LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
TESTING CERT #1255.01
W66 N220 Commerce Court ● Cedarburg, WI 53012 ● USA
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www.lsr.com

# TEST REPORT # 311330
# LSR Job #: C-1349

Compliance Testing of:
**Wireless Entry/Exit Remote / Wireless Vent and Filter Boost Remote**

Test Date(s):
November 23, 28, 29, December 1, 2011

Prepared For:
Honeywell
Attn: Dave Mulhouse
1985 Douglas Drive North
Golden Valley, MN 55422

**In accordance with:**
**Federal Communications Commission (FCC)**
**Part 15, Subpart C, Section 15.247**
**Industry Canada (IC) RSS 210 Annex 8**
**Frequency Hopping Spread Spectrum (FHSS) Operating in the Frequency Band 902-928 MHz**

This Test Report is issued under the Authority of:

Signature: Thomas T. Smith Date: 12/28/2011

| Test Report Reviewed by: | Tested by: |
|---|---|
| Signature: Thomas T. Smith Date: 12/28/2011 | Peter Feilen, EMC Engineer.<br>Signature: Peter Feilen Date:12/1/11 |

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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 | Title |
|---|---|
| 47 CFR, Parts 0-15 (FCC) | Code of Federal Regulations - Telecommunications |
| RSS 210 Annex 8 | Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment |
| 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. |
| CISPR 16-1-1 | Specification for radio disturbance and immunity measuring apparatus and methods.<br>Part 1-1: Measuring Apparatus. |
| CISPR 16-2-1 | Specification for radio disturbance and immunity measuring apparatus and methods.<br>Part 201: Conducted disturbance measurement. |
| FCC Public Notice<br>DA 00-75 | Part 15 Unlicensed Modular Transmitter Approval |

## 1.3 - LS Research, LLC Test Facility

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

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

## 1.4 – Location of Testing

All testing was performed at the following location utilizing the facilities listed below, unless otherwise noted.

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA,

List of Facilities Located at LS Research, LLC:

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

## 1.5 – Test Equipment Utilized

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

# EXHIBIT 2. PERFORMANCE ASSESSMENT

## 2.1 – Client Information

| | |
|---|---|
| Manufacturer Name: | Honeywell |
| Address: | 1985 Douglas Drive North, Golden Valley, MN 55422 |
| Contact Name: | Dave Mulhouse |

## 2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

| | |
|---|---|
| Product Name: | Honeywell |
| Model Number: | REM1000R, HVC20A |
| Serial Number: | Engineering Sample |

## 2.3 - Associated Antenna Description

Ceramic chip antenna, with a gain of -0.5 dBi.

## 2.4 - EUT'S Technical Specifications

| | |
|---|---|
| EUT Frequency Range (in MHz) | 903-926.4 MHz |
| Maximum Conducted RF Power in Watts | 0.0116 W |
| Minimum Conducted RF Power in Watts | 0.0114 W |
| Maximum Conducted Output Power (in dBm) | 10.65 dBm |
| Minimum Conducted Output Power (in dBm) | 10.65 dBm |
| Field Strength at 3 meters | 106.1 dBuV/m @ 3m |
| Occupied Bandwidth (99% BW) | 68.2 kHz |
| Type of Modulation | FSK |
| Emission Designator | 68K2FXD |
| EIRP (in mW) | 10.35 mW |
| Transmitter Spurious (worst case) at 3 meters | 51.2 dBuV/m @ 3m @ 3705.6 MHz, see P.14 |
| Receiver Spurious (worst case) at 3 meters | 43.3 dBuV/m @ 3m @ 5487 MHz, see P.23 |
| Receiver Bandwidth | 101.562kHz |
| Receiver Sensitivity | -104 dB |
| Frequency Tolerance %, Hz, ppm | Better than 100 ppm |
| Microprocessor Model # (if applicable) | Texas Instrument MSP430F5524 |
| Antenna Information | |
| Detachable/non-detachable | Non-detachable |
| Type | Chip |
| Gain (in dBi) | -0.5 dBi |
| EUT will be operated under FCC Rule Part(s) | 15.247 |
| EUT will be operated under RSS Rule Part(s) | RSS-210 |
| Modular Filing | ☐ Yes ☒ No |
| Portable or Mobile? | Portable |

RF Technical Information:

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

*Procedure for Portable RF Exposure from KDB 447498:*

$$Output\ Power\ \leq \frac{60}{f\ (GHz)}(mW)$$

$$Output\ Power\ \leq \frac{60}{f\ (0.915)}(mW)$$

$$10.35\ mW\ \leq 65.57\ mW$$

Note: Since the peak output power of 10.35 mW is below the low threshold of 65.57 mW this device does not need SAR evaluation

## 2.5 - Product Description

This device has two functions, depending on which application it is paired with. As such, two product descriptions are possible.

Wireless Entry/Exit Remote:
The Wireless Entry/Exit Remote provides one-touch control of your heating or cooling system at the entry/exit point of your home or building.

The remote has three buttons. The button that is pressed sets the thermostat to that setting of the program schedule. That setting is held until another button is pressed on the remote or the regular program schedule is resumed at the thermostat.

Wireless Vent and Filter Boost Remote:
The Wireless Vent and Filter Boost Remote provides one-touch control of your ventilation and filtration system from bathrooms, laundry rooms, or any location in your home or building.

The remote has three buttons: 20, 40, and 60 minutes. The ventilation and filtration can be temporarily boosted for 20, 40, or 60 minutes, depending on the button pressed.

# EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

## 3.1 - Climate Test Conditions

| | |
|---|---|
| Temperature: | 68-74 ˚F |
| Humidity: | 40-45 % |
| Pressure: | 695-745 mmHg |

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

| FCC and IC Paragraph | Test Requirements | Compliance (Yes/No) |
|---|---|---|
| FCC : 15.247 (a)(1)(i)<br>IC : RSS 210 A8.1 (a) | 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 (a)(1)(i)<br>IC: RSS 210 (b) | Carrier Frequency Separation | YES |
| FCC:15.247 (a)(1)(i),(ii),(iii)<br>IC: RSS 210 (c),(d),(e) | Number of hopping channels | YES |
| FCC:15.247 (a)(1)(i),(ii),(iii)<br>IC: RSS 210 (c),(d),(e) | Time of occupancy (Dwell Time) | 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 |

## 3.3 - Modifications Incorporated In The EUT For Compliance Purposes

☐ None ☒ Yes (explain below)

The device was operated at power level 0xC2. This is a one step reduction from full power.

## 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 (2010), Annex 8 for a Frequency Hopping Spread Spectrum (FHSS) 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 C63.4-2003. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous modulated transmit mode for final testing using power as provided by a bench DC supply. 3 separate units were provided for testing on 3 different 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 (903.0), middle (914.6) and high (926.4) to comply with FCC Part 15.35. The channels and operating modes were set on 3 separate units.

## 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 10000 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 Bi-conical 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 10 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.

## 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 IEC/ISO 17025 accredited calibration laboratory, traceable to the SI standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The EMI Receiver was operated with resolution bandwidths as prescribed in ANSI C63.4.

## 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 (2010), Annex 8 for a FHSS 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 902 to 928 MHz band, as specified in Title 47 CFR 15.247 and RSS 210 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 A8.5, 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):
dBμV/m = 20 $\log_{10}$ (100)= 40 dBμV/m (from 30-88 MHz)

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

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

**Sample Calculation:**
**Reported Measurement data = Raw receiver measurement (dBμV/m) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB)**
**Generic example of reported data at 880 MHz:**

**Reported Measurement data = 9.8 (raw receiver measurement ) + 23.3 (antenna factor) + 1.45 (cable factor) = 34.6 (dBμV/m).**

## 5.6 - Radiated Emissions Test Data Chart

Frequency Range Inspected: 30 MHz to 10000 MHz

| | | | | | | |
|---|---|---|---|---|---|---|
| Manufacturer: | Honeywell | | | | | |
| Date(s) of Test: | November 23, 28, December 1, 2011 | | | | | |
| Project Engineer: | Peter Feilen | | | | | |
| Voltage: | 3.0 VDC | | | | | |
| Operation Mode: | Continuous transmit, modulated mode | | | | | |
| Environmental Conditions in the Lab: | Temperature: 71° F<br>Relative Humidity: 32 % | | | | | |
| EUT Power[1]: | | Single Phase ___VAC | | | 3 Phase ___VAC | |
| | X | Battery | | X | Other: Bench DC 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 | X | Final |
| Detectors Used: | | Peak | X | Quasi-Peak | | Average |

*Note 1: While the device typically operates with a coin cell battery, a DC supply was used for test purposes as battery life in continuous transmit mode was extremely limited.*

The following table depicts the level of significant spurious radiated RF emissions found (other than the fundamentals and its harmonics):

| Frequency (MHz) | Height (m) | Azimuth (degree) | Quasi Peak Reading (dBµV/m) | Quasi Peak Limit (dBµV/m) | Margin (dB) | Antenna Polarity | EUT orientation |
|---|---|---|---|---|---|---|---|
| 880.1 | 1.00 | 0 | 34.6 | 46.0 | 11.4 | H | V |
| 879.2 | 1.00 | 0 | 29.5 | 46.0 | 16.5 | V | V |
| 952.4 | 1.09 | 151 | 37.9 | 46.0 | 8.1 | V | V |
| 939.4 | 1.16 | 0 | 34.9 | 46.0 | 11.1 | V | V |
| 984.9 | 1.00 | 0 | 29.7 | 54.0 | 24.3 | V | V |
| 985.3 | 1.00 | 0 | 30.3 | 54.0 | 23.7 | H | V |

Note:
1. H: Horizontal, V: Vertical, F: Flat.
2. Emissions were the same per channel and EUT orientation.

