LS Research, LLC

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ENGINEERING TEST REPORT # 306503 TX TCB Rev. 1

Compliance Testing of:
Matrix 10mW Module
Model # MTX10

Test Date(s):
October 16, 17,25; November 8, 2006; and Jan. 8-11, 2007

Prepared For:
LS Research, LLC
Attn.: Mr. William Steinike
W66 N220 Commerce Court
Cedarburg, WI 53012

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Modulation Transmitters (DTS) Operating in the
Frequency Band 2400 MHz – 2483.5 MHz

This Test Report is issued under the Authority of:
Kenneth Boston, Laboratory Manager

Signature:  Date: March 16, 2007

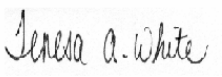
Test Report Prepared by:	**Tested by:**
Kenneth Boston PE, Laboratory Manager Teresa A. White, Document Coordinator	Abtin Spantman, EMC Engineer
Signature:  	Signature: 
Date: March 16, 2007	Date: January 31, 2007

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EXHIBIT 1. INTRODUCTION

1.1 SCOPE

References:	FCC Part 15, Subpart C, Section 15.247
Title:	Telecommunication – Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Digital Modulation Transmitters operating in the Frequency Band of 2400 MHz – 2483.5 MHz
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 – 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.
Environmental Classification:	• Commercial, Industrial or Business • Residential

1.2 NORMATIVE REFERENCES

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2005	Code of Federal Regulations - Telecommunications
ANSI C63.4	2004	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.
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	2002	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.
FCC Procedures	2005, 03-23	Measurement of Digital Transmission Systems operating under Section 15.247.

1.3 LS Research, LLC TEST FACILITY

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories".

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted. A copy of the accreditation may be accessed on our web site: www.lsr.com. Accreditation status can be verified at A2LA's web site: www.a2la2.net.

1.4 LOCATION OF TESTING

All testing was performed at LS Research, LLC, W66 N220 Commerce Court, Cedarburg, Wisconsin, 53012 USA, utilizing the facilities listed below, unless otherwise noted.

List of Facilities Located at LS Research, LLC:

- Compact Chamber
- Semi-Anechoic Chamber
- Open Area Test Site (OATS)

1.5 TEST EQUIPMENT UTILIZED

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated in accordance with A2LA standards.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	**LS Research, LLC**
Address:	**W66 N220 Commerce Court Cedarburg, WI 53012**
Contact Person:	**William Steinike**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	Matrix 10mW
Model Number:	MTX10
Serial Number:	n/a

2.3 ASSOCIATED ANTENNA DESCRIPTION

The Matrix 10 mW Module was tested with two antennas as covered in this report.
The first antenna is an inverted-F type antenna that appears as a printed circuit board trace on the module circuit board.

The second antenna is a monopole whip antenna with a short length of coaxial cable and an MMCX type connector.

The two antennas are mutually exclusive and would not be used at the same time. This would be insured during manufacturing process by population options on the circuit board.

Detailed information about the antennas may be found in the appendices of this report.

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	2400 – 2483 MHz
RF Power in Watts	0.0066, at 2440 MHz
Conducted Output Power (in dBm)	8.2 dBm
Field Strength (and at what distance)	111.8 dB/uV/M, at 2475 MHz, 3 meters
Occupied Bandwidth (99% BW)	1580 kHz at 2475 MHz
Type of Modulation	DTS
Emission Designator	G1DEN
EIRP (in mW)	45.7 mw
Transmitter Spurious (worst case)	46.6 dBuV/m at 2484 MHz
Frequency Tolerance %, Hz, ppm	620 Hz
Microprocessor Model # (if applicable)	n/a
Antenna Information	
Type	2 types: PCB Trace (F) and external Whip
Gain (in dBi)	3.8 dBi (Whip)
EUT will be operated under FCC Rule Part(s)	CFR 47 15.247
Modular Filing	☒ Yes ☐ No
Portable/Mobile	☒ Portable ☐ Mobile

RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	x	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

- Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
- Duty Cycle used in evaluation: 100 %
- Standard used for evaluation: OET 65
- Measurement Distance: 3 m
- RF Value: 106.5 dBuV/m ☐ V/m ☐ A/m ☐ W/m^2
  ☒ Measured ☐ Computed ☐ Calculated

2.5 PRODUCT DESCRIPTION

The Matrix module is a direct sequence spread spectrum transceiver, operating in the 2400 – 2483.5 MHz ISM band. The system is based on the IEEE 802.15.4 standard, with channels spaced at 5 MHz intervals in the ISM band. The system operates at a chip rate of 2 Mcps, a symbol rate of 62.5 ksps, and a bit rate of 250 kbps. O-QPSK modulation is used with 16-ary orthogonal symbols. It transmits with a maximum power of 10 milliwatts (+10 dBm) into a printed circuit board inverted-f antenna or an external dipole antenna. The RF power level and channel are selectable within the operating mask provided by the manufacturer. Modulation characteristics are fixed by the transceiver.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	25 C
Humidity:	45%
Pressure:	98.0 kPa

3.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Paragraph	Test Requirements	Compliance (yes/no)
15.207	Power Line Conducted Emissions Measurements	Yes
15.247(a)(2)	6 dB Bandwidth of a Digital Modulation System	Yes
15.247(b) & 1.1310	Maximum Output Power	Yes
15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers. The Receiver Test Report is available upon request.		

3.3 MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

☒ **None** ☐ **Yes (explain below)**

3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS

☒ **None** ☐ **Yes (explain below)**

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, and Industry Canada RSS-210 (2005), Section Annex 8 (section 8.2) for a Digital Spread Spectrum (DTS) Transmitter.

If some emissions are seen to be within 3 dB 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.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 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 CW and O-QPSK modulated modes, and final testing was performed using full bandwidth digital modulation mode, using power as provided by an HP bench DC supply, model. The unit has the capability to operate on 16 channels, controllable via a circuit board resistor assignment.

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 (2405 MHz), middle (2440 MHz) and high (2475 2480 MHz) to comply with FCC Part 15.35. The channels and operating modes were changed using a circuit board resistor assignment.

5.2 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 25000 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. From 18 GHz to 25 GHz, the EUT was measured at a 0.3 meter separation, using a standard gain Horn Antenna and pre-amplifier.

The EUT was configured for test along three orthogonal axis during the investigations to find the highest emission levels.

5.3 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 From 5 GHz to 18 GHz, an HP E4407B Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the HP E4407B Spectrum Analyzer with a standard gain horn, and preamp were used.

Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for a DTS transmitter [Canada RSS-210 (2005), Annex 8 (section 8.2). The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.4 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.
EMI Receiver	HP	8546A	3617A00320
EMI Receiver Pre-Select.	HP	85460A	3448A00296
Spectrum Analyzer	Agilent	E4446A	US45300564
Log Periodic Antenna	EMCO	93146	9701-4855
Horn Antenna	EMCO	3115	6907
Bicon Antenna	EMCO	93110B	9702-2918
Pre-Amp	Adv. Microwave	WLA612	1145A04094
Horn Antenna – Std. Gain	EMCO	3160-09	9809-1120

5.5 CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 2400-2483.5 MHz band, as specified in Title 47 CFR 15.247 (b)(3), is 1 Watt. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c).

The following table depicts the general radiated emission limits above 30 MHz. 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 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

For measurements made at 0.3 meter, a 20 dB correction has been invoked.

960 MHz to 10,000 MHz
500μV/m or 54.0 dB/μV/m at 3 meters
54.0 + 20 = 74 dB/μV/m at 0.3 meters

5.6 RADIATED EMISSIONS DATA CHART

3 Meter Measurements of Electromagnetic Radiated Emissions
Test Standard: 47CFR, Part 15.205 and 15.247(DTS)
Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	LS Research, LLC						
Date(s) of Test:	Oct. 16, 17, Nov. 8, 2006 and Jan. 8-11, 2007						
Test Engineer(s):	Abtin Spantman						
Voltage:	3.3 VAC supplied by HP 6113A						
Operation Mode:	Normal, continuous transmit, modulated or C.W. mode						
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %						
EUT Power:	X	Single Phase 115 VAC to PS		3 Phase ___VAC			
		Battery		Other:			
EUT Placement:	X	80cm non-conductive pedestal		10cm Spacers			
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS			
Measurements:		Pre-Compliance		Preliminary	X	Final	
Detectors Used:		Peak		Quasi-Peak	X	Average	

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

Frequency (MHz)	Ant./EUT Polarity	Channel (MHz)	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 & 15.205 Limit (dBμV/m)	Margin (dB)
2389.5	V/S	2405	1.0	0	46.0	54.0	8.0
2399.5	V/S	2405		0	61.8	89.5	27.7
2484.0	V/S	2475	1.0	0	40.7	54.0	13.3
2484.0	V/S	2480	1.0	0	46.6	54.0	7.4
4810.0	V/S	2405	1.0	0	37.5	54.0	16.5
4880.0	V/S	2440	1.0	0	37.6	54.0	16.4
4950.0	V/S	2475	1.0	0	37.8	54.0	16.2
4960.0	V/S	2480	1.0	0	38.2	54.0	15.8

* Measurement at receiver noise floor.
** Measurement of EUT equipped with whip antenna, otherwise all measurements reported for EUT equipped with F antenna.

