LS RESEARCH LLC
Wireless Product Development

ACCREDITED
TESTING CERT #1255.01

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# TEST REPORT #: 311198
# LSR Job #: C-1243

Compliance Testing of:

WRZ Radio Module

Test Date(s):

December 9th – 20th, 2011, January 30th, 2012 and May 8-9th, 2012

Prepared For:
Johnson Controls, Inc.
Attn: Steve Whitsitt
507 E. Michigan Street
Milwaukee, WI 53202

**This Test Report is issued under the Authority of:**
Shane D. Rismeyer, EMC Engineer

Signature: Date: 5/10/12

| **Quality Assurance by:** | **Project Engineer:** |
|---|---|
| Peter Feilen, EMC Engineer | Shane D. Rismeyer, EMC Engineer |
| Signature: Date: 4/2/12 | Signature: Date: 4/1/12 |

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# EXHIBIT 1. INTRODUCTION

## 1.1 - Scope

| | |
|---|---|
| **References:** | FCC Part 15, Subpart C, Section 15.247 and 15.209<br>FCC Part 2, Section 2.1043 paragraph (b)1.<br>RSS GEN and RSS 210 Annex 8 |
| **Title:** | FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15.<br>IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment |
| **Purpose of Test:** | To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters. |
| **Test Procedures:** | Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |
| **Environmental Classification:** | Commercial, Industrial or Business<br>Residential |

## 1.2 – Normative References

| Publication | Year | Title |
|---|---|---|
| 47 CFR, Parts 0-15 (FCC) | 2008-10 | Code of Federal Regulations - Telecommunications |
| RSS 210 Annex 8 | 2010-12 | Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment |
| ANSI C63.10 | 2009 | American National Standard for Testing Unlicensed Wireless Devices |
| CISPR 16-1-1 | 2006-03<br>A1: 2006-09<br>A2: 2007-07 | Specification for radio disturbance and immunity measuring apparatus and methods.<br>Part 1-1: Measuring Apparatus. |
| CISPR 16-2-1 | 2003<br>A1: 2004-04<br>A2: 2007-07 | Specification for radio disturbance and immunity measuring apparatus and methods.<br>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. |

## 1.3 - LS Research, LLC in Review

*As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:*


*A2LA – American Association for Laboratory Accreditation*

*Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation*
*A2LA Certificate Number: 1255.01*

*Federal Communications Commission (FCC) – USA*

*Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948*
*FCC Registration Number: 90756*


*Industry Canada*

*On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1*
*File Number: IC 3088-A*
*On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1*
*File Number: IC 3088*

*U. S. Conformity Assessment Body (CAB) Validation*

*Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).*
*Date of Validation: January 16, 2001*

*Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.*
*Date of Validation: November 20, 2002*
*Notified Body Identification Number: 1243*

# EXHIBIT 2. PERFORMANCE ASSESSMENT

## 2.1 – Client Information

| | |
|---|---|
| Manufacturer Name: | Johnson Controls, Inc. |
| Address: | 507 E. Michigan Street, Milwaukee, WI 53202 |
| Contact Name: | Steve Whitsitt |

## 2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

| | |
|---|---|
| Product Name: | WRZ Radio Module |
| Model Number: | 25-2845 |
| Serial Number: | 9552 |

## 2.3 - Associated Antenna Description

Two antennas are possible to use with the WRZ Radio Module, a PIFA and a dipole antenna.

Antenna information for the dipole can be found in Appendix D.

PIFA description: The PCB antenna is an Inverted-F Antenna - a variant of a monopole, where the radiating element is folded down parallel to the ground plane. Impedance matching is accomplished by introducing a stub attached at one end to the ground plane. Antenna information for the dipole can be found in Appendix D.

## 2.4 - EUT'S Technical Specifications

| | |
|---|---|
| EUT Frequency Range (in MHz) | 2405-2480 |
| Conducted Power (dBm) | |
| Minimum: | 6.72 |
| Maximum: | 10.90 |
| Occupied Bandwidth (99% BW) | 2423 kHz |
| Type of Modulation | O-QPSK |
| Emission Designator | 2M42G1D |
| Transmitter Spurious (worst case) at 3 meters | 52.42 dBµV/m at 7438.5 MHz |
| Receiver Spurious (worst case) at 3 meters | 47.08 dBµV/m at 4960 MHz |
| Stepped (Y/N) | No |
| Step Value: | N/A |
| Frequency Tolerance %, Hz, ppm | 10ppm |
| Microprocessor Model # (if applicable) | CC2530 |
| Antenna Information | |
| Detachable/non-detachable | Detachable/Non-detachable |
| Type | Dipole/PIFA |
| Gain (in dBi) | 2.0/-0.2 |
| EUT will be operated under FCC Rule Part(s) | 15.247 |
| EUT will be operated under RSS Rule Part(s) | 210 |
| Modular Filing | ☒ Yes ☐ No |
| Portable or Mobile? | Mobile |

RF Technical Information:

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

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

Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
Duty Cycle used in evaluation: 100%
Standard used for evaluation: OET 65
Measurement Distance: 20 cm
RF Value: 0.003879 ☐ V/m ☐ A/m ☒ mW/cm$^2$
☐ Measured ☐ Computed ☒ Calculated

Margin of compliance at 20cm: 24.1dB

## 2.5 - Product Description

The Johnson Controls WRZ Radio 2.4G RF Module is a single printed wiring board that implements a self-contained, complete wireless interface module. The radio section utilizes Texas Instruments CC2530 radio chip, following the 802.15.4 standard and is driven by a 32.000 MHz crystal circuit on board. The CC2530 chip drives a balun which couples the signal through transmit/receive switches to an RF amplifier delivering 10 mW to either an internal F antenna or external antenna through a MMCX connector.

# EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

## 3.1 - Climate Test Conditions

| | |
|---|---|
| Temperature: | 68-72°F |
| Humidity: | 30-40% |
| Pressure: | 740-750mmHg |

## 3.2 - Applicability & Summary Of EMC Emission Test Results

| FCC and IC Paragraph | Test Requirements | Compliance (Yes/No) |
|---|---|---|
| FCC : 15.207<br>IC : RSS GEN sect. 7.2.2 | Power Line Conducted Emissions Measurements | Yes |
| FCC : 15.247(a)(2)<br>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<br>IC : RSS 210 A8.4 | Maximum Output Power | Yes |
| FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093<br>IC : RSS 102 | RF Exposure Limit | Yes |
| FCC :15.247(c)<br>IC : RSS 210 A8.5 | RF Conducted Spurious Emissions at the Transmitter Antenna Terminal | Yes |
| FCC : 15.247(d)<br>IC : RSS 210 A8.2(b) | Transmitted Power Spectral Density of a Digital Modulation System | Yes |
| FCC : 15.247(c), 15.209 & 15.205<br>IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7 | Transmitter Radiated Emissions | Yes |
| The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices (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. | | |

## 3.3 - Modifications Incorporated In the EUT for Compliance Purposes

☐ None ☒ Yes (explain below)

In order to pass Upper Band Edge Channel 26 power set to level 210 all remaining channels set to 240.

## 3.4 - Deviations & Exclusions from Test Specifications

☒ None ☐ Yes (explain below)

# EXHIBIT 4. DECLARATION OF CONFORMITY

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

*Note: If some emissions are seen to be within 3 dB of their respective limits; as these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.*

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

# EXHIBIT 5. RADIATED EMISSIONS TEST

## 5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4. 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 applicable limits apply at a 3 meter distance. Measurements above 4 GHz were performed at a 1 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (2405 MHz), middle (2440 MHz) and high (2480 MHz). The channels and operating modes were changed using a PC via HyperTerminal.

## 5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in 3 meter Semi-Anechoic and Compact Semi-Anechoic FCC listed Chambers. 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. For the lower frequency ranges the EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber with the antenna mast placed so that the separation distance between the antenna and EUT was 3 meters. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, 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 4 GHz in the 3 meter Semi-Anechoic Chamber. The remaining measurements were taken in the Compact Semi-Anechoic Chamber at a separation distance of 1 meter. The Double-Ridged Waveguide Horn Antenna used from 4 GHz to 18 GHz and a Standard Gain Horn Antenna was used 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 below 4GHz and 1 to 1.8 meters above 4GHz, using both horizontal and vertical antenna polarities. The EUT was rotated along three orthogonal axes during the investigations to find the highest emission levels.

## 5.3 - Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. The Agilent E4445A 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 4 GHz to 25 GHz, an Agilent E4446A Spectrum Analyzer was used.

## 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 8, 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.

## 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 μV/m | 3 m Limit (dBμV/m) | 1 m Limit (dBμV/m) |
|---|---|---|---|
| 30-88 | 100 | 40.0 | - |
| 88-216 | 150 | 43.5 | - |
| 216-960 | 200 | 46.0 | - |
| 960-24,000 | 500 | 54.0 | 63.5 |

Sample conversion of field strength (μV/m to dBμV/m):

$dB\mu V/m = 20 \log_{10} (100) = 40\ dB\mu V/m$ (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
500μV/m or 54.0 dBμV/m at 3 meters
54.0 + 9.5 = 63.5 dBμV/m at 1 meter

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Sample reported data:

Raw Data + Antenna Factor + Cable Factor = Reported Data

12.0 dBμV/m + 10.4 dB + 0.7 dB = 23.1 dBμV/m

# 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:** | Johnson Controls, Inc. | | | | | |
| **Date(s) of Test:** | 12/9/11, 12/15/11, 1/30/12 | | | | | |
| **Test Engineer(s):** | Shane Rismeyer and Peter Feilen | | | | | |
| **Voltage:** | 3.3 VDC | | | | | |
| **Operation Mode:** | Modulated | | | | | |
| **Environmental Conditions in the Lab:** | Temperature: 20 – 25° C<br>Relative Humidity: 30 – 60 % | | | | | |
| **EUT Power:** | | Single Phase ___VAC | | 3 Phase ___VAC | | |
| | | Battery | **X** | Other: 3.3VDC | | |
| **EUT Placement:** | **X** | 80cm non-conductive table | | 10cm Spacers | | |
| **EUT Test Location:** | **X** | 3 Meter Semi-Anechoic FCC Listed Chamber | | 3/10m OATS | | |
| **Measurements:** | | Pre-Compliance | | Preliminary | **X** | Final |
| **Detectors Used:** | **X** | Peak | **X** | Quasi-Peak | **X** | Average |

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

| Frequency (MHz) | Height (meters) | Azimuth (degrees) | Reading (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Polarity | EUT Orientation |
|---|---|---|---|---|---|---|---|
| 106.1 | 1.00 | 0 | 23.1 | 43.5 | 20.4 | V | F |
| 299.9 | 1.00 | 0 | 25.3 | 46.0 | 20.7 | H | F |
| 106.1 | 1.00 | 274 | 22.4 | 43.5 | 21.1 | V | V |
| 97.3 | 1.16 | 0 | 22 | 43.5 | 21.5 | V | V |

*RADIATED EMISSIONS DATA CHART (continued)*

**Dipole Harmonics:**

The following table depicts the level of significant radiated RF harmonic emissions seen on Channel 11:

| Frequency (MHz) | Ant./EUT Polarity | Height (cm) | Azimuth (degrees) | Peak (dBμV/m) | Corrected Peak (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 4810.0 | H/Side | 104.6 | 212.5 | 63.10 | 49.12 | 63.5 | 14.38 |
| 4811.0 | V/Vertical | 108.3 | 250.2 | 61.96 | 47.98 | 63.5 | 15.52 |

The following table depicts the level of significant radiated RF harmonic emissions seen on Channel 18:

| Frequency (MHz) | Ant./EUT Polarity | Height (cm) | Azimuth (degrees) | Peak (dBμV/m) | Corrected Peak (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 7321.5 | H/Side | 109.8 | 212.5 | 74.46 | 60.48 | 63.5 | 3.02 |
| 7321.5 | V/Vertical | 125.7 | 94.0 | 73.15 | 59.17 | 63.5 | 4.33 |
| 4880.1 | H/Vertical | 102.9 | 219.1 | 60.80 | 46.82 | 63.5 | 16.68 |
| 4880.0 | V/Vertical | 102.2 | 343.0 | 58.35 | 44.37 | 63.5 | 19.13 |

The following table depicts the level of significant radiated RF harmonic emissions seen on Channel 26:

| Frequency (MHz) | Ant./EUT Polarity | Height (cm) | Azimuth (degrees) | Peak (dBμV/m) | Corrected Peak (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 7438.5 | H/Side | 102.0 | 204.0 | 75.90 | 61.92 | 63.5 | 1.58 |
| 7439.0 | V/Side | 109.0 | 20.0 | 71.99 | 58.01 | 63.5 | 5.49 |
| 4959.8 | H/Vertical | 117.2 | 225.0 | 58.29 | 44.31 | 63.5 | 19.19 |

RADIATED EMISSIONS DATA CHART (continued)

**PIFA Unit:**

The following table depicts the level of significant radiated RF harmonic emissions seen on Channel 11:

| Frequency (MHz) | Ant./EUT Polarity | Height (cm) | Azimuth (degrees) | Peak (dBμV/m) | Corrected Peak (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 4810.0 | H/Flat | 120.0 | 230.0 | 62.40 | 48.42 | 63.5 | 15.08 |
| 4810.0 | V/Side | 117.0 | 135.0 | 60.35 | 46.37 | 63.5 | 16.13 |

The following table depicts the level of significant radiated RF harmonic emissions seen on Channel 18:

| Frequency (MHz) | Ant./EUT Polarity | Height (cm) | Azimuth (degrees) | Peak (dBμV/m) | Corrected Peak (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 7321.4 | H/Side | 117.1 | 167.4 | 71.82 | 57.84 | 63.5 | 5.66 |
| 7321.4 | V/Side | 102.2 | 53.8 | 70.95 | 56.97 | 63.5 | 6.53 |
| 4880.0 | H/Vertical | 100.0 | 217.0 | 63.70 | 49.72 | 63.5 | 13.78 |
| 12197.0 | V/Flat | 100.0 | 229.8 | 60.11 | 46.13 | 63.5 | 17.37 |

The following table depicts the level of significant radiated RF harmonic emissions seen on Channel 26:

| Frequency (MHz) | Ant./EUT Polarity | Height (cm) | Azimuth (degrees) | Peak (dBμV/m) | Corrected Peak (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 7438.5 | V/Vertical | 105.6 | 139.9 | 72.99 | 59.01 | 63.5 | 4.49 |
| 7438.5 | H/Flat | 109.6 | 282.9 | 72.81 | 58.83 | 63.5 | 4.67 |
| 4960.0 | H/Vertical | 102.0 | 143.1 | 60.47 | 46.49 | 63.5 | 17.01 |

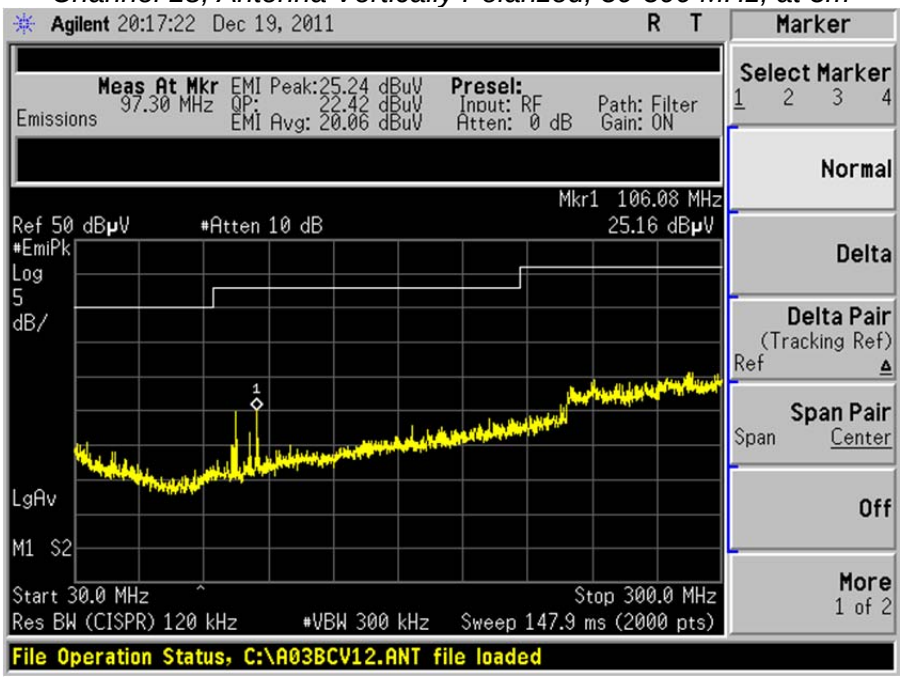
**Notes:**

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 limit.
2. Measurements above 4 GHz were made at 1 meters of separation from the EUT.
3. A relaxation of the limit is invoked based on the average duty factor of the transmitter on-air-time. Justification appears in Appendix E. The measurements have been recalculated and reduced by -16.33 dB as justified by the averaging factor.
4. All other measurements were greater than 20dB from the respective limit.

