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

COMPLIANCE TESTING OF:

S4 Module

Prepared For:
Nivis, LLC
Re: StatSignal
Attn.: Mr. Trae Harrison
900 Circle 75 Parkway, Suite 1700
Atlanta, GA 30339

Test Report Number:

305539 TX

Test Dates:

April 2nd to 10th, 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

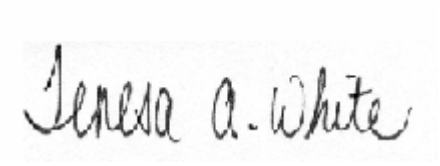
U. S. Conformity Assessment Body (CAB) Validation

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.

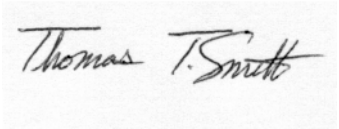
Date of Validation: November 20, 2002
Notified Body Identification Number: 1243

2. Signature Page



Prepared By: May 12, 2006

Teresa A. White, Document Coordinator Date



Tested By: May 12, 2006

Thomas T. Smith, EMC Engineer Date

Tested By: May 12, 2006

Abtin Spantman, EMC Engineer Date

Approved By: **May 12, 2006**

Brian E. Petted, VP of Engineering **Date**

3. Product and General Information

Manufacturer:	Nivis, LLC					
Date(s) of Test:	April 2nd – 10th, 2006					
Test Engineer(s):	√	Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	S4 Module					
Serial #:	Engineering Unit					
Voltage:	+3.6 VDC					
Operation Mode:	Normal, continuous transmit, and 'Hopping' mode					

4. Introduction

Between April 2nd – 10th, 2006, a series of Conducted and Radiated RF Emission tests were performed on one sample of the S4 Module, 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 Thomas T. Smith, EMC Engineer and Abtin Spantman, 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 Radioelelectriques (CISPR) Number 16-1, 2003.

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

5. Product Description

The S4 Module acts as a modem in an S4 meter housing. This device uses an external antenna attached to the side of the housing and connects to it via a cable. It communicates within a network of electric meters. The frequency band used is the 915 MHz ISM band with a maximum transmit power of ½ Watt. 50 hopping channels are used. The data is FSK modulated and uses a 9600 baud rate.

6. Test Requirements

The above mentioned tests were performed in order to determine the compliance of the S4 Module 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 S4 Module was found to **MEET** the requirements as described within the specification of Title 47 CFR FCC, Part 15.247, and Industry Canada RSS-210, Section 6.2.2(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 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 transmit mode, with modulation from typical data. Final testing was performed using 3.6 VDC as provided by an external DC power supply. The unit has the capability to operate on 50 channels, controllable via a laptop PC using proprietary software.

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 (Channel 1: 910.5 MHz), middle (Channel 25: 918.8 MHz) and high (Channel 50: 927.5 MHz) to comply with FCC Part 15.35. The channels and operating modes were changed using a PC and interface software.

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 10,000 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.

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 an EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into an EMI Receiver database. As a result, the data taken from an 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 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).

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:

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

~ ~

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:

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

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 10,000 MHz

Manufacturer:	Nivis, LLC					
Date(s) of Test:	April 2nd – 10th, 2006					
Test Engineer(s):	√	Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	S4 Module					
Serial #:	Engineering Unit					
Voltage:	+3.6 VDC					
Operation Mode:	Normal, continuous transmit, 'Hopping' mode, or C.W. mode					
EUT Power:		Single Phase ___VAC		3 Phase ___VAC		
		Battery	√	Other: Bench DC 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 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 /Config.	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
39.97	V	25	1.0	300	37.2	104.4 Note 2	67.2
129.9	V	25	1.0	255	41.7	43.5	1.8
897.6	V	1	1.5	317	52.9	103.7 Note 2	50.8
897.6	H	1	1.7	0	58.6	103.7 Note 2	45.1
933.6	H	25	1.7	0	53.8	104.4 Note 2	50.6
928.5	H	25	1.7	0	53.4	104.4 Note 2	51.0
959.9	H	50	1.7	0	43.1	54.0	10.9

Notes:

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

2) Limit is based on -20 dBc, as signal is outside of restricted band.

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 1:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
910.5	H	1.7	0	123.7	125.2	1.5
1821	V	1.0	280	63.8	103.7	39.9
2732	V	1.0	320	51.7	54 Note 4	2.3
3642	V	1.0	75	40.0	54 Note 4	14.0
4553	H	1.0	60	41.1	54 Note 4	12.9
5463	V	1.2	260	56.3	113.2	56.9
6373	V	1.1	300	56.3	113.2	56.9
7284	H	1.0	110	51.5	63.5 Note 4	12.0
8194	V	1.0	377	45.1	63.5 Note 4	18.4
9105	V	1.0	320	55.9	63.5 Note 4	7.6

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	1.7	0	124.4	125.2	0.8
1838	V	1.0	280	62.5	104.4	41.9
2757	H	1.0	40	49.8	54 Note 4	4.2
3675	H	1.0	0	36.8	54 Note 4	17.2
4594	V	1.0	0	38.5	54 Note 4	15.5
5512	V	1.2	255	58.0	113.9	55.9
6431	H	1.1	102	60.0	113.9	53.9
7350	H	1.0	340	51.2	63.5 Note 4	12.3
8269	V	1.0	90	43.0	63.5 Note 4	20.5
9188	V	1.0	320	57.8	63.5 Note 4	5.7

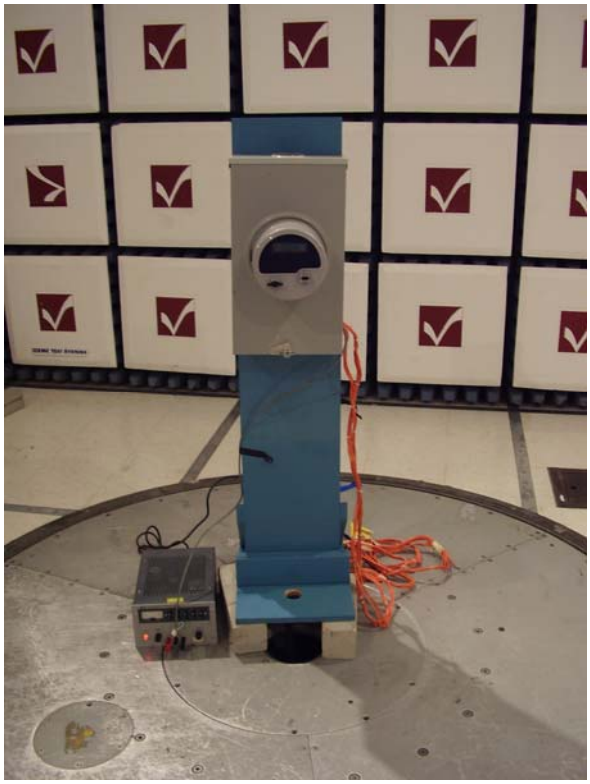
The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 50:

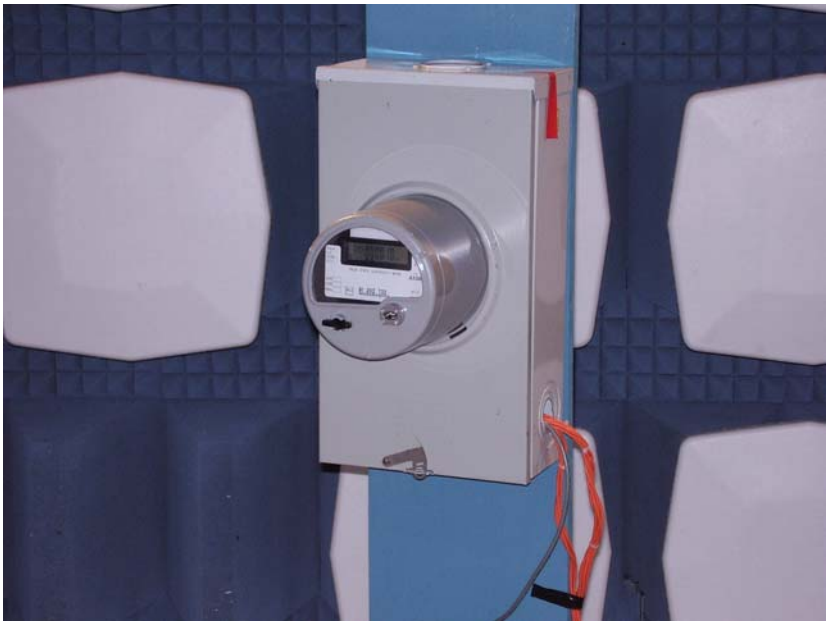
Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
927.5	H	1.7	0	124.5	125.2	0.7
1855	V	1.0	280	62.7	104.5	41.8
2783	V	1.0	305	48.9	54 Note 4	5.1
3710	V	1.4	85	38.0	54 Note 4	16.0
4637	H	1.0	0	39.5	54 Note 4	14.5
5564	V	1.0	260	58.1	114.0	55.9
6492	H	1.0	105	63.7	114.0	50.3
7419	V	1.0	320	51.1	63.5 Note 4	12.4
8347	V	1.0	66	43.7	63.5 Note 4	19.8
9274	V	1.0	318	56.9	114.0	57.1

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 above 18 GHz.
3) Measurement at receiver system noise floor.
4) Emission falls within a restricted band of operation as defined in 47CFR 15.205 and is subject to part 15.205 limits.

Photos Taken During Radiated Emission Testing





Photos Taken During Radiated Emission Testing *(continued)*

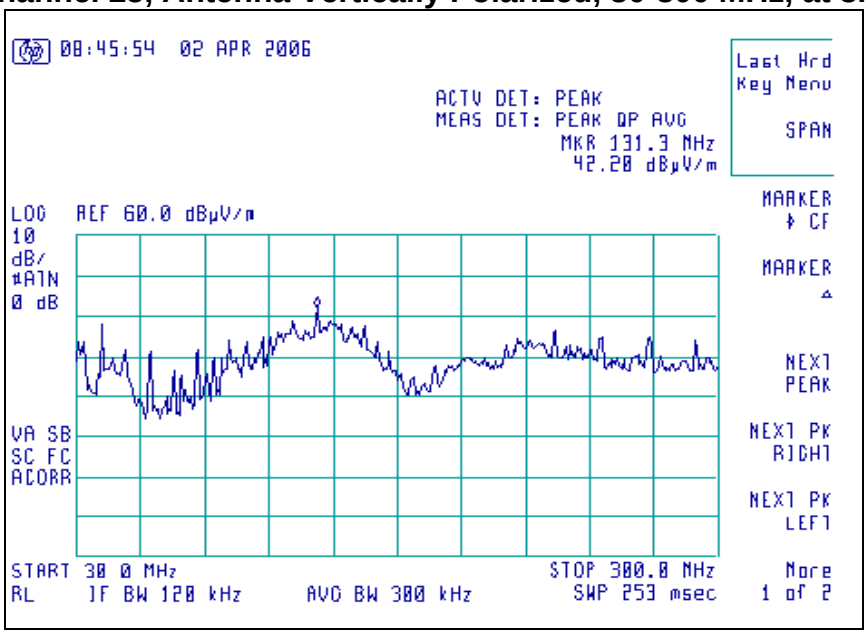
Graphs made during Radiated Emission Testing

Screen Captures of Radiated RF Emissions:

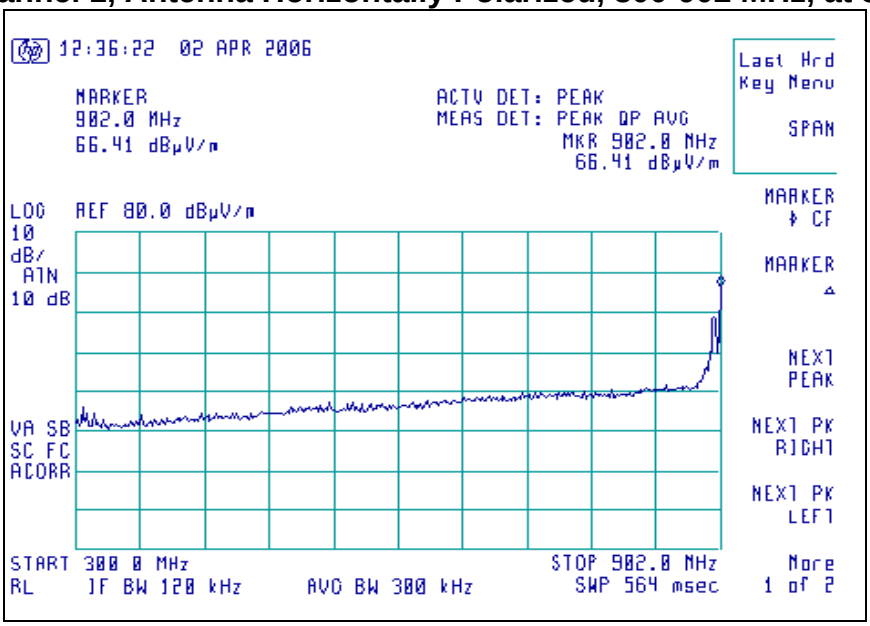
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 1, 25, or 50, with the sense and EUT antennas both in vertical polarity for worst case presentations.

