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

COMPLIANCE TESTING OF:

Bluetooth Sleep Transceiver

PREPARED FOR:

Pro-Tech Services, Inc.
Attn.: Mr. Patrick Lichter
4338 Harbour Point Boulevard, S.W.
Mukilteo, WA 98275

TEST REPORT NUMBER:

303373-TX a

TEST DATE(S):

September 22nd through November 7th, 2003

Table of Contents

1. L. S. Compliance In Review

Brief Review of
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:

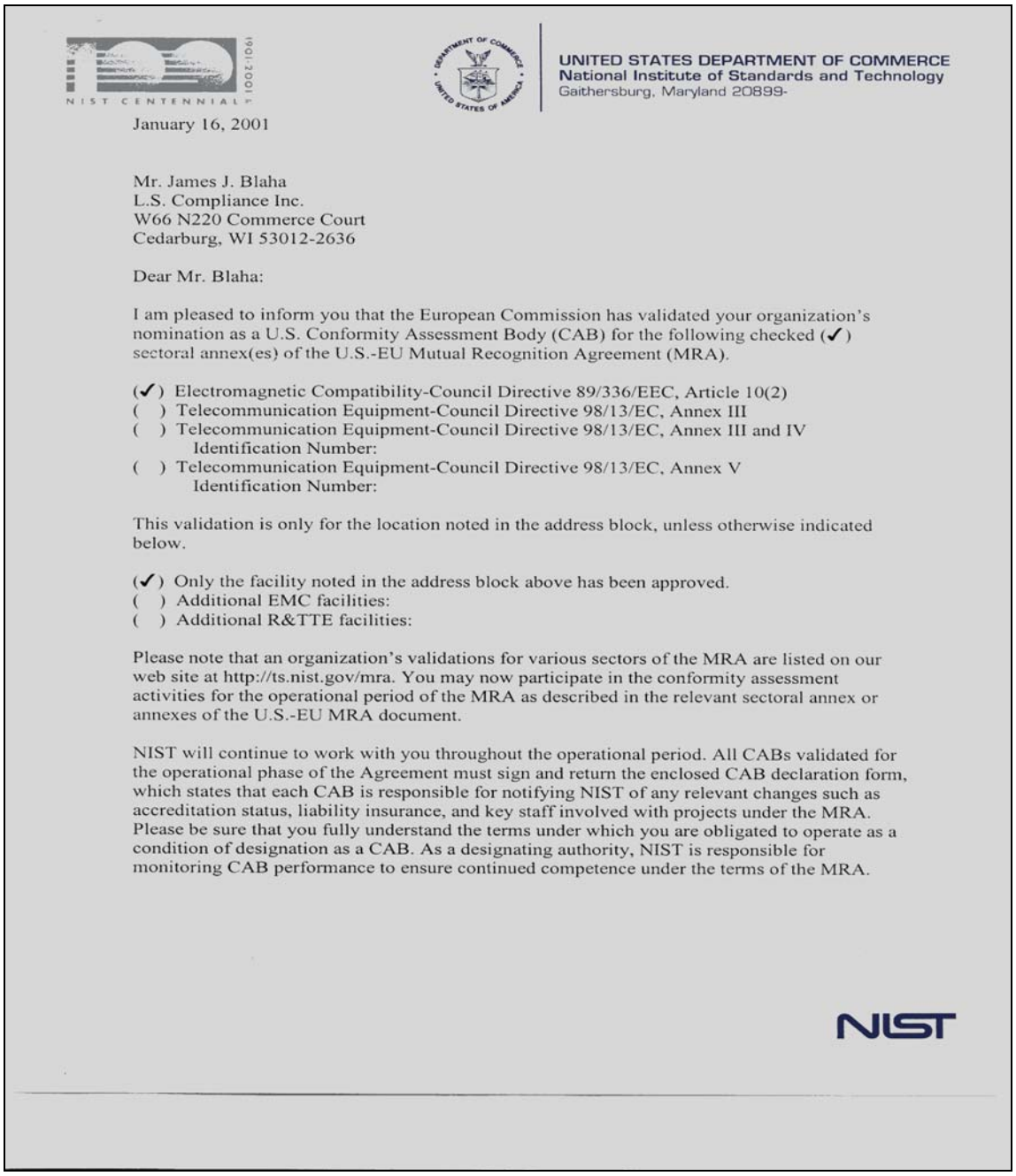
Test	Test Method(s)
Emissions	
Conducted	
Continuous/Discontinuous	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4; EN: 55011, 55022, 50081-1, 50081-2; CISPR: 11, 12, 14-1, 22; CNS 13438
Radiated	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4; 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.

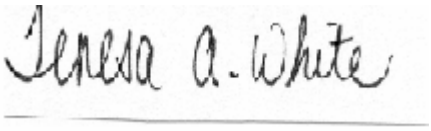
(✓) Only the facility noted in the address block above has been approved.
( ) Additional EMC facilities:
( ) Additional R&TTE facilities:

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

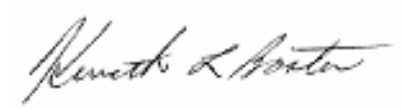


Prepared By: **February 17, 2004**

Teresa A. White, Document Coordinator **Date**

Tested By: **February 17, 2004**

Abtin Spantman, EMC Engineer **Date**



Approved By: **February 17, 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:	Pro-Tech Services, Inc.
Model No.:	UBST1
Serial No.:	E09150301
Description:	2.4 GHz wireless transceiver for sleep sensors.

7. Product Description

The Pro-Tech Services' Universal Bluetooth Sleep Transceiver system (UBST) provides a wireless solution for a set of Pro-Tech sleep Sensors. The Universal Bluetooth Sleep Transceiver will connect to a pre-defined set of Pro-Tech sleep sensors available on the market. The patient wears the transceiver, which replaces the wires and jack-box from the current monitoring systems, and allows direct data collection from the sleep sensor to the data collection computer. The data collection computer would have a generic Bluetooth transceiver. The Pro-Tech Services' Universal Bluetooth Sleep Transceiver system will include a universal analog front-end circuit including a fixed gain, low/high pass filters along with analog to digital conversion. The Universal Bluetooth Sleep Transceiver will send the digitized sleep sensor data to a generic Bluetooth transceiver, installed on the data collection computer. The data collection computer will be executing a Sleep Data Collection Software application that assimilates the sleep sensor data from each of the Universal Bluetooth Sleep Transceivers and formats it into the industry standard EDF format file. The EDF file can then be imported into a number of third-party commercially available sleep analysis software packages.

The system uses a frequency-hopping spread spectrum technique, and is capable of hopping to 79 channels. The radio module uses Gaussian Frequency-Shift Keying (GFSK) techniques to transmit binary encoded data. Three channels would be selected for testing, channel 1 (2402 MHz), channel 40 (2441 MHz), and channel 79 (2480 MHz).

The Universal Bluetooth Sleep Transceiver operates on an internal rechargeable battery at 3.6 VDC.The transceiver incorporates a ***Centurion*** brand, model CAF95901 surface mount "Chip" type antenna, permanently installed internally on the printed circuit board. The declared gain of this antenna is better than 2 dBi.

8. Test Requirements

The tests were performed in order to determine the compliance of the Pro-Tech Services' Universal Bluetooth Sleep Transceiver system with limits contained in various provisions of Title 47 CFR, FCC Part 15, including 15.109, 15.205, 15.207, and 15.247.

All radiated emissions tests were performed to measure the emissions in the frequency bands described by the above sections, and to determine whether said emissions are below the limits established by the above sections. These tests were performed in accordance with the procedure described in the American National Standard for methods of measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2001). Another document used as reference for the EMI receiver specification was the International Special Committee on Radio Interference CISPR 16-1 (2002). Measurement technique guidelines found in Appendix C to FCC 97-114 were also consulted, as well as FCC Public Notice DA00-705, and 97-114.

9. DECLARATION OF CONFORMITY

The Pro-Tech Services' Universal Bluetooth Sleep Transceiver system was found to **MEET** the requirements as described within the specification of Title 47 CFR FCC, Part 15.247, for a digitally modulated spread spectrum transmitter.

10. Introduction

Between September 24th and October 15th, 2003, a series of Radiated and Conducted Emission tests were performed on the Pro-Tech Services' Universal Bluetooth Sleep Transceiver system, model number: 'UBST1', serial number: 'E09150301', 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 for a digital device. These tests were performed by Abtin Spantman, EMC Engineer at L.S. Compliance, Incorporated.

11. Purpose

All Radiated and Conducted Emission tests upon the EUT were performed to measure the emissions in the frequency bands described in Title 47 CFR, FCC Part 15, including 15.35, 15.207, and 15.247 to determine whether these emissions are below the limits expressed within the standards. These tests were performed in accordance with the procedure described in the American National Standard for methods of measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2001). Another document used as a reference for the EMI Receiver specification was the Comite International Special Des Perturbations Radioelelectriques CISPR 16-1, 2002. Measurement technique guidelines found in Appendix C to FCC 97-114 were also consulted, as well as FCC Public Notice DA00-705, and 97-114.

12. Radiated Emissions Test

Test Setup

The test setup was assembled in accordance with Title 47, CRF 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 the 3 Meter Semi-Anechoic, FCC listed Chamber located at L. S. Compliance, Inc., Cedarburg, Wisconsin. The EUT was operated in continuous transmit mode, using power from an onboard 3.6 VDC Lithium type battery. The battery were checked constantly during the testing, and recharged as needed. The applicable radiated emission limits apply at a 3-meter measurement distance. Measurements above 6 GHz were performed at a 1-meter measurement distance. The calculations to determine the 3-meter limits are detailed in the following pages. Please refer to Appendix A for a list of the test equipment. The test sample was operated on one of three standard channels: low (2402 MHz), medium (2441 MHz) and high (2480 MHz) to comply with FCC Part 15.35.

Test Procedure

Radiated Emission measurements were performed on the EUT in the 3 Meter Semi-Anechoic, FCC listed Chamber, located at L. S. Compliance, Inc. in Cedarburg, Wisconsin. The frequency range from 30 MHz to 25,000 MHz was scanned, and 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 table in the 3 Meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters separation from the test object during tests below 6 GHz, and at 1 meter separation during tests above 6 GHz. 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 and a Pyramidal Horn Antenna was used from 18 GHz to 25 GHz. The maximum radiated emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities, and rotating the EUT on the turntable to expose all sides of the device to the sense antenna. This procedure was repeated with the EUT in different orientations to measure emissions from the EUT across all three axis.

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 a 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 bandwidth of 120 kHz for measurements below 1 GHz, and a bandwidth of 1 MHz for measurements above 1 GHz. Both the Peak and Quasi-Peak Detector functions were utilized. From 6 GHz to 25 GHz, an Agilent E4407B Spectrum Analyzer was utilized along with the appropriate horn antenna.

Test Results

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

CALCULATION OF RADIATED EMISSIONS LIMITS

The following limits are obtained from Title 47CFR, Part 15.247 for spread-spectrum intentional radiators:

- Maximum peak output power for fundamental = 1 watt conducted = 30 dBm
  or equivalently, when measured at a 3 meter separation distance = 125.2 dBμV/m

- Maximum spurious emissions are limited to the higher limit of -20 dBc or 15.209 general emissions limits, as outlined below.

The following table depicts the general radiated emission limits. These limits are obtained from Title 47 CFR, part 15.209a, for radiated emissions measurements, and are applied as limits in restricted bands as expressed in 47 CFR, part 15.205.

