FCC PART 15, SUBPART C
IC RSS-210, ISSUE 8, DECEMBER 2010

TEST AND MEASUREMENT REPORT

For

Punch Through Design LLC

665 Chestnut Street, Floor 3

San Francisco, CA 94133, USA

FCC ID: 2AAV5-LBM313-2540
IC: 11371A- LBM3132540

Report Type:	**Product Type:**
Original Report	Bluetooth 4.0 GFSK Module

Prepared By: Jeffrey Wu

Report Number: R1307313-247

Report Date: 2013-09-03

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1307313-247	Original Report	2013-09-03

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Punch Through Design LLC.*, and their product *FCC ID: 2AAV5-LBM313-2540, IC: 11371A-LBM3132540, model: LBM313-2540-256* or the "EUT" as referred on this report is a Bluetooth 4.0 GFSK module which operates on 2402-2480 MHz.

1.2 Mechanical Description of EUT

The "EUT" measures approximately 1.6 *cm (L) x 1.2 cm (W) x 0.2 cm (H),* and weighs approximately 0.83 g.

The test data gathered are from typical production sample, serial number: J09697 for the radiated testing and G3D261 for the conducted, which are assigned by BACL.

1.3 Objective

This report is prepared on behalf of *Punch Through Design.* In accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commissions rules and IC RSS-210 Issue 8, Dec 2010.

The objective is to determine compliance with FCC Part 15.247 and IC RSS-210 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, and power spectral density, 100 kHz Bandwidth of Band Edges Measurement, Spurious Emissions, Conducted and Radiated Spurious Emissions.

1.4 Related Submittal(s)/Grant(s)

N/A

1.5 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.4-2009, 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 and FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the 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 CISPR16-4-2:2007, The Treatment of Uncertainty in EMC Measurements, the values ranging from $\pm$2.0 dB 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 Corp.

1.7 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 site at BACL Corp. has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports have 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 test site also complies with the test methods and procedures set forth in CISPR 22:2008 §10.4 for measurements below 1 GHz and §10.6 for measurements above 1 GHz as well as ANSI C63.4-2003, ANSI C63.4-2009, TIA/EIA-603 & CISPR 24:2010.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: A-0027. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL Corp. is an American Association for Laboratory Accreditation (A2LA) accredited laboratory (Lab Code 3297-02). The current scope of accreditations can be found at

http://www.a2la.org/scopepdf/3297-02.pdf?CFID=1132286&CFTOKEN=e42a3240dac3f6ba-6DE17DCB-1851-9E57-477422F667031258&jsessionid=8430d44f1f47cf2996124343c704b367816b

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.4-2009 and FCC KDB 558074 D01 DTS Meas Guidance v03r01.

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power, peak power and PPSD across all data rates bandwidths, and modulations.

2.2 EUT Exercise Software

The test utility used was CoolTerm, Version 1.4.1 (Build 162) was provided by Punch Through Design LLC. And was verified by Jeffrey Wu to comply with the standard requirements being tested against.

Radio Mode	Frequency (MHz)		
	Low CH	Mid CH	High CH
Bluetooth 4.0	2402	2442	2480

2.3 Special Equipment

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

2.4 Equipment Modifications

No modifications were made to the EUT.

2.5 Local Support Equipment

Manufacturer	Description	Model	Serial Number
Punch Through Design	Supporting Board 1	PTD0113002B	-
Punch Through Design	Supporting Board 2	PTD0313003E	-

2.6 EUT Internal Configuration Details

Manufacturer	Description	Model	Serial Number
Punch Through Design	Main PCB (Radiated)	LBM313	J09697
Punch Through Design	Main PCB (Conducted)	LBM313	G3D261

2.7 Interface Ports and Cables

Cable Description	Length (m)	To	From
USB	< 1	EUT	Laptop

2.8 External I/O Cabling List and AC Cord

N/A

2.9 Power Supply List and Details

N/A

3 Summary of Test Results

Results reported relate only to the product tested.

FCC & IC Rules	Description of Test	Results
FCC §15.247(i), §2.1093 IC RSS-102	RF Exposure	Compliant
FCC §15.203 IC RSS-Gen §7.1.2	Antenna Requirement	Compliant
FCC §15.207(a) IC RSS-Gen §7.2.4	AC Line Conducted Emissions	Compliant
FCC §15.247 (d) IC RSS-210 §A8.5	Spurious Emissions at Antenna Port	Compliant
FCC §15.209, §15.205, §15.247(d) IC RSS-210 §2.2, §A8.5	Restricted Bands, Radiated Spurious Emissions	Compliant
FCC §15.247(a)(2) IC RSS-210 §A8.2	6 dB Emission Bandwidth	Compliant
FCC §15.247(b)(3) IC RSS-210 §A8.4	Maximum Peak Output Power	Compliant
FCC §15.247(d) IC RSS-210 §A8.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(e) IC RSS-210 §A8.2(b)	Power Spectral Density	Compliant
IC RSS-210 §2.3 & RSS-Gen §6.1	Receiver Spurious Emission	Compliant

4 FCC §15.247 (i), §2.1093 & IC RSS-102 – RF Exposure

4.1 Applicable Standard

FCC §2.1093, §15.247(i) and IC RSS-102

4.2 SAR Exemption Guild lines

According to FCC KDB 447498 D01, Appendix A:

SAR Test Exclusion Thresholds for 100 MHz-6 GHz and ≤ 50 mm

Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Test Separation Distance are illustrated in the following Table:

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	SAR Test Exclusion Threshold (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	

According to IC RSS-102 §2.5.1: Exemption from Routine Evaluation Limits-SAR evaluation

SAR evaluation is required if the separation distance between the user and the radiated element of the device is less than or equal to 20 cm, except when the device operates as follows.

- Above 2.2 GHz and up to 3GHz inclusively, and with output power (i.e. the higher of the conducted or radiated(e.i.r.p.) source-based, time-average output power) that is less than or equal to 20 mW for general public use and 100 mW for controlled used;

4.3 Evaluation Result

The maximum conducted output power of this device is -0.38 dBm, the antenna gain is 1.7 dBi, the maximum e.i.r.p. is -0.33+ 1.7 = 1.37 dBm, i.e. 1.37 mW which is less than the SAR threshold of 10 mw (FCC KDB 447498 D01 Appendix A), and 20 mw (IC RSS-102 §2.5.1). SAR evaluation is not required.

5 FCC §15.203 & IC RSS-Gen §7.1.2 – Antenna Requirements

5.1 Applicable Standard

According to FCC §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

And according to FCC §15.247 (b) (4), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to IC RSS-Gen §7.1.2: Transmitter Antenna

A transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be 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 RSS-210 or RSS-310 for devices of RF output powers of 10 mW or less. For devices of output powers greater than 10 mW, except devices subject to RSS-210 Annex 8 (Frequency Hopping and Digital Modulation Systems Operating in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz Bands) or RSS-210 Annex 9 (Local Area Network Devices), the total antenna gain shall be added to the measured RF output power before using the specified power limits. For devices subject to RSS-210 Annex 8 or Annex 9, the antenna gain shall not be added.

5.2 Antenna List

Manufacturers	Models/Name	Antenna Gain (dBi) @ 2.4 GHz
Pulse	W3008	1.7

5.3 Result

The EUT’s antenna has the maximum gain of 1.7 dBi and permanently attached to the PCB; which complies with sections FCC Part 15.203 and IC RSS-Gen §7.1.2.

6 FCC §15.207 & IC RSS-Gen §7.2.4 – AC Line Conducted Emissions

6.1 Applicable Standards

As per FCC §15.207 and IC RSS-Gen §7.2.4 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.*

6.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.4-2009 measurement procedure. The specification used was FCC §15.207 and IC RSS-Gen §7.2.4 limits.

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

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

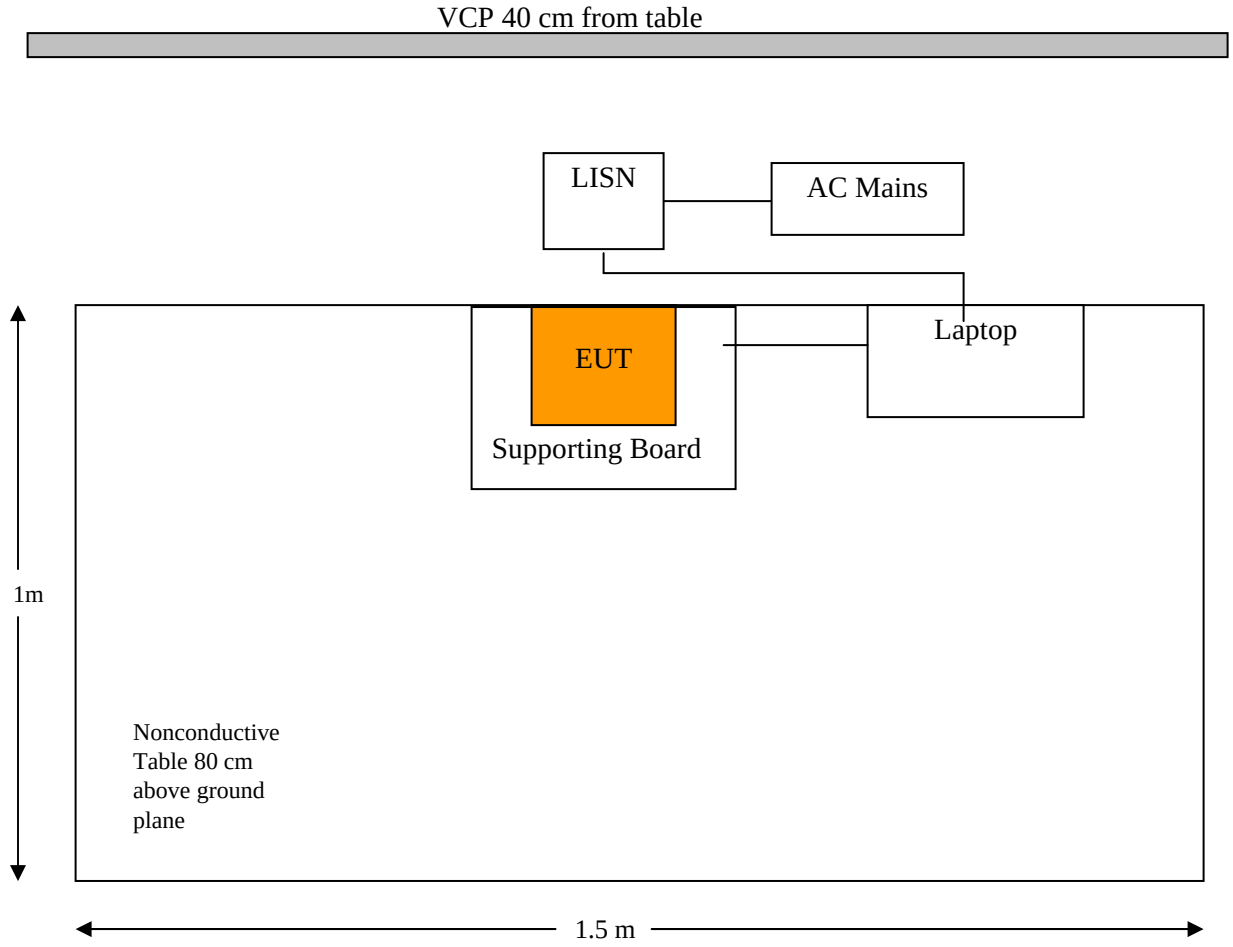
6.3 Test Procedure

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

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”.

