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IC RSS-210, ISSUE 8, DECEMBER 2010

TEST AND MEASUREMENT REPORT

For

CentraLite Systems, Inc.

1000 Cody Road, Suite A, Mobile, Alabama 36695, USA

FCC ID: T3L-SS003
IC: 12192A-SS003

Report Type:	**Product Type:**
Original Report	ZigBee Garage Door Controller

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1411172-247	Initial Report	2015-02-11

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-SS003, IC: 12192A-SS003; model: 3221, or the "EUT" (Equipment Under Testing) as referred to in this report. The EUT is a Zigbee Garage Door Controller operates in 2.4 GHz ISM band.

1.2 Mechanical Description of EUT

The EUT measures approximately 17.78 cm (L) x 17.78 cm (W) x 5.9 cm (H) and weighs 2.3 kg.

Note: The EUT was tested without enclosure.

The test data gathered are from typical production sample, serial number: 3320 assigned by Client.

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 Commissions rules and IC RSS-210, Issue 8,

The objective is to determine compliance with FCC Part 15.247 rules 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)

Sensor with FCC ID: T3L-SS004, IC: 12192A-SS004.

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 v03r02: 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.

The following calculation follows the procedures as set forth in clause 7.2.3, ETSI TR 100 028-1 V1.4.1 (2001-12), the expression of Uncertainty in Radiated RF Testing is in accordance to ISO/IEC 17025 and TR 100 028-1 V1.4.1 (2001-12).

The expanded Measurement Uncertainty value having a confidence factor of 95%, is within a range of 5.48 dB. This means that the value of conducted RF carrier power test will be within +/- 2.74 dB of the measuring radiated emissions power versus the expected value.
The expected value is defined as the power at the antenna of the Transmitter under Test.

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 C63.10-2009 and FCC KDB 558074 D01 DTS Meas Guidance v03r02.

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

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

EUT was exercised using putty.exe.

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
Dell	Laptop	Latitude D160	-
Silicon Labs	Debug Adapter	ISA3	-

2.6 EUT Internal Configuration Details

Manufacturer	Description	Model	Serial Number
Silicon Labs	ZigBee Radio with power amplifier	EM357/SE2432L	-
Silicon Labs	FM Receiver	Si4355	-
Power Integration	Series AC/DC Converters	LNK305 & LNK306	-
Cirrus Logic	Two Channel Energy Measurement IC	CS5490	-

2.7 Interface Ports and Cables

Description	Length	From	To
Ethernet Cable	1m	Laptop	Debug Adapter
Ethernet Cable	1m	Debug Adapter	EUT

2.8 Power Supply List and Details

Manufacturer	Description	Model	Serial Number
CentraLite System	Power cord	-	-

3 Summary of Test Results

Results reported relate only to the product tested.

FCC/IC Rules	Description of Test	Results
FCC §15.247(i), §2.1091 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	N/A [1]
FCC §15.205 IC RSS-210 §2.2	Restricted Bands	Compliant
FCC §15.209, §15.247 (d) IC RSS-210 §A8.5	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

4 FCC §15.247(i), §2.1091 & IC RSS-102 – RF Exposure

4.1 Applicable Standards

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

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

According to IC RSS-102 Issue 2 section 4.1, 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)	Time Averaging (min)
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

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):	1.819
Maximum peak output power at antenna input terminal (mW):	1.520
Prediction distance (cm):	20
Prediction frequency (MHz):	2480
Maximum Antenna Gain, typical (dBi):	0.77
Maximum Antenna Gain (numeric):	1.194
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.000361
Power density of prediction frequency at 20.0 cm (W/m^2):	0.003611
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

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.000361mW/cm^2 (0.003611 W/m^2). Limit is 1.0 mW/cm^2 (10 W/m^2).

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

5.1 Applicable Standards

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.

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.

Note: The power setting was controlled by manufacture with different antenna configuration. The power setting of the different antenna will be set with the corresponded value and no more than the level reported.

5.2 Antenna Description

The EUT uses a PCB antenna, which complies with the antenna requirement. And the antenna gain is 0.77 dBi. Please refer to the internal photos.

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 Note	56 to 46 Note
0.5-5	56	46
5-30	60	50

Note: Decreases with the logarithm of the frequency.

6.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.10-2009 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-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 Cable Loss (CL), the Attenuator Factor (Atten) to indicated Amplitude (Ai) reading. The basic equation is as follows:

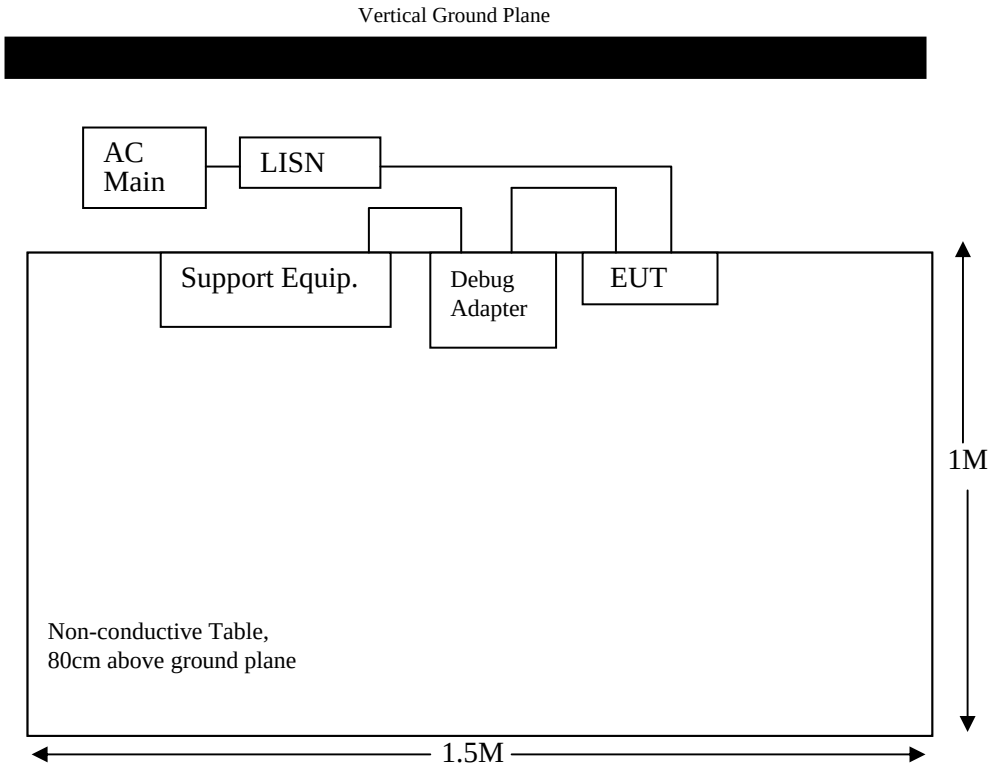
CA = Ai + CL + Atten

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

6.5 Test Setup Block Diagram



6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100044	2014-07-17	1 year
Solar Electronics	LISN, EMC	9252-50-R-24-N	511205	2014-06-25	1 year
TTE	Filter, High Pass	H985-150k-50-720N	M1195	2014-06-13	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:	17 º C
Relative Humidity:	55 %
ATM Pressure:	103.1-104.1 kPa

The testing was performed by Todd Moy on 2015-01-14 in 5m chamber 3.

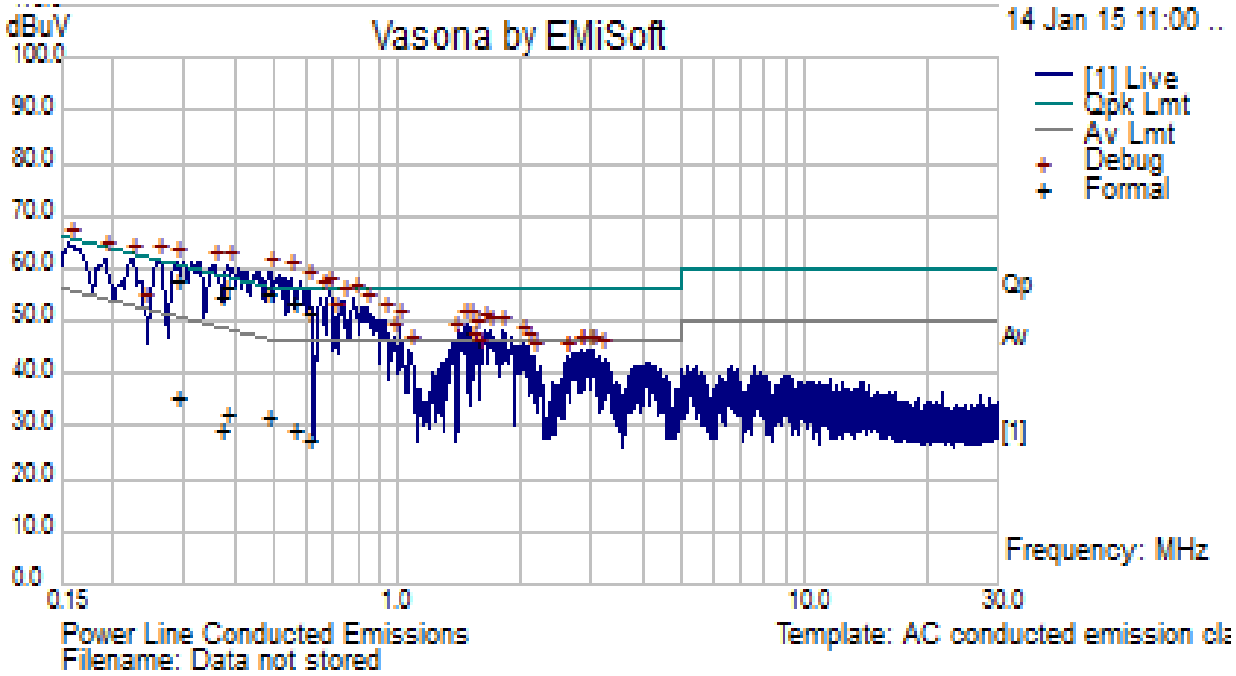
6.8 Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC 15C and IC RSS-Gen standard's conducted emissions limits, with the margin reading of:

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Line/Neutral)**	**Range (MHz)**
-1.18	0.481323	Line	0.15-30

6.9 Conducted Emissions Test Plots and Data

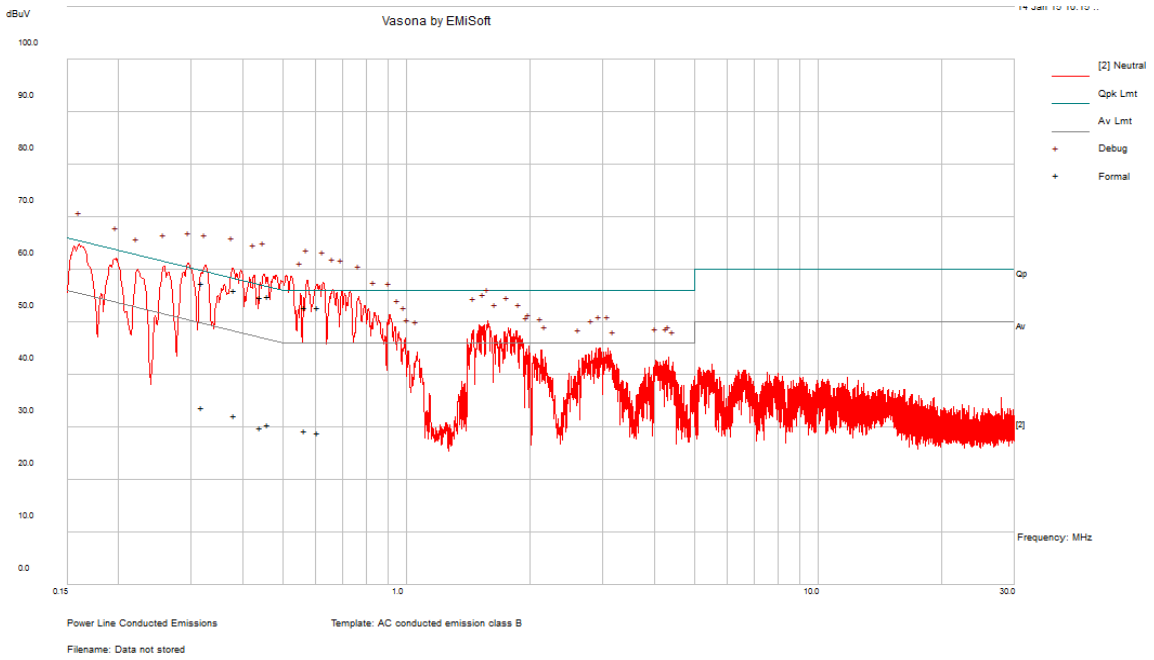
120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.481323	55.13	Line	56.32	-1.18	QP
0.381432	56.52	Line	58.25	-1.73	QP
0.553806	53.12	Line	56	-2.88	QP
0.287427	57.57	Line	60.6	-3.03	QP
0.364821	54.75	Line	58.62	-3.87	QP
0.605082	51.50	Line	56	-4.50	QP

