FCC PART 15, SUBPART C

TEST AND MEASUREMENT REPORT

For

CentraLite Systems, Inc.

1000 Cody Road South,

Mobile, AL 36695, USA

FCC ID: T3L-TS004

Report Type:	Product Type:
Original Report	Zigbee Transceiver

Prepared By: Lionel Lara

Report Number: R1307291-247

Report Date: 2013-08-30

Reviewed By: Victor Zhang, EMC/RF Lead

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1307291-247	Original Report	2013-08-30

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *CentraLite Systems, Inc.*, and their product FCC ID: T3L-TS004, model: *BLUESHARK* or the "EUT" as referred on this report is a thermostat with Zigbee transceiver.

1.2 Mechanical Description of EUT

The "EUT" measures approximately *13.4cm (L) x 3cm (W) x 11cm (H),* and weighs approximately *171*g.

The test data gathered are from typical production sample, serial number: 9014 for the conducted testing and serial number: 9017 for the radiated testing, provided by the manufacturer.

1.3 Objective

This report is prepared on behalf of *CentraLite Systems, Inc.* in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission's rules.

The objective is to determine compliance with FCC Part 15.247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, power spectral density, 100 kHz Bandwidth of Band Edges Measurement, Conducted Spurious Emissions 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 CISPR16-4-2:2011, 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

Bay Area Compliance Laboratories Corp. (BACL) is:

1- An independent Commercial Test Laboratory accredited to **ISO 17025: 2005** by **A2LA**, in the fields of: Electromagnetic Compatibility & Telecommunications covering Emissions, Immunity, Radio, RF Exposure, Safety and Telecom. This includes NEBS (Network Equipment Building System), Wireless RF, Telecommunications Terminal Equipment (TTE); Network Equipment; Information Technology Equipment (ITE); Medical Electrical Equipment; Industrial, Commercial, and Medical Test Equipment; Professional Audio and Video Equipment; Electronic (Digital) Products; Industrial and Scientific Instruments; Cabled Distribution Systems and Energy Efficiency Lighting.

2- An ENERGY STAR Recognized Laboratory, for the LM80 Testing, a wide variety of Luminares and Computers.

3- A NIST Designated Phase-I and Phase-II CAB including: ACMA (Australian Communication and Media Authority), BSMI (Bureau of Standards, Metrology and Inspection of Taiwan), IDA (Infocomm Development Authority of Singapore), IC(Industry Canada), Korea (Ministry of Communications Radio Research Laboratory), NCC (Formerly DGT; Directorate General of Telecommunication of Chinese Taipei) OFTA (Office of the Telecommunications Authority of Hong Kong), Vietnam, VCCI - Voluntary Control Council for Interference of Japan and a designated EU CAB (Conformity Assessment Body) (Notified Body) for the EMC and R&TTE Directives.

4- A Product Certification Body accredited to **ISO Guide 65:1996** by **A2LA** to certify:
1- Unlicensed, Licensed radio frequency devices and Telephone Terminal Equipment for the FCC. Scope A1, A2, A3, A4, B1, B2, B3, B4 & C.
2. Radio Standards Specifications (RSS) in the Category I Equipment Standards List and All Broadcasting Technical Standards (BETS) in Category I Equipment Standards List for Industry Canada.
3. Radio Communication Equipment for Singapore.
4. Radio Equipment Specifications, GMDSS Marine Radio Equipment Specifications, and Fixed Network Equipment Specifications for Hong Kong.
5. Japan MIC Telecommunication Business Law (A1, A2) and Radio Law (B1, B2 and B3).
6. Audio/Video, Battery Charging Systems, Computers, Displays, Enterprise Servers, Imaging Equipment, Set-Top Boxes, Telephony, Televisions, Ceiling Fans, CFLs (Including GU24s),Decorative Light Strings, Integral LED Lamps, Luminaires, Residential Ventilating Fans.

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 C63.4-2009, 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 EUT was tested in a testing mode to represent worst-case results during the final qualification test.

The EUT had been tested with the following Channels:

Channel/Frequency			
Low CH (MHz)	**Mid CH (MHz)**	**Channel 25 (MHz)**	**High CH (MHz)**
2405	2440	2475	2480

2.2 EUT Exercise Software

The test utility used was Putty, was provided by CentraLite Systems, Inc. and was verified by Lionel Lara to comply with the standard requirements being tested against.

2.3 Special Equipment

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 Local Support Equipment

Manufacturer	Description	Model No.	Serial No.
Dell	Laptop	Inspiron 15	-
Silicon Labs	Ember Debug Adapter	ISA3	-

2.6 EUT Internal Configuration Details

Manufacturers	Descriptions	Models	Serial Numbers
CentraLite Systems, Inc.	Main PCB Board	BLUESHARK	-

2.7 Interface Ports and Cabling

Cable Description	Length (m)	From	To
RF cable	< 1	EUT	Spectrum Analyzer
10-pin Ribbon cable	> 1	EUT	Debug Adapter
Ethernet cable	> 1	Laptop	Debug Adapter
USB cable	> 1	Laptop	Debug Adapter

2.8 Power Supply List and Details

Manufacturer	Description	Model	Serial Number
CUI, Inc.	AC Adaptor	48A-24-500	-

3 Summary of Test Results

Results reported relate only to the product tested.

FCC Rules	Description of Test	Results
§15.247(i), §2.1091	RF Exposure	Compliant
§15.203	Antenna Requirement	Compliant
§15.207(a)	AC Line Conducted Emissions	Compliant
§15.247 (d)	Spurious Emissions at Antenna Port	Compliant
§15.205	Restricted Bands	Compliant
§15.209, §15.247 (d)	Radiated Spurious Emissions	Compliant
§15.247(a)(2)	6 dB Emission Bandwidth	Compliant
§15.247(b)(3)	Maximum Peak Output Power	Compliant
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247(e)	Power Spectral Density	Compliant

4 FCC §15.247 (i) & §2.1091 – RF Exposure

4.1 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.

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

4.2 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

4.3 MPE Results

Maximum peak output power at antenna input terminal (dBm):	14.13
Maximum peak output power at antenna input terminal (mW):	25.88
Prediction distance (cm):	20
Prediction frequency (MHz):	2440
Maximum Antenna Gain, typical (dBi):	2.73
Maximum Antenna Gain (numeric):	1.87
Power density of prediction frequency at 20 cm (mW/cm^2):	0.0097
MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.0097 mW/cm^2, limit is 1.0 mW/cm^2.

5 FCC §15.203 – 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.

5.2 Antenna List

Manufacturers	Models/Name	Antenna Gain (dBi) @ 2.4 GHz
CentraLite	-	2.73

5.3 Result

The EUT has maximum gain of 2.73 dBi antenna, which in accordance to sections FCC Part 15.203, is considered sufficient to comply with the provisions of these sections. Please refer to the EUT photos.

The chip antenna has less than 6 dBi gain; therefore, it complies with the antenna requirement. Please refer to the internal photos.

6 FCC §15.207 – AC Line Conducted Emissions

6.1 Applicable Standards

As per FCC §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.*

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 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-1 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-1.

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 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 = Corrected Amplitude - Limit

6.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100044	2013-04-23	1 year
Solar Electronics	LISN	9252-R-24-BNC	511205	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.*

6.6 Test Environmental Conditions

Temperature:	21 °C
Relative Humidity:	48 %
ATM Pressure:	101.1 kPa

The testing was performed by Lionel Lara on 2013-08-08 at the 5 meter chamber 3.

