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ENGINEERING TEST REPORT # 309123 (C-600) Rev. 6-17-09
Supersedes 309123 (C-600)

Compliance Testing of:
FreeStar Pro Zigbee Module

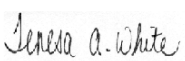
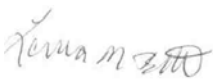
Test Date(s):
April 5-May 9, and May 27, 2009

Prepared For:
California Eastern Laboratories
Attn: Dave Wilde
1253 N Old Rand Road
Wauconda, IL 60084

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
And RSS-Gen
Issue 2 June 2007

This Test Report is issued under the Authority of:
Ryan Urness, EMC Lab Manager

Signature:  Date: June 17, 2009

Test Report Reviewed by:	**Tested by:**
Teresa A. White, Quality Manager	Laura Bott, EMC Engineer
Signature: 	Signature: 
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LSC Revision Control

Date	Revision #	Revised By
9-06-06	2.0	AS/TAW

EXHIBIT 1. INTRODUCTION

1.1 SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247
Title:	Telecommunication – Code of Federal Regulations, CFR 47, Part 15
References:	RSS-Gen, Issue 2, June 2007
Title:	General Requirements and Information for the Certification of Radiocommunication Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Digital Modulation Transmitters (and Receivers) operating in the Frequency Band of 2400 MHz – 2483.5 MHz
Test Procedures:	Both conducted and radiated emissions measurements were performed 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 from 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)	2008	Code of Federal Regulations - Telecommunications
RSS-Gen Issue 2	2007	Spectrum Management and Telecommunications Radio Standards Specification
ANSI C63.4	2003	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	2008, 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:	**California Eastern Laboratories**
Address:	**1253 N Old Rand Road** **Wauconda, IL 60084**
Contact Person:	**Dave Wilde** **David.Wilde@cel.com** **847-487-6364**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	FreeStar Pro Zigbee module
Model Number:	ZFS0-201-1-ES
Serial Number:	ES0401 .

2.3 ASSOCIATED ANTENNA DESCRIPTION

-1.03 dBi inverted F trace antenna

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	2405-2480 MHz
RF Power in Watts	0.116 Watts
Conducted Output Power (in dBm)	Max: 20.56 dBm (2440 MHz) Min: -1.17 dBm (2480 MHz)
Field Strength (and at what distance)	114.0 dBµV/m at 3m (2410 MHz)
Occupied Bandwidth (99% BW)	2550 kHz (CH 18: 2440 MHz)
Type of Modulation	O-QPSK
Emission Designator	2M550G1D
EIRP (in mW)	91.83 mW
Transmitter Spurious (worst case)	70.8 dBµV/m @1m (4880 MHz) 6103 dBµV/m @3m (4880 MHz)
Receiver Spurious (worst case)	52.89 dBµV/m @ 3m (2989 MHz)
Receiver Bandwidth	1.8 MHz
Receiver Sensitivity	-96 dBm
Frequency Tolerance %, Hz, ppm	100 ppm
Microprocessor Model # (if applicable)	MC13224
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	PCB inverted F
Gain (in dBi)	-1.03 dBi
EUT will be operated under FCC Rule Part(s)	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
	√	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: 20 cm
- RF Value: 0.0014988 ☐ V/m ☐ A/m ☒ W/m^2
  ☐ Measured ☐ Computed ☒ Calculated

2.5 PRODUCT DESCRIPTION

The Freestar Pro modules provide a high performance and cost effective RF transceiver solution for 2.4GHz IEEE 802.15.4 applications.

The Freestar Pro module is based on the Freescale™ MC13224 transceiver platform. It combines Freescale's transceiver IC with an on board 100mW Power Amplifier, a TX/RX switch and an integrated trace antenna.

The Freescale MC132234 transceiver is a Spread Spectrum modem implementing O-QPSK modulation, operating in the 2400-2483.5 MHz ISM frequency band, with 5MHz channel spacing, and supports clear channel assessment (CCA), Energy Detect (ED) and Link Quality Indication (LQI). The system operates at 250Kbps and is capable of operating from (0-10dBm, or 20dBm) into a printed circuit board inverted-F antenna.

The processing power of the MC13224 enables the Freestar Pro to provide at a level of integration unprecedented in a Zigbee module. The ARM 32-bit processor and expansive on-chip memory (128K Serial Flash, 96KB SRAM, 80KB ROM) enable designers to eliminate the peripheral host processors often required by 8 and 16-bit transceiver solutions. In addition, designers have 61 GPIO Ports available, and two 12-Bit ADC's which share 8 input channels. The module also contains 96Kbytes of RAM, 80Kbytes of ROM and 128Kbyte serial Flash memory that can be mirrored into the 96Kbyte RAM. Two on-chip UARTS allow communication to the module via a Serial Port Interface (SPI).

PHOTO (Optional)

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	20-25°C
Humidity:	30-60%
Pressure:	86-106 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)**

In order to meet the radiated emissions requirements for 15.247, Channels 11 and 12 must be operated at a power setting no higher than 4 and Channel 26 must be operated at a power setting no higher than 1.

Channel 11 power setting 4 → 10.52 dBm
Channel 12 power setting 4 → 11.37 dBm
Channel 26 power setting 1 → -1.17 dBm

Also a 15 dB desensitization correction factor was invoked to demonstrate compliance, thus the EUT may only be operated at a max duty cycle of 35%.

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, RSS-Gen, and Industry Canada RSS-210 Issue 7 (2007), 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

Transmit Mode

5.1 Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.4-2003.

Measurements at frequencies 30 MHz – 4 GHz where taken when 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 radiated emissions limits for unintentional radiators, denoted in FCC §15.109, apply at a 3 meter distance; the measurement antenna was placed 3 meters from the EUT radiating element.

Measurements above 4 GHz were performed at a 1.0 meter separation distance in a semi-anechoic mini chamber. The calculations to determine the limits at the 1.0 meter separation distance are detailed in the following pages.

The EUT was tested in continuous modulated transmit mode. Power was supplied to the EUT by a bench type power supply. The unit has the capability to operate on 16 channels, controllable customer supplied programming board and proprietary firmware.

The test sample was operated on one of three (3) standard channels: low (2405 MHz), middle (2440 MHz) and high (2480 MHz) to comply with FCC § 15.31(m), plus the lowest and highest channels operated at full power: Channel 13 (2415 MHz) and Channel 25 (2475 MHz).

Please refer to Appendix A for a complete list of test equipment.

5.2 Test Procedure

Radiated Emissions measurements were taken from 30-25000 MHz. Measurements from 30 - 4000 MHz were performed a 3 meter Semi-Anechoic, FCC listed Chamber. Measurements from 4000-25000 MHz were taken at a 1 meter separation distance, in a semi-anechoic mini chamber. The radiated RF emission levels were manually noted at discrete turntable azimuths and measurement antenna heights, corresponding to peak emission levels at various frequencies.

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 an EMCO standard gain horn antenna was used for measurements from 18 to 25 GHz. The maximum radiated RF emissions were found by rotating the EUT 360°, and raising and lowering the antenna between 1 and 4 meters for measurements taken at 3 meters in the 3 meter chamber, and the antenna was exercised between 1 and 1.8 meters vertically for measurements taken at 1 meter in the mini chamber; using both horizontal and vertical antenna polarities.

The EUT was rotated along three orthogonal axes 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 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.

For measurements 30 MHz – 4 GHz, the HP 8546A EMI receiver was used, and an Agilent E4446A Spectrum Analyzer was utilized for measurements 4 GHz – 25 GHz. An EMCO horn antenna was used for measurements between 1 GHz and 18 GHz (accompanied by a preamp for measurements over 4 GHz), and a standard gain horn with preamp were used for measurements 18-25 GHz.

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

5.4 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 Issue 7 (2007), Annex 8 (section 8.2). The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 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, 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	-
960-24,000	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

5.6 RADIATED EMISSIONS TEST 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:	California Eastern Laboratories						
Date(s) of Test:	April 23-May 7, 2009						
Test Engineer(s):	Laura bott						
Voltage:	3.3 VDC						
Operation Mode:	Normal, continuous modulated transmit mode						
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %						
EUT Power:		Single Phase ___VAC		3 Phase ___VAC			
		Battery	√	Other: Bench type power supply			
EUT Placement:	√	80cm non-conductive table		10cm Spacers			
EUT Test Location:	√	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS			
Measurements:		Pre-Compliance		Preliminary	√	Final	
Detectors Used:	√	Peak	√	Quasi-Peak	√	Average	

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

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
744.5	1.00	293	33.6	46.0	12.4	Horizontal	Flat
792.8	1.30	140	37.6	46.0	8.4	Horizontal	Flat
841.1	1.00	135	41.9	46.0	4.1	Horizontal	Flat
842.5	1.00	173	34.5	46.0	11.5	Vertical	Flat
842.5	1.00	137	40.8	46.0	5.2	Horizontal	Side
864.9	1.04	134	39.7	46.0	6.3	Horizontal	Flat
867.0	1.00	126	38.3	46.0	7.7	Horizontal	Side
888.0	1.12	38	39.3	46.0	6.7	Horizontal	Vertical
889.4	1.00	135	42.6	46.0	3.4	Horizontal	Flat
913.2	1.00	129	39	46.0	7.0	Horizontal	Flat
937.0	1.00	111	39.6	46.0	6.4	Horizontal	Flat
960.0	1.00	0	37.7	54.0	16.3	Horizontal	Side
985.3	1.00	106	43.2	54.0	10.8	Horizontal	Flat

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

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2405	1.53	275	110.1	98.8	125.0	26.2	Horizontal	Flat
2410	1.00	121	109.8	99.0	125.0	26.0	Horizontal	Flat
2415	1.10	273	121.8	113.4	125.0	11.6	Horizontal	Flat
2440	1.63	107	120.9	112.2	125.0	12.8	Horizontal	Flat
2475	1.10	272	122.7	113.4	125.0	11.6	Horizontal	Flat
2480	1.11	272	101.5	92.7	125.0	32.3	Horizontal	Flat

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 11 (2405 MHz):

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4810	1.09	9	70.9	54.4	63.5	9.1	Vertical	Vertical
7215	1.14	6	68.7	51.5	88.8	37.3	Vertical	Vertical
9620	1.00	157	67.2	51	88.8	37.8	Horizontal	Vertical
12025	1.05	316	61.2	46.8	63.5	16.7	Horizontal	Flat
14430	1.00	190	67.3	51.5	88.8	37.3	Horizontal	Flat
16835	1.17	214	60.5	47.5	88.8	41.3	Horizontal	Vertical
19240			Note 3		74			
21645			Note 3		98.8			
24050			Note 3		98.8			

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 11 (2405 MHz), corrected to reflect 3 meter measurements:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4810	1.09	9	61.4	44.9	54	9.1	Vertical	Vertical
7215	1.14	6	59.2	42	79.3	37.3	Vertical	Vertical
9620	1.00	157	57.7	41.5	79.3	37.8	Horizontal	Vertical
12025	1.05	316	51.7	37.3	54	16.7	Horizontal	Flat
14430	1.00	190	57.8	42	79.3	37.3	Horizontal	Flat
16835	1.17	214	51	38	79.3	41.3	Horizontal	Vertical
19240			Note 3					
21645			Note 3					
24050			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 12 (2410 MHz):

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4820	1.08	205	59	45.7	63.5	17.8	Horizontal	Side
7230	1.04	83	67.3	51.0	89.0	38.0	Vertical	Side
9640	1.20	165	66.8	50.3	89.0	38.7	Vertical	Side
12050	1.04	245	67.2	50.7	63.5	12.8	Horizontal	Side
14460	1.07	188	71.6	53.2	89.0	35.8	Horizontal	Vertical
16870	1.00	9	62.3	48.9	89.0	40.1	Horizontal	Side
19280			Note 3					
21690			Note 3					
24100			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 12 (2410 MHz), corrected to reflect 3 meter measurements:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4820	1.08	205	49.5	36.2	54.0	17.8	Vertical	Vertical
7230	1.04	83	57.8	41.5	79.5	38.0	Vertical	Vertical
9640	1.20	165	57.3	40.8	79.5	38.7	Horizontal	Vertical
12050	1.04	245	57.7	41.2	54.0	12.8	Horizontal	Flat
14460	1.07	188	62.1	43.7	79.5	35.8	Horizontal	Flat
16870	1.00	9	52.8	39.4	79.5	40.1	Horizontal	Vertical
19280			Note 3					
21690			Note 3					
24100			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 13 (2415 MHz):

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4830	1.00	174	68.6	53.2	63.5	10.3	Horizontal	Side
7245	1.00	193	70.3	53.7	103.4	49.7	Vertical	Flat
9660	1.12	43	62.5	47.2	103.4	56.2	Horizontal	Flat
12075	1.00	319	60.4	45.8	63.5	17.7	Horizontal	Flat
14490	1.04	202	63.4	48.6	63.5	14.9	Horizontal	Vertical
16905	1.00	251	55.9	43.6	103.4	59.8	Horizontal	Side
19320			Note 3					
21735			Note 3					
24150			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 13 (2415 MHz), corrected to reflect 3 meter measurements:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4830	1.00	174	59.1	43.7	54.0	10.3	Vertical	Vertical
7245	1.00	193	60.8	44.2	93.9	49.7	Vertical	Vertical
9660	1.12	43	53.0	37.7	93.9	56.2	Horizontal	Vertical
12075	1.00	319	50.9	36.3	54.0	17.7	Horizontal	Flat
14490	1.04	202	53.9	39.1	54.0	14.9	Horizontal	Flat
16905	1.00	251	46.4	34.1	93.9	59.8	Horizontal	Vertical
19320			Note 3					
21735			Note 3					
24150			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 18 (2440 MHz):