RADIATED EMISSIONS DATA CHART *(continued), 1.0/0.3 meter separation*

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 2405:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 & 15.205 Limit (dBμV/m)	Margin (dB)
7215	V/S	1.0	0	34.4 *	99.0	64.6
9620	H/V	1.0	35	48.6	99.0	50.4
12025	H/S	1.0	265	48.9	63.5	14.6
14430	H/V	1.0	0	40.0 *	99.0	59.0
7215 **	V/V	1.0	190	35.8	99.0	63.2
9620 **	V/V	1.0	100	46.8	99.0	52.2

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 2440:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 & 15.205 Limit (dBμV/m)	Margin (dB)
7320	V/S	1.0	0	35.2 *	63.5	28.3
9760	H/V	1.04	25	52.4	100.4	48.0
12200	H/S	1.07	255	47.5	63.5	16.0
14640	H/V	1.0	0	40.0 *	100.4	60.4
7320 **	V/V	1.0	190	31.7 *	63.5	31.8
9760 **	V/V	1.0	110	37.7	100.4	62.7

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 2475:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 & 15.205 Limit (dBμV/m)	Margin (dB)
7425	V/S	1.06	0	36.7	63.5	26.8
9900	H/V	1.0	290	57.2	101.2	44.0
12375	H/S	1.0	310	45.3	63.5	18.2
14850	H/V	1.0	0	38.8 *	101.2	62.4
7425 **	V/V	1.03	5	35.2	63.5	28.3
9900 **	V/V	1.0	195	34.0	101.2	67.2

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 2480:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 & 15.205 Limit (dBμV/m)	Margin (dB)
7440	--	--	--	Note 3	--	--
9920	--	--	--	Note 3	--	--
12400	--	--	--	Note 3	--	--
14880	--	--	--	Note 3	--	--

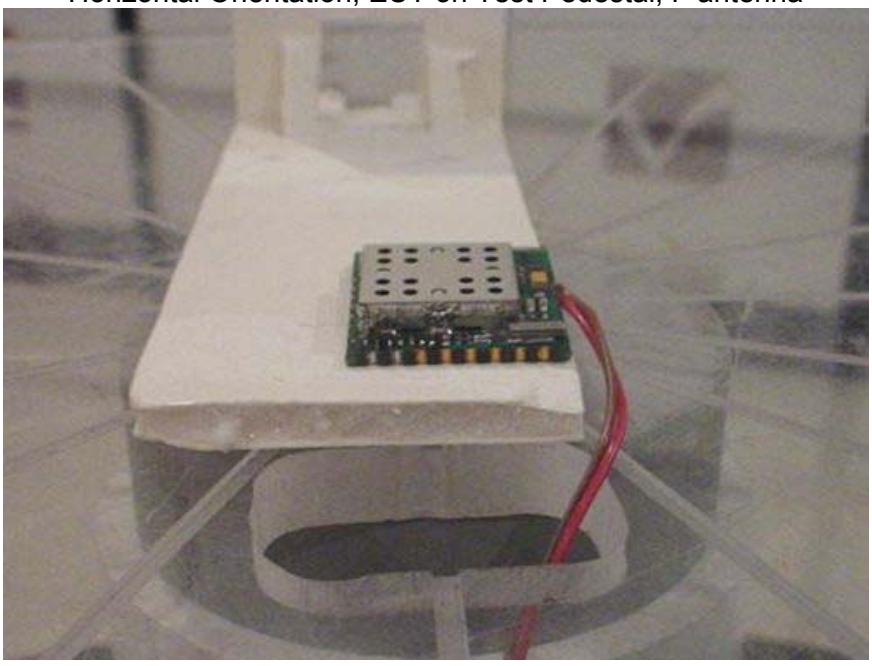
Notes:

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. Peak emissions were inspected, and did not exceed the limit +20dB.
2) Measurements above 5 GHz were made at 1 meters of separation from the EUT, and at 0.3 m separation for frequencies between 18 – 25 GHz.
3) Measurement at receiver system noise floor (*); all higher harmonics were below system noise floor.

5.7 Test Setup Photo(s) – Radiated Emissions Test

Vertical Orientation, EUT on Test Pedestal, F antenna

Horizontal Orientation, EUT on Test Pedestal, F antenna

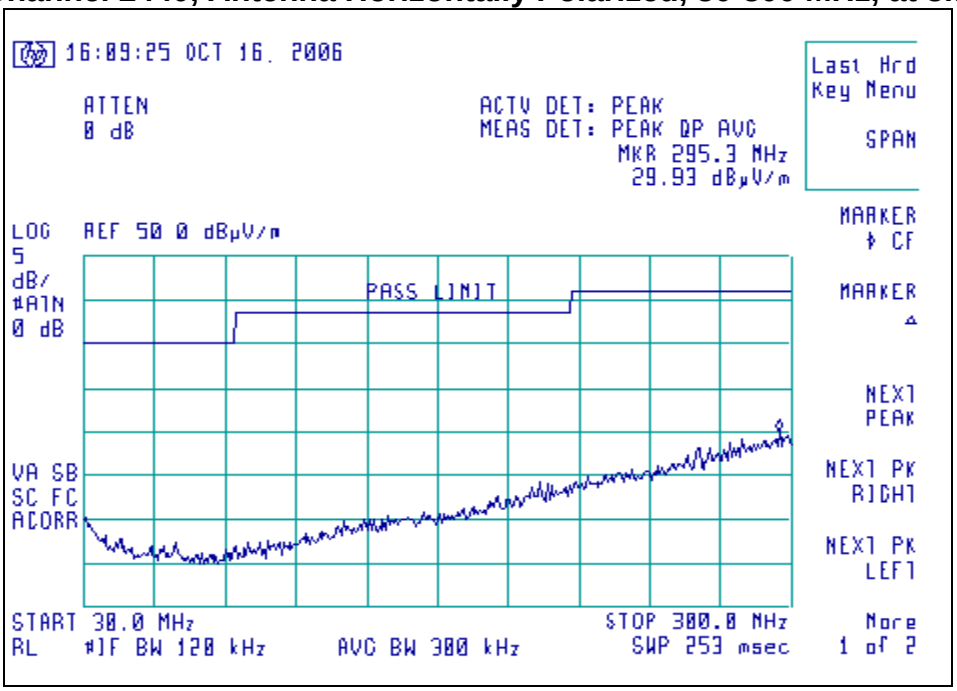


Side Orientation, EUT on Test Pedestal, Whip antenna

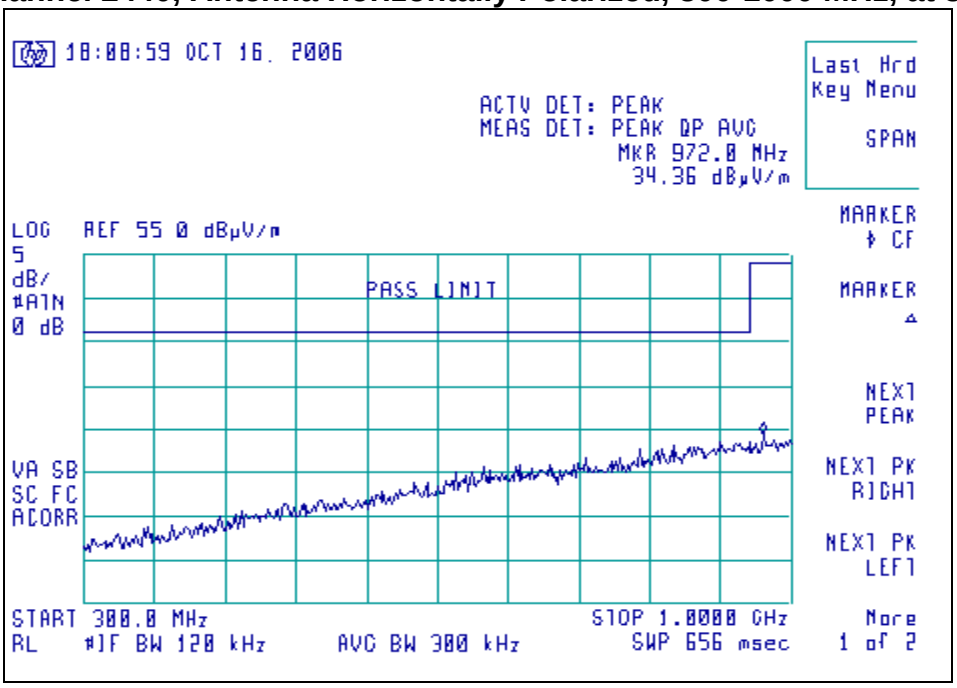
5.8 Screen Captures - Radiated Emissions Testing

These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz. The signature scans shown here are from worst-case emissions, as measured on the channel center frequencies as noted.