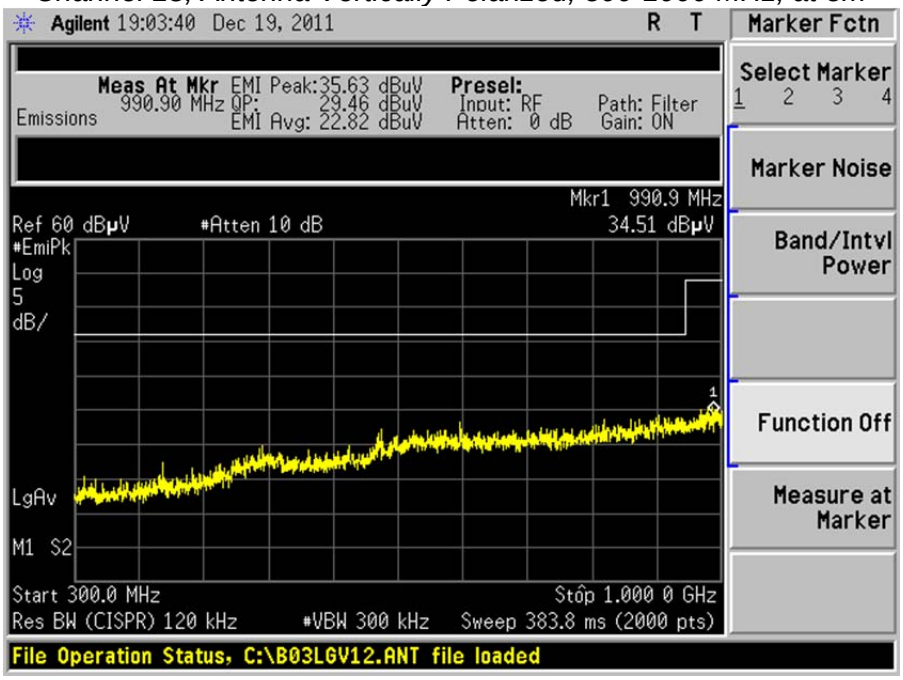
## 5.7 - Screen Captures - Radiated Emissions Test

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.

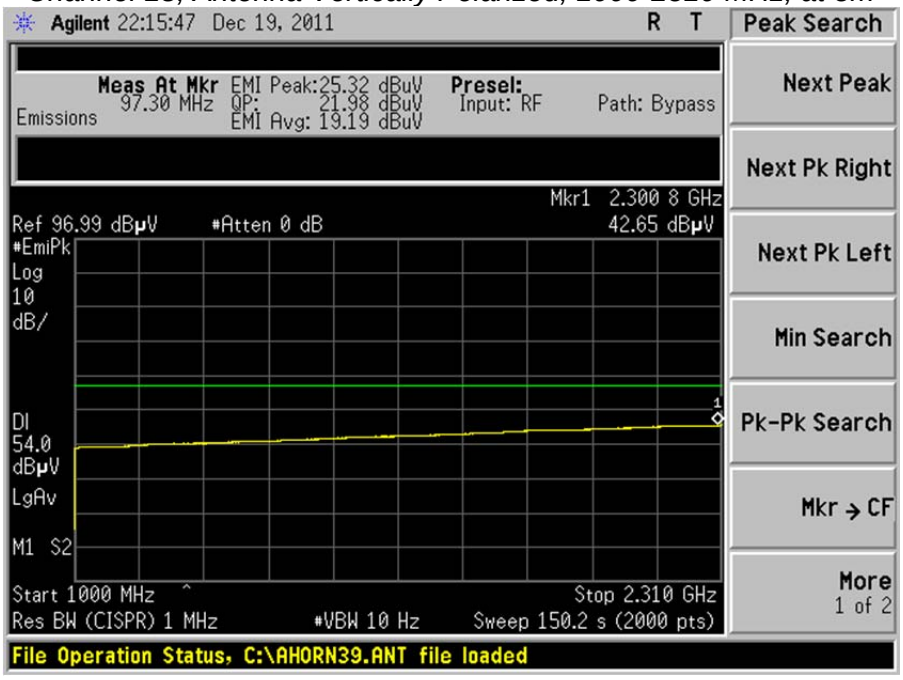
*Channel 18, Antenna Vertically Polarized, 30-300 MHz, at 3m*



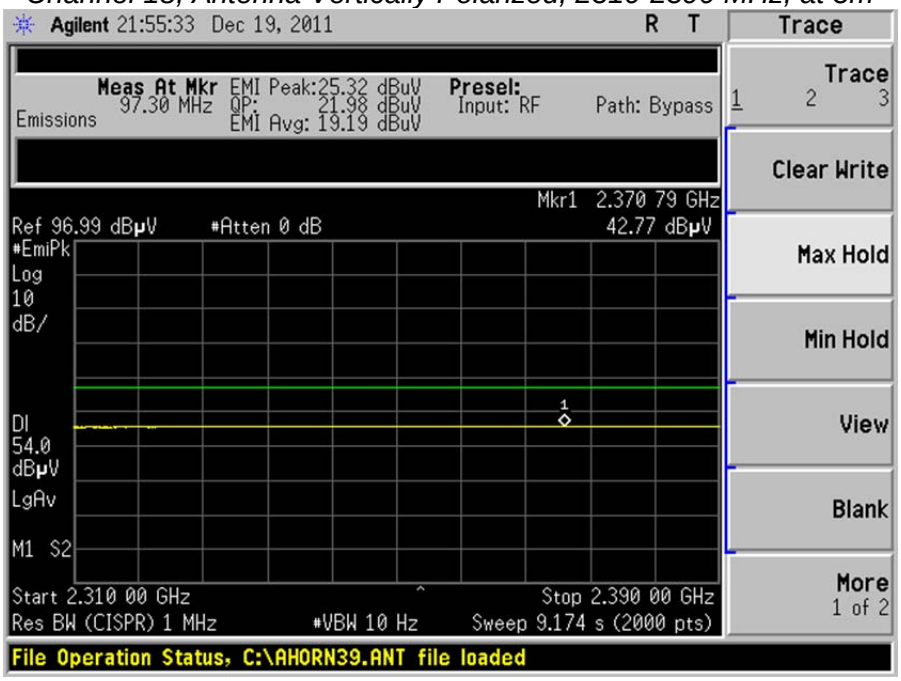

*Channel 18, Antenna Vertically Polarized, 300-1000 MHz, at 3m*



*Channel 18, Antenna Vertically Polarized, 1000-2310 MHz, at 3m*

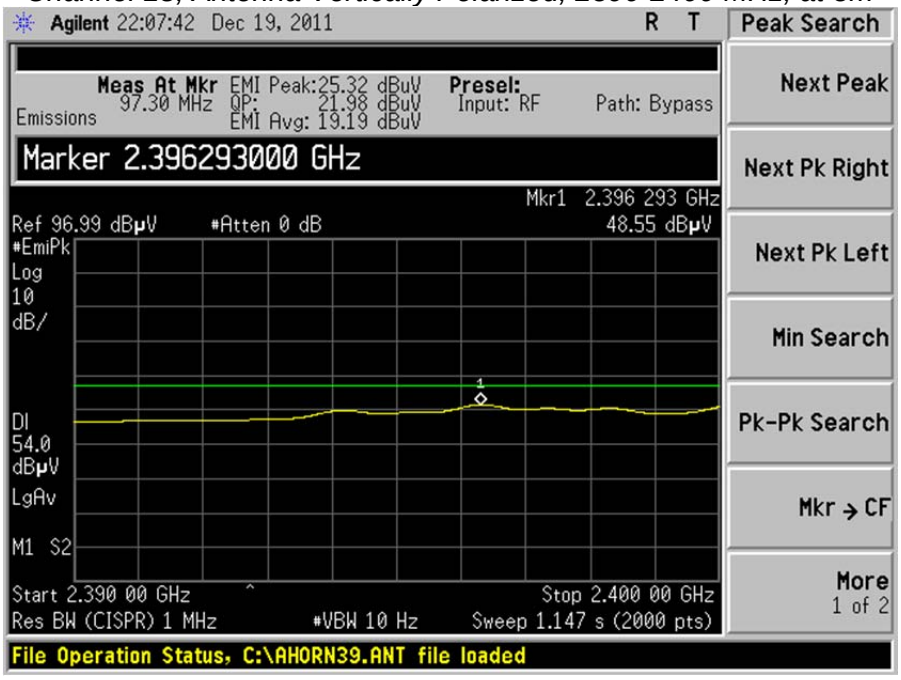



*Channel 18, Antenna Vertically Polarized, 2310-2390 MHz, at 3m*

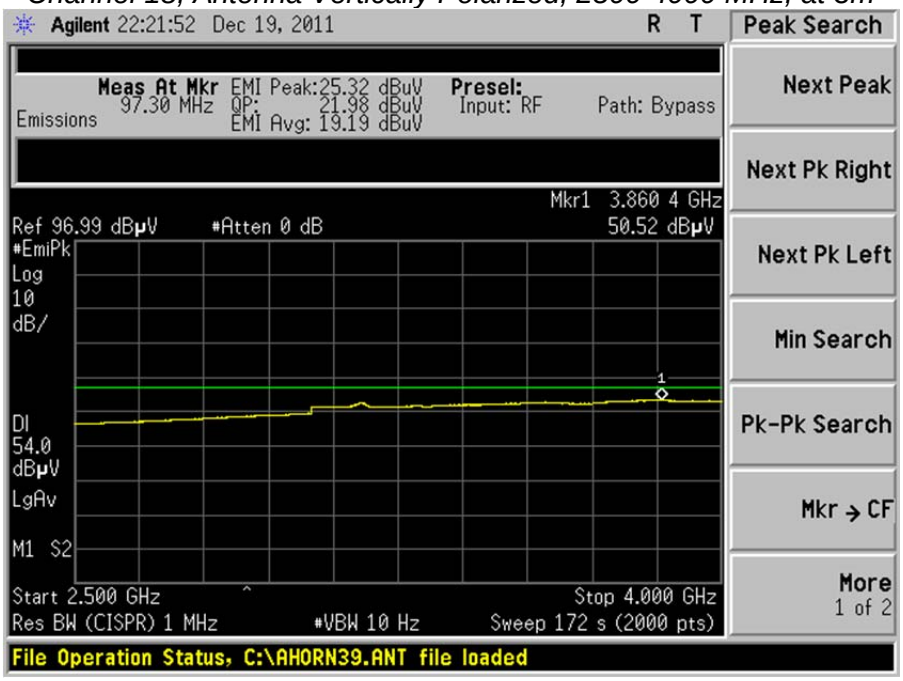


Screen Captures - Radiated Emissions Testing *(continued)*

*Channel 18, Antenna Vertically Polarized, 2390-2400 MHz, at 3m*

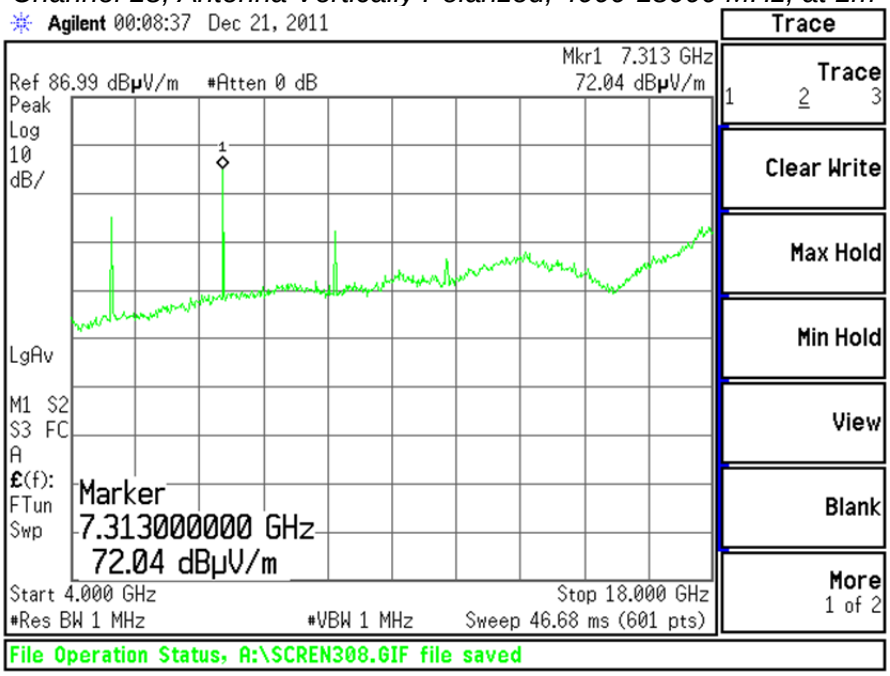



*Channel 18, Antenna Vertically Polarized, 2500-4000 MHz, at 3m*

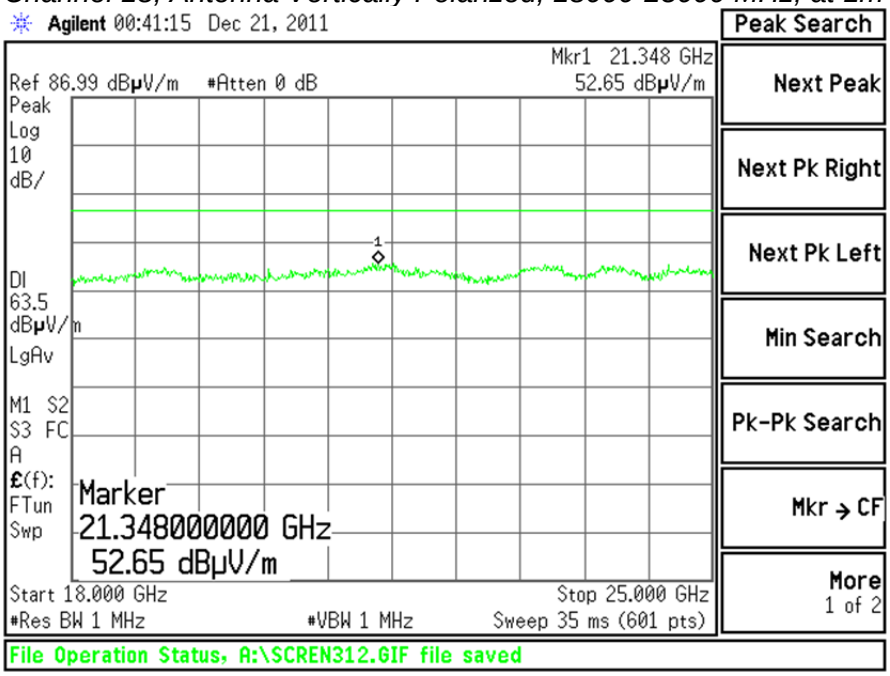


*Screen Captures - Radiated Emissions Testing* (continued)

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




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



## 5.8 - Receive Mode Testing

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:

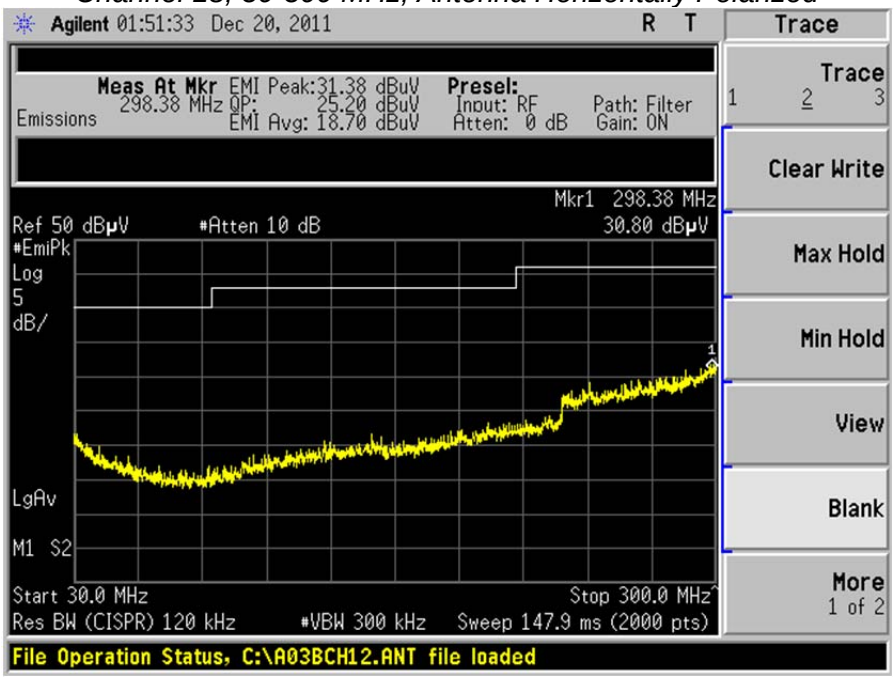
| Frequency (MHz) | Height (m) | Azimuth (degree) | Quasi Peak Reading (dBµV/m) | Quasi Peak Limit (dBµV/m) | Margin (dB) | Antenna Polarity | EUT orientation |
|---|---|---|---|---|---|---|---|
| 989.5 | 1.00 | 0 | 30.2 | 54.0 | 23.8 | H | F |
| 281.6 | 1.00 | 0 | 23.2 | 46.0 | 22.8 | V | F |

| Frequency (GHz) | Height (m) | Azimuth (degree) | Peak Reading (dBµV/m) | Average Reading (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) | Antenna Polarity | EUT orientation | EUT Channel |
|---|---|---|---|---|---|---|---|---|---|
| 4960.0 | 1.20 | 352.1 | 59.63 | 56.58 | 63.5 | 6.9 | H | F | 26 |
| 3917.5 | 1.00 | 0 | 35.1 | 27.5 | 54.0 | 26.5 | H | V | 18 |
| 3905.5 | 1.00 | 0 | 35.8 | 27.4 | 54.0 | 26.6 | V | F | 18 |

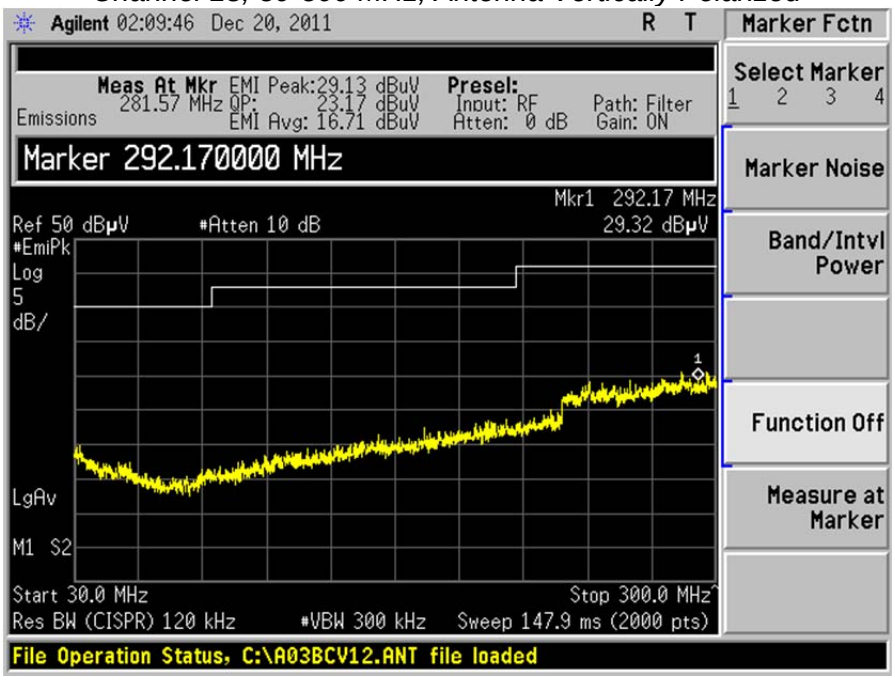
## 5.9 - Screen Captures - Radiated Emissions Testing – Receive Mode

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

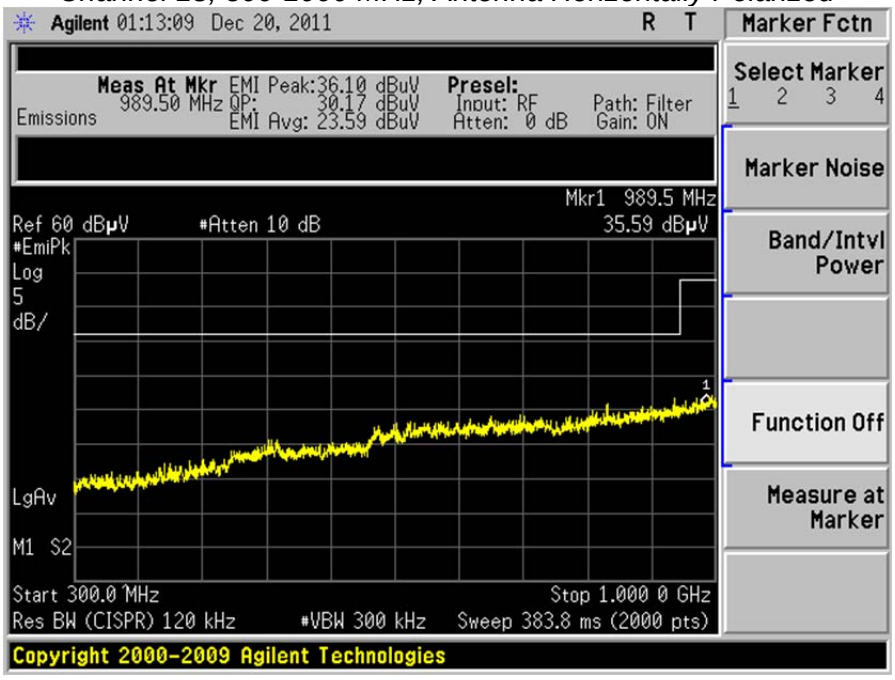
*Channel 18, 30-300 MHz, Antenna Horizontally Polarized*



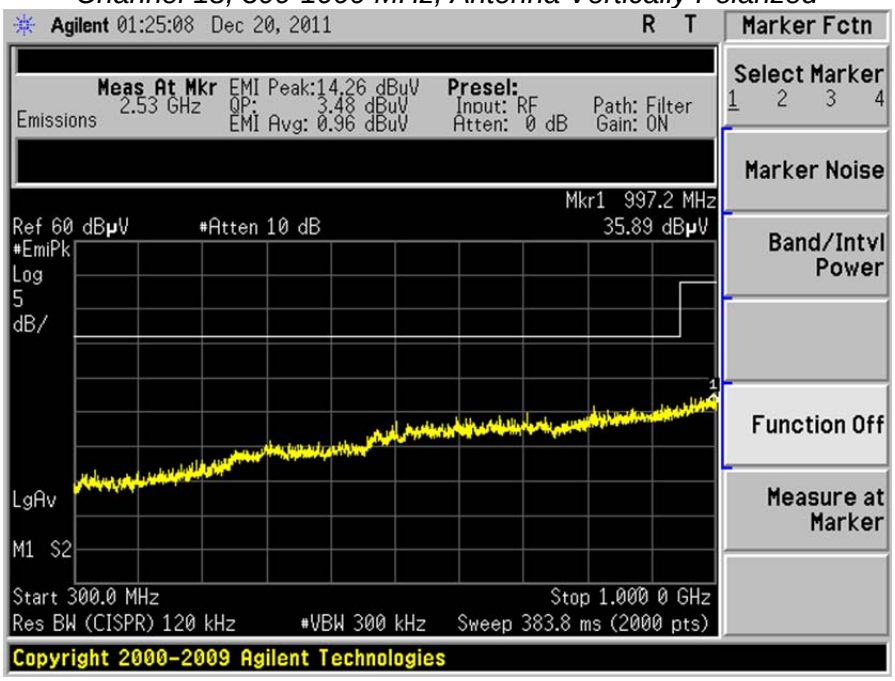

*Channel 18, 30-300 MHz, Antenna Vertically Polarized*



*Channel 18, 300-1000 MHz, Antenna Horizontally Polarized*

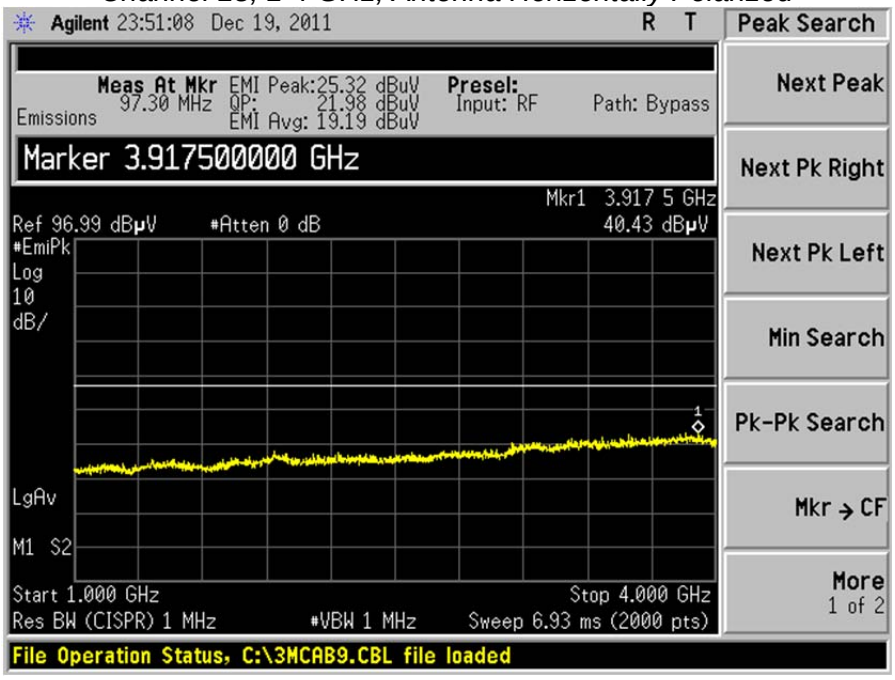



*Channel 18, 300-1000 MHz, Antenna Vertically Polarized*

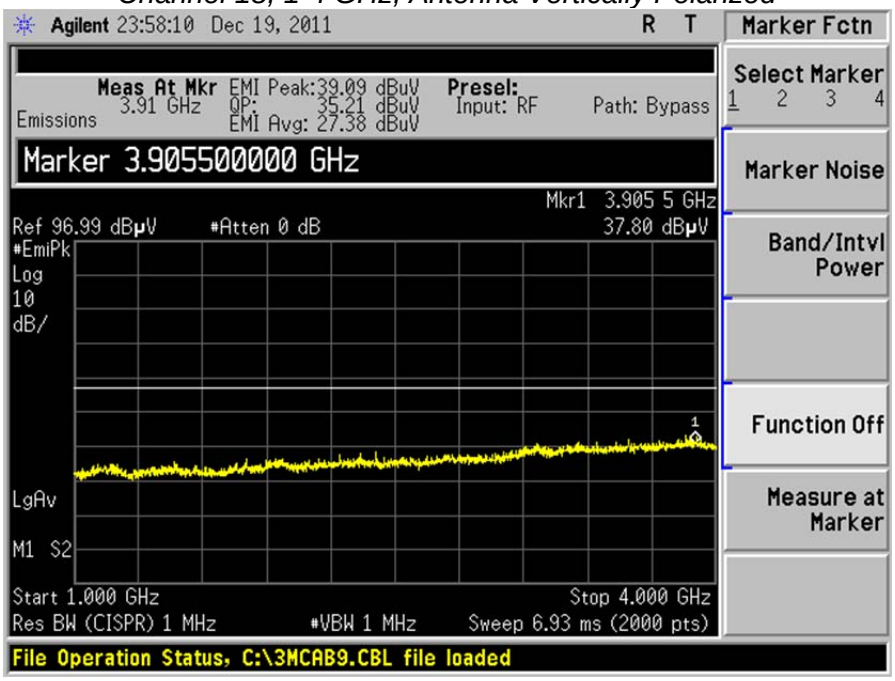


Screen Captures - Radiated Emissions Testing – Receive Mode *(continued)*

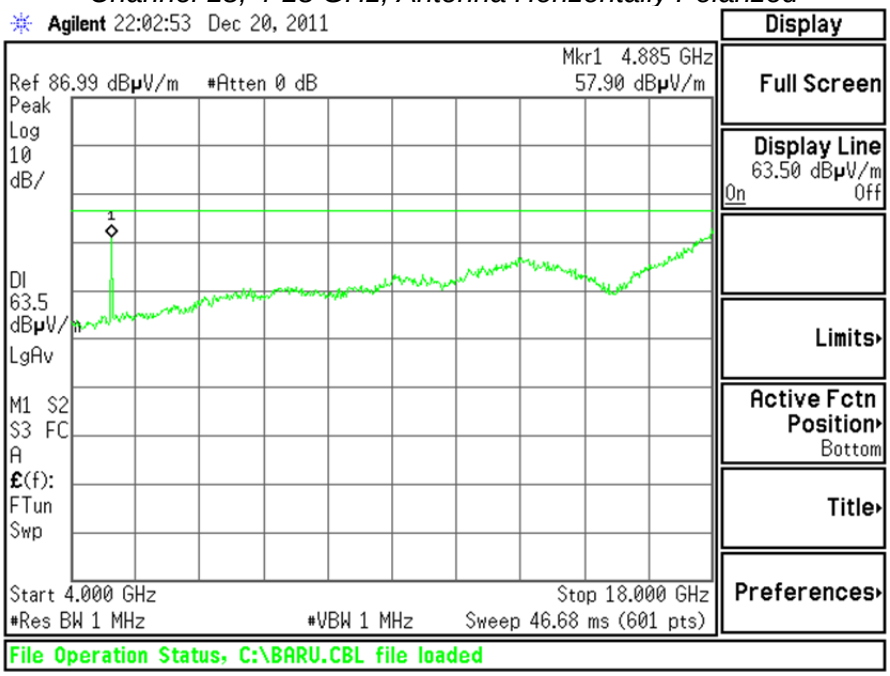
*Channel 18, 1-4 GHz, Antenna Horizontally Polarized*



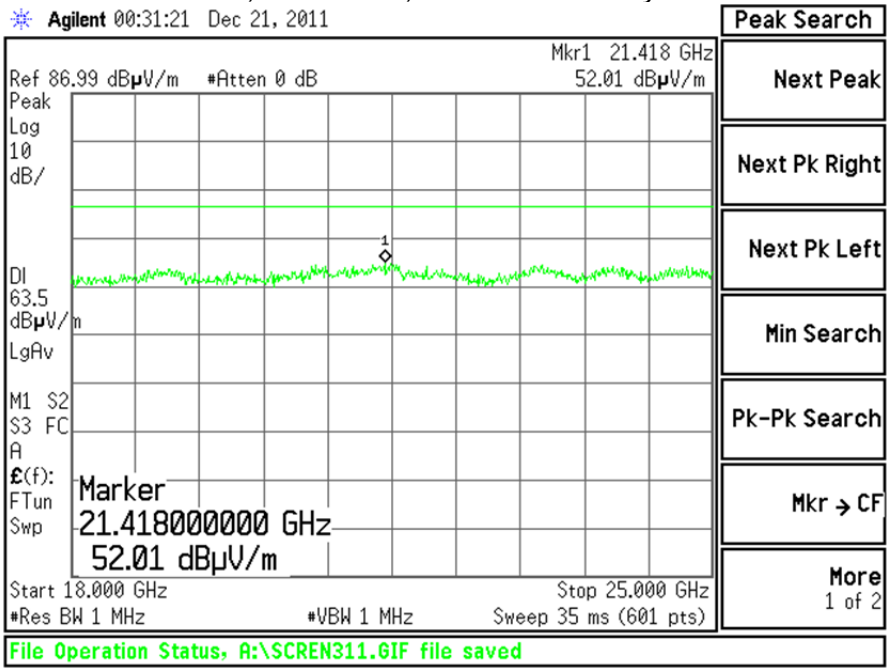

*Channel 18, 1-4 GHz, Antenna Vertically Polarized*



*Channel 18, 4-18 GHz, Antenna Horizontally Polarized*




*Channel 18, 18-25 GHz, Antenna Vertically Polarized*



# EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

## 6.1 - Test Setup

The test area and setup are in accordance with ANSI C63.4 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided inside the 3 Meter Semi-Anechoic Chamber via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the HP 8546A EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

