



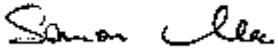
FCC PART 15, SUBPART C
ISEDC RSS-247, ISSUE 2, FEBRUARY 2017
TEST AND MEASUREMENT REPORT

For

Emotiv Inc.

490 Post St., Suite 824, San Francisco, CA 94102, USA

**FCC ID: 2ADIH-EPOC03
IC: 12769A-EPOC03**

Report Type: Original Report	Product Type: Mobile BCI Headset, Gaming Interface
Prepared By: <u>Matthew Riego de Dios</u> Test Technician 	
Report Number: <u>R2002182-247</u>	
Report Issue Date: <u>2020-03-04</u>	
Reviewed By: <u>Simon Ma</u> RF Supervisor 	
Bay Area Compliance Laboratories Corp. 1274 Anvilwood Avenue, Sunnyvale, CA 94089, USA Tel: +1 (408) 732-9162, Fax: +1 (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 “*” (Rev.2)

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2002182-247	Original Report	2020-03-04

TABLE OF CONTENTS

1 General Description.....	5
1.1 Product Description for Equipment Under Test (EUT)	5
1.2 Mechanical Description of EUT	5
1.3 Objective.....	5
1.4 Related Submittal(s)/Grant(s)	5
1.5 Test Methodology	5
1.6 Measurement Uncertainty	6
1.7 Test Facility Registrations	6
1.8 Test Facility Accreditations	7
2 System Test Configuration.....	9
2.1 Justification.....	9
2.2 EUT Exercise Software.....	9
2.3 Equipment Modifications.....	9
2.4 Local Support Equipment	9
2.5 Support Equipment	9
2.6 Interface Ports and Cabling.....	9
3 Summary of Test Results	10
4 FCC §15.203 & ISEDC RSS-Gen §6.8 - Antenna Requirements	11
4.1 Applicable Standards	11
4.2 Antenna Description	11
5 FCC §2.1093 & ISEDC RSS-102 - RF Exposure	12
5.1 Applicable Standards	12
5.2 RF Exposure Evaluation Exemption for FCC.....	14
5.3 RF Exposure Evaluation Exemption for ISED	14
6 FCC §15.207 & ISEDC RSS-Gen §8.8 – AC Line Conducted Emissions.....	15
6.1 Applicable Standards	15
6.2 Test Setup	15
6.3 Test Procedure	15
6.4 Corrected Amplitude & Margin Calculation.....	16
6.5 Test Setup Block Diagram.....	16
6.6 Test Equipment List and Details	17
6.7 Test Environmental Conditions	17
6.8 Summary of Test Results	17
6.9 Conducted Emissions Test Plots and Data.....	18
7 FCC §15.247(a) (2) & ISEDC RSS-247 §5.2(a) - 99% & 6 dB Occupied Bandwidth.....	20
7.1 Applicable Standards	20
7.2 Measurement Procedure.....	20
7.3 Test Equipment List and Details	20
7.4 Test Environmental Conditions	20
7.5 Test Results.....	21
8 FCC §15.247(b) (3) & ISEDC RSS-247 §5.4(d) - Output Power	23
8.1 Applicable Standards	23
8.2 Measurement Procedure.....	23
8.3 Test Equipment List and Details	24
8.4 Test Environmental Conditions	24
8.5 Test Results.....	24
9 FCC §15.247(e) & ISEDC RSS-247 §5.2(b) - Power Spectral Density.....	26
9.1 Applicable Standards	26
9.2 Measurement Procedure.....	26
9.3 Test Equipment List and Details	26

9.4	Test Environmental Conditions	26
9.5	Test Results.....	27
10	FCC §15.247(d) & ISEDC RSS-247 §5.5 - Band Edge	28
10.1	Applicable Standards	28
10.2	Measurement Procedure.....	28
10.3	Test Equipment List and Details.....	28
10.4	Test Environmental Conditions	29
10.5	Test Results.....	29
11	FCC §15.247(d) & ISEDC RSS-247 §5.5 - Spurious Emissions at Antenna Terminals	30
11.1	Applicable Standards	30
11.2	Test Procedure	30
11.3	Test Equipment List and Details.....	30
11.4	Test Environmental Conditions	31
11.5	Test Results.....	31
12	FCC §2.1053, §15.205, §15.209, §15.247(d) & ISEDC RSS-247 §5.5, RSS-Gen §8.9, §8.10 - Spurious Radiated Emissions	32
12.1	Applicable Standards	32
12.2	Test Setup	34
12.3	Test Procedure	34
12.4	Corrected Amplitude & Margin Calculation.....	34
12.5	Test Equipment List and Details	35
12.6	Test Environmental Conditions	35
12.7	Summary of Test Results	36
12.8	Radiated Emissions Test Results	37
13	Annex A - Test Setup Photographs	41
14	Annex B - EUT External Photographs	42
15	Annex C - EUT Internal Photographs	43
16	Annex D (Normative) - A2LA Electrical Testing Certificate.....	44

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Emotiv Inc* and their product model: *3.0, FCC ID: 2ADIH-EPOC03; IC: 12769A-EPOC03* or the “EUT” as referred to in this report. It is a consumer EEG headset for brain computer interface applications that operates within the 2402 MHz and 2480 MHz frequency range.

1.2 Mechanical Description of EUT

The EUT measures approximately 17 cm (L), 17 cm (W), 15 cm (H) and 0.2 kg (weight)

The data gathered are from a typical production sample provided by Emotiv Inc.

1.3 Objective

This report was prepared on behalf of *Emotiv Inc*, in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission’s rules and ISED RSS-247 Issue 2, February 2017.

The objective was to determine compliance with FCC Part 15.247 and ISED RSS-247 for AC Line Conducted Emissions, Radiated Spurious Emissions, Antenna Requirement, RF Exposure Evaluation, Output Power, 99% & 6 dB Bandwidth, Band Edges, Conducted Spurious Emissions and Power Spectral Density.

1.4 Related Submittal(s)/Grant(s)

None

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	$\pm 5\%$
RF output power, conducted	$\pm 0.57\text{ dB}$
Power Spectral Density, conducted	$\pm 1.48\text{ dB}$
Unwanted Emissions, conducted	$\pm 1.57\text{ dB}$
All emissions, radiated	$\pm 4.0\text{ dB}$
AC power line Conducted Emission	$\pm 2.0\text{ dB}$
Temperature	$\pm 2\text{ }^\circ\text{C}$
Humidity	$\pm 5\%$
DC and low frequency voltages	$\pm 1.0\%$
Time	$\pm 2\%$
Duty Cycle	$\pm 3\%$

1.7 Test Facility Registrations

BACL's 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, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2005 by A2LA (Test Laboratory Accreditation Certificate Number 3297.02), 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 3297.03) 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 & Fixed Radio Services;
- 4 All Scope 4-Licensed Maritime & 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 3297.01) 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 & 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: (Innovation, Science and Economic development Canada - ISEDC) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & 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 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
 - o Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
 - o Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA) APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & 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 in accordance to ANSI C63.10.

2.2 EUT Exercise Software

The test utility used was nRF Connect; the software was verified by *Matthew Riego de Dios* to comply with the standard requirements being tested against.