6.4 Test Setup Block Diagram



6.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Cable Loss (CL), the Attenuator Factor (Atten) to indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + CL + Atten

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Cable Loss (3.7 dB) + Attenuator (10 dB)

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. The equation for margin calculation is as follows:

Margin = Corrected Amplitude - Limit

6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100338	2012-09-19	1 year
Solar Electronics	LISN	9252-R-24-BNC	511213	2013-06-25	1 year
TTE	Filter, High Pass	H9962-150K-50-21378	K7133	2013-05-30	1 year

Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

6.7 Test Environmental Conditions

Temperature:	25.6 ºC
Relative Humidity:	47 %
ATM Pressure:	101.3 kPa

The testing was performed by Jeffrey Wu on 2013-08-20 in 5 m chamber 3.

6.8 Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC and IC standards conducted emissions limits, with the margin reading of:

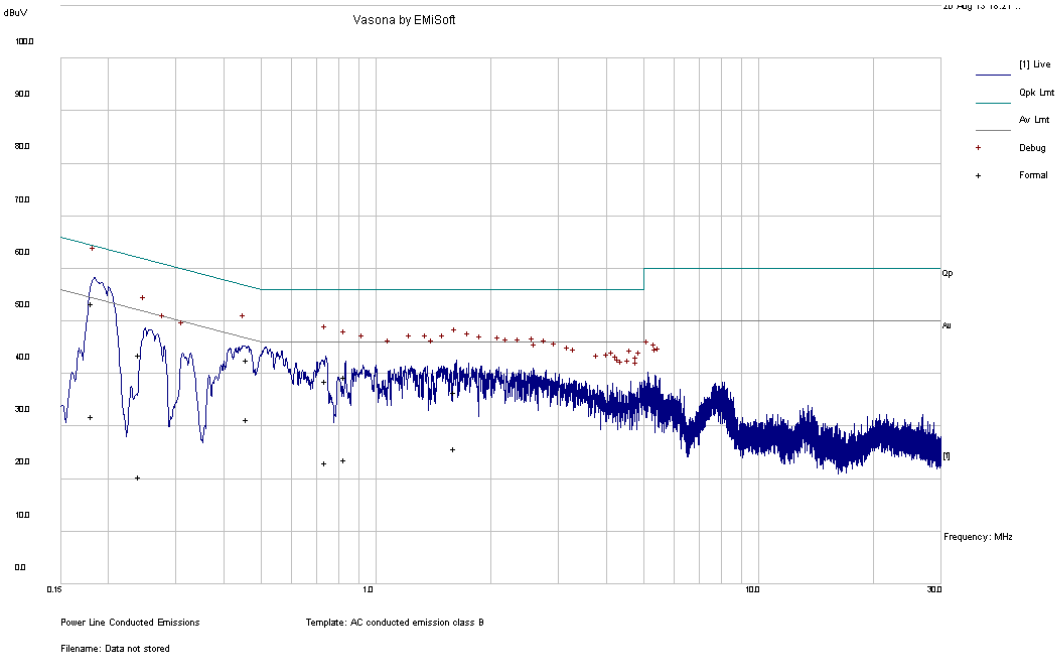
Transmitting Mode: Worst Channel: Low Channel

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Line/Neutral)**	**Range (MHz)**
-10.97	0.181302	Line	0.15-30

6.9 Conducted Emissions Test Plots and Data

Transmitting Mode: Low Channel 2402 MHz

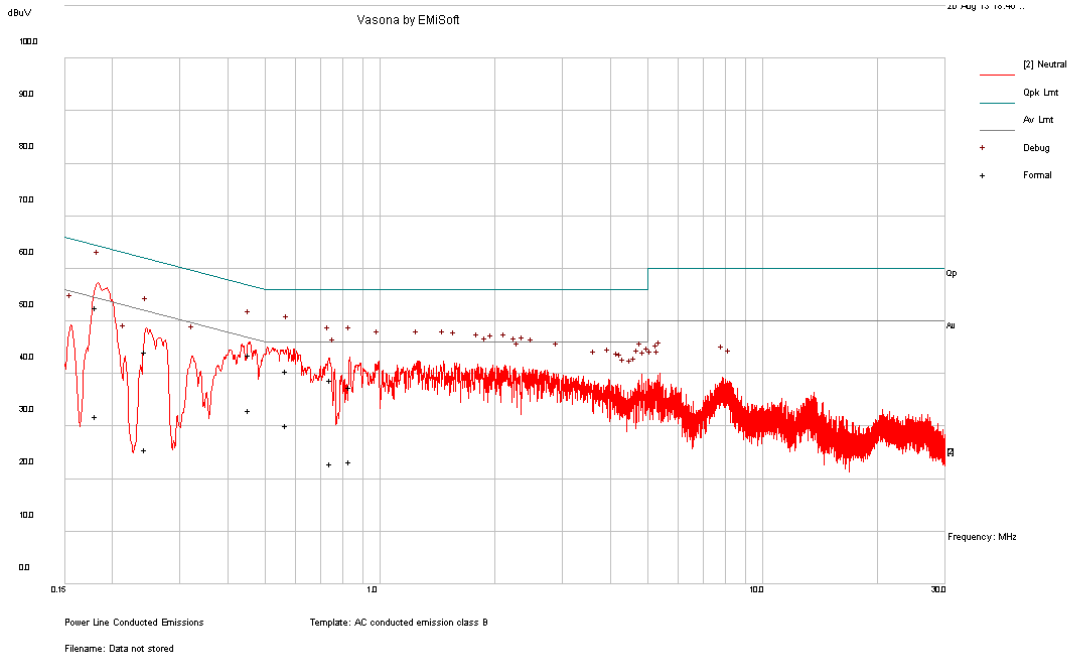
120 V, 60 Hz – Line, AC/DC Adaptor



Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.181302	53.46	Line	64.43	-10.97	QP
0.459816	42.73	Line	56.7	-13.97	QP
0.832095	39.39	Line	56	-16.61	QP
0.740865	38.52	Line	56	-17.48	QP
0.241518	43.58	Line	62.04	-18.46	QP
1.609014	36.56	Line	56	-19.44	QP

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.459816	31.33	Line	46.7	-15.37	Ave.
1.609014	25.83	Line	46	-20.17	Ave.
0.832095	23.73	Line	46	-22.27	Ave.
0.181302	31.96	Line	54.43	-22.47	Ave.
0.740865	23.18	Line	46	-22.82	Ave.
0.241518	20.39	Line	52.04	-31.66	Ave.

120 V, 60 Hz – Neutral, AC/DC Adaptor



Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.181446	52.68	Neutral	64.42	-11.74	QP
0.455358	43.51	Neutral	56.78	-13.27	QP
0.570057	40.47	Neutral	56	-15.53	QP
0.742839	38.8	Neutral	56	-17.20	QP
0.243708	44.08	Neutral	61.97	-17.89	QP
0.833496	37.51	Neutral	56	-18.49	QP

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.455358	33	Neutral	46.78	-13.78	Ave.
0.570057	30.1	Neutral	46	-15.90	Ave.
0.181446	31.99	Neutral	54.42	-22.43	Ave.
0.833496	23.27	Neutral	46	-22.73	Ave.
0.742839	22.93	Neutral	46	-23.07	Ave.
0.243708	25.52	Neutral	51.97	-26.45	Ave.

7 FCC §15.247(d) & IC RSS-210 §A8.5 – Spurious Emissions at Antenna Terminals

7.1 Applicable Standard

For FCC §15.247(d) and IC RSS-210 §A8.5, 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, provided the transmitter demonstrates compliance with the peak conducted power limits.

7.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 11: Emissions in non-restricted frequency bands and section 12: Emissions in restricted frequency bands.

7.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-09-29	1 Year

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

7.4 Test Environmental Conditions

Temperature:	22 °C
Relative Humidity:	35 %
ATM Pressure:	101.4 kPa

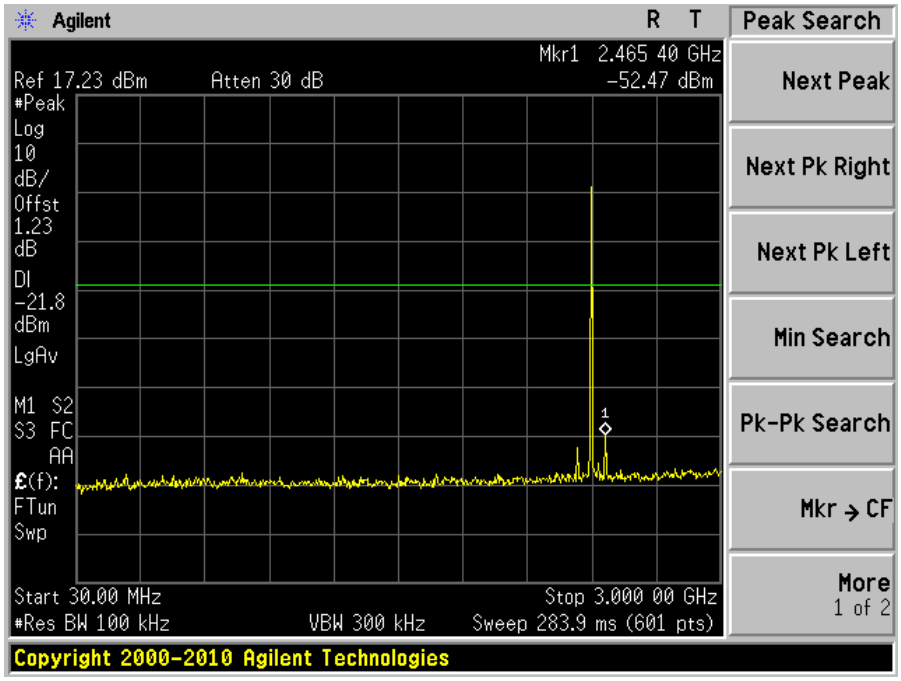
The testing was performed by Jeffrey Wu on 2013-08-08 at the RF Test Site.