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.481323	31.52	Line	46.32	-14.79	Ave.
0.287427	35.20	Line	50.60	-15.40	Ave.
0.381432	32.35	Line	48.25	-15.90	Ave.
0.553806	29.32	Line	46.00	-16.68	Ave.
0.605082	27.52	Line	46.00	-18.48	Ave.
0.364821	29.44	Line	48.62	-19.18	Ave.

120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.460848	54.98	Neutral	56.68	-1.70	QP
0.381321	56.11	Neutral	58.25	-2.14	QP
0.441285	54.70	Neutral	57.04	-2.34	QP
0.318963	57.34	Neutral	59.73	-2.40	QP
0.565572	52.85	Neutral	56.00	-3.15	QP
0.610848	52.76	Neutral	56.00	-3.24	QP

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Detector (QP/Ave.)
0.318963	33.73	Neutral	49.73	-16.00	Ave.
0.381321	32.24	Neutral	48.25	-16.01	Ave.
0.460848	30.55	Neutral	46.68	-16.13	Ave.
0.565572	29.41	Neutral	46.00	-16.59	Ave.
0.610848	28.94	Neutral	46.00	-17.06	Ave.
0.441285	29.92	Neutral	47.04	-17.12	Ave.

7 FCC §15.209 & §15.247(d) & IC RSS-210 A8.5 – Spurious Radiated Emissions

7.1 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 Out-of-band Emissions, 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.

7.2 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.

7.3 Test Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v03r02: 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 allinstallation 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 = 3MHz / Sweep = Auto
(2) Average: RBW = 1MHz / VBW = 10Hz / Sweep = Auto

7.4 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

7.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Sunol Sciences	System Controller	SC99V	122303-1	N/R	N/R
Sunol Sciences	Antenna, Biconi-Log	JB3	A020106-2	2014-09-17	1 year
Hewlett Packard	Amplifier, Pre	8447D	2944A07030	2014-04-26	1 year
HP/ Agilant	Pre Amplifier	8449B OPT HO2	3008A0113	2014-03-10	1year
Agilent	Analyzer, Spectrum	E4440A	MY44303352	2014-11-13	1 year
Eaton	Antenna, Horn	96001	2617	2014-11-18	1 year
Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100044	2014-07-17	1 year

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

7.6 Test Environmental Conditions

Temperature:	17 ºC
Relative Humidity:	55 %
ATM Pressure:	101.9 kPa

The testing was performed by Todd Moy on 2015-01-12 in 5 m chamber 3.

7.7 Summary of Test Results

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

30-1000 MHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Range (MHz)**
-7.82	49.7125	Vertical	30-1000 MHz

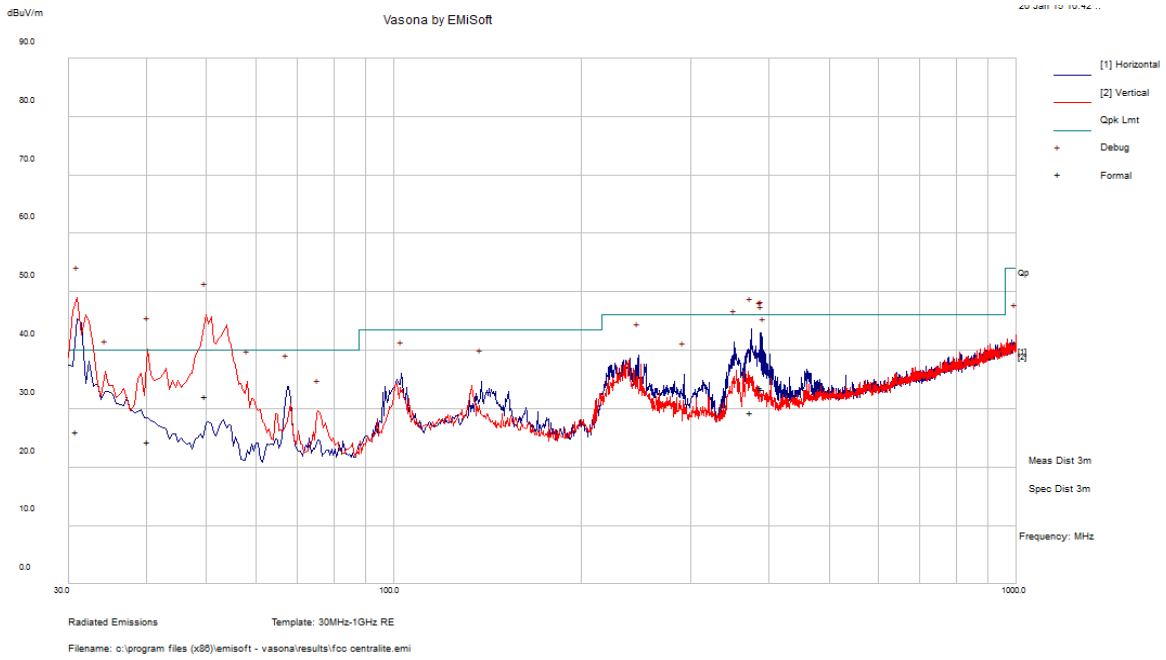
Above 1 GHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Range (MHz)**
-2.443	2483.5	Vertical	1000-25000

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

7.8 Radiated Emissions Test Results

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



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comments (PK/QP/Ave)
49.713	32.18	114	V	218	40	-7.82	QP
387.810	33.71	101	H	136	46	-12.29	QP
389.449	33.40	105	H	113	46	-12.60	QP
30.959	26.02	382	V	189	40	-13.98	QP
40.3053	24.39	101	V	310	40	-15.61	QP
374.955	29.31	218	H	231	46	-16.69	QP