2.3 Equipment Modifications

N/A

2.4 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E6410

2.5 Support Equipment

Manufacturer	Description	Model
NORDIC Semiconductor	Programmer/Support Board	nRF52

2.6 Interface Ports and Cabling

Cable Description	Length (m)	To	From
USB Cable	< 1 m	Laptop	Support Board
USB Cable-Type C	< 1 m	Laptop/Power Adapter	EUT
Serial Debugger Cable	< 1 m	EUT/Laptop	Support Board

3 Summary of Test Results

Results reported relate only to the product tested.

FCC & ISEDC Rules	Description of Test	Results
FCC §15.203 ISEDC RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §2.1093 ISEDC RSS-102	RF Exposure	Compliant
FCC §15.207 ISEDC RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §15.247(a)(2) ISEDC RSS-247 §5.2 (a)	6 dB & 99% Emission Bandwidth	Compliant
FCC §15.247(b)(3) ISEDC RSS-247 §5.4(d)	Maximum Peak Output Power	Compliant
FCC §15.247(e) ISEDC RSS-247 §5.2 (b)	Power Spectral Density	Compliant
FCC §15.247 (d) ISEDC RSS-247 §5.5	Conducted Band Edges	Compliant
FCC §15.247 (d) ISEDC RSS-247 §5.5	Spurious Emissions at Antenna Port	Compliant
FCC §2.1053, §15.205, §15.209, §15.247(d) ISEDC RSS-Gen §5.5 RSS-Gen §8.9, §8.10	Radiated Spurious Emissions	Compliant

4 FCC §15.203 & ISEDC RSS-Gen §6.8 - 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.

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

According to ISEDC RSS-Gen §6.8: Transmitter Antenna

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

4.2 Antenna Description

The antenna type used by the EUT is Punched Metal.

Antenna Type	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
Punched Metal	2400-2500 MHz	4.9

5 FCC §2.1093 & ISEDC RSS-102 - RF Exposure

5.1 Applicable Standards

According to FCC KDB 447498 D01 General RF Exposure Guidance v06 Section 4.3.1, Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition, listed below, is satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The minimum test separation distance is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander (see 5) of section 4.1). To qualify for SAR test exclusion, the test separation distances applied must be fully explained and justified by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, typically in the SAR measurement or SAR analysis report, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting is required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for the SAR test exclusion. When required, the device specific conditions described in the other published RF exposure KDB procedures must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops & tablets etc.

- 1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where}$$

- f (GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

- 2) At 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following, and as illustrated in Appendix B:

- a) $[\text{Power allowed at numeric threshold for } 50 \text{ mm in step 1} + (\text{test separation distance} - 50 \text{ mm}) \cdot (f(\text{MHz})/150)] \text{ mW, at } 100 \text{ MHz to } 1500 \text{ MHz}$
- b) $[\text{Power allowed at numeric threshold for } 50 \text{ mm in step 1} + (\text{test separation distance} - 50 \text{ mm}) \cdot 10] \text{ mW at } > 1500 \text{ MHz and } \leq 6 \text{ GHz}$

- 3) At frequencies below 100 MHz, the following may be considered for SAR test exclusion, and as illustrated in Appendix C:

- a) The power threshold at the corresponding test separation distance at 100 MHz in step 2) is multiplied by $[1 + \log(100/f(\text{MHz}))]$ for test separation distances > 50 mm and < 200 mm
- b) The power threshold determined by the equation in a) for 50 mm and 100 MHz is multiplied by $\frac{1}{2}$ for test separation distances ≤ 50 mm

c) SAR measurement procedures are not established below 100 MHz. When SAR test exclusion cannot be applied, a KDB inquiry is required to determine SAR evaluation requirements for any test results to be acceptable.

According to ISED RSS-102 Issue 5 Section 2.5.1 Exemption Limits for Routine Evaluation-SAR Evaluation:

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in table below,

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71	101	132	162	193
450	52	70	88	106	123
835	17	30	42	55	67
1900	7	10	18	34	60
2450	4	7	15	30	52
3500	2	6	16	32	55
5800	1	6	15	27	41

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223	254	284	315	345
450	141	159	177	195	213
835	80	92	105	117	130
1900	99	153	225	316	431
2450	83	123	173	235	309
3500	86	124	170	225	290
5800	56	71	85	97	106

5.2 RF Exposure Evaluation Exemption for FCC

The maximum conducted output power measured from the EUT is 4.39 dBm (2.748 mW), the antenna gain is 4.9 dBi. Therefore, the maximum EIRP is 9.29 dBm (8.49 mW). The separation distance between the antenna and human head is measured approximately 25 mm, please refer to the EUT external photographs annex.

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] [\sqrt{f(\text{GHz})}] = (8.49 \text{ mW}/25\text{mm}) * \sqrt{2.48} = 0.53$, which is less than 3.0. Therefore, FCC SAR testing is excluded.

5.3 RF Exposure Evaluation Exemption for ISED

The separation distance between the antenna and human head is measured approximately 25 mm, please refer to the EUT external photographs annex. Therefore, 52 mW was selected as the exemption limit. Maximum EIRP power = $4.39\text{dBm} + 4.9 \text{ dBi} = 9.29 \text{ dBm}$ (8.49 mW), which is less than 52 mW. Therefore, ISED SAR testing is not required.

6 FCC §15.207 & ISED RSS-Gen §8.8 – AC Line Conducted Emissions

6.1 Applicable Standards

As per FCC §15.207 and ISED 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 μ 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 ^{Note1}	56 to 46 ^{Note2}
0.5-5	56	46
5-30	60	50

Note1: Decreases with the logarithm of the frequency.

Note2: A linear average detector is required

6.2 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 ISED 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.

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 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”.

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:

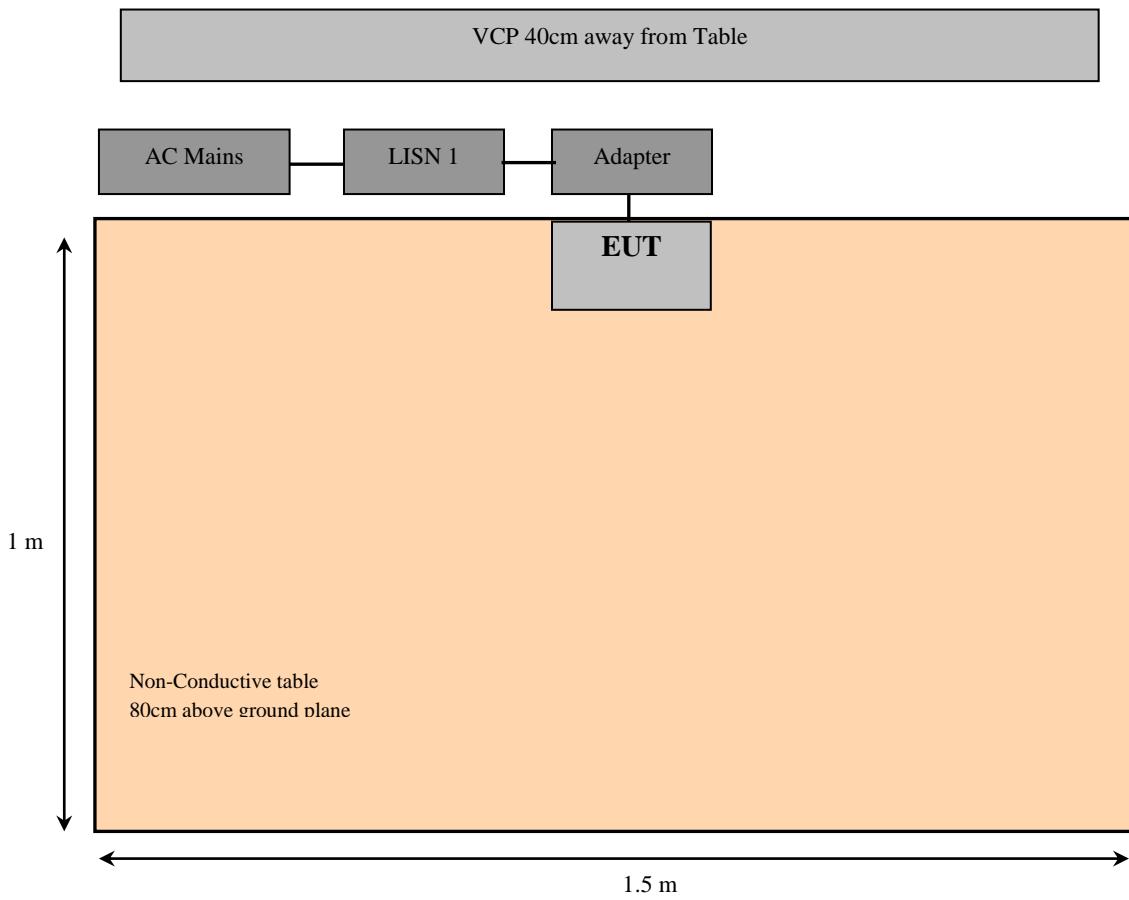
$$CA = Ai + CL + Atten$$

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:

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

6.5 Test Setup Block Diagram



6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rhode & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100044	2018-10-26	2 years
Rohde & Schwarz	Impulse Limiter	ESH3-Z2	101964	2019-07-31	1 year
Solar Electronics Company	High Pass Filter	Type 7930-100	7930150202	2020-02-26	1 year
FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2019-04-11	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.

6.7 Test Environmental Conditions

Temperature:	25° C
Relative Humidity:	44 %
ATM Pressure:	102.1 kPa

The testing was performed by Matthew Riego de Dios on 2020-02-27 at Ground Plane Test Site.

6.8 Summary of Test Results

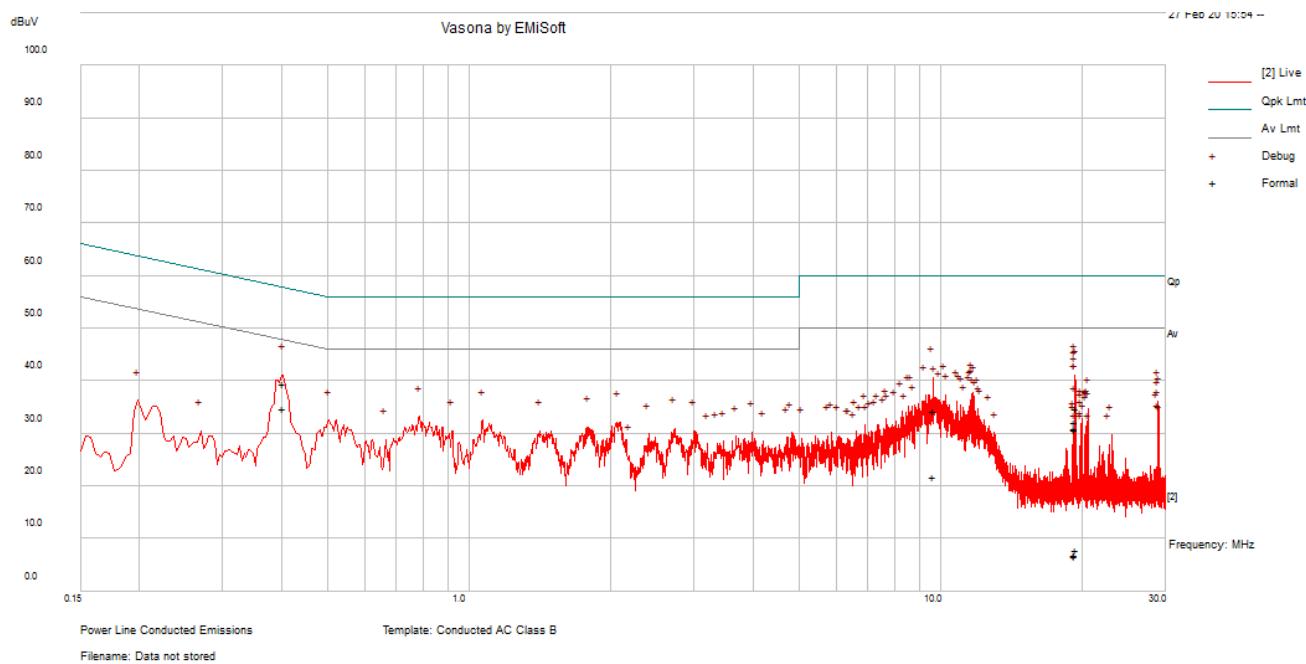
According to the recorded data in following table, the EUT complied with the FCC 15C and ISED RSS-Gen standard's conducted emissions limits, with the margin reading of:

Connection: AC/DC Adaptor of EUT connected to 120 V/60 Hz, AC			
Margin (dB)	Frequency (MHz)	Conductor Mode (Live/Neutral)	Range (MHz)
-12.96	0.402986	Live	0.15-30