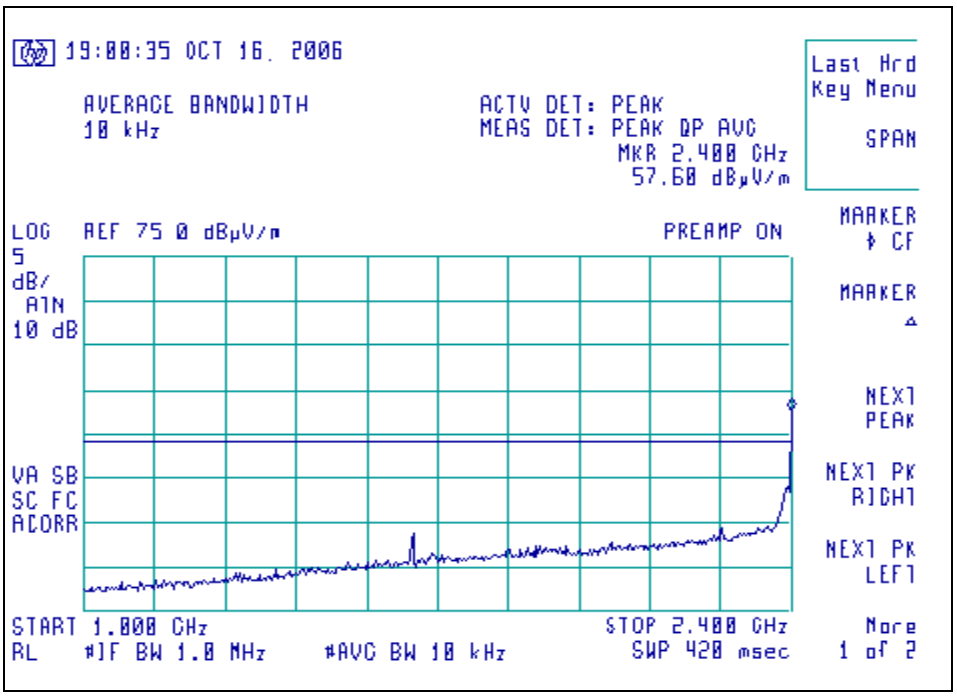
Channel 2440, Antenna Horizontally Polarized, 30-300 MHz, at 3m



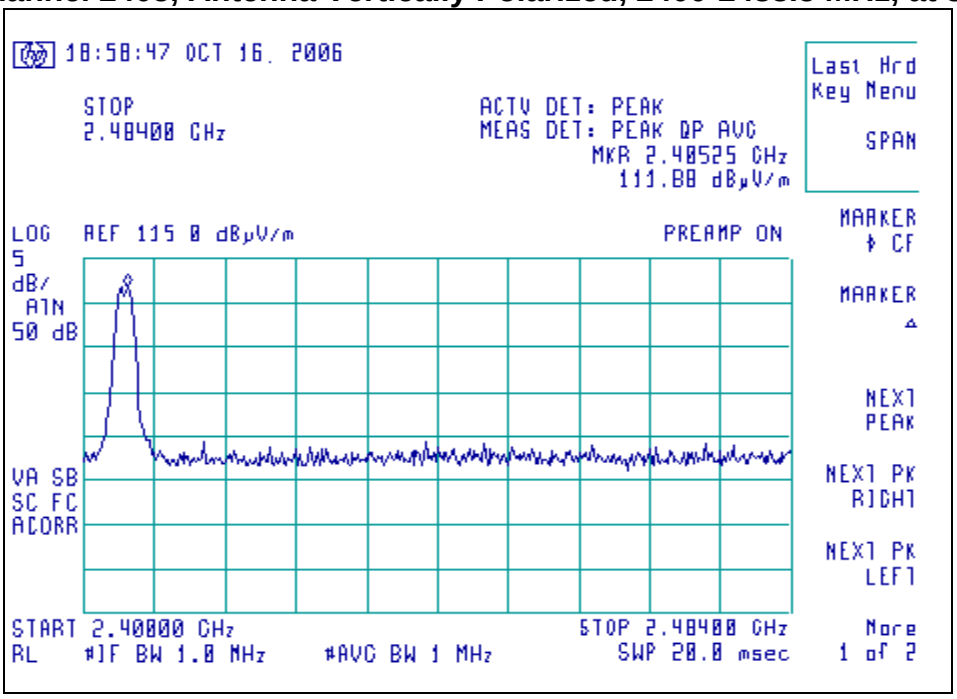
Channel 2440, Antenna Horizontally Polarized, 300-1000 MHz, at 3m



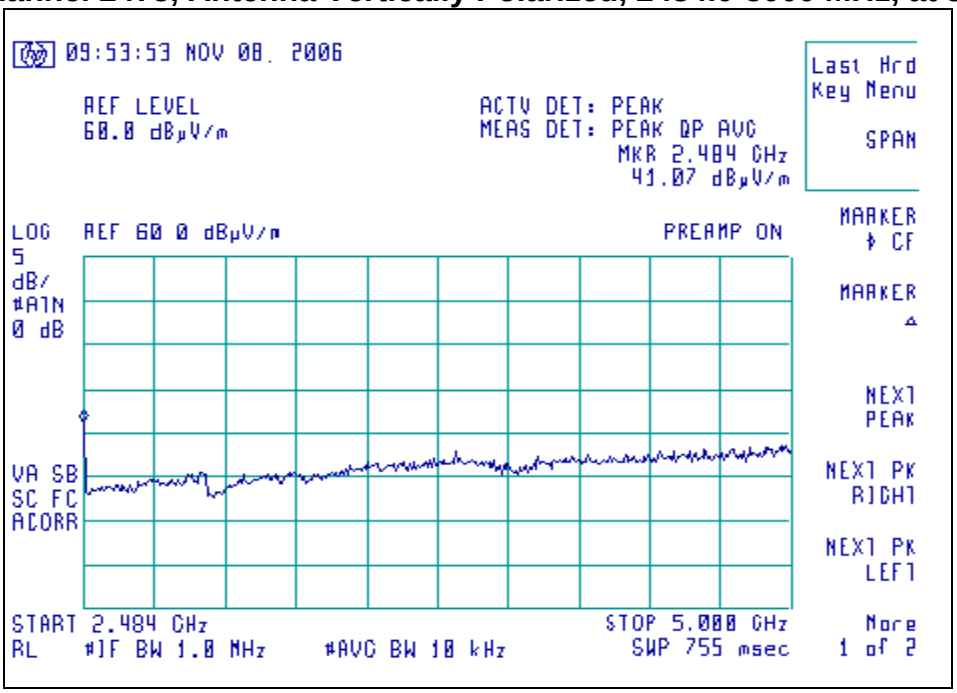
Channel 2405, Antenna Vertically Polarized, 1000-2400 MHz, at 3m



