

# LS Research, LLC

W66 N220 Commerce Court • Cedarburg, WI 53012 • USA  
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## ENGINEERING TEST REPORT 307224.1 TX TCB Rev. 1 Job # R-383

**Compliance Testing of:**

APEX module with external dipole antenna

**Test Date(s):**

October 15<sup>th</sup> – December 27<sup>th</sup> 2007

**Prepared For:**

LS Research, LLC  
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**

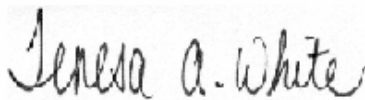
**This Test Report is issued under the Authority of:**  
Brian E. Petted, VP of Engineering



Signature:

Date: December 28, 2007

**Test Report Reviewed by:**  
Teresa A. White, Quality Manager



Signature:

Date: December 28, 2007

**Tested by:**  
Khairul Aidil Zainal, Senior EMC Engineer



Signature:

Date: December 28, 2007

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LSC Revision Control

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

## EXHIBIT 1. INTRODUCTION

### 1.1 SCOPE

<b>References:</b>	FCC Part 15, Subpart C, Section 15.247
<b>Title:</b>	Telecommunication – Code of Federal Regulations, CFR 47, Part 15
<b>Purpose of Test:</b>	To gain FCC Certification Authorization for Digital Modulation Transmitters operating in the Frequency Band of 2400 MHz – 2483.5 MHz
<b>Test Procedures:</b>	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.
<b>Environmental Classification:</b>	<ul style="list-style-type: none"> <li>• Commercial, Industrial or Business</li> <li>• Residential</li> </ul>

### 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.

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### 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](http://www.lsr.com). Accreditation status can be verified at A2LA’s web site: [www.a2la2.net](http://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.

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## EXHIBIT 2. PERFORMANCE ASSESSMENT

### 2.1 CLIENT INFORMATION

<b>Manufacturer Name:</b>	<b>LS Research, LLC</b>
<b>Address:</b>	<b>W66 N220 Commerce Court Cedarburg, WI 53012</b>
<b>Contact Person:</b>	<b>William Steinike</b>

### 2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

*The following information has been supplied by the applicant.*

<b>Product Name:</b>	APEX
<b>Model Number:</b>	ZAXM-201-1
<b>Serial Number:</b>	07040088

### 2.3 ASSOCIATED ANTENNA DESCRIPTION

The antenna used was a Nearson S131CL 2.4GHz half-wave dipole with an MMCX connector and a gain of 2.0 dBi.

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## 2.4 EUT'S TECHNICAL SPECIFICATIONS

### Additional Information:

Frequency Range (in MHz)	2400 MHz to 2483.5 MHz
RF Power in Watts	0.096 Watts
Conducted Output Power (in dBm)	19.8 dBm
Field Strength (and at what distance)	116.5 dBuV/m at 3m (2410MHz)
Occupied Bandwidth (20db/6dB)	2680 kHz / 1670 kHz
Type of Modulation	O-QPSK
Emission Designator	G1D2M68
EIRP (in mW)	134.0 mW
Transmitter Spurious (worst case)	68.2 dBuV/m at 9620MHz (channel b at maximum power. 1m distance)
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Microprocessor Model # (if applicable)	Ember EM250
Antenna Information	
Detachable/non-detachable	Detachable with reverse MMCX connectors.
Type	Half-wave Dipole
Gain (in dBi)	1.5 dBi (calculated from measurements) 2.0 dBi (From data sheet)
EUT will be operated under FCC Rule Part(s)	CFR 47 15.247 RSS 210
Modular Filing	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

### RF Technical Information:

Type of Evaluation (check one)	<input type="checkbox"/>	SAR Evaluation: Device Used in the Vicinity of the Human Head
	<input type="checkbox"/>	SAR Evaluation: Body-worn Device
	<input checked="" type="checkbox"/>	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: CFR 47-15.247, RSS 210
- Measurement Distance: 3 m
- RF Value: 0.67  V/m     A/m     W/m<sup>2</sup>  
 Measured     Computed     Calculated

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## 2.5 PRODUCT DESCRIPTION

The APEX module is a 802.15.4/Zigbee module based upon the Ember EM250 transceiver. It is used in point to point, point to multi-point, and mesh networks. It operates in the 2.4GHz ISM band. The modulation is standard IEEE 802.15.4 format, O-QPSK with half sine filter operating with a chip rate of 2 Mcps. The effective bit rate is 250kbps. The modulation data is generated by the EM250 transceiver itself and spread using 16 orthogonal sequences. 16 channels are used in 5 MHz steps from 2405 to 2480 MHz. An external supply running at 3.3VDC typically is used. A serial port is used to program the test modes with the module. Two antenna configurations are used, an on-board PCB trace antenna and an external whip antenna.

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## EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

### 3.1 CLIMATE TEST CONDITIONS

Temperature:	71° Fahrenheit
Humidity:	40%
Pressure:	753 mmHg

### 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
<i>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.</i>		

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**3.3 MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES**

None  Yes (explain below)

The module was operated in reduced power setting on several channels:

Channel	Power Setting
b (2405MHz)	-4 (Reduced setting)
c (2410MHz)	3 (Maximum setting)
12 (2440MHz)	3 (Maximum setting)
17 (2460MHz)	3 (Maximum setting)
18 (2470MHz)	-7 (Reduced setting)
19 (2475MHz)	-14 (Reduced setting)
1a (2480MHz)	-26 (Minimum setting)

Note: Channels and power level settings are in hex.

**3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS**

None  Yes (explain below)

1. Although the fundamental and the band edge measurements were made on 7 channels, the harmonics measurements were made on the lowest, medium and highest channel at full power (instead of reduced power on the lowest and highest channel). Based on sound engineering principles, it would be valid to conclude that if the harmonics on the lowest and highest channel operating at full power are below the limit, the harmonics of the remaining channels operating at reduced power levels will also.

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## 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.

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## 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 continuous modulated transmit mode for final testing using power as provided by a standard bench DC supply. The unit has the capability to operate on 8 channels, controllable via Metrowerks Code warrior development software installed on a laptop PC.

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 seven (7) standard channels: b (2405MHz), c (2410MHz), 12 (2440MHz), 17 (2465MHz), 18 (2470MHz), 19 (2475MHz), 1a (2480MHz), to comply with FCC Part 15.35. The channels and operating modes were changed using an APEX interface board (to provide the USB to RS232 translation) which was controlled using hyper-terminal software.

### 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 rotated along three orthogonal axes with the dipole antenna in two configurations (vertical and 90 degree bend) during the investigations to find the highest emission levels.**

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### 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 1 GHz to 18 GHz, an HP E4446A 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 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 (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.

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## 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 $\mu\text{V/m}$	3 m Limit (dB $\mu\text{V/m}$ )	1 m Limit (dB $\mu\text{V/m}$ )
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  $\mu\text{V/m}$  to dB $\mu\text{V/m}$ :

$$\begin{aligned} \text{dB}\mu\text{V/m} &= 20 \log_{10} (100) \\ &= 40 \text{ dB}\mu\text{V/m (from 30-88 MHz)} \end{aligned}$$

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

$$\begin{aligned} &960 \text{ MHz to } 10,000 \text{ MHz} \\ &500\mu\text{V/m or } 54.0 \text{ dB}/\mu\text{V/m at } 3 \text{ meters} \\ &54.0 + 9.5 = 63.5 \text{ dB}/\mu\text{V/m at } 1 \text{ meter} \end{aligned}$$

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

$$\begin{aligned} &960 \text{ MHz to } 10,000 \text{ MHz} \\ &500\mu\text{V/m or } 54.0 \text{ dB}/\mu\text{V/m at } 3 \text{ meters} \\ &54.0 + 20 = 74 \text{ dB}/\mu\text{V/m at } 0.3 \text{ meters} \end{aligned}$$

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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:	October 15 <sup>th</sup> – December 28 <sup>th</sup> 2007				
Test Engineer(s):	Khairul Aidi Zainal				
Voltage:	3.3 VDC				
Operation Mode:	continuous transmit, modulated				
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %				
EUT Power:		Single Phase ___ VAC		3 Phase ___ VAC	
		Battery	√	Other: Bench DC power supply	
EUT Placement:	√	80cm non-conductive table		10cm Spacers	
EUT Test Location:	√	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS	
Measurements:		Pre-Compliance		Preliminary	√ Final
Detectors Used:	√	Peak		Quasi-Peak	√ Average

## RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of radiated RF fundamental measured at a separation distance of 1 meter.

Frequency (MHz)	Ant./EUT Polarity	Channel	Height (meters)	Azimuth (0° - 360°)	Measured EFI (PEAK) (dBμV/m)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
2405	H/SV	b	1.26	0	120.4	113.9	125.2	11.3
2410	H/SV	c	1.27	0	122.5	116.5	125.2	8.7
2440	H/SV	12	1.00	0	121.6	115.2	125.2	10
2465	H/SV	17	1.22	349	122.3	116.0	125.2	9.2
2470	H/SV	18	1.22	350	118.9	112.3	125.2	12.9
2475	H/SV	19	1.22	176	108.5	102.1	125.2	23.1
2480	H/SV	1a	1.23	0	85.7	80.0	125.2	45.2

Notes:

- 1) An average Detector was used in measurements above 1 GHz. Only the results from the average detector are published in the table above.
- 2) For measurements of the fundamental power, because of spectral bandwidth, the receiver was set to RBW=VBW=3 MHz.

### Naming convention for EUT and antenna configuration.

	Sense Antenna	EUT	EUT antenna (dipole)
H/HV	Horizontal	Horizontal	Vertical
V/HV	Vertical	Horizontal	Vertical
V/HB	Vertical	Horizontal	Bent
H/HB	Horizontal	Horizontal	Bent
H/VV	Horizontal	Vertical	Vertical
V/VV	Vertical	Vertical	Vertical
V/VB	Vertical	Vertical	Bent
H/VB	Horizontal	Vertical	Bent
H/SV	Horizontal	Side	Vertical
V/SV	Vertical	Side	Vertical
V/SB	Vertical	Side	Bent
H/SB	Horizontal	Side	Bent



The following table depicts the level of significant radiated harmonic emissions seen on Channel b:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (PEAK) (dBμV/m)	Measured EFI (AVG) (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
4810	H/SV	1.10	6	65.4	56.6	63.5	6.9
7215	V/HB	1.03	202	57.6	47.8	104.7	56.9
9620	H/SV	1.01	213	73.2	68.2	104.7	36.5
12025	V/HB	1.00	155	48.0	45.8	63.5	17.7
14430	H/VV	1.10	234	52.2	49.3	104.7	55.4
16835	H/VB	1.03	221	51.6	48.9	104.7	55.8
19240 Note4	V/SB	1.00	11	65.3	61.3	74.0	12.7
21645 Note4	V/SB	1.00	60	65.1	61.3	115.2	53.9
24050 Note4	V/SV	1.00	41	57.6	54.6	115.2	60.6

The following table depicts the level of significant radiated harmonic emissions seen on Channel 12:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (PEAK) (dBμV/m)	Measured EFI (AVG) (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
4880	V/SB	1.10	104	66.8	57.4	63.5	6.1
7320	V/HB	1.10	156	58.7	48.4	63.5	15.1
9760	V/SV	1.00	6	69.2	64.4	104.7	40.3
12200	V/HB	1.00	155	54.6	51.5	63.5	12.0
14640	H/VV	1.00	147	50.2	47.3	104.7	57.4
17080	H/VV	1.02	113	58.4	55.5	104.7	49.2
19520 Note4	V/SB	1.00	9	65.1	60.8	74.0	13.2
21960 Note4	V/SB	1.00	63	68.9	64.6	115.2	50.6
24400 Note4	V/SV	1.00	48	58.3	54.5	115.2	60.7

The following table depicts the level of significant radiated harmonic emissions seen on Channel 1a:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (PEAK) (dBμV/m)	Measured EFI (AVG) (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
4960	V/SB	1.00	109	66.2	56.9	63.5	6.6
7440	V/HB	1.02	158	60.4	50.2	63.5	13.3
9920	V/SV	1.00	352	66.8	61.8	104.7	42.9
12400	V/HB	1.00	153	58.9	55.4	63.5	8.1
14880	H/VV	1.00	143	53.3	50.3	104.7	54.4
17360	H/VV	1.02	108	62.1	58.8	104.7	45.9
19840 Note4	V/SB	1.00	18	64.2	60.3	74.0	13.7
22320 Note4	V/SB	1.00	74	67.8	63.3	74.0	10.7
24800 Note4	V/SV	1.00	50	58.4	54.8	115.2	60.4

