



FCC PART 15, SUBPART C  
ISED RSS-210, ISSUE 9, AUGUST 2016  
TEST AND MEASUREMENT REPORT



For

**Courtmatics Corporation**

3899 VIA MILANO,

CAMPBELL, CA 95008-2629, USA

**FCC ID: 2AO22-S30000**  
**IC: 23623-S30000**

<b>Report Type:</b> Original Report	<b>Product Type:</b> Smart Tennis Dampener
<b>Prepared By:</b> Troy Pandhumsoporn Test Engineer	
<b>Report Number:</b> R1801156-249	
<b>Report Date:</b> 2018-01-24	
<b>Reviewed By:</b> Frank Wang	
Bay Area Compliance Laboratories Corp. 1274 Anvilwood Avenue, Sunnyvale, CA 94089, USA Tel: (408) 732-9162 Fax: (408) 732-9164	

**Note:** This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This report **must not** be used by the customer to claim product certification, approval, or endorsement by A2LA\*, NIST, or any agency of the Federal Government.

\* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "\*" ...

## TABLE OF CONTENTS

<b>1 General Description.....</b>	<b>4</b>
1.1 Product Description for Equipment Under Test (EUT) .....	4
1.2 Mechanical Description of EUT .....	4
1.3 Objective.....	4
1.4 Related Submittal(s)/Grant(s) .....	4
1.5 Test Methodology .....	4
1.6 Measurement Uncertainty .....	4
<b>2 System Test Configuration.....</b>	<b>8</b>
2.1 Justification.....	8
2.2 EUT Exercise Software.....	8
2.3 Duty Cycle Correction Factor .....	8
2.4 Equipment Modifications.....	10
2.5 Local Support Equipment .....	10
2.6 Support Equipment .....	10
2.7 Interface Ports and Cabling.....	10
<b>3 Summary of Test Results .....</b>	<b>11</b>
<b>4 FCC §15.203 &amp; ISED RSS-Gen §8.3 - Antenna Requirements .....</b>	<b>12</b>
4.1 Applicable Standards .....	12
4.2 Antenna Description .....	12
<b>5 FCC §15.207 &amp; ISED RSS-Gen §8.8 - AC Line Conducted Emissions.....</b>	<b>13</b>
5.1 Applicable Standards .....	13
5.2 Test Setup .....	13
5.3 Test Procedure .....	13
5.4 Corrected Amplitude & Margin Calculation.....	14
5.5 Test Setup Block Diagram .....	14
5.6 Test Equipment List and Details.....	15
5.7 Test Environmental Conditions .....	15
5.8 Summary of Test Results .....	15
5.9 Conducted Emissions Test Plots and Data.....	16
<b>6 FCC §15.209, §15.249(a) &amp; ISED RSS-210 - Spurious Radiated Emissions .....</b>	<b>18</b>
6.1 Applicable Standards .....	18
6.2 Test Setup .....	19
6.3 Test Procedure .....	19
6.4 Corrected Amplitude & Margin Calculation.....	20
6.5 Test Equipment List and Details.....	20
6.6 Test Environmental Conditions .....	21
6.7 Summary of Test Results .....	21
6.8 Radiated Emissions Test Results .....	22
<b>7 FCC §15.215 (c) &amp; ISED RSS-Gen §6.6 - Emission Bandwidth.....</b>	<b>25</b>
7.1 Applicable Standards .....	25
7.2 Measurement Procedure.....	25
7.3 Test Equipment List and Details.....	26
7.4 Test Environmental Conditions .....	26
7.5 Test Results.....	26

**DOCUMENT REVISION HISTORY**

<b>Revision Number</b>	<b>Report Number</b>	<b>Description of Revision</b>	<b>Date of Revision</b>
0	R1801156-249	Original Report	2018-01-24

# 1 General Description

---

## 1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Courtmatrics Corporation*, and their product model: *Courtmatrics Smart Dampener*, FCC ID: 2AO22-S30000, IC: 23623-S30000 or the “EUT” as referred to in this report. It is a smart dampener that contains a 2.4 GHz *Nordic Semiconductors* BLE radio operates at 2480 MHz.

## 1.2 Mechanical Description of EUT

The EUT measures approximately 20 mm (L) x 20 mm (W) x 13 mm (H) and weighs approximately 0.008 kg.

*The test data gathered are from typical production sample, serial number: R1801156-01 and R1801156-02 assigned by BACL.*

## 1.3 Objective

This report is prepared on behalf of *Courtmatrics Corporation*, in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission’s rules and ISED RSS-210 Issue 9, AUG 2016.

The objective is to determine compliance with FCC Part 15.249 and ISED RSS-210 rules for AC Conducted Emissions, Antenna Requirements, Occupied Bandwidth, 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 C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

## 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.

Parameter	Measurement uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.57 dB
Power Spectral Density, conducted	±1.48dB
Unwanted Emissions, conducted	±1.57dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 ° C
Humidity	±5 %
DC and low frequency voltages	±1.0 %
Time	±2 %
Duty Cycle	±3 %

## 1.7 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

## 1.8 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

**A- An independent, 3<sup>rd</sup>-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2005 by A2LA (Test Laboratory Accreditation Certificate Number 3279.02)**, in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (\*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

