LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
Testing Cert. 1255.01
W66 N220 Commerce Court ● Cedarburg, WI 53012 ● USA
Phone: 262.375.4400 ● Fax: 262.375.4248
www.lsr.com

TEST REPORT # 311360
LSR Job #: C-1370

Compliance Testing of:
Asthmapolis Sensor

Test Date(s):
December 12,14,16,21, 2011
January 26, 30-31, February 1, 2012

Prepared For:
Reciprocal Labs Corporation
612 West Main St
Suite 201
Madison, WI 53073

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 2400-2483.5 MHz

This Test Report is issued under the Authority of:
Thomas T. Smith, Manager EMC Test Services

Signature: Thomas T. Smith Date: 2/2/12

Test Report Reviewed by:	**Tested by:**
Thomas T. Smith, Manager EMC Test Services	Peter Feilen, EMC Engineer
Signature: Thomas T. Smith Date: 2/2/12	Signature: Peter Feilen Date: 2/1/12

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EXHIBIT 1. INTRODUCTION

1.1 SCOPE

References:	FCC Part 15, Subpart C, Section 15.247 and 15.209 FCC Part 2, Section 2.1043 paragraph (b)1. RSS GEN and RSS 210 Annex 8
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. 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 (2003) – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	Commercial, Industrial or Business Residential

1.2 NORMATIVE REFERENCES

Please reference Appendix B for test standard references.

1.3 LS Research, LLC TEST FACILITY

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

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

1.4 LOCATION OF TESTING

All testing was performed at LS Research, LLC, W66 N220 Commerce Court, Cedarburg, Wisconsin, 53012 USA, utilizing the facilities listed below, unless otherwise noted.

List of Facilities Located at LS Research, LLC:

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

1.5 TEST EQUIPMENT UTILIZED

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

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	**Reciprocal Labs Corporation**
Address:	**612 West Main St, Suite 201, Madison, WI 53073**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	Asthmapolis Sensor
Model Number:	I
Serial Number:	51(conducted), 81(radiated)

2.3 ASSOCIATED ANTENNA DESCRIPTION

The Asthmapolis uses a ceramic chip antenna.

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

EUT Frequency Range (in MHz)	2402-2480 MHz
Maximum EIRP in Watts	0.000871 W
Minimum EIRP in Watts	0.000531 W
Maximum Conducted Output Power (in dBm)	-0.6 dBm
Minimum Conducted Output Power (in dBm)	-2.9 dBm
Occupied Bandwidth (99% BW)	878 kHz
Type of Modulation	GFSK
Emission Designator	8K78F1D
Transmitter Spurious (worst case) at 3 meters	52.6 dBuV/m @ 3m @ 7440 MHz (see pg 15)
Receiver Spurious (worst case) at 3 meters	41.8 dBuV/m @ 3m @ 3890 MHz (see pg 22)
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Transceiver Model # (if applicable)	ST Micro STM32F103RDY6TR
Receiver Bandwidth	1 MHz
Receiver Sensitivity	-70 dBm
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	Chip
Gain (in dBi)	0 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)		SAR Evaluation: Device Used in the Vicinity of the Human Head
	X	SAR Evaluation: Body-worn Device
		RF Evaluation

Procedure for Portable RF Exposure from KDB 447498:

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

$$0.87\ mW\ \leq 24.9\ mW$$

Note: Since the peak output power of 0.87 mW is below the low threshold of 24.9mW this device does not need SAR evaluation

2.5 PRODUCT DESCRIPTION

The Asthmapolis Sensor attaches to the top of your inhaler and monitors your inhaler usage. With a compatible mobile phone, the Sensor also records the location of each inhaler use. This information can provide insight into when and where you are using your rescue inhaler, and how well you're adhering to your controller medication. The Sensor uses Bluetooth® wireless technology to transmit inhaler use data.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	20-35 ˚C
Humidity:	35-45 % R.H

3.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	N/A
FCC : 15.247 (a)(1)(i) IC : RSS 210 A8.1 (a)	20 dB Bandwidth	YES
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	YES
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	YES
FCC :15.247(c) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	YES
FCC:15.247 (a)(1)(i) IC: RSS 210 (b)	Carrier Frequency Separation	YES
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 210 (c),(d),(e)	Number of hopping channels	YES
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 210 (c),(d),(e)	Time of occupancy (Dwell Time)	YES
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	YES

3.3 MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

☐ **None** ☒ **Yes (explain below)**

In order to meet all spurious emissions requirements under 15.209, the maximum software power setting is "13" which produces a maximum output power of -0.6 dBm.

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), Section Annex 8 (section A8.1) 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 and final testing was performed using continuous transmit mode. The unit has the capability to operate on 79 channels, controllable via laptop PC.

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 (2402 MHz), middle (2441 MHz) and high (2480 MHz) to comply with FCC Part 15.31(m). The channels were changed using a PC with specific software for the application.

5.2 Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. From 18 GHz to 25 GHz, the EUT was measured using a standard gain Horn Antenna and pre-amplifier.

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 N.I.S.T. traceable site. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an Agilent E4445A/N9039A EMI System. 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 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 for peak measurements, 10Hz for average measurements). From 4 GHz to 18 GHz, an Agilent E4446A Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the Agilent E4446A Spectrum Analyzer as well as a standard gain horn, and preamp were used.

Test Equipment List

Please see Appendix A

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 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	500	54.0	63.5

Sample conversion from field strength μV/m to dBμV/m:
$dB\mu V/m = 20 \log_{10} (100)$
= 40 dBμV/m (from 30-88 MHz)

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

> 960 MHz
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 of device emissions using correction factors

Raw Receiver Data + Antenna Factor + Cable Factor + = Reported Value

Example of reported data at 64 MHz:

Reported Measurement data = 11.6 (raw receiver measurement) + 8.9 (antenna factor) + 0.68 (cable factor) = 21.2 dBμV

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:	Reciprocal						
Date(s) of Test:	December 12, 14, 15, 2011						
Test Engineer(s):	Peter Feilen						
Voltage:	3.7 VDC						
Operation Mode:	continuous modulated transmit						
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %						
EUT Power:		Single Phase ___VAC		3 Phase ___VAC			
		Battery	X	Other: DC Bench Supply			
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 (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Quasi Peak Reading (dBµV/m)	Average Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation	EUT Channel
3960.1	1.07	270	63.95	58.93	51.03	54.0	3.0	H	V	75
64.0	1.05	68	23.29	21.24	19.46	40.0	18.8	V	V	1
298.0	1.00	0	31.73	25.82	19.46	46.0	26.5	H	V	1
296.9	1.00	0	31.41	25.62	19.22	46.0	20.4	H	S	1
64.0	1.03	11	23.75	21.71	20.02	40.0	18.3	V	S	1
64.0	1.03	352	22.21	19.58	17.53	40.0	20.4	V	F	1
64.0	2.51	316	17.67	12.69	6.74	40.0	27.3	H	F	1
64.0	1.19	38	23.85	21.43	19.75	40.0	20.3	V	V	40
995.4	1.00	0	34.41	29.26	22.74	54.0	24.7	V	V	40
1000.0	1.00	0	35.47	30.45	23.83	54.0	23.6	H	V	40

RADIATED EMISSIONS DATA CHART *(continued)*

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

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4804	1.00	163	58.2	54.9	63.5	8.6	Vertical	Flat
12010	1.06	152	65.7	59.6	63.5	3.9	Vertical	Vertical
19216	Note 3	-	-	-	63.5	-		

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 40:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4882	1.00	167	59.9	58.0	63.5	5.5	Horizontal	Flat
7323	1.07	48	63.7	61.0	63.5	2.5	Vertical	Vertical
12205	1.00	281	63.6	57.2	63.5	6.3	Horizontal	Vertical
19528	Note 3	-	-	-	63.5	-		

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 79:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4960	1.00	156	59.5	56.9	63.5	6.6	Horizontal	Flat
7440	1.19	84	65.0	62.1	63.5	1.4	Vertical	Vertical
12400	1.10	88	58.4	51.2	63.5	12.3	Horizontal	Side
19840	Note 3	-	-	-	63.5	-		
22320	Note 3	-	-	-	63.5	-		

Notes:

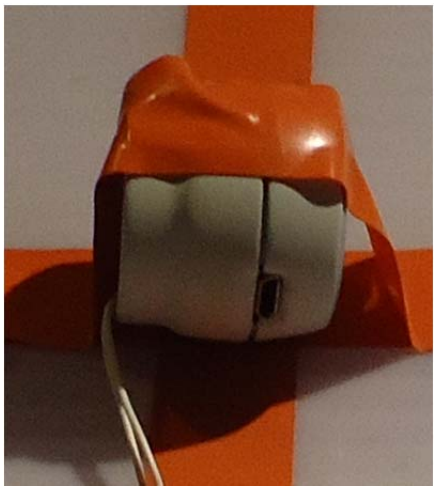
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
2) Measurements above 4 GHz were made at 1 meters of separation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

5.7 Test Setup Photo(s) – Radiated Emissions Test

Vertical Orientation

Flat Orientation

Side Orientation

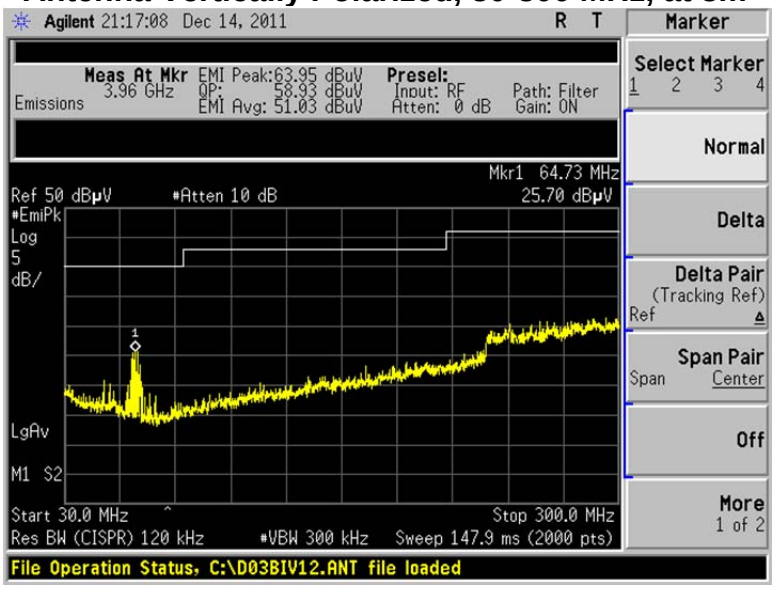


5.8 Screen Captures - Radiated Emissions Test

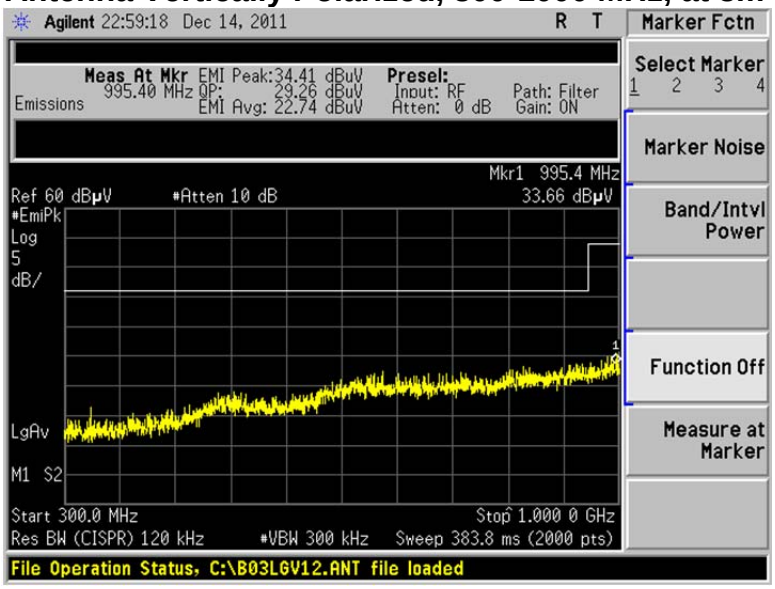
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 1, 40, or 79, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

