



W66 N220 Commerce Court • Cedarburg, WI 53012 • USA

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## TEST REPORT # 309028-2 LSR Job #: C-690

### Compliance Testing of:

2.4 GHz Module

### Test Date(s):

August 17- September 30, 2009

### Prepared For:

Niles Audio Corporation  
Attn: Mr. Alastair Roxburgh  
12331 S.W. 130 Street  
Miami, FL 33186

In accordance with:  
**Federal Communications Commission (FCC)**  
**Part 15, Subpart C, Section 15.247**  
**Industry Canada (IC) RSS 210 Annex 8**  
**Digital Modulation Transmitters (DTS) Operating in the**  
**Frequency Band 2400 MHz – 2483.5 MHz**

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

Signature: *Teresa A. White*  
Date: September 30, 2009

**Tested by:**  
Laura Bott, EMC Engineer

Signature: *Laura M. Bott*  
Date: September 30, 2009

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## EXHIBIT 1. INTRODUCTION

### 1.1 SCOPE

<b>References:</b>	FCC Part 15, Subpart C, Section 15.247 and 15.209 FCC Part 2, Section 2.1043 paragraph (b)1. RSS GEN and RSS 210 Annex 8
<b>Title:</b>	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
<b>Purpose of Test:</b>	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
<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)	2008-10	Code of Federal Regulations - Telecommunications
RSS 210 Annex 8	2007 June	Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
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	2006-03 A1: 2006-09 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	2003 A1: 2004-04 A2: 2007-07	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	2007	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>Niles Audio</b>
<b>Address:</b>	<b>12331 S.W. 130 Street Miami, FL 33186</b>
<b>Contact Name:</b>	<b>Alastair Roxburgh</b>

### 2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

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

<b>Product Name:</b>	2.4 GHz Radio Module
<b>Model Number:</b>	2.4 GHz Radio Module
<b>Serial Number:</b>	Inverted F:PC00395 A0 SMA Dipole:PC00395 A0 BNC Dipole:PC00395 B0 Wire Whip:PC00395 B0 Heat shrink Dipole: PC00395A0

### 2.3 ASSOCIATED ANTENNA DESCRIPTION

There are 5 antenna options presented with this module:

- 1) Inverted F: On board antenna with measured gain of 4.56 dBi.
- 2) SMA Dipole: External antenna option which may be used in straight and bent configurations, with measured gains of 6.96 dBi and 6.36 dBi respectively.
- 3) BNC Dipole: External antenna option with measured gain of 4.37 dBi.
- 4) Wire Whip: External antenna option with measured gain of 2.37 dBi.
- 5) Heat Shrink Dipole: External antenna option with measured gain of 1.26 dBi.

Note: All antenna gains were calculated based off a known power at the antenna port (via a conducted measurement), and the field strength taken over a reflective ground plane.

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## 2.4 EUT'S TECHNICAL SPECIFICATIONS

### Additional Information:

EUT Frequency Range (in MHz)	2400-2483.5 MHz
Minimum RF Power in Watts:	0.0526 W (2475 MHz)
Maximum RF Power in Watts:	0.06934 W (2445 MHz)
Conducted Output Power (in dBm)	18.41 dBm (2445 MHz)
Field Strength at 3 meters	Inverted F Antenna: 4.56 dBi SMA Straight: 6.96 dBi SMA Bent: 6.36 dBi BNC: 4.37 dBi Wire: 2.37 dBi Heat Shrink Dipole: 1.26 dBi
Occupied Bandwidth (99% BW)	2820 KHz
Type of Modulation	O-QPSK
Emission Designator	2M820G1D
EIRP (in mW)	Inverted F Antenna: 198.1 mW SMA Straight: 279.9 mW SMA Bent: 261.2 mW BNC: 189.2 mW Wire: 119.4 mW Heat Shrink Dipole: 90.6 mW
Transmitter Spurious (worst case) at 1 meter	Inverted F Antenna: 57.7 dB $\mu$ V/m (7215 MHz) SMA Straight: 55.7 dB $\mu$ V/m (7425 MHz) SMA Bent: 57.0 dB $\mu$ V/m (7215 MHz) BNC: 56.5 dB $\mu$ V/m (7335 MHz) Wire: 59.0 dB $\mu$ V/m (7335 MHz) Heat Shrink Dipole: 30.3 dB $\mu$ V/m (7215 MHz)
Receiver Spurious (worst case) at 3 meters	Inverted F Antenna: 30.03 dB $\mu$ V/m (966.5 MHz) SMA Straight: 32.24 dB $\mu$ V/m (956.9 MHz) SMA Bent: 29.43 dB $\mu$ V/m (990.6) BNC: 30.13 dB $\mu$ V/m (998.63 MHz) Wire: 27.4 dB $\mu$ V/m (919.0 MHz) Heat Shrink Dipole: dB $\mu$ V/m
Stepped (Y/N)	N
Step Value:	N/A
Frequency Tolerance %, Hz, ppm	N/A
Microprocessor Model # (if applicable)	ATMEGA128L
Antenna Information	
Detachable/non-detachable	Detachable (BNC & SMA) & Non-detachable (Inverted F, Heat Shrink Dipole, Wire Dipole)
Type/ Gain (in dBi) Please see note on bottom of page 6.	Inverted F Antenna: 4.56 dBi SMA Straight: 6.96 dBi SMA Bent: 6.36 dBi BNC: 4.37 dBi Wire: 2.37 dBi Heat Shrink Dipole: 1.26 dBi
EUT will be operated under FCC Rule Part(s)	15.247
EUT will be operated under RSS Rule Part(s)	RSS-210 Issue 7
Modular Filing	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Portable or Mobile?	Portable

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**RF Technical Information:**

Type of Evaluation (check one)	SAR Evaluation: Device Used in the Vicinity of the Human Head
	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: OET 65
- Measurement Distance: 3 m
- RF Value: 0.68349  V/m  A/m  W/m<sup>2</sup>  
 Measured  Computed  Calculated

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## 2.5 PRODUCT DESCRIPTION

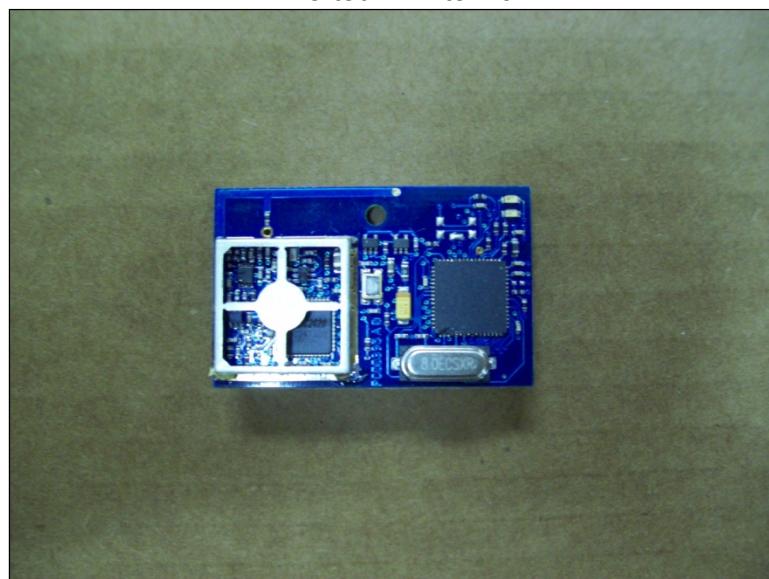
The Niles Audio RF module is an 802.15.4 base RF transceiver operating in the 2.4 GHz frequency band. It is a self contained unit incorporating a transceiver, RF PA, antenna, microprocessor, and RAM. It enables mesh communications for the Niles application.

All inputs to the module are through the 8-pin header on the back of the unit, including pins for the module power at 3.3 VDC at 200 mA. The transceiver is capable of transmitting 2MCps with O-QPSK modulation, and is tested for compliance against 47CFR15.247 as a DTS type device. The module is being qualified with two types of antennas. The first antenna is an inverted F type printed circuit board antenna integrated on the module itself. The second antenna is a straight wire whip, 1.25 inches in length, orthogonal to the PC-board.

During the testing, an interface board was provided in order to set the test modes of operation as well as provide the D.C. voltage to the unit. The interface board includes an RS-232 serial port to interface with the laptop. The Niles CC2420RF Test tool was used along with a laptop PC to select the test mode for the unit

### PHOTO(s)

Inverted F Antenna



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SMA Straight

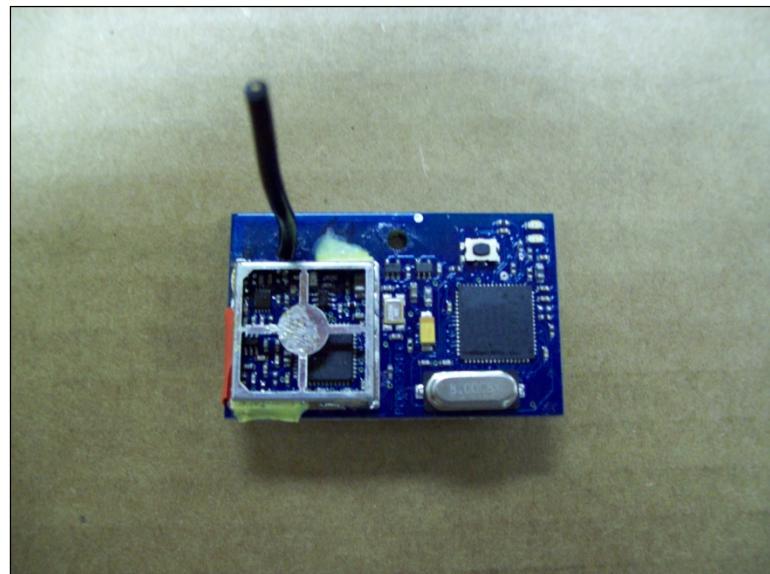
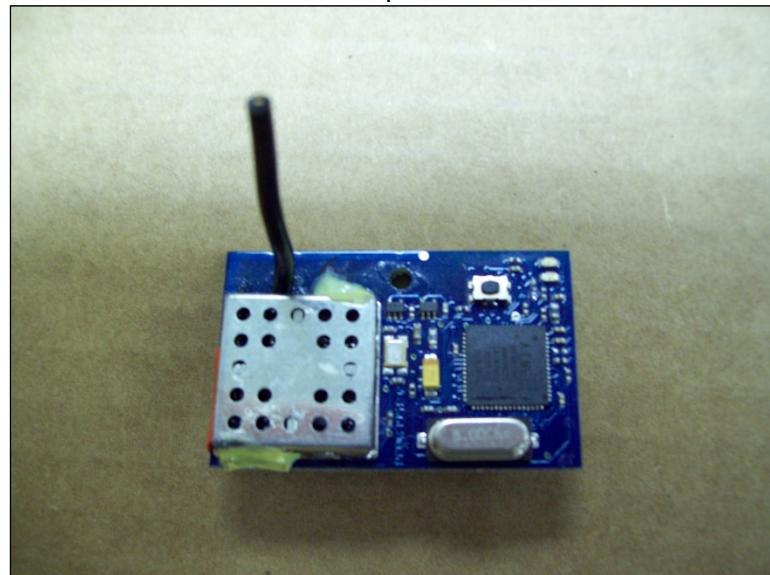


SMA Bent



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Wire Whip Antenna

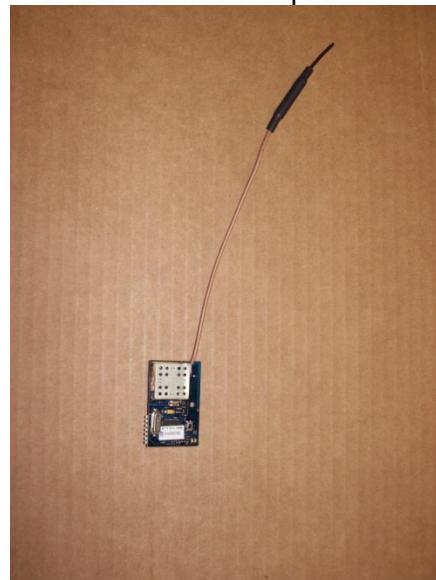


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BNC Antenna



Heat Shrink Dipole



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

#### **3.1 CLIMATE TEST CONDITIONS**

<b>Temperature:</b>	20-25°C
<b>Humidity:</b>	30-60%
<b>Pressure:</b>	86-106 kPa

#### **3.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS**

<b>FCC and IC Paragraph</b>	<b>Test Requirements</b>	<b>Compliance (yes/no)</b>
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	Yes
FCC : 15.247(a)(2) IC : RSS 210 A8.2(a)	6 dB Bandwidth of a Digital Modulation System	Yes
IC : RSS GEN section 4.6.1	20 dB Bandwidth	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	Yes
FCC : 15.247(c) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(d) IC : RSS 210 A8.2(b)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	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 (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC). The Receiver Test Report is available upon request.</i>		

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

None  Yes (explain below)

An 8.2 nH shunt inductor was added at location C21 on the wire antenna unit.

On the heat shrink dipole antenna unit, C30 was switched from a 5.6 pF capacitor to a 3.9 nH.

#### **3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS**

None  Yes (explain below)

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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, 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.

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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, RSS GEN 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 constant modulated transmit and receive modes, using power provided by a bench power supply. The unit has the capability to operate on 14 channels.

The applicable limits apply at a 3 meter distance. Measurements above 4 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (2405 MHz), middle (2445 MHz) and high (2475 MHz) to comply with FCC Part 15.35.

### 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 and a standard gain Horn Antenna and pre-amplifier were used for measurements from 18 GHz to 25 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.

The EUT was rotated along three orthogonal axes 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 Agilent 4445A Spectrum Analyzer. The resulting correction factors and the cable loss factors from these calibrations were entered into the Agilent 4445A Spectrum Analyzer database. As a result, the data taken from the HP Agilent 4445A Spectrum Analyzer 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 Agilent 4445A Spectrum Analyzer was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 1200 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz). From 4 GHz to 18 GHz, an Agilent E4446A Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the HP E4446A Spectrum Analyzer with a standard gain horn, and preamp were used.

Please refer to Appendix A for a complete list of test equipment used for all radiated emissions measurements.

### **5.4 Test Results**

The EUT was found to meet the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and Canada RSS-210, Issue 7 (2007), Annex 8 for a DTS transmitter. 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) and RSS 210 A8.4 is 1 Watt. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d) and RSS 210 A8.2(b), 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) for FCC and section 2.2,2.6 and 2.7 of RSS 210 for IC.