Frequency (MHz)	3 m Limit μV/m	3 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

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

$dB\mu V/m = 20 \log_{10}$ (3m limit)

from 30 - 88 MHz for example: $dB\mu V/m = 20 \log_{10}$ (100)

$40.0\ dB\mu V/m = 20 \log_{10}$ (100)

For measurements made at 1 meter, a 9.5 dB correction has been invoked.

960 MHz to 25,000 MHz

500 μV/m or 54.0 dBμV/m at 3 meters

54.0 + 9.5 = 63.5 dBμV/m at 1 meter

Note: Limits are conservatively rounded to the nearest tenth of a whole number.

Summary of Results and Conclusions

Based on the procedures outlined in this report, and the test results, it can be determined that the EUT does **MEET** the emission requirements of Title 47 CFR, FCC Part 15.247, for a digitally modulated spread spectrum transmitter.

The enclosed test results pertain to the samples of the test item listed, and only for the tests performed per 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.

Measurement of Electromagnetic Radiated Emissions Within the 3 Meter FCC Listed Chamber

Manufacturer: Pro-Tech Services, Incorporated
Model No.: UBST1
Serial No.: E09150301
Date of Test: October 15th through September 24th, 2003

Test Requirements: 15.247 and 15.205

Distance: 3 meter (f<6 GHz), 1 meter (F>6 GHz)	**Frequency Range Inspected:** 25 to 25,000 MHz
Configuration: Continuous Transmit	

Test Equipment Used:

Receiver: HP 8546A (Below 6 GHz),						Biconical Antenna: EMCO 93110B	
Receiver: Agilent E4407B (Above 6 GHz)						Log Periodic Antenna: EMCO 43146A	
Double-Ridged Wave Guide/Horn Antenna: EMCO 3115						Pyramidal Horn Antenna: EMCO 3160	
Detector(s) Used:	√	Peak	√	Quasi-Peak (f<1 GHz)	√	Average (f>1 GHz)	

The following table depicts the E.I.R.P. measured at 3 meters distance from the EUT.

Frequency (MHz)	Antenna Polarity	Channel #	Antenna Height (m)	Azimuth (0° 360°)	EMI Meter Reading (dBuV/m)	15.247 Limit (dBuV/m)	Margin (dB)
2402	H	Low	1.10	50	100.1	125.2	25.1
2441	H	Mid	1.05	55	99.7	125.2	25.5
2480	H	High	1.05	55	96.7	125.2	28.5

Notes:

1) The highest level of fundamental emissions were measured on the 'Low' channel, with the EUT in a horizontal orientation.

The following table depicts the level of significant radiated emissions measured, at 3 meters if below 6 GHz, and at 1 meter distance from the EUT if above 6 GHz.

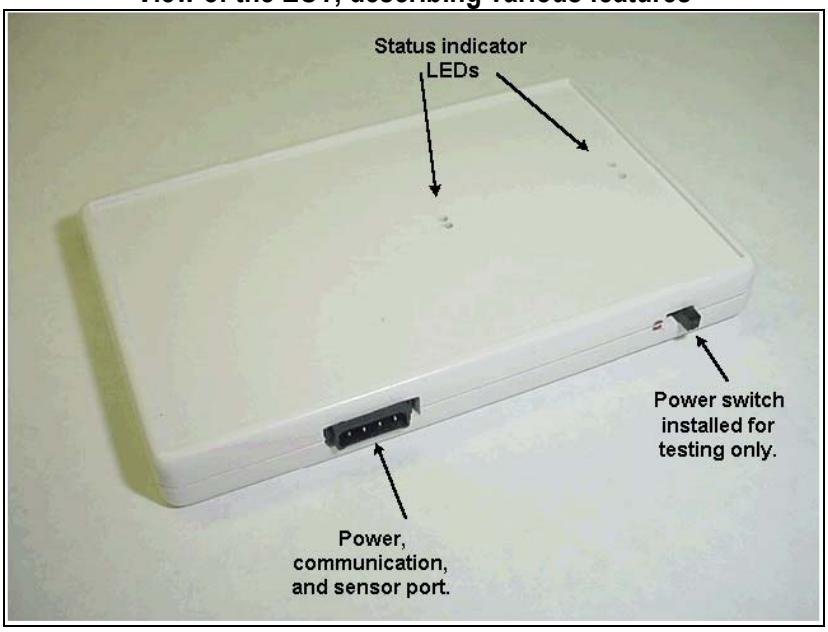
Frequency (MHz)	Antenna Polarity	Channel #	Antenna Height (m)	Azimuth (0° 360°)	EMI Meter Reading (dBuV/m)	15.247 Limit (dBuV/m)	Margin (dB)
4804	H	Low	1.05	295	43.3	54.0	10.7
4882	H	Mid	1.15	350	46.4	54.0	7.6
4960	H	High	1.10	0	48.9	54.0	5.1
7206	H	Low	1.00	135	62.0	63.5	1.5
9608	V	Low	1.00	35	44.3	63.5	19.2
12010	V	Low	1.00	100	54.8	63.5	8.7
14412	V	Low	1..00	45	46.3	63.5	17.2
16814	H	Low	1.00	20	41.8	63.5	21.7

Notes:

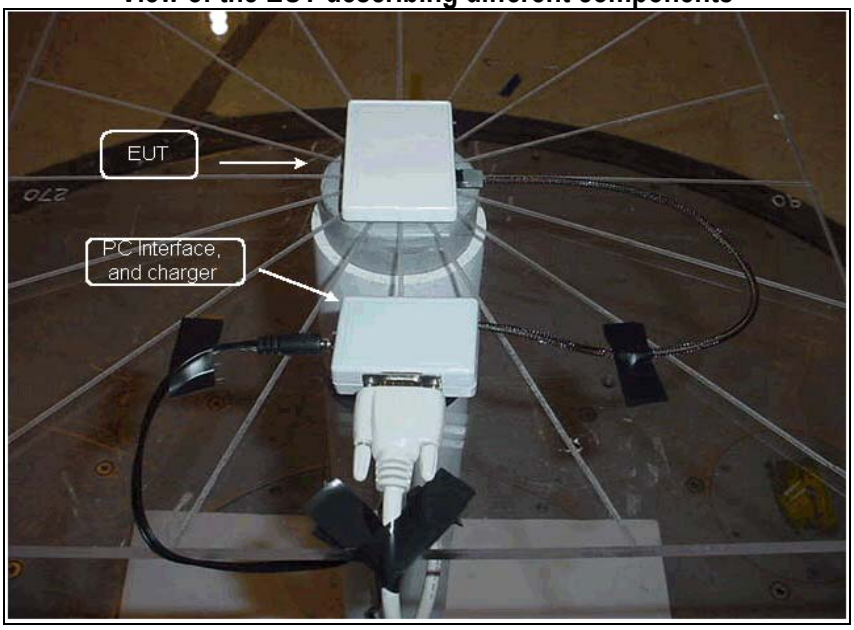
2) All peak spurious emissions seen were greater than 20 dB below the 74 dBµV/m limit, above 1 GHz.
3) The highest spurious emissions observed were with the EUT in the vertical orientation.
4) All emissions seen, other than noise floor, were greater than 20 dB below the limit.

Photos Taken During Radiated Emission Testing

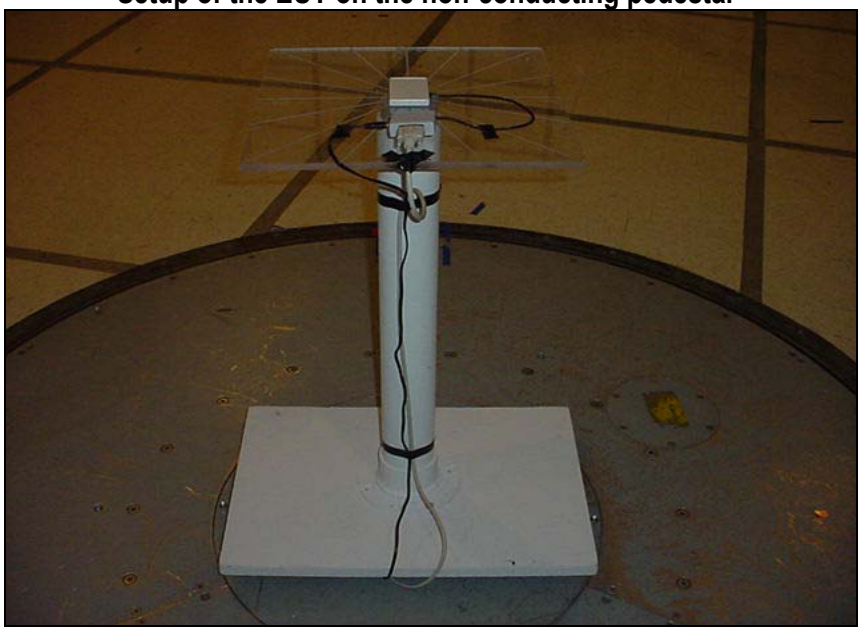
View of the EUT, describing various features



