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

COMPLIANCE TESTING OF:

EVIRNET™ Base Station Unit

Prepared For:

Zonar Systems, L.L.C.
Attention: Mr. Mike McQuade
19518 International Boulevard
Seattle, WA 98188

Test Report Number:

304390-TCB Rev. 1

Test Dates:

July 20th through August 25th , 2004

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

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

Industry Canada

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

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

U. S. Conformity Assessment Body (CAB) Validation

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

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

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

2. A2LA Certificate 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. Testing and calibration laboratories that comply with this International Standard also operate in accordance with ISO 9001 or ISO 9002 (1994).

Presented this 26th day of March 2003.

President
For the Accreditation Council
Certificate Number 1255.01
Valid to January 31, 2005

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

3. A2LA Scope of Accreditation

American Association for Laboratory Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025-1999

L.S. COMPLIANCE, INC.
W66 N220 Commerce Court
Cedarburg, WI 53012
James Blaha Phone: 262 375 4400

ELECTRICAL (EMC)

Valid to: January 31, 2005 Certificate Number: 1255-01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests:

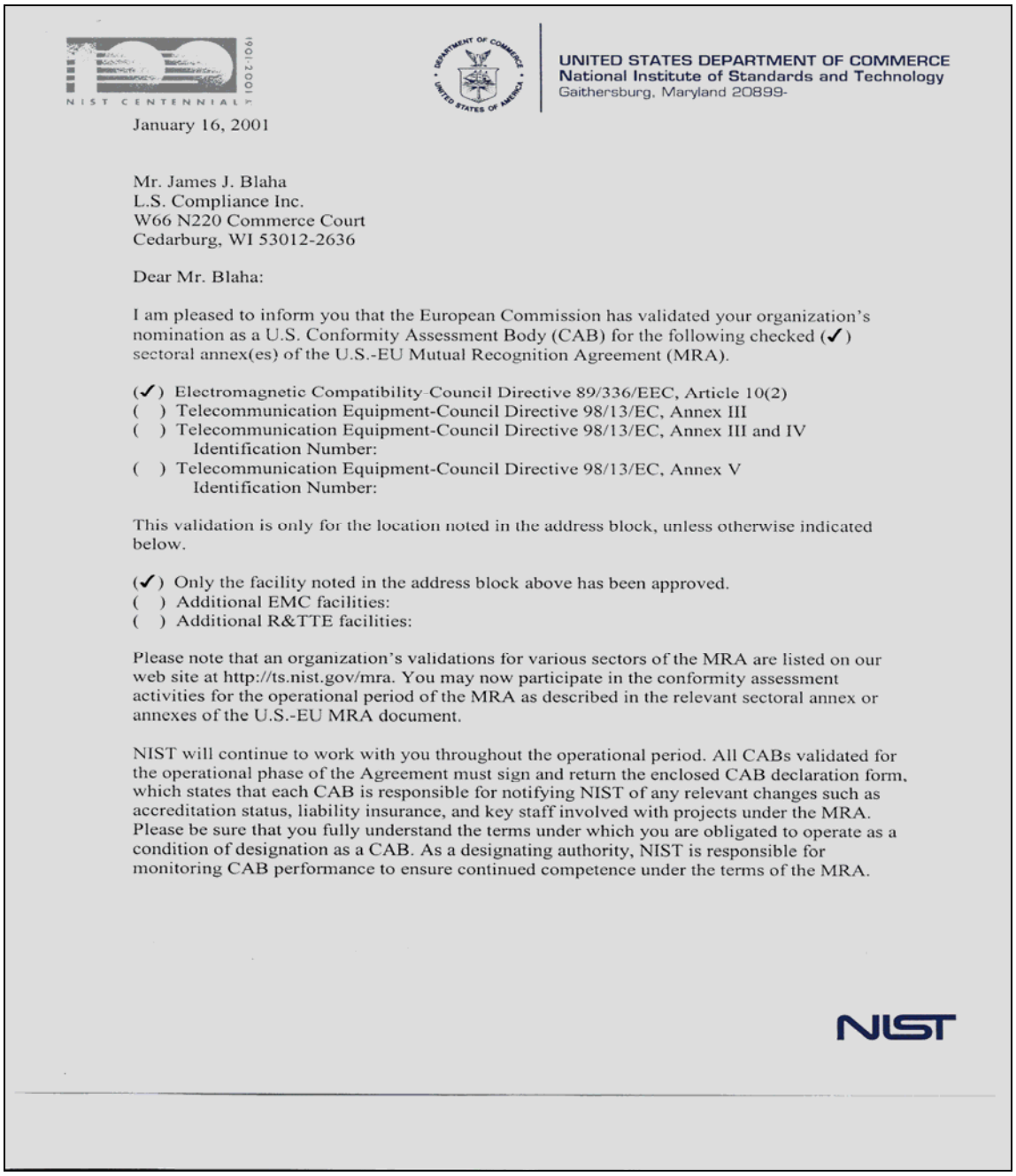
Test	Test Method(s)
Emissions	
Conducted	
Continuous/Discontinuous	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4; EN: 55011, 55022, 50081-1, 50081-2; CISPR: 11, 12, 14-1, 22; CNS 13438
Radiated	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4; EN: 55011, 55022, 50081-1, 50081-2; CISPR: 11, 12, 14-1, 22; CNS 13438
Current Harmonics	IEC 61000-3-2; EN 61000-3-2
Voltage Fluctuations & Flicker	IEC 61000-3-3; EN 61000-3-3
Immunity	EN: 50082-1, 50082-2 EN 61000-6-2 CISPR: 14-2, 24
Conducted Immunity	
Fast Transients/Burst	IEC 61000-4-4; EN 61000-4-4
Surge	IEC: 61000-4-5; ENV 50142; EN 61000-4-5
RF Fields	IEC: 61000-4-6; ENV 50141; EN 61000-4-6
Voltage Dips/Interruptions	IEC 61000-4-11; EN 61000-4-11

Roxanne M. Robinson

(A2LA Cert. No. 1255-01) 05/13/03 Page 1 of 2

5301 Buckeystown Pike, Suite 350 • Frederick, MD 21704-8373 • Phone: 301-644 3248 • Fax: 301-662 2974

4. 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.

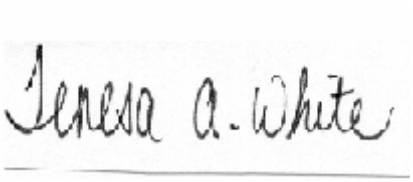
(✓) Only the facility noted in the address block above has been approved.
( ) Additional EMC facilities:
( ) Additional R&TTE facilities:

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

5. Signature Page

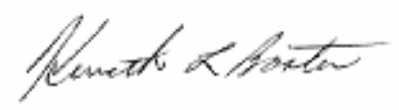


Prepared By: August 30, 2004

Teresa A. White, Document Coordinator Date

Tested By: August 30, 2004

Abtin Spantman, EMC Engineer Date



Approved By: August 30, 2004

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

6. Product and General Information

Manufacturer:	Zonar Systems, LLC					
Date(s) of Test:	July 20th – Aug 25th , 2004					
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	EVIRNET™ Base Station					
Serial #:	LSC-B02					
Voltage:	12VDC from wall-type transformer					
Operation Mode:	Normal, continuous transmit, and 'Hopping' mode					

7. Introduction

Between August 9th to August 26th, 2004, a series of Conducted and Radiated Emission tests were performed on one sample of the Zonar EVIRNET™ Base Station, serial number LSC-B02 here forth referred to as the "*Equipment Under Test*" or "*EUT*". These tests were performed using the procedures outlined in ANSI C63.4-2001 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 Emission tests were performed upon the EUT to measure the emissions in the frequency bands described in Title 47 CFR, FCC Part 15, including 15.35, 15.209, 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 C63.4-2001). Another document used as a reference for the EMI Receiver specification was the Comite International Special Des Perturbations Radioelelectriques (CISPR) Number 16-1, 2002.

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

8. Product Description

The Zonar EVIRNET™ Base Station radio is a transceiver operating within the 902-928 MHz ISM band. The base station radio connects to a computer via an RS-232 type serial port. With appropriate software, the computer can communicate with EVIRNET™ radios located in vehicles within the range of the base station. This communication allows for short range (approximately 1500 feet) transfer of Zonar Systems inspection data.

9. Test Requirements

The above mentioned tests were performed in order to determine the compliance of the EVIRNET™ Base Station Unit with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

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

10. Summary of Test Report

DECLARATION OF CONFORMITY

The Zonar Systems' EVIRNET™ Base Station Unit 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(0) for a Frequency Hopping Spread Spectrum Transmitter.

11. Radiated Emissions Test

Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.4-2001. 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 modulated continuous transmit and hopping modes (including a special 5 channel hop sequence to allow direct average readings to be taken of the three tested channels. This hop sequence is 1, 27, 52,12, 40 and repeat) during various portions of the test sequence, using power as provided by a 12 VDC, 1 Amp, wall-type transformer connected to the 120 VAC mains. The unit has the capability to operate on 53 channels, controllable during testing via a computer connected through the RS-232 port.

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 (902.77), medium (914.86) and high (927.21) to comply with FCC Part 15.35. The channels and operating modes were changed using a PC during the tests.

Test Procedure

Radiation 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 attitude for maximum radiated RF emission was found while raising and lowering the antenna height between 1 and 4 meters, and changing the antenna polarization to horizontal and vertical.

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 (VIDOE BANDWIDTH OF 1 MHz). The Peak, Quasi-Peak and Average Detector functions were utilized. From 5 GHz to 10 GHz, an HP E4407 Spectrum Analyzer and an EMCO Horn Antenna were used.

Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for a FHSS transmitter [Canada RSS-210, Clause 6.2.2(0)]. The frequencies with significant signals 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 (c), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c).

