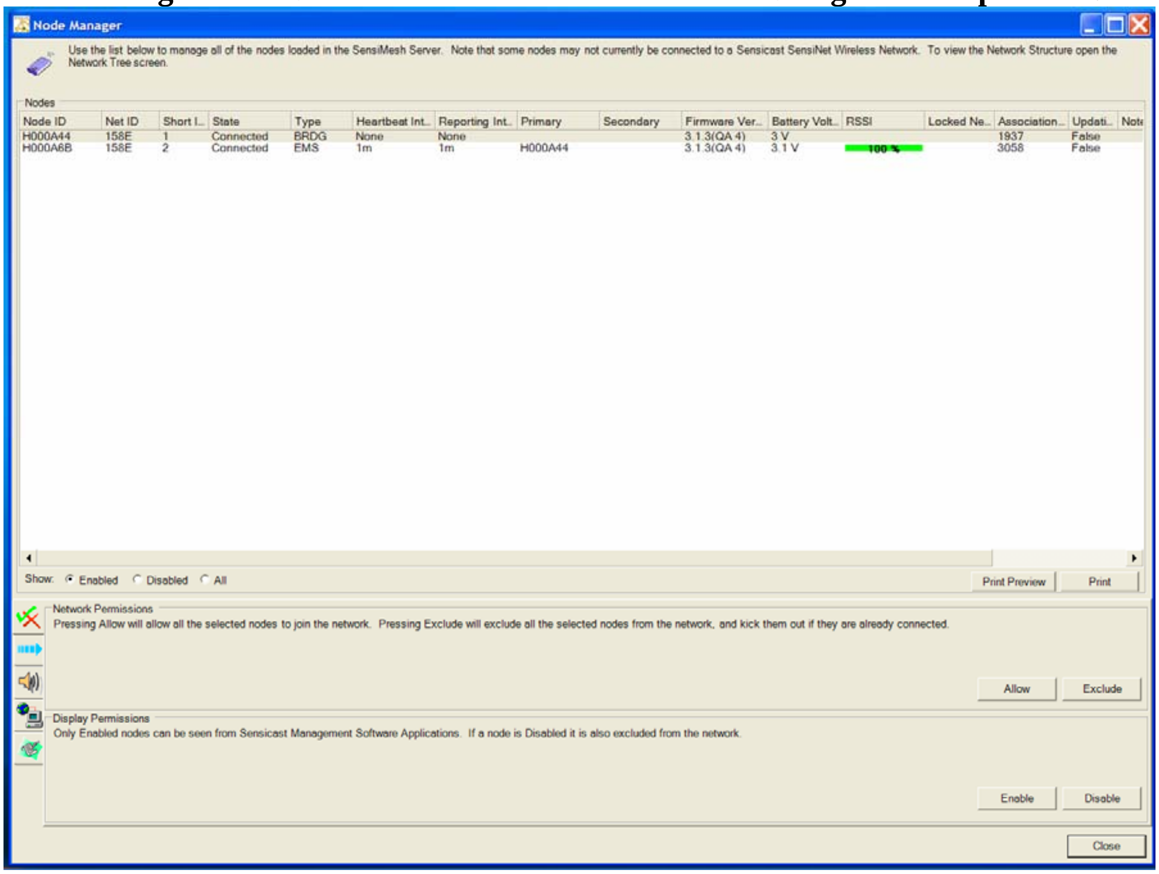
Appendix C

Firmware and Setup instructions

The EUT presented used two different firmware instruction sets for normal operation versus operation in the required test modes. These firmware instructions were programmed during the testing process and are not available to the end users.

For normal operation, standard software programming was used as provided by the manufacturer, as would be provided for the end users. This software set included the Sensicast's proprietary Server, Service Manager, Protocol Service and Administration software.

Screen Capture of the Node Manager Software
Showing link status between a sensor and the EUT during normal operation.



For specific test modes, a special test firmware was uploaded on to the EUT, enabling mode control through a laptop PC with standard RS-232 communication (9600-8-N-1-N), along with a special interface fixture to connect the EUT to the RS-232 port.

Screen Capture of the terminal program
Showing sample commands during test mode changes.