6.9 Conducted Emissions Test Plots and Data

Worst Case: High Channel Frequency 2480 MHz Power Setting: 4

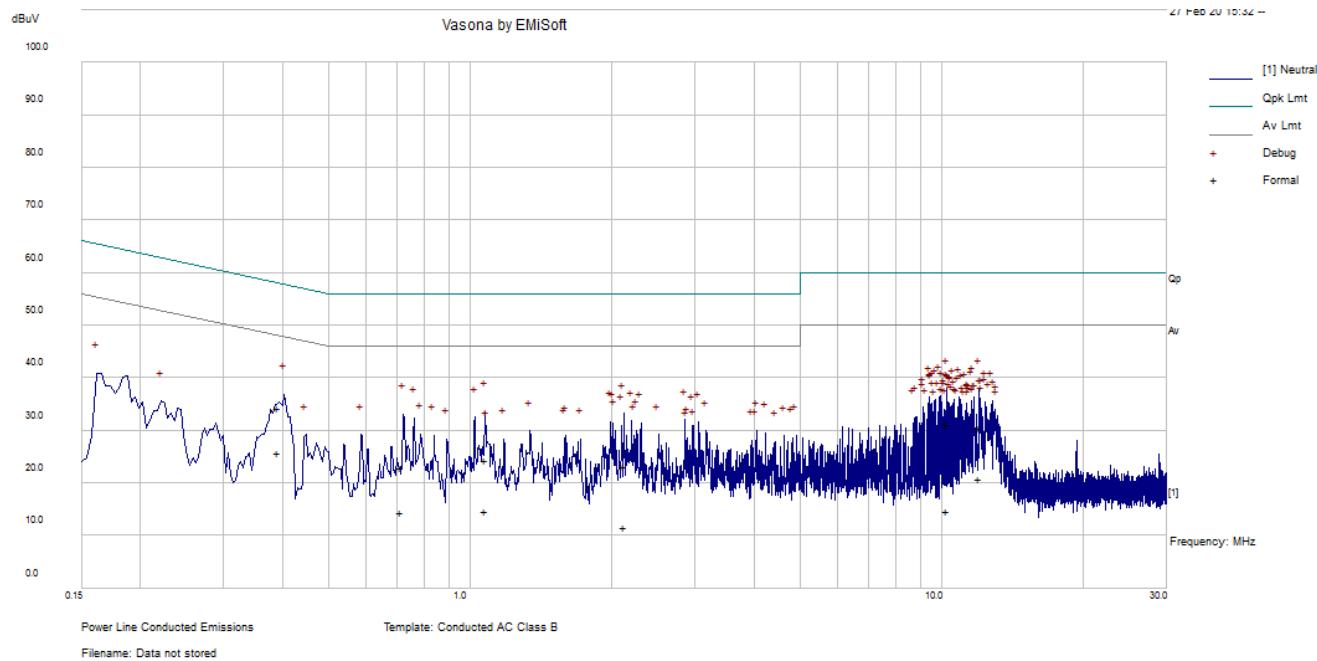
120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.402986	39.53	Line	57.79	-18.26	QP
19.224342	32.1	Line	60	-27.9	QP
9.634547	34.24	Line	60	-25.76	QP
19.342776	34.67	Line	60	-25.33	QP
19.260849	30.8	Line	60	-29.2	QP
19.265581	31.05	Line	60	-28.95	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.402986	34.84	Line	47.79	-12.96	Ave.
19.224342	6.89	Line	50	-43.11	Ave.
9.634547	21.76	Line	50	-28.24	Ave.
19.342776	7.72	Line	50	-42.28	Ave.
19.260849	6.67	Line	50	-43.33	Ave.
19.265581	6.95	Line	50	-43.05	Ave.

120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.40142	34.6	Neutral	57.82	-23.22	QP
10.267549	30.56	Neutral	60	-29.44	QP
12.017074	30.17	Neutral	60	-29.83	QP
1.063946	23.75	Neutral	56	-32.25	QP
2.107663	24.94	Neutral	56	-31.06	QP
0.735752	23.09	Neutral	56	-32.91	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.40142	26.4	Neutral	47.82	-21.42	Ave.
10.267549	14.86	Neutral	50	-35.14	Ave.
12.017074	20.54	Neutral	50	-29.46	Ave.
1.063946	14.57	Neutral	46	-31.43	Ave.
2.107663	14.35	Neutral	46	-31.65	Ave.
0.735752	14.17	Neutral	46	-31.83	Ave.

7 FCC §15.247(a) (2) & ISEDC RSS-247 §5.2(a) - 99% & 6 dB Occupied Bandwidth

7.1 Applicable Standards

According to *FCC §15.247(a) (2)* and *ISED RSS-247 §5.2(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.

7.2 Measurement Procedure

According to *ANSI C63.10-2013 Section 11.8.2*:

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described in 11.8.1 (i.e., $RBW = 100$ kHz, $VBW = 3 \times RBW$, and peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

7.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2019-03-19	1 year
-	SMA cable	-	-	Each time ¹	N/A

Note¹: cable 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

Temperature:	25° C
Relative Humidity:	44 %
ATM Pressure:	102.1 KPa

The testing was performed by Matthew Riego de Dios on 2020-02-18 at RF Bench.

7.5 Test Results

Channel	Frequency (MHz)	99% OBW (MHz)	6 dB OBW (kHz)	6 dB OBW Limit (kHz)	Comments
Low	2402	1.0516	700.092	500	Passed
Middle	2442	1.0521	702.561	500	Passed
High	2480	1.0531	706.089	500	Passed

Please refer to the following plots for detailed test results.

99% Occupied Bandwidth

Low Channel 2402 MHz



Middle Channel 2442 MHz



High Channel 2480 MHz

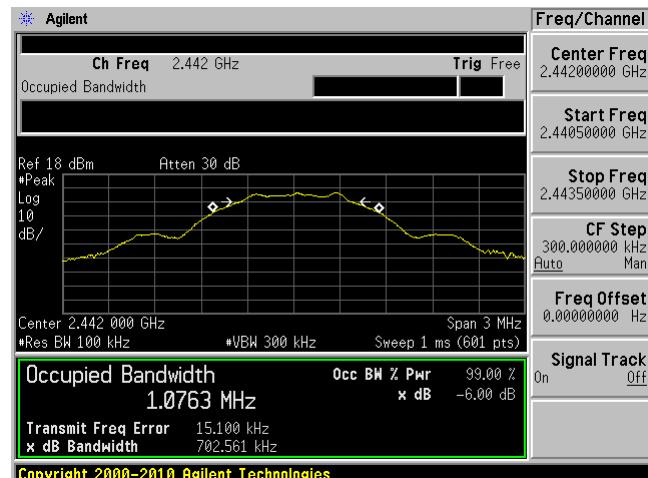


6 dB Occupied Bandwidth

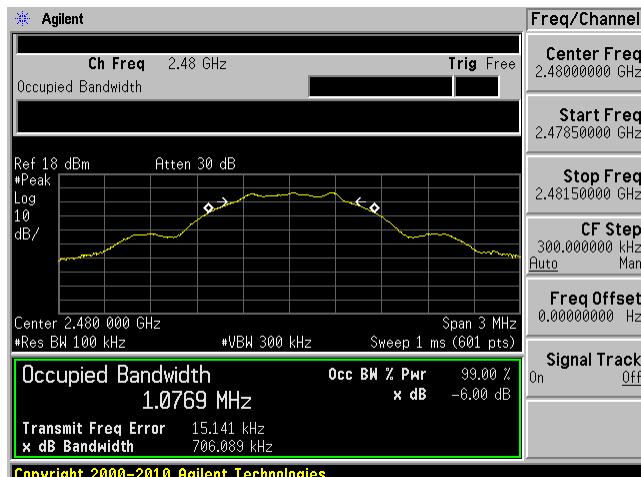
Low Channel 2402 MHz



Middle Channel 2442 MHz



High Channel 2480 MHz



8 FCC §15.247(b) (3) & ISEDC RSS-247 §5.4(d) - Output Power

8.1 Applicable Standards

According to *FCC §15.247(b) (3)*:

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to *RSS-247 §5.4(d)*:

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

8.2 Measurement Procedure

According to *ANSI C63.10-2013 Section 11.9.1.1*:

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

- a) Set the RBW \geq DTS bandwidth.
- b) Set VBW $\geq [3 \times \text{RBW}]$.
- c) Set span $\geq [3 \times \text{RBW}]$.
- d) Sweep time = auto couple.
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use peak marker function to determine the peak amplitude level.

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2019-03-19	1 year
-	SMA cable	-	-	Each time ¹	N/A

Note¹: cable 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.

8.4 Test Environmental Conditions

Temperature:	25° C
Relative Humidity:	44 %
ATM Pressure:	102.0 KPa

The testing was performed by Matthew Riego de Dios on 2020-02-18 at RF Bench.