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

Frequency (MHz)	3 m Limit μV/m	3 m Limit (dBμV/m)	1 m Limit (dBμV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion from field strength μV/m to dBμV/m:

$dB\mu V/m = 20 \log_{10} (100)$

= 40 dBμV/m (from 30-88 MHz)

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

960 MHz to 10,000 MHz

500μV/m or 54.0 dB/μV/m at 3 meters

54.0 + 9.5 = 63.5 dB/μV/m at 1 meter

Radiated Emissions Data Chart

3 Meter Measurements of Electromagnetic Radiated Emissions
Test Standard: 47CFR, Part 15.205 FHSS
Frequency Range Inspected: 30 MHz to 10,000 MHz

Manufacturer:	Zonar Systems, LLC							
Date(s) of Test:	July 20th – Aug 25th , 2004							
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston		
Model #:	EVIRNET™ Base Station							
Serial #:	LSC-B02							
Voltage:	12VDC from wall-type transformer							
Operation Mode:	continuous transmit, 'Hopping' mode, and 5 channel hopping mode							
EUT Power:	√	Single Phase 115VAC to supply		3 Phase ___VAC				
		Battery		Other:				
EUT Placement:	√	80cm non-conductive table		10cm Spacers				
EUT Test Location:	√	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS				
Measurements:		Pre-Compliance		Preliminary	√	Final		
Detectors Used:	√	Peak	√	Quasi-Peak	√	Average		

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

Test Equipment Used:
EMI Measurement Instrument: HP8546A and Agilent E4407B
Log Periodic Antenna: EMCO #93146
Horn Antenna: EMCO #3115
Biconical Antenna: EMCO 3110
Pre-Amp: Advanced Microwave WHA6224
Standard Gain Horn: EMCO 3160-09

The following table depicts the level of spurious emissions seen:

Frequency (MHz)	Antenna Polarity	Channel	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
966.4	V	52	1.05	325	52.8	54.0	1.2

Tables containing emission from the fundamental and harmonics can be found on the next page.

Other emissions seen were greater than 20 dB below the limits.

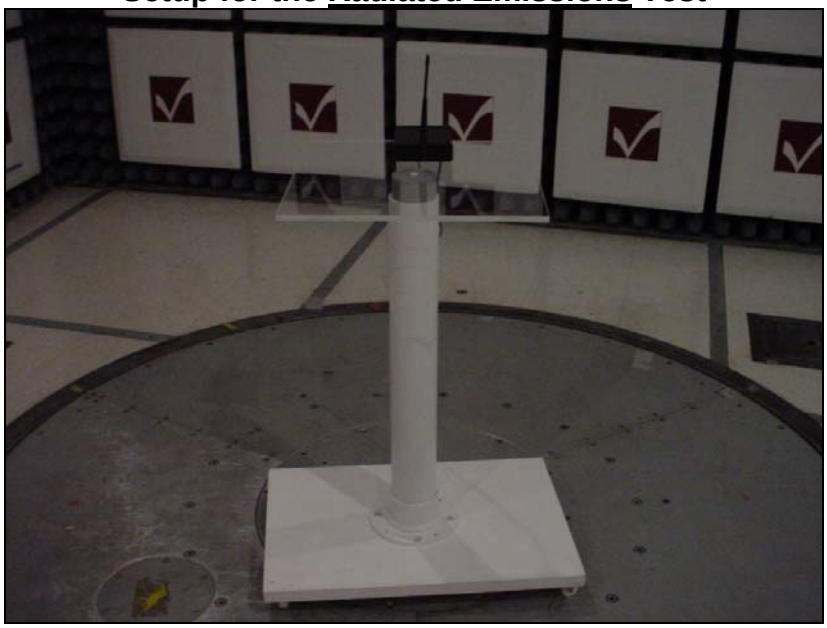
The following table depicts the level of significant radiated RF fundamental and harmonic emissions

Frequency (MHz)	Antenna Polarity	Channel	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
2710	V	01	1.30	165	49.2	54.0	4.8
3613	V	01	1.00	160	41.0	54.0	13.0
4516	V	01	1.00	180	43.9	54.0	10.1
5418	H	01	1.00	30	44.0	63.5	19.5
8130	H	01	1.00	45	43.5	63.5	20.0
9028	H	01	1.00	30	45.7	63.5	17.8
3659	V	26	1.00	180	42.9	54.0	11.1
4575	V	26	1.00	220	42.5	54.0	11.5
7319	V	26	1.00	180	55.4	63.5	8.1
8235	H	26	1.00	120	47.8	63.5	15.7
9148	V	26	1.00	180	48.9	63.5	14.6
2781	V	52	1.05	200	46.4	54.0	7.6
3710	V	52	1.15	180	44.2	54.0	9.8
4636	V	52	1.15	185	42.4	54.0	11.6
7417	V	52	1.00	180	52.8	63.5	10.7
8346	H	52	1.00	295	52.4	63.5	11.1

Notes: 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. Measurements above 5 GHz were made at 1 meters of separation from the EUT.

Photos Taken During Radiated Emission Testing

Setup for the Radiated Emissions Test



Close-up view of EUT, showing the EUT antenna orientations during testing

Vertical orientation

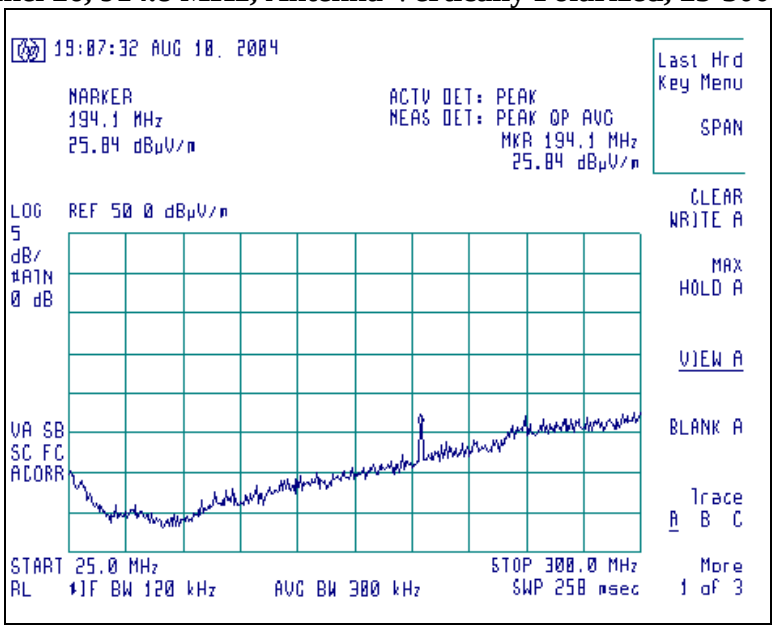
Horizontal orientation

Screen Captures of Radiated RF Emissions:

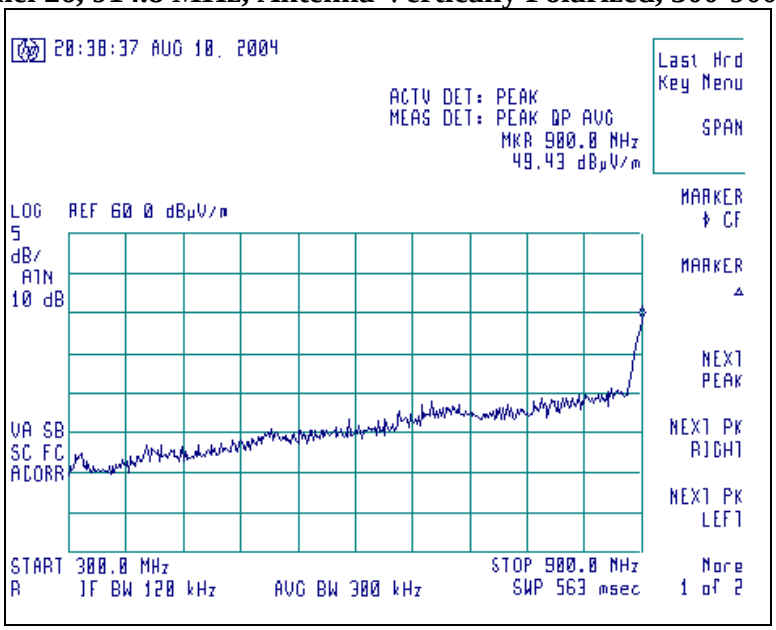
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from channel 26, chosen as being a good representative of channels, with the sense and EUT antennas both in vertical polarity for worst case presentations.

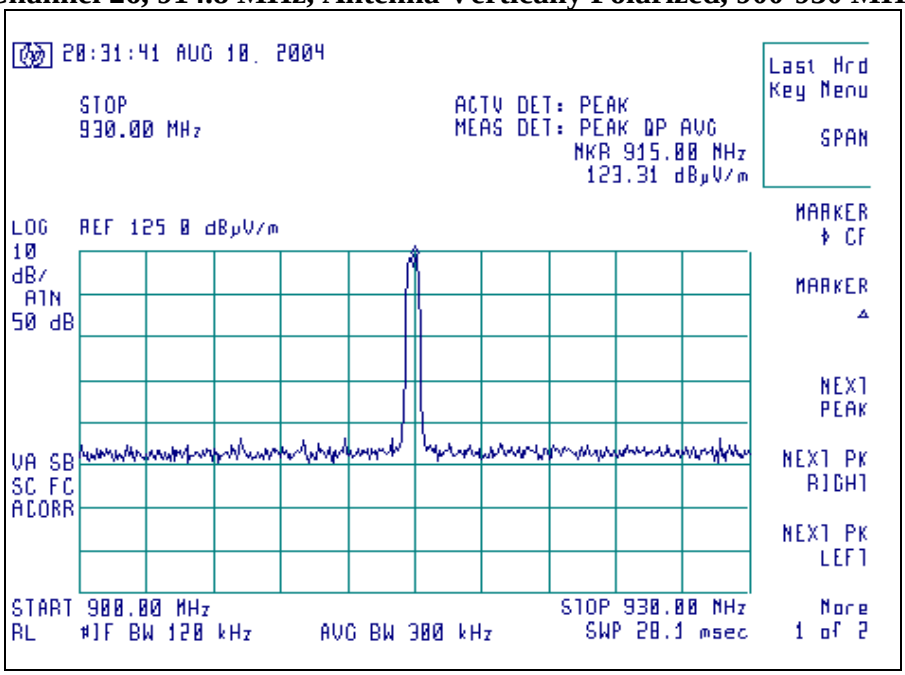
Channel 26, 914.8 MHz, Antenna Vertically Polarized, 25-300 MHz