6.7 Summary of Test Results

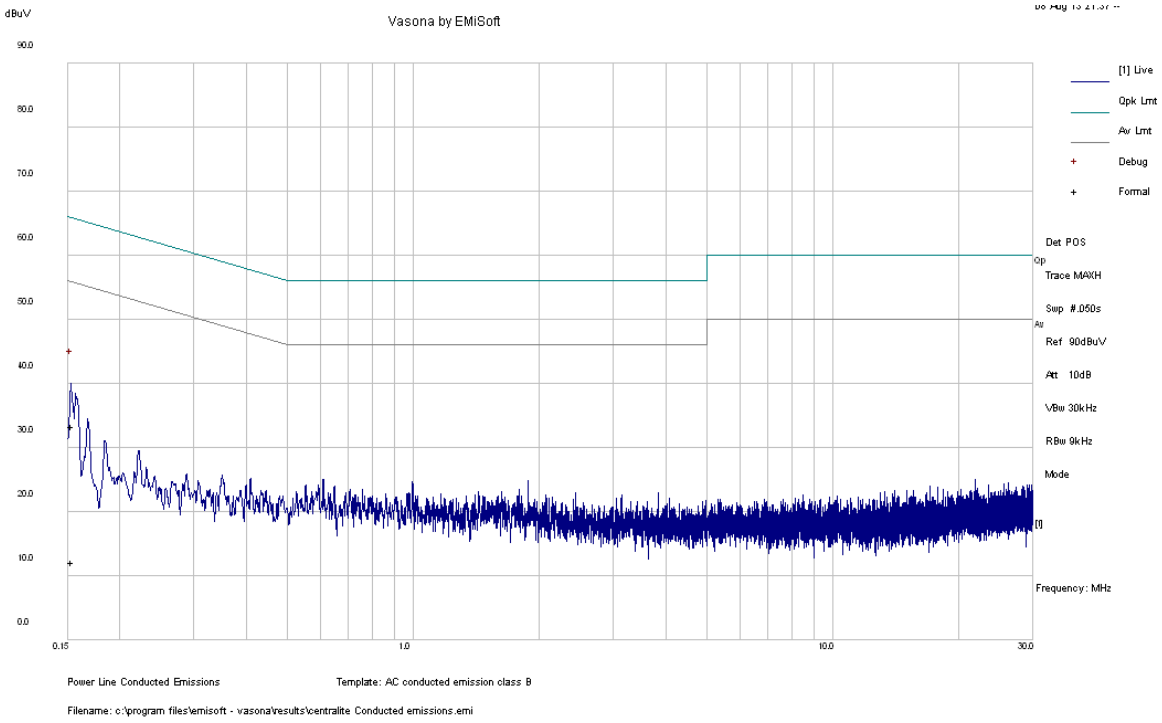
According to the recorded data in following table, the EUT complied with the FCC standard's conducted emissions limits, with the margin reading of:

Connection: Connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Line/Neutral)**	**Range (MHz)**
-32.4	0.153879	Line	0.15 - 30

6.8 Conducted Emissions Test Plots and Data

Transmitting Mode

120 V, 60 Hz – Line



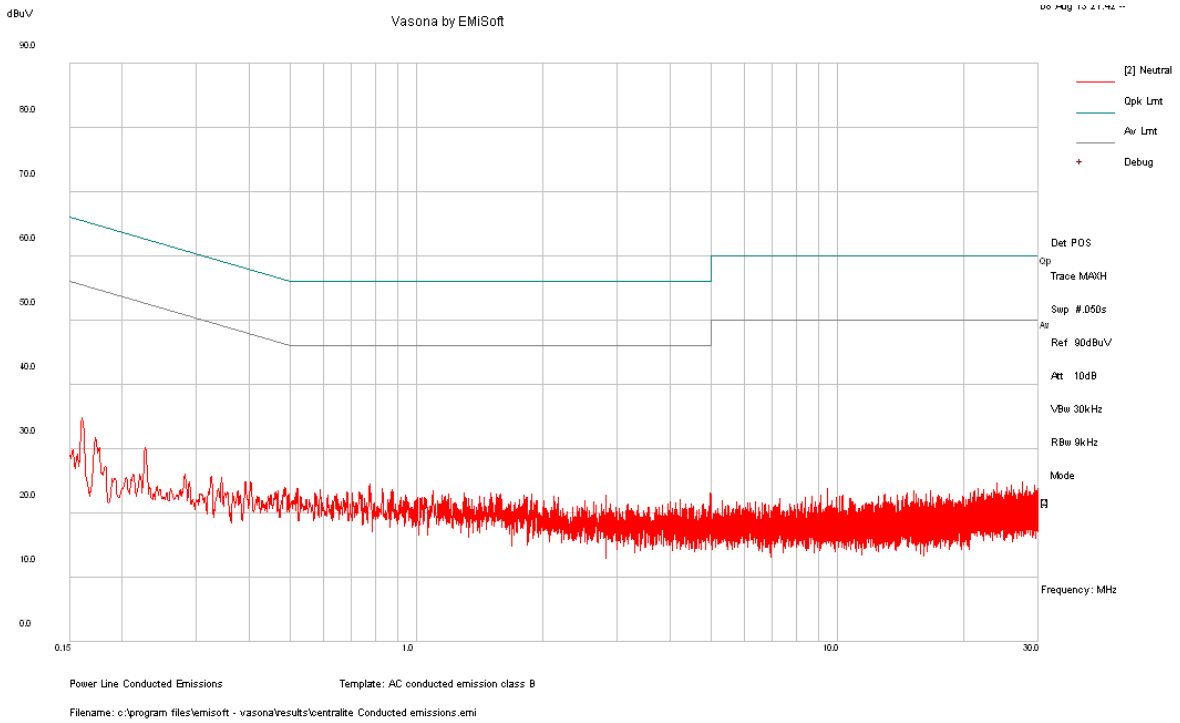
Quasi-Peak Measurements

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/ Neutral)	Limit (dBµV)	Margin (dB)
0.153879	33.39	Line	65.79	-32.4

Average Measurements

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/ Neutral)	Limit (dBµV)	Margin (dB)
0.153879	12.16	Line	55.79	-43.63

120 V, 60 Hz – Neutral



Quasi-Peak Measurements

Note: No peaks were found by the software.

Average Measurements

Note: No peaks were found by the software.

7 FCC §2.1051, §15.247(d) – Spurious Emissions at Antenna Terminals

7.1 Applicable Standard

For 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.

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
Agilent	Spectrum Analyzer	E4440A	US42221851	2013-03-05

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

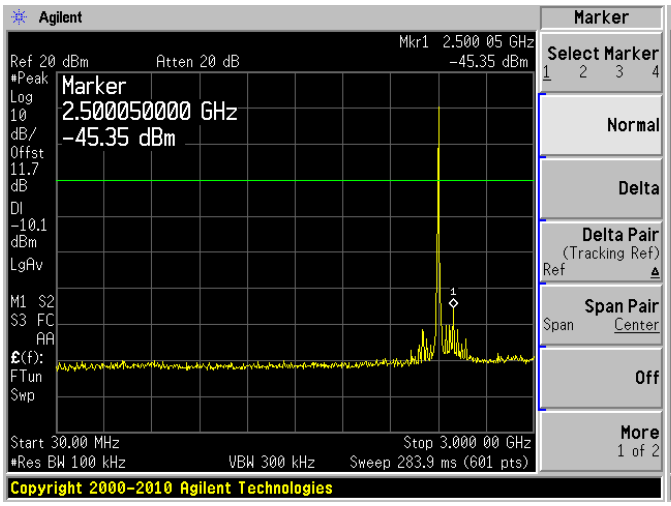
Temperature:	21 °C
Relative Humidity:	48 %
ATM Pressure:	101.1 kPa

The testing was performed by Lionel Lara on 2013-08-08 at the RF test site.