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. The mentioned limits correspond to those limits listed in RSS 210 section 2.7.

Frequency (MHz)	3 m Limit $\mu$ V/m	3 m Limit (dB $\mu$ V/m)	1 m Limit (dB $\mu$ 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  $\mu$ V/m to dB $\mu$ V/m:  
$$\text{dB}\mu\text{V/m} = 20 \log_{10} (100)$$
$$= 40 \text{ dB}\mu\text{V/m (from 30-88 MHz)}$$

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

960 MHz to 10,000 MHz  
500 $\mu$ V/m or 54.0 dB/ $\mu$ V/m at 3 meters  
54.0 + 9.5 = 63.5 dB/ $\mu$ V/m at 1 meter

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

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

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## 5.6 RADIATED EMISSIONS TEST DATA CHART

3 Meter Measurements of Electromagnetic Radiated Emissions

Test Standard: 47CFR, Part 15.205 and 15.247(DTS)

RSS 210 A8, sections 2.2, 2.6 and 2.7

Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	Niles Audio Corporation				
Date(s) of Test:	August 17-September 30, 2009				
Test Engineer(s):	Laura Bott, Peter Feilen, Shane Rismeyer				
Voltage:	3.3 VDC				
Operation Mode:	Normal, continuous transmit, modulated 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

### 5.6.1 Radiated Emissions from Inverted F Unit

The Inverted F unit was originally tested January 2 – 11, 2006. The data from the original testing is shown below. Verification testing was performed in August and September of 2009 and data is presented in Section 5.6.1.1

#### 5.6.1.1 Transmit test on Original Unit

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

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dB $\mu$ V/m)	15.247 Limit (dB $\mu$ V/m)	Margin (dB)
2405	H	1.05	335	118.1	125.2	7.1
4810	V	1.05	340	40.2	54.0	13.8
7215	V	1.05	330	53.4	107.6	54.2
9620	H	1.00	195	53.9	107.6	53.7
12025	H	1.00	200	51.6	63.5	11.9
14430	H	1.00	200	42.1	63.5	21.4
16835	H	1.00	0	44.3	107.6	63.3
19240					74.0	
21645					74.0	
24050					118.1	

Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
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The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Mid Channel:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dB $\mu$ V/m)	15.247 Limit (dB $\mu$ V/m)	Margin (dB)
2445	H	1.05	0	117.4	125.2	7.8
4890	V	1.00	10	40.5	54.0	13.5
7335	V	1.05	310	51.2	63.5	12.3
9780	H	1.00	195	50.8	87.9	37.1
12225	H	1.00	210	42.4	63.5	21.1
14670	H	1.00	190	41.8	87.9	46.1
17115	H	1.00	0	41.4	87.9	46.5
19580					74.0	
22005					117.4	
24450					117.4	

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

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dB $\mu$ V/m)	15.247 Limit (dB $\mu$ V/m)	Margin (dB)
2475	H	1.00	340	118.3	125.2	6.9
4950	V	1.00	20	42.8	54.0	11.2
7425	V	1.00	340	49.7	63.5	13.8
9900	H	1.00	200	49.2	107.8	58.6
12375	H	1.00	255	47.2	63.5	16.3
14850	H	1.00	200	41.5	107.8	66.3
17325	H	1.00	0	43.2	107.8	64.6
19800					74.0	
22275					74.0	
24750					118.3	

### 5.6.1.2 Transmit test on current unit

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

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Quasi Peak Reading (dB $\mu$ V/m)	Quasi Peak Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
129.6	1.00	0	18.81	12.34	43.5	31.2	Vertical	Side
188.5	1.00	0	21.33	15.12	43.5	28.4	Vertical	Vertical
199.5	2.50	0	22.21	15.31	43.5	28.2	Horizontal	Vertical
205.6	1.00	0	22.26	15.5	43.5	28.0	Horizontal	Side
263.2	2.50	0	27.65	21.49	46.0	24.5	Horizontal	Vertical
287.2	1.00	0	29.74	23.24	46.0	22.8	Vertical	Vertical
299.5	2.50	0	31.43	25.33	46.0	20.7	Horizontal	Vertical
434.0	1.00	0	19.92	13.51	46.0	32.5	Horizontal	Side
648.5	1.00	0	32.45	25.98	46.0	20.0	Horizontal	Vertical
786.5	1.00	0	32.52	26.14	46.0	19.9	Vertical	Side
880.5	1.00	0	33.58	27.41	46.0	18.6	Vertical	Vertical

Note: All emissions are buried in noise floor.

Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
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## Radiated Emissions Data Chart - Inverted F Unit (continued)

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 0:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2405	1.10	87	117.1	116.1	125.0	8.9	Vertical	Vertical
4810	1.00	132	61.4	51.6	63.5	11.9	Horizontal	Side
7215	1.11	330	68.3	57.7	104.6	46.9	Vertical	Flat
9620	1.07	245	64.8	54.8	104.6	49.8	Horizontal	Side
12025	1.00	282	59.6	49.4	63.5	14.1	Vertical	Flat
14430	1.03	229	52.3	41.3	104.6	63.3	Horizontal	Side
16835	1.05	171	53.0	41.0	104.6	63.6	Horizontal	Vertical
19240			Note 3		63.5			
21645			Note 3		104.6			
24050			Note 3		104.6			

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 8:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2445	1.00	87	119.4	118.2	125.0	6.8	Vertical	Vertical
4890	1.06	74	58.6	50.6	63.5	12.9	Horizontal	Vertical
7335	1.03	106	60.7	49.8	63.5	13.7	Horizontal	Side
9780	1.12	142	54.0	52.3	106.7	54.4	Vertical	Side
12225	1.08	354	56.3	45.3	63.5	18.2	Vertical	Flat
14670	1.11	123	51.3	40.0	106.7	66.7	Vertical	Side
17115	1.03	15	55.2	42.8	106.7	63.9	Horizontal	Vertical
19560			Note 3		63.5			
22005			Note 3		106.7			
24450			Note 3		106.7			

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 14:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2475	1.08	151	115.2	114.8	125.0	10.2	Vertical	Vertical
4950	1.08	25	62.4	53.4	63.5	10.1	Horizontal	Flat
7425	1.00	315	62.2	51.0	63.5	12.5	Horizontal	Side
9900	1.05	285	59.3	48.1	103.3	55.2	Vertical	Flat
12375	1.03	132	59.1	48.8	63.5	14.7	Vertical	Flat
14850	1.05	84	52.0	41.2	103.3	62.0	Horizontal	Vertical
17325	1.03	21	55.9	44.0	103.3	59.3	Horizontal	Vertical
19800			Note 3		63.5			
22275			Note 3		63.5			
24750			Note 3		103.3			

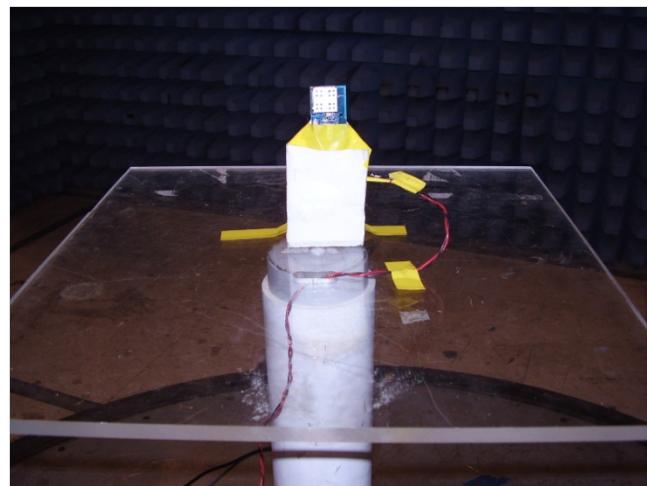
Notes:

- 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.

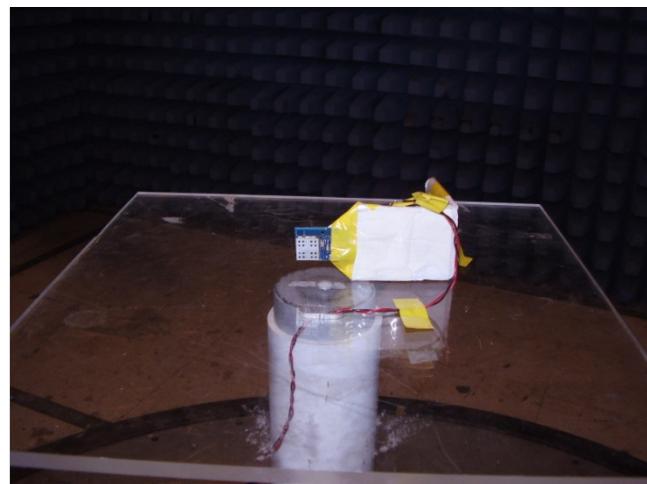
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 21 of 159

**Test Setup Photo(s) – Radiated Emissions Test (Inverted F Unit)**

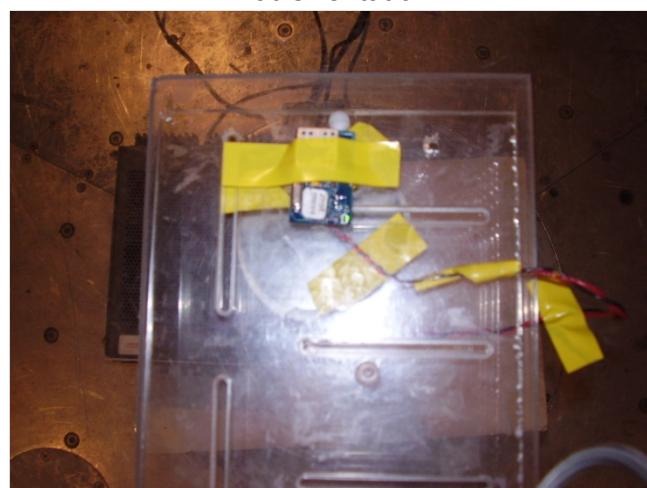
Vertical Orientation



Side Orientation



Flat Orientation



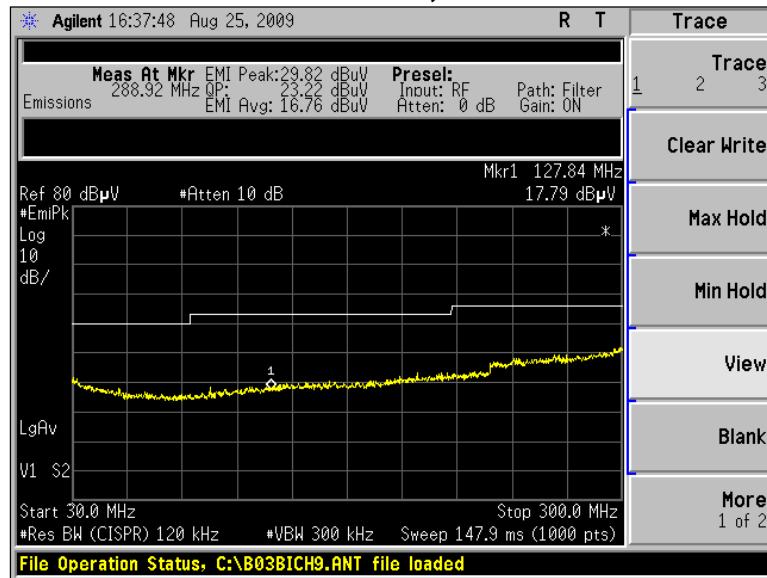
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 22 of 159

## Screen Captures - Radiated Emissions Test (Inverted F Unit)

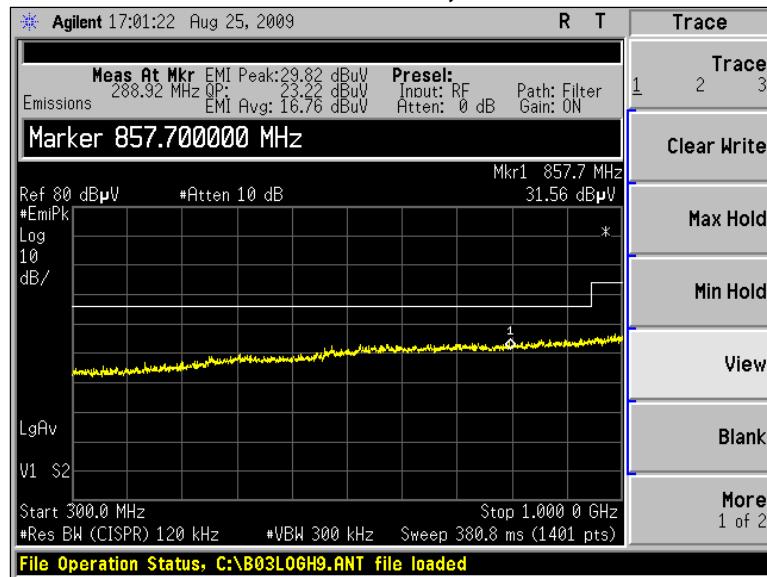
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 0, 8, or 14, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

### Channel 8, Antenna Horizontally Polarized, EUT Vertical 30-300 MHz, at 3m



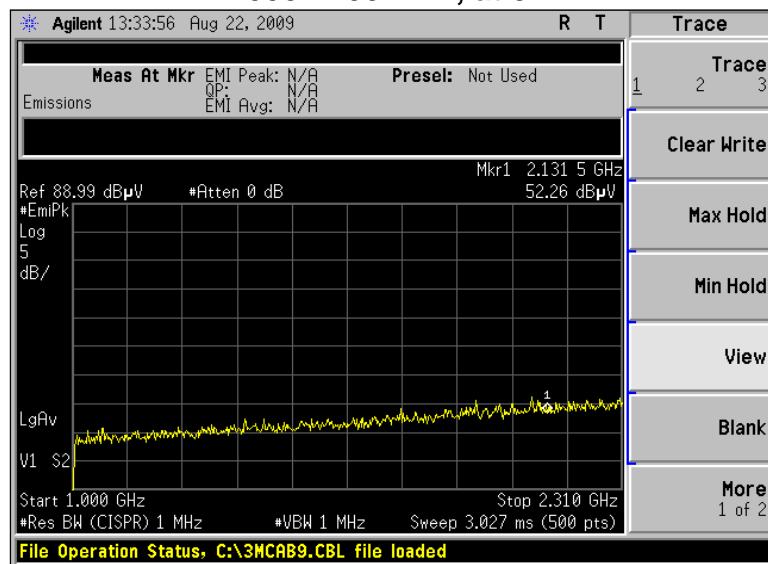
### Channel 8, Antenna Horizontally Polarized, EUT Vertical, 300-1000 MHz, at 3m