**B- A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3279.03) to certify**

- For the USA (Federal Communications Commission):
  - 1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
  - 2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
  - 3- All Telephone Terminal Equipment within FCC Scope C.
- For the Canada (Industry Canada):
  - 1 All Scope 1-Licence-Exempt Radio Frequency Devices;
  - 2 All Scope 2-Licensed Personal Mobile Radio Services;
  - 3 All Scope 3-Licensed General Mobile and Fixed Radio Services;
  - 4 All Scope 4-Licensed Maritime and Aviation Radio Services;
  - 5 All Scope 5-Licensed Fixed Microwave Radio Services
  - 6 All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.
- For Singapore (Info-Communications Development Authority (IDA)):
  - 1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2
  2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2
- For the Hong Kong Special Administrative Region:
  - 1 All Radio Equipment, per KHCA 10XX-series Specifications;
  - 2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
  - 3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
  - 1 MIC Telecommunication Business Law (Terminal Equipment):
    - All Scope A1 - Terminal Equipment for the Purpose of Calls;
    - All Scope A2 - Other Terminal Equipment
  - 2 Radio Law (Radio Equipment):
    - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
    - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
    - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

**C- A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3279.01) to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:**

- 1 Electronics and Office Equipment:
  - for Telephony (ver. 3.0)
  - for Audio/Video (ver. 3.0)
  - for Battery Charging Systems (ver. 1.1)
  - for Set-top Boxes and Cable Boxes (ver. 4.1)
  - for Televisions (ver. 6.1)
  - for Computers (ver. 6.0)
  - for Displays (ver. 6.0)
  - for Imaging Equipment (ver. 2.0)
  - for Computer Servers (ver. 2.0)
- 2 Commercial Food Service Equipment
  - for Commercial Dishwashers (ver. 2.0)
  - for Commercial Ice Machines (ver. 2.0)
  - for Commercial Ovens (ver. 2.1)

- for Commercial Refrigerators and Freezers
- 3 Lighting Products
  - For Decorative Light Strings (ver. 1.5)
  - For Luminaires (including sub-components) and Lamps (ver. 1.2)
  - For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
  - For Integral LED Lamps (ver. 1.4)
- 4 Heating, Ventilation, and AC Products
  - for Residential Ceiling Fans (ver. 3.0)
  - for Residential Ventilating Fans (ver. 3.2)
- 5 Other
  - For Water Coolers (ver. 3.0)

**D- A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:**

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (Industry Canada - ISED) Foreign Certification Body – FCB – APEC Tel MRA -Phase I and Phase II;
- Chinese Taipei (Republic of China – Taiwan):
  - o BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - o NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - o EMC Directive 2004/108/EC US-EU EMC and Telecom MRA CAB
  - o Radio and Teleterminal Equipment (RandTTE) Directive 1995/5/EC  
US -EU EMC and Telecom MRA CAB
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA)  
APEC Tel MRA -Phase I and Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Development Authority - IDA) APEC Tel MRA -Phase I and Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - o ENERGY STAR Recognized Test Laboratory – US EPA
  - o Telecommunications Certification Body (TCB) – US FCC;
  - o Nationally Recognized Test Laboratory (NRTL) – US OSHA
- Vietnam: APEC Tel MRA -Phase I;

## 2 System Test Configuration

### 2.1 Justification

The EUT was configured for testing according to ANSI C63.10-2013.

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

### 2.2 EUT Exercise Software

Modulation	Frequency (MHz)	Power Setting
GFSK	2480	Default

### 2.3 Duty Cycle Correction Factor

According to ANSI C63.10-2013 section 11.6:

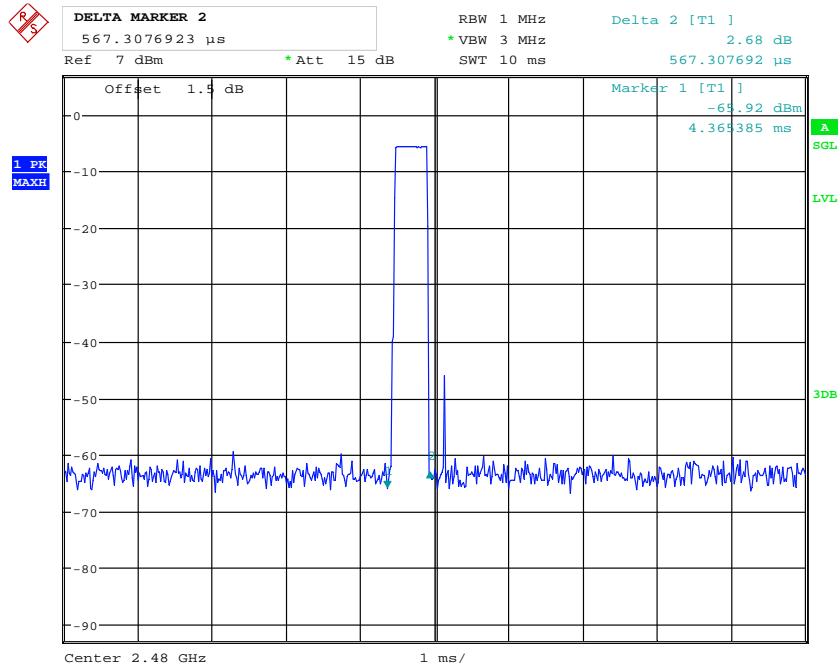
Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (T) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed T at any time that data is being acquired (i.e., no transmitter off-time is to be considered).