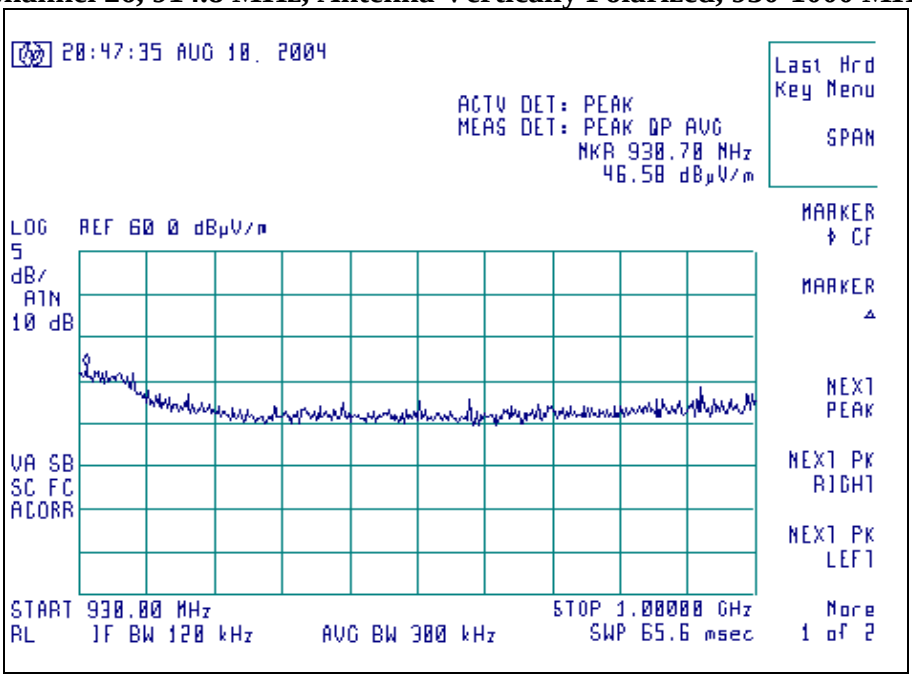
Channel 26, 914.8 MHz, Antenna Vertically Polarized, 300-900 MHz



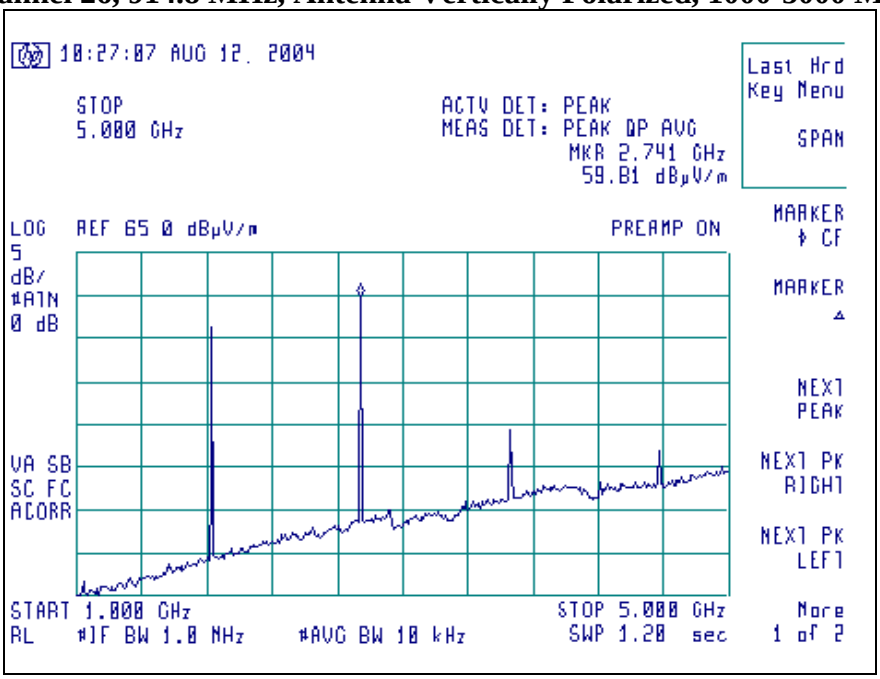
Channel 26, 914.8 MHz, Antenna Vertically Polarized, 900-930 MHz



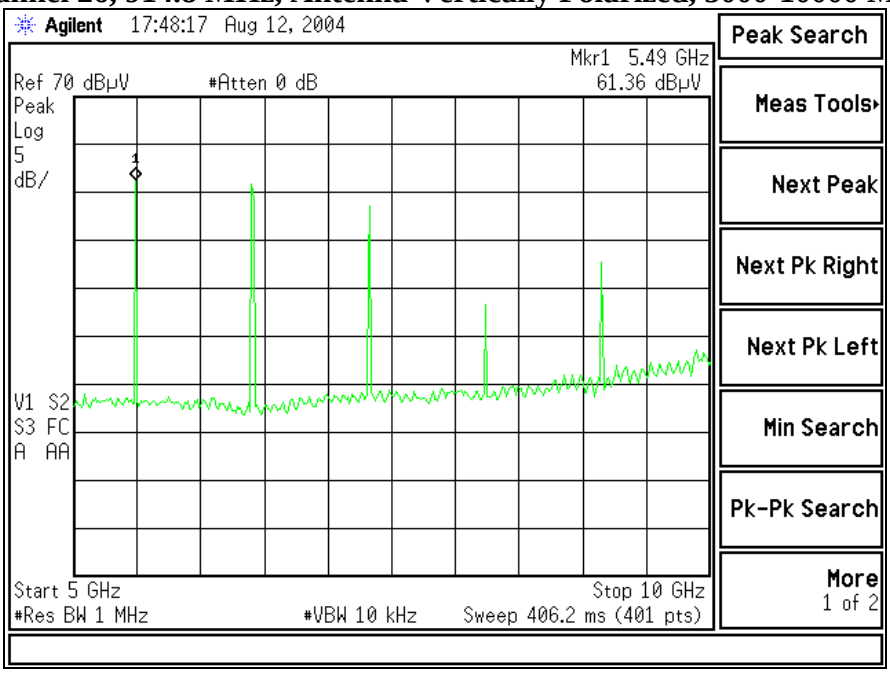
Channel 26, 914.8 MHz, Antenna Vertically Polarized, 930-1000 MHz



Channel 26, 914.8 MHz, Antenna Vertically Polarized, 1000-5000 MHz



Channel 26, 914.8 MHz, Antenna Vertically Polarized, 5000-10000 MHz



12. Conducted Emissions Test, AC Power Line

Test Setup

The Conducted Emissions test was performed at L.S. Compliance, Inc. in Cedarburg, Wisconsin. The test area and setup are in accordance with ANSI C63.4-2001 and with Title 47 CFR, FCC Part 15 (Industry Canada RSS-210). The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided inside the Shielded Room via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the HP 8546A EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

Test Procedure

The EUT was placed 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 (2002), Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30MHz. Final readings were then taken and recorded.

Test Equipment Utilized

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

Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15, Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

Measurement of Electromagnetic Conducted Emission
In the Shielded Room

Frequency Range inspected: 150 KHz to 30 MHz

Manufacturer:	Zonar Systems, LLC							
Date(s) of Test:	July 20th – Aug 25th , 2004							
Test Engineer:		Tom Smith	√	Abtin Spantman		Ken Boston		
Model #:	EVIRNET™ Base Station							
Serial #:	LSC-B02							
Voltage:	12VDC from wall-type transformer							
Operation Mode:	Normal, continuous transmit, and 'Hopping' mode							
Test Location:	√	Shielded Room				Chamber		
EUT Placed On:	√	40cm from Vertical Ground Plane				10cm Spacers		
	√	80cm above Ground Plane				Other:		
Measurements:		Pre-Compliance		Preliminary	√	Final		
Detectors Used:		Peak	√	Quasi-Peak	√	Average		

Environmental Conditions in the Lab:
Temperature: 20 – 25° C
Atmospheric Pressure: 86 kPa – 106 kPa
Relative Humidity: 30 – 60%

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

		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Q-Peak Reading (dBμV/m)	Q-Peak Limit (dBμ V/m)	Quasi-Peak Margin (dB)	Average Reading (dBμV/m)	Average Limit (dBμ V/m)	Average Margin (dB)
0.158	L1	46.6	65.7	19.1	16.7	55.7	39.0
0.327	L1	42.3	59.5	17.2	12.8	49.5	36.7
0.450	L1	38.7	56.9	18.2	24.7	46.9	22.2
0.505	L1	38.4	56.0	17.6	8.4	46.0	37.6
5.825	L1	38.5	60.0	21.5	32.4	50.0	17.6
15.32	L1	28.2	60.0	31.8	24.7	50.0	25.3
0.162	L2	47.5	65.4	17.9	17.4	55.4	38.0
0.218	L2	47.1	62.9	15.8	16.6	52.9	36.3
0.261	L2	46.7	61.4	14.7	15.7	51.4	35.7
0.358	L2	44.4	58.8	14.4	13.4	48.8	35.4
0.550	L2	36.2	56.0	19.8	6.6	46.0	39.4
1.786	L2	27.2	56.0	28.8	23.3	46.0	22.7
5.799	L2	*38.4*	60.0	21.6	32.0	50.0	18.0
6.254	L2	*39.7*	*60.0*	20.3	31.3	50.0	18.7

Notes:

1) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested. Representative data presented above is from channel 26 in transmit mode.

