



L.S. Compliance, Inc.

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

COMPLIANCE TESTING OF:

OEM 200 2.4 GHz Module

PREPARED FOR:

Sensicast Systems
Attn.: Mr. Jay Werb
220-3 Reservoir Street
Needham, MA 02494

TEST REPORT NUMBER:

304365-TCB-v1

TEST DATE(S):

February 4th, 7th, 15th, 18th and March 2nd, 2005

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

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1. L. S. Compliance In Review

L.S. Compliance - Accreditations and Listing's

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

A2LA – American Association for Laboratory Accreditation

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

Federal Communications Commission (FCC) – USA

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

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

Industry Canada

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

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

U. S. Conformity Assessment Body (CAB) Validation

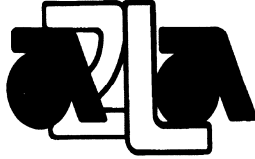
Validated by the European Commission as a U. S. Competent Body operating under the U. S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 89/336/EEC, Article 10.2.

Date of Validation: January 16, 2001

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

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

2. A2LA Certificate



**THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION**

ACCREDITED LABORATORY

A2LA has accredited

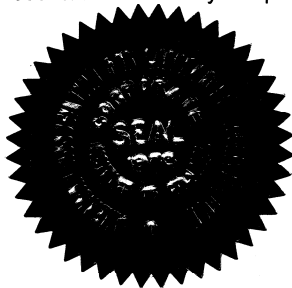
L.S. COMPLIANCE, INC.
Cedarburg, WI

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. 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, 2007

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:

<u>Test</u>	<u>Test Method(s)</u>
Emissions	
Conducted	
Continuous/Discontinuous	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4; EN: 55011, 55022, CISPR: 11, 12, 14-1 (excluding clicks), 22;
Radiated	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4 (3 meter chamber only); EN: 55011, 55022, CISPR: 11, 12, 14-1, 22;
Current Harmonics	IEC 61000-3-2; EN 61000-3-2
Voltage Fluctuations & Flicker	IEC 61000-3-3; EN 61000-3-3
Generic and Specific	EN 61000-6-3, EN 61000-6-4
Immunity	
Generic and Specific	EN 61000-6-1 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

(A2LA Cert. No. 1255.01) 04/29/05
5301 Buckeystown Pike, Suite 350 • Frederick, MD 21704-8373 • Phone: 301-644 3248 • Fax: 301-662 2974 

Peter Blaha

Page 1 of 2

<u>Test</u>	<u>Test Method(s)</u>
Voltage Dips/Interruptions	IEC 61000-4-11; EN 61000-4-11
Radiated Immunity	
RF Fields	IEC: 61000-4-3; EN: 61000-4-3
RF Fields (50 Hz)	IEC 61000-4-8; EN 61000-4-8
RF Fields (Pulse Mode)	ENV 50204
Electrostatic Discharge (ESD)	IEC: 61000-4-2; EN 60801-2; EN: 61000-4-2

Peter Blaha

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

 January 16, 2001		UNITED STATES DEPARTMENT OF COMMERCE National Institute of Standards and Technology Gaithersburg, Maryland 20899-
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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.

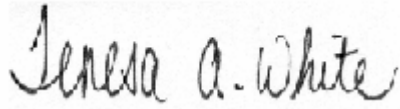
- (✓) Only the facility noted in the address block above has been approved.
- () Additional EMC facilities:
- () Additional R&TTE facilities:

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

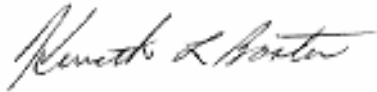


Prepared By:

December 28, 2005

Teresa A. White, Document Coordinator

Date



Tested and 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

6. Product and General Information

Manufacturer:	Sensicast Systems				
Date(s) of Test:	Feb. 4 th , 7 th , 18 th and Mar. 2 nd , 2005				
Test Engineer(s):		Tom Smith		Abtin Spantman	√ Ken Boston
Model #:	OEM 200				
Serial #:	Engineering Unit				
Voltage:	3.3 VDC				
Operation Mode:	Continuous modulated transmit on channels 0,7 and 14				

7. Introduction

During February and March, 2005 a series of Conducted and Radiated Emission tests were performed on one sample of the Sensicast Systems OEM 200, 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 15.109 (Industry Canada RSS-210) for a receiver or digital device. These tests were performed by Kenneth L. Boston, EMC Lab Manager, of L.S. Compliance, Inc.

All Radiated and Conducted Emission tests upon the EUT were performed to measure the emissions in the frequency bands described in Title 47 CFR, FCC Part 15, including 15.35, 15.247, 15.109a 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 procedure described in the American National Standard for methods of measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2003). Another document used as a reference for the EMI Receiver specification was the Comite International Special Des Perturbations Radioelectriques CISPR 16-1, 2003.

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

8. Product Description

The OEM200 End Node is a battery-operated, 2400MHz transceiver that can wirelessly transmit and receive data to and from A2400 Coordinator devices. It is not a routing device. The OEM200 will require a power source to operate (typically a battery) and a sensor and/or actuator to be useful. The device can measure and report temperature and humidity using and onboard sensor but typically the OEM200 will be plugged into a mating receptacle on a carrier board. This carrier board will house a sensor and/or actuator, a power source and mount into a physical package

9. Test Requirements

The above mentioned tests were performed in order to determine the compliance of the OEM 200 with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

15.207	15.247b	15.247e
15.205	15.247c	15.209
15.247a2	15.247d	15.31

10. Summary of Test Report

DECLARATION OF CONFORMITY

The Sensicast Systems OEM 200 was found to **MEET** the requirements as described within the specification of Title 47 CFR FCC, Part 15.247, Subpart c; and I.C. RSS-210, Section 6.2.2(0) for an intentional radiator.

11. 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. The EUT was operated in continuous modulated transmit mode. The unit has the capability to operate on three channels, controllable via pre-programming from a laptop PC or switches. The applicable limits apply at a 3 meter distance, and are found on Page 12 of this report. 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 (0), medium (7) and high (14) 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 25,000 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 1.0 meter separation, using a standard gain Horn Antenna and pre-amplifier.

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 E4407 Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the EUT was measured at a 1.0 meter separation, using a standard gain horn and a pre-amplifier.

Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for a digitally modulated spread spectrum transmitter (Canada RSS-210). The frequencies with significant signals were recorded and plotted as shown in the Data Charts and Graphs.

CALCULATION OF RADIATED EMISSIONS LIMITS

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)	$\mu\text{V/m}$	3 m Limit (dB $\mu\text{V/m}$)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-24,000	500	54.0

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

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

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

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

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

$$54.0 + 9.5 = 63.5 \text{ dB}\mu\text{V/m at 1.0 meters.}$$

Radiated Emissions Data Chart
3 Meter Measurements of Electromagnetic Radiated Emissions
Test Standard: Title 47 CFR Parts 15.247 and 15.205
Frequency Range Inspected: 30 MHz to 25,000 MHz

Manufacturer:	Sensicast Systems					
Date(s) of Test:	February 4 th and 7 th , 2005					
Test Engineer(s):		Tom Smith		Abtin Spantman	√	Ken Boston
Model #:	OEM 200					
Serial #:	Engineering Unit					
Voltage:	3.3 VDC					
Operation Mode:	continuous data modulation					
Distance:	√	3 Meters/1 Meter			10 Meters	
EUT Power:		Single Phase ___ VAC			3 Phase ___ VAC	
		Battery		√	Other: 3.3 VDC	
EUT Placement:	√	80cm pedestal			10cm Spacers	
EUT Test Location:	√	3 Meter Semi-Anechoic FCC Listed Chamber			3/10m OATS	
Measurements:		Pre-Compliance			Preliminary	√
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 3110
Pre-Amp: Advanced Microwave WHA6224
Standard Gain Horn: EMCO 3160-09

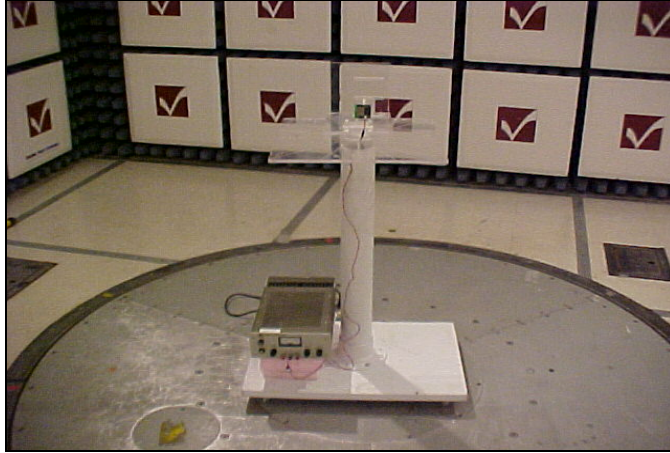
The following table depicts the level of significant radiated emissions found:

Frequency (MHz)	Antenna Polarity	Position/ Channel	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
1700	H	H/7	2.2	210	45.7	54.0	8.3
2262	H	H/0	2.0	215	46.7	54.0	7.3
2387.5	H	H/0	2.25	205	47.7	54.0	6.3
2484	H	H/14	12	195	48.2	54.0	5.8
2491	H	H/14	1.2	195	46.6	54.0	7.4
4809	V	H/0	1.08	130	48.8	54.0	5.2
4879	H	H/7	1.2	275	48.4	54.0	5.6
4951	V	V/14	1.0	225	52.2	54.0	1.8
7213.6	H	H/0	1.05	190	47.8	65.3	17.5
9618	H	H/0	1.10	270	57.7	65.3	7.6
9758	H	H/7	1.1	270	59.7	65.3	5.6
9898	H	H/14	1.0	145	58.3	65.3	7.0
12198	H	H/7	1.0	250	53.0	65.3	12.3
19805	H	H/14	1.0	210	47.8	63.5	15.7

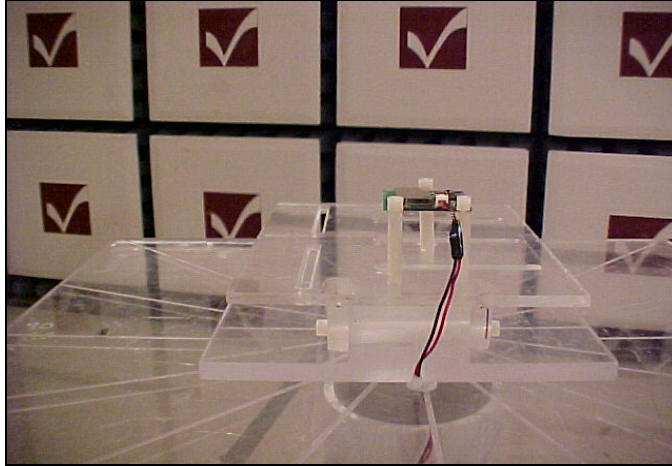
Note: A Quasi-Peak Detector was used in measurements below 1 GHz, and both Peak and Average Detectors was used in measurements above 1 GHz.
All peak readings were greater than 20 dB below the peak limits.
All other emissions seen were greater than 20 dB below the average limits (>1GHz) or quasi-peak limits (<1GHz).
EUT was tested in three positions.
Measured distance set at 1 meter for signals above 5 GHz.