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)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2405 MHz, measured at 3 meters											
2405	65.86	46	100	V	28.348	2.865	0	97.073	-	-	Peak
2405	63.26	39	153	H	28.200	2.865	0	94.325	-	-	Peak
2405	63.39	45	100	V	28.348	2.865	0	94.603	-	-	Ave
2405	60.23	40	146	H	28.200	2.865	0	91.295	-	-	Ave
2390	22.87	46	100	V	28.348	2.865	0	54.083	74	-19.917	Peak
2390	22.6	39	153	H	28.200	2.865	0	53.665	74	-20.335	Peak
2390	12.58	45	100	V	28.348	2.865	0	43.793	54	-10.207	Ave
2390	12.47	40	146	H	28.200	2.865	0	43.535	54	-10.465	Ave
4810	51.97	303	100	V	32.891	4.297	35.858	53.300	74	-20.700	Peak
4810	53.25	0	100	H	32.739	4.297	35.858	54.428	74	-19.572	Peak
4810	38.19	37	100	V	32.891	4.297	35.858	39.520	54	-14.480	Ave
4810	41.94	0	100	H	32.739	4.297	35.858	43.118	54	-10.882	Ave
7215	44.87	0	100	V	36.252	5.675	36.011	50.786	77.073	-26.287	Peak
7215	46.47	0	100	H	36.141	5.675	36.011	52.275	74.325	-22.050	Peak
7215	32.7	0	100	V	36.252	5.675	36.011	38.616	74.603	-35.987	Ave
7215	32.71	0	100	H	36.141	5.675	36.011	38.515	71.295	-32.780	Ave
9620	45.87	0	100	V	38.001	8.704	36.044	56.530	77.073	-20.542	Peak
9620	46.63	0	100	H	37.918	8.704	36.044	57.207	74.325	-17.117	Peak
9620	32.98	0	100	V	38.001	8.704	36.044	43.640	74.603	-30.962	Ave
9620	32.95	0	100	H	37.918	8.704	36.044	43.527	71.295	-27.767	Ave
Middle Channel 2440 MHz, measured at 3 meters											
2440	62.94	152	108	V	28.348	2.865	0	94.153	-	-	Peak
2440	62.6	43	152	H	28.200	2.865	0	93.665	-	-	Peak
2440	64.13	47	100	V	28.348	2.865	0	95.343	-	-	Ave
2440	61.48	42	143	H	28.200	2.865	0	92.545	-	-	Ave
4880	60.63	149	100	V	33.295	4.404	35.896	62.433	74	-11.567	Peak
4880	54.75	167	108	H	32.932	4.404	35.896	56.190	74	-17.810	Peak
4880	40.69	185	100	V	33.295	4.404	35.896	42.493	54	-11.507	Ave
4880	39.67	125	114	H	32.932	4.404	35.896	41.110	54	-12.890	Ave
7320	46.35	0	100	V	36.694	5.788	35.958	52.874	74	-21.126	Peak
7320	44.62	0	100	H	36.575	5.788	35.958	51.025	74	-22.975	Peak
7320	32.14	0	100	V	36.694	5.788	35.958	38.664	54	-15.336	Ave
7320	32.08	0	100	H	36.575	5.788	35.958	38.485	54	-15.515	Ave
9760	47.02	0	100	V	38.128	8.157	36.032	57.274	74.153	-16.879	Peak
9760	46.81	0	100	H	37.896	8.157	36.032	56.832	73.665	-16.833	Peak
9760	33.05	0	100	V	38.128	8.157	36.032	43.304	75.343	-32.039	Ave
9760	33.01	0	100	H	37.896	8.157	36.032	43.032	72.545	-29.513	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	70.25	64	100	V	28.607	2.950	0	101.807	-	-	Peak
2480	66.12	41	124	H	28.515	2.950	0	97.585	-	-	Peak
2480	67.89	65	100	V	28.607	2.950	0	99.447	-	-	Ave
2480	63.49	42	119	H	28.515	2.950	0	94.955	-	-	Ave
2483.5	40	64	100	V	28.607	2.950	0	71.557	74	-2.443	Peak
2483.5	37	40	125	H	28.515	2.950	0	68.465	74	-5.535	Peak
2483.5	18.25	65	100	V	28.607	2.950	0	49.807	54	-4.193	Ave
2483.5	16.16	42	100	H	28.515	2.950	0	47.625	54	-6.375	Ave
4960	52.8	81	146	V	33.315	4.485	35.909	54.691	74	-19.309	Peak
4960	53.6	236	153	H	33.240	4.485	35.909	55.416	74	-18.584	Peak
4960	40.51	80	119	V	33.315	4.485	35.909	42.401	54	-11.599	Ave
4960	41.22	194	156	H	33.240	4.485	35.909	43.036	54	-10.964	Ave
7440	46.02	0	100	V	36.883	5.869	35.963	52.809	74	-21.191	Peak
7440	46.38	0	100	H	36.756	5.869	35.963	53.042	74	-20.958	Peak
7440	34	302	147	V	36.883	5.869	35.963	40.789	54	-13.211	Ave
7440	31.85	0	100	H	36.756	5.869	35.963	38.512	54	-15.488	Ave
9920	47.27	0	100	V	38.364	7.444	35.976	57.102	81.807	-24.705	Peak
9920	45.59	0	100	H	38.373	7.444	35.976	55.431	77.585	-22.154	Peak
9920	32.95	0	100	V	38.364	7.444	35.976	42.782	79.447	-36.665	Ave
9920	32.28	0	100	H	38.373	7.444	35.976	42.121	74.955	-32.834	Ave

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

8.1 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

8.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Sunol Sciences	System Controller	SC99V	122303-1	N/R	N/R
Agilent	Analyzer, Spectrum	E4440A	MY44303352	2014-11-13	1 year
A.R.A.	Horn Antenna	DRG-118A	1132	2014-01-30	1 year