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

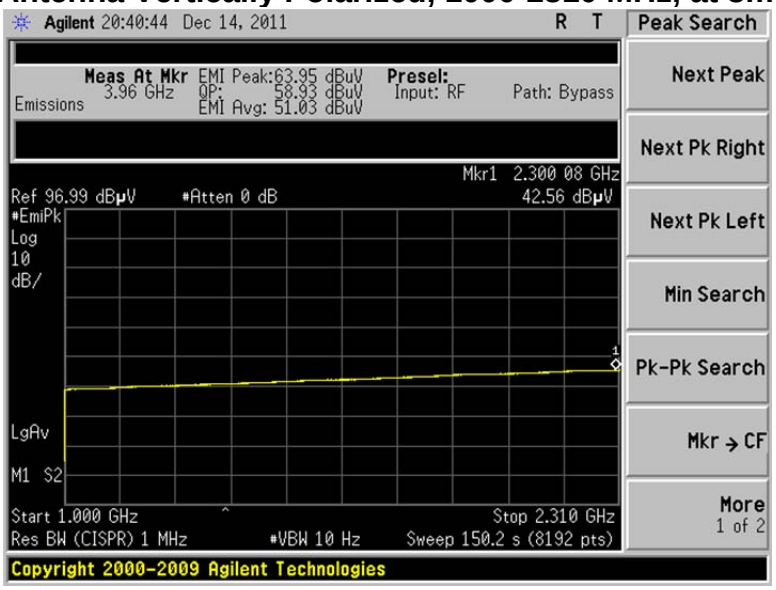


Antenna Vertically Polarized, 300-1000 MHz, at 3m

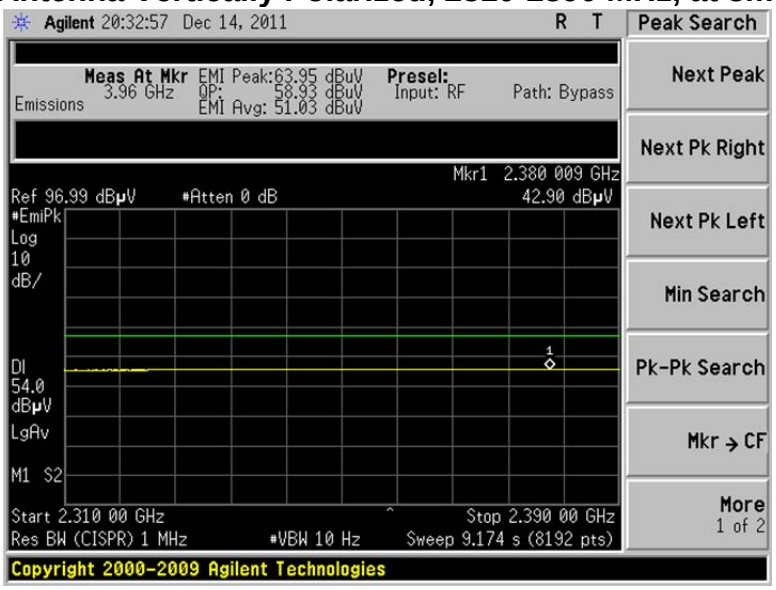


Screen Captures - Radiated Emissions Testing *(continued)*

Antenna Vertically Polarized, 1000-2310 MHz, at 3m



Antenna Vertically Polarized, 2310-2390 MHz, at 3m

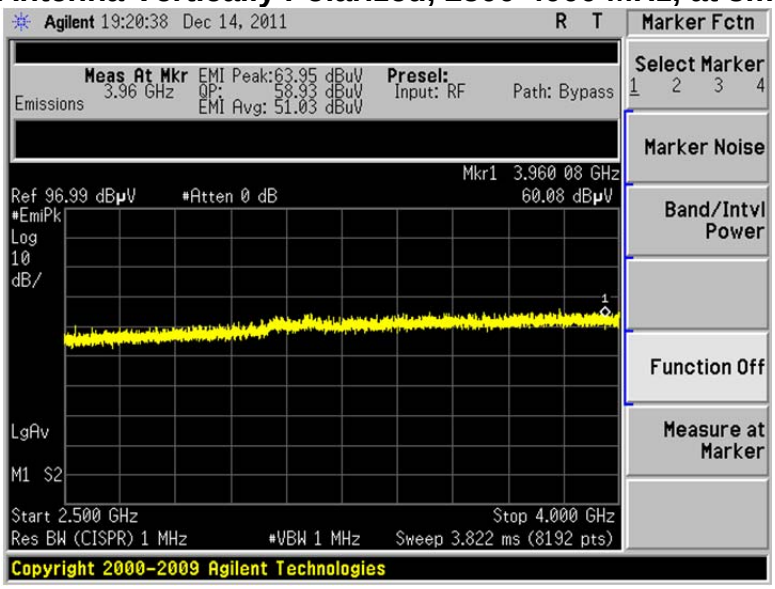


2390-2400 MHz is represented in Section 8, Bandedge Measurements

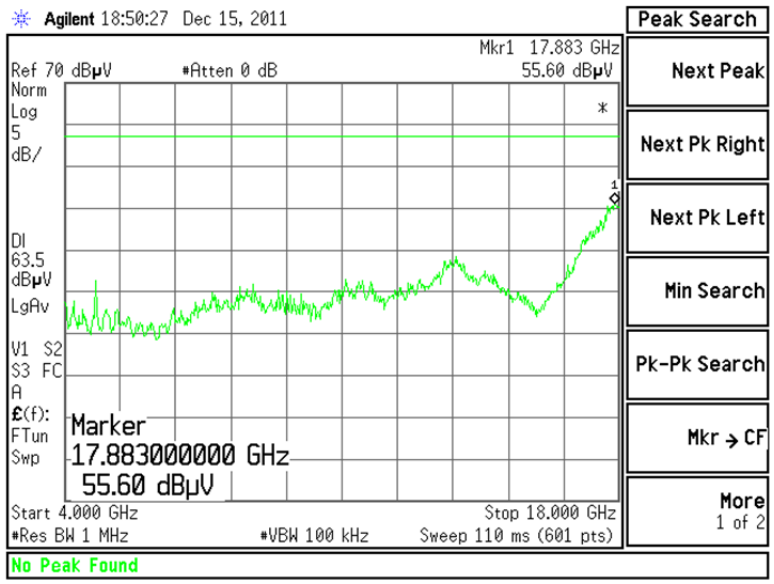
2483.5-2500 MHz is represented in Section 8, Bandedge Measurements

Screen Captures - Radiated Emissions Testing *(continued)*

Antenna Vertically Polarized, 2500-4000 MHz, at 3m

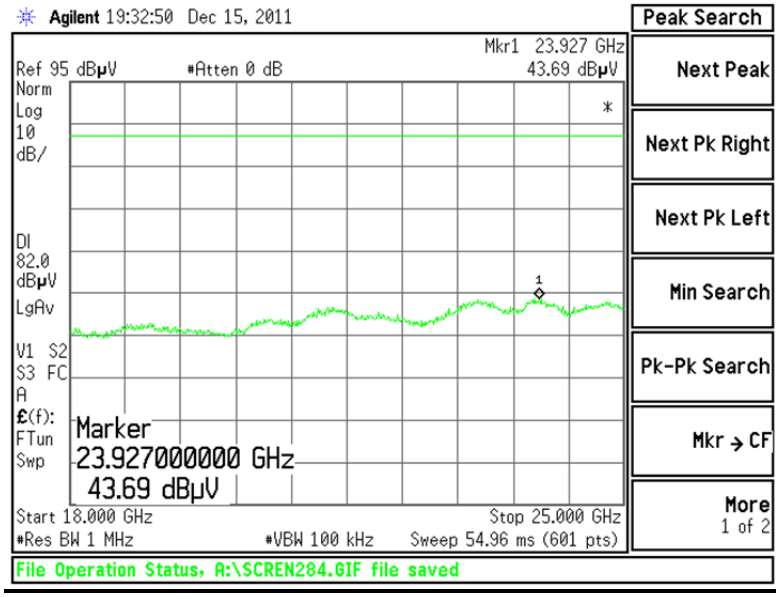


Antenna Vertically Polarized, 4000-18000 MHz, at 1m



Screen Captures - Radiated Emissions Testing *(continued)*

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



5.9 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:

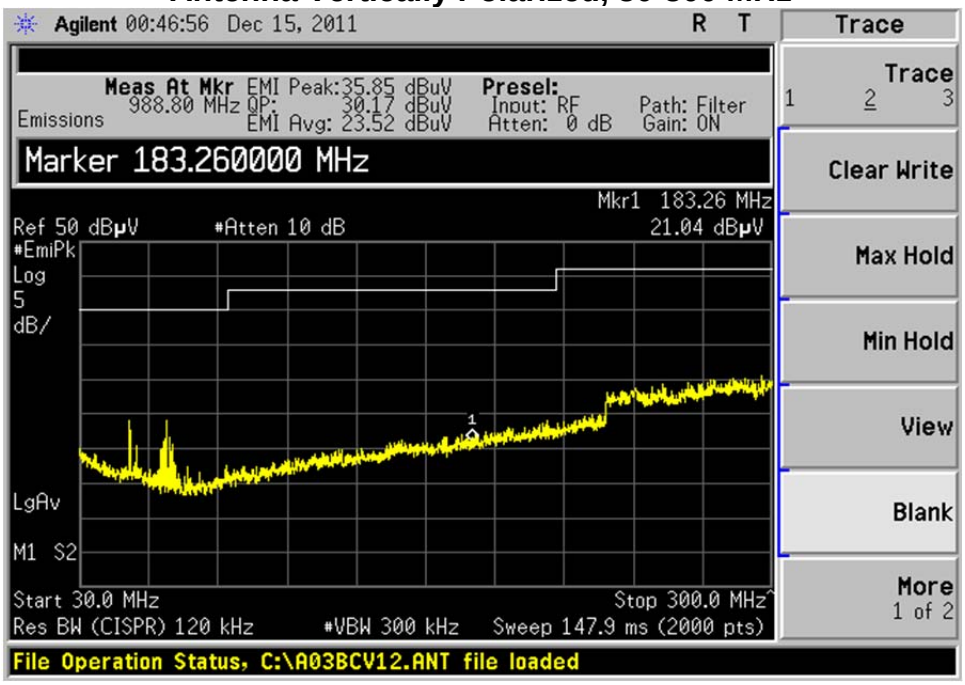
Frequency (MHz)	Height (m)	Azimuth (degree)	Electric Field Strength Reading (dBµV/m)	Electric Field Strength Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
997.5	1.00	0	30.2	54.0	23.8	H	V
975.1	1.00	0	29.0	54.0	25.0	V	V
990.4	1.00	0	29.3	54.0	24.7	V	S
988.0	1.00	0	30.2	54.0	23.8	H	S
64.0	1.00	339	20.8	40.0	19.2	V	V
299.7	1.00	0	25.3	46.0	20.7	H	V
3890.4	1.00	0	41.8	54.0	12.2	H	V

Screen Captures - Radiated Emissions Testing – Receive Mode

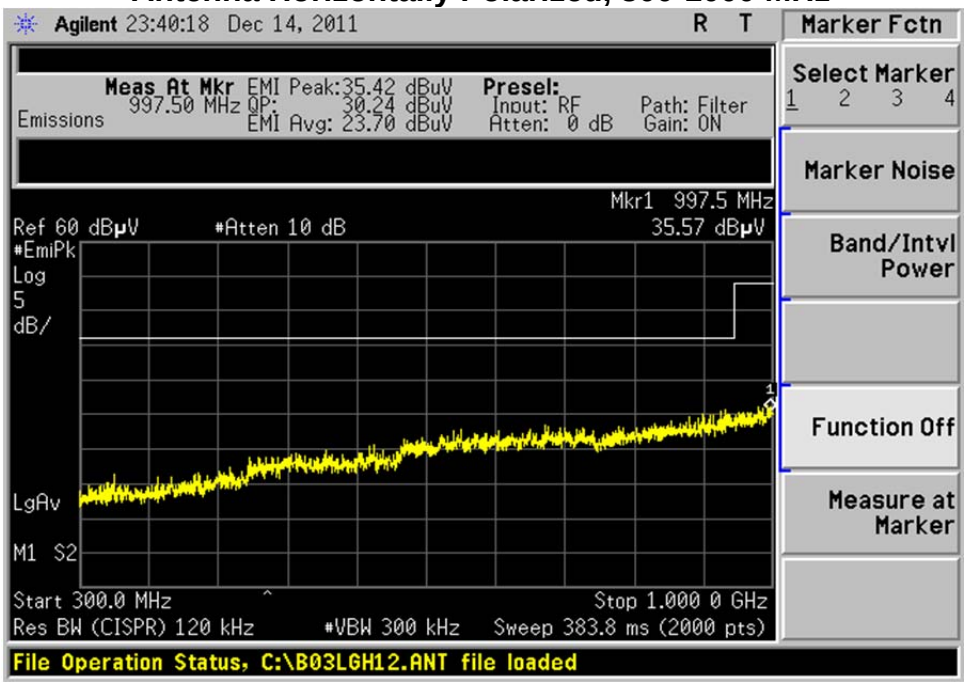
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 1, 40 and 79, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Antenna Vertically Polarized, 30-300 MHz