View of the EUT describing different components

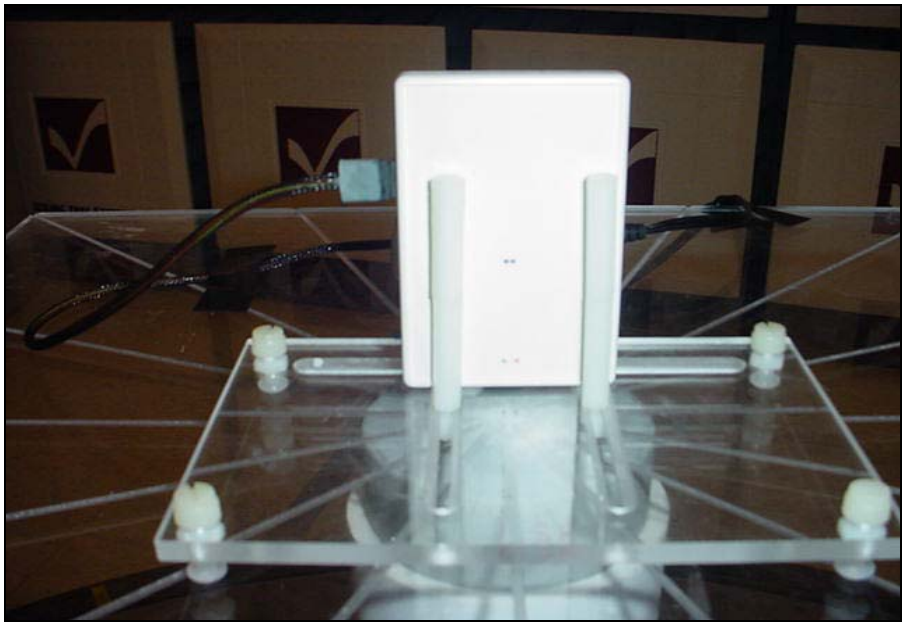


Setup of the EUT on the non-conducting pedestal

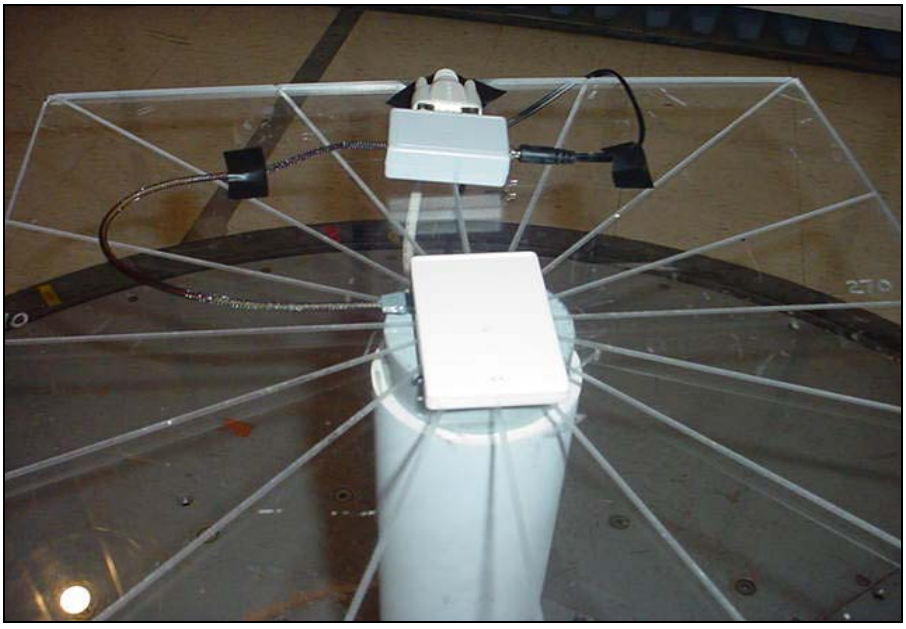


Setup for the Radiated Emissions Tests

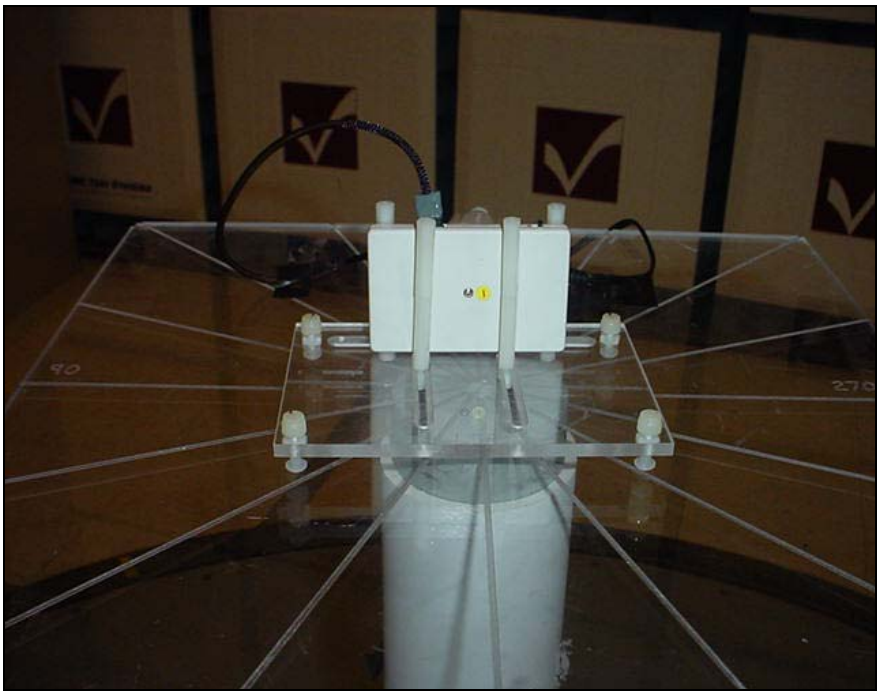
View of the EUT, as setup during radiated emissions tests, shown on vertical orientation



View of the EUT in horizontal orientation

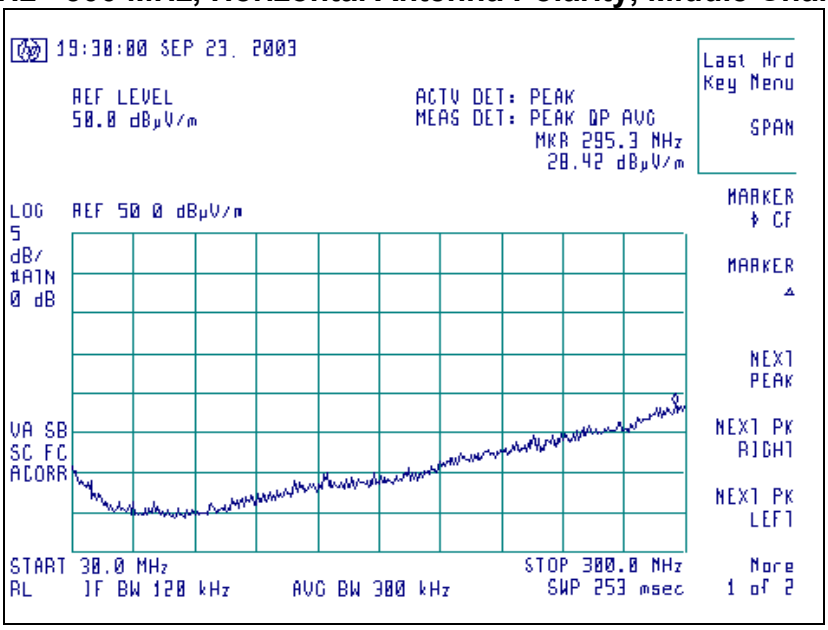


View of the EUT in the side orientation.

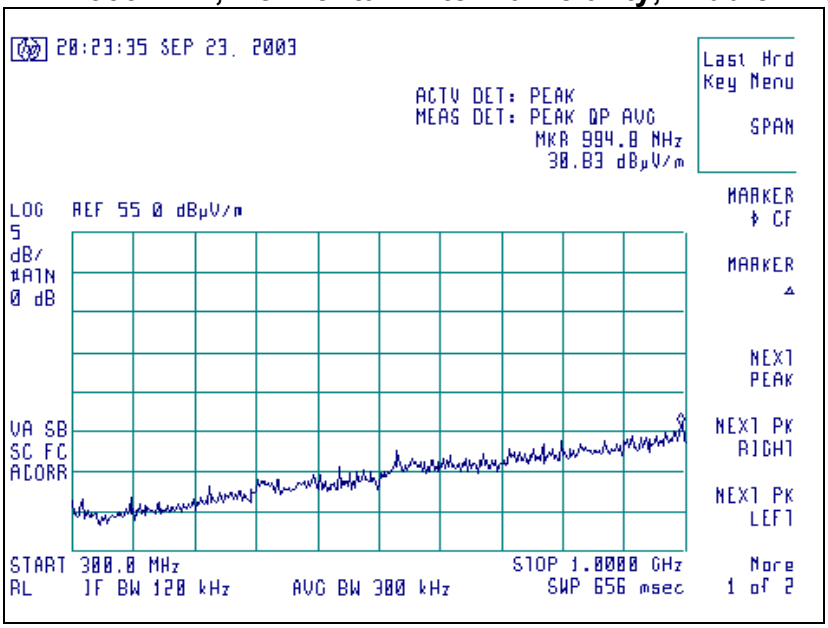


Graphs made during Radiated Emission Testing

Signature Scan of Radiated Emissions, at 3 meter
30MHz - 300 MHz, Horizontal Antenna Polarity, Middle Channel.

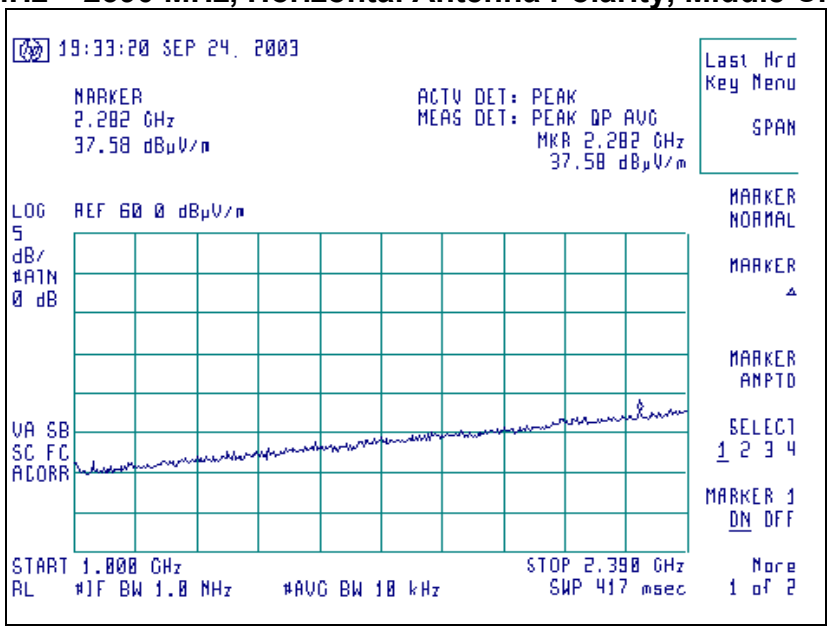


Signature Scan of Radiated Emissions, at 3 meter
300 MHz - 1000 MHz, Horizontal Antenna Polarity, Middle Channel.



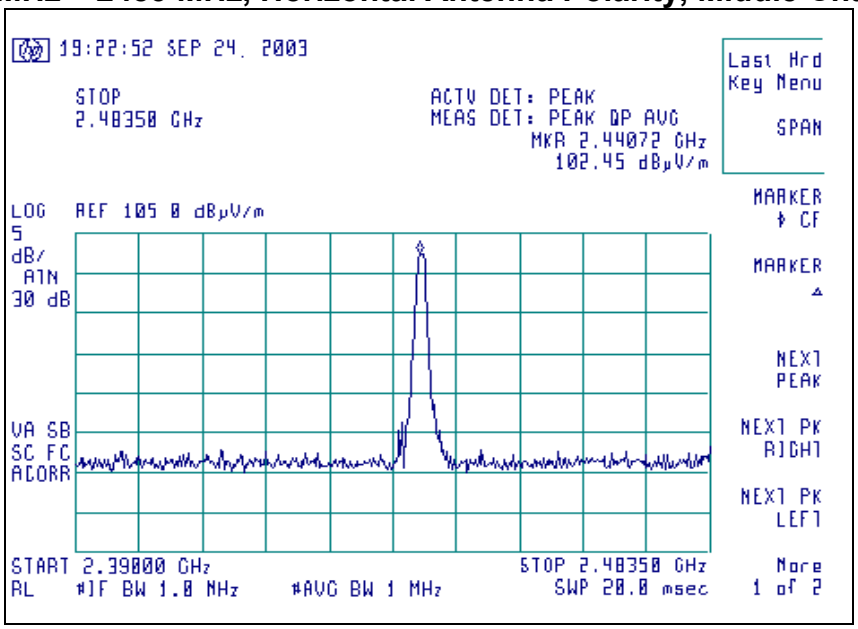
Signature Scan of Radiated Emissions, at 3 meter