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

8.4 Test Environmental Conditions

Temperature:	17 ºC
Relative Humidity:	55 %
ATM Pressure:	101.9 kPa

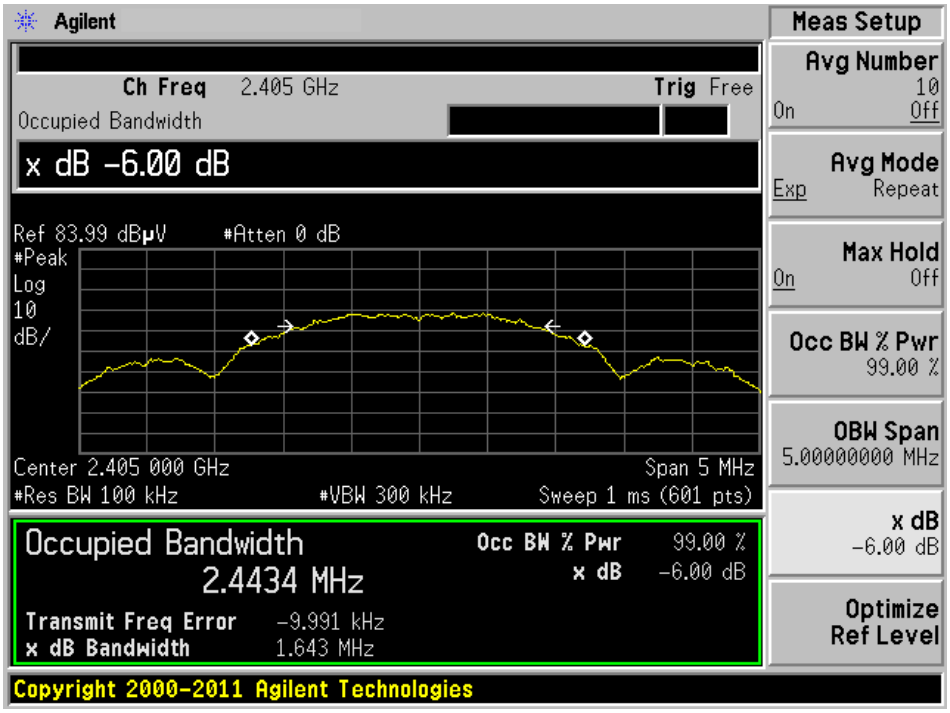
The testing was performed by Todd Moy on 2015-01-09 in 5 m chamber 3.

8.5 Test Results and Plots

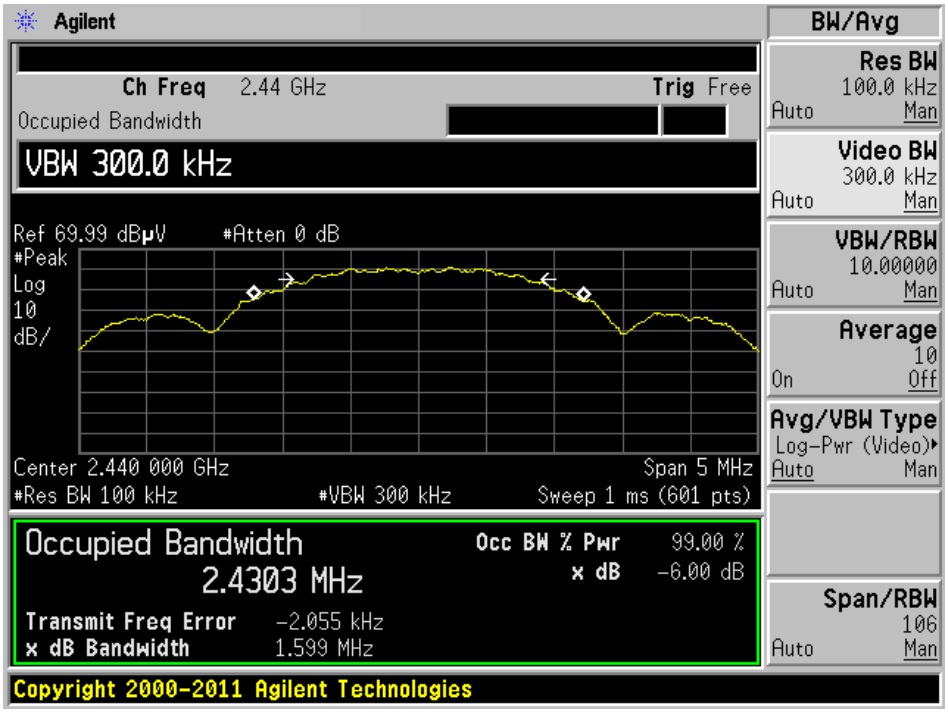
Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	99% Emission Bandwidth (MHz)	Limit (MHz)	Results
Low	2405	1.643	2.4435	> 0.5	Compliant
Middle	2440	1.599	2.4303	> 0.5	Compliant
High	2480	1.601	2.4254	> 0.5	Compliant

Please refer to the following plots for detailed test results

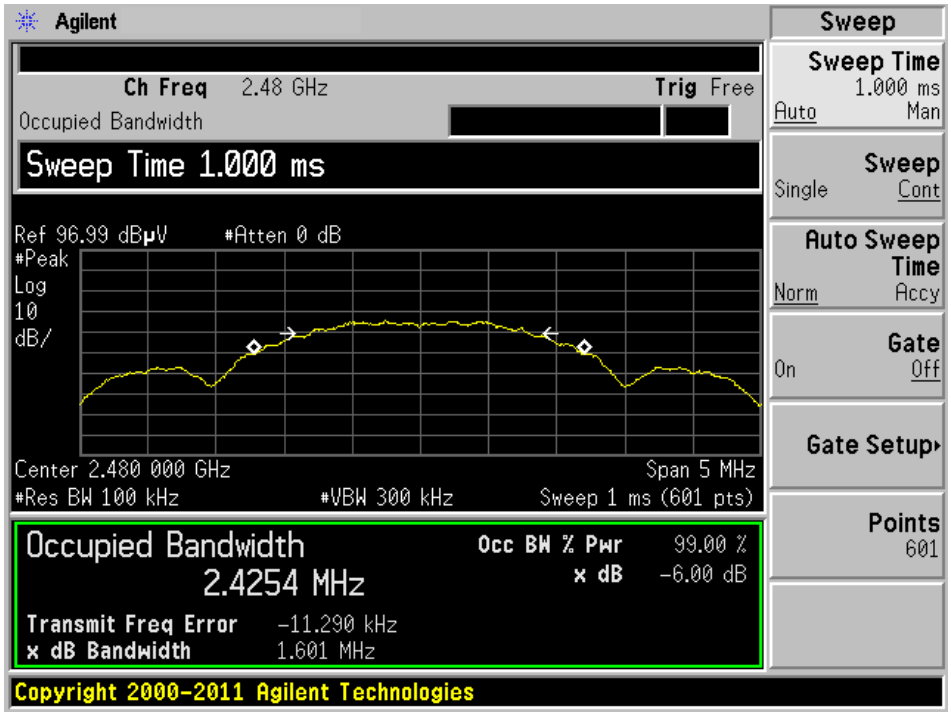
Low channel: 2405 MHz



Middle channel: 2440 MHz



High Channel 2480 MHz



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

9.1 Applicable Standards

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.