## 6.2 - Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

## 6.3 - Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A.

## 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.

## 6.5 - FCC Limits of Conducted Emissions at the AC Mains Ports

The follow table represents the limits for Conducted Emissions Class B taken from CFR 15.207:

| Frequency Range (MHz) | Quasi-Peak Limit (dBµV) | Average Limit (dBµV) |
|---|---|---|
| 0.150 -0.50 * | 66-56 | 56-46 |
| 0.5 – 5.0 | 56 | 46 |
| 5.0 – 30 | 60 | 50 |
| * The limit decreases linearly with the logarithm of the frequency in this range. | | |

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

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

For a frequency of 200 kHz for example:

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

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

$$\text{Average Limit (F=200 kHz)} = -19.12 (\text{Log}_{10} (0.2[\text{MHz}]/0.15[\text{MHz}])) + 56.0\ \text{dB}\mu\text{V}$$

$$\text{Average Limit (F = 200 kHz)} = 53.6\ \text{dB}\mu\text{V}$$

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Sample reported data:

Raw Data + Antenna Factor (LISN) + Transient Limiter= Reported Data

2.4 dBµV + 0.1 dB + 10.2 dB = 12.7 dBµV

# 6.6 – Conducted Emissions Test Data Chart

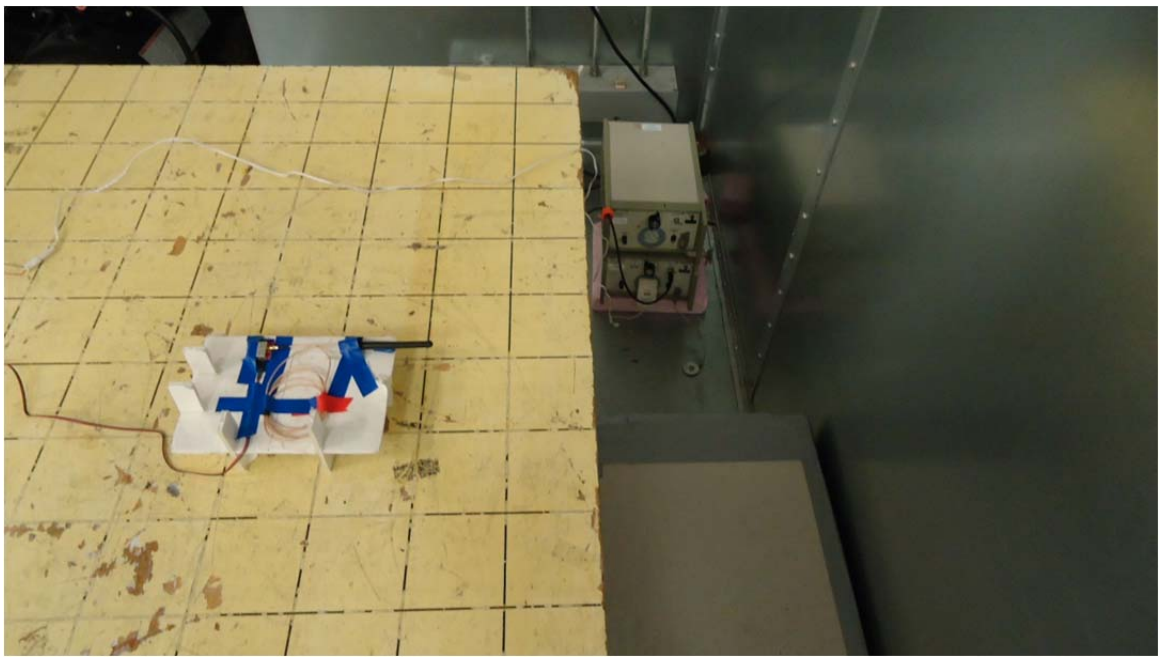
Frequency Range inspected: 150 KHz to 30 MHz
Test Standard: FCC 15.207 Class B
IC RSS GEN 7.2.2

| | | | | | | |
|---|---|---|---|---|---|---|
| **Manufacturer:** | Johnson Controls, Inc. | | | | | |
| **Date(s) of Test:** | 12/20/11 | | | | | |
| **Test Engineer:** | Shane Rismeyer | | | | | |
| **Voltage:** | 3.3VDC | | | | | |
| **Operation Mode:** | Modulated | | | | | |
| **Environmental Conditions in the Lab:** | Temperature: 20 – 25° C<br>Relative Humidity: 30 – 60 % | | | | | |
| **Test Location:** | **X** | Conducted Test Area | | | | Chamber |
| **EUT Placed On:** | **X** | 40cm from Vertical Ground Plane | | | | 10cm Spacers |
| | **X** | 80cm above Ground Plane | | | | Other: |
| **Measurements:** | | Pre-Compliance | | Preliminary | **X** | Final |
| **Detector Used:** | | Peak | **X** | Quasi-Peak | **X** | Average |

| | | *QUASI-PEAK* | | | *AVERAGE* | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Line** | **Reading (dBµV)** | **Limit (dBµV)** | **Margin (dB)** | **Reading (dBµV)** | **Limit (dBµV)** | **Margin (dB)** |
| 0.187 | L1 | 12.700 | 64.169 | 51.469 | 1.100 | 54.169 | 53.069 |
| 0.620 | L2 | 38.200 | 56.000 | 17.800 | 35.100 | 46.000 | 10.900 |

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

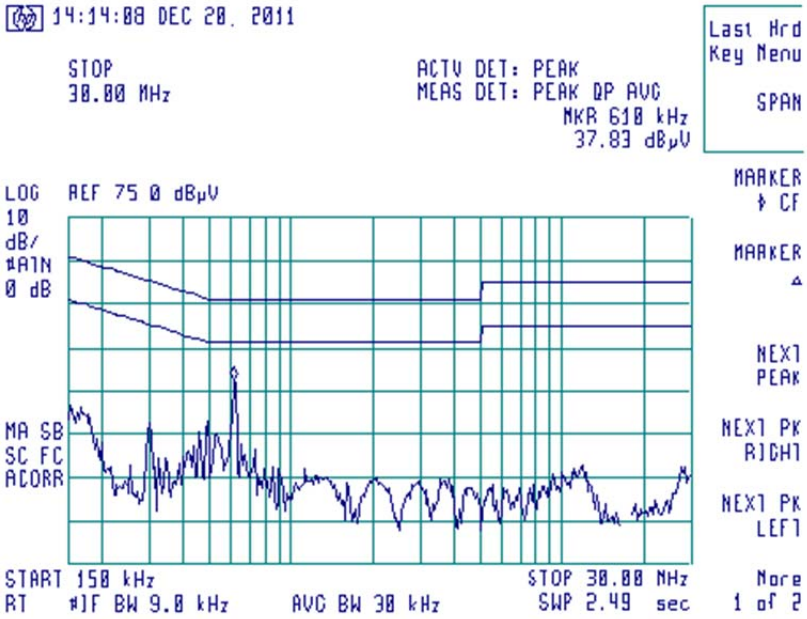
## 6.7 - Test Setup Photo(s) – Conducted Emissions Test



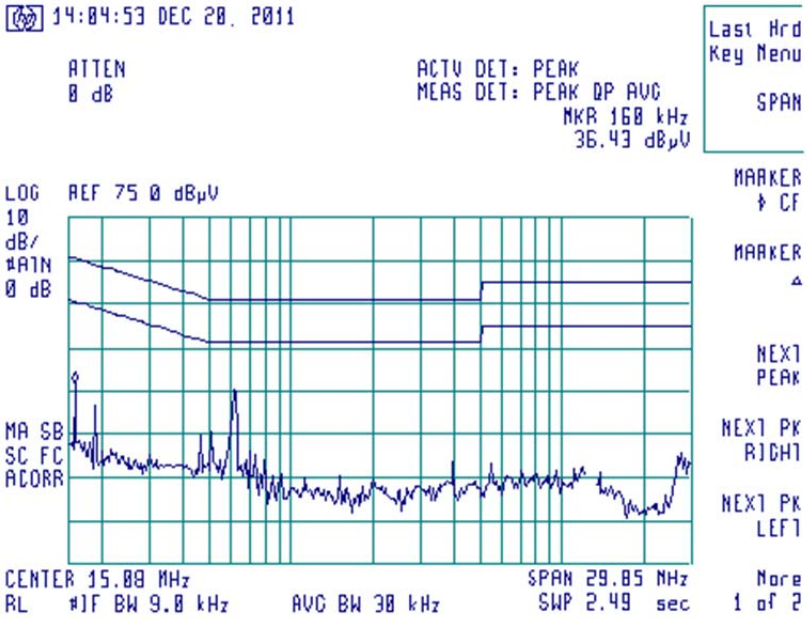
## 6.8 - Screen Captures – Conducted Emissions Test

Note: These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The signature scans shown here are from Channel 18, chosen as being a good representative of channels.

*Channel 18, 2440 MHz, Line 1*




*Channel 18, 2440 MHz, Line 2*



# EXHIBIT 7. OCCUPIED BANDWIDTH

## 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 (2003) and FCC Procedures (2007) for Digital Transmission Systems operating under 15.247. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 30 kHz RBW and VBW=300 kHz. The bandwidth requirement found in FCC Part 15.247(a)(2) and RSS 210 A8.2(a) requires a minimum -6dBc occupied bandwidth of 500 kHz. In addition, Industry Canada (IC RSS GEN 4.6.1) requires the measurement of the 99% occupied bandwidth. 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 Agilent 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. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

From this data, the closest measurement (6 dB bandwidth) when compared to the specified limit, is 1447 kHz, which is above the minimum of 500 kHz.

## 7.3 - Test Equipment List

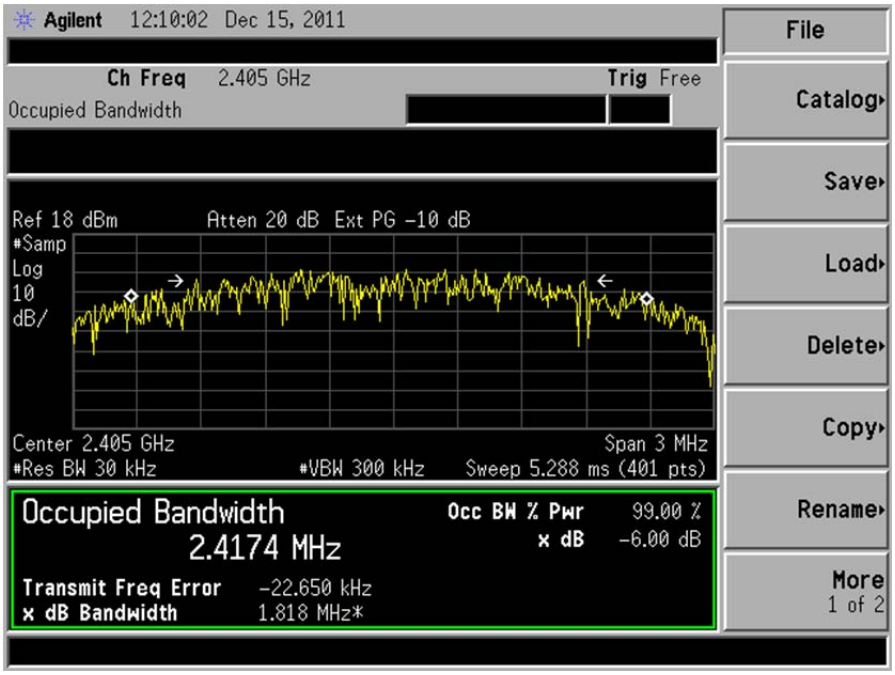
A complete list of test equipment that was used for this test can be found in Appendix A.

## 7.4 - Test Data

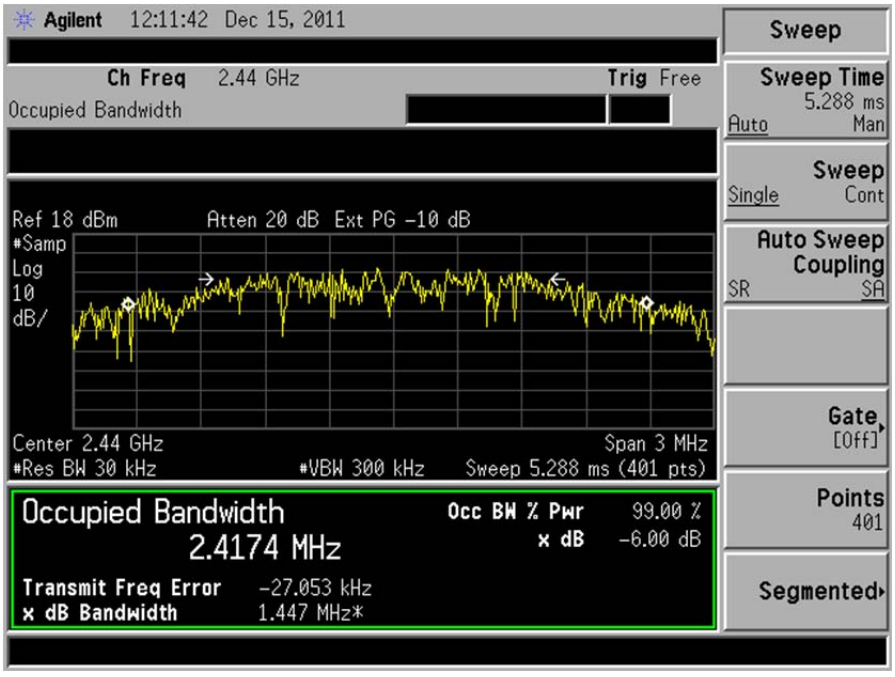
| Channel | Center Freq (MHz) | -6 dBc OBW (kHz) | 99% OBW (kHz) |
|---|---|---|---|
| 11 | 2405 | 1818 | 2417 |
| 18 | 2440 | 1447 | 2417 |
| 25 | 2475 | 1552 | 2442 |
| 26 | 2480 | 1819 | 2423 |