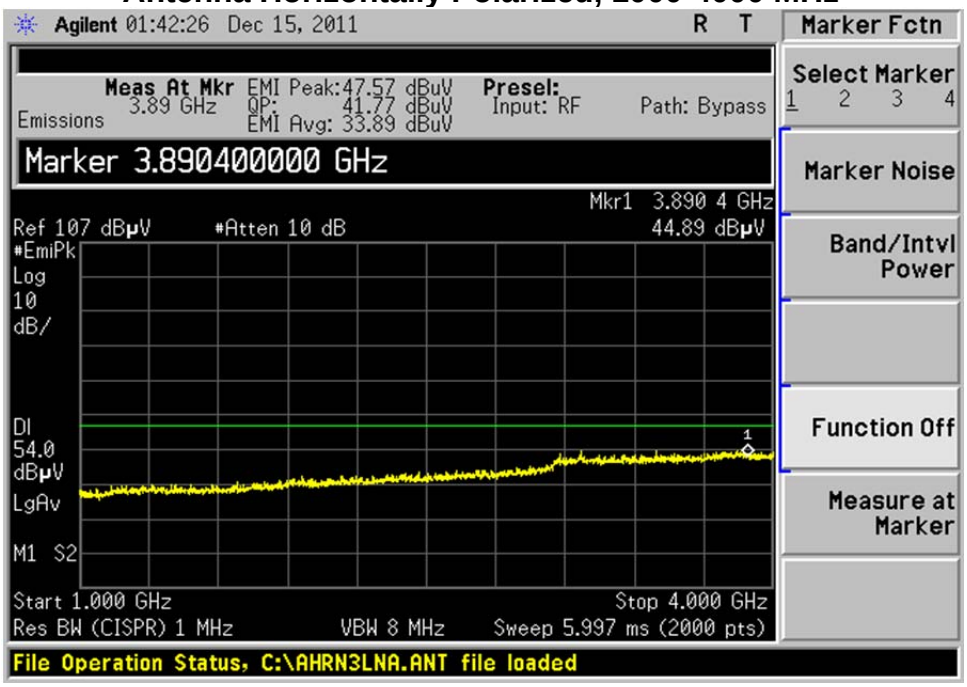


Antenna Horizontally Polarized, 300-1000 MHz

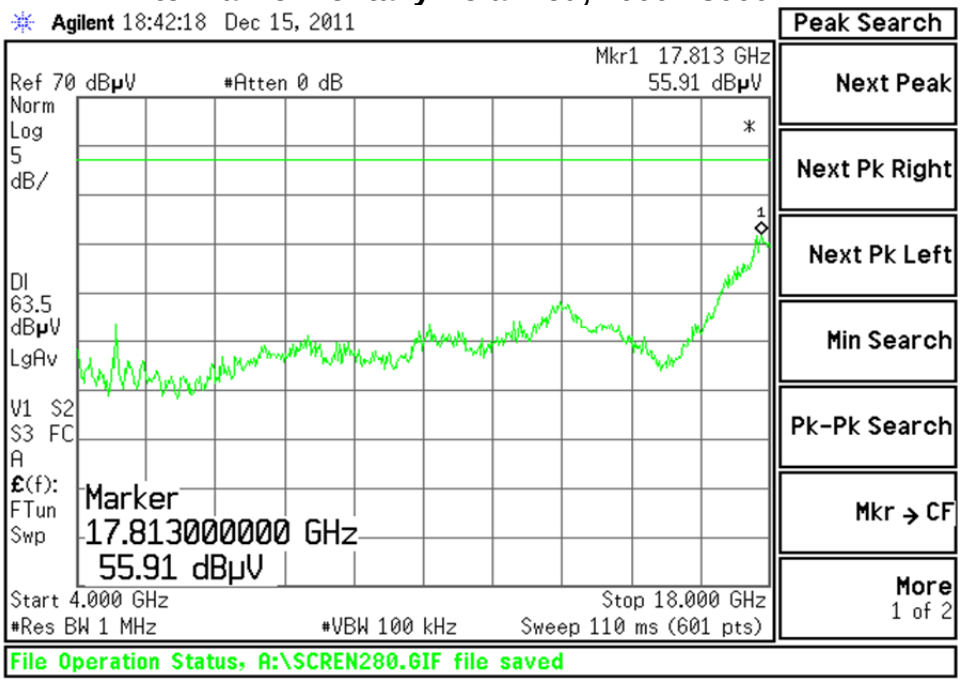


Screen Captures - Radiated Emissions Testing – Receive Mode **(continued)**

Antenna Horizontally Polarized, 1000-4000 MHz



Antenna Horizontally Polarized, 4000-18000 MHz



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

Antenna Horizontally Polarized, 18000-25000 MHz

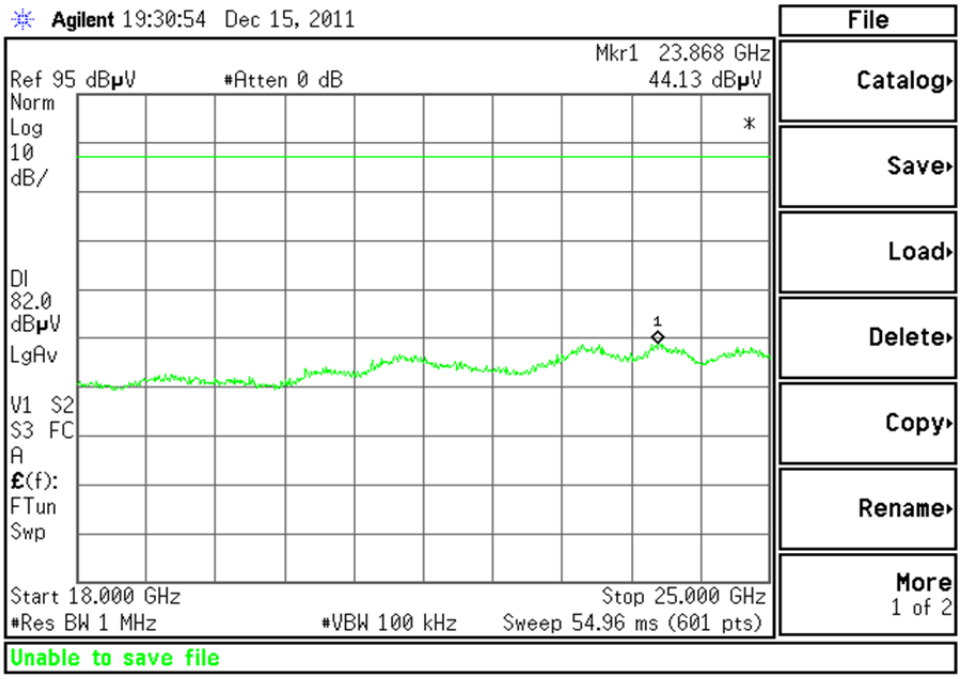


EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE:

This test was not performed as this is strictly a battery-operated device and will not operate under power from AC power.

EXHIBIT 7. OCCUPIED BANDWIDTH:

7.1 Requirement

For a frequency hopping system in the 2400 to 2483.5 MHz band, the channel separation shall be at minimum 25 kHz or two-thirds of the 20 dB bandwidth.

7.2 Method of Measurements

The transmitter output was connected to the Spectrum Analyzer. The 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. 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 10 kHz, video bandwidth set to 100 kHz, for this portion of the tests. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

7.3 Test Equipment List

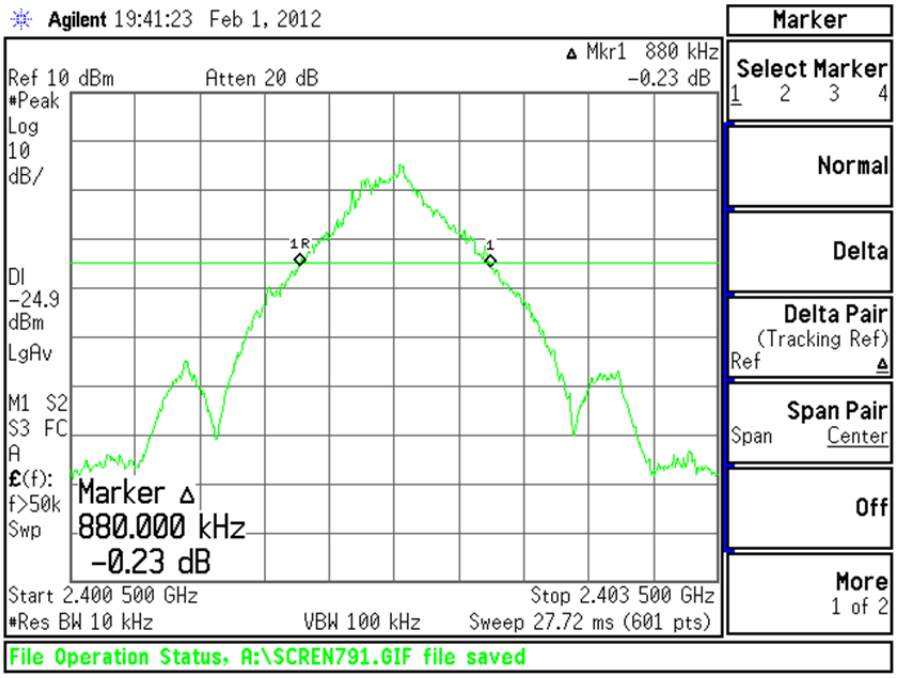
Please see Appendix A

7.4 Test Data

Channel	Center Frequency (MHz)	Measured -20 dBc Occ. BW (kHz)	Measured 99% Occ. BW (kHz)
1	2402	880	878
40	2441	875	825
79	2480	880	841

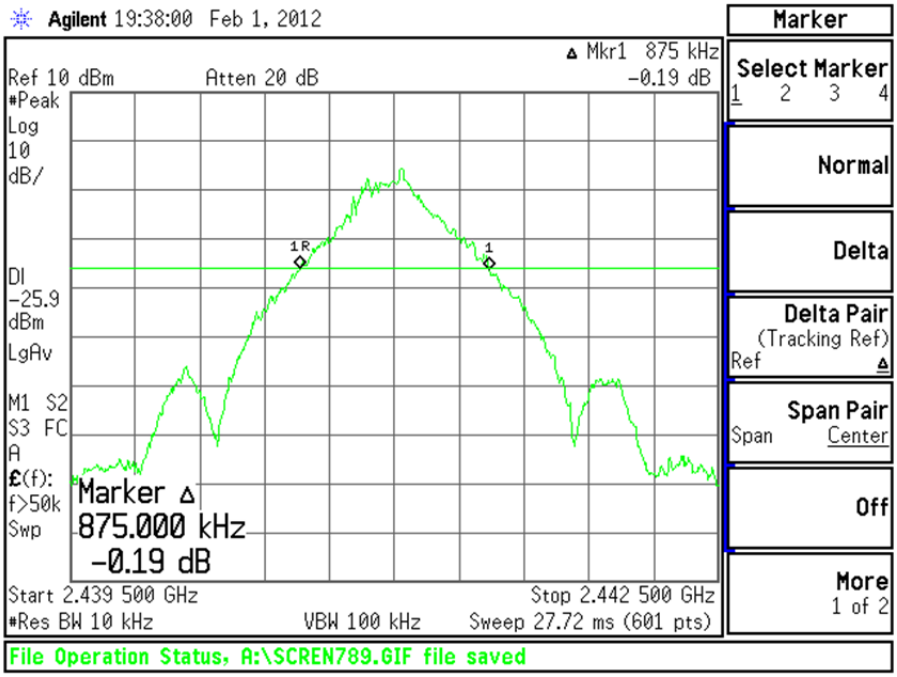
7.5 Screen Captures - OCCUPIED BANDWIDTH