7.5 Test Results

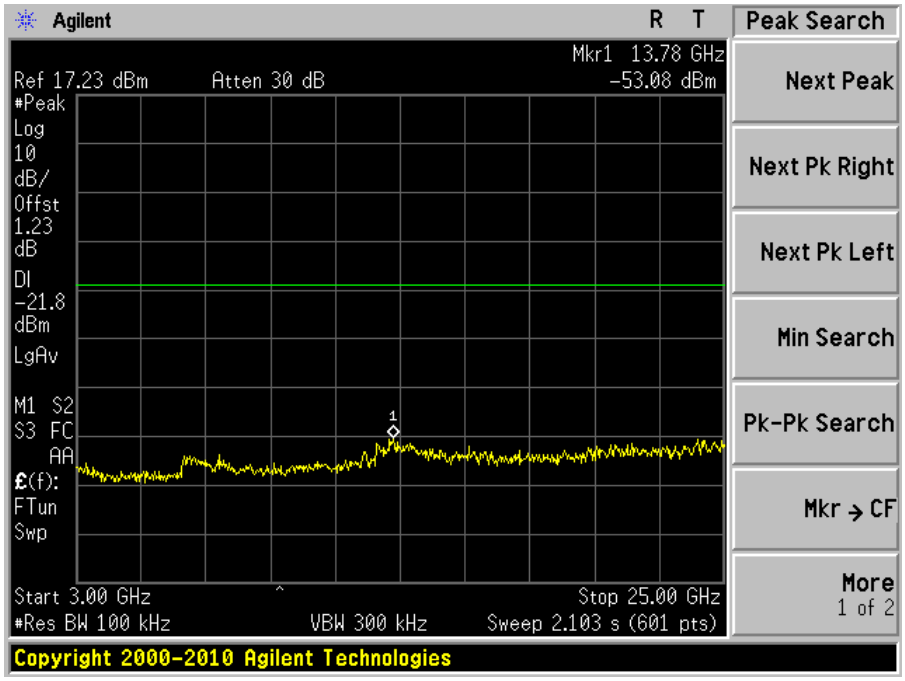
Please refer to following plots of spurious emissions.