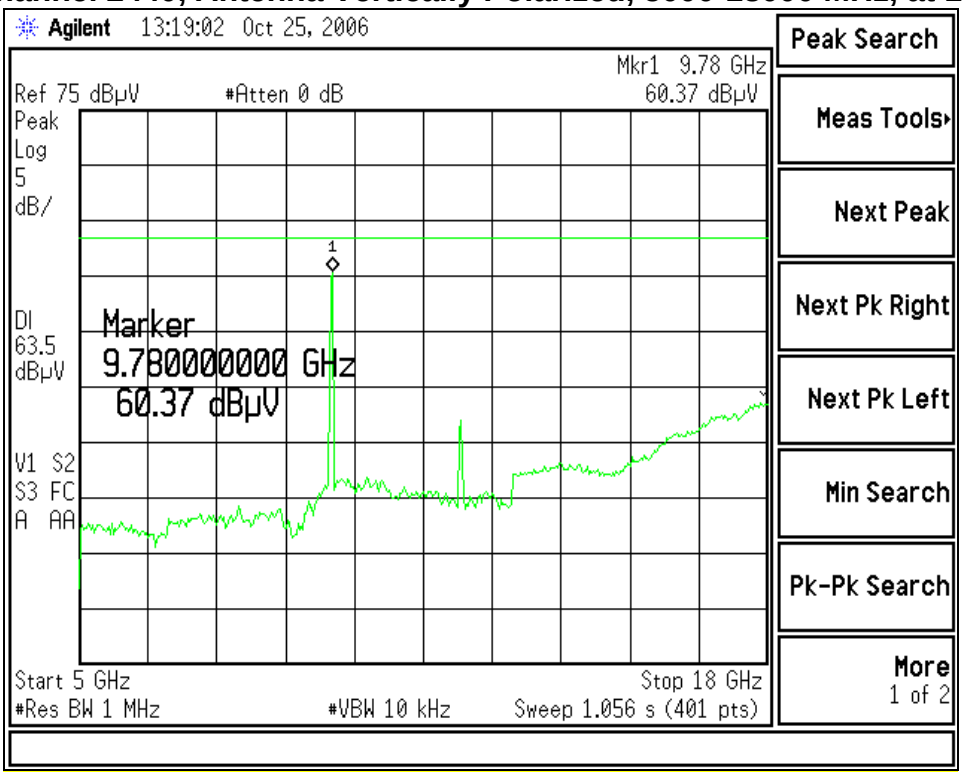
Channel 2405, Antenna Vertically Polarized, 2400-2483.5 MHz, at 3m



Channel 2475, Antenna Vertically Polarized, 2484.0-5000 MHz, at 3m



Channel 2440, Antenna Vertically Polarized, 5000-18000 MHz, at 1m



Channel 2475, Antenna Vertically Polarized, 18000-25000 MHz, at 30cm

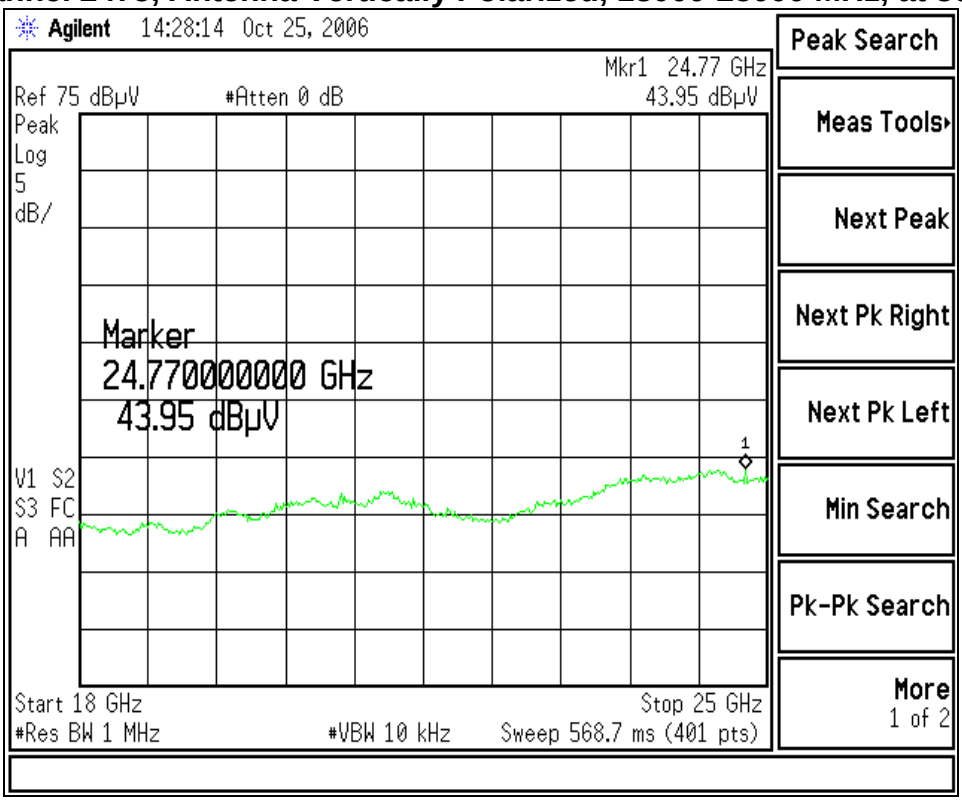


EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE: 15.207

6.1 Test Setup

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, Issue 6). 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).

6.2 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.

6.3 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.
EMI Receiver	HP	8546A	3617A00320
Spectrum Analyzer	Agilent	E4446A	US45300564
LISN	EMCO	3816/2NM	9701-1057
Transient Limiter	HP	119474A	3107A01708

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.

6.4 FCC Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dBµV)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

6.5 TEST DATA CHART CONDUCTED EMISSION

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.207 Class B

Manufacturer:	LS Research, LLC					
Date(s) of Test:	November 8, 2006					
Test Engineer:	Abtin Spantman					
Model #:	MTX10					
Serial #:	n/a					
Voltage:	115 VAC supplied to HP supply					
Operation Mode:	Normal, continuous transmit, modulated or C.W. mode					
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %					
Test Location:					X	Chamber
EUT Placed On:		40cm from Vertical Ground Plane				10cm Spacers
	X	80cm above Ground Plane				Other:
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:		Peak	X	Quasi-Peak	X	Average

		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµ V)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµ V)	Average Margin (dB)
0.152	1	42.0	65.9	23.9	14.3	55.9	41.6
0.212	1	36.8	63.1	26.3	10.8	53.1	42.3
0.320	1	32.3	59.7	27.4	6.0	49.7	43.7
0.153	2	41.7	65.8	24.1	13.8	55.8	42.0
0.210	2	45.3	63.2	17.9	11.0	53.2	42.2
0.320	2	42.8	59.7	16.9	7.0	49.7	42.7

Notes:

1) The emissions listed are characteristic of the power supply used.

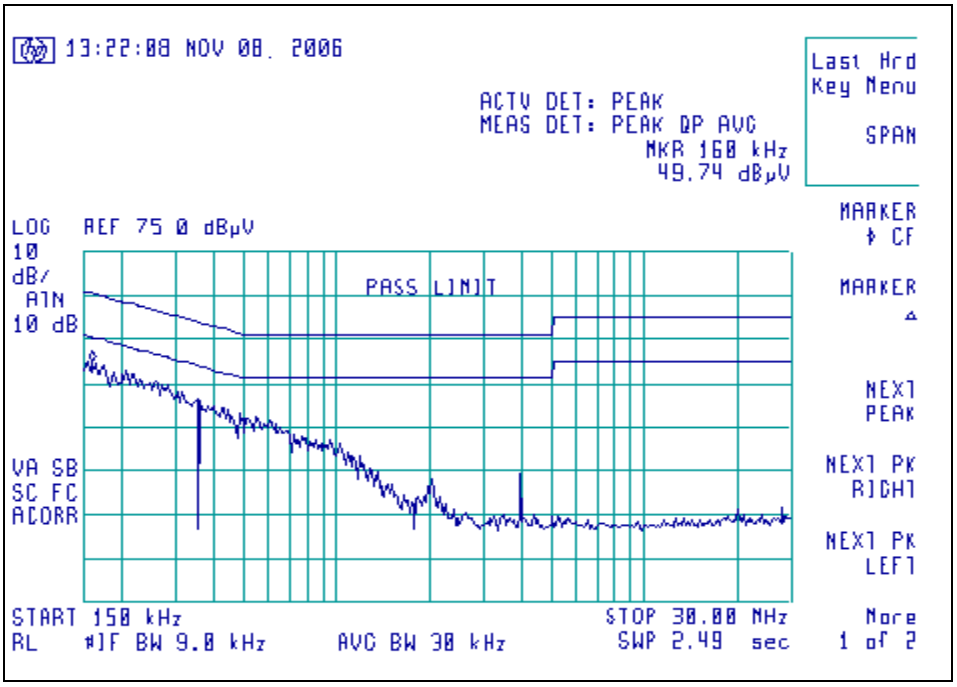
2) All other emissions were better than 20 dB below the limits.

3) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested.

6.6 Screen Captures – Conducted Emissions Test

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207.