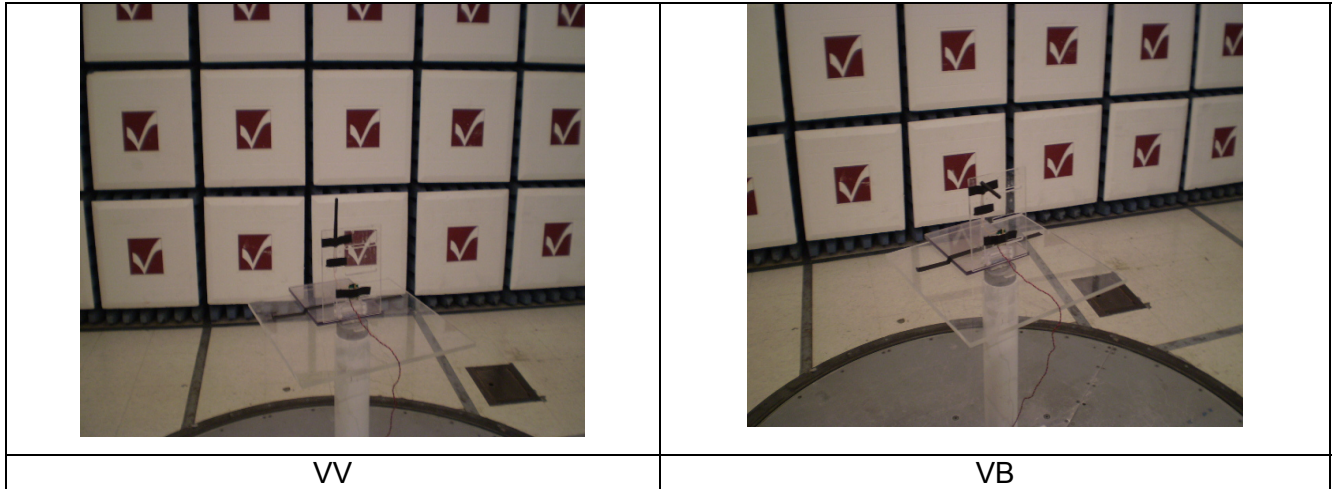
Notes:

- 1) Measurements above 4 GHz were made at 1 meters of separation from the EUT, and at 0.3 m separation for frequencies between 18 – 25 GHz.
- 2) Measurement at receiver system noise floor.
- 3) All measured channels were set at power level '3' (maximum operating power level) for measurements of harmonics, even though 1b operates on a reduced power level.
- 4) Measurements above 18GHz were made with 30cm separation. Limits were adjusted accordingly.
- 5) The 104dBuV/m limit is based on the lowest fundamental power of the channel operating at maximum power settings (20dB below and adjusted for 1m separation).115.2dBuV/m is the same limit adjusted for separation of 30cm.

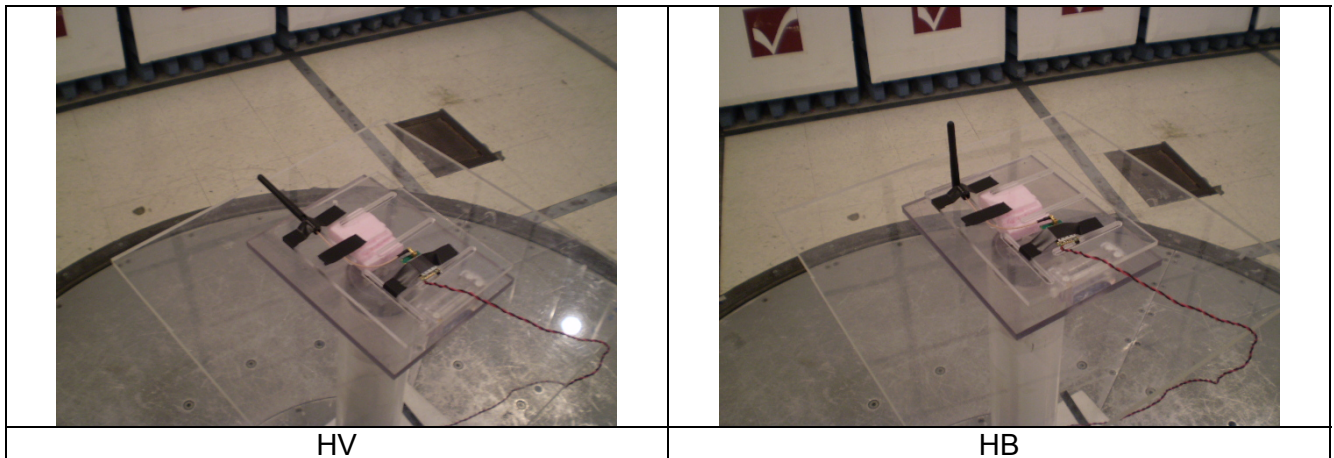
LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	<b>Page 17 of 54</b>

## 5.7 Test Setup Photo(s) – Radiated Emissions Test

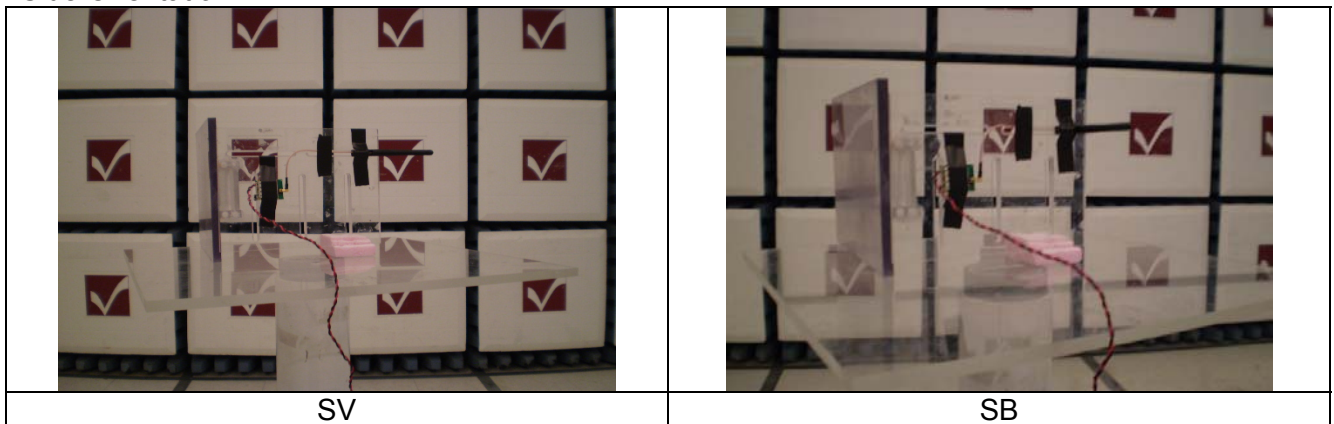
### Vertical Orientation



### Horizontal Orientation



### Side Orientation

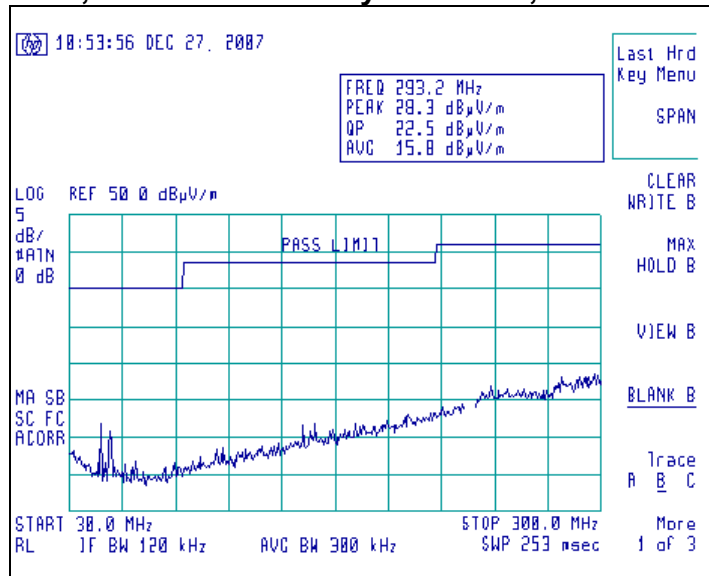


### 5.8 Screen Captures - Radiated Emissions Testing

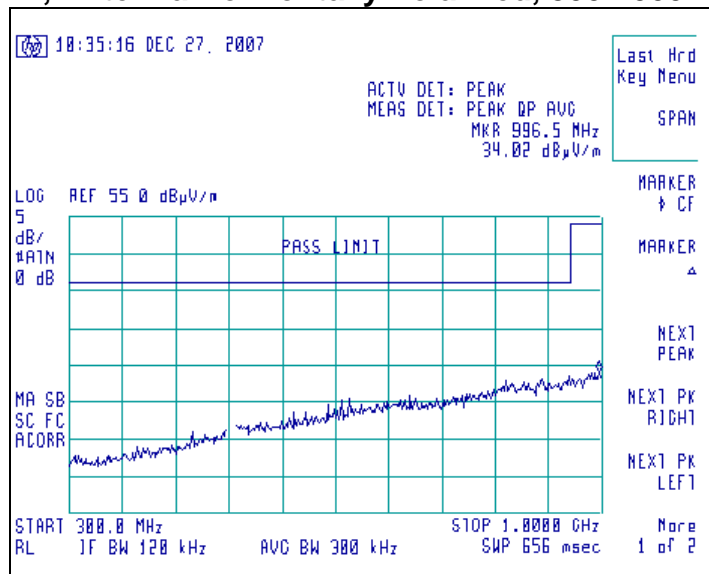
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 0, 1,7,11, 12, 13, 14, or 15, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

#### Channel 12, Antenna Vertically Polarized, 30-300 MHz, at 3m



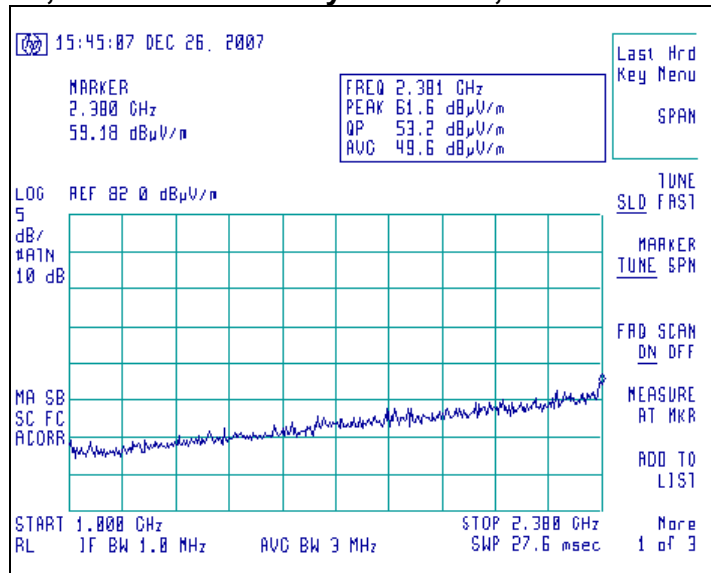
#### Channel 12, Antenna Horizontally Polarized, 300-1000 MHz, at 3m



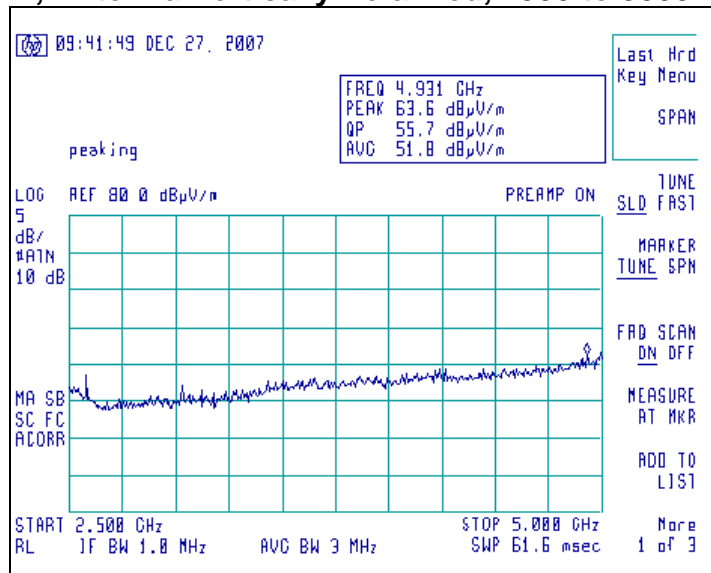
LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
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**Screen Captures - Radiated Emissions Testing (continued)**

