Lab Code: 200167-0

FCC PART 15.247

IC RSS-210, ISSUE 7, JUNE 2007

TEST AND MEASUREMENT REPORT

For

LumenRadio AB

Stena Center 1, Gothenburg, Sweden, SE-41292

FCC ID: XRSCRMXNOVA101
IC: 8879A-CRMXN101

Report Type:	**Product Type:**
Original Report	Wireless Transceiver Module

Test Engineer:	Dennis Huang
Report Number:	R1002024-247
Report Date:	2010-03-11
Reviewed By:	Boni Baniqued EMC/RF Supervisor
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Note: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This report **must not** be used by the customer to claim product certification, approval, or endorsement by NVLAP*, NIST, or any agency of the Federal Government.
* This report may contain data that are not covered by the NVLAP accreditation and are marked with an asterisk "*"

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1002024-247	Original Report	2010-03-08

1 General Information

1.1 Product Description for Equipment under Test (EUT)

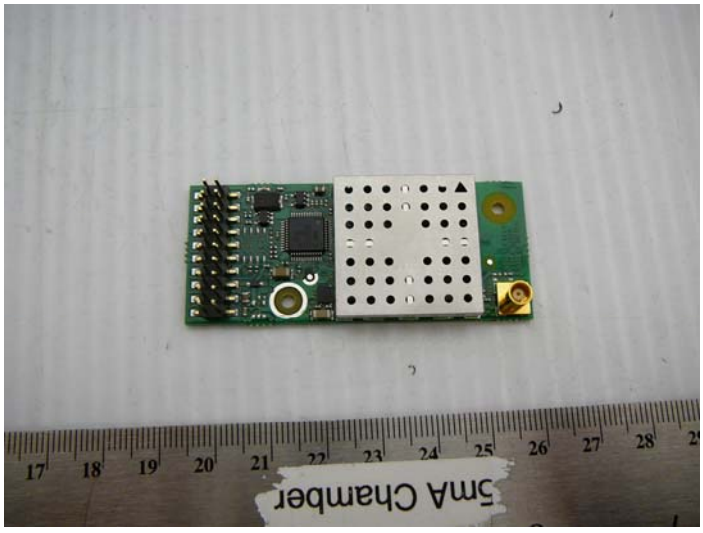
This test and measurement report was prepared on behalf of *LumenRadio AB* and their product, *model: CRMX Nova, FCC ID: XRSCRMXNOVA101, IC: 8879A-CRMXN101* or the "EUT" as referred to this report a wireless system that communicates reliably with perfect fidelity. CRMX-PD is the most powerful wireless lighting control system on the market, with ground breaking features to ensure unrivalled reliability. CRMX-PD distributes DMX and RDM with full frame integrity and provides range and reliability that surpass all other systems available today. Operating Frequency: 2.4GHz ~ 2.4835GHz

1.2 Mechanical Description of EUT

The EUT measures approximately 65 mm **(L)** x 27.5 mm **(W)** x 5 mm **(H)** and weighs approximately 6 g.

**The data gathered are from a typical production sample provided by the manufacturer with serial number: R0907163-1, R0907163-2, and R0907163-3 assigned by BACL.*

1.3 EUT Photo



Please refer to Exhibit C for addition EUT photographs.

1.4 Objective

This report is prepared on behalf of *LumenRadio AB* in accordance with Part 2, Subpart J, Part 15, Subparts A, B and C of the Federal Communication Commissions rules and Industry Canada RSS-210 Issue 7, June 2007.

1.5 Related Submittal(s)/Grant(s)

No related submittals.

1.6 Test Methodology

All measurements contained in this report were conducted in accordance with 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.

1.7 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the values range from $\pm$2.0 for Conducted Emissions tests and $\pm$4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL.

Detailed instrumentation measurement uncertainties can be found in BACL report QAP-018.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

1.8 Test Facility

The test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test sites at BACL have been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2003.

The Federal Communications Commission, Industry Canada, and Voluntary Control Council for Interference has the reports on file and is listed under FCC registration number: 90464, IC registration number: 3062A, and VCCI Registration Number: C-2463 and R-2698. The test site has been approved by the FCC, IC, and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (Lab Code 200167-0). The current scope of accreditations can be found at http://ts.nist.gov/Standards/scopes/2001670.htm

2 System Test Configuration

2.1 Justification

The host system was configured for testing according to ANSI C63.4-2003.

The EUT was tested in the testing mode to represent *worst*-case results during the final qualification test.

2.2 EUT Exercise Software

The EUT is programmed with the following settings that were used during testing:

Low Channel (MHz)	Low Channel (MHz)	Low Channel (MHz)	Receive Mode (MHz)	Full Hopping Mode (MHz)
2402	2442	2480	2402-2480	2402-2480

2.3 Special Accessories

There were no special accessories were required, included, or intended for use with EUT during these tests.

2.4 Equipment Modifications

No modifications were made to the EUT.

2.5 Internal Parts List and Details

Manufacturers	Descriptions	Models	Serial Numbers
Lumen Radio	PCB Assembly	NOVA TRX Rev B	E225430 KB-04

2.6 Interface Ports and Cabling

N/A

3 Summary of Test Results

FCC 15C & IC RSS-210 Rules	Description of Test	Results
FCC §15.203 IC RSS-Gen §7.1.4	Antenna Requirements	Compliant
FCC §15.207 (a) IC RSS-Gen §7.2.2	Conducted Emissions	N/A*
FCC §15.205, §15.209 & §15.247(d) IC RSS-210 §2.2, §A8.5	Restricted Band and Unwanted Emissions	Compliant
FCC §2.1051 & 15.247(d) IC RSS-210 §A8.5 & RSS-Gen §7.2	Spurious Emissions at Antenna Port	Compliant
FCC §15.247 (a)(1) IC RSS-210 §A8.1 (a)	20 dB Bandwidth & 99% Bandwidth	Compliant
FCC §15.247 (a)(1) IC RSS-210 §A8.1(d)	Hopping Channel Separation	Compliant
FCC §15.247 (a)(1)(iii) IC RSS-210 §A8.1(d)	Number of Hopping Frequencies Used	Compliant
FCC §15.247 (a)(1)(iii) IC RSS-210 §A8.1(d)	Dwell Time	Compliant
FCC §15.247 (b)(3) IC RSS-210 §A8.4(2)	Maximum Peak Output Power	Compliant
FCC § 15.247 (d) IC RSS-210 §A8.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
IC RSS-Gen §4.10	Receiver Spurious Emissions	Compliant
FCC §15.247(i) & §2.1091 IC RSS-Gen §5.5 & RSS-102	RF Exposure	Compliant

**Note: Not Applicable, EUT is DC Powered.*

4 FCC §15.203 & IC RSS-Gen §7.1.4 - Antenna Requirement

4.1 Applicable Standard

For intentional device, according to FCC Part §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used.

Per IC RSS-Gen §7.1.4, A transmitter can only be sold or operated with antennas with which it was certified. A transmitter maybe certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns. Testing shall be performed using the highest-gain antenna of each combination of transmitter and antenna type for which certification is being sought, with the transmitter output power set at the maximum level. Any antenna of the same type and having equal or lesser gain as an antenna that had been successfully tested for certification with the transmitter, will also be considered certified with the transmitter, and may be used and marketed with the transmitter. The manufacturer shall include with the application for certification a list of acceptable antenna types to be used with the transmitter.

When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on measurement or on data from the antenna manufacturer. Any antenna gain in excess of 6 dBi (6 dB above isotropic gain) shall be added to the measured RF output power before using the power limits specified in IC RSS-210 or RSS-310 for devices of RF output powers of 10 milliwatts or less. For devices of output powers greater than 10 milliwatts, except devices subject to IC RSS-210 Annex 8 or RSS-210 Annex 9, the total antenna gain shall be added to the measured RF output power before using the specified power limits. For devices subject to IC RSS-210 Annex 8 or Annex 9, the antenna gain shall not be added.

4.2 Antenna Connected Construction

The antenna for this device is an integral antenna that the end user cannot access. It is fully enclosed by the EUT chassis and removal/modification would result in irreparable damage to the device. Maximum gain is 5dBi

☒ **Compliant** ☐ **N/A**

5 FCC §15.207 & IC RSS-GEN §7.2.2- Conducted Emissions

5.1 Applicable Standard

FCC Part 15.207 Conducted limits:

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

** Decreases with the logarithm of the frequency.*

5.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.4 – 2003 measurement procedure. The specification used was FCC Part15.207 limits.

External I/O cables were draped along the edge of the test table and bundle when necessary.

The EUT AC/DC power adapter was connected with LISN-1 which provided 120 V / 60 Hz AC power.

5.3 Test Procedure

During the conducted emissions test, the power cord of the EUT host system was connected to the mains outlet of the LISN-2.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the peak detection mode, quasi-peak and average. Quasi-Peak readings are distinguished with a “QP”. Average readings are distinguished with an “Ave”.

5.4 Test Results

According to the recorded data in following table, the EUT complied with the FCC & IC standard’s conducted emissions limits for consumer devices, with the *worst* margin reading of:

N/A, EUT is powered by DC Voltage.

6 FCC §15.205, §15.209 & §15.247(D) & IC RSS-210 §2.2, §8.5 – Restrict Band and Unwanted Emissions

6.1 Applicable Standard:

As per FCC §15.205 and IC RSS-210 §2.2, Restricted bands of operation

(a) Except as shown in §15.205 paragraphs (d), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	MHz	GHz	GHz
0.090 – 0.110	8.291 – 8.294	16.69475 – 16.69525	156.7 – 156.9	1435 – 1626.5	3.332 – 3.339	10.6 – 12.7
0.495 – 0.505	8.362 – 8.366	25.5 – 25.67	162.0125 –167.17	1645.5 – 1646.5	3.3458 – 3.358	13.25 – 13.4
2.1735 – 2.1905	8.37625 – 8.38675	37.5 – 38.25	167.72 – 173.2	1660 – 1710	3.600 – 4.400	14.47 – 14.5
4.125 – 4.128	8.41425 – 8.41475	73 – 74.6	240 – 285	1718.8 – 1722.2	4.5 – 5.15	15.35 – 16.2
4.17725 – 4.17775	12.29 – 12.293	74.8 – 75.2	322 – 335.4	2200 – 2300	5.35 – 5.46	17.7 – 21.4
4.20725 – 4.20775	12.51975 – 12.52025	108 – 121.94	399.9 – 410	2310 – 2390	7.25 – 7.75	22.01 – 23.12
6.215 – 6.218	12.57675 – 12.57725	123 – 138	608 – 614	2483.5 – 2500	8.025 – 8.5	23.6 – 24.0
6.26775 – 6.26825	13.36 – 13.41	149.9 – 150.05	960 – 1240	2690 – 2900	9.0 – 9.2	31.2 – 31.8
6.31175 – 6.31225	16.42 – 16.423	156.52475 – 156.52525	1300 – 1427	3260 – 3267	9.3 – 9.5	36.43 – 36.5
						Above 38.6

(b) Except as provided in 15.205 paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

(c) Except as provided in paragraphs (d) and (e), regardless of the field strength limits specified elsewhere in this Subpart, the provisions of this Section apply to emissions from any intentional radiator.

