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

COMPLIANCE TESTING OF:

NIVIS Portable RF Sniffer

Prepared For:

Nivis, LLC
Attention: Mr. Trae Harrison
1000 Circle 75 Parkway, 3rd Floor
Atlanta, GA 30339

Test Report Number:

306277 TX TCB Rev. 1

Test Dates:

May 9th – May 12th, 2006

Table of Contents

1. L. S. Compliance In Review

L.S. Compliance - Accreditations and Listing's

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

A2LA – American Association for Laboratory Accreditation

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

Federal Communications Commission (FCC) – USA

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

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

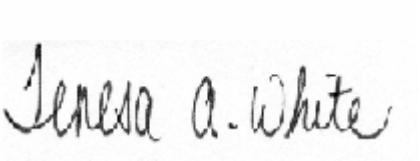
U. S. Conformity Assessment Body (CAB) Validation

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 2004/108/EC (formerly 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. Signature Page



Prepared By: May 23, 2006

Teresa A. White, Document Coordinator Date

Tested By: May 23, 2006

Khairul Aidi Zainal, EMC Engineer Date

Approved By: May 23, 2006

Brian E. Petted, VP of Engineering Date

3. Product and General Information

Manufacturer:	Nivis, LLC					
Date(s) of Test:	May 9th – May 12th , 2006					
Test Engineer(s):	√	Aidi Zainal		Abtin Spantman		Ken Boston
Model #:	RF-SNF-00-02					
Serial #:	0000402F					
Voltage:	3.6 VDC					
Operation Mode:	Continuous transmit, and 'Hopping' mode					

4. Introduction

Between May 9th and May 12th, 2006, a series of Conducted and Radiated RF Emission tests were performed on one sample of the Nivis RF Sniffer, Model Number RF-SNF-00-02, Serial Number 0000402F, 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 Khairul Aidi Zainal, EMC Engineer at L.S. Compliance, Inc.

All Radiated and Conducted RF Emission tests were performed upon the EUT to measure the emissions in the frequency bands described in FCC Title 47 CFR Part 15, including 15.35, 15.209, 15.247 and Industry Canada RSS-210 to determine whether these emissions are below the limits expressed within the standards. These tests were performed in accordance with the procedures described in the American National Standard for methods of measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2003). Another document used as a reference for the EMI Receiver specification was the Comite International Special Des Perturbations Radioelectriques (CISPR) Number 16-1, 2003.

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

5. Product Description

The Portable RF sniffer is a deployment tool which provides a link between a device operating on a specially designed software and mesh network. It communicates via the 900 MHz spread spectrum mesh network and connects to a personal computer or PDA via a USB port. The portable RF sniffer is a self contained, battery powered device that can be recharged from the USB port or from an optional wall adapter. When charging with the wall adapter, the sniffer is turned off and the USB disconnected.

Based on the Chipcon CC1020 transceiver IC, the sniffer is a transceiver that operates in the 915 MHz ISM band. The modulation is FSK with the data source being the on-board microprocessor using a baud rate of 9600. The system uses 50 hop channels and an on-board PCB trace F-antenna is the only antenna option available.

6. Test Requirements

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

15.205	15.247a	15.247d	15.247i
15.207	15.247b	15.247g	
15.209	15.247c	15.247h	

7. Summary of Test Report

DECLARATION OF CONFORMITY

The Nivis RF sniffer 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 Frequency Hopping Spread Spectrum Transmitter.

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

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

8. Radiated Emissions Test

Test Setup

The Nivis RF sniffer was tested in two modes for transmitted emissions.

1. Mode 1: Transceiver in continuous transmit operation with a 3.6 VDC rechargeable battery as a source.
2. Mode 2: Transceiver turned off while charging using a CUI Stack charger model number 41-9-650D (120 V 60 Hz 10 Watts rated input). The transceiver is not able to operate while charging.

The test setup for mode 1 and mode 2 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. In mode 1, the EUT was operated in continuous transmit mode using power as provided by a 3.6 VDC rechargeable Motorola battery. The unit has the capability to operate on 50 channels, controllable via laptop PC with the NivisLink_10 GUI. The EUT was turned off for testing in mode 2 since the unit is unable to operate during charging (as specified by the customer).

The applicable limits apply at a 3 meter distance. Measurements above 1 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 (910.5 MHz), middle (918.8 MHz) and high (927.5 MHz) to comply with FCC Part 15.35. The channels and operating modes were changed using a PC with the NivisLink_10 GUI.

Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 10000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 10 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

The battery voltage was checked frequently, and the batteries were replaced as necessary.

The EUT was rotated along three orthogonal axis 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 an HP 8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the HP 8546A EMI Receiver database. As a result, the data taken from the HP 8546A EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The HP 8546A EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz). From 5 GHz to 10 GHz, the HP E4407B Spectrum Analyzer and an EMCO Horn Antenna were used.

Test Results

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

CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 902-928 MHz band, as specified in 47 CFR 15.247 (b)(2), is 1 Watt for systems employing at least 50 hopping channels or 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c).

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

Frequency (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	-
960-25,000	500	54.0	63.5

Sample calculations:

Sample conversion from a field strength measurement with units of μV/m to dBμV/m would be:

$$dB\mu V/m = 20Log_{10}\left(\frac{XX\mu V/m}{1\mu V/m}\right)$$

Limit in the frequency range of (30-88 MHz) is calculated to be:

$$40.0dB\mu V/m = 20Log_{10}\left(\frac{100\mu V/m}{1\mu V/m}\right)$$

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Sample conversion from a field conducted RF power measurement in mW to a radiated field strength measurement in dBμV/m would be:

$$dB\mu V/m@3m = 95.23 + 10Log_{10}\left(\frac{XXmW}{1mW}\right)$$

AT the fundamental frequency, the limit for the RF power output of 1W (1000mW) at the antenna port of a transmitter with an antenna gain of 0 dBi would be equivalent to an Equivalent Isotropic Radiated Power (e.i.r.p.) measurement of 125.23 dBμV/m at 3 meters.

$$125.23dB\mu V/m@3m = 95.23 + 10Log_{10}\left(\frac{1000mW}{1mW}\right)$$

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Sample conversion from a measurement distance of 3 meters to a distance of 1meter would be:

$$dB = -20Log_{10}\left(\frac{XXm}{3m}\right)$$

A sample limit, within the frequency range of 960-25,000 MHz for example, when measured at 1 meter instead of 3 meters would change according to the equation:

$$63.5dB\mu V/m = 54.0dB\mu V/m + \left(-20Log_{10}\left(\frac{1m}{3m}\right)\right)$$

Mode 1 Radiated Emissions Data Chart

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

Manufacturer:	Nivis, LLC							
Date(s) of Test:	May 9th – May 12th, 2006							
Test Engineer(s):	√	Aidi Zainal		Abtin Spantman		Ken Boston		
Model #:	RF-SNF-00-02							
Serial #:	0000402F							
Voltage:	3.6 VDC							
Operation Mode:	Continuous transmit and 'Hopping' mode, or C.W.							
EUT Power:		Single Phase ___VAC				3 Phase ___VAC		
	√	Battery				Other:		
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 or Agilent E4407B or E4446A
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 Sense/EUT	Channel	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
119.7	H/H	25	1.20	274	32.2	43.5	11.3
281.3	H/H	25	1.38	325	25.8	46.0	20.2
320.0	H/S	01	1.00	321	35.5	104.8	69.3
897.6	H/H	01	1.00	42	59.5	104.8	45.3
934.1	H/H	50	1.52	77	57.3	104.8	47.5
960.8	H/S	50	1.43	172	46.9	54.0	7.1
964.4	V/V	50	1.00	46	44.3	54.0	9.7

Notes:

1) A Quasi-Peak Detector was used in measurements below 1 GHz, and an Average Detector was used in measurements above 1 GHz. The Peak detector was also use to ensure that the emission levels do not exceed 20 dB beyond the Average limits.

No significant spurious emissions observed. All spurious emissions were better than 20 dB below the limits..

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

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
910.5	H/H	1.00	82	124.8	125.2	0.4
1821.0	V/S	1.24	92	48.8	104.8	56
2731.5	V/S	1.00	22	45.8	63.5	17.7
3642.0	H/V	1.24	199	50.6	63.5	12.9
4552.5	H/S	1.17	207	48.6	63.5	14.9
5463.0	H/S	1.07	258	43.7	104.8	61.1
6373.5	H/S	1.00	202	41.7	104.8	63.1
7284.0	H/S	1.00	281	51.8	63.5	11.7
8194.5	H/S	1.00	115	39.2	63.5	24.3
9105.0	H/S	1.00	192	49.5	63.5	14

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 EFI (DbμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
918.8	H/H	1.60	79	124.0	125.2	1.2
1837.7	V/S	1.24	57	52.6	104.8	52.2
2756.5	V/S	1.00	49	46.6	63.5	16.9
3675.3	H/V	1.31	88	51.6	63.5	11.9
4594.1	H/S	1.10	202	48.7	63.5	14.8
5513.0	H/S	1.15	160	42.7	104.8	62.1
6431.8	H/S	1.00	178	42.3	104.8	62.5
7350.6	H/S	1.00	282	53.0	63.5	10.5
8269.4	H/S	1.00	120	39.1	63.5	24.4
9188.3	H/S	1.00	184	50.3	63.5	13.2

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 50:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
927.5	H/H	1.64	66	122.8	125.2	2.4
1855.0	V/S	1.18	214	46.1	104.8	58.7
2782.5	V/S	1.00	144	46.7	63.5	16.8
3710.0	H/V	1.00	0	47.7	63.5	15.8
4637.5	H/S	1.00	198	51.4	63.5	12.1
5564.9	H/S	1.04	175	44.3	104.8	60.5
6492.4	H/S	1.05	175	41.5	104.8	63.3
7419.9	H/S	1.00	287	51.7	63.5	11.8
8347.4	H/S	1.00	121	40.0	63.5	23.5
9274.9	H/S	1.00	190	54.3	104.8	50.5

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 1 GHz were made at 1 meters of separation from the EUT.

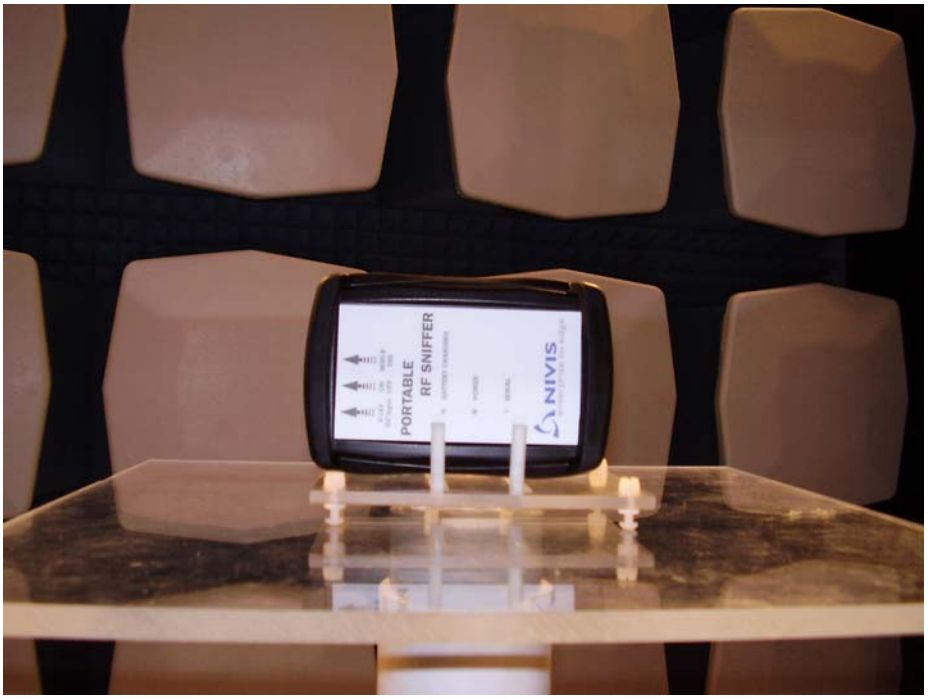
Photos Taken During Mode 1 Radiated Emission Testing

View of the EUT setup in vertical orientation

View of the EUT setup in Horizontal orientation

Photos Taken During Mode 1 Radiated Emission Testing (continued)

View of the EUT setup in Side orientation



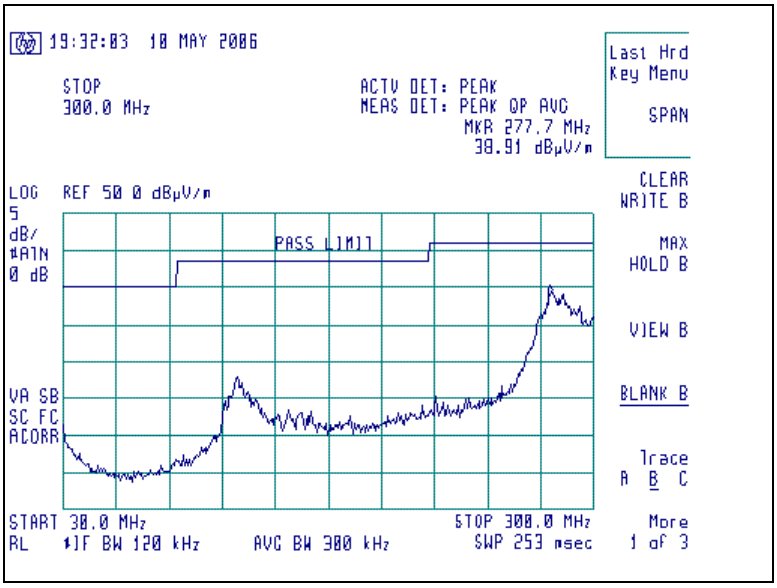
Graphs made during Mode 1 Radiated Emission Testing

Screen Captures of Radiated RF Emissions:

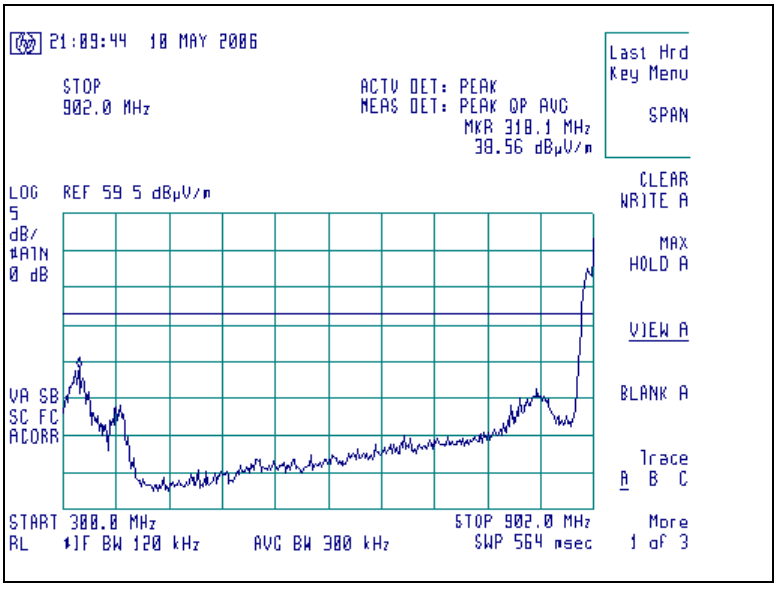
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 01, 25, or 50.