*RADIATED EMISSIONS DATA CHART (continued)*

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

| Frequency (MHz) | Height (m) | Azimuth (degree) | Peak Reading (dBµV/m) | Avg Reading (dBµV/m) | Avg Limit (dBµV/m) | Margin (dB) | Antenna Polarity | EUT orientation |
|---|---|---|---|---|---|---|---|---|
| 2709 | 1.18 | 313 | 49.8 | 48.2 | 54.0 | 5.8 | Horizontal | Side |
| 3612 | 1.03 | 16 | 50.2 | 47.6 | 54.0 | 6.4 | Horizontal | Flat |
| 4515 | 1.00 | 6 | 54.8 | 52.5 | 63.5 | 11.0 | Vertical | Vertical |
| 5418 | 1.00 | 4 | 56.9 | 54.6 | 63.5 | 8.9 | Vertical | Vertical |
| 8127 | 1.07 | 354 | 53.2 | 49.3 | 63.5 | 14.2 | Vertical | Side |
| 9030 | 1.00 | 302 | 54.8 | 49.7 | 63.5 | 13.8 | Horizontal | Side |

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

| Frequency (MHz) | Height (m) | Azimuth (degree) | Peak Reading (dBµV/m) | Avg Reading (dBµV/m) | Avg Limit (dBµV/m) | Margin (dB) | Antenna Polarity | EUT orientation |
|---|---|---|---|---|---|---|---|---|
| 2743.8 | 1.14 | 306 | 48.1 | 45.9 | 54.0 | 8.1 | Horizontal | Side |
| 3658.4 | 1.00 | 27 | 50.4 | 47.8 | 54.0 | 6.2 | Horizontal | Flat |
| 4573 | 1.08 | 32 | 56.0 | 54.4 | 63.5 | 9.1 | Horizontal | Vertical |
| 7316.8 | 1.06 | 9 | 52.7 | 48.5 | 63.5 | 15.0 | Horizontal | Side |
| 8231.4 | 1.12 | 277 | 47.5 | 52.5 | 63.5 | 11.0 | Vertical | Vertical |
| 9146 | 1.00 | 11 | 53.5 | 48.3 | 63.5 | 15.3 | Horizontal | Side |

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

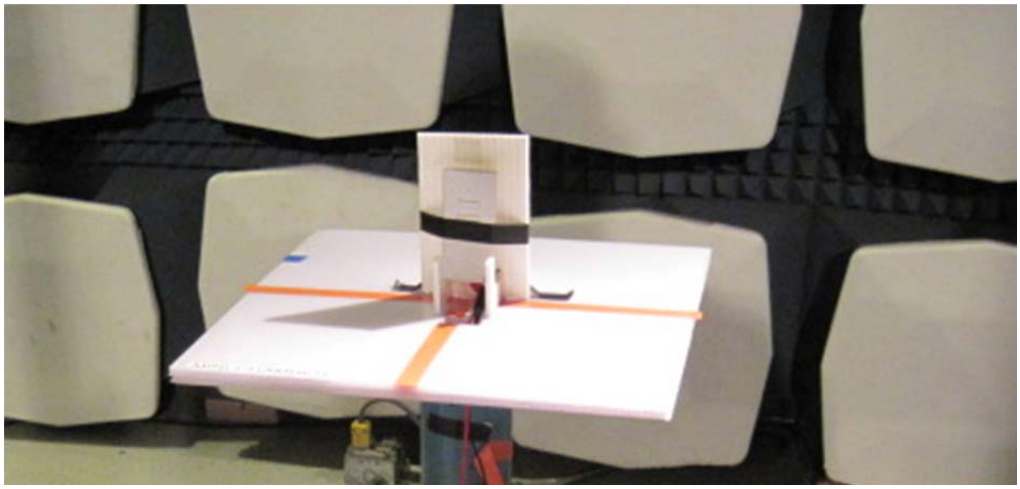
| Frequency (MHz) | Height (m) | Azimuth (degree) | Peak Reading (dBµV/m) | Avg Reading (dBµV/m) | Avg Limit (dBµV/m) | Margin (dB) | Antenna Polarity | EUT orientation |
|---|---|---|---|---|---|---|---|---|
| 2779.2 | 1.15 | 306 | 47.4 | 45.0 | 54.0 | 9.0 | Horizontal | Side |
| 3705.6 | 1.04 | 304 | 52.9 | 51.2 | 54.0 | 2.8 | Horizontal | Flat |
| 4632 | 1.09 | 21 | 52.5 | 50.3 | 54.0 | 3.7 | Vertical | Side |
| 7411.2 | 1.01 | 29 | 54.9 | 51.3 | 63.5 | 12.2 | Horizontal | Side |
| 8337.6 | 1.08 | 353 | 51.6 | 46.4 | 63.5 | 17.1 | Horizontal | Side |

*Notes:*

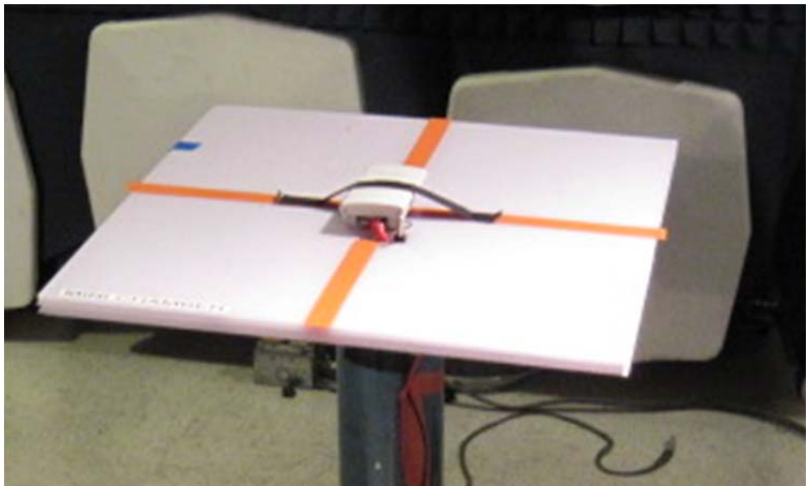
1. A Quasi-Peak Detector was used in measurements below 1 GHz. To ensure the peak emissions did not exceed 20 dB above the limits a peak detector was used. A peak detector with video averaging was used for measurements above 1 GHz.
2. Measurements above 4 GHz were made at 1 meters of separation from the EUT. Limits have been corrected to reflect the change in measurement distance.
3. H: Horizontal, V: Vertical, F: Flat, S: Side.

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

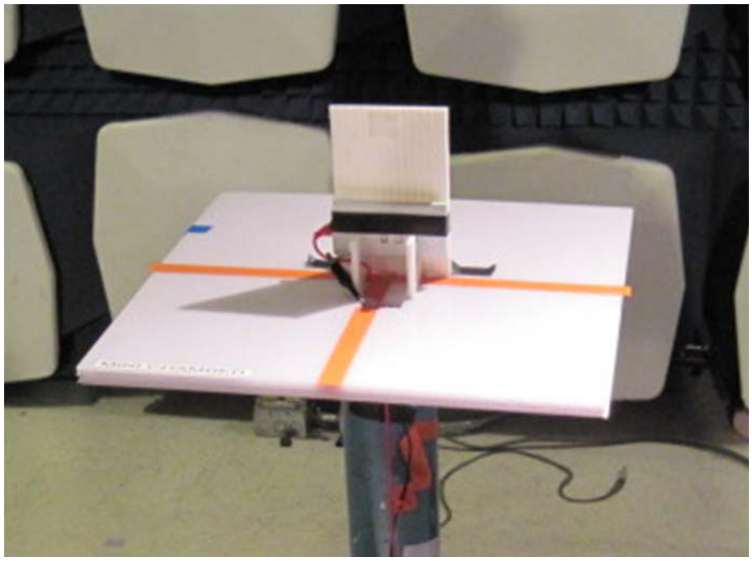
Vertical Orientation



Flat Orientation



Side Orientation

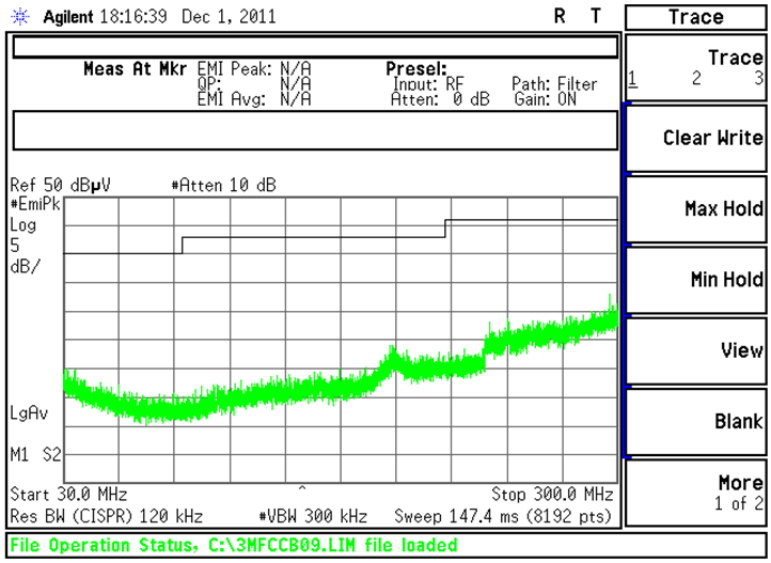


## 5.8 - Screen Captures - Radiated Emissions Test

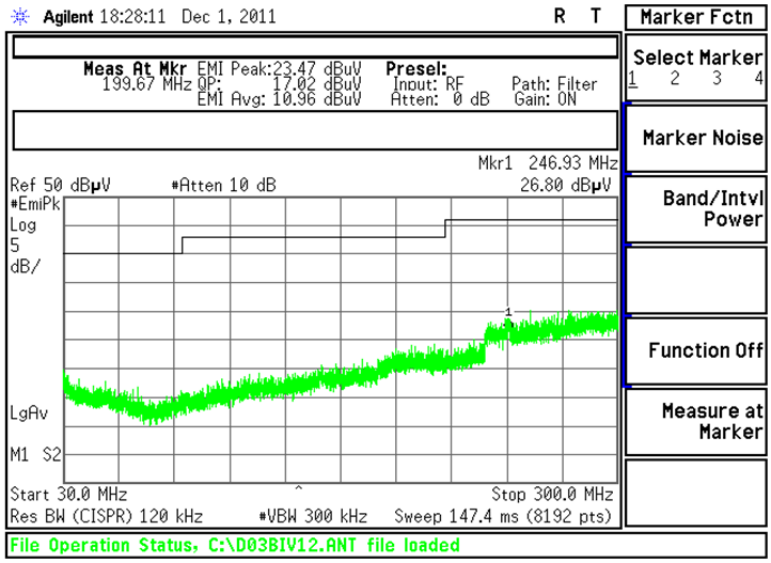
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and a video averaged Peak detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 903 MHz, 914.6 MHz, or 926.4 MHz, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

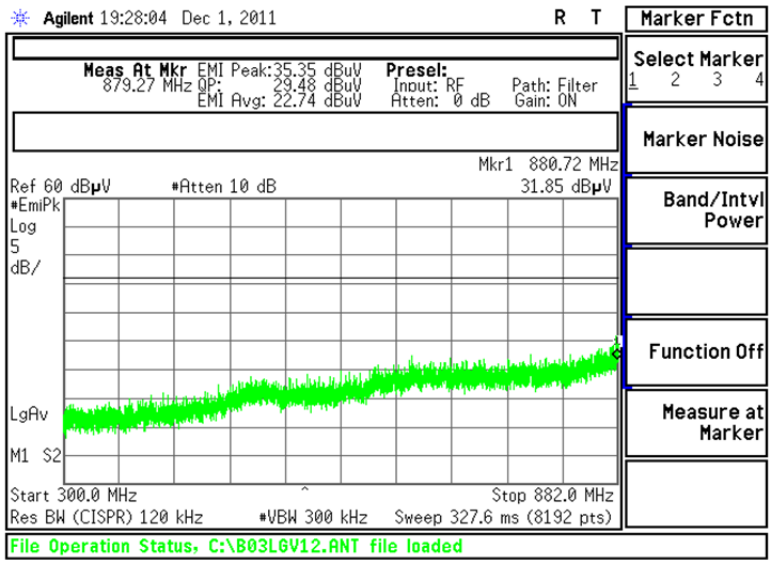
*Antenna Vertically Polarized, 30-300 MHz, at 3m*