## 7.5 - Screen Captures - Occupied Bandwidth

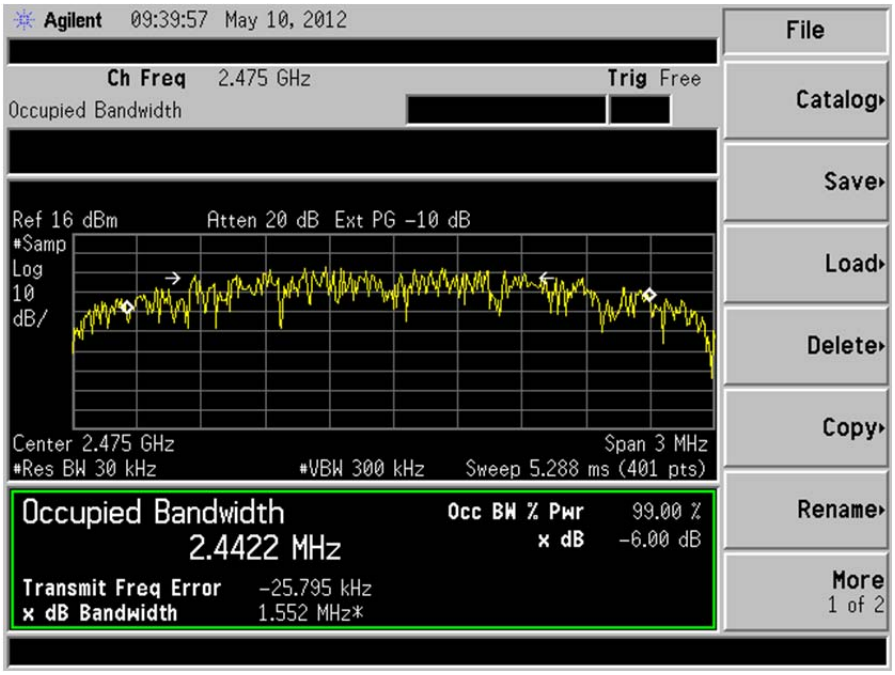
*Channel 11*



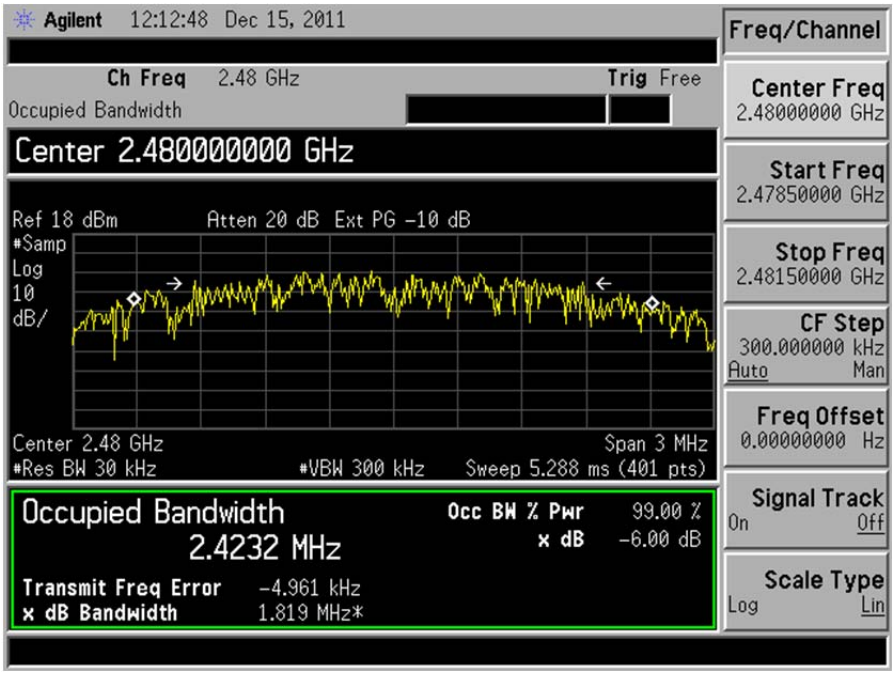

*Channel 18*



*Channel 25*




*Channel 26*



# EXHIBIT 8. BAND EDGE MEASUREMENTS

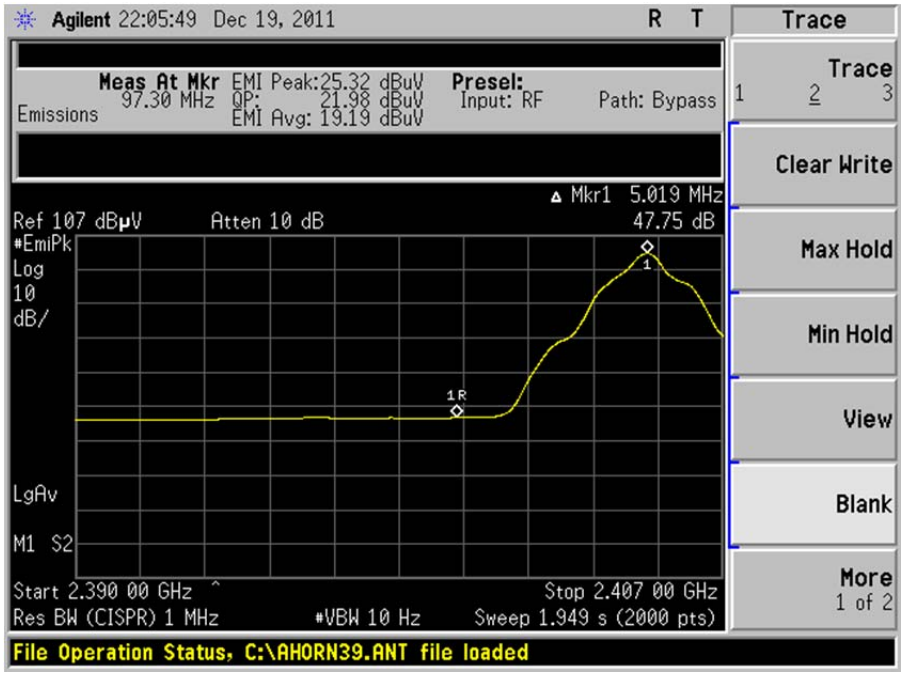
## 8.1 - Method of Measurements

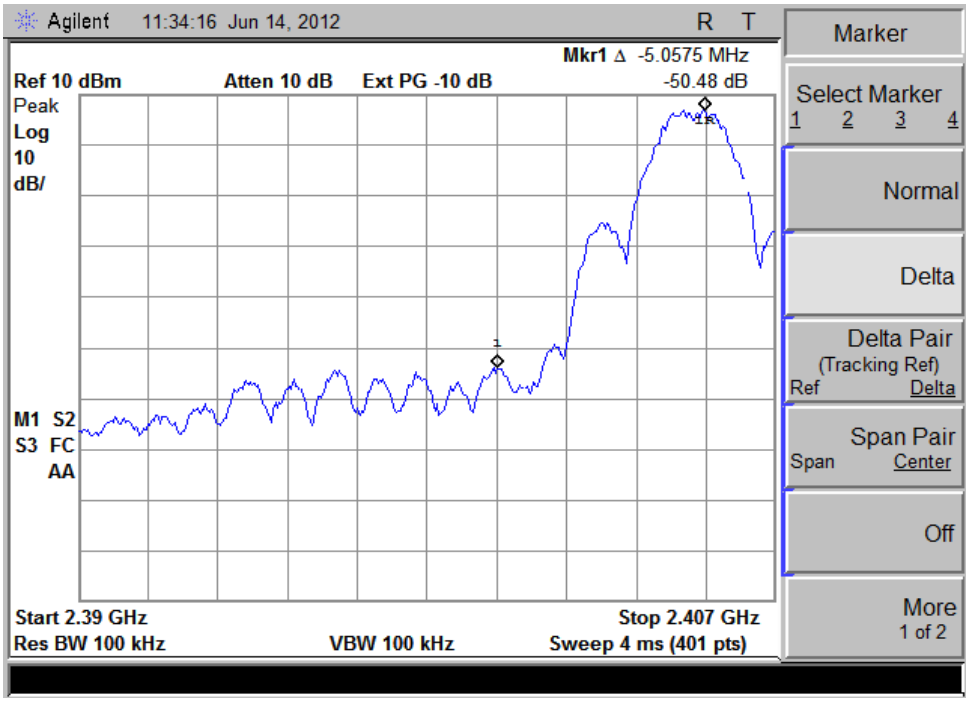
FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in tables 2 and 3 of the same standard and also to the limits in the applicable annex. The following screen captures demonstrate compliance of the intentional radiator at the 2400-2483.5 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

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

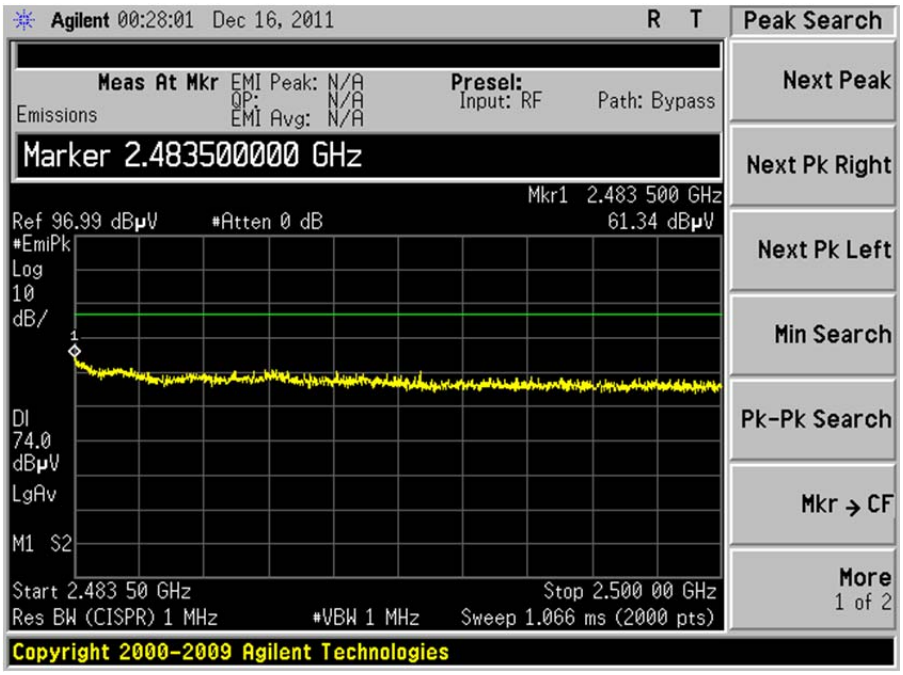
The Upper Band-Edge limit, in this case, would be + 54 dBµV/m at 3m.

Screen Capture Demonstrating Compliance at the Lower Band-Edge

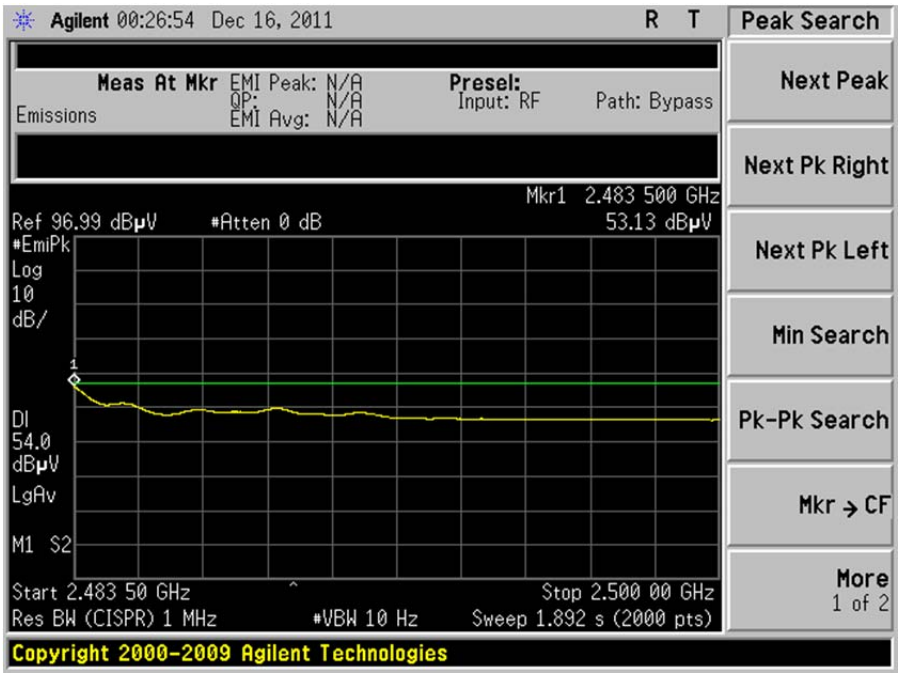




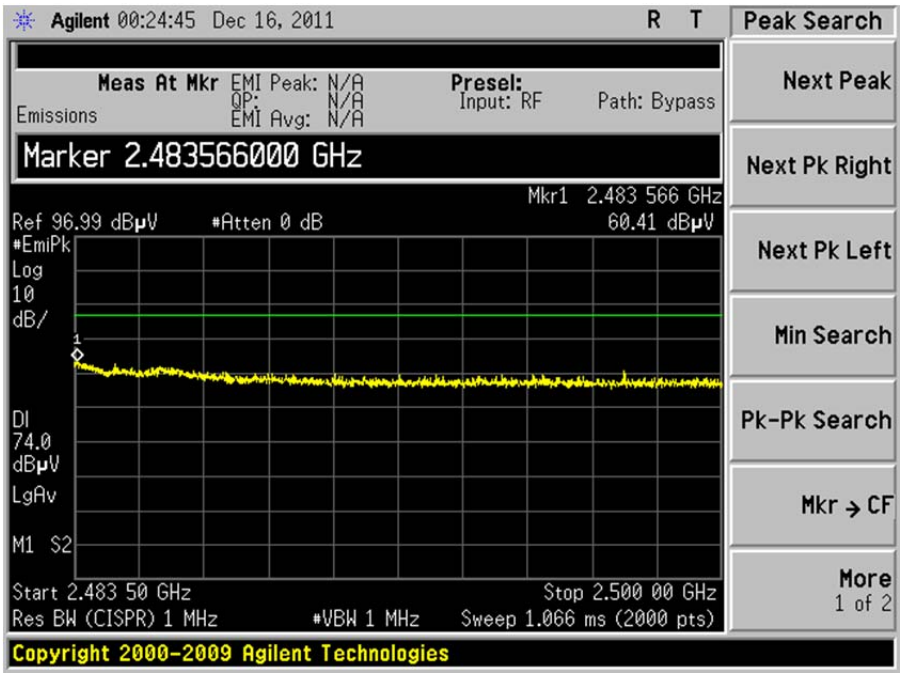

Screen Capture Demonstrating Compliance at the Higher Band-Edge



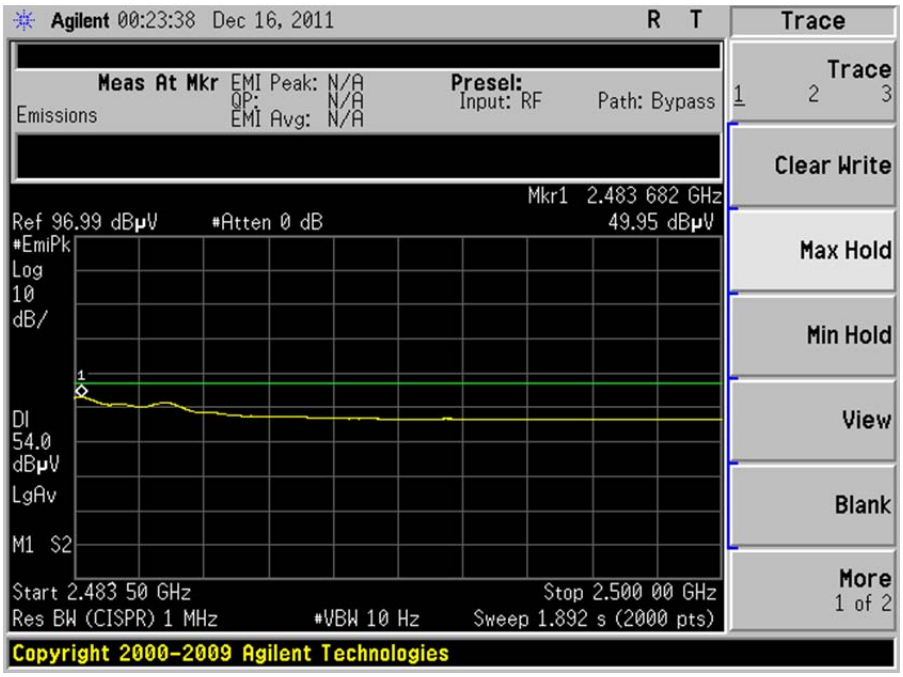

Channel 26, Power Level 210




Channel 26, Power Level 210




Channel 25, Full Power (245)




Channel 25, Full Power (245)

# 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. 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 20 MHz, with measurements from a peak detector presented in the chart below.

## 9.2 - Test Equipment List

A complete list of test equipment that was used for this test can be found in Appendix A.