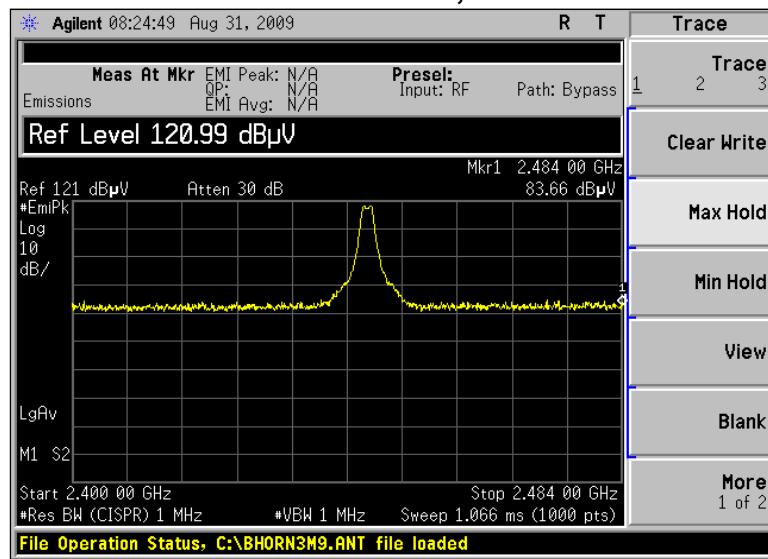
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 23 of 159

## Screen Captures - Radiated Emissions Testing (Inverted F Unit) (continued)

### Channel 8, Antenna Vertically Polarized, EUT Vertical 1000-2400 MHz, at 3m



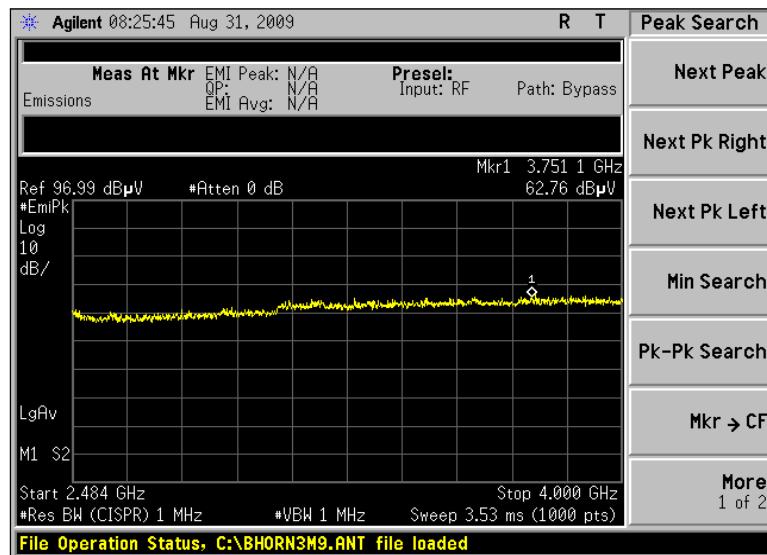
### Channel 8, Antenna Vertically Polarized, EUT Vertical 2400-2484 MHz, at 3m



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 24 of 159

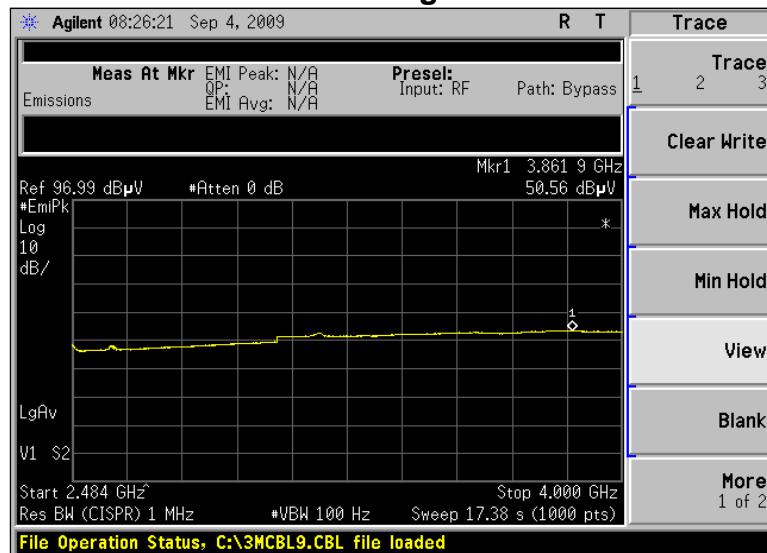
## Screen Captures - Radiated Emissions Testing (Inverted F Unit) (continued)

### Channel 8, Antenna Vertically Polarized, EUT Vertical 2484.0-4000 MHz, at 3m Peak



Note: because the peak value (of the noise floor) was above the average limit, the video average bandwidth was decreased to demonstrate that the video-averaged signal is below the radiated limit.

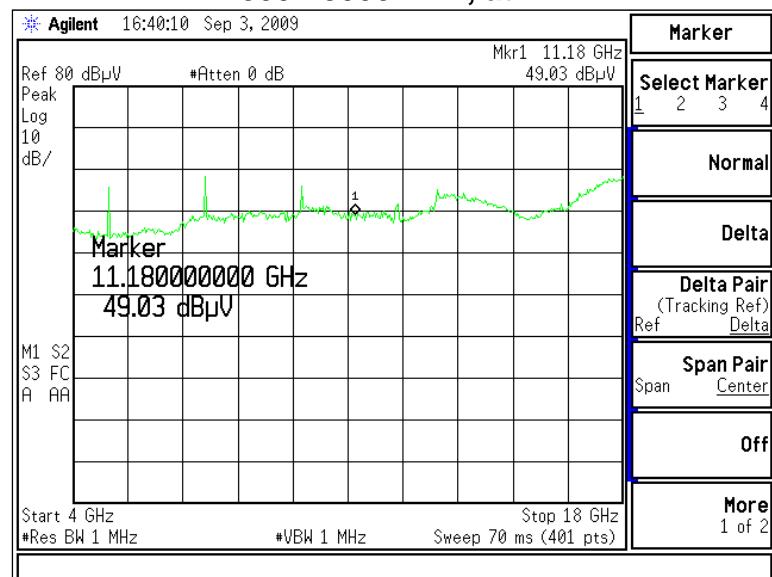
### Channel 8, Antenna Vertically Polarized, EUT Vertical 2484.0-4000 MHz, at 3m Average



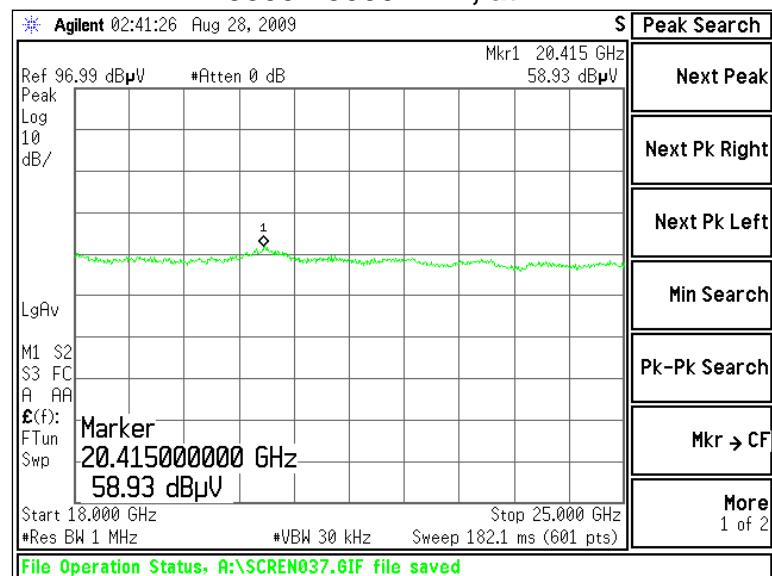
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 25 of 159

**Screen Captures - Radiated Emissions Testing (Inverted F Unit) (continued)**

**Channel 8, Antenna Vertically Polarized, EUT Vertical  
4000-18000 MHz, at 1m**



**Channel 14, Antenna Vertically Polarized, EUT Vertical  
18000-25000 MHz, at 1 m**



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 26 of 159

### 5.6.1.3 Receive Mode Testing of Inverted F Antenna

Per the requirements of RSS-210, the EUT was placed in continuous receive mode and the radiated spurious emissions were measured and compared to the limits stated in RSS-Gen Section 4.10.

The test setup, procedure, and equipment utilized were identical to that described in sections 5.1, 5.2, and 5.3 of this document.

Measurement data and screen captures from the receive tests are presented below:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Quasi Peak Reading (dB $\mu$ V/m)	Quasi Peak Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
216.00	1.00	0	23.44	16.52	46.0	29.5	Vertical	Flat
294.50	1.00	0	30.33	24.38	46.0	21.6	Horizontal	Vertical
297.82	1.00	0	30.62	25.08	46.0	20.9	Horizontal	Side
299.24	1.00	0	30.89	25.03	46.0	21.0	Vertical	Vertical
960.00	1.00	0	34.27	28.02	54.0	26.0	Vertical	Flat
985.73	1.00	0	35.76	29.82	54.0	24.2	Horizontal	Vertical
988.38	1.00	0	34.69	29.05	54.0	25.0	Vertical	Side
996.50	1.00	0	36.03	30.03	54.0	24.0	Horizontal	Flat

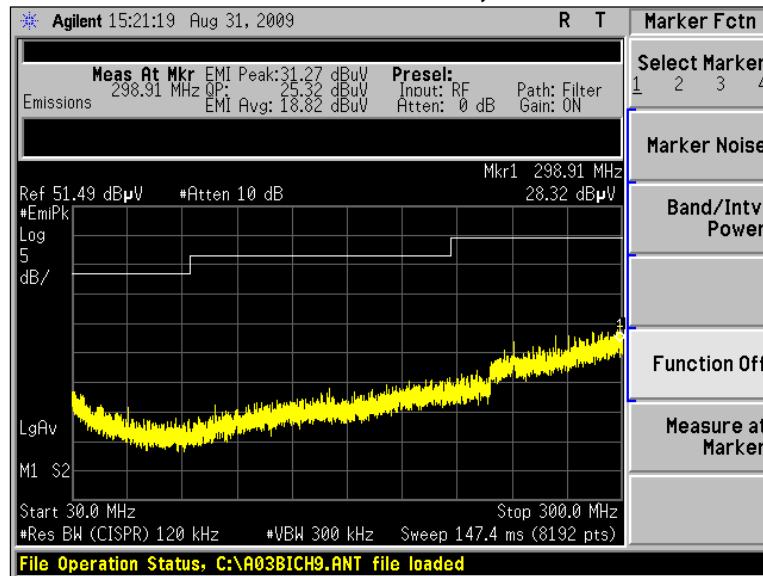
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 27 of 159

## Screen Captures - Radiated Emissions Testing – Receive Mode (Inverted F Unit)

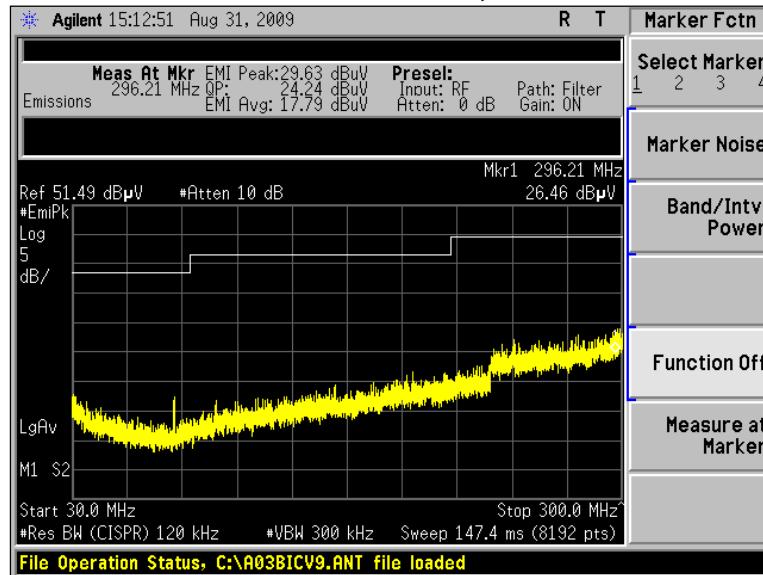
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 0, 8 and 14, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

### **Channel 8, Antenna Horizontally Polarized, EUT Vertical 30 MHz – 300 MHz, at 3m**



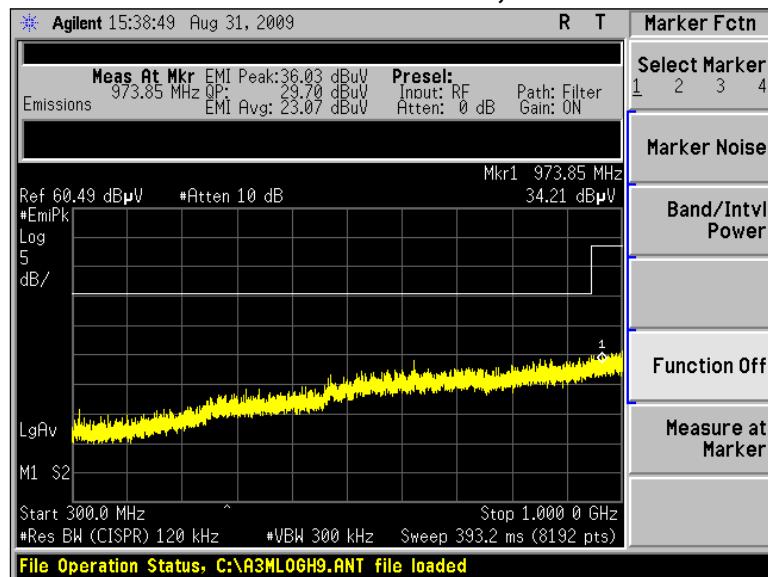
### **Channel 8, Antenna Vertically Polarized, EUT Vertical 30 MHz – 300 MHz, at 3m**



