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TEST REPORT

For

MbientLab, Inc.

848 Girard St.,

San Francisco, CA 94134, USA

FCC ID: 2ACEB-MMR
IC: 12118A-MMR

Report Type: Original Report	Product Type: Wireless Sensor
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* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk “*” Rev. 03

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1804095-247	Original Report	2018-05-14

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

Manufacturer:	MbientLab Inc.
EUT Name:	MetaMotionR
EUT Model(s):	MetaMotionR
FCC ID:	2ACEB-MMR
IC:	12118A-MMR
Serial Number(s):	R1803095-01 and R1803095-02

1.2 Mechanical Description of EUT

Height (mm)	Width (mm)	Dimension (mm)	Weight (kg)
400	300	100	0.1

1.3 Objective

This report is prepared on behalf of *MbientLab 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 on February 2017.

The objective is to determine compliance with FCC Part 15.247 and ISED RSS-247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

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 and FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

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, 3rd-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 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 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 and FCC KDB 558074 D01 DTS Meas Guidance v04.

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

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

2.2 EUT Exercise Software

N/A

Modulation	Frequency (MHz)	Power Setting
GFSK (1 MHz)	2402	Default
	2440	Default
	2480	Default
GFSK (2 MHz)	2402	Default
	2440	Default
	2480	Default

2.3 Duty Cycle Correction Factor

According to KDB 558074 D01 DTS Meas Guidance v04 section 6.0:

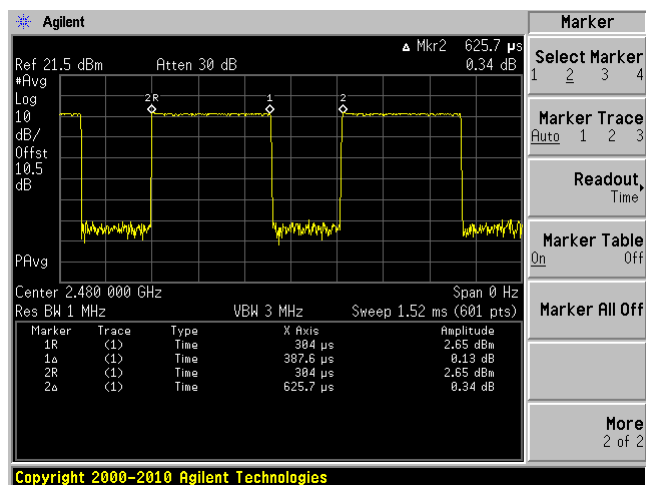
Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized 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).

Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
GFSK (1 MHz)	0.3876	0.6257	61.94	2.08
GFSK (2 MHz)	0.2001	0.6232	32.11	4.93

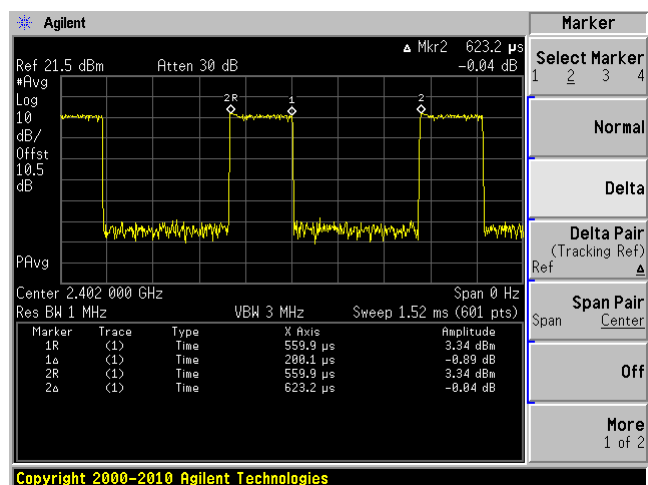
Duty Cycle = On Time (ms)/ Period (ms)
Duty Cycle Correction Factor (dB) = $10 \cdot \log(1/\text{Duty Cycle})$

Please refer to the following plots.

GFSK (1 MHz)



GFSK (2 MHz)



2.4 Equipment Modifications

N/A

2.5 Local Support Equipment

There was no local support equipment required for use with EUT during these tests.

2.6 Support Equipment

None

2.7 Power Supply/Adapter

Manufacturer	Description	Model
FLEXTRONICS	AC Adaptor	A00910-01

2.8 Interface Ports and Cabling

Cable Description	Length (m)	To	From
Micro USB	1	EUT	USB Charger

2.9 Hardware Version

Manufacturer	Description	Model
MbientLab Inc.	Mbientlab MetaMotionR	N/A

3 Summary of Test Results

Results reported relate only to the product tested.

FCC and ISEDC Rules	Description of Test	Results
FCC §15.203 ISEDC RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §15.207 ISEDC RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §2.1093, §15.247(i) ISEDC RSS-102	RF Exposure	Compliant
FCC §2.1051, §15.247 (d) ISEDC RSS-247 §5.5 ISEDC RSS-Gen §8.9	Spurious Emissions at Antenna Port	Compliant
FCC §2.1053, §15.205, §15.209, §15.247(d) ISEDC RSS-247 §5.5 ISEDC RSS-Gen §8.9 and §8.10	Radiated Spurious Emissions	Compliant
FCC §15.247(a)(2) ISEDC RSS-247 §5.2 (1)	6 dB and 99% Emission Bandwidth	Compliant
FCC §15.247(b)(3) ISEDC RSS-247 §5.4(4)	Maximum Peak Output Power	Compliant
FCC §15.247(d) ISEDC RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(e) ISEDC RSS-247 §5.2(2)	Power Spectral Density	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.

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 antennas used by the EUT are permanent attached antennas. The following antenna specifications were provided by the applicant.

Frequency Range (MHz)	ANT Gain (dBi)
2402-2480	1.0

5 FCC §2.1093, §15.247(i) & ISEDC RSS-102 - RF Exposure

5.1 Applicable Standards

According to FCC KDB 447498 D01 General RF Exposure Guidance v05r02 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:

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

- $f(\text{GHz})$ 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) $[\text{Power allowed at numeric threshold for 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) \cdot (f(\text{MHz})/150)] \text{ mW}$, at 100 MHz to 1500 MHz
 - b) $[\text{Power allowed at numeric threshold for 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) \cdot 10] \text{ mW}$ at > 1500 MHz and ≤ 6 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 §2.5.1,

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 1.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance

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

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required. For medical implants devices, the exemption limit for routine evaluation is set at 1 mW.

The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.

5.2 RF Exposure Evaluation Results MPE Prediction

The highest measured conducted power as reported in Section 9.5 of this report was 3.54 dBm (2.259 mW) at 2402 MHz.

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

$(2.259/5) \cdot \sqrt{2.402} = 0.70$ which is less than 3.0

For ISED, based on table 1, the max EIRP power 2.844 mW is less than 4 mW.

Conclusion:

The maximum average output power is lower than both FCC and ISED SAR Exemption limit. Thus, SAR was exempted for this device.

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

6.1 Applicable Standards

As per FCC §15.207 and ISEDC 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 ISEDC 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 and 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:

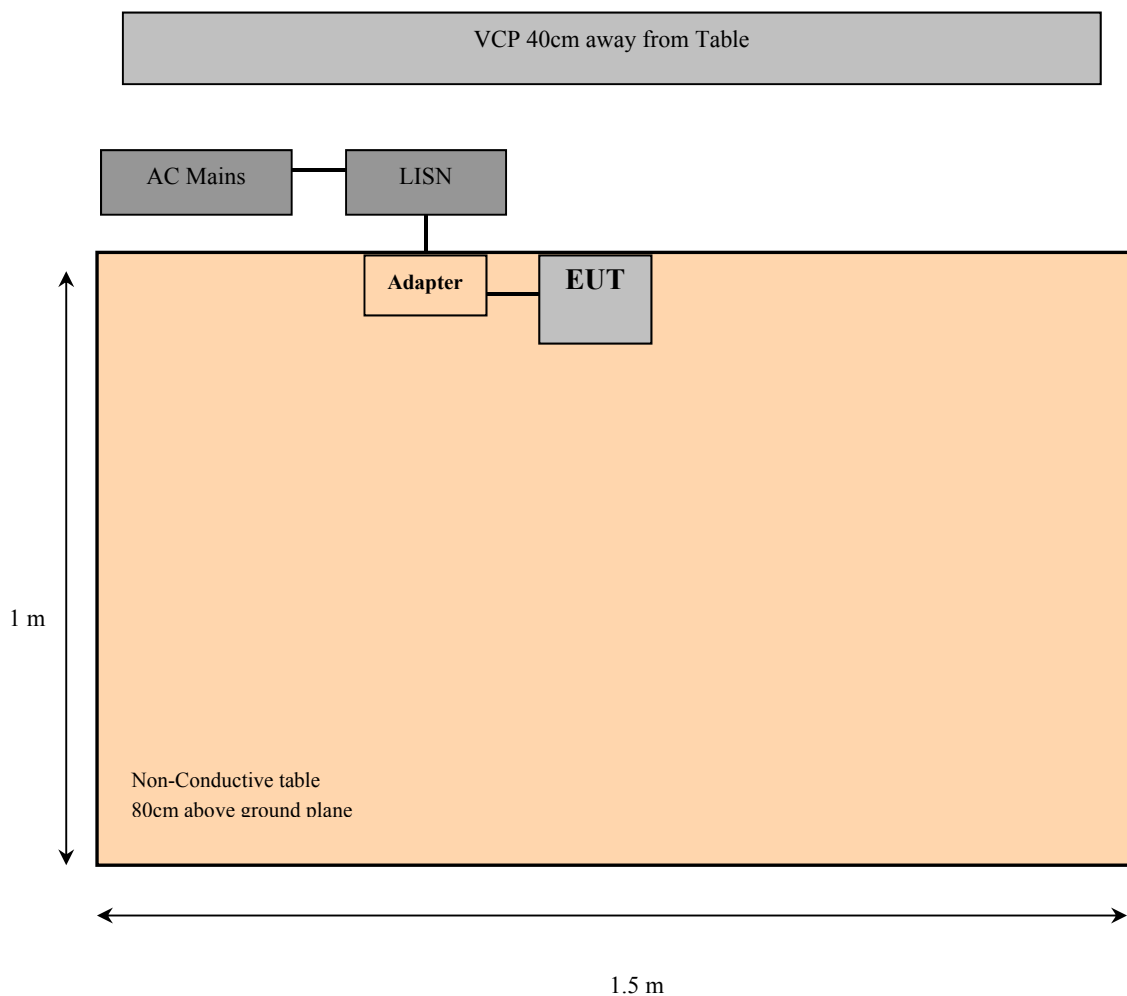
$$CA = A_i + CL + \text{Atten}$$

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:

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

6.5 Test Setup Block Diagram



6.6 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	2016-06-23	2 years
Rohde and Schwarz	Impulse Limiter	ESH3-Z2	101964	2017-07-25	1 year
Keysight Technologies	RF Limiter	11867A	MY42242931	2018-02-05	1 year
Solar Electronics Company	High Pass Filter	Type 7930-100	7930150202	2018-02-27	1 year
Suirong	30 ft conductive emission cable	LMR 400	-	N/R	N/A
FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160134	2017-05-22	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Statement of Traceability: BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) “A2LA Policy on Metrological Traceability”.