As per FCC §15.209 Radiated emission limits, general requirements.

(a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

*** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.*

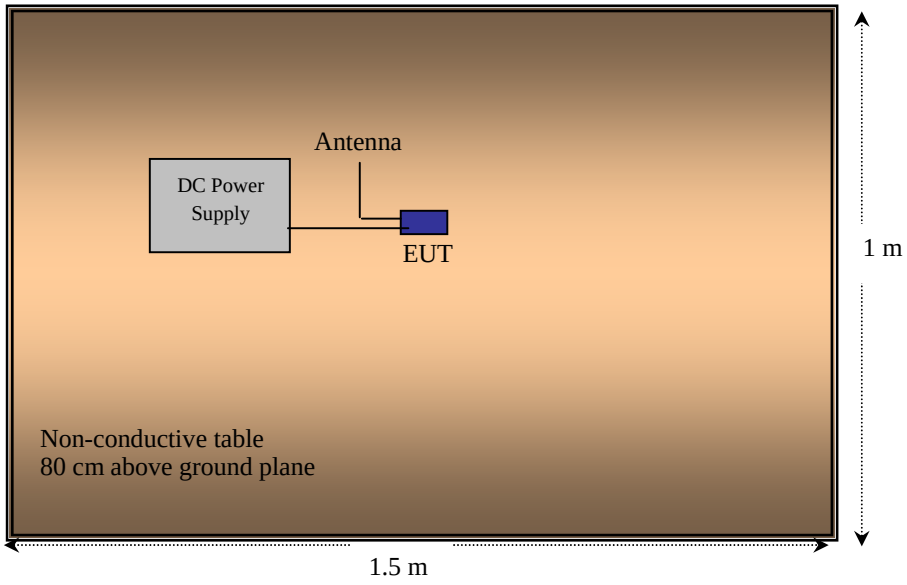
According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) see §15.205(c)).

IC RSS-Gen §4.9 the measurement method shall be described in the test report. The same parameter, peak power or average power, used for the transmitter output power measurement shall be used for unwanted emission measurements. The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate or carrier frequency), or from 30 MHz, whichever is the lower, to the 5th harmonic of the highest frequency generated without exceeding 40 GHz.

6.2 Test Setup

The radiated emissions tests were performed in the 3-meter semi-anechoic chamber test site, using the setup in accordance with ANSI C63.4-2003. The specification used was the FCC 15C & IC RSS-210 limits.

6.3 Test Setup Diagram



6.4 Test Procedure

For the radiated emissions test, the EUT was powered by DC power supply, and all support equipment power cords was connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT is set 3 meter away from the testing antenna, which is varied from 1-4 mete, and the EUT is placed on a turntable, which is 0.8 meter above ground plane, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal and vertical.

The spectrum analyzer or receiver is set as:

Below 1000 MHz:

RBW = 100 kHz/VBW = 300 kHz/Sweep = Auto

Above 1000 MHz:

Peak: RBW = 1MHz/VBW = 1MHz/Sweep = Auto
Average: RBW = 1MHz/VBW = 10Hz/Sweep = Auto

6.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Cable Loss, and Attenuator Factor adding to the Indicated Reading. The basic equation is as follows:

Corrected Amplitude = Indicated Reading + Cable Loss + Attenuator Factor

For example, a Corrected Amplitude of 34.08 dBuV/m = Indicated Reading (23.85 dBuV) + Cable Factor (0.22 dB) + Attenuator Factor (10dB)

The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit.

6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2009-04-27
Sunol Sciences	Antenna	JB1	A020106-1	2009-04-17
A.R.A	Horn Antenna	DRG-118/A	1132	2009-07-28
Ducommun	Amplifier	ALN-09173030-01	988251-03R	2009-03-04
HP	Pre-Amplifier	8447D	2944A06639	2009-06-05

*** Statement of Traceability:** BACL attests that all calibrations have been performed per the NVLAP requirements, traceable to NIST.

6.7 Test Environmental Conditions

Temperature:	20~22°C
Relative Humidity:	40~50 %
ATM Pressure:	99~101.1kPa

**The testing was performed by Dennis Huang on 2010-02-03.*

6.8 Summary of Test Results

According to the data hereinafter, the EUT complied with the FCC Part 15C & IC RSS-210 emissions limits, and had the worst margin of:

30-1000 MHz

Worst Case, Middle Channel – 2442 MHz

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel, Range**
-14.18	383.9864	Horizontal	Middle, 30-1000 MHz

Above 1 GHz:

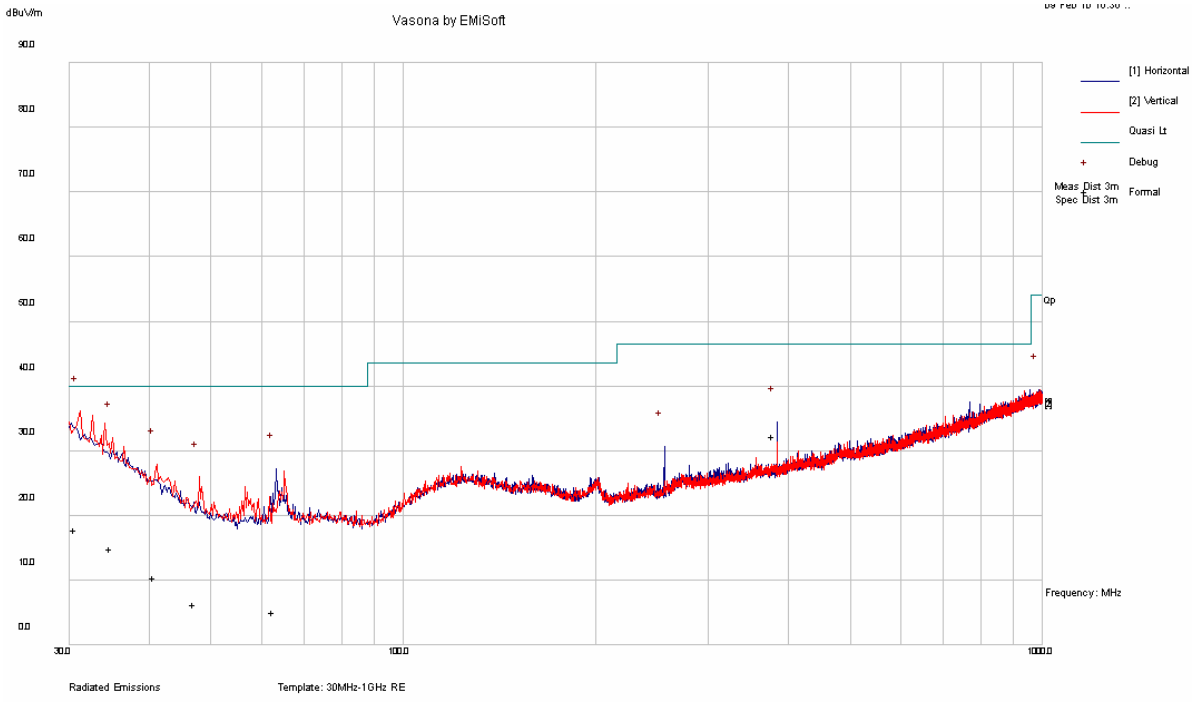
Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel, Range**
-0.85	7206	Vertical	Low, 1-25 GHz
-2.65	4884	Vertical	Mid, 1-25 GHz
-0.32	4960	Vertical	High, 1-25 GHz

Please refer to the following table and plots for specific test result details

6.9 Radiated Emissions Test Result Data:

30 MHz – 1 GHz:

Worst Case, Middle Channel (2442 MHz) @ Measured at 3 meter



Quasi-Peak Measurements

Frequency (MHz)	Corrected Amplitude (dB)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
383.9864	32.32	100	H	60	46.5	-14.18
31.08506	17.85	380	V	254	40	-22.15
35.32314	14.9	300	V	22	40	-25.10
41.22988	10.45	320	V	110	40	-29.55
47.71268	6.28	357	V	30	40	-33.72
63.32042	5.06	323	H	82	40	-34.94

1 – 25 GHz:

Low Channel 2402 MHz, measured at 3 meters

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC & IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
4804	65.18	23	100	V	32.3	8	36.1	69.38	74	-4.62	peak
4804	59.61	173	100	H	32.3	8	36.1	63.81	74	-10.19	peak
4804	28.57	23	100	V	32.3	8	36.1	32.77	54	-21.23	Ave
4804	28.4	173	100	H	32.3	8	36.1	32.6	54	-21.40	Ave
7206	61.29	225	100	V	37.2	10.63	35.97	73.15	74	-0.85	peak
7206	48.92	27	100	H	37.2	10.63	35.97	60.78	74	-13.22	peak
7206	28.47	225	100	V	37.2	10.63	35.97	40.33	54	-13.67	Ave
7206	28.11	27	100	H	37.2	10.63	35.97	39.97	54	-14.03	Ave

Middle channel 2442 MHz measured at 3 meters

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC & IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
4884	67	155	100	V	32.3	8.12	36.07	71.35	74	-2.65	peak
4884	60	176	100	H	32.3	8.12	36.07	64.35	74	-9.65	peak
4884	28.6	155	100	V	32.3	8.12	36.07	32.95	54	-21.05	Ave
4884	28.53	176	100	H	32.3	8.12	36.07	32.88	54	-21.12	Ave
7326	51.1	215	100	V	37.2	10.68	36.01	62.97	74	-11.03	peak
7326	47.57	162	100	H	37.2	10.68	36.01	59.44	74	-14.56	peak
7326	28.29	215	100	V	37.2	10.68	36.01	40.16	54	-13.84	Ave
7326	27.81	162	100	H	37.2	10.68	36.01	39.68	54	-14.32	Ave

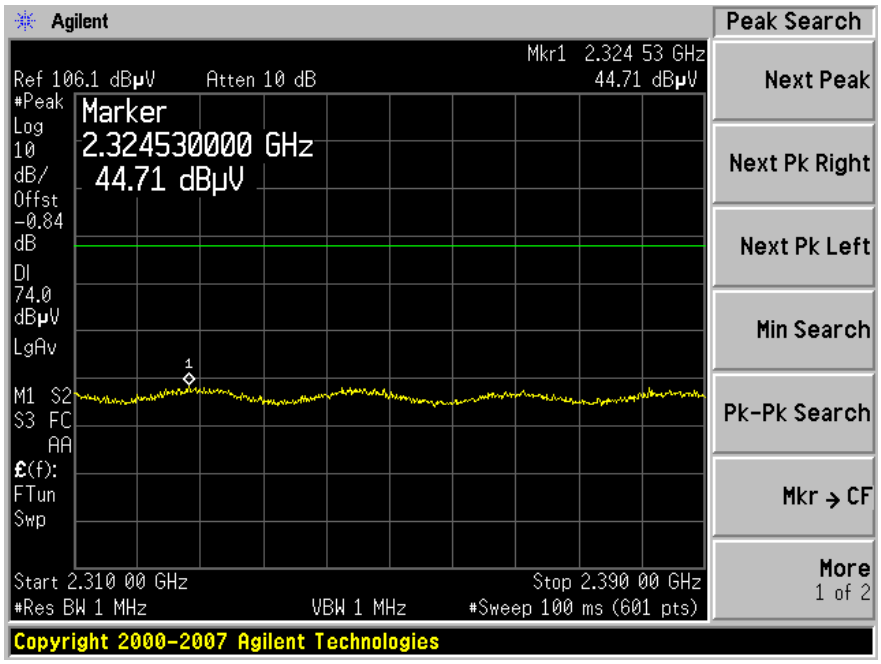
High channel 2480 MHz measured at 3 meters