**Channel b, Antenna Vertically Polarized, 1000-2380 MHz, at 3m**

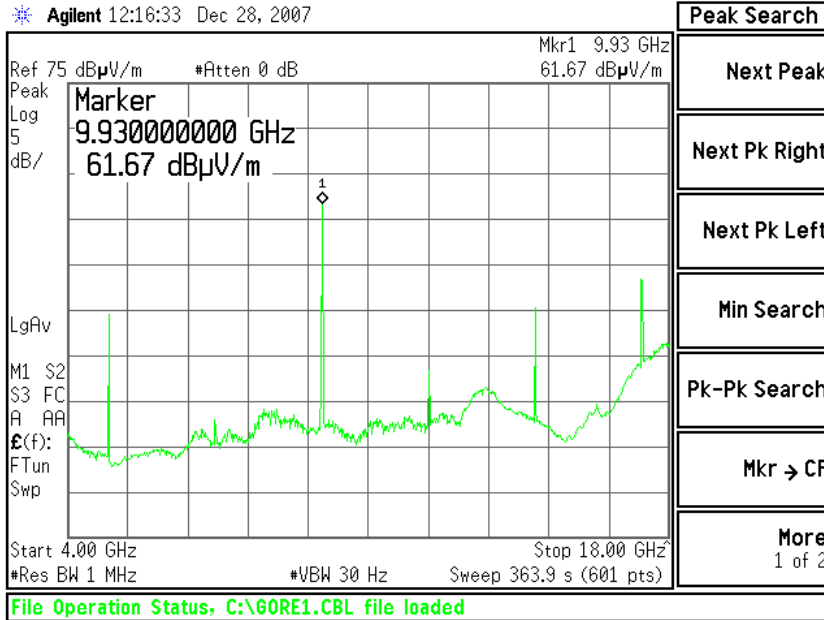


**Channel 17, Antenna Vertically Polarized, 2500 to 5000 MHz, at 3m**

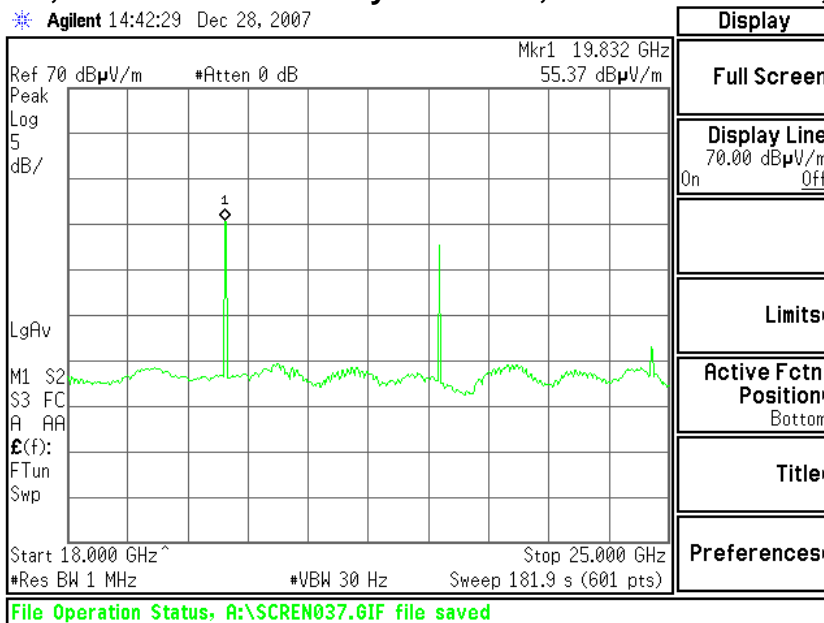


**Screen Captures - Radiated Emissions Testing (continued)**

**Channel 1a, Antenna Horizontally Polarized, 4000 - 18000 MHz, at 1m**



**Channel 1a, Antenna Horizontally Polarized, 18000-25000 MHz, at 30cm**



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## 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 50 $\Omega$  (ohm), 50/250  $\mu$ H 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 50 $\Omega$  (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.

### 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 Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

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**6.5 FCC Limits of Conducted Emissions at the AC Mains Ports**

Frequency Range (MHz)	Class B Limits (dB $\mu$ V)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW $\geq$ 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

### 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:	October 15 <sup>th</sup> – December 28 <sup>th</sup> 2007				
Test Engineer:	Khairul Aidi Zainal				
Model #:	APX01				
Serial #:	07040088				
Voltage:	120 VAC				
Operation Mode:	continuous transmit, modulated				
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %				
Test Location:					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	<u>QUASI-PEAK</u>			<u>AVERAGE</u>		
		Q-Peak Reading (dBμV)	Q-Peak Limit (dBμ V)	Quasi-Peak Margin (dB)	Average Reading (dBμV)	Average Limit (dBμ V)	Average Margin (dB)
0.311	1	46.2	59.9	13.7	18.8	49.9	31.1
0.347	1	46.3	59.0	12.7	18.4	49.0	30.6
0.374	1	45.5	58.4	12.9	17.9	48.4	30.5
0.150	2	52.6	66.0	13.4	25.4	56.0	30.6
0.324	2	46.0	59.6	13.6	18.6	49.6	31.0
0.349	2	46.1	59.0	12.9	18.3	49.0	30.7
0.378	2	45.4	58.3	12.9	17.8	48.3	30.5

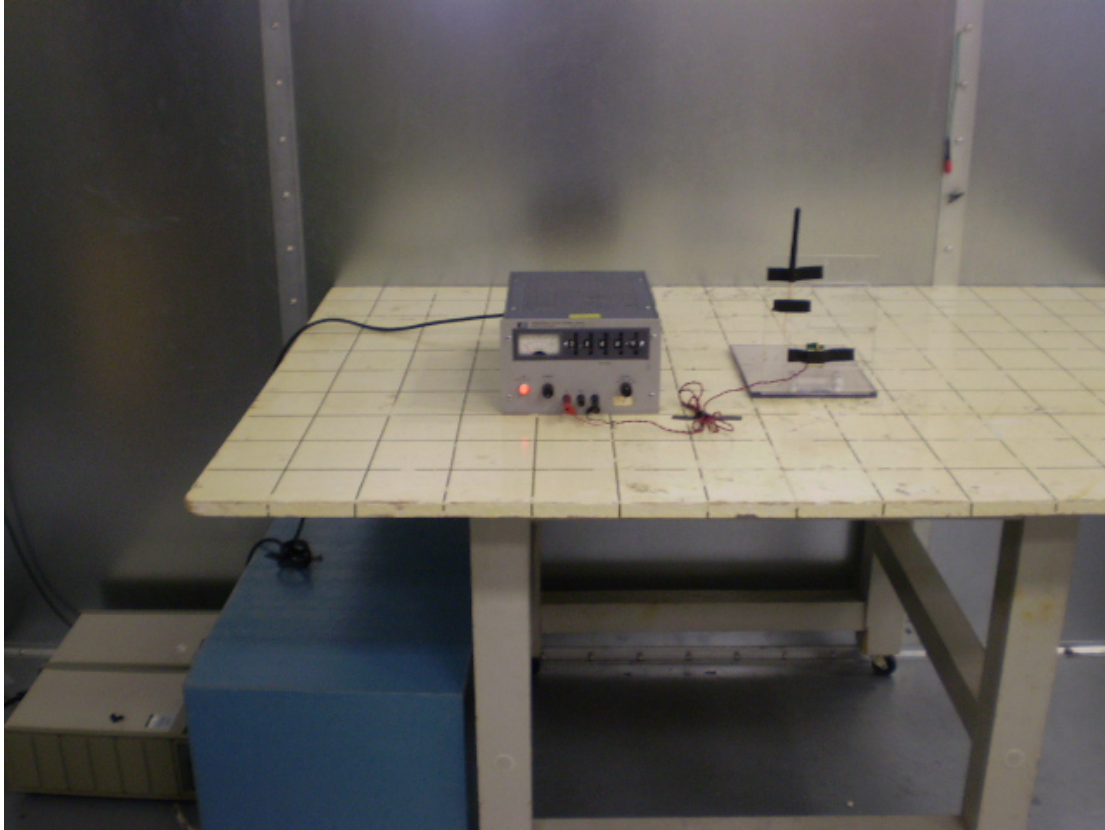
**Notes:**

- 1) The emissions listed are characteristic of the power supply used, and did not change by the EUT.
- 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 all 7 channels tested.

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## 6.7 Test Setup Photo(s) – Conducted Emissions Test



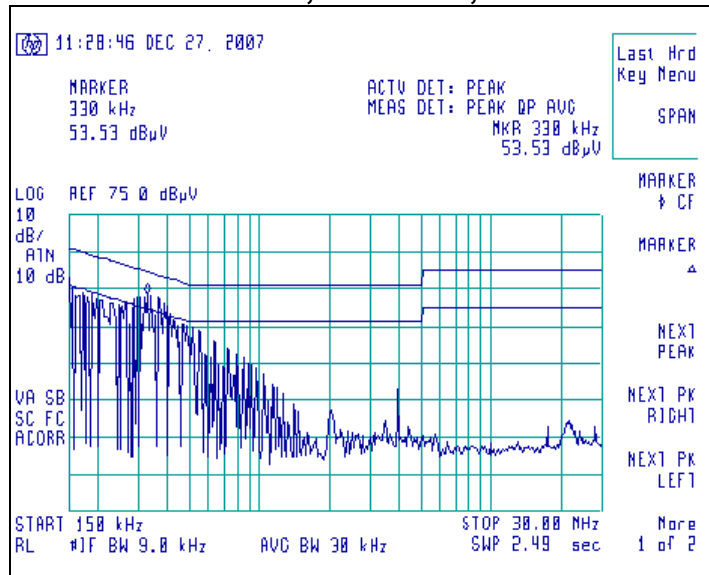
LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	<b>Page 25 of 54</b>

## 6.8 Screen Captures – Conducted Emissions Test

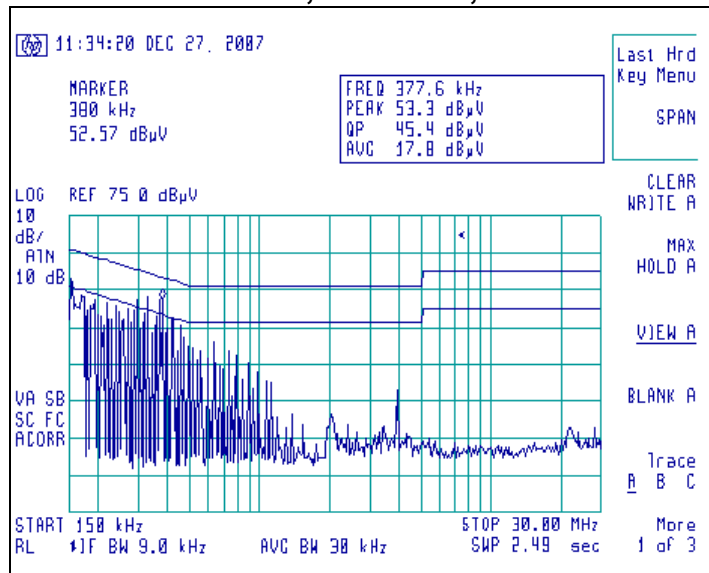
These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207.

The signature scans shown here are from channel 7, chosen as being a good representative of channels.

### Channel 7, 2440 MHz, Line 1



### Channel 7, 2440 MHz, Line 2



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## 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 E4446A 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, thereby 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.