Channel 1, -20 dBc Occupied Bandwidth

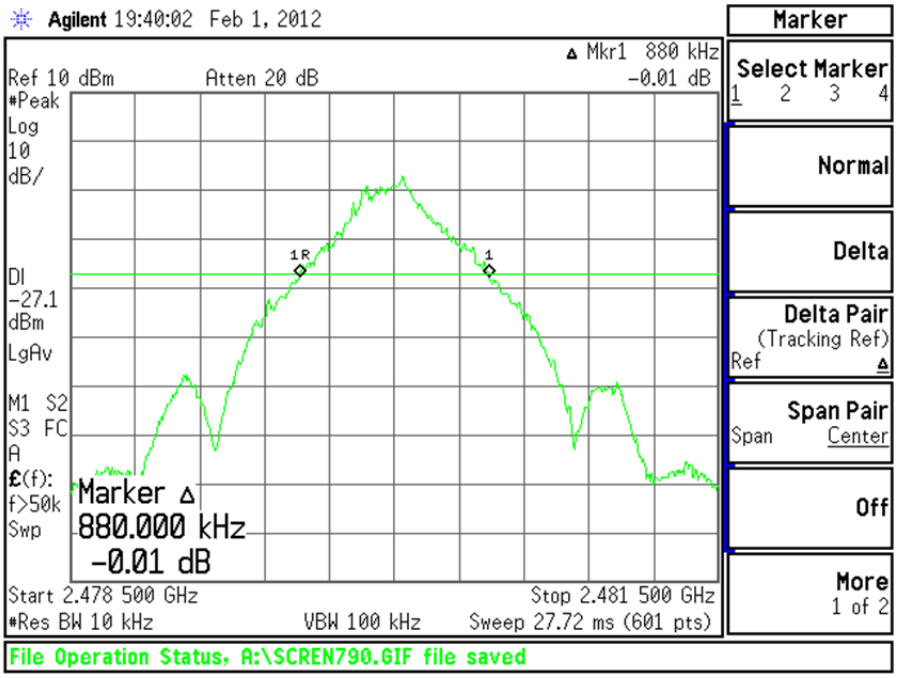


Channel 40, -20 dBc Occupied Bandwidth

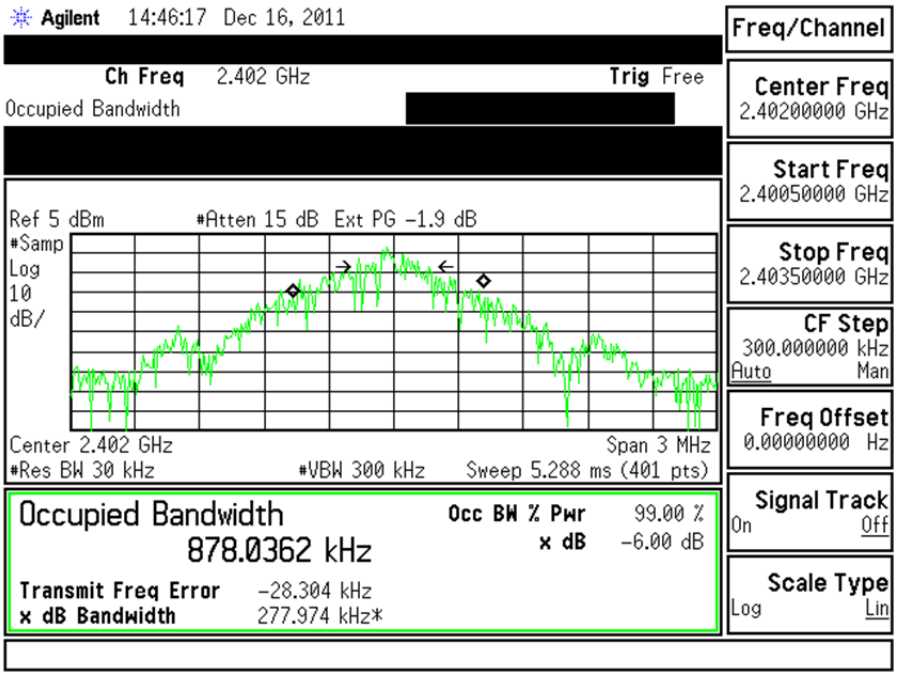
Screen790, 875 kHz



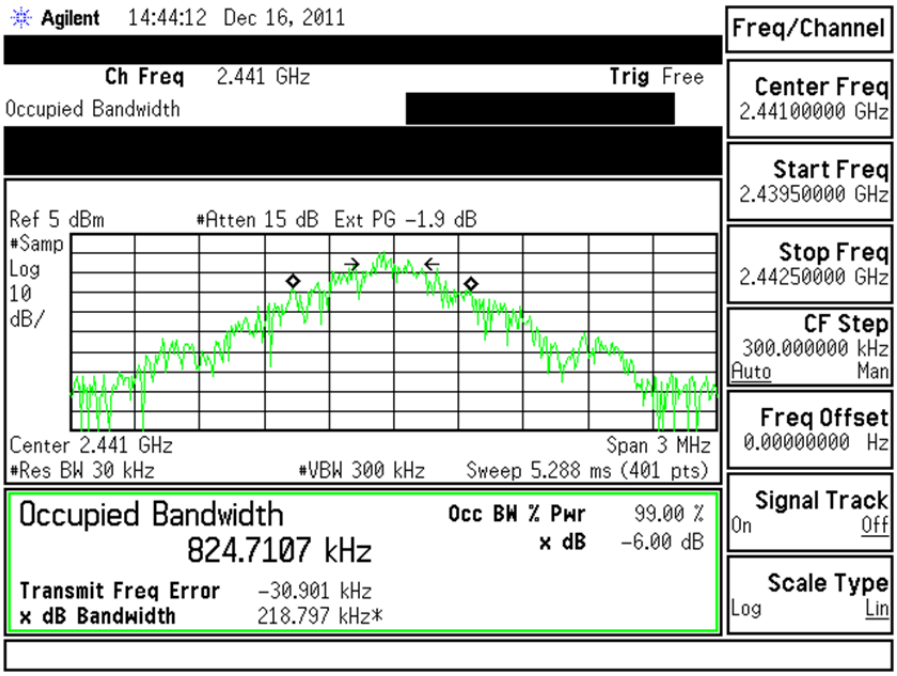
Channel 79, -20 dBc Occupied Bandwidth



Channel 1, 99% Occupied Bandwidth



Channel 40, 99% Occupied Bandwidth



Channel 79, 99% Occupied Bandwidth

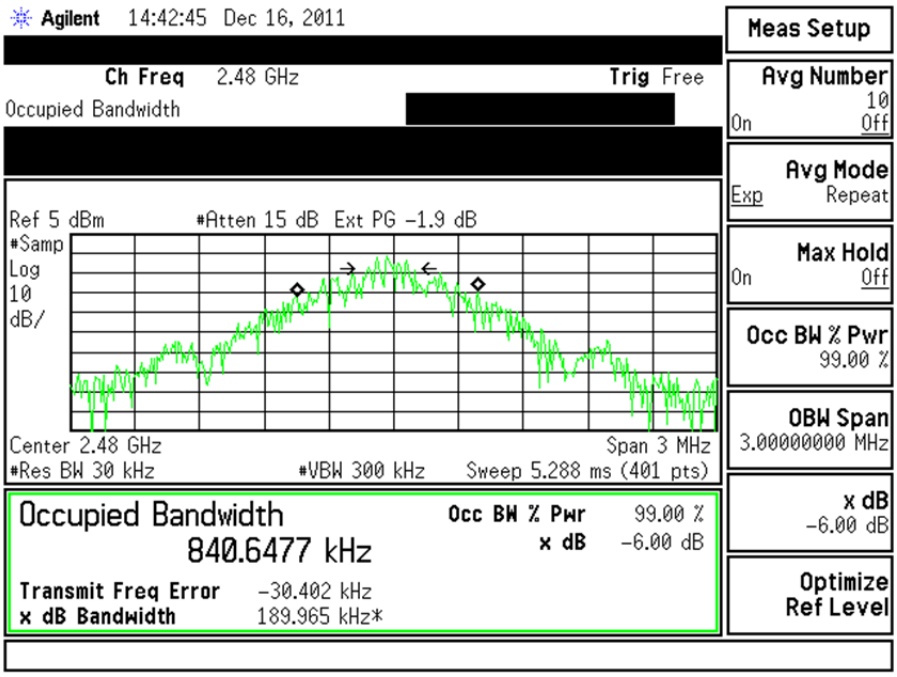


EXHIBIT 8. BANDEDGE MEASUREMENTS

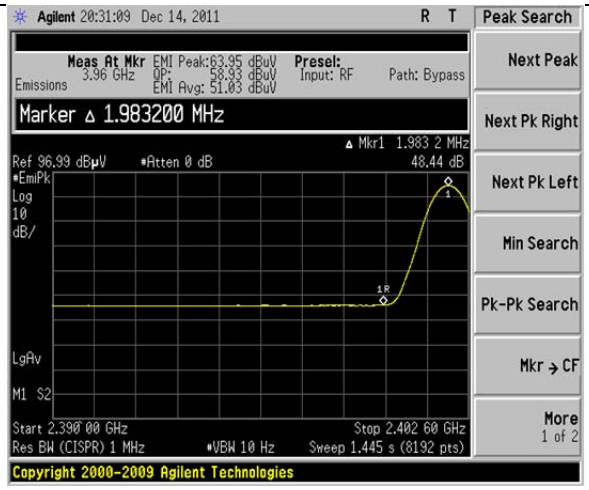
Method of Measurements

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.

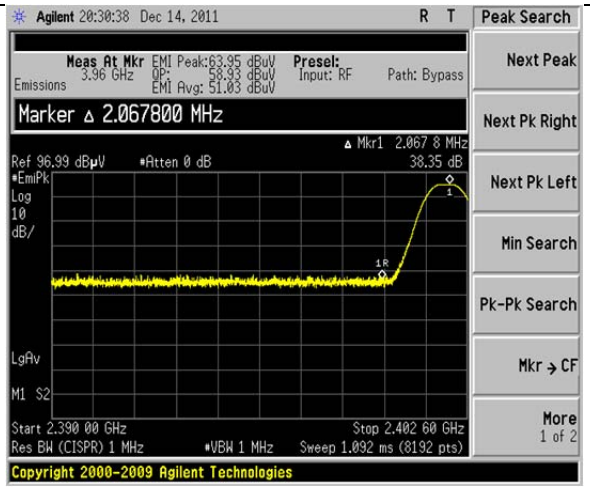
The Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.

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

Screen Captures Demonstrating Compliance at the Lower Band-Edge

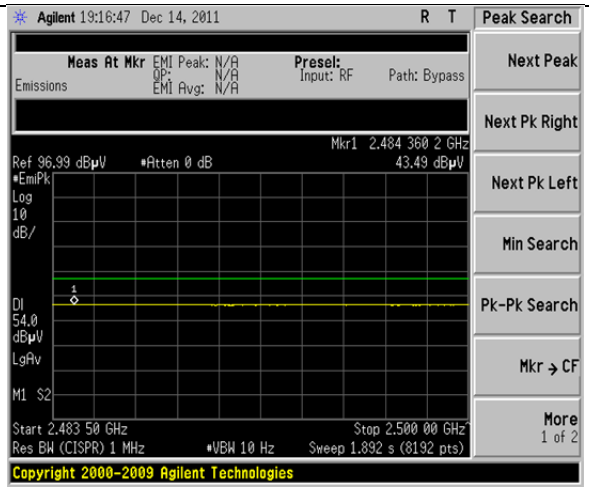


Lower bandedge average

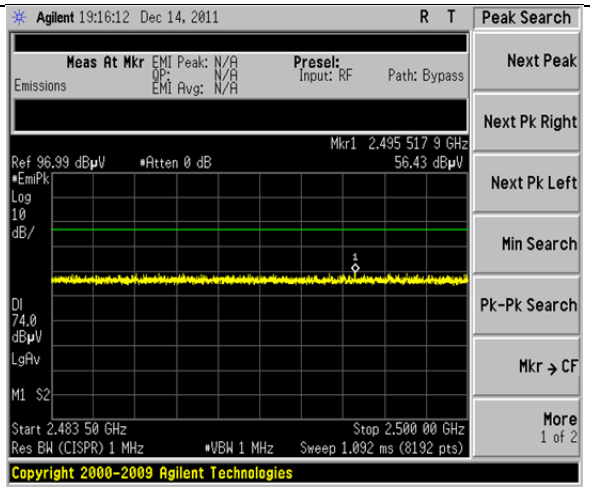


Lower bandedge peak

Screen Captures Demonstrating Compliance at the Upper Band-Edge



Upper bandedge average



Upper bandedge peak

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

9.1 Method of Measurements

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

9.2 Test Equipment List

Please see Appendix A for a complete list of test equipment.