8.5 Test Results

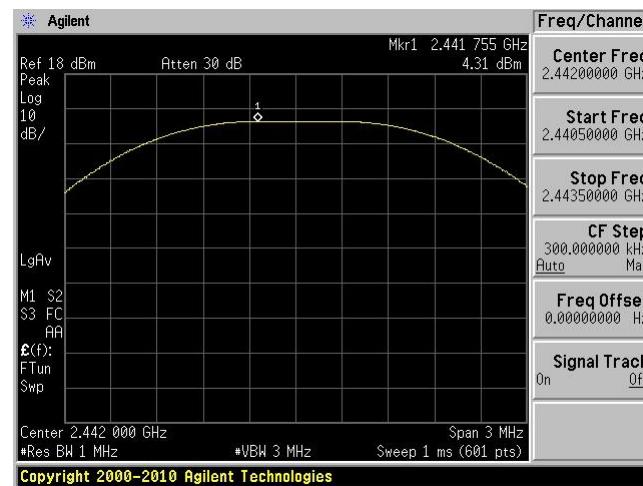
Channel	Frequency (MHz)	Conducted Output Power (dBm)	Limit (dBm)	Comments
Low	2402	4.21	30	Passed
Middle	2442	4.31	30	Passed
High	2480	4.39	30	Passed

Please refer to the following plots for detailed test results.

Low Channel 2402 MHz



Middle Channel 2442 MHz



High Channel 2480 MHz



9 FCC §15.247(e) & ISEDC RSS-247 §5.2(b) - Power Spectral Density

9.1 Applicable Standards

According to *FCC §15.247(e)* and *RSS-247 §5.2(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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

9.2 Measurement Procedure

According to *ANSI C63.10-2013 Section 11.10.2*:

The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

- a) Set analyzer center frequency to DTS channel center frequency.
- b) Set the span to 1.5 times the DTS bandwidth.
- c) Set the RBW to 3 kHz = RBW = 100 kHz.
- d) Set the VBW = [3 × RBW].
- e) Detector = peak.
- f) Sweep time = auto couple.
- g) Trace mode = max hold.
- h) Allow trace to fully stabilize.
- i) Use the peak marker function to determine the maximum amplitude level within the RBW.
- j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2019-03-19	1 year
-	SMA cable	-	-	Each time ¹	N/A

Note¹: cable 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.

9.4 Test Environmental Conditions

Temperature:	25° C
Relative Humidity:	44 %
ATM Pressure:	102.1 KPa

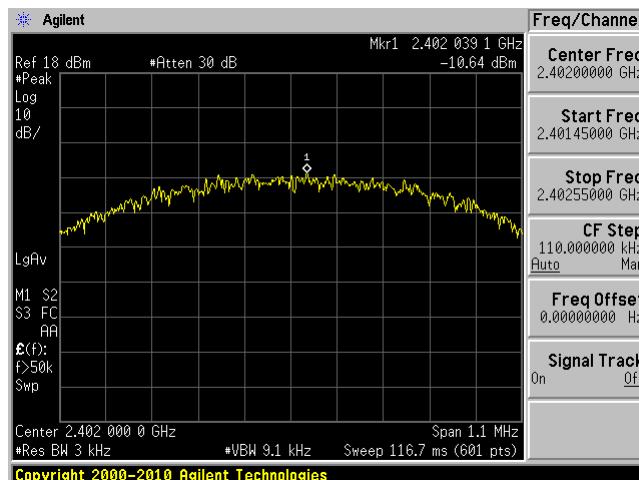
The testing was performed by Matthew Riego de Dios on 2020-02-18 at RF Bench.

9.5 Test Results

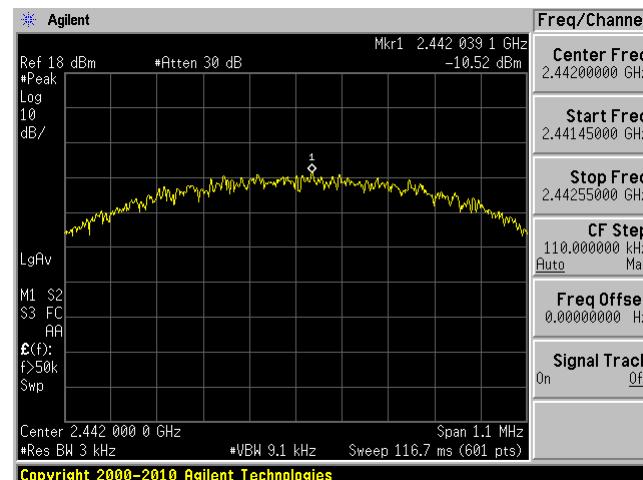
Channel	Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Comments
Low	2402	-10.64	8	Passed
Middle	2442	-10.52	8	Passed
High	2480	-10.54	8	Passed

Please refer to the following plots for detailed test results.

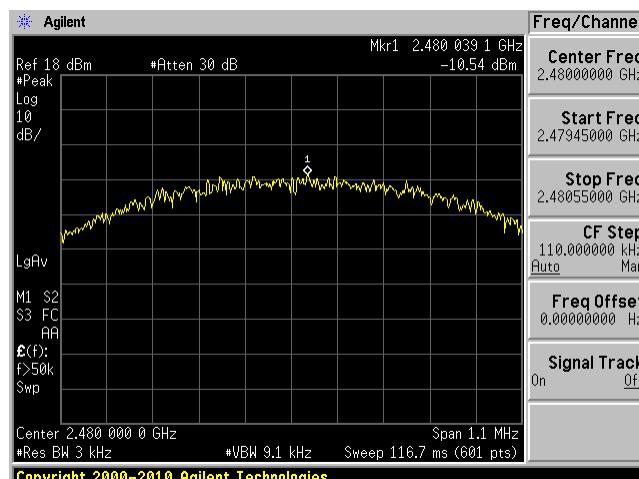
Low Channel 2402 MHz



Middle Channel 2442 MHz



High Channel 2480 MHz



10 FCC §15.247(d) & ISEDC RSS-247 §5.5 - Band Edge

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 *ISEDC RSS-247 §5.5*:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(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.

10.2 Measurement Procedure

Spectrum analyzer settings:

- a) Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
- b) RBW = 100 kHz
- c) VBW = 300 kHz
- d) Sweep = coupled
- e) Detector function = peak
- f) Trace = max hold

Step 1: Use peak search to place first marker on the highest point of the fundamental signal and place another marker to the band edge.

Step 2: Compare with limit.

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2019-03-19	1 year
-	SMA cable	-	-	Each time ¹	N/A

Note¹: cable 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.