Photos Taken During Radiated Emission Testing

Setup for the Radiated Emissions Test, Vertical Position



Setup for the Radiated Emissions Test, Horizontal Position

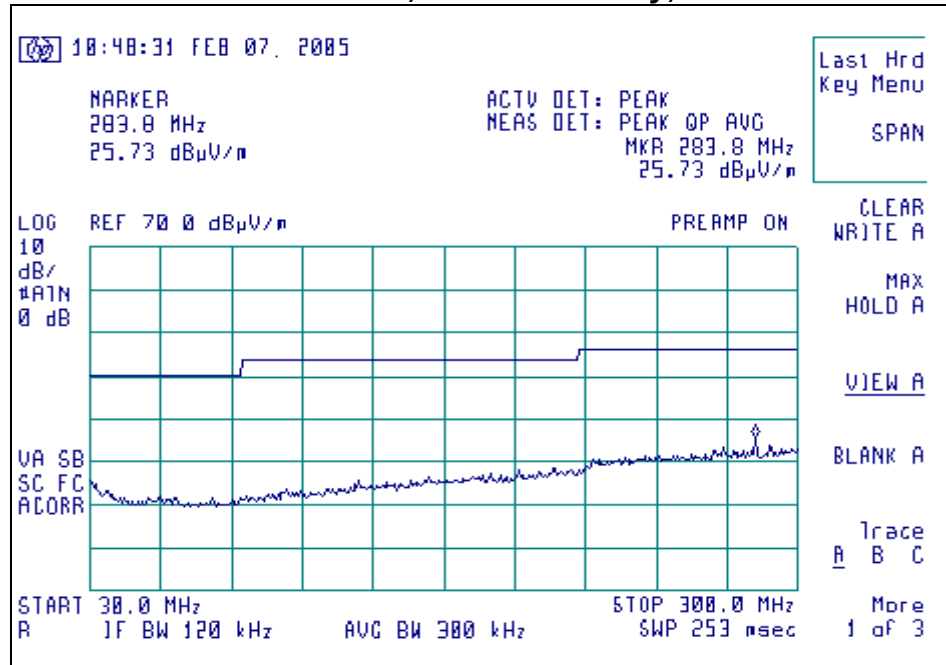


Setup for the Radiated Emissions Test, Side Position

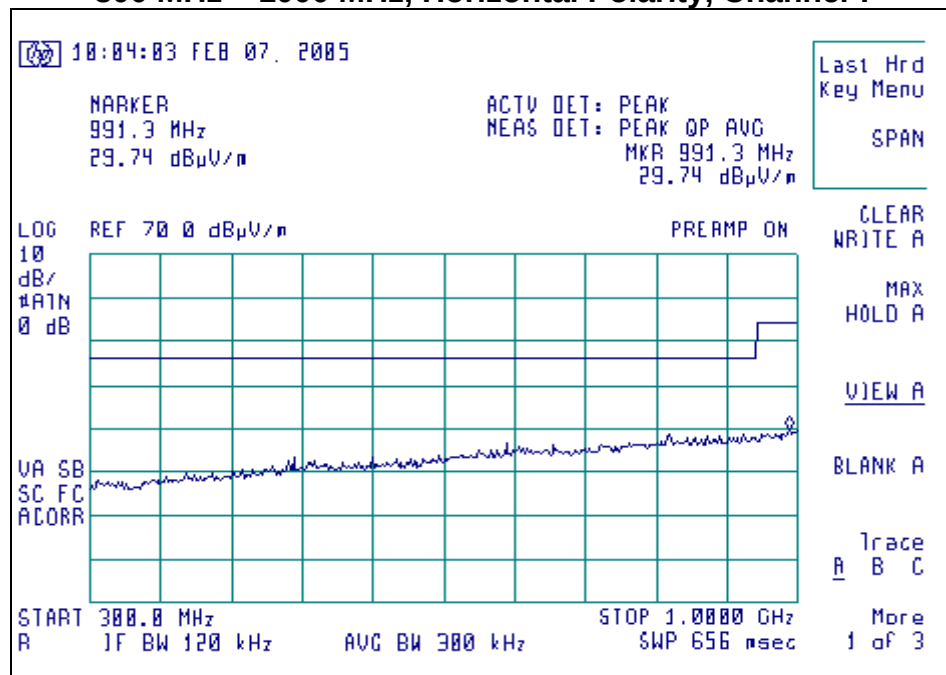


Graphs made during Radiated Emission Testing

Signature Scan of Peak Radiated Emissions 30 MHz – 300 MHz, Vertical Polarity, Channel 7

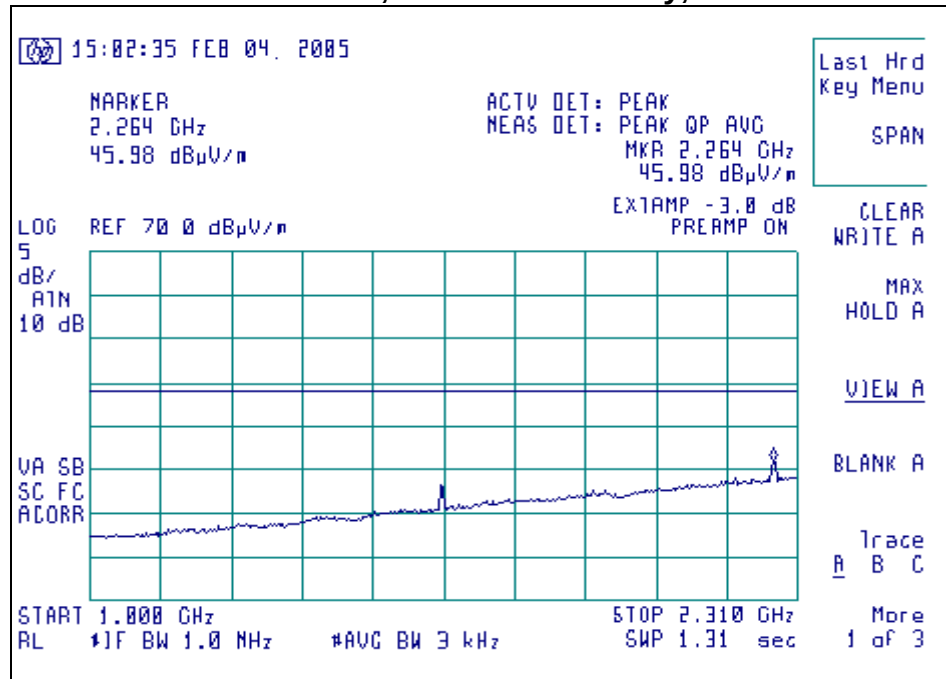


Signature Scan of Peak Radiated Emissions 300 MHz – 1000 MHz, Horizontal Polarity, Channel 7

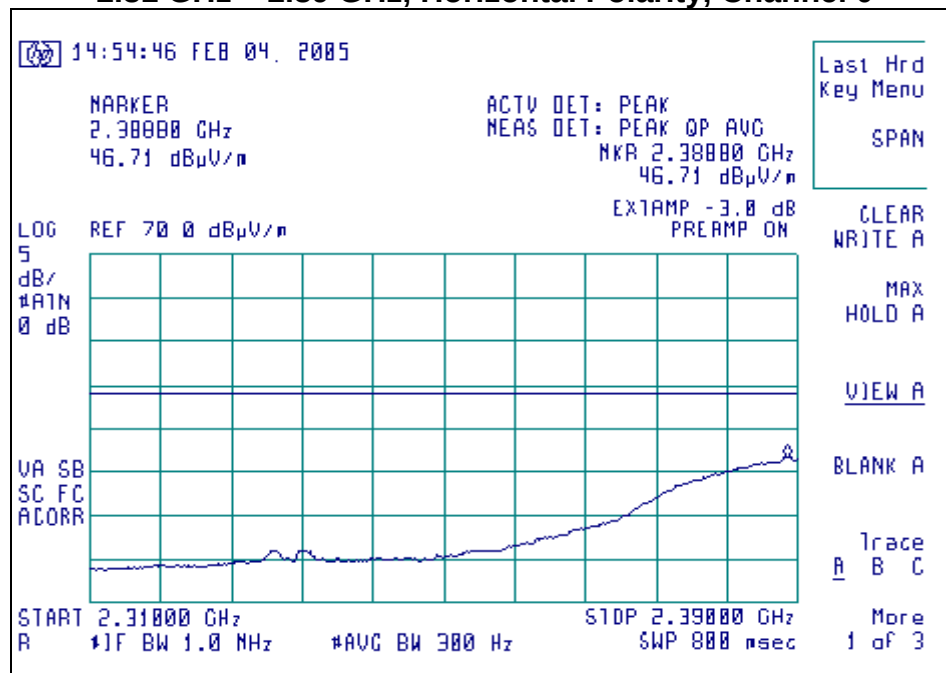


Graphs made during Radiated Emission Testing (continued)

Signature Scan of Peak Radiated Emissions 1 GHz – 2.31 GHz, Horizontal Polarity, Channel 0

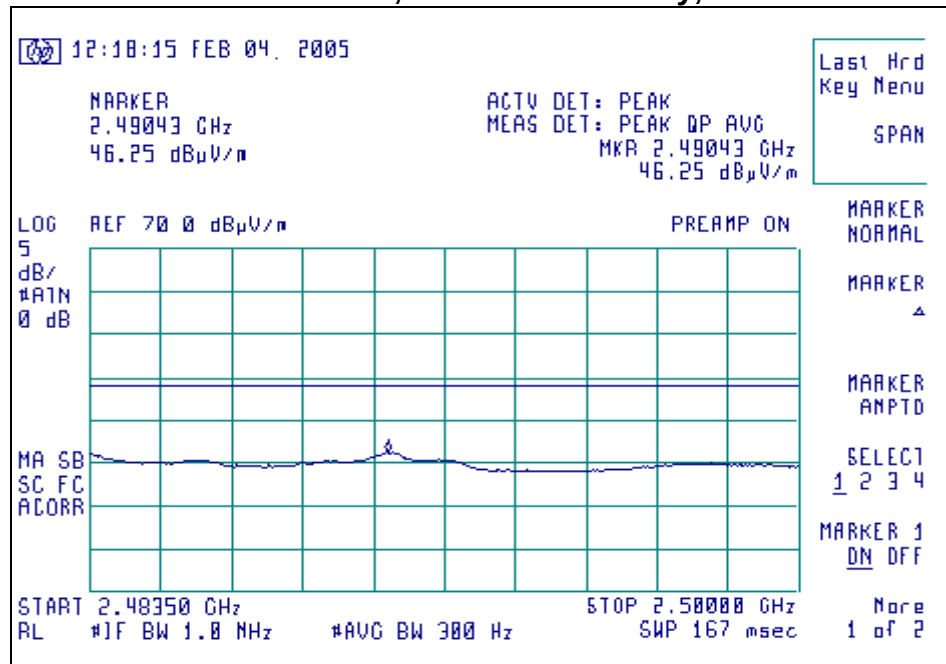


Signature Scan of Peak Radiated Emissions 2.31 GHz – 2.39 GHz, Horizontal Polarity, Channel 0

