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

COMPLIANCE TESTING OF:

Focus RF Module

Prepared For:

Nivis, Incorporated
Attention: Mr. Trae Harrison
900 Circle 75 Parkway, Suite 1700
Atlanta, GA 30339

Test Report Number:

305170-Tx-v0

Test Dates:

November 10TH Through November 14TH, 2005

Table of Contents

1. L. S. Compliance In Review

L.S. Compliance - Accreditations and Listing's

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

A2LA – American Association for Laboratory Accreditation

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

Federal Communications Commission (FCC) – USA

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

Industry Canada

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

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

U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 89/336/EEC, Article 10.2.
Date of Validation: January 16, 2001

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

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

2. A2LA Certificate of Accreditation

THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

L.S. COMPLIANCE, INC.
Cedarburg, WI

for technical competence in the field of

Electrical Testing

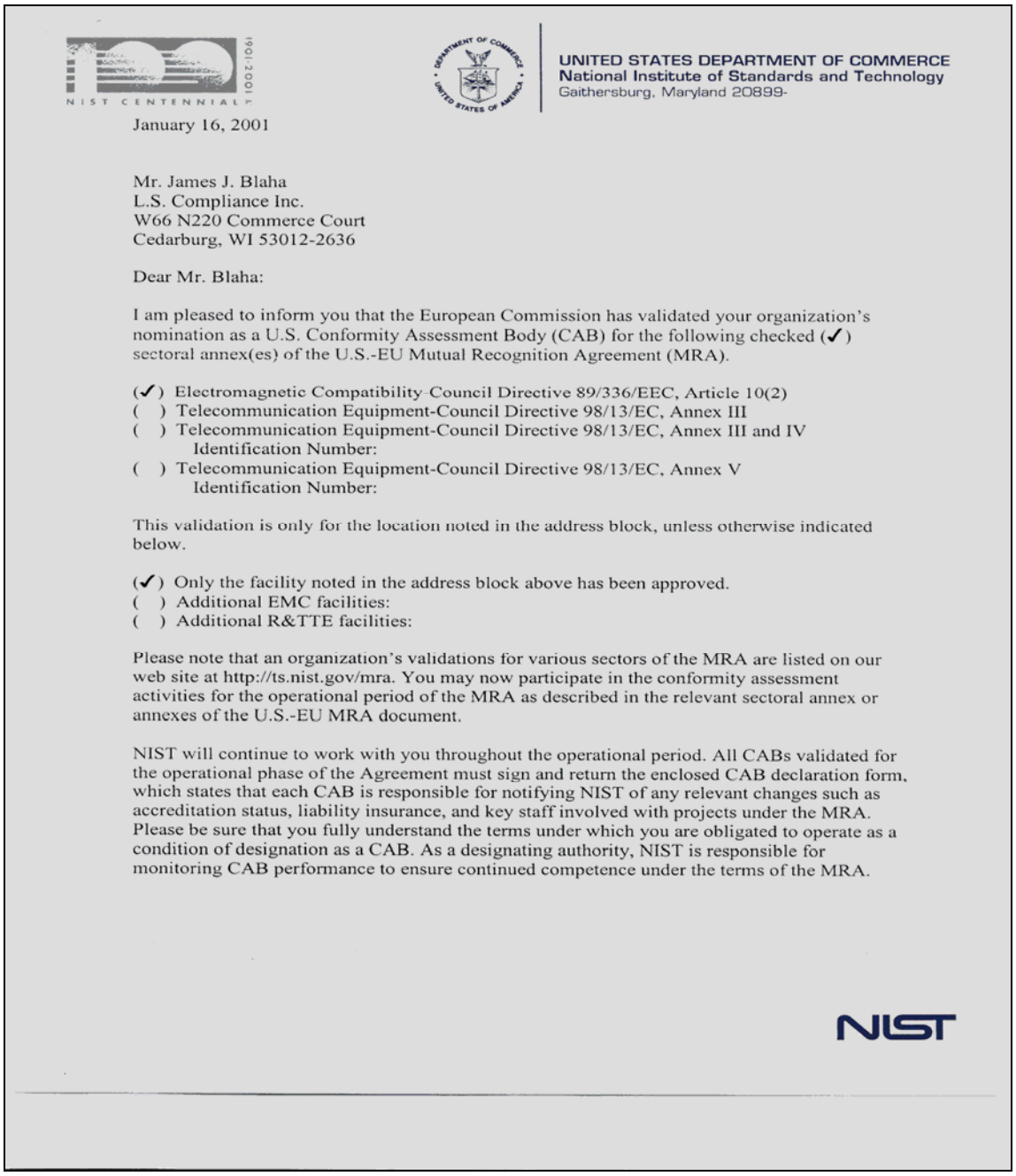
The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC 17025 - 1999 "General Requirements for the Competence of Testing and Calibration Laboratories" and any additional program requirements in the identified field of testing.

Presented this 29th day of April 2005.

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

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

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



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

January 16, 2001

Mr. James J. Blaha
L.S. Compliance Inc.
W66 N220 Commerce Court
Cedarburg, WI 53012-2636

Dear Mr. Blaha:

I am pleased to inform you that the European Commission has validated your organization's nomination as a U.S. Conformity Assessment Body (CAB) for the following checked (✓) sectoral annex(es) of the U.S.-EU Mutual Recognition Agreement (MRA).

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

This validation is only for the location noted in the address block, unless otherwise indicated below.

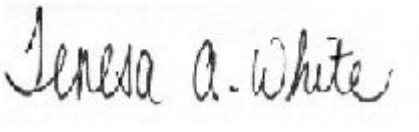
(✓) Only the facility noted in the address block above has been approved.
( ) Additional EMC facilities:
( ) Additional R&TTE facilities:

Please note that an organization's validations for various sectors of the MRA are listed on our web site at http://ts.nist.gov/mra. You may now participate in the conformity assessment activities for the operational period of the MRA as described in the relevant sectoral annex or annexes of the U.S.-EU MRA document.

NIST will continue to work with you throughout the operational period. All CABs validated for the operational phase of the Agreement must sign and return the enclosed CAB declaration form, which states that each CAB is responsible for notifying NIST of any relevant changes such as accreditation status, liability insurance, and key staff involved with projects under the MRA. Please be sure that you fully understand the terms under which you are obligated to operate as a condition of designation as a CAB. As a designating authority, NIST is responsible for monitoring CAB performance to ensure continued competence under the terms of the MRA.

NIST

4. Signature Page



Prepared By: December 2, 2005

Teresa A. White, Document Coordinator Date

Tested By: December 2, 2005

Abtin Spantman, EMC Engineer Date

Approved By: December 2, 2005

Brian E. Petted, VP of Engineering Date

5. Product and General Information

Manufacturer:	Nivis Incorporated					
Date(s) of Test:	November 10TH through November 14TH, 2005					
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	Focus RF Module Board					
Serial #:	3AC5, 3A51 and 3AC9					
Voltage:	3.6 VDC					
Operation Mode:	Normal, continuous transmit, and 'Hopping' mode					

6. Introduction

Between November 10TH and November 14TH, 2005, a series of Conducted and Radiated RF Emission tests were performed on three samples of the Nivis RF modules, Model type "Focus RF Module", Serial Numbers: 3AC5 (coded for test modes), 3AC9 and 3A51 (coded for frequency hopping communication), here forth collectively referred to as the "*Equipment Under Test*" or "*EUT*". These tests were performed using the procedures outlined in ANSI C63.4-2003 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.247 (Industry Canada RSS-210) for a low power transmitter. These tests were performed by Abtin Spantman, EMC Engineer of L.S. Compliance, Incorporated.

All Radiated and Conducted RF Emission tests were performed upon the EUT to measure the emissions in the frequency bands described in 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.

7. Product Description

The Nivis "Focus Module" is a modular transceiver radio designed to operate as a Modem in electric meter applications. This module will use an external antenna to communicate with a network of electric meters and other Modem devices. The transceiver module is designed to operate as a frequency-hopper on 50 channels, with FSK type modulation, 9.9 kHz deviation, in the 902-928 MHz ISM band, with a nominal RF output power of 400 mW. The module operates on 3.6 VDC, 500 mA, and transfers NRZ raw data at a baud rate of 9600. During the testing, the "Focus Module" was programmed for the desired modes by proprietary GUI software and a laptop PC through an RS-232 link using a programming fixture board, then removed from the programming fixture and tested as a stand-alone module with only DC power supplied to the module.

Top and Bottom view of the Nivis Focus RF Module

Top view of the RS-232 programming and interface fixture.

8. Test Requirements

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

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

9. Summary of Test Report

DECLARATION OF CONFORMITY

The Nivis "Focus RF 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 FSK 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.

10. Radiated Emissions Test

Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.4-2003. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous transmit mode, with modulation from typical data, using 3.6 VDC, 500 mA power as provided by an external DC power supply. The unit has the capability to operate on 50 channels, controlled during testing 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 (Ch:01; 910.50 MHz), middle (Ch:25 ; 918.82 MHz) and high (Ch:50 ; 927.49 MHz) to comply with FCC Part 15.35.

Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 10000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

The EUT was 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 a HP 8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the HP 8546A EMI Receiver database. As a result, the data taken from the HP 8546A EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The HP 8546A EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz).