On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
0.5673	22.621	2.5	16.02

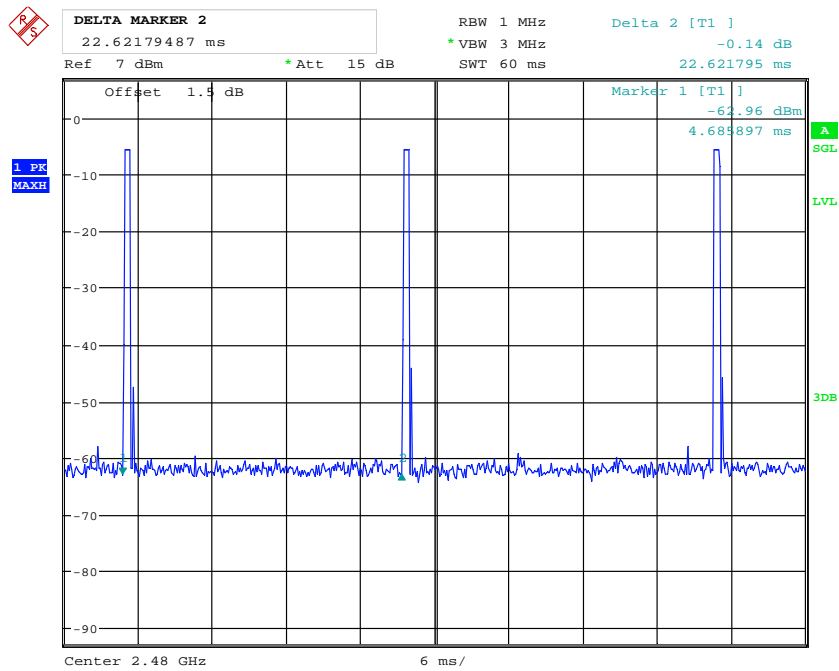
Duty Cycle = On Time (ms)/ Period (ms); Duty Cycle Correction Factor (dB) = 10\*log (1/Duty Cycle)

Please refer to the following plots.





Date: 24.JAN.2018 18:04:40



Date: 24.JAN.2018 18:02:48

## 2.4 Equipment Modifications

We provided the RF cable to the customer to solder to a trace near the antenna for conducted measurements.

## 2.5 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E7450

## 2.6 Support Equipment

Manufacturer	Description	Model
Samsung	Travel Adapter	ETA0U61JWE

## 2.7 Interface Ports and Cabling

Cable Description	Length (m)	To	From
Micro USB to USB	< 1 m	Laptop	EUT
RF Cable	< 1 m	UUT	PSA

### 3 Summary of Test Results

---

Results reported relate only to the product tested.

<b>FCC &amp; ISED Rules</b>	<b>Description of Test</b>	<b>Results</b>
FCC §15.203 ISED RSS-Gen §8.3	Antenna Requirement	Compliant
FCC §15.207 ISED RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §2.1053, §15.205, §15.209, §15.249 (a) ISED RSS-210	Radiated Spurious Emissions	Compliant
FCC §15.215 ISED RSS-Gen §6.6	Emission Bandwidth	Compliant

## 4 FCC §15.203 & ISED RSS-Gen §8.3 - Antenna Requirements

### 4.1 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 ISED RSS-Gen §8.3: Transmitter Antenna

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the license-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

License-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the license-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of license-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. 9 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 a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

### 4.2 Antenna Description

The antenna used by the EUT is a chip antenna.

Antenna usage	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
BLE	2480	2.72

## 5 FCC §15.207 & ISED RSS-Gen §8.8 - AC Line Conducted Emissions

### 5.1 Applicable Standards

As per FCC §15.207 and IC RSS-Gen §8.8 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  $\mu$ H/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 <sup>Note1</sup>	56 to 46 <sup>Note2</sup>
0.5-5	56	46
5-30	60	50

*Note1: Decreases with the logarithm of the frequency.*

*Note2: A linear average detector is required*

### 5.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.10-2013 measurement procedure. The specification used were FCC §15.207 and IC RSS-Gen §8.8 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.

### 5.3 Test Procedure

During the conducted emissions test, the power cord of the EUT host system was connected to the mains outlet of the LISN-1 and the power cords of support equipment were connected to LISN-2.