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC & IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
4960	67.6	329	100	V	34	8.12	36.04	73.68	74	-0.32	peak
4960	57.45	151	100	H	34	8.12	36.04	63.53	74	-10.47	peak
4960	28.31	329	100	V	34	8.12	36.04	34.39	54	-19.61	Ave
4960	28.19	151	100	H	34	8.12	36.04	34.27	54	-19.73	Ave
7440	47.53	172	100	V	39.1	10.65	36.04	61.24	74	-12.76	peak
7440	44.53	189	100	H	39.1	10.65	36.04	58.24	74	-15.76	peak
7440	27.96	172	100	V	39.1	10.65	36.04	41.67	54	-12.33	Ave
7440	27.87	189	100	H	39.1	10.65	36.04	41.58	54	-12.42	Ave

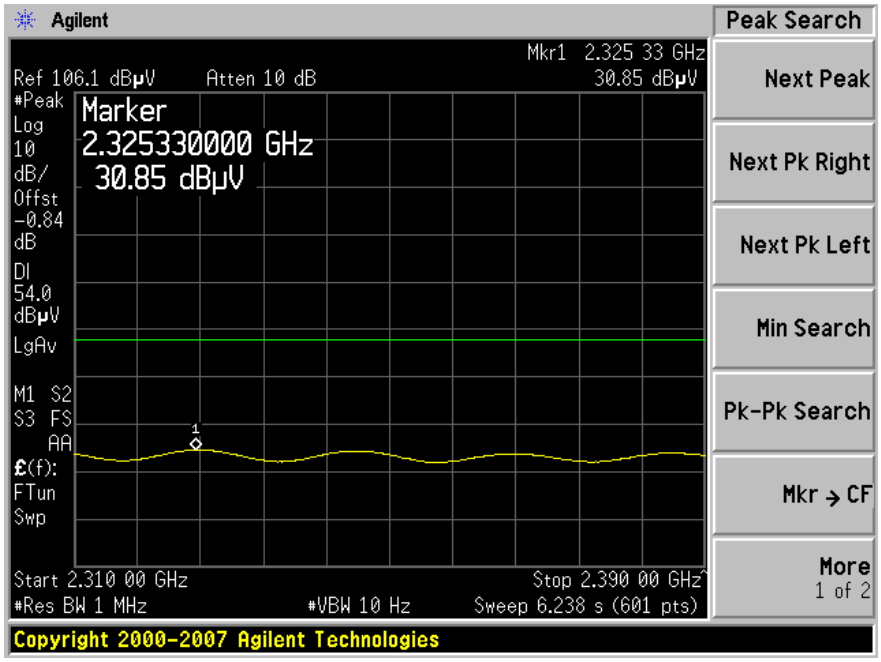
Restricted Band:

Lowest Channel- 2402 MHz

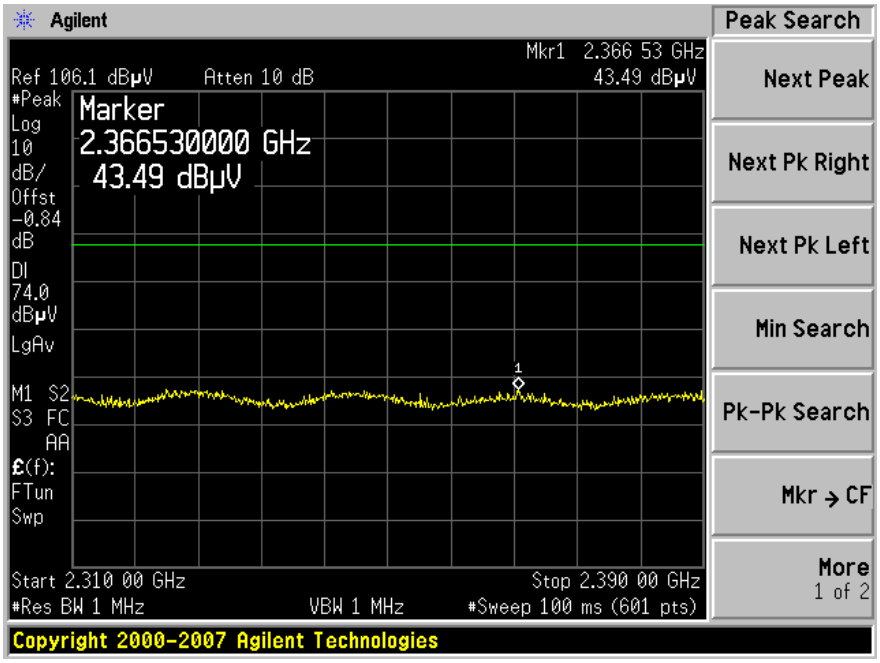
Polarization: Vertical, Peak



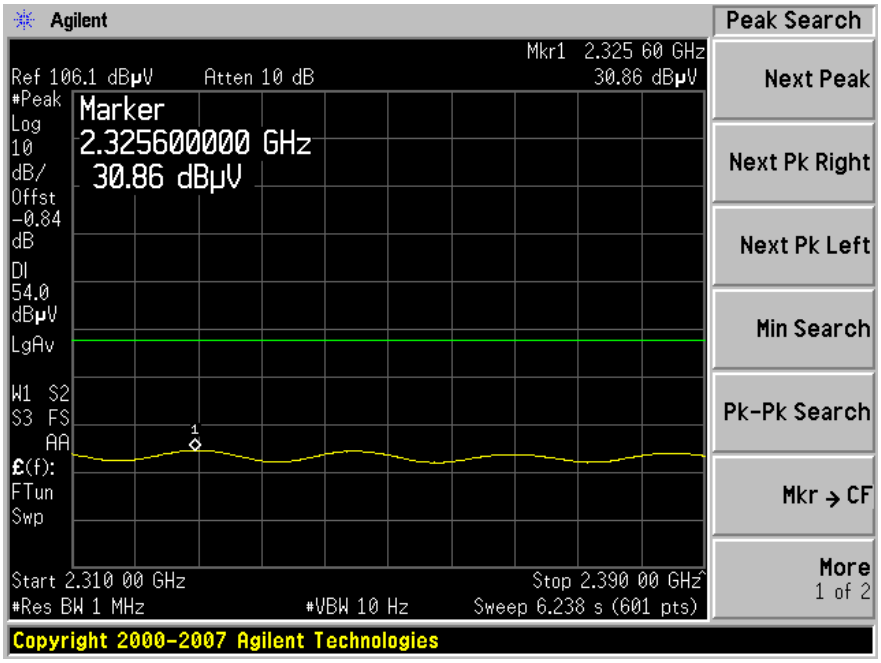
Polarization: Vertical, Average



Polarization: Horizontal, Peak

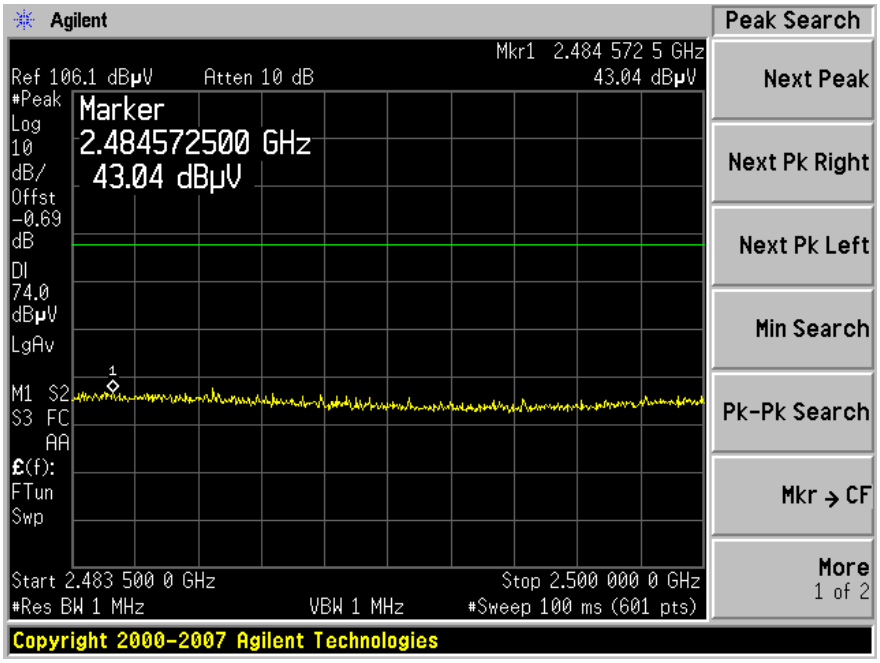


Polarization: Horizontal, Average

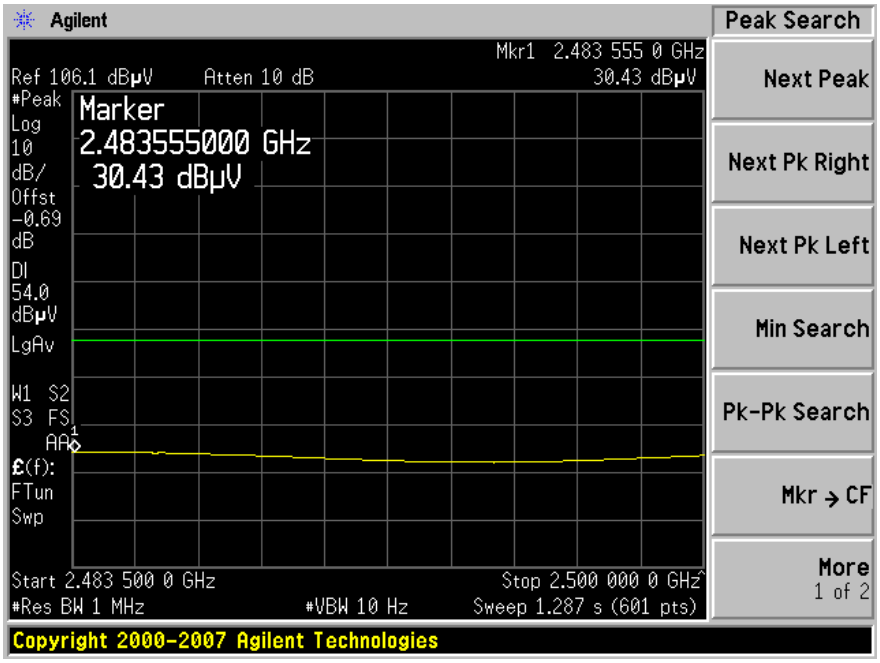


Highest Channel- 2480 MHz

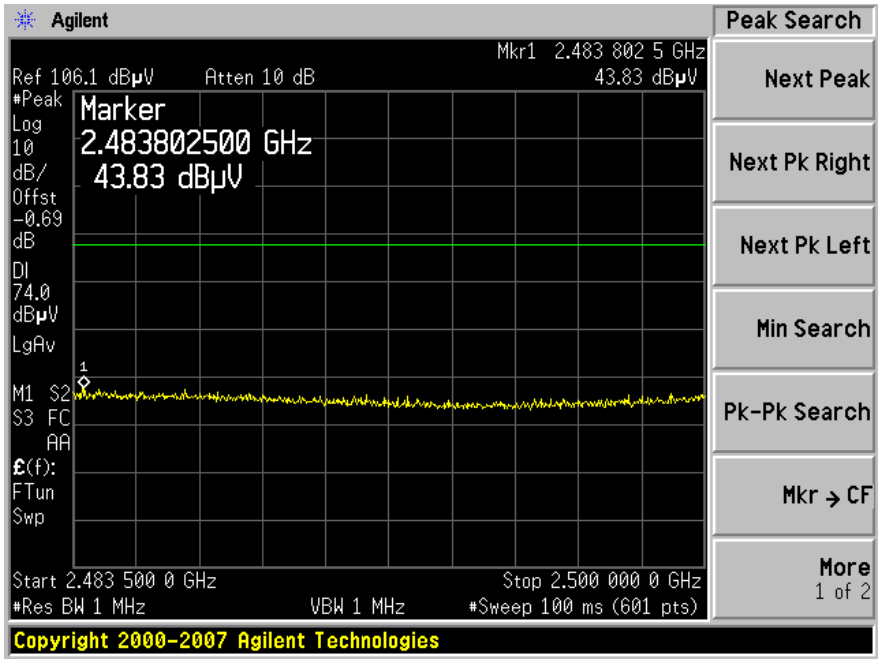
Polarization: Vertical, Peak



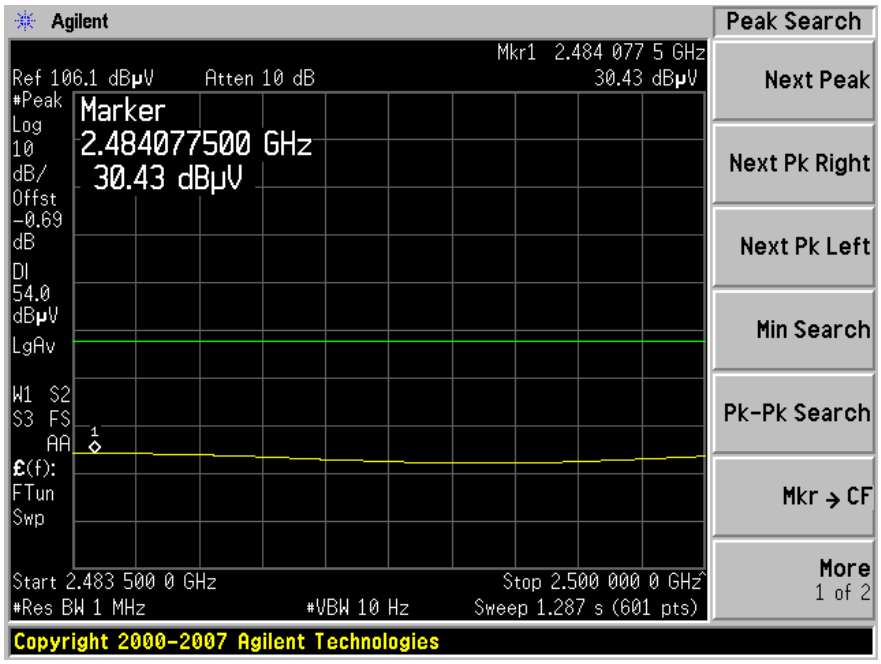
Polarization: Vertical, Average



Polarization: Horizontal, Peak



Polarization: Horizontal, Average



7 FCC §15.247(a)(1) & IC RSS-210 §A8.1(d) – 20 dB Channel Bandwidth

7.1 Applicable Standard

According to FCC§15.247(a)(l), the maximum 20 dB bandwidth of the hopping channel shall be presented.

According to IC RSS-210 §A8.1 (d), the frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

7.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emissions bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

7.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2009-04-27

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

7.4 Test Environmental Conditions

Temperature:	20~22°C
Relative Humidity:	40~50 %
ATM Pressure:	99~101.1kPa

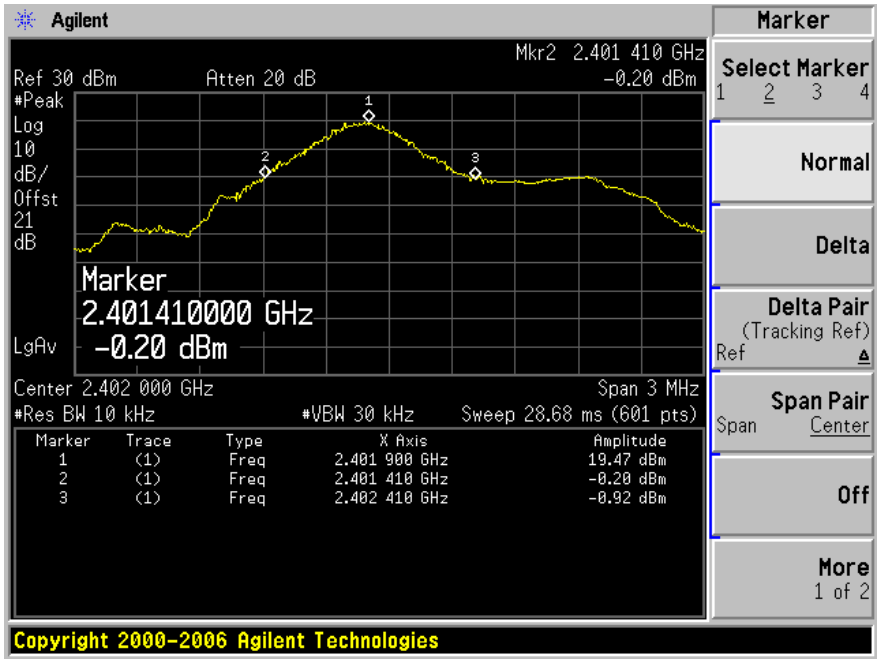
**The testing was performed by Dennis Huang on 2010-02-25.*

7.5 Test Results

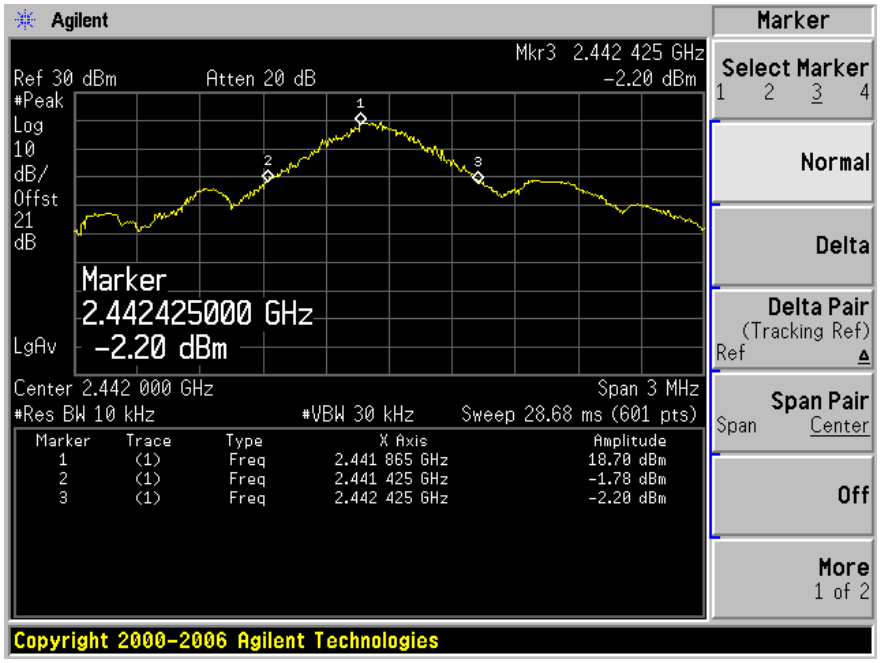
Channel	Frequency (MHz)	20 dB Channel Bandwidth (kHz)
Low	2402	1000
Middle	2440	1000
High	2480	955

Please refer to the following plots.

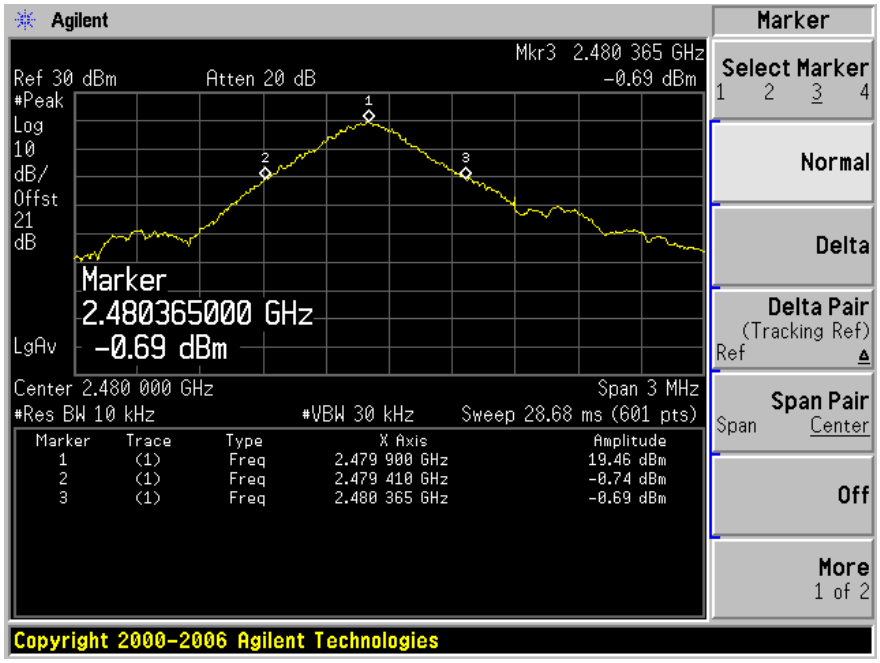
Low Channel



Middle Channel



High Channel



8 FCC §15.247(a)(1) & IC RSS-210 §A8.1(b) - Hopping Channel Separation

8.1 Applicable Standard

According to §15.247(a)(1): Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

According to IC RSS-210 §A8.1 (b), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125 W. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