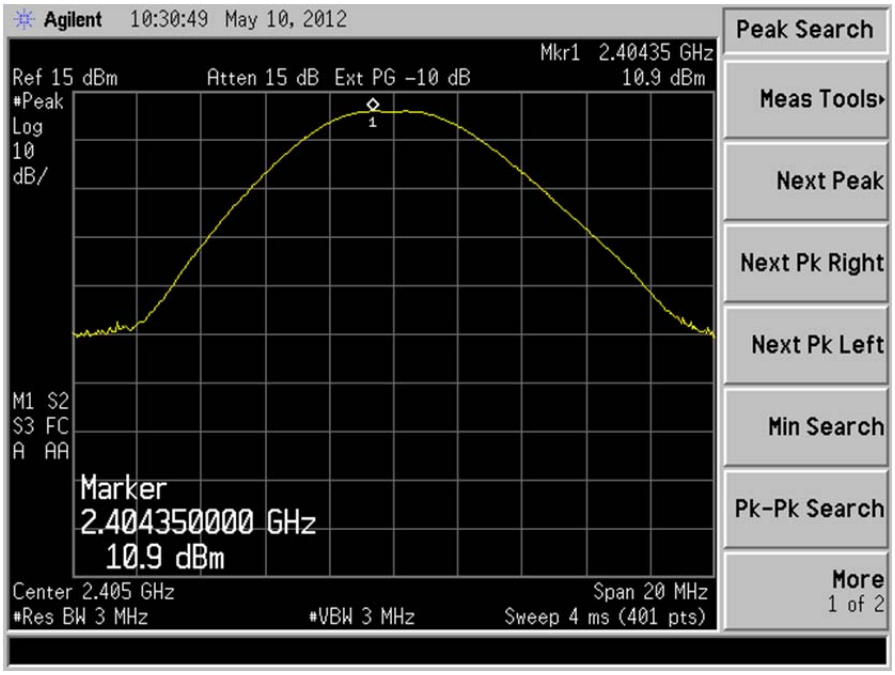
## 9.3 - Test Data

| Transmitter Channel | Freq. (MHz) | Peak Power at Antenna Terminal (dBm) | Conducted Power Limit (dBm) | Calculated EIRP (dBm) [(1)] | EIRP Limit (dBm) |
|---|---|---|---|---|---|
| 11 | 2405 | 10.90 | 30.0 | 12.90 | 36.0 |
| 18 | 2440 | 10.48 | 30.0 | 12.48 | 36.0 |
| 25 | 2475 | 10.00 | 30.0 | 12.00 | 36.0 |
| 26 | 2480 | 6.72 | 30.0 | 8.72 | 36.0 |

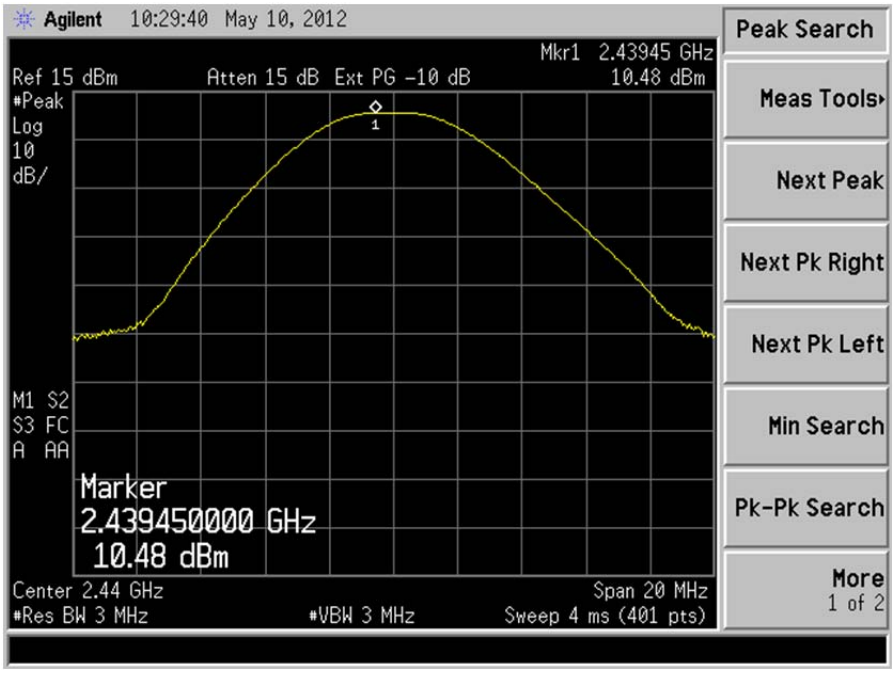
(1) EIRP Calculation:
EIRP = (Peak power at antenna terminal in dBm) + (EUT Antenna gain in dBi)

## 9.4 - Screen Captures – Power Output (Conducted)

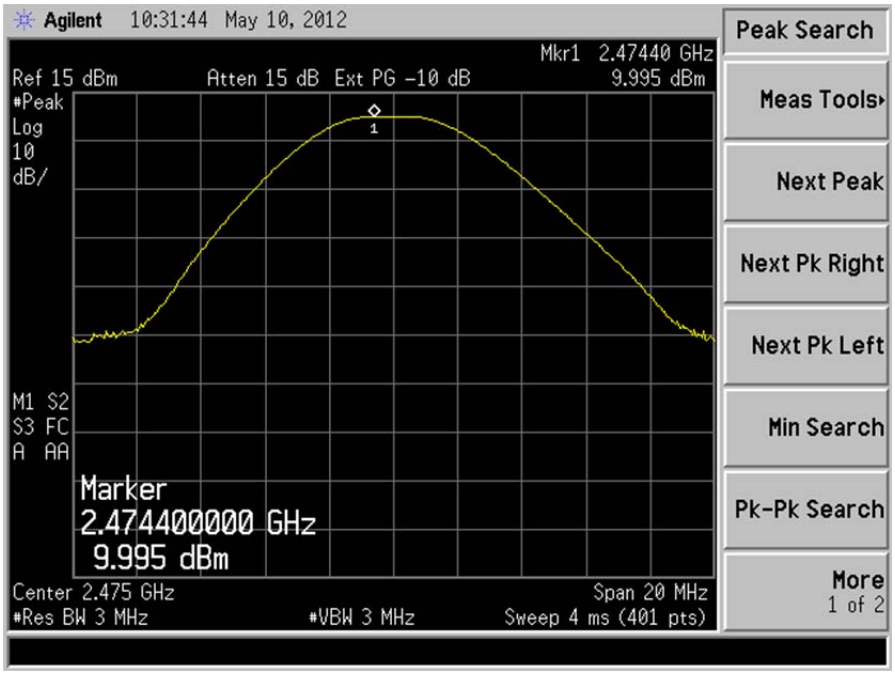
*Channel 11*



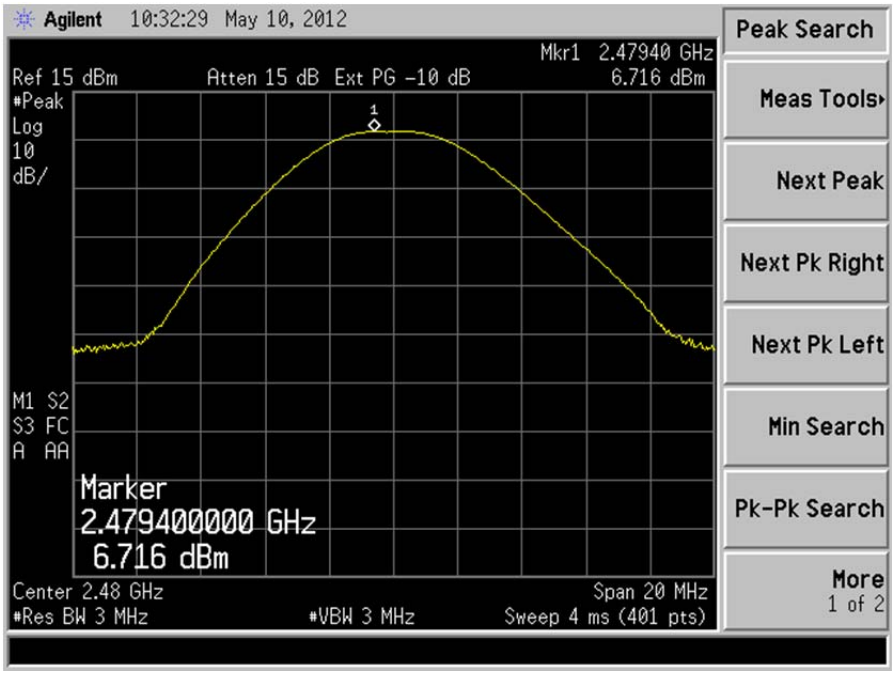

*Channel 18*



*Channel 25*




*Channel 26*



# 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) and RSS 210 A8.2(b), 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. The resultant density was then corrected to a 3 kHz bandwidth. The highest density was found to be no greater than -14.08 dBm, which is under the allowable limit by 22.08 dB.

## 10.2 - Test Equipment List

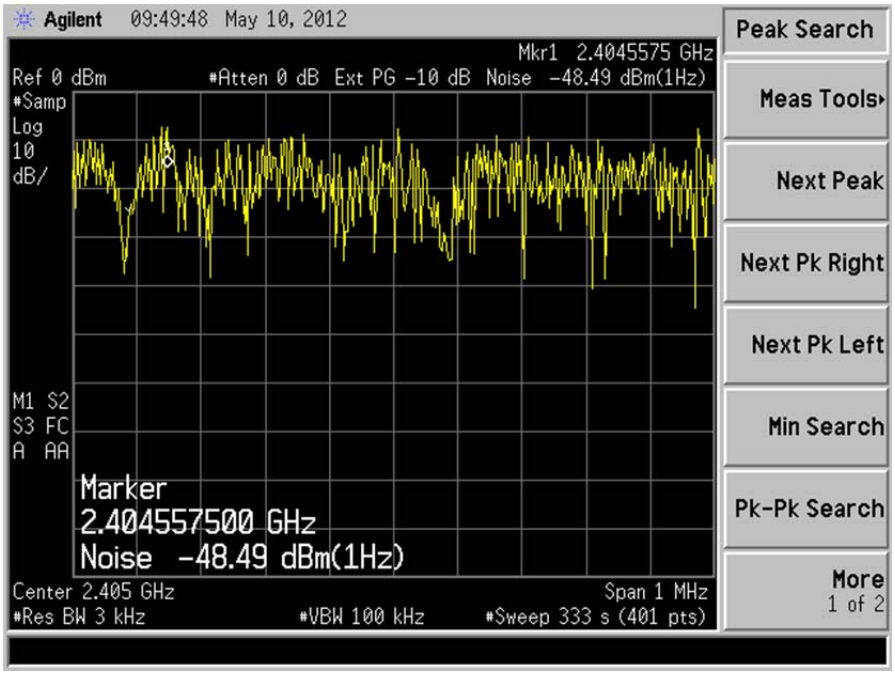
A complete list of test equipment can be found in Appendix A.

## 10.3 - Test Data

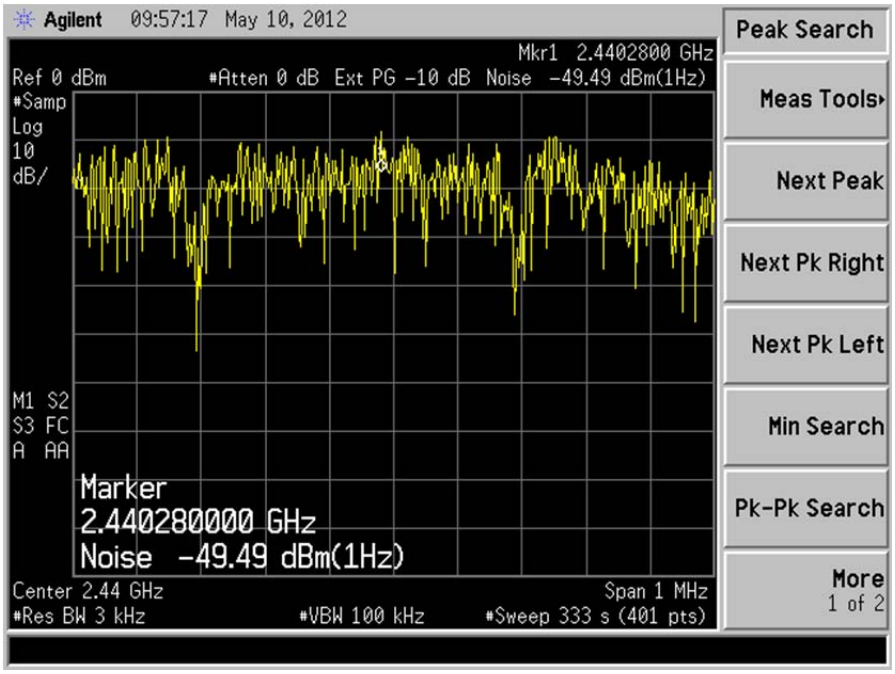
| Channel | Center Frequency (MHz) | Measured Power (dBm/Hz) | 3 kHz Correction (dB) | Corrected Measurement (dBm/3kHz) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|
| 11 | 2405 | -48.49 | 35.0 | -13.49 | +8.0 | 21.49 |
| 18 | 2440 | -49.49 | 35.0 | -14.49 | +8.0 | 22.49 |
| 25 | 2475 | -50.07 | 35.0 | -15.07 | +8.0 | 23.07 |
| 26 | 2480 | -55.97 | 35.0 | -20.97 | +8.0 | 28.97 |

## 10.4 - Screen Captures – Power Spectral Density

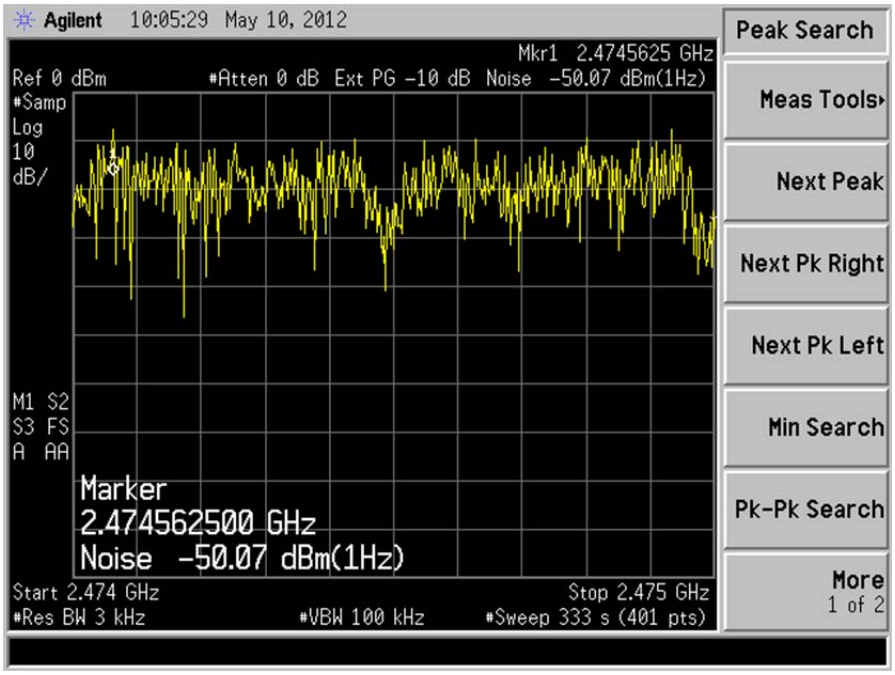
Channel 11



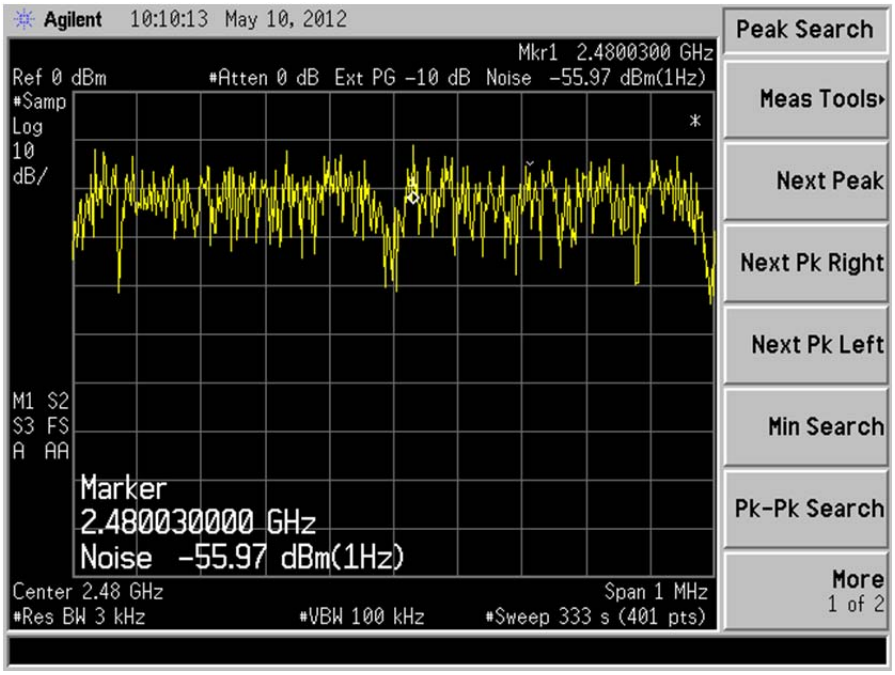

Channel 18



Channel 25




Channel 26



# EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

## 11.1 - Limits

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

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Sample reported data:

Raw Data + Cable Factor = Reported Data

6.23 dBm + 0.58 dB = 6.81 dBm

## 11.2 – Conducted Harmonic And Spurious RF Measurements

FCC Part 15.247(d) and IC RSS 210 A8.5 both require 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. An Agilent 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 -40 dBc of the fundamental level for this product.

| Frequency | Channel 11 2405 MHz | Channel 18 2440 MHz | Channel 25 2475MHz | Channel 26 2480 MHz |
|---|---|---|---|---|
| Fundamental | 6.92 | 6.20 | 5.819 | 2.80 |
| 2nd Harmonic | -48.72 | -52.87 | -54.84 | -58.41 |
| 3rd Harmonic | -37.03 | -39.10 | -41.58 | -52.26 |
| 4th Harmonic | -47.72 | -48.82 | -50.84 | -62.17 |
| 5th Harmonic | -68.65 | -68.42 | Note (1) | Note (1) |
| 6th Harmonic | Note (1) | Note (1) | Note (1) | Note (1) |
| 7th Harmonic | Note (1) | Note (1) | Note (1) | Note (1) |
| 8th Harmonic | Note (1) | Note (1) | Note (1) | Note (1) |
| 9th Harmonic | Note (1) | Note (1) | Note (1) | Note (1) |

| | | | | |
|---|---|---|---|---|
| 10th Harmonic | Note (1) | Note (1) | Note (1) | Note (1) |

Notes:
1. Measurement at system noise floor.
2. All measurements in dBm.