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

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

## 5.4 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:

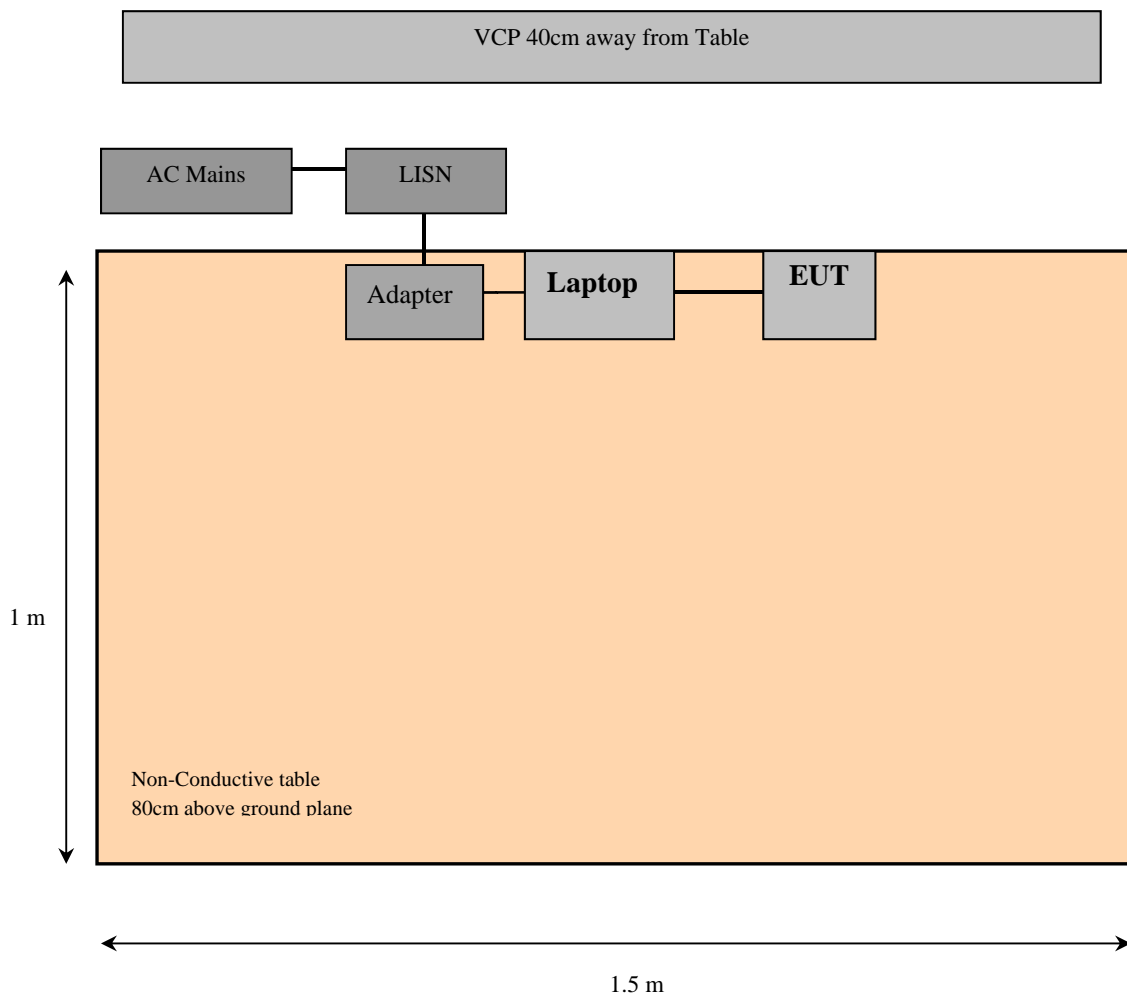
$$CA = A_i + CL + \text{Atten}$$

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:

$$\text{Margin} = \text{Corrected Amplitude} - \text{Limit}$$

## 5.5 Test Setup Block Diagram



## 5.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2016-02-04	2 years
Rohde and Schwarz	Impulse Limiter	ESH3-Z2	101964	2017-07-22	1 year
Keysight Technologies	RF Limiter	11867A	MY42242932	2017-02-07	1 year
Solar Electronics Company	High Pass Filter	Type 7930-100	7930150204	2017-03-13	1 year
Suirong	30 ft conductive emission cable	LMR 400	-	N/R	N/A
FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2017-04-24	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

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

## 5.7 Test Environmental Conditions

<b>Temperature:</b>	23° C
<b>Relative Humidity:</b>	42 %
<b>ATM Pressure:</b>	101.31 kPa

*The testing was performed by Troy Pandhumsoporn on 2018-01-15 at RF site.*

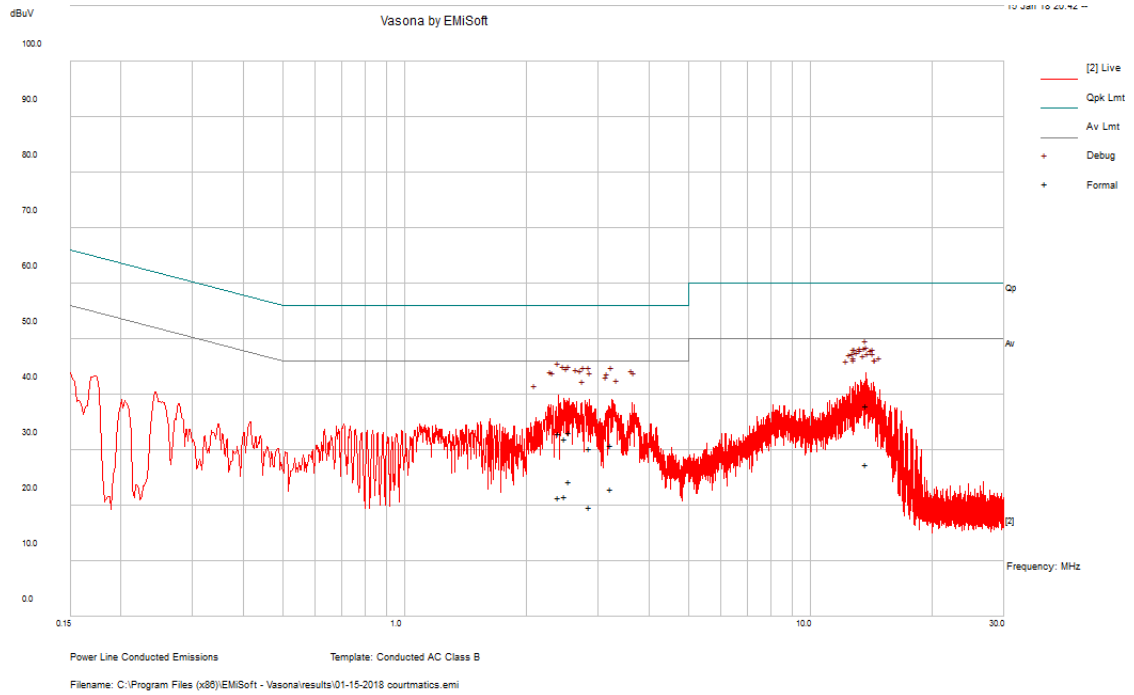
## 5.8 Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC 15C and ISED 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 (Live/Neutral)	Range (MHz)
-21.55	2.547115	Line	0.15-30