Test Results

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

CALCULATION OF RADIATED EMISSIONS LIMITS

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

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

Frequency (MHz)	3 m Limit (μV/m)	3 m Limit (dBμV/m)	1 m Limit (dBμV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-25,000	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:

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

Radiated Emissions Data Chart

Test Standard: 47CFR, Part 15.205 and 15.247(FHSS)

Frequency Range Inspected: 30 MHz to 10000 MHz

Manufacturer:	Nivis Incorporated								
Date(s) of Test:	November 10TH through November 14TH, 2005								
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston			
Model #:	Focus RF Module Board								
Serial #:	3AC5, 3A51 and 3AC9								
Voltage:	3.6 VDC								
Operation Mode:	Normal, continuous transmit, and 'Hopping' mode								
EUT Power:		Single Phase ___VAC				3 Phase ___VAC			
		Battery			√	Other: Bench DC Power Supply			
EUT Placement:	√	80cm non-conductive table				10cm Spacers			
EUT Test Location:	√	3 Meter Semi-Anechoic FCC Listed Chamber				3/10m OATS			
Measurements:		Pre-Compliance		Preliminary		Final			
Detectors Used:		Peak	√	Quasi-Peak	√	Average			

Environmental Conditions in the Lab:
Temperature: 20 – 25°C
Relative Humidity: 30 – 60 %

Test Equipment Used:
EMI Measurement Instrument: HP8546A and Agilent E4407B
Log Periodic Antenna: EMCO #93146
Horn Antenna: EMCO #3115
Biconical Antenna: EMCO 93110

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

Frequency (MHz)	Antenna Polarity	Channel	Height (meters)	Azimuth (0° - 360°)	Measured ERP (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
893.9	H	01	1.00	275	51.8	105.9	54.1
897.6	H	01	1.00	275	60.7	105.9	45.2
934.2	H	50	1.55	290	62.8	106.6	43.8
935.6	H	50	1.55	290	55.1	106.6	51.5
942.3	H	50	1.55	290	53.6	106.6	53.0
960.2	H	50	1.55	290	42.6	54.0	11.4

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 ERP (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
910.5	H	1.00	275	125.9	131.2	5.3
1821	H	1.05	140	41.3	105.9	64.6
2731	V	1.00	100	42.4	54.0 (Note 4)	11.6
3642	H	1.15	150	44.4	54.0 (Note 4)	9.6
4553	H	1.45	315	51.9	54.0 (Note 4)	2.1
5463	H	1.15	270	58.6	115.4	56.8
6347	H	1.10	90	55.1	115.4	60.3
7284	H	1.05	100	53.5	63.5 (Note 4)	10.0
8195	H	1.00	275	46.5 (Note 3)	63.5 (Note 4)	17.0
9105	H	1.00	275	53.5	63.5 (Note 4)	10.0

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

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured ERP (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
918.8	H	1.60	290	126.7	131.2	4.5
1838	H	1.10	300	38.9	106.7	67.8
2756	V	1.00	90	40.8	54.0 (Note 4)	13.2
3675	H	1.25	140	44.9	54.0 (Note 4)	9.1
4594	H	1.75	290	51.6	54.0 (Note 4)	2.4
5513	H	1.15	270	57.2	116.2	59.0
6432	H	1.10	90	52.9	116.2	63.3
7351	H	1.00	100	54.5	63.5 (Note 4)	9.0
8270	H	1.05	275	48.7	63.5 (Note 4)	14.8
9188	H	1.00	275	55.0	63.5 (Note 4)	8.5

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

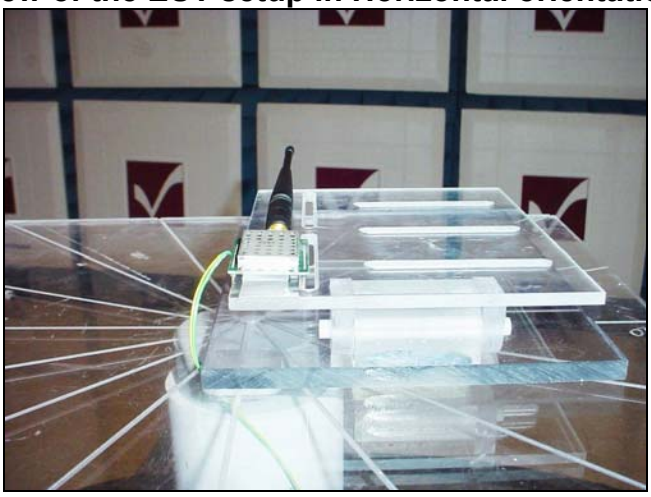
Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured ERP (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
927.5	H	1.55	290	126.6	131.2	4.6
1855	H	1.05	280	37.2	106.6	69.4
2783	V	1.00	95	39.5	54.0 (Note 4)	14.5
3710	H	1.50	140	43.5	54.0 (Note 4)	10.5
4638	H	1.25	330	50.8	54.0 (Note 4)	3.2
5565	H	1.15	270	56.0	116.1	60.1
6493	H	1.15	90	52.1	116.1	64.0
7420	H	1.00	100	56.1	63.5 (Note 4)	7.4
8347	H	1.00	275	48.8	63.5 (Note 4)	14.7
9275	H	1.00	275	57.9	116.1	58.2

Notes:

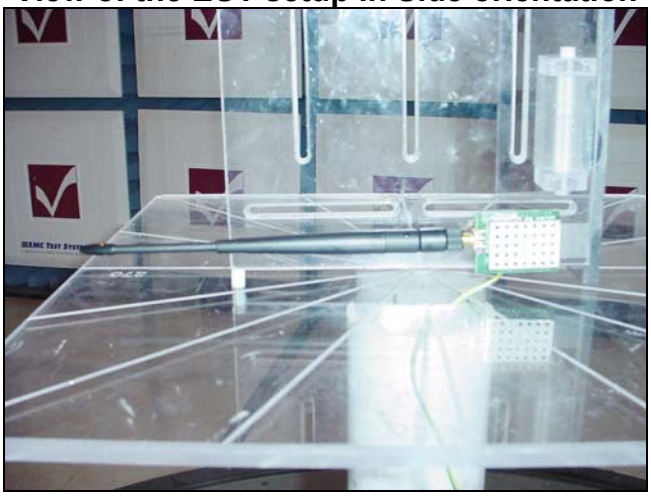
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. Only the results from the Average detector are published in the table above. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
2) Measurements above 5 GHz were made at 1 meters of separation from the EUT.
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.

View of the EUT setup in vertical orientation

View of the EUT setup in Horizontal orientation



View of the EUT setup in Side orientation



View of the EUT setup in Vertical orientation on the test pedestal.

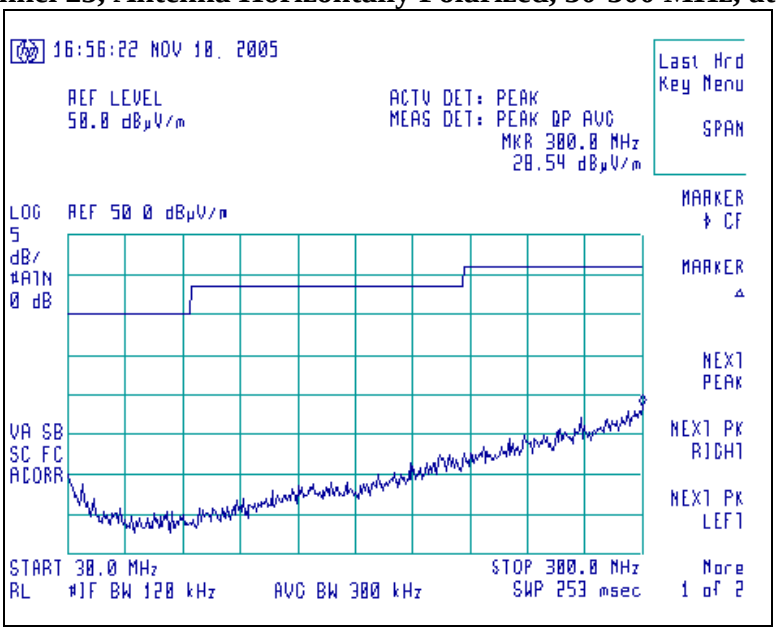
Graphs made during Radiated Emission Testing

Screen Captures of Radiated RF Emissions:

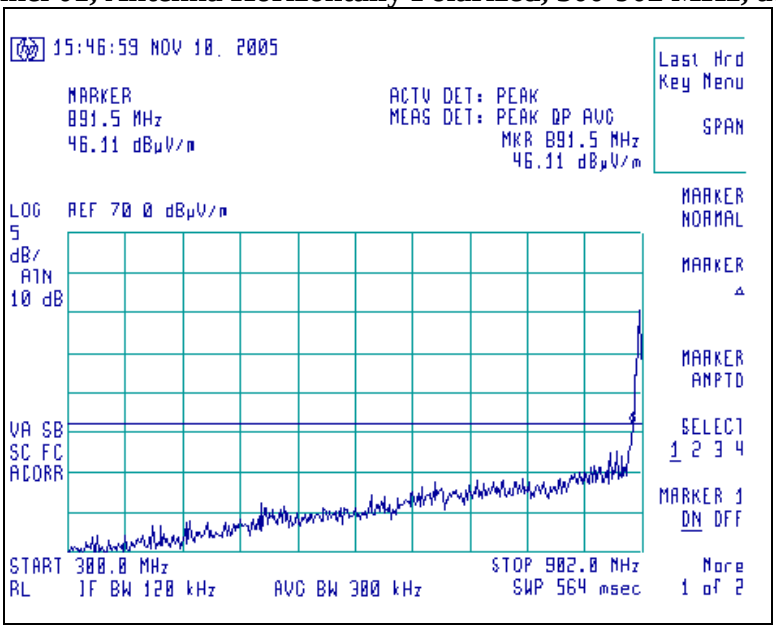
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 01, 25 or 50 with the sense and EUT antennas both in vertical polarity for worst case presentations.