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



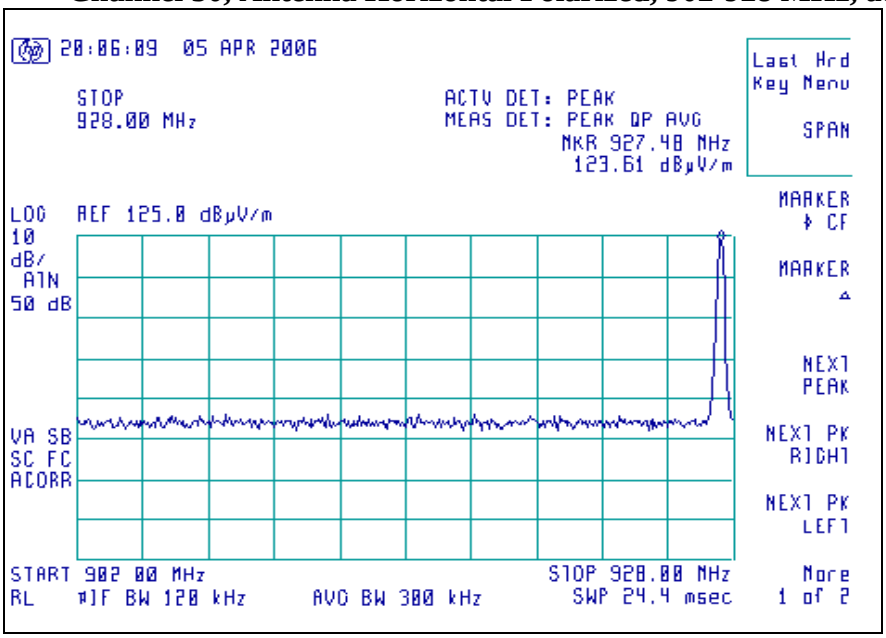
Channel 1, Antenna Horizontally Polarized, 300-902 MHz, at 3m.



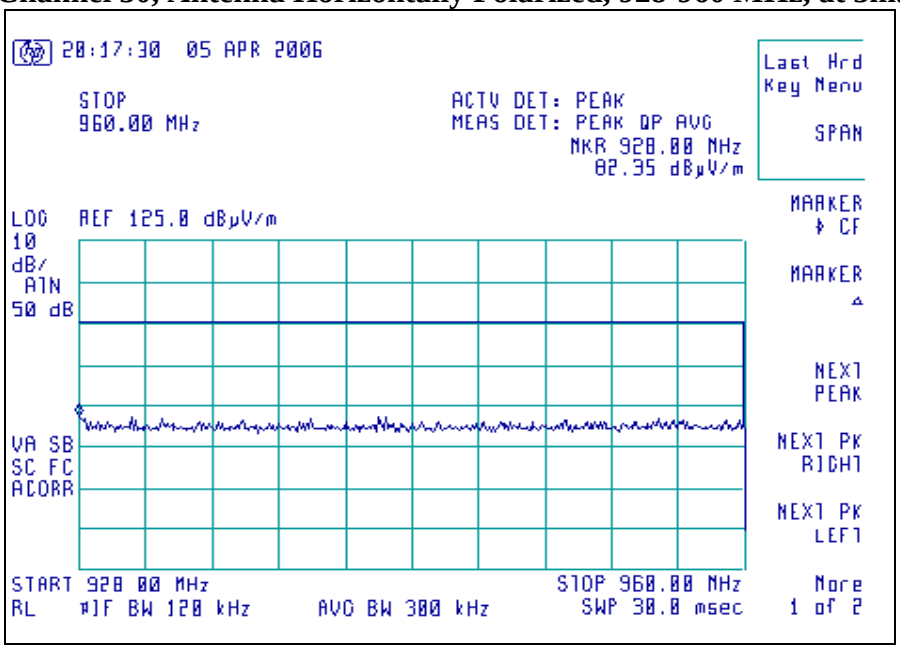
Graphs made during Radiated Emission Testing

Screen Captures of Radiated RF Emissions (continued)

Channel 50, Antenna Horizontal Polarized, 902-928 MHz, at 3m.



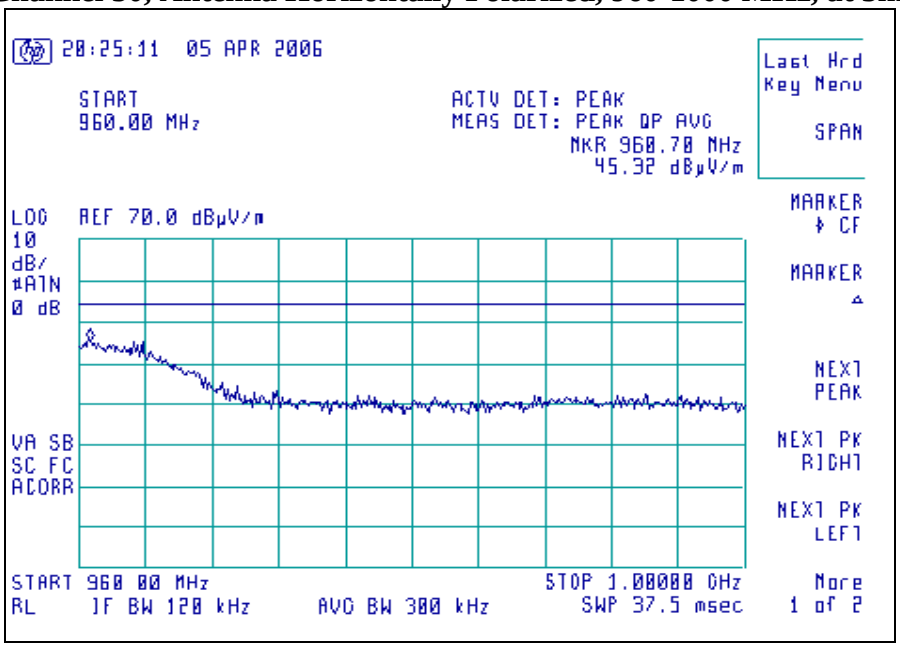
Channel 50, Antenna Horizontally Polarized, 928-960 MHz, at 3m.



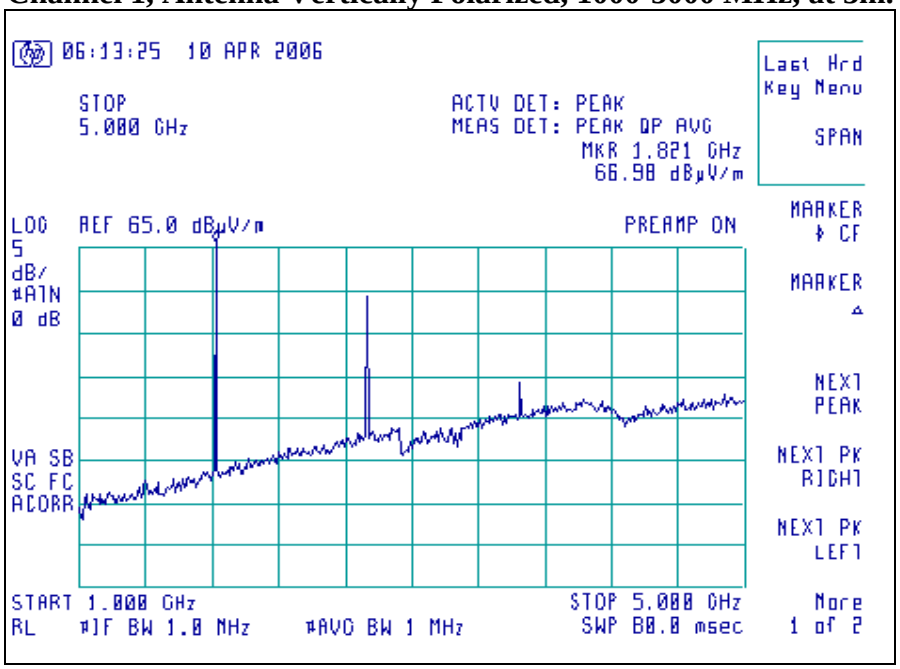
Graphs made during Radiated Emission Testing

Screen Captures of Radiated RF Emissions (continued)

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



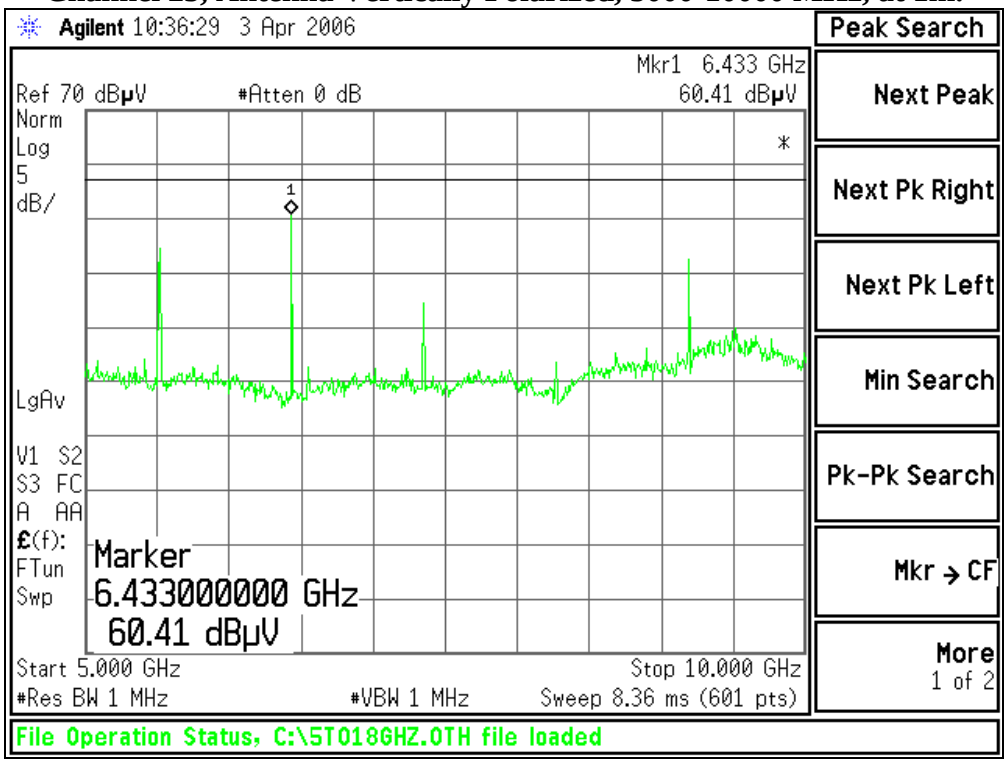
Channel 1, Antenna Vertically Polarized, 1000-5000 MHz, at 3m.