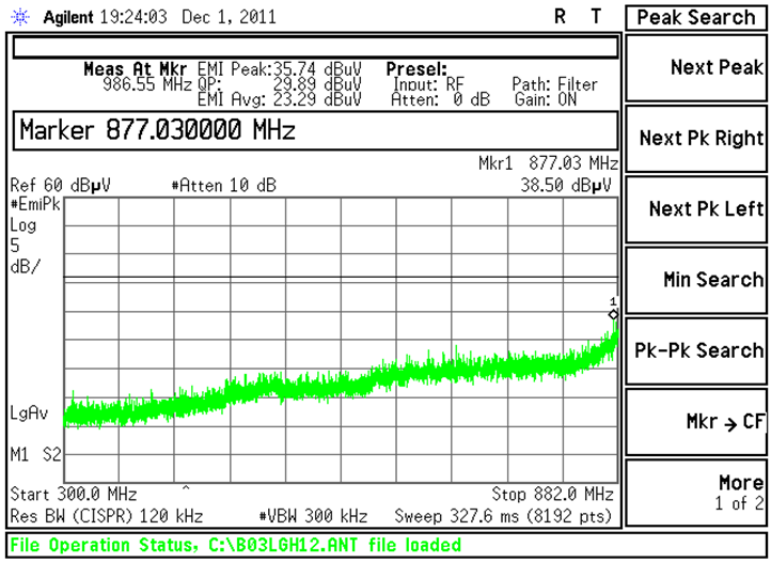
*Antenna Horizontally Polarized, 30-300 MHz, at 3m*




*Antenna Vertically Polarized, 300-882 MHz, at 3m*

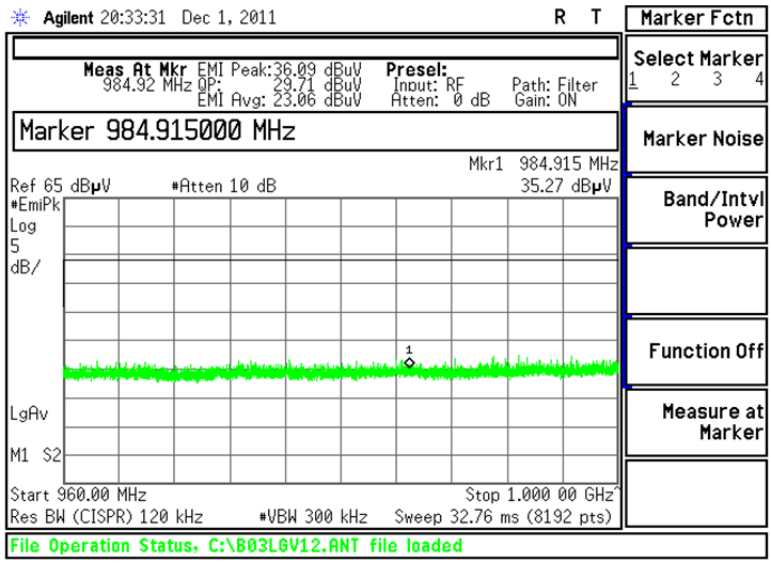


*Antenna Horizontally Polarized, 300-882 MHz, at 3m*

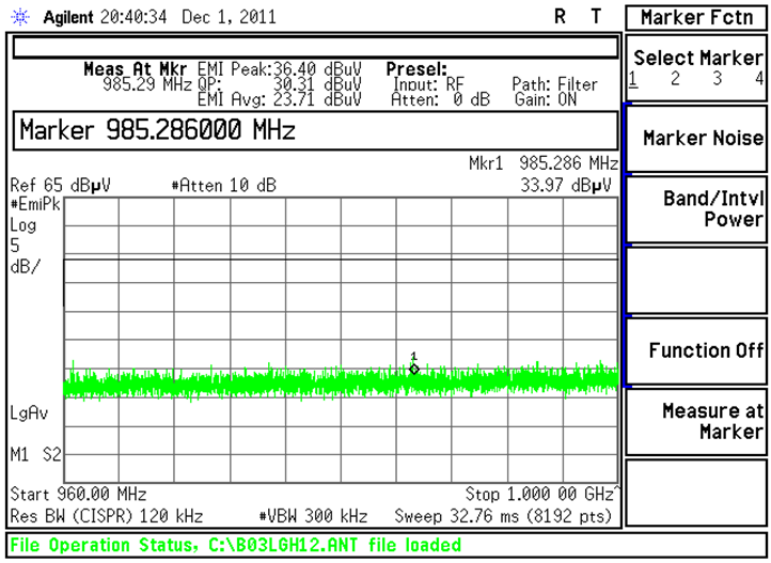



Note: The frequency range 882-902 MHz and 928-960 MHz is in the Band-edge section (Exhibit 7).

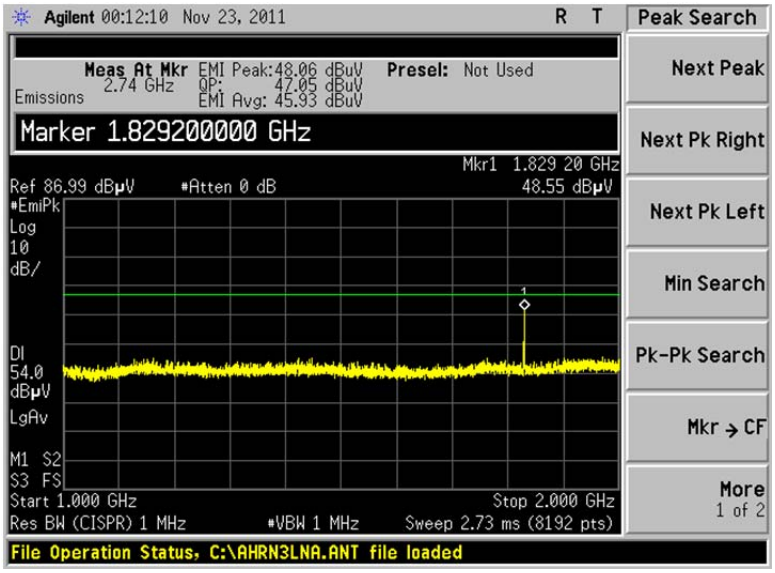
*Antenna Vertically Polarized, 960-1000 MHz, at 3m*



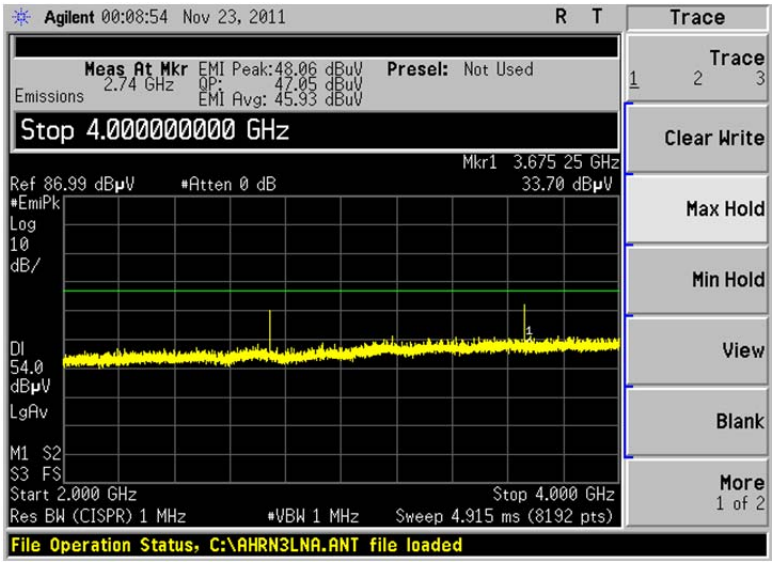
*Antenna Horizontally Polarized, 960-1000 MHz, at 3m*



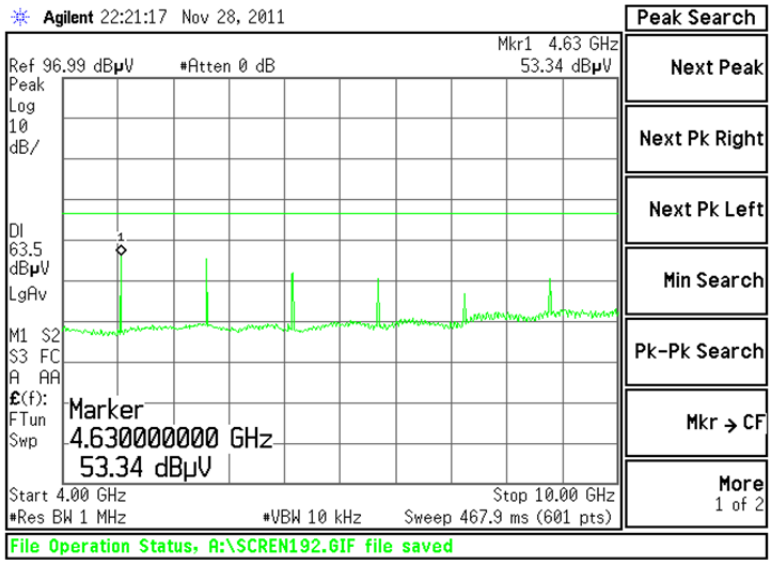

*Antenna Vertically Polarized, 1000-2000 MHz, at 3m*



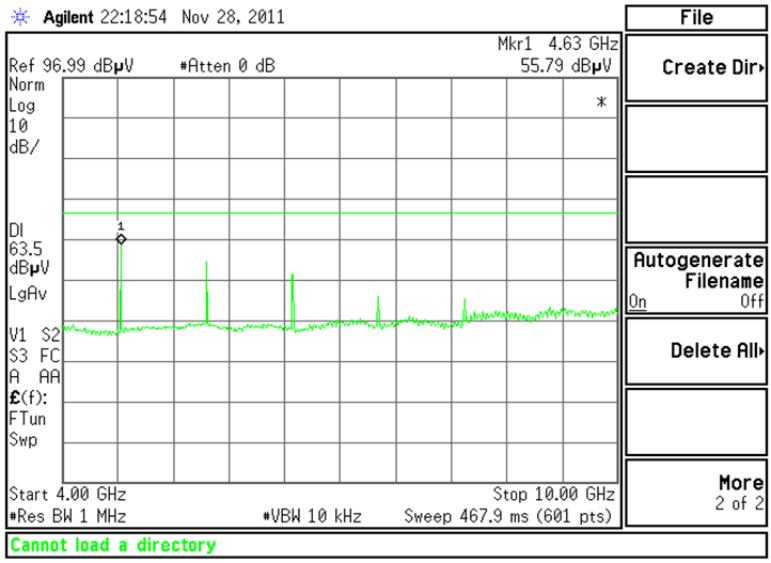
*Antenna Vertically Polarized, 2000-4000 MHz, at 3m*




*Antenna Vertically Polarized, 4000-10000 MHz, at 1m*



*Antenna Horizontally Polarized, 4000-10000 MHz, at 1m*



## 5.9 - Receive Mode Testing

Per the requirements of RSS-210 and CFR 47 part 15, 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 and CFR 47 15.109.