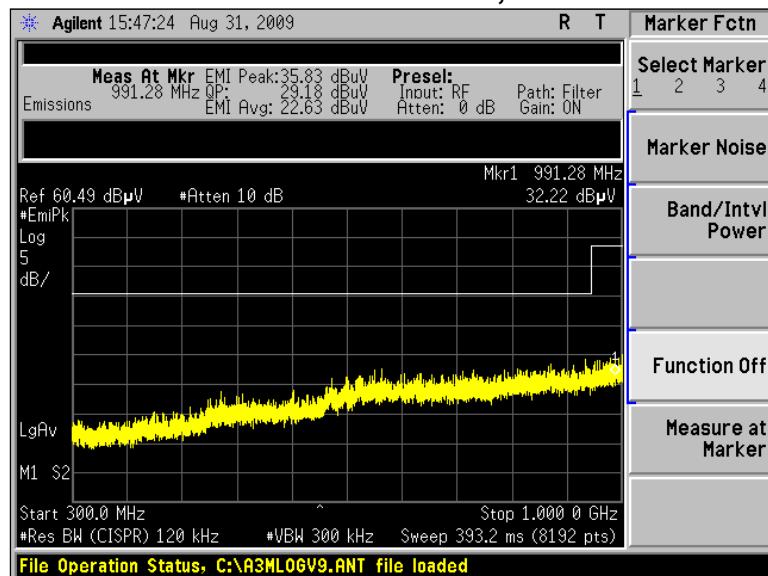
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 28 of 159

**Screen Captures - Radiated Emissions Testing – Receive Mode (Inverted F Unit)  
(continued)**

**Channel 8, Antenna Horizontally Polarized, EUT Vertical  
300 MHz – 1000 MHz, at 3m**



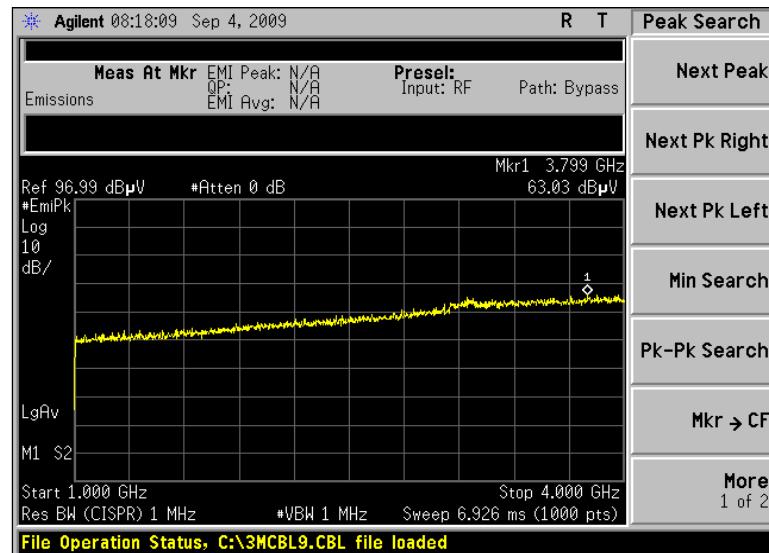
**Channel 8, Antenna Vertically Polarized, EUT Vertical  
300 MHz – 1000 MHz, at 3m**



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 29 of 159

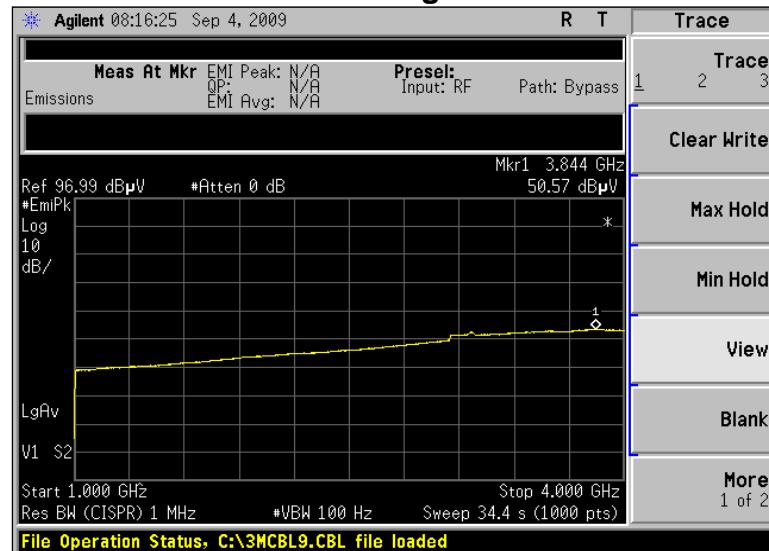
**Screen Captures - Radiated Emissions Testing – Receive Mode (Inverted F Unit)  
(continued)**

**Channel 8, Antenna Horizontally Polarized, EUT Vertical  
1000 MHz – 4000 MHz, at 3m  
Peak**



Note: because the peak value (of the noise floor) was above the average limit, the video average bandwidth was decreased to demonstrate that the video-averaged signal is below the radiated limit.

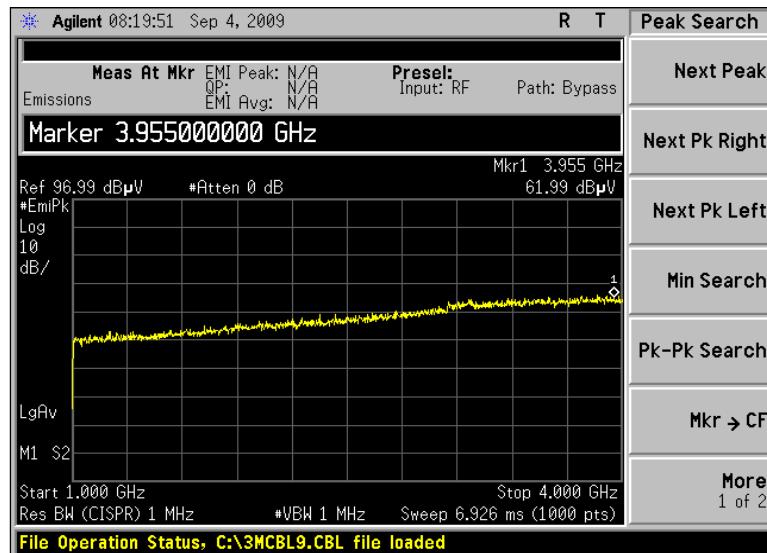
**Channel 8, Antenna Horizontally Polarized, EUT Vertical  
1000 MHz – 4000 MHz, at 3m  
Average**



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 30 of 159

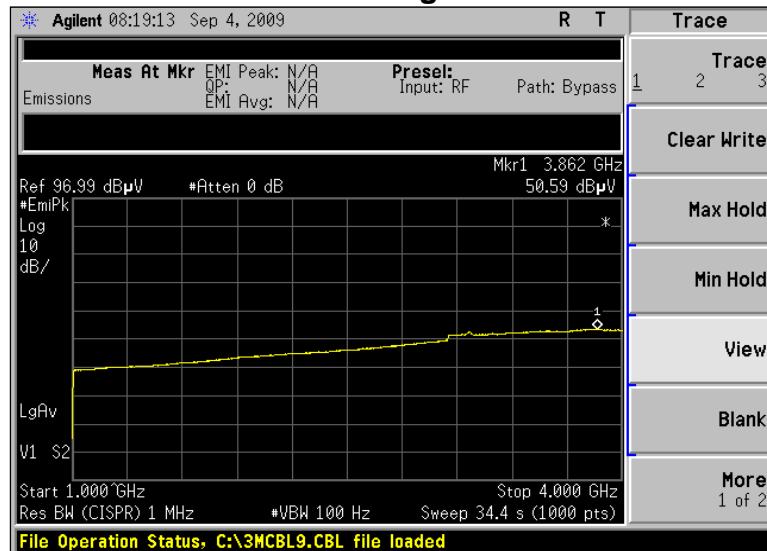
**Screen Captures - Radiated Emissions Testing – Receive Mode (Inverted F Unit)  
(continued)**

**Channel 8, Antenna Vertically Polarized, EUT Vertical  
1000 MHz – 4000 MHz, at 3m  
Peak**



Note: because the peak value (of the noise floor) was above the average limit, the video average bandwidth was decreased to demonstrate that the video-averaged signal is below the radiated limit.

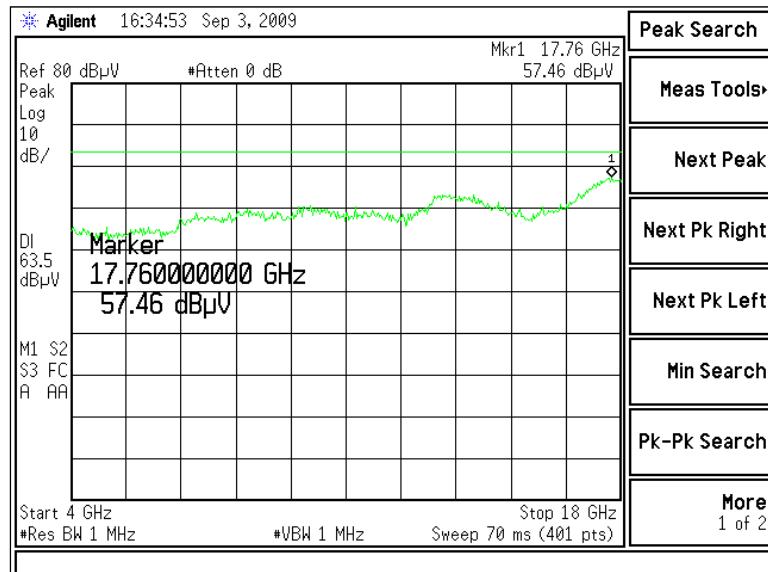
**Channel 8, Antenna Vertically Polarized, EUT Vertical  
1000 MHz – 4000 MHz, at 3m  
Average**



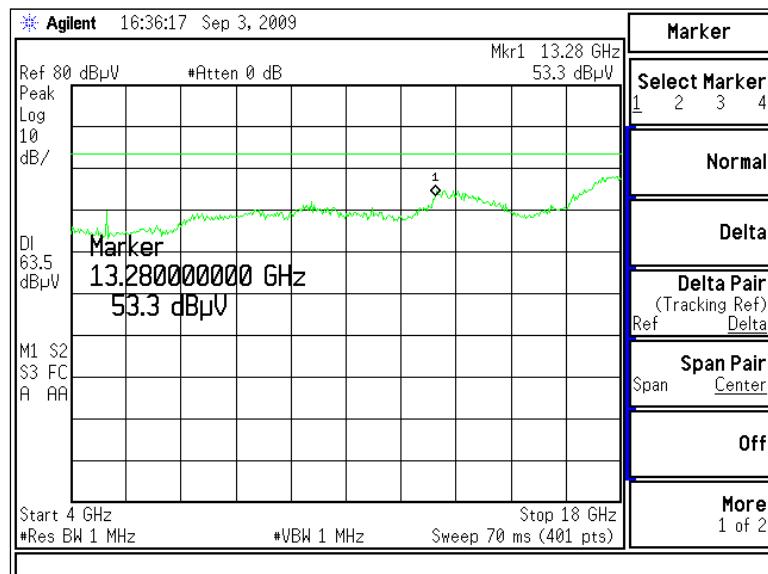
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 31 of 159

**Screen Captures - Radiated Emissions Testing – Receive Mode (Inverted F Unit)**  
 (continued)

**Channel 8, Antenna Horizontally Polarized, EUT Vertical  
 4000 MHz – 18000 MHz**



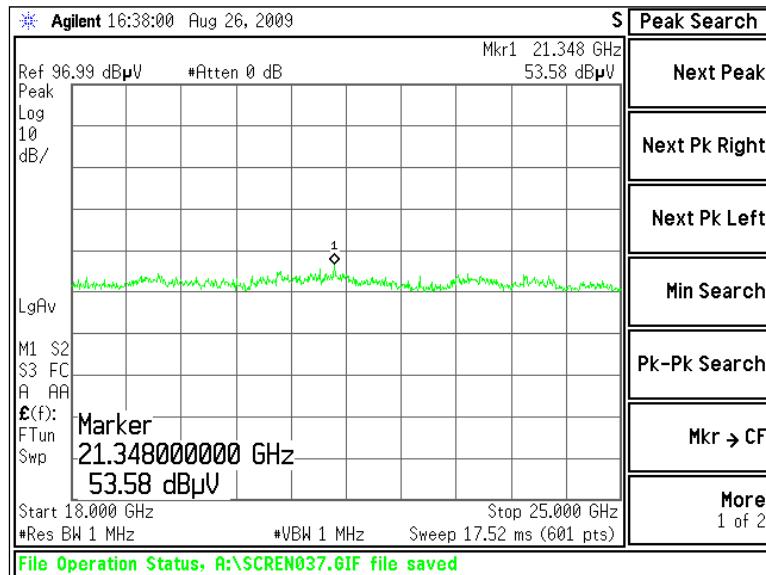
**Channel 8, Antenna Vertically Polarized, EUT Vertical  
 4000 MHz – 18000 MHz**



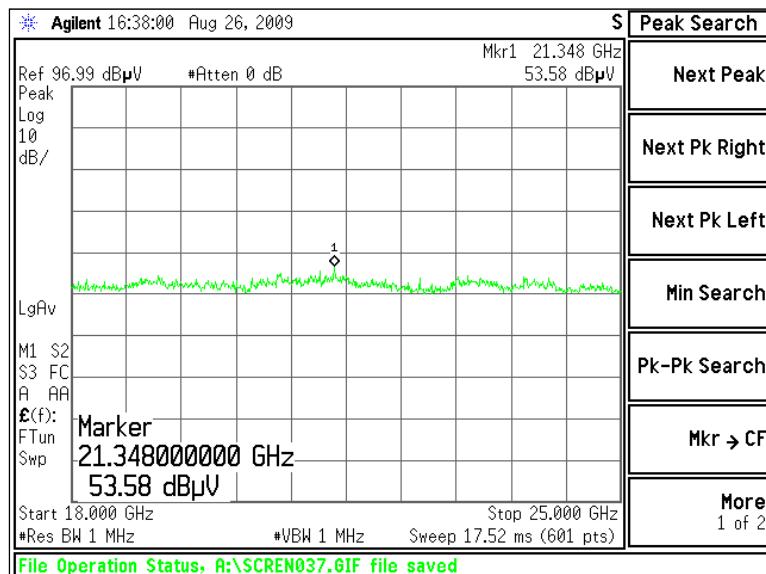
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 32 of 159