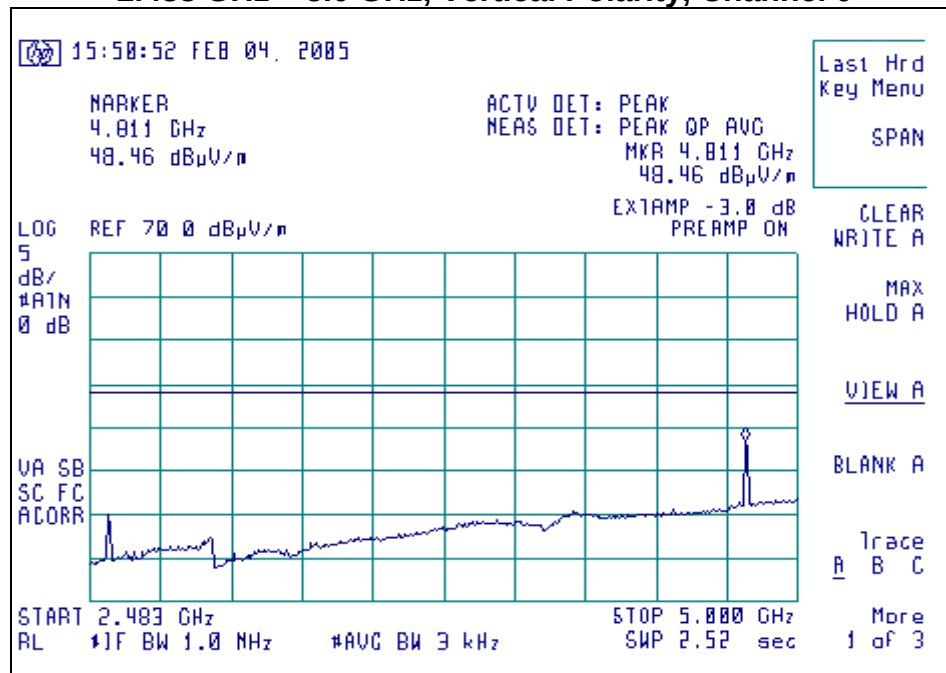


Graphs made during Radiated Emission Testing (continued)

Signature Scan of Peak Radiated Emissions 2.483 GHz – 2.5 GHz, Horizontal Polarity, Channel 14

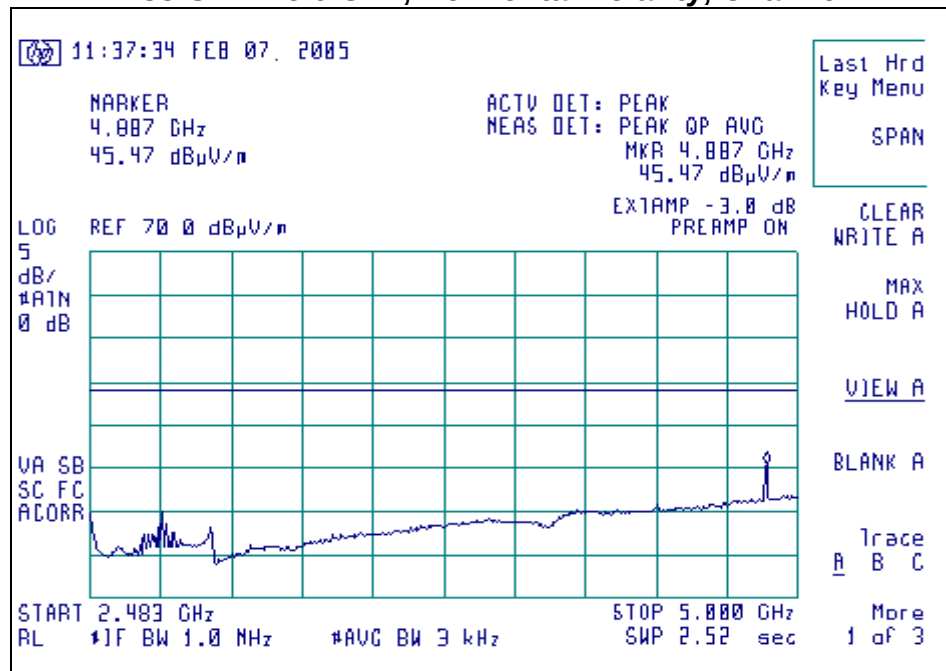


Signature Scan of Peak Radiated Emissions 2.483 GHz – 5.0 GHz, Vertical Polarity, Channel 0

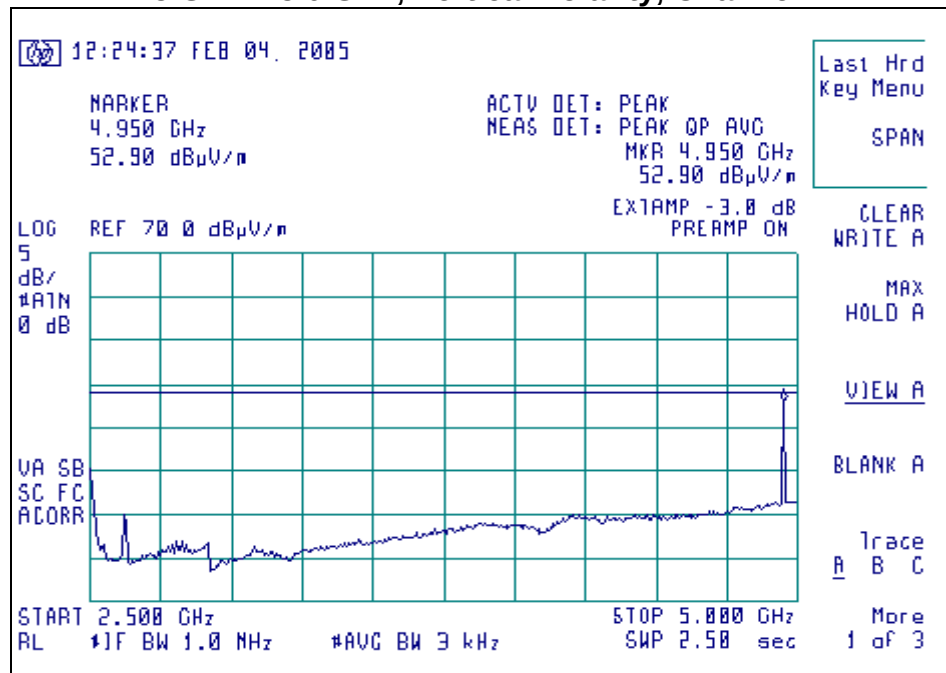


Graphs made during Radiated Emission Testing (continued)

Signature Scan of Peak Radiated Emissions 2.483 GHz – 5.0 GHz, Horizontal Polarity, Channel 7

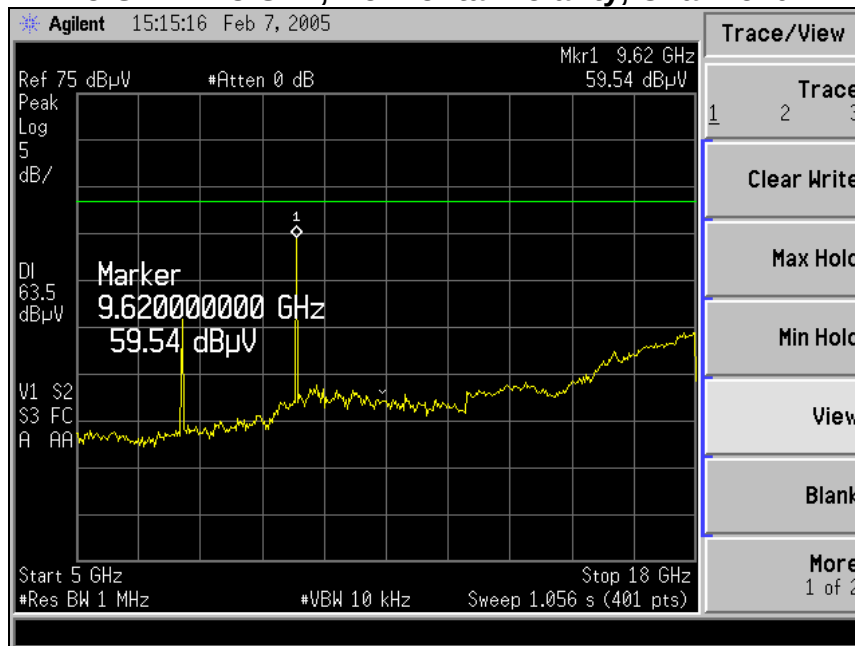


Signature Scan of Peak Radiated Emissions 2.5 GHz – 5.0 GHz, Vertical Polarity, Channel 14

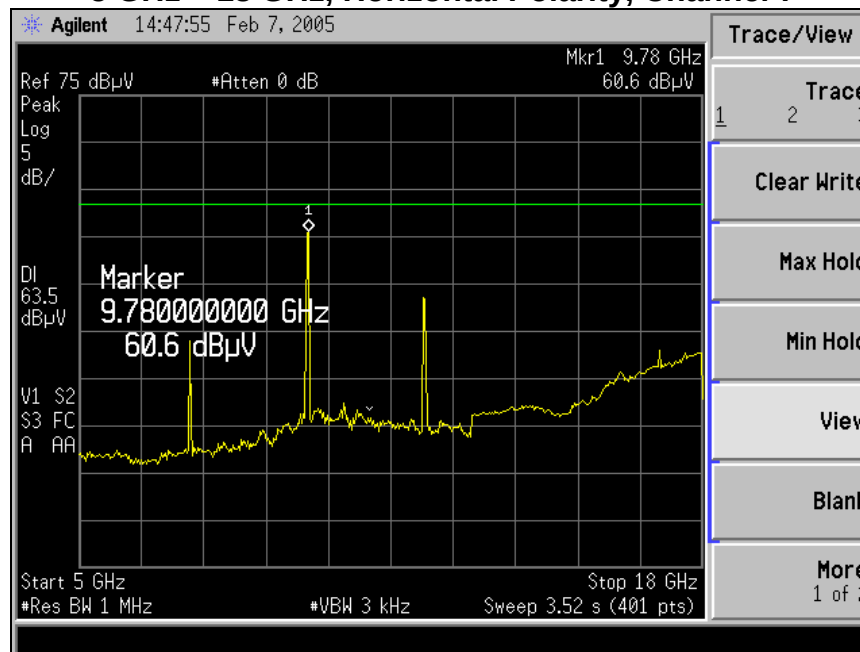


Graphs made during Radiated Emission Testing (continued)

Signature Scan of Peak Radiated Emissions 5 GHz – 18 GHz, Horizontal Polarity, Channel 0

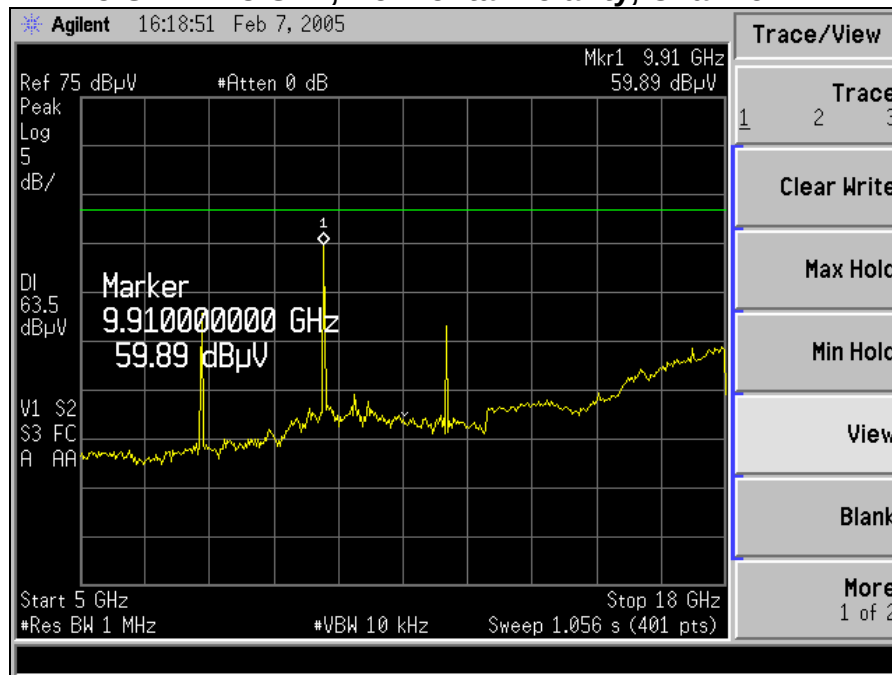


Signature Scan of Peak Radiated Emissions 5 GHz – 18 GHz, Horizontal Polarity, Channel 7