Graphs made during Radiated Emission Testing

Screen Captures of Radiated RF Emissions (continued)

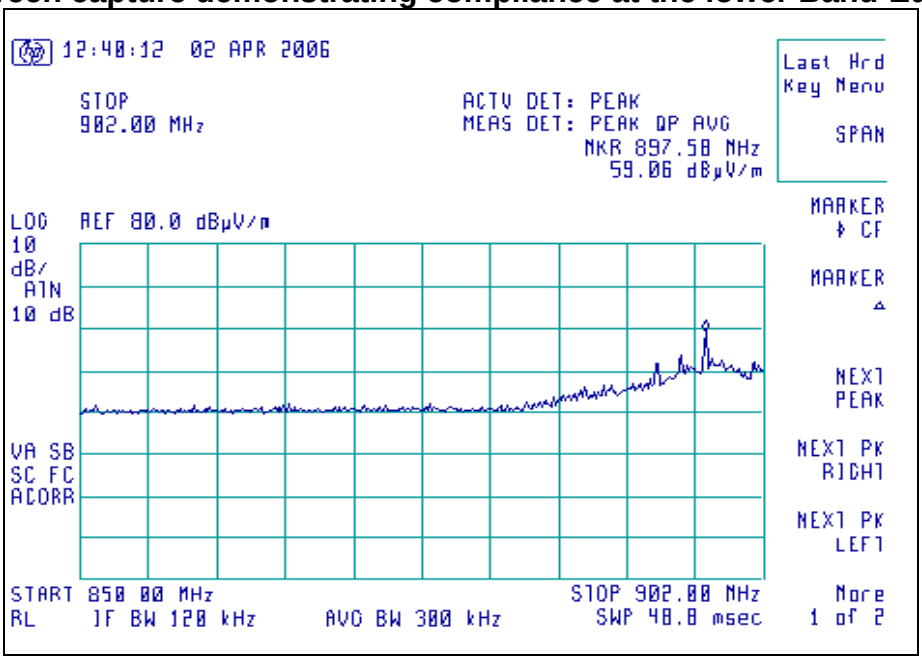
Channel 25, Antenna Vertically Polarized, 5000-10000 MHz, at 1m.



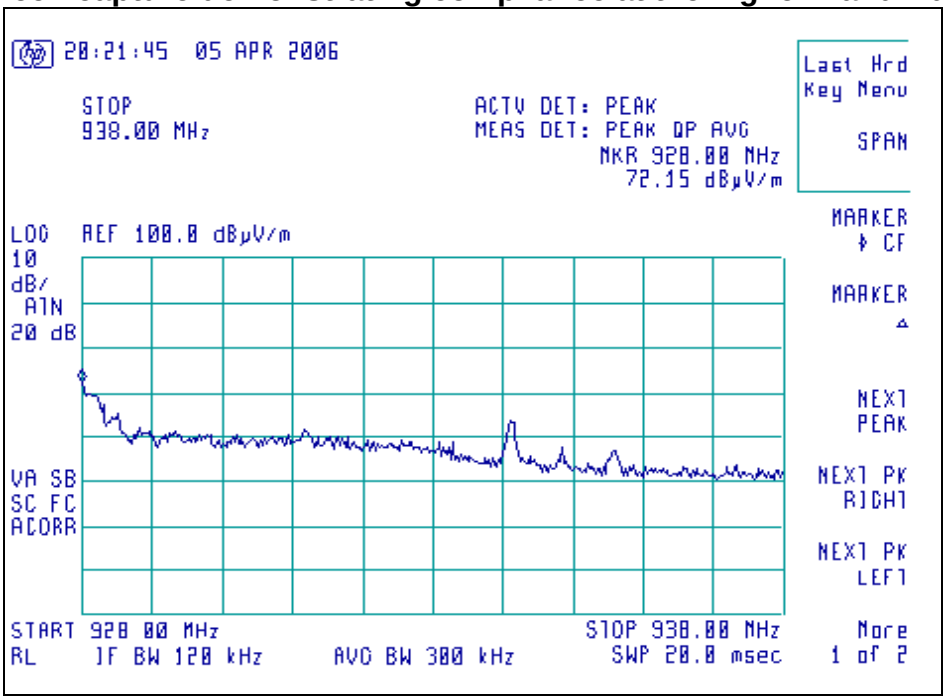
9. Band-Edge Measurements

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

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

Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. Calibrations of the LISN and Limiter are traceable to N.I.S.T. All cables are calibrated and checked periodically for conformance. The emissions are measured on the HP 8546A EMI Receiver, which has automatic correction for all factors 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:	April 2nd – 10th, 2006					
Test Engineer:	√	Tom Smith		Abtin Spantman		Ken Boston
Model #:	S4 Module					
Serial #:	Engineering Unit					
Voltage:	+3.6 VDC via 120 VAC / 60 Hz Bench DC Supply					
Operation Mode:	Normal, continuous transmit, and 'Hopping' mode					
Test Location:	√	Horizontal & Vertical Ground Plane				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

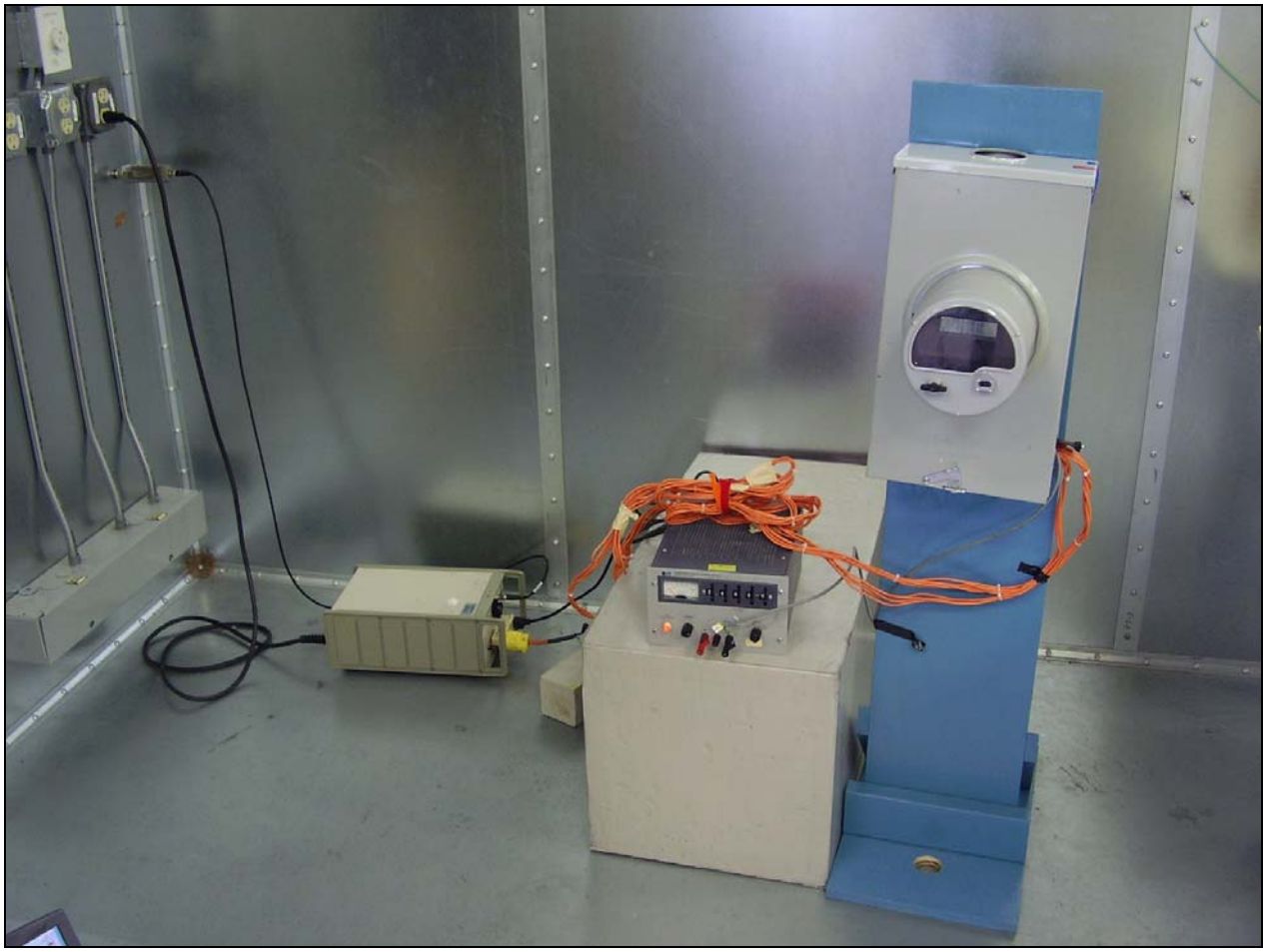
		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Q-Peak Reading (dBµV/m)	Q-Peak Limit (dBµ V/m)	Quasi-Peak Margin (dB)	Average Reading (dBµV/m)	Average Limit (dBµ V/m)	Average Margin (dB)
0.1598	L1	58.6	65.5	6.9	46.0	55.5	9.0
0.1600	L1	58.5	65.5	7.0	49.5	55.5	6.0
0.1646	L1	53.5	65.0	11.5	41.1	55.0	13.9
0.1752	L1	55.6	64.7	9.1	42.8	54.7	11.9
0.1850	L1	52.4	64.2	11.8	37.7	54.2	16.5
0.4025	L1	39.6	57.9	18.3	18.9	47.9	29.0
9.9	L1	40.0	60.0	20.0	37.8	50.0	12.2
0.1517	L2	58.2	66.0	7.8	39.0	56.0	17.0
0.1617	L2	57.0	65.5	8.5	42.4	55.5	13.1
0.1660	L2	58.1	65.2	7.1	38.9	55.2	16.3
0.1799	L2	55.0	64.5	9.5	38.7	54.5	15.8
0.3222	L2	45.6	62.7	17.1	24.3	52.7	28.4
0.3620	L2	45.8	58.7	12.9	18.8	48.7	29.9
9.9	L2	45.7	60.0	14.3	43.5	50.0	6.5

Notes:

1) All other emissions were better than 20 dB below the limits.
2) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested.
3) 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

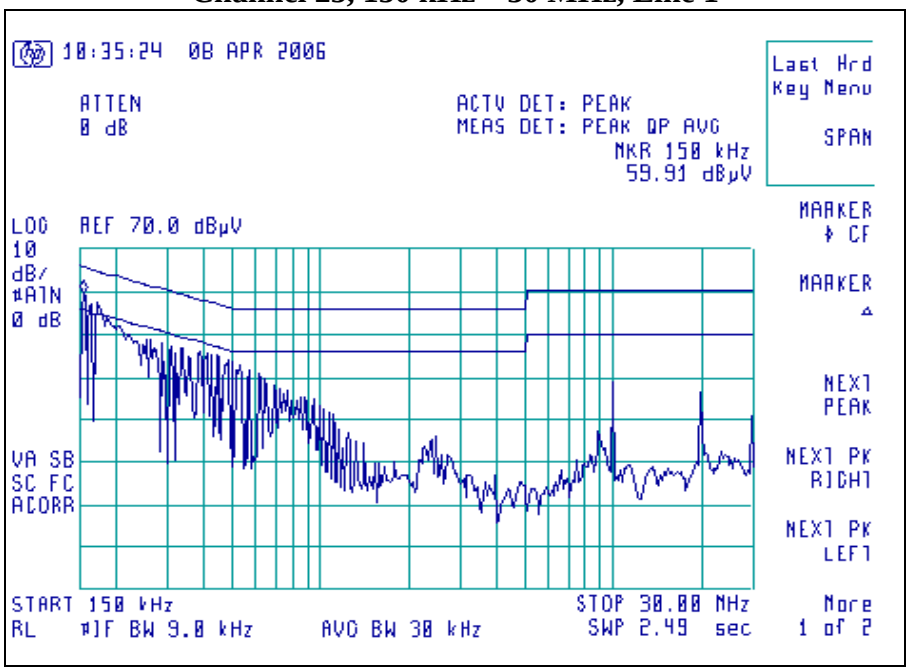


Screen Captures of Conducted AC Mains Emissions:

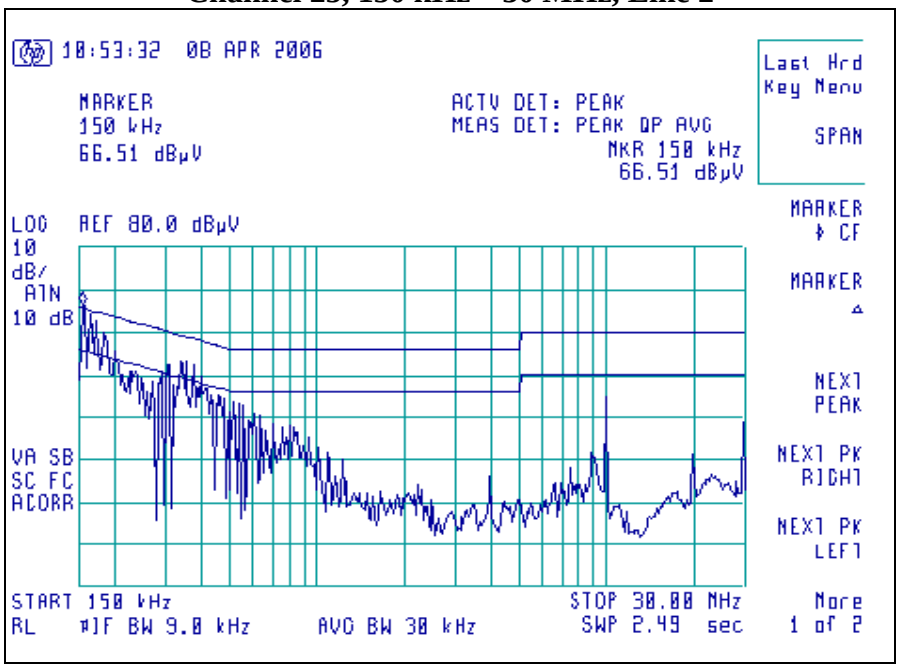
Please note these screen captures represent Peak Emissions. For conducted emission measurements, we utilize both a Quasi-Peak detector function as well as the Average detector function for measurements. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.209.

The signature scans shown here are from channel 25, chosen as being a good representative of channels.

Channel 25, 150 kHz – 30 MHz, Line 1



Channel 25, 150 kHz – 30 MHz, Line 2



11. Occupied Bandwidth

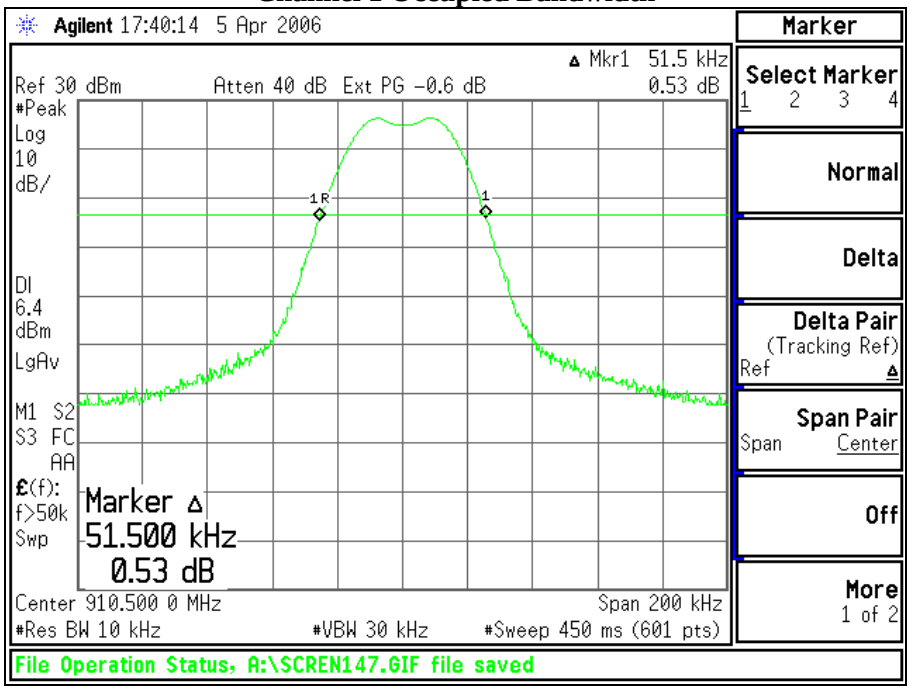
The 20 dB bandwidth requirement found in FCC Part 15.247(a)(1)(i) states a maximum allowed occupied bandwidth of 500 kHz. For this portion of the tests, a direct conducted measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4407B spectrum 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 51.5 kHz, which is below the maximum limit of 500 kHz.

Channel	Center Frequency (MHz)	Measured 20 dB BW (kHz)	Maximum Limit (kHz)
1 (low)	910.5	51.5	500
25 (middle)	918.8	51.1	500
50 (high)	927.5	51.5	500

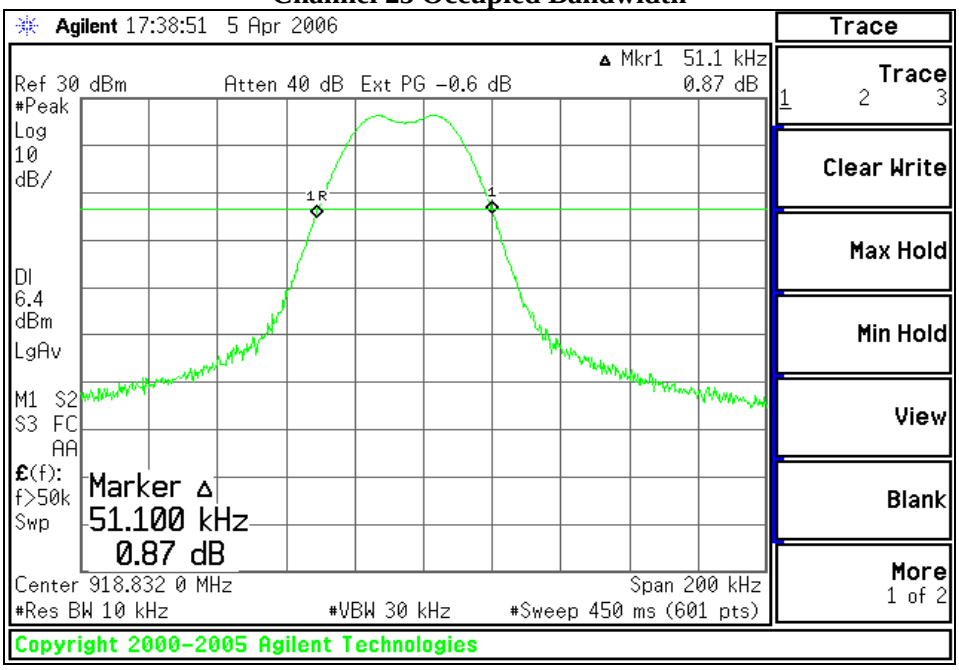
Plots of Occupied Bandwidth

Channel 1 Occupied Bandwidth

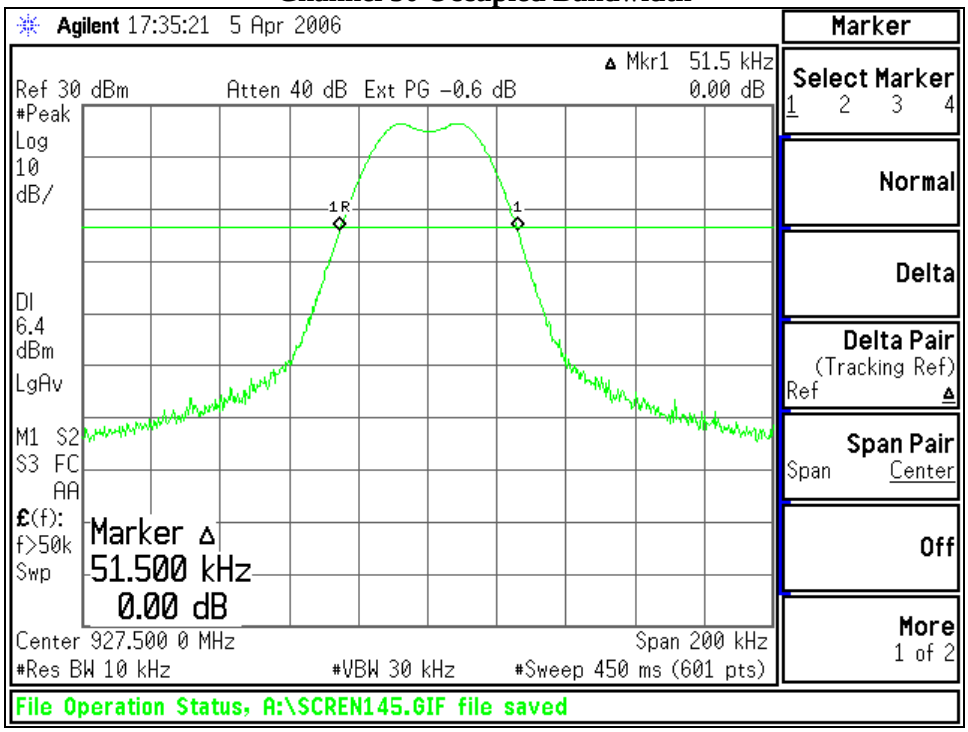


Plots of Occupied Bandwidth *(continued)*

Channel 25 Occupied Bandwidth



Channel 50 Occupied Bandwidth

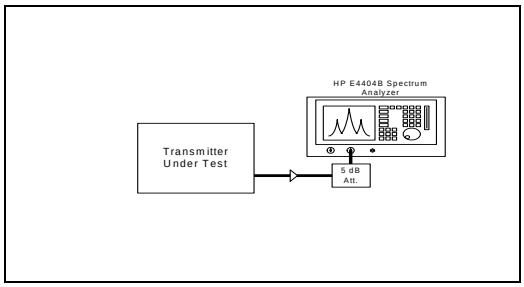


12. Power Output 15.247(b) (2)

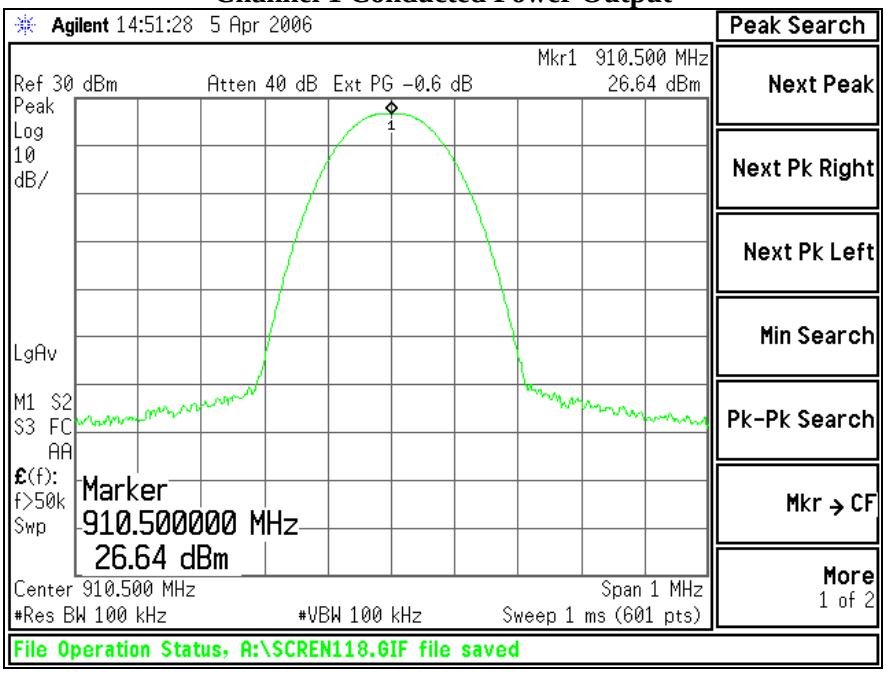
The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, there by allowing direct readings of the measurements 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 as a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 100 kHz, and a span of 1 MHz, with measurements from a peak detector presented in the chart below. RF Power Output was also monitored while varying the DC voltage as sourced by a DC wall/bench type power supply. No considerable variation in output power was seen while setting the DC voltage to 3.06 VDC (-15%) or to 4.14 VDC (+15%).