### 5.9 Conducted Emissions Test Plots and Data

#### 120 V, 60 Hz – Line

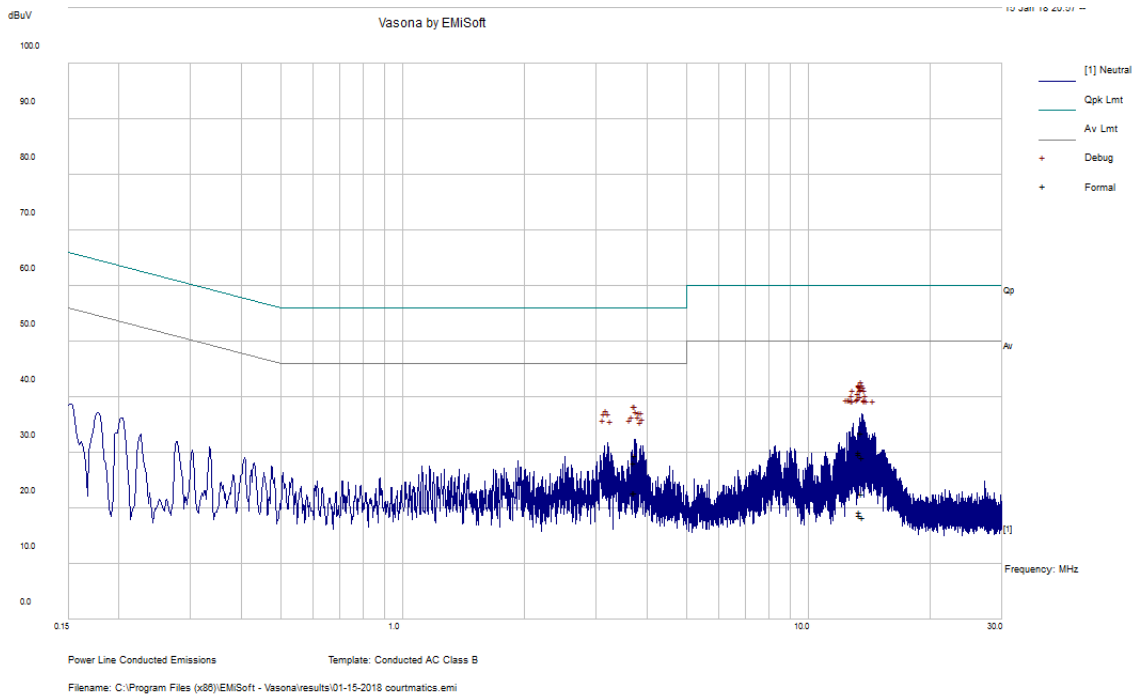


Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
13.71442	37.94	Line	60	-22.06	QP
2.40022	32.99	Line	56	-23.01	QP
2.547115	33.22	Line	56	-22.78	QP
2.481764	31.96	Line	56	-24.04	QP
2.857333	30.29	Line	56	-25.71	QP
3.23197	30.87	Line	56	-25.13	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
13.71442	27.42	Line	50	-22.58	Ave.
2.40022	21.44	Line	46	-24.56	Ave.
2.547115	24.45	Line	46	<b>-21.55</b>	Ave.
2.481764	21.76	Line	46	-24.24	Ave.
2.857333	19.69	Line	46	-26.31	Ave.
3.23197	23.04	Line	46	-22.96	Ave.



**120 V, 60 Hz – Neutral**



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
13.58023	33.53	Neutral	60	-26.47	QP
3.754087	29.47	Neutral	56	-26.53	QP
3.73313	28.13	Neutral	56	-27.87	QP
13.61524	29.19	Neutral	60	-30.81	QP
13.3911	30.12	Neutral	60	-29.88	QP
13.39326	29.75	Neutral	60	-30.25	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
13.58023	22.66	Neutral	50	-27.34	Ave.
3.754087	22.76	Neutral	46	-23.24	Ave.
3.73313	22.81	Neutral	46	-23.19	Ave.
13.61524	18.49	Neutral	50	-31.51	Ave.
13.3911	19.38	Neutral	50	-30.62	Ave.
13.39326	18.7	Neutral	50	-31.3	Ave.

## 6 FCC §15.209, §15.249(a) & ISED RSS-210 - Spurious Radiated Emissions

### 6.1 Applicable Standards

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 §15.205(a) and RSS-Gen 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	3332 – 3339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	33458 – 3358	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 §15.209(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 §15.249(a) and RSS-210 Annex 2 section A2.9: Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Frequency (MHz)	Field Strength of Fundamental (millivolts/meter)	Field Strength of Harmonics (microvolts/meter)
902-928	50	500
2400-2483.5	50	500
5725-5875	50	500
24000-24250	250	2500

## 6.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.10-2013. The specification used was FCC 15 Subpart C 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.

## 6.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords were 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 was set 3 meter away from the testing antenna, which was varied from 1-4 meter, and the EUT was placed on a turntable, which was 0.8 meter and 1.5 meter above the ground plane for below and above 1000 MHz measurements, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna's polarity should be changed between horizontal and vertical.