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4880	1.00	192	70.9	59.6	63.5	3.9	Horizontal	Side
7320	1.11	349	68.8	52.2	63.5	11.3	Vertical	Vertical
9760	1.21	41	69.7	52.3	102.2	49.9	Vertical	Side
12200	1.11	224	63.5	48.3	63.5	15.2	Horizontal	Side
14640	1.00	200	66.9	51.1	102.2	51.1	Horizontal	Flat
17080	1.07	145	65.0	51.5	102.2	50.7	Horizontal	Side
19520			Note 3					
21960			Note 3					
24400			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 18 (2440 MHz), corrected to reflect 3 meter measurements:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4880	1.00	6	61.4	50.1	54.0	3.9	Vertical	Vertical
7320	1.11	349	59.3	42.7	54.0	11.3	Vertical	Vertical
9760	1.21	41	60.2	42.8	92.7	49.9	Horizontal	Vertical
12200	1.11	224	54.0	38.8	54.0	15.2	Horizontal	Flat
14640	1.00	200	57.4	41.6	92.7	51.1	Horizontal	Flat
17080	1.07	145	55.5	42.0	92.7	50.7	Horizontal	Vertical
19520			Note 3					
21960			Note 3					
24400			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 25 (2475 MHz):

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4950	1.11	88	64.7	51.7	63.5	11.8	Vertical	Side
7425	1.11	353	66.9	50.5	63.5	13.0	Vertical	Vertical
9900	1.18	98	70.0	52.3	103.4	51.1	Vertical	Vertical
12375	1.15	225	61.5	47.2	63.5	16.3	Horizontal	Side
14850	1.00	265	65.4	50.5	103.4	52.9	Horizontal	Vertical
17325	1.00	121	63.7	50.8	103.4	52.6	Vertical	Side
19800			Note 3					
22275			Note 3					
24750			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 25(2475 MHz), corrected to reflect 3 meter measurements:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4950	1.11	88	55.2	42.2	54.0	11.8	Vertical	Vertical
7425	1.11	353	57.4	41.0	54.0	13.0	Vertical	Vertical
9900	1.18	98	60.5	42.8	93.9	51.1	Horizontal	Vertical
12375	1.15	225	52.0	37.7	54.0	16.3	Horizontal	Flat
14850	1.00	265	55.9	41.0	93.9	52.9	Horizontal	Flat
17325	1.00	121	54.2	41.3	93.9	52.6	Horizontal	Vertical
19800			Note 3					
22275			Note 3					
24750			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 26 (2480 MHz):

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4960	1.11	327	48.3	40.7	63.5	22.8	Vertical	Side
7440	1.03	4	46.9	34.8	63.5	28.7	Vertical	Vertical
9920	1.11	4	50.2	37.8	82.7	44.9	Horizontal	Side
12400	1.07	4	49.8	38.2	63.5	25.3	Vertical	Side
14880	1.05	5	49.4	38.2	82.7	44.5	Horizontal	Side
17360	1.07	9	55.0	43.8	82.7	38.9	Horizontal	Side
19800			Note 3					
22275			Note 3					
24750			Note 3					

The following table depicts the measured level of significant radiated RF harmonic emissions seen on Channel 26 (2480 MHz), corrected to reflect 3 meter measurements:

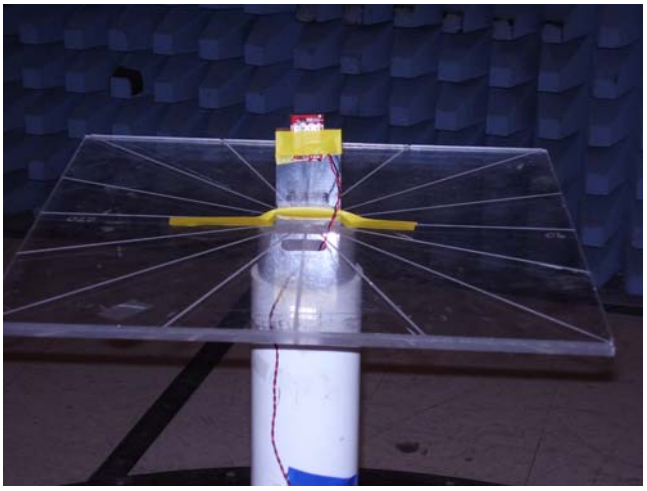
Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4960	1.11	327	38.8	31.2	54.0	22.8	Vertical	Vertical
7440	1.03	4	37.4	25.3	54.0	28.7	Vertical	Vertical
9920	1.11	4	40.7	28.3	73.2	44.9	Horizontal	Vertical
12400	1.07	4	40.3	28.7	54.0	25.3	Horizontal	Flat
14880	1.05	5	39.9	28.7	73.2	44.5	Horizontal	Flat
17360	1.07	9	45.5	34.3	73.2	38.9	Horizontal	Vertical
19800			Note 3					
22275			Note 3					
24750			Note 3					

Notes:

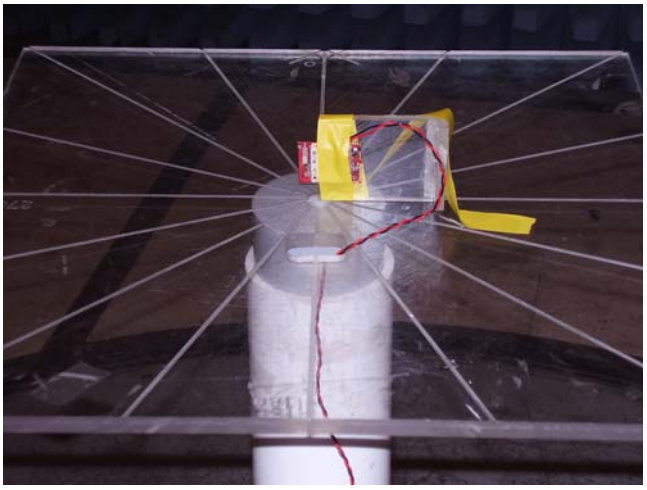
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
2) Measurements above 4 GHz were made at 1 meters of separation from the EUT.
3) Measurement at receiver system noise floor.
4) For measurements of the fundamental power, because of spectral bandwidth, the receiver was set to RBW=VBW=3 MHz.

5.7 Test Setup Photo(s) – Radiated Emissions Test

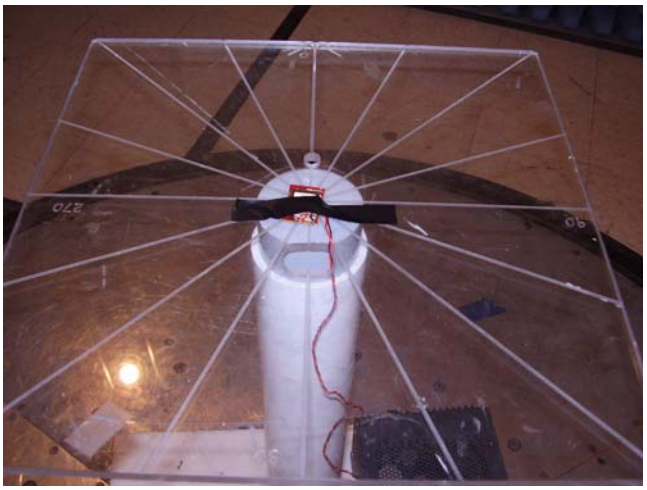
Vertical Orientation



Side Orientation



Flat Orientation

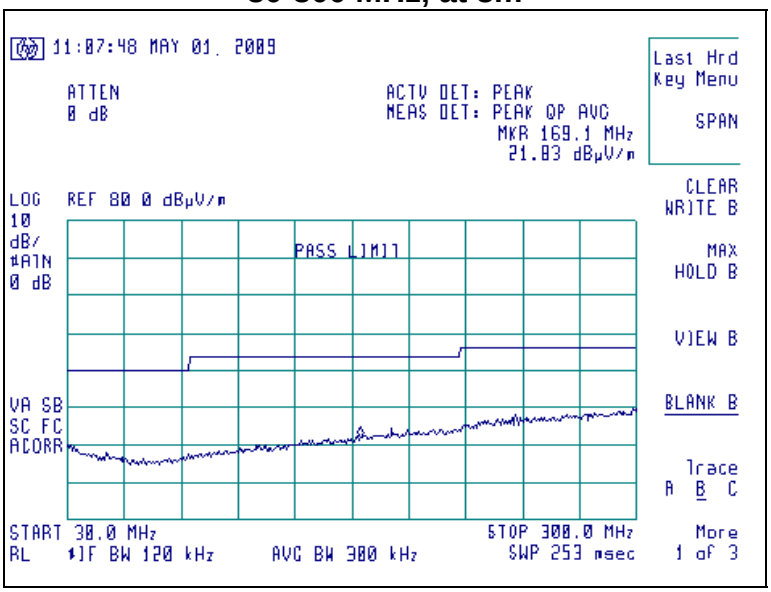


5.8 Screen Captures - Radiated Emissions Testing – Transmit Mode

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.

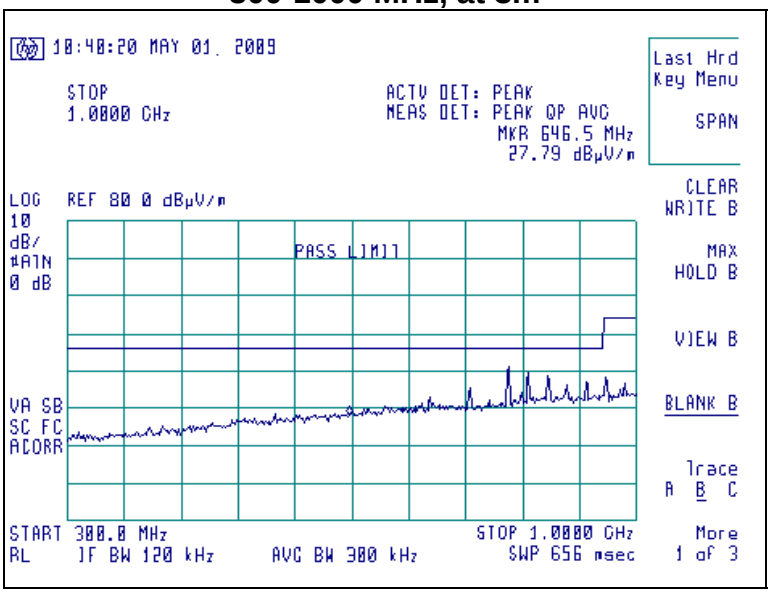
The signature scans shown here are from worst-case emissions, as measured on channels 11, 18, or 26, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Channel 18, Antenna Horizontally Polarized, EUT Flat
30-300 MHz, at 3m

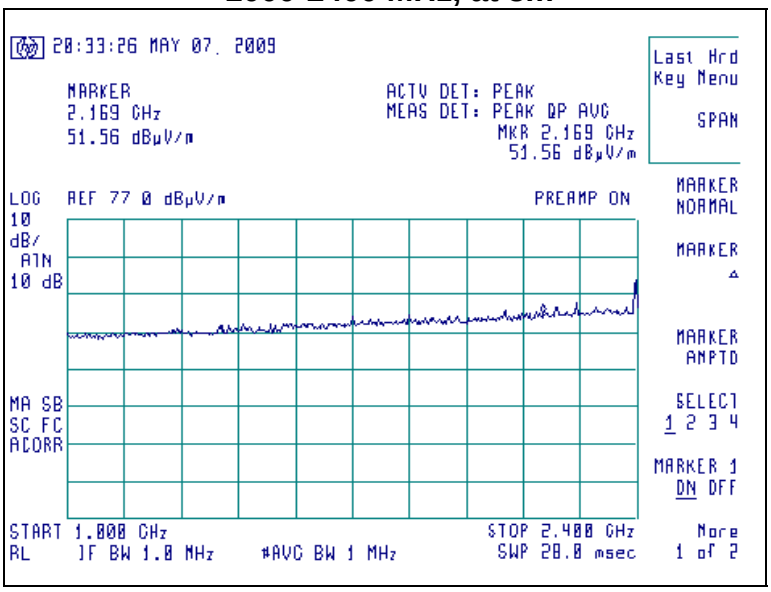


Screen Captures - Radiated Emissions Testing *(continued)*

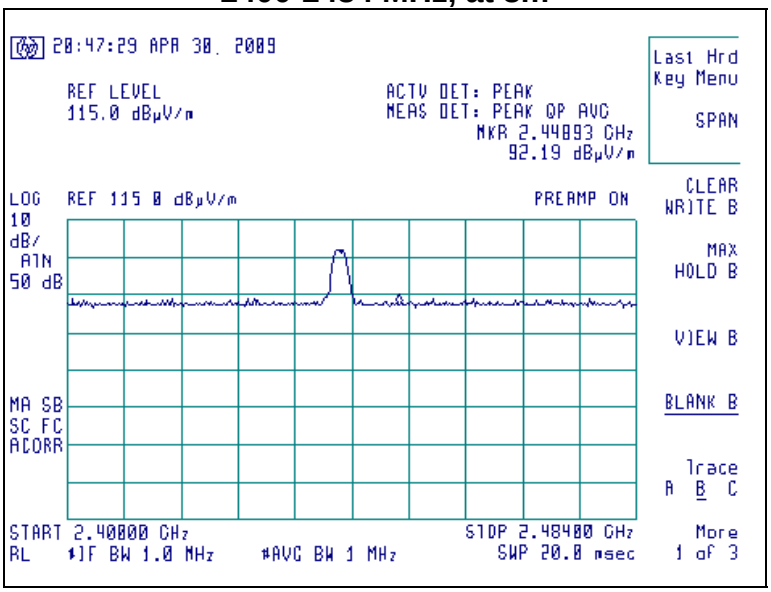
Channel 18, Antenna Horizontally Polarized, EUT Flat 300-1000 MHz, at 3m