**Screen Captures - Radiated Emissions Testing – Receive Mode (Inverted F Unit)  
(continued)**

**Channel 8, Antenna Horizontally Polarized, EUT on Side  
18000 MHz – 25000 MHz**



**Channel 8, Antenna Vertically Polarized, EUT on Side  
18000 MHz – 25000 MHz**



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 33 of 159

## 5.6.2 Radiated Emissions on unit with SMA antenna (straight)

### 5.6.2.1 Transmit Mode

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

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Quasi Peak Reading (dB $\mu$ V/m)	Quasi Peak Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
216.0	1.00	0	22.42	15.92	46.0	30.1	Horizontal	Vertical
236.1	1.00	0	26.36	20.67	46.0	25.3	Horizontal	Side
246.7	1.00	0	29.15	23.09	46.0	22.9	Vertical	Flat
288.4	1.00	0	28.30	22.35	46.0	23.7	Horizontal	Flat
298.6	1.00	0	31.44	24.39	46.0	21.6	Vertical	Side
299.5	1.00	0	31.79	25.02	46.0	21.0	Vertical	Vertical
904.0	1.00	0	34.03	28.25	46.0	17.8	Horizontal	Side
981.2	1.00	0	34.70	22.88	54.0	31.1	Vertical	Vertical
982.0	1.00	0	35.75	29.82	54.0	24.2	Horizontal	Flat
984.8	1.00	0	36.11	29.07	54.0	24.9	Vertical	Side
987.7	1.00	0	36.20	29.80	54.0	24.2	Horizontal	Vertical
991.3	1.00	0	35.03	29.21	54.0	24.8	Vertical	Flat

Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 34 of 159

## Radiated Emissions Data Chart on Unit with Straight SMA Antenna (continued)

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 0:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2405	1.00	161	120.7	119.7	125.0	5.3	Horizontal	Vertical
4810	1.07	122	55.6	51.4	63.5	12.1	Horizontal	Vertical
7215	1.05	175	62.1	51.5	108.2	56.7	Vertical	Vertical
9620	1.00	271	59.9	49.7	108.2	58.5	Horizontal	Vertical
12025	1.02	220	60.8	50.4	63.5	13.1	Vertical	Flat
14430	1.07	197	53.7	42.9	108.2	65.3	Vertical	Side
16835	1.03	119	52.4	41.9	108.2	66.3	Vertical	Vertical
19240			Note 3		63.5			
21645			Note 3		108.2			
24050			Note 3		108.2			

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 8:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2445	1.00	258	119.3	118.2	125.0	6.8	Vertical	Vertical
4890	1.07	93	57.7	51.9	63.5	11.6	Horizontal	Side
7335	1.03	178	60.1	50.0	63.5	13.5	Horizontal	Side
9780	1.03	321	50.6	40.1	106.7	66.6	Horizontal	Vertical
12225	1.03	178	53.6	43.9	63.5	19.6	Vertical	Vertical
14670	1.03	178	51.8	39.6	106.7	67.2	Horizontal	Vertical
17115	1.05	10	54.5	42.8	106.7	63.9	Horizontal	Vertical
19560			Note 3		63.5			
22005			Note 3		106.7			
24450			Note 3		106.7			

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 14:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2475	1.18	204	120.4	119.4	125.0	5.6	Horizontal	Vertical
4950	1.07	150	57.2	49.3q	63.5	14.2	Vertical	Vertical
7425	1.10	220	66.4	55.7	63.5	7.8	Vertical	Flat
9900	1.10	328	58.7	48.6	107.9	59.3	Horizontal	Vertical
12375	1.03	278	59.9	49.4	63.5	14.1	Horizontal	Vertical
14850	1.03	206	50.3	38.4	107.9	69.5	Horizontal	Vertical
17325	1.04	6	55.5	44.1	107.9	63.8	Horizontal	Side
19800			Note 3		63.5			
22275			Note 3		63.5			
24750			Note 3		107.9			

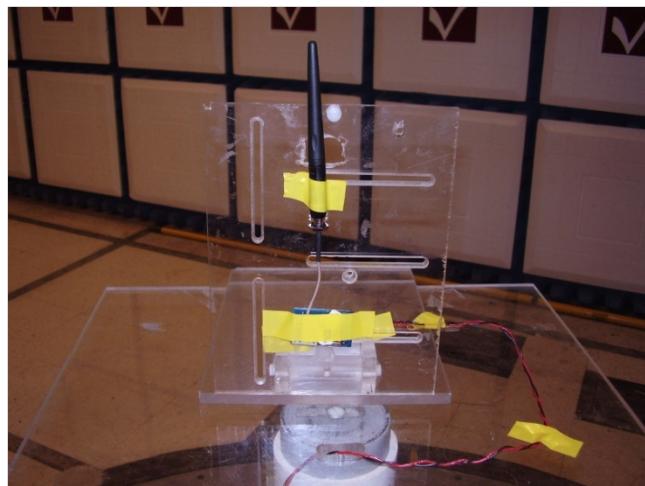
Notes:

- 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.

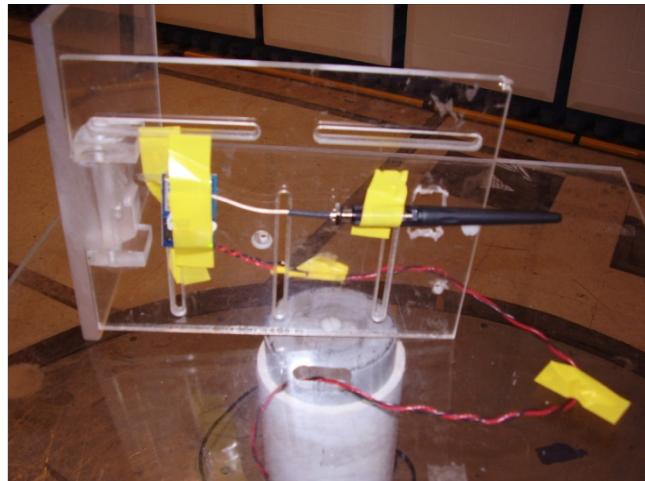
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 35 of 159

## Test Setup Photo(s) – Radiated Emissions Test Straight SMA

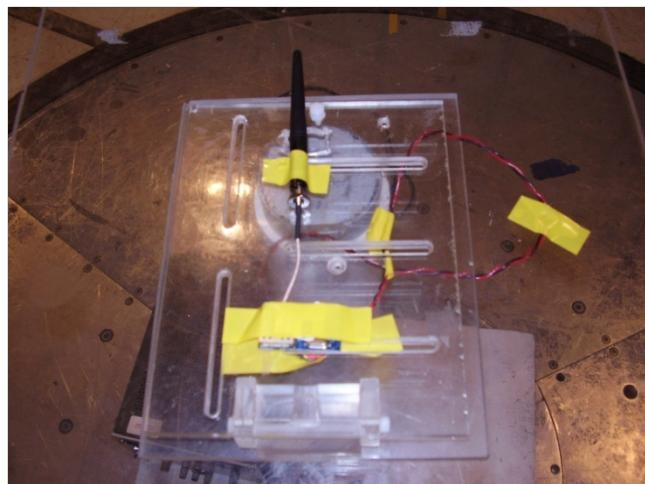
Vertical Orientation



Side Orientation



Flat Orientation



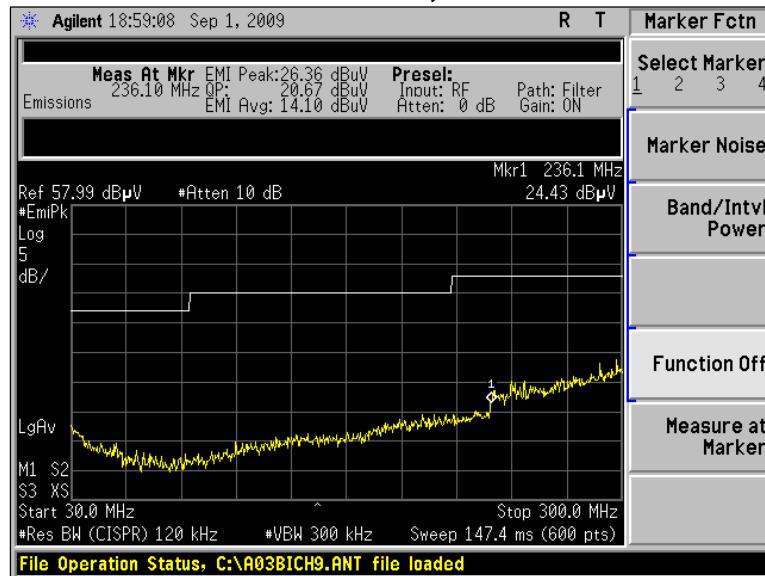
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 36 of 159

## Screen Captures - Radiated Emissions Test Straight SMA

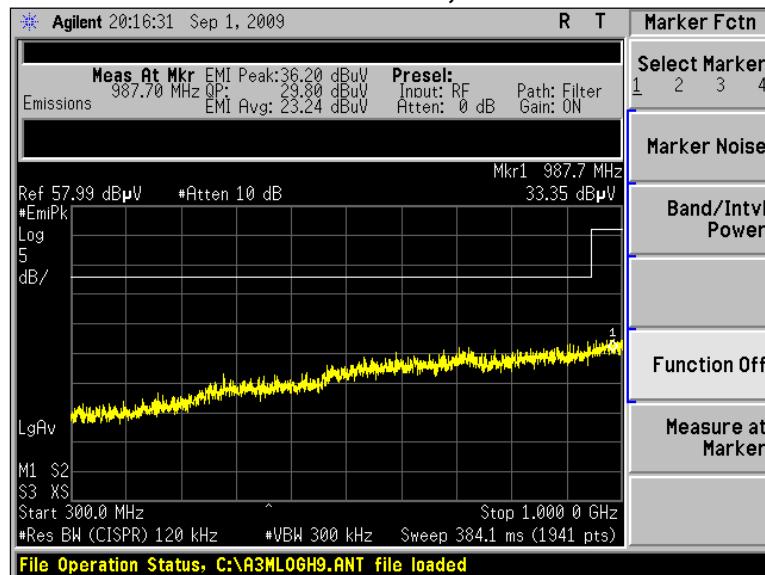
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 0, 8, or 14, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

### Channel 0, Antenna Horizontally Polarized, EUT on Side 30-300 MHz, at 3m



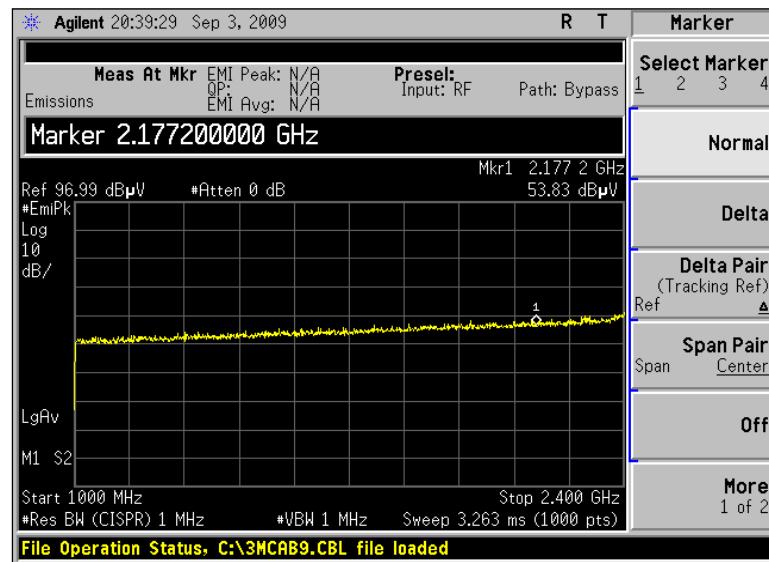
### Channel 0, Antenna Horizontally Polarized, EUT Vertical 300-1000 MHz, at 3m



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 37 of 159

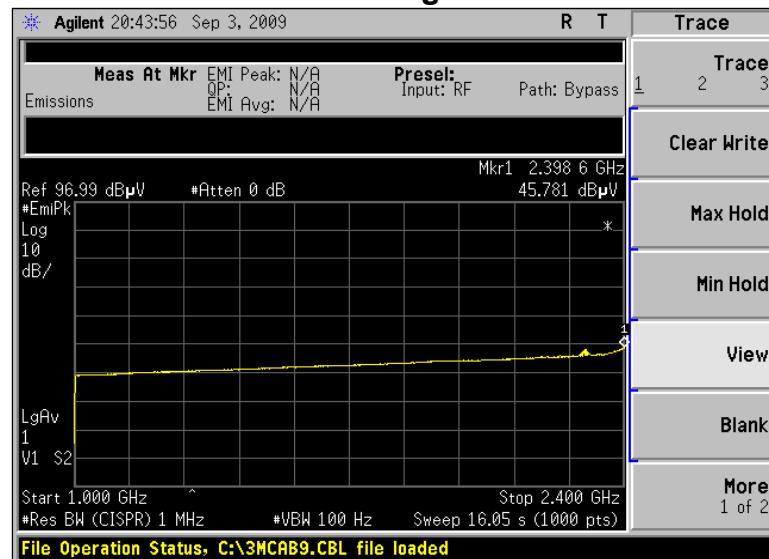
## Screen Captures - Radiated Emissions Testing Straight SMA (continued)