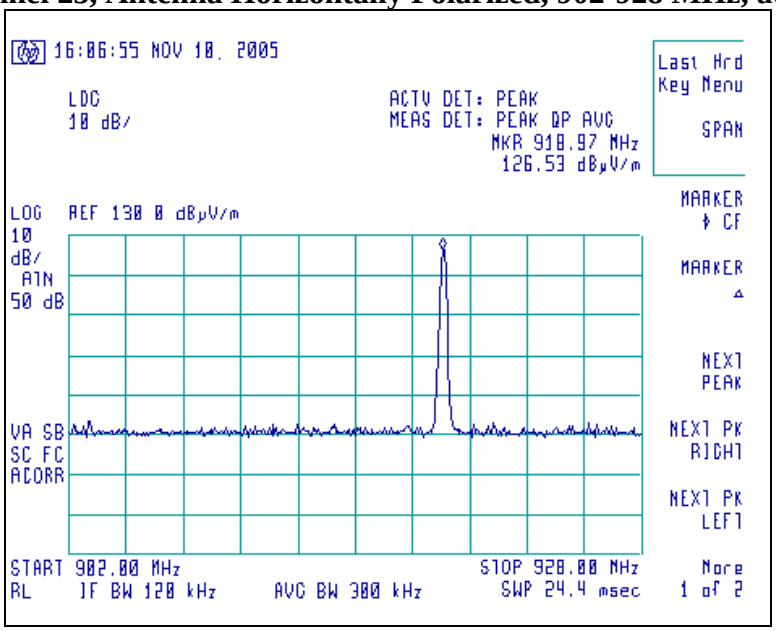
Channel 25, Antenna Horizontally Polarized, 30-300 MHz, at 3m.



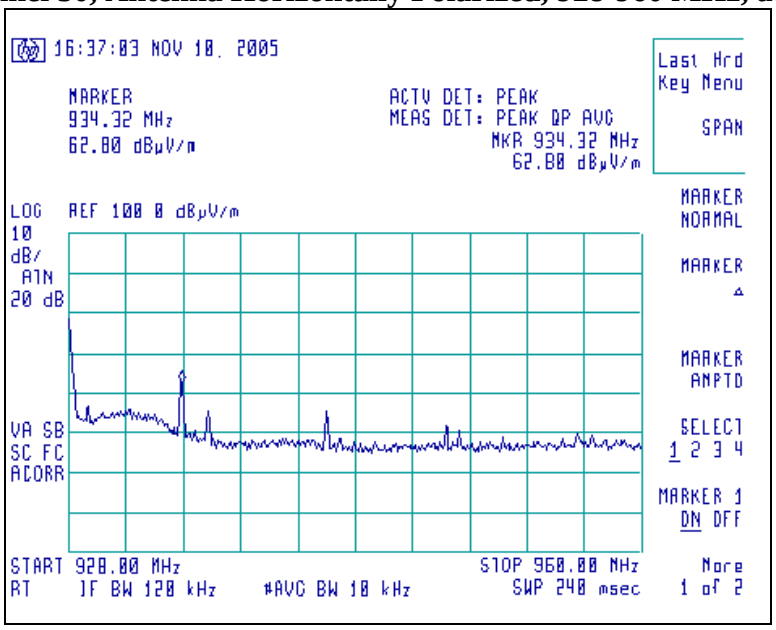
Channel 01, Antenna Horizontally Polarized, 300-902 MHz, at 3m.



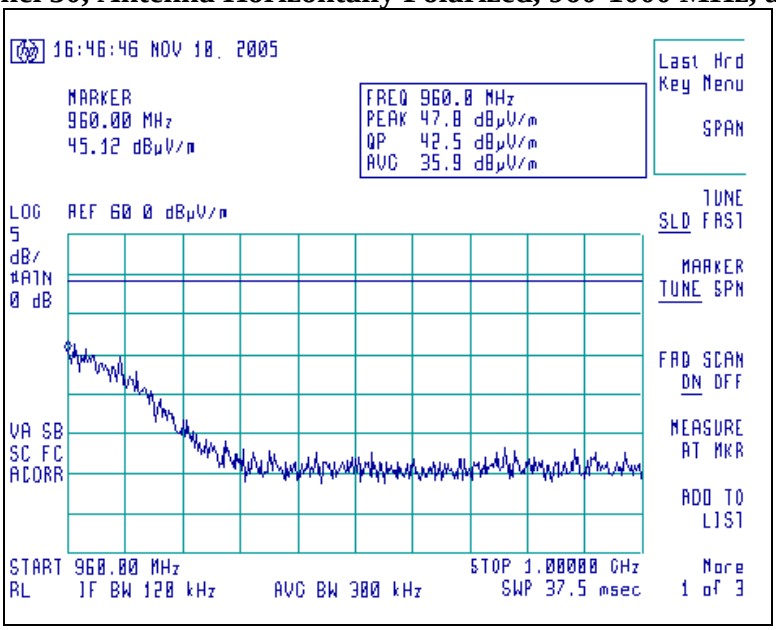
Channel 25, Antenna Horizontally Polarized, 902-928 MHz, at 3m.



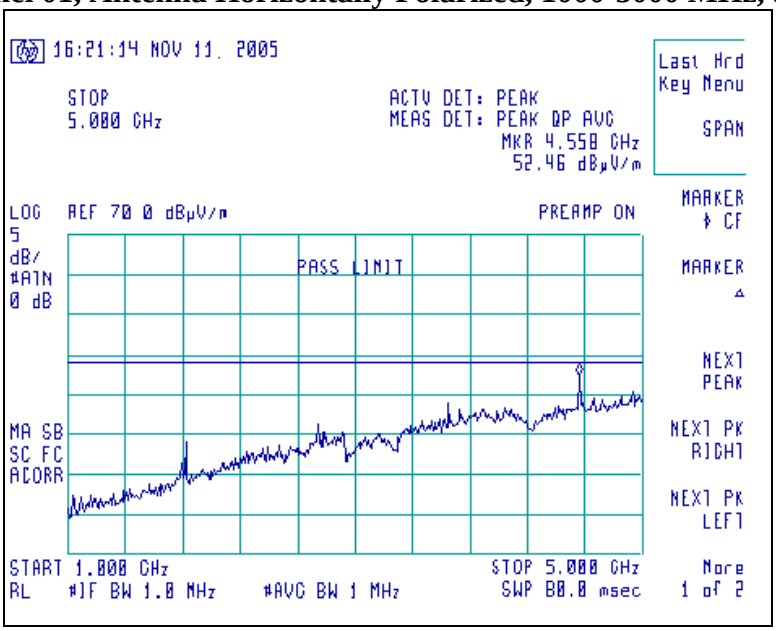
Channel 50, Antenna Horizontally Polarized, 928-960 MHz, at 3m.



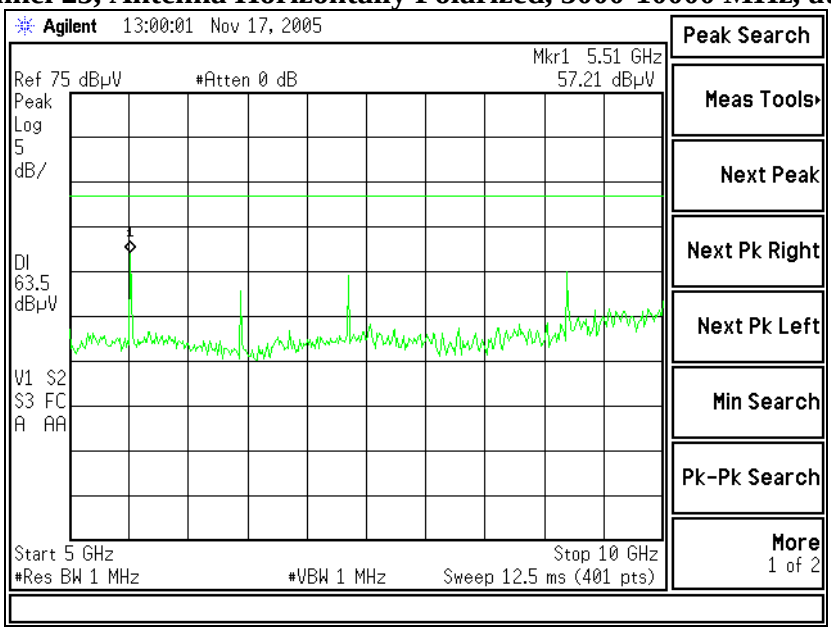
Channel 50, Antenna Horizontally Polarized, 960-1000 MHz, at 3m.



Channel 01, Antenna Horizontally Polarized, 1000-5000 MHz, at 3m.



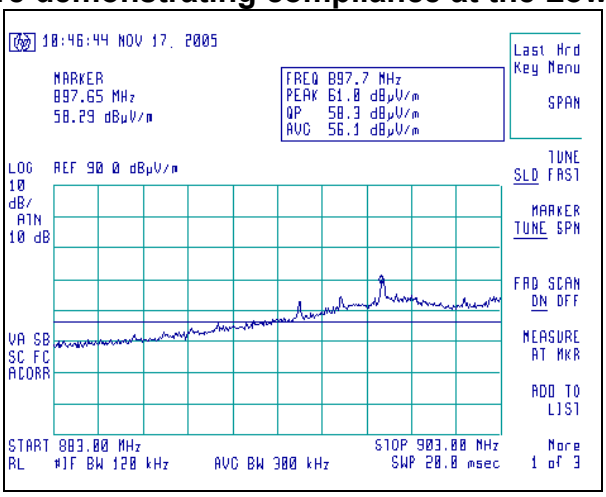
Channel 25, Antenna Horizontally Polarized, 5000-10000 MHz, at 3m.