1000 MHz – 2390 MHz, Horizontal Antenna Polarity, Middle Channel.



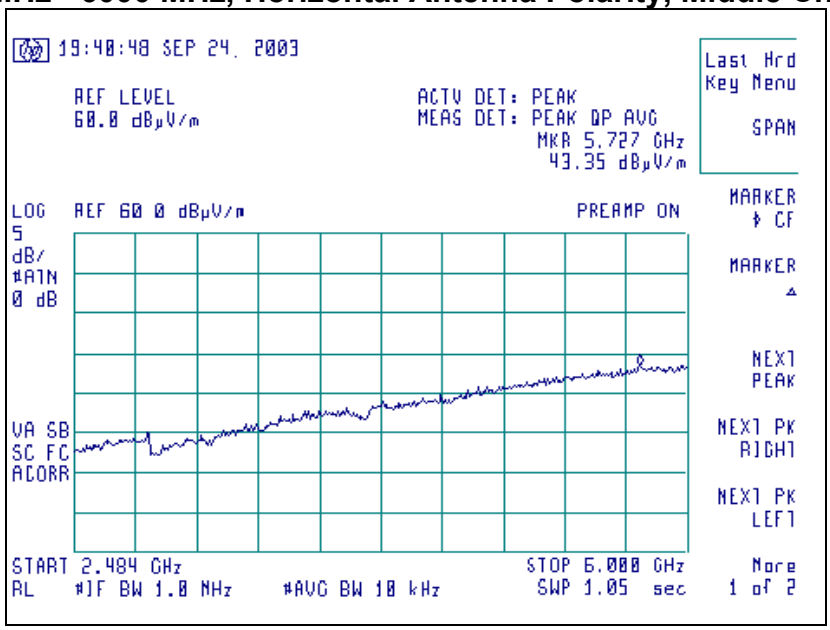
Signature Scan of Radiated Emissions, at 3 meter

2390 MHz – 2483 MHz, Horizontal Antenna Polarity, Middle Channel.



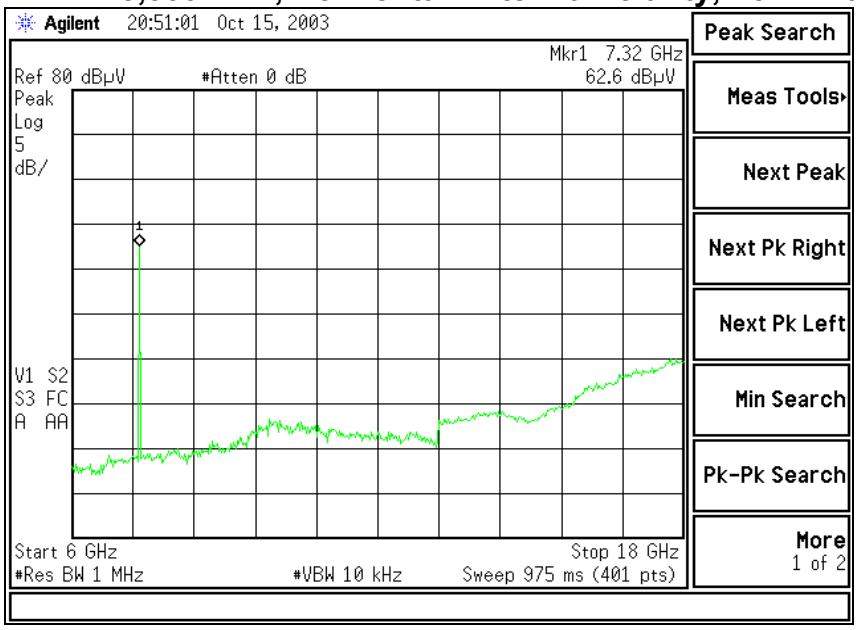
Signature Scan of Radiated Emissions, at 3 meter

2484 MHz - 6000 MHz, Horizontal Antenna Polarity, Middle Channel.



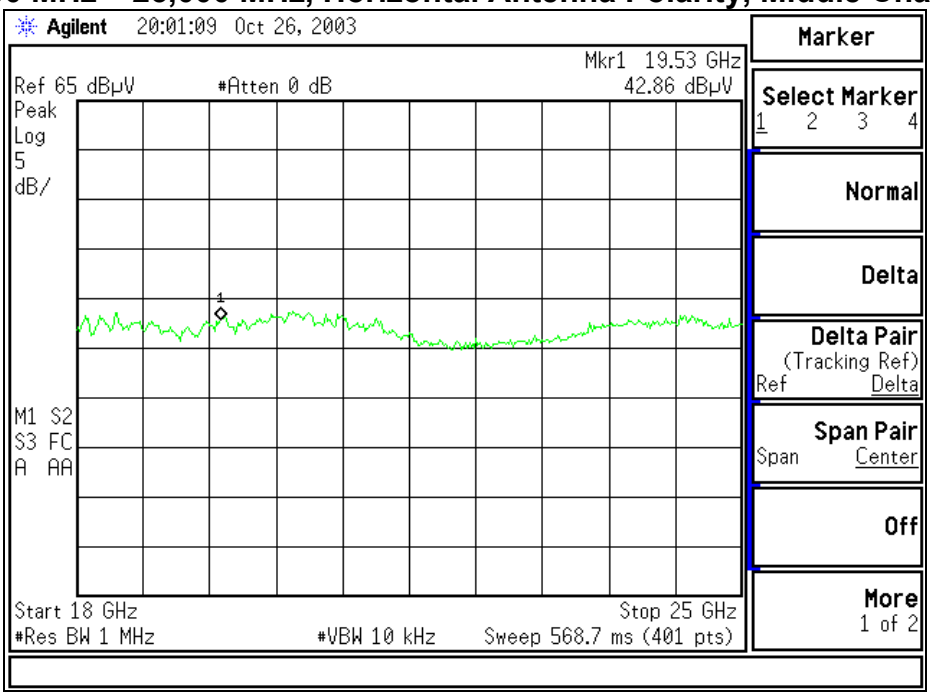
Signature Scan of Radiated Emissions, at 1 meter

6000 MHz – 18,000 MHz, Horizontal Antenna Polarity, Low Channel.



Signature Scan of Radiated Emissions, at 1 meter

18,000 MHz – 25,000 MHz, Horizontal Antenna Polarity, Middle Channel.



**Emissions observed to be 15 to 20 dB below 63.5 dBµV/m limit, or at receiver system noise floor.

13. Conducted Emissions Test (AC Power Line)

Test Setup

Although the normal operation of the EUT is defined with the battery, the EUT does utilize the AC mains during the battery charging cycle. A typical wall step-down transformer is utilized as a charger, providing 5 VDC, 300 milli-amperes to the EUT. The emissions into the mains were measured through that wall transformer.

The Conducted Emissions test was performed within the FCC Listed Shielded Room, located 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, Subpart B (Industry Canada RSS-210). The EUT was placed on a non-conductive pedestal, with a height of 80 cm above the reference ground plane. The EUT's power supply was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The Mains supply of 110 VAC was provided into the Shielded Room through an appropriate broadband EMI Filter, and then to the LISN line input. After the EUT was setup in the FCC Listed Shielded Room and connected to the LISN, the RF Sampling Port of the LISN was cabled 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 appropriate frequency range and bandwidths were entered into the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1 (2002), Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. 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 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. 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 (Industry Canada RSS-210), Conducted Emissions for an intentional Radiator. See the Data Charts and Graphs for more details of the test results.

Calculation of Conducted Emissions Limits

These limits are obtained from Title 47 CFR, Part 15.207(a) for Conducted Emissions.

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

* Decreases with the logarithm of the frequency.

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

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

For a frequency of 200 kHz for example:

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

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

Measurements of Electromagnetic Conducted Emission into the AC Mains

Frequency Range Inspected: 0.15 MHz – 30.0 MHz
Test Requirements: Title 47CFR 15.207

Manufacturer:	Pro-Tech Services, Incorporated						
Date(s) of Test:	November 7th, 2003						
Model #:	UBST1						
Serial #:	E09150301						
Voltage:	110 VAC into 5 VDC, 300 mA Wall transformer						
Detectors Used:			Peak	√	Quasi-Peak	√	Average

Test Equipment Utilized:
EMI Receiver: HP 8546A
LISN: 3816NM
Transient Limiter: HP 11947A

Emissions measurements into the AC mains. Data presented is from transmitter testing, on Low channel. Middle and high channels presented similar emissions performance.

Frequency (MHz)	Line	EMI Quasi-Peak Reading (dBμV/m)	Quasi-Peak Limit (dBμV/m)	Quasi-Peak Margin (dB)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)
0.18	L1	38.8	64.5	25.7	37.1	54.5	17.4
0.44	L1	33.0	57.1	24.1	30.7	47.1	16.4
19.73	L1	29.1	60.0	30.9	8.8	50.0	41.2
0.18	L2	36.0	64.5	28.5	33.7	54.5	20.8
0.44	L2	31.7	57.1	25.4	28.6	47.1	18.5
19.88	L2	28.4	60.0	31.6	10.0	50.0	40.0

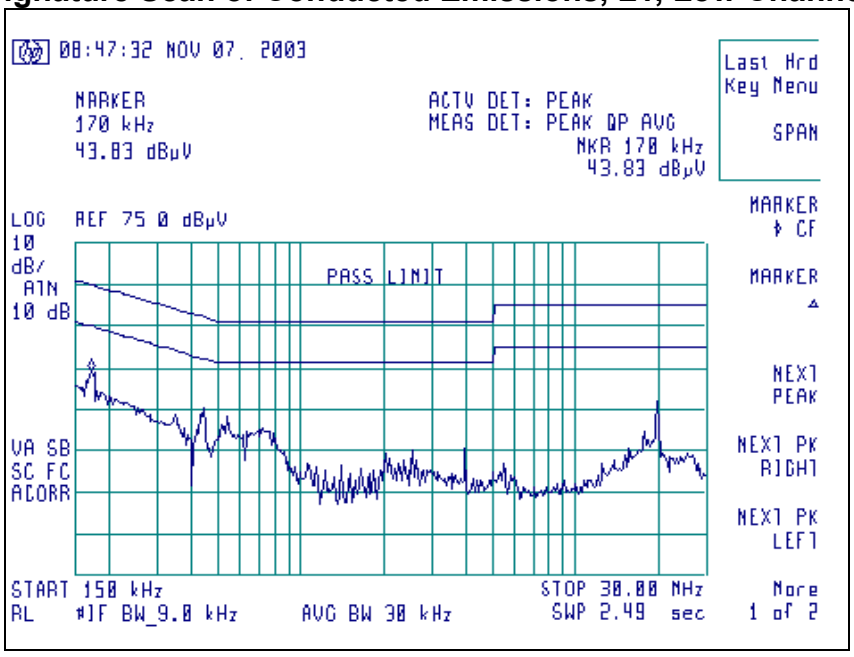
Notes:
1) All other emissions were better than 20 dB below the limits.
2) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Mid, and High channels tested.