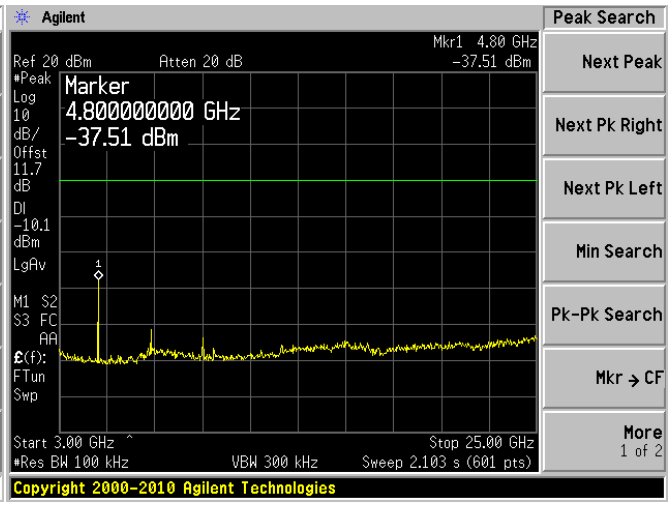
7.5 Test Results

Please refer to following plots of spurious emissions.

Low Channel, 2405 MHz

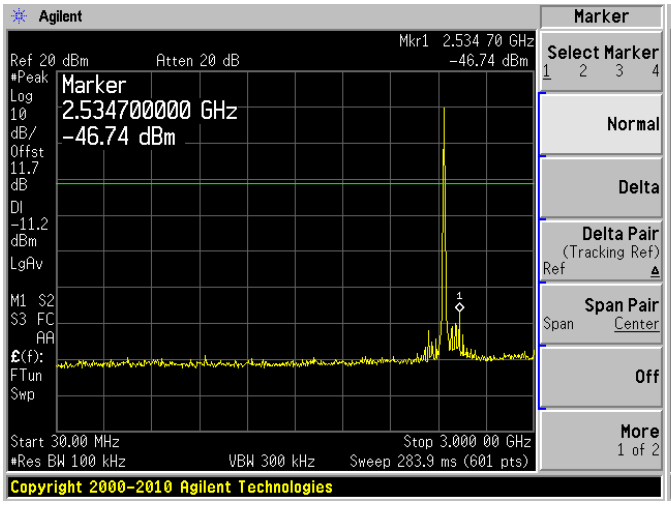


30 MHz to 3 GHz

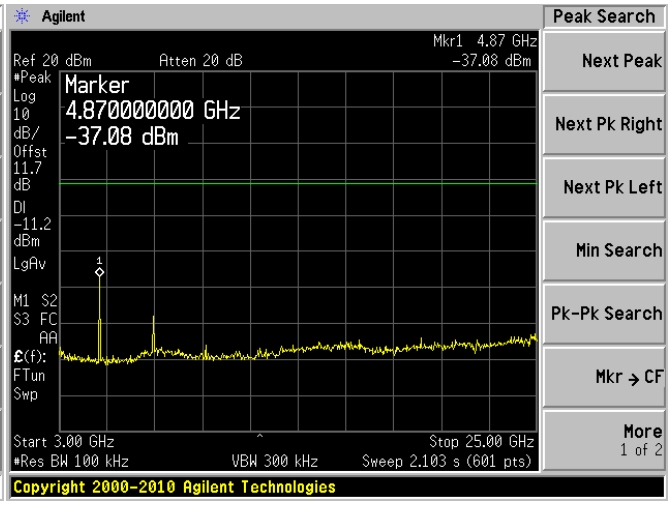


3 GHz to 25 GHz

Middle Channel, 2440 MHz

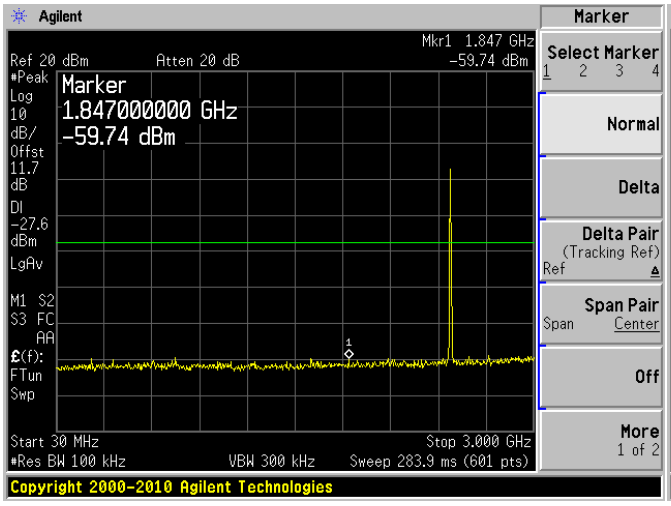


30 MHz to 3 GHz

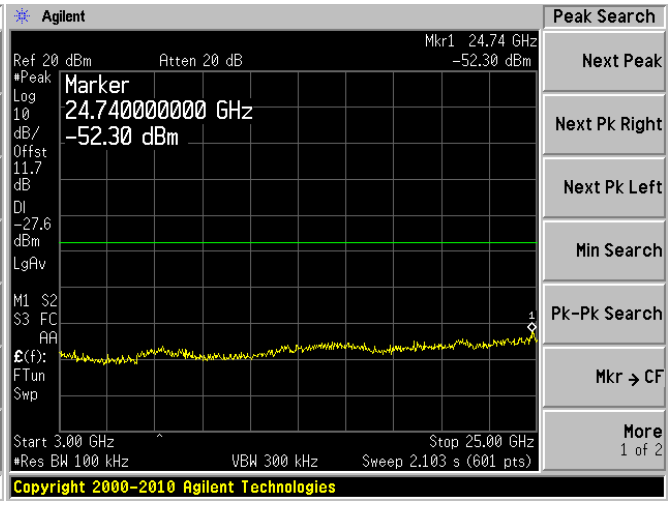


3 GHz to 25 GHz

High Channel, 2480 MHz



30 MHz to 3 GHz



3 GHz to 25 GHz

8 FCC §15.205, §15.209 & §15.247(d) – 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): 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).

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 limits.

The spacing between the peripherals was 3 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 = Corrected Amplitude - Limit

8.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4440A	US42221851	2013-03-05
Sunol Science Corp	System Controller	SC99V	122303-1	N/R
Sunol Science Corp	Combination Antenna	JB3	A020106-2	2012-08-15
Hewlett Packard	Pre-amplifier	8447D	2944A06639	2012-06-09
Mini-Circuits	Pre-amplifier	ZVA-183-S	570400946	2013-05-09
EMCO	Horn Antenna	3115	9511-4627	2012-10-17
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100338	2012-09-19

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

8.6 Test Environmental Conditions

Temperature:	21 °C
Relative Humidity:	48 %
ATM Pressure:	101.1 kPa

The testing was performed by Lionel Lara on 2013-08-08 at the 5 meter chamber 3.