Channel 25, Antenna Horizontally Polarized, 30-300 MHz, at 3m.

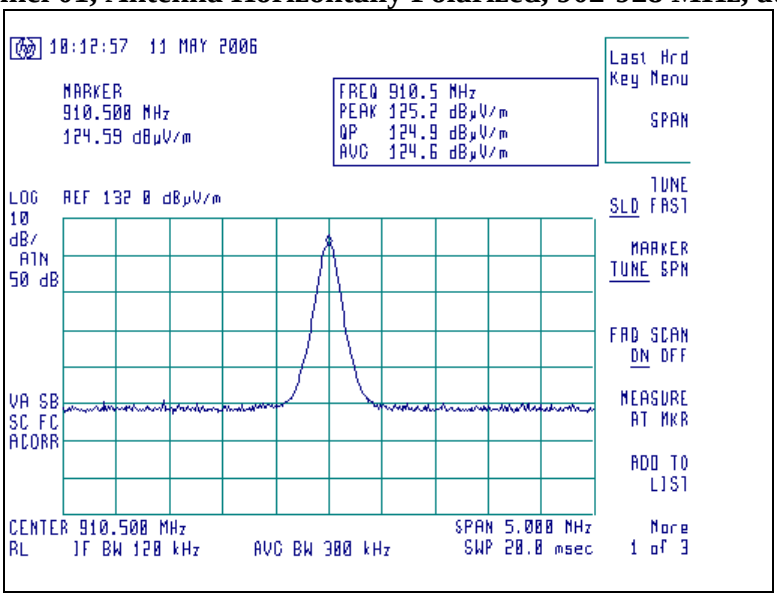


Channel 25, Antenna Horizontally Polarized, 300-902 MHz, at 3m.

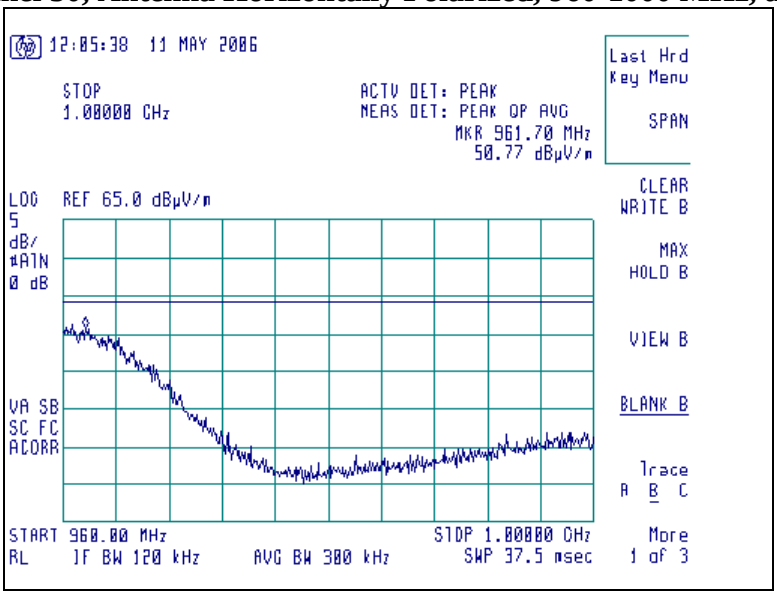


Graphs made during Mode 1 Radiated Emission Testing (continued)

Channel 01, Antenna Horizontally Polarized, 902-928 MHz, at 3m.

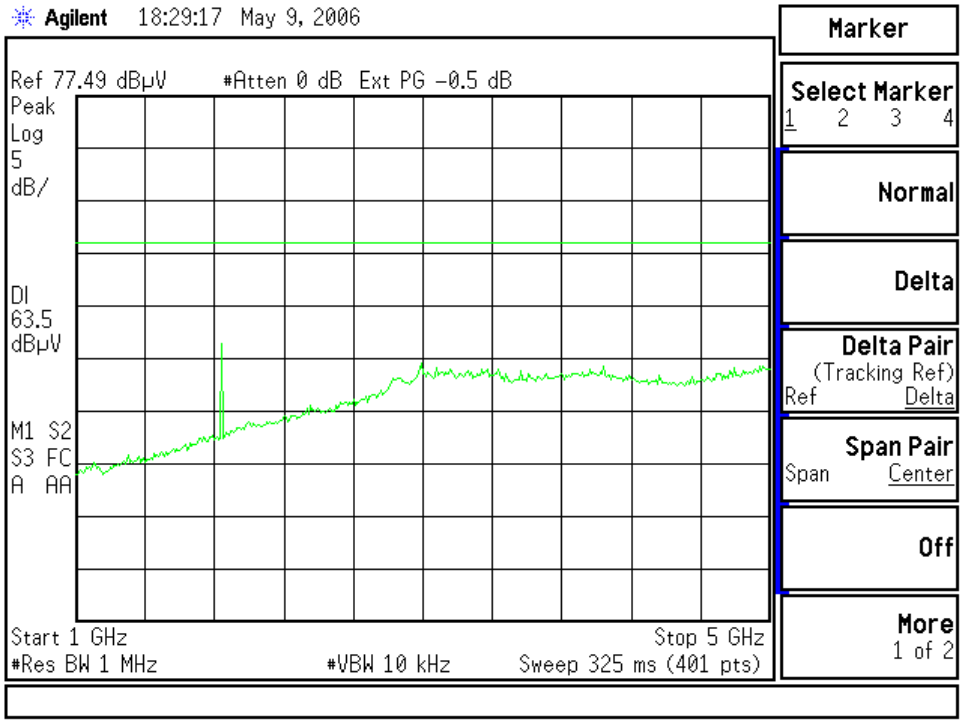


Channel 50, Antenna Horizontally Polarized, 960-1000 MHz, at 3m.

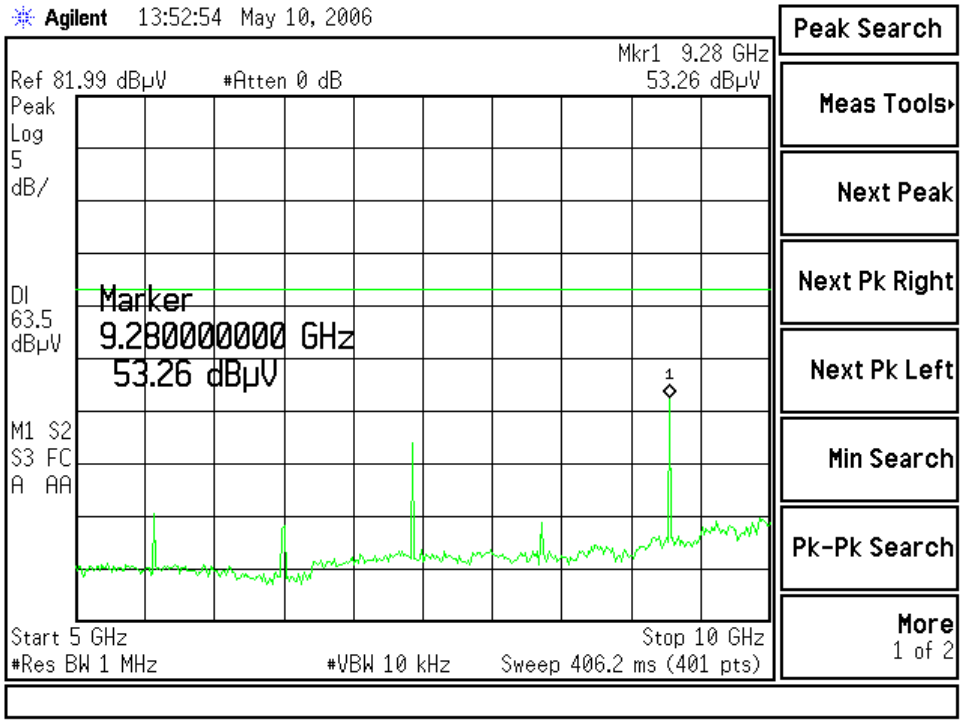


Graphs made during Mode 1 Radiated Emission Testing (continued)

Channel 25, Antenna Vertically Polarized, 1000-5000 MHz, at 1m.



Channel 50, Antenna Horizontally Polarized, 5000-10000 MHz, at 1m.



Mode 2 Radiated Emissions Data Chart

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

Manufacturer:	Nivis, LLC							
Date(s) of Test:	May 9th – May 12th, 2006							
Test Engineer(s):	√	Aidi Zainal		Abtin Spantman		Ken Boston		
Model #:	RF-SNF-00-02							
Serial #:	0000402F							
Voltage:	120 VAC 60 Hz							
Operation Mode:	Charging Mode with EUT off.							
EUT Power:		Single Phase ___VAC				3 Phase ___VAC		
		Battery				Other: 120 VAC 60 Hz charger		
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

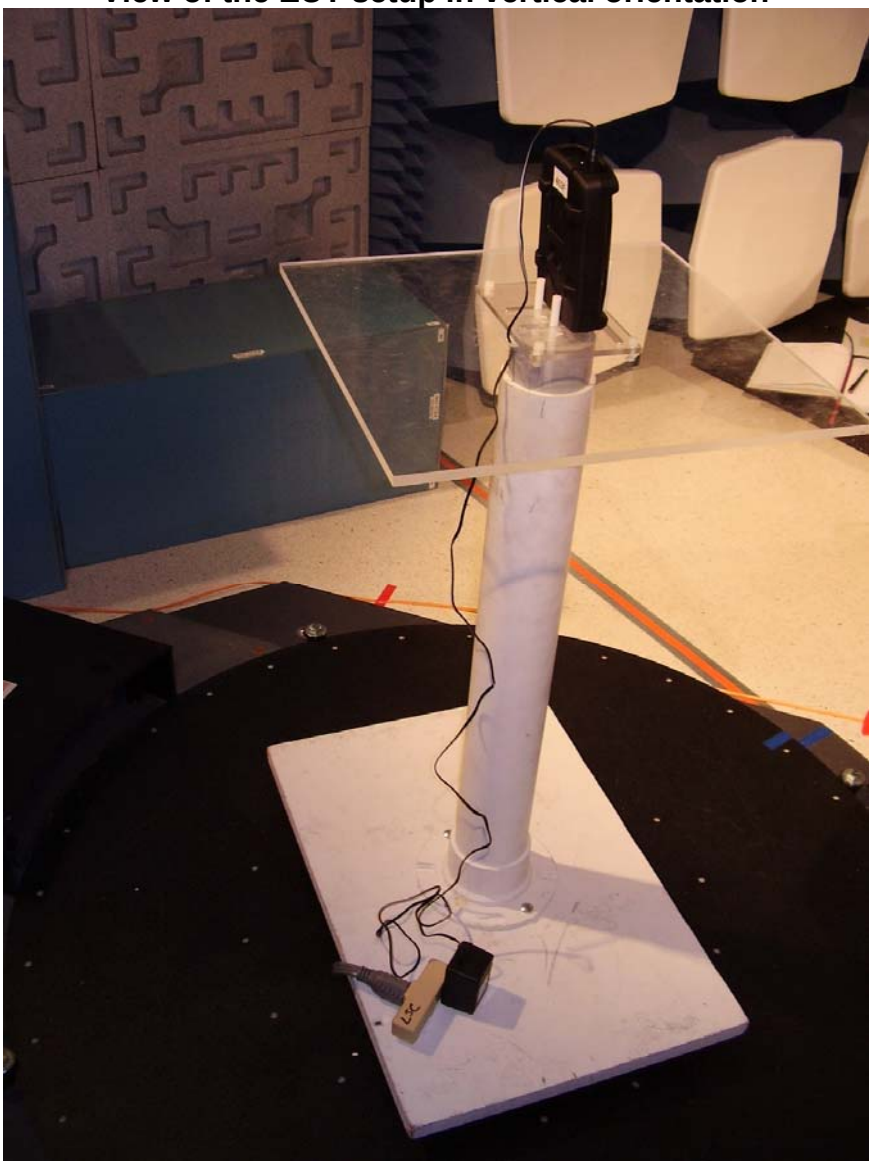
Relative Humidity: 30 – 60 %

Test Equipment Used:
EMI Measurement Instrument: HP8546A or Agilent E4407B or E4446A
Log Periodic Antenna: EMCO #93146
Horn Antenna: EMCO #3115
Biconical Antenna: EMCO 93110
Pre-Amp: Advanced Microwave WHA6224
Standard Gain Horn: EMCO 3160-09

Scans in the range of 30 MHz up to 10000 MHz show no significant spurious emissions while the EUT was charging (in the off mode) with the USB cable disconnected.