9.2 Measurement Procedure

The measurements are base on FCC KDB 558074 D01 DTS Meas Guidance v03r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 9: Fundamental emission output power

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Sunol Sciences	System Controller	SC99V	122303-1	N/R	N/R
Agilent	Analyzer, Spectrum	E4440A	MY44303352	2014-11-13	1 year
A.R.A.	Horn Antenna	DRG-118A	1132	2014-01-30	1 year

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

9.4 Test Environmental Conditions

Temperature:	17º C
Relative Humidity:	55 %
ATM Pressure:	101.9 kPa

The testing was performed by Todd Moy on 2014-01-09 in 5 m chamber 3.

9.5 Test Results

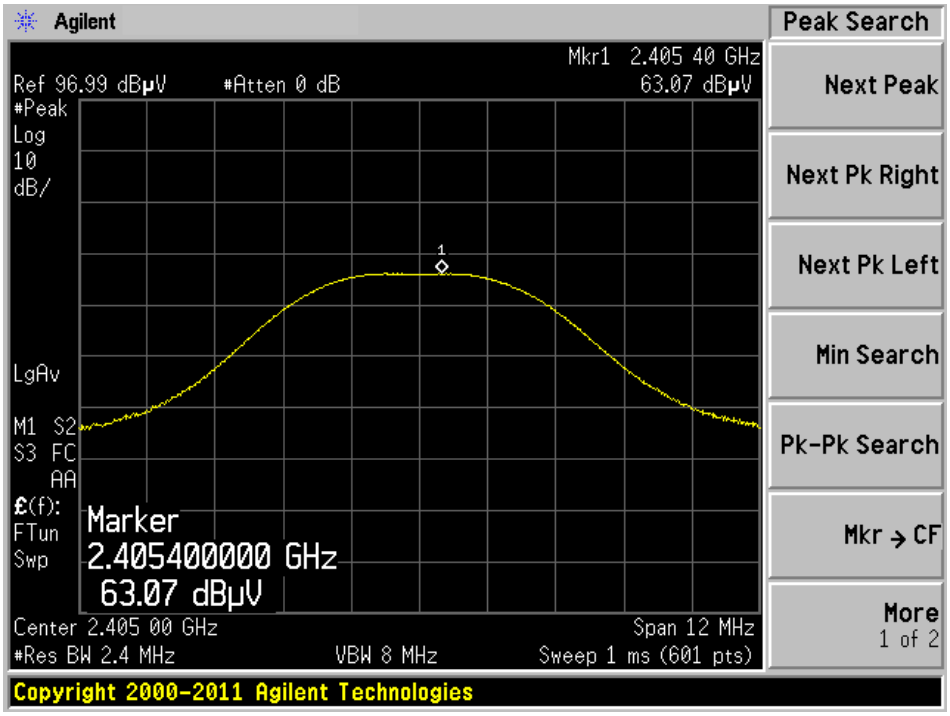
Frequency (MHz)	S.A. Reading (dBµV)	Antenna Factor (dB/m)	Cable Loss (dB)	Cord. Reading (dBµV/m)	EIRP (dBm)	Antenna Gain (dBi)	Output Power (dBm)	Limit (dBm)	Power Setting
2405	63.07	28.197	2.864	94.131	-1.128	0.77	-1.899	30	4
2440	64.34	28.197	2.864	95.401	0.141	0.77	-0.629	30	4
2480	65.90	28.999	2.950	97.849	2.589	0.77	1.819	30	4

The field strength converts to conducted power should be as following:

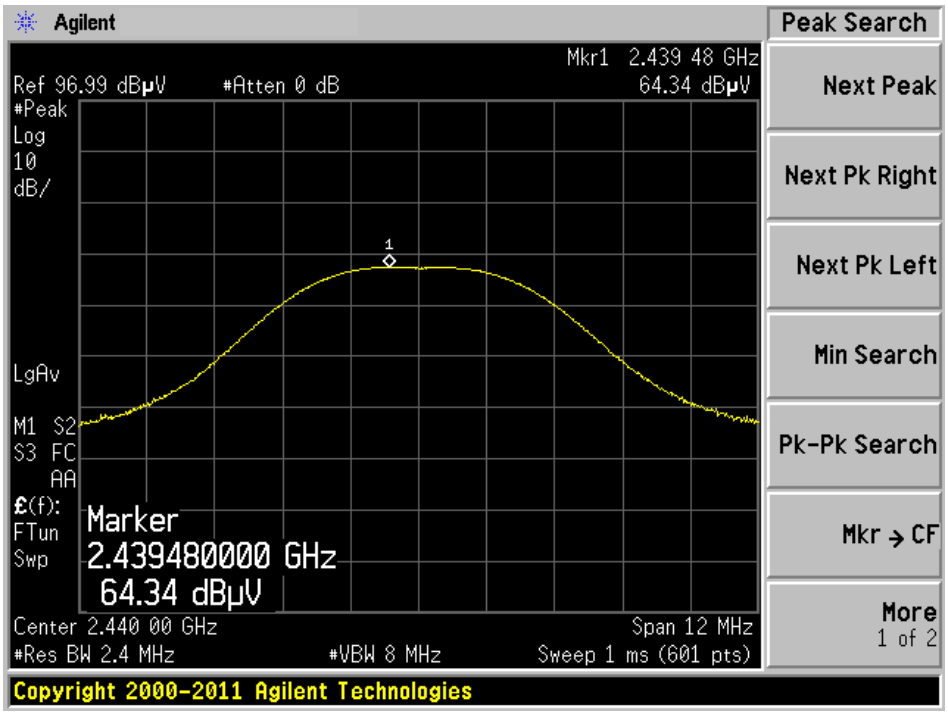
E (dBµV/m) = EIRP [dBm] + 95.26 for the distance at 3 meters.