6.7 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Troy Pandhumsoporn on 2018-04-13 at 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:

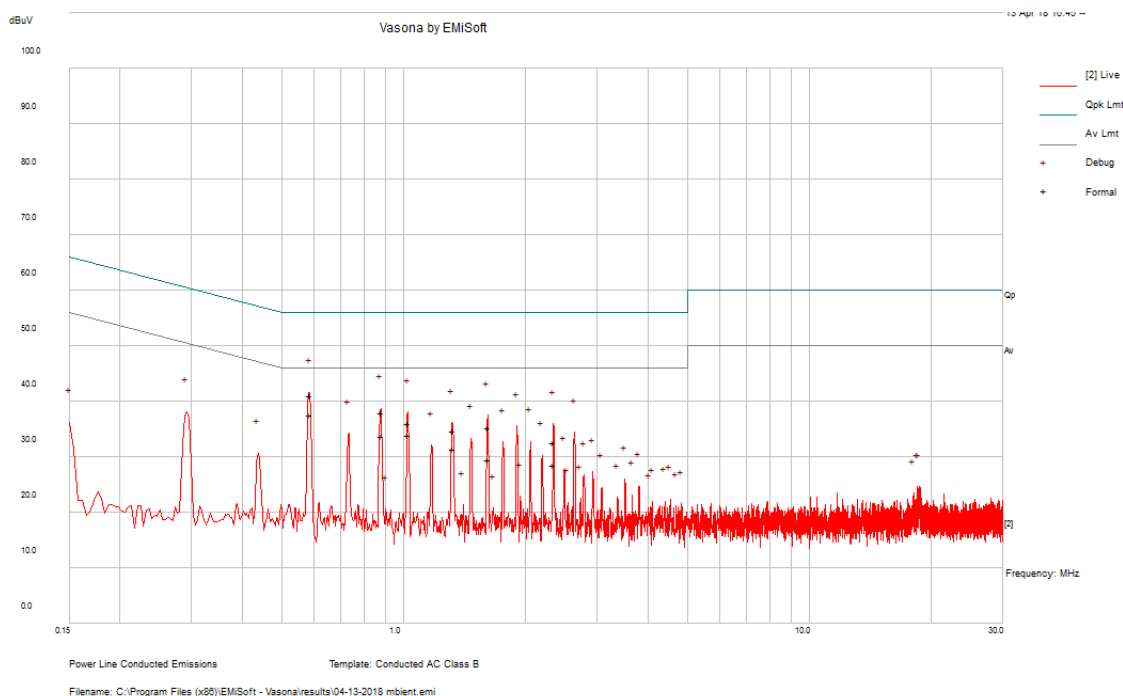
2.4 GHz BLE, GFSK, 2402 MHz, 2 MHz BW

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	Frequency (MHz)	Conductor Mode (Line/Neutral)	Range (MHz)
-7.68	0.586094	Neutral	0.15-30

6.9 Conducted Emissions Test Plots and Data

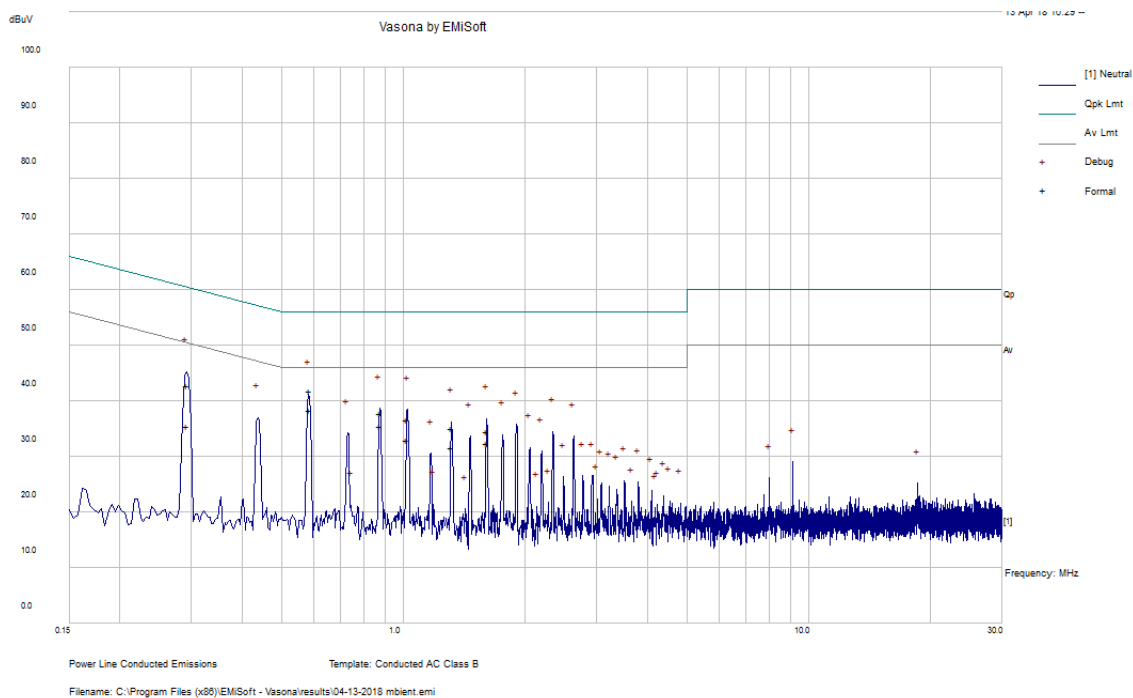
2.4 GHz BLE, GFSK, 2402 MHz, 2 MHz BW

120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.58763	41.16	Line	56	-14.84	QP
0.881765	37.92	Line	56	-18.08	QP
1.025961	36.15	Line	56	-19.85	QP
1.614885	35.23	Line	56	-20.77	QP
1.319916	34.77	Line	56	-21.23	QP
2.340841	32.63	Line	56	-23.37	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.58763	37.56	Line	46	-8.44	Ave.
0.881765	33.69	Line	46	-12.31	Ave.
1.025961	33.9	Line	46	-12.1	Ave.
1.614885	29.6	Line	46	-16.4	Ave.
1.319916	31.49	Line	46	-14.51	Ave.
2.340841	28.62	Line	46	-17.38	Ave.

120 V, 60 Hz – Neutral

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.586094	41.86	Neutral	56	-14.14	QP
0.292787	42.86	Neutral	60.44	-17.58	QP
0.877169	37.88	Neutral	56	-18.12	QP
1.022271	36.62	Neutral	56	-19.38	QP
1.610451	34.57	Neutral	56	-21.43	QP
1.31583	35.16	Neutral	56	-20.84	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.586094	38.32	Neutral	46	-7.68	Ave.
0.292787	35.49	Neutral	50.44	-14.96	Ave.
0.877169	35.58	Neutral	46	-10.42	Ave.
1.022271	32.99	Neutral	46	-13.01	Ave.
1.610451	32.4	Neutral	46	-13.6	Ave.
1.31583	31.58	Neutral	46	-14.42	Ave.

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

7.1 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	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		

ISED RSS-Gen §8.10 Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	13.36 - 13.41	608 - 614	
0.495 - 0.505	16.42-16.432	960 - 1427	
2.1735 - 2.1905	16.69475 - 16.69525	1435 - 1626.5	
3.020 - 3.026	16.80425 - 16.80475	1645.5 - 1646.5	9.0 - 9.2
4.125 - 4.128	25.5 - 25.67	1660 - 1710	9.3 - 9.5
4.17725 - 4.17775	37.5 - 38.25	1718.8-1722.22	10.6 - 12.7
4.20725 - 4.20775	73 - 74.6	2200 - 2300	13.25 - 13.4
5.677 - 5.683	74.8 - 75.2	2310 – 2390	14.47 - 14.5
6.215 - 6.218	108 – 138	2483.5 - 2500	15.35 - 16.2
6.26775 - 6.26825	149.9 - 150.05	2655 - 2900	17.7 - 21.4
6.31175 - 6.31225	156.52475 - 156.52525	3260 - 3267	22.01 -23.12
8.291 - 8.294	156.7 - 156.9	3332 - 3339	23.6 - 24.0
8.362 - 8.366	162.0125 - 167.17	3345.8 - 3358	31.2 - 31.8
8.37625 - 8.38675	167.72 - 173.2	3500 - 4400	36.43 - 36.5
8.41425 - 8.41475	240 - 285	4500 - 5150	Above 38.6
12.29 - 12.293	322 - 335.4	5350 - 5460	
12.51975 - 12.52025	399.9 - 410	7250 - 7750	
12.57675 - 12.57725		8025 -8500	

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 ISED 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. Additionally, 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 (µv/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 license-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 ISED 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.

7.2 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 ISED 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.

7.3 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:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

Above 1000 MHz:

(1) Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto

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

7.4 Corrected Amplitude and 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:

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

7.5 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	2016-06-23	2 years
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2017-06-08	2 year
Sunol Sciences	System Controller	SC99V	011003-1	N/R	N/A
Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2018-02-26	31 Months
Agilent	Amplifier, Pre	8447D	2944A06639	2017-06-28	1 year
Wisewave	Antenna, Horn 18-26.5GHz	ARH-4223-02	10555-02	2017-12-15	2 years
AH Systems	Pre-Amplifier 18-40GHz	PAM-1840VH	170	2017-02-28	14 Months
-	N-Type Cable	-	C00014	Each time ¹	N/A
Agilent	Pre-Amplifier	8449B	3147A00400	2017-06-15	1 year
Sunol Sciences	Antenna, Horn	DRH-118	A052704	2017-03-27	2 years
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) “A2LA Policy on Metrological Traceability”.

7.6 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Troy Pandhumsoporn 2018-04-10 to 2018-04-11 in 5 m chamber 3 and Harry Zhao in 10 m chamber 1.