Photos Taken During Mode 2 Radiated Emission Testing

View of the EUT setup in vertical orientation



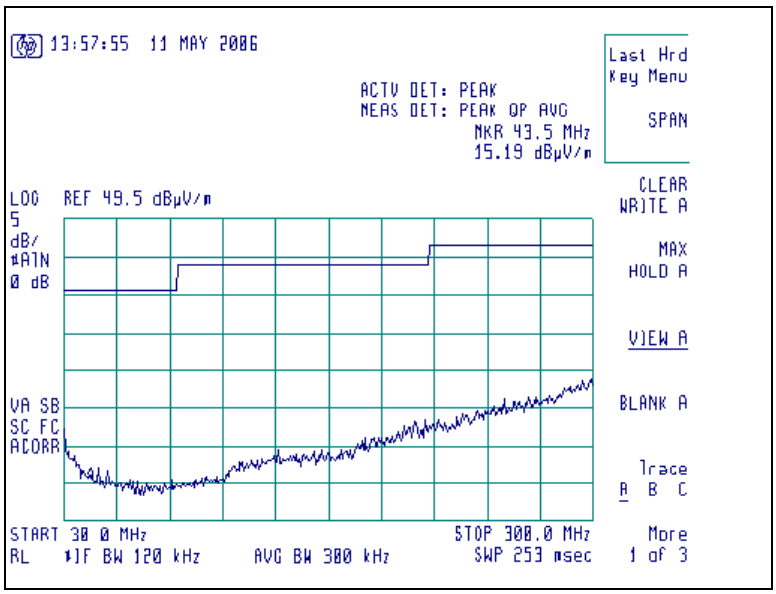
Graphs made during Mode 2 Radiated Emission Testing

Screen Captures of Radiated RF Emissions:

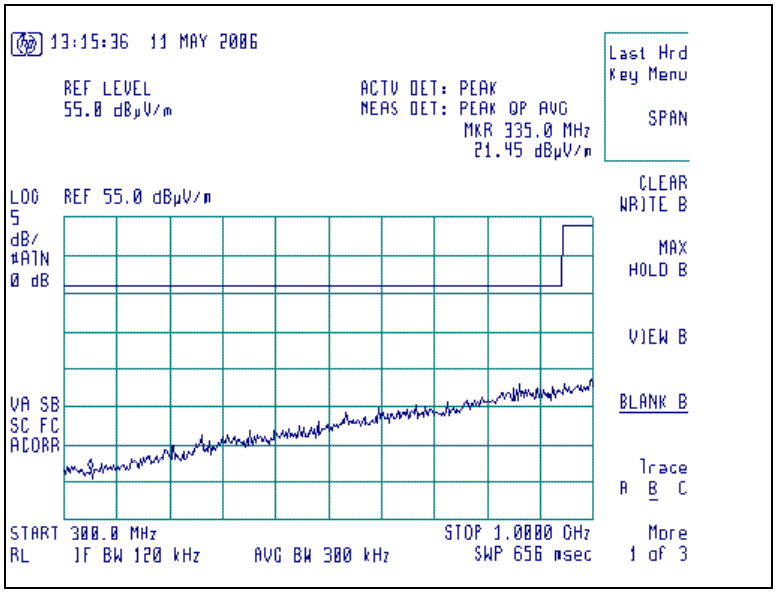
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions.

Antenna Horizontally Polarized, 30-300 MHz, at 3m.

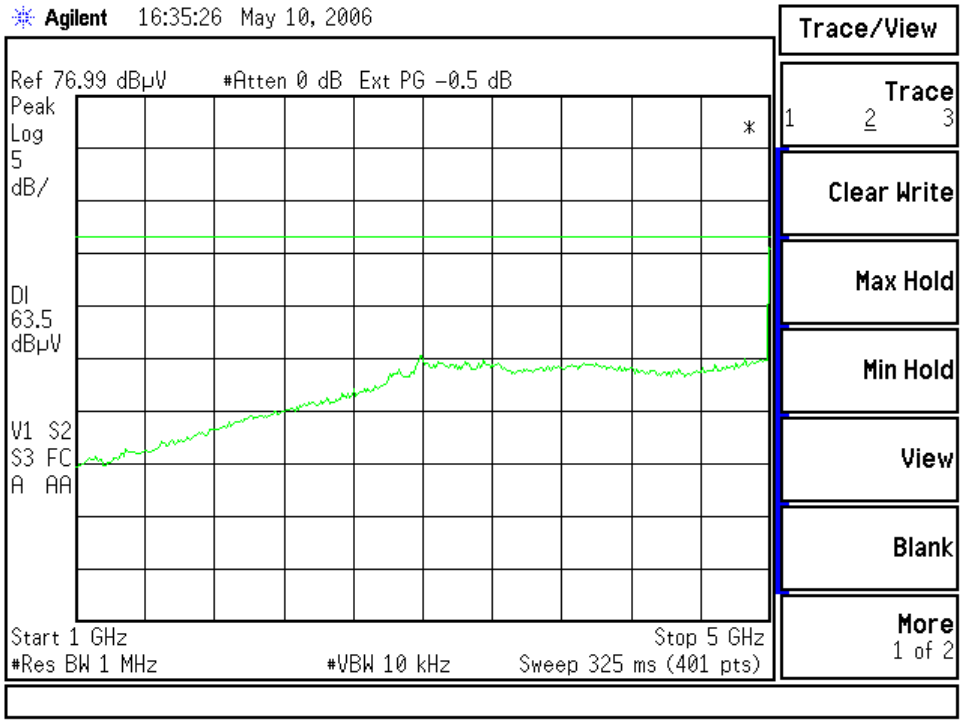


Antenna Horizontally Polarized, 300-1000 MHz, at 3m.

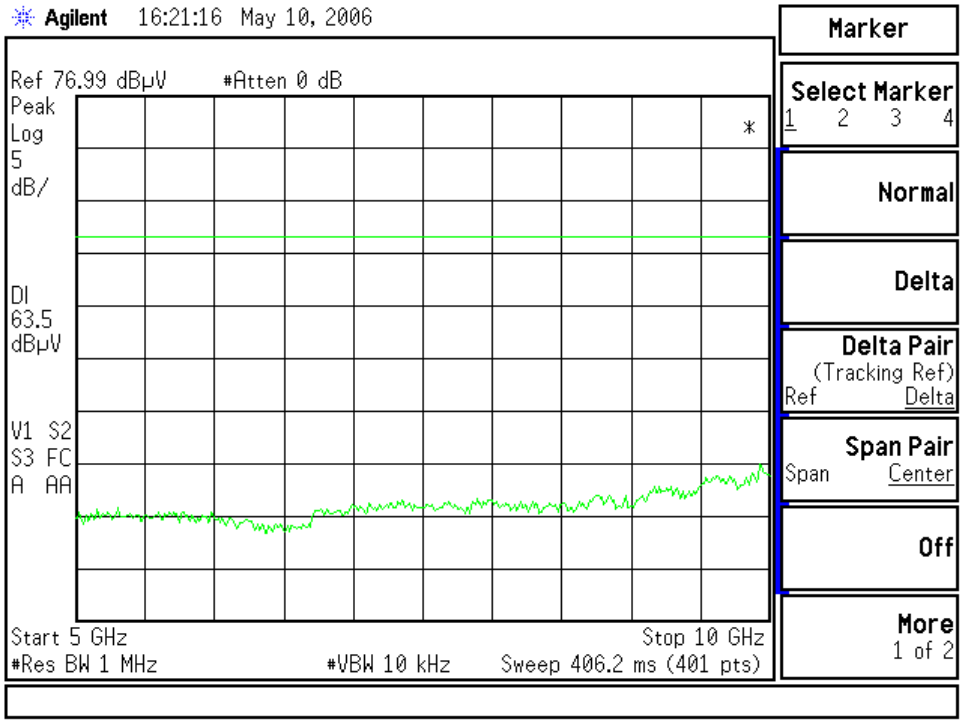


***Graphs made during Mode 2 Radiated Emission Testing* (continued)**

Antenna Vertically Polarized, 1000-5000 MHz, at 1m.



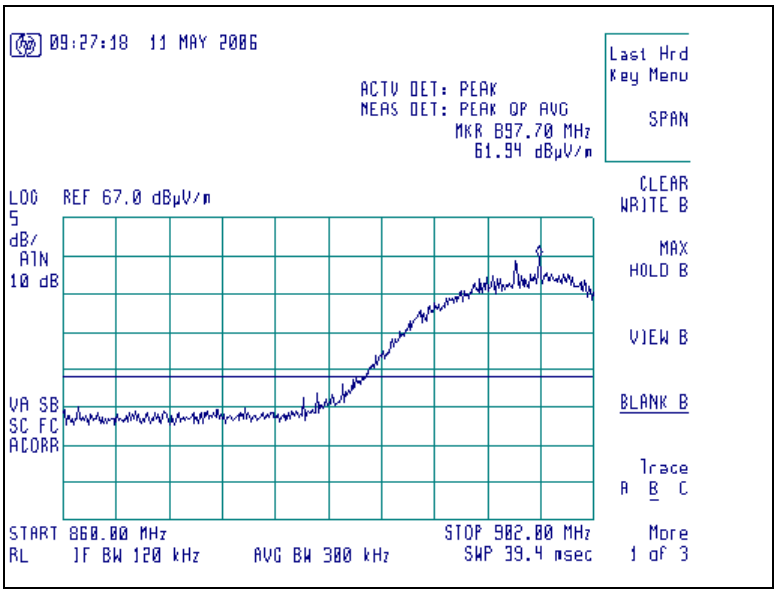
Antenna Horizontally Polarized, 5000-10000 MHz, at 1m.



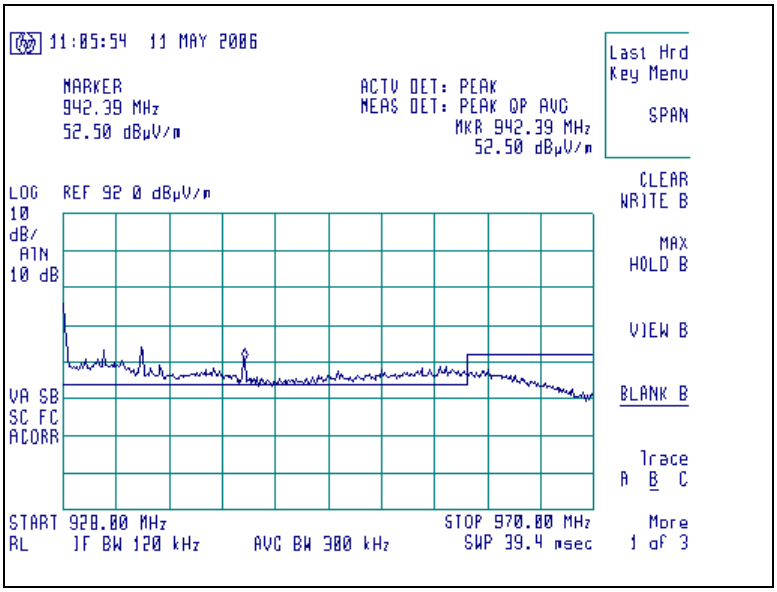
9. Band-Edge Measurements

FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the band-edges where the intentional radiator operates. The following screen captures demonstrate compliance of the intentional radiator at the 902-928 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.

Screen Capture demonstrating compliance at the Lower Band-Edge



Screen Capture demonstrating compliance at the Higher Band-Edge



10. Conducted RF Emissions onto AC Power Line (In Mode 2).

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 wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH 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. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the HP 8546A EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

Test Procedure

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

Test Equipment Utilized

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

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 intentional 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

10Decreases with the logarithm of the frequency.

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

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

For a frequency of 200 kHz for example:

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

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

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

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

Measurement of Electromagnetic Conducted Emission

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.207 (a)

Manufacturer:	NIVIS, LLC					
Date(s) of Test:	May 9th – May 12th 2006					
Test Engineer:	√	Aidi Zainal		Abtin Spantman		Ken Boston
Model #:	RF-SNF-00-02					
Serial #:	0000402F					
Voltage:	120 VAC 60 Hz					
Operation Mode:	EUT charging mode (transceiver off and USB cable not attached).					
Test Location:		Other				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)
191.5	L1	41.0	64.0	23	17.0	54.0	37
340.4	L1	36.3	59.2	22.9	6.8	49.2	42.4
441.6	L1	32.5	57.0	24.5	4.0	47.0	43
538.5	L1	29.5	56.0	26.5	3.0	46.0	43
803.3	L1	23.6	56.0	32.4	1.8	46.0	44.2
192.8	L2	41.6	63.9	22.3	17.4	53.9	36.5
332.7	L2	36.8	59.4	22.6	7.1	49.4	42.3
425.8	L2	34.4	57.3	22.9	4.9	47.3	42.4
526.6	L2	31.9	56.0	24.1	2.9	46.0	43.1
702.2	L2	28.2	56.0	27.8	1.9	46.0	44.1
804.4	L2	24.6	56.0	31.4	1.0	46.0	45

Notes:

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

2) The emissions listed are characteristic of the power supply used, and did not change by the EUT.