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 |
|---|---|---|---|---|---|---|---|
| 287.4 | 1.00 | 0 | 24.65 | 46.0 | 21.4 | V | V |
| 298.3 | 1.00 | 0 | 25.95 | 46.0 | 20.1 | H | V |
| 986.6 | 1.00 | 0 | 29.89 | 54.0 | 24.1 | H | V |
| 993.1 | 1.00 | 0 | 28.96 | 54.0 | 25.0 | V | V |

| Frequency (MHz) | Height (m) | Azimuth (degree) | Peak Reading (dBµV/m) | Average Reading (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) | Antenna Polarity | EUT orientation |
|---|---|---|---|---|---|---|---|---|
| 3889.0 | 1.00 | 0 | 44.85 | 35.43 | 54.0 | 18.5 | H | V |
| 5417.0 | 1.21 | 25 | 50.34 | 44.69 | 63.5 | 18.8 | H | F |
| 5417.0 | 1.00 | 137 | 51.04 | 46.86 | 63.5 | 16.6 | V | F |
| 5417.0 | 1.18 | 327 | 52.97 | 49.97 | 63.5 | 13.5 | V | S |
| 5417.0 | 1.13 | 145 | 51.77 | 47.77 | 63.5 | 15.7 | H | S |
| 5417.0 | 1.00 | 327 | 53.92 | 51.12 | 63.5 | 12.4 | H | V |
| 5417.0 | 1.16 | 220 | 51.41 | 47.02 | 63.5 | 16.5 | V | V |
| 5487.0 | 1.18 | 221 | 51.64 | 47.98 | 63.5 | 15.5 | V | V |
| 5487.0 | 1.00 | 31 | 55.08 | 52.79 | 63.5 | 10.7 | H | V |
| 5487.0 | 1.10 | 150 | 52.94 | 48.34 | 63.5 | 15.2 | H | S |
| 5487.0 | 1.01 | 340 | 54.1 | 50.82 | 63.5 | 12.7 | V | S |
| 5487.0 | 1.06 | 122 | 53.8 | 50.39 | 63.5 | 13.1 | V | F |
| 5487.0 | 1.16 | 17 | 50.76 | 44.98 | 63.5 | 18.5 | H | F |
| 5558.0 | 1.27 | 37 | 50.21 | 44.38 | 63.5 | 19.1 | H | F |
| 5558.0 | 1.13 | 95 | 51.54 | 47.04 | 63.5 | 16.5 | V | F |
| 5558.0 | 1.00 | 2 | 53.06 | 49.30 | 63.5 | 14.2 | V | S |
| 5558.0 | 1.13 | 149 | 50.88 | 46.37 | 63.5 | 17.1 | H | S |
| 5558.0 | 1.00 | 29 | 54.38 | 51.74 | 63.5 | 11.8 | H | V |
| 5558.0 | 1.00 | 27 | 50.88 | 45.11 | 63.5 | 18.4 | V | V |

*Notes:*

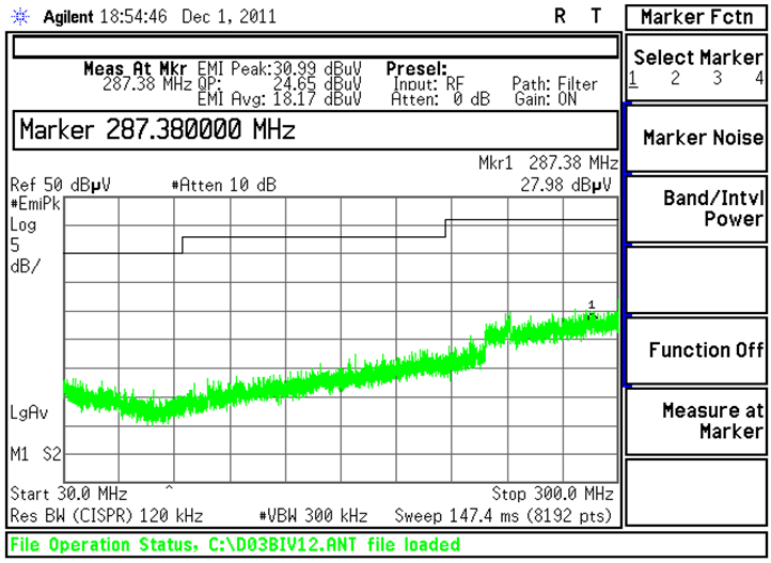
1. A Quasi-Peak Detector was used in measurements below 1 GHz. To ensure the peak emissions did not exceed 20 dB above the limits a peak detector was used. A peak detector with video averaging was used for measurements above 1 GHz.
2. Measurements above 4 GHz were made at 1 meters of separation from the EUT.
3. H: Horizontal, V: Vertical, F: Flat, S: Side.

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

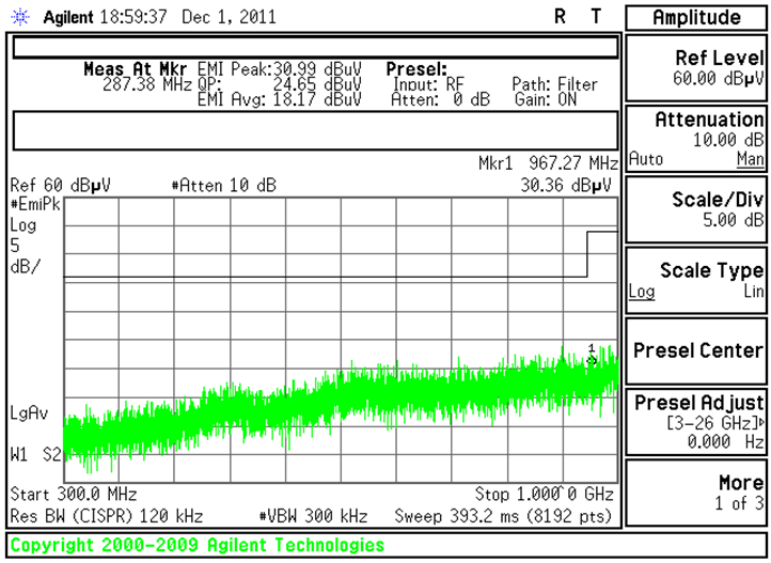
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and a video averaged peak detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 903 MHz, 914.6 MHz, or 926.4 MHz, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

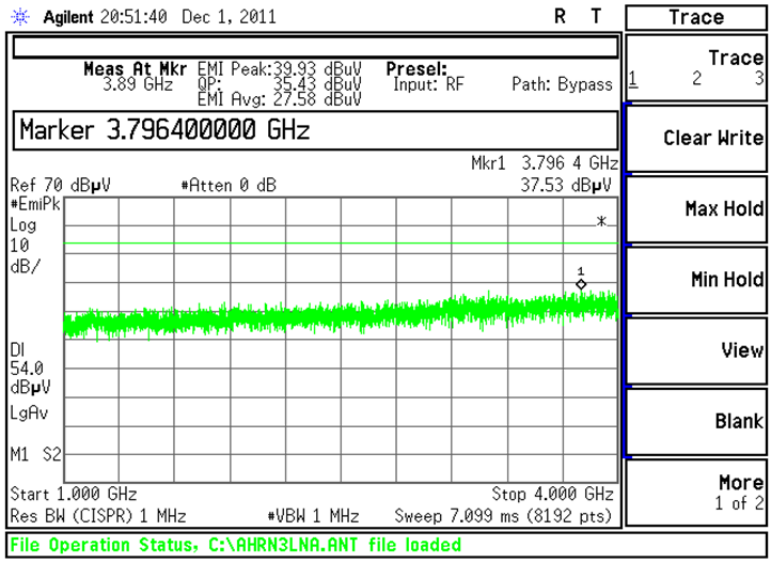
*Antenna Vertically Polarized, 30 MHz to 300 MHz*



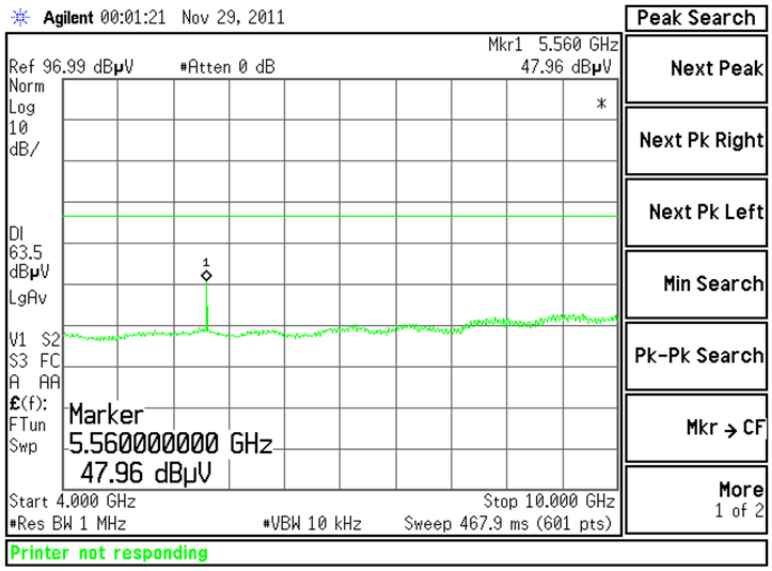
*Antenna Horizontally Polarized, 300 MHz to 1000 MHz*




*Antenna Vertically Polarized, 1000 MHz to 4000 MHz*



*Antenna Horizontally Polarized, 4000 MHz to 10000MHz*



# EXHIBIT 6. OCCUPIED BANDWIDTH

## 6.1 - Limits

For a frequency Hopping system in the 902 to 928 MHz band, the 20 dB bandwidth shall not exceed 500 kHz for FCC CFR 47 15.247 (a)(1)(i) and IC RSS 210 A8.1(c).