Center Channel (2440 MHz), Line 1



Center Channel (2440 MHz), Line 2

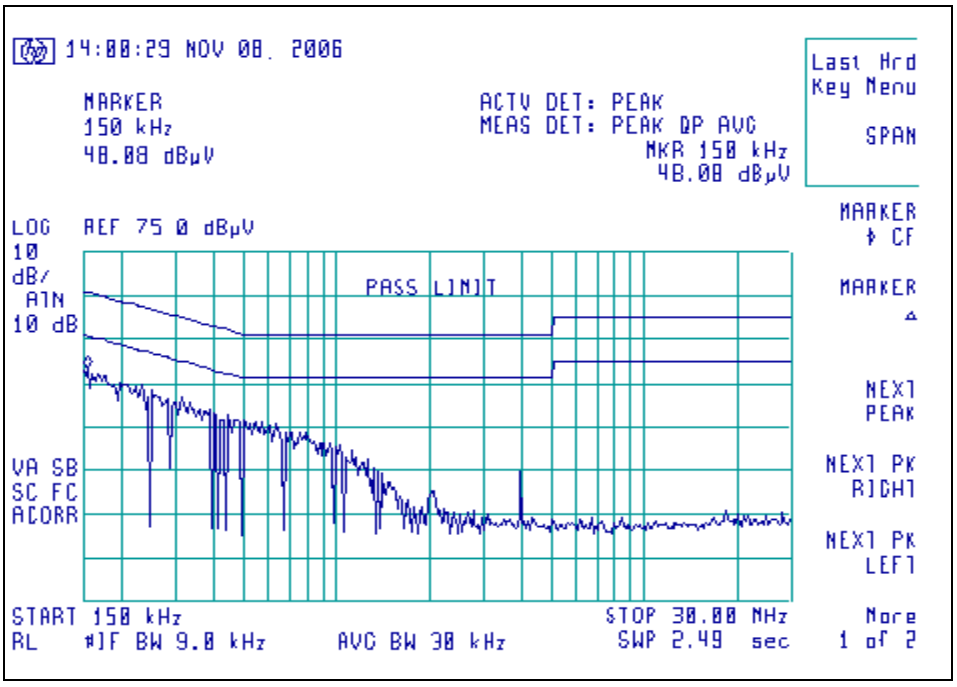


EXHIBIT 7. OCCUPIED BANDWIDTH: 15.247(a)(2)

7.1 Limits

For a Digital Modulation System, the 6 dB bandwidth shall be at least 500 kHz.

7.2 Method of Measurements

Refer to ANSI C63.4 and FCC Procedures (March 23, 2005) for Digital Transmission Systems operating under 15.247. The transmitter output was connected to the Spectrum Analyzer. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 100 kHz RBW and VBW=300 kHz.

The bandwidth requirement found in FCC Part 15.247(a)(2) requires a minimum -6dBc 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 measurements, 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 EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

From this data, the closest measurement when compared to the specified limit, is 1580 kHz, which is above the minimum of 500 kHz.

Test Data

Channel	Center Frequency (MHz)	Measured -6 dBc Occ. BW (kHz)	Minimum -6 dBc Limit (kHz)
2405	2405	1,740	500
2440	2440	1,680	500
2475	2475	1,580	500
2480	2480	1,680	500

7.3 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4407B	US39160256
Spectrum Analyzer	Agilent	E4446A	US45300564

7.4 Screen Captures - OCCUPIED BANDWIDTH

Channel 2475 -6 dBc Occupied Bandwidth, closest Bandwidth to the specification

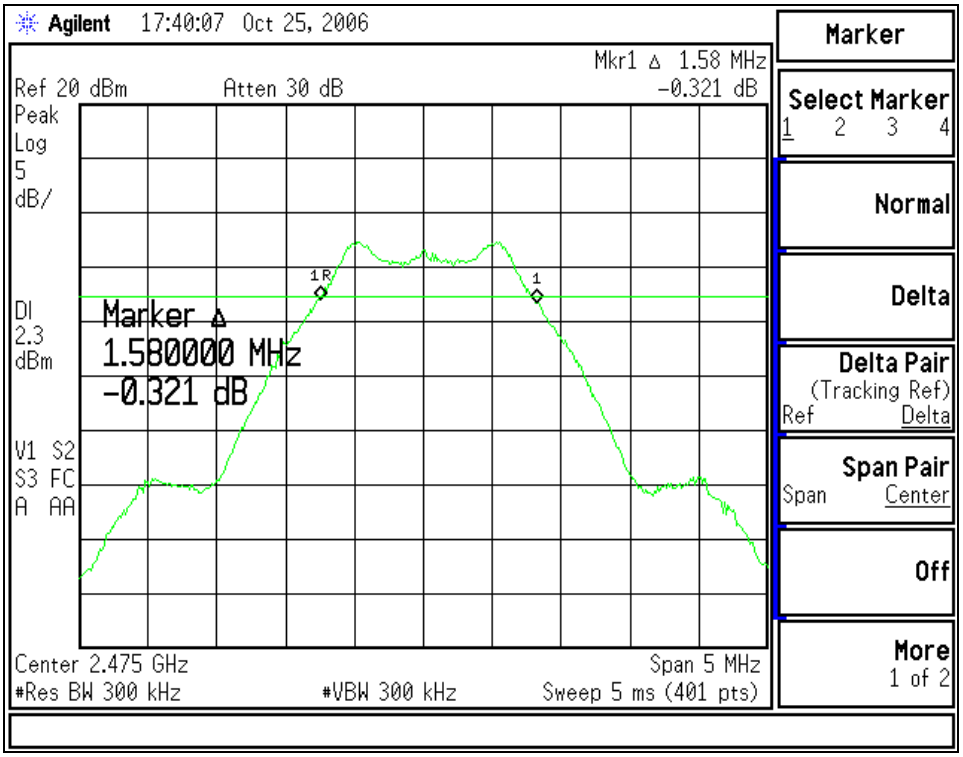


EXHIBIT 8. BAND-EDGE MEASUREMENTS

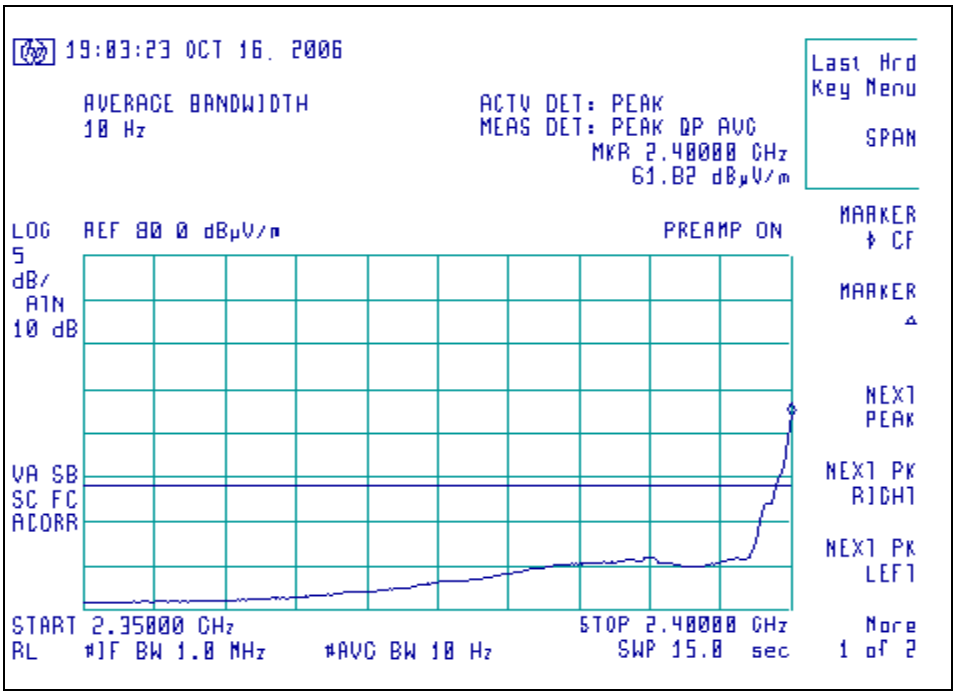
8.1 Method of Measurements

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 2400-2483.5 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 two highest channels for the investigation of the higher Band-Edge.