Photo Taken During Conducted Emission Testing

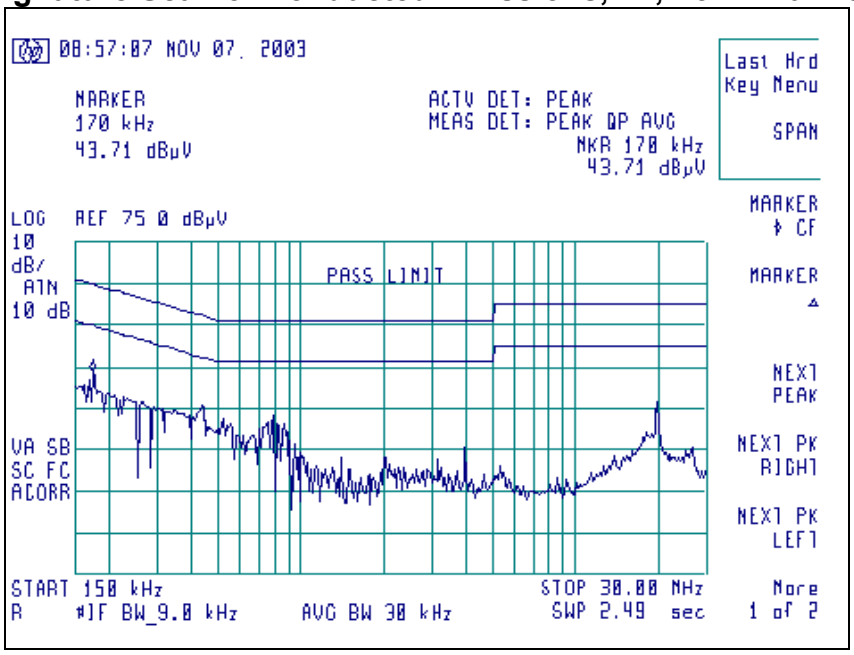
View of the EUT during Conducted Emissions Testing

Graphs made during Conducted Emission Testing

Signature Scan of Conducted Emissions, L1, Low Channel



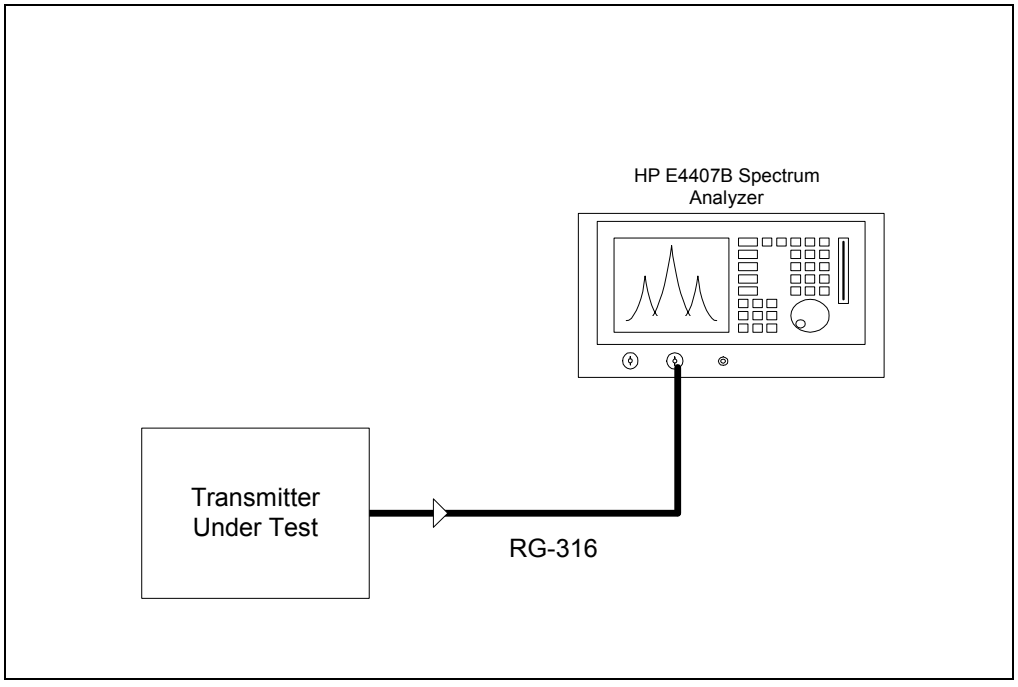
Signature Scan of Conducted Emissions, L2, Low Channel



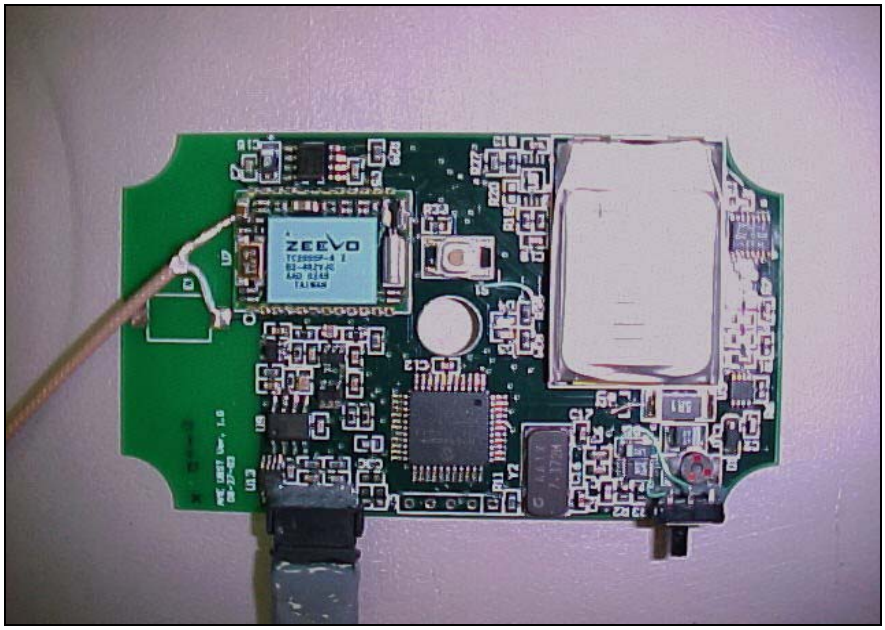
14. Power Output Test Performed

Conducted measurements were carried out on the RF Transceiver Board to verify conformance with the FCC Part 15.247.b.3 measurement. The PCB antenna on the transceiver was disconnected and the RF output port connected via a short jumper cable, to the input of the HP E4407B Spectrum Analyzer. The unit was configured to run in a normal continuous transmit mode, while being supplied with normal data packets as a modulation source. The HP receiver was set for a resolution bandwidth of 3 MHz, and the peak transmit signal was then stored. This power level was collected for three channels, then adjusted to reflect 3.3 dB of cable loss in this frequency range, can be seen in the chart presented below.

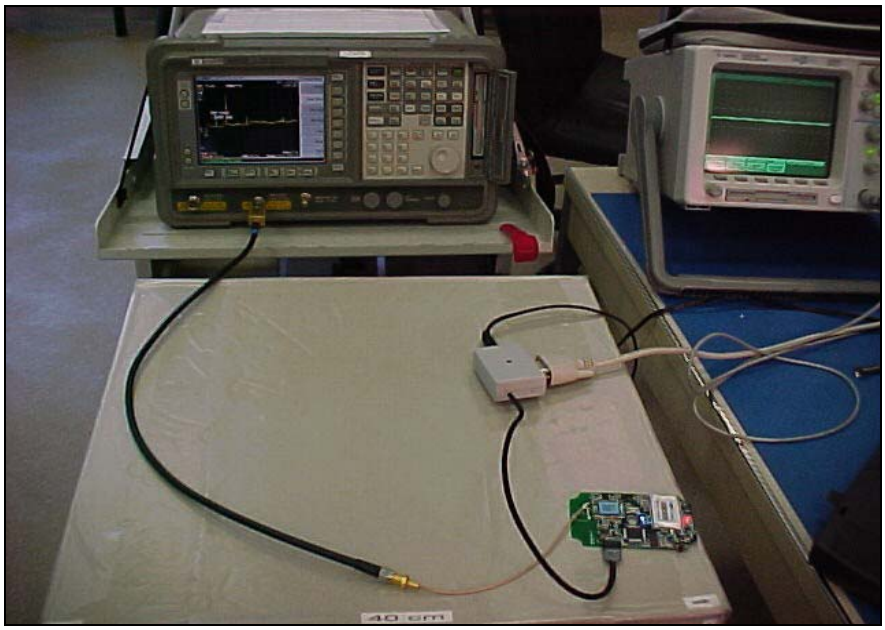
CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MEASURED POWER Corrected for Cable Loss (dBm)	MARGIN (dB)
Low	2402	30 dBm	-10.2	-6.9	36.9
Mid	2441	30 dBm	-11.7	-8.4	38.4
High	2480	30 dBm	-13.9	-10.6	40.6



Photos taken during Conducted RF Testing

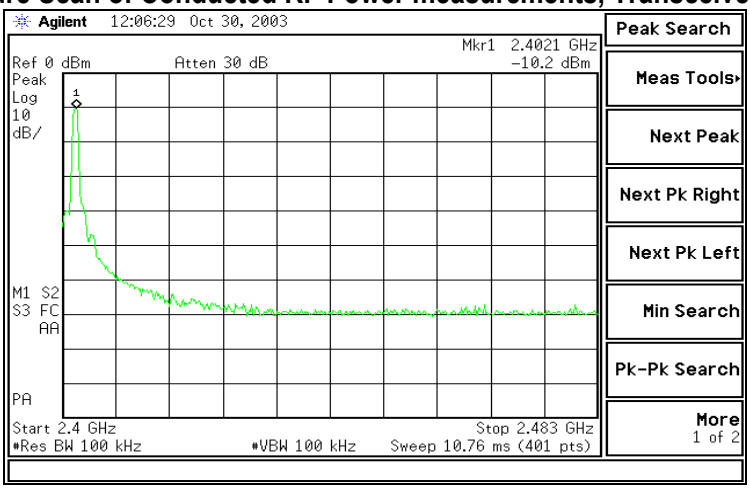


View of RF port connection during the Conducted RF measurements.

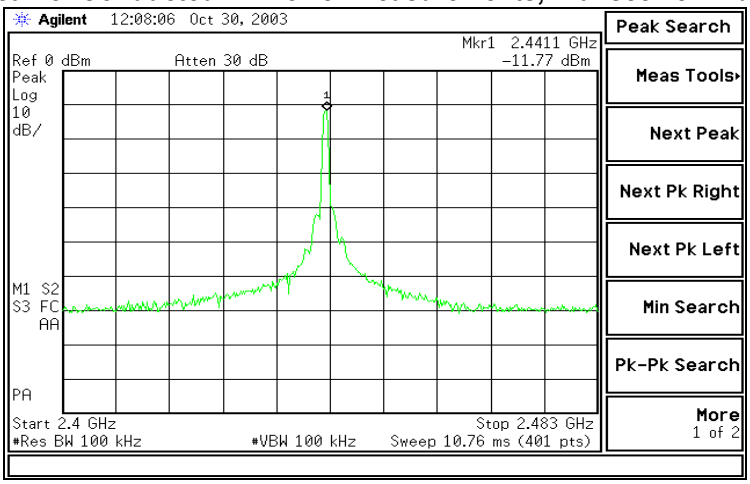


View of Test Setup During the Conducted RF measurements.