8.2 Measurement Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Position the EUT on a bench without connection to measurement instrument Turn on the EUT and set it to any one convenient frequency within its operating range.
3. By using the Max-Hold function record the separation of two adjacent channels.
4. Measure the frequency difference of these two adjacent channels by SA MARK function, and then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2009-04-27

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

8.4 Test Environmental Conditions

Temperature:	20~22°C
Relative Humidity:	40~50 %
ATM Pressure:	99~101.1kPa

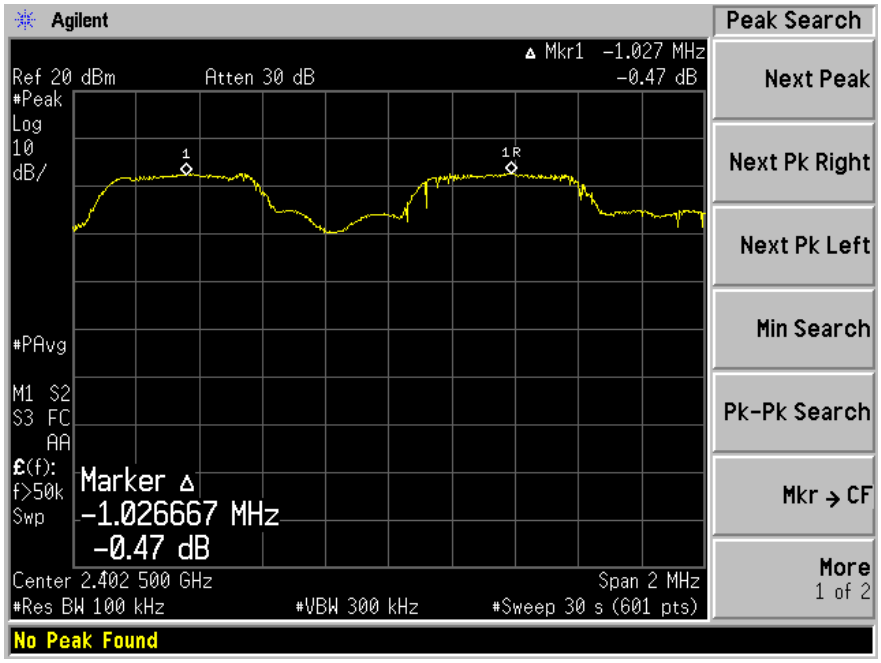
**The testing was performed by Dennis Huang on 2010-02-25.*

8.5 Measurement Results

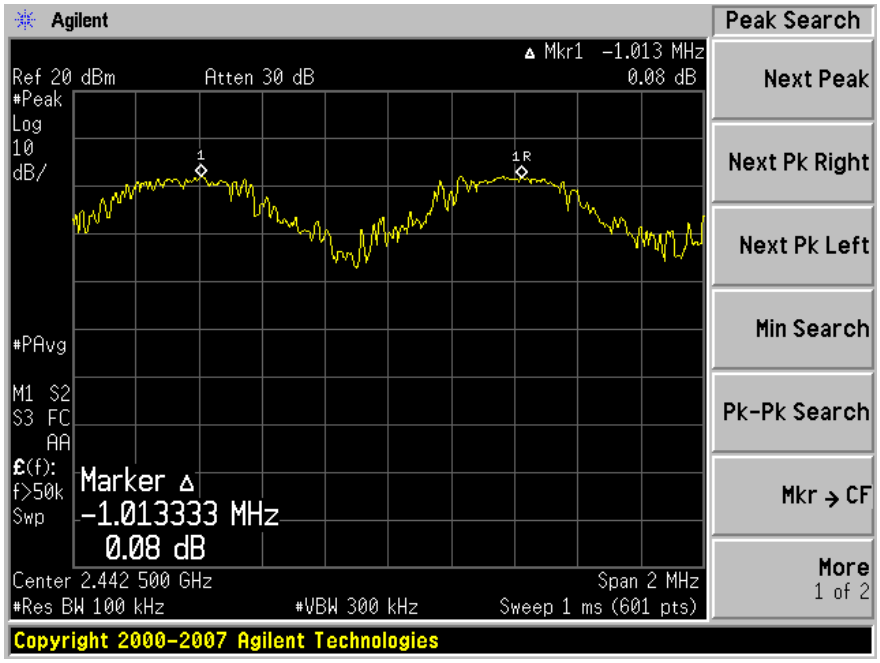
Channel	Frequency (MHz)	Measured Channel Separation (kHz)	Limit > 20 dB BW (kHz)
Low	2402	1026	1000
Mid	2441	1013	1000
High	2480	1010	1000

Please refer to the following plots.

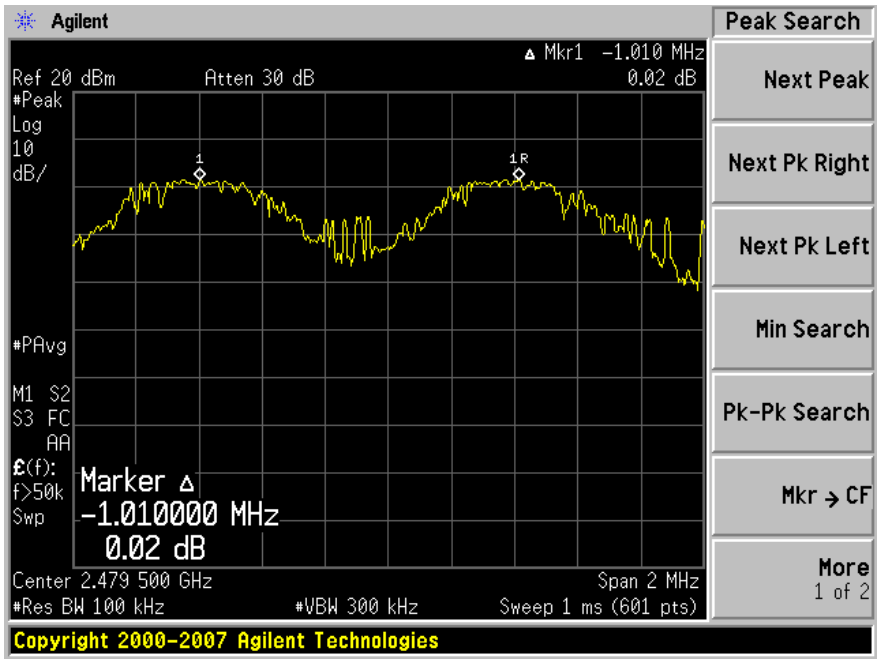
Low Channel



Middle Channel



High Channel



9 FCC §15.247(a)(1)(iii) & IC RSS-210 §A8.1(d) - Number Of Hopping Frequencies Used

9.1 Applicable Standard

According to FCC §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

According to IC RSS-210 §A8.1(d), the frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

9.2 Measurement Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Position the EUT on the bench without connection to measurement instrument. Turn on the EUT and set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set the SA on Max-Hold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
4. Set the SA on View mode and then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2009-04-27

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

9.4 Test Environmental Conditions

Temperature:	20~22°C
Relative Humidity:	40~50 %
ATM Pressure:	99~101.1kPa

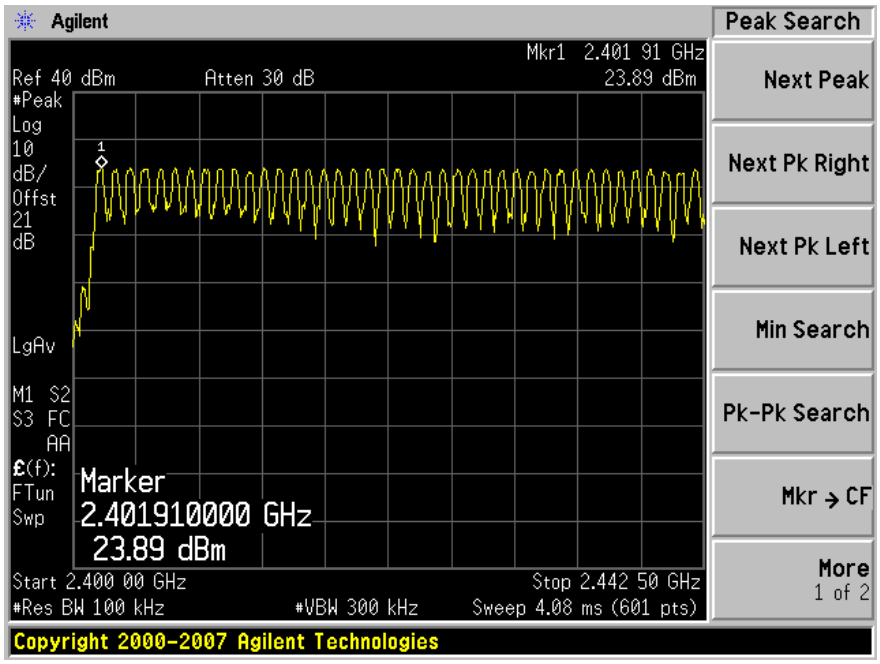
**The testing was performed by Dennis Huang on 2010-02-25.*

9.5 Measurement Result

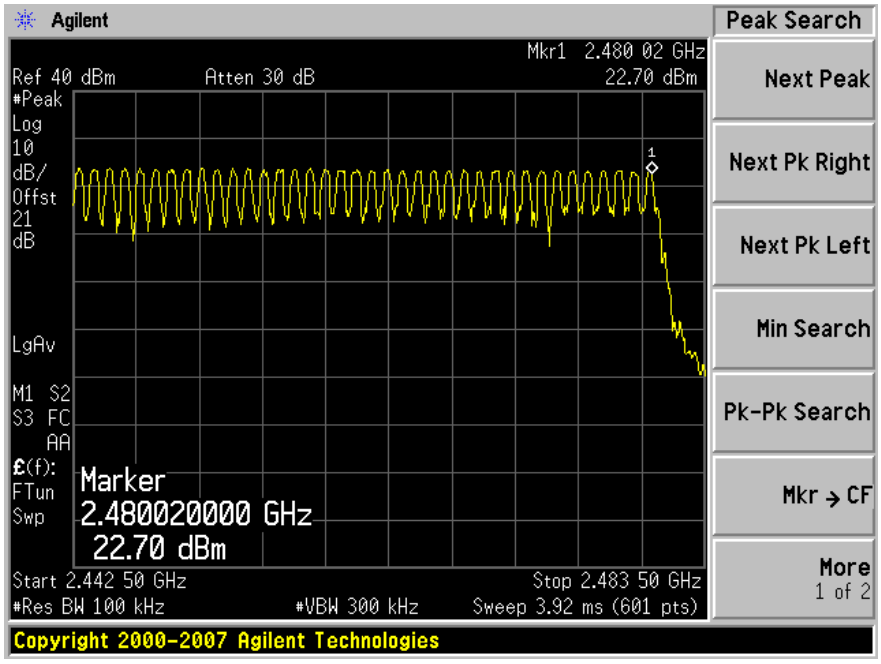
Result: 79 channels, please refer to the following plots.