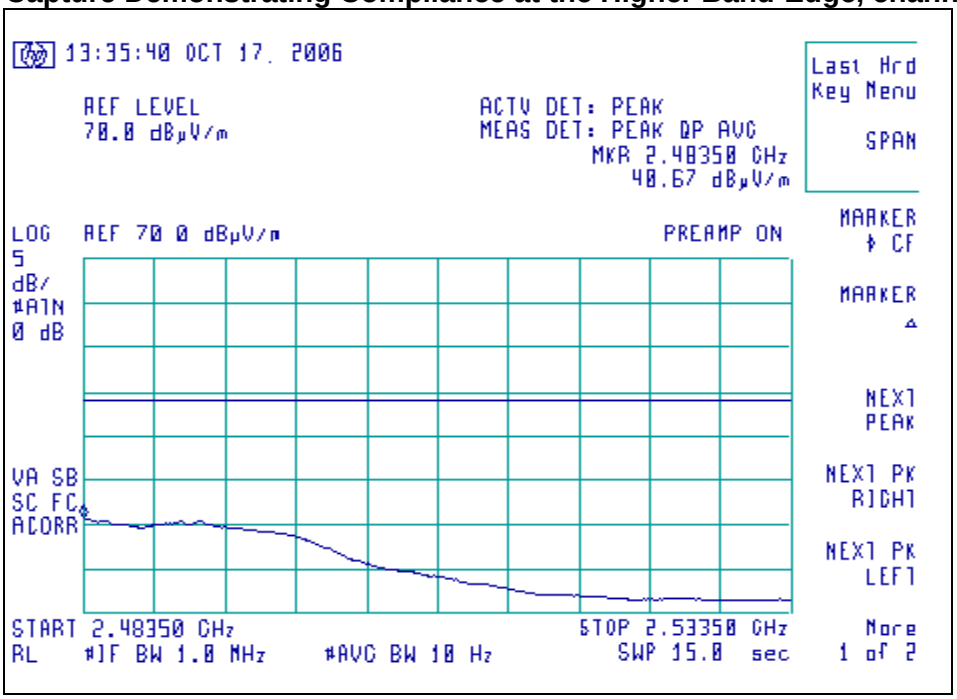
The Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.

The Upper Band-Edge limit, in this case, would be + 54 dBµV/m at 3m.

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Screen Capture Demonstrating Compliance at the Higher Band-Edge, channel 2475



Screen Capture Demonstrating Compliance at the Higher Band-Edge, channel 2480

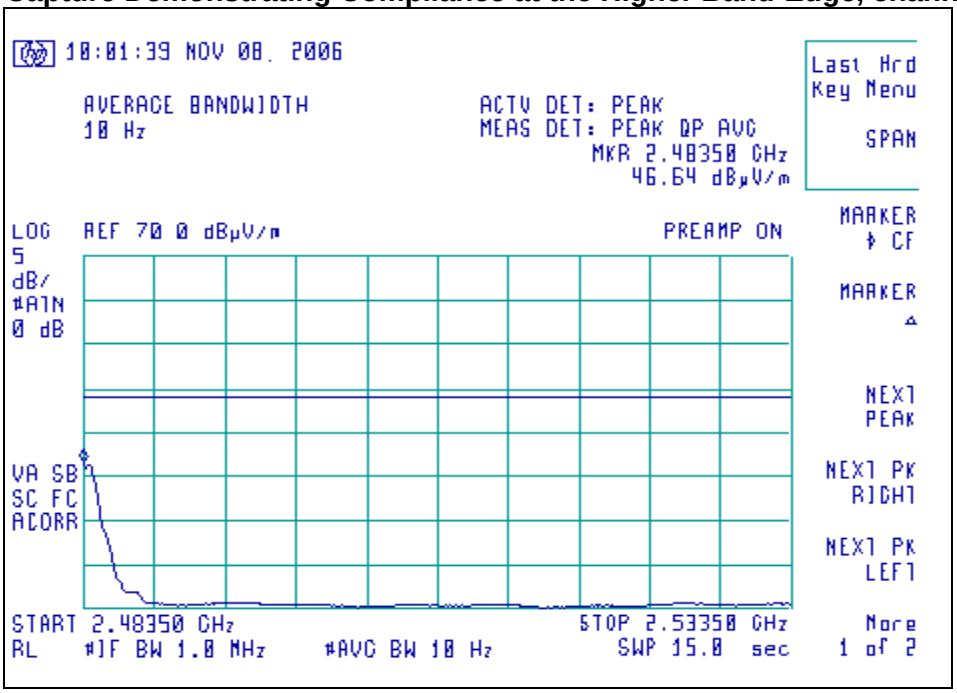


EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

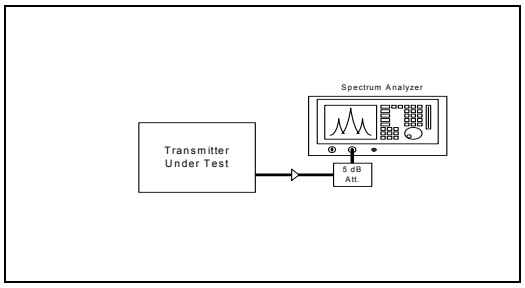
9.1 Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, there by allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with an internal test program as a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 3 MHz, and a span of 10 MHz, with measurements from a peak detector presented in the chart below.

9.2 Test Data

Transmitter Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Calculated EIRP (dBm) [1]	Conducted Power Limit (dBm)	EIRP Limit (dBm)
2405	2405	+7.52	15.0	30.0	36.0
2440	2440	+8.23	15.7	30.0	36.0
2475	2475	+8.09	15.6	30.0	36.0
2480	2480	-7.66	-0.2	30.0	36.0

[1] EIRP Calculation:
EIRP = (Peak power at antenna terminal in dBm) + (EUT Antenna gain in dBi). 7.5 dBi typical antenna gain used.



Rated RF power output (in watts): 0.010

Measured RF Power Output (in Watts): 0.0066

Declared RF Power Output (in Watts): 0.010

9.3 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

9.4 Screen Captures – Power Output (Conducted)

Channel 2440, highest output channel observed

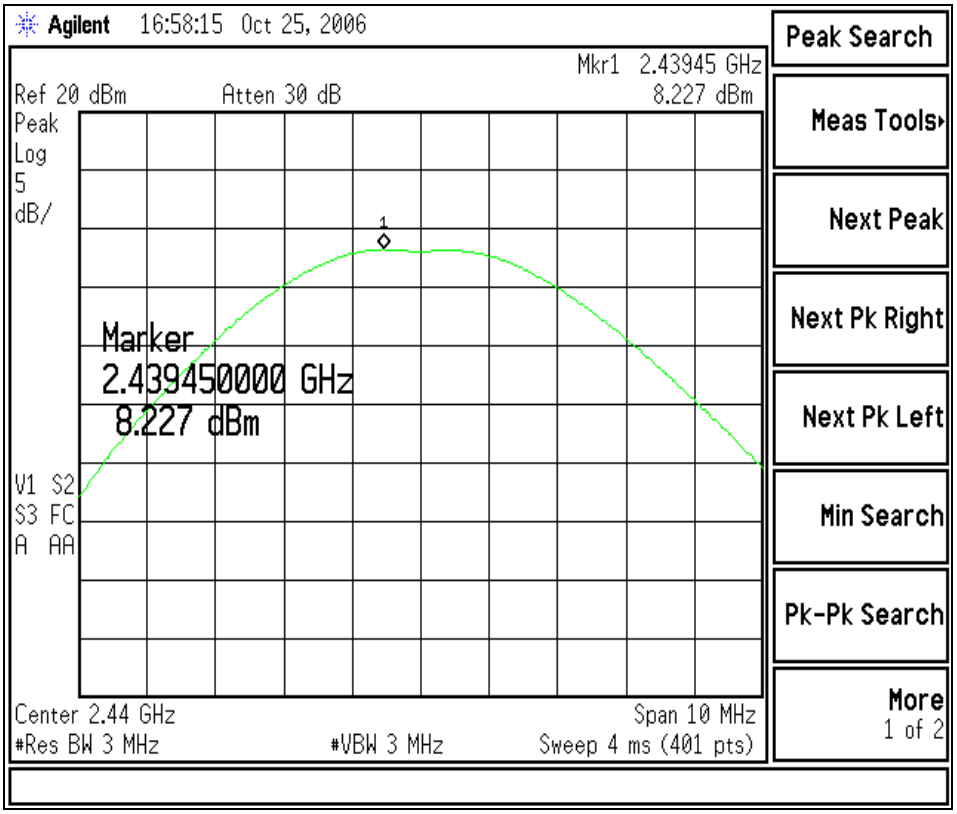


EXHIBIT 10. POWER SPECTRAL DENSITY: 15.247(e)

10.1 Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of the EUT during continuous transmission.

In accordance with FCC Part 15.247(e), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed using the utility built into the HP Analyzer. The resultant density was then corrected to a 3 kHz bandwidth. The highest density was found to be no greater than -6.4 dBm, which is under the allowable limit by 14.4 dB.