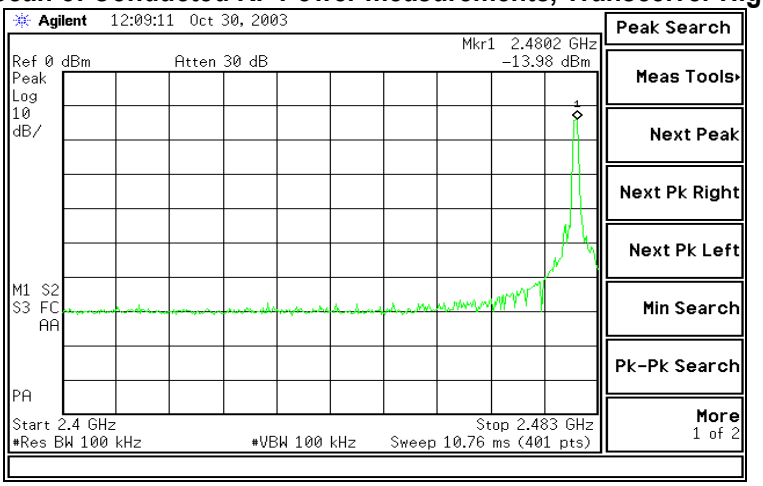
Typical Signature Scan of Conducted RF Power measurements, Transceiver, Low Channel



Signature Scan of Conducted RF Power measurements, Transceiver Middle Channel



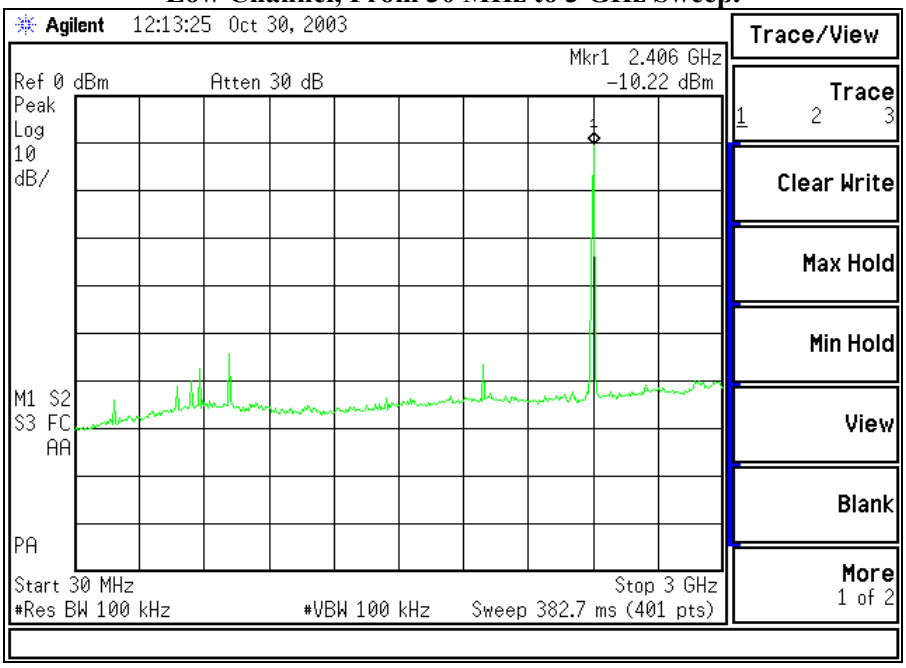
Signature Scan of Conducted RF Power measurements, Transceiver High Channel



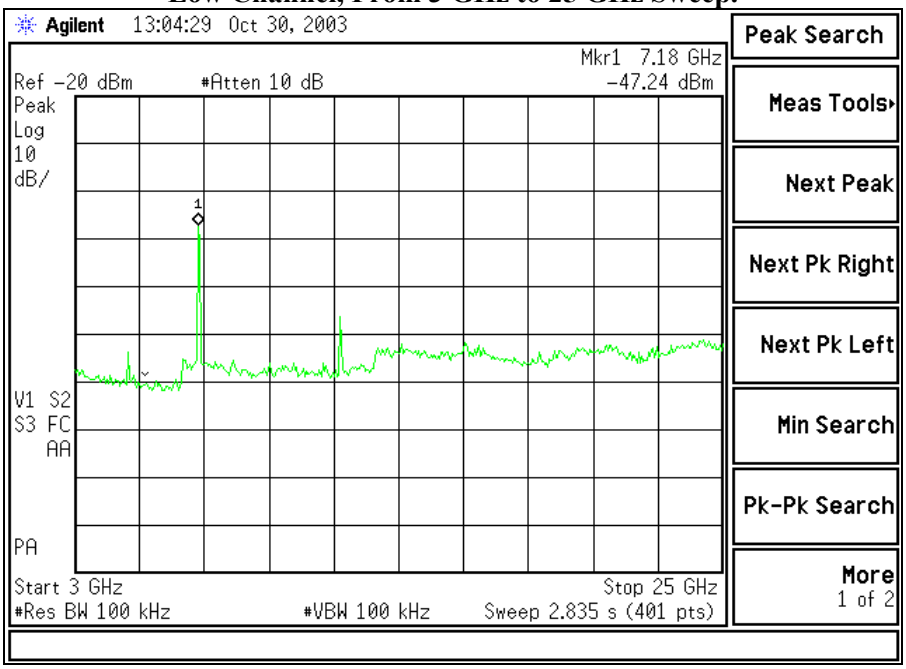
15. Conducted RF Test Setup and Measurements

FCC Part 15.247.c requires a measurement of conducted harmonic and spurious levels, as reference to the carrier frequency in a 100 kHz bandwidth. For this test, the transmitter was directly connected to the HP E4407B Spectrum Analyzer, through a very short Coaxial Cable. Plots were then taken, with any noticeable spurious or harmonic signals identified. The third harmonic was the highest harmonic/spurious emission observed, measuring at -42dBm on the highest channel. No other significant emission levels or any spurious products could be found within -20 dBc of the fundamental of the transmitter. Signals that were observed were greater than 28 dB down (In the 100 kHz bandwidth).

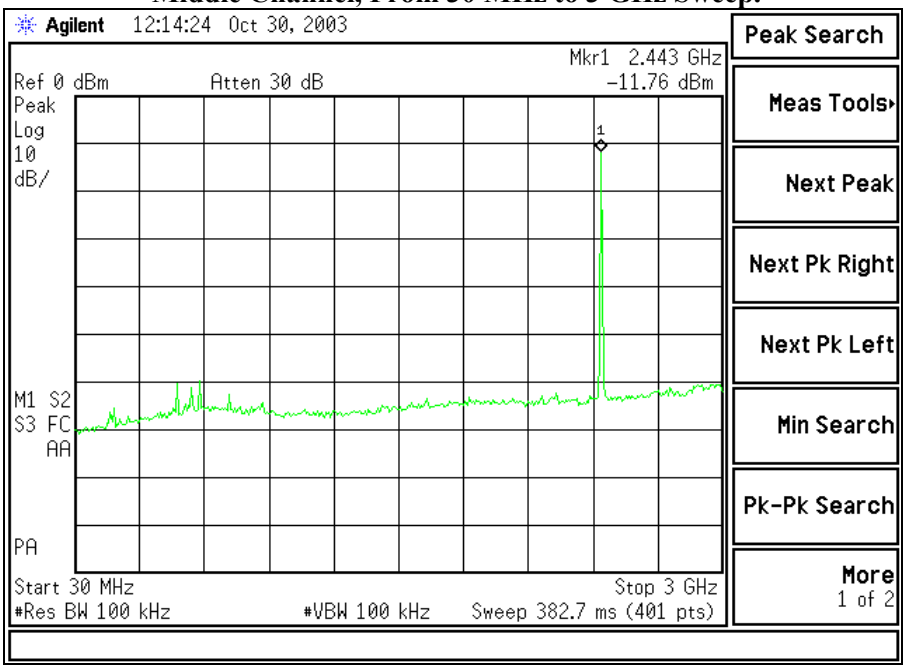
Signature Scan of Conducted Spurious measurements, Transceiver Low Channel, From 30 MHz to 3 GHz Sweep.



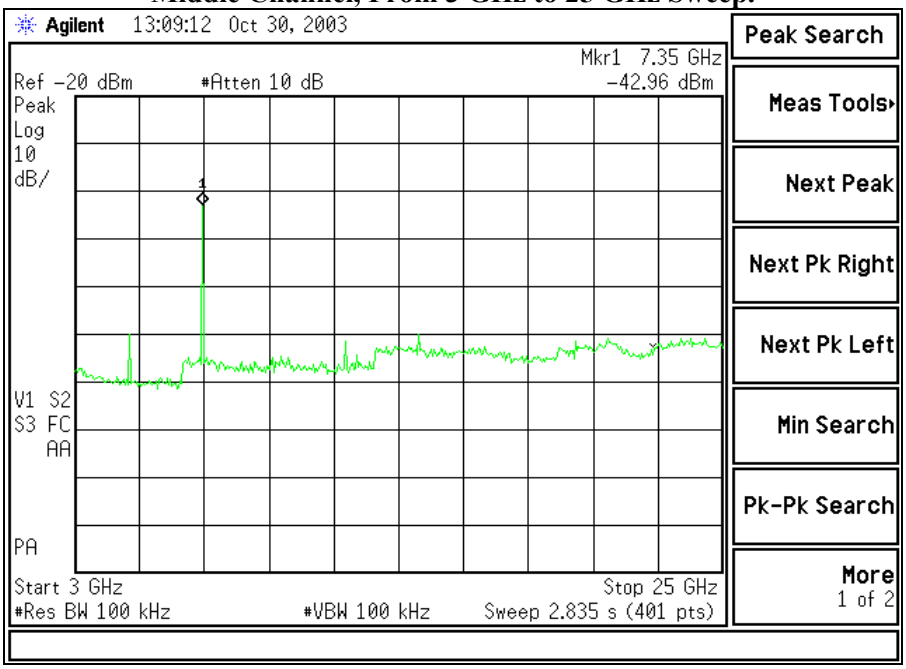
Signature Scan of Conducted Spurious measurements, Transceiver Low Channel, From 3 GHz to 25 GHz Sweep.



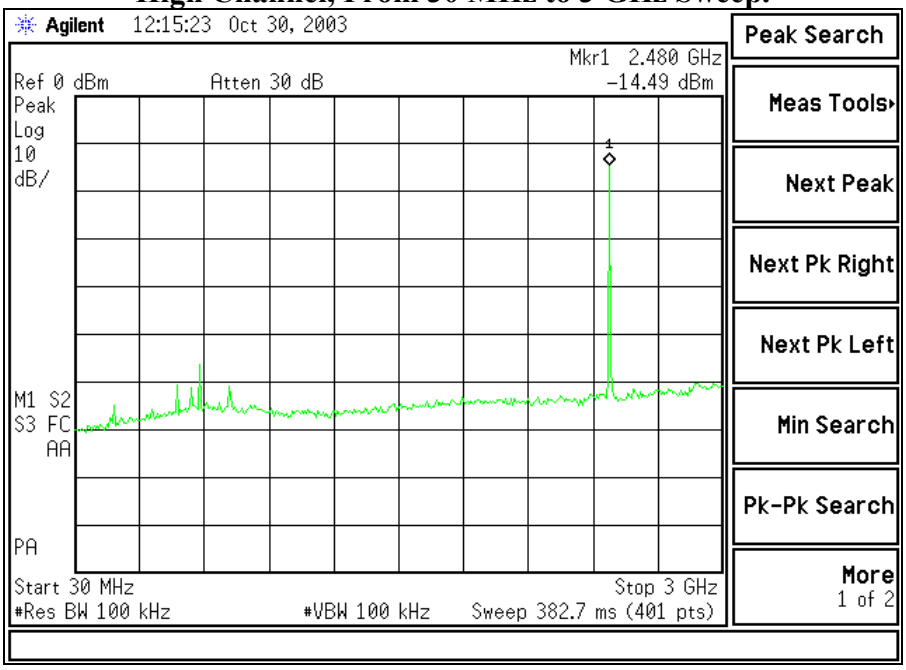
Signature Scan of Conducted Spurious measurements, Transceiver Middle Channel, From 30 MHz to 3 GHz Sweep.