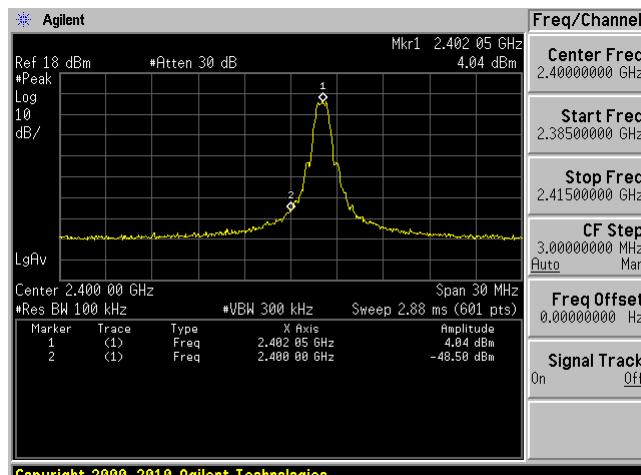
10.4 Test Environmental Conditions

Temperature:	25° C
Relative Humidity:	44 %
ATM Pressure:	102.0 KPa

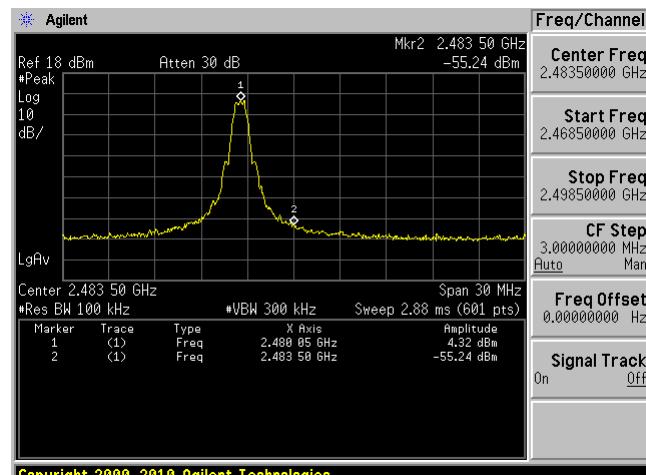
The testing was performed by Matthew Riego de Dios on 2020-02-18 at RF Bench.

10.5 Test Results

Low Channel 2402 MHz



High Channel 2480 MHz



Comments: Band Edges are 20 dB below the peak fundamental signal – Passed.

11 FCC §15.247(d) & ISEDC RSS-247 §5.5 - Spurious Emissions at Antenna Terminals

11.1 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 *ISEDC RSS-247 §5.5*:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(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.

11.2 Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 1 MHz. Sufficient scans were taken to show any out of band emissions up to the 10th harmonic.

11.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2019-03-19	1 year
-	SMA cable	-	-	Each time ¹	N/A

Note¹: cable 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.

11.4 Test Environmental Conditions

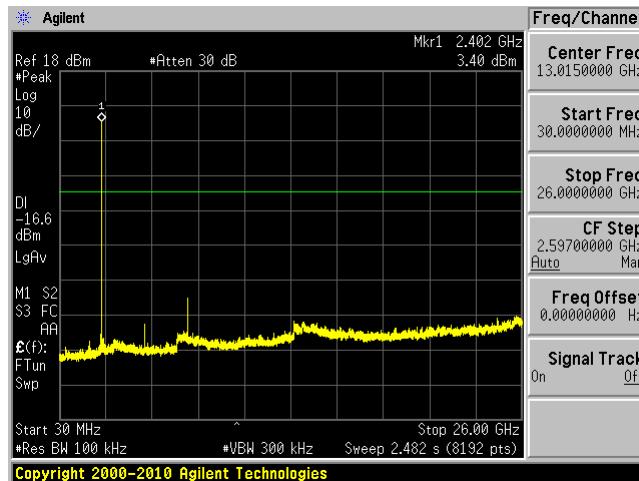
Temperature:	25° C
Relative Humidity:	44 %
ATM Pressure:	102.0 KPa

The testing was performed by Matthew Riego de Dios on 2020-02-18 at RF Bench.

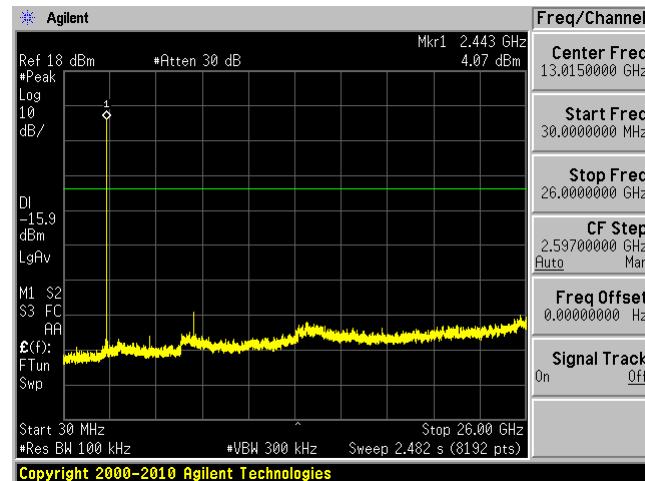
11.5 Test Results

Please refer to the following plots.

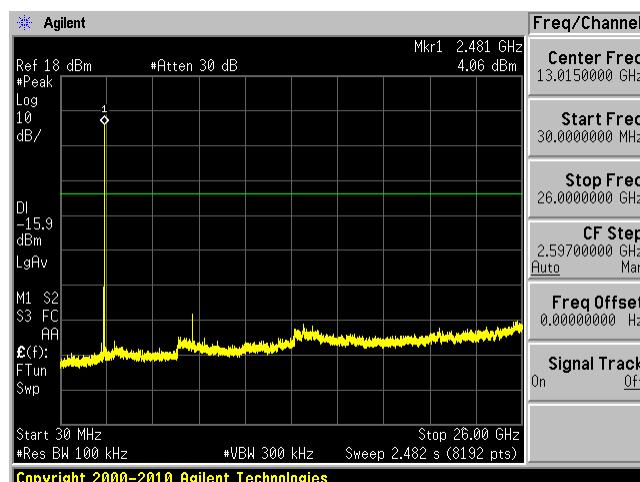
Low Channel, 2402 MHz



Middle Channel, 2442 MHz



High Channel, 2480 MHz



12 FCC §2.1053, §15.205, §15.209, §15.247(d) & ISEDC RSS-247 §5.5, RSS-Gen §8.9, §8.10 - Spurious Radiated Emissions

12.1 Applicable Standards

As per *FCC §2.1053(a)*, Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.

(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

- (1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
- (2) All equipment operating on frequencies higher than 25 MHz.
- (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
- (4) Other types of equipment as required, when deemed necessary by the Commission.

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	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 §15.209(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 §15.247 (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 *ISEDC RSS-Gen 8.9*, Except when the requirements applicable to a given device state otherwise, emission from licence-exempt transmitters shall comply with the field strength limits shown in the table below. Additional, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for Licence-Exemption Transmitters at Frequencies above 30 MHz

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

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

As per ISEDC RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(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.

12.2 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 the FCC 15 Subpart C and ISEDC RSS-247 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.

12.3 Test Procedure

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 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 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

12.4 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:

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

12.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rhode & Schwarz	EMI Test Receiver	ESU-40	100433	2019-02-06	13 months
Rhode & Schwarz	Signal Analyzer	FSV40	1321.3008K39 -101203-UW	2019-08-06	1 year
Sunol Science Corp	System Controller	SC99V	011003-1	N/R	N/R
Sunol Sciences	Biconilog Antenna	JB3	A020106-2	2019-11-20	2 years
ETS Lindgren	Horn Antenna	3117	00218973	2019-02-13	2 years
IW Microwave	150 Series 2.92mm Cable	KPS-1501AN-3780-KPS	DC 1925	2019-09-11	1 year
MDP DIgital	Times Microwave LMR 400 UltraFex Coaxial Cable 35\'	LMR400UF	BACL1904161	2019-04-16	1 year
IW Microwave	157 Series 2.92mm Cable	KPS-1571AN-2400-KPS	DC 1922	2019-06-07	1 year
-	SMA cable	-	-	Each time ¹	N/A
HP/ Agilant	Pre Amplifier	8449B OPT HO2	3008A0113	2019-09-30	1 year
Agilent	Amplifier, Pre	8447D	2944A10187	2019-04-11	1 year
Wisewave	Antenna, Horn	ARH-4223-02	10555-02	2020-02-05	2 years
Agilent	Spectrum Analyzer	E4446A	MY48250238	2019-06-26	1 year
AH Systems	Preamplifier	PAM 1840 VH	170	2019-09-24	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R
MICRO -TRONICS	Band Reject	BRM50701	160	Each time ¹	N/A

Note¹: cable and notch filter 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.