## 6.2 - Method of Measurements

The transmitter output was connected to the Spectrum Analyzer. The built-in measurement function of the Agilent E4446A spectrum analyzer was used. The occupied bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 10 kHz RBW and VBW=100 kHz.

For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to a 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, allowing direct measurements, without the need for any further corrections. A spectrum analyzer was used with the resolution bandwidth set to 1 kHz for this portion of the tests. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

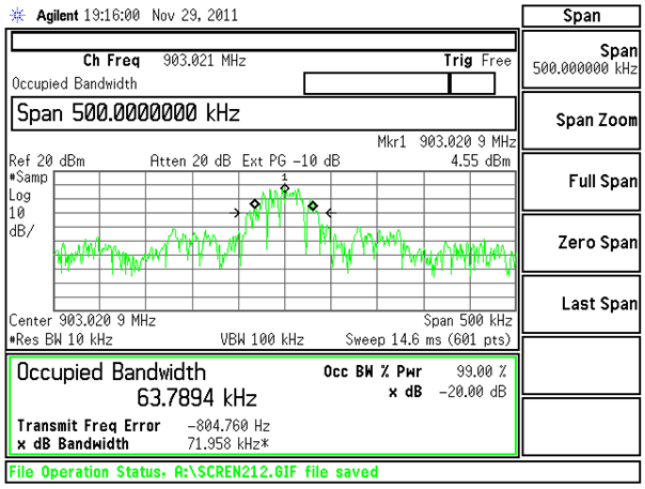
From this data, the greatest 20 dB occupied bandwidth is 73.2 kHz.

## 6.3 - Test Data

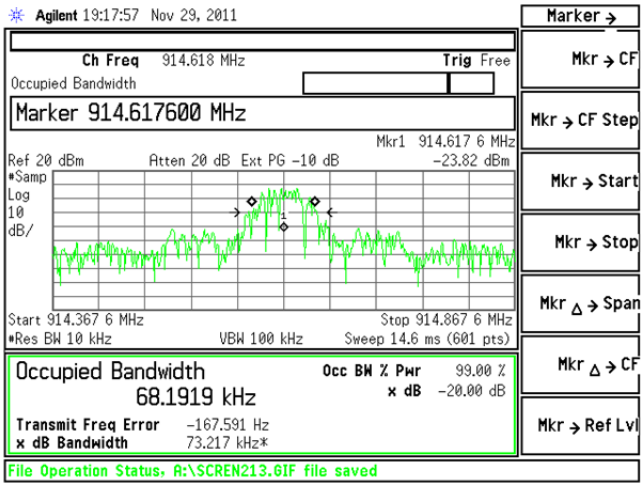
| Center Frequency (MHz) | Measured -20 dBc Occ. BW (kHz) |
|---|---|
| 903.0 | 71.96 |
| 914.6 | 73.22 |
| 926.4 | 72.85 |

## 6.4 - Screen Captures - Occupied Bandwidth

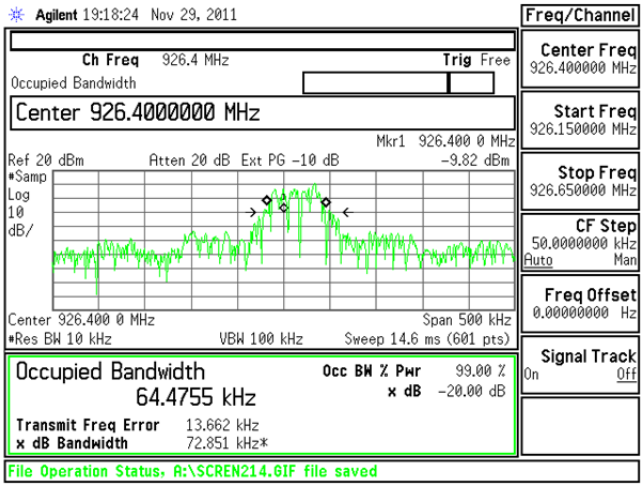
Channel low -20 dBc Occupied Bandwidth



Channel middle -20 dBc Occupied Bandwidth




Channel high -20 dBc Occupied Bandwidth



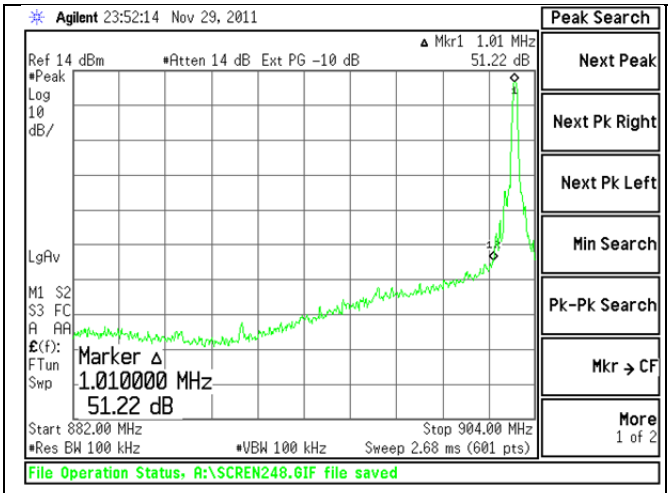
# EXHIBIT 7. BAND EDGE MEASUREMENTS

## 7.1 - Method of Measurements

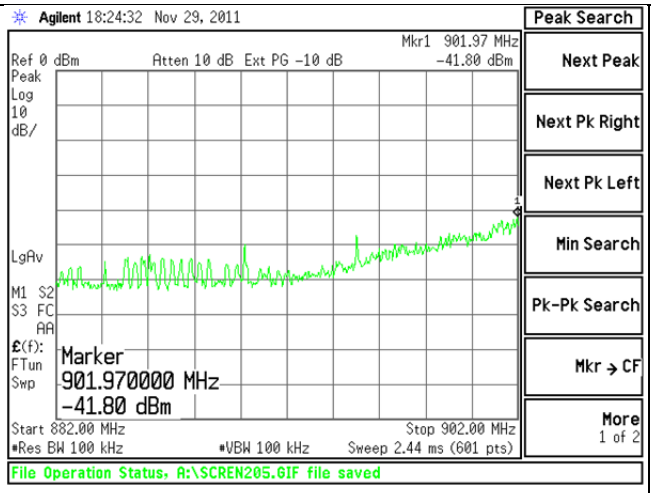
FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in tables 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 902 MHz to 928 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.

## 7.2 – Screen Captures

Screen Capture Demonstrating Compliance at the Lower Band-Edge




In CW Mode

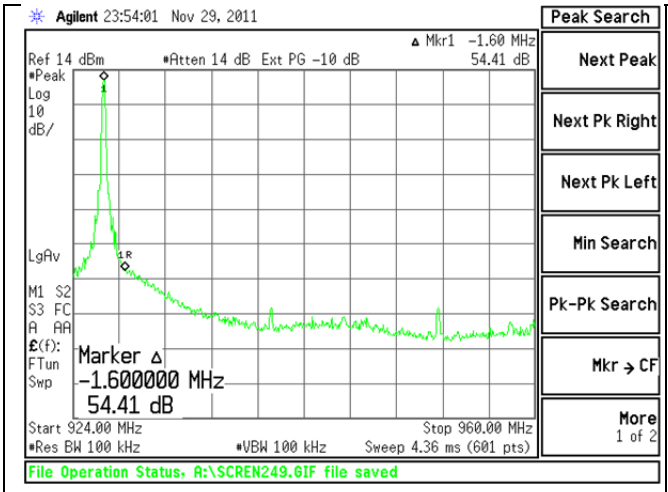



In Hopping Mode

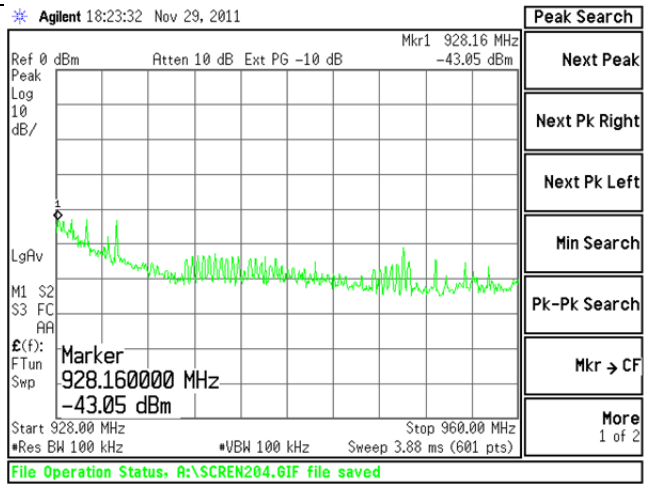
The Lower Band-Edge limit, in this case, would be 86.1 dBuV/m at 3m radiated.

The Lower Band-Edge limit, in this case, would be -9.45 dBm conducted.

## Screen Capture Demonstrating Compliance at the Higher Band-Edge




In CW Mode




In Hopping Mode

The Upper Band-Edge limit, in this case, would be 85.9 dBuV/m at 3m radiated.

The Upper Band-Edge limit, in this case, would be -9.35 dBm at 3m conducted.

# EXHIBIT 8. POWER OUTPUT (CONDUCTED)

## 8.1 - Method of Measurements

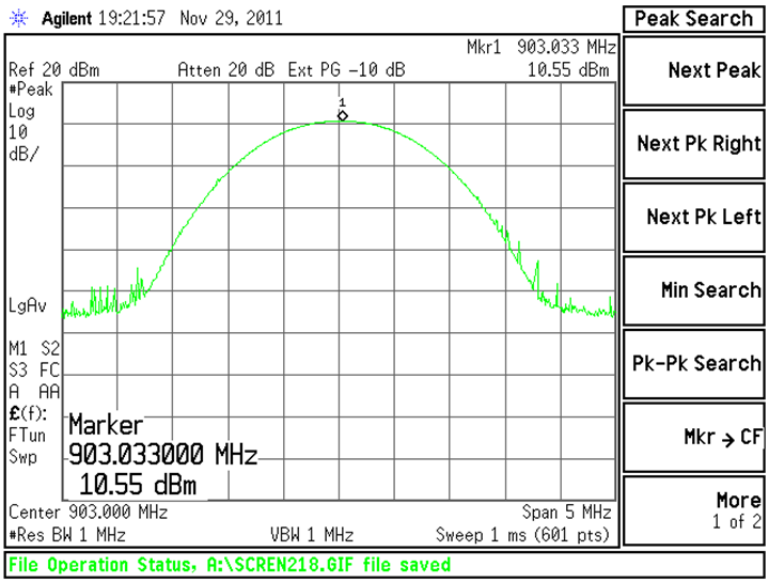
The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with resolution bandwidths set to 1 MHz and a span of 5 MHz with measurements from a peak detector presented in the chart below.