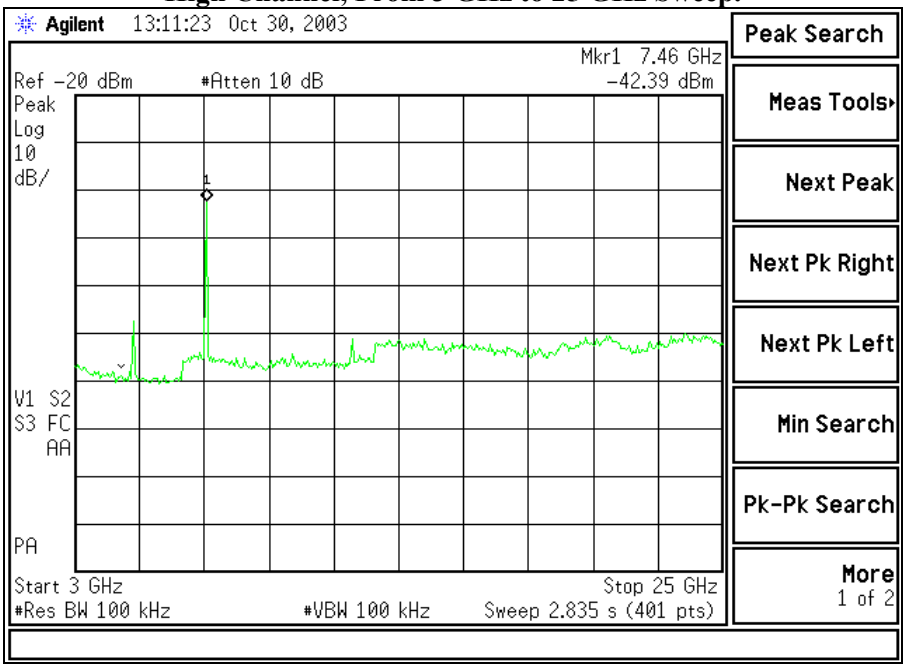
Signature Scan of Conducted Spurious measurements, Transceiver Middle Channel, From 3 GHz to 25 GHz Sweep.



Signature Scan of Conducted Spurious measurements, Transceiver High Channel, From 30 MHz to 3 GHz Sweep.



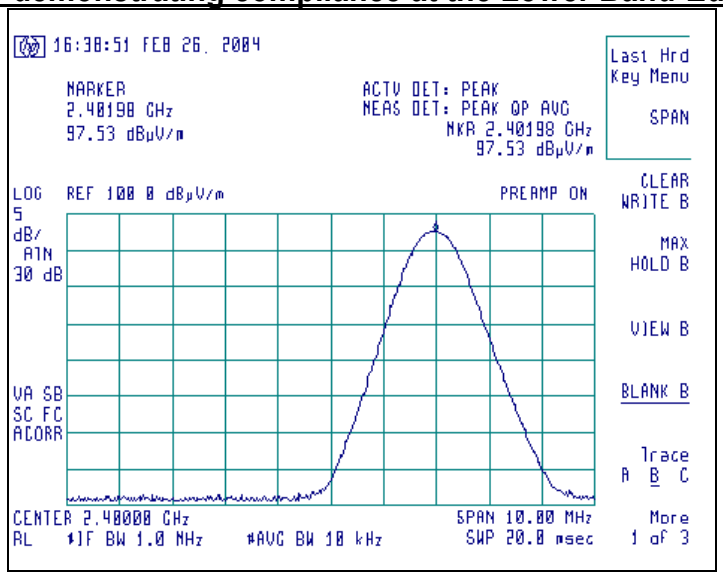
Signature Scan of Conducted Spurious measurements, Transceiver High Channel, From 3 GHz to 25 GHz Sweep.

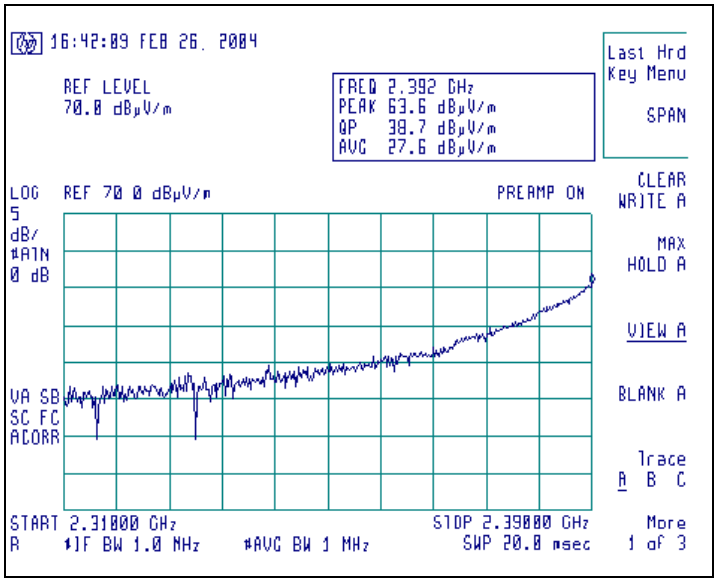


16. Band-Edge Measurements

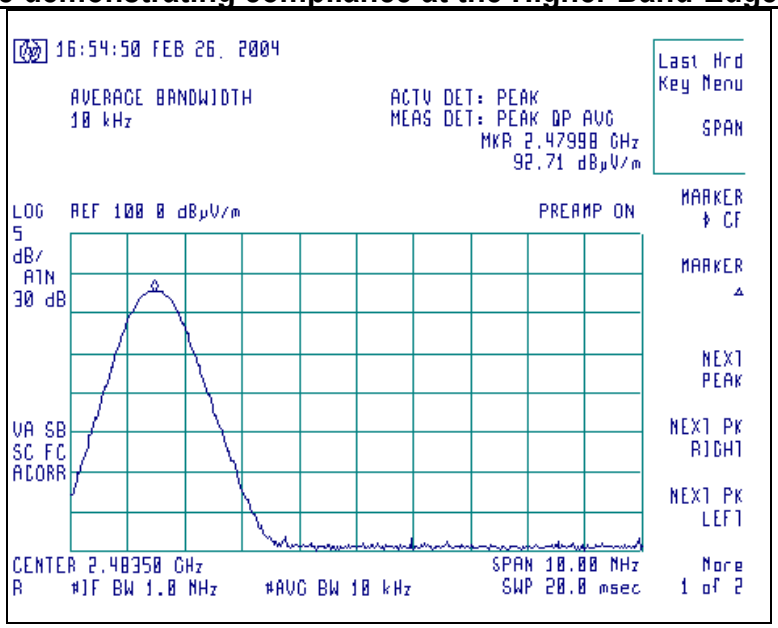
FCC Part 15.247(c) requires a measurement of spurious emission levels, in particular at the band-edges where the intentional radiator operates. Spurious emissions levels need to be at least 20 dB below that of the desired fundamental transmit power level, when measured using a 100 kHz bandwidth in both cases. Attenuation below the general limits as stated in 15.209(a) is not required, but adherence to the 15.205 limits for emissions in the restricted frequency bands is required. The following screen captures demonstrate compliance of the intentional radiator at the 2400-2483.5 MHz band edges, by operating the EUT at the lowest channel, with a continuous data stream of '1010' as the modulating source, and investigating the lower 2400 MHz band-edge, and again by operating the EUT at the highest channel, and investigating the higher 2483.5 MHz band-edge.

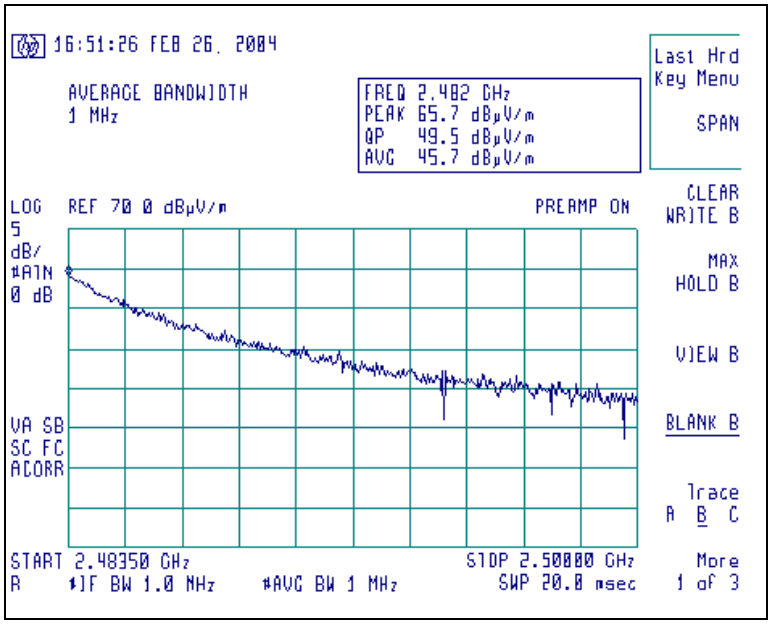
Screen Capture demonstrating compliance at the Lower Band-Edge of 2400 MHz





Screen Capture demonstrating compliance at the Higher Band-Edge of 2483.5 MHz



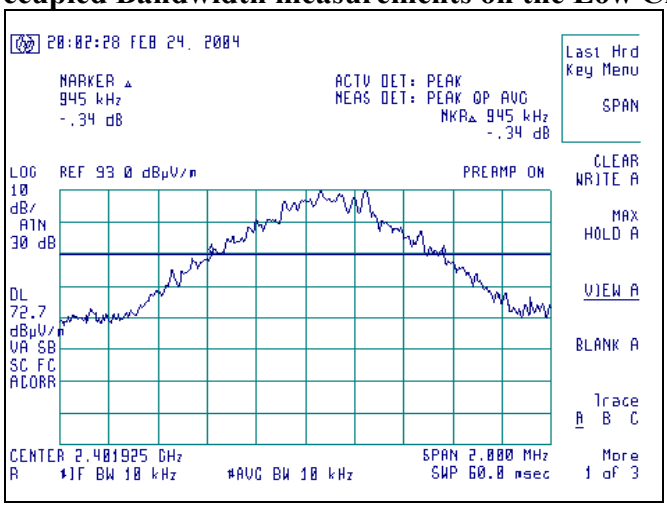


17. Occupied Bandwidth Measurements

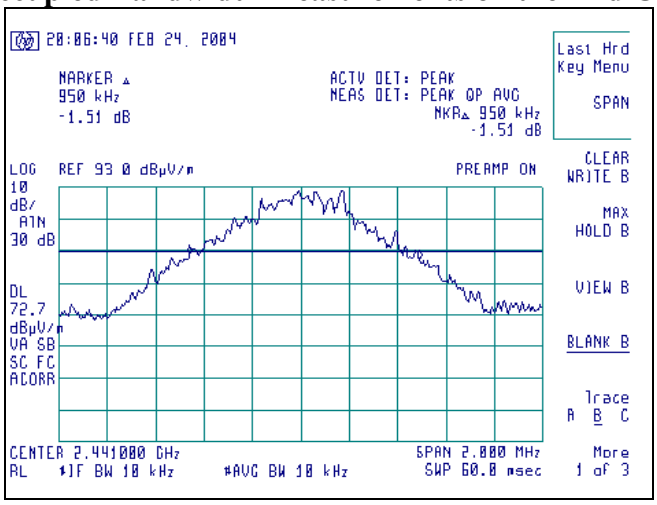
The 20 dB bandwidth requirement found in FCC Part 15.247(a.2) is a minimum of 1 MHz, for this channel spacing. Direct measurement of the transmitted signal, via a cabled connection to the HP E4407B analyzer, was then used to determine the signal bandwidth. For each of the representative channels, refer to the graphs found on the following pages. From this data, the bandwidth of the Mid channel, which is the closest data to the specification limit, is 950 kHz, which is above the minimum of 1 MHz.