8.7 Summary of Test Results

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

30-1000 MHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel**
-21.97	30.70025	Vertical	Middle

1 – 25 GHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel**
-0.33	2483.5	Vertical	High

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

8.8 Radiated Emissions Test Data

1) 30 MHz–1 GHz, Quasi-Peak, Measured at 3 meters

Low Channel

Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
136.669	12.11	254	V	343	43.5	-31.39

Middle Channel

Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
30.70025	18.03	143	V	360	40	-21.97

High Channel

Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
60.3405	6.44	99	V	159	40	-33.56
135.8343	11.19	351	H	298	43.5	-32.31

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		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2405 MHz, measured at 3 meters											
2405	83.32	280	100	V	28.96	2.94	0	115.22	Fund.	-	Peak
2405	73.63	145	100	H	28.96	2.94	0	105.53	Fund.	-	Peak
2405	81.06	280	100	V	28.96	2.94	0	112.96	Fund.	-	Ave
2405	71.93	145	100	H	28.96	2.94	0	103.83	Fund.	-	Ave
4810	52.87	225	100	V	33.08	4.06	27.78	62.23	74	-11.77	Peak
4810	47.9	56	100	H	33.08	4.06	27.78	57.26	74	-16.74	Peak
4810	43.45	225	100	V	33.08	4.06	27.78	52.81	54	-1.19	Ave
4810	37.54	56	100	H	33.08	4.06	27.78	46.9	54	-7.1	Ave
7215	41.86	89	154	V	35.93	4.93	27.59	55.13	74	-18.87	Peak
7215	39.48	141	100	H	35.93	4.93	27.59	52.75	74	-21.25	Peak
7215	31.01	89	154	V	35.93	4.93	27.59	44.28	54	-9.72	Ave
7215	28.26	141	100	H	35.93	4.93	27.59	41.53	54	-12.47	Ave
9620	40.29	30	100	V	37.95	5.82	27.02	57.04	74	-16.96	Peak
9620	37.46	2	100	H	37.95	5.82	27.02	54.21	74	-19.79	Peak
9620	29.14	30	100	V	37.95	5.82	27.02	45.89	54	-8.11	Ave
9620	25.88	2	100	H	37.95	5.82	27.02	42.63	54	-11.37	Ave
Middle Channel 2440 MHz, measured at 3 meters											
2440	80.32	281	100	V	28.96	2.94	0	112.22	Fund.	-	Peak
2440	70.91	139	100	H	28.96	2.94	0	102.81	Fund.	-	Peak
2440	77.93	281	100	V	28.96	2.94	0	109.83	Fund.	-	Ave
2440	68.27	139	100	H	28.96	2.94	0	100.17	Fund.	-	Ave
4880	53.17	181	100	V	33.33	4.1	27.67	62.93	74	-11.07	Peak
4880	51.31	294	108	H	33.33	4.1	27.67	61.07	74	-12.93	Peak
4880	43.43	181	100	V	33.33	4.1	27.67	53.19	54	-0.81	Ave
4880	41.37	294	108	H	33.33	4.1	27.67	51.13	54	-2.87	Ave
7320	41.66	71	134	V	36.36	4.88	27.51	55.39	74	-18.61	Peak
7320	41.9	141	146	H	36.36	4.88	27.51	55.63	74	-18.37	Peak
7320	30.76	71	134	V	36.36	4.88	27.51	44.49	54	-9.51	Ave
7320	30.79	141	146	H	36.36	4.88	27.51	44.52	54	-9.48	Ave
9760	36.35	48	100	V	38.29	5.77	26.98	53.43	74	-20.57	Peak
9760	35.71	308	100	H	38.29	5.77	26.98	52.79	74	-21.21	Peak
9760	24.62	48	100	V	38.29	5.77	26.98	41.7	54	-12.3	Ave
9760	23.98	308	100	H	38.29	5.77	26.98	41.06	54	-12.94	Ave

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Channel 2475 MHz, measured at 3 meters											
2475	83.36	281	100	V	29.16	3.01	0	115.53	Fund.	-	Peak
2475	78.17	48	100	H	29.16	3.01	0	110.34	Fund.	-	Peak
2475	80.8	281	100	V	29.16	3.01	0	112.97	Fund.	-	Ave
2475	75.73	48	100	H	29.16	3.01	0	107.9	Fund.	-	Ave
4950	54.13	336	100	V	33.46	4.21	27.7	64.1	74	-9.9	Peak
4950	52.61	151	101	H	33.46	4.21	27.7	62.58	74	-11.42	Peak
4950	43.59	336	100	V	33.46	4.21	27.7	53.56	54	-0.44	Ave
4950	42.52	151	101	H	33.46	4.21	27.7	52.49	54	-1.51	Ave
7425	45.47	276	100	V	36.51	4.89	27.53	59.34	74	-14.66	Peak
7425	50.01	107	131	H	36.51	4.89	27.53	63.88	74	-10.12	Peak
7425	34.47	276	100	V	36.51	4.89	27.53	48.34	54	-5.66	Ave
7425	38.7	107	131	H	36.51	4.89	27.53	52.57	54	-1.43	Ave
9900	38.14	118	100	V	38.54	5.92	27.01	55.59	74	-18.41	Peak
9900	37.1	270	108	H	38.54	5.92	27.01	54.55	74	-19.45	Peak
9900	26.66	118	100	V	38.54	5.92	27.01	44.11	54	-9.89	Ave
9900	25.6	270	108	H	38.54	5.92	27.01	43.05	54	-10.95	Ave

Note: The channel (2475 MHz) before the highest channel (2480 MHz) was tested to show compliance at a higher power setting.

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
High Channel 2480 MHz, measured at 3 meters											
2480	61.87	282	100	V	29.16	3.01	0	94.04	Fund.	-	Peak
2480	55.9	300	100	H	29.16	3.01	0	88.07	Fund.	-	Peak
2480	59.54	282	100	V	29.16	3.01	0	91.71	Fund.	-	Ave
2480	52.98	300	100	H	29.16	3.01	0	85.15	Fund.	-	Ave
4960	52.85	180	100	V	33.46	4.21	27.7	62.82	74	-11.18	Peak
4960	51.87	295	107	H	33.46	4.21	27.7	61.84	74	-12.16	Peak
4960	43.01	180	100	V	33.46	4.21	27.7	52.98	54	-1.02	Ave
4960	41.94	295	107	H	33.46	4.21	27.7	51.91	54	-2.09	Ave
7440	43.74	68	100	V	36.51	4.89	27.53	57.61	74	-16.39	Peak
7440	44.98	119	127	H	36.51	4.89	27.53	58.85	74	-15.15	Peak
7440	32.53	68	100	V	36.51	4.89	27.53	46.4	54	-7.6	Ave
7440	34.38	119	127	H	36.51	4.89	27.53	48.25	54	-5.75	Ave
9920	34.35	208	100	V	38.54	5.92	27.01	51.8	74	-22.2	Peak
9920	34.45	110	100	H	38.54	5.92	27.01	51.9	74	-22.1	Peak
9920	21.98	208	100	V	38.54	5.92	27.01	39.43	54	-14.57	Ave
9920	22.17	110	100	H	38.54	5.92	27.01	39.62	54	-14.38	Ave

Note: The harmonics for the high channel were tested at a higher power setting than the restricted band edge.