Spurious Conducted Emissions

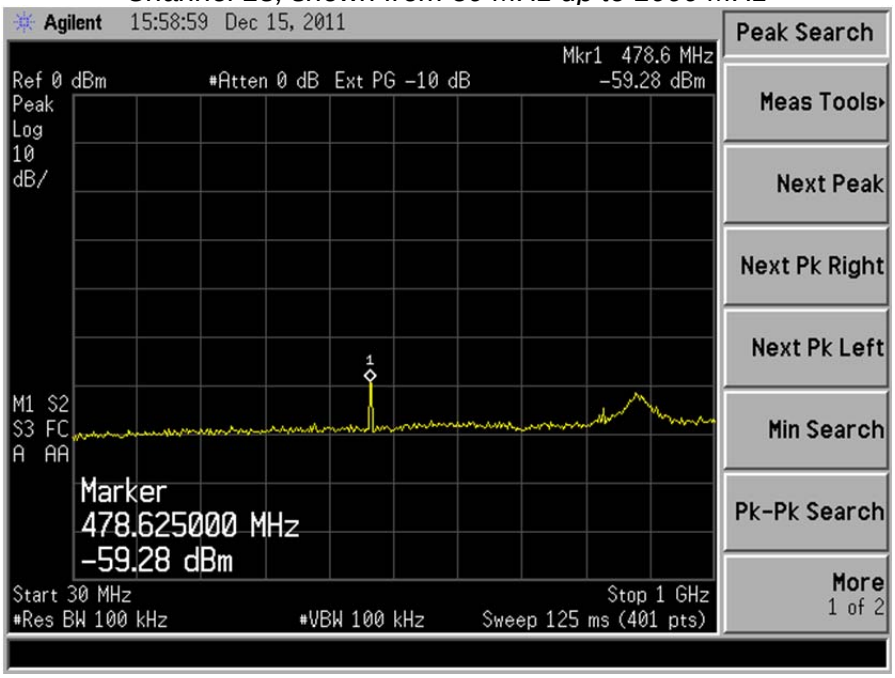
| Frequency (MHz) | Channel | Level(dBm) |
|---|---|---|
| 478.625 | 18 | -59.28 |
| 881.175 | 18 | -61.87 |
| 881.175 | 11 | -63.41 |
| 811.175 | 26 | -61.83 |

## 11.3 - Test Equipment List

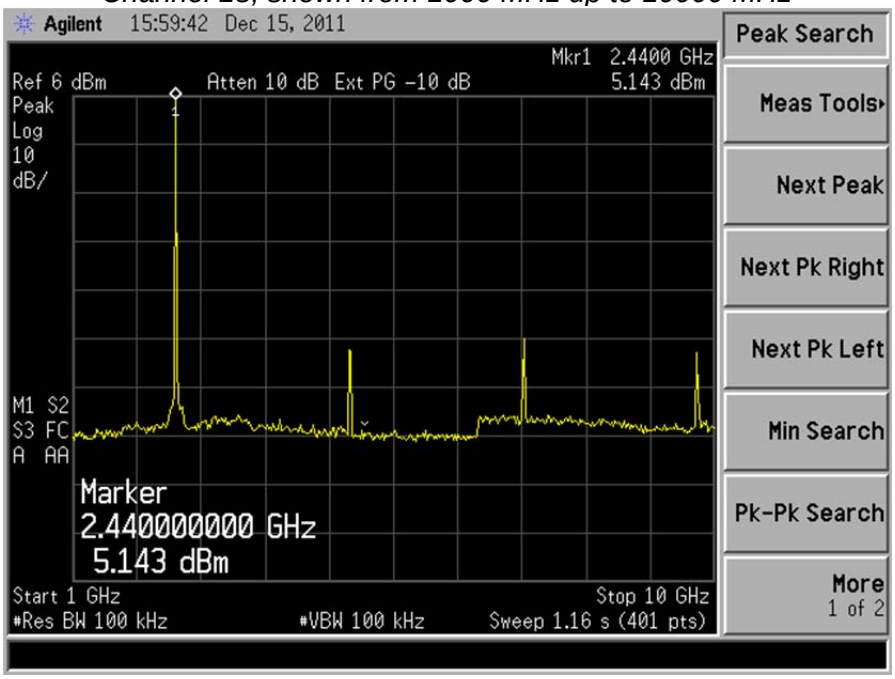
A complete list of test equipment that was used for this test can be found in Appendix A.

## 11.4 - Screen Captures – Spurious Radiated Emissions

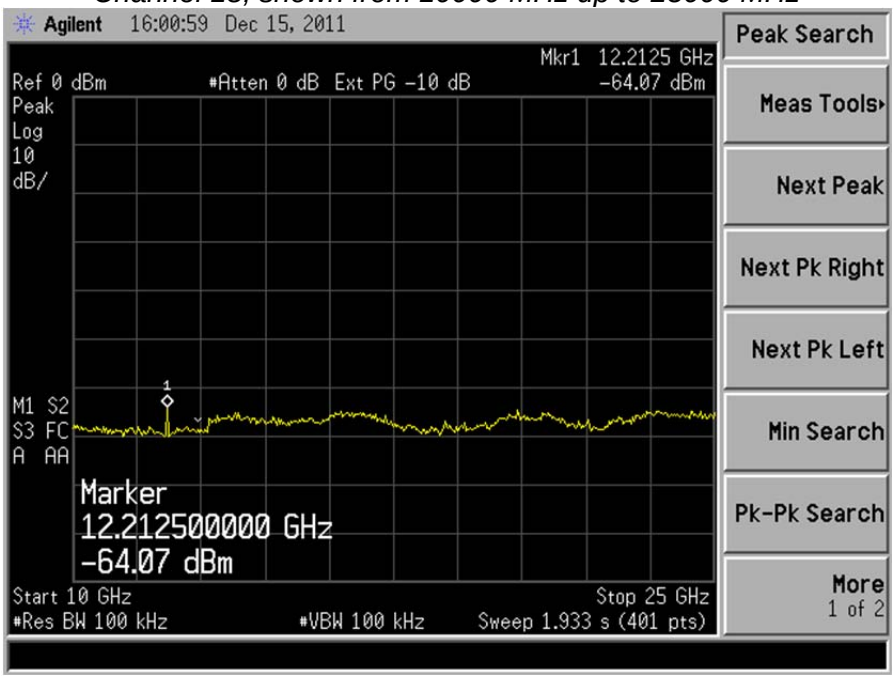
*Channel 18, shown from 30 MHz up to 1000 MHz*



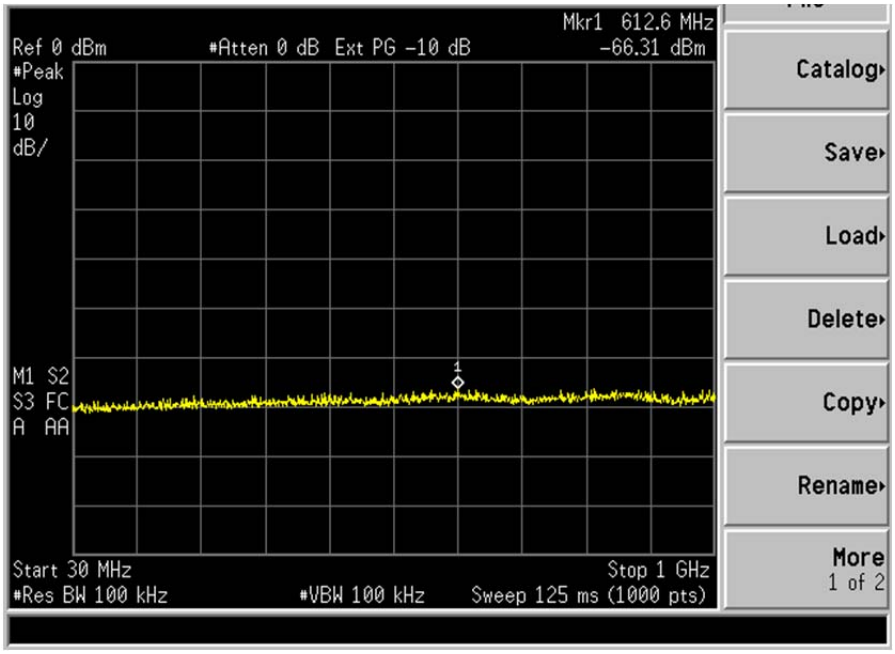
*Channel 18, shown from 1000 MHz up to 10000 MHz*



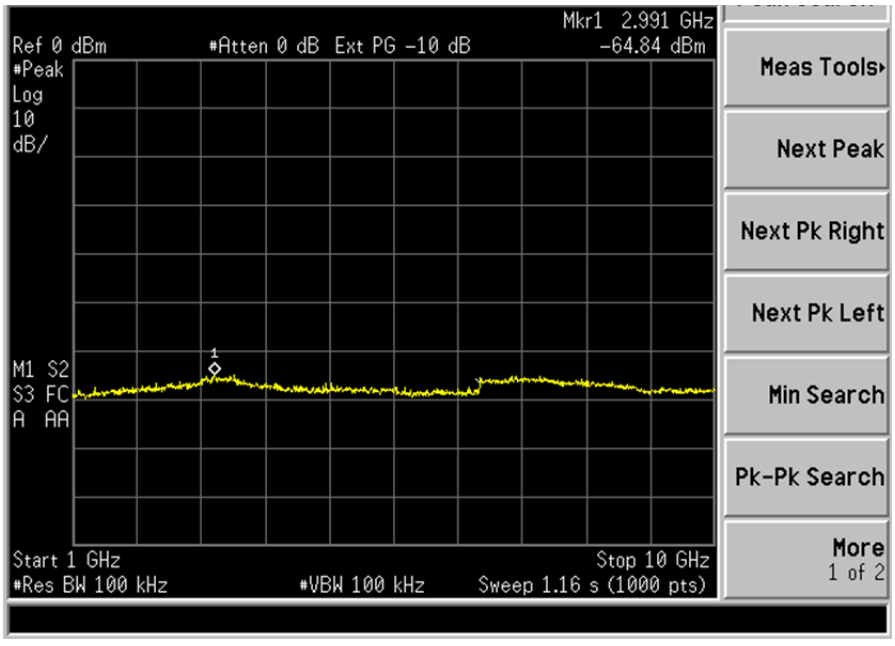

*Channel 18, shown from 10000 MHz up to 25000 MHz*



*Channel 18, shown from 30 MHz up to 1000 MHz*
*Receive Mode*

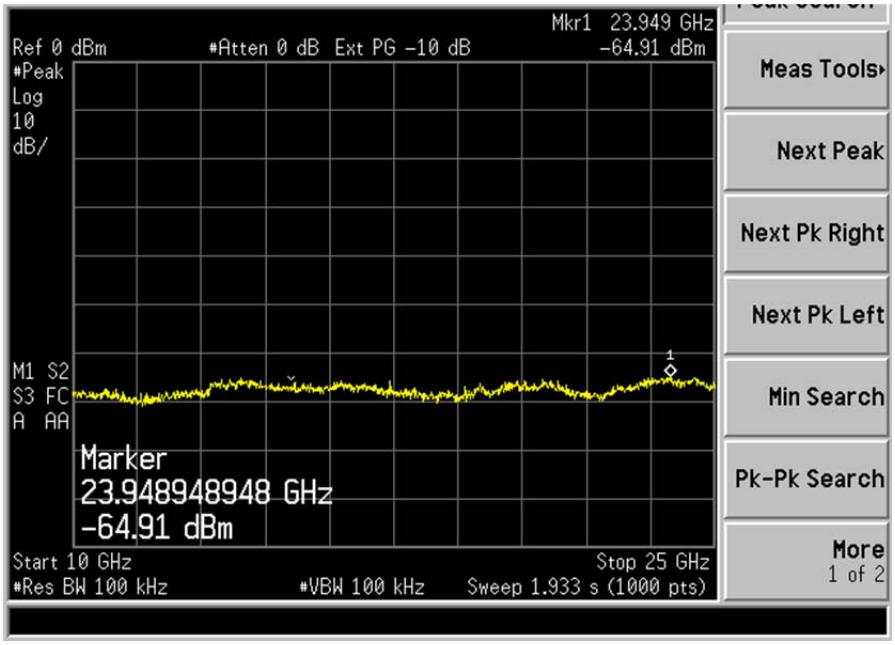



*Channel 18, shown from 1000 MHz up to 10000 MHz*
*Receive Mode*



*Channel 18, shown from 10000 MHz up to 25000 MHz*

Receive Mode



# EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

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=1 kHz settings while the voltage was varied. 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.

| Channel | 2.8VDC | | 3.3VDC | | 3.8VDC | |
|---|---|---|---|---|---|---|
| | **Power (dBm)** | **Frequency (Hz)** | **Power (dBm)** | **Frequency (Hz)** | **Power (dBm)** | **Frequency (Hz)** |
| 11 | 10.28 | 2404542500 | 10.90 | 2404533750 | 11.40 | 2404555000 |
| 18 | 9.87 | 2439541250 | 10.48 | 2439532500 | 10.98 | 2439533750 |
| 25 | 9.38 | 2475044250 | 10.00 | 2475045000 | 10.47 | 2475046800 |
| 26 | 6.39 | 2480040000 | 6.72 | 2480053750 | 7.02 | 2480065000 |

| Channel | Maximum Frequency (Hz) | Minimum Frequency (Hz) | Frequency Drift (Hz) |
|---|---|---|---|
| 11 | 2404555000 | 2404533750 | 21250 |
| 18 | 2439541250 | 2439532500 | 8750 |
| 25 | 2475046800 | 2475044250 | 2550 |
| 26 | 2480065000 | 2480040000 | 25000 |

# APPENDIX A – Test Equipment List

LS RESEARCH LLC
Wireless Product Development
**Equipment Calibration**

Date: 17-Dec-2011 Type Test: Radiated Emissions Job #: C-1243

Prepared By: Peter Customer: JCI Quote #: 311198

| No. | Asset # | Description | Manufacturer | Model # | Serial # | Cal Date | Cal Due Date | Equipment Status |
|---|---|---|---|---|---|---|---|---|
| 1 | EE 960156 | 100kHz-1GHz Analog Signal Generator | Agilent | N5181A | MY49060062 | 6/6/2011 | 6/6/2012 | Active Calibration |
| 2 | EE 960157 | 3Hz-13.2GHz Spectrum Analyzer | Agilent | E4445A | MY48250225 | 6/6/2011 | 6/6/2012 | Active Calibration |
| 3 | EE 960158 | RF Preselecter | Agilent | N9039A | MY46520110 | 6/11/2011 | 6/11/2012 | Active Calibration |
| 4 | AA 960078 | Log Periodic Antenna | EMCO | 93146 | 9701-4855 | 11/15/2011 | 11/15/2012 | Active Calibration |
| 5 | AA 960005 | Biconical Antenna | EMCO | 93110B | 9601-2280 | 6/10/2011 | 6/10/2012 | Active Calibration |
| 6 | AA 960007 | Double Ridge Horn Antenna | EMCO | 3115 | 9311-4138 | 4/27/2011 | 4/27/2012 | Active Calibration |
| 7 | EE 960160 | 0.8-21GHz LNA | Mini-Circuits | ZVA-213X-S+ | 977711030 | 4/27/2011 | 4/27/2012 | Active Calibration |

Project Engineer: Peter Fielen Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
**Equipment Calibration**

Date: 1-Jul-2011 Type Test: Occupied Bandwidth (6dB & 20dB) Job #: C-1243

Prepared By: Shane Rismeyer Customer: JCI Quote #: 311198

| No. | Asset # | Description | Manufacturer | Model # | Serial # | Cal Date | Cal Due Date | Equipment Status |
|---|---|---|---|---|---|---|---|---|
| 1 | AA 960143 | Phaseflex | Gore | EKD01D01048.0 | 5546519 | 6/1/2011 | 6/1/2012 | Active Calibration |
| 2 | EE 960073 | Spectrum Analyzer | Agilent | E4446A | US45300564 | 4/25/2011 | 4/25/2012 | Active Calibration |