Please refer to the following plots:

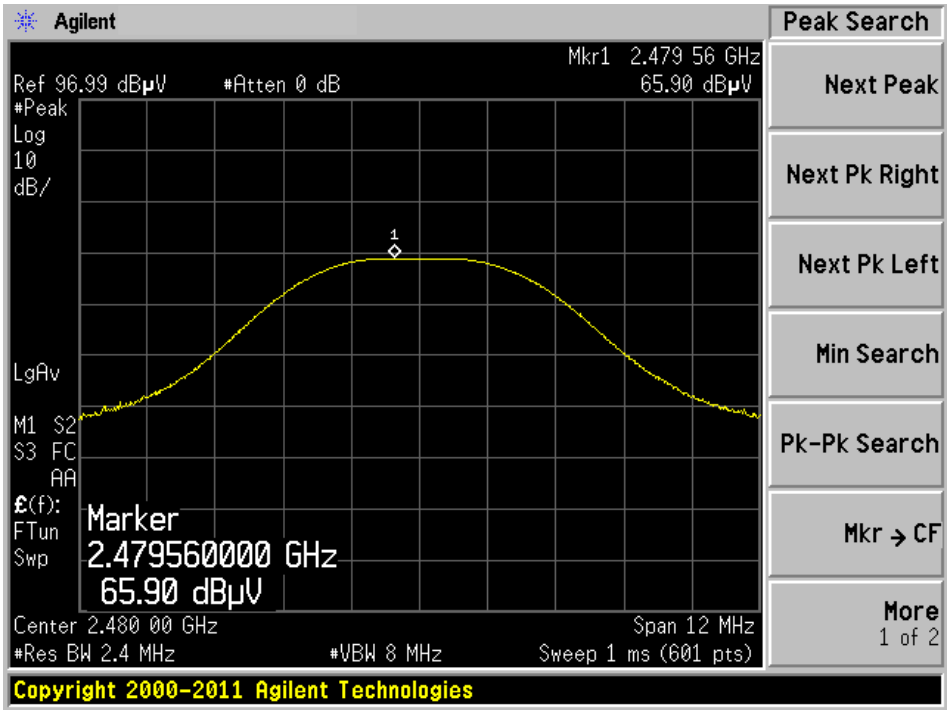
Low channel: 2405 MHz



Middle channel: 2440 MHz



High Channel 2480 MHz



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

10.1 Applicable Standards

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.

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 13: Band-edge measurements

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Sunol Sciences	System Controller	SC99V	122303-1	N/R	N/R
Agilent	Analyzer, Spectrum	E4440A	MY44303352	2014-11-13	1 year
A.R.A.	Horn Antenna	DRG-118A	1132	2014-01-30	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

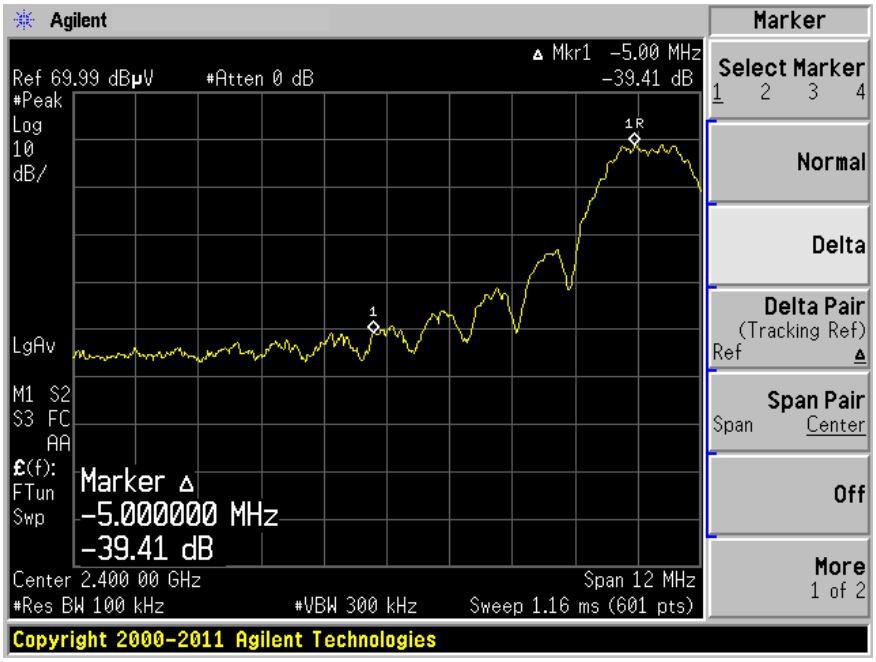
Temperature:	17 ºC
Relative Humidity:	55 %
ATM Pressure:	101.9 kPa

The testing was performed by Todd Moy on 2015-01-09 in 5 m chamber 3.

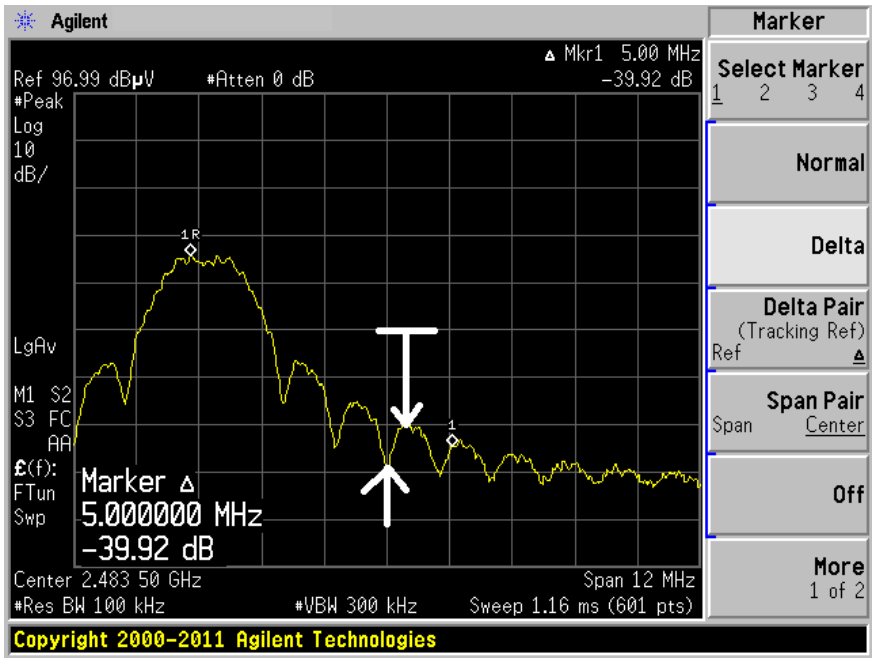
10.5 Test Results

Please refer to following pages for plots of band edge.