Low Channel, 2402 MHz

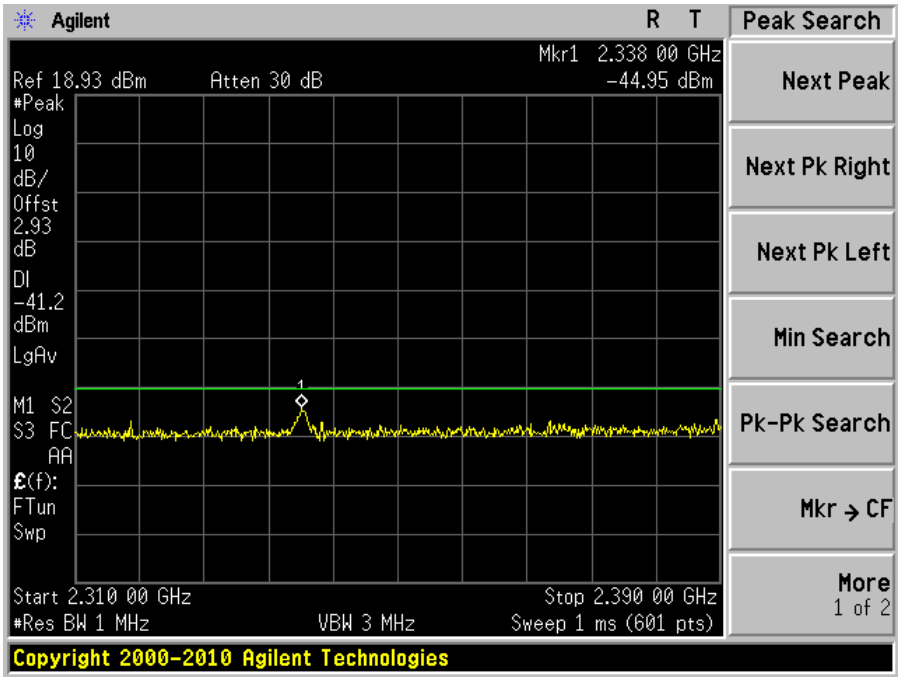
Plot: 30 MHz – 3 GHz



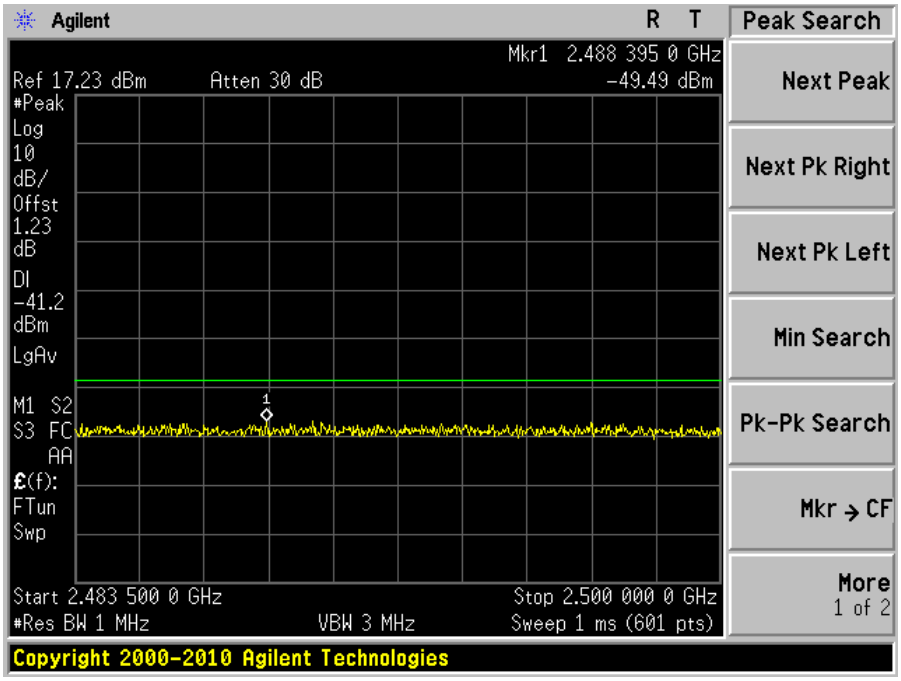
Plot: 3 GHz – 25 GHz



Plot: 2310 MHz – 2390 MHz

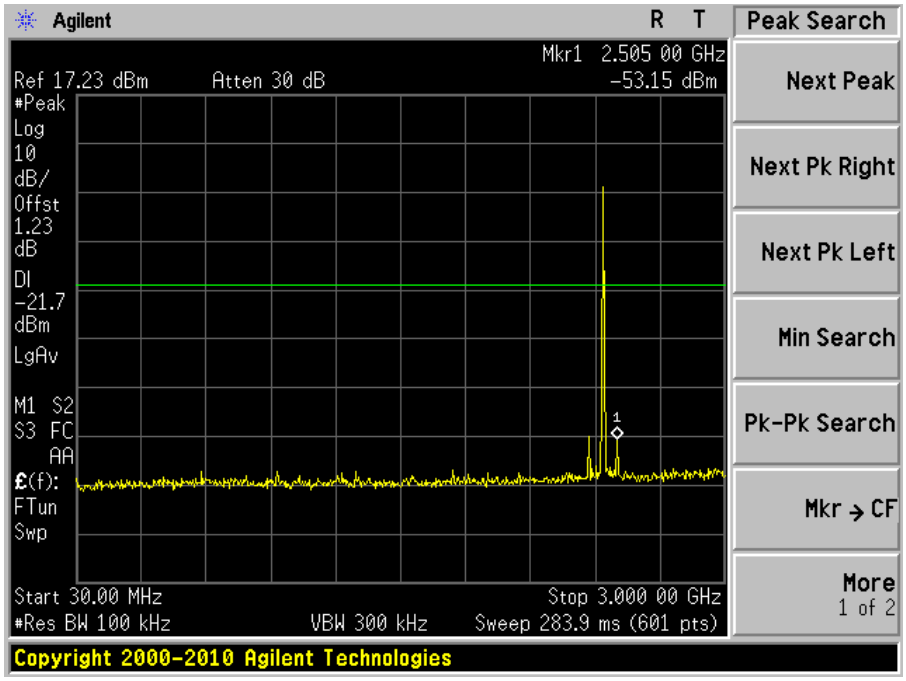


Plot: 2483.5 MHz – 2500 MHz

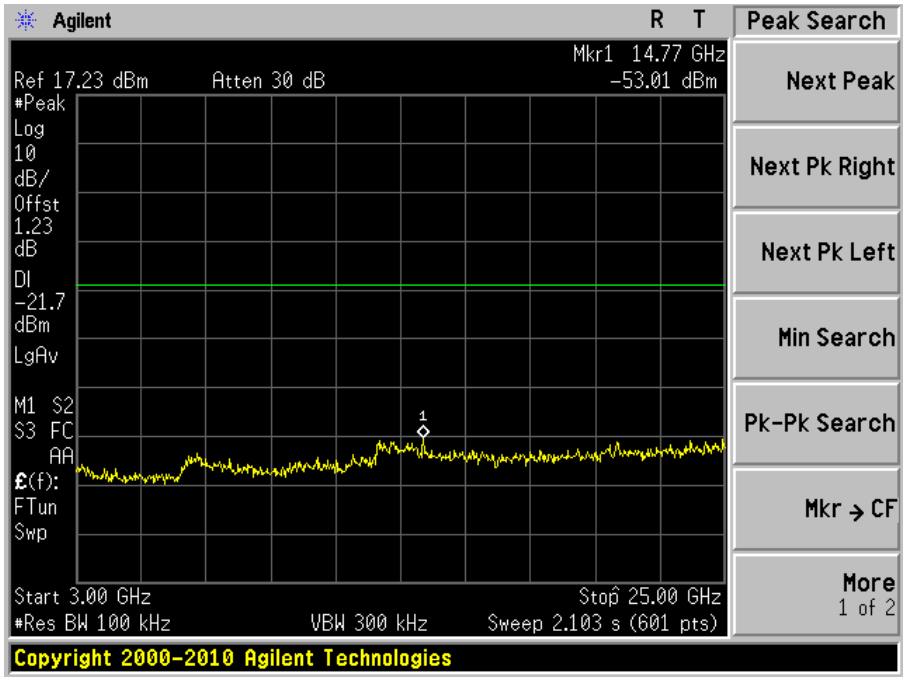


Middle Channel, 2442 MHz

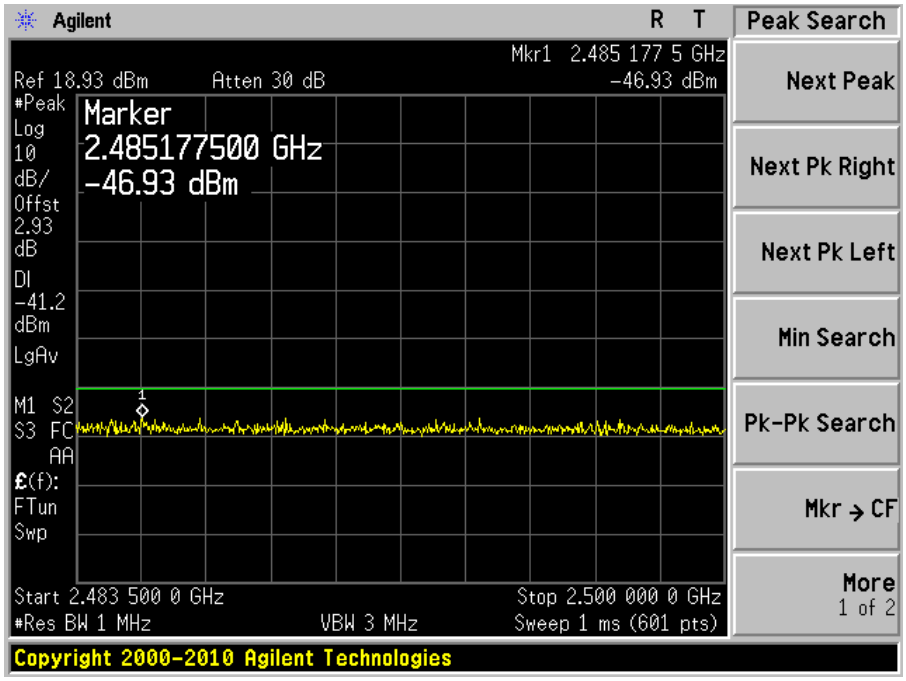
Plot: 30 MHz – 3 GHz



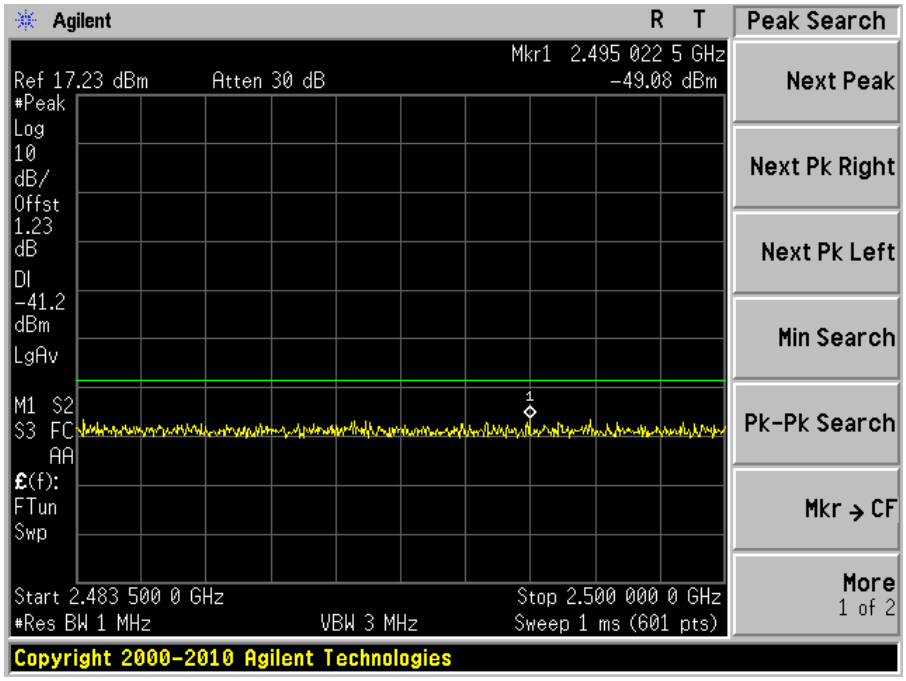
Plot: 3 GHz – 25 GHz



Plot: 2310 MHz – 2390 MHz

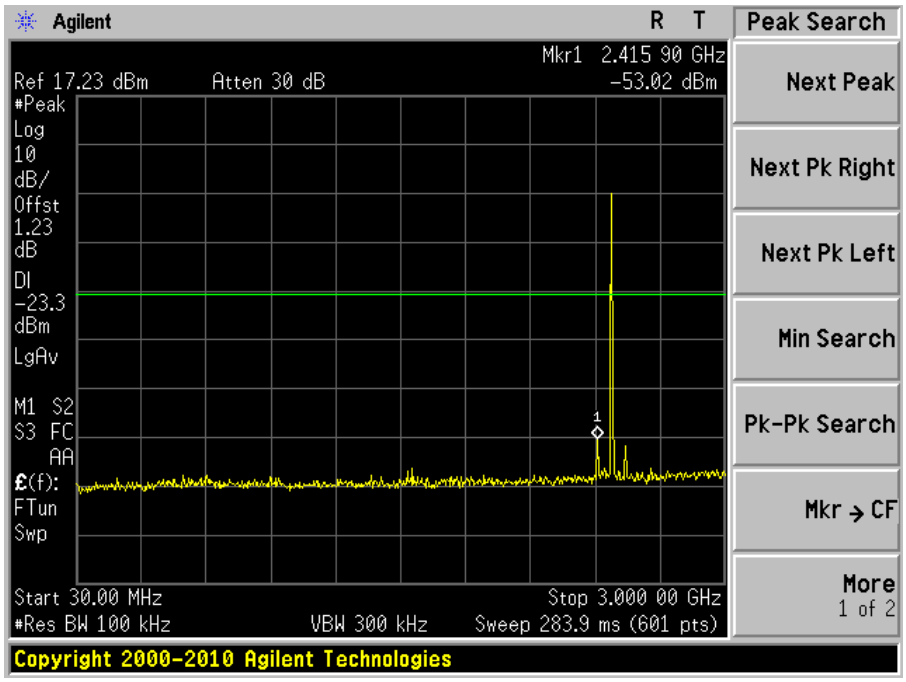


Plot: 2483.5 MHz – 2500 MHz

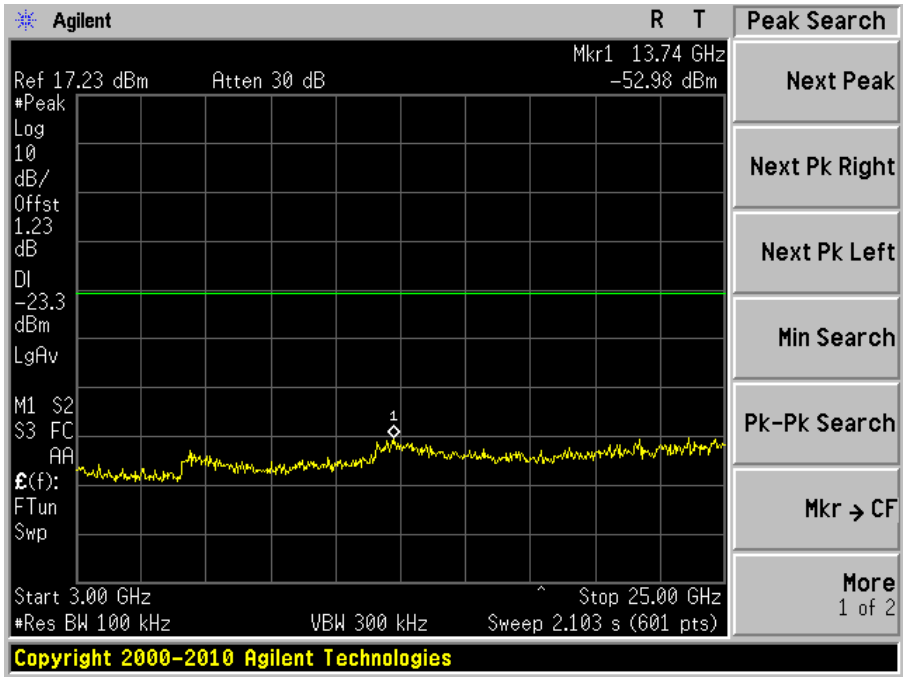


High Channel, 2480 MHz

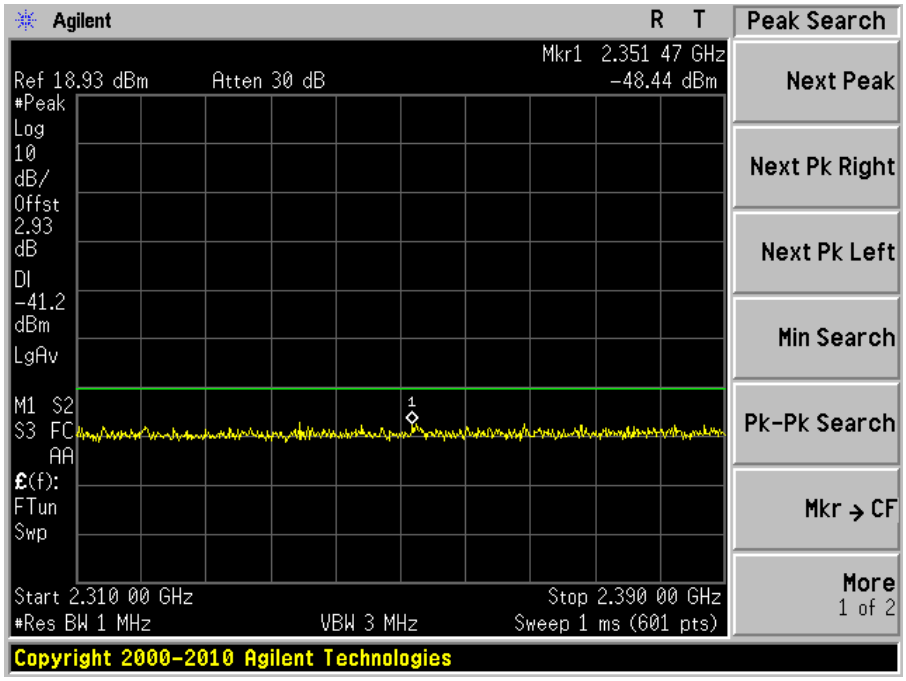
Plot: 30 MHz – 3 GHz



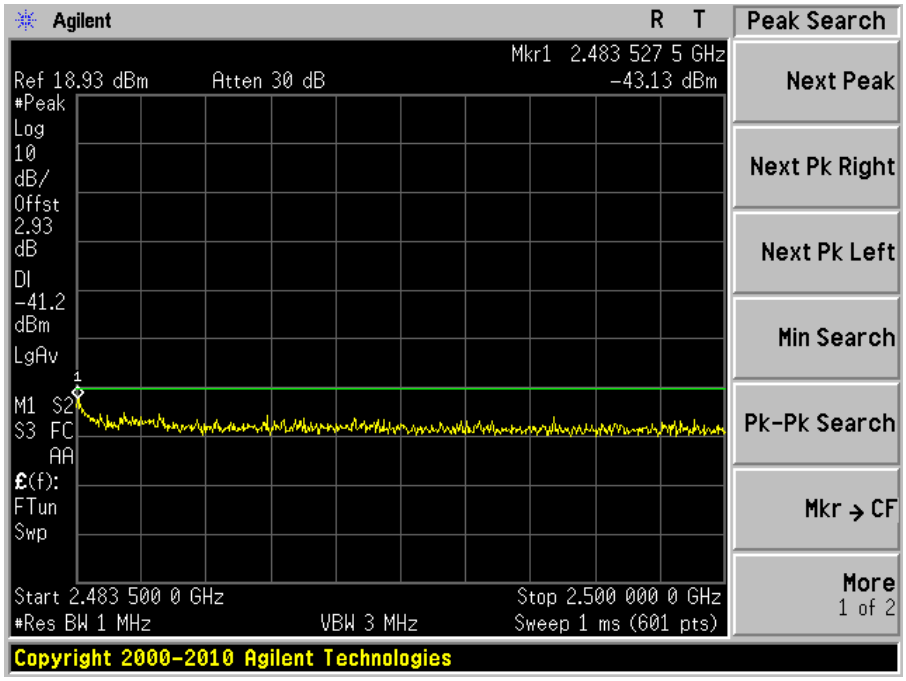
Plot: 3 GHz – 25 GHz



Plot: 2310 MHz – 2390 MHz



Plot: 2483.5 MHz – 2500 MHz



8 FCC §15.205, §15.209, §15.247(d) & IC RSS-210 §2.2, §A8.5 – Spurious Radiated Emissions

8.1 Applicable Standard

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As per FCC §15.209(a) and RSS-210: 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 (micro volts/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.

As Per FCC §15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	960 – 1240	4. 5 – 5. 15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5. 35 – 5. 46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 –167.17	3.332 – 3.339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3 3458 – 3 358	23.6 – 24.0
12.29 – 12.293	240 – 285	3.600 – 4.400	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4		36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per FCC §15.247 (d) 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, 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 paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

As per 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 RF 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square 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 field strength limits specified in RSS-Gen is not required.

8.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.4-2009. The specification used was the FCC 15 Subpart C and IC RSS-210 limits.

The spacing between the peripherals was 10 centimeters.

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

8.3 Test Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 11: Emissions in non-restricted frequency bands and section 12: Emissions in restricted frequency bands. As well as ANSI C63.4: 2009 as described below:

For the radiated emissions test, the EUT host, 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 meter, 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:

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

8.4 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

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. The equation for margin calculation is as follows:

Margin (dB) = Corrected Amplitude (dBuV/m) - Limit (dBuV/m)

8.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-09-29	1 Year
EMCO	Horn Antenna	3115	9511-4627	2012-10-17	1 Year
Mini-Circuits	Pre-amplifier	ZVA-183-S	570400946	2013-05-09	1 Year
Rohde & Schwarz	Test Receiver	ESCI 1166.5950K03	100338	2012-09-19	1 Year
Sunol Sciences	Biconi-Log Antenna	JB3	A020106-3	2013-07-11	1 Year
Agilent	Pre-amplifier	8447D	2944A10187	2013-03-08	1 Year
Sunol Sciences	System Controller	SC104V	113005-1	N/A	N/A

Statement of Traceability: BACL attests that all calibrations have been performed per the A2LA requirements, traceable to NIST.

8.6 Test Environmental Conditions

Temperature:	20-23 °C
Relative Humidity:	38-45 %
ATM Pressure:	101-102 kPa

The testing was performed by Jeffrey Wu from 2013-08-19 to 2013-08-20 at the 5m chamber 3.

8.7 Summary of Test Results

According to the data hereinafter, the EUT complied with the FCC Title 47, Part 15C and IC RSS-210 standard's radiated emissions limits, and had the worst margin of:

30-1000 MHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel, Range**
-9.9	144.0308	Vertical	High, 30 MHz to 1 GHz

1-25 GHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel, Range**
-7.512	2483.5	Horizontal	Low, 1GHz to 25 GHz

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