3) Restricted Band Edge, 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		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2405 MHz, measured at 3 meters											
2390	30.64	280	100	V	28.96	2.94	0	62.54	74	-11.46	Peak
2390	28.08	145	100	H	28.96	2.94	0	59.98	74	-14.02	Peak
2390	18.56	280	100	V	28.96	2.94	0	50.46	54	-3.54	Ave
2390	14.77	145	100	H	28.96	2.94	0	46.67	54	-7.33	Ave
High Channel 2480 MHz, measured at 3 meters											
2483.5	33.34	282	100	V	29.16	3.01	0	65.51	74	-8.49	Peak
2483.5	31.2	300	100	H	29.16	3.01	0	63.37	74	-10.63	Peak
2483.5	21.5	282	100	V	29.16	3.01	0	53.67	54	-0.33	Ave
2483.5	17.67	300	100	H	29.16	3.01	0	49.84	54	-4.16	Ave

Note: The restricted band edge for the high channel was tested at a lower power setting due to failure.

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Channel 2475 MHz, measured at 3 meters											
2483.5	33.58	281	100	V	29.16	3.01	0	65.75	74	-8.25	Peak
2483.5	31.67	48	100	H	29.16	3.01	0	63.84	74	-10.16	Peak
2483.5	21.15	281	100	V	29.16	3.01	0	53.32	54	-0.68	Ave
2483.5	18.35	48	100	H	29.16	3.01	0	50.52	54	-3.48	Ave

Note: The channel (2475 MHz) before the highest channel (2480 MHz) was tested to show compliance at a higher power setting.

9 FCC§15.247(a) (2) – 6 dB & 99% Emission Bandwidth

9.1 Applicable Standard

According to FCC §15.247(a) (2): 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
Agilent	Spectrum Analyzer	E4440A	US42221851	2013-03-05

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

9.4 Test Environmental Conditions

Temperature:	21 °C
Relative Humidity:	48 %
ATM Pressure:	101.1 kPa

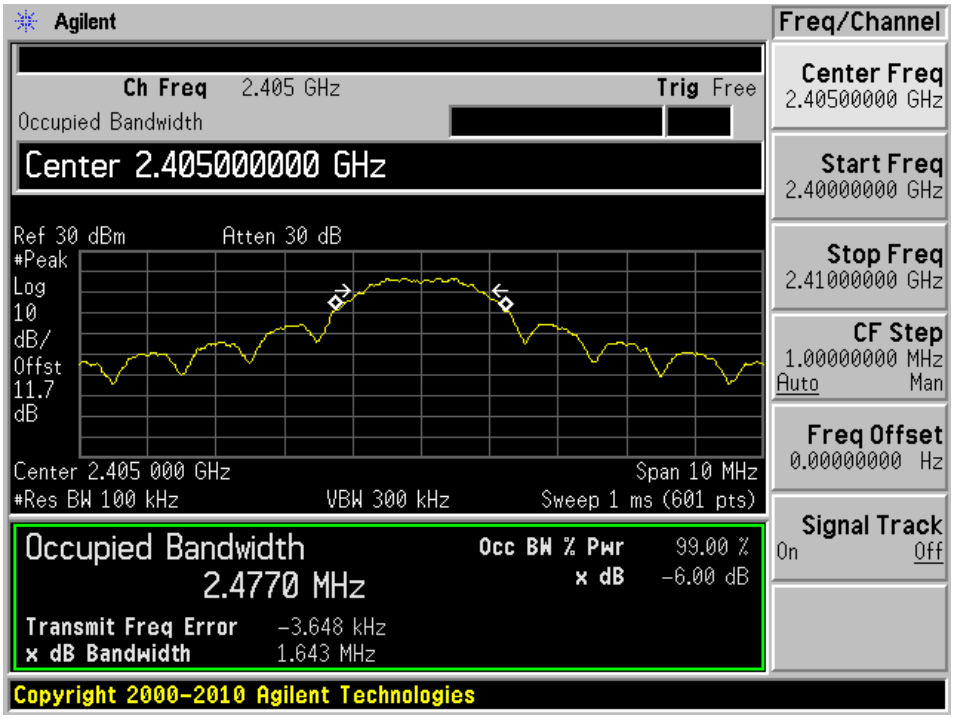
The testing was performed by Lionel Lara on 2013-08-08 at the RF test site.

9.5 Test Results

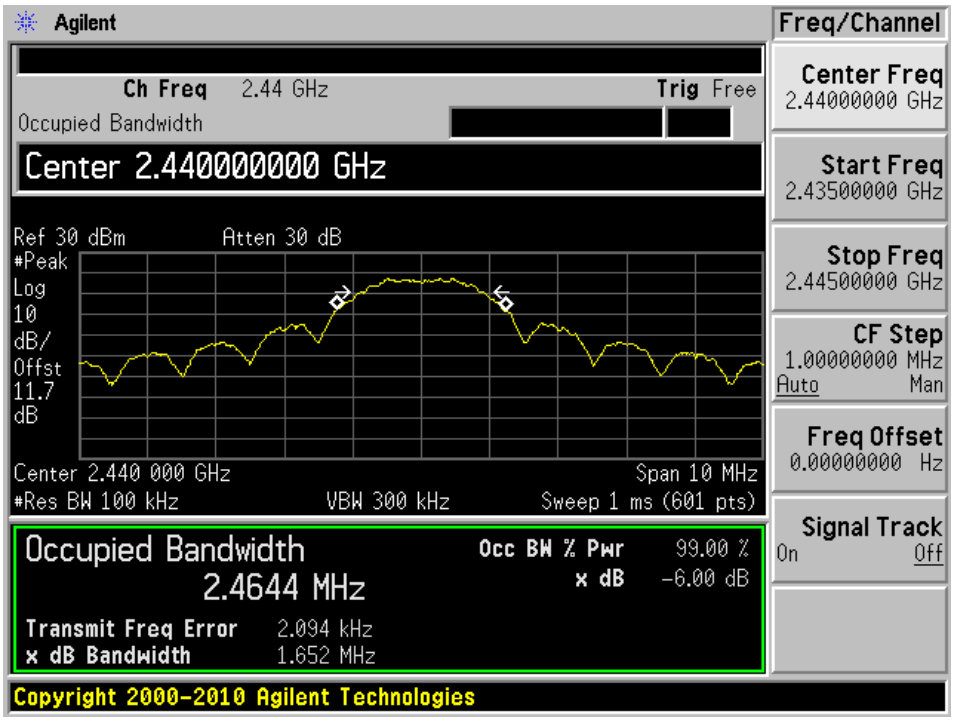
Frequency (MHz)	6 dB Emission Bandwidth (MHz)	99% Emission Bandwidth (MHz)	6 dB OBW Limit (MHz)	Results
2405	1.643	2.4770	0.5	Pass
2440	1.652	2.4644	0.5	Pass
2480	1.631	2.481	0.5	Pass

Please refer to the following plots for detailed test results.