9.3 Test Data

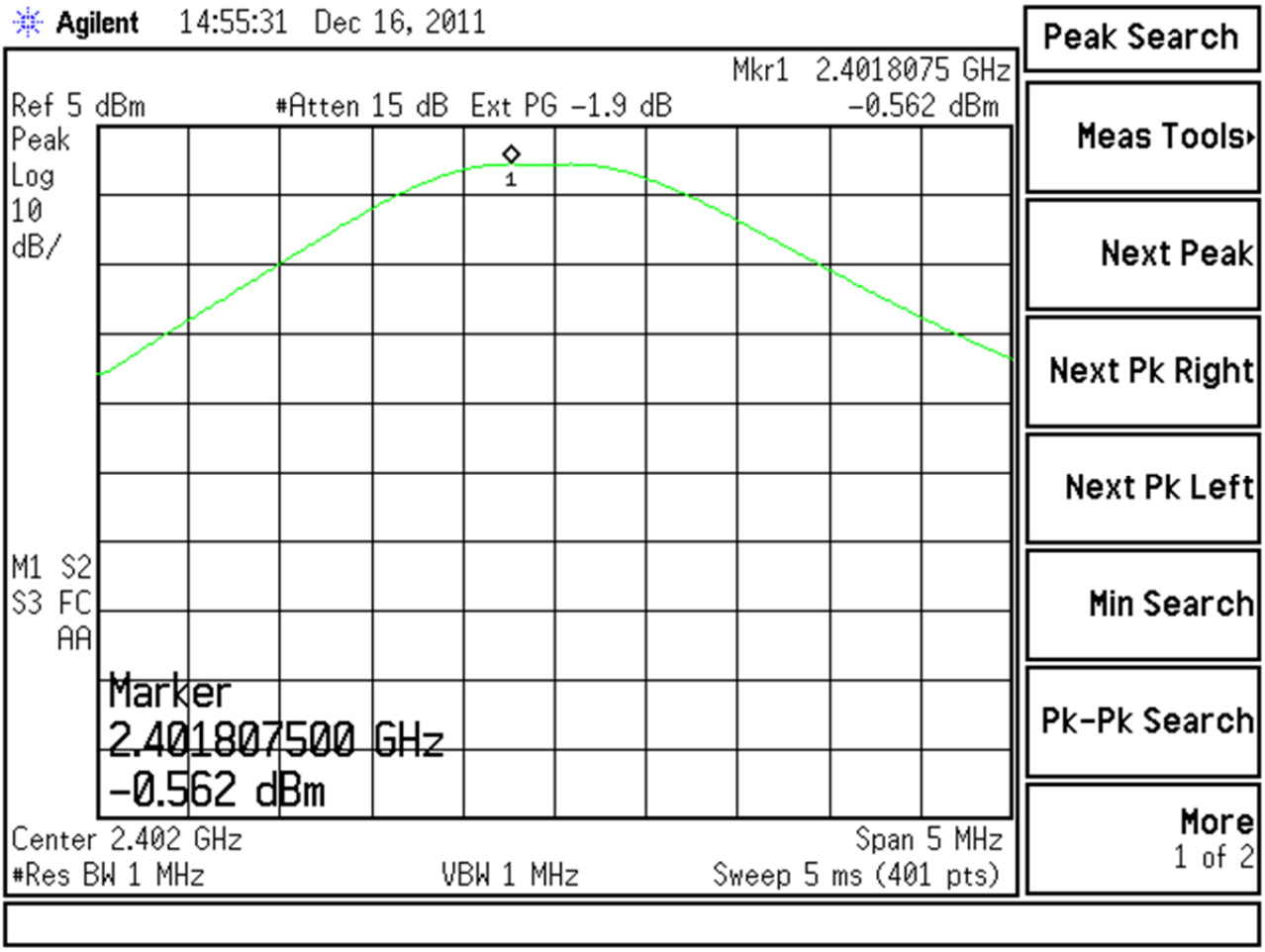
CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
1	2402	+30 dBm	-0.6	30.6
40	2441	+30 dBm	-2.0	32.0
79	2480	+30 dBm	-2.9	32.9

Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Antenna Gain (dBi)	Calculated EIRP (dBm)	Conducted Power Limit (dBm)	Conducted Power Margin (dBm)	EIRP Limit (dBm)	EIRP Margin (dBm)
1	2402	-0.6	0.0	-0.6	30.0	30.6	36.0	-36.6
40	2445	-2.0	0.0	-2.0	30.0	32.0	36.0	-38.0
79	2480	-2.9	0.0	-2.9	30.0	32.9	36.0	-38.9

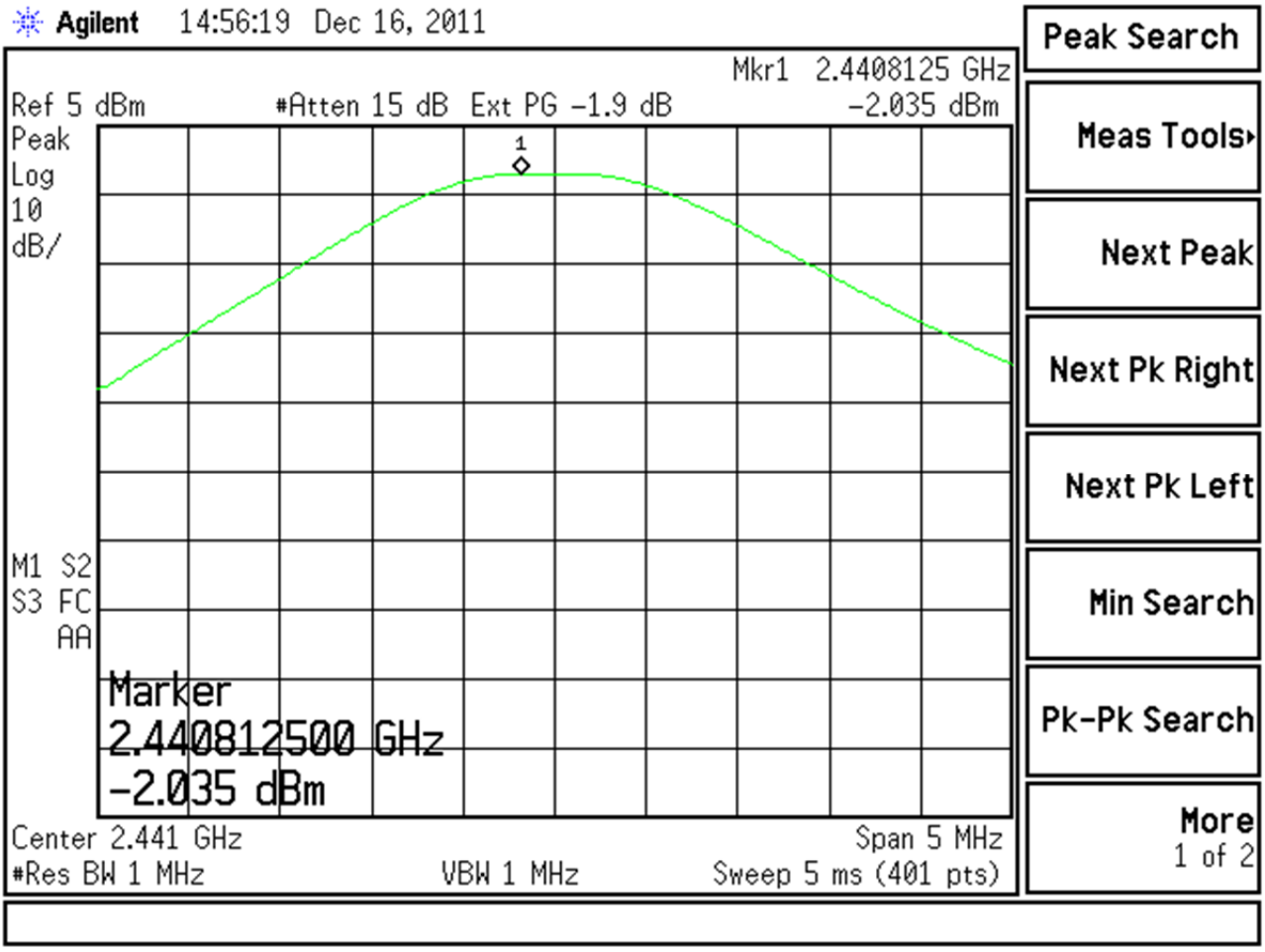
EIRP Calculation:
EIRP = (Peak power at antenna terminal in dBm) + (EUT Antenna gain in dBi)

9.4 Screen Captures – Power Output (Conducted)

Channel 1



Channel 40


Agilent 14:56:19 Dec 16, 2011
Mkr1 2.4408125 GHz
Ref 5 dBm
#Atten 15 dB Ext PG -1.9 dB
-2.035 dBm
Peak
Log
10
dB/
M1 S2
S3 FC
AA
Marker
2.440812500 GHz
-2.035 dBm
Center 2.441 GHz
#Res BW 1 MHz
VBW 1 MHz
Span 5 MHz
Sweep 5 ms (401 pts)
Peak Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

Channel 79

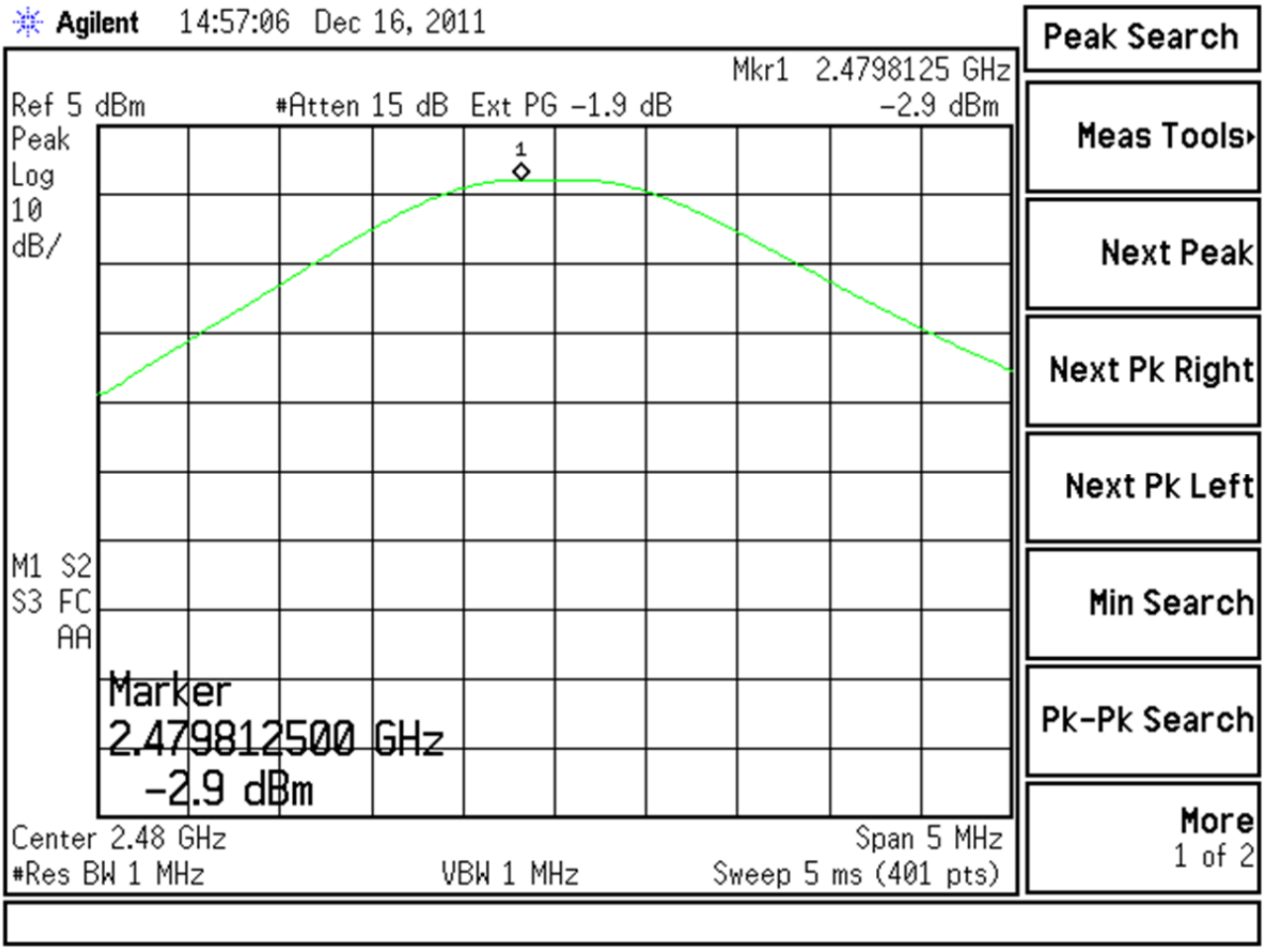

Agilent 14:57:06 Dec 16, 2011
Mkr1 2.4798125 GHz
Ref 5 dBm
#Atten 15 dB Ext PG -1.9 dB
-2.9 dBm
Peak
Log
10
dB/
1
M1 S2
S3 FC
AA
Marker
2.479812500 GHz
-2.9 dBm
Center 2.48 GHz
Span 5 MHz
#Res BW 1 MHz
VBW 1 MHz
Sweep 5 ms (401 pts)
Peak Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

EXHIBIT 10. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

10.1 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.