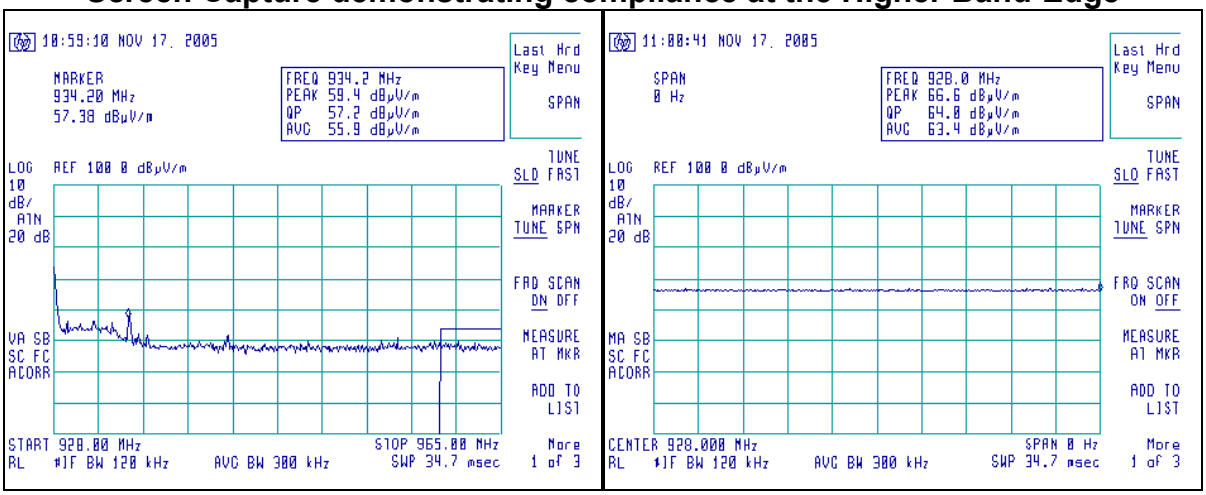
11. Band-Edge Measurements

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



12. 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 inside the 3 Meter Semi-Anechoic Chamber via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the HP 8546A EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

Test Procedure

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

Test Equipment Utilized

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

Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

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 Incorporated					
Date(s) of Test:	November 10TH through November 14TH, 2005					
Test Engineer:		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	Focus RF Module Board					
Serial #:	3AC5, 3A51 and 3AC9					
Voltage:	3.6 VDC					
Operation Mode:	Normal, continuous transmit, and 'Hopping' mode					
Test Location:	√	Other: Conducted AC test bench				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)
0.155	L1	39.4	65.7	26.3	17.7	55.7	38.0
0.360	L1	35.4	58.7	23.3	6.6	48.7	42.1
0.554	L1	27.4	56.0	28.6	2.4	46.0	43.6
0.155	L2	38.9	65.7	26.8	17.0	55.7	38.7
0.364	L2	35.3	58.6	23.3	6.0	48.6	42.6
0.557	L2	28.5	56.0	27.5	2.0	46.0	44.0

Notes:

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

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

3) The EUT/system exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested. Sample data from channel 25 is shown above.

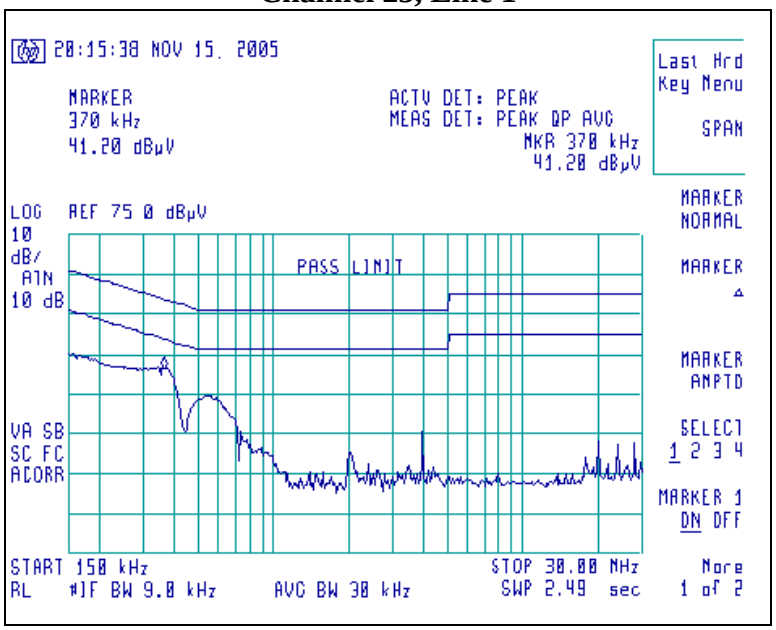
View of the EUT setup during the Conducted Emissions Test

Screen Captures of Conducted AC Mains Emissions:

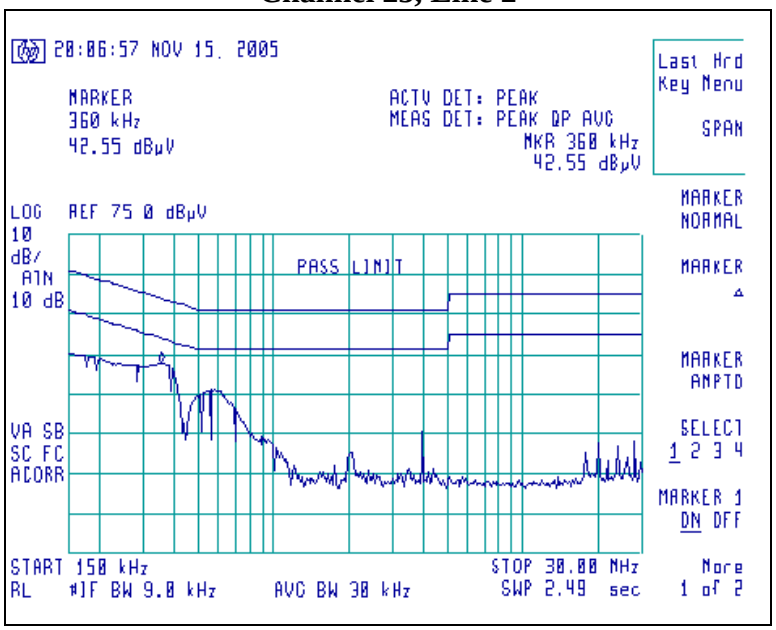
Please note these screen captures represent Peak Emissions. For conducted emission measurements, we utilize both a Quasi-Peak detector function as well as the Average detector function for measurements. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.209.

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

Channel 25, Line 1



Channel 25, Line 2



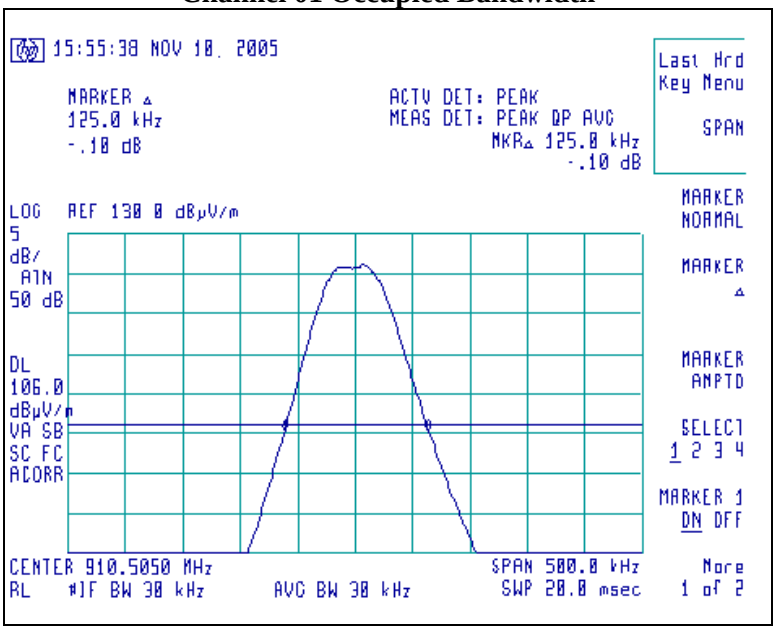
13. Occupied Bandwidth

The operating bandwidth requirement found in FCC Part 15.247(a)(1)(i) states a maximum allowed occupied bandwidth of 500 kHz. The receiver resolution bandwidth was set to 30 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.

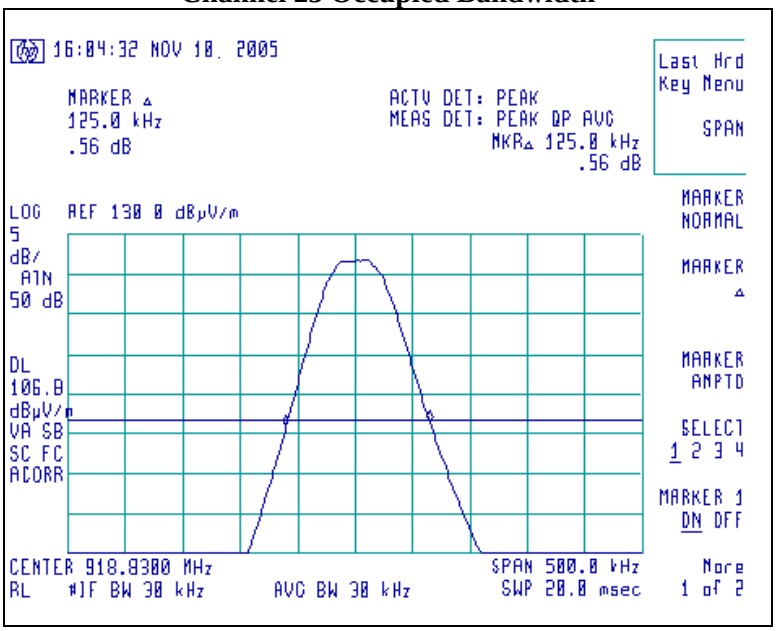
Channel	Center Frequency (MHz)	Measured 20 dB BW (kHz)	Maximum Limit (kHz)
01	910.50	125	500
25	918.82	125	500
50	927.49	125	500