Photo(s) Taken During Conducted Emission Testing

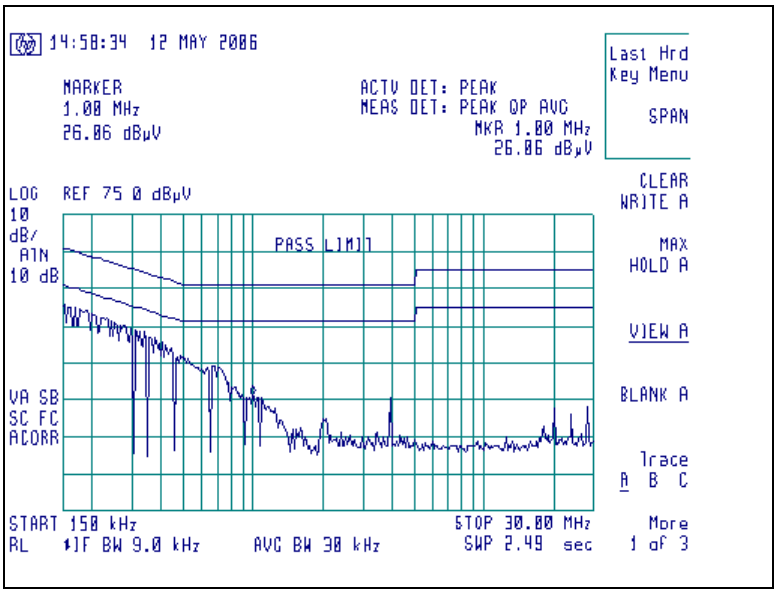
Setup for the Conducted Emissions Test

Screen Captures of Conducted AC Mains Emissions:

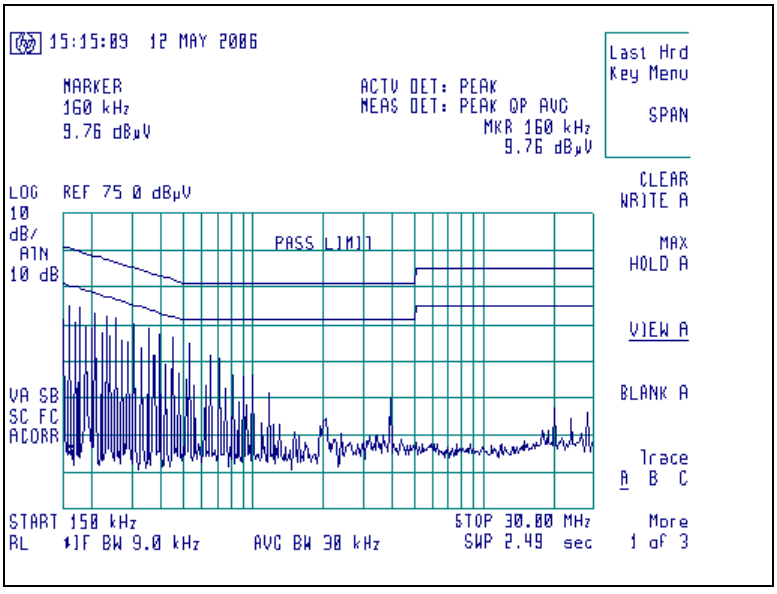
Please note these screen captures represent Peak Emissions. For conducted emission measurements, we utilize both a Quasi-Peak detector function as well as the Average detector function for measurements. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.209.

The signature scans shown here are for when the EUT is charging. In order for the EUT to properly charge, the EUT must be on 'OFF' mode.

Line 1



Line 2



11. Occupied Bandwidth (In Mode 1).

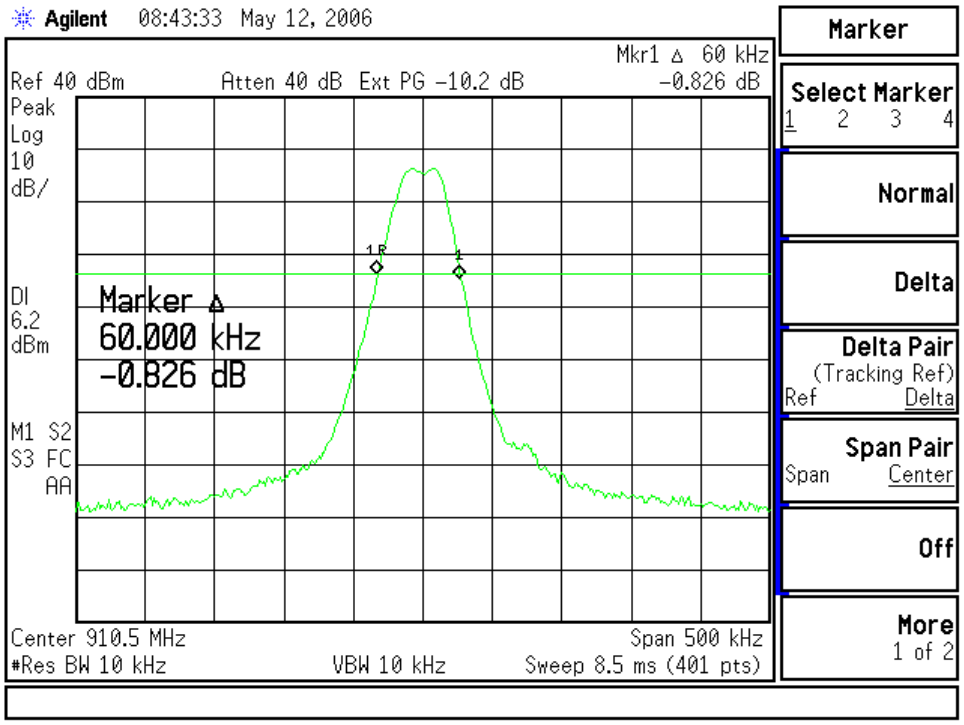
The 20 dB bandwidth requirement found in FCC Part 15.247(a)(1)(i) states a maximum allowed occupied bandwidth of 500 kHz. For this portion of the tests, a direct conducted measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4407B spectrum analyzer. An attenuator was placed in series with the cable to protect the 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 without the need for any further corrections. A spectrum analyzer was used with the resolution bandwidth set to 10 kHz for this portion of the tests. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

From this data, the closest measurement when compared to the specified limit is 60.8 kHz, which is below the maximum limit of 500 kHz.

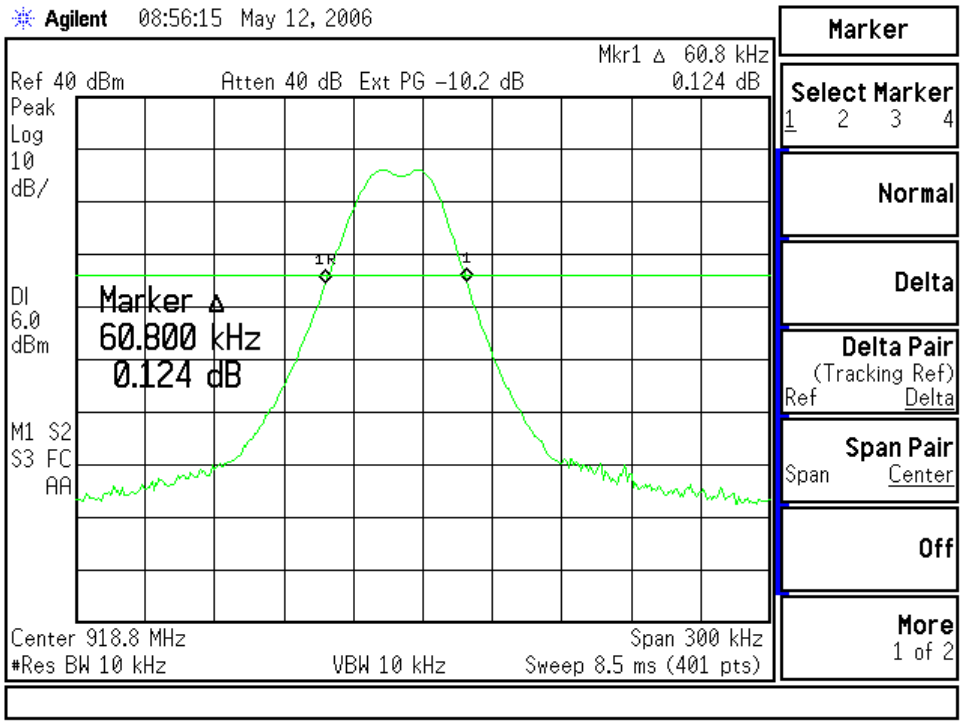
Channel	Center Frequency (MHz)	Measured 20 dB BW (kHz)	Maximum Limit (kHz)
01	910.5	60.0	500
25	918.8	60.8	500
50	927.5	60.0	500

Plots of Occupied Bandwidth

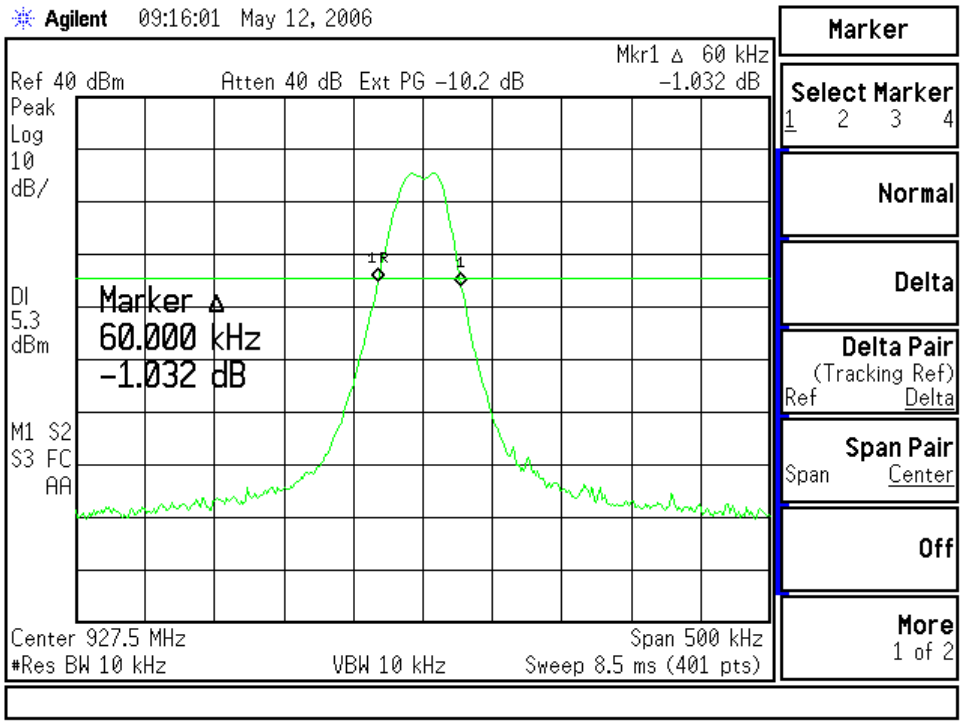
Channel 01, Occupied Bandwidth



Channel 25, Occupied Bandwidth



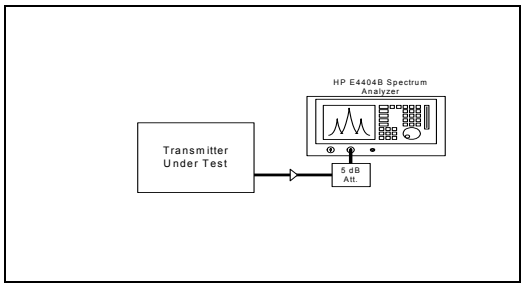
Channel 50, Occupied Bandwidth



12. Power Output 15.247(b) (2)

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the 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. The unit was configured to run in a continuous transmit mode, while being supplied with typical data a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 100 kHz, and a span of 500 kHz, with measurements from a peak detector presented in the chart below.

CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
01	910.5	30.0	27.0	3.0
25	918.8	30.0	26.7	3.3
50	927.5	30.0	25.8	4.2



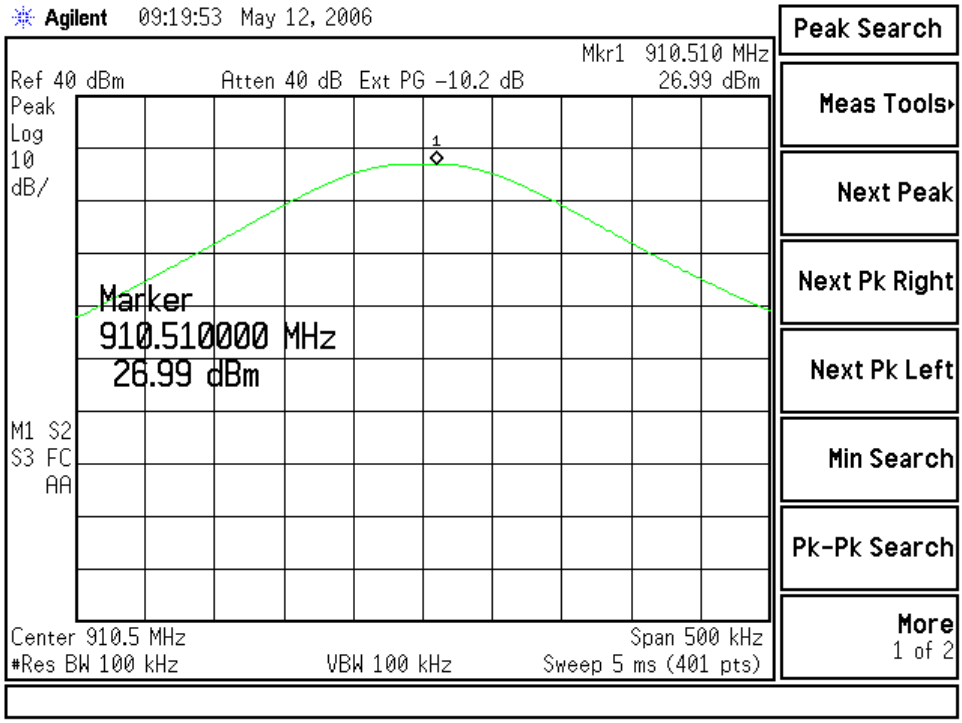
Rated RF power output at antenna port (in miliwatts): 398.1