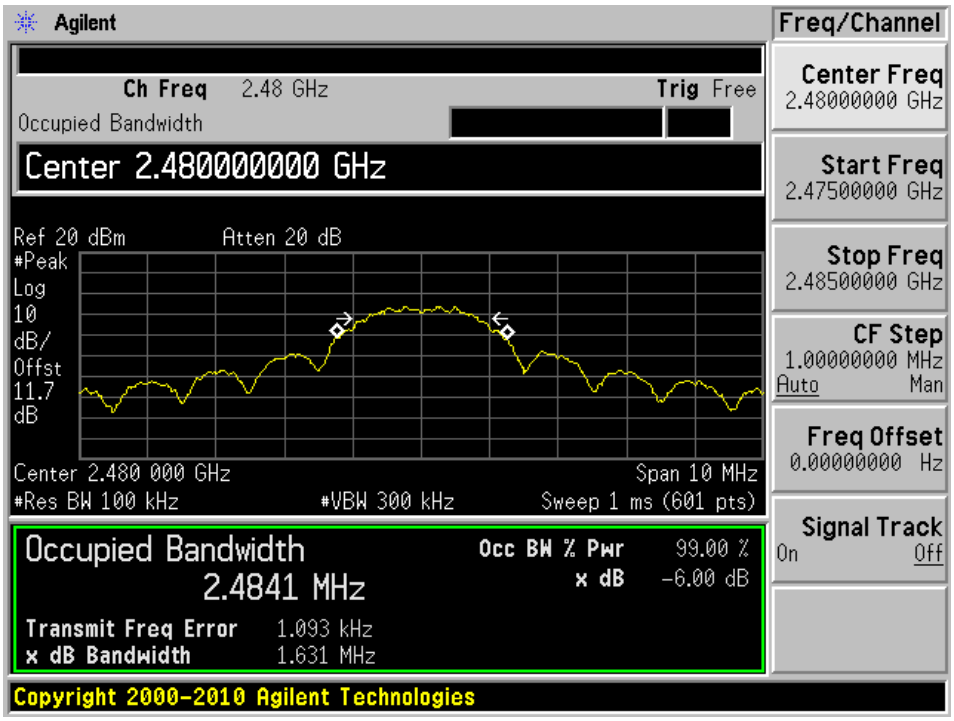
Low Channel, 2405 MHz



Middle Channel, 2440 MHz



High Channel, 2480 MHz



10 FCC §15.247(b) – Peak Output Power Measurement

10.1 Applicable Standard

According to FCC §15.247(b): The maximum peak conducted output power of the intentional radiator, for systems using digital modulation in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands, shall not exceed 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	E4440A	US42221851	2013-03-05	1 year

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

10.4 Test Environmental Conditions

Temperature:	21 °C
Relative Humidity:	48 %
ATM Pressure:	101.1 kPa

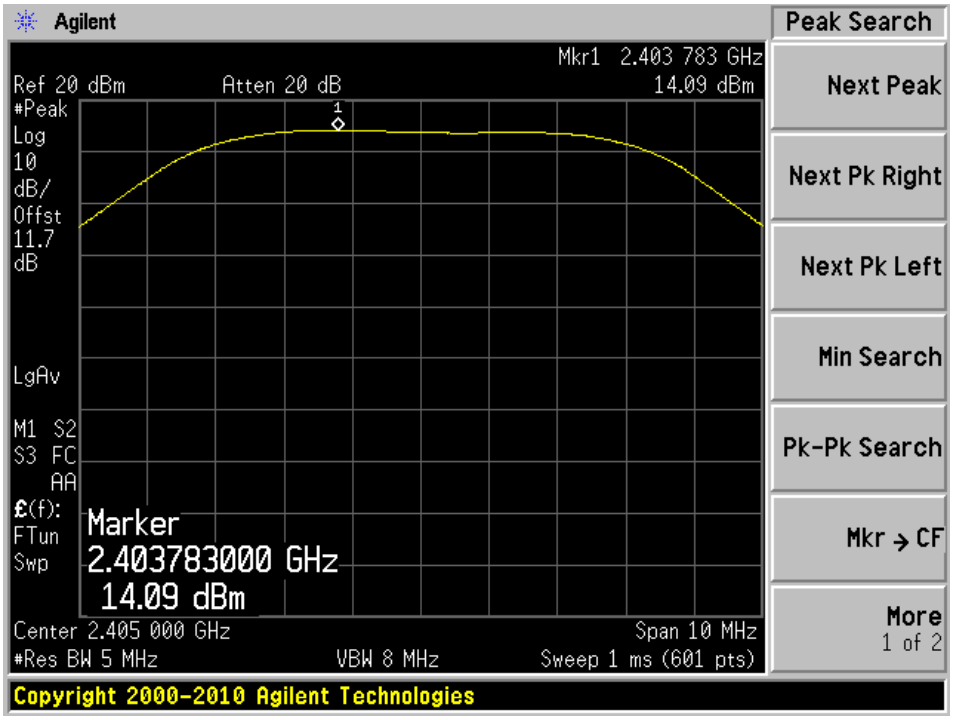
The testing was performed by Lionel Lara on 2013-08-08 at the RF test site.

10.5 Test Results

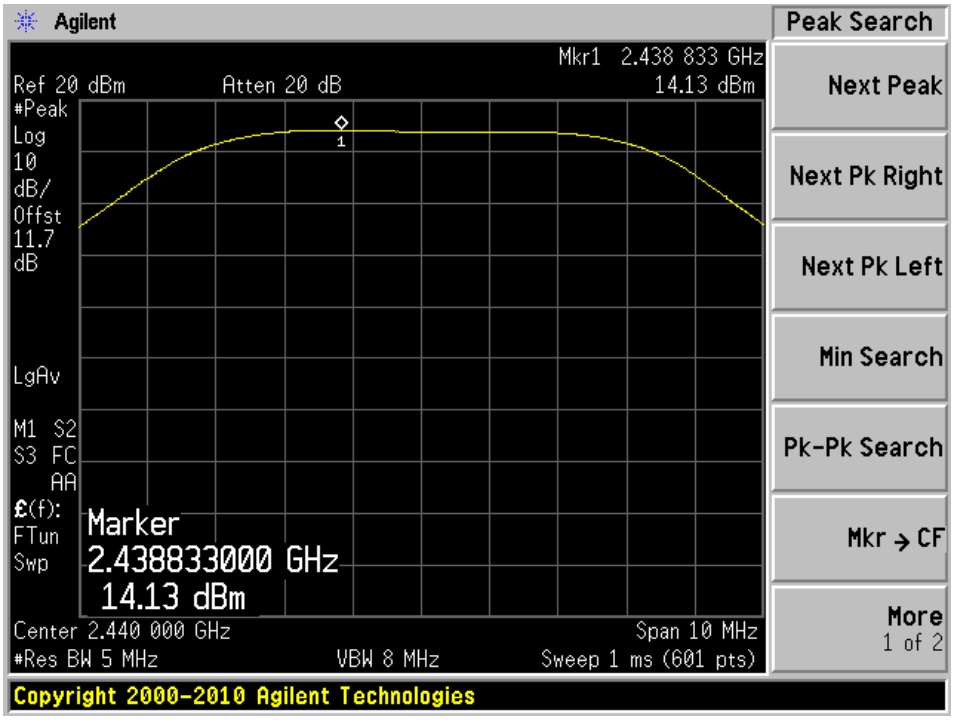
Frequency (MHz)	Conducted Output Power (dBm)	Limit (dBm)	Margin (dB)
2405	14.09	30	-15.91
2440	14.13	30	-15.87
2475	14.60	30	-15.40
2480	-2.29	30	-32.29

Note: The channel (2475MHz) before the highest channel (2480MHz) was tested to show compliance at a power setting comparable to the low and middle channels. The low power at the highest channel is due to failure at the radiated band edge.