7.7 Summary of Test Results

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

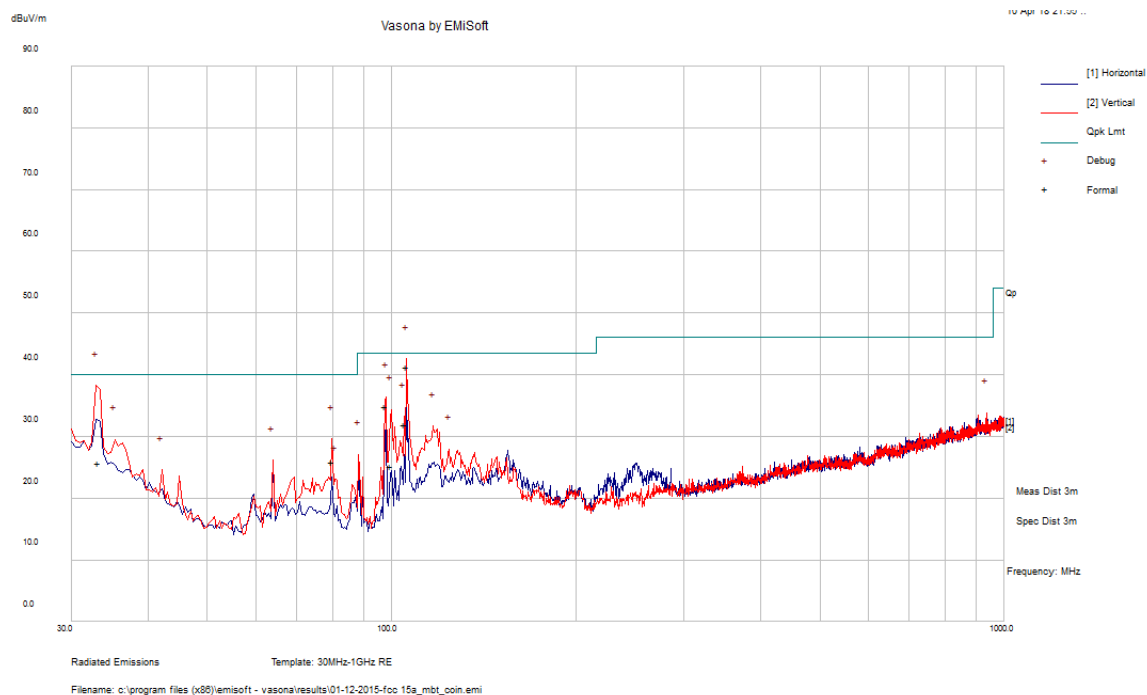
Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Mode, channel
-2.21	105.69525	Vertical	GFSK, 2402 MHz, 2 MHz BW

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

7.8 Radiated Emissions Test Results

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

2.4 GHz BLE, GFSK, 2402 MHz, 2 MHz BW



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comment
105.69525	41.29	100	V	339	43.5	-2.21	QP
33.158	25.8	116	V	121	40	-14.2	QP
97.74675	34.82	104	V	176	43.5	-8.68	QP
99.8005	25.14	130	V	9	43.5	-18.36	QP
104.8995	31.93	117	V	0	43.5	-11.57	QP
79.985	25.97	150	V	147	40	-14.03	QP

2) 1–25 GHz Measured at 3 meters

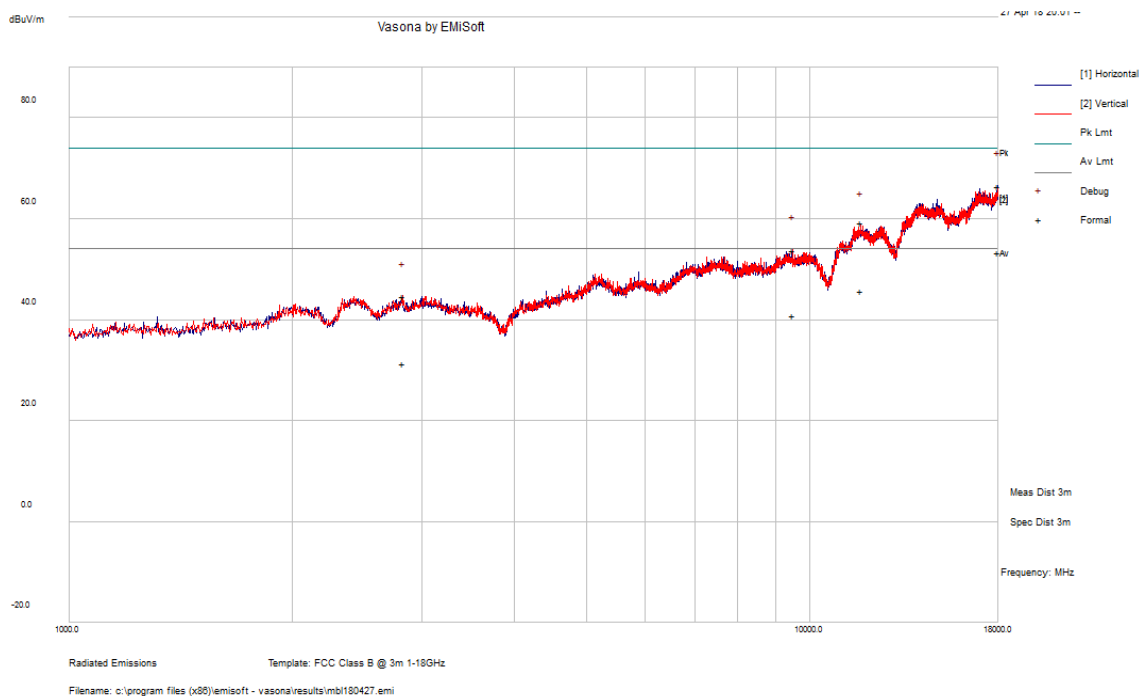
GFSK mode

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/ISED		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel 2402 MHz											
2402	52.33	246	203	H	28.94	5.76	0	87.03	-	-	PK
2402	48.55	246	203	H	28.94	5.76	0	83.25	-	-	AV
2402	50.84	169	191	V	28.93	5.76	0	85.53	-	-	PK
2402	45.95	169	191	V	28.93	5.76	0	80.64	-	-	AV
2390	48.88	0	246	H	28.94	6.49	32.21	52.11	74.00	-21.89	PK
2390	34.86	0	246	H	28.94	6.49	32.21	38.09	54.00	-15.91	AV
2390	48.09	0	100	V	28.93	6.49	32.21	51.30	74.00	-22.70	PK
2390	34.92	0	100	V	28.93	6.49	32.21	38.13	54.00	-15.87	AV
4804	46.13	294	100	H	32.54	9.36	33.15	54.88	74.00	-19.12	PK
4804	32.16	294	100	H	32.54	9.36	33.15	40.91	54.00	-13.09	AV
7206	44.85	0	100	H	36.73	12.01	33.25	60.34	74.00	-13.66	PK
7206	31.64	0	100	H	36.73	12.01	33.25	47.13	54.00	-6.87	AV
Middle Channel 2440 MHz											
2440	55.05	235	157	H	29.15	5.76	0.00	89.96	-	-	PK
2440	51.44	235	157	H	29.15	5.76	0.00	86.35	-	-	AV
2440	52.29	169	208	V	29.19	5.76	0.00	87.24	-	-	PK
2440	48.47	169	208	V	29.19	5.76	0.00	83.42	-	-	AV
4880	45.06	0	190	H	32.81	9.46	33.15	54.17	74.00	-19.83	PK
4880	31.82	0	190	H	32.81	9.46	33.15	40.93	54.00	-13.07	AV
7320	45.60	0	100	H	37.06	11.97	33.22	61.40	74.00	-12.60	PK
7320	31.81	0	100	H	37.06	11.97	33.22	47.61	54.00	-6.39	AV
High Channel 2480 MHz											
2480	54.79	229	154	H	29.25	5.76	0.00	89.80	-	-	PK
2480	50.74	229	154	H	29.25	5.76	0.00	85.75	-	-	AV
2480	53.19	172	208	V	29.18	5.76	0.00	88.13	-	-	PK
2480	48.52	172	208	V	29.18	5.76	0.00	83.46	-	-	AV
2483.5	54.10	232	156	H	29.25	6.62	32.21	57.76	74.00	-16.24	PK
2483.5	42.18	232	156	H	29.25	6.62	32.21	45.84	54.00	-8.16	AV
2483.5	52.89	165	211	V	29.18	6.62	32.21	56.48	74.00	-17.52	PK
2483.5	40.68	165	211	V	29.18	6.62	32.21	44.27	54.00	-9.73	AV
4960	45.37	0	100	H	32.78	9.46	33.15	54.46	74.00	-19.54	PK
4960	32.28	0	100	H	32.78	9.46	33.15	41.37	54.00	-12.63	AV
7440	45.65	0	100	H	37.07	12.01	33.22	61.51	74.00	-12.49	PK
7440	32.74	0	100	H	37.07	12.01	33.22	48.60	54.00	-5.40	AV

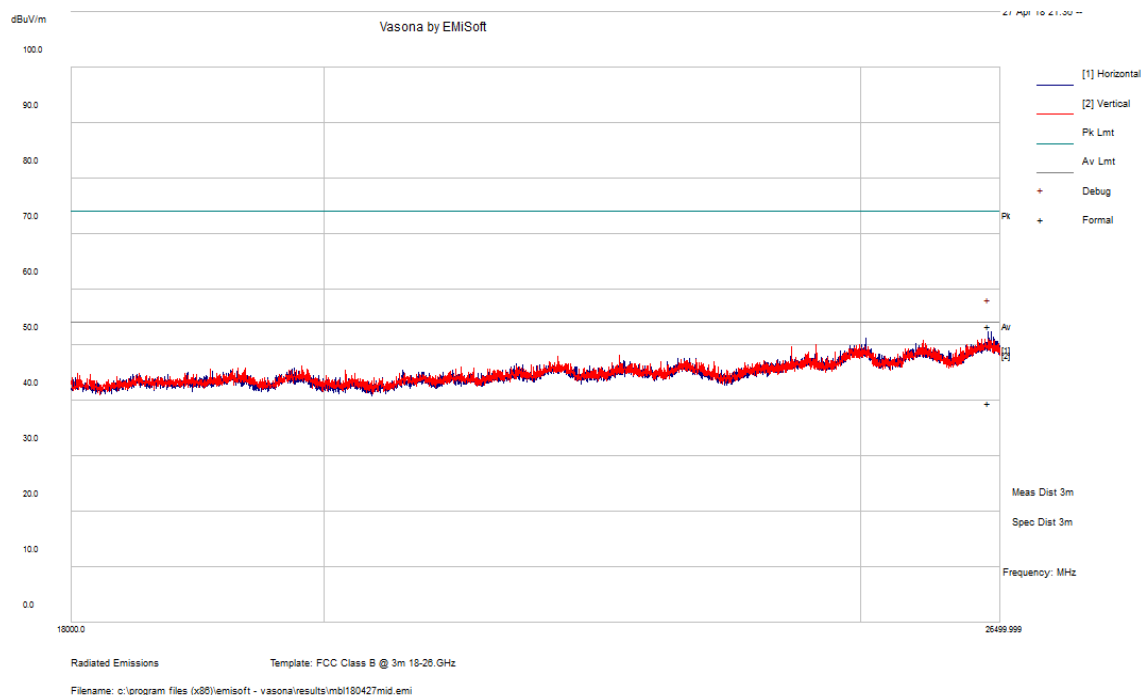
The worst case GFSK mode Low Channel has been listed below.