FCC Part 15.247(d) and IC RSS 210 A8.5 requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable was added on the analyzer as gain offset settings, thereby allowing direct readings of the measurements
made without the need for any further corrections. An Agilent model E4446A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

No significant emissions could be noted within -39 dBc of the fundamental level for this product.

Freq\Chan	1\2402	40\2441	79\2480
fo	-0.6	-2.0	-2.9
2fo	-39.7	-42.6	-44.6
3fo	-47.3	-47.1	-48.4
4fo	-61.8	-59.3	-55.9
5fo	-51.3	-56.3	-57.0
6fo	-65.7	-64.7	-62.2
7fo	-53.2	-55.6	-52.9
8fo	-69.2	-67.4	-71.1
9fo	Note 1	Note 1	Note 1
10fo	Note 1	Note 1	Note 1

Notes:
(1) Measurement at system noise floor.

10.2 Test Equipment List

Please see Appendix A

10.3 Test Data

Modulation: GFSK
Frequency Test Range: 2402-2480 MHz

Conducted Spurious Harmonic Emissions

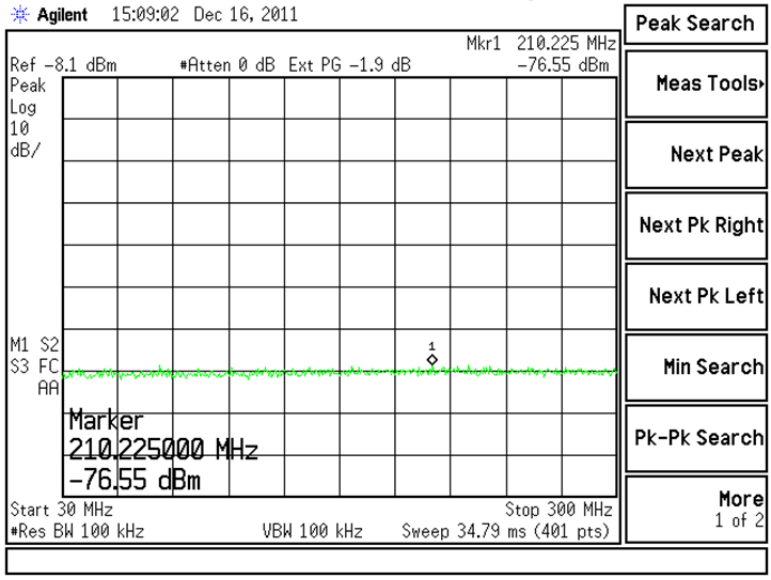
Freq\Chan	1\2402	40\2441	79\2480
fo	-0.6	-2.0	-2.9
2fo	-39.7	-42.6	-44.6
3fo	-47.3	-47.1	-48.4
4fo	-61.8	-59.3	-55.9
5fo	-51.3	-56.3	-57.0
6fo	-65.7	-64.7	-62.2
7fo	-53.2	-55.6	-52.9
8fo	-69.2	-67.4	-71.1
9fo	Note 1	Note 1	Note 1
10fo	Note 1	Note 1	Note 1

Extra Spurious Emissions

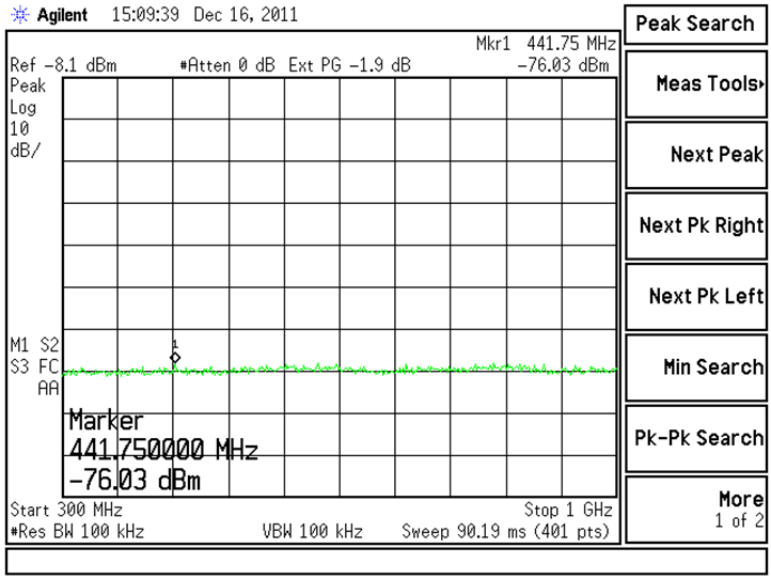
Freq(MHz)	Chan	level(dBm)
13187.5	40	-72.5
15250.00	40	-73.3
482.00	40	-71.7
585.25	79	-75.4

10.4 Screen Captures – Spurious Radiated Emissions

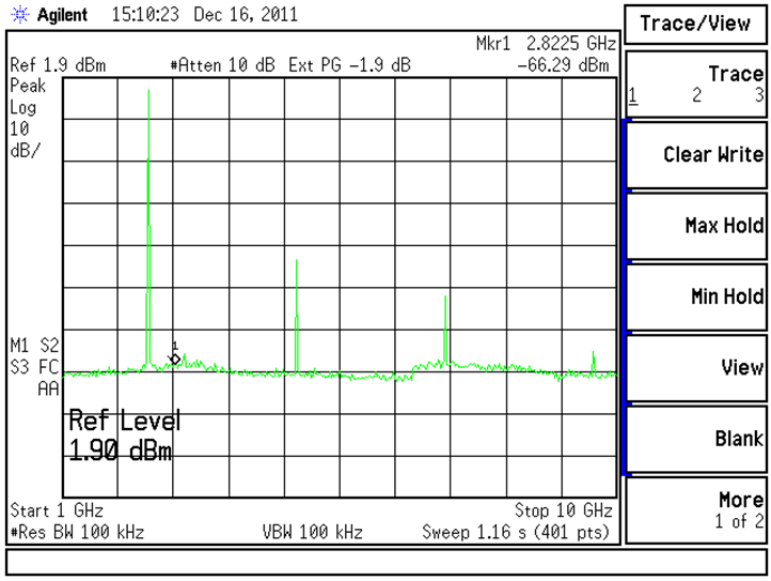
Channel 1, shown from 30 MHz up to 1000 MHz



Channel 1, shown from 300 MHz up to 1000 MHz



Channel 1, shown from 1000 MHz up to 10000 MHz



Channel 1, shown from 10000 MHz up to 25000 MHz

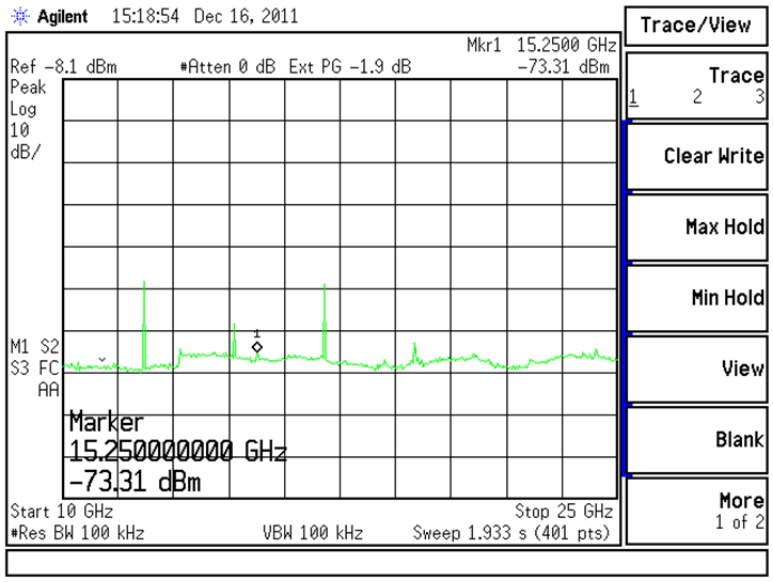


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

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

In this case, the EUT uses a single battery, with a nominal voltage of 3.7 VDC. The working range of the product is limited to 4.2 VDC on the high end.

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.

3.15 VDC		3.7 VDC		4.2 VDC* (limited voltage)		
Power (dBm)	Frequency (MHz)	Power (dBm)	Frequency (MHz)	Power (dBm)	Frequency (MHz)	Channel
-0.70	2401.97	-0.7	2401.95	-0.72	2401.97	1
-1.89	2440.96	-1.92	2440.96	-1.803	2440.96	40
-2.89	2479.94	-2.92	2479.94	-2.94	2479.94	79

The power was then cycled On/Off to observe system response. No abnormal system response was noted.

EXHIBIT 13. CHANNEL OCCUPANCY

Part 15.247(a)(1) requires a channel occupancy, for this device, of no more than 400 milliseconds in a 31.6 second window (400ms*79 channels yields 31.6 seconds). The channel occupancy for this EUT was measured using a spectrum analyzer, set to zero-span at the frequency of interest and a video out signal to an Agilent 54624A Megazoom Oscilloscope. The analyzer utilized an extended sweep time allowing for not extraneous clear-write signals to appear on the oscilloscope. The transmission lengths can be measured by adjusting the horizontal scale of the oscilloscope once after obtaining a capture with demonstrating the entire data train.

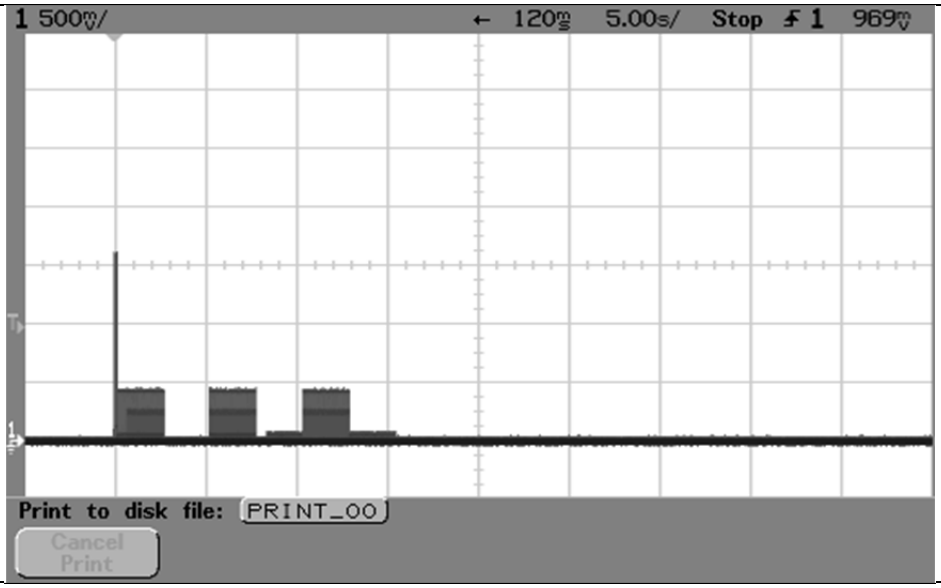
FCC Public Notice DA 00-705 was used for the procedure to measure the dwell time. As the spectrum analyzer has a limited resolution, an oscilloscope was utilized to further understand the dwell time. The video-out port of the spectrum analyzer was connected to the video-input to the oscilloscope. This allowed for closer analysis of the dwell time, but dissecting the individual data packet.

A sweep was made at the low, mid and high channels to verify channel occupancy.

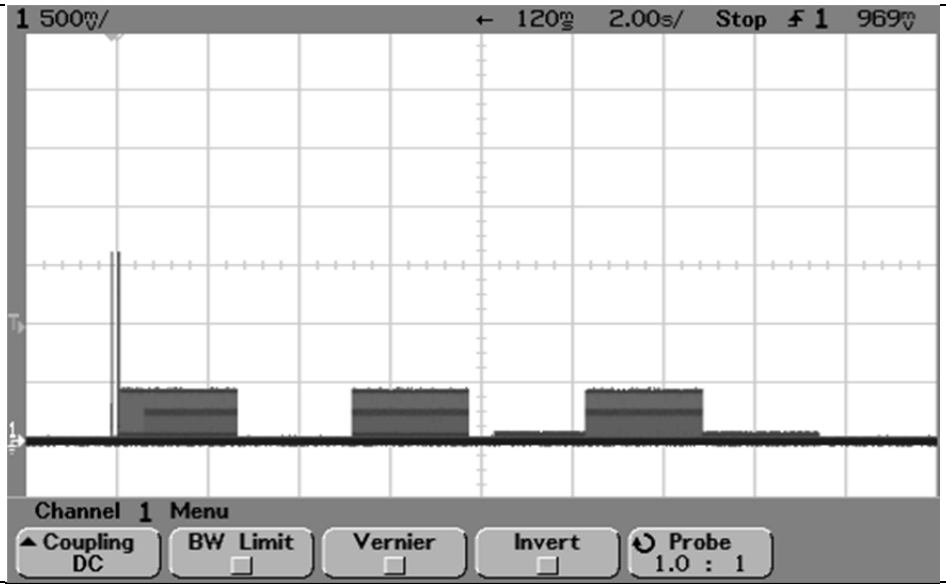
The longest time any transmission will occur on a single channel is 74.4 milliseconds. In a 31.6 second window, each channel has a worst-case transmission cycle comprised of 2 short initial pulses followed by three pulses of equal length. This represents the device not being able to connect to a corresponding unit and attempting 3 times to communicate. The maximum occupancy in a 31.6 second window is calculated by summing all time in 1 transmission cycle. Please see explanation below.