12.6 Test Environmental Conditions

Temperature:	25 °C
Relative Humidity:	34 %
ATM Pressure:	102.2 kPa

The testing was performed by Matthew Riego de Dios from 2020-02-27 to 2020-03-02 in 5 meter Chamber 3.

12.7 Summary of Test Results

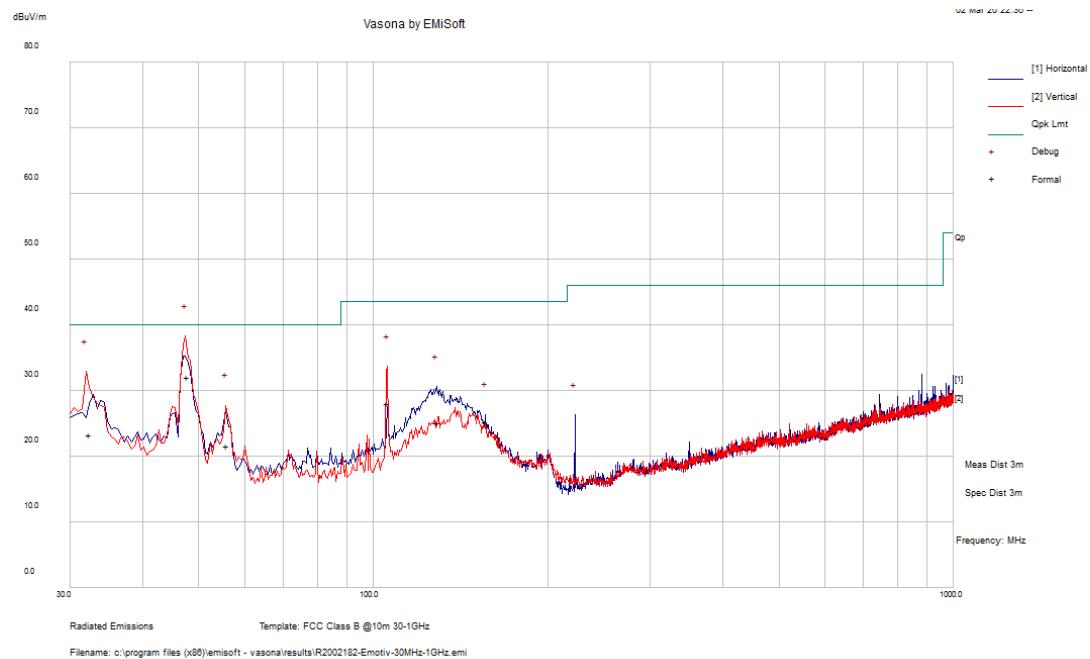
According to the data hereinafter, the EUT complied with FCC Title 47, Part 15C& ISEDC RSS-247 standard's radiated emissions limits, and had the worst margin of:

Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Transmitting Channel
-0.29	7326	Horizontal	2442 MHz

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

12.8 Radiated Emissions Test Results

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



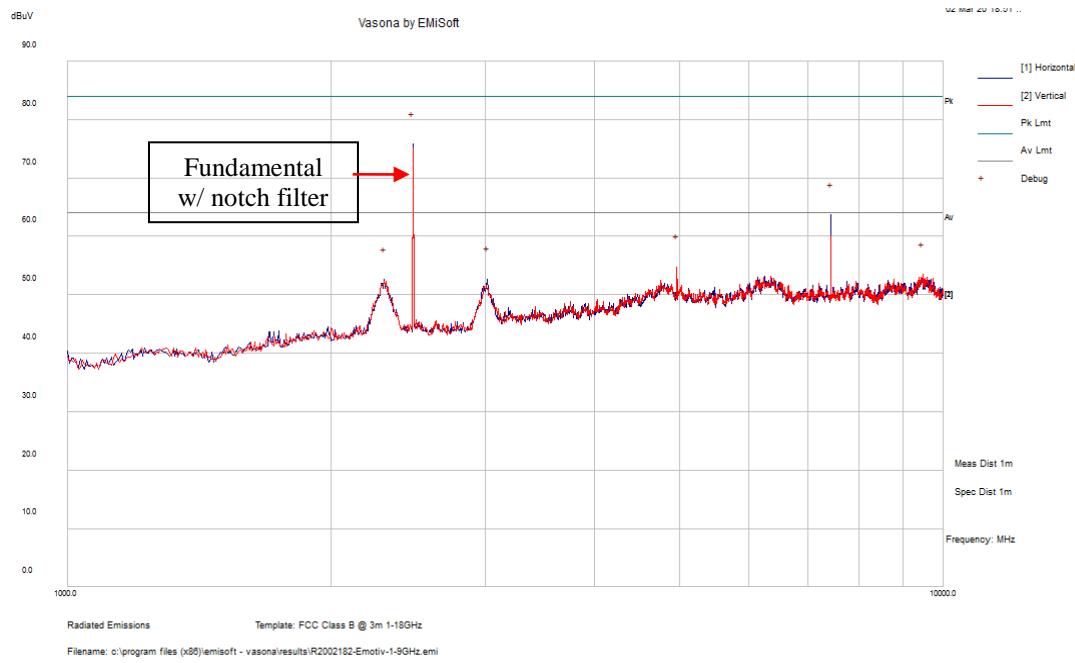
Frequency (MHz)	Corrected Amplitude (dB μ V/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turtable Azimuth (degrees)	Limit (dB μ V/m)	Margin (dB)	Comment
47.7955	32.04	125	V	214	40	-7.96	QP
32.41025	23.36	205	V	95	40	-16.64	QP
105.69	28.1	233	V	309	43.5	-15.4	QP
55.90775	21.61	145	H	173	40	-18.39	QP
128.7375	25.13	289	H	192	43.5	-18.37	QP
156.382	25.29	289	H	141	43.5	-18.21	QP