1 GHz – 18 GHz

This test was performed with a 2.4 – 2.4835GHz band reject filter.



18 GHz – 26.5 GHz



8 FCC §15.247(a)(2) & ISEDC RSS-247 §5.2 -Emission Bandwidth

8.1 Applicable Standards

According to ECFR §15.247(a)(2) and ISEDC RSS-247 §5.2, systems using digital modulation techniques may operate in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz

8.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2018-02-26	1 year
-	RF cable	-	-	Each time ¹	N/A
-	10dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) “A2LA Policy on Metrological Traceability”.

8.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Harry Zhao on 2018-04-11 to 2018-04-12 in RF site.

8.5 Test Results

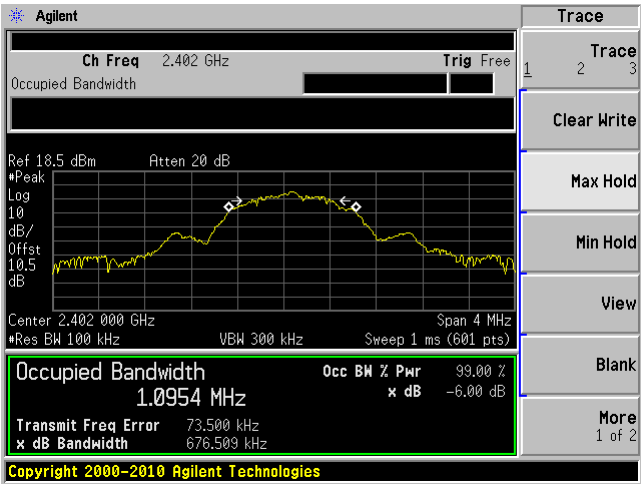
Channel	Frequency (MHz)	99 % OBW (MHz)	6 dB OBW (MHz)	6 dB OBW Limit (kHz)	Result
GFSK (1 MHz)					
Low	2402	1.0532	0.676509	≥ 500	Pass
Middle	2440	1.0944	0.624161	≥ 500	Pass
High	2480	1.0509	0.700571	≥ 500	Pass
GFSK (2 MHz)					
Low	2402	2.0829	1.053	≥ 500	Pass
Middle	2440	2.0735	1.034	≥ 500	Pass
High	2480	2.1034	0.587	≥ 500	Pass

Please refer to the following plots for detailed test results.

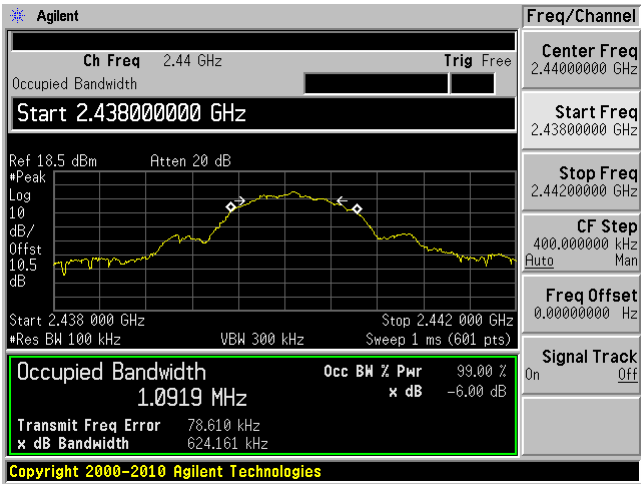
6 dB Emission Bandwidth

GFSK (1 MHz)

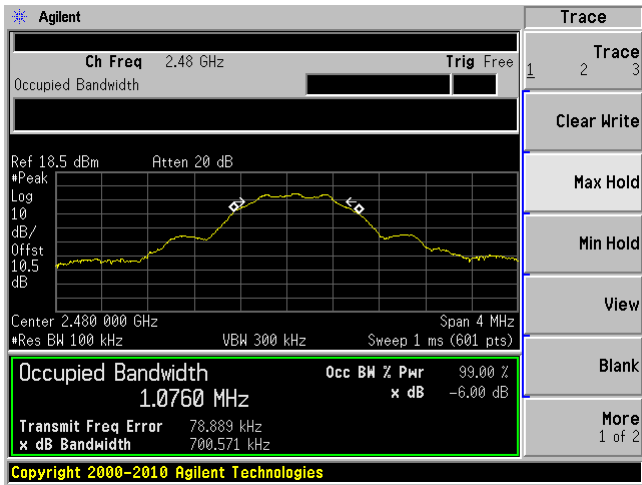
Low Channel 2402 MHz



Middle Channel 2440 MHz

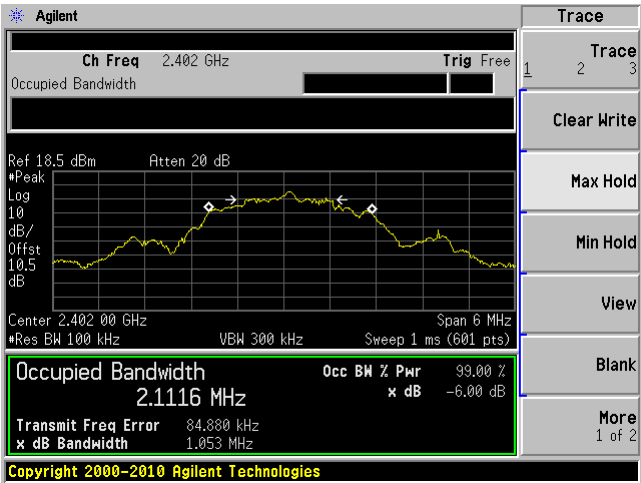


High Channel 2480 MHz

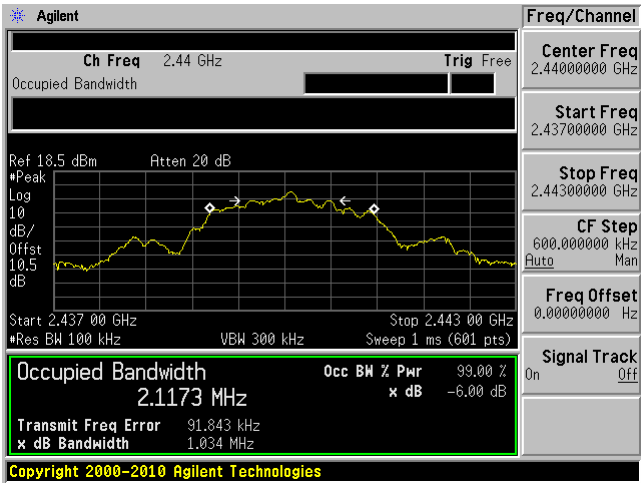


GFSK (2 MHz)

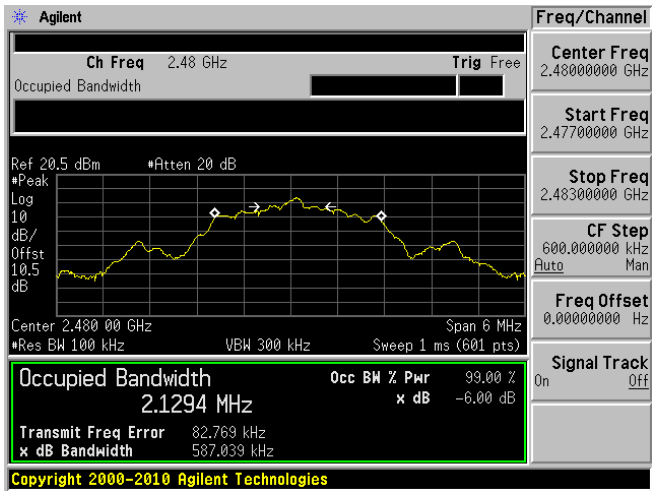
Low Channel 2402 MHz



Middle Channel 2440 MHz



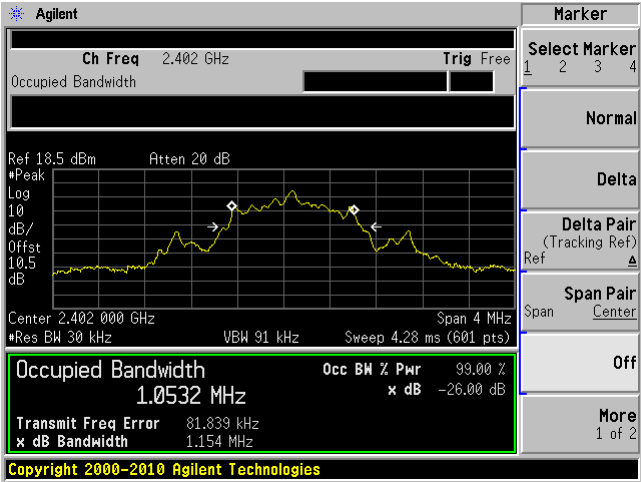
High Channel 2480 MHz



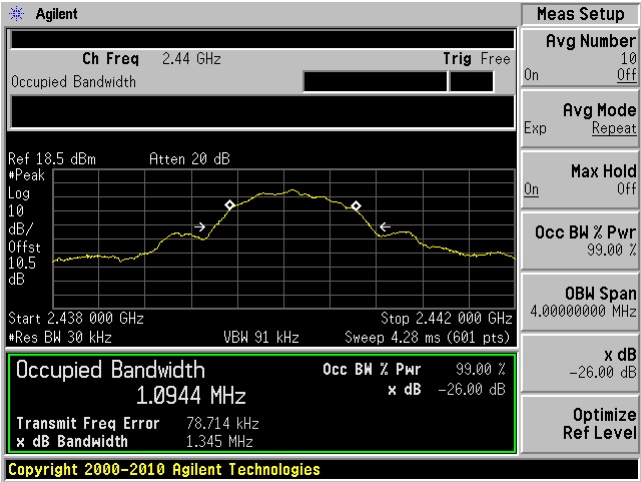
99% Emission Bandwidth

GFSK (1 MHz)