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

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

Calculation of Conducted Emissions Limits

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

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

22. Decreases 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:

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

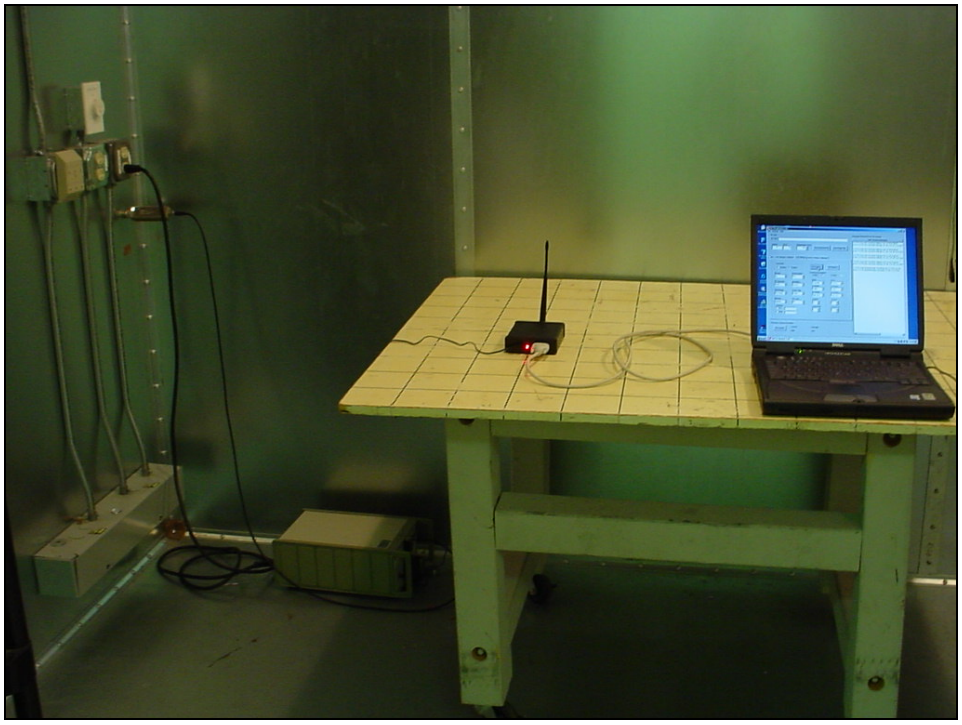
$$\text{Quasi-Peak Limit (F=200kHz)} = 63.6 \text{ dB}\mu\text{V}$$

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

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

Photo(s) Taken During Conducted Emission Testing

Setup for the Conducted Emissions Test

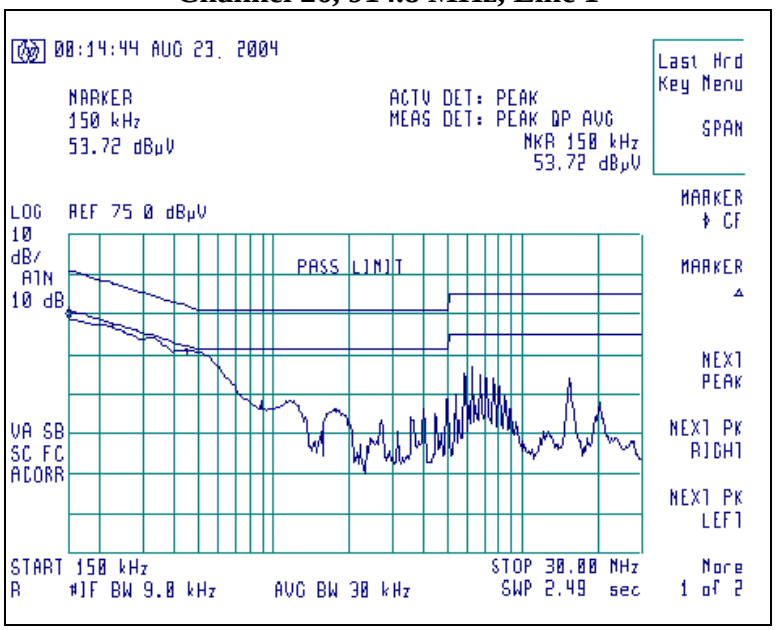


Screen Captures of Conducted AC Mains Emissions:

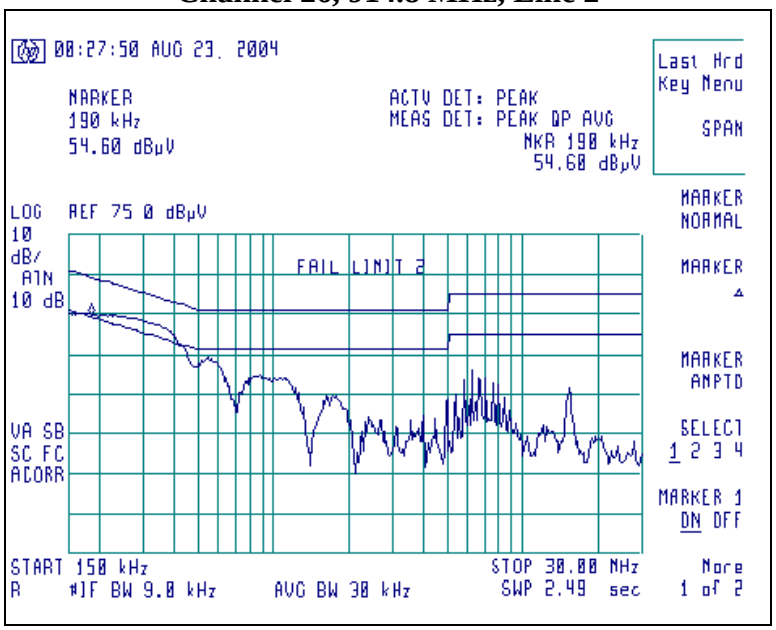
Please note these screen captures represent Peak Emissions. For conducted emission measurements, we utilize both a Quasi-Peak detector function as well as the Average detector function for measurements. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.209.

The signature scans shown here are from channel 26, chosen as being a good representative of channels.

Channel 26, 914.8 MHz, Line 1



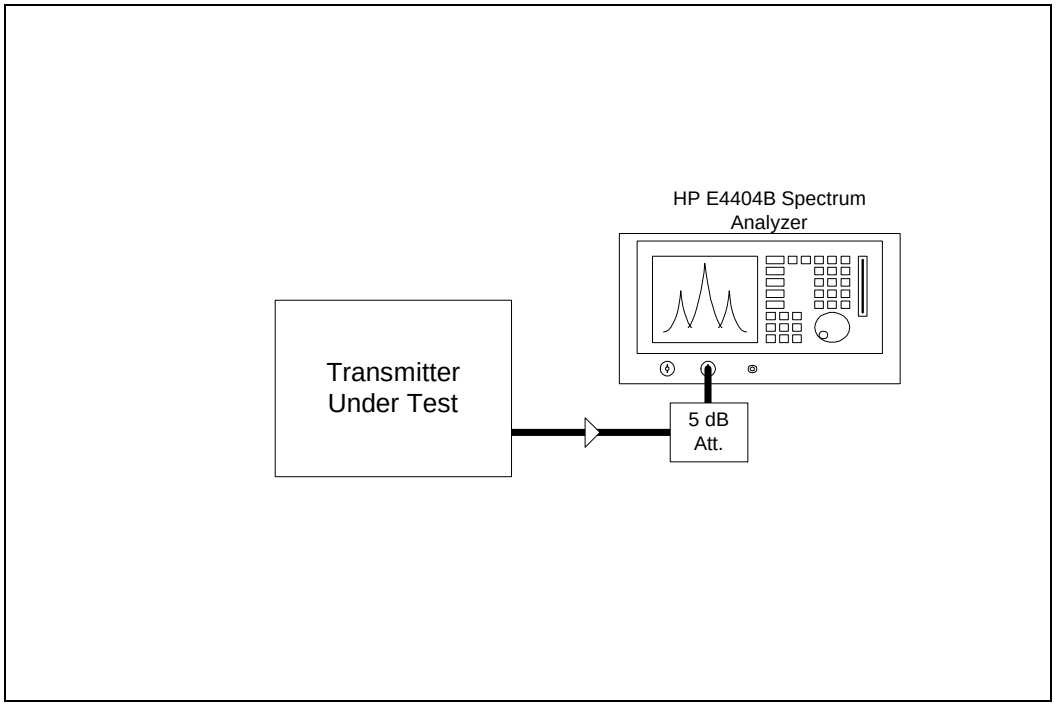
Channel 26, 914.8 MHz, Line 2



13. Conducted Emissions Test, Power Output 15.247(b)

The conducted 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. A Hewlett Packard model E4407B spectrum analyzer was used with the resolution bandwidth set to 1 MHz 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 resolution and video bandwidths set to 1 MHz, and a span of 1 MHz, with measurements from a peak detector presented in the chart below. Power output was also monitored while varying the AC voltage to the AC wall supply. No variation in output was seen while setting the AC voltage to 97.7 VAC (-15%) or to 132.3 VAC (+15%).

CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
01	903.29	30 dBm	26.25	3.75
26	914.86	30 dBm	24.74	5.26
52	927.21	30 dBm	24.43	5.57



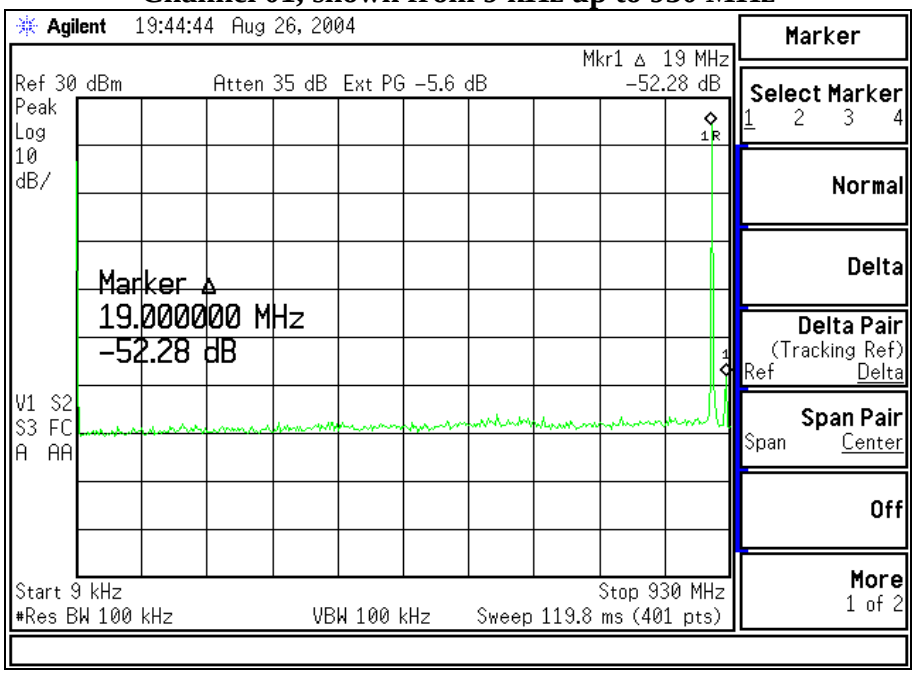
14. Conducted Emissions Test, Spurious Emissions 15.247(c)

FCC Part 15.247(c) 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 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.

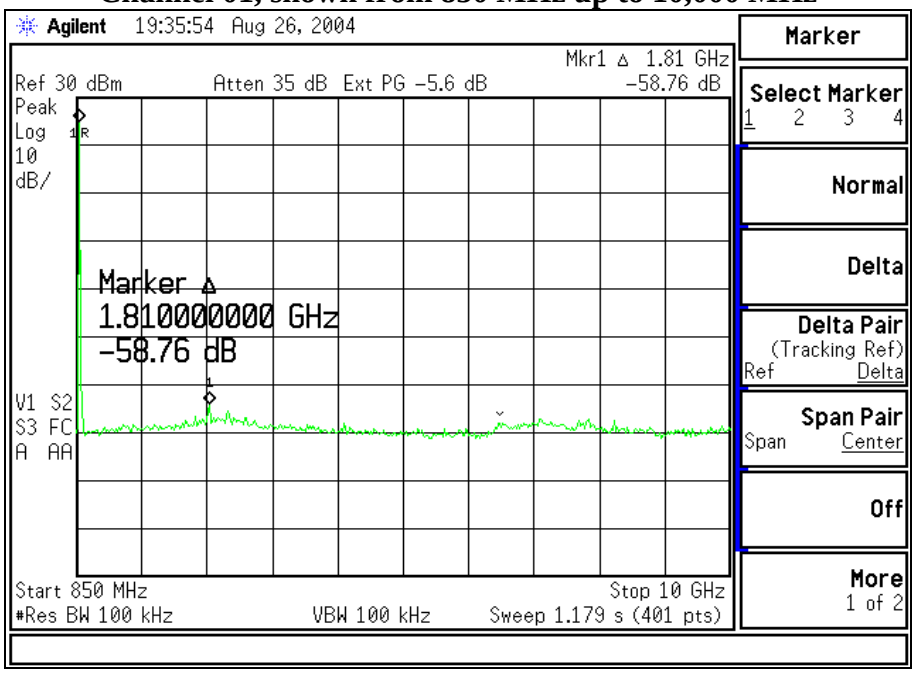
No significant emissions could be noted within -50 dBc of the fundamental level for this product.

Plots of Conducted Spurious and Fundamental Levels

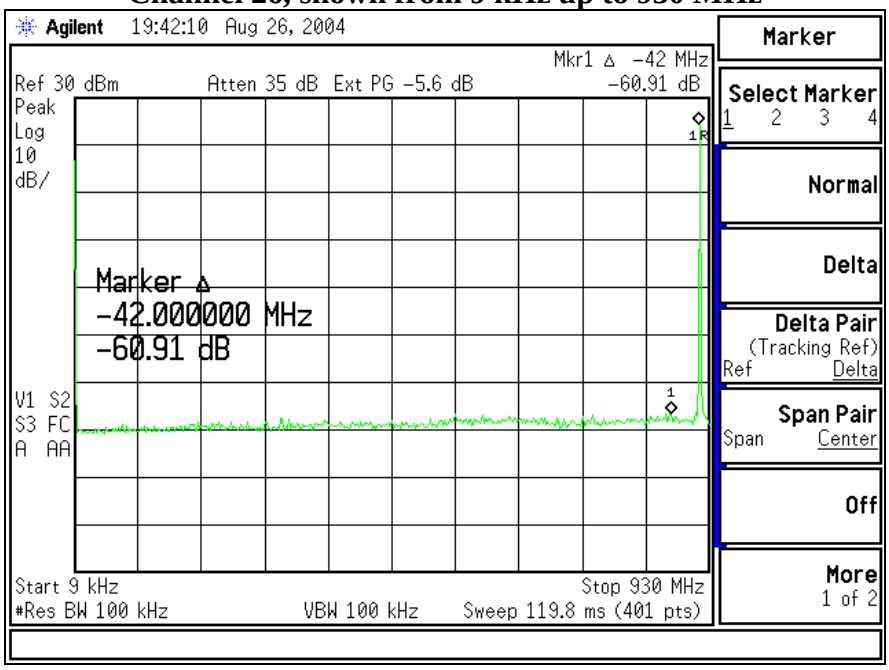
Channel 01, shown from 9 kHz up to 930 MHz



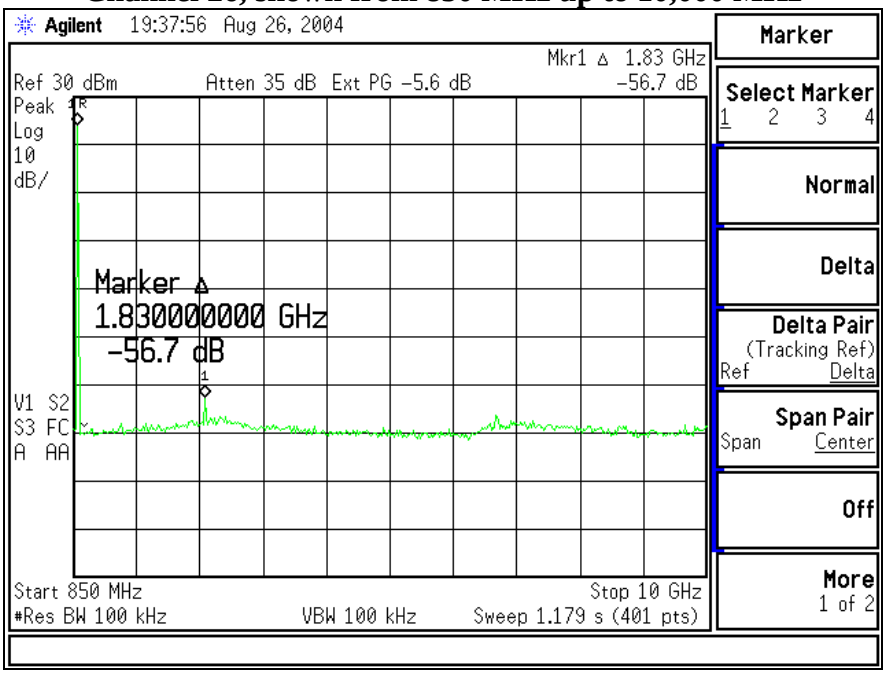
Channel 01, shown from 850 MHz up to 10,000 MHz



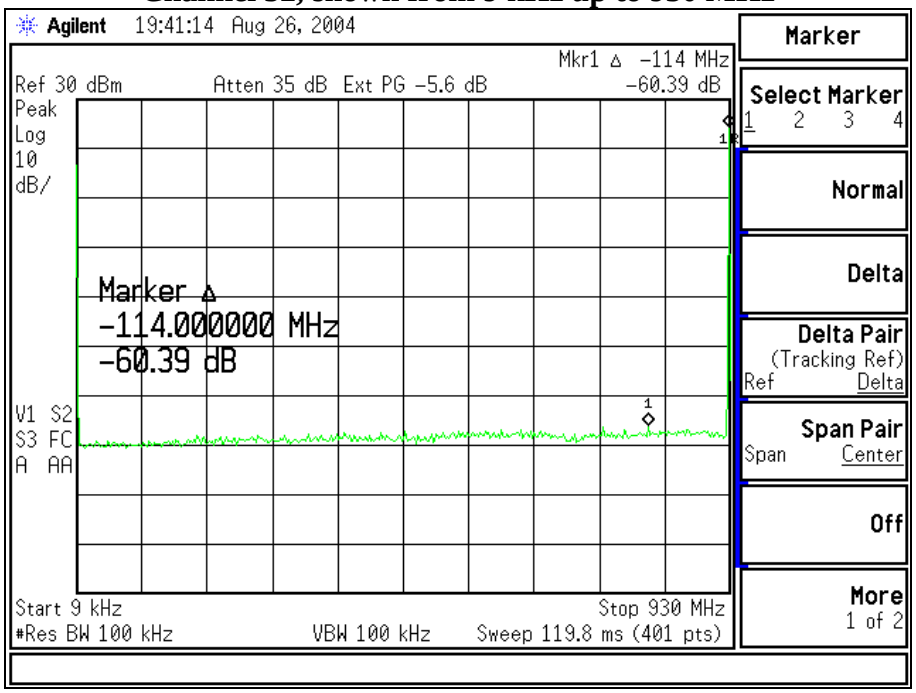
Channel 26, shown from 9 kHz up to 930 MHz