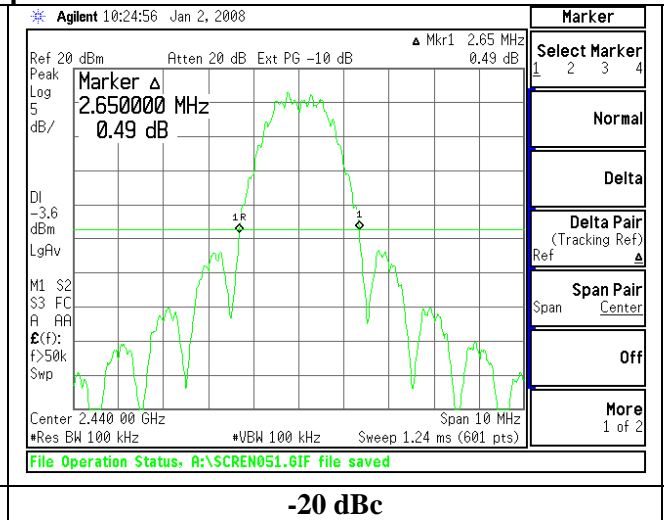
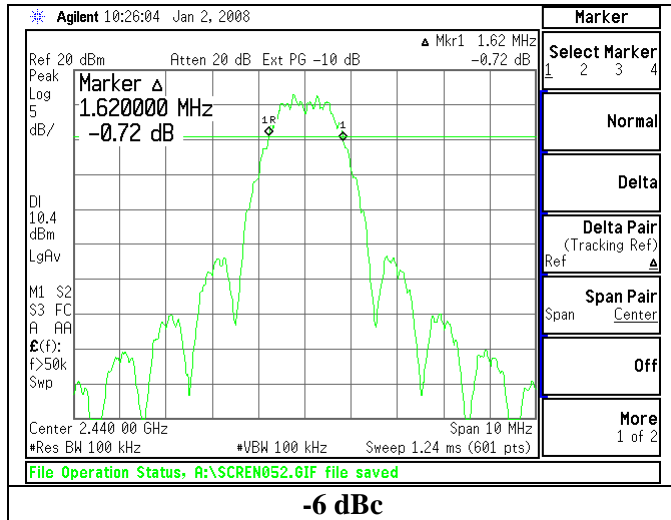
From this data, the closest measurement when compared to the specified limit is 1620 kHz, which is above the minimum of 500 kHz.

### 7.3 Test Data

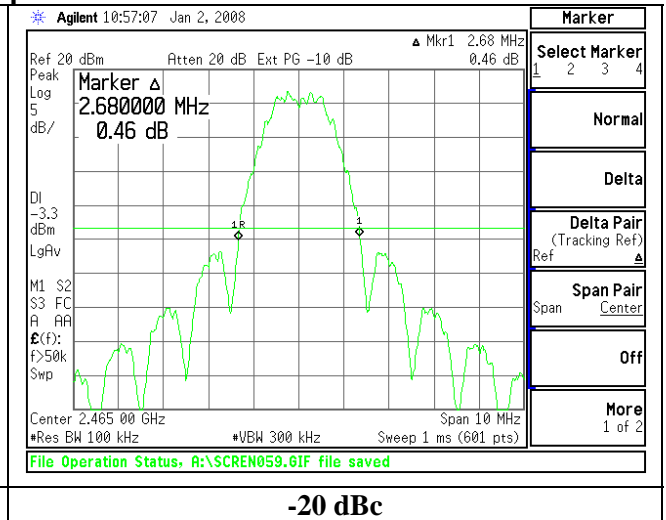
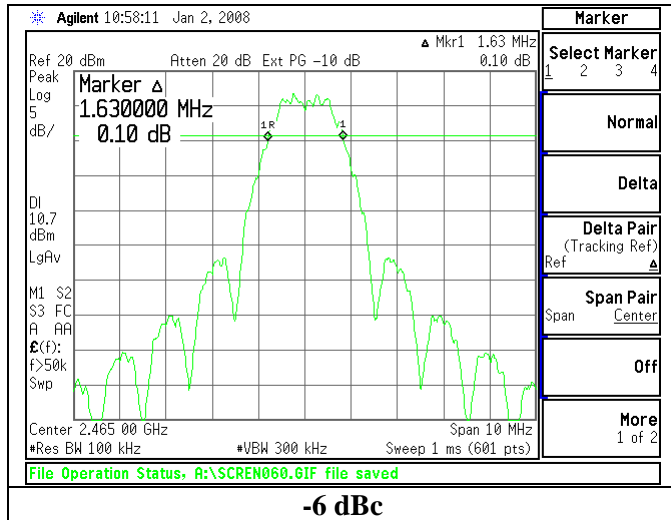
Channel	Center Frequency (MHz)	Measured -6 dBc Occ. BW (kHz)	Minimum -6 dBc Limit (kHz)	Measured -20 dBc Occ.Bw (kHz)
b	2405	1620	500	2650
c	2410	1650	500	2680
12	2440	1620	500	2650
17	2465	1630	500	2680
18	2470	1650	500	2680
19	2475	1620	500	2670
1a	2480	1630	500	2670



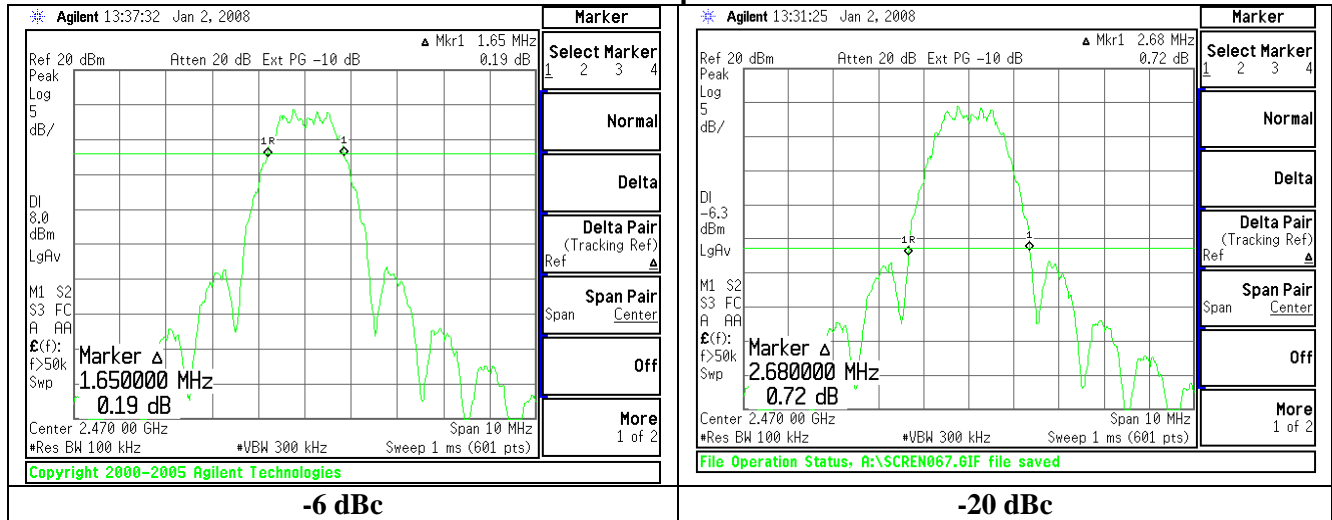
### Channel 12 Occupied Bandwidth



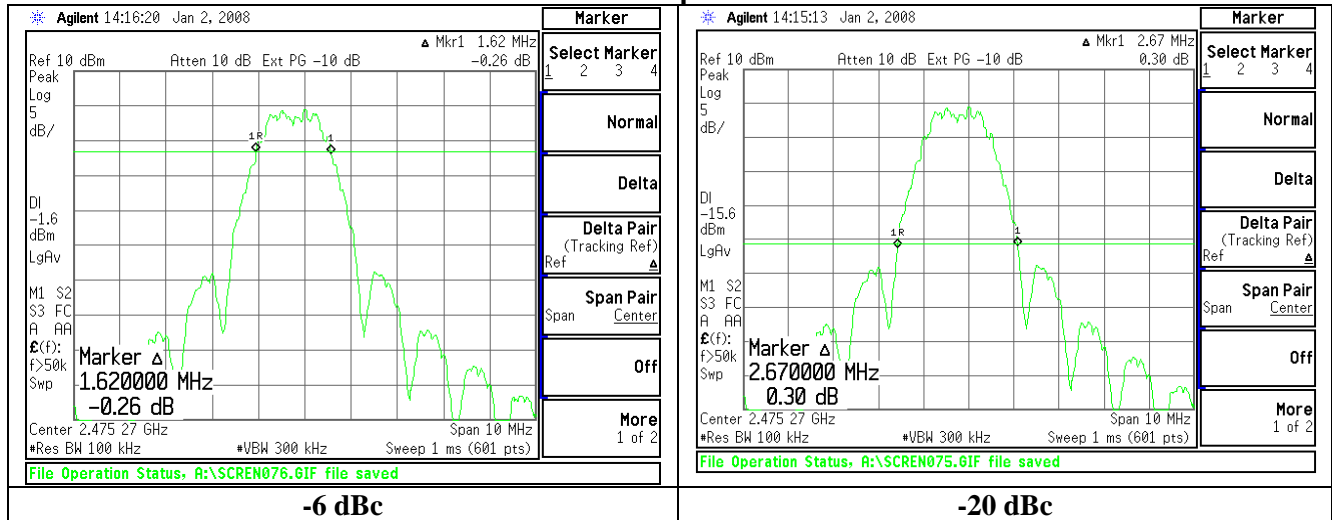
### Channel 17 Occupied Bandwidth



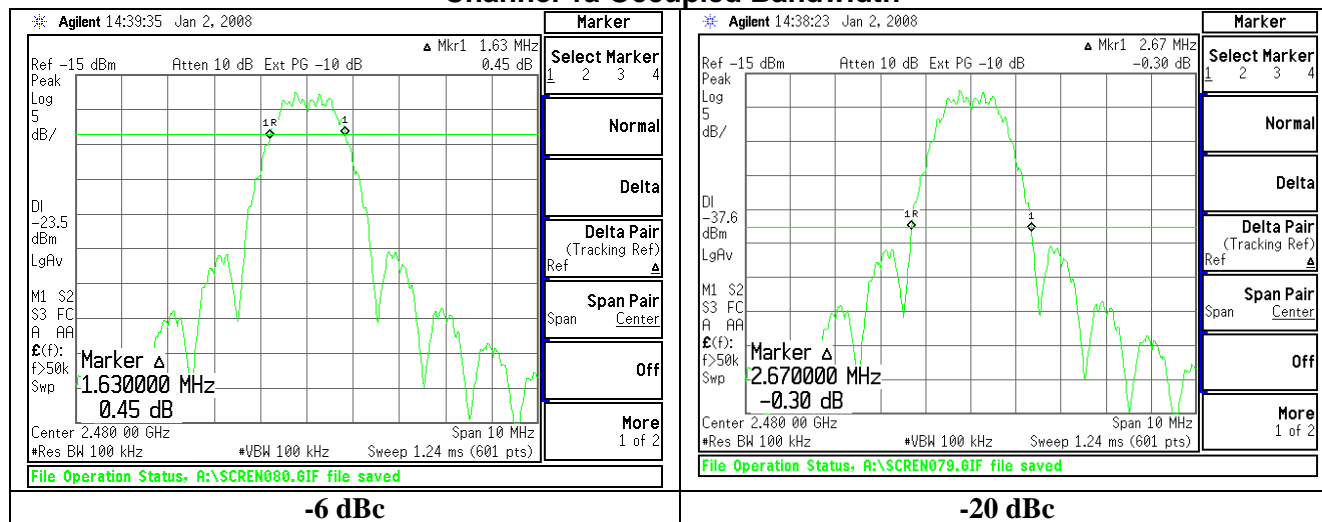
### Channel 18 Occupied Bandwidth



### Channel 19 Occupied Bandwidth



### Channel 1a 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 2 lowest channels for the investigation of the lower Band-Edge, and at the 4 highest channels for the investigation of the higher Band-Edge.