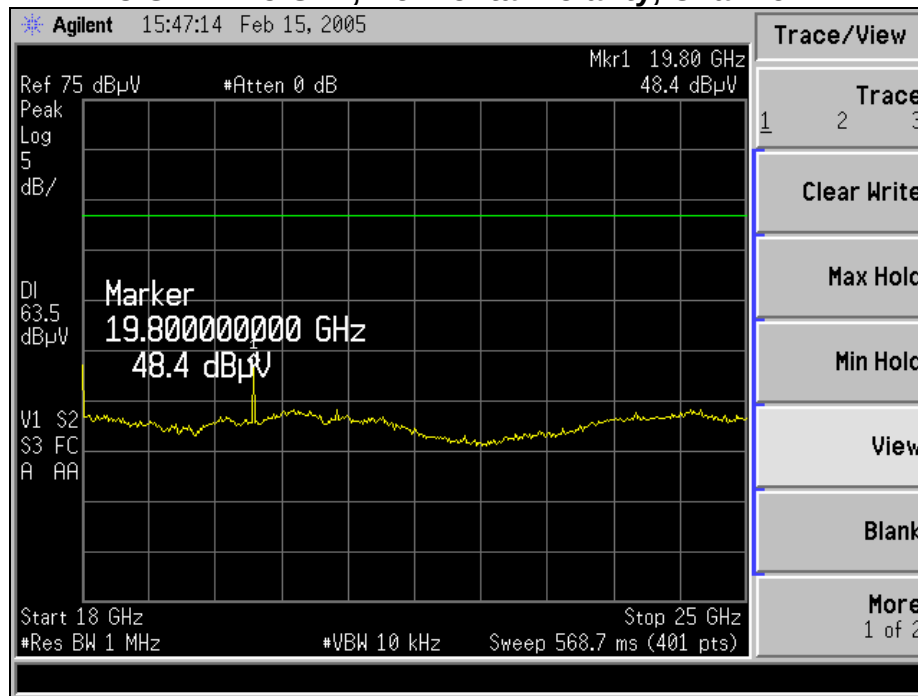


Graphs made during Radiated Emission Testing (continued)

Signature Scan of Peak Radiated Emissions 5 GHz – 18 GHz, Horizontal Polarity, Channel 14



Signature Scan of Peak Radiated Emissions 18 GHz – 25 GHz, Horizontal Polarity, Channel 14



12. Conducted Emissions Test, 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 C63.4-2001 and with Title 47 CFR, FCC Part 15 (Industry Canada RSS-210). The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50 Ω (ohm), 50/250 μ H Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided via an appropriate broadband EMI Filter, and then to the LISN line input. This supply, a standard DC wall pack, supplies the 3.3 VDC to the EUT. 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 EMC LISN used has the ability to terminate the unused port with a 50 Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

Test Procedure

The EUT was investigated/placed in continuous transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were entered into the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1 (2002), 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, Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

Conducted Emissions Data Chart
Test Standard: CISPR 11 (EN 55011)
Frequency Range Inspected: 150 kHz to 30 MHz

Manufacturer:	Sensicast Systems				
Date(s) of Test:	March 2 nd , 2005				
Test Engineer:		Tom Smith		Abtin Spantman	√ Ken Boston
Model #:	OEM 200				
Serial #:	Engineering Unit				
Voltage:	115 VAC / 60 Hz to manufacturer's supplied DC power pack				
Operation Mode:	Normal				
Test Location:	√	Shielded Area			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

Notes:

- 1) All emissions seen were better than 20 dB below the limits.
- 2) The EUT exhibited similar emissions across the Low, Middle and High channels.

Calculation of Conducted Emissions Limits

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

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

* Decreases with the logarithm of the frequency.

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

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

For a frequency of 200 kHz for example:

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

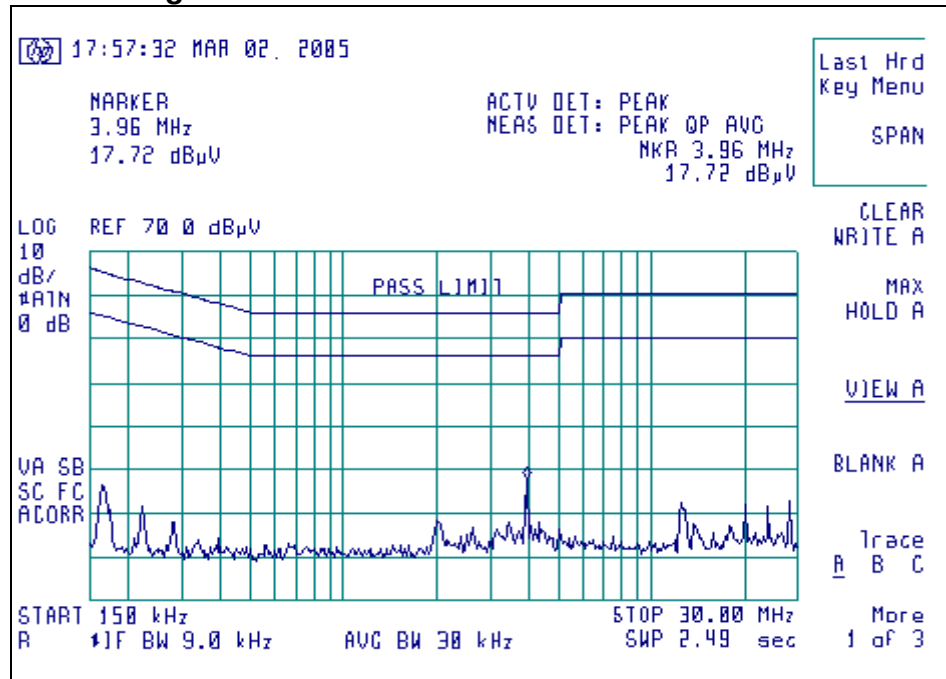
$$\text{Quasi-Peak Limit (F=200kHz)} = 63.6 \text{ dB}\mu\text{V}$$

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

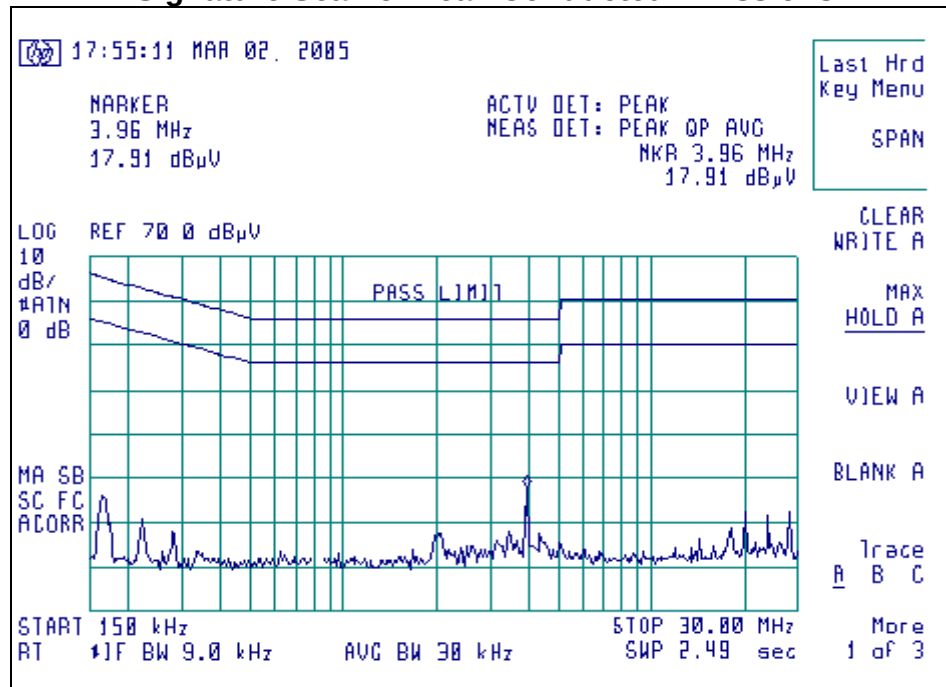
$$\text{Average Limit (F = 200 kHz)} = 53.6 \text{ dB}\mu\text{V}$$

Graphs made during Conducted Emission Testing

Signature Scan of Peak Conducted Emissions



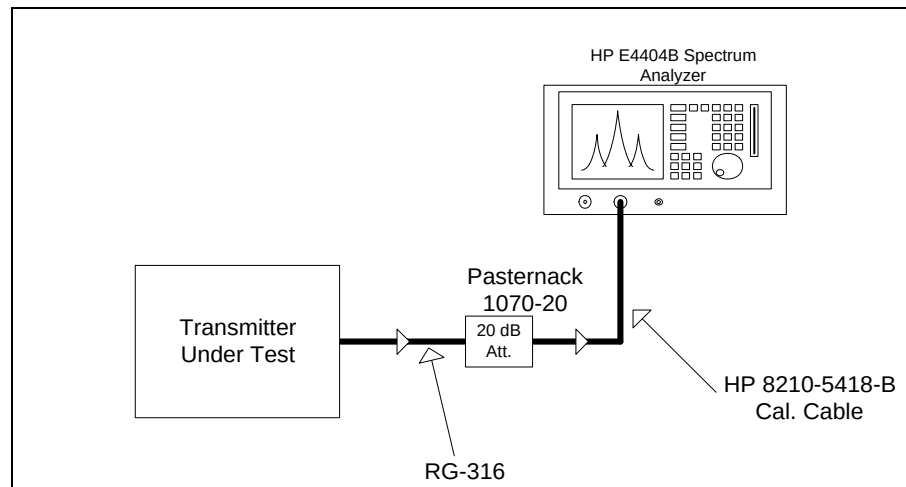
Signature Scan of Peak Conducted Emissions