The spectrum analyzer or receiver was set as:

Below 1000 MHz:

$$\text{RBW} = 100 \text{ kHz} / \text{VBW} = 300 \text{ kHz} / \text{Sweep} = \text{Auto}$$

Above 1000 MHz:

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

## 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:

$$\text{Margin} = \text{Corrected Amplitude} - \text{Limit}$$

## 6.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2016-02-04	2 years
Agilent	Analyzer, Spectrum	E4440A	US44300386	2017-04-20	1 year
Sunol Sciences	System Controller	SC99V	011003-1	N/R	N/A
Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2015-07-11	31 months
EMCO	Antenna, Horn	3115	9511-4627	2016-01-28	2 years
Agilent	Amplifier, Pre	8447D	2944A06639	2017-03-13	1 year
Wisewave	Antenna, Horn	ARH-4223-02	10555-02	2017-12-15	2 years
A.H Systems, inc	Amplifier, Pre	PAM-1840VH	170	2017-02-28	1 year
IW	AOBOR Hi frequency Co AX Cable	DC 1531	KPS- 1501A3960K PS	2017-08-05	1 year
-	SMA cable	-	C0002	Each time <sup>1</sup>	N/A
-	N-Type Cable	-	C00012	Each time <sup>1</sup>	N/A
-	N-Type Cable	-	C00014	Each time <sup>1</sup>	N/A
Agilent	Pre-Amplifier	8449B	3147A00400	2017-06-15	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note<sup>1</sup>: cable and attenuator included in the test set-up will be checked each time before testing.

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

## 6.6 Test Environmental Conditions

<b>Temperature:</b>	20-22 °C
<b>Relative Humidity:</b>	42-50 %
<b>ATM Pressure:</b>	102.7 kPa

*The testing was performed by Troy Pandhumsoporn on 2017-01-18 in 5m chamber 3.*

## 6.7 Summary of Test Results

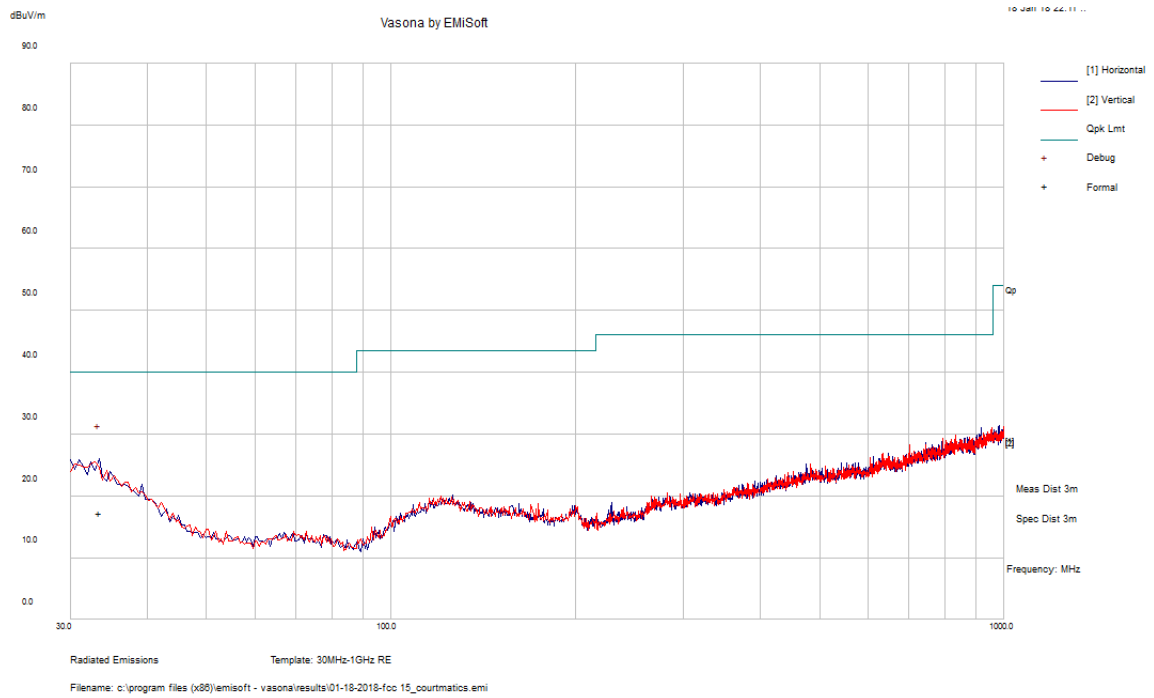
According to the data hereinafter, the EUT complied with FCC Title 47, Part 15C and ISED RSS-210 standard's radiated emissions limits, and had the worst margin of:

<b>Mode: Transmitting</b>		
<b>Margin (dB)</b>	<b>Frequency (MHz)</b>	<b>Polarization (Horizontal/Vertical)</b>
<b>-7.95</b>	7440	Horizontal