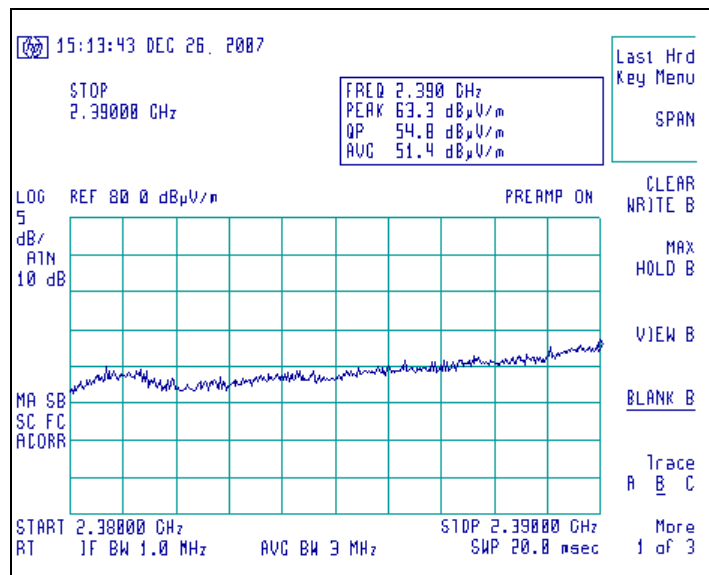
*The Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.*

*The Upper Band-Edge limit, in this case, would be + 54.0 dB $\mu$ V/m at 3m*

Screen Captures Demonstrating Compliance at the **Lower Band-Edge**

### Channel b

1). 2380MHz to 2390 MHz

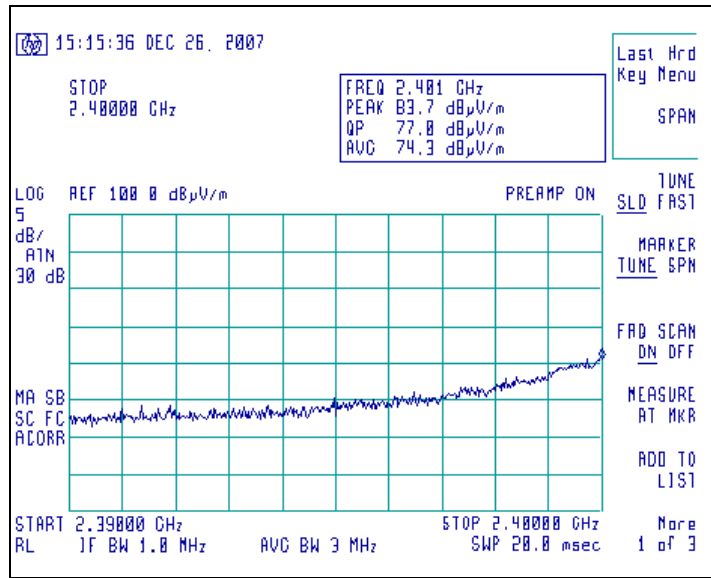


**Note: At peak point within range, the average detector (since above 1GHz) measurement was below limit (54dBuV/m).**

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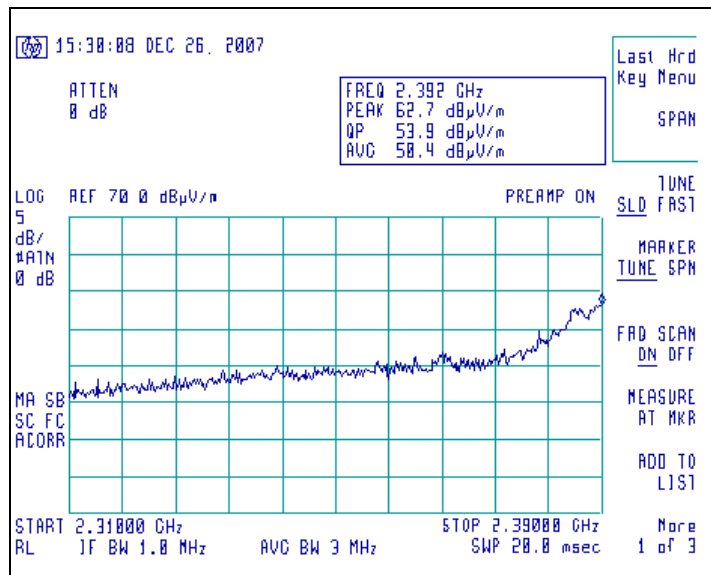
2). 2390MHz to 2400MHz



Note: Within this range the limit is 20dB below the fundamental (93.9 dBuV/m)

Channel c

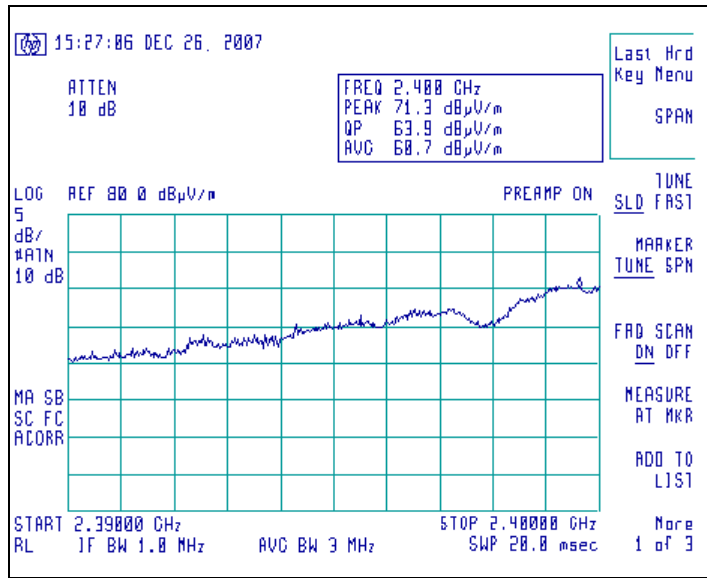
1). 2310MHz to 2390 MHz



Note: At peak point within range, the average detector (since above 1GHz) measurement was below limit (54dBuV/m).

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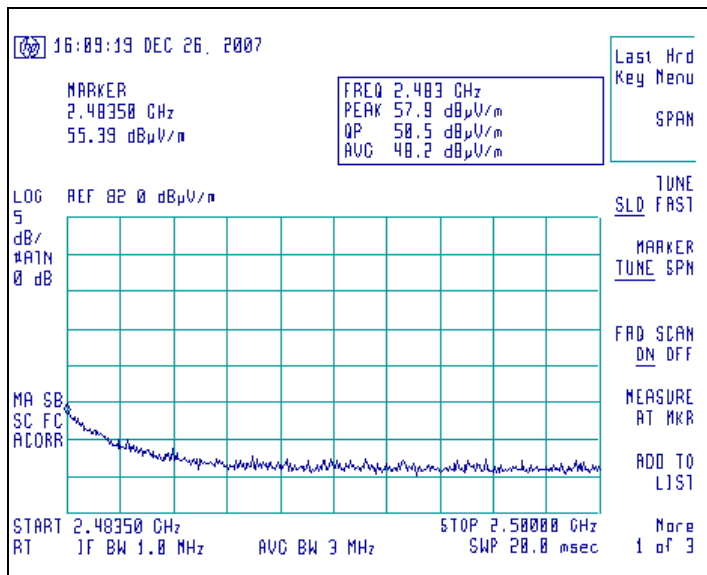
2). 2390MHz to 2400MHz



Note: Within this range the limit is 20dB below the fundamental (96.5 dBuV/m)

Screen Captures Demonstrating Compliance at the Higher Band-Edge

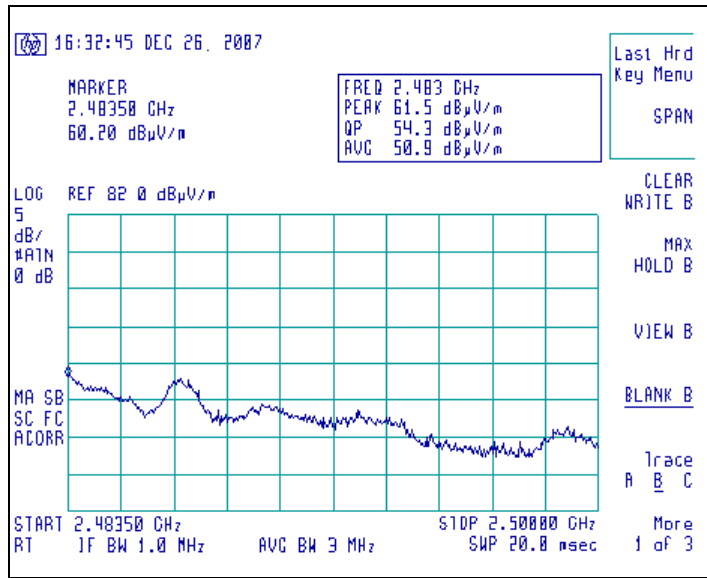
Channel 1a



Note: At peak point within range, the average detector (since above 1GHz) measurement was below limit (54dBuV/m).

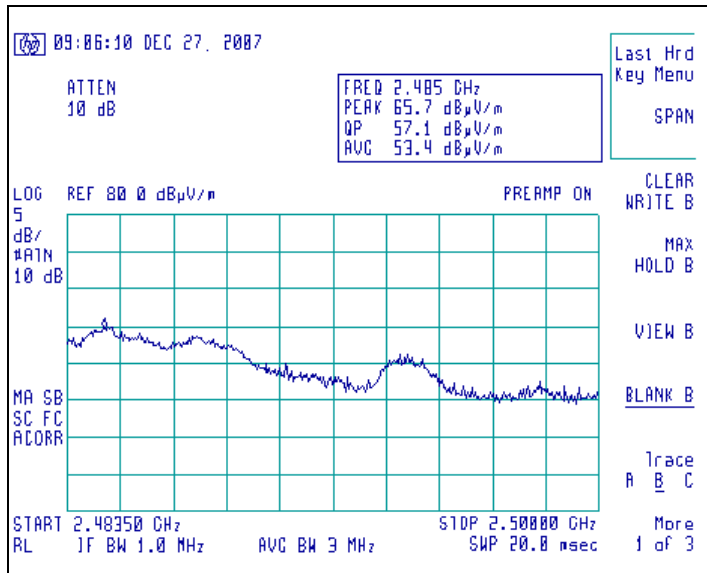
LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
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### Channel 19



Note: At peak point within range, the average detector (since above 1GHz) measurement was below limit (54dBuV/m).

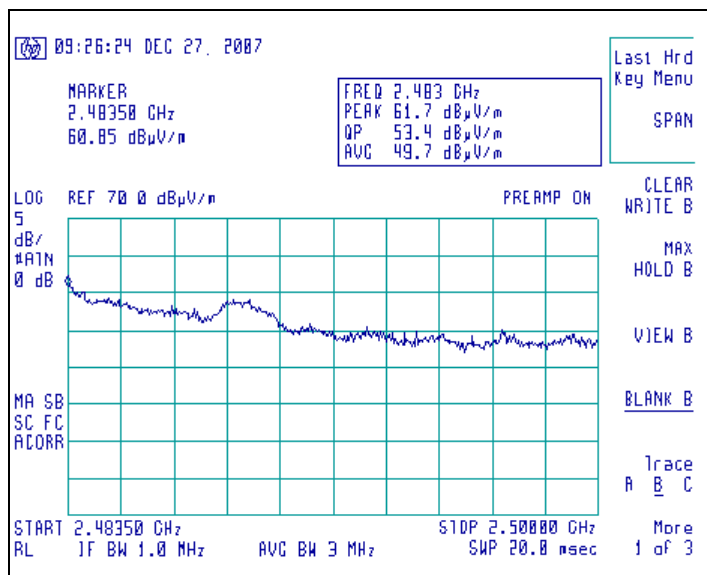
### Channel 18



Note: At peak point within range, the average detector (since above 1GHz) measurement was below limit (54dBuV/m).

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### Channel 17



**Note: At peak point within range, the average detector (since above 1GHz) measurement was below limit (54dBuV/m).**

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Model #: ZAXM-201-1	EUT: Apex	<b>Page 36 of 54</b>

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

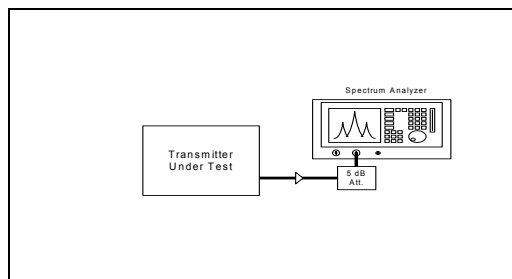
### 9.1 Method of Measurements

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 typical data 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.