2. Max Power
900 MHz
= 1W (+30 dBm) if utilizing at least 50 channels
= 0.25W (+24 dBm) if utilizing less than 50, but at least 25 channels

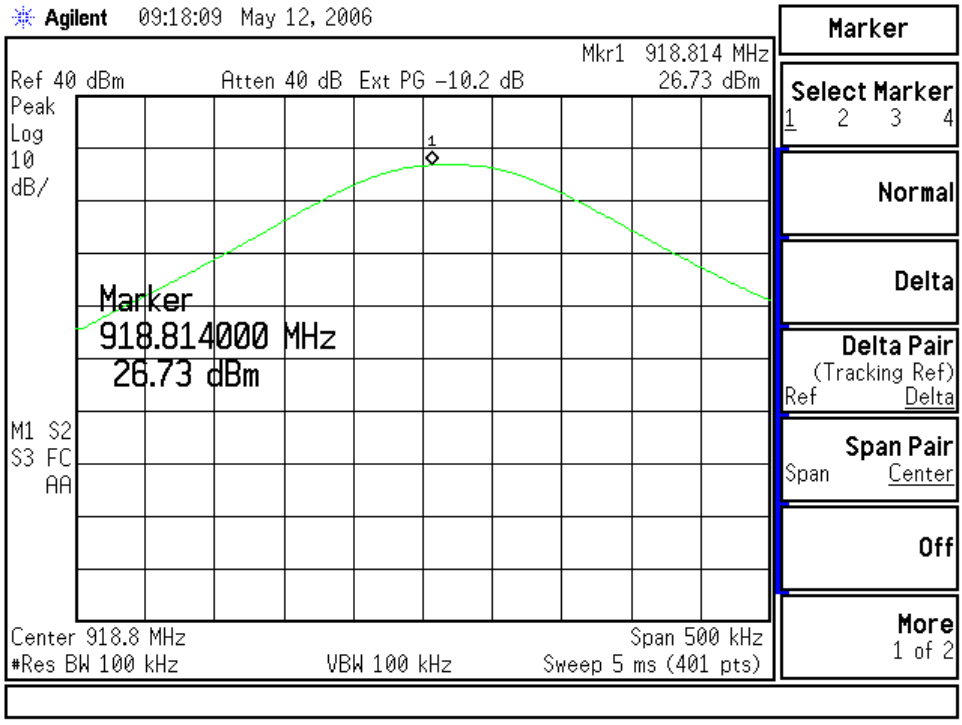
Max Power
2400 MHz
&
5700 MHz
= 1W (+30 dBm) if utilizing at least 75 channels

2400 MHz **= 0.125W (+21 dBm) other than 75 channels (or less)**

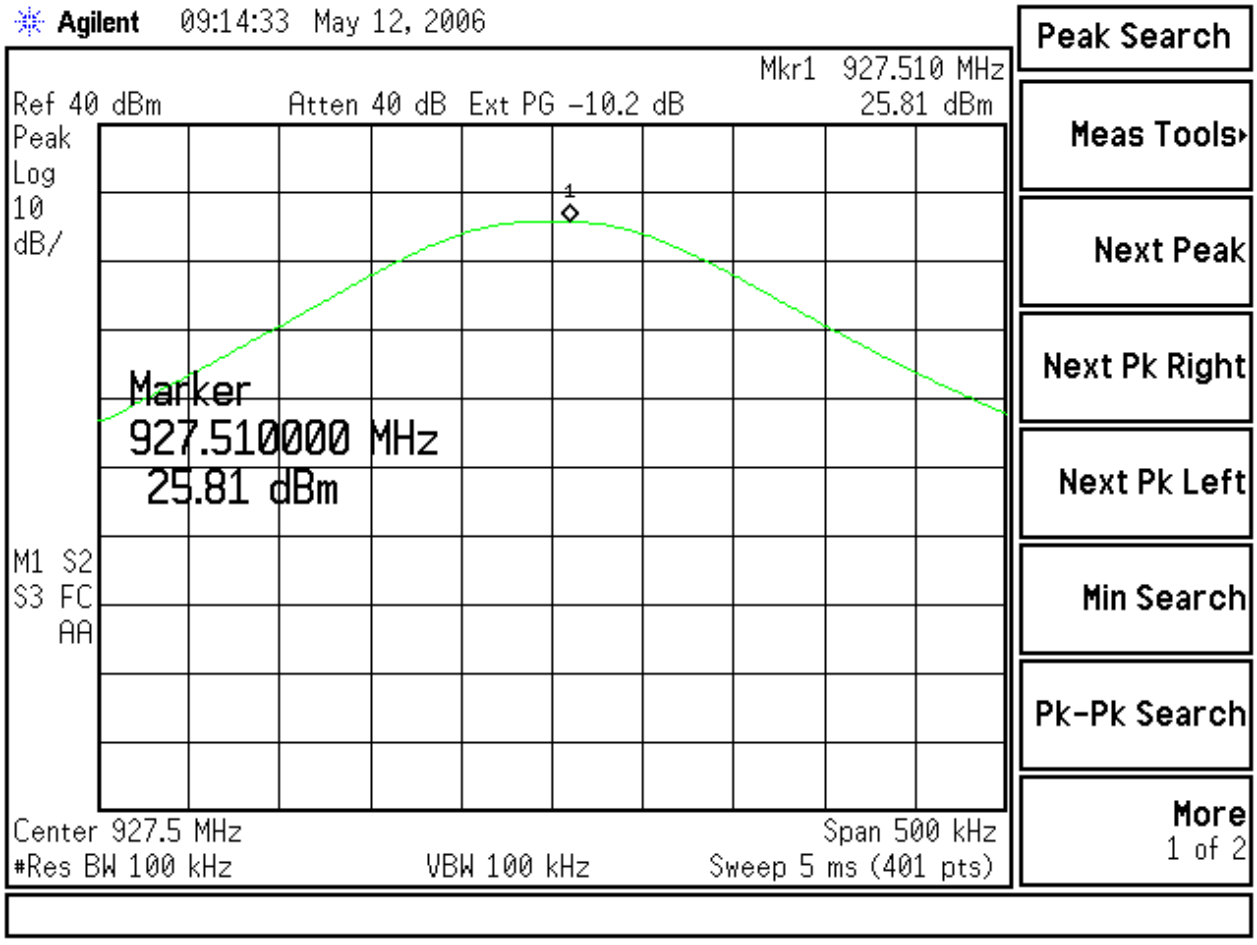
Channel 01 Conducted Power Output



Channel 25 Conducted Power Output



Channel 50 Conducted Power Output



13. 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 along with an attenuator as protection for the 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 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.

	Channel 01	Channel 25	Channel 50	Limit (dBm)
Fundamental	+ 27.0 (dBm)	+ 26.7 (dBm)	+ 25.8 (dBm)	30.0
2nd Harmonic	- 16.3 (dBm)	- 17.1 (dBm)	- 20.1 (dBm)	7.0
3rd Harmonic	- 5.7 (dBm)	- 5.4 (dBm)	- 8.2 (dBm)	7.0
4th Harmonic	- 65.9 (dBm)	- 68.9 (dBm)	- 67.5 (dBm)	7.0
5th Harmonic	- 62.0 (dBm)	- 62.3 (dBm)	- 63.9 (dBm)	7.0
6th Harmonic	- 62.0 (dBm)	- 62.9 (dBm)	- 64.2 (dBm)	7.0
7th Harmonic	- 65.6 (dBm)	- 66.2 (dBm)	- 66.5 (dBm)	7.0
8th Harmonic	- 42.2 (dBm)	- 43.7 (dBm)	- 48.2 (dBm)	7.0
9th Harmonic	- 63.6 (dBm)	- 65.2 (dBm)	- 66.5 (dBm)	7.0
10th Harmonic	- 59.3 (dBm)	- 60.8 (dBm)	- 64.1 (dBm)	7.0

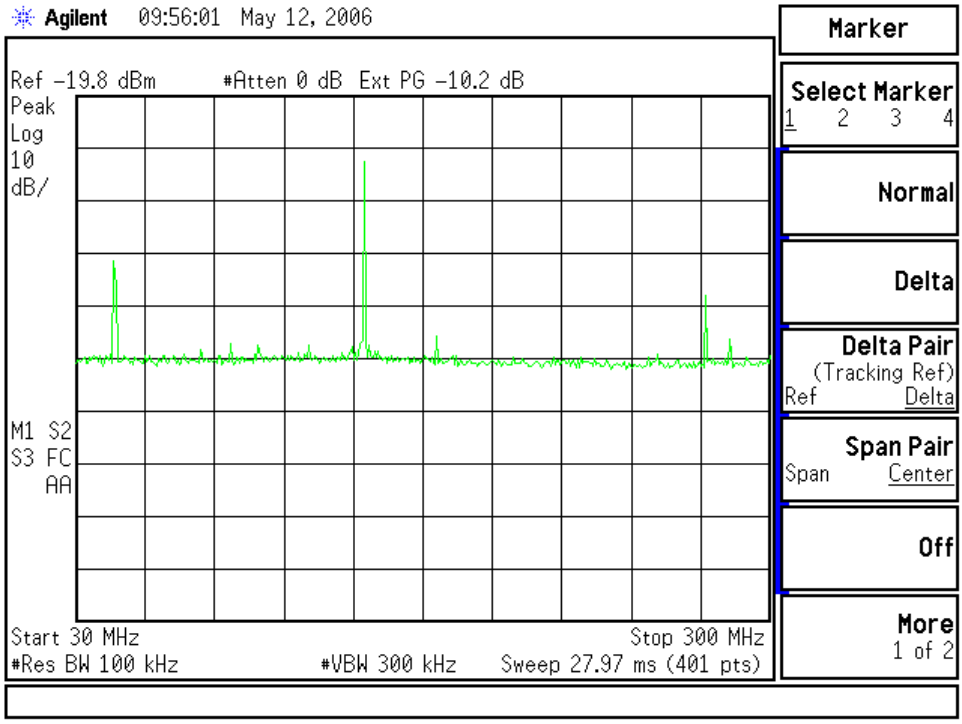
Spurious signals, other than the harmonics.

FREQUENCY (MHz)	MEASURED POWER (dBm)	CHANNEL
117.3	- 31.3	01
142.1	- 32.5	25
168.4	- 34.1	50
317.0	- 38.6	01
338.0	- 39.8	25
428.0	- 32.8	25
505.0	- 40.5	50
724.0	- 44.34	01
822.0	- 47.8	50
900.0	- 21.4	01
928.0	- 25.9	50
933.9	- 33.2	50
942.2	- 39.9	50

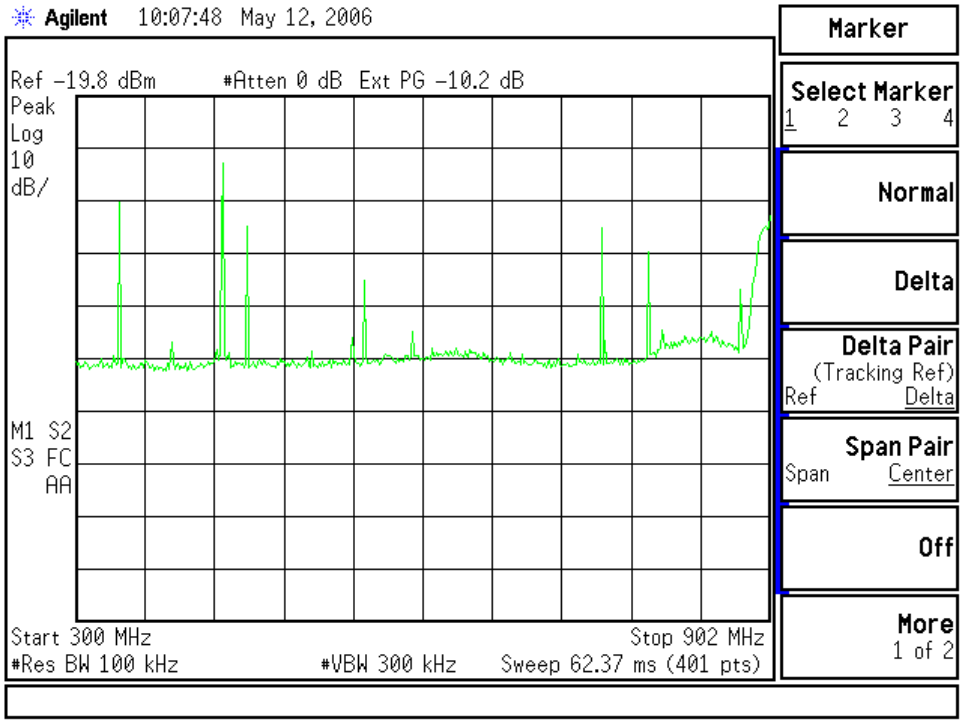
Note: Limit for spurious signal is + 7 dBm