Plots of Channel Occupancy

Channel Occupancy



Entire Data Train in 50s sweep



Entire data train in 20s sweep

Total Occupancy Mathematical Justification

Entire data train consists of 2 initial pulses and 3 communication trials.

Initial pulses

***20 components/pulse**

***40 components/2 pulses**

***1 component=96 us**

***total on-time for two pulses = 3.84ms**
(40*96 us = 3840 us = 3.84 ms)

Communication Trials

***245 individual components/pulse**

***3 pulses**

***1 component = 96 us**

***total on-time for three transmission trials = 70.56 ms**

Total on-time for one channel in 31.6ms
= (initial pulses + communication trials)
= (3.84 + 70.56) ms

= 74.4 ms

EXHIBIT 14. CHANNEL PLAN AND SEPARATION

A spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT.

The minimum and maximum channel-separations measured for this device are 998.0 kHz and 1020 kHz respectively. The maximum occupied bandwidth of the device, as reported in the previous section is 880 kHz.

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

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

The following plots describe this spacing, and also establish the channel separation and plan.

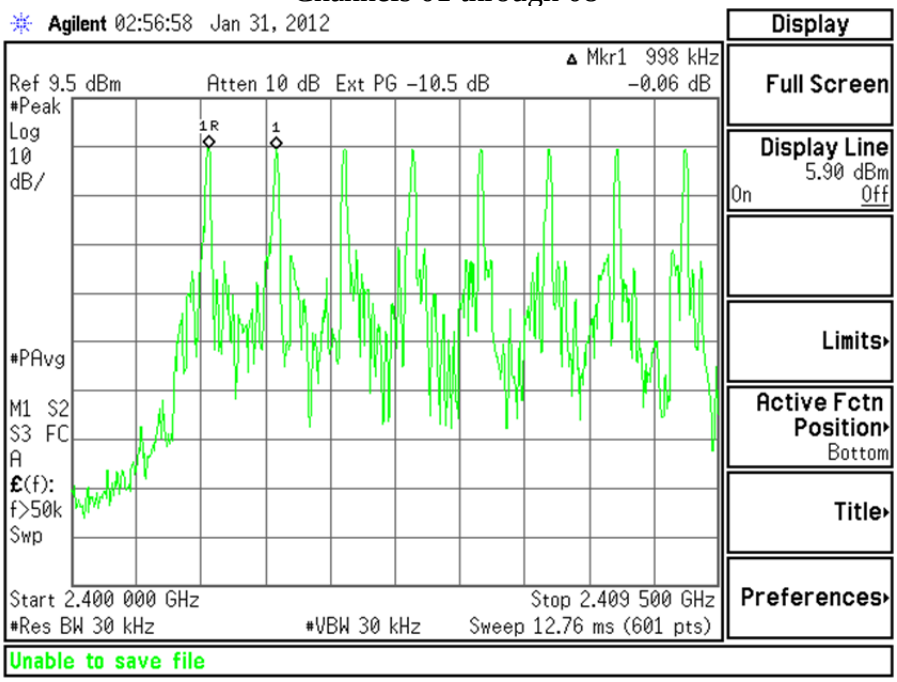
RANGE (MHz)	NUMBER OF CHANNELS PER CAPTURE	Max separation (kHz)
2400-2409.5	8	998
2409.5-2418.5	9	1005
2418.5-2427.5	9	1020
2427.5-2436.5	9	1005
2436.5-2446.5	10	1000
2446.5-2455.5	9	1005
2455.5-2465.5	10	1000
2465.5-2475.5	10	1017
2475.5-2483.5	5	1000