### Channel 8, Antenna Vertically Polarized, EUT Vertical 1000-2400 MHz, at 3m Peak



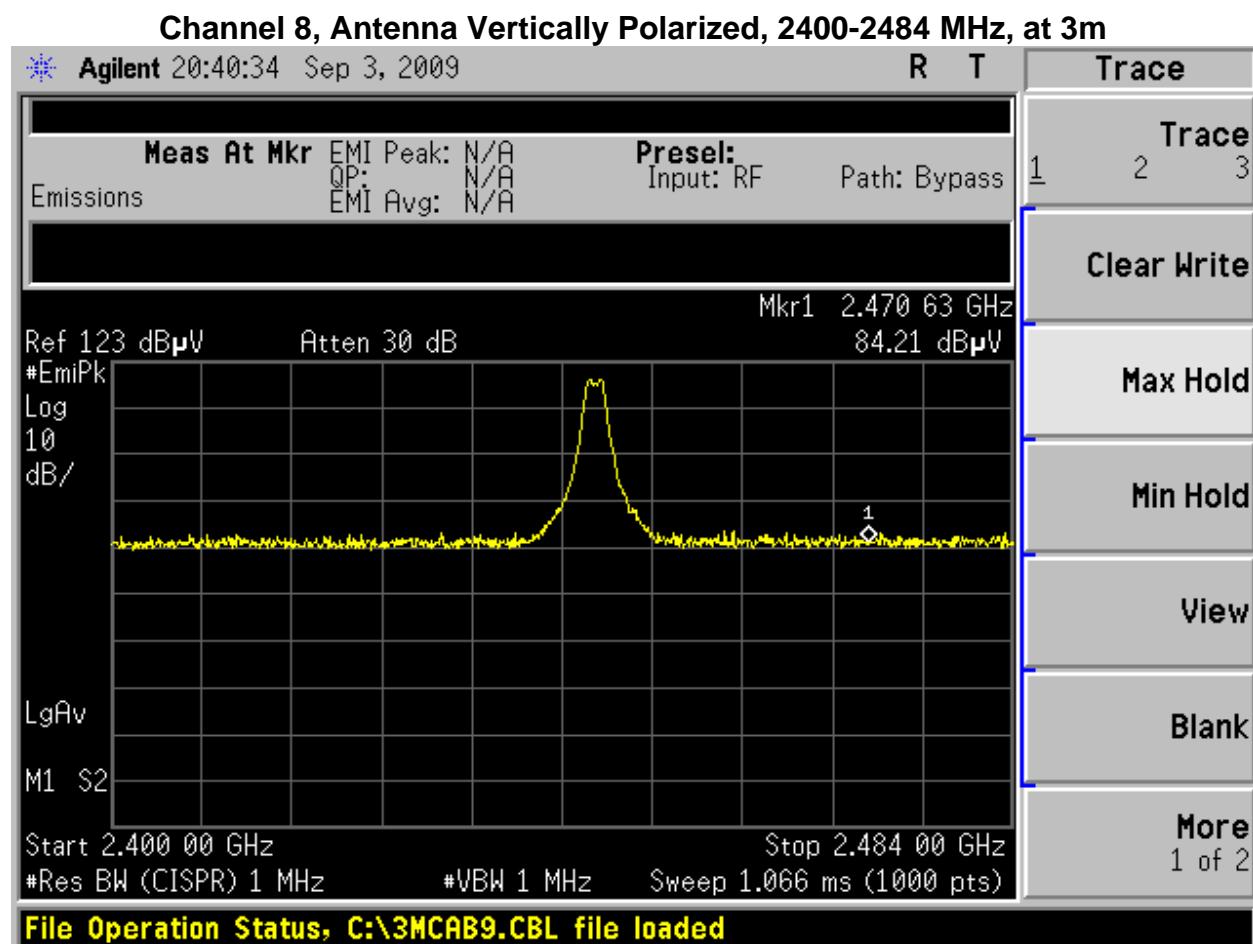
Note: because the peak value (of the noise floor) was above the average limit, the video average bandwidth was decreased to demonstrate that the video-averaged signal is below the radiated limit.

### Channel 8, Antenna Vertically Polarized, EUT Vertical 1000-2400 MHz, at 3m Average



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 38 of 159

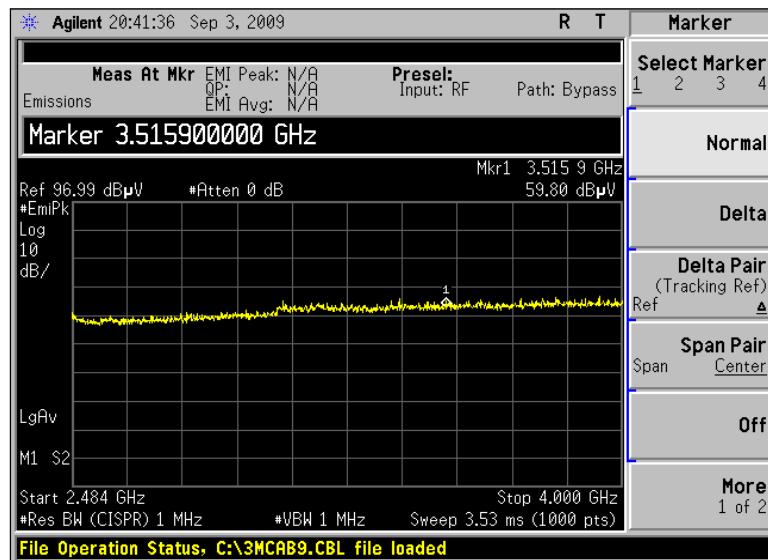
## Screen Captures - Radiated Emissions Testing Straight SMA (continued)



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 39 of 159

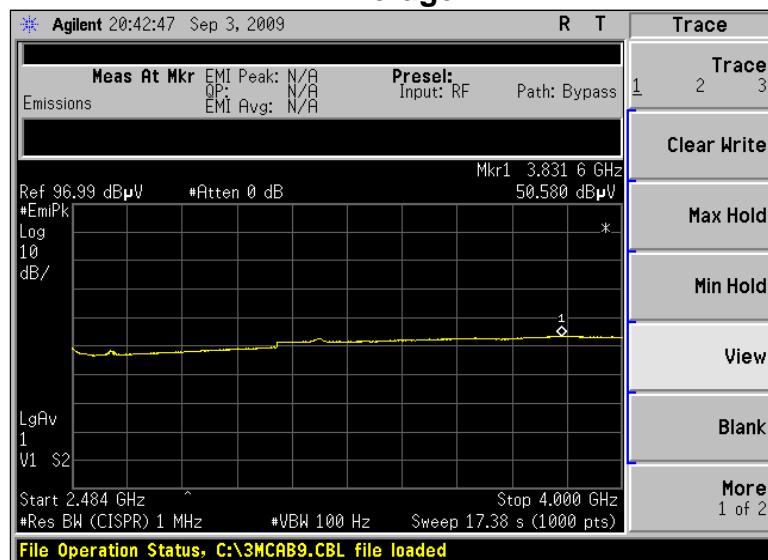
## Screen Captures - Radiated Emissions Testing Straight SMA (continued)

### Channel 8, Antenna Vertically Polarized, EUT Vertical 2484.0-4000 MHz, at 3m Peak



Note: because the peak value (of the noise floor) was above the average limit, the video average bandwidth was decreased to demonstrate that the video-averaged signal is below the radiated limit

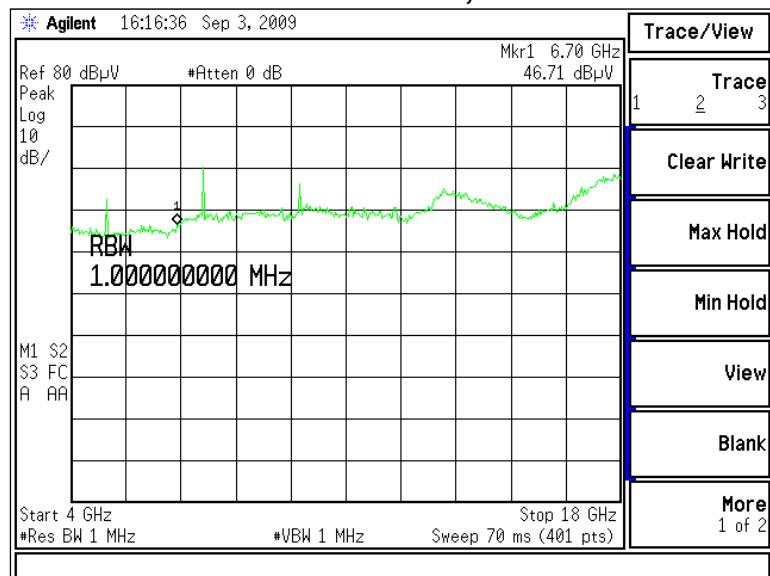
### Channel 8, Antenna Vertically Polarized, EUT Vertical 2484.0-4000 MHz, at 3m Average



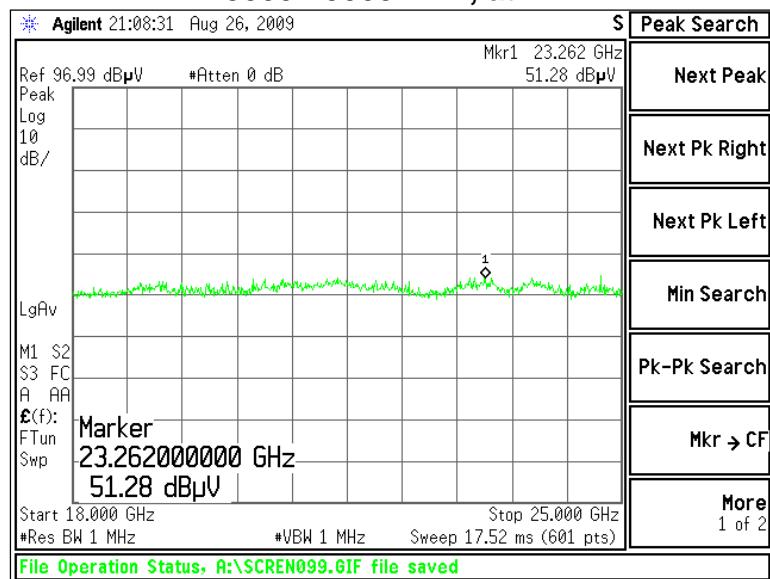
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 40 of 159

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

**Channel 8, Antenna Horizontally Polarized, EUT Vertical  
4000-18000 MHz, at 1m**



**Channel 14, Antenna Vertically Polarized, EUT on Side  
18000-25000 MHz, at 1 m**



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 41 of 159

### 5.6.2.2 Receive Mode of SMA Straight Antenna

Per the requirements of RSS-210, the EUT was placed in continuous receive mode and the radiated spurious emissions were measured and compared to the limits stated in RSS-Gen Section 4.10.

The test setup, procedure, and equipment utilized were identical to that described in sections 5.1, 5.2, and 5.3 of this document.

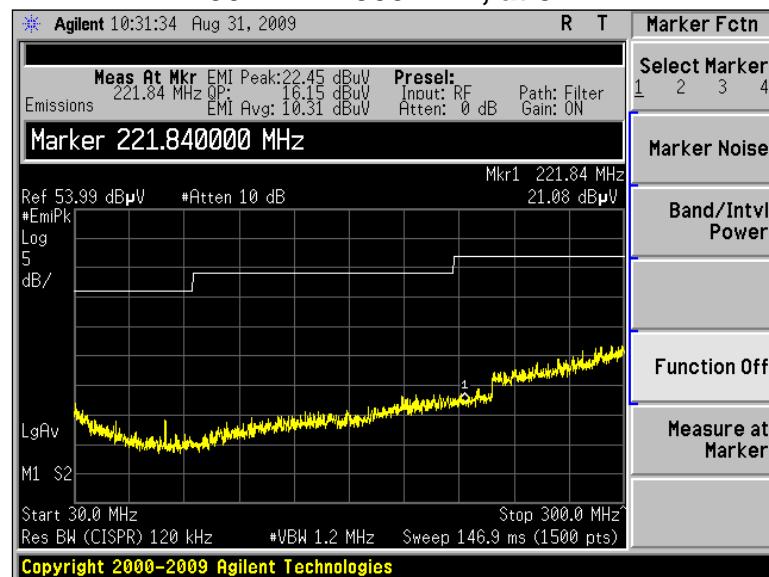
Measurement data and screen captures from the receive tests are presented below:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Quasi Peak Reading (dB $\mu$ V/m)	Quasi Peak Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
74.51	1.00	0	29.55	28.32	40.0	11.7	Vertical	Vertical
119.27	1.00	0	28.24	26.13	43.5	17.4	Vertical	Vertical
179.72	1.00	0	35.67	31.55	43.5	12.0	Vertical	Side
212.38	1.00	0	30.98	21.79	43.5	21.7	Horizontal	Flat
294.59	1.00	0	37.66	27.58	46.0	18.4	Horizontal	Side
790.70	1.00	0	38.39	29.95	46.0	16.1	Horizontal	Side
894.40	1.00	0	34.28	27.61	46.0	18.4	Vertical	Vertical
946.20	1.00	0	40.17	30.76	46.0	15.2	Vertical	Side
956.90	1.00	0	40.94	32.24	46.0	13.8	Horizontal	Flat

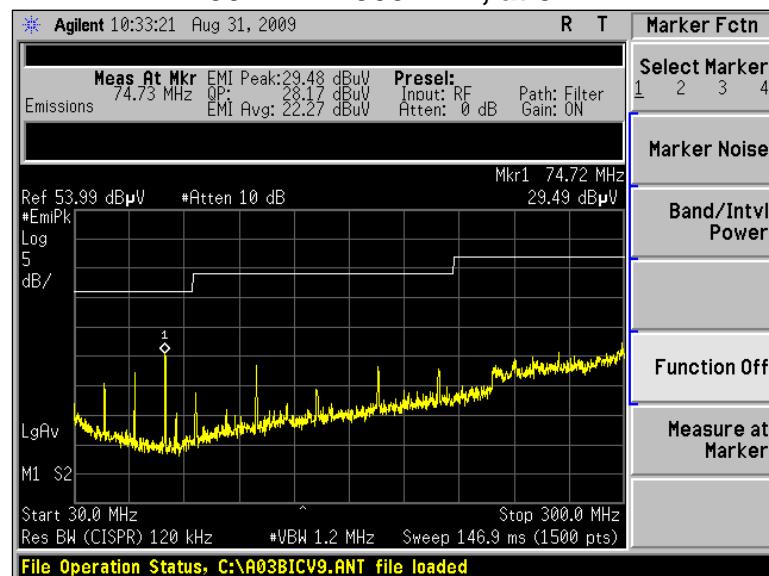
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 42 of 159