### Test Data

#### 9.2 Test Data

CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
b	2405	+30 dBm	18.0	12.0
c	2410	+30 dBm	19.8	10.2
12	2440	+30 dBm	19.6	10.4
17	2465	+30 dBm	19.6	10.4
18	2470	+30 dBm	17.4	12.6
19	2475	+30 dBm	7.4	22.6
1a	2480	+30 dBm	-14.3	44.3



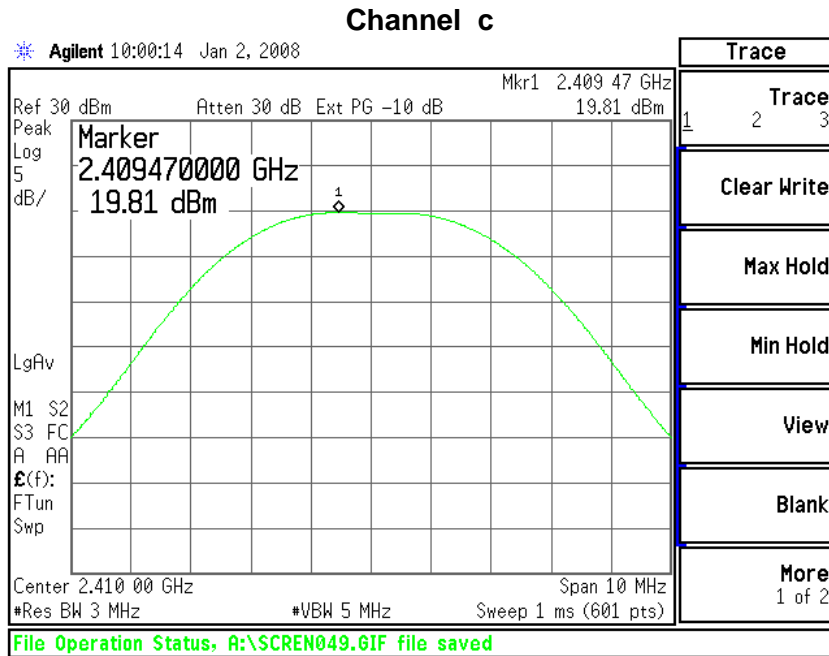
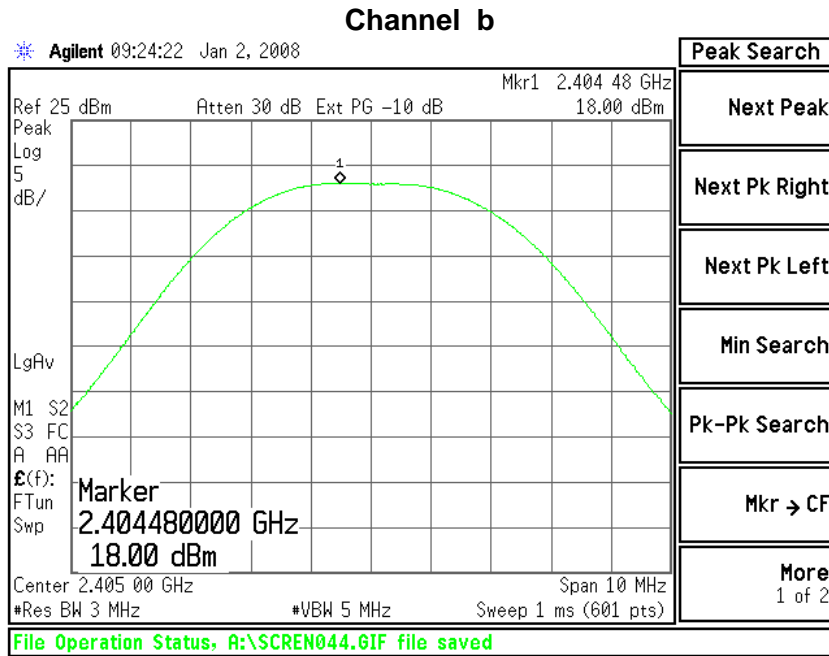
**Measured RF Power Output (in Watts): 0.096 Watts**  
**Declared RF Power Output (in Watts): 0.100 Watts**

### 9.3 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4407B	US39160256	40GHz

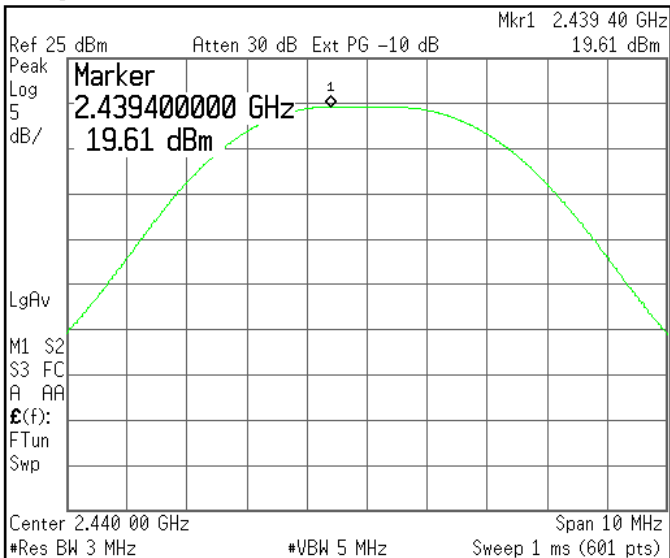
LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	<b>Page 37 of 54</b>

## 9.4 Screen Captures – Power Output (Conducted)



### Channel 12

Agilent 10:28:43 Jan 2, 2008

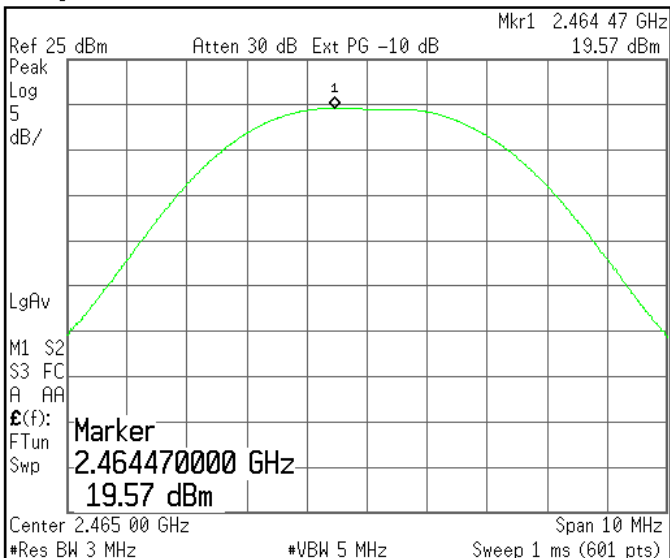


Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More 1 of 2

File Operation Status. A:\SCREN053.GIF file saved

### Channel 17

Agilent 11:00:50 Jan 2, 2008



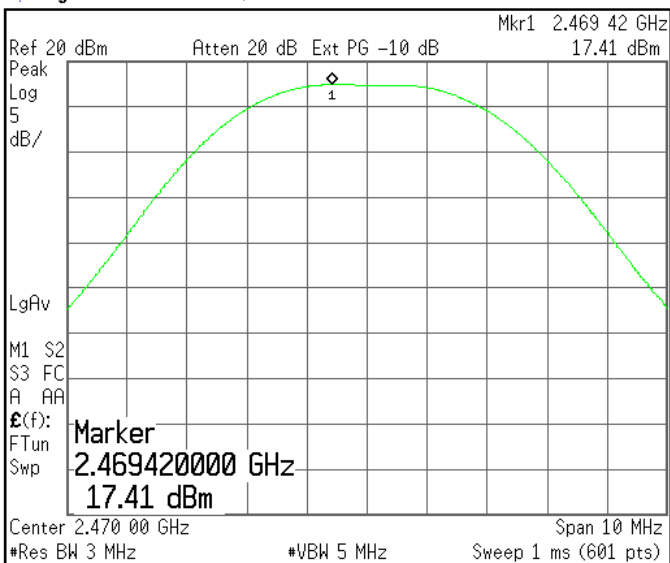
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More 1 of 2

File Operation Status. A:\SCREN061.GIF file saved

LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	Page 39 of 54

### Channel 18

Agilent 13:38:47 Jan 2, 2008

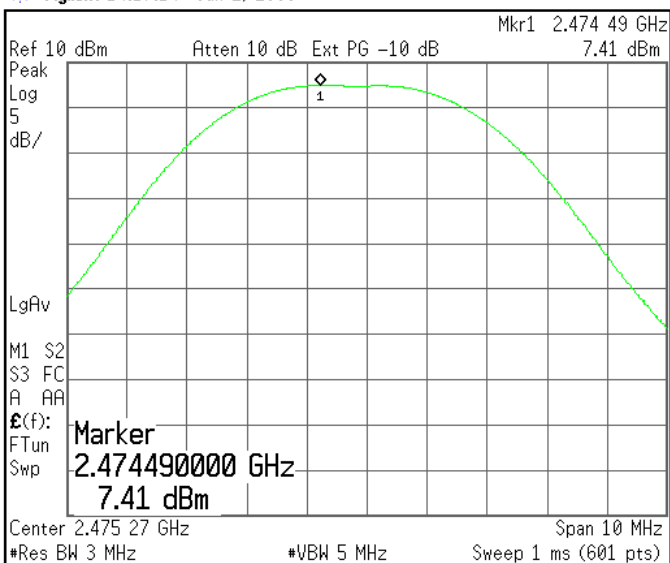


Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More 1 of 2

File Operation Status, A:\SCREN069.GIF file saved

### Channel 19

Agilent 14:17:14 Jan 2, 2008



Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More 1 of 2

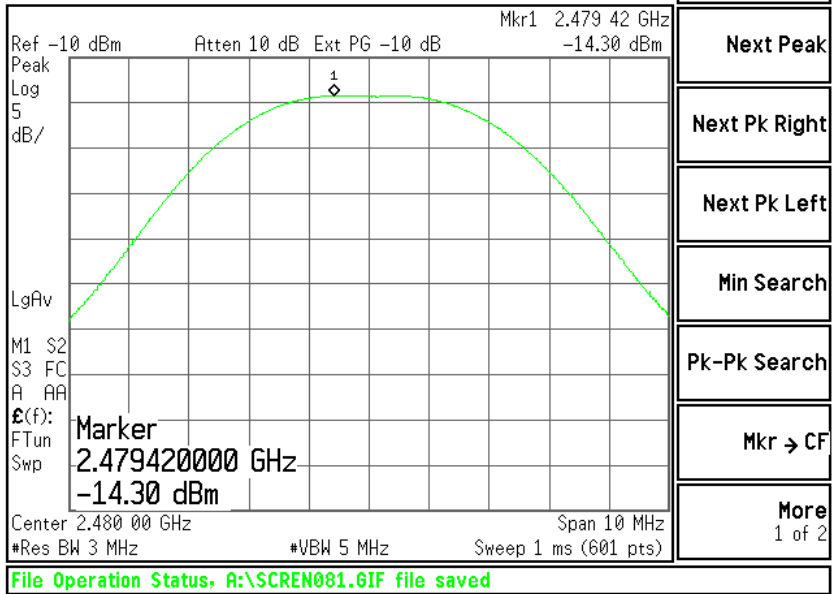
File Operation Status, A:\SCREN077.GIF file saved

LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	Page 40 of 54



# Channel 1a

Agilent 14:40:42 Jan 2, 2008



LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	<b>Page 41 of 54</b>

## 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 using the noise marker 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 -5.1 dBm, which is under the allowable limit by 13.1 dB.

### 10.2 Test Equipment List

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

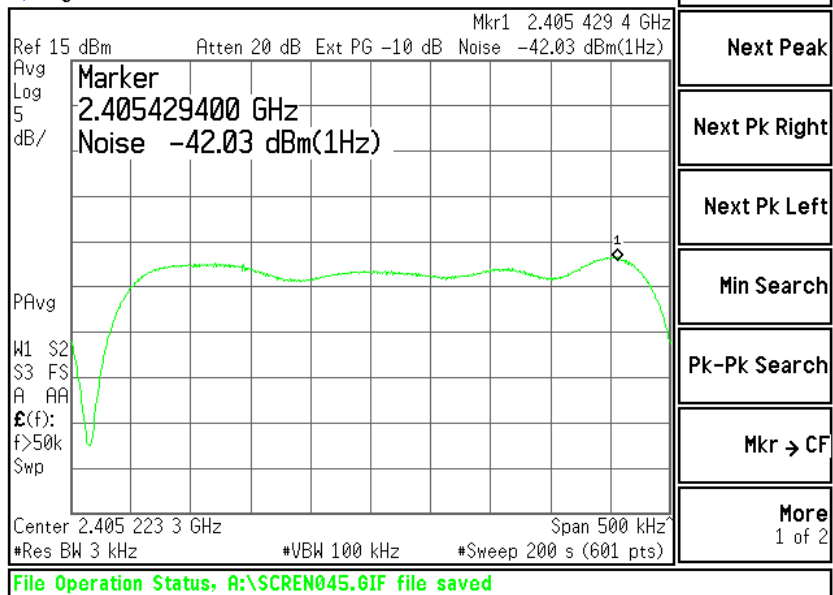
### 10.3 Test Data

Channel	Frequency (MHz)	Noise Marker (dBm/1 Hz)	RF Power Level In 3 kHz BW (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Comments Pass/Fail
b	2405	-42.03	-7.3	8.0	15.3	Pass
c	2410	-39.85	-5.1	8.0	13.1	Pass
12	2440	-41.25	-6.5	8.0	14.5	Pass
17	2465	-41.20	-6.4	8.0	14.4	Pass
18	2470	-42.02	-7.2	8.0	15.2	Pass
19	2475	-52.44	-17.7	8.0	25.7	Pass
1a	2480	-73.96	-39.2	8.0	47.2	Pass