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

### 6.8 Radiated Emissions Test Results

#### 1) 30 MHz – 1 GHz Worst Case, Measured at 3 meters



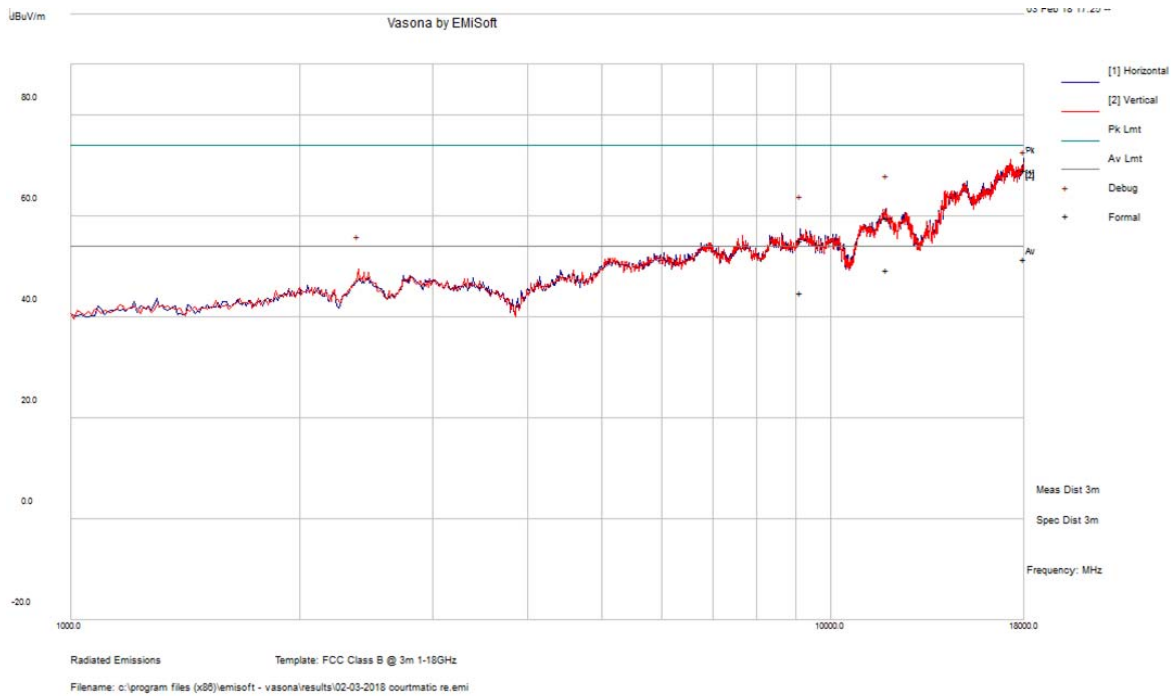
Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
33.479	17.24	101	H	92	40	-22.76	QP

2) 1–25 GHz Measured at 3 meters

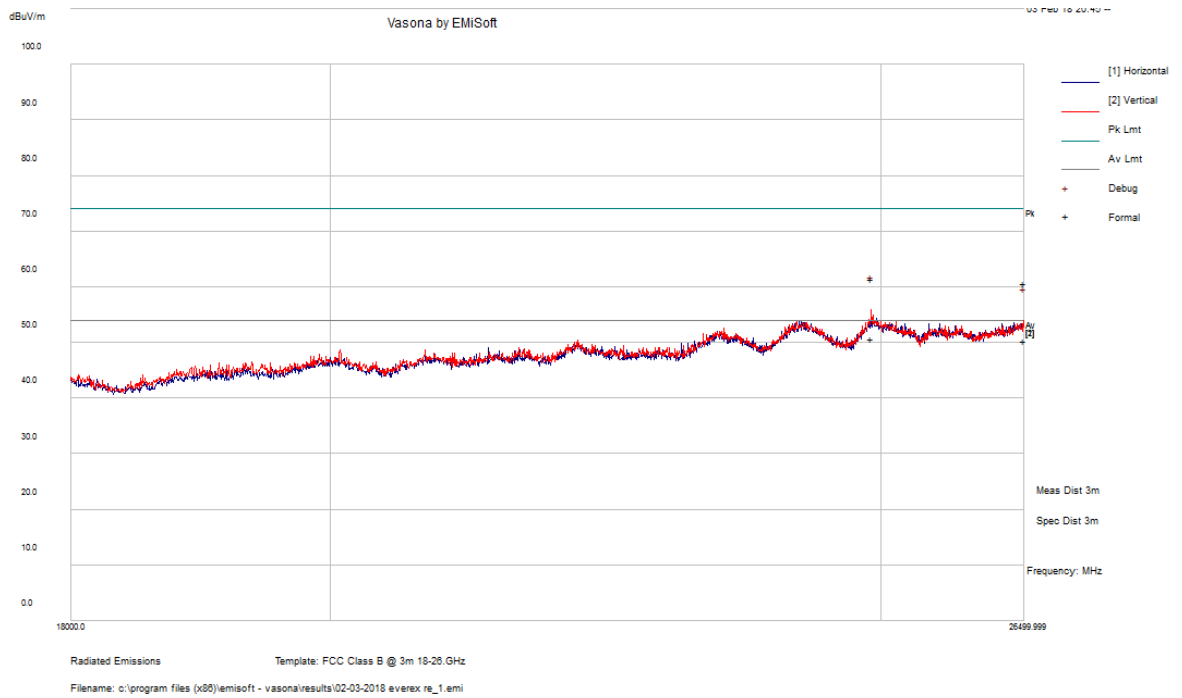
Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
2480 MHz											
2480	50.33	225	107	H	29.25	5.76	0.00	85.34	114	-28.66	PK
2480	40.53	225	107	H	29.25	5.76	0.00	75.54	94	-18.46	AV
2480	44.09	289	100	V	29.18	5.76	0.00	79.03	114	-34.97	PK
2480	33.85	289	100	V	29.18	5.76	0.00	68.79	94	-25.21	AV
2483.5	52.41	194	100	H	29.25	6.51	36.59	51.58	74.00	-22.42	PK
2483.5	47.70	222	100	V	29.18	6.51	36.59	46.80	74.00	-27.20	PK
4960	44.90	0	100	H	32.78	9.46	36.28	50.86	74.00	-23.14	PK
4960	45.20	0	100	V	32.79	9.46	36.28	51.17	74.00	-22.83	PK
7440	45.47	0	100	H	37.07	12.01	36.41	58.15	74.00	-15.85	PK
7440	33.37	0	100	H	37.07	12.01	36.41	46.05	54.00	<b>-7.95</b>	AV
7440	45.56	0	100	V	37.02	12.01	36.41	58.18	74.00	-15.82	PK
7440	33.37	0	100	V	37.02	12.01	36.41	45.99	54.00	-8.01	AV

1 GHz-18 GHz

This test was performed with the 2.4-2.4835 GHz band reject filter.