Plots of Conducted Spurious and Fundamental Levels

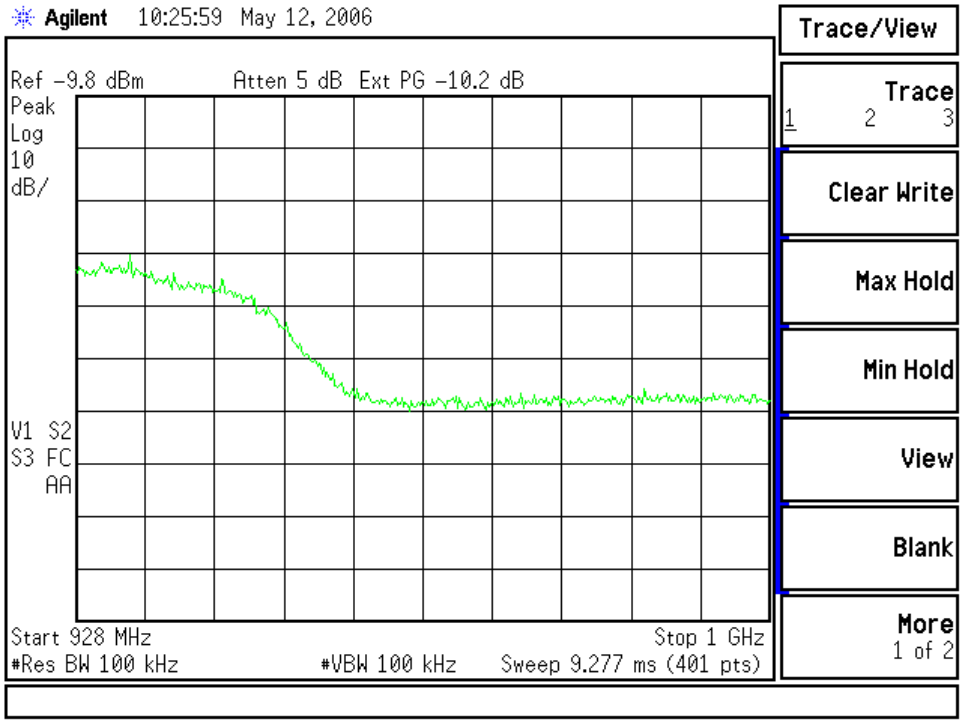
Channel 25, shown from 30 MHz up to 300 MHz



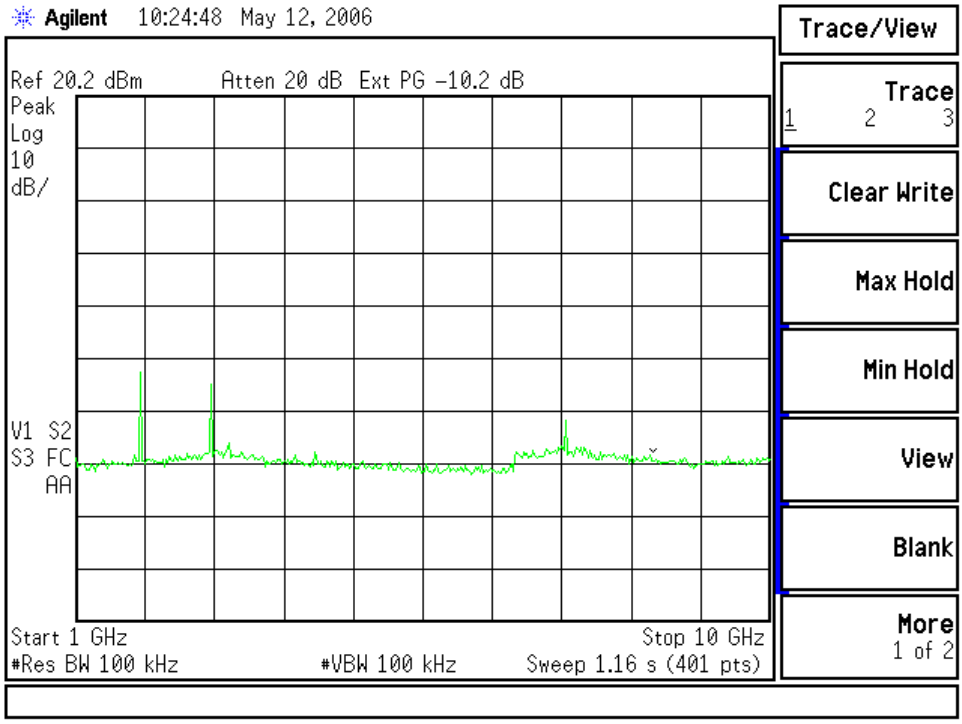
Channel 25, shown from 300 MHz up to 902 MHz



Channel 25, shown from 928 MHz up to 1000 MHz



Channel 25, shown from 1000 MHz up to 10,000 MHz



14. Minimum Channel Separation

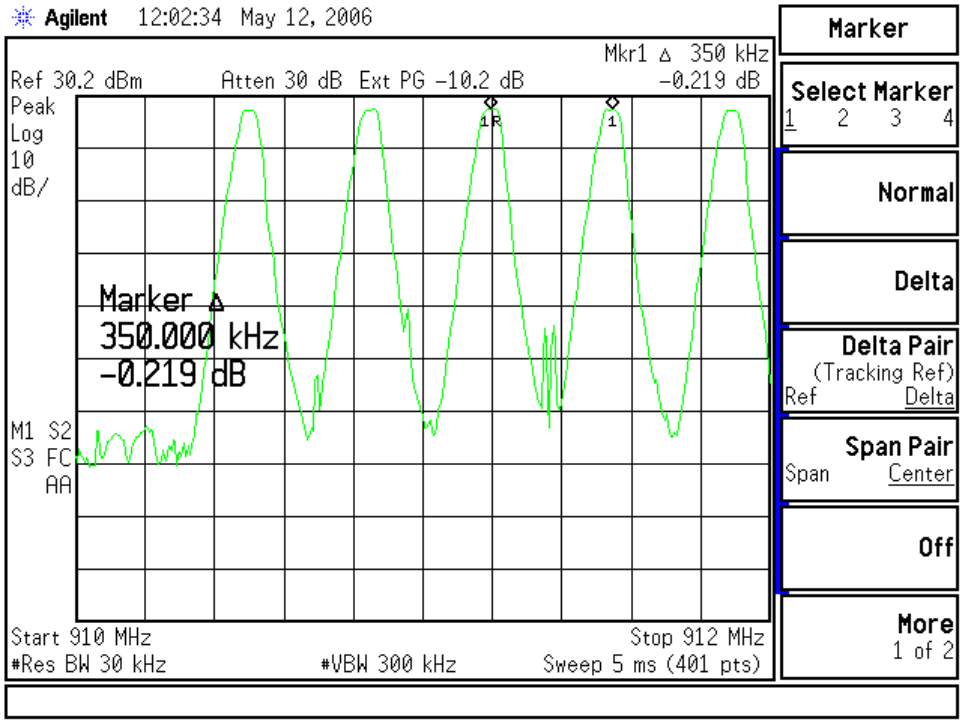
Part 15.247(a)(1) requires a minimum channel separation of 25 kHz or the equivalent of the 20 dB occupied bandwidth of the fundamental transmission, whichever is greater. An HP E4407B spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT.

The minimum channel-separation measured for this device is 345 kHz. The maximum occupied bandwidth of the device, as reported in the previous section is 60.8 kHz. The minimum channel separation for the EUT exceeds both the 25 kHz criteria and the 20 dB occupied bandwidth criteria, and hence meets the requirements. The following plots describe this spacing, and also establish the number of hop channels, total of 50.

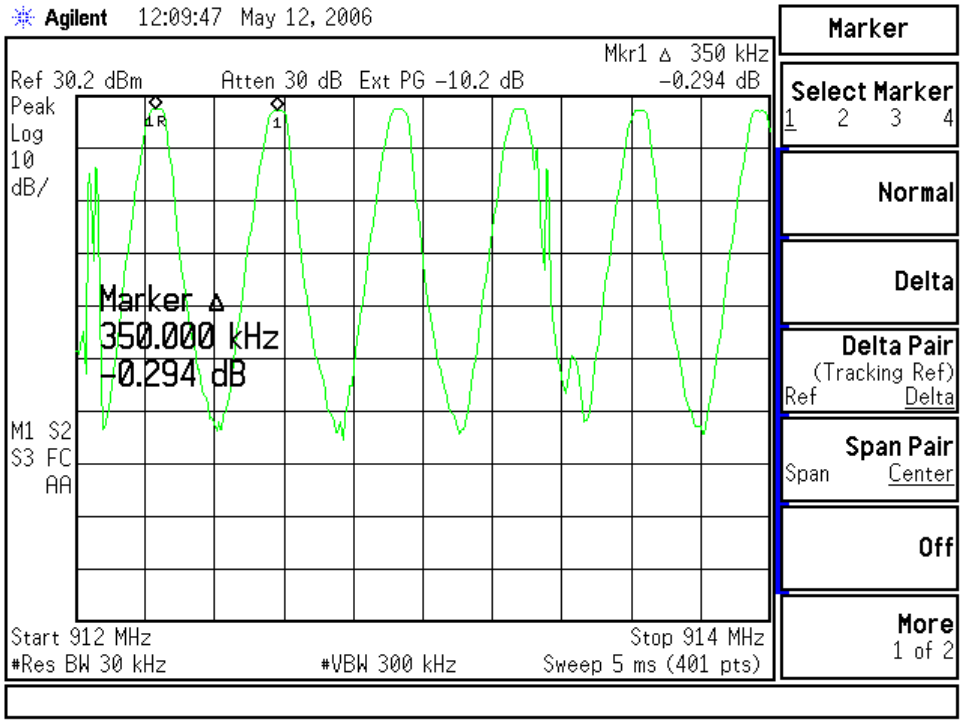
Frequency Span (MHz)	Number of Channels	Minimum Separation (kHz)
910 – 912	5	350
912 – 914	6	350
914 – 916	6	350
916 – 918	5	347
918 – 920	6	350
920 – 922	6	345
922 – 924	5	345
924 – 926	6	345
926 – 928	5	350