## 8.2 - Test Data

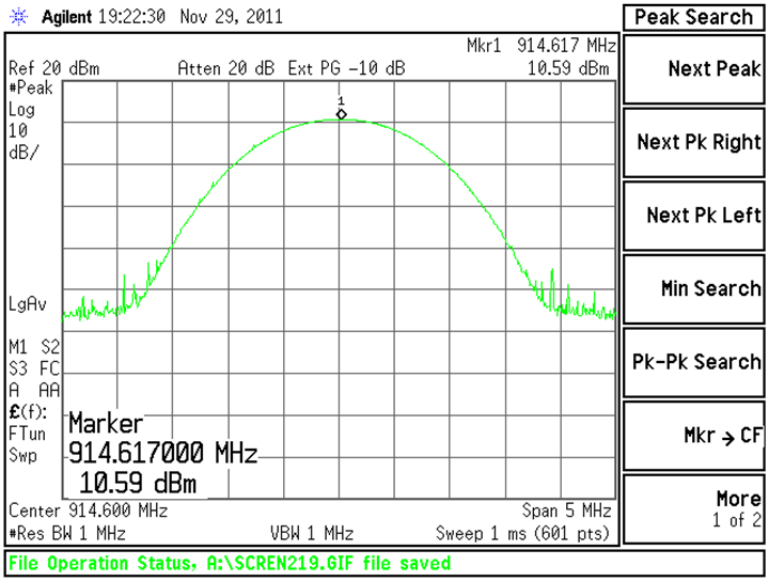
| CHANNEL | CENTER FREQ (MHz) | LIMIT (dBm) | MEASURED POWER (dBm) | MARGIN (dB) |
|---|---|---|---|---|
| LOW | 903.0 | 30.0 | 10.55 | 19.45 |
| MIDDLE | 914.6 | 30.0 | 10.59 | 19.41 |
| HIGH | 926.4 | 30.0 | 10.65 | 19.35 |

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

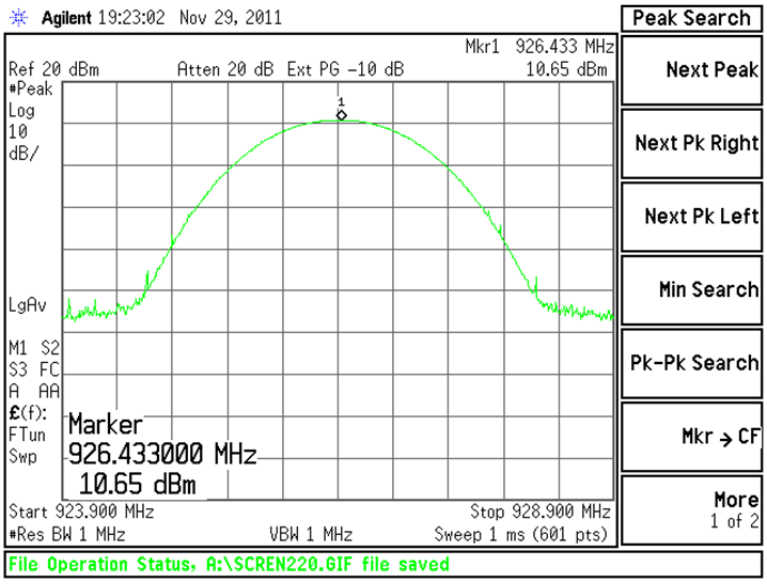
Channel Low



Channel Middle




Channel High



# EXHIBIT 9. CONDUCTED SPURIOUS EMISSIONS: 15.247(d)

## 9.1 - 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.

## 9.2 – 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 along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct readings of the measurements made without the need for any further corrections. A 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.

Conducted harmonics:

| Freq\Chan | 0\906 | 914.6 | 926.4 |
|---|---|---|---|
| fo | 10.5 | 10.6 | 10.6 |
| 2fo | -32.4 | -32.6 | -32.7 |
| 3fo | -48.6 | -49.1 | -49.9 |
| 4fo | -69.6 | -69.0 | -68.6 |
| 5fo | -68.6 | -70.6 | -71.9 |
| 6fo | -78.7 | -79.5 | -79.7 |
| 7fo | -73.8 | -73.4 | -73.1 |
| 8fo | -74.1 | -73.9 | -73.4 |
| 9fo | -66.4 | -64.4 | -65.2 |
| 10fo | -71.6 | -71.4 | -70.5 |

Conducted spurious emissions:

Hopping Mode On:

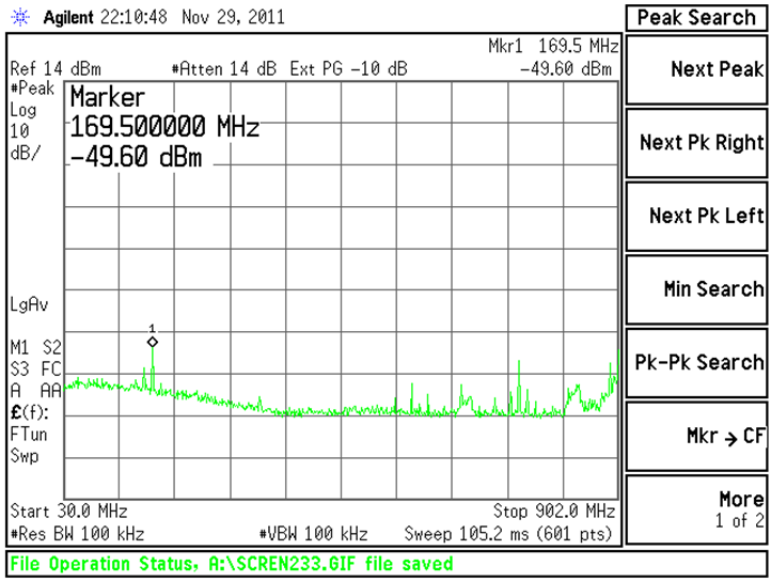
| Freq(MHz) | Chan | level(dBm) |
|---|---|---|
| 743.6 | N/A | -51.56 |
| 169.50 | N/A | -48.96 |
| 1853.00 | N/A | -35.5 |
| 30.00 | N/A | -48.89 |
| 928.36 | N/A | -30.46 |

One Channel at a Time On (CW Mode)

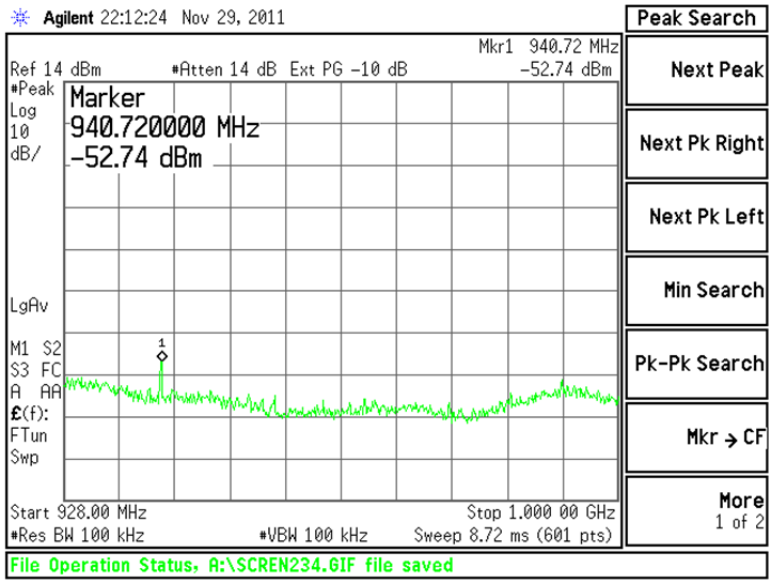
| Freq(MHz) | Chan | level(dBm) |
|---|---|---|
| 9933 | low | -60.49 |
| 929.08 | low | -56.62 |
| 902.00 | low | -19.66 |
| 745.00 | mid | -52.64 |
| 902.00 | mid | -50.3 |
| 169.50 | mid | -49.6 |
| 940.60 | mid | -51.54 |
| 1087.00 | mid | -55.5 |
| 5667 | mid | -57.47 |
| 5667 | high | -58.13 |
| 1093 | high | -58.26 |
| 952.36 | high | -53.51 |
| 939.4 | high | -52.84 |
| 928.12 | high | -41.08 |
| 169.5 | high | -50.48 |

## 9.3- Screen Captures – Spurious Radiated Emissions

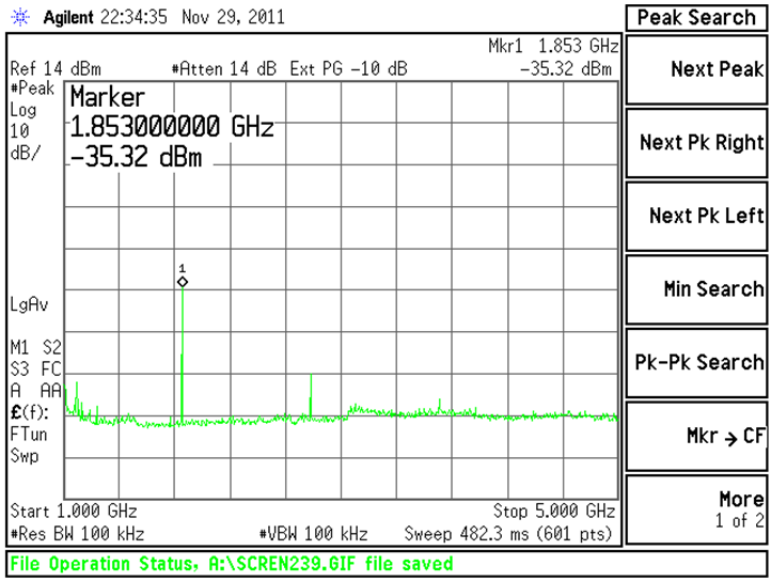
*30 MHz up to 902 MHz*



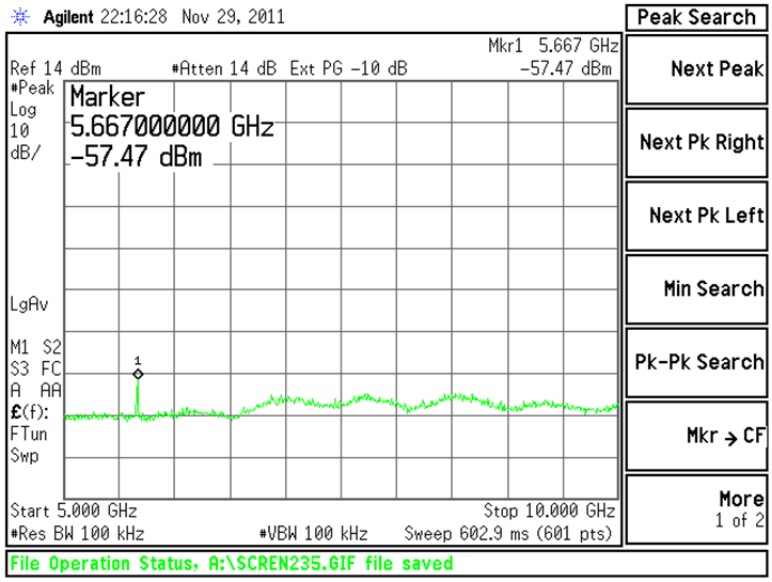

928 MHz up to 1000 MHz



*1000 MHz up to 5000 MHz*




*5000 MHz up to 10000 MHz*



# EXHIBIT 10. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

For measurements of the frequency and power stability, the transmitter was powered by an external bench-type variable power supply. A Spectrum Analyzer was used to measure the frequency at the appropriate frequency markers and also the output power at the antenna port.