## Screen Captures - Radiated Emissions Testing – Receive Mode Straight SMA

### Channel 8, Antenna Horizontally Polarized, EUT on Side 30 MHz – 300 MHz, at 3m



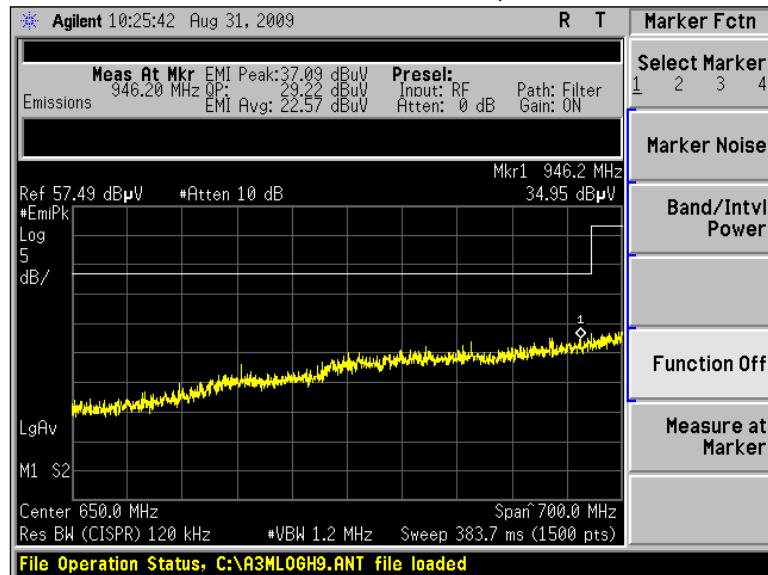
### Channel 8, Antenna Vertically Polarized, EUT on Side 30 MHz – 300 MHz, at 3m



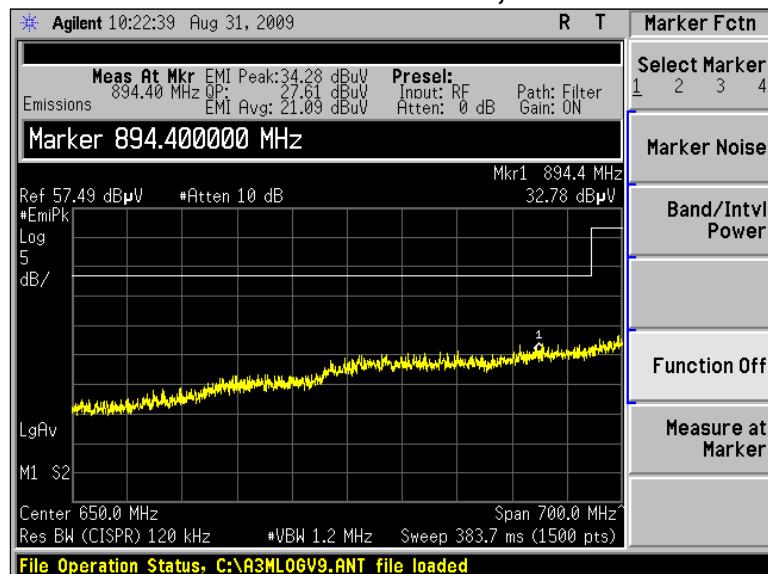
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 43 of 159

**Screen Captures - Radiated Emissions Testing – Receive Mode Straight SMA (continued)**

**Channel 8, Antenna Horizontally Polarized, EUT Vertical  
300 MHz – 1000 MHz, at 3m**



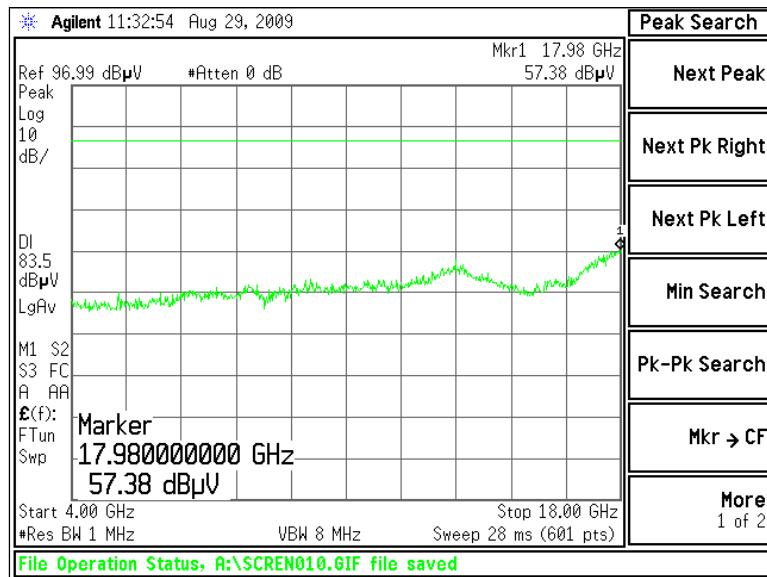
**Channel 8, Antenna Vertically Polarized, EUT Vertical  
300 MHz – 1000 MHz, at 3m**



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 44 of 159

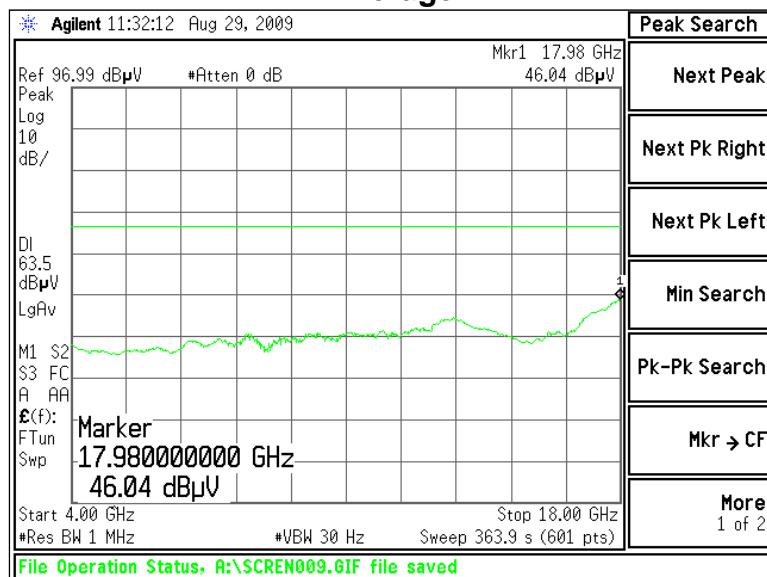
**Screen Captures - Radiated Emissions Testing – Receive Mode Straight SMA  
(continued)**

**Channel 8, Antenna Horizontally Polarized, EUT Vertical  
1000 MHz – 4000 MHz, at 3m  
Peak**



Note: because the peak value (of the noise floor) was above the average limit, the video average bandwidth was decreased to demonstrate that the video-averaged signal is below the radiated limit.

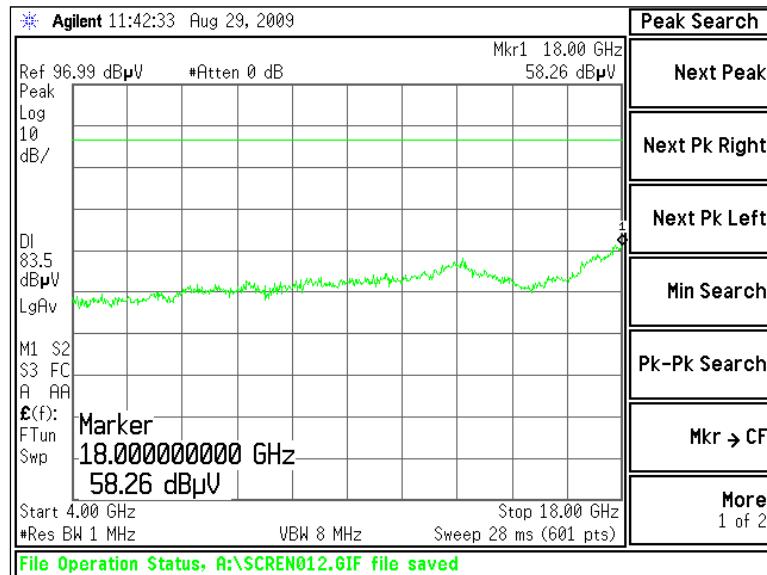
**Channel 8, Antenna Horizontally Polarized, EUT Vertical  
1000 MHz – 4000 MHz, at 3m  
Average**



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 45 of 159

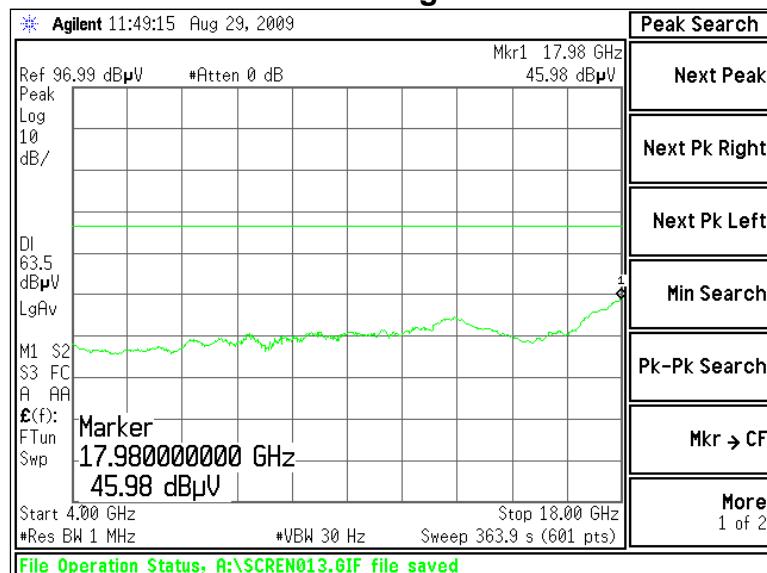
**Screen Captures - Radiated Emissions Testing – Receive Mode Straight SMA  
(continued)**

**Channel 8, Antenna Vertically Polarized, EUT Vertical  
1000 MHz – 4000 MHz, at 3m  
Peak**



Note: because the peak value (of the noise floor) was above the average limit, the video average bandwidth was decreased to demonstrate that the video-averaged signal is below the radiated limit.

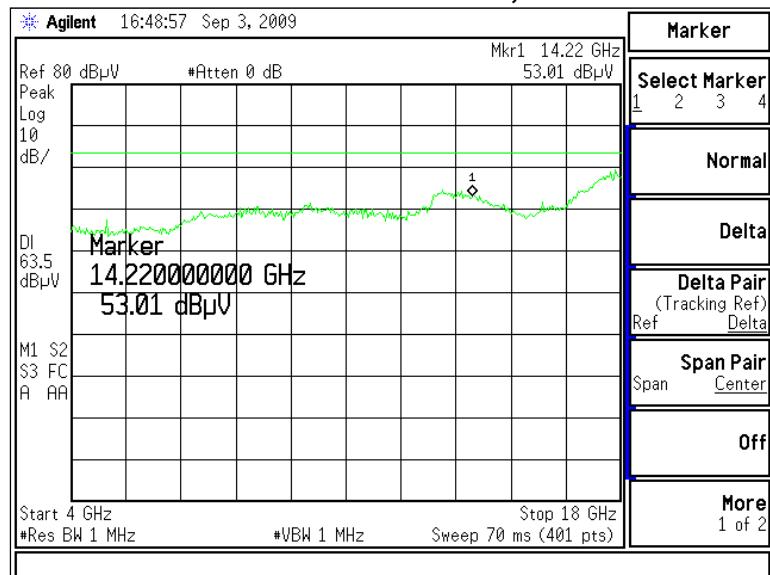
**Channel 8, Antenna Vertically Polarized, EUT Vertical  
1000 MHz – 4000 MHz, at 3m  
Average**



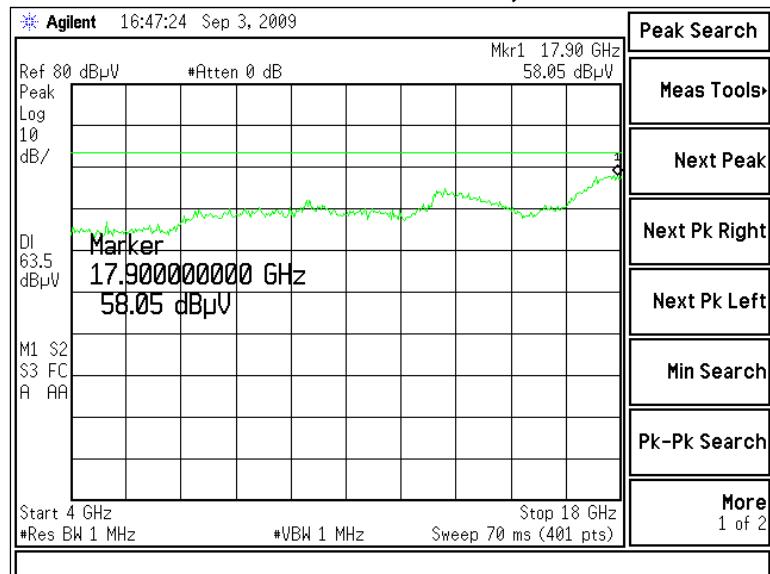
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 46 of 159

**Screen Captures - Radiated Emissions Testing – Receive Mode Straight SMA  
(continued)**

**Channel 8, Antenna Horizontally Polarized, EUT Vertical  
4000 MHz – 18000 MHz, at 1 m**



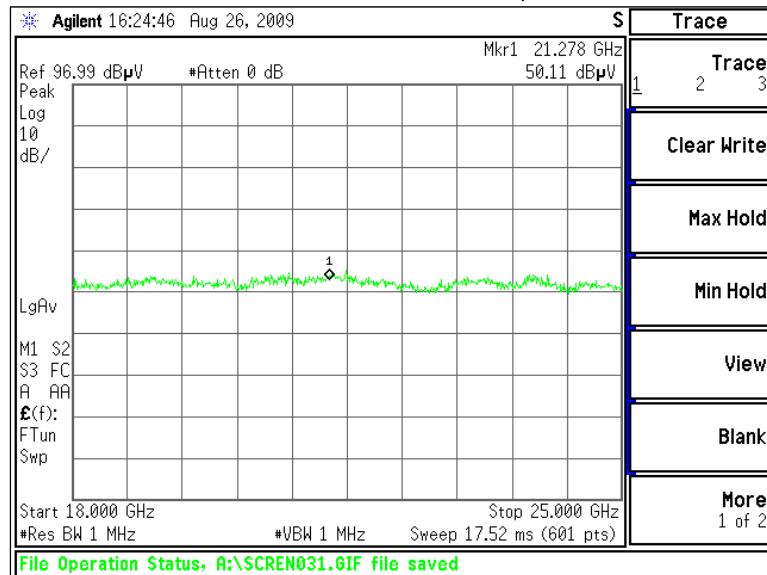
**Channel 8, Antenna Vertically Polarized, EUT Vertical  
4000 MHz – 18000 MHz, at 1 m**