Rated Conducted RF power output (in watts): 0.47

CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
1 (Low)	910.5	30.0	+26.6 dBm	3.4
25 (Middle)	918.8	30.0	+26.6 dBm	3.4
50 (High)	927.5	30.0	+26.7 dBm	3.3

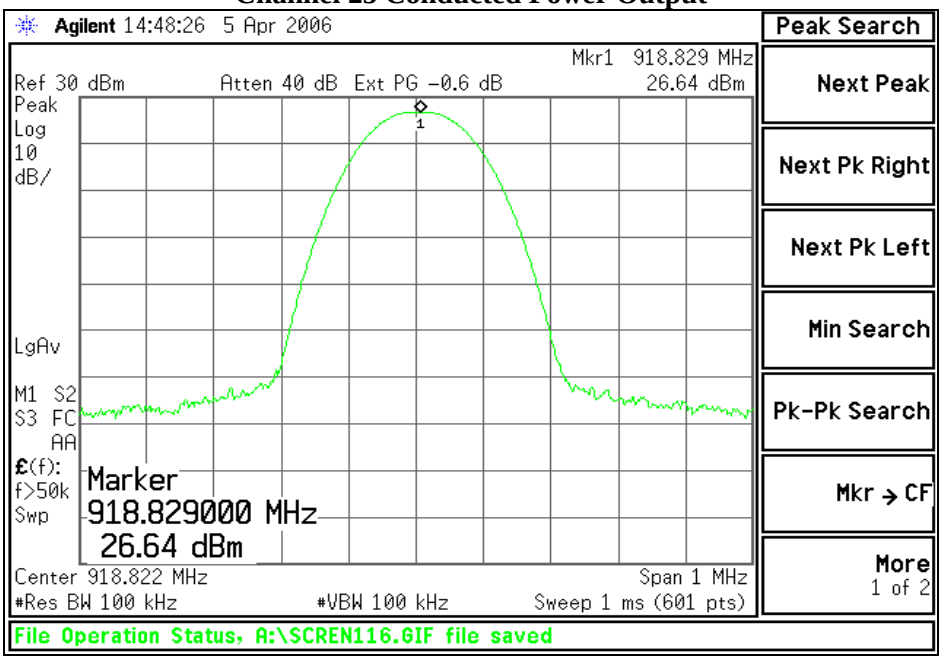


Channel 1 Conducted Power Output

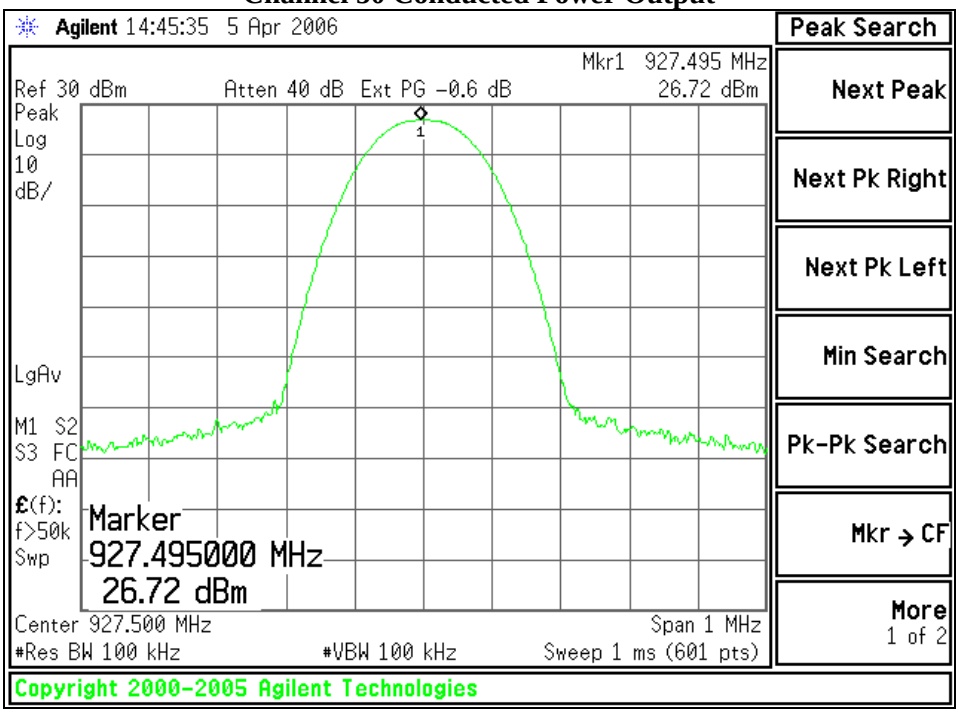


Screen Captures Conducted Power Output

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.

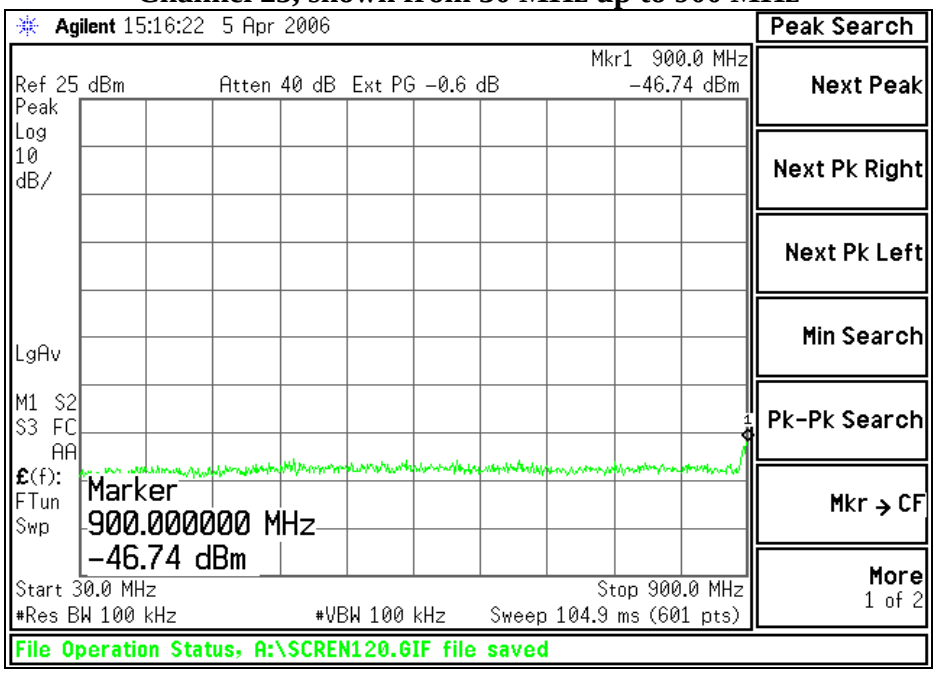
No significant emissions could be noted within -40 dBc of the fundamental level for this product.

	Channel 1	Channel 25	Channel 50	Limit
897/897/897 MHz	-36.0 (dBm)	-46.7 (dBm)	-45.8 (dBm)	-20 dBc
905/913/912 MHz	-26.7 (dBm)	-28.9 (dBm)	-38.8 (dBm)	-20 dBc
909/916/921 MHz	-29.3 (dBm)	-27.3 (dBm)	-31.4 (dBm)	-20 dBc
912/921/934 MHz	-28.1 (dBm)	-26.4 (dBm)	-32.4 (dBm)	-20 dBc
916/923/942 MHz	-25.7 (dBm)	-27.7 (dBm)	-40.0 (dBm)	-20 dBc
Fundamental	+ 26.6 (dBm)	+ 26.7 (dBm)	+ 26.8 (dBm)	Reference
2nd Harmonic	- 59.3 (dBm)	- 59.4 (dBm)	- 55.4 (dBm)	-20 dBc
3rd Harmonic	- 75.5 (dBm)	- 73.7 (dBm)	- 74.4 (dBm)	-20 dBc
4th Harmonic	- 79.0 (dBm)	- 72.3 (dBm)	- 78.5 (dBm)	-20 dBc
5th Harmonic	- 77.2 (dBm)	- 75.7 (dBm)	- 71.5 (dBm)	-20 dBc
6th Harmonic	- 80.3 (dBm)	- 82.3 (dBm)	- 77.5 (dBm)	-20 dBc
7th Harmonic	- 71.0 (dBm)	- 66.4 (dBm)	- 60.3 (dBm)	-20 dBc
8th Harmonic	- 58.1 (dBm)	- 56.1 (dBm)	- 58.3 (dBm)	-20 dBc
9th Harmonic	- 70.7 (dBm)	- 70.1 (dBm)	- 71.5 (dBm)	-20 dBc
10th Harmonic	- 78.0 (dBm)	- 78.2 (dBm)	- 74.3 (dBm)	-20 dBc

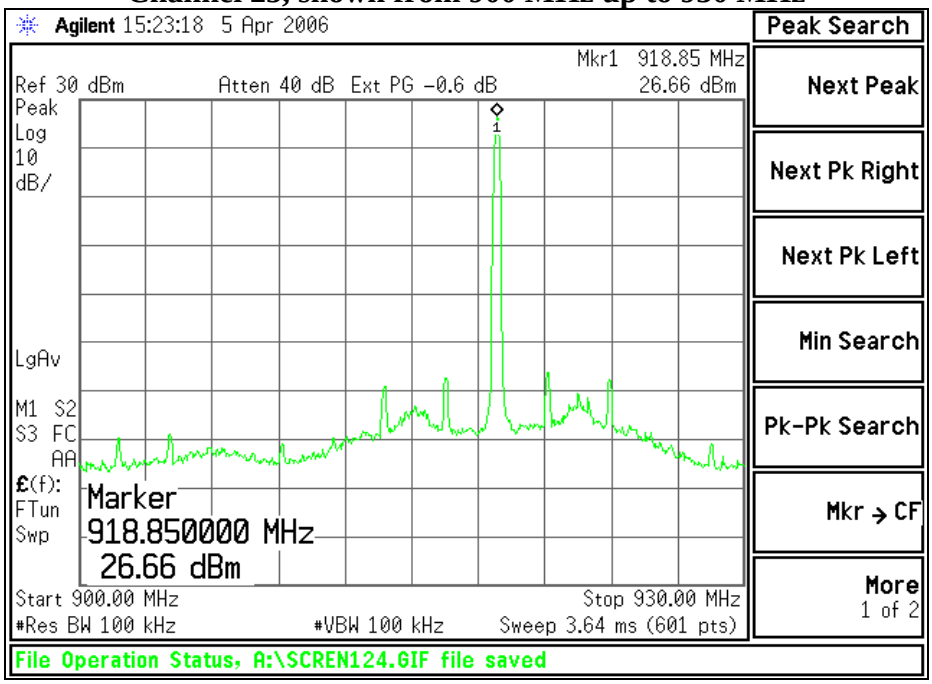
Notes:
(1) Measurement at system noise floor.