Plots of Occupied Bandwidth

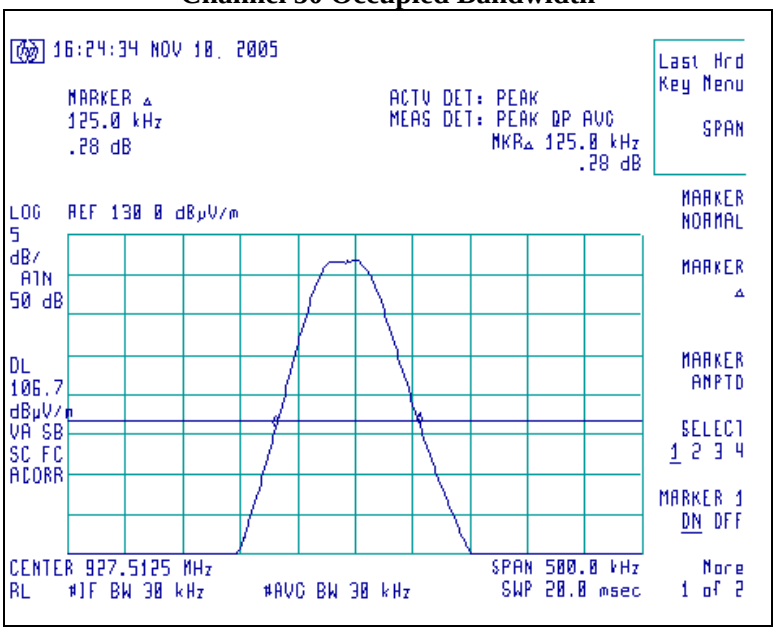
Channel 01 Occupied Bandwidth



Channel 25 Occupied Bandwidth



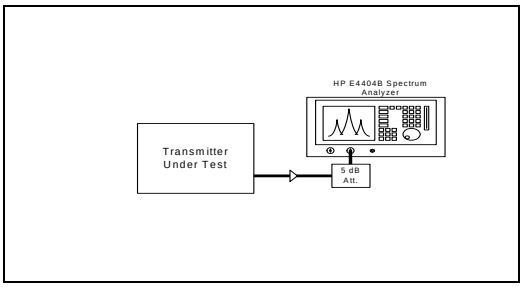
Channel 50 Occupied Bandwidth



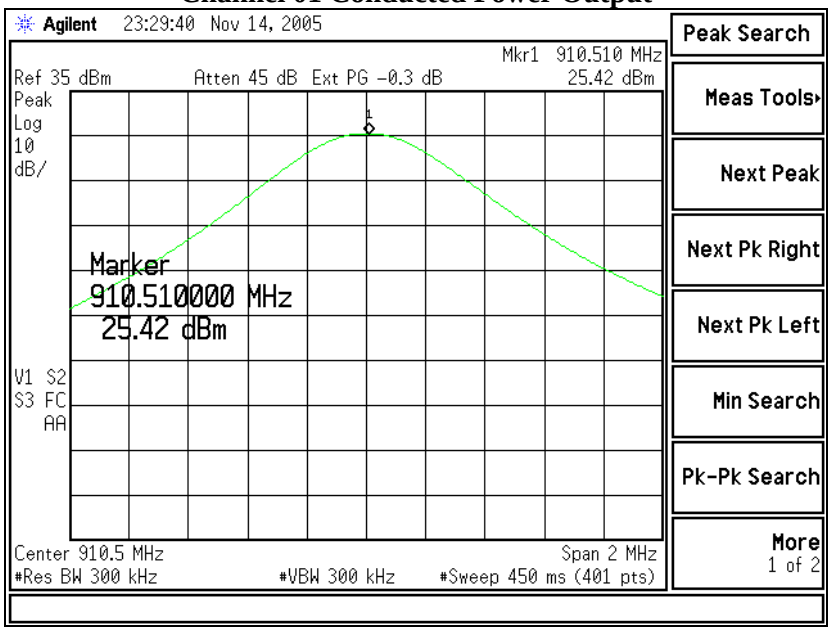
14. Power Output 15.247(b)

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable to the spectrum analyzer. The loss from the cable was added on the analyzer as gain offset settings, there by allowing direct readings of the measurements made without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 300 kHz, and a span of 2 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 variable DC bench type power supply.

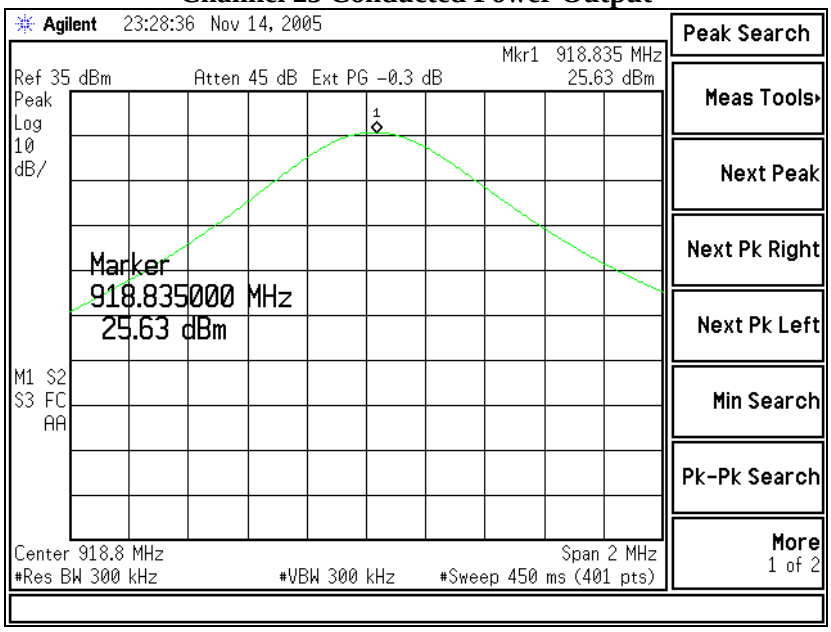
CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
01	910.5	+ 30 dBm	+ 25.4	4.6
25	918.8	+ 30 dBm	+25.6	4.4
50	927.5	+ 30 dBm	+25.5	4.5



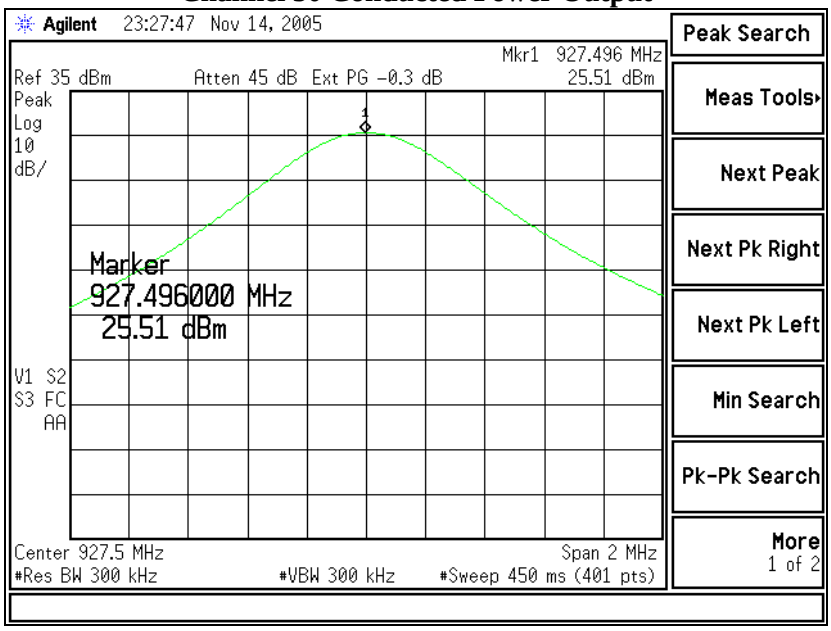
Channel 01 Conducted Power Output



Channel 25 Conducted Power Output



Channel 50 Conducted Power Output



15. Spurious Emissions 15.247(d)

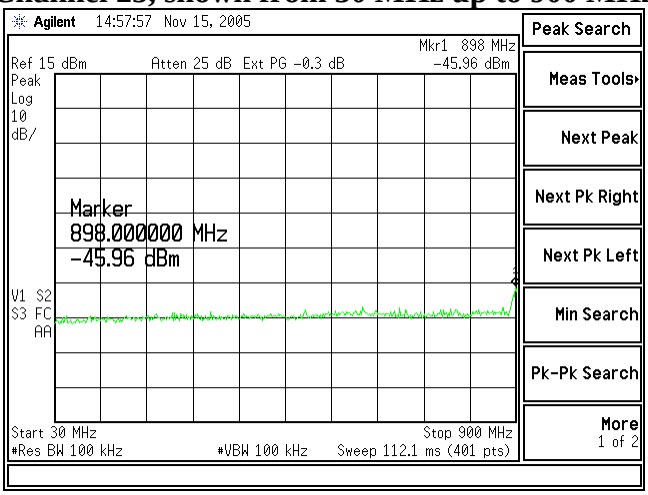
FCC Part 15.247(d) requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable to the spectrum analyzer. The loss from the cable was added on the analyzer as gain offset settings, there by allowing direct readings of the measurements made without the need for any further corrections. A Hewlett Packard model E4407B spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

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

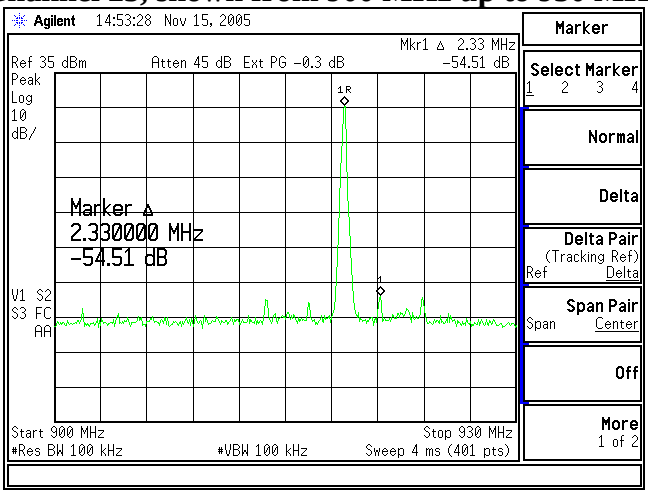
	Channel 01	Channel 25	Channel 50
905-913 MHz	- 29.3 (dBm)	- 35.1 (dBm)	- 37.4 (dBm)
916-917 MHz	- 29.0 (dBm)	- 32.1 (dBm)	- 35.0 (dBm)
923-934 MHz	- 37.4 (dBm)	- 29.8 (dBm)	- 36.4 (dBm)
Fundamental	+ 25.3 (dBm)	+ 25.5 (dBm)	+ 25.3 (dBm)
2nd Harmonic	- 43.2 (dBm)	- 42.0 (dBm)	- 42.3 (dBm)
3rd Harmonic	- 56.2 (dBm)	- 54.1 (dBm)	- 54.9 (dBm)
4th Harmonic	- 63.4 (dBm)	- 62.6 (dBm)	- 60.9 (dBm)
5th Harmonic	- 62.8 (dBm)	- 58.2 (dBm)	- 58.7 (dBm)
6th Harmonic	- 62.8 (dBm)	- 58.5 (dBm)	- 55.7 (dBm)
7th Harmonic	- 65.9 (dBm)	- 64.1 (dBm)	- 62.7 (dBm)
8th Harmonic	- 67.8 (dBm)	- 63.7 (dBm)	- 63.8 (dBm)
9th Harmonic	- 77.2 (dBm)	- 77.3 (dBm)	- 76.4 (dBm)
10th Harmonic	- 67.2 (dBm)	- 61.3 (dBm)	- 58.6 (dBm)