10.2 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4446A	US45300564

10.3 Test Data

Transmitter Channel	Frequency (MHz)	RF Power Level In 3 kHz BW (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Comments Pass/Fail
Lowest	2405	-7.22 dBm	8.0	15.2	Pass
Middle	2440	-6.37 dBm	8.0	14.4	Pass
Highest	2475	-6.86 dBm	8.0	14.9	Pass
Highest	2480	-22.72 dBm	8.0	30.7	Pass

10.4 Screen Captures – Power Spectral Density

Channel 2440, observed to be closest to the specification

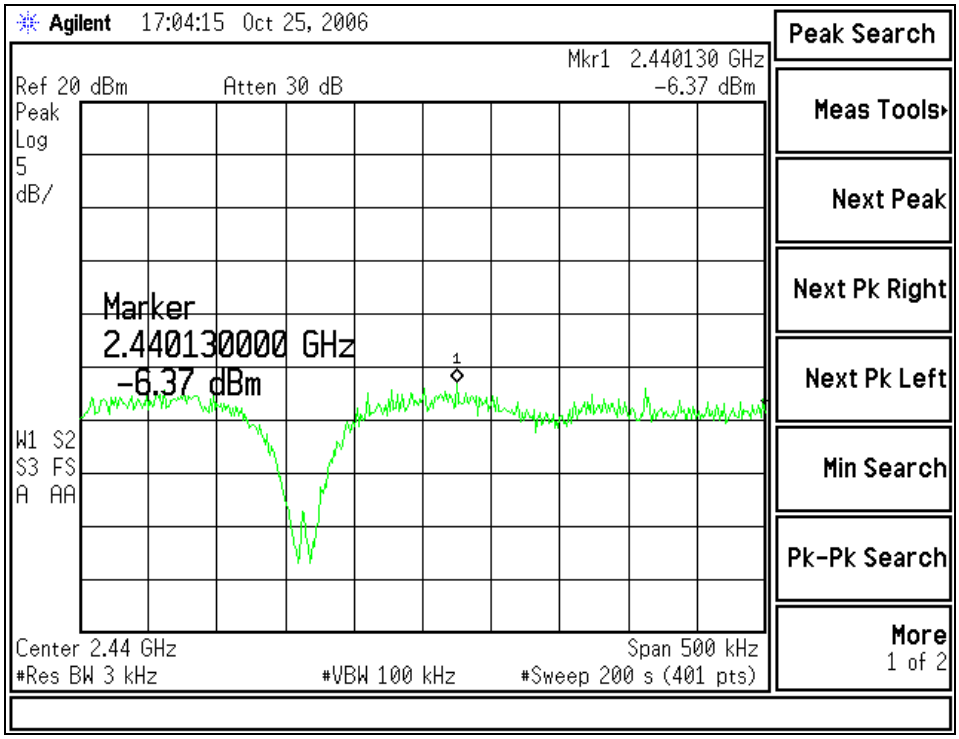


EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

11.1 Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at lease 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

In addition, radiated emissions, which fall in any restricted band, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(e); refer to exhibit 5 for radiated emissions results.

Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in Section 15.35 for limiting peak emissions apply.

FCC 47 CFR 15.205(a) – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 – 0.110	162.0125 – 167.17	2310 – 2390	9.3 – 9.5
0.49 – 0.51	167.72 – 173.2	2483.5 – 2500	10.6 – 12.7
2.1735 – 2.1905	240 – 285	2655 – 2900	13.25 – 13.4
8.362 – 8.366	322 – 335.4	3260 – 3267	14.47 – 14.5
13.36 – 13.41	399.9 – 410	3332 – 3339	14.35 – 16.2
25.5 – 25.67	608 – 614	3345.8 – 3358	17.7 – 21.4
37.5 – 38.25	960 – 1240	3600 – 4400	22.01 – 23.12
73 – 75.4	1300 – 1427	4500 – 5250	23.6 – 24.0
108 – 121.94	1435 – 1626.5	5350 – 5460	31.2 – 31.8
123 – 138	1660 – 1710	7250 – 7750	36.43 – 36.5
149.9 – 150.05	1718.8 – 1722.2	8025 – 8500	Above 38.6
156.7 – 156.9	2200 – 2300	9000 – 9200	

FCC Part 15.247(d) requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, there by allowing direct readings of the measurements made without the need for any further corrections. A Hewlett Packard model E4446 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 2405	Channel 2440	Channel 2475	Channel 2480
Fundamental	+ 3.7 (dBm)	+ 3.7 (dBm)	+ 4.2 (dBm)	-11.7 (dBm)
2nd Harmonic	- 74.8 (dBm)	- 75.8 (dBm)	- 71.9 (dBm)	Note (1)
3rd Harmonic	- 76.2 (dBm)	- 71.5 (dBm)	- 72.1 (dBm)	Note (1)
4th Harmonic	- 74.2 (dBm)	- 76.0 (dBm)	- 77.5 (dBm)	Note (1)
5th Harmonic	Note (1)	Note (1)	Note (1)	Note (1)
6th Harmonic	Note (1)	Note (1)	Note (1)	Note (1)
7th Harmonic	Note (1)	Note (1)	Note (1)	Note (1)
8th Harmonic	Note (1)	Note (1)	Note (1)	Note (1)
9th Harmonic	Note (1)	Note (1)	Note (1)	Note (1)
10th Harmonic	Note (1)	Note (1)	Note (1)	Note (1)

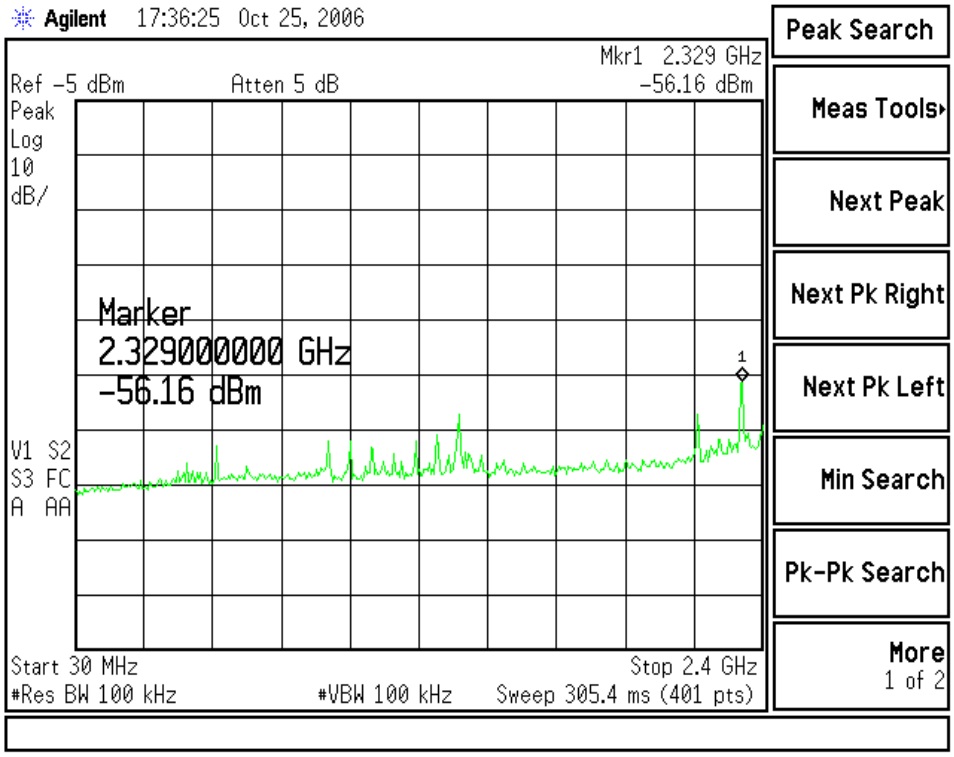
Notes:
(1) Measurement at system noise floor.