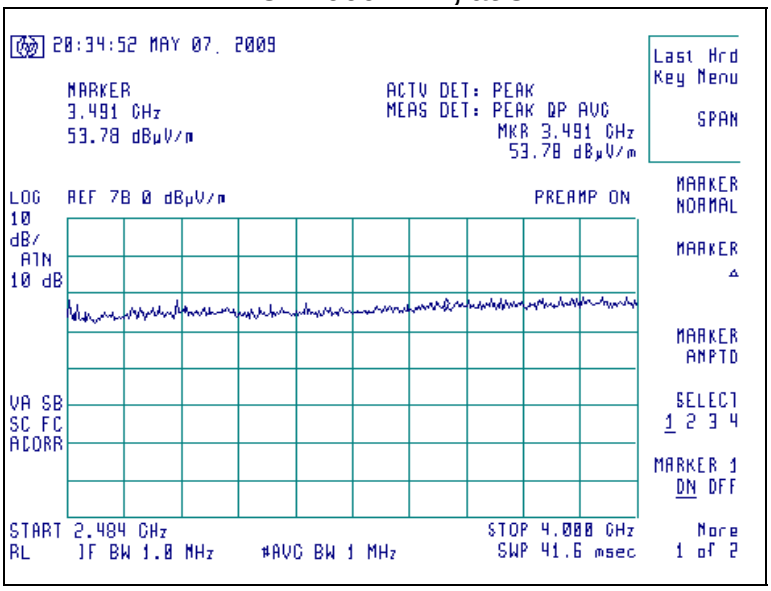
Channel 18, Antenna Horizontally Polarized, EUT Flat 1000-2400 MHz, at 3m



Channel 7, Antenna Horizontally Polarized, EUT Flat
2400-2484 MHz, at 3m

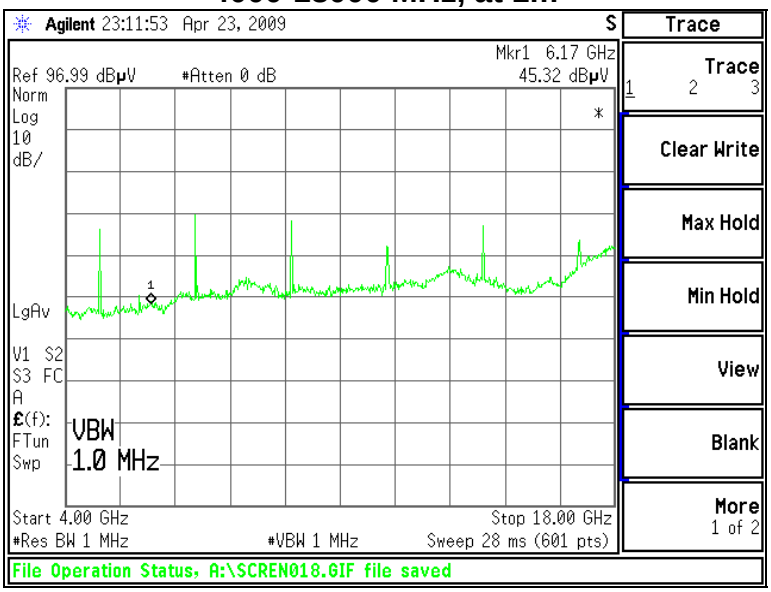


Channel 18, Antenna Horizontally Polarized, EUT Flat
2484-4000 MHz, at 3m

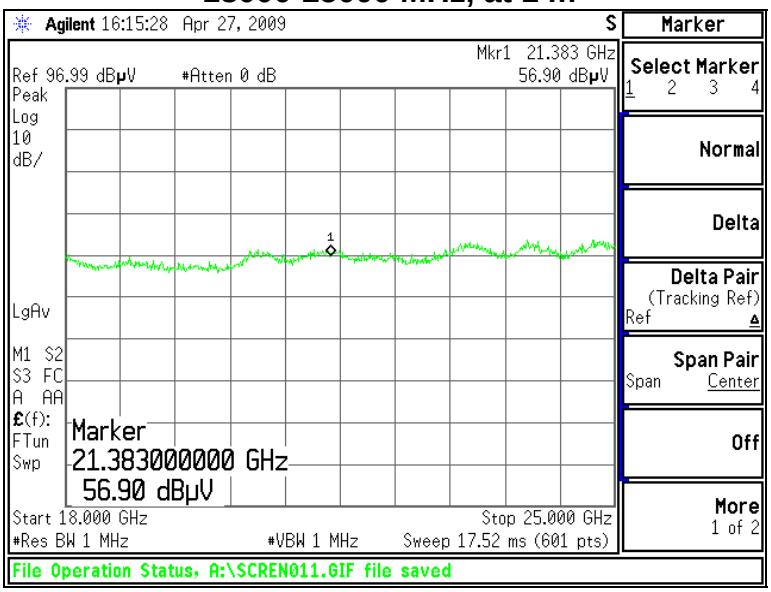


Screen Captures - Radiated Emissions Testing *(continued)*

Channel 18, Antenna Vertically Polarized
4000-18000 MHz, at 1m



Channel 18, Antenna Vertically Polarized
18000-25000 MHz, at 1 m



Receive Mode

5.9 Test Setup

The test setup was assembled in accordance with RSS GEN and ANSI C63.4-2003.

Measurements at frequencies 30 MHz – 4 GHz where taken when 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. Because the radiated emissions limits for unintentional radiators, denoted in RSS-Gen Section 6(a) apply at a 3 meter distance, the measurement antenna was placed 3 meters from the EUT radiating element.

Measurements 4-25 GHz were performed at a 1.0 meter separation distance in a semi-anechoic mini chamber. The calculations to determine the limits at the 1.0 meter separation distance are detailed in the following pages.

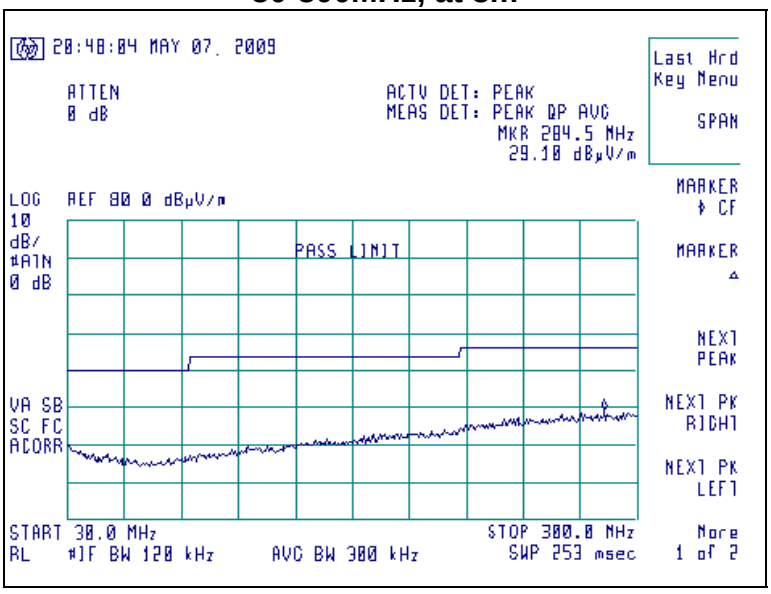
The EUT was tested in normal receive mode at the middle channel, per RSS-Gen Section 4.10.

Power was supplied to the EUT by a bench type power supply. The unit has the capability to operate on 16 channels, controllable via a dev board with USB interface to a PC.

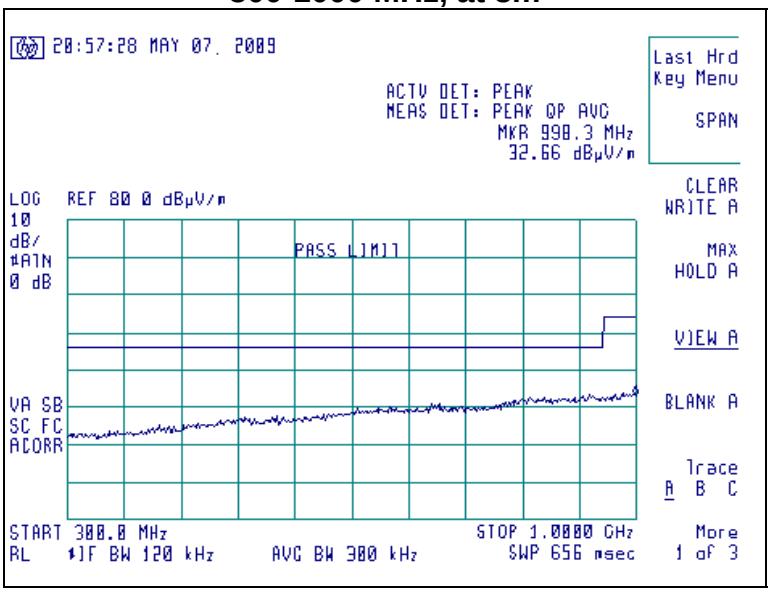
Please refer to Appendix A for a complete list of test equipment.

Screen Captures of Radiated Emissions

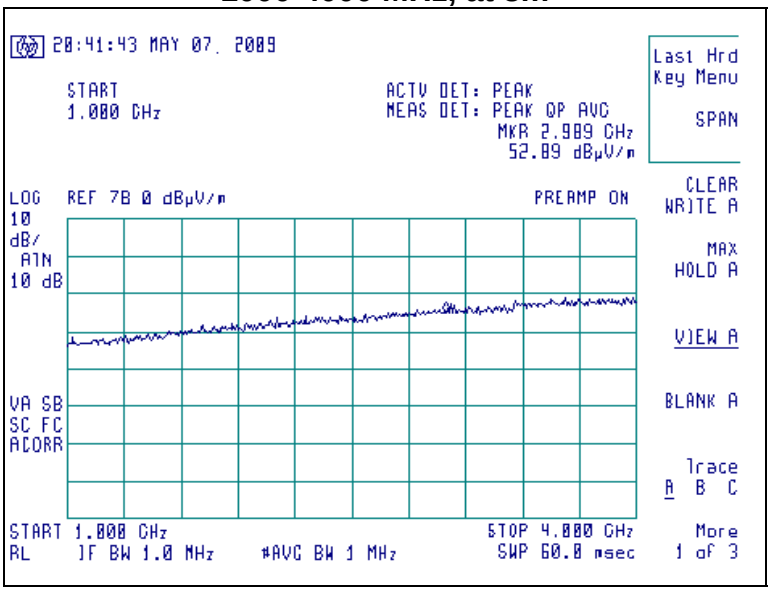
Channel 18, Antenna Vertically Polarized, EUT Vertical
30-300MHz, at 3m



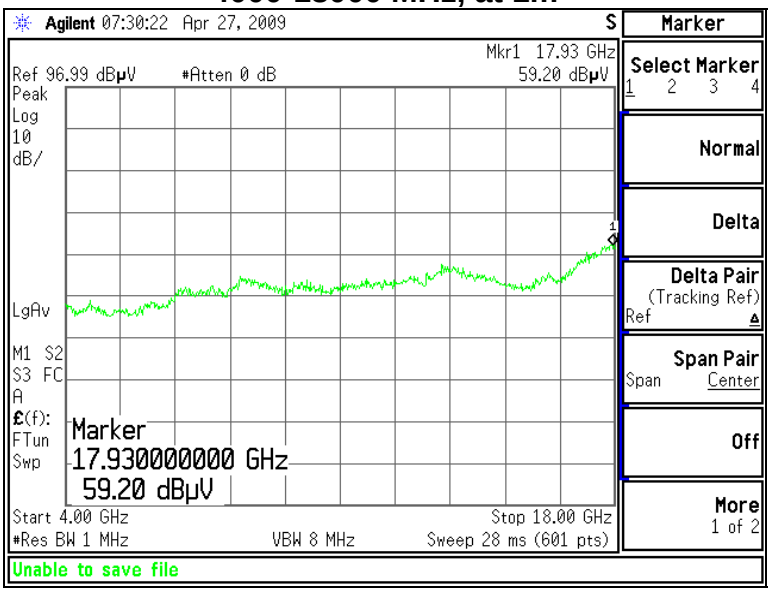
Channel 18, Antenna Vertically Polarized, EUT Vertical 300-1000 MHz, at 3m



Channel 18, Antenna Vertically Polarized, EUT Vertical 1000-4000 MHz, at 3m



Channel 18, Antenna Vertically Polarized, EUT Vertical
4000-18000 MHz, at 1m



Channel 18, Antenna Vertically Polarized, EUT Vertical
18000-25000 MHz, at 1m

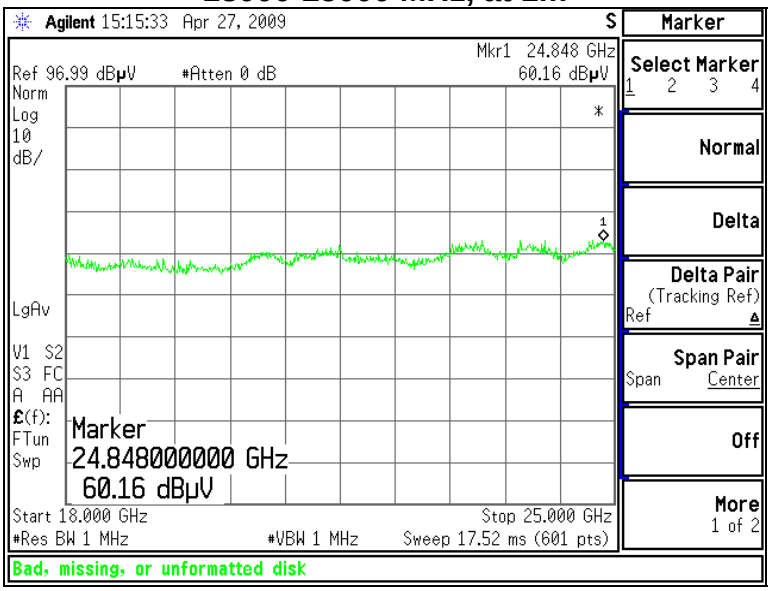


EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE: FCC 15.207 and RSS-Gen 7.2.2

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. Power was provided to the EUT via a generic wall pack whose output was connected to a voltage regulator to supply the appropriate voltage to the EUT. The wall pack was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The 120 VAC power supply was fed to the test area 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. Measurements were made from 150 kHz-30MHz. The Intermediate Frequency Bandwidth was set to 9.0 kHz and the Average Bandwidth to 30 kHz, per CISPR 16-1 (2003), Section 1, Table 1. Plots of peak values were captured and are shown below. Quasi-peak and average signal strength values were measured at discrete frequencies; these are denoted in the table in Section 6.5 of this report.