| 2.55 VDC | | 3.0 VDC | | 3.45 VDC | | |
|---|---|---|---|---|---|---|
| Power | Frequency | Power | Frequency | Power | Frequency | Channel |
| 10.49 | 903.000000 | 10.5 | 903.000000 | 10.53 | 903.038700 | low |
| 10.56 | 914.598300 | 10.57 | 914.598300 | 10.6 | 914.598300 | mid |
| 10.69 | 926.394900 | 10.69 | 926.394900 | 10.72 | 926.394900 | high |

| Channel | max | min | freq drift (Hz) |
|---|---|---|---|
| lo | 903.038700 | 903.000000 | 0.0387 |
| mid | 914.598300 | 914.598300 | 0 |
| hi | 926.394900 | 926.394900 | 0 |

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

The maximum shift in frequency is **0.0387 Hz** which is better than 100 ppm in the 902 MHz to 928 MHz band.

# EXHIBIT 11. CHANNEL PLAN AND SEPARATION

A spectrum analyzer was used with a resolution bandwidth of 100 kHz to measure the channel separation of the EUT.

The minimum and maximum channel-separations measured for this device are 400.0 kHz and 2007 kHz respectively. The maximum occupied bandwidth of the device, as reported in the previous section is 73.2 kHz.

The minimum channel separation limit as stated in FCC CFR 47 15.247 and IC RSS210 is 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

The minimum number of channels limit as stated in FCC CFR 47 15.247 and IC RSS210 is 50 channels for channel bandwidth less than 250 kHz. and 25 channels for channel bandwidth greater than 250 kHz.

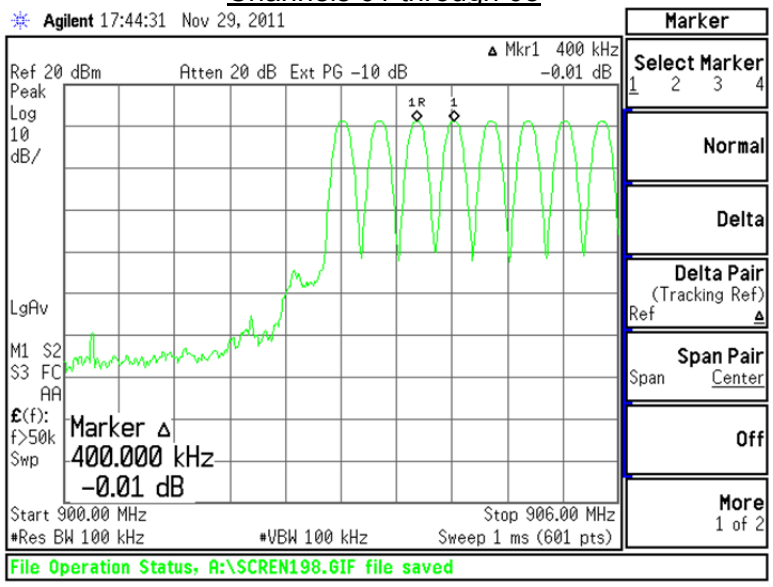
The following plots show compliance is met as well as describe this spacing, and also establish the channel separation and plan.

| RANGE (MHz) | # OF CHANS | Max separation |
|---|---|---|
| 900-906 | **8.0** | **400 kHz** |
| 906-912 | **11.0** | **2.000 MHz** |
| 912-918 | **13.5** | **800 kHz** |
| 918-925 | **13.5** | **2.007 MHz** |
| 925-928 | **4.0** | **400 kHz** |

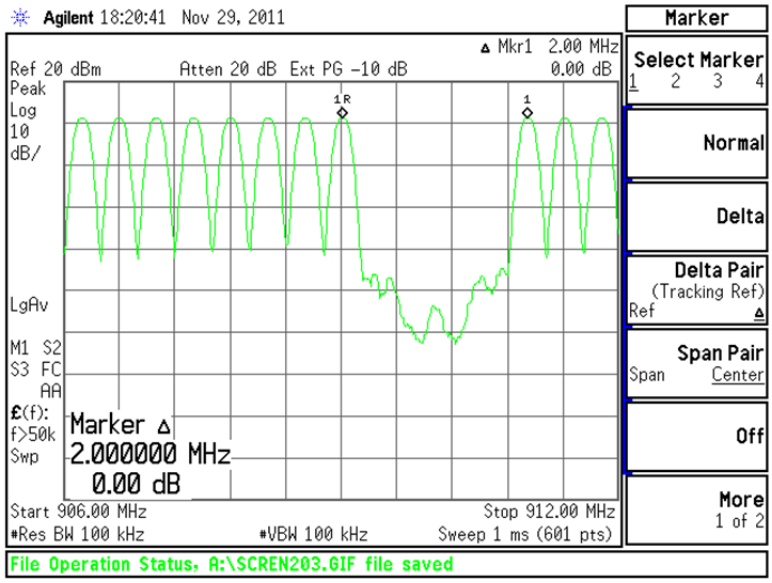
Total number of channels = 50

## 11.1 - Screen Captures – Channel Separation

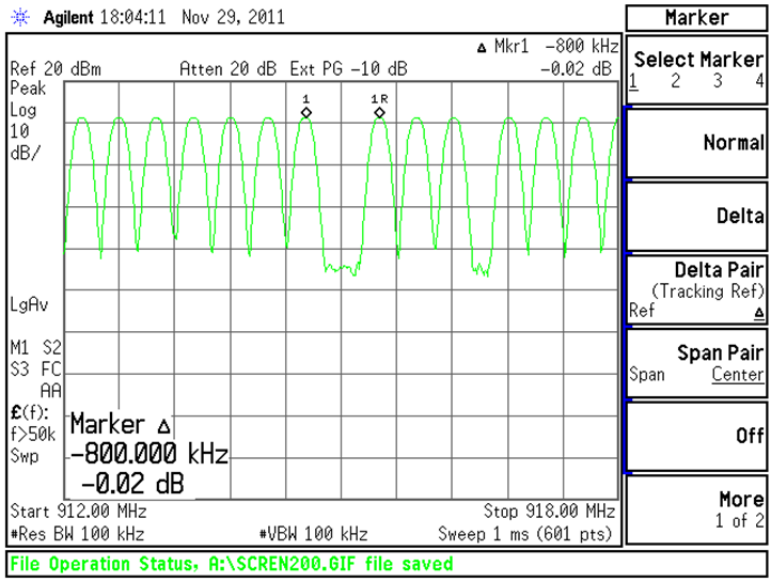
Channels 01 through 08



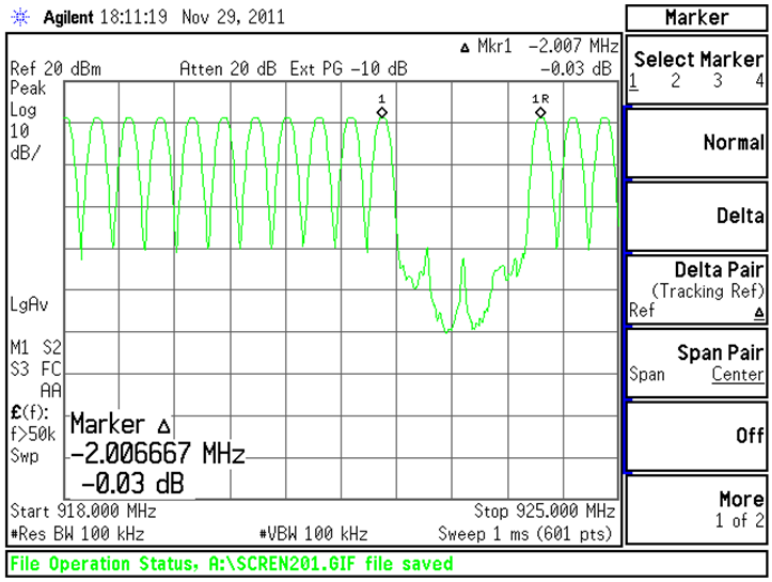
Channels 9 through 19



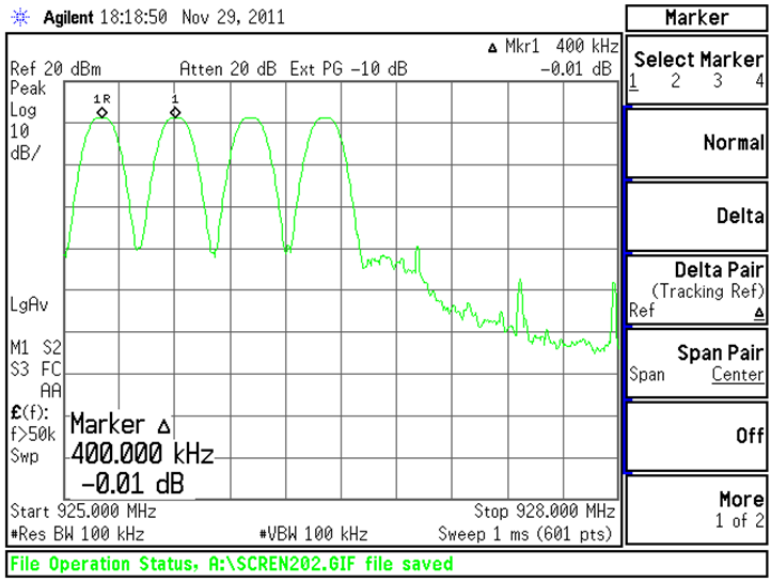

Channels 20 through 34



Channels 34 through 47




Channels 47 through 50



# EXHIBIT 12. CHANNEL OCCUPANCY

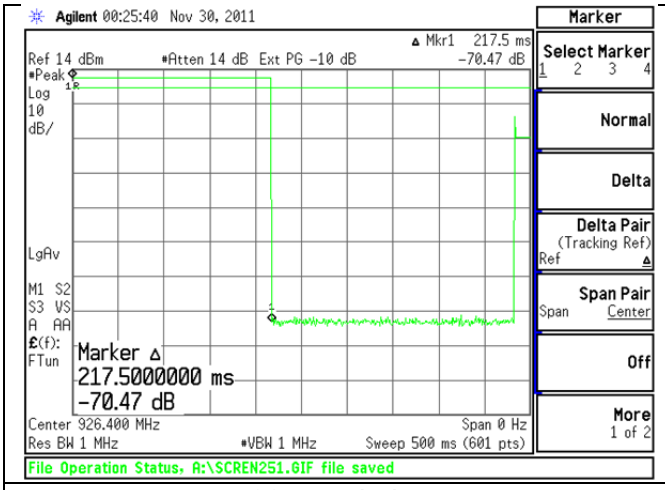
Part 15.247(a)(1) requires a channel occupancy, for this device, of no more than 400 milliseconds in a 20 second window. The channel occupancy for this EUT was measured using a spectrum analyzer, set to zero-span at the frequency of interest. With the analyzer in peak-hold mode, the transmission lengths can be measured by adjusting the sweep rate of the analyzer. A suitable sweep rate was used to measure the channel occupancy at the low, mid and high channels.