## 10.4 Screen Captures – Power Spectral Density

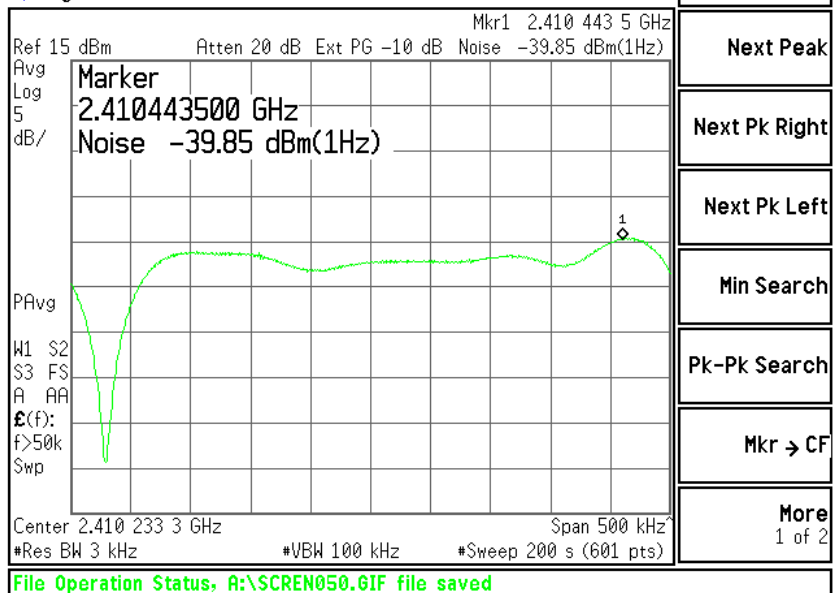
### Channel b

Agilent 09:34:46 Jan 2, 2008



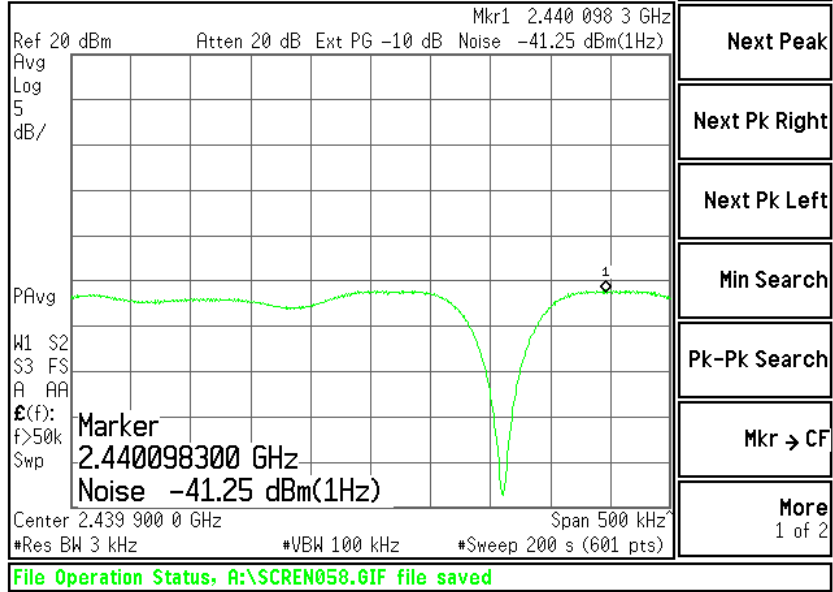
### Channel c

Agilent 10:12:27 Jan 2, 2008



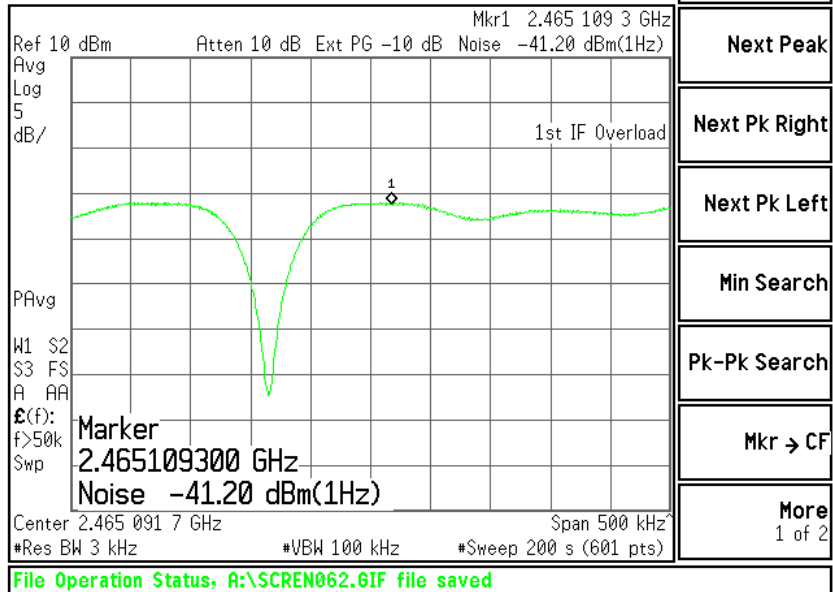
### Channel 12

Agilent 10:52:49 Jan 2, 2008



### Channel 17

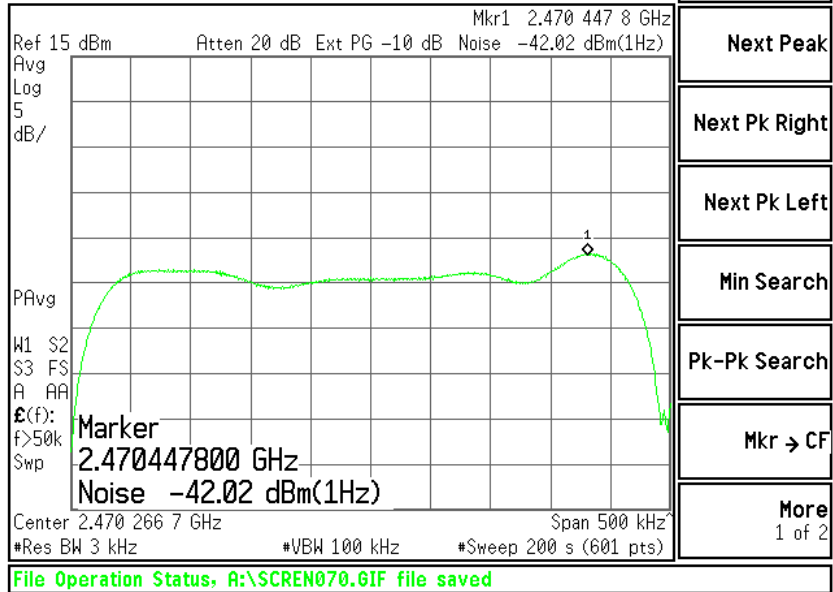
Agilent 11:16:08 Jan 2, 2008



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Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	Page 44 of 54

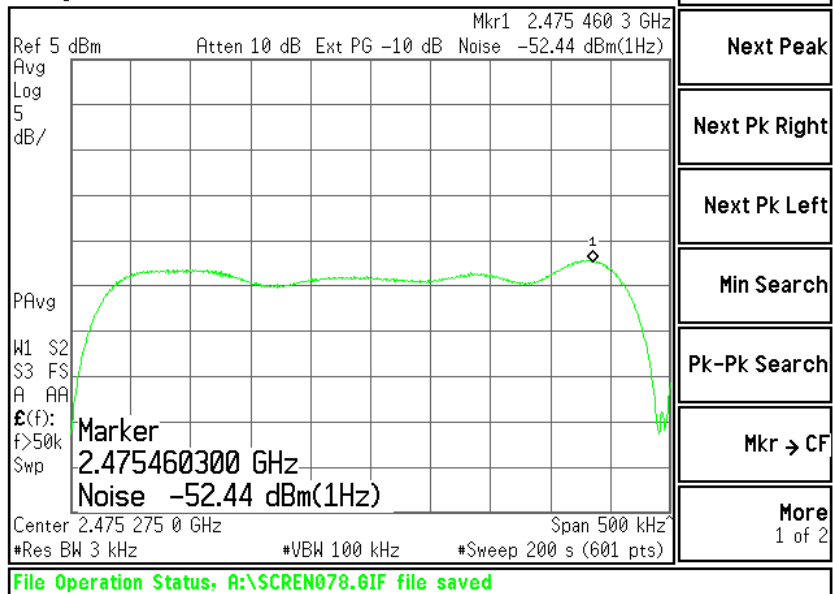
### Channel 18

Agilent 13:49:42 Jan 2, 2008



### Channel 19

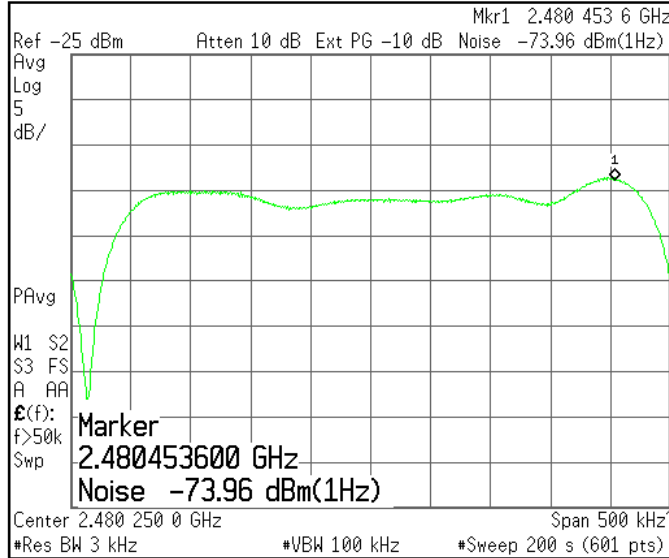
Agilent 14:29:29 Jan 2, 2008



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Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	Page 45 of 54

# Channel 1a

Agilent 14:48:50 Jan 2, 2008



Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More 1 of 2

File Operation Status, A:\SCREEN082.6IF file saved

LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	Page 46 of 54

## EXHIBIT 11. SPURIOUS RADIATED 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.

In addition, radiated emissions, which fall in the restricted band, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(e)

#### 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 47 CFR 15.209(a) Field Strength Limits within Restricted Frequency Bands

Frequency (MHz)	Field Strength Limits (microvolts/m)	Distance (Meters)
0.009 – 0.490	2,400 / F (kHz)	300
0.490 – 1.705	24,000 / F (kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

#### Calculation of Radiated Emission Measurements

Frequency (MHz)	3 m Limit ( $\mu\text{V}/\text{m}$ )	3 m Limit ( $\text{dB}\mu\text{V}/\text{m}$ )	1 m Limit ( $\text{dB}\mu\text{V}/\text{m}$ )
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-25,000	500	54.0	63.5

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Model #: ZAXM-201-1	EUT: Apex	<b>Page 47 of 54</b>

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 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, 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 -65 dBc of the fundamental level for this product.

## 11.2 Test Data

	Channel b	Channel c	Channel 12	Channel 17	Channel 18	Channel 19	Channel 1a
Fundamental	14.5 (dBm)	16.4 (dBm)	16.1 (dBm)	16.7 (dBm)	14.3 (dBm)	4.4 (dBm)	-17.6 (dBm)
2 <sup>nd</sup> Harmonic	-55.6 (dBm)	-51.2 (dBm)	-52.1 (dBm)	-54.1 (dBm)	-59.7 (dBm)	-79.4 (dBm)	Note (1)
3 <sup>rd</sup> Harmonic	-61.2 (dBm)	-57.3 (dBm)	-59.6 (dBm)	-61.9 (dBm)	-65.1 (dBm)	Note (1)	Note (1)
4 <sup>th</sup> Harmonic	-59.2 (dBm)	-54.9 (dBm)	-63.6 (dBm)	-74.4 (dBm)	-77.9 (dBm)	Note (1)	Note (1)
5 <sup>th</sup> Harmonic	Note (1)	Note (1)	-75.0 (dBm)	-75.6 (dBm)	Note (1)	Note (1)	Note (1)
6 <sup>th</sup> Harmonic	-74.1 (dBm)	-73.2 (dBm)	-72.3 (dBm)	-73.2 (dBm)	Note (1)	Note (1)	Note (1)
7 <sup>th</sup> Harmonic	Note (1)	Note (1)		Note (1)	Note (1)	Note (1)	Note (1)
8 <sup>th</sup> Harmonic	-75.3 (dBm)	-73.2 (dBm)	-75.4 (dBm)	-74.5 (dBm)	Note (1)	Note (1))	Note (1)
9 <sup>th</sup> Harmonic	Note (1)	Note (1)	Note (1)	-73.2 (dBm)	Note (1)	Note (1)	Note (1)
10 <sup>th</sup> Harmonic	Note (1)	Note (1)	Note (1)	Note (1)	Note (1)	Note (1)	Note (1)

	Channel b (Power set at 3 instead of the reduced setting -4)	Channel 1a (Power set at 3 instead of the reduced setting -2b)
Fundamental	16.5(dBm)	16.3(dBm)
2 <sup>nd</sup> Harmonic	-51.4(dBm)	-55.6(dBm)
3 <sup>rd</sup> Harmonic	-59.1(dBm)	-63.2(dBm)
4 <sup>th</sup> Harmonic	-55.2(dBm)	-70.9(dBm)
5 <sup>th</sup> Harmonic	Note (1)	-73.3(dBm)
6 <sup>th</sup> Harmonic	-72.1(dBm)	-73.0(dBm)
7 <sup>th</sup> Harmonic	Note (1)	Note (1)
8 <sup>th</sup> Harmonic	-74.4(dBm)	-74.4(dBm)
9 <sup>th</sup> Harmonic	Note (1)	Note (1)
10 <sup>th</sup> Harmonic	Note (1)	Note (1)

Notes:

(1) Measurement at system noise floor.