6.3 Test Equipment Utilized

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

Test 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

6.4 Test Results

The EUT was found to meet the Conducted Emission requirements of FCC Part 15.207 and RSS-Gen 7.2.2 Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

6.5 FCC and RSS-Gen 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.			

6.6 CONDUCTED EMISSION TEST DATA CHART

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.207 Class B and RSS-Gen

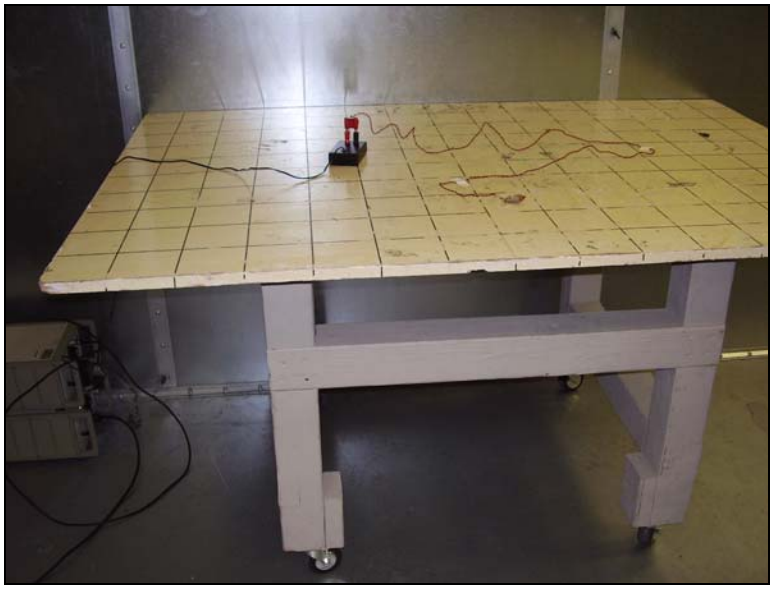
Manufacturer:	California Eastern Laboratories					
Date(s) of Test:	May 27, 2009					
Test Engineer:	Laura Bott					
Model #:	ZSFM-201-F-ES					
Serial #:	ES0401					
Voltage:	3.3 VDC					
Operation Mode:	Normal, continuous modulated transmit					
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %					
Test Location:	√	Conducted emissions bench area				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

Frequency (MHz)	Line	Q-Peak Reading	Q-Peak Limit	Margin	Average Reading	Average Limit	Margin
0.178	1	28.40	64.58	36.18	15.70	54.58	38.88
0.265	1	26.50	61.29	34.79	2.40	51.29	48.89
1.125	1	23.60	56.00	32.40	2.20	46.00	43.80
4.000	1	36.70	56.00	19.30	35.50	46.00	10.50
0.179	2	27.30	64.54	37.24	15.70	54.54	38.84
0.262	2	24.20	61.37	37.17	2.40	51.37	48.97
1.044	2	23.90	56.00	32.10	1.90	46.00	44.10
3.999	2	36.60	56.00	19.40	35.40	46.00	10.60

Notes:

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

6.7 Test Setup Photo(s) – Conducted Emissions Test

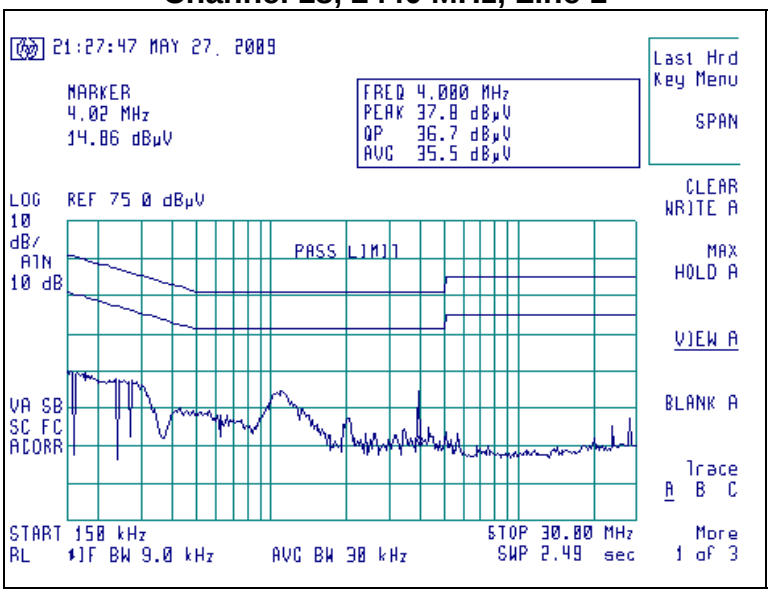


6.8 Screen Captures – Conducted Emissions Test

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 and RSS-Gen Section 7.2.2 Table 2.

The signature scans shown here are from channel 18, chosen as a good representative of channels.

Channel 18, 2440 MHz, Line 1



Channel 18, 2440 MHz, Line 2

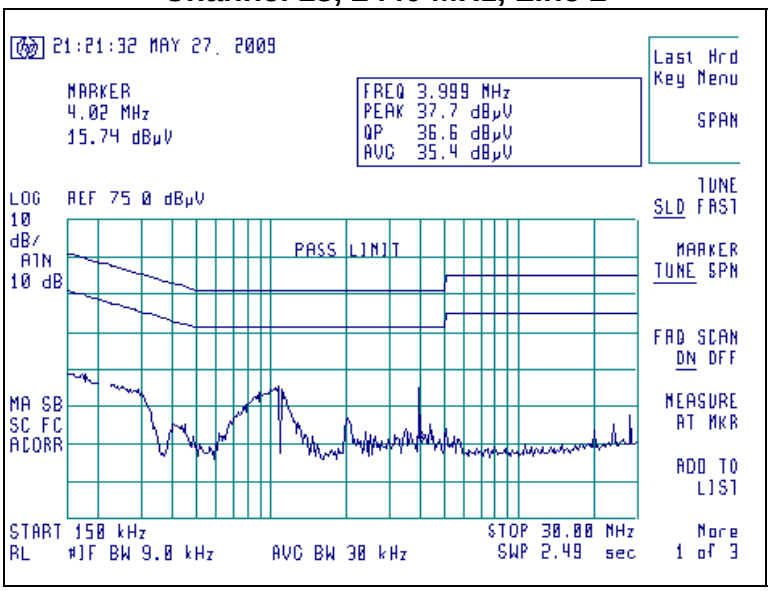


EXHIBIT 7. OCCUPIED BANDWIDTH: 15.247(a)(2) and RSS 210

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 -6 dBc bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 100 kHz RBW and VBW=300 kHz. The -20 dBc occupied bandwidth was then measured by finding the peak value with a RBW greater than the signal bandwidth, then decreasing the resolution bandwidth to an estimated 1 % of the emission bandwidth. The 20 dB OBW was measured with the reduced RBW.

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 E4446A spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. Correction factors for the RF cable were loaded onto the spectrum analyzer and the loss from the attenuator was added on the analyzer as gain offset.

The EUT was configured to run in a continuous transmit, modulated mode. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

7.3 Test Data

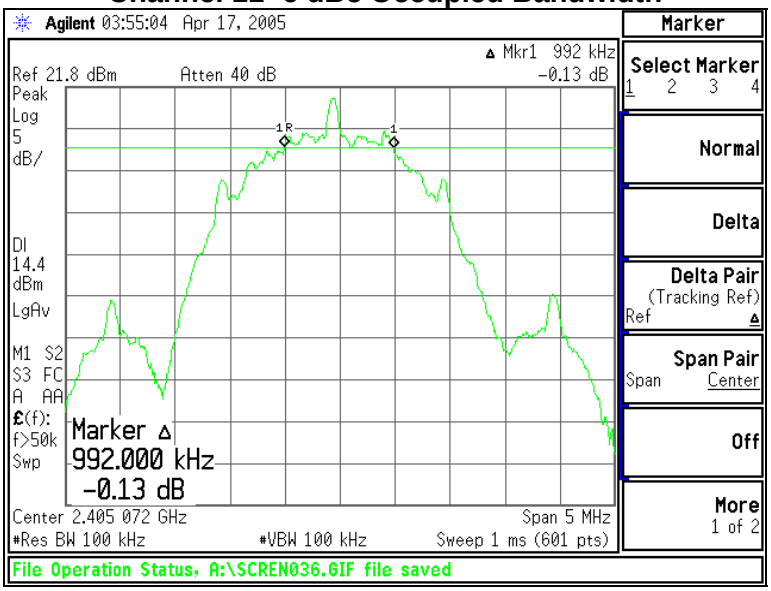
Channel	Center Frequency (MHz)	Measured -6 dBc Occupied Bandwidth (kHz)	Minimum -6 dBc (kHz)	Measured -20 dBc Occupied Bandwidth (kHz)
11	2405	992	500	2400
12	2410	1150	500	2530
13	2415	1158	500	2520
18	2440	1017	500	2550
25	2475	1008	500	2520
26	2480	1183	500	2480

7.4 Test Equipment List

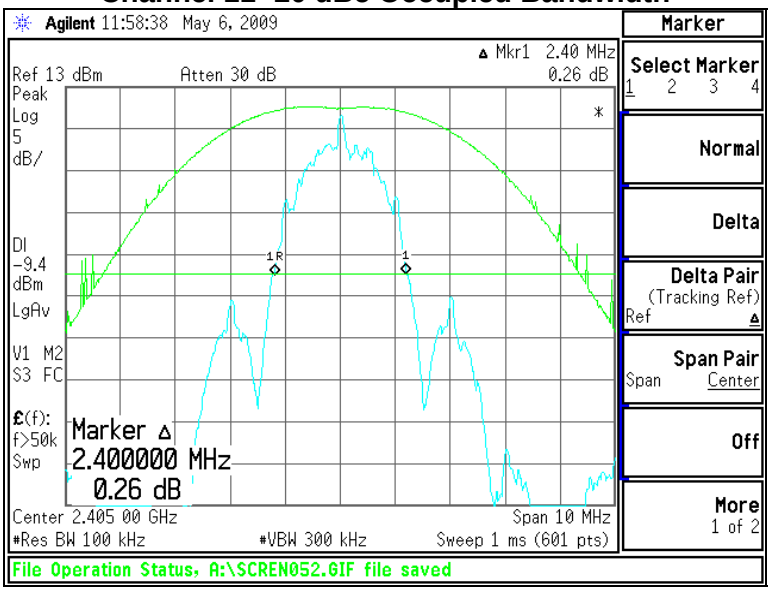
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4446A	US45300564