8.8 Radiated Emissions Test Data

1) 30 MHz – 1 GHz, Measured at 3 meters

Quasi-Peak Measurements

Low Channel, 2402 MHz

Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
144.0308	33.6	112	V	24	43.5	-9.9
156.0865	27.32	121	V	105	43.5	-16.18
336.0208	31.09	112	H	169	46	-14.91
492.0268	30.17	105	H	311	46	-15.83
998.1	30.4	144	V	108	54	-23.6

Middle Channel, 2442 MHz

Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
117.1243	30.67	112	V	123	43.5	-12.83
155.8003	29.13	178	H	94	43.5	-14.37
335.9653	27.74	103	H	123	46	-18.26
492.2278	30.26	151	H	157	46	-15.74
996.899	24.5	100	V	4	54	-29.5

High Channel, 2480 MHz

Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
114.5708	26.95	185	V	86	43.5	-16.55
156.024	29.79	118	V	12	43.5	-13.71
335.9435	27.96	129	H	160	46	-18.04
491.9513	29.57	157	H	165	46	-16.43
995.971	34.62	100	V	62	54	-19.38

2) 1–25 GHz, Measured at 3 meters

Frequency (MHz)	S.A. Reading (dBµV)	Turntable 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)	
Low Channel 2402 MHz, measured at 3 meters											
2402	56.49	278	100	V	28.956	3.120	-	88.566	Fund.	-	Peak
2402	53.96	14	100	H	28.956	3.120	-	86.036	Fund.	-	Peak
2402	55.53	278	100	V	28.956	3.120	-	87.606	Fund.	-	Ave
2402	52.65	14	100	H	28.956	3.120	-	84.726	Fund.	-	Ave
4806	39.9	282	100	V	33.084	4.560	27.780	49.764	74	-24.236	Peak
4806	36.75	26	100	H	33.084	4.560	27.780	46.614	74	-27.386	Peak
4806	35.77	282	100	V	33.084	4.560	27.780	45.634	54	-8.366	Ave
4806	29.69	26	100	H	33.084	4.560	27.780	39.554	54	-14.446	Ave
7206	34.93	0	100	V	35.928	5.490	27.590	48.758	68.566	-19.808	Peak
7206	34.24	0	100	H	35.928	5.490	27.590	48.068	66.036	-17.968	Peak
7206	19.64	0	100	V	35.928	5.490	27.590	33.468	67.606	-34.138	Ave
7206	19.9	0	100	H	35.928	5.490	27.590	33.728	64.726	-30.998	Ave
9608	33.18	0	100	V	37.946	6.540	27.050	50.616	68.566	-17.950	Peak
9608	33.01	0	100	H	37.946	6.540	27.050	50.446	66.036	-15.590	Peak
9608	19.41	0	100	V	37.946	6.540	27.050	36.846	67.606	-30.760	Ave
9608	19.49	0	100	H	37.946	6.540	27.050	36.926	64.726	-27.800	Ave
Middle Channel 2442 MHz, measured at 3 meters											
2442	56.67	276	100	V	28.956	3.250	-	88.876	Fund.	-	Peak
2442	53.18	17	100	H	28.956	3.250	-	85.386	Fund.	-	Peak
2442	55.81	276	100	V	28.956	3.250	-	88.016	Fund.	-	Ave
2442	52.14	17	100	H	28.956	3.250	-	84.346	Fund.	-	Ave
4884	40.52	282	100	V	33.327	4.540	27.670	50.717	74	-23.283	Peak
4884	38.36	25	100	H	33.327	4.540	27.670	48.557	74	-25.443	Peak
4884	36.11	282	100	V	33.327	4.540	27.670	46.307	54	-7.693	Ave
4884	30.45	25	100	H	33.327	4.540	27.670	40.647	54	-13.353	Ave
7320	33.53	0	100	V	36.357	5.570	27.510	47.947	74	-26.053	Peak
7320	33.08	0	100	H	36.357	5.570	27.510	47.497	74	-26.503	Peak
7320	18.79	0	100	V	36.357	5.570	27.510	33.207	54	-20.793	Ave
7320	18.78	0	100	H	36.357	5.570	27.510	33.197	54	-20.803	Ave
9760	33.98	0	100	V	38.287	6.620	27.030	51.857	68.876	-17.019	Peak
9760	32.8	0	100	H	38.287	6.620	27.030	50.677	65.386	-14.709	Peak
9760	19.31	0	100	V	38.287	6.620	27.030	37.187	68.016	-30.829	Ave
9760	18.36	0	100	H	38.287	6.620	27.030	36.237	64.346	-28.109	Ave

Frequency (MHz)	S.A. Reading (dBµV)	Turntable 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)	
High Channel 2480 MHz, measured at 3 meters											
2480	54.26	275	100	V	29.155	3.250	-	86.665	Fund.	-	Peak
2480	50.01	16	100	H	29.155	3.250	-	82.415	Fund.	-	Peak
2480	53.3	275	100	V	29.155	3.250	-	85.705	Fund.	-	Ave
2480	48.84	16	100	H	29.155	3.250	-	81.245	Fund.	-	Ave
4958	39.41	279	100	V	33.457	4.520	27.700	49.687	74	-24.31	Peak
4958	38.28	17	100	H	33.457	4.520	27.700	48.557	74	-25.44	Peak
4958	35.46	279	100	V	33.457	4.520	27.700	45.737	54	-8.26	Ave
4958	31.45	17	100	H	33.457	4.520	27.700	41.727	54	-12.27	Ave
7440	33.26	0	100	V	36.505	5.660	27.530	47.895	74	-26.11	Peak
7440	33.26	0	100	H	36.505	5.660	27.530	47.895	74	-26.11	Peak
7440	18.39	0	100	V	36.505	5.660	27.530	33.025	54	-20.98	Ave
7440	18.33	0	100	H	36.505	5.660	27.530	32.965	54	-21.04	Ave
9920	31.38	0	100	V	38.541	6.670	27.010	49.581	66.665	-17.08	Peak
9920	31.04	0	100	H	38.541	6.670	27.010	49.241	62.415	-13.17	Peak
9920	16.97	0	100	V	38.541	6.670	27.010	35.171	65.705	-30.53	Ave
9920	16.94	0	100	H	38.541	6.670	27.010	35.141	61.245	-26.10	Ave