Plots of Conducted Spurious and Fundamental Levels

Channel 25, shown from 30 MHz up to 900 MHz

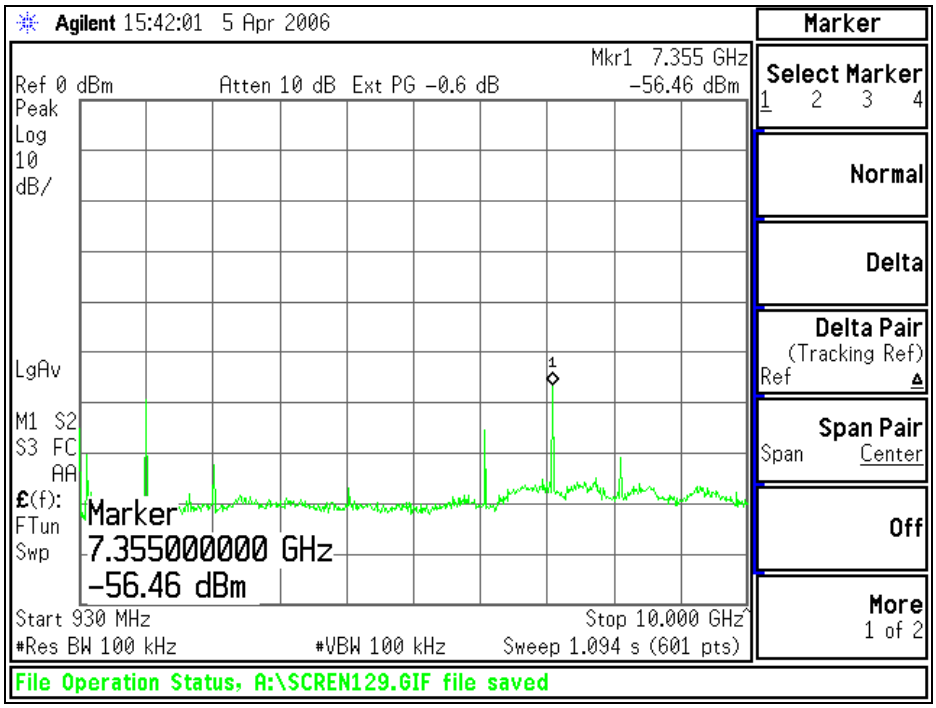


Channel 25, shown from 900 MHz up to 930 MHz



Plots of Conducted Spurious and Fundamental Levels *(continued)*

Channel 25, shown from 930 MHz up to 10,000 MHz



14. Minimum Channel Separation

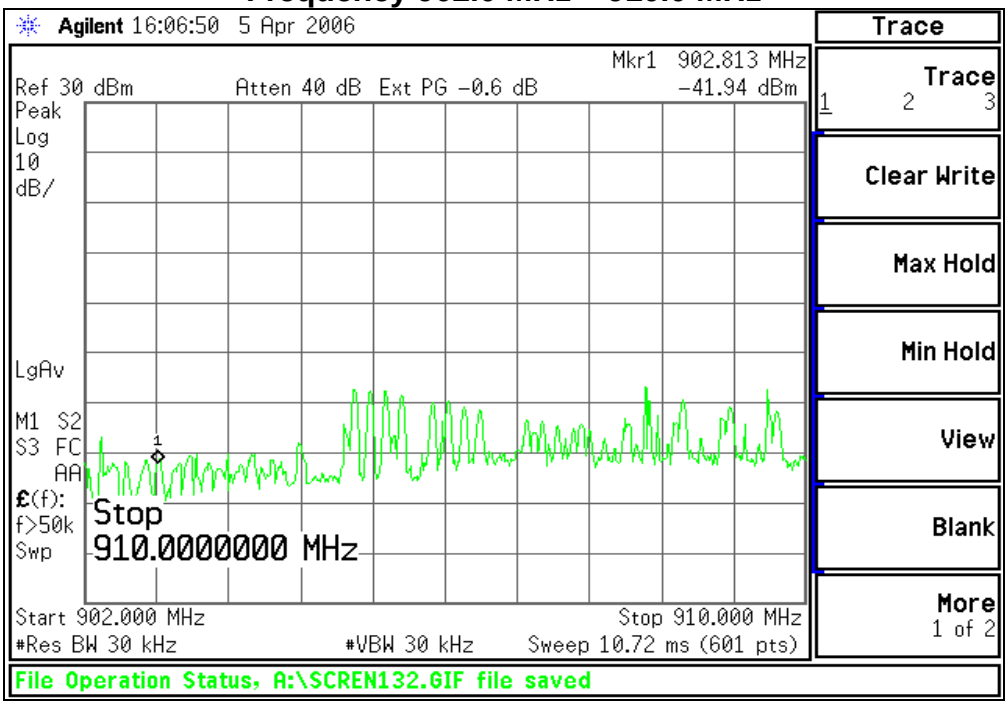
Part 15.247(a)(1) requires a minimum channel separation of 25 kHz or the equivalent of the 20 dB occupied bandwidth of the fundamental transmission, whichever is greater. An HP E4407B spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT.

The minimum and maximum channel-separations measured for this device are 341 kHz and 350 kHz respectively. The maximum occupied bandwidth of the device, as reported in the previous section is 51.5 kHz. The minimum channel separation for the EUT exceeds both the 25 kHz criteria and the 20 dB occupied bandwidth criteria, and hence meets the requirements. The following plots describe this spacing, and also establish the number of hop channels, total of 50.

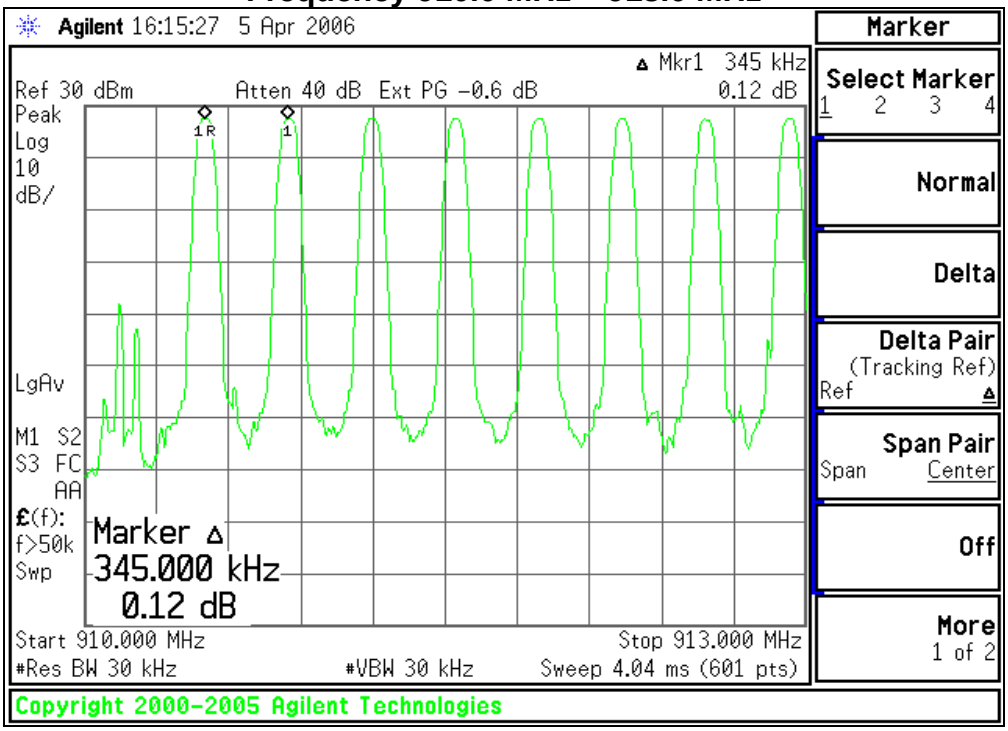
Frequency Span	Number of Channels	Minimum Separation (kHz)
902.0 – 910.0	0	N/A
910.0 – 913.0	8	345
913.0 – 916.0	8	345
916.0 – 919.0	9	345
919.0 – 921.0	6	343
921.0 – 923.8	8	350
923.8- 926.6	8	341
926.6 – 928.0	3	346