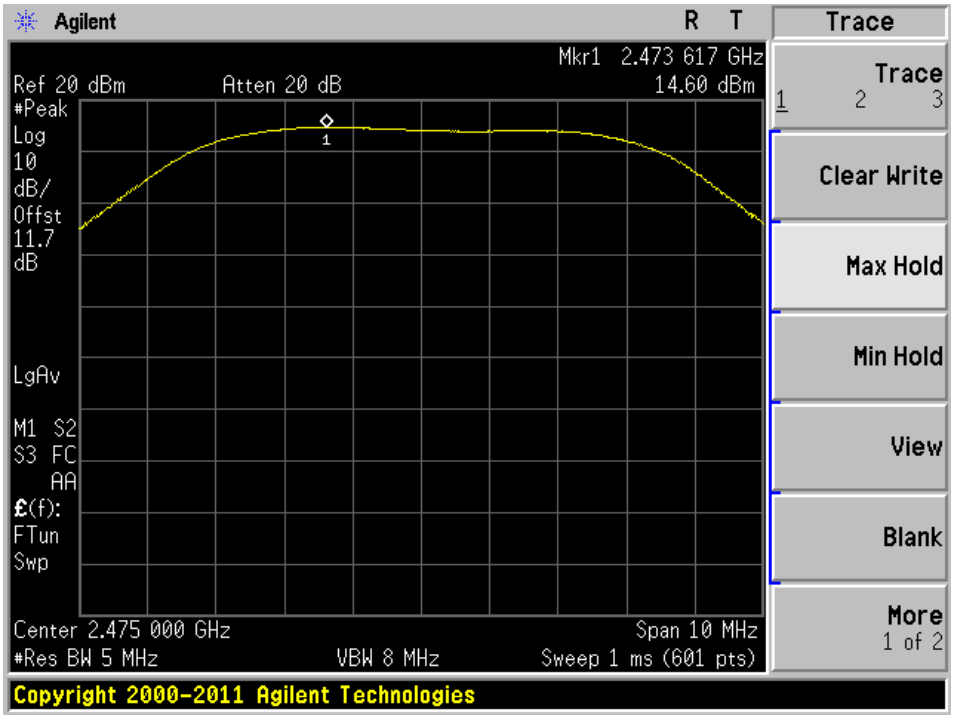
Low Channel, 2405 MHz



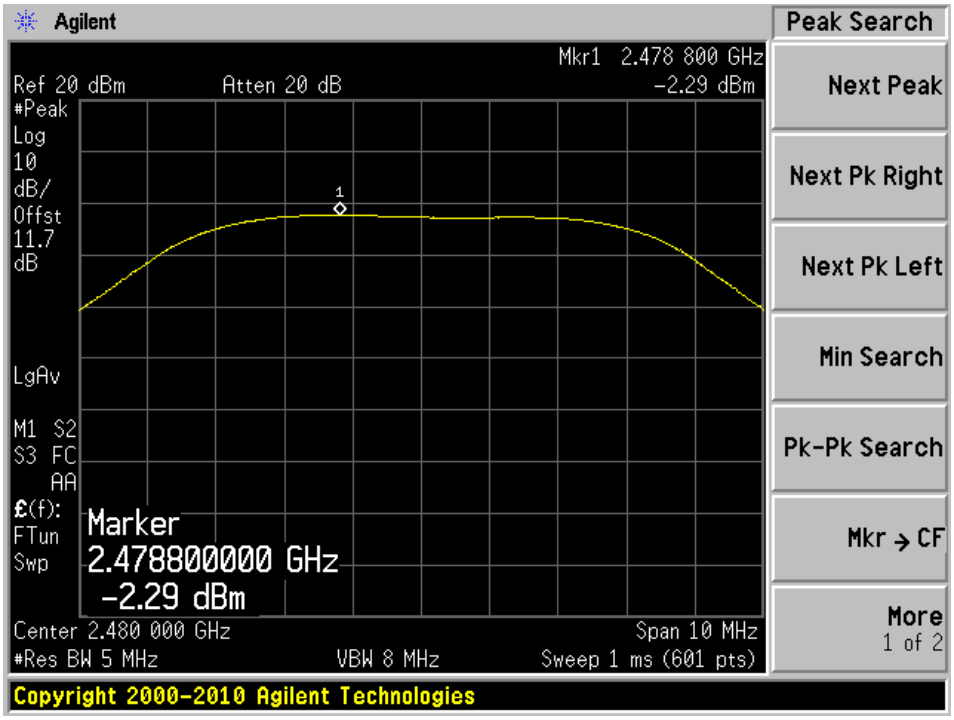
Middle Channel, 2440 MHz



Channel 25, f=2475 MHz



High Channel, 2480 MHz



11 FCC §15.247(d) – 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).

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	E4440A	US42221851	2013-03-05	1 year

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

11.4 Test Environmental Conditions

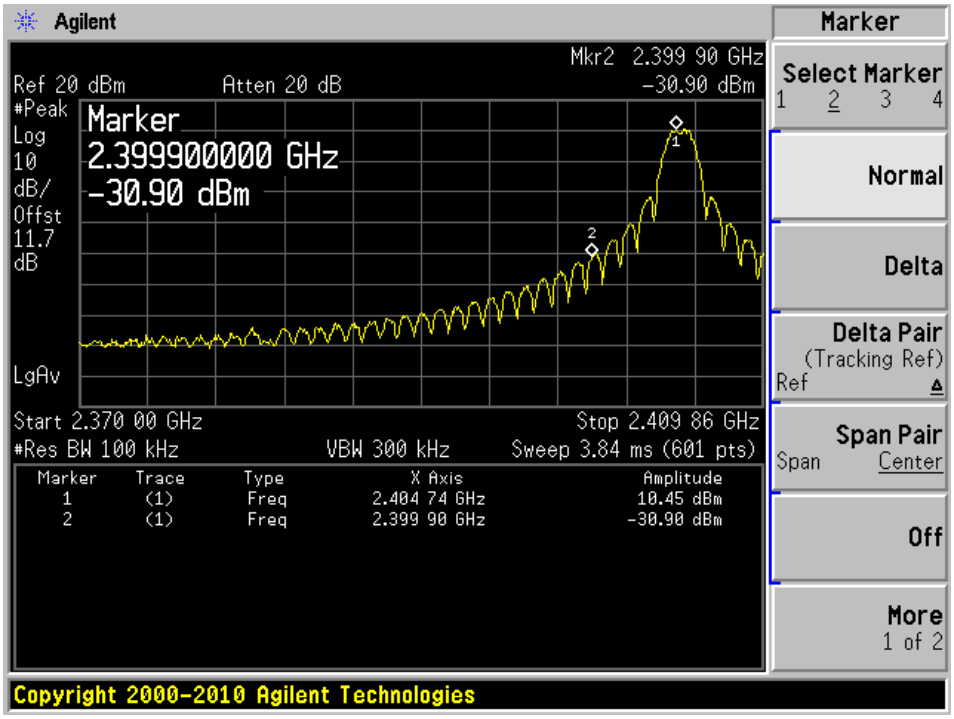
Temperature:	21 °C
Relative Humidity:	48 %
ATM Pressure:	101.1 kPa

The testing was performed by Lionel Lara on 2013-08-08 at the RF test site.