3) Restricted Band Edge

Frequency (MHz)	S.A. Reading (dBµV)	Turntable 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)	
Low Channel 2402 MHz, measured at 3 meters											
2390	28.41	0	100	V	28.956	3.120	-	60.486	74	-13.514	Peak
2390	27.68	0	100	H	28.956	3.120	-	59.756	74	-14.244	Peak
2390	13.87	0	100	V	28.956	3.120	-	45.946	54	-8.054	Ave
2390	13.84	0	100	H	28.956	3.120	-	45.916	54	-8.084	Ave
High Channel 2480 MHz, measured at 3 meters											
2483.5	28.51	0	100	V	29.155	3.253	-	60.918	74	-13.082	Peak
2483.5	27.87	0	100	H	29.155	3.253	-	60.278	74	-13.722	Peak
2483.5	13.33	0	100	V	29.155	3.253	-	45.738	54	-8.262	Ave
2483.5	14.08	0	100	H	29.155	3.253	-	46.488	54	-7.512	Ave

9 FCC§15.247(a)(2) & IC RSS-210 §A8.2 – 6 dB & 99% Emission Bandwidth

9.1 Applicable Standard

According to FCC §15.247(a)(2) and IC RSS-210 A8.2 (a), systems using digital modulation techniques may operate in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz

9.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-09-29	1 Year

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

9.4 Test Environmental Conditions

Temperature:	22 °C
Relative Humidity:	35 %
ATM Pressure:	101.4 kPa

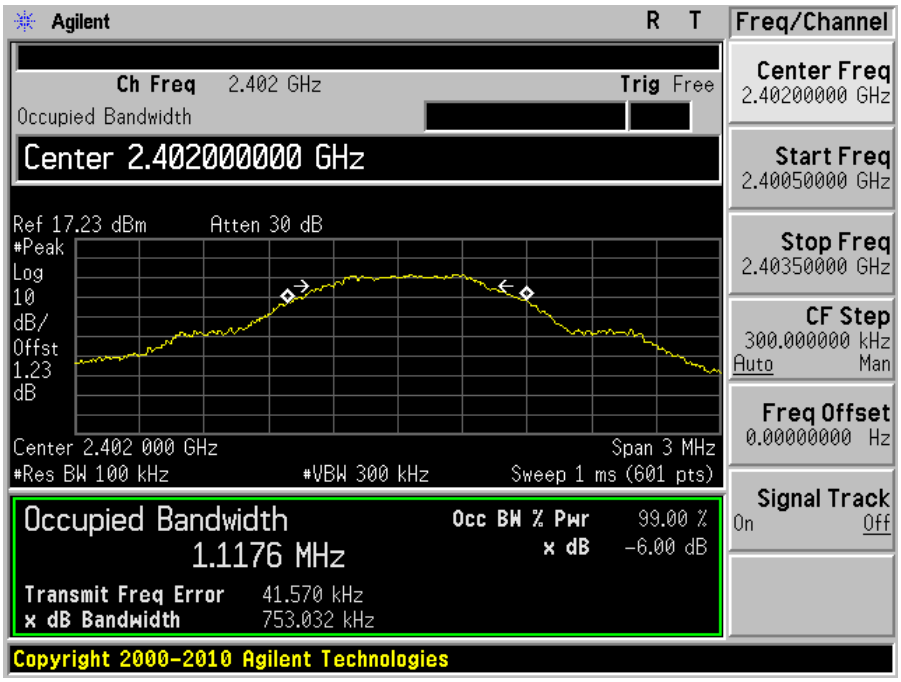
The testing was performed by Jeffrey Wu on 2013-08-08 at the RF Test Site.

9.5 Test Results

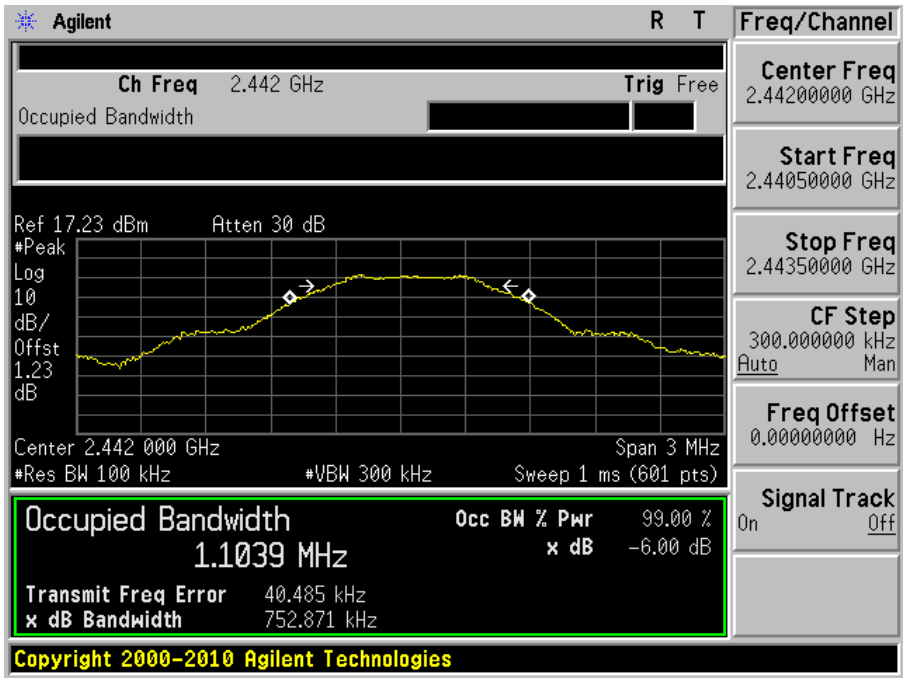
Channel	Frequency (MHz)	6 dB Emission Bandwidth (kHz)	99% Emission Bandwidth (kHz)	6 dB OBW Limit (kHz)	Results
Low	2402	753.032	1117.6	> 500	Pass
Middle	2442	752.871	1103.9	> 500	Pass
High	2480	764.074	1111.5	> 500	Pass

Please refer to the following plots for detailed test results

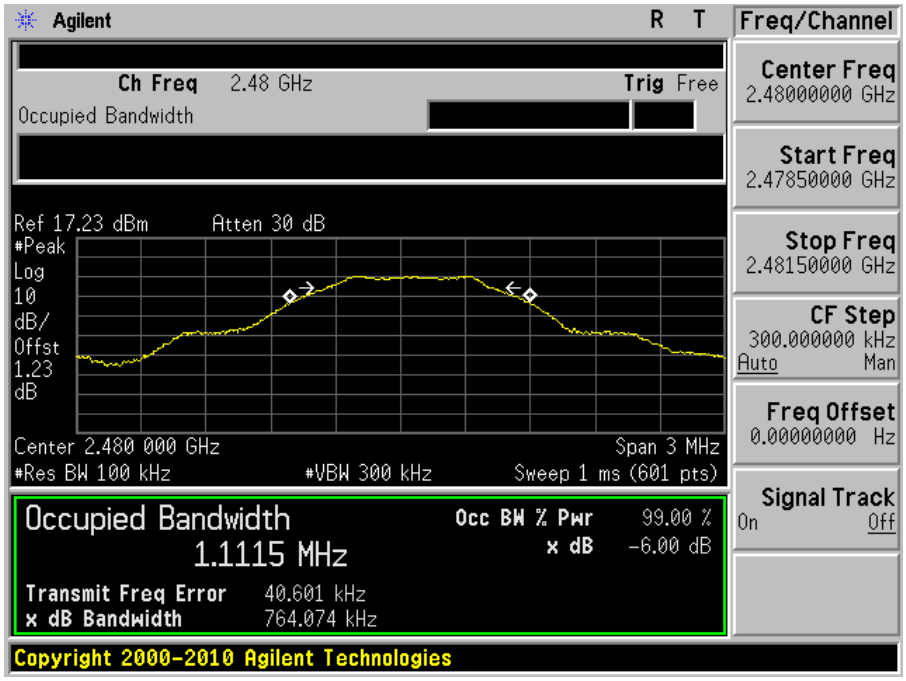
Low channel: 2402 MHz



Middle channel: 2442 MHz



High channel: 2480 MHz



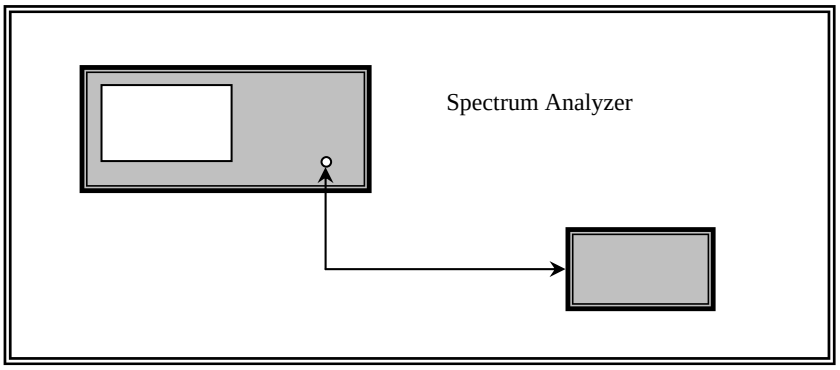
10 FCC §15.247(b) & IC RSS-210 §A8.4 – Peak Output Power Measurement

10.1 Applicable Standard

According to FCC §15.247(b) and IC RSS-210 §A8.4 (4) for systems using digital modulation in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands: 1 Watt.