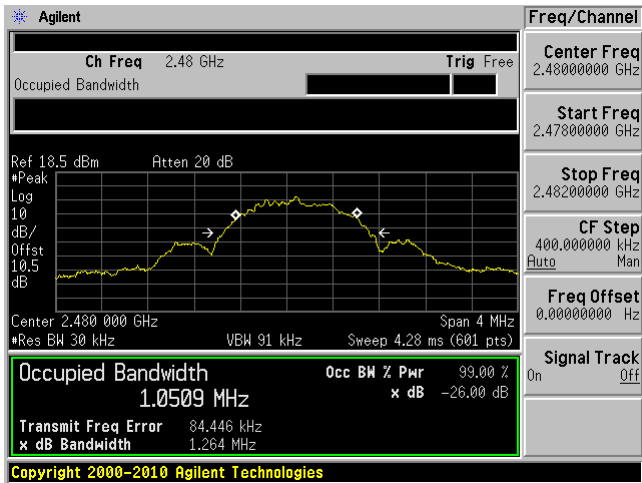
Low Channel 2402 MHz



Middle Channel 2440 MHz

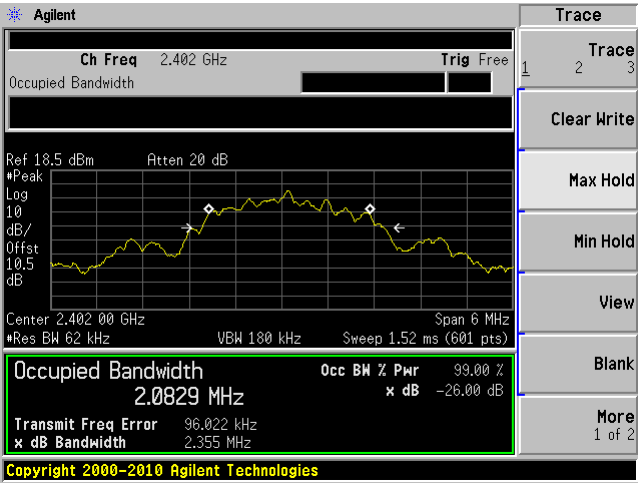


High Channel 2480 MHz

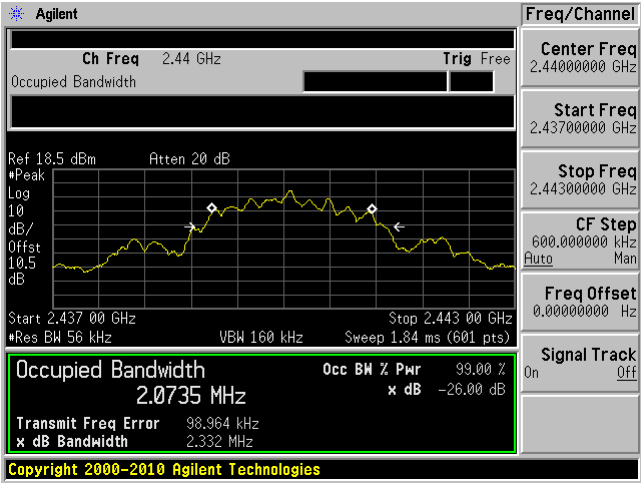


GFSK (2 MHz)

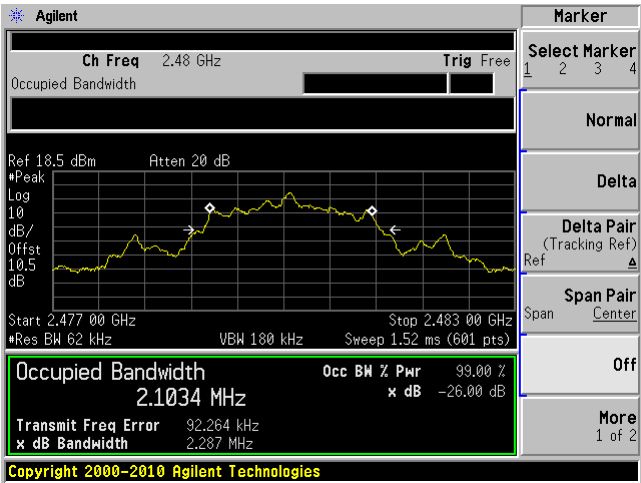
Low Channel 2402 MHz



Middle Channel 2440 MHz



High Channel 2480 MHz



9 FCC §15.247(b)(3) & ISEDC RSS-247 §5.4(4) - Output Power Measurement

9.1 Applicable Standards

According to ECFR §15.247(b)(3) and ISEDC RSS-247 §5.4(4) for systems using digital modulation in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands: 1 Watt.

9.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 9: Fundamental emission output power

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2018-02-26	1 year
-	RF Cable	-	-	Each time ¹	N/A
-	10 dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) “A2LA Policy on Metrological Traceability”.

9.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

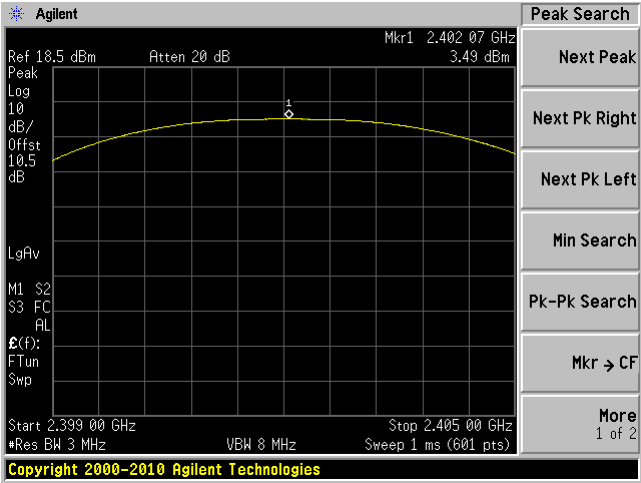
The testing was performed by Harry Zhao on 2018-04-11 in RF site.

9.5 Test Results

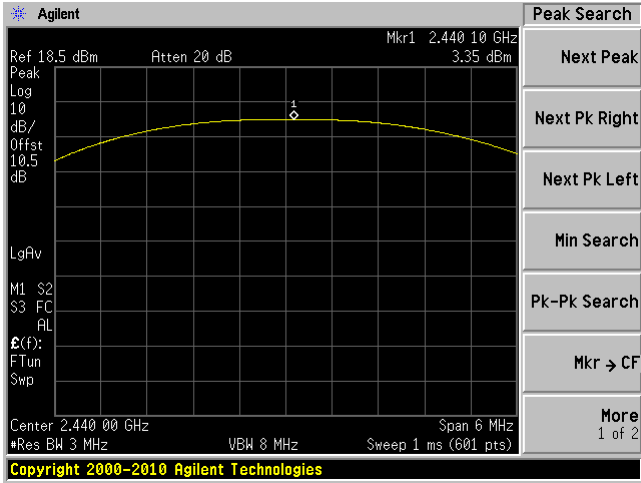
Channel	Frequency (MHz)	Conducted Output Power (dBm)	Limit (dBm)	Result
GFSK (1 MHz)				
Low	2402	3.49	30	Pass
Middle	2440	3.35	30	Pass
High	2480	3.12	30	Pass
GFSK (2 MHz)				
Low	2402	3.54	30	Pass
Middle	2440	3.45	30	Pass
High	2480	3.20	30	Pass

GFSK (1 MHz)

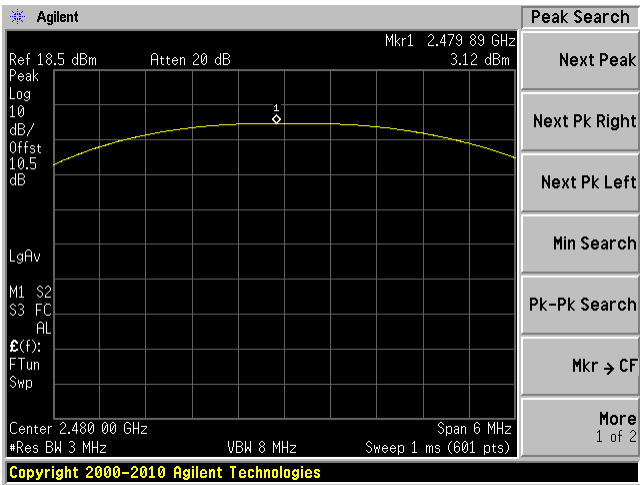
Low Channel 2402 MHz



Middle Channel 2440 MHz

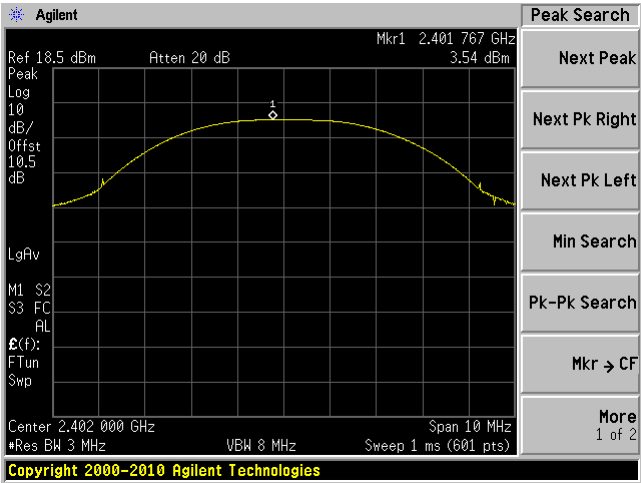


High Channel 2480 MHz

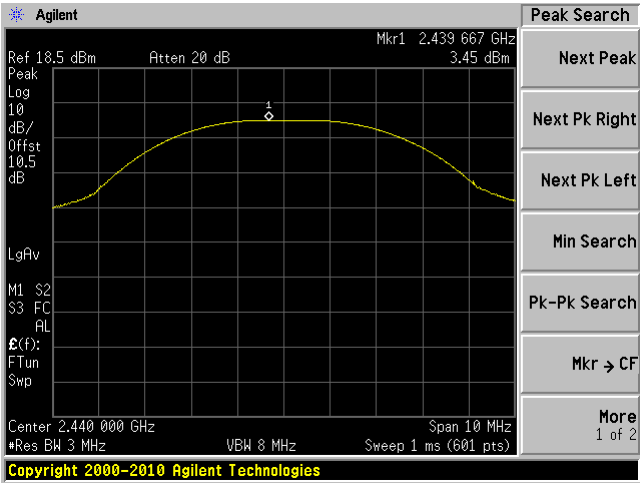


GFSK (2 MHz)