Plots of Conducted Spurious and Fundamental Levels

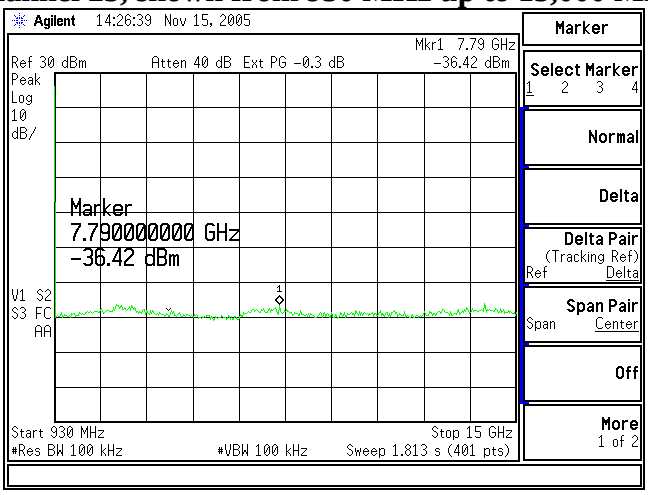
Channel 25, shown from 30 MHz up to 900 MHz



Channel 25, shown from 900 MHz up to 930 MHz



Channel 25, shown from 930 MHz up to 15,000 MHz



16. Minimum Channel Separation

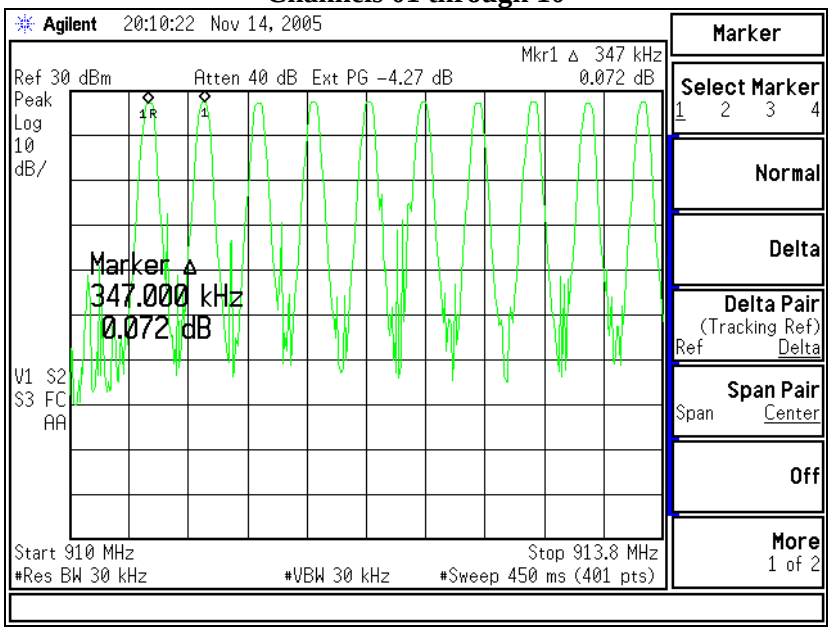
Part 15.247(a)(1) requires a minimum channel separation of 25 kHz or the equivalent of the 20 dB occupied bandwidth of the fundamental transmission, whichever is greater. An HP E4407B spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT.

The minimum and maximum channel-separations measured for this device are 342 kHz and 350 kHz respectively. The maximum occupied bandwidth of the device, as reported in the previous section is 125 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.

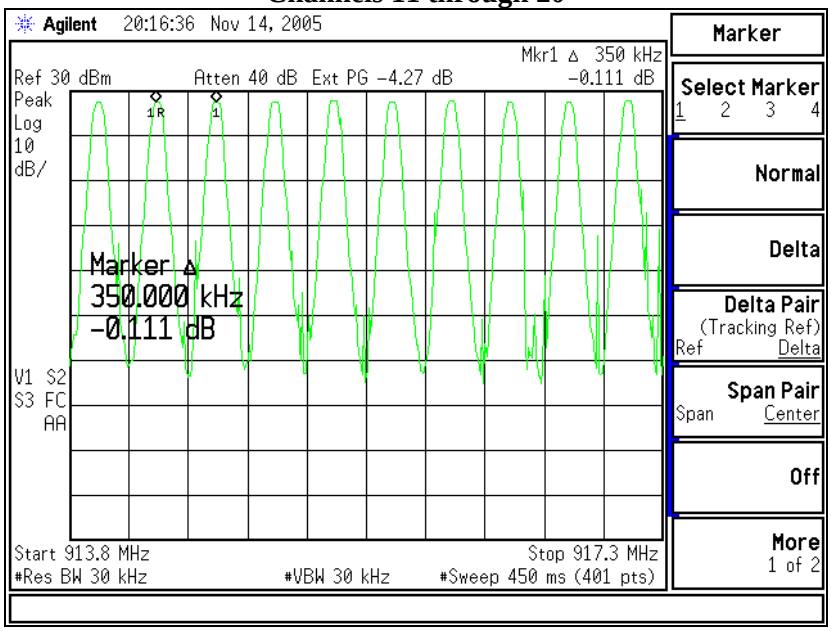
Frequency Span	Number of Channels	Minimum Separation (kHz)
910.0-913.8 MHz	10	347
913.8-917.3 MHz	10	350
917.3-920.8 MHz	10	350
920.8-924.2 MHz	10	349
924.2-928.0 MHz	10	342