10.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 9: Fundamental emission output power



10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-09-29	1 Year

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

10.4 Test Environmental Conditions

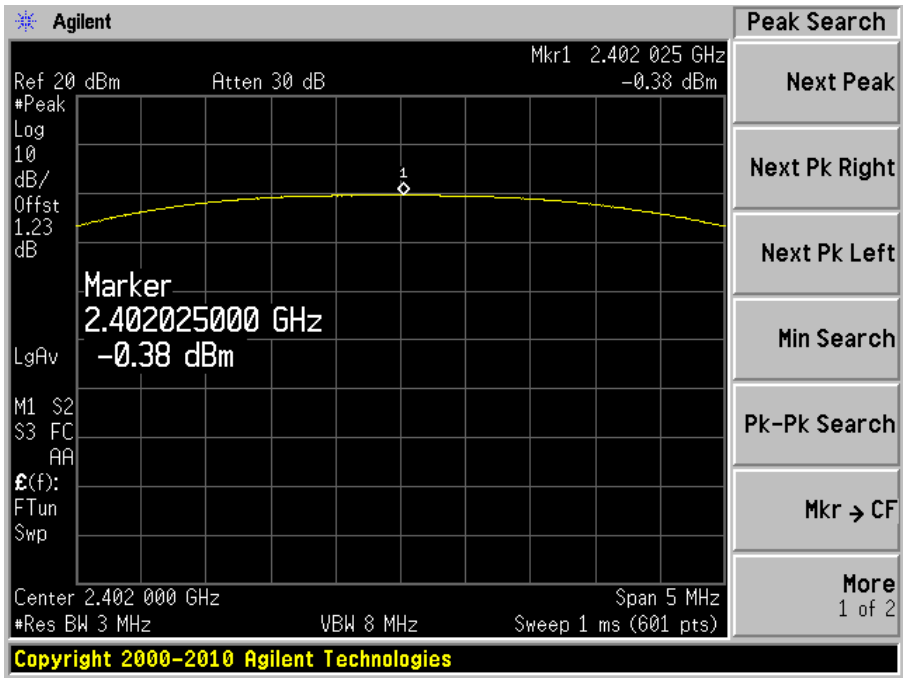
Temperature:	22 °C
Relative Humidity:	35 %
ATM Pressure:	101.4 kPa

The testing was performed by Jeffrey Wu on 2013-08-08 at the RF Test Site.

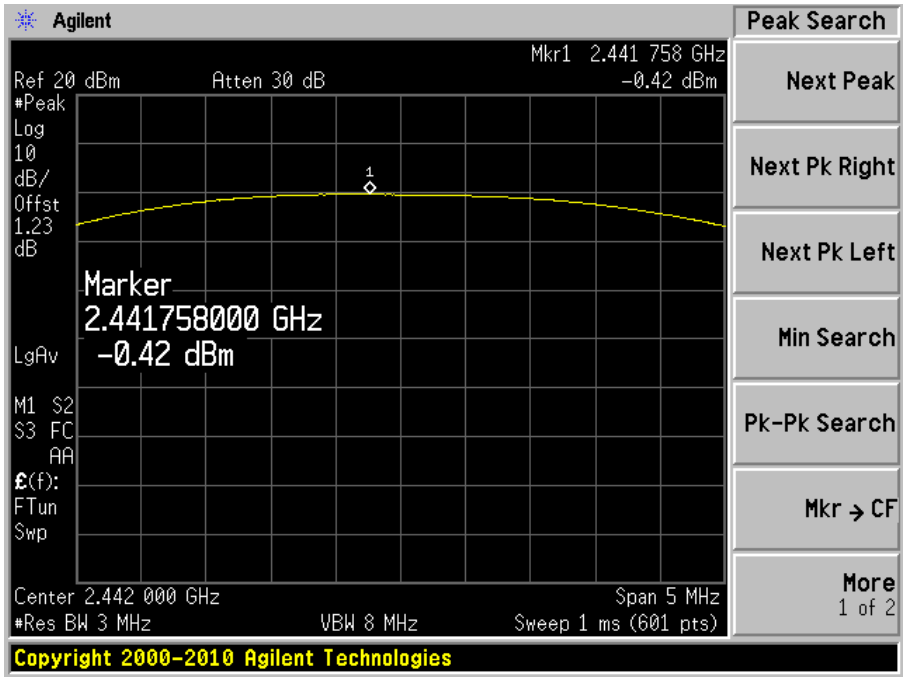
10.5 Test Results

Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)	FCC/IC Limit (dBm)	Margin (dB)
Low	2402	-0.38	30	-30.38
Middle	2442	-0.42	30	-30.42
High	2480	-1.62	30	-31.62

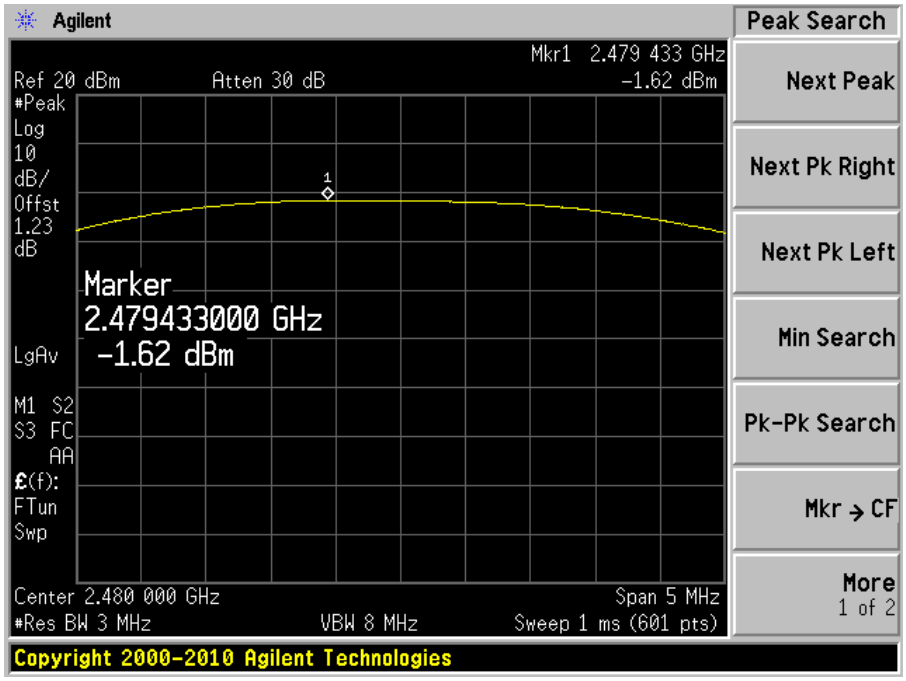
Low channel: 2402 MHz



Middle channel: 2442 MHz



High channel: 2480 MHz



11 FCC §15.247(d) & IC RSS-210 §A8.5 – 100 kHz Bandwidth of Band Edges

11.1 Applicable Standard

According to FCC §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).

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.

11.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 13: Band-edge measurements

11.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-09-29	1 Year

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

11.4 Test Environmental Conditions

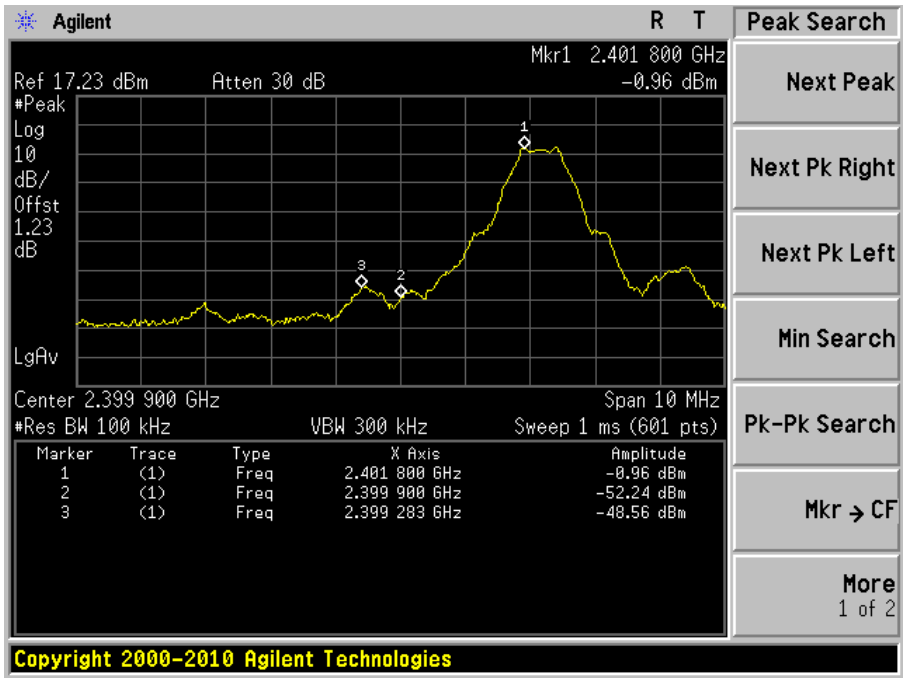
Temperature:	22 °C
Relative Humidity:	35 %
ATM Pressure:	101.4 kPa

The testing was performed by Jeffrey Wu on 2013-08-08 at the RF Test Site.

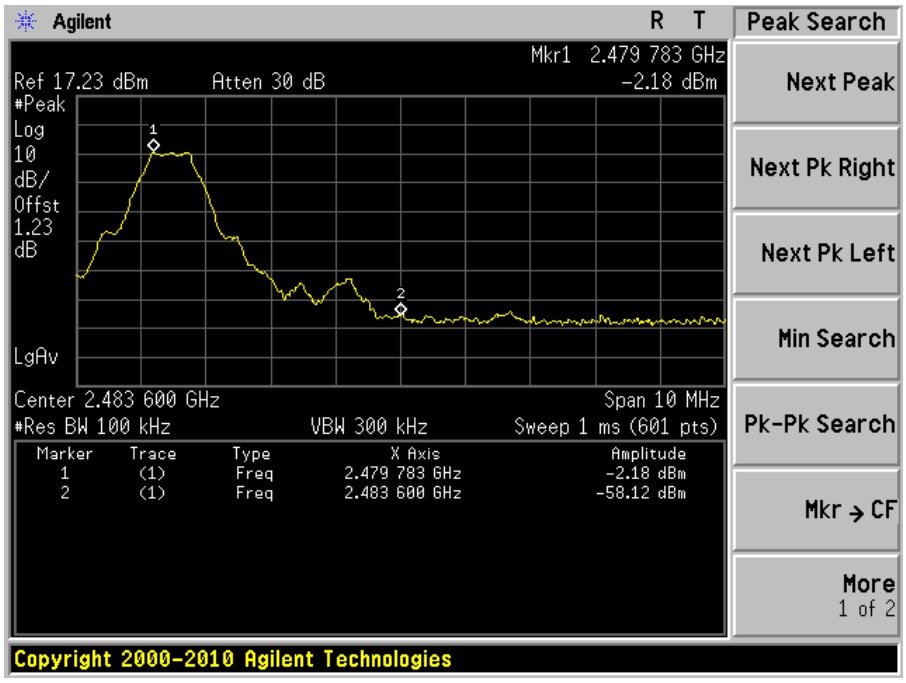
11.5 Test Results

Please refer to following pages for plots of band edge.