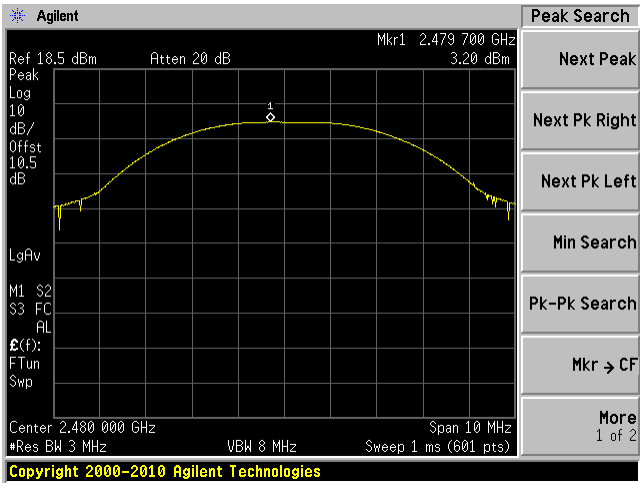
Low Channel 2402 MHz



Middle Channel 2440 MHz



High Channel 2480 MHz



10 FCC §15.247(d) & ISEDC RSS-247 §5.5 - 100 kHz Bandwidth of Band Edges

10.1 Applicable Standards

According to ECFR §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

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 13: Band-edge measurements

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2018-02-26	1 year
-	RF Cable	-	-	Each time ¹	N/A
-	10dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) “A2LA Policy on Metrological Traceability”.

10.4 Test Environmental Conditions

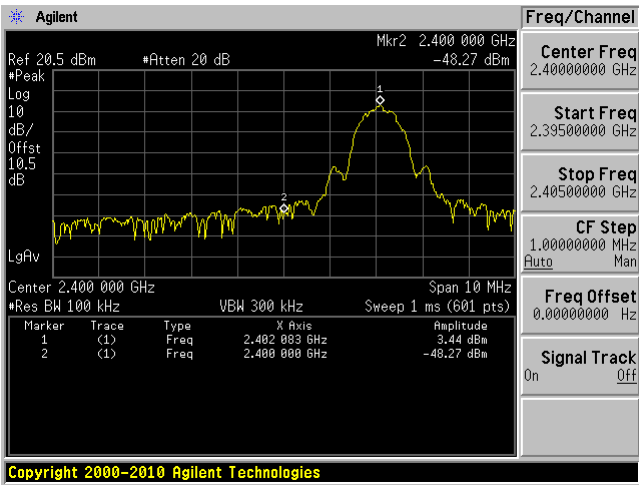
Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Harry Zhao on 2018-04-11 in RF site.

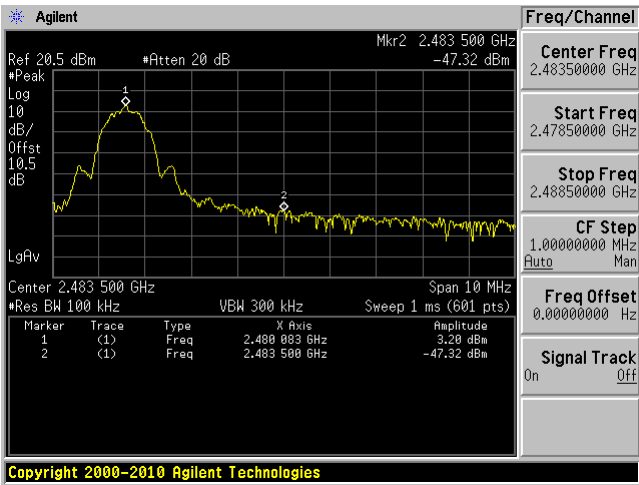
10.5 Test Results

GFSK (1 MHz)

Low Channel 2402 MHz

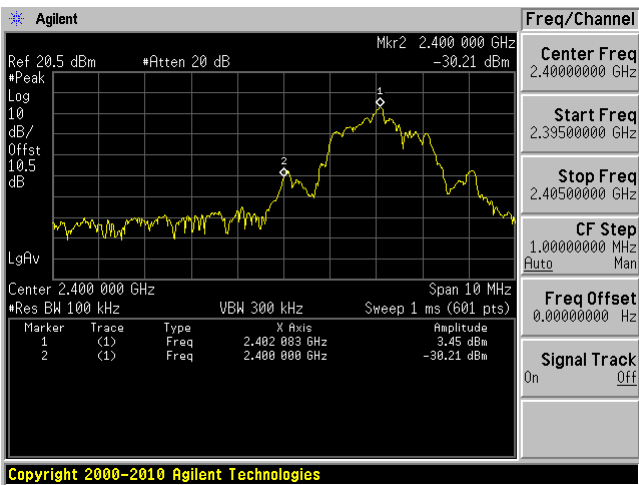


High Channel 2480 MHz

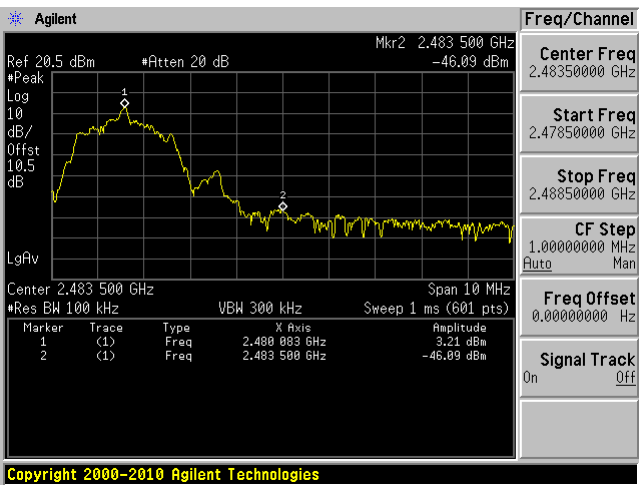


GFSK (2 MHz)

Low Channel 2402 MHz



High Channel 2480 MHz



11 FCC §15.247(e) & ISEDC RSS-247 §5.2(2) - Power Spectral Density

11.1 Applicable Standards

According to ECFR §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.

11.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 10: Maximum power spectral density level in the fundamental emission.

11.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2018-02-26	1 year
-	RF Cable	-	-	Each time ¹	N/A
-	10dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) “A2LA Policy on Metrological Traceability”.

11.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Harry Zhao on 2018-04-11 in RF site.

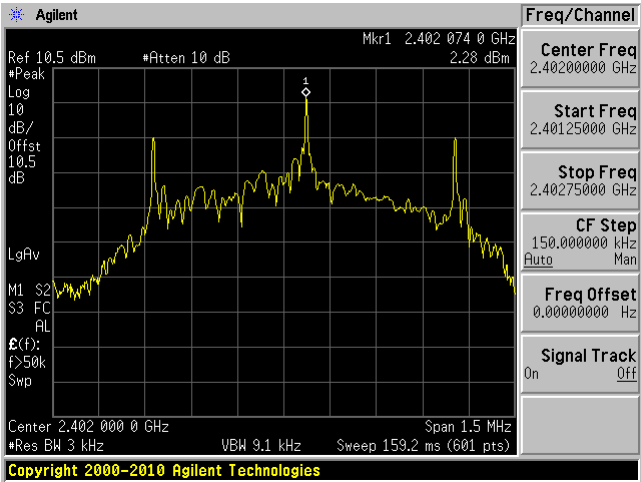
11.5 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
GFSK (1 MHz)			
Low	2402	2.28	8
Middle	2440	2.13	8
High	2480	1.91	8
GFSK (2 MHz)			
Low	2402	-0.85	8
Middle	2440	-0.98	8
High	2480	-1.18	8

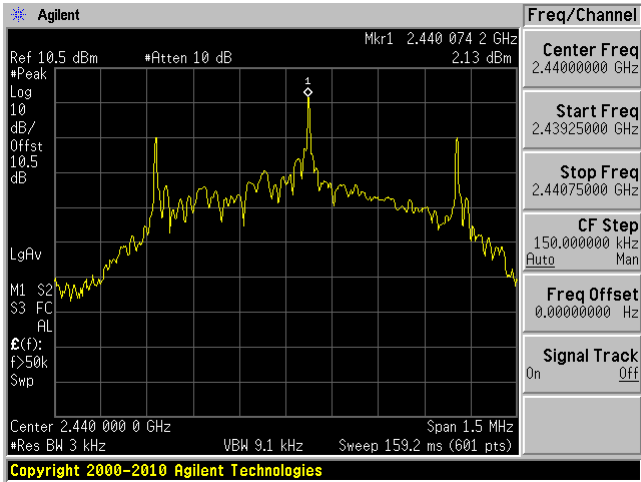
Please refer to the following plots for detailed test results

GFSK (1 MHz)