Hopping Channel Number

41 Channels between 2400 to 2442.5MHz



38 Channels between 2442 to 2483.5MHz



10 FCC §15.247(a)(1)(iii) & IC RSS-210 §A8.1(d) - Dwell Time

10.1 Applicable Standard

According to FCC §15.247 (a)(1)(iii), the average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

According to IC RSS-210 §A8.1 (d), the frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

10.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT was set without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
4. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
5. Repeat above procedures until all frequencies measured were complete.

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2009-04-27

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

10.4 Test Environmental Conditions

Temperature:	20~22°C
Relative Humidity:	40~50 %
ATM Pressure:	99~101.1kPa

**The testing was performed by Dennis Huang on 2010-02-25.*

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10.5 Measurement Results:

Channel	Frequency (MHz)	Pulse Width (ms)	Dwell Time (Sec.)	Limit (Sec.)	Results
Low	2402	0.360	0.0156	0.4	Compliant
Mid	2440	0.358	0.0155	0.4	Compliant
High	2480	0.361	0.0156	0.4	Compliant

Note:

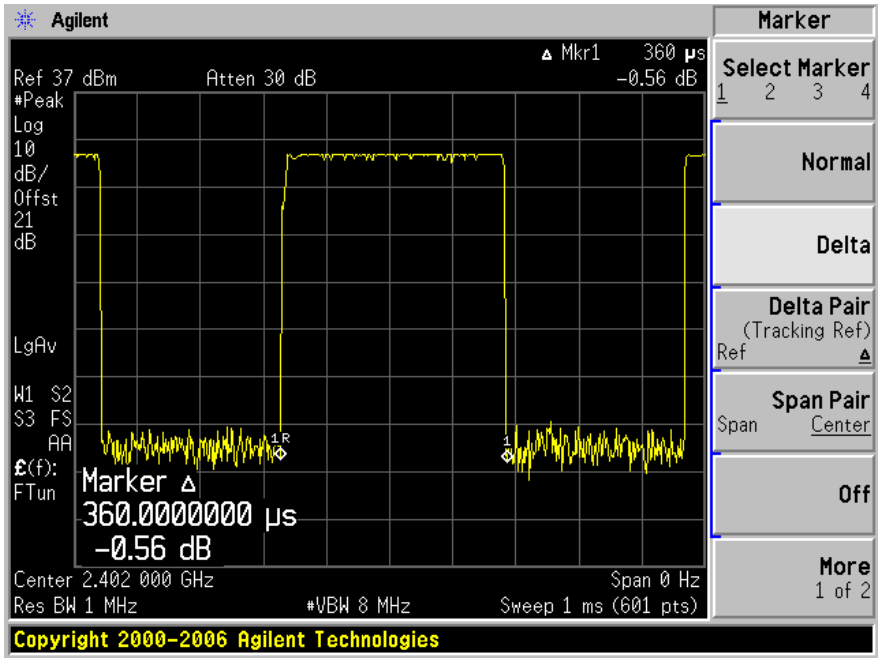
Dwell time = Pulse time*(hop rate/6/number of channels)*31.6 sec

• Hop Rate = 0.65ms
• Number of Channels = 79

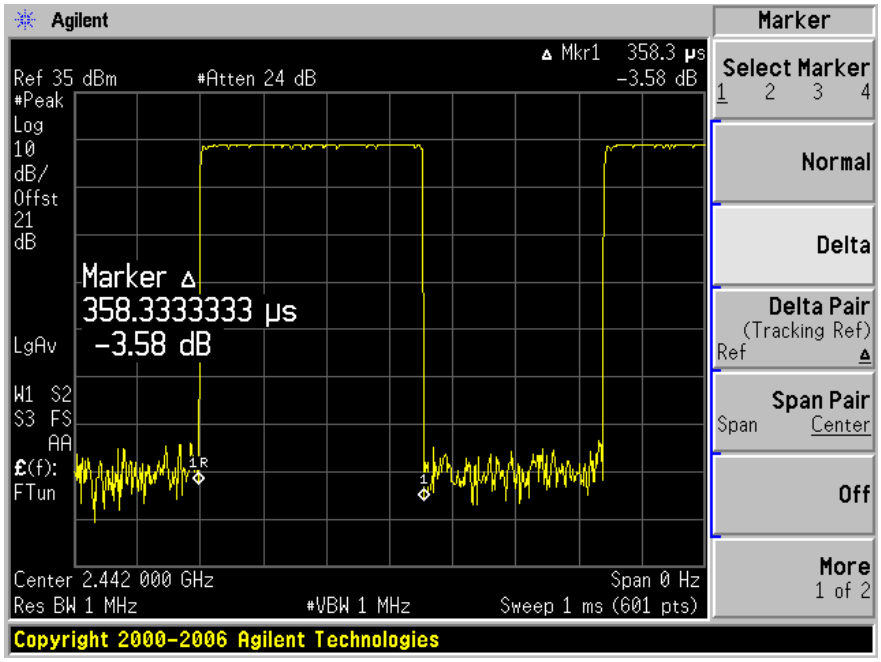
Dwell time = Pulse time*(0.65/6/79)*31.6 sec

Please refer the following plots.

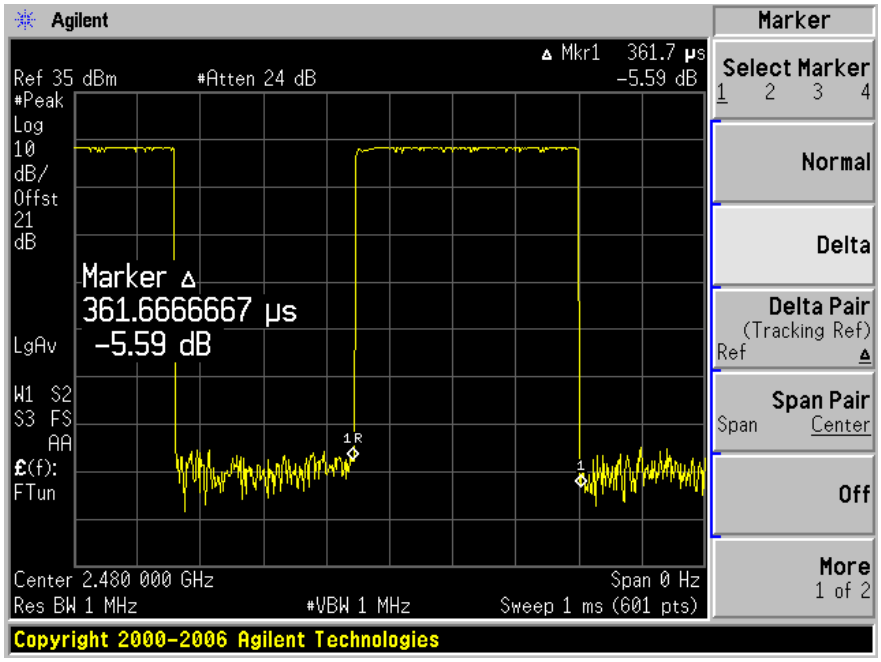
Low Channel



Middle Channel



High Channel



11 FCC §15.247(b)(1) & IC RSS-210 §A8.4(2) - Maximum Peak Output Power

11.1 Applicable Standard

According to FCC §15.247(b)(1), for frequency hopping systems in the 2400-2483.5MHz band employing at least 75 hopping channels, and all direct sequence systems, the maximum peak output power of the transmitter shall not exceed 1 Watt. For all other frequency hopping system in the 2400 – 2483.5 MHz band, the maximum peak output power of the transmitter shall not exceed 0.125 Watt.

According to IC RSS-210 §A8.4(2), For frequency hopping systems operating in the band 2400-2483.5 MHz employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W. Except as provided in Section A8.4(5), the e.i.r.p. shall not exceed 4W.

11.2 Measurement Procedure

1. Place the EUT on the turntable and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

11.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2009-04-27

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

11.4 Test Environmental Conditions

Temperature:	20~22°C
Relative Humidity:	40~50 %
ATM Pressure:	99~101.1kPa

**The testing was performed by Dennis Huang on 2010-02-25.*

11.5 Measurement Result

Hopping Channels: 79
Power Limit: 1 Watt

Channel	Frequency (MHz)	Max Peak Output Power		Limit (mw)	Result
		(dBm)	(mw)		
Low	2402	25.03	318.4	1000	Pass
Mid	2442	24.95	312.6	1000	Pass
High	2480	24.01	251.7	1000	Pass

12 FCC §15.247(d) & IC RSS-210 §A8.5 - Band Edges

12.1 Applicable Standard

According to FCC §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. Attenuation below the general limits specified in §15.209(a) is not required.

According to IC RSS-210 §A8.5 In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required.

12.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

12.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2009-04-27

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

12.4 Test Environmental Conditions

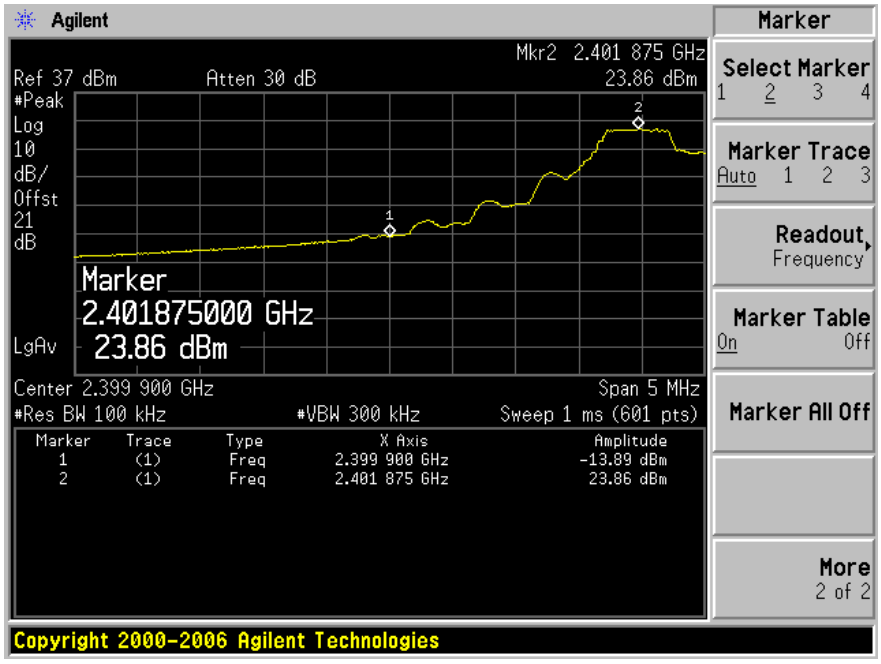
Temperature:	20~22°C
Relative Humidity:	40~50 %
ATM Pressure:	99~101.1kPa