Plots of Channel Separations

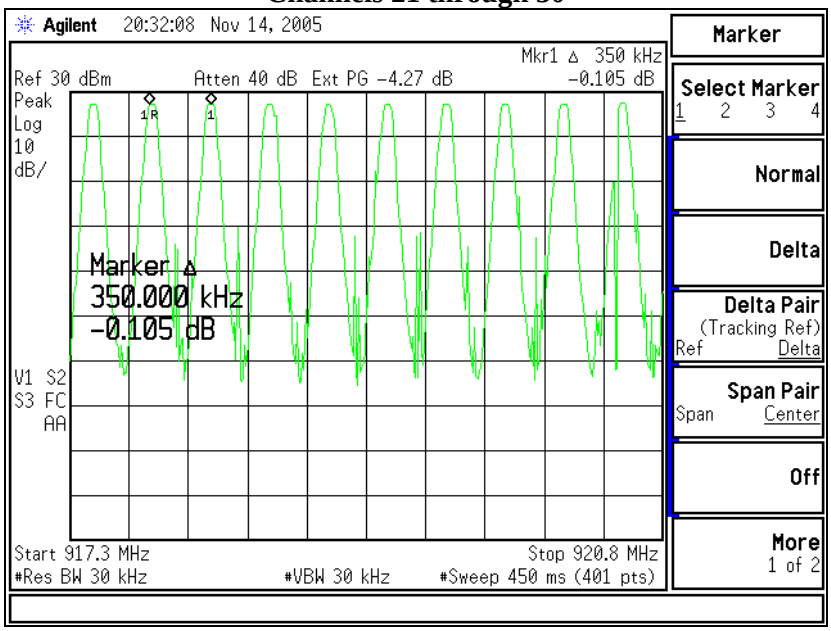
Channels 01 through 10



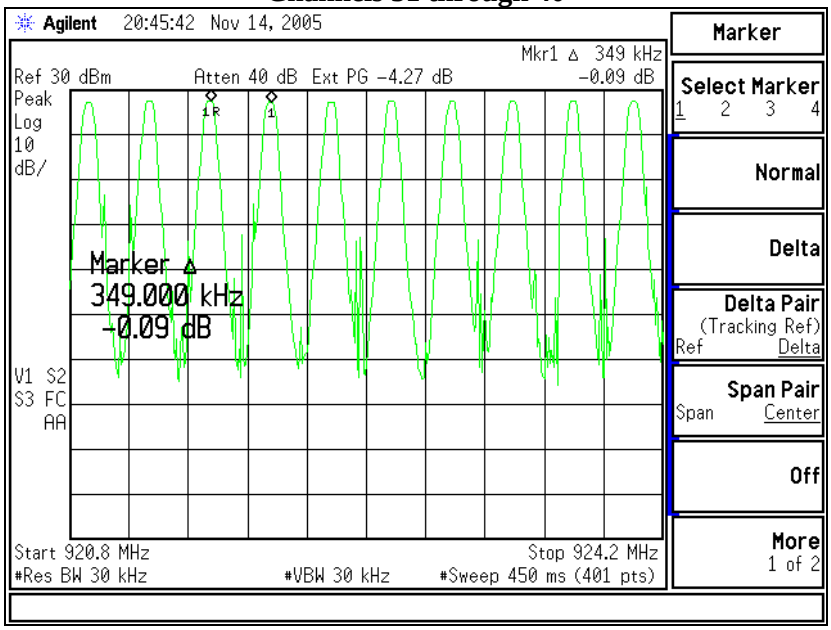
Channels 11 through 20



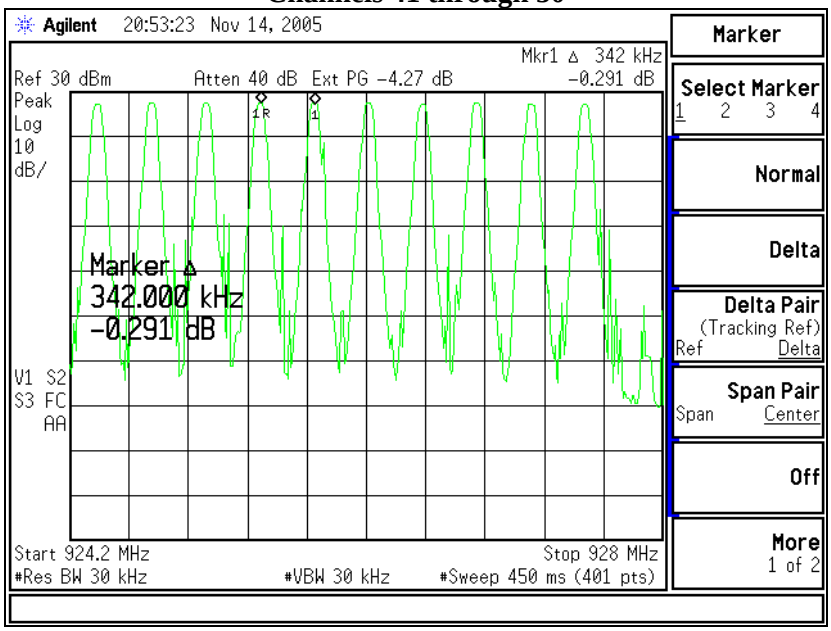
Channels 21 through 30



Channels 31 through 40



Channels 41 through 50



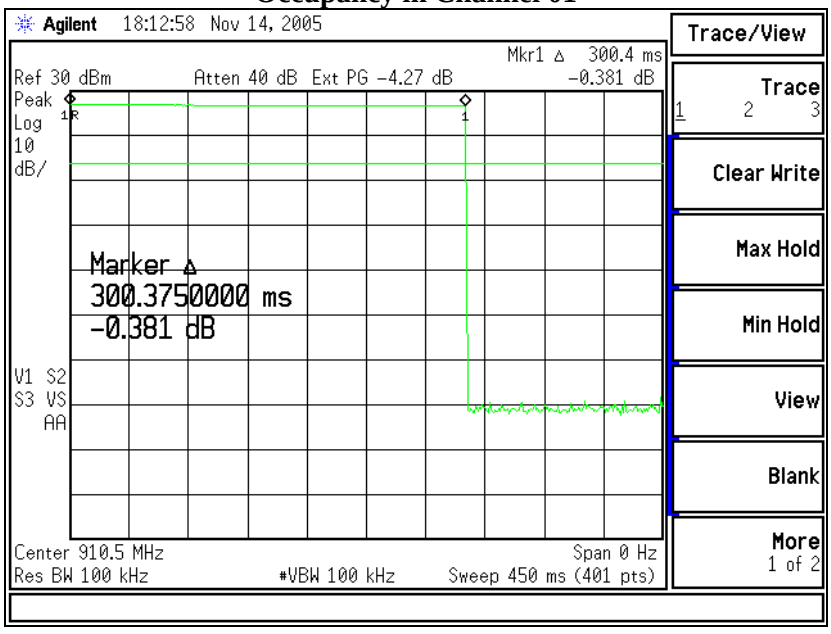
17. Channel Occupancy

Part 15.247(a)(1)(i) 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 EUT may exhibit different transmission durations depending on the packet lengths, with the following examples: "Acknowledge" takes approximately 8 ms, "Minimum Data Packet" takes approximately 95 ms, and "Maximum Data Packet" takes approximately 300 ms. The EUT dwell time was measured with the "Maximum Data Packet" lengths being transmitted. The longest dwell time measured on transmission cycles was 300.4 ms. With a total of 50 channels used, each occupying a 300.4 ms slot, it will take 15.02 seconds for the sequence to repeat. In a 20 second window, each channel would have 1.33 transmission cycles. The maximum occupancy in a 20 second window is calculated by multiplying the 1.33 transmission cycles by 300.4 ms transmission duration per cycle, to arrive at 399.5 ms total occupancy.

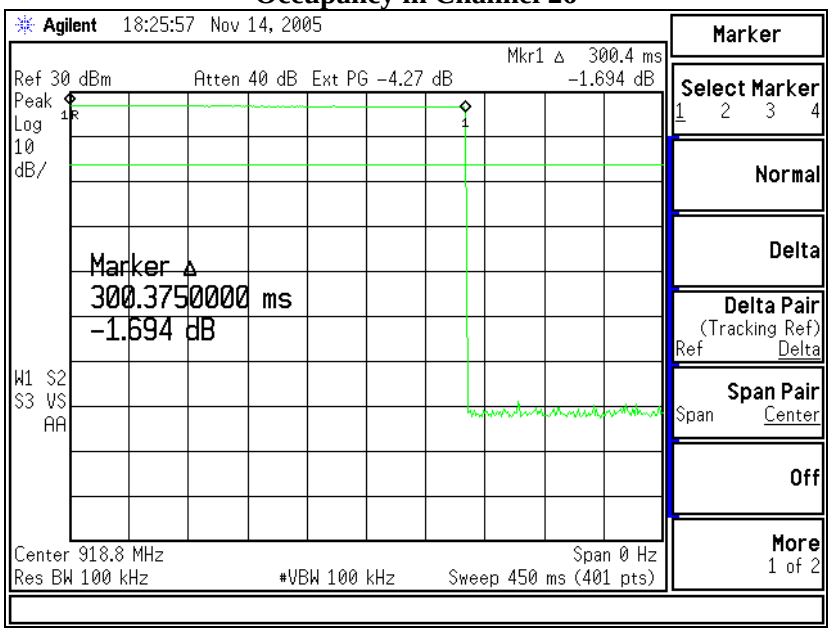
Channel	Frequency (MHz)	Occupancy Per transmission (ms)	Occupancy in 400 ms window (ms)	Occupancy in 20 s window (ms)
01	910.5	300.4	300.4	399.5
25	918.8	300.4	300.4	399.5
50	927.5	300.4	300.4	399.5

Plots of Channel Occupancy

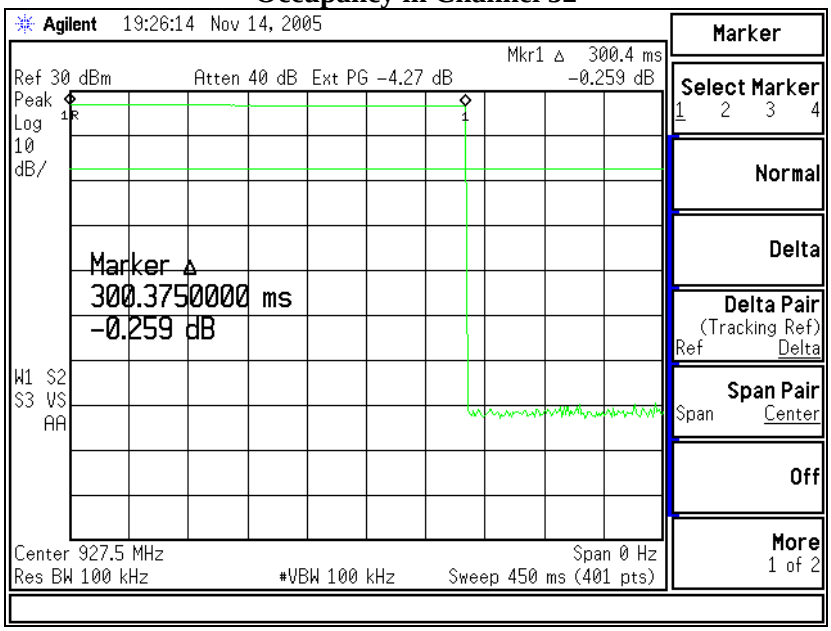
Occupancy in Channel 01



Occupancy in Channel 26



Occupancy in Channel 52



18. Frequency and Power Stability requirements

For measurements of the frequency and voltage stability, the EUT was placed in continuous-wave, 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 at the appropriate frequency markers. The frequency was measured with a receiver resolution bandwidth of 300 Hz, and video bandwidth of 300 Hz.

	DC Voltage Source		
	3.06 V	3.60 V	4.14 V
Channel 01	23.7 (dBm)	26.2 (dBm)	26.4 (dBm)
Channel 25	24.2 (dBm)	25.9 (dBm)	26.6 (dBm)
Channel 50	24.8 (dBm)	25.8 (dBm)	26.6 (dBm)

	DC Voltage Source		
	3.06 V	3.60 V	4.14 V
Channel 01	910.509800 (MHz)	910.510100 (MHz)	910.510100 (MHz)
Channel 25	918.836225 (MHz)	918.836425 (MHz)	918.836438 (MHz)
Channel 50	927.510063 (MHz)	927.510213 (MHz)	927.510263 (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 stand-by state of operation as expected.

At the extreme 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 less than 2 dB, during the voltage variation tests.

The information on this page is provided by the manufacturer.

19. Pseudorandom Hopping Pattern and Equal Channel Usage

50 channels are available and used. The frequency order and usage is based on the CHIPCON public code examples and the Ayantra code. The start frequency is changed based on the RTC at every 125 ms interval, and because messages are sent randomly in time, all frequencies have the same chance of being used. The system uses the same hopping pattern for all devices. The pseudo-random hopping table is based on the CHIPCON recommendation.