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Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	<b>Page 48 of 54</b>

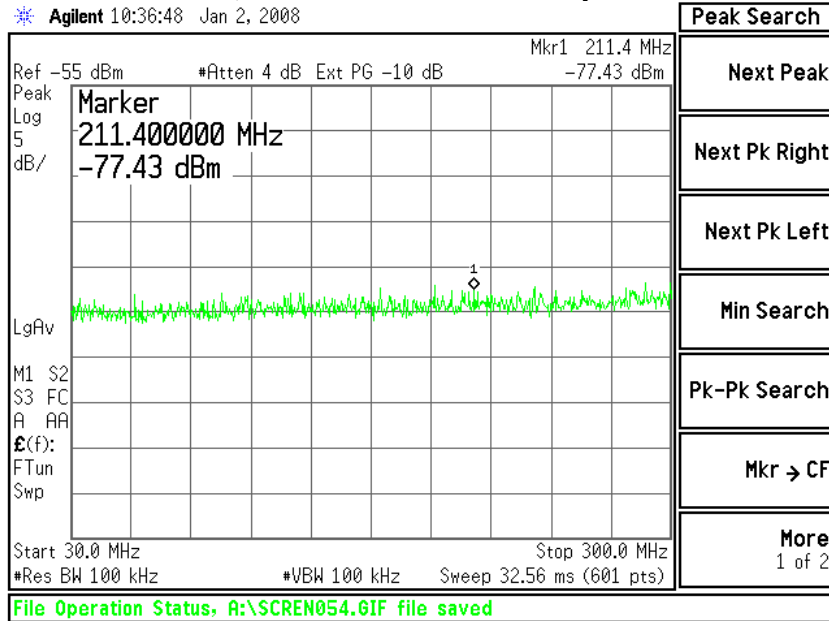


### 11.3 Test Equipment List

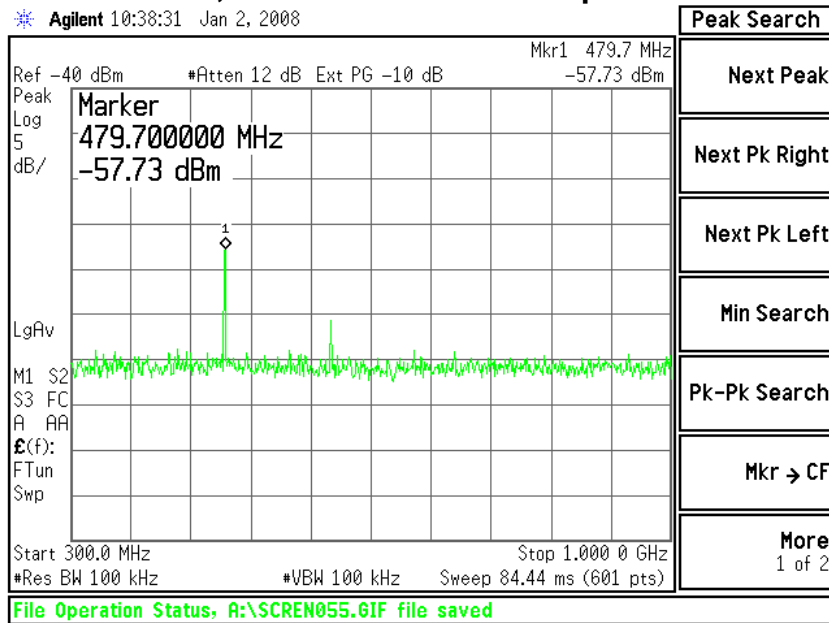
Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

### 11.4 Screen Captures – Spurious Radiated Emissions

#### Channel 12, shown from 30 MHz up to 300 MHz



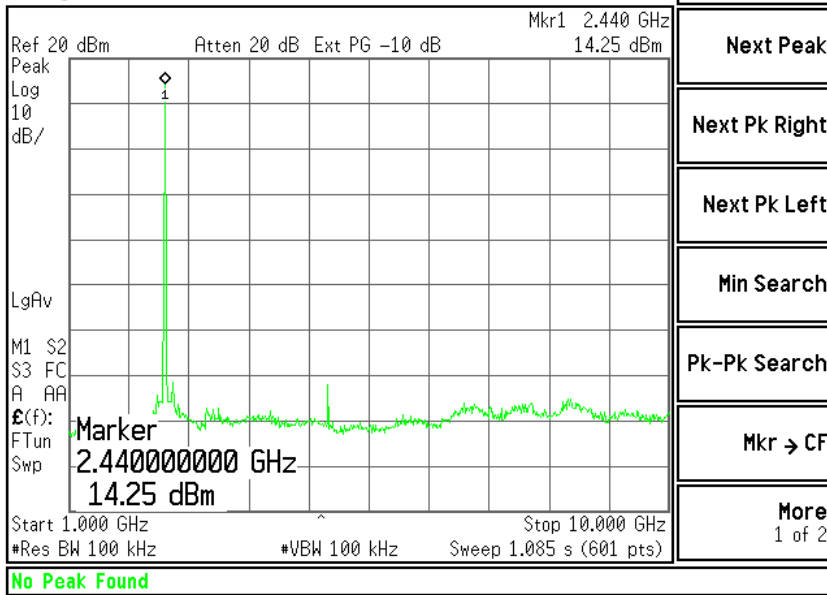
#### Channel 12, shown from 300 MHz up to 1000 MHz



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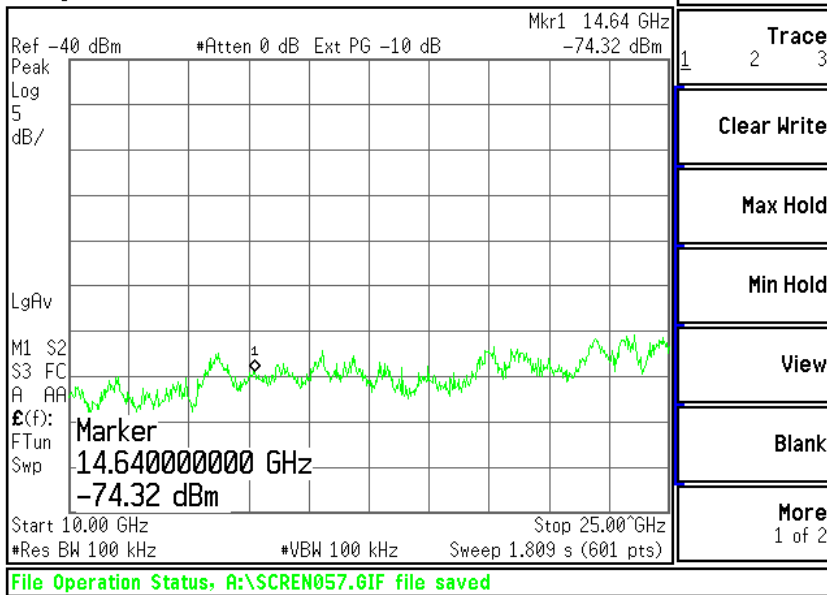
### Channel 12, shown from 1000 MHz up to 10000 MHz

Agilent 10:43:06 Jan 2, 2008



### Channel 12, shown from 10000 MHz up to 25000 MHz

Agilent 10:46:12 Jan 2, 2008



**EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE**

In this case, the EUT was powered using a standard bench DC supply with a nominal voltage of 3.3 VDC.

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=3 kHz settings while the voltage was varied.

	DC Voltage Source		
	2.8 VDC	3.3 VDC	3.8 VDC
Channel b	2405009300(Hz)	2405010300(Hz)	2405009800(Hz)
Channel 12	2440011600(Hz)	2440012400(Hz)	2440011900(Hz)
Channel 1a	2480011500(Hz)	2480011800(Hz)	2480011800(Hz)

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.

	DC Voltage Source		
	2.8 VDC	3.3 VDC	3.8 VDC
Channel b	16.4(dBm)	18.0(dBm)	19.3(dBm)
Channel 12	19.5(dBm)	19.6(dBm)	19.7(dBm)
Channel 1a	-16.4(dBm)	-14.3(dBm)	-11.8(dBm)

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characterizes were well behaved, and the system returned to the same state of operation as before the power cycle.

## EXHIBIT 13. CHANNEL PLAN AND SEPARATION

### Optional for DTS

## EXHIBIT 14. MPE CALCULATIONS

The following MPE calculations are based on the Nearson S131CL half wavelength dipole antenna with a measured ERP of 116.5 dBuV/m (at 3 meters) and conducted RF power of +19.8 dBm as presented to the antenna. The gain of this antenna, based on the specification sheet is 2.0 dBi.

<u>Prediction of MPE limit at a given distance</u>	
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:	19.80 (dBm)
Maximum peak output power at antenna input terminal:	95.499 (mW)
Antenna gain(typical):	2 (dBi)
Maximum antenna gain:	1.585 (numeric)
Prediction distance:	20 (cm)
Prediction frequency:	2405 (MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1 (mW/cm <sup>2</sup> )
Power density at prediction frequency:	0.030111 (mW/cm <sup>2</sup> )
Maximum allowable antenna gain:	17.2 (dBi)
Margin of Compliance at 20 cm =	15.2 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	9/19/07	9/19/08
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/19/07	9/19/08
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	12/04/07	12/04/08
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	9/20/07	9/20/08
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/20/07	9/20/08
EE960073	Agilent	E4446A	US45300564	Spectrum Analyzer	8/17/07	8/17/08
N/A	LSC	Cable	0011	3 Meter 1/2" 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

LS Research, LLC	Prepared For: LS Research, LLC	LS Research, LLC
Report #: 307224.1 TX TCB Rev. 1	Customer FCC ID #: TFB-APEX	Template: 15.247 DTS TX (V2 9-06-06)
Model #: ZAXM-201-1	EUT: Apex	<b>Page 53 of 54</b>

## Appendix B

### Antenna Specification(s)

**Electrical Properties:**

Frequency Range: 2.4~2.5 GHz  
 Impedance: 50Ω nominal  
 VSWR: <2.0:1  
 Gain: 2 dBi (without ext. cable)  
 Radiation: Omni  
 Polarization: Vertical  
 Wave: Half Wave Dipole

\*Gain is measured under no flying lead.

**Mechanical Properties:**

Cable: M17/93-RG178 Coaxial Cable with L inches.  
 Material:  
 Whip: Polyurethane(Black)  
 Swivel Joint: Polyurethane(Black)  
 Nut: Polycarbonate(Black)  
 Operation Temp.: +20°C to +65°C  
 Storage Temp.: -30°C to +75°C

Connector Code - XXX -	Description	P / N
RMM	MMCX Right Angle Plug	S131CL - L - RMM - 2450S
MM	MMCX Straight Plug	S131CL - L - MM - 2450S
NC	No Connector (Stripped)	S131CL - L - NC - 2450S

TITLE	2.4GHz flying lead panel click antenna	DATE	111804	SHEET	1 of 4
UNIT	DWG. NO.	S131CL - L - XXX - 2450S			
in.(mm)					
SCALE	none				

**NEARSON**  
http://www.nearson.com

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Model #: ZAXM-201-1	EUT: Apex	<b>Page 54 of 54</b>