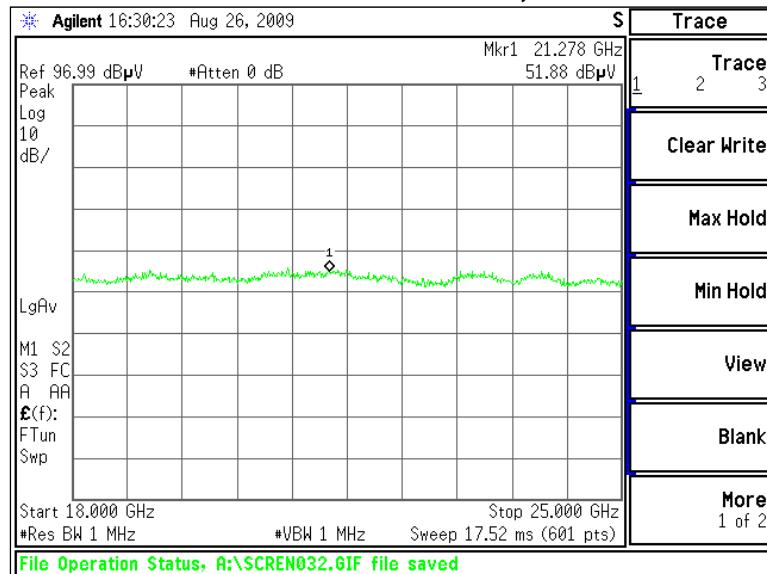
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 47 of 159

**Screen Captures - Radiated Emissions Testing – Receive Mode Straight SMA  
(continued)**

**Channel 8, Antenna Horizontally Polarized, EUT on Side  
18000 MHz – 25000 MHz, at 1 m**



**Channel 8, Antenna Vertically Polarized EUT on Side  
18000 MHz – 25000 MHz, at 1 m**



Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 48 of 159

### **5.6.3 Radiated Emissions on Unit with Bent SMA Antenna**

#### **5.6.3.1 Transmit Mode**

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

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Quasi Peak Reading (dB $\mu$ V/m)	Quasi Peak Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
245.9	1.00	0	28.1	22.45	46.0	23.6	Vertical	Vertical
289.6	1.00	0	30.3	24.29	46.0	21.7	Horizontal	Vertical
290.1	1.00	0	29.59	24.2	46.0	21.8	Horizontal	Side
291.0	1.00	0	30.19	24.27	46.0	21.7	Horizontal	Flat
297.7	1.00	0	31.33	24.64	46.0	21.4	Vertical	Side
299.5	1.00	0	32.05	24.89	46.0	21.1	Vertical	Flat
882.0	1.00	0	33.9	27.36	46.0	18.6	Vertical	Side
985.2	1.00	0	35.95	30.12	54.0	23.9	Horizontal	Flat
988.5	1.00	0	36.25	29.96	54.0	24.0	Horizontal	Side
990.3	1.00	0	37.7	29.07	54.0	24.9	Vertical	Vertical
994.2	1.00	0	35.02	29.42	54.0	24.6	Vertical	Flat
996.4	1.00	0	36.6	29.99	54.0	24.0	Horizontal	Vertical

Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 49 of 159

## **Radiated Emissions Data Chart on Unit with Bent SMA Antenna (continued)**

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 0:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2405	1.41	239	120.1	119.1	125.0	5.9	Horizontal	Side
4810	1.03	338	55.4	49.0	63.5	14.5	Vertical	Flat
7215	1.05	152	67.6	57.0	107.6	50.6	Horizontal	Flat
9620	1.06	98	60.5	50.6	107.6	57.0	Horizontal	Vertical
12025	1.04	267	61.2	50.9	63.5	12.6	Horizontal	Vertical
14430	1.04	296	53.4	42.9	107.6	64.7	Vertical	Flat
16835	1.03	191	53.0	41.3	107.6	66.3	Vertical	Side
19240			Note 3		63.5			
21645			Note 3		107.6			
24050			Note 3		107.6			

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 8:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2445	1.46	92	120.4	119.4	125.0	5.6	Horizontal	Vertical
4890	1.03	97	57.3	51.5	63.5	12.0	Horizontal	Side
7335	1.05	151	62.4	52.4	63.5	11.1	Horizontal	Flat
9780	1.00	267	50.9	41.3	107.9	66.5	Horizontal	Vertical
12225	1.12	41	54.1	43.8	63.5	19.7	Horizontal	Vertical
14670			Note 3		107.9			
17115			Note 3		107.9			
19560			Note 3		63.5			
22005			Note 3		107.9			
24450			Note 3		107.9			

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 14:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2475	1.13	98	119.9	118.8	125.0	6.2	Horizontal	Side
4950	1.15	157	53.3	46.7	63.5	16.8	Vertical	Vertical
7425	1.05	241	67.4	56.6	63.5	6.9	Vertical	Flat
9900	1.04	46	58.3	47.8	107.3	59.6	Horizontal	Vertical
12375	1.03	272	60.7	50.3	63.5	13.2	Horizontal	Vertical
14850	1.05	8	49.4	38.4	107.3	68.9	Vertical	Flat
17325	1.07	8	55.9	43.9	107.3	63.4	Horizontal	Side
19800			Note 3		63.5			
22275			Note 3		63.5			
24750			Note 3		107.3			

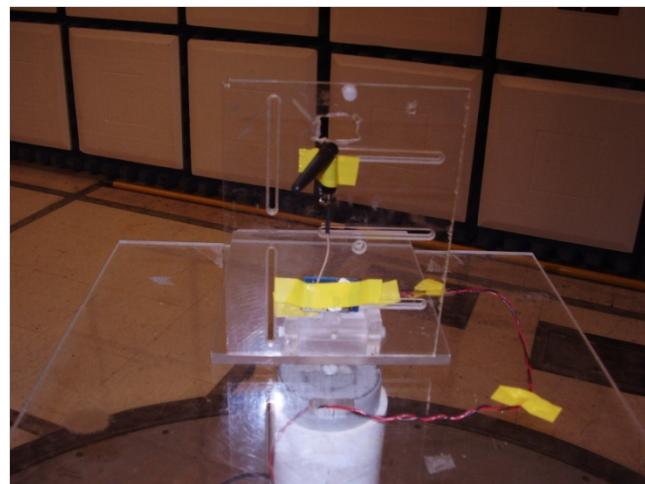
Notes:

- 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.

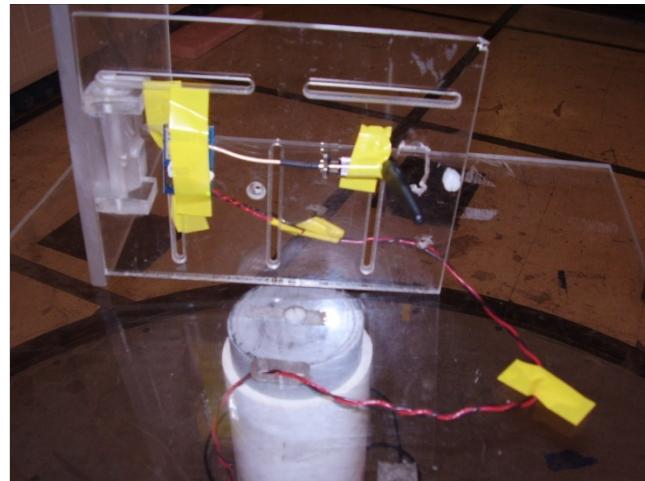
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 50 of 159

## Test Setup Photo(s) – Radiated Emissions Test with Bent SMA Antenna

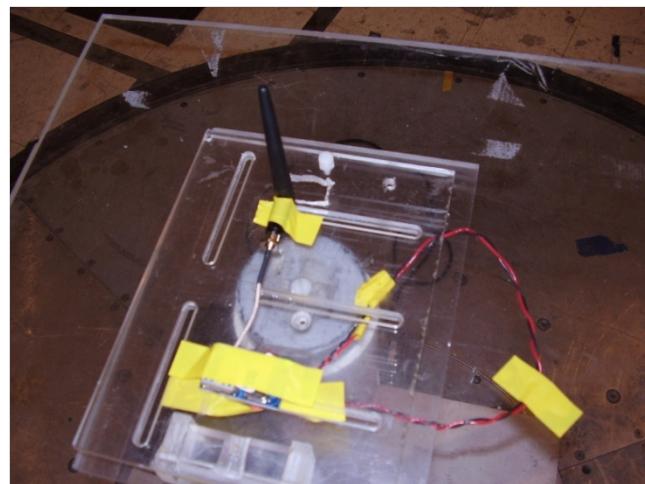
Vertical Orientation



Side Orientation



Flat Orientation



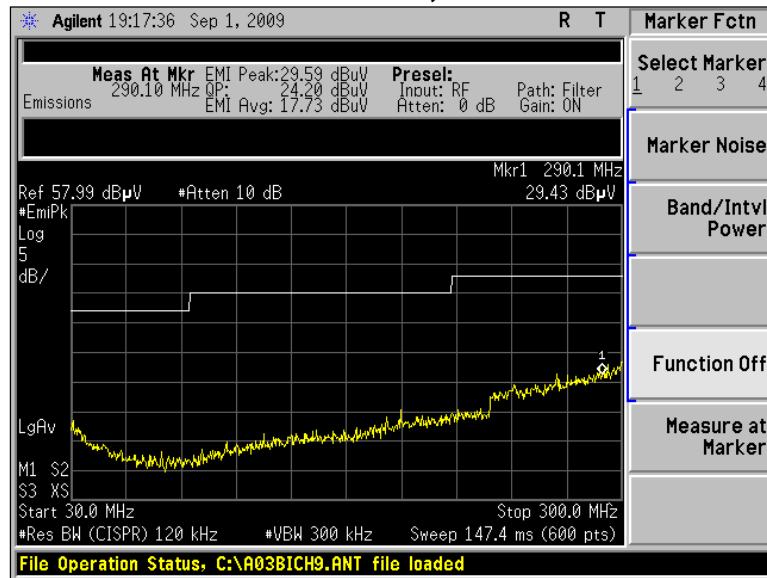
Prepared For: Niles Audio	EUT: 2.4 GHz module	LS Research, LLC
Report #: 309028-2	Model #: 2.4 GHz RF Transceiver Module	
LSR Job #: C-690	Serial #: see page 6	Page 51 of 159

## Screen Captures - Radiated Emissions Test with Bent SMA Antenna

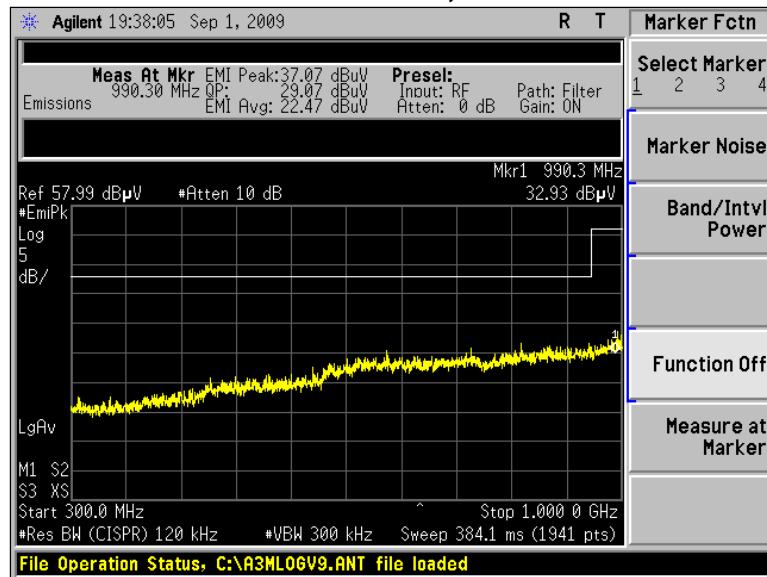
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 0, 8, or 14, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

### Channel 0, Antenna Horizontally Polarized, EUT Vertical 30-300 MHz, at 3m



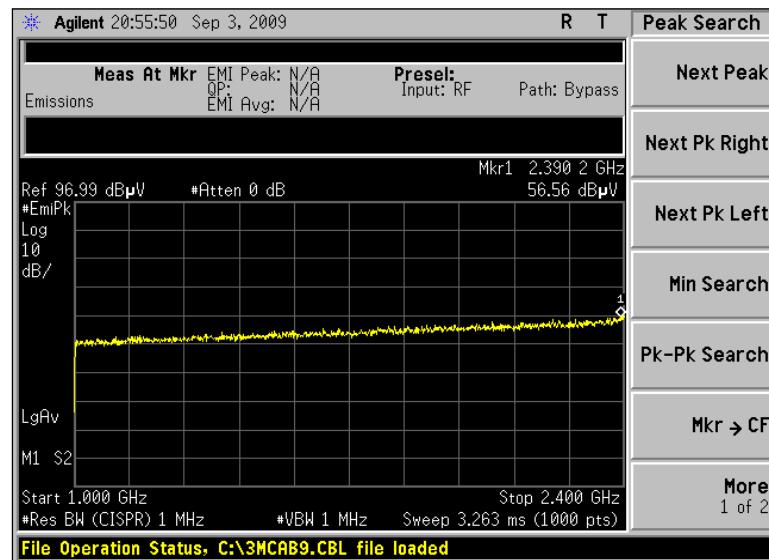
### Channel 0 Antenna Vertically Polarized, EUT Vertical 300-1000 MHz, at 3m



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## Screen Captures - Radiated Emissions Testing with Bent SMA Antenna (continued)

### Channel 8, Antenna Vertically Polarized, EUT Vertical 1000-2400 MHz, at 3m Peak



Note: because the peak value (of the noise floor) was above the average limit, the video average bandwidth was decreased to demonstrate that the video-averaged signal is below the radiated limit.

### Channel 8, Antenna Vertically Polarized, EUT Vertical 1000-2400 MHz, at 3m Average



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