7.5 Screen Captures - OCCUPIED BANDWIDTH

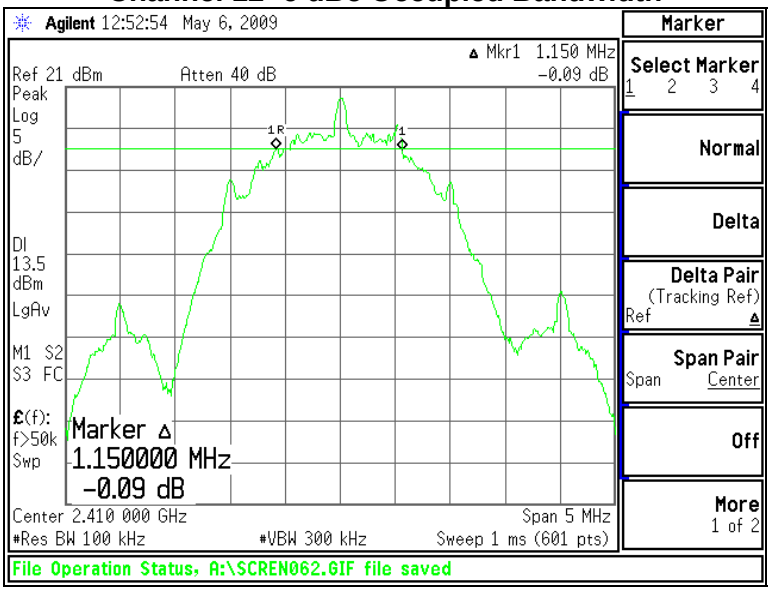
Channel 11 -6 dBc Occupied Bandwidth



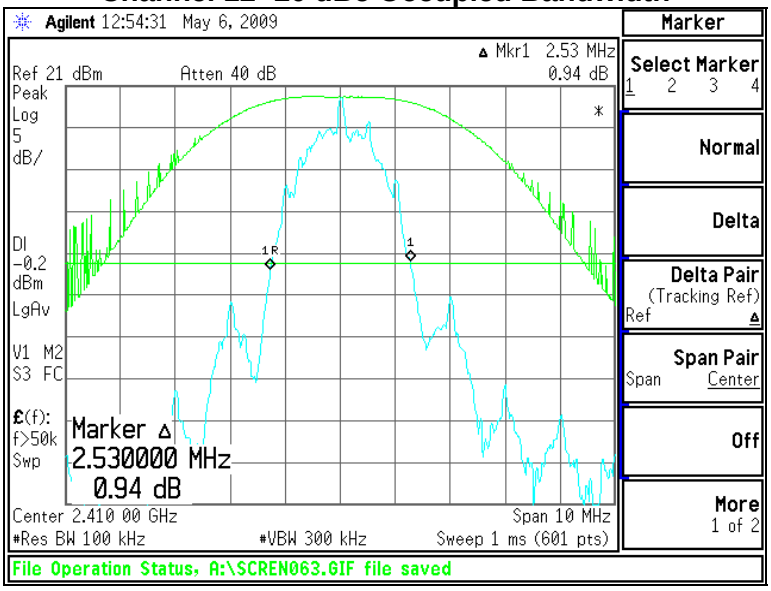
Channel 11 -20 dBc Occupied Bandwidth



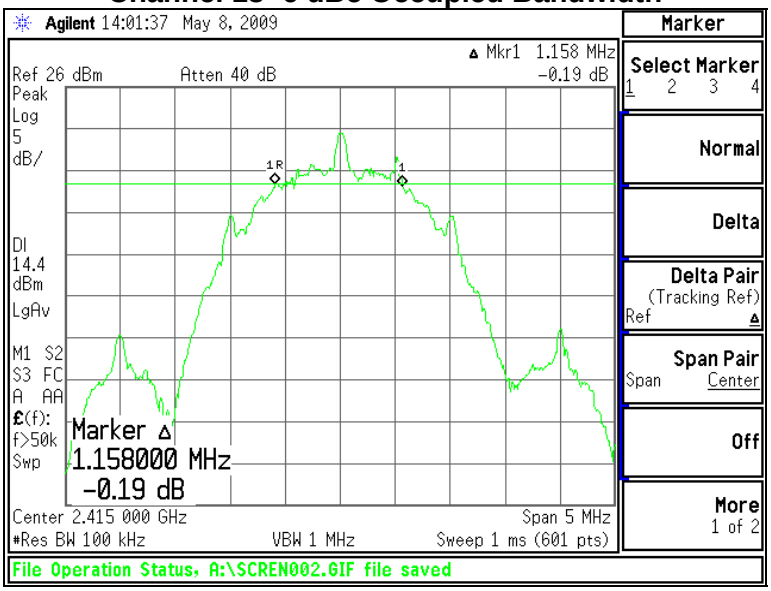
Channel 12 -6 dBc Occupied Bandwidth



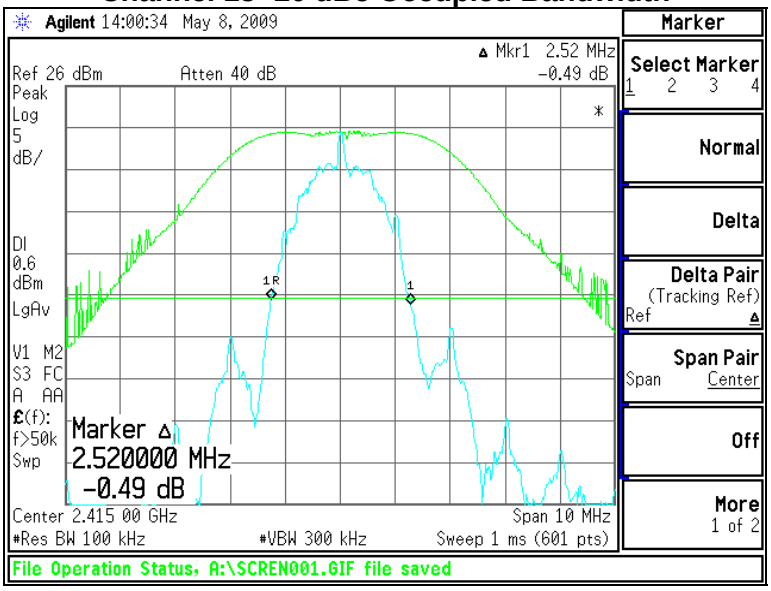
Channel 12 -20 dBc Occupied Bandwidth



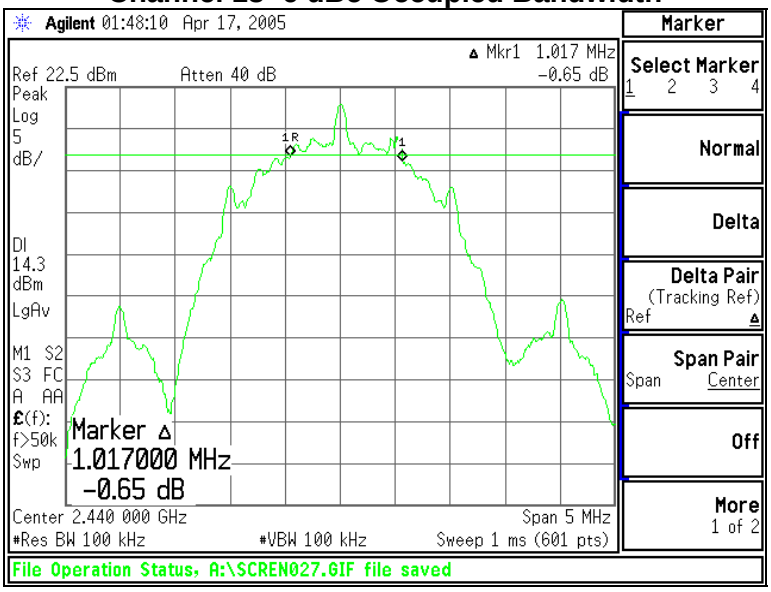
Channel 13 -6 dBc Occupied Bandwidth



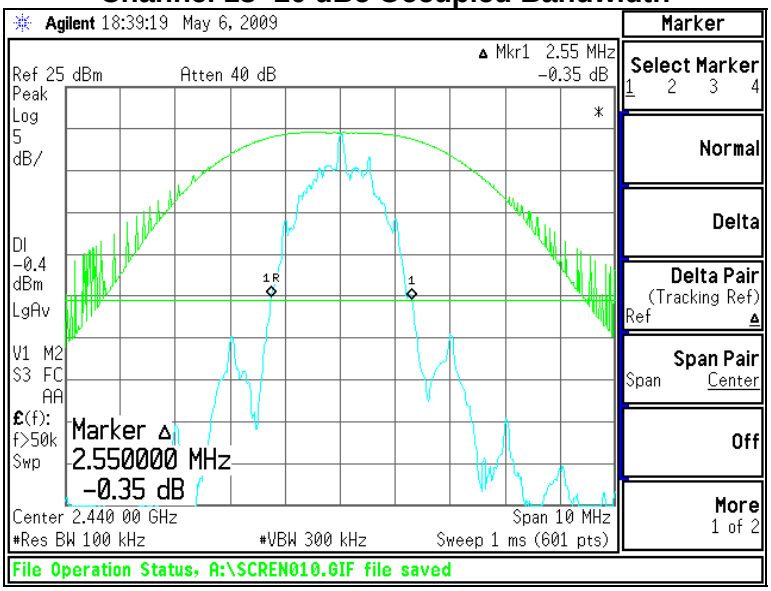
Channel 13 -20 dBc Occupied Bandwidth



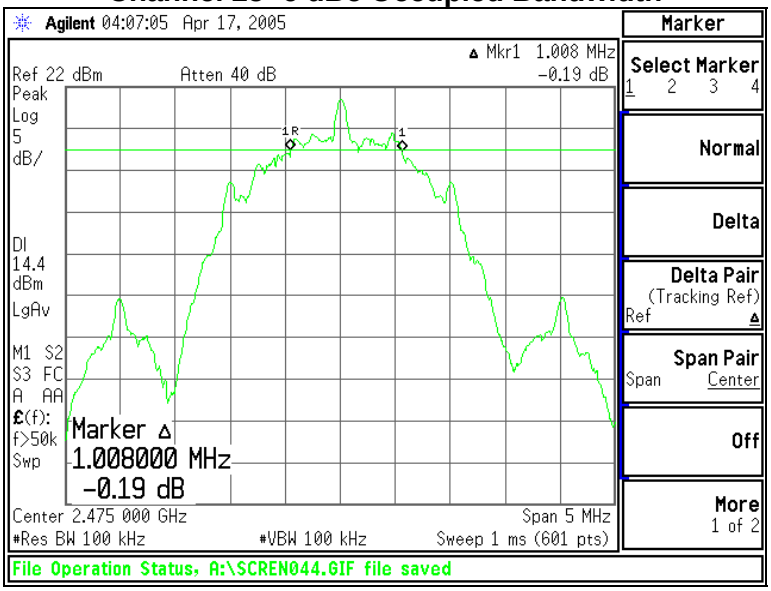
Channel 18 -6 dBc Occupied Bandwidth



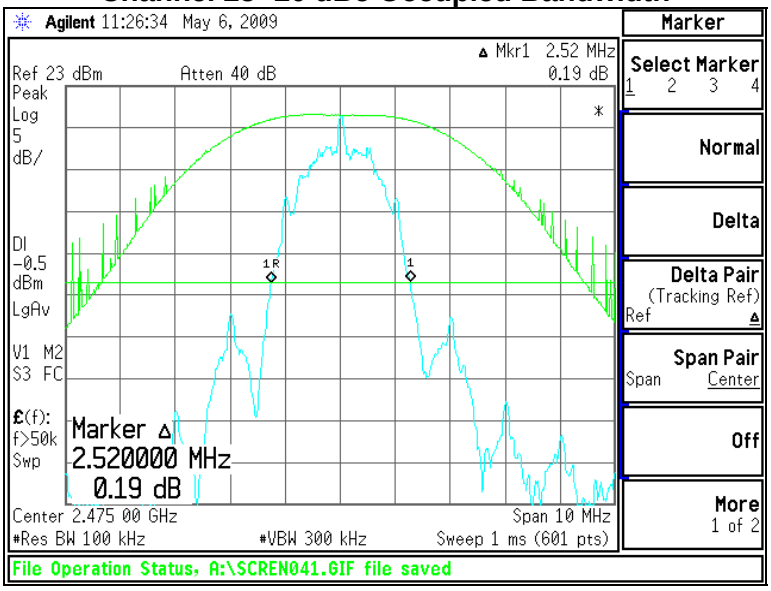
Channel 18 -20 dBc Occupied Bandwidth



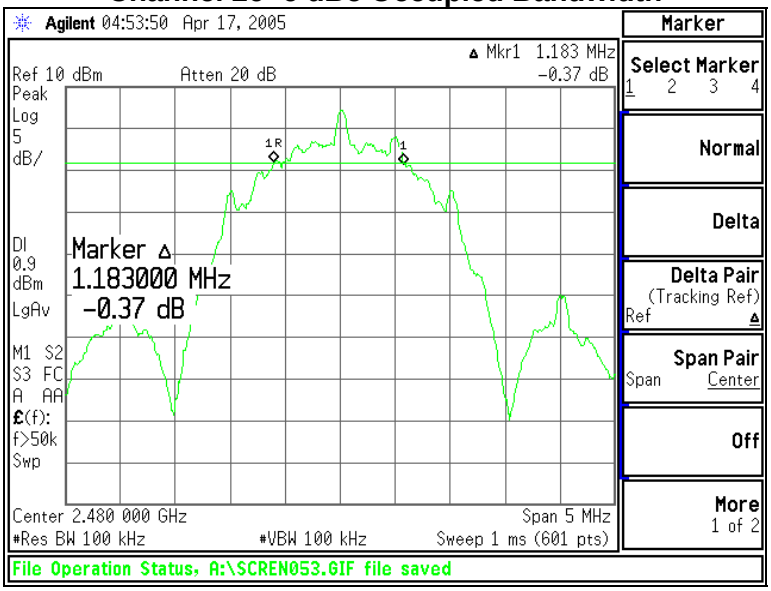
Channel 25 -6 dBc Occupied Bandwidth



Channel 25 -20 dBc Occupied Bandwidth



Channel 26 -6 dBc Occupied Bandwidth



Channel 26 -20 dBc Occupied Bandwidth

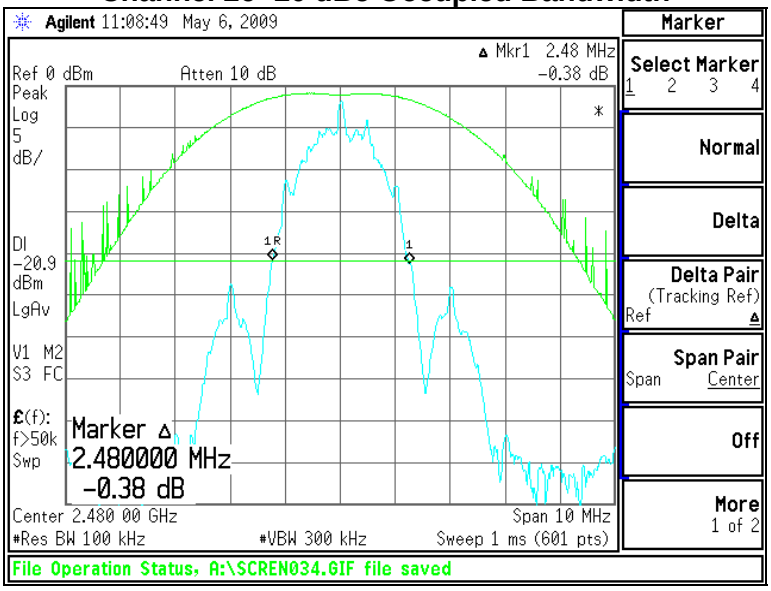


EXHIBIT 8. BAND-EDGE MEASUREMENTS

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 highest channel for the investigation of the higher Band-Edge.