**The testing was performed by Dennis Huang on 2010-02-25.*

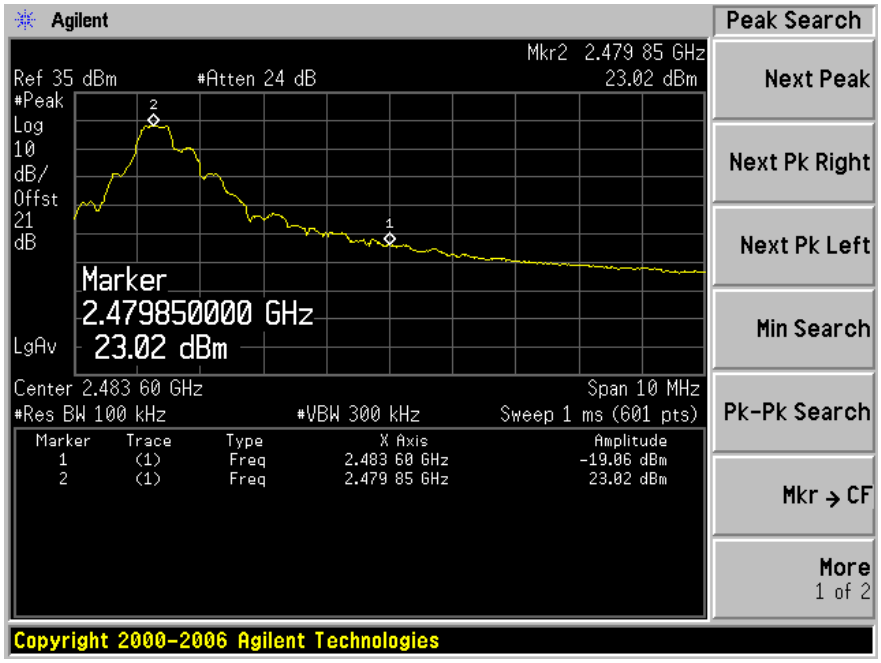
12.5 Measurement Results

Please refer to the following plots.

Band Edge: Lowest Channel



Band Edge: Highest Channel



13 FCC §15.247(d) & IC RSS-210 §A8.5 - Spurious Emissions at Antenna Port

13.1 Applicable Standard

According to FCC §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. Attenuation below the general limits specified in §15.209(a) is not required.

According to IC RSS-210 §A8.5 In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required.

13.2 Measurement Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.

2. Position the EUT on a bench without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.

3. Set the SA on Max-Hold Mode, and then keep the EUT in transmitting mode. Record all the signals from each channel until each one has been recorded.

4. Set the SA on View mode and then plot the result on SA screen.

5. Repeat above procedures until all frequencies measured were complete.

13.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2009-04-27

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

13.4 Test Environmental Conditions

Temperature:	20~22°C
Relative Humidity:	40~50 %
ATM Pressure:	99~101.1kPa

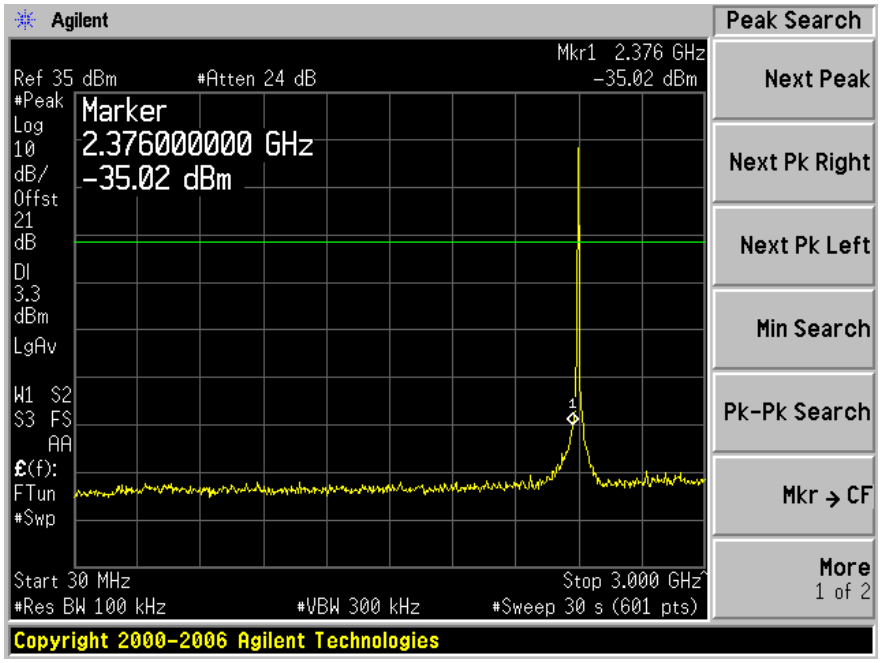
**The testing was performed by Dennis Huang on 2010-02-25.*

13.5 Measurement Result

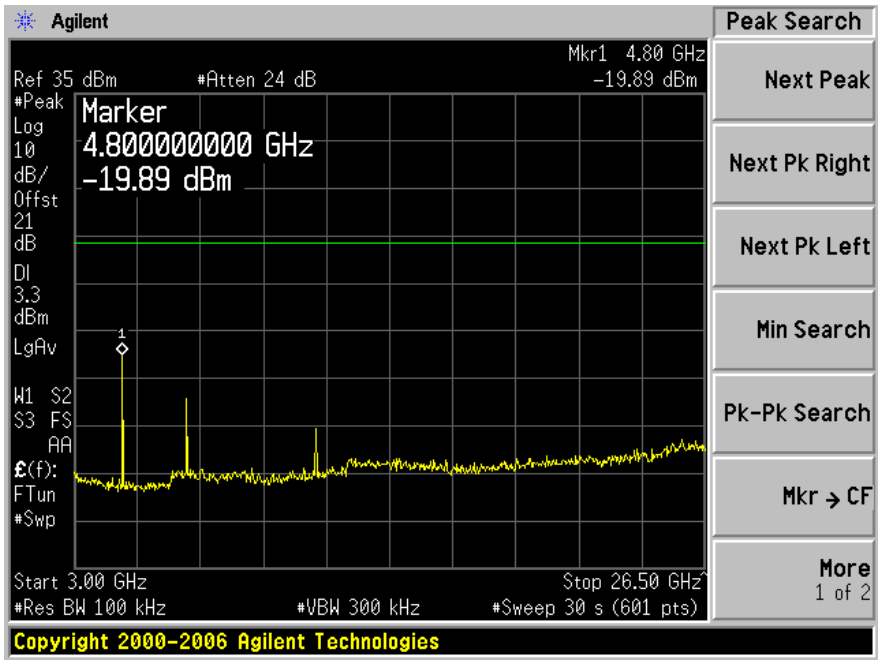
Please refer to the following plots.