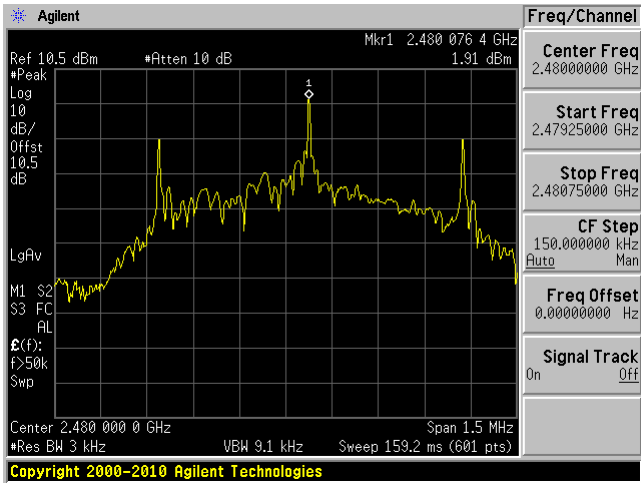
Low Channel 2402 MHz



Middle Channel 2440 MHz

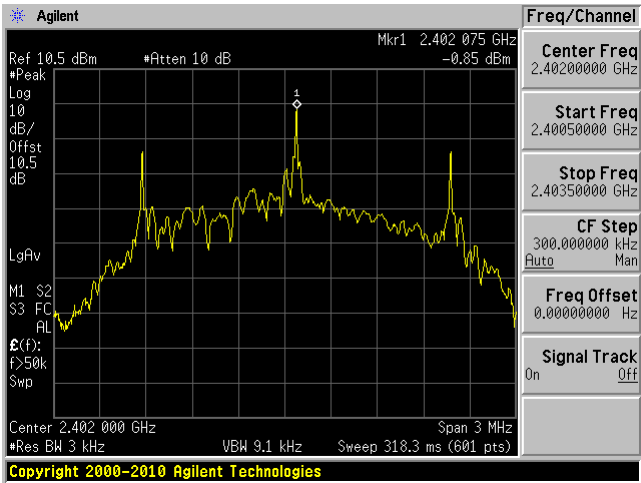


High Channel 2480 MHz

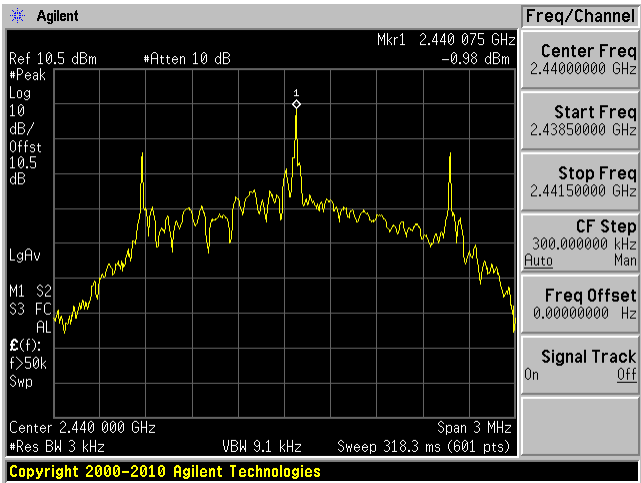


GFSK (2 MHz)

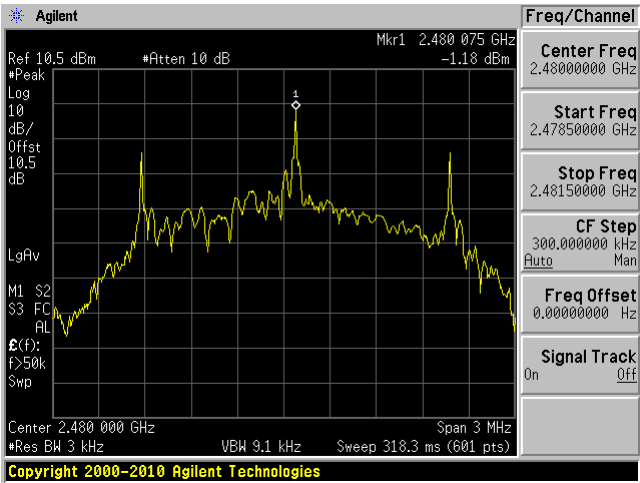
Low Channel 2402 MHz



Middle Channel 2440 MHz



High Channel 2480 MHz



12 FCC §15.247(d) & ISEDC RSS-247 §5.5, RSS-GEN §8.9 - Spurious Emissions at Antenna Terminals

12.1 Applicable Standards

For ECFR §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-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 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 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

12.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2018-02-26	1 year
-	RF cable	-	-	Each time ¹	N/A
-	10dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) "A2LA Policy on Metrological Traceability".

12.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

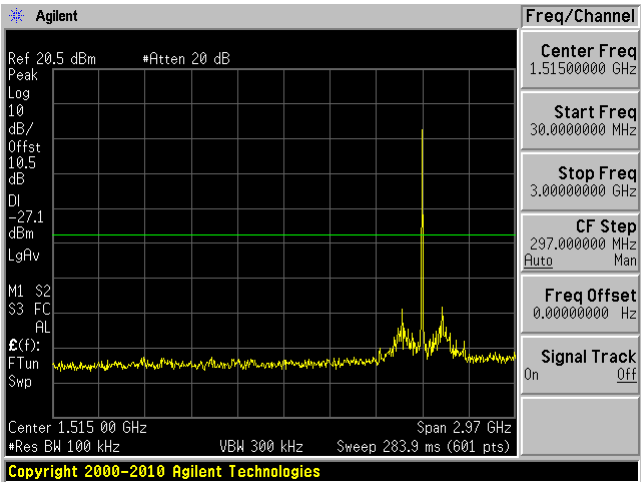
The testing was performed by Harry Zhao on 2018-04-11 in RF site.

12.5 Test Results

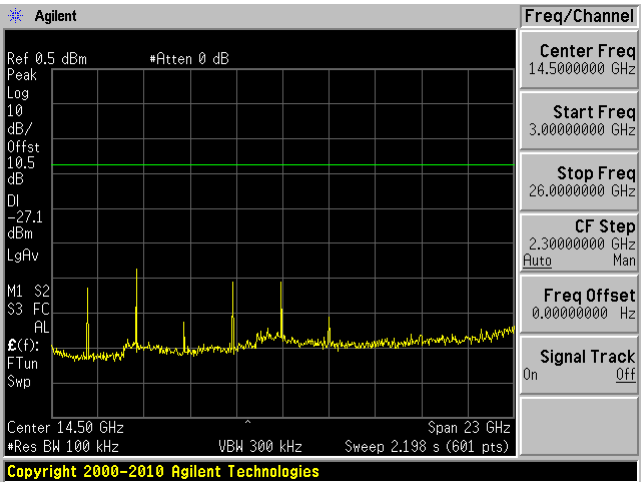
Please refer to following plots.

GFSK (1 MHz)

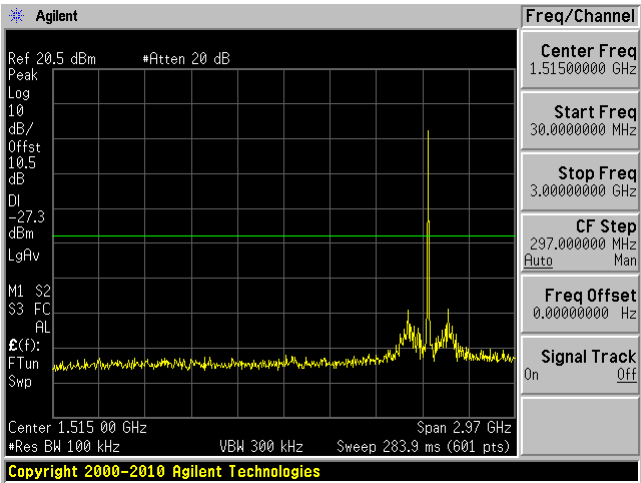
Low Channel 30 MHz – 3 GHz



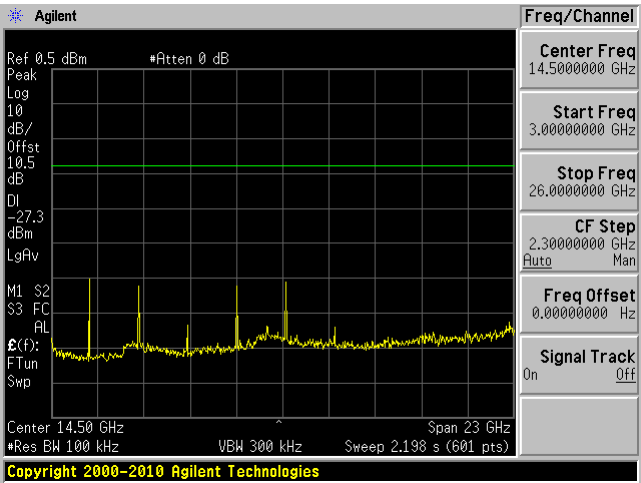
Low Channel 3 GHz – 26 GHz



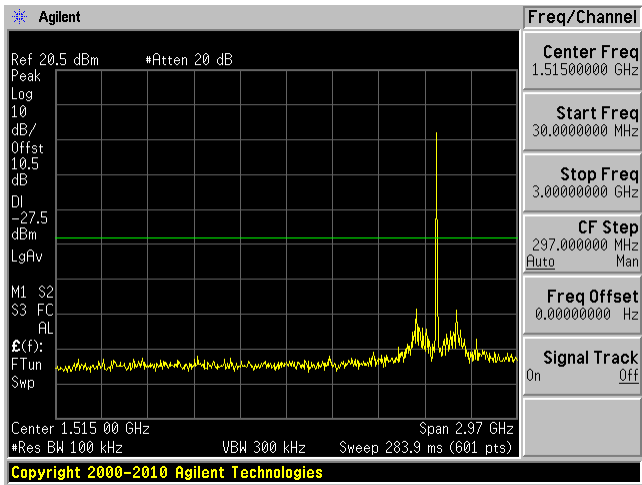
Middle Channel 30 MHz – 3 GHz



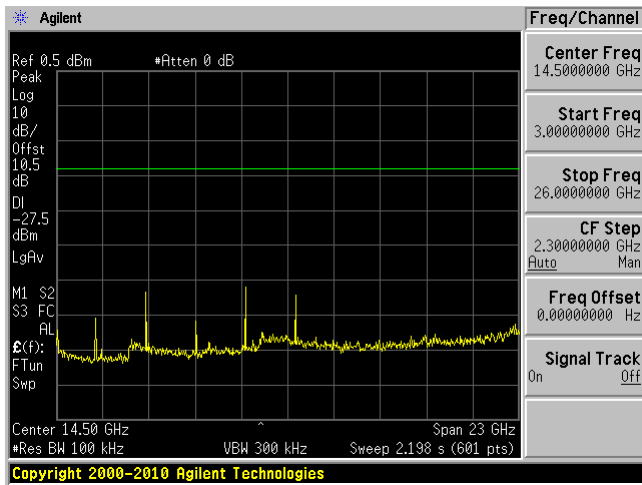
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz

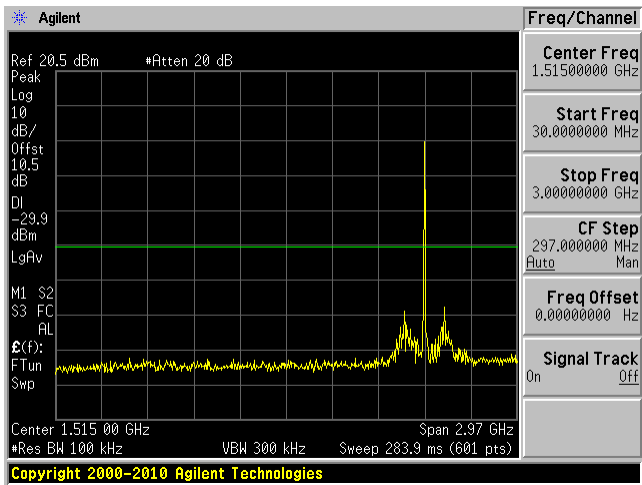


High Channel 3 GHz – 26 GHz

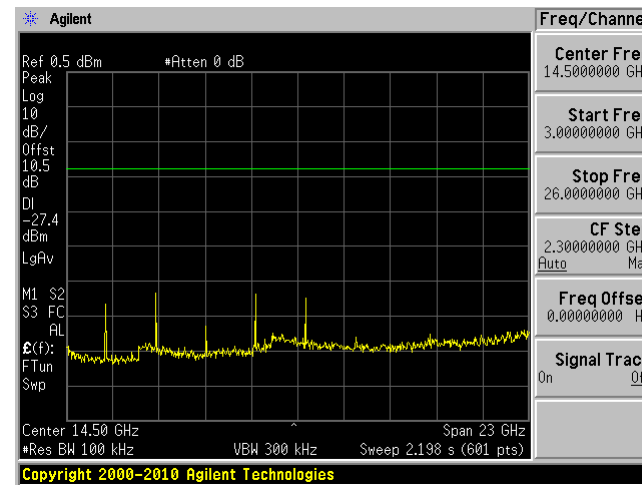


GFSK (2 MHz)

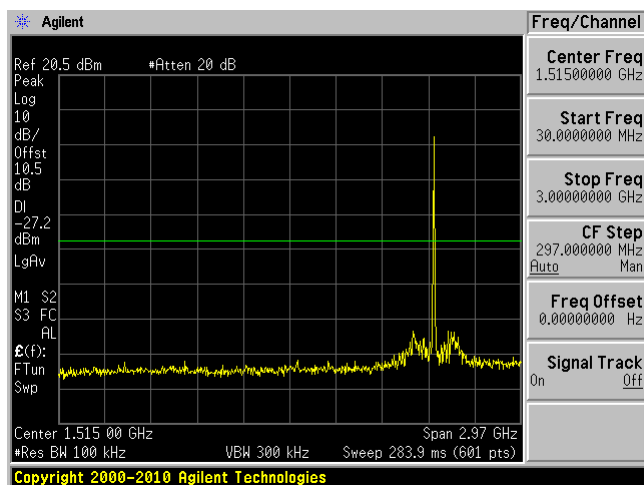
Low Channel 30 MHz – 3 GHz



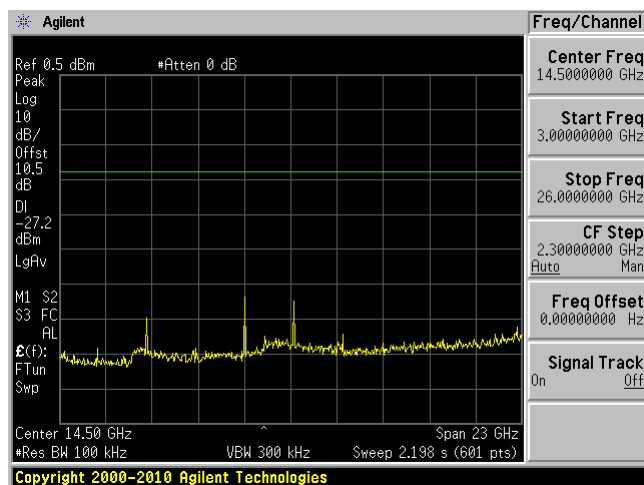
Low Channel 3 GHz – 26 GHz



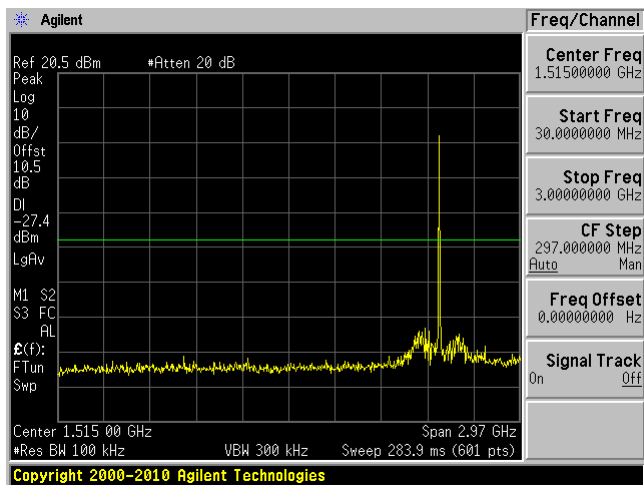
Middle Channel 30 MHz – 3 GHz



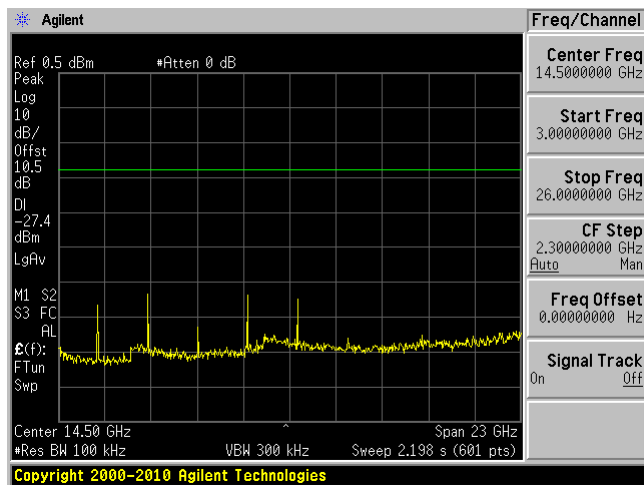
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz



High Channel 3 GHz – 26 GHz



13 Annex A - FCC & ISED Equipment Labeling Requirements

13.1 FCC ID Label Requirements

As per FCC §2.925,

(a) Each equipment covered in an application for equipment authorization shall bear a nameplate or label listing the following:

(1) FCC Identifier consisting of the two elements in the exact order specified in §2.926. The FCC Identifier shall be preceded by the term FCC ID in capital letters on a single line, and shall be of a type size large enough to be legible without the aid of magnification.

Example: FCC ID: XXX123

Where: XXX—Grantee Code, 123—Equipment Product Code

As per FCC §15.19,

(a) In addition to the requirements in part 2 of this chapter, a device subject to certification, or verification shall be labeled as follows:

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified above is required to be affixed only to the main control unit. If the EUT is integrated within another device then a label affixed to the host shall also state, "Contains FCC ID: XXXXXX"

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

5.2 IC Label Requirements

As per IC RSP-100 Section 3.1, the certification number shall appear as follows:

IC: XXXXXX-YYYYYYYY

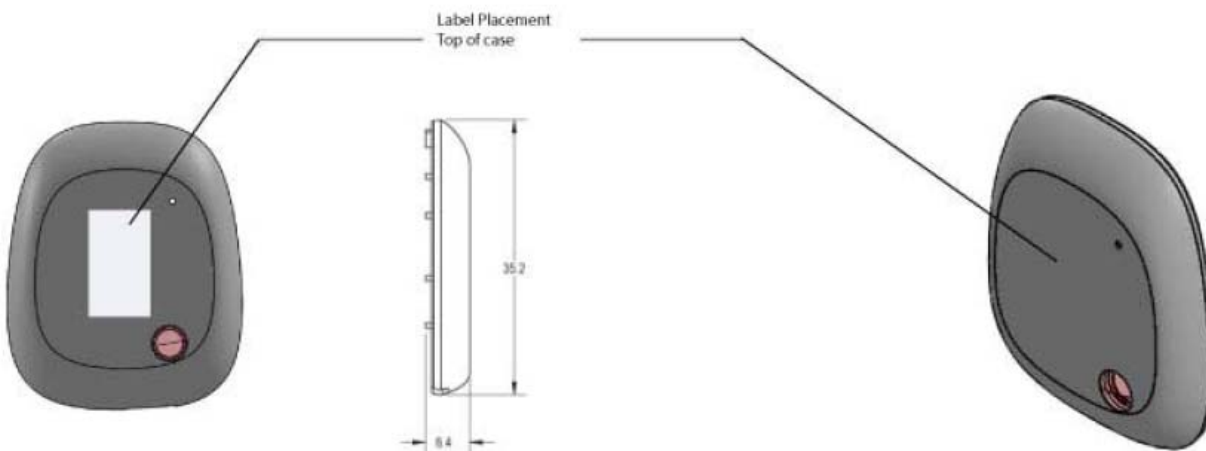
Where:

- The letters "IC:" indicate that this is an Innovation, Science and Economic Development Canada's certification number, but they are not part of the certification number. XXXXXXYYYYYYYYYYY is the ISED certification number.
- XXXXXX is the CN assigned by Innovation, Science and Economic Development Canada. Newly assigned CNs will be made up of five numeric characters (e.g. "20001") whereas existing CNs may consist of up to five numeric characters followed by an alphabetic character (e.g. "21A" or "15589J").
- YYYYYYYYYYYY is the Unique Product Number (UPN) assigned by the applicant, made up of a maximum of 11 alphanumeric characters.
- The CN and UPN are limited to capital alphabetic characters (A-Z) and numerals (0-9) only. The use of punctuation marks or other symbols, including "wildcard" characters, is not permitted.
- The HVIN may contain punctuation marks or symbols but they shall not represent any indeterminate ("wildcard") characters.

As per RSS-Gen §2.1 Equipment Labeling:

The application for equipment certification shall be submitted in accordance with Industry Canada's Radio Standards Procedure RSP-100, Radio Equipment Certification Procedure which sets out the requirements for certification and labelling of radio apparatus. RSP-100 shall be used in conjunction with RSS-Gen and other Radio Standards Specifications (RSSs) specifically applicable to the type of radio apparatus for which certification is sought.

13.3 Label Contents and Location



14 Annex B -Photographs

Please see attachments:

- Exhibit A – EUT Test Setup Photographs
- Exhibit B – EUT External Photographs
- Exhibit C – EUT Internal Photographs

15 Annex D (Informative) - 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 the requirements of any additional program requirements in the Electrical field. 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 8 January 2009).



Presented this 30th day of August 2016.

President and CEO
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2018
Revised November 14, 2016

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



--- END OF REPORT ---