2) 1–18 GHz, Measured at 3 meters

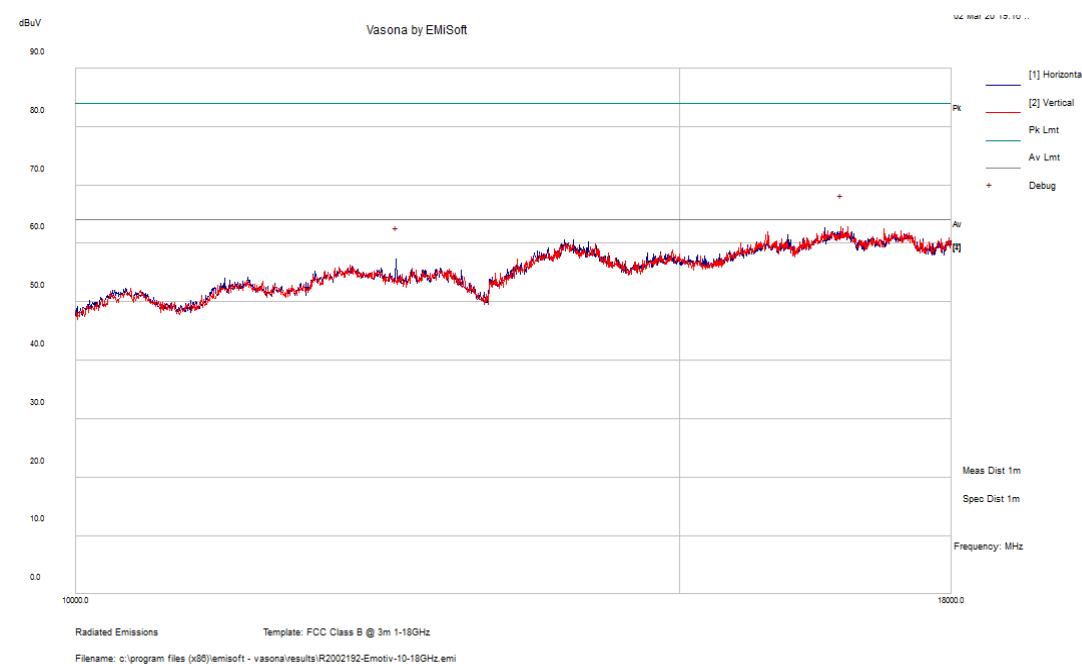
Frequency (MHz)	S.A. Reading (dB μ V)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dB μ V/m)	FCC/ISEDC		Comment
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dB μ V/m)	Margin (dB)	
Low Channel Frequency: 2402 MHz Power Setting: 4											
2402	104.35	93	281	H	32.60	6.33	39.31	103.97	-	-	PK
2402	96.79	323	157	V	32.60	6.33	39.31	96.41	-	-	PK
2390	48.47	0	100	H	32.60	6.33	39.31	48.09	74	-25.91	PK
2390	36.76	0	100	H	32.60	6.33	39.31	36.38	54	-17.62	AV
2390	48.11	0	100	V	32.60	6.33	39.31	47.73	74	-26.27	PK
2390	36.73	0	100	V	32.60	6.33	39.31	36.35	54	-17.65	AV
4804	46.32	70	195	H	35.00	9.89	37.60	49.37	74	-24.63	PK
4804	36.50	70	195	H	35.00	9.89	37.60	43.79	54	-10.21	AV
7206	51.91	122	240	H	36.10	9.83	37.67	60.17	83.97	-23.80	PK
Middle Channel Frequency: 2442 MHz Power Setting: 4											
4884	44.81	137	100	H	35.30	10.96	37.60	53.47	74	-20.53	PK
4884	34.13	137	100	H	35.30	10.96	37.60	42.79	54	-11.21	AV
7326	52.25	134	100	H	36.10	10.99	37.67	61.67	74	-12.33	PK
7326	44.29	134	100	H	36.10	10.99	37.67	53.71	54	-0.29	AV
High Channel Frequency: 2480 MHz Power Setting: 4											
2483.5	60.18	107	260	H	33.00	5.65	39.02	59.81	74	-14.19	PK
2483.5	43.83	107	260	H	33.00	5.65	39.02	43.46	54	-10.54	AV
2483.5	54.39	330	130	V	33.00	5.65	39.02	54.02	74	-19.98	PK
2483.5	39.40	330	130	V	33.00	5.65	39.02	39.03	54	-14.97	AV
4960	45.48	134	251	H	35.40	11.07	37.60	54.35	74	-19.65	PK
4960	34.37	134	251	H	35.40	11.07	37.60	43.24	54	-10.76	AV
7440	51.61	175	250	H	36.10	11.01	37.75	60.98	74	-13.03	PK
7440	43.34	175	250	H	36.10	11.01	37.75	52.71	54	-1.29	AV

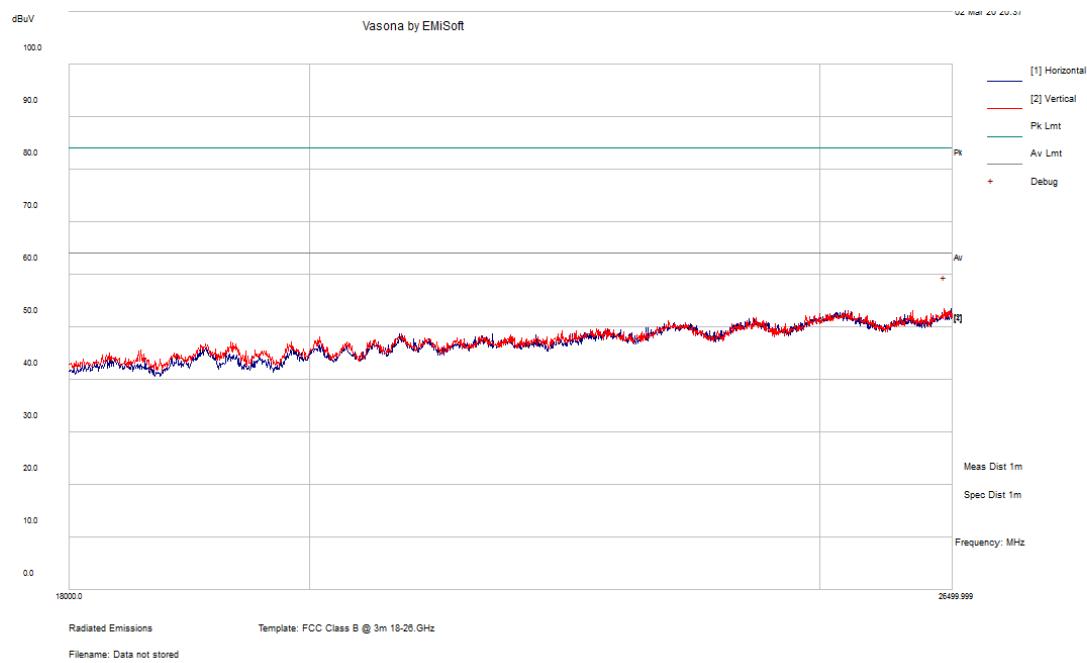
Worst Case: High Channel, Freq. 2480 MHz, Power Setting: 4

1 GHz – 10 GHz Worst Case, Measured at 1 meter



10 GHz – 18 GHz Worst Case, Measured at 1 meter



18 GHz – 26.5 GHz Worst Case, Measured at 1 meter

13 Annex A - Test Setup Photographs

Please refer to the attachment

14 Annex B - EUT External Photographs

Please refer to the attachment

15 Annex C - EUT Internal Photographs

Please refer to the attachment

16 Annex D (Normative) - A2LA Electrical Testing Certificate



Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories. This laboratory also meets A2LA R222

- Specific Requirements EPA ENERGY STAR Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



Presented this 2nd day of October 2018.

A blue ink signature of a person's name, which is the Vice President of Accreditation Services.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2020
Revised June 5, 2019

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

Please follow the web link below for a full ISO 17025 scope

<https://www.a2la.org/scopepdf/3297-02.pdf>

--- END OF REPORT ---