Low Channel 2405 MHz



High Channel 2480 MHz



Note: For the High Channel band edge measurements, it can be observed that the highest emission just outside of the edge (indicated with an arrow with a bar) is approximately 35 dB below the peak of the emission since vertical each division is 10 dB. The edge of the band is marked with only an arrow.

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

11.1 Applicable Standards

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.

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 10: Maximum power spectral density level in the fundamental emission

11.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Sunol Sciences	System Controller	SC99V	122303-1	N/R	N/R
Agilent	Analyzer, Spectrum	E4440A	MY44303352	2014-11-13	1 year
A.R.A.	Horn Antenna	DRG-118A	1132	2014-01-30	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:	17º C
Relative Humidity:	55 %
ATM Pressure:	101.9 kPa

The testing was performed by Todd Moy on 2015-01-09 in 5 m chamber 3.

11.5 Test Results

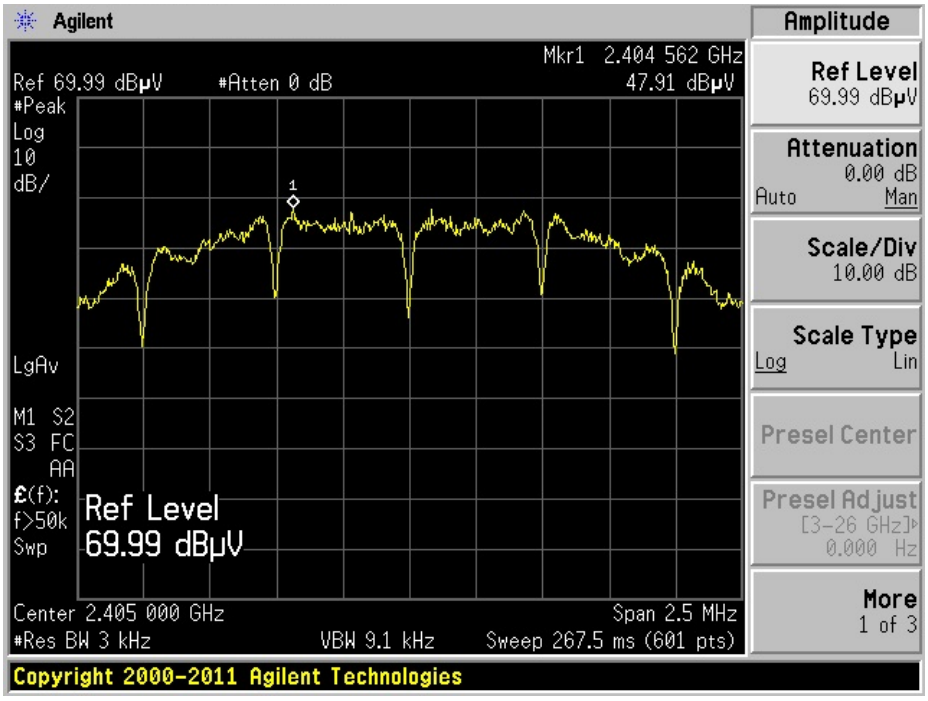
Frequency (MHz)	S.A. Reading (dBµV)	Antenna Factor (dB/m)	Cable Loss (dB)	Cord. Reading (dBµV/m)	EIRP (dBm)	Antenna Gain (dBi)	Output Power (dBm)	Limit
2405	47.91	28.197	2.864	78.971	-16.289	0.77	-17.059	8
2440	49.66	28.197	2.864	80.721	-14.539	0.77	-15.309	8
2480	50.04	28.999	2.950	81.989	-13.271	0.77	-14.041	8

The field strength converts to conducted power should be as following:

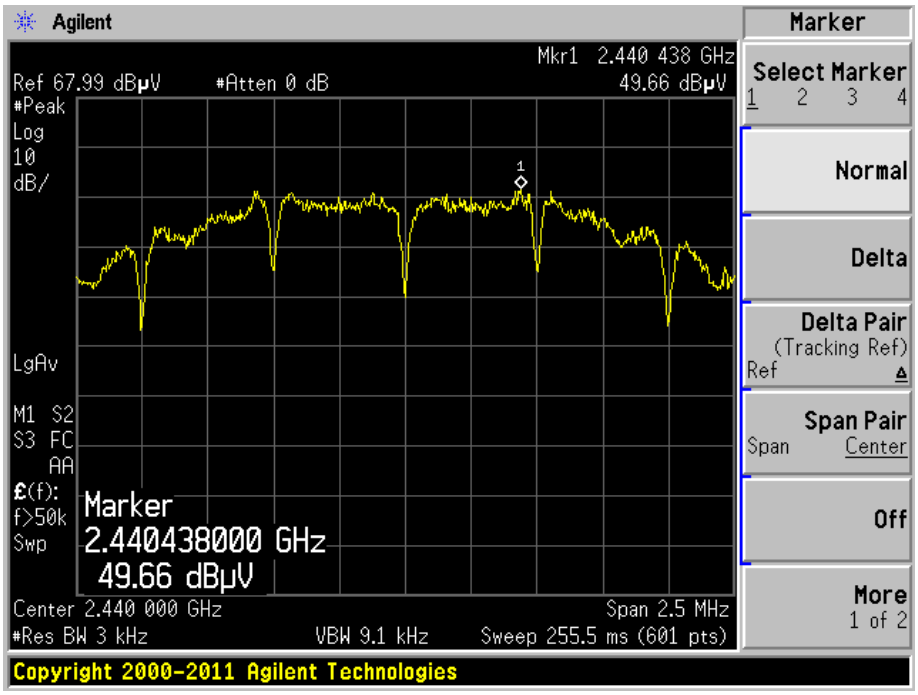
E (dBµV/m) = EIRP [dBm] + 95.26 for the distance at 3 meters.

Please refer to the following plots for detailed test results:

Low channel: 2405 MHz



Middle channel: 2440 MHz



High Channel 2480 MHz