13. Conducted Emissions Test, Power Output

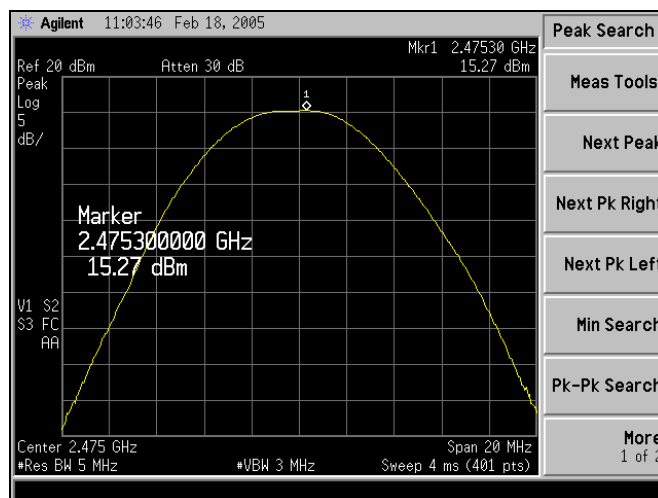
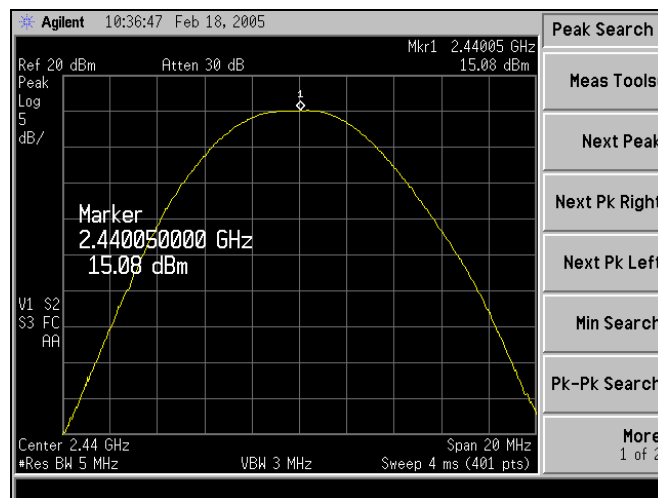
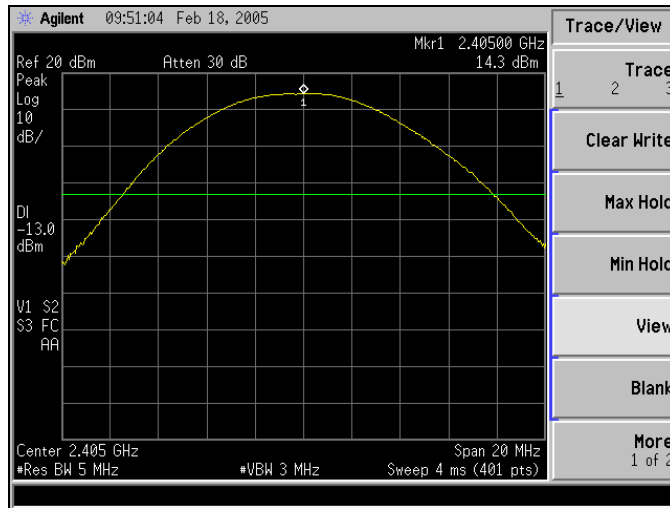
For the FCC Part 15.247b measurement, the output of the EUT was connected via a short jumper cable created only for this measurement, into the input of the HP E4407B Spectrum Analyzer. The unit was configured to run in a normal transmit mode, while being supplied with an internal software program with random data as a modulation source. The HP receiver was set to a 5 MHz Bandwidth, and the transmit signal was then stored, with the peak signal level stored. This power level was collected for three channels and can be seen in the chart presented below. Data to support power level changes with voltage changes is also supplied in a separate chart, found below.

CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
11 (0)	2405	30 dBm	14.3	15.7
18 (7)	2440	30 dBm	15.1	14.9
25 (14)	2475	30 dBm	15.3	14.7



Channel	Voltage (VDC)	Power (dBm)	Power Delta (dB)
11 2405 MHz	2.8 V (-15%)	13.0	-1.3
11 2405 MHz	3.8 V (+15%)	15.2	+0.9
18 2440 MHz	2.8 V (-15%)	13.7	-1.4
18 2440 MHz	3.8 V (+15%)	15.8	+0.7
25 2475 MHz	2.8 V (-15%)	13.9	-1.4
25 2475 MHz	3.8 V (+15%)	16.2	+0.9

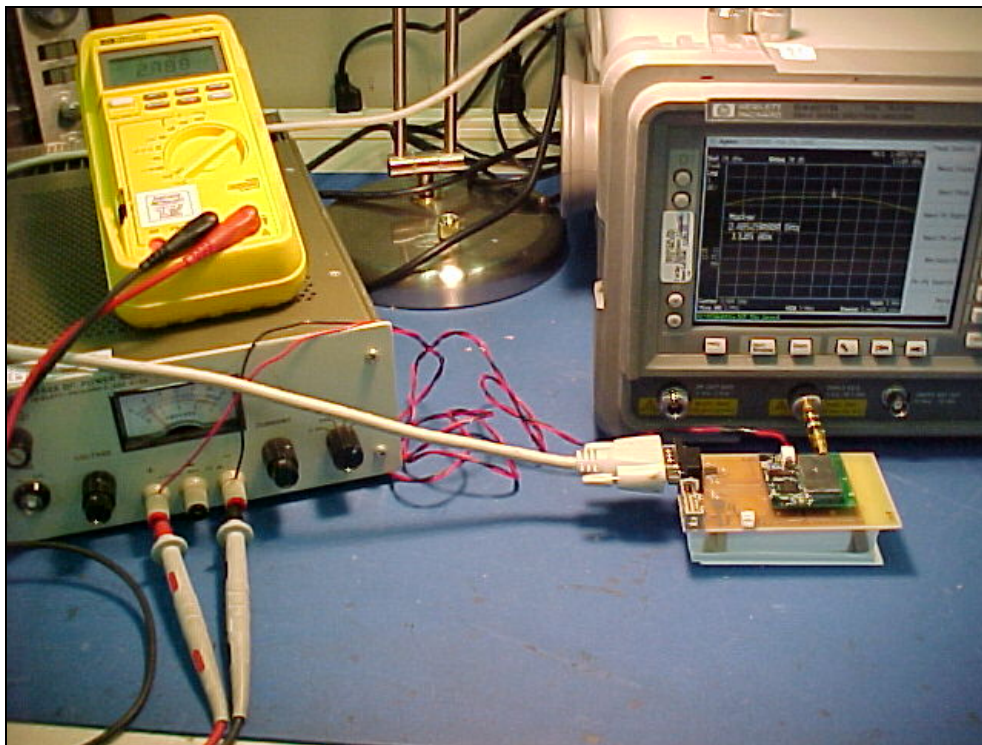
SCREEN CAPTURES – POWER OUTPUT



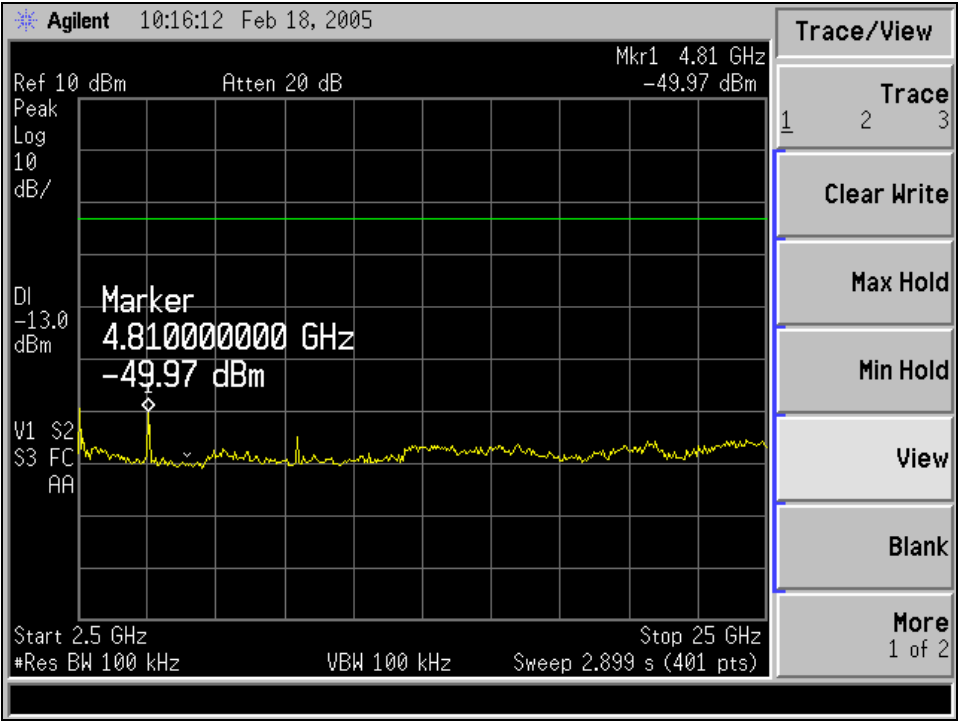
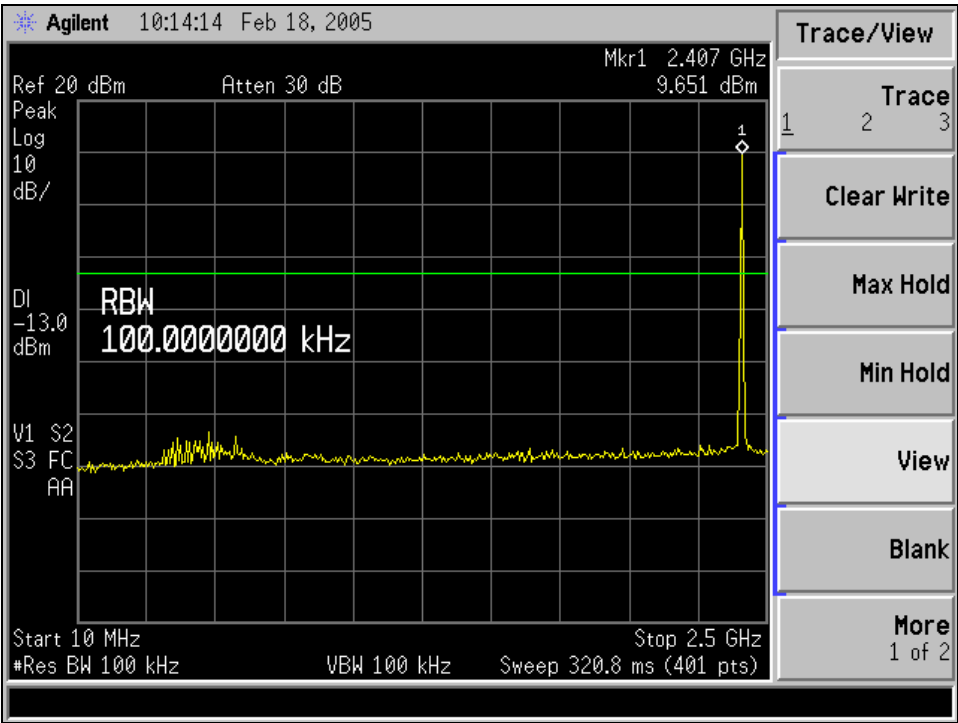
14. Conducted Emissions Test, Spurious Emissions

FCC Part 15.247 (c) requires an antenna conducted measurement of conducted harmonic and spurious levels, as reference to the carrier frequency in a 100 kHz bandwidth. For this test, the video transmitter module was directly connected to the HP E4407B Spectrum Analyzer, through a very short Coaxial Cable and a 10 DB Attenuator. Plots were then taken, with any noticeable spurious or harmonic signals identified. No significant levels at any spurious products could be found within -20 dBc of the fundamental of the transmitter. Signals that were observed were greater than 50 dB down. (In the 100 kHz bandwidth)