Total Channels	79
Max separation (kHz)	1017
Min Separation (kHz)	998

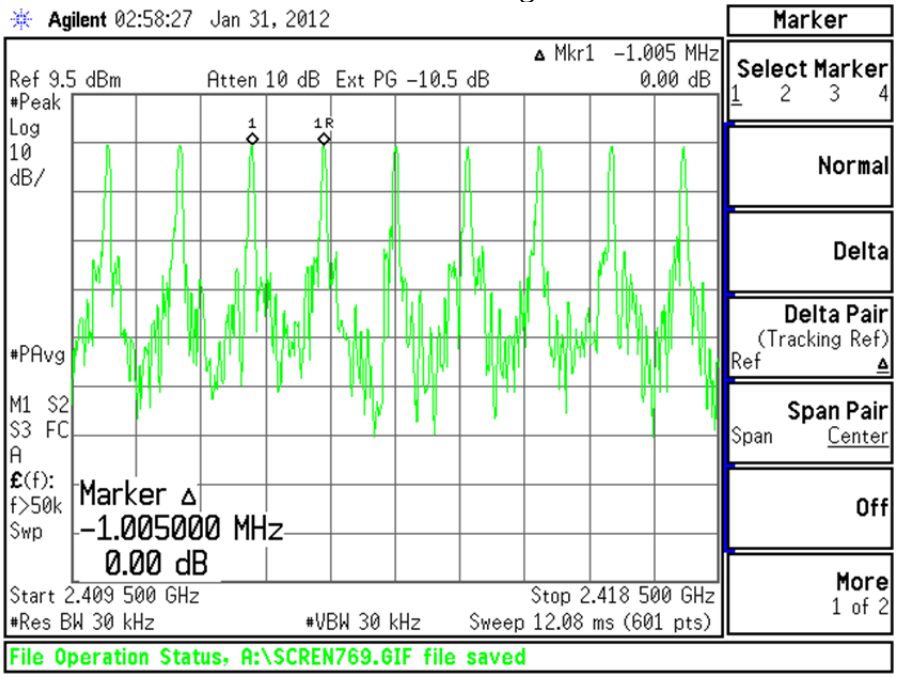
Total number of channels = 79

14.1 - Screen Captures – Channel Separation

Channels 01 through 08

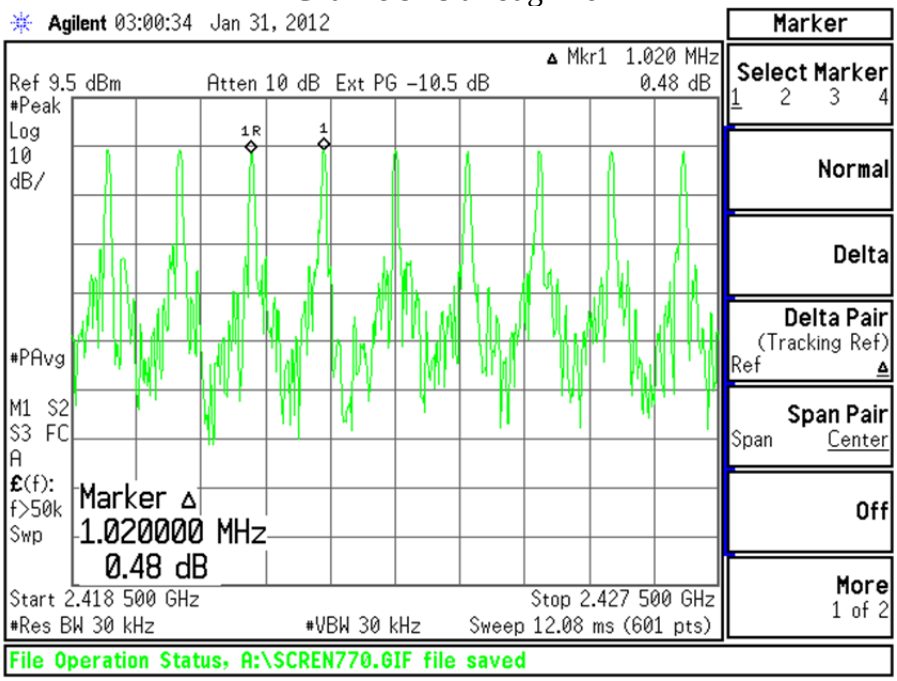


Channels 9 through 17

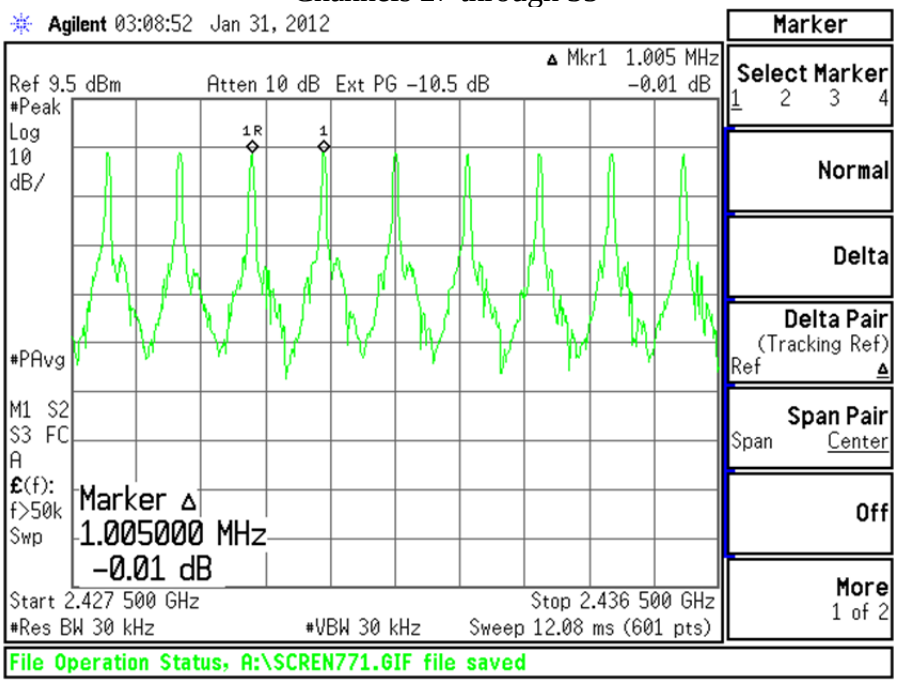


Screen Captures – Channel Separation *(continued)*

Channels 18 through 26

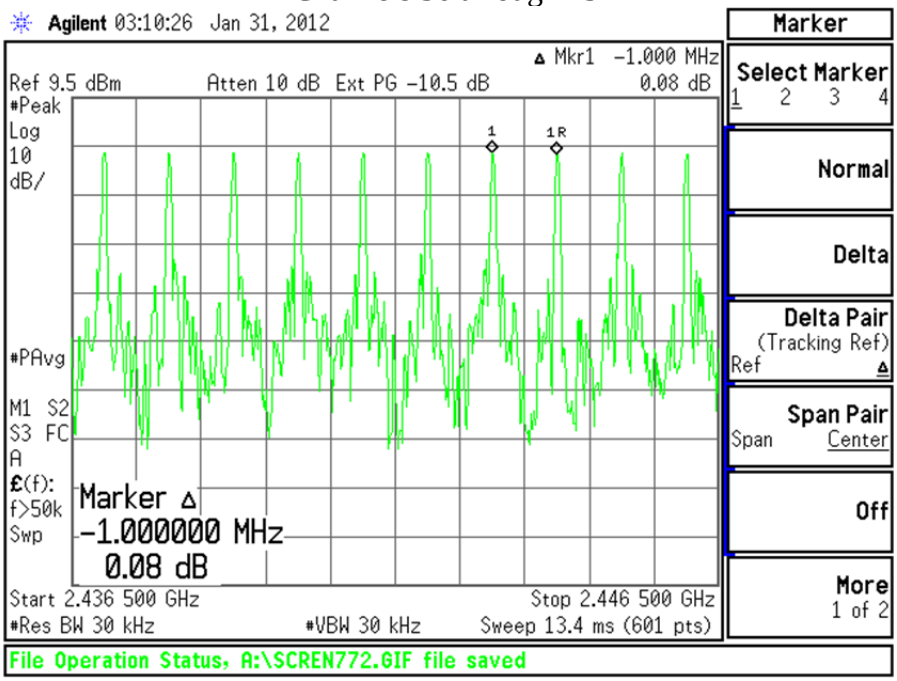


Channels 27 through 35

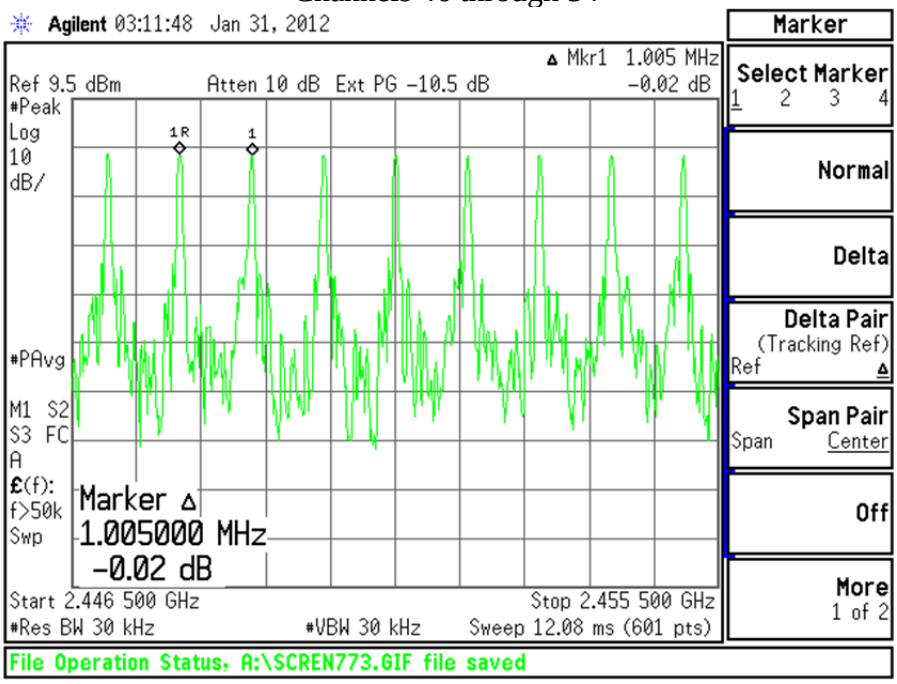


Screen Captures – Channel Separation *(continued)*

Channels 36 through 45

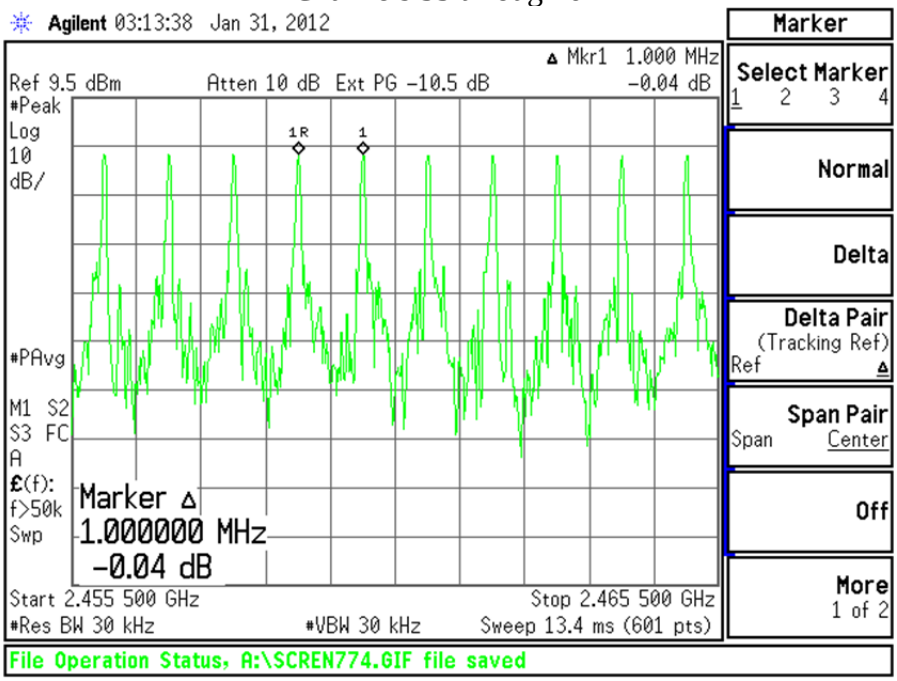


Channels 46 through 54

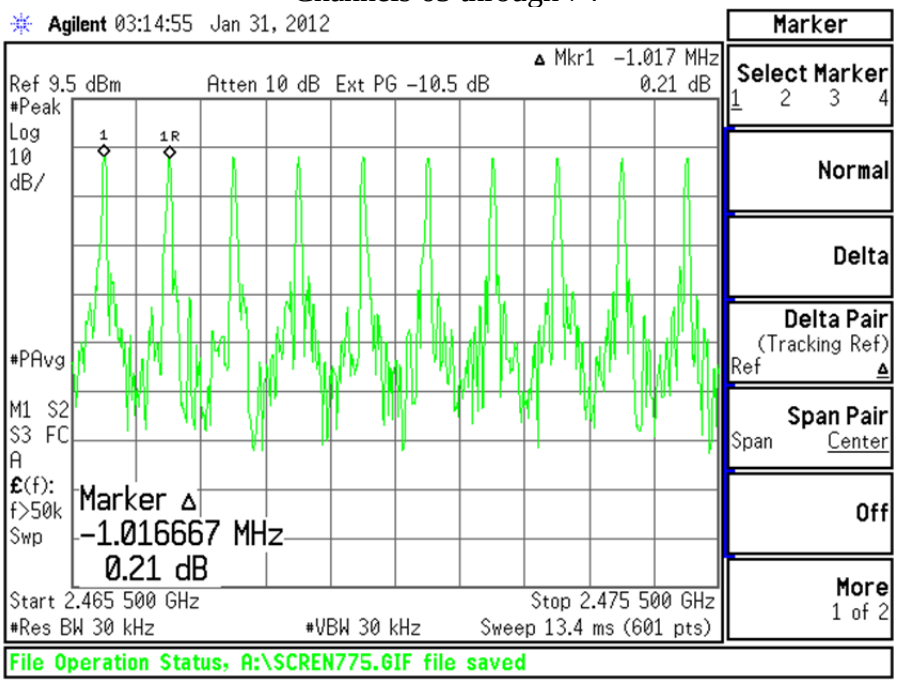


Screen Captures – Channel Separation *(continued)*

Channels 55 through 64



Channels 65 through 74



Screen Captures – Channel Separation *(continued)*

Channels 75 through 79

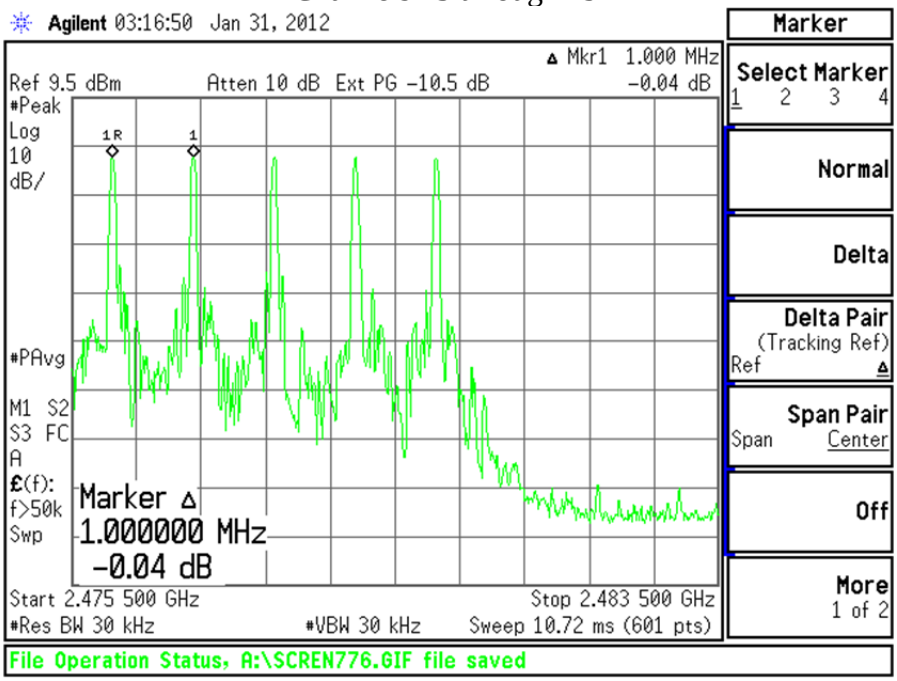


EXHIBIT 15. EQUAL CHANNEL USAGE AND PSEUDORANDOM HOPPING SEQUENCE.

In total, six types of hopping sequence are defin*ed − five for the basic hop sys*tem and one for an adapted set of hop locations used by adaptive frequency hopping (AFH). These sequences are:

•A page hopping sequence with 32 wake-up frequencies distributed equally over the 79 MHz, with a period length of 32;
•A page response hopping sequence covering 32 response frequencies that are in a one-to-one correspondence to the current page hopping sequence. The master and slave use different rules to obtain the same sequence;
•An inquiry hopping sequence with 32 wake-up frequencies distributed equally over the 79 MHz, with a period length of 32;
•An inquiry response hopping sequen*ce covering 32 response frequen*cies that are in a one-to-one correspondence to the current inquiry hopping sequence.
•A basic channel hopping sequence which has a very long period length, which does not show repetitive patterns over a short time interval, and which distributes the hop frequencies equally over the 79 MHz during a short time interval.
•An adapted channel hopping sequence derived from the basic channel hopping sequence which uses the same channel mechanism and may use fewer than 79 frequencies. The adapted channel hopping sequence is only *used in place of* the basic channel hopping sequence. All other hopping sequences are not affected by hop sequence adaptation.

Note: The information in this section is provided by the manufacturer.

EXHIBIT 16. RECEIVER SYNCHRONIZATION AND RECEIVER INPUT BANDWIDTH.

The hop table is determined by the master's Bluetooth address and the master's Bluetooth clock. The hop sequence generation is described in the Bluetooth Baseband Specification section 2.6. The slave creates an offset from its own clock to create a clock synchronized to the master. The clock is a 28 bit counter with a period of 312.5 us (one half of a time slot). Using the master's Bluetooth address and its synchronized version of the master clock the slave generates the hop sequence of the piconet.

Master transmissions start on even number slots and slave transmissions start in odd slots. Each packet starts with an access code which provides synchronization information and packet information. During an active conversation the slave is constantly synchronizing its clock with the master clock. When the slave goes into sniff mode (low power mode) it must listen for packets to obtain synchronization information before transmitting. Before a connection is made the slave connects to the master using a special hop sequence in a mode called Paging. This is described in section 2.4.3 of the Bluetooth Baseband Specification.

The receiver input bandwidth is 1 MHz.

Note: The information in this section is provided by the manufacturer.

APPENDIX A

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 21-Dec-2011 Type Test : Radiated Emissions Job # : C-1370

Prepared By: Peter Customer : Reciprocal Quote #: 311360

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
2	AA 960154	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-02	6/10/2011	6/10/2012	Active Calibration
3	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/4/2011	1/4/2012	Active Calibration
4	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	1/4/2011	1/4/2012	Active Calibration
5	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2012	Active Calibration
6	EE 960156	100kHz-1GHz Analog Signal Generator	Agilent	N5181A	MY49060062	6/6/2011	6/6/2012	Active Calibration
7	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/6/2011	6/6/2012	Active Calibration
8	EE 960158	RF Preselecter	Agilent	N9039A	MY46520110	6/11/2011	6/11/2012	Active Calibration
9	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	4/27/2011	4/27/2012	Active Calibration
10	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	11/15/2011	11/15/2012	Active Calibration
11	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	11/15/2011	11/15/2012	Active Calibration

Peter Felix

Project Engineer: _____ Quality Assurance: _____

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 1-Feb-2012 Type Test : Conducted Radio Measurements (20dB) Job # : C-1370

Prepared By: Peter Customer : Reciprocal Quote #: 311360

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
3	CC 000267C	Oscilloscope	Agilent	54624A	US40020305	8/13/2011	8/13/2012	Active Calibration

Project Engineer: Peter Felix Quality Assurance: _____

APPENDIX B – TEST STANDARDS: CURRENT PUBLICATION DATES

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	2009		
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	2007-06	
RSS 119	2007-06	
RSS 123	1999-11	
RSS 125	2000-03	
RSS 131	2003-07	
RSS 136	2002-10	
RSS 137	2009-02	
RSS 210	2007-06	
RSS 213	2005-12	
RSS 243	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