Project Engineer: Quality Assurance: Peter Fielen

LS RESEARCH LLC
Wireless Product Development
**Equipment Calibration**

Date: 1-Jul-2011 Type Test: Conducted Power Output Job #: C-1243

Prepared By: Shane Rismeyer Customer: JCI Quote #: 311198

| No. | Asset # | Description | Manufacturer | Model # | Serial # | Cal Date | Cal Due Date | Equipment Status |
|---|---|---|---|---|---|---|---|---|
| 1 | AA 960143 | Phaseflex | Gore | EKD01D01048.0 | 5546519 | 6/1/2011 | 6/1/2012 | Active Calibration |
| 2 | EE 960073 | Spectrum Analyzer | Agilent | E4446A | US45300564 | 4/25/2011 | 4/25/2012 | Active Calibration |

Project Engineer: Quality Assurance: Peter Fielen

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 1-Jul-2011 Type Test: Power Spectral Density Job #: C-1243

Prepared By: Shane Riismeyer Customer: JCI Quote #: 311198

| No. | Asset # | Description | Manufacturer | Model # | Serial # | Cal Date | Cal Due Date | Equipment Status |
|---|---|---|---|---|---|---|---|---|
| 1 | AA 960143 | Phaseflex | Gore | EKD01D01048.0 | 5546519 | 6/1/2011 | 6/1/2012 | Active Calibration |
| 2 | EE 960073 | Spectrum Analyzer | Agilent | E4446A | US45300564 | 4/25/2011 | 4/25/2012 | Active Calibration |

Project Engineer: Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 1-Jul-2011 Type Test: Conducted Emissions Job #: C-1243

Prepared By: Shane Riismeyer Customer: JCI Quote #: 311198

| No. | Asset # | Description | Manufacturer | Model # | Serial # | Cal Date | Cal Due Date | Equipment Status |
|---|---|---|---|---|---|---|---|---|
| 1 | EE 960013 | EMI Receiver | HP | 8546A System | 3617A00320;3448A | 11/22/2011 | 11/22/2012 | Active Calibration |
| 2 | EE 960014 | EMI Receiver-filter section | HP | 85460A | 3448A00296 | 11/22/2011 | 11/22/2012 | Active Calibration |
| 3 | AA 960072 | Transient Limiter | HP | 11947A | 3107A02515 | 11/2/2011 | 11/2/2012 | Active Calibration |
| 4 | AA 960008 | LISN | EMCO | 3816/2NM | 9701-1057 | 1/4/2011 | 1/4/2012 | Active Calibration |

Project Engineer: Quality Assurance:

# APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

| STANDARD # | DATE | Am. 1 | Am. 2 |
|---|---|---|---|
| ANSI C63.10 | 2009 | | |
| FCC 47 CFR, Parts 0-15, 18, 90, 95 | 2009 | | |
| RSS 210 | 2010-12 | | |
| RSS GEN | 2010-12 | | |

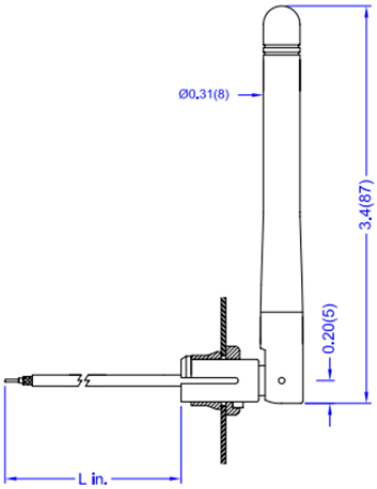
# APPENDIX C - Uncertainty Statement

***Table of Expanded Uncertainty Values, (K=2) for Specified Measurements***

| Measurement Type | Particular Configuration | Uncertainty Values |
|---|---|---|
| Radiated Emissions | 3 – Meter chamber, Biconical Antenna | 4.82 dB |
| Radiated Emissions | 3-Meter Chamber, Log Periodic Antenna | 4.88 dB |
| Radiated Emissions | 3-Meter Chamber, Horn Antenna | 4.85 dB |
| Radiated Emissions | 10-Meter OATS, Biconical Antenna | 4.32 dB |
| Radiated Emissions | 10-Meter OATS, Log Periodic Antenna | 3.63 dB |
| Absolute Conducted Emissions | Agilent PSA/ESA Series | 1.38 dB |
| AC Line Conducted Emissions | Shielded Room/EMCO LISN | 3.20 dB |
| Radiated Immunity | 3 Volts/Meter in 3-Meter Chamber | 2.05 Volts/Meter |
| Conducted Immunity | 3 Volts level | 2.33 V |
| EFT Burst, Surge, VDI | 230 VAC | 54.4 V |
| ESD Immunity | Discharge at 15kV | 3200 V |
| Temperature/Humidity | Thermo-hygrometer | 0.64° / 2.88 %RH |

# APPENDIX D - Antenna Specification(s)

Dipole Antenna Data Sheet




**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: | Polyurethene(Black) |
| Swivel Joint: | Polyurethene(Black) |
| Clip 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 In.(mm) | DWG. NO. | S131CL - L - XXX - 2450S | |
| SCALE none | NEARSON | | |

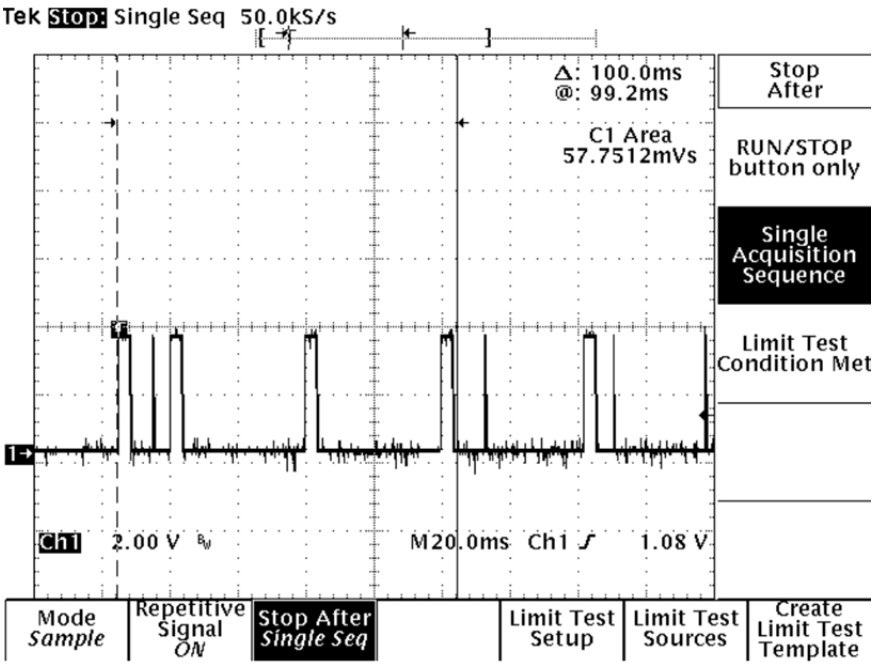
http://www.nearson.com

# APPENDIX E - Justifications of Average Duty Factor Calculations

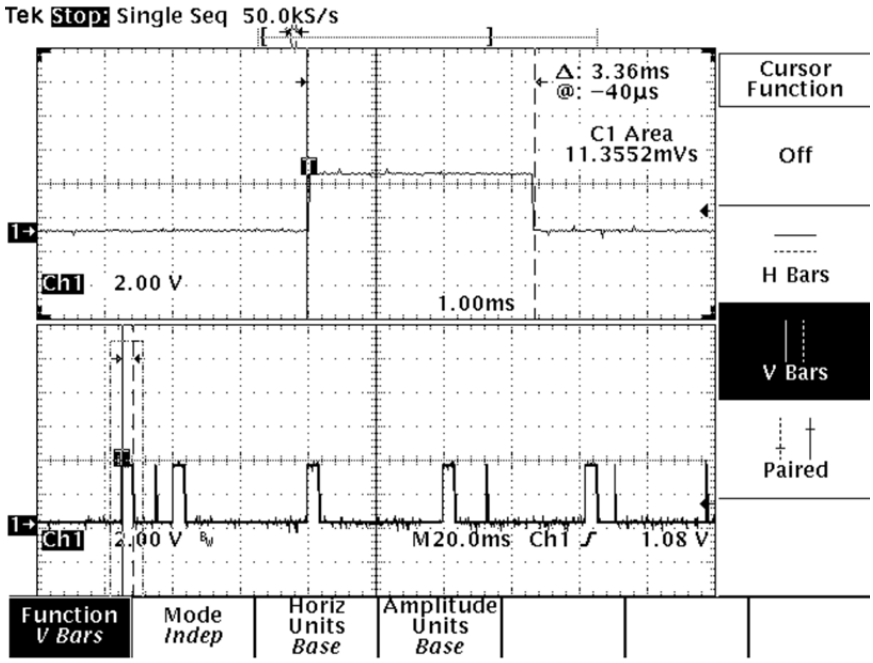
Average (Relaxation) Factor

Sum of 5 pulses = 3.36 ms + 0.42 ms + 3.86 ms + 3.80 ms + 3.82 ms = 15.26 ms

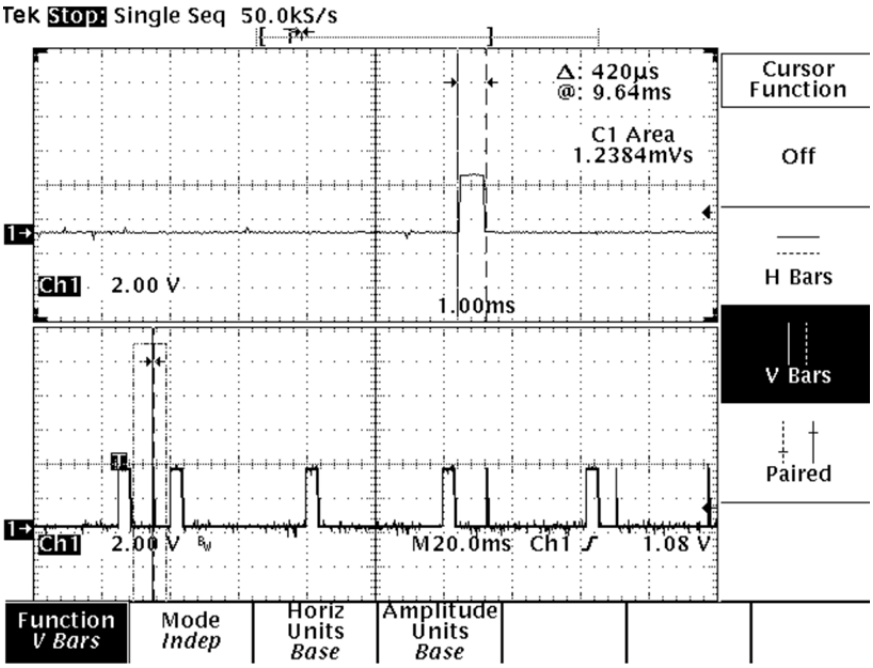
Average Factor = 20* $Log_{10}$ (.1526) = -16.33 dB



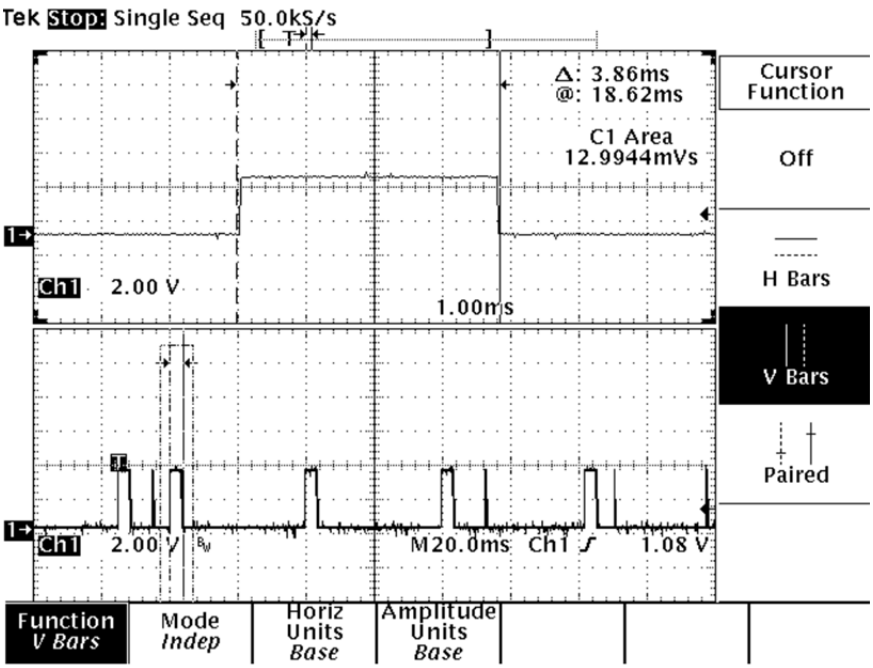

100 ms capture



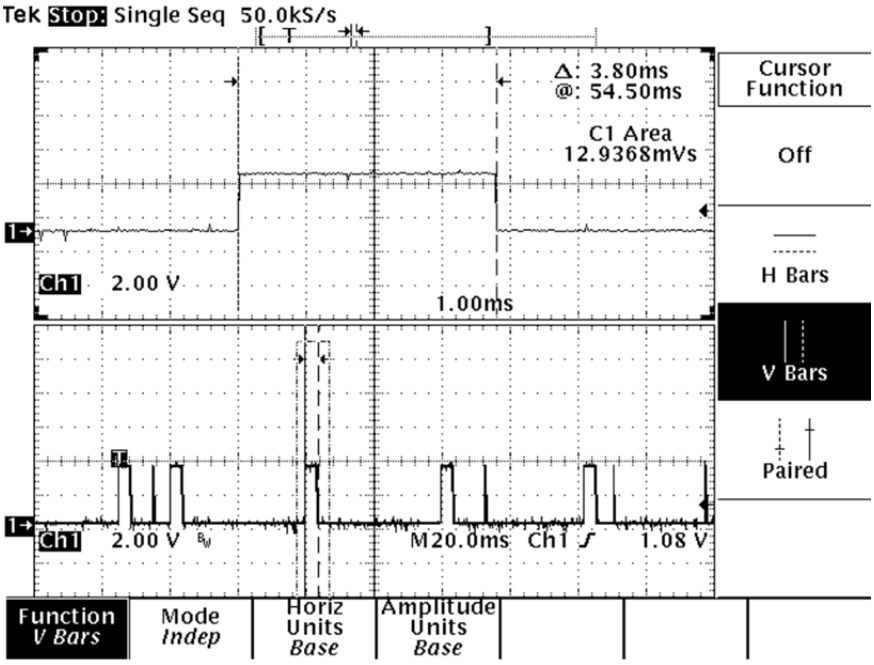

1st transmission pulse



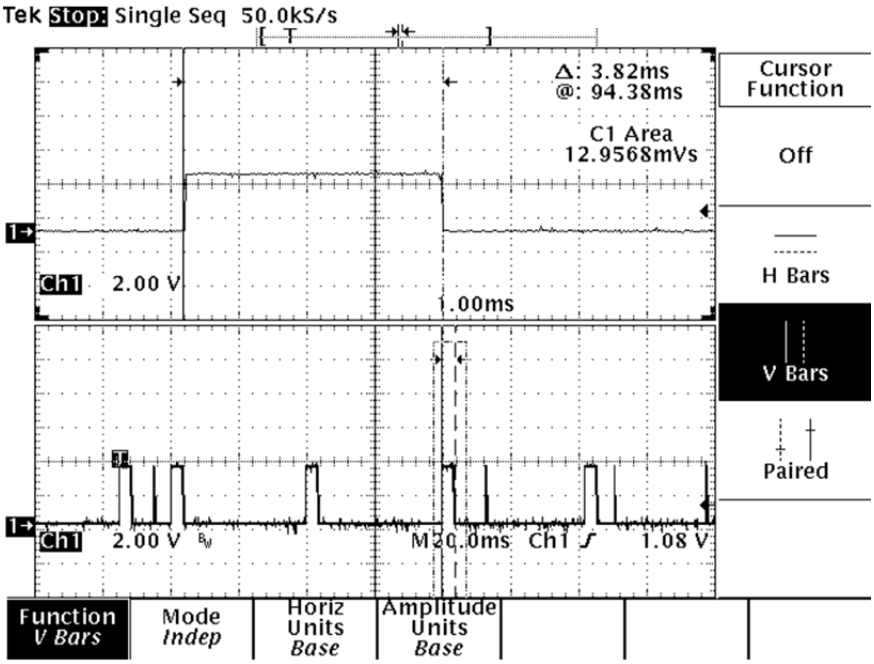

2nd transmission pulse




3rd transmission pulse




4th transmission pulse




5th transmission pulse