Low Channel -2402 MHz

30 MHz ~3 GHz

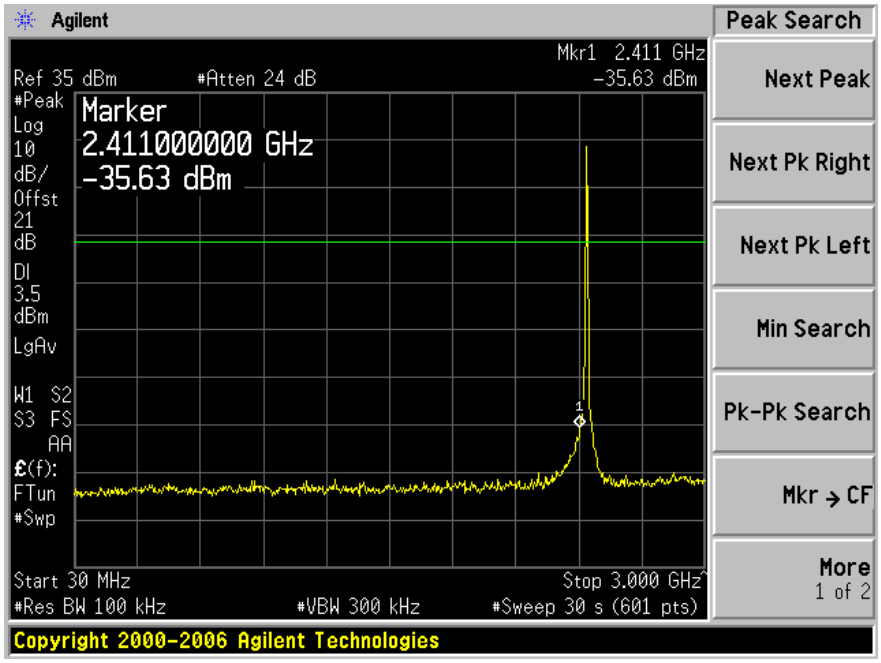


3 GHz – 26.5 GHz

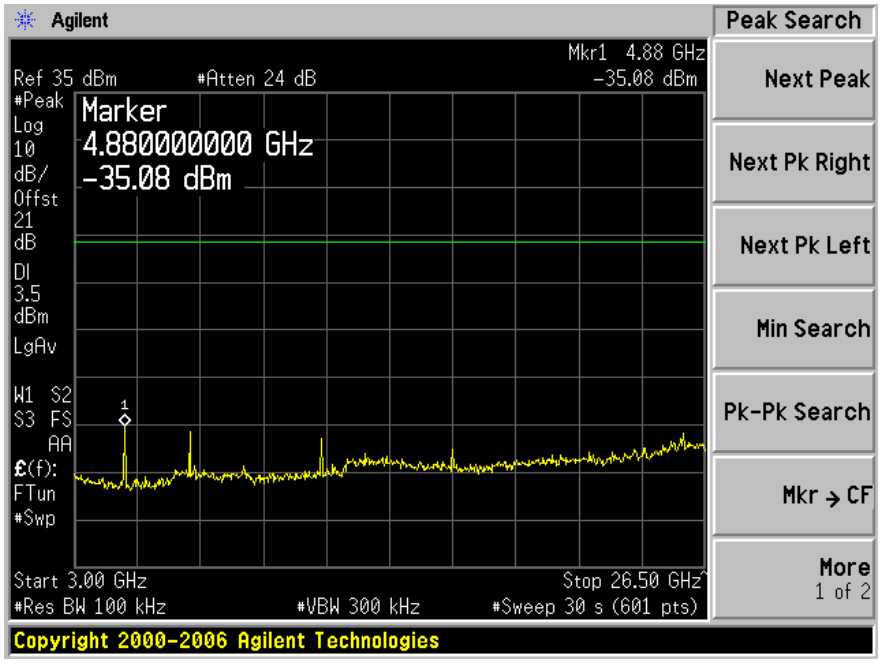


Middle Channel – 2442 MHz

30 MHz – 3 GHz

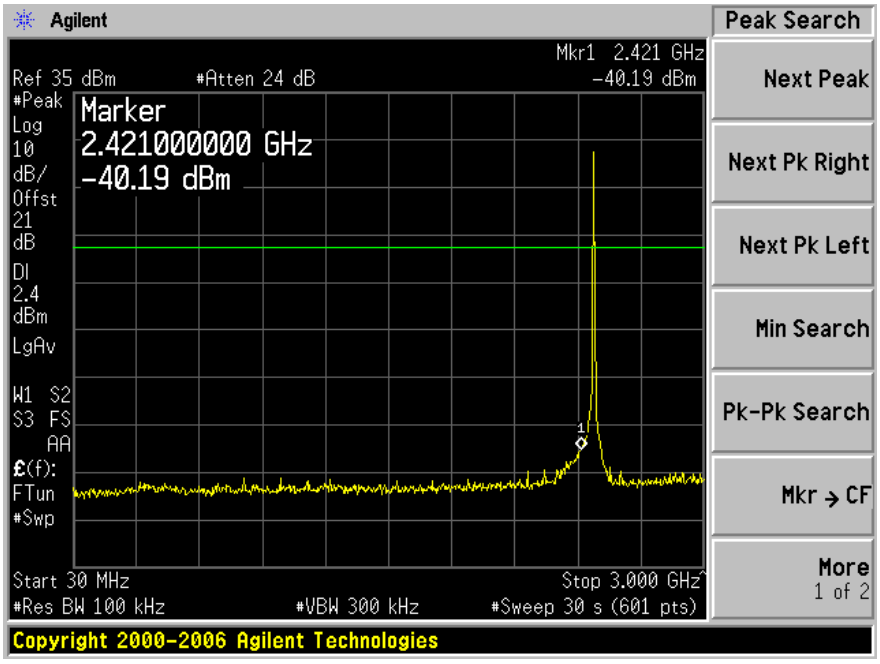


3 GHz – 26.5 GHz

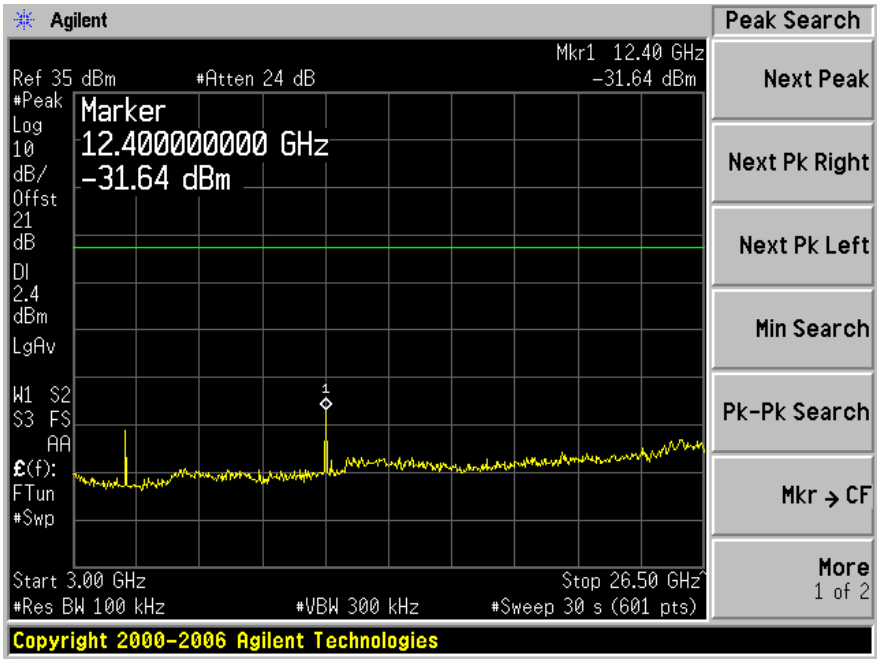


High Channel – 2480 MHz

30 MHz – 3 GHz



3 GHz – 26.5 GHz



14 IC RSS-Gen §4.10 & RSS-210 - §2.6 Receiver Spurious Emissions

14.1 Applicable Standard

IC RSS-Gen §4.10 & RSS-210 §2.6.

General Field Strength Limits for Transmitters and Receivers at Frequencies above 30 MHz

Frequency (MHz)	Field Strength microvolts/m at 3 meters (watts, e.i.r.p.)	
	Transmitters	Receivers
30 - 88	100 (3 nW)	100 (3 nW)
88 - 216	150 (6.8 nW)	150 (6.8 nW)
216 - 960	200 (12 nW)	200 (12 nW)
Above 960	500 (75 nW)	500 (75 nW)

14.2 Test Setup

The radiated emissions tests were performed in the 3 meter chamber, using the setup in accordance with ANSI C63.4-2003.

14.3 Test Equipment Lists and Details

Manufacturer	Description	Model No.	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2009-04-27
Sunol Sciences	Antenna	JB1	A020106-1	2009-04-17
A.R.A	Horn Antenna	DRG-118/A	1132	2009-07-28
Ducommun	Amplifier	ALN-09173030-01	988251-03R	2009-03-04
HP	Pre-Amplifier	8447D	2944A06639	2009-06-05

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

14.4 Test Environmental Conditions

Temperature:	20~22°C
Relative Humidity:	40~50 %
ATM Pressure:	99~101.1kPa

**The testing was performed by Dennis Huang on 2010-02-18.*

14.5 Test Procedure

Maximizing procedure was performed on the six (6) highest emissions to ensure EUT compliance is with all installation combinations.

All data were recorded in the peak detection mode. Quasi-peak readings was performed only when an emissions was found to be marginal (within -4 dB of specification limits), and are distinguished with a "**QP**" in the data table.

14.6 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corrected Amplitude = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emissions are 7dB below the maximum limit. The equation for margin calculation is as follows:

Margin = Corrected Amplitude - Limit

14.7 Summary of Test Results

According to the test data,, the EUT complied with the with the applicable IC Standards, with the closest margins from the limit listed below:

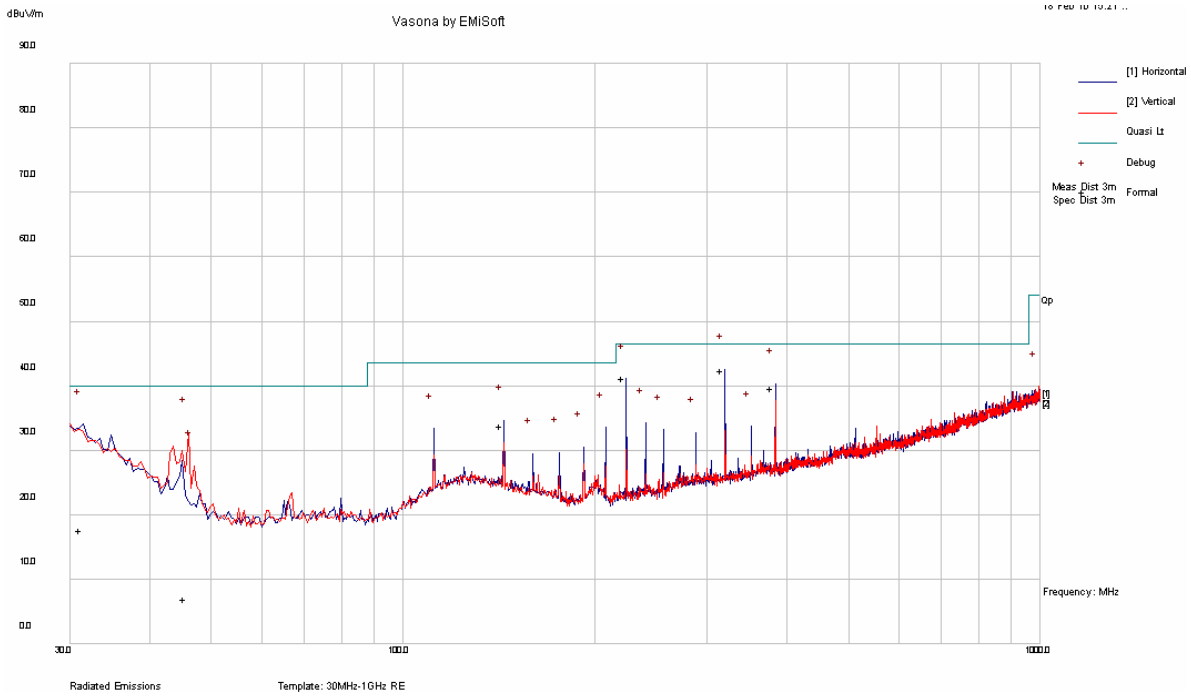
30 MHz - 1 GHz

-4.09 dB at **319.9942 MHz** in the **Horizontal** polarization

Above 1 GHz

***Note:** All emission levels are at the noise floor level and/or more than 20 dB below the limit.

30 MHz – 1 GHz @ Measured at 3 meter



Quasi-Peak Measurements

Frequency (MHz)	Corrected Amplitude (dB)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
319.9942	42.41	98	H	45	46.5	-4.09
223.9834	41.22	127	H	315	46.5	-5.28
383.9905	39.61	98	H	351	46.5	-6.89
143.9944	33.73	198	H	160	43.5	-9.77
31.48476	17.58	348	H	87	40.0	-22.42
46.0074	6.97	338	V	47	40.0	-33.03

Above 1 GHz @ Measured at 3 meter

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
-	-	-	-	-	-	-	-	-	-	-*	-*

***Note:** All emission levels are at the noise floor level and/or more than 20 dB below the limit.

15 §FCC 15.247(i) & IC RSS-102 - RF Exposure

15.1 Applicable Standard

According to FCC §15.247(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to FCC §1.1310 and §2.1091 RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

Before equipment certification is granted, the procedure of RSS-102 must be followed concerning the exposure of humans to RF fields.

According to IC RSS-102 Issue 4 section 4.2, RF limits used for general public will be applied to the EUT.

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Averaging Time (Minutes)
0.003 - 1	280	2.19	-	6
1 - 10	280 / f	2.19 / f	-	6
10 - 30	28	2.19 / f	-	6
30 – 300	28	0.073	2*	6
300 – 1 500	$1.585\ f^{0.5}$	$0.0042\ f^{0.5}$	f / 150	6
1 500 – 15 000	61.4	0.163	10	6
15 000 – 150 000	61.4	0.163	10	$616000 / f^{1.2}$
150 000- 300 000	$0.158\ f^{0.5}$	$4.21 \times 10\ -4\ f^{0.5}$	$6.67 \times 10^{-5}\ f$	$616000 / f^{1.2}$

Note: *f* is frequency in MHz
* Power density limit is applicable at frequencies greater than 100 MHz

15.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal (dBm):	25.03
Maximum peak output power at antenna input terminal (mW):	318.4
Prediction distance (cm):	20
Prediction frequency (MHz):	2402
Maximum Antenna Gain, typical (dBi):	5
Maximum Antenna Gain (numeric):	3.1622
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.2
Power density of prediction frequency at 20.0 cm (W/m^2):	2
MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0
MPE limit for uncontrolled exposure at prediction frequency (W/m^2):	10

15.3 Test Result

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.2 mW/cm^2 (2 W/m^2).Limit is 1 mW/cm^2 (10 W/m^2).