11.2 Test Equipment List

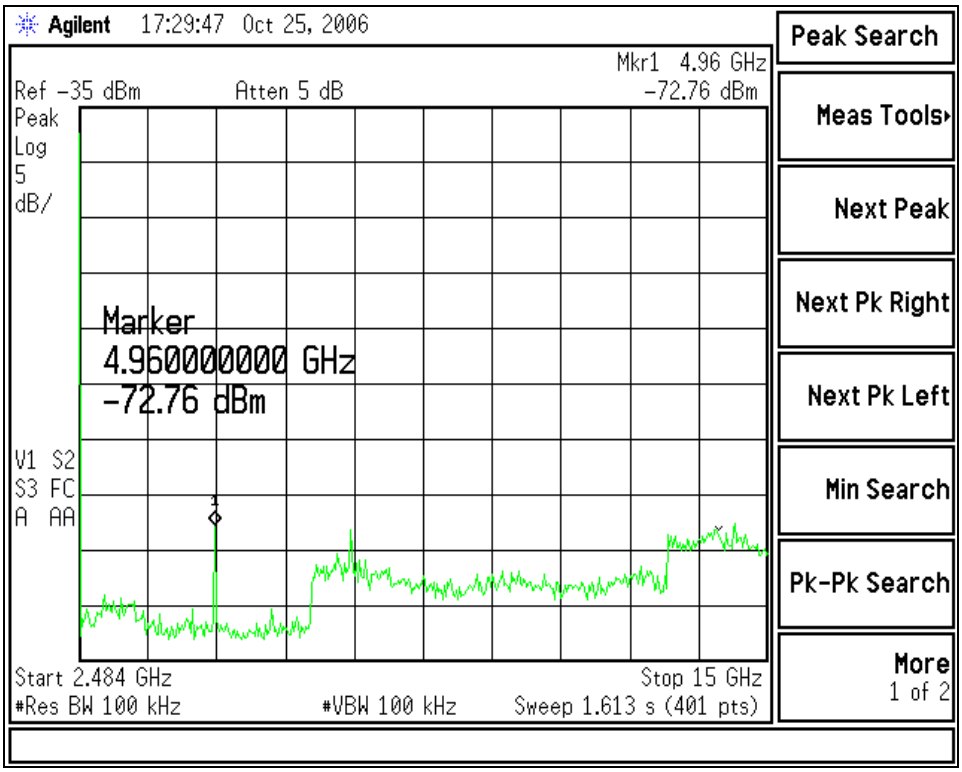
Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

11.3 Screen Captures – Spurious Conducted Emissions

Channel 2475, shown from 30 MHz up to 2400 MHz



Channel 2475, shown from 2400 MHz up to 15000 MHz



Channel 2475, shown from 15000 MHz up to 25000 MHz

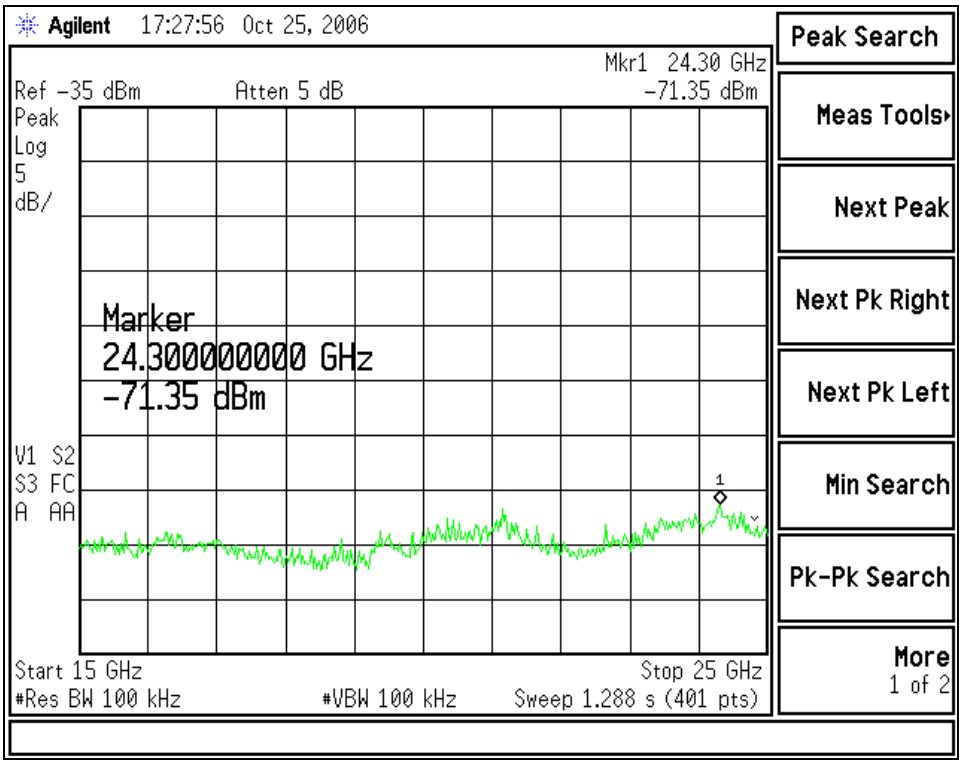


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

The stability of the device was examined as a function of the input voltage available to the EUT.

In this case, the EUT uses a single type “CR-123” Lithium battery, with a nominal voltage of 3.0 VDC. The working range of this battery is 3.4 VDC to 2.5 VDC (50% life), but the defined operation range of the EUT is limited to 2.80 VDC on the low end.

A spectrum analyzer, connected directly to the transmitter was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit CW mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer with RBW=VBW=1 kHz settings while the voltage was varied.

	DC/AC Voltage Source		
	2.4 VDC	3.0 VDC	3.9 VDC
	(MHz)	(MHz)	(MHz)
Channel 2440	2440.018360	2440.018680	2440.018980

The RF Power Output of the EUT was monitored in a separate test, also using a Spectrum Analyzer with RBW=VBW=3 MHz setting while the voltage was varied.

	DC/AC Voltage Source		
	2.4 VDC	3.0 VDC	3.9 VDC
Channel 2440	7.2 (dBm)	7.8 (dBm)	7.8 (dBm)

EXHIBIT 13. CHANNEL PLAN AND SEPARATION

Optional for DTS---Not Applicable to this equipment.

EXHIBIT 14. MPE CALCULATIONS

The following MPE calculations are based on a 1.8 centimeter inverted-F printed circuit board trace antenna, at 2440 MHz, with a measured ERP of 110.9 dBµV/m, at 3 meters, and conducted RF power of +8.23 dBm as presented to the antenna. The calculated gain of this antenna, based on the ERP measurements is 7.5 dB.

Prediction MPE limit at a given distance

Reference equation from page 18 OET Bulletin 65, Edition 97-01

Maximum peak output power at antenna input terminal: 8.23(dBm)
Maximum peak output power at antenna input terminal: 6.653 (mW)
Antenna Gain (typical): 7.5 (dBi)
Maximum Antenna Gain: 5.623(numeric)
Prediction Distance: 20 (cm)
Prediction Frequency: 2440 (MHz)
MPE Limit for uncontrolled exposure at prediction frequency: 1 (mW/cm^2)

Power density at prediction frequency: 0.007443
Maximum allowable antenna gain: 28.8 (dBi)
Margin of Compliance at 20 cm = 21.3 dB

APPENDIX A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	12/6/07	12/6/08
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	7/26/06	7/26/07
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	7/20/06	7/20/07
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	12/04/06	12/04/07
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	1/11/07	1/11/08
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
EE960073	Agilent	E4446A	US45300564	Spectrum Analyzer	2/01/06	2/01/07
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(s)

Portable Antenna NEARSON 131

This type of antenna is the most common mounting style. These antennas simply attach to the outside of housing using one of many different type RF Connectors. The most common of these are the SMA, TNC, and BNC, all of which are available in standard and reverse polarity configurations. Reverse Polarity connectors are important for FCC approval through Reg. 15 parts compliancy, which states that an antenna connecting to the outside of housing must have a non-conforming connector type. FCC Compliant connectors include Reverse Polarity and Reverse Thread styles. Connector Mounts are available for all frequencies from UHF/VHF to 5.2 GHz. Please refer to the Antenna Selection guide to choose the best style for your application.

Model	131						
Photo							
Description	Dipole 1/2 Wave						
Gain	2 dBi (2.4 GHz) 0 dBi (Dual Band) 4 dBi (5.X GHz)						
Length	3.5"						
Connector	SMA						
Style	Right Angle Swivel						
Frequency							
SMR 806-866 MHz							
Cellular (AMPS) 824-896 MHz							
Cellular (GSM) 890-960 MHz							
ISM 902-928 MHz 867-869 MHz							
WLAN/ISM 2.4-2.5 GHz	X						
WiMax 3.5-3.6 GHz							
WLAN/UNII 5.X GHz							
Cellular PCS 1850-1990 MHz							
Cellular DCS 1710-1880 MHz							
Dual Band AMPS/ PCS or GSM/ DCS	X						
Tri-Band GSM/PCS/DCS							
Tri-Band 2.4-2.5/4.9-5.35/ 5.725-5.85 GHz	X						