Plots of Channel Separations
Hop Mode Verification of 50 Channels

Frequency 902.0 MHz – 910.0 MHz

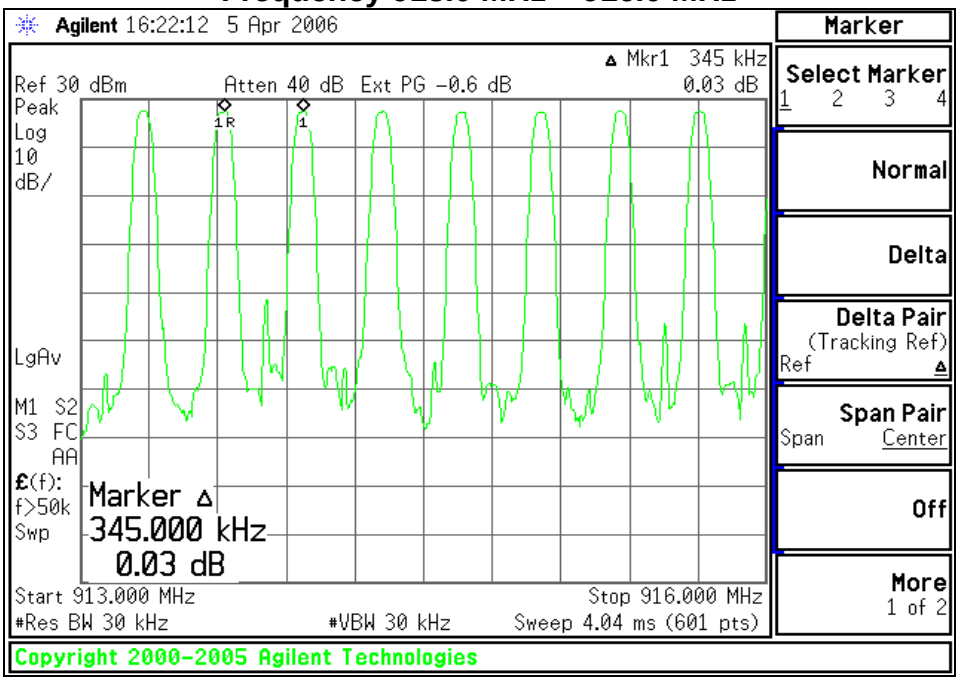


Frequency 910.0 MHz – 913.0 MHz

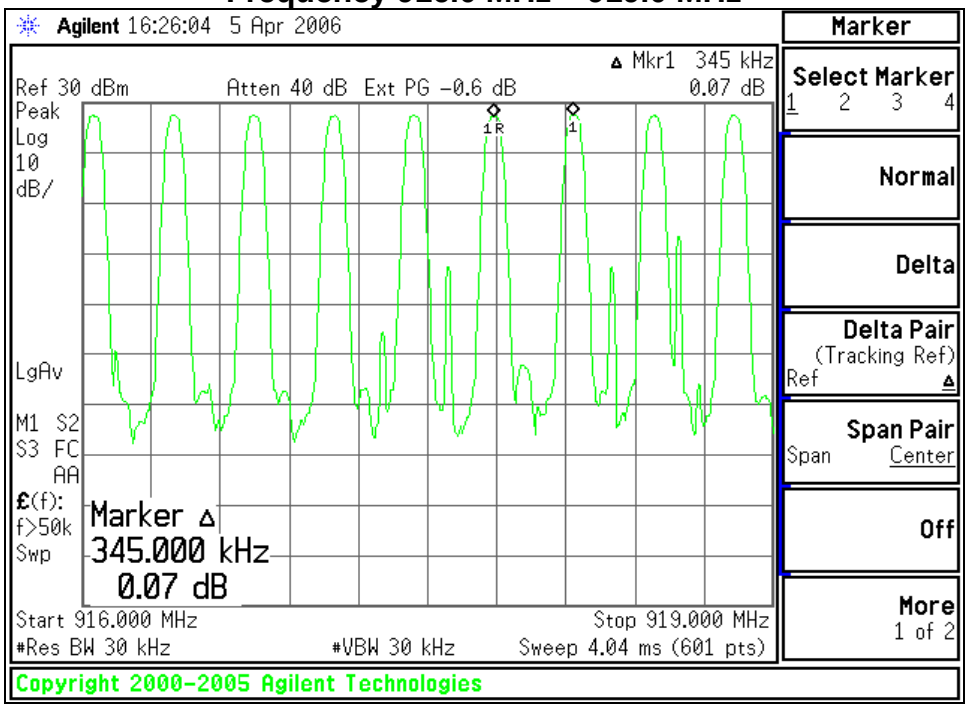


Plots of Channel Separations *(continued)*
Hop Mode Verification of 50 Channels

Frequency 913.0 MHz – 916.0 MHz

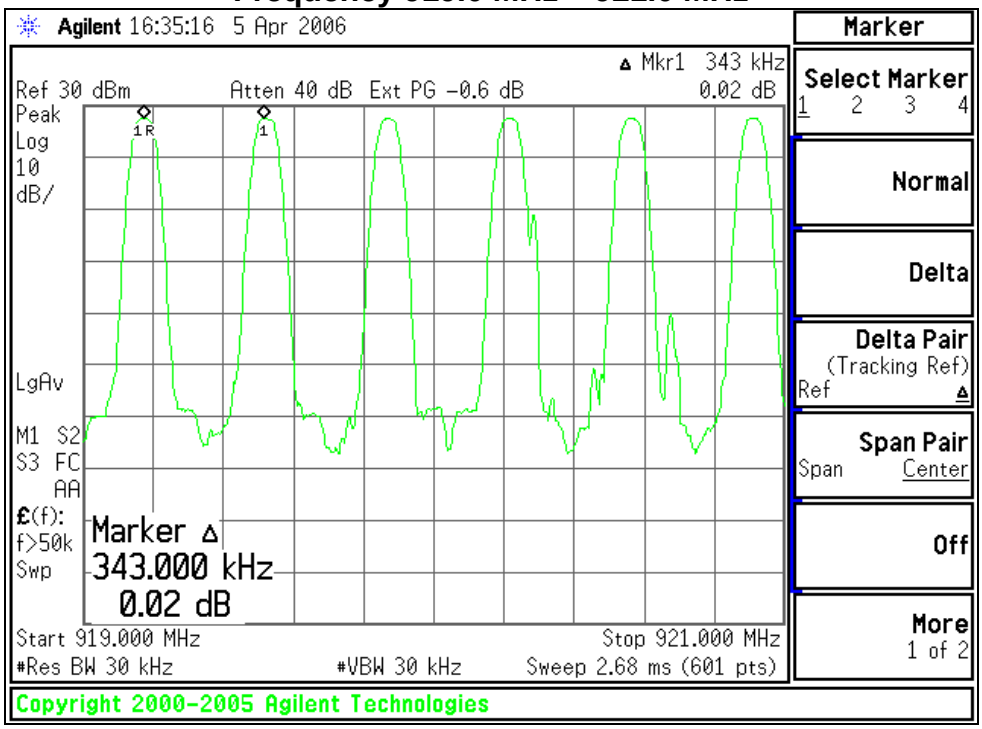


Frequency 916.0 MHz – 919.0 MHz

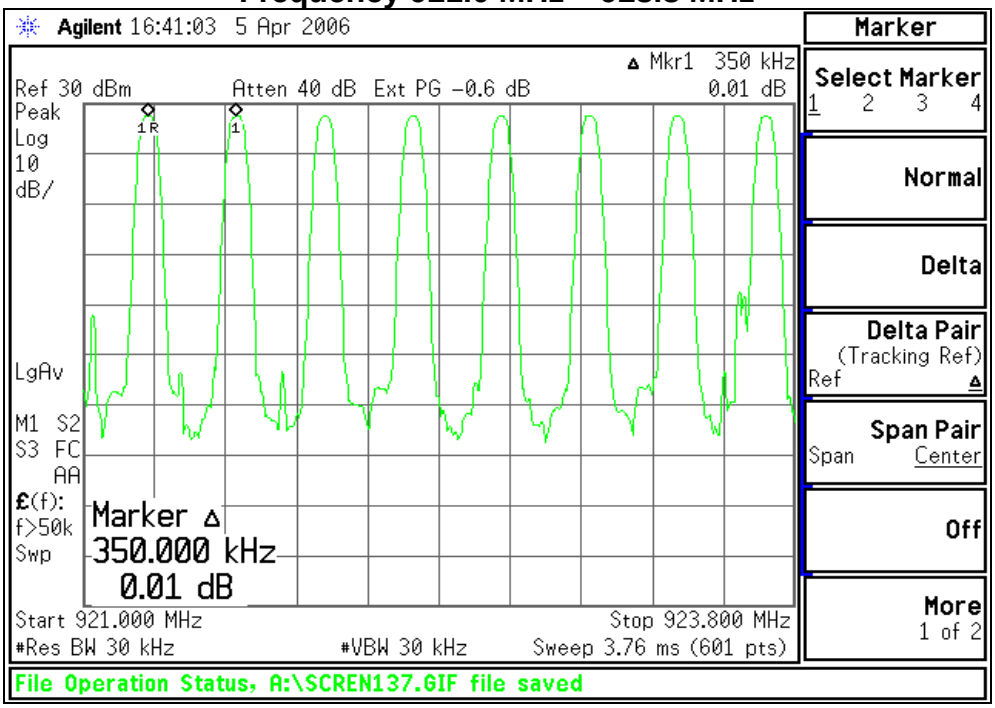


Plots of Channel Separations *(continued)*
Hop Mode Verification of 50 Channels

Frequency 919.0 MHz – 921.0 MHz

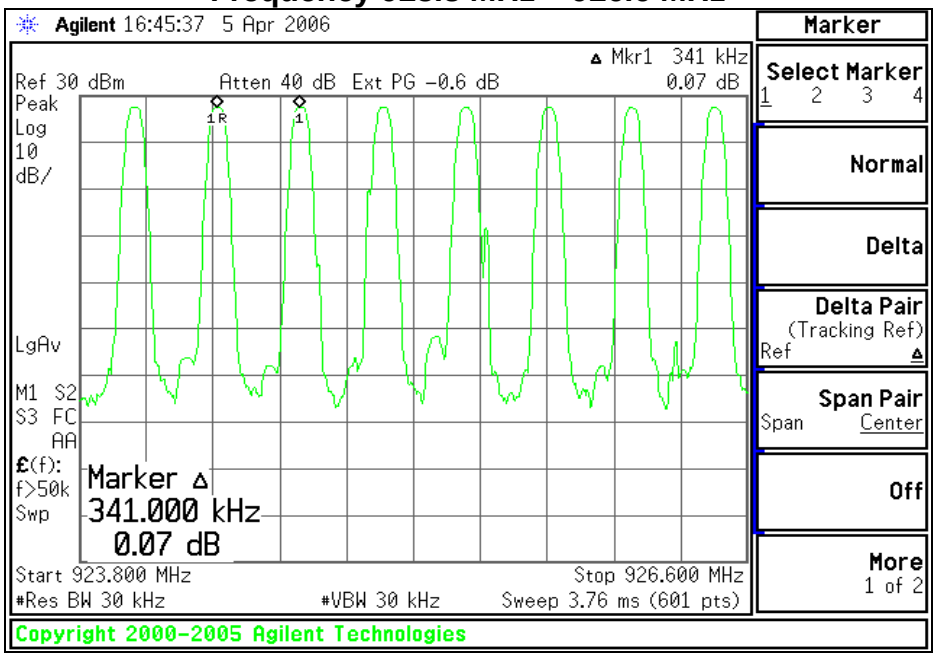


Frequency 921.0 MHz – 923.8 MHz

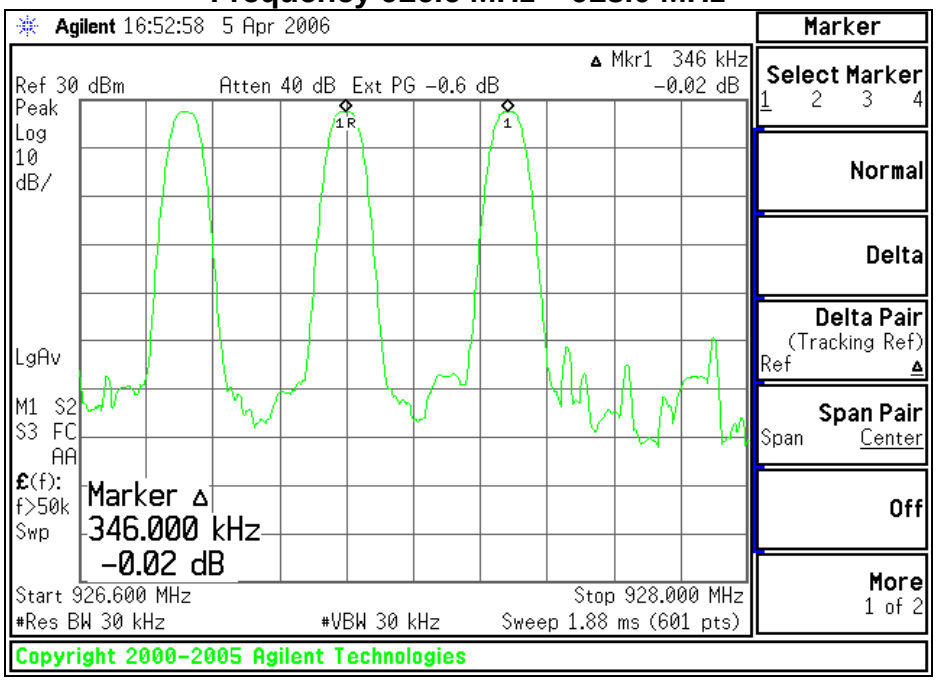


Plots of Channel Separations *(continued)*
Hop Mode Verification of 50 Channels

Frequency 923.8 MHz – 926.6 MHz



Frequency 926.6 MHz – 928.0 MHz



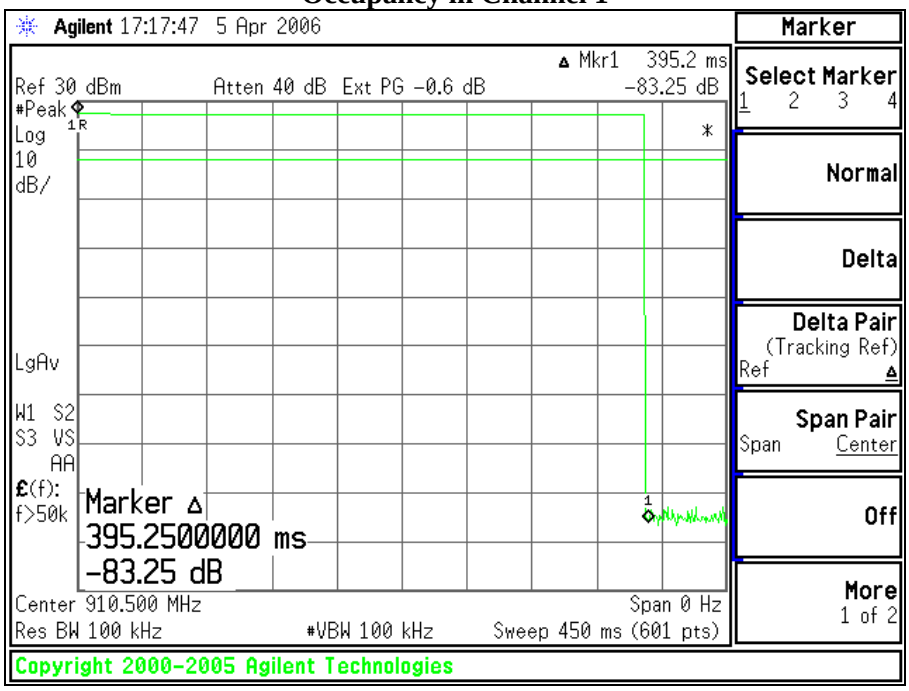
15. Channel Occupancy

Part 15.247(a)(1) requires a channel occupancy, for this device, of no more than 400 milliseconds in a 20 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 395.2 ms. Due to the 395.2 ms transmission, the device is allowed to transmit only once on a channel in a given 20 second window.