### 18 GHz-26.5 GHz





## **7 FCC §15.215 (c) & ISED RSS-Gen §6.6 - Emission Bandwidth**

### **7.1 Applicable Standards**

As per FCC §15.215 (c),

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

As per ISED RSS-Gen §6.6,

The emission bandwidth ( $\times$ dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated  $\times$  dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least  $3\times$  the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

### **7.2 Measurement Procedure**

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.

The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately  $3\times$ RBW.

**Note:** Video averaging is not permitted.

A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

### 7.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2017-03-20	1 year
-	10dB attenuator	-	-	Each time <sup>1</sup>	N/A

Note<sup>1</sup>: cable and attenuator included in the test set-up will be checked each time before testing.

**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

<b>Temperature:</b>	22° C
<b>Relative Humidity:</b>	42 %
<b>ATM Pressure:</b>	102.7 KPa

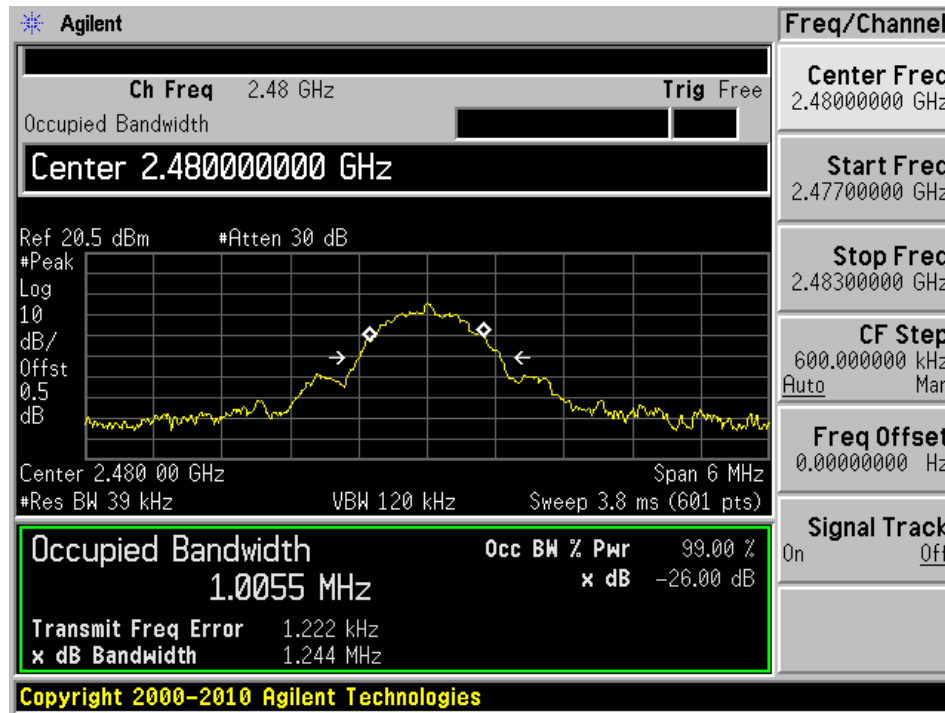
The testing was performed by Troy Pandhumsoporn on 2018-01-19 in RF site.

### 7.5 Test Results

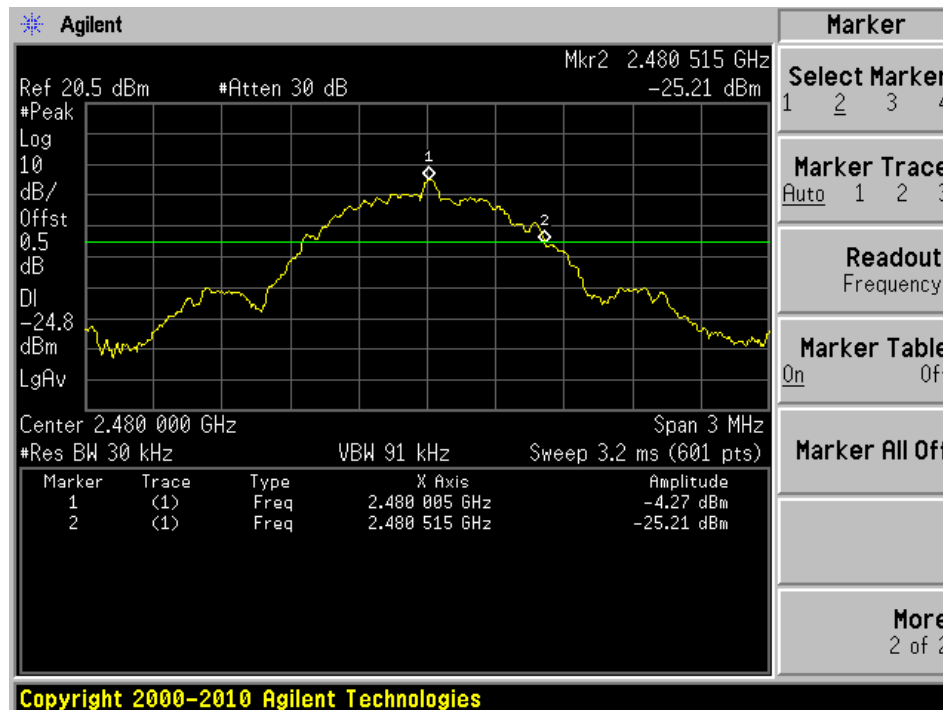
Mode	Frequency (MHz)	99% OBW (kHz)	20 dB Bandwidth
BLE	2480	1005.5	Within 2.4-2.4835 GHz band

Please refer to the following plots for detailed test results.

### 99% Occupied Bandwidth



### 20 dB Occupied Bandwidth



---- END OF REPORT ----