To meet the band edge requirements, Channels 11 and 12 must be set to a power level of 4 and Channel 26 must be set to a power level of 1.

Lower Band-Edge Limit,

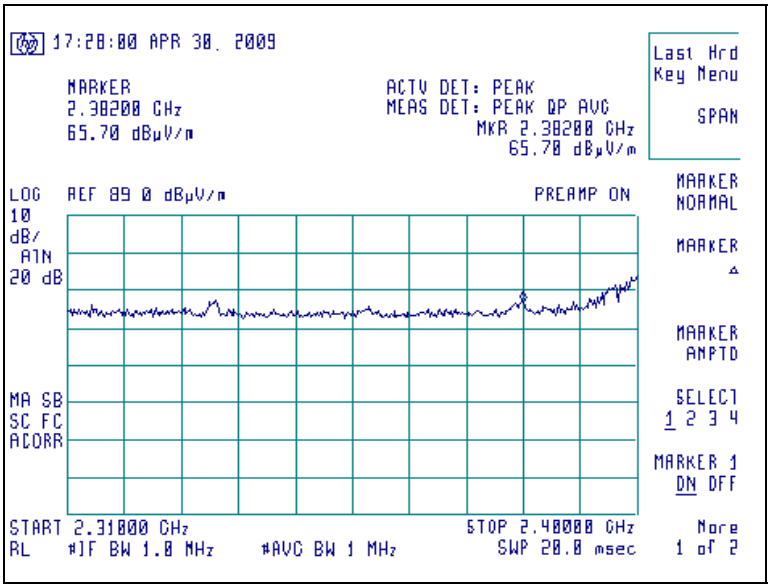
2.39 GHz = +54 dBµV/m at 3m

2.40 GHz = -20 dBc with respect to the peak fundamental radiated emissions.

Upper Band-Edge Limi,

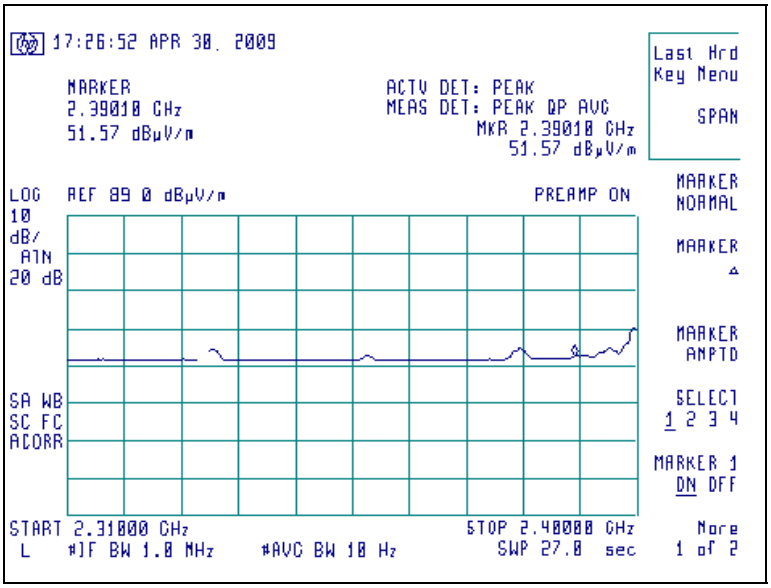
2.4835 GHz =e + 54 dBµV/m at 3m.

Screen Capture Demonstrating Compliance at the Lower Band-Edge (Peak Emissions)



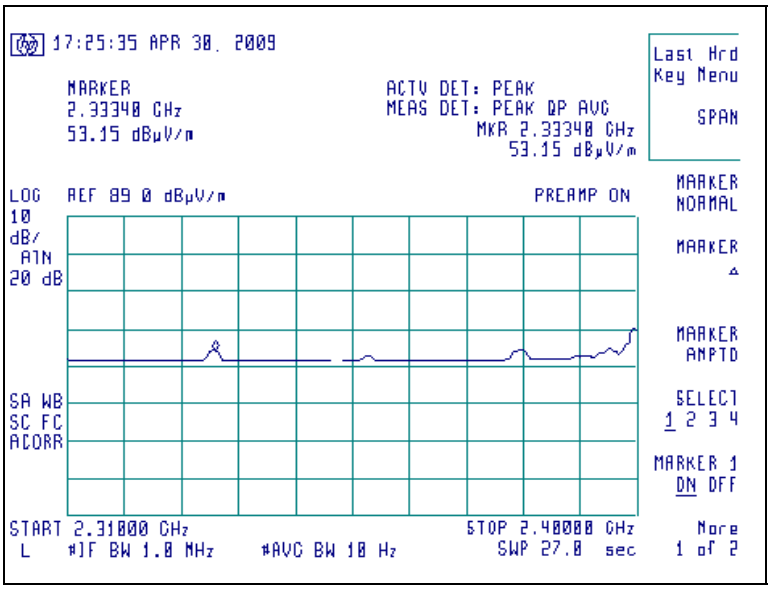
Screen Capture Demonstrating Compliance at the Lower Band-Edge (Average Emissions)

2390 MHz – 51.57 dBµV/m @ 3 meters

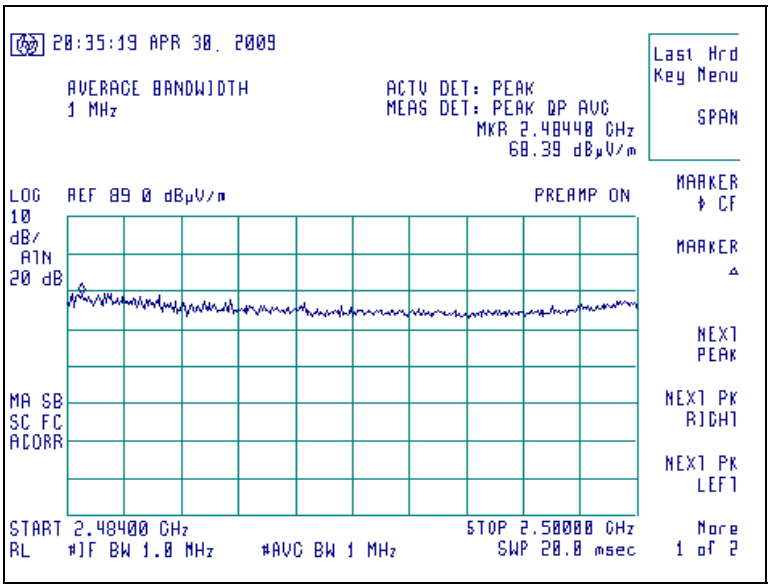


Screen Capture Demonstrating Compliance at the Lower Band-Edge (Average Emissions)

2333 MHz – 53.15 dBµV/m @ 3 meters



Screen Capture Demonstrating Compliance at the High Band-Edge (Peak Emissions)



Screen Capture Demonstrating Compliance at the High Band-Edge (Average Emissions)

2499 MHz – 53.27 dBµV/m @ 3 meters

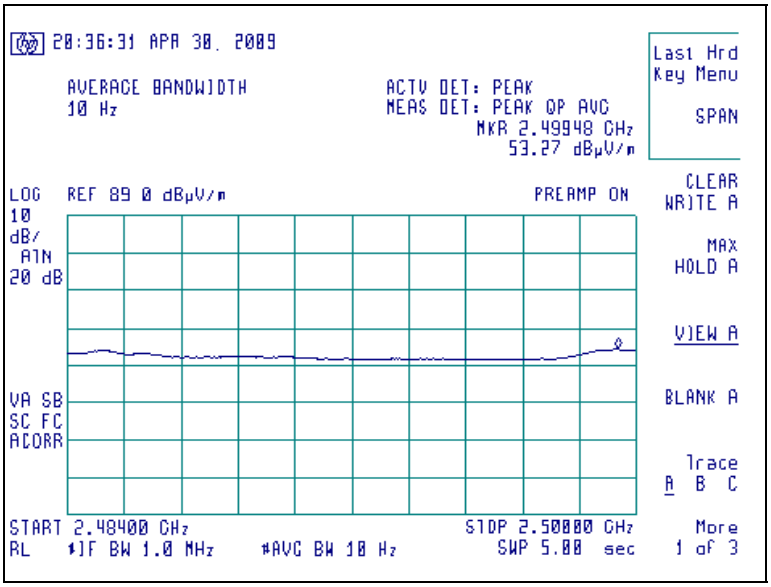


EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

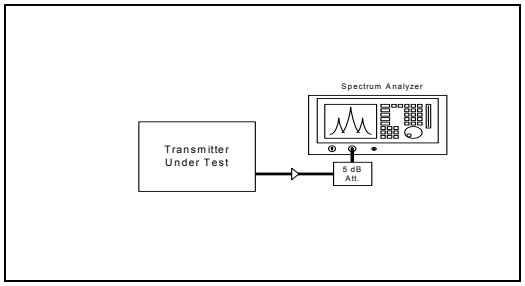
9.1 Method of Measurements

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. Correction factors for the RF cable were loaded onto the spectrum analyzer and the loss from the attenuator was added on the analyzer as gain offset. The unit was configured to run in a continuous transmit mode. The spectrum analyzer was used with resolution and video bandwidths set to 3 MHz, and a span of 20 MHz, with measurements from a peak detector presented in the chart below.

9.2 Test Data

Channel	Center Frequency (MHz)	Measured Power (dBm)	Limit (dBm)	Margin (dB)	Calculated EIRP (dBm)	EIRP Limit (dBm)	Calculated EIRP (mw)
11	2405	10.52	30	19.48	9.49	36.0	8.89
12	2410	11.37	30	18.63	10.34	36.0	10.81
13	2415	20.66	30	9.34	19.63	36.0	91.83
18	2440	20.56	30	9.44	19.53	36.0	89.74
25	2475	19.48	30	10.52	18.45	36.0	69.98
26	2480	-1.17	30	31.17	-2.20	36.0	0.60

(1) EIRP Calculation:
EIRP = (Peak power at antenna terminal in dBm) + (EUT Antenna gain in dBi)



Rated RF power output (in watts): 0.1 Watts

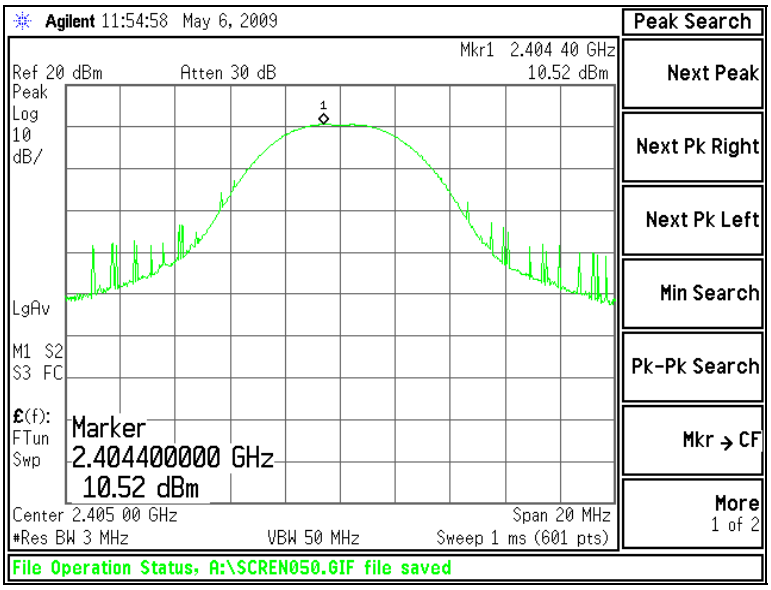
Measured RF Power Output (in Watts): 0.116 Watts
Declared RF Power Output (in Watts): 0.1 Watts

9.3 Test Equipment List

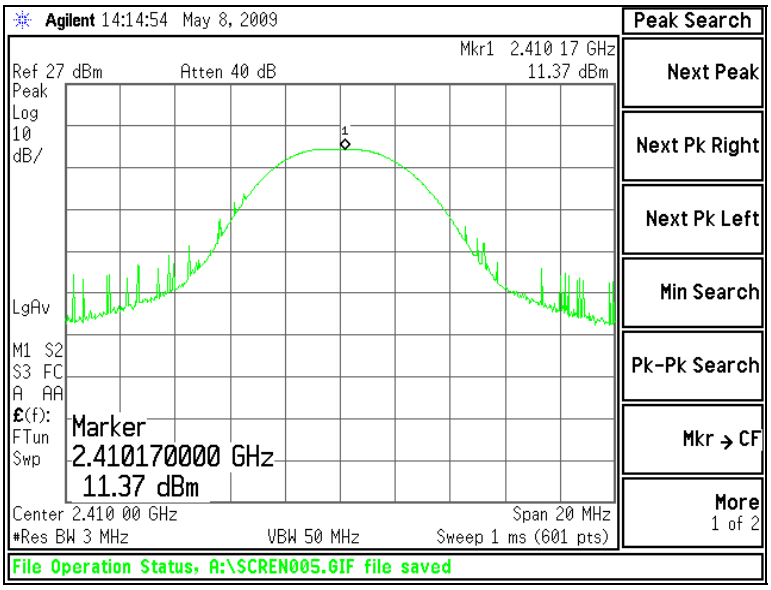
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4446A	US45300564