CHANNEL	CENTER FREQ (MHz)	MEASURED 20 dB BW (kHz)	MINIMUM LIMIT (kHz)
Low	2402	945	1000
Mid	2441	950	1000
High	2480	940	1000

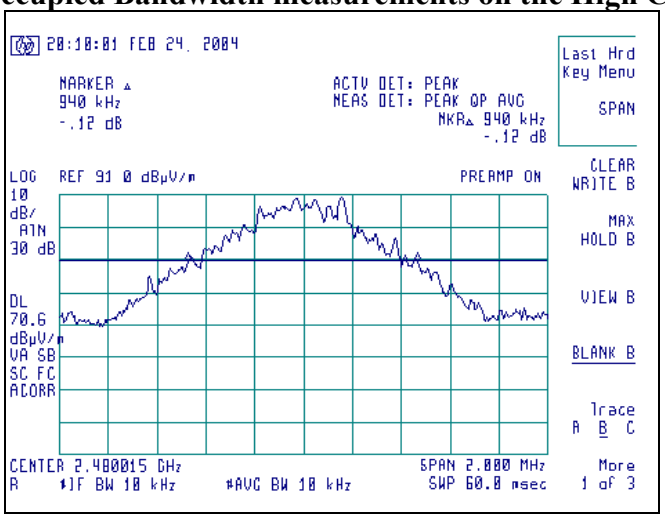
Signature Scan of Occupied Bandwidth measurements on the Low Channel



Signature Scan of Occupied Bandwidth measurements on the Mid Channel



Signature Scan of Occupied Bandwidth measurements on the High Channel



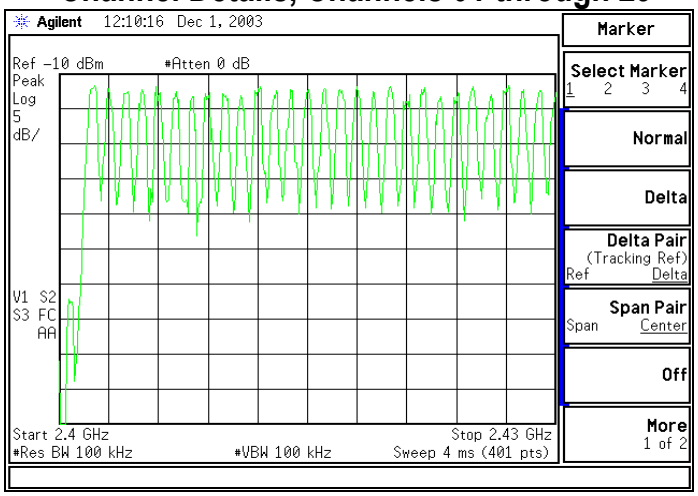
18. Channel Number, Channel Spacing, Channel Occupancy

During the testing of power and bandwidth, a set of spectrum analyzer plots were obtained to demonstrate channel number, spacing, and time of channel occupancy. The graphs presented in the following pages show the number of channels at 79, with 1 MHz spacing between channels.

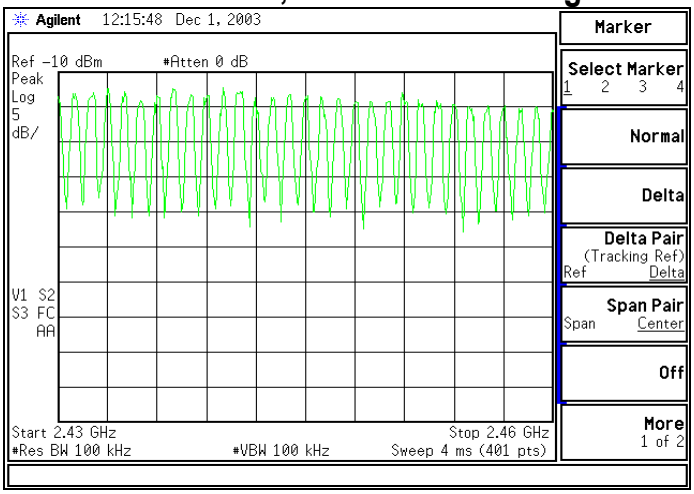
The occupancy time of a pseudo-random frequency-hopping transmitter is a little more difficult to demonstrate. Two plots are presented, that demonstrate dwell time at one channel (2.9 milliseconds) and the worst case occurrence of the signal in a 250 millisecond window. These plots demonstrate a dwell time of 2.9 milliseconds over a period of 250 milliseconds, for a ratio of 0.725 percent, satisfying the 15.247(a.1.iii) section.

Channel Details:

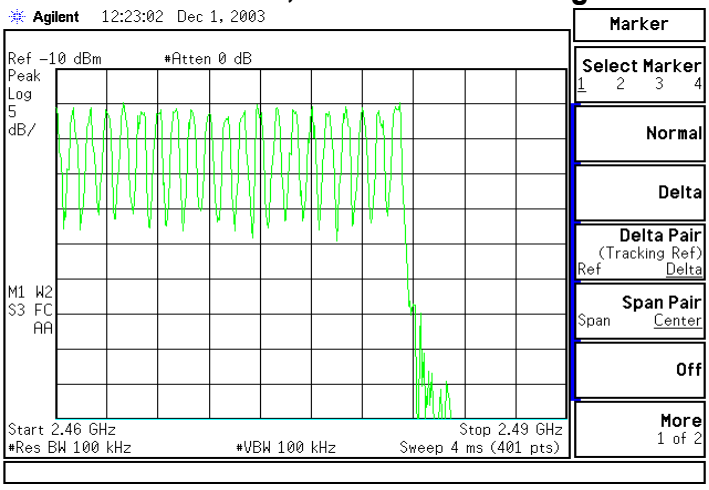
Channel Details, Channels 01 through 29



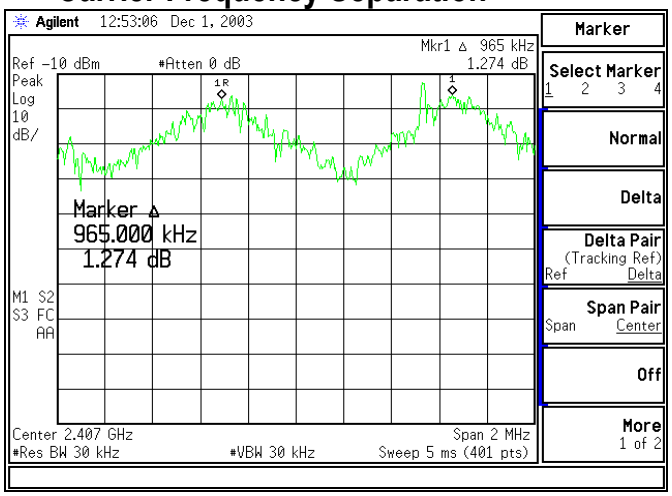
Channel Details, Channels 30 through 59



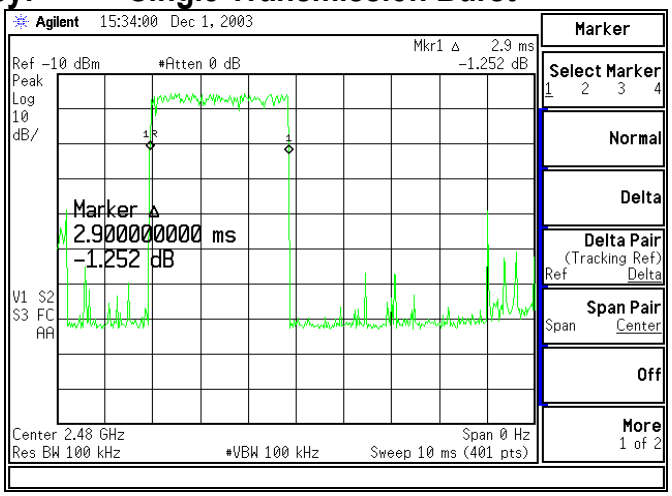
Channel Details, Channels 60 through 79



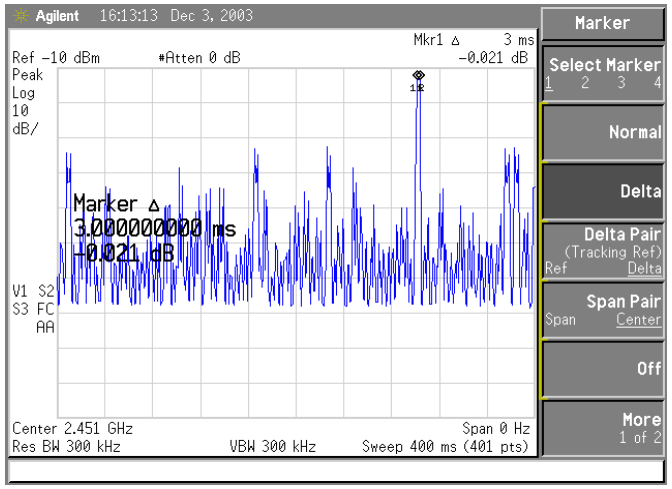
Channel Spacing: Carrier Frequency Separation



Channel Occupancy: Single Transmission Burst



Channel Dwell Time



19. MPE Calculations

Parts 15.247(b)(2) and 15.247(b)(3) set maximum power limit of 1 watt (+30 dBm) conducted into an antenna with 6.0 dBi of gain, or less. This gives a maximum ERP of +36.0 dBm.

The EUT module has a declared maximum conducted output power of +0.5 dBm. The specified Centurion model CAF95901 antenna has a declared gain greater than 2 dBi at 2400-2500 MHz range, yielding a calculated worst case power greater than +2.5 dBm, which is less than the limit of +36.0 dBm.

The maximum conducted power measured on the EUT at the antenna output was at –6.9 dBm. The measured power is lower than the module maximum declaration of +0.5 dBm, therefore the module maximum declaration was used in the MPE calculations.

Maximum Permissible Exposure [Part 15.247(b)(4)]

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: 0.050 (dBm)
Maximum peak output power at antenna input terminal: 1.122 (mW)
Antenna gain (typical): 2 (dBi)
Maximum antenna gain: 1.585 (numeric)
Prediction distance: 20 (cm)
Prediction frequency: 821 (MHz)
MPE limit for uncontrolled exposure at prediction frequency: 0.55 (mW/cm^2)

Power density at prediction frequency: 0.000354 (mW/cm^2)

Maximum allowable antenna gain: 33.9 (dBi)

Margin of Compliance at 30 cm = 33 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	11/12/02	11/12/03
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	10/01/03	10/01/04
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
EE960146	EMCO	EMCO	3160-09	Pyramidal Horn Antenna	Note 1	Note 1
N/A	LSC	Cable	0011	3 Meter ½" Armored Cable	6/07/03	6/07/04
N/A	LSC	Cable	0038	1 Meter RG 214 Cable	6/07/03	6/07/04
N/A	LSC	Cable	0050	10 Meter RG 214 Cable	6/07/03	6/07/04
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