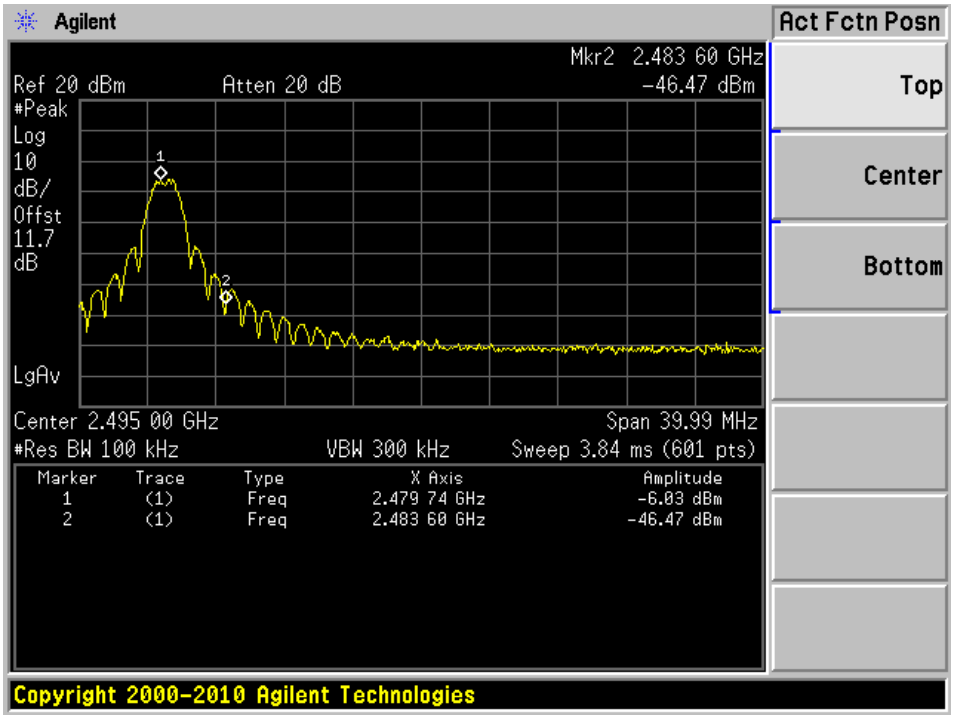
11.5 Test Results

Please refer to following pages for plots of band edge.

Low Channel, 2405 MHz



High Channel, 2480 MHz



12 FCC §15.247(e) – Power Spectral Density

12.1 Applicable Standard

According to FCC §15.247(e): 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	E4440A	US42221851	2013-03-05	1 year

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

12.4 Test Environmental Conditions

Temperature:	21 °C
Relative Humidity:	48 %
ATM Pressure:	101.1 kPa

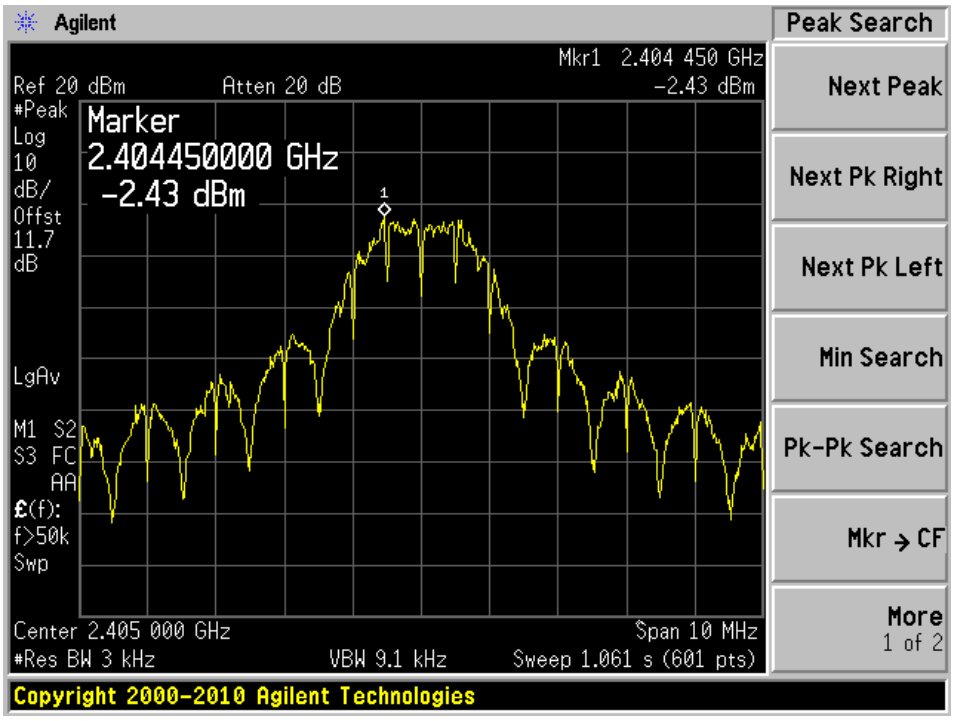
The testing was performed by Lionel Lara on 2013-08-08 at the RF test site.

12.5 Test Results

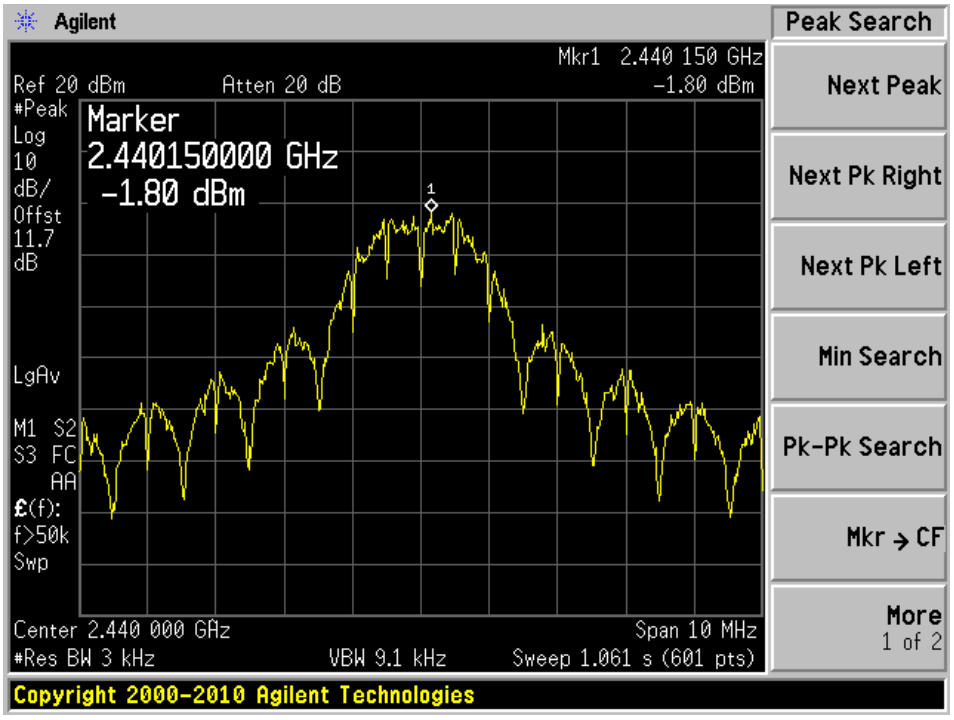
Frequency (MHz)	Power Spectral Density (dBm)	Limit (dBm)	Result
2405	-2.43	8	Pass
2440	-1.80	8	Pass
2480	-18.11	8	Pass

Please refer to the following plots for detailed test results:

Low Channel, 2405 MHz



Middle Channel, 2440 MHz



High Channel, 2480 MHz