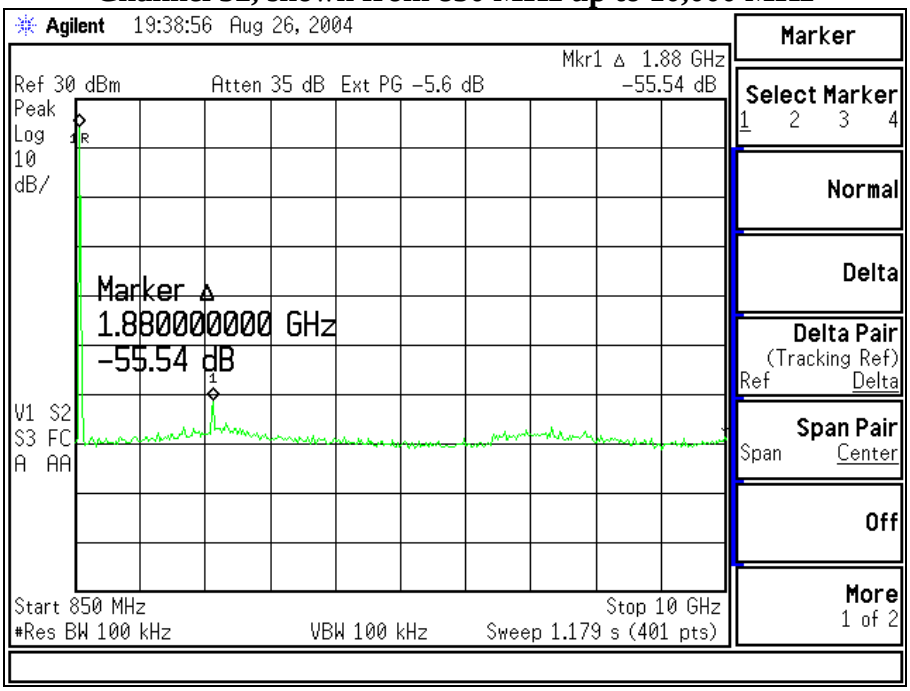
Channel 26, shown from 850 MHz up to 10,000 MHz



Channel 52, shown from 9 kHz up to 930 MHz



Channel 52, shown from 850 MHz up to 10,000 MHz



15. Conducted Emissions Test, Occupied Bandwidth

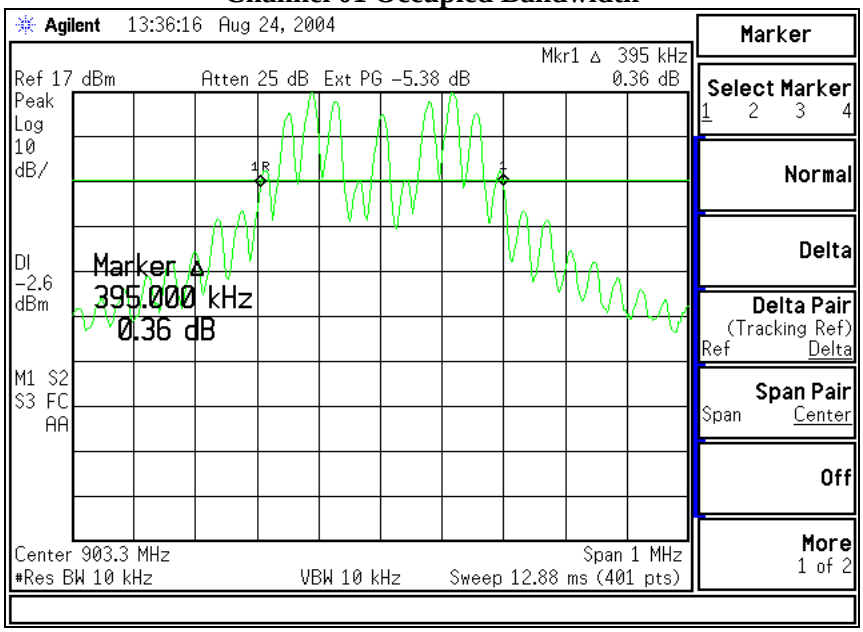
The 20 dB bandwidth requirement found in FCC Part 15.247(a)(1)(i) states a maximum allowed occupied bandwidth of 500 kHz. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4407B spectrum analyzer. 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 made without the need for any further corrections. A Hewlett Packard model E4407B 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 bandwidth of Channel 26, which is the closest data to the specification limit, is 398 kHz, which is below the maximum of 500 kHz.

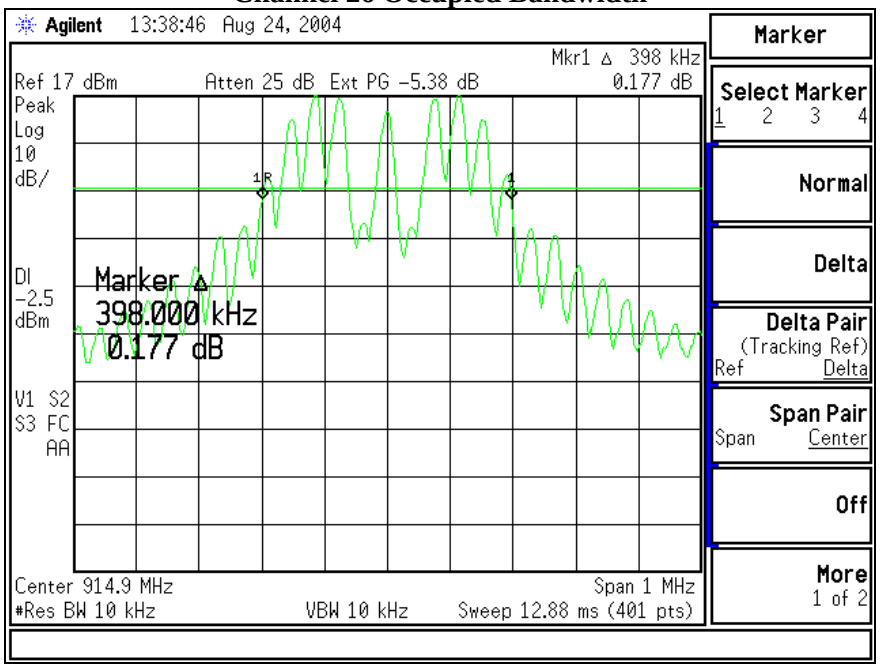
Channel	Center Frequency (MHz)	Measured 20 dB BW (kHz)	Maximum Limit (kHz)
01	903.29	395	500
26	914.86	398	500
52	927.21	395	500

Plots of Occupied Bandwidth

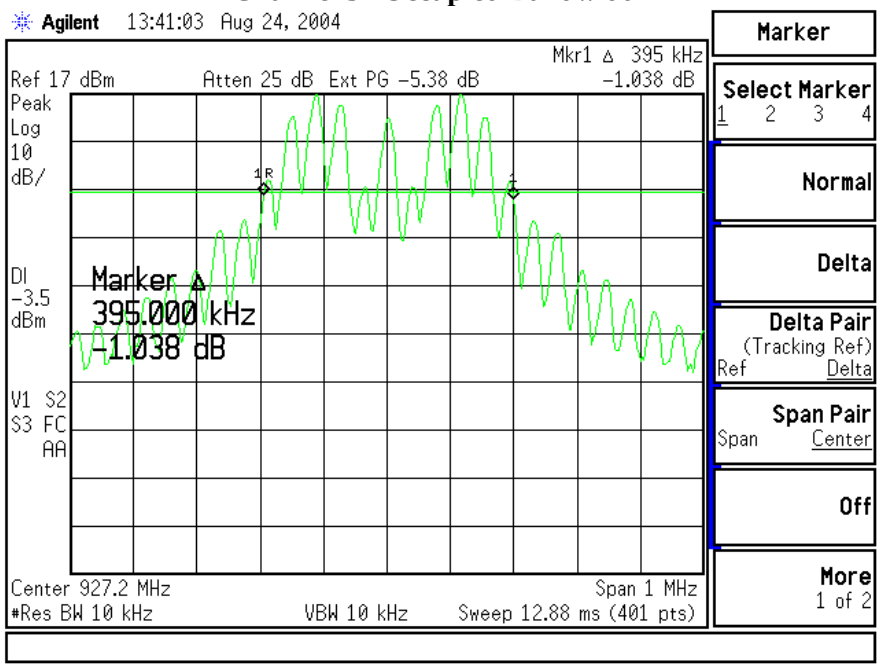
Channel 01 Occupied Bandwidth



Channel 26 Occupied Bandwidth



Channel 52 Occupied Bandwidth



16. Conducted Emissions Test, Minimum Channel Separation

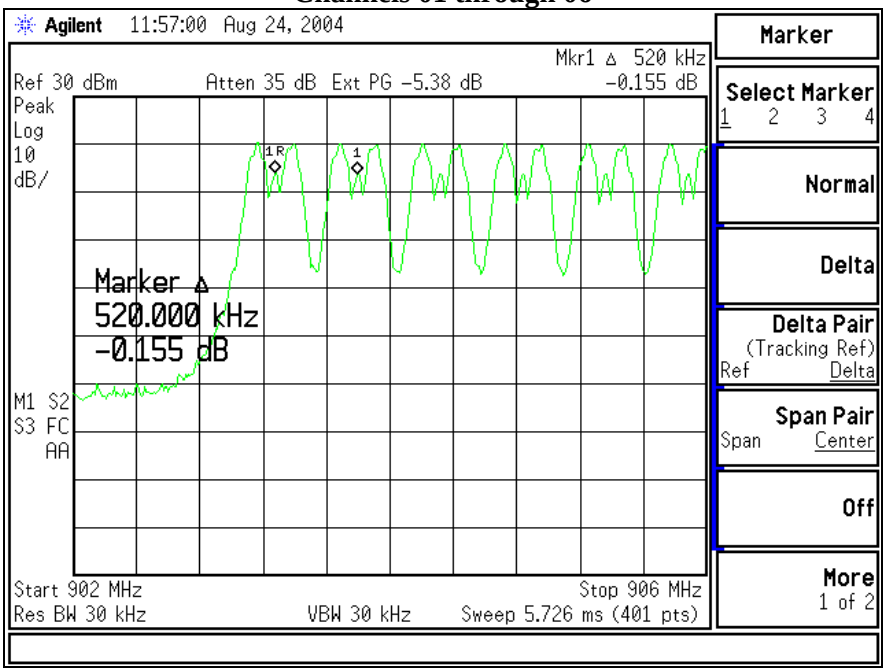
Part 15.247(a)(1) requires a minimum channel separation of 25 kHz or the equivalent of the 20 dB occupied bandwidth of the fundamental transmission, whichever is greater. An HP E4407B spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT.