9.4 Screen Captures – Power Output (Conducted)

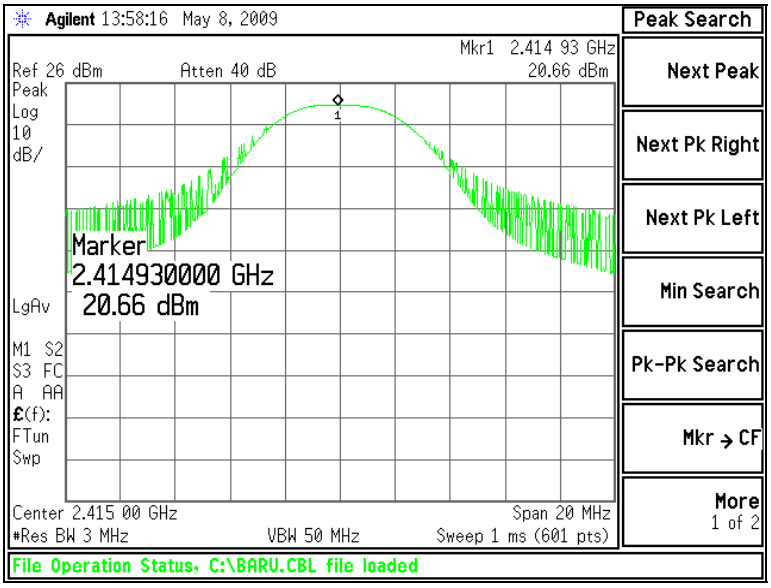
Channel 11: 2405 MHz



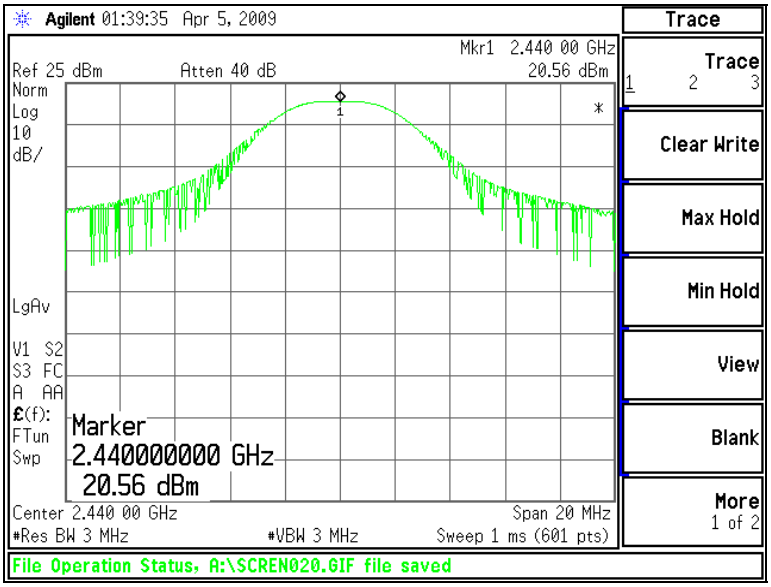
Channel 12: 2410 MHz



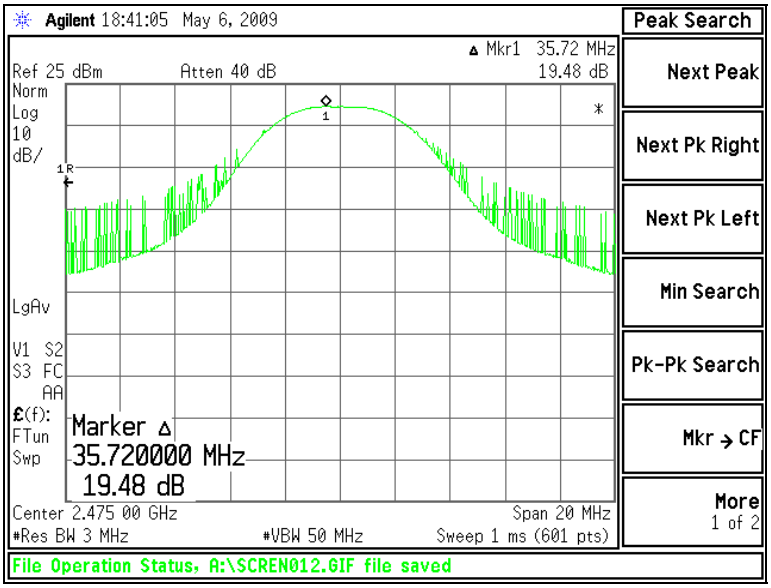
Channel 13: 2415 MHz



Channel 18: 2440 MHz



Channel 25: 2475 MHz



Channel 26: 2480 MHz

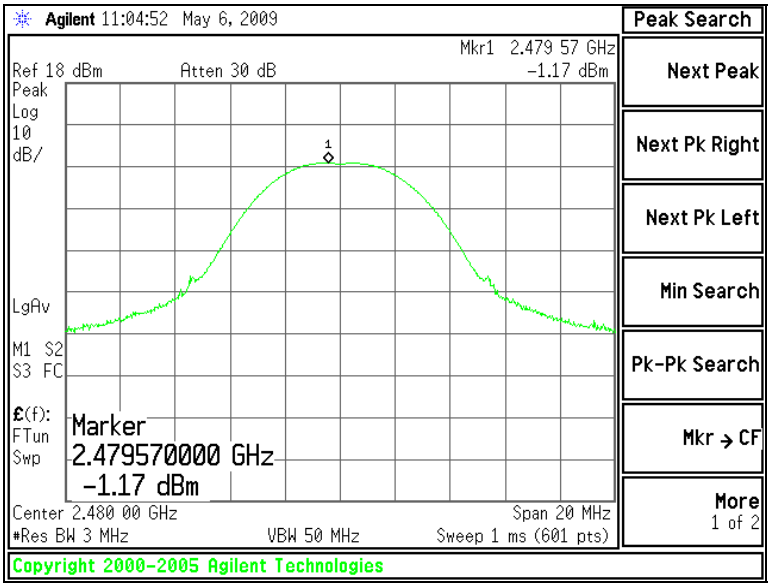


EXHIBIT 10. POWER SPECTRAL DENSITY: 15.247(e)

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 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.

10.2 Test Equipment List

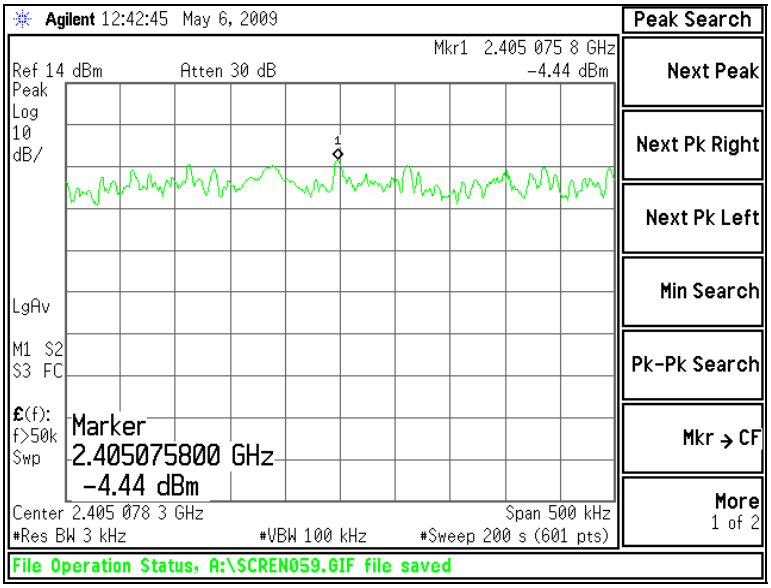
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4446A	US45300564

10.3 Test Data

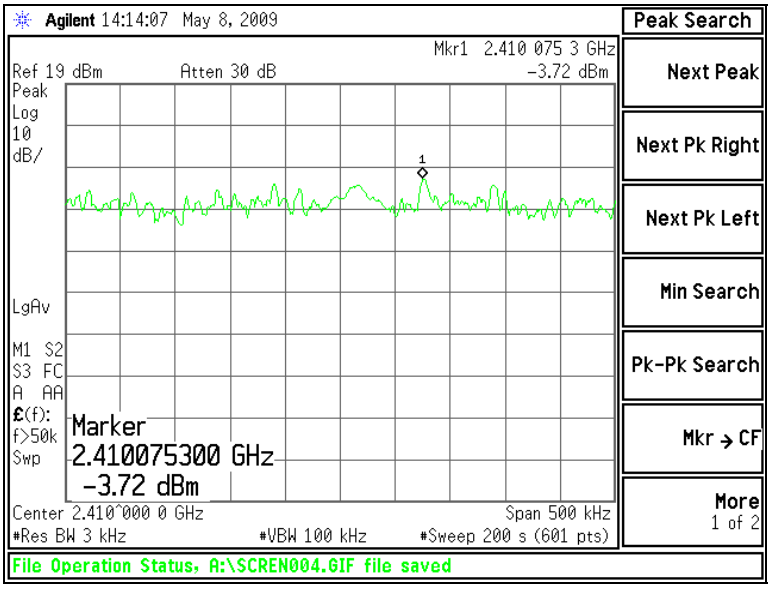
Transmitter Channel	Frequency (MHz)	RF Power Level in 3 kHz BW (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Comments Pass/Fail
11	2405	-4.44	8.0	12.4	Pass
12	2410	4.71	8.0	3.29	Pass
13	2415	5.55	8.0	2.45	Pass
18	2440	5.57	8.0	2.43	Pass
25	2475	4.61	8.0	3.39	Pass
26	2480	-15.85	8.0	23.85	Pass

10.4 Screen Captures – Power Spectral Density

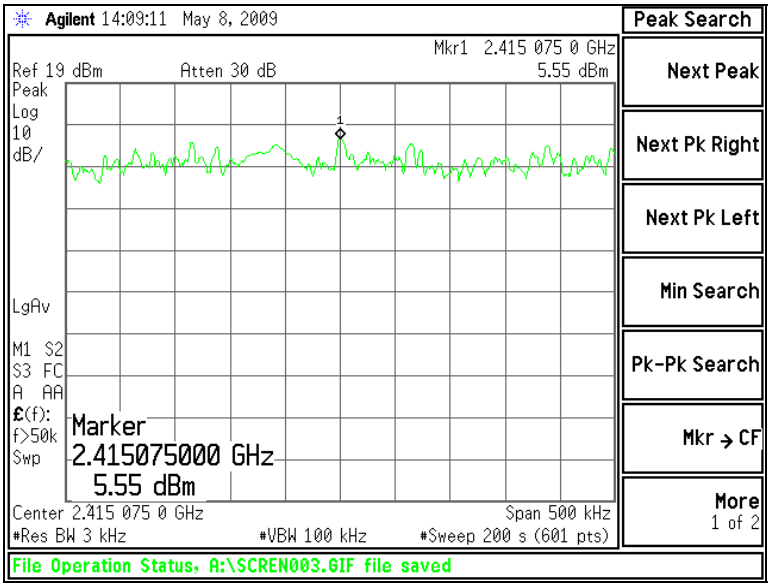
Channel 11



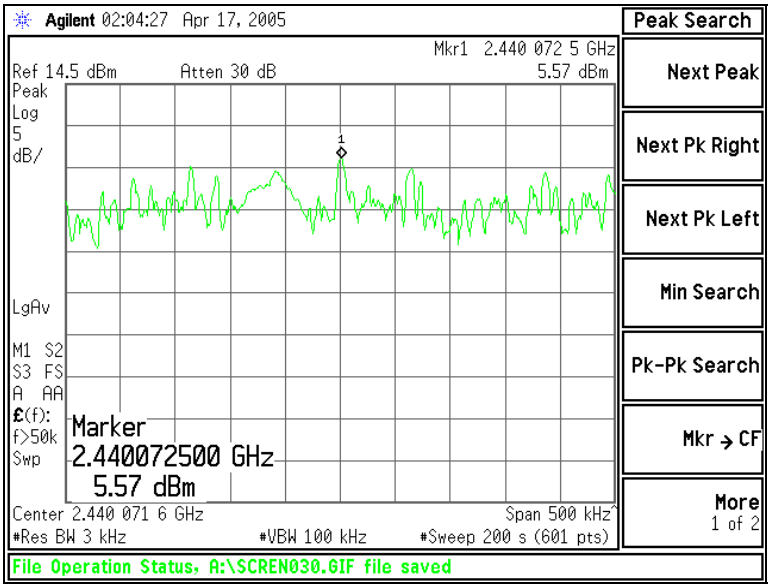
Channel 12



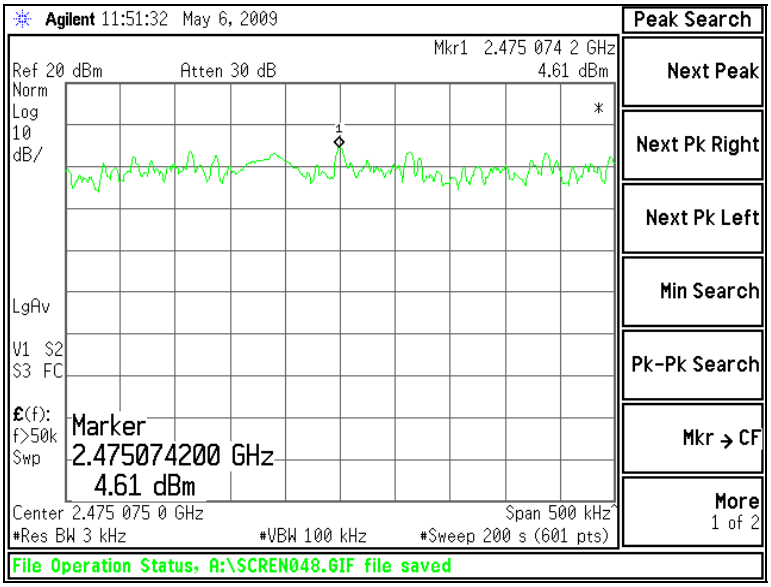
Channel 13



Channel 18



Channel 25



Channel 26

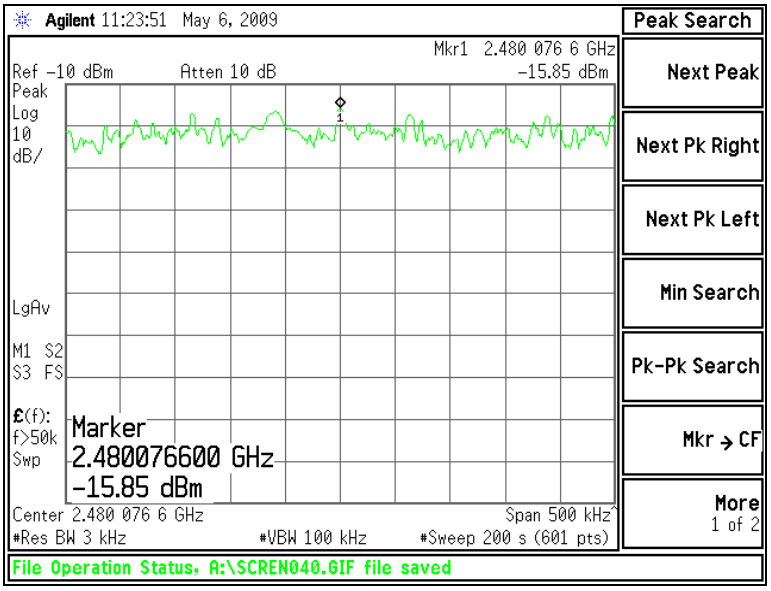


EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

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 least 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.