Channel	Frequency (MHz)	Occupancy Per transmission (ms)	Occupancy in 400 ms window (ms)
1 (Low)	910.5	395.2	395.2
25 (middle)	918.8	393.8	393.8
50 (High)	927.5	394.5	394.5

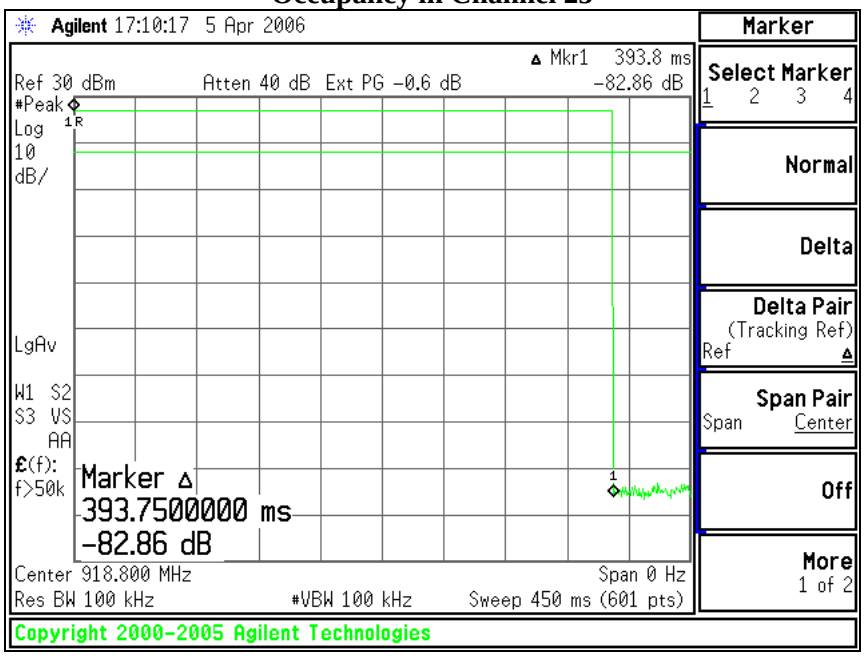
Plots of Channel Occupancy

Occupancy in Channel 1

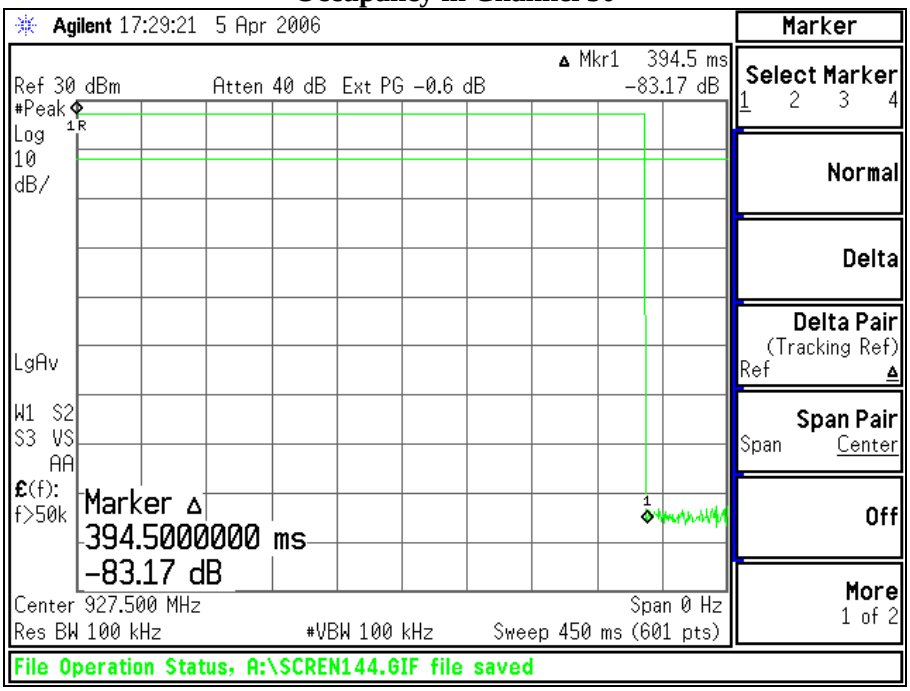


Plots of Channel Occupancy *(continued)*

Occupancy in Channel 25

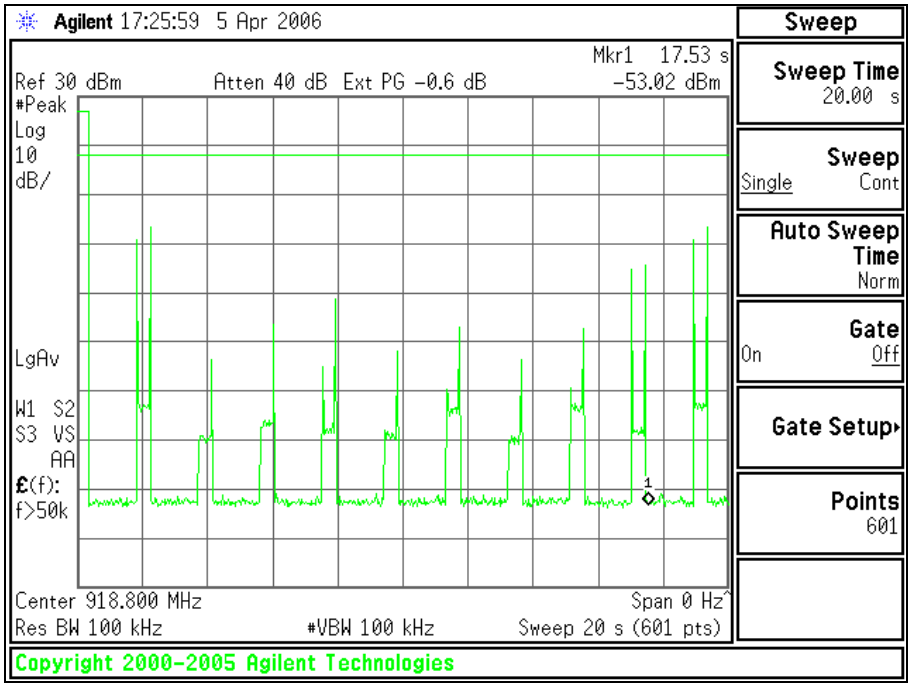


Occupancy in Channel 50



Plots of Channel Occupancy *(continued)*

Occupancy on Channel 25 in a 20 second window, demonstrating 5 cycles in 20 seconds.



16. Frequency and Power Stability requirements

A Spectrum Analyzer was used to measure the frequency at the appropriate frequency markers with the transmitter portion of the EUT placed in modulated continuous transmit mode. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer.

The output power was measured with a receiver resolution bandwidth of 1 MHz, and a video bandwidth of 1 MHz.

	DC Voltage Source		
	3.06 V	3.60 V	4.14 V
Channel 1	25.1 (dBm)	26.6 (dBm)	27.5 (dBm)
Channel 25	25.2 (dBm)	26.6 (dBm)	27.6 (dBm)
Channel 50	25.2 (dBm)	26.7 (dBm)	27.6 (dBm)

The frequency was measured with a receiver resolution bandwidth of 1 kHz and video bandwidth of 1 kHz.

	DC Voltage Source		
	3.06 V	3.60 V	4.14 V
Channel 1	910.50017 (MHz)	910.50033 (MHz)	910.50042 (MHz)
Channel 25	918.82658 (MHz)	918.82675 (MHz)	918.82667 (MHz)
Channel 50	927.50033 (MHz)	927.50050 (MHz)	927.50058 (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 same state of operation as before the power cycle.

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, varying +0.9/+1.5 dB during the voltage variation tests.

The information on this page is provided by the manufacturer.

17. 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

18. 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

19. 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.

20. 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:	26.70	(dBm)
Maximum peak output power at antenna input terminal:	467.735	(mW)
Antenna gain(typical):	2.57	(dBi)
Maximum antenna gain:	1.807	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	918.8	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.62	(mW/cm^2)
Power density at prediction frequency:	0.168163	(mW/cm^2)
Maximum allowable antenna gain:	8.2	(dBi)
Margin of Compliance at 20 cm =	5.7	dB

Appendix A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	9/27/05	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

Appendix B

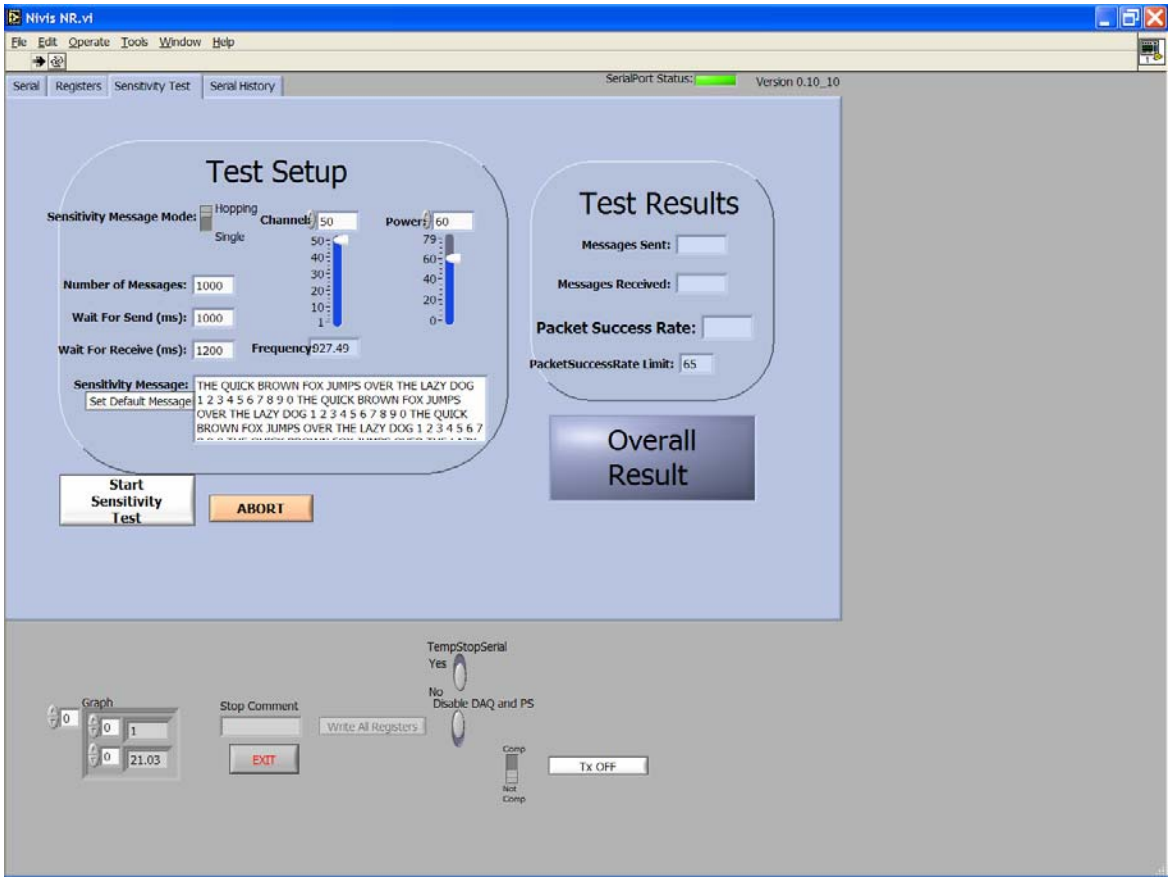
Antenna Specification

Antenna Data Sheets provided separately with FCC filing documentation.

Appendix C

Firmware and Setup Instructions

GUI Setup for Frequency Hopping Test Mode



GUI Setup for Continuous Transmit Test Modes