A portion of the actual hop table is presented here:

```
//          Fr2A   Fr1A  Fr0A     Fr2B  Fr1B  Fr0B
      { { 0x3C, 0x6F, 0x11 }, { 0x3C, 0x74, 0x67 } },  // 902.5   MHz   //00
      { { 0x3D, 0x36, 0xB9 }, { 0x3D, 0x3C, 0x0F } },  // 914     MHz   //01
      { { 0x3D, 0x3F, 0x67 }, { 0x3D, 0x44, 0xBD } },  // 914.5   MHz   //02
      { { 0x3C, 0xF1, 0x47 }, { 0x3C, 0xF6, 0x9D } },  // 910     MHz   //03
      { { 0x3D, 0x96, 0x35 }, { 0x3D, 0x9B, 0x8B } },  // 919.5   MHz   //04
      { { 0x3C, 0xF9, 0xF5 }, { 0x3C, 0xFF, 0x4B } },  // 910.5   MHz   //05
      { { 0x3D, 0x2E, 0x0B }, { 0x3D, 0x33, 0x61 } },  // 913.5   MHz   //06
      { { 0x3D, 0xF5, 0xB1 }, { 0x3D, 0xFB, 0x07 } },  // 925     MHz   //07
      { { 0x3D, 0x0B, 0x51 }, { 0x3D, 0x10, 0xA7 } },  // 911.5   MHz   //08
      { { 0x3D, 0x14, 0x01 }, { 0x3D, 0x19, 0x55 } },  // 912     MHz   //09
      { { 0x3D, 0x73, 0x7D }, { 0x3D, 0x78, 0xD1 } },  // 917.5   MHz   //10
```

20. 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.

21. MPE Calculations

Focus RF Module
MPE Calcluation
Base on the 'Nearson' brand, model number 'C467AT-925S' antenna.

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:	25.60	(dBm)
Maximum peak output power at antenna input terminal:	363.078	(mW)
Antenna gain(typical):	2	(dBi)
Maximum antenna gain:	1.585	(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:	0.114480	(mW/cm^2)
Maximum allowable antenna gain:	9.3	(dBi)
Margin of Compliance at 20 cm =	7.3	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	12/06/04	12/06/05
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	12/07/04	12/07/05
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/29/05	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.

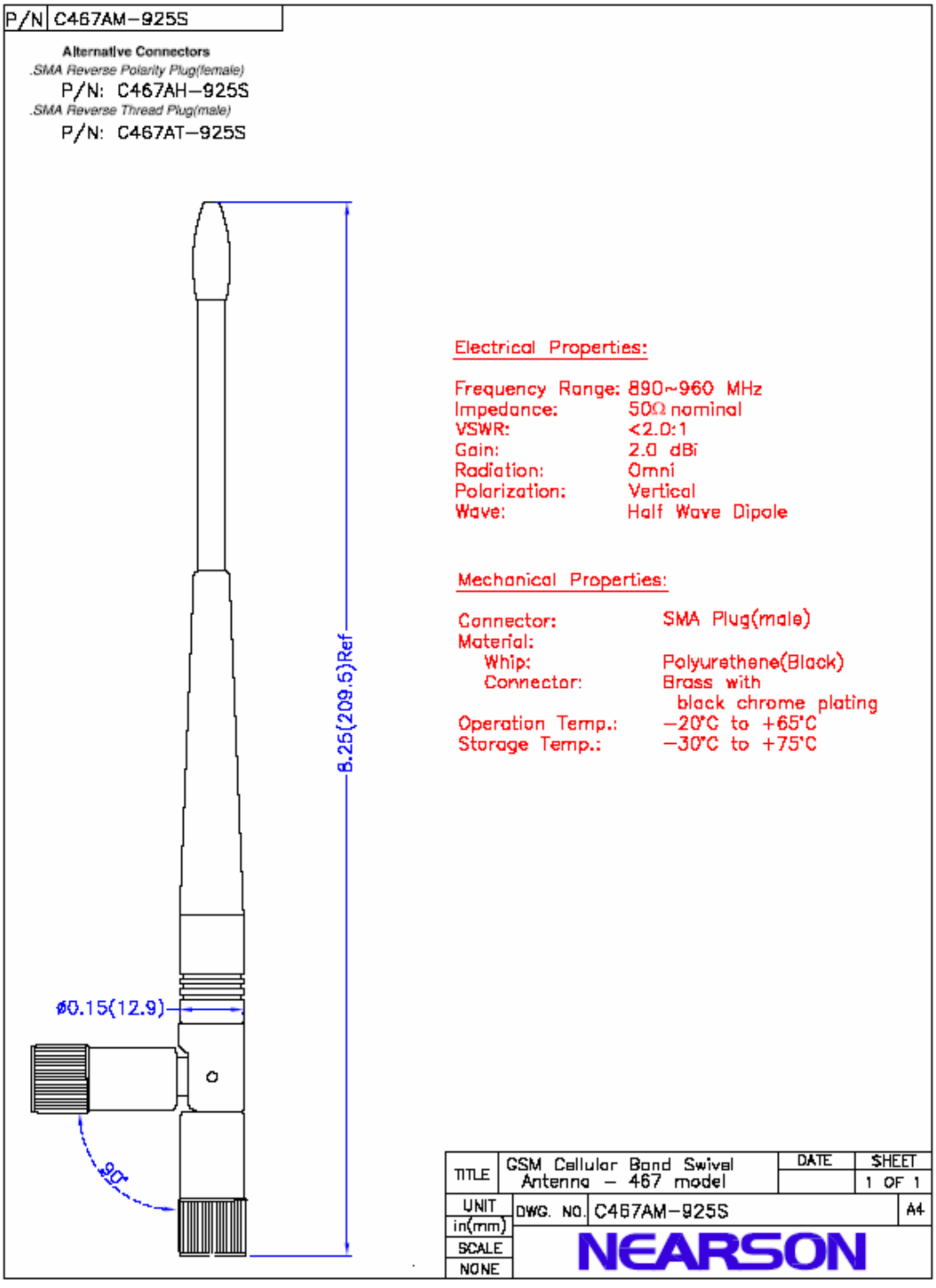
Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

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

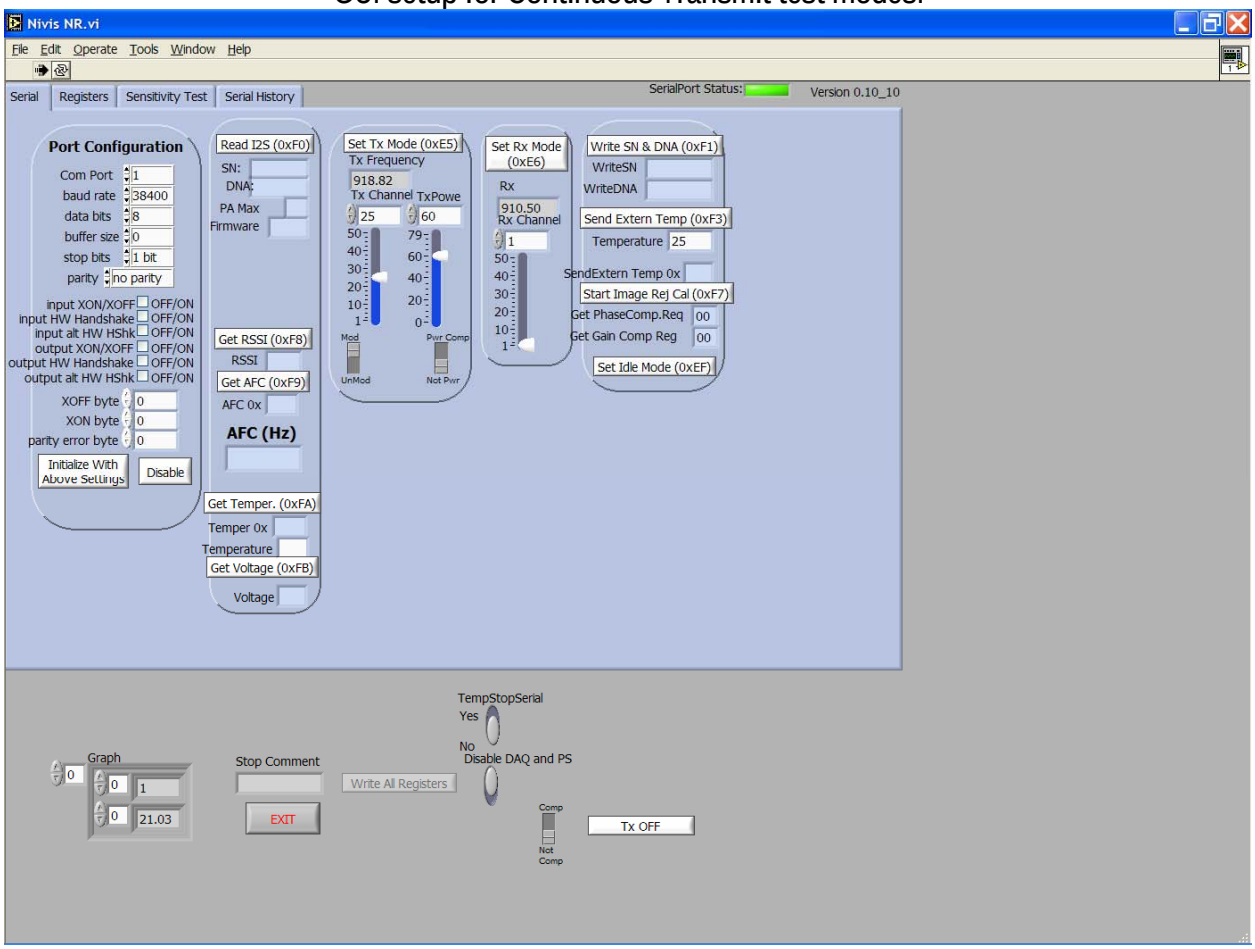
'Nearson' brand antenna, model number 'C467AT-925S'.



Appendix C

Firmware and Setup Instructions

GUI setup for Continuous Transmit test modes.



GUI setup for Frequency Hopping test mode.