For data from the radiated measurements, please refer to section 5.6 of this report.

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. The cable calibration file was loaded into the spectrum analyzer to compensate for the loss of the cable between the antenna port of the EUT to the spectrum analyzer. A Hewlett Packard model E4446A 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. 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 11	Channel 12	Channel 13	Channel 18	Channel 25	Channel 26
	Power in dBm					
Fundamental	6.16	14.73	15.74	14.78	14.85	-7.01
2nd Harmonic	Note 1	-51.44	-50.04	-51.60	-53.03	-77.30
3rd Harmonic	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
4th Harmonic	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
5th Harmonic	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
6th Harmonic	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
7th Harmonic	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
8th Harmonic	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
9th Harmonic	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
10th Harmonic	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1

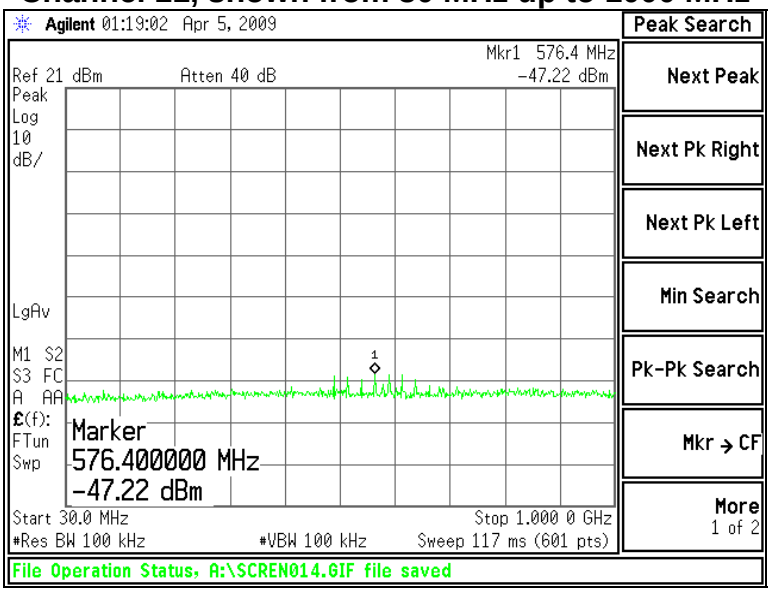
Notes:
(1) Measurement at system noise floor.

11.2 Test Equipment List

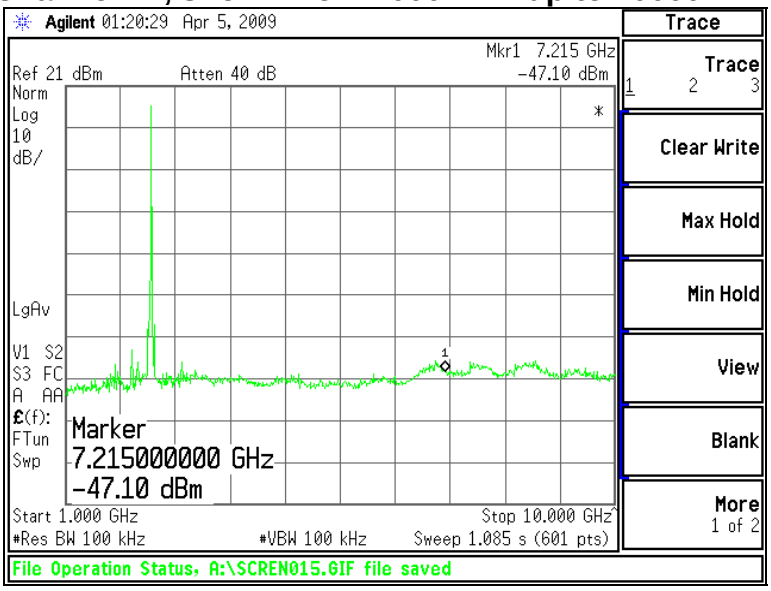
Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

11.3 Screen Captures – Spurious Radiated Emissions

Channel 11, shown from 30 MHz up to 1000 MHz



Channel 11, shown from 1000 MHz up to 10000 MHz



Channel 11, shown from 10000 MHz up to 25000 MHz

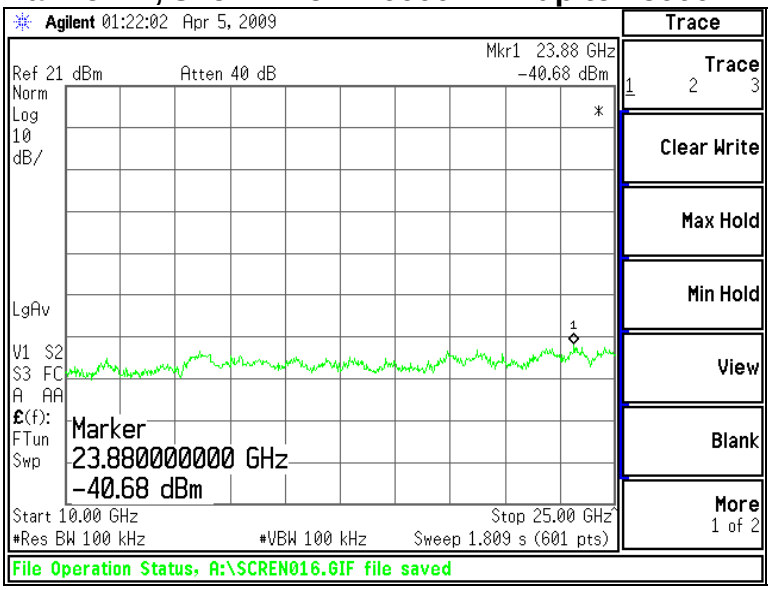


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

The stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the frequency at the appropriate frequency markers. The transmitter of the EUT placed in modulated continuous transmit mode. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer.

In this case, the EUT uses a single type operates on a nominal voltage of 3.0 VDC. The test was performed to measure the stability of the frequency and power at ±15% of the nominal operating voltage: 2.8V and 3.8V.

A spectrum analyzer 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=10Hz settings while the voltage was varied.

	VDC Voltage Source		
	2.8 VDC	3.3 VDC	3.8 VDC
Channel 11	2405.013200 MHz	2405.011300 MHz	2405.011800 MHz
Channel 18	2440.012500 MHz	2440.011500 MHz	2440.009800 MHz
Channel 26	2480.011800 MHz	2480.013200 MHz	2480.0102000 MHz

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

	VDC Voltage Source		
	2.8 VDC	3.3 VDC	3.8 VDC
Channel 11	5.94 dBm	6.34 dBm	7.11 dBm
Channel 18	16.09 dBm	16.07 dBm	16.11 dBm
Channel 26	-6.01 dBm	-5.94 dBm	-4.15 dBm

EXHIBIT 13. MPE CALCULATIONS

The following MPE calculations are based on a 1.8 centimeter inverted-F printed circuit board trace antenna, with a measured ERP of 114.0 dBµV/m, at 3 meters, and conducted RF power of +19.8 dBm as presented to the antenna. The calculated gain of this antenna, based on the ERP measurements is -1.03 dBi.

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:	20.66	(dBm)
Maximum peak output power at antenna input terminal:	116.413	(mW)
Antenna gain(typical):	-1.03	(dBi)
Maximum antenna gain:	0.789	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2400	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)
Power density at prediction frequency:	0.018270	(mW/cm^2)
Maximum allowable antenna gain:	16.4	(dBi)
Margin of Compliance at 20 cm =	17.4	dB

APPENDIX A

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 24-Apr-2009 Type Test : Radiated Emissions Radio EMC Job # : C-600

Prepared By: Bott Customer : CEL Quote # : 309123

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	9/23/2008	9/23/2009	Active Calibration
2	AA 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 30-Apr-2009 Type Test : Radiated Emissions Job # : C-600

Prepared By: Bott Customer : CEL Quote # : 309123

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	9/23/2008	9/23/2009	Active Calibration
2	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	9/23/2008	9/23/2009	Active Calibration
3	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	12/23/2008	12/23/2009	Active Calibration
4	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/20/2008	10/20/2009	Active Calibration
5	AA 960077	Bicon Antenna	EMCO	93110B	9702-2918	11/24/2008	11/24/2009	Active Calibration
6	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
7	AA 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration
8	AA 960063	Pyramidal Horn Antenna	EMCO	3160-09	9809-1120	6/17/2008	6/17/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 24-Apr-2009 Type Test : Conducted Emissions Job # : C-600

Prepared By: Bott Customer : CEL Quote # : 309123

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	9/23/2008	9/23/2009	Active Calibration
2	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	9/23/2008	9/23/2009	Active Calibration
3	EE 960009	Decoupling Network	Haefely	IP6-2	083180-21	4/15/2008	4/15/2010	Active Calibration
4	AA 960031	Transient Limiter	HP	11947A	3107A01708	9/23/2008	9/23/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 24-Apr-2009 Type Test : Occupied Bandwidth (6dB & 20dB) Job # : C-600

Prepared By: Bott Customer : CEL Quote # : 309123

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	AA 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 24-Apr-2009 Type Test : Conducted Power Output Job # : C-600

Prepared By: Bott Customer : CEL Quote #: 309123

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	AA 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 24-Apr-2009 Type Test : Power Spectral Density Job # : C-600

Prepared By: Bott Customer : CEL Quote #: 309123

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	AA 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 24-Apr-2009 Type Test : Spurious Emissions Job # : C-600

Prepared By: Bott Customer : CEL Quote #: 309123

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	AA 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

APPENDIX B
TEST STANDARDS – CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
CISPR 11	2003-03	2004-05	2006-06
CISPR 12	2007-05		
CISPR 14-1	2005-11	2008-11	
CISPR 14-2	2001-11	2001-11	2008-05
CISPR 16-1-1 Note 1	2006-03	2006-09	2007-07
CISPR 16-1-2 Note 1	2003	2004-04	2006-07
CISPR 22	2008-09		
CISPR 24	1997-09	2001-07	2002-10
EN 55011	2007-05		
EN 55014-1	2006		
EN 55014-2	1997		
EN 55022	2006	2007	
EN 60601-1-2	2007-03		
EN 61000-3-2	2006-05		
EN 61000-3-3	2008-12		
EN 61000-4-2	2001	1998	2001
EN 61000-4-3	2006-07	2008-05	
EN 61000-4-4	2004		
EN 61000-4-5	2006-12		
EN 61000-4-6	2007-08		
EN 61000-4-8	1993	1994-01	
EN 61000-4-11	2004-10		
EN 61000-6-1	2007-02		
EN 61000-6-2	2005-12		
EN 61000-6-3	2007-02		
EN 61000-6-4	2007-02		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2007		
FCC Public Notice DA 00-1407	2000		
FCC ET Docket # 99-231	2002		
FCC Procedures	2007		
ICES 001	2006-06		
ICES 002	2007-02		
ICES 003	2004-02		
IEC 60601-1-2 Note 1	2007-03		
IEC 61000-3-2	2005-11	2008-03	
IEC 61000-3-3	2008-06		
IEC 61000-4-2	2008-12		
IEC 61000-4-3	2008-04	incl in 2006	
IEC 61000-4-4	2004-07		

STANDARD #	DATE	Am. 1	Am. 2
IEC 61000-4-5	2005-11		
IEC 61000-4-6	2008-06		
IEC 61000-4-8	2001-03		
IEC 61000-4-11	2004-03		
IEC 61326-1	2006-06		
ISO 14082	1998-07		
MIL Std. 461E	1999-08		
RSS GEN	2007-06		
RSS 119	2007-06		
RSS 123	1999-11		
RSS 125	2000-03		
RSS 131	2003-07		
RSS 136	2002-10		
RSS 137	2009-02		
RSS 210	2007-06		
RSS 213	2005-12		
RSS 243	2005-11		
RSS 310	2007-06		

Note 1: Test not on LSR Scope of Accreditation.

Updated on 5-13-09

APPENDIX C

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 D

Firmware and Setup Instructions

The FreeStar Pro Test tool which was constructed in-house was used to set the channel, power and state of the radio.