Low Band Edge



High Band Edge



12 FCC §15.247(e) & IC RSS-210 §A8.2 (b) – Power Spectral Density

12.1 Applicable Standard

According to FCC §15.247(e) and RSS-210 §A8.2 (b) , for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

12.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 10: Maximum power spectral density level in the fundamental emission

12.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-09-29	1 Year

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

12.4 Test Environmental Conditions

Temperature:	22 °C
Relative Humidity:	35 %
ATM Pressure:	101.4 kPa

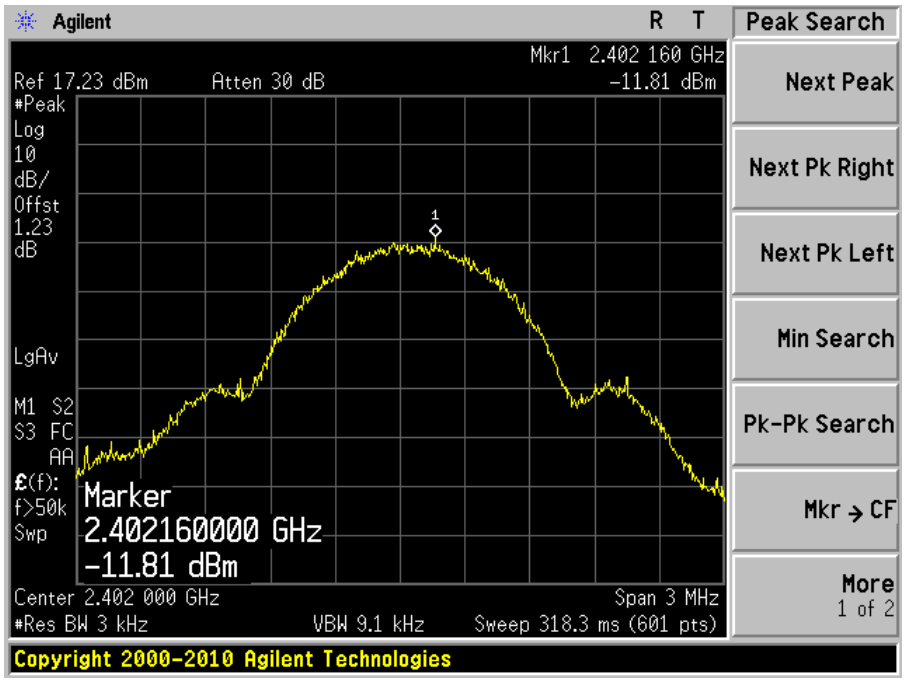
The testing was performed by Jeffrey Wu on 2013-08-08 at the RF Test Site.

12.5 Test Results

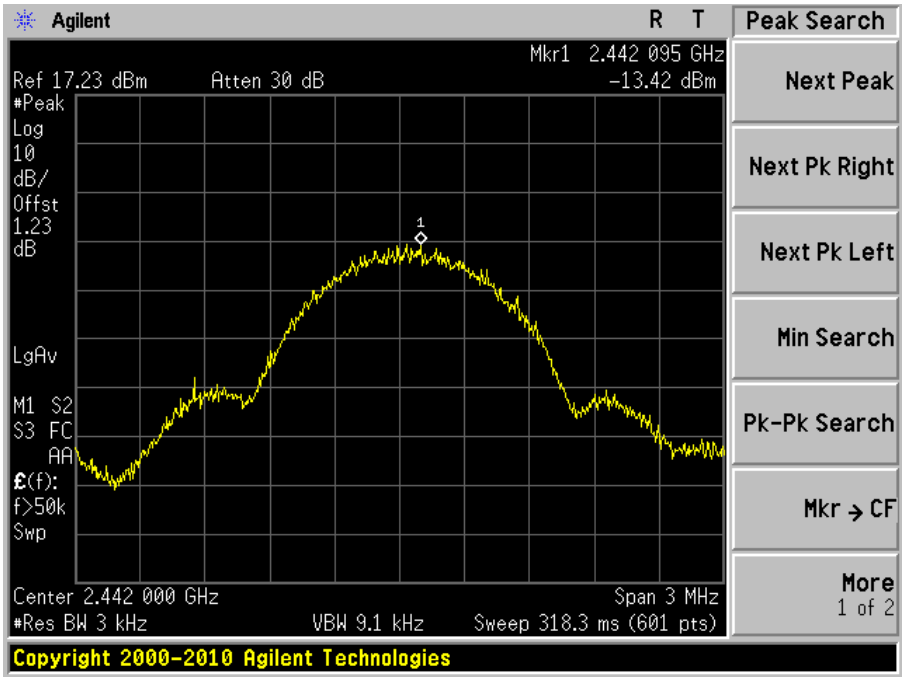
Channel	Frequency (MHz)	Power Spectral Density (dBm)	FCC/IC Limit (dBm)	Results
Low	2402	-11.81	8	Pass
Mid	2442	-13.84	8	Pass
High	2480	-13.27	8	Pass

Please refer to the following plots for detailed test results:

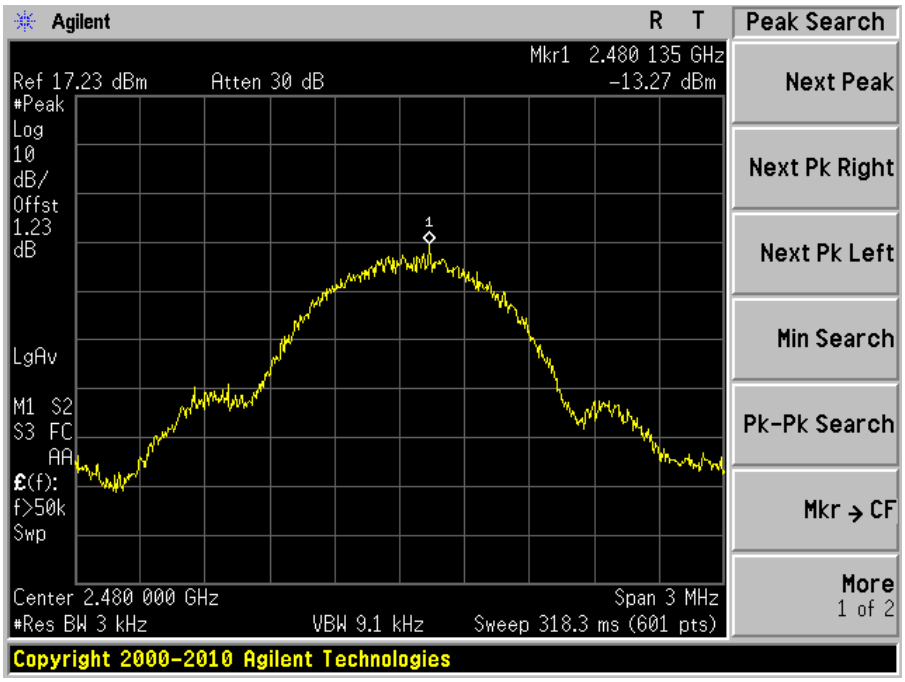
Low channel: 2402 MHz



Middle channel: 2442 MHz



High channel: 2480 MHz



13 IC RSS-210 §2.3 & RSS-Gen §6.1 – Receiver Spurious Radiated Emissions

13.1 Applicable Standards

According to IC RSS-Gen §6.1, spurious emissions from receivers shall not exceed the radiated limits shown in the table below.

Table 2: General Field Strength Limits for Transmitters and Receivers at Frequencies above 30 MHz

Frequency (MHz)	Field Strength Microvolts/m at 3 meters
30-88	100
88-216	150
216-960	200
Above 960	500

13.2 EUT Setup

The radiated emissions tests were performed in the 3 meter chamber, using the setup in accordance with ANSI C63.4-2009.

13.3 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.

13.4 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to the indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

For example, the Corrected Amplitude (CA) of 40.3 dBuV/m = indicated Amplitude reading (Ai) 32.5 dBuV + Antenna Factor (AF) 23.5dB + Cable Loss (CL) 3.7 dB + Attenuator (Atten) 10 dB - Amplifier Gain (Ga) 29.4 dB

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 The equation for margin calculation is as follows:

Margin (dB) = Corrected Amplitude (dBuV/m) - Limit (dBuV/m)

13.5 Test Equipment Lists and Details

Manufacturer	Description	Model Number	Serial Number	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-09-29	1 Year
EMCO	Horn Antenna	3115	9511-4627	2012-10-17	1 Year
Mini-Circuits	Pre-amplifier	ZVA-183-S	570400946	2013-05-09	1 Year
Rohde & Schwarz	Test Receiver	ESCI 1166.5950K03	100338	2012-09-19	1 Year
Sunol Sciences	Biconi-Log Antenna	JB3	A020106-3	2013-07-11	1 Year
Agilent	Pre-amplifier	8447D	2944A10187	2013-03-08	1 Year
Sunol Sciences	System Controller	SC104V	113005-1	N/A	N/A

Statement of Traceability: BACL attests that all calibrations have been performed per the A2LA requirements, traceable to NIST.

13.6 Test Environmental Conditions

Temperature:	22-25 °C
Relative Humidity:	38-42 %
ATM Pressure:	101-102 kPa

The testing was performed by Jeffrey Wu from 2013-08-19 to 2013-08-22 at the 5m chamber 3.

13.7 Summary of Test Results

According to the test data, the EUT complied with the RSS-210, with the closest margins from the limit listed below:

Mode: Receiving			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Range (MHz)**
-11.12	165.0555	Vertical	30 to 25000

13.8 Test Results

1) 30-1000 MHz, Measured at 3 meters

Quasi-Peak Measurements

Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
68.92	24.49	264	V	306	40	-15.51
95.9555	28.11	108	V	110	43.5	-15.39
165.0555	32.38	100	V	140	43.5	-11.12
384.0335	34.66	100	H	343	46	-11.34
996.7415	27.56	159	V	153	54	-26.44

2) Above 1 GHz, Measured at 3 meters

Frequency (MHz)	S.A. Reading (dBµV)	Turntable 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)	
2845	35.92	35	100	V	29.391	3.370	27.820	40.861	74	-33.139	Peak
2845	35.39	92	100	H	29.391	3.370	27.820	40.331	74	-33.669	Peak
2845	21.63	35	100	V	29.391	3.370	27.820	26.571	54	-27.429	Ave
2845	21.56	92	100	H	29.391	3.370	27.820	26.501	54	-27.499	Ave
4270	34.48	42	100	V	32.323	4.190	27.840	43.153	74	-30.847	Peak
4270	34.91	67	100	H	32.323	4.190	27.840	43.583	74	-30.417	Peak
4270	19.94	42	100	V	32.323	4.190	27.840	28.613	54	-25.387	Ave
4270	19.97	67	100	H	32.323	4.190	27.840	28.643	54	-25.357	Ave