The longest time any transmission will occur on a single channel is 217.5 milliseconds. In a 20 second window, each channel has 1 transmission cycle. The maximum occupancy in a 20 second window is calculated by multiplying 1 transmission cycle by 217.5 milliseconds transmission duration per cycle, to arrive at 217.5 milliseconds total occupancy.

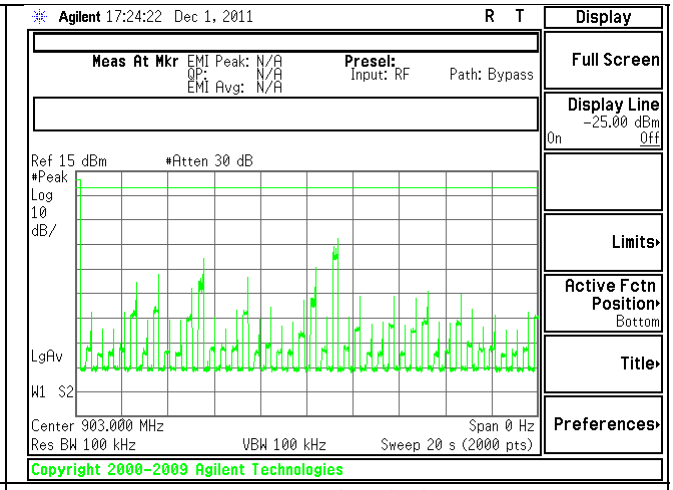
| Channel | Frequency (MHz) | Total Occupancy in 20 seconds (ms) | Occupancy in 400 ms window (ms) |
|---|---|---|---|
| Low | 903.0 | 217.50 | 217.50 |
| Middle | 914.6 | 217.50 | 217.50 |
| High | 926.4 | 217.50 | 217.50 |

**Plots of Channel Occupancy**

**Channel Occupancy**




500 ms window
(as shown on high channel)




20 seconds window
(as shown on the low channel)

# EXHIBIT 13. EQUAL CHANNEL USAGE AND PSEUDORANDOM HOPPING SEQUENCE.

Note: This section is provided by the manufacturer. Please review the operation manual (confidential).

# EXHIBIT 14. RECEIVER SYNCHRONIZATION AND RECEIVER INPUT BANDWIDTH.

Note: This section is provided by the manufacturer.

At the core of the radio block is an integrated transceiver, CC1101 manufactured by Texas Instruments. The CC1101 is configured by the RF protocol microcontroller to operate at frequencies as determined by a frequency sequencing algorithm. The bandwidth, transmit power, and modulation rate and type are set identically for all of the 50 frequencies utilized by this system.
The protocol microcontroller provides the commissioned network with a synchronization signal periodically.

# APPENDIX A – Test Equipment List

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

Date : 1-Dec-2011 Type Test : TX and RX Radiated Spurious Emissions Job # : C-1349

Prepared By: Peter Customer : Honeywell Quote #: 311330

| 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 | EE 960159 | 0.8 - 21GHz LNA | Mini-Circuits | ZVA-213X-S+ | 740411007 | 9/19/2011 | 9/19/2012 | Active Calibration |
| 5 | AA 960007 | Double Ridge Horn Antenna | EMCO | 3115 | 9311-4138 | 4/27/2011 | 4/27/2012 | Active Calibration |
| 6 | AA 960150 | Bicon Antenna | ETS | 3110B | 0003-3346 | 11/15/2011 | 11/15/2012 | Active Calibration |
| 7 | AA 960078 | Log Periodic Antenna | EMCO | 93146 | 9701-4855 | 11/15/2011 | 11/15/2012 | Active Calibration |
| 8 | EE 960160 | 0.8-21GHz LNA | Mini-Circuits | ZVA-213X-S+ | 977711030 | 4/27/2011 | 4/27/2012 | Active Calibration |
| 9 | AA 960081 | Double Ridge Horn Antenna | EMCO | 3115 | 6907 | 1/4/2011 | 1/4/2012 | Active Calibration |
| 10 | AA 960144 | Phaseflex | Gore | EKD01D010720 | 5800373 | 6/1/2011 | 6/1/2012 | Active Calibration |
| 11 | EE 960073 | Spectrum Analyzer | Agilent | E4446A | US45300564 | 4/25/2011 | 4/25/2012 | Active Calibration |
| | AA 960155 | 900MHz High Pass Filter | KWM | HPF-L-14185 | 7272-03 | 2/28/2011 | 2/28/2012 | Active Calibration |

Project Engineer: Peter Fiduccia Quality Assurance: Thomas J. Smith

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

Date : 1-Dec-2011 Type Test : Conducted Measurements Job # : C-1349

Prepared By: Peter Customer : Honeywell Quote #: 311330

| No. | Asset # | Description | Manufacturer | Model # | Serial # | Cal Date | Cal Due Date | Equipment Status |
|---|---|---|---|---|---|---|---|---|
| 1 | AA 960144 | Phaseflex | Gore | EKD01D010720 | 5800373 | 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: Peter Fiduccia Quality Assurance: Thomas J. Smith

# APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

| STANDARD # | DATE | Am. 1 | Am. 2 |
|---|---|---|---|
| ANSI C63.4 | 2003 | | |
| ANSI C63.10 | 2009 | | |
| CISPR 11 | 2009-05 | 2009-12 P | |
| CISPR 12 | 2007-05 | | |
| CISPR 14-1 | 2005-11 | 2008-11 | |
| CISPR 14-2 | 2001-11 | 2001-11 | 2008-05 |
| CISPR 16-1-1 Note 1 | 2010-01 | | |
| CISPR 16-1-2 Note 1 | 2003 | 2004-04 | 2006-07 |
| CISPR 22 | 2008-09 | | |
| CISPR 24 | 1997-09 | 2001-07 | 2002-10 |
| EN 55011 | 2009 | | |
| EN 55014-1 | 2006 | | |
| EN 55014-2 | 1997 | | |
| EN 55022 | 2006 | 2007 | |
| EN 60601-1-2 | 2007-03 | | |
| EN 61000-3-2 | 2006-05 | | |
| EN 61000-3-3 | 2008-12 | | |
| EN 61000-4-2 | 2009-05 | | |
| EN 61000-4-3 | 2006-07 | 2008-05 | |
| EN 61000-4-4 | 2004 | | |
| EN 61000-4-5 | 2006-12 | | |
| EN 61000-4-6 | 2009-05 | | |
| EN 61000-4-8 | 1994 | 2001 | |
| EN 61000-4-11 | 2004-10 | | |
| EN 61000-6-1 | 2007-02 | | |
| EN 61000-6-2 | 2005-12 | | |
| EN 61000-6-3 | 2007-02 | | |
| EN 61000-6-4 | 2007-02 | | |
| FCC 47 CFR, Parts 0-15, 18, 90, 95 | 2011 | | |
| FCC Public Notice DA 00-1407 | 2000 | | |
| FCC ET Docket # 99-231 | 2002 | | |
| FCC Procedures | 2007 | | |
| ICES 001 | 2006-06 | | |
| ICES 002 | 2009-08 | | |
| ICES 003 | 2004-02 | | |
| IEC 60601-1-2 Note 1 | 2007-03 | | |
| IEC 61000-3-2 | 2005-11 | 2008-03 | 2009-02 |
| IEC 61000-3-3 | 2008-06 | | |
| IEC 61000-4-2 | 2008-12 | | |
| IEC 61000-4-3 | 2008-04 | 2008-04 | 2009-12 FD |

| STANDARD # | DATE | Am. 1 |
|---|---|---|
| IEC 61000-4-4 | 2004-07 | 2010-10 |
| IEC 61000-4-5 | 2005-11 | |
| IEC 61000-4-6 | 2008-10 | |
| IEC 61000-4-8 | 2009-09 | |
| IEC 61000-4-11 | 2004-03 | |
| IEC 61000-6-1 | 2005-03 | |
| IEC 61326-1 | 2006-06 | |
| ISO 14982 | 1998-07 | |
| MIL Std. 461E | 1999-08 | |
| RSS GEN | 2010-12 | |
| RSS 119 | 2007-06 | |
| RSS 123 | 1999-11 | |
| RSS 125 | 2000-03 | |
| RSS 131 | 2003-07 | |
| RSS 136 | 2002-10 | |
| RSS 137 | 2009-02 | |
| RSS 210 | 2010-12 | |
| RSS 213 | 2005-12 | |
| RSS 243 | 2010-02 | |
| RSS 310 | 2007-06 | |
| | | |
| | | |
| | | |
| Updated on 08-23-11 | | |

*Note 1: Test not on LSR Scope of Accreditation.*

# APPENDIX C - Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

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

| Measurement Type | Particular Configuration | Uncertainty Values |
|---|---|---|
| Radiated Emissions | 3 – Meter chamber, Biconical Antenna | 4.24 dB |
| Radiated Emissions | 3-Meter Chamber, Log Periodic Antenna | 4.8 dB |
| Radiated Emissions | 10-Meter OATS, Biconical Antenna | 4.18 dB |
| Radiated Emissions | 10-Meter OATS, Log Periodic Antenna | 3.92 dB |
| Conducted Emissions | Shielded Room/EMCO LISN | 1.60 dB |
| Radiated Immunity | 3 Volts/Meter in 3-Meter Chamber | 1.128 Volts/Meter |
| Conducted Immunity | 3 Volts level | 1.0 V |