The minimum and maximum channel separation for this device, as measured, are 420 kHz and 530 kHz. The maximum occupied bandwidth of the device, as reported in the previous section is 398 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 52.

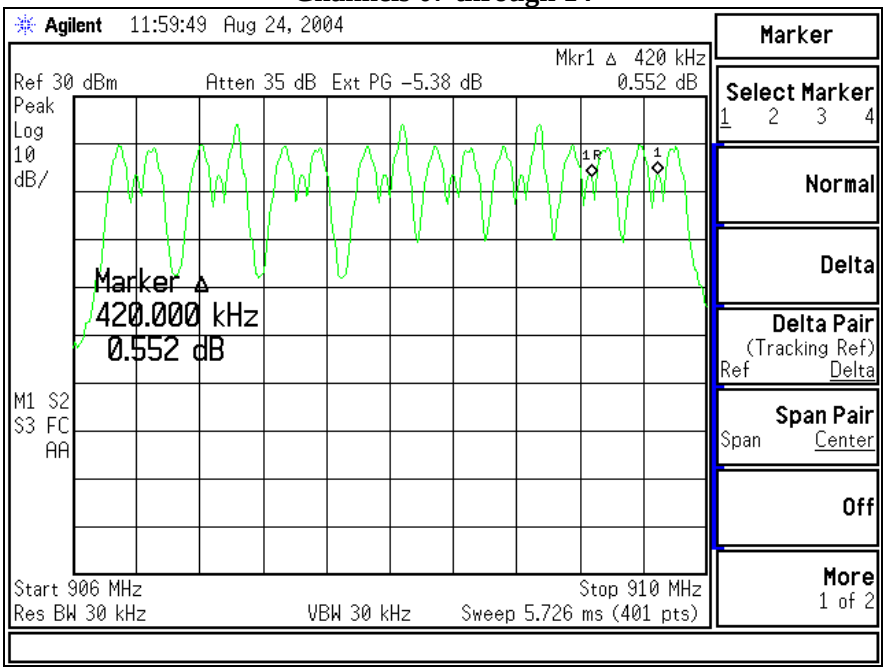
Channel Span	Minimum Separation (kHz)
01-06	520
07-14	420
15-23	420
24-33	420
34-42	430
43-52	530