Plots of Channel Separations

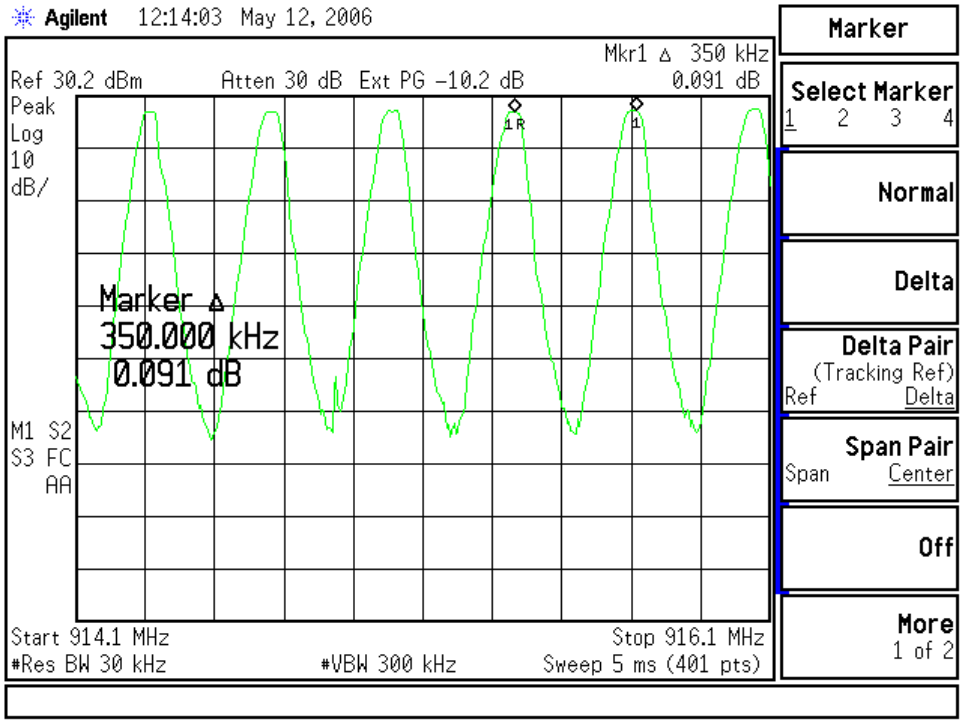
Channels 01 through 05



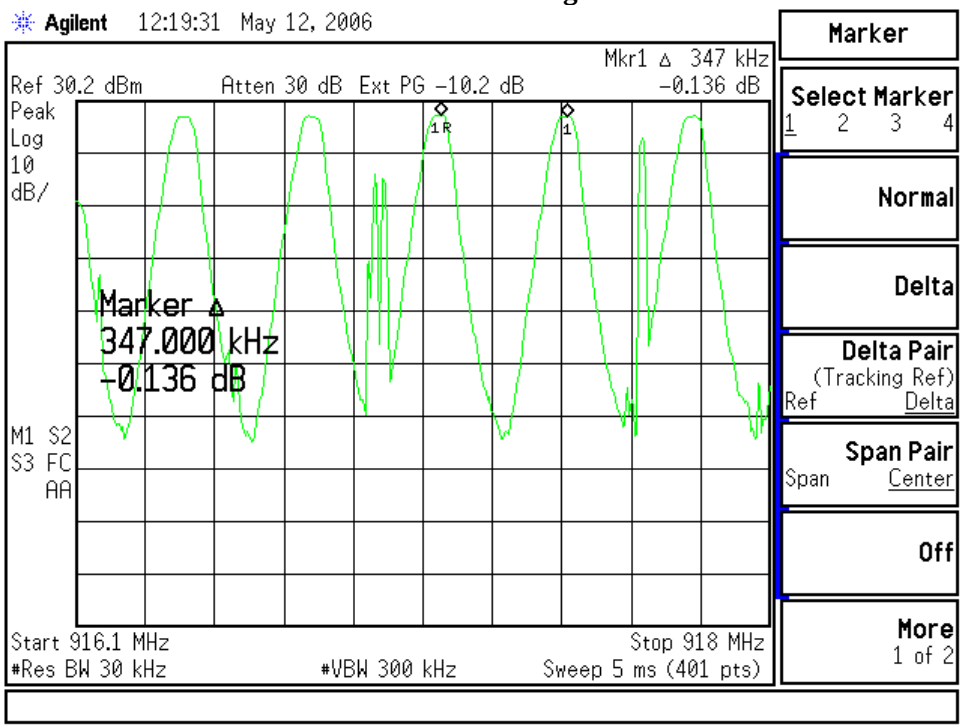
Channels 06 through 11



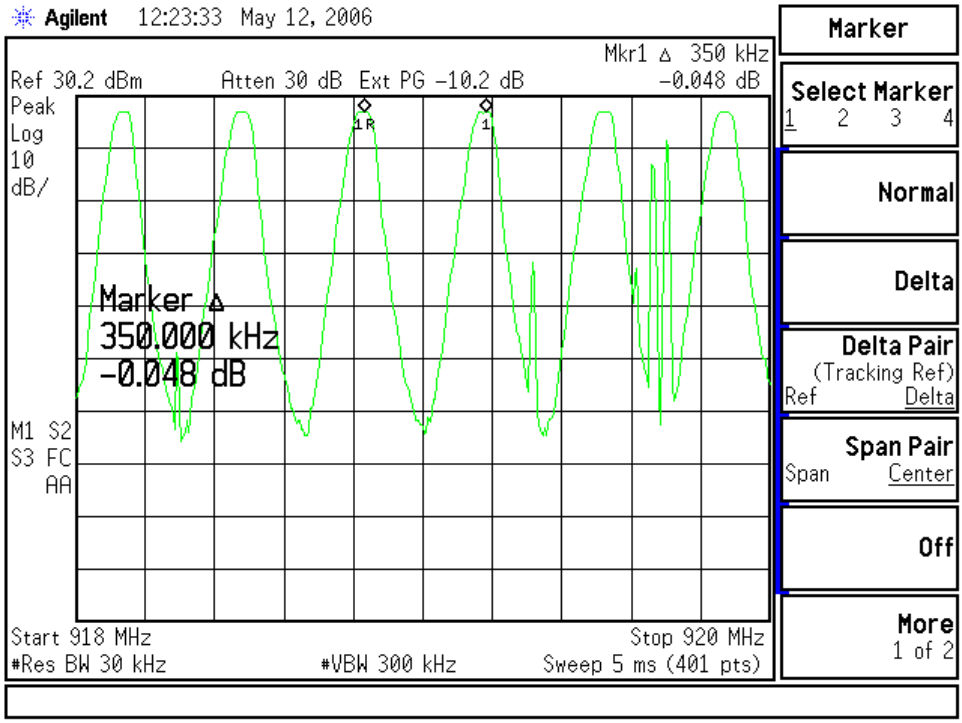
Channels 12 through 17



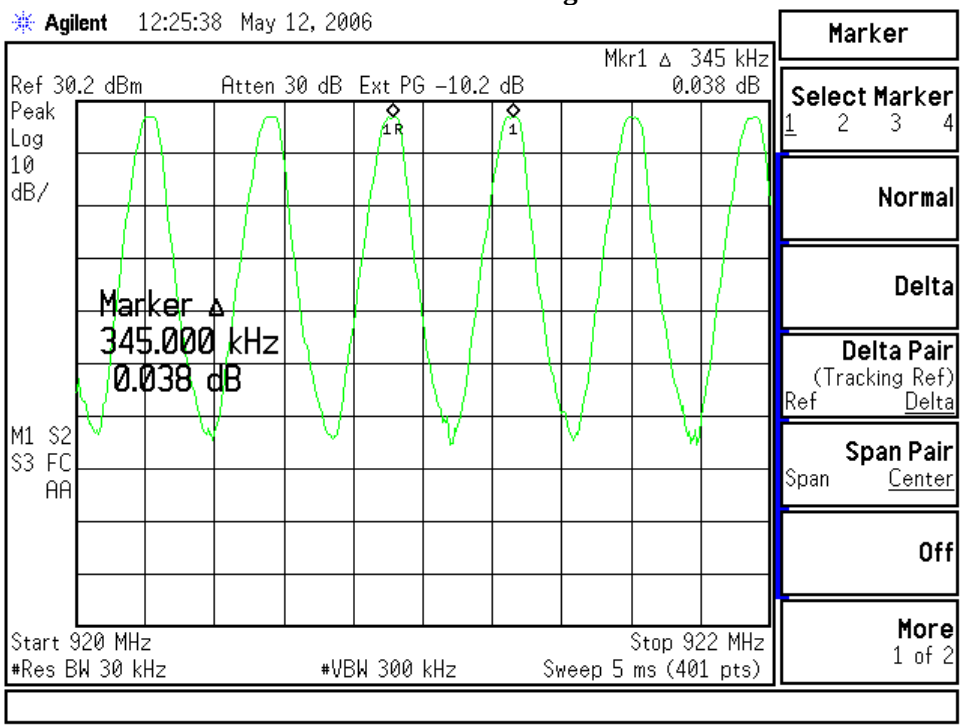
Channels 18 through 22



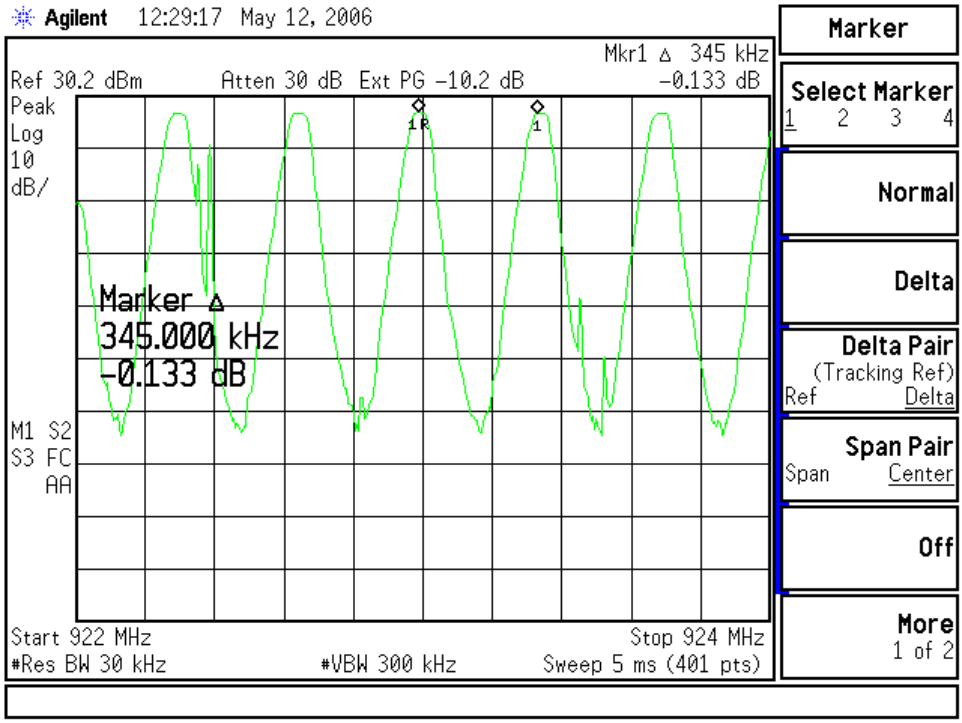
Channels 23 through 28



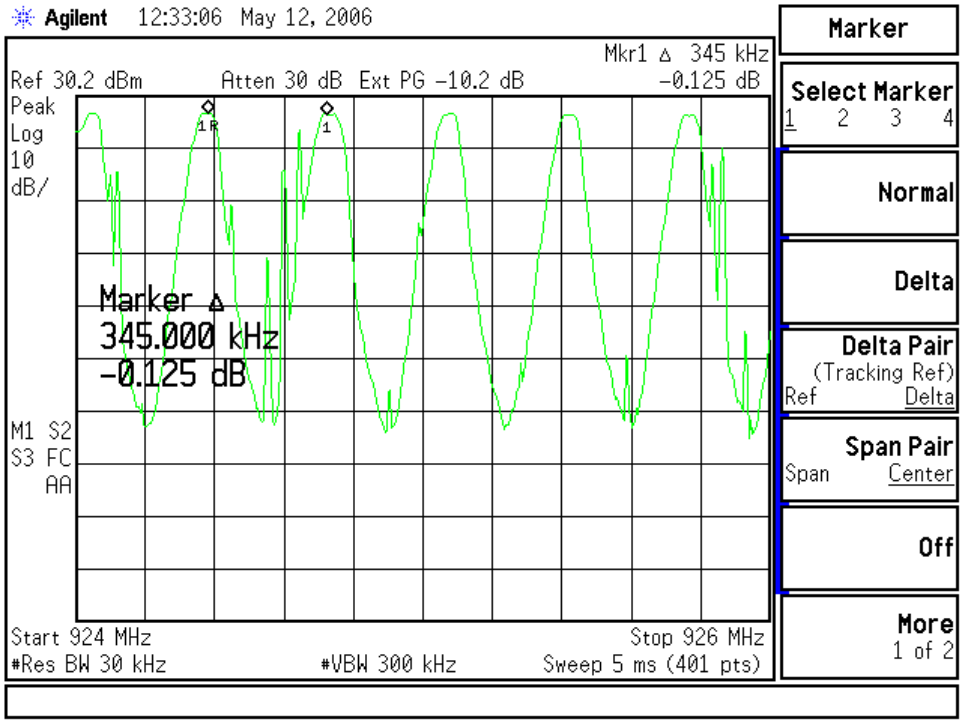
Channels 29 through 34



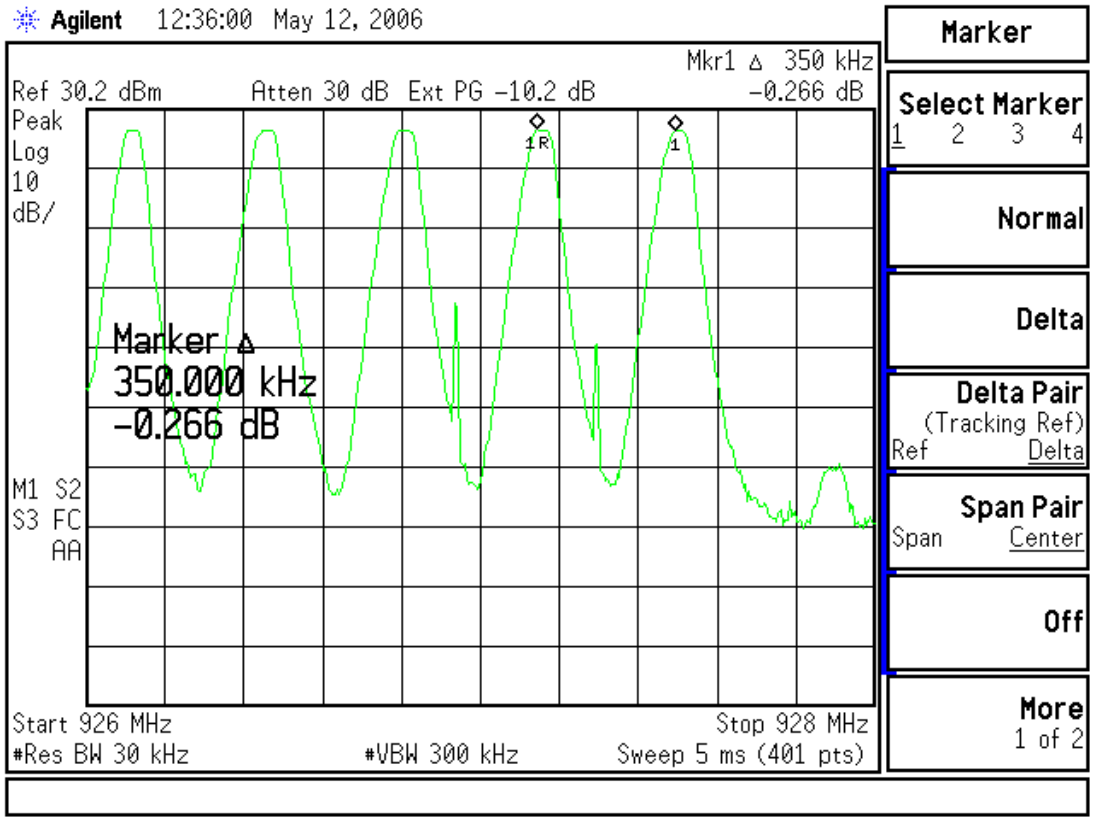
Channels 35 through 39



Channels 40 through 45



Channels 46 through 50



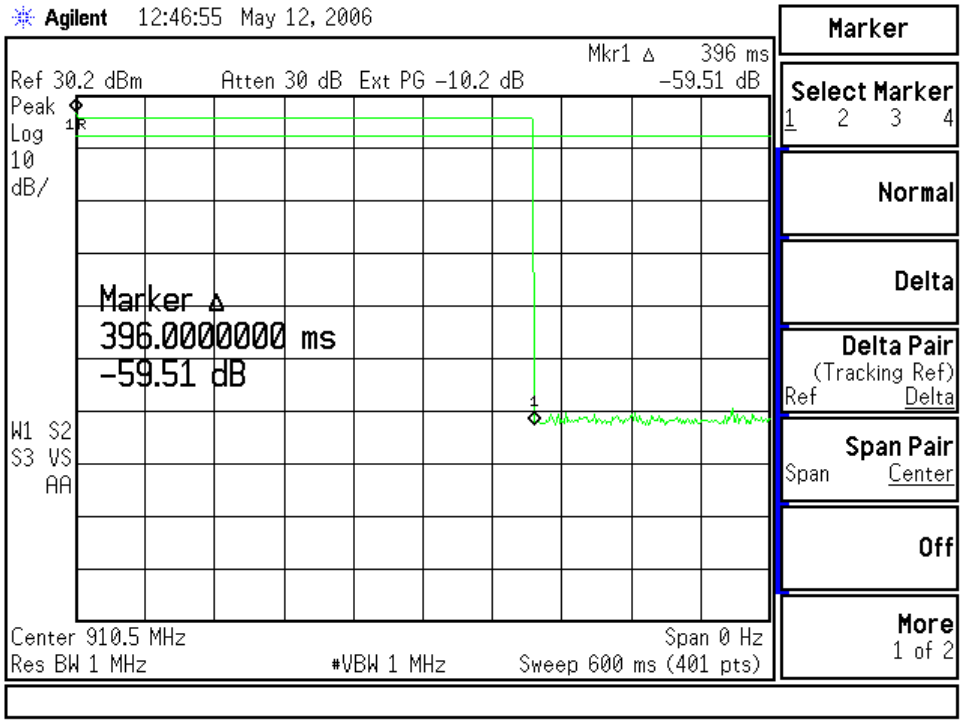
15. Channel Occupancy

Part 15.247(a)(1) requires a channel occupancy, for this device, of no more than 400 milliseconds in a 10 second window. The channel occupancy for this EUT was measured using an HP E4407B spectrum analyzer, set to zero-span at the frequency of interest. With the analyzer in peak-hold mode, the transmission lengths can be measured by adjusting the sweep rate of the analyzer. A suitable sweep rate was used to measure the channel occupancy at the low, mid and high channels. The longest time any transmission will occur on a single channel is 396.2 ms. With a total of 50 channels used, each occupying a 396.2 ms slot, it will take 19.81 seconds for the sequence to repeat. In a 20 second window, each channel would have 1 transmission cycle. The maximum occupancy in a 20 second window is calculated by multiplying 1 transmission cycle by 396.2 ms transmission duration per cycle, to arrive at 396.2 ms total occupancy.