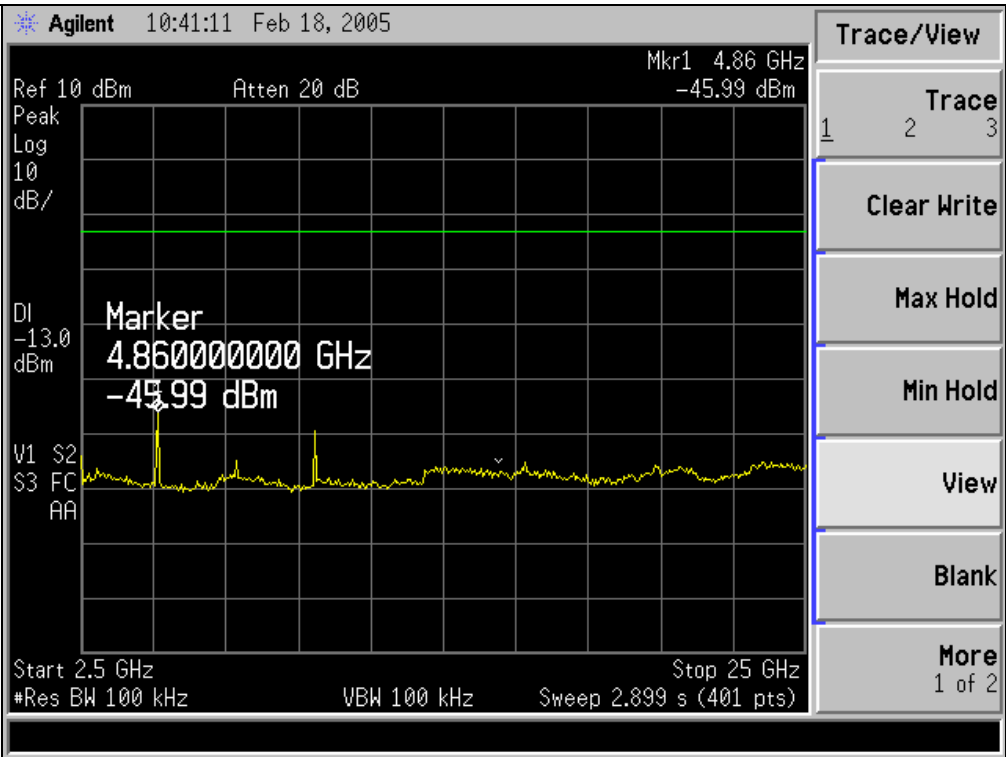
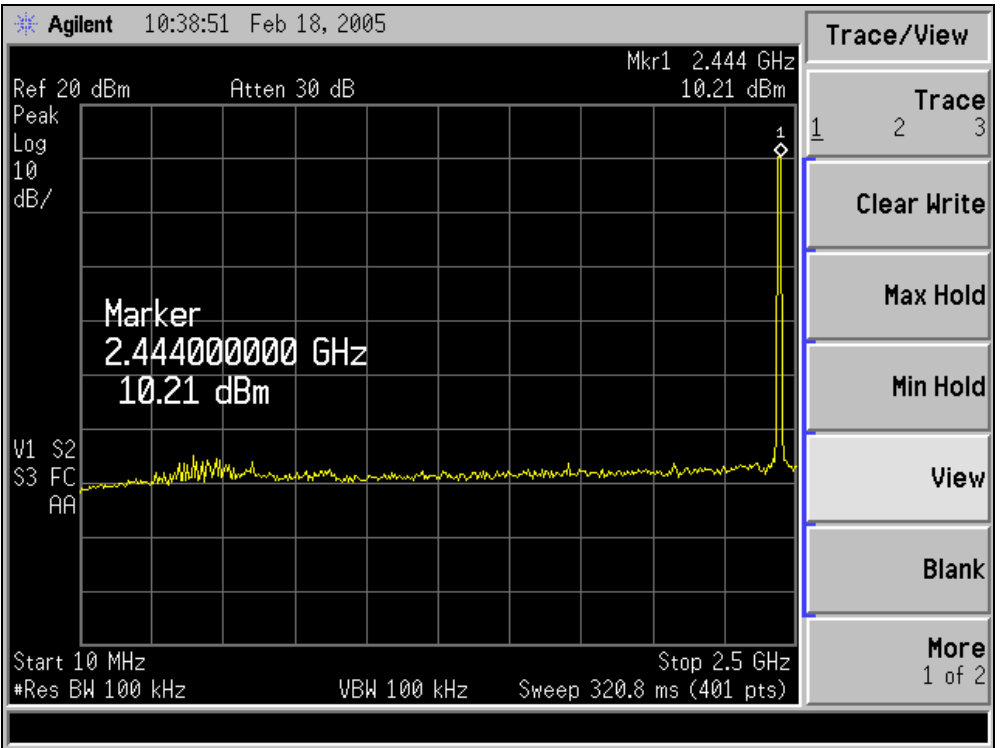
Test Setup for the Conducted RF Measurements



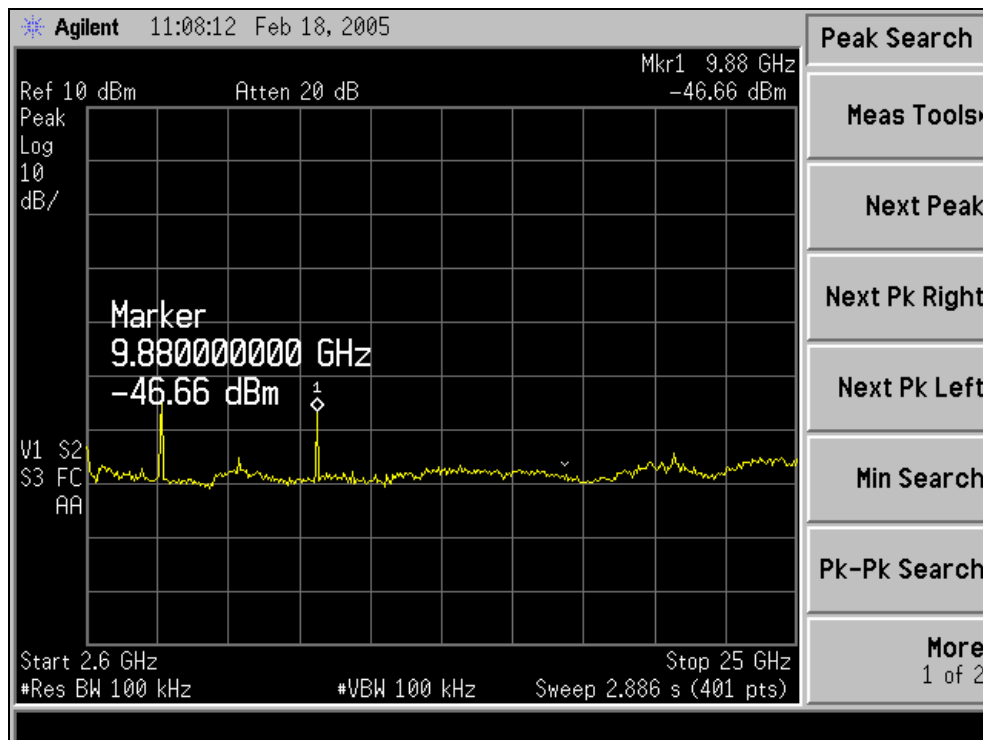
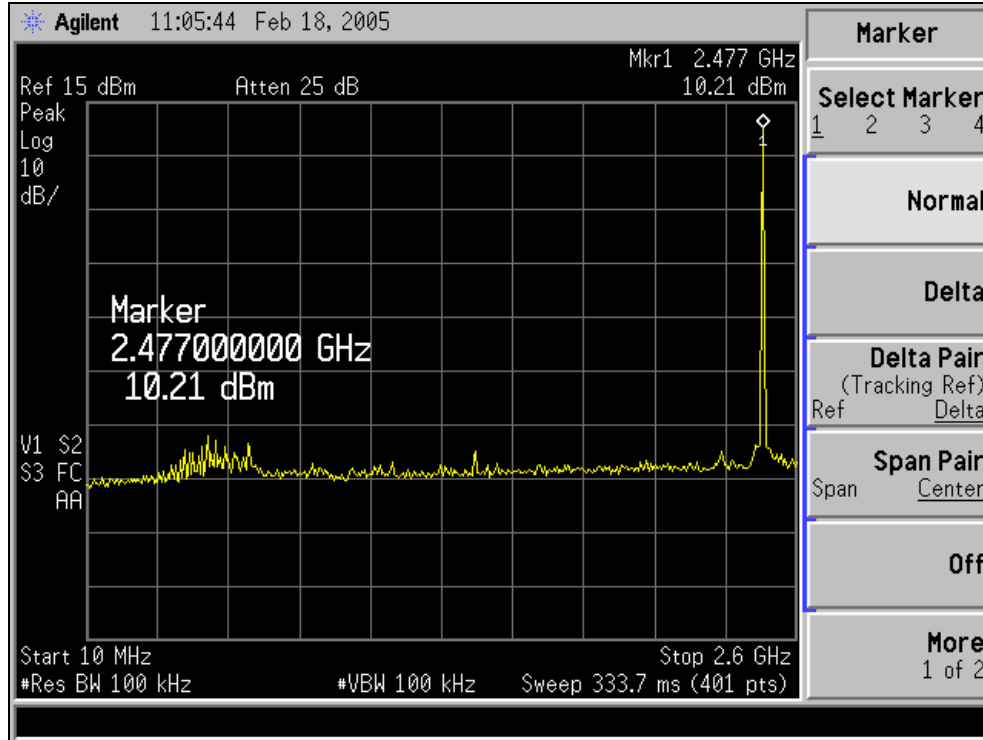
Plots of Conducted Spurious and Fundamental Levels, Channel 0



Plots of Conducted Spurious and Fundamental Levels, Channel 7



Plots of Conducted Spurious and Fundamental Levels, Channel 14



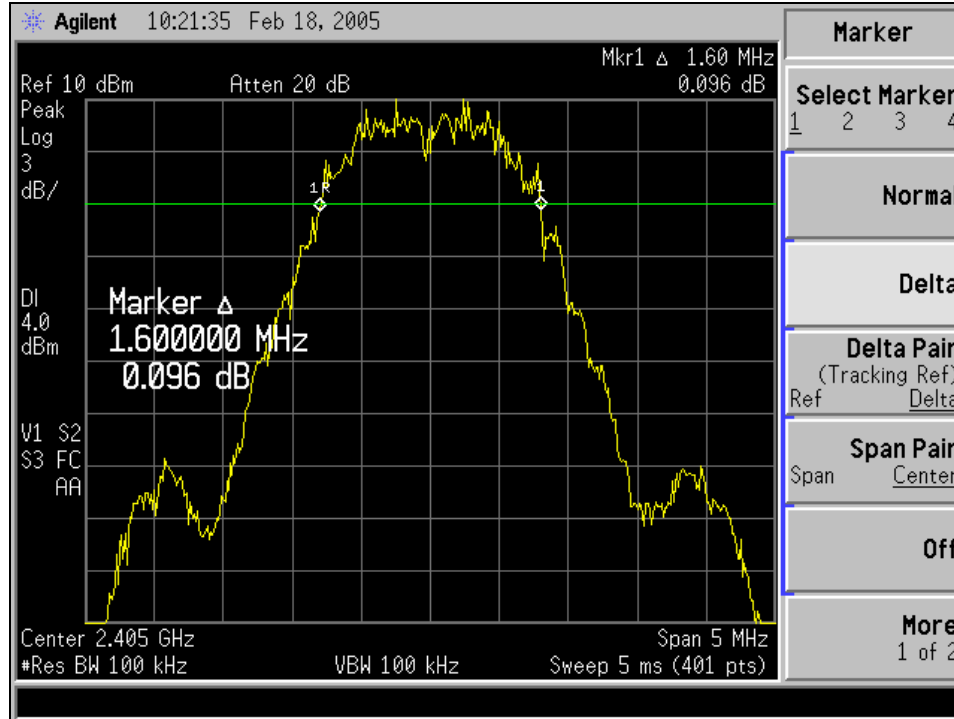
15. Conducted Emissions Test, Occupied Bandwidth

The 6 dB bandwidth requirement found in FCC Part 15.247.a.2 is a minimum of 500 kHz for a D.S.S.S. system. Direct measurement of the transmitted signal, via a direct cabled connection to the HP E4407B Analyzer, was then used to determine the signal bandwidth. For each of the representative channels, refer to the graphs found in Appendix C. From this data, the bandwidth of channel 11, which is the closest data to the specification limit, is 1600 kHz, which is above the minimum of 500 kHz.

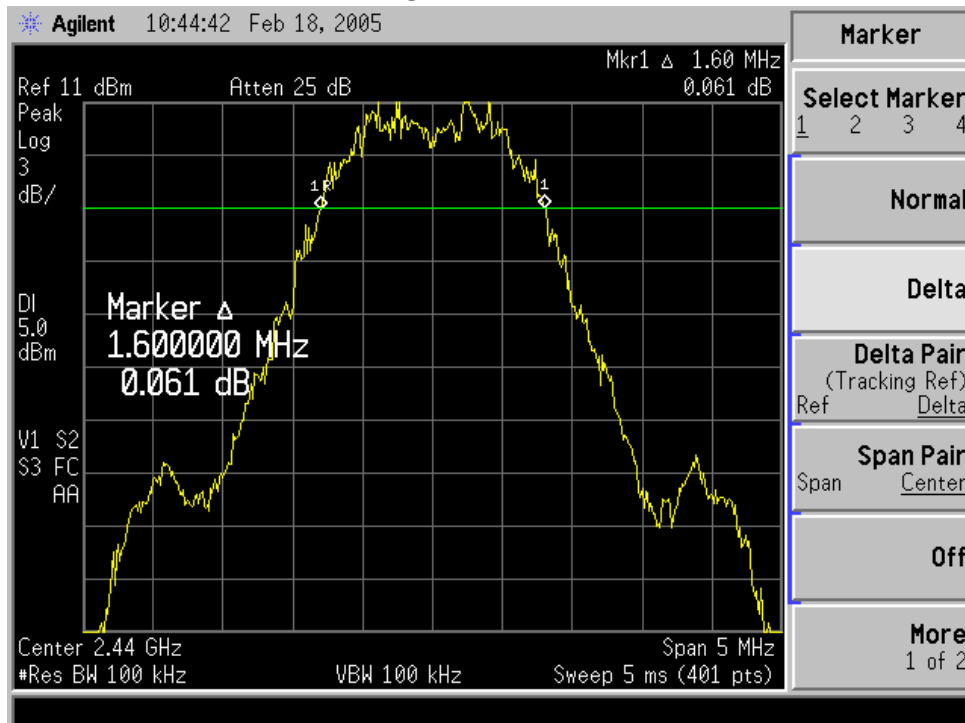
CHANNEL	CENTER FREQ (MHz)	MEASURED 6 dB BW (kHz)	MINIMUM LIMIT (kHz)
11 (0)	2405	1600	500
18 (7)	2440	1600	500
25 (14)	2475	1660	500

Plots of Occupied Bandwidth

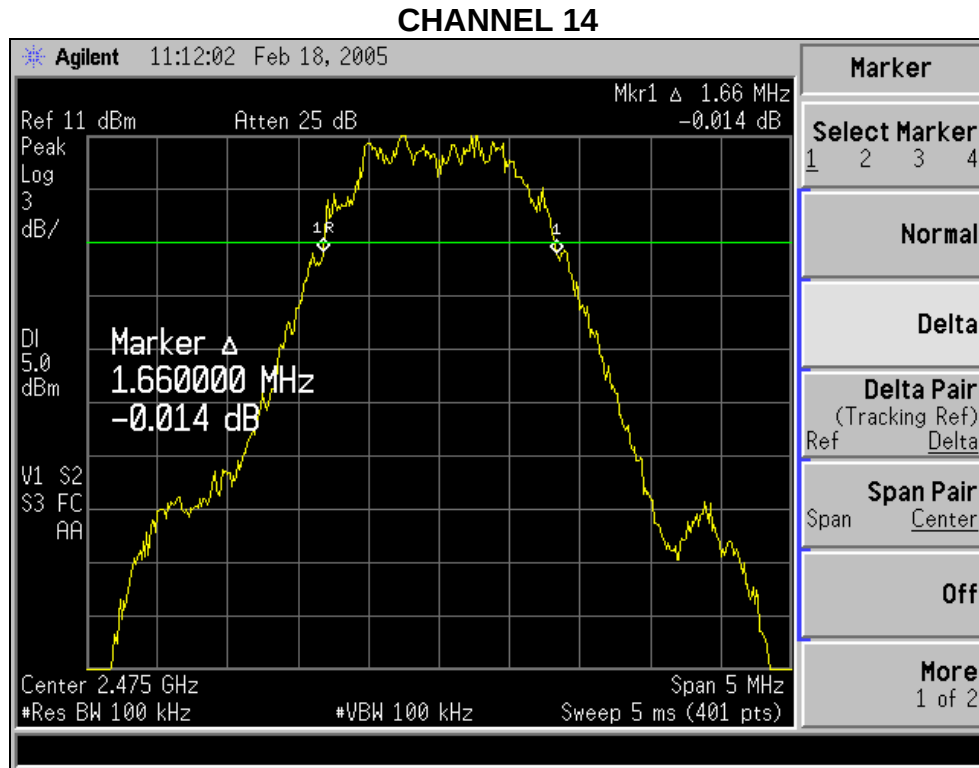
CHANNEL 0



CHANNEL 7



Plots of Occupied Bandwidth

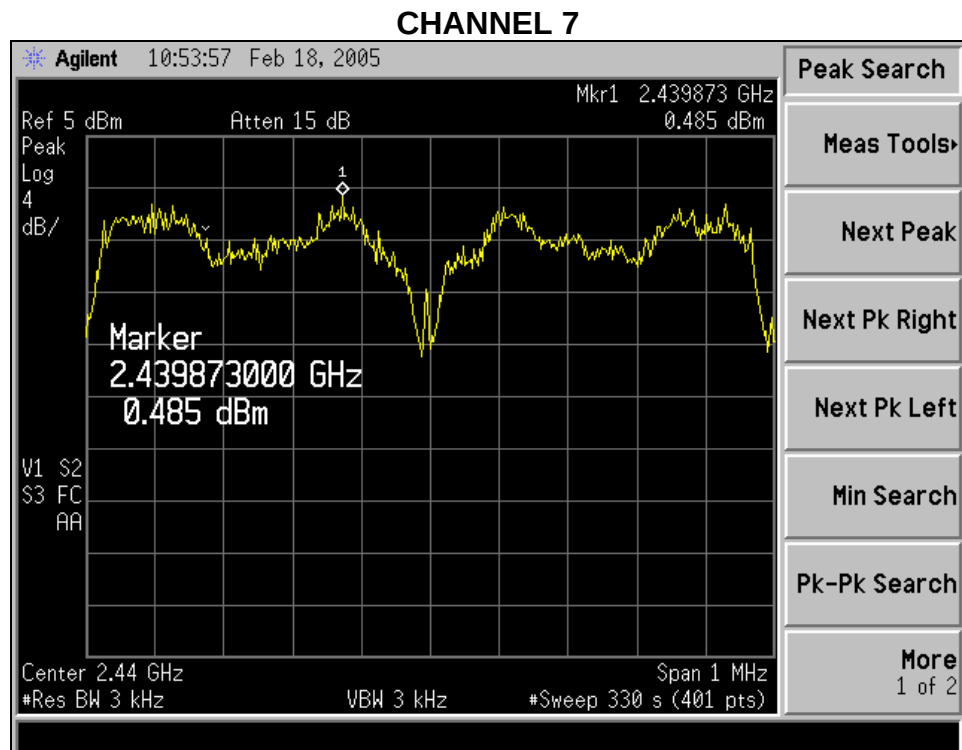
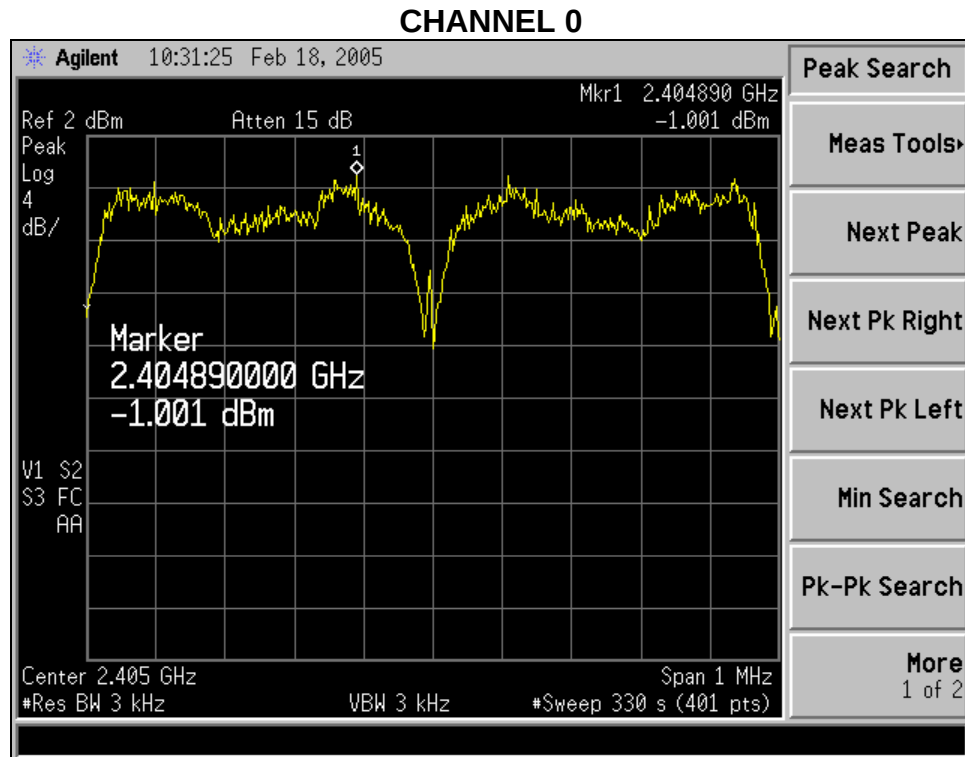


16. Conducted Emissions Test, Spectral Density

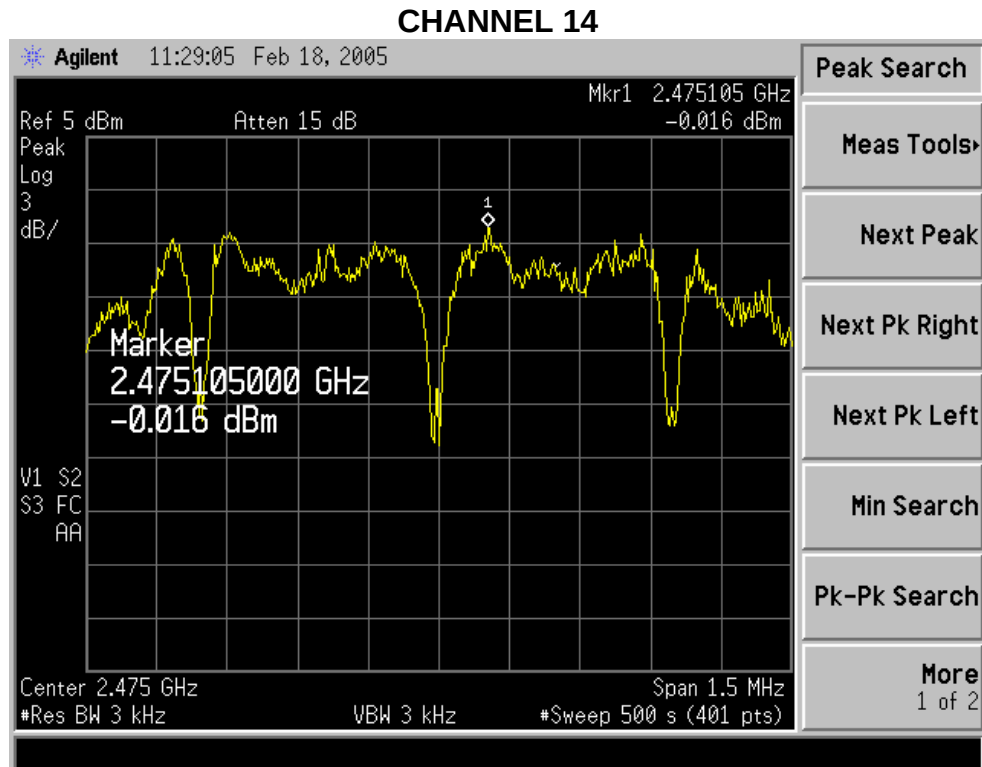
In accordance with FCC Part 15.247(d), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in Section 14. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed using the utility built into the HP Analyzer. The resultant density was then corrected to a 3 kHz bandwidth, and can be determined by inspection of the graphs found in Appendix C. The highest density was found to be no greater than +0.5 dBm, which is under the allowable limit by 7.5 dB.

CHANNEL	CENTER FREQ	MEASURED P	SPEC	MARGIN
11 (0)	2405	-1.0 dBm	+8.0dBm	9.0 dB
18 (7)	2440	+0.5 dBm	+8.0dBm	7.5 dB
25 (14)	2475	+0.0 dBm	+8.0dBm	8.0 dB

Plots of Spectral Density



Plots of Spectral Density



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.

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
ADDITIONAL TEST INFORMATION

Due to the identical topology between the A2400 and OEM 200 units manufactured by Sensicast Systems, the test data supplied is representative for both units.

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.

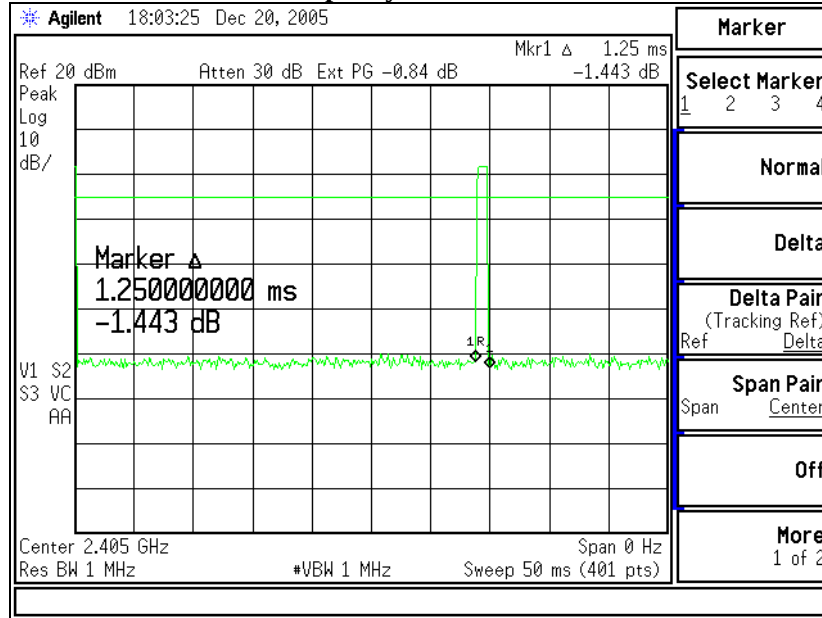
*The following information is provided by the manufacturer:
"On the OEM200 and A2400, the packet lengths are fixed in the software to 64 bytes. This corresponds to a 3.5ms dwell time per transmission. The system will operate on a single frequency for 300msec during which a maximum of 12 transmissions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

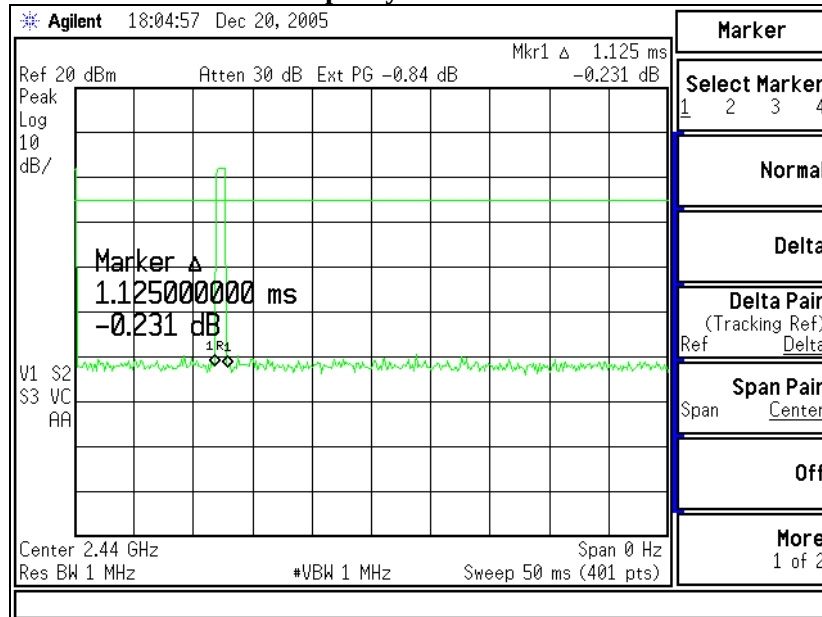
Plots of Channel Occupancy

Occupancy in Channel 11

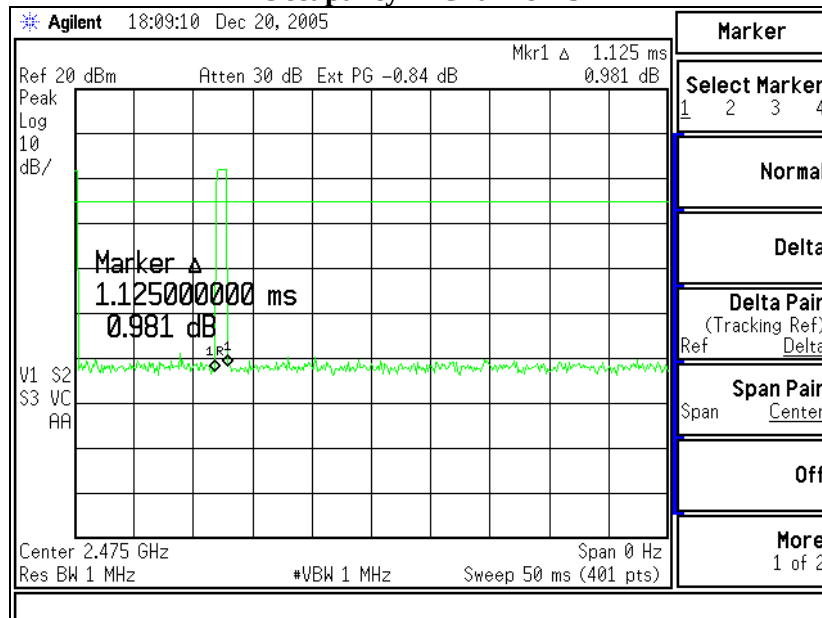


Note 1: The measurements reflect what was seen in actual operation, given a fully functional unit, in the setup that was provided. In no instance did more than two transmissions occur, during the testing, but the declarations indicate the possibility of a maximum of 12 transmissions that should be used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

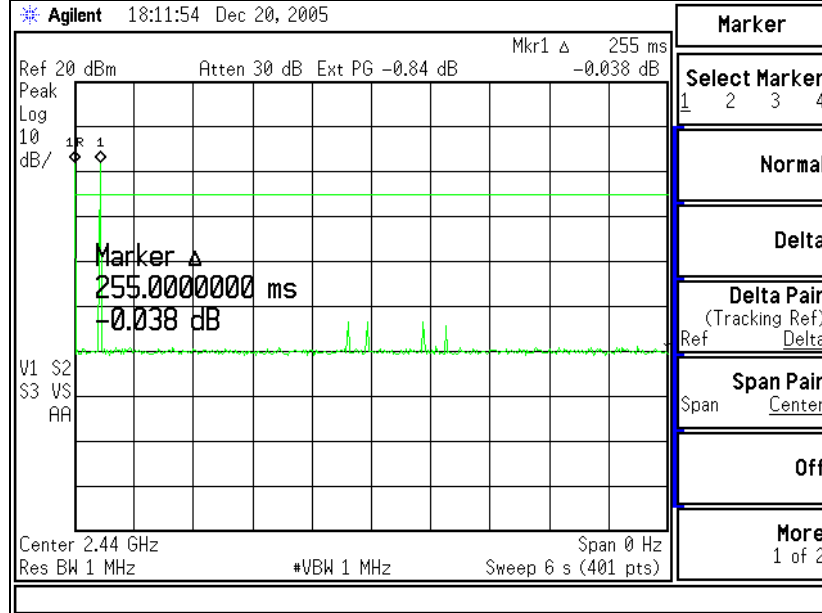
Occupancy in Channel 18



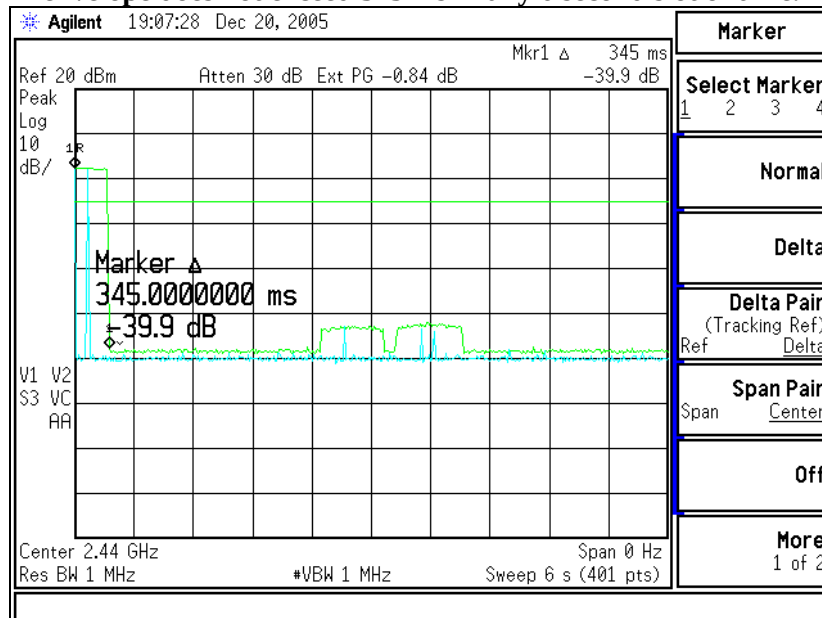
Occupancy in Channel 25



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 for Equal Channel Usage, Pseudorandom Hopping Pattern and Receiver Synchronization and Input Bandwidth is provided by the manufacturer.

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.)

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.

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.