Plots of Channel Separations

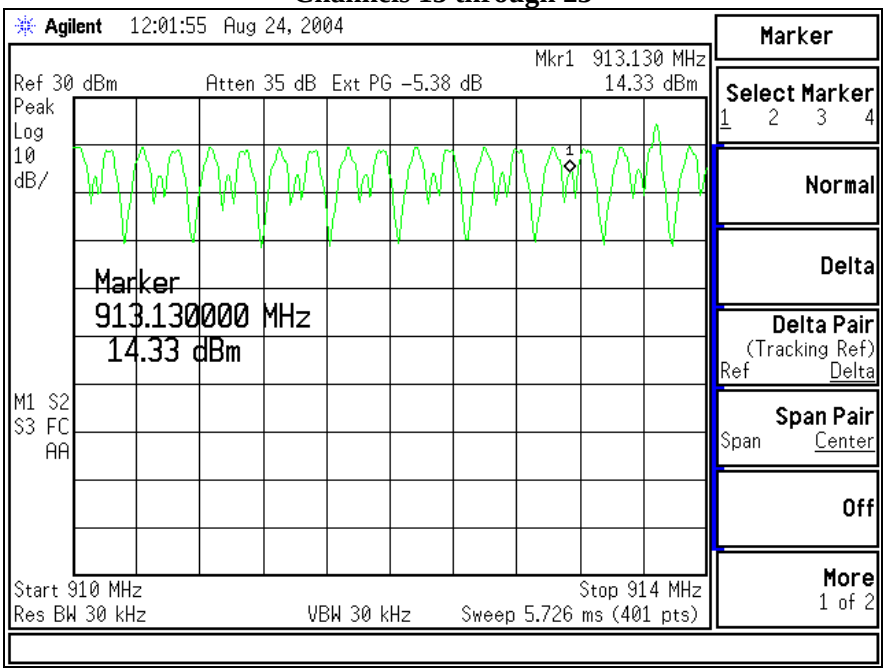
Channels 01 through 06



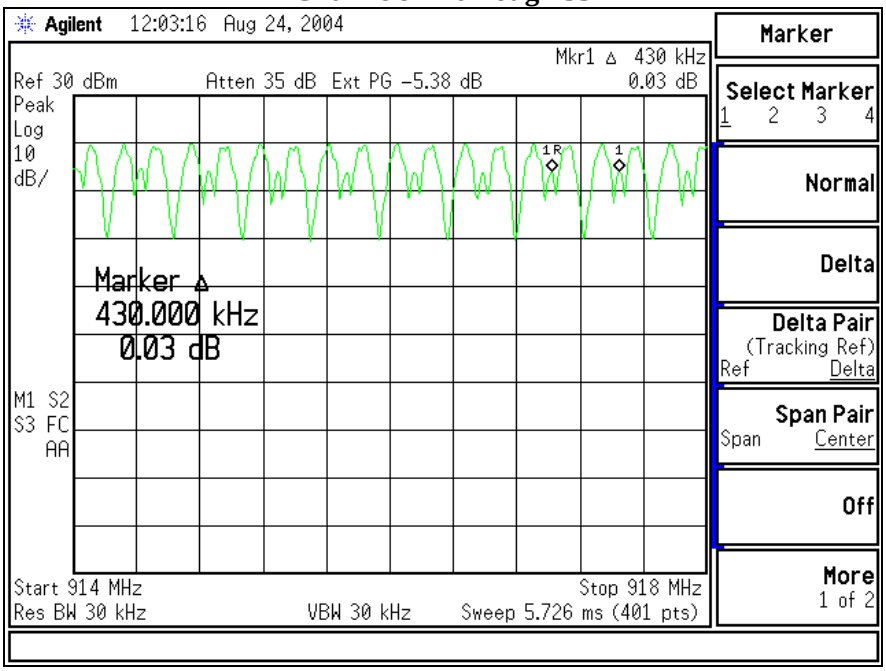
Channels 07 through 14



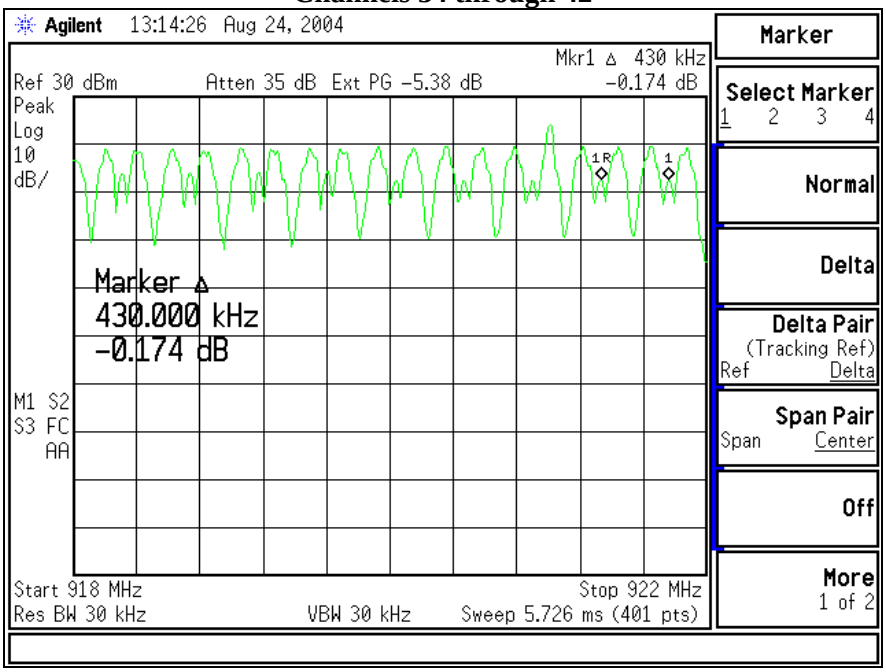
Channels 15 through 23



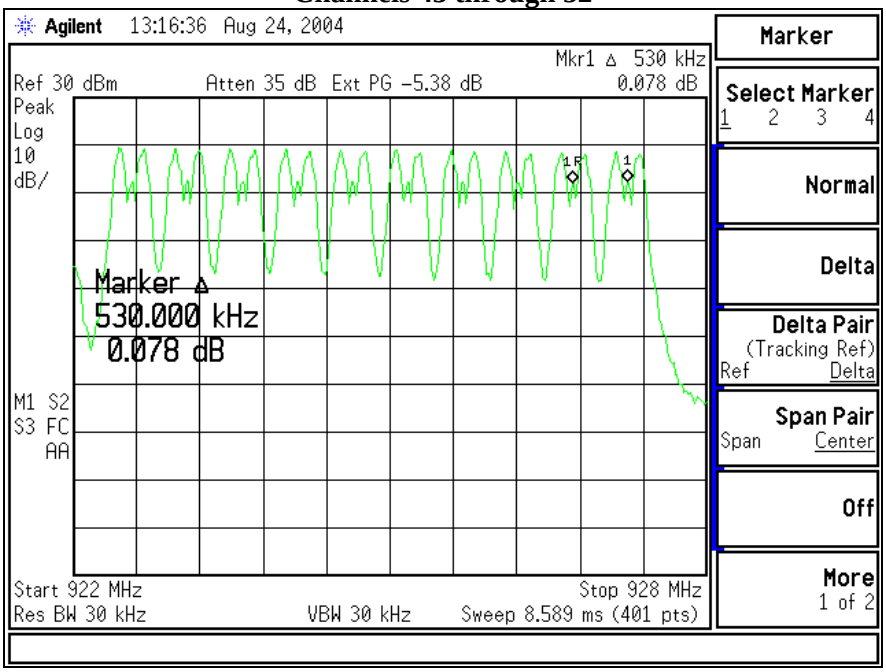
Channels 24 through 33



Channels 34 through 42



Channels 43 through 52



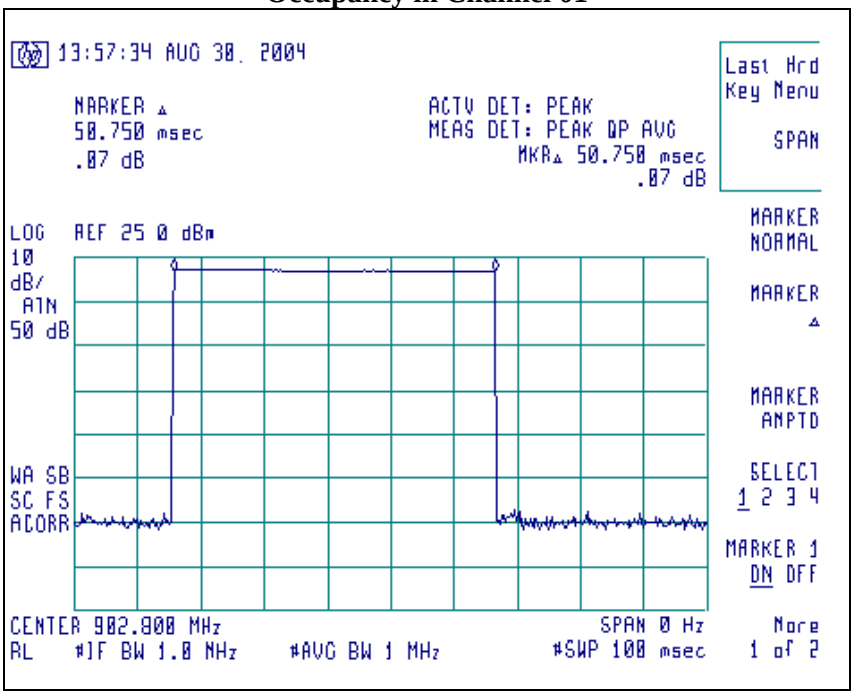
17. Conducted Emissions Test, Channel Occupancy

Part 15.247(a)(1) requires a channel occupancy, for this device, of no more than 400 milliseconds in a 10 second window. The channel occupancy for this EUT was measured using an HP E4407B spectrum analyzer, set to zero-span at the frequency of interest. With the analyzer in peak-hold mode, the transmission lengths can be measured by adjusting the sweep rate of the analyzer. A suitable sweep rate was used to measure the channel occupancy at the low, mid and high channels. The longest time any transmission will occur on a single channel is 51 ms. With a total of 50 channels used, each occupying a 51.0 ms slot, it will take 2.55 seconds for the sequence to repeat. In a 10 second window, each channel would have 3.92 transmission cycles. The maximum occupancy in a 10 second window is calculated by multiplying the 3.92 transmission cycles by 51.0 ms transmission duration per cycle, to arrive at 200 ms total occupancy.

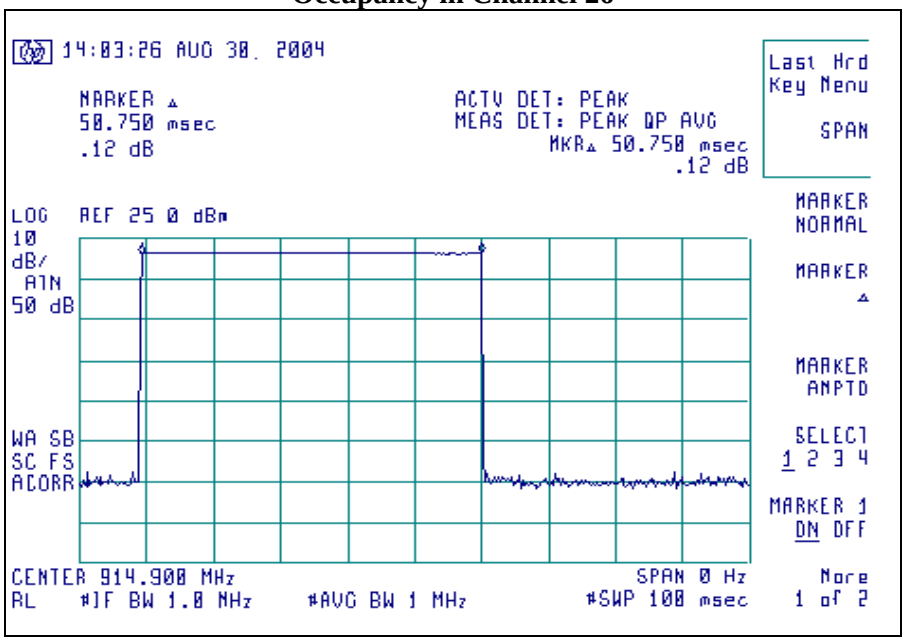
Channel	Frequency (MHz)	Occupancy Per transmission (ms)	Occupancy in 400 ms window (ms)
00	902.77	50.75	200
26	914.86	50.75	200
52	927.21	50.75	200

Plots of Channel Occupancy

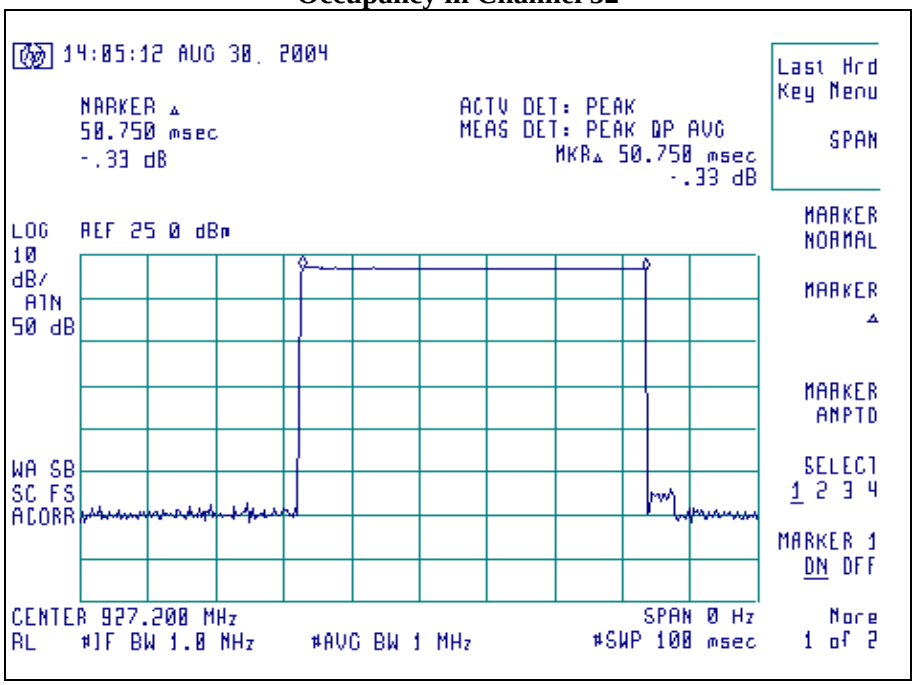
Occupancy in Channel 01



Occupancy in Channel 26



Occupancy in Channel 52



The information in the following sections is provided by the manufacturer.

18. Equal Channel Usage

50 channels are chosen from a pool of 53 available frequencies. These 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.

19. Pseudorandom Hopping Pattern

The hopping table is built using an 8 bit seed into an $X^{15}+1$ pseudorandom number generator giving the possibility of 256 unique pseudorandom hopping tables. Output from the generator is used to pick frequencies from a pool of 53 available channels. This also addresses part 15.247(h) concerns.

20. Receiver Synchronization

Each receiver requires the same seed for the pseudorandom sequence generator as the transmitter with which it is operating. The same seed will produce the same hop sequence in each device. Once the receiver scans and finds the transmitter on any given channel it will automatically be synchronized to go to the next correct channel by virtue of using the same hopping table.

21. Receiver Input Bandwidth

The radio receiver is a direct conversion type with a baseband filter whose cutoff frequency is matched to the transmission spectrum. The bandwidth is 600 kHz for use at the 76.8 kbps rate. Two level frequency shift keying is used for modulation. The simple Carson bandwidth for this type of signal is given as the bit rate plus 2 times the deviation. This system uses 114 kHz deviation for the 76.8 kbps rate, giving a bandwidth of 304.8 kHz. The excess filter bandwidth allows for frequency tolerance errors between the transmitter and receiver.

22. MPE Calculations

Base Station Transceiver
MPE Calcluation

Nearson S467AH-915S

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:	27.0	(dBm)
Maximum peak output power at antenna input terminal:	501.19	(mW)
Antenna gain(typical):	2.0	(dBi)
Maximum antenna gain:	1.58	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	915	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.61	(mW/cm^2)
Power density at prediction frequency:	0.15803	(mW/cm^2)
Maximum allowable antenna gain:	7.87	(dBi)
Margin of Compliance at 100cm:	5.866	(dB)

Appendix A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	9/03/03	9/03/04
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	9/02/03	9/02/04
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/02/03	9/02/04
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	11/14/03	11/14/04
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	11/04/03	11/04/04
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/04/03	9/04/04
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/04/03	9/04/04
N/A	LSC	Cable	0011	3 Meter ½" Armored Cable	6/07/04	6/07/05
N/A	LSC	Cable	0038	1 Meter RG 214 Cable	6/07/04	6/07/05
N/A	LSC	Cable	0050	10 Meter RG 214 Cable	6/07/04	6/07/05
N/A	Pasternack	Attenuator	N/A	10 dB Attenuator	Note 1	Note 1

Note 1 - Equipment calibrated within a traceable system.

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

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V