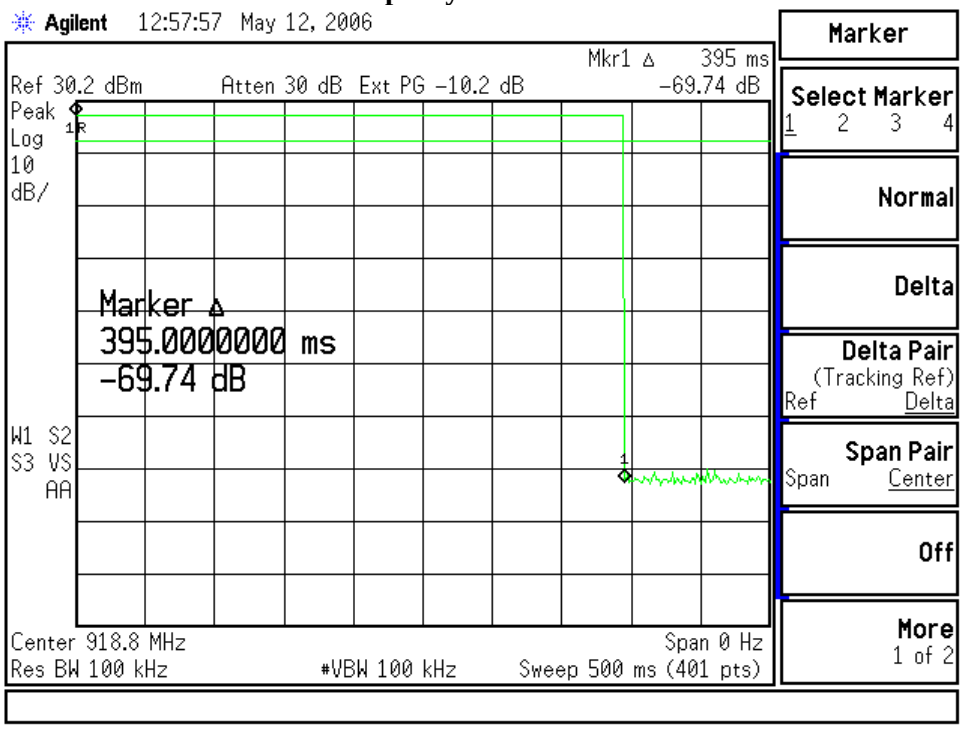
Channel	Frequency (MHz)	Occupancy Per transmission (ms)	Occupancy in 400 ms window (ms)
01	910.5	396.0	396.0
25	918.8	395.0	395.0
50	927.5	396.2	396.2

Plots of Channel Occupancy

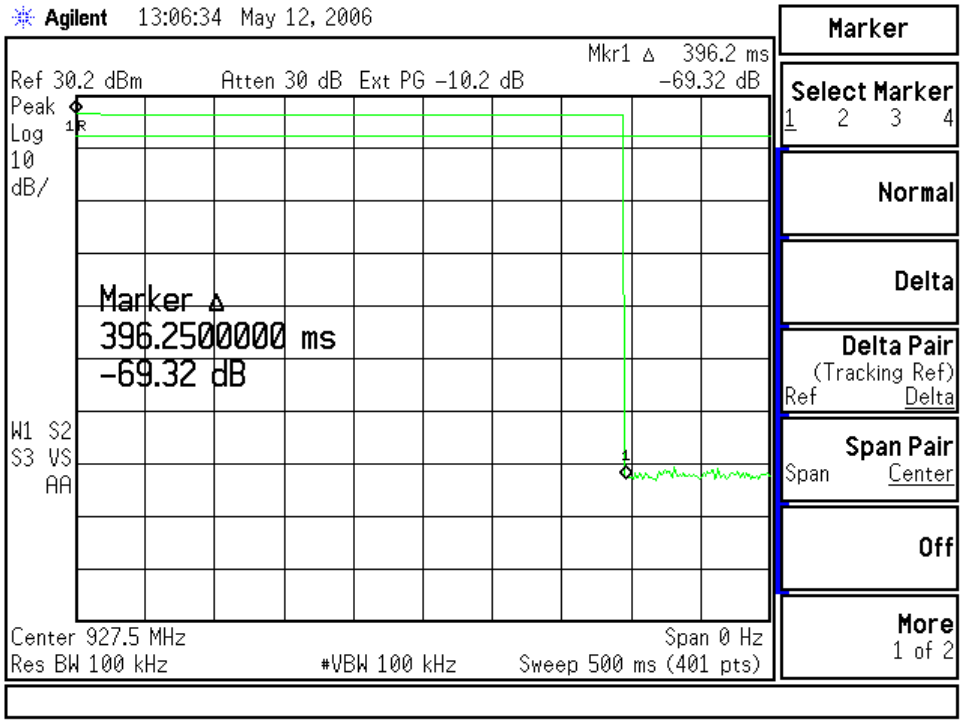
Occupancy in Channel 01



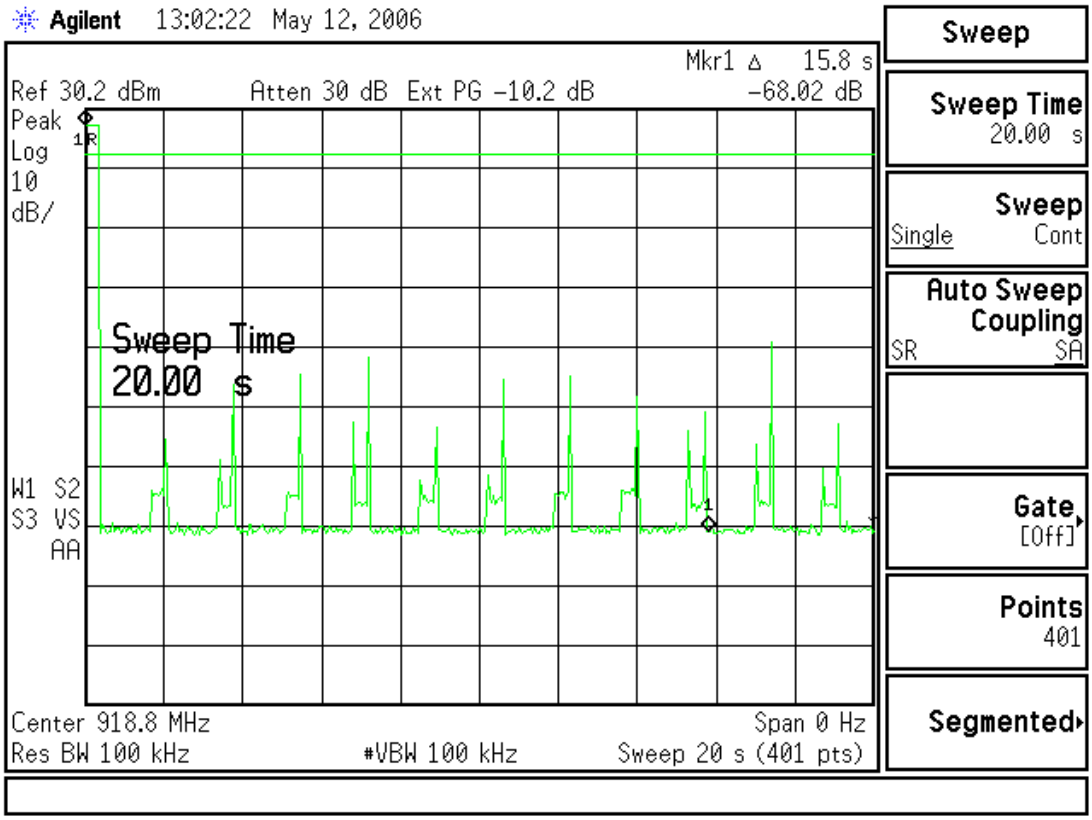
Occupancy in Channel 25



Occupancy in Channel 50



Occupancy on middle channel in a 20 second window demonstrating 1 hop cycle in 20 seconds as shown below.



16. Equal Channel Usage

The 50 channels are arrayed in a table which the system uses to determine the next hopping channel. Each time a transmission is made the system uses the next frequency in the table. The table is started over once the end has been reached. Thus, any given frequency will not be reused until all other frequencies have been accessed. This also addresses part 15.247(g) concerns. The following table shows the channel separation between each channel from 910.5 MHZ to 927.5 MHz.

Channel	Frequency	Separation
0	910.500000	-
29	910.846938	0.347
12	911.193876	0.347
41	911.540814	0.347
31	911.887752	0.347
24	912.234690	0.347
17	912.581628	0.347
46	912.928566	0.347
42	913.275504	0.347
38	913.622442	0.347
11	913.969380	0.347
43	914.316318	0.347
36	914.663256	0.347
25	915.010194	0.347
16	915.357132	0.347
3	915.704070	0.347
5	916.051008	0.347
19	916.397946	0.347

(table continued on next page)

(Equal Channel Usage - table continued from previous page)

Channel	Frequency	Separation
8	916.744884	0.347
9	917.091822	0.347
49	917.438760	0.347
21	917.785698	0.347
6	918.132636	0.347
1	918.479574	0.347
2	918.826512	0.347
20	919.173450	0.347
27	919.520388	0.347
30	919.867326	0.347
32	920.214264	0.347
33	920.561202	0.347
10	920.908140	0.347
35	921.255078	0.347
22	921.602016	0.347
18	921.948954	0.347
4	922.295892	0.347
34	922.642830	0.347
39	922.989768	0.347
40	923.336706	0.347
26	923.683644	0.347
15	924.030582	0.347
45	924.377520	0.347
37	924.724458	0.347
48	925.071396	0.347
47	925.418334	0.347
28	925.765272	0.347
7	926.112210	0.347
23	926.459148	0.347
14	926.806086	0.347
44	927.153024	0.347
13	927.499962	0.347

17. Pseudorandom Hopping Pattern

The hopping patterns were chosen to maintain uniform usage of the spectrum, while maintaining the pseudorandom nature of the channels. The following table addresses part 15.247(h) concerns.

Channel	Frequency
0	910.500000
1	918.479574
2	918.826512
3	915.704070
4	922.295892
5	916.051008
6	918.132636
7	926.112210
8	916.744884
9	917.091822
10	920.908140
11	913.969380
12	911.193876
13	927.499962
14	926.806086
15	924.030582
16	915.357132
17	912.581628
18	921.948954
19	916.397946
20	919.173450
21	917.785698
22	921.602016
23	926.459148
24	912.234690
25	915.010194
26	923.683644

(table continued on next page)

(Pseudorandom Hopping Pattern - table continued from previous page)

Channel	Frequency
27	919.520388
28	925.765272
29	910.846938
30	919.867326
31	911.887752
32	920.214264
33	920.561202
34	922.642830
35	921.255078
36	914.663256
37	924.724458
38	913.622442
39	922.989768
40	923.336706
41	911.540814
42	913.275504
43	914.316318
44	927.153024
45	924.377520
46	912.928566
47	925.418334
48	925.071396
49	917.438760

18. Receiver Synchronization and Receiver Input Bandwidth

The radio receiver is a low-IF receiver. The received signal is down-converted in quadrature (I&Q) to the intermediate frequency (IF) of 307.2kHz. At IF, the signal is complex filtered and demodulated. The system uses a 9.6kHz data rate with GFSK modulation at a deviation of 9.9kHz. The Carson's rule bandwidth is 29.4kHz (Baud rate + Frequency separation). The receiver IF bandwidth is programmable and is set to 51.2kHz in this system, giving excess bandwidth but still less than the system channel separation of 347kHz. At the start of every message, the transmitter sends a long preamble. During this time the receiver checks all frequencies to find the preamble. If a message is expected to be more than one packet length (300 ms max.), both devices (receiver and transmitter) hop to the next frequency on the hop table as needed.

The information on this page is provided by the manufacturer.

19. MPE Calculations

Base Station Transceiver
MPE Calcluation

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:	26.99	(dBm)
Maximum peak output power at antenna input terminal:	500.035	(mW)
Antenna gain(typical):	2.58	(dBi)
Maximum antenna gain:	1.811	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	915	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.62	(mW/cm^2)
Power density at prediction frequency:	0.180190	(mW/cm^2)
Maximum allowable antenna gain:	7.9	(dBi)
Margin of Compliance at 20 cm =	5.4	dB

Appendix A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	9/27/05	9/27/06
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	9/27/05	9/27/06
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/27/05	9/27/06
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	12/07/05	12/07/06
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	12/29/05	12/29/06
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/29/05	9/29/06
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/29/05	9/29/06
N/A	LSC	